PATENT COOPERATION TREATY

From the
INTERNATIONAL SEARCHING AUTHORITY

To: see form PCT/ISA/220	PCT WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY (PCT Rule 43*bis*.1)
	Date of mailing (*day/month/year*) see form PCT/ISA/210 (second sheet)
Applicant's or agent's file reference see form PCT/ISA/220	**FOR FURTHER ACTION** See paragraph 2 below

International application No.	International filing date (*day/month/year*)	Priority date (*day/month/year*)
PCT/US2017/058229	25.10.2017	

International Patent Classification (IPC) or both national classification and IPC
INV. G06F17/27 G06F17/30 G06N3/02

Applicant
GOOGLE LLC

1. This opinion contains indications relating to the following items:

- ☒ Box No. I — Basis of the opinion
- ☐ Box No. II — Priority
- ☐ Box No. III — Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☐ Box No. IV — Lack of unity of invention
- ☒ Box No. V — Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step and industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI — Certain documents cited
- ☐ Box No. VII — Certain defects in the international application
- ☐ Box No. VIII — Certain observations on the international application

2. **FURTHER ACTION**

If a demand for international preliminary examination is made, this opinion will usually be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notifed the International Bureau under Rule 66.1*bis*(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.

For further options, see Form PCT/ISA/220.

Name and mailing address of the ISA:	Date of completion of this opinion	Authorized Officer
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Box No. I Basis of the opinion

1. With regard to the **language**, this opinion has been established on the basis of:

   ☒ the international application in the language in which it was filed.

   ☐ a translation of the international application into , which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1 (b)).

2. ☐ This opinion has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43*bis*.1(a))

3. ☐ With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, this opinion has been established on the basis of a sequence listing:

   a. ☐ forming part of the international application as filed:

      ☐ in the form of an Annex C/ST.25 text file.

      ☐ on paper or in the form of an image file.

   b. ☐ furnished together with the international application under PCT Rule 13*ter*.1(a) for the purposes of international search only in the form of an Annex C/ST.25 text file.

   c. ☐ furnished subsequent to the international filing date for the purposes of international search only:

      ☐ in the form of an Annex C/ST.25 text file (Rule 13*ter*.1(a)).

      ☐ on paper or in the form of an image file (Rule 13*ter*.1(b) and Administrative Instructions, Section 713).

4. ☐ In addition, in the case that more than one version or copy of a sequence listing has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that forming part of the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

5. Additional comments:

Box No. V Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1-29
	No:	Claims	
Inventive step (IS)	Yes:	Claims	
	No:	Claims	1-29
Industrial applicability (IA)	Yes:	Claims	1-29
	No:	Claims	

2. Citations and explanations

see separate sheet

Re Item V

Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

Reference is made to the following documents:

D1 **XP080728513** CHEN LIANG ET AL: "Neural Symbolic Machines: Learning Semantic Parsers on Freebase with Weak Supervision",
ARXIV.ORG, CORNELL UNIVERSITY LIBRARY, 201 OLIN LIBRARY CORNELL UNIVERSITY ITHACA, NY 14853, DOI: 10.18653/V1/P17-1003
cited in the application
31 October 2016 (2016-10-31)

D2 **XP055404542** JUN YIN ET AL: "Neural Generative Question Answering",
PROCEEDINGS OF THE WORKSHOP ON HUMAN-COMPUTER QUESTION ANSWERING, pages 36-42, Stroudsburg, PA, USA
DOI: 10.18653/v1/W16-0106
22 April 2016 (2016-04-22)

D3 **US 2016/124962 A1** (BARBORAK MICHAEL A [US] ET AL)
5 May 2016 (2016-05-05)

D4 **XP055490035** ZIHANG DAI ET AL: "CFO: Conditional Focused Neural Question Answering with Large-scale Knowledge Bases",
PROCEEDINGS OF THE 54TH ANNUAL MEETING OF THE ASSOCIATION FOR COMPUTATIONAL LINGUISTICS (VOLUME 1: LONG PAPERS), pages 800-810, Stroudsburg, PA, USA
DOI: 10.18653/v1/P16-1076
7 August 2016 (2016-08-07)

1 The present application does not meet the criteria of Article 33(3) PCT, because the subject-matter of claim 1 does not involve an inventive step.

1.1 D1 may be regarded as being the prior art closest to the subject-matter of claim 1, and discloses

A computing system, comprising: at least one processor; (abstract)

a machine-learned natural language processing model (section 1 - neural network model applied to semantic parsing)

comprising:

an encoder model, ~~wherein the encoder model is trained to receive a natural language text body and, in response to receipt of the natural language text body, output a knowledge graph;~~ (fig. 2, section 2.2 - A typical sequence-to-sequence model consists of two RNNs, an encoder and a decoder.)

and a programmer model, wherein the programmer model is trained to receive a natural language question, and, in response to receipt of the natural language question, output a program; (e.g. fig. 1, section 2 - a sequence- to-sequence neural network model ("programmer"). Section 2.3, subsection entitled "REINFORCE TRAINING"- output program))

and at least one tangible, non-transitory computer-readable medium that stores instructions that, when executed by the at least one processor, cause the at least one processor to perform operations, the operations (implicit to the implementation)

comprising:

~~obtaining the natural language text body;~~

~~inputting the natural language text body into the encoder model;~~

receiving, ~~as an output of the encoder model,~~ the knowledge graph;

obtaining the natural language question; (section 2 - given a knowledge base (KB) K, and a question q = (w1, w2, ..., wk), produce a program or logical form z that when executed against K generates the right answer y. section 3.1 example input question "who plays meg in family guy")

inputting the natural language question into the programmer model; (section 2 - given a knowledge base (KB) K, and a question q = (w1, w2, ..., wk), produce a program or logical form z that when executed against K generates the right answer y. In the example in section 3, the question the question "who plays meg in family guy" is input)

receiving, as an output of the programmer model, the program; (section 2.2 "Progammer" - The "programmer" only needs to map natural language into a program, which is a sequence of tokens that references operations and values in the "computer".)

and executing the program on the knowledge graph to produce an answer to the natural language question (section 3.3 - query the knowledge graph; section 2.2 "Progammer" - The value of the last variable is returned by the "programmer" as the answer.)

1.2 The subject matter of claim 1 differs from that of D1 only in that a knowledge graph is created from natural language text. D1 discloses all of the architecture used by D1, however, it accesses an existing knowledge graph. It would be obvious to a person skilled in the art faced with the problem of the default knowledge graph not being suitable for a given task, to create a relevant knowledge graph from a relevant e.g. domain corpus. Purely as illustrative examples, see D2 (section 2.2) and D3 (paragraph 37) which take natural language text as an input and create new, task specific knowledge bases for their QA systems. As this solution is immediately obvious to a person skilled in the art wishing to perform domain based processing with an unsuitable knowledge base, the solution cannot be considered to involve an inventive step (Article 33(3) PCT).

2 The present application does not meet the criteria of Article 33(3) PCT, because the subject-matter of claim 9 does not involve an inventive step.

2.1 D1 may be regarded as being the prior art closest to the subject-matter of claim 9, and discloses

`A computer-implemented method, the method comprising: obtaining, by one or more computing devices,` (abstract)

`a natural language processing model` (section 1 - neural network model applied to semantic parsing)

`that comprises`

`an encoder model, a decoder model,` (fig. 2, section 2.2 - A typical sequence-to-sequence model consists of two RNNs, an encoder and a decoder. Uses a 1-layer GRU [5] for both the encoder and the decoder)

`and a programmer model,` (e.g. fig. 1, section 2 - a sequence- to-sequence neural network model ("programmer"))

`wherein the encoder model is configured to receive a natural language text body`
~~`and, in response to receipt of the natural language text body, output a knowledge graph,`~~
`wherein the decoder model is configured to receive the knowledge graph and, in response to receipt of the knowledge graph,` (section 3.3 - during encoding and decoding a natural language input is processed according to a knowledge graph resulting in a semantic parse)

`output a reconstruction of the natural language text body, and wherein the programmer model is trained to receive a natural language question,` (section 3.1 - input question-answer pairs, output semantic parse) and, in response to receipt of the natural language question, output a program; (section 2.3, subsection entitled "REINFORCE TRAINING"- output program)

inputting, by the one or more computing devices, a training data set that comprises the natural language text body and the natural language question into the natural language processing model to receive an answer to the natural language question; (section 3.1 - question-answer pairs for training)

evaluating, by the one or more computing devices, a total objective function that comprises an autoencoder objective function and a question answer objective function, wherein the autoencoder objective function describes a reconstruction loss between the natural language text body and the reconstruction of the natural language text body, and wherein the question answer objective function describes a reward that is based on a comparison of the answer and an expected answer included in the training data set; and training, by the one or more computing devices, the natural language processing model based on the total objective function.(section 2.3, subsection entitled "REINFORCE TRAINING" outlines the objective function, expected reward and training using the function)

2.2 The subject matter of claim 9 differs from that of D1 only in that a knowledge graph is created from natural language text. D1 discloses all of the architecture used by D1, however, it accesses an existing knowledge graph. It would be obvious to a person skilled in the art faced with the problem of the default knowledge graph not being suitable for a given task, to create a relevant knowledge graph from a relevant e.g. domain corpus. As this solution is immediately obvious to a person skilled in the art wishing to perform domain based processing with an unsuitable knowledge base, the solution cannot be considered to involve an inventive step Article 33(3) PCT.

3 The present application does not meet the criteria of Article 33(3) PCT, because the subject-matter of claim 17 does not involve an inventive step.

3.1 D1 may be regarded as being the prior art closest to the subject-matter of claim 17, and discloses:

A computing system for responding to a natural language query; (abstract; section 2 - given a knowledge base (KB) K, and a question q = (w1, w2, ..., wk), produce a program or logical form z that when executed against K generates the right answer y)

comprising:

an encoding system (section 2.2)

~~configured to receive a natural language text body and generate, using a machine-learned natural language encoder model,~~

a knowledge graph (section 2 - knowledge base)

~~based on the natural language text body;~~

a query programming system configured to receive a natural language input query, and generate, using a machine-learned natural language query programmer model, a program for querying the knowledge graph based on the natural language input query; and a query execution system configured to execute the generated program on the generated knowledge graph and to output a query response. (section 3.3 - query the knowledge graph; section 2.2 "Programmer" - The value of the last variable is returned by the "programmer" as the answer.)

3.2 The subject matter of claim 17 differs from that of D1 only in that a knowledge graph is created from natural language text. D1 discloses all of the architecture used by D1, however, it accesses an existing knowledge graph. It would be obvious to a person skilled in the art faced with the problem of the default knowledge graph not being suitable for a given task, to create a relevant knowledge graph from a relevant e.g. domain corpus. As this solution is immediately obvious to a person skilled in the art wishing to perform domain based processing with an unsuitable knowledge base, the solution cannot be considered to involve an inventive step Article 33(3) PCT.

4 Dependent claims 2-8, 10-16, 18-29 do not contain any features which, in combination with the features of any claim to which they refer, meet the requirements of the PCT in respect of inventive step, for the following reasons:

4.1 The additional features of the following claims are disclosed in D1:

4.1.1 Claim 2: (section 3.3 - during encoding and decoding a natural language input is processed according to a knowledge graph resulting in a semantic parse)

4.1.2 Claim 5: (section 2.3, subsection entitled "REINFORCE TRAINING" outlines the objective function, expected reward and training using the function)

4.1.3 Claim 6: (abstract)

4.1.4 Claims 7, 8 and 18 and 19: section 2.2 - A typical sequence-to-sequence model consists of two RNNs, an encoder and a decoder

4.1.5 Claims 10-12: (section 2.3, subsection entitled "REINFORCE TRAINING")

4.1.6 Claim 14: (section 2.1 - e.g. to create a better neural computer interface, the interpreter provides code assist by producing a list of valid tokens for the "programmer" to pick from at each step.

4.1.7 Claim 22: (section 2.3, subsection entitled "REINFORCE TRAINING")

4.2 Regarding claims 3 and 23: The mere use of n-grams (as employed, for example in the similar system described in D4) rather than the freebase triples of D1 appears to be a matter of implementation choice which would be made by the person skilled in the art according to circumstances.

4.3 Regarding claim 4: The size of the corpus used is entirely a matter of implementation choice.

4.4 Regarding claims 13 and 19: D1 (section 2.3, subsection entitled "REINFORCE TRAINING") describes an autoencoder objective function that describes the reward that is based on the comparison of the answer and the expected answer. D1 does not appear to disclose an autoencoder function that describes the reconstruction loss. However, such a function is purely mathematical and has no technical effect. As the implementation of such a mathematical function is straightforward, the subject matter of claims 13 and does nor involve an inventive step in the sense of Article 33(3) PCT.

4.5 Regarding claims 15, 16 and 29, D1 does not disclose the outlined structural tweaking function. However, given that this function is mathematical and a priori non-technical, it must be demonstrated that there is a technical effect e.g. relative to the encoder which is demonstrably attributable to the tweaking and that the effect is not simply that "better" representations are learned. The latter would be a subjective an thus non-technical effect.

4.6 Regarding claim 21 merely sets out an example of the REINFORCE training described in D1 (section 2.3, subsection entitled "REINFORCE TRAINING").

4.7 The additional features of claims 24-28 appear to relate merely to implementation details which would be considered by a programmer according to circumstances and thus cannot contribute to inventive step.