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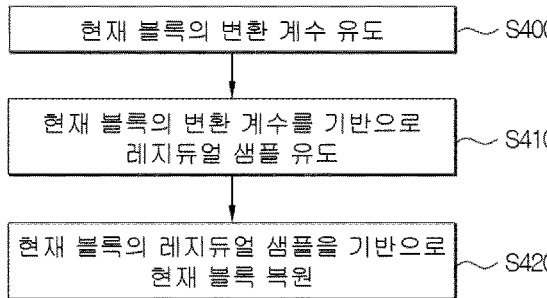
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(54) Title: IMAGE ENCODING/DECODING METHOD AND DEVICE, AND RECORDING MEDIUM ON WHICH BITSTREAM IS STORED

(54) 발명의 명칭: 영상 인코딩/디코딩 방법 및 장치, 그리고 비트스트림을 저장한 기록 매체



S400 ... Derive transform coefficients of current block

S410 ... Derive residual samples on basis of transform coefficients of current block

S420 ... Restore current block on basis of residual samples of current block

(57) Abstract: An image decoding method and device, according to the present disclosure, derive transform coefficients of the current block from a bitstream, determine a non-separable primary transform (NSPT) set for the current block, determine an NSPT kernel of the current block on the basis of the NSPT set and a transform index, perform NSPT on the transform coefficients of the current block on the basis of the NSPT kernel so as to derive residual samples, and can restore the current block on the basis of the residual samples. The NSPT can be applied on the basis that the size of the current block belongs to a group of one or more block sizes to which the NSPT can be applied.

(57) 요약서: 본 개시에 따른 영상 디코딩 방법 및 장치는, 비트스트림으로부터 현재 블록의 변환 계수들을 유도하고, 현재 블록에 대한 비분리 일차 변환(non-separable primary transform, NSPT) 세트를 결정하고, NSPT 세트 및 변환 인덱스를 기반으로 현재 블록의 NSPT 커널을 결정하고, NSPT 커널을 기반으로 현재 블록의 변환 계수들에 NSPT를 수행하여 레지듀얼 샘플들을 유도하고, 레지듀얼 샘플들을 기반으로 현재 블록을 복원할 수 있다. NSPT는 현재 블록의 크기가 NSPT가 적용될 수 있는 하나 또는 그 이상의 블록 크기들의 그룹에 속하는 것에 기초하여 적용될 수 있다.

[다음 쪽 계속]



UG, ZM, ZW), 유라시아 (AM, AZ, BY, KG, KZ, RU, TJ, TM), 유럽 (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, ME, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

공개:

— 국제조사보고서와 함께 (조약 제21조(3))

명세서

발명의 명칭: 영상 인코딩/디코딩 방법 및 장치, 그리고 비트스트림을 저장한 기록 매체

기술분야

- [1] 본 발명은 영상 인코딩/디코딩 방법 및 장치, 그리고 비트스트림을 저장한 기록 매체에 관한 것이다.

배경기술

- [2] 최근 HD(High Definition) 영상 및 UHD(Ultra High Definition) 영상과 같은 고해상도, 고품질의 영상에 대한 수요가 다양한 응용 분야에서 증가하고 있고, 이에 따라 고효율의 영상 압축 기술들이 논의되고 있다.
- [3] 영상 압축 기술로 현재 픽처의 이전 또는 이후 픽처로부터 현재 픽처에 포함된 화소값을 예측하는 인터 예측 기술, 현재 픽처 내의 화소 정보를 이용하여 현재 픽처에 포함된 화소값을 예측하는 인트라 예측 기술, 출현 빈도가 높은 값에 짧은 부호를 할당하고 출현 빈도가 낮은 값에 긴 부호를 할당하는 엔트로피 부호화 기술 등 다양한 기술이 존재하고 이러한 영상 압축 기술을 이용해 영상 데이터를 효과적으로 압축하여 전송 또는 저장할 수 있다.

발명의 상세한 설명

기술적 과제

- [4] 본 개시는, 비분리 일차 변환을 이용하여 변환을 수행하는 방법 및 장치를 제공하고자 한다.
- [5] 본 개시는, 축소된 차원의 비분리 일차 변환 커널을 이용하여 변환을 수행하는 방법 및 장치를 제공하고자 한다.
- [6] 본 개시는, 부호화 파라미터를 기반으로 비분리 변환 커널을 결정/시그널링하는 방법 및 장치 제공하고자 한다.

과제 해결 수단

- [7] 본 개시에 따른 영상 디코딩 방법 및 장치는, 비트스트림으로부터 현재 블록의 변환 계수들을 유도하고, 상기 현재 블록에 대한 비분리 일차 변환(non-separable primary transform, NSPT) 세트를 결정하고, 상기 NSPT 세트 및 변환 인덱스를 기반으로 상기 현재 블록의 NSPT 커널을 결정하고, 상기 NSPT 커널을 기반으로 상기 현재 블록의 변환 계수들에 NSPT를 수행하여 상기 현재 블록의 레지듀얼 샘플들을 유도하고, 상기 레지듀얼 샘플들을 기반으로 상기 현재 블록을 복원할 수 있다. 상기 변환 인덱스는 상기 NSPT 세트에 속한 복수의 NSPT 커널 후보들 중 어느 하나를 특정할 수 있다.
- [8] 본 개시에 따른 영상 디코딩 방법 및 장치에 있어서, 상기 NSPT는, 상기 현재 블록의 크기가 상기 NSPT가 적용될 수 있는 하나 또는 그 이상의 블록 크기들의 그룹에 속하는 것에 기초하여 적용될 수 있다.

- [9] 본 개시에 따른 영상 디코딩 방법 및 장치에 있어서, 상기 NSPT 세트는 기-정의된 35개의 NSPT 세트들 중 어느 하나로 결정될 수 있다.
- [10] 본 개시에 따른 영상 디코딩 방법 및 장치에 있어서, 상기 NSPT 세트는 3개의 NSPT 커널 후보들을 포함할 수 있다.
- [11] 본 개시에 따른 영상 디코딩 방법 및 장치에 있어서, 상기 그룹은, 4x4, 4x8, 8x4, 8x8, 16x8, 8x16, 16x4, 4x16, 8x32, 또는 32x8 중 적어도 하나의 블록 크기를 포함할 수 있다.
- [12] 본 개시에 따른 영상 디코딩 방법 및 장치에 있어서, 상기 현재 블록의 크기가 8x32 또는 32x8인 것에 기초하여, 상기 NSPT가 적용되는 변환 계수들의 개수는 48보다 작거나 같을 수 있다.
- [13] 본 개시에 따른 영상 인코딩 방법 및 장치는, 현재 블록의 레지듀얼 샘플들을 유도하고, 상기 현재 블록에 대한 비분리 일차 변환(non-separable primary transform, NSPT) 세트를 결정하고, 상기 NSPT 세트에 속한 복수의 NSPT 커널 후보들 중 어느 하나를 기반으로 상기 현재 블록의 레지듀얼 샘플들에 대해 NSPT를 적용하여, 상기 현재 블록의 변환 계수들을 유도하고, 상기 현재 블록의 변환 계수들 및 상기 복수의 NSPT 커널 후보들 중 어느 하나를 특정하는 변환 인덱스를 부호화하여 비트스트림을 생성할 수 있다.
- [14] 본 개시에 따른 영상 인코딩 방법 및 장치에 있어서, 상기 NSPT는, 상기 현재 블록의 크기가 상기 NSPT가 적용될 수 있는 하나 또는 그 이상의 블록 크기들의 그룹에 속하는 것에 기초하여 적용될 수 있다.
- [15] 본 개시에 따른 디코딩 장치에 의하여 영상 디코딩 방법을 수행하도록 야기하는 인코딩된 비디오/영상 정보가 저장된 컴퓨터 판독 가능한 디지털 저장 매체가 제공된다.
- [16] 본 개시에 따른 영상 인코딩 방법에 따라 생성된 비디오/영상 정보가 저장된 컴퓨터 판독 가능한 디지털 저장 매체가 제공된다.
- [17] 본 개시에 따른 영상 인코딩 방법에 따라 생성된 비디오/영상 정보를 전송하는 방법 및 장치가 제공된다.

발명의 효과

- [18] 본 개시는, 일차 변환으로서 비분리 일차 변환을 이용함으로써, 변환의 성능을 향상시킬 수 있다.
- [19] 본 개시는, 축소된 차원의 비분리 일차 변환 커널을 이용하여 변환을 수행함으로써, 변환의 성능을 향상시킬 수 있다.
- [20] 본 개시는, 부호화 파라미터를 기반으로 비분리 변환 커널을 효과적으로 결정 및/또는 시그널링함으로써, 부호화 효율을 향상시킬 수 있다.

도면의 간단한 설명

- [21] 도 1은 본 개시에 따른 비디오/영상 코딩 시스템을 도시한 것이다.

- [22] 도 2는 본 개시의 실시예가 적용될 수 있고, 비디오/영상 신호의 인코딩이 수행되는 인코딩 장치의 개략적인 블록도를 나타낸다.
- [23] 도 3은 본 개시의 실시예가 적용될 수 있고, 비디오/영상 신호의 디코딩이 수행되는 디코딩 장치의 개략적인 블록도를 나타낸다.
- [24] 도 4는 본 개시에 따른 일실시예로서, 디코딩 장치(300)에 의해 수행되는 영상 디코딩 방법을 도시한 것이다.
- [25] 도 5는 본 개시에 따른 인트라 예측 모드와 그 예측 방향을 예시적으로 나타낸다.
- [26] 도 6은 본 개시에 따른 영상 디코딩 방법을 수행하는 디코딩 장치(300)의 개략적인 구성을 도시한 것이다.
- [27] 도 7은 본 개시에 따른 일실시예로서, 인코딩 장치(200)에 의해 수행되는 영상 인코딩 방법을 도시한 것이다.
- [28] 도 8은 본 개시에 따른 영상 인코딩 방법을 수행하는 인코딩 장치(200)의 개략적인 구성을 도시한 것이다.
- [29] 도 9는 본 개시의 실시예들이 적용될 수 있는 콘텐츠 스트리밍 시스템의 예를 나타낸다.

발명의 실시를 위한 최선의 형태

- [30] 본 개시는 다양한 변경을 가할 수 있고 여러 가지 실시예를 가질 수 있는 바, 특정 실시예들을 도면에 예시하고 상세하게 설명하고자 한다. 그러나, 이는 본 개시를 특정한 실시 형태에 대해 한정하려는 것이 아니며, 본 개시의 사상 및 기술 범위에 포함되는 모든 변경, 균등물 내지 대체물을 포함하는 것으로 이해되어야 한다. 각 도면을 설명하면서 유사한 참조부호를 유사한 구성요소에 대해 사용하였다.
- [31] 제1, 제2 등의 용어는 다양한 구성요소들을 설명하는데 사용될 수 있지만, 상기 구성요소들은 상기 용어들에 의해 한정되어서는 안 된다. 상기 용어들은 하나의 구성요소를 다른 구성요소로부터 구별하는 목적으로만 사용된다. 예를 들어, 본 개시의 권리 범위를 벗어나지 않으면서 제1 구성요소는 제2 구성요소로 명명될 수 있고, 유사하게 제2 구성요소도 제1 구성요소로 명명될 수 있다. 및/또는 이라는 용어는 복수의 관련된 기재된 항목들의 조합 또는 복수의 관련된 기재된 항목들 중의 어느 항목을 포함한다.
- [32] 어떤 구성요소가 다른 구성요소에 "연결되어" 있다거나 "접속되어" 있다고 언급된 때에는, 그 다른 구성요소에 직접적으로 연결되어 있거나 또는 접속되어 있을 수도 있지만, 중간에 다른 구성요소가 존재할 수도 있다고 이해되어야 할 것이다. 반면에, 어떤 구성요소가 다른 구성요소에 "직접 연결되어" 있다거나 "직접 접속되어" 있다고 언급된 때에는, 중간에 다른 구성요소가 존재하지 않는 것으로 이해되어야 할 것이다.

- [33] 본 출원에서 사용한 용어는 단지 특정한 실시예를 설명하기 위해 사용된 것으로, 본 개시를 한정하려는 의도가 아니다. 단수의 표현은 문맥상 명백하게 다르게 뜻하지 않는 한, 복수의 표현을 포함한다. 본 출원에서, "포함하다" 또는 "가지다" 등의 용어는 명세서상에 기재된 특징, 숫자, 단계, 동작, 구성요소, 부품 또는 이들을 조합한 것이 존재함을 지정하려는 것이지, 하나 또는 그 이상의 다른 특징들이나 숫자, 단계, 동작, 구성요소, 부품 또는 이들을 조합한 것들의 존재 또는 부가 가능성을 미리 배제하지 않는 것으로 이해되어야 한다.
- [34] 본 개시는 비디오/영상 코딩에 관한 것이다. 예를 들어, 본 명세서에서 개시된 방법/실시예는 VVC (versatile video coding) 표준에 개시되는 방법에 적용될 수 있다. 또한, 이 명세서에서 개시된 방법/실시예는 EVC (essential video coding) 표준, AV1 (AOMedia Video 1) 표준, AVS2 (2nd generation of audio video coding standard) 또는 차세대 비디오/영상 코딩 표준(ex. H.267 or H.268 등)에 개시되는 방법에 적용될 수 있다.
- [35] 이 명세서는 비디오/영상 코딩에 관한 다양한 실시예들을 제시하며, 다른 언급이 없는 한 상기 실시예들은 서로 조합되어 수행될 수도 있다.
- [36] 이 명세서에서 비디오(video)는 시간의 흐름에 따른 일련의 영상(image)들의 집합을 의미할 수 있다. 픽처(picture)는 일반적으로 특정 시간대의 하나의 영상을 나타내는 단위를 의미하며, 슬라이스(slice)/타일(tile)은 코딩에 있어서 픽처의 일부를 구성하는 단위이다. 슬라이스/타일은 하나 이상의 CTU(coding tree unit)를 포함할 수 있다. 하나의 픽처는 하나 이상의 슬라이스/타일로 구성될 수 있다. 하나의 타일은 하나의 픽처의 특정 타일 열과 특정 타일 행 내에 있는 복수의 CTU들로 구성된 직사각형 영역이다. 타일 열은 픽처의 높이와 동일한 높이와 픽처 파라미터 세트의 선택스 요구에 의해 지정된 너비를 갖는 CTU들의 직사각형 영역이다. 타일 행은 픽처 파라미터 세트에 의해 지정된 높이와 픽처의 너비와 동일한 너비를 갖는 CTU들의 직사각형 영역이다. 하나의 타일 내에 CTU들은 CTU 래스터 스캔에 따라 연속적으로 배열되는 반면, 하나의 픽처 내 타일들은 타일의 래스터 스캔에 따라 연속적으로 배열될 수 있다. 하나의 슬라이스는 단일 NAL 유닛에 배타적으로 포함될 수 있는 픽처의 타일 내에서 정수 개수의 완전한 타일 또는 정수 개수의 연속적인 완전한 CTU 행을 포함할 수 있다. 한편, 하나의 픽처는 둘 이상의 서브픽처로 구분될 수 있다. 서브픽처는 픽처 내 하나 이상의 슬라이스들의 직사각형 영역일 수 있다.
- [37] 화소, 픽셀(pixel) 또는 펠(pel)은 하나의 픽처(또는 영상)을 구성하는 최소의 단위를 의미할 수 있다. 또한, 픽셀에 대응하는 용어로서 '샘플(sample)'이 사용될 수 있다. 샘플은 일반적으로 픽셀 또는 픽셀의 값을 나타낼 수 있으며, 휘도(luma) 성분의 픽셀/픽셀값만을 나타낼 수도 있고, 색차(chroma) 성분의 픽셀/픽셀 값만을 나타낼 수도 있다.
- [38] 유닛(unit)은 영상 처리의 기본 단위를 나타낼 수 있다. 유닛은 픽처의 특정 영역 및 해당 영역에 관련된 정보 중 적어도 하나를 포함할 수 있다. 하나의 유닛은 하

나의 루마 블록 및 두개의 크로마(ex. cb, cr) 블록을 포함할 수 있다. 유닛은 경우에 따라서 블록(block) 또는 영역(area) 등의 용어와 혼용하여 사용될 수 있다. 일반적인 경우, MxN 블록은 M개의 열과 N개의 행으로 이루어진 샘플들(또는 샘플 어레이) 또는 변환 계수(transform coefficient)들의 집합(또는 어레이)을 포함할 수 있다.

- [39] 본 명세서에서 "A 또는 B(A or B)"는 "오직 A", "오직 B" 또는 "A와 B 모두"를 의미할 수 있다. 달리 표현하면, 본 명세서에서 "A 또는 B(A or B)"는 "A 및/또는 B(A and/or B)"으로 해석될 수 있다. 예를 들어, 본 명세서에서 "A, B 또는 C(A, B or C)"는 "오직 A", "오직 B", "오직 C", 또는 "A, B 및 C의 임의의 모든 조합(any combination of A, B and C)"를 의미할 수 있다.
- [40] 본 명세서에서 사용되는 슬래쉬(/)나 쉼표(comma)는 "및/또는(and/or)"을 의미할 수 있다. 예를 들어, "A/B"는 "A 및/또는 B"를 의미할 수 있다. 이에 따라 "A/B"는 "오직 A", "오직 B", 또는 "A와 B 모두"를 의미할 수 있다. 예를 들어, "A, B, C"는 "A, B 또는 C"를 의미할 수 있다.
- [41] 본 명세서에서 "적어도 하나의 A 및 B(at least one of A and B)"는, "오직 A", "오직 B" 또는 "A와 B 모두"를 의미할 수 있다. 또한, 본 명세서에서 "적어도 하나의 A 또는 B(at least one of A or B)"나 "적어도 하나의 A 및/또는 B(at least one of A and/or B)"라는 표현은 "적어도 하나의 A 및 B(at least one of A and B)"와 동일하게 해석될 수 있다.
- [42] 또한, 본 명세서에서 "적어도 하나의 A, B 및 C(at least one of A, B and C)"는, "오직 A", "오직 B", "오직 C", 또는 "A, B 및 C의 임의의 모든 조합(any combination of A, B and C)"를 의미할 수 있다. 또한, "적어도 하나의 A, B 또는 C(at least one of A, B or C)"나 "적어도 하나의 A, B 및/또는 C(at least one of A, B and/or C)"는 "적어도 하나의 A, B 및 C(at least one of A, B and C)"를 의미할 수 있다.
- [43] 또한, 본 명세서에서 사용되는 괄호는 "예를 들어(for example)"를 의미할 수 있다. 구체적으로, "예측(인트라 예측)"로 표시된 경우, "예측"의 일례로 "인트라 예측"이 제안된 것일 수 있다. 달리 표현하면 본 명세서의 "예측"은 "인트라 예측"으로 제한(limit)되지 않고, "인트라 예측"이 "예측"의 일례로 제안될 것일 수 있다. 또한, "예측(즉, 인트라 예측)"으로 표시된 경우에도, "예측"의 일례로 "인트라 예측"이 제안된 것일 수 있다.
- [44] 본 명세서에서 하나의 도면 내에서 개별적으로 설명되는 기술적 특징은, 개별적으로 구현될 수도 있고, 동시에 구현될 수도 있다.
- [45] 도 1은 본 개시에 따른 비디오/영상 코딩 시스템을 도시한 것이다.
- [46] 도 1을 참조하면, 비디오/영상 코딩 시스템은 제1 장치(소스 디바이스) 및 제2 장치(수신 디바이스)를 포함할 수 있다.
- [47] 소스 디바이스는 인코딩된 비디오(video)/영상(image) 정보 또는 데이터를 파일 또는 스트리밍 형태로 디지털 저장매체 또는 네트워크를 통하여 수신 디바이스

로 전달할 수 있다. 상기 소스 디바이스는 비디오 소스, 인코딩 장치, 전송부를 포함할 수 있다. 상기 수신 디바이스는 수신부, 디코딩 장치 및 렌더러를 포함할 수 있다. 상기 인코딩 장치는 비디오/영상 인코딩 장치라고 불릴 수 있고, 상기 디코딩 장치는 비디오/영상 디코딩 장치라고 불릴 수 있다. 송신기는 인코딩 장치에 포함될 수 있다. 수신기는 디코딩 장치에 포함될 수 있다. 렌더러는 디스플레이부를 포함할 수도 있고, 디스플레이부는 별개의 디바이스 또는 외부 컴포넌트로 구성될 수도 있다.

- [48] 비디오 소스는 비디오/영상의 캡처, 합성 또는 생성 과정 등을 통하여 비디오/영상을 획득할 수 있다. 비디오 소스는 비디오/영상 캡처 디바이스 및/또는 비디오/영상 생성 디바이스를 포함할 수 있다. 비디오/영상 캡처 디바이스는 하나 이상의 카메라, 이전에 캡처된 비디오/영상을 포함하는 비디오/영상 아카이브 등을 포함할 수 있다. 비디오/영상 생성 디바이스는 컴퓨터, 태블릿 및 스마트폰 등을 포함할 수 있으며 (전자적으로) 비디오/영상을 생성할 수 있다. 예를 들어, 컴퓨터 등을 통하여 가상의 비디오/영상이 생성될 수 있으며, 이 경우 관련 데이터가 생성되는 과정으로 비디오/영상 캡처 과정이 같음될 수 있다.
- [49] 인코딩 장치는 입력 비디오/영상을 인코딩할 수 있다. 인코딩 장치는 압축 및 코딩 효율을 위하여 예측, 변환, 양자화 등 일련의 절차를 수행할 수 있다. 인코딩된 데이터(인코딩된 비디오/영상 정보)는 비트스트림(bitstream) 형태로 출력될 수 있다.
- [50] 전송부는 비트스트림 형태로 출력된 인코딩된 비디오/영상 정보 또는 데이터를 파일 또는 스트리밍 형태로 디지털 저장매체 또는 네트워크를 통하여 수신 디바이스의 수신부로 전달할 수 있다. 디지털 저장 매체는 USB, SD, CD, DVD, 블루레이, HDD, SSD 등 다양한 저장 매체를 포함할 수 있다. 전송부는 미리 정해진 파일 포맷을 통하여 미디어 파일을 생성하기 위한 엘리먼트를 포함할 수 있고, 방송/통신 네트워크를 통한 전송을 위한 엘리먼트를 포함할 수 있다. 수신부는 상기 비트스트림을 수신/추출하여 디코딩 장치로 전달할 수 있다.
- [51] 디코딩 장치는 인코딩 장치의 동작에 대응하는 역양자화, 역변환, 예측 등 일련의 절차를 수행하여 비디오/영상을 디코딩할 수 있다.
- [52] 렌더러는 디코딩된 비디오/영상을 렌더링할 수 있다. 렌더링된 비디오/영상은 디스플레이부를 통하여 디스플레이될 수 있다.
- [53] 도 2는 본 개시의 실시예가 적용될 수 있고, 비디오/영상 신호의 인코딩이 수행되는 인코딩 장치의 개략적인 블록도를 나타낸다.
- [54] 도 2를 참조하면, 인코딩 장치(200)는 영상 분할부(image partitioner, 210), 예측부(predictor, 220), 레지듀얼 처리부(residual processor, 230), 엔트로피 인코딩부(entropy encoder, 240), 가산부(adder, 250), 필터링부(filter, 260) 및 메모리(memory, 270)를 포함하여 구성될 수 있다. 예측부(220)는 인터 예측부(221) 및 인트라 예측부(222)를 포함할 수 있다. 레지듀얼 처리부(230)는 변환부(transformer, 232), 양자화부(quantizer 233), 역양자화부(dequantizer 234), 역변환부(inverse

transformer, 235)를 포함할 수 있다. 레지듀얼 처리부(230)은 감산부(subtractor, 231)를 더 포함할 수 있다. 가산부(250)는 복원부(reconstructor) 또는 복원 블록 생성부(reconstructged block generator)로 불릴 수 있다. 상술한 영상 분할부(210), 예측부(220), 레지듀얼 처리부(230), 엔트로피 인코딩부(240), 가산부(250) 및 필터링부(260)는 실시예에 따라 하나 이상의 하드웨어 컴포넌트(예를 들어 인코딩 장치 칩셋 또는 프로세서)에 의하여 구성될 수 있다. 또한 메모리(270)는 DPB(decoded picture buffer)를 포함할 수 있고, 디지털 저장 매체에 의하여 구성될 수도 있다. 상기 하드웨어 컴포넌트는 메모리(270)를 내/외부 컴포넌트로 더 포함할 수도 있다.

- [55] 영상 분할부(210)는 인코딩 장치(200)에 입력된 입력 영상(또는, 픽처, 프레임)을 하나 이상의 처리 유닛(processing unit)으로 분할할 수 있다. 일 예로, 상기 처리 유닛은 코딩 유닛(coding unit, CU)이라고 불릴 수 있다. 이 경우 코딩 유닛은 코딩 트리 유닛(coding tree unit, CTU) 또는 최대 코딩 유닛(largest coding unit, LCU)으로부터 QTBT (Quad-tree binary-tree ternary-tree) 구조에 따라 재귀적으로(recursively) 분할될 수 있다.
- [56] 예를 들어, 하나의 코딩 유닛은 쿼드 트리 구조, 바이너리 트리 구조, 및/또는 터너리 구조를 기반으로 하위(deeper) 템스를 가진 복수의 코딩 유닛들로 분할될 수 있다. 이 경우, 예를 들어 쿼드 트리 구조가 먼저 적용되고 바이너리 트리 구조 및/또는 터너리 구조가 나중에 적용될 수 있다. 또는, 바이너리 트리 구조가 쿼드 트리 구조보다 먼저 적용될 수도 있다. 더 이상 분할되지 않는 최종 코딩 유닛을 기반으로 본 명세서에 따른 코딩 절차가 수행될 수 있다. 이 경우 영상 특성에 따른 코딩 효율 등을 기반으로, 최대 코딩 유닛이 바로 최종 코딩 유닛으로 사용될 수 있고, 또는 필요에 따라 코딩 유닛은 재귀적으로(recursively) 하위 템스의 코딩 유닛들로 분할되어, 최적의 크기를 가진 코딩 유닛이 최종 코딩 유닛으로 사용될 수 있다. 여기서, 코딩 절차라 함은 후술하는 예측, 변환, 및 복원 등의 절차를 포함할 수 있다.
- [57] 다른 예로, 상기 처리 유닛은 예측 유닛(PU: Prediction Unit) 또는 변환 유닛(TU: Transform Unit)을 더 포함할 수 있다. 이 경우, 상기 예측 유닛 및 상기 변환 유닛은 각각 상술한 최종 코딩 유닛으로부터 분할 또는 파티셔닝될 수 있다. 상기 예측 유닛은 샘플 예측의 단위일 수 있고, 상기 변환 유닛은 변환 계수를 유도하는 단위 및/또는 변환 계수로부터 레지듀얼 신호(residual signal)를 유도하는 단위일 수 있다.
- [58] 유닛은 경우에 따라서 블록(block) 또는 영역(area) 등의 용어와 혼용하여 사용될 수 있다. 일반적인 경우, $M \times N$ 블록은 M개의 열과 N개의 행으로 이루어진 샘플들 또는 변환 계수(transform coefficient)들의 집합을 나타낼 수 있다. 샘플은 일반적으로 픽셀 또는 픽셀의 값을 나타낼 수 있으며, 휘도(luma) 성분의 픽셀/픽셀 값만을 나타낼 수도 있고, 색차(chroma) 성분의 픽셀/픽셀 값만을 나타낼 수도 있

다. 샘플은 하나의 픽처(또는 영상)을 픽셀(pixel) 또는 펠(pel)에 대응하는 용어로서 사용될 수 있다.

- [59] 인코딩 장치(200)는 입력 영상 신호(원본 블록, 원본 샘플 어레이)에서 인터 예측부(221) 또는 인트라 예측부(222)로부터 출력된 예측 신호(예측 블록, 예측 샘플 어레이)를 감산하여 레지듀얼 신호(residual signal, 잔여 블록, 잔여 샘플 어레이)를 생성할 수 있고, 생성된 레지듀얼 신호는 변환부(232)로 전송된다. 이 경우, 인코딩 장치(200) 내에서 입력 영상 신호(원본 블록, 원본 샘플 어레이)에서 예측 신호(예측 블록, 예측 샘플 어레이)를 감산하는 유닛은 감산부(231)라고 불릴 수 있다.
- [60] 예측부(220)는 처리 대상 블록(이하, 현재 블록이라 함)에 대한 예측을 수행하고, 상기 현재 블록에 대한 예측 샘플들을 포함하는 예측 블록(predicted block)을 생성할 수 있다. 예측부(220)는 현재 블록 또는 CU 단위로 인트라 예측이 적용되는지 또는 인터 예측이 적용되는지 결정할 수 있다. 예측부(220)는 각 예측 모드에 대한 설명에서 후술하는 바와 같이 예측 모드 정보 등 예측에 관한 다양한 정보를 생성하여 엔트로피 인코딩부(240)로 전달할 수 있다. 예측에 관한 정보는 엔트로피 인코딩부(240)에서 인코딩되어 비트스트림 형태로 출력될 수 있다.
- [61] 인트라 예측부(222)는 현재 픽처 내의 샘플들을 참조하여 현재 블록을 예측할 수 있다. 상기 참조되는 샘플들은 예측 모드에 따라 상기 현재 블록의 주변(neighbor)에 위치할 수 있고, 또는 현재 블록으로부터 일정 거리만큼 떨어져서 위치할 수도 있다. 인트라 예측에서 예측 모드들은 하나 이상의 비방향성 모드와 복수의 방향성 모드를 포함할 수 있다. 비방향성 모드는, DC 모드 또는 플레너 모드(Planar 모드) 중 적어도 하나를 포함할 수 있다. 방향성 모드는 예측 방향의 세밀한 정도에 따라 33개의 방향성 모드 또는 65개의 방향성 모드를 포함할 수 있다. 다만, 이는 예시로서 설정에 따라 그 이상 또는 그 이하의 개수의 방향성 모드들이 사용될 수 있다. 인트라 예측부(222)는 주변 블록에 적용된 예측 모드를 이용하여, 현재 블록에 적용되는 예측 모드를 결정할 수도 있다.
- [62] 인터 예측부(221)는 참조 픽처 상에서 움직임 벡터에 의해 특정되는 참조 블록(참조 샘플 어레이)을 기반으로, 현재 블록에 대한 예측 블록을 유도할 수 있다. 이때, 인터 예측 모드에서 전송되는 움직임 정보의 양을 줄이기 위해, 주변 블록과 현재 블록 간의 움직임 정보의 상관성에 기초하여 움직임 정보를 블록, 서브 블록 또는 샘플 단위로 예측할 수 있다. 상기 움직임 정보는 움직임 벡터 및 참조 픽처 인덱스를 포함할 수 있다. 상기 움직임 정보는 인터 예측 방향 정보(L0 예측, L1 예측, Bi 예측 등)를 더 포함할 수 있다. 인터 예측의 경우에, 주변 블록은 현재 픽처 내에 존재하는 공간적 주변 블록(spatial neighboring block)과 참조 픽처에 존재하는 시간적 주변 블록(temporal neighboring block)을 포함할 수 있다. 상기 참조 블록을 포함하는 참조 픽처와 상기 시간적 주변 블록을 포함하는 참조 픽처는 동일할 수도 있고, 다를 수도 있다. 상기 시간적 주변 블록은 동일 위치 참조 블록(collocated reference block), 동일 위치 CU(colCU) 등의 이름으로 불릴 수 있

으며, 상기 시간적 주변 블록을 포함하는 참조 픽처는 동일 위치 픽처(collocated picture, colPic)라고 불릴 수도 있다. 예를 들어, 인터 예측부(221)는 주변 블록들을 기반으로 움직임 정보 후보 리스트를 구성하고, 상기 현재 블록의 움직임 벡터 및/또는 참조 픽처 인덱스를 도출하기 위하여 어떤 후보가 사용되는지를 지시하는 정보를 생성할 수 있다. 다양한 예측 모드를 기반으로 인터 예측이 수행될 수 있으며, 예를 들어, 스킵 모드와 머지 모드의 경우에, 인터 예측부(221)는 주변 블록의 움직임 정보를 현재 블록의 움직임 정보로 이용할 수 있다. 스킵 모드의 경우, 머지 모드와 달리 레지듀얼 신호가 전송되지 않을 수 있다. 움직임 정보 예측(motion vector prediction, MVP) 모드의 경우, 주변 블록의 움직임 벡터를 움직임 벡터 예측자(motion vector predictor)로 이용하고, 움직임 벡터 차분(motion vector difference)을 시그널링함으로써 현재 블록의 움직임 벡터를 지시할 수 있다.

[63] 예측부(220)는 후술하는 다양한 예측 방법을 기반으로 예측 신호를 생성할 수 있다. 예를 들어, 예측부는 하나의 블록에 대한 예측을 위하여 인트라 예측 또는 인터 예측을 적용할 수 있을 뿐 아니라, 인트라 예측과 인터 예측을 동시에 적용할 수 있다. 이는 combined inter and intra prediction (CIIP) 모드라고 불릴 수 있다. 또한, 예측부는 블록에 대한 예측을 위하여 인트라 블록 카피(intra block copy, IBC) 예측 모드에 기반할 수도 있고 또는 팔레트 모드(palette mode)에 기반할 수도 있다. 상기 IBC 예측 모드 또는 팔레트 모드는 SCC(screen content coding) 등과 같이 게임 등의 콘텐츠 영상/동영상 코딩을 위하여 사용될 수 있다. IBC는 기본적으로 현재 픽처 내에서 예측을 수행하나, 현재 픽처 내에서 참조 블록을 도출하는 점에서 인터 예측과 유사하게 수행될 수 있다. 즉, IBC는 본 명세서에서 설명되는 인터 예측 기법들 중 적어도 하나를 이용할 수 있다. 팔레트 모드는 인트라 코딩 또는 인트라 예측의 일 예로 볼 수 있다. 팔레트 모드가 적용되는 경우 팔레트 테이블 및 팔레트 인덱스에 관한 정보를 기반으로 픽처 내 샘플 값을 시그널링할 수 있다. 상기 예측부(220)를 통해 생성된 예측 신호는 복원 신호를 생성하기 위해 이용되거나, 레지듀얼 신호를 생성하기 위해 이용될 수 있다.

[64] 변환부(232)는 레지듀얼 신호에 변환 기법을 적용하여 변환 계수들(transform coefficients)을 생성할 수 있다. 예를 들어, 변환 기법은 DCT(Discrete Cosine Transform), DST(Discrete Sine Transform), KLT(Karhunen-Loeve Transform), GBT(Graph-Based Transform), 또는 CNT(Conditionally Non-linear Transform) 중 적어도 하나를 포함할 수 있다. 여기서, GBT는 픽셀 간의 관계 정보를 그래프로 표현한다고 할 때, 이 그래프로부터 얻어진 변환을 의미한다. CNT는 이전에 복원된 모든 픽셀을 이용하여 예측 신호를 생성하고, 그에 기초하여 획득되는 변환을 의미한다. 또한, 변환 과정은 정사각형의 동일한 크기를 갖는 픽셀 블록에 적용될 수도 있고, 정사각형이 아닌 가변 크기의 블록에도 적용될 수 있다.

[65] 양자화부(233)는 변환 계수들을 양자화하여 엔트로피 인코딩부(240)로 전송되고, 엔트로피 인코딩부(240)는 양자화된 신호(양자화된 변환 계수들에 관한 정

보)를 인코딩하여 비트스트림으로 출력할 수 있다. 상기 양자화된 변환 계수들에 관한 정보는 레지듀얼 정보라고 불릴 수 있다. 양자화부(233)는 계수 스캔 순서(scan order)를 기반으로 블록 형태의 양자화된 변환 계수들을 1차원 벡터 형태로 재배열할 수 있고, 상기 1차원 벡터 형태의 양자화된 변환 계수들을 기반으로 상기 양자화된 변환 계수들에 관한 정보를 생성할 수도 있다.

- [66] 엔트로피 인코딩부(240)는 지수 골롬(exponential Golomb), CAVLC(context-adaptive variable length coding), CABAC(context-adaptive binary arithmetic coding) 등과 같은 다양한 인코딩 방법을 수행할 수 있다. 엔트로피 인코딩부(240)는 양자화된 변환 계수들 외 비디오/이미지 복원에 필요한 정보들(예컨대, 선택스 요소들(syntax elements)의 값 등)을 함께 또는 별도로 인코딩할 수도 있다.
- [67] 인코딩된 정보(ex. 인코딩된 비디오/영상 정보)는 비트스트림 형태로 NAL(network abstraction layer) 유닛 단위로 전송 또는 저장될 수 있다. 상기 비디오/영상 정보는 어댑테이션 파라미터 세트(APS), 픽처 파라미터 세트(PPS), 시퀀스 파라미터 세트(SPS) 또는 비디오 파라미터 세트(VPS) 등 다양한 파라미터 세트에 관한 정보를 더 포함할 수 있다. 또한, 상기 비디오/영상 정보는 일반 제한 정보(general constraint information)을 더 포함할 수 있다. 본 명세서에서 인코딩 장치에서 디코딩 장치로 전달/시그널링되는 정보 및/또는 선택스 요소들은 비디오/영상 정보에 포함될 수 있다. 상기 비디오/영상 정보는 상술한 인코딩 절차를 통하여 인코딩되어 상기 비트스트림에 포함될 수 있다. 상기 비트스트림은 네트워크를 통하여 전송될 수 있고, 또는 디지털 저장매체에 저장될 수 있다. 여기서, 네트워크는 방송망 및/또는 통신망 등을 포함할 수 있고, 디지털 저장매체는 USB, SD, CD, DVD, 블루레이, HDD, SSD 등 다양한 저장매체를 포함할 수 있다. 엔트로피 인코딩부(240)로부터 출력된 신호는 전송하는 전송부(미도시) 및/또는 저장하는 저장부(미도시)가 인코딩 장치(200)의 내/외부 엘리먼트로서 구성될 수 있고, 또는 전송부는 엔트로피 인코딩부(240)에 포함될 수도 있다.
- [68] 양자화부(233)로부터 출력된 양자화된 변환 계수들은 예측 신호를 생성하기 위해 이용될 수 있다. 예를 들어, 양자화된 변환 계수들에 역양자화부(234) 및 역변환부(235)를 통해 역양자화 및 역변환을 적용함으로써 레지듀얼 신호(레지듀얼 블록 or 레지듀얼 샘플들)를 복원할 수 있다. 가산부(250)는 복원된 레지듀얼 신호를 인터 예측부(221) 또는 인트라 예측부(222)로부터 출력된 예측 신호에 더함으로써 복원(reconstructed) 신호(복원 픽처, 복원 블록, 복원 샘플 어레이)가 생성될 수 있다. 스킵 모드가 적용된 경우와 같이 처리 대상 블록에 대한 레지듀얼이 없는 경우, 예측된 블록이 복원 블록으로 사용될 수 있다. 가산부(250)는 복원부 또는 복원 블록 생성부라고 불릴 수 있다. 생성된 복원 신호는 현재 픽처 내 다음 처리 대상 블록의 인트라 예측을 위하여 사용될 수 있고, 후술하는 바와 같이 필터링을 거쳐서 다음 픽처의 인터 예측을 위하여 사용될 수도 있다. 한편, 픽처 인코딩 및/또는 복원 과정에서 LMCS (luma mapping with chroma scaling)가 적용될 수도 있다.

- [69] 필터링부(260)는 복원 신호에 필터링을 적용하여 주관적/객관적 화질을 향상시킬 수 있다. 예를 들어, 필터링부(260)은 복원 픽처에 다양한 필터링 방법을 적용하여 수정된(modified) 복원 픽처를 생성할 수 있고, 상기 수정된 복원 픽처를 메모리(270), 구체적으로 메모리(270)의 DPB에 저장할 수 있다. 상기 다양한 필터링 방법은, 디블록킹 필터링, 샘플 적응적 오프셋(sample adaptive offset), 적응적 루프 필터(adaptive loop filter), 양방향 필터(bilateral filter) 등을 포함할 수 있다. 필터링부(260)은 필터링에 관한 다양한 정보를 생성하여 엔트로피 인코딩부(240)로 전달할 수 있다. 필터링 관한 정보는 엔트로피 인코딩부(240)에서 인코딩되어 비트스트림 형태로 출력될 수 있다.
- [70] 메모리(270)에 전송된 수정된 복원 픽처는 인터 예측부(221)에서 참조 픽처로 사용될 수 있다. 인코딩 장치는 이를 통하여 인터 예측이 적용되는 경우, 인코딩 장치(200)와 디코딩 장치에서의 예측 미스매치를 피할 수 있고, 부호화 효율도 향상시킬 수 있다.
- [71] 메모리(270)의 DPB는 수정된 복원 픽처를 인터 예측부(221)에서의 참조 픽처로 사용하기 위해 저장할 수 있다. 메모리(270)는 현재 픽처 내 움직임 정보가 도출된(또는 인코딩된) 블록의 움직임 정보 및/또는 이미 복원된 픽처 내 블록들의 움직임 정보를 저장할 수 있다. 상기 저장된 움직임 정보는 공간적 주변 블록의 움직임 정보 또는 시간적 주변 블록의 움직임 정보로 활용하기 위하여 인터 예측부(221)에 전달할 수 있다. 메모리(270)는 현재 픽처 내 복원된 블록들의 복원 샘플들을 저장할 수 있고, 인트라 예측부(222)에 전달할 수 있다.
- [72] 도 3은 본 개시의 실시예가 적용될 수 있고, 비디오/영상 신호의 디코딩이 수행되는 디코딩 장치의 개략적인 블록도를 나타낸다.
- [73] 도 3을 참조하면, 디코딩 장치(300)는 엔트로피 디코딩부(entropy decoder, 310), 레지듀얼 처리부(residual processor, 320), 예측부(predictor, 330), 가산부(adder, 340), 필터링부(filter, 350) 및 메모리(memoery, 360)를 포함하여 구성될 수 있다. 예측부(330)는 인터 예측부(331) 및 인트라 예측부(332)를 포함할 수 있다. 레지듀얼 처리부(320)는 역양자화부(dequantizer, 321) 및 역변환부(inverse transformer, 321)를 포함할 수 있다.
- [74] 상술한 엔트로피 디코딩부(310), 레지듀얼 처리부(320), 예측부(330), 가산부(340) 및 필터링부(350)는 실시예에 따라 하나의 하드웨어 컴포넌트(예를 들어 디코딩 장치 칩셋 또는 프로세서)에 의하여 구성될 수 있다. 또한 메모리(360)는 DPB(decoded picture buffer)를 포함할 수 있고, 디지털 저장 매체에 의하여 구성될 수도 있다. 상기 하드웨어 컴포넌트는 메모리(360)을 내/외부 컴포넌트로 더 포함할 수도 있다.
- [75] 비디오/영상 정보를 포함하는 비트스트림이 입력되면, 디코딩 장치(300)는 도 2의 인코딩 장치에서 비디오/영상 정보가 처리된 프로세스에 대응하여 영상을 복원할 수 있다. 예를 들어, 디코딩 장치(300)는 상기 비트스트림으로부터 획득한 블록 분할 관련 정보를 기반으로 유닛들/블록들을 도출할 수 있다. 디코딩 장치

(300)는 인코딩 장치에서 적용된 처리 유닛을 이용하여 디코딩을 수행할 수 있다. 따라서, 디코딩의 처리 유닛은 코딩 유닛일 수 있고, 코딩 유닛은 쿼드 트리 구조, 바이너리 트리 구조 및/또는 터너리 트리 구조에 따라서 코딩 트리 유닛 또는 최대 코딩 유닛으로부터 분할된 것일 수 있다. 코딩 유닛으로부터 하나 이상의 변환 유닛이 도출될 수 있다. 그리고, 디코딩 장치(300)를 통해 디코딩 및 출력된 복원 영상 신호는 재생 장치를 통해 재생될 수 있다.

- [76] 디코딩 장치(300)는 도 2의 인코딩 장치로부터 출력된 신호를 비트스트림 형태로 수신할 수 있고, 수신된 신호는 엔트로피 디코딩부(310)를 통해 디코딩될 수 있다. 예를 들어, 엔트로피 디코딩부(310)는 상기 비트스트림을 파싱하여 영상 복원(또는 픽처 복원)에 필요한 정보(ex. 비디오/영상 정보)를 도출할 수 있다. 상기 비디오/영상 정보는 어댑테이션 파라미터 세트(APS), 픽처 파라미터 세트(PPS), 시퀀스 파라미터 세트(SPS) 또는 비디오 파라미터 세트(VPS) 등 다양한 파라미터 세트에 관한 정보를 더 포함할 수 있다. 또한 상기 비디오/영상 정보는 일반 제한 정보(general constraint information)을 더 포함할 수 있다. 디코딩 장치는 상기 파라미터 세트에 관한 정보 및/또는 상기 일반 제한 정보를 더 기반으로 픽처를 디코딩할 수 있다. 본 명세서에서 후술되는 시그널링/수신되는 정보 및/또는 선택 요소들은 상기 디코딩 절차를 통하여 디코딩되어 상기 비트스트림으로부터 획득될 수 있다. 예컨대, 엔트로피 디코딩부(310)는 지수 곱셈 부호화, CAVLC 또는 CABAC 등의 코딩 방법을 기초로 비트스트림 내 정보를 디코딩하고, 영상 복원에 필요한 선택 요소의 값, 레지듀얼에 관한 변환 계수의 양자화된 값들을 출력할 수 있다. 보다 상세하게, CABAC 엔트로피 디코딩 방법은, 비트스트림에서 각 구문 요소에 해당하는 빈을 수신하고, 디코딩 대상 구문 요소 정보와 주변 및 디코딩 대상 블록의 디코딩 정보 혹은 이전 단계에서 디코딩된 심볼/빈의 정보를 이용하여 문맥(context) 모델을 결정하고, 결정된 문맥 모델에 따라 빈(bin)의 발생 확률을 예측하여 빈의 산술 디코딩(arithmetic decoding)을 수행하여 각 구문 요소의 값에 해당하는 심볼을 생성할 수 있다. 이때, CABAC 엔트로피 디코딩 방법은 문맥 모델 결정 후 다음 심볼/빈의 문맥 모델을 위해 디코딩된 심볼/빈의 정보를 이용하여 문맥 모델을 업데이트할 수 있다. 엔트로피 디코딩부(310)에서 디코딩된 정보 중 예측에 관한 정보는 예측부(인터 예측부(332) 및 인트라 예측부(331))로 제공되고, 엔트로피 디코딩부(310)에서 엔트로피 디코딩이 수행된 레지듀얼 값, 즉 양자화된 변환 계수들 및 관련 파라미터 정보는 레지듀얼 처리부(320)로 입력될 수 있다. 레지듀얼 처리부(320)는 레지듀얼 신호(레지듀얼 블록, 레지듀얼 샘플들, 레지듀얼 샘플 어레이)를 도출할 수 있다. 또한, 엔트로피 디코딩부(310)에서 디코딩된 정보 중 필터링에 관한 정보는 필터링부(350)으로 제공될 수 있다. 한편, 인코딩 장치로부터 출력된 신호를 수신하는 수신부(미도시)가 디코딩 장치(300)의 내/외부 엘리먼트로서 더 구성될 수 있고, 또는 수신부는 엔트로피 디코딩부(310)의 구성요소일 수도 있다.

- [77] 한편, 본 명세서에 따른 디코딩 장치는 비디오/영상/픽처 디코딩 장치라고 불릴 수 있고, 상기 디코딩 장치는 정보 디코딩 장치(비디오/영상/픽처 정보 디코딩 장치) 및 샘플 디코딩 장치(비디오/영상/픽처 샘플 디코딩 장치)로 구분할 수도 있다. 상기 정보 디코딩 장치는 상기 엔트로피 디코딩부(310)를 포함할 수 있고, 상기 샘플 디코딩 장치는 상기 역양자화부(321), 역변환부(322), 가산부(340), 필터링부(350), 메모리(360), 인터 예측부(332) 및 인트라 예측부(331) 중 적어도 하나를 포함할 수 있다.
- [78] 역양자화부(321)에서는 양자화된 변환 계수들을 역양자화하여 변환 계수들을 출력할 수 있다. 역양자화부(321)는 양자화된 변환 계수들을 2차원의 블록 형태로 재배열할 수 있다. 이 경우, 상기 재배열은 인코딩 장치에서 수행된 계수 스캔 순서를 기반으로 재배열을 수행할 수 있다. 역양자화부(321)는 양자화 파라미터(예를 들어 양자화 스텝 사이즈 정보)를 이용하여 양자화된 변환 계수들에 대한 역양자화를 수행하고, 변환 계수들(transform coefficient)을 획득할 수 있다.
- [79] 역변환부(322)에서는 변환 계수들을 역변환하여 레지듀얼 신호(레지듀얼 블록, 레지듀얼 샘플 어레이)를 획득하게 된다.
- [80] 예측부(320)는 현재 블록에 대한 예측을 수행하고, 상기 현재 블록에 대한 예측 샘플들을 포함하는 예측 블록(predicted block)을 생성할 수 있다. 예측부(320)는 엔트로피 디코딩부(310)로부터 출력된 상기 예측에 관한 정보를 기반으로 상기 현재 블록에 인트라 예측이 적용되는지 또는 인터 예측이 적용되는지 결정할 수 있고, 구체적인 인트라/인터 예측 모드를 결정할 수 있다.
- [81] 예측부(320)는 후술하는 다양한 예측 방법을 기반으로 예측 신호를 생성할 수 있다. 예를 들어, 예측부(320)는 하나의 블록에 대한 예측을 위하여 인트라 예측 또는 인터 예측을 적용할 수 있을 뿐 아니라, 인트라 예측과 인터 예측을 동시에 적용할 수 있다. 이는 combined inter and intra prediction (CIIP) 모드라고 불릴 수 있다. 또한, 예측부는 블록에 대한 예측을 위하여 인트라 블록 카피(intra block copy, IBC) 예측 모드에 기반할 수도 있고 또는 팔레트 모드(palette mode)에 기반할 수도 있다. 상기 IBC 예측 모드 또는 팔레트 모드는 SCC(screen content coding) 등과 같이 게임 등의 콘텐츠 영상/동영상 코딩을 위하여 사용될 수 있다. IBC는 기본적으로 현재 픽처 내에서 예측을 수행하나 현재 픽처 내에서 참조 블록을 도출하는 점에서 인터 예측과 유사하게 수행될 수 있다. 즉, IBC는 본 명세서에서 설명되는 인터 예측 기법들 중 적어도 하나를 이용할 수 있다. 팔레트 모드는 인트라 코딩 또는 인트라 예측의 일 예로 볼 수 있다. 팔레트 모드가 적용되는 경우 팔레트 테이블 및 팔레트 인덱스에 관한 정보가 상기 비디오/영상 정보에 포함되어 시그널링될 수 있다.
- [82] 인트라 예측부(331)는 현재 픽처 내의 샘플들을 참조하여 현재 블록을 예측할 수 있다. 상기 참조되는 샘플들은 예측 모드에 따라 상기 현재 블록의 주변(neighbor)에 위치할 수 있고, 또는 현재 블록으로부터 일정 거리만큼 떨어져서 위치할 수도 있다. 인트라 예측에서 예측 모드들은 하나 이상의 비방향성 모드와

- 복수의 방향성 모드를 포함할 수 있다. 인트라 예측부(331)는 주변 블록에 적용된 예측 모드를 이용하여, 현재 블록에 적용되는 예측 모드를 결정할 수도 있다.
- [83] 인터 예측부(332)는 참조 픽처 상에서 움직임 벡터에 의해 특정되는 참조 블록(참조 샘플 어레이)을 기반으로, 현재 블록에 대한 예측 블록을 유도할 수 있다. 이때, 인터 예측 모드에서 전송되는 움직임 정보의 양을 줄이기 위해 주변 블록과 현재 블록 간의 움직임 정보의 상관성에 기초하여 움직임 정보를 블록, 서브 블록 또는 샘플 단위로 예측할 수 있다. 상기 움직임 정보는 움직임 벡터 및 참조 픽처 인덱스를 포함할 수 있다. 상기 움직임 정보는 인터 예측 방향 정보(L0 예측, L1 예측, Bi 예측 등)를 더 포함할 수 있다. 인터 예측의 경우에, 주변 블록은 현재 픽처 내에 존재하는 공간적 주변 블록(spatial neighboring block)과 참조 픽처에 존재하는 시간적 주변 블록(temporal neighboring block)을 포함할 수 있다. 예를 들어, 인터 예측부(332)는 주변 블록들을 기반으로 움직임 정보 후보 리스트를 구성하고, 수신한 후보 선택 정보를 기반으로 상기 현재 블록의 움직임 벡터 및/또는 참조 픽처 인덱스를 도출할 수 있다. 다양한 예측 모드를 기반으로 인터 예측이 수행될 수 있으며, 상기 예측에 관한 정보는 상기 현재 블록에 대한 인터 예측 모드를 지시하는 정보를 포함할 수 있다.
- [84] 가산부(340)는 획득된 레지듀얼 신호를 예측부(인터 예측부(332) 및/또는 인트라 예측부(331) 포함)로부터 출력된 예측 신호(예측 블록, 예측 샘플 어레이)에 더함으로써 복원 신호(복원 픽처, 복원 블록, 복원 샘플 어레이)를 생성할 수 있다. 스킵 모드가 적용된 경우와 같이 처리 대상 블록에 대한 레지듀얼이 없는 경우, 예측 블록이 복원 블록으로 사용될 수 있다.
- [85] 가산부(340)는 복원부 또는 복원 블록 생성부라고 불릴 수 있다. 생성된 복원 신호는 현재 픽처 내 다음 처리 대상 블록의 인트라 예측을 위하여 사용될 수 있고, 후술하는 바와 같이 필터링을 거쳐서 출력될 수도 있고 또는 다음 픽처의 인터 예측을 위하여 사용될 수도 있다. 한편, 픽처 디코딩 과정에서 LMCS (luma mapping with chroma scaling)가 적용될 수도 있다.
- [86] 필터링부(350)는 복원 신호에 필터링을 적용하여 주관적/객관적 화질을 향상시킬 수 있다. 예를 들어 필터링부(350)는 복원 픽처에 다양한 필터링 방법을 적용하여 수정된(modified) 복원 픽처를 생성할 수 있고, 상기 수정된 복원 픽처를 메모리(360), 구체적으로 메모리(360)의 DPB에 전송할 수 있다. 상기 다양한 필터링 방법은, 디블록킹 필터링, 샘플 적응적 오프셋(sample adaptive offset), 적응적 루프 필터(adaptive loop filter), 양방향 필터(bilateral filter) 등을 포함할 수 있다.
- [87] 메모리(360)의 DPB에 저장된 (수정된) 복원 픽처는 인터 예측부(332)에서 참조 픽처로 사용될 수 있다. 메모리(360)는 현재 픽처 내 움직임 정보가 도출된(또는 디코딩된) 블록의 움직임 정보 및/또는 이미 복원된 픽처 내 블록들의 움직임 정보를 저장할 수 있다. 상기 저장된 움직임 정보는 공간적 주변 블록의 움직임 정보 또는 시간적 주변 블록의 움직임 정보로 활용하기 위하여 인터 예측부(260)에

전달할 수 있다. 메모리(360)는 현재 픽처 내 복원된 블록들의 복원 샘플들을 저장할 수 있고, 인트라 예측부(331)에 전달할 수 있다.

[88] 본 명세서에서, 인코딩 장치(200)의 필터링부(260), 인터 예측부(221) 및 인트라 예측부(222)에서 설명된 실시예들은 각각 디코딩 장치(300)의 필터링부(350), 인터 예측부(332) 및 인트라 예측부(331)에도 동일 또는 대응되도록 적용될 수 있다.

[89] 도 4는 본 개시에 따른 일실시예로서, 디코딩 장치에 의해 수행되는 영상 디코딩 방법을 도시한 것이다.

[90] 도 4를 참조하면, 비트스트림으로부터 현재 블록의 변환 계수(transform coefficients)를 유도할 수 있다(S400). 즉, 비트스트림은 현재 블록의 레지듀얼 정보를 포함할 수 있고, 해당 레지듀얼 정보를 복호화하여 현재 블록의 변환 계수를 유도할 수 있다.

[91] 도 4를 참조하면, 현재 블록의 변환 계수에 역양자화(dequantization) 또는 역변환(inverse-transform) 중 적어도 하나를 수행하여, 현재 블록의 레지듀얼 샘플(residual samples)을 유도할 수 있다(S410).

[92] 적응적 다중 핵심 변환(Adaptive Multiple Transform Selection, MTS)이 적용되는 경우, DCT-2, DST-7, 또는 DCT-8 중 적어도 하나를 기반으로 역변환이 수행될 수 있다. 여기서, DCT-2, DST-7, DCT-8 등은 변환 타입, 변환 커널(kernel) 또는 변환 코어(core)라고 불릴 수 있다.

[93] 본 개시에서의 역변환은 분리 변환(separable transform)을 의미할 수 있다. 다만, 이에 한정되지 아니하며, 역변환은 비분리 변환(non-separable transform)을 의미할 수도 있고, 분리 변환과 비분리 변환을 포함하는 개념일 수도 있다. 또한, 본 개시에서의 역변환은 1차 변환(primary transform)을 의미하나, 이에 한정되지 아니하며, 동일/유사한 형태로 변형되어 2차 변환(secondary transform)에 적용될 수도 있다.

[94] 예를 들어, 역변환을 위한 방법으로, DCT-2와 비분리 변환만을 사용할 수도 있고, DCT-2, DST-7, 또는 DCT-8 중 적어도 하나에 추가로 비분리 변환을 사용할 수도 있으며, DCT-2, DST-7, 또는 DCT-8 중 하나 이상의 변환 커널을 비분리 변환이 대체할 수도 있다.

[95] 보다 구체적인 예시로서, 분리 변환을 위한 변환 커널 후보로서, (DCT-2, DCT-2), (DST-7, DST-7), (DCT-8, DST-7), (DST-7, DCT-8), (DCT-8, DCT-8)이 존재하는 경우, 비분리 변환이 상기 5개의 변환 커널 후보 중 하나 이상을 대체하거나 추가될 수 있다. 여기서, (변환1, 변환2)와 같은 표기는, 수평 방향으로 변환1이 적용되고, 수직 방향으로 변환2가 적용되는 것을 가리킨다. 비분리 변환이 해당 변환 커널 후보 중 일부를 대체하는 경우, (DCT-2, DCT-2), (DST-7, DST-7)을 제외한 나머지 변환 커널 후보를 비분리 변환으로 대체할 수 있다. 다만, 상기 변환 커널 후보는 일예에 불과하고, 다른 타입의 DCT 및/또는 DST가 포함될 수도 있고, 변환 커널 후보로 변환 스킵(transform skip)이 포함될 수도 있다.

[96] 비분리 변환은, 비분리 변환 매트릭스(non-separable transform matrix)를 기반으로 하는 변환 또는 역변환을 의미할 수 있다. 즉, 수직 변환 및 수평 변환을 분리하여 수평 변환과 수직 변환을 독립적으로 수행하는 분리 변환과 달리, 비분리 변환은 수평 및 수직 변환을 한번에 수행할 수 있다.

[97] 예를 들어, 4x4 블록에 비분리 변환이 수행되는 경우, 비분리 변환으로의 입력 데이터 X는 다음 수학식 1과 같다.

[98] [수식1]

$$X = \begin{bmatrix} X_{00} & X_{01} & X_{02} & X_{03} \\ X_{10} & X_{11} & X_{12} & X_{13} \\ X_{20} & X_{21} & X_{22} & X_{23} \\ X_{30} & X_{31} & X_{32} & X_{33} \end{bmatrix}$$

[99] 상기 입력 데이터 X를 벡터 형태로 나타내는 경우, 벡터 X' 다음과 같이 나타낼 수 있다.

[100] [수식2]

$$X' = [X_{00}, X_{01}, X_{02}, X_{03}, X_{10}, X_{11}, X_{12}, X_{13}, X_{20}, X_{21}, X_{22}, X_{23}, X_{30}, X_{31}, X_{32}, X_{33}]^T$$

[101] 이 경우, 상기 비분리 변환은 다음 수학식 3과 같이 수행될 수 있다.

[102] [수식3]

$$F = T \cdot X'$$

[103] 수학식 3에서, F는 변환 계수 벡터를 나타내고, T는 16x16 비분리 변환 매트릭스를 나타내며, $\cdot$ 는 행렬과 벡터의 곱셈을 의미한다.

[104] 상기 수학식 3을 통해 16x1 변환 계수 벡터 F가 도출될 수 있으며, 상기 F는 소정의 스캔 순서에 따라 4x4 블록으로 재구성될 수 있다. 상기 스캔 순서는, 수평 스캔, 수직 스캔, 대각 스캔, z 스캔, 래스터 스캔, 또는 기-정의된 스캔일 수 있다.

[105] 상기 비분리 변환을 위한 비분리 변환 세트 및/또는 변환 커널은, 예측 모드(ex. intra mode, inter mode 등), 현재 블록의 너비, 높이, 또는 픽셀 수, 현재 블록 내 서브 블록의 위치, 명시적으로 시그널링된 구문 요소, 주변 샘플들의 통계적 특성, 2차 변환의 사용 여부, 또는 양자화 파라미터(QP) 중 적어도 하나에 기반하여 다양하게 구성될 수 있다.

[106] 구체적으로, 인트라 모드의 경우, n개의 비분리 변환 세트에 대응되도록 기-정의된 인트라 예측 모드들을 그룹핑하고, 각 비분리 변환 세트는 k개의 변환 커널 후보들이 포함될 수 있다. 여기서 n과 k는 인코딩 장치와 디코딩 장치에 동일하게 정의된 규칙(조건)에 따른 임의의 상수일 수 있다.

[107] 비분리 변환 세트의 개수 및/또는 비분리 변환 세트에 포함되는 변환 커널 후보의 개수는, 현재 블록의 너비 및/또는 높이에 따라 상이하게 구성될 수 있다. 예를 들어, 4x4 블록에 대해서, n_1 개의 비분리 변환 세트와 k_1 개의 변환 커널 후보가 구성될 수 있다. 4x8 블록에 대해서, n_2 개의 비분리 변환 세트와 k_2 개의 변환 커널 후보가 구성될 수 있다. 또한, 현재 블록의 너비와 높이의 곱에 따라 비분리 변환 세트의 개수와 각 비분리 변환 세트에 포함되는 변환 커널 후보의 개수가 상이하게

구성될 수 있다. 예를 들어 현재 블록의 너비와 높이의 곱이 256 이상(또는 초과)일 경우, n_3 개의 비분리 변환 세트와 k_3 개의 변환 커널 후보가 구성될 수 있고, 그렇지 않은 경우, n_4 개의 비분리 변환 세트와 k_4 개의 변환 커널 후보가 구성될 수 있다. 즉, 블록 크기에 따라 레지듀얼 신호의 통계적 특성의 변화도가 다르기 때문에, 이를 반영하기 위해 비분리 변환 세트와 변환 커널 후보의 개수를 상이하게 구성할 수 있다.

- [108] 현재 블록이 복수의 서브 블록들로 분할되는 경우, 해당 서브 블록마다 레지듀얼 신호의 통계적 특성이 다를 수 있으므로, 비분리 변환 세트와 변환 커널 후보의 개수를 상이하게 구성할 수 있다. 예를 들어, 4×8 또는 8×4 블록이 두 개의 4×4 서브 블록들로 분할되고, 각 서브 블록에 비분리 변환이 적용되는 경우, 좌상단 4×4 서브 블록에 대해서 n_5 개의 비분리 변환 세트와 k_5 개의 변환 커널 후보가 구성될 수 있고, 다른 4×4 서브 블록에 대해서 n_6 개의 비분리 변환 세트와 k_6 개의 변환 커널 후보가 구성될 수 있다.
- [109] 명시적으로 시그널링되는 구문 요소에 기초하여, 비분리 변환 세트와 변환 커널 후보의 개수를 상이하게 구성할 수 있다. 상기 구문 요소로서, 복수의 비분리 변환 구성 중 어느 하나를 지시하는 정보가 이용될 수 있다. 예를 들어, 세 종류의 비분리 변환 구성이 지원되는 경우(i.e., n_7 개의 비분리 변환 세트와 k_7 개의 변환 커널 후보, n_8 개의 비분리 변환 세트와 k_8 개의 변환 커널 후보, n_9 개의 비분리 변환 세트와 k_9 개의 변환 커널 후보), 해당 구문 요소가 0, 1, 2의 값을 가질 수 있고, 시그널링되는 구문 요소의 값에 따라 현재 블록에 적용되는 비분리 변환 구성이 결정될 수 있다.
- [110] 2차 변환의 적용 여부 및/또는 어떤 2차 변환이 적용되는지에 따라, 비분리 변환 세트와 변환 커널 후보의 개수를 상이하게 구성할 수 있다. 예를 들어, 2차 변환이 적용되지 않는 경우, n_{10} 개의 비분리 변환 세트와 k_{10} 개의 변환 커널 후보를 포함한 비분리 변환 구성을 적용할 수 있다. 2차 변환이 적용되는 경우, n_{11} 개의 비분리 변환 세트와 k_{11} 개의 변환 커널 후보를 포함한 비분리 변환 구성을 적용할 수 있다.
- [111] 양자화 파라미터(QP) 및/또는 QP 값의 범위에 따라, 상이한 비분리 변환 구성을 적용할 수 있다. 예를 들어, QP 값이 작은 값을 가지는 경우, n_{12} 개의 비분리 변환 세트와 k_{12} 개의 변환 커널 후보를 포함한 비분리 변환 구성을 적용할 수 있다. 반면, QP 값이 큰 값을 가지는 경우, n_{13} 개의 비분리 변환 세트와 k_{13} 개의 변환 커널 후보를 포함한 비분리 변환 구성을 적용할 수 있다. QP 값이 문턱값(e.g., 32) 이하(또는 미만)이면, QP 값이 작은 값을 가지는 경우로 분류하고, 그렇지 않으면, QP 값이 큰 값을 가지는 경우로 분류할 수 있다. 또는, QP 값의 범위를 3개 이상으로 구분하고, 각 범위에 대해 각기 다른 비분리 변환 구성을 적용할 수도 있다.
- [112] 상대적으로 큰 블록에 대해서, 해당 블록의 너비와 높이에 대응하는 비분리 변환을 사용하지 않고, 해당 블록을 복수의 서브 블록으로 분할하고, 서브 블록의

너비와 높이에 대응하는 비분리 변환을 사용할 수 있다. 예를 들어, 4x8 블록에 대한 비분리 변환을 수행할 때, 4x8 블록을 두 개의 4x4 서브 블록으로 분할하고, 각각의 4x4 서브 블록에 대해서 4x4 블록 기반의 비분리 변환을 사용할 수 있다. 또는, 8x16 블록의 경우, 2개의 8x8 서브 블록으로 분할하고, 8x8 블록 기반의 비분리 변환을 사용할 수 있다.

- [113] 상기 비분리 변환 세트는, 현재 블록의 인트라 예측 모드와 매핑 테이블을 기반으로 결정될 수 있다. 매핑 테이블은, 기-정의된 인트라 예측 모드들과 비분리 변환 세트들 간의 매핑 관계를 정의할 수 있다. 기-정의된 인트라 예측 모드들은 2개의 비방향성 모드(non-directional modes)와 65개의 방향성 모드(directional modes)를 포함할 수 있다. 일반적으로 비분리 변환은 분리 변환에 비해서 변환 커널의 크기가 크다. 이는, 변환 과정에 소요되는 계산적 복잡도가 높고, 변환 커널의 저장을 위해 요구되는 메모리가 큼을 의미한다. 한편, 분리 변환은 수평 및/또는 수직 방향으로 존재하는 통계적 특성만을 고려할 수 있지만, 비분리 변환은 수평 및 수직 방향을 포함하는 2차원 공간 상의 통계적 특성을 동시에 고려할 수 있으므로 더 나은 압축 효율을 제공한다. 인트라 예측 모드의 방향성에 따라서 레지듀얼의 통계적 특성 및 다양성이 다르기 때문에, 비분리 변환이 절대적으로 필요한 경우가 있을 수 있으며, 분리 변환만으로 충분히 레지듀얼의 특성을 파악할 수 있는 인트라 예측 모드가 존재할 수 있다. 따라서, 인코딩 장치와 디코딩 장치에서 인트라 예측 모드에 따라 어떤 변환을 사용할 것인지 미리 정의함으로써, 복잡도 및 메모리 요구량을 최적화하여 변환 과정을 설계할 수 있다. 상기 비방향성 모드는 0번인 planar 모드 및 1번인 DC 모드를 포함할 수 있고, 상기 방향성 모드는 2번 내지 66번의 인트라 예측 모드를 포함할 수 있다. 다만, 이는 예시로서, 본 개시는 기-정의된 인트라 예측 모드의 개수가 다른 경우에도 적용될 수 있다.
- [114] wide angle intra prediction(WAIP)의 적용으로 인해, 기-정의된 인트라 예측 모드는, -14번 내지 -1번의 인트라 예측 모드와 67번 내지 80번의 인트라 예측 모드를 더 포함할 수 있다.
- [115] 도 5는 본 개시에 따른 인트라 예측 모드와 그 예측 방향을 예시적으로 나타낸다. 도 5를 참조하면, -14번 내지 -1번 및 2번 내지 33번까지의 모드와 35번 내지 80번까지의 모드는 34번 모드를 중심으로 예측 방향 관점에서 대칭이다. 예를 들어 10번 모드와 58번 모드는 34번 모드에 해당하는 방향을 중심으로 대칭이고, -1번 모드는 67번 모드와 대칭이다. 따라서, 34번 모드를 중심으로 수평 방향성 모드에 대칭되는 수직 방향성 모드에 대해서는, 입력 데이터를 트랜스포즈(transpose)해서 사용할 수 있다. 입력 데이터를 transpose한다는 것은 2차원 블록의 입력 데이터 $M \times N$ 에서의 행이 열이 되고 열이 행이 되어 $N \times M$ 데이터를 구성하는 것을 의미한다.
- [116] 예를 들어, 4x4 블록이 사용되는 경우, 비분리 변환을 위해 4x4 블록을 이루는 16개의 데이터를 적절히 배열하여 16x1의 1차원 벡터를 구성할 수 있다. 이때, 행

우선의 순서로 1차원 벡터를 구성할 수도 있고, 열 우선의 순서로 1차원 벡터를 구성할 수도 있다. 비분리 변환의 결과인 레지듀얼 샘플들을 위 순서로 배열하여 2차원 블록을 구성할 수 있다.

- [117] -14번 내지 -1번 및 2번 내지 33번 모드에 대하여, 16x1 입력 벡터를 구성하기 위한 데이터 배열 순서가 행 우선의 순서인 경우, 35번 내지 80번 모드에 대해서는 열 우선의 순서에 따라 입력 벡터가 구성될 수 있다.
- [118] 34번 모드는 수평 방향성 모드도 아니고 수직 방향성 모드도 아니라고 볼 수 있으나, 본 개시에서는 수평 방향성 모드에 속하는 것으로 분류한다. 즉, -14번 내지 -1번 및 2번 내지 33번 모드에 대해서는 수평 방향성 모드에 대한 입력 데이터 정렬 방식, 즉 행 우선의 순서를 사용하고, 34번 모드를 중심으로 대칭되는 수직 방향성 모드에 대해서 입력 데이터를 transpose하여 사용할 수 있다.
- [119] 비정방향 블록의 경우, 정방향 블록에서의 대칭성(즉, $N \times N$ 블록에서 P 번 모드와 $(68-P)$ 번 모드 간의 대칭성($2 \leq P \leq 33$) 또는 Q 번 모드와 $(66-Q)$ 번 모드 간의 대칭성($-14 \leq Q \leq -1$))을 활용할 수 없다. 이에, 인트라 예측 모드만을 기준으로 한 대칭성 외에 서로 전치 관계에 있는 블록 형태 간의 대칭성, 즉 $K \times L$ 블록과 $L \times K$ 블록 간의 대칭성을 함께 활용할 수도 있다. 구체적으로, P 번 모드로 예측되는 $K \times L$ 블록과 $(68-P)$ 번 모드로 예측되는 $L \times K$ 블록 간에 대칭 관계가 존재한다. 또는, Q 번 모드로 예측되는 $K \times L$ 블록과 $(66-Q)$ 번 모드로 예측되는 $L \times K$ 블록 간에 대칭 관계가 존재한다.
- [120] 2번 모드를 갖는 $K \times L$ 블록과 66번 모드를 갖는 $L \times K$ 블록은 서로 대칭이라 볼 수 있으므로, $K \times L$ 블록과 $L \times K$ 블록에 동일한 변환 커널을 적용할 수 있다. 만약, $K \times L$ 블록의 인트라 예측 모드에 대한 비분리 변환 세트가 매핑되어 있다고 했을 때, $L \times K$ 블록에 비분리 변환을 적용하기 위해서는, $L \times K$ 블록에 적용되는 P 번 모드 대신 $(68-P)$ 번 모드를 기반으로, 상기 $K \times L$ 블록에 대응하는 매핑 테이블을 통해 비분리 변환 세트를 유도할 수 있다. 또는, $L \times K$ 블록에 적용되는 Q 번 모드 대신 $(66-Q)$ 번 모드를 기반으로, 상기 $K \times L$ 블록에 대응하는 매핑 테이블을 통해 비분리 변환 세트를 유도할 수 있다.
- [121] 예를 들어, $L \times K$ 블록에 비분리 변환을 적용하기 위해서는, 66번 모드 대신 2번 모드를 기준으로 비분리 변환 세트를 선택할 수 있다. 또한, $K \times L$ 블록에 대해서는 입력 데이터를 기-결정된 순서(e.g., 행 우선의 순서 또는 열 우선의 순서)에 따라 읽어서 1차원 벡터를 구성한 후 해당 비분리 변환을 적용할 수 있다. $L \times K$ 블록에 대해서는 입력 데이터를 transpose한 순서에 따라 읽어서 1차원 벡터를 구성한 후 해당 비분리 변환을 적용할 수 있다. 즉, $K \times L$ 블록에 대해 행 우선의 순서로 읽었다면, $L \times K$ 블록에 대해 열 우선의 순서로 읽을 수 있다. 반대로, $K \times L$ 블록에 대해 열 우선의 순서로 읽었다면, $L \times K$ 블록에 대해 행 우선의 순서로 읽을 수 있다.
- [122] 또한, 34번 모드가 $K \times L$ 블록에 적용되는 경우, 34번 모드를 기반으로 비분리 변환 세트를 결정하고, 기-결정된 순서에 따라 입력 데이터를 읽어 1차원 벡터를 구성하여 해당 비분리 변환을 수행할 수 있다. 34번 모드가 $L \times K$ 블록에 적용되는

경우, 마찬가지로 34번 모드를 기반으로 비분리 변환 세트를 결정하되, 입력 데이터를 transpose한 순서에 따라 읽어 1차원 벡터를 구성하여 해당 비분리 변환을 수행할 수 있다.

- [123] 본 개시에서는 $K \times L$ 블록을 기준으로 비분리 변환 세트의 결정 방법 및 입력 데이터의 구성 방법을 설명하였으나, $L \times K$ 블록을 기준으로 $K \times L$ 블록에 대해 전술한 대칭성을 동일하게 활용하여 해당 비분리 변환을 수행할 수 있다. 또는, 너비가 높이보다 큰 블록이 기준 블록으로 이용되도록 제한될 수도 있다. 또는, 비정방형 블록의 경우 대칭성을 활용하지 않도록 제한될 수 있다. 이 경우, 비정방형 블록은 정방형 블록과는 다른 개수의 비분리 변환 세트 및/또는 변환 커널 후보를 사용할 수도 있고, 정방형 블록과는 다른 매핑 테이블을 사용하여 비분리 변환 세트를 선택할 수도 있다.

- [124] 비분리 변환 세트를 선택하기 위한 매핑 테이블의 예는 다음과 같다.

- [125] [표1]

predModeIntra	TrSetIdx
predModeIntra < 0	4
0 <= predModeIntra <= 1	0
2 <= predModeIntra <= 12	1
13 <= predModeIntra <= 23	2
24 <= predModeIntra <= 44	3
45 <= predModeIntra <= 55	2
56 <= predModeIntra <= 66	1
67 <= predModeIntra <= 80	4

- [126] 표 1은, 5개의 비분리 변환 세트가 존재할 때, 인트라 예측 모드 별로 비분리 변환 세트를 할당하는 예시를 보여준다. predModeIntra의 값은 WAIP를 고려한 인트라 예측 모드의 값을 의미하며, TrSetIdx는 특정 비분리 변환 세트를 나타내는 인덱스이다. 표 1에서 인트라 예측 모드에 따라 서로 대칭되는 방향에 위치하는 모드들에 동일한 비분리 변환 세트가 적용되는 것을 확인할 수 있다. 표 1은 5개의 비분리 변환 세트를 사용하는 일례에 불과하며, 비분리 변환을 위한 전체 비분리 변환 세트의 개수를 한정하지 않는다.

- [127] 또는, 표 2와 같이, 압축 성능을 위해 WAIP에 대해서는 비분리 변환을 적용하지 않을 수도 있다.

- [128] [표2]

predModeIntra	TrSetIdx
0 <= predModeIntra <= 1	0
2 <= predModeIntra <= 12	1

$13 \leq \text{predModeIntra} \leq 23$	2
$24 \leq \text{predModeIntra} \leq 44$	3
$45 \leq \text{predModeIntra} \leq 55$	2
$56 \leq \text{predModeIntra} \leq 66$	1

[129] 또는, 표 3과 같이, WAIP에 대해 별도의 비분리 변환 세트를 구성하지 않고, 인접한 인트라 예측 모드에 대응하는 비분리 변환 세트가 공유될 수도 있다.

[130] [표3]

predModeIntra	TrSetIdx
$\text{predModeIntra} < 0$	1
$0 \leq \text{predModeIntra} \leq 1$	0
$2 \leq \text{predModeIntra} \leq 12$	1
$13 \leq \text{predModeIntra} \leq 23$	2
$24 \leq \text{predModeIntra} \leq 44$	3
$45 \leq \text{predModeIntra} \leq 55$	2
$56 \leq \text{predModeIntra} \leq 80$	1

[131] 상기 비분리 변환 세트는 복수의 변환 커널 후보를 포함할 수 있고, 복수의 변환 커널 후보 중 어느 하나가 선택적으로 이용될 수 있다. 이를 위해, 비트스트림을 통해 시그널링되는 인덱스가 이용될 수 있다. 또는, 현재 블록의 컨텍스트 정보에 기초하여, 복수의 변환 커널 후보 중 어느 하나가 묵시적으로 결정될 수도 있다. 여기서, 컨텍스트 정보는, 현재 블록의 크기 또는 주변 블록에 비분리 변환이 적용되는지 여부를 의미할 수 있다. 여기서, 현재 블록의 크기는, 너비, 높이, 너비와 높이의 최대값/최소값, 너비와 높이의 합, 또는 너비와 높이의 곱으로 정의될 수 있다.

[132] 이하, 현재 블록의 역변환을 위한 변환 커널을 결정하는 방법에 대해서 자세히 살펴보도록 한다.

[133] 실시예 1

[134] 전술한 바와 같이, 역변환은 분리 변환과 비분리 변환으로 구분될 수 있다. 분리 변환은 2차원 블록에 대해 수평 방향과 수직 방향에 대해 각각 변환을 수행하는 것을 의미하고, 비분리 변환은 2차원 블록 전체 또는 일부 영역을 구성하는 샘플들에 대해 한 번의 변환을 수행하는 것을 의미할 수 있다. 분리 변환을 표기할 때, 수평 변환과 수직 변환의 쌍(pair)으로 표기할 수 있으며, 본 개시에서는 (수평 변환, 수직 변환)과 같이 나타내기로 한다.

[135] 현재 블록의 역변환을 위해 복수의 변환 세트가 정의될 수 있다. 각 변환 세트는, 하나 또는 그 이상의 변환 커널 후보를 포함할 수 있다.

- [136] 예를 들어, (DST-7, DST-7), (DCT-8, DST-7), (DST-7, DCT-8), 또는 (DCT-8, DCT-8) 중 어느 하나가 분리 변환으로서 적용될 수 있으며, 해당 4개의 변환 커널 후보가 하나의 변환 세트로 간주될 수 있다. 또한, (DCT-2, DCT-2)가 하나의 변환 세트로 간주될 수 있다. 변환을 적용하지 않는 변환 스킵도 하나의 변환 세트로 간주될 수 있고, (DCT-2, DCT-2)와 변환 스킵이 하나의 변환 세트로 간주될 수 있다. 본 개시에서 변환 커널(transform kernel)은 하나의 변환(e.g., DCT-2, DST-7)을 지칭할 수도 있고, 2개의 변환 쌍(e.g., (DCT-2, DCT-2))을 지칭할 수도 있다.
- [137] 또 다른 변환 세트의 예로서, 전술한 비분리 변환 세트가 있을 수 있다. 본 개시에서는 일차 변환으로서 적용되는 비분리 변환을 Non-Separable Primary Transform(NSPT)으로 표기할 수 있다. NSPT에서는, 복수의 비분리 변환 세트가 구성될 수 있고, 각 비분리 변환 세트는 변환 커널 후보로서 하나 또는 그 이상의 변환 커널들을 포함할 수 있다. NSPT의 경우, 인트라 예측 모드에 따라 복수의 비분리 변환 세트 중 어느 하나가 선택되며, NSPT를 위한 복수의 비분리 변환 세트를 NSPT 세트 리스트라고 표기할 수 있다. 이는 앞서 살펴본 바와 같으며, 여기서 자세한 설명은 생략하기로 한다.
- [138] 기-정의된 복수의 변환 세트로부터 현재 블록이 이용 가능한 하나 또는 그 이상의 변환 세트의 그룹을 구성할 수 있다. 상기 하나 또는 그 이상의 변환 세트의 그룹은, 현재 블록이 속한 소정의 영역 단위로 구성될 수 있으며, 이하 컬렉션(collection)이라 부르기로 한다. 여기서, 소정의 영역 단위는, 픽처, 슬라이스, 코딩 트리 유닛 행(CTU row), 또는 코딩 트리 유닛(CTU) 중 적어도 하나일 수 있다.
- [139] 예를 들어, (DCT-2, DCT-2)으로 구성된 변환 세트를 S_1 , (DST-7, DST-7), (DCT-8, DST-7), (DST-7, DCT-8) 및 (DCT-8, DCT-8)으로 구성된 변환 세트를 S_2 라 각각 부르기로 한다. 또한, 전술한 NSPT 세트 리스트는 N 개의 비분리 변환 세트를 포함할 수 있으며, N 개의 비분리 변환 세트를 $S_{3,1}$, $S_{3,2}$, ..., $S_{3,N}$ 라 각각 부르기로 한다. 여기서, N 은 35일 수 있으나, 이에 한정되지 아니한다.
- [140] 현재 블록의 인트라 예측 모드에 의해 $S_{3,13}$ 이 NSPT를 위한 비분리 변환 세트로 선택된 경우, 현재 블록에 적용 가능한 변환 커널은 S_1 , S_2 , 또는 $S_{3,13}$ 중 어느 하나에 속한 것일 수 있다. 이 경우, 현재 블록이 이용 가능한 컬렉션을 $\{S_1, S_2, S_{3,13}\}$ 으로 표기할 수 있다.
- [141] 전술한 바와 같이, 본 개시에 따른 컬렉션은 현재 블록이 이용 가능한 하나 또는 그 이상의 변환 세트의 그룹이므로, 현재 블록의 컨텍스트에 따라 상기 컬렉션은 상이하게 구성될 수 있다. 여기서, 컨텍스트는 형태, 크기, 또는 인트라 예측 모드 중 적어도 하나를 포함할 수 있다. 만약, 총 K 개의 컨텍스트가 정의되는 경우, K 개의 컬렉션이 생성될 수 있으며, 각 컬렉션은 C_i 로 표기될 수 있다($i=1, 2, \dots, N$). 예를 들어, NSPT가 적용될 수 있는 블록의 크기가 4×4 , 8×8 , 16×16 , 32×32 이고, 인트라 예측 모드에 의해 총 35개의 비분리 변환 세트 중 어느 하나가 선택되는 경

우, 만약 블록의 크기마다 적용되는 변환 커널이 다르다면 총 $4 \times 35 = 140$ 개의 컨텍스트가 정의될 수 있다.

- [142] 현재 블록의 컨텍스트를 기반으로 하나의 컬렉션이 구성될 수 있고, 이때, 해당 컬렉션에 속한 복수의 변환 세트 중 어느 하나를 선택하고, 선택된 변환 세트에 속한 복수의 변환 커널 후보 중 어느 하나를 선택하는 과정이 수행될 수 있다. 여기서, 변환 세트와 변환 커널 후보의 선택은, 현재 블록의 컨텍스트를 기반으로 묵시적으로 수행되거나, 명시적으로 시그널링되는 인덱스를 기반으로 수행될 수도 있다. 또는, 컬렉션에 속한 복수의 변환 세트 중 어느 하나를 선택하는 과정과 선택된 변환 세트에 속한 복수의 변환 커널 후보 중 어느 하나를 선택하는 과정은 각각 수행될 수도 있다. 예를 들어, 변환 세트를 선택하기 위한 인덱스를 먼저 시그널링되어 이를 기반으로 컬렉션에 속한 복수의 변환 세트 중 어느 하나를 선택할 수 있다. 그런 다음, 변환 세트에 속한 복수의 변환 커널 후보 중 어느 하나를 지시하는 인덱스가 시그널링될 수 있고, 시그널링된 인덱스를 기반으로 변환 세트로부터 어느 하나의 변환 커널 후보를 선택할 수 있다. 선택된 변환 커널 후보를 기반으로 현재 블록의 변환 커널이 결정될 수 있다. 또는, 컬렉션으로부터 어느 하나의 변환 세트의 선택은 현재 블록의 컨텍스트에 기초하여 묵시적으로 수행되고, 선택된 변환 세트로부터 어느 하나의 변환 커널 후보의 선택은 시그널링된 인덱스를 기반으로 수행될 수 있다. 또는, 컬렉션으로부터 어느 하나의 변환 세트의 선택은 시그널링된 인덱스를 기반으로 수행되고, 선택된 변환 세트로부터 어느 하나의 변환 커널 후보의 선택은 현재 블록의 컨텍스트에 기초하여 묵시적으로 수행될 수 있다. 또는, 컬렉션으로부터 어느 하나의 변환 세트의 선택은 현재 블록의 컨텍스트에 기초하여 묵시적으로 수행되고, 선택된 변환 세트로부터 어느 하나의 변환 커널 후보의 선택 역시 현재 블록의 컨텍스트에 기초하여 묵시적으로 수행될 수 있다. 물론, 컬렉션에 속한 변환 세트의 개수가 1개인 경우, 변환 세트를 선택하기 위한 인덱스가 시그널링되지 않을 수 있다. 마찬가지로, 선택된 변환 세트에 속한 변환 커널 후보의 개수가 1개인 경우, 해당 변환 커널 후보를 지시하기 위한 인덱스가 시그널링되지 않을 수 있다. 또는, 현재 컬렉션에 속한 모든 변환 커널 후보 중 어느 하나를 지시하는 인덱스가 시그널링될 수도 있다. 이 경우, 컬렉션으로부터 어느 하나의 변환 세트를 선택하는 과정이 생략될 수 있다. 이때, 컬렉션에 속한 모든 변환 세트는 우선 순위를 고려하여 재배열될 수 있다. 예를 들어, truncated unary 코드와 같이, 작은 값의 인덱스에 대해 작은 길이의 바이너리 코드를 할당하는 경우, 코딩 성능의 향상에 보다 유리한 변환 커널 후보에 대해 작은 값의 인덱스를 할당하는 것이 유리할 수 있다. 컬렉션에 속한 모든 변환 커널 후보를 우선 순위에 따라 재배열할 때(shuffling), 컬렉션마다 다른 shuffling을 적용할 수도 있다. 또한, 컬렉션에 속한 모든 변환 커널 후보를 재배열하는 것이 아니라, 일부만을 선택적으로 재배열할 수도 있다.

- [143] 실시예 2

- [144] 현재 블록의 역변환을 위한 변환 커널은 MTS(Multiple Transform Selection)을 기반으로 결정될 수 있다.
- [145] 본 개시에 따른 MTS는 DST-7, DCT-8, DCT-5, DST-4, DST-1, 또는 IDT(identity transform, 항등 변환) 중 적어도 하나를 변환 커널로 이용할 수 있다. 또한, 본 개시에 따른 MTS는 DCT-2의 변환 커널을 더 포함할 수도 있다.
- [146] 본 개시에서, MTS를 위한 복수의 MTS 세트가 정의될 수 있다. 현재 블록의 크기 및/또는 인트라 예측 모드에 기초하여, 복수의 MTS 세트 중 어느 하나가 결정될 수 있다. 예를 들어, 어느 하나의 MTS 세트를 결정함에 있어서, 16개의 변환 블록 크기가 고려될 수 있고, 방향성 모드에 대해서는 변환 블록의 형태와 인트라 예측 모드들 간의 대칭성이 고려될 수 있다. WAIP(Wide Angle Intra Prediction)의 모드(즉, -1번 내지 -14번(또는 -15번), 67번 내지 80번(또는 81번))의 경우, -1번 내지 -14번(또는 -15번) 모드에 대해서는 2번 모드에 대응하는 MTS 세트를 적용하고, 67번 내지 80번(또는 81번) 모드에 대해서는 66번 모드에 대응하는 MTS 세트를 적용할 수 있다. MIP(Matrix-based Intra Prediction) 모드에 대해서는 별도의 MTS 세트가 할당될 수 있다.
- [147] 예를 들어, 변환 블록 크기와 인트라 예측 모드에 따른 MTS 세트는 다음 표 4와 같이 할당/정의될 수 있다.

- [148] [표4]

블록 크기		인트라 예측 모드				
너비	높이	[0, 1]	[2, 12]	[13, 23]	[24, 34]	MIP
4	4	0	1	2	3	4
4	8	5	6	7	8	9
4	16	10	11	12	13	14
4	32	15	16	17	18	19
8	4	20	21	22	23	24
8	8	25	26	27	28	29
8	16	30	31	32	33	34
8	32	35	36	37	38	39
16	4	40	41	42	43	44
16	8	45	46	47	48	49
16	16	50	51	52	53	54
16	32	55	56	57	58	59
32	4	60	61	62	63	64
32	8	65	66	67	68	69

32	16	70	71	72	73	74
32	32	75	76	77	78	79

[149] 표 4는 16가지의 변환 블록 크기와 인트라 예측 모드에 따른 MTS 세트의 할당을 보여준다. 기-정의된 MTS 세트의 개수는 80개이며, 80개의 MTS 세트 중 어느 하나를 지시하는 인덱스는 표 4와 같이 0부터 79까지를 가질 수 있다.

[150] [표5]

MTS 세트 인덱스	변환 커널 후보 인덱스					
	0	1	2	3	4	5
0	18	24	17	23	8	12
1	18	3	7	22	0	16
2	18	2	17	22	3	23
3	18	3	15	17	12	23
4	18	12	3	19	10	13
5	18	12	19	23	13	24
6	18	12	17	2	3	23
7	18	2	17	22	12	23
8	18	2	11	17	22	23
9	18	12	19	23	3	10
10	16	12	13	24	7	8
11	16	2	11	23	12	18
12	13	17	2	22	12	18
13	17	11	2	21	12	18
14	16	13	19	22	3	10
15	18	12	13	7	14	22
16	16	12	11	1	18	22
17	17	13	3	22	12	18
18	6	12	1	22	13	17
19	16	12	13	15	2	23
20	18	24	23	19	12	17
21	18	24	2	17	0	23
22	17	3	4	22	2	13

23	18	12	19	23	3	15
24	18	12	19	23	3	10
25	6	12	18	24	13	19
26	6	12	2	21	13	18
27	17	11	1	22	2	18
28	16	17	3	11	12	23
29	8	12	19	23	11	24
30	16	13	7	23	12	19
31	6	12	1	11	18	22
32	17	11	1	21	12	18
33	6	11	17	21	12	18
34	8	11	14	17	12	22
35	6	12	11	21	14	16
36	6	12	11	1	17	21
37	6	12	11	2	17	21
38	6	11	21	1	12	17
39	16	12	11	7	1	5
40	8	12	19	24	11	17
41	18	13	1	22	2	24
42	6	2	17	21	19	22
43	16	12	11	19	8	15
44	8	12	17	24	13	15
45	6	12	19	21	17	18
46	6	12	13	21	2	18
47	16	2	17	21	1	11
48	6	17	19	23	12	16
49	6	12	14	17	8	22
50	6	7	11	21	9	12
51	16	12	11	1	7	21
52	6	12	11	1	17	21

53	6	12	11	21	1	16
54	8	7	9	11	12	21
55	6	12	7	11	14	21
56	6	12	7	11	1	21
57	16	12	11	1	2	21
58	6	11	17	21	1	12
59	6	12	7	11	9	21
60	18	12	14	21	6	21
61	16	11	1	22	2	17
62	16	11	1	22	2	17
63	16	13	15	7	14	19
64	8	12	1	19	16	23
65	6	12	7	9	13	21
66	6	12	13	2	7	18
67	16	12	1	21	11	17
68	16	11	7	19	12	15
69	8	12	7	11	14	21
70	6	12	7	11	8	9
71	6	12	7	11	2	21
72	6	12	1	11	21	22
73	6	7	11	16	9	12
74	6	12	7	11	9	21
75	6	12	7	11	13	17
76	6	12	11	21	2	7
77	6	12	1	11	2	7
78	6	12	7	11	16	21
79	6	12	7	11	9	16

- [151] 표 5는, 표 4에서 살펴본 각 MTS 세트에 포함되는 변환 커널 후보를 나타낸다. 각 MTS 세트는 6개의 변환 커널 후보로 구성될 수 있다. 변환 커널 후보 인덱스는 0 내지 5 중 어느 하나의 값을 가지며, 상기 6개의 변환 커널 후보 중 어느 하나를 지시할 수 있다. 여기서, 각 변환 커널 후보는 분리 변환을 위한 수평 변환 커

널과 수직 변환 커널의 조합일 수 있고, 0 내지 24의 인덱스를 가진 25개의 변환 커널 후보가 정의될 수 있다.

[152] [표6]

커널 조합 인덱스	인트라 예측 모드의 값이 35 미만인 경우	인트라 예측 모드의 값이 35 이상인 경우
0	(DCT-8, DCT-8)	(DCT-8, DCT-8)
1	(DST-7, DCT-8)	(DCT-8, DST-7)
2	(DCT-5, DCT-8)	(DCT-8, DCT-5)
3	(DST-4, DCT-8)	(DCT-8, DST-4)
4	(DST-1, DCT-8)	(DCT-8, DST-1)
5	(DCT-8, DST-7)	(DST-7, DCT-8)
6	(DST-7, DST-7)	(DST-7, DST-7)
7	(DCT-5, DST-7)	(DST-7, DCT-5)
8	(DST-4, DST-7)	(DST-7, DST-4)
9	(DST-1, DST-7)	(DST-7, DST-1)
10	(DCT-8, DCT-5)	(DCT-5, DCT-8)
11	(DST-7, DCT-5)	(DCT-5, DST-7)
12	(DCT-5, DCT-5)	(DCT-5, DCT-5)
13	(DST-4, DCT-5)	(DCT-5, DST-4)
14	(DST-1, DCT-5)	(DCT-5, DST-1)
15	(DCT-8, DST-4)	(DST-4, DCT-8)
16	(DST-7, DST-4)	(DST-4, DST-7)
17	(DCT-5, DST-4)	(DST-4, DCT-5)
18	(DST-4, DST-4)	(DST-4, DST-4)
19	(DST-1, DST-4)	(DST-4, DST-1)
20	(DCT-8, DST-1)	(DST-1, DCT-8)
21	(DST-7, DST-1)	(DST-1, DST-7)
22	(DCT-5, DST-1)	(DST-1, DCT-5)
23	(DST-4, DST-1)	(DST-1, DST-4)
24	(DST-1, DST-1)	(DST-1, DST-1)

- [153] 표 6은, 표 5에서 살펴본 25개의 변환 커널 후보의 일예이다. 구체적으로, 변환 커널 후보의 수평 변환과 수직 변환은 (수평 변환, 수직 변환)로 표시되고 있다. 각 변환 커널 후보 인덱스에 대해서, 인트라 예측 모드가 35 미만인 경우의 수평/수직 변환은 인트라 예측 모드가 35 이상인 경우의 수평/수직 변환과 서로 반대일 수 있다. 인트라 예측 모드의 값이 35 이상일 경우, 34번 모드를 중심으로 대칭인 모드를 유도하고, 해당 모드를 기반으로 상기 표 4로부터 MTS 세트를 선택할 수 있다. 또한, 블록 형태의 대칭성이 추가적으로 고려될 수 있다. 원래 변환 블록이 $W \times H$ 크기를 가진 경우, 원래 변환 블록을 대칭시켜 $H \times W$ 크기를 가진 것으로 간주하고, 표 4로부터 MTS 세트를 선택할 수 있다. 여기서, 인트라 예측 모드의 값은 수정된 인트라 예측 모드의 값일 수 있다. 즉, WAIP을 위한 모드 값으로서, -14번(또는 -15번)부터 -1번까지는 2번 모드로 수정하고, 67번부터 80번(또는 81번)까지는 66번 모드로 수정하며, 나머지 모드는 원래 인트라 예측 모드의 값을 그대로 수정된 인트라 예측 모드의 값으로 설정할 수 있다. 이 경우, WAIP를 위한 확장된 모드들도 34번 모드를 중심으로 하여 대칭으로 구성되기 때문에, Planar 모드와 DC 모드를 제외한 모든 방향성 모드에 대해서는 34번 모드를 중심으로 하는 대칭성을 이용할 수 있다.
- [154] 예를 들어, 16×32 블록이 54번 모드로 예측되는 경우, 54번에 대칭되는 모드로서 14번 모드(=68-54)가 유도되고, 블록 크기가 32×16 으로 간주될 수 있다. 이 경우, 표 4에 정의된 바와 같이, 72의 인덱스를 가진 MTS 세트가 선택될 수 있다.
- [155] MIP 모드가 적용되는 경우, 블록 형태의 대칭성을 고려하지 않고, 현재 블록의 크기를 기반으로 MIP 모드에 할당된 MTS 세트가 선택될 수 있다. 또는, MIP 모드가 적용되는 경우, 블록 형태의 대칭성을 고려하여, 대칭되는 블록 크기를 기반으로 MIP 모드에 할당된 MTS 세트가 선택될 수도 있다. 예를 들어, 8×16 블록에 대해 MIP 모드가 적용되는 경우, 8×16 블록은 이에 대칭되는 16×8 블록으로 간주될 수 있고, 표 4에 정의된 바와 같이, 49의 인덱스를 가진 MTS 세트가 선택될 수 있다. 또는, MIP 모드가 적용되는 경우, 인트라 예측 모드는 Planar 모드로 간주될 수 있다. 이 경우, 블록 형태의 대칭성을 고려하지 않고, 현재 블록의 크기를 기반으로 MIP 모드에 할당된 MTS 세트가 선택될 수 있다. 또는, 블록 형태의 대칭성을 고려하여, 대칭되는 블록 크기를 기반으로 MIP 모드에 할당된 MTS 세트가 선택될 수도 있다.
- [156] MIP 모드의 경우, MIP 모드가 transpose 모드로 적용되는지 여부를 나타내는 플래그가 이용될 수 있다. $M \times N$ 의 현재 블록에 MIP 모드가 적용되고 상기 플래그가 transpose 모드의 적용을 지시하는 경우, 인트라 예측 모드는 Planar 모드로 간주되고, $M \times N$ 의 현재 블록은 $N \times M$ 블록으로 간주될 수 있다. 즉, 표 4로부터, $N \times M$ 의 블록 크기와 Planar 모드에 대응하는 MTS 세트가 선택될 수 있다. 표 6에서 살펴본 바와 같이, 인트라 예측 모드의 값이 35 이상인 경우 수평 변환과 수직 변환을 서로 바꾸게 되나, 현재 블록의 인트라 예측 모드가 Planar 모드로 간주되므로 변환 커널 후보의 수평 변환과 수직 변환을 서로 바꾸지 않을 수 있다. 또는, $M \times N$ 의

현재 블록에 MIP 모드가 적용되고 상기 플래그가 transpose 모드의 적용을 지시하는 경우, 인트라 예측 모드는 Planar 모드로 간주되지 않고, $M \times N$ 의 현재 블록은 $N \times M$ 블록으로 간주될 수 있다. 즉, 표 4로부터, $N \times M$ 의 블록 크기와 MIP 모드에 대응하는 MTS 세트가 선택될 수도 있다.

- [157] 표 5에서, 변환 커널 후보 인덱스에 의해 선택된 변환 커널 후보가 현재 블록의 변환 커널로 설정될 수 있다. 또는, 현재 블록의 크기에 따라, 상기 선택된 변환 커널 후보의 수평 변환 또는 수직 변환 중 적어도 하나가 다른 변환 커널로 변경될 수도 있다. 예를 들어, 변환 커널 후보 인덱스가 3이고, 현재 블록의 너비와 높이가 모두 16 이하인 경우, 3인 변환 커널 후보 인덱스에 대응하는 변환 커널 후보의 수평 변환 또는 수직 변환 중 적어도 하나가 다른 변환 커널로 변경될 수 있다. 이때, 수평 변환과 수직 변환이 서로 독립적으로 변경될 수 있다. 현재 블록의 인트라 예측 모드의 값과 수평 모드의 값 간의 차이(또는 차이의 절대값)가 소정의 문턱값 이하인 경우, 상기 선택된 변환 커널 후보의 수직 변환은 IDT(항등 변환)으로 변경될 수 있다. 현재 블록의 인트라 예측 모드의 값과 수직 모드의 값 간의 차이(또는 차이의 절대값)가 소정의 문턱값 이하인 경우, 상기 선택된 변환 커널 후보의 수평 변환은 IDT(항등 변환)으로 변경될 수 있다. 여기서, 문턱값은 현재 블록의 너비와 높이에 기초하여 다음 표 7과 같이 결정될 수 있다.

- [158] [표7]

블록 크기		문턱값
너비	높이	
4	4	8
4	8	6
4	16	4
8	4	8
8	8	8
8	16	6
16	4	4
16	8	2
16	16	-1

- [159] 표 7은, 변환 커널 후보 인덱스에 의해 선택된 변환 커널 후보의 수평 변환 및/또는 수직 변환을 다른 변환 커널로 변경하기 위한 것으로서, 변환 블록의 크기에 따른 문턱값을 정의한다.
- [160] 하나의 MTS 세트를 구성하는 6개의 변환 커널 후보는 표 5에 정의된 바와 같이 0 내지 5의 변환 커널 후보 인덱스로 구분될 수 있다. 해당 변환 커널 후보 인덱스는 비트스트림을 통해 시그널링될 수 있다. MTS 세트의 가용/적용 여부를 나

타내는 플래그(MTS enabled flag 또는 MTS flag)가 시그널링될 수 있고, 상기 플래그가 MTS 세트의 가용/적용을 지시하는 경우에 변환 커널 후보 인덱스가 시그널링될 수 있다. 상기 MTS flag는 1개의 빈(bin)으로 구성될 수 있고, 해당 빈에 대해 1개 이상의 CABAC 기반의 엔트로피 코딩을 위한 컨텍스트(이하, CABAC context라 함)가 할당될 수 있다. 예를 들어, MIP 모드가 아닌 경우와 MIP 모드인 경우에 대해 각각 다른 CABAC context가 할당될 수 있다.

[161] 전술한 현재 블록의 컨텍스트에 따라, 현재 블록이 이용 가능한 변환 커널 후보의 개수가 상이하게 설정될 수 있다. 예를 들어, 현재 블록의 컨텍스트로서, 현재 블록 내 전부 또는 일부 변환 계수의 절대값의 합이 고려될 수 있다. 해당 변환 계수의 절대값의 합을 AbsSum이라 지칭하기로 한다. AbsSum이 T1보다 작거나 같은 경우, 0의 변환 커널 후보 인덱스에 대응하는 1개의 변환 커널 후보만이 이용 가능할 수 있다. AbsSum이 T1보다 크고 T2보다 작거나 같은 경우, 0 내지 3의 변환 커널 후보 인덱스에 대응하는 4개의 변환 커널 후보가 이용 가능할 수 있다. AbsSum이 T2보다 큰 경우, 0 내지 5의 변환 커널 후보 인덱스에 대응하는 6개의 변환 커널 후보가 이용 가능할 수 있다. 여기서, T1은 6이고, T2는 32일 수 있으나, 이는 일예에 불과하다.

[162] AbsSum이 T1보다 작거나 같은 경우, 현재 블록이 이용 가능한 변환 커널 후보의 개수가 1개이므로, 변환 커널 후보 인덱스의 시그널링없이, 0의 변환 커널 후보 인덱스에 대응하는 변환 커널 후보가 현재 블록의 변환 커널로 설정될 수 있다. AbsSum이 T1보다 크고 T2보다 작거나 같은 경우 4개의 변환 커널 후보가 이용 가능하므로, 2개의 빈을 가진 변환 커널 후보 인덱스를 기반으로 4개의 변환 커널 후보 중 어느 하나가 선택될 수 있다. 즉, 0 내지 3의 변환 커널 후보 인덱스는 각각 00, 01, 10, 11로 시그널링될 수 있다. 상기 2개의 빈에 대해서 MSB(Most Significant Bit)가 먼저 시그널링되고, LSB(Least Significant Bit)가 나중에 시그널링될 수 있다. 각 빈에 대해서 서로 다른 CABAC context가 할당될 수 있다. 예를 들어, 2개의 빈에 대해서 상기 MTS flag를 위해 할당된 CABAC context가 아닌 다른 CABAC context를 각 빈마다 할당할 수 있다. 또는, 2개의 빈에 대해서 CABAC context가 할당되지 않고 bypass 코딩이 적용될 수도 있다. AbsSum이 T2보다 큰 경우 변환 커널 후보 인덱스는 0 내지 5의 값을 가지므로, 2개의 빈만으로는 변환 커널 후보 인덱스를 표현할 수 없다. 이 경우, truncated binary 코딩과 같이 2개 이상의 빈을 할당하여 변환 커널 후보 인덱스를 표현할 수 있다. 상기 truncated binary 코딩 방식에 의해 할당되는 각각의 빈에 대해서, CABAC context가 할당될 수도 있고, CABAC context의 할당없이 bypass 코딩이 적용될 수도 있다. 또는, 복수의 빈 중 일부(예를 들어, 첫번째 빈, 또는 첫번째 및 두번째 빈)에 대해서 CABAC context가 할당되고, 나머지 빈에 대해서 bypass 코딩이 적용될 수도 있다.

[163] 실시예 3

- [164] 현재 블록의 변환 커널은 하나 또는 그 이상의 변환 커널 후보를 포함하는 변환 세트를 기반으로 결정될 수 있다. 현재 블록의 변환 커널은 상기 변환 세트에 속한 하나 또는 그 이상의 변환 커널 후보 중 어느 하나로 유도될 수 있다.
- [165] 현재 블록의 변환 커널을 결정하는 과정은, 1) 현재 블록의 변환 세트를 결정하는 과정 또는 2) 현재 블록의 변환 세트로부터 어느 하나의 변환 커널 후보를 선택하는 과정 중 적어도 하나를 포함할 수 있다. 상기 변환 세트를 결정하는 과정은, 인코딩 장치와 디코딩 장치에 동일하게 기-정의된 복수의 변환 세트 중 어느 하나를 선택하는 과정일 수 있다. 또는, 상기 변환 세트를 결정하는 과정은, 인코딩 장치와 디코딩 장치에 동일하게 기-정의된 복수의 변환 세트 중에서 현재 블록이 이용 가능한 하나 또는 그 이상의 변환 세트를 구성하고, 구성된 변환 세트 중 어느 하나를 선택하는 과정일 수 있다. 또는, 상기 변환 세트를 결정하는 과정은, 인코딩 장치와 디코딩 장치에 동일하게 기-정의된 복수의 변환 커널 후보 중에서 현재 블록이 이용 가능한 변환 커널 후보를 기반으로 하나의 변환 세트를 구성하는 과정일 수 있다.
- [166] 현재 블록의 변환 세트에 복수의 변환 커널 후보가 포함되는 경우, 현재 블록에 대해 복수의 변환 커널 후보 중 어느 하나를 선택하는 과정이 수행될 수 있다. 다만, 현재 블록의 변환 세트에 1개의 변환 커널 후보가 포함된 경우(즉, 현재 블록이 이용 가능한 변환 커널 후보가 1개인 경우), 현재 블록의 변환 커널은 해당 변환 커널 후보로 설정될 수 있다.
- [167] 본 개시에 따른 변환 세트는, 전술한 실시예 1에서의 (비분리) 변환 세트를 의미하거나, 실시예 2에서의 MTS 세트를 의미할 수도 있다. 또는, 상기 변환 세트는, 실시예 1의 (비분리) 변환 세트 또는 실시예 2의 MTS 세트와 별개로 정의된 것일 수 있다. 이 경우, 상기 변환 세트는 변환 커널 후보로서 하나 또는 그 이상의 특정 변환 커널을 포함할 수 있다. 하나의 특정 변환 커널은, 수평 변환을 위한 변환 커널과 수직 변환을 위한 변환 커널의 쌍으로 정의되거나, 수평 및 수직 변환에 동일하게 적용되는 하나의 변환 커널로 정의될 수 있다.
- [168] 본 개시의 실시예에서는, 일차 변환으로 적용되는 비분리 변환인 NSPT 적용 과정을 상세히 설명한다. NSPT는 변환 블록의 전부 또는 일부 영역에 적용될 수 있다. 순방향 NSPT를 기준으로, NSPT가 적용되는 영역에 존재하는 레지듀얼 샘플이 NSPT의 일차원 벡터로 입력될 수 있다. 즉, 한 변환 블록 전체 또는 일부 영역(본 개시에서, Region Of Interest, ROI라고 지칭함)에 존재하는 레지듀얼 샘플들을 일차원 벡터로 모아서 입력으로 구성할 수 있다. 이후, 순방향 NSPT를 적용하면 일차 변환 계수를 획득할 수 있다. 반대로, 일차 변환 계수에 대해 역방향 NSPT를 적용하면 일차원 벡터 출력을 획득할 수 있다. 해당 출력 벡터를 구성하는 각 엘리먼트 값을 2D 변환 블록 내부에 정해진 위치에 배치함으로써 ROI에 대한 레지듀얼 샘플을 획득할 수 있다.
- [169] NSPT를 위한 비분리 변환 커널은 ROI의 크기에 따라 행렬의 차원이 결정될 수 있다. 본 개시에서, 변환 커널은 변환 타입, 변환 행렬로 지칭될 수 있고, NSPT

를 위한 비분리 변환 커널은 NSPT 커널로 지칭될 수 있다. 예를 들어, 현재 블록이 $M \times N$ 변환 블록이고, ROI가 $M \times N$ 변환 블록 전부의 영역이고, 정방향 NSPT가 적용되는 경우, 해당 변환 행렬의 차원은 $MN \times MN$ 일 수 있다. 예를 들어, ROI가 8×8 변환 블록 전부의 영역인 경우, NSPT 커널의 차원은 64×64 일 수 있다.

- [170] 본 개시의 일 실시예에 따르면, NSPT를 인트라 예측에 의해 생성된 레지듀얼에 적용되는 경우, 인트라 예측 모드에 따라 NSPT 커널을 적응적으로 결정할 수 있다. 레지듀얼 블록에 대한 통계적 특성이 인트라 예측 모드마다 달라질 수 있기 때문에, 인트라 예측 모드에 따라 NSPT 커널을 적응적으로 결정함으로써 압축 효율을 높일 수 있다.
- [171] 하나 이상의 인트라 예측 모드에 대해 적용되는 NSPT 커널을 공유하도록 구성할 수 있다. 전술한 바와 같이, 비분리 변환 세트는, 현재 블록의 인트라 예측 모드와 매핑 테이블을 기반으로 결정될 수 있다. 매핑 테이블은, 기-정의된 인트라 예측 모드들과 비분리 변환 세트들 간의 매핑 관계를 정의할 수 있다. 기-정의된 인트라 예측 모드들은 2개의 비방향성 모드와 65개의 방향성 모드들을 포함할 수 있다.
- [172] 일 실시예로서, 인트라 예측 모드들을 인트라 예측 모드 그룹으로 그룹핑할 수 있다. 인트라 예측 모드 그룹에 1개의 NSPT 커널이 할당될 수도 있고, 복수 개의 NSPT 커널이 할당될 수도 있다. 다시 말해, 인트라 예측 모드 그룹에 하나 이상의 NSPT 커널을 포함하는 비분리 변환 세트(NSPT 세트)가 할당될 수 있다. 인트라 예측 모드에 비분리 변환 세트가 매핑되고, 비분리 변환 세트에 포함된 NSPT 커널 N 개 중 하나가 선택될 수 있다.
- [173] 일 예로서, 인트라 예측 그룹은 인접한 예측 모드들(e.g., 17, 18, 19번 모드)을 포함할 수 있다. 또한, 인트라 예측 그룹은 대칭성을 가지는 모드들을 포함할 수 있다. 예를 들어, 앞서 설명한 도 5의 대각 모드(즉, 34번 인트라 예측 모드)를 중심으로 방향성 모드들이 대칭을 이룰 수 있다. 이때, 대칭을 이루는 두 모드는 하나의 그룹(또는 페어)을 구성할 수 있다. 예를 들어, 18번 모드와 50번 모드는 34번 모드를 중심으로 대칭을 이루므로 동일한 그룹에 포함될 수 있다. 다만, 대칭성을 가지는 모드들에 대해서는 순방향 NSPT 커널을 적용하기 전에 2D 입력 블록을 전치시킨 후 일차원 입력 벡터를 구성하는 과정이 추가될 수 있다. 예를 들어, 인트라 예측 모드가 34 이하인 경우, 2D 입력 블록을 전치시키지 않고, 행 우선 방향(row first order)으로 해당 입력 블록으로부터 일차원 입력 벡터를 유도할 수 있다. 만약, 인트라 예측 모드가 34보다 큰 경우, 먼저 2D 입력 블록을 전치시킨 후, 행 우선 방향으로 해당 입력 블록을 읽거나, 2D 입력 블록을 그대로 두고 열 우선 방향(column first order)으로 해당 입력 블록을 읽음으로써 일차원 입력 벡터를 구성할 수 있다.
- [174] 다음의 표 8은 인트라 예측 모드에 따른 NSPT 세트를 할당 매핑 테이블을 예시한다. 표 8을 참조하면, 0부터 34까지 총 35개의 NSPT 세트가 정의될 수 있다. 확장된 WAIP 모드(즉, 도 5에서 -14부터 -1까지 모드와 67부터 80까지의 모드)에는

가장 인접한 일반 방향성 모드에 할당된 NSPT 세트가 할당될 수 있다. 즉, 확장된 WAIP 모드에는 2번 NSPT 세트가 할당될 수 있다.

[175] [표8]

Intra pred. mode	-14	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
NSPT set index	2	2	2	2	2	2	2	2	2	2	2	2	2	2	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Intra pred. mode	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49
NSPT set index	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	33	32	31	30	29	28	27	26	25	24	23	22	21	20	19
Intra pred. mode	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	
NSPT set index	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2

[176] NSPT 세트는 하나 이상의 NSPT 커널(또는 커널 후보)을 포함할 수 있다. 즉, NSPT 세트는 N개의 NSPT 커널 후보를 포함할 수 있다. 일 예로, N은 1, 2, 3, 4 등의 1보다 같거나 큰 값으로 설정될 수 있다. NSPT 세트에 포함된 하나 이상의 NSPT 커널 중 현재 블록에 적용되는 커널을 인덱스를 이용하여 시그널링할 수 있다. 본 개시에서, 해당 인덱스는 NSPT 인덱스로 지칭될 수 있다. 일 예로서, NSPT 인덱스는 0, 1, 2, ..., N - 1의 값을 가질 수 있다.

[177] 또한, 일 실시예로서, NSPT 커널 후보의 개수가 1 개인 경우, NSPT 인덱스 값이 0으로 고정될 수 있다. 이 경우, NSPT 인덱스는 별도로 시그널링되지 않고 추론될 수 있다. 또한, NSPT 인덱스와 별개로 NSPT의 적용 여부를 지시하는 플래그가 시그널링될 수 있다. 본 개시에서, 해당 플래그는 NSPT 플래그로 지칭될 수 있다.

[178] NSPT 플래그 값이 1인 경우, NSPT가 적용될 수 있다. NSPT 플래그 값이 0인 경우, NSPT가 적용되지 않을 수 있다. NSPT 플래그가 시그널링되지 않는 경우, NSPT 플래그 값은 0으로 추론될 수 있다. 일 예로서, NSPT 플래그 값이 1인 경우, NSPT 인덱스가 시그널링될 수 있다. 시그널링된 NSPT 인덱스에 기초하여 인트라 예측 모드에 의해 선택되는 NSPT 세트 내 포함된 N개의 커널 후보 중 하나가 특정될 수 있다.

[179] 일 실시예에서, NSPT 인덱스의 엔트로피 코딩 방법은 NSPT 세트에 포함된 NSPT 커널의 개수(N)를 고려하여 다양한 여러 방법으로 정의될 수 있다. 예를 들어, 0부터 N-1까지의 값을 빈 스트링으로 매핑하는 방법(i.e., 이진화 방법)으로서, 절삭형 단항 이진화(truncated unary binarization), 절삭형 이진화, 고정 길이 이진화 방법이 이용될 수 있다.

[180] 예를 들어, NSPT 세트를 구성하는 커널 후보의 개수 N 값이 2인 경우, 하나의 빈(bin)으로 2개의 후보 중 하나를 특정할 수 있다. 예를 들어, 0은 첫 번째 후보를 지시하고, 1은 두 번째 후보를 지시할 수 있다. 또한, N 값이 3이고 절삭형 단항 이진화를 적용하는 경우, 2개의 빈으로 후보가 특정될 수 있다. 예를 들어, 첫 번째, 두 번째, 세 번째 후보를 각각 0, 10, 11로 이진화하여 시그널링할 수 있다. 실시예로서, 이진화된 빈들은 컨텍스트 코딩(context coding) 또는 바이패스 코딩(bypass coding)을 이용하여 코딩될 수 있다.

[181] 본 개시에서는, 일차 변환으로 축소된 차원의 변환 커널을 이용하는 축소된 일차 변환(RPT, reduced primary transform) 방법을 설명한다. 전술한 바와 같이, 순

방향 NSPT가 적용되는 경우, 2D 레지듀얼 블록에 속하는 샘플들은 행 우선 순위(또는 열 우선 순위)에 따라 1D 벡터로 배열(또는 재배열)될 수 있다. 이후, NSPT를 위한 변환 행렬이 배열된 벡터에 곱해질 수 있다. 해당 2D 레지듀얼 블록이 $M \times N$ 블록(M 은 가로 길이, N 은 세로 길이)일 때, 재배열된 1D 벡터의 길이는 $M \times N$ 이 될 수 있다. 즉, 해당 2D 레지듀얼 블록은 $M \times N \times 1$ 차원을 가진 열 벡터로 나타낼 수도 있다. 본 개시에서, $M \times N$ 은 편의상 MN 으로 표기될 수 있다. 이때, 해당 변환 행렬의 차원은 $MN \times MN$ 일 수 있다. 정리하면, 순방향 NSPT는 $MN \times 1$ 벡터의 좌측에 해당 $MN \times MN$ 변환 행렬을 곱하여 $MN \times 1$ 변환 계수 벡터를 얻는 방식으로 동작할 수 있다.

- [182] RPT가 적용되는 경우, 상술한 순방향 NSPT 변환 행렬로서 $MN \times MN$ 행렬을 곱하는 것이 아니라, $r \times MN$ 행렬을 곱하여 r 개의 변환 계수를 획득할 수 있다. 여기서, r 은 변환 행렬의 행의 개수를 나타내고, MN 은 변환 행렬의 열의 개수를 나타낸다. 본 개시의 실시예에 따르면, r 값은 MN 보다 작거나 같게 설정될 수 있다. 즉, 기존의 순방향 NSPT 변환 행렬은 MN 개의 행을 포함하며, 각 행은 $1 \times MN$ 행 벡터로서 해당 NSPT 변환 행렬의 변환 기저 벡터(transform basis vector)이다. 각 변환 기저 벡터 $MN \times 1$ 샘플 열 벡터를 곱하여 해당 변환 계수가 획득될 수 있다.
- [183] 기존의 순방향 NSPT 변환 행렬은 MN 개의 행 벡터로 구성되므로, 순방향 NSPT의 적용을 통해 MN 개의 변환 계수(즉, $MN \times 1$ 변환 계수 열 벡터)가 획득될 수 있다. 한편, 순방향 RPT의 경우, MN 개의 변환 기저 벡터 대신에 r 개의 변환 기저 벡터로 변환 행렬이 구성될 수 있다. 이에 따라, 순방향 RPT가 적용되는 경우, MN 개 대신 r 개의 변환 계수(즉, $r \times 1$ 변환 계수 열 벡터)가 획득될 수 있다.
- [184] $MN \times MN$ 순방향 NSPT 커널을 구성하는 변환 기저 벡터들 중 일부인 r 개의 변환 기저 벡터를 선택하여 RPT 커널을 구성할 수 있다. 본 개시에서, 변환 커널은 변환 타입, 변환 행렬로 지칭될 수 있고, NSPT를 위한 비분리 변환 커널은 RPT 커널로 지칭될 수 있다. 즉, $MN \times MN$ 순방향 NSPT 커널로부터 r 개의 $1 \times MN$ 행 벡터들을 선택하는 경우, 코딩 성능 관점에서 가장 중요한 변환 기저 벡터들을 선택하는 것이 유리할 수 있다. 구체적으로, 변환을 통한 에너지 압축(energy compaction) 측면에서, 순방향 NSPT 변환 행렬을 곱하여 먼저 등장하는 변환 계수들에 보다 큰 에너지가 몰릴 수 있다. 다시 말해, 순방향 NSPT 변환 행렬 상측에 위치하는 변환 기저 벡터일수록 보다 큰 에너지를 가지는 변환 계수를 생성할 수 있다. 이러한 점을 감안하여, 순방향 NSPT 커널의 상측부터 r 개를 취하여 $r \times MN$ 순방향 RPT 커널을 구성(또는 유도)할 수 있다.
- [185] 본 개시에 따른 RPT는 기존의 NSPT를 적용하여 획득되는 변환 계수들 중 일부(i.e., r 개)만을 취하는 것으로서, 원래 신호가 가지는 에너지 중 일부에 대한 손실이 발생할 수 있다. 즉, 해당 과정을 통해 원본 신호와 본래 신호 사이의 왜곡이 발생할 수 있다. 그럼에도, RPT를 적용함으로써, MN 개 대신에 r 개의 변환 계수만이 생성되므로, 해당 변환 계수들을 코딩하는데 드는 비트 양을 줄일 수 있다. 그렇기 때문에, 적은 개수의 변환 계수들에 에너지가 많이 몰리는 신호의 경우

(e.g., 영상 레지듀얼 신호), 시그널링 비트를 줄임으로써 얻는 이득이 현저히 클 수 있고, 이를 통해 코딩 성능을 향상시킬 수 있다.

- [186] 역방향 NSPT는 변환 행렬로서 상술한 순방향 NSPT 커널의 전치 행렬일 수 있다. 이때, 입력 데이터는 레지듀얼 신호와 같은 샘플 신호 대신 변환 계수 신호일 수 있다. 구체적으로, 순방향 NSPT 변환 행렬이 G 이고 1D 벡터로 재배열된 샘플 신호가 x 이면, 해당 변환 행렬을 좌측에 곱하여 획득되는 변환 계수 벡터는 다음의 수학적 식 4와 같이 표현될 수 있다.

- [187] [수식4]

$$y=Gx$$

- [188] 수학적 식 4를 참조하면, x 와 y 는 $MN \times 1$ 열 벡터일 수 있다. G 는 $MN \times MN$ 행렬의 형태를 가질 수 있다. 역방향 NSPT 과정은 같은 변수를 이용하여 다음의 수학적 식 5와 같이 표현될 수 있다.

- [189] [수식5]

$$x=G^T y$$

- [190] 수학적 식 5에서, G^T 는 G 의 전치 행렬(Transpose matrix)을 의미한다. 본 개시에 따른 순방향 RPT 연산 및 역방향 RPT 연산 또한 상기 두 수학적 식으로 표현될 수 있다. 다만, RPT가 적용되는 경우, y 는 $MN \times 1$ 열 벡터 대신에 $r \times 1$ 열 벡터이고, G 는 $MM \times MN$ 행렬 대신에 $r \times MN$ 행렬이다. 즉, NSPT 대신에 RPT를 적용하더라도 샘플 신호(e.g., 영상 레지듀얼 신호)의 차원은 변하지 않는데, 이는 역방향 RPT를 통해 r 개의 변환 계수만 가지고도 원래 개수의 샘플 신호(즉, MN 개의 샘플 신호)를 복원할 수 있음을 의미할 수 있다. 즉, MN 개 보다 적은 r 개의 변환 계수만을 코딩하여 원래의 MN 개의 샘플 신호를 복원할 수 있어 코딩 성능의 향상을 가져올 수 있다.

- [191] 본 개시의 일 실시예에서는, 레지듀얼 블록의 통계적 특성을 고려하여 r 값을 정의하고, 정의된 r 값에 따라 결정되는 감소된 크기의 레지듀얼 블록으로부터 기존 변환 블록 크기의 레지듀얼 블록을 유도하는 RPT 구조를 제안한다. 만약 일차 변환 계수의 통계적 분포를 예측하기 위하여 추가적인 다른 변환(i.e., 이차 변환)을 적용하는 경우, 일차 변환 계수에 양자화 과정이 적용이 되므로 상대적으로 낮은 주파수 영역에 양자화된 논-제로 계수들(quantized non-zero coefficients)이 집중하여 존재할 수 있다. 이에 따라, 일차 변환 계수의 통계적 분포를 위한 축소된 이차 변환(reduced secondary transform)은 주어진 낮은 주파수 영역을 위한 r 값을 설정하는 형태로 일차 변환 계수의 통계적 특성을 상대적으로 간단하게 정의할 수 있다. 그러나, 본 개시에 따른 RPT의 경우에는 일차 변환 계수의 분포와는 매우 상이한 특성을 가지는 레지듀얼 블록 내 샘플들의 통계적 특성을 고려하여 r 값을 정의하기 위한 기술로서 축소된 이차 변환과는 근본적인 차이점을 가진다. 이하에서는, 축소된 차원의 변환 행렬인 RPT 커널을 결정하는 다양한 여러

실시예를 설명하도록 한다. 다시 말해, RPT에서의 r 값을 결정 또는 정의하기 위한 방법을 이하에서 설명한다.

- [192] 본 개시의 일 실시예에서는, 변환 시스템에서 허용하는 워스트 케이스 복잡도(worst case complexity)를 고려하여 RPT에서의 r 값을 결정할 수 있다. 일 실시예로서, 샘플당 곱셈수를 기준으로 워스트 케이스 복잡도를 산정할 수 있다. $M \times N$ 블록을 기준으로 순방향 및 역방향 모두 RPT를 적용하는데에는 $MN * r$ 개의 곱셈이 필요하다. 2D 블록은 총 MN 개의 샘플들로 구성되므로 샘플당 곱셈수는 $(MN * r) / MN = r$ 개로 계산될 수 있다. 따라서, r 값을 허용되는 최대 샘플당 곱셈수 이하로 유지되도록 구성할 수 있다. 예를 들어, 16×16 블록에 대해 최대 가능한 샘플당 곱셈수가 16으로 설정되는 경우, r 값은 16 이하로 결정될 수 있다. 즉, 순방향 RPT 커널은 16×256 으로 설정될 수 있다.
- [193] 다른 일 실시예에서, 워스트 케이스 복잡도의 척도로서 메모리 사용량(memory usage)을 고려할 수 있다. 일 예로서, 커널 한 개당 허용되는 메모리 크기를 설정할 수 있다. 예를 들어, 커널 계수(본 개시에서 변환 커널을 구성하는 각 엘리먼트를 커널 계수로 지칭함)마다 p 바이트가 필요하고, 커널 1개당 q 바이트 이하로 메모리 사용량이 설정되는 경우, r 값은 $q / (MN * p)$ 이하로 설정될 수 있다. 예를 들어, 16×16 블록에 대한 순방향 RPT 커널에 대해 p 가 1 바이트이고 커널 1개당 8KB 이하로 메모리 사용량이 설정되는 경우($q = 8KB = 2^{13}$ 바이트), r 값은 32 이하로 설정될 수 있다.
- [194] 또한, 다른 일 예로서, 워스트 케이스 복잡도의 척도로서 메모리 사용량 및/또는 샘플당 곱셈수를 고려할 수 있다. 예를 들어, 16×16 블록에 대해 최대 가능한 샘플당 곱셈수를 16으로 설정하고, 커널 1개당 8KB 이하로 메모리 사용량이 설정되는 경우(커널 계수는 1 바이트로 표현), r 값은 16 이하로 설정될 수 있다.
- [195] 또한, 일 실시예에서, RPT 커널을 구성하는 r 값은 특정한 정보에 의해 결정될 수 있다. 다시 말해, RPT 커널을 구성하는 r 값은 미리 정의된 부호화 파라미터에 기초하여 결정될 수 있다. 예를 들어, 블록의 크기에 따라 r 값이 결정될 수 있다. 다시 말해, 블록의 크기에 따라 RPT 커널이 가변적으로 결정될 수 있다. 여기서, 블록은 코딩 블록, 변환 블록, 예측 블록 중 적어도 하나일 수 있다. 또한, 예를 들어, 예측 정보에 기초하여 r 값이 결정될 수 있다. 여기서, 예측 정보는 인터/인트라 예측에 관한 정보, 인트라 예측 모드 정보 등을 포함할 수 있다. 또한, 예를 들어, 시그널링되는 정보(신택스 요소의 값)에 기초하여 r 값이 결정될 수 있다. 예를 들어, 양자화 파라미터 값에 따라 r 값이 가변적으로 결정될 수 있다. 또한, 복잡도 개선 측면에서, r 값으로 미리 정의된 고정된 값이 사용될 수도 있으며, 상기 미리 정의된 고정된 값은 시그널링되는 정보를 기반으로 결정될 수 있다.
- [196] RPT 커널 $r \times MN$ 을 샘플 신호에 곱하면, r 개의 변환 계수가 획득될 수 있다. 획득된 r 개의 변환 계수는 미리 정의된 변환 계수의 스캔 순서(ex., 정방향/역방향 지그재그(zig-zag) 스캔 순서, 정방향/역방향 수평(horizontal) 스캔 순서, 정방향/역방향 수직(vertical) 스캔 순서, 정방향/역방향 대각(diagonal) 스캔 순서, 인트라

예측 모드를 기반으로 특정된 스캔 순서 등)에 따라 배치될 수 있다. 이러한 스캔 순서(예컨대, 계수 그룹(coefficient group, CG) 단위의 스캔 순서도 적용 가능함)에 따라 순방향 RPT 적용으로부터 획득되는 변환 계수들을 배치하는 경우, r 값이 MN 보다 작으면 r 개의 변환 계수를 가지고 $M \times N$ 블록 내부를 전부 채우지 못하게 되어 빈 공간이 발생할 수 있다. 본 개시의 실시예로서, 상술한 빈 공간은 레지듀얼 신호의 특성을 고려하여 다음과 같은 방법으로 예측될 수 있다.

- [197] - 이용 가능한 주변 화소의 값을 이용하여 빈 공간의 값을 채울 수 있다.
- [198] - 이용 가능한 주변 화소의 값 및 인트라 예측 모드에 기초하여 빈 공간의 값을 채울 수 있다. 예를 들어, 이용 가능한 주변 화소의 값 및 인트라 예측 모드를 기반으로 인트라 예측을 수행하여 빈 공간의 값을 예측할 수 있다.
- [199] - 미리 정의된 고정된 값(예컨대, 0)을 이용하여 빈 공간의 값을 채울 수 있다.
- [200] - 미리 정해진 인트라 예측 모드(예컨대, 플래너 모드)를 이용하여 이용 가능한 주변 화소로부터 빈 공간의 값을 채울 수 있다.
- [201] 본 개시에서, 상술한 예시 중 빈 공간을 0으로 채우는 것은 제로 아웃 과정으로 지칭될 수 있다. 빈 공간을 0으로 채우는 경우, 다음과 같은 실시예가 적용될 수 있다. 디코딩 장치 측에서 변환 계수의 파싱 중에 해당 빈 공간 부분에 0이 아닌 변환 계수가 검출(또는 파싱)되는 경우, RPT가 적용되지 않는 것으로 간주(또는 추론)할 수 있다. 다시 말해, 상기 해당 빈 공간을 나타내는 미리 정의된 영역에 0이 아닌 변환 계수가 존재하는 경우, RPT가 적용되지 않는 것으로 간주될 수 있다. 이 경우, RPT의 적용 여부를 지시하는 플래그 및/또는 복수의 RPT 커널 후보들 중 하나를 지정하는 인덱스에 대한 시그널링(또는 파싱)이 수행되지 않을 수 있다. 일 예로서, 상기 해당 빈 공간을 나타내는 미리 정의된 영역에 0이 아닌 변환 계수가 존재하는 경우, 미리 정의된 변수 값이 업데이트될 수 있고, 업데이트된 변수 값에 기초하여 RPT가 적용되지 않는 것으로 추론될 수 있다.
- [202] 본 개시의 일 실시예에서, 블록의 크기 및/또는 형태에 따라 RPT의 적용 여부가 결정될 수 있다. 또한, 블록의 크기 및/또는 형태에 따라 RPT 커널이 가변적으로 결정될 수 있다. 블록의 크기 및/또는 형태에 따라(즉, $M \times N$ 블록 별로), r 값은 다를 수 있으므로, 블록의 크기 및/또는 형태에 따라 빈 공간은 달라질 수 있다. 이에 따라, 블록의 크기 및/또는 형태 별로 0이 아닌 변환 계수가 검출되는지 여부를 체크하는 영역은 다르게 정의될 수 있다. 다시 말해, 제로 아웃 영역은 가변적으로 결정될 수 있다.
- [203] 일 예로서, 8×8 블록에 대한 순방향 RPT 행렬로서 16×64 행렬이 적용되는 경우, r 값은 16일 수 있다. 이 경우, CG가 4×4 서브 블록일 때, 좌상단 4×4 블록에만 0이 아닌 RPT 변환 계수가 채워질 수 있고, 빈 공간인 나머지 3개의 4×4 서브 블록들(즉, 우상단, 좌하단, 우하단 서브 블록)에는 0 값이 채워질 수 있다. 이때, 디코딩 과정 중에 해당 나머지 3개의 4×4 서브 블록 영역에 0이 아닌 변환 계수가 검출되는 경우, RPT가 적용되지 않는 것으로 간주할 수 있다. 그리고, 전술한 바와 같이,

RPT의 적용 여부를 지시하는 플래그 또는 복수의 RPT 커널 후보들 중 하나를 지정하는 인덱스는 시그널링 되지 않을 수 있다.

- [204] 또한, 일 예로서, 16x8 블록에 대한 순방향 RPT 행렬로서 32x128 행렬이 적용되고(즉, r 값은 32), CG는 4x4 서브 블록일 때, 스캔 순서 상 2개의 CG에만 0이 아닌 RPT 변환 계수가 채워질 수 있다. 예를 들어, 좌상단 4x4 서브 블록 및 좌상단 서브 블록 하측에 인접한 4x4 서브 블록에 해당 RPT 변환 계수들이 채워질 수 있다. 빈 공간으로서 0으로 채워지는 영역은 해당 2개의 4x4 서브 블록들을 제외한 나머지 영역으로 결정될 수 있다. 블록의 크기 및/또는 형태에 따라 RPT 커널이 가변적으로 결정될 수 있고, 살펴본 바와 같이, 8x8 블록과 16x8 블록에 대해서는 빈 공간이 다르게 결정될 수 있다.
- [205] 실시예로서, r 값이 CG 크기의 배수이고 CG 단위로 변환 계수가 스캔되는 경우, 빈 공간에 속한 CG들에 0이 아닌 변환 계수가 존재하는 것이 검출되면 RPT와 관련된 플래그 및/또는 인덱스가 시그널링 되지 않을 수 있다. 즉, CG마다 CG 내부 변환 계수들을 지정된 순서에 따라 스캔하고, CG 단위에 대한 스캔 순서에 따라 다음 CG로 넘어가서 동일하게 CG 내부 변환 계수들을 스캔할 수 있다. 종래의 영상 압축 기술에서는, 각 CG에 대해 해당 CG 내에 0이 아닌 변환 계수가 존재하는지 여부에 대한 플래그가 먼저 시그널링되므로, 해당 정보만으로 RPT 적용 여부가 결정될 수 있으며, 이를 통해 시그널링 오버헤드가 줄 수 있고 관련 구현 복잡도가 감소할 수 있다.
- [206] 상술한 바와 같이, RPT가 적용되는 경우 0으로 채워지는 빈 공간 영역에 0이 아닌 변환 계수가 검출되면, RPT가 적용되지 않을 수 있다. 이 경우, RPT와 관련된 정보에 대한 시그널링이 생략될 수 있다. 다만, 해당 빈 공간 영역에 0이 아닌 변환 계수가 검출되지 않는 경우 RPT의 적용 여부를 판단할 수 없으므로, 관련 변환 계수 파싱(또는 시그널링) 이후 RPT 적용 여부를 가리키는 플래그를 파싱하여 RPT 적용 여부를 최종 판단할 수 있다.
- [207] 일 실시예로서, RPT 적용을 통해 생성된 변환 계수들에 대하여 순방향 이차 변환을 추가적으로 적용할 수 있다. 또는, $M \times N$ 블록 내 해당 생성된 변환 계수들이 위치하는 영역에 대하여 순방향 이차 변환을 추가적으로 적용할 수 있다. 본 개시에서, 해당 영역 또는 해당 영역의 일부는 순방향 이차 변환 관점에서는 ROI로 지칭될 수 있다. 역방향에 대해서는 역방향 이차 변환을 먼저 적용한 후 역방향 RPT를 적용할 수 있다. 구체적으로, 순방향 RPT 적용으로 생성된 r 개의 변환 계수가 배치된 영역 또는 해당 영역의 일부를 ROI로 설정하여 순방향 이차 변환을 적용할 수 있다. 이 경우, 8x8 영역에 대해 16x64 순방향 RPT 변환 행렬이 적용되는 경우, 생성된 16개의 변환 계수는 좌상단 4x4 서브 블록에 위치할 수 있고 해당 서브블록 영역을 ROI로 설정하여 해당 ROI에 대해 순방향 이차 변환이 적용될 수 있다.
- [208] 또한, RPT 커널은 정수 연산 또는 고정 소수점 연산과 같은 연산을 고려하여 계수 값이 조정될 수 있다. 즉, RPT 커널은 이론적인 직교 변환 또는 비-직교(non-

orthogonal) 변환 (여기서, 직교 변환 및 비-직교 변환은 각 변환 기저 벡터의 놈 (norm)이 1인 변환을 나타냄)이 아닌, 해당 커널에 속한 커널 계수들을 적절히 스케일링하여 실제적인 코덱 시스템에서 정수 연산(또는 고정 소수점 연산)을 통해 변환을 수행하도록 구성할 수 있다. 기존의 영상 압축 기술에서 분리 변환을 적용할 때 곱해지는 스케일링 팩터(scaling factor) 만큼, RPT를 적용하는 경우에도 동일하게 반영할 수 있다. 이 경우, 변환 이외의 다른 과정(e.g., 양자화, 역양자화 과정)은 유지하면서 분리 변환 또는 비분리 변환(RPT 포함)을 수행할 수 있다.

[209] 변환 기저 벡터에 상술한 스케일링 값을 곱함으로써 RPT 커널의 정수화된 계수를 획득할 수 있다. 실시예로서, 스케일링 값을 곱하는 것은 각 커널 계수에 반올림, floor, ceiling 등의 연산을 적용하는 것을 포함할 수 있다. 즉, 상술한 방법을 통해 획득된 정수화된 RPT 커널이 정의되고 변환/역변환 과정에 이용될 수 있다. 상술한 바와 같이, 반올림, floor, ceiling 등의 연산을 거쳐 스케일링된 정수값의 커널 계수들을 획득하면 모든 커널 계수들에 대해 최대값과 최소값을 구할 수 있으므로, 해당 최대값과 최소값으로부터 모든 커널 계수들을 표현할 수 있을만큼의 비트 수를 얻을 수 있다. 예를 들어, 해당 최대값이 127 이하이고 해당 최소값이 -128 이상이라면 8개의 bit로(특히, 2의 보수 표현 등을 통해) 모든 정수 커널 계수들을 표현할 수 있다.

[210] 일반화하면, 해당 최대값이 $(2^{(N-1)} - 1)$ 이하이고 해당 최소값이 $-2^{(N-1)}$ 이상이라면 N개의 bit로 모든 정수 커널 계수들을 표현할 수 있다. 만약, 최대값이 $(2^{(N-1)} - 1)$ 보다 크거나 최소값이 $-2^{(N-1)}$ 보다 작은 경우, N개의 bit로 모든 정수 커널 계수들을 표현할 수 없을 수 있다. 이러한 경우, 1) 모든 커널 계수들에 추가적으로 스케일링 값을 곱하여 N 비트 범위 안에 들어오도록 조정하거나, 2) 커널 계수를 표현하는데 필요한 비트 수를 늘릴 수 있다(즉, N+1 비트 이상). 만약, N 비트로 표현하기 위해 모든 커널 계수들에 2^p 만큼을 곱해야 하는 경우($p \geq 1$), 기존의 부호화/복호화 과정에 융합되도록, 이후 2^p 만큼을 곱하여 보상할 수 있다. 실시예로서, 2^p 만큼을 곱하는 것은 왼쪽으로 p 비트 만큼 추가적으로 시프트 연산을 수행하거나, 양자화 또는 역양자화 과정에서 적용되는 오른쪽 시프트 양을 p 만큼 줄이는 방식 등으로 구현될 수 있다.

[211] 이상에서 설명한 방법으로 모든 커널 계수들을 8-bit, 9-bit, 10-bit 등으로 표현할 수 있으며, 물론 블록 크기나 커널마다 커널 계수의 스케일링 값을 다르게 설정할 수도 있고, 커널 계수를 표현하기 위한 비트 수를 다르게 설정할 수도 있다.

[212] 전술한 NSPT는 현재 블록의 크기, 트리 타입, 또는 성분 타입 중 적어도 하나에 기초하여 적용될 수 있다. 일례로, 현재 블록의 크기, 트리 타입, 또는 성분 타입 중 적어도 하나에 기초하여, NSPT의 적용 여부가 결정될 수 있다. 현재 블록의 크기, 트리 타입, 또는 성분 타입 중 적어도 하나에 기초하여, NSPT 인덱스가 시그널링될 수 있다. 현재 블록의 크기, 트리 타입, 또는 성분 타입 중 적어도 하나에 기초하여, NSPT 세트 또는 NSPT 커널이 유도될 수 있다.

- [213] 디코딩 장치에 기-정의된 허용 변환 블록 크기들(allowed transform block sizes)들은 크게 2개 그룹으로 구분될 수 있다. 2개의 그룹 중 어느 하나(이하, 제1 그룹이라 함)는, NSPT가 적용될 수 있는 블록 크기의 집합을 의미할 수 있다. 상기 제1 그룹은, 상기 허용 변환 블록 크기들 중 어느 하나로 구성될 수도 있고, 상기 허용 블록 크기들 중 둘 또는 그 이상의 블록 크기들로 구성될 수도 있다. NSPT가 적용될 수 있는 블록 크기는, 너비와 높이 중 적어도 하나가 소정의 문턱값보다 작거나 같은 블록 크기로 정의될 수 있다. 또는, NSPT가 적용될 수 있는 블록 크기는, 너비와 높이의 곱이 소정의 문턱값보다 작거나 같은 블록 크기로 정의될 수도 있다. 또는, NSPT가 적용될 수 있는 블록 크기는, 너비와 높이 중 최대값이 소정의 문턱값보다 작거나 같은 블록 크기로 정의될 수도 있다. 상기 문턱값은, 4, 8, 16, 32, 64, 128 또는 그 이상의 정수일 수 있다.
- [214] 상기 2개의 그룹 중 다른 하나(이하, 제2 그룹이라 함)는, NSPT가 적용되지 않는 블록 크기의 집합을 의미할 수 있다. 상기 제2 그룹에 속한 블록 크기들에 대해서는 전술한 분리 일차 변환이 적용될 수 있다. 또한, 상기 제2 그룹에 속한 블록 크기들 전부 또는 일부에 대해서는 비분리 이차 변환이 적용될 수도 있다.
- [215] 예를 들어, 현재 블록의 크기가 제1 그룹에 속하는 경우, 현재 블록의 (역양자화된) 변환 계수에 역방향의 NSPT가 적용될 수 있다. 현재 블록의 크기가 제2 그룹에 속하는 경우, 현재 블록의 (역양자화된) 변환 계수에 역방향의 분리 일차 변환이 적용될 수 있다. 또는, 현재 블록의 크기가 제2 그룹에 속하는 경우, 현재 블록의 (역양자화된) 변환 계수에 대해 역방향의 비분리 이차 변환(e.g., low frequency non-separable transform, LFNST)이 먼저 적용되고, 그로부터 얻어진 변환 계수에 대해 역방향의 분리 일차 변환(e.g. DCT-2)이 적용될 수 있다.
- [216] 일례로, NSPT가 적용될 수 있는 블록 크기의 집합인 제1 그룹은, 4x4, 4x8, 8x4, 8x8의 집합으로 정의될 수 있다. 또는, 제1 그룹은, 4x8, 8x4, 8x8의 집합으로 정의될 수 있다. 또는, 제1 그룹은, 4x8, 8x4의 집합으로 정의될 수 있다. 또는, 제1 그룹은, 4x4, 4x8, 4x16, 8x4, 8x8, 16x4의 집합으로 정의될 수 있다. 또는, 제1 그룹은, 4x8, 4x16, 8x4, 8x8, 16x4의 집합으로 정의될 수 있다. 또는, 제1 그룹은, 4x8, 4x16, 8x4, 16x4의 집합으로 정의될 수 있다. 또는, 제1 그룹은, 4x4, 4x8, 8x4, 8x8, 8x16, 16x8, 16x16의 집합으로 정의될 수 있다. 또는, 제1 그룹은, 4x4, 4x8, 8x4, 8x8, 8x16, 16x8의 집합으로 정의될 수 있다. 또는, 제1 그룹은, 4x8, 8x4, 8x8, 8x16, 16x8의 집합으로 정의될 수 있다. 또는, 제1 그룹은, 4x8, 8x4, 8x16, 16x8의 집합으로 정의될 수 있다. 또는, 제1 그룹은, 4x4, 4x8, 8x4, 8x8, 8x16, 16x8, 16x16, 16x32, 32x16, 32x32의 집합으로 정의될 수 있다. 또는, 제1 그룹은, 4x4, 4x8, 8x4, 8x8, 8x16, 16x8, 16x16, 16x32, 32x16의 집합으로 정의될 수 있다. 또는, 제1 그룹은, 4x8, 8x4, 8x8, 8x16, 16x8, 16x16, 16x32, 32x16의 집합으로 정의될 수 있다. 또는, 제1 그룹은, 4x8, 8x4, 8x16, 16x8, 16x16, 16x32, 32x16의 집합으로 정의될 수 있다. 또는, 제1 그룹은, 4x8, 8x4, 8x16, 16x8, 16x32, 32x16의 집합으로 정의될 수 있다. 또는, 제1 그룹은, 4x4, 4x8, 4x16, 8x4, 16x4의 집합으로 정의될 수 있다. 또

는, 제1 그룹은, 4×4 , 4×8 , 4×16 , 8×4 , 8×8 , 8×16 , 16×4 , 16×8 의 집합으로 정의될 수 있다. 또는, 제1 그룹은, 4×8 , 4×16 , 8×4 , 8×8 , 8×16 , 16×4 , 16×8 의 집합으로 정의될 수 있다. 또는, 제1 그룹은, 4×4 , 4×8 , 4×16 , 8×4 , 8×16 , 16×4 , 16×8 의 집합으로 정의될 수 있다. 또는, 제1 그룹은, 4×8 , 4×16 , 8×4 , 8×16 , 16×4 , 16×8 의 집합으로 정의될 수 있다. 또는, 제1 그룹은, 4×4 , 4×8 , 4×16 , 8×4 , 8×8 , 8×16 , 16×4 , 16×8 , 16×16 의 집합으로 정의될 수 있다. 또는, 제1 그룹은, 4×8 , 4×16 , 8×4 , 8×8 , 8×16 , 16×4 , 16×8 , 16×16 의 집합으로 정의될 수 있다. 또는, 제1 그룹은, 4×4 , 4×8 , 4×16 , 8×4 , 8×16 , 16×4 , 16×8 , 16×16 의 집합으로 정의될 수 있다. 또는, 제1 그룹은, 4×8 , 4×16 , 8×4 , 8×16 , 16×4 , 16×8 , 16×16 의 집합으로 정의될 수 있다. 또는, 제1 그룹은, 4×4 , 4×8 , 4×16 , 4×32 , 8×4 , 8×16 , 8×32 , 16×4 , 16×8 , 32×4 , 32×8 의 집합으로 정의될 수 있다. 또는, 제1 그룹은, 4×8 , 4×16 , 4×32 , 8×4 , 8×16 , 8×32 , 16×4 , 16×8 , 32×4 , 32×8 의 집합으로 정의될 수 있다. 제1 그룹은, 4×4 , 4×8 , 4×16 , 4×32 , 8×4 , 8×8 , 8×16 , 8×32 , 16×4 , 16×8 , 16×16 , 32×4 , 32×8 의 집합으로 정의될 수 있다. 또는, 제1 그룹은, 4×4 , 4×8 , 4×16 , 4×32 , 8×4 , 8×8 , 8×16 , 8×32 , 16×4 , 16×8 , 16×16 , 16×32 , 32×4 , 32×8 , 32×16 의 집합으로 정의될 수 있다. 또는, 제1 그룹은, 4×4 , 4×8 , 4×16 , 4×32 , 8×4 , 8×8 , 8×16 , 8×32 , 16×4 , 16×8 , 16×16 , 16×32 , 32×4 , 32×8 , 32×16 의 집합으로 정의될 수 있다. 또는, 제1 그룹은, 4×8 , 4×16 , 4×32 , 8×4 , 8×16 , 8×32 , 16×4 , 16×8 , 16×32 , 32×4 , 32×8 , 32×16 의 집합으로 정의될 수 있다. 또는, 제1 그룹은, 4×4 , 4×8 , 4×16 , 4×32 , 8×4 , 8×8 , 8×16 , 8×32 , 16×4 , 16×8 , 16×16 , 16×32 , 32×4 , 32×8 , 32×16 , 32×32 의 집합으로 정의될 수 있다.

- [217] 상기 제1 그룹에 속한 블록 크기들에 대해서 소정의 차원을 가진 NSPT 행렬(또는, NSPT 커널)이 적용될 수 있다. 여기서, NSPT 행렬은, 역방향의 변환 행렬로서 $P \times Q$ 의 차원을 가진 행렬로 표현될 수 있고, $P \times Q$ 행렬은 행(row)의 개수와 열(column)의 개수가 각각 P 와 Q 인 행렬을 나타낸다.
- [218] 일례로, 4×4 블록에 대해서는 16×16 의 NSPT 행렬이 적용될 수 있다. 4×8 블록 또는 8×4 블록 중 적어도 하나에 대해서는 32×20 의 NSPT 행렬이 적용될 수 있다. 4×16 블록 또는 16×4 블록 중 적어도 하나에 대해서는 64×24 의 NSPT 행렬이 적용될 수 있다. 8×8 블록에 대해서는 64×32 의 NSPT 행렬이 적용될 수 있다. 8×16 블록 또는 16×8 블록 중 적어도 하나에 대해서는 128×40 의 NSPT 행렬이 적용될 수 있다. 16×16 블록에 대해서는 256×44 의 NSPT 행렬이 적용될 수 있다. 4×32 블록 또는 32×4 블록에 대해서는 128×36 , 128×38 , 또는 128×40 의 NSPT 행렬이 적용될 수 있다. 8×32 블록 또는 32×8 블록에 대해서는 256×48 의 NSPT 행렬이 적용될 수 있다. 16×32 블록 또는 32×16 블록에 대해서는 512×52 또는 512×54 의 NSPT 행렬이 적용될 수 있다.
- [219] 상기 $P \times Q$ 행렬은 역방향의 NSPT 행렬이므로, $Q \times 1$ 입력 벡터에 $P \times Q$ 행렬을 적용하여(즉, $(P \times Q \text{ 행렬}) \times (Q \times 1 \text{ 입력 벡터})$) $P \times 1$ 출력 벡터를 획득할 수 있다. 여기서, $Q \times 1$ 입력 벡터는 NSPT가 적용되는 현재 블록 내 (역양자화된) 변환 계수들에 대응될 수 있다. 이때, Q 의 값은, NSPT가 적용되는 변환 계수들의 개수를 의미할

수 있고, 현재 블록의 너비와 높이의 곱보다 작거나 같을 수 있다. Q의 값은, 전술한 제1 그룹에 속한 블록 크기들 중 현재 블록의 크기에 기초하여 가변적으로 결정될 수 있다. 또는, Q의 값은, 제1 그룹에 속한 블록 크기들에 대해서 동일하게 설정될 수도 있다. Px1 출력 벡터는 잔차 신호(또는, 복호화된 레지듀얼 샘플들)에 대응될 수 있다. P의 값은 현재 블록의 너비와 높이의 곱과 같을 수 있다.

[220] 반대로, 순방향의 NSPT 행렬은 상기 PxQ 행렬의 전치 행렬인 QxP 행렬로 표현될 수 있다. Px1 입력 벡터에 QxP 행렬을 적용하여(즉, (QxP 행렬)x(Px1 입력 벡터)) Qx1 출력 벡터를 획득할 수 있다. 여기서, Px1 입력 벡터는 NSPT가 적용되는 현재 블록 내 레지듀얼 샘플들에 대응될 수 있다. P의 값은 현재 블록의 너비와 높이의 곱과 같을 수 있다. Qx1 출력 벡터는 NSPT를 통해 유도되는 현재 블록 내 변환 계수들에 대응될 수 있다. 이때, Q의 값은, NSPT를 통해 출력되는 변환 계수들의 개수를 의미할 수 있고, 현재 블록의 너비와 높이의 곱보다 작거나 같을 수 있다. 마찬가지로, Q의 값은, 전술한 제1 그룹에 속한 블록 크기들 중 현재 블록의 크기에 기초하여 가변적으로 결정될 수 있다. 또는, Q의 값은, 제1 그룹에 속한 블록 크기들에 대해서 동일하게 설정될 수도 있다.

[221] 상기 예와 같이, 비정방향 블록인 MxN 블록과 NxM 블록에 대해 NSPT가 적용될 수 있다. 예를 들어, 4x8 블록과 8x4 블록에 대해 NSPT가 적용될 수 있다. 또는, 4x16 블록과 16x4 블록에 대해 NSPT가 적용되거나, 8x16 블록과 16x8 블록에 대해 NSPT가 적용되거나, 16x32 블록과 32x16 블록에 대해 NSPT가 적용될 수 있다.

[222] 상기 제1 그룹에 속한 특정 블록 크기들에 대해서 NSPT를 적용함으로써, 보다 정교하게 변환을 수행할 수 있고, 코딩 성능이 향상될 수 있다. 순방향의 LFNST가 적용될 때, LFNST가 적용되는 영역(i.e. Region-Of-Interest, ROI)을 제외한 나머지 영역의 일차 변환된 변환 계수들이 zero-out될 수 있다. 또한, LFNST는 적은 개수의 변환 기저 벡터들(transform basis vectors)로 구성될 수 있다. 이러한 경우, 해당 블록 크기들에 대해 NSPT 대신 DCT-2와 같은 분리 일차 변환과 LFNST와 같은 비분리 이차 변환을 적용하게 되면, 성능 저하가 발생할 수 있다. 해당 경우에 대해 LFNST 대신에 NSPT를 적용하게 되면, 상기 zero-out 과정이 생략되고, LFNST를 적용하는 경우에 비해 코딩 성능이 향상될 수 있다. 또한, NSPT를 적용하는 방식에 의해서도 성능 향상이 기대될 수 있다. 후술할 대칭성(symmetry)을 이용하여 NSPT 또는 LFNST가 적용될 수 있다. 여기서, LFNST의 경우, ROI 영역에 대해서만 대칭성을 이용하여 해당 입력 블록에 대해 transpose 연산을 수행한다. 반면, NSPT의 경우, 블록 전체에 대해 대칭성을 이용하여 transpose 연산을 수행한다. 따라서, NSPT의 경우, 보다 정교한 방식의 대칭성을 이용하여 해당 NSPT 커널을 training하고 적용할 수 있게 되어 성능 향상이 기대될 수 있다.

[223] 또한, 8x8 블록에 대해서 NSPT가 아니라 LFNST를 적용하는 경우, 순방향의 변환 관점에서 16x64 변환 행렬 대신에 32x64 변환 행렬을 적용할 수 있다. 여기서, 16x64 변환 행렬은 32x64 변환 행렬에서 상위 16개의 행(row)을 샘플링하여 구

성될 수 있다. 8x8 블록에 대해 16x64 변환 행렬 기반의 LFNST를 적용할 경우, LFNST를 적용하는데 샘플당 16개의 곱셈이 필요하게 되나, 32x64 변환 행렬을 이용할 경우, LFNST를 적용하는데 샘플당 32개의 곱셈이 필요하게 된다. 하지만, 이와 같이 32x64 변환 행렬을 이용하는 경우, 코딩 성능의 향상이 기대될 수 있다.

- [224] 현재 블록의 트리 타입이 싱글 트리(single tree)인 경우, 현재 블록의 루마 성분에 대해서 NSPT를 적용하고, 현재 블록의 크로마 성분에 대해서 NSPT를 적용하지 않을 수 있다. 현재 블록의 트리 타입이 듀얼 트리(dual tree)인 경우, 현재 블록의 루마 성분과 크로마 성분에 대해서 NSPT를 적용할 수 있다.
- [225] 또는, 현재 블록의 트리 타입이 싱글 트리인지 여부와 관계없이, 현재 블록의 루마 성분에 대해서 NSPT를 적용하고, 현재 블록의 크로마 성분에 대해서 NSPT를 적용하지 않을 수 있다. 또는, 현재 블록의 트리 타입이 싱글 트리인지 여부와 관계없이, 현재 블록의 루마 성분과 크로마 성분에 대해서 NSPT를 적용할 수도 있다.
- [226] 일례로, 현재 블록의 트리 타입이 싱글 트리이고, 루마 성분과 크로마 성분에 대해서 NSPT가 허용되고, 현재 블록의 크기가 제1 그룹에 속하는 경우, 하나의 NSPT 인덱스가 시그널링될 수 있고, 현재 블록의 루마 성분과 크로마 성분은 해당 NSPT 인덱스를 공유할 수 있다. 여기서, NSPT 인덱스는 NSPT를 위한 변환 커널 후보들 중 어느 하나를 선택하기 위한 인덱스일 수 있다. 현재 블록의 루마 블록과 크로마 블록의 크기가 상기 제1 그룹에 속하는 경우, 상기 동일한 NSPT 인덱스에 의해 선택된 변환 커널 후보가 루마 성분과 크로마 성분에 적용될 수 있다. 현재 블록의 트리 타입이 싱글 트리이면서 루마 성분에 대해서만 NSPT가 적용되는 경우, 현재 블록의 크로마 성분에 대해서는 LFNST가 적용되지 않을 수 있고, 분리 변환이 적용될 수 있다. 또는, 현재 블록의 트리 타입이 싱글 트리이면서 루마 성분에 대해서만 NSPT가 적용되는 경우, 현재 블록의 크로마 성분에 대해서 LFNST가 적용될 수 있다.
- [227] 싱글 트리의 경우, 루마 성분과 크로마 성분 간에 연관성이 높은 특성을 가질 수 있다. 이 경우, 루마 성분에만 NSPT를 적용하거나, 하나의 NSPT 인덱스에 의해 선택된 변환 커널 후보를 루마 성분과 크로마 성분에 공통적으로 적용함으로써, 불필요한 시그널링을 줄이고, 압축 효율을 향상시킬 수 있다. 반면, 싱글 트리가 아닌 경우, 루마 성분과 크로마 성분이 각자 독립적인 분할 및 부호화 구조를 가지게 된다. 이 경우, 성분 별로 NSPT 인덱스를 시그널링함으로써, 각 성분의 특성을 반영하고, 압축 효율을 향상시킬 수 있다.
- [228] 상기 NSPT를 위한 NSPT 커널은, 인트라 예측 모드 간의 대칭성 또는 블록 형태 간의 대칭성 중 적어도 하나에 기초하여 유도될 수 있다. 일례로, NSPT 커널은, 현재 블록의 인트라 예측 모드에 대칭인 모드 또는 현재 블록의 블록 형태에 대칭인 블록 형태 중 적어도 하나에 대응하는 NSPT 커널로 유도될 수 있다. 또는, NSPT 커널은 하나 또는 그 이상의 NSPT 커널 후보들을 포함한 NSPT 세트에 기

초하여 유도될 수 있고, 여기서의 NSPT 세트는 현재 블록의 인트라 예측 모드에 대칭인 모드 또는 현재 블록의 블록 형태에 대칭인 블록 형태 중 적어도 하나에 대응하는 NSPT 세트로 유도될 수 있다. 상기 NSPT 세트에 속한 하나 또는 그 이상의 NSPT 커널 후보들 중 어느 하나가 현재 블록의 NSPT 커널로 설정될 수 있다. 이를 위해, NSPT 세트에 속한 하나 또는 그 이상의 NSPT 커널 후보들 중 어느 하나를 특정하는 NSPT 인덱스가 이용될 수 있다. NSPT 인덱스는 비트스트림을 통해 시그널링될 수도 있고, 전술한 대칭성을 기반으로 유도될 수도 있다.

[229] 디코딩 장치에 기-정의된 인트라 예측 모드들 중 적어도 둘의 인트라 예측 모드들 간에는 대칭성이 존재할 수 있다. 이하, 설명의 편의를 위해 좌상단 대각 모드(즉, 34번 모드)를 중심으로 한 대칭성을 설명하기로 한다. 도 5를 참조하면, 방향성 모드들 사이에는 대칭성이 존재한다. 0번인 Planar 모드와 1번인 DC 모드를 제외하고는 모든 모드가 예측 방향을 가진다. 2번 모드부터 66번 모드는 노멀(normal) 방향성 모드라고 명명하고([2, 66]과 같이 표기 가능), -14번 모드부터 -1번 모드([-14, -1]와 같이 표기 가능)와 67번 모드부터 80번 모드([67, 80]와 같이 표기 가능)는 와이드(wide) 방향성 모드로 명명할 수 있다. 와이드 방향성 모드는, -14보다 더 작은 값을 가진 모드 또는 80보다 더 큰 값을 가진 모드 중 적어도 하나를 포함할 수 있다. 도 5를 참조하면, 0번 모드와 1번 모드를 제외하고 모든 모드들이 34번 모드를 중심으로 대칭이다. 구체적으로, [2, 66] 모드에 대해서는 x 번 모드와 $(68 - x)$ 번 모드가 대칭이고, [-14, -1] 모드와 [67, 80] 모드 사이에서 x 번 모드와 $(66 - x)$ 번 모드가 대칭이다. $[N, -1]$ 모드와 $[67, 66 - N]$ 모드 사이에서 동일한 대칭 관계가 성립될 수 있다. 여기서, N 은 -14보다 작거나 같은 정수일 수 있다.

[230] 한편, 블록 형태 간의 대칭성과 관련하여, $M \times N$ 블록과 $N \times M$ 블록은 서로 대칭성을 가진 블록으로 정의될 수 있다. 여기서, M 과 N 은 동일할 수도 있고, 서로 상이할 수도 있다. 또는, $M1 \times N1$ 블록의 너비와 높이의 비($M1/N1$)와 $M2 \times N2$ 블록의 높이와 너비의 비($N2/M2$)가 동일한 경우, $M1 \times N1$ 블록과 $M2 \times N2$ 블록은 서로 대칭성을 가진 블록으로 정의될 수 있다. 또는, $M1 \times N1$ 블록의 너비와 높이의 비($M1/N1$)와 $M2 \times N2$ 블록의 너비와 높이의 비($M2/N2$)가 동일한 경우, $M1 \times N1$ 블록과 $M2 \times N2$ 블록은 서로 대칭성을 가진 블록으로 정의될 수 있다.

[231] 정방향 블록에서, 서로 대칭인 모드들은 NSPT 세트, NSPT 인덱스, 또는 NSPT 커널 중 적어도 하나를 공유할 수 있다. 즉, 대칭인 모드들 중 어느 하나에 대한 NSPT 세트, NSPT 인덱스, 또는 NSPT 커널 중 적어도 하나가, 대칭인 모드들 중 다른 하나에 대해 동일하게 적용될 수 있다.

[232] 일례로, 서로 대칭인 모드들은 하나의 NSPT 커널을 공유할 수 있다. 다만, 서로 대칭인 모드들 중 어느 하나에 대해서는 입력 데이터에 해당 NSPT 커널을 적용하고, 다른 하나에 대해서는 입력 데이터에 전치(transpose) 연산을 적용한 후 해당 NSPT 커널을 적용할 수 있다. 구체적으로, x 번 모드가 [2, 33] 모드에 속하는 경우, x 번 모드에 대해서는 입력 데이터인 $M \times M$ 블록에 대해 열 우선(row-first) 순서에 따라 일차원 벡터(1D vector)를 구성하고, 해당 1D vector에 대해 NSPT 커널

을 적용할 수 있다. 여기서, 열 우선 순서에 따른 1D vector의 구성은, 입력 데이터인 $M \times M$ 블록으로부터 열 단위로 입력 데이터를 읽어서 M 개의 열을 획득하고, 이를 차례대로 배열하여 1D vector를 구성하는 것일 수 있다. 반면, x 번 모드에 대칭인 $(68 - x)$ 번 모드에 대해서는 행 우선(column-first) 순서에 따라 1D vector를 구성하고, 해당 1D vector에 대해 해당 동일 NSPT 커널을 적용할 수 있다. 여기서, 행 우선 순서에 따른 1D vector의 구성은, 입력 데이터인 $M \times M$ 블록으로부터 행 단위로 입력 데이터를 읽어서 M 개의 행을 획득하고, 이를 차례대로 배열하여 1D vector를 구성하는 것일 수 있다. x 번 모드가 $[N, -1]$ 모드에 속하는 경우($N \leq -14$), x 번 모드에 대칭인 $(66 - x)$ 모드에 대해서는 행 우선(column-first) 순서에 따라 1D vector를 구성하고, 해당 1D vector에 대해 x 번 모드의 경우와 동일한 NSPT 커널을 적용할 수 있다. 0번 모드와 1번 모드에 대해서는 열 우선 순서 또는 행 우선 순서를 적용할 수 있으며, 34번 모드에 대해서도 열 우선 순서 또는 행 우선 순서를 적용할 수 있다. 또한, $[2, 33]$ 모드에 속한 인트라 예측 모드에 대해서는 행 우선 순서를 적용하고, 해당 인트라 예측 모드에 대칭인 모드에 대해서는 열 우선 순서를 적용할 수도 있다. $[N, -1]$ 모드에 속한 인트라 예측 모드에 대해서 행 우선 순서를 적용하고, 이에 대칭인 모드에 대해서는 열 우선 순서를 적용할 수도 있다.

[233] 비정방형 블록의 경우, 인트라 예측 모드 간의 대칭성 외에 블록 형태 간의 대칭성이 더 고려될 수 있다. 너비와 높이가 각각 M 과 N 인 비정방형 블록은, 너비와 높이가 각각 N 과 M 인 비정방형 블록과 대칭 관계를 가지는 것으로 볼 수 있다. 일례로, $[2, 66]$ 모드에서, $M \times N$ 블록의 x 번 모드와 $N \times M$ 블록의 $(68 - x)$ 번 모드 사이에 대칭성이 존재할 수 있다. 마찬가지로, $M \times N$ 블록의 x 번 모드가 $[N, -1]$ 모드에 속하는 경우($N \leq -14$), $M \times N$ 블록의 x 번 모드와 $N \times M$ 블록의 $(66 - x)$ 번 모드 사이에 대칭성이 존재할 수 있다.

[234] 입력 데이터 블록으로부터 1D vector를 구성하는 방법은 앞서 살펴본 바와 같다. 즉, x 번 모드에 대해서 열 우선 순서가 적용된다면, 이에 대칭인 모드에 대해서는 행 우선 순서가 적용될 수 있다. 또는, x 번 모드에 대해서 행 우선 순서가 적용된다면, 이에 대칭인 모드에 대해서는 열 우선 순서가 적용될 수 있다. 구체적으로, x 번 모드에 대해 열 우선 순서가 적용되는 경우, 입력 데이터인 $M \times N$ 블록으로부터 열 단위로 입력 데이터를 읽어서 M 개의 열을 획득하고, 이를 차례대로 배열하여 1D vector를 구성할 수 있다. 여기서, 각 열은 N 의 길이를 가질 수 있다. x 번 모드에 대칭인 모드에 대해서는, 입력 데이터인 $M \times N$ 블록으로부터 행 단위로 입력 데이터를 읽어서 N 개의 행을 획득하고, 이를 차례대로 배열하여 1D vector를 구성할 수 있다. 여기서, 각 행은 M 의 길이를 가질 수 있다. 또는, x 번 모드에 대해 행 우선 순서가 적용되는 경우, 입력 데이터인 $M \times N$ 블록으로부터 행 단위로 입력 데이터를 읽어서 N 개의 행을 획득하고, 이를 차례대로 배열하여 1D vector를 구성할 수 있다. 여기서, 각 행은 M 길이를 가질 수 있다. x 번 모드에 대칭인 모드에 대해서는, 입력 데이터인 $M \times N$ 블록으로부터 열 단위로 입력 데이터

를 읽어서 M 개의 열을 획득하고, 이를 차례대로 배열하여 1D vector를 구성할 수 있다. 여기서, 각 열은 N 의 길이를 가질 수 있다.

- [235] 현재 블록이 x 번 모드를 가진 $M \times N$ 블록이고, 현재 블록에 대해 전술한 대칭성을 이용할 경우, 현재 블록의 NSPT 세트 및/또는 NSPT 커널은 x 번 모드에 대칭인 인트라 예측 모드 또는 $M \times N$ 의 블록 크기에 대칭인 $N \times M$ 의 블록 크기 중 적어도 하나에 기초하여 결정될 수 있다. 여기서, NSPT 커널은, $M \times N$ 블록에 대한 NSPT 커널이 아니라 $N \times M$ 블록에 대한 NSPT 커널로 설정될 수 있다. 즉, 현재 블록에 대해 대칭성이 이용되는 경우, 현재 블록과 대칭성을 가진 블록에 대한 NSPT 세트 및/또는 NSPT 커널이 동일하게 이용될 수 있다. 전술한 바와 같이, 소정의 우선 순서에 따라 입력 데이터 블록으로부터 1D vector를 구성할 수 있고, 이는 상기 NSPT 커널의 입력에 해당할 수 있다.
- [236] 또한, 현재 블록의 인트라 예측 모드의 값이 34보다 큰 경우에 대해서만 상기 대칭성이 이용되도록 제한될 수 있다. 즉, 현재 블록의 인트라 예측 모드의 값이 34보다 큰 경우, 입력 데이터 블록으로부터 1D vector 구성시 전치 연산이 적용될 수 있고, 현재 블록과 대칭성을 가진 모드 및/또는 블록 형태에 대응하는 NSPT 세트 또는 NSPT 커널이 이용될 수 있다. 구체적으로, 현재 블록의 인트라 예측 모드가 $[N, -1]$ 모드와 $[2, 34]$ 모드에 속하는 경우, 현재 블록에 대해 대칭성이 이용되지 않을 수 있다. 반면, 현재 블록의 인트라 예측 모드가 $[35, 66]$ 모드와 $[67, 66 - N]$ 모드에 속하는 경우, 현재 블록에 대해 대칭성이 이용될 수 있다. 여기서, N 은 -14보다 작거나 같은 정수일 수 있다.
- [237] 상기 대칭성에 기반한 NSPT 세트 또는 NSPT 커널의 유도는, 현재 블록의 크기에 기초하여 적응적으로 수행될 수 있다. 일례로, 4×4 블록과 8×8 블록에 대해서는, 대칭성에 기반하여 NSPT 세트 또는 NSPT 커널이 유도되고, 4×8 블록과 8×4 블록에 대해서는, 대칭성에 기반하여 NSPT 세트 또는 NSPT 커널이 유도되지 않을 수 있다.
- [238] 상기 대칭성이 이용되는지 여부에 따라, 이용 가능한 NSPT 세트의 개수는 상이할 수 있다. 일례로, 대칭성이 이용되는 경우, 이용 가능한 NSPT 세트의 개수는 35개이고, 대칭성이 이용되지 않는 경우, 이용 가능한 NSPT 세트의 개수는 67개일 수 있다.
- [239] 다음 표 9는 대칭성을 이용하여 NSPT 세트가 결정되는 예에 관한 것으로서, 이용 가능한 NSPT 세트의 개수가 35개인 경우의 인트라 예측 모드와 NSPT 세트 간 매핑 관계를 나타낸다.

[240] [표9]

인트라 예측 모드	NSPT 세트 인덱스
$X < 0$	2
$0 \leq X \leq 34$	X
$35 \leq X \leq 66$	$68 - X$

$X > 66$	2
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- [241] 표 9를 참조하면, 현재 블록의 인트라 예측 모드의 값(X)이 0보다 작은 경우, 현재 블록의 NSPT 세트는 35개의 NSPT 세트들 중 2의 NSPT 세트 인덱스를 가진 NSPT 세트로 결정될 수 있다. 현재 블록의 인트라 예측 모드의 값(X)이 0보다 크거나 같고 34보다 작거나 같은 경우, 현재 블록의 NSPT 세트는 35개의 NSPT 세트들 중 X 의 NSPT 세트 인덱스를 가진 NSPT 세트로 결정될 수 있다. 현재 블록의 인트라 예측 모드의 값(X)이 35보다 크거나 같고 66보다 작거나 같은 경우, 현재 블록의 NSPT 세트는 35개의 NSPT 세트들 중 $(68-X)$ 의 NSPT 세트 인덱스를 가진 NSPT 세트로 결정될 수 있다. 현재 블록의 인트라 예측 모드의 값(X)이 35보다 크거나 같고 66보다 작거나 같은 경우, 현재 블록의 NSPT 세트는 현재 블록의 인트라 예측 모드에 대칭되는 모드의 값($68-X$)에 대응되는 NSPT 세트와 동일할 수 있다. 마찬가지로, 현재 블록의 인트라 예측 모드의 값(X)이 66보다 큰 경우, 현재 블록의 NSPT 세트는 35개의 NSPT 세트들 중 2의 NSPT 세트 인덱스를 가진 NSPT 세트로 결정될 수 있다. 현재 블록의 인트라 예측 모드의 값(X)이 66보다 큰 경우, 현재 블록의 NSPT 세트는 현재 블록의 인트라 예측 모드에 대칭되는 모드에 대응되는 NSPT 세트와 동일할 수 있다.

- [242] 다음 표 10은 대칭성을 이용하지 않고 NSPT 세트가 결정되는 예에 관한 것으로서, 이용 가능한 NSPT 세트의 개수가 67개인 경우의 인트라 예측 모드와 NSPT 세트 간 매핑 관계를 나타낸다.

- [243] [표10]

인트라 예측 모드	NSPT 세트 인덱스
$X < 0$	2
$0 \leq X \leq 66$	X
$X > 66$	66

- [244] 표 10을 참조하면, 현재 블록의 인트라 예측 모드의 값(X)이 0보다 작은 경우, 현재 블록의 NSPT 세트는 67개의 NSPT 세트들 중 2의 NSPT 세트 인덱스를 가진 NSPT 세트로 결정될 수 있다. 현재 블록의 인트라 예측 모드의 값(X)이 0보다 크거나 같고 66보다 작거나 같은 경우, 현재 블록의 NSPT 세트는 67개의 NSPT 세트들 중 X 의 NSPT 세트 인덱스를 가진 NSPT 세트로 결정될 수 있다. 현재 블록의 인트라 예측 모드의 값(X)이 66보다 큰 경우, 현재 블록의 NSPT 세트는 67개의 NSPT 세트들 중 66의 NSPT 세트 인덱스를 가진 NSPT 세트로 결정될 수 있다.
- [245] 상기 대칭성을 활용함으로써, 변환 적용에 따른 성능은 유지하면서 변환 커널의 저장에 필요한 메모리 크기를 절감할 수 있다. 예를 들어, 67개의 NSPT 세트들 대신에 대칭성을 활용하여 35개의 NSPT 세트들을 이용할 경우, NSPT 커널의 저장에 필요한 메모리 크기를 대폭 저감할 수 있다.

- [246] 이용 가능한 NSPT 세트의 개수 및/또는 NSPT 세트에 속한 NSPT 커널 후보의 개수는, 블록 크기에 따라 상이할 수 있다. 예를 들어, 4x4 블록에 대해 이용 가능한 NSPT 세트들의 개수는 35개이고, 4x8 블록과 8x4 블록에 대해 이용 가능한 NSPT 세트들의 개수는 19개이며, 8x8 블록에 대해 이용 가능한 NSPT 세트들의 개수는 10개일 수 있다. 4x4 블록에 대한 NSPT 세트는 3개의 NSPT 커널 후보들로 구성될 수 있고, 4x8 블록과 8x4 블록에 대한 NSPT 세트는 3개 또는 2개의 NSPT 커널 후보들로 구성되며, 8x8 블록에 대한 NSPT 세트는 1개의 NSPT 커널 후보로 구성될 수 있다.
- [247] 블록 크기의 증가에 따라 변환 커널의 크기가 증가할 수 있다. 이에, 이용 가능한 NSPT 세트의 개수 및/또는 NSPT 세트에 속한 NSPT 커널 후보들의 개수를 줄임으로써, 변환 커널의 저장에 필요한 메모리 크기를 절약할 수 있다. 또한, 블록 크기의 증가에 따라 해당 블록 내의 잔차 신호 특성이 보다 일반화되는 경향이 있다. 따라서, 이용 가능한 NSPT 세트의 개수 및/또는 NSPT 세트에 속한 NSPT 커널 후보들의 개수를 줄이는 것은, 이런 통계적 특성을 반영하여 구현 복잡도를 줄이면서 압축 효율을 유지하는 데 도움이 될 수 있다.
- [248] NSPT 커널은 8-bit 정밀도(precision)로 구성될 수 있다. NSPT 커널 내 계수들의 범위는 -128보다 크거나 같고 127보다 작거나 같을 수 있다. 해당 정밀도를 8-bit 보다 올리는 경우, 행렬 곱셈을 통해 얻어지는 결과값에 대해 올라간 정밀도만큼 오른쪽으로 쉬프트할 수 있다. 예를 들어, 8-bit 정밀도를 가진 NSPT 커널을 기반으로 행렬 곱셈 후 얻어진 값을 S 비트만큼 오른쪽으로 쉬프트하여 버퍼에 저장하는 경우, 만일 N-bit 정밀도로 커널의 계수를 구성한다면 (S+(N-8)) 비트만큼 오른쪽으로 쉬프트하여 버퍼에 저장할 수 있다.
- [249] 8-bit 정밀도로 NSPT 커널을 구성하는 경우, 변환을 수행하는 부/복호화기 내 내부 정밀도의 과도한 상승을 막을 수 있어, 메모리 요구량과 연산량 관점에서 구현 복잡도를 저감하면서도 압축 효율의 하락을 최소화할 수 있다.
- [250] MxN 크기의 현재 블록에 대해 역방향의 NSPT를 적용하는 경우, NSPT 커널(또는, NSPT 행렬)의 크기는 $MN \times r$ 으로 표현될 수 있다. 여기서, MN은 현재 블록의 너비와 높이의 곱을 의미할 수 있다. 이는, NSPT의 출력 길이 또는 NSPT에 의해 생성되는 레지듀얼 샘플의 개수를 의미할 수 있다. 또한, r은 NSPT의 입력 길이 또는 NSPT가 적용되는 (역양자화된) 변환 계수의 개수를 의미할 수 있다. r은 0보다 크거나 같고, MN보다 작거나 같은 정수일 수 있다. 다음은 블록 크기에 따른 $MN \times r$ 의 NSPT 행렬에 대한 예이다.
- [251] 4x4 블록에 대한 NSPT 행렬은 16x16 행렬로 구성될 수 있다. 4x8 블록과 8x4 블록에 대한 NSPT 행렬은 32x20 행렬, 32x16 행렬, 32x24 행렬, 32x28 행렬, 또는 32x32 행렬로 구성될 수 있다. 8x8 블록에 대한 NSPT 행렬은 64x16 행렬, 64x24 행렬, 64x32 행렬, 64x40 행렬, 64x48 행렬, 64x56 행렬, 또는 64x64 행렬로 구성될 수 있다. 4x16 블록과 16x4 블록에 대한 NSPT 행렬은 64x16 행렬, 64x24 행렬, 64x32 행렬, 64x40 행렬, 64x48 행렬, 64x56 행렬, 또는 64x64 행렬로 구성될

수 있다. 8x16 블록과 16x8 블록에 대한 NSPT 행렬은 128x96 행렬, 128x64 행렬, 128x48 행렬, 또는 128x32 행렬로 구성될 수 있다. 16x16 블록에 대한 NSPT 행렬은 256x128 행렬, 256x96 행렬, 또는 256x64 행렬로 구성될 수 있다. 16x32 블록과 32x16 블록에 대한 NSPT 행렬은 512x256 행렬 또는 512x128 행렬로 구성될 수 있다. 32x32 블록에 대한 NSPT 행렬은 1024x512 행렬, 1024x256 행렬, 또는 1024x128 행렬로 구성될 수 있다.

[252] 또는, 4xN 블록과 Nx4 블록에 대해서 16x16 행렬이 적용될 수 있다. 여기서, N은 4보다 크거나 같은 정수일 수 있다. 8x8 블록에 대해서 64x16 행렬이 적용될 수 있다. 8xN 블록과 Nx8 블록에 대해서 64x32 행렬이 적용될 수 있다. 여기서, N은 16보다 크거나 같은 정수일 수 있다. 16xN 블록과 Nx16 블록에 대해서 96x32 행렬이 적용될 수 있다. 여기서, N은 16보다 크거나 같은 정수일 수 있다.

[253] 또는, 소정의 기준에 따라 상기 $MN \times r$ 의 NSPT 행렬에서 r 의 값을 결정할 수도 있다. 여기서의 기준은, (1) 일차 변환에 대한 계산량과 이차 변환에 대한 계산량의 합이 일정 수준 이하가 되도록 하고, (2) NSPT 연산에 필요한 샘플 당 곱셈의 개수가 일정 개수 이하가 되도록 하는 것일 수 있다.

[254] 역방향의 변환을 기준으로, $M \times N$ 블록에 대해 분리 일차 변환을 행렬 곱셈으로 수행할 경우, 해당 일차 변환을 수행하는데 샘플 당 $(M+N)$ 개의 곱셈이 필요하게 된다. 또한, 일정 ROI(Region-Of-Interest) 영역에 대해 LFNST를 적용하는 경우, 역변환의 LFNST 행렬이 $P \times Q$ 행렬이라 가정하면, 샘플 당 $(P \times Q)/(M \times N)$ 개의 곱셈이 필요하게 된다. 여기서, $P \times Q$ 행렬은, 행의 개수가 P 이고 열의 개수가 Q 인 행렬을 의미할 수 있다.

[255] $M \times N$ 블록에 대해 DCT-2 변환(또는, KLT와 같은 분리 변환)과 LFNST를 적용하는 대신 NSPT를 적용하는 경우, 해당 NSPT를 적용하는 경우에 대한 샘플 당 곱셈의 개수가 DCT-2 변환과 LFNST를 적용하는 경우에 대한 샘플 당 곱셈의 개수보다 작거나 같도록 하는 r 의 값은 다음과 같이 결정될 수 있다.

[256] [수식6]

$$r \leq (M+N+(P \times Q)/(M \times N))$$

[257] 상기 수식 6을 만족하면서 r 의 값을 최대값으로 설정한다면(즉, $r = M + N + (P \times Q)/(M \times N)$), 블록 크기 별 NSPT 행렬에서 r 의 값은 다음과 같이 설정될 수 있다. 수식 6에서 $(P \times Q)/(M \times N)$ 의 값이 정수가 아닌 경우, $(P \times Q)/(M \times N)$ 의 값에 가까운 정수가 이용될 수 있다. 일례로, $(P \times Q)/(M \times N)$ 의 값에 floor 연산이 적용될 수 있다. 이 경우, r 은 $(M + N + \text{floor}((P \times Q)/(M \times N)))$ 으로 설정될 수 있다. 여기서, $\text{floor}(x)$ 는 x 를 넘지 않는 가장 큰 정수를 의미할 수 있다. 또는, $(P \times Q)/(M \times N)$ 의 값에 round 연산이 적용될 수 있다. 이 경우, r 은 $(M + N + \text{round}((P \times Q)/(M \times N)))$ 으로 설정될 수 있다. 여기서, $\text{round}(x)$ 는 x 을 반올림한 값을 의미할 수 있다. 또는, $(P \times Q)/(M \times N)$ 의 값에 ceil 연산이 적용될 수 있다. 이 경우, r 은 $(M + N + \text{ceil}((P \times Q)/(M \times N)))$ 으로 설정될 수 있다. 여기서, $\text{ceil}(x)$ 는 x 보다 크거나 같은 가장 작은 정수

를 의미할 수 있다. floor 연산이 적용되는 경우, 상기 수학식 6의 부등식을 만족할 수 있다. 다만, round 연산 또는 ceil 연산이 적용되는 경우, 상기 수학식 6의 부등식을 만족하지 않을 수 있다.

- [258] 4x4 블록에 대한 NSPT에 대해, r 의 최대값은 24이다. 그러나, r 의 값은 16보다 작거나 같아야 하므로 r 의 값은 16으로 설정될 수 있다.
- [259] 4x8 블록과 8x4 블록에 대한 NSPT에 대해, r 의 최대값은 20이다. r 의 값은 20으로 설정될 수 있다.
- [260] 8x8 블록에 대한 NSPT에 대해, r 의 최대값은 32이다. r 의 값은 32로 설정될 수 있다.
- [261] 4x16 블록과 16x4 블록에 대한 NSPT에 대해, r 의 최대값은 24이다. r 의 값은 24로 설정될 수 있다.
- [262] 8x16 블록과 16x8 블록에 대한 NSPT에 대해, r 의 최대값은 40이다. r 의 값은 40으로 설정될 수 있다.
- [263] 16x16 블록에 대한 NSPT에 대해, r 의 최대값은 44이다. r 의 값은 44로 설정될 수 있다.
- [264] 16x32 블록과 32x16 블록에 대한 NSPT에 대해, r 의 최대값은 54이다. r 의 값은 54로 설정될 수 있다.
- [265] 32x32 블록에 대한 NSPT에 대해, r 의 최대값은 67이다. r 의 값은 67로 설정될 수 있다.
- [266] 4x32 블록과 32x4 블록에 대한 NSPT에 대해, r 의 최대값은 38이다. r 의 값은 38로 설정될 수 있다. 또는, r 의 값은 20으로 설정될 수 있다.
- [267] 8x32 블록과 32x8 블록에 대한 NSPT에 대해, r 의 최대값은 48이다. r 의 값은 48로 설정될 수 있다. 또는, r 의 값은 24로 설정될 수 있다.
- [268] 전술한 블록 크기 별 NSPT 행렬에서 r 의 값이 4의 배수가 아닌 경우가 존재할 수 있다. 구현의 용이성을 위해, r 의 값이 4의 배수인 것이 유리할 수도 있다. 예를 들어, SIMD (Single Instruction Multiple Data) 명령 등을 통한 병렬 처리를 구현하는데 있어서, 순방향의 NSPT를 적용하는 과정에서 4개의 변환 기저 벡터에 대한 내적을 동시에 처리하는 경우(즉, 변환 계수 4개를 동시에 생성하는 경우), r 의 값을 4의 배수가 되도록 설정하는 것이 유리할 수 있다.
- [269] 일례로, 16x32 블록과 32x16 블록에 대한 NSPT에 대해, r 의 값은 54 대신에 52 또는 56으로 설정될 수 있다. 32x32 블록에 대한 NSPT에 대해, r 의 값은 67 대신에 64 또는 68로 설정될 수 있다. 4x32 블록과 32x4 블록에 대한 NSPT에 대해, r 의 값은 38 대신에 36 또는 40으로 설정될 수 있다.
- [270] 보다 일반화하여, r 의 값은 K 의 배수가 되도록 설정될 수 있다. 여기서, K 는 1보다 크거나 같은 정수일 수 있다. 일례로, r 의 값은 다음 수학식 7의 부등식을 만족하는 K 의 배수로 설정될 수 있다.

[271] [수식7]

$$r \leq \text{func}((M+N+(P \times Q)/(M \times N))/K) \times K$$

[272] 상기 수식식 7에서 func()는 전술한 floor, round, 또는 ceil일 수 있다.

[273] 전술한 소정의 기준에 따른 r의 값은 zero-out을 고려하지 않은 경우에 대한 것이다. 즉, 순방향의 LFNST가 적용되는 경우, LFNST가 적용되는 영역을 제외한 나머지 영역의 일차 변환된 변환 계수들은 zero-out되기 때문에, DCT-2와 LFNST를 적용하는데 필요한 실질적인 계산량은 상기 계산량보다 적을 수 있다. 따라서, 상기 zero-out을 고려할 경우, r의 값은 상기 소정의 기준에 따른 r의 값보다 작은 값으로 설정될 수 있다.

[274] 4x4 블록에 대해서는 zero-out이 수행되지 않으므로, r의 값은 16보다 작거나 같은 값으로 설정될 수 있다.

[275] 4x8 블록에 대해서는, 순방향의 변환을 기준으로 좌상단 4x4 블록을 제외하고 나머지 영역에 대해서는 zero-out이 수행될 수 있고, 좌상단 4x4 블록에 대해서는 순방향의 LFNST 행렬인 16x16 행렬이 적용될 수 있다. 이와 같은 zero-out이 수행되는 경우, 순방향의 분리 일차 변환에서 필요한 샘플 당 곱셈의 개수는 8개 $((4 \times 4 \times 8) + (4 \times 8 \times 4)) / (4 \times 8) = 8$ 이고, LFNST에서 필요한 샘플 당 곱셈의 개수는 8개 $((16 \times 16) / 32 = 8)$ 이다. 따라서, 분리 일차 변환과 LFNST를 NSPT로 대체할 경우, r의 값은 분리 일차 변환에서의 샘플 당 곱셈의 개수와 LFNST에서의 샘플 당 곱셈의 개수의 합인 16보다 작거나 같은 값으로 설정될 수 있다. 역방향의 분리 일차 변환과 LFNST를 적용하는 경우에도 동일한 계산량이 필요하므로, r의 값은 16보다 작거나 같은 값으로 설정될 수 있다.

[276] 8x4 블록에 대해서는 순방향의 변환을 기준으로 좌상단 4x4 블록을 제외하고 나머지 영역에 대해서는 zero-out이 수행될 수 있고, 좌상단 4x4 블록에 대해서는 순방향의 LFNST 행렬인 16x16 행렬이 적용될 수 있다. 이와 같은 zero-out이 수행되는 경우, 순방향의 분리 일차 변환에서 필요한 샘플 당 곱셈의 개수는 6개 $((4 \times 8 \times 4) + (4 \times 4 \times 4)) / (8 \times 4) = 6$ 이고, LFNST에서 필요한 샘플 당 곱셈의 개수는 8개 $((16 \times 16) / 32 = 8)$ 이다. 따라서, 분리 일차 변환과 LFNST를 NSPT로 대체할 경우, r의 값은 분리 일차 변환에서의 샘플 당 곱셈의 개수와 LFNST에서의 샘플 당 곱셈의 개수의 합인 14보다 작거나 같은 값으로 설정될 수 있다. 역방향의 분리 일차 변환과 LFNST를 적용하는 경우에도 동일한 계산량이 필요하므로, r의 값은 14보다 작거나 같은 값으로 설정될 수 있다.

[277] 8x8 블록에 대해서는 분리 일차 변환에 대해 zero-out이 수행되지 않을 수 있으며, 이 경우 r의 값은 32보다 작거나 같은 값으로 설정될 수 있다.

[278] 8x16 블록에 대해서는 순방향의 변환을 기준으로 좌상단 8x8 블록을 제외하고 나머지 영역에 대해서는 zero-out이 수행될 수 있고, 좌상단 8x8 블록에 대해서는 순방향의 LFNST 행렬인 64x32 행렬이 적용될 수 있다. 이와 같은 zero-out이 수행되는 경우, 순방향의 분리 일차 변환에서 필요한 샘플 당 곱셈의 개수는 16개

$((8 \times 8 \times 16) + (8 \times 16 \times 8)) / (8 \times 16) = 16$ 이고, LFNST에서 필요한 샘플 당 곱셈의 개수는 16개($((64 \times 32) / 128 = 16)$)이다. 따라서, 분리 일차 변환과 LFNST를 NSPT로 대체할 경우, r 의 값은 분리 일차 변환에서의 샘플 당 곱셈의 개수와 LFNST에서의 샘플 당 곱셈의 개수의 합인 32보다 작거나 같은 값으로 설정될 수 있다. 역방향의 분리 일차 변환과 LFNST를 적용하는 경우에도 동일한 계산량이 필요하므로, r 의 값은 32보다 작거나 같은 값으로 설정될 수 있다.

- [279] 16x8 블록에 대해서는 순방향의 변환을 기준으로 좌상단 8x8 블록을 제외하고 나머지 영역에 대해서는 zero-out이 수행될 수 있고, 좌상단 8x8 블록에 대해서는 순방향의 LFNST 행렬인 64x32 행렬이 적용될 수 있다. 이와 같은 zero-out이 수행되는 경우, 순방향의 분리 일차 변환에서 필요한 샘플 당 곱셈의 개수는 12개($((8 \times 16 \times 8) + (8 \times 8 \times 8)) / (16 \times 8) = 12$)이고, LFNST에서 필요한 샘플 당 곱셈의 개수는 16개($((64 \times 32) / 128 = 16)$)이다. 따라서, 분리 일차 변환과 LFNST를 NSPT로 대체할 경우, r 의 값은 분리 일차 변환에서의 샘플 당 곱셈의 개수와 LFNST에서의 샘플 당 곱셈의 개수의 합인 28보다 작거나 같은 값으로 설정될 수 있다. 역방향의 분리 일차 변환과 LFNST를 적용하는 경우에도 동일한 계산량이 필요하므로, r 의 값은 28보다 작거나 같은 값으로 설정될 수 있다.
- [280] 16x16 블록에 대해서는 순방향의 변환을 기준으로 좌상단 12x12 블록을 제외하고 나머지 영역에 대해서는 zero-out이 수행될 수 있고, 좌상단 12x12 블록에 대해서는 순방향의 LFNST 행렬인 96x32 행렬이 적용될 수 있다. 이와 같은 zero-out이 수행되는 경우, 순방향의 분리 일차 변환에서 필요한 샘플 당 곱셈의 개수는 21개($((12 \times 16 \times 16) + (12 \times 16 \times 12)) / (16 \times 16) = 21$)이고, LFNST에서 필요한 샘플 당 곱셈의 개수는 12개($((96 \times 32) / 256 = 12)$)이다. 따라서, 분리 일차 변환과 LFNST를 NSPT로 대체할 경우, r 의 값은 분리 일차 변환에서의 샘플 당 곱셈의 개수와 LFNST에서의 샘플 당 곱셈의 개수의 합인 33보다 작거나 같은 값으로 설정될 수 있다. 역방향의 분리 일차 변환과 LFNST를 적용하는 경우에도 동일한 계산량이 필요하므로, r 의 값은 33보다 작거나 같은 값으로 설정될 수 있다.
- [281] 4x16 블록에 대해서는 순방향의 변환을 기준으로 좌상단 4x4 블록을 제외하고 나머지 영역에 대해서는 zero-out이 수행될 수 있고, 좌상단 4x4 블록에 대해서는 순방향의 LFNST 행렬인 16x16 행렬이 적용될 수 있다. 이와 같은 zero-out이 수행되는 경우, 순방향의 분리 일차 변환에서 필요한 샘플 당 곱셈의 개수는 8개($((4 \times 4 \times 16) + (4 \times 16 \times 4)) / (4 \times 16) = 8$)이고, LFNST에서 필요한 샘플 당 곱셈의 개수는 4개($((16 \times 16) / 64 = 4)$)이다. 따라서, 분리 일차 변환과 LFNST를 NSPT로 대체할 경우, r 의 값은 분리 일차 변환에서의 샘플 당 곱셈의 개수와 LFNST에서의 샘플 당 곱셈의 개수의 합인 12보다 작거나 같은 값으로 설정될 수 있다. 역방향의 분리 일차 변환과 LFNST를 적용하는 경우에도 동일한 계산량이 필요하므로, r 의 값은 12보다 작거나 같은 값으로 설정될 수 있다.
- [282] 16x4 블록에 대해서는 순방향의 변환을 기준으로 좌상단 4x4 블록을 제외하고 나머지 영역에 대해서는 zero-out이 수행될 수 있고, 좌상단 4x4 블록에 대해서

는 순방향의 LFNST 행렬인 16×16 행렬이 적용될 수 있다. 이와 같은 zero-out이 수행되는 경우, 순방향의 분리 일차 변환에서 필요한 샘플 당 곱셈의 개수는 5개 $((4 \times 16 \times 4) + (4 \times 4 \times 4)) / (16 \times 4) = 5$ 이고, LFNST에서 필요한 샘플 당 곱셈의 개수는 4개 $((16 \times 16) / 64 = 4)$ 이다. 따라서, 분리 일차 변환과 LFNST를 NSPT로 대체할 경우, r 의 값은 분리 일차 변환에서의 샘플 당 곱셈의 개수와 LFNST에서의 샘플 당 곱셈의 개수의 합인 9보다 작거나 같은 값으로 설정될 수 있다. 역방향의 분리 일차 변환과 LFNST를 적용하는 경우에도 동일한 계산량이 필요하므로, r 의 값은 9보다 작거나 같은 값으로 설정될 수 있다.

[283] 4×32 블록에 대해서는 순방향의 변환을 기준으로 좌상단 4×4 블록을 제외하고 나머지 영역에 대해서는 zero-out이 수행될 수 있고, 좌상단 4×4 블록에 대해서는 순방향의 LFNST 행렬인 16×16 행렬이 적용될 수 있다. 이와 같은 zero-out이 수행되는 경우, 순방향의 분리 일차 변환에서 필요한 샘플 당 곱셈의 개수는 8개 $((4 \times 4 \times 32) + (4 \times 32 \times 4)) / (4 \times 32) = 8$ 이고, LFNST에서 필요한 샘플 당 곱셈의 개수는 2개 $((16 \times 16) / 128 = 2)$ 이다. 따라서, 분리 일차 변환과 LFNST를 NSPT로 대체할 경우, r 의 값은 분리 일차 변환에서의 샘플 당 곱셈의 개수와 LFNST에서의 샘플 당 곱셈의 개수의 합인 10보다 작거나 같은 값으로 설정될 수 있다. 역방향의 분리 일차 변환과 LFNST를 적용하는 경우에도 동일한 계산량이 필요하므로, r 의 값은 10보다 작거나 같은 값으로 설정될 수 있다.

[284] 32×4 블록에 대해서는 순방향의 변환을 기준으로 좌상단 4×4 블록을 제외하고 나머지 영역에 대해서는 zero-out이 수행될 수 있고, 좌상단 4×4 블록에 대해서는 순방향의 LFNST 행렬인 16×16 행렬이 적용될 수 있다. 이와 같은 zero-out이 수행되는 경우, 순방향의 분리 일차 변환에서 필요한 샘플 당 곱셈의 개수는 4.5개 $((4 \times 32 \times 4) + (4 \times 4 \times 4)) / (32 \times 4) = 4.5$ 이고, LFNST에서 필요한 샘플 당 곱셈의 개수는 2개 $((16 \times 16) / 128 = 2)$ 이다. 따라서, 분리 일차 변환과 LFNST를 NSPT로 대체할 경우, r 의 값은 6.5보다 작거나 같은 값으로 설정될 수 있다. 역방향의 분리 일차 변환과 LFNST를 적용하는 경우에도 동일한 계산량이 필요하므로, r 의 값은 6.5보다 작거나 같은 값으로 설정될 수 있다. 여기서, r 의 값은 행렬 차원을 구성하는 값이므로, 6.5 대신에 6 또는 7의 정수로 설정될 수 있다.

[285] 8×32 블록에 대해서는 순방향의 변환을 기준으로 좌상단 8×8 블록을 제외하고 나머지 영역에 대해서는 zero-out이 수행될 수 있고, 좌상단 8×8 블록에 대해서는 순방향의 LFNST 행렬인 64×32 행렬이 적용될 수 있다. 이와 같은 zero-out이 수행되는 경우, 순방향의 분리 일차 변환에서 필요한 샘플 당 곱셈의 개수는 16개 $((8 \times 8 \times 32) + (8 \times 32 \times 8)) / (8 \times 32) = 16$ 이고, LFNST에서 필요한 샘플 당 곱셈의 개수는 8개 $((64 \times 32) / 256 = 8)$ 이다. 따라서, 분리 일차 변환과 LFNST를 NSPT로 대체할 경우, r 의 값은 24보다 작거나 같은 값으로 설정될 수 있다. 역방향의 분리 일차 변환과 LFNST를 적용하는 경우에도 동일한 계산량이 필요하므로, r 의 값은 24보다 작거나 같은 값으로 설정될 수 있다.

- [286] 32x8 블록에 대해서는 순방향의 변환을 기준으로 좌상단 8x8 블록을 제외하고 나머지 영역에 대해서는 zero-out이 수행될 수 있고, 좌상단 8x8 블록에 대해서는 순방향의 LFNST 행렬인 64x32 행렬이 적용될 수 있다. 이와 같은 zero-out이 수행되는 경우, 순방향의 분리 일차 변환에서 필요한 샘플 당 곱셈의 개수는 10개 $((8 \times 32 \times 8) + (8 \times 8 \times 8)) / (32 \times 8) = 10$ 이고, LFNST에서 필요한 샘플 당 곱셈의 개수는 8개 $((64 \times 32) / 256 = 8)$ 이다. 따라서, 분리 일차 변환과 LFNST를 NSPT로 대체할 경우, r의 값은 18보다 작거나 같은 값으로 설정될 수 있다. 역방향의 분리 일차 변환과 LFNST를 적용하는 경우에도 동일한 계산량이 필요하므로, r의 값은 18보다 작거나 같은 값으로 설정될 수 있다.
- [287] 16x32 블록에 대해서는 순방향의 변환을 기준으로 좌상단 12x12 블록을 제외하고 나머지 영역에 대해서는 zero-out이 수행될 수 있고, 좌상단 12x12 블록에 대해서는 순방향의 LFNST 행렬인 96x32 행렬이 적용될 수 있다. 이와 같은 zero-out이 수행되는 경우, 순방향의 분리 일차 변환에서 필요한 샘플 당 곱셈의 개수는 21개 $((12 \times 16 \times 32) + (12 \times 32 \times 12)) / (16 \times 32) = 21$ 이고, LFNST에서 필요한 샘플 당 곱셈의 개수는 6개 $((96 \times 32) / 512 = 6)$ 이다. 따라서, 분리 일차 변환과 LFNST를 NSPT로 대체할 경우, r의 값은 27보다 작거나 같은 값으로 설정될 수 있다. 역방향의 분리 일차 변환과 LFNST를 적용하는 경우에도 동일한 계산량이 필요하므로, r의 값은 27보다 작거나 같은 값으로 설정될 수 있다.
- [288] 32x16 블록에 대해서는 순방향의 변환을 기준으로 좌상단 12x12 블록을 제외하고 나머지 영역에 대해서는 zero-out이 수행될 수 있고, 좌상단 12x12 블록에 대해서는 순방향의 LFNST 행렬인 96x32 행렬이 적용될 수 있다. 이와 같은 zero-out이 수행되는 경우, 순방향의 분리 일차 변환에서 필요한 샘플 당 곱셈의 개수는 13.5개 $((12 \times 32 \times 12) + (12 \times 16 \times 12)) / (32 \times 16) = 13.5$ 이고, LFNST에서 필요한 샘플 당 곱셈의 개수는 6개 $((96 \times 32) / 512 = 6)$ 이다. 따라서, 분리 일차 변환과 LFNST를 NSPT로 대체할 경우, r의 값은 19.5보다 작거나 같은 값으로 설정될 수 있다. 역방향의 분리 일차 변환과 LFNST를 적용하는 경우에도 동일한 계산량이 필요하므로, r의 값은 19.5보다 작거나 같은 값으로 설정될 수 있다. 여기서, r의 값은 행렬 차원을 구성하는 값이므로, 19.5 대신에 19 또는 20의 정수로 설정될 수 있다.
- [289] 전술한 블록 크기 별 NSPT 행렬에서, r의 값이 K의 배수가 아닌 경우가 존재할 수 있다. 여기서, K는 4일 수 있다. 이 경우, 구현의 용이성을 위해 r의 값을 K의 배수가 되도록 설정할 수도 있다. 전술한 방법을 통해 기-설정된 r의 값을 r_{prev} 라 할 경우, K의 배수가 되는 r의 값은 다음과 같이 설정될 수 있다.
- [290] [수식8]
- $$r = \text{func}(r_{prev} / K) \times K$$
- [291] 상기 수학적 식 8에서 func()는 전술한 floor, round, 또는 ceil일 수 있다.
- [292] 전술한 바와 같이, MxN 블록에 대한 NSPT 행렬에서의 r의 값은 NxM 블록에 대한 NSPT 행렬에서의 r의 값과 상이할 수 있다. 일례로, 4x8 블록에 대한 역방향의

NSPT 행렬은 32×16 행렬이고, 8×4 블록에 대한 역방향의 NSPT 행렬은 32×14 행렬일 수 있다. 이때, $M \times N$ 블록과 $N \times M$ 블록 간의 대칭성을 이용하여 NSPT 행렬이 결정될 수 있다.

- [293] 현재 블록이 x 번 모드를 가진 $M \times N$ 블록임을 가정한다. 현재 블록에 대해 전술한 대칭성을 이용하는 경우, x 번 모드 또는 $M \times N$ 의 블록 크기에 대응하는 NSPT 행렬이 적용되는 대신에, x 번 모드에 대칭인 모드 또는 $M \times N$ 의 블록 크기에 대칭인 $N \times M$ 의 블록 크기 중 적어도 하나에 대응하는 NSPT 행렬이 적용될 수 있다. 이때, 현재 블록에 대해 $N \times M$ 의 블록 크기에 대응하는 NSPT 행렬이 그대로 적용될 수 있다. 또는, $N \times M$ 의 블록 크기에 대응하는 NSPT 행렬을 적용하되, r 의 값은 $M \times N$ 의 블록 크기에 대응하는 NSPT 행렬에서의 r 의 값이 이용될 수 있다.
- [294] 일례로, 4×8 블록에 대한 역방향의 NSPT 행렬은 32×16 행렬이고(즉, NSPT 행렬에서의 r 의 값이 16임), 8×4 블록에 대한 역방향의 NSPT 행렬은 32×14 행렬일 수 있다(즉, NSPT 행렬에서의 r 의 값은 14임). 현재 블록이 x 번 모드를 가진 8×4 블록인 경우, 현재 블록에 대해 x 번 모드에 대칭인 모드 또는 8×4 블록에 대칭인 4×8 블록 중 적어도 하나에 대한 NSPT 행렬이 적용될 수 있다. 이 경우, 4×8 블록에 대한 역방향의 NSPT 행렬인 32×16 행렬이 그대로 이용될 수도 있고, 8×4 블록에 대한 역방향의 NSPT 행렬에서의 r 의 값을 가진 32×14 행렬이 이용될 수도 있다. 여기서, 32×14 행렬은, 32×16 행렬에서 왼쪽부터 14개의 행들을 샘플링하여 유도될 수 있다. 이와 같이, 8×4 의 블록 크기를 가진 현재 블록에 대해 32×14 행렬을 적용할 경우, 전술한 소정의 기준을 만족하게 된다.
- [295] 반대로, 현재 블록이 x 번 모드를 가진 4×8 블록인 경우, 현재 블록에 대해 x 번 모드에 대칭인 모드 또는 4×8 블록에 대칭인 8×4 블록 중 적어도 하나에 대한 NSPT 행렬이 적용될 수 있다. 이 경우, 현재 블록에 대해, 4×8 블록에 대한 32×16 행렬이 아닌, 8×4 블록에 대한 32×14 행렬이 적용될 수 있다. 이를 통해, 4×8 블록에 대해 허용되는 곱셈의 개수보다 적은 곱셈을 사용하여 NSPT가 수행될 수 있다.
- [296] $M \times N$ 블록과 $N \times M$ 블록에 대한 NSPT에 대해서 전술한 소정의 조건을 만족하는 r 의 값이 각각 r_1 과 r_2 인 경우, $M \times N$ 블록과 $N \times M$ 블록에 대한 역방향의 NSPT 행렬은 $MN \times \max(r_1, r_2)$ 로 설정될 수 있다. 여기서, $\max(r_1, r_2)$ 는 r_1 과 r_2 중 크거나 같은 값을 선택하는 것을 의미할 수 있다.
- [297] 일례로, 4×8 블록에 대한 역방향의 NSPT 행렬은 32×16 행렬이고(즉, NSPT 행렬에서의 r 의 값이 16임), 8×4 블록에 대한 역방향의 NSPT 행렬은 32×14 행렬일 수 있다(즉, NSPT 행렬에서의 r 의 값은 14임). 현재 블록이 x 번 모드를 가진 4×8 블록인 경우, 현재 블록에 대해 x 번 모드에 대칭인 모드 또는 4×8 블록에 대칭인 8×4 블록 중 적어도 하나에 대한 NSPT 행렬이 적용될 수 있다. 이 경우, 8×4 블록에 대한 역방향의 NSPT 행렬인 32×16 행렬이 이용될 수 있다. 만약 역방향의 NSPT 행렬을 $MN \times \max(r_1, r_2)$ 와 같이 구성하지 않았다면, 8×4 블록에 대한 NSPT 행렬로서 32×14 행렬을 이용될 것이다. 그러나, 4×8 블록에 대한 NSPT 행렬과 8×4 블록

에 대한 NSPT 행렬을 $32 \times \max(16, 14)$ 행렬로 구성할 경우, 32×16 행렬이 온전히 적용될 수 있다.

- [298] 반대로, 현재 블록이 x 번 모드를 가진 8×4 블록인 경우, 현재 블록에 대해 x 번 모드에 대칭인 모드 또는 8×4 블록에 대칭인 4×8 블록 중 적어도 하나에 대한 NSPT 행렬이 적용될 수 있다. 이 경우, 4×8 블록에 대한 역방향의 NSPT 행렬인 32×16 행렬이 이용될 수도 있고, 32×14 행렬이 이용될 수도 있다. 여기서, 32×14 행렬은, 32×16 행렬에서 왼쪽부터 14개의 행들을 샘플링하여 유도될 수 있다.
- [299] 전술한 바와 같이 NSPT 행렬을 구성할 경우, 상기 소정의 조건을 만족하면서 최대 개수의 변환 기저 벡터들로 구성된 변환을 적용할 수 있어서 코딩 성능을 극대화할 수 있다.
- [300] 전술한 실시예에서 r 의 값은 16의 배수가 되도록 설정될 수 있다. 일례로, 4×8 블록과 8×4 블록에 대한 역방향의 NSPT의 경우, 32×20 행렬이 아닌 32×16 행렬이 적용될 수 있다. 변환 블록의 변환 계수들은 소정의 계수 그룹(Coefficient Group, CG)의 단위로 부호화될 수 있다. 여기서, CG는 16개의 변환 계수들의 그룹으로 정의될 수 있고, 일례로 CG는 4×4 , 2×8 , 8×2 와 같은 크기의 서브 블록일 수 있다. 하나의 CG 내에 널-제로 변환 계수가 존재하지 않는 경우가 있을 수 있고, 이 경우 해당 CG에 대해서는 변환 계수의 부호화 과정이 스킵될 수 있다. 따라서, r 의 값을 16의 배수로 설정할 경우, 구현의 복잡도가 낮아지는 장점이 있다.
- [301] $M \times N$ 블록의 레지듀얼 샘플들에 순방향의 NSPT를 적용하여 변환 계수들이 유도될 수 있다. 이때, 유도되는 변환 계수들의 개수는 zero-out에 의해 $(M \times N)$ 의 값보다 작거나 같을 수 있다. 즉, 순방향의 NSPT 행렬은 $r \times (M \times N)$ 행렬로 정의될 수 있고, 여기서 r 은 NSPT의 출력 길이 또는 NSPT를 통해 유도되는 변환 계수의 개수를 의미하고 $(M \times N)$ 은 NSPT의 입력 길이 또는 NSPT가 적용되는 레지듀얼 샘플의 개수를 의미할 수 있다.
- [302] 상기 유도된 변환 계수들은 소정의 스캔 순서에 따라 $M \times N$ 블록 내부에 배열될 수 있고, 상기 변환 계수들이 채워지지 않은 영역은 0으로 채워질 수 있다(즉, zero-out). 따라서, 디코딩 장치에서 변환 계수들을 스캔하는 과정에서, NSPT가 적용되었다면 0으로 채워졌을 영역에서 널-제로 변환 계수가 발견된 경우(또는, $M \times N$ 블록 내 마지막 유효 계수의 스캔 위치가 r 보다 크거나 같은 경우), 해당 $M \times N$ 블록에 대해 NSPT가 적용되지 않은 것으로 간주되고, NSPT 인덱스가 시그널링되지 않을 수 있다. $M \times N$ 블록 내 좌상단 계수(즉, DC 성분 계수)에 0의 스캔 위치를 나타내는 인덱스가 할당되고, 소정의 순서에 따라 $M \times N$ 블록 내 나머지 계수에 1씩 증가된 인덱스가 할당될 수 있다.
- [303] NSPT가 적용될 수 있는 블록 크기들에 대해 이용 가능한 하나 또는 그 이상의 r 의 값들이 정의될 수 있다. 일례로, NSPT가 적용될 수 있는 블록 크기들 각각에 대해서 하나 또는 그 이상의 r 의 값들이 정의될 수 있다. 또는, NSPT가 적용될 수 있는 블록 크기 별로 하나의 r 의 값이 정의될 수 있고, NSPT가 적용될 수 있는 블록 크기들 중 어느 하나에 대한 r 의 값은, 다른 하나에 대한 r 의 값과 상이할 수 있

다. 또는, NSPT가 적용될 수 있는 블록 크기들 중 일부에 대해서는 하나의 r 의 값이 정의되고, 나머지에 대해서는 둘 이상의 r 의 값들이 정의될 수 있다.

- [304] 복수의 r 의 값들이 이용 가능한 경우, 복수의 r 의 값들 중 어느 하나를 특정하는 인덱스 또는 r 의 자체가 시그널링될 수 있다. 해당 인덱스는, VPS, SPS, PPS, PH, SH와 같은 하이 레벨 신택스(HLS)에서 시그널링되거나, CTU, CU, TU와 같은 블록 레벨에서 시그널링될 수도 있다. r 의 값이 특정 범위에 속하는 값인 경우, 해당 범위를 포함할 수 있을만큼의 비트들을 할당하여 시그널링할 수 있다. 예를 들어, r 의 값이 1 내지 256의 범위에 속하는 경우, 8-비트만큼을 fixed-length로 지정하여 시그널링할 수 있다.
- [305] 현재 블록의 변환 커널은, 전술한 실시예 1 내지 3 중 어느 하나를 기반으로 결정될 수 있다. 또는, 현재 블록의 변환 커널은, 전술한 실시예 1 내지 3에 따른 발명이 서로 충돌되지 않는 범위 내에서, 실시예 1 내지 3 중 적어도 둘의 조합에 기초하여 결정될 수도 있다.
- [306] 현재 블록의 역변환을 위한 변환 인덱스가 시그널링될 수 있다. 여기서, 변환 인덱스는, 변환 세트에 속한 하나 또는 그 이상의 변환 커널들(또는, 변환 행렬들) 중 어느 하나를 특정할 수 있다. 여기서, 변환 인덱스는, NSPT 세트에 속한 하나 또는 그 이상의 NSPT 커널들 중 어느 하나를 특정하는 NSPT 인덱스를 의미할 수 있다. 또는, 상기 변환 인덱스는, LFNST 세트에 속한 하나 또는 그 이상의 LFNST 커널들 중 어느 하나를 특정하는 LFNST 인덱스를 의미할 수도 있다.
- [307] 상기 변환 인덱스가 NSPT 인덱스에 해당하는지 여부는, 현재 블록의 크기가 전술한 제1 그룹에 속한 블록 크기들 중 어느 하나인지 여부에 기초하여 결정될 수 있다. 이는, NSPT가 적용 가능한 블록 크기들과 LFNST가 적용 가능한 블록 크기들이 서로 구분되는 경우를 전제로 한다. 이 경우, 현재 블록의 크기가 제1 그룹에 속하면, 현재 블록에 대해 시그널링된 변환 인덱스는 NSPT 인덱스에 해당하고, 해당 변환 인덱스를 기반으로 NSPT 세트로부터 NSPT 커널이 결정될 수 있다. 반면, 현재 블록의 크기가 제1 그룹에 속하지 않는 경우, 현재 블록에 대해 시그널링된 변환 인덱스는 LFNST 인덱스에 해당하고, 해당 변환 인덱스를 기반으로 LFNST 세트로부터 LFNST 커널이 결정될 수 있다. 현재 블록의 크기가 제1 그룹에 속하지 않는 경우는, 현재 블록의 크기가 전술한 제2 그룹에 속하는 경우를 의미할 수 있다. 또는, 현재 블록의 크기가 제1 그룹에 속하지 않는 경우는, 현재 블록의 크기가 제2 그룹에 속한 블록 크기들 중 LFNST가 적용 가능한 블록 크기에 해당하는 경우를 의미할 수도 있다. 이와 같이, NSPT 인덱스와 LFNST 인덱스가 별개의 신택스로 구성되는 것이 아니라, 통합된 하나의 신택스로 구성될 수 있다.
- [308] 일례로, 제1 그룹에 속한 NSPT가 적용 가능한 블록 크기들이 4x4, 4x8, 8x4, 8x8인 경우를 가정한다. 제1 그룹에 속한 블록 크기들에 대해서는 LFNST 대신에 NSPT가 적용될 수 있다. 구체적으로, 분리 일차 변환(e.g., DCT-2, separable KLT)과 LFNST의 조합 대신에 NSPT가 적용될 수 있다. 제1 그룹에 속한 4개의 블록

크기들에 대해서는 NSPT 인덱스가 시그널링될 수 있고, (LFNST가 허용되는) 나머지 블록 크기들에 대해서는 LFNST 인덱스가 시그널링될 수 있다.

[309] 이와 같이, NSPT 인덱스와 LFNST 인덱스를 통합된 하나의 신택스로 시그널링하는 경우, 부호화되는 정보량을 줄일 수 있다. 또한, 엔트로피 코딩을 위한 이진화, CABAC 컨텍스트, 또는 초기 값(initial value) 중 적어도 하나를 NSPT/LFNST 인덱스에 대해 동일하게 적용함으로써, 구현의 복잡도를 줄일 수도 있다.

[310] 또는, NSPT 인덱스와 LFNST 인덱스를 별개의 신택스로서 각각 시그널링할 수도 있다. 이 경우, 구현의 복잡도가 일부 증가될 수는 있으나, 각 인덱스에 대해 최적화된 엔트로피 코딩을 함으로써 압축 성능을 향상시킬 수 있다.

[311] LFNST 세트에 속한 LFNST 커널 후보의 개수와 NSPT 세트에 속한 NSPT 커널 후보의 개수가 동일한 경우, LFNST 인덱스와 NSPT 인덱스에 대해 동일한 이진화(binization)가 적용될 수 있다. LFNST 인덱스와 NSPT 인덱스의 빈(bin)들에 대해 동일한 CABAC 컨텍스트(또는, CABAC context increment)가 할당될 수도 있다.

[312] LFNST 인덱스와 NSPT 인덱스에 대해 서로 다른 이진화 및/또는 CABAC 컨텍스트가 이용될 수 있다. LFNST 인덱스와 NSPT 인덱스에 대해 서로 다른 CABAC 초기 값이 할당될 수 있다. 일례로, LFNST 인덱스와 NSPT 인덱스 중 어느 하나는 fixed-length binarization을 기반으로 이진화되고, 다른 하나는 truncated unary binarization을 기반으로 이진화될 수 있다. LFNST 인덱스와 NSPT 인덱스의 이진화가 동일하더라도, 서로 다른 CABAC 컨텍스트 및/또는 CABAC 초기 값이 할당될 수 있다. LFNST 세트에 속한 LFNST 커널 후보의 개수와 NSPT 세트에 속한 NSPT 커널 후보의 개수가 서로 상이한 경우, LFNST 인덱스와 NSPT 인덱스에 대해 서로 다른 이진화 및/또는 CABAC 컨텍스트가 이용될 수 있다.

[313] NSPT 세트에 속한 NSPT 커널 후보의 개수는, 블록 크기 별로 상이하게 설정될 수 있다. 또는, 상기 제1 그룹에 속한 블록 크기들은 복수의 서브 그룹으로 구분될 수 있다. 이 경우, NSPT 세트에 속한 NSPT 커널 후보의 개수는, 상기 복수의 서브 그룹 별로 상이하게 설정될 수 있다. 여기서, 복수의 서브 그룹 중 적어도 하나는 서로 다른 복수의 블록 크기들을 포함할 수 있다.

[314] NSPT 세트에 속한 NSPT 커널 후보의 개수에 따라, NSPT 인덱스에 적용되는 이진화가 상이할 수 있다.

[315] 일례로, 특정 블록 크기에 대한 NSPT 세트 내 NSPT 커널 후보의 개수가 3개인 경우, NSPT 인덱스는 0 내지 3 중 어느 하나의 값을 가질 수 있다. NSPT 인덱스의 값이 0인 경우, 이는 현재 블록에 NSPT가 적용되지 않음을 나타낼 수 있다. NSPT 인덱스의 값이 0이 아닌 경우, 이는 3개의 NSPT 커널 후보들 중 해당 NSPT 인덱스에 대응하는 NSPT 커널 후보를 나타낼 수 있다. 하나의 빈(bin)을 할당하여 NSPT가 적용되는 경우와 그렇지 않은 경우를 구분할 수 있다. 해당 빈의 값이 0인 경우는 NSPT 인덱스의 값이 0인 경우에 해당할 수 있다. 반면, 해당 빈의 값이 1인 경우는 NSPT 인덱스의 값이 1, 2, 또는 3인 경우에 해당할 수 있다. 이 경

우, 3개의 NSPT 커널 후보들을 구분하기 위해 truncated unary binarization이 적용될 수 있다. 즉, 2개의 빈들을 할당하여 0, 10, 11로 3개의 NSPT 커널 후보들을 구분할 수 있다.

- [316] 특정 블록 크기에 대한 NSPT 세트 내 NSPT 커널 후보의 개수가 2개인 경우, NSPT 인덱스는 0 내지 2 중 어느 하나의 값을 가질 수 있다. NSPT 인덱스의 값이 0인 경우, 이는 현재 블록에 NSPT가 적용되지 않음을 나타낼 수 있다. NSPT 인덱스의 값이 0이 아닌 경우, 이는 2개의 NSPT 커널 후보들 중 해당 NSPT 인덱스에 대응하는 NSPT 커널 후보를 나타낼 수 있다. 하나의 빈(bin)을 할당하여 NSPT가 적용되는 경우와 그렇지 않은 경우를 구분할 수 있다. 2개의 NSPT 커널 후보들 중 어느 하나를 나타내는 하나의 빈을 할당하여, 2개의 NSPT 커널 후보들을 구분할 수 있다.
- [317] 특정 블록 크기에 대한 NSPT 세트 내 NSPT 커널 후보의 개수가 1개인 경우, NSPT 인덱스는 0 또는 1 중 어느 하나의 값을 가질 수 있다. NSPT 인덱스의 값이 0인 경우, 이는 현재 블록에 NSPT가 적용되지 않음을 나타낼 수 있다. NSPT 인덱스의 값이 1인 경우, 이는 1개의 NSPT 커널 후보를 나타낼 수 있다. 이와 같은 경우, 하나의 빈만으로 NSPT의 적용 여부 및 NSPT 커널 후보를 특정할 수 있다.
- [318] 상기 현재 블록의 역변환은 분리 일차 변환 및/또는 LFNST 기반의 역변환일 수 있다. 즉, 현재 블록의 (역양자화된) 변환 계수들 전부 또는 일부에 대해 역방향의 LFNST를 적용하고, 그런 다음 LFNST를 통해 유도된 변환 계수들에 대해 역방향의 분리 일차 변환을 적용하여 레지듀얼 샘플들을 유도할 수 있다. 일례로, 현재 블록의 일부 영역에 속한 (역양자화된) 변환 계수들에 대해 역방향의 LFNST가 적용될 수 있다. 여기서, 일부 영역은 순방향의 LFNST가 적용된 영역을 의미하며, 이하 ROI (region of interest) 영역이라 부르기로 한다. LFNST를 통해 유도된 변환 계수들은 소정의 스캔 순서에 따라 ROI 영역에 배열될 수 있다. 소정의 스캔 순서는, 행 우선 순서(row-first order) 또는 열 우선 순서(column-first order)일 수 있다. 상기 LFNST를 통해 유도된 변환 계수들 및 상기 현재 블록 내 ROI 영역을 제외한 나머지 영역에 속한 변환 계수들에 대해서 역방향의 분리 일차 변환이 적용될 수 있다. 또는, 순방향의 변환 과정에서, 상기 현재 블록 내 ROI 영역을 제외한 나머지 영역에 대해서 zero-out이 수행된 경우(즉, 해당 나머지 영역 내 변환 계수들이 0으로 설정된 경우), LFNST를 통해 유도된 변환 계수들에 대해서 역방향의 분리 일차 변환이 적용될 수 있다. 상기 ROI 영역의 크기는 현재 블록의 너비 또는 높이 중 적어도 하나에 기초하여 결정될 수 있다. 여기서, ROI 영역의 크기는, ROI 영역의 너비 또는 높이 중 적어도 하나를 의미할 수도 있고, ROI 영역에 속한 샘플 위치들의 개수를 의미할 수도 있다.
- [319] NSPT 커널은 8-bit 정밀도(precision)로 구성될 수 있다. NSPT 커널 내 계수들의 범위는 -128보다 크거나 같고 127보다 작거나 같을 수 있다. 해당 정밀도를 8-bit보다 올리는 경우, 행렬 곱셈을 통해 얻어지는 결과값에 대해 올라간 정밀도만큼 오른쪽으로 쉬프트할 수 있다. 예를 들어, 8-bit 정밀도를 가진 NSPT 커널을 기반

으로 행렬 곱셈 후 얻어진 값을 S 비트만큼 오른쪽으로 쉬프트하여 버퍼에 저장하는 경우, 만일 N -bit 정밀도로 커널의 계수를 구성한다면 $(S+(N-8))$ 비트만큼 오른쪽으로 쉬프트하여 버퍼에 저장할 수 있다.

- [320] 8-bit 정밀도로 NSPT 커널을 구성하는 경우, 변환을 수행하는 부/복호화기 내부 정밀도의 과도한 상승을 막을 수 있어, 메모리 요구량과 연산량 관점에서 구현 복잡도를 저감하면서도 압축 효율의 하락을 최소화할 수 있다.
- [321] 표 11와 표 12는 8×32 블록에 적용될 수 있는 NSPT 커널들의 예시이고, 표 13과 표 14는 32×8 블록에 적용될 수 있는 NSPT 커널들의 예시이다. NSPT 커널을 구성하는 계수들은 8-bit 정밀도로 표현된 것이다. NSPT 커널의 계수들은 -128부터 127까지의 값을 가질 수 있다. 본 예시에서, 인코딩 장치와 디코딩 장치에 동일하게 기-정의된 NSPT 세트들의 개수는 총 35개이고, 각 NSPT 세트는 3개의 NSPT 커널 후보들로 구성될 수 있다.
- [322] 본 예시에서, $g_nspt_{8 \times 32}[35][3][48][256]$ 은 8×32 블록에 적용될 수 있는 NSPT 커널들을 나타내고, $g_nspt_{32 \times 8}[35][3][48][256]$ 는 32×8 블록에 적용될 수 있는 NSPT 커널들을 나타낼 수 있다. 다만, 전술한 대칭성을 고려하여 NSPT 세트 및/또는 NSPT 커널이 결정될 수도 있다. 현재 블록이 8×32 블록이고 특정 인트라 예측 모드(예를 들어, 수직 방향성을 가진 모드)를 가지는 경우, 이러한 현재 블록과 대칭성을 가진 블록 즉, 32×8 블록에 대한 NSPT 세트 및/또는 NSPT 커널이 현재 블록에 동일하게 적용될 수 있다. 또는, 현재 블록이 32×8 블록이고 특정 인트라 예측 모드(예를 들어, 수직 방향성을 가진 모드)를 가지는 경우, 이러한 현재 블록과 대칭성을 가진 블록 즉, 8×32 블록에 대한 NSPT 세트 및/또는 NSPT 커널이 현재 블록에 동일하게 적용될 수 있다. 이때, 현재 블록으로부터의 입력 데이터를 전치한 후 해당 NSPT 커널을 곱해주게 된다.
- [323] 아래 $g_nspt_{8 \times 32}[35][3][48][256]$ 와 $g_nspt_{32 \times 8}[35][3][48][256]$ 에서, [35]는 35개 NSPT 세트들로 구성됨을 나타내고, [3]은 각 NSPT 세트가 3개의 NSPT 커널 후보들로 구성되어 있음을 나타낼 수 있다. 예를 들어, 표 11 내지 표 14에서 k 는 세트 인덱스가 k 인 NSPT 세트를 의미할 수 있고, k 는 0 내지 34의 범위에 속할 수 있다. k 에 속한 3개의 행렬은 변환 인덱스가 각각 0, 1, 2인 NSPT 커널 후보들을 나타낼 수 있다. 또한, [48][256]은 순방향의 NSPT 행렬을 기준으로 48×256 행렬을 나타낼 수 있다. 구체적으로, 첫번째 [48]은 48개의 변환 기저 벡터들을 나타내고, 두번째 [256]은 각 변환 기저 벡터가 256개의 계수들로 구성된 일차원 벡터임을 나타낼 수 있다. 이는 순방향의 NSPT 관점에서, 순방향의 NSPT로의 입력이 길이가 256인 일차원 벡터임을 나타낼 수 있다. 역방향의 NSPT 행렬은 아래 $g_nspt_{8 \times 32}$ 어레이 또는 $g_nspt_{32 \times 8}$ 어레이로부터 선택된 NSPT 커널을 전치하여 유도될 수 있다. 이 경우, 역방향의 NSPT 행렬은 256×48 행렬이 될 수 있다.
- [324] 또는, R 개의 변환 기저 벡터(들)이 사용될 수 있다. 여기서, R 은 48보다 작은 정수일 수 있다. 이 경우, 표 11 내지 표 14의 각 NSPT 커널에 대해서 위에서부터

48개가 아닌 R개의 행만이 선택될 수 있고, 순방향의 NSPT 행렬은 Rx256 행렬이 될 수 있다. 이때, 위에서부터 선택된 R개의 행(즉, 변환 기저 벡터)을 제외한 나머지 (48-R)개의 행들은 제거될 수 있다. 8x32 블록에 적용될 수 있는 NSPT 커널들은 $g_nspt8x32[35][3][R][256]$ 로 표현될 수 있고, 32x8 블록에 적용될 수 있는 NSPT 커널들은 $g_nspt32x8[35][3][R][256]$ 로 표현될 수 있다. 역방향의 NSPT 행렬은 아래 $g_nspt8x32$ 어레이 또는 $g_nspt32x8$ 어레이로부터 선택된 R개의 행을 전치하여 유도될 수 있다. 이 경우, 역방향의 NSPT 행렬은 256xR 행렬이 될 수 있다.

[325] [표11]

```
const int8_t g_nspt8x32[35][3][48][256] = {
{ /0
{
{ -1,-1,-2,-2,-2,-2,-3,-3,-2,-3,-3,-4,-4,-4,-5,-5,-2,-4,-5,-6,-6,-7,-7,-7,-3,-5,-7,-8,-8,-9,-9,
-9,-4,-7,-9,-10,-11,-11,-11,-11,-5,-8,-10,-12,-12,-13,-13,-13,-5,-9,-12,-14,-15,-15,-15,-
15,-6,-11,-14,-16,-17,-17,-17,-17,-7,-12,-16,-18,-19,-20,-20,-19,-8,-14,-18,-20,-22,-22
,-22,-21,-9,-16,-20,-23,-24,-25,-25,-24,-10,-17,-23,-26,-27,-28,-27,-27,-11,-19,-25,-29
,-31,-31,-31,-29,-12,-21,-28,-32,-34,-35,-34,-32,-13,-23,-30,-35,-38,-38,-37,-36,-14,-2
4,-33,-38,-41,-42,-41,-39,-15,-26,-35,-41,-45,-46,-45,-42,-15,-27,-37,-44,-48,-49,-48,-
46,-15,-28,-38,-45,-50,-51,-51,-48,-16,-28,-39,-47,-52,-54,-53,-51,-16,-28,-39,-47,-53
,-55,-55,-53,-15,-28,-39,-47,-53,-56,-56,-54,-15,-27,-38,-46,-53,-56,-57,-55,-14,-26,-3
7,-45,-52,-56,-57,-56,-13,-24,-35,-44,-51,-55,-57,-56,-12,-23,-33,-42,-49,-53,-55,-55,-
11,-21,-30,-39,-46,-51,-54,-54,-9,-18,-28,-36,-43,-49,-52,-52,-8,-16,-25,-33,-40,-46,-4
9,-50,-7,-14,-22,-30,-37,-42,-46,-48,-5,-12,-19,-26,-33,-39,-43,-45,-5,-10,-16,-23,-29,
-35,-39,-42 },
{ -4,-7,-8,-8,-9,-8,-7,-6,-7,-10,-13,-14,-14,-14,-12,-10,-9,-14,-17,-19,-20,-19,-17,-15,-
10,-17,-22,-24,-25,-24,-22,-19,-12,-20,-26,-29,-30,-28,-26,-23,-14,-23,-29,-33,-34,-33
,-30,-26,-15,-26,-33,-37,-38,-37,-34,-30,-16,-28,-36,-40,-42,-40,-37,-33,-17,-30,-39,-4
4,-45,-44,-40,-36,-18,-31,-41,-47,-48,-47,-43,-38,-18,-32,-42,-49,-51,-50,-46,-40,-18,-
32,-43,-50,-53,-52,-48,-42,-17,-31,-43,-50,-53,-53,-49,-43,-16,-29,-41,-49,-52,-53,-49
,-44,-14,-26,-37,-45,-50,-50,-48,-43,-12,-22,-32,-40,-45,-47,-45,-40,-8,-17,-25,-32,-38
,-40,-40,-36,-5,-11,-17,-24,-29,-32,-33,-31,-2,-4,-8,-14,-19,-23,-24,-24,2,2,0,-3,-8,-12,
-15,-16,5,8,9,7,3,-1,-5,-8,8,13,16,17,14,10,5,1,10,18,23,25,24,20,15,10,12,22,29,33,3
3,30,25,19,14,25,34,39,41,39,34,27,14,26,36,43,46,45,40,34,14,27,38,45,49,49,45,39
,13,26,37,45,50,51,48,42,12,24,35,44,50,51,49,44,11,22,33,41,47,50,49,45,9,19,29,3
7,43,46,46,44,7,15,24,32,38,42,43,41 },
{ 5,8,10,11,11,11,9,8,8,12,16,18,18,18,16,13,10,16,21,24,25,24,22,19,11,19,25,29,30
,30,27,24,13,22,29,33,35,35,32,28,13,23,31,37,39,39,36,32,13,24,33,39,42,42,39,35,
```

13,24,33,40,43,44,41,37,11,22,32,39,44,45,43,39,9,19,28,37,42,44,42,39,6,13,22,31,
38,41,40,37,1,6,13,22,30,35,36,35,-4,-3,2,11,19,26,30,30,-9,-13,-10,-3,6,15,21,24,-15
,-22,-23,-18,-9,1,10,15,-20,-32,-36,-34,-25,-14,-3,5,-24,-39,-48,-48,-41,-29,-16,-5,-26
,-44,-55,-58,-52,-41,-27,-14,-26,-45,-59,-63,-60,-50,-36,-21,-25,-44,-58,-64,-63,-54,-4
1,-26,-22,-39,-53,-60,-60,-53,-42,-28,-17,-31,-43,-51,-51,-47,-37,-26,-11,-21,-30,-36,-
38,-35,-28,-19,-5,-10,-15,-19,-21,-20,-16,-10,1,1,0,-2,-3,-3,-1,1,6,10,12,14,14,14,13,1
3,10,17,23,27,29,28,27,24,12,22,31,37,40,41,38,34,13,25,36,44,49,50,47,42,13,25,37
,47,53,55,52,48,12,24,36,46,53,56,54,50,11,22,33,42,49,53,53,50 },

{ -7,-9,-10,-9,-7,-4,-1,1,-10,-14,-15,-13,-10,-6,-2,2,-13,-18,-20,-18,-13,-8,-2,3,-15,-22,
-24,-22,-16,-9,-2,3,-17,-26,-28,-25,-18,-10,-2,4,-19,-29,-32,-28,-20,-11,-2,6,-21,-32,-3
4,-30,-21,-10,-1,7,-22,-34,-37,-31,-21,-10,1,10,-24,-36,-38,-32,-21,-8,3,12,-24,-37,-39
,-32,-19,-6,6,16,-24,-36,-38,-30,-17,-2,11,20,-23,-36,-36,-27,-13,2,16,26,-24,-35,-35,-
24,-8,9,22,32,-24,-35,-33,-21,-3,15,30,39,-24,-35,-32,-18,2,22,38,47,-25,-36,-32,-16,
6,29,45,55,-27,-38,-34,-17,9,33,52,63,-29,-42,-38,-19,8,35,56,68,-32,-46,-43,-24,4,33
,57,71,-34,-51,-49,-31,-2,30,56,73,-36,-55,-56,-38,-9,24,53,72,-37,-58,-60,-46,-17,16,
48,69,-37,-58,-63,-50,-24,9,41,65,-36,-58,-64,-53,-29,3,35,61,-34,-55,-62,-53,-31,-1,3
0,56,-31,-50,-57,-51,-31,-3,27,53,-26,-43,-50,-45,-28,-3,25,50,-22,-36,-42,-38,-23,-1,
25,48,-17,-28,-34,-30,-17,3,26,47,-12,-21,-25,-22,-10,6,27,47,-8,-14,-16,-13,-4,11,29,
46,-4,-7,-8,-5,3,15,31,46 },

{ 7,11,14,15,15,15,13,10,10,16,21,24,25,24,21,18,12,20,26,30,32,32,29,25,13,22,30,
35,38,38,35,30,13,22,31,37,41,42,39,34,11,20,29,37,41,43,41,36,8,15,25,33,39,42,41
,37,3,9,17,27,34,39,39,36,-3,0,7,17,27,33,35,34,-9,-11,-6,4,15,24,29,30,-17,-23,-21,-
12,1,12,20,24,-23,-36,-38,-30,-16,-2,9,16,-29,-46,-53,-47,-34,-17,-3,8,-31,-53,-63,-61
,-48,-31,-14,0,-31,-53,-67,-67,-57,-40,-22,-7,-27,-49,-63,-67,-59,-44,-27,-11,-21,-39,-
53,-57,-52,-40,-26,-11,-12,-25,-35,-39,-36,-29,-17,-6,-2,-8,-13,-16,-14,-10,-3,3,7,8,9,
9,10,11,13,15,13,21,27,30,32,31,29,27,16,28,37,45,47,47,42,37,16,28,40,49,55,54,50
,43,13,24,36,46,52,54,51,44,8,16,25,34,42,45,45,40,1,4,10,17,24,30,32,31,-6,-8,-7,-3,
3,10,15,18,-11,-19,-23,-23,-18,-11,-4,2,-15,-27,-36,-39,-37,-30,-22,-13,-17,-31,-43,-5
0,-50,-45,-36,-26,-16,-32,-45,-54,-57,-54,-46,-35,-16,-30,-43,-53,-58,-57,-51,-42 },

{ 3,2,-1,-5,-8,-11,-13,-12,4,3,-1,-7,-14,-18,-20,-20,6,6,1,-8,-17,-23,-27,-26,9,10,4,-7,-
18,-27,-32,-32,13,16,9,-3,-17,-29,-35,-36,17,23,16,2,-14,-29,-37,-39,23,31,26,10,-9,-
26,-37,-41,29,41,37,20,-2,-22,-35,-41,36,51,49,31,7,-17,-33,-41,40,59,59,42,15,-11,-
30,-40,42,64,66,50,23,-5,-27,-38,41,65,69,55,27,-1,-24,-37,37,59,66,53,28,-1,-24,-37,
29,49,54,45,22,-3,-25,-38,19,32,36,29,11,-10,-29,-40,8,14,16,10,-4,-20,-34,-42,-3,-3,-
5,-9,-18,-29,-38,-43,-11,-17,-20,-23,-28,-33,-38,-41,-16,-25,-29,-30,-31,-32,-33,-34,-1
9,-29,-32,-30,-26,-23,-22,-23,-20,-29,-30,-23,-15,-8,-6,-7,-19,-27,-24,-14,0,10,14,12,-
18,-24,-19,-4,15,29,35,32,-18,-24,-16,2,25,44,53,50,-19,-25,-17,3,30,52,65,64,-21,-3
0,-23,-3,25,51,67,70,-24,-35,-33,-15,13,41,61,68,-27,-42,-43,-29,-4,25,49,61,-28,-46,

-52,-43,-21,8,34,51,-27,-47,-56,-52,-34,-8,19,38,-24,-43,-56,-55,-44,-21,4,24,-21,-38,-50,-53,-46,-29,-7,13 },

{ 13,19,21,21,18,14,10,6,18,28,32,31,27,22,15,10,23,34,40,39,35,28,20,13,25,39,45,45,39,31,22,14,26,41,48,47,41,32,23,14,25,40,46,45,38,29,20,12,22,35,40,38,32,23,15,7,17,28,31,28,22,14,7,1,12,19,19,15,8,2,-4,-7,7,9,7,0,-7,-13,-16,-18,3,1,-6,-15,-23,-29,-30,-29,1,-4,-14,-27,-38,-43,-44,-40,2,-4,-17,-33,-47,-54,-55,-49,6,3,-11,-30,-47,-58,-59,-55,14,14,3,-16,-36,-50,-56,-54,21,28,22,6,-16,-36,-46,-48,27,40,42,29,8,-14,-31,-38,28,46,53,48,30,8,-12,-24,24,42,54,55,45,26,6,-10,16,31,44,50,47,35,17,2,4,12,24,33,37,33,22,9,-9,-10,-2,8,17,21,17,11,-22,-32,-31,-22,-9,2,7,7,-32,-50,-54,-48,-33,-17,-4,3,-37,-58,-69,-64,-50,-30,-12,0,-35,-58,-69,-68,-53,-33,-13,2,-28,-48,-58,-56,-44,-24,-5,9,-19,-33,-39,-36,-25,-8,9,20,-10,-17,-18,-13,-1,13,26,34,-1,-2,2,10,22,34,44,48,6,11,19,30,42,53,60,61,13,21,31,43,55,65,70,70 },

{ -10,-12,-9,-4,4,10,13,14,-15,-18,-14,-5,6,15,21,23,-19,-24,-19,-7,8,20,28,31,-23,-31,-25,-11,7,24,34,38,-28,-37,-32,-16,6,25,38,43,-31,-44,-39,-21,2,24,40,46,-34,-48,-46,-28,-2,22,40,48,-35,-52,-51,-34,-7,19,39,49,-33,-51,-53,-38,-12,15,37,48,-28,-45,-49,-38,-14,12,34,47,-19,-33,-39,-32,-14,10,31,44,-7,-16,-23,-22,-9,10,28,41,7,4,-4,-7,-3,10,25,36,20,24,17,8,5,9,19,29,31,41,36,22,9,5,9,18,39,54,48,30,9,-4,-4,3,42,59,55,31,3,-17,-22,-15,40,58,51,26,-7,-32,-40,-34,35,50,43,17,-18,-46,-56,-50,29,42,34,9,-25,-55,-67,-61,22,32,27,5,-26,-54,-69,-65,15,23,21,6,-20,-44,-59,-59,7,14,15,8,-8,-26,-40,-43,-1,4,9,10,4,-6,-16,-21,-9,-8,-1,8,13,13,9,3,-17,-21,-13,1,16,26,28,25,-25,-33,-27,-9,13,32,42,42,-31,-45,-42,-23,4,31,48,54,-34,-52,-54,-37,-8,24,49,59,-34,-54,-59,-47,-19,14,43,59,-30,-50,-58,-49,-27,4,34,53,-24,-42,-50,-46,-28,-2,25,44 },

{ 16,24,28,28,26,21,16,10,22,33,40,41,38,33,24,16,25,38,46,48,45,39,30,20,25,39,47,50,47,40,31,21,21,34,42,44,42,37,28,20,14,23,30,32,31,27,21,14,5,9,12,14,14,13,10,6,-4,-7,-8,-8,-6,-5,-4,-5,-12,-21,-28,-29,-27,-23,-19,-16,-15,-29,-39,-45,-44,-39,-33,-26,-13,-27,-41,-49,-52,-48,-42,-34,-6,-17,-30,-42,-48,-49,-44,-38,5,0,-10,-22,-33,-38,-39,-36,15,20,16,7,-6,-18,-25,-28,23,35,40,35,24,9,-5,-14,23,40,51,55,47,33,16,1,14,30,47,56,57,47,31,14,-1,7,22,37,45,45,34,20,-18,-22,-14,2,18,26,26,18,-32,-48,-49,-36,-16,2,11,11,-38,-60,-70,-62,-43,-20,-4,3,-33,-57,-68,-67,-51,-30,-11,-1,-20,-36,-47,-48,-39,-23,-9,0,-3,-9,-14,-15,-11,-4,3,7,13,18,20,20,21,21,19,16,23,36,43,46,44,40,31,23,26,41,51,55,53,45,34,23,22,36,44,47,44,37,26,15,14,22,26,26,23,16,8,0,3,4,2,-2,-7,-13,-18,-21,-8,-14,-22,-31,-39,-44,-46,-44,-17,-29,-41,-53,-62,-68,-68,-63 },

{ 5,9,15,21,26,29,28,23,4,10,18,28,37,42,41,36,0,4,14,26,39,47,49,44,-7,-6,3,17,33,45,49,47,-15,-19,-13,2,21,36,45,46,-23,-33,-30,-16,4,23,35,40,-28,-43,-45,-34,-15,6,22,31,-27,-47,-55,-49,-32,-10,9,21,-20,-39,-54,-54,-43,-23,-3,11,-5,-19,-36,-45,-42,-28,-11,4,16,11,-4,-20,-28,-24,-13,-1,36,44,33,13,-5,-13,-10,-3,50,68,66,45,19,1,-6,-4,50,75,76,60,33,10,-3,-6,37,58,63,51,29,7,-7,-11,15,27,30,22,7,-8,-17,-19,-7,-9,-11,-15,-22,-28,-30,-28,-22,-34,-40,-43,-42,-41,-37,-31,-27,-41,-49,-49,-45,-38,-32,-25,-22,-34,-3

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,-24,-34,-39,-35,-26,-15,1,-3,-15,-31,-45,-51,-46,-36,12,14,6,-11,-32,-46,-51,-45,23,3
5,33,20,-2,-24,-38,-41,32,51,59,52,33,9,-12,-24,37,61,74,74,60,39,15,-2 },
{ 27,37,37,31,22,12,4,-2,36,50,52,44,30,17,4,-4,40,56,58,48,32,15,1,-8,40,56,57,46,2
8,10,-5,-14,35,50,50,37,19,0,-14,-22,27,38,36,23,5,-12,-24,-30,17,23,18,6,-10,-25,-35
,-39,7,7,1,-11,-26,-38,-45,-46,-1,-6,-14,-25,-37,-46,-51,-49,-5,-12,-20,-29,-38,-46,-49,
-47,-5,-11,-17,-23,-29,-34,-38,-38,-4,-8,-9,-8,-10,-14,-19,-22,-5,-6,0,8,14,13,7,-1,-8,-9
,2,19,34,39,33,22,-14,-17,-6,17,42,55,53,42,-20,-30,-22,1,32,56,62,55,-23,-38,-40,-21
,10,40,58,58,-17,-36,-46,-40,-16,15,38,48,-3,-18,-35,-42,-34,-12,13,29,16,9,-9,-29,-3
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32,-28,42,63,64,46,15,-14,-30,-31,25,38,42,30,9,-14,-29,-30,3,7,9,5,-5,-17,-25,-25,-1
7,-24,-24,-22,-20,-19,-17,-14,-30,-45,-47,-40,-28,-16,-6,1,-34,-51,-56,-45,-27,-6,11,2
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{ -5,-4,0,3,3,0,-4,-7,-5,-3,3,7,7,2,-5,-11,-7,-3,5,11,12,5,-5,-14,-9,-4,6,15,16,8,-5,-17,-1
3,-8,6,17,20,11,-5,-20,-18,-13,3,18,22,13,-5,-22,-24,-21,-2,16,23,14,-5,-24,-31,-29,-8,
14,23,15,-5,-27,-39,-39,-15,11,24,17,-5,-28,-45,-46,-20,11,26,20,-4,-30,-50,-51,-22,1
2,31,24,-1,-30,-52,-54,-22,17,37,31,2,-30,-53,-53,-18,24,47,38,6,-31,-52,-52,-14,31,5
5,45,8,-33,-52,-49,-10,36,60,47,7,-38,-52,-49,-9,38,60,46,2,-46,-53,-49,-9,36,58,40,-7
,-56,-52,-50,-11,34,52,33,-17,-68,-50,-49,-11,31,49,27,-25,-77,-48,-46,-10,32,48,25,-
29,-83,-46,-44,-7,34,53,29,-26,-84,-45,-43,-7,37,57,37,-19,-78,-45,-44,-8,36,60,44,-8,
-68,-45,-46,-14,31,58,50,2,-56,-45,-49,-21,21,52,48,9,-46,-43,-50,-27,11,41,43,10,-38
,-39,-46,-29,2,30,33,8,-34,-31,-39,-26,-1,22,26,4,-32,-21,-26,-17,1,18,20,2,-30,-10,-1
3,-6,7,18,18,0,-28,-1,0,6,14,20,17,0,-25,5,8,13,20,22,17,1,-22 },
{ -23,-27,-21,-9,5,16,23,23,-31,-38,-30,-13,8,25,34,36,-36,-45,-37,-17,9,30,43,45,-37,
-49,-41,-20,8,32,47,51,-35,-47,-42,-21,6,31,47,53,-28,-39,-36,-20,4,27,43,50,-16,-25,
-26,-16,1,20,35,42,-1,-5,-10,-9,-1,12,24,32,16,17,10,2,-2,3,11,18,29,37,29,12,-2,-8,-5
,1,38,51,44,21,-4,-19,-22,-17,37,56,51,26,-6,-30,-38,-35,28,45,47,24,-10,-38,-52,-50,
9,23,28,16,-12,-40,-55,-57,-15,-8,3,5,-9,-30,-47,-53,-36,-37,-20,-3,0,-11,-27,-39,-51,-
57,-37,-6,16,16,1,-16,-54,-64,-40,-1,32,43,30,9,-48,-56,-35,5,44,59,50,28,-34,-42,-25,
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,23,33,30,13,-14,-39,-53,-55,24,37,39,22,-9,-42,-65,-69,16,30,36,28,3,-29,-55,-66,3,1
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{ -24,-20,-3,11,16,9,-4,-14,-31,-26,-3,18,25,15,-5,-21,-38,-32,-4,23,32,20,-6,-27,-43,-37,-5,26,37,23,-7,-33,-49,-42,-7,28,40,24,-9,-39,-51,-46,-8,30,42,25,-11,-44,-52,-46,-8,30,44,25,-13,-48,-50,-45,-7,32,45,26,-14,-51,-46,-41,-5,32,46,26,-15,-53,-39,-35,-3,32,44,25,-15,-53,-28,-25,0,29,41,23,-15,-51,-14,-13,3,24,32,18,-15,-47,2,1,5,14,20,10,-15,-41,17,14,5,2,4,1,-13,-31,33,27,4,-13,-14,-8,-8,-16,46,39,4,-26,-30,-15,0,4,57,48,4,-36,-44,-19,13,27,58,52,4,-42,-50,-19,25,50,54,47,3,-42,-53,-18,34,67,44,39,0,-42,-51,-17,38,76,31,27,-3,-37,-47,-17,36,73,16,16,-3,-27,-37,-17,26,61,0,3,-1,-12,-21,-12,13,38,-15,-10,1,5,0,-5,1,12,-31,-24,0,20,21,7,-9,-14,-44,-39,-4,29,37,18,-13,-35,-54,-50,-12,31,48,28,-15,-49,-57,-58,-19,29,52,34,-14,-59,-56,-58,-23,26,54,37,-13,-63,-46,-51,-20,24,50,37,-11,-62,-32,-36,-13,23,45,34,-9,-57,-17,-20,-4,22,38,30,-6,-48 },

{ 27,34,30,14,-8,-28,-42,-44,31,42,38,20,-8,-36,-56,-62,26,37,38,23,-4,-34,-59,-68,14,24,30,24,3,-25,-51,-64,-5,2,14,20,11,-10,-35,-52,-26,-25,-7,12,18,8,-14,-32,-44,-49,-29,1,23,25,10,-9,-51,-64,-46,-9,24,39,31,14,-43,-60,-50,-16,23,45,46,32,-18,-34,-35,-14,18,43,49,41,19,8,-6,-6,8,27,38,36,51,51,26,2,-5,3,15,21,68,74,46,4,-24,-25,-13,0,57,66,38,-4,-39,-49,-37,-19,26,29,13,-17,-44,-52,-44,-27,-11,-13,-16,-23,-31,-34,-28,-17,-37,-42,-32,-15,-1,5,7,7,-39,-47,-28,2,29,42,40,31,-26,-29,-13,16,44,56,54,41,-6,-7,2,17,32,40,37,30,11,12,10,6,3,0,-2,-2,19,23,14,-3,-22,-37,-42,-37,19,24,17,-2,-28,-49,-60,-55,11,18,17,8,-10,-31,-46,-49,-3,2,10,16,15,5,-10,-20,-16,-18,-7,10,27,34,28,16,-22,-30,-27,-9,19,41,50,43,-15,-29,-36,-29,-5,25,45,50,4,-7,-26,-36,-28,-4,23,37,30,28,5,-22,-35,-28,-6,13,53,62,44,8,-25,-37,-29,-12,61,81,69,35,-4,-31,-37,-28 },

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35 },

{ -28,-11,9,13,3,-3,5,17,-28,-7,19,21,4,-6,3,21,-30,-4,26,25,1,-14,-3,19,-33,-4,29,25,-6,-24,-12,15,-40,-8,30,24,-12,-34,-22,11,-47,-13,30,25,-14,-40,-26,10,-54,-16,32,29,-12,-38,-24,15,-57,-18,35,35,-6,-34,-17,24,-60,-17,39,38,-4,-30,-10,36,-58,-15,41,38,-8,-34,-7,45,-53,-10,43,33,-19,-43,-10,50,-47,-5,45,30,-29,-56,-17,51,-47,-5,46,30,-34,-63,-22,51,-48,-8,44,35,-26,-60,-20,53,-52,-17,37,38,-12,-45,-14,53,-46,-23,24,35,-1,-32,-7,51,-27,-18,12,24,1,-23,-7,41,3,-2,4,10,-2,-20,-11,24,33,16,-3,-5,-5,-14,-14,6,50,23,-15,-18,-2,1,-7,-7,56,18,-32,-31,6,24,9,-13,55,11,-47,-43,12,45,23,-19,57,10,-54,-48,15,56,30,-29,62,17,-49,-49,14,58,26,-44,68,26,-40,-44,13,54,19,-60,66,30,-34,-43,10,51,14,-69,57,24,-35,-42,8,49,17,-66,45,16,-37,-45,5,51,25,-53,39,12,-36,-43,2,49,35,-37,35,15,-26,-38,-1,43,35,-24,33,19,-14,-29,-5,29,26,-22,27,20,-5,-20,-9,14,11,-25 },

{ -7,7,23,23,2,-30,-57,-63,-12,4,26,33,12,-25,-59,-73,-23,-9,18,33,24,-8,-42,-59,-32,-25,2,25,29,13,-13,-31,-33,-34,-16,9,26,26,15,2,-16,-26,-23,-9,11,26,31,27,15,3,-14,-20,-10,12,31,39,46,39,5,-24,-30,-10,20,40,59,58,23,-21,-45,-32,2,31,32,45,25,-14,-44,-42,-12,19,-22,-4,11,-2,-25,-32,-15,10,-71,-54,-8,16,8,-6,-6,8,-88,-69,-9,37,42,21,6,7,-51,-40,11,50,50,26,4,1,5,14,31,38,23,-2,-16,-13,42,47,31,5,-24,-42,-39,-23,43,38,9,-28,-55,-56,-38,-13,13,6,-15,-35,-37,-23,2,23,-17,-23,-24,-15,6,30,52,60,-24,-29,-17,6,32,53,63,64,-11,-12,-2,13,23,22,19,19,8,9,11,11,-2,-27,-46,-46,18,17,15,10,-8,-41,-75,-82,13,9,4,9,11,-8,-41,-64,5,-8,-18,-4,26,40,25,-4,6,-13,-35,-29,11,53,65,45,22,4,-30,-44,-23,22,54,52,37,32,-1,-34,-42,-21,9,22,34,41,30,-1,-30,-38,-30,-18,0,15,30,29,8,-18,-34,-39,-50,-41,-5,29,40,21,-8,-29,-83,-86,-46,8,45,47,22,-6 },

{ -67,-63,-30,15,46,46,24,-2,-66,-67,-31,18,51,51,22,-10,-40,-42,-19,17,42,37,7,-25,3,-2,1,14,24,15,-14,-42,45,39,19,7,4,-6,-31,-54,66,58,22,-5,-13,-18,-34,-51,62,48,5,-24,-26,-17,-20,-31,37,19,-23,-44,-31,-5,7,0,13,-9,-45,-54,-27,15,40,36,2,-16,-40,-44,-12,34,61,59,2,-2,-12,-14,7,39,60,57,1,12,18,16,17,24,29,26,-15,5,29,30,12,-8,-21,-24,-36,-18,15,27,3,-33,-60,-66,-44,-33,-1,19,7,-27,-62,-73,-21,-21,-4,15,20,6,-20,-39,17,12,2,5,20,32,33,18,38,34,4,-21,-14,20,50,56,31,30,1,-40,-55,-22,27,54,-1,11,5,-25,-54,-48,-8,27,-38,-16,18,21,-6,-28,-22,1,-58,-38,18,58,47,12,-12,-13,-53,-43,2,49,61,31,-4,-18,-16,-25,-15,9,22,13,-9,-21,38,19,-13,-29,-27,-20,-18,-17,70,56,6,-35,-43,-28,-8,0,67,58,17,-21,-28,-6,19,26,23,19,-1,-16,-8,19,40,42,-26,-31,-32,-21,1,25,37,31,-43,-50,-38,-17,5,16,10,-4,-24,-22,-6,13,22,8,-22,-47,11,21,37,49,41,9,-38,-73 },

{ 41,51,59,61,59,50,38,24,20,25,32,37,38,34,26,16,-16,-24,-23,-17,-11,-7,-6,-7,-34,-52,-56,-53,-47,-39,-32,-26,-19,-33,-41,-42,-42,-38,-34,-28,15,15,12,7,1,-5,-8,-10,32,46,55,53,45,33,23,14,12,29,46,53,49,43,35,26,-29,-24,-7,3,9,13,18,20,-44,-53,-46,-43,-40,-30,-14,1,-18,-22,-25,-36,-50,-49,-34,-13,19,35,39,22,-9,-27,-24,-9,20,46,70,64,37,11,3,9,-22,-9,18,34,29,19,17,22,-49,-60,-52,-33,-18,-7,7,21,-16,-36,-47,-48,-41,-28,-8,12,46,43,26,8,-8,-14,-8,5,53,64,57,47,30,11,0,2,3,-1,0,13,23,16,2,-5,-37,-63,-68,-44,-10,3,-4,-13,-17,-42,-59,-43,-11,5,-2,-15,39,33,14,11,22,24,8,-11,60,66,54,40,34,26,

8,-10,18,21,12,2,-2,-3,-8,-14,-36,-43,-48,-47,-41,-27,-17,-12,-43,-47,-39,-32,-23,-13,-1,5,-13,1,22,31,29,23,24,26,8,31,57,63,46,27,20,25,-6,10,29,28,4,-18,-19,-1,-28,-26,-17,-22,-43,-60,-48,-20,-25,-25,-18,-19,-32,-39,-26,1,6,14,26,33,31,27,34,48 },

{ 49,27,-1,-9,4,12,3,-11,48,20,-17,-23,-2,14,4,-17,43,8,-35,-36,-6,16,7,-19,39,0,-44,-41,-3,24,13,-19,41,0,-45,-37,7,35,21,-17,46,6,-37,-28,19,47,26,-17,49,11,-30,-19,27,50,26,-23,45,10,-29,-18,26,47,17,-34,38,4,-34,-23,19,35,4,-48,30,0,-35,-27,11,27,-7,-58,24,1,-27,-21,12,25,-8,-59,18,5,-14,-10,18,31,1,-48,6,4,-4,-2,20,33,13,-28,-10,-1,2,-3,5,21,16,-9,-30,-6,12,-3,-18,-7,9,6,-48,-7,32,12,-30,-34,-4,19,-68,-9,59,41,-26,-50,-14,32,-79,-19,65,62,-15,-56,-16,45,-83,-30,54,57,-13,-55,-16,55,-64,-30,37,43,-18,-58,-16,59,-30,-11,29,28,-22,-53,-17,57,5,9,23,18,-17,-42,-12,49,27,15,8,4,-8,-20,-4,35,33,7,-17,-13,0,3,4,16,38,-1,-41,-30,8,24,10,-8,47,3,-46,-37,16,42,13,-31,62,17,-40,-34,23,52,15,-50,69,28,-35,-37,20,56,15,-62,66,26,-38,-46,10,51,16,-64,54,20,-40,-53,-1,46,20,-56,43,16,-35,-46,-3,43,29,-37,33,16,-20,-31,2,42,34,-17 },

{ -6,-17,-30,-31,-10,27,63,75,5,-5,-23,-33,-19,18,60,80,21,18,0,-21,-25,-4,31,54,26,35,23,-3,-25,-26,-8,13,13,29,34,15,-15,-36,-38,-24,-20,0,23,26,2,-28,-44,-43,-52,-38,-1,26,23,-3,-29,-40,-57,-57,-21,20,38,24,-3,-23,-26,-36,-24,10,39,40,19,-3,32,14,-8,-5,18,31,24,8,80,59,8,-22,-17,2,12,7,76,63,6,-39,-46,-26,-6,-1,26,17,-15,-42,-45,-26,-9,-3,-34,-35,-28,-18,-4,8,11,5,-59,-50,-15,22,47,47,31,10,-34,-23,10,42,55,46,20,-4,10,18,24,21,11,-5,-24,-35,29,34,16,-13,-37,-48,-50,-49,17,18,0,-27,-44,-37,-24,-17,-8,-6,-7,-14,-9,14,37,40,-24,-18,-5,4,17,43,71,72,-19,-12,3,8,6,14,32,44,-6,4,15,9,-17,-39,-40,-24,2,12,24,20,-10,-51,-73,-67,-2,1,13,25,21,-4,-36,-47,-7,-19,-17,3,32,44,31,9,4,-17,-39,-33,4,45,63,50,31,14,-24,-49,-36,3,37,43,50,47,17,-24,-46,-35,-11,3,25,39,36,18,-10,-29,-33,-31,-37,-23,9,33,34,12,-15,-33,-91,-88,-42,15,49,46,16,-15 },

{ 61,62,34,-8,-39,-38,-13,11,49,54,30,-12,-44,-41,-10,21,8,15,9,-15,-36,-30,2,33,-38,-29,-11,-10,-18,-11,15,42,-68,-53,-15,6,6,7,23,42,-62,-45,2,29,26,15,17,29,-35,-14,28,47,33,7,-4,3,-5,14,42,48,22,-14,-33,-28,10,19,31,27,-1,-35,-54,-47,10,5,0,-6,-19,-37,-46,-40,12,-8,-28,-30,-21,-12,-7,-5,23,-1,-31,-33,-6,24,42,40,36,17,-15,-21,6,43,68,65,29,23,0,-11,0,24,41,44,1,3,1,-4,-11,-16,-18,-14,-27,-23,-3,11,2,-28,-57,-65,-32,-29,-2,29,38,5,-44,-70,-5,-12,-2,24,46,42,5,-31,29,16,-8,-15,6,33,39,19,41,35,-7,-50,-53,-14,30,44,23,30,10,-37,-70,-46,5,38,-24,1,26,17,-17,-30,-8,21,-71,-41,22,57,46,10,-6,2,-7,4,-62,-2,51,57,24,-9,-16,-25,-30,-14,11,20,0,-24,-28,45,32,2,-18,-22,-25,-25,-21,85,70,19,-25,-39,-23,-3,8,60,50,7,-28,-29,0,32,41,-1,-10,-28,-33,-15,21,50,50,-40,-48,-40,-24,1,23,29,19,-36,-31,-10,14,26,14,-15,-39,-3,10,35,55,47,8,-48,-87 },

{ -52,-18,25,32,8,-12,-7,11,-58,-17,37,44,8,-19,-11,15,-61,-15,42,43,-1,-31,-18,17,-57,-12,42,36,-14,-45,-25,19,-51,-8,41,28,-26,-54,-26,27,-41,-2,39,24,-29,-53,-18,39,-32,3,39,23,-26,-44,-5,54,-26,3,33,21,-21,-35,6,64,-20,-2,21,13,-20,-29,9,63,-10,-6,6,4,-17,-26,3,50,6,-4,-6,-1,-8,-18,-6,25,25,3,-13,-1,9,-2,-11,-3,45,8,-26,-6,28,23,-9,-27,55,7,-44,-23,35,46,0,-43,62,6,-61,-44,28,55,10,-50,61,14,-55,-54,16,56,16,-53,48,23,-31,-

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 ,8,28,14,-31,-47,-1,59,0,-2,1,-3,-21,-27,3,46,9,-7,-17,-9,0,1,7,21,28,0,-25,-10,21,27,7,
 -13,48,12,-29,-18,27,42,4,-46,65,21,-38,-35,19,46,2,-66,67,25,-43,-51,6,48,10,-65,59,
 23,-41,-53,-1,48,28,-42,43,19,-29,-43,-1,47,39,-17 },
 { 43,49,53,57,59,53,38,21,15,13,13,21,29,29,19,6,-21,-36,-42,-35,-23,-15,-16,-19,-26
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 ,-35,-44,-42,-27,-9,21,34,42,25,-5,-21,-18,-6,20,47,68,63,33,10,3,8,-27,-15,11,25,21,
 11,12,17,-48,-64,-54,-38,-24,-13,2,15,-3,-20,-33,-36,-33,-24,-7,9,54,57,40,24,7,-4,-2,
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 18,-4,-54,-58,-41,-32,-29,-23,-6,10,-5,9,33,40,31,20,20,26,28,47,63,64,43,22,14,19,1
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 22,18,26,44,57,48,29,29,28,24,28,41,45,34,11,-5,-14,-29,-37,-36,-34,-38,-46 },
 { -12,-2,20,36,28,-11,-61,-86,-17,-12,10,36,37,2,-53,-88,-16,-22,-12,16,35,21,-20,-56,
 2,-19,-30,-12,20,34,18,-10,34,5,-33,-36,-4,32,43,29,58,35,-18,-46,-27,14,42,45,59,49,
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 0,40,24,-4,-19,-16,-77,-50,13,51,44,11,-12,-16,-18,-8,20,38,28,5,-11,-12,45,38,19,-1,-
 17,-20,-14,-3,57,45,0,-38,-49,-35,-7,14,22,9,-21,-41,-39,-13,18,36,-21,-27,-23,-10,9,2
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 -8,0,27,48,-25,-2,27,25,-11,-45,-42,-15,-27,-5,33,42,10,-42,-70,-51,-21,-16,9,33,29,1,
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 { 37,-5,-50,-46,-6,22,14,-12,54,6,-50,-49,0,33,19,-17,69,22,-36,-35,14,45,22,-25,67,2
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 6,-32,5,5,-16,-19,70,18,-47,-37,22,38,-2,-37,52,13,-39,-26,38,62,16,-40,13,-3,-29,-21,
 28,54,16,-40,-23,-13,-9,-12,1,14,-2,-38,-41,-6,26,15,-12,-20,-16,-22,-50,1,55,40,-14,-
 35,-12,12,-55,-6,54,44,-18,-42,0,49,-51,-17,33,25,-29,-48,3,69,-25,-14,13,11,-27,-46,
 -1,61,13,5,5,7,-8,-23,-6,31,41,17,-7,1,15,9,-5,-5,55,13,-34,-22,24,36,1,-36,55,5,-56,-5
 0,16,51,9,-53,58,11,-53,-53,11,54,19,-53,57,26,-28,-36,13,53,25,-42 },
 { 78,72,38,-7,-39,-42,-24,-2,50,48,21,-14,-38,-38,-17,8,-7,-10,-12,-18,-21,-13,7,25,-5
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,37,23,-5,-29,-34,40,38,27,18,-4,-35,-59,-61,26,11,-7,-14,-21,-37,-53,-54,1,-20,-36,-30,-12,-3,-5,-8,-3,-22,-35,-21,13,41,54,48,11,3,-7,-4,19,50,69,70,15,22,20,5,-5,2,23,38,-8,9,22,10,-28,-54,-47,-21,-36,-22,11,21,-10,-52,-71,-52,-32,-33,-1,33,34,4,-25,-27,10,-8,-13,13,44,48,36,24,48,23,-19,-32,-9,22,38,41,51,34,-10,-47,-55,-33,-4,16,7,13,8,-6,-24,-34,-28,-12,-47,-30,12,43,46,17,-11,-17,-53,-51,-7,41,59,42,8,-9,-5,-16,-16,-4,6,4,-3,-6,53,42,5,-30,-47,-42,-21,-3,62,57,24,-17,-44,-36,-9,15,3,6,5,3,1,8,25,37,-57,-55,-29,6,32,36,34,30,-51,-57,-31,6,28,22,0,-11,9,6,8,17,15,-11,-45,-54,54,54,35,21,5,-19,-45,-53,42,32,7,-10,-8,0,4,2,-7,-26,-50,-54,-26,20,55,67 },

{ 24,18,-8,-33,-34,4,58,85,20,21,-1,-31,-41,-11,43,79,1,14,13,-8,-31,-26,7,38,-27,-4,24,22,-4,-28,-27,-10,-53,-26,23,45,27,-13,-42,-44,-48,-36,9,45,43,9,-31,-49,-10,-20,-9,18,35,22,-7,-30,45,15,-20,-21,3,19,13,-4,84,46,-24,-53,-32,5,25,17,60,43,-17,-55,-41,-3,25,26,-7,0,-7,-21,-17,4,21,19,-67,-43,2,24,25,18,8,-3,-72,-43,18,51,46,15,-14,-30,-15,-2,26,37,19,-9,-32,-42,42,38,15,-11,-30,-30,-25,-22,43,35,-7,-46,-51,-21,14,26,0,-2,-17,-33,-25,13,56,65,-32,-23,-2,9,14,26,41,46,-31,-16,17,38,29,1,-21,-25,-3,1,14,26,15,-22,-62,-78,23,12,-8,-10,-2,-6,-32,-56,27,14,-21,-38,-12,28,40,17,12,12,-12,-34,-19,32,72,64,-17,5,14,-5,-20,-4,27,39,-47,-10,36,34,-5,-37,-43,-27,-48,-22,27,46,17,-25,-51,-54,-19,-14,3,18,21,11,-4,-19,28,13,-15,-28,-12,22,42,32,61,40,-14,-53,-49,0,46,47,37,33,0,-35,-40,-16,12,15,-25,-12,6,14,14,5,-14,-34,-75,-58,-5,45,63,39,-13,-60 },

{ -62,-26,9,-4,-44,-62,-43,-10,-51,-4,41,29,-19,-45,-25,11,-36,15,63,53,8,-14,7,41,-31,10,48,41,6,-6,22,57,-30,-11,9,0,-24,-23,11,48,-11,-13,-17,-31,-46,-41,-9,25,25,12,-9,-23,-31,-29,-15,2,47,33,7,4,12,10,-1,-11,39,17,-9,8,44,50,18,-20,14,-20,-50,-25,35,58,21,-33,10,-23,-66,-53,7,40,8,-49,28,19,-22,-38,-4,25,-2,-58,21,49,36,4,4,20,2,-47,-37,15,41,16,-1,13,13,-20,-93,-36,14,-3,-29,-9,20,12,-77,-24,25,-2,-46,-32,17,33,-16,35,71,29,-35,-36,11,39,11,38,53,25,-19,-25,7,27,1,-11,-23,-24,-15,0,8,1,8,-27,-62,-52,0,34,16,-24,44,18,-29,-26,29,60,23,-44,45,47,14,-3,26,52,12,-57,-11,12,12,-12,-12,8,-5,-50,-70,-31,3,-15,-38,-23,-3,-16,-79,-24,36,22,-24,-21,20,34,-42,11,68,55,-6,-21,24,59,-11,20,52,34,-20,-39,-1,40,1,-1,-1,-13,-38,-48,-23,6,16,-10,-35,-32,-15,-4,-5,-10,39,8,-29,-19,30,57,33,-12,55,22,-23,-17,38,69,36,-30,41,11,-37,-45,-6,22,-8,-67 },

{ -6,25,66,77,55,27,21,30,-37,-14,28,41,17,-7,-3,19,-57,-48,-19,-12,-36,-52,-34,3,-30,-30,-16,-20,-47,-62,-38,4,20,23,27,16,-13,-29,-11,26,41,44,46,43,24,9,21,48,16,6,7,19,23,17,26,45,-13,-46,-52,-29,-7,-3,2,18,3,-40,-63,-41,-15,-16,-24,-17,49,16,-11,3,21,5,-26,-37,65,42,23,39,59,37,-9,-36,21,-4,-17,8,42,39,2,-26,-21,-49,-67,-46,-10,6,-2,-14,-7,-17,-25,-30,-24,-15,-5,2,15,40,60,43,6,-12,0,21,-12,18,60,63,18,-16,-3,30,-56,-55,-19,4,-16,-39,-20,27,-16,-46,-43,-22,-22,-37,-20,22,69,34,4,13,21,5,-1,20,86,53,9,18,43,32,8,9,28,-16,-57,-33,14,17,-10,-18,-19,-55,-73,-47,-2,4,-23,-36,-9,-9,-1,17,29,14,-13,-21,7,33,60,64,40,11,-1,7,-18,5,33,26,-13,-34,-12,27,-42,-37,-18,-22,-53,-66,-21,38,-21,-23,-11,-5,-24,-35,-4,48,25,20,24,40,36,17,17,40,43,23,9,25,42,27,2,-1,30,-10,-48,-39,-4,-1,-29,-47,29,-14,-62,-57,-14,6,-20,-49,50,26,-9,-4,36,59,35,-6 },

{ -20,3,17,14,16,25,21,-1,-15,9,16,4,3,16,15,-12,-12,11,8,-16,-21,-2,2,-24,-8,15,7,-26,-33,-10,-1,-29,-9,19,14,-21,-28,2,13,-18,-18,18,21,-10,-13,22,34,-2,-33,9,21,-8,-9,30,45,5,-42,3,17,-15,-19,20,36,-3,-40,11,23,-20,-36,0,17,-23,-31,27,39,-13,-39,-7,7,-36,-35,29,47,-6,-30,6,19,-33,-50,16,36,-14,-27,24,40,-19,-59,8,24,-32,-40,28,56,-8,-47,26,36,-37,-53,19,52,-13,-41,44,60,-23,-55,11,40,-31,-57,34,60,-15,-46,17,36,-45,-81,9,42,-25,-43,31,47,-48,-71,14,38,-36,-49,39,61,-42,-44,42,57,-35,-61,32,67,-37,-40,53,67,-31,-69,20,59,-39,-64,24,55,-28,-66,15,55,-42,-78,1,38,-23,-49,25,54,-41,-60,9,41,-14,-36,31,56,-39,-26,33,47,-14,-39,23,47,-38,-13,36,40,-24,-53,7,38,-36,-28,15,23,-30,-50,7,38,-27,-43,-3,16,-17,-30,19,45,-17,-40,-1,24,1,-12,24,39,-16,-25,11,33,8,-14,7,19,-25,-14,14,25,-1,-27,-13,3,-27,-11,7,12,-11,-30,-10,11,-8,-12,1,6,-8,-14,10,34,19 }

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{ -73,-77,-51,-7,31,43,38,25,-28,-32,-19,5,26,30,20,10,40,40,29,18,8,-5,-16,-19,64,67,41,11,-16,-36,-44,-38,28,26,7,-14,-31,-39,-38,-28,-28,-34,-35,-29,-18,-8,3,12,-44,-51,-40,-13,15,34,48,51,-8,-13,-4,16,35,47,54,57,34,33,29,26,19,10,9,16,31,29,17,6,-17,-43,-51,-37,-3,-13,-18,-14,-26,-52,-69,-58,-16,-35,-30,-3,16,3,-19,-24,9,-10,-14,18,55,60,46,31,37,19,-1,3,24,41,45,45,29,17,-7,-27,-40,-38,-20,6,-7,-8,-3,-8,-36,-67,-62,-27,-31,-28,10,48,43,-2,-26,-8,-7,-26,-4,46,66,45,23,28,40,0,-32,-20,2,5,13,33,64,28,-28,-50,-50,-49,-29,9,38,20,-1,-2,-6,-25,-29,-2,-18,-26,-2,45,64,35,2,4,-41,-54,-30,26,60,37,5,3,4,-18,-28,-14,-5,-18,-27,-10,60,45,13,-13,-37,-49,-41,-6,42,42,26,13,-4,-18,-6,26,-24,-26,-12,13,27,23,29,50,-50,-65,-44,-4,22,18,12,27,-4,-17,-17,2,9,-14,-36,-24,52,47,30,24,12,-20,-48,-44,46,36,16,8,11,4,-9,-8,-15,-34,-51,-45,-12,20,37,44 },

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{ 1,1,1,1,1,0,0,-2,1,1,1,1,1,0,-1,-3,1,1,1,1,0,-1,-3,-6,1,1,1,0,-1,-3,-6,-9,1,1,0,-1,-3,-5,-8,-12,1,0,-1,-2,-4,-7,-11,-15,1,0,-1,-3,-6,-10,-14,-18,0,0,-2,-5,-8,-12,-17,-22,0,-1,-3,-7,-11,-15,-21,-26,0,-2,-5,-8,-13,-18,-24,-30,-1,-3,-6,-11,-16,-22,-28,-33,-1,-4,-8,-13,-19,-26,-32,-37,-2,-5,-10,-16,-22,-29,-36,-41,-2,-6,-12,-18,-26,-33,-40,-45,-3,-8,-14,-21,-29,-37,-43,-48,-4,-9,-16,-24,-32,-40,-47,-51,-4,-10,-18,-27,-36,-44,-50,-54,-5,-12,-20,-29,-39,-47,-52,-56,-6,-13,-22,-32,-41,-49,-55,-58,-7,-15,-24,-34,-44,-51,-56,-59,-7,-16,-26,-36,-46,-53,-58,-60,-8,-17,-27,-38,-47,-54,-58,-60,-8,-18,-29,-39,-48,-55,-59,-61,-9,-19,-30,-40,-49,-55,-59,-61,-9,-20,-31,-41,-50,-56,-59,-61,-10,-20,-31,-41,-50,-56,-59,-60,-10,-20,-32,-42,-50,-55,-58,-59,-10,-21,-32,-42,-49,-55,-57,-58,-10,-21,-32,-42,-49,-54,-56,-57,-10,-21,-32,-41,-48,-52,-55,-55,-10,-21,-31,-40,-46,-50,-53,-53,-11,-21,-31,-39,-44,-48,-50,-51 },

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{ -7,-11,-13,-15,-16,-14,-10,-3,-10,-17,-21,-25,-25,-22,-14,-5,-14,-23,-29,-32,-32,-26,-16,-3,-17,-28,-35,-38,-36,-29,-15,1,-20,-32,-40,-42,-38,-28,-12,7,-22,-35,-42,-44,-37,-24,-5,14,-23,-36,-43,-42,-33,-17,3,24,-23,-36,-41,-38,-27,-9,14,35,-23,-35,-39,-33,-19,2,26,47,-22,-33,-34,-26,-9,13,38,57,-20,-29,-28,-17,1,25,48,66,-18,-25,-22,-9,11,35,57,72,-16,-21,-16,-2,19,42,63,75,-14,-17,-11,3,24,45,63,74,-12,-15,-9,5,24,43,60,69,-11,-14,-9,3,20,38,53,62,-11,-15,-12,-2,14,29,43,53,-12,-18,-17,-9,3,18,32,43,-15,-23,-25,-20,-9,5,20,32,-17,-29,-34,-31,-22,-8,8,23,-20,-35,-43,-42,-33,-19,-1,16,-24,-41,-51,-52,-42,-27,-7,12,-27,-46,-58,-58,-48,-31,-10,10,-29,-51,-62,-62,-50,-32,-10,10,-31,-53,-64,-62,-50,-30,-8,12,-31,-53,-62,-60,-46,-26,-3,17,-30,-49,-58,-53,-38,-18,3,22,-28,-45,-51,-44,-29,-9,11,28,-25,-39,-42,-34,-18,1,19,34,-20,-31,-32,-23,-7,10,27,40,-15,-22,-20,-10,4,19,34,44,-8,-12,-9,1,14,27,39,48 },

{ -2,-4,-7,-9,-10,-11,-12,-13,-4,-8,-12,-16,-18,-20,-22,-23,-6,-11,-17,-22,-26,-29,-32,-34,-7,-14,-21,-27,-32,-37,-41,-43,-8,-16,-23,-30,-36,-42,-48,-50,-9,-16,-23,-30,-37,-44,-50,-54,-8,-14,-20,-27,-34,-42,-49,-54,-6,-11,-16,-21,-28,-37,-45,-52,-3,-5,-8,-12,-19,-28,-39,-48,1,2,2,-1,-7,-17,-31,-43,6,11,14,14,7,-5,-21,-37,12,21,28,29,22,8,-12,-31,18,33,43,44,36,18,-5,-28,24,43,55,57,45,25,-3,-27,30,51,64,64,51,25,-4,-29,34,58,70,68,50,22,-9,-33,37,61,73,66,45,14,-16,-38,38,62,69,59,34,3,-26,-45,37,57,60,46,19,-11,-35,-49,34,50,48,31,4,-24,-43,-52,30,41,36,15,-11,-34,-49,-52,24,31,21,1,-22,-41,-49,-49,18,20,9,-10,-30,-42,-46,-42,11,10,-2,-17,-32,-39,-38,-33,6,2,-8,-20,-29,-31,-28,-21,2,-2,-9,-18,-21,-20,-15,-8,0,-2,-6,-9,-9,-5,1,6,0,0,2,6,11,16,19,1,4,9,15,21,27,30,31,4,11,19,28,36,41,42,40,9,19,30,40,48,51,51,47,15,27,38,48,55,58,55,50 },

{ -8,-14,-19,-21,-20,-16,-9,-1,-13,-23,-30,-33,-30,-23,-12,-1,-18,-30,-39,-40,-36,-25,-11,2,-22,-36,-44,-45,-37,-24,-7,7,-24,-40,-47,-45,-35,-18,0,15,-25,-41,-46,-42,-28,-9,11,26,-25,-38,-41,-34,-17,5,24,36,-23,-35,-35,-24,-3,19,38,47,-22,-31,-27,-12,10,34,50,54,-19,-26,-19,-2,22,45,57,57,-16,-20,-11,7,31,50,59,53,-14,-16,-6,13,35,51,54,45,-12,-13,-3,15,34,45,44,31,-11,-12,-4,11,25,32,27,13,-12,-14,-8,3,12,15,7,-7,-13,-18,-15,-8,-3,-3,-12,-25,-15,-22,-22,-18,-16,-19,-29,-41,-17,-26,-27,-26,-25,-30,-40,-51,-19,-27,-28,-27,-29,-34,-45,-55,-18,-26,-26,-24,-27,-34,-45,-57,-16,-20,-19,-16,-19,-28,-42,-

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{ 5,7,9,12,14,17,19,19,7,11,15,20,24,29,32,32,9,14,20,25,32,38,43,43,9,15,21,28,36,
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5 },

{ -1,-3,-6,-11,-17,-23,-27,-27,-2,-5,-10,-18,-29,-39,-44,-44,-2,-4,-11,-21,-36,-49,-56,-
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{ 36,48,49,35,16,-5,-21,-26,47,63,59,40,11,-16,-33,-39,51,64,55,29,-2,-28,-42,-42,46,55,39,11,-18,-38,-43,-37,37,37,18,-9,-30,-38,-33,-21,21,15,-5,-24,-30,-25,-10,3,5,-7,-22,-28,-19,1,21,28,-9,-24,-31,-23,2,31,49,47,-19,-33,-33,-11,24,54,66,51,-24,-35,-26,1,37,61,57,35,-24,-30,-18,9,36,43,28,2,-21,-24,-11,8,19,11,-14,-37,-16,-15,-5,3,-4,-26,-54,-66,-6,-3,2,-1,-21,-50,-69,-74,5,11,12,0,-25,-48,-59,-54,16,25,23,9,-12,-27,-27,-21,24,33,32,19,8,7,12,14,25,33,29,24,25,35,40,37,18,18,15,18,32,47,51,40,3,-4,-8,3,2,6,45,44,29,-16,-32,-34,-14,14,30,25,8,-34,-54,-50,-27,0,10,-1,-17,-44,-60,-50,-26,-7,-8,-24,-36,-41,-50,-34,-13,-6,-19,-38,-47,-29,-24,-5,8,2,-21,-42,-45,-6,9,26,30,11,-16,-32,-31,17,37,50,42,18,-6,-15,-8,32,53,55,40,17,1,2,15,35,45,40,21,6,4,17,35,19,18,5,-9,-11,2,25,49,-9,-24,-39,-42,-30,-3,28,53,-40,-62,-73,-67,-42,-8,27,51 },

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{ 37,38,19,-14,-42,-46,-27,2,47,49,20,-21,-50,-52,-22,14,49,47,16,-21,-44,-36,-3,33,4
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{ 60,54,23,-17,-40,-35,-13,12,63,55,13,-29,-46,-35,-4,22,51,35,-1,-30,-34,-15,12,30,26,10,-13,-20,-8,10,24,30,2,-13,-18,-3,19,26,22,14,-17,-26,-13,15,33,24,-2,-13,-27,-27,-2,29,34,0,-35,-36,-27,-22,10,36,22,-26,-57,-40,-25,-13,21,36,8,-41,-56,-13,-20,-7,24,32,-1,-38,-22,35,-19,-6,20,22,-6,-19,20,78,-21,-11,10,11,-8,-6,42,91,-23,-14,2,-1,-18,-10,32,64,-20,-11,3,-5,-26,-28,-6,13,-11,2,14,3,-25,-41,-42,-38,-2,15,29,21,-8,-34,-52,-62,0,16,36,36,19,-5,-30,-52,-12,0,22,36,37,30,6,-25,-33,-28,-7,16,39,50,36,0,-44,-48,-34,-13,20,49,45,9,-34,-37,-43,-38,-7,31,36,1,8,3,-30,-51,-28,11,15,-16,62,50,-9,-50,-35,0,0,-31,98,79,0,-44,-24,6,-4,-37,103,64,-12,-34,0,24,3,-35,62,20,-30,-20,28,42,8,-28,9,-29,-41,1,50,45,6,-18,-31,-53,-31,21,49,29,-4,-9,-41,-39,-6,28,27,-6,-19,5,-17,-4,17,18,-14,-40,-21,27,17,30,26,-8,-51,-53,-5,59,41,47,21,-27,-59,-44,20,85 },

{ 35,20,-6,-18,-2,26,28,-1,32,11,-23,-34,-6,30,27,-14,27,0,-37,-42,-6,32,21,-34,24,-3,-39,-40,2,38,12,-53,29,4,-30,-27,16,44,9,-65,38,16,-18,-16,25,49,8,-65,47,23,-14,-14,24,46,11,-49,48,21,-22,-26,11,38,16,-26,44,10,-37,-43,-6,27,23,0,37,2,-46,-53,-15,19,25,20,37,5,-38,-42,-14,10,18,27,43,19,-14,-19,-6,-2,1,24,49,31,10,5,-1,-20,-21,17,37,28,20,19,-2,-38,-37,15,9,3,16,26,-2,-45,-37,27,-29,-28,11,36,5,-40,-23,44,-63,-47,17,51,15,-31,-8,57,-74,-46,33,61,10,-33,-2,54,-67,-25,45,48,-12,-41,-6,36,-47,-6,42,22,-36,-49,-12,13,-30,5,31,-4,-46,-34,-6,-8,-16,9,16,-13,-24,0,8,-23,-8,6,6,-4,13,38,22,-38,-6,0,-2,6,40,62,22,-54,-5,-8,-13,3,45,58,11,-68,-1,-12,-27,-17,22,40,-2,-69,11,-8,-41,-42,-5,23,1,-50,34,8,-43,-56,-15,27,22,-20,63,30,-36,-54,-8,44,49,7,81,47,-26,-47,2,54,54,14,86,44,-25,-42,-2,36,31,-9,66,27,-32,-47,-20,3,-8,-40 },

{ 5,10,13,7,-14,-44,-74,-76,3,10,16,14,-5,-38,-67,-74,-4,2,15,23,17,-3,-26,-35,-16,-11,8,29,39,37,23,11,-30,-27,-6,21,43,53,52,40,-36,-38,-22,-2,17,34,41,36,-28,-30,-30,-29,-23,-9,4,6,0,-4,-21,-43,-52,-43,-26,-20,40,37,5,-33,-50,-39,-27,-27,67,67,29,-7,-12,-1,1,-13,66,60,29,15,28,42,30,-1,29,14,-3,9,44,58,31,-5,-20,-43,-47,-12,30,34,4,-22,-48,-70,-58,-22,6,-2,-25,-31,-35,-40,-26,-6,-7,-25,-32,-12,11,21,26,18,-9,-26,-10,24,52,64,55,20,-14,-14,20,56,48,52,28,-3,-21,-8,30,60,8,-4,-18,-25,-23,-7,17,32,-37,-50,-36,-18,-9,-11,-11,-7,-55,-47,-8,22,14,-16,-36,-37,-35,-9,41,60,25,-19,-40,-41,-8,27,65,58,17,-16,-23,-19,1,26,38,20,-6,-7,9,11,-13,-9,-16,-30,-23,13,42,33,-26,-36,-49,-52,-17,33,51,28,-16,-25,-40,-36,2,37,33,-6,18,15,-4,-8,12,23,-4,-47,53,49,23,6,9,-1,-36,-70,56,47,13,-4,-3,-9,-33,-57,25,3,-22,-20,1,14,7,-8,-20,-43,-48,-22,23,53,55,43 },

{ -76,-76,-60,-38,-24,-16,-10,-7,-59,-53,-30,-13,-6,-4,-4,-5,-14,7,25,26,19,11,6,-1,31,57,59,43,22,11,8,0,47,62,49,19,-3,-3,2,-4,25,25,-1,-29,-33,-17,-1,-6,-9,-26,-50,-60,-42,-8,9,-6,-30,-48,-59,-50,-12,24,25,-5,-20,-25,-25,-4,33,51,31,-13,11,18,20,32,47,45,10,-31,39,46,36,24,19,5,-21,-40,42,39,8,-19,-30,-32,-30,-27,25,6,-32,-55,-51,-26,-3,12,6,-17,-42,-45,-17,15,37,46,0,-11,-14,4,32,44,47,44,4,8,21,39,40,22,8,12,4,15,32,32,1,-39,-49,-23,-8,2,15,3,-40,-75,-61,-23,-25,-16,-1,-9,-39,-48,-22,9,-33,-19,6,11,3,11,34,

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{ 52,57,47,15,-22,-27,8,54,34,40,30,1,-34,-38,8,64,-8,-6,2,-8,-35,-38,3,54,-50,-41,-6,6,-14,-30,-6,33,-69,-43,16,42,16,-19,-19,5,-59,-22,46,71,31,-16,-29,-18,-43,0,57,62,19,-22,-30,-23,-31,1,34,25,-10,-23,-12,-11,-26,-10,-3,-21,-30,-2,24,8,-13,-12,-26,-44,-20,32,50,13,11,3,-26,-36,2,51,46,-12,38,24,-14,-23,15,44,9,-51,56,33,-11,-18,11,15,-29,-70,46,20,-19,-20,2,-2,-32,-43,21,-5,-25,-11,7,3,1,19,-3,-19,-15,7,14,11,34,70,-15,-13,8,19,1,-8,32,76,-14,1,25,15,-33,-48,-2,42,-11,13,34,4,-55,-67,-33,-4,-13,14,35,9,-36,-45,-30,-30,-27,2,33,27,13,10,-4,-35,-42,-18,16,34,48,54,18,-32,-47,-32,-11,10,45,57,21,-28,-23,-26,-38,-29,11,33,9,-27,27,4,-48,-58,-20,9,-2,-18,75,40,-35,-55,-18,6,1,-1,95,50,-17,-23,6,13,7,18,63,26,-7,8,25,10,1,27,4,-19,-6,27,21,-17,-20,27,-49,-48,3,36,0,-49,-36,26,-64,-33,30,40,-16,-61,-36,37,-37,6,57,48,-13,-49,-15,53 },

{ -29,0,49,75,67,37,21,19,-43,-14,36,58,35,6,1,13,-57,-34,2,5,-25,-42,-25,4,-47,-31,-13,-29,-60,-63,-25,9,-16,2,5,-21,-49,-35,5,27,20,39,35,9,-6,12,37,34,33,47,41,25,24,39,39,9,11,15,9,7,18,28,5,-37,-24,-32,-36,-24,-3,2,-32,-72,-36,-47,-43,-27,-3,1,-30,-63,-13,-14,-10,2,21,24,7,-12,25,30,23,20,27,38,41,37,46,42,16,-7,-7,14,40,51,32,16,-21,-49,-48,-26,6,29,4,-14,-36,-46,-49,-41,-24,-4,-13,-13,2,13,2,-20,-28,-19,-19,7,56,76,51,6,-18,-16,-27,5,56,72,37,3,-5,-3,-44,-23,5,2,-15,-10,9,11,-43,-42,-43,-56,-44,-5,24,16,-7,-13,-40,-54,-25,22,33,5,49,43,2,-14,16,40,17,-19,79,62,22,15,33,23,-17,-41,46,23,-2,8,16,-11,-42,-42,-15,-40,-37,-6,-2,-27,-35,-7,-50,-61,-27,7,2,-15,5,43,-37,-20,19,31,9,3,37,72,3,31,49,29,-8,-6,33,59,24,41,33,-9,-44,-32,0,13,5,9,-8,-39,-49,-38,-26,-30,-26,-24,-19,-10,1,2,-18,-47,-38,-24,14,53,73,58,10,-37 },

{ -20,10,34,13,-46,-81,-61,-12,-22,16,49,30,-31,-64,-31,17,-35,6,50,41,-2,-14,21,51,-56,-17,32,34,9,15,47,55,-71,-34,9,8,-6,9,31,13,-53,-25,-1,-14,-26,-11,-8,-44,-12,10,10,-17,-28,-13,-24,-75,30,43,22,-9,-6,18,0,-64,43,41,10,-11,17,57,43,-26,20,6,-27,-33,15,67,55,-2,-6,-27,-53,-50,-7,31,30,1,-5,-17,-31,-36,-26,-14,-5,-3,19,26,26,6,-27,-42,-22,7,25,50,63,38,-18,-42,-6,26,-9,19,50,33,-14,-19,18,34,-65,-37,12,13,-12,-1,25,17,-97,-57,-2,3,-10,5,12,-19,-57,-15,20,6,-7,6,-5,-47,12,44,37,-2,-8,12,-4,-46,50,56,8,-30,-7,26,12,-25,40,10,-45,-48,4,38,28,1,3,-31,-56,-30,17,34,22,12,-12,-23,-14,10,14,-3,-4,12,-1,16,42,35,-15,-48,-24,13,3,35,64,24,-48,-62,-18,24,-22,13,37,1,-46,-36,14,34,-56,-25,6,-5,-14,15,41,19,-60,-33,2,8,21,45,30,-22,-29,-2,13,13,26,31,-8,-70,18,27,7,-9,0,5,-29,-79,44,25,-22,-42,-17,11,1,-28,40,5,-45,-49,1,50,62,43 },

{ 13,21,20,0,-18,2,59,95,4,14,16,-8,-34,-18,41,81,-13,2,13,-8,-45,-44,-4,26,-28,-3,25,12,-29,-51,-39,-27,-40,-2,44,45,8,-25,-39,-49,-46,-9,44,58,36,14,-5,-34,-53,-23,16,29,

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6,14,-19,82,66,10,-24,-12,10,-2,-33,62,49,17,7,17,15,-7,-27,-4,-13,-4,19,25,6,-6,-3,-6
5,-62,-14,20,7,-14,2,24,-76,-45,12,20,-21,-31,11,40,-30,13,49,16,-43,-35,20,35,14,54,
59,-4,-51,-16,24,5,12,35,20,-24,-25,15,15,-34,-23,-17,-21,-19,15,38,0,-62,-43,-41,-24
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1,-48,11,49,8,-31,3,12,-65,-52,10,45,-4,-48,-19,-16,-91,-50,9,38,-11,-41,5,18,-58,-45,
11,34,-11,-17,54,79,-2,-35,15,24,-23,-16,63,86,14,-25,16,12,-42,-46,18,43,-13,-17,22
,15,-45,-68,-27,-4,-41,-16,30,40,-14,-52,-29,-10,-34,-30,27,60,24,-13,4,22,-5,-60,4,55
,32,6,30,49,17,-81,-21,28,4,-14,20,42,10,-71,-16,6,-34,-48,-6,14,-16,-19,22,10,-42,-4
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{ 19,43,72,79,64,34,8,-8,-15,0,25,33,19,2,-10,-16,-56,-53,-38,-34,-38,-30,-18,-13,-50,
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,2,-26,-1,-10,-25,-37,-33,-22,-28,-50,-46,-52,-47,-35,-21,-10,-15,-34,-38,-28,-2,17,24,
30,25,5,1,27,52,49,36,36,43,27,18,41,43,13,-21,-12,18,16,-3,5,-7,-52,-83,-51,-7,-7,-2
6,-19,-21,-49,-56,-21,6,-15,-26,0,25,24,26,41,32,-17,-17,22,60,63,51,51,23,-28,-27,7,
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,-1,10,45,53,25,28,47,47,31,28,33,26,-1,-6,8,17,6,-14,-20,-24,-34,-53,-38,-16,-25,-49,
-49,-37,-31,-57,-31,1,-9,-29,-18,2,3,-19,23,50,29,15,34,50,32,13,47,47,23,16,39,44,2
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{ 55,38,-5,-35,-29,-4,-5,-35,51,30,-16,-38,-16,16,8,-35,27,5,-24,-23,12,42,26,-27,-2,-
16,-22,-6,28,51,28,-22,-16,-18,-11,4,19,25,10,-23,-12,-2,8,4,-12,-12,-7,-18,0,18,26,-3
,-42,-35,-1,5,3,28,33,-7,-51,-30,26,32,-14,17,34,-4,-42,-4,55,35,-40,-2,30,4,-26,12,47,
0,-62,-12,32,10,-20,5,15,-56,-60,-5,41,12,-24,-1,-2,-84,-47,12,47,2,-29,12,23,-63,-29,
21,33,-20,-34,40,68,-18,-20,17,12,-45,-44,49,91,7,-16,15,4,-54,-55,29,65,-9,-14,24,2
7,-32,-60,-7,20,-40,-23,33,61,7,-46,-22,0,-46,-51,20,78,30,-32,-8,20,-22,-86,-6,64,21,
-29,14,52,6,-105,-19,41,-10,-42,23,65,8,-74,1,28,-36,-51,18,44,-16,-18,38,29,-39,-47,
8,14,-45,18,52,25,-27,-24,10,-1,-52,8,22,12,-6,5,20,5,-30,-34,-19,2,10,14,21,18,2,-62,
-32,8,11,-4,2,23,29,-47,-5,29,3,-37,-27,18,37,-12,32,46,-10,-61,-39,11,27,1,38,35,-14
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{ 20,-18,-49,-18,45,61,17,-32,31,-16,-54,-24,41,53,-2,-45,51,1,-45,-23,25,20,-24,-36,64,18,-28,-17,9,-6,-27,-4,59,17,-17,-5,3,-17,-13,43,27,-1,-9,9,4,-22,1,72,-11,-20,0,24,6,-29,-7,62,-35,-28,15,38,5,-43,-31,27,-41,-18,30,45,5,-43,-46,-9,-26,-7,26,36,11,-19,-26,-20,-6,-5,-2,5,18,24,12,-12,18,-9,-41,-32,20,55,31,-11,45,-5,-65,-51,16,48,16,-25,66,13,-46,-37,10,16,-16,-31,68,27,-9,-1,6,-17,-26,-5,30,13,17,26,-2,-29,-2,38,-32,-21,23,30,-17,-27,28,59,-66,-35,26,22,-31,-25,28,34,-57,-9,36,7,-37,-16,10,-25,-16,25,36,-4,-22,7,-4,-70,9,27,11,-16,6,42,5,-76,6,1,-24,-27,25,64,22,-48,-4,-20,-39,-26,20,47,31,-4,4,-6,-18,-20,-13,5,25,29,21,26,23,-12,-52,-38,16,42,10,37,48,0,-62,-52,12,35,-33,13,55,17,-42,-28,14,5,-81,-19,48,29,-9,5,13,-28,-98,-25,39,24,7,24,10,-56,-52,-1,20,-6,-4,31,13,-57,15,28,-10,-50,-23,35,32,-30,60,38,-34,-72,-25,44,51,0 },

{ 16,3,-22,-30,-2,50,87,66,20,8,-19,-36,-18,25,45,22,22,17,-1,-24,-32,-21,-22,-46,12,23,25,7,-18,-32,-49,-72,-15,10,40,36,15,-2,-15,-36,-49,-18,26,37,23,30,41,23,-68,-37,1,1,-8,24,62,47,-45,-20,-7,-36,-54,-12,34,21,8,31,18,-39,-70,-32,-1,-28,41,65,44,-9,-30,-5,-5,-50,19,36,36,17,20,37,16,-40,-46,-31,-4,10,30,48,26,-19,-83,-61,-25,-11,-2,12,15,1,-41,-12,7,-16,-41,-27,5,16,31,62,53,-7,-50,-29,11,24,46,69,46,-5,-26,-3,17,16,-12,-7,-7,-6,10,19,5,-12,-67,-62,-28,8,29,15,-21,-33,-58,-36,1,24,25,-5,-32,-20,9,29,27,15,-1,-17,-13,17,56,47,6,-21,-19,-6,15,50,37,5,-40,-39,-6,8,16,44,-2,-35,-46,-6,26,4,-18,5,-14,-26,-2,45,43,-17,-55,-26,2,7,35,57,31,-35,-62,-17,13,10,9,18,5,-23,-19,24,12,-18,-45,-30,0,14,29,56,20,-27,-65,-36,19,35,28,38,48,-1,-36,-2,37,13,-24,-17,60,25,0,27,27,-28,-69,-48,33,3,0,25,13,-35,-52,-6,-23,-41,-23,13,18,3,21,72 },

{ 50,21,-10,-15,-11,-13,-1,37,32,1,-23,-12,-1,-13,-7,38,7,-19,-22,10,21,-11,-22,27,-11,-26,-6,37,39,-16,-41,13,-13,-20,6,49,43,-25,-55,10,-2,-15,-1,35,29,-30,-45,22,14,-13,-25,3,16,-18,-23,41,35,-11,-45,-18,18,1,-7,44,59,-4,-55,-15,37,16,-17,18,69,0,-48,1,53,10,-45,-13,63,-6,-42,17,57,-8,-66,-18,44,-21,-41,21,47,-19,-49,15,28,-29,-40,17,32,-16,-10,59,25,-20,-26,12,13,-17,9,64,34,0,-11,6,-4,-23,-3,15,34,9,-3,3,-8,-18,-19,-39,16,-1,-3,6,8,11,-6,-63,-5,-15,-6,5,17,43,27,-48,-14,-13,-5,-11,-1,45,54,-22,-4,9,4,-34,-42,22,57,-10,5,33,26,-45,-77,0,52,-14,-10,40,47,-32,-71,0,43,-27,-50,23,67,0,-45,15,41,-40,-92,4,73,15,-29,26,39,-46,-110,0,66,-3,-40,22,41,-42,-77,17,43,-37,-55,20,42,-30,-30,36,25,-53,-52,26,45,-16,-2,39,15,-42,-27,33,37,-10,-8,18,12,-12,-4,18,15,-10,-37,-6,20,14,-5,-13,-11,-5,-57,-12,34,23,-19,-36,-15,19,-47,0,41,21,-25,-35,4,49 },

{ 88,47,-16,-40,-24,-10,-24,-44,64,19,-34,-36,2,20,-3,-31,19,-20,-39,-8,40,47,20,-6,-16,-38,-25,18,48,40,14,5,-21,-23,1,24,15,-13,-17,4,-3,8,24,14,-34,-62,-30,13,11,27,34,0,-56,-56,-2,33,0,19,28,-1,-33,-8,41,39,-29,-8,14,5,1,36,54,-2,-46,-24,4,4,8,36,13,-67,-35,-11,7,-5,-8,7,-21,-94,-2,19,17,-15,-25,4,2,-51,20,33,19,-24,-27,28,63,24,5,19,7,-30,-29,32,73,49,-27,-5,7,-20,-38,-7,22,7,-48,-5,37,11,-38,-44,-34,-38,-52,14,73,40,-17,-33,-34,-33,-47,13,54,31,4,11,14,8,-41,-12,-5,-16,11,44,45,34,-15,-22,-51,-49,5,32,16,16,38,5,-44,-33,5,-10,-42,-16,68,34,-6,13,18,-36,-62,-14,50,17,11,45,33,-27,-36,29,-13,-35,-6,40,31,-12,1,67,-50,-58,-24,15,10,-12,9,60,-12,-20,-14,-1,-5,-22,-16,16,55,3

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, -12,-8,2,17,29,37,39,-12,-19,-16,-5,13,29,39,43,-16,-26,-25,-13,7,27,40,45,-20,-33,-3
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, -44,-19,10,34,46,-29,-50,-58,-48,-23,7,32,46,-30,-52,-60,-51,-26,4,30,45,-30,-52,-61,
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{ -11,-18,-24,-27,-26,-22,-15,-8,-17,-31,-41,-47,-45,-38,-26,-15,-22,-41,-57,-64,-62,-50,-35,-21,-26,-48,-66,-74,-70,-57,-39,-23,-26,-49,-69,-76,-71,-56,-37,-20,-24,-45,-61,-68,-61,-47,-29,-14,-19,-35,-48,-52,-45,-32,-17,-5,-13,-24,-31,-32,-24,-13,-2,6,-7,-13,-15,-12,-4,5,13,17,-2,-3,-1,5,13,21,25,26,2,4,10,18,27,33,35,33,4,10,17,27,36,41,42,38,6,13,22,32,41,46,46,42,7,14,23,34,43,48,48,44,6,13,22,33,42,48,48,44,6,12,20,30,39,45,46,43,4,10,17,26,35,42,44,41,3,7,13,21,30,37,40,38,2,4,8,15,24,31,35,35,0,1,3,9,17,24,29,30,-2,-3,-2,2,9,17,23,25,-4,-7,-8,-5,1,9,16,20,-6,-11,-14,-13,-8,0,8,13,-8,-14,-19,-20,-16,-9,0,7,-9,-18,-24,-27,-25,-18,-8,0,-11,-21,-29,-33,-32,-26,-16,-6,-12,-23,-33,-39,-39,-33,-23,-12,-13,-25,-36,-44,-45,-40,-29,-18,-13,-26,-39,-48,-51,-46,-35,-23,-14,-27,-40,-51,-54,-50,-40,-28,-14,-27,-41,-51,-56,-53,-43,-31,-14,-27,-40,-50,-55,-53,-45,-33 },

{ 5,5,1,-7,-15,-20,-21,-20,9,10,4,-9,-24,-35,-39,-36,14,19,12,-7,-31,-48,-55,-51,21,30,24,1,-31,-55,-65,-62,28,42,39,14,-24,-55,-70,-67,33,53,53,29,-11,-48,-66,-67,37,60,64,43,3,-36,-58,-62,37,63,71,54,16,-23,-48,-55,35,61,72,59,26,-12,-38,-47,30,55,66,57,29,-5,-29,-40,24,44,55,49,28,0,-22,-32,17,32,41,39,23,2,-16,-26,10,20,28,27,18,2,-12,-20,4,9,15,16,11,2,-9,-15,-2,-1,3,5,5,0,-6,-10,-6,-9,-9,-5,-2,-1,-3,-6,-11,-17,-19,-15,-8,-3,-1,-1,-14,-24,-27,-23,-13,-4,1,3,-17,-29,-34,-29,-17,-5,4,7,-19,-33,-39,-34,-20,-5,7,12,-21,-36,-43,-38,-22,-4,10,16,-22,-39,-46,-40,-23,-3,13,21,-23,-40,-47,-41,-23,0,17,26,-23,-40,-47,-41,-21,2,21,31,-22,-39,-47,-40,-19,6,26,36,-21,-37,-44,-37,-16,10,31,41,-20,-35,-41,-33,-12,14,35,45,-18,-31,-36,-28,-7,19,40,50,-16,-27,-31,-22,-2,23,44,54,-13,-23,-25,-16,4,28,48,58,-10,-17,-18,-9,10,32,51,60,-6,-11,-10,-2,15,36,52,61 },

{ 17,28,36,37,31,22,11,3,26,44,57,60,51,35,18,5,31,54,71,73,62,40,18,2,31,56,71,73,58,34,10,-6,26,46,60,58,42,18,-4,-18,15,28,36,32,16,-5,-22,-31,4,8,9,2,-12,-27,-39,-42,-6,-10,-15,-23,-34,-45,-51,-50,-12,-22,-31,-38,-47,-54,-57,-54,-14,-26,-35,-42,-47,-52,-54,-52,-14,-25,-32,-36,-39,-42,-46,-45,-12,-21,-25,-25,-25,-29,-34,-37,-10,-15,-16,-12,-10,-13,-21,-27,-7,-9,-7,0,4,2,-7,-16,-4,-4,2,12,19,16,7,-5,-1,2,10,22,31,30,19,5,1,6,16,30,41,41,30,15,2,8,19,35,47,49,38,22,2,8,20,36,50,53,44,28,2,7,19,35,50,55,47,31,1,5,16,32,47,54,48,33,0,2,11,26,42,50,46,33,-3,-3,4,18,33,43,42,31,-5,-8,-3,8,24,35,35,28,-8,-13,-12,-2,13,24,28,23,-11,-18,-20,-13,1,13,19,17,-14,-24,-28,-24,-12,1,8,9,-16,-29,-36,-35,-25,-12,-2,1,-18,-33,-43,-45,-37,-25,-13,-7,-19,-36,-48,-53,-47,-36,-23,-15,-20,-37,-51,-57,-55,-45,-33,-23,-20,-37,-52,-59,-58,-51,-39,-29 },

{ 7,10,7,-3,-17,-27,-31,-28,11,17,13,-3,-25,-44,-50,-48,16,24,21,2,-27,-52,-65,-63,17,31,31,14,-19,-52,-69,-70,16,32,40,27,-4,-38,-62,-68,11,27,40,39,15,-18,-46,-59,2,15,33,42,32,4,-26,-44,-8,-1,19,39,42,23,-6,-28,-20,-19,1,29,45,36,11,-14,-30,-36,-18,16,41,43,22,-3,-38,-51,-36,-1,34,43,29,4,-44,-63,-52,-16,24,41,31,9,-48,-70,-63,-27,15,38,33,11,-48,-72,-66,-34,10,35,32,12,-46,-69,-66,-35,6,31,30,12,-42,-64,-61,-33,5,29,28,11,-38,-57,-54,-29,5,26,25,8,-32,-48,-45,-23,7,25,22,6,-26,-38,-34,-15,10,24,19,3,-20,-28,-23,-5,14,23,16,-1,-14,-17,-11,4,19,22,12,-5,-8,-7,1,13,23,22,8,-10,-2,2,12,22,26,20,3,-16,4,11,21,29,29,18,-2,-23,8,18,29,35,31,14,-9,-30,12,24,35,39,30,10,-16,-37,14,27,38,40,28,4,-23,-44,16,30,39,39,24,-2,-30,-51,16,30,39,36,19,-9,-38,-58,16,28,35,31,12,-16,-45,-65,14,24,29,23,4,-23,-51,-69,10,19,22,16,-3,-29,-54,-71 },

{ -7,-15,-26,-33,-34,-27,-16,-4,-7,-18,-34,-48,-51,-42,-24,-5,-1,-10,-29,-47,-56,-46,-24,-1,10,8,-9,-32,-45,-39,-16,8,24,31,19,-5,-23,-21,-1,21,36,52,44,21,-1,-3,14,34,43,63,59,34,12,8,23,42,44,65,58,33,10,8,25,46,40,55,46,18,-4,-3,20,45,31,42,26,-4,-25,-19,10,40,23,26,5,-27,-47,-36,-1,34,16,13,-11,-46,-64,-50,-11,28,11,5,-22,-57,-75,-58,-17,25,10,3,-25,-60,-77,-61,-19,24,10,5,-21,-55,-73,-57,-17,25,12,9,-14,-46,-63,-50,-12,28,16,15,-4,-34,-52,-41,-6,32,19,22,6,-21,-39,-31,1,37,22,29,17,-7,-25,-19,9,41,25,35,27,6,-12,-9,17,46,28,41,36,17,0,2,23,50,29,44,42,26,9,9,28,52,29,45,45,30,14,13,30,52,28,44,45,31,16,14,30,51,26,41,41,28,14,12,27,48,22,34,34,22,8,7,22,43,17,25,23,10,-2,-2,13,35,11,15,10,-3,-15,-14,3,26,4,4,-4,-18,-30,-28,-9,15,-2,-7,-18,-34,-45,-42,-22,3,-9,-18,-32,-48,-59,-55,-36,-9,-15,-27,-42,-59,-69,-66,-46,-19 },

{ 27,39,42,35,23,9,1,-1,38,58,62,51,28,9,-1,-3,46,68,70,51,22,-1,-9,-6,46,69,64,38,4,-18,-20,-11,42,57,47,13,-22,-38,-32,-14,32,40,22,-15,-47,-55,-37,-13,22,23,0,-37,-64,-61,-35,-5,16,12,-13,-48,-67,-57,-25,7,14,8,-17,-47,-61,-43,-9,24,14,11,-10,-37,-45,-26,10,40,17,17,0,-22,-28,-7,27,55,20,23,10,-9,-13,8,41,67,22,27,17,0,-3,17,50,75,23,30,20,4,0,20,52,79,23,30,20,3,-3,16,50,77,23,29,18,-1,-8,9,43,73,21,26,15,-6,-16,0,35,67,20,24,11,-12,-24,-10,25,59,18,21,7,-18,-33,-21,13,49,16,19,3,-23,-41,-32,2,39,16,17,1,-27,-47,-41,-9,28,15,17,1,-28,-51,-48,-18,19,15,17,2,-26,-52,-52,-25,11,16,20,6,-23,-50,-54,-31,4,17,22,11,-17,-46,-53,-34,-1,19,26,17,-9,-38,-49,-34,-4,21,31,25,1,-28,-41,-31,-5,23,36,33,12,-16,-32,-25,-4,25,40,41,24,-2,-20,-18,-2,25,43,47,34,11,-7,-9,3,26,44,51,42,23,5,1,9,25,43,52,46,30,15,9,14 },

{ -1,-5,-12,-24,-37,-45,-45,-36,0,-1,-11,-28,-49,-65,-66,-55,5,7,2,-15,-41,-63,-71,-63,8,17,22,14,-10,-39,-56,-55,6,21,40,45,30,-1,-27,-37,-2,13,39,60,58,34,3,-16,-16,-9,18,49,65,51,24,2,-30,-36,-15,21,49,51,33,13,-42,-58,-48,-13,23,37,30,16,-45,-68,-65,-39,-3,19,21,13,-41,-63,-67,-49,-20,2,9,8,-31,-50,-55,-46,-26,-8,0,2,-18,-30,-36,-32,-23,-13,-5,-1,-4,-7,-11,-13,-14,-12,-8,-4,10,15,15,9,0,-6,-7,-5,21,35,38,30,14,0,-6,-5,30,50,57,46,25,5,-5,-5,34,57,64,54,29,6,-6,-6,34,56,64,52,27,4,-8,-7,31,52,57,45,20,-2,-12,-9,26,42,46,33,10,-10,-17,-12,18,30,30,17,-4,-20,-22,-14,10,15,12,-1,-19,-29,-27,-15,2,2,-5,-18,-32,-38,-30,-15,-5,-10,-19,-32,-43,-42,-31,-13,-10,-18,-29,-40,-46,-42,-26,-7,

-13,-22,-33,-42,-44,-35,-17,3,-13,-23,-32,-38,-36,-24,-4,15,-12,-20,-27,-28,-22,-6,14,31,-8,-14,-16,-13,-2,15,35,50,-2,-3,-1,7,21,39,57,68,6,9,15,25,41,59,74,82 },

{ -21,-35,-46,-46,-33,-12,8,18,-25,-44,-60,-63,-44,-13,16,31,-19,-36,-54,-57,-40,-5,28,45,-4,-14,-28,-35,-22,9,40,55,16,18,8,-4,-1,20,46,59,33,47,39,21,9,18,38,52,42,60,54,27,4,2,19,35,41,60,50,17,-15,-23,-6,14,33,47,35,-2,-38,-46,-30,-5,21,29,15,-19,-52,-61,-43,-18,8,11,-2,-29,-55,-61,-46,-23,-2,-3,-11,-29,-47,-52,-40,-21,-9,-11,-15,-22,-32,-34,-27,-15,-12,-14,-12,-10,-12,-13,-10,-4,-13,-14,-6,4,10,11,9,8,-14,-13,0,17,30,32,27,20,-15,-13,4,27,46,50,42,30,-16,-15,3,31,53,59,50,36,-19,-19,-2,26,51,58,50,36,-21,-24,-9,18,43,52,45,32,-25,-30,-18,7,31,40,36,23,-27,-36,-27,-6,15,25,21,12,-28,-38,-34,-18,-1,7,4,-3,-27,-39,-39,-28,-15,-11,-14,-18,-25,-37,-38,-32,-25,-25,-30,-33,-20,-29,-31,-29,-27,-32,-39,-43,-12,-17,-18,-18,-21,-32,-44,-49,-4,-3,-1,-1,-9,-26,-42,-50,6,14,20,20,8,-14,-36,-48,16,30,41,43,29,3,-24,-40,26,45,61,65,52,24,-7,-28,33,56,74,81,69,41,9,-15 },

{ 28,31,18,-3,-19,-20,-10,3,42,51,30,-4,-30,-32,-12,8,54,65,39,-7,-42,-40,-12,18,58,73,42,-13,-50,-45,-7,29,56,68,37,-22,-58,-43,3,44,46,56,23,-31,-59,-37,16,58,34,38,8,-37,-57,-26,29,70,22,23,-4,-41,-50,-15,40,78,14,13,-10,-38,-42,-6,46,80,9,8,-9,-31,-32,-1,44,76,6,6,-5,-20,-23,0,38,65,3,5,0,-10,-14,0,28,52,0,4,5,-1,-7,-1,17,36,-2,3,8,6,-1,-4,5,19,-5,0,9,11,3,-7,-7,2,-8,-4,8,15,6,-10,-19,-15,-11,-8,7,18,11,-11,-28,-31,-15,-12,4,20,15,-10,-34,-43,-18,-16,2,21,20,-6,-37,-51,-21,-21,-1,23,26,-1,-37,-58,-24,-25,-3,25,33,6,-35,-61,-27,-29,-6,27,39,14,-30,-61,-29,-33,-10,27,45,23,-22,-58,-32,-37,-13,26,50,32,-14,-54,-35,-41,-18,24,52,39,-6,-48,-37,-45,-23,20,52,44,1,-43,-39,-49,-30,13,49,45,6,-37,-40,-53,-35,6,44,45,10,-32,-40,-54,-40,-1,37,42,12,-27,-37,-53,-42,-7,29,37,12,-23,-33,-48,-41,-12,21,30,11,-20,-28,-42,-37,-13,15,24,9,-18 },

{ 2,7,17,34,52,62,59,43,0,2,14,35,60,78,76,60,-6,-9,-5,10,35,56,64,54,-8,-19,-28,-29,-14,10,26,30,-2,-15,-38,-56,-58,-40,-16,-1,13,6,-18,-50,-69,-64,-42,-23,29,34,19,-12,-43,-53,-44,-29,36,54,53,33,1,-21,-28,-23,29,50,65,59,38,12,-5,-11,10,25,43,55,49,31,12,0,-14,-12,4,25,38,33,21,9,-34,-47,-36,-11,15,25,21,12,-47,-68,-65,-39,-7,14,18,13,-47,-72,-72,-51,-18,5,13,11,-39,-60,-62,-45,-20,0,8,8,-25,-40,-41,-30,-14,-1,5,4,-10,-16,-15,-9,-3,1,2,1,5,8,11,12,10,5,0,-2,18,29,34,31,21,8,-2,-5,28,44,51,46,29,9,-5,-9,33,52,61,53,32,7,-9,-13,31,50,57,50,26,1,-15,-18,24,40,45,36,15,-9,-22,-22,15,25,27,19,0,-20,-29,-26,5,9,8,0,-15,-29,-33,-27,-4,-7,-10,-17,-27,-34,-32,-25,-12,-18,-24,-28,-33,-32,-26,-17,-16,-26,-32,-34,-32,-25,-15,-5,-18,-29,-35,-32,-24,-11,1,10,-16,-26,-28,-22,-8,9,23,29,-10,-15,-13,-2,15,34,46,49,-1,-2,4,18,37,56,65,65 },

{ -33,-52,-68,-65,-47,-18,10,23,-33,-56,-73,-76,-52,-15,20,38,-17,-30,-45,-48,-32,2,35,50,9,12,6,-2,1,20,43,55,30,48,52,38,24,24,36,46,35,60,64,47,19,5,11,23,24,41,45,24,-9,-28,-22,-5,2,10,10,-8,-38,-57,-49,-28,-18,-19,-19,-28,-49,-63,-59,-38,-30,-36,-29,-25,-33,-45,-45,-33,-34,-38,-23,-5,0,-10,-18,-17,-33,-34,-11,20,35,26,10,1,-31,-29,-1,37,60,53,33,16,-28,-26,2,42,67,64,43,24,-26,-25,-1,35,60,58,41,24,-24,-26,-8,21,43,44,

31,18,-22,-26,-14,6,22,23,16,8,-19,-23,-18,-8,1,1,-3,-4,-12,-16,-17,-16,-17,-20,-21,-17,-5,-7,-11,-19,-29,-37,-36,-28,4,5,-2,-17,-35,-47,-47,-35,13,18,11,-8,-32,-49,-49,-36,21,30,26,5,-22,-41,-43,-31,28,41,38,19,-9,-30,-33,-22,31,46,47,29,3,-16,-19,-9,29,45,46,33,11,-4,-5,4,23,35,37,27,14,5,9,18,13,20,20,15,10,11,20,31,1,1,-1,-3,1,12,29,42,-11,-20,-26,-25,-13,8,32,49,-23,-39,-49,-47,-30,-1,30,50,-33,-53,-65,-63,-42,-10,24,48 },

{ 45,50,28,-9,-33,-27,-1,23,60,72,41,-11,-45,-36,4,40,64,77,46,-15,-55,-39,12,57,52,67,36,-23,-60,-40,20,71,30,38,15,-33,-63,-36,26,78,3,7,-5,-35,-52,-29,28,77,-20,-19,-14,-22,-32,-16,25,65,-35,-33,-11,1,-3,-3,18,48,-43,-36,0,28,24,6,7,26,-43,-35,10,47,41,8,-8,2,-44,-33,14,54,46,4,-25,-20,-42,-33,13,53,43,-5,-40,-39,-42,-34,9,46,37,-12,-52,-53,-39,-35,4,40,31,-17,-56,-60,-36,-33,1,33,27,-17,-54,-58,-32,-31,-2,27,23,-13,-46,-51,-28,-27,-3,22,21,-8,-36,-39,-24,-23,-2,20,20,-2,-23,-25,-19,-17,0,17,18,4,-10,-9,-14,-12,1,14,16,8,3,7,-8,-6,2,9,11,9,12,22,-4,-2,3,3,3,6,18,33,1,3,3,-3,-8,0,20,41,6,8,4,-9,-18,-9,19,46,11,15,6,-14,-29,-19,15,49,17,22,10,-17,-37,-28,10,50,23,29,15,-17,-44,-36,4,48,28,37,22,-14,-46,-43,-1,45,33,44,30,-9,-46,-46,-6,42,36,50,36,-3,-41,-45,-8,39,37,51,40,3,-34,-39,-8,35,34,49,40,8,-25,-32,-6,32 },

{ 23,27,21,1,-25,-46,-55,-47,27,34,27,6,-25,-52,-64,-60,22,28,26,15,-6,-28,-46,-48,7,10,12,19,20,10,-7,-19,-10,-17,-13,8,34,42,31,12,-21,-38,-38,-14,25,51,47,30,-20,-39,-50,-35,2,33,40,29,-4,-19,-37,-41,-20,6,18,15,21,16,-5,-25,-28,-16,-5,-2,42,49,28,-1,-20,-24,-20,-16,53,66,51,20,-7,-20,-24,-24,49,64,52,28,4,-12,-21,-25,35,43,36,21,7,-4,-14,-22,13,12,6,3,4,3,-5,-16,-9,-20,-26,-19,-2,8,5,-7,-27,-47,-53,-38,-8,14,15,3,-37,-62,-70,-48,-10,19,24,11,-37,-61,-67,-46,-6,25,30,16,-27,-45,-50,-31,4,30,32,18,-11,-21,-24,-10,16,34,32,15,7,6,6,13,27,34,27,9,23,31,31,31,32,28,15,-2,35,47,48,40,29,15,-3,-17,40,55,53,39,19,-2,-22,-33,39,52,49,29,4,-22,-41,-47,30,40,32,12,-14,-37,-51,-54,17,19,9,-9,-29,-44,-52,-51,1,-4,-15,-27,-38,-43,-42,-38,-12,-23,-34,-38,-35,-27,-21,-15,-20,-34,-40,-35,-17,3,15,18,-21,-31,-32,-15,14,43,58,56,-15,-21,-14,9,45,78,92,87 } ,

{ 44,60,66,55,36,14,-4,-12,42,58,60,51,30,7,-10,-18,22,23,18,9,-1,-10,-17,-21,-3,-18,-34,-39,-32,-23,-16,-15,-14,-38,-61,-61,-41,-15,-1,-1,-4,-24,-43,-42,-15,12,22,17,18,12,0,1,21,39,40,27,37,41,33,30,39,47,40,25,41,46,36,26,27,28,21,8,30,29,12,-2,-5,-4,-7,-12,12,2,-19,-34,-36,-31,-30,-30,-1,-17,-38,-50,-48,-41,-39,-39,-7,-22,-39,-43,-37,-30,-33,-37,-4,-15,-24,-21,-9,-5,-13,-26,3,-3,-4,8,24,27,12,-9,8,8,13,31,52,54,34,6,10,12,21,43,67,70,48,17,8,9,16,37,61,67,47,17,2,-1,1,16,38,46,32,8,-5,-14,-19,-11,7,18,10,-6,-9,-23,-36,-36,-24,-13,-13,-21,-8,-23,-41,-50,-45,-36,-32,-34,-1,-14,-33,-48,-51,-46,-41,-40,10,3,-15,-34,-43,-43,-40,-39,23,23,9,-10,-25,-29,-31,-31,34,42,33,16,1,-7,-12,-17,40,52,49,36,24,16,10,1,38,52,52,45,38,35,29,18,27,36,38,35,37,40,40,30,5,5,2,4,14,29,37,33,-22,-36,-46,-44,-27,0,20,25,-46,-71,-87,-87,-66,-32,-3,10 } ,

{ -40,-28,5,30,26,-1,-23,-27,-51,-36,11,50,42,2,-32,-38,-63,-46,11,57,51,2,-38,-40,-67
 ,-55,4,53,45,-3,-38,-34,-65,-53,0,41,31,-12,-34,-19,-52,-41,3,30,12,-21,-25,1,-33,-19,
 14,22,-4,-29,-15,25,-16,3,28,21,-17,-36,-6,46,-6,16,39,21,-26,-43,-1,63,-7,17,40,22,-3
 0,-50,-2,70,-16,7,36,21,-31,-54,-7,70,-28,-6,28,23,-27,-55,-11,66,-40,-20,23,27,-19,-5
 2,-16,61,-49,-30,19,34,-8,-48,-19,54,-55,-37,18,42,5,-40,-22,46,-59,-42,17,49,16,-33,
 -24,37,-62,-45,16,54,26,-27,-28,29,-62,-47,14,57,31,-24,-30,20,-61,-47,12,55,33,-22,-
 34,13,-59,-47,9,51,31,-24,-37,7,-56,-45,7,46,28,-25,-39,3,-50,-41,7,42,24,-26,-39,2,-4
 3,-33,8,38,19,-26,-37,4,-34,-25,10,34,15,-26,-32,8,-26,-16,14,31,11,-25,-28,15,-18,-8,
 17,28,7,-25,-22,21,-10,0,19,24,3,-24,-15,29,-3,6,20,19,-3,-24,-9,36,1,9,18,12,-11,-26,
 -6,42,2,10,14,3,-19,-30,-4,45,2,7,8,-5,-26,-32,-4,45,1,5,3,-10,-28,-31,-4,42 },
 { -24,-29,-15,13,32,22,-7,-31,-30,-42,-27,10,37,28,-12,-47,-21,-36,-30,3,35,27,-16,-5
 8,4,-13,-23,-4,27,26,-14,-58,36,21,-9,-11,15,25,-5,-48,63,50,0,-24,-2,23,8,-31,77,62,-
 2,-42,-23,19,22,-11,76,61,-11,-61,-39,17,35,8,69,49,-22,-71,-47,18,45,21,54,37,-27,-
 69,-39,23,49,26,41,24,-25,-53,-24,29,47,22,29,16,-20,-34,-5,35,40,11,18,7,-15,-17,10
 ,37,30,-5,8,-1,-13,-6,19,35,15,-23,1,-8,-14,-1,24,29,-1,-43,-5,-14,-15,2,26,24,-15,-61,-
 11,-18,-16,4,27,19,-27,-76,-12,-20,-16,6,28,18,-31,-83,-11,-18,-15,7,30,21,-28,-81,-7,
 -14,-13,8,31,26,-21,-74,-4,-10,-11,6,31,30,-10,-60,1,-5,-9,3,26,33,2,-44,7,1,-9,-4,18,3
 2,14,-24,12,6,-9,-12,7,29,24,-4,18,12,-9,-22,-7,21,32,13,25,20,-8,-31,-23,10,32,26,33,
 29,-4,-37,-40,-5,29,34,41,40,4,-40,-52,-20,22,39,50,52,15,-36,-59,-31,16,41,56,63,26,
 -28,-58,-37,11,42,58,68,37,-17,-51,-35,8,40,55,66,40,-6,-38,-29,7,37 },
 { 4,6,-1,-22,-53,-76,-82,-67,7,13,10,-8,-40,-72,-84,-75,6,15,24,24,8,-18,-39,-44,-3,3,2
 0,41,53,45,23,5,-17,-20,-10,19,55,70,62,40,-20,-35,-42,-28,9,42,52,44,-4,-20,-46,-57,
 -43,-11,14,21,23,20,-10,-45,-59,-47,-22,-5,45,56,39,-1,-37,-46,-35,-20,43,64,60,35,1,
 -22,-26,-21,19,35,45,42,27,7,-8,-13,-14,-11,5,24,32,24,9,-3,-42,-52,-38,-6,23,29,18,5,
 -54,-73,-61,-28,9,25,19,7,-48,-65,-60,-32,0,17,15,6,-27,-39,-37,-22,-2,10,9,2,0,-1,-4,-
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{ 15,13,19,34,54,59,51,31,1,-12,-17,-15,-7,0,1,0,-1,-15,-24,-33,-48,-51,-44,-29,9,10,19,21,1,-18,-19,-10,1,8,32,51,50,37,32,28,-17,-26,-18,-4,7,16,24,28,-8,-20,-37,-47,-50,-36,-18,-4,26,30,16,-6,-22,-28,-25,-20,24,39,48,45,38,24,4,-10,-22,-17,-1,17,32,36,19,0,-48,-55,-51,-39,-16,7,10,-1,-14,-17,-25,-39,-36,-17,-4,-3,41,54,44,11,-15,-14,-4,-2,42,64,64,39,8,0,2,2,-14,-3,13,15,6,4,6,3,-66,-73,-48,-23,-7,1,5,1,-61,-72,-54,-25,-5,2,3,0,6,0,2,9,12,8,2,-2,72,73,58,38,20,7,-1,-6,73,75,50,23,2,-8,-9,-8,18,5,-15,-28,-30,-23,-13,-6,-40,-60,-66,-55,-33,-16,-2,5,-52,-63,-53,-26,4,16,19,18,-15,-12,8,33,48,43,30,20,26,40,57,63,56,31,10,2,28,39,39,32,10,-17,-29,-24,2,-3,-14,-29,-48,-59,-52,-34,-19,-31,-44,-54,-57,-49,-29,-10,-10,-16,-21,-19,-7,10,28,34,12,17,22,33,46,59,61,53,12,20,27,33,37,33,25,14,-14,-16,-17,-21,-31,-45,-55,-56 },

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8,14,15,16,24,33,33,28,18,4,-1,-11,-19,-26,-37,-45,-46 },
}
},
...
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}
},
    }

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[326] [표 12]

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{ 15,21,23,22,19,15,10,6,21,30,34,33,29,23,16,10,25,36,41,40,35,28,20,13,26,40,45,44,39,31,22,14,27,41,47,45,40,31,23,14,26,40,44,43,37,29,20,12,23,35,39,36,30,23,15,7,18,28,30,27,21,14,7,1,13,19,19,15,8,2,-3,-8,7,9,6,0,-6,-12,-16,-18,3,1,-6,-14,-22,-27,-29,-29,1,-4,-15,-26,-36,-42,-43,-41,2,-4,-17,-32,-46,-53,-54,-51,6,2,-11,-29,-45,-57,-59,-56,14,14,3,-16,-36,-50,-57,-56,21,28,21,5,-16,-35,-47,-50,28,40,41,28,8,-14,-30,-38,29,47,52,46,29,9,-11,-24,26,43,54,54,44,26,6,-9,17,32,44,50,46,35,18,3,5,13,25,33,37,32,22,10,-9,-9,-2,8,17,20,17,11,-23,-32,-31,-22,-9,2,7,7,-33,-50,-54,-47,-33,-17,-4,3,-38,-60,-69,-63,-49,-30,-12,0,-36,-59,-69,-66,-52,-33,-13,1,-30,-49,-58,-55,-43,-24,-6,7,-21,-34,-39,-36,-24,-8,8,19,-10,-17,-18,-12,-1,13,26,34,-1,-1,3,10,22,34,44,50,7,12,20,30,41,52,60,63,13,22,32,43,54,64,70,71 },

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{ -23,-28,-22,-9,5,17,24,24,-31,-39,-31,-13,8,25,35,38,-36,-45,-37,-16,9,30,43,47,-37,-49,-40,-19,8,31,47,52,-35,-46,-40,-20,6,30,47,53,-28,-39,-35,-19,4,25,42,50,-16,-25,-25,-15,1,19,34,42,-1,-6,-10,-9,-1,11,23,31,16,16,8,1,-2,2,10,17,29,38,28,11,-3,-8,-5,1,39,52,44,21,-3,-18,-21,-17,38,57,51,26,-5,-28,-37,-35,29,47,47,25,-8,-36,-51,-51,10

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0,-60,-25,4,2,-13,13,34,34,2,-25,-15,0,4,-7,44,93,80,18,-13,1,23,-66,-51,12,38,3,-28,-
11,29,-31,-73,-65,-33,-34,-46,-22,24,76,34,-11,-3,5,-9,-9,19,98,81,27,28,52,41,11,10,
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{

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{ -8,-11,-14,-16,-17,-15,-10,-3,-11,-17,-22,-25,-25,-22,-14,-4,-14,-23,-29,-32,-32,-26,-15,-2,-17,-28,-35,-38,-36,-28,-14,1,-20,-32,-40,-42,-38,-27,-12,7,-22,-35,-42,-43,-36,-24,-5,14,-23,-36,-42,-41,-33,-17,3,24,-23,-36,-41,-38,-27,-9,14,35,-23,-35,-39,-33,-19,2,26,47,-22,-33,-34,-26,-9,13,38,58,-20,-29,-28,-18,1,24,48,67,-18,-25,-22,-9,11,34,57,73,-16,-21,-16,-2,19,42,63,76,-14,-17,-11,3,23,45,63,76,-12,-15,-9,5,24,43,60,70,-11,-14,-9,3,20,37,53,63,-11,-15,-11,-2,13,28,43,54,-13,-18,-17,-10,3,17,32,43,-15,-23,-25,-20,-9,4,20,33,-18,-29,-33,-31,-22,-8,8,23,-21,-35,-43,-42,-33,-19,-1,16,-24,-41,-50,-51,-42,-27,-7,11,-27,-46,-57,-57,-48,-31,-10,10,-30,-51,-61,-61,-50,-32,-10,10,-32,-53,-64,-62,-50,-30,-8,12,-32,-53,-62,-59,-45,-26,-3,16,-32,-50,-57,-52,-38,-18,3,22,-29,-46,-50,-44,-28,-9,11,28,-26,-39,-42,-33,-18,0,19,34,-21,-32,-32,-23,-7,10,27,40,-16,-22,-20,-11,4,19,34,45,-9,-13,-9,1,14,27,39,48 },

{ -2,-5,-7,-9,-11,-12,-13,-14,-4,-8,-12,-16,-19,-21,-24,-25,-6,-11,-17,-22,-26,-30,-33,-35,-7,-14,-20,-26,-32,-37,-41,-44,-8,-16,-23,-29,-35,-41,-47,-50,-9,-16,-23,-29,-36,-43,-49,-54,-8,-14,-20,-26,-33,-41,-49,-54,-6,-11,-16,-21,-28,-36,-45,-52,-4,-6,-9,-12,-19,-28,-39,-48,0,1,1,-1,-7,-17,-30,-43,6,11,14,13,7,-5,-21,-37,12,21,27,29,22,8,-12,-31,18,32,42,44,36,18,-5,-28,24,43,54,56,46,25,-2,-27,30,52,64,64,51,26,-3,-29,35,59,70,67,50,23,-8,-33,38,62,73,65,45,14,-16,-39,39,62,68,59,34,3,-25,-45,38,57,60,46,20,-10,-35,-49,34,51,48,31,4,-23,-43,-53,30,41,35,15,-11,-34,-49,-53,24,31,21,1,-22,-41,-49,-50,18,19,8,-10,-29,-42,-46,-42,11,10,-2,-18,-31,-39,-38,-33,6,2,-9,-20,-29,-31,-28,-21,2,-2,-10,-18,-21,-19,-14,-8,0,-3,-7,-10,-9,-5,1,6,0,-1,0,1,6,11,16,19,1,4,8,14,21,27,30,31,5,11,19,27,35,40,42,41,10,20,30,39,47,51,51,47,17,29,39,48,55,57,56,51 },

{ -9,-15,-20,-21,-20,-16,-9,-1,-15,-24,-30,-33,-30,-23,-12,-1,-19,-31,-39,-40,-35,-25,-11,2,-22,-36,-44,-44,-36,-24,-7,7,-25,-40,-47,-44,-34,-18,0,15,-26,-40,-45,-41,-27,-9,10

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{ 5,8,10,12,15,17,20,20,7,12,16,20,25,30,33,34,9,14,20,25,32,39,44,45,9,15,21,28,36
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{ -15,-23,-27,-26,-22,-14,-4,5,-21,-33,-38,-38,-30,-18,-2,11,-26,-40,-46,-42,-31,-14,4,
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},

{ -1,-3,-6,-11,-18,-24,-28,-28,-2,-5,-10,-19,-29,-39,-45,-46,-1,-4,-11,-22,-35,-48,-56,-
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{ 0,-3,-11,-19,-25,-21,-8,10,0,-5,-15,-27,-33,-27,-5,21,3,-2,-14,-28,-35,-25,2,34,7,4,-8,-24,-31,-20,12,48,13,13,0,-17,-26,-14,21,60,20,22,9,-11,-22,-11,25,66,27,31,16,-9,-24,-14,23,65,33,39,20,-11,-31,-23,15,58,39,44,20,-17,-42,-35,4,48,42,46,16,-26,-53,-47,-5,38,43,45,12,-33,-61,-50,-10,30,44,45,10,-35,-59,-48,-8,25,45,44,11,-30,-50,-35,-2,21,44,45,14,-20,-31,-16,8,17,43,43,18,-7,-11,3,14,7,39,40,19,4,6,16,14,-8,32,30,15,9,17,23,8,-27,19,14,4,7,20,23,-2,-46,3,-7,-11,2,22,21,-12,-61,-14,-27,-24,0,24,21,-19,-72,-28,-42,-30,5,33,25,-20,-76,-36,-49,-26,16,44,33,-17,-75,-41,-46,-16,31,58,41,-12,-69,-39,-40,-3,43,66,48,-6,-61,-37,-33,5,49,69,47,-3,-53,-34,-32,3,45,61,42,-2,-46,-36,-37,-7,30,47,33,-2,-37,-41,-49,-23,13,32,25,0,-27,-49,-59,-38,-2,20,21,5,-16,-52,-66,-44,-10,16,23,12,-4,-50,-61,-41,-7,19,27,19,5,-40,-48,-28,2,24,32,25,12 },

{ -16,-22,-27,-30,-34,-36,-35,-29,-18,-26,-30,-36,-42,-47,-46,-40,-14,-17,-21,-26,-35,-41,-43,-38,-4,-1,-1,-6,-15,-25,-30,-28,9,19,24,20,9,-3,-12,-14,21,37,43,41,30,17,6,0,28,45,52,48,39,26,16,9,28,43,46,41,33,24,17,12,21,27,26,20,15,12,11,10,4,1,-5,-10,-9,-4,2,4,-16,-30,-38,-37,-28,-14,-4,-1,-35,-55,-60,-51,-31,-13,-3,-3,-46,-64,-63,-41,-16,24,4,-4,-42,-53,-37,-10,14,21,9,-7,-27,-21,2,29,42,31,7,-14,-4,13,39,57,52,27,-5,-24,15,39,61,61,41,5,-25,-33,24,45,52,41,11,-22,-37,-33,21,29,24,4,-23,-39,-36,-18,7,3,-12,-30,-42,-40,-19,6,-9,-24,-39,-46,-41,-20,9,33,-23,-40,-45,-39,-18,10,36,55,-28,-36,-30,-12,14,36,53,59,-21,-21,-5,17,36,48,50,47,-10,1,19,34,40,35,28,22,3,17,29,31,19,2,-8,-8,12,24,26,9,-17,-37,-42,-30,15,23,11,-18,-51,-70,-62,-39,16,18,-2,-37,-70,-77,-61,-26,18,19,-3,-36,-57,-56,-28,7,26,29,13,-8,-19,-6,22,51,38,47,40,31,33,48,71,89 },

{ 36,49,48,34,16,-5,-20,-26,47,64,58,39,11,-16,-33,-39,51,64,54,29,-2,-28,-43,-43,45,55,39,12,-17,-37,-44,-39,36,36,19,-7,-28,-37,-34,-23,20,15,-4,-22,-29,-25,-11,2,5,-7,-21,-27,-19,0,19,28,-9,-24,-31,-23,0,29,48,49,-19,-34,-34,-12,22,53,67,54,-24,-37,-28,0,36,61,59,39,-26,-32,-19,9,37,44,30,3,-23,-26,-11,9,20,12,-13,-38,-17,-16,-5,3,-3,-26,-54,-68,-6,-3,2,-1,-21,-50,-70,-75,5,11,12,0,-25,-47,-59,-54,16,25,23,8,-12,-26,-27,-20,25,34,32,19,8,6,12,16,25,34,29,24,25,34,40,39,18,18,15,18,31,46,52,42,2,-5,-9,3,25,44,45,30,-16,-33,-35,-14,13,29,25,7,-33,-54,-49,-26,0,10,-1,-19,-44,-59,-49,-25,-7,-8,-25,-39,-41,-50,-33,-13,-6,-18,-38,-50,-29,-23,-4,8,2,-20,-42,-47,-6,10,26,30,12,-14,-31,-32,17,37,49,40,19,-4,-14,-9,32,53,53,39,17,2,3,15,35,44,39,21,6,4,17,35,19,17,4,-9,-11,2,25,48,-8,-24,-39,-41,-29,-3,28,52,-39,-62,-71,-64,-40,-7,26,49 },

{ -12,-12,-6,4,11,8,-6,-23,-15,-15,-5,9,17,11,-12,-37,-17,-17,-4,14,23,13,-17,-49,-19,-19,-2,19,29,17,-19,-57,-22,-21,-1,24,36,22,-18,-59,-25,-24,-1,28,42,28,-14,-57,-29,-27,-3,30,48,33,-8,-48,-32,-32,-5,30,48,36,-3,-39,-37,-38,-10,26,46,34,1,-28,-41,-44,-16

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,-10,-18,-3,28,49,33,-16,-70,-32,-45,-23,18,45,34,-13,-64,-54,-68,-39,12,46,36,-5,-52,
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{ -51,-57,-46,-28,-21,-25,-32,-28,-54,-57,-36,-16,-12,-25,-36,-34,-40,-30,-3,16,13,-10,
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{ -23,-18,0,18,25,21,21,23,-22,-14,9,27,28,20,21,31,-21,-9,13,23,15,2,7,30,-18,-7,11,
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,20,-42,-51,8,-65,-35,37,72,33,-31,-34,34,-54,-20,53,80,31,-29,-16,58,-50,-13,52,63,9
, -38,-11,70,-50,-20,32,33,-19,-54,-11,69,-53,-29,12,6,-42,-61,-16,58,-51,-30,6,-1,-41,
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{ 34,38,20,-13,-40,-44,-26,1,45,50,21,-21,-51,-53,-23,12,47,47,17,-21,-46,-38,-4,31,38,36,10,-16,-26,-13,19,47,24,18,1,-8,-4,12,35,48,4,-3,-6,0,13,23,27,29,-16,-22,-12,8,21,14,-2,-6,-31,-35,-12,15,20,-6,-37,-40,-38,-35,-2,28,21,-25,-65,-53,-34,-24,15,43,21,-33,-62,-37,-28,-9,32,52,24,-25,-36,11,-22,-2,37,52,22,-15,0,61,-25,-8,26,34,7,-13,22,93,-32,-22,5,8,-16,-27,19,93,-40,-33,-8,-8,-36,-46,-5,63,-39,-28,0,-3,-38,-62,-32,28,-26,-4,29,23,-24,-61,-48,2,-9,23,58,52,0,-48,-46,-7,-2,29,68,66,20,-27,-34,-2,-17,6,48,60,28,-12,-18,8,-48,-36,12,41,25,-5,-6,19,-77,-73,-14,25,17,-4,-1,23,-91,-77,-16,18,8,-10,-2,24,-73,-51,5,20,-3,-19,-5,21,-38,-1,34,19,-17,-29,-9,18,6,39,43,8,-30,-33,-7,16,33,50,32,-9,-36,-24,1,12,34,35,5,-25,-27,-5,12,6,18,2,-23,-26,-5,19,20,-7,-7,-26,-30,-10,25,39,13,-28,-23,-32,-18,18,49,39,-5,-52,-24,-23,2,36,49,23,-28,-70 },

{ -26,-24,-12,-5,-13,-36,-56,-52,-26,-20,-1,10,-4,-37,-61,-60,-20,-6,20,32,18,-16,-41,-36,-13,6,35,51,39,10,-7,-1,-13,4,34,50,44,24,19,31,-23,-13,12,27,23,16,25,47,-36,-34,-17,-8,-12,-11,12,41,-41,-45,-36,-35,-41,-36,-6,28,-31,-30,-27,-35,-48,-42,-14,15,-3,8,10,-6,-25,-29,-11,6,30,51,53,32,6,-5,-2,-3,48,70,65,43,21,9,1,-11,37,42,32,17,11,10,0,-21,-3,-16,-25,-21,-3,11,0,-26,-46,-67,-64,-35,0,18,4,-24,-62,-76,-53,-14,20,30,10,-18,-42,-32,-4,23,37,30,11,-14,4,28,39,34,19,11,4,-10,45,61,41,-1,-23,-13,0,-4,58,57,1,-52,-55,-20,10,5,49,20,-46,-80,-54,4,30,11,24,-9,-57,-63,-10,40,38,3,12,-11,-32,-9,41,57,28,-19,13,5,8,35,59,45,-4,-44,18,19,28,42,41,5,-40,-56,12,11,12,14,-3,-33,-50,-42,-4,-13,-17,-21,-33,-39,-26,1,-18,-29,-31,-31,-27,-11,21,49,-18,-20,-19,-13,1,27,61,76,1,7,9,10,18,38,55,61,23,32,27,9,-2,-3,2,5,30,35,13,-22,-52,-64,-61,-53 },

{ -29,-26,-9,8,11,5,8,24,-30,-23,2,18,14,1,7,34,-24,-11,15,23,7,-13,-3,38,-14,2,24,23,-7,-35,-18,36,-7,10,28,18,-22,-53,-33,35,-6,10,26,14,-28,-62,-34,38,-11,4,24,17,-22,-52,-26,44,-20,-5,24,29,-4,-36,-15,48,-33,-16,26,43,15,-22,-11,43,-46,-27,27,54,24,-21,-19,29,-57,-34,27,54,21,-32,-35,12,-63,-39,26,49,7,-47,-44,4,-66,-36,27,41,-5,-50,-38,10,-56,-25,30,37,-8,-37,-12,25,-43,-9,35,30,-5,-12,17,33,-28,1,29,16,-6,8,33,27,-18,3,13,-7,-14,14,33,0,-10,2,-6,-27,-20,15,17,-32,-2,3,-16,-35,-17,17,5,-60,10,11,-15,-31,-4,28,0,-74,24,22,-8,-19,16,44,9,-74,33,27,-9,-14,27,59,20,-61,36,20,-21,-23,27,63,33,-43,30,6,-42,-42,15,63,42,-27,29,-3,-59,-59,1,55,45,-18,37,4,-58,-67,-11,44,36,-18,58,26,-43,-61,-16,31,25,-25,79,54,-23,-52,-18,23,15,-29,95,65,-11,-44,-14,21,13,-29,81,54,-15,-39,-4,28,15,-25,50,18,-30,-29,11,36,20,-19,6,-19,-39,-20,20,39,19,-17 },

{ 27,40,54,60,52,21,-15,-34,20,32,47,58,45,11,-29,-47,-6,-7,9,23,19,-8,-37,-42,-39,-50,-33,-10,-5,-17,-28,-22,-60,-72,-51,-21,-8,-8,-4,11,-53,-59,-32,-4,7,11,22,42,-27,-17,8,24,23,21,34,52,8,26,41,37,17,6,19,42,34,50,48,18,-17,-30,-12,18,37,44,22,-19,-54,-61,-34,-1,24,15,-12,-42,-62,-53,-29,-6,1,-13,-24,-26,-17,-7,0,2,-18,-24,-10,23,48,45,25,3,-26,-23,15,62,76,56,14,-11,-30,-18,23,54,50,12,-20,-27,-30,-21,6,14,-11,-41,-44,-

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{ 31,21,-3,-17,-4,21,27,3,30,14,-20,-33,-8,29,28,-10,27,4,-33,-41,-7,32,23,-31,23,-1,-
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{ 0,6,13,9,-9,-39,-71,-74,0,6,14,15,-3,-38,-71,-80,-4,1,14,23,18,-5,-32,-41,-12,-10,8,2
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{ -48,-42,-31,-27,-33,-21,15,44,-34,-21,-4,-8,-25,-19,23,57,-4,23,39,20,-12,-16,16,41,20,52,60,32,-11,-25,-7,10,17,40,48,18,-21,-34,-26,-20,-13,-3,5,-5,-20,-24,-22,-31,-47,-45,-26,-10,2,10,4,-21,-60,-54,-20,11,35,48,30,-9,-46,-25,9,31,46,49,31,-10,-9,15,25,15,4,9,4,-19,25,39,12,-36,-57,-33,-11,-16,42,42,-15,-72,-71,-24,11,4,46,28,-28,-53,-19,35,47,16,28,10,-16,-3,48,70,33,-2,5,-7,-2,32,59,22,-25,-31,-17,-19,6,31,6,-53,-66,-32,-32,-21,11,11,-42,-78,-45,15,-27,-6,21,7,-34,-30,30,66,-12,13,33,13,-1,35,78,64,-5,16,19,0,9,46,48,7,-4,0,-12,-26,-11,7,-19,-64,-5,-11,-27,-34,-19,-19,-57,-91,3,0,-12,-8,8,-2,-39,-54,17,19,14,25,41,33,11,9,19,14,10,25,44,42,43,53,0,-15,-19,-6,5,12,31,56,-18,-34,-40,-38,-42,-34,-4,31,-9,-13,-18,-31,-53,-59,-30,6,21,31,36,14,-22,-41,-30,-2,27,48,61,55,20,-7,-11,-1,-15,-2,30,47,37,13,0,0,-83,-81,-36,4,15,5,-5,-5 },

{ 37,44,40,14,-18,-27,2,43,29,36,28,4,-29,-38,4,61,0,-1,5,-5,-32,-39,2,57,-35,-34,-6,6,-15,-33,-7,37,-57,-43,10,38,15,-21,-19,9,-56,-31,38,71,33,-17,-29,-15,-47,-11,53,67,24,-21,-31,-24,-34,-2,39,33,-6,-25,-14,-14,-27,-4,9,-16,-33,-6,23,5,-13,-5,-17,-47,-30,30,53,11,5,5,-25,-44,-5,57,55,-13,29,23,-16,-30,14,52,13,-54,49,33,-11,-20,14,17,-33,-70,45,23,-19,-20,4,-5,-36,-38,27,-3,-28,-10,11,0,-2,27,3,-19,-18,11,19,8,31,75,-12,-17,5,23,4,-11,28,73,-14,-2,24,17,-33,-52,-7,33,-11,11,34,5,-56,-67,-32,-10,-14,12,35,8,-34,-37,-22,-32,-26,2,33,25,14,21,6,-35,-38,-16,18,31,46,59,23,-33,-44,-28,-9,4,37,53,19,-29,-25,-23,-33,-34,3,27,6,-25,17,7,-43,-60,-22,9,-1,-12,68,45,-34,-56,-14,9,1,4,96,53,-22,-23,12,13,3,20,68,26,-15,10,30,6,-7,26,11,-25,-13,34,27,-24,-30,26,-47,-57,2,46,5,-55,-41,29,-65,-37,34,46,-14,-62,-33,39,-34,8,59,46,-16,-49,-11,52 },

{ -23,-6,37,67,66,38,22,22,-34,-16,32,60,40,9,3,18,-48,-32,6,12,-21,-42,-27,6,-47,-32,-9,-24,-60,-70,-32,8,-26,-4,7,-20,-53,-44,-4,23,6,33,35,9,-7,9,35,34,26,47,43,25,24,42,46,13,17,24,13,5,17,35,15,-33,-7,-20,-34,-29,-7,5,-26,-71,-26,-44,-48,-34,-8,-1,-32,-65,-20,-23,-17,-1,20,21,2,-15,10,20,24,27,32,39,38,36,37,42,25,1,-2,16,41,50,33,23,-16,-50,-51,-27,7,27,12,-10,-40,-54,-53,-40,-23,-7,-5,-14,-7,7,5,-14,-26,-20,-14,2,49,75,58,9,-17,-15,-23,4,58,75,38,2,-4,0,-40,-20,12,3,-21,-14,11,13,-45,-40,-38,-60,-53,-7,26,15,-18,-11,-34,-56,-30,24,34,0,36,45,7,-12,18,44,15,-25,73,65,23,15,38,24,-21,-41,50,25,-8,3,19,-12,-43,-33,-5,-43,-46,-7,3,-28,-35,6,-45,-67,-30,13,6,-20,1,50,-39,-23,23,38,11,-5,29,69,1,32,54,33,-9,-12,25,51,23,41,32,-12,-45,-31,-2,8,6,6,-14,-42,-45,-31,-21,-26,-23,-28,-23,-9,6,6,-15,-39,-34,-23,19,58,69,48,3,-34 },

{ -17,1,25,18,-27,-68,-62,-17,-18,7,40,34,-22,-65,-40,9,-27,2,44,41,-3,-24,11,48,-43,-15,31,34,5,7,46,61,-60,-31,13,13,-7,9,42,26,-52,-27,4,-9,-28,-10,4,-34,-26,1,11,-17,-35,-16,-21,-77,11,36,27,-10,-16,11,-4,-73,34,47,22,-9,11,54,40,-35,25,22,-16,-33,15,75,56,-5,0,-19,-53,-53,0,43,36,3,-9,-25,-46,-43,-20,-7,-7,-2,15,15,11,2,-22,-45,-31,8,32,50,58,42,-14,-47,-11,31,9,26,54,38,-12,-20,20,37,-51,-36,12,13,-13,-2,27,15,-95,-62,-2,3,-15,5,13,-25,-68,-23,26,7,-11,7,-4,-50,-5,43,45,-4,-12,13,-3,-44,45,63,10,-36,-8,30,14,-18,47,18,-51,-51,9,41,27,5,12,-32,-64,-28,24,31,14,12,-7,-29,-20,17,21,-10,-14,12,2,11,39,42,-13,-56,-29,14,7,33,66,26,-48,-62,-15,23,-20,10,34,-3,-46,-27,21,28,-5

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 { -8,-16,-26,-32,-33,-27,-16,-5,-8,-20,-35,-48,-51,-43,-25,-7,-1,-11,-29,-47,-55,-46,-25
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 { -2,-6,-13,-24,-36,-42,-42,-36,0,-2,-12,-29,-48,-63,-65,-58,5,7,2,-15,-39,-60,-71,-66,9
 ,19,23,14,-9,-37,-55,-59,8,23,40,43,29,1,-27,-40,0,15,39,58,56,34,4,-17,-15,-7,19,48,
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{ -23,-36,-46,-44,-33,-14,5,17,-28,-47,-60,-61,-43,-15,14,32,-21,-38,-54,-55,-39,-7,26
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,-31,-26,-16,-12,-14,-12,-10,-9,-9,-8,-4,-13,-13,-5,5,12,14,12,10,-14,-13,1,18,31,34,30
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3,-17,-1,6,4,-3,-29,-40,-37,-26,-15,-10,-14,-19,-27,-38,-38,-31,-25,-24,-29,-34,-22,-31
,-31,-29,-27,-31,-38,-45,-14,-18,-19,-18,-22,-30,-42,-51,-4,-3,-1,-2,-10,-24,-41,-53,7,1
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67,42,10,-15 },
{ 27,31,18,-2,-18,-20,-11,2,42,50,29,-4,-29,-33,-14,7,55,65,38,-8,-40,-40,-14,17,60,7
3,39,-13,-48,-45,-8,30,59,68,33,-22,-56,-44,1,45,49,56,19,-32,-58,-39,13,61,37,38,5,-
39,-57,-29,27,74,25,23,-6,-41,-50,-18,38,83,16,12,-12,-38,-42,-9,44,84,10,7,-11,-31,-
31,-3,42,79,7,5,-6,-20,-21,0,36,67,3,4,0,-9,-12,0,26,52,1,4,4,1,-4,-1,14,33,-2,2,8,7,1,-
3,2,15,-5,0,8,11,4,-6,-10,-4,-8,-4,8,14,7,-8,-20,-21,-12,-8,7,16,11,-8,-28,-36,-15,-12,5,
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,9,-31,-62,-28,-28,-4,26,37,16,-25,-62,-31,-32,-7,27,42,24,-18,-58,-34,-37,-11,26,46,3
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,8,-36,-42,-53,-31,9,41,43,11,-31,-42,-54,-36,2,36,40,13,-26,-40,-54,-39,-4,29,36,13,-
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{ 2,6,17,32,48,57,56,43,-1,2,14,35,58,76,76,64,-7,-9,-5,10,35,56,66,60,-9,-20,-29,-28,
-13,10,28,35,-3,-16,-38,-55,-57,-40,-17,1,12,5,-19,-50,-68,-65,-46,-25,29,33,18,-13,-4
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-48,-73,-71,-50,-20,2,11,12,-39,-58,-58,-42,-20,-2,6,8,-25,-37,-36,-26,-12,-2,3,4,-9,-1
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{ -34,-52,-64,-60,-45,-19,6,22,-36,-59,-72,-72,-51,-17,17,38,-20,-33,-45,-47,-32,-1,33,52,7,9,4,-3,1,19,42,58,31,48,49,35,24,24,37,48,38,62,63,45,19,7,12,24,27,45,45,24,-7,-26,-23,-7,5,13,11,-8,-36,-55,-51,-33,-18,-19,-19,-28,-48,-62,-61,-44,-31,-37,-29,-25,-31,-43,-45,-37,-36,-39,-23,-4,2,-6,-15,-18,-34,-35,-10,20,36,31,15,3,-32,-28,1,37,59,55,38,19,-29,-25,4,42,64,64,46,27,-27,-24,1,34,56,56,43,26,-25,-25,-5,21,39,41,31,19,-23,-24,-12,6,19,20,15,8,-18,-22,-16,-7,-1,-1,-4,-5,-12,-15,-15,-15,-17,-21,-22,-18,-4,-6,-11,-19,-29,-37,-38,-30,5,5,-2,-17,-35,-47,-48,-38,14,18,9,-9,-31,-48,-50,-39,22,30,24,4,-21,-40,-44,-34,29,41,36,17,-9,-28,-33,-24,32,46,45,27,4,-15,-19,-11,30,45,44,32,12,-2,-4,4,24,35,36,27,15,7,10,19,13,20,20,16,12,12,21,33,1,0,-1,-2,3,13,29,44,-13,-21,-26,-23,-12,8,31,50,-25,-41,-49,-45,-29,-2,28,51,-34,-55,-65,-61,-42,-13,21,47 },

{ 42,46,24,-9,-31,-27,-3,21,58,70,38,-12,-44,-38,1,38,64,76,43,-16,-55,-41,10,57,53,67,33,-24,-60,-43,18,73,33,39,13,-33,-62,-38,25,81,6,9,-6,-35,-51,-30,27,80,-17,-17,-14,-21,-30,-17,23,66,-34,-32,-10,2,-2,-3,16,46,-44,-36,0,28,25,7,4,21,-45,-35,13,48,41,9,-10,-4,-46,-32,18,55,47,5,-27,-27,-44,-32,17,53,43,-2,-40,-46,-44,-33,12,46,36,-9,-50,-58,-41,-33,7,39,30,-13,-52,-62,-39,-32,4,32,25,-12,-49,-58,-35,-30,1,27,22,-10,-41,-50,-31,-26,0,22,20,-6,-31,-37,-26,-22,0,19,18,-1,-20,-23,-20,-17,2,17,17,3,-8,-7,-15,-11,3,14,14,7,4,9,-9,-6,3,9,10,8,13,24,-4,-1,3,4,2,5,17,35,2,4,3,-3,-7,-1,18,42,7,9,3,-9,-17,-10,16,47,12,15,5,-14,-28,-19,13,50,18,22,8,-18,-36,-29,7,51,24,29,13,-18,-43,-37,2,49,29,37,19,-16,-45,-43,-4,46,35,45,27,-12,-46,-46,-8,43,38,51,34,-6,-41,-46,-10,40,39,52,38,1,-35,-40,-9,37,35,49,37,6,-26,-33,-7,34 },

{ 22,27,20,1,-21,-39,-47,-41,26,35,26,5,-24,-49,-61,-59,22,28,25,12,-7,-29,-47,-51,7,10,12,17,17,8,-9,-23,-11,-17,-12,8,33,41,31,11,-21,-38,-36,-12,25,51,48,32,-20,-39,-47,-32,3,33,42,31,-4,-20,-37,-39,-19,6,18,17,22,15,-7,-26,-27,-16,-6,-4,43,50,26,-2,-20,-25,-22,-20,54,65,48,19,-6,-20,-26,-27,49,63,50,27,4,-11,-21,-28,34,41,33,19,8,-2,-13,-22,12,10,4,2,5,5,-2,-14,-10,-23,-28,-20,-2,10,9,-3,-29,-50,-54,-38,-8,15,18,6,-39,-64,-70,-47,-10,19,26,14,-38,-62,-65,-43,-6,24,30,19,-27,-45,-46,-27,4,28,32,19,-11,-20,-20,-6,16,32,31,16,7,8,8,15,27,33,25,9,24,32,32,31,31,27,13,-4,36,49,48,38,28,14,-4,-19,42,58,53,37,17,-3,-23,-36,41,55,49,28,3,-21,-41,-51,32,42,32,11,-14,-36,-51,-58,18,20,9,-10,-29,-43,-52,-53,2,-3,-15,-27,-37,-42,-43,-40,-12,-23,-34,-37,-35,-27,-22,-16,-21,-34,-40,-35,-18,0,14,19,-22,-33,-32,-16,12,40,57,60,-15,-22,-14,9,44,77,95,95 },

{ 42,58,62,51,35,16,-1,-10,43,58,58,48,30,11,-7,-17,23,25,18,9,1,-7,-15,-21,-2,-17,-32,-37,-31,-22,-18,-18,-16,-40,-61,-60,-41,-18,-5,-4,-8,-28,-45,-43,-18,8,19,17,16,8,-2,0,19,37,41,30,37,41,33,31,40,49,44,29,42,48,38,28,28,31,25,11,31,30,12,-3,-6,-5,-7,-14,12,1,-21,-36,-39,-35,-34,-35,-3,-20,-40,-51,-50,-44,-43,-45,-9,-25,-40,-42,-36,-30,-33,-41,-6,-16,-22,-17,-6,-1,-10,-25,1,-3,0,12,28,31,17,-6,8,9,17,34,53,57,39,11,10,13,24,43,65,68,51,21,7,9,17,36,56,63,47,20,1,-2,1,15,33,41,32,10,-5,-15,-19,-12,3,13,9,-

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{ -37,-27,2,25,24,1,-20,-26,-50,-35,12,48,42,5,-29,-39,-63,-44,14,58,51,4,-36,-42,-69,-54,9,55,45,-2,-37,-37,-68,-53,3,43,31,-11,-34,-20,-55,-41,6,32,12,-22,-25,2,-35,-18,17,24,-5,-31,-16,28,-17,5,31,22,-18,-40,-7,51,-7,18,41,21,-28,-47,-3,68,-8,19,42,20,-32,-54,-4,75,-18,8,36,20,-33,-57,-10,73,-31,-7,29,22,-27,-57,-15,67,-44,-20,24,28,-17,-52,-20,59,-52,-30,22,36,-5,-45,-22,49,-58,-35,22,43,7,-36,-24,41,-61,-40,21,48,17,-30,-25,32,-64,-42,20,52,25,-24,-28,24,-63,-44,19,54,29,-21,-29,16,-63,-43,17,52,29,-20,-32,10,-60,-43,14,48,27,-21,-34,5,-57,-41,12,44,24,-23,-36,2,-51,-37,12,41,20,-24,-35,1,-44,-30,13,37,17,-24,-34,3,-36,-23,14,33,13,-25,-30,7,-28,-15,16,30,9,-24,-26,14,-20,-8,18,27,5,-25,-21,20,-13,0,20,23,1,-24,-15,28,-6,6,21,19,-4,-25,-10,35,-1,9,19,13,-11,-27,-7,41,0,9,15,5,-17,-30,-5,44,0,6,8,-3,-24,-31,-5,44,-1,3,3,-9,-26,-31,-4,42 },

{ -22,-26,-12,13,30,23,-3,-26,-30,-41,-25,11,37,30,-9,-44,-24,-37,-30,4,36,30,-13,-57,-1,-17,-23,-2,29,29,-13,-60,31,17,-10,-10,17,26,-5,-51,59,47,-1,-24,-1,24,7,-33,77,61,-3,-43,-23,18,23,-10,78,62,-13,-63,-41,15,35,11,73,50,-26,-74,-49,16,46,24,58,37,-30,-72,-41,22,49,29,42,22,-28,-52,-23,29,48,23,28,12,-22,-32,-2,37,40,10,16,4,-17,-14,14,39,29,-10,7,-3,-13,-3,23,36,13,-30,-1,-10,-13,3,27,30,-3,-51,-7,-15,-14,5,27,24,-17,-68,-12,-19,-15,7,28,20,-26,-80,-12,-20,-15,8,29,20,-28,-85,-11,-18,-13,8,30,22,-23,-80,-8,-15,-12,8,30,26,-15,-69,-4,-10,-10,6,29,29,-5,-55,1,-5,-10,2,24,32,6,-38,8,0,-10,-5,16,30,16,-18,13,6,-10,-12,5,26,24,0,20,12,-11,-22,-7,18,30,17,26,19,-10,-30,-22,7,30,29,34,28,-6,-36,-37,-7,26,36,42,39,1,-39,-49,-21,19,40,51,50,11,-37,-57,-32,13,42,56,61,22,-31,-56,-37,8,42,58,66,33,-19,-49,-35,6,39,53,65,37,-8,-37,-29,6,36 },

{ 5,6,-2,-21,-48,-68,-76,-63,10,15,10,-9,-40,-72,-85,-79,9,18,26,23,6,-20,-44,-50,-2,4,21,42,52,44,22,1,-19,-22,-10,20,56,72,65,42,-23,-40,-44,-27,10,45,56,49,-7,-24,-48,-57,-43,-12,15,25,23,19,-11,-45,-60,-50,-25,-5,47,58,40,-1,-37,-47,-40,-24,45,67,62,38,4,-20,-28,-25,19,35,46,44,31,11,-5,-14,-16,-15,2,22,33,28,13,-2,-44,-56,-43,-10,20,30,21,6,-52,-74,-63,-31,6,24,20,8,-44,-62,-58,-32,-3,14,15,6,-22,-34,-34,-21,-4,7,8,1,4,3,-1,-2,1,3,2,-4,27,36,28,17,5,-1,-4,-8,43,57,48,26,6,-5,-9,-11,49,65,53,27,2,-11,-14,-13,45,57,46,17,-8,-18,-18,-14,29,37,23,-1,-19,-24,-18,-11,10,9,-4,-20,-29,-24,-12,-3,-8,-17,-28,-35,-33,-20,-2,8,-21,-34,-42,-40,-29,-8,12,20,-25,-38,-41,-32,-14,9,26,30,-22,-30,-27,-13,7,26,37,34,-13,-15,-7,9,27,40,40,31,-3,0,11,25,38,41,33,17,4,10,19,29,32,26,8,-10,6,11,16,17,10,-7,-30,-46,2,4,3,-4,-20,-43,-66,-78 },

{ -50,-71,-78,-59,-31,-3,13,14,-42,-64,-67,-52,-19,10,22,20,-5,-6,-6,2,17,27,26,15,35,54,55,50,41,29,12,-2,46,65,66,48,26,4,-17,-27,19,26,15,-2,-18,-30,-39,-43,-17,-30,-46,-52,-48,-39,-35,-34,-32,-53,-62,-56,-31,-9,-1,-6,-20,-28,-30,-14,15,37,41,26,7,13,17,29,48,62,58,41,26,39,41,40,45,48,44,31,27,38,30,17,8,7,8,6,17,18,4,-17,-33,-34,-28,

-20,4,-1,-17,-38,-52,-56,-46,-35,-4,-11,-23,-37,-48,-50,-44,-35,-7,-11,-16,-21,-26,-29,-27,-24,-6,-6,-2,2,3,1,-2,-6,-4,1,11,23,29,30,22,12,-3,4,17,33,45,47,39,25,-4,0,13,31,45,51,45,31,-10,-9,0,16,33,40,38,27,-14,-19,-16,-5,9,18,19,13,-15,-24,-28,-26,-18,-10,-6,-7,-11,-22,-32,-38,-38,-34,-29,-25,0,-8,-23,-35,-43,-44,-42,-37,15,13,0,-16,-30,-38,-39,-37,30,36,28,12,-4,-15,-22,-25,37,50,48,38,24,12,1,-6,32,45,50,47,41,33,23,12,12,18,22,28,33,36,31,23,-20,-29,-30,-20,-2,14,23,22,-50,-72,-80,-71,-45,-18,2,11 },

{ 35,20,-12,-21,0,18,8,-16,50,27,-26,-40,-3,28,12,-26,66,33,-38,-54,-3,40,19,-36,73,39,-45,-64,3,57,27,-45,78,39,-51,-65,10,69,34,-53,71,37,-49,-64,14,76,32,-61,60,28,-45,-55,16,70,26,-66,46,21,-38,-47,14,61,18,-69,32,13,-30,-35,14,48,11,-64,20,9,-19,-23,11,37,7,-55,9,5,-9,-11,8,25,5,-39,-1,2,0,-3,4,14,4,-23,-10,-2,7,3,-1,2,4,-6,-17,-5,12,9,-5,-8,2,7,-22,-8,16,14,-8,-17,-1,18,-26,-10,19,18,-10,-25,-4,28,-31,-12,22,22,-11,-31,-8,35,-33,-15,23,26,-11,-36,-10,41,-36,-16,25,30,-9,-39,-14,43,-39,-19,26,35,-6,-42,-18,44,-43,-23,26,38,-4,-43,-22,43,-46,-27,25,41,0,-43,-24,42,-49,-29,24,43,4,-42,-27,40,-49,-31,24,45,8,-40,-28,38,-50,-31,24,47,11,-37,-28,37,-48,-31,22,47,14,-36,-28,35,-44,-29,21,45,14,-33,-28,32,-40,-27,18,42,13,-32,-28,29,-36,-25,15,36,11,-30,-27,27,-31,-23,11,30,7,-29,-24,25,-25,-19,8,23,3,-27,-21,24,-18,-13,8,19,2,-23,-16,23 },

{ 49,43,4,-44,-63,-36,9,38,59,60,11,-52,-74,-41,20,59,50,53,20,-30,-54,-22,33,66,14,22,17,-1,-12,1,33,55,-32,-27,-1,19,21,15,17,20,-61,-65,-18,29,37,13,-14,-26,-63,-65,-19,31,41,3,-43,-62,-34,-37,-4,32,34,-4,-52,-76,3,6,16,27,26,-2,-40,-63,31,35,21,10,9,4,-12,-31,45,40,8,-18,-15,6,17,7,45,36,-11,-46,-36,5,37,39,43,28,-22,-60,-50,2,49,58,35,23,-22,-58,-48,0,48,65,28,20,-13,-42,-37,0,39,54,20,17,-3,-21,-20,1,25,36,11,12,6,-1,-3,3,10,13,0,4,10,13,11,4,-5,-10,-13,-8,8,22,22,5,-18,-32,-24,-21,3,26,30,7,-27,-49,-34,-32,-4,27,36,10,-33,-61,-38,-39,-9,27,38,14,-31,-64,-38,-40,-12,23,38,18,-25,-57,-33,-36,-14,18,34,21,-15,-45,-24,-27,-12,12,29,21,-4,-28,-11,-14,-8,5,18,18,4,-11,5,3,-2,-3,3,9,11,8,21,21,5,-12,-15,-4,14,24,36,37,11,-21,-34,-17,16,39,44,48,17,-27,-47,-29,14,49,47,51,20,-28,-55,-36,12,52,42,48,18,-27,-52,-37,10,51 },

{ 16,20,23,28,42,54,59,46,14,14,9,9,22,45,56,52,6,-1,-18,-32,-32,-11,13,22,2,-4,-22,-46,-61,-57,-35,-17,4,8,6,-9,-31,-44,-45,-34,-1,12,33,45,35,11,-11,-21,-16,-6,24,56,69,52,25,3,-29,-36,-18,13,38,43,29,14,-23,-40,-47,-38,-19,-2,7,8,4,-7,-30,-48,-49,-35,-16,-2,37,39,18,-15,-39,-37,-22,-6,49,67,55,25,-6,-18,-13,-2,37,54,57,40,18,3,1,5,4,12,22,26,20,12,9,10,-31,-37,-24,-4,8,11,11,12,-55,-73,-59,-30,-5,7,11,12,-61,-80,-69,-36,-9,4,8,9,-42,-57,-44,-20,-1,5,4,5,-11,-11,-1,11,14,8,1,0,22,35,42,41,27,10,-4,-6,45,63,69,55,31,6,-10,-13,46,65,62,45,17,-6,-19,-19,31,39,32,14,-7,-22,-26,-20,6,4,-7,-21,-32,-35,-28,-16,-15,-28,-40,-47,-47,-36,-21,-6,-25,-42,-50,-51,-39,-21,-2,11,-23,-36,-39,-31,-14,7,24,31,-11,-17,-13,1,19,37,46,45,3,6,15,28,44,53,55,45,14,21,28,36,41,42,34,21,14,19,20,15,7,-6,-18,-26,3,2,-7,-22,-42,-61,-74,-75 },

{ -53,-66,-63,-41,-17,4,16,17,-42,-52,-42,-26,-5,12,22,23,-2,10,20,21,17,14,15,14,32,60,65,48,17,-4,-8,-5,27,48,51,25,-11,-30,-32,-24,-10,-6,-10,-24,-36,-37,-29,-21,-39,-4

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24,-31,-29,-29,-29,-26,-16,-5,16,25,28,16,-5,-24,-31,-26,53,77,83,66,30,-7,-30,-34 },
{ 38,10,-36,-39,2,33,20,-15,58,24,-46,-58,1,47,21,-32,74,39,-42,-57,8,56,20,-52,69,4
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13,-16,4,27,9,-38,-29,-12,13,9,-3,5,7,-12,-43,-9,40,31,-11,-19,2,13,-50,-11,51,42,-21,
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{ 45,39,1,-43,-57,-21,27,51,51,51,7,-48,-62,-23,39,73,33,36,15,-22,-38,-11,35,60,-11,
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{ -9,-8,-14,-34,-62,-76,-69,-43,-5,5,10,-3,-30,-54,-53,-35,-6,12,36,46,39,22,11,9,-15,-
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18,-4,-2,52,81,72,35,-3,-13,-3,2,40,67,71,42,6,-6,0,5,2,19,30,21,0,-6,1,6,-39,-37,-20,-
9,-11,-8,2,7,-61,-71,-48,-26,-15,-7,3,7,-61,-68,-46,-20,-7,0,5,7,-39,-39,-17,2,10,10,8,6
,-7,3,21,29,25,15,8,3,20,37,45,42,27,12,2,-3,34,48,48,33,12,-2,-8,-10,30,39,28,8,-12,-
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{ -57,-58,-46,-28,-10,11,22,15,-43,-26,-4,-6,-4,14,26,15,-13,33,60,28,-5,3,13,-1,-7,55,80,28,-27,-22,-6,-21,-38,16,46,-11,-57,-28,-4,-27,-68,-28,3,-39,-53,3,29,-15,-69,-26,5,-29,-26,46,66,-1,-39,16,43,-4,-10,62,73,-6,-14,50,71,-1,-30,33,48,-32,-16,47,58,-25,-67,-7,14,-59,-38,15,31,-44,-83,-20,3,-67,-56,-8,20,-34,-58,5,24,-53,-60,-10,30,-6,-20,42,57,-30,-53,-1,42,13,1,62,74,-11,-45,7,47,13,-6,51,71,-6,-36,11,42,-1,-31,21,48,-14,-31,13,35,-19,-60,-13,21,-27,-26,14,31,-27,-73,-35,3,-34,-23,16,34,-19,-68,-35,0,-33,-22,18,40,-3,-47,-19,12,-23,-24,13,44,13,-22,5,30,-8,-30,5,37,20,-4,23,45,6,-37,-9,24,15,1,30,51,11,-41,-21,8,1,-7,24,44,7,-41,-25,-4,-12,-21,9,30,-4,-29,-16,-2,-18,-31,-7,12,-18,-10,4,12,-11,-33,-16,-3,-31,10,28,31,3,-25,-16,-9,-36,20,40,44,16,-11,-5,-3,-30,12,28,33,16,-1,9,12,-15,-12,-8,-3,-7,-4,19,29,5,-36,-43,-40,-36,-17,18,37,21 },

{ 35,54,51,27,11,4,-12,-29,23,46,37,8,-3,3,-8,-36,-20,-10,-17,-39,-28,10,10,-28,-52,-44,-39,-57,-31,31,39,-12,-48,-12,10,-18,-14,44,57,-3,-23,43,81,27,-13,28,40,-14,-27,49,98,25,-45,-14,9,-33,-63,4,54,-14,-79,-41,-4,-41,-92,-34,20,-30,-75,-19,21,-23,-81,-28,30,-3,-30,29,60,4,-49,9,59,22,0,55,79,13,-19,36,64,14,-15,39,62,0,-8,35,43,-22,-56,0,29,-26,-11,23,19,-49,-80,-25,6,-46,-18,10,11,-48,-74,-21,4,-52,-23,6,16,-26,-43,4,19,-46,-26,6,27,2,-7,35,40,-34,-28,4,33,19,15,55,53,-22,-32,-2,28,17,15,54,55,-16,-35,-10,15,1,-3,37,45,-17,-34,-13,5,-16,-27,10,27,-23,-27,-7,5,-25,-46,-13,9,-29,-14,8,17,-21,-52,-26,-2,-30,-3,24,34,-5,-43,-26,-2,-24,2,31,48,12,-27,-14,7,-11,-4,24,46,22,-12,0,21,6,-22,3,30,19,-5,9,32,20,-40,-24,6,6,-8,8,34,27,-51,-41,-14,-8,-17,-2,25,24,-43,-37,-11,-8,-20,-14,8,9,-19,-6,16,12,-11,-19,-11,-10,10,30,48,38,7,-16,-20,-23 },

{ 22,-9,-51,-43,4,27,4,-29,43,6,-55,-53,14,49,6,-48,64,32,-34,-36,31,63,11,-56,60,43,-13,-24,29,60,11,-54,26,18,-14,-26,3,28,5,-38,-24,-19,-13,-20,-20,-6,-3,-13,-56,-32,15,15,-18,-24,-2,18,-57,-20,54,61,-1,-33,0,43,-52,-10,68,70,-2,-46,-8,55,-38,-16,38,43,-20,-60,-16,54,-23,-22,1,5,-32,-55,-19,43,1,-13,-17,-11,-21,-35,-12,33,29,6,-18,-9,5,1,1,20,46,21,-16,-5,28,31,10,4,55,24,-23,-11,36,45,12,-13,54,19,-37,-26,31,47,6,-32,51,11,-51,-41,20,41,-2,-49,44,6,-54,-51,10,35,-7,-59,40,7,-48,-46,8,32,-6,-57,37,14,-32,-33,12,34,-2,-50,32,19,-14,-16,18,35,7,-35,22,18,-1,-3,19,32,12,-18,8,8,3,3,13,20,13,-1,-8,-4,2,3,2,4,8,13,-26,-18,0,4,-10,-17,-3,23,-37,-27,3,10,-16,-36,-15,30,-41,-26,14,23,-15,-47,-25,34,-40,-20,32,45,-4,-52,-31,38,-41,-14,47,65,10,-49,-33,43,-42,-18,46,72,18,-44,-28,47,-48,-31,25,52,11,-42,-25,47,-50,-45,-2,23,-5,-44,-26,40 },

{ -53,-45,2,52,61,20,-26,-43,-52,-50,-2,50,55,14,-35,-55,-19,-18,-4,11,12,-7,-29,-33,30,30,3,-27,-36,-21,0,12,59,55,10,-41,-54,-13,38,57,37,37,6,-28,-29,4,47,67,-13,-15,-10,2,8,10,20,31,-47,-55,-17,29,38,4,-25,-26,-45,-46,-7,43,49,-5,-60,-67,-8,-14,3,35,36,-7,-54,-68,29,21,4,5,11,-1,-20,-28,47,37,-4,-26,-16,6,20,21,49,34,-16,-47,-36,6,47,57,34,22,-21,-51,-39,1,47,68,13,7,-15,-30,-27,-3,31,52,-7,-5,-2,-2,-5,-5,8,25,-23,-14,10,27,18,-5,-16,-9,-31,-21,16,46,34,-6,-35,-37,-37,-25,16,51,41,-6,-45,-51,-37,-31,9,44,39,-5,-45,-53,-34,-31,-1,30,31,-3,-37,-41,-21,-25,-9,12,16,0,-16,-17,-2,-9,-12,-7,-1,1,7,15,20,12,-8,-21,-18,1,27,45,41,33,-1,-30,-34,-5,39,66,50,46,6,-35,-42,-13,34,66,48,45,

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{ -3,-9,-4,23,57,68,57,33,1,-14,-21,-6,24,41,34,21,11,-1,-24,-35,-36,-33,-28,-18,22,24
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편 편

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[327] [표 13]

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{ -14,-19,-25,-30,-36,-41,-44,-46,-45,-40,-32,-21,-8,4,15,22,26,25,22,15,9,4,3,4,8,11,10,4,-9,-27,-47,-64,-18,-24,-29,-35,-41,-47,-50,-50,-47,-39,-26,-9,9,24,35,40,38,31,19,6,-3,-7,-4,4,14,19,16,3,-19,-45,-71,-89,-7,-6,-7,-9,-12,-16,-20,-22,-20,-15,-4,9,23,32,35,31,21,6,-10,-22,-27,-22,-8,10,26,35,31,16,-8,-36,-61,-77,18,29,36,38,34,27,17,7,-1,-4,-3,2,7,10,8,0,-13,-27,-38,-42,-36,-21,2,26,46,57,53,39,18,-6,-29,-44,42,60,69,67,58,41,21,1,-16,-25,-27,-23,-17,-11,-9,-13,-21,-30,-35,-35,-26,-10,12,34,52,60,58,49,34,17,-1,-15,46,60,62,53,34,11,-13,-33,-44,-46,-36,-20,-3,11,17,14,5,-7,-18,-25,-25,-17,-4,11,25,34,38,36,31,21,10,-1,26,30,24,10,-9,-27,-41,-46,-41,-25,-1,24,46,56,56,44,24,0,-22,-38,-46,-46,-37,-24,-9,4,13,18,20,17,11,4,1,-2,-9,-19,-29,-34,-32,-22,-3,21,45,65,76,75,60,37,9,-19,-43,-60,-68,-67,-58,-44,-28,-13,-1,7,12,12,9,4 },

{ -32,-42,-46,-43,-34,-20,-5,11,24,31,34,31,25,17,10,5,2,0,-2,-6,-12,-20,-27,-32,-33,-26,-16,-1,12,21,24,20,-46,-60,-61,-52,-34,-10,15,36,50,55,49,38,22,9,-1,-5,-5,-3,-3,-7,-15,-25,-34,-39,-35,-22,-3,17,32,37,31,16,-48,-60,-57,-40,-17,11,35,51,56,46,28,7,-13,-24,-24,-15,-2,10,17,14,4,-10,-22,-27,-22,-7,11,27,35,29,11,-12,-39,-46,-38,-20,3,24,36,36,24,3,-22,-44,-53,-48,-27,1,30,49,53,43,22,0,-17,-24,-19,-6,10,19,18,3,-22,-47,-24,-25,-15,0,13,20,17,3,-20,-43,-62,-68,-57,-29,7,42,68,73,61,35,4,-22,-36,-36,-24,-6,9,14,7,-13,-41,-66,-5,-1,7,15,18,15,2,-17,-37,-52,-54,-44,-20,11,39,58,59,44,16,-14,-39,-52,-47,-30,-5,17,30,30,15,-10,-41,-67,12,19,26,28,27,19,6,-9,-22,-26,-21,-8,9,23,31,26,11,-12,-35,-50,-54,-42,-20,9,37,54,58,48,26,-4,-36,-61,23,30,35,36,33,26,16,6,-1,-3,-1,3,7,6,0,-12,-26,-38,-43,-39,-24,-2,25,50,67,74,67,49,24,-5,-32,-53 },

{ -24,-28,-30,-28,-25,-21,-18,-17,-20,-25,-33,-40,-45,-46,-41,-29,-15,0,12,17,15,3,-15,-36,-56,-69,-74,-68,-55,-33,-11,7,-28,-30,-28,-22,-14,-7,-2,-2,-8,-18,-30,-40,-46,-44,-31,-12,10,29,40,40,27,3,-26,-53,-73,-81,-73,-54,-27,0,21,33,-16,-13,-5,7,19,28,33,30,22,8,-6,-18,-23,-18,-4,16,37,51,56,48,31,9,-12,-26,-31,-24,-8,11,28,37,39,34,3,10,21,33,44,51,52,47,36,22,8,-4,-9,-7,2,15,27,34,36,33,28,24,23,26,33,39,41,39,29,16,3,-6,8,11,15,20,25,28,28,25,18,8,-2,-12,-19,-23,-24,-21,-17,-12,-4,6,18,30,40,46,45,34,17,-4,-25,-40,-46,-42,-14,-22,-28,-30,-28,-23,-15,-8,-2,-2,-6,-15,-26,-37,-46,-51,-51,-44,-31,-15,3,16,21,19,7,-11,-31,-48,-58,-58,-47,-30,-38,-53,-62,-61,-52,-35,-14,6,22,29,27,16,0,-18,-34,-44,-46,-41,-29,-15,-3,5,5,-2,-12,-23,-32,-34,-28,-15,4,22,-38,-49,-48,-38,-19,6,33,56,72,77,70,55,36,15,-2,-12,-16,-13,-5,4,11,15,15,13,10,9,12,19,31,46,60,70 },

{ 2,1,3,7,12,18,23,25,23,16,6,-3,-8,-7,3,20,41,62,78,84,81,69,52,36,25,22,24,30,34,32,24,11,0,-2,0,5,13,22,27,28,20,7,-10,-25,-32,-28,-10,16,46,70,81,78,60,37,12,-4,-7,1,17,32,38,32,14,-6,-9,-15,-14,-8,2,12,18,17,6,-12,-33,-51,-60,-55,-39,-15,8,19,16,0,-24,-46,-59,-56,-40,-14,11,26,25,9,-15,-37,-22,-31,-30,-22,-8,6,15,16,7,-10,-31,-50,-61,-61,-51,-38,-28,-28,-38,-53,-67,-73,-64,-44,-15,10,24,24,9,-15,-40,-56,-30,-38,-34,-20

,0,20,35,41,37,25,7,-9,-19,-21,-17,-11,-7,-8,-14,-20,-21,-15,-2,14,28,34,29,14,-6,-25,-41,-46,-27,-31,-24,-7,15,36,52,61,60,53,41,31,26,27,32,38,42,42,39,36,33,32,32,31,27,21,11,1,-8,-14,-16,-13,-23,-29,-26,-16,-1,13,24,29,29,24,19,16,18,23,30,36,39,37,32,24,16,7,1,-4,-7,-7,-5,0,6,14,21,25,-30,-43,-49,-50,-47,-43,-40,-40,-41,-42,-42,-39,-34,-27,-22,-18,-17,-20,-25,-32,-37,-40,-39,-35,-27,-16,-2,13,27,38,45,48 },

{ 1,4,10,19,29,36,38,35,25,8,-11,-30,-45,-52,-53,-47,-39,-32,-29,-29,-31,-33,-32,-25,-14,0,10,13,4,-16,-41,-63,-1,2,11,23,36,45,47,41,25,2,-23,-44,-56,-57,-46,-29,-12,-2,-2,-9,-20,-27,-24,-13,5,22,31,26,4,-28,-63,-87,-13,-14,-8,4,19,30,36,32,20,3,-14,-23,-23,-9,12,34,50,51,38,16,-6,-18,-16,-1,21,40,47,38,14,-19,-51,-69,-33,-42,-39,-27,-9,8,20,25,23,17,11,11,20,36,55,69,69,56,30,0,-25,-35,-27,-5,22,44,53,48,31,8,-15,-29,-50,-63,-61,-46,-25,-2,14,22,23,16,8,4,7,15,24,28,22,7,-16,-37,-51,-50,-36,-12,14,33,44,45,37,26,13,3,-48,-59,-52,-35,-12,6,16,14,1,-17,-36,-47,-48,-40,-27,-16,-10,-13,-21,-31,-38,-37,-30,-18,-4,8,16,21,22,21,18,15,-23,-22,-11,5,20,27,22,6,-19,-43,-60,-64,-56,-35,-10,12,26,30,23,9,-6,-20,-28,-32,-30,-25,-16,-7,3,10,15,17,12,21,33,44,50,47,34,14,-7,-22,-26,-18,3,29,54,71,78,72,54,30,4,-19,-36,-45,-47,-42,-32,-19,-5,6,13,16 },

{ -53,-64,-65,-57,-44,-28,-15,-6,-2,-4,-9,-14,-17,-16,-13,-9,-7,-8,-12,-18,-23,-21,-12,4,24,42,55,59,56,47,38,29,-63,-74,-67,-48,-23,1,18,25,22,12,0,-11,-14,-11,-2,6,10,6,-5,-18,-25,-23,-9,13,35,52,56,49,33,17,7,5,-44,-43,-26,1,29,49,57,50,33,11,-7,-16,-13,1,18,31,33,21,1,-20,-33,-33,-22,-6,7,9,0,-17,-34,-40,-32,-13,-11,-2,18,40,56,61,49,26,-3,-27,-37,-32,-13,13,36,47,40,19,-8,-32,-44,-43,-32,-22,-18,-25,-40,-54,-58,-46,-17,16,5,13,24,30,29,16,-7,-32,-53,-60,-51,-27,3,30,45,42,26,3,-17,-26,-23,-9,6,13,9,-5,-21,-30,-25,-3,31,62,-3,-2,-3,-6,-14,-26,-39,-48,-48,-38,-18,6,24,33,28,14,-2,-11,-8,8,31,52,63,60,42,19,-1,-10,-3,19,50,76,-9,-10,-11,-10,-10,-10,-8,-3,5,14,21,22,15,1,-17,-29,-33,-21,2,30,56,68,65,46,18,-10,-28,-33,-22,2,32,56,4,7,12,19,26,32,37,39,36,29,15,-3,-26,-47,-60,-63,-53,-34,-10,12,24,23,7,-16,-42,-61,-69,-65,-48,-22,7,29 },

{ -13,-17,-16,-10,0,14,29,43,54,58,56,48,36,20,5,-7,-14,-13,-7,4,17,28,32,29,17,-4,-27,-46,-58,-57,-47,-28,-22,-29,-26,-17,-2,16,34,49,57,56,46,30,10,-9,-24,-32,-32,-24,-7,11,28,38,38,28,8,-16,-38,-52,-52,-41,-19,3,-31,-39,-37,-29,-16,-3,8,14,14,7,-5,-17,-28,-34,-35,-31,-24,-13,-1,10,19,22,22,18,11,4,-1,-1,6,16,30,40,-30,-37,-35,-30,-25,-21,-21,-25,-29,-33,-32,-26,-16,-4,5,9,6,-1,-10,-16,-17,-10,4,20,34,42,42,37,31,27,28,32,-9,-7,-3,-1,-3,-10,-20,-28,-31,-24,-8,15,38,52,53,36,8,-23,-47,-57,-50,-28,1,27,42,39,24,3,-15,-21,-15,0,29,42,48,45,33,16,-3,-16,-17,-5,18,44,62,65,48,16,-22,-53,-68,-63,-42,-14,10,22,16,-5,-32,-55,-65,-57,-31,0,51,65,67,54,32,5,-19,-33,-34,-20,3,25,38,35,19,-4,-27,-37,-33,-18,3,20,24,14,-7,-33,-55,-64,-56,-29,8,42,37,44,35,15,-11,-37,-57,-65,-59,-42,-19,2,17,21,19,14,12,17,27,39,48,48,38,20,-1,-18,-25,-19,1,31,62,87 },

{ 14,17,16,9,0,-9,-15,-17,-15,-11,-10,-14,-25,-41,-60,-73,-77,-66,-42,-10,22,44,53,48,35,20,12,14,26,40,51,52,20,24,20,10,-3,-13,-18,-15,-5,7,12,9,-6,-28,-52,-67,-66,-46,-11,27,56,65,52,26,-4,-22,-22,-6,18,40,48,41,21,24,19,8,-5,-12,-10,3,23,43,56,55,42,1

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[328] [14]

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{ -26,-34,-39,-39,-33,-23,-10,4,16,24,27,24,17,8,-3,-13,-20,-24,-24,-20,-13,-4,6,17,26,33,38,40,39,36,30,23,-32,-47,-55,-58,-52,-40,-21,0,20,36,44,44,36,22,4,-14,-30,-40,-44,-41,-33,-21,-4,13,29,42,51,56,57,54,47,37,-22,-34,-43,-47,-46,-37,-23,-4,17,34,46,50,46,33,15,-5,-25,-39,-48,-50,-47,-37,-22,-5,11,25,36,43,46,45,39,30,0,-2,-6,-10,-13,-13,-8,0,10,21,30,35,35,30,19,6,-8,-20,-29,-35,-36,-33,-26,-18,-9,-1,5,9,11,10,6,1,21,29,32,30,25,18,12,7,3,2,3,4,6,6,6,4,3,1,0,0,-1,-1,-1,-2,-5,-8,-13,-19,-25,-30,-35,-38,30,44,51,51,46,37,24,11,-3,-14,-22,-28,-30,-28,-23,-16,-7,4,14,24,32,36,37,34,26,14,-1,-17,-33,-47,-57,-62,28,41,50,51,48,39,26,11,-6,-22,-36,-46,-53,-54,-50,-42,-30,-15,3,20,37,49,57,59,55,44,27,7,-14,-34,-50,-60,19,30,37,39,37,31,21,8,-7,-21,-36,-48,-57,-61,-61,-56,-47,-34,-18,0,18,34,47,55,58,54,43,28,9,-10,-28,-42 },

{ 8,7,1,-6,-12,-13,-7,5,23,41,57,67,71,67,58,46,34,23,14,8,5,4,4,3,2,-1,-6,-12,-19,-25,-28,-29,19,18,7,-9,-25,-37,-37,-27,-6,20,45,64,73,72,61,45,26,11,-1,-7,-8,-5,-1,3,5,2,-4,-14,-26,-37,-45,-48,36,40,29,8,-19,-42,-56,-57,-47,-26,-2,18,30,30,20,4,-15,-30,-39,-41,-36,-25,-10,3,13,16,12,1,-14,-29,-43,-51,51,63,58,40,13,-15,-36,-48,-49,-40,-24,-10,-2,-3,-12,-27,-45,-60,-67,-66,-56,-38,-15,9,28,39,40,31,16,-3,-22,-36,49,64,66,55,37,16,-2,-14,-18,-13,-4,6,12,11,3,-10,-27,-42,-51,-53,-46,-30,-8,18,41,56,62,57,44,24,2,-17,27,37,38,33,22,11,2,-2,0,7,17,29,37,41,38,30,18,5,-7,-14,-15,-9,3,20,37,50,55,52,41,26,5,-12,-1,-1,-5,-11,-18,-24,-27,-26,-20,-9,4,18,31,39,44,43,38,30,21,12,5,2,2,6,12,16,17,13,5,-7,-21,-33,-18,-27,-35,-44,-51,-56,-58,-56,-50,-41,-29,-16,-2,9,16,21,22,19,14,7,0,-6,-11,-15,-18,-21,-25,-31,-38,-47,-55,-61 },

{ 35,43,42,32,16,0,-15,-25,-30,-32,-32,-32,-34,-37,-40,-42,-42,-38,-29,-18,-5,9,21,29,33,32,26,18,7,-3,-12,-18,48,63,63,51,29,5,-15,-28,-32,-29,-23,-19,-19,-23,-31,-39,-45,-46,-40,-29,-11,8,27,42,50,50,42,27,10,-8,-23,-33,41,56,57,44,22,-2,-20,-28,-24,-10,9,25,34,32,23,9,-8,-20,-26,-24,-13,4,23,40,51,52,44,26,4,-19,-39,-52,23,32,29,14,-8,-30,-43,-46,-34,-11,19,47,67,76,71,57,35,14,-4,-15,-16,-8,7,23,35,39,31,15,-8,-33,-55,-69,11,15,9,-7,-28,-49,-63,-66,-57,-35,-6,25,50,64,67,58,41,20,-2,-19,-29,-28,-19,-5,9

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{ -27,-34,-36,-30,-19,-5,11,22,27,23,12,-4,-19,-30,-35,-32,-22,-8,8,21,30,31,25,14,1,-12,-24,-33,-38,-39,-35,-27,-31,-43,-47,-44,-30,-10,13,35,47,47,33,10,-17,-39,-52,-54,-42,-22,4,28,46,54,49,35,16,-5,-24,-40,-50,-53,-49,-40,-17,-24,-31,-32,-27,-13,8,29,47,53,46,26,0,-26,-46,-54,-50,-32,-6,21,44,55,56,46,30,10,-9,-25,-36,-39,-36,-28,12,13,8,0,-8,-10,-4,7,19,29,32,27,14,-3,-20,-30,-33,-26,-12,6,22,32,34,29,20,10,0,-6,-8,-6,0,7,37,48,46,33,15,-3,-16,-21,-20,-13,-4,4,9,9,7,3,-1,-1,-1,2,0,-5,-12,-17,-19,-15,-6,7,22,36,46,45,62,63,51,29,4,-20,-38,-47,-47,-38,-25,-10,4,16,24,29,29,25,17,5,-10,-26,-41,-51,-52,-43,-25,0,26,50,67,39,54,59,51,33,10,-15,-36,-52,-57,-54,-43,-27,-8,11,28,41,47,47,39,26,7,-15,-36,-53,-59,-54,-38,-14,15,44,65,25,38,43,39,28,12,-7,-26,-40,-48,-49,-43,-32,-16,1,19,35,46,51,50,42,28,10,-9,-27,-38,-39,-32,-15,7,31,51 },

{ -33,-36,-26,-9,8,17,16,6,-8,-20,-24,-19,-7,7,19,25,24,17,7,-1,-4,-2,5,14,22,24,20,10,-5,-21,-34,-42,-50,-58,-42,-13,19,40,42,27,1,-25,-39,-38,-21,2,24,36,36,24,6,-11,-21,-19,-6,12,29,39,36,22,-1,-28,-52,-68,-58,-66,-50,-14,27,56,63,47,14,-21,-45,-50,-36,-8,21,38,40,25,-1,-28,-47,-48,-33,-7,22,42,48,37,12,-21,-56,-80,-50,-62,-46,-14,26,56,64,50,19,-17,-44,-53,-40,-13,19,42,47,33,4,-31,-59,-70,-59,-32,5,36,53,52,32,-2,-41,-72,-36,-44,-34,-10,20,42,48,36,11,-18,-41,-49,-39,-14,17,43,56,49,25,-9,-43,-62,-63,-44,-12,22,48,58,49,21,-16,-50,-18,-23,-16,-1,16,29,30,20,1,-21,-39,-45,-38,-18,9,35,52,55,42,18,-10,-33,-43,-38,-19,7,32,47,47,31,2,-27,-3,-3,1,9,18,22,21,11,-4,-20,-33,-39,-36,-23,-3,18,35,42,39,27,9,-9,-22,-26,-20,-6,10,22,26,19,2,-18,5,7,10,15,19,20,18,10,-1,-13,-23,-30,-30,-24,-12,2,14,22,23,19,10,-1,-12,-18,-19,-15,-8,-2,1,-1,-10,-21 },

{ -26,-33,-33,-26,-14,3,20,36,49,53,50,39,22,2,-20,-40,-56,-63,-63,-56,-44,-27,-9,8,21,28,31,30,26,21,15,10,-28,-38,-41,-38,-26,-10,9,27,44,54,56,50,36,17,-6,-30,-52,-65,-68,-64,-51,-33,-11,10,27,36,40,38,32,24,16,10,-7,-11,-14,-15,-14,-11,-9,-6,-3,0,5,9,12,11,8,2,-6,-12,-16,-16,-12,-3,8,18,26,29,27,21,12,3,-5,-9,18,24,28,29,26,18,4,-14,-33,

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17,14,10,5,-3,-13,-24,-34,-42,-46,-44,-35,-20,-2,17,33,43,45,-41,-60,-70,-72,-66,-53,-
36,-18,-1,13,24,31,36,38,36,32,25,16,5,-7,-20,-32,-39,-42,-38,-27,-8,16,42,65,80,86 }
,
{ -32,-37,-32,-16,5,24,36,36,25,6,-16,-32,-38,-31,-16,1,14,19,15,3,-13,-26,-35,-36,-28
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7,50,30,4,-17,-28,-28,-21,-9,1,7,7,4,1,-2,-5,-6,-8,-9,-9,-6,1,11,21,25,24,16,0,-18,-37,-
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{ 32,12,-24,-37,-10,33,50,24,-21,-44,-28,5,23,10,-19,-38,-32,-7,18,26,17,4,3,16,31,31,13,-14,-31,-22,8,36,61,31,-35,-73,-42,29,67,40,-24,-61,-39,15,50,39,-4,-39,-38,-7,27,33,10,-21,-30,-9,25,40,20,-23,-52,-42,4,51,79,52,-20,-71,-53,18,65,43,-21,-59,-40,19,63,54,9,-32,-34,3,44,48,10,-42,-68,-46,6,42,35,-12,-56,-51,0,58,59,45,-8,-48,-37,14,50,35,-17,-51,-35,12,45,35,-10,-49,-47,-4,49,64,30,-32,-72,-58,0,54,61,18,-34,-45,-3,56,19,10,-15,-31,-19,14,34,20,-17,-37,-22,14,38,25,-18,-57,-62,-25,28,58,45,-5,-48,-47,-2,50,67,34,-18,-40,-14,37,-10,-16,-21,-19,-4,18,25,9,-17,-29,-14,19,43,40,8,-27,-42,-27,8,36,37,10,-24,-34,-11,23,37,16,-24,-47,-29,11,-15,-16,-12,-2,13,24,22,4,-20,-31,-21,3,28,35,24,2,-15,-15,-1,14,19,8,-10,-19,-13,3,11,2,-18,-30,-19,8,-7,-7,-1,10,22,28,21,4,-17,-29,-30,-18,-1,10,10,3,-6,-10,-5,1,4,2,-5,-9,-7,1,8,8,4,3,13,27 },

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{

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{ 2,5,11,19,28,34,36,33,24,8,-11,-30,-45,-52,-53,-47,-40,-32,-28,-27,-29,-32,-31,-24,-13,1,12,15,6,-15,-42,-64,0,3,11,23,35,44,46,40,24,1,-24,-45,-57,-58,-46,-29,-12,-2,-2,-9,-19,-27,-25,-14,5,23,33,28,5,-28,-63,-86,-12,-14,-8,4,18,30,35,32,20,3,-14,-24,-23,-9,13,36,52,52,39,17,-5,-17,-16,-2,20,39,48,39,16,-17,-48,-65,-32,-42,-39,-27,-9,9,21,26,24,18,11,11,20,38,57,71,72,58,31,1,-24,-35,-27,-6,21,43,53,48,32,10,-12,-25,-49,-63,-61,-45,-23,0,16,23,23,16,8,5,9,17,27,30,24,8,-15,-37,-51,-50,-35,-12,14,33,44,43,36,24,13,4,-47,-59,-52,-34,-12,7,15,13,0,-18,-35,-46,-47,-39,-27,-17,-12,-16,-24,-34,-38,-37,-29,-16,-3,8,16,20,21,20,18,15,-24,-24,-13,4,20,27,21,5,-20,-43,-60,-65,-57,-37,-13,9,23,26,21,8,-6,-19,-27,-30,-29,-24,-16,-7,3,10,15,17,9,18,32,44,51,48,34,14,-8,-24,-28,-19,2,28,54,72,79,73,55,31,5,-18,-35,-45,-47,-42,-32,-19,-6,5,13,15 },

{ -50,-63,-66,-57,-44,-28,-14,-4,-1,-2,-7,-12,-16,-15,-12,-8,-6,-7,-11,-17,-21,-20,-12,4,24,42,55,59,56,46,36,27,-63,-75,-67,-48,-22,2,19,27,24,14,1,-10,-14,-11,-2,6,10,6,-4,-17,-24,-23,-9,13,36,51,54,48,32,15,5,4,-44,-43,-25,2,30,50,57,50,33,11,-7,-17,-14,0,18,30,33,22,2,-19,-33,-33,-22,-7,5,6,-4,-20,-36,-42,-33,-13,-12,-2,18,40,56,61,48,25,-3,-27,-37,-33,-13,13,36,47,41,20,-7,-31,-43,-43,-32,-22,-19,-26,-41,-55,-58,-47,-17,17,5,13,24,30,29,17,-5,-30,-52,-59,-51,-28,3,30,45,42,26,3,-17,-26,-23,-9,6,13,10,-4,-21,-31,-26,-4,31,62,-2,-1,-2,-5,-13,-26,-39,-49,-50,-40,-20,4,24,34,28,14,-2,-12,-9,7,30,52,62,60,42,18,-2,-11,-4,19,50,75,-8,-10,-11,-12,-13,-13,-11,-6,2,12,20,23,17,2,-16,-29,-33,-22,1,30,56,68,65,46,18,-10,-29,-33,-21,3,32,54,2,5,10,16,24,31,37,40,39,32,19,0,-23,-45,-60,-63,-54,-34,-9,14,27,26,10,-14,-40,-61,-69,-65,-47,-21,6,26 },

{ -12,-15,-14,-8,2,16,30,42,52,55,54,47,35,20,5,-7,-15,-14,-7,4,16,27,33,30,18,-3,-27,-47,-59,-58,-46,-26,-20,-28,-25,-16,0,18,35,48,55,55,46,31,11,-8,-24,-33,-33,-24,-7,11,28,39,38,28,7,-17,-39,-52,-52,-39,-17,6,-28,-37,-37,-28,-16,-2,8,13,14,7,-4,-15,-27,-33,-36,-32,-24,-13,0,11,19,22,21,17,10,4,1,2,9,19,32,42,-28,-36,-35,-30,-25,-22,-22,-26,-30,-33,-32,-26,-16,-5,4,8,6,0,-9,-15,-17,-11,3,20,35,43,43,38,32,29,28,31,-10,-8,-4,-2,-4,-11,-21,-29,-32,-24,-8,14,37,51,52,35,8,-22,-47,-57,-51,-28,1,27,42,39,24,3,-14,-21,-16,-1,24,39,46,45,33,15,-3,-15,-16,-4,19,44,63,66,48,16,-22,-54,-68,-64,-43,-15,10,22,15,-5,-32,-55,-64,-57,-31,1,47,65,68,56,34,5,-19,-32,-32,-17,6,27,40,36,19,-5,-28,-38,-34,-17,4,20,24,14,-8,-34,-56,-63,-55,-28,9,43,37,46,38,18,-11,-39,-59,-67,-60,-42,-19,2,16,19,16,10,10,16,28,41,50,50,37,18,-3,-21,-26,-19,2,32,61,83 },

{ 13,17,15,9,0,-9,-15,-17,-16,-12,-10,-13,-23,-38,-56,-70,-75,-65,-42,-10,22,44,54,49,37,20,11,13,24,39,50,49,18,24,20,10,-4,-14,-18,-15,-5,5,12,9,-5,-27,-50,-67,-66,-47,-11,28,57,66,53,27,-4,-24,-24,-8,17,40,47,39,20,24,19,8,-4,-11,-9,3,22,42,55,56,44,21,

-4,-21,-22,-7,16,32,34,15,-15,-47,-69,-69,-50,-21,5,15,9,-8,17,19,12,0,-11,-16,-9,7,31,55,70,73,62,41,16,-2,-9,-7,-3,-6,-18,-36,-52,-60,-53,-35,-12,5,7,-7,-31,-51,9,8,0,-14,-28,-36,-34,-22,-4,15,28,32,26,12,-2,-12,-15,-13,-10,-9,-9,-6,2,13,27,37,39,27,4,-24,-50,-63,5,6,-1,-16,-34,-49,-56,-56,-48,-37,-25,-17,-11,-8,-5,-1,6,13,20,27,35,44,51,56,56,50,36,16,-6,-25,-35,-36,22,33,32,20,1,-18,-34,-42,-44,-37,-26,-14,-2,9,15,17,18,16,14,12,13,14,14,13,12,9,6,3,2,4,8,12,50,71,77,70,54,34,17,5,0,1,7,13,18,17,9,-3,-18,-33,-45,-53,-57,-57,-53,-44,-32,-18,-3,13,27,39,46,47 },

{ -30,-37,-43,-48,-52,-53,-50,-41,-27,-10,6,17,22,19,11,2,-6,-9,-6,3,15,24,29,30,27,21,13,1,-16,-38,-66,-87,-25,-27,-29,-33,-36,-37,-32,-20,-3,16,31,38,34,21,2,-14,-23,-23,-12,3,17,24,23,18,12,10,9,6,-5,-26,-54,-77,11,22,27,23,15,7,4,6,13,22,28,26,14,-4,-23,-35,-36,-26,-12,-1,3,-4,-14,-19,-16,2,26,46,53,37,5,-29,49,67,68,55,34,12,-4,-13,-13,-8,-3,-2,-8,-18,-24,-23,-13,-1,7,4,-12,-31,-44,-44,-24,11,51,80,86,67,26,-15,51,59,48,22,-7,-31,-44,-44,-34,-18,-3,6,8,6,8,15,26,33,30,13,-14,-38,-53,-50,-29,2,34,52,50,28,-6,-35,14,9,-9,-30,-46,-51,-41,-21,4,24,33,31,21,13,13,21,33,41,38,22,-2,-28,-46,-52,-45,-29,-13,-3,-5,-16,-30,-41,-14,-21,-29,-30,-23,-6,17,37,49,44,25,-3,-29,-39,-33,-11,17,38,46,39,19,-5,-27,-39,-42,-36,-25,-15,-9,-7,-8,-10,-11,-10,-3,9,25,40,49,46,28,-3,-41,-75,-93,-89,-62,-24,17,47,60,57,42,22,5,-6,-9,-4,6,18,27,31,30,26 },

{ 19,19,14,4,-3,-4,2,16,35,51,59,56,43,22,1,-13,-17,-11,-3,0,-7,-24,-46,-61,-62,-42,-8,31,57,57,36,4,21,18,6,-12,-26,-29,-18,5,32,52,57,45,19,-10,-31,-37,-24,-1,20,25,11,-17,-47,-63,-53,-21,24,60,67,44,-4,-47,17,11,-7,-31,-51,-56,-46,-22,5,22,22,6,-20,-41,-47,-31,3,41,66,67,45,9,-24,-37,-28,-1,26,37,22,-17,-60,-85,21,20,2,-25,-47,-57,-50,-30,-7,7,6,-7,-26,-37,-31,-7,30,63,76,68,39,4,-22,-31,-22,-6,6,6,-10,-33,-51,-55,42,50,37,12,-12,-25,-23,-9,9,21,21,8,-10,-24,-26,-15,4,20,24,16,0,-16,-24,-21,-9,4,13,16,14,11,10,11,61,74,62,38,12,-4,-5,6,23,35,33,19,-6,-30,-46,-50,-43,-31,-19,-11,-5,-1,2,7,12,18,23,29,36,42,45,44,44,47,32,7,-16,-27,-22,-4,19,35,37,23,-1,-25,-42,-45,-37,-19,0,15,24,23,16,5,-4,-9,-7,1,12,22,30,30,-1,-9,-28,-47,-57,-54,-35,-9,20,39,45,38,23,8,0,1,10,23,32,34,25,8,-15,-37,-53,-60,-55,-44,-28,-13,-2,4 },

{ -54,-65,-58,-35,-7,20,38,43,38,23,5,-11,-22,-25,-24,-18,-8,3,15,22,23,17,5,-10,-24,-30,-27,-15,1,14,18,11,-68,-76,-55,-18,23,53,65,59,37,11,-14,-30,-34,-29,-18,-5,7,16,22,25,21,11,-4,-19,-29,-29,-17,1,19,26,16,-1,-55,-53,-26,10,41,54,47,25,-4,-27,-37,-30,-14,3,14,15,9,0,-3,1,6,8,6,0,-6,-6,0,10,17,12,-5,-25,-27,-20,0,18,25,17,-6,-30,-45,-43,-21,11,38,47,33,4,-29,-47,-40,-17,13,33,36,24,5,-9,-12,-6,2,0,-14,-34,-2,5,12,11,-2,-22,-43,-52,-43,-12,28,60,71,48,5,-41,-72,-68,-36,9,45,55,38,5,-26,-38,-29,-5,17,21,3,-27,17,25,24,13,-8,-28,-39,-34,-11,22,50,61,44,7,-34,-60,-57,-29,12,45,52,31,-8,-43,-56,-42,-5,35,58,50,12,-33,31,39,36,20,-1,-18,-25,-18,-1,17,27,21,3,-18,-31,-24,-2,25,43,40,16,-20,-51,-60,-44,-4,40,69,72,40,-13,-62,30,37,30,15,-5,-20,-25,-22,-13,-5,-2,-5,-8,-7,2,17,33,40,30,8,-22,-46,-52,-39,-8,28,53,59,38,-3,-52,-89 },

{ -21,-25,-20,-6,9,19,23,21,19,19,26,38,52,58,51,28,-7,-44,-71,-76,-60,-29,2,23,29,18,5,-3,2,19,38,48,-28,-31,-20,-1,16,24,19,8,-5,-8,2,23,46,57,48,19,-25,-61,-73,-58,-20,21,46,48,26,-6,-29,-31,-12,16,37,41,-27,-28,-16,3,15,12,-6,-32,-55,-61,-47,-18,15,37,40,22,-3,-17,-12,11,38,51,43,13,-27,-55,-61,-43,-13,8,12,-1,-18,-16,-3,13,19,10,-15,-46,-72,-78,-61,-29,7,34,42,36,26,20,21,26,25,13,-10,-33,-47,-42,-21,3,16,9,-18,-45,-5,0,14,31,40,35,17,-7,-28,-36,-30,-14,4,14,16,10,3,-3,-7,-9,-13,-17,-17,-9,10,31,48,49,31,-5,-45,-69,-5,-3,10,30,48,57,54,43,25,7,-7,-16,-23,-26,-28,-27,-24,-19,-13,-8,-3,4,15,30,46,55,52,37,10,-20,-43,-51,-32,-43,-37,-16,11,35,48,46,34,14,-8,-25,-33,-30,-20,-7,6,14,15,10,4,-2,-3,0,4,8,8,6,2,-1,-1,2,-64,-86,-84,-65,-34,-5,14,22,18,8,-3,-7,-2,12,27,39,41,33,14,-9,-33,-50,-58,-56,-46,-30,-10,9,26,38,45,46 },

{ 29,34,37,41,45,48,49,44,35,21,5,-9,-16,-17,-13,-9,-8,-9,-13,-16,-16,-7,13,37,62,76,76,55,21,-19,-57,-75,19,17,13,13,17,21,23,20,10,-4,-17,-24,-22,-14,-2,7,8,1,-12,-24,-29,-21,-2,21,40,49,41,19,-9,-34,-51,-55,-20,-36,-45,-45,-37,-25,-14,-8,-9,-12,-13,-9,1,15,28,33,28,12,-10,-29,-42,-44,-40,-36,-29,-22,-13,-1,13,23,26,18,-43,-59,-60,-50,-32,-13,1,8,10,9,8,10,16,24,27,27,21,12,2,-7,-17,-26,-39,-49,-48,-34,-5,30,62,76,65,40,-16,-12,-1,13,25,30,29,21,11,2,-6,-9,-11,-11,-10,-5,5,20,36,46,45,28,3,-19,-30,-23,-2,23,37,32,10,-16,33,48,53,50,37,18,-2,-18,-27,-28,-26,-25,-29,-33,-34,-27,-7,21,49,67,64,43,11,-18,-36,-40,-33,-25,-24,-33,-47,-58,38,41,30,7,-18,-38,-45,-36,-17,6,20,19,4,-19,-38,-43,-33,-10,15,31,31,17,-3,-20,-29,-28,-23,-18,-17,-22,-29,-32,2,-6,-23,-39,-47,-40,-15,21,59,85,87,69,31,-11,-44,-60,-58,-42,-19,0,11,15,15,16,23,30,37,41,40,33,24,17 },

{ -3,-9,-20,-29,-32,-22,0,27,52,62,54,30,-1,-27,-39,-32,-17,-2,3,-4,-14,-17,-6,16,36,43,29,-1,-26,-28,-2,36,1,-5,-20,-36,-41,-29,0,36,62,66,44,6,-33,-54,-46,-19,13,29,21,-4,-26,-30,-10,23,46,43,10,-34,-57,-40,14,69,22,21,2,-24,-42,-39,-18,10,30,29,7,-23,-44,-38,-8,31,58,53,21,-22,-52,-50,-20,18,39,27,-11,-51,-64,-31,30,81,52,57,32,-7,-41,-54,-42,-19,2,7,-1,-14,-17,-2,26,52,56,33,-8,-47,-63,-47,-6,32,46,29,-8,-42,-49,-23,23,60,71,76,48,1,-38,-51,-40,-12,14,24,17,1,-10,-8,4,16,18,6,-15,-31,-30,-9,23,45,47,27,-5,-30,-38,-24,-1,17,59,60,32,-4,-29,-31,-9,21,41,39,14,-20,-44,-48,-30,-4,18,25,18,5,-3,-1,10,21,23,14,0,-15,-23,-23,-21,-16,22,17,-2,-19,-22,-8,17,39,45,25,-9,-42,-57,-43,-10,24,47,45,24,-5,-29,-37,-28,-8,11,24,25,16,3,-11,-23,-27,-13,-20,-27,-29,-18,2,21,32,27,8,-15,-28,-23,-2,25,43,41,20,-13,-43,-59,-56,-33,0,31,50,52,41,22,1,-16,-25 },

{ 62,68,56,30,3,-17,-23,-14,2,22,36,39,33,17,-2,-17,-27,-25,-11,11,35,51,53,36,9,-19,-38,-39,-25,-3,13,17,64,60,31,-9,-42,-58,-49,-26,4,28,38,33,16,-6,-24,-36,-38,-29,-10,12,31,39,30,8,-18,-36,-36,-20,5,22,23,10,33,17,-15,-45,-61,-54,-31,-3,18,23,15,0,-14,-18,-15,-10,-8,-10,-14,-17,-15,-11,-7,-3,0,5,11,19,22,15,-3,-22,6,-7,-21,-25,-13,8,27,33,22,-2,-24,-31,-16,14,42,52,34,1,-34,-53,-45,-20,12,33,38,29,13,0,-8,-14,-25,-36,0,-2,3,19,41,55,54,29,-10,-45,-59,-39,6,55,83,72,30,-19,-52,-48,-18,21,44,38,11,-19,-36,-29,-10,7,6,-11,-7,-10,-2,15,31,37,23,-8,-44,-66,-59,-27,17,48,48,22,-16,-39,-33,-4,29,

42,25,-12,-48,-61,-38,5,47,62,40,-2,-31,-41,-36,-18,2,13,10,-4,-21,-27,-22,-8,5,3,-11,-27,-33,-16,12,37,45,24,-14,-48,-59,-36,9,54,77,58,9,-43,-41,-49,-38,-14,15,36,45,42,32,21,10,0,-12,-23,-29,-25,-7,17,37,42,26,-2,-28,-40,-29,-1,29,44,31,-6,-54,-94 },

{ 34,35,19,-7,-30,-42,-40,-29,-20,-18,-24,-28,-23,-3,29,58,72,56,18,-25,-55,-57,-38,-9,15,22,16,6,5,15,29,36,44,44,19,-15,-39,-42,-24,0,15,10,-12,-32,-35,-12,28,61,66,37,-13,-55,-65,-42,1,34,40,19,-13,-31,-24,0,22,28,43,39,16,-10,-21,-6,26,55,64,40,-5,-47,-63,-45,-8,24,30,10,-19,-29,-12,24,52,49,15,-31,-62,-59,-31,2,15,1,25,18,0,-15,-13,11,44,67,65,31,-20,-62,-74,-53,-14,14,22,13,3,7,25,42,37,10,-29,-51,-42,-11,25,35,7,-35,1,-9,-25,-36,-32,-13,13,31,33,14,-12,-27,-22,-1,19,22,10,-8,-16,-10,3,10,4,-9,-16,-3,26,54,62,31,-25,-75,-3,-9,-22,-36,-42,-36,-20,-1,14,22,26,30,34,32,16,-9,-35,-47,-40,-21,-1,9,6,1,3,16,35,46,34,1,-44,-77,29,36,27,5,-19,-33,-32,-18,0,18,30,32,25,7,-16,-32,-36,-22,0,20,27,15,-6,-24,-30,-20,-2,15,18,7,-12,-27,61,76,64,35,-1,-27,-38,-34,-20,-8,-1,-1,-5,-10,-10,0,18,38,50,46,23,-12,-43,-60,-58,-39,-7,23,42,46,37,24 },

{ -5,-1,-2,-7,-13,-19,-22,-21,-18,-16,-16,-21,-30,-39,-50,-58,-67,-72,-76,-75,-73,-64,-55,-47,-40,-35,-33,-32,-36,-40,-45,-44,7,14,14,7,-1,-6,-6,0,9,16,17,14,9,4,1,1,1,2,2,1,1,5,7,8,9,7,6,3,-1,-8,-16,-19,20,27,24,15,6,4,9,19,30,37,40,40,42,48,58,68,78,78,73,62,53,46,41,37,34,33,34,36,37,33,25,14,13,10,1,-10,-17,-18,-12,-6,-3,-6,-12,-16,-14,-7,3,10,12,6,-5,-15,-19,-19,-16,-14,-13,-12,-7,4,16,21,18,8,-8,-16,-24,-28,-29,-24,-20,-22,-31,-45,-58,-66,-66,-61,-57,-56,-62,-66,-67,-59,-45,-31,-25,-29,-39,-44,-40,-26,-11,-3,-4,-11,-8,-7,-1,8,19,29,31,28,16,6,1,2,9,15,15,9,3,1,8,25,39,42,31,9,-12,-22,-18,-8,1,3,-4,-17,3,10,20,30,40,45,45,41,37,38,48,58,69,69,60,46,35,33,41,52,57,49,33,14,2,1,8,17,20,13,-1,-16,-11,-16,-21,-26,-32,-39,-44,-47,-44,-36,-23,-14,-12,-19,-33,-47,-53,-49,-37,-24,-17,-15,-15,-13,-7,3,14,20,18,8,-7,-19 },

{ -17,-23,-32,-40,-46,-44,-32,-12,12,35,51,55,47,30,13,5,4,8,11,8,-3,-17,-25,-21,-4,26,58,72,61,21,-31,-70,-5,-6,-12,-22,-31,-33,-22,-4,17,33,38,29,8,-13,-24,-22,-6,11,18,14,-2,-21,-32,-30,-12,17,44,52,33,-5,-45,-67,33,42,39,23,4,-10,-15,-15,-13,-14,-19,-28,-40,-42,-35,-17,6,20,25,19,6,-9,-24,-36,-41,-35,-20,-3,9,12,9,3,54,64,54,34,11,-8,-19,-24,-26,-24,-21,-15,-7,2,10,14,12,10,9,14,20,20,6,-19,-44,-53,-38,-6,29,53,58,45,19,12,2,-4,-4,0,5,9,11,15,22,32,40,37,22,-3,-27,-34,-22,10,45,62,53,21,-15,-32,-27,-4,20,32,27,9,-46,-61,-55,-30,4,31,39,32,14,1,-2,5,14,12,-7,-34,-56,-59,-34,8,47,66,56,26,-8,-31,-35,-28,-19,-19,-26,-37,-66,-69,-43,0,40,52,34,-4,-45,-63,-54,-23,11,29,22,-5,-34,-47,-39,-16,8,21,19,6,-10,-20,-19,-14,-12,-17,-25,-31,-26,-17,12,42,55,41,2,-41,-69,-64,-25,27,73,91,74,35,-9,-40,-49,-41,-23,-6,7,14,20,25,31,34,31,23,9,-1 },

{ -25,-20,-10,-3,-5,-20,-45,-68,-76,-60,-31,0,18,15,-3,-26,-38,-36,-24,-10,-1,5,14,26,41,54,60,53,42,34,38,46,-13,0,21,37,36,14,-20,-46,-47,-20,20,51,56,35,-2,-28,-32,-16,7,16,9,-7,-18,-15,0,13,10,-6,-24,-25,-2,27,-4,12,39,60,65,46,15,-6,-3,19,46,55,42,11,-18,-22,0,30,44,26,-15,-55,-72,-59,-32,-15,-24,-51,-71,-59,-20,23,-28,-25,-4,21,32,23,1,-16,-17,-9,-2,-6,-21,-36,-32,-6,34,59,53,17,-25,-46,-30,10,47,53,26,-12,-33,-21,14,4

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{ 6,9,12,14,16,19,20,22,23,23,23,23,22,22,22,23,24,26,28,31,33,35,36,36,35,33,30,26,22,18,13,8,9,14,19,23,26,29,32,34,35,35,34,33,32,32,31,32,34,37,41,46,50,54,56,57,56,53,49,43,36,29,22,15,11,17,22,27,31,34,36,37,38,37,35,33,31,28,27,28,30,33,38,44,51,56,60,62,62,60,55,49,42,34,25,17,12,18,23,27,30,32,33,33,32,30,27,23,18,15,12,11,12,15,21,28,35,42,48,52,53,52,49,43,37,30,22,14,11,16,20,23,25,25,25,24,21,17,12,6,0,-6,-10,-13,-13,-11,-6,2,10,18,25,30,34,34,33,29,24,18,12,6,8,12,14,16,16,15,13,10,6,1,-6,-13,-21,-28,-33,-37,-39,-38,-33,-27,-19,-11,-3,4,8,10,10,9,6,2,-2,-6,4,6,7,7,5,3,0,-4,-9,-15,-23,-31,-39,-47,-53,-58,-61,-60,-57,-51,-45,-37,-30,-23,-18,-14,-13,-12,-13,-15,-17,-19,0,0,-1,-2,-5,-8,-12,-17,-23,-29,-36,-44,-52,-59,-66,-71,-74,-74,-72,-68,-63,-57,-50,-44,-39,-35,-32,-31,-30,-30,-31,-31 },

{ -7,-10,-12,-14,-15,-14,-12,-8,-3,3,11,19,27,32,35,35,31,24,15,5,-4,-10,-14,-15,-13,-9,-4,2,7,11,14,17,-10,-16,-21,-24,-25,-25,-21,-16,-7,4,17,31,44,55,59,58,50,38,22,5,-10,-21,-27,-27,-22,-14,-4,6,15,22,27,30,-14,-22,-28,-32,-35,-34,-30,-22,-12,2,18,36,53,65,71,69,59,42,21,-1,-20,-33,-39,-37,-29,-17,-3,11,24,33,39,42,-16,-25,-33,-38,-41,-40,-36,-29,-18,-4,14,32,50,64,69,67,55,36,13,-11,-31,-44,-47,-44,-33,-18,-1,15,30,41,47,50,-17,-27,-35,-41,-44,-44,-41,-34,-24,-11,5,23,40,52,57,53,42,23,0,-22,-40,-50,-52,-46,-34,-17,1,18,33,45,52,55,-16,-26,-35,-41,-44,-45,-43,-37,-29,-18,-4,10,24,34,37,34,23,7,-12,-30,-44,-52,-51,-44,-31,-15,3,20,34,45,52,55,-15,-24,-32,-38,-42,-43,-42,-38,-31,-23,-13,-2,8,15,17,13,5,-8,-22,-35,-44,-48,-46,-38,-26,-11,4,19,32,42,49,51,-12,-21,-28,-34,-37,-39,-38,-36,-31,-25,-18,-11,-5,-1,0,-3,-9,-18,-27,-35,-40,-42,-39,-31,-21,-8,5,17,28,37,43,46 },

{ -12,-17,-21,-25,-28,-30,-31,-31,-31,-29,-28,-27,-26,-25,-25,-24,-23,-20,-15,-9,-1,9,18,27,34,37,38,36,33,27,20,12,-17,-25,-32,-38,-42,-45,-45,-45,-43,-40,-37,-34,-32,-32,-32,-32,-29,-23,-13,0,14,29,43,54,60,61,58,52,43,32,20,-19,-28,-36,-42,-46,-47,-46,-43,-40,-34,-29,-25,-22,-22,-24,-26,-29,-29,-24,-15,-2,13,30,45,58,64,65,62,56,46,33,20,-18,-27,-33,-37,-39,-39,-35,-30,-24,-16,-9,-3,0,0,-4,-11,-17,-22,-22,-17,-7,6,20,34,45,52,52,49,43,34,23,11,-14,-21,-25,-27,-27,-24,-18,-10,-1,8,17,23,27,25,19,9,-2,-12,-18,-19,-15,-8,3,12,21,26,27,24,19,12,4,-5,-9,-13,-14,-14,-11,-6,1,11,21,31,40,47,49,47,38,26,11,-3,-14,-21,-24,-22,-17,-12,-7,-4,-4,-6,-9,-14,-19,-23,-3,-4,-3,0,4,10,18,28,38,48,56,61,63,59,50,36,19,3,-12,-23,-30,-34,-34,-33,-32,-31,-31,-32,-35,-37,-39,-4

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{ 7,10,11,11,10,6,0,-8,-16,-24,-31,-35,-34,-28,-18,-4,10,22,29,30,27,19,9,0,-5,-6,-3,2,8,14,20,24,11,16,19,20,17,11,1,-11,-25,-39,-50,-57,-56,-47,-29,-6,19,39,49,50,40,26,8,-6,-14,-15,-8,3,15,27,36,43,15,22,26,27,25,18,6,-9,-26,-43,-57,-65,-66,-54,-32,-3,27,49,59,56,42,21,-1,-19,-29,-27,-16,1,19,36,49,57,17,26,32,34,32,25,14,-2,-20,-37,-51,-61,-61,-50,-27,2,31,52,58,51,32,7,-17,-36,-44,-40,-24,-3,19,40,56,65,19,29,36,39,38,32,22,8,-8,-24,-38,-46,-47,-37,-17,8,32,48,50,38,16,-9,-34,-50,-56,-49,-31,-8,16,39,56,67,18,29,37,41,41,38,29,18,4,-9,-20,-27,-27,-20,-5,13,29,39,36,22,0,-23,-44,-58,-60,-53,-35,-12,12,34,51,63,17,27,35,40,41,39,33,25,15,5,-3,-9,-9,-5,4,15,24,27,21,8,-11,-31,-47,-57,-58,-50,-34,-14,7,27,43,54,14,23,31,35,38,37,34,28,21,14,9,5,4,6,10,15,18,17,10,-2,-16,-31,-43,-49,-49,-42,-29,-13,4,20,34,44 },

{ 14,20,25,28,30,31,30,28,25,21,17,12,6,0,-8,-16,-26,-33,-40,-43,-43,-37,-26,-13,1,14,26,33,37,36,31,24,20,29,36,41,44,44,42,38,33,27,21,14,7,-1,-11,-22,-34,-46,-55,-62,-61,-54,-38,-19,3,24,40,52,57,56,49,39,21,31,38,42,44,42,38,33,27,20,14,9,5,0,-6,-13,-23,-34,-45,-53,-56,-50,-37,-18,4,25,43,54,61,59,52,40,18,26,31,33,32,28,23,16,9,3,-1,-2,0,3,5,6,3,-4,-14,-24,-31,-32,-25,-13,3,19,32,41,46,46,39,29,12,17,18,17,13,8,1,-7,-14,-18,-19,-15,-7,4,16,27,32,31,25,13,1,-7,-10,-8,-2,5,12,17,20,19,15,8,5,5,3,-1,-7,-14,-21,-29,-35,-38,-35,-27,-14,3,23,41,53,58,53,42,27,13,1,-7,-11,-11,-11,-10,-10,-12,-14,-16,-3,-6,-11,-17,-24,-31,-39,-46,-51,-51,-46,-36,-20,0,22,43,59,66,64,54,40,22,5,-9,-20,-27,-32,-35,-37,-39,-40,-39,-8,-14,-20,-27,-34,-42,-49,-54,-57,-56,-50,-40,-24,-5,16,36,51,59,58,50,37,21,3,-13,-27,-38,-46,-51,-55,-57,-57,-55 },

{ -9,-13,-13,-11,-5,3,13,23,31,33,29,19,4,-13,-28,-36,-36,-26,-10,7,21,26,24,15,5,-4,-9,-9,-5,3,13,23,-15,-21,-22,-19,-10,3,19,36,49,54,48,32,7,-21,-45,-59,-56,-40,-12,17,37,45,37,21,1,-13,-19,-17,-7,7,24,38,-20,-29,-31,-28,-18,-2,18,38,56,63,57,38,9,-24,-52,-67,-64,-41,-7,27,50,54,40,16,-9,-26,-32,-26,-10,10,33,50,-24,-36,-40,-37,-28,-12,9,31,50,60,56,39,10,-22,-48,-61,-55,-32,3,35,54,54,34,5,-23,-41,-44,-34,-13,12,38,59,-27,-40,-47,-45,-38,-23,-3,19,38,48,48,34,11,-15,-37,-45,-38,-16,13,38,51,44,22,-9,-36,-51,-52,-38,-14,14,42,63,-27,-42,-49,-50,-44,-32,-15,4,21,32,34,26,10,-8,-22,-27,-19,-1,20,36,41,32,8,-20,-43,-55,-52,-37,-13,15,42,63,-26,-40,-48,-50,-47,-37,-24,-8,6,16,19,16,7,-3,-10,-11,-4,8,21,29,29,18,-2,-25,-43,-50,-46,-31,-10,15,40,59,-21,-34,-42,-45,-43,-37,-27,-16,-5,3,7,7,4,0,-2,-1,4,12,18,21,18,8,-7,-24,-36,-41,-36,-23,-5,16,36,52 },

{ -23,-31,-37,-39,-39,-36,-31,-24,-15,-6,3,11,18,23,26,25,21,12,-1,-16,-32,-43,-50,-49,-42,-28,-11,6,20,29,33,31,-31,-44,-51,-54,-53,-48,-39,-28,-15,-3,9,19,26,32,34,35,30,20,3,-17,-38,-55,-64,-66,-55,-36,-11,14,35,48,52,48,-32,-43,-50,-51,-48,-40,-29,-17,-5,6,14,19,22,23,25,26,26,22,12,-4,-23,-39,-51,-54,-47,-28,-4,20,41,53,57,52,-25,-33,-36,-34,-28,-19,-9,2,11,16,16,12,6,1,-1,3,10,17,20,17,7,-6,-18,-25,-24,-14,2,19,34,43,4

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{ -5,-6,-7,-8,-9,-11,-14,-18,-24,-30,-38,-46,-54,-58,-61,-60,-59,-55,-51,-47,-45,-43,-43,-43,-43,-41,-38,-34,-29,-23,-16,-10,-6,-7,-6,-6,-7,-8,-11,-15,-22,-30,-39,-48,-57,-63,-64,-62,-58,-53,-47,-43,-41,-41,-42,-44,-45,-46,-44,-41,-36,-30,-23,-16,-4,-3,-1,1,3,4,4,2,-2,-7,-13,-19,-24,-25,-24,-19,-14,-8,-4,-2,-3,-6,-10,-13,-18,-21,-22,-23,-23,-20,-17,-12,-1,1,5,9,13,16,19,21,21,20,19,19,20,23,28,34,39,43,43,42,38,33,28,24,19,14,10,6,2,-1,-2,-3,0,3,7,12,16,20,25,28,31,34,37,40,45,50,57,61,65,64,61,56,52,47,45,42,40,37,34,29,23,16,10,6,0,1,3,6,9,12,16,19,22,25,28,32,36,41,44,46,44,41,35,30,26,26,28,31,34,36,36,33,28,22,14,8,-4,-5,-6,-6,-6,-6,-5,-5,-4,-4,-3,-2,-1,-1,-2,-5,-10,-16,-22,-26,-26,-22,-15,-5,4,11,16,18,17,13,7,2,-7,-12,-16,-20,-23,-26,-28,-31,-34,-37,-40,-43,-46,-50,-55,-61,-68,-75,-80,-82,-79,-72,-61,-48,-34,-23,-14,-8,-5,-5,-6,-9 },

{ -2,-2,1,6,14,23,31,35,32,21,4,-15,-29,-32,-22,-1,24,42,48,39,20,-3,-21,-30,-28,-17,-4,7,10,7,-3,-15,-6,-8,-4,4,17,31,43,51,48,33,6,-25,-49,-56,-39,-7,33,63,70,55,22,-13,-39,-48,-39,-19,3,17,20,11,-7,-26,-13,-18,-16,-7,7,24,40,51,51,36,6,-30,-60,-69,-52,-15,31,62,69,47,10,-27,-51,-53,-36,-8,18,32,32,15,-11,-37,-21,-31,-31,-24,-11,7,26,40,45,35,9,-25,-55,-68,-54,-21,20,48,50,28,-8,-39,-53,-46,-20,11,36,47,39,16,-17,-48,-28,-41,-45,-41,-29,-11,9,26,36,32,14,-12,-38,-50,-43,-19,10,28,27,6,-22,-43,-47,-30,-1,29,50,54,40,11,-25,-58,-31,-47,-53,-51,-40,-24,-4,15,28,31,22,5,-13,-24,-22,-10,5,14,9,-8,-27,-38,-32,-13,15,40,53,51,32,2,-35,-66,-30,-45,-52,-51,-44,-29,-10,8,23,31,29,21,11,3,0,3,7,8,1,-11,-22,-25,-17,1,23,39,46,39,19,-10,-44,-71,-25,-38,-44,-44,-38,-26,-10,6,21,30,33,31,27,22,17,15,12,8,1,-7,-13,-13,-6,7,21,31,32,23,4,-21,-48,-70 },

{ -33,-44,-49,-48,-43,-34,-22,-11,-2,3,4,1,-5,-12,-18,-22,-24,-24,-23,-18,-8,7,25,42,55,56,48,32,12,-7,-24,-34,-44,-59,-64,-61,-51,-36,-18,-1,12,18,16,10,0,-10,-17,-21,-22,-24,-24,-23,-15,2,25,51,68,73,61,39,10,-18,-41,-54,-42,-55,-57,-50,-36,-18,2,19,30,33,27,16,4,-5,-7,-5,-2,-3,-10,-19,-23,-16,3,27,47,54,47,26,-1,-29,-51,-64,-30,-38,-35,-25,-10,7,24,37,42,38,26,11,-1,-5,1,14,26,27,14,-8,-28,-37,-29,-12,7,18,19,8,-11,-32,-49,-60,-16,-18,-12,0,14,27,38,43,40,28,11,-8,-19,-17,0,24,46,50,36,6,-27,-48,-54,-45,-29,-13,-4,-3,-10,-21,-33,-41,-4,-1,7,17,28,36,39,36,25,7,-14,-34,-42,-36,-12,20,49,61,48,19,-17,-45,-57,-55,-41,-24,-7,3,6,2,-4,-11,5,10,17,24,31,33,29,20,3,-18,-40,-57,-64,-53,-27,8,40,55,49,27,-2,-27,-41,-40,-30,-11,7,22,31,32,29,21,9,14,18,22,24,22,15,2,-16,-36,-55,-69,-72,-61,-36,-5,24,42,42,30,12,-5,-15,-14,-5,11,28,43,53,57,53,45 },

{ 0,0,1,4,10,17,26,36,47,55,61,62,60,51,38,22,5,-10,-22,-30,-35,-35,-33,-30,-31,-34,-39,-44,-48,-46,-40,-29,-3,-6,-5,-3,3,12,24,36,47,57,62,64,59,50,34,18,0,-16,-27,-34,-36,-33,-26,-21,-21,-27,-37,-48,-56,-59,-53,-42,-9,-14,-16,-16,-13,-6,2,10,16,21,22,21,1

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{ 42,33,2,-32,-47,-30,5,33,34,7,-25,-34,-14,12,18,5,-2,7,14,4,-15,-15,6,21,8,-21,-31,-7,30,36,-2,-53,52,41,-3,-48,-62,-38,13,49,44,4,-39,-46,-10,26,22,-7,-21,0,21,8,-23,-26,9,37,17,-31,-50,-16,39,56,2,-71,54,40,-2,-41,-52,-22,25,53,42,-5,-44,-36,12,45,23,-27,-45,-5,35,18,-29,-36,9,49,33,-26,-61,-27,40,64,14,-68,43,34,1,-26,-29,-3,32,46,23,-20,-45,-21,35,61,19,-44,-56,1,53,32,-32,-51,-1,55,48,-13,-60,-39,27,63,25,-49,26,18,-2,-16,-13,6,28,27,0,-34,-45,-10,46,58,9,-53,-54,15,70,39,-36,-61,-14,49,58,1,-54,-46,8,48,31,-27,7,1,-10,-15,-8,8,19,12,-14,-39,-39,-5,39,44,-5,-55,-43,24,67,36,-36,-65,-23,39,52,10,-41,-47,-7,30,26,-11,-6,-11,-14,-12,-2,10,16,8,-11,-27,-25,2,30,26,-13,-46,-31,21,53,25,-31,-53,-23,26,43,14,-26,-36,-14,15,19,-3,-10,-13,-12,-6,5,16,20,16,3,-7,-5,10,23,16,-12,-32,-19,15,34,17,-19,-34,-13,21,34,17,-11,-22,-11,7,12,0 },

{ 68,69,52,21,-11,-32,-40,-29,-9,11,21,14,-3,-19,-25,-21,-11,8,36,57,51,4,-57,-85,-70,-14,40,56,39,1,-26,-32,51,49,28,0,-23,-37,-36,-23,-2,17,23,15,-3,-13,-11,-8,-11,-14,2,34,45,17,-34,-66,-44,7,48,53,23,-14,-33,-33,-1,-13,-21,-20,-13,-5,1,7,13,15,11,2,-6,1,21,29,7,-33,-52,-28,11,30,21,7,11,23,25,8,-16,-27,-18,-2,-44,-57,-44,-16,16,37,37,26,11,-1,-10,-18,-20,-3,29,52,33,-19,-60,-59,-17,26,46,44,30,9,-18,-40,-42,-20,17,42,-50,-52,-31,6,39,51,40,14,-8,-19,-21,-21,-25,-18,5,31,41,17,-17,-33,-22,5,24,25,11,-15,-41,-48,-33,6,46,63,-22,-18,1,23,36,31,7,-20,-32,-24,-2,10,0,-22,-32,-18,14,37,35,15,-6,-17,-16,-12,-10,-15,-18,-15,0,23,37,38,8,15,23,24,15,-7,-35,-50,-43,-7,37,58,42,-7,-52,-59,-25,24,52,40,7,-25,-38,-28,-8,13,25,26,22,8,-10,-26,21,29,27,15,-7,-35,-55,-56,-31,16,64,86,66,13,-44,-67,-44,1,34,35,8,-20,-31,-18,10,38,49,41,15,-22,-58,-82 },

{ 18,22,30,40,54,59,55,31,-3,-40,-72,-80,-70,-37,4,36,54,47,31,13,0,-13,-31,-47,-54,-43,-21,8,36,53,61,53,0,-7,-8,-2,10,22,26,20,4,-15,-28,-31,-20,-5,9,18,13,1,-10,-8,3,10,5,-5,-11,-12,-7,0,9,19,27,29,-16,-32,-46,-50,-48,-36,-22,-7,9,25,43,54,55,33,6,-18,-39,-46,-43,-23,5,27,39,42,42,32,15,-10,-35,-43,-38,-25,0,-9,-21,-31,-38,-40,-33,-21,-1,25,49,62,51,20,-13,-28,-26,-17,-9,-5,0,5,10,17,24,29,20,-3,-31,-50,-50,-40,30,35,35,28,18,6,-6,-15,-18,-11,-1,1,-11,-27,-33,-11,25,47,44,19,-6,-25,-37,-39,-31,-10,10,18,16,7,0,-4,28,38,45,50,50,42,23,1,-21,-35,-39,-43,-45,-43,-24,10,44,58,39,13,-6,-18,-29,-42,-44,-30,-3,25,44,51,44,32,-14,-16,-8,8,23,29,25,11,-5,-18,-24,-20,-14,-3,8,15,13,-4,-23,-24,-3,21,29,15,-7,-18,-15,-1,16,25,27,20,-57,-74,-70,-53,-30,-8,5,10,12,15,21,33,45,50,38,11,-29,-65,-77,-54,-2,50,74,66,34,0,-25,-38,-39,-35,-28,-25 },

{ 34,29,16,5,7,10,2,-18,-39,-29,11,46,38,-19,-63,-32,50,89,48,-29,-59,-25,22,30,5,-16,-10,12,24,17,1,-9,25,15,-5,-14,-3,15,16,-8,-41,-43,4,59,53,-19,-83,-60,38,89,28,-59,-71,-10,47,43,-8,-39,-22,12,27,13,-10,-16,8,-8,-31,-36,-14,21,40,21,-21,-43,-14,41,59,4,-61,-54,14,43,-6,-59,-41,28,65,30,-29,-47,-19,16,20,-4,-21,-15,7,-10,-35,-43,-18,26,57,49,3,-40,-38,6,41,29,-10,-19,7,11,-19,-32,5,50,46,-2,-42,-34,8,30,12,-18,-22,2,29,15,-17,-37,-26,13,50,53,17,-32,-54,-29,14,32,23,10,8,-1,-14,-2,27,31,1,-37,-41,0,42,40,2,-31,-17,30,54,47,7,-31,-40,-17,21,39,22,-16,-44,-39,-8,17,18,9,-2,-8,-6,10,18,0,-34,-50,-20,30,55,33,-18,-46,-12,53,66,61,22,-27,-53,-42,-8,21,28,9,-13,-19,-9,1,0,-6,-1

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{ 19,18,17,16,14,2,-22,-38,-29,11,48,33,-26,-55,-6,72,79,-14,-92,-58,28,63,25,-27,-34,-1,22,9,-17,-22,-4,13,5,0,-2,4,13,12,-9,-36,-34,6,51,46,-28,-84,-32,70,82,-16,-92,-48,50,73,5,-50,-32,18,37,12,-22,-24,2,21,-11,-21,-25,-13,9,26,19,-8,-28,-12,29,43,-3,-59,-48,21,46,-6,-40,3,52,27,-36,-52,-8,37,36,1,-24,-12,12,17,-5,-18,-28,-22,3,32,39,16,-21,-35,-7,33,36,0,-28,-20,-4,0,13,35,23,-25,-52,-25,25,39,8,-21,-21,4,16,2,23,12,-12,-25,-11,18,39,26,-13,-46,-41,7,51,45,5,-31,-34,-4,30,29,-7,-40,-29,21,48,17,-30,-39,-10,24,20,-21,53,44,5,-30,-35,-10,24,33,5,-35,-50,-23,25,45,18,-18,-25,-3,16,7,-19,-26,8,50,38,-14,-53,-39,13,45,17,-42,63,53,9,-38,-55,-30,13,40,34,-1,-33,-33,-9,11,10,-3,-4,6,7,-7,-23,-11,25,42,16,-32,-51,-17,37,55,14,-54,46,41,1,-41,-57,-36,9,46,53,31,-3,-22,-20,-11,0,5,12,16,6,-11,-19,-7,15,19,-5,-32,-31,3,43,50,6,-54 },

{ -18,-16,-13,-13,-20,-26,-30,-28,-28,-32,-41,-52,-64,-62,-54,-38,-22,-6,8,21,35,45,52,55,62,69,72,61,42,24,17,18,-5,3,11,14,10,6,6,12,18,21,22,20,19,21,23,23,18,9,-3,-11,-14,-20,-26,-36,-34,-22,-8,-8,-17,-22,-9,7,6,16,23,22,18,16,19,25,32,34,39,46,56,56,50,37,22,5,-13,-25,-31,-36,-46,-60,-72,-66,-52,-45,-47,-40,-21,-1,-1,1,-1,-7,-13,-16,-14,-12,-14,-23,-29,-26,-19,-22,-29,-33,-24,-10,2,8,21,37,46,43,28,22,24,22,11,5,7,13,-8,-11,-16,-22,-26,-25,-20,-18,-26,-40,-52,-50,-46,-47,-55,-49,-24,5,19,17,22,40,63,67,61,55,55,52,42,28,19,14,2,3,3,1,3,10,19,26,22,14,10,18,30,34,25,18,25,31,13,-20,-44,-47,-35,-34,-35,-32,-21,-10,-5,-7,-11,-11,11,14,14,13,16,21,28,35,35,32,34,43,57,58,46,30,23,16,0,-25,-45,-48,-49,-54,-63,-61,-52,-38,-27,-22,-23,-20,0,-1,-6,-11,-16,-18,-19,-21,-26,-32,-35,-32,-27,-29,-40,-45,-38,-22,0,20,40,56,62,56,43,30,25,25,24,18,12,7 },

{ -22,-3,27,37,15,-24,-41,-15,31,47,17,-25,-29,8,32,21,10,13,1,-28,-25,16,33,-5,-43,-26,19,31,-2,-38,-27,21,-36,-11,34,53,20,-33,-55,-27,32,53,7,-46,-36,17,28,-12,-25,15,22,-27,-36,25,55,4,-52,-29,39,58,4,-49,-28,39,-51,-25,24,46,19,-29,-51,-20,31,39,-11,-52,-18,43,26,-53,-63,25,58,-13,-56,10,63,14,-51,-29,41,59,5,-48,-25,52,-51,-31,14,36,17,-18,-30,-2,34,28,-22,-47,7,72,36,-62,-66,45,83,-10,-76,-14,56,23,-46,-40,20,43,-1,-51,-26,49,-37,-20,12,26,12,-13,-16,9,34,17,-30,-44,11,69,38,-51,-53,48,79,-17,-82,-19,56,30,-38,-45,3,31,1,-40,-28,34,-16,-4,12,16,1,-17,-13,11,29,13,-28,-43,-5,40,20,-43,-37,31,45,-22,-58,-2,57,35,-26,-39,4,38,19,-20,-21,15,3,11,14,6,-12,-24,-16,8,26,14,-17,-32,-13,16,9,-24,-22,13,17,-19,-31,11,47,24,-22,-30,5,37,30,-3,-17,-3,10,16,13,-1,-18,-25,-15,6,23,20,2,-12,-2,13,13,0,0,11,7,-11,-13,8,20,0,-30,-33,-5,22,21,-1,-17,-13 },

{ -59,-56,-33,0,26,31,20,2,-3,9,29,31,7,-26,-40,-15,24,46,49,27,-15,-64,-85,-38,38,72,49,-11,-54,-43,-1,36,-41,-31,-5,20,31,24,0,-20,-22,-8,14,25,8,-18,-24,-9,5,-1,-3,19,28,

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}
},

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- [329] 도 4를 참조하면, 현재 블록의 레지듀얼 샘플을 기반으로 현재 블록을 복원할 수 있다(S420).
- [330] 현재 블록의 인트라 예측 모드를 기반으로 현재 블록의 예측 샘플을 유도할 수 있다. 현재 블록의 예측 샘플과 레지듀얼 샘플을 기반으로, 현재 블록의 복원 샘플을 생성할 수 있다.
- [331] 도 6은 본 개시에 따른 영상 디코딩 방법을 수행하는 디코딩 장치 (300)의 개략적인 구성을 도시한 것이다.
- [332] 도 6을 참조하면, 본 개시에 따른 디코딩 장치(300)는, 변환 계수 유도부(600), 레지듀얼 샘플 유도부(610), 복원 블록 생성부(620)를 포함할 수 있다. 변환 계수 유도부(600)는 도 3의 엔트로피 디코딩부(310)에 구성될 수 있고, 레지듀얼 샘플 유도부(610)는 도 3의 레지듀얼 처리부(320)에 구성될 수 있고, 복원 블록 생성부(620)는 도 3의 가산부(340)에 구성될 수 있다.
- [333] 변환 계수 유도부(600)는, 비트스트림으로부터 현재 블록의 레지듀얼 정보를 획득하고, 이를 복호화하여 현재 블록의 변환 계수를 유도할 수 있다.
- [334] 레지듀얼 샘플 유도부(610)는, 현재 블록의 변환 계수에 역양자화 또는 역변환 중 적어도 하나를 수행하여, 현재 블록의 레지듀얼 샘플을 유도할 수 있다.

- [335] 레지듀얼 샘플 유도부(610)는, 소정의 변환 커널 결정 방법을 통해 현재 블록의 역변환을 위한 변환 커널을 결정하고, 이를 기반으로 현재 블록의 레지듀얼 샘플을 유도할 수 있다. 이에 대해서는 도 4를 참조하여 살펴본 바와 같으며, 여기서 자세한 설명은 생략하기로 한다.
- [336] 복원 블록 생성부(620)는, 현재 블록의 레지듀얼 샘플을 기반으로 현재 블록을 복원할 수 있다.
- [337] 도 7은 본 개시에 따른 일실시예로서, 인코딩 장치(200)에 의해 수행되는 영상 인코딩 방법을 도시한 것이다.
- [338] 도 7을 참조하면, 현재 블록의 레지듀얼 샘플(residual samples)을 유도할 수 있다(S700).
- [339] 현재 블록의 레지듀얼 샘플은, 현재 블록의 원본 샘플(original samples)에서 예측 샘플(prediction samples)을 차분하여 유도될 수 있다. 여기서, 예측 샘플은, 소정의 인트라 예측 모드에 기초하여 유도된 것일 수 있다.
- [340] 도 7을 참조하면, 현재 블록의 레지듀얼 샘플에 변환 또는 양자화 중 적어도 하나를 수행하여 현재 블록의 변환 계수(transform coefficients)를 유도할 수 있다(S710).
- [341] 본 개시에 따른 변환 방법은 도 4를 참조하여 살펴본 역변환의 역과정으로 이해될 수 있다. 상기 변환을 위한 변환 커널을 결정하는 방법은 도 4를 참조하여 살펴본 바와 같다. 여기서 자세한 설명은 생략하기로 한다.
- [342] 예를 들어, 현재 블록의 변환을 위한 하나 또는 그 이상의 변환 세트가 정의/구성될 수 있고, 각 변환 세트는 하나 또는 그 이상의 변환 커널 후보를 포함할 수 있다. 이때, 복수의 변환 세트로부터 어느 하나가 현재 블록의 변환 세트로 선택될 수 있다. 현재 블록의 변환 세트에 속한 복수의 변환 커널 후보 중 어느 하나가 선택될 수 있다. 상기 선택은, 현재 블록의 컨텍스트를 기반으로 묵시적으로 수행될 수 있다. 또는, 현재 블록을 위한 최적의 변환 세트 및/또는 변환 커널 후보를 선택하고, 이를 지시하는 인덱스가 시그널링될 수도 있다.
- [343] 또는, 현재 블록의 변환 커널은 MTS 세트를 기반으로 결정될 수 있다. 현재 블록의 크기 또는 인트라 예측 모드 중 적어도 하나를 기반으로, 복수의 MTS 세트 중 어느 하나가 선택될 수 있다. 선택된 MTS 세트는 하나 또는 그 이상의 변환 커널 후보를 포함할 수 있다. 상기 하나 또는 그 이상의 변환 커널 후보 중 어느 하나가 선택될 수 있고, 선택된 변환 커널 후보를 기반으로 현재 블록의 변환 커널이 결정될 수 있다. 상기 변환 커널 후보의 선택은, 현재 블록의 컨텍스트를 기반으로 유도된 변환 커널 후보 인덱스를 이용하여 수행될 수 있다. 또는, 현재 블록을 위한 최적의 변환 커널 후보가 선택되고, 선택된 변환 커널 후보를 지시하는 변환 커널 후보 인덱스가 시그널링될 수도 있다.
- [344] 또는, 현재 블록의 변환 커널은 비분리 일차 변환(NSPT) 커널을 기반으로 결정될 수 있다. 현재 블록의 크기가 NSPT가 적용될 수 있는 블록 크기의 집합인 제1 그룹에 속하는 경우, 현재 블록에 대해 순방향의 NSPT가 적용될 수 있고, 현재 블

록의 크기가 제2 그룹에 속하는 경우, 현재 블록에 대해 순방향의 NSPT가 적용되지 않을 수 있다. 현재 블록의 크기가 제2 그룹에 속하는 경우, 현재 블록의 레지듀얼 샘플에 순방향의 분리 일차 변환(e.g., DCT-2)을 적용하여 변환 계수들을 유도할 수 있다. 상기 분리 일차 변환을 통해 유도된 변환 계수들 전부 또는 일부에 대해 순방향의 LFNST가 추가적으로 적용될 수도 있다.

- [345] 또한, 상기 NSPT는 현재 블록의 트리 타입 또는 성분 타입 중 적어도 하나에 기초하여 적용될 수 있다. 상기 NSPT를 위한 NSPT 커널(또는, NSPT 행렬)은, 인트라 예측 모드 간의 대칭성 또는 블록 형태 간의 대칭성을 이용하여 결정될 수 있다. $M \times N$ 의 현재 블록에 대해 순방향의 NSPT가 적용되는 경우, NSPT 커널은 $r \times MN$ 으로 표현될 수 있다. 여기서 r 은 NSPT의 출력 길이 또는 NSPT에 의해 생성되는 변환 계수의 개수를 의미하고, MN 은 현재 블록의 너비와 높이의 곱으로서, NSPT의 입력 길이 또는 NSPT가 적용되는 레지듀얼 샘플의 개수를 의미할 수 있다. 이러한 NSPT 커널의 크기를 결정하는 방법에 대해서는 도 4를 참조하여 살펴본 바와 같다.
- [346] 변환을 위한 LFNST 인덱스 및/또는 NSPT 인덱스는 통합된 하나의 신텍스로 부호화될 수도 있고, LFNST 인덱스와 NSPT 인덱스가 각각 부호화되어 비트스트림에 삽입될 수도 있다. LFNST 인덱스와 NSPT 인덱스에 대한 이진화, 그리고 CABAC 컨텍스트와 초기 값의 할당에 대해서는 도 4를 참조하여 살펴본 바와 같다.
- [347] 또한, 도 4를 참조하여 변환 인덱스를 시그널링하는 방법을 살펴보았으며, 이는 변환을 변환 인덱스를 부호화하는 방법에도 동일하게 적용될 수 있다.
- [348] 도 7을 참조하면, 현재 블록의 변환 계수를 부호화하여 비트스트림을 생성할 수 있다(S720).
- [349] 상기 현재 블록의 변환 계수를 기반으로, 상기 변환 계수에 관한 레지듀얼 정보가 생성될 수 있고, 레지듀얼 정보를 부호화하여 비트스트림이 생성될 수 있다.
- [350] 도 8은 본 개시에 따른 영상 인코딩 방법을 수행하는 인코딩 장치(200)의 개략적인 구성을 도시한 것이다.
- [351] 도 8을 참조하면, 본 개시에 따른 인코딩 장치(200)는, 레지듀얼 샘플 유도부(800), 변환 계수 유도부(810) 및 변환 계수 인코딩부(820)를 포함할 수 있다. 레지듀얼 샘플 유도부(800)와 변환 계수 유도부(810)는 도 2의 레지듀얼 처리부(230)에 구성될 수 있고, 변환 계수 인코딩부(820)는 도 2의 엔트로피 인코딩부(240)에 구성될 수 있다.
- [352] 레지듀얼 샘플 유도부(800)는, 현재 블록의 원본 샘플에서 예측 샘플을 차분하여 현재 블록의 레지듀얼 샘플을 유도할 수 있다. 여기서, 예측 샘플은, 소정의 인트라 예측 모드에 기초하여 유도된 것일 수 있다.
- [353] 변환 계수 유도부(810)는, 현재 블록의 레지듀얼 샘플에 변환 또는 양자화 중 적어도 하나를 수행하여 현재 블록의 변환 계수를 유도할 수 있다. 변환 계수 유도부(810)는, 전술한 실시예 1 내지 3 중 적어도 하나에 기초하여 현재 블록의 변환

커널을 결정하고, 현재 블록의 레지듀얼 샘플에 상기 변환 커널을 적용하여 변환 계수를 유도할 수 있다.

[354] 변환 계수 인코딩부(820)는, 현재 블록의 변환 계수를 부호화하여 비트스트림을 생성할 수 있다.

[355] 상술한 실시예에서, 방법들은 일련의 단계 또는 블록으로써 순서도를 기초로 설명되고 있지만, 해당 실시예는 단계들의 순서에 한정되는 것은 아니며, 어떤 단계는 상술한 바와 다른 단계와 다른 순서로 또는 동시에 발생할 수 있다. 또한, 당업자라면 순서도에 나타내어진 단계들이 배타적이지 않고, 다른 단계가 포함되거나 순서도의 하나 또는 그 이상의 단계가 본 문서의 실시예들의 범위에 영향을 미치지 않고 삭제될 수 있음을 이해할 수 있을 것이다.

[356] 상술한 본 문서의 실시예들에 따른 방법은 소프트웨어 형태로 구현될 수 있으며, 본 문서에 따른 인코딩 장치 및/또는 디코딩 장치는 예를 들어 TV, 컴퓨터, 스마트폰, 셋톱박스, 디스플레이 장치 등의 영상 처리를 수행하는 장치에 포함될 수 있다.

[357] 본 문서에서 실시예들이 소프트웨어로 구현될 때, 상술한 방법은 상술한 기능을 수행하는 모듈(과정, 기능 등)로 구현될 수 있다. 모듈은 메모리에 저장되고, 프로세서에 의해 실행될 수 있다. 메모리는 프로세서 내부 또는 외부에 있을 수 있고, 잘 알려진 다양한 수단으로 프로세서와 연결될 수 있다. 프로세서는 ASIC(application-specific integrated circuit), 다른 칩셋, 논리 회로 및/또는 데이터 처리 장치를 포함할 수 있다. 메모리는 ROM(read-only memory), RAM(random access memory), 플래쉬 메모리, 메모리 카드, 저장 매체 및/또는 다른 저장 장치를 포함할 수 있다. 즉, 본 문서에서 설명한 실시예들은 프로세서, 마이크로 프로세서, 컨트롤러 또는 칩 상에서 구현되어 수행될 수 있다. 예를 들어, 각 도면에서 도시한 기능 유닛들은 컴퓨터, 프로세서, 마이크로 프로세서, 컨트롤러 또는 칩 상에서 구현되어 수행될 수 있다. 이 경우 구현을 위한 정보(ex. information on instructions) 또는 알고리즘이 디지털 저장 매체에 저장될 수 있다.

[358] 또한, 본 명세서의 실시예(들)이 적용되는 디코딩 장치 및 인코딩 장치는 멀티미디어 방송 송수신 장치, 모바일 통신 단말, 홈 시네마 비디오 장치, 디지털 시네마 비디오 장치, 감시용 카메라, 비디오 대화 장치, 비디오 통신과 같은 실시간 통신 장치, 모바일 스트리밍 장치, 저장 매체, 캠코더, 주문형 비디오(VoD) 서비스 제공 장치, OTT 비디오(Over the top video) 장치, 인터넷 스트리밍 서비스 제공 장치, 3차원(3D) 비디오 장치, VR(virtual reality) 장치, AR(argumente reality) 장치, 화상 전화 비디오 장치, 운송 수단 단말(ex. 차량(자율주행차량 포함) 단말, 비행기 단말, 선박 단말 등) 및 의료용 비디오 장치 등에 포함될 수 있으며, 비디오 신호 또는 데이터 신호를 처리하기 위해 사용될 수 있다. 예를 들어, OTT 비디오(Over the top video) 장치로는 게임 콘솔, 블루레이 플레이어, 인터넷 접속 TV, 홈시어터 시스템, 스마트폰, 태블릿 PC, DVR(Digital Video Recorder) 등을 포함할 수 있다.

- [359] 또한, 본 명세서의 실시예(들)이 적용되는 처리 방법은 컴퓨터로 실행되는 프로그램의 형태로 생산될 수 있으며, 컴퓨터가 판독할 수 있는 기록 매체에 저장될 수 있다. 본 명세서의 실시예(들)에 따른 데이터 구조를 가지는 멀티미디어 데이터도 또한 컴퓨터가 판독할 수 있는 기록 매체에 저장될 수 있다. 상기 컴퓨터가 판독할 수 있는 기록 매체는 컴퓨터로 읽을 수 있는 데이터가 저장되는 모든 종류의 저장 장치 및 분산 저장 장치를 포함한다. 상기 컴퓨터가 판독할 수 있는 기록 매체는, 예를 들어, 블루레이 디스크(BD), 범용 직렬 버스(USB), ROM, PROM, EPROM, EEPROM, RAM, CD-ROM, 자기 테이프, 플로피 디스크 및 광학적 데이터 저장 장치를 포함할 수 있다. 또한, 상기 컴퓨터가 판독할 수 있는 기록 매체는 반송파(예를 들어, 인터넷을 통한 전송)의 형태로 구현된 미디어를 포함한다. 또한, 인코딩 방법으로 생성된 비트스트림이 컴퓨터가 판독할 수 있는 기록 매체에 저장되거나 유무선 통신 네트워크를 통해 전송될 수 있다.
- [360] 또한, 본 명세서의 실시예(들)은 프로그램 코드에 의한 컴퓨터 프로그램 제품으로 구현될 수 있고, 상기 프로그램 코드는 본 명세서의 실시예(들)에 의해 컴퓨터에서 수행될 수 있다. 상기 프로그램 코드는 컴퓨터에 의해 판독가능한 캐리어 상에 저장될 수 있다.
- [361] 도 9는 본 개시의 실시예들이 적용될 수 있는 콘텐츠 스트리밍 시스템의 예를 나타낸다.
- [362] 도 9를 참조하면, 본 명세서의 실시예(들)이 적용되는 콘텐츠 스트리밍 시스템은 크게 인코딩 서버, 스트리밍 서버, 웹 서버, 미디어 저장소, 사용자 장치 및 멀티미디어 입력 장치를 포함할 수 있다.
- [363] 상기 인코딩 서버는 스마트폰, 카메라, 캠코더 등과 같은 멀티미디어 입력 장치들로부터 입력된 콘텐츠를 디지털 데이터로 압축하여 비트스트림을 생성하고 이를 상기 스트리밍 서버로 전송하는 역할을 한다. 다른 예로, 스마트폰, 카메라, 캠코더 등과 같은 멀티미디어 입력 장치들이 비트스트림을 직접 생성하는 경우, 상기 인코딩 서버는 생략될 수 있다.
- [364] 상기 비트스트림은 본 명세서의 실시예(들)이 적용되는 인코딩 방법 또는 비트스트림 생성 방법에 의해 생성될 수 있고, 상기 스트리밍 서버는 상기 비트스트림을 전송 또는 수신하는 과정에서 일시적으로 상기 비트스트림을 저장할 수 있다.
- [365] 상기 스트리밍 서버는 웹 서버를 통한 사용자 요청에 기초하여 멀티미디어 데이터를 사용자 장치에 전송하고, 상기 웹 서버는 사용자에게 어떠한 서비스가 있는지를 알려주는 매개체 역할을 한다. 사용자가 상기 웹 서버에 원하는 서비스를 요청하면, 상기 웹 서버는 이를 스트리밍 서버에 전달하고, 상기 스트리밍 서버는 사용자에게 멀티미디어 데이터를 전송한다. 이때, 상기 콘텐츠 스트리밍 시스템은 별도의 제어 서버를 포함할 수 있고, 이 경우 상기 제어 서버는 상기 콘텐츠 스트리밍 시스템 내 각 장치 간 명령/응답을 제어하는 역할을 한다.

- [366] 상기 스트리밍 서버는 미디어 저장소 및/또는 인코딩 서버로부터 콘텐츠를 수신할 수 있다. 예를 들어, 상기 인코딩 서버로부터 콘텐츠를 수신하게 되는 경우, 상기 콘텐츠를 실시간으로 수신할 수 있다. 이 경우, 원활한 스트리밍 서비스를 제공하기 위하여 상기 스트리밍 서버는 상기 비트스트림을 일정 시간동안 저장할 수 있다.
- [367] 상기 사용자 장치의 예로는, 휴대폰, 스마트 폰(smart phone), 노트북 컴퓨터(laptop computer), 디지털방송용 단말기, PDA(personal digital assistants), PMP(portable multimedia player), 네비게이션, 슬레이트 PC(slate PC), 태블릿 PC(tablet PC), 울트라북(ultrabook), 웨어러블 디바이스(wearable device, 예를 들어, 위치형 단말기 (smartwatch), 글래스형 단말기 (smart glass), HMD(head mounted display)), 디지털 TV, 데스크탑 컴퓨터, 디지털 사이니지 등이 있을 수 있다.
- [368] 상기 콘텐츠 스트리밍 시스템 내 각 서버들은 분산 서버로 운영될 수 있으며, 이 경우 각 서버에서 수신하는 데이터는 분산 처리될 수 있다.
- [369] 본 명세서에 기재된 청구항들은 다양한 방식으로 조합될 수 있다. 예를 들어, 본 명세서의 방법 청구항의 기술적 특징이 조합되어 장치로 구현될 수 있고, 본 명세서의 장치 청구항의 기술적 특징이 조합되어 방법으로 구현될 수 있다. 또한, 본 명세서의 방법 청구항의 기술적 특징과 장치 청구항의 기술적 특징이 조합되어 장치로 구현될 수 있고, 본 명세서의 방법 청구항의 기술적 특징과 장치 청구항의 기술적 특징이 조합되어 방법으로 구현될 수 있다.

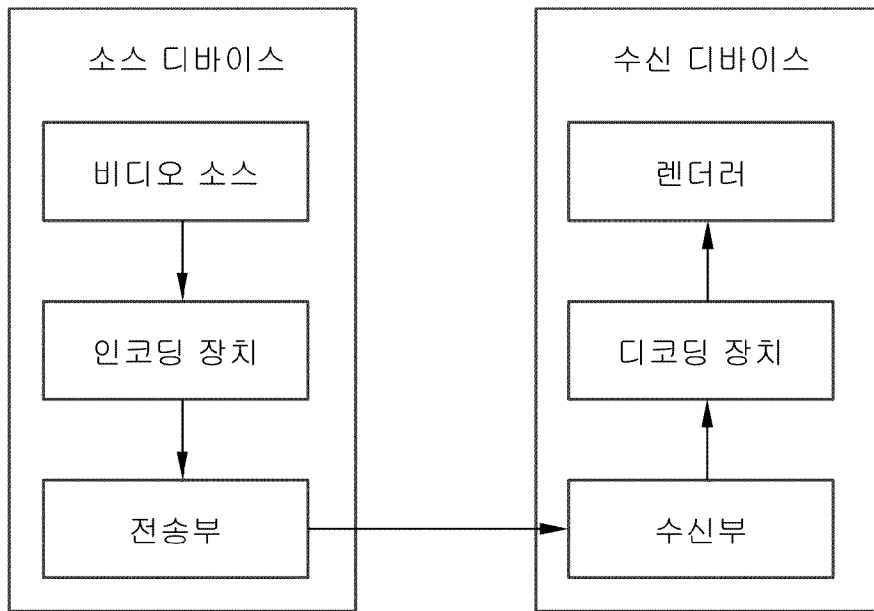
청구범위

- [청구항 1] 비트스트림으로부터 현재 블록의 변환 계수들을 유도하는 단계;
 상기 현재 블록에 대한 비분리 일차 변환(non-separable primary transform, NSPT) 세트를 결정하는 단계;
 상기 NSPT 세트와 변환 인덱스를 기반으로 상기 현재 블록의 NSPT 커널을 결정하는 단계; 여기서, 상기 변환 인덱스는 상기 NSPT 세트에 속한 복수의 NSPT 커널 후보들 중 어느 하나를 특정함,
 상기 NSPT 커널을 기반으로 상기 현재 블록의 변환 계수들에 대해 NSPT를 수행하여, 상기 현재 블록의 레지듀얼 샘플들을 유도하는 단계; 및
 상기 레지듀얼 샘플들을 기반으로 상기 현재 블록을 복원하는 단계를 포함하고,
 상기 NSPT는, 상기 현재 블록의 크기가 상기 NSPT가 적용될 수 있는 하나 또는 그 이상의 블록 크기들의 그룹에 속하는 것에 기초하여 적용되는, 영상 디코딩 방법.
- [청구항 2] 제1항에 있어서,
 상기 NSPT 세트는 기-정의된 35개의 NSPT 세트들 중 어느 하나로 결정되는, 영상 디코딩 방법.
- [청구항 3] 제1항에 있어서,
 상기 NSPT 세트는 3개의 NSPT 커널 후보들을 포함하는, 영상 디코딩 방법.
- [청구항 4] 제1항에 있어서,
 상기 그룹은, 4x4, 4x8, 8x4, 8x8, 16x8, 8x16, 16x4, 4x16, 8x32, 또는 32x8 중 적어도 하나의 블록 크기를 포함하는, 영상 디코딩 방법.
- [청구항 5] 제1항에 있어서,
 상기 현재 블록의 크기가 8x32 또는 32x8인 것에 기초하여, 상기 NSPT가 적용되는 변환 계수들의 개수는 48보다 작거나 같은, 영상 디코딩 방법.
- [청구항 6] 현재 블록의 레지듀얼 샘플들을 유도하는 단계;
 상기 현재 블록에 대한 비분리 일차 변환(non-separable primary transform, NSPT) 세트를 결정하는 단계;
 상기 NSPT 세트로에 속한 복수의 NSPT 커널 후보들 중 어느 하나를 기반으로 상기 현재 블록의 레지듀얼 샘플들에 대해 NSPT를 적용하여, 상기 현재 블록의 변환 계수들을 유도하는 단계; 및
 상기 현재 블록의 변환 계수들 및 상기 복수의 NSPT 커널 후보들 중 어느 하나를 특정하는 변환 인덱스를 부호화하여 비트스트림을 생성하는 단계를 포함하되,

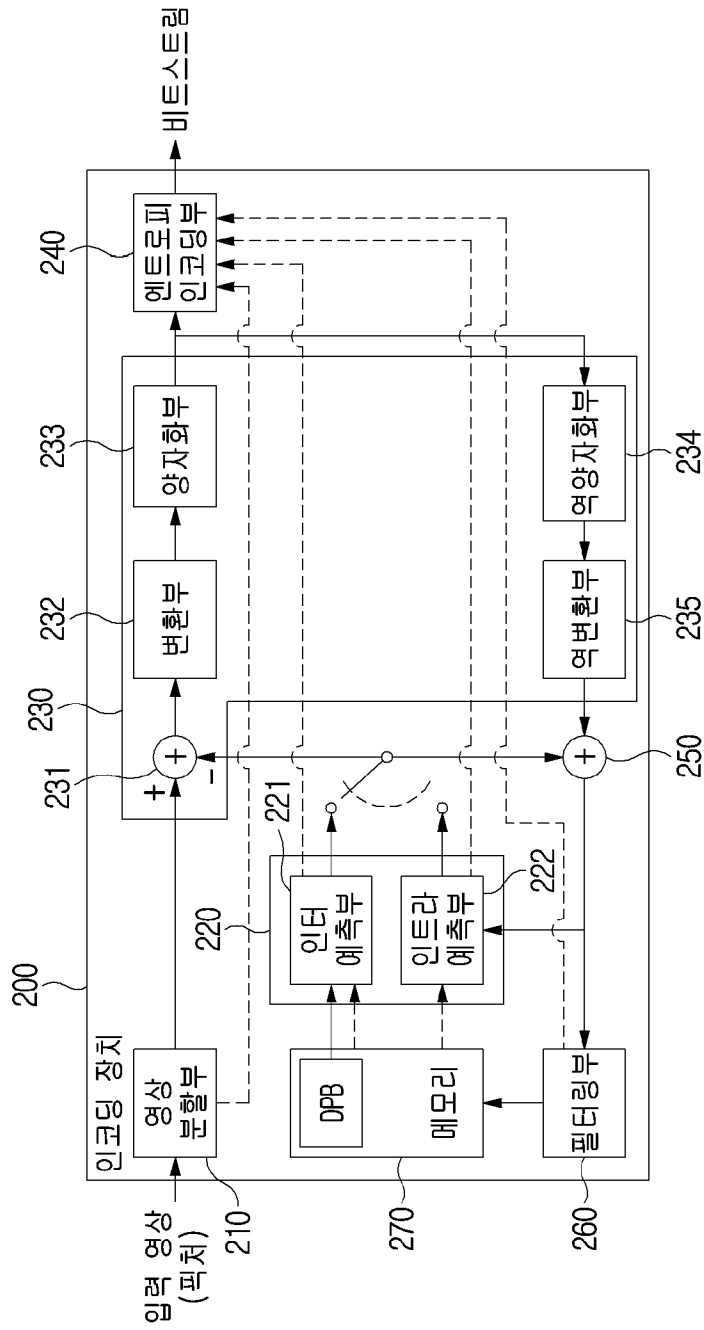
상기 NSPT는, 상기 현재 블록의 크기가 상기 NSPT가 적용될 수 있는 하나 또는 그 이상의 블록 크기들의 그룹에 속하는 것에 기초하여 적용되는, 영상 인코딩 방법.

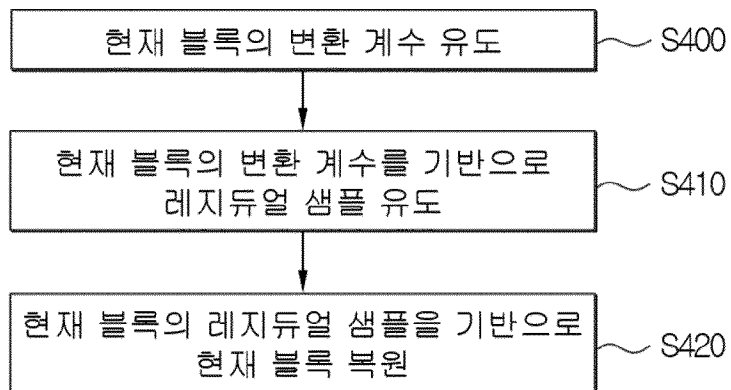
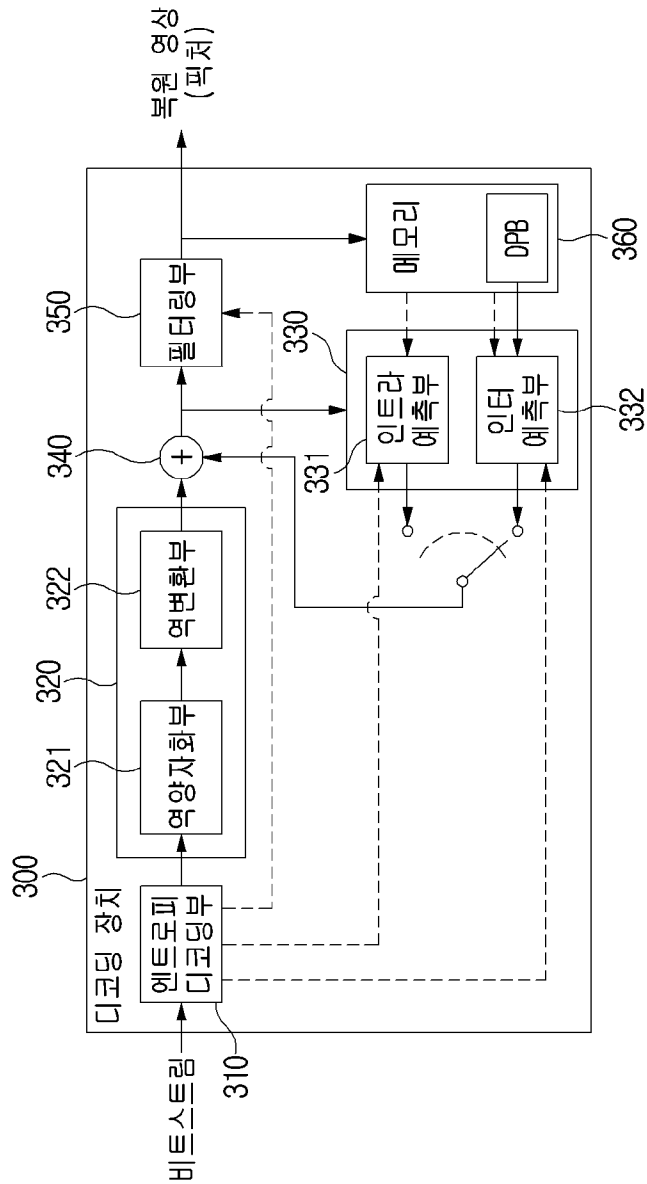
- [청구항 7] 제6항에 있어서,
상기 NSPT 세트는, 기-정의된 35개의 NSPT 세트들 중 어느 하나로 결정되는, 영상 인코딩 방법.
- [청구항 8] 제6항에 있어서,
상기 NSPT 세트는 3개의 NSPT 커널 후보들을 포함하는, 영상 인코딩 방법.
- [청구항 9] 제6항에 있어서,
상기 그룹은, 4x4, 4x8, 8x4, 8x8, 16x8, 8x16, 16x4, 4x16, 8x32, 또는 32x8 중 적어도 하나의 블록 크기를 포함하는, 영상 인코딩 방법.
- [청구항 10] 제6항에 있어서,
상기 현재 블록의 크기가 8x32 또는 32x8인 것에 기초하여, 상기 NSPT를 통해 유도되는 변환 계수들의 개수는 48보다 작거나 같은, 영상 인코딩 방법.
- [청구항 11] 제6항에 따른 영상 인코딩 방법에 의해 생성된 비트스트림을 저장하는 컴퓨터 판독 가능한 저장 매체.
- [청구항 12] 영상 정보에 대한 비트스트림을 획득하는 단계; 여기서, 상기 비트스트림은, 현재 블록의 레지듀얼 샘플들을 유도하고, 상기 현재 블록에 대한 비분리 일차 변환(non-separable primary transform, NSPT) 세트를 결정하고, 상기 NSPT 세트에 속한 복수의 NSPT 커널 후보들 중 어느 하나를 기반으로 상기 현재 블록의 레지듀얼 샘플들에 대해 NSPT를 적용하여, 상기 현재 블록의 변환 계수들을 유도하고, 상기 현재 블록의 변환 계수들 및 상기 복수의 NSPT 커널 후보들 중 어느 하나를 특정하는 변환 인덱스를 부호화하여 생성됨, 및
상기 비트스트림을 포함한 데이터를 전송하는 단계를 포함하되,
상기 NSPT는, 상기 현재 블록의 크기가 상기 NSPT가 적용될 수 있는 하나 또는 그 이상의 블록 크기들의 그룹에 속하는 것에 기초하여 적용되는, 데이터 전송 방법.

[도1]

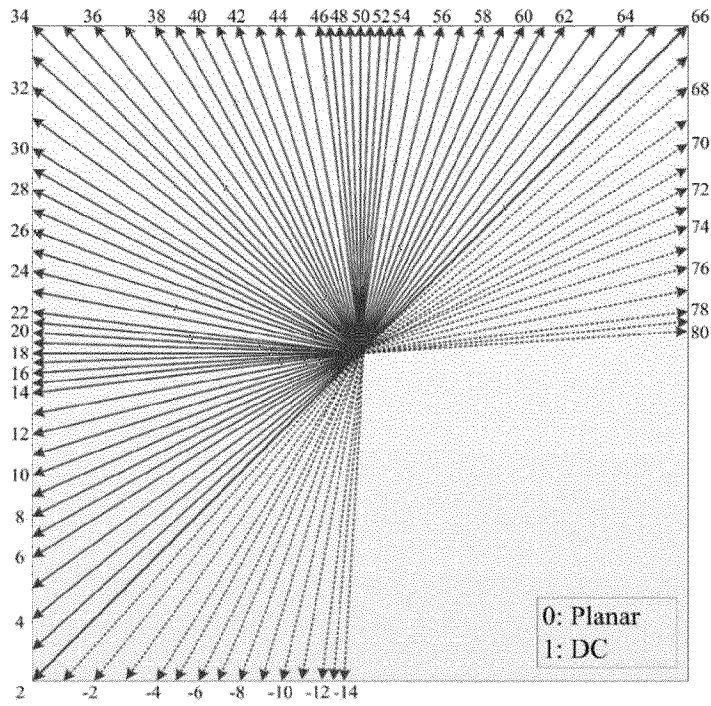


[도2]

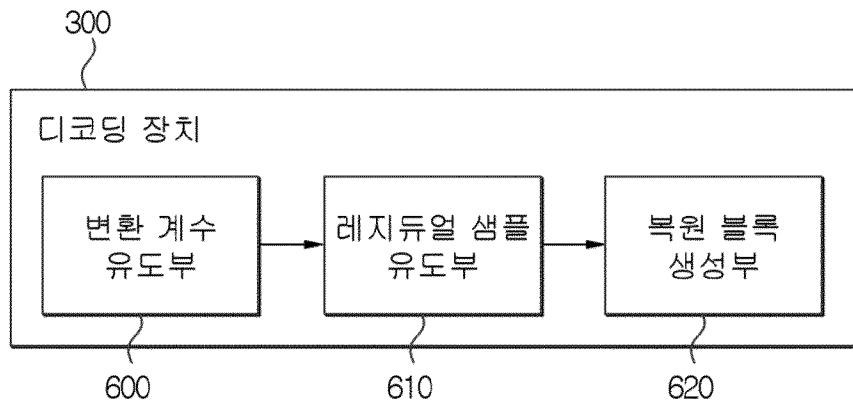




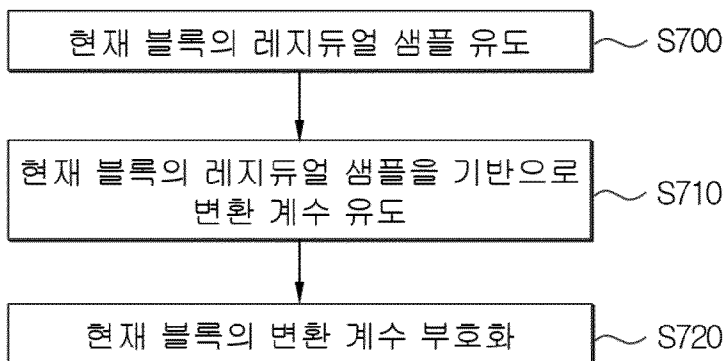
[도5]



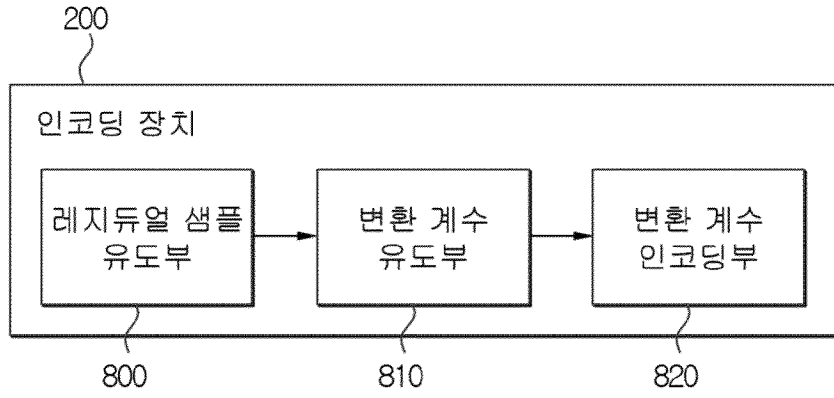
[도6]



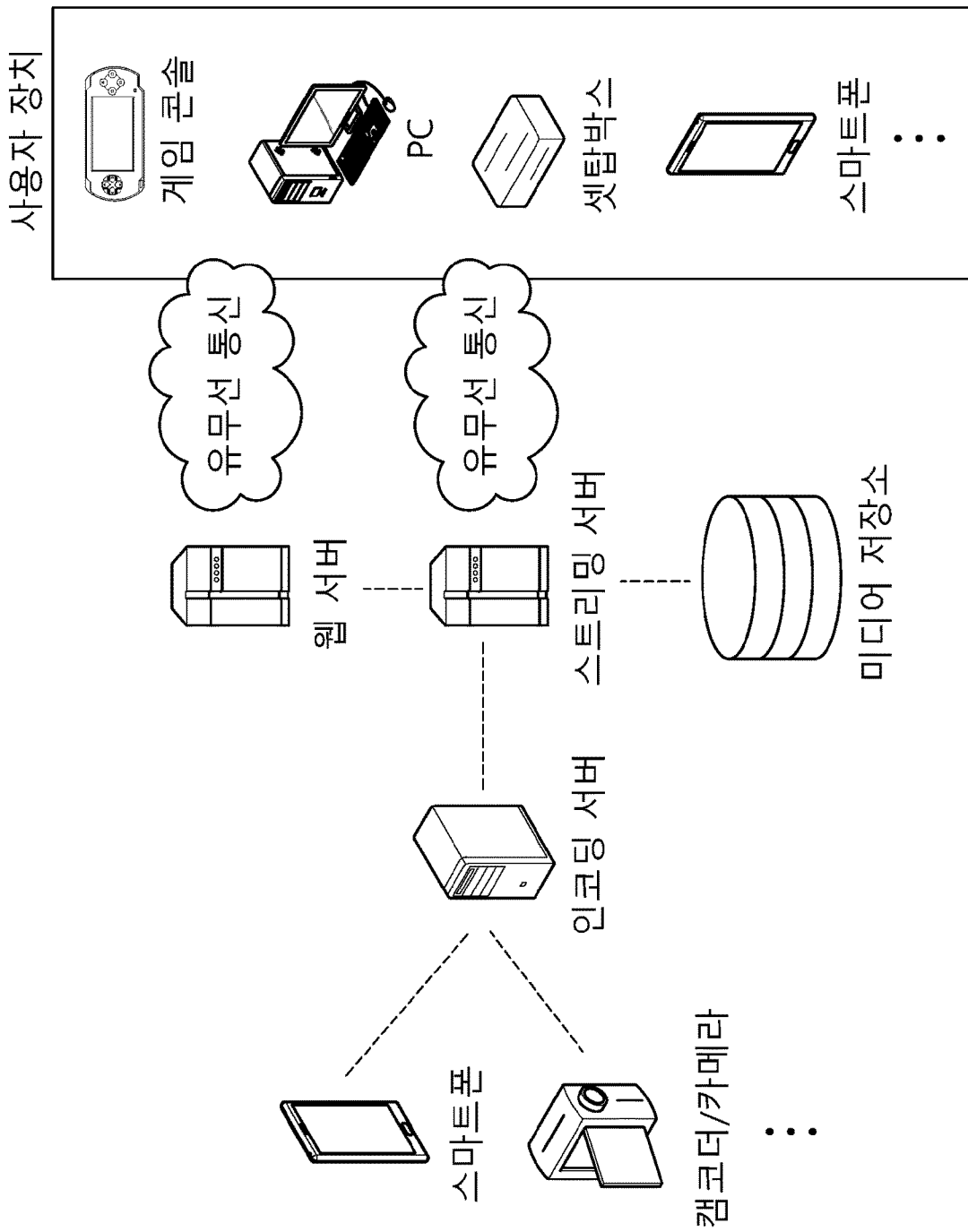
[도7]



[도8]



[도9]



INTERNATIONAL SEARCH REPORT

International application No.

PCT/KR2024/007915

A. CLASSIFICATION OF SUBJECT MATTER**H04N 19/122(2014.01)i; H04N 19/60(2014.01)i; H04N 19/176(2014.01)i; H04N 19/70(2014.01)i**

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

H04N 19/122(2014.01); H04N 19/11(2014.01); H04N 19/12(2014.01); H04N 19/18(2014.01); H04N 19/60(2014.01);
H04N 19/61(2014.01)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean utility models and applications for utility models: IPC as above
Japanese utility models and applications for utility models: IPC as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKOMPASS (KIPO internal) & keywords: 복호화(decoding), 변환 계수(transform coefficient), 비분리(non-separable), 일차(primary), 잔차(residual), 세트(set), 커널(kernel)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 2023-075353 A1 (LG ELECTRONICS INC.) 04 May 2023 (2023-05-04) See paragraphs [0077] and [0213]; and claims 1 and 19-20.	1-12
Y	GARUS, Patrick et al. EE2-4.2: Non-Separable Primary Transform for Intra Coding. JVET-AC0130-v2, Joint Video Experts Team (JVET) of ITU-T SG 16 WP 3 and ISO/IEC JTC 1/SC 29/WG 11, 29th Meeting, by teleconference. pp. 1-5, 10 January 2023. See pages 1-2; and figure 1.	1-12
Y	KOO, Moonmo et al. Non-EE2: On large NSPT. JVET-AD0187-v1, Joint Video Experts Team (JVET) of ITU-T SG 16 WP 3 and ISO/IEC JTC 1/SC 29, 30th Meeting. Antalya, TR. pp. 1-2, 14 April 2023. See page 1.	5,10
A	KR 10-2021-0135320 A (TENCENT AMERICA LLC) 12 November 2021 (2021-11-12) See claims 1-11.	1-12
A	KR 10-2435840 B1 (QUALCOMM INCORPORATED) 23 August 2022 (2022-08-23) See claims 14-17, 19 and 21-22.	1-12



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

“A” document defining the general state of the art which is not considered to be of particular relevance
“D” document cited by the applicant in the international application
“E” earlier application or patent but published on or after the international filing date
“L” document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
“O” document referring to an oral disclosure, use, exhibition or other means
“P” document published prior to the international filing date but later than the priority date claimed

“T” later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

“X” document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

“Y” document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

“&” document member of the same patent family

Date of the actual completion of the international search

20 September 2024

Date of mailing of the international search report

20 September 2024

Name and mailing address of the ISA/KR

**Korean Intellectual Property Office
Government Complex-Daejeon Building 4, 189 Cheongsaro, Seo-gu, Daejeon 35208**

Facsimile No. +82-42-481-8578

Authorized officer

Telephone No.

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/KR2024/007915

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)		Publication date (day/month/year)
WO	2023-075353	A1	04 May 2023	KR 10-2024-0097825	A	27 June 2024
KR	10-2021-0135320	A	12 November 2021	CN 113853745	A	28 December 2021
				EP 4066385	A1	05 October 2022
				JP 2022-526400	A	24 May 2022
				JP 7285954	B2	02 June 2023
				US 11800126	B2	24 October 2023
				US 2023-0421790	A1	28 December 2023
				WO 2021-108027	A1	03 June 2021
KR	10-2435840	B1	23 August 2022	CN 110800300	A	14 February 2020
				CN 110800300	B	07 June 2024
				EP 3646592	A1	06 May 2020
				KR 10-2020-0021944	A	02 March 2020
				US 11134272	B2	28 September 2021
				US 2019-0007705	A1	03 January 2019
				WO 2019-006148	A1	03 January 2019

A. 발명이 속하는 기술분류(국제특허분류(IPC)) H04N 19/122(2014.01)i; H04N 19/60(2014.01)i; H04N 19/176(2014.01)i; H04N 19/70(2014.01)i		
B. 조사된 분야 조사된 최소문헌(국제특허분류를 기재) H04N 19/122(2014.01); H04N 19/11(2014.01); H04N 19/12(2014.01); H04N 19/18(2014.01); H04N 19/60(2014.01); H04N 19/61(2014.01) 조사된 기술분야에 속하는 최소문헌 이외의 문헌 한국등록실용신안공보 및 한국공개실용신안공보: 조사된 최소문헌란에 기재된 IPC 일본등록실용신안공보 및 일본공개실용신안공보: 조사된 최소문헌란에 기재된 IPC 국제조사에 이용된 전산 데이터베이스(데이터베이스의 명칭 및 검색어(해당하는 경우)) eKOMPASS(특허청 내부 검색시스템) & 키워드: 복호화(decoding), 변환 계수(transform coefficient), 비분리(non-separable), 일차(primary), 잔차(residual), 세트(set), 커널(kernel)		
C. 관련 문헌		
카테고리*	인용문헌명 및 관련 구절(해당하는 경우)의 기재	관련 청구항
Y	WO 2023-075353 A1 (LG ELECTRONICS INC.) 2023.05.04 단락 [0077], [0213]; 및 청구항 1, 19-20	1-12
Y	PATRICK GARUS 등, 'EE2-4.2: Non-Separable Primary Transform for Intra Coding', JVET-AC0130-v2, Joint Video Experts Team (JVET) of ITU-T SG 16 WP 3 and ISO/IEC JTC 1/SC 29/WG 11, 29th Meeting, by teleconference, 페이지 1-5, 2023.01.10 페이지 1-2; 및 도면 1	1-12
Y	MOONMO KOO 등, 'Non-EE2: On large NSPT', JVET-AD0187-v1, Joint Video Experts Team (JVET) of ITU-T SG 16 WP 3 and ISO/IEC JTC 1/SC 29, 30th Meeting, Antalya, TR, 페이지 1-2, 2023.04.14 페이지 1	5,10
A	KR 10-2021-0135320 A (텐센트 아메리카 엔앤씨) 2021.11.12 청구항 1-11	1-12
A	KR 10-2435840 B1 (웹컴 인코퍼레이티드) 2022.08.23 청구항 14-17, 19, 21-22	1-12
☐ 추가 문헌이 C(계속)에 기재되어 있습니다. ☒ 대응특허에 관한 별지를 참조하십시오.		
* 인용된 문헌의 특별 카테고리: "A" 특별히 관련이 없는 것으로 보이는 일반적인 기술수준을 정의한 문헌 "D" 본 국제출원에서 출원인이 인용한 문헌 "E" 국제출원일보다 빠른 출원일 또는 우선일을 가지나 국제출원일 이후에 공개된 선출원 또는 특허 문헌 "L" 우선권 주장에 의문을 제기하는 문헌 또는 다른 인용문헌의 공개일 또는 다른 특별한 이유(이유를 명시)를 밝히기 위하여 인용된 문헌 "O" 구두 개시, 사용, 전시 또는 기타 수단을 언급하고 있는 문헌 "P" 우선일 이후에 공개되었으나 국제출원일 이전에 공개된 문헌 "T" 국제출원일 또는 우선일 후에 공개된 문헌으로, 출원과 상충하지 않으며 발명의 기초가 되는 원리나 이론을 이해하기 위해 인용된 문헌 "X" 특별한 관련이 있는 문헌. 해당 문헌 하나만으로 청구된 발명의 신규성 또는 진보성이 없는 것으로 본다. "Y" 특별한 관련이 있는 문헌. 해당 문헌이 하나 이상의 다른 문헌과 조합하는 경우로 그 조합이 당업자에게 자명한 경우 청구된 발명은 진보성이 없는 것으로 본다. "&" 동일한 대응특허문헌에 속하는 문헌		
국제조사의 실제 완료일 2024년09월20일(20.09.2024)		국제조사보고서 발송일 2024년09월20일(20.09.2024)
ISA/KR의 명칭 및 우편주소 대한민국 특허청 (35208) 대전광역시 서구 청사로 189, 4동 (둔산동, 정부대전청사) 팩스 번호 +82-42-481-8578		심사관 양정록 전화번호 +82-42-481-5709

국제조사보고서에서 인용된 특허문헌	공개일	대응특허문헌	공개일
WO 2023-075353 A1	2023/05/04	KR 10-2024-0097825 A	2024/06/27
KR 10-2021-0135320 A	2021/11/12	CN 113853745 A	2021/12/28
		EP 4066385 A1	2022/10/05
		JP 2022-526400 A	2022/05/24
		JP 7285954 B2	2023/06/02
		US 11800126 B2	2023/10/24
		US 2023-0421790 A1	2023/12/28
		WO 2021-108027 A1	2021/06/03
KR 10-2435840 B1	2022/08/23	CN 110800300 A	2020/02/14
		CN 110800300 B	2024/06/07
		EP 3646592 A1	2020/05/06
		KR 10-2020-0021944 A	2020/03/02
		US 11134272 B2	2021/09/28
		US 2019-0007705 A1	2019/01/03
		WO 2019-006148 A1	2019/01/03