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(71) Applicant: JPMORGAN CHASE BANK, N.A. [US/US];

383 Madison Avenue, New York, New York 10179 (US).

(72) Inventors: ZEHTABI, Parisa; c/o JPMorgan Chase Bank,

N.A., 383 Madison Avenue, New York, New York 10179

(US). MAHFOUZ, Mahmoud Ahmed; c/o JPMorgan

Chase Bank, N.A., 383 Madison Avenue, New York, New

York 10179 (US). BORRAJO, Daniel; c/o JPMorgan

Chase Bank, N.A., 383 Madison Avenue, New York, New

York 10179 (US). MAGAZZENI, Daniele; c/o JPMor-

gan Chase Bank, N.A., 383 Madison Avenue, New York,

New York 10179 (US). VELOSO, Manuela; c/o JPMor-

gan Chase Bank, N.A., 383 Madison Avenue, New York,

New York 10179 (US). WU, Yufei; c/o JPMorgan Chase

Bank, N.A., 383 Madison Avenue, New York, New York

10179 (US). ANZAGIRA, Allan; c/o JPMorgan Chase

Bank, N.A., 383 Madison Avenue, New York, New York

10179 (US). PATRA, Sunandita; c/o JPMorgan Chase

Bank, N.A., 383 Madison Avenue, New York, 10179 (US).

HORN, Jonathan Roger; c/o JPMorgan Chase Bank,

N.A., 383 Madison Avenue, New York, New York 10179

(US). RASCO, Tracy; c/o JPMorgan Chase Bank, N.A.,

383 Madison Avenue, New York, 10179 (US). KADRI,

Raghavendra; c/o JPMorgan Chase Bank, N.A., 383 Madi-

son Avenue, New York, New York 10179 (US). ONIG-

BANJO, Ade; c/o JPMorgan Chase Bank, N.A., 383 Madi-

son Avenue, New York, New York 10179 (US).

(74) Agent: MUELLER, Robert W. et al.; GREENBLUM &

BERNSTEIN, P.L.C., 1950 Roland Clarke Place, Reston,

Virginia 20191 (US).

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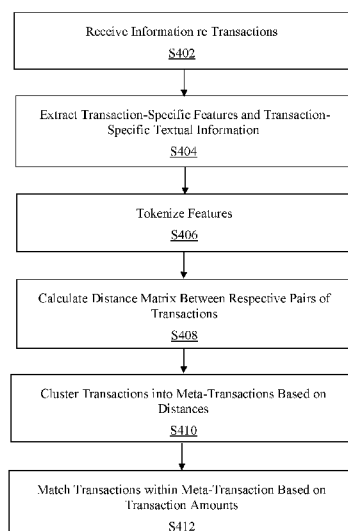


FIG. 4

(57) Abstract: A method and a system for solving transactions reconciliation tasks by integrating clustering and optimization are provided. The method includes: receiving first information that relates to a plurality of transactions; extracting, from the first information, a set of transaction-specific features and a set of transaction-specific textual information; generating at least one meta-transaction by clustering a subset of the plurality of transactions based on the extracted set of transaction-specific features and the extracted set of transaction-specific textual information; and matching transactions from within the clustered subset based on the amounts of the transactions.

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METHOD FOR SOLVING RECONCILIATION TASKS BY INTEGRATING CLUSTERING AND OPTIMIZATION

BACKGROUND

1. Field of the Disclosure

[0001] This technology generally relates to methods and systems for performing transactions reconciliation, and more particularly to methods and systems for solving transactions reconciliation tasks by integrating clustering and optimization.

2. Background Information

[0002] Transactions reconciliation is the process of ensuring that transaction details between two or more parties to a particular transaction are matching. This process is an important activity that is carried out by financial institutions, and it is typically quite labor-intensive and time consuming.

[0003] Reconciliations are performed on an everyday basis. For a large financial institution, the volume of transactions to be matched and reconciled may be on the order of several millions of transactions per month.

[0004] In many instances, a reconciliation is completed on the same day as the execution of the corresponding transaction; these reconciliations may be referred to as matches. In some cases, a reconciliation for a particular transaction may not be completed until a subsequent day; these cases may be referred to as breaks.

[0005] Conventionally, many transactions reconciliations may be performed by using a rule-based system. Such a rule-based system may be suitable for handling most reconciliations, i.e., upwards of 80% of matches and breaks. In addition, some financial institutions may utilize customized systems for processing some number of transactions reconciliations. However, there remains a significant percentage of transactions reconciliations that must be handled manually, and in view of the huge volume of transactions, such manual processes are quite cumbersome and expensive. Accordingly, there is a need for an automated mechanism for solving transactions reconciliation tasks that would otherwise require manual processing.

SUMMARY

[0006] The present disclosure, through one or more of its various aspects, embodiments, and/or specific features or sub-components, provides, inter alia, various systems, servers, devices, methods, media, programs, and platforms for solving transactions reconciliation tasks by integrating clustering and optimization.

[0007] According to an aspect of the present disclosure, a method for reconciling transactions is provided. The method is implemented by at least one processor. The method includes: receiving, by the at least one processor, first information that relates to a plurality of transactions; extracting, by the at least one processor from the first information, a set of transaction-specific features and a set of transaction-specific textual information; generating, by the at least one processor, at least one meta-transaction by clustering a subset of the plurality of transactions based on the extracted set of transaction-specific features and the extracted set of transaction-specific textual information; and matching, by the at least one processor, at least a first transaction from among the clustered subset with at least a second transaction from among the plurality of transactions by determining that a difference between an amount of the at least the first transaction and an amount of the at least the second transaction is less than a predetermined threshold.

[0008] The set of transaction-specific features may include at least one from among a transaction code and a security code.

[0009] The set of transaction-specific textual information may include a name of a party to a transaction.

[0010] The generating of the at least one meta-transaction may include: converting the set of transaction-specific features into transaction-specific words; calculating a distance matrix between respective pairs of transactions from among the plurality of transactions based on the transaction-specific words and the transaction-specific textual information; and clustering the subset of the plurality of transactions based on the distance matrix.

[0011] The calculating of the distance matrix may include applying a Jaccard similarity algorithm to each respective pair of transactions.

[0012] The clustering may include applying a density-based spatial clustering of applications with noise (DBSCAN) algorithm to the plurality of transactions.

[0013] The matching may include applying a mixed integer programming (MIP) algorithm to each transaction included in the clustered subset of the plurality of transactions.

[0014] The predetermined threshold may be less than or equal to one dollar.

[0015] According to another aspect of the present disclosure, a computing apparatus for reconciling transactions is provided. The computing apparatus includes a processor; a memory; and a communication interface coupled to each of the processor and the memory. The processor is configured to: receive, from a user via the communication interface, first information that relates to a plurality of transactions; extract, from the first information, a set of transaction-specific features and a set of transaction-specific textual information; generate at least one meta-transaction by clustering a subset of the plurality of transactions based on the extracted set of transaction-specific features and the extracted set of transaction-specific textual information; and match at least a first transaction from among the clustered subset with at least a second transaction from among the plurality of transactions by determining that a difference between an amount of the at least the first transaction and an amount of the at least the second transaction is less than a predetermined threshold.

[0016] The set of transaction-specific features may include at least one from among a transaction code and a security code.

[0017] The set of transaction-specific textual information may include a name of a party to a transaction.

[0018] The processor may be further configured to generate the at least one meta-transaction by: converting the set of transaction-specific features into transaction-specific words; calculating a distance matrix between respective pairs of transactions from among the plurality of transactions based on the transaction-specific words and the transaction-specific textual information; and clustering the subset of the plurality of transactions based on the distance matrix.

[0019] The processor may be further configured to calculate the distance matrix by applying a Jaccard similarity algorithm to each respective pair of transactions.

[0020] The processor may be further configured to perform the clustering by applying a density-based spatial clustering of applications with noise (DBSCAN) algorithm to the plurality of transactions.

[0021] The processor may be further configured to perform the matching by applying a mixed integer programming (MIP) algorithm to each transaction included in the clustered subset of the plurality of transactions.

[0022] The predetermined threshold may be less than or equal to one dollar.

[0023] According to yet another aspect of the present disclosure, a non-transitory computer readable storage medium storing instructions for reconciling transactions is provided. The storage medium includes executable code which, when executed by a processor, causes the processor to: receive first information that relates to a plurality of transactions; extract, from the first information, a set of transaction-specific features and a set of transaction-specific textual information; generate at least one meta-transaction by clustering a subset of the plurality of transactions based on the extracted set of transaction-specific features and the extracted set of transaction-specific textual information; and match at least a first transaction from among the clustered subset with at least a second transaction from among the plurality of transactions by determining that a difference between an amount of the at least the first transaction and an amount of the at least the second transaction is less than a predetermined threshold.

[0024] The set of transaction-specific features may include at least one from among a transaction code and a security code.

[0025] The set of transaction-specific textual information may include a name of a party to a transaction.

[0026] The executable code may be further configured to cause the processor to generate the at least one meta-transaction by: converting the set of transaction-specific features into transaction-specific words; calculating a distance matrix between respective pairs of transactions from among the plurality of transactions based on the transaction-specific words and the transaction-specific textual information; and clustering the subset of the plurality of transactions based on the distance matrix.

BRIEF DESCRIPTION OF THE DRAWINGS

[0027] The present disclosure is further described in the detailed description which follows, in reference to the noted plurality of drawings, by way of non-limiting examples of preferred embodiments of the present disclosure, in which like characters represent like elements throughout the several views of the drawings.

[0028] FIG. 1 illustrates an exemplary computer system.

[0029] FIG. 2 illustrates an exemplary diagram of a network environment.

[0030] FIG. 3 shows an exemplary system for implementing a method for solving transactions reconciliation tasks by integrating clustering and optimization.

[0031] FIG. 4 is a flowchart of an exemplary process for implementing a method for solving transactions reconciliation tasks by integrating clustering and optimization.

DETAILED DESCRIPTION

[0032] Through one or more of its various aspects, embodiments and/or specific features or sub-components of the present disclosure, are intended to bring out one or more of the advantages as specifically described above and noted below.

[0033] The examples may also be embodied as one or more non-transitory computer readable media having instructions stored thereon for one or more aspects of the present technology as described and illustrated by way of the examples herein. The instructions in some examples include executable code that, when executed by one or more processors, cause the processors to carry out steps necessary to implement the methods of the examples of this technology that are described and illustrated herein.

[0034] FIG. 1 is an exemplary system for use in accordance with the embodiments described herein. The system 100 is generally shown and may include a computer system 102, which is generally indicated.

[0035] The computer system 102 may include a set of instructions that can be executed to cause the computer system 102 to perform any one or more of the methods or computer-based functions disclosed herein, either alone or in combination

with the other described devices. The computer system 102 may operate as a standalone device or may be connected to other systems or peripheral devices. For example, the computer system 102 may include, or be included within, any one or more computers, servers, systems, communication networks or cloud environment. Even further, the instructions may be operative in such cloud-based computing environment.

[0036] In a networked deployment, the computer system 102 may operate in the capacity of a server or as a client user computer in a server-client user network environment, a client user computer in a cloud computing environment, or as a peer computer system in a peer-to-peer (or distributed) network environment. The computer system 102, or portions thereof, may be implemented as, or incorporated into, various devices, such as a personal computer, a tablet computer, a set-top box, a personal digital assistant, a mobile device, a palmtop computer, a laptop computer, a desktop computer, a communications device, a wireless smart phone, a personal trusted device, a wearable device, a global positioning satellite (GPS) device, a web appliance, or any other machine capable of executing a set of instructions (sequential or otherwise) that specify actions to be taken by that machine. Further, while a single computer system 102 is illustrated, additional embodiments may include any collection of systems or sub-systems that individually or jointly execute instructions or perform functions. The term “system” shall be taken throughout the present disclosure to include any collection of systems or sub-systems that individually or jointly execute a set, or multiple sets, of instructions to perform one or more computer functions.

[0037] As illustrated in FIG. 1, the computer system 102 may include at least one processor 104. The processor 104 is tangible and non-transitory. As used herein, the term “non-transitory” is to be interpreted not as an eternal characteristic of a state, but as a characteristic of a state that will last for a period of time. The term “non-transitory” specifically disavows fleeting characteristics such as characteristics of a particular carrier wave or signal or other forms that exist only transitorily in any place at any time. The processor 104 is an article of manufacture and/or a machine component. The processor 104 is configured to execute software instructions in order to perform functions as described in the various embodiments herein. The processor 104 may be a general-purpose processor or may be part of an application specific

integrated circuit (ASIC). The processor 104 may also be a microprocessor, a microcomputer, a processor chip, a controller, a microcontroller, a digital signal processor (DSP), a state machine, or a programmable logic device. The processor 104 may also be a logical circuit, including a programmable gate array (PGA) such as a field programmable gate array (FPGA), or another type of circuit that includes discrete gate and/or transistor logic. The processor 104 may be a central processing unit (CPU), a graphics processing unit (GPU), or both. Additionally, any processor described herein may include multiple processors, parallel processors, or both. Multiple processors may be included in, or coupled to, a single device or multiple devices.

[0038] The computer system 102 may also include a computer memory 106. The computer memory 106 may include a static memory, a dynamic memory, or both in communication. Memories described herein are tangible storage mediums that can store data as well as executable instructions and are non-transitory during the time instructions are stored therein. Again, as used herein, the term “non-transitory” is to be interpreted not as an eternal characteristic of a state, but as a characteristic of a state that will last for a period of time. The term “non-transitory” specifically disavows fleeting characteristics such as characteristics of a particular carrier wave or signal or other forms that exist only transitorily in any place at any time. The memories are an article of manufacture and/or machine component. Memories described herein are computer-readable mediums from which data and executable instructions can be read by a computer. Memories as described herein may be random access memory (RAM), read only memory (ROM), flash memory, electrically programmable read only memory (EPROM), electrically erasable programmable read-only memory (EEPROM), registers, a hard disk, a cache, a removable disk, tape, compact disk read only memory (CD-ROM), digital versatile disk (DVD), floppy disk, blu-ray disk, or any other form of storage medium known in the art. Memories may be volatile or non-volatile, secure and/or encrypted, unsecure and/or unencrypted. Of course, the computer memory 106 may comprise any combination of memories or a single storage.

[0039] The computer system 102 may further include a display 108, such as a liquid crystal display (LCD), an organic light emitting diode (OLED), a flat panel

display, a solid state display, a cathode ray tube (CRT), a plasma display, or any other type of display, examples of which are well known to skilled persons.

[0040] The computer system 102 may also include at least one input device 110, such as a keyboard, a touch-sensitive input screen or pad, a speech input, a mouse, a remote control device having a wireless keypad, a microphone coupled to a speech recognition engine, a camera such as a video camera or still camera, a cursor control device, a global positioning system (GPS) device, an altimeter, a gyroscope, an accelerometer, a proximity sensor, or any combination thereof. Those skilled in the art appreciate that various embodiments of the computer system 102 may include multiple input devices 110. Moreover, those skilled in the art further appreciate that the above-listed, exemplary input devices 110 are not meant to be exhaustive and that the computer system 102 may include any additional, or alternative, input devices 110.

[0041] The computer system 102 may also include a medium reader 112 which is configured to read any one or more sets of instructions, e.g. software, from any of the memories described herein. The instructions, when executed by a processor, can be used to perform one or more of the methods and processes as described herein. In a particular embodiment, the instructions may reside completely, or at least partially, within the memory 106, the medium reader 112, and/or the processor 110 during execution by the computer system 102.

[0042] Furthermore, the computer system 102 may include any additional devices, components, parts, peripherals, hardware, software or any combination thereof which are commonly known and understood as being included with or within a computer system, such as, but not limited to, a network interface 114 and an output device 116. The output device 116 may be, but is not limited to, a speaker, an audio out, a video out, a remote-control output, a printer, or any combination thereof.

[0043] Each of the components of the computer system 102 may be interconnected and communicate via a bus 118 or other communication link. As illustrated in FIG. 1, the components may each be interconnected and communicate via an internal bus. However, those skilled in the art appreciate that any of the components may also be connected via an expansion bus. Moreover, the bus 118 may enable communication via any standard or other specification commonly known and

understood such as, but not limited to, peripheral component interconnect, peripheral component interconnect express, parallel advanced technology attachment, serial advanced technology attachment, etc.

[0044] The computer system 102 may be in communication with one or more additional computer devices 120 via a network 122. The network 122 may be, but is not limited to, a local area network, a wide area network, the Internet, a telephony network, a short-range network, or any other network commonly known and understood in the art. The short-range network may include, for example, Bluetooth, Zigbee, infrared, near field communication, ultraband, or any combination thereof. Those skilled in the art appreciate that additional networks 122 which are known and understood may additionally or alternatively be used and that the exemplary networks 122 are not limiting or exhaustive. Also, while the network 122 is illustrated in FIG. 1 as a wireless network, those skilled in the art appreciate that the network 122 may also be a wired network.

[0045] The additional computer device 120 is illustrated in FIG. 1 as a personal computer. However, those skilled in the art appreciate that, in alternative embodiments of the present application, the computer device 120 may be a laptop computer, a tablet PC, a personal digital assistant, a mobile device, a palmtop computer, a desktop computer, a communications device, a wireless telephone, a personal trusted device, a web appliance, a server, or any other device that is capable of executing a set of instructions, sequential or otherwise, that specify actions to be taken by that device. Of course, those skilled in the art appreciate that the above-listed devices are merely exemplary devices and that the device 120 may be any additional device or apparatus commonly known and understood in the art without departing from the scope of the present application. For example, the computer device 120 may be the same or similar to the computer system 102. Furthermore, those skilled in the art similarly understand that the device may be any combination of devices and apparatuses.

[0046] Of course, those skilled in the art appreciate that the above-listed components of the computer system 102 are merely meant to be exemplary and are not intended to be exhaustive and/or inclusive. Furthermore, the examples of the components listed above are also meant to be exemplary and similarly are not meant to be exhaustive and/or inclusive.

[0047] In accordance with various embodiments of the present disclosure, the methods described herein may be implemented using a hardware computer system that executes software programs. Further, in an exemplary, non-limited embodiment, implementations can include distributed processing, component/object distributed processing, and parallel processing. Virtual computer system processing can be constructed to implement one or more of the methods or functionalities as described herein, and a processor described herein may be used to support a virtual processing environment.

[0048] As described herein, various embodiments provide optimized methods and systems for solving transactions reconciliation tasks by integrating clustering and optimization.

[0049] Referring to FIG. 2, a schematic of an exemplary network environment 200 for implementing a method for solving transactions reconciliation tasks by integrating clustering and optimization is illustrated. In an exemplary embodiment, the method is executable on any networked computer platform, such as, for example, a personal computer (PC).

[0050] The method for providing a data-driven tool for individualized financial planning and navigation may be implemented by a Transactions Reconciliation by Integrating Clustering and Optimization (TRICO) device 202. The TRICO device 202 may be the same or similar to the computer system 102 as described with respect to FIG. 1. The TRICO device 202 may store one or more applications that can include executable instructions that, when executed by the TRICO device 202, cause the TRICO device 202 to perform actions, such as to transmit, receive, or otherwise process network messages, for example, and to perform other actions described and illustrated below with reference to the figures. The application(s) may be implemented as modules or components of other applications. Further, the application(s) can be implemented as operating system extensions, modules, plugins, or the like.

[0051] Even further, the application(s) may be operative in a cloud-based computing environment. The application(s) may be executed within or as virtual machine(s) or virtual server(s) that may be managed in a cloud-based computing environment. Also, the application(s), and even the TRICO device 202 itself, may be

located in virtual server(s) running in a cloud-based computing environment rather than being tied to one or more specific physical network computing devices. Also, the application(s) may be running in one or more virtual machines (VMs) executing on the TRICO device 202. Additionally, in one or more embodiments of this technology, virtual machine(s) running on the TRICO device 202 may be managed or supervised by a hypervisor.

[0052] In the network environment 200 of FIG. 2, the TRICO device 202 is coupled to a plurality of server devices 204(1)-204(n) that hosts a plurality of databases 206(1)-206(n), and also to a plurality of client devices 208(1)-208(n) via communication network(s) 210. A communication interface of the TRICO device 202, such as the network interface 114 of the computer system 102 of FIG. 1, operatively couples and communicates between the TRICO device 202, the server devices 204(1)-204(n), and/or the client devices 208(1)-208(n), which are all coupled together by the communication network(s) 210, although other types and/or numbers of communication networks or systems with other types and/or numbers of connections and/or configurations to other devices and/or elements may also be used.

[0053] The communication network(s) 210 may be the same or similar to the network 122 as described with respect to FIG. 1, although the TRICO device 202, the server devices 204(1)-204(n), and/or the client devices 208(1)-208(n) may be coupled together via other topologies. Additionally, the network environment 200 may include other network devices such as one or more routers and/or switches, for example, which are well known in the art and thus will not be described herein. This technology provides a number of advantages including methods, non-transitory computer readable media, and TRICO devices that efficiently implement a method for solving transactions reconciliation tasks by integrating clustering and optimization.

[0054] By way of example only, the communication network(s) 210 may include local area network(s) (LAN(s)) or wide area network(s) (WAN(s)), and can use TCP/IP over Ethernet and industry-standard protocols, although other types and/or numbers of protocols and/or communication networks may be used. The communication network(s) 210 in this example may employ any suitable interface mechanisms and network communication technologies including, for example, teletraffic in any suitable form (e.g., voice, modem, and the like), Public Switched

Telephone Network (PSTNs), Ethernet-based Packet Data Networks (PDNs), combinations thereof, and the like.

[0055] The TRICO device 202 may be a standalone device or integrated with one or more other devices or apparatuses, such as one or more of the server devices 204(1)-204(n), for example. In one particular example, the TRICO device 202 may include or be hosted by one of the server devices 204(1)-204(n), and other arrangements are also possible. Moreover, one or more of the devices of the TRICO device 202 may be in a same or a different communication network including one or more public, private, or cloud networks, for example.

[0056] The plurality of server devices 204(1)-204(n) may be the same or similar to the computer system 102 or the computer device 120 as described with respect to FIG. 1, including any features or combination of features described with respect thereto. For example, any of the server devices 204(1)-204(n) may include, among other features, one or more processors, a memory, and a communication interface, which are coupled together by a bus or other communication link, although other numbers and/or types of network devices may be used. The server devices 204(1)-204(n) in this example may process requests received from the TRICO device 202 via the communication network(s) 210 according to the HTTP-based and/or JavaScript Object Notation (JSON) protocol, for example, although other protocols may also be used.

[0057] The server devices 204(1)-204(n) may be hardware or software or may represent a system with multiple servers in a pool, which may include internal or external networks. The server devices 204(1)-204(n) hosts the databases 206(1)-206(n) that are configured to store unreconciled transactions data that relates to transactions that have been executed but not yet reconciled and data that relates to search and optimization algorithms that are usable for matching transactions.

[0058] Although the server devices 204(1)-204(n) are illustrated as single devices, one or more actions of each of the server devices 204(1)-204(n) may be distributed across one or more distinct network computing devices that together comprise one or more of the server devices 204(1)-204(n). Moreover, the server devices 204(1)-204(n) are not limited to a particular configuration. Thus, the server devices 204(1)-204(n) may contain a plurality of network computing devices that

operate using a master/slave approach, whereby one of the network computing devices of the server devices 204(1)-204(n) operates to manage and/or otherwise coordinate operations of the other network computing devices.

[0059] The server devices 204(1)-204(n) may operate as a plurality of network computing devices within a cluster architecture, a peer-to peer architecture, virtual machines, or within a cloud architecture, for example. Thus, the technology disclosed herein is not to be construed as being limited to a single environment and other configurations and architectures are also envisaged.

[0060] The plurality of client devices 208(1)-208(n) may also be the same or similar to the computer system 102 or the computer device 120 as described with respect to FIG. 1, including any features or combination of features described with respect thereto. For example, the client devices 208(1)-208(n) in this example may include any type of computing device that can interact with the TRICO device 202 via communication network(s) 210. Accordingly, the client devices 208(1)-208(n) may be mobile computing devices, desktop computing devices, laptop computing devices, tablet computing devices, virtual machines (including cloud-based computers), or the like, that host chat, e-mail, or voice-to-text applications, for example. In an exemplary embodiment, at least one client device 208 is a wireless mobile communication device, i.e., a smart phone.

[0061] The client devices 208(1)-208(n) may run interface applications, such as standard web browsers or standalone client applications, which may provide an interface to communicate with the TRICO device 202 via the communication network(s) 210 in order to communicate user requests and information. The client devices 208(1)-208(n) may further include, among other features, a display device, such as a display screen or touchscreen, and/or an input device, such as a keyboard, for example.

[0062] Although the exemplary network environment 200 with the TRICO device 202, the server devices 204(1)-204(n), the client devices 208(1)-208(n), and the communication network(s) 210 are described and illustrated herein, other types and/or numbers of systems, devices, components, and/or elements in other topologies may be used. It is to be understood that the systems of the examples described herein are for exemplary purposes, as many variations of the specific hardware and software

used to implement the examples are possible, as will be appreciated by those skilled in the relevant art(s).

[0063] One or more of the devices depicted in the network environment 200, such as the TRICO device 202, the server devices 204(1)-204(n), or the client devices 208(1)-208(n), for example, may be configured to operate as virtual instances on the same physical machine. In other words, one or more of the TRICO device 202, the server devices 204(1)-204(n), or the client devices 208(1)-208(n) may operate on the same physical device rather than as separate devices communicating through communication network(s) 210. Additionally, there may be more or fewer TRICO devices 202, server devices 204(1)-204(n), or client devices 208(1)-208(n) than illustrated in FIG. 2.

[0064] In addition, two or more computing systems or devices may be substituted for any one of the systems or devices in any example. Accordingly, principles and advantages of distributed processing, such as redundancy and replication also may be implemented, as desired, to increase the robustness and performance of the devices and systems of the examples. The examples may also be implemented on computer system(s) that extend across any suitable network using any suitable interface mechanisms and traffic technologies, including by way of example only teletraffic in any suitable form (e.g., voice and modem), wireless traffic networks, cellular traffic networks, Packet Data Networks (PDNs), the Internet, intranets, and combinations thereof.

[0065] The TRICO device 202 is described and illustrated in FIG. 3 as including a transactions reconciliation by integrating clustering and optimization module 302, although it may include other rules, policies, modules, databases, or applications, for example. As will be described below, the transactions reconciliation by integrating clustering and optimization module 302 is configured to implement a method for solving transactions reconciliation tasks by integrating clustering and optimization.

[0066] An exemplary process 300 for implementing a mechanism for solving transactions reconciliation tasks by integrating clustering and optimization by utilizing the network environment of FIG. 2 is illustrated as being executed in FIG. 3. Specifically, a first client device 208(1) and a second client device 208(2) are

illustrated as being in communication with TRICO device 202. In this regard, the first client device 208(1) and the second client device 208(2) may be “clients” of the TRICO device 202 and are described herein as such. Nevertheless, it is to be known and understood that the first client device 208(1) and/or the second client device 208(2) need not necessarily be “clients” of the TRICO device 202, or any entity described in association therewith herein. Any additional or alternative relationship may exist between either or both of the first client device 208(1) and the second client device 208(2) and the TRICO device 202, or no relationship may exist.

[0067] Further, TRICO device 202 is illustrated as being able to access a raw transactions data repository 206(1) and a search and optimization algorithms database 206(2). The transactions reconciliation by integrating clustering and optimization module 302 may be configured to access these databases for implementing a method for solving transactions reconciliation tasks by integrating clustering and optimization.

[0068] The first client device 208(1) may be, for example, a smart phone. Of course, the first client device 208(1) may be any additional device described herein. The second client device 208(2) may be, for example, a personal computer (PC). Of course, the second client device 208(2) may also be any additional device described herein.

[0069] The process may be executed via the communication network(s) 210, which may comprise plural networks as described above. For example, in an exemplary embodiment, either or both of the first client device 208(1) and the second client device 208(2) may communicate with the TRICO device 202 via broadband or cellular communication. Of course, these embodiments are merely exemplary and are not limiting or exhaustive.

[0070] Upon being started, the transactions reconciliation by integrating clustering and optimization module 302 executes a process for solving transactions reconciliation tasks by integrating clustering and optimization. An exemplary process for solving transactions reconciliation tasks by integrating clustering and optimization is generally indicated at flowchart 400 in FIG. 4.

[0071] In process 400 of FIG. 4, at step S402, the transactions reconciliation by integrating clustering and optimization module 302 receives first information that

relates to a number of transactions. In an exemplary embodiment, for each respective transaction, the first information may include raw transaction data, such as, for example, an identification of the parties to the transaction, an amount of the transaction, a date and time of the transaction, and any other suitable types of information. Each transaction resides in one of two sides, i.e., a statement side (S) and a ledger side (L); and within each side, a transaction may be a credit (C) or a debit (D), and the credit amounts are always expressed as positive numerical amounts and the debit amounts are always expressed as negative numerical amounts. Thus, the first information may also include an indication as to whether the transaction is a statement credit (SC), a statement debit (SD), a ledger credit (LC), or a ledger debit (LD).

[0072] At step S404, the transactions reconciliation by integrating clustering and optimization module 302 extracts transaction-specific features and transaction-specific textual information from the first information received in step S402. In an exemplary embodiment, the transaction-specific features may include any one or more of a reference one (Ref 1) feature, a reference two (Ref 2) feature, a reference three (Ref 3) feature, a reference four (Ref 4) feature, a transaction code, and a security code. The textual information may include a name of a party to a particular transaction, such as, for example, a name of a bank.

[0073] At step S406, the transactions reconciliation by integrating clustering and optimization module 302 tokenizes the features extracted in step S404 by converting the raw information into words and/or tokens. Then, at step S408, the transactions reconciliation by integrating clustering and optimization module 302 calculates a distance matrix between respective pairs of transactions. In an exemplary embodiment, the distance matrix may be a Jaccard similarity matrix, and the distance matrix may be calculated by applying a Jaccard similarity algorithm to the tokenized features and textual information associated with each transaction.

[0074] At step S410, the transactions reconciliation by integrating clustering and optimization module 302 clusters the transactions into meta-transactions based on the distances calculated in step S408. In an exemplary embodiment, the clustering is performed by applying a density-based spatial clustering of applications with noise (DBSCAN) algorithm to the transactions.

[0075] At step S412, the transactions reconciliation by integrating clustering and optimization module 302 matches transactions from within a particular meta-transaction based on the amounts of the transactions. In an exemplary embodiment, the matching is performed by applying a mixed integer programming (MIP) model or algorithm to the transactions included in a particular meta-transaction. In this aspect, the MIP model checks transactions on a many-to-one basis, a one-to-many basis, and a many-to-many basis in order to determine whether one or more credit transactions can be combined with one or more debit transactions to add up to zero. In an exemplary embodiment, the transactions may be deemed as matching when the amounts add up to less than a predetermined threshold amount, such as, for example, one dollar (i.e., \$1.00). In an alternative embodiment, the matching operation may be performed between transactions that are in different meta-transactions.

[0076] In an exemplary embodiment, the transactions reconciliation by integrating clustering and optimization module 302 is designed to reduce the time-consuming and expensive process of manually matching transactions that are not successfully processed by conventional rules-based systems, and to detect breaks, i.e., transactions that are not successfully reconciled on the same day as they are executed.

[0077] Accordingly, with this technology, an optimized process for solving transactions reconciliation tasks by integrating clustering and optimization is provided.

[0078] Although the invention has been described with reference to several exemplary embodiments, it is understood that the words that have been used are words of description and illustration, rather than words of limitation. Changes may be made within the purview of the appended claims, as presently stated and as amended, without departing from the scope and spirit of the present disclosure in its aspects. Although the invention has been described with reference to particular means, materials and embodiments, the invention is not intended to be limited to the particulars disclosed; rather the invention extends to all functionally equivalent structures, methods, and uses such as are within the scope of the appended claims.

[0079] For example, while the computer-readable medium may be described as a single medium, the term “computer-readable medium” includes a single medium or multiple media, such as a centralized or distributed database, and/or associated

caches and servers that store one or more sets of instructions. The term “computer-readable medium” shall also include any medium that is capable of storing, encoding or carrying a set of instructions for execution by a processor or that cause a computer system to perform any one or more of the embodiments disclosed herein.

[0080] The computer-readable medium may comprise a non-transitory computer-readable medium or media and/or comprise a transitory computer-readable medium or media. In a particular non-limiting, exemplary embodiment, the computer-readable medium can include a solid-state memory such as a memory card or other package that houses one or more non-volatile read-only memories. Further, the computer-readable medium can be a random-access memory or other volatile re-writable memory. Additionally, the computer-readable medium can include a magneto-optical or optical medium, such as a disk or tapes or other storage device to capture carrier wave signals such as a signal communicated over a transmission medium. Accordingly, the disclosure is considered to include any computer-readable medium or other equivalents and successor media, in which data or instructions may be stored.

[0081] Although the present application describes specific embodiments which may be implemented as computer programs or code segments in computer-readable media, it is to be understood that dedicated hardware implementations, such as application specific integrated circuits, programmable logic arrays and other hardware devices, can be constructed to implement one or more of the embodiments described herein. Applications that may include the various embodiments set forth herein may broadly include a variety of electronic and computer systems. Accordingly, the present application may encompass software, firmware, and hardware implementations, or combinations thereof. Nothing in the present application should be interpreted as being implemented or implementable solely with software and not hardware.

[0082] Although the present specification describes components and functions that may be implemented in particular embodiments with reference to particular standards and protocols, the disclosure is not limited to such standards and protocols. Such standards are periodically superseded by faster or more efficient equivalents having essentially the same functions. Accordingly, replacement standards and protocols having the same or similar functions are considered equivalents thereof.

[0083] The illustrations of the embodiments described herein are intended to provide a general understanding of the various embodiments. The illustrations are not intended to serve as a complete description of all the elements and features of apparatus and systems that utilize the structures or methods described herein. Many other embodiments may be apparent to those of skill in the art upon reviewing the disclosure. Other embodiments may be utilized and derived from the disclosure, such that structural and logical substitutions and changes may be made without departing from the scope of the disclosure. Additionally, the illustrations are merely representational and may not be drawn to scale. Certain proportions within the illustrations may be exaggerated, while other proportions may be minimized. Accordingly, the disclosure and the figures are to be regarded as illustrative rather than restrictive.

[0084] One or more embodiments of the disclosure may be referred to herein, individually and/or collectively, by the term “invention” merely for convenience and without intending to voluntarily limit the scope of this application to any particular invention or inventive concept. Moreover, although specific embodiments have been illustrated and described herein, it should be appreciated that any subsequent arrangement designed to achieve the same or similar purpose may be substituted for the specific embodiments shown. This disclosure is intended to cover any and all subsequent adaptations or variations of various embodiments. Combinations of the above embodiments, and other embodiments not specifically described herein, will be apparent to those of skill in the art upon reviewing the description.

[0085] The Abstract of the Disclosure is submitted with the understanding that it will not be used to interpret or limit the scope or meaning of the claims. In addition, in the foregoing Detailed Description, various features may be grouped together or described in a single embodiment for the purpose of streamlining the disclosure. This disclosure is not to be interpreted as reflecting an intention that the claimed embodiments require more features than are expressly recited in each claim. Rather, as the following claims reflect, inventive subject matter may be directed to less than all of the features of any of the disclosed embodiments. Thus, the following claims are incorporated into the Detailed Description, with each claim standing on its own as defining separately claimed subject matter.

[0086] The above disclosed subject matter is to be considered illustrative, and not restrictive, and the appended claims are intended to cover all such modifications, enhancements, and other embodiments which fall within the true spirit and scope of the present disclosure. Thus, to the maximum extent allowed by law, the scope of the present disclosure is to be determined by the broadest permissible interpretation of the following claims, and their equivalents, and shall not be restricted or limited by the foregoing detailed description.

What is claimed is:

1. A method for reconciling transactions, the method being implemented by at least one processor, the method comprising:

receiving, by the at least one processor, first information that relates to a plurality of transactions;

extracting, by the at least one processor from the first information, a set of transaction-specific features and a set of transaction-specific textual information;

generating, by the at least one processor, at least one meta-transaction by clustering a subset of the plurality of transactions based on the extracted set of transaction-specific features and the extracted set of transaction-specific textual information; and

matching, by the at least one processor, at least a first transaction from among the clustered subset with at least a second transaction from among the plurality of transactions by determining that a difference between an amount of the at least the first transaction and an amount of the at least the second transaction is less than a predetermined threshold.

2. The method of claim 1, wherein the set of transaction-specific features includes at least one from among a transaction code and a security code.

3. The method of claim 1, wherein the set of transaction-specific textual information includes a name of a party to a transaction.

4. The method of claim 1, wherein the generating of the at least one meta-transaction comprises:

converting the set of transaction-specific features into transaction-specific words;

calculating a distance matrix between respective pairs of transactions from among the plurality of transactions based on the transaction-specific words and the transaction-specific textual information; and

clustering the subset of the plurality of transactions based on the distance matrix.

5. The method of claim 4, wherein the calculating of the distance matrix comprises applying a Jaccard similarity algorithm to each respective pair of transactions.

6. The method of claim 4, wherein the clustering comprises applying a density-based spatial clustering of applications with noise (DBSCAN) algorithm to the plurality of transactions.

7. The method of claim 1, wherein the matching comprises applying a mixed integer programming (MIP) algorithm to each transaction included in the clustered subset of the plurality of transactions.

8. The method of claim 1, wherein the predetermined threshold is less than or equal to one dollar.

9. A computing apparatus for reconciling transactions, the computing apparatus comprising:

a processor;

a memory; and

a communication interface coupled to each of the processor and the memory, wherein the processor is configured to:

receive, from a user via the communication interface, first information that relates to a plurality of transactions;

extract, from the first information, a set of transaction-specific features and a set of transaction-specific textual information;

generate at least one meta-transaction by clustering a subset of the plurality of transactions based on the extracted set of transaction-specific features and the extracted set of transaction-specific textual information; and

match at least a first transaction from among the clustered subset with at least a second transaction from among the plurality of transactions by determining that a difference between an amount of the at least the first transaction and an amount of the at least the second transaction is less than a predetermined threshold.

10. The computing apparatus of claim 9, wherein the set of transaction-specific features includes at least one from among a transaction code and a security code.

11. The computing apparatus of claim 9, wherein the set of transaction-specific textual information includes a name of a party to a transaction.

12. The computing apparatus of claim 9, wherein the processor is further configured to generate the at least one meta-transaction by:

converting the set of transaction-specific features into transaction-specific words;

calculating a distance matrix between respective pairs of transactions from among the plurality of transactions based on the transaction-specific words and the transaction-specific textual information; and

clustering the subset of the plurality of transactions based on the distance matrix.

13. The computing apparatus of claim 12, wherein the processor is further configured to calculate the distance matrix by applying a Jaccard similarity algorithm to each respective pair of transactions.

14. The computing apparatus of claim 12, wherein the processor is further configured to perform the clustering by applying a density-based spatial clustering of applications with noise (DBSCAN) algorithm to the plurality of transactions.

15. The computing apparatus of claim 9, wherein the processor is further configured to perform the matching by applying a mixed integer programming (MIP) algorithm to each transaction included in the clustered subset of the plurality of transactions.

16. The computing apparatus of claim 9, wherein the predetermined threshold is less than or equal to one dollar.

17. A non-transitory computer readable storage medium storing instructions for reconciling transactions, the storage medium comprising executable code which, when executed by a processor, causes the processor to:

receive first information that relates to a plurality of transactions;

extract, from the first information, a set of transaction-specific features and a set of transaction-specific textual information;

generate at least one meta-transaction by clustering a subset of the plurality of transactions based on the extracted set of transaction-specific features and the extracted set of transaction-specific textual information; and

match at least a first transaction from among the clustered subset with at least a second transaction from among the plurality of transactions by determining that a difference between an amount of the at least the first transaction and an amount of the at least the second transaction is less than a predetermined threshold.

18. The storage medium of claim 17, wherein the set of transaction-specific features includes at least one from among a transaction code and a security code.

19. The storage medium of claim 17, wherein the set of transaction-specific textual information includes a name of a party to a transaction.

20. The storage medium of claim 17, wherein the executable code is further configured to cause the processor to generate the at least one meta-transaction by:

converting the set of transaction-specific features into transaction-specific words;

calculating a distance matrix between respective pairs of transactions from among the plurality of transactions based on the transaction-specific words and the transaction-specific textual information; and

clustering the subset of the plurality of transactions based on the distance matrix.

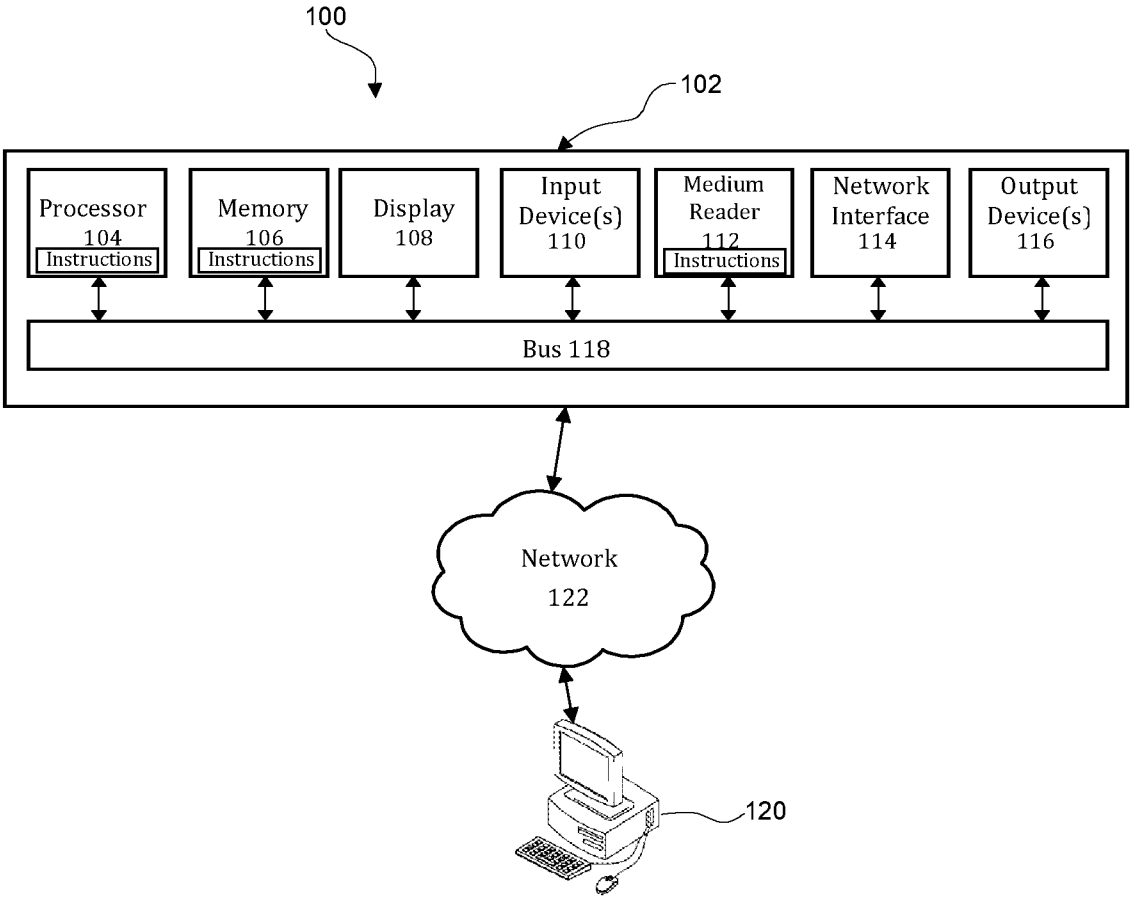


FIG. 1

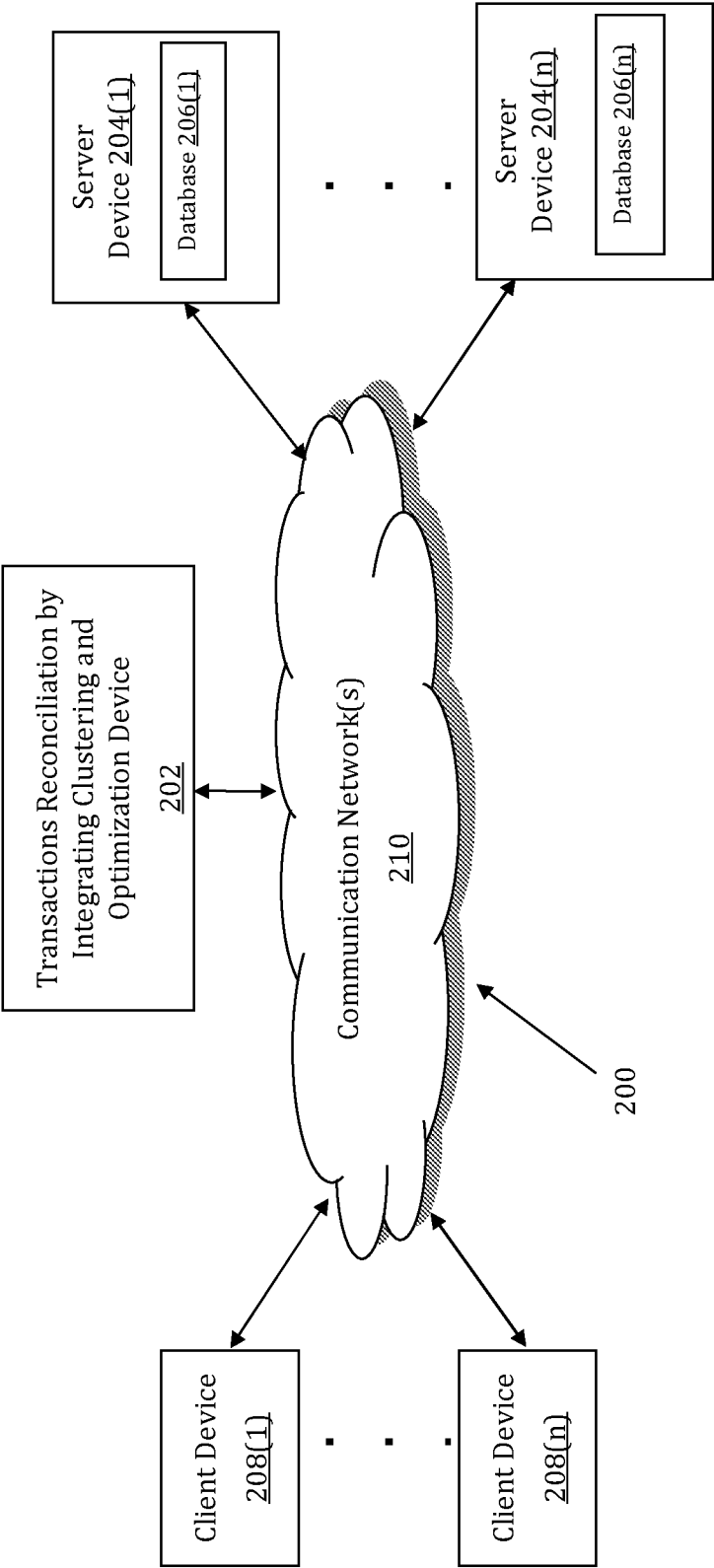
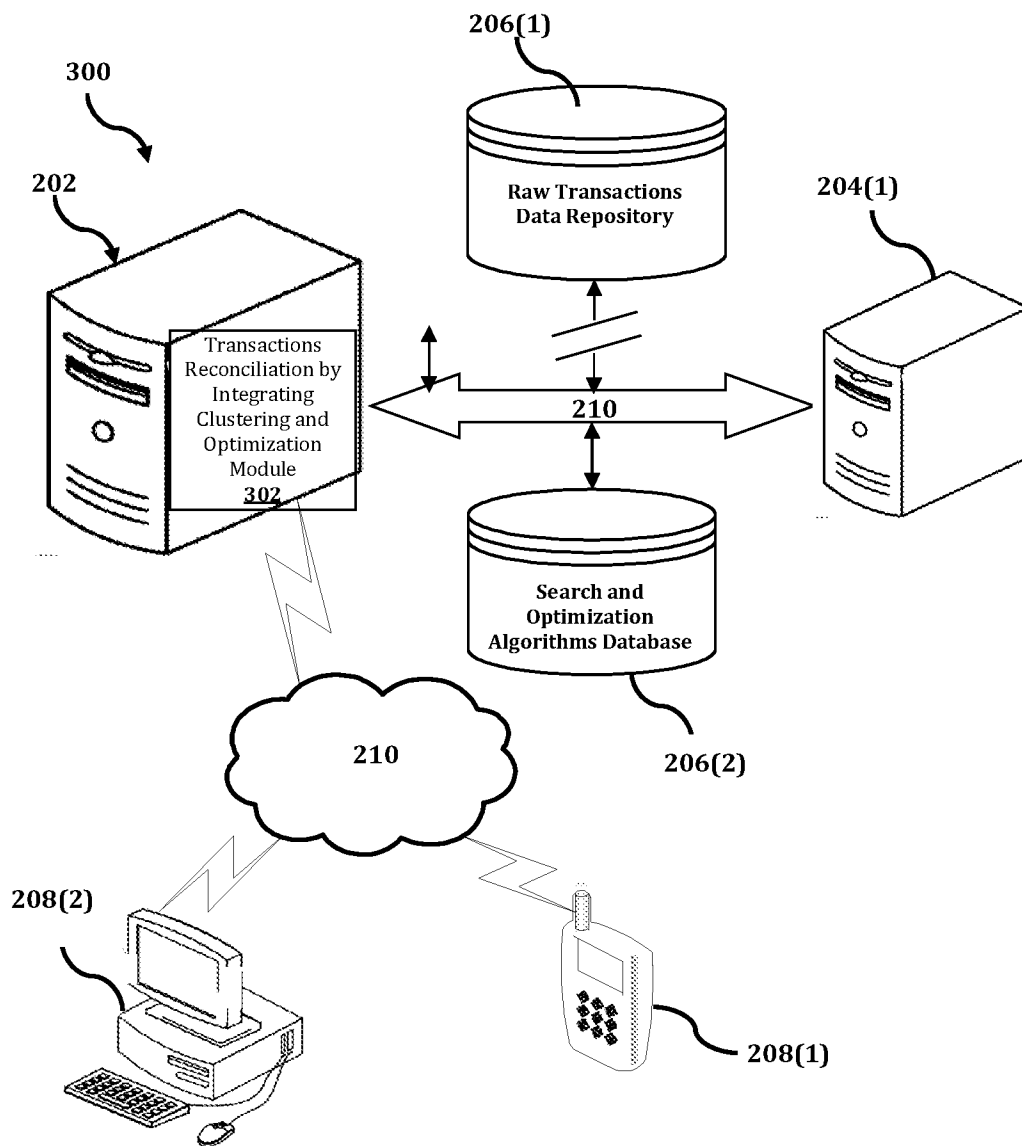
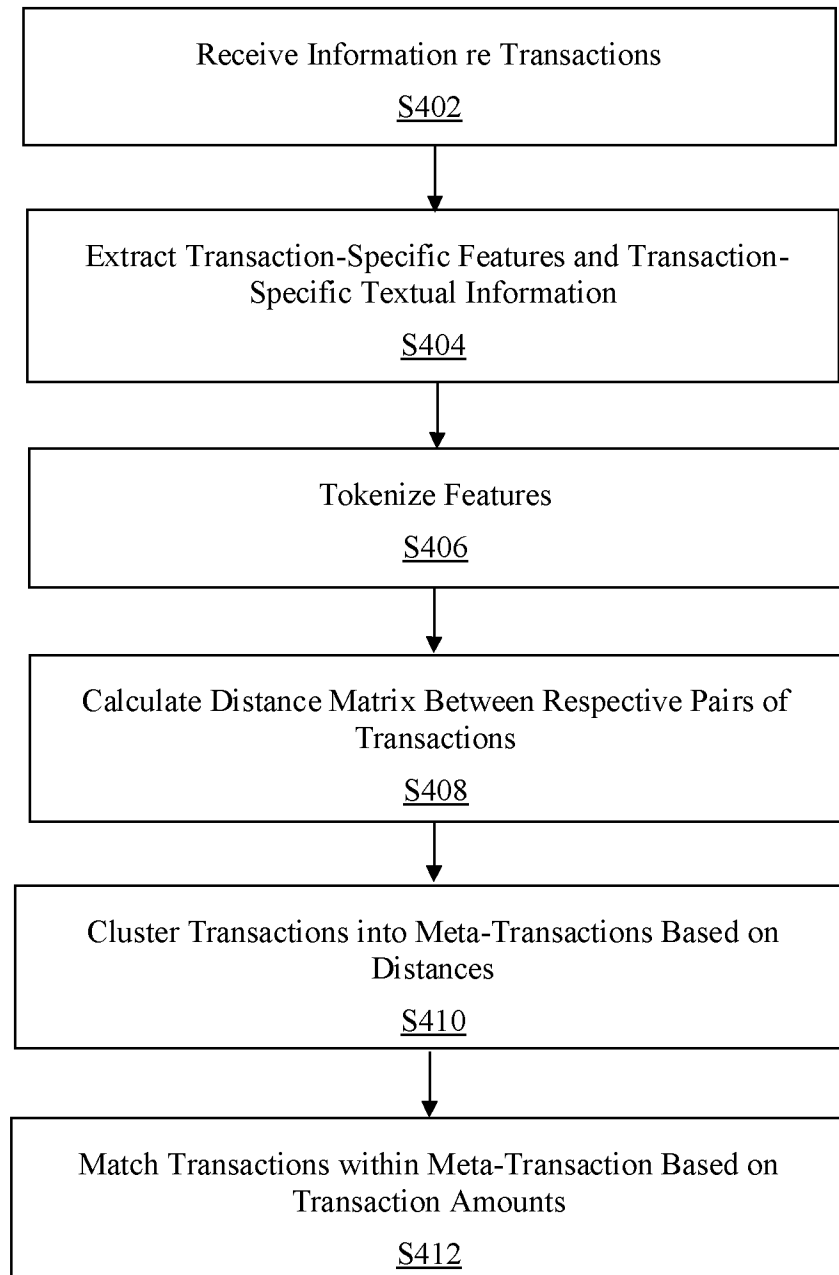


FIG. 2

**FIG. 3**

400**FIG. 4**

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 22/26758

A. CLASSIFICATION OF SUBJECT MATTER

IPC - INV. G06Q 40/00 (2022.01)

CPC - INV. G06Q 20/401

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)

See Search History document

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

See Search History document

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

See Search History document

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y	US 2015/0073949 A1 (CLEARWATER ANALYTICS, LLC) 12 March 2015 (12.03.2015), entire document, especially Fig. 1; para [0011]; para [0017]-[0018]; para [0020]; para [0025]; para [0029]; para [0034]-[0035]; para [0054]; para [0059]	1, 3, 8-9, 11, 16-17, 19 ----- 2, 4-7, 10, 12-15, 18, 20
Y	US 2005/0187852 A1 (HWANG) 25 August 2005 (25.08.2005), para [0184]	2, 10, 18
Y	US 2019/0012733 A1 (XERO LIMITED) 10 January 2019 (10.01.2019), entire document, especially para [0037]; para [0056]; para [0059]; para [0102]; para [0113]	4-6, 12-14, 20
Y	US 2020/0394658 A1 (PAYPAL, INC.) 17 December 2020 (17.12.2020), entire document, especially para [0036]; para [0043]; para [0073]; para [0082]; para [0102]	5, 13
Y	US 2019/0295158 A1 (INTUIT INC.) 26 September 2019 (26.09.2019), para [0042]; para [0047]; para [0102]	6, 14
Y	US 7,512,558 B1 (ELAD et. al) 31 March 2009 (31.03.2009), col 4, ln 66 - col 5, ln 4; col 10, ln 26-51	7, 15

☐ Further documents are listed in the continuation of Box C.☐ See patent family annex.

* Special categories of cited documents:

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Date of the actual completion of the international search

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Name and mailing address of the ISA/US

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Facsimile No. 571-273-8300

Authorized officer

Kari Rodriguez

Telephone No. PCT Helpdesk: 571-272-4300