US012387058B2

(12) **United States Patent**
Ranganathan et al.

(10) **Patent No.: US 12,387,058 B2**
(45) **Date of Patent: Aug. 12, 2025**

(54) **SYSTEMS AND METHODS FOR REDUCING INPUT TO AND INCREASING PROCESSING SPEEDS OF NATURAL LANGUAGE PROCESSING MODELS**

(71) Applicant: **Verizon Patent and Licensing Inc.**, Basking Ridge, NJ (US)

(72) Inventors: **Prakash Ranganathan**, Gingee (IN); **Miruna Jayakrishnasamy**, Vellore (IN)

(73) Assignee: **Verizon Patent and Licensing Inc.**, Basking Ridge, NJ (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **18/758,444**

(22) Filed: **Jun. 28, 2024**

(65) **Prior Publication Data**

US 2024/0354518 A1 Oct. 24, 2024

Related U.S. Application Data

(63) Continuation of application No. 17/752,230, filed on May 24, 2022, now Pat. No. 12,050,879.

(51) **Int. Cl.**

G06F 40/30	(2020.01)
G06F 40/226	(2020.01)
G06F 40/284	(2020.01)
G06F 40/40	(2020.01)

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

CPC ***G06F 40/40*** (2020.01); ***G06F 40/226*** (2020.01); ***G06F 40/284*** (2020.01); ***G06F 40/30*** (2020.01)

(58) **Field of Classification Search**

CPC G06F 40/211; G06F 40/253; G06F 40/268; G06F 40/284; G06F 40/30

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

9,135,242	B1 *	9/2015	Wang	G06F 40/30
9,336,192	B1 *	5/2016	Barba	G06F 40/284
9,767,165	B1 *	9/2017	Tacchi	G06F 16/9535
11,379,538	B1 *	7/2022	McClusky	G06F 16/93
11,620,320	B1 *	4/2023	Shukla	G06F 40/30 707/692
2008/0189269	A1 *	8/2008	Olsen	G06F 16/951 707/999.005
2009/0193011	A1 *	7/2009	Blair-Goldensohn	G06F 16/345 707/999.005
2011/0106807	A1 *	5/2011	Srihari	G06F 16/288 707/E17.046

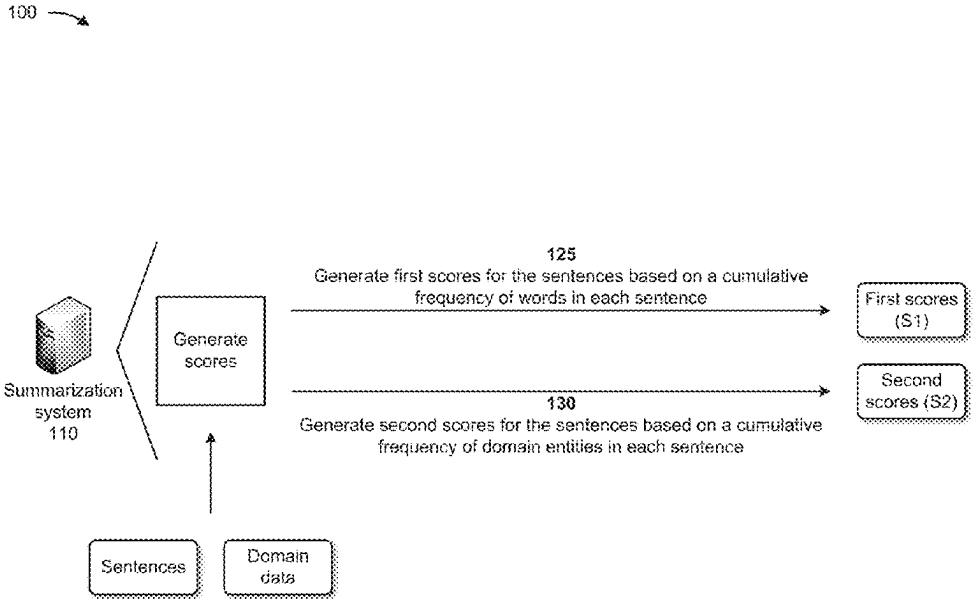
(Continued)

Primary Examiner — Lamont M Spooner

(57) **ABSTRACT**

A device may generate first scores for sentences of text based on a cumulative frequency of words in each sentence, may generate second scores for the sentences based on a cumulative frequency of domain entities in each sentence, and may generate third scores for the sentences based on a sentiment analysis of each sentence. The device may generate a summary of the text, may filter the sentences to extract a first set of sentences, may filter the sentences to extract a second set of sentences, and may filter the sentences to extract a third set of sentences. The device may identify and assign weights to a first group of sentences, a second group of sentences, and a third group of sentences, may generate a ranked list of sentences based on the weighted first group, second group, and third group, and may perform actions based on the final summary.

20 Claims, 12 Drawing Sheets



(56) **References Cited**

U.S. PATENT DOCUMENTS

2011/0209043	A1*	8/2011	Guo	G06F 40/30 715/230
2011/0251977	A1*	10/2011	Cialowicz	G06F 16/313 705/342
2013/0311485	A1*	11/2013	Khan	G06F 16/335 707/758
2015/0339288	A1*	11/2015	Baker	G06F 40/166 704/9
2018/0113855	A1*	4/2018	Bostick	G06F 40/205
2018/0121539	A1*	5/2018	Ciulla	G06F 16/3344
2018/0336507	A1*	11/2018	Torrado	G06N 20/00
2019/0121852	A1*	4/2019	Applegate	H04L 12/1831
2019/0129920	A1*	5/2019	Bainer	G06F 40/30
2019/0179903	A1*	6/2019	Terry	G06N 3/004
2019/0180195	A1*	6/2019	Terry	G06F 40/295
2019/0279101	A1*	9/2019	Habti	G06F 9/541
2019/0332666	A1*	10/2019	Dadachev	G06F 40/284
2020/0034433	A1*	1/2020	Cassidy	G06F 21/32
2020/0090059	A1*	3/2020	Kim	G06Q 50/18
2020/0210490	A1*	7/2020	Hutchins	G06V 30/412
2020/0210521	A1*	7/2020	Hutchins	G06F 40/221
2020/0311344	A1*	10/2020	Tripathi	G06F 16/24575
2021/0110113	A1*	4/2021	Brousseau	G06F 40/55
2022/0253605	A1*	8/2022	Tan	G06Q 10/1095
2022/0254348	A1*	8/2022	Tay	G06F 16/345
2023/0112589	A1*	4/2023	Kanagovi	G06N 3/08 707/739
2023/0116515	A1*	4/2023	Kanagovi	G06F 40/295 704/9

* cited by examiner

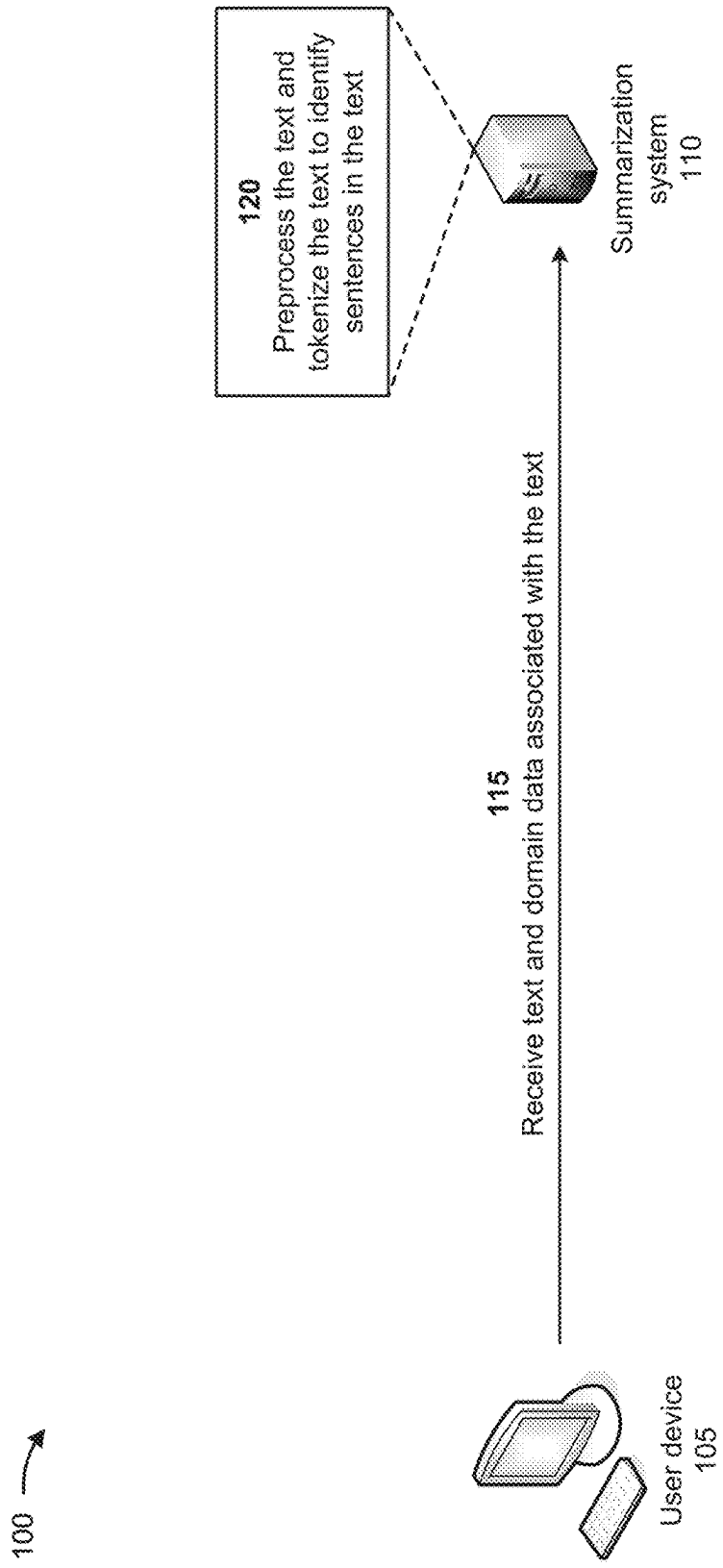

100
User device
105
115
Receive text and domain data associated with the text
Summarization
system
110
120
Preprocess the text and
tokenize the text to identify
sentences in the text

FIG. 1A

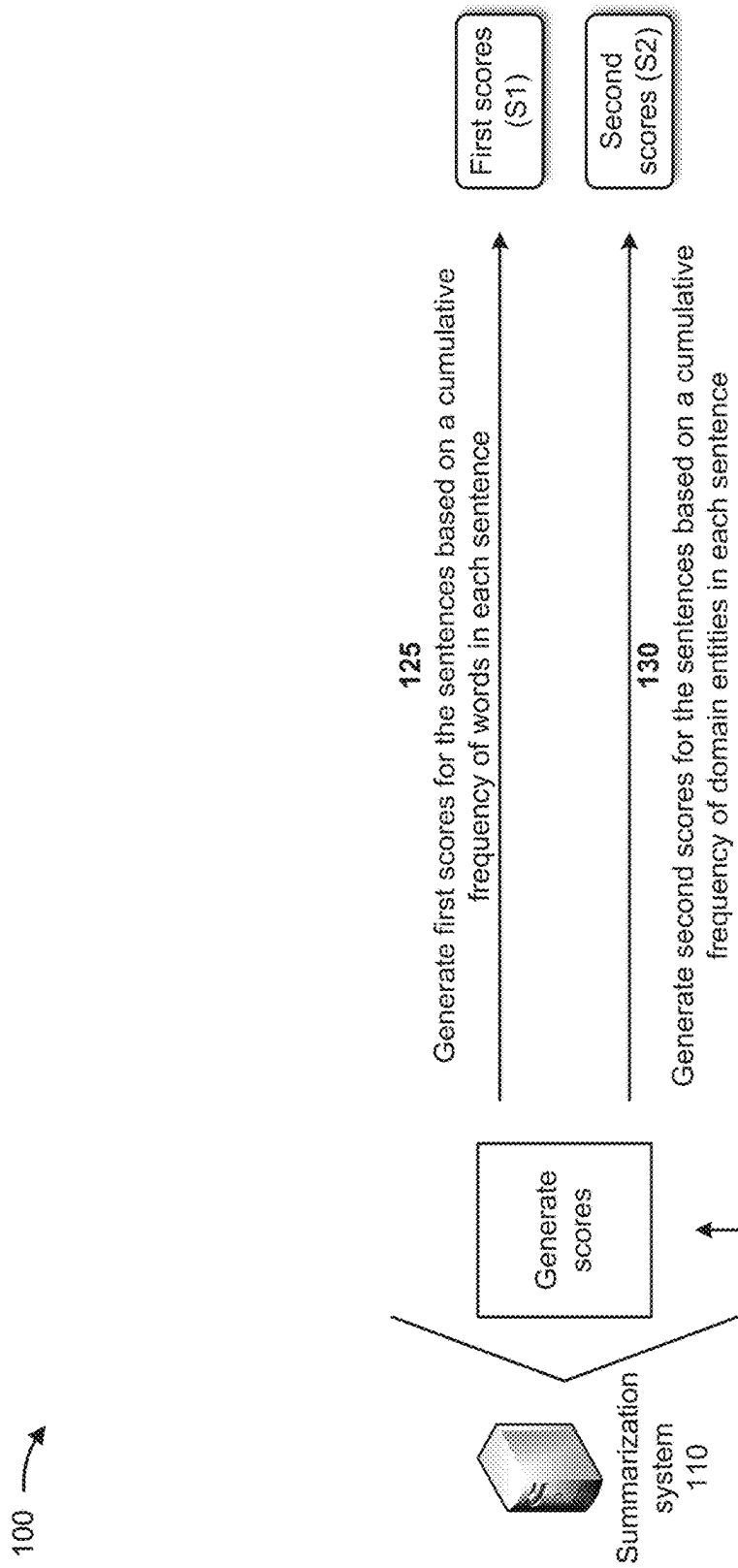

100
Summarization system 110
Sentences
Domain data
Generate scores
125
Generate first scores for the sentences based on a cumulative frequency of words in each sentence
130
Generate second scores for the sentences based on a cumulative frequency of domain entities in each sentence
First scores (S1)
Second scores (S2)

FIG. 1B

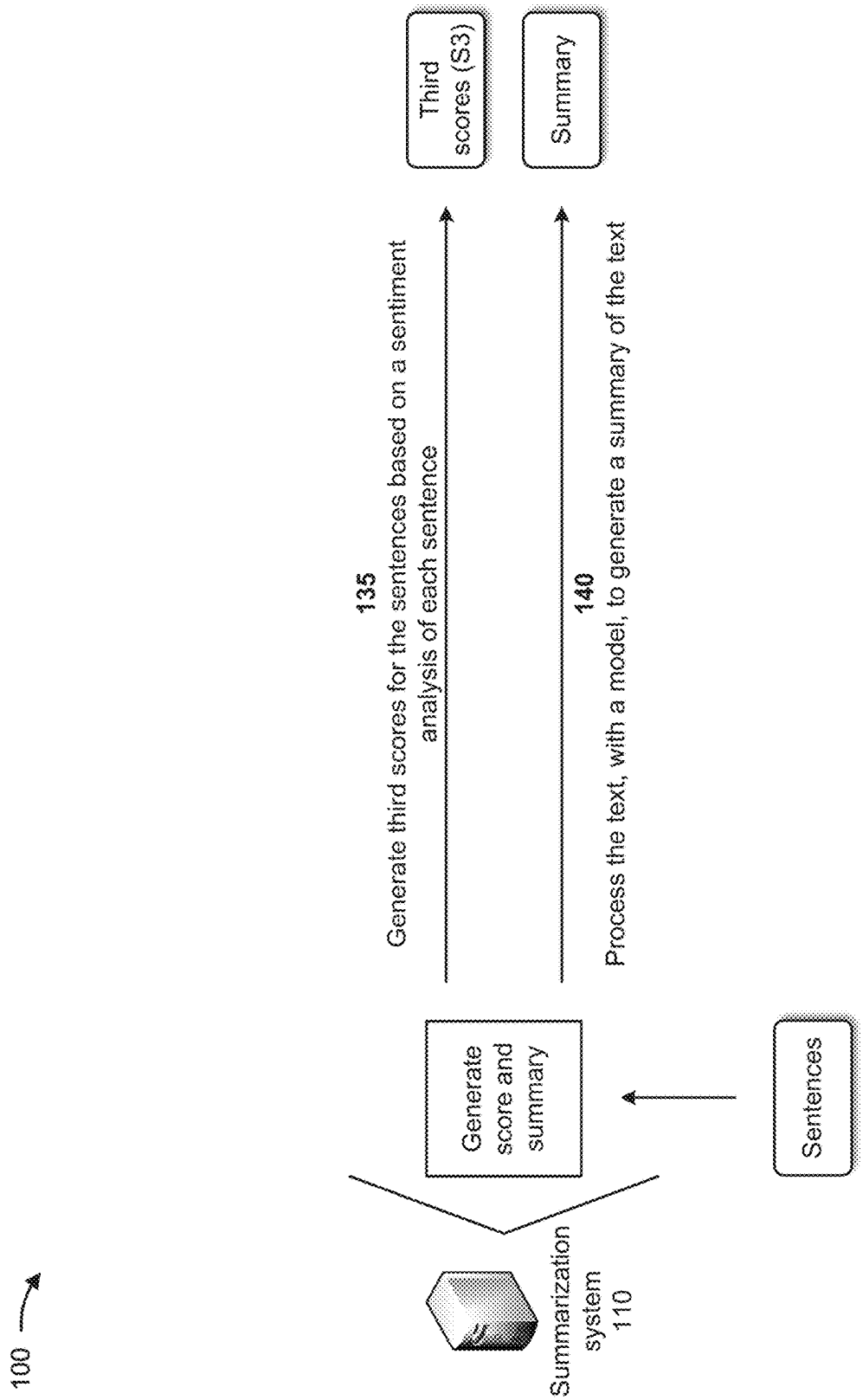

100
Summarization system 110
Generate score and summary
Sentences
135
Generate third scores for the sentences based on a sentiment analysis of each sentence
140
Process the text, with a model, to generate a summary of the text
Third scores (S3)
Summary

FIG. 1C

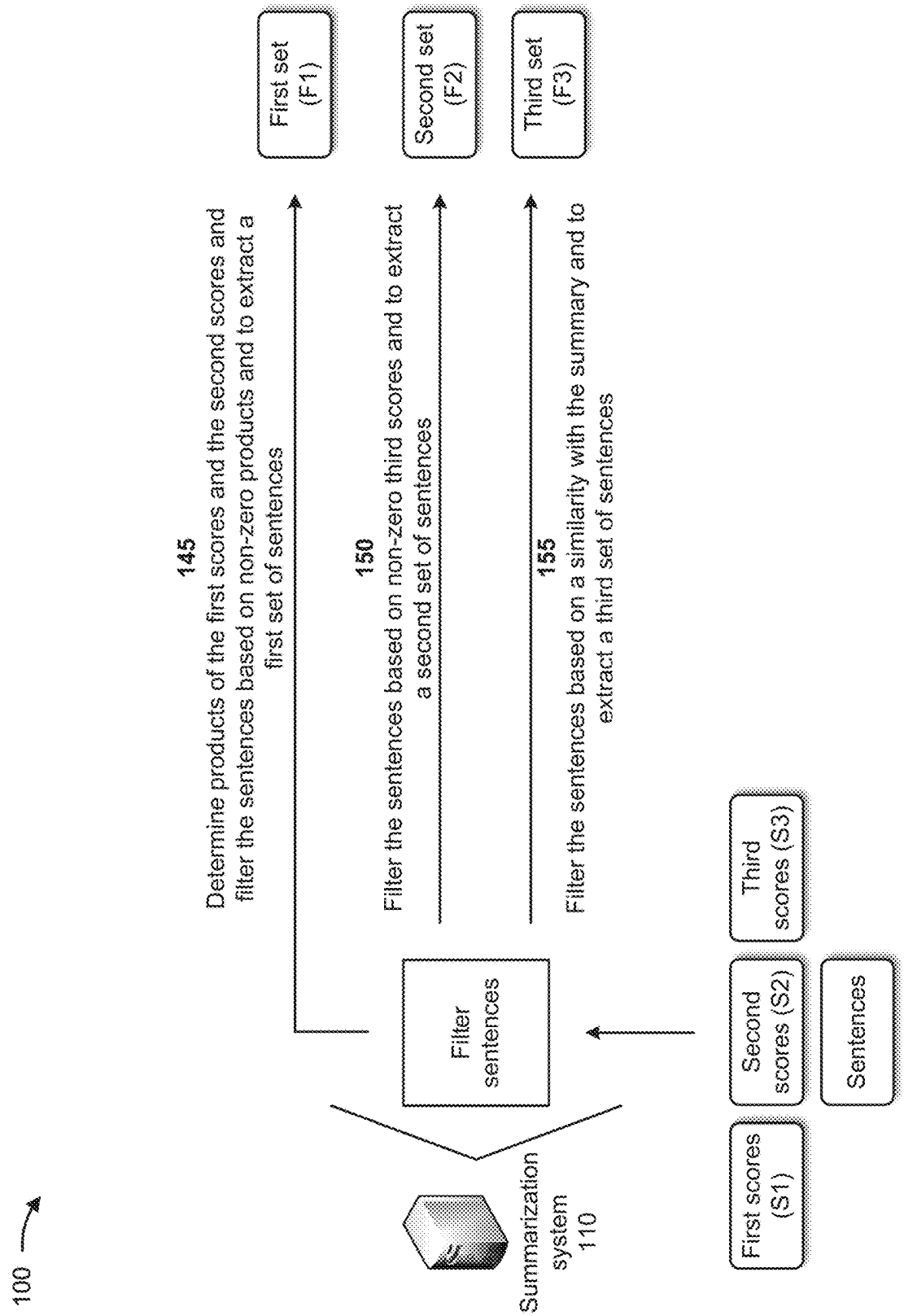

100
Summarization system 110
First scores (S1)
Second scores (S2)
Third scores (S3)
Sentences
Filter sentences
145
Determine products of the first scores and the second scores and filter the sentences based on non-zero products and to extract a first set of sentences
150
Filter the sentences based on non-zero third scores and to extract a second set of sentences
155
Filter the sentences based on a similarity with the summary and to extract a third set of sentences
First set (F1)
Second set (F2)
Third set (F3)

FIG. 1D

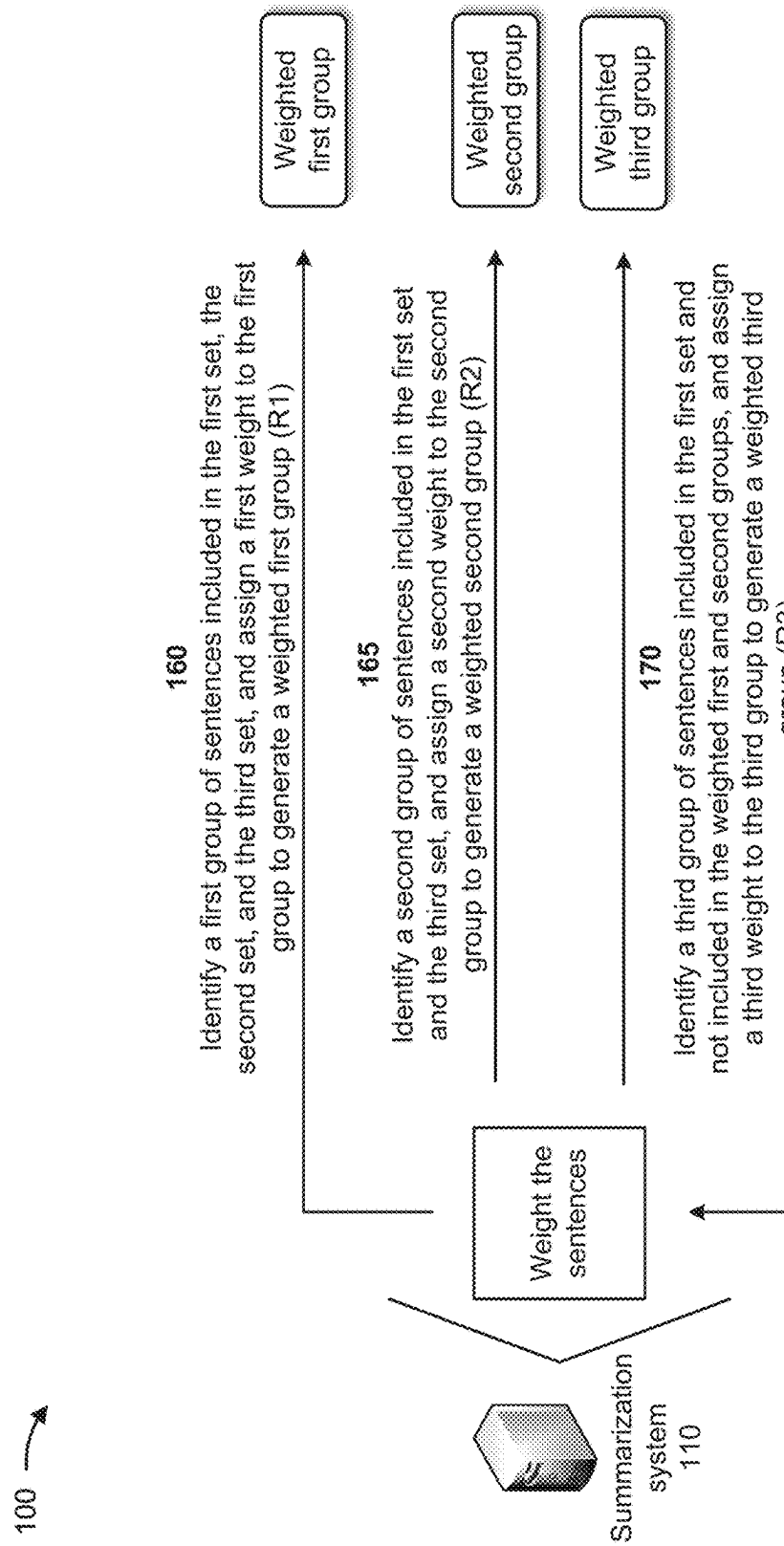

100
Summarization system 110
First set (F1)
Second set (F2)
Third set (F3)
Weight the sentences
160
Identify a first group of sentences included in the first set, the second set, and the third set, and assign a first weight to the first group to generate a weighted first group (R1)
165
Identify a second group of sentences included in the first set and the third set, and assign a second weight to the second group to generate a weighted second group (R2)
170
Identify a third group of sentences included in the first set and not included in the weighted first and second groups, and assign a third weight to the third group to generate a weighted third group (R3)
Weighted first group
Weighted second group
Weighted third group

FIG. 1E

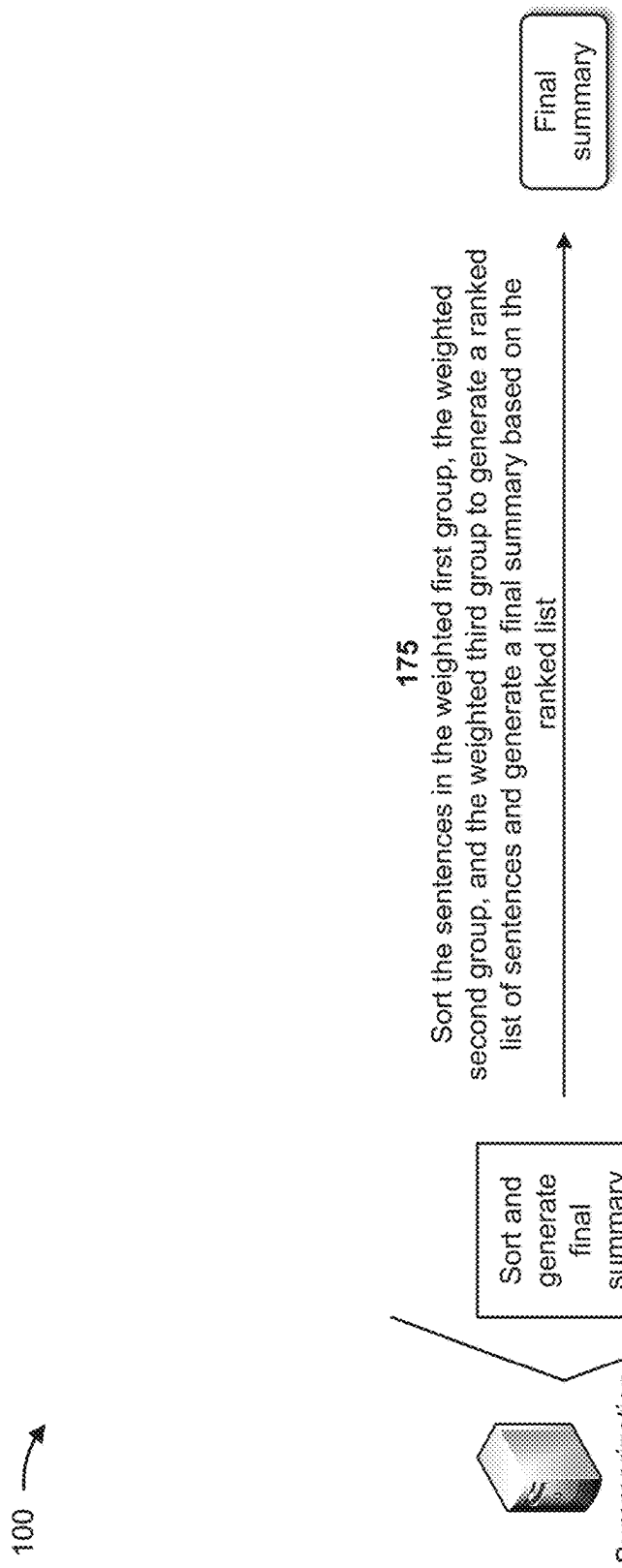

100
Summarization system 110
Weighted first group
Weighted second group
Weighted third group
Sort and generate final summary
175
Sort the sentences in the weighted first group, the weighted second group, and the weighted third group to generate a ranked list of sentences and generate a final summary based on the ranked list
Final summary

FIG. 1F

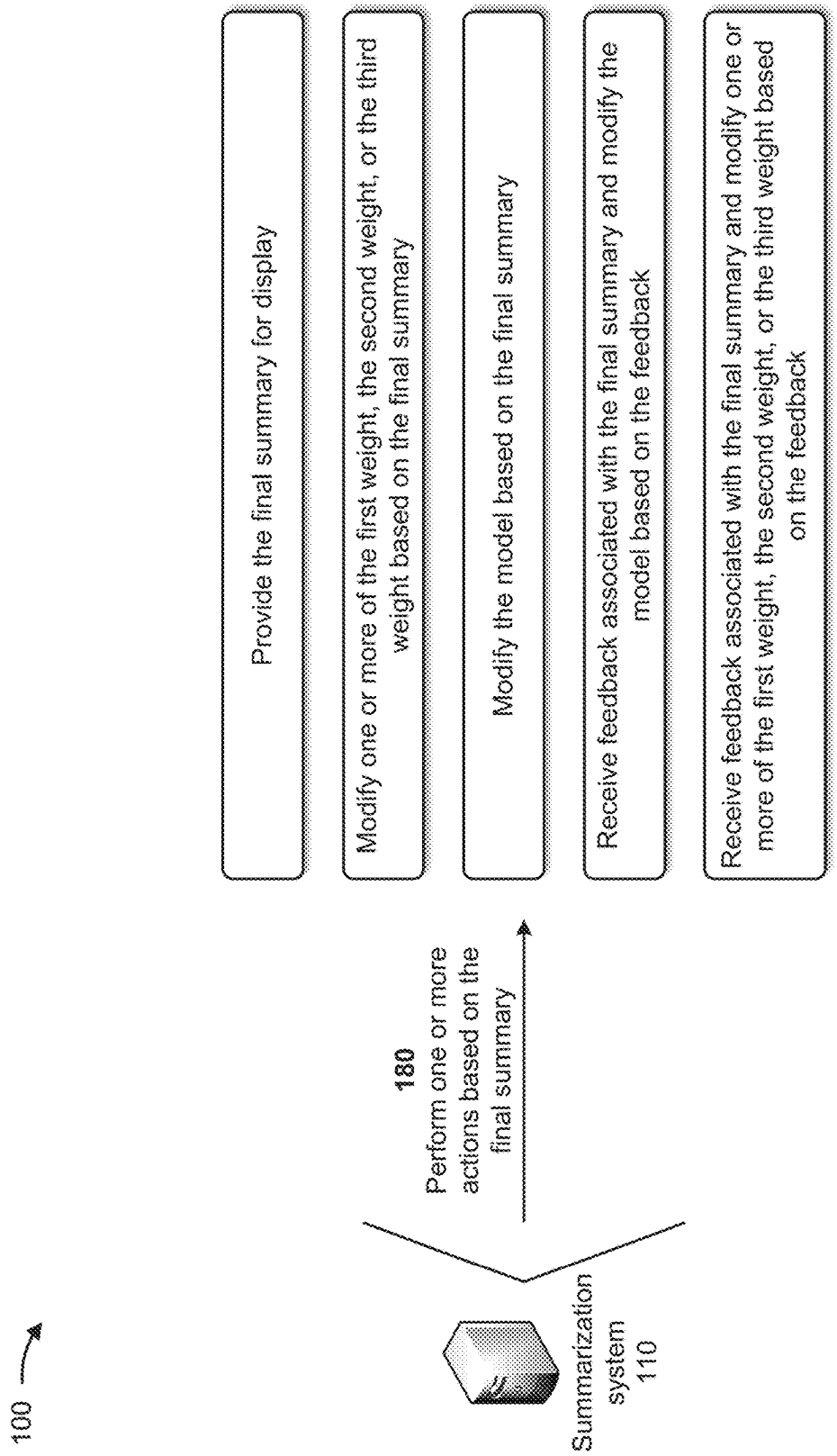

100
Summarization system 110
180
Perform one or more actions based on the final summary
Provide the final summary for display
Modify one or more of the first weight, the second weight, or the third weight based on the final summary
Modify the model based on the final summary
Receive feedback associated with the final summary and modify the model based on the feedback
Receive feedback associated with the final summary and modify one or more of the first weight, the second weight, or the third weight based on the feedback

FIG. 1G

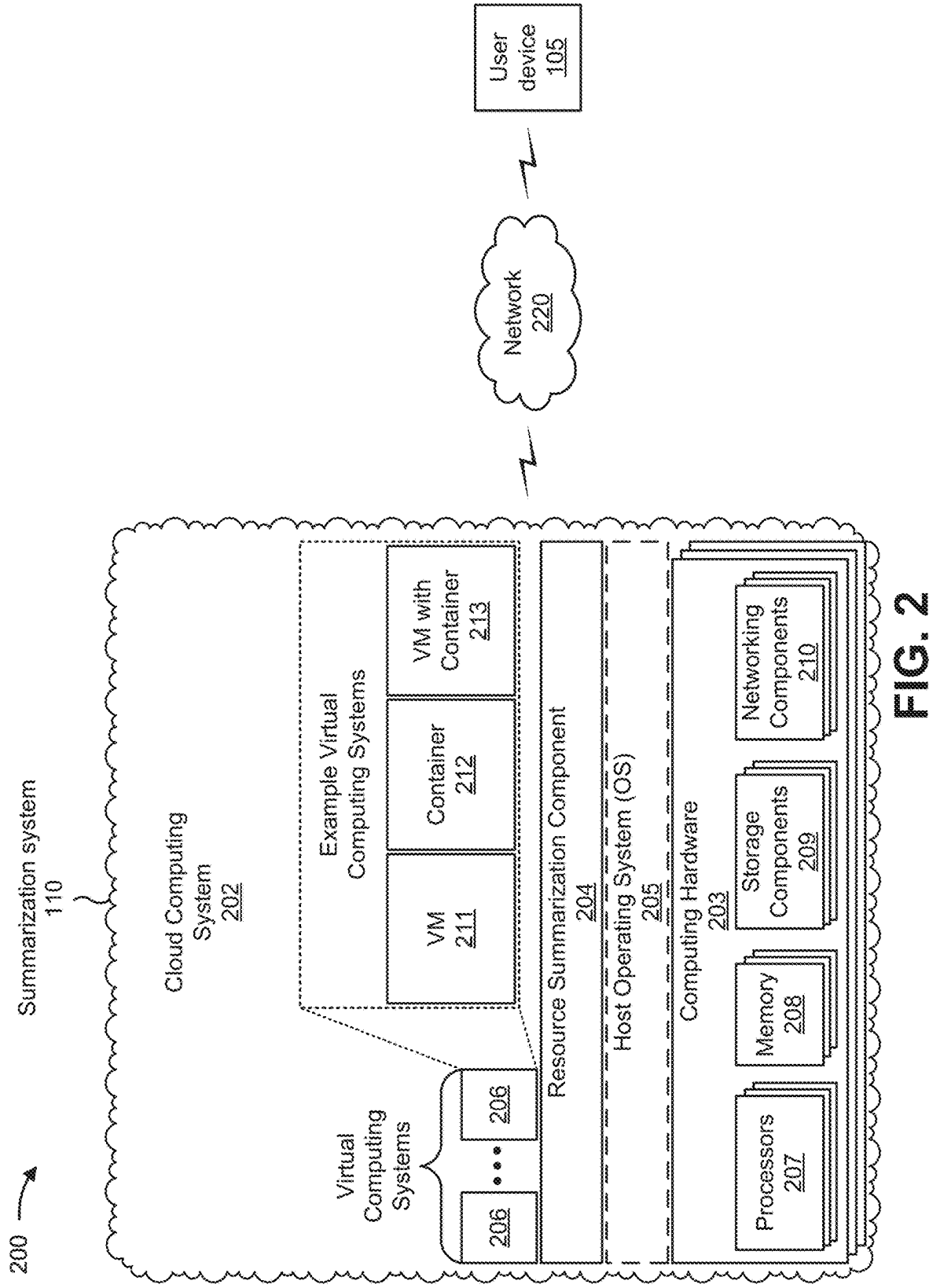

200
Summarization system
110
Cloud Computing System
202
Example Virtual Computing Systems
VM
211
Container
212
VM with Container
213
Virtual Computing Systems
206
206
Resource Summarization Component
204
Host Operating System (OS)
205
Computing Hardware
203
Processors
207
Memory
208
Storage Components
209
Networking Components
210
Network
220
User device
105

FIG. 2

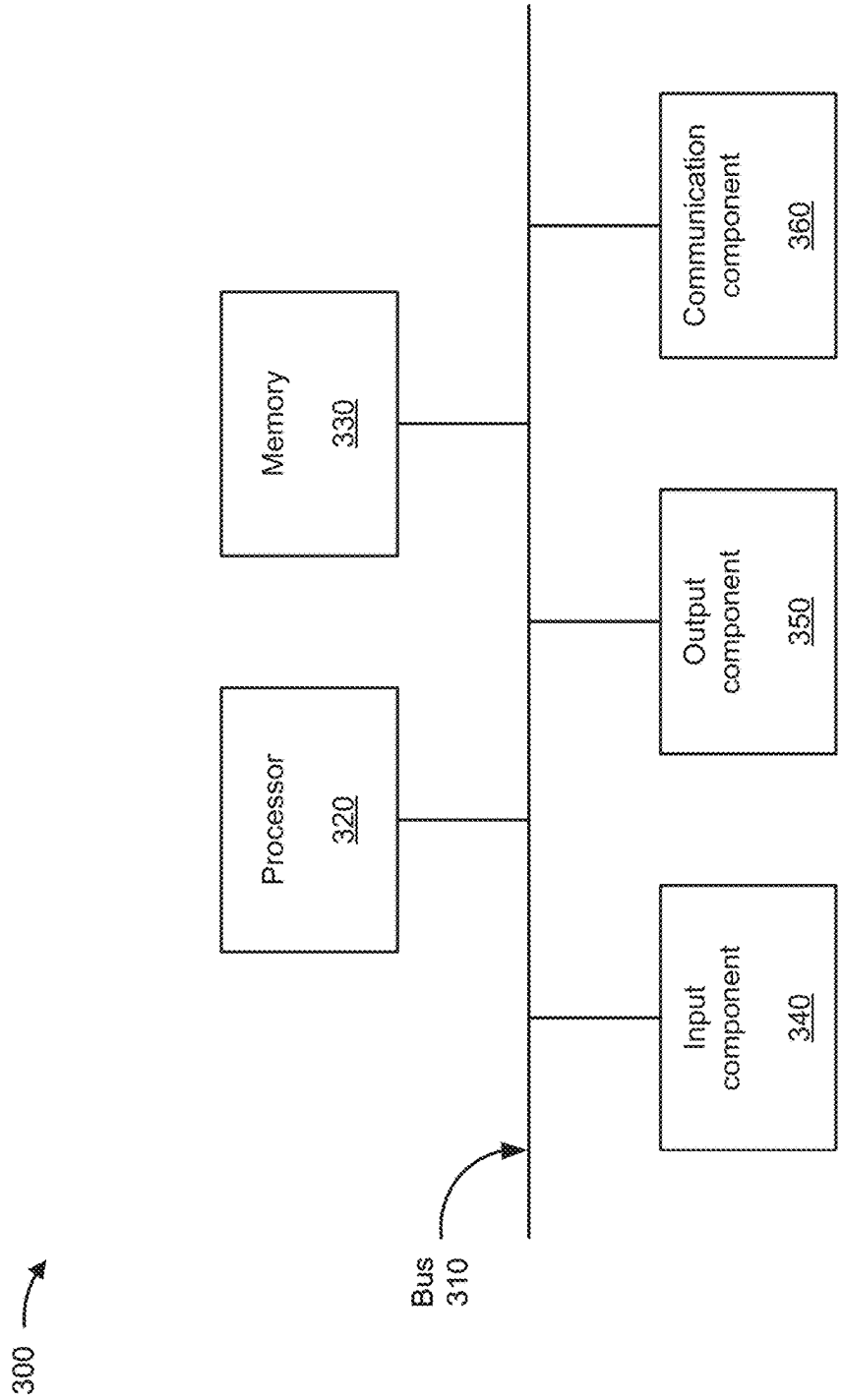

300
Bus
310
Processor
320
Memory
330
Input component
340
Output component
350
Communication component
360

FIG. 3

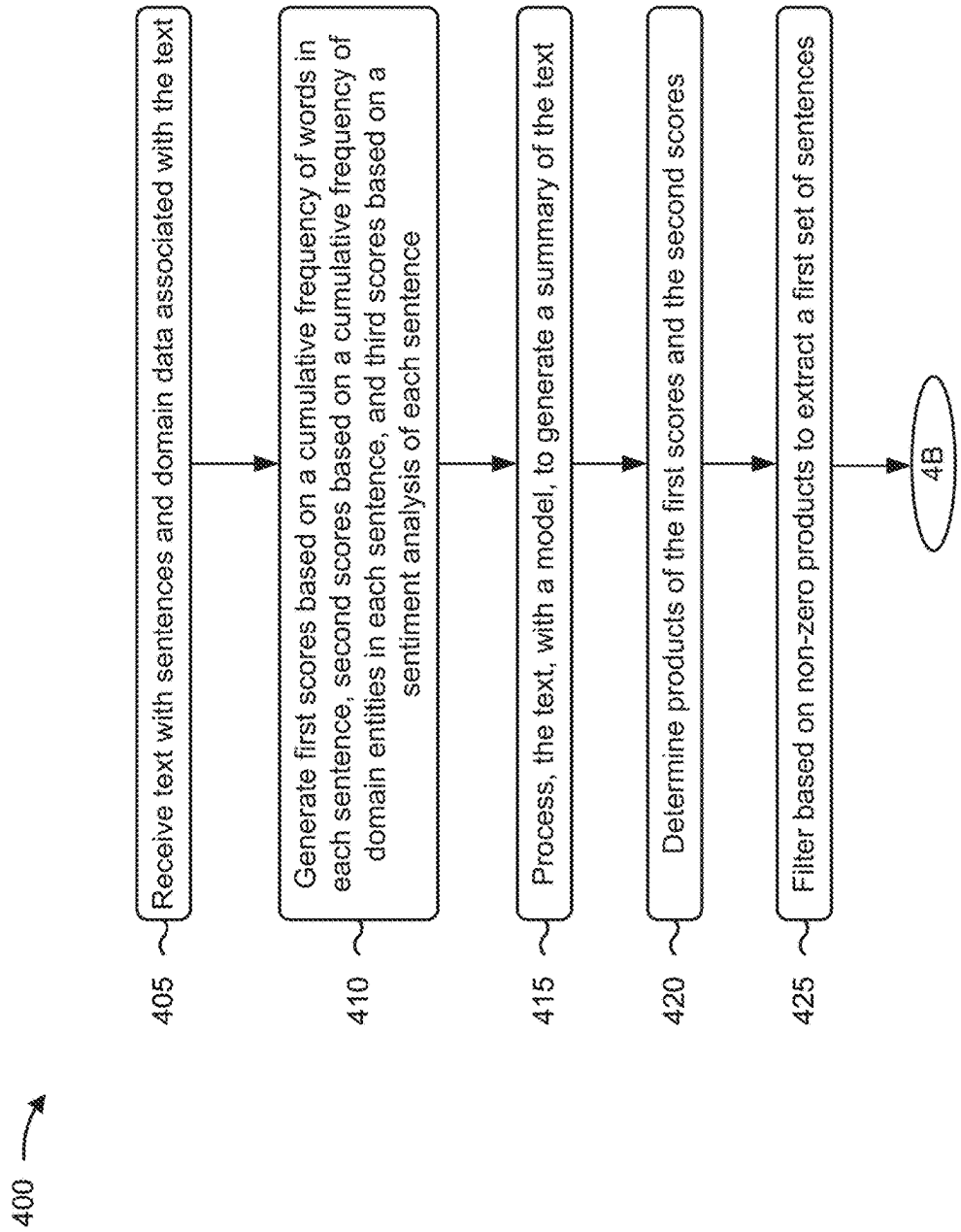

400
405
Receive text with sentences and domain data associated with the text
410
Generate first scores based on a cumulative frequency of words in each sentence, second scores based on a cumulative frequency of domain entities in each sentence, and third scores based on a sentiment analysis of each sentence
415
Process, the text, with a model, to generate a summary of the text
420
Determine products of the first scores and the second scores
425
Filter based on non-zero products to extract a first set of sentences
4B

FIG. 4A

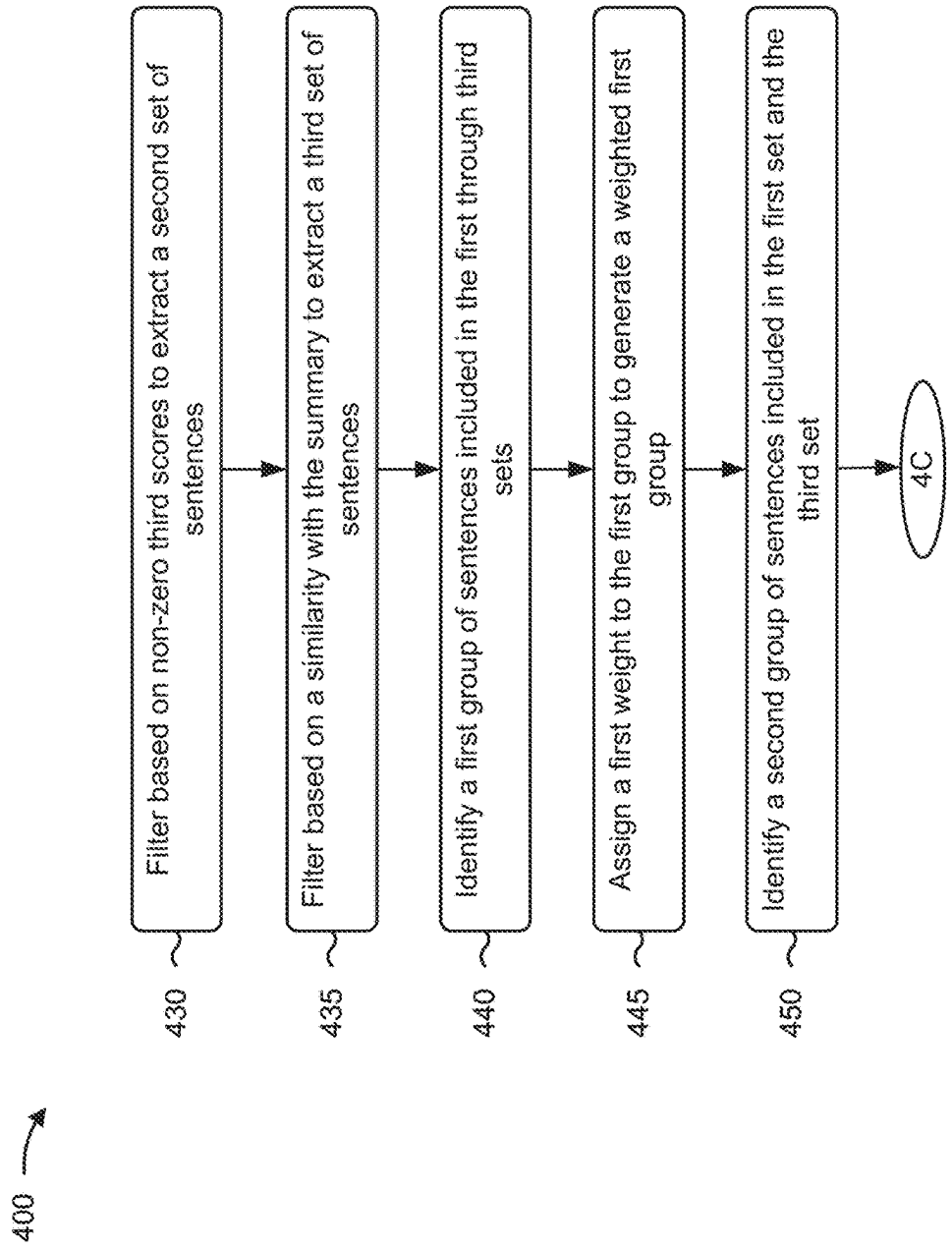

400
430
Filter based on non-zero third scores to extract a second set of sentences
435
Filter based on a similarity with the summary to extract a third set of sentences
440
Identify a first group of sentences included in the first through third sets
445
Assign a first weight to the first group to generate a weighted first group
450
Identify a second group of sentences included in the first set and the third set
4C

FIG. 4B

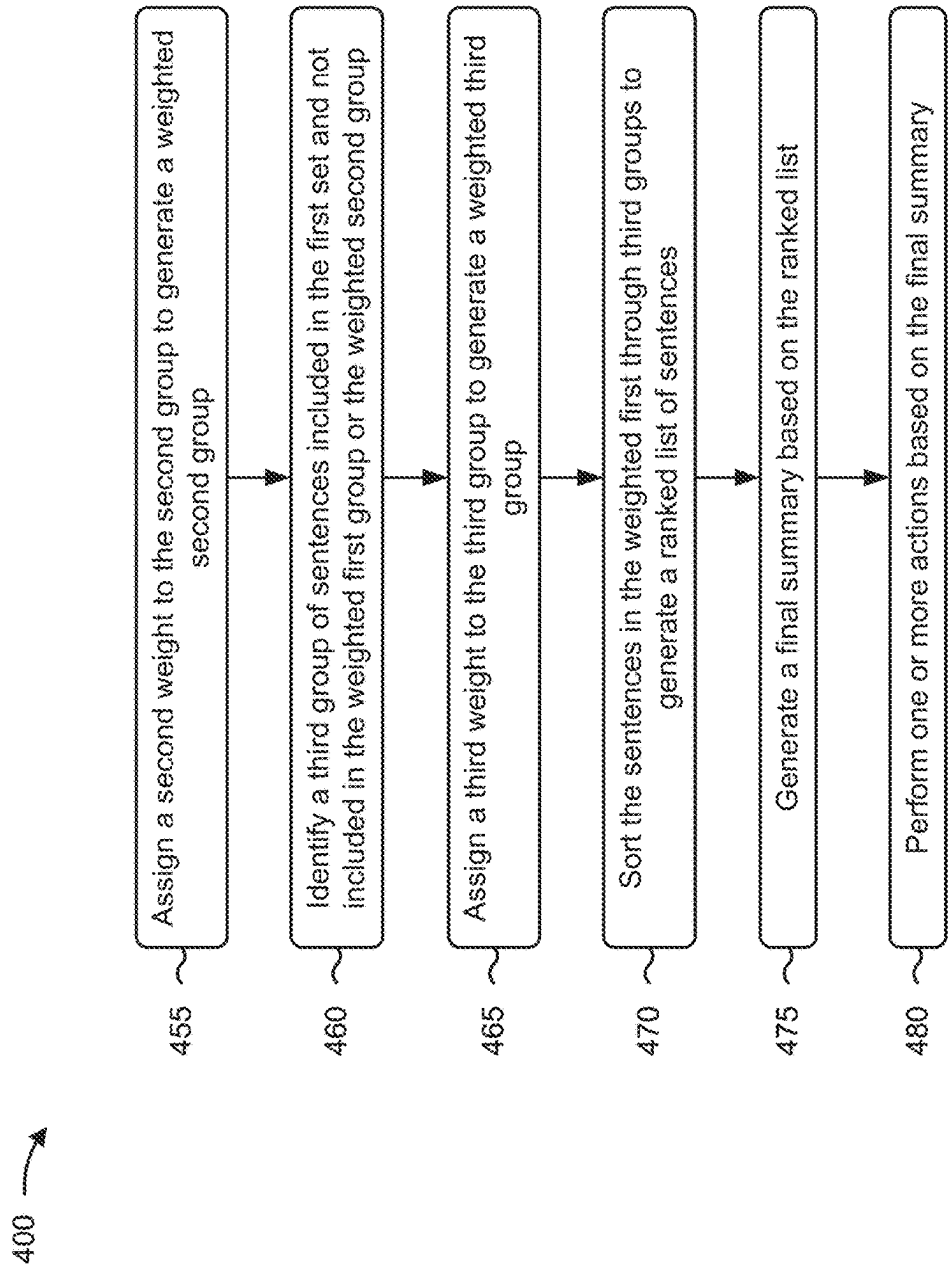

400
455
Assign a second weight to the second group to generate a weighted second group
460
Identify a third group of sentences included in the first set and not included in the weighted first group or the weighted second group
465
Assign a third weight to the third group to generate a weighted third group
470
Sort the sentences in the weighted first through third groups to generate a ranked list of sentences
475
Generate a final summary based on the ranked list
480
Perform one or more actions based on the final summary

FIG. 4C

SYSTEMS AND METHODS FOR REDUCING INPUT TO AND INCREASING PROCESSING SPEEDS OF NATURAL LANGUAGE PROCESSING MODELS

RELATED APPLICATION

This application is a continuation of U.S. patent application Ser. No. 17/752,230, entitled "SYSTEMS AND METHODS FOR REDUCING INPUT TO AND INCREASING PROCESSING SPEEDS OF NATURAL LANGUAGE PROCESSING MODELS," filed May 24, 2022, which is incorporated herein by reference in its entirety.

BACKGROUND

Natural language processing (NLP) is a subfield of linguistics, computer science, and artificial intelligence concerned with interactions between computers and human language. In particular, NLP includes processing and analyzing large quantities of natural language data with a goal of understanding content of documents, including contextual nuances of languages within the documents. NLP may extract information and insights contained in the documents, as well as categorize and organize the documents.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGS. **1**A-**1**G are diagrams of an example associated with reducing input to and increasing processing speeds of NLP models.

FIG. **2** is a diagram of an example environment in which systems and/or methods described herein may be implemented.

FIG. **3** is a diagram of example components of one or more devices of FIG. **2**.

FIGS. **4**A-**4**C depict a flowchart of an example process for reducing input to and increasing processing speeds of NLP models.

DETAILED DESCRIPTION OF EXAMPLE EMBODIMENTS

The following detailed description of example implementations refers to the accompanying drawings. The same reference numbers in different drawings may identify the same or similar elements.

One challenge of NLP is dimensionality, especially when processing documents in real time. Dimensionality means that text from documents includes additional words and/or sentences that are not necessary to understand a context of the text. However, NLP still processes the additional words and/or sentences, which results in unnecessary computational overload, reduced accuracy, ambiguity, increased carbon emission, failure to process documents in real time, and/or the like. For example, user interactions with respect to products may include sharing opinions on products that the users have purchased. An effective multi-document summarization of user reviews, chats, calls, and other kinds of evaluative text containing opinions and preferences is an ever-growing area of NLP. However, due to dimensionality, NLP-generated summary text may contain words and/or sentences not related to a context of the summary text. Thus, current NLP products consume computing resources (e.g., processing resources, memory resources, communication resources, and/or the like), networking resources, and/or other resources associated with handling computational overload due to high dimensionality (e.g., or greater than a dimensionality threshold), generating less accurate summary text due to high dimensionality, generating ambiguous summary text due to high dimensionality, increasing carbon emissions due to high dimensionality, and/or the like.

Some implementations described herein provide a summarization system that reduces input to and increases processing speeds of NLP models (e.g., in real time). For example, the summarization system may receive text with sentences and domain data associated with the text, and may generate first scores for the sentences based on a cumulative frequency of words in each sentence. The summarization system may generate second scores for the sentences based on a cumulative frequency of domain entities in the domain data and in each sentence, and may generate third scores for the sentences based on a sentiment analysis of each sentence. The summarization system may process the text, with a model, to generate a summary of the text, and may determine products of the first scores and the second scores. The summarization system may filter the sentences based on non-zero products and to extract a first set of sentences, and may filter the sentences based on non-zero third scores and to extract a second set of sentences. The summarization system may filter the sentences based on a similarity with the summary and to extract a third set of sentences, and may identify a first group of sentences included in the first set, the second set, and the third set. The summarization system may identify a second group of sentences included in the first set and the third set, and may assign a first weight to the first group to generate a weighted first group, and a second weight to the second group to generate a weighted second group. The summarization system may identify a third group of sentences included in the first set and not included in the weighted first group or the weighted second group, and may assign a third weight to the third group to generate a weighted third group. The summarization system may sort the sentences in the weighted first group, the weighted second group, and the weighted third group to generate a ranked list of sentences, may generate a final summary based on the ranked list, and may perform one or more actions based on the final summary.

In this way, the summarization system reduces input to and increases processing speeds of NLP models. For example, the summarization system may generate a text summary that combines sentiment, domain knowledge associated with entities, word frequency, and an abstract summary associated with the text. The summarization system may examine the text, based on the sentiment, the domain knowledge, the word frequency, and the abstract summary associated with the text, to capture knowledge of the text in a reduced (e.g., a summarized) form. The summarization system may identify and retain sentences of the text associated with strong sentiment aspects, and may retain sentences of the text that include the domain knowledge. The summarization system may generate the abstract summary in order to identify an objective of the text. Thus, the summarization system may conserve computing resources, networking resources, and/or other resources that would have otherwise been consumed by handling computational overload due to high dimensionality, generating less accurate summary text due to high dimensionality, generating ambiguous summary text due to high dimensionality, increasing carbon emissions due to high dimensionality, and/or the like.

FIGS. **1**A-**1**G are diagrams of an example **100** associated with reducing input to and increasing processing speeds of NLP models. As shown in FIGS. **1**A-**1**G, example **100**

includes a user device **105** associated with a summarization system **110**. Further details of the user device **105** and the summarization system **110** are provided elsewhere herein.

As shown in FIG. **1**A, and by reference number **115**, the summarization system **110** may receive text and domain data associated with the text. For example, the summarization system **110** may receive the text from the user device **105** in a textual format, an audio format, a video format, and/or the like. If the text is received in an audio format or a video format, the summarization system **110** may convert the audio or video format to a textual format. In one example use case, the text may include text received during a bot chat session or a bot telephone call that is to be transferred to a call center employee. The summarization system **110** may receive the domain data from the user device **105** and/or from a secondary source. The domain data may include data identifying one or more domain entities (e.g., companies, agencies, products, services, offers, reviews, chats, calls, refunds, payments, cancellations, and/or the like) associated with the text.

As further shown in FIG. **1**A, and by reference number **120**, the summarization system **110** may preprocess the text and tokenize the text to identify sentences in the text. For example, the summarization system **110** may preprocess the text by applying one or more data cleansing techniques to the text. A data cleansing technique may remove and/or modify one or more particular words (e.g., common words such as "a," "the," and/or the like) from the text to generate clean text. In some implementations, when preprocessing the text, with the data cleansing technique, the summarization system **110** may remove duplicate data from the text, may convert incorrectly formatted data of the text into correct formats, may combine date and time data of the text, and/or the like, to generate the clean text. In some implementations, the data cleansing technique may detect and correct (or remove) corrupt or inaccurate data in the text, and may replace, modify, or delete the corrupt or inaccurate data. The data cleansing technique may detect and correct inconsistencies in the text caused by corruption in transmission or storage, caused by utilization of different definitions for similar data in different data structures, and/or the like. The data cleansing technique may remove typographical errors from the text or may validate and correct values against a known list of values. The data cleansing technique may clean the text by cross checking the text with validated text, standardizing the text by changing a reference data set to a new standard, and/or the like. Additionally, the data cleansing technique may include data enhancement, where the text is made more complete by adding related information to the text.

The summarization system **110** may tokenize the clean text to identify sentences in the clean text. In some implementations, the summarization system **110** may tokenize the text using a tokenization technique. For example, the summarization system **110** may generate various sequences of characters from the text. The summarization system **110** may generate a set of multiple terms from a multi-term phrase, may contract a phrase to an acronym (or may expand an acronym), may classify text as a particular type of text and may remove a symbol from the text that indicates the classification of the text (e.g., may classify "$1.00" as a dollar amount and may tokenize "$1.00" to "1"), may remove particular terms and/or phrases from the text (e.g., may remove ", Inc." or "Company" from text that includes an organization's name), and/or the like. This may reduce a size of the text, thereby conserving memory resources, processing resources, and/or the like associated with the summarization system **110**.

As shown in FIG. **1**B, and by reference number **125**, the summarization system **110** may generate first scores (S1) for the sentences based on a cumulative frequency of words in each sentence. For example, the summarization system **110** may identify words in each of the sentences and may calculate a cumulative frequency of the words identified in each of the sentences. The summarization system **110** may generate a first score for each of the sentences based on the cumulative frequency of words identified in each of the sentences. In some implementations, when generating the first scores for the sentences based on the cumulative frequency of the words in each sentence, the summarization system **110** may normalize the cumulative frequency of the words in each sentence to generate the first scores for the sentences.

As further shown in FIG. **1**B, and by reference number **130**, the summarization system **110** may generate second scores (S2) for the sentences based on a cumulative frequency of domain entities (e.g., identified in the domain data) in each sentence. For example, the summarization system **110** may identify domain entities in each of the sentences and may calculate a cumulative frequency of the domain entities identified in each of the sentences. The summarization system **110** may generate a second score for each of the sentences based on the cumulative frequency of domain entities identified in each of the sentences. In some implementations, when generating the second scores for the sentences based on the cumulative frequency of the domain entities in each sentence, the summarization system **110** may normalize the cumulative frequency of the domain entities in each sentence to generate the second scores for the sentences.

As shown in FIG. **1**C, and by reference number **135**, the summarization system **110** may generate third scores (S3) for the sentences based on a sentiment analysis of each sentence. For example, the summarization system **110** may extract phrases from the sentences, and may determine sentiments associated with the phrases. The summarization system **110** may generate the third scores for the sentences based on the sentiments associated with the phrases. In some implementations, the summarization system **110** may increment frequencies for phrases with zero sentiments, and may normalize final frequencies (e.g., by calculating 1−(final frequency/total quantity of phrases)) to generate the third scores for the sentences. In some implementations, the summarization system **110** may generate the third scores for the sentences based on the following sentiment analysis of each sentence (e.g., where ct is a counter, K is frequency, and N is a quantity of phrases):

```
ct=1
Score=[ ]
for each sentence D:
  K=3      {N<5}
  K=5      {N<30 and N>5}
  K=10     {N>30}
  startindex=0
  endindex=K
  Iterate below step N/K Times:
        If startindex=0:
          sentiment (D[startindex to endindex]) is zero -> ct=ct+1
        Else:
          sentiment (D[startindex-1 to endindex]) is zero -> ct=ct+1
        Endindex=startindex+K    {endindex<(startindex+K)<N}
        Endindex=N               {endindex<=(startindex+K)>=N}
```

-continued

```
    If all N/K parts are neutral then
        Score.append(0.0)
    Else Score.append(1−(ct/N))
Return Score.
```

As further shown in FIG. **1**C, and by reference number **140**, the summarization system **110** may process the text, with a model (e.g., a machine learning model, a skipping text model, and/or the like), to generate a summary of the text. For example, the summarization system **110** may utilize a machine learning model (e.g., an encoder-decoder with a beam three width) to process the text and generate the summary of the text. The summary of the text may identify an objective of the text and may include vocabulary (e.g., one or more words) not included in the text. The machine learning model may process the text to identify sentences in the text associated with the objective of the text and may weight the identified sentences so that identified sentences are retained in the summary of the text. The vocabulary included in the summary, but not included in the text, may aid in identifying the objective of the text.

As shown in FIG. **1**D, and by reference number **145**, the summarization system **110** may determine perform an operation with the first scores and the second scores (e.g., calculate products of the first scores and the second scores) and may filter the sentences based on non-zero products and to extract a first set (F1) of sentences. For example, the summarization system **110** may multiply the first scores and corresponding second scores to determine the products of the first scores and the second scores. In some implementations, the summarization system **110** may multiply a first score and a second score associated with a first sentence to determine a first product, may multiply a first score and a second score associated with a second sentence to determine a second product, and/or the like. This process may continue until the corresponding first and second scores for all of the sentences are multiplied together.

The summarization system **110** may identify sentences associated with non-zero products of the first scores and the second scores, and may filter out the identified sentences into the first set of sentences. In some implementations, the summarization system **110** may sort the first set of sentences based on the products associated with the first set of sentences. For example, a sentence with a greatest product may be listed first in the first set of sentences, a sentence with a next greatest product may be listed second in the first set of sentences, and/or the like. Since the first scores relate to the cumulative frequency of words in each sentence and the second scores relate to the cumulative frequency of domain entities in each sentence, a greater product of the first scores and the second scores may indicate that corresponding sentences are preferable since they include more frequent words and domain entities.

As further shown in FIG. **1**D, and by reference number **150**, the summarization system **110** may filter the sentences based on non-zero third scores and to extract a second set (F2) of sentences. For example, the summarization system **110** may identify sentences associated with non-zero third scores, and may filter out the identified sentences into the second set of sentences. In some implementations, the summarization system **110** may sort the second set of sentences based on the third scores associated with the second set of sentences. For example, a sentence with a greatest third score may be listed first in the second set of sentences, a sentence with a next greatest third score may be listed second in the second set of sentences, and/or the like.

As further shown in FIG. **1**D, and by reference number **155**, the summarization system **110** may filter the sentences based on a similarity with the summary and to extract a third set (F3) of sentences. For example, the summarization system **110** may identify sentences that include keywords (or words similar to the keywords other than domain entities) included in the summary of the text, and may filter out the identified sentences into the third set of sentences. In some implementations, the summarization system **110** may sort the third set of sentences based on a quantity of summary keywords included in the third set of sentences. For example, a sentence with the greatest quantity of summary keywords may be listed first in the third set of sentences, a sentence with a next greatest quantity of summary keywords may be listed second in the third set of sentences, and/or the like.

As shown in FIG. **1**E, and by reference number **160**, the summarization system **110** may identify a first group of sentences included in the first set, the second set, and the third set, and may assign a first weight to the first group to generate a weighted first group of sentences (R1). For example, the summarization system **110** may identify sentences included in the first set of sentences, the second set of sentences, and the third set of sentences, and may group the identified sentences into the first group of sentences. The summarization system **110** may assign the first weight to the first group of sentences to generate the weighted first group of sentences. In some implementations, the first weight may include a value (e.g., 0.8, 0.9, and/or the like) that provides a high weight to the weighted first group of sentences.

As further shown in FIG. **1**E, and by reference number **165**, the summarization system **110** may identify a second group of sentences included in the first set and the third set, and may assign a second weight to the second group to generate a weighted second group of sentences (R2). For example, the summarization system **110** may identify sentences included in the first set of sentences and the third set of sentences, and may group the identified sentences into the second group of sentences. The summarization system **110** may assign the second weight to the second group of sentences to generate the weighted second group of sentences. In some implementations, the second weight may include a value (e.g., 0.5, 0.6, and/or the like) that is less than the first weight and that provides a less high weight to the weighted second group of sentences than provided to the weighted first group of sentences.

As further shown in FIG. **1**E, and by reference number **170**, the summarization system **110** may identify a third group of sentences included in the first set and not included in the weighted first group or the weighted second group, and may assign a third weight to the third group to generate a weighted third group of sentences (R3). For example, the summarization system **110** may identify sentences included in the first set of sentences and not included in the weighted first group of sentences or the weighted second group of sentences, and may group the identified sentences into the third group of sentences. The summarization system **110** may assign the third weight to the third group of sentences to generate the weighted third group of sentences. In some implementations, the third weight may include a value (e.g., 0.2, 0.3, and/or the like) that is less than the second weight and that provides a less high weight to the weighted third group of sentences than provided to the weighted second

group of sentences. In this way, the summarization system **110** may account for sentences that include more frequent words and domain entities.

As shown in FIG. **1**F, and by reference number **175**, the summarization system **110** may sort the sentences in the weighted first group, the weighted second group, and the weighted third group to generate a ranked list of sentences, and may generate a final summary based on the ranked list. For example, the summarization system **110** may generate a list that includes the weighted first group of sentences, the weighted second group of sentences, and the weighted third group of sentences, and may sort the list of sentences, based on the weights assigned to the weighted first group of sentences, the weighted second group of sentences, and the weighted third group of sentences, to generate the ranked list of sentences. Based on the assigned weights, the weighted first group of sentences may be listed first in the ranked list, the weighted second group of sentences may be listed after the weighted first group of sentences in the ranked list, and the weighted third group of sentences may be listed after the weighted second group of sentences in the ranked list.

The summarization system **110** may generate the final summary based on the ranked list and based on a maximum length of text to be included in the final summary. For example, the summarization system **110** may calculate a quantity of sentences to be included in the final summary based on the maximum length of the text to be included in the final summary. The summarization system **110** may select the quantity of sentences from the ranked list of sentences based on the rankings provided to the sentences in the ranked list. For example, the summarization system **110** may select, for the final summary, the top-ranked quantity of sentences included in the ranked list.

As shown in FIG. **1**G, and by reference number **180**, the summarization system **110** may perform one or more actions based on the final summary. In some implementations, performing the one or more actions includes the summarization system **110** providing the final summary for display. For example, the summarization system **110** may provide the final summary to the user device **105** and the user device **105** may display the final summary to a user of the user device **105** (e.g., a call center employee). In this way, the summarization system **110** may conserve computing resources, networking resources, and/or other resources that would have otherwise been consumed by generating less accurate summary text due to high dimensionality, generating ambiguous summary text due to high dimensionality, and/or the like.

In some implementations, performing the one or more actions includes the summarization system **110** modifying one or more of the first weight, the second weight, or the third weight based on the final summary. For example, the summarization system **110** may analyze the final summary and the text to determine a similarity between the final summary and the initial text. The summarization system **110** may modify one or more of the first weight, the second weight, or the third weight based on the similarity (or lack thereof) between the final summary and the initial text so that an improved final summary is generated. In this way, the summarization system **110** may conserve computing resources, networking resources, and/or other resources that would have otherwise been consumed by generating less accurate summary text due to high dimensionality, generating ambiguous summary text due to high dimensionality, and/or the like.

In some implementations, performing the one or more actions includes the summarization system **110** modifying the model based on the final summary. For example, the summarization system **110** may analyze the final summary and the initial text to determine a similarity between the final summary and the initial text. The summarization system **110** may modify the model based on the similarity (or lack thereof) between the final summary and the initial text so that an improved final summary is generated. In this way, the summarization system **110** may conserve computing resources, networking resources, and/or other resources that would have otherwise been consumed by handling computational overload due to high dimensionality, generating ambiguous summary text due to high dimensionality, increasing carbon emissions due to high dimensionality, and/or the like.

In some implementations, performing the one or more actions includes the summarization system **110** receiving feedback associated with the final summary and modifying the model based on the feedback. For example, the summarization system **110** may receive feedback (e.g., from a user of the user device **105**) about the final summary, and may modify the model based on the feedback. In this way, the summarization system **110** may conserve computing resources, networking resources, and/or other resources that would have otherwise been consumed by generating less accurate summary text due to high dimensionality, generating ambiguous summary text due to high dimensionality, and/or the like.

In some implementations, performing the one or more actions includes the summarization system **110** receiving feedback associated with the final summary and modifying one or more of the first weight, the second weight, or the third weight based on the feedback. For example, the summarization system **110** may receive feedback (e.g., from a user of the user device **105**) about the final summary, and may modify one or more of the first weight, the second weight, or the third weight based on the feedback. In this way, the summarization system **110** may conserve computing resources, networking resources, and/or other resources that would have otherwise been consumed by generating less accurate summary text due to high dimensionality, generating ambiguous summary text due to high dimensionality, and/or the like.

In this way, the summarization system **110** reduces input to and increases processing speeds of NLP models. For example, the summarization system **110** may generate a text summary that combines sentiment, domain knowledge associated with entities, word frequency, and an abstract summary associated with the text. The summarization system **110** may examine the text, based on the sentiment, the domain knowledge, the word frequency, and the abstract summary associated with the text, to capture knowledge of the text in a reduced (e.g., a summarized) form. The summarization system **110** may identify and retain sentences of the text associated with strong sentiment aspects, and may retain sentences of the text that include the domain knowledge. The summarization system **110** may generate the abstract summary in order to identify an objective of the text. Thus, the summarization system **110** may conserve computing resources, networking resources, and/or other resources that would have otherwise been consumed by handling computational overload due to high dimensionality, generating less accurate summary text due to high dimensionality, generating ambiguous summary text due to high dimensionality, increasing carbon emissions due to high dimensionality, and/or the like.

As indicated above, FIGS. **1**A-**1**G are provided as an example. Other examples may differ from what is described

with regard to FIGS. **1**A-**1**G. The number and arrangement of devices shown in FIGS. **1**A-**1**G are provided as an example. In practice, there may be additional devices, fewer devices, different devices, or differently arranged devices than those shown in FIGS. **1**A-**1**G. Furthermore, two or more devices shown in FIGS. **1**A-**1**G may be implemented within a single device, or a single device shown in FIGS. **1**A-**1**G may be implemented as multiple, distributed devices. Additionally, or alternatively, a set of devices (e.g., one or more devices) shown in FIGS. **1**A-**1**G may perform one or more functions described as being performed by another set of devices shown in FIGS. **1**A-**1**G.

FIG. **2** is a diagram of an example environment **200** in which systems and/or methods described herein may be implemented. As shown in FIG. **2**, the environment **200** may include the summarization system **110**, which may include one or more elements of and/or may execute within a cloud computing system **202**. The cloud computing system **202** may include one or more elements **203**-**213**, as described in more detail below. As further shown in FIG. **2**, the environment **200** may include the user device **105** and/or a network **220**. Devices and/or elements of the environment **200** may interconnect via wired connections and/or wireless connections.

The user device **105** includes one or more devices capable of receiving, generating, storing, processing, and/or providing information, as described elsewhere herein. The user device **105** may include a communication device and/or a computing device. For example, the user device **105** may include a wireless communication device, a mobile phone, a user equipment, a laptop computer, a tablet computer, a desktop computer, a gaming console, a set-top box, a wearable communication device (e.g., a smart wristwatch, a pair of smart eyeglasses, a head mounted display, or a virtual reality headset), or a similar type of device.

The cloud computing system **202** includes computing hardware **203**, a resource management component **204**, a host operating system (OS) **205**, and/or one or more virtual computing systems **206**. The cloud computing system **202** may execute on, for example, an Amazon Web Services platform, a Microsoft Azure platform, or a Snowflake platform. The resource management component **204** may perform virtualization (e.g., abstraction) of the computing hardware **203** to create the one or more virtual computing systems **206**. Using virtualization, the resource management component **204** enables a single computing device (e.g., a computer or a server) to operate like multiple computing devices, such as by creating multiple isolated virtual computing systems **206** from the computing hardware **203** of the single computing device. In this way, the computing hardware **203** can operate more efficiently, with lower power consumption, higher reliability, higher availability, higher utilization, greater flexibility, and lower cost than using separate computing devices.

The computing hardware **203** includes hardware and corresponding resources from one or more computing devices. For example, the computing hardware **203** may include hardware from a single computing device (e.g., a single server) or from multiple computing devices (e.g., multiple servers), such as multiple computing devices in one or more data centers. As shown, the computing hardware **203** may include one or more processors **207**, one or more memories **208**, one or more storage components **209**, and/or one or more networking components **210**. Examples of a processor, a memory, a storage component, and a networking component (e.g., a communication component) are described elsewhere herein.

The resource management component **204** includes a virtualization application (e.g., executing on hardware, such as the computing hardware **203**) capable of virtualizing computing hardware **203** to start, stop, and/or manage one or more virtual computing systems **206**. For example, the resource management component **204** may include a hypervisor (e.g., a bare-metal or Type 1 hypervisor, a hosted or Type 2 hypervisor, or another type of hypervisor) or a virtual machine monitor, such as when the virtual computing systems **206** are virtual machines **211**. Additionally, or alternatively, the resource management component **204** may include a container manager, such as when the virtual computing systems **206** are containers **212**. In some implementations, the resource management component **204** executes within and/or in coordination with a host operating system **205**.

A virtual computing system **206** includes a virtual environment that enables cloud-based execution of operations and/or processes described herein using the computing hardware **203**. As shown, the virtual computing system **206** may include a virtual machine **211**, a container **212**, or a hybrid environment **213** that includes a virtual machine and a container, among other examples. The virtual computing system **206** may execute one or more applications using a file system that includes binary files, software libraries, and/or other resources required to execute applications on a guest operating system (e.g., within the virtual computing system **206**) or the host operating system **205**.

Although the summarization system **110** may include one or more elements **203**-**213** of the cloud computing system **202**, may execute within the cloud computing system **202**, and/or may be hosted within the cloud computing system **202**, in some implementations, the summarization system **110** may not be cloud-based (e.g., may be implemented outside of a cloud computing system) or may be partially cloud-based. For example, the summarization system **110** may include one or more devices that are not part of the cloud computing system **202**, such as the device **300** of FIG. **3**, which may include a standalone server or another type of computing device. The summarization system **110** may perform one or more operations and/or processes described in more detail elsewhere herein.

The network **220** includes one or more wired and/or wireless networks. For example, the network **220** may include a cellular network, a public land mobile network (PLMN), a local area network (LAN), a wide area network (WAN), a private network, the Internet, and/or a combination of these or other types of networks. The network **220** enables communication among the devices of the environment **200**.

The number and arrangement of devices and networks shown in FIG. **2** are provided as an example. In practice, there may be additional devices and/or networks, fewer devices and/or networks, different devices and/or networks, or differently arranged devices and/or networks than those shown in FIG. **2**. Furthermore, two or more devices shown in FIG. **2** may be implemented within a single device, or a single device shown in FIG. **2** may be implemented as multiple, distributed devices. Additionally, or alternatively, a set of devices (e.g., one or more devices) of the environment **200** may perform one or more functions described as being performed by another set of devices of the environment **200**.

FIG. **3** is a diagram of example components of a device **300**, which may correspond to the user device **105** and/or the summarization system **110**. In some implementations, the user device **105** and/or the summarization system **110** may include one or more devices **300** and/or one or more

components of the device **300**. As shown in FIG. **3**, the device **300** may include a bus **310**, a processor **320**, a memory **330**, an input component **340**, an output component **350**, and a communication component **360**.

The bus **310** includes one or more components that enable wired and/or wireless communication among the components of the device **300**. The bus **310** may couple together two or more components of FIG. **3**, such as via operative coupling, communicative coupling, electronic coupling, and/or electric coupling. The processor **320** includes a central processing unit, a graphics processing unit, a microprocessor, a controller, a microcontroller, a digital signal processor, a field-programmable gate array, an application-specific integrated circuit, and/or another type of processing component. The processor **320** is implemented in hardware, firmware, or a combination of hardware and software. In some implementations, the processor **320** includes one or more processors capable of being programmed to perform one or more operations or processes described elsewhere herein.

The memory **330** includes volatile and/or nonvolatile memory. For example, the memory **330** may include random access memory (RAM), read only memory (ROM), a hard disk drive, and/or another type of memory (e.g., a flash memory, a magnetic memory, and/or an optical memory). The memory **330** may include internal memory (e.g., RAM, ROM, or a hard disk drive) and/or removable memory (e.g., removable via a universal serial bus connection). The memory **330** may be a non-transitory computer-readable medium. The memory **330** stores information, instructions, and/or software (e.g., one or more software applications) related to the operation of the device **300**. In some implementations, the memory **330** includes one or more memories that are coupled to one or more processors (e.g., the processor **320**), such as via the bus **310**.

The input component **340** enables the device **300** to receive input, such as user input and/or sensed input. For example, the input component **340** may include a touch screen, a keyboard, a keypad, a mouse, a button, a microphone, a switch, a sensor, a global positioning system sensor, an accelerometer, a gyroscope, and/or an actuator. The output component **350** enables the device **300** to provide output, such as via a display, a speaker, and/or a light-emitting diode. The communication component **360** enables the device **300** to communicate with other devices via a wired connection and/or a wireless connection. For example, the communication component **360** may include a receiver, a transmitter, a transceiver, a modem, a network interface card, and/or an antenna.

The device **300** may perform one or more operations or processes described herein. For example, a non-transitory computer-readable medium (e.g., the memory **330**) may store a set of instructions (e.g., one or more instructions or code) for execution by the processor **320**. The processor **320** may execute the set of instructions to perform one or more operations or processes described herein. In some implementations, execution of the set of instructions, by one or more processors **320**, causes the one or more processors **320** and/or the device **300** to perform one or more operations or processes described herein. In some implementations, hard-wired circuitry may be used instead of or in combination with the instructions to perform one or more operations or processes described herein. Additionally, or alternatively, the processor **320** may be configured to perform one or more operations or processes described herein. Thus, implementations described herein are not limited to any specific combination of hardware circuitry and software.

The number and arrangement of components shown in FIG. **3** are provided as an example. The device **300** may include additional components, fewer components, different components, or differently arranged components than those shown in FIG. **3**. Additionally, or alternatively, a set of components (e.g., one or more components) of the device **300** may perform one or more functions described as being performed by another set of components of the device **300**.

FIGS. **4**A-**4**C depict a flowchart of an example process **400** for reducing input to and increasing processing speeds of NLP models. In some implementations, one or more process blocks of FIGS. **4**A-**4**C may be performed by a device (e.g., the summarization system **110**). In some implementations, one or more process blocks of FIGS. **4**A-**4**C may be performed by another device or a group of devices separate from or including the device, such as a user device (e.g., the user device **105**). Additionally, or alternatively, one or more process blocks of FIGS. **4**A-**4**C may be performed by one or more components of the device **300**, such as the processor **320**, the memory **330**, the input component **340**, the output component **350**, and/or the communication component **360**.

As shown in FIG. **4**A, process **400** may include receiving text with sentences and domain data associated with the text (block **405**). For example, the device may receive text with sentences and domain data associated with the text, as described above.

As further shown in FIG. **4**A, process **400** may include generating first scores based on a cumulative frequency of words in each sentence, second scores based on a cumulative frequency of domain entities in the domain data and in each sentence, and third scores based on a sentiment analysis of each sentence (block **410**). For example, the device may generate first scores for the sentences based on a cumulative frequency of words in each sentence, may generate second scores for the sentences based on a cumulative frequency of domain entities in the domain data and in each sentence, and may generate third scores for the sentences based on a sentiment analysis of each sentence, as described above. In some implementations, generating the first scores for the sentences based on the cumulative frequency of the words in each sentence includes normalizing the cumulative frequency of the words in each sentence to generate the first scores for the sentences. In some implementations, generating the second scores for the sentences based on the cumulative frequency of the domain entities in the domain data and in each sentence includes normalizing the cumulative frequency of the domain entities in the domain data and in each sentence to generate the second scores for the sentences. In some implementations, generating the third scores for the sentences based on the sentiment analysis of each sentence includes extracting phrases from the sentences, determining sentiments associated with the phrases, and generating the third scores for the sentences based on the sentiments associated with the phrases.

As further shown in FIG. **4**A, process **400** may include processing the text, with a model, to generate a summary of the text (block **415**). For example, the device may process the text, with a model, to generate a summary of the text, as described above. In some implementations, the model is an encoder-decoder model. In some implementations, the summary of the text includes one or more words not included in the text.

As further shown in FIG. **4**A, process **400** may include determining products of the first scores and the second

scores (block **420**). For example, the device may determine products of the first scores and the second scores, as described above.

As further shown in FIG. **4**A, process **400** may include filtering based on non-zero products and to extract a first set of sentences (block **425**). For example, the device may filter the sentences based on non-zero products and to extract a first set of sentences, as described above.

As shown in FIG. **4**B, process **400** may include filtering based on non-zero third scores and to extract a second set of sentences (block **430**). For example, the device may filter the sentences based on non-zero third scores and to extract a second set of sentences, as described above.

As further shown in FIG. **4**B, process **400** may include filtering based on a similarity with the summary and to extract a third set of sentences (block **435**). For example, the device may filter the sentences based on a similarity with the summary and to extract a third set of sentences, as described above.

As further shown in FIG. **4**B, process **400** may include identifying a first group of sentences included in the first through third sets (block **440**). For example, the device may identify a first group of sentences included in the first set, the second set, and the third set, as described above.

As further shown in FIG. **4**B, process **400** may include assigning a first weight to the first group to generate a weighted first group (block **445**). For example, the device may assign a first weight to the first group to generate a weighted first group, as described above.

As further shown in FIG. **4**B, process **400** may include identifying a second group of sentences included in the first set and the third set (block **450**). For example, the device may identify a second group of sentences included in the first set and the third set, as described above.

As shown in FIG. **4**C, process **400** may include assigning a second weight to the second group to generate a weighted second group (block **455**). For example, the device may assign a second weight to the second group to generate a weighted second group, as described above.

As further shown in FIG. **4**C, process **400** may include identifying a third group of sentences included in the first set and not included in the weighted first group or the weighted second group (block **460**). For example, the device may identify a third group of sentences included in the first set and not included in the weighted first group or the weighted second group, as described above.

As further shown in FIG. **4**C, process **400** may include assigning a third weight to the third group to generate a weighted third group (block **465**). For example, the device may assign a third weight to the third group to generate a weighted third group, as described above. In some implementations, the first weight is greater than the second weight, and the second weight is greater than the third weight.

As further shown in FIG. **4**C, process **400** may include sorting the sentences in the weighted first through third groups to generate a ranked list of sentences (block **470**). For example, the device may sort the sentences in the weighted first group, the weighted second group, and the weighted third group to generate a ranked list of sentences, as described above.

As further shown in FIG. **4**C, process **400** may include generating a final summary based on the ranked list (block **475**). For example, the device may generate a final summary based on the ranked list, as described above. In some implementations, the text is a transcript of a bot call and the final summary provides a summary of the transcript.

As further shown in FIG. **4**C, process **400** may include performing one or more actions based on the final summary (block **480**). For example, the device may perform one or more actions based on the final summary, as described above. In some implementations, performing the one or more actions includes one or more of providing the final summary for display, modifying one or more of the first weight, the second weight, or the third weight based on the final summary, or modifying the model based on the final summary. In some implementations, performing the one or more actions includes receiving feedback associated with the final summary, and modifying the model based on the feedback. In some implementations, performing the one or more actions includes receiving feedback associated with the final summary, and modifying one or more of the first weight, the second weight, or the third weight based on the feedback.

In some implementations, process **400** includes preprocessing and tokenizing the text to identify the sentences in the text.

In some implementations, process **400** includes receiving information identifying a maximum quantity of sentences to be included in the final summary, wherein the final summary includes less than or equal to the maximum quantity of sentences.

Although FIGS. **4**A-**4**C show example blocks of process **400**, in some implementations, process **400** may include additional blocks, fewer blocks, different blocks, or differently arranged blocks than those depicted in FIGS. **4**A-**4**C. Additionally, or alternatively, two or more of the blocks of process **400** may be performed in parallel.

As used herein, the term "component" is intended to be broadly construed as hardware, firmware, or a combination of hardware and software. It will be apparent that systems and/or methods described herein may be implemented in different forms of hardware, firmware, and/or a combination of hardware and software. The actual specialized control hardware or software code used to implement these systems and/or methods is not limiting of the implementations. Thus, the operation and behavior of the systems and/or methods are described herein without reference to specific software code—it being understood that software and hardware can be used to implement the systems and/or methods based on the description herein.

As used herein, satisfying a threshold may, depending on the context, refer to a value being greater than the threshold, greater than or equal to the threshold, less than the threshold, less than or equal to the threshold, equal to the threshold, not equal to the threshold, or the like.

To the extent the aforementioned implementations collect, store, or employ personal information of individuals, it should be understood that such information shall be used in accordance with all applicable laws concerning protection of personal information. Additionally, the collection, storage, and use of such information can be subject to consent of the individual to such activity, for example, through well known "opt-in" or "opt-out" processes as can be appropriate for the situation and type of information. Storage and use of personal information can be in an appropriately secure manner reflective of the type of information, for example, through various encryption and anonymization techniques for particularly sensitive information.

Even though particular combinations of features are recited in the claims and/or disclosed in the specification, these combinations are not intended to limit the disclosure of various implementations. In fact, many of these features may be combined in ways not specifically recited in the

claims and/or disclosed in the specification. Although each dependent claim listed below may directly depend on only one claim, the disclosure of various implementations includes each dependent claim in combination with every other claim in the claim set. As used herein, a phrase referring to "at least one of" a list of items refers to any combination of those items, including single members. As an example, "at least one of: a, b, or c" is intended to cover a, b, c, a-b, a-c, b-c, and a-b-c, as well as any combination with multiple of the same item.

No element, act, or instruction used herein should be construed as critical or essential unless explicitly described as such. Also, as used herein, the articles "a" and "an" are intended to include one or more items and may be used interchangeably with "one or more." Further, as used herein, the article "the" is intended to include one or more items referenced in connection with the article "the" and may be used interchangeably with "the one or more." Furthermore, as used herein, the term "set" is intended to include one or more items (e.g., related items, unrelated items, or a combination of related and unrelated items), and may be used interchangeably with "one or more." Where only one item is intended, the phrase "only one" or similar language is used. Also, as used herein, the terms "has," "have," "having," or the like are intended to be open-ended terms. Further, the phrase "based on" is intended to mean "based, at least in part, on" unless explicitly stated otherwise. Also, as used herein, the term "or" is intended to be inclusive when used in a series and may be used interchangeably with "and/or," unless explicitly stated otherwise (e.g., if used in combination with "either" or "only one of").

In the preceding specification, various example embodiments have been described with reference to the accompanying drawings. It will, however, be evident that various modifications and changes may be made thereto, and additional embodiments may be implemented, without departing from the broader scope of the invention as set forth in the claims that follow. The specification and drawings are accordingly to be regarded in an illustrative rather than restrictive sense.

What is claimed is:

1. A method, comprising:

generating, by a device, first scores for sets of words based on a frequency of words related to each set of words, second scores for the sets of words based on a frequency of domain entities related to each set of words, and third scores for the sets of words based on a sentiment analysis related to each set of words;

processing, by the device, the sets of words to generate a summary associated with the sets of words;

filtering, by the device, the sets of words based on the first scores, the second scores, the third scores, and a similarity with the summary;

identifying, by the device and based on the filtering the sets of words, a first group, a second group, and a third group, of sets of words, of the sets of words;

generating, by the device, another summary based on the sets of words in the first group, the second group, and the third group; and

performing, by the device, one or more actions based on the other summary.

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

processing the sets of words to identify sentences in the sets of words.

3. The method of claim **1**, wherein filtering the sets of words based on the first scores, the second scores, and the third scores comprises:

filtering the sets of words based on products of the first scores and the second scores.

4. The method of claim **1**, wherein generating the other summary based on the sets of words in the first group, the second group, and the third group comprises:

sorting the sets of words in the first group, the second group, and the third group; and

generating the other summary based on the sorting.

5. The method of claim **4**, wherein sorting the sets of words in the first group, the second group, and the third group comprises:

assigning weights to the first group, the second group, and the third group; and

sorting the sets of words in the first group, the second group, and the third group based on the weights.

6. The method of claim **1**, wherein the sentiment analysis is based on phrases extracted from the sets of words.

7. The method of claim **1**, wherein the other summary includes one or more words not included in the set of words.

8. A device, comprising:

one or more processors configured to:

generate first scores for sets of words based on a frequency of words related to each set of words, second scores for the sets of words based on a frequency of domain entities related to each set of words, and third scores for the sets of words based on a sentiment analysis related to each set of words;

process the sets of words, with a model, to generate a summary associated with the sets of words;

filter the sets of words based on the first scores, the second scores, the third scores, and a similarity with the summary;

identify, based on the filtering the sets of words, a first group, a second group, and a third group, of sets of words, of the sets of words;

generate another summary based on the sets of words in the first group, the second group, and the third group; and

perform one or more actions based on the other summary.

9. The device of claim **8**, wherein the one or more processors are further configured to:

process the sets of words to identify sentences in the sets of words.

10. The device of claim **8**, wherein the one or more processors, to generate the other summary based on the sets of words in the first group, the second group, and the third group, are configured to:

sort the sets of words in the first group, the second group, and the third group to generate a ranked list; and

generate the other summary based on the ranked list.

11. The device of claim **8**, wherein the one or more processors, to perform the one or more actions, are configured to:

receive feedback associated with the other summary; and

modify, based on the feedback, the model.

12. The device of claim **8**, wherein the one or more processors, to perform the one or more actions, are configured to:

modify a weight assigned to the first group, the second group, or the third group.

13. The device of claim **8**, wherein the one or more processors are further configured to:

receive domain data associated with the sets of words; and

wherein the second scores are further based on a frequency of domain entities in the domain data.

14. The device of claim 8, wherein the summary includes one or more words not included in the sets of words.

15. A non-transitory computer-readable medium storing a set of instructions, the set of instructions comprising:

one or more instructions that, when executed by one or more processors of a device, cause the device to:

generate first scores for sets of words based on a frequency of words related to each set of words, second scores for the sets of words based on a frequency of domain entities related to each set of words, and third scores for the sets of words based on a sentiment analysis related to each set of words;

process the sets of words to generate a summary associated with the sets of words;

filter the sets of words based on the first scores, the second scores, the third scores, and a similarity with the summary;

identify, based on the filtering the sets of words, a first group, a second group, and a third group, of sets of words, of the sets of words;

generate another summary based on the sets of words in the first group, the second group, and the third group; and

perform one or more actions based on the other summary.

16. The non-transitory computer-readable medium of claim 15, wherein the one or more instructions, that cause the device to filter the sets of words based on the first scores, the second scores, cause the device to:

filter the sets of words based on products of the first scores and the second scores.

17. The non-transitory computer-readable medium of claim 15, wherein the one or more instructions, that cause the device to generate the other summary based on the sets of words in the first group, the second group, and the third group, cause the device to:

sort the sets of words in the first group, the second group, and the third group; and

generate the other summary based on the sorting.

18. The non-transitory computer-readable medium of claim 15, wherein the other summary includes less than or equal to a maximum quantity of sets of words to be included in the other summary.

19. The non-transitory computer-readable medium of claim 15, wherein the sets of words are sentences.

20. The non-transitory computer-readable medium of claim 15, wherein the summary includes one or more words not included in the sets of words.

* * * * *