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(54) **COMPLEXITY ASSESSMENTS FOR AGENT PERFORMANCE ANALYSIS USING MEMORY NEURAL NETWORKS**

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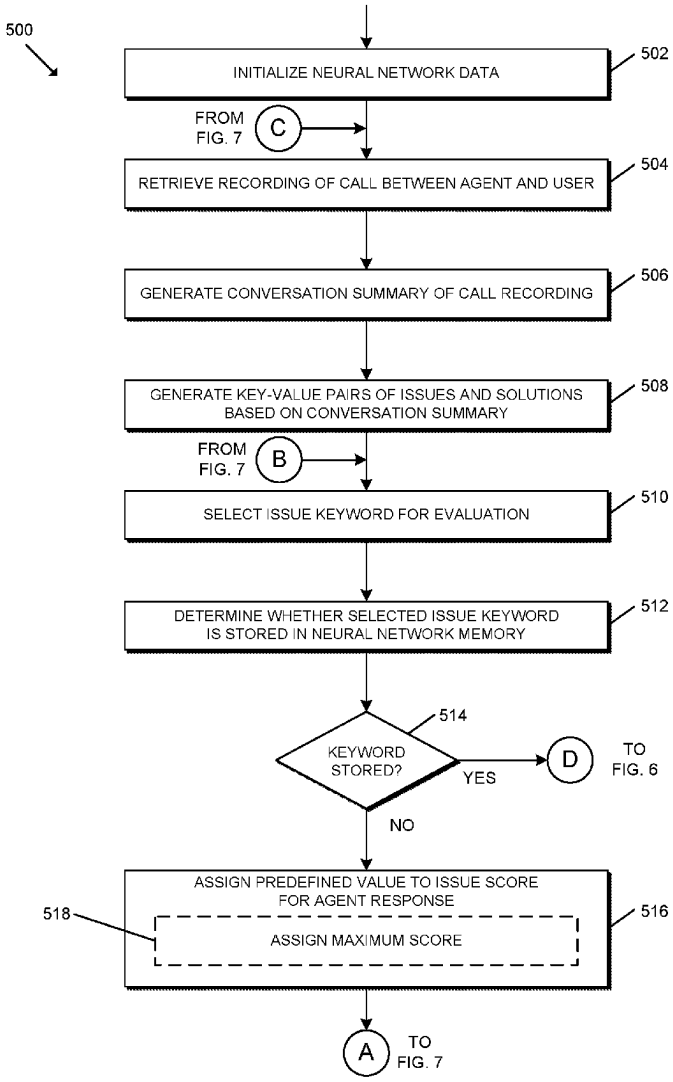
(57) **ABSTRACT**

A system for complexity assessments for agent performance analysis using a memory neural network according to an embodiment includes receiving a plurality of call recordings of calls between a contact center agent and one or more users, generating, for each call recording, a respective conversation summary of the call recording, analyzing each respective conversation summary using the memory neural network to determine a respective agent performance category for performance of the agent during the respective call, each respective agent performance category being selected from a plurality of predefined agent performance categories and associated with a respective call score, comparing each respective call score to a predefined threshold value and updating a topics array based on the respective conversation summary in response to determining that the respective call score is below the predefined threshold value, and determining a total performance score for the agent based on each respective call score.



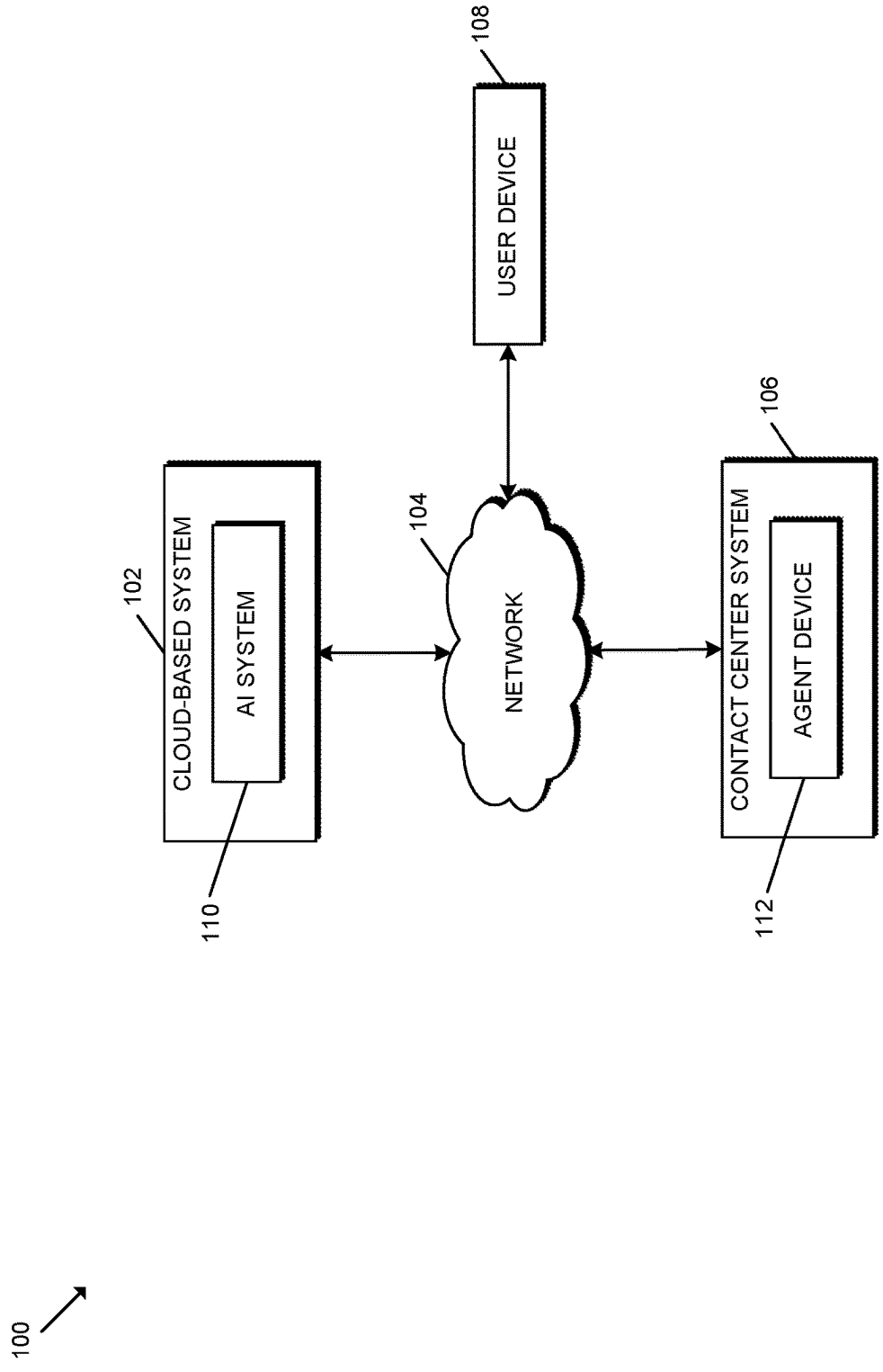

100
102
CLOUD-BASED SYSTEM
AI SYSTEM
110
104
NETWORK
108
USER DEVICE
106
CONTACT CENTER SYSTEM
AGENT DEVICE
112

FIG. 1

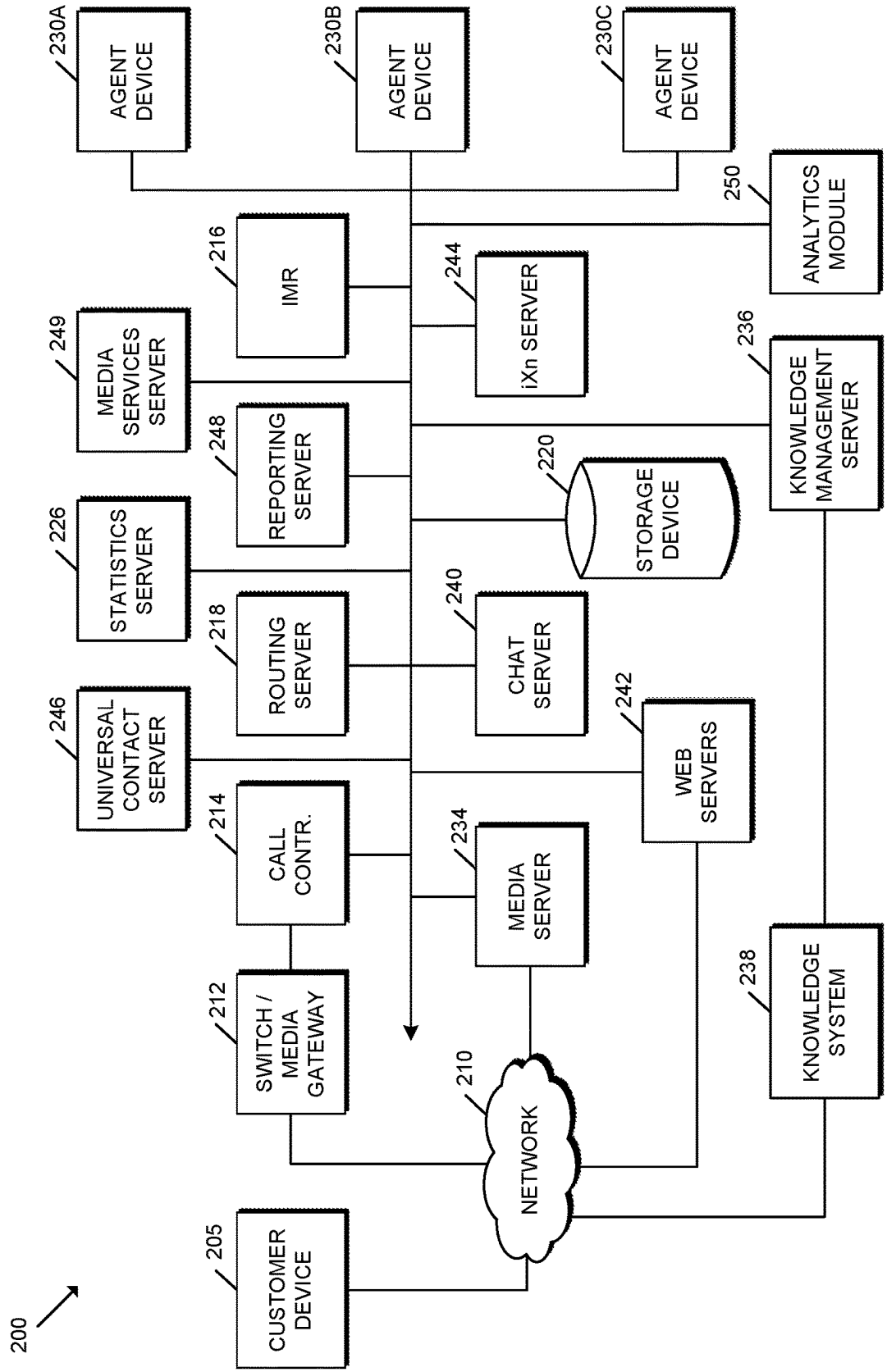

200
230A
AGENT DEVICE
230B
AGENT DEVICE
230C
AGENT DEVICE
250
ANALYTICS MODULE
216
IMR
244
iXn SERVER
249
MEDIA SERVICES SERVER
236
KNOWLEDGE MANAGEMENT SERVER
248
REPORTING SERVER
220
STORAGE DEVICE
226
STATISTICS SERVER
240
CHAT SERVER
218
ROUTING SERVER
242
WEB SERVERS
246
UNIVERSAL CONTACT SERVER
214
CALL CONTR.
234
MEDIA SERVER
238
KNOWLEDGE SYSTEM
212
SWITCH / MEDIA GATEWAY
210
NETWORK
205
CUSTOMER DEVICE

FIG. 2

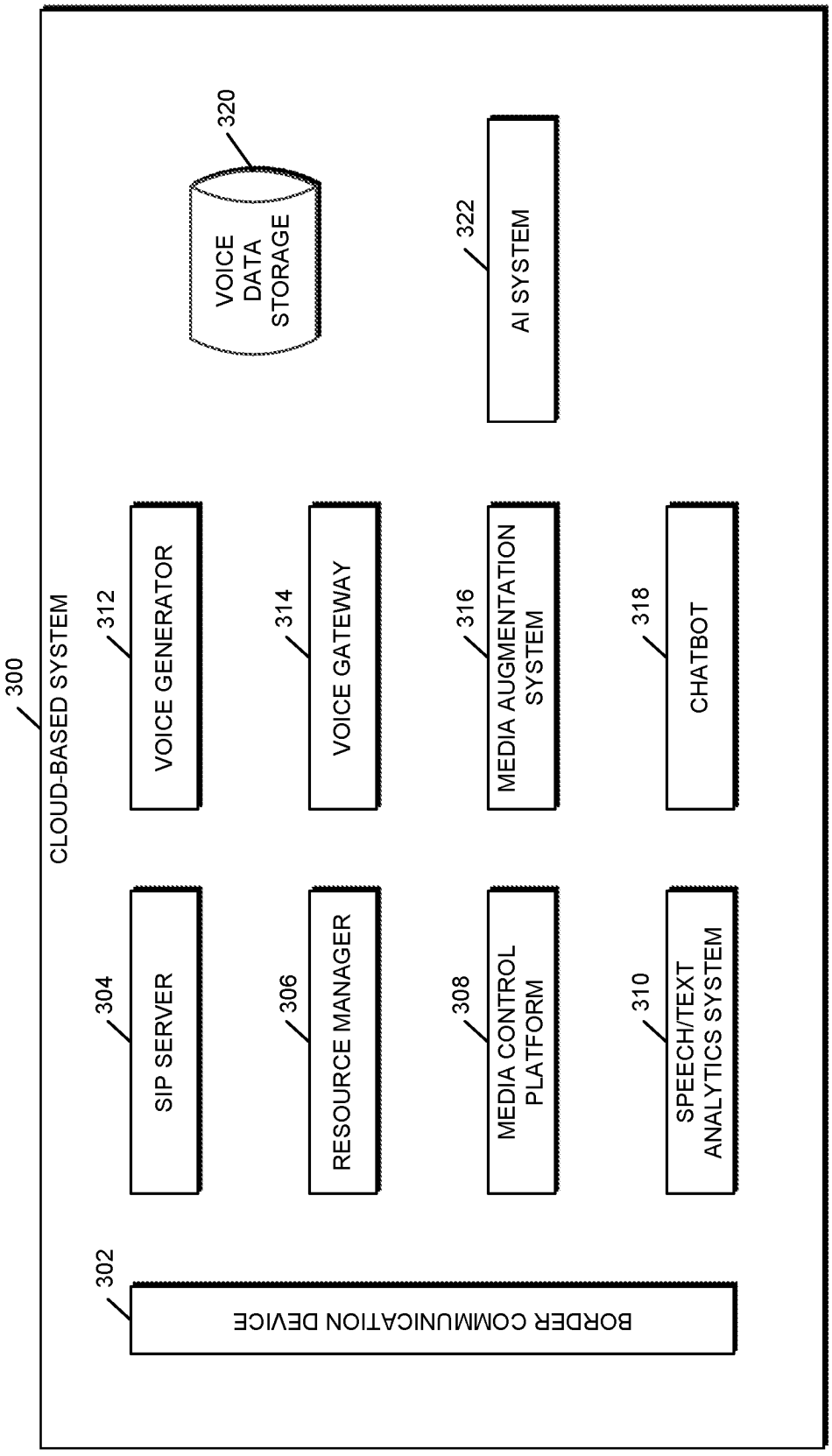

300
CLOUD-BASED SYSTEM
302
BORDER COMMUNICATION DEVICE
304
SIP SERVER
306
RESOURCE MANAGER
308
MEDIA CONTROL PLATFORM
310
SPEECH/TEXT ANALYTICS SYSTEM
312
VOICE GENERATOR
314
VOICE GATEWAY
316
MEDIA AUGMENTATION SYSTEM
318
CHATBOT
320
VOICE DATA STORAGE
322
AI SYSTEM

FIG. 3

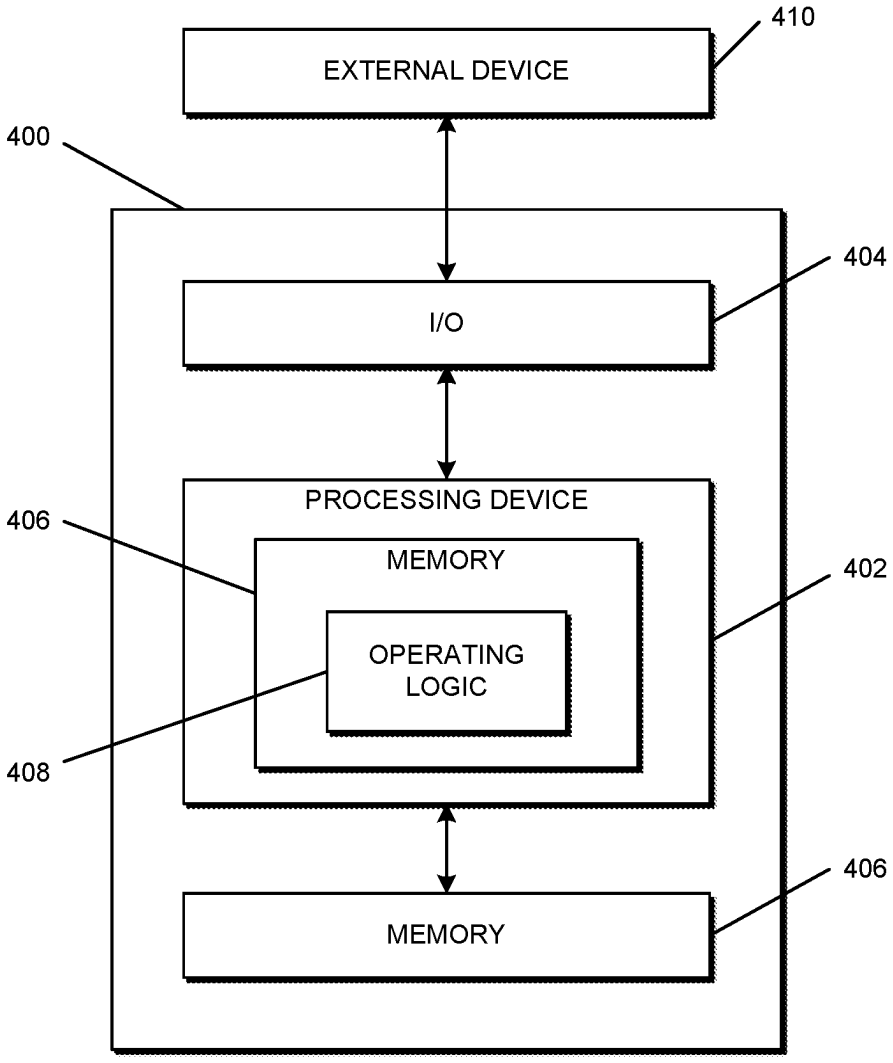

410
EXTERNAL DEVICE
400
404
I/O
PROCESSING DEVICE
406
MEMORY
402
OPERATING LOGIC
408
406
MEMORY

FIG. 4

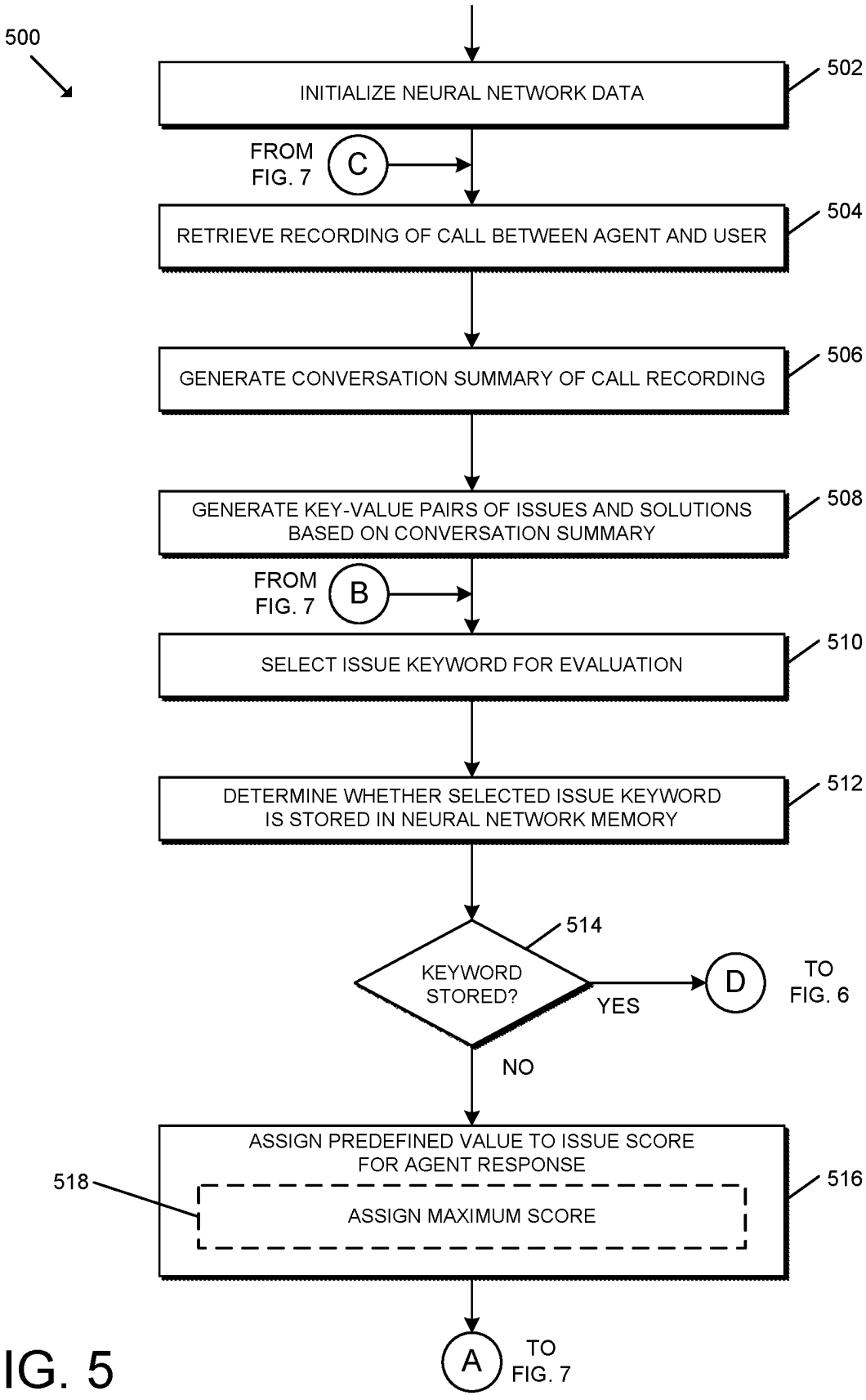

500
INITIALIZE NEURAL NETWORK DATA
502
FROM FIG. 7
C
RETRIEVE RECORDING OF CALL BETWEEN AGENT AND USER
504
GENERATE CONVERSATION SUMMARY OF CALL RECORDING
506
GENERATE KEY-VALUE PAIRS OF ISSUES AND SOLUTIONS BASED ON CONVERSATION SUMMARY
508
FROM FIG. 7
B
SELECT ISSUE KEYWORD FOR EVALUATION
510
DETERMINE WHETHER SELECTED ISSUE KEYWORD IS STORED IN NEURAL NETWORK MEMORY
512
514
KEYWORD STORED?
YES
D
TO FIG. 6
NO
ASSIGN PREDEFINED VALUE TO ISSUE SCORE FOR AGENT RESPONSE
518
ASSIGN MAXIMUM SCORE
516
A
TO FIG. 7

FIG. 5

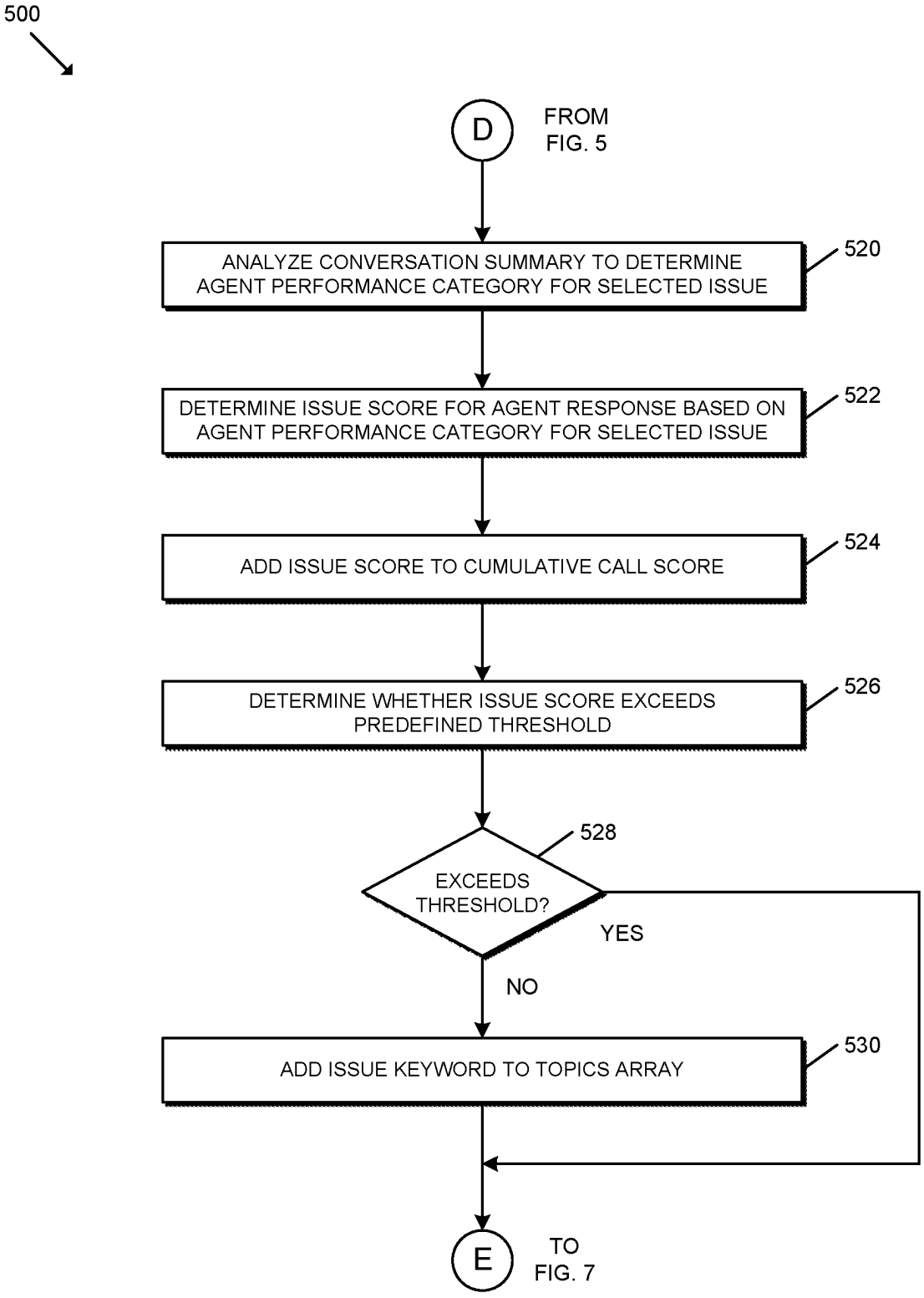

500
D
FROM FIG. 5
ANALYZE CONVERSATION SUMMARY TO DETERMINE AGENT PERFORMANCE CATEGORY FOR SELECTED ISSUE
520
DETERMINE ISSUE SCORE FOR AGENT RESPONSE BASED ON AGENT PERFORMANCE CATEGORY FOR SELECTED ISSUE
522
ADD ISSUE SCORE TO CUMULATIVE CALL SCORE
524
DETERMINE WHETHER ISSUE SCORE EXCEEDS PREDEFINED THRESHOLD
526
528
EXCEEDS THRESHOLD?
YES
NO
ADD ISSUE KEYWORD TO TOPICS ARRAY
530
E
TO FIG. 7

FIG. 6

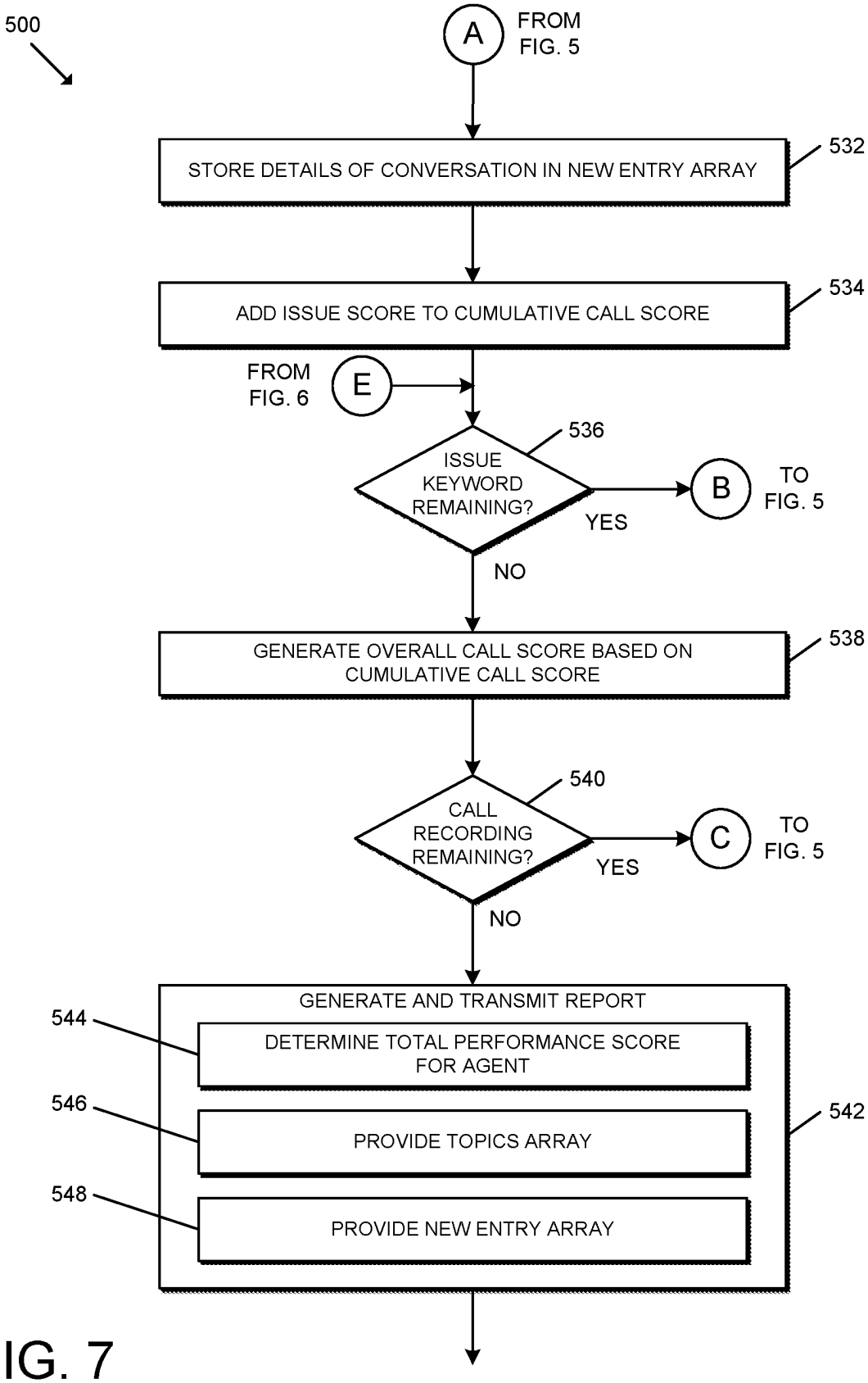

500
A
FROM FIG. 5
STORE DETAILS OF CONVERSATION IN NEW ENTRY ARRAY
532
ADD ISSUE SCORE TO CUMULATIVE CALL SCORE
534
FROM FIG. 6
E
536
ISSUE KEYWORD REMAINING?
YES
B
TO FIG. 5
NO
GENERATE OVERALL CALL SCORE BASED ON CUMULATIVE CALL SCORE
538
540
CALL RECORDING REMAINING?
YES
C
TO FIG. 5
NO
GENERATE AND TRANSMIT REPORT
544
DETERMINE TOTAL PERFORMANCE SCORE FOR AGENT
546
PROVIDE TOPICS ARRAY
548
PROVIDE NEW ENTRY ARRAY
542

FIG. 7

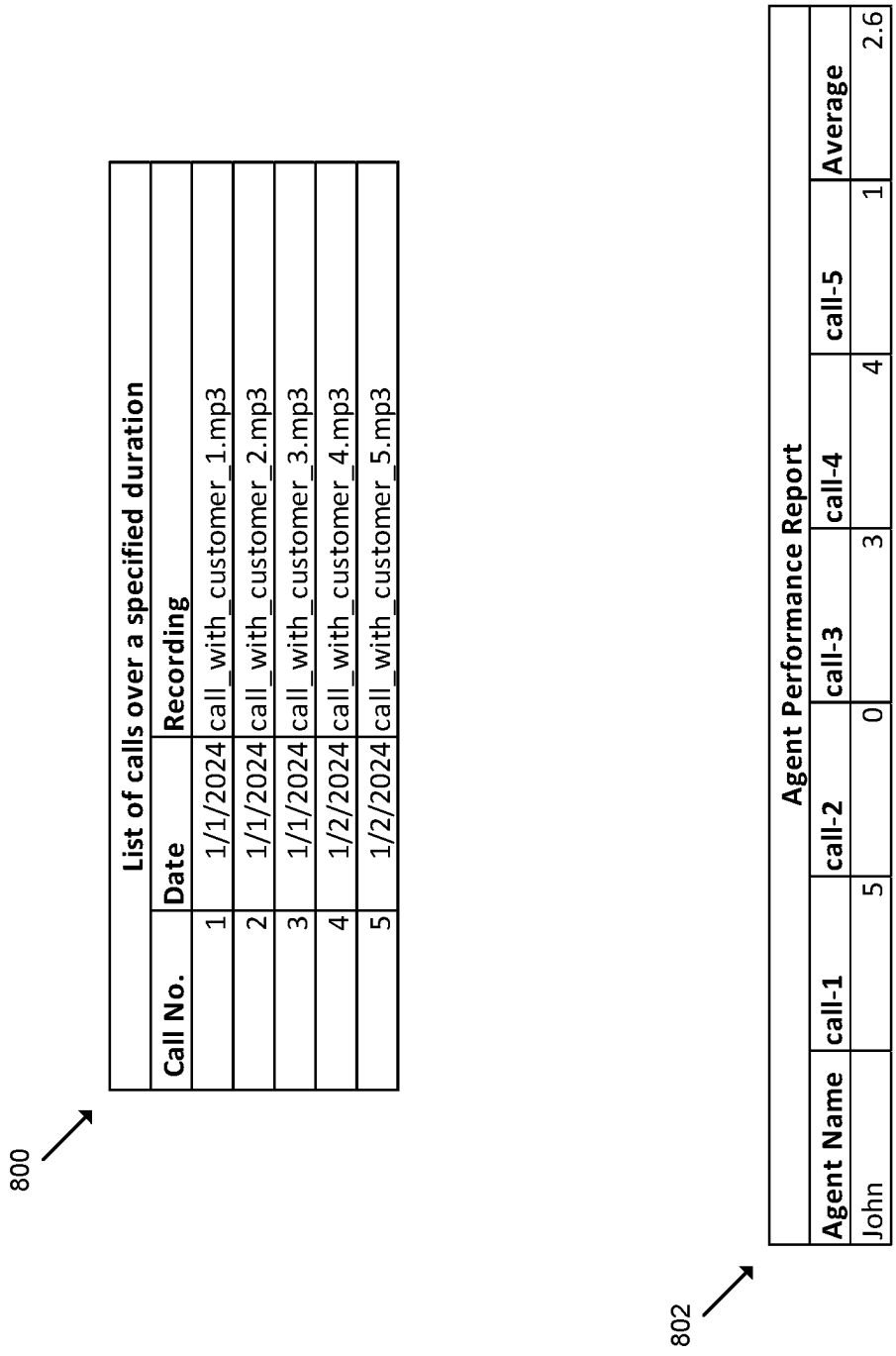

800
List of calls over a specified duration
Call No.
Date
Recording
1
1/1/2024
call_with_customer_1.mp3
2
1/1/2024
call_with_customer_2.mp3
3
1/1/2024
call_with_customer_3.mp3
4
1/2/2024
call_with_customer_4.mp3
5
1/2/2024
call_with_customer_5.mp3
802
Agent Performance Report
Agent Name
call-1
call-2
call-3
call-4
call-5
Average
John
5
0
3
4
1
2.6

FIG. 8

COMPLEXITY ASSESSMENTS FOR AGENT PERFORMANCE ANALYSIS USING MEMORY NEURAL NETWORKS

BACKGROUND

[0001] Contact centers rely on agents to communicate with and respond to client inquiries; however, in large contact centers, only a very small fraction of agent-user interactions are ever evaluated, as agent performance analysis traditionally requires substantial effort and time, and live agent monitoring tools and supervisor-led agent performance analyses, for example, traditionally require a lot of resources. The sheer volume of interactions makes it impractical to analyze each interaction comprehensively using traditional agent performance analysis techniques. Moreover, analyzing such small samples often results in skewed and unreliable data.

SUMMARY

[0002] One embodiment is directed to a unique system, components, and methods for complexity assessments for agent performance analysis using memory neural networks. Other embodiments are directed to apparatuses, systems, devices, hardware, methods, and combinations thereof for complexity assessments for agent performance analysis using memory neural networks.

[0003] According to an embodiment, a method for complexity assessments for agent performance analysis using a memory neural network may include receiving, by a computing system, a plurality of call recordings of calls between a contact center agent and one or more users, generating, by the computing system for each call recording of the plurality of call recordings, a respective conversation summary of the call recording, analyzing, by the computing system, each respective conversation summary using the memory neural network to determine a respective agent performance category for performance of the contact center agent during the respective call, wherein each respective agent performance category is selected from a plurality of predefined agent performance categories and is associated with a respective call score, comparing, by the computing system, the respective call score for each determined respective agent performance category to a predefined threshold value and updating a topics array based on the respective conversation summary in response to determining that the respective call score is below the predefined threshold value, and determining, by the computing system, a total performance score for the contact center agent based on each respective call score.

[0004] In some embodiments, analyzing each respective conversation summary using the memory neural network may include generating one or more issue-solution key-value pairs using the memory neural network based on the respective conversation summary.

[0005] In some embodiments, analyzing each respective conversation summary using the memory neural network may include determining a respective issue-specific agent performance category for performance of the contact center agent during the respective call with respect to each issue of the one or more issue-solution key value pairs generated using the memory neural network, wherein each respective issue-specific agent performance category is associated with a respective issue score.

[0006] In some embodiments, updating the topics array based on the respective conversation summary may include updating the topics array to include a particular issue in response to determining that the respective issue score is below the predefined threshold value.

[0007] In some embodiments, the respective call score may be based on each respective issue score.

[0008] In some embodiments, the method may further include determining, by the computing system, that a particular issue of the one or more issue-solution key-value pairs is not stored in a memory associated with the memory neural network, and storing, by the computing system, data associated with the particular issue in a new entry array in response to determining that the particular issue is not stored in the memory associated with the memory neural network.

[0009] In some embodiments, the method may further include generating, by the computing system, a report based on the agent performance analysis using the memory neural network, and the report may include the total performance score, the topics array, and the new entry array.

[0010] In some embodiments, the memory neural network may be embodied as or include a long short-term memory neural network.

[0011] In some embodiments, the memory neural network may be embodied as or include a primary recurrent neural network and a secondary recurrent neural network.

[0012] In some embodiments, analyzing each respective conversation summary using the memory neural network to determine the respective agent performance category for performance of the contact center agent during the respective call may include analyzing each respective conversation summary using the secondary recurrent neural network to determine the respective agent performance category for performance of the contact center agent during the respective call.

[0013] According to another embodiment, a computing system for complexity assessments for agent performance analysis using a memory neural network may include at least one processor and at least one memory comprising a plurality of instructions stored thereon that, in response to execution by the at least one processor, causes the computing system to receive a plurality of call recordings of calls between a contact center agent and one or more users, generate, for each call recording of the plurality of call recordings, a respective conversation summary of the call recording, analyze each respective conversation summary using the memory neural network to determine a respective agent performance category for performance of the contact center agent during the respective call, wherein each respective agent performance category is selected from a plurality of predefined agent performance categories and is associated with a respective call score, compare the respective call score for each determined respective agent performance category to a predefined threshold value and update a topics array based on the respective conversation summary in response to a determination that the respective call score is below the predefined threshold value, and determine a total performance score for the contact center agent based on each respective call score.

[0014] In some embodiments, to analyze each respective conversation summary using the memory neural network may include to generate one or more issue-solution key-value pairs using the memory neural network based on the respective conversation summary.

[0015] In some embodiments, to analyze each respective conversation summary using the memory neural network may include to determine a respective issue-specific agent performance category for performance of the contact center agent during the respective call with respect to each issue of the one or more issue-solution key value pairs generated using the memory neural network, wherein each respective issue-specific agent performance category is associated with a respective issue score.

[0016] In some embodiments, to update the topics array based on the respective conversation summary may include to update the topics array to include a particular issue in response to determining that the respective issue score is below the predefined threshold value.

[0017] In some embodiments, the respective call score may be based on each respective issue score.

[0018] In some embodiments, the plurality of instructions may further cause the computing system to determine that a particular issue of the one or more issue-solution key-value pairs is not stored in a memory associated with the memory neural network, and store data associated with the particular issue in a new entry array in response to a determination that the particular issue is not stored in the memory associated with the memory neural network.

[0019] In some embodiments, the plurality of instructions may further cause the computing system to generate a report based on the agent performance analysis using the memory neural network, and the report may include the total performance score, the topics array, and the new entry array.

[0020] In some embodiments, the memory neural network may be embodied as or include a long short-term memory neural network.

[0021] In some embodiments, the memory neural network may be embodied as or include a primary recurrent neural network and a secondary recurrent neural network.

[0022] In some embodiments, to analyze each respective conversation summary using the memory neural network to determine the respective agent performance category for performance of the contact center agent during the respective call may include to analyze each respective conversation summary using the secondary recurrent neural network to determine the respective agent performance category for performance of the contact center agent during the respective call.

[0023] This summary is not intended to identify key or essential features of the claimed subject matter, nor is it intended to be used as an aid in limiting the scope of the claimed subject matter. Further embodiments, forms, features, and aspects of the present application shall become apparent from the description and figures provided herewith.

BRIEF DESCRIPTION OF THE DRAWINGS

[0024] The concepts described herein are illustrative by way of example and not by way of limitation in the accompanying figures. For simplicity and clarity of illustration, elements illustrated in the figures are not necessarily drawn to scale. Where considered appropriate, references labels have been repeated among the figures to indicate corresponding or analogous elements.

[0025] FIG. **1** depicts a simplified block diagram of at least one embodiment of a system for complexity assessments for agent performance analysis using memory neural networks;

[0026] FIG. **2** is a simplified block diagram of at least one embodiment of a contact center system;

[0027] FIG. **3** is a simplified block diagram of at least one embodiment of a cloud-based system;

[0028] FIG. **4** is a simplified block diagram of at least one embodiment of a computing device;

[0029] FIGS. **5-7** are a simplified flow diagram of at least one method for complexity assessments for agent performance analysis using memory neural networks; and

[0030] FIG. **8** illustrate an example list of recorded calls and at least a portion of an example agent performance report generated based on the list of recorded calls.

DETAILED DESCRIPTION

[0031] Although the concepts of the present disclosure are susceptible to various modifications and alternative forms, specific embodiments have been shown by way of example in the drawings and will be described herein in detail. It should be understood, however, that there is no intent to limit the concepts of the present disclosure to the particular forms disclosed, but on the contrary, the intention is to cover all modifications, equivalents, and alternatives consistent with the present disclosure and the appended claims.

[0032] References in the specification to "one embodiment," "an embodiment," "an illustrative embodiment," etc., indicate that the embodiment described may include a particular feature, structure, or characteristic, but every embodiment may or may not necessarily include that particular feature, structure, or characteristic. Moreover, such phrases are not necessarily referring to the same embodiment. It should be further appreciated that although reference to a "preferred" component or feature may indicate the desirability of a particular component or feature with respect to an embodiment, the disclosure is not so limiting with respect to other embodiments, which may omit such a component or feature. Further, when a particular feature, structure, or characteristic is described in connection with an embodiment, it is submitted that it is within the knowledge of one skilled in the art to implement such feature, structure, or characteristic in connection with other embodiments whether or not explicitly described. Further, particular features, structures, or characteristics may be combined in any suitable combinations and/or sub-combinations in various embodiments.

[0033] Additionally, it should be appreciated that items included in a list in the form of "at least one of A, B, and C" can mean (A); (B); (C); (A and B); (B and C); (A and C); or (A, B, and C). Similarly, items listed in the form of "at least one of A, B, or C" can mean (A); (B); (C); (A and B); (B and C); (A and C); or (A, B, and C). Further, with respect to the claims, the use of words and phrases such as "a," "an," "at least one," and/or "at least one portion" should not be interpreted so as to be limiting to only one such element unless specifically stated to the contrary, and the use of phrases such as "at least a portion" and/or "a portion" should be interpreted as encompassing both embodiments including only a portion of such element and embodiments including the entirety of such element unless specifically stated to the contrary.

[0034] The disclosed embodiments may, in some cases, be implemented in hardware, firmware, software, or a combination thereof. The disclosed embodiments may also be implemented as instructions carried by or stored on one or more transitory or non-transitory machine-readable (e.g., computer-readable) storage media, which may be read and executed by one or more processors. A machine-readable

storage medium may be embodied as any storage device, mechanism, or other physical structure for storing or transmitting information in a form readable by a machine (e.g., a volatile or non-volatile memory, a media disc, or other media device).

[0035] In the drawings, some structural or method features may be shown in specific arrangements and/or orderings. However, it should be appreciated that such specific arrangements and/or orderings may not be required. Rather, in some embodiments, such features may be arranged in a different manner and/or order than shown in the illustrative figures unless indicated to the contrary. Additionally, the inclusion of a structural or method feature in a particular figure is not meant to imply that such feature is required in all embodiments and, in some embodiments, may not be included or may be combined with other features.

[0036] Referring now to FIG. **1**, a system **100** for complexity assessments for agent performance analysis using memory neural networks includes a cloud-based system **102**, a network **104**, a contact center system **106**, and a user device **108**. Additionally, the illustrative cloud-based system **102** includes an artificial intelligence (AI) system **110**, and the illustrative contact center system **106** includes an agent device **112**. Although only one cloud-based system **102**, one network **104**, one contact center system **106**, one user device **108**, one artificial intelligence system **110**, and one agent device **112** are shown in the illustrative embodiment of FIG. **1**, the system **100** may include multiple cloud-based systems **102**, networks **104**, contact center systems **106**, user devices **108**, artificial intelligence systems **110**, and/or agent devices **112** in other embodiments. For example, in some embodiments, multiple cloud-based systems **102** (e.g., related or unrelated systems) may be used to perform the various functions described herein. Further, in some embodiments, one or more of the systems described herein may be excluded from the system **100**, one or more of the systems described as being independent may form a portion of another system, and/or one or more of the systems described as forming a portion of another system may be independent.

[0037] Historically, evaluating the performance (e.g., the effectiveness) of contact center agents has been a labor-intensive and subjective process, for example, reliant on manual monitoring. Using traditional techniques, supervisors and quality assurance teams meticulously sift through recorded calls or transcripts, assessing agent performance based on one or more predefined criteria. This approach, while providing some insights, is plagued by inherent limitations. For example, traditional analyses introduce subjectivity and inconsistency in evaluations, as interpretations of tone, empathy, and adherence to scripts generally vary across evaluators. Furthermore, the sheer volume of interactions makes it impractical to analyze every instance comprehensively, resulting in a sampling bias that may not capture the full spectrum of agent capabilities. The traditional method's reliance on manual monitoring is not only resource-intensive but also restricts scalability, hindering contact centers from achieving the agility required in today's fast-paced user-centric landscape. Accordingly, the technologies described herein leverage artificial intelligence technologies in agent performance analysis, which allows for the efficient and thorough analysis of every agent interaction, thereby addressing various shortcomings of the conventional approach, such as eliminating potential sampling biases.

[0038] During a typical agent-user interaction, the user calls the contact center and is re-directed to a contact center agent who is responsible for clarifying and/or resolving various issues or concerns for the user. In many circumstances, the issues or concerns will be resolved, and the calls will be disposed properly. In some cases, however, the user query will not be answered, the call may be re-scheduled, the call may be disconnected by the user, or the call may be transferred to another contact center agent. For example, the user's query may be complex, the contact center agent's interpretation of the user's query may be wrong, or the contact center agent may not be equipped with the proper knowledge to answer the user's query. In these cases, the contact center agents dispose of the call with comments, and the user often makes another call to the contact center to have the issue resolved by another contact center agent, who may receive a summary of the interaction between the user and the prior contact center agent.

[0039] In the illustrative embodiment, the system **100** analyzes the contact center agent's performance using AI/ML, which may monitor calls the agent has closed. For example, as described herein, the system **100** may receive the summarized data (e.g., as AI model inputs) and transform the data into specific key-value pairs of issues and solutions (e.g., issue-solution pairs), which may be added to a neural network. It should be appreciated that the AI/ML model (e.g., neural network model) may be trained (e.g., a priori) with predefined solutions from a knowledgebase along with the respective keywords/issues and solutions. The system **100** may determine whether the keywords associated with the key-value pairs are already present in an existing list in the memory of the neural network (or other machine learning model/system) and, if present, the system **100** may fetch solutions that are mapped to those keywords and analyze the summarized data based on the call handling scenarios. Based on this analysis, the system **100** may provide a call-specific score (e.g., potentially based on or issue-specific scores) for the contact center agent's performance during the analyzed call.

[0040] The system **100** may also monitor calls (e.g., all calls) of a contact center agent over a period of time (e.g., a predefined or requested analysis period) and provide cumulative performance analytics for the contact center agent based on the agent's performance during that period of time. If a user has a query that is not present in the memory of the neural network (or other machine learning model/system), the system **100** may record the relevant keywords (e.g., from the relevant key-value pairs), and potentially generate a report including those keywords (e.g., for the agent's supervisor).

[0041] Referring back to FIG. **1**, the cloud-based system **102** may be embodied as any one or more types of devices/systems capable of performing the functions described herein. For example, as described herein, the artificial intelligence system **110** may receive summarized data (e.g., as AI model inputs) associated with agent-user calls and transform the data into specific key-value pairs of issues and solutions (e.g., issue-solution pairs), which may be added to a neural network. The artificial intelligence system **110** may determine whether the keywords associated with the key-value pairs are already present in an existing list in the memory of the neural network (or other machine learning model/system) and, if present, the artificial intelligence system **110** may fetch solutions that are mapped to those keywords and

analyze the summarized data based on the call handling scenarios as described above. Based on this analysis, the artificial intelligence system **110** may provide a call-specific score (e.g., potentially based on or issue-specific scores) for the contact center agent's performance during the analyzed call. As described below, the artificial intelligence system **110** may monitor calls (e.g., all calls) of a contact center agent over a period of time (e.g., a predefined or requested analysis period) and provide cumulative performance analytics for the contact center agent based on the agent's performance during that period of time. If a user has a query that is not present in the memory of the neural network (or other machine learning model/system), the artificial intelligence system **110** may record the relevant keywords (e.g., from the relevant key-value pairs), and generate a report including those keywords (e.g., for the agent's supervisor). In some embodiments, it should be appreciated that the artificial intelligence system **110** may execute, in full or in part, the method **500** described in reference to FIGS. **5-7**.

[0042] It should be appreciated that the artificial intelligence system **110** may leverage a memory neural network, which includes memory that functions as long-term storage or permanent memory (e.g., storing information explicitly in an external memory component that persists across different instances and/or sessions of the neural network) and the neural network, which functions as a controller to process information retrieved from the memory and perform computations (e.g., accessing the external memory and interacting with it by reading, writing, and/or updating information). Suppose, for example, that a user has initiated a call for a problem related to slow internet speed, and the contact center agent has provided a solution of changing the router configurations. The user has made the suggested changes, and the issue has resolved. The call duration was five minutes, and the contact center agent closed the call with the issue resolved. When processing the exemplary call, the artificial intelligence system **110** may categorize the issues and solutions in respective arrays (e.g., issues: [slow internet speed]; solutions: [change the router configurations]), create a key-value pair from the obtained arrays (e.g., [{'slow internet speed': 'change the router configurations'}]), and store the key-value pair and the issues and solutions array in the neural network.

[0043] In some embodiments, the memory neural network may be embodied as or include a long short-term memory (LSTM) neural network. In another embodiments, the memory neural network may be embodied as or include a primary recurrent neural network and a secondary recurrent neural network, such that the secondary recurrent neural network is leveraged to perform the various analyses and the primary recurrent neural network functions as a persistent long-term memory for the memory neural network.

[0044] Although the cloud-based system **102** is described herein in the singular, it should be appreciated that the cloud-based system **102** may be embodied as or include multiple servers/systems in some embodiments. Further, although the cloud-based system **102** is described herein as a cloud-based system, it should be appreciated that the system **102** may be embodied as one or more servers/systems residing outside of a cloud computing environment in other embodiments. In cloud-based embodiments, the cloud-based system **102** may be embodied as a server-ambiguous computing solution similar to that described below.

[0045] The network **104** may be embodied as any one or more types of communication networks that are capable of facilitating communication between the various devices communicatively connected via the network **104**. As such, the network **104** may include one or more networks, routers, switches, access points, hubs, computers, and/or other intervening network devices. For example, the network **104** may be embodied as or otherwise include one or more cellular networks, telephone networks, local or wide area networks, publicly available global networks (e.g., the Internet), ad hoc networks, short-range communication links, or a combination thereof. In some embodiments, the network **104** may include a circuit-switched voice or data network, a packet-switched voice or data network, and/or any other network able to carry voice and/or data. In particular, in some embodiments, the network **104** may include Internet Protocol (IP)-based and/or asynchronous transfer mode (ATM)-based networks. In some embodiments, the network **104** may handle voice traffic (e.g., via a Voice over IP (VOIP) network), web traffic (e.g., such as hypertext transfer protocol (HTTP) traffic and hypertext markup language (HTML) traffic), and/or other network traffic depending on the particular embodiment and/or devices of the system **100** in communication with one another. In various embodiments, the network **104** may include analog or digital wired and wireless networks (e.g., IEEE 802.11 networks, Public Switched Telephone Network (PSTN), Integrated Services Digital Network (ISDN), and Digital Subscriber Line (xDSL)), Third Generation (3G) mobile telecommunications networks, Fourth Generation (4G) mobile telecommunications networks, Fifth Generation (5G) mobile telecommunications networks, a wired Ethernet network, a private network (e.g., such as an intranet), radio, television, cable, satellite, and/or any other delivery or tunneling mechanism for carrying data, or any appropriate combination of such networks. The network **104** may enable connections between the various devices/systems **102**, **106**, **108**, **110**, **112** of the system **100**. It should be appreciated that the various devices/systems **102**, **106**, **108**, **110**, **112** may communicate with one another via different networks **104** depending on the source and/or destination devices/systems **102**, **106**, **108**, **110**, **112**.

[0046] The contact center system **106** may be embodied as any system capable of providing contact center services (e.g., call center services) to an end user and otherwise performing the functions described herein. Depending on the particular embodiment, it should be appreciated that the contact center system **106** may be located on the premises/campus of the organization utilizing the contact center system **106** and/or located remotely relative to the organization (e.g., in a cloud-based computing environment). In some embodiments, a portion of the contact center system **106** may be located on the organization's premises/campus while other portions of the contact center system **106** are located remotely relative to the organization's premises/campus. As such, it should be appreciated that the contact center system **106** may be deployed in equipment dedicated to the organization or third-party service provider thereof 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. In some embodiments, the contact center system **106** includes resources (e.g., personnel, computers, and telecommunication equipment) to enable deliv-

ery of services via telephone and/or other communication mechanisms. Such services may include, for example, technical support, help desk support, emergency response, and/or other contact center services depending on the particular type of contact center. In some embodiments, the contact center system **200** may be a contact center system similar to the contact center system **200** described in reference to FIG. **2**.

[0047] The agent device **112** may be embodied as any type of device or system of the contact center system **106** that may be used by an agent of the contact center for communication with the user device **108** (e.g., of a contact center client), the cloud-based system **102**, and/or otherwise capable of performing the functions described herein. In some embodiments, the agent device **112** may be embodied as an agent device similar to the agent devices **230** described in reference to the contact center system **200** of FIG. **2**.

[0048] The user device **108** may be embodied as any type of device (e.g., of a contact center client) capable of executing an application and otherwise performing the functions described herein. For example, in some embodiments, the user device **108** is configured to execute an application to participate in a conversation with a human agent (e.g., via the agent device **112**), personal bot, automated agent, chat bot, or other automated system. As such, the user device **108** may have various input/output devices with which a user may interact to provide and receive audio, text, video, and/or other forms of data. It should be appreciated that the application may be embodied as any type of application suitable for performing the functions described herein. In particular, in some embodiments, the application may be embodied as a mobile application (e.g., a smartphone application), a cloud-based application, a web application, a thin-client application, and/or another type of application. For example, in some embodiments, application may serve as a client-side interface (e.g., via a web browser) for a web-based application or service.

[0049] It should be appreciated that each of the cloud-based system **102**, the network **104**, the contact center system **106**, the user device **108**, the artificial intelligence system **110**, and the agent device **112** may be embodied as, executed by, form a portion of, or associated with any type of device/system, collection of devices/systems, and/or portion(s) thereof suitable for performing the functions described herein (e.g., the computing device **400** of FIG. **4**). In various embodiments, it should be appreciated that the contact center system **106** may form a portion of, constitute a feature/device superset of, or involve a contact center system similar to the contact center system **200** of FIG. **2**. Additionally, the cloud-based system **102** may form a portion of, constitute a feature/device superset of, or involve a cloud-based system similar to the cloud-based system **300** of FIG. **3**.

[0050] In some embodiments, it should be appreciated that the cloud-based system **102** may be communicatively coupled to the contact center system **106**, form a portion of the contact center system **106**, and/or be otherwise used in conjunction with the contact center system **106**. For example, in some embodiments, the user device **108** may communicate directly with the cloud-based system **102**.

[0051] Referring now to FIG. **2**, a simplified block diagram of at least one embodiment of a communications infrastructure and/or content center system, which may be used in conjunction with one or more of the embodiments described herein, is shown. The contact center system **200** may be embodied as any system capable of providing contact center services (e.g., call center services, chat center services, SMS center services, etc.) to an end user and otherwise performing the functions described herein. The illustrative contact center system **200** includes a customer device **205**, a network **210**, a switch/media gateway **212**, a call controller **214**, an interactive media response (IMR) server **216**, a routing server **218**, a storage device **220**, a statistics server **226**, agent devices **230**A, **230**B, **230**C, a media server **234**, a knowledge management server **236**, a knowledge system **238**, chat server **240**, web servers **242**, an interaction (iXn) server **244**, a universal contact server **246**, a reporting server **248**, a media services server **249**, and an analytics module **250**. Although only one customer device **205**, one network **210**, one switch/media gateway **212**, one call controller **214**, one IMR server **216**, one routing server **218**, one storage device **220**, one statistics server **226**, one media server **234**, one knowledge management server **236**, one knowledge system **238**, one chat server **240**, one iXn server **244**, one universal contact server **246**, one reporting server **248**, one media services server **249**, and one analytics module **250** are shown in the illustrative embodiment of FIG. **2**, the contact center system **200** may include multiple customer devices **205**, networks **210**, switch/media gateways **212**, call controllers **214**, IMR servers **216**, routing servers **218**, storage devices **220**, statistics servers **226**, media servers **234**, knowledge management servers **236**, knowledge systems **238**, chat servers **240**, iXn servers **244**, universal contact servers **246**, reporting servers **248**, media services servers **249**, and/or analytics modules **250** in other embodiments. Further, in some embodiments, one or more of the components described herein may be excluded from the system **200**, one or more of the components described as being independent may form a portion of another component, and/or one or more of the component described as forming a portion of another component may be independent.

[0052] It should be understood that the term "contact center system" is used herein to refer to the system depicted in FIG. **2** and/or the components thereof, while the term "contact center" is used more generally to refer to contact center systems, customer service providers operating those systems, and/or the organizations or enterprises associated therewith. Thus, unless otherwise specifically limited, the term "contact center" refers generally to a contact center system (such as the contact center system **200**), the associated customer service provider (such as a particular customer service provider/agent providing customer services through the contact center system **200**), as well as the organization or enterprise on behalf of which those customer services are being provided.

[0053] By way of background, customer service providers may offer many types of services through contact centers. Such contact centers may be staffed with employees or customer service agents (or simply "agents"), with the agents serving as an interface between a company, enterprise, government agency, or organization (hereinafter referred to interchangeably as an "organization" or "enterprise") and persons, such as users, individuals, or customers (hereinafter referred to interchangeably as "individuals," "customers," or "contact center clients"). For example, the agents at a contact center may assist customers in making purchasing decisions, receiving orders, or solving problems

with products or services already received. Within a contact center, such interactions between contact center agents and outside entities or customers may be conducted over a variety of communication channels, such as, for example, via voice (e.g., telephone calls or voice over IP or VoIP calls), video (e.g., video conferencing), text (e.g., emails and text chat), screen sharing, co-browsing, and/or other communication channels.

[0054] Operationally, contact centers generally strive to provide quality services to customers while minimizing costs. For example, one way for a contact center to operate is to handle every customer interaction with a live agent. While this approach may score well in terms of the service quality, it likely would also be prohibitively expensive due to the high cost of agent labor. Because of this, most contact centers utilize some level of automated processes in place of live agents, such as, for example, interactive voice response (IVR) systems, interactive media response (IMR) systems, internet robots or "bots", automated chat modules or "chatbots", and/or other automated processed. In many cases, this has proven to be a successful strategy, as automated processes can be highly efficient in handling certain types of interactions and effective at decreasing the need for live agents. Such automation allows contact centers to target the use of human agents for the more difficult customer interactions, while the automated processes handle the more repetitive or routine tasks. Further, automated processes can be structured in a way that optimizes efficiency and promotes repeatability. Whereas a human or live agent may forget to ask certain questions or follow-up on particular details, such mistakes are typically avoided through the use of automated processes. While customer service providers are increasingly relying on automated processes to interact with customers, the use of such technologies by customers remains far less developed. Thus, while IVR systems, IMR systems, and/or bots are used to automate portions of the interaction on the contact center-side of an interaction, the actions on the customer-side remain for the customer to perform manually.

[0055] It should be appreciated that the contact center system **200** may be used by a customer service provider to provide various types of services to customers. For example, the contact center system **200** may be used to engage and manage interactions in which automated processes (or bots) or human agents communicate with customers. As should be understood, the contact center system **200** may be an in-house facility to a business or enterprise for performing the functions of sales and customer service relative to products and services available through the enterprise. In another embodiment, the contact center system **200** may be operated by a third-party service provider that contracts to provide services for another organization. Further, the contact center system **200** may be deployed on 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 contact center system **200** may include software applications or programs, which may be executed on premises or remotely or some combination thereof. It should further be appreciated that the various components of the contact center system **200** may be distributed across various geographic locations and not necessarily contained in a single location or computing environment.

[0056] It should further be understood that, unless otherwise specifically limited, any of the computing elements of the present invention may be implemented in cloud-based or cloud computing environments. As used herein and further described below in reference to the computing device **400**, "cloud computing"—or, simply, the "cloud"—is defined as a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned via virtualization and released with minimal management effort or service provider interaction, and then scaled accordingly. Cloud computing can be composed of various characteristics (e.g., on-demand self-service, broad network access, resource pooling, rapid elasticity, measured service, etc.), service models (e.g., Software as a Service ("SaaS"), Platform as a Service ("PaaS"), Infrastructure as a Service ("IaaS"), and deployment models (e.g., private cloud, community cloud, public cloud, hybrid cloud, etc.). Often referred to as a "serverless architecture," a cloud execution model generally includes a service provider dynamically managing an allocation and provisioning of remote servers for achieving a desired functionality.

[0057] It should be understood that any of the computer-implemented components, modules, or servers described in relation to FIG. **2** may be implemented via one or more types of computing devices, such as, for example, the computing device **400** of FIG. **4**. As will be seen, the contact center system **200** generally manages resources (e.g., personnel, computers, telecommunication equipment, etc.) to enable delivery of services via telephone, email, chat, or other communication mechanisms. Such services may vary depending on the type of contact center and, for example, may include customer service, help desk functionality, emergency response, telemarketing, order taking, and/or other characteristics.

[0058] Customers desiring to receive services from the contact center system **200** may initiate inbound communications (e.g., telephone calls, emails, chats, etc.) to the contact center system **200** via a customer device **205**. While FIG. **2** shows one such customer device—i.e., customer device **205**—it should be understood that any number of customer devices **205** may be present. The customer devices **205**, for example, may be a communication device, such as a telephone, smart phone, computer, tablet, or laptop. In accordance with functionality described herein, customers may generally use the customer devices **205** to initiate, manage, and conduct communications with the contact center system **200**, such as telephone calls, emails, chats, text messages, web-browsing sessions, and other multimedia transactions.

[0059] Inbound and outbound communications from and to the customer devices **205** may traverse the network **210**, with the nature of the network typically depending on the type of customer device being used and the form of communication. As an example, the network **210** may include a communication network of telephone, cellular, and/or data services. The network **210** may be a private or public switched telephone network (PSTN), local area network (LAN), private wide area network (WAN), and/or public WAN such as the Internet. Further, the network **210** may 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, 5G, etc.

[0060] The switch/media gateway **212** may be coupled to the network **210** for receiving and transmitting telephone calls between customers and the contact center system **200**. The switch/media gateway **212** may include a telephone or communication switch configured to function as a central switch for agent level routing within the center. The switch may be a hardware switching system or implemented via software. For example, the switch **212** may include an automatic call distributor, a private branch exchange (PBX), an IP-based software switch, and/or any other switch with specialized hardware and software configured to receive Internet-sourced interactions and/or telephone network-sourced interactions from a customer, and route those interactions to, for example, one of the agent devices **230**. Thus, in general, the switch/media gateway **212** establishes a voice connection between the customer and the agent by establishing a connection between the customer device **205** and agent device **230**.

[0061] As further shown, the switch/media gateway **212** may be coupled to the call controller **214** which, for example, serves as an adapter or interface between the switch and the other routing, monitoring, and communication-handling components of the contact center system **200**. The call controller **214** may be configured to process PSTN calls, VoIP calls, and/or other types of calls. For example, the call controller **214** may include computer-telephone integration (CTI) software for interfacing with the switch/media gateway and other components. The call controller **214** may include a session initiation protocol (SIP) server for processing SIP calls. The call controller **214** may also extract data about an incoming interaction, such as the customer's telephone number, IP address, or email address, and then communicate these with other contact center components in processing the interaction.

[0062] The interactive media response (IMR) server **216** may be configured to enable self-help or virtual assistant functionality. Specifically, the IMR server **216** may be similar to an interactive voice response (IVR) server, except that the IMR server **216** is not restricted to voice and may also cover a variety of media channels. In an example illustrating voice, the IMR server **216** may be configured with an IMR script for querying customers on their needs. For example, a contact center for a bank may instruct customers via the IMR script to "press 1" if they wish to retrieve their account balance. Through continued interaction with the IMR server **216**, customers may receive service without needing to speak with an agent. The IMR server **216** may also be configured to ascertain why a customer is contacting the contact center so that the communication may be routed to the appropriate resource. The IMR configuration may be performed through the use of a self-service and/or assisted service tool which comprises a web-based tool for developing IVR applications and routing applications running in the contact center environment.

[0063] The routing server **218** may function to route incoming interactions. For example, once it is determined that an inbound communication should be handled by a human agent, functionality within the routing server **218** may select the most appropriate agent and route the communication thereto. This agent selection may be based on which available agent is best suited for handling the communication. More specifically, the selection of appropriate agent may be based on a routing strategy or algorithm that is implemented by the routing server **218**. In doing this, the routing server **218** may query data that is relevant to the incoming interaction, for example, data relating to the particular customer, available agents, and the type of interaction, which, as described herein, may be stored in particular databases. Once the agent is selected, the routing server **218** may interact with the call controller **214** to route (i.e., connect) the incoming interaction to the corresponding agent device **230**. As part of this connection, information about the customer may be provided to the selected agent via their agent device **230**. This information is intended to enhance the service the agent is able to provide to the customer.

[0064] It should be appreciated that the contact center system **200** may include one or more mass storage devices—represented generally by the storage device **220**—for storing data in one or more databases relevant to the functioning of the contact center. For example, the storage device **220** may store customer data that is maintained in a customer database. Such customer data may include, for example, customer profiles, contact information, service level agreement (SLA), and interaction history (e.g., details of previous interactions with a particular customer, including the nature of previous interactions, disposition data, wait time, handle time, and actions taken by the contact center to resolve customer issues). As another example, the storage device **220** may store agent data in an agent database. Agent data maintained by the contact center system **200** may include, for example, agent availability and agent profiles, schedules, skills, handle time, and/or other relevant data. As another example, the storage device **220** may store interaction data in an interaction database. Interaction data may include, for example, data relating to numerous past interactions between customers and contact centers. More generally, it should be understood that, unless otherwise specified, the storage device **220** may be configured to include databases and/or store data related to any of the types of information described herein, with those databases and/or data being accessible to the other modules or servers of the contact center system **200** in ways that facilitate the functionality described herein. For example, the servers or modules of the contact center system **200** may query such databases to retrieve data stored therein or transmit data thereto for storage. The storage device **220**, for example, may take the form of any conventional storage medium and may be locally housed or operated from a remote location. As an example, the databases may be Cassandra database, NoSQL database, or a SQL database and managed by a database management system, such as, Oracle, IBM DB2,Microsoft SQL server, or Microsoft Access, PostgreSQL.

[0065] The statistics server **226** may be configured to record and aggregate data relating to the performance and operational aspects of the contact center system **200**. Such information may be compiled by the statistics server **226** and made available to other servers and modules, such as the reporting server **248**, which then may use the data to produce reports that are used to manage operational aspects of the contact center and execute automated actions in accordance with functionality described herein. Such data may relate to the state of contact center resources, e.g., average wait time, abandonment rate, agent occupancy, and others as functionality described herein would require.

[0066] The agent devices **230** of the contact center system **200** may be communication devices configured to interact with the various components and modules of the contact center system **200** in ways that facilitate functionality described herein. An agent device **230**, for example, may include a telephone adapted for regular telephone calls or VoIP calls. An agent device **230** may further include a computing device configured to communicate with the servers of the contact center system **200**, perform data processing associated with operations, and interface with customers via voice, chat, email, and other multimedia communication mechanisms according to functionality described herein. Although FIG. **2** shows three such agent devices **230**—i.e., agent devices **230**A, **230**B and **230**C—it should be understood that any number of agent devices **230** may be present in a particular embodiment.

[0067] The multimedia/social media server **234** may be configured to facilitate media interactions (other than voice) with the customer devices **205** and/or the servers **242**. Such media interactions may be related, for example, to email, voice mail, chat, video, text-messaging, web, social media, co-browsing, etc. The multi-media/social media server **234** may take the form of any IP router conventional in the art with specialized hardware and software for receiving, processing, and forwarding multi-media events and communications.

[0068] The knowledge management server **236** may be configured to facilitate interactions between customers and the knowledge system **238**. In general, the knowledge system **238** may be a computer system capable of receiving questions or queries and providing answers in response. The knowledge system **238** may be included as part of the contact center system **200** or operated remotely by a third party. The knowledge system **238** may include an artificially intelligent computer system capable of answering questions posed in natural language by retrieving information from information sources such as encyclopedias, dictionaries, newswire articles, literary works, or other documents submitted to the knowledge system **238** as reference materials. As an example, the knowledge system **238** may be embodied as IBM Watson or a similar system.

[0069] The chat server **240**, it may be configured to conduct, orchestrate, and manage electronic chat communications with customers. In general, the chat server **240** is configured to implement and maintain chat conversations and generate chat transcripts. Such chat communications may be conducted by the chat server **240** in such a way that a customer communicates with automated chatbots, human agents, or both. In exemplary embodiments, the chat server **240** may perform as a chat orchestration server that dispatches chat conversations among the chatbots and available human agents. In such cases, the processing logic of the chat server **240** may be rules driven so to leverage an intelligent workload distribution among available chat resources. The chat server **240** further may implement, manage, and facilitate user interfaces (UIs) associated with the chat feature, including those UIs generated at either the customer device **205** or the agent device **230**. The chat server **240** may be configured to transfer chats within a single chat session with a particular customer between automated and human sources such that, for example, a chat session transfers from a chatbot to a human agent or from a human agent to a chatbot. The chat server **240** may also be coupled to the knowledge management server **236** and the knowledge systems **238** for receiving suggestions and answers to queries posed by customers during a chat so that, for example, links to relevant articles can be provided.

[0070] The web servers **242** may be included to provide site hosts for a variety of social interaction sites to which customers subscribe, such as Facebook, Twitter, Instagram, etc. Though depicted as part of the contact center system **200**, it should be understood that the web servers **242** may be provided by third parties and/or maintained remotely. The web servers **242** may also provide webpages for the enterprise or organization being supported by the contact center system **200**. For example, customers may browse the webpages and receive information about the products and services of a particular enterprise. Within such enterprise webpages, mechanisms may be provided for initiating an interaction with the contact center system **200**, for example, via web chat, voice, or email. An example of such a mechanism is a widget, which can be deployed on the webpages or websites hosted on the web servers **242**. As used herein, a widget refers to a user interface component that performs a particular function. In some implementations, a widget may include a graphical user interface control that can be overlaid on a webpage displayed to a customer via the Internet. The widget may show information, such as in a window or text box, or include buttons or other controls that allow the customer to access certain functionalities, such as sharing or opening a file or initiating a communication. In some implementations, a widget includes a user interface component having a portable portion of code that can be installed and executed within a separate webpage without compilation. Some widgets can include corresponding or additional user interfaces and be configured to access a variety of local resources (e.g., a calendar or contact information on the customer device) or remote resources via network (e.g., instant messaging, electronic mail, or social networking updates).

[0071] The interaction (iXn) server **244** may be configured to manage deferrable activities of the contact center and the routing thereof to human agents for completion. As used herein, deferrable activities may include back-office work that can be performed off-line, e.g., responding to emails, attending training, and other activities that do not entail real-time communication with a customer. As an example, the interaction (iXn) server **244** may be configured to interact with the routing server **218** for selecting an appropriate agent to handle each of the deferrable activities. Once assigned to a particular agent, the deferrable activity is pushed to that agent so that it appears on the agent device **230** of the selected agent. The deferrable activity may appear in a workbin as a task for the selected agent to complete. The functionality of the workbin may be implemented via any conventional data structure, such as, for example, a linked list, array, and/or other suitable data structure. Each of the agent devices **230** may include a workbin. As an example, a workbin may be maintained in the buffer memory of the corresponding agent device **230**.

[0072] The universal contact server (UCS) **246** may be configured to retrieve information stored in the customer database and/or transmit information thereto for storage therein. For example, the UCS **246** may be utilized as part of the chat feature to facilitate maintaining a history on how chats with a particular customer were handled, which then may be used as a reference for how future chats should be handled. More generally, the UCS **246** may be configured to

facilitate maintaining a history of customer preferences, such as preferred media channels and best times to contact. To do this, the UCS **246** may be configured to identify data pertinent to the interaction history for each customer such as, for example, data related to comments from agents, customer communication history, and the like. Each of these data types then may be stored in the customer database **222** or on other modules and retrieved as functionality described herein requires.

[0073] The reporting server **248** may be configured to generate reports from data compiled and aggregated by the statistics server **226** or other sources. Such reports may include near real-time reports or historical reports and concern the state of contact center resources and performance characteristics, such as, for example, average wait time, abandonment rate, and/or agent occupancy. The reports may be generated automatically or in response to specific requests from a requestor (e.g., agent, administrator, contact center application, etc.). The reports then may be used toward managing the contact center operations in accordance with functionality described herein.

[0074] The media services server **249** may be configured to provide audio and/or video services to support contact center features. In accordance with functionality described herein, such features may include prompts for an IVR or IMR system (e.g., playback of audio files), hold music, voicemails/single party recordings, multi-party recordings (e.g., of audio and/or video calls), speech recognition, dual tone multi frequency (DTMF) recognition, faxes, audio and video transcoding, secure real-time transport protocol (SRTP), audio conferencing, video conferencing, coaching (e.g., support for a coach to listen in on an interaction between a customer and an agent and for the coach to provide comments to the agent without the customer hearing the comments), call analysis, keyword spotting, and/or other relevant features.

[0075] The analytics module **250** may be configured to provide systems and methods for performing analytics on data received from a plurality of different data sources as functionality described herein may require. In accordance with example embodiments, the analytics module **250** also may generate, update, train, and modify predictors or models based on collected data, such as, for example, customer data, agent data, and interaction data. The models may include behavior models of customers or agents. The behavior models may be used to predict behaviors of, for example, customers or agents, in a variety of situations, thereby allowing embodiments of the present invention to tailor interactions based on such predictions or to allocate resources in preparation for predicted characteristics of future interactions, thereby improving overall contact center performance and the customer experience. It will be appreciated that, while the analytics module is described as being part of a contact center, such behavior models also may be implemented on customer systems (or, as also used herein, on the "customer-side" of the interaction) and used for the benefit of customers.

[0076] According to exemplary embodiments, the analytics module **250** may have access to the data stored in the storage device **220**, including the customer database and agent database. The analytics module **250** also may have access to the interaction database, which stores data related to interactions and interaction content (e.g., transcripts of the interactions and events detected therein), interaction metadata (e.g., customer identifier, agent identifier, medium of interaction, length of interaction, interaction start and end time, department, tagged categories), and the application setting (e.g., the interaction path through the contact center). Further, the analytic module **250** may be configured to retrieve data stored within the storage device **220** for use in developing and training algorithms and models, for example, by applying machine learning techniques.

[0077] One or more of the included models may be configured to predict customer or agent behavior and/or aspects related to contact center operation and performance. Further, one or more of the models may be used in natural language processing and, for example, include intent recognition and the like. The models may be developed based upon known first principle equations describing a system; data, resulting in an empirical model; or a combination of known first principle equations and data. In developing a model for use with present embodiments, because first principles equations are often not available or easily derived, it may be generally preferred to build an empirical model based upon collected and stored data. To properly capture the relationship between the manipulated/disturbance variables and the controlled variables of complex systems, in some embodiments, it may be preferable that the models are nonlinear. This is because nonlinear models can represent curved rather than straight-line relationships between manipulated/disturbance variables and controlled variables, which are common to complex systems such as those discussed herein. Given the foregoing requirements, a machine learning or neural network-based approach may be a preferred embodiment for implementing the models. Neural networks, for example, may be developed based upon empirical data using advanced regression algorithms.

[0078] The analytics module **250** may further include an optimizer. As will be appreciated, an optimizer may be used to minimize a "cost function" subject to a set of constraints, where the cost function is a mathematical representation of desired objectives or system operation. Because the models may be non-linear, the optimizer may be a nonlinear programming optimizer. It is contemplated, however, that the technologies described herein may be implemented by using, individually or in combination, a variety of different types of optimization approaches, including, but not limited to, linear programming, quadratic programming, mixed integer non-linear programming, stochastic programming, global non-linear programming, genetic algorithms, particle/swarm techniques, and the like.

[0079] According to some embodiments, the models and the optimizer may together be used within an optimization system. For example, the analytics module **250** may utilize the optimization system as part of an optimization process by which aspects of contact center performance and operation are optimized or, at least, enhanced. This, for example, may include features related to the customer experience, agent experience, interaction routing, natural language processing, intent recognition, or other functionality related to automated processes.

[0080] The various components, modules, and/or servers of FIG. **2** (as well as the other figures included herein) may each include one or more processors executing computer program instructions and interacting with other system components for performing the various functionalities described herein. Such computer program instructions may be stored in a memory implemented using a standard memory device,

such as, for example, a random-access memory (RAM), or stored in other non-transitory computer readable media such as, for example, a CD-ROM, flash drive, etc. Although the functionality of each of the servers is described as being provided by the particular server, a person of skill in the art should recognize that the functionality of various servers may be combined or integrated into a single server, or the functionality of a particular server may be distributed across one or more other servers without departing from the scope of the present invention. Further, the terms "interaction" and "communication" are used interchangeably, and generally refer to any real-time and non-real-time interaction that uses any communication channel including, without limitation, telephone calls (PSTN or VoIP calls), emails, vmails, video, chat, screen-sharing, text messages, social media messages, WebRTC calls, etc. Access to and control of the components of the contact center system **200** may be affected through user interfaces (UIs) which may be generated on the customer devices **205** and/or the agent devices **230**. As already noted, the contact center system **200** may operate as a hybrid system in which some or all components are hosted remotely, such as in a cloud-based or cloud computing environment. It should be appreciated that each of the devices of the contact center system **200** may be embodied as, include, or form a portion of one or more computing devices similar to the computing device **400** described below in reference to FIG. **4**.

[0081] Referring now to FIG. **3**, a simplified block diagram of at least one embodiment cloud-based system **300** is shown. The illustrative cloud-based system **300** includes a border communication device **302**, a SIP server **304**, a resource manager **306**, a media control platform **308**, a speech/text analytics system **310**, a voice generator **312**, a voice gateway **314**, a media augmentation system **316**, a chatbot **318**, voice data storage **320**, and an artificial intelligence (AI) system **322**. Although only one border communication device **302**, one SIP server **304**, one resource manager **306**, one media control platform **308**, one speech/text analytics system **310**, one voice generator **312**, one voice gateway **314**, one media augmentation system **316**, one chatbot **318**, one voice data storage **320**, and one artificial intelligence system **322** are shown in the illustrative embodiment of FIG. **3**, the cloud-based system **300** may include multiple border communication devices **302**, SIP servers **304**, resource managers **306**, media control platforms **308**, speech/text analytics systems **310**, voice generators **312**, voice gateways **314**, media augmentation systems **316**, chatbots **318**, voice data storages **320**, and/or artificial intelligence systems **322** in other embodiments. For example, in some embodiments, multiple chatbots **318** may be used to communicate regarding different subject matters handled by the same cloud-based system **300**. Further, in some embodiments, one or more of the components described herein may be excluded from the system **300**, one or more of the components described as being independent may form a portion of another component, and/or one or more of the component described as forming a portion of another component may be independent.

[0082] The border communication device **302** may be embodied as any one or more types of devices/systems that are capable of performing the functions described herein. For example, in some embodiments, the border communication device **302** may be configured to control signaling and media streams involved in setting up, conducting, and tearing down voice conversations and other media communications between, for example, an end user and contact center system. In some embodiments, the border communication device **302** may be a session border controller (SBC) controlling the signaling and media exchanged during a media session (also referred to as a "call," "telephony call," or "communication session") between the end user and contact center system. In some embodiments, the signaling exchanged during a media session may include SIP, H.323, Media Gateway Control Protocol (MGCP), and/or any other voice-over IP (VoIP) call signaling protocols. The media exchanged during a media session may include media streams that carry the call's audio, video, or other data along with information of call statistics and quality.

[0083] In some embodiments, the border communication device **302** may operate according to a standard SIP back-to-back user agent (B2BUA) configuration. In this regard, the border communication device **302** may be inserted in the signaling and media paths established between a calling and called parties in a VoIP call. In some embodiments, it should be understood that other intermediary software and/or hardware devices may be invoked in establishing the signaling and/or media paths between the calling and called parties.

[0084] In some embodiments, the border communication device **302** may exert control over signaling (e.g., SIP messages) and media streams (e.g., RTP data) routed to and from a contact center system (e.g., the contact center system **106**) and other devices (e.g., a customer/client device such as the user device **108**, the cloud-based system **102**, and/or other devices) that traverse the network (e.g., the network **104**). In this regard, the border communication device **302** may be coupled to trunks that carry signals and media for calls to and from the user device over the network, and to trunks that carry signals and media to and from the contact center system over the network.

[0085] The SIP server **304** may be embodied as any one or more types of devices/systems that are capable of performing the functions described herein. For example, in some embodiments, the SIP server **204** may act as a SIP B2UBA and may control the flow of SIP requests and responses between SIP endpoints. Any other controller configured to set up and tear down VoIP communication sessions may be contemplated in addition to or in lieu of the SIP server **304** in other embodiments. The SIP server **304** may be a separate logical component or may be combined with the resource manager **306**. In some embodiments, the SIP server **304** may be hosted at a contact center system (e.g., the contact center system **106**). Although a SIP server **304** is used in the illustrative embodiment, another call server configured with another VoIP protocol may be used in addition to or in lieu of SIP, such as, for example, H.232 protocol, Media Gateway Control Protocol, Skype protocol, and/or other suitable technologies in other embodiments.

[0086] The resource manager **306** may be embodied as any one or more types of devices/systems that are capable of performing the functions described herein. In the illustrative embodiment, the resource manager **306** may be configured to allocate and monitor a pool of media control platforms for providing load balancing and high availability for each resource type. In some embodiments, the resource manager **306** may monitor and may select a media control platform **308** from a cluster of available platforms. The selection of the media control platform **308** may be dynamic, for example, based on identification of a location of a calling

end user, type of media services to be rendered, detected quality of a current media service, and/or other factors.

[0087] In some embodiments, the resource manager **306** may be configured to process requests for media services, and interact with, for example, a configuration server having a configuration database, to determine an interactive voice response (IVR) profile, voice application (e.g. Voice Extensible Markup Language (Voice XML) application), announcement, and conference application, resource, and service profile that can deliver the service, such as, for example, a media control platform. According to some embodiments, the resource manager may provide hierarchical multi-tenant configurations for service providers, enabling them to apportion a select number of resources for each tenant.

[0088] In some embodiments, the resource manager **306** may be configured to act as a SIP proxy, a SIP registrar, and/or a SIP notifier. In this regard, the resource manager **306** may act as a proxy for SIP traffic between two SIP components. As a SIP registrar, the resource manager **306** may accept registration of various resources via, for example, SIP REGISTER messages. In this manner, the cloud-based system **300** may support transparent relocation of call-processing components. In some embodiments, components such as the media control platform **308** do not register with the resource manager **306** at startup. The resource manager **306** may detect instances of the media control platform **308** through configuration information retrieved from the configuration database. If the media control platform **308** has been configured for monitoring, the resource manager **306** may monitor resource health by using, for example, SIP OPTIONS messages. In some embodiments, to determine whether the resources in the group are alive, the resource manager **306** may periodically send SIP OPTIONS messages to each media control platform **308** resource in the group. If the resource manager **306** receives an OK response, the resources are considered alive. It should be appreciated that the resource manager **306** may be configured to perform other various functions, which have been omitted for brevity of the description. The resource manager **306** and the media control platform **308** may collectively be referred to as a media controller.

[0089] In some embodiments, the resource manager **306** may act as a SIP notifier by accepting, for example, SIP SUBSCRIBE requests from the SIP server **304** and maintaining multiple independent subscriptions for the same or different SIP devices. The subscription notices are targeted for the tenants that are managed by the resource manager **306**. In this role, the resource manager **306** may periodically generate SIP NOTIFY requests to subscribers (or tenants) about port usage and the number of available ports. The resource manager **306** may support multi-tenancy by sending notifications that contain the tenant name and the current status (in-or out-of-service) of the media control platform **308** that is associated with the tenant, as well as current capacity for the tenant.

[0090] The media control platform **308** may be embodied as any service or system capable of providing media services and otherwise performing the functions described herein. For example, in some embodiments, the media control platform **308** may be configured to provide call and media services upon request from a service user. Such services may include, without limitation, initiating outbound calls, playing music or providing other media while a call is placed on hold, call recording, conferencing, call progress detection, playing audio/video prompts during a customer self-service session, and/or other call and media services. One or more of the services may be defined by voice applications (e.g. VoiceXML applications) that are executed as part of the process of establishing a media session between the media control platform **308** and the end user.

[0091] The speech/text analytics system (STAS) **310** may be embodied as any service or system capable of providing various speech analytics and text processing functionalities (e.g., text-to-speech) as will be understood by a person of skill in the art and otherwise performing the functions described herein. The speech/text analytics system **310** may perform automatic speech and/or text recognition and grammar matching for end user communications sessions that are handled by the cloud-based system **300**. The speech/text analytics system **310** may include one or more processors and instructions stored in machine-readable media that are executed by the processors to perform various operations. In some embodiments, the machine-readable media may include non-transitory storage media, such as hard disks and hardware memory systems.

[0092] The voice generator **312** may be embodied as any service or system capable of generating a voice communication and otherwise performing the functions described herein. In some embodiments, the voice generator **312** may generate the voice communication based on a particular voice signature.

[0093] The voice gateway **314** may be embodied as any service or system capable of performing the functions described herein. In the illustrative embodiment, the voice gateway **314** receives end user calls from or places calls to voice communications devices, such as an end user device, and responds to the calls in accordance with a voice program that corresponds to a communication routing configuration of the contact center system. In some embodiments, the voice program may include a voice avatar. The voice program may be accessed from local memory within the voice gateway **314** or from other storage media in the cloud-based system **300**. In some embodiments, the voice gateway **314** may process voice programs that are script-based voice applications. The voice program, therefore, may be a script written in a scripting language, such as voice extensible markup language (VoiceXML) or speech application language tags (SALT). The cloud-based system **300** may also communicate with the voice data storage **320** to read and/or write user interaction data (e.g., state variables for a data communications session) in a shared memory space.

[0094] The media augmentation system **316** may be embodied as any service or system capable of specifying how the portions of the cloud-based system **300** (e.g., one or more of the border communications device **302**, the SIP server **304**, the resource manager **306**, the media control platform **308**, the speech/text analytics system **310**, the voice generator **312**, the voice gateway **314**, the media augmentation system **316**, the chatbot **318**, the voice data storage **320**, the artificial intelligence system **322**, and/or one or more portions thereof) interact with each other and otherwise performing the functions described herein. In some embodiments, the media augmentation system **316** may be embodied as or include an application program interface (API). In some embodiments, the media augmentation system **316** enables integration of differing parameters and/or

protocols that are used with various planned application and media types utilized within the cloud-based system **300**.

[0095] The chatbot **318** may be embodied as any automated service or system capable of using automation to engage with end users and otherwise performing the functions described herein. For example, in some embodiments, the chatbot **318** may operate, for example, as an executable program that can be launched according to demand for the particular chatbot. In some embodiments, the chatbot **318** simulates and processes human conversation (either written or spoken), allowing humans to interact with digital devices as if the humans were communicating with another human. In some embodiments, the chatbot **318** may be as simple as rudimentary programs that answer a simple query with a single-line response, or as sophisticated as digital assistants that learn and evolve to deliver increasing levels of personalization as they gather and process information. In some embodiments, the chatbot **318** includes and/or leverages artificial intelligence, adaptive learning, bots, cognitive computing, and/or other automation technologies. Chatbot **318** may also be referred to herein as one or more chat robots, AI chatbots, automated chat robot, chatterbots, dialog systems, conversational agents, automated chat resources, and/or bots.

[0096] A benefit of utilizing automated chat robots for engaging in chat conversations with end users may be that it helps contact centers to more efficiently use valuable and costly resources like human resources, while maintaining end user satisfaction. For example, chat robots may be invoked to initially handle chat conversations without a human end user knowing that it is conversing with a robot. The chat conversation may be escalated to a human resource if and when appropriate. Thus, human resources need not be unnecessarily tied up in handling simple requests and may instead be more effectively used to handle more complex requests or to monitor the progress of many different automated communications at the same time.

[0097] The voice data storage **320** may be embodied as one or more databases, data structures, and/or data storage devices capable of storing data in the cloud-based system **300** or otherwise facilitating the storage of such data for the cloud-based system **300**. For example, in some embodiments, the voice data storage **320** may include one or more cloud storage buckets. In other embodiments, it should be appreciated that the voice data storage **320** may, additionally or alternatively, include other types of voice data storage mechanisms that allow for dynamic scaling of the amount of data storage available to the cloud-based system **300**. In some embodiments, the voice data storage **320** may store scripts (e.g., pre-programmed scripts or otherwise). Although the voice data storage **320** is described herein as data storages and databases, it should be appreciated that the voice data storage **320** may include both a database (or other type of organized collection of data and structures) and data storage for the actual storage of the underlying data. The voice data storage **320** may store various data useful for performing the functions described herein.

[0098] The artificial intelligence system **322** may be embodied as any device, system, or collection of devices/systems capable of performing the functions described herein. For example, in some embodiments, the artificial intelligence system **322** may be embodied as a system similar to the artificial intelligence system **110** described above in reference to the system **100** of FIG. **1**.

[0099] Referring now to FIG. **4**, a simplified block diagram of at least one embodiment of a computing device **400** is shown. The illustrative computing device **400** depicts at least one embodiment of each of the computing devices, systems, servicers, controllers, switches, gateways, engines, modules, and/or computing components described herein (e.g., which collectively may be referred to interchangeably as computing devices, servers, or modules for brevity of the description). For example, the various computing devices may be a process or thread running on one or more processors of one or more computing devices **400**, which may be executing computer program instructions and interacting with other system modules in order to perform the various functionalities described herein. Unless otherwise specifically limited, the functionality described in relation to a plurality of computing devices may be integrated into a single computing device, or the various functionalities described in relation to a single computing device may be distributed across several computing devices. Further, in relation to the computing systems described herein—such as the contact center system **200** of FIG. **2** and/or the cloud-based system **300** of FIG. **3**—the various servers and computer devices thereof may be located on local computing devices **400** (e.g., on-site at the same physical location as the agents of the contact center), remote computing devices **400** (e.g., off-site or in a cloud-based or cloud computing environment, for example, in a remote data center connected via a network), or some combination thereof. In some embodiments, 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) accessed over the Internet using various protocols, such as by exchanging data via extensible markup language (XML), JSON, and/or the functionality may be otherwise accessed/leveraged.

[0100] In some embodiments, the computing device **400** may be embodied as a server, desktop computer, laptop computer, tablet computer, notebook, netbook, Ultrabook™, cellular phone, mobile computing device, smartphone, wearable computing device, personal digital assistant, Internet of Things (IoT) device, processing system, wireless access point, router, gateway, and/or any other computing, processing, and/or communication device capable of performing the functions described herein.

[0101] The computing device **400** includes a processing device **402** that executes algorithms and/or processes data in accordance with operating logic **408**, an input/output device **404** that enables communication between the computing device **400** and one or more external devices **410**, and memory **406** which stores, for example, data received from the external device **410** via the input/output device **404**.

[0102] The input/output device **404** allows the computing device **400** to communicate with the external device **410**. For example, the input/output device **404** may include a transceiver, a network adapter, a network card, an interface, one or more communication ports (e.g., a USB port, serial port, parallel port, an analog port, a digital port, VGA, DVI, HDMI, Fire Wire, CAT 5, or any other type of communication port or interface), and/or other communication circuitry. Communication circuitry of the computing device **400** may be configured to use any one or more communication technologies (e.g., wireless or wired communications) and associated protocols (e.g., Ethernet, Bluetooth®,

Wi-Fi®, WiMAX, etc.) to effect such communication depending on the particular computing device **400**. The input/output device **404** may include hardware, software, and/or firmware suitable for performing the techniques described herein.

[0103] The external device **410** may be any type of device that allows data to be inputted or outputted from the computing device **400**. For example, in various embodiments, the external device **410** may be embodied as one or more of the devices/systems described herein, and/or a portion thereof. Further, in some embodiments, the external device **410** may be embodied as another computing device, switch, diagnostic tool, controller, printer, display, alarm, peripheral device (e.g., keyboard, mouse, touch screen display, etc.), and/or any other computing, processing, and/or communication device capable of performing the functions described herein. Furthermore, in some embodiments, it should be appreciated that the external device **410** may be integrated into the computing device **400**.

[0104] The processing device **402** may be embodied as any type of processor(s) capable of performing the functions described herein. In particular, the processing device **402** may be embodied as one or more single or multi-core processors, microcontrollers, or other processor or processing/controlling circuits. For example, in some embodiments, the processing device **402** may include or be embodied as an arithmetic logic unit (ALU), central processing unit (CPU), digital signal processor (DSP), graphics processing unit (GPU), field-programmable gate array (FPGA), application-specific integrated circuit (ASIC), and/or another suitable processor(s). The processing device **402** may be a programmable type, a dedicated hardwired state machine, or a combination thereof. Processing devices **402** with multiple processing units may utilize distributed, pipelined, and/or parallel processing in various embodiments. Further, the processing device **402** may be dedicated to performance of just the operations described herein, or may be utilized in one or more additional applications. In the illustrative embodiment, the processing device **402** is programmable and executes algorithms and/or processes data in accordance with operating logic **408** as defined by programming instructions (such as software or firmware) stored in memory **406**. Additionally or alternatively, the operating logic **408** for processing device **402** may be at least partially defined by hardwired logic or other hardware. Further, the processing device **402** may include one or more components of any type suitable to process the signals received from input/output device **404** or from other components or devices and to provide desired output signals. Such components may include digital circuitry, analog circuitry, or a combination thereof.

[0105] The memory **406** may be of one or more types of non-transitory computer-readable media, such as a solid-state memory, electromagnetic memory, optical memory, or a combination thereof. Furthermore, the memory **406** may be volatile and/or nonvolatile and, in some embodiments, some or all of the memory **406** may be of a portable type, such as a disk, tape, memory stick, cartridge, and/or other suitable portable memory. In operation, the memory **406** may store various data and software used during operation of the computing device **400** such as operating systems, applications, programs, libraries, and drivers. It should be appreciated that the memory **406** may store data that is manipulated by the operating logic **408** of processing device **402**, such as, for example, data representative of signals received from and/or sent to the input/output device **404** in addition to or in lieu of storing programming instructions defining operating logic **408**. As shown in FIG. **4**, the memory **406** may be included with the processing device **402** and/or coupled to the processing device **402** depending on the particular embodiment. For example, in some embodiments, the processing device **402**, the memory **406**, and/or other components of the computing device **400** may form a portion of a system-on-a-chip (SoC) and be incorporated on a single integrated circuit chip.

[0106] In some embodiments, various components of the computing device **400** (e.g., the processing device **402** and the memory **406**) may be communicatively coupled via an input/output subsystem, which may be embodied as circuitry and/or components to facilitate input/output operations with the processing device **402**, the memory **406**, and other components of the computing device **400**. For example, the input/output subsystem may be embodied as, or otherwise include, memory controller hubs, input/output control hubs, firmware devices, communication links (i.e., point-to-point links, bus links, wires, cables, light guides, printed circuit board traces, etc.) and/or other components and subsystems to facilitate the input/output operations.

[0107] The computing device **400** may include other or additional components, such as those commonly found in a typical computing device (e.g., various input/output devices and/or other components), in other embodiments. It should be further appreciated that one or more of the components of the computing device **400** described herein may be distributed across multiple computing devices. In other words, the techniques described herein may be employed by a computing system that includes one or more computing devices. Additionally, although only a single processing device **402**, I/O device **404**, and memory **406** are illustratively shown in FIG. **4**, it should be appreciated that a particular computing device **400** may include multiple processing devices **402**, I/O devices **404**, and/or memories **406** in other embodiments. Further, in some embodiments, more than one external device **410** may be in communication with the computing device **400**.

[0108] The computing device **400** may be one of a plurality of devices connected by a network or connected to other systems/resources via a network. The network may be embodied as any one or more types of communication networks that are capable of facilitating communication between the various devices communicatively connected via the network. As such, the network may include one or more networks, routers, switches, access points, hubs, computers, client devices, endpoints, nodes, and/or other intervening network devices. For example, the network may be embodied as or otherwise include one or more cellular networks, telephone networks, local or wide area networks, publicly available global networks (e.g., the Internet), ad hoc networks, short-range communication links, or a combination thereof. In some embodiments, the network may include a circuit-switched voice or data network, a packet-switched voice or data network, and/or any other network able to carry voice and/or data. In particular, in some embodiments, the network may include Internet Protocol (IP)-based and/or asynchronous transfer mode (ATM)-based networks. In some embodiments, the network may handle voice traffic (e.g., via a Voice over IP (VOIP) network), web traffic, and/or other network traffic depending on the particular

embodiment and/or devices of the system in communication with one another. In various embodiments, the network may include analog or digital wired and wireless networks (e.g., IEEE 802.11 networks, Public Switched Telephone Network (PSTN), Integrated Services Digital Network (ISDN), and Digital Subscriber Line (xDSL)), Third Generation (3G) mobile telecommunications networks, Fourth Generation (4G) mobile telecommunications networks, Fifth Generation (5G) mobile telecommunications networks, a wired Ethernet network, a private network (e.g., such as an intranet), radio, television, cable, satellite, and/or any other delivery or tunneling mechanism for carrying data, or any appropriate combination of such networks. It should be appreciated that the various devices/systems may communicate with one another via different networks depending on the source and/or destination devices/systems.

[0109] It should be appreciated that the computing device **400** may communicate with other computing devices **400** via any type of gateway or tunneling protocol such as secure socket layer or transport layer security. The network interface may include a built-in network adapter, such as a network interface card, suitable for interfacing the computing device to any type of network capable of performing the operations described herein. Further, the network environment may be a virtual network environment where the various network components are virtualized. For example, the various machines may be virtual machines implemented as a software-based computer running on a physical machine. The virtual machines may share the same operating system, or, in other embodiments, different operating system may be run on each virtual machine instance. For example, a "hypervisor" type of virtualizing is used where multiple virtual machines run on the same host physical machine, each acting as if it has its own dedicated box. Other types of virtualization may be employed in other embodiments, such as, for example, the network (e.g., via software defined networking) or functions (e.g., via network functions virtualization).

[0110] Accordingly, one or more of the computing devices **400** described herein may be embodied as, or form a portion of, one or more cloud-based systems. In cloud-based embodiments, the cloud-based system may be embodied as a server-ambiguous computing solution, for example, that executes a plurality of instructions on-demand, contains logic to execute instructions only when prompted by a particular activity/trigger, and does not consume computing resources when not in use. That is, system may be embodied as a virtual computing environment residing "on" a computing system (e.g., a distributed network of devices) in which various virtual functions (e.g., Lambda functions, Azure functions, Google cloud functions, and/or other suitable virtual functions) may be executed corresponding with the functions of the system described herein. For example, when an event occurs (e.g., data is transferred to the system for handling), the virtual computing environment may be communicated with (e.g., via a request to an API of the virtual computing environment), whereby the API may route the request to the correct virtual function (e.g., a particular server-ambiguous computing resource) based on a set of rules. As such, when a request for the transmission of data is made by a user (e.g., via an appropriate user interface to the system), the appropriate virtual function(s) may be executed to perform the actions before eliminating the instance of the virtual function(s).

[0111] Referring now to FIG. **5**, in use, a computing system (e.g., the system **100**, the cloud-based system **102**, the contact center system **106**, the user device **108**, the artificial intelligence system **110**, the agent device **112**, and/or other computing devices described herein) may execute a method **500** for complexity assessments for agent performance analysis using memory neural networks. In the illustrative embodiment, it should be appreciated that the method **500** of FIGS. **5-7** may be executed, in full or in part, by the artificial intelligence system **110** of the system **100**. It should be appreciated that the particular blocks of the method **500** are illustrated by way of example, and such blocks may be combined or divided, added or removed, and/or reordered in whole or in part depending on the particular embodiment, unless stated to the contrary.

[0112] The illustrative method **500** begins with block **502** of FIG. **5** in which the computing system initializes neural network data (e.g., a set of variables and initial values). For example, in the illustrative embodiment, the neural network data includes a score variable (e.g., initialized to zero), a topics variable (e.g., initialized as an empty array, [ ]), a call number variable (e.g., initialized as one), a total number of calls variable (e.g., initialized to be the number of calls within the selected duration for analysis), a new entry variable (e.g., initialized as an empty array, [ ]), a query number variable (e.g., initialized as one), and a total number of queries variable (e.g., initialized as one, subject to subsequent modification based on the particular call). It should be appreciated that additional and/or alternative variables may be initialized in other embodiments. The call number variable may be incremented each time a call recording is analyzed, and the call number variable may be compared to the total number of calls variable to determine whether each call has been analyzed. Similarly, the query number variable may be incremented each time a query is analyzed, and the query number variable may be compared to the total number of queries variable to determine whether each query/issue has been analyzed. The score variable may be used to store the total performance score of the agent; in some embodiments, various intermediate variables may be used as well. The topics variable may be used to store each of the topics (e.g., each issue, issue-solution, etc.) for which the agent performed unsatisfactorily. The new entry variable may be used to store each of the new topics (e.g., each issue, issue-solution, etc.) for which the memory of the neural network (and therefore the knowledgebase) has no stored solution. It should be appreciated that the neural network and the knowledgebase may be periodically synchronized.

[0113] In block **504**, the computing system retrieves or otherwise receives a recording of a call between a contact center agent and a user. For example, in some embodiments, the computing system retrieves the call recording from a list of calls based on an index value present in the all number variable.

[0114] In block **506**, the computing system generates a conversation summary of the recorded call and, in block **508**, the computing system generates key-value pairs of issues and solutions (e.g., issue-solution pairs) based on the generated conversation summary, and stores the key-value pairs in the memory of the neural network. For example, as described above, suppose that a user has initiated a call for a problem related to slow internet speed, and the contact center agent has provided a solution of changing the router configurations. The user has made the suggested changes,

and the issue has resolved. When processing the exemplary call, the computing system may categorize the issues and solutions in respective arrays (e.g., issues: [slow internet speed]; solutions: [change the router configurations]), create a key-value pair from the obtained arrays (e.g., [{'slow internet speed': 'change the router configurations'}]), and store the key-value pair and the issues and solutions array in the memory of the neural network. It should be appreciated that each conversation may have a different number of issues that are raised by the user. Accordingly, in some embodiments, the computing system may initialize the query number variable (e.g., to one) and initialize the total number of queries variable (e.g., to the number of queries identified from the conversation summary) as described above.

[0115] In block **510**, the computing system selects an issue keyword (e.g., an issue from the issue-solution pairs generated by the computing system) for evaluation and, in block **512**, the computing system determines whether the selected issue keyword is stored in the memory of the neural network. It should be appreciated that the memory of the neural network includes pre-trained data from a knowledgebase that has solutions for particular issues. Accordingly, the computing system is able to search for particular issue keywords in the memory of the neural network to determine whether any solutions match the provided keywords.

[0116] If the computing system determines, in block **514**, that the selected issue keyword is stored in the memory of the neural network, the method **500** advances to block **520** in which the computing system analyzes the conversation summary to determine an agent performance category for the selected issue. In block **522**, the computing system determines an issue score for the agent response based on the agent performance category for the selected issue.

[0117] In other words, in some embodiments, the computing system analyzes the conversation summary to determine how the contact center agent handled the call, the effectiveness at which the call was handled, the efficiency at which the call was handled, and/or other characteristics associated with the agent's handling of the call. It should be appreciated that the number of agent performance categories and the classification criteria associated with each of the agent performance categories may vary depending on the particular embodiment. It should be further appreciated that each agent performance category is associated with a particular score, which is returned by the artificial intelligence system.

[0118] In the illustrative embodiment, the computing system utilizes seven different agent performance categories: a first agent performance category indicating that the contact center agent was unable to provide an answer and having a score of 0, a second agent performance category indicating that the contact center agent was unable to understand the user query and the user disconnected the call and having a score of 0, a third agent performance category indicating that the contact center agent transferred the call to another agent due to a lack of knowledge and having a score of 1, a fourth agent performance category indicating that the contact center agent crossed a threshold time and was unable to answer the user's query properly and having a score of 2, a fifth agent performance category indicating that the contact center agent tried to provide a solution to the user but the solution was not satisfactory to the user and having a score of 3, a sixth agent performance category indicating that the contact center agent provided an optimum solution to the user's query but did so in an amount of time that exceeded the threshold time and having a score of 4, and a seventh agent performance category indicating that the contact center agent provided an optimum solution to the user's query within the threshold time and having a score of 5. It should be appreciated that the threshold time described in reference to the agent performance categories is a predefined maximum period of time during which a contact center agent is expected to answer a user query, which may be defined by the contact center. For example, in some embodiments, the threshold time may be ten minutes.

[0119] In block **524**, the computing system adds the issue score to the cumulative call score. In other words, in the illustrative embodiment, the issue score associated with the agent performance categorization of each issue represented in a particular call may be added to generate the cumulative call score. It should be appreciated that the cumulative call score may be otherwise generated based on the respective issue scores in other embodiments. Further, in an embodiment in which only one issue is present, the cumulative call score and issue score may be the same score.

[0120] In block **526**, the computing system determines whether the issue score exceeds a predefined score threshold. For example, in the embodiment described above, the computing system may establish a predefined score threshold of 3 such that issue scores of 4 and 5 exceed the predefined score threshold, whereas scores of 0, 1, 2, and 3 do not exceed the predefined score threshold. It should be appreciated that the predefined score threshold may be configured by the contact center.

[0121] If the computing system determines, in block **528**, that the predefined score threshold is not exceeded, the method **500** advances to block **530** in which the computing system adds the issue keyword to the topics array. In other words, the computing system determines that the contact center agent performed unsatisfactorily with respect to addressing the issue associated with the issue keyword, so the issue keyword is added to the topics array. The method **500** advances to block **536** of FIG. **7** in which the computing system determines whether any issue keywords remain for analysis. However, if the computing system determines, in block **528**, that the predefined score threshold is exceeded, the method **500** advances to block **536** of FIG. **7** in which the computing system determines whether any issue keywords remain for analysis. In other words, the computing system does not add the issue keyword to the topics array when the computing system determines that the contact center has performed satisfactorily with respect to addressing the issue associated with the issue keyword.

[0122] Returning to block **514** of FIG. **5**, if the computing system determines that the selected issue keyword is not stored in the memory of the neural network, then the method **500** advances to block **516** in which the computing system assigns a predefined value to the issue score for the agent response. In particular, in block **518**, the computing system may assign the maximum score possible (or other satisfactory score) to the issue score in some embodiments. In the embodiment described above, the computing system may assign a value of 5 to the issue score. Suppose the contact center received a query that is not present in the knowledgebase and, therefore, not stored in the memory of the neural network. By assigning the maximum (or other satisfactory) score to the issue score, the computing system ensures that

the contact center agent is not punished for not being able to answer a user query that is not even addressed by the contact center knowledgebase.

[0123] In some embodiments, however, skilled agents may actually be able to answer the user query, in which case that answer may be recorded and saved for supervisor review and potential addition to the knowledgebase. Accordingly, the method **500** advances to block **532** of FIG. **7** in which the computing system stores details of the conversation in a new entry array (e.g., including the agent's solution for the issue). If the contact center agent was unable to answer the query, the relevant issue keyword may be stored to the new entry array without a corresponding solution.

[0124] In block **534**, the computing system adds the issue score to the cumulative call score. As described above, in the illustrative embodiment, the issue score associated with the agent performance categorization of each issue represented in a particular call may be added to generate the cumulative call score. It should be appreciated that the cumulative call score may be otherwise generated based on the respective issue scores in other embodiments.

[0125] As indicated above, in block **536**, the computing system determines whether any issue keywords remain for analysis. If so, the method **500** returns to block **510** in which the computing system selects another issue keyword for evaluation. If the computing system determines, in block **536**, that no issue keywords remain for analysis, the method **500** advances to block **538** in which the computing system generates an overall call score based on the cumulative call score. For example, in some embodiments, the overall call score may be an average of the issue scores (e.g., determined by dividing the cumulative call score by the number of queries/issues stored in the total number of queries variable). In other embodiments, the computing system may store the individual issue scores and calculate the overall call score directly.

[0126] In block **540**, the computing system determines whether any call recordings remain for analysis. If so, the method **500** returns to block **504** of FIG. **5** in which the computing system retrieves the call recording of another call between the contact center agent and a user. However, if the computing system determines, in block **540**, that no call recordings remain for analysis, the method **500** advances to block **542** in which the computing system generates and/or transmits a report indicative of the performance of the contact center agent based on the analysis described herein.

[0127] In doing so, in block **544**, the computing system may generate a total performance score for the contact center agent. For example, in some embodiments, the total performance score may be an average of the overall call scores. In other embodiments, the total performance score may be otherwise determined. In block **546**, the computing system may provide the topics array generated by the computing system. As described above, the topics array may include each issue keyword associated with an issue the contact center agent was not able to satisfactorily handle. In block **548**, the computing system may provide the new entry array generated by the computing system. As described above, the new entry array may include each issue keyword associated with issues/keywords that had no data stored in the memory of the neural network and, therefore, not stored in the contact center knowledgebase. If the agent was able to provide a solution, the solution is stored as well.

[0128] It should be appreciated that the report may be generated in any suitable format and/or transmitted using any suitable technologies. For example, in some embodiments, the report is transmitted to the agent's supervisor. The agent's supervisor may check the keywords and confirm the accuracy of any solutions provided in the new entry array, and update the contact center knowledgebase and/or neural network accordingly.

[0129] Although the blocks **502-548** are described in a relatively serial manner, it should be appreciated that various blocks of the method **500** may be performed in parallel in some embodiments.

[0130] FIG. **8** includes an example list **800** of recorded calls and at least a portion of an example agent performance report **802** generated based on the list of recorded calls. It should be appreciated that the illustrative agent performance report **802** identifies the call scores for each of the calls identified in the list **800**.

What is claimed is:

1. A method for complexity assessments for agent performance analysis using a memory neural network, the method comprising:

receiving, by a computing system, a plurality of call recordings of calls between a contact center agent and one or more users;

generating, by the computing system for each call recording of the plurality of call recordings, a respective conversation summary of the call recording;

analyzing, by the computing system, each respective conversation summary using the memory neural network to determine a respective agent performance category for performance of the contact center agent during the respective call, wherein each respective agent performance category is selected from a plurality of predefined agent performance categories and is associated with a respective call score;

comparing, by the computing system, the respective call score for each determined respective agent performance category to a predefined threshold value and updating a topics array based on the respective conversation summary in response to determining that the respective call score is below the predefined threshold value; and

determining, by the computing system, a total performance score for the contact center agent based on each respective call score.

2. The method of claim **1**, wherein analyzing each respective conversation summary using the memory neural network comprises generating one or more issue-solution key-value pairs using the memory neural network based on the respective conversation summary.

3. The method of claim **2**, wherein analyzing each respective conversation summary using the memory neural network comprises determining a respective issue-specific agent performance category for performance of the contact center agent during the respective call with respect to each issue of the one or more issue-solution key value pairs generated using the memory neural network, wherein each respective issue-specific agent performance category is associated with a respective issue score.

4. The method of claim **3**, wherein updating the topics array based on the respective conversation summary comprises updating the topics array to include a particular issue

in response to determining that the respective issue score is below the predefined threshold value.

5. The method of claim **4**, wherein the respective call score is based on each respective issue score.

6. The method of claim **2**, further comprising:

determining, by the computing system, that a particular issue of the one or more issue-solution key-value pairs is not stored in a memory associated with the memory neural network; and

storing, by the computing system, data associated with the particular issue in a new entry array in response to determining that the particular issue is not stored in the memory associated with the memory neural network.

7. The method of claim **6**, further comprising generating, by the computing system, a report based on the agent performance analysis using the memory neural network; and

wherein the report includes the total performance score, the topics array, and the new entry array.

8. The method of claim **1**, wherein the memory neural network comprises a long short-term memory neural network.

9. The method of claim **1**, wherein the memory neural network comprises a primary recurrent neural network and a secondary recurrent neural network.

10. The method of claim **9**, wherein analyzing each respective conversation summary using the memory neural network to determine the respective agent performance category for performance of the contact center agent during the respective call comprises analyzing each respective conversation summary using the secondary recurrent neural network to determine the respective agent performance category for performance of the contact center agent during the respective call.

11. A computing system for complexity assessments for agent performance analysis using a memory neural network, the computing system comprising:

at least one processor; and

at least one memory comprising a plurality of instructions stored thereon that, in response to execution by the at least one processor, causes the computing system to:

receive a plurality of call recordings of calls between a contact center agent and one or more users;

generate, for each call recording of the plurality of call recordings, a respective conversation summary of the call recording;

analyze each respective conversation summary using the memory neural network to determine a respective agent performance category for performance of the contact center agent during the respective call, wherein each respective agent performance category is selected from a plurality of predefined agent performance categories and is associated with a respective call score;

compare the respective call score for each determined respective agent performance category to a predefined threshold value and update a topics array based on the respective conversation summary in response to a determination that the respective call score is below the predefined threshold value; and

determine a total performance score for the contact center agent based on each respective call score.

12. The computing system of claim **11**, wherein to analyze each respective conversation summary using the memory neural network comprises to generate one or more issue-solution key-value pairs using the memory neural network based on the respective conversation summary.

13. The computing system of claim **12**, wherein to analyze each respective conversation summary using the memory neural network comprises to determine a respective issue-specific agent performance category for performance of the contact center agent during the respective call with respect to each issue of the one or more issue-solution key value pairs generated using the memory neural network, wherein each respective issue-specific agent performance category is associated with a respective issue score.

14. The computing system of claim **13**, wherein to update the topics array based on the respective conversation summary comprises to update the topics array to include a particular issue in response to determining that the respective issue score is below the predefined threshold value.

15. The computing system of claim **14**, wherein the respective call score is based on each respective issue score.

16. The computing system of claim **12**, wherein the plurality of instructions further causes the computing system to:

determine that a particular issue of the one or more issue-solution key-value pairs is not stored in a memory associated with the memory neural network; and

store data associated with the particular issue in a new entry array in response to a determination that the particular issue is not stored in the memory associated with the memory neural network.

17. The computing system of claim **16**, wherein the plurality of instructions further causes the computing system to generate a report based on the agent performance analysis using the memory neural network; and

wherein the report includes the total performance score, the topics array, and the new entry array.

18. The computing system of claim **11**, wherein the memory neural network comprises a long short-term memory neural network.

19. The computing system of claim **11**, wherein the memory neural network comprises a primary recurrent neural network and a secondary recurrent neural network.

20. The computing system of claim **19**, wherein to analyze each respective conversation summary using the memory neural network to determine the respective agent performance category for performance of the contact center agent during the respective call comprises to analyze each respective conversation summary using the secondary recurrent neural network to determine the respective agent performance category for performance of the contact center agent during the respective call.

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