US 20250258825A1

(19) **United States**

(12) **Patent Application Publication** (10) **Pub. No.: US 2025/0258825 A1**

KRISHNAN et al. (43) **Pub. Date: Aug. 14, 2025**

(54) **METHOD, APPARATUS, AND COMPUTER-READABLE MEDIUM FOR RETRIEVAL AUGMENTED GENERATION OF OPTIMAL CODING**

(71) Applicant: **LateralCare Inc.**, Southlake, TX (US)

(72) Inventors: **Sowri KRISHNAN**, Southlake, TX (US); **Manikandan NEDUNCHELIAN**, Southlake, TX (US)

(21) Appl. No.: **19/049,518**

(22) Filed: **Feb. 10, 2025**

Related U.S. Application Data

(60) Provisional application No. 63/551,702, filed on Feb. 9, 2024.

Publication Classification

(51) **Int. Cl.**

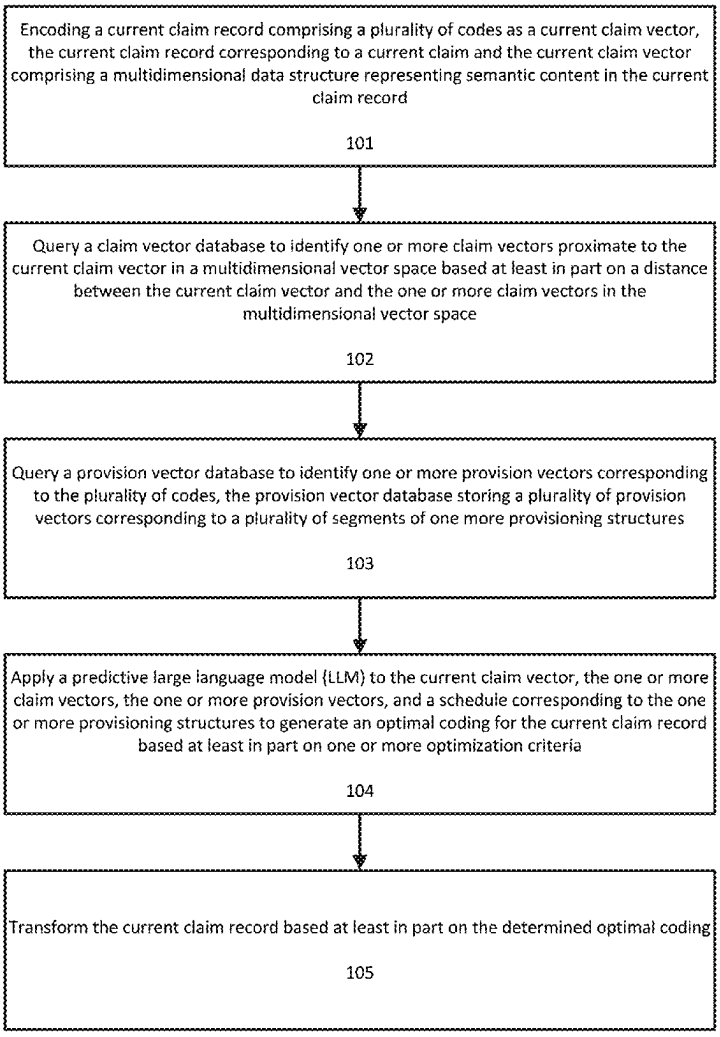
G06F 16/2455	(2019.01)
G06F 16/22	(2019.01)
G16H 10/60	(2018.01)

(52) **U.S. Cl.**

CPC ***G06F 16/2455*** (2019.01); ***G06F 16/2237*** (2019.01); ***G16H 10/60*** (2018.01)

(57) **ABSTRACT**

An apparatus, computer-readable medium, and computer-implemented method retrieval augmented generation of optimal coding, including encoding a current claim record comprising codes as a current claim vector, querying a claim vector database to identify claim vectors proximate to the current claim, querying a provision vector database to identify provision vectors corresponding to the codes, applying a predictive large language model (LLM) to the current claim vector, the claim vectors, the provision vectors, and a schedule corresponding to the provisioning structures to generate an optimal coding for the current claim record based on optimization criteria, and transforming the current claim record based at least in part on the determined optimal coding



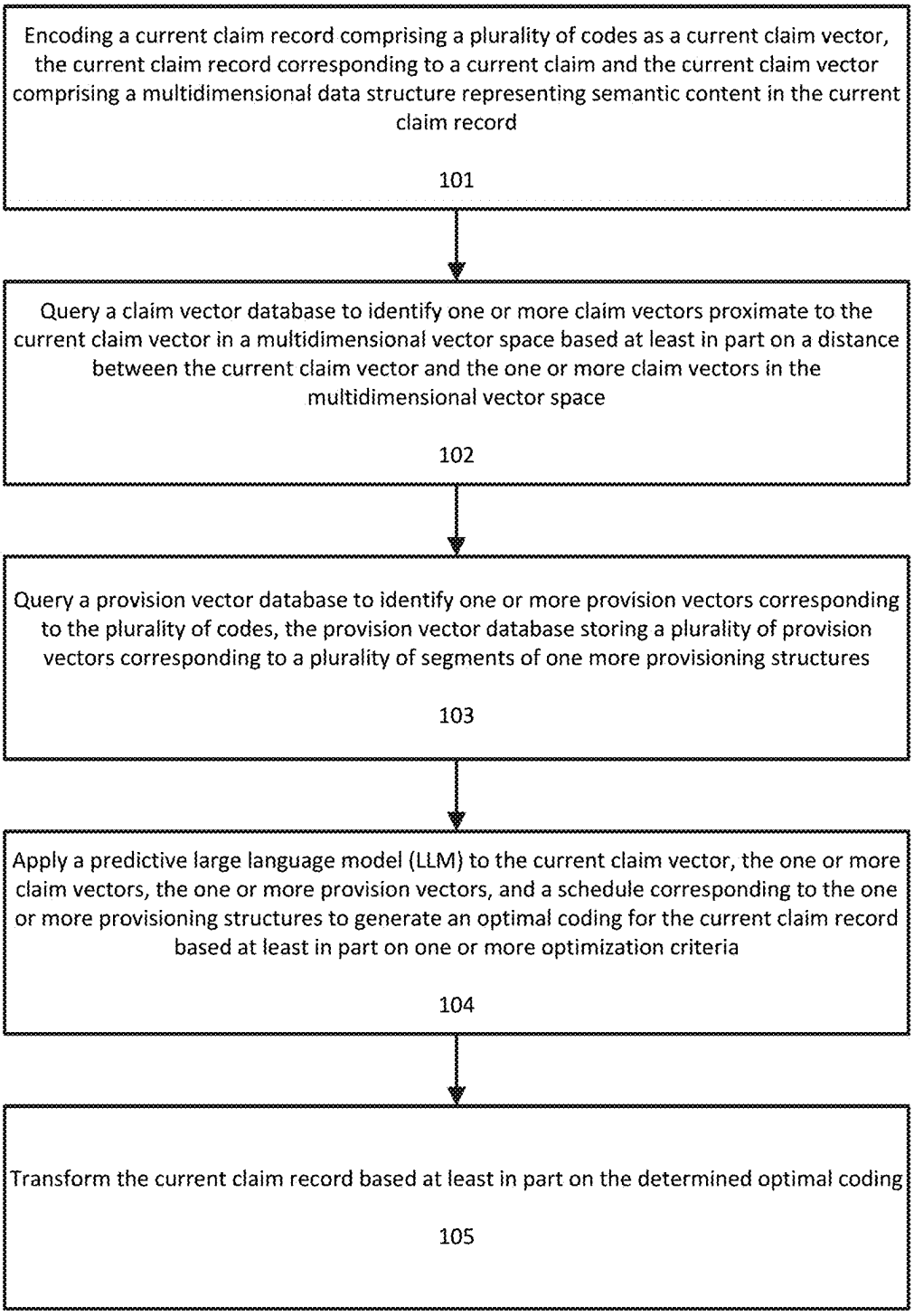

Encoding a current claim record comprising a plurality of codes as a current claim vector, the current claim record corresponding to a current claim and the current claim vector comprising a multidimensional data structure representing semantic content in the current claim record
101
Query a claim vector database to identify one or more claim vectors proximate to the current claim vector in a multidimensional vector space based at least in part on a distance between the current claim vector and the one or more claim vectors in the multidimensional vector space
102
Query a provision vector database to identify one or more provision vectors corresponding to the plurality of codes, the provision vector database storing a plurality of provision vectors corresponding to a plurality of segments of one more provisioning structures
103
Apply a predictive large language model (LLM) to the current claim vector, the one or more claim vectors, the one or more provision vectors, and a schedule corresponding to the one or more provisioning structures to generate an optimal coding for the current claim record based at least in part on one or more optimization criteria
104
Transform the current claim record based at least in part on the determined optimal coding
105

Fig. 1

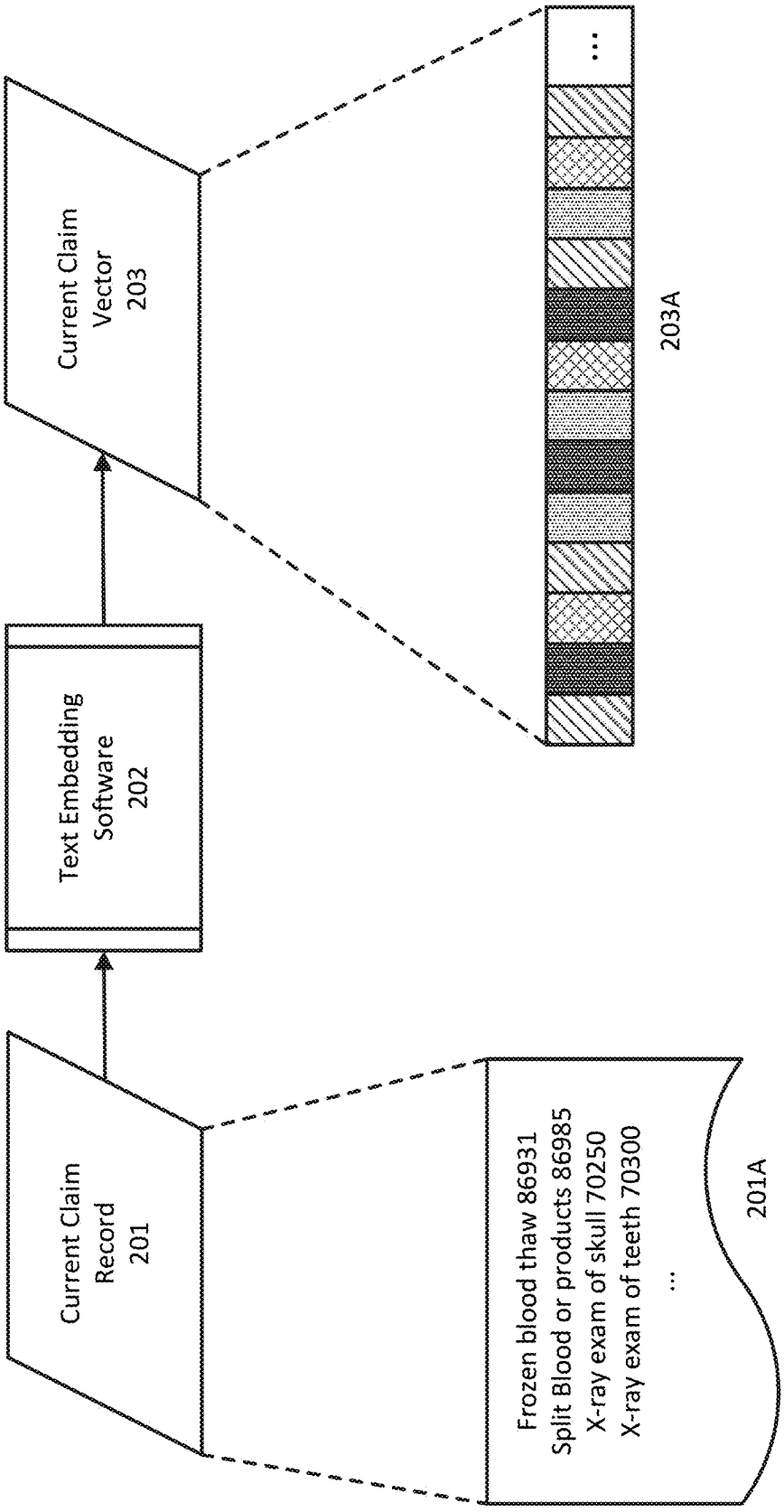

Current Claim Record 201
Frozen blood thaw 86931
Split Blood or products 86985
X-ray exam of skull 70250
X-ray exam of teeth 70300
...
201A
Text Embedding Software 202
Current Claim Vector 203
...
203A

Fig. 2

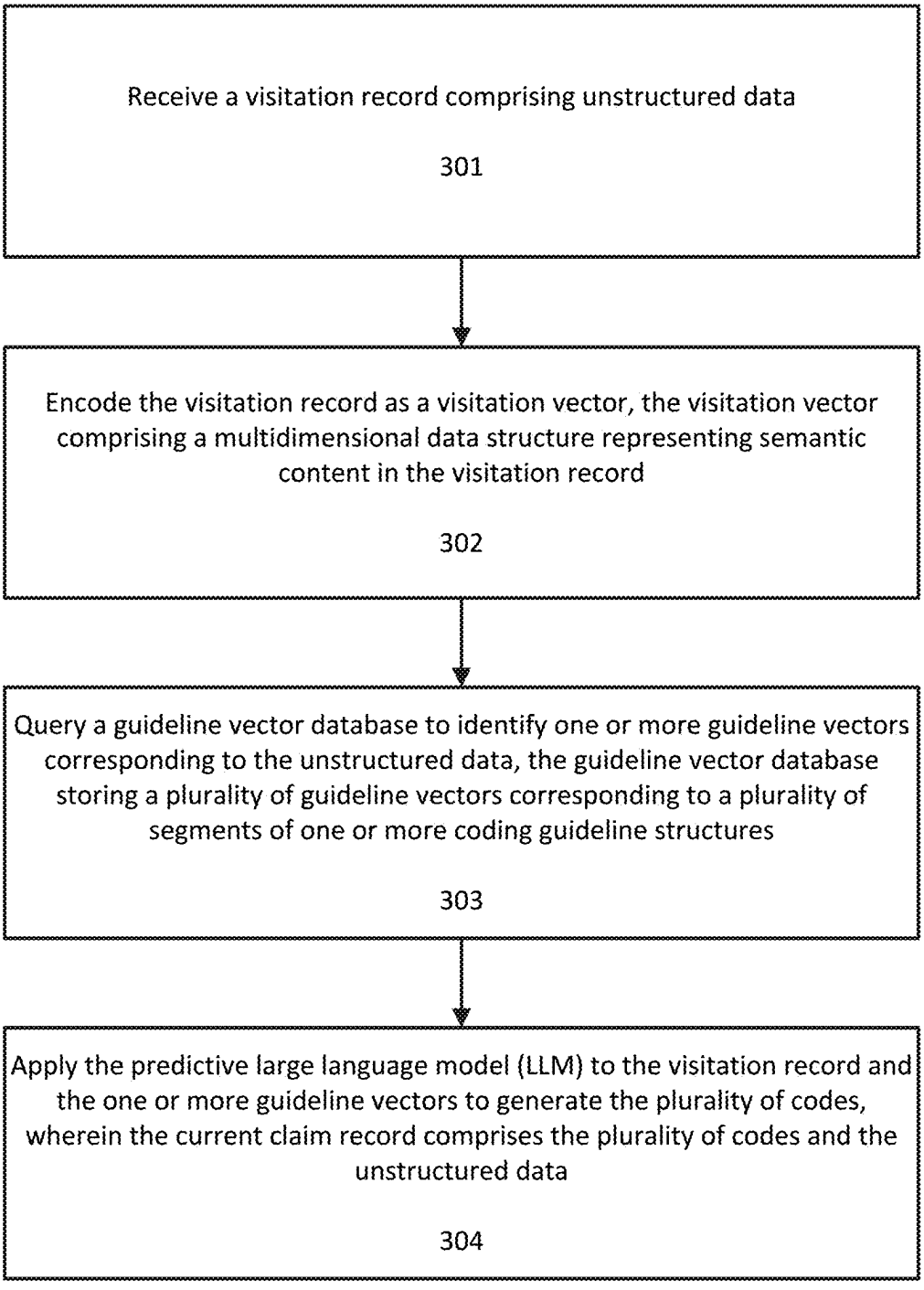

Receive a visitation record comprising unstructured data
301
Encode the visitation record as a visitation vector, the visitation vector comprising a multidimensional data structure representing semantic content in the visitation record
302
Query a guideline vector database to identify one or more guideline vectors corresponding to the unstructured data, the guideline vector database storing a plurality of guideline vectors corresponding to a plurality of segments of one or more coding guideline structures
303
Apply the predictive large language model (LLM) to the visitation record and the one or more guideline vectors to generate the plurality of codes, wherein the current claim record comprises the plurality of codes and the unstructured data
304

Fig. 3

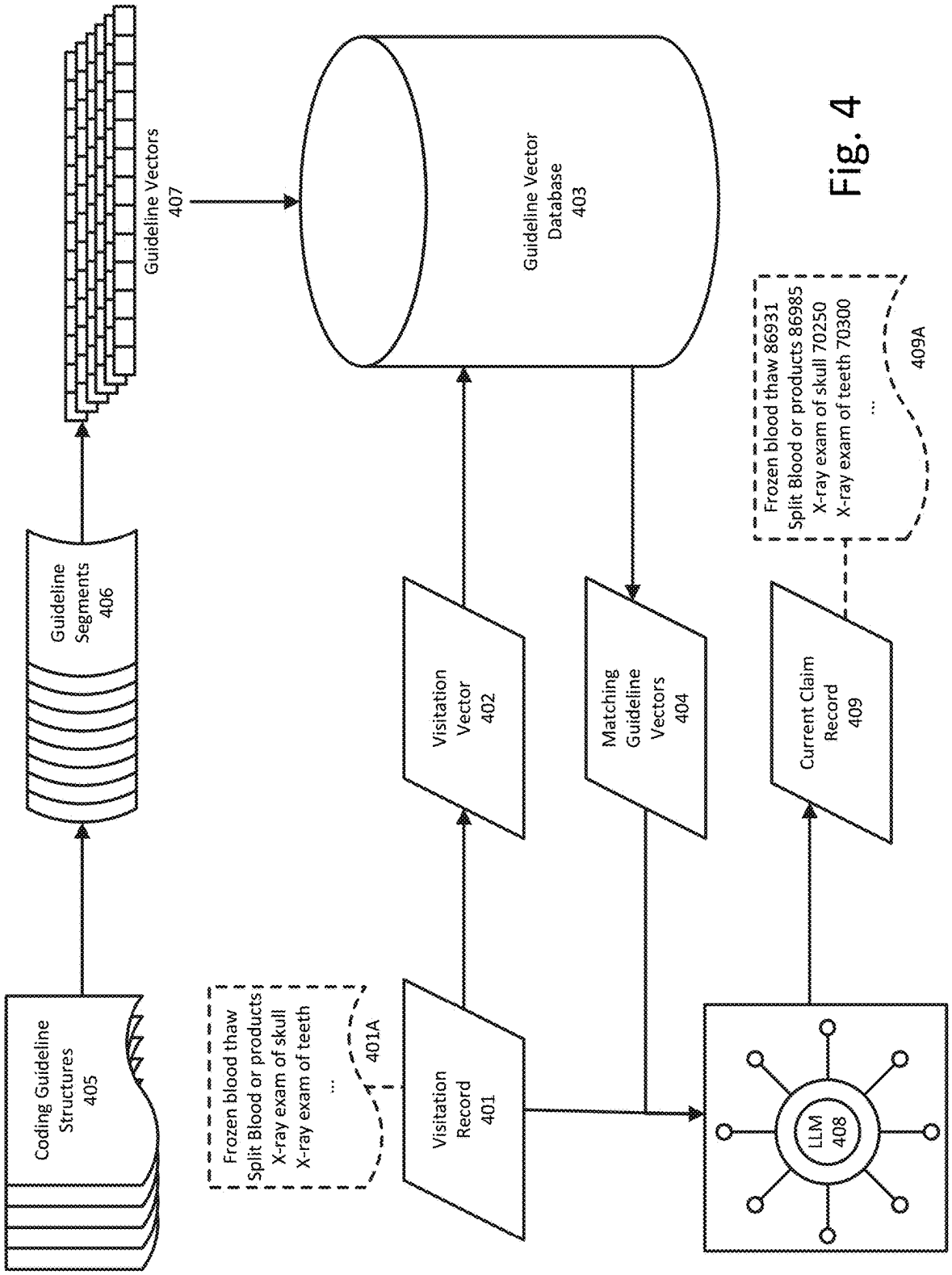

Coding Guideline Structures 405
Guideline Segments 406
Guideline Vectors 407
Guideline Vector Database 403
Visitation Record 401
Frozen blood thaw
Split Blood or products
X-ray exam of skull
X-ray exam of teeth
...
401A
Visitation Vector 402
Matching Guideline Vectors 404
LLM 408
Current Claim Record 409
Frozen blood thaw 86931
Split Blood or products 86985
X-ray exam of skull 70250
X-ray exam of teeth 70300
...
409A

Fig. 4

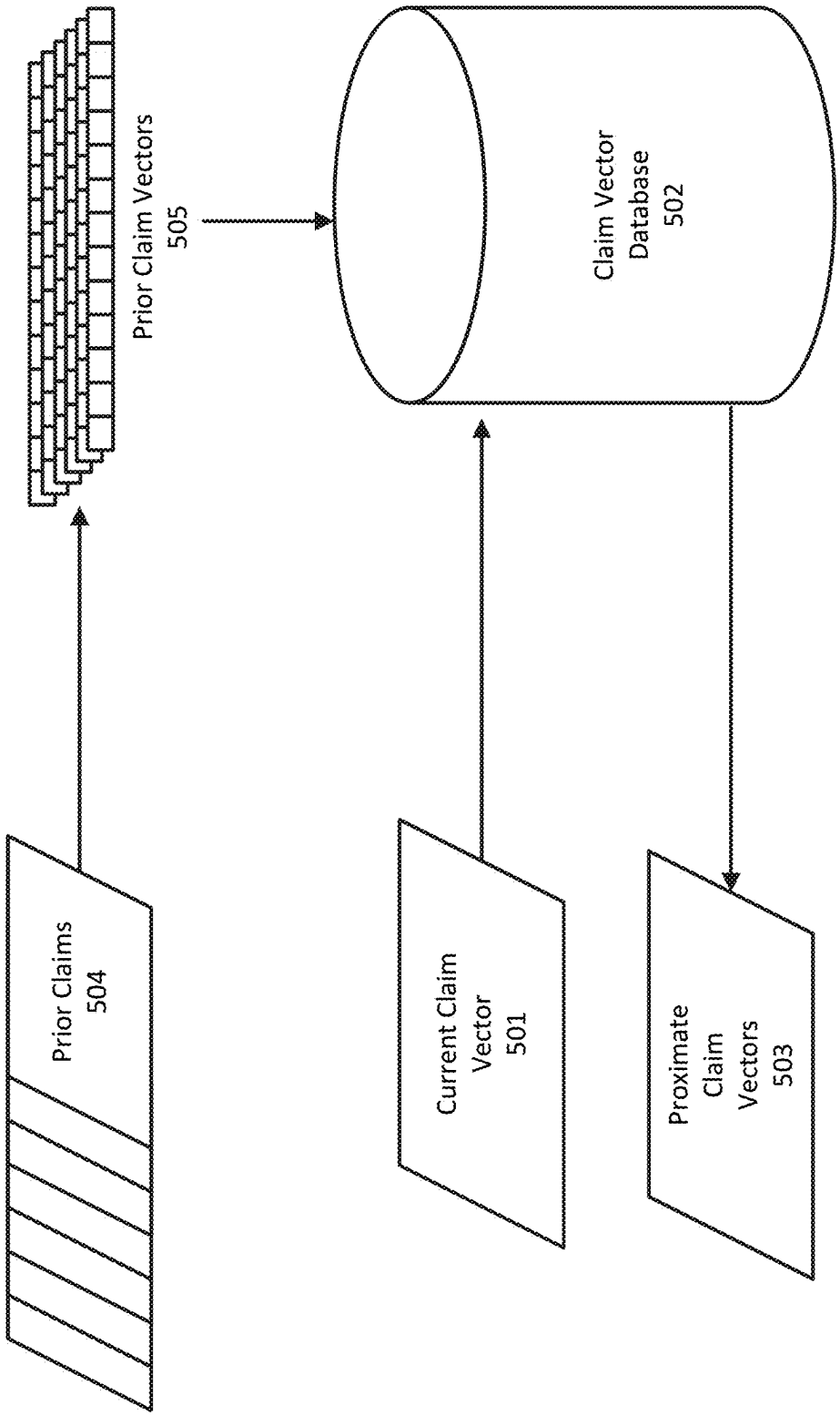

Prior Claim Vectors
505
Claim Vector
Database
502
Prior Claims
504
Current Claim
Vector
501
Proximate
Claim
Vectors
503

Fig. 5

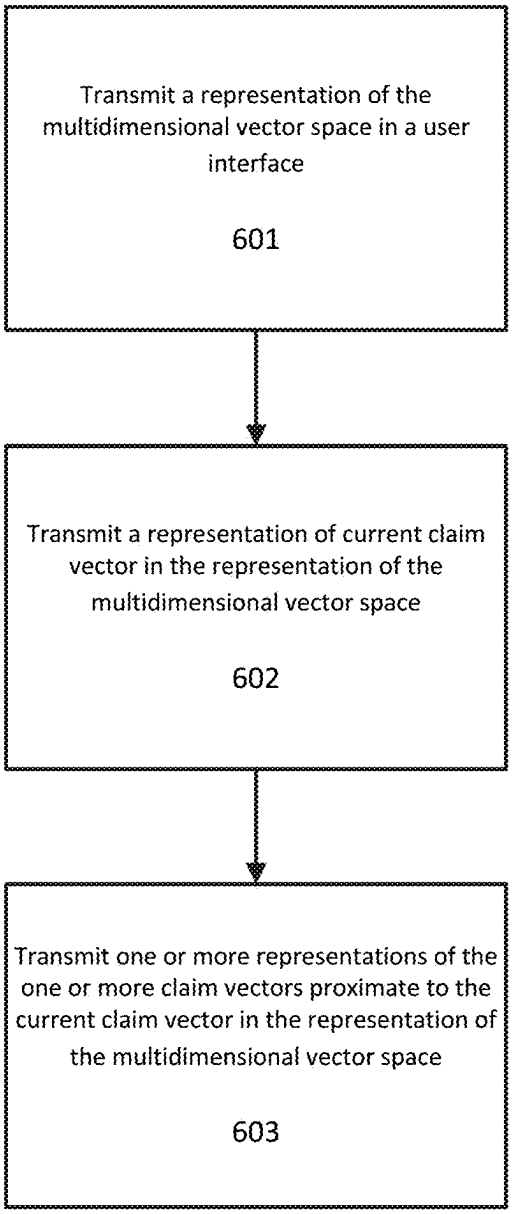

Transmit a representation of the multidimensional vector space in a user interface
601
Transmit a representation of current claim vector in the representation of the multidimensional vector space
602
Transmit one or more representations of the one or more claim vectors proximate to the current claim vector in the representation of the multidimensional vector space
603

Fig. 6A

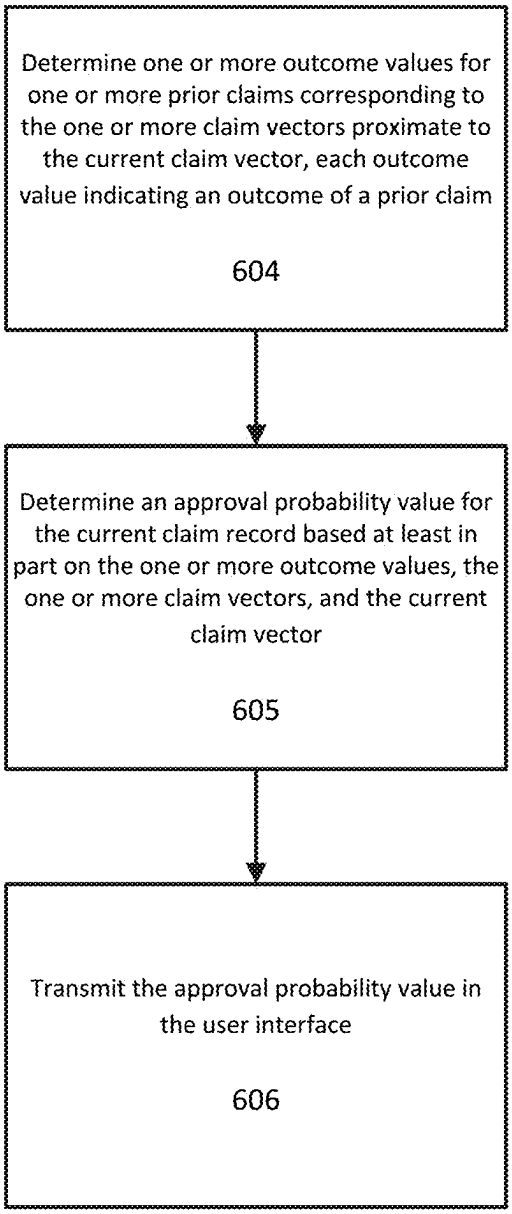

Determine one or more outcome values for one or more prior claims corresponding to the one or more claim vectors proximate to the current claim vector, each outcome value indicating an outcome of a prior claim
604
Determine an approval probability value for the current claim record based at least in part on the one or more outcome values, the one or more claim vectors, and the current claim vector
605
Transmit the approval probability value in the user interface
606

Fig. 6B

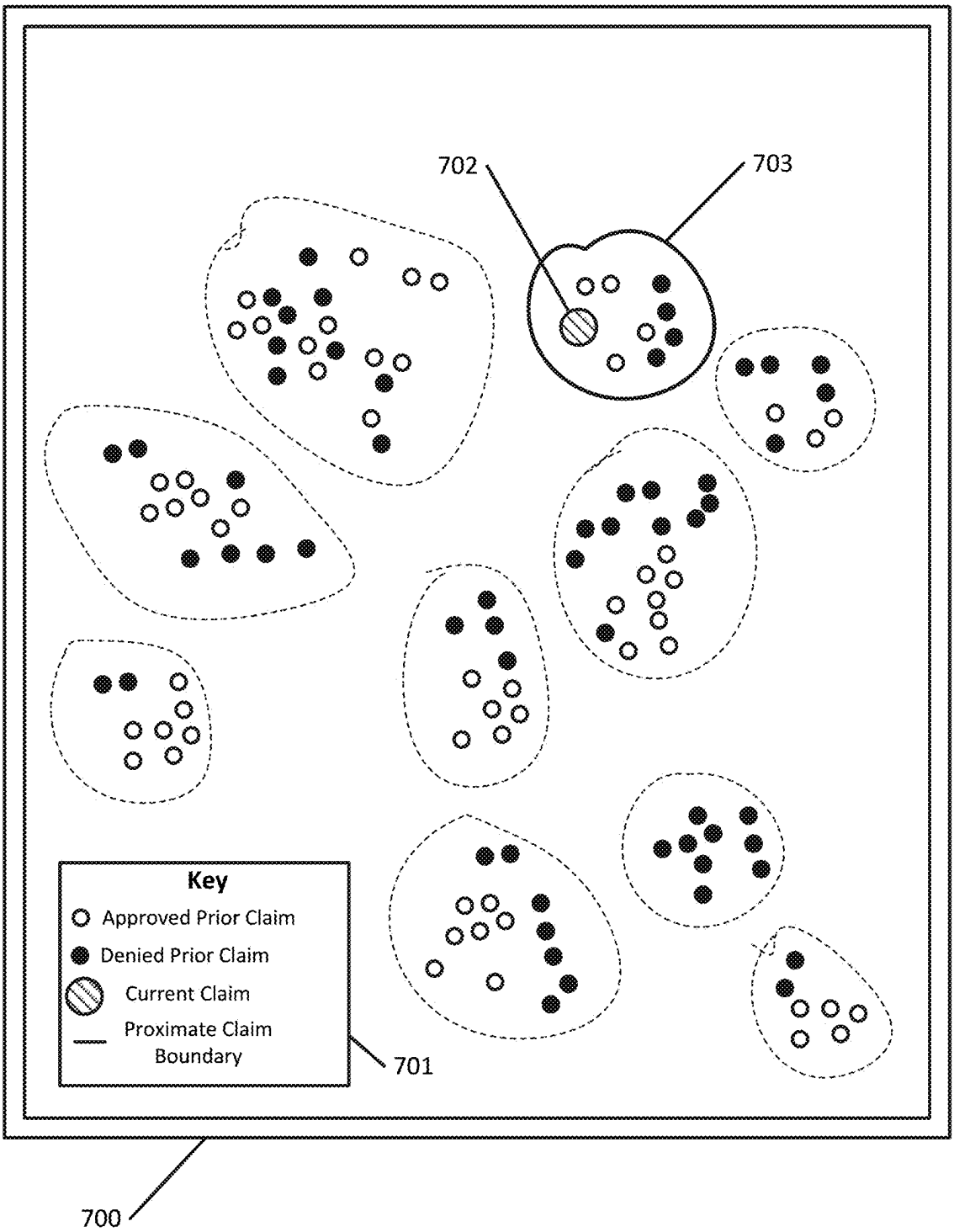

702
703
Key
Approved Prior Claim
Denied Prior Claim
Current Claim
Proximate Claim Boundary
701
700

Fig. 7A

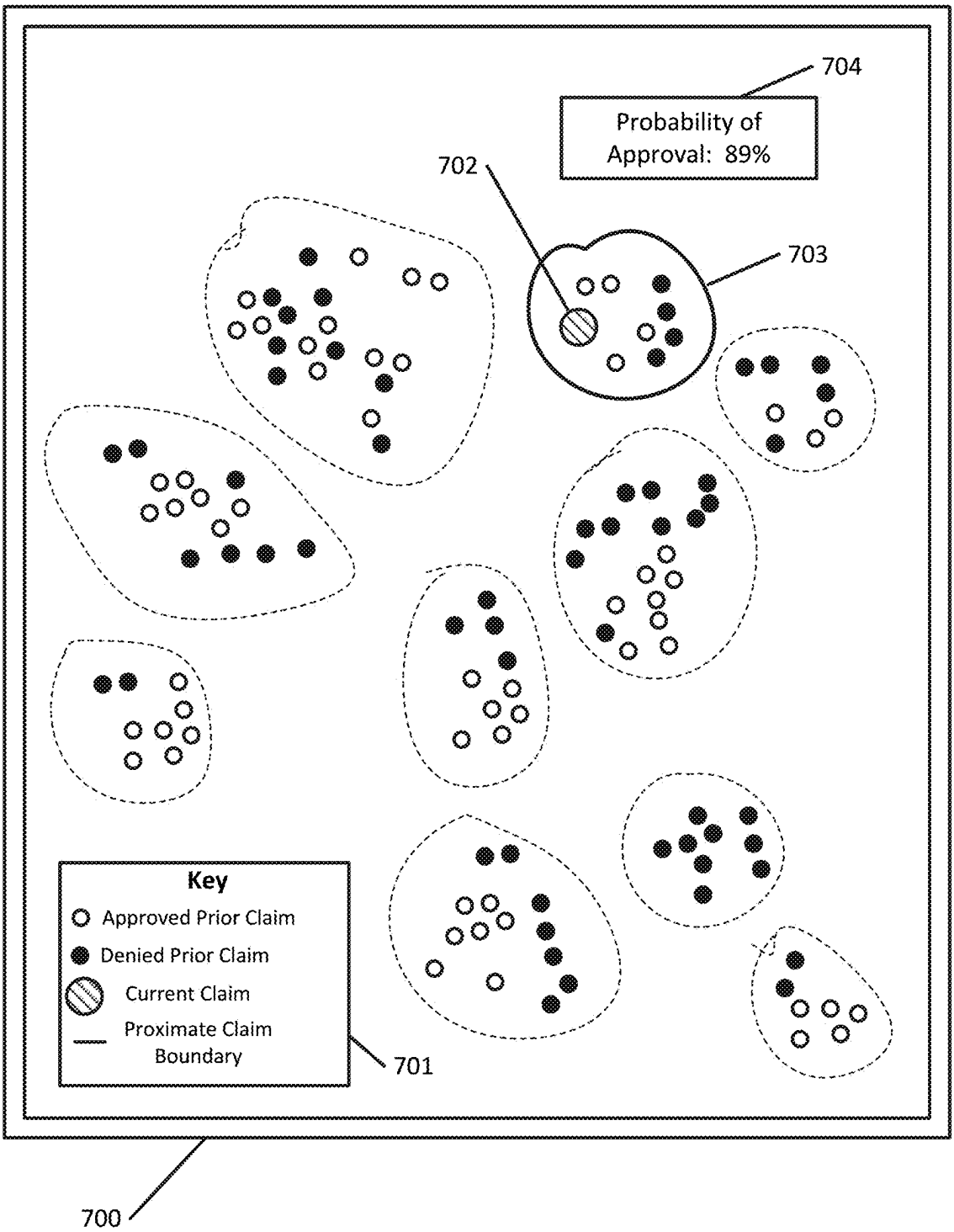

704
Probability of Approval: 89%
702
703
Key
Approved Prior Claim
Denied Prior Claim
Current Claim
Proximate Claim Boundary
701
700

Fig. 7B

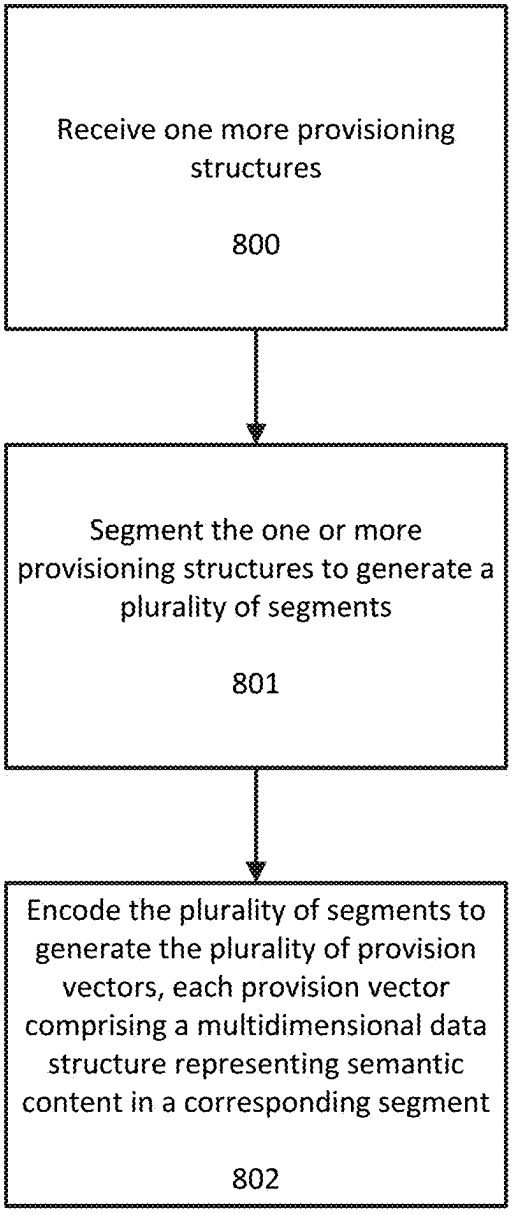

Receive one more provisioning structures
800
Segment the one or more provisioning structures to generate a plurality of segments
801
Encode the plurality of segments to generate the plurality of provision vectors, each provision vector comprising a multidimensional data structure representing semantic content in a corresponding segment
802

Fig. 8

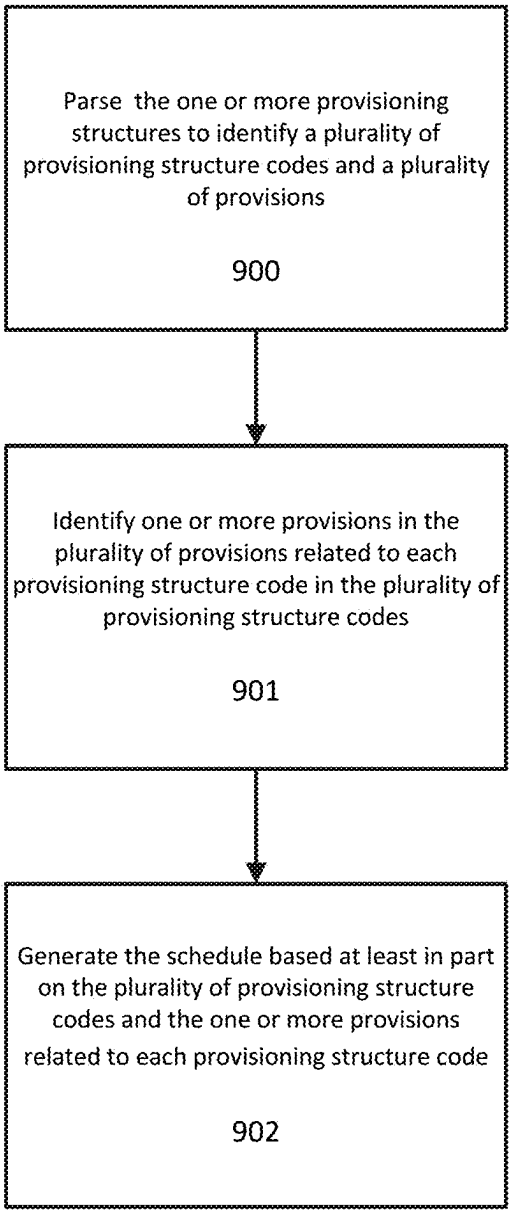

Parse the one or more provisioning structures to identify a plurality of provisioning structure codes and a plurality of provisions
900
Identify one or more provisions in the plurality of provisions related to each provisioning structure code in the plurality of provisioning structure codes
901
Generate the schedule based at least in part on the plurality of provisioning structure codes and the one or more provisions related to each provisioning structure code
902

Fig. 9

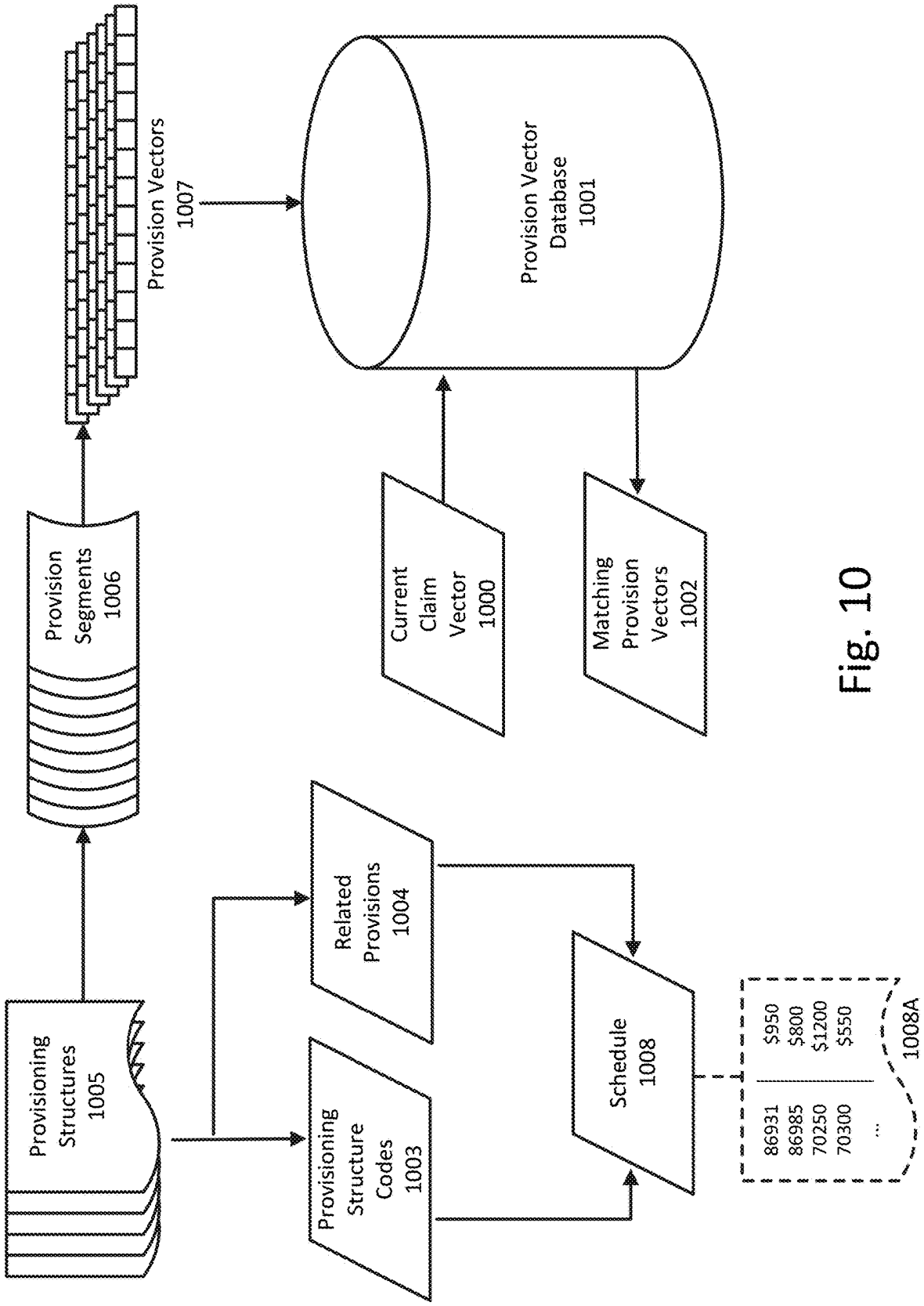

Provision Vectors
1007
Provision Vector
Database
1001
Provision
Segments
1006
Current
Claim
Vector
1000
Matching
Provision
Vectors
1002
Provisioning
Structures
1005
Related
Provisions
1004
Provisioning
Structure
Codes
1003
Schedule
1008
86931 $950
86985 $800
70250 $1200
70300 $550
...
1008A

Fig. 10

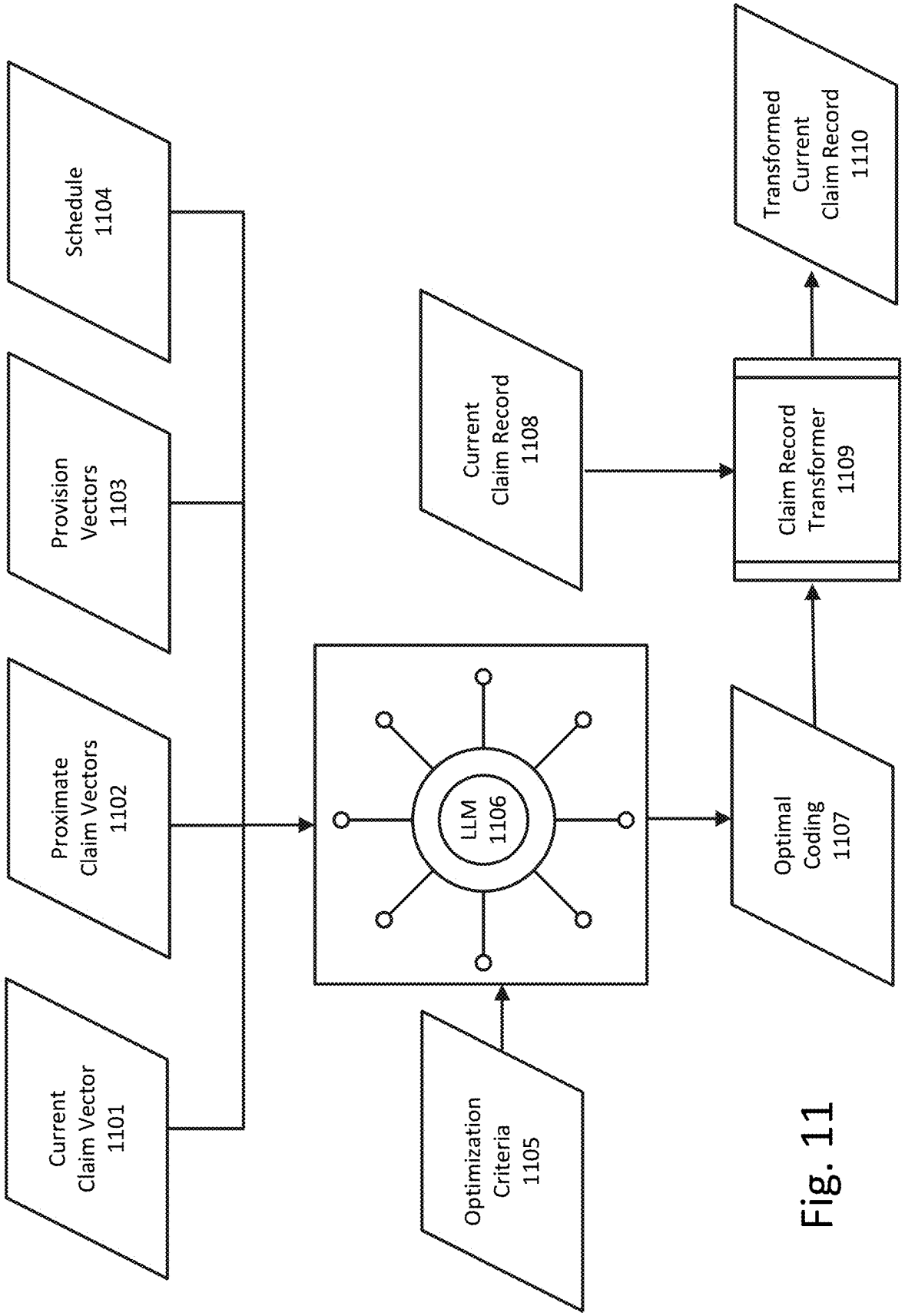

Current Claim Vector 1101
Proximate Claim Vectors 1102
Provision Vectors 1103
Schedule 1104
Optimization Criteria 1105
LLM 1106
Optimal Coding 1107
Current Claim Record 1108
Claim Record Transformer 1109
Transformed Current Claim Record 1110

Fig. 11

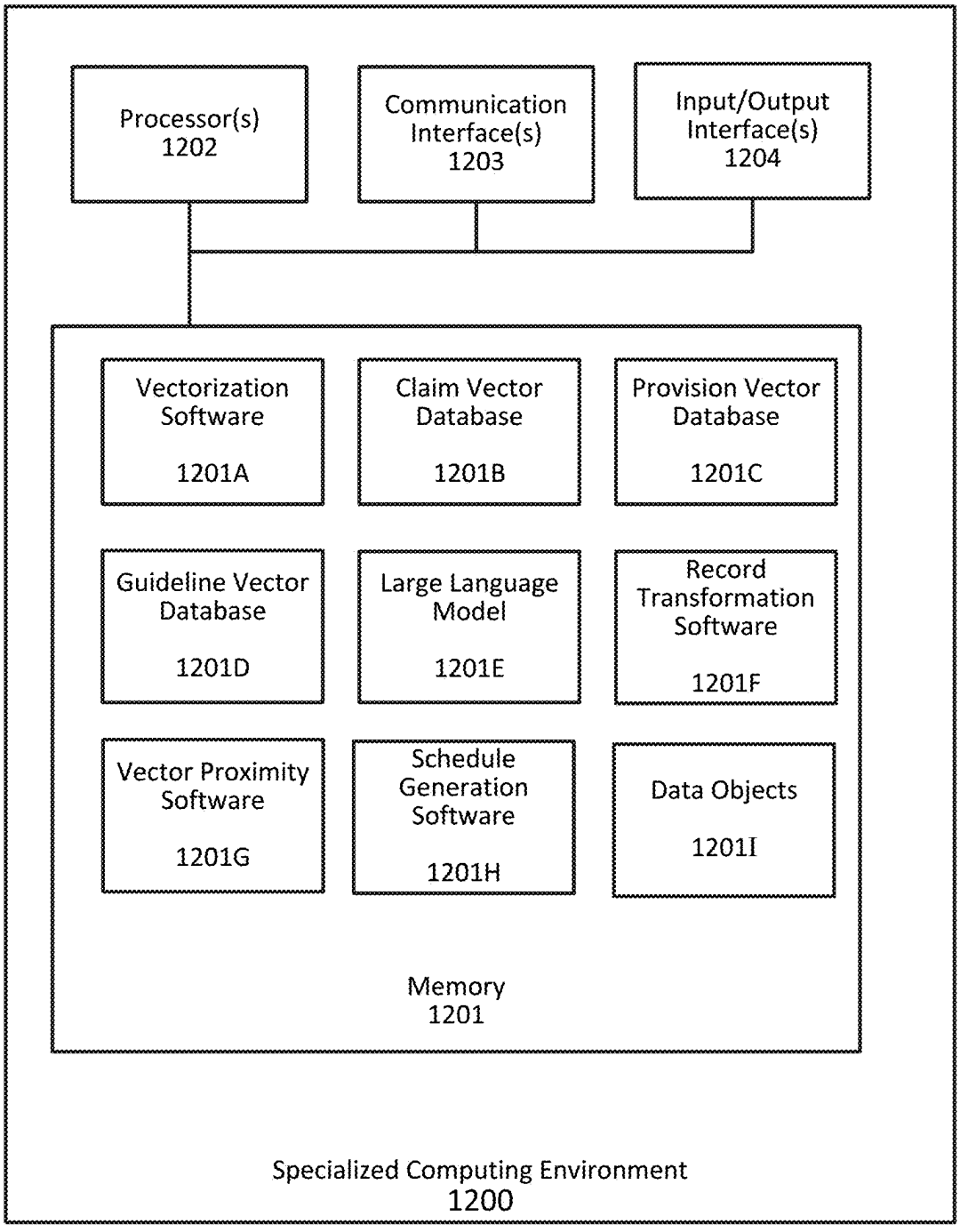

Processor(s)
1202
Communication Interface(s)
1203
Input/Output Interface(s)
1204
Vectorization Software
1201A
Claim Vector Database
1201B
Provision Vector Database
1201C
Guideline Vector Database
1201D
Large Language Model
1201E
Record Transformation Software
1201F
Vector Proximity Software
1201G
Schedule Generation Software
1201H
Data Objects
1201I
Memory
1201
Specialized Computing Environment
1200

Fig. 12

METHOD, APPARATUS, AND COMPUTER-READABLE MEDIUM FOR RETRIEVAL AUGMENTED GENERATION OF OPTIMAL CODING

RELATED APPLICATION DATA

[0001] This application claims priority to U.S. Provisional Application No. 63/551,702, filed Feb. 9, 2024, the disclosure of which is hereby incorporated by reference in its entirety.

BACKGROUND

[0002] Traditionally, the documentation of patient encounters involves recording a plethora of observations and diagnostic details. This process, predominantly manual, is not only labor-intensive but also prone to human error. Such errors can lead to administrative inaccuracies and the potential loss of critical medical insights, which are vital for both patient care and the intricacies of claim processing.

[0003] Current systems for claim submission and tracking do not provide any mechanism for viewing historical data in context or adjusting coding to account for previous pattern and behaviors. Furthermore, there are often multiple different coding strategies available for claim submission and there is currently no way to optimize coding for claims that integrates prior claim history, provisions governing coding, and other criteria.

BRIEF DESCRIPTION OF THE DRAWINGS

[0004] FIG. **1** illustrates a flowchart for retrieval augmented generation of optimal coding according to an exemplary embodiment.

[0005] FIG. **2** illustrates an example of encoding a current claim record as a current claim vector according to an exemplary embodiment.

[0006] FIG. **3** illustrates a flowchart for generating a current claim record according to an exemplary embodiment.

[0007] FIG. **4** illustrates a system diagram of a process for generating a current claim record according to an exemplary embodiment.

[0008] FIG. **5** illustrates a system chart for determining proximate claim vectors according to an exemplary embodiment.

[0009] FIG. **6**A illustrates a flowchart for transmitting representations of the current claim vector and the claim vectors proximate to the current claim vector according to an exemplary embodiment.

[0010] FIG. **6**B illustrates a flowchart for generating and transmitting an approval probability value according to an exemplary embodiment.

[0011] FIGS. **7**A-**7**B illustrate a user interface for viewing a current claim vector and proximate claim vectors and an approval probability according to an exemplary embodiment.

[0012] FIG. **8** illustrates a flowchart for generating a provision vector database according to an exemplary embodiment.

[0013] FIG. **9** illustrates a flowchart for generating a schedule corresponding to the one or more provisioning structures according to an exemplary embodiment.

[0014] FIG. **10** illustrates a system chart showing the process for building a provision vector database, extracting a schedule from the provisioning structures, and querying a provision vector database to identify provision vectors corresponding to codes according to an exemplary embodiment.

[0015] FIG. **11** illustrates a system chart illustrating the process for generating a transformed current record with the optimal coding according to an exemplary embodiment.

[0016] FIG. **12** illustrates the components of the specialized computing environment for retrieval augmented generation of optimal coding according to an exemplary embodiment.

DETAILED DESCRIPTION

[0017] While methods, apparatuses, and computer-readable media are described herein by way of examples and embodiments, those skilled in the art recognize that methods, apparatuses, and computer-readable media for retrieval augmented generation of optimal coding are not limited to the embodiments or drawings described. It should be understood that the drawings and description are not intended to be limited to the particular form disclosed. Rather, the intention is to cover all modifications, equivalents and alternatives falling within the spirit and scope of the appended claims. Any headings used herein are for organizational purposes only and are not meant to limit the scope of the description or the claims. As used herein, the word "may" is used in a permissive sense (i.e., meaning having the potential to) rather than the mandatory sense (i.e., meaning must). Similarly, the words "include," "including," and "includes" mean including, but not limited to.

[0018] Applicant has discovered a novel method, apparatus, and computer-readable medium for retrieval augmented generation of optimal coding.

[0019] The present system integrates two advanced technological systems: an Inference Engine and a Retrieval Augmented Generation (RAG) Engine. Together, these engines revolutionize the processing of documentation and the optimization of coding, significantly alleviating system burdens and markedly enhancing the efficiency of healthcare management systems.

[0020] The advanced technological framework disclosed herein utilizes an Inference Engine, implemented as a fine-tuned Large Language Model (LLM), which performs multiple key functions. The Inference Engine interprets and makes sense of the vast array of unstructured text generated by healthcare professionals during patient interactions. This text ranges from doctors' notes to physiotherapists' observations, encompassing a wide spectrum of data that poses a formidable challenge to conventional processing methods. The Inference Engine further optimizes the coding of claim records based on its specialized training and multiple vector databases of prior claims, provisioning structures, and optimization criteria.

[0021] FIG. **1** illustrates a flowchart for retrieval augmented generation of optimal coding according to an exemplary embodiment.

[0022] At step **101** a current claim record comprising a plurality of codes is encoded as a current claim vector, the current claim record corresponding to a current claim and the current claim vector comprising a multidimensional data structure representing semantic content in the current claim record.

[0023] The current claim record can be a record of a patient visit to a medical provider, such as a doctor, urgent

care provider, emergency room, clinic, etc. The plurality of codes can be medical codes, such as ICD (International Classification of Diseases), CPT (Current Procedural Terminology), or HCPCS (Healthcare Common Procedure Coding System) codes.

[0024] FIG. **2** illustrates an example of encoding a current claim record as a current claim vector according to an exemplary embodiment. As shown in FIG. **2**, current claim record **201** is a record of a visit to a medical provider and includes both description unstructured text, as well as medical codes. For example, the record portion **201**A includes the description "Frozen blood thaw" and the corresponding code "86931." The current claim record **201** is provided to text embedding software **202**, which converts the current claim record **201** into a current claim vector **203**.

[0025] Text embedding software **202** projects the text in the current claim record **201** into a high-dimensional latent space, represented as a vector **203**. The vector can have any number of dimensions, such as several hundred dimensions or over a thousand dimensions. For example, the vector can have **1536** dimensions or **3072** dimensions. The dimensions can represent different syntactical, semantic, or other attributes, features, or properties of the text that is embedded. Text embedding converts text into a multidimensional data structure storing numerical values that are utilized by large language models (LLMs) for various applications. FIG. **2** illustrates a representation of a portion **203**A of the current claim vector. Each dimension is indicated in portion **203**A using a different shading pattern, but it is understood that each dimension in the vector stores a numerical value corresponding to the value of that dimension for the vector. For example, the vector can use floating point numbers to store the dimension values for each dimension of the vector.

[0026] The codes in the current claim record can be generated by a hospital or medical provider coding department based on the description of services/procedures performed. For example, a medical providers notes can be provided to a coding department, which typically inserts the relevant healthcare codes for billing to a healthcare payer and optionally generates a description of the services provided and procedures performed.

[0027] Optionally, the codes in the current claim record can be generated through an inference process using a large language model (LLM). FIG. **3** illustrates a flowchart for generating a current claim record according to an exemplary embodiment.

[0028] At step **301** a visitation record comprising unstructured data is received. The visitation record can include healthcare provider notes, diagnostic tests, lab results, or any other documentation of a patient visit. The visitation record can include multiple different documents or notes and can be consolidated or formatted into a standardized format. The visitation record can take any format, such as JSON document.

[0029] At step **302** the visitation record is encoded as a visitation vector. The visitation record can be encoded using text embedding software, as discussed previously. The visitation vector is a multidimensional data structure representing semantic content in the visitation record.

[0030] At step **303** a guideline vector database is queried to identify one or more guideline vectors corresponding to the unstructured data. The guideline vector database can be queried with the visitation vector to identify guideline vectors corresponding to semantic content that is related to the semantic content of the visitation vector.

[0031] The guideline vector database stores a plurality of guideline vectors corresponding to a plurality of segments of one or more coding guideline structures, each guideline vector comprising a multidimensional data structure representing semantic content in a corresponding guideline segment. The one or more coding guideline structures can include healthcare guidelines and documents, such as ICD official guidelines, HCPCS, CPT healthcare coding guidelines, etc. The coding guideline structures can be segmented into segments/chunks prior to being vectorized and stored in the guideline vector database. The guideline vector database can updated in near real-time whenever guidelines change, ensuring that the system always utilizes the most current data.

[0032] Step **303** identifies the relevant policies and guidelines in the coding guideline structures that correspond to the procedures, services, or conditions described in the visitation record. For example, if the visitation record includes a certain procedure name, then the visitation vector corresponding to that record will encode a representation of that procedure name. When the visitation vector is used to query the guideline vector database, then vectors can be returned which correspond to sections of the coding guideline structures that reference the procedure.

[0033] At step **304** a predictive large language model (LLM) is applied to the visitation record and the one or more guideline vectors to generate the current claim record including the plurality of codes. The LLM is part of the inference engine of the present system and is meticulously fine-tuned for the nuances of the healthcare sector. This model excels in its deep comprehension of complex medical terminologies and its capability to distil these into precise medical codes. These codes are crucial for streamlining billing and claims processes, thereby enhancing the overall efficiency of healthcare administration. The LLM is configured to translate visitation records, such as healthcare professionals notes, into accurate medical codes.

[0034] The present system implements a Retrieval Augmented Generation (RAG) pattern by first querying the guideline vector database for vector embeddings that match the visitation record. The returned vector embeddings are then processed by the fine-tuned LLM. This model is adept at deconstructing and reconstructing the text, contextualizing the notes, and predicting the appropriate medical codes (ICD, CPT, HCPCS) based on this analysis.

[0035] The predicted codes can optionally be streamed to an application, where medical coders can review and approve them. In instances where the LLM-predicted codes are modified during manual review, this discrepancy can be flagged as a drift or error. The difference can automatically captured and subjected to an automated learning process known as Reinforcement Learning from Human Feedback (RLHF). This process continually refines and enhances the accuracy of the Inference Engine and the LLM.

[0036] FIG. **4** illustrates a system diagram of a process for generating a current claim record according to an exemplary embodiment. The visitation record **401** can include a description of procedures performed, as shown in note **401**A, and is encoded as a visitation vector **402**, which is then used to query guideline vector database **403** and return matching guideline vectors **404**.

[0037] The matching guideline vectors **404** and the visitation record **401** are provided to the fine-tuned LLM **408** (optionally with appropriate prompting, e.g., "generate codes correspond to the visitation record") to generate the current claim record **409**. As shown in record portion **409**A, the current claim record includes medical codes corresponding to the procedures in the visitation record.

[0038] As shown in FIG. **4**, the guideline vector database **403** is generated using the coding guideline structures **405**. The coding guideline structures **405** are divided into guideline segments **406** and then encoded as guideline vectors **407**. The segmentation of the coding guideline structures **405** can be optimized based on the type of guideline structure, such that different types of files can be segmented differently. For example, PDF files can be segmented into 1-page chunks, whereas Word documents can be segmented differently. The guideline vectors **407** are then stored in the guideline vector database **403**.

[0039] Returning to FIG. **1**, regardless of how the current claim record is generated, at step **102** a claim vector database is queried to identify one or more claim vectors proximate to the current claim vector in a multidimensional vector space based at least in part on a distance between the current claim vector and the one or more claim vectors in the multidimensional vector space. The claim vector database stores a plurality of claim vectors corresponding to a plurality of prior claims, each claim vector comprising a multidimensional data structure representing semantic content in a corresponding prior claim. The vector space of the claim vectors can have many dimensions, including dimensions corresponding to charges, diagnosis codes, diagnosis related group codes, procedure codes, revenue codes, etc.

[0040] Proximity can be determined in a variety of ways, such as cosine similarity or distance. Proximity can also be determined based on clustering of the vectors, with vectors within the same cluster being considered proximate to the current claim vector. A variety of techniques can be used for clustering. For example, the density-based spatial clustering of applications with noise (DBSCAN) clustering method can be used. Clustering can also be performed using the Balanced Iterative Reducing and Clustering using Hierarchies ("BIRCH") method. Additionally, clustering methods other than DBSCAN or BIRCH can be used during the clustering step. For example, clustering algorithms such as K-means or DENGRIS can be used to group the vectors into clusters.

[0041] FIG. **5** illustrates a system chart for determining proximate claim vectors according to an exemplary embodiment. Prior claims **504** are encoded/vectorized to generate prior claim vectors **505**. The encoding can be performed through text embedding software, as discussed previously. The current claim vector **501** is then used to query the claim vector database **502** to retrieve the proximate claim vectors **503**.

[0042] Once the proximate claim vectors are retrieved, a user can optionally be presented with a graphical user interface (GUI) showing the current claim record and the proximate claim vectors. In the complex world of healthcare management, providers often face the challenge of not being able to effectively visualize and compare claim data. This limitation hinders their ability to identify deviations and drifts across various dimensions such as codes, contracts, and patient notes. Understanding these nuances is crucial for optimizing claim management and revenue cycle processes. The present system addresses this critical issue by transforming the vector space associated with prior claim vectors. The process involves scaling down the dimensions of these vectors from a large number of dimensions, such as 1536, to a more manageable three or two. This dimensionality reduction is key to enabling the visualization of these vectors in a 3D or 2D graph. Such a graphical representation is not just a visual aid; it's a powerful tool that allows users to interact with and analyze the data in an intuitive and insightful manner.

[0043] FIG. **6**A illustrates a flowchart for transmitting representations of the current claim vector and the claim vectors proximate to the current claim vector according to an exemplary embodiment.

[0044] At step **601** a representation of the multidimensional vector space is transmitted in a user interface. The representation of multidimensional vector space can be generated by reducing the number of dimensions in the vector space using a variety of dimensionality reduction techniques. One dimensionality reduction technique that can be used is the Principal Components Analysis ("PCA") method which reduces the number of the data object's dimensions as compared to the number of data object's dimensions in the original universe of discourse. The PCA input data dimensionality reduction method transforms input data coordinates in such way that eigenvectors of the covariance matrix become new coordinate axis. Horn's Parallel Analysis ("PA") technique can be used with PCA. PA is based on comparing eigenvalues of an actual data set with eigenvalues of an artificial data set of uncorrelated normal variables of the same dimensionality as the actual data set. Of course, techniques other than the combination of the PCA and PA methods can be used to reduce data dimensionality of the training data. For example, the Linear Discriminant Analysis method or the Sufficient Dimensionality Reduction approach can also be used to achieve the objective of reducing dimensionality. Another technique for dimensionality reduction that can be utilized is t-SNE(t-Distributed Stochastic Neighbor Embedding).

[0045] At step **602** a representation of current claim vector is transmitted in the representation of the multidimensional vector space. Once again, the above-mentioned dimensionality reduction techniques can be used to represent the current claim vector in two or three dimensions.

[0046] At step **603** one or more representations of the one or more claim vectors proximate to the current claim vector are transmitted in the representation of the multidimensional vector space. These vectors can also be mapped to the reduced dimensions using the above-mentioned dimensionality reduction techniques.

[0047] In addition to the representation of the current claim vector and the proximate vectors, the present system can determine and present relevant information about the proximate claim vectors (such as whether the prior claims were approved or rejected), and a probability of success of the current claim record. FIG. **6**B illustrates a flowchart for generating and transmitting an approval probability value according to an exemplary embodiment. The steps shown in FIG. **6**B can be performed in conjunction with, after, or instead of the steps shown in FIG. **6**A.

[0048] At step **604** one or more outcome values are determined for one or more prior claims corresponding to the one or more claim vectors proximate to the current claim vector, each outcome value indicating an outcome of a prior claim. The outcome values can indicate the outcomes of the

prior claims, such as whether the claim was approved or rejected, or additional outcome values, such as the time/delay required for approval or rejection, or other outcomes. The outcome values can be determined by querying a database outside the vector database that stores the prior claims and metadata about prior claims, such as outcomes.

[0049] At step **605** an approval probability value is determined for the current claim record based at least in part on the one or more outcome values, the one or more proximate claim vectors, and the current claim vector. The approval probability value can be determined on a variety of factors, such as whether the proximate claim vectors were approved, how many proximate claim vectors were approved, and the relative distances between the current claim vector and proximate claim vectors that were approved or rejected.

[0050] At step **606** the approval probability value is transmitted in the user interface. The approval probability can be shown in a variety of ways, such as a numerical percentage, a color code with high probabilities (e.g., greater than 70%) shown in green, low probabilities (e.g., less than 50%) in red, and medium probabilities (e.g., between 50%-70%) shown in yellow. Of course, these indicators are provided only as an example, and the approval probabilities can be displayed in a variety of ways.

[0051] FIGS. **7**A-**7**B illustrate a user interface for viewing a current claim vector and proximate claim vectors and an approval probability according to an exemplary embodiment. FIG. **7**A illustrates a user interface **700** showing a two-dimensional vector space, which can be generated from the multidimensional vector space using the dimensionality reduction techniques described above. Of course, a two-dimensional space is presented for case of illustration only, and it is understood that a three-dimensional space vector space can be utilized as well.

[0052] User interface **700** includes a key **701** explaining the icons shown in the user interface. As shown in the key **701**, the claim vectors corresponding to prior claims that were rejected are shown as black circles and the claim vectors corresponding to prior claims that were approved are shown as white circles. Additionally, the current claim vector **702** is shown with a larger circle having a diagonal line pattern. The dashed lines indicate groupings of claim vectors that are close to one another in the vector space. The solid lines **704** indicate a proximate claim vector boundary of the proximate claim vectors close to the current claim vector. A predetermined distance threshold can be used to determine the proximate claim vector boundary in order to classify prior claim vectors as proximate. The distance threshold can also be automatically computed based on clustering algorithms that cluster the vectors.

[0053] FIG. **7**B illustrates the user interface **700** with an indication of the probability of approval **704**. As shown in user interface element **704**, the probability of approval is 89%. As discussed previously, this probability can be determined based on the closest proximate vectors within boundary **703**.

[0054] The graph and user interface serves as an interactive platform where users can observe clusters of prior claims/visits. They can engage with individual vector chunks or select groups to examine all the attributes within a chosen segment. This interactive capability is pivotal in unravelling the complexities of claim data, offering a clear and comprehensive view of how different claims are related or divergent. This visualization and interaction with the data helps users to dissect various aspects of a claim. For instance, they can investigate why a particular visit deviated from its expected cluster. Such insights are invaluable in identifying anomalies and patterns that might otherwise go unnoticed.

[0055] This approach facilitates the identification of potential new claiming strategies. By analyzing the proximity of visits in the vector space and examining the differences in their attributes, such as the order of diagnosis or treatment codes, users can uncover opportunities for optimizing claims. For example, if two visits are closely related but have different arrangements of diagnoses that lead to a higher claim amount for one, this insight can be pivotal. Users can use this information to advise the coding team about specific drifts that could result in optimized revenue for similar claims.

[0056] The present system enables the more efficient handling of denials/rejections. As discussed above, the denied claims are converted into text embedding vectors and projected into a 2D or 3D vector space view. The denied claim can pass through two vector indexes and based on its occupying neighbors, a confidence score can be calculated and the insights can be presented to the user. The two vector indexes can be the Claims Parity Index (CPI) and Denials Parity Index (DPI).

[0057] The Claims Parity Index (CPI) functions as a three-dimensional vector visualization tool. It is intricately connected to all successful claim submissions historically associated with a particular provider/payer. When a denied claim is introduced into this index's vector space, it is represented as a vector. Due to the nature of this data representation, the denied claim vector tends to be positioned in proximity to other vectors that correspond to historically successful claims. The system then employs a method to measure the cosine distance between the vector of the denied claim and those of successful claims. Based on this distance, one or more vectors representing successful claims are selected and fed into a custom AI model. This model is adept at making precise predictions about which data points need to be altered in the denied claim to align it more closely with the characteristics of a successful claim.

[0058] The Denials Parity Index (DPI) operates on a similar principle to the CPI but with a focus on denied claims. The vector index in this case is populated with vectors representing past denied claims. This setup allows for a comprehensive visualization of the current denied claim in the context of historical denial patterns. By analyzing how the current claim compares to these past denials, the system can identify recurring patterns or anomalies in the denial process, providing valuable insights for addressing and rectifying these issues.

[0059] The CPI and DPI work in tandem to enhance the denial management process. By leveraging these two indices, the present system provides a more nuanced and data-driven approach to handling denials. This method not only increases the efficiency of the process but also contributes to a higher success rate in converting denied claims into successful ones. The integration of these advanced analytical tools provides significant advantages to systems for optimizing coding.

[0060] Optionally, the process described in FIGS. **6**A-**6**B and shown in FIGS. **7**A-**7**B can be performed after transformation of current claim record (i.e., step **105** of FIG. **1**), discussed below. In this case, the user is able to see the

probability of approval of the transformed current claim record and compare it with the probability prior to transformation.

[0061] Returning to FIG. **1**, at step **103** a provision vector database is queried to identify one or more provision vectors corresponding to the plurality of codes. The provision vector database stores a plurality of provision vectors corresponding to a plurality of segments of one more provisioning structures, each provision vector comprising a multidimensional data structure representing semantic content in a corresponding segment.

[0062] The provisioning structures can be segmented into segments/chunks prior to being encoded/vectorized and stored in the provision vector database. In this phase, the processed content is transformed into text embeddings using Large Language Models (LLMs). The content is segmented into manageable chunks, which are then vectorized and stored in a vector database. This database becomes a valuable resource for specialists, enabling them to conduct ad-hoc analyses as needed. The vectorization of provisioning structures not only simplifies the retrieval process but also enhances the precision and speed of analysis. Optionally, the system can include a chat functionality with a Generative Pre-trained Transformer (GPT) and the LLM that enables users to query the provisioning structures to obtain accurate information about provisions in the provisioning structure.

[0063] The one or more provisioning structures can include contracts, such as health insurance contracts, payor contracts, or other documents specifying the terms and conditions pertaining to different codes. For example, the provisioning structure can be a contract between a hospital and health insurance company that specifies the terms and conditions, and payment amounts for different medical procedures and codes. In the intricate and demanding sphere of Revenue Cycle Management (RCM), one of the most formidable challenges is the interpretation and application of complex payer or insurance contracts. These contracts are crucial for accurately filing claims based on various codes and stipulations.

[0064] FIG. **8** illustrates a flowchart for generating a provision vector database according to an exemplary embodiment. At step **801** one more provisioning structures are received. As discussed above, the provisioning structures can be complex payer or insurance contracts. These contracts are crucial for accurately filing claims based on various codes and stipulations.

[0065] Optionally, after receiving the provisioning structures, the provisioning structures can be sanitized to ensure data quality. The sanitation process can include correcting for errors or data quality issues, such incorrectly formatted or missing characters or sections of the documents. The sanitation process can also include standardizing and formatting the provisioning structures into a standardized format.

[0066] At step **802** the one or more provisioning structures are segmented to generate a plurality of segments. The provisioning structures can be segmented according to various criteria, such as the file type, the type of provisioning structure (e.g., contract type), or other criteria. The segments/chunks can be based on page breaks, a predetermined number of words or characters, or larger chunks such as different sections or clauses of a contract.

[0067] At step **803** the plurality of segments are encoded to generate the plurality of provision vectors, each provision vector comprising a multidimensional data structure representing semantic content in a corresponding segment. The encoding process can be performed with text embedding software as discussed above. The vector space of the provision vectors can have many dimensions, including dimensions corresponding to payer names, payer codes, financial classes, etc.

[0068] Along with segmenting and encoding the provisioning structures as vectors, the present system can extract additional information from the provisioning structures that are relevant to claim optimization process. This additional information includes a schedule of fees/costs pertaining to different codes, which can be utilized by the LLM as part of the optimization process.

[0069] In this step, the system automatically compiles a comprehensive table summarizing payment codes and their corresponding rates. This summary can optionally be reviewed by an RCM specialist for validation and accuracy and then stored in a database. The Fee Schedule can be used in conjunction with the codes generated by the Inference Engine, facilitating a seamless crosswalk and ensuring that claims are filed accurately and in accordance with the specific stipulations of each contract.

[0070] FIG. **9** illustrates a flowchart for generating a schedule corresponding to the one or more provisioning structures according to an exemplary embodiment.

[0071] At step **901** the one or more provisioning structures are parsed to identify a plurality of provisioning structure codes and a plurality of provisions. The provisioning structure codes can correspond to healthcare/medical codes and the provisions can be unstructured data or text. The provisioning structure codes can be identified using a variety of natural language processing techniques, regular expression matching, and/or lexical analysis. The provisions can be identified based on proximity/distance to provisioning structure codes.

[0072] At step **902** one or more provisions in the plurality of provisions related to each provisioning structure code in the plurality of provisioning structure codes are identified. The related provisions can be identified based on proximity/distance to each provisioning structure code. For example, a provisioning structure code can first be identified using regular expression matching and a proximity search can identify provisions on the same page or within a certain number of characters.

[0073] At step **903** the schedule is generated based at least in part on the plurality of provisioning structure codes and the one or more provisions related to each provisioning structure code. The schedule includes provisioning structure codes and corresponding fees or amounts. This step can utilize pre-existing knowledge about the layout and format of the provisioning structures, probabilistic methods for determining fees, or other techniques for matching a provisioning structure code to an amount. The final output of this step is a fee schedule with codes and corresponding amounts.

[0074] FIG. **10** illustrates a system chart showing the process for building a provision vector database, extracting a schedule from the provisioning structures, and querying a provision vector database to identify provision vectors corresponding to codes according to an exemplary embodiment.

[0075] The provisioning structures **1005** are divided into provision segments **1006**. These segments **1006** are encoded to generate the provision vectors **1007**, which are then stored in the provision vector database **1001**. As shown in the FIG. **10**, the provisioning structures are parsed as discussed above to extract provisioning structure codes **1003** and related provisions **1004**. The provisioning structure codes **1003** and related provisions **1004** are then used to generate the schedule **1008**. The portion **1008**A of schedule **1008** illustrates an example of the format of the schedule, including codes and corresponding amounts/fees. As additionally shown in FIG. **10**, the current claim vector **1000** is used to query the provision vector database **1001**, which returns matching provision vectors **1002**.

[0076] Returning to FIG. **1**, at step **104** the predictive large language model (LLM) is applied to the current claim vector, the one or more claim vectors, the one or more provision vectors, and the schedule corresponding to the one or more provisioning structures to generate an optimal coding for the current claim record based at least in part on one or more optimization criteria.

[0077] The optimization criteria can include one or more of a predicted probability of approval of the current claim record, an overall revenue resulting from the current claim record, a predicted response time for the current claim record, reordering to match payer expectation. Multiple sets of optimization criteria can be utilized as well. For example, the LLM can be configured to first optimize for probability of approval and then optimize according to maximum revenue. The optimization process can optimize along different criteria in parallel (e.g., revenue and approval probability) and present both options to users for selection. Options can be presented with projected review and risk score/probability of success to aid users in selection of an optimization strategy.

[0078] The generated optimal coding can include the optimal codes recommended for utilization in the current claim record. The generated optimal coding can also include one or more transformations to be applied to the current claim record to transform the record into one having the optimal coding.

[0079] At step **105** the current claim record is transformed based at least in part on the determined optimal coding. The step of transforming the current claim record can be performed in a variety of ways, such as:

[0080] replacing at least one code in the plurality of codes with at least one alternate code;

[0081] removing at least one code in the plurality of codes;

[0082] adding at least one new code to the plurality of codes;

[0083] changing an ordering of two or more codes in the plurality of codes; and/or

[0084] modifying a description associated with at least one code in the plurality of codes.

[0085] FIG. **11** illustrates a system chart illustrating the process for generating a transformed current record with the optimal coding according to an exemplary embodiment.

[0086] As shown in FIG. **11**, the current claim vector **1101**, the proximate claim vector **1102**, the provision vectors **1103**, and the schedule **1104** are all provided as input to the LLM **1106**, along with optimization criteria **1105**. The LLM generates an optimal coding **1107** based on all the inputs, and this optimal coding **1107** is applied to the current claim record **1108** by a claim record transformer **1109** to produce a transformed current claim record **1110**.

[0087] Optionally, this transformed current claim record can be encoded as a vector and viewed in a user interface, along with proximate vectors and a probability of approval, as shown in FIGS. **6**A-**6**B and **7**A-**7**B. This allows users of the system to evaluate the transformed current claim and make any additional necessary changes.

[0088] FIG. **12** illustrates the components of the specialized computing environment **1200** configured to perform the processes described herein. Specialized computing environment **1200** is a computing device that includes a memory **1201** that is a non-transitory computer-readable medium and can be volatile memory (e.g., registers, cache, RAM), non-volatile memory (e.g., ROM, EEPROM, flash memory, etc.), or some combination of the two.

[0089] As shown in FIG. **12**, memory **1201** can include vectorization/encoding/text embedding software **1201**A, a claim vector database **1201**B, a provision vector database **1201**C, a guideline vector database **1201**D, a large language model **1201**E, record transformation software **1201**F, vector proximity software **1201**G, schedule generation software **1201**H, and one or more data objects **12011**. Each of the software components in memory **1201** store specialized instructions and data structures configured to perform the corresponding functionality and techniques described herein.

[0090] All of the software stored within memory **1201** can be stored as a computer-readable instructions, that when executed by one or more processors **1202**, cause the processors to perform the functionality described with respect to FIGS. **1**-**11**.

[0091] Processor(s) **1202** execute computer-executable instructions and can be a real or virtual processors. In a multi-processing system, multiple processors or multicore processors can be used to execute computer-executable instructions to increase processing power and/or to execute certain software in parallel.

[0092] Specialized computing environment **1200** additionally includes a communication interface **903**, such as a network interface, which is used to communicate with devices, applications, or processes on a computer network or computing system, collect data from devices on a network, and implement encryption/decryption actions on network communications within the computer network or on data stored in databases of the computer network. The communication interface conveys information such as computer-executable instructions, audio or video information, or other data in a modulated data signal. A modulated data signal is a signal that has one or more of its characteristics set or changed in such a manner as to encode information in the signal. By way of example, and not limitation, communication media include wired or wireless techniques implemented with an electrical, optical, RF, infrared, acoustic, or other carrier.

[0093] Specialized computing environment **1200** further includes input and output interfaces **1204** that allow users (such as system administrators) to provide input to the system to display information, to edit data stored in memory **1201**, or to perform other administrative functions.

[0094] An interconnection mechanism (shown as a solid line in FIG. **12**), such as a bus, controller, or network interconnects the components of the specialized computing environment **1200**.

[0095] Input and output interfaces **1204** can be coupled to input and output devices. For example, Universal Serial Bus (USB) ports can allow for the connection of a keyboard, mouse, pen, trackball, touch screen, or game controller, a voice input device, a scanning device, a digital camera, remote control, or another device that provides input to the specialized computing environment **1200**.

[0096] Specialized computing environment **1200** can additionally utilize a removable or non-removable storage, such as magnetic disks, magnetic tapes or cassettes, CD-ROMs, CD-RWs, DVDs, USB drives, or any other medium which can be used to store information and which can be accessed within the specialized computing environment **1200**.

[0097] Having described and illustrated the principles of our invention with reference to the described embodiment, it will be recognized that the described embodiment can be modified in arrangement and detail without departing from such principles. It should be understood that the programs, processes, or methods described herein are not related or limited to any particular type of computing environment, unless indicated otherwise. Various types of general purpose or specialized computing environments may be used with or perform operations in accordance with the teachings described herein. Elements of the described embodiment shown in software may be implemented in hardware and vice versa.

[0098] In view of the many possible embodiments to which the principles of our invention may be applied, we claim as our invention all such embodiments as may come within the scope and spirit of the following claims and equivalents thereto.

What is claimed is:

1. A method executed by one or more computing devices for retrieval augmented generation of optimal coding, the method comprising:

encoding a current claim record comprising a plurality of codes as a current claim vector, the current claim record corresponding to a current claim and the current claim vector comprising a multidimensional data structure representing semantic content in the current claim record;

querying a claim vector database to identify one or more claim vectors proximate to the current claim vector in a multidimensional vector space based at least in part on a distance between the current claim vector and the one or more claim vectors in the multidimensional vector space, the claim vector database storing a plurality of claim vectors corresponding to a plurality of prior claims, each claim vector comprising a multidimensional data structure representing semantic content in a corresponding prior claim;

querying a provision vector database to identify one or more provision vectors corresponding to the plurality of codes, the provision vector database storing a plurality of provision vectors corresponding to a plurality of segments of one more provisioning structures, each provision vector comprising a multidimensional data structure representing semantic content in a corresponding segment;

applying a predictive large language model (LLM) to the current claim vector, the one or more claim vectors, the one or more provision vectors, and a schedule corresponding to the one or more provisioning structures to generate an optimal coding for the current claim record based at least in part on one or more optimization criteria; and

transforming the current claim record based at least in part on the determined optimal coding.

2. The method of claim **1**, wherein the current claim record is generated by:

receiving a visitation record comprising unstructured data;

encoding the visitation record as a visitation vector, the visitation vector comprising a multidimensional data structure representing semantic content in the visitation record;

querying a guideline vector database to identify one or more guideline vectors corresponding to the unstructured data, the guideline vector database storing a plurality of guideline vectors corresponding to a plurality of segments of one or more coding guideline structures, each guideline vector comprising a multidimensional data structure representing semantic content in a corresponding segment; and

applying the predictive large language model (LLM) to the visitation record and the one or more guideline vectors to generate the current claim record including the plurality of codes.

3. The method of claim **1**, further comprising:

transmitting a representation of the multidimensional vector space in a user interface;

transmitting a representation of current claim vector in the representation of the multidimensional vector space; and

transmitting one or more representations of the one or more claim vectors proximate to the current claim vector in the representation of the multidimensional vector space.

4. The method of claim **3**, further comprising:

determining one or more outcome values for one or more prior claims corresponding to the one or more claim vectors proximate to the current claim vector, each outcome value indicating an outcome of a prior claim;

determining an approval probability value for the current claim record based at least in part on the one or more outcome values, the one or more claim vectors, and the current claim vector; and

transmitting the approval probability value in the user interface.

5. The method of claim **1**, wherein the provision vector database is generated by:

receiving one more provisioning structures;

segmenting the one or more provisioning structures to generate a plurality of segments; and

encoding the plurality of segments to generate the plurality of provision vectors, each provision vector comprising a multidimensional data structure representing semantic content in a corresponding segment.

6. The method of claim **5**, wherein the schedule corresponding to the one or more provisioning structures is generated by:

parsing the one or more provisioning structures to identify a plurality of provisioning structure codes and a plurality of provisions;

identifying one or more provisions in the plurality of provisions related to each provisioning structure code in the plurality of provisioning structure codes; and

generating the schedule based at least in part on the plurality of provisioning structure codes and the one or more provisions related to each provisioning structure code.

7. The method of claim **1**, wherein the optimization criteria comprises one or more of:

a predicted probability of approval of the current claim record;

an overall revenue resulting from the current claim record; or

a predicted response time for the current claim record.

8. The method of claim **1**, wherein transforming the current claim record based at least in part on the determined optimal coding comprises one or more of:

replacing at least one code in the plurality of codes with at least one alternate code;

removing at least one code in the plurality of codes;

adding at least one new code to the plurality of codes;

changing an ordering of two or more codes in the plurality of codes; or

modifying a description associated with at least one code in the plurality of codes.

9. An apparatus for retrieval augmented generation of optimal coding, the apparatus comprising:

one or more processors; and

one or more memories operatively coupled to at least one of the one or more processors and having instructions stored thereon that, when executed by at least one of the one or more processors, cause at least one of the one or more processors to:

encode a current claim record comprising a plurality of codes as a current claim vector, the current claim record corresponding to a current claim and the current claim vector comprising a multidimensional data structure representing semantic content in the current claim record;

query a claim vector database to identify one or more claim vectors proximate to the current claim vector in a multidimensional vector space based at least in part on a distance between the current claim vector and the one or more claim vectors in the multidimensional vector space, the claim vector database storing a plurality of claim vectors corresponding to a plurality of prior claims, each claim vector comprising a multidimensional data structure representing semantic content in a corresponding prior claim;

query a provision vector database to identify one or more provision vectors corresponding to the plurality of codes, the provision vector database storing a plurality of provision vectors corresponding to a plurality of segments of one more provisioning structures, each provision vector comprising a multidimensional data structure representing semantic content in a corresponding segment;

apply a predictive large language model (LLM) to the current claim vector, the one or more claim vectors, the one or more provision vectors, and a schedule corresponding to the one or more provisioning structures to generate an optimal coding for the current claim record based at least in part on one or more optimization criteria; and

transform the current claim record based at least in part on the determined optimal coding.

10. The apparatus of claim **9**, wherein the current claim record is generated by:

receiving a visitation record comprising unstructured data;

encoding the visitation record as a visitation vector, the visitation vector comprising a multidimensional data structure representing semantic content in the visitation record;

querying a guideline vector database to identify one or more guideline vectors corresponding to the unstructured data, the guideline vector database storing a plurality of guideline vectors corresponding to a plurality of segments of one or more coding guideline structures, each guideline vector comprising a multidimensional data structure representing semantic content in a corresponding segment; and

applying the predictive large language model (LLM) to the visitation record and the one or more guideline vectors to generate the current claim record including the plurality of codes.

11. The apparatus of claim **9**, wherein at least one of the one or more memories has further instructions stored thereon that, when executed by at least one of the one or more processors, cause at least one of the one or more processors to:

transmit a representation of the multidimensional vector space in a user interface;

transmit a representation of current claim vector in the representation of the multidimensional vector space; and

transmit one or more representations of the one or more claim vectors proximate to the current claim vector in the representation of the multidimensional vector space.

12. The apparatus of claim **11**, wherein at least one of the one or more memories has further instructions stored thereon that, when executed by at least one of the one or more processors, cause at least one of the one or more processors to:

determine one or more outcome values for one or more prior claims corresponding to the one or more claim vectors proximate to the current claim vector, each outcome value indicating an outcome of a prior claim;

determine an approval probability value for the current claim record based at least in part on the one or more outcome values, the one or more claim vectors, and the current claim vector; and

transmit the approval probability value in the user interface.

13. The apparatus of claim **9**, wherein the provision vector database is generated by:

receiving one more provisioning structures;

segmenting the one or more provisioning structures to generate a plurality of segments; and

encoding the plurality of segments to generate the plurality of provision vectors, each provision vector comprising a multidimensional data structure representing semantic content in a corresponding segment.

14. The apparatus of claim **13**, wherein the schedule corresponding to the one or more provisioning structures is generated by:

parsing the one or more provisioning structures to identify a plurality of provisioning structure codes and a plurality of provisions;

identifying one or more provisions in the plurality of provisions related to each provisioning structure code in the plurality of provisioning structure codes; and

generating the schedule based at least in part on the plurality of provisioning structure codes and the one or more provisions related to each provisioning structure code.

15. The apparatus of claim **9**, wherein the optimization criteria comprises one or more of:

a predicted probability of approval of the current claim record;

an overall revenue resulting from the current claim record; or

a predicted response time for the current claim record.

16. The apparatus of claim **9**, wherein transforming the current claim record based at least in part on the determined optimal coding comprises one or more of:

replacing at least one code in the plurality of codes with at least one alternate code;

removing at least one code in the plurality of codes;

adding at least one new code to the plurality of codes;

changing an ordering of two or more codes in the plurality of codes; or

modifying a description associated with at least one code in the plurality of codes.

17. At least one non-transitory computer-readable medium storing computer-readable instructions for retrieval augmented generation of optimal coding that, when executed by one or more computing devices, cause at least one of the one or more computing devices to:

encode a current claim record comprising a plurality of codes as a current claim vector, the current claim record corresponding to a current claim and the current claim vector comprising a multidimensional data structure representing semantic content in the current claim record;

query a claim vector database to identify one or more claim vectors proximate to the current claim vector in a multidimensional vector space based at least in part on a distance between the current claim vector and the one or more claim vectors in the multidimensional vector space, the claim vector database storing a plurality of claim vectors corresponding to a plurality of prior claims, each claim vector comprising a multidimensional data structure representing semantic content in a corresponding prior claim;

query a provision vector database to identify one or more provision vectors corresponding to the plurality of codes, the provision vector database storing a plurality of provision vectors corresponding to a plurality of segments of one more provisioning structures, each provision vector comprising a multidimensional data structure representing semantic content in a corresponding segment;

apply a predictive large language model (LLM) to the current claim vector, the one or more claim vectors, the one or more provision vectors, and a schedule corresponding to the one or more provisioning structures to generate an optimal coding for the current claim record based at least in part on one or more optimization criteria; and

transform the current claim record based at least in part on the determined optimal coding.

18. The at least one non-transitory computer-readable medium of claim **17**, wherein the current claim record is generated by:

receiving a visitation record comprising unstructured data;

encoding the visitation record as a visitation vector, the visitation vector comprising a multidimensional data structure representing semantic content in the visitation record;

querying a guideline vector database to identify one or more guideline vectors corresponding to the unstructured data, the guideline vector database storing a plurality of guideline vectors corresponding to a plurality of segments of one or more coding guideline structures, each guideline vector comprising a multidimensional data structure representing semantic content in a corresponding segment; and

applying the predictive large language model (LLM) to the visitation record and the one or more guideline vectors to generate the current claim record including the plurality of codes.

19. The at least one non-transitory computer-readable medium of claim **17**, further storing computer-readable instructions that, when executed by at least one of the one or more computing devices, cause at least one of the one or more computing devices to:

transmit a representation of the multidimensional vector space in a user interface;

transmit a representation of current claim vector in the representation of the multidimensional vector space; and

transmit one or more representations of the one or more claim vectors proximate to the current claim vector in the representation of the multidimensional vector space.

20. The at least one non-transitory computer-readable medium of claim **19**, further storing computer-readable instructions that, when executed by at least one of the one or more computing devices, cause at least one of the one or more computing devices to:

determine one or more outcome values for one or more prior claims corresponding to the one or more claim vectors proximate to the current claim vector, each outcome value indicating an outcome of a prior claim;

determine an approval probability value for the current claim record based at least in part on the one or more outcome values, the one or more claim vectors, and the current claim vector; and

transmit the approval probability value in the user interface.

21. The at least one non-transitory computer-readable medium of claim **17**, wherein the provision vector database is generated by:

receiving one more provisioning structures;

segmenting the one or more provisioning structures to generate a plurality of segments; and

encoding the plurality of segments to generate the plurality of provision vectors, each provision vector comprising a multidimensional data structure representing semantic content in a corresponding segment.

22. The at least one non-transitory computer-readable medium of claim **21**, wherein the schedule corresponding to the one or more provisioning structures is generated by:

parsing the one or more provisioning structures to identify a plurality of provisioning structure codes and a plurality of provisions;

identifying one or more provisions in the plurality of provisions related to each provisioning structure code in the plurality of provisioning structure codes; and

generating the schedule based at least in part on the plurality of provisioning structure codes and the one or more provisions related to each provisioning structure code.

23. The at least one non-transitory computer-readable medium of claim **17**, wherein the optimization criteria comprises one or more of:

a predicted probability of approval of the current claim record;

an overall revenue resulting from the current claim record; or

a predicted response time for the current claim record.

24. The at least one non-transitory computer-readable medium of claim **17**, wherein transforming the current claim record based at least in part on the determined optimal coding comprises one or more of:

replacing at least one code in the plurality of codes with at least one alternate code;

removing at least one code in the plurality of codes;

adding at least one new code to the plurality of codes;

changing an ordering of two or more codes in the plurality of codes; or

modifying a description associated with at least one code in the plurality of codes.

* * * * *