# Recent Trends in AI-related Inventions

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Patent Examination department (Electronic Technology),
Japan Patent Office

In recent years, Artificial Intelligence (AI) -related technology has shown remarkable development centering on deep learning. Accordingly, AI-related patent applications are increasing across technological fields. In addition, with AI researchers winning the Nobel Prize in Physics and the Prize in Chemistry, attention has been focused on the impact of AI on human development. As numerous AI-related technological developments and patent applications are expected in the future, the JPO has been conducting a survey to clarify the current status of AI-related applications both domestically and internationally.

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＜Attachment＞



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# 1. Introduction

## 1-1. Definition of AI-related Invention and Survey Targets

○ While various definitions of AI are possible, in this survey, as shown in Figure 1, we defined "AI-related inventions"[1] as ①AI Core Inventions and ②AI-applied Inventions, which were the subjects of our investigation.

① AI Core Inventions:

Inventions characterized by the mathematical or statistical information processing technology that forms the basis of AI, such as knowledge-based models and fuzzy logic, as well as various machine learning technologies including neural networks, deep learning, support vector machines, reinforcement learning, etc. (In this survey, G06N[2] is mainly assumed as the FI[3] allocated to the AI Core Invention.)

② AI-applied Inventions:

Inventions characterized by the application of the mathematical or statistical information processing technology that forms the basis of AI to various technologies such as image processing, speech processing, natural language processing, equipment control and robotics, diagnosis, detection, prediction, and optimization systems. (There are many FIs expected to be allocated.)

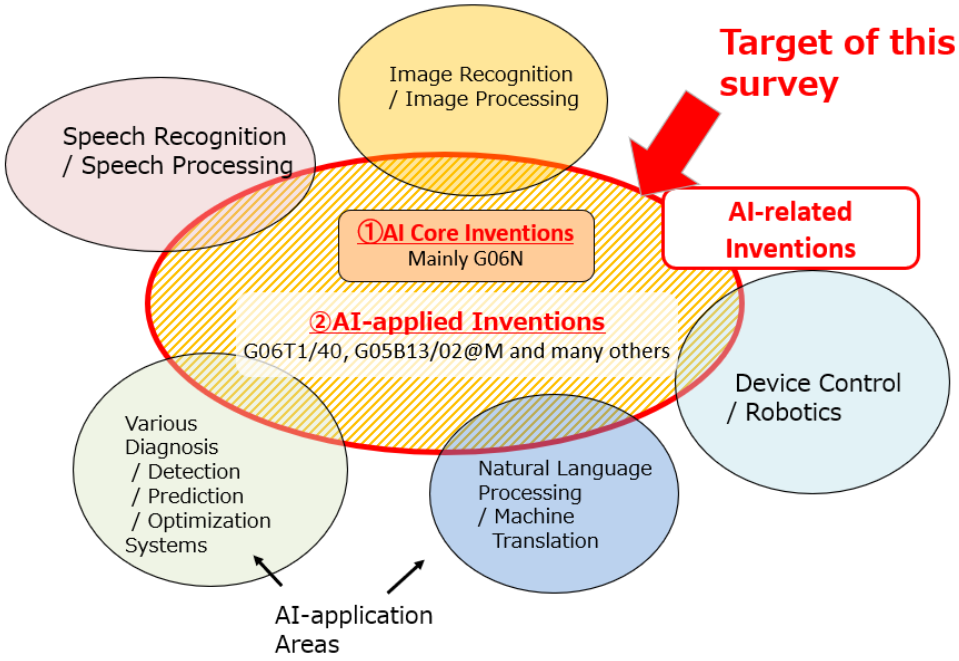


Fig. 1: Target of this research (Scope of AI-related Inventions)

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[1] The definitions of "AI Core Invention," "AI-applied Invention" and "AI-related Invention" are valid only in this investigation and do not represent official definitions by the Japan Patent Office.

[2] This is "COMPUTING ARRANGEMENTS BASED ON SPECIFIC COMPUTIONAL MODELS", which includes G06F15/18 before the FI revision.

[3] This is a classification unique to the Japan Patent Office, further developed based on the IPC. For details, please refer to J-PlatPat.

## 1-2. Survey Methods

- The union of the following sets of domestic patent applications (A∪B∪C) is extracted as "AI-related Inventions".
  - Set A: Patent applications allocated with G06N (AI Core Technology) as FI (In order to capture AI Core Inventions)
  - Set B: Patent applications allocated with any of the AI-related FIs listed in Attachment 1 (Purpose: to capture AI-applied Inventions through classification)
  - Set C: Patent applications that have any of the AI Core Keywords listed in Attachment 2 included in any of "[Abstract]," "[Problem to be solved by the invention]," or "[Means for solving the problem]" in the application (In order to capture AI-applied Inventions through keyword search)
- The AI-related FI and AI Core Keywords were selected based on the classifications and keywords used in the "Methodology" of WIPO Technology Trends - Artificial Intelligence, so that "AI-related Inventions" can be appropriately extracted from domestic patent documents.
- The applications surveyed include Japanese applications and international applications filed under the PCT (Patent Cooperation Treaty) that entered the national phase in Japan, with filing years[4] from 1988 to 2022.
- The above sets A, B and C include 25,937, 29,305 and 57,845 patent applications respectively, and the union of these sets, which totals 82,351, was the subject of the survey (Figure 2).
- The findings of this report are based on statistics on classification information and bibliographic information of applicants, etc. given in the patent literature of extracted AI-related Inventions, and the patent documents themselves have not been read.

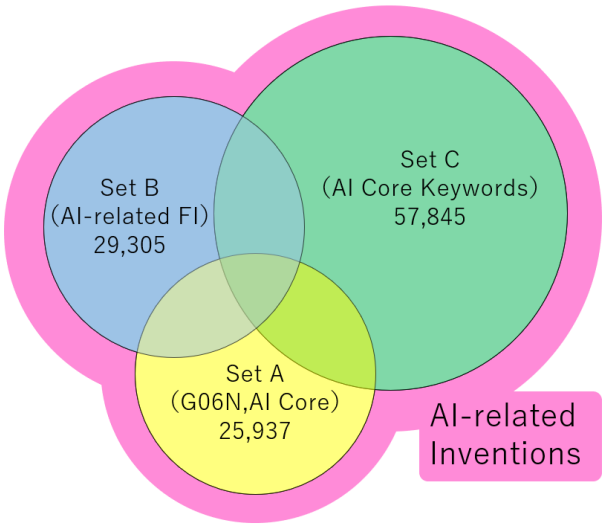


**Fig. 2: Sets of AI-related Inventions surveyed (total of 82,351 cases)**

[4] The "filing year" is determined based on the actual filing date for domestic applications and the acceptance date of domestic documents for international applications based on the PCT.

## 2. Application trends in AI-related Invention

### 2-1. Overall Trends in Application, Examination and Technology

○ Figure 3 shows the number of applications for AI-related Inventions. The number of applications for AI-related Inventions (pink bars) has increased rapidly since 2014, with approximately 10,300 applications filed in 2022. Among AI-related Inventions, the number of patent applications allocated with G06N (AI Core Technology) as an FI (Set A) (yellow bars) was approximately 3,000 in 2022, and it still shows an increasing trend although the growth rate has slowed somewhat.

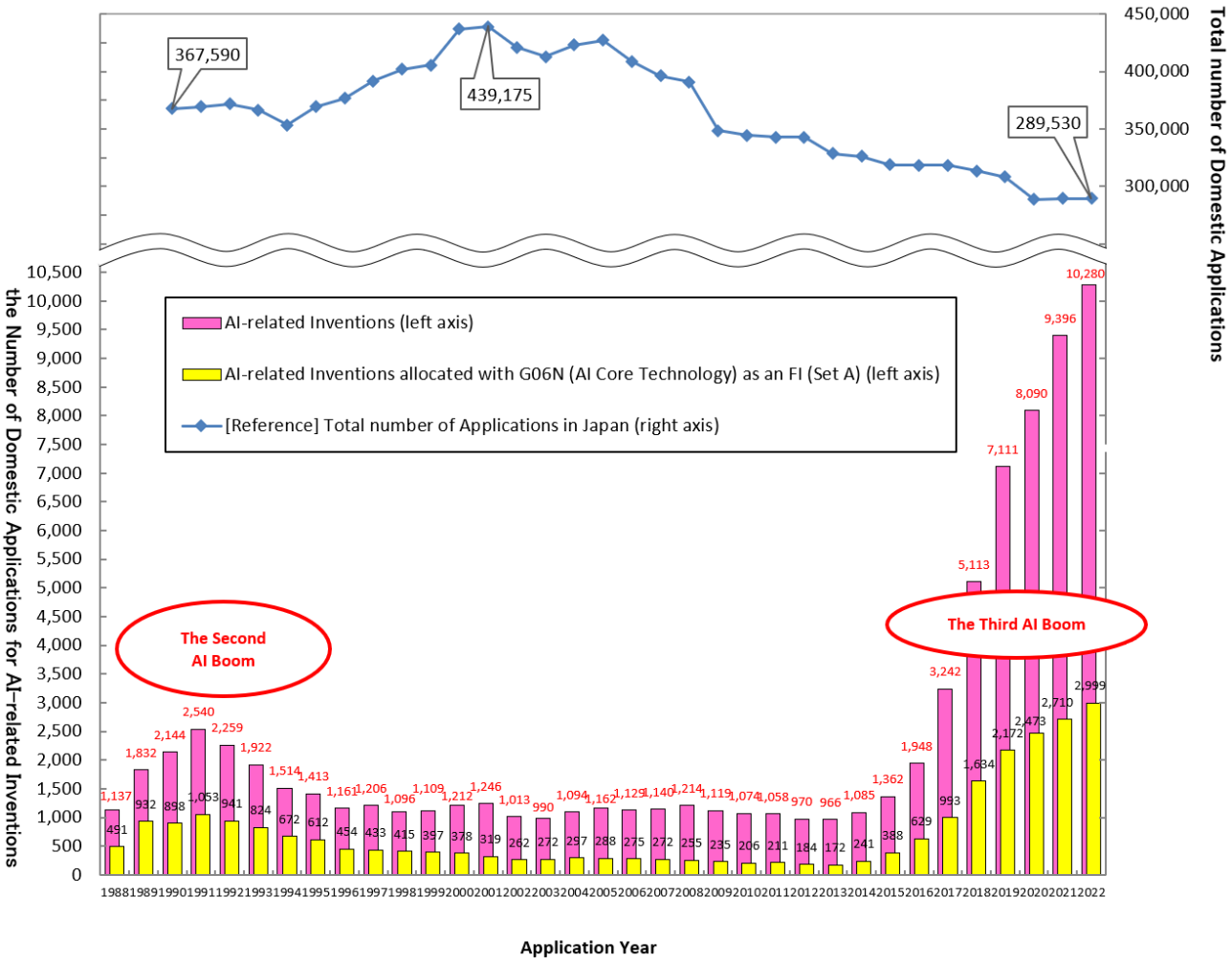


Fig. 3: The Number of Domestic Applications for AI-related Inventions

【Remarks】

- "The number of applications" includes unpublished applications that were finally rejected to be granted, (deemed) withdrawn or abandoned before publication.

- AI-related Inventions experienced a boom in patent applications in the early 1990s due to the influence of the so-called second AI boom. However, the number of applications remained low for nearly 20 years since then.
- The technologies that were popular during the second AI boom included knowledge-based models and expert systems. However, the boom came to an end due to the difficulty of pre-programming computers with rules for every possible event in advance. Additionally, neural networks, which have been around for a long time, were also actively researched at the time, but the boom was only temporary due to limitations in their performance.
- This trend is also reflected in Figure 4, which shows the transition in the number of patent applications allocated with subclassifications of G06N (AI Core Technology). In the first half of the 1990s, the number of applications for G06N3/02-3/10 (Neural Networks), G06N5/ (Knowledge Base), G06N7/ (Fuzzy Logic, etc.), and G06N20/ (Machine Learning; including G06N99/00 and 150-159 before the FI revision; The same applies hereinafter.) all increased, but then began to decline, and the number of applications for G06N5/ and G06N7/ remains at a low level even now.
- The increase in the number of patent applications since 2014 is considered to be due to the influence of the so-called "third AI boom," with machine learning technologies, including neural networks, playing a leading role (among which deep learning technology occupies a major position, which will be discussed later in Section 2-3). Figure 4 shows that the factors driving up the number of applications during the third AI boom are G06N3/02 - 3/10 (Neural Networks) and G06N20/ (Machine Learning).
- Figure 5 shows the transition of the machine learning rate, which is the percentage of applications allocated with G06N3/02-3/10 (Neural Networks) or G06N20/ (Machine Learning) among the number of applications allocated with G06N (AI Core Technology). The machine learning rate, which had been around 50 to 60% for many years, began to rise around 2013, and reached approximately 90% in 2019. The machine learning rate in 2022 remains high at 87%, indicating that many recent AI-related Inventions are implemented through machine learning.
- The third AI boom is said to have been caused by the development of methods to suppress overlearning in machine learning and the improvements in the performance of computers and the increased amount of data distributed, which made it possible to put AI-related theories into practical use. For example, the concept of layering neural networks, which is the key to deep learning, has been around for several decades, but research had not progressed until now due to the enormous computational cost. However, in 2012, a team from the University of Toronto in Canada won a landslide victory[5] using deep learning in the world-famous global image recognition contest "ILSVRC (ImageNet Large Scale Visual Recognition Competition),"

[5] The technical content is described in detail in "ImageNet Classification with Deep Convolutional Neural Networks, A. Krizhevsky et al., NIPS2012".

which was a momentum that led to the current third AI boom.

○ In recent years, among deep learning, generative AI such as ChatGPT (registered trademark) has not only been evaluated in various tasks[6] in the academic world, but has also attracted social discussion, and is expected to have an impact on future AI-related Inventions.

○ The patent grant rate for AI-related Inventions (Figure 6) has been on the rise since 2004, reaching approximately 83% in 2020.

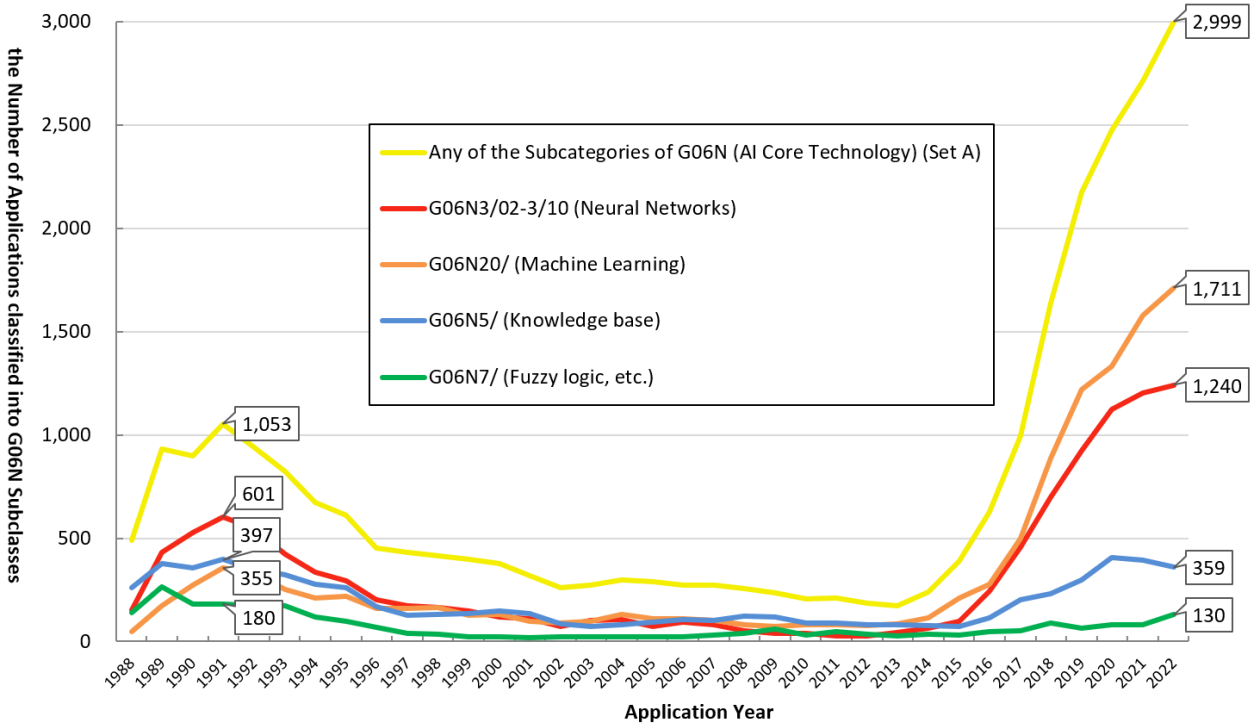


**Fig. 4: The Number of Applications for the G06N (AI Core Technology) Sub-Classification (the numbers of applications in 1991 and 2022 noted)**

【Remarks】

- Since multiple FIs may be allocated to a single application, the total number of sub-classifications of G06N (AI Core Technology) does not match the number in "Any of the sub-classification of G06N (AI Core Technology) (Set A)."

[6] Evaluations in various tasks are described in "A Systematic Study and Comprehensive Evaluation of ChatGPT on Benchmark Datasets, Laskar et al., Findings 2023", for example.

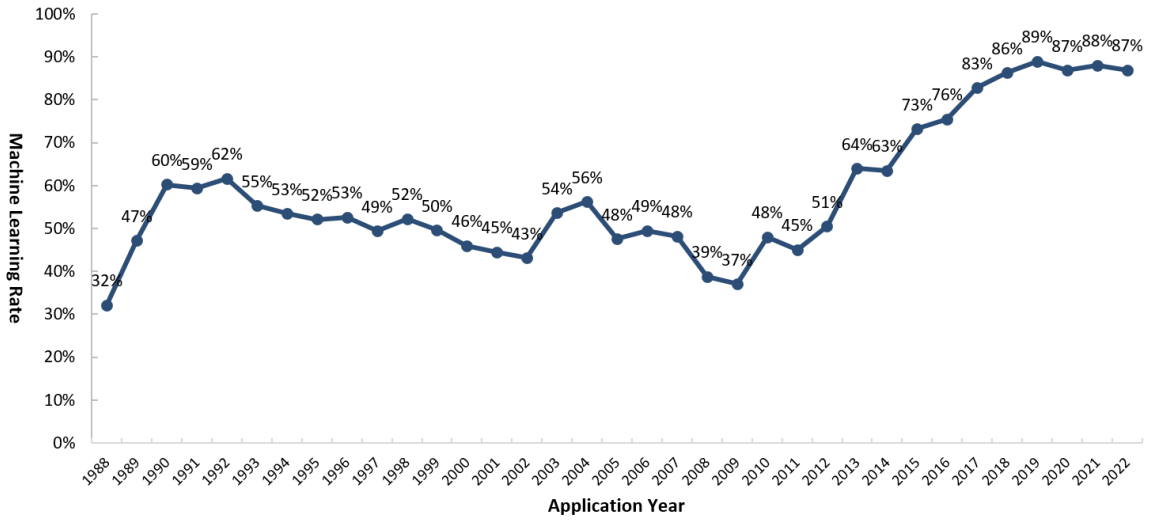


Fig. 5: The Machine Learning Rate

(The percentage of the patent applications allocated with G06N3/02-3/10 or G06N20/ among the total number of patent applications (Set A) allocated with G06N (AI Core Technology))

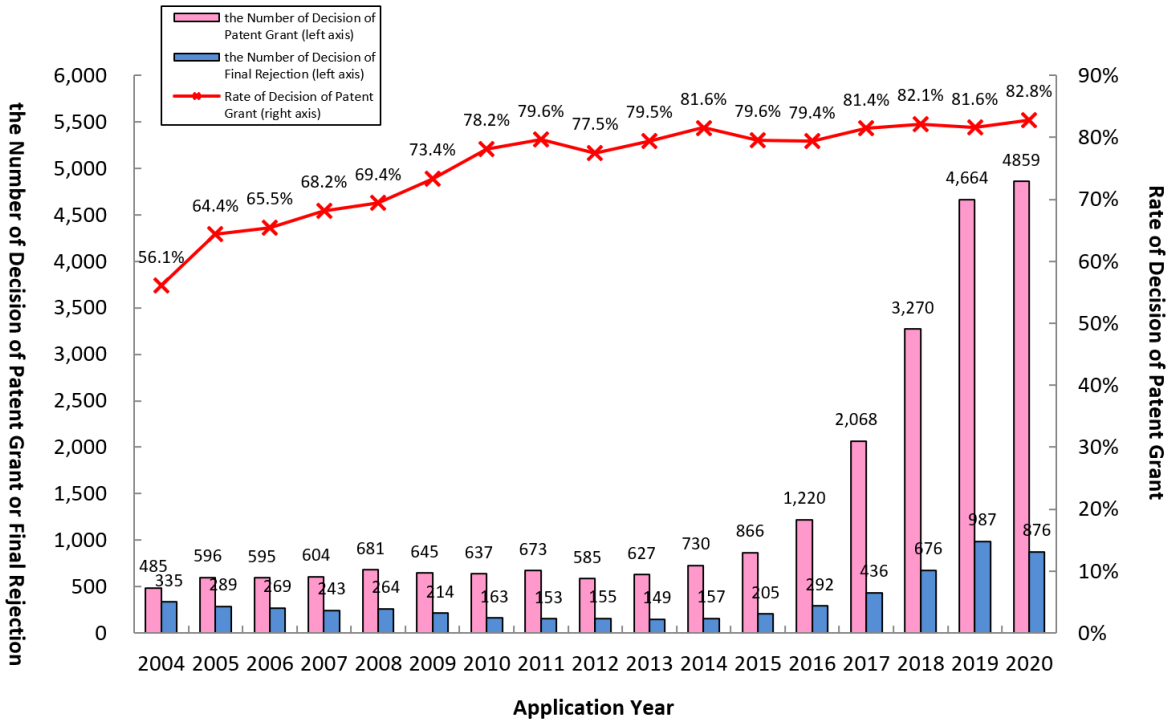


Fig. 6: The Patent Grant Rate of AI-related Inventions

【Remarks】

- Patent Grant Rate = Number of final decision of patent grant / (Number of patent grants + Number of final decisions of refusal + Number of withdrawals and abandonments after request for examination)

  (The definition is different from the patent examination rate in the 2024 version of the Patent Administrative Annual Report.)

## 2-2. Trends in AI-application Area

- In order to investigate trends in the application of AI-related Inventions, we surveyed the main classification[7] of all AI-related Inventions (Fig. 7). The FI with more than 100 applications in 2022 (the top four digits of FI) are remarked; among which only for G06F having a large number of applications, subclasses including 16/ (including 17/30 before the revision of FI) and 40/ (including 17/20-28 before the revision of FI) are specifically listed.
- As main classification other than G06N (AI Core Technology) to be allocated to the AI-related applications, G06T, G06V (Image Processing/Recognition) have been on the rise since 2016, and have exceeded G06N to become the most common since 2019.
- In addition to the above, the main classifications that can be said to be the main application areas of AI technology include G06Q (Business; including G06F17/60 before the revision of FI) , A61B (Medical Diagnosis), G01N (Material Analysis), G06F16/ (Information Retrieval/Recommendation), G16H (Healthcare), G05B (Control System and Adjustment System in General), G06F40/ (Natural Language Processing), H04N (Video Processing), etc.
- Further, the scale of other G06F (Information in General) is also large, and it includes information processing-related technologies such as G06F3/ (Interface Arrangements) and G06F21/ (Security Arrangements).
- The number of main classifications summarized in "Others" is also on the rise, suggesting that the number of applications of AI technology is expanding.

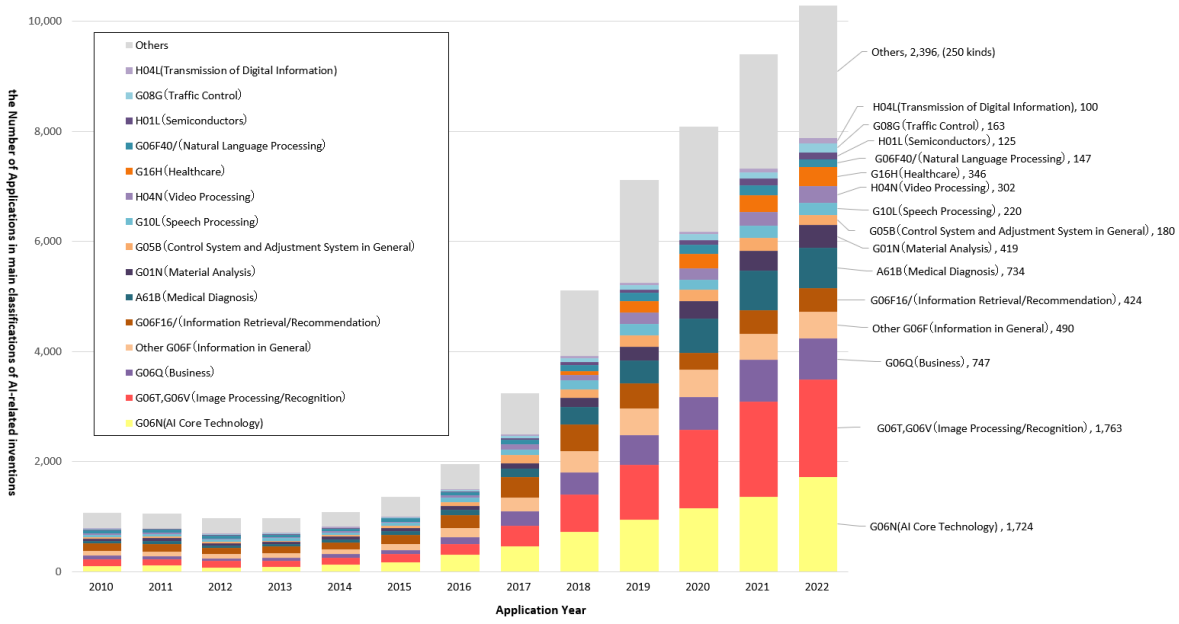


**Fig. 7: Composition of Main Classification of AI-related Inventions (with the number of applications in 2022 noted)**

[7] The main classification refers to the classification that best describes the invention.

【Remarks】

- Among the 2,396 cases included in "Others" in 2022, the following are cases with a relatively large number of applications:
- H04W (Wireless Communication Networks): 90 cases, G16C (Cheminformatics): 87 cases, B25J (Manipulators): 85 cases, G16B (Bioinformatics): 82 cases, C12Q (Methods for Measuring or Testing Enzymes, etc.): 80 cases, G01M (Testing Static or Dynamic Balance of Machines or Structures): 78 cases, B60W (Conjoined Control of Vehicle Subunits of Different Type or Different Function): 71 cases, G01S (Radi Direction Finding): 63 cases, H02J (Circuit Arrangements or Systems for Supplying or Distributing Electric Power): 55 cases.

○ Figure 8 shows the ratio of the number of applications filed in each year, assuming that the number of applications filed in 2010 for each major classification is 100%. For all main classifications, the number of applications filed in 2022 was more than double the number of applications filed in 2010, but among them, main classifications such as A61B (Diagnosis), G06T & G06V (Image Processing/Recognition), and G08G (Traffic Control Systems) showed extremely high growth rates. This shows that the application of AI technology has been rapidly expanding in these fields in recent years.

○ On the other hand, the growth in the number of applications in recent years has been slowing down for some main classifications.

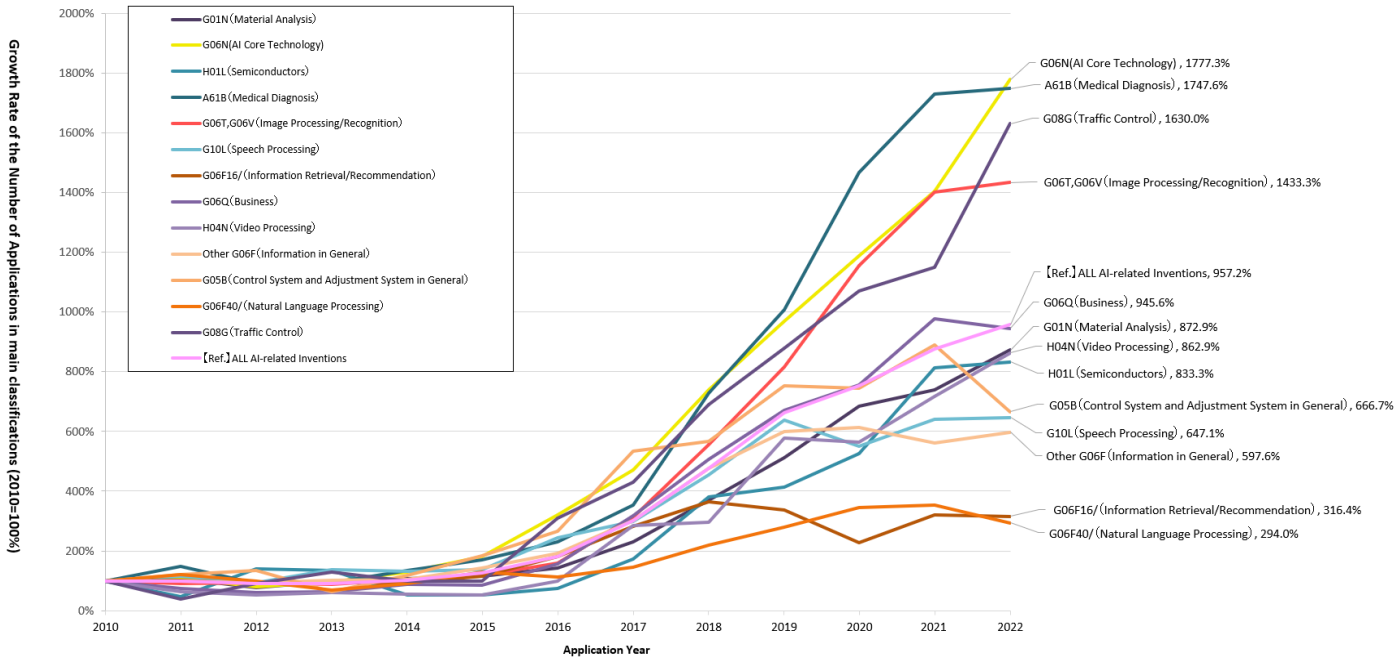


Fig. 8: Growth rate of the Number of Applications in main classifications (2010=100%)

## 2-3. Status of Application for Deep Learning

○ We investigated the status of applications for Deep Learning technology, which is considered to be a major factor in the increase in the number of applications of AI-related Inventions since 2014. Among AI-related Inventions, applications in which any of the Deep-Learning-related Keywords listed in Attachment 3 appear in the application documents (abstract, claim, specification) are defined as AI-related Inventions that refer to deep learning. Figure 9 shows the transition in the number of applications.

○ AI-related Inventions referring to Deep Learning had been increasing since 2014.

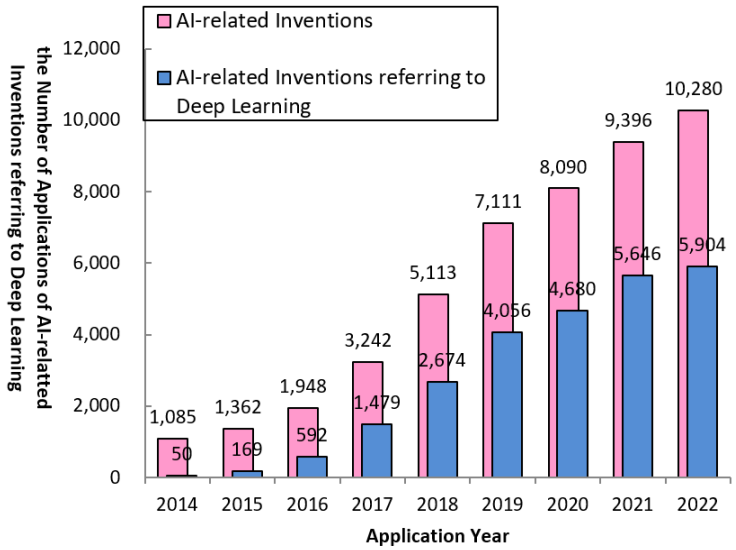


**Fig. 9: The Number of Applications for AI-related Inventions referring to Deep Learning**

○ Figure 10 shows transition in the number of applications of AI-related Inventions referring to the following 4 methods, which are particularly important among Deep Learning technologies (The keywords used are those in Attachment 3).

(1) Convolutional Neural Network (CNN)

(2) Recurrent Neural Network (RNN) or Long Short Term Memory (LSTM), which is an extension of RNN

(3) Deep Reinforcement Learning

(4) Transformer[8][9]

○ The number of applications for AI-related Inventions referring to CNN has been increasing since 2014. On the other hand, the number of applications for AI-related

[8] A Deep Learning model announced in 2017. Transformer is similar to recurrent neural networks in that it handles time-series data such as natural language, but since it does not need to process time-series data sequentially, it allows for much greater parallelization than recurrent neural networks, thereby shortening training times.

[9] Only applications filed on or after June 12, 2017 are counted, which date is the date of publication of the supposedly first paper on Transformer (Ashish Vaswani, et. Al., "Attention Is All You Need," [online], June 12, 2017, [Retrieved October 9, 2024], Internet <URL: https://arxiv.org/abs/1706.03762v1>

Inventions referring to Deep Reinforcement Learning has been flat in recent years. In addition, the number of applications for AI-related Inventions referring to transformers has been on an increasing trend, surpassing the number of applications for Deep Reinforcement Learning in 2020.

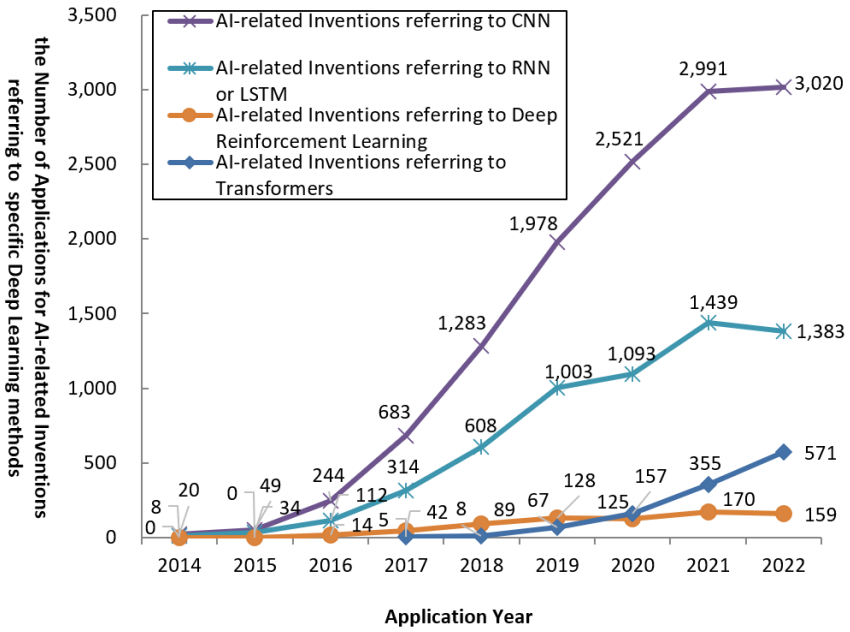


**Fig. 10 The Number of Applications for AI-related Inventions referring to specific Deep Learning methods**

- Figures 11-1 to 11-4 show the breakdown of the main classifications of AI-related Inventions referring to (1) CNN, (2) RNN or LSTM, (3) Deep Reinforcement Learning, and (4) Transformers, respectively.
- CNN, RNN, and LSTM are known to have a high affinity with video recognition and analysis, Deep Reinforcement Learning with system control and optimization, and Transformers with natural language processing, and such affinity tends to appear in the main classification compositions of Figures 11-1 to 11-4. G06T, G06V (Image Processing/Recognition), and H04N (Video Processing) stand out as the main classifications of AI-related Inventions referring to CNN, and G06T, G06V (Image Processing/Recognition) stand out as the main classifications of AI-related Inventions referring to RNN or LSTM. Although the number of applications is small, the main classifications of AI-related Inventions referring to Deep Reinforcement Learning stand out as including G05B (Control System and Adjustment System in General) and B25J (Manipulators), which are often used in control system technology. The main classifications of AI-related Inventions referring to Transformers stand out as including G06F40/ (Natural Language Processing) and G06F16/(Information Retrieval/Recommendation) .

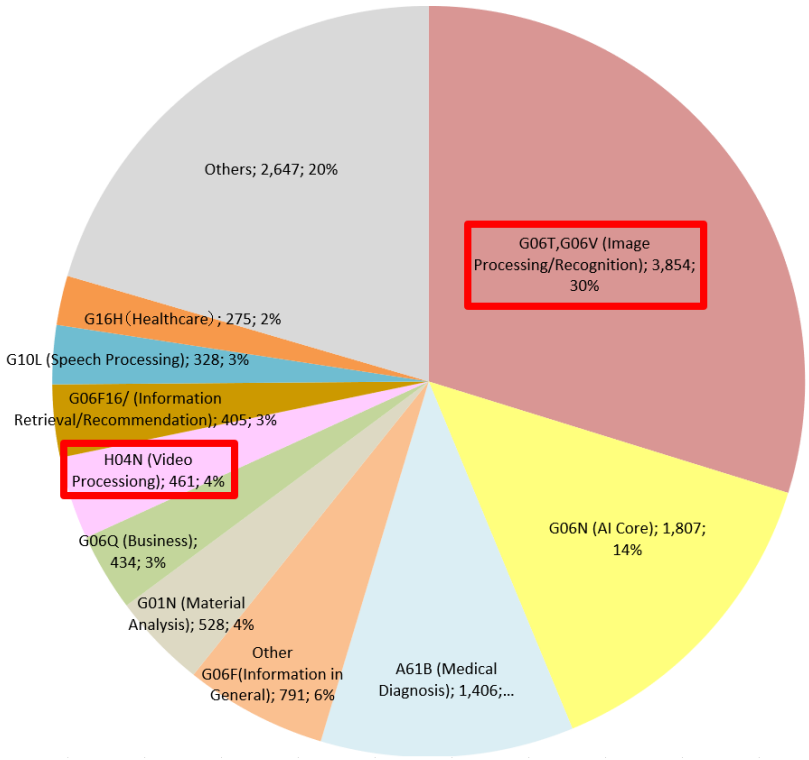


Fig. 11-1: Main Classification Composition of AI-related Inventions referring to CNN (applications filed between 2014 and 2022)

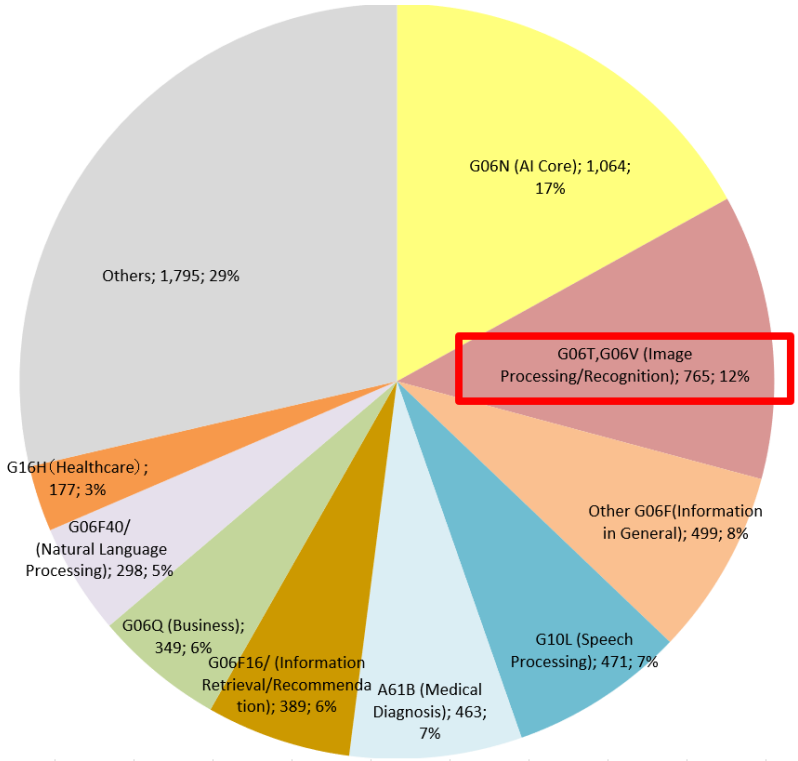


Fig. 11-2: Main Classification Composition of AI-related Inventions referring to RNN and LSTM (applications filed between 2014 and 2022)

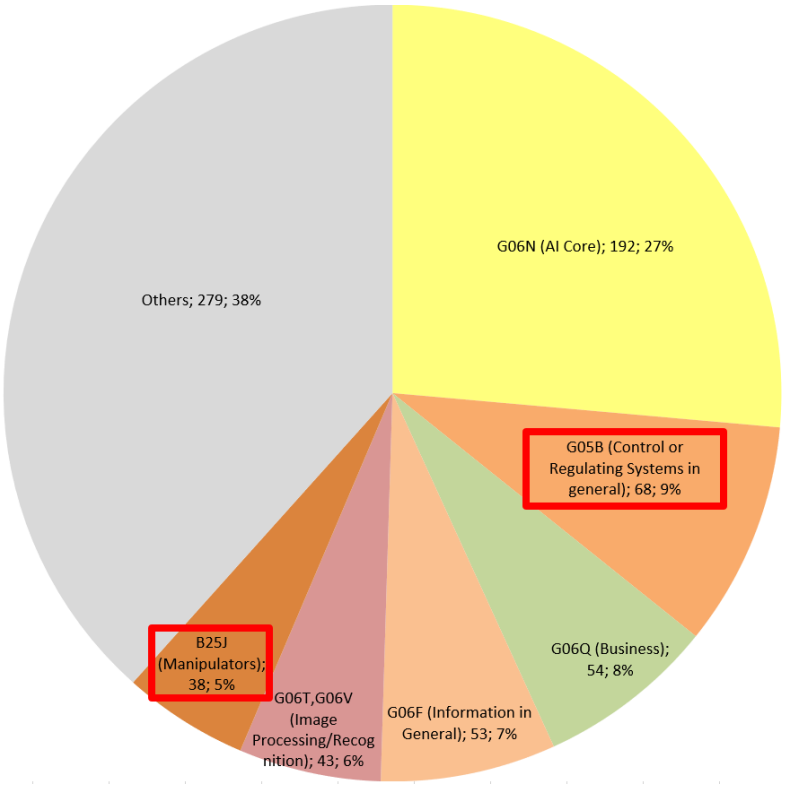


Fig. 11-3: Main Classification Composition of AI-related Inventions referring to Deep Reinforcement Learning (applications filed between 2016 and 2022)

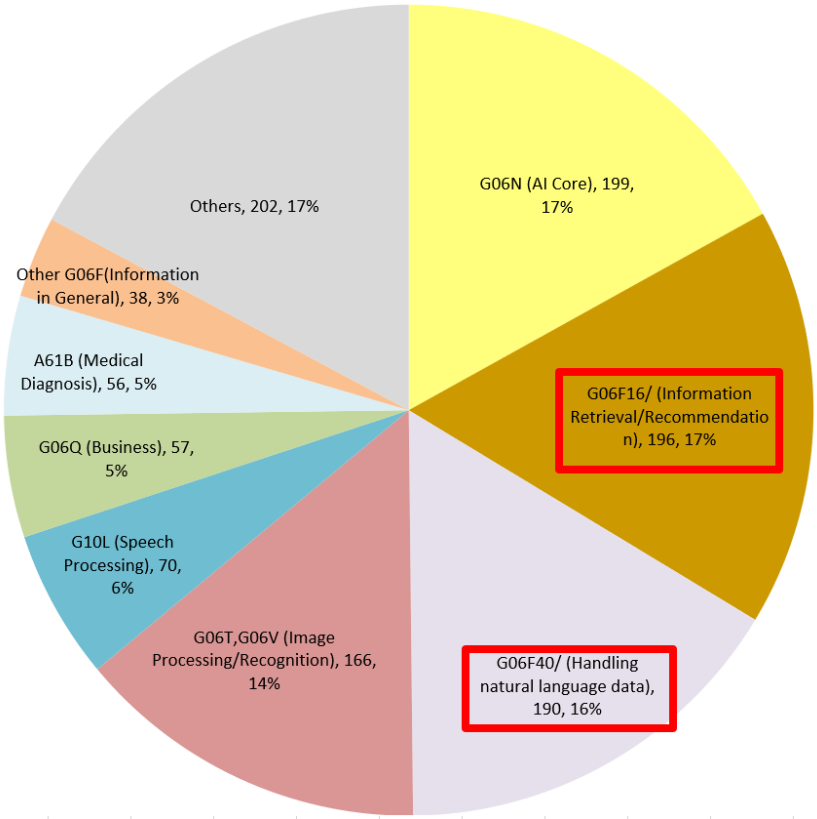


Fig. 11-4: Main Classification Composition of AI-related Inventions referring to Transformers (applications filed between 2017 and 2022)

## 2-4. Trends in Applicants

○ Figure 12 shows the applicants with the higher number of applications for AI-related Inventions in recent years. Figure 12 also lists the number of applications for AI-related Inventions referring to Deep Learning. The target is applications which were filed between 2014 and 2022 and whose patent gazettes, (including Granted Patent Publication, Unexamined Patent Publication, etc.) were issued by August 2024.

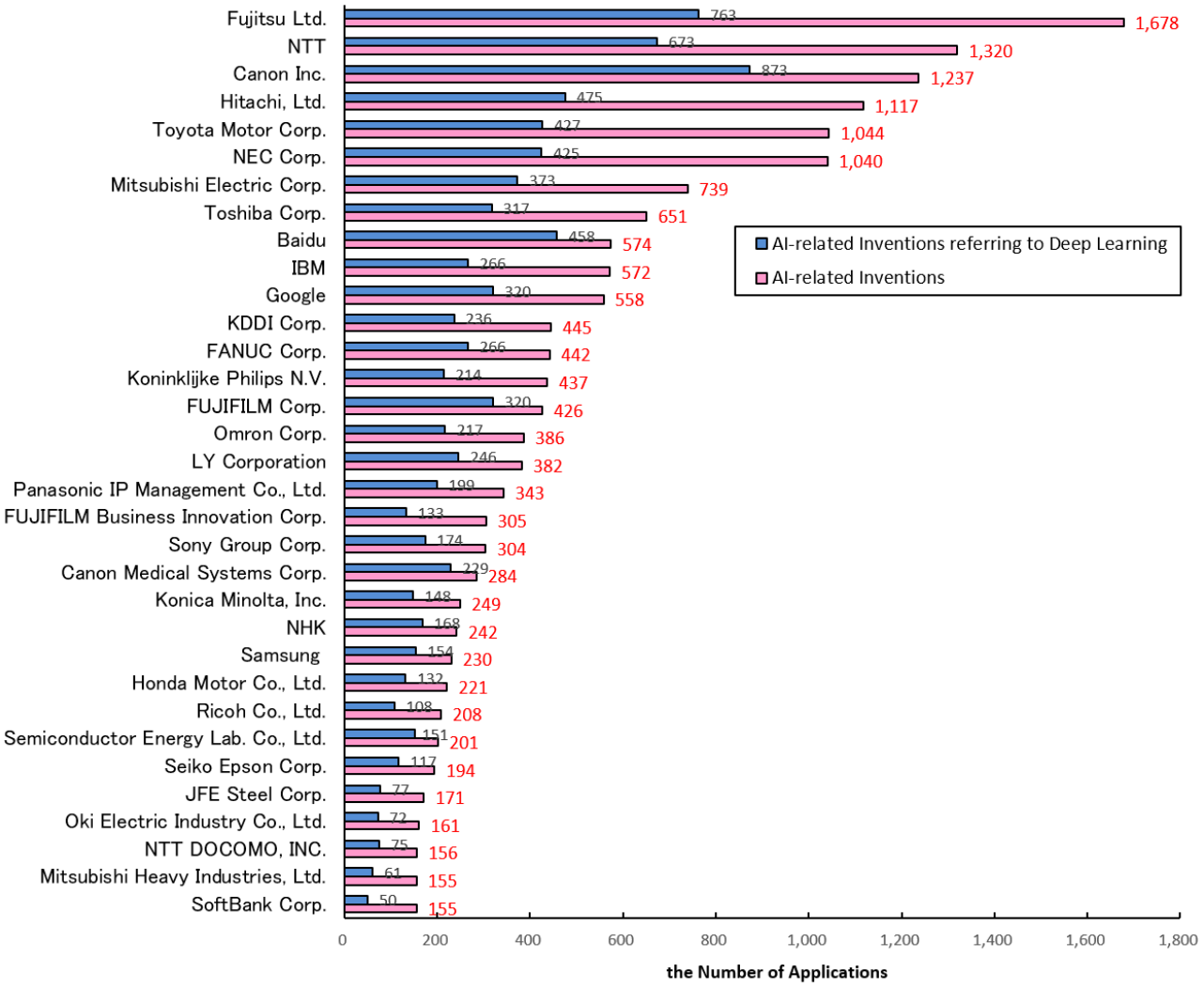


Fig. 12 The Number of Applications for AI-related Inventions by Applicant
(Applications filed between 2014 and 2022,
for which patent gazettes, etc. were issued by August 2024)

○ Figure 13 shows the percentage of the main classification composition of the AI-related Inventions filed by the applicants shown in Fig. 12. As shown in Fig. 13, here, several main classifications are collectively labeled as "Video Image Processing/Recognition," "Control/Robotics," etc.

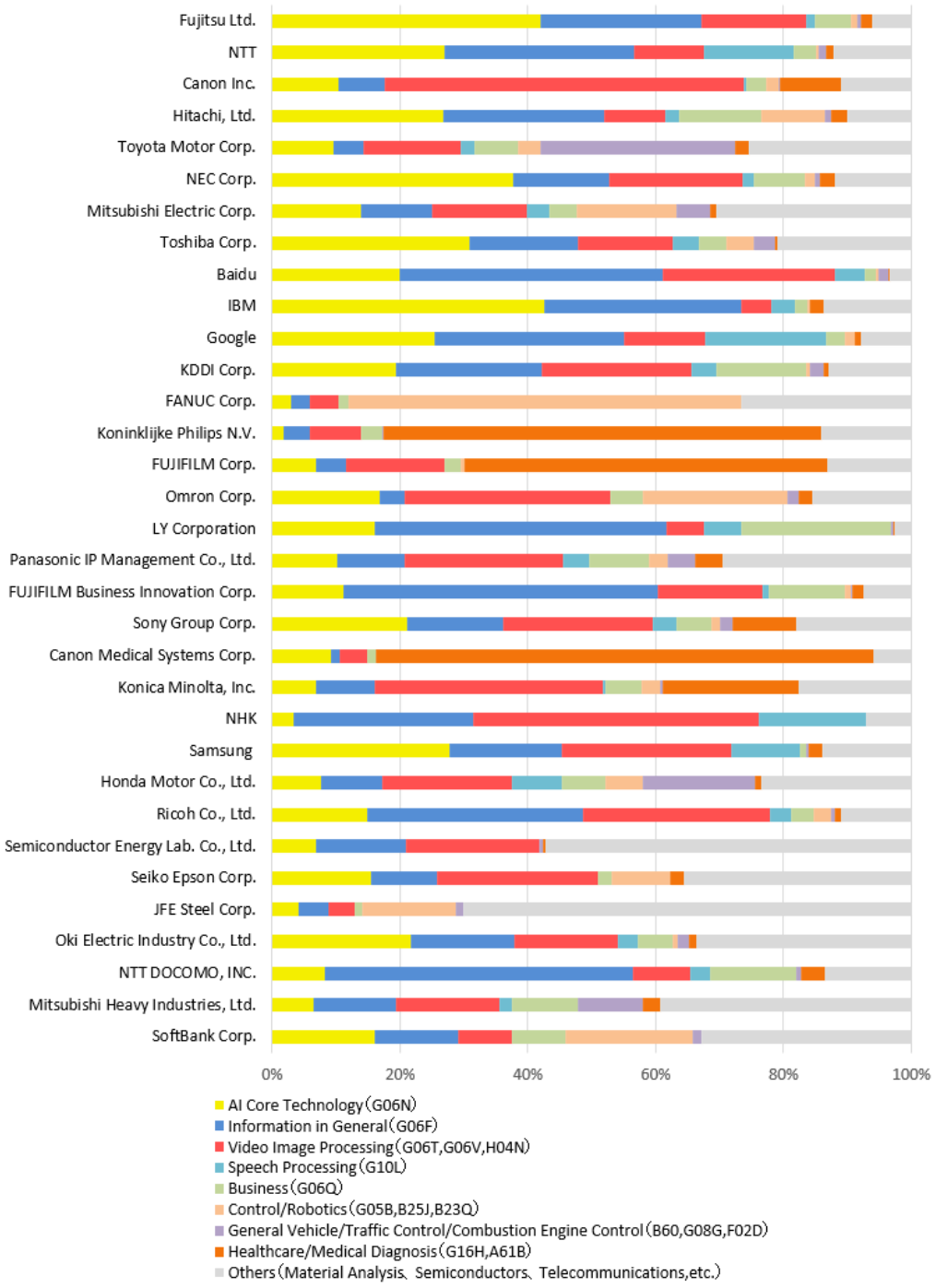


Fig. 13: Percentage of Main Classification Composition of AI-related Inventions by Applicant

【Remarks】

- The “number of applications” in Figures 12 and 13 refers to the number of applications filed between 2014 and 2022 and for which any of the published patent gazette, published patent gazette, patent gazette or republished patent was issued by August 2024.
- In the case of joint applications, the first applicant is counted.
- “Baidu” includes “Beijing Baidu Netcom Science Technology Company Limited”, “Beijing Baidu Netcom Science and Technology Company Limited" and "Peking Baidu Netcom Science and Technology Company Limited”.
- “IBM” stands for “International Business Machines Corporation”.
- “Google” is a generic term for “Google LLC” and “Google Inc.”.
- “Koninklijk Philipps” indicates “Koninklijk Philipps N.V.”.
- “LY Corporation” includes “Yahoo Japan Corporation”.
- “FUJIFILM Business Innovation Corp.” includes “FUJI Xerox Co., Ltd.”, the previous company name.
- “Sony Group Corp.” includes “Sony Corp.”, the previous company name.
- “Samsung” is the collective name for “Samsung Electronics Co., Ltd.” and “Samsung Electronics Company Limited.”

## 3. Application Status in Major Countries

- ○ Figure 14 shows the transition in the number of applications filed with the five IP Offices (Japan, the United States, Europe, China and Korea) or the International Bureau, to which IPC: G06N (AI Core Technology) has been allocated. It can be seen that the number of applications allocated with G06N (AI Core Technology) is on the increase at all of the offices except the United States. China is particularly prominent in the number of applications filed, and is a major destination for applications among the five offices.
- ○ Furthermore, as a trend of applications related to Neural Networks, Figure 15 shows the transition of the number of applications allocated with IPC: G06N3/02-3/10 (Neural Networks). In Japan, the United States, and Europe, the number of applications has been on a downward trend since peaking in 2020, but the number of applications in China, Korea, and the International Bureau is still on an upward trend.
- ○ Figure 16 shows, the ratio of the applications including the representative Deep-Learning-related Keywords listed in Attachment 4 in its application documents (abstract, claim or specification) among applications allocated with G06N3/02-3/10. It can be seen that the growth rate is slowing down in all application destinations, and in particular, the rate has decreased compared to the previous year in all countries other than Japan and the United States in 2021.

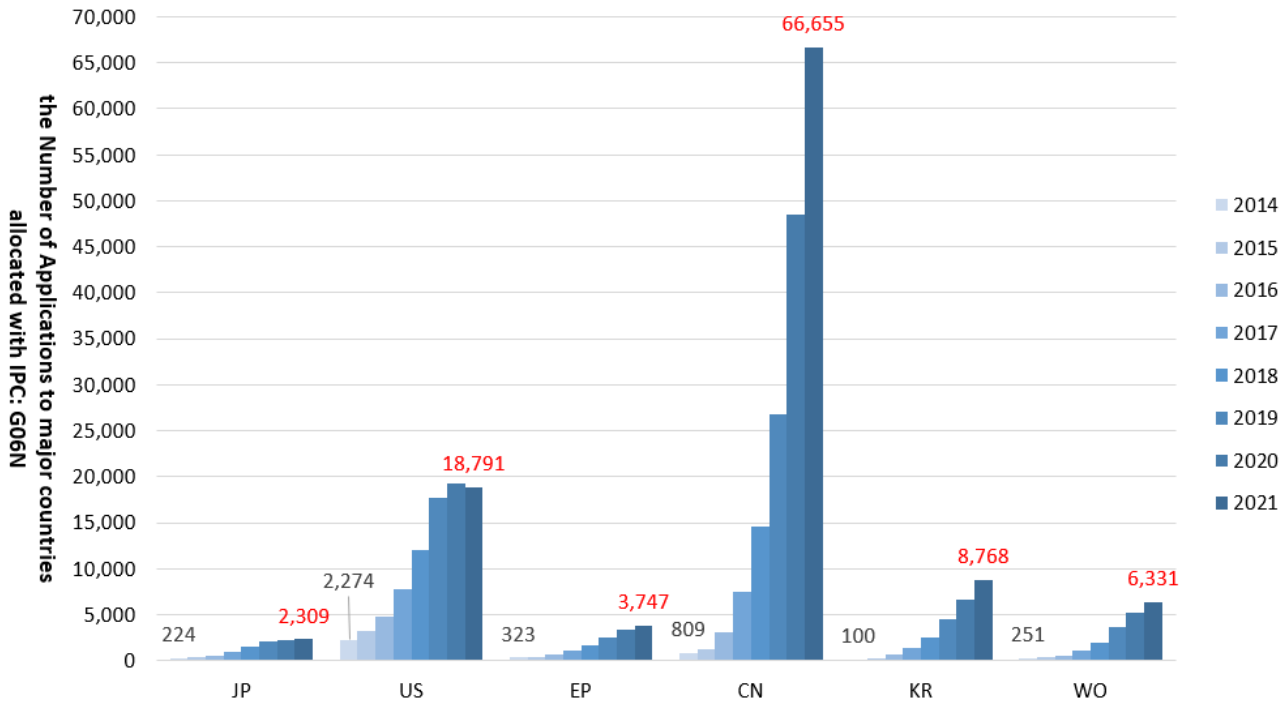


Fig. 14: The Number of Applications allocated with IPC: G06N (with the numbers in 2014 and 2021 noted)

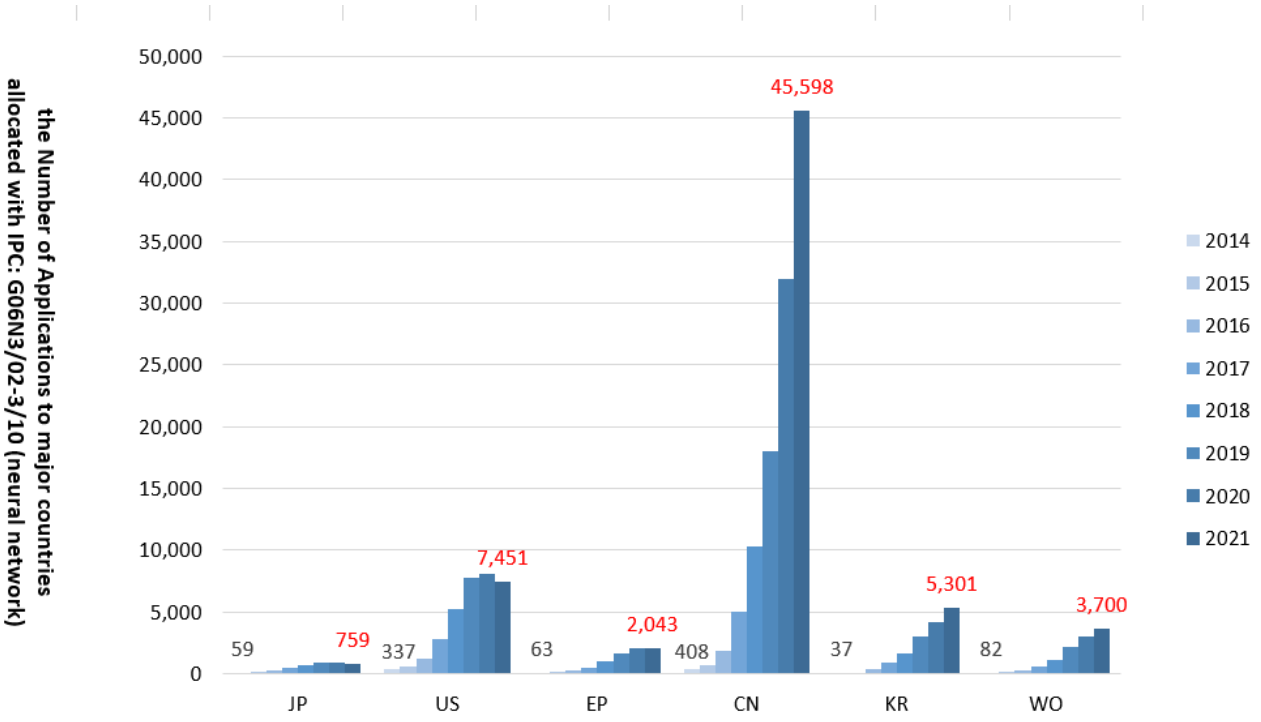


Fig. 15: The Number of Applications allocated with IPC: G06N3/02-3/10 (Neural Networks) (with the numbers in 2014 and 2021 noted)

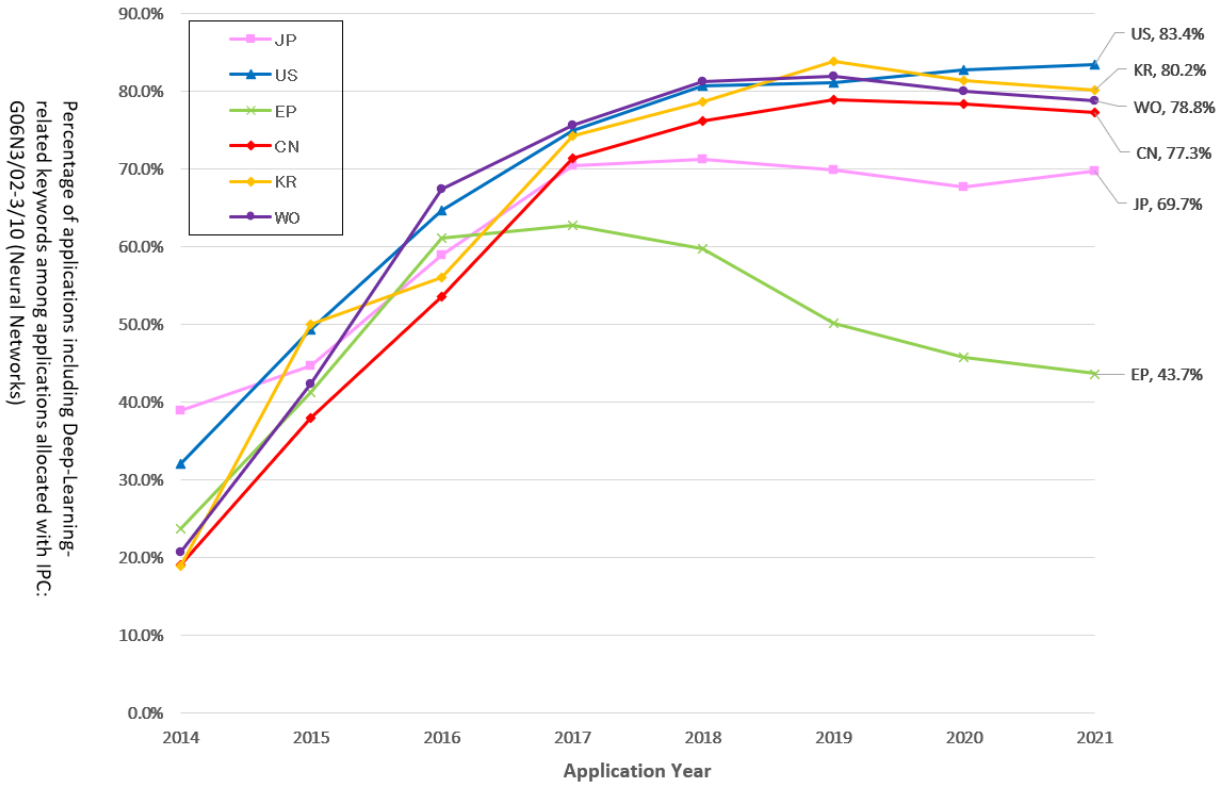


Fig. 16: Percentage of Applications including Deep-Learning-related Keywords in its Application Documents among Applications allocated with IPC: G06N3/02-3/10 (Neural Networks)

【Remarks】

- Figures 14-16 were created by the JPO using data obtained from WIPO Patentscope (searched on September 19, 2024). The number of JP applications does not match the number of domestic applications in Figure 3 because the databases are different.
- The number of applications in recent years may not reflect all the data, depending on the timing of reflecting the application to the database. In addition, the allocated IPC may be changed depending on the examination process, etc.
- The country codes in the figure mean JP: Japan, US: United States, EP: Europe (EPO), CN: China, KR: Korea, WO: PCT international application (regardless of applicant nationality).
- “Application year” follows the definition in WIPO Patentscope.
- For Japan, China and Korea, the number of utility model applications is included.

## 4. Reference Information on AI-related Inventions

① WIPO Technology Trends - Artificial Intelligence (This is a report on the application and research trends in each country regarding AI technology, published by WIPO in January 2019. This report is detailed on trends in AI-related technologies from a global perspective. In selecting classifications and queries that define the scope of AI-related inventions in this survey, we referred to "Methodology" attached to this report.

② Patent Application Technology Trend Research("Artificial Intelligence Technology" in 2014)

③ J-PlatPat Patent Utility Model Classification Inquiry (PMGS) (For more information on FI and IPC, please refer to here.)

④ Patent Examination Case Examples pertinent to AI-related technologies

⑤ Recent Trends in Business-related Invention

【Attachment 1】AI-related FI

| AI-related FI | Description | 【Ref.】Description of Upper Subclass |
|---|---|---|
| A61B1/045,614 | conducting machine learning, data mining or statistical analysis, e.g. extracting lesion parts by using AI; extracting lesion parts by cluster analysis | A61B: DIAGNOSIS; SURGERY; IDENTIFICATION |
| B23Q15/00,301@C | Program creation by knowledge accumulation and inference | B23Q: DETAILS, COMPONENTS, OR ACCESSORIES FOR MACHINE TOOLS, e.g. ARRANGEMENTS FOR COPYING OR CONTROLLING; MACHINE TOOLS IN GENERAL, CHARACTERISED BY THE CONSTRUCTION OF PARTICULAR DETAILS OR COMPONENTS; COMBINATIONS OR ASSOCIATIONS OF METAL-WORKING MACHINES, NOT DIRECTED TO A PARTICULAR RESULT |
| B60T8/174 | characterized by using special control logic, e.g., fuzzy logic | 860T: VEHICLE BRAKE CONTROL SYSTEMS OR PARTS THEREOF; BRAKE CONTROL SYSTEMS OR PARTS THEREOF, IN GENERAL; ARRANGEMENT OF BRAKING ELEMENTS ON VEHICLES IN GENERAL; PORT ABLE DEVICES FOR PREVENTING UNWANTED MOVEMENT OF VEHICLES; VEHICLE MODIFICATIONS TO FACILITATE COOLING OF BRAKES |
| F02D41/14,310@H | Learning Control | F02D: CONTROLLING COMBUSTION ENGINES |
| F24H1/10,302@N | Fuzzy control e.g., neural networks | F24H: FLUID HEATERS, e.g. WATER OR AIR HEATERS, HAVING HEAT-GENERATING MEANS, e.g. HEAT PUMPS, IN GENERAL |
| G05B13/02@L | Learning Control | G05B: CONTROL OR REGULATING SYSTEMS IN GENERAL; FUNCTIONAL ELEMENTS OF SUCH SYSTEMS; MONITORING OR TESTING ARRANGEMENTS FOR SUCH |
| G05B13/02@M | using AI and inference method | |
| G05B13/02@N | Fuzzy control | |
| G05B19/4155@V | inferencing or learning | |

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|---|---|---|
| | | SYSTEMS OR ELEMENTS |
| G06F7/02,630 | adaptation, e.g., self- study | G06F: ELECTRIC DIGITAL DATA PROCESSING |
| G06F11/14,676 | in neural net | |
| G06F11/22,657 | using expert system | |
| G06F11/22,663 | using neural network | |
| G06F16/36 | creation of semantic tools, e.g., ontology or thesauri | |
| G06F16/90,100 | knowledge database, e.g., Q and A System | |
| G06F17/22,682 | automatically learning conversion rule, e.g. learning by examples, e.g., Learning by example | |
| G06F17/27,615 | statistical method | |
| G06F17/28,618 | statistical method, e.g. probability model | |
| G06F17/30,180@A | knowledge database, e.g., Question and Answer System | |
| G06F17/30,180@B | expert system | |
| G06F17/30,180@C | fuzzy searching | |
| G06F30/27 | using machine learning, e.g. artificial intelligence, neural networks, support vector machines [SVM] or training models | |
| G06F40/16 | automatic learning of transformation rules, e.g., from examples | |
| G06F40/216 | statistical methods | |
| G06F40/44 | statistical methods, e.g., probability models | |
| G06F17/50,604@D | using AI, inference | |
| G06K7/14,082 | step using fuzzy logic solution or solution taking natural phenomenon as model such as neural network, genetic algorithm, simulated annealing | G06K：GRAPHICAL DATA READING; PRESENTATION OF DATA; RECORD CARRIERS; HANDLING RECORDCARRIERS |
| G06T1/40 | Neural networks | G06T：IMAGE DATA PROCESSING OR GENERATION, IN GENERAL |
| G06T3/4046 | using neural network | |
| G06T3/40,725 | using neural network | |
| G06T5/60 | using machine learning, e.g. neural networks | |
| G06T7/00,350@B | recognition by learning algorithm | |
| G06T7/00,350@C | using neural network | |
| G06T7/00,350@D | by heriditical algorithm | |
| G06T7/143 | something involving probabilistic approaches, e.g., Markov | |

| | | |
|---|---|---|
| | random field [MRF] modelling | |
| G06T9/00,200 | using neural networks | |
| G06V10/82 | using neural networks | G06V10/00: ARRANGEMENT FOR IMAGE OR VIDEO RECOGNITION OR UNDERSTANDING |
| G08B31/00@A | for example, analyzing the cause of anomaly by the use of reasoning or fuzzy theory, or showing the measures and methods | G08B: SIGNALING OR CALLING SYSTEMS; ORDER TELEGRAPHS; ALARM SYSTEMS |
| G10L15/10,300@J | characterized by calculation of the degree of resemblance or the distance by using the fuzzy theory or chaotic theory | G10L：SPEECH ANALYSIS TECHNIQUES OR SPEECH SYNTHESIS; SPEECH RECOGNITION; SPEECH OR VOICE PROCESSING TECHNIQUES; SPEECH OR AUDIO CODING OR DECODING |
| G10L15/14 | using statistical models, e.g., Hidden Markov Models [HMM] | |
| G10L15/16 | using artificial neural networks | |
| G10L17/10 | Multimodal systems, i.e.<br>based on the integration of multiple recognition engines or fusion of expert systems | |
| G10L17/16 | Hidden Markov models [HMMs] | |
| G10L17/18 | Artificial neural networks; Connectionist approaches | |
| G10L25/30 | using neural networks | |
| G10L25/33 | using fuzzy logic | |
| G10L25/36 | using chaos theory | |
| G10L25/39 | using genetic algorithms | |
| G16B40/00 | ICT specially adapted for biostatistics; ICT specially adapted for bioinformatics-related machine learning or data mining, e.g., knowledge discovery or pattern finding | G16B：BIOINFORMATICS, i.e., INFORMATION AND COMMUNICATION TECHNOLOGY [ICT] SPECIALLY ADAPTED FOR GENETIC OR PROTEIN-RELATED DATA PROCESSING IN COMPUTATIONAL MOLECULAR BIOLOGY |
| G16C20/70 | Machine learning, data mining or chemometrics | G16C：COMPUTATIONAL CHEMISTRY; CHEMOINFORMATICS; COMPUTATIONAL MATERIALS SCIENCE |
| G16H50/20 | for computer-aided diagnosis, e.g., based on medical expert systems | G16H：HEALTHCARE INFORMATICS, i.e., INFORMATION AND COMMUNICATION TECHNOLOGY [ICT] SPECIALLY ADAPTED FOR THE HANDLING OR |

| | | |
|---|---|---|
| | | PROCESSING OF MEDICAL OR HEALTHCARE DAT |
| H01M8/04992 | characterized by the implementation of mathematical or computational algorithms, e.g., feedback control loops, fuzzy logic, neural networks or artificial intelligence | H01M：PROCESSES OR MEANS, e.g., BATTERIES, FOR THE DIRECT CONVERSION OF CHEMICAL ENERGY INTO ELECTRICAL ENERGY |
| H04L41/16 | using machine learning or artificial intelligence | H04L41/00: ARRANGEMENT FOR MAINTENANCE, ADMINISTRATION OR MANAGEMENT OF DATA SWITCHING NETWORKS, E.G. OF PACKET SWITCHING NETWORKS |

【Attachment 2】AI Core Keywords（Hereinafter, ○C or ○N respectively means ○ characters neighborhood search with or without specifying word order.

- 機械学習
- (マシン+machine),2C,(ラーニング+learning)
- (学習アルゴリズム+学習モデル+学習済モデル+学習済みモデル+学習済のモデル+学習済みのモデル)
- (教師あり+教師有+教師付+教師つき),2C,(学習+トレーニング+訓練)
- (教師なし+教師無),2C,(学習+トレーニング+訓練)
- (ニューラル+neural),2C,(ネット+network)
- 多層,2C,パーセプトロン
- ネオコグニトロン
- (コネクショニスト+コネクショニズム)
- バック,2C,プロパゲーション
- 誤差逆伝播
- (過剰適合+過剰学習+過適合+過学習)
- (シグモイド+活性化),2C,関数
- (深層+ディープ+deep),2C,(学習+ラーニング+learning)
- (deep+ディープ+深層),2C,(強化+reinforcement+Q+信頼+ビリーフ+belief)
- オートエンコ
- 自己符号化
- ボルツマンマシン
- 潜在表現
- 次元削減
- (強化+レインフォースメント+リインフォースメント),2C,(学習+ラーニング)
- Q,1C,(学習+ラーニング+learning)
- long,2C,short,2C,term
- 長,2C,短期記憶
- (敵対+generative),2C,(生成+adversarial),2C,(ネット+network)
- 表現学習
- 転移学習
- アンサンブル学習
- ファイン,2C,チューニング
- (アクティブ+能動),2C,(ラーニング+学習)
- セルフ,2C,ラーニング
- 自己学習
- 遺伝,2C,(アルゴリズム+モデル+モデリ)
- 群知能
- スワーム,2C,インテリ

- (サポート+support),2c,(ベク+vector),3c,(マシン+machine)
- ランダム,2C,フォレスト
- (決定+ディシジョン),2C,(木+トリー+ツリー)
- (ベイズ+ベイジアン),2C,(ネット+モデル+モデリ+推定)
- (決定+ディシジョン),2C,(モデル+モデリ)
- (勾配+gradient),2C,(ブースト+ブースティング+boost)
- XG,2C,(ブースト+ブースティング+boost)
- (ADA+エイダ+アダ),2C,(ブースト+ブースティング+boost)
- (RANK+ランク+ランキング),2C,(ブースト+ブースティング+boost)
- ロジスティ,3C,回帰
- 確率,2C,勾配,2C,降下
- (潜在+latent),2C,(意味+セマンティ+概念+semantic)
- (潜在+latent),2C,(ディリクレ+ディレクレ+dirichlet)
- (隠+確率+モデル+モデリ+ネット+過程),2N,マルコフ
- (コンピュー+コンピュテ),7C,クリエイティ
- 記述,2C,(モデル+モデリ)
- 特徴選択
- (ワード+単語),3n,(分散表現+埋め込+埋めこ+埋込+エンベッド+エンベッディング+エンベディング)
- 確率,2C,(アプローチ+テクニック+手法+方法+アルゴリズム)
- ファジ,2C,(論理+理論+ロジック+制御)
- カオス,2C,(モデル+モデリ+理論)
- 混合ガウス
- トピック,2C,(モデル+モデリ+分析+ラベ+抽出)
- (チャット+AI),2C,ボット
- ロボ,2C,アドバイ
- エキスパート,2C,システム
- マルチ,2C,エージェント,2C,システム
- (帰納+論理),2C,プログラミング
- オントロジ
- (概念+セマンティック+意味論),2C,(モデル+モデリ)
- (知識ベース+知識モデル)
- (人工知能+計算知能)
- artificial,2C,intelligence
- (生成 AI+生成系 AI+生成人工知能+生成系人工知能)
- Chat,2c,GPT
- ジェネ,4c,ティブ,3c,(AI+人工知能)
- generative,2c,AI
- 規模,1c,言語モデル

- (large+small),2c,language,2c,model
- AI モデル
- (検索拡張生成+取得拡張生成)
- retrieval,2c,augmented,2c,generation

【Attachment 3】Deep-Learning-related Keywords (Hereinafter, ○C or ○N respectively means ○ characters neighborhood search with or without specifying word order.)

① (深層+ディープ+deep),2C,(学習+ラーニング+learning)
② (deep+ディープ+深層),2C,(ニューラル+neural+信頼+ビリーフ+belief)
③ (オートエンコーダ+オート・エンコーダ+自己符号化)
④ (制限+制約),2c,ボルツマン
⑤ (畳み+畳込+たたみ+convolutional+convolution+コンボリューション+コンボリューショナル),3C,(ニューラル+neural)
⑥ (リカレント+再帰+recurrent),2C,(ニューラル+neural)
⑦ long,2C,short,2C,term
⑧ 長,2C,短期記憶
⑨ (deep+ディープ+深層),2C,(強化+reinforcement+Q),2C,(ネット+学習+ラーニング+network+learning)
⑩ (敵対+generative),2C,(生成+adversarial),2c,(ネット+network)
⑪ トランスフォーマ
+transformer+BERT,not,(ABERT,・・・,JBERT)*BERT,not,(KBERT,・・・,TBERT)*BERT,not,(UBERT,・・・,ZBERT)* transformer+BERT,not,(BERTA,・・・,BERTJ)*BERT,not,(BERTK,・・・,BERTT)*BERT,not,(BERTU,・・・,BERTZ)

・CNN-related Keywords → ⑤
・RNN-or-LSTM-related Keywords → ⑥⑦⑧
・Deep-Reinforcement-Learning-related Keywords → ⑨
・Transformer-related Keywords → ⑪

【Attachment 4】Deep-Learning-related Keywords in different languages

| English | Japanese | Chinese | Korean |
|---|---|---|---|
| "deep learning" | "ディープラーニング" OR "ディープ・ラーニング" OR "深層学習" | "深度学习" | "딥러닝" OR "심층학습" |
| "deep neural net*" | "ディープニューラル" OR "ディープ・ニューラル" OR "深層ニューラル" | "深度神经网络" | "심층신경망" OR "딥신경망" |
| "deep belief net*" | "ディープ信頼ネット" OR "ディープビリーフネット" OR "ディープ・ビリーフ・ネット" | "深度信仰网络" | "딥 빌리프 네트워크" |
| "auto encoder" OR "autoencoder" | "自己符号化" OR "オートエンコーダ" OR "オート・エンコーダ" | "自编码器" | "오토인코더" |
| "restricted boltzmann" | "制限ボルツマン" OR "制約ボルツマン" OR "制限付きボルツマン" OR "制約付きボルツマン" | "受限玻尔兹曼机" | "제한된 볼츠만 머신" |
| "convolutional neural net*" | "畳み込みニューラル" OR "畳込みニューラル" OR "畳みこみニューラル" OR "畳み込ニューラル" OR "畳込ニューラル" OR "たたみ込みニューラル" OR "たたみこみニューラル" OR "コンボリューショナルニューラル" OR "コンボリューショナル・ニューラル" | "卷积神经网络" | "합성곱신경망" OR "콘볼루션신경망" |
| "recurrent neural net*" | "リカレントニューラル" OR "リカレント・ニューラル" OR "リカレント型ニューラル" OR "再帰型ニューラル" | "循环神经网络" | "순환신경망" |
| "long short term memory" | "長短期記憶" OR "長・短期記憶" | "長短期記憶" | "장단기메모리" |
| "deep reinforcement" | "ディープ強化" OR "深層強化" | "深度强化" | "심층강화" OR "딥강화" |
| "generative adversarial net*" | "敵対的生成ネット" | "生成对抗网络" | "생성적 적대 신경망" |
| "transformer" | "トランスフォーマ" | "变换器" | "트랜스포머" |

● Query actually used in WIPO Patentscope (Set one of JP, US, EP, CN, KR, or WO in **XX** of CTR; and set the range of application year in **YY** of AD.)

CTR:**XX** AND AD:([01.01.20**YY** TO 31.12.20**YY**]) AND IC:G06N3/02 AND (EN_ALLTXT:("deep learning" OR "deep neural net*" OR "deep belief net*" OR "autoencoder" OR "auto encoder" OR "restricted boltzmann" OR "convolutional neural net*" OR "recurrent neural net*" OR "long short term memory" OR "deep reinforcement" OR "generative adversarial net*" OR "transformer") OR JA_ALLTXT:("deep learning" OR "ディープラーニング" OR "ディープ・ラーニング" OR "深層学習" OR "deep neural net*" OR "ディープニューラル" OR "ディープ・ニューラル" OR "深層ニューラル" OR "deep belief net*" OR "ディープ信頼ネット" OR "ディープビリーフネット" OR "ディープ・ビリーフ・ネット" OR "autoencoder" OR "auto encoder" OR "自己符号化" OR "オートエンコーダ" OR "オート・エンコーダ" OR "restricted boltzmann" OR "制限ボルツマン" OR "制約ボルツマン" OR "制限付きボルツマン" OR "制約付きボルツマン" OR "convolutional neural net*" OR "畳み込みニューラル" OR "畳込みニューラル" OR "畳みこみニューラル" OR "畳み込ニューラル" OR "畳込ニューラル" OR "たたみ込みニューラル" OR "たたみこみニューラル" OR "コンボリューショナルニューラル" OR "コンボリューショナル・ニューラル" OR "recurrent neural net*" OR "リカレントニューラル" OR "リカレント・ニューラル" OR "リカレント型ニューラル" OR "再帰型ニューラル" OR "long short term memory" OR "長短期記憶" OR "長・短期記憶" OR "deep reinforcement" OR "ディープ強化" OR "深層強化" OR "generative adversarial net*" OR "敵対的生成ネット" OR "transformer" OR "トランスフォーマ") OR ZH_ALLTXT:("deep learning" OR "深度学习" OR "deep neural net*" OR "深度神经网络" OR "deep belief net*" OR "深度信仰网络" OR "autoencoder" OR "auto encoder" OR "自编码器" OR "restricted boltzmann" OR "受限玻尔兹曼机" OR "convolutional neural net*" OR "卷积神经网络" OR "recurrent neural net*" OR "循环神经网络" OR "long short term memory" OR "長短期記憶" OR "deep reinforcement" OR "深度强化" OR "generative adversarial net*" OR "生成对抗网络" OR "transformer" OR "变换器") OR KO_ALLTXT:("deep learning" OR "딥러닝" OR "심층학습" OR "deep neural net*" OR "심층신경망" OR "딥신경망" OR "deep belief net*" OR "딥 빌리프 네트워크" OR "autoencoder" OR "auto encoder" OR "오토인코더" OR "restricted boltzmann" OR "제한된 볼츠만 머신" OR "convolutional neural net*" OR "합성곱신경망" OR "콘볼루션신경망" OR "recurrent neural net*" OR "순환신경망" OR "long short term memory" OR "장단기메모리" OR "deep reinforcement" OR "심층강화" OR "딥강화" OR "generative adversarial net*" OR "생성적 적대 신경망" OR "transformer" OR "트랜스포머"))