

Google and Samsung top the list of applicants for AI-related patents at the EPO

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16 December 2021



More entities are seeking protection for AI-related inventions at the European Patent Office, but while grant rates are also on the rise they continue to lag the overall rate. In this co-published piece, Frances Wilding of Haseltine Lake Kempner offers a guide to key data points

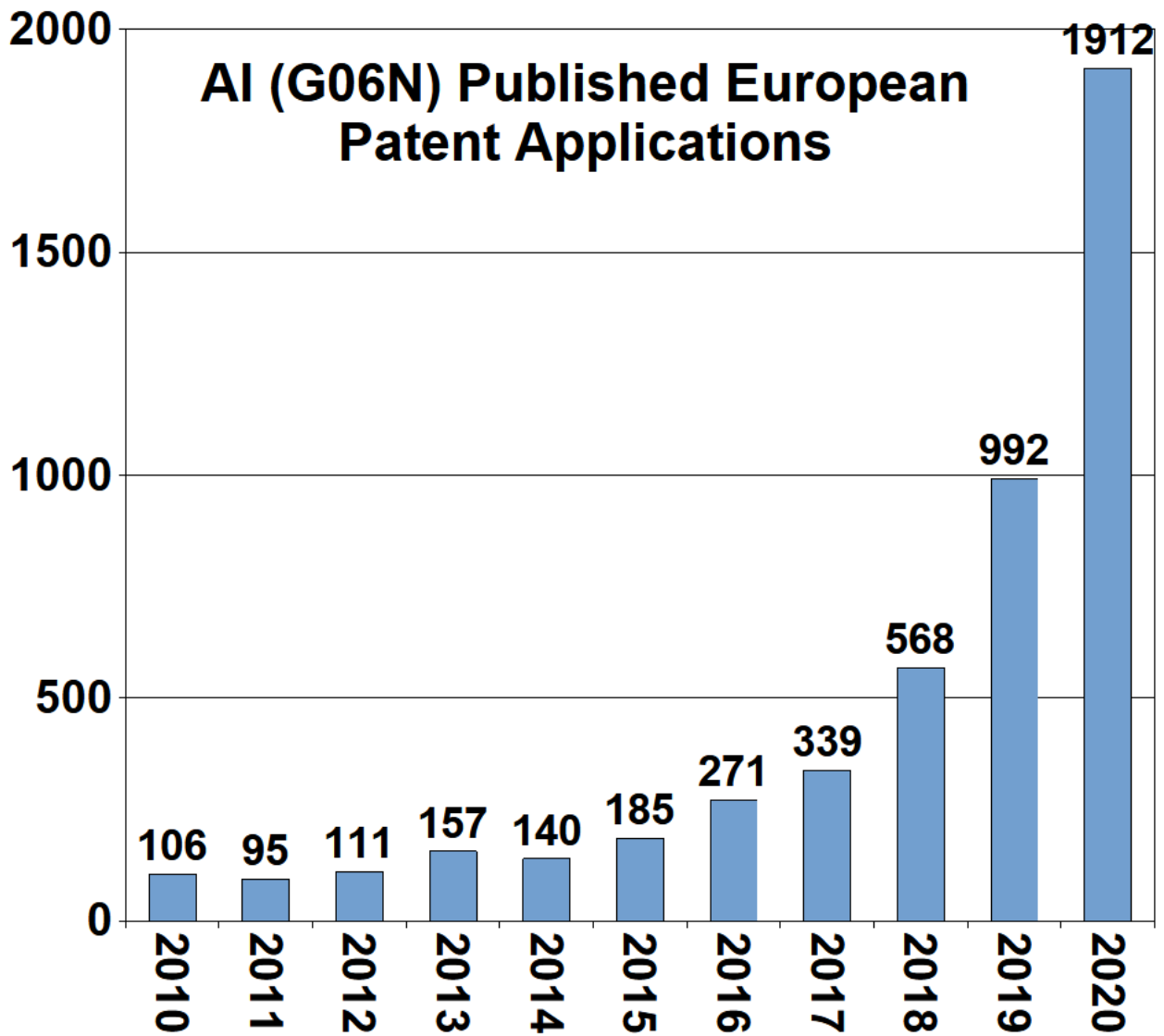
The term “artificial intelligence” is sometimes used in European patent applications and patents without further explanation or elaboration, AI apparently being taken to be no more than a known, off-the-shelf option. It is very unlikely that such applications and patents are concerned with developments in AI.

The International Patent Classification (IPC) helps us here. It has an extensive dictionary in which catchwords are linked to classifications. The catchword “Artificial Intelligence” is linked to only one class: G06N. That at least covers machine learning and neural networks, technologies at the core of developments related to artificial intelligence.

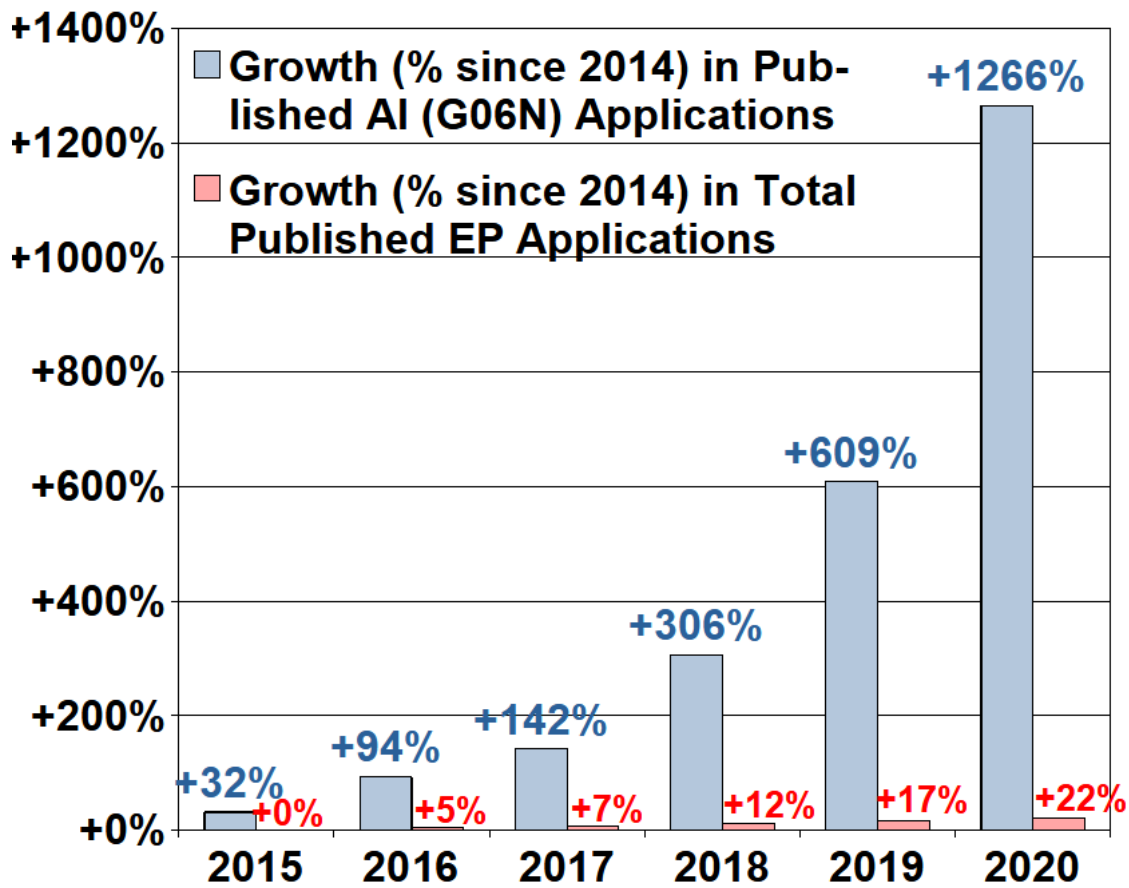
The details of the technologies covered by G06N are given further below. Applications and patents given the classification G06N provide a useful indication of EPO-related trends.

AI applications at the EPO growing

There is huge growth in AI filings at the EPO. The chart below shows the numbers of European patent applications having the classification G06N which were published year by year from 2010 to 2020.



Growth in the numbers of published G06N applications took off from 2014. Taking that year as the base, the number of published G06N applications in 2020 was over 12 times the level of 2014. This means that the percentage growth in published G06N applications over that period has been far greater than the percentage growth in total European patent applications published (shown in a comparison graph below). Also, Covid-19 does not appear to have affected this growth.



The applicants

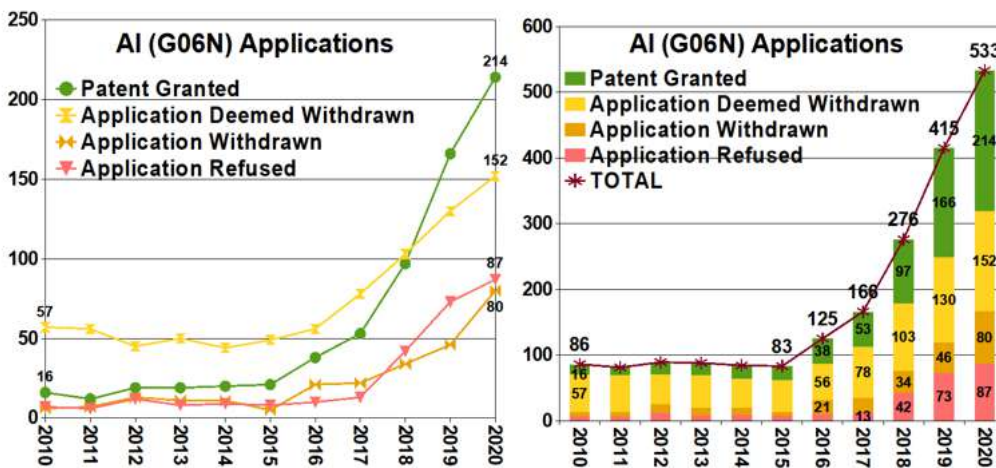
Between 2016 and 2020, just over 4,000 AI (G06N) applications were published. Around 1,000 different applicants were responsible for them. The top 25 applicants are listed in the table below. They accounted for just about half of all applications.

Rank	Applicant	No. of AI (G06N) Applications 2016-2020
1	Google	266
2	Samsung Group	187
3	Microsoft Technology Licensing LLC	170
4	Intel Corporation	140
5	Siemens Group	140
6	DeepMind Technologies Limited	91
7	Cambricon Technologies Group	90
8	Fujitsu Limited	81
9	Qualcomm Incorporated	81
10	Huawei Technologies Co. Ltd.	68
11	StradVision, Inc.	67
12	Sony Group	61
13	Robert Bosch GmbH	58

Rank	Applicant	No. of AI (G06N) Applications 2016-2020
14	Accenture Global Group	46
15	Nokia Group	44
16	Tata Consultancy Services Limited	41
17	Koninklijke Philips N.V.	39
18	Baidu Group	37
19	HRL Laboratories LLC	32
20	Commissariat à l'Energie Atomique et aux Energies Alternatives	31
21	Panasonic Group	31
22	Advanced New Technologies Co., Ltd.	27
23	General Electric Group	25
24	Hitachi Group	24
25	Northrop Grumman Systems Corporation	24

Number of grants increasing but lower than in other fields

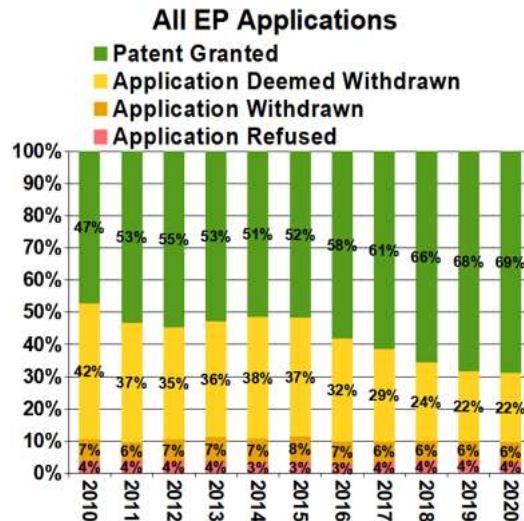
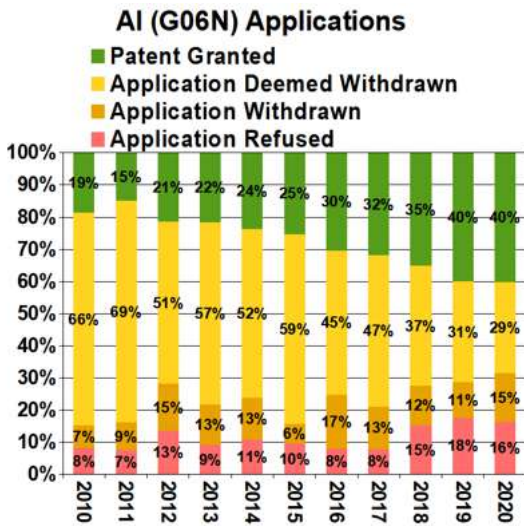
Apart from grant as a patent, processing of a European patent application may be concluded by the application being refused, withdrawn or deemed withdrawn. The charts below show year by year numbers of AI (G06N) applications processed to conclusions.



For AI (G06N) applications

processed to conclusions, the proportion granted as EP patents has been increasing. For AI (G06N) applications concluded in 2019 and 2020 grant as patents was the most likely outcome but was still the outcome for less than half of the applications. The 40% grant rate for AI (G06N) applications in 2020 well behind the EPO's overall 69% grant rate in the same year, while the 16% refusal rate in 2020 was far higher than the overall 4% EPO refusal rate.

These statistics are likely to be caused by the classification of AI at the EPO as a mathematical method which is not technical and cannot support an inventive step unless linked to implementation or specific technical application. The percentage outcomes for AI and all European applications are shown clearly below.

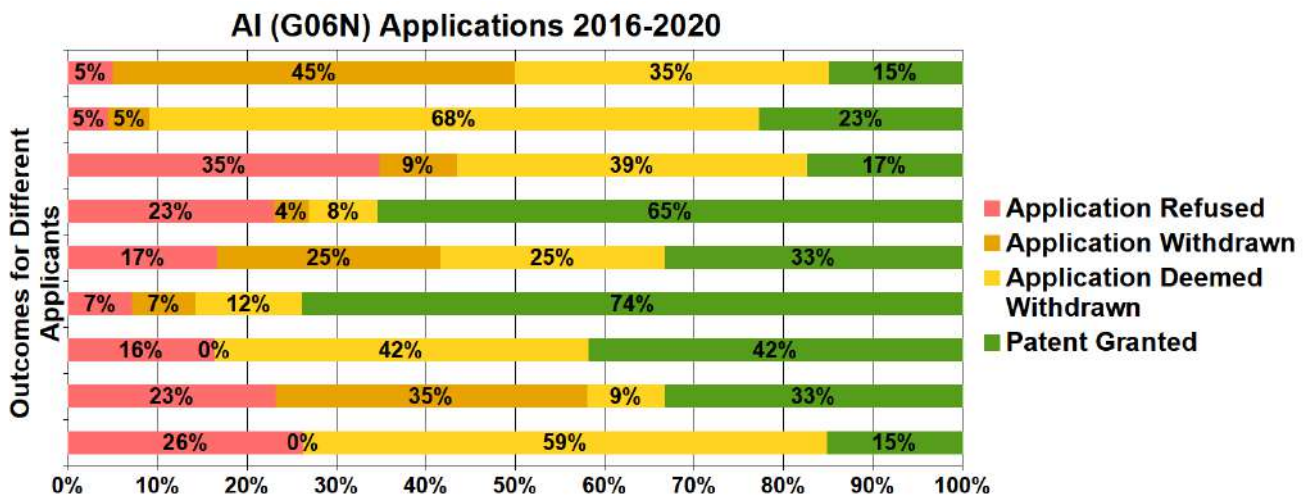


Although the

statistics indicate that, in general, grant is less likely and refusal more likely for AI applications than for EPO applications overall, outcomes do vary greatly for different AI applicants.

The outcomes of applications processed to conclusions over the five-year period 2016 to 2020 for different AI applicants/patentees are indicated in the chart below. The proportion of patents granted varies from 15% to 74% and the proportion of applications refused ranges from 5% to 35%.

Different applicants/patentees also appear to have quite different policies regarding withdrawal of applications – two of the 10 applicants did not positively withdraw any applications as opposed to allowing them to be deemed withdrawn. Other applicants have positively withdrawn good proportions of their applications (which may be as a result of a general policy, or a reaction to poor prospects for success).



The technologies covered by AI patent applications at the EPO

The IPC can help us again here. The 4,000 European patent applications having G06N IPC classifications published between 2016 and 2020 have lead classifications and, usually, further classifications along with these. The 4,000 lead classifications are spread over more than 700 different individual classifications and the applications have a total of around 15,000 classifications spread over about 2,000 different individual classifications.

The detailed hierarchy of IPC classifications of the technologies covered by G06N is given in the table below, along with the number of occurrences of the classifications across the 4,000 European patent applications. By a clear margin the most frequent classification, G06N 3/04, concerns architecture of neural network models, followed by learning methods for neural network models

International Patent Classification G06N Computer systems based on specific computational models (Catchword: "Artificial Intelligence")	Occurrences of this classification as lead IPC	Total occurrences of this classification
G06N 3/00 Computer systems based on biological models	84	253
• G06N 3/02 using neural network models	77	289
• • G06N 3/04 Architecture, eg interconnection topology	643	1502
• • G06N 3/06 Physical realisation, i.e. hardware implementation of neural networks, neurons or parts of neurons	12	31
• • • G06N 3/063 using electronic means	220	546
• • • G06N 3/067 using optical means	7	8
• • G06N 3/08 Learning methods	247	1258
• • G06N 3/10 Simulation on general purpose computers	15	50
• G06N 3/12 using genetic models	15	83
G06N 5/00 Computer systems using knowledge-based models	47	226
• G06N 5/02 Knowledge representation	85	248
• G06N 5/04 Inference methods or devices	53	255
G06N 7/00 Computer systems based on specific mathematical models	52	314
• G06N 7/02 using fuzzy logic	0	8
• • G06N 7/04 Physical realisation	2	5
• • G06N 7/06 Simulation on general purpose computers	3	5
• G06N 7/08 using chaos models or non-linear system models	3	5
G06N 10/00 Quantum computers, i.e. computer systems based on quantum-mechanical phenomena	97	149
G06N 20/00 Machine learning	82	522
• G06N 20/10 using kernel methods, eg support vector machines [SVM]	6	48

International Patent Classification G06N Computer systems based on specific computational models (Catchword: "Artificial Intelligence")	Occurrences of this classification as lead IPC	Total occurrences of this classification
• G06N 20/20 Ensemble learning	26	110
G06N 99/00 Subject matter not provided for in other groups of this subclass	214	555
G06F 15/18 Digital computers/data processing equipment in which a programme is changed according to experience gained by the computer itself during a complete run; Learning machines <i>Most of subclass G06N was added to the IPC in the year 2000 but groups and subgroups G06N 10/** and G06N 20/** were not added until 2019. Parts of the subject-matters of what are now G06N 10/** and G06N 20/** were formerly included in G06N 99/00 but machine learning was formerly included in G06F 15/18 (now subsumed into G06N 20/**).</i>	17	40

Where AI is being used, according to EPO applications

AI has found use across many fields, from internet search engines through self-driving cars, to medical diagnostics, finance and even agriculture. If potential fields of use of a development in AI are only mentioned in the description in a European patent application, they may not be reflected in an IPC classification applied to the application. Nonetheless, and particularly if a potential field of use appears in a claim of the application, this may be reflected in an IPC classification applied to the application, either as lead classification or as a further classification, which is not a G06N classification.

The most common non-G06N classifications applied to the 4,000 European patent applications published between 2016 and 2020 are indicated in the table below. The most frequent classifications relate to pattern recognition and image analysis. Of course, these techniques can, in turn, be used in many different contexts.

IPC Classification	Occurrences of this classification as Lead IPC	Total occurrences of this Classification	
G06K 9/00	99	320	Methods or arrangements for reading or recognising printed or written characters or for recognising patterns; eg, fingerprints
G06K 9/46	28	147	Extraction of features or characteristics of the image

IPC Classification	Occurrences of this classification as Lead IPC	Total occurrences of this Classification	
G06K 9/62	56	337	Methods or arrangements for recognition using electronic means
G06F 17/30	49	113	Database structures for information retrieval for digital computing or data processing equipment or methods
H04L 29/06	49	164	Communication control/Communication processing characterised by a protocol
G06F 9/50	46	91	Allocation of resources; eg, of the central processing unit [CPU] in arrangements for program control; eg, control units
G06F 3/01	37	84	Input arrangements or combined input and output arrangements for interaction between user and computer
G06Q 10/06	29	70	Resources, workflows, human or project management; eg, organising, planning, scheduling or allocating time, human or machine resources; Enterprise planning; Organisational models
B25J 9/16	27	46	Program controls for program-controlled manipulators
G06F 17/27	26	60	Automatic analysis; eg, parsing, orthograph correction, when handling natural language data
H04L 29/08	17	91	Transmission control procedure; eg, data link level control procedure, for communication control/communication processing
G06Q 30/02	25	86	Marketing; eg, market research and analysis, surveying, promotions, advertising, buyer profiling, customer management or rewards; Price estimation or determination

IPC Classification	Occurrences of this classification as Lead IPC	Total occurrences of this Classification	
G06T 7/00	19	77	Image analysis
A61B 5/00	15	64	Measuring for diagnostic purposes in medical or veterinary science

Some of the recent AI applications granted at the EPO

Below are the 32 AI (G06N) patents granted in November 2021, with links to the European Patents Register.

That use for AI has been found across many fields could be illustrated by the patents granted in November, which have concerns from cell (biological) analysis and motor vehicle loss assessment (for insurance purposes), through optimisation of mobile phone networks, to detecting whether a self-driving vehicle is travelling in a one-way street.

AI (G06N) Patents Granted in November 2021

Patent No.	Patentee	Title
<u>3262417</u>	Cellanix Diagnostics, LLC	Cell Imaging And Analysis To Differentiate Clinically Relevant Sub-Populations Of Cells
<u>3444758</u>	Cambricon Technologies Corporation Limited	Discrete Data Representation-Supporting Apparatus And Method For Back-Training Of Artificial Neural Network
<u>3471005</u>	Nokia Technologies Oy	Artificial Neural Network
<u>3520045</u>	Advanced New Technologies Co., Ltd.	Image-Based Vehicle Loss Assessment Method, Apparatus, And System, And Electronic Device
<u>3292471</u>	Hasan, Syed Kamran	Method And Device For Managing Security In A Computer Network
<u>3407265</u>	Cambricon Technologies Corporation Limited	Device And Method For Executing Forward Calculation Of Artificial Neural Network
<u>3619652</u>	Midea Group Co., Ltd.	Adaptive Bit-Width Reduction For Neural Networks
<u>3392809</u>	Accenture Global Solutions Limited	Quantum Computing Machine Learning Module
<u>3469496</u>	Neura, Inc.	Situation Forecast Mechanisms For Internet Of Things Integration Platform
<u>3557484</u>	Shanghai Cambricon Information Technology Co., Ltd	Neural Network Convolution Operation Device And Method
<u>3557487</u>	ZF Friedrichshafen AG	Generation Of Validation Data With Generative Contradictory Networks
<u>3636001</u>	Huawei Technologies Co., Ltd.	Optimizing Cellular Networks Using Deep Learning

<u>3686837</u>	StradVision, Inc.	Learning Method And Learning Device For Reducing Distortion Occurred In Warped Image Generated In Process Of Stabilizing Jittered Image By Using GAN To Enhance Fault Tolerance And Fluctuation Robustness In Extreme Situations
<u>3703332</u>	Advanced New Technologies Co., Ltd.	Graph Structure Model Training And Junk Account Identification
<u>3706267</u>	ABB Schweiz AG	Artificial Intelligence Monitoring System Using Infrared Images To Identify Hotspots In A Switchgear
<u>3719447</u>	Honeywell International Inc.	Deep Neural Network-Based Inertial Measurement Unit (IMU) Sensor Compensation Method
<u>2973248</u>	PPG Industries Ohio, Inc.	Systems And Methods For Determining A Coating Formulation
<u>3192017</u>	Northrop Grumman Systems Corporation	Tunable Transmon Circuit Assembly
<u>3291090</u>	Deutsche Telekom AG	Method And System For Forming A Digital Interface Between Terminal And Application Logic Via Deep Learning And Cloud
<u>3301611</u>	STMicroelectronics S.r.l.	Artificial Neural Networks For Human Activity Recognition
<u>3343392</u>	INTEL Corporation	Hardware Accelerator Architecture And Template For Web-Scale K-Means Clustering
<u>3398295</u>	Dish Technologies L.L.C.	Systems And Methods For Bandwidth Estimation In Oscillating Networks
<u>3399431</u>	ServiceNow, Inc.	Shared Machine Learning
<u>3399716</u>	ServiceNow, Inc.	Network Security Threat Intelligence Sharing
<u>3490449</u>	Tata Consultancy Services Limited	System And Method For Aiding Communication
<u>3542322</u>	Google LLC	Management And Evaluation Of Machine-Learned Models Based On Locally Logged Data
<u>3611472</u>	Mobileye Vision Technologies Ltd.	Controlling Host Vehicle Based On Detected Parked Vehicle Characteristics
<u>3627213</u>	Eagle Technology, LLC	Multi-Channel Laser System Including An Acousto-Optic Modulator (AOM) With Beam Polarization Switching And Related Methods
<u>3631623</u>	Microsoft Technology Licensing, LLC	Tensor Processor Instruction Set Architecture
<u>3662515</u>	International Business Machines Corporation	Josephson Junctions For Improved Qubits

<u>3671526</u>	Accenture Global Solutions Limited	Dependency Graph Based Natural Language Processing
<u>3783477</u>	Cambricon Technologies Corporation Limited	Integrated Circuit Chip Device

AI patents being opposed at the EPO

Since 2010, only nine AI (G06N) European patents have been opposed, as listed in the table below.

Two oppositions have been finally decided by first instance decisions (1825424 – Opposition rejected, no appeal; 2748686 – Opposition rejected, appeal withdrawn). No oppositions have yet been finally decided after appeal.

The last four oppositions listed in the table appear to be “straw man” oppositions.

Patent No.	Proprietor	Title (en)	IPC	Opponent
<u>1825424</u>	Becton, Dickinson and Company	Graphical User Interface For Use With Open Expert System	G06N 5/02	Beckman Coulter, Inc.
<u>2449510</u>	Dow AgroSciences LLC	Application Of Machine Learning Methods For Mining Association Rules In Plant And Animal Data Sets Containing Molecular Genetic Markers, Followed By Classification Or Prediction Utilizing Features Created From These Association Rules	G06N 5/02	KWS SAAT SE & Co. KGaA
<u>2458178</u>	General Electric Company	Turbine Performance Diagnostic System And Methods	F02C 9/00 G06N 7/00	Siemens Aktiengesellschaft
<u>2582341</u>	Fred Bergman Healthcare Pty Ltd	Method For Analysing Events From Sensor Data By Optimization	A61F 13/42 G08B 19/00 G08B 23/00 G06N 5/04 G06N 99/00	Ontex BVBA
<u>2748686</u>	Robert Bosch GmbH	Method For The Creation Of A Function For A Control Device	G05B 17/00 G06N 7/00 G06F 17/50 G05B 13/04	FEV GmbH
<u>2807526</u>	Omron Corporation	Autonomous Mobile Robot For Handling Job Assignments In A Physical Environment Inhabited By Stationary And Non-Stationary Obstacles	G05B 19/18 G05D 1/02 G06N 3/00	Vershelde, Claire

Patent No.	Proprietor	Title (en)	IPC	Opponent
<u>3111380</u>	Rigetti & Co., Inc.	Processing Signals In A Quantum Computing System	G06N 10/00 G06F 13/36 G06F 13/40 G06F 15/80	Ueberfluss, Eva U.
<u>3111381</u>	Rigetti & Co., Inc.	Operating A Multi-Dimensional Array Of Qubit Devices	G06N 10/00 G06F 13/36 G06F 13/40	Schorr, Frank
<u>3217336</u>	Rigetti & Co., Inc.	Impedance-Matched Microwave Quantum Circuit Systems	G06N 99/00 H01L 39/02 H01L 39/22 H03H 7/38 G06F 15/80 G06N 10/00 H01L 27/18 H01P 1/201 H01P 5/02	Ueberfluss, Eva U.

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