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(54) **PROCESSING APPARATUS, PROCESSING METHOD, AND NON-TRANSITORY COMPUTER-READABLE MEDIUM**

(71) Applicant: **NEC Corporation**, Tokyo (JP)

(72) Inventors: **Takuma NOZAWA**, Tokyo (JP); **Masafumi Oyamada**, Tokyo (JP)

(73) Assignee: **NEC Corporation**, Tokyo (JP)

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G06F 40/279	(2020.01)

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

CPC ***G06F 40/40*** (2020.01); ***G06F 16/322*** (2019.01); ***G06F 40/279*** (2020.01); *G06F 40/166* (2020.01)

(57) **ABSTRACT**

To improve quality of an answer to be output from a large language model (LLM), a processing apparatus according to the present disclosure accepts an input of a question and an analysis perspective. Then, the processing apparatus repeatedly performs processing of generating an answer by inputting a prompt indicating a question and an analysis perspective to the LLM with use of an input question, and a new question generated based on the answer.

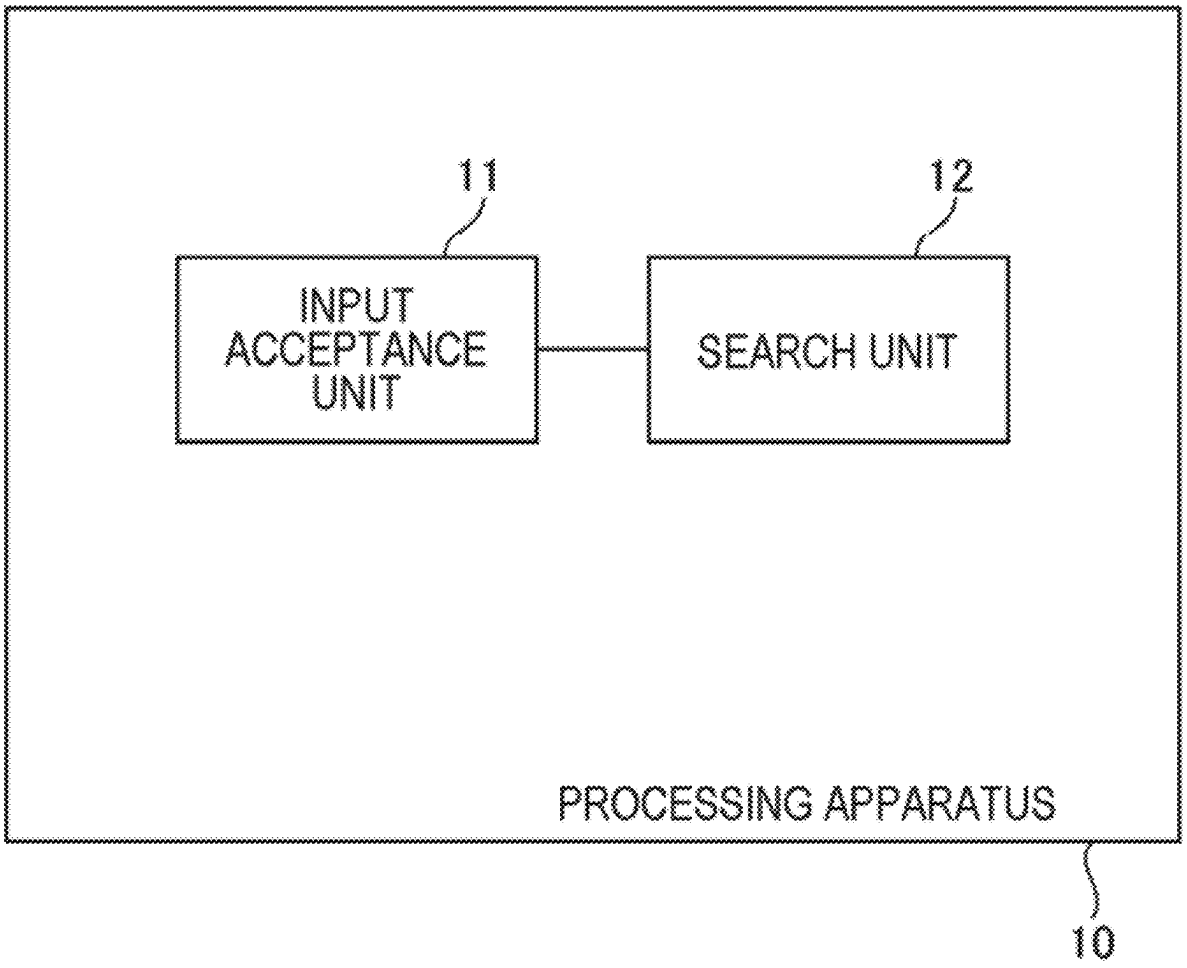


FIG. 1

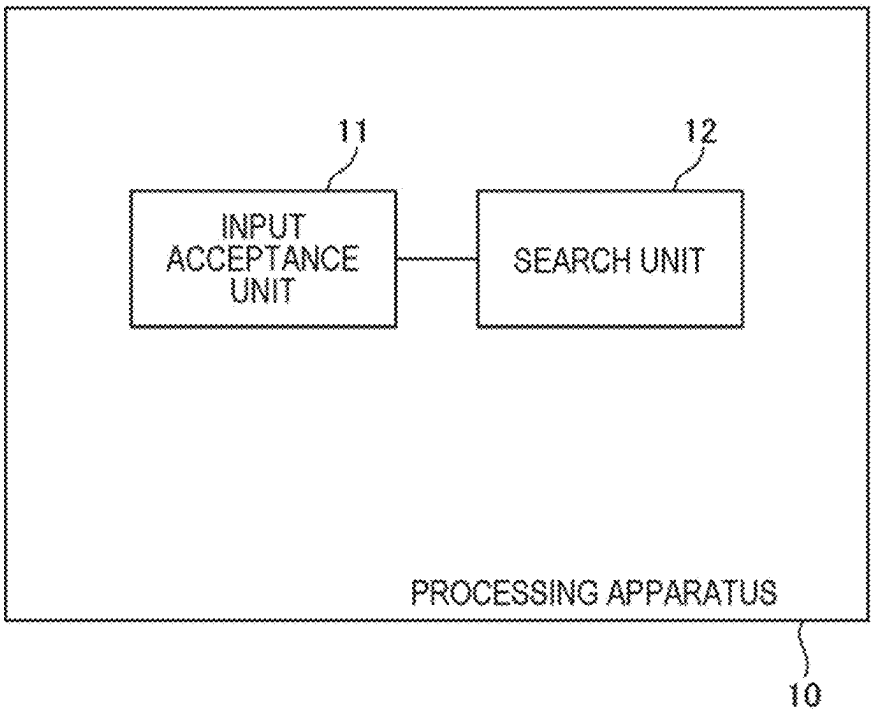
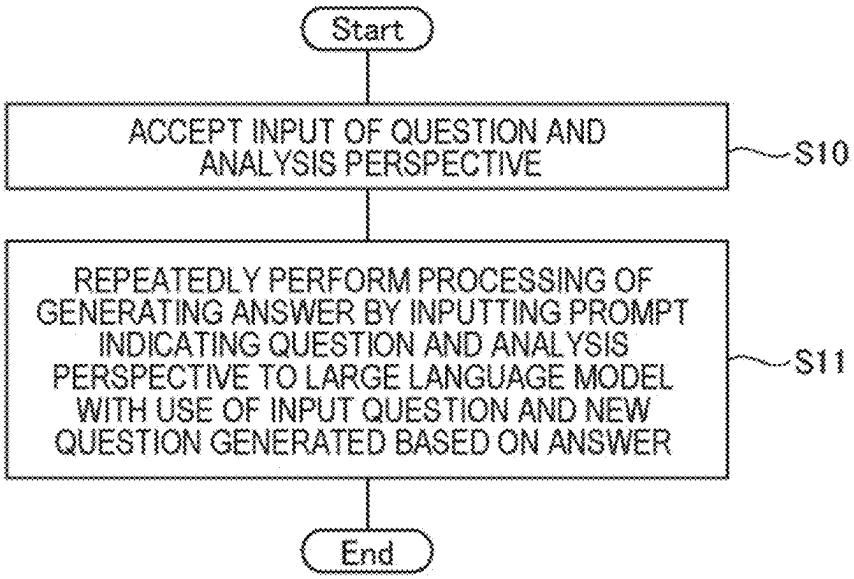

11
12
INPUT ACCEPTANCE UNIT
SEARCH UNIT
PROCESSING APPARATUS
10

FIG. 2


Start
ACCEPT INPUT OF QUESTION AND ANALYSIS PERSPECTIVE
S10
REPEATEDLY PERFORM PROCESSING OF GENERATING ANSWER BY INPUTTING PROMPT INDICATING QUESTION AND ANALYSIS PERSPECTIVE TO LARGE LANGUAGE MODEL WITH USE OF INPUT QUESTION AND NEW QUESTION GENERATED BASED ON ANSWER
S11
End

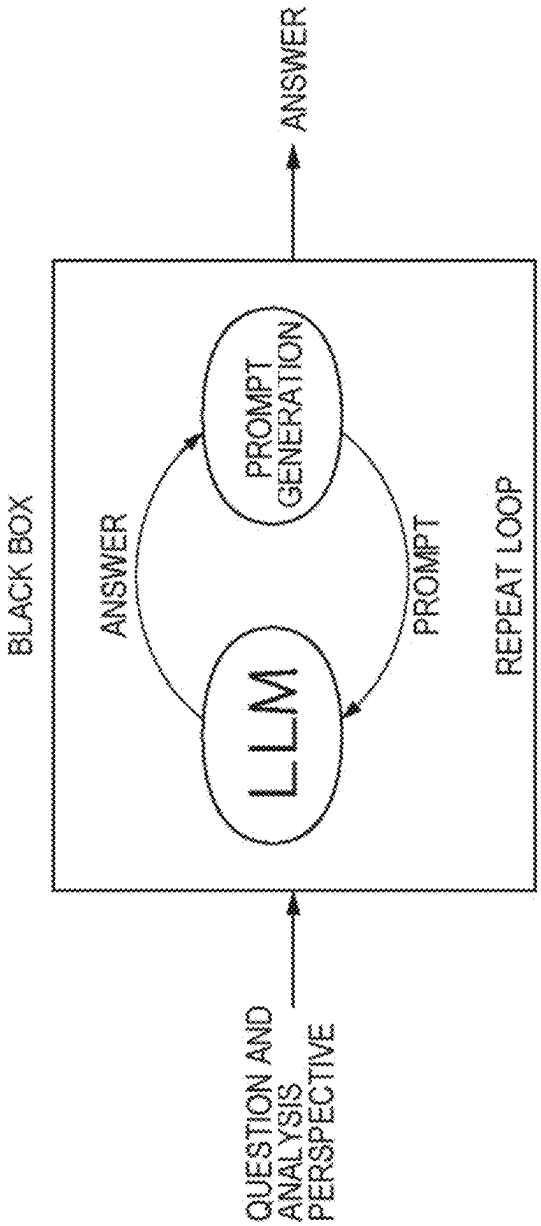

QUESTION AND ANALYSIS PERSPECTIVE
BLACK BOX
LLM
ANSWER
PROMPT GENERATION
PROMPT
REPEAT LOOP
ANSWER

FIG. 3

FIG. 4

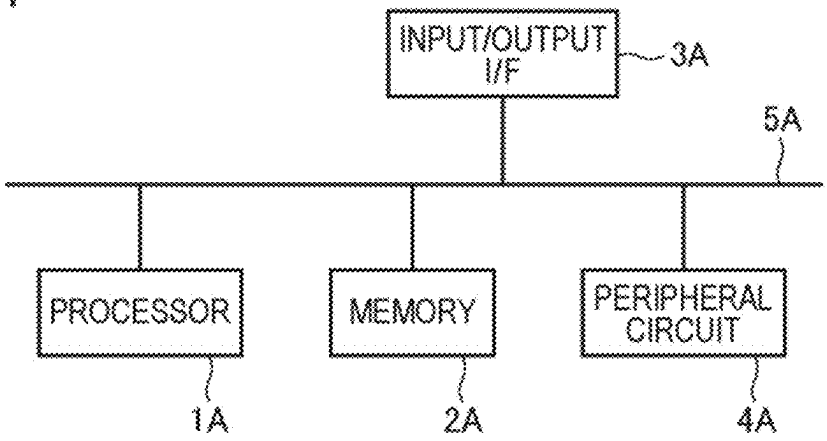

INPUT/OUTPUT I/F
3A
5A
PROCESSOR
MEMORY
PERIPHERAL CIRCUIT
1A
2A
4A

FIG. 5

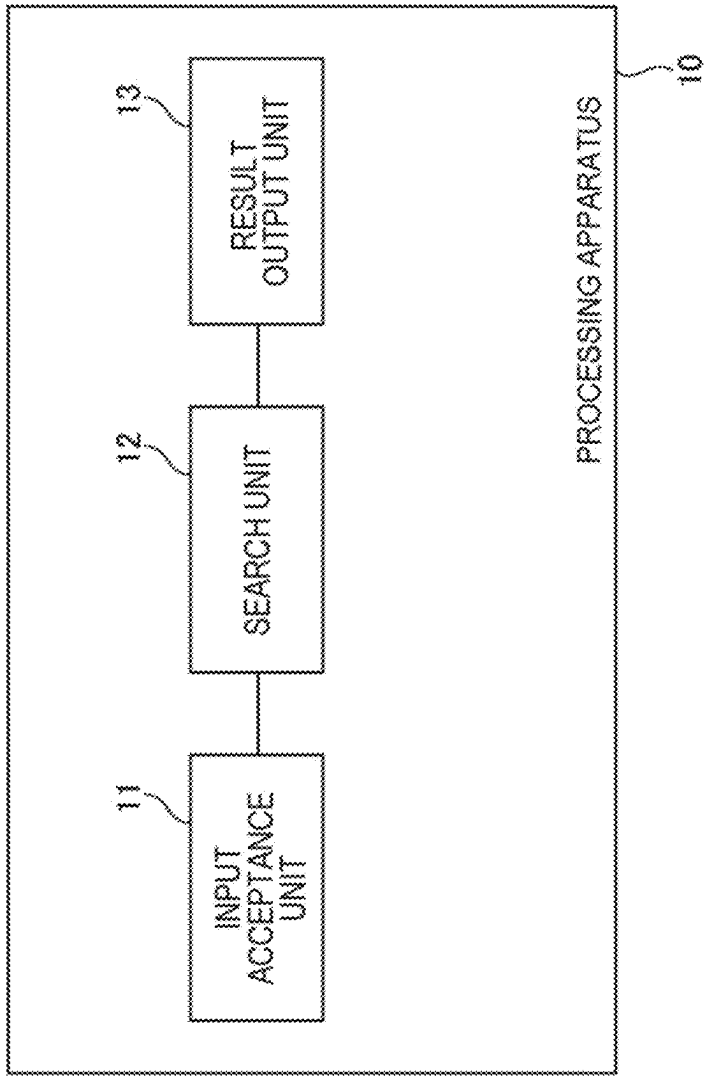

PROCESSING APPARATUS
10
INPUT ACCEPTANCE UNIT
11
SEARCH UNIT
12
RESULT OUTPUT UNIT
13

FIG. 6

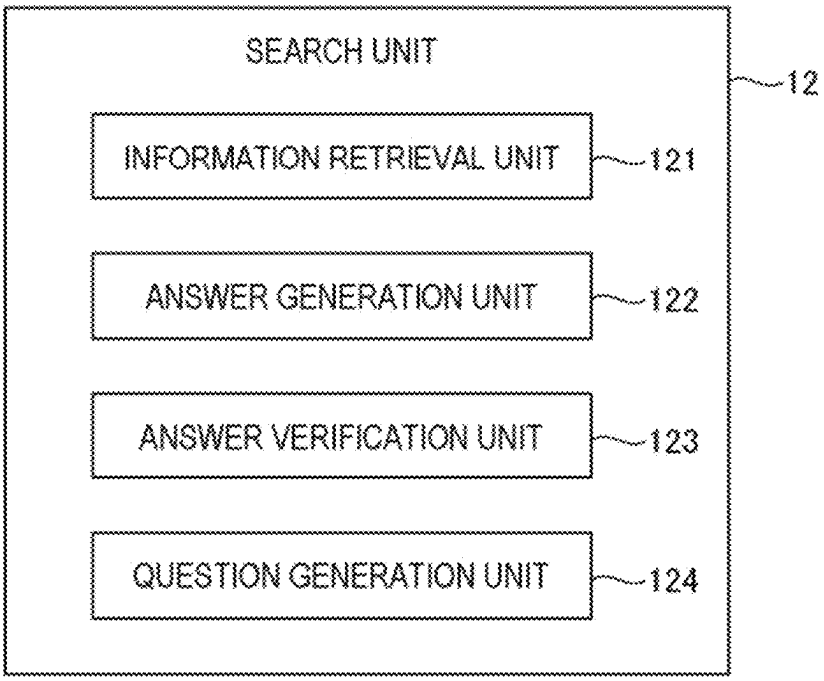

SEARCH UNIT
12
INFORMATION RETRIEVAL UNIT
121
ANSWER GENERATION UNIT
122
ANSWER VERIFICATION UNIT
123
QUESTION GENERATION UNIT
124

FIG. 7

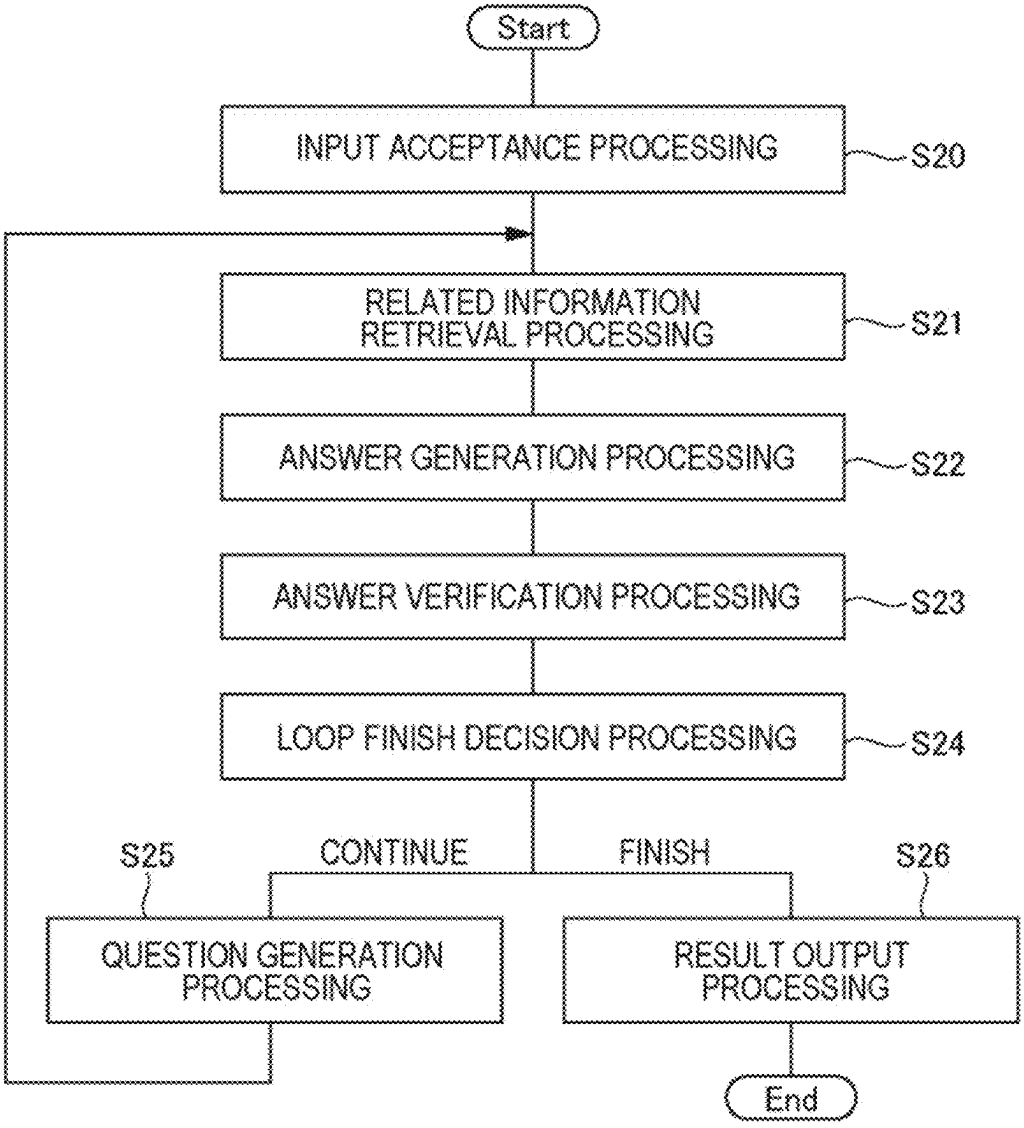

Start
INPUT ACCEPTANCE PROCESSING
S20
RELATED INFORMATION RETRIEVAL PROCESSING
S21
ANSWER GENERATION PROCESSING
S22
ANSWER VERIFICATION PROCESSING
S23
LOOP FINISH DECISION PROCESSING
S24
S25
CONTINUE
FINISH
S26
QUESTION GENERATION PROCESSING
RESULT OUTPUT PROCESSING
End

FIG. 8

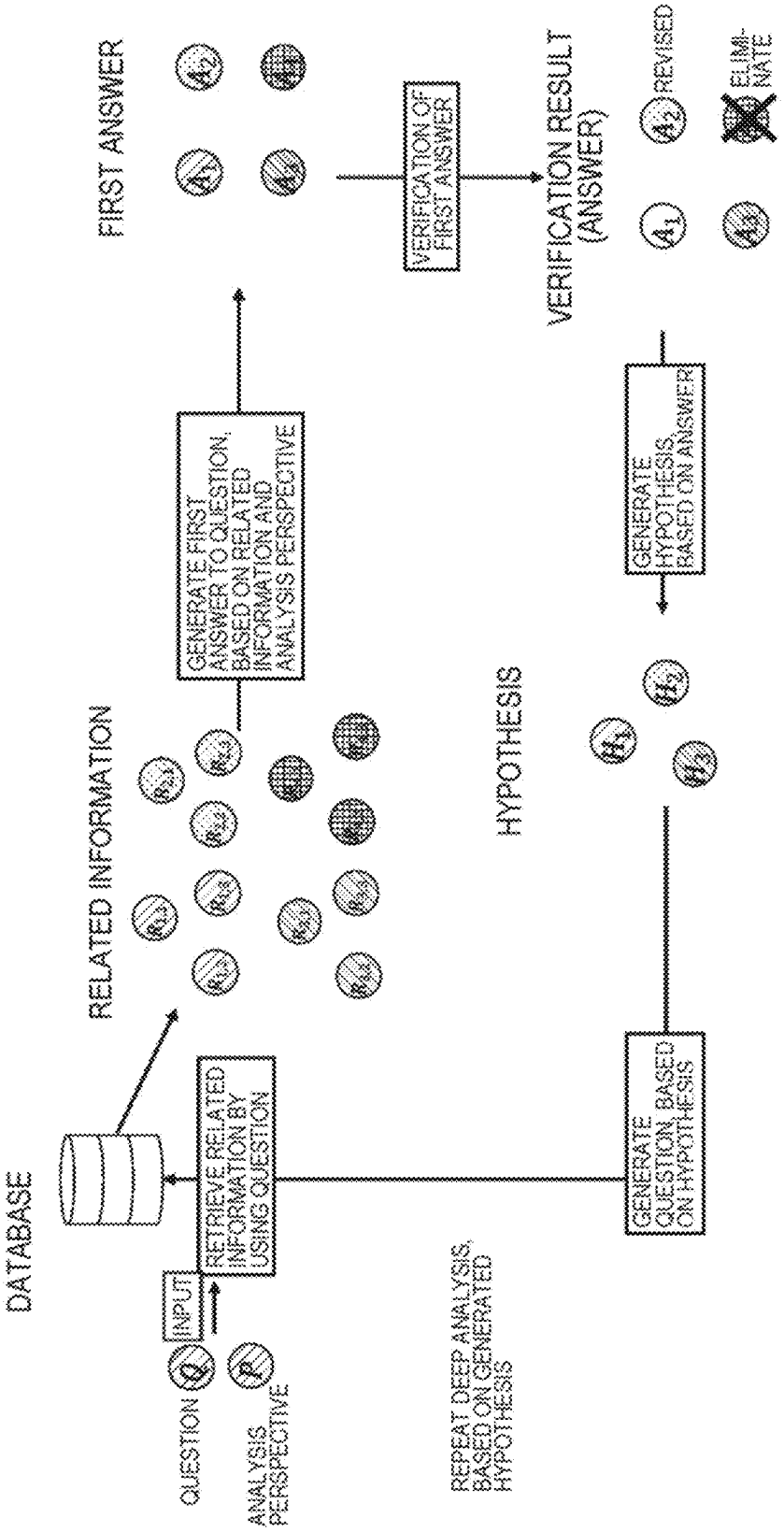

QUESTION
ANALYSIS PERSPECTIVE
INPUT
DATABASE
RETRIEVE RELATED INFORMATION BY USING QUESTION
RELATED INFORMATION
GENERATE FIRST ANSWER TO QUESTION, BASED ON RELATED INFORMATION AND ANALYSIS PERSPECTIVE
FIRST ANSWER
VERIFICATION OF FIRST ANSWER
VERIFICATION RESULT (ANSWER)
REVISED
ELIMINATE
GENERATE HYPOTHESIS BASED ON ANSWER
HYPOTHESIS
GENERATE QUESTION BASED ON HYPOTHESIS
REPEAT DEEP ANALYSIS BASED ON GENERATED HYPOTHESIS

FIG. 9

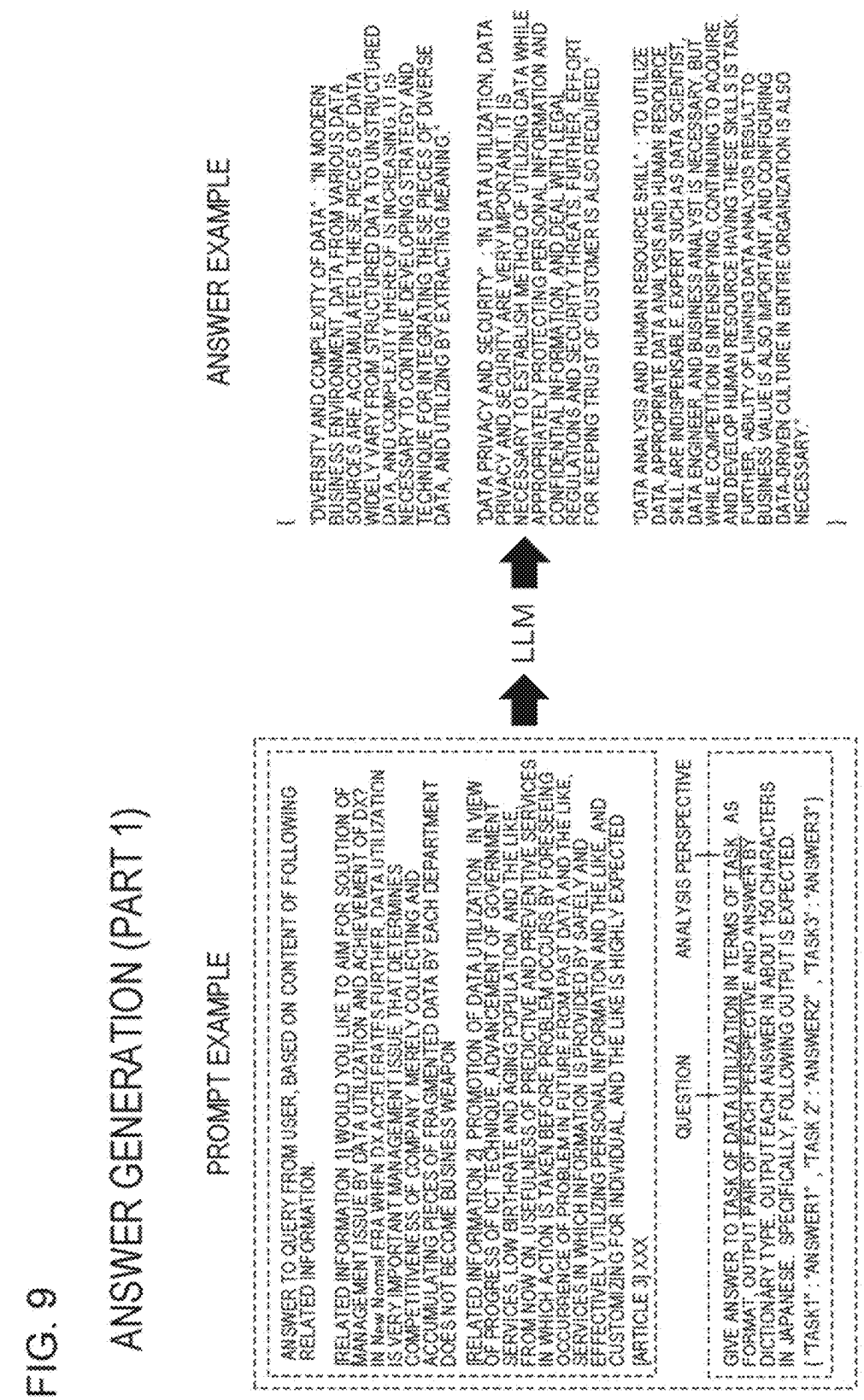

ANSWER GENERATION (PART 1)
PROMPT EXAMPLE
ANSWER TO QUERY FROM USER, BASED ON CONTENT OF FOLLOWING RELATED INFORMATION.
[RELATED INFORMATION 1] WOULD YOU LIKE TO AIM FOR SOLUTION OF MANAGEMENT ISSUE BY DATA UTILIZATION AND ACHIEVEMENT OF DX? IN New Normal ERA WHEN DX ACCELERATES FURTHER, DATA UTILIZATION IS VERY IMPORTANT MANAGEMENT ISSUE THAT DETERMINES COMPETITIVENESS OF COMPANY. MERELY COLLECTING AND ACCUMULATING PIECES OF FRAGMENTED DATA BY EACH DEPARTMENT DOES NOT BECOME BUSINESS WEAPON
[RELATED INFORMATION 2] PROMOTION OF DATA UTILIZATION IN VIEW OF PROGRESS OF ICT TECHNIQUE, ADVANCEMENT OF GOVERNMENT SERVICES, LOW BIRTHRATE AND AGING POPULATION, AND THE LIKE, FROM NOW ON, USEFULNESS OF PREDICTIVE AND PREVENTIVE SERVICES IN WHICH ACTION IS TAKEN BEFORE PROBLEM OCCURS BY FORESEEING OCCURRENCE OF PROBLEM IN FUTURE FROM PAST DATA AND THE LIKE, SERVICES IN WHICH INFORMATION IS PROVIDED BY SAFELY AND EFFECTIVELY UTILIZING PERSONAL INFORMATION AND THE LIKE, AND CUSTOMIZING FOR INDIVIDUAL, AND THE LIKE IS HIGHLY EXPECTED
[ARTICLE 3] XXX
QUESTION
ANALYSIS PERSPECTIVE
GIVE ANSWER TO TASK OF DATA UTILIZATION IN TERMS OF TASK, AS FORMAT, OUTPUT PAIR OF EACH PERSPECTIVE AND ANSWER BY DICTIONARY TYPE. OUTPUT EACH ANSWER IN ABOUT 150 CHARACTERS IN JAPANESE. SPECIFICALLY, FOLLOWING OUTPUT IS EXPECTED.
{ "TASK1" : "ANSWER1" , "TASK 2" : "ANSWER2" , "TASK3" : "ANSWER3" }
LLM
ANSWER EXAMPLE
{
"DIVERSITY AND COMPLEXITY OF DATA" : "IN MODERN BUSINESS ENVIRONMENT, DATA FROM VARIOUS DATA SOURCES ARE ACCUMULATED. THESE PIECES OF DATA WIDELY VARY FROM STRUCTURED DATA TO UNSTRUCTURED DATA, AND COMPLEXITY THEREOF IS INCREASING. IT IS NECESSARY TO CONTINUE DEVELOPING STRATEGY AND TECHNIQUE FOR INTEGRATING THESE PIECES OF DIVERSE DATA, AND UTILIZING BY EXTRACTING MEANING."
"DATA PRIVACY AND SECURITY" : "IN DATA UTILIZATION, DATA PRIVACY AND SECURITY ARE VERY IMPORTANT. IT IS NECESSARY TO ESTABLISH METHOD OF UTILIZING DATA WHILE APPROPRIATELY PROTECTING PERSONAL INFORMATION AND CONFIDENTIAL INFORMATION, AND DEAL WITH LEGAL REGULATIONS AND SECURITY THREATS. FURTHER, EFFORT FOR KEEPING TRUST OF CUSTOMER IS ALSO REQUIRED."
"DATA ANALYSIS AND HUMAN RESOURCE SKILL" : "TO UTILIZE DATA, APPROPRIATE DATA ANALYSIS AND HUMAN RESOURCE SKILL ARE INDISPENSABLE. EXPERT SUCH AS DATA SCIENTIST, DATA ENGINEER, AND BUSINESS ANALYST IS NECESSARY. BUT, WHILE COMPETITION IS INTENSIFYING, CONTINUING TO ACQUIRE AND DEVELOP HUMAN RESOURCE HAVING THESE SKILLS IS TASK. FURTHER, ABILITY OF LINKING DATA ANALYSIS RESULT TO BUSINESS VALUE IS ALSO IMPORTANT, AND CONFIGURING DATA-DRIVEN CULTURE IN ENTIRE ORGANIZATION IS ALSO NECESSARY."
}

FIG. 10

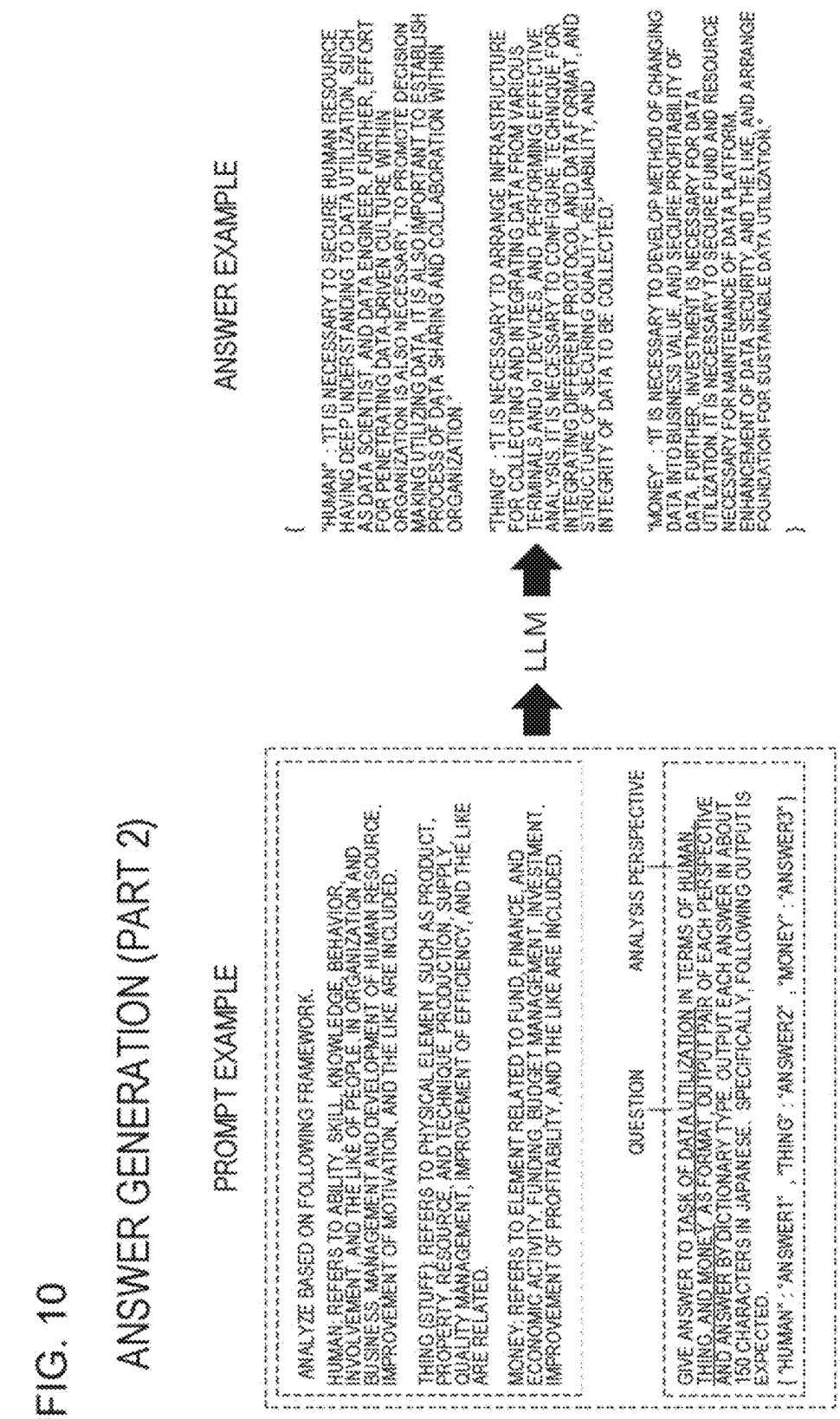

ANSWER GENERATION (PART 2)
PROMPT EXAMPLE
ANALYZE BASED ON FOLLOWING FRAMEWORK.
HUMAN: REFERS TO ABILITY, SKILL, KNOWLEDGE, BEHAVIOR, INVOLVEMENT, AND THE LIKE OF PEOPLE IN ORGANIZATION AND BUSINESS. MANAGEMENT AND DEVELOPMENT OF HUMAN RESOURCE, IMPROVEMENT OF MOTIVATION, AND THE LIKE ARE INCLUDED.
THING (STUFF): REFERS TO PHYSICAL ELEMENT SUCH AS PRODUCT, PROPERTY, RESOURCE, AND TECHNIQUE. PRODUCTION, SUPPLY, QUALITY MANAGEMENT, IMPROVEMENT OF EFFICIENCY, AND THE LIKE ARE RELATED.
MONEY: REFERS TO ELEMENT RELATED TO FUND, FINANCE, AND ECONOMIC ACTIVITY. FUNDING, BUDGET MANAGEMENT, INVESTMENT, IMPROVEMENT OF PROFITABILITY, AND THE LIKE ARE INCLUDED.
QUESTION
ANALYSIS PERSPECTIVE
GIVE ANSWER TO TASK OF DATA UTILIZATION IN TERMS OF HUMAN, THING, AND MONEY AS FORMAT: OUTPUT PAIR OF EACH PERSPECTIVE AND ANSWER BY DICTIONARY TYPE. OUTPUT EACH ANSWER IN ABOUT 150 CHARACTERS IN JAPANESE. SPECIFICALLY, FOLLOWING OUTPUT IS EXPECTED.
[{"HUMAN" : "ANSWER1" , "THING" : "ANSWER2" , "MONEY" : "ANSWER3" }]
LLM
ANSWER EXAMPLE
{
"HUMAN" : "IT IS NECESSARY TO SECURE HUMAN RESOURCE HAVING DEEP UNDERSTANDING TO DATA UTILIZATION, SUCH AS DATA SCIENTIST, AND DATA ENGINEER. FURTHER, EFFORT FOR PENETRATING DATA-DRIVEN CULTURE WITHIN ORGANIZATION IS ALSO NECESSARY. TO PROMOTE DECISION MAKING UTILIZING DATA, IT IS ALSO IMPORTANT TO ESTABLISH PROCESS OF DATA SHARING AND COLLABORATION WITHIN ORGANIZATION."
"THING" : "IT IS NECESSARY TO ARRANGE INFRASTRUCTURE FOR COLLECTING AND INTEGRATING DATA FROM VARIOUS TERMINALS AND IoT DEVICES, AND PERFORMING EFFECTIVE ANALYSIS. IT IS NECESSARY TO CONFIGURE TECHNIQUE FOR INTEGRATING DIFFERENT PROTOCOL AND DATA FORMAT, AND STRUCTURE OF SECURING QUALITY, RELIABILITY, AND INTEGRITY OF DATA TO BE COLLECTED."
"MONEY" : "IT IS NECESSARY TO DEVELOP METHOD OF CHANGING DATA INTO BUSINESS VALUE, AND SECURE PROFITABILITY OF DATA. FURTHER, INVESTMENT IS NECESSARY FOR DATA UTILIZATION. IT IS NECESSARY TO SECURE FUND AND RESOURCE NECESSARY FOR MAINTENANCE OF DATA PLATFORM, ENHANCEMENT OF DATA SECURITY, AND THE LIKE, AND ARRANGE FOUNDATION FOR SUSTAINABLE DATA UTILIZATION."
}

FIG. 11

ANSWER VERIFICATION (PART 1 : Rerank)

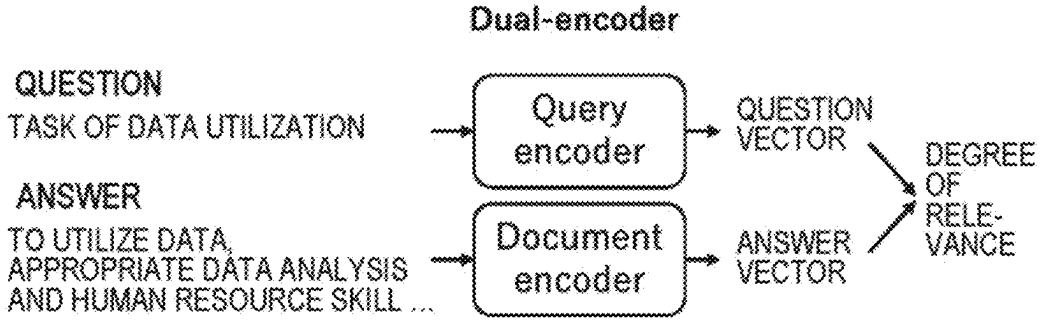


FIG. 12

ANSWER VERIFICATION (PART 2 : Rerank)

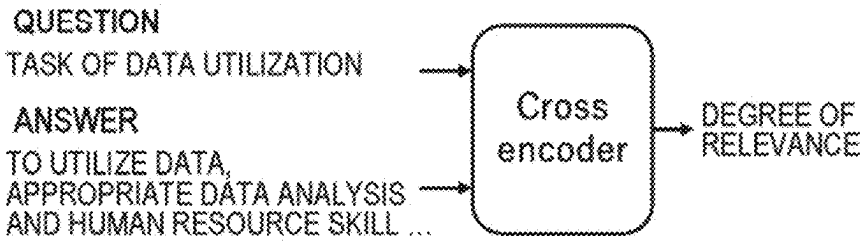


FIG. 13

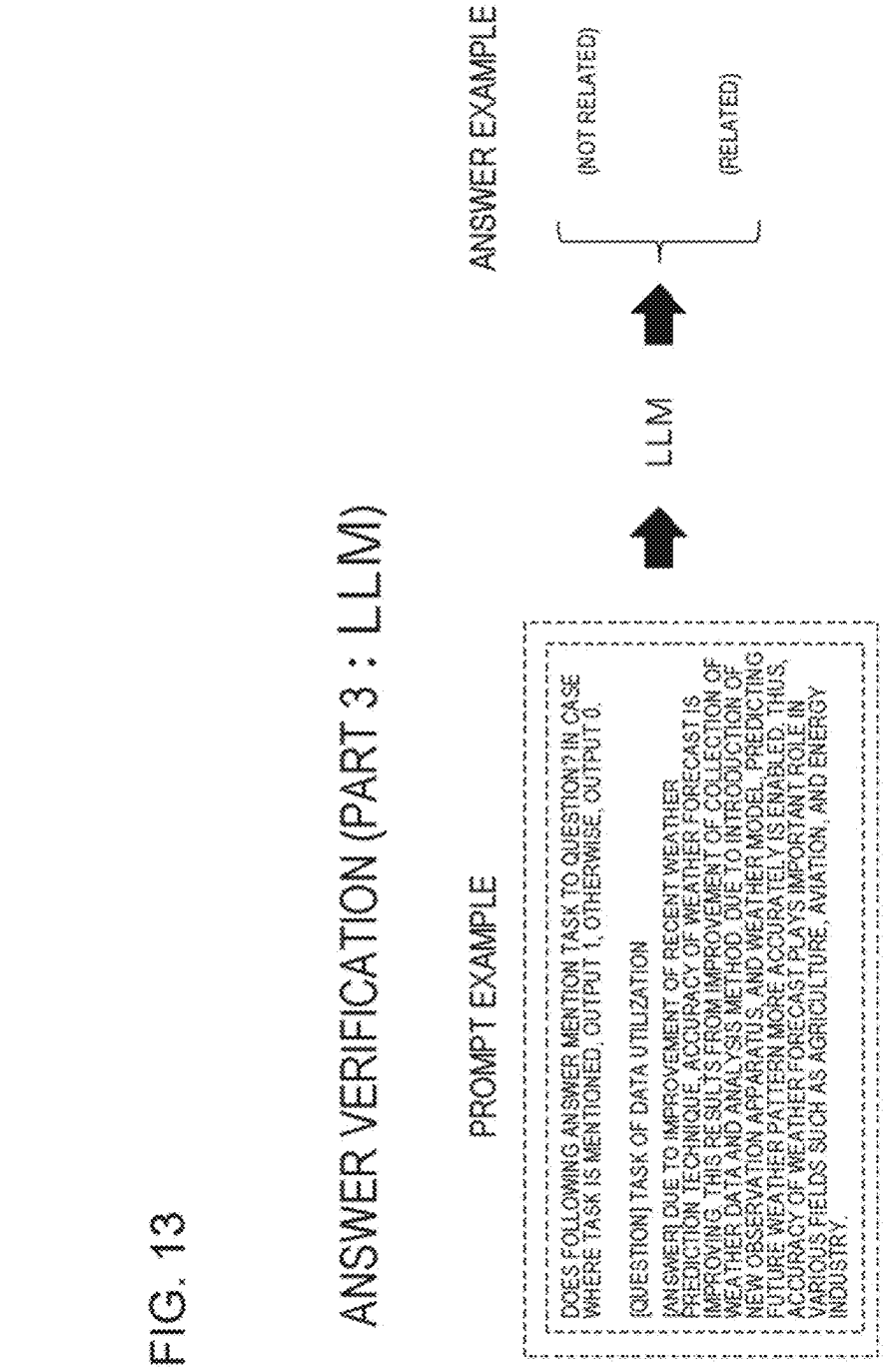

ANSWER VERIFICATION (PART 3 : LLM)
PROMPT EXAMPLE
DOES FOLLOWING ANSWER MENTION TASK TO QUESTION? IN CASE WHERE TASK IS MENTIONED, OUTPUT 1, OTHERWISE, OUTPUT 0.
[QUESTION] TASK OF DATA UTILIZATION
[ANSWER] DUE TO IMPROVEMENT OF RECENT WEATHER PREDICTION TECHNIQUE, ACCURACY OF WEATHER FORECAST IS IMPROVING. THIS RESULTS FROM IMPROVEMENT OF COLLECTION OF WEATHER DATA AND ANALYSIS METHOD. DUE TO INTRODUCTION OF NEW OBSERVATION APPARATUS AND WEATHER MODEL, PREDICTING FUTURE WEATHER PATTERN MORE ACCURATELY IS ENABLED. THUS, ACCURACY OF WEATHER FORECAST PLAYS IMPORTANT ROLE IN VARIOUS FIELDS SUCH AS AGRICULTURE, AVIATION, AND ENERGY INDUSTRY.
LLM
ANSWER EXAMPLE
(NOT RELATED)
(RELATED)

FIG. 14

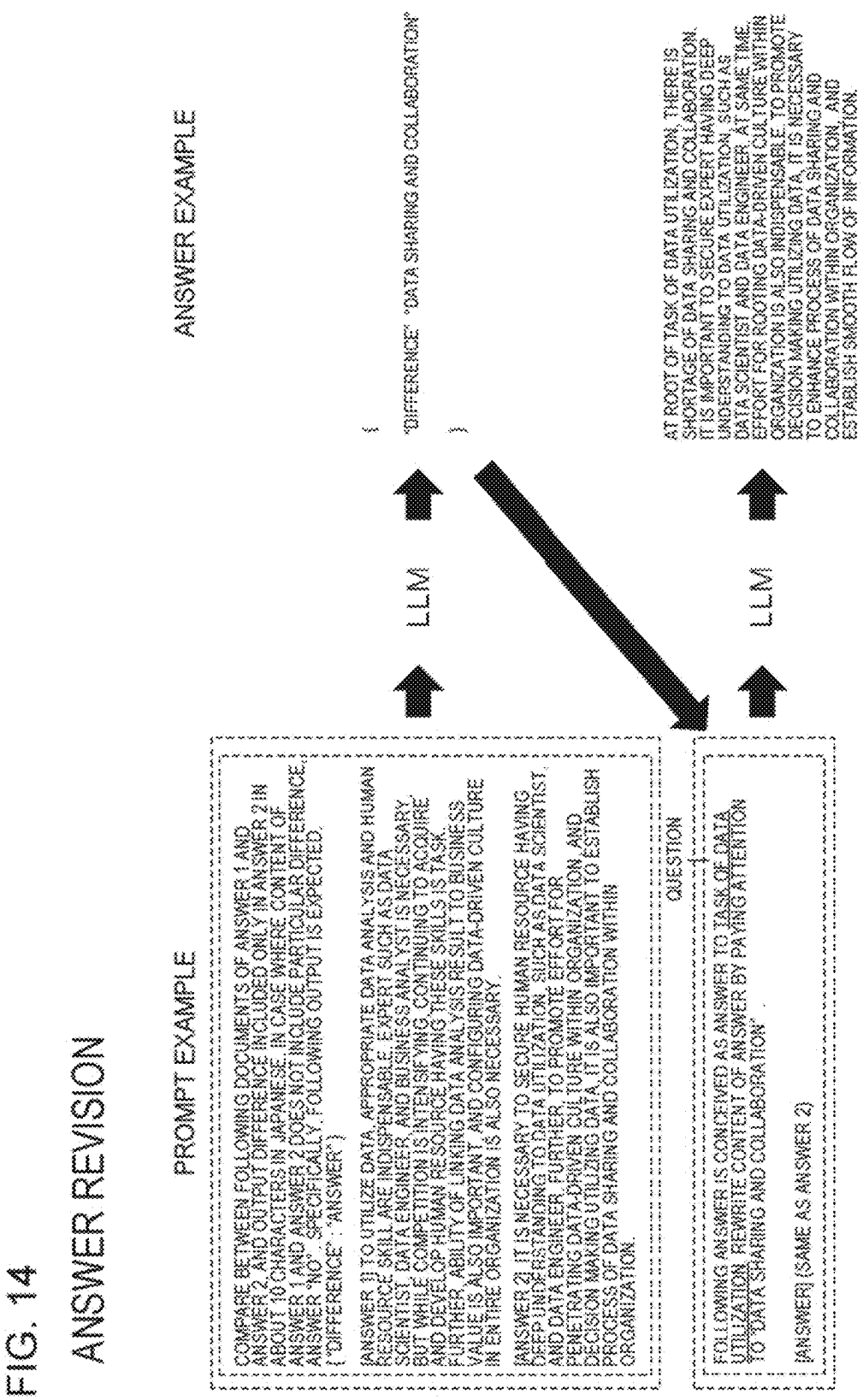

ANSWER REVISION
PROMPT EXAMPLE
COMPARE BETWEEN FOLLOWING DOCUMENTS OF ANSWER 1 AND ANSWER 2, AND OUTPUT DIFFERENCE INCLUDED ONLY IN ANSWER 2 IN ABOUT 10 CHARACTERS IN JAPANESE. IN CASE WHERE CONTENT OF ANSWER 1 AND ANSWER 2 DOES NOT INCLUDE PARTICULAR DIFFERENCE, ANSWER "NO". SPECIFICALLY, FOLLOWING OUTPUT IS EXPECTED. { "DIFFERENCE" : "ANSWER" }
[ANSWER 1] TO UTILIZE DATA, APPROPRIATE DATA ANALYSIS AND HUMAN RESOURCE SKILL ARE INDISPENSABLE. EXPERT SUCH AS DATA SCIENTIST, DATA ENGINEER, AND BUSINESS ANALYST IS NECESSARY, BUT WHILE COMPETITION IS INTENSIFYING, CONTINUING TO ACQUIRE AND DEVELOP HUMAN RESOURCE HAVING THESE SKILLS IS TASK. FURTHER, ABILITY OF LINKING DATA ANALYSIS RESULT TO BUSINESS VALUE IS ALSO IMPORTANT, AND CONFIGURING DATA-DRIVEN CULTURE IN ENTIRE ORGANIZATION IS ALSO NECESSARY.
[ANSWER 2] IT IS NECESSARY TO SECURE HUMAN RESOURCE HAVING DEEP UNDERSTANDING TO DATA UTILIZATION, SUCH AS DATA SCIENTIST AND DATA ENGINEER. FURTHER, TO PROMOTE EFFORT FOR PENETRATING DATA-DRIVEN CULTURE WITHIN ORGANIZATION, AND DECISION MAKING UTILIZING DATA, IT IS ALSO IMPORTANT TO ESTABLISH PROCESS OF DATA SHARING AND COLLABORATION WITHIN ORGANIZATION.
LLM
{ "DIFFERENCE" : "DATA SHARING AND COLLABORATION" }
QUESTION
FOLLOWING ANSWER IS CONSTRUED AS ANSWER TO TASK OF DATA UTILIZATION. REWRITE CONTENT OF ANSWER BY PAYING ATTENTION TO "DATA SHARING AND COLLABORATION".
[ANSWER] (SAME AS ANSWER 2)
LLM
AT ROOT OF TASK OF DATA UTILIZATION, THERE IS SHORTAGE OF DATA SHARING AND COLLABORATION. IT IS IMPORTANT TO SECURE EXPERT HAVING DEEP UNDERSTANDING TO DATA UTILIZATION, SUCH AS DATA SCIENTIST AND DATA ENGINEER. AT SAME TIME, EFFORT FOR ROOTING DATA-DRIVEN CULTURE WITHIN ORGANIZATION IS ALSO INDISPENSABLE. TO PROMOTE DECISION MAKING UTILIZING DATA, IT IS NECESSARY TO ENHANCE PROCESS OF DATA SHARING AND COLLABORATION WITHIN ORGANIZATION, AND ESTABLISH SMOOTH FLOW OF INFORMATION.
ANSWER EXAMPLE

FIG. 15

HYPOTHESIS GENERATION

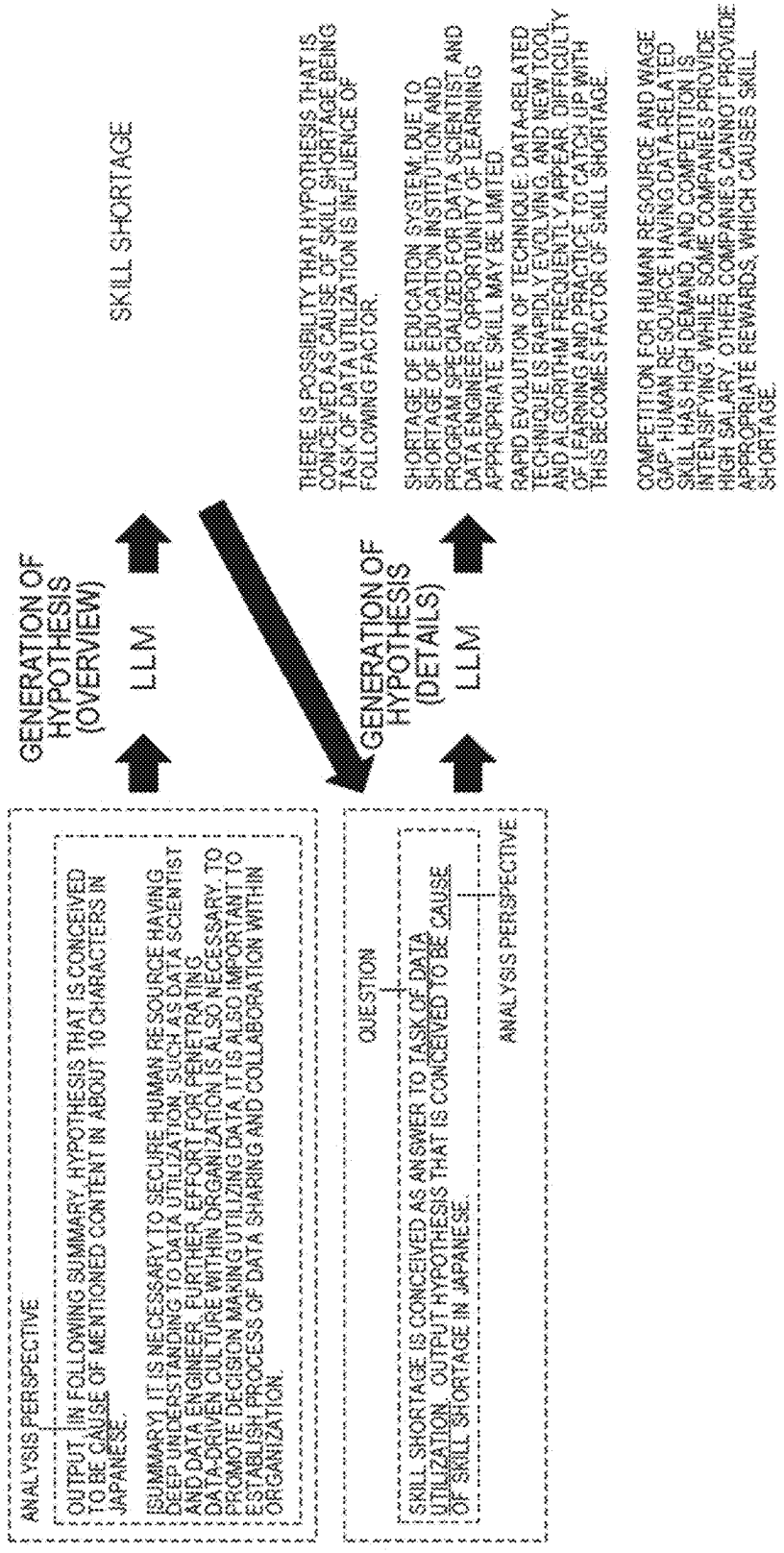


FIG. 16

IMAGE DIAGRAM OF VISUALIZED PART

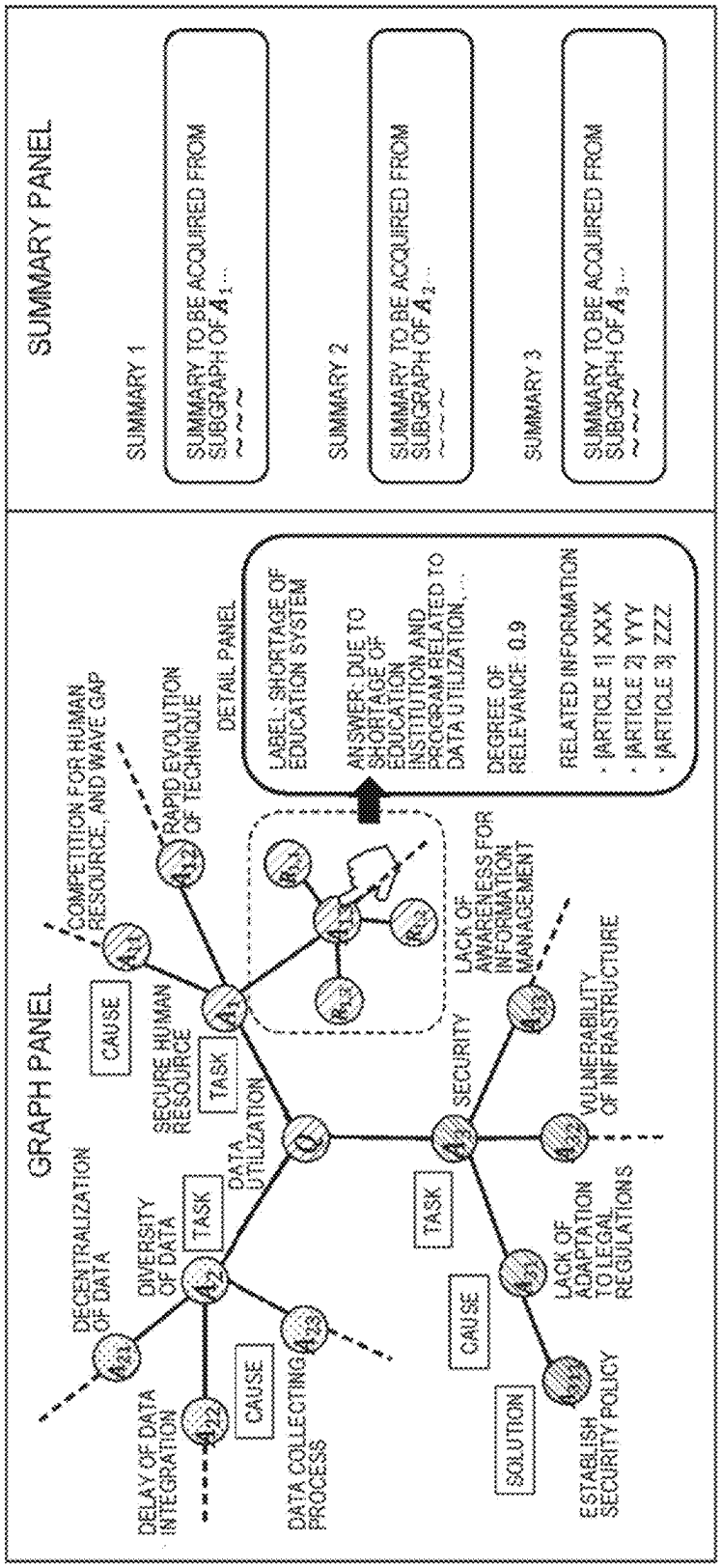


FIG. 17

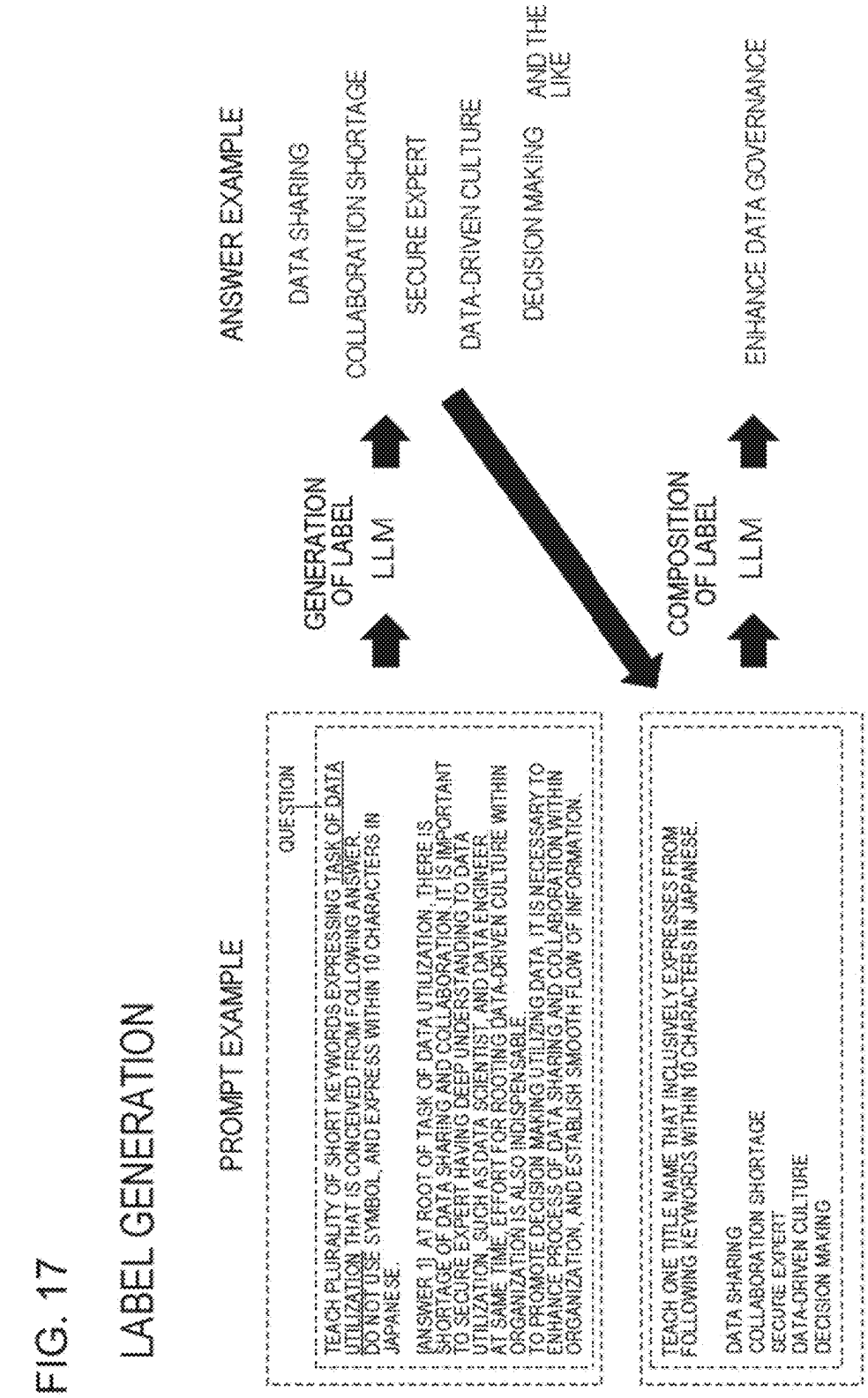
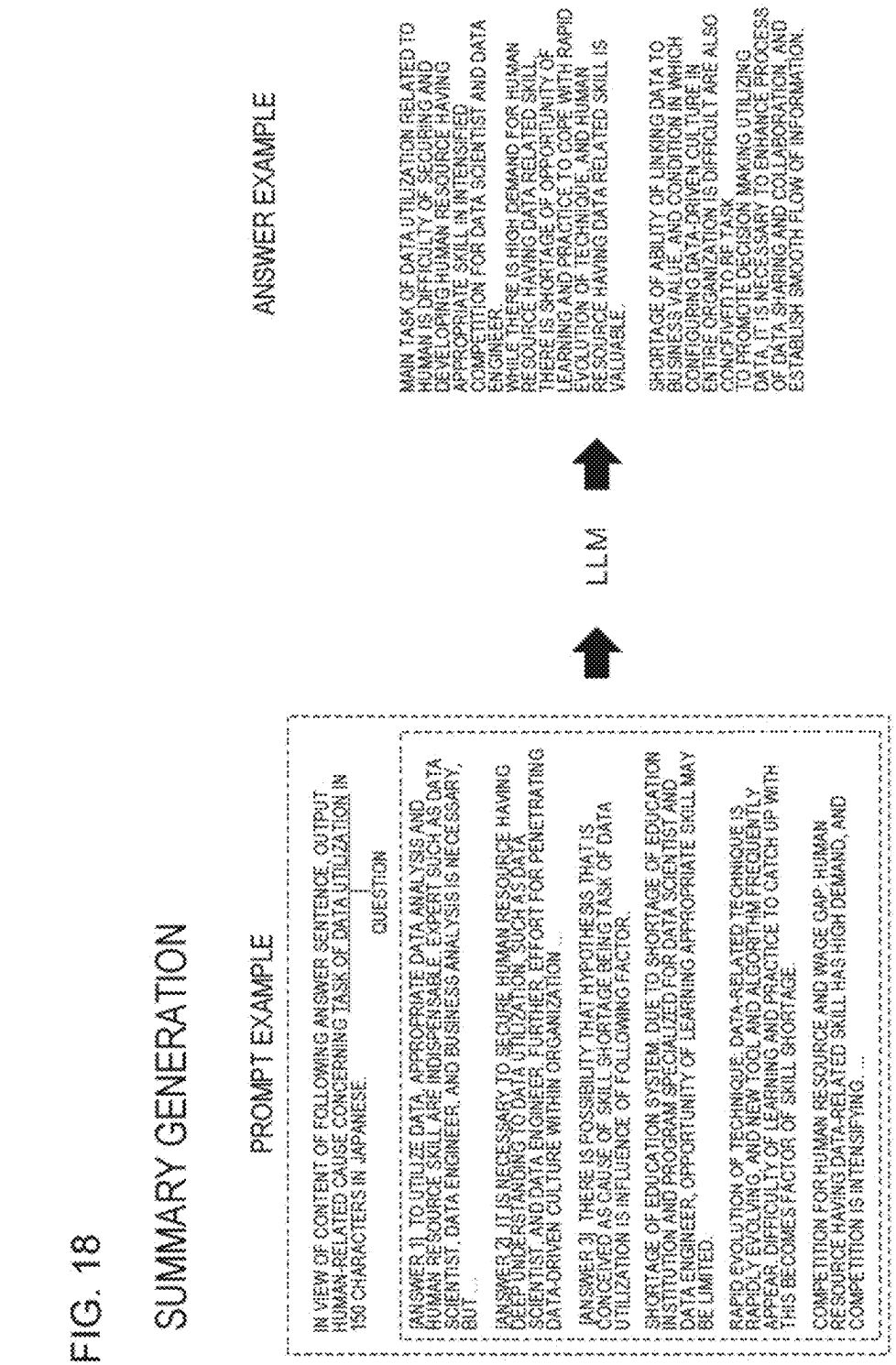

LABEL GENERATION
PROMPT EXAMPLE
QUESTION
TEACH PLURALITY OF SHORT KEYWORDS EXPRESSING TASK OF DATA UTILIZATION THAT IS CONCEIVED FROM FOLLOWING ANSWER.
DO NOT USE SYMBOL, AND EXPRESS WITHIN 10 CHARACTERS IN JAPANESE.
[ANSWER 1] AT ROOT OF TASK OF DATA UTILIZATION, THERE IS SHORTAGE OF DATA SHARING AND COLLABORATION. IT IS IMPORTANT TO SECURE EXPERT HAVING DEEP UNDERSTANDING TO DATA UTILIZATION, SUCH AS DATA SCIENTIST AND DATA ENGINEER. AT SAME TIME, EFFORT FOR ROOTING DATA-DRIVEN CULTURE WITHIN ORGANIZATION IS ALSO INDISPENSABLE.
TO PROMOTE DECISION MAKING UTILIZING DATA, IT IS NECESSARY TO ENHANCE PROCESS OF DATA SHARING AND COLLABORATION WITHIN ORGANIZATION, AND ESTABLISH SMOOTH FLOW OF INFORMATION.
GENERATION OF LABEL
LLM
COMPOSITION OF LABEL
LLM
ANSWER EXAMPLE
DATA SHARING
COLLABORATION SHORTAGE
SECURE EXPERT
DATA-DRIVEN CULTURE
DECISION MAKING
AND THE LIKE
ENHANCE DATA GOVERNANCE
TEACH ONE TITLE NAME THAT INCLUSIVELY EXPRESSES FROM FOLLOWING KEYWORDS WITHIN 10 CHARACTERS IN JAPANESE.
DATA SHARING
COLLABORATION SHORTAGE
SECURE EXPERT
DATA-DRIVEN CULTURE
DECISION MAKING

FIG. 18


SUMMARY GENERATION
PROMPT EXAMPLE
IN VIEW OF CONTENT OF FOLLOWING ANSWER SENTENCE, OUTPUT HUMAN-RELATED CAUSE CONCERNING TASK OF DATA UTILIZATION IN 150 CHARACTERS IN JAPANESE.
QUESTION
[ANSWER 1] TO UTILIZE DATA, APPROPRIATE DATA ANALYSIS AND HUMAN RESOURCE SKILL ARE INDISPENSABLE. EXPERT SUCH AS DATA SCIENTIST, DATA ENGINEER, AND BUSINESS ANALYSIS IS NECESSARY, BUT, ...
[ANSWER 2] IT IS NECESSARY TO SECURE HUMAN RESOURCE HAVING DEEP UNDERSTANDING TO DATA UTILIZATION, SUCH AS DATA SCIENTIST AND DATA ENGINEER. FURTHER, EFFORT FOR PENETRATING DATA-DRIVEN CULTURE WITHIN ORGANIZATION ...
[ANSWER 3] THERE IS POSSIBILITY THAT HYPOTHESIS THAT IS CONCEIVED AS CAUSE OF SKILL SHORTAGE BEING TASK OF DATA UTILIZATION IS INFLUENCE OF FOLLOWING FACTOR.
SHORTAGE OF EDUCATION SYSTEM DUE TO SHORTAGE OF EDUCATION INSTITUTION AND PROGRAM SPECIALIZED FOR DATA SCIENTIST AND DATA ENGINEER, OPPORTUNITY OF LEARNING APPROPRIATE SKILL MAY BE LIMITED
RAPID EVOLUTION OF TECHNIQUE, DATA-RELATED TECHNIQUE IS RAPIDLY EVOLVING AND NEW TOOL AND ALGORITHM FREQUENTLY APPEAR. DIFFICULTY OF LEARNING AND PRACTICE TO CATCH UP WITH THIS BECOMES FACTOR OF SKILL SHORTAGE.
COMPETITION FOR HUMAN RESOURCE AND WAGE GAP. HUMAN RESOURCE HAVING DATA-RELATED SKILL HAS HIGH DEMAND, AND COMPETITION IS INTENSIFYING. ...
LLM
ANSWER EXAMPLE
MAIN TASK OF DATA UTILIZATION RELATED TO HUMAN IS DIFFICULTY OF SECURING AND DEVELOPING HUMAN RESOURCE HAVING APPROPRIATE SKILL IN INTENSIFIED COMPETITION FOR DATA SCIENTIST AND DATA ENGINEER.
WHILE THERE IS HIGH DEMAND FOR HUMAN RESOURCE HAVING DATA RELATED SKILL, THERE IS SHORTAGE OF OPPORTUNITY OF LEARNING AND PRACTICE TO COPE WITH RAPID EVOLUTION OF TECHNIQUE, AND HUMAN RESOURCE HAVING DATA RELATED SKILL IS VALUABLE.
SHORTAGE OF ABILITY OF LINKING DATA TO BUSINESS VALUE, AND CONDITION IN WHICH CONFIGURING DATA-DRIVEN CULTURE IN ENTIRE ORGANIZATION IS DIFFICULT ARE ALSO CONTRIVED TO BE TASK.
TO PROMOTE DECISION MAKING UTILIZING DATA, IT IS NECESSARY TO ENHANCE PROCESS OF DATA SHARING AND COLLABORATION, AND ESTABLISH SMOOTH FLOW OF INFORMATION.

PROCESSING APPARATUS, PROCESSING METHOD, AND NON-TRANSITORY COMPUTER-READABLE MEDIUM

TECHNICAL FIELD

[0001] This application is based upon and claims the benefit of priority from Japanese patent application No. 2024-18512, filed on Feb. 9, 2024, the disclosure of which is incorporated herein in its entirety by reference.

[0002] The present disclosure relates to a processing apparatus, a processing method, and a program.

BACKGROUND ART

[0003] A technique for performing natural language processing such as a question and answer by using large language models (LLMs) has been widely used. In the technique, there is a task of improving quality of an answer to be output from the LLM. A related technique is disclosed in Japanese Patent No. 7313757.

[0004] The technique disclosed in Japanese Patent No. 7313757 generates a prompt in which a passage valid to an input question is added as reference information within a range of a predetermined character limit. The technique improves quality of an answer to be output from the LLM by generating a prompt as described above.

SUMMARY

[0005] One example of an object of the present disclosure is to improve quality of an answer to be output from an LLM.

[0006] An example aspect of the present disclosure provides a processing apparatus including:

[0007] an input acceptance unit that accepts an input of a question and an analysis perspective; and

[0008] a search unit that repeatedly performs processing of generating an answer by inputting a prompt indicating a question and an analysis perspective to a large language model with use of an input question, and a new question generated based on the answer.

[0009] Further, an example aspect of the present disclosure provides a processing method including,

[0010] by one or more computers:

[0011] accepting an input of a question and an analysis perspective; and

[0012] repeatedly performing processing of generating an answer by inputting a prompt indicating a question and an analysis perspective to a large language model with use of an input question, and a new question generated based on the answer.

[0013] Further, an example aspect of the present disclosure provides a program that causes a computer to function as:

[0014] an input acceptance unit that accepts an input of a question and an analysis perspective; and

[0015] a search unit that repeatedly performs processing of generating an answer by inputting a prompt indicating a question and an analysis perspective to a large language model with use of an input question, and a new question generated based on the answer.

[0016] According to one example aspect of the present disclosure, it is possible to improve quality of an answer to be output from an LLM.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] FIG. **1** is a diagram illustrating one example of a functional block diagram of a processing apparatus according to the present disclosure.

[0018] FIG. **2** is a flowchart illustrating one example of a flow of processing of the processing apparatus according to the present disclosure.

[0019] FIG. **3** is a diagram for describing an overview of the processing apparatus according to the present disclosure.

[0020] FIG. **4** is a diagram illustrating one example of a hardware configuration of the processing apparatus according to the present disclosure.

[0021] FIG. **5** is a diagram illustrating one example of a functional block diagram of the processing apparatus according to the present disclosure.

[0022] FIG. **6** is a diagram illustrating one example of a functional block diagram of a search unit according to the present disclosure.

[0023] FIG. **7** is a flowchart illustrating another example of a flow of processing of the processing apparatus according to the present disclosure.

[0024] FIG. **8** is a diagram for describing a flow of processing of the processing apparatus according to the present disclosure.

[0025] FIG. **9** is a diagram for describing one example of processing of the processing apparatus according to the present disclosure.

[0026] FIG. **10** is a diagram for describing another example of processing of the processing apparatus according to the present disclosure.

[0027] FIG. **11** is a diagram for describing another example of processing of the processing apparatus according to the present disclosure.

[0028] FIG. **12** is a diagram for describing another example of processing of the processing apparatus according to the present disclosure.

[0029] FIG. **13** is a diagram for describing another example of processing of the processing apparatus according to the present disclosure.

[0030] FIG. **14** is a diagram for describing another example of processing of the processing apparatus according to the present disclosure.

[0031] FIG. **15** is a diagram for describing another example of processing of the processing apparatus according to the present disclosure.

[0032] FIG. **16** is a diagram illustrating one example of information to be output from the processing apparatus according to the present disclosure.

[0033] FIG. **17** is a diagram for describing another example of processing of the processing apparatus according to the present disclosure.

[0034] FIG. **18** is a diagram for describing another example of processing of the processing apparatus according to the present disclosure.

EXAMPLE EMBODIMENT

[0035] Hereinafter, example embodiments according to the present disclosure are described by using the drawings. In the present disclosure, drawings are associated with one or more example embodiments. Further, in all the drawings, a similar constituent element is indicated by a similar reference sign, and description thereof is omitted as necessary.

First Example Embodiment

[0036] FIG. **1** is a functional block diagram illustrating an overview of a processing apparatus **10**. FIG. **2** is a flowchart illustrating one example of a flow of processing to be performed by the processing apparatus **10**.

[0037] As illustrated in FIG. **1**, the processing apparatus **10** includes an input acceptance unit **11**, and a search unit **12**. Processing of the flowchart in FIG. **2** is performed by these functional units.

[0038] In S**10**, the input acceptance unit **11** accepts an input of a question and an analysis perspective.

[0039] In S**11**, the search unit **12** repeatedly performs processing of generating an answer by inputting a prompt indicating a question and an analysis perspective to an LLM with use of an input question, and a new question generated based on the answer.

[0040] Specifically, as illustrated in FIG. **3**, in a case where an input of a question and an analysis perspective is accepted, the processing apparatus **10** repeats processing of generating an answer by inputting a prompt to the LLM. According to the processing apparatus **10** that repeats processing as described above, it is possible to imitate behavior of a human who thinks deeply by repeating thought. Thus, an answer of higher quality can be generated.

[0041] Further, the processing apparatus **10** automatically generates a prompt, and inputs the generated prompt to the LLM during processing to be repeatedly performed. Specifically, a user only needs to input a question and an analysis perspective once for a first time, and does not need to input a prompt every time during processing to be repeatedly performed. In this way, the processing apparatus **10** can imitate behavior of a human who thinks deeply by repeating thought, without an effort of a user. Thus, an answer of higher quality can be generated.

[0042] Further, the processing apparatus **10** can generate a question, based on an answer, and generate a prompt by using a generated new question. According to the processing apparatus **10** as described above, after acquiring a result of thought, behavior of a human who thinks further deeply, based on the result, can be imitated. Thus, an answer of higher quality can be generated.

[0043] Further, the processing apparatus **10** can acquire an answer by inputting, to the LLM, a prompt indicating not only a question but also an analysis perspective. Adding an analysis perspective enables to generate an answer of higher quality.

Second Example Embodiment

Overview

[0044] A processing apparatus **10** according to a second example embodiment is an embodiment that embodies the configuration of the processing apparatus **10** according to the first example embodiment. Hereinafter, details are described.

Hardware Configuration

[0045] First, one example of a hardware configuration of the processing apparatus **10** is described. Each functional unit of the processing apparatus **10** is achieved by any combination of hardware and software. A person skilled in the art may naturally understand that there are various modification examples, as a method and an apparatus of achieving the configuration. The software includes a program stored in advance at a stage of shipping an apparatus, a program downloaded from a medium such as a compact disc (CD), a server or the like on the Internet, and the like.

[0046] FIG. **4** is a block diagram illustrating a hardware configuration of the processing apparatus **10**. As illustrated in FIG. **4**, the processing apparatus **10** includes a processor **1**A, a memory **2**A, an input/output interface **3**A, a peripheral circuit **4**A, and a bus **5**A. The peripheral circuit **4**A includes various modules. The processing apparatus **10** may not include the peripheral circuit **4**A. Note that, the processing apparatus **10** may be composed of a plurality of apparatuses that are physically and/or logically separated. In this case, each of the plurality of apparatuses can include the above-described hardware configuration.

[0047] The bus **5**A is a data transmission path along which the processor **1**A, the memory **2**A, the peripheral circuit **4**A, and the input/output interface **3**A mutually transmit and receive data. The processor **1**A is an arithmetic processing apparatus, for example, such as a central processing unit (CPU) and a graphics processing unit (GPU). The memory **2**A is a memory, for example, such as a random access memory (RAM) and a read only memory (ROM). The input/output interface **3**A includes an interface for acquiring information from an input apparatus, an external apparatus, an external server, an external sensor, a camera, and the like, an interface for outputting information to an output apparatus, an external apparatus, an external server, and the like, and the like. Further, the input/output interface **3**A includes an interface for connecting to a communication network such as the Internet. The input apparatus is, for example, a keyboard, a mouse, a microphone, a physical button, a touch panel, and the like. The output apparatus is, for example, a display, a projection apparatus, a speaker, a printer, a mailer, and the like. The processor **1**A can issue a command to each module, and perform an arithmetic operation, based on these arithmetic operation results.

Functional Configuration

[0048] Next, a functional configuration of the processing apparatus **10** is described in detail. FIG. **5** illustrates one example of a functional block diagram of the processing apparatus **10**. As illustrated in FIG. **5**, the processing apparatus **10** includes an input acceptance unit **11**, a search unit **12**, and a result output unit **13**. Further, as illustrated in FIG. **6**, the search unit **12** includes an information retrieval unit **121**, an answer generation unit **122**, an answer verification unit **123**, and a question generation unit **124**.

[0049] By these functional units, processing illustrated in a flowchart in FIG. **7** is performed. An overview of each piece of processing, and an overall image of processing are described with reference to FIG. **8**.

[0050] Input acceptance processing S**20**: The input acceptance unit **11** accepts an input of a question and an analysis perspective. For example, as illustrated in FIG. **8**, the input acceptance unit **11** accepts an input of a question Q and an analysis perspective P.

[0051] Related information retrieval processing S**21**: The information retrieval unit **121** retrieves related information related to a question. For example, as illustrated in FIG. **8**, the information retrieval unit **121** retrieves, from among information stored in a database, pieces of related information $R_{1.1}$ to $R_{4.3}$ related to the question Q.

[0052] Answer generation processing S**22**: The answer generation unit **122** generates a prompt by using a question, an analysis perspective, and related information, and generates a first answer by inputting the generated prompt to an LLM. For example, the information retrieval unit **121** generates a prompt by using the question Q, the analysis perspective P, and the pieces of related information $R_{1.1}$ to $R_{4.3}$ illustrated in FIG. **8**, and generates first answers A_1 to A_4 by inputting the generated prompt to the large language model.

[0053] Answer verification processing S**23**: The answer verification unit **123** decides whether a degree of relevance between a first answer and a question satisfies a passing condition, and outputs, as an answer, a first answer that satisfies the passing condition. For example, the answer verification unit **123** decides whether a degree of relevance between the question Q, and each of the first answers A_1 to A_4 illustrated in FIG. **8** satisfies a passing condition. Then, the answer verification unit **123** outputs, toward next piece of processing, the first answers A_1 to A_3 that satisfy the passing condition, as an answer. Note that, as illustrated in FIG. **8**, the answer verification unit **123** may discard the first answer A_4 that does not satisfy the passing condition, without outputting the first answer A_4 toward the next piece of processing. Further, as illustrated in FIG. **8**, the answer verification unit **123** may revise the first answer A_2 that does not satisfy the passing condition, and output, toward the next piece of processing, the first answer A_2 after revision that satisfies the passing condition, as an answer.

[0054] Loop finish decision processing S**24**: The answer verification unit **123** decides whether a loop is to be finished. In a case where the loop is not finished, the processing apparatus **10** proceeds to question generation processing S**25**. In a case where the loop is finished, the processing apparatus **10** proceeds to result output processing S**26**.

[0055] Question generation processing S**25**: The question generation unit **124** generates a hypothesis, based on an answer output in the answer verification processing S**23**, and generates a new question, based on the generated hypothesis. For example, as illustrated in FIG. **8**, the question generation unit **124** generates hypotheses H_1 to H_3, based on each of the answers A_1 to A_3 output in the answer verification processing S**23**. Then, the answer generation unit **124** generates a new question, based on each of the generated hypotheses H_1 to H_3. Thereafter, the processing apparatus **10** returns to the related information retrieval processing S**21**, and repeats similar processing. In processing at a second time and thereafter, a new question generated in the question generation processing S**25** is used, in place of the question Q input in the input acceptance processing S**20**.

[0056] Result output processing S**26**: A result is output.

[0057] Next, each piece of processing is described in detail.

Input Acceptance Processing S**20**

[0058] The input acceptance unit **11** accepts an input of a question and an analysis perspective. The question is composed of, for example, a passage. The analysis perspective is composed of, for example, a word or a passage.

[0059] An input format of the question and the analysis perspective is not particularly limited. For example, a free description style may be adopted. In this case, the input acceptance unit **11** can decrypt an input content by using a technique such as morphological analysis, and determine the question and the analysis perspective. One example of the input is described below. A content in parentheses is data input by a user.

[0060] (Input example 1) "What is a task of data utilization? An analysis perspective is a task, a cause, and a solution."

[0061] (Input example 2) "Regarding a task of data utilization, answer in terms of an analysis perspective of a task, a cause, and a solution."

[0062] In addition, the input acceptance unit **11** may individually provide, on a user interface (UI) screen for accepting an input, a column in which an input of a question is accepted, and a column in which an input of an analysis perspective is accepted. Then, the input acceptance unit **11** may accept, as a question, a content input in the question column, and accept, as an analysis perspective, a content input in the analysis perspective column. One example of the input is described below. A content in parentheses is data input by a user.

[0063] (Input example 3) Question column: "What is a task of data utilization?" Analysis perspective column: "a task, a cause, and a solution."

[0064] The input acceptance unit **11** can accept the above-described input via any input apparatus such as a keyboard, a touch panel, a mouse, a microphone, and a physical button. Further, the processing apparatus **10** may be a server. In this case, the input acceptance unit **11** can receive a question and an analysis perspective transmitted from a client terminal.

Related Information Retrieval Processing S**21**

[0065] The information retrieval unit **121** retrieves related information related to a question.

[0066] As described by using FIGS. **7** and **8**, the processing apparatus **10** repeats a loop. In a loop at a first time, the information retrieval unit **121** can retrieve related information related to a question input in the input acceptance processing S**20**. Then, in a loop at a second time and thereafter, the information retrieval unit **121** can retrieve related information related to a new question generated by the question generation unit **124**.

[0067] The related information is document data, image data (a drawing, a photograph, and the like), data in another format (a table and the like), and the like, but is not limited thereto. A source (retrieval destination) of the related information may be one or plural. The related information may be information widely and publicly available on a web. Further, the related information may be locally saved information. The locally saved information may be data prepared for processing by the processing apparatus **10**, or may be information publicly available in such a way as to be widely utilized in local.

[0068] The information retrieval unit **121** can acquire related information by using a retrieval model that performs retrieval of related information, based on a certain degree of relevance to a question.

[0069] For example, the information retrieval unit **121** may retrieve related information by using a web retrieval engine. In a case of this example, the information retrieval unit **121** performs retrieval by inputting a question to the web retrieval engine. Then, the information retrieval unit **121** acquires, as related information related to the input question, information on a webpage included in a result of the retrieval. In a case where the number of hits of retrieval results is large, the information retrieval unit **121** may

acquire, as related information, information on a predetermined top number of retrieval results.

[0070] In addition, the information retrieval unit **121** may perform retrieval by inputting a question to a retrieval engine that retrieves locally saved information. Then, the information retrieval unit **121** may acquire, as related information related to the input question, local information included in a result of the retrieval. In a case where the number of hits of retrieval results is large, the information retrieval unit **121** may acquire, as related information, information on a predetermined top number of retrieval results.

[0071] Note that, a method exemplified herein is merely one example, and the information retrieval unit **121** may retrieve related information related to a question by another method.

[0072] Meanwhile, actually (in a case where a person decides), there is a possibility that data (noise data) in which a degree of relevance to a question is low may be included in related information retrieved by a method as described above. In view of the above, the information retrieval unit **121** may perform processing of eliminating noise data from retrieved related information.

[0073] For example, the information retrieval unit **121** may compute a degree of relevance between a question and retrieved related information, and eliminate, as noise data, related information in which the degree of relevance is equal to or less than a threshold value. The information retrieval unit **121** can compute a degree of relevance between a question and retrieved related information by using a relationship decision model being prepared in advance.

[0074] As one example of the relationship decision model, upon accepting an input of a question and retrieved related information, similarity between the question and the retrieved related information is output as a degree of relevance. In this case, the information retrieval unit **121** eliminates, as noise data, related information in which the similarity (degree of relevance) to the question is equal to or less than a threshold value.

[0075] In recent years, a technique for computing similarity between passages is widely used. In one example, a passage is converted into a vector, and similarity (cosine similarity or the like) between vectors is computed as similarity between passages. One example of the relationship decision model can compute similarity between a question and retrieved related information by using a technique as described above.

[0076] Note that, in a case where related information is image data such as a drawing and a photograph, the information retrieval unit **121** may generate document data from the image data by using a learning model that has trained in such a way as to generate, from the image data, document data representing an image. Then, the information retrieval unit **121** may compute, as similarity (degree of relevance) between image data and a question, similarity between the generated document data and the question. Also in a case where related information is data in another format such as a table, it is possible to compute similarity (degree of relevance) between a question and retrieved related information by a method similar to that for image data.

[0077] Another example of the relationship decision model is an LLM. The LLM is a model of natural language processing being trained by using a large amount of text data. For example, in a case where a query is input to the LLM, an answer to the query is output from the LLM. A passage (query) to be input to the LLM is referred to as a "prompt".

[0078] The information retrieval unit **121** may generate a prompt asking for whether a question and retrieved related information are related to each other, input the generated prompt to the LLM, and thereby acquire a query as to whether the question and the retrieved related information are related to each other. Then, the information retrieval unit **121** may eliminate, as noise data, related information in which the answer is "not related". Various examples are conceived for a prompt in this processing, however, one example is as follows.

[0079] "Are the following question and related information related to each other? In a case where they are related to each other, output 1, and in a case where they are not related to each other, output 0.

[0080] [Question] What is a task of data utilization?

[0081] [Related information] Recent . . . "

[0082] The information retrieval unit **121** may generate a prompt, for example, by using a template being prepared in advance. For example, the template may be a passage in which a position where a question is inserted, and a position where related information is inserted are blank. Then, the information retrieval unit **121** may generate a prompt by inserting the question and the related information to a predetermined position of the template. In addition, the information retrieval unit **121** may generate a prompt on the basis of a generation model, in place of generating a prompt on the basis of a template. The generation model herein can be achieved by using any widely known technique.

Answer Generation Processing S22

[0083] The answer generation unit **122** generates a prompt (hereinafter, may also referred to as a "prompt for first answer generation" by using a question, an analysis perspective, and related information, and generates a first answer by inputting the generated prompt for first answer generation to the LLM.

[0084] One example is illustrated in FIG. **9**. A prompt example in FIG. **9** is one example of a prompt for first answer generation. Further, an answer example in FIG. **9** is one example of a first answer output from the LLM. As illustrated in FIG. **9**, the LLM may generate and output a plurality of first answers (in a case of the example in FIG. **9**, three first answers) in response to one input of a prompt for first answer generation. Note that, the LLM may generate and output one first answer in response to one input of a prompt for first answer generation.

[0085] The answer generation unit **122** can generate a prompt for first answer generation, for example, by using a template being prepared in advance. For example, the template may be a passage in which a position where a question is inserted, a position where an analysis perspective is inserted, and a position where related information is inserted are blank. Then, the answer generation unit **122** may generate a prompt for first answer generation by inserting the question, the analysis perspective, and the related information to a predetermined position of the template. In addition, the answer generation unit **122** may generate a prompt for first answer generation on the basis of a generation model, in place of generating a prompt for first answer generation on the basis of a template. The generation model herein can be achieved by using any widely known technique.

[0086] The answer generation unit **122** can refer to related information, after giving the related information to a context of the LLM, and generate a prompt for first answer generation asking for an answer to a question in terms of a specified analysis perspective. A first answer to be acquired by a prompt for first answer generation as described above is an "answer to a question" that is generated by referring to related information, and is related to a specified analysis perspective. A technique for using related information as described above is known as retrieval augmented generation (RAG).

[0087] As described by using FIGS. **7** and **8**, the processing apparatus **10** repeats a loop. In a loop at a first time, the answer generation unit **122** can ask for an answer to a question input in the input acceptance processing S**20**. Related information included in a prompt for first answer generation in the loop at the first time is related information related to the question input in the input acceptance processing S**20**.

[0088] Then, in a loop at a second time and thereafter, the answer generation unit **122** can ask for an answer to a new question generated by the question generation unit **124**. Related information included in a prompt for first answer generation in the loop at the second time and thereafter is related information related to a new question generated by the question generation unit **124**.

[0089] An analysis perspective included in a prompt for first answer generation is decided, for example, based on an analysis perspective input in the input acceptance processing S**20**.

[0090] It is preferable to differentiate an analysis perspective included in a prompt for first answer generation in a loop at each of a plurality of times. Specifically, as illustrated in FIGS. **7** and **8**, in processing to be repeatedly performed, it is preferable to differentiate an analysis perspective for use in processing at each time. Performing as described above achieves deepening of thought in various perspectives, as the loop is repeated.

[0091] One analysis perspective may be included, or a combination of a plurality of analysis perspectives may be included in a prompt for first answer generation.

[0092] In a case where only one analysis perspective is included in a prompt for first answer generation, the answer generation unit **122** can select, for example, each one of a plurality of analysis perspectives input in the input acceptance processing S**20**, and include the selected analysis perspective in a prompt for first answer generation in each of a plurality of loops.

[0093] Performing as described above enables to narrow down thought in a loop at each time to one analysis perspective. Consequently, a possibility of acquiring, from the LLM, an answer of high accuracy in which the one analysis perspective is deepened increases.

[0094] On the other hand, in a case where including a plurality of analysis perspectives in a prompt for first answer generation is permitted, the answer generation unit **122** generates all combinations composed of at least one constituent element (analysis perspective) by using, for example, a plurality of analysis perspectives input in the input acceptance processing S**20**. Then, the answer generation unit **122** can select each one pair among the plurality of generated combinations, and include the selected pair in a prompt for first answer generation in each of a plurality of loops.

[0095] In this case, it is assumed that "analysis perspective A", and "analysis perspective A+analysis perspective B" are combinations of different analysis perspectives. Although both of the combinations include a same analysis perspective being "analysis perspective A", there is a possibility that an answer of the LLM may be different, in a case where the analysis perspective A is combined with another analysis perspective. Acquiring an answer from the LLM by using combinations of various analysis perspectives achieves deepening of thought in terms of various perspectives.

[0096] Note that, the answer generation unit **122** may include, in a prompt for first answer generation, an analysis perspective other than an analysis perspective input in the input acceptance processing S**20**. For example, a candidate of an analysis perspective may be registered in advance in the processing apparatus **10**. Then, the answer generation unit **122** may decide, from among the candidate of the analysis perspective being registered in advance, an analysis perspective included in a prompt for first answer generation by a method similar to the above.

[0097] In addition, the answer generation unit **122** may generate a prompt asking for an analysis perspective preferable to a question, input the generated prompt to the LLM, and thereby acquire the analysis perspective preferable to the question. Then, the answer generation unit **122** may decide, from among the analysis perspective acquired as described above, an analysis perspective included in a prompt for first answer generation by a method similar to the above.

[0098] Various examples are conceived for a prompt in this processing, however, one example is as follows.

[0099] "Mention five analysis perspectives preferable to the following question.

[0100] [Question] What is a task of data utilization?"

[0101] The answer generation unit **122** may generate a prompt, for example, by using a template being prepared in advance. For example, the template may be a passage in which a position where a question is inserted is blank. Then, the answer generation unit **122** may generate a prompt by inserting the question to a predetermined position of the template. In addition, the answer generation unit **122** may generate a prompt on the basis of a generation model, in place of generating a prompt on the basis of a template. The generation model herein can be achieved by using any widely known technique.

[0102] Note that, the analysis perspective may include a perspective of a business framework such as a "human", a "thing", and "money". Thus, an answer in which a perspective important for business is secured can be expected.

[0103] In this way, an analysis perspective included in a prompt for first answer generation is not specifically limited, and various analysis perspectives can be included. However, in a case as described above, there is a possibility that the LLM does not hold knowledge related to the analysis perspectives sufficiently. Consequently, accuracy of an answer of the LLM may be lowered. In view of the above, related information related to various analysis perspectives may be registered in advance in the processing apparatus **10**. Further, as illustrated in FIG. **10**, the answer generation unit **122** may further include, in a prompt for first answer generation, related information on an analysis perspective.

[0104] In addition, the information retrieval unit **121** my acquire related information related to an analysis perspective by a method similar to a method of acquiring related

information related to a question. Further, the answer generation unit **122** may include, in a prompt for first answer generation, the related information on the analysis perspective acquired by a method as described above.

[0105] Including related information on an analysis perspective as described above in a prompt for first answer generation makes it easy to acquire an answer of high accuracy from the LLM.

[0106] Note that, in a case where related information is enormous, and cannot be stored in a context length available in the LLM, the answer generation unit **122** may select related information in descending order of a degree of relevance, and include the selected related information in a prompt for first answer generation. In addition, the answer generation unit **122** may generate a summary of related information by using the LLM, and include, in a prompt for first answer generation, the generated summary of the related information, in place of the related information.

[0107] Further, the answer generation unit **122** may classify related information for each topic, and generate a plurality of prompts for first answer generation including the related information of each topic. Then, the answer generation unit **122** may input, to the LLM, each of the plurality of prompts for first answer generation generated as described above, and generate an answer to a question in the LLM for each topic. In this case, the prompt for first answer generation associated with each topic includes related information of each topic, and does not include related information of another topic. Classification of the related information can be achieved by various methods. As one example, a method of vectorizing each piece of related information, and clustering based on similarity between vectors is exemplified, but the present example embodiment is not limited thereto.

Answer Verification Processing S**23**

[0108] The answer verification unit **123** decides whether a degree of relevance between a first answer, and a question (question included in a prompt for first answer generation for acquiring the first answer) satisfies a passing condition. Then, the answer verification unit **123** may output, as an answer to the question, a first answer that satisfies the passing condition. The answer verification unit **123** may output, as an answer to the question, one first answer, or may output, as an answer to the question, a plurality of first answers. The processing enables to perform pieces of processing thereafter (generation of a question, loop processing based on a new question, output of a result, and the like), based on a first answer in which a degree of relevance to the question is high.

[0109] The answer verification unit **123** can decide, based on any of the following pieces of verification processing 1 to 4, whether a degree of relevance between a first answer and a question satisfies a passing condition.

Verification Processing 1

[0110] As illustrated in FIG. **11**, the answer verification unit **123** can compute a degree of relevance between a first answer and a question by using a Dual-encoder. Then, in a case where the computed degree of relevance is equal to or more than a threshold value, the answer verification unit **123** can decide that the relationship between the first answer and the question satisfies a passing condition. On the other hand, in a case where the computed degree of relevance is less than the threshold value, the answer verification unit **123** can decide that the relationship between the first answer and the question does not satisfy the passing condition.

[0111] The Dual-encoder includes a Query encoder and a Document encoder.

[0112] Upon accepting an input of the question (passage), the Query encoder converts the question into a vector, and outputs the vector.

[0113] Upon accepting an input of the first answer (passage), the Document encoder converts the first answer into a vector, and outputs the vector.

[0114] Then, the answer verification unit **123** computes, as a degree of relevance between the first answer and the question, similarity (cosine similarity or the like) between the two vectors output from the two encoders.

Verification Processing 2

[0115] As illustrated in FIG. **12**, the answer verification unit **123** can compute a degree of relevance between a first answer and a question by using a Cross encoder. Then, in a case where the computed degree of relevance is equal to or more than a threshold value, the answer verification unit **123** can decide that the relationship between the first answer and the question satisfies a passing condition. On the other hand, in a case where the computed degree of relevance is less than the threshold value, the answer verification unit **123** can decide that the relationship between the first answer and the question does not satisfy the passing condition.

[0116] Upon accepting an input of the question (passage) and the first answer (passage), the Cross encoder outputs a degree of relevance.

Verification Processing 3

[0117] As illustrated in FIG. **13**, the answer verification unit **123** can compute a degree of relevance between a first answer and a question by using the LLM.

[0118] The answer verification unit **123** can generate a prompt asking for whether a first answer and a question are related to each other, input the generated prompt to the LLM, and thereby acquire an answer as to whether the first answer and the question are related to each other. Then, in a case where the answer indicates "related", the answer verification unit **123** can decide that the relationship between the first answer and the question satisfies a passing condition. On the other hand, in a case where the answer indicates "not related", the answer verification unit **123** can decide that the relationship between the first answer and the question does not satisfy the passing condition.

[0119] Various examples are conceived for a prompt in this processing, however, one example is as illustrated in FIG. **13**. The answer verification unit **123** may generate a prompt, for example, by using a template being prepared in advance. For example, the template may be a passage in which a position where a question is inserted, and a position where a first answer is inserted are blank. Then, the answer verification unit **123** may generate a prompt by inserting the question and the first answer to a predetermined position of the template. In addition, the template may be configured in such a way that a position (position of a "task" in FIG. **13**) where an analysis perspective is inserted is blank. In addition, the answer verification unit **123** may generate a prompt on the basis of a generation model, in place of generating a

prompt on the basis of a template. The generation model herein can be achieved by using any widely known technique.

Verification Processing 4

[0120] The answer verification unit **123** can decide whether a degree of relevance between a first answer and a question satisfies a passing condition by a method in which at least two pieces of processing among the verification processing 1 to 3 are combined.

[0121] In a case of this example, in a case where a verification result of each of the plurality of pieces of verification processing satisfies a predetermined condition, the answer verification unit **123** decides that a degree of relevance between the first answer and the question satisfies the passing condition.

[0122] The predetermined condition is any of the following.

[0123] Relationship between a first answer and a question satisfies a passing condition in all of the plurality of pieces of verification processing

[0124] Relationship between a first answer and a question satisfies a passing condition in at least one of the plurality of pieces of verification processing

[0125] Relationship between a first answer and a question satisfies a passing condition by a predetermine ratio or more of the plurality of pieces of verification processing

[0126] Relationship between a first answer and a question satisfies a passing condition by a predetermined number or more of the plurality of pieces of verification processing

[0127] A rating value computed (e.g., added up) based on a weighting score of each of the pieces of verification processing in which it is decided that relationship between a first answer and a question satisfies a passing condition is equal to or more than a threshold value

[0128] Note that, in a case where a degree of relevance between a first answer and a question does not satisfy a passing condition, the answer verification unit **123** may discard the first answer. The processing enables to suppress an inconvenience that pieces of processing thereafter (generation of a question, loop processing based on a new question, output of a result, and the like) is performed based on a first answer in which a degree of relevance to a question is low.

[0129] In addition, in a case where a degree of relevance between a first answer and a question does not satisfy a passing condition, the answer verification unit **123** may revise the first answer. Then, the answer verification unit **123** may decide whether the degree of relevance between the first answer after revision and the question satisfies the passing condition. Then, the answer verification unit **123** may output, as an answer to the question, the first answer after revision that satisfies the passing condition. The processing enables to perform pieces of processing thereafter (generation of a question, loop processing based on a new question, output of a result, and the like), based on the first answer being revised in such a way that the degree of relevance to the question satisfies the passing condition.

[0130] Note that, in a case where a degree of relevance between a first answer and a question is lower than a predetermined level, the answer verification unit **123** may discard the first answer. Then, in a case where the degree of relevance between the first answer and the question is higher than the predetermined level, but does not satisfy a passing condition, the answer verification unit **123** may revise the first answer.

[0131] The predetermined level herein may be defined by a degree of relevance to be computed in the verification processing 1 and the verification processing 2.

[0132] In one example, in a case where a degree of relevance is less than a first threshold value, the answer verification unit **123** discards the first answer. Then, in a case where the degree of relevance is equal to or more than the first threshold value, but is less than a second threshold value, the answer verification unit **123** revises the first answer. Then, in a case where the degree of relevance is equal to or more than the second threshold value, the answer verification unit **123** decides that the first answer satisfies the passing condition.

[0133] In addition, the predetermined level herein may be defined based on a verification result of each of the plurality of pieces of verification processing.

[0134] In one example, a weighting score is determined in advance for each of the plurality of pieces of verification processing. Then, the answer verification unit **123** computes (e.g., adds up) a rating value of a first answer, based on a weighting score of each of the pieces of verification processing in which it is decided that a passing condition is satisfied.

[0135] Then, in a case where the rating value is less than a first threshold value, the answer verification unit **123** discards the first answer. Then, in a case where the rating value is equal to or more than the first threshold value, but is less than a second threshold value, the answer verification unit **123** revises the first answer. Then, in a case where the rating value is equal to or more than the second threshold value, the answer verification unit **123** decides that the first answer satisfies the passing condition.

[0136] Next, processing of revising a first answer is described. The answer verification unit **123** can perform any of the following pieces of revision processing 1 and 2.

Revision Processing 1

[0137] The answer verification unit **123** can generate a prompt asking for revision of a first answer, input the generated prompt to the LLM, and thereby acquire a first answer after revision. Various examples are conceived for a prompt in this processing, however, one example is as follows.

[0138] "Revise the following first answer to the following question in such a way as to increase a degree of relevance to the question.

[0139] [Question] What is a task of data utilization? [First answer] To utilize data, . . . "

[0140] The answer verification unit **123** may generate a prompt, for example, by using a template being prepared in advance. For example, the template may be a passage in which a position where a question is inserted, and a position where a first answer is inserted are blank. Then, the answer verification unit **123** may generate a prompt by inserting the question and the first answer to a predetermined position of the template. In addition, the answer verification unit **123** may generate a prompt on the basis of a generation model, in place of generating a prompt on the basis of a template. The generation model herein can be achieved by using any widely known technique.

Revision Processing 2

[0141] In a case where a first answer is revised by using the LLM, in a case where a content of a prompt is inappropriate, desired revision may not be performed, and a content after revision may become almost the same as the content before revision. To suppress the inconvenience, the answer verification unit **123** can generate a prompt as follows.

[0142] First, as illustrated in FIG. **14**, the answer verification unit **123** computes a difference between a first answer and reference information by using the LLM. Various examples are conceived for a prompt in this processing, however, one example is as described in an upper portion of a prompt example in FIG. **14**.

[0143] The answer verification unit **123** may generate a prompt, for example, by using a template being prepared in advance. For example, the template may be a passage in which a position where a first answer is inserted, and a position where a reference sentence is inserted are blank. Then, the answer verification unit **123** may generate a prompt by inserting the first answer and the reference sentence to a predetermined position of the template. In addition, the answer verification unit **123** may generate a prompt on the basis of a generation model, in place of generating a prompt on the basis of a template. The generation model herein can be achieved by using any widely known technique.

[0144] The reference sentence is information acquired by the processing so far. For example, the answer verification unit **123** can use, as the reference sentence, an answer acquired in a preceding loop, or related information used for generation of the answer.

[0145] After acquiring the difference, the answer verification unit **123** generates a prompt that revises the first answer by paying attention to the difference. Various examples are conceived for a prompt in this processing, however, one example is as described in a lower portion of the prompt example in FIG. **14**.

[0146] The answer verification unit **123** may generate a prompt, for example, by using a template being prepared in advance. For example, the template may be a passage in which a position where a question is inserted, a position where a first answer is inserted, and a position where a difference is inserted are blank. Then, the answer verification unit **123** may generate a prompt by inserting the question, the first answer, and the difference to a predetermined position of the template. In addition, the answer verification unit **123** may generate a prompt on the basis of a generation model, in place of generating a prompt on the basis of a template. The generation model herein can be achieved by using any widely known technique.

Loop Finish Decision Processing S**24**

[0147] The answer verification unit **123** decides whether a loop is to be finished. In a case where the loop is not finished, the processing apparatus **10** proceeds to the question generation processing S**25**. In a case where the loop is finished, the processing apparatus **10** proceeds to the result output processing S**26**.

[0148] A condition for finishing the loop is determined in advance. Then, the answer verification unit **123** decides whether a finishing condition for finishing the loop is satisfied. In a case where the finishing condition is satisfied, the answer verification unit **123** decides that the loop is finished. On the other hand, in a case where the finishing condition is not satisfied, the answer verification unit **123** decides that the loop is not finished.

[0149] The loop finishing condition can be various contents. For example, the loop finishing condition may be any of the following.

[0150] The loop is repeated by a predetermined number of times or more

[0151] All or all combinations of analysis perspectives to be used are used at least once

[0152] A desired retrieval result cannot be acquired any more in the related information retrieval processing S**21** (the number of retrieval results becomes equal to or less than a threshold value)

[0153] The analysis perspective to be used may be an analysis perspective input in the input acceptance processing S**20**. In addition, the analysis perspective to be used may be a candidate of an analysis perspective being registered in advance. In addition, the analysis perspective to be used may be an analysis perspective acquired by using the LLM. In addition, the analysis perspective to be used may be a combination of at least two of these analysis perspectives.

Question Generation Processing S**25**

[0154] The question generation unit **124** generates a hypothesis, based on an answer output in the answer verification processing S**23**. Then, the question generation unit **124** generates a new question, based on the generated hypothesis. In this way, since specificity of a question increases by including a perspective of a hypothesis, it can be expected that a more interesting answer can be easily acquired in performing a next loop.

[0155] In a case where one answer is output in the answer verification processing S**23**, the question generation unit **124** generates one or a plurality of hypotheses in association with the one answer, and generates one or a plurality of questions. Hereinafter, the processing apparatus **10** repeats the above-described loop by using the one question, or each of the plurality of questions.

[0156] On the other hand, in a case where a plurality of answers are output in the answer verification processing S**23**, the question generation unit **124** generates one or a plurality of hypotheses in association with each of the plurality of answers, and generates one or a plurality of questions. Hereinafter, the processing apparatus **10** repeats the above-described loop by using the one question, or each of the plurality of questions.

[0157] Next, processing of generating a hypothesis is described.

[0158] The question generation unit **124** generates a hypothesis by inputting, to the LLM, a prompt that generates a hypothesis, based on an answer output in the answer verification processing S**23**, and acquiring a result.

[0159] The question generation unit **124** may generate a prompt, for example, by using a template being prepared in advance. For example, the template may be a passage in which a position where an answer (or a summary thereof) output in the answer verification processing S**23** is inserted is blank. Then, the question generation unit **124** may generate a prompt by inserting the answer (or the summary thereof) output in the answer verification processing S**23** to a predetermined position of the template. In addition, the question generation unit **124** may generate a prompt on the basis of a generation model, in place of generating a prompt

on the basis of a template. The generation model herein can be achieved by using any widely known technique.

[0160] Note that, a hypothesis to be generated herein may be a hypothesis of a next analysis perspective of an answer output in the answer verification processing S**23**. Specifically, the question generation unit **124** may generate, in the question generation processing S**25** in the n-th loop (where n is an integer of 1 or more), a hypothesis of an analysis perspective in the (n+1)-th loop of an answer output in the answer verification processing S**23** in the n-th loop. For example, it is assumed that, regarding an analysis perspective being a "task" in the n-th loop, an answer (task) thereof is output in the answer verification processing S**23** in the n-th loop. In this case, in the question generation processing S**25** in the n-th loop, the question generation unit **124** can generate a hypothesis of a cause (analysis perspective in the (n+1)-th loop) of the answer (task) output in the answer verification processing S**23** in the n-th loop.

[0161] The next analysis perspective is an analysis perspective (one analysis perspective, or a combination of analysis perspectives) not being used in the loop so far.

[0162] Herein, one example of hypothesis generation is described by using FIG. **15**. Note that, in an example in FIG. **15**, a 2-step configuration in which an overview of a hypothesis is generated, and then, details of the hypothesis are generated is configured. By configuring a 2-step configuration as described above, a hypothesis of high accuracy is generated. However, a prompt directly asking for "a hypothesis of a next analysis perspective of an answer output in the answer verification processing S**23**" may be generated, and details of a hypothesis may be generated by 1-step. By configuring as described above, a hypothesis of sufficient accuracy to some extent is also generated.

[0163] In the example in FIG. **15**, first, as illustrated in an upper portion of a prompt example in FIG. **15**, the question generation unit **124** generates a prompt that generates an overview of a hypothesis of a next analysis perspective of an answer output in the answer verification processing S**23**. Then, the question generation unit **124** inputs the prompt to the LLM, and acquires the overview of the hypothesis.

[0164] Note that, as illustrated in the example in FIG. **15**, the question generation unit **124** may generate a prompt by using a summary of an answer output in the answer verification processing S**23**, in place of the answer. The question generation unit **124** can generate the summary by using the LLM.

[0165] The question generation unit **124** may generate a prompt, for example, by using a template being prepared in advance. For example, the template may be a passage in which a position where an answer (or a summary thereof) output in the answer verification processing S**23** is inserted, and a position where a next analysis perspective is inserted are blank. Then, the question generation unit **124** may generate a prompt by inserting the answer (or the summary thereof) output in the answer verification processing S**23**, and the next analysis perspective to a predetermined position of the template. In addition, the question generation unit **124** may generate a prompt on the basis of a generation model, in place of generating a prompt on the basis of a template. The generation model herein can be achieved by using any widely known technique.

[0166] After acquiring the overview of the hypothesis, as illustrated in a lower portion of the prompt example in FIG. **15**, the question generation unit **124** deepens the acquired overview of the hypothesis, and generates a prompt that generates details of the hypothesis. Then, the question generation unit **124** acquires the details of the hypothesis by inputting the prompt to the LLM.

[0167] The prompt that generates details of the hypothesis becomes a content asking for details of a hypothesis of a next analysis perspective of an overview of the hypothesis. The "next analysis perspective" herein can be set as a same analysis perspective as the "next analysis perspective" used at a time of generating the overview of the hypothesis. Specifically, the question generation unit **124** can perform generation of an overview of a hypothesis, and generation of details of the hypothesis by using a same analysis perspective, as a next analysis perspective.

[0168] In the example in FIG. **15**, "skill shortage" is acquired as an overview of a hypothesis of a cause (next analysis perspective) of an answer output in the answer verification processing S**23**. Then, a prompt asking for a hypothesis of the cause (next analysis perspective) of "skill shortage" (overview of a hypothesis) is generated.

[0169] The question generation unit **124** may generate a prompt, for example, by using a template being prepared in advance. For example, the template may be a passage in which a position where an overview of a hypothesis is inserted, and a position where a next analysis perspective is inserted are blank. Then, the question generation unit **124** may generate a prompt by inserting the overview of the hypothesis, and the next analysis perspective to a predetermined position of the template. In addition, the template may be configured in such a way that a position where a question is inserted is blank. In addition, the question generation unit **124** may generate a prompt on the basis of a generation model, in place of generating a prompt on the basis of a template. The generation model herein can be achieved by using any widely known technique.

[0170] Next, processing of generating a question, based on a hypothesis, is described.

[0171] The question generation unit **124** generates a question asking for a next analysis perspective, based on a generated hypothesis. The "next analysis perspective" herein can be set as a same analysis perspective as the "next analysis perspective" used at a time of generating the hypothesis. Specifically, the question generation unit **124** performs generation of an overview of a hypothesis, generation of details of the hypothesis, and generation of a new question by using a same analysis perspective, as a next analysis perspective.

[0172] For example, it is assumed that, regarding an analysis perspective being a "task" in the n-th loop, an answer (task) thereof is output in the answer verification processing S**23** in the n-th loop. In this case, in the question generation processing S**25** in the n-th loop, the question generation unit **124** generates a hypothesis of a cause (analysis perspective in the (n+1)-th loop) of the answer (task) output in the answer verification processing S**23** in the n-th loop. Then, in the question generation processing S**25** in the n-th loop, the question generation unit **124** can generate a question asking for a cause (analysis perspective in the (n+1)-th loop) of the hypothesis.

[0173] The question generation unit **124** may generate a question, for example, by using a template being prepared in advance. For example, the template may be a passage in which a position where a hypothesis and a next analysis perspective are inserted is blank. Then, the question gen-

eration unit **124** may generate a question by inserting the hypothesis and the next analysis perspective to a predetermined position of the template. In addition, the question generation unit **124** may generate a question on the basis of a generation model, in place of generating a question on the basis of a template. The generation model herein can be achieved by using any widely known technique.

Result Output Processing S**26**

[0174] The result output unit **13** outputs, toward a user, an answer screen indicating an answer output from the answer verification unit **123** in the answer verification processing S**23**. The result output unit **13** may display an answer screen via an output apparatus such as a display or a projection apparatus. In addition, in a case where the processing apparatus **10** is a server, the result output unit **13** may transmit an answer screen toward a client terminal.

[0175] As a result of performing a loop a plurality of times, an answer output from the answer verification unit **123** in the answer verification processing S**23** may become plural. For example, the processing apparatus **10** to acquire a result in which answers in terms of various analysis perspectives are linked in a row in order of execution of the loop by repeating the loop. The result output unit **13** may output, toward a user, an answer screen on which the plurality of answers are displayed as a list. In addition, the result output unit **13** may output, toward a user, an answer screen on which an answer selected from among the plurality of answers in accordance with a predetermined rule is displayed.

[0176] Further, the result output unit **13** may further output related information used in acquiring each answer. For example, the result output unit **13** may indicate, on an answer screen, each answer, and related information used in acquiring each answer in association with each other. In addition, the result output unit **13** may specify one answer on an answer screen, and output, on the answer screen or on another screen (e.g., on another window), related information used in acquiring the specified answer in response to a user input of causing to display the related information.

[0177] Further, the result output unit **13** may further output a question to each answer. For example, the result output unit **13** may indicate, on an answer screen, each answer, and a question to each answer in association with each other. In addition, the result output unit **13** may specify one answer on an answer screen, and output, on the answer screen or on another screen (e.g., on another window), a question to the specified answer in response to a user input of causing to display the question.

[0178] Further, the result output unit **13** may further output an analysis perspective used in acquiring each answer. For example, the result output unit **13** may indicate, on an answer screen, each answer, and an analysis perspective used in acquiring each answer in association with each other. In addition, the result output unit **13** may specify one answer on an answer screen, and output, on the answer screen or on another screen (e.g., on another window), an analysis perspective used in acquiring the specified answer in response to a user input of causing to display the analysis perspective.

[0179] Further, the result output unit **13** may further output a hypothesis (including an overview and details) used in acquiring each answer. For example, the result output unit **13** may indicate, on an answer screen, each answer, and a hypothesis used in acquiring each answer in association with each other. In addition, the result output unit **13** may specify one answer on an answer screen, and output, on the answer screen or on another screen (e.g., on another window), a hypothesis used in acquiring the specified answer in response to a user input of causing to display the hypothesis.

[0180] Note that, the amount of information to be output from the above-described result output unit **13** may become enormous. In view of the above, the result output unit **13** may output the above-described information by using various display methods such as a tree structure or a graph. A specific example of this display is described in the following example embodiment.

Advantageous Effect

[0181] In the processing apparatus **10** according to the second example embodiment, an advantageous effect similar to that of the processing apparatus **10** according to the first example embodiment is achieved.

[0182] Further, the processing apparatus **10** can automatically generate a prompt for acquiring a desired answer, based on an input question and analysis perspective, by a method on the basis of a template or on the basis of a generation model. Therefore, it is possible to reduce time and effort for generating a template by a user.

[0183] Further, the processing apparatus **10** can automatically collect pieces of related information necessary for acquiring a desired answer by cross-sectionally searching for a plurality of information sources, based on a generated question. Further, the processing apparatus **10** can increase accuracy and specificity of an answer by generating an answer to a question with use of the collected pieces of related information.

[0184] Further, the processing apparatus **10** can generate a plurality of questions from an acquired answer, and perform collection of the above-described pieces of related information and generation of an answer by individually using the plurality of questions. According to the processing apparatus **10** as described above, generation of an answer in which thought is allowed to flow and considered from various perspectives is achieved.

[0185] The processing apparatus **10** can reproduce a deep thinking process by a human in an imitative manner and automate a desired analysis of a perspective by implementing question generation and cross-sectional related information search in a chain reaction manner. Further, for example, allowing thought to flow as described above or using various pieces of related information enables to discover an unexpected relationship, or new measures and ideas that a human could not notice.

[0186] Further, the processing apparatus **10** according to the second example embodiment can generate an answer to a question by combining the LLM and the RAG. Using the RAG enables to improve quality of an answer to be output from the LLM. Combining the LLM and the RAG enables to extract various insights from collected pieces of related information, and making great progress of data utilization in various scenes such as information search, hypothesis verification, and idea support is expected.

[0187] Meanwhile, in recent years, an attempt to generate a data infrastructure of an entire organization, and cancel data siloing has been made. However, there is a problem that the number of users to be used does not increase, even if a data infrastructure of an entire organization is generated, and

data siloing is canceled. The following examples are exemplified as a cause of this problem.

Problem in Prompt Generation

[0188] In order to extract information skillfully from the LLM, it is necessary to write a prompt skillfully. Specifically, a user is required to have a skill of writing a prompt skillfully. Since users sufficiently with a skill as described above are less, use of a data infrastructure of the entire organization does not progress as expected.

Problem in Related Information Utilization

[0189] In order to extract information skillfully from the LLM, it is necessary to use related information skillfully. Specifically, a user is required to have a skill of skillfully retrieving and using related information. This skill includes a skill of determining what kind of related information is to be utilized to acquire an intended answer, in addition to an information retrieval skill. Since users sufficiently with a skill as described above are less, use of a data infrastructure of the entire organization does not progress as expected.

Deepening Thought

[0190] There is a case where a desired answer is acquired by repeating thought from various perspectives. In this case, a user is required to have a skill of repeating thought from various perspectives, while using a data infrastructure of the entirety organization. Since users sufficiently with a skill as described above are less, use of a data infrastructure of the entire organization does not progress as expected.

[0191] The processing apparatus **10** according to the second example embodiment is configured in such a way as to enable to solve problems as described above. Specifically, the processing apparatus **10** automatically performs prompt generation, related information utilization, and deepening of thought. Work to be done by a user is inputting a question and an analysis perspective first. Thereafter, the processing apparatus **10** automatically performs prompt generation, related information utilization, and deepening of thought, and outputs a result.

[0192] By using the processing apparatus **10** as described above, it is expected to solve the above-described problem, specifically, a problem that use of a data infrastructure of the entire organization does not progress as expected.

Third Example Embodiment

[0193] A processing apparatus **10** according to a third example embodiment can output a result of thought to a question by a characteristic tree structure in result output processing S**26**. Hereinafter, details are described.

[0194] As described in the second example embodiment, the processing apparatus **10** can acquire a result in which answers in terms of various analysis perspectives are linked in a row in order of execution of a loop by repeating the loop. As described above, since there is a case where a plurality of questions are generated by a one-time loop, a result in which answers are linked in a row may become the one in which the answers are branched into a plurality of lines at a midpoint, instead of the one in which the answers are linearly linked by one line. For example, in a case where m questions are generated in a loop at a certain time, thereafter, answers are branched into m lines in the loop at the certain time being a base point.

[0195] A result output unit **13** can display a plurality of answers acquired by a loop of a plurality of times by a tree structure indicating a row or a branching status as described above. Specifically, the result output unit **13** can generate and output a result screen on which a relationship among a plurality of answers acquired by repeatedly performing a loop (processing) is displayed by a tree structure.

[0196] FIG. **16** illustrates one example of a result screen output from the result output unit **13**. The illustrated result screen includes a graph panel, a summary panel, and a detail panel. Note that, the result screen may not include at least one of the summary panel and the detail panel.

[0197] A tree structure indicating a relationship among a plurality of answers acquired by repeatedly performing a loop (processing) is displayed on the graph panel.

[0198] A node Q is a node associated with a question input in input acceptance processing S**20**. The result output unit **13** can display a question in association with the node Q. However, in a case where a question is a relatively long sentence, the amount of information to be displayed on the result screen at once becomes large, and thereby it makes difficult to visually recognize. In view of the above, as illustrated in FIG. **16**, the result output unit **13** can display a label ("data utilization" in FIG. **16**) indicating a question in short. Note that, the result output unit **13** may display a question or a label in response to a user input or the like of specifying the node Q by mouseover or another operation, without displaying the question or the label under a normal circumstance. Further, the result output unit **13** may display a question or a label within a display area of the node Q. Specifically, the result output unit **13** may display a question or a label, in place of a character "Q" in FIG. **16**.

[0199] A plurality of nodes A (a node to which a character A is attached) are nodes associated with an answer output in answer verification processing S**23**. As described above, in some cases, one answer is output by a one-time loop, and in other cases, a plurality of answers are output by a one-time loop. Nodes of a plurality of answers generated by a same loop are displayed on a same level. In an example in FIG. **16**, the result output unit **13** displays three nodes A_1 to A_3 linked to the node Q. Three answers each associated with the nodes A_1 to A_3 are answers generated by a one-time loop using a question at the node Q. In the example in FIG. **16**, the three nodes A_1 to A_3 each associated with the three answers are linked to the node Q in parallel, and are displayed on a same level.

[0200] Further, the result output unit **13** can display an answer in association with the node A. However, in a case where an answer is a relatively long sentence, the amount of information to be displayed on the result screen at once becomes large, and thereby it makes difficult to visually recognize. In view of the above, as illustrated in FIG. **16**, the result output unit **13** may display a label ("securing a human resource" or the like in FIG. **16**) indicating an answer in short. Note that, the result output unit **13** may display an answer or a label in response to a user input or the like of specifying the node A by mouseover or another operation, without displaying the answer or the label under a normal circumstance. Further, the result output unit **13** may display an answer or a label within a display area of the node A. Specifically, the result output unit **13** may display an answer or a label, in place of a character "A_1" or the like in FIG. **16**.

[0201] Further, in the example in FIG. **16**, the result output unit **13** displays an analysis perspective ("a task," "a cause,

"a solution", and the like in FIG. **16**) used for acquiring an answer on each level. Note that, the result output unit **13** may display an analysis perspective in response to a user input or the like of specifying the node A by mouseover or another operation, without displaying the analysis perspective under a normal circumstance. Further, the result output unit **13** may display an analysis perspective within a display area of the node A. Specifically, the result output unit **13** may display an analysis perspective, in place of the character "A_1" or the like in FIG. **16**.

[0202] Further, in the example in FIG. **16**, the result output unit **13** displays, on the detail panel, information related to an answer at one node A in response to a user input of specifying the one node A by mouseover or another operation.

[0203] The information related to the answer includes at least one of a question, an answer, an analysis perspective, a degree of relevance between a question and an answer, a label indicating an answer in short, a summary of an answer, related information used for acquiring an answer, a summary of related information, and a hypothesis (including an overview and details). Note that, the amount of information of the related information is likely to increase. In view of the above, as illustrated in FIG. **16**, the result output unit **13** may display, on the detail panel, only a heading of the related information as a list. Then, the result output unit **13** may display the related information in response to a user input of specifying a heading of one piece of related information by mouseover or another operation.

[0204] Further, in the example in FIG. **16**, the result output unit **13** displays a node R associated with each of at least one piece of related information used for acquiring an answer at one node A in response to a user input of specifying the one node A. The result output unit **13** may display related information, or a summary of the related information in response to a user input of specifying the one node R by mouseover or another operation.

[0205] Further, in the example in FIG. **16**, the result output unit **13** displays, on the summary panel, a summary of an answer at a node group being a part of a tree structure and composed of a plurality of nodes hanging on a same node. A user may also specify the node group.

[0206] "Summary 1" illustrated in FIG. **16** is a summary of an answer at a node group composed of a plurality of nodes A hanging on the node A_1. "Summary 2" illustrated in FIG. **16** is a summary of an answer at a node group composed of a plurality of nodes A hanging on the node A_2. "Summary 3" illustrated in FIG. **16** is a summary of an answer at a node group composed of a plurality of nodes A hanging on the node A_3.

[0207] Note that, although the example in FIG. **16** does not clearly illustrate, the result output unit **13** may change a display pattern (a color, a size, or the like) of a node, based on a predetermined score. The score may be, for example, a score proportional to a degree of relevance of an answer to a question or the number of edges connected to each node, or the like. A search unit **12** or the result output unit **13** can compute a score for each node (for each answer) in accordance with a predetermined score computation rule.

[0208] Further, although the example in FIG. **16** does not clearly illustrate, the result output unit **13** may change a display pattern (a color, a type of a line, a thickness of a line, or the like) of an edge in accordance with a predetermined rule. For example, the result output unit **13** may set an edge on a same level, as a same display pattern, and differentiate a display pattern of the edge for each level.

[0209] Further, although the example in FIG. **16** does not clearly illustrate, the result output unit **13** may group a plurality of nodes, and display the group in an identifiable manner. For example, the result output unit **13** may display a border or the like embracing a node belonging to a same group. In addition, the result output unit **13** may set a node belonging to a same group, as a same display pattern (a color, a size, or the like), and differentiate a display pattern of the node for each group.

[0210] There are various grouping methods, but, for example, grouping may be performed by gathering similar nodes, based on similarity of a question, or a similarity of an answer. For example, it is possible to compute similarity of a question or similarity of an answer by using a technique for computing the above-described similarity between passages. The search unit **12** or the result output unit **13** can perform the grouping processing.

[0211] Next, processing of generating a "label" and a "summary" is described. The result output unit **13** can generate at least one of a label and a summary by using an LLM, and display, on the above-described result screen, at least one of the generated label and summary.

[0212] The result output unit **13** may generate a prompt, for example, by using a template being prepared in advance. For example, the template may be a passage in which a position where a target (an answer, a question, related information, or the like) for which a label or a summary is generated is inserted is blank. Then, the result output unit **13** may generate a prompt by inserting the target (the answer, the question, the related information, or the like) for which the label or the summary is generated to a predetermined position of the template. In addition, the result output unit **13** may generate a prompt on the basis of a generation model, in place of generating a prompt on the basis of a template. The generation model herein can be achieved by using any widely known technique.

[0213] Herein, one example of label generation is described by using FIG. **17**. Note that, in an example in FIG. **17**, a 2-step configuration in which a plurality of keywords are determined (e.g., use of a technique such as the LLM or MultipartieRank), and then, a label is generated based on the plurality of determined keywords is configured. By configuring a 2-step configuration as described above, a label of high accuracy is generated. However, a prompt directly asking for "a label that expresses a target passage in short" may be generated, and a label may be generated by 1-step. Further, a keyword determined by using a technique such as the LLM or the MultipartieRank may be used as a label. By configuring as described above, a label of sufficient accuracy to some extent is also generated.

[0214] In the example in FIG. **17**, first, as illustrated in an upper portion of a prompt example in FIG. **17**, the result output unit **13** generates a prompt asking for a plurality of keywords expressing, in short, a target (answer) for which a label is generated. Then, the result output unit **13** acquires a plurality of keywords by inputting the prompt to the LLM.

[0215] After acquiring the plurality of keywords, as illustrated in a lower portion of the prompt example in FIG. **17**, the result output unit **13** generates a prompt asking for a title expressing the plurality of acquired keywords in a compre-

hensive manner. Then, the result output unit **13** acquires a tile by inputting the prompt to the LLM. This tile becomes a label.

[0216] As illustrated in the prompt example in FIG. **17**, it is possible to acquire a label of a desired length by adding character limit to an answer to be output from the LLM.

[0217] Next, one example of summary generation is described by using FIG. **18**. In an example in FIG. **18**, the result output unit **13** generates a prompt asking for an answer to a predetermined question within a predetermined number of characters, based on a target (answer) for which a summary is generated. In this way, adding character limit to an answer to be output from the LLM enables to acquire a summary of a desired length.

[0218] Other configurations of the processing apparatus **10** according to the third example embodiment are similar to the configurations of the processing apparatus **10** according to the first and second example embodiments.

[0219] In the processing apparatus **10** according to the third example embodiment, an advantageous effect similar to that of the processing apparatus **10** according to the first and second example embodiments is achieved. Further, according to the processing apparatus **10**, a result acquired by characteristic processing described in the second example embodiment can be displayed by a characteristic tree structure.

[0220] As described in the second example embodiment, according to the processing apparatus **10**, implementing question generation, and cross-sectional related information search in a chain reaction manner enables to reproduce a deep thinking process by a human in an imitative manner, and automate a desired analysis of a perspective. Further, for example, allowing thought to flow or using various pieces of related information enables to discover an unexpected relationship, or new measures and ideas that a human could not notice.

[0221] However, in a case where processing of imitating complicated thought as described above is performed, an acquired result may also include a complicated relationship. Displaying a result on a complicated relationship as described above by a tree structure allows for a user to systematically recognize a result. Consequently, the user can easily understand the result.

Modification Examples

Modification Example 1

[0222] A search unit **12** may not include an information retrieval unit **121**. In this case, related information retrieval processing S**21** is not performed. Then, an information apparatus **10** performs the above-described processing, without using related information. Even in a case where the above-described processing is repeated without using related information, it is possible to acquire an answer to a question with sufficient accuracy to some extent.

Modification Example 2

[0223] The search unit **12** may not include an answer verification unit **123**. In this case, answer verification processing S**23** is not performed. Then, the processing apparatus **10** performs pieces of processing thereafter (generation of a question, loop processing based on a new question, output of a result, and the like), based on all first answers output in answer generation processing S**22**. In a case of this modification example, although an inconvenience that pieces of processing thereafter are performed based on a first answer in which a degree of relevance to a question is low cannot be avoided, it is possible to acquire an answer to a question with sufficient accuracy to some extent.

Modification Example 3

[0224] In the third example embodiment, the processing apparatus **10** outputs a result screen with a tree structure. Specifically, the processing apparatus **10** that generates an answer to a question by processing as described in the second example embodiment further outputs a result screen with a tree structure.

[0225] In the modification example, an information providing apparatus being physically and/or logically separated from the processing apparatus **10** that generates an answer to a question by processing as described in the second example embodiment acquires data on a result of an answer to a question from the processing apparatus **10**. Then, the information providing apparatus outputs a result screen with a tree structure by processing as described in the third example embodiment. One example of a hardware configuration of the information providing apparatus is similar to that of the processing apparatus **10**, and, for example, is illustrated in FIG. **4**. Also in the modification example, an advantageous effect similar to that of the above-described example embodiments is achieved.

[0226] As described above, while the present disclosure has been described with reference to the example embodiments, the present disclosure is not limited to the above-described example embodiments. A configuration and details of the present disclosure can be changed in various ways comprehensible to a person skilled in the art within the scope of the present disclosure. Further, each example embodiment can be combined with another example embodiment as necessary.

[0227] Further, in a plurality of flowcharts used in the above description, a plurality of processes (pieces of processing) are described in order. However, the order of execution of processes to be performed in each example embodiment is not limited to the order of description. In each example embodiment, the illustrated order of processes can be changed within a range that does not adversely affect a content.

[0228] A part or all of the above-described example embodiments may also be described as the following supplementary notes, but is not limited to the following.

[0229] 1. A processing apparatus including:

[0230] an input acceptance unit that accepts an input of a question and an analysis perspective; and

[0231] a search unit that repeatedly performs processing of generating an answer by inputting a prompt indicating a question and an analysis perspective to a large language model with use of an input question, and a new question generated based on the answer.

[0232] 2. The processing apparatus according to supplementary note 1, wherein

[0233] the search unit further includes a question generation unit that generates a hypothesis, based on the answer, and generates the new question, based on a generated hypothesis.

[0234] 3. The processing apparatus according to supplementary note 2, wherein

[0235] the question generation unit generates a hypothesis by acquiring a result by inputting, to a large language model, a prompt that generates a hypothesis related to a predetermined analysis perspective, based on the answer.

[0236] 4. The processing apparatus according to supplementary note 2, wherein

[0237] the question generation unit includes, in a prompt indicating the new question, a generated hypothesis.

[0238] 5. The processing apparatus according to any one of supplementary notes 1 to 4, wherein

[0239] the search unit includes

[0240] an answer generation unit that generates a prompt indicating a question and an analysis perspective, and generates a first answer by inputting a generated prompt to a large language model, and

[0241] an answer verification unit that decides whether a degree of relevance between the first answer and a question satisfies a passing condition, and outputs, as an answer to a question, the first answer that satisfies the passing condition.

[0242] 6. The processing apparatus according to supplementary note 5, wherein

[0243] the answer verification unit revises the first answer that does not satisfy the passing condition, and outputs, as an answer to a question, the first answer that satisfies the passing condition after revision.

[0244] 7. The processing apparatus according to supplementary note 6, wherein

[0245] the answer verification unit computes a difference between the first answer and reference information, acquires a result by inputting, to a large language model, a prompt that revises the first answer by paying attention to the difference and thereby revises the first answer.

[0246] 8. The processing apparatus according to any one of supplementary notes 5 to 7, wherein

[0247] the answer verification unit discards the first answer that does not satisfy the passing condition.

[0248] 9. The processing apparatus according to any one of supplementary notes 1 to 8, wherein

[0249] the search unit includes

[0250] an information retrieval unit that retrieves related information related to a question, and

[0251] an answer generation unit that generates a prompt by using a question, an analysis perspective, and the related information, and generates an answer by inputting a generated prompt to a large language model.

[0252] 10. The processing apparatus according to any one of supplementary notes 1 to 9, wherein

[0253] the search unit differentiates, in the processing to be repeatedly performed, an analysis perspective to be used in the processing at each time.

[0254] 11. The processing apparatus according to any one of supplementary notes 1 to 10, further including

[0255] a result output unit that generates and outputs a result screen on which a relationship between a plurality of the answers acquired by repeatedly performing the processing is displayed by a tree structure.

[0256] 12. The processing apparatus according to supplementary note 11, wherein

[0257] the result output unit displays, in the tree structure, information related to the answer in association with a node associated with each of a plurality of the answers.

[0258] 13. The processing apparatus according to supplementary note 12, wherein

[0259] the result output unit generates at least one of a label and a summary by using a large language model, and displays at least one of a generated label and a generated summary.

[0260] 14. The processing apparatus according to any one of supplementary notes 11 to 13, wherein

[0261] the result output unit generates and displays, by using a large language model, a summary of the answer at a node group being a part of the tree structure, the node group being composed of a plurality of nodes hanging on a same node.

[0262] 15. A processing method including,

[0263] by one or more computers:

[0264] accepting an input of a question and an analysis perspective; and

[0265] repeatedly performing processing of generating an answer by inputting a prompt indicating a question and an analysis perspective to a large language model with use of an input question, and a new question generated based on the answer.

[0266] 16. A program that causes a computer to function as:

[0267] an input acceptance unit that accepts an input of a question and an analysis perspective; and

[0268] a search unit that repeatedly performs processing of generating an answer by inputting a prompt indicating a question and an analysis perspective to a large language model with use of an input question, and a new question generated based on the answer.

[0269] A part or all of supplementary notes 2 to 14 depending on the processing apparatus of supplementary note 1 described above may also depend on the processing method of supplementary note 15, and the program of supplementary note 16 by dependency similar to dependency between supplementary note 1, and supplementary notes 2 to 14. Further, a part or all of a configuration described as a supplementary note can be achieved in various hardware, software, various recording means for recording software, or a system in a range that does not depart from the above-described each example embodiment.

[0270] **10** Processing apparatus

[0271] **11** Input acceptance unit

[0272] **12** Search unit

[0273] **121** Information retrieval unit

[0274] **122** Answer generation unit

[0275] **123** Answer verification unit

[0276] **124** Question generation unit

[0277] **1**A Processor

[0278] 2A Memory
[0279] 3A Input/output I/F
[0280] 4A Peripheral circuit
[0281] 5A Bus

1. A processing apparatus comprising:
at least one memory configured to store one or more instructions; and
at least one processor configured to execute the one or more instructions to:
accept an input of a question and an analysis perspective; and
repeatedly perform processing of generating an answer by inputting a prompt indicating a question and an analysis perspective to a large language model with use of an input question, and a new question generated based on the answer.

2. The processing apparatus according to claim 1, wherein
the at least one processor is further configured to execute the one or more instructions to generate a hypothesis, based on the answer, and generate the new question, based on a generated hypothesis.

3. The processing apparatus according to claim 2, wherein
the at least one processor is further configured to execute the one or more instructions to generate a hypothesis by acquiring a result by inputting, to a large language model, a prompt that generates a hypothesis related to a predetermined analysis perspective, based on the answer.

4. The processing apparatus according to claim 2, wherein
the at least one processor is further configured to execute the one or more instructions to include, in a prompt indicating the new question, a generated hypothesis.

5. The processing apparatus according to claim 1, wherein
the at least one processor is further configured to execute the one or more instructions to
generate a prompt indicating a question and an analysis perspective,
generate a first answer by inputting a generated prompt to a large language model,
decides whether a degree of relevance between the first answer and a question satisfies a passing condition, and
output, as an answer to a question, the first answer that satisfies the passing condition.

6. The processing apparatus according to claim 5, wherein
the at least one processor is further configured to execute the one or more instructions to revise the first answer that does not satisfy the passing condition, and output, as an answer to a question, the first answer that satisfies the passing condition after revision.

7. The processing apparatus according to claim 6, wherein
the at least one processor is further configured to execute the one or more instructions to compute a difference between the first answer and reference information, acquire a result by inputting, to a large language model, a prompt that revises the first answer by paying attention to the difference, and thereby revise the first answer.

8. The processing apparatus according to claim 5, wherein
the at least one processor is further configured to execute the one or more instructions to discard the first answer that does not satisfy the passing condition.

9. The processing apparatus according to claim 1, wherein
the at least one processor is further configured to execute the one or more instructions to
retrieve related information related to a question,
generate a prompt by using a question, an analysis perspective, and the related information, and
generate an answer by inputting a generated prompt to a large language model.

10. The processing apparatus according to claim 1, wherein
the at least one processor is further configured to execute the one or more instructions to differentiate, in the processing to be repeatedly performed, an analysis perspective to be used in the processing at each time.

11. The processing apparatus according to claim 1, wherein
the at least one processor is further configured to execute the one or more instructions to generate and output a result screen on which a relationship between a plurality of the answers acquired by repeatedly performing the processing is displayed by a tree structure.

12. The processing apparatus according to claim 11, wherein
the at least one processor is further configured to execute the one or more instructions to display, in the tree structure, information related to the answer in association with a node associated with each of a plurality of the answers.

13. The processing apparatus according to claim 12, wherein
the at least one processor is further configured to execute the one or more instructions to generate at least one of a label and a summary by using a large language model, and display at least one of a generated label and a generated summary.

14. The processing apparatus according to claim 11, wherein
the at least one processor is further configured to execute the one or more instructions to generate and display, by using a large language model, a summary of the answer at a node group being a part of the tree structure, the node group being composed of a plurality of nodes hanging on a same node.

15. A processing method comprising,
by one or more computers:
accepting an input of a question and an analysis perspective; and
repeatedly performing processing of generating an answer by inputting a prompt indicating a question and an analysis perspective to a large language model with use of an input question, and a new question generated based on the answer.

16. The processing method according to claim 15, wherein
the one or more computers generates a hypothesis, based on the answer, and generates the new question, based on a generated hypothesis.

17. The processing method according to claim 16, wherein
the one or more computers generates a hypothesis by acquiring a result by inputting, to a large language model, a prompt that generates a hypothesis related to a predetermined analysis perspective, based on the answer.

18. A non-transitory computer-readable medium storing a program that causes a computer to:

accept an input of a question and an analysis perspective; and

repeatedly perform processing of generating an answer by inputting a prompt indicating a question and an analysis perspective to a large language model with use of an input question, and a new question generated based on the answer.

19. The non-transitory computer-readable medium according to claim **18**, wherein

the program causes the computer to generate a hypothesis, based on the answer, and generate the new question, based on a generated hypothesis.

20. The non-transitory computer-readable medium according to claim **19**, wherein

the program causes the computer to generate a hypothesis by acquiring a result by inputting, to a large language model, a prompt that generates a hypothesis related to a predetermined analysis perspective, based on the answer.

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