

# PATENT COOPERATION TREATY

From the  
INTERNATIONAL SEARCHING AUTHORITY

# PCT

## WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY (PCT Rule 43bis.1)

To:

see form PCT/ISA/220

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.  
PCT/GB2019/053335

International filing date (day/month/year)  
26.11.2019

Priority date (day/month/year)  
26.11.2018

International Patent Classification (IPC) or both national classification and IPC  
INV. G06N3/04 G06N5/00 G06N3/08

Applicant  
IMPERIAL COLLEGE OF SCIENCE, TECHNOLOGY AND...

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 43bis.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 notified the International Bureau under Rule 66.1bis(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:



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Date of completion of  
this opinion

see form  
PCT/ISA/210

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**Box No. I Basis of the opinion**

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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 43bis.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 13ter.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 13ter.1(a)).
    - on paper or in the form of an image file (Rule 13ter.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:

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

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1. Statement

Novelty (N)	Yes: Claims	<u>1-18</u>
	No: Claims	
Inventive step (IS)	Yes: Claims	<u>1-18</u>
	No: Claims	
Industrial applicability (IA)	Yes: Claims	
	No: Claims	<u>1-18</u>

2. Citations and explanations

see separate sheet

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**Box No. VII Certain defects in the international application**

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The following defects in the form or contents of the international application have been noted:

see separate sheet

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**Box No. VIII Certain observations on the international application**

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The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

see separate sheet

**Re Item VIII**

**Certain observations on the international application**

1. The application does not meet the requirements of Article 6 PCT, because claim 1 is not clear.

1.1 In claim 1 it is stated that each element of a convolutional neural network is encoded into algebraic constraints. This simple set of statements presents a number of issues. Algebra comprises, virtually, almost all of mathematics, as defined by the Merriam-Webster: "*any of various systems or branches of mathematics or logic concerned with the properties and relationships of abstract entities (such as complex numbers, matrices, sets, vectors, groups, rings, or fields) manipulated in symbolic form*". An algebraic constraint can be defined, for instance, as "*In mathematics, a constraint is a condition of an optimization problem that the solution must satisfy*". Given the broadness of such definitions the possible alternatives for encoding the elements of neural network are almost endless, however, in the claim, no indication is provided as to how such encoding is performed.

1.2 The claim also comprises a step of "determining whether a solution exists which satisfies the classifier constraints, transformation constraints and output constraints". Such step implies that the set of such constraints is equivalent to an equation which may have a solution. However, a classifier neural network may have different types of outputs, e.g. a set of probabilities, rather than an algebraic "solution" as commonly understood.

1.3 Furthermore, the determination that "no solution" exists, particularly in the case of a very complex equation, or set of equations, as may derive by mathematically encoding a convolutional neural network is typically an extremely difficult task. However, in the claim there is no indication on how such task is performed. Therefore, claim 1 does not meet the requirements of Article 6 PCT because the matter for which protection is sought is not clearly defined. The claim attempts to define the subject-matter in terms of the result to be achieved, which merely amounts to a statement of the underlying problem, without providing the technical features necessary for achieving this result.

1.4 The same objections apply, mutatis mutandis, to the other independent claims 17 and 18.

**Re Item V**

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

2. Reference is made to the following documents:

- D1 FAWZI ALHUSSEIN ET AL: "Analysis of classifiers' robustness to adversarial perturbations",  
MACHINE LEARNING, KLUWER ACADEMIC PUBLISHERS, BOSTON,  
US,  
vol. 107, no. 3, 25 August 2017 (2017-08-25), pages 481-508,  
XP036615144,  
ISSN: 0885-6125, DOI: 10.1007/S10994-017-5663-3  
[retrieved on 2017-08-25]
- D2 Tsui-Wei Weng ET AL: "EVALUATING THE ROBUSTNESS OF NEURAL  
NET- WORKS: AN EXTREME VALUE THEORY APPROACH",  
, 31 January 2018 (2018-01-31), XP055645354,  
Retrieved from the Internet:  
URL:<https://arxiv.org/pdf/1801.10578.pdf>  
[retrieved on 2019-11-21]

3.1 In view of the objections raised above at § 1 a detailed assessment of the novelty and inventive step of the claims cannot be performed.

3.2 It is noted that documents D1 and D2 both disclose methods to mathematically evaluate the robustness of convolutional neural networks and, as such, represent the most relevant state of the art with regard to the independent claims currently on file.

4. With regard to the dependent claims 2-16 it is noted that such claims refer to either implementation details and/or standard features of convolutional neural networks. Consequently, also their assessment relies on the clarification of the independent claims.

### **Re Item VII**

#### **Certain defects in the international application**

5.1 To meet the requirements of Rule 6.3(b) PCT the independent claims should have been properly cast in the two part form, with those features which in combination are part of the closest prior art being placed in the preamble.

5.2 Reference signs in parentheses should have been inserted in the claims to increase their intelligibility, Rule 6.2(b) PCT. This applies to both the preamble and characterising portion.

5.3 The description should have been brought into conformity with the claims (Rule 5.1 (a)(ii)(iii) PCT).

5.4 Document D1 should have been identified in the description (Rule 5.1(a)(ii) PCT).