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(71) Applicant: **GENESYS TELECOMMUNICATIONS LABORATORIES, INC.** [US/US]; 2001 Junipero Serra Blvd., Daly City, California 94014 (US).

(72) Inventors: **LEV-TOV, Amir**; c/o GENESYS TELECOMMUNICATIONS LABORATORIES, INC., 2001 Junipero Serra Blvd., Daly City, California 94014 (US). **TAPUHI, Tamir**; c/o GENESYS TELECOMMUNICATIONS LABORATORIES, INC., 2001 Junipero Serra Blvd., Daly City, California 94014 (US). **FAIZAKOF, Avraham**; c/o GENESYS TELECOMMUNICATIONS LABORATORIES, INC., 2001 Junipero Serra Blvd., Daly City, California 94014 (US). **KONIG, David**; c/o GENESYS TELECOMMUNICATIONS LABORATORIES, INC., 2001 Junipero Serra Blvd., Daly City, California 94014 (US). **KONIG, Yochai**; c/o GENESYS TELECOMMUNICATIONS LABORATORIES, INC., 2001 Junipero Serra Blvd., Daly City, California 94014 (US).

(74) Agent: **CHANG, Josephine E.**; LEWIS ROCA ROTHGERBER CHRISTIE LLP, P.O. Box 29001, Glendale, California 91209-9001 (US).

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(54) Title: SYSTEM AND METHOD FOR AUTOMATIC QUALITY MANAGEMENT AND COACHING

(57) Abstract: A method includes: receiving, by a processor, an evaluation form including a plurality of evaluation questions; receiving, by the processor, an interaction to be evaluated by the evaluation form; selecting, by the processor, an evaluation question of the evaluation form, the evaluation question including a rule associated with one or more topics, each of the topics including one or more words or phrases; searching, by the processor, the interaction for the one or more topics of the rule in accordance with the presence of one or more words or phrases in the interaction to generate a search result; calculating, by the processor, an answer to the evaluation question in accordance with the rule and the search result; and outputting, by the processor, the calculated answer to the evaluation question of the evaluation form.



SYSTEM AND METHOD FOR AUTOMATIC QUALITY MANAGEMENT AND COACHING

FIELD

[0001] Aspects of embodiments of the present invention relate to the field of software for operating contact centers, in particular, software for performing speech recognition and analytics on voice interactions occurring in a contact center and for monitoring and controlling the operation of the contact center in accordance with the analytics.

BACKGROUND

[0002] Generally, a contact center is staffed with agents who serve as an interface between an organization, such as a company, and outside entities, such as customers. For example, human sales agents at contact centers may assist customers in making purchasing decisions and may receive purchase orders from those customers. Similarly, human support agents at contact centers may assist customers in resolving issues with products or services provided by the organization. Interactions between contact center agents and outside entities (customers) may be conducted by voice (e.g., telephone calls or voice over IP or VoIP calls), video (e.g., video conferencing), text (e.g., emails and text chat), or through other media.

[0003] Quality monitoring in contact centers refers to the process of evaluating agents and ensuring that the agents are providing sufficiently high quality service. Generally, a quality monitoring process will monitor the performance of an agent by evaluating the interactions that the agent participated in for events such as whether the agent was polite and courteous, whether the agent was efficient, and whether the agent proposed the correct solutions to resolve a customer's issue.

SUMMARY

[0004] Aspects of embodiments of the present invention are directed to systems and methods for automatically monitoring, evaluating, and managing the performance of agents of a contact center.

[0005] According to one embodiment of the present invention, a method includes: receiving, by a processor, an evaluation form including a plurality of evaluation questions; receiving, by the processor, an interaction to be evaluated by the evaluation form; selecting, by the processor, an evaluation question of the evaluation form, the evaluation question including a rule associated with one or more topics, each of the topics including one or more words or phrases; searching, by the processor, the interaction for the one or more topics of the rule in accordance with

1 the presence of one or more words or phrases in the interaction to generate a search result; calculating, by the processor, an answer to the evaluation question in accordance with the rule and the search result; and outputting, by the processor, the calculated answer to the evaluation question of the evaluation form.

5 **[0006]** The method may further include: determining whether the calculated answer triggers a coaching rule of a plurality of coaching rules, the coaching rule corresponding to the evaluation question; and generating a notification in accordance with the answer to the evaluation question.

10 **[0007]** The generating the notification may include identifying, based on the calculated answer, a coaching tip from a plurality of coaching tips associated with the coaching rule, and the notification may include the coaching tip.

[0008] The generating the notification may occur in real-time during the interaction.

15 **[0009]** The interaction may be a voice interaction, the method may further include supplying the voice interaction to an automatic speech recognition engine to generate a speech recognition output, and the detecting the one or more detected topics in the interaction may include identifying one or more instances of the one or more topics in the speech recognition output.

20 **[0010]** According to one embodiment of the present invention, a method for generating a customized coaching session for an agent includes: receiving, by a processor, one or more evaluations of interactions involving the agent, each of the evaluations being computed based on an evaluation form and an interaction, the evaluation form including a plurality of evaluation questions, the evaluation including a plurality of answers corresponding to the evaluation questions; computing, by the processor, one or more aggregated quality metrics in accordance with the answers of the one or more evaluations; comparing, by the processor, each of the one or more aggregated quality metrics against corresponding threshold values; identifying, by the processor, one or more underperforming quality metrics in accordance with the comparisons of the aggregated quality metrics with the threshold values; 25 generating, by the processor, the customized coaching session in accordance with the identified one or more underperforming quality metrics; and outputting, by the processor, the customized coaching session.

30 **[0011]** The method may further include, for each of the one or more underperforming quality metrics, identifying portions of the interactions corresponding to the answer corresponding to the evaluation question; and adding the identified portions to the customized coaching session.

35 **[0012]** The method may further include: identifying one or more previous customized coaching sessions generated for the agent, each including a timestamp

1 and one or more coaching session reasons; grouping the one or more previous
customized coaching sessions by coaching session reason; computing an average
interval between coaching sessions having the same coaching session reason; and
scheduling a customized coaching session for the agent in accordance with the
5 computed average interval.

[0013] According to one embodiment of the present invention, a method for
automatic monitoring of performance trends based on evaluations of all agents
includes: receiving, by a processor, a plurality of evaluations involving a plurality of
different agents, each of the evaluations including one or more quality metrics;
10 comparing, by the processor, each of the one or more quality metrics with a
corresponding threshold value; identifying, by the processor, a metric of the one or
more quality metrics that fails to meet the corresponding threshold value; calculating,
by the processor, a level of correlation of the metric between agents; identifying, by
the processor, the metric as being an individual metric when the correlation is low;
15 identifying, by the processor, the metric as being a group metric when the correlation
is high; identifying, by the processor, a process issue corresponding to the metric
when substantially all of the agents fail to meet the corresponding threshold value
with respect to the metric; and outputting, by the processor, a classification of the
metric in accordance with the individual metric, the group metric, and the process
20 issue.

[0014] According to one embodiment, a system includes: a processor; memory
storing instructions that, when executed by the processor, cause the processor to:
receive an evaluation form including a plurality of evaluation questions; receive an
interaction to be evaluated by the evaluation form; select an evaluation question of
25 the evaluation form, the evaluation question including a rule associated with one or
more topics, each of the topics including one or more words or phrases; search the
interaction for the one or more topics of the rule in accordance with the presence of
one or more words or phrases in the interaction to generate a search result;
calculate an answer to the evaluation question in accordance with the rule and the
30 search result; and output the calculated answer to the evaluation question of the
evaluation form.

[0015] The memory may further store instructions that, when executed by the
processor, cause the processor to: determine whether the calculated answer triggers
a coaching rule of a plurality of coaching rules, the coaching rule corresponding to
35 the evaluation question; and generate a notification in accordance with the answer to
the evaluation question.

[0016] The memory may further store instructions that, when executed by the
processor, cause the processor to generate the notification by identifying, based on

1 the calculated answer, a coaching tip from a plurality of coaching tips associated with the coaching rule, and the notification may include the coaching tip.

5 **[0017]** The memory may further store instructions that, when executed by the processor, cause the processor to generate the notification in real-time during the interaction.

[0018] The interaction may be a voice interaction, the memory may further store instructions that, when executed by the processor, cause the processor to supply the voice interaction to an automatic speech recognition engine to generate a speech recognition output, and the memory may further store instructions that, when
10 executed by the processor, cause the processor to detect the one or more detected topics in the interaction by identifying one or more instances of the one or more topics in the speech recognition output.

[0019] According to one embodiment of the present invention, a system includes: a processor; memory storing instructions that, when executed by the processor,
15 cause the processor to generate a customized coaching session for an agent by: receiving one or more evaluations of interactions involving the agent, each of the evaluations being computed based on an evaluation form and an interaction, the evaluation form including a plurality of evaluation questions, the evaluation including a plurality of answers corresponding to the evaluation questions; computing one or
20 more aggregated quality metrics in accordance with the answers of the one or more evaluations; comparing each of the one or more aggregated quality metrics against corresponding threshold values; identifying one or more underperforming quality metrics in accordance with the comparisons of the aggregated quality metrics with the threshold values; generating the customized coaching session in accordance
25 with the identified one or more underperforming quality metrics; and outputting the customized coaching session.

[0020] The memory may further stores instructions that, when executed by the processor, cause the processor to, for each of the one or more underperforming quality metrics: identify portions of the interactions corresponding to the answer
30 corresponding to the evaluation question; and add the identified portions to the customized coaching session.

[0021] The memory may further store instructions that, when executed by the processor, cause the processor to: identify one or more previous customized coaching sessions generated for the agent, each including a timestamp and one or
35 more coaching session reasons; group the one or more previous customized coaching sessions by coaching session reason; compute an average interval between coaching sessions having the same coaching session reason; and

1 schedule a customized coaching session for the agent in accordance with the
computed average interval.

5 **[0022]** According to one embodiment of the present invention, a system includes:
a processor; memory storing instructions that, when executed by the processor,
cause the processor to: receive a plurality of evaluations involving a plurality of
different agents, each of the evaluations including one or more quality metrics;
compare each of the one or more quality metrics with a corresponding threshold
value; identify a metric of the one or more quality metrics that fails to meet the
corresponding threshold value; calculate a level of correlation of the metric between
10 agents; identify the metric as being an individual metric when the correlation is low;
identify the metric as being a group metric when the correlation is high; identify a
process issue corresponding to the metric when substantially all of the agents fail to
meet the corresponding threshold value with respect to the metric; and output a
classification of the metric in accordance with the individual metric, the group metric,
15 and the process issue.

[0023] Aspects of embodiments of the present invention are directed to systems
and methods for automatically monitoring, evaluating, and managing the
performance of agents of a contact center.

20 **[0024]** According to one embodiment of the present invention, a method for
automatically calculating an overall evaluation score of an interaction includes:
receiving, by a processor, an evaluation form, the evaluation form comprising a
plurality of automatic questions and a plurality of manual questions; automatically
extracting, by a processor, a set of features from the interaction, the set of features
comprising answers to the automatic questions without manually generated answers
25 to the manual questions; and computing an overall evaluation score based on the set
of features.

[0025] The set of features from the interaction may consist of the answers to the
automatic questions.

30 **[0026]** The set of features from the interaction may further include particular
words or phrases detected in the interaction.

[0027] The set of features from the interaction may include topics detected in the
interaction.

35 **[0028]** The method may further include: receiving a second evaluation form, the
second evaluation form comprising a second plurality of automatic questions and a
second plurality of manual questions, wherein the interaction is associated with one
evaluation form; creating a super set of automatic questions comprising the plurality
of automatic questions of the evaluation form and the second plurality of automatic
questions of the second evaluation form; creating a super set of manual questions

1 comprising the plurality of manual questions of the evaluation form and the second
plurality of manual questions of the second evaluation form; and computing an index
vector, wherein each value in the index vector corresponds to a question of the
super set of manual questions, wherein each value of the index vector indicates
5 whether the evaluation form associated with the interaction includes the
corresponding question of the super set of manual questions, wherein the set of
features further comprise the index vector.

[0029] The set of features from the interaction may further include automatically
generated answers to the manual questions.

10 **[0030]** Each of the automatically generated answers to the manual questions may
be generated by: detecting one or more topics in the interaction; computing a
semantic similarity between a manual question and the detected one or more topics
in the interaction; and generating an answer in accordance with the semantic
similarity.

15 **[0031]** Each of the automatically generated answers to the manual questions may
be generated by: identifying a closest question-answer-document triple from a
plurality of question-answer-document triples, the closest question-answer-document
triple being most similar to a manual question and the interaction; and returning the
answer associated with the closest question-answer-document triple.

20 **[0032]** The computing the overall evaluation score based on the set of features
may include: supplying the set of features to a deep neural network trained based on
the evaluation form; and computing an overall evaluation score by forward
propagating the set of features through the deep neural network.

[0033] The deep neural network may be trained based on answers to the
25 automatic questions of the evaluation form and manually generated answers to the
manual questions of the evaluation form.

[0034] According to one embodiment of the present invention, a system includes:
a processor; memory storing instructions that, when executed by the processor,
cause the processor to: receive an evaluation form, the evaluation form including a
30 plurality of automatic questions and a plurality of manual questions; receive an
interaction for evaluation; automatically extract a set of features from the interaction,
the set of features comprising answers to the automatic questions without manually
generated answers to the manual questions; and compute an overall evaluation
score based on the set of features.

35 **[0035]** The memory may further store instructions that, when executed by the
processor, cause the processor to: receive a second evaluation form, the second
evaluation form comprising a second plurality of automatic questions and a second
plurality of manual questions; create a super set of automatic questions comprising

1 the plurality of automatic questions of the evaluation form and the second plurality of
automatic questions of the second evaluation form; create a super set of manual
questions comprising the plurality of manual questions of the evaluation form and the
second plurality of manual questions of the second evaluation form; and compute an
5 index vector, wherein each value in the index vector corresponds to a question of the
super set of manual questions, wherein each value of the index vector indicates
whether the evaluation form associated with the interaction includes the
corresponding question of the super set of manual questions, wherein the set of
features further comprise the index vector.

10 **[0036]** The memory may further stores instructions that, when executed by the
processor, cause the processor to generate the automatically generated answers to
the manual questions by: detecting one or more topics in the interaction; computing
a semantic similarity between a manual question and the detected one or more
topics in the interaction; and generating an answer in accordance with the semantic
15 similarity.

[0037] The memory may further store instructions that, when executed by the
processor, cause the processor to generate the automatically generated answers to
the manual questions by: identifying a closest question-answer-document triple from
a plurality of question-answer-document triples, the closest question-answer-
20 document triple being most similar to a manual question and the interaction; and
returning the answer associated with the closest question-answer-document triple.

[0038] The memory may further store instructions that, when executed by the
processor, cause the processor to compute the overall evaluation score based on
the set of features by: supplying the set of features to a deep neural network trained
25 based on the evaluation form; and computing an overall evaluation score by forward
propagating the set of features through the deep neural network.

[0039] The deep neural network may be trained based on answers to the
automatic questions of the evaluation form and manually generated answers to the
manual questions of the evaluation form.

30 BRIEF DESCRIPTION OF THE DRAWINGS

[0040] The accompanying drawings, together with the specification, illustrate
exemplary embodiments of the present invention, and, together with the description,
serve to explain the principles of the present invention.

35 **[0041]** FIG. 1 is a schematic block diagram of a system for supporting a contact
center in providing contact center services according to one exemplary embodiment
of the invention.

- 1 **[0042]** FIG. 2 is a flowchart of a method according to one embodiment of the present invention for automatically answering questions of an evaluation form.
- [0043]** FIG. 3 is a flowchart of a method according to one embodiment of the present invention for automatically generating coaching feedback during an
- 5 interaction.
- [0044]** FIG. 4 is a flowchart illustrating a method according to one embodiment of the present invention for determining whether an issue is a non-repeating individual agent issue, a repeating individual agent issue, a non-process systemic issue, or a process systemic issue.
- 10 **[0045]** FIG. 5 is a flowchart illustrating a method for generating a customized training session according to one embodiment of the present invention.
- [0046]** FIG. 6 is a flowchart illustrating a method for calculating a knowledge refresh interval according to one embodiment of the present invention.
- [0047]** FIG. 6 is a flowchart illustrating a method according to one embodiment of the present invention for training a neural network to compute an overall evaluation
- 15 score for an interaction based on automatic answered questions.
- [0048]** FIG. 7 is a block diagram of a general prediction model according to one embodiment of the present invention.
- [0049]** FIG. 8 is a block diagram illustrating the training of a prediction model
- 20 according to one embodiment of the present invention using answers to the automatic questions.
- [0050]** FIG. 9A is a block diagram illustrating the training of a prediction model according to one embodiment of the present invention using answers to the automatic questions of multiple different forms.
- 25 **[0051]** FIG. 9B is a flowchart illustrating a method for generating a predictive model for multiple quality monitoring evaluation forms according to one embodiment of the present invention.
- [0052]** FIG. 10A is a block diagram illustrating the training of a prediction model according to one embodiment of the present invention in which interaction context is
- 30 also used to predict the overall evaluation score.
- [0053]** FIG. 10B is a flowchart illustrating a method for applying a prediction model to an interaction using interaction context according to one embodiment of the present invention.
- [0054]** FIG. 11 is a block diagram illustrating the training of a prediction model
- 35 using semantic relevance analysis according to one embodiment of the present invention.
- [0055]** FIG. 12A is a block diagram of a computing device according to an embodiment of the present invention.

1 **[0056]** FIG. 12B is a block diagram of a computing device according to an embodiment of the present invention.

[0057] FIG. 12C is a block diagram of a computing device according to an embodiment of the present invention.

5 **[0058]** FIG. 12D is a block diagram of a computing device according to an embodiment of the present invention.

[0059] FIG. 12E is a block diagram of a network environment including several computing devices according to an embodiment of the present invention.

10 DETAILED DESCRIPTION

[0060] Quality monitoring (QM) in a contact center refers to the process of evaluating agents to measure and ensure the quality of the service provided by the human agents. Typically, quality monitoring is performed to measure agent performance during interactions (e.g., calls, text chats, and email exchanges) between the agents and customers, such as whether the agent was polite and courteous, and to measure agent effectiveness, such as whether the agent was able to resolve the customer's issue and whether the agent was time efficient in doing so.

15 **[0061]** Systems for quality monitoring or quality management are described in U.S. Patent Application No. 14/726,491 "System and Method for Quality Management Platform," filed in the United States Patent and Trademark Office on May 30, 2015, and in U.S. Patent Application No. 15/133,188 "Quality Monitoring Automation in Contact Centers," filed in the United States Patent and Trademark Office on April 19, 2016, the entire disclosures of which are incorporated by reference herein.

25 **[0062]** Broadly, performing quality monitoring and coaching according to one embodiment of the present invention broadly involves: automatically evaluating individual interactions in accordance with defined quality criteria; automatically providing feedback to the agent based on those evaluations, whether in real-time during the interaction or after the interaction; providing customized training to the agent based on the evaluations; automatically monitoring performance trends among the agents; and automatically calculating evaluation scores of individual interactions. These various components allow an organization to monitor and improve the performance of its contact center in a way that is substantially automatic, while still retaining the ability to monitor performance. These various aspects of embodiments of the present invention will be described in more detail below.

35 **Contact center overview**

[0063] FIG. 1 is a schematic block diagram of a system for supporting a contact center in providing contact center services according to one exemplary embodiment

1 of the invention. For the purposes of the discussion herein, interactions between
customers using end user devices 10 and agents at a contact center using agent
devices 38 may be recorded by call recording module 40 and stored in call recording
storage 42. The recorded calls may be processed by speech recognition module 44
5 to generate recognized text which is stored in recognized text storage 46. In some
embodiments of the present invention, a voice analytics system 45 configured to
perform analytics on recognized speech data such as by detecting events occurring
in the interactions and categorizing the interactions in accordance with the detected
events. Aspects of speech analytics systems are described, for example, in U.S.
10 Patent Application Serial No. 14/586,730 "System and Method for Interactive Multi-
Resolution Topic Detection and Tracking," filed in the United States Patent and
Trademark Office on December 30, 2014, the entire disclosure of which is
incorporated herein by reference. Embodiments of the present invention may also
include a quality monitoring (QM) system 47, which will be described in more detail
15 below.

[0064] The contact center may be an in-house facility to a business or corporation
for serving the enterprise in performing the functions of sales and service relative to
the products and services available through the enterprise. In another aspect, the
contact center may be a third-party service provider. The contact center may be
20 deployed in equipment dedicated to the enterprise or third-party service provider,
and/or deployed in a remote computing environment such as, for example, a private
or public cloud environment with infrastructure for supporting multiple contact centers
for multiple enterprises. The various components of the contact center system may
also be distributed across various geographic locations and computing environments
25 and not necessarily contained in a single location, computing environment, or even
computing device.

[0065] According to one exemplary embodiment, the contact center system
manages resources (e.g. personnel, computers, and telecommunication equipment)
to enable delivery of services via telephone or other communication mechanisms.
30 Such services may vary depending on the type of contact center, and may range
from customer service to help desk, emergency response, telemarketing, order
taking, and the like.

[0066] Customers, potential customers, or other end users (collectively referred to
as customers) desiring to receive services from the contact center may initiate
35 inbound telephony calls to the contact center via their end user devices 10a-10c
(collectively referenced as 10). Each of the end user devices 10 may be a
communication device conventional in the art, such as, for example, a telephone,
wireless phone, smart phone, personal computer, electronic tablet, and/or the like.

1 Users operating the end user devices 10 may initiate, manage, and respond to telephone calls, emails, chats, text messaging, web-browsing sessions, and other multi-media transactions.

5 **[0067]** Inbound and outbound telephony calls from and to the end users devices 10 may traverse a telephone, cellular, and/or data communication network 14 depending on the type of device that is being used. For example, the communications network 14 may include a private or public switched telephone network (PSTN), local area network (LAN), private wide area network (WAN), and/or public wide area network such as, for example, the Internet. The communications network 14 may also include a wireless carrier network including a code division multiple access (CDMA) network, global system for mobile communications (GSM) network, or any wireless network/technology conventional in the art, including but not limited to 3G, 4G, LTE, and the like.

10 **[0068]** According to one exemplary embodiment, the contact center includes a switch/media gateway 12 coupled to the communications network 14 for receiving and transmitting telephony calls between end users and the contact center. The switch/media gateway 12 may include a telephony switch configured to function as a central switch for agent level routing within the center. The switch may be a hardware switching system or a soft switch implemented via software. For example, 15 the switch 12 may include an automatic call distributor, a private branch exchange (PBX), an IP-based software switch, and/or any other switch configured to receive Internet-sourced calls and/or telephone network-sourced calls from a customer, and route those calls to, for example, an agent telephony device. In this example, the switch/media gateway establishes a voice path/connection (not shown) between the 20 calling customer and the agent telephony device, by establishing, for example, a connection between the customer's telephony device and the agent telephony device.

25 **[0069]** According to one exemplary embodiment of the invention, the switch is coupled to a call server 18 which may, for example, serve as an adapter or interface between the switch and the remainder of the routing, monitoring, and other call-handling components of the contact center.

30 **[0070]** The call server 102 may be configured to process PSTN calls, VoIP calls, and the like. For example, the call server 102 may include a session initiation protocol (SIP) server for processing SIP calls. According to some exemplary 35 embodiments, the call server 102 may, for example, extract data about the customer interaction such as the caller's telephone number, often known as the automatic number identification (ANI) number, or the customer's internet protocol (IP) address,

1 or email address, and communicate with other CC components and/or CC iXn controller 18 in processing the call.

[0071] According to one exemplary embodiment of the invention, the system further includes an interactive media response (IMR) server 34, which may also be referred to as a self-help system, virtual assistant, or the like. The IMR server 34 may be similar to an interactive voice response (IVR) server, except that the IMR server is not restricted to voice, but may cover a variety of media channels including voice. Taking voice as an example, however, the IMR server may be configured with an IMR script for querying calling customers on their needs. For example, a contact center for a bank may tell callers, via the IMR script, to "press 1" if they wish to get an account balance. If this is the case, through continued interaction with the IMR, customers may complete service without needing to speak with an agent. The IMR server 34 may also ask an open ended question such as, for example, "How may I assist you?" and the customer may speak or otherwise enter a reason for contacting the contact center. The customer's speech may then be processed by the speech recognition module 44 and the customer's response may then be used by the routing server 20 to route the call to an appropriate contact center resource.

[0072] In more detail, a speech driven IMR receives audio containing speech from a user. The speech is then processed to find phrases and the phrases are matched with one or more speech recognition grammars to identify an action to take in response to the user's speech. As used herein, the term "phrases" may also include "fragments" in which words are extracted from utterances that are not necessarily sequential. As such, the term "phrase" includes portions or fragments of transcribed utterances that omit some words (e.g., repeated words and words with low saliency such as "um" and "ah"). For example, if a user says "what is my account balance?" then the speech driven IMR may attempt to match phrases detected in the audio (e.g., the phrase "account balance") with existing grammars associated with actions such as account balance, recent transactions, making payments, transferring funds, and connecting to a human customer service agent. Each grammar may encode a variety of ways in which customers may request a particular action. For example, an account balance request may match phrases such as "account balance," "account status," "how much money is in my accounts," and "what is my balance." Once a match between the spoken phrase from the user and a grammar is detected, the action associated with the grammar is performed in a manner similar to the receiving a user selection of an action through a keypress. These actions may include, for example, a VoiceXML response that is dynamically generated based on the user's request and based on stored business information (e.g., account balances and transaction records).

1 **[0073]** In some embodiments, the speech recognition module 44 may also
operate during a voice interaction between a customer and a live human agent in
order to perform analytics on the voice interactions. During a voice interaction, audio
containing speech from the customer and speech from the human agent (e.g., as
5 separate audio channels or as a combined audio channel) may be processed by the
speech recognition module 44 to identify words and phrases uttered by the customer
and/or the agent during the interaction. In some embodiments of the present
invention, a different speech recognition modules are used for the IMR and for
performing voice analytics of the interactions (e.g., the speech recognition module
10 may be configured differently for the IMR as compared to the voice interactions, due,
or example, to differences in the range of different types of phrases expected to be
spoken in the two different contexts).

[0074] In some embodiments, the routing server 20 may query a customer
database, which stores information about existing clients, such as contact
15 information, service level agreement (SLA) requirements, nature of previous
customer contacts and actions taken by contact center to resolve any customer
issues, and the like. The database may be, for example, Cassandra or any non-SQL
database, and may be stored in a mass storage device 30. The database may also
be a SQL database and may be managed by any database management system such
20 as, for example, Oracle, IBM DB2, Microsoft SQL server, Microsoft Access,
PostgreSQL, MySQL, FoxPro, and SQLite. The routing server 20 may query the
customer information from the customer database via an API or any other
information collected by the IMR server 34.

[0075] According to one exemplary embodiment of the invention, the mass
25 storage device(s) 30 may store one or more databases relating to agent data (e.g.
agent profiles, schedules, etc.), customer data (e.g. customer profiles), interaction
data (e.g. details of each interaction with a customer, including reason for the
interaction, disposition data, time on hold, handle time, etc.), and the like. According
to one embodiment, some of the data (e.g. customer profile data) may be maintained
30 in a customer relations management (CRM) database hosted in the mass storage
device 30 or elsewhere. The mass storage device may take form of a hard disk or
disk array as is conventional in the art.

Automatic evaluation of interactions

[0076] Aspects of embodiments of the present invention are directed to
35 automatically aspects of embodiments of the present invention, the quality
monitoring system 47 automatically evaluates individual interactions in accordance
with defined quality criteria.

1 **[0077]** The quality criteria can be defined by a form developer, such as a person
who manages a team of agents at a contact center. The manager may author an
evaluation form using techniques described in, for example, U.S. Patent Application
No. 15/133,188 “Quality Monitoring Automation in Contact Centers,” filed in the
5 United States Patent and Trademark Office on April 19, 2016, the entire disclosure of
which are incorporated by reference herein, where answers to the questions in the
evaluation form represent evaluation of the interaction against the defined quality
criteria.

10 **[0078]** An evaluation form includes one or more questions that relate to an
agent’s performance during an interaction, such as “did the agent present himself?”
and “was the agent attentive?” The form developer may also set the data types of
the answers to the questions, e.g., whether the answers are: a yes/no data type
(“yes” or “no”); a multiple response data type (a multiple choice question); numerical
15 value data type (e.g., on a scale from 1 to 10); or free text data type (e.g., a free
written response). In addition, portions of the evaluation form may automatically be
presented or not presented (e.g., automatically hidden or shown) based on a
condition. For example, if the particular interaction being evaluated included an
“escalation request” (e.g., as identified by an evaluator or by the agent) the form may
20 be automatically populated with the question “how did the agent handle the
escalation request?”

[0079] The various questions of the evaluation form are with various quality
criteria. For example, questions such as “was the agent attentive?” and “did the
agent use profanity?” may relate to the criteria of “agent sociability.”

25 **[0080]** In comparative quality monitoring systems, human evaluators review
interactions and manually answer the questions on the evaluation form. For
example, the human evaluators may read chat transcripts and/or listen to recorded
audio from the interactions between agents and customers. Due to the time and
expense required for manual evaluation of the interactions, generally speaking, only
a small fraction of all interactions (e.g., 1% to 2%) are evaluated, where these
30 interactions may be selected randomly or selected based various criteria. As a
result, in these comparative systems, agents receive feedback based on only a very
small sample of their actual work, and it may be difficult to obtain information about
general trends and the quality of agent performance within a contact center.

35 **[0081]** As described in U.S. Patent Application No. 15/133,188 “Quality
Monitoring Automation in Contact Centers,” a quality monitoring system is capable of
automatically filling in answers to at least some portions of the evaluation form based
on an automatic analysis of the interaction. In one embodiment, each question of
the evaluation form is associated with one or more answers. For example, the

1 question may be a “yes or no” question, a multiple choice questions, or a rating on a scale (e.g., from 1 to 10). In addition, each of the answers is associated with one or more “topics.” Detecting a topic within an interaction can be used as support or evidence that a particular answer to the question is appropriate.

5 **[0082]** Broadly, a “topic” refers to a concept or event that occurred in an interaction. A topic may be constructed from one or more phrases and interactions that contain those phrases can be identified as relating to that topic. For example, a topic called “delinquency” may include the phrases: “delinquent balance,” “past due,” “delinquency notice,” and “set up payment arrangement.” As another example, a
10 topic called “profanity” may include a number of phrases that are understood to be inappropriate for use by an agent in a professional interaction. Detecting any of the phrases within an interaction (e.g., within a speech-to-text transcript of a voice interaction or based on matching the text within the transcript of a text-based chat session) can identify the section containing the phrases as relating to the associated
15 topic. Topics can be grouped together into “meta topics” and meta topics may be grouped with other meta topics and/or topics to form a semantic hierarchy or taxonomy of meta topics and topics.

[0083] Additional detail regarding analytics systems and methods for automatically detecting and tracking topics can be found, for example, in: U.S.
20 Patent Application Serial No. 13/952,459 “System and Method for Discovering and Exploring Concepts,” filed in the United States Patent and Trademark Office on July 26, 2013; U.S. Patent Application Serial No. 14/327,476 “System and Method for Semantically Exploring Concepts,” filed in the United States Patent and Trademark Office on July 9, 2014; and U.S. Patent Application Serial No. 14/586,730 “System
25 and Method for Interactive Multi-Resolution Topic Detection and Tracking,” filed in the United States Patent and Trademark Office on December 30, 2014, the entire disclosures of which are incorporated by reference herein. In the context of a voice interaction, an automatic speech recognition engine may be used to transform audio data into voice recognition output (e.g., Large Vocabulary Continuous Speech
30 Recognition or LVCSR output or text output), which may be analyzed to detect the topics.

[0084] Therefore, as described in U.S. Patent Application No. 15/133,188 “Quality Monitoring Automation in Contact Centers,” each of the questions can be associated with one or more “topics,” where the detection of a topic within an interaction or a
35 portion of an interaction can be used to answer a particular question. For example, a question such as “did the agent use profanity” can be answered “yes” or “no” in accordance with whether or not the topic “profanity” was detected within the interaction. As another example, a question such as “did the agent take ownership

1 of the problem” can be answered in accordance with whether or not the “assume ownership” topic was detected, which may include a phrase such as “sorry, that was our mistake.”

5 **[0085]** Furthermore, as discussed in U.S. Patent Application No. 15/133,188 “Quality Monitoring Automation in Contact Centers,” particular portions of the interactions containing the answers to the questions can be automatically identified. For example, as evidence of the presence of the “ownership,” the portion of the interaction during which the agent spoke the phrase can be automatically identified and played back to a user.

10 **[0086]** As such, embodiments of the present invention enable at least some evaluation questions to be automatically answered by detecting the presence of one or more topics within an interaction.

15 **[0087]** FIG. 2 is a flowchart of a method 200 according to one embodiment of the present invention for automatically answering questions of an evaluation form. In operation 202, an interaction for evaluation is identified, along with an evaluation form to use to evaluate the interaction. For each question q of the evaluation form (operation 204), in operation 206 the quality monitoring system 47 identifies one or more portions of the interaction that are relevant to the question q . This identification of relevant portions may include, for example identifying portions that correspond to a topic that is associated with the question q . As a more specific example, if the question q is “did the agent use profanity?” then the topic may be the “profanity” topic and the identified portions of the interaction are portions that include one or more phrases belonging to the “profanity” topic.

20 **[0088]** In operation 208, the quality monitoring system 47 answers the question q based on the topics detected in the identified portions, or the lack of such identified portions. For example, the failure to find any portions of the interaction corresponding to the “profanity” topic can be treated as evidence that the answer to the question “did the agent use profanity?” to be “no.” On the other hand, finding portions corresponding to profanity would cause the automatically determined answer to be “yes.”

25 **[0089]** The quality monitoring system 47 may also store the identified portions. This may include, for example, storing the locations of the identified portions within the interactions (e.g., start and end timestamps or other identifiers).

30 **[0090]** In operation 210, the quality monitoring system 47 determines if there are more answers to evaluate. If so, then the process returns to operation 204, where the next question q from the evaluation form is selected.

35 **[0091]** The automatic analysis of interactions to answer questions of the evaluation form 200 can be done after the completion of the interaction or may be

1 performed in real-time during the interaction. In embodiments where the automatic
analysis is performed after the completion of the interaction, the entire interaction
can be searched for relevant portions in operation 206. In embodiments where the
automatic analysis is performed during the interaction, the quality monitoring system
5 47 may continuously analyze the content of the interaction available so far. For
example, only the portions of the interaction from the start until the current time or
from the time of the last analysis until the current time (e.g., a few seconds) are
analyzed to identify whether one or more events or topics corresponding to answers
to any of the questions have occurred in the interaction.

10 **[0092]** While a quality monitoring system 47 may be able to answer some types
of questions automatically, other types of questions may require a human evaluator
to manually answer those questions. Questions that can be answered automatically
may generally relate to the presence or absence of particular phrases in the
interaction. On the other hand, questions that need to be answered manually may
15 require more qualitative evaluations of the interaction, such as whether the agent
was effective at establishing rapport with the customer or whether the agent used a
calm and caring tone of voice, which may be more difficult to automatically
determine.

Automatically providing feedback to the agents

20 **[0093]** Aspects of embodiments of the present invention relate to automatically
providing feedback to the agents based on the automatic evaluations. In various
embodiments, the feedback may be provided in real-time during the interaction or
may be provided after the interaction.

[0094] As discussed above, aspects of embodiments of the present invention
25 relate to the process of applying automatic quality monitoring to automatically
evaluate an interaction in accordance with various quality metrics or key
performance indicators (KPIs). These quality metrics may be provided as feedback
to the agents in order to congratulate the agent on quality metrics of the interaction
that were positive, and in order to provide advice or tips on improving aspects of the
30 interaction that were negative.

[0095] The term “coaching” is used herein to refer to the process of guiding an
agent in order to improve the agent’s performance and efficiency when interacting
with customers based on the quality metrics. The term “real-time coaching” is used
herein to refer to the process of doing coaching in real-time during a live interaction.
35 In the context of embodiments of the present invention, the “real-time coaching” is
performed automatically based on the quality metrics that are automatically
computed during a real-time automatic quality evaluation of the interaction.

1 **[0096]** In addition, aspects of embodiments of the present invention relate to quality monitoring gamification, in which tips, feedback, and scores may be presented in real time or offline in order to encourage continuous improvement.

[0097] *Automatic real-time coaching*

5 **[0098]** Aspects of embodiments of the present invention apply automatic quality monitoring during an interaction to provide real-time feedback on the ongoing behavior of the agent, and can supply guidance for the rest of the interaction.

[0099] For example, a quality monitoring evaluation form may include the question: "Did the agent communicate in positive terms, e.g., what we can do for the consumer rather than state what cannot do?"

10 **[00100]** Under typical conditions, if an agent communicated with a customer in negative terms during an interaction, such as by saying "sorry, we can't help you with that," the particular interaction might not ever be evaluated by a human evaluator, and, even if it was reviewed, the agent might receive corrective feedback at a much later time, such as days or weeks after the event.

15 **[00101]** However, with the addition of automatic quality monitoring of every interaction, it is possible to immediately detect the use of negative phrasing during a call and to provide a real-time alert to the agent to refrain from using words and phrases such as "unfortunately," "I can't," "we don't," and the like. This notification may be displayed, for example, as a pop-up balloon or an alert on the agent's device 38.

20 **[00102]** As another example, an evaluation question may be: "Did the agent communicate an ownership statement to let the consumer know we are there to help?" If the agent fails to communicate such a statement within a particular amount of time (e.g., within one minute of a customer stating an issue), then the quality monitoring system 47 may generate a real-time alert to the agent to remind the agent to assume ownership of the problem sometime during the remainder of the interaction in order to avoid getting a low score on this evaluation question.

25 **[00103]** As such, embodiments of the present invention provide real-time coaching to agents in order to improve their performance by satisfying various quality criteria.

30 **[00104]** FIG. 3 is a flowchart of a method 300 according to one embodiment of the present invention for automatically generating coaching feedback during an interaction.

35 **[00105]** In operation 302, the quality monitoring system 47 identifies an interval of the interaction for analysis. For example, if this is the first time that the current interaction is being analyzed for performing real-time coaching, then the start of the interval may be the beginning of the interaction and the end of the interval may be the current point in the interaction. If this is not the first analysis for the current

1 interaction, then the start of the interval may be the end point of the previous interval. In other embodiments, the entire length of the interaction from the beginning of the interaction to the current time in the interaction is the interval.

5 **[00106]** In operation 304, the quality monitoring system 47 selects a next question q of the evaluation form. In operation 306, the quality monitoring system 47 searches for portions of the interaction that are relevant to the current question q to generate search results. As discussed above, these relevant portions in the search results may be portions of the interaction that contain topics that correspond to one or more of the answers to the question q . In some circumstances, none of the
10 portions of the interaction will be relevant to the current question, in which case the search results include no matching portions.

[00107] In operation 308, the quality monitoring system 47 scores or answers a question based on the search results for the topics the identified portions of the interaction. For example, a question relating to “agent politeness” may be answered
15 with a higher score based on the frequency with which the agent uses the words “please” and “thank you” during the interaction. As another example, a question relating to “agent profanity” may be answered “yes” if there is even a single instance of the topic “profanity” on the agent side of the interaction. On the other hand, if no profanity was detected, then the “agent profanity” question may be answered “no.” If
20 the interaction terminates with the “agent profanity” question unanswered, then the answer may be set to a default answer of “no.” The scores and answers determined in operation 308 are stored for later output.

[00108] In operation 310, the quality monitoring system 47 determines if there are more questions to attempt to answer. If so, then the process returns to operation
25 304 to select a next question. If not, then the quality monitoring system 47 generates notifications, if warranted, for any of the scores or answers associated with the questions in accordance with coaching rules associated with the questions. For example, a coaching rule associated with the “agent profanity” question may be triggered when the “profanity” topic is detected in the interaction, and the coaching
30 rule may generate a notification to remind the agent to refrain from using profanity. As another example, if the “agent politeness” score was low, then a coaching rule associated with the “agent politeness” question may indicate that the quality monitoring system should generate a coaching tip to suggest that the agent use polite language more frequently. The generated notifications may be displayed on
35 the user device 38.

[00109] After generating the notifications in operation 312, the quality monitoring system 47 proceeds to operation 314 to determine if the interaction is still ongoing. If so, then the process returns to operation 302 to identify a next interval for analysis.

1 In some embodiments, a delay (e.g., 1–2 seconds) is included before selecting the next interval. If the interaction is not still on going, then the process ends.

5 **[00110]** Embodiments of the present invention are also directed to quality monitoring systems in which a manager can define when to take an action on a specific automatic question from the quality monitoring evaluation form. In one such embodiment, a manager may define a “trigger point” that specifies conditions for taking an action on a particular evaluation question from the evaluation form. For instance, a trigger point may be when a specified question receives a very low score or when a specified question is not answered within a time period (e.g., within 90
10 seconds) of the start of the interaction. The manager may also define what message should be presented to the agent or what other action should be taken in response to reaching the trigger point.

[00111] *Gamification*

15 **[00112]** Aspects of embodiments of the present invention relate to gamification mechanisms to reward agents in a contact center based on good performance, such as based on the quality metrics from the evaluations of the interactions. In addition, these gamification techniques may notify and penalize agents for misbehavior or poor performance. The behavior or misbehavior can be automatically detected during an interaction through the real-time automatic evaluation, or after an
20 interaction or a set of interactions.

[00113] For example, the quality monitoring system 47 may automatically encourage agents to improve themselves when needed, for example in case of low conversion rate the quality monitoring system 47 can send an encouraging message for a successful new sale. As another example, the agent’s performance should be
25 transparent to him or her during the interaction, which may be presented using an automatically computed call performance indicator (e.g., an indicator that shifts between green for good performance and red for bad performance in accordance with the current overall result of the automatic evaluation).

30 **[00114]** Other aspects of the gamification of agent performance metrics include using a points and rewards system. For example, an overall score for an interaction can be translated into points which may be added to the agent’s accumulated set of points over a time period (e.g., a shift and/or a month). In another embodiment, only the overall scores of successful interactions are included in the points, where the success may be determined according to sentiment analysis or appearance of
35 certain topic (e.g., successful sales conversion). If the number of points earned by the agent is above a certain threshold, a reward may be given (e.g., a gift card).

[00115] According to other aspects of embodiments of the present invention, bonus points can be awarded based on achieving particular goals. For example, an

1 agent having a high daily ratio of successful calls may earn bonus points, and bonus points may be automatically awarded to an agent who is able to solve a problem that has gone unresolved for several interactions.

5 **[00116]** According to other aspects of embodiments of the present invention, bonus points can be awarded to mark milestones in achieved proficiency level. For example, for each working day we compute the average number of points the agent got for an interaction and a current proficiency score is computed for each agent by summing up the daily average for each day. Various proficiency levels can be defined by putting thresholds on the proficiency scores. As such, each time the
10 agent passes a threshold proficiency score, the agent reaches the next level and may get a "medal." Each level may be marked by a "Badge" or "Rank" e.g., "Junior", "Senior", "Advanced," and "Expert."

15 **[00117]** According to other aspects of embodiments of the present invention, bonus points can be displayed on a progress bar. The progress bar may be shown in real-time, in other words, showing the current aggregate score of the current interaction divided by the maximum possible score on this interaction. Another progress bar may also show an ongoing score, in other words, the aggregate number of points in the current day divided by a daily point quota. Still another progress bar may relate to a proficiency score, in other words, the agent's current
20 proficiency score divided by the maximal proficiency score among the agents. Still another progress bar may refer to a long term score, such as the current rank divided by the maximal rank of agents (e.g., the agent's performance percentile when compared with other agents).

25 **[00118]** According to other aspects of embodiments of the present invention, the quality monitoring system 47 provides each agent's personal performance history and progress/trend graph so that each agent can view their performance over a long term (e.g., months or years) in order to provide context for the agent's current achievements, next achievements, scores, feedback, and the like. Other information provided to the agent by the quality monitoring system 47 includes statistics about
30 particular situations and how many other agents resolved various situations correctly. Looking in the dimension of a specific question or a question group, and the quality monitoring system 47 can provide information across agents or interactions regarding average score, average success cases, and the like. In addition, the quality monitoring system can show the current percentile of the agent
35 with regard to a specific situation or question raised in the interaction.

Monitoring performance trends among the agents

[00119] Aspects of embodiments of the present invention relate to automatically monitoring performance trends among the agents and determining the character of

various trends, such as whether problems are specific to particular agents, systemic problems in the training of groups of agents, or systemic problems affecting all agents.

[00120] A “non-repeating individual agent issue” refers to sub-par performance or underperforming metrics that is confined to a particular agent or a small group of agents and it is a first time (at least in a particular time period) that the particular agent has this issue. These issues may be addressed with a self-coaching session as described in more detail below.

[00121] A “repeating individual agent issue” refers to sub-par performance that is confined to a particular agent or a small group of agents and it is not the first time (at least in particular time period) that the particular agent has had this issue. Because this may be a more serious issue, one action may be to generate a side-by-side coaching session with a supervisor or a trainer.

[00122] A “non-process group issue” refers to sub-par performance on a specific issue in a group of agents, but not necessarily all agents. This may represent a failure to properly train the group of agents, or may reflect the need for a refresh on a particular issue by a human trainer or instructor.

[00123] A “process group issue” refers to sub-par performance by all agents or substantially all agents on a specific issue. The failure of all agents to be able to address the issue may be indicative of problems of agent empowerment (e.g., agents do not have the authority or resources available to address the issue). These problems can be addressed by the managers/analysts who are able to change the processes within the contact center. For instance, allowing a first tier agent issue refunds of up to a certain amount without supervisor approval versus referring the customers to a supervisor for every refund request.

[00124] To distinguish between the above four types of issues, the quality monitoring system 47 collects and aggregates scores for every agent on a periodic basis, such as once per day. One example of such scores on N metrics and a Quality Monitoring (QM) evaluation score for M agents is shown below in Table 1:

Table 1

Agent Id	QM Evaluation score	Quality metric 1	...	Quality metric N
1	7	8	...	7
2	3	7	...	1
...	...	...	...	...
M	9	8	...	10

[00125] In some circumstances, scores can be specified on an even finer granularity, such as the agent’s score on every question in the K questions in the QM evaluation form, as shown, for example, in Table 2:

Table 2

Agent Id	QM Q ₁ Score	QM Q ₂ Score	...	QM Q _K Score
1				
2				
...				
M				

[00126] In some embodiments of the present invention, the questions Q are all the questions of the QM score that are answered automatically by processing the content of the interaction. These questions may include, for example: "Did the agent greet the customer?" "Did the agent use profanity?" and "Did the agent confirm that all the customer's issues were resolved?"

[00127] Embodiments of the present invention detect agent or process problems based on these scores, in both the rough granularity of the metrics of Table 1 and the finer granularity of the metrics of Table 2.

[00128] FIG. 4 is a flowchart illustrating a method according to one embodiment of the present invention for determining whether an issue is a non-repeating individual agent issue, a repeating individual agent issue, a non-process systemic issue, or a process systemic issue.

[00129] To determine if the problem is an individual agent issue, in operation 402, the quality monitoring system 47 identifies an agent from the set of agents to analyze. In operation 404, the quality monitoring system 47 identifies scores that are low in comparison with other agents or in comparison with previous performance. For example, in some embodiments, "low" can mean lower than a threshold score, e.g., lower than a score of 3 out of a possible 5 points. In some embodiments, "low" may be compared with the score average of other agents, e.g., if for a certain score almost all agents regularly score 5, then an agent that scores 4.5 might need training. In some embodiments, "low" may refer to decreased performance compared to historical performance, such as when a particular agent previously had a consistently high score and more recently has had a lower score because the agent has started to use "shortcuts" to skip parts of the contact center script. If any of these conditions occur, agent coaching will be assigned to this agent, based on the scores that were low.

[00130] To determine if the individual agent issue is a repeating or a non-repeating individual agent issue, in operation 406 the quality monitoring system 47 searches a history of automatically generated coaching sessions for this particular agent to determine if this issue has previously occurred (e.g., this agent already had two coaching sessions for profanity in the past 2 months). In this case, in one embodiment, the quality monitoring system 47 tags the issue as repeating in

1 operation 408 and automatically schedules a coaching session with a person (e.g., a manager or a trainer), as described in more detail below. If this incident has not occurred, then it is tagged as non-repeating in operation 410.

5 **[00131]** In operation 412, the quality monitoring system 47 determines if there are more agents to analyze. If so, then the process returns to operation 402 to select the next agent. If not, then the process continues to operation 414.

10 **[00132]** To determine if the issue is a group issue, after detecting issues among all of the agents, in operation 414 the quality monitoring system 47 detects whether a group of agents (e.g., multiple agents) has a problem with one or more quality metrics based on their quality monitoring scores. In some embodiments, the group may be identified based on shared characteristics (e.g., membership in the same team). When the quality monitoring system 47 detects that a group of agents has a problem with one or more quality metrics then, in some embodiments, group training is automatically scheduled for all of the affected agents to be trained together.

15 **[00133]** In some embodiments, in addition to the scores from the quality monitoring evaluation form, the score may also be correlated based on the topics detected by the voice analytics system 45. For example, if a new product was released, and suddenly many people may interact with the contact center to ask about the cost of an upgrade. If this question was unexpected, then the agents may not have
20 received recent training on this issue (e.g., the various upgrade options, the features associated with each option, and the comparative costs of each option). While the quality monitoring evaluation form may lack a specific question related to this issue, many interactions that relate to the upgrade will not end with a positive customer answer to the question "Have I solved all your problems today?" This will result in
25 the agents receiving low scores in these interactions. However, by correlating (or finding the intersection) the question "Problem Solved?" of the quality monitoring evaluation form with all the topics detected by the voice analytics system 45, and in particular, interactions with the topic "upgrade," the quality monitoring system 47 detects low "Problem Solved?" score for this topic across a large number of agents.

30 **[00134]** To determine if the issue is a non-process group issue or a process group issue, after detecting issues among all of the agents, in operation 420 the quality monitoring system 47 determines what portion of all agents have low scores on a particular quality metric (e.g., on a particular question). When the quality monitoring system 47 determines that substantially all (e.g., more than 80%) of the agents have
35 low scores on a particular question, then this may be an indication that the problem lies in the general agent training program or that the problem lies in the overall systemic processes, such as resources or authority granted to agents to solve problems. For example, problems with systemic processes include situations where

1 when agents are not allowed to offset a fee, offer a replacement, or otherwise take an action that would solve a common problem. This may be contrasted with problems in the training of a specific agent in how to address a problem.

5 **[00135]** When a process issue is detected, then the issue is tagged as a process issue in operation 422. Several possible actions can take place in response to detecting a process issue: in the short term, until all agents are trained, customers interacting with the contact center about the problematic issues that agents don't know how to handle must be referred to someone else, e.g. a supervisor. In some circumstances, detecting a process issue indicates that the general agent training is to be updated, and all the agents in the contact center must undergo the revised training – or at least the relevant places where their training was flawed. In other circumstances, management may change the processes by giving the agent power to resolve issues (e.g., by offsetting charges). In some embodiments, the quality monitoring system 47 identifies specific examples of several agents behaving
10 incorrectly in order to be used as examples in the generic agent coaching. In still other circumstances, the process error may relate to a problem in the way the automatic quality evaluation is being performed, such as the failure to detect particular topics that do indicate satisfaction of the question of the evaluation form that is incorrectly being judged with failing scores.

15 **[00136]** On the other hand, when the issue is a non-process issue, then in operation 424 the issue is tagged accordingly and, as discussed above, the problem may be resolved by scheduling group training for the agents affected by the issue.

Automatically generating customized training for agents

20 **[00137]** Aspects of embodiments of the present invention relate to automatically generating customized training to the agent based on the evaluations. As discussed above with respect to FIG. 4, in when the quality monitoring system 47 detects low scores for particular questions among individual agents or groups of agents, the quality monitoring system 47 may automatically schedule training sessions for the agents. Because the quality monitoring system 47 can automatically evaluate every
25 interaction in the contact center in real-time, customized training can be provided to agents shortly or immediately after problems occur, thereby tightening the feedback loop and improving the management of agent performance.

30 **[00138]** These customized training sessions can be automatically generated to address the particular areas that need improvement (e.g., areas in which the agent is underperforming) and can be customized using examples from interactions that the agent was involved in. These results can be triggered in any desired interval of time and without a human intervention. For example, the training session can be initiated
35 immediately after an interaction ends, or in real-time during the call, as described

1 above with respect to FIG. 3, based on the quality metrics needing additional training during the interaction. As another example, the training session can be customized based on a set of interactions handled by the same agent, in which case it may contain aggregate results. In other embodiments, the coaching sessions can be
5 scheduled based on a refresh interval that is determined based on past performance.

[00139] *Self-coaching sessions generation*

[00140] In one aspect of embodiments of the present invention, the quality monitoring system 47 automatically generates customized coaching sessions that
10 are tailored to the individual agent or groups of agent who will be receiving the coaching based on the particular problems associated with that group (e.g., particular quality metrics that the individual or group). The coaching session can also be customized by including "positive examples" of the desired behavior and "negative examples" of the undesired behavior, where the examples may be taken
15 directly from the interactions of the individual agent or from interactions of the group of agents.

[00141] For example, in one embodiment of the present invention, the quality monitoring system 47 receives one or more evaluations of interactions involving the agents, where the evaluations are computed based on an evaluation form. The
20 evaluations are generated by evaluating the interaction against each of the evaluation questions of the evaluation form, as described above, in order to compute as set of answers and/or scores for each question, where the answer or score to each question corresponds to a quality metric. By aggregating the answers and scores across all of the evaluations, aggregated quality metrics can be computed for
25 each agent (e.g., the agent's computed "politeness" score or "issue resolution" score). Each of these scores can then be compared to a threshold value to determine whether the agent's performance on the quality metric is satisfactory, or if the agent's performance is sub-par. In other words, one or more underperforming quality metrics can be determined from comparisons of the agents' aggregated
30 quality metrics against the thresholds. A customized coaching session can then be generated for the agent by identifying coaching session "reasons" based on which quality metrics are underperforming, where each coaching session reason may be associated with a training module (e.g., descriptions and examples of good and bad performance on each quality metric).

35 **[00142]** FIG. 5 is a flowchart illustrating a method 500 for generating a customized coaching session according to one embodiment of the present invention. In operation 502, the quality monitoring system 47 identifies a next interaction to be considered when generating the customized coaching session (where there may

only be a single interaction), and in operation 504, identifies a next question from the quality monitoring evaluation form. In operation 506, the quality monitoring system 47 identifies a portion of the interaction that led to the determination of the score (e.g., the stored portions of the interactions evidencing the score) for question q . For example, for a quality monitoring question relating to "agent politeness," portions of an interaction that contain the topic "profanity" may lead the quality monitoring system 47 to assign a low score to the interaction, whereas portions of an interaction that contain the topic "polite" (e.g., the phrases "please" and "thank you") may lead the quality monitoring system 47 to assign a higher score to the "agent politeness" question.

[00143] In operation 508 the quality monitoring system 47 includes the identified examples (e.g., the positive and negative examples) in the customized coaching session. In operation 510, the quality monitoring system 47 determines if there are more questions to consider. If so, then the process returns to operation 504 to select the next question. If not, then the process continues to operation 512, where the quality monitoring system determines if there are more interactions to consider for generating the customized training session. If so, then the process returns to operation 502 to identify the next interaction. If not, then the generated coaching session is output in operation 516.

[00144] In some embodiments, the customized coaching session includes both positive and negative examples so the agent can compare the examples, learn the difference, and improve performance. In some circumstances, the quality monitoring system 47 may fail to identify positive examples from the agent's own interactions, and therefore the quality monitoring system 47 may retrieve examples from interactions that involved other agents. In some embodiments these examples involving other agents may be selected from interactions involving similar call reasons or topics (e.g., "upgrade request" or "angry customer"). In some circumstances, the coaching session is limited to topics and questions on which the agent received a low score, such as a score below the 30th percentile among all agents or a score below a particular threshold value, which may be set by a manager.

[00145] An example customized coaching session may include the following:

Your score in the Quality Monitoring question

<Did the agent make sure that all the customer's questions were answered?>

Is lower than

<the average of other agents>

For example, here are several calls on which you did not score well in this question

<call 1>

1 <call 2>

<call 3>

Here are several examples where agents acted correctly in the same situation

<good example 1>

5 <good example 2>

<good example 3>

[00146] In some embodiments of the present invention, the customized coaching session is presented to the agent (e.g., via the agent device 38). After viewing the coaching session, in some embodiments, the agent may provide a confirmation that they understood the examples and how to avoid low scores in the future. In some
10 embodiments, the agent may also provide feedback that the automated quality monitoring system is incorrect in the assessment and that the agent would like coaching by a human supervisor. When the agent is correct that the system was incorrect in its assessment, a human manager may also modify the automatic quality
15 monitoring system 47 to correct the manner in which it evaluates the interactions.

[00147] *Knowledge refresh*

[00148] Some aspects of embodiments of the present invention are directed to automatically scheduling trainings for individual agents or groups of agents based on historical performance. For example, these scheduled trainings are not prompted or
20 triggered by any particular incident or event (e.g., a low score in a particular quality metric), but instead may be triggered based on predicting when an agent may benefit from proactive knowledge refresh training before those skills are lost and before performance begins to appreciably decline.

[00149] As such, in some embodiments of the present invention, the quality
25 monitoring system 47 automatically predicts when a particular agent may need to refresh their knowledge regarding subject matter relevant to the contact center. FIG. 6 is a flowchart illustrating a method 600 for calculating a knowledge refresh interval according to one embodiment of the present invention.

[00150] In one embodiment, the quality monitoring system 47 generates a report or
30 list of coaching sessions that were previously automatically generated for a particular agent, a timestamp corresponding to the date on which the coaching session was generated, and the reason or reasons for triggering the coaching session. One example of such a report is shown below in Table 3:

Table 3

35 Agent Id	Date	Coaching session reason
345	May 30 2016	Profanity
345	July 10 2016	Profanity
345	Aug 17 2016	Profanity

1 **[00151]** In operation 604, the quality monitoring system 47 groups the coaching sessions by reason. If a coaching session had multiple reasons, then it may be split into multiple rows, one row for each reason, such that the coaching session appears in each group corresponding to one of its coaching session reasons.

5 **[00152]** The quality monitoring system 47 can use the report, grouped by coaching session reason, for the agent to predict, automatically, the next time that the agent will require additional coaching for a given reason based on the time intervals between previous training sessions for that coaching session reason. In the above Table 3, the same agent underwent three coaching sessions for “profanity” on May
10 30, 2016, July 10, 2016, and August 17, 2016. These coaching sessions were triggered by the agent’s use of profanity during an interaction with a customer, and the coaching sessions are approximately 40 days apart from each other. This suggests that the agent has a repeating pattern of using profanity and that the agent relapses into using profanity approximately 40 days after a coaching session that
15 reminds the agent to avoid using profanity.

[00153] Based on this prediction of a 40 day lifetime of training to avoid the use of profanity, in operation 608, the quality monitoring system 47 may automatically schedule coaching sessions to refresh the agent’s knowledge based on the predicted intervals (e.g., slightly less than 40 days after the previous training
20 session). For example, the quality monitoring system may schedule a coaching session on profanity to occur 35 days after the most recent coaching session on profanity.

[00154] Alternatively, the interval between knowledge refresh coaching sessions can be scheduled by tracking the quality monitoring scores over time (either in
25 general or on a question specific basis). Generally, it is assumed that performance (or quality metric) improves immediately after a coaching session and then declines from that peak until the next training. At some point during the decline, the performance level may cross a threshold performance level to become unacceptable. As such, the training intervals may be defined by the average (or
30 expected) time from the coaching session until the performance crosses below the threshold performance level. Averaging across several “performance drops” from the history.

[00155] In other embodiments of the present invention, the quality monitoring system 47 uses the report to estimate intervals for scheduling trainings to refresh
35 agents on general knowledge regarding the contact center. For example, in many agents of a particular contact require profanity training every five weeks, then this training may be made a part of the contact center’s general processes.

Automatically calculating evaluation scores for individual interactions

1 [00156] Aspects of embodiments of the present invention relate to automatically
calculating overall evaluation scores of individual interactions. Generally, an overall
evaluation score of an interaction combines the scores from the questions of the
evaluation form, where the questions may have different weights when combined to
5 generate the overall score.

[00157] As noted above, while the quality monitoring system 47 may be able to
answer some questions of the evaluation form accurately and automatically using
the topics detected within the interaction being evaluated, the evaluation form may
include other questions that cannot be answered by an automatic system (e.g., the
10 automatic system may have a high error rate and therefore may fail to produce
answers to these questions with sufficiently high accuracy). Questions that can be
answered automatically will be referred to herein as “automatic questions” Q^A ,
whereas questions that cannot be answered automatically are answered manually
by a human and therefore will be referred to as “manual questions” Q^M .

15 [00158] As a result, when an evaluation form includes manual questions, it can be
difficult to calculate the overall evaluation score through an automatic process.

[00159] As such, embodiments of the present invention relate to using a trained
predictive model to predict an overall evaluation score automatically for each
interaction without answers to the manual questions Q^M of the evaluation form.

20 Generally, an input is supplied to the predictive model where the input is a
representation of an interaction.

[00160] In one embodiment of the present invention, a prediction of the overall
evaluation score, which also encapsulates the answers to the “difficult” questions
(e.g., the questions that cannot be accurately answered automatically by the quality
25 monitoring system 47) can be computed using machine learning techniques. In
these embodiments of the present invention, the quality monitoring system 47
automatically computes answers to the automatic question and supplies the
automatically computed answers to a trained prediction model, which, in response,
outputs a prediction of the overall evaluation score. The trained prediction model
30 may be, for example, a neural network or a deep neural network.

[00161] When applying a supervised machine learning technique to predict an
overall evaluation score, interactions that were evaluated by human evaluators and
the associated answers to an evaluation form may be used as training data. The
associated answers include the answers to the manual questions provided by the
human evaluators, along with answers to the automatic questions (which may be
35 provided by the quality monitoring system or by the human evaluators).

[00162] The inputs to the prediction model may include the automatically
computed scores of the interaction on the automatic questions of the evaluation

1 form. The inputs may also include a representation of the interaction and/or the context of the manual questions, where the context can be deduced from the interaction and deduced from the manual questions in the form and their relation to the interaction.

5 **[00163]** The prediction model outputs the overall score of the quality monitoring evaluation form. This overall score is a weighted function of the scores on all the questions (both automatic questions and manual questions) of the evaluation form. The output may also be referred to as a “target.”

10 **[00164]** FIG. 7 is a block diagram illustrating the training of a general prediction model according to one embodiment of the present invention. As shown in FIG. 7, a stored collection 702 of pairs of previous interactions I and their associated evaluations QM (pairs I, QM) is used as training data for training a prediction model 710. During training, each a collection of features is extracted from the interaction I to create an input 720. This input 720 may include, for example, the scores of the
15 interaction I on the automatic questions of a quality monitoring evaluation form. The input 720 is supplied to the predictive model 710, and the desired output (or target) is the overall evaluation score, where the overall evaluation score is extracted from the corresponding evaluation QM associated with the interaction I .

20 **[00165]** FIG. 8 is a block diagram illustrating the training of a prediction model according to one embodiment of the present invention using answers to the automatic questions, thereby using only the answers to the automatic questions to predict an the overall evaluation score without the use of answers to the manual questions. As shown in FIG. 7, the training data 702 includes interactions I and their corresponding filled evaluation forms QM .

25 **[00166]** In one embodiment, the answers to the automatic questions are represented as a collection (e.g., a vector or a feature vector) $\bar{q}$ of scores (e.g., $\bar{q} = [0.03, 0.05, 0.4, \dots, 0.2]$). The target output σ (in this case, the overall evaluation score) is influenced by both the automatic and manual questions. FIG. 8 shows one sample interaction 704 and its corresponding filled evaluation form QM 706 from the
30 training data being used to train the prediction model 710.

[00167] Using the automatic questions paired with the associated target output $\{(\bar{q}, \sigma)\}$ extracted from the historical data, the quality monitoring system 47 trains a predictive model that estimates the overall score σ from the input answers to the automatic questions $\bar{q}$. For example, the predictive model may be a deep neural
35 network (DNN) that can be trained on the training using backpropagation. In another embodiment, the predictive model is a linear regression model, where the training process computes weights for each of the scores on the automatic questions $\bar{q}$.

1 [00168] Once the prediction model 710 has been trained, such as through linear regression or applying backpropagation to train a neural network or a deep neural network, the prediction model 710 can be applied to predict an overall evaluation score σ . Note that, when performing predictions, the external inputs are the interaction to be evaluated, an empty evaluation form (e.g., an evaluation form that has no answers), and the trained prediction model 710.

5 [00169] Using the automatic evaluation process described above, the automatic questions Q^A of the evaluation form 706 can be filled in, but the manual questions Q^M of the form will remain unanswered. As such, the computed input to the prediction model will include the answers to the automatic questions Q^A .

10 [00170] The performance of the trained prediction model can be tested using a test set of data from the historical interactions.

15 [00171] In some circumstances, a contact center may use more than one type of quality monitoring evaluation form. For example, one quality monitoring evaluation form may relate to sales capabilities, while another quality monitoring form may relate to agent professionalism. However, there may be some interrelation between the answers in one form and the overall score for another form.

20 [00172] FIG. 9A is a block diagram illustrating the training of a prediction model according to one embodiment of the present invention using answers to the automatic questions of multiple different forms, thereby using the answers to the automatic questions of multiple forms to predict an the overall evaluation score without the use of answers to the manual questions.

25 [00173] In this embodiment, the training data includes multiple sets of pairs of interactions and completed evaluations QM scores. FIG. 9A illustrates two completed evaluation forms QM_1 and QM_2 , each of which has scores for each of the questions on the forms. These two different completed evaluation forms correspond to two different sets of pairs of interactions and completed forms: $\{(I, QM_1)\}$ and $\{(I, QM_2)\}$. Applying the above technique, two different prediction models may be generated using the two data sets. However, there may be some overlap between the questions in the different forms (e.g., questions that appear on multiple forms). As such, it may be possible, instead, to produce a single predictive model that can predict both QM_1 and QM_2 for an interaction. In that case, a predictive model can be trained to make a prediction of an overall QM score while taking into account the latent influence of the manual questions that exist in the form on the overall score.

30 [00174] FIG. 9B is a flowchart illustrating a method for generating a predictive model for multiple quality monitoring evaluation forms according to one embodiment of the present invention. Referring to FIG. 9B, in operation 902, the quality monitoring system 47 receives all of the evaluation forms to be used in the predictive

1 model. In operation 904, the quality monitoring system 47 creates a list of all
 automatically answered questions in all of the evaluation forms $\overline{Q^A}$ (where $\overline{Q^A}$ is
 defined as a super set of all the automatic questions from all the QM forms in the
 site), and creates a list of all manually answered questions in all of the forms $\overline{Q^M}$
 5 (where $\overline{Q^M}$ is defined as a super set of all the manual questions from all the QM
 forms in the site).

[00175] Given a quality monitoring evaluation form of a certain type: $\overline{q^M}$ is defined
 herein to be the vector that indicates which manual questions from $\overline{Q^M}$ appear in the
 form ("1-of-N" encoding) and $\overline{q^A}$ is defined to be the vector of scores of automatic
 10 questions from $\overline{Q^A}$ with zeros for questions that do not appear in the form. In
 addition, N' may be defined as the number of elements in the set of automatic
 questions $\overline{Q^A}$, and L' may be defined as the number of questions in the set of manual
 questions $\overline{Q^M}$.

[00176] When processing the training data, in operation 906, the quality monitoring
 15 system 47 selects a next interaction I and evaluation form QM pair. In operation
 908, the quality monitoring system 47 creates a vector $\overline{q^A}$ with scores of the
 automatically answered questions in the current evaluation form, where questions
 without answers (e.g., questions that do not appear in the current evaluation form
 QM) receive a default value (e.g., zero). In addition, the quality monitoring system
 20 47 generates an index vector $\overline{q^M}$ for the manual questions in the current evaluation
 form QM in operation 910, where the value of is "one" where the manual question
 exists in the current evaluation form QM and is "zero" if the question does not exist in
 the current form QM .

[00177] In operation 912, the quality monitoring system determines if there are
 25 more interaction / evaluation form pairs. If so, then the process returns to operation
 906 to select the next pair. If not, then the generated training inputs $\overline{q^A}$ and $\overline{q^M}$ are
 output in operation 914 so that they can be supplied to the predictive model 710 for
 training the predictive model (e.g., using linear regression or backpropagation).

[00178] As such, the training module can be trained based on both the automatic
 30 scores of the evaluated interactions and the context of the evaluation (e.g., the
 presence of particular manual questions in the form).

[00179] FIG. 10A is a block diagram illustrating the training of a prediction model
 according to one embodiment of the present invention in which interaction context is
 also used to predict the overall evaluation score. One way to add this interaction
 35 context is to include context features $\overline{c}$ that represent the interaction itself to the input
 to the prediction model.

[00180] In one embodiment, the presence of particular words, phrases, and/or
 topics in the interaction can be supplied as the context features $\overline{c}$ that are supplied as

1 additional input to the prediction model. In embodiments where the interaction is a voice interaction, an automatic speech recognition (ASR) engine 708 may be used to convert the voice data into text data or "Interaction LVCSR" data 709. In some embodiments, the presence of particular words and phrases is represented as a term frequency-inverse document frequency (tf-idf) vector 721.

5 **[00181]** As such, when preparing the training data from the collection of historical interactions, in one embodiment, the quality monitoring system 47 generates the set of context features $\bar{c}$ for each interaction by calculating the tf-idf of each word and phrase in a defined set of words and phrases. This set of context features $\bar{c}$ (or context vector) is supplied along with the answers to the automatic questions $\bar{q}^A$ to train the prediction model 710 to generate the desired target output (e.g., the known overall evaluation score from the evaluation form QM of the interaction I), by applying an appropriate training algorithm such as linear regression or, in the case of a neural network or deep neural network, backpropagation.

15 **[00182]** After training the prediction model, the quality monitoring system 47 can apply the prediction model to evaluate, automatically, new interactions. FIG. 10B is a flowchart illustrating a method 1000 for applying a prediction model to an interaction using interaction context according to one embodiment of the present invention. In operation 1001, the quality monitoring system 47 selects a next interaction from the training data for processing. In operation 1002, the quality monitoring system 47 assigns the interaction under evaluation to a quality monitoring evaluation form (e.g., based on a manager selection, such as a sales evaluation form for a sales interaction). In operation 1004, the automatic questions of the evaluation form are answered (e.g., using the method described above with respect to FIG. 2) to generate a set of automatic answers $\bar{q}^A$. In operation 1006, a set of context features $\bar{c}$ is generated (e.g., by calculating tf-idf for words and phrases in the interaction). In operation 1008, the quality monitoring system 47 determines if there are more interactions in the training data to prepare. If so, then the process returns to operation 1001. If not, then, in operation 1010, the quality monitoring system 47 supplies the resulting automatic answers $\bar{q}^A$ and context features $\bar{c}$ as inputs to the prediction model 710, which may be trained using, for example, linear regression or backpropagation, in the case of a neural network.

25 **[00183]** In some embodiments, other context features may be used instead of, or alongside the tf-idf of the words or phrases. These may include semantic features such as "word2vec" embedding of words from the interaction and sentiment analysis features (e.g., detected topics within the interaction).

1 [00184] As such, in some embodiments of the present invention, the overall quality monitoring score can be predicted using contextual data found in the interaction along with scores of the automatic questions.

5 [00185] In still other embodiments of the present invention, the inputs to the prediction model 710 include scores for the manual questions that are automatically generated using semantic relevance analysis, in addition to the automatic answered questions. FIG. 11A is a block diagram illustrating the training of a prediction model using semantic relevance analysis according to one embodiment of the present invention. The input to the prediction model 710 includes $\bar{q}^A$, which are the scores of
10 the automated answered questions along with $\bar{f}$, which are values assigned to the manual questions.

[00186] In one embodiment, the $\bar{f}$ values are computed using a scoring method similar to that described in U.S. Patent Application No. 15/133,188 "Quality Monitoring Automation in Contact Centers."

15 [00187] In some embodiments, manual question of the evaluation form is scored in accordance with its similarity to topics found in the current interaction being evaluated. For example, word2vec may be used to compute a similarity between the manual questions and the topics found in the interaction.

20 [00188] In some embodiments, information retrieval based techniques can be applied to score the manual questions. In particular, the manual questions of the evaluation forms of the training data can be indexed according to sets of question-answer-document triples $\{q, a, i_d\}$, where q is the question, a is the corresponding answer (e.g., a score from a manually completed evaluation form from the training data), and i_d is the interaction document. To automatically score a manual question
25 for which there was no manually generated answer, the quality monitoring system 47 searches the indexed triples to find a best match. In particular, given the current manual question being answered q_k and the current interaction document i_{dk} , an indexed triple $\{q, a, i_d\}$ having q and i_d values that are most similar to q_k and i_{dk} is identified, and the score a associated with that identified triple is output as the score
30 for the manual question.

[00189] As such, in some embodiments of the present invention, the training of the prediction model is performed using the interactions themselves along with the relations between interactions and the manual questions.

Computing devices

35 [00190] As described herein, various applications and aspects of the present invention may be implemented in software, firmware, hardware, and combinations thereof. When implemented in software, the software may operate on a general purpose computing device such as a server, a desktop computer, a tablet computer,

1 a smartphone, or a personal digital assistant. Such a general purpose computer includes a general purpose processor and memory.

5 **[00191]** Each of the various servers, controllers, switches, gateways, engines, and/or modules (collectively referred to as servers) in the afore-described figures may be a process or thread, running on one or more processors, in one or more computing devices 1500 (e.g., FIG. 12A, FIG. 12B), executing computer program instructions and interacting with other system components for performing the various functionalities described herein. The computer program instructions are stored in a memory which may be implemented in a computing device using a standard memory
10 device, such as, for example, a random access memory (RAM). The computer program instructions may also be stored in other non-transitory computer readable media such as, for example, a CD-ROM, flash drive, or the like. Also, a person of skill in the art should recognize that a computing device may be implemented via firmware (e.g. an application-specific integrated circuit), hardware, or a combination
15 of software, firmware, and hardware. A person of skill in the art should also recognize that the functionality of various computing devices may be combined or integrated into a single computing device, or the functionality of a particular computing device may be distributed across one or more other computing devices without departing from the scope of the exemplary embodiments of the present
20 invention. A server may be a software module, which may also simply be referred to as a module. The set of modules in the contact center may include servers, and other modules.

25 **[00192]** The various servers may be located on a computing device on-site at the same physical location as the agents of the contact center or may be located off-site (or in the cloud) in a geographically different location, e.g., in a remote data center, connected to the contact center via a network such as the Internet. In addition, some of the servers may be located in a computing device on-site at the contact center while others may be located in a computing device off-site, or servers providing redundant functionality may be provided both via on-site and off-site computing
30 devices to provide greater fault tolerance. In some embodiments of the present invention, functionality provided by servers located on computing devices off-site may be accessed and provided over a virtual private network (VPN) as if such servers were on-site, or the functionality may be provided using a software as a service (SaaS) to provide functionality over the internet using various protocols, such
35 as by exchanging data using encoded in extensible markup language (XML) or JavaScript Object notation (JSON).

[00193] FIG. 12A–FIG. 12B depict block diagrams of a computing device 1500 as may be employed in exemplary embodiments of the present invention. Each

1 computing device 1500 includes a central processing unit 1521 and a main memory
unit 1522. As shown in FIG. 12A, the computing device 1500 may also include a
storage device 1528, a removable media interface 1516, a network interface 1518,
an input/output (I/O) controller 1523, one or more display devices 1530c, a keyboard
5 1530a and a pointing device 1530b, such as a mouse. The storage device 1528 may
include, without limitation, storage for an operating system and software. As shown
in FIG. 12B, each computing device 1500 may also include additional optional
elements, such as a memory port 1503, a bridge 1570, one or more additional
input/output devices 1530d, 1530e and a cache memory 1540 in communication with
10 the central processing unit 1521. The input/output devices 1530a, 1530b, 1530d, and
1530e may collectively be referred to herein using reference numeral 1530.

[00194] The central processing unit 1521 is any logic circuitry that responds to and
processes instructions fetched from the main memory unit 1522. It may be
implemented, for example, in an integrated circuit, in the form of a microprocessor,
15 microcontroller, or graphics processing unit (GPU), or in a field-programmable gate
array (FPGA) or application-specific integrated circuit (ASIC). The main memory unit
1522 may be one or more memory chips capable of storing data and allowing any
storage location to be directly accessed by the central processing unit 1521. As
shown in FIG. 12A, the central processing unit 1521 communicates with the main
20 memory 1522 via a system bus 1550. As shown in FIG. 12B, the central processing
unit 1521 may also communicate directly with the main memory 1522 via a memory
port 1503.

[00195] FIG. 12B depicts an embodiment in which the central processing unit 1521
communicates directly with cache memory 1540 via a secondary bus, sometimes
25 referred to as a backside bus. In other embodiments, the central processing unit
1521 communicates with the cache memory 1540 using the system bus 1550. The
cache memory 1540 typically has a faster response time than main memory 1522.
As shown in FIG. 12A, the central processing unit 1521 communicates with various
I/O devices 1530 via the local system bus 1550. Various buses may be used as the
30 local system bus 1550, including a Video Electronics Standards Association (VESA)
Local bus (VLB), an Industry Standard Architecture (ISA) bus, an Extended Industry
Standard Architecture (EISA) bus, a MicroChannel Architecture (MCA) bus, a
Peripheral Component Interconnect (PCI) bus, a PCI Extended (PCI-X) bus, a PCI-
Express bus, or a NuBus. For embodiments in which an I/O device is a display
35 device 1530c, the central processing unit 1521 may communicate with the display
device 1530c through an Advanced Graphics Port (AGP). FIG. 12B depicts an
embodiment of a computer 1500 in which the central processing unit 1521
communicates directly with I/O device 1530e. FIG. 12B also depicts an embodiment

1 in which local busses and direct communication are mixed: the central processing unit 1521 communicates with I/O device 1530d using a local system bus 1550 while communicating with I/O device 1530e directly.

5 **[00196]** A wide variety of I/O devices 1530 may be present in the computing device 1500. Input devices include one or more keyboards 1530a, mice, trackpads, trackballs, microphones, and drawing tablets. Output devices include video display devices 1530c, speakers, and printers. An I/O controller 1523, as shown in FIG. 12A, may control the I/O devices. The I/O controller may control one or more I/O devices such as a keyboard 1530a and a pointing device 1530b, e.g., a mouse or optical
10 pen.

[00197] Referring again to FIG. 12A, the computing device 1500 may support one or more removable media interfaces 1516, such as a floppy disk drive, a CD-ROM drive, a DVD-ROM drive, tape drives of various formats, a USB port, a Secure Digital or COMPACT FLASH™ memory card port, or any other device suitable for reading
15 data from read-only media, or for reading data from, or writing data to, read-write media. An I/O device 1530 may be a bridge between the system bus 1550 and a removable media interface 1516.

[00198] The removable media interface 1516 may for example be used for installing software and programs. The computing device 1500 may further include a
20 storage device 1528, such as one or more hard disk drives or hard disk drive arrays, for storing an operating system and other related software, and for storing application software programs. Optionally, a removable media interface 1516 may also be used as the storage device. For example, the operating system and the software may be run from a bootable medium, for example, a bootable CD.

25 **[00199]** In some embodiments, the computing device 1500 may include or be connected to multiple display devices 1530c, which each may be of the same or different type and/or form. As such, any of the I/O devices 1530 and/or the I/O controller 1523 may include any type and/or form of suitable hardware, software, or combination of hardware and software to support, enable or provide for the
30 connection to, and use of, multiple display devices 1530c by the computing device 1500. For example, the computing device 1500 may include any type and/or form of video adapter, video card, driver, and/or library to interface, communicate, connect, or otherwise use the display devices 1530c. In one embodiment, a video adapter may include multiple connectors to interface to multiple display devices 1530c. In
35 other embodiments, the computing device 1500 may include multiple video adapters, with each video adapter connected to one or more of the display devices 1530c. In some embodiments, any portion of the operating system of the computing device 1500 may be configured for using multiple display devices 1530c. In other

1 embodiments, one or more of the display devices 1530c may be provided by one or
more other computing devices, connected, for example, to the computing device
1500 via a network. These embodiments may include any type of software designed
and constructed to use the display device of another computing device as a second
5 display device 1530c for the computing device 1500. One of ordinary skill in the art
will recognize and appreciate the various ways and embodiments that a computing
device 1500 may be configured to have multiple display devices 1530c.

[00200] A computing device 1500 of the sort depicted in FIG. 12A–FIG. 12B may
operate under the control of an operating system, which controls scheduling of tasks
10 and access to system resources. The computing device 1500 may be running any
operating system, any embedded operating system, any real-time operating system,
any open source operating system, any proprietary operating system, any operating
systems for mobile computing devices, or any other operating system capable of
running on the computing device and performing the operations described herein.

15 **[00201]** The computing device 1500 may be any workstation, desktop computer,
laptop or notebook computer, server machine, handheld computer, mobile telephone
or other portable telecommunication device, media playing device, gaming system,
mobile computing device, or any other type and/or form of computing,
telecommunications or media device that is capable of communication and that has
20 sufficient processor power and memory capacity to perform the operations described
herein. In some embodiments, the computing device 1500 may have different
processors, operating systems, and input devices consistent with the device.

[00202] In other embodiments the computing device 1500 is a mobile device, such
as a Java-enabled cellular telephone or personal digital assistant (PDA), a smart
25 phone, a digital audio player, or a portable media player. In some embodiments, the
computing device 1500 includes a combination of devices, such as a mobile phone
combined with a digital audio player or portable media player.

[00203] As shown in FIG. 12C, the central processing unit 1521 may include
multiple processors P1, P2, P3, P4, and may provide functionality for simultaneous
30 execution of instructions or for simultaneous execution of one instruction on more
than one piece of data. In some embodiments, the computing device 1500 may
include a parallel processor with one or more cores. In one of these embodiments,
the computing device 1500 is a shared memory parallel device, with multiple
processors and/or multiple processor cores, accessing all available memory as a
35 single global address space. In another of these embodiments, the computing device
1500 is a distributed memory parallel device with multiple processors each
accessing local memory only. In still another of these embodiments, the computing
device 1500 has both some memory which is shared and some memory which may

1 only be accessed by particular processors or subsets of processors. In still even
another of these embodiments, the central processing unit 1521 includes a multicore
microprocessor, which combines two or more independent processors into a single
package, e.g., into a single integrated circuit (IC). In one exemplary embodiment,
5 depicted in FIG. 12D, the computing device 1500 includes at least one central
processing unit 1521 and at least one graphics processing unit 1521'.

[00204] In some embodiments, a central processing unit 1521 provides single
instruction, multiple data (SIMD) functionality, e.g., execution of a single instruction
simultaneously on multiple pieces of data. In other embodiments, several processors
10 in the central processing unit 1521 may provide functionality for execution of multiple
instructions simultaneously on multiple pieces of data (MIMD). In still other
embodiments, the central processing unit 1521 may use any combination of SIMD
and MIMD cores in a single device.

[00205] A computing device may be one of a plurality of machines connected by a
15 network, or it may include a plurality of machines so connected. FIG. 12E shows an
exemplary network environment. The network environment includes one or more
local machines 1502a, 1502b (also generally referred to as local machine(s) 1502,
client(s) 1502, client node(s) 1502, client machine(s) 1502, client computer(s) 1502,
client device(s) 1502, endpoint(s) 1502, or endpoint node(s) 1502) in communication
20 with one or more remote machines 1506a, 1506b, 1506c (also generally referred to
as server machine(s) 1506 or remote machine(s) 1506) via one or more networks
1504. In some embodiments, a local machine 1502 has the capacity to function as
both a client node seeking access to resources provided by a server machine and as
a server machine providing access to hosted resources for other clients 1502a,
25 1502b. Although only two clients 1502 and three server machines 1506 are
illustrated in FIG. 12E, there may, in general, be an arbitrary number of each. The
network 1504 may be a local-area network (LAN), e.g., a private network such as a
company Intranet, a metropolitan area network (MAN), or a wide area network
(WAN), such as the Internet, or another public network, or a combination thereof.

[00206] The computing device 1500 may include a network interface 1518 to
30 interface to the network 1504 through a variety of connections including, but not
limited to, standard telephone lines, local-area network (LAN), or wide area network
(WAN) links, broadband connections, wireless connections, or a combination of any
or all of the above. Connections may be established using a variety of
35 communication protocols. In one embodiment, the computing device 1500
communicates with other computing devices 1500 via any type and/or form of
gateway or tunneling protocol such as Secure Socket Layer (SSL) or Transport
Layer Security (TLS). The network interface 1518 may include a built-in network

1 adapter, such as a network interface card, suitable for interfacing the computing
device 1500 to any type of network capable of communication and performing the
operations described herein. An I/O device 1530 may be a bridge between the
system bus 1550 and an external communication bus.

5 **[00207]** According to one embodiment, the network environment of FIG. 12E may
be a virtual network environment where the various components of the network are
virtualized. For example, the various machines 1502 may be virtual machines
implemented as a software-based computer running on a physical machine. The
virtual machines may share the same operating system. In other embodiments,
10 different operating system may be run on each virtual machine instance. According
to one embodiment, a "hypervisor" type of virtualization is implemented where
multiple virtual machines run on the same host physical machine, each acting as if it
has its own dedicated box. Of course, the virtual machines may also run on different
host physical machines.

15 **[00208]** Other types of virtualization is also contemplated, such as, for example,
the network (e.g. via Software Defined Networking (SDN)). Functions, such as
functions of the session border controller and other types of functions, may also be
virtualized, such as, for example, via Network Functions Virtualization (NFV).

20 **[00209]** While the present invention has been described in connection with certain
exemplary embodiments, it is to be understood that the invention is not limited to the
disclosed embodiments, but, on the contrary, is intended to cover various
modifications and equivalent arrangements included within the spirit and scope of
the appended claims, and equivalents thereof.

1 WHAT IS CLAIMED IS:

1. A method comprising:

receiving, by a processor, an evaluation form comprising a plurality of evaluation questions;

5 receiving, by the processor, an interaction to be evaluated by the evaluation form;

selecting, by the processor, an evaluation question of the evaluation form, the evaluation question comprising a rule associated with one or more topics, each of the topics comprising one or more words or phrases;

10 searching, by the processor, the interaction for the one or more topics of the rule in accordance with the presence of one or more words or phrases in the interaction to generate a search result;

calculating, by the processor, an answer to the evaluation question in accordance with the rule and the search result; and

15 outputting, by the processor, the calculated answer to the evaluation question of the evaluation form.

2. The method of claim 1, further comprising:

20 determining whether the calculated answer triggers a coaching rule of a plurality of coaching rules, the coaching rule corresponding to the evaluation question; and

generating a notification in accordance with the answer to the evaluation question.

25 3. The method of claim 2, wherein the generating the notification comprises identifying, based on the calculated answer, a coaching tip from a plurality of coaching tips associated with the coaching rule, and wherein the notification comprising the coaching tip.

30 4. The method of claim 2, wherein the generating the notification occurs in real-time during the interaction.

5. The method of claim 1, wherein the interaction is a voice interaction, wherein the method further comprises supplying the voice interaction to an automatic speech recognition engine to generate a speech recognition output, and wherein the detecting the one or more detected topics in the interaction comprises identifying one or more instances of the one or more topics in the speech recognition output.

35

1

6. A method for generating a customized coaching session for an agent, the method comprising:

5 receiving, by a processor, one or more evaluations of interactions involving the agent, each of the evaluations being computed based on an evaluation form and an interaction, the evaluation form comprising a plurality of evaluation questions, the evaluation comprising a plurality of answers corresponding to the evaluation questions;

10 computing, by the processor, one or more aggregated quality metrics in accordance with the answers of the one or more evaluations;

comparing, by the processor, each of the one or more aggregated quality metrics against corresponding threshold values;

15 identifying, by the processor, one or more underperforming quality metrics in accordance with the comparisons of the aggregated quality metrics with the threshold values;

generating, by the processor, the customized coaching session in accordance with the identified one or more underperforming quality metrics; and

outputting, by the processor, the customized coaching session.

20 7. The method of claim 6, further comprising, for each of the one or more underperforming quality metrics:

identifying portions of the interactions corresponding to the answer corresponding to the evaluation question; and

adding the identified portions to the customized coaching session.

25

8. The method of claim 6, further comprising:

identifying one or more previous customized coaching sessions generated for the agent, each comprising a timestamp and one or more coaching session reasons;

30 grouping the one or more previous customized coaching sessions by coaching session reason;

computing an average interval between coaching sessions having the same coaching session reason; and

scheduling a customized coaching session for the agent in accordance with the computed average interval.

35

9. A method for automatic monitoring of performance trends based on evaluations of all agents, comprising:

1 receiving, by a processor, a plurality of evaluations involving a plurality of
different agents, each of the evaluations comprising one or more quality metrics;
comparing, by the processor, each of the one or more quality metrics with a
corresponding threshold value;
5 identifying, by the processor, a metric of the one or more quality metrics that
fails to meet the corresponding threshold value;
calculating, by the processor, a level of correlation of the metric between
agents;
identifying, by the processor, the metric as being an individual metric when
10 the correlation is low;
identifying, by the processor, the metric as being a group metric when the
correlation is high;
identifying, by the processor, a process issue corresponding to the metric
when substantially all of the agents fail to meet the corresponding threshold value
15 with respect to the metric; and
outputting, by the processor, a classification of the metric in accordance with
the individual metric, the group metric, and the process issue.

10. A system comprising:
20 a processor;
memory storing instructions that, when executed by the processor, cause the
processor to:
receive an evaluation form comprising a plurality of evaluation
questions;
25 receive an interaction to be evaluated by the evaluation form;
select an evaluation question of the evaluation form, the evaluation question
comprising a rule associated with one or more topics, each of the topics comprising
one or more words or phrases;
search the interaction for the one or more topics of the rule in
30 accordance with the presence of one or more words or phrases in the interaction to
generate a search result;
calculate an answer to the evaluation question in accordance with the
rule and the search result; and
output the calculated answer to the evaluation question of the
35 evaluation form.

11. The system of claim 10, wherein the memory further stores instructions
that, when executed by the processor, cause the processor to:

1 determine whether the calculated answer triggers a coaching rule of a plurality
of coaching rules, the coaching rule corresponding to the evaluation question; and
 generate a notification in accordance with the answer to the evaluation
question.

5 12. The system of claim 11, wherein the memory further stores instructions
that, when executed by the processor, cause the processor to generate the
notification by identifying, based on the calculated answer, a coaching tip from a
plurality of coaching tips associated with the coaching rule, and
10 wherein the notification comprising the coaching tip.

 13. The system of claim 11, wherein the memory further stores instructions
that, when executed by the processor, cause the processor to generate the
notification in real-time during the interaction.

15 14. The system of claim 10, wherein the interaction is a voice interaction,
 wherein the memory further stores instructions that, when executed by the
processor, cause the processor to supply the voice interaction to an automatic
speech recognition engine to generate a speech recognition output, and
20 wherein the memory further stores instructions that, when executed by the
processor, cause the processor to detect the one or more detected topics in the
interaction comprises identifying one or more instances of the one or more topics in
the speech recognition output.

25 15. A system comprising:
 a processor;
 memory storing instructions that, when executed by the processor, cause the
processor to generate a customized coaching session for an agent by:
 receiving one or more evaluations of interactions involving the agent,
30 each of the evaluations being computed based on an evaluation form and an
interaction, the evaluation form comprising a plurality of evaluation questions, the
evaluation comprising a plurality of answers corresponding to the evaluation
questions;
 computing one or more aggregated quality metrics in accordance with
35 the answers of the one or more evaluations;
 comparing each of the one or more aggregated quality metrics against
corresponding threshold values;

1 identifying one or more underperforming quality metrics in accordance
with the comparisons of the aggregated quality metrics with the threshold values;
generating the customized coaching session in accordance with the
identified one or more underperforming quality metrics; and
5 outputting the customized coaching session.

16. The system of claim 15, wherein the memory further stores instructions
that, when executed by the processor, cause the processor to, for each of the one or
more underperforming quality metrics:

10 identify portions of the interactions corresponding to the answer
corresponding to the evaluation question; and
add the identified portions to the customized coaching session.

17. The system of claim 15, wherein the memory further stores instructions
15 that, when executed by the processor, cause the processor to:

identify one or more previous customized coaching sessions generated for the
agent, each comprising a timestamp and one or more coaching session reasons;
group the one or more previous customized coaching sessions by coaching
session reason;

20 compute an average interval between coaching sessions having the same
coaching session reason; and
schedule a customized coaching session for the agent in accordance with the
computed average interval.

25 18. A system comprising:

a processor;

memory storing instructions that, when executed by the processor, cause the
processor to:

30 receive a plurality of evaluations involving a plurality of different agents,
each of the evaluations comprising one or more quality metrics;

compare each of the one or more quality metrics with a corresponding
threshold value;

identify a metric of the one or more quality metrics that fails to meet the
corresponding threshold value;

35 calculate a level of correlation of the metric between agents;

identify the metric as being an individual metric when the correlation is
low;

identify the metric as being a group metric when the correlation is high;

1 identify a process issue corresponding to the metric when substantially
all of the agents fail to meet the corresponding threshold value with respect to the
metric; and

5 output a classification of the metric in accordance with the individual
metric, the group metric, and the process issue.

19. A method for automatically calculating an overall evaluation score of an
interaction, the method comprising:

10 receiving, by a processor, an evaluation form, the evaluation form comprising
a plurality of automatic questions and a plurality of manual questions;

automatically extracting, by a processor, a set of features from the interaction,
the set of features comprising answers to the automatic questions without manually
generated answers to the manual questions; and

15 computing an overall evaluation score based on the set of features.

20. The method of claim 19, wherein the set of features from the
interaction consist of the answers to the automatic questions.

21. The method of claim 19, wherein the set of features from the
20 interaction further comprises particular words or phrases detected in the interaction.

22. The method of claim 19, wherein the set of features from the
interaction comprises topics detected in the interaction.

25 23. The method of claim 19, further comprising:
receiving a second evaluation form, the second evaluation form comprising a
second plurality of automatic questions and a second plurality of manual questions,
wherein the interaction is associated with one evaluation form;

30 creating a super set of automatic questions comprising the plurality of
automatic questions of the evaluation form and the second plurality of automatic
questions of the second evaluation form;

creating a super set of manual questions comprising the plurality of manual
questions of the evaluation form and the second plurality of manual questions of the
second evaluation form; and

35 computing an index vector, wherein each value in the index vector
corresponds to a question of the super set of manual questions, wherein each value
of the index vector indicates whether the evaluation form associated with the
interaction includes the corresponding question of the super set of manual questions,

1 wherein the set of features further comprise the index vector.

24. The method of claim 19, wherein the set of features from the
interaction further comprises automatically generated answers to the manual
5 questions.

25. The method of claim 24, wherein each of the automatically generated
answers to the manual questions is generated by:
detecting one or more topics in the interaction;
10 computing a semantic similarity between a manual question and the detected
one or more topics in the interaction; and
generating an answer in accordance with the semantic similarity.

26. The method of claim 24, wherein each of the automatically generated
15 answers to the manual questions is generated by:
identifying a closest question-answer-document triple from a plurality of
question-answer-document triples, the closest question-answer-document triple
being most similar to a manual question and the interaction; and
returning the answer associated with the closest question-answer-document
20 triple.

27. The method of claim 19, wherein the computing the overall evaluation
score based on the set of features comprises:
supplying the set of features to a deep neural network trained based on
25 the evaluation form; and
computing an overall evaluation score by forward propagating the set
of features through the deep neural network.

28. The method of claim 27, wherein the deep neural network is trained
30 based on answers to the automatic questions of the evaluation form and manually
generated answers to the manual questions of the evaluation form.

29. A system comprising:
a processor;
35 memory storing instructions that, when executed by the processor, cause the
processor to:
receive an evaluation form, the evaluation form comprising a plurality of
automatic questions and a plurality of manual questions;

1 receive an interaction for evaluation;
 automatically extract a set of features from the interaction, the set of
features comprising answers to the automatic questions without manually generated
answers to the manual questions; and
5 compute an overall evaluation score based on the set of features.

30. The system of claim 29, wherein the set of features from the interaction
consist of the answers to the automatic questions.

10 31. The system of claim 29, wherein the set of features from the interaction
further comprises particular words or phrases detected in the interaction.

32. The system of claim 29, wherein the set of features from the interaction
comprises topics detected in the interaction.

15 33. The system of claim 29, wherein the memory further stores instructions
that, when executed by the processor, cause the processor to:

 receive a second evaluation form, the second evaluation form comprising a
second plurality of automatic questions and a second plurality of manual questions;

20 create a super set of automatic questions comprising the plurality of automatic
questions of the evaluation form and the second plurality of automatic questions of
the second evaluation form;

 create a super set of manual questions comprising the plurality of manual
questions of the evaluation form and the second plurality of manual questions of the
25 second evaluation form; and

 compute an index vector, wherein each value in the index vector corresponds
to a question of the super set of manual questions, wherein each value of the index
vector indicates whether the evaluation form associated with the interaction includes
the corresponding question of the super set of manual questions,

30 wherein the set of features further comprise the index vector.

34. The system of claim 29, wherein the set of features from the interaction
further comprises automatically generated answers to the manual questions.

35 35. The system of claim 34, wherein the memory further stores instructions
that, when executed by the processor, cause the processor to generate the
automatically generated answers to the manual questions by:

 detecting one or more topics in the interaction;

1 computing a semantic similarity between a manual question and the detected
one or more topics in the interaction; and
 generating an answer in accordance with the semantic similarity.

5 36. The system of claim 34, wherein the memory further stores instructions
that, when executed by the processor, cause the processor to generate the
automatically generated answers to the manual questions by:

 identifying a closest question-answer-document triple from a plurality of
question-answer-document triples, the closest question-answer-document triple
10 being most similar to a manual question and the interaction; and

 returning the answer associated with the closest question-answer-document
triple.

15 37. The system of claim 29, wherein the memory further stores instructions
that, when executed by the processor, cause the processor to compute the overall
evaluation score based on the set of features by:

 supplying the set of features to a deep neural network trained based on
the evaluation form; and

20 computing an overall evaluation score by forward propagating the set
of features through the deep neural network.

25 38. The system of claim 37, wherein the deep neural network is trained
based on answers to the automatic questions of the evaluation form and manually
generated answers to the manual questions of the evaluation form.

30 39. A system substantially as hereinbefore described with reference to the
accompanying drawings.

35 40. A method substantially as hereinbefore described with reference to
accompanying drawings.

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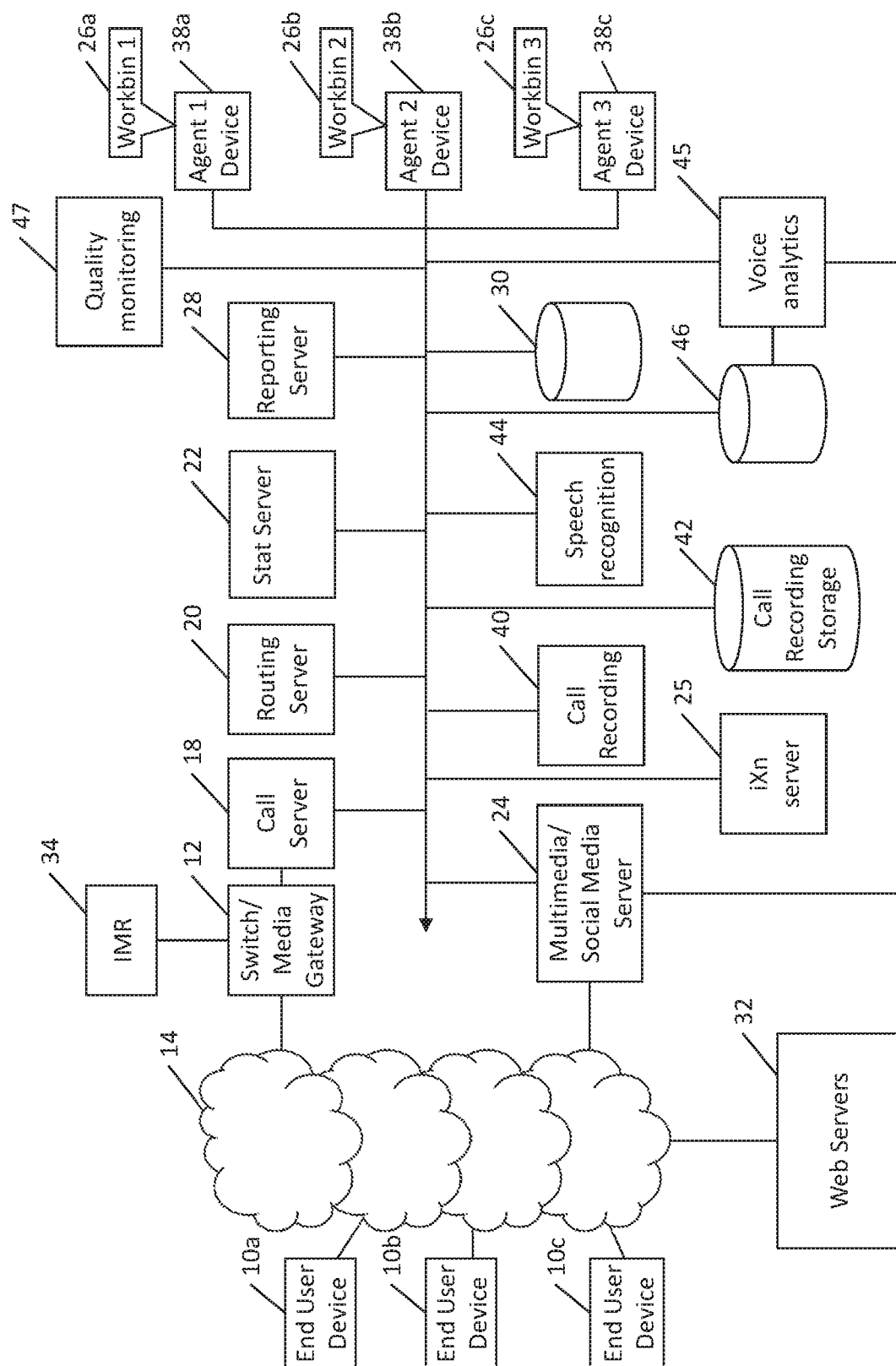


Figure 1

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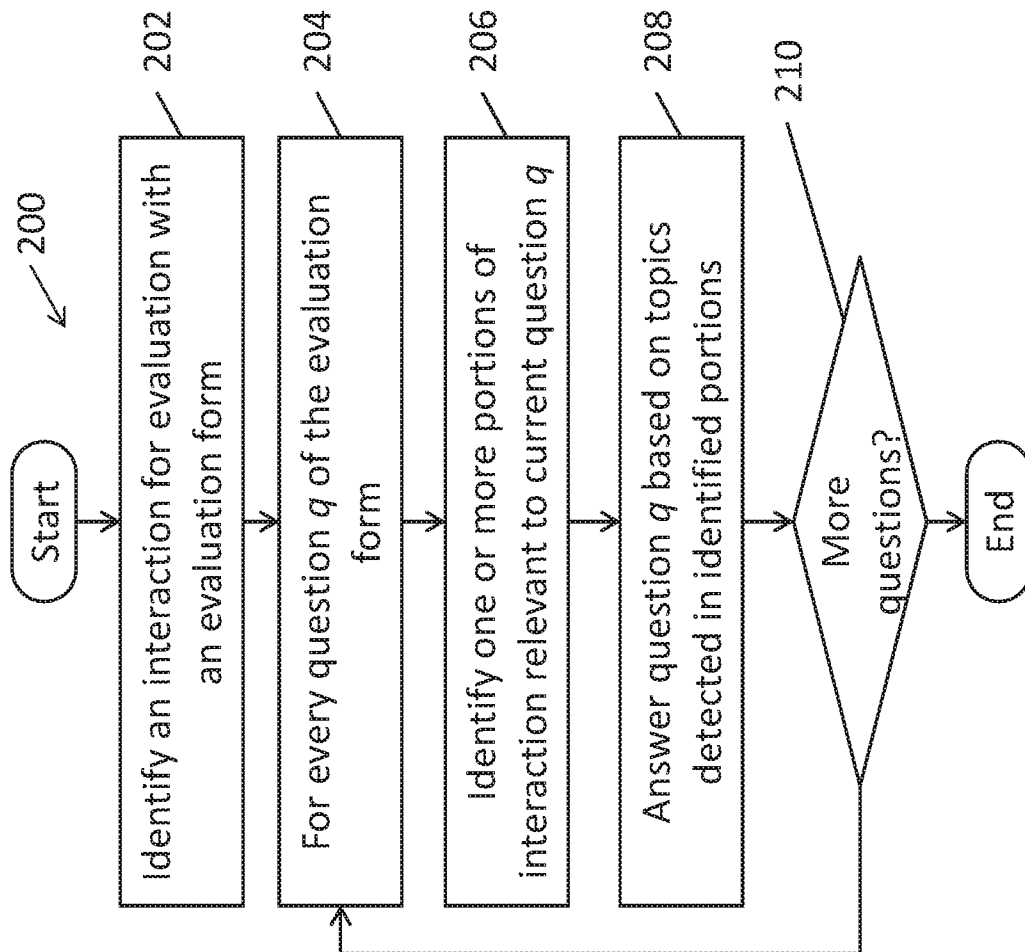


FIG. 2

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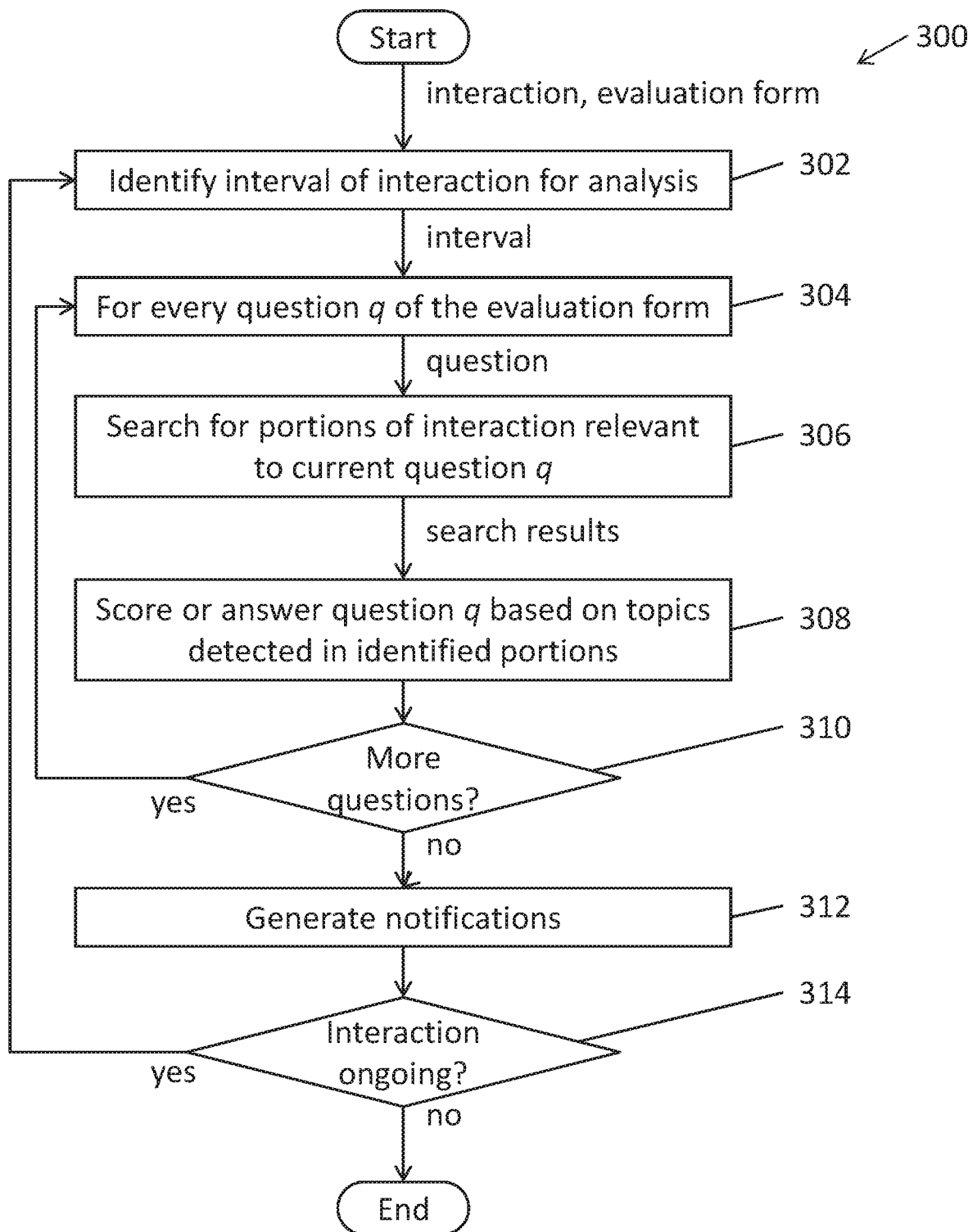


FIG. 3

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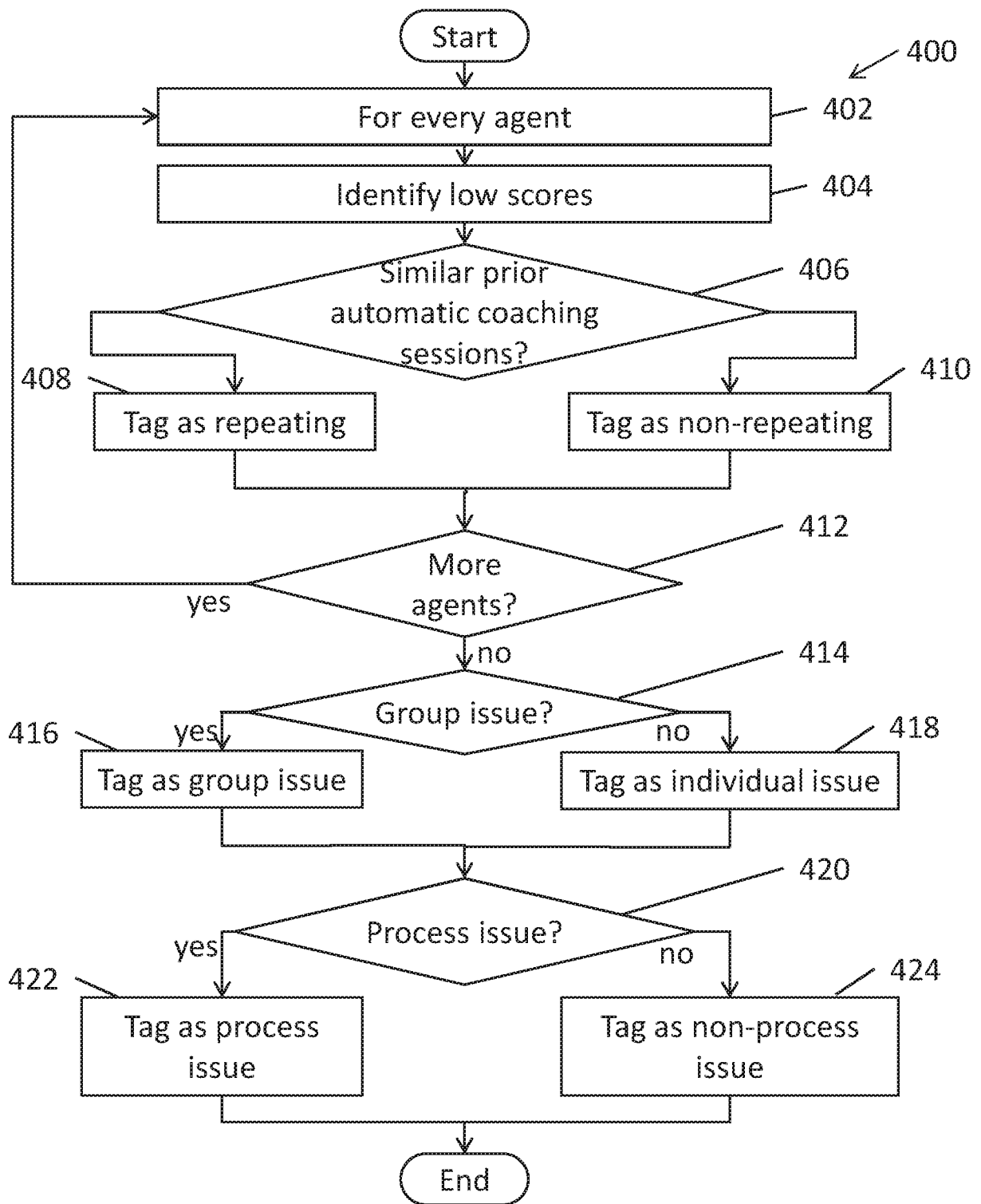


FIG. 4

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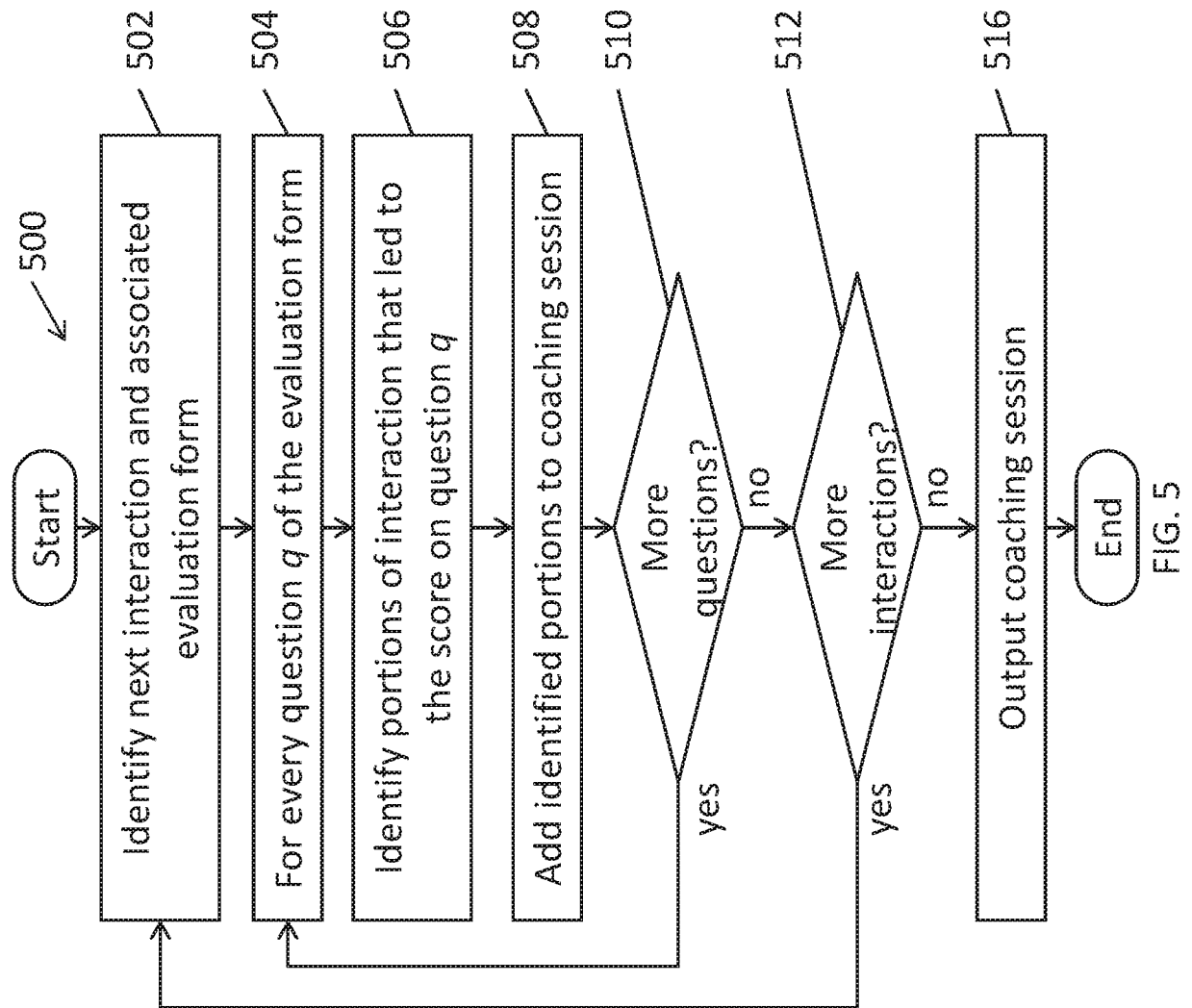


FIG. 5

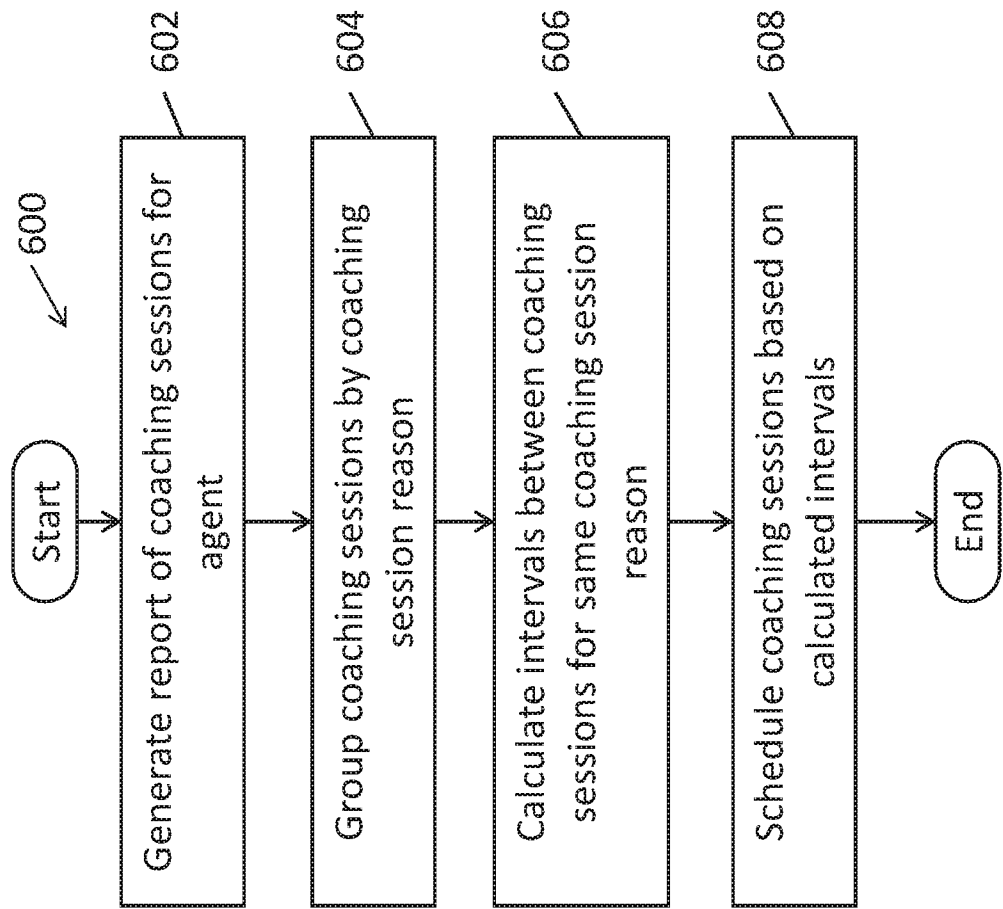


FIG. 6

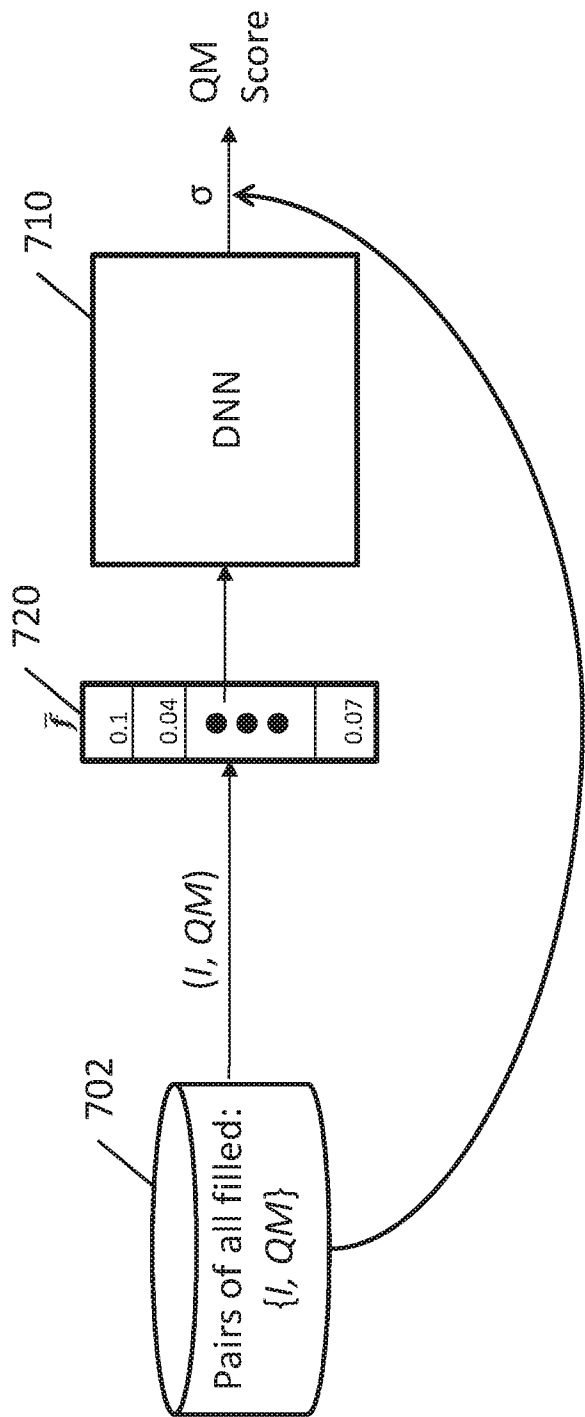


FIG. 7

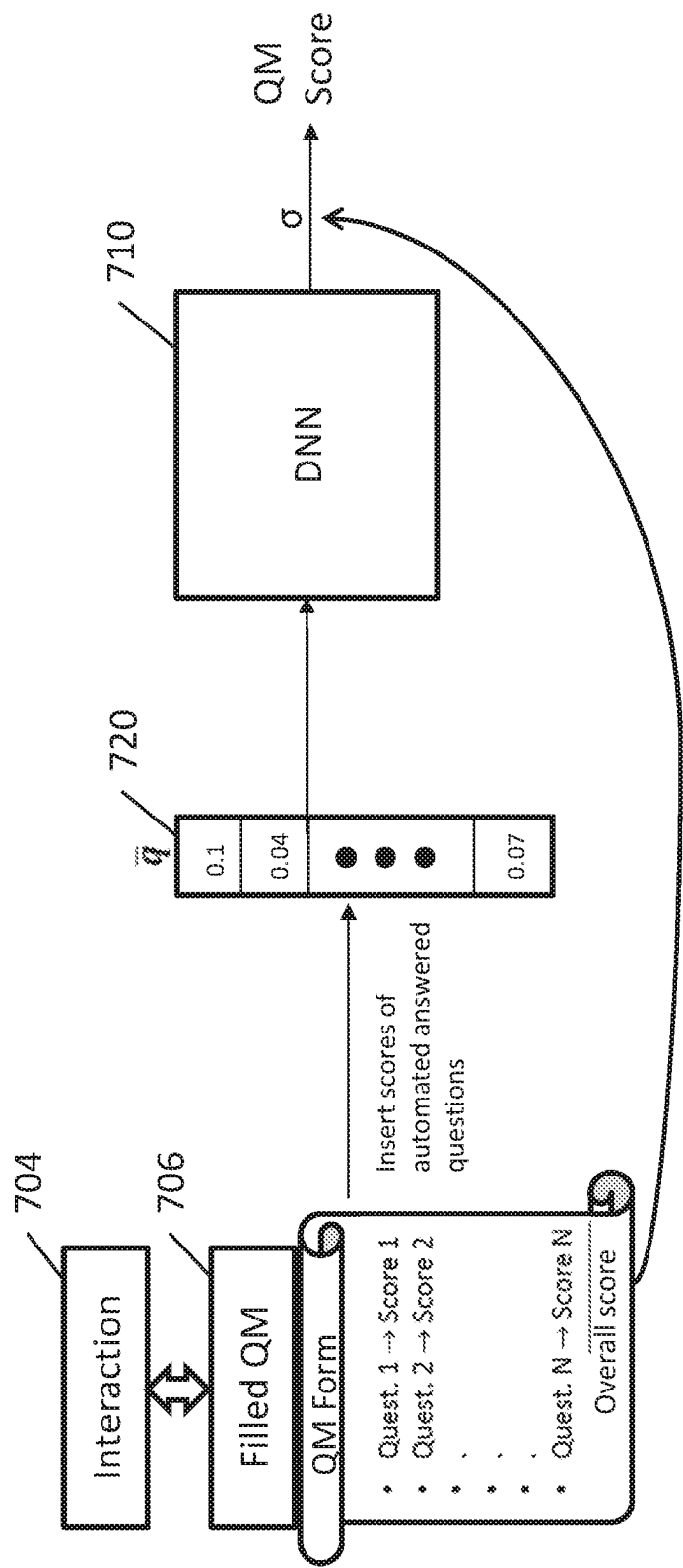


FIG. 8

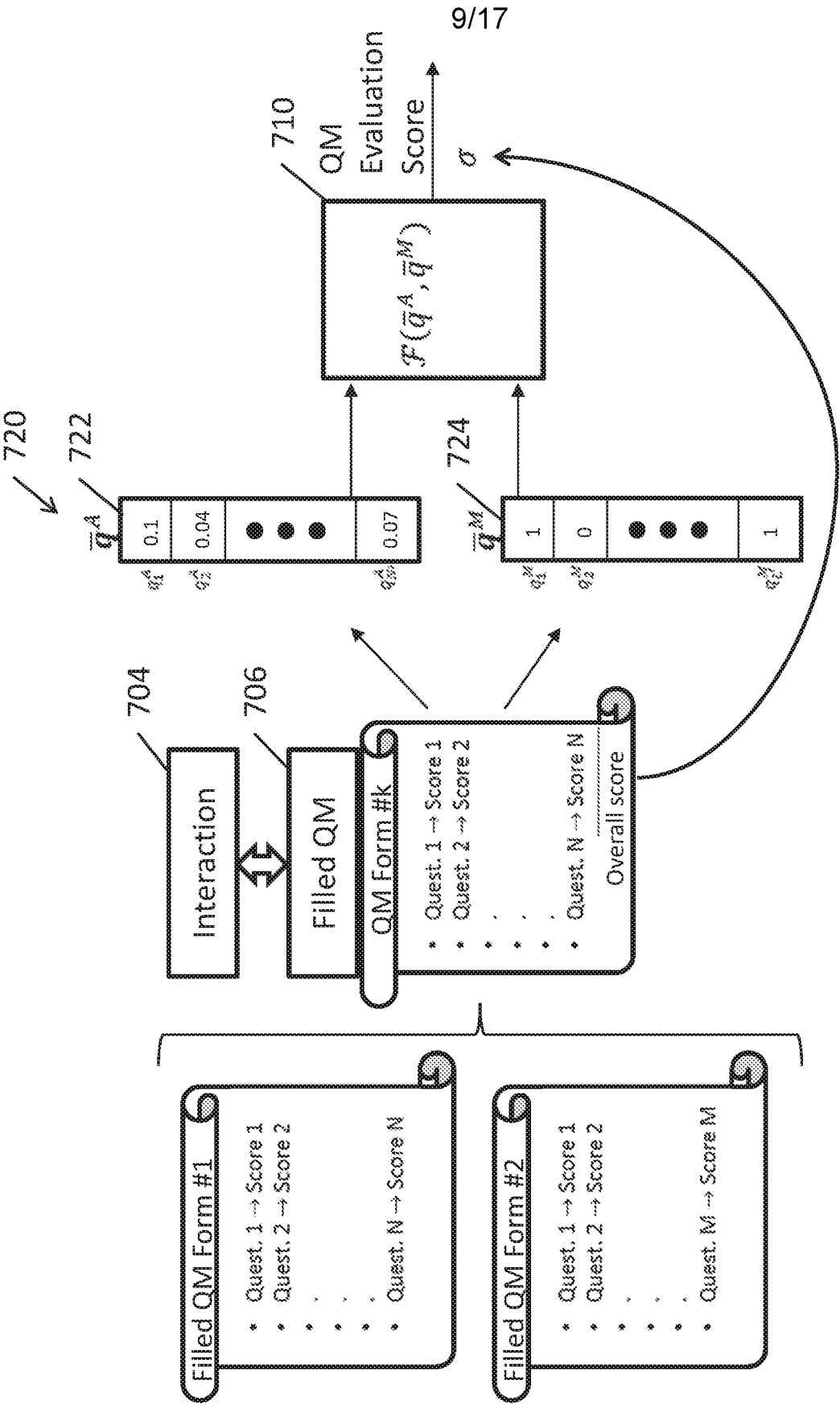


FIG. 9A

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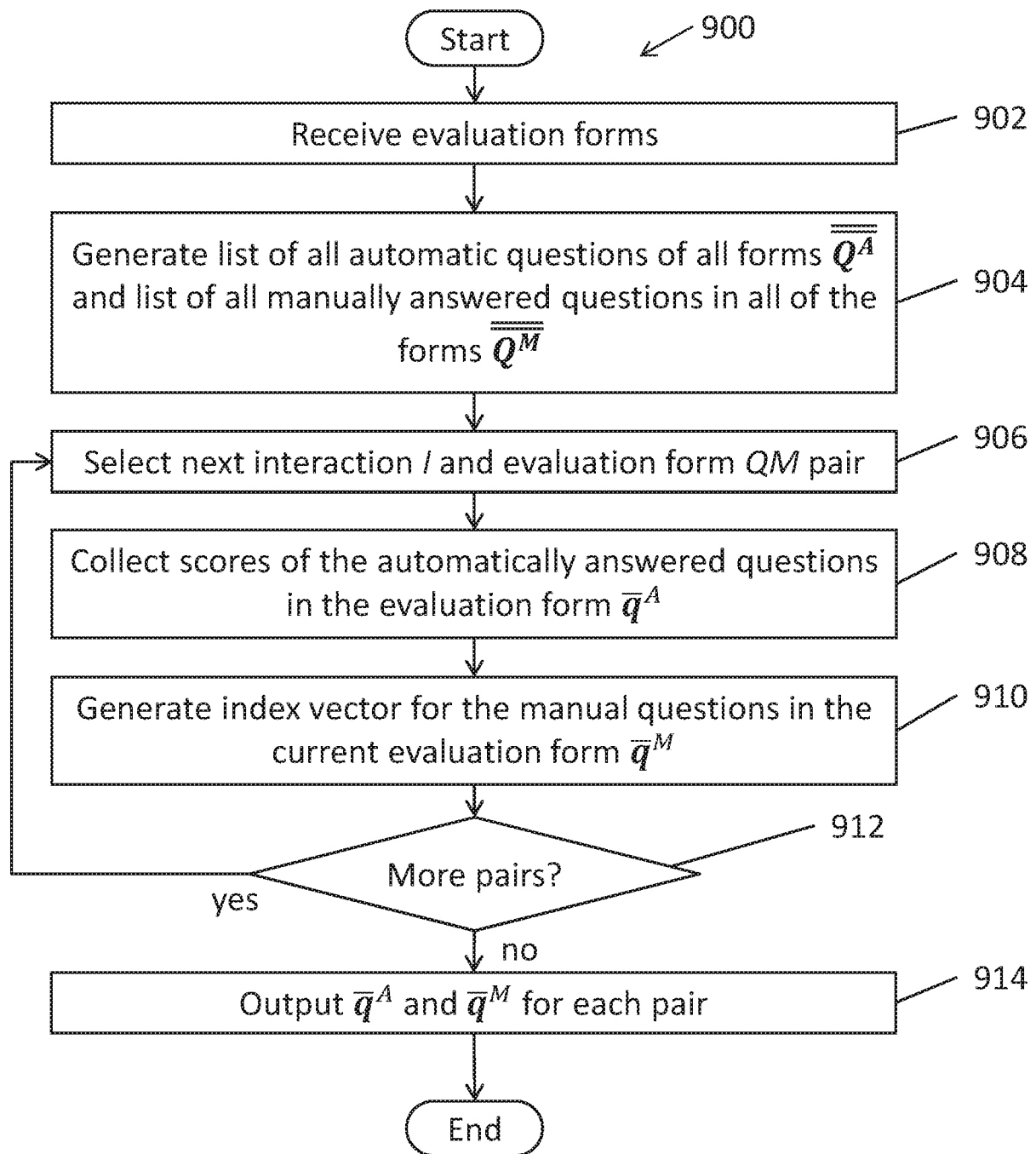


FIG. 9B

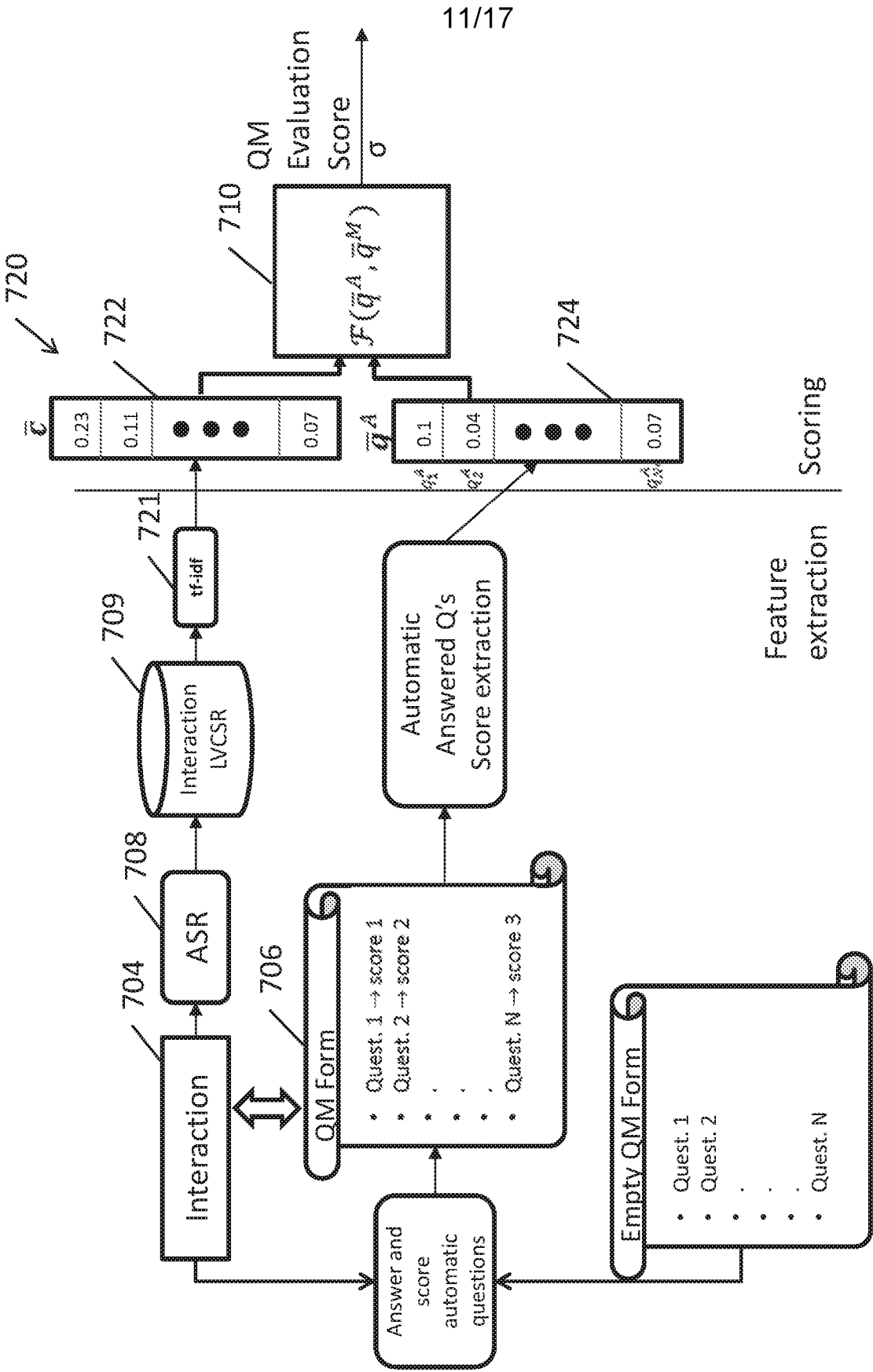


FIG. 10A

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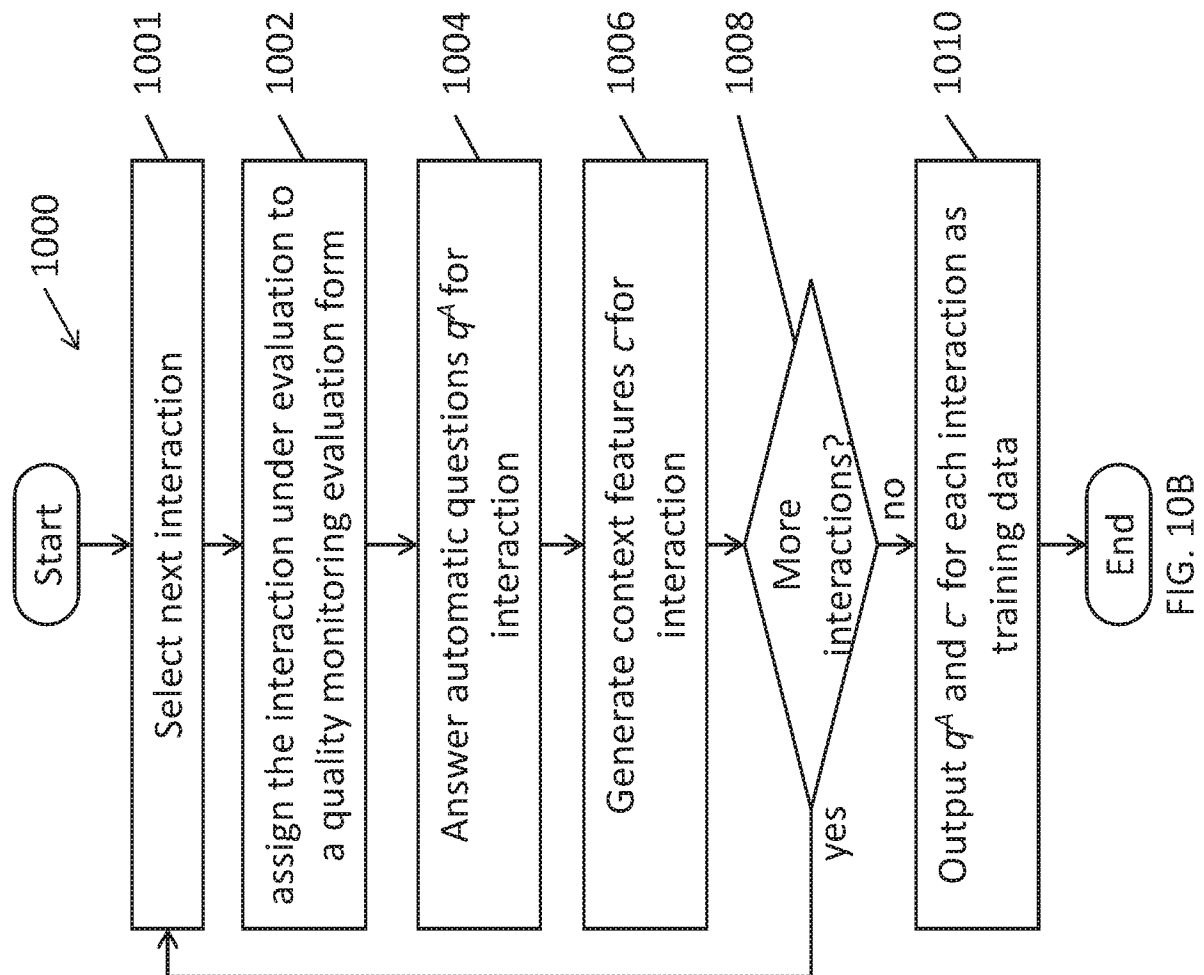


FIG. 10B

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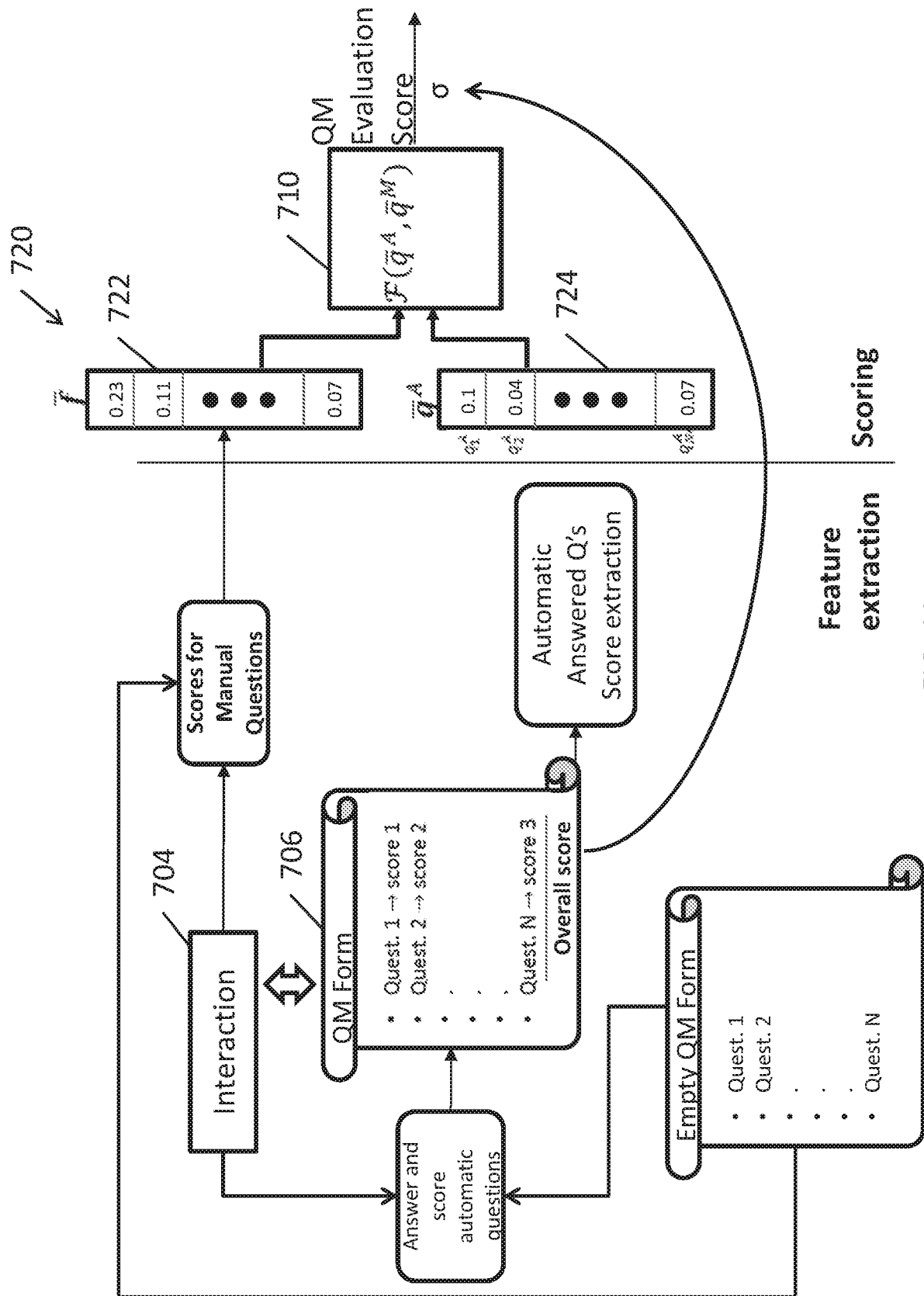


FIG. 11

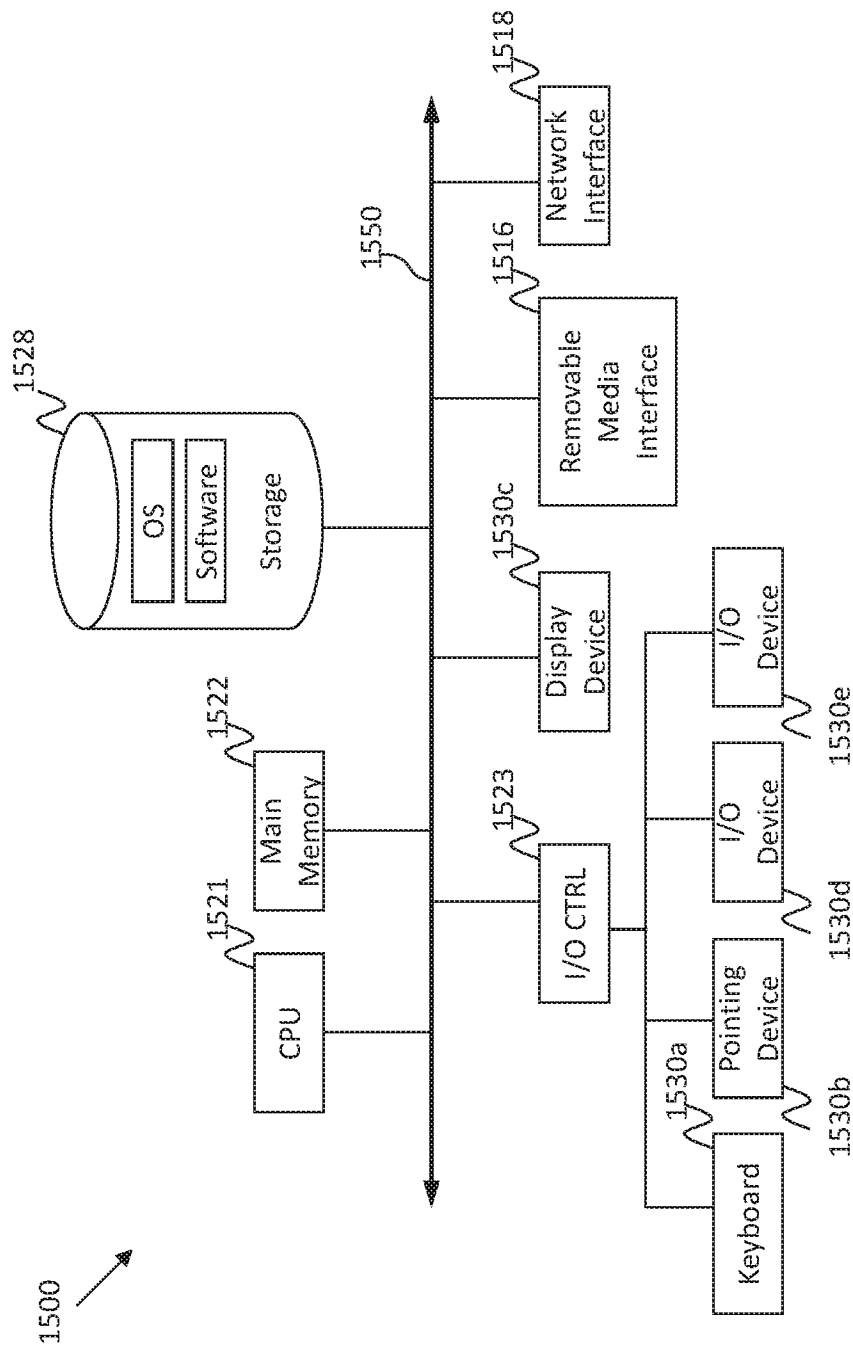


FIG. 12A

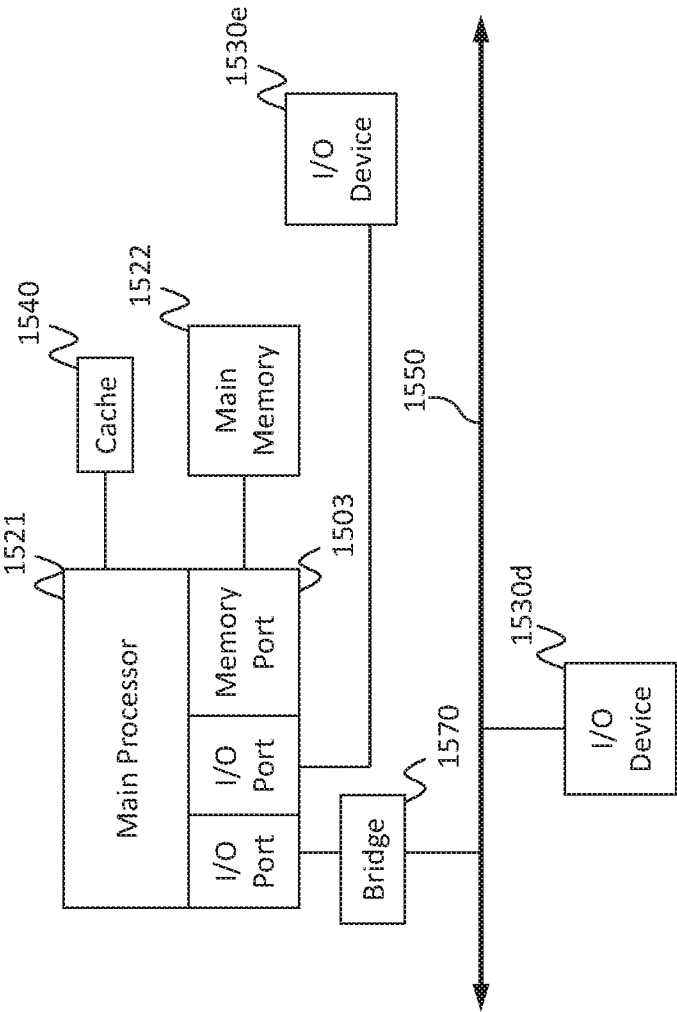


FIG. 12B

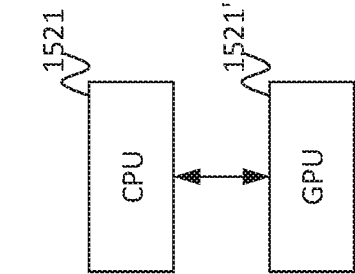


FIG. 12D

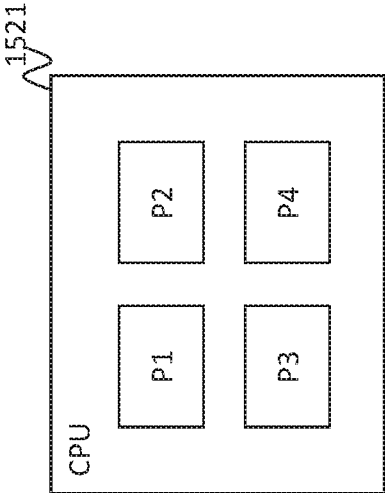


FIG. 12C

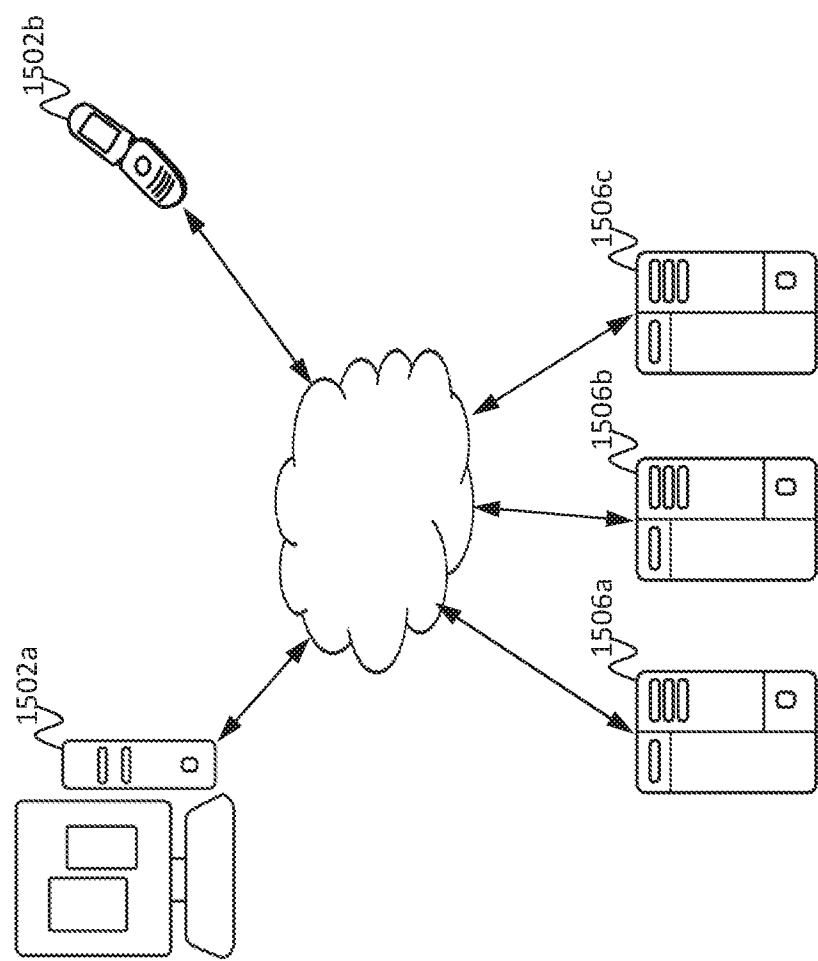


FIG. 12E