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Artificial intelligence companies, goods and services: A trademark-based analysis

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Abstract

This work proposes an experimental methodology to identify and measure artificial intelligence (AI)-related trademarks. It aims to shed light on the extent to which (new) companies and products appearing on the market rely on, exploit or propose AI-related goods and services, and to help identify the companies and organisations that are active in the AI space. The paper finds evidence that AI-related goods and services have expanded in consumer markets in recent years. Companies and other economic agents appear to register AI-related trademarks primarily to protect computer-related products and/or services, especially software, audio-visual devices and for analytical purposes. Important trademark activities related to AI also emerge in the education space, with AI-related keywords being frequently associated with educational services as well as classes, publications, workshops and online material.

Keywords: trademarks, Artificial Intelligence, goods and services, markets

JEL Codes: O31, O34, L25

Synthèse

Ce travail propose une méthodologie expérimentale visant à identifier et à mesurer les dépôts de marques commerciales liées à l'intelligence artificielle (IA). Il vise à montrer dans quelle mesure les (nouvelles) entreprises et produits apparaissant sur le marché s'appuient sur, utilisent ou proposent des biens et services liés à l'IA, et à contribuer à identifier les entreprises et organisations qui sont actives dans le domaine de l'IA. Ce document montre que les biens et services liés à l'IA se sont activement développés dans les marchés de consommation ces dernières années. Les entreprises et autres agents économiques semblent déposer des marques liées à l'IA principalement pour protéger des biens et/ou services en lien avec l'informatique, particulièrement des logiciels, des appareils audiovisuels et d'analyse. D'importants développements de marques liées à l'IA apparaissent également dans le domaine de l'éducation, les mots-clés liés à l'IA étant fréquemment associés à des services éducatifs mais aussi à des cours, des publications, des ateliers et des contenus en ligne.

Kurzfassung

Diese Studie schlägt eine experimentelle Methodik vor, um Handelsmarken mit Bezug zur künstlichen Intelligenz (KI) zu identifizieren und diese zu messen. Ziel ist es zu erkennen, inwieweit (neue) Unternehmen und Produkte, die auf dem Markt erscheinen, Waren und Dienstleistungen im Zusammenhang mit KI benötigen, diese nutzen oder empfehlen. Ferner soll diese Methodik dabei helfen Unternehmen und Organisationen zu identifizieren, die im KI-Bereich tätig sind. Die Studie weist darauf hin, dass Waren und Dienstleistungen im Zusammenhang mit KI in den letzten Jahren auf den Verbrauchermärkten zugenommen haben. Unternehmen und andere Wirtschaftsakteure scheinen KI-bezogene Marken in erster Linie ins Handelsregister einzutragen, um computerbezogene Produkte und/oder Dienstleistungen, insbesondere Software, audiovisuelle Geräte und Möglichkeiten der Analyse zu schützen. Wichtige derartige Aktivitäten im Zusammenhang mit KI sind auch im Bildungsbereich sichtbar, wobei KI-bezogene Schlüsselwörter häufig mit Bildungsdiensten sowie Klassen, Veröffentlichungen, Workshops und Online-Material in Verbindung stehen.

Executive Summary

Artificial intelligence (AI) refers to machines performing human-like cognitive functions, such as learning, understanding, reasoning and interacting. AI promises to change production, improve efficiency, reduce costs and multiply product and service offerings, among others.

Understanding the extent to which AI is permeating economies and societies requires identifying, classifying and measuring AI developments, i.e. both scientific and technological advances, as well as shedding light on AI-related goods and services sold on markets worldwide.

This work proposes a keyword and text mining-based methodology that relies on trademark (TM) data to identify and characterise AI-related goods and services. TMs are distinctive signs (e.g. names, images or combination thereof) used by producers to guide customers' choice, and help identify and purchase products meeting consumers' needs and expectations in terms of, e.g. nature, quality, and price.

This first-time TM-based analysis sheds light on whether and to what extent the goods and services that are trademarked and enter consumer markets embed AI-related technologies and components, or in any way relate to AI. To this end, AI-related trademarks are identified using a novel keyword-based strategy that builds on earlier OECD work (Baruffaldi et al, 2020) and on information contained in reports by the Japan Patent Office (JPO, 2019), the United Kingdom Intellectual Property Office (UK IPO, 2019) and the World Intellectual Property Organization (WIPO, 2019).

The study relies on trademark applications filed either at the European Union Intellectual Property Office (EUIPO), the JPO or the United States Patent and Trademark Office (USPTO), and covers the period 2009-18.

Key results are:

- The availability of AI-related goods and services has seemingly expanded in consumer markets in recent years. The number of AI-related trademarks is found to increase throughout the period 2009-18, with growth rates of about 100% after 2016.
- Of the top 20 applicants registering the highest number of AI-related trademarks at the EU IPO, the JPO or the USPTO in 2009-18, more than half (i.e. 12) are located in the United States, roughly one third in Asia, 2 in the United Kingdom and 1 in Canada.
- Looking at common word marks, i.e. TMs featuring the very same word mark or a very similar one at the three offices considered (EUIPO, the JPO and the USPTO), it emerges that top applicants of AI-related trademarks tend to differentiate trademark portfolios depending on the target market considered.
- An analysis of the Nice classes, i.e. of the goods and/or services classes that trademarks refer to (i.e. seek protection for), shows that, compared to trademarks in general, AI-related TMs tend to have greater scope and to protect a relatively wider range of products.
- Focusing on the words that most frequently co-occur with AI-related keywords in AI-related trademarks, we see that:

  - In class 9, featuring trademarks related to goods such as "Instruments and computers", many words emerge that signal use of AI in goods related to video and audio functions, data analytics, and management and communication, in addition to words such as computer software, hardware and program.
  - In class 35, when it comes to services related to "Business and advertising", business analytics, consultancy and online sales and marketing appear among the most AI-powered type of services.
  - AI-related keywords appear to also often feature in service trademarks protected in class 41, related to "Education and sport", with training and education that top the list.
  - Finally, when it comes to TM service class 42 "R&D and software", we find a wide array of words related to developing and implementing AI itself.
- Network analysis assessing the relationship among the most frequent words that co-occur with AI-related keywords in trademark registrations shows that:
  - Companies and other organisations are mainly registering AI-related trademarks to protect computer-related products and/or services. These relate especially to software, audio-visual devices and analytical purposes.
  - Important trademark activity related to AI occurs in the education space, with AI-related keywords being found often in association to educational services, as well as classes, publications and workshops, and online material.
- In the goods space, supervised and unsupervised learning as well as natural language generation-related developments are used in products related to statistical learning, predictive analytics and graphics processing.
- In the services space, supervised / unsupervised learning and natural language generation technologies often appear to be co-occurring with "statistical learning", "computer chipset" and "image rendering"-related services and technologies.

The results of this experimental approach show the wide range of possibilities that identifying and measuring AI-related trademarks open to help shed light on the development and adoption of AI.

Résumé

L'intelligence artificielle (IA) fait référence aux machines exécutant des fonctions cognitives de type humain, telles que l'apprentissage, la compréhension, le raisonnement et l'interaction. L'IA porte en soi la promesse de changer la production, d'augmenter l'efficacité, de réduire les coûts et de multiplier l'offre de produits et de services.

Comprendre dans quelle mesure l'IA imprègne les économies et les sociétés nécessite d'identifier, de classer et de mesurer les développements de l'IA, c'est-à-dire les avancées scientifiques et technologiques, ainsi que les biens et services liés à l'IA vendus sur les marchés dans le monde entier.

Ce travail propose une méthodologie basée sur l'exploration de mots-clés et de textes contenus dans les données de dépôts de marques pour identifier et caractériser les biens et services liés à l'IA. Les marques sont des signes distinctifs (par exemple des noms, images ou leurs combinaisons) utilisés par les producteurs pour guider les consommateurs dans leurs choix, et qui aident à identifier et à acheter des produits correspondant aux besoins et attentes des consommateurs en termes, par exemple, de nature, de qualité et de prix.

Cette analyse nouvelle basée sur les marques montre si, et dans quelle mesure, les biens et services qui bénéficient d'une marque et entrent sur les marchés de consommation intègrent des technologies et des composants liés à l'IA, ou sont d'une manière ou d'une autre liés à l'IA. Dans ce but, les marques liées à l'IA sont identifiées à l'aide d'une nouvelle stratégie basée sur des mots-clés, construite à partir de travaux antérieurs réalisés par l'OCDE (Baruffaldi et al, 2020) et d'informations contenues dans des rapports de l'Office des Brevets du Japon (JPO, 2019), de l'Office de Propriété Intellectuelle du Royaume-Uni (UK IPO, 2019) et de l'Organisation Mondiale de la Propriété Intellectuelle (OMPI, 2019)

L'étude s'appuie sur les dépôts de marques effectués auprès de l'Office de l'Union Européenne pour la Propriété Intellectuelle (EUIPO), du JPO ou de l'Office des Brevets et des Marques des États-Unis (USPTO), et couvre la période 2009-18.

Les principaux résultats sont :

- La disponibilité des biens et services liés à l'IA s'est apparemment étendue sur les marchés de consommation ces dernières années. Le nombre de marques liées à l'IA a augmenté au cours de la période 2009-18, avec des taux de croissance d'environ 100% après 2016.
- Sur les 20 principaux déposants ayant enregistré le plus grand nombre de marques liées à l'IA auprès de l'EUIPO, du JPO et de l'USPTO en 2009-18, plus de la moitié (soit 12) sont localisés aux États-Unis, environ un tiers en Asie, 2 au Royaume-Uni et 1 au Canada.
- En regardant les marques communes aux trois offices considérés (EUIPO, JPO et USPTO), c'est-à-dire les marques présentant exactement la même description ou une description très similaire , il apparait que les principaux déposants de marques liées à l'IA ont tendance à différencier leur portefeuille de marques selon le marché cible considéré.
- Une analyse de la classification internationale de produits et de services aux fins de l'enregistrement des marques (classification de Nice), c'est-à-dire des classes de biens et/ou de services auxquelles les marques se réfèrent et pour lesquelles elles recherchent une protection, montre que, par rapport à l'ensemble des marques, les

marques liées à l'IA ont tendance à avoir une plus grande portée et à protéger une gamme de produits relativement plus large.

- Si l'on se concentre sur les mots qui coïncident le plus souvent avec les mots-clés liés à l'IA dans les marques liées à l'IA, on peut observer que :
  - Dans la classe 9, qui contient les marques correspondant à des produits comme "Instruments et ordinateurs", de nombreux mots qui apparaissent signalent une utilisation de l'IA dans les produits présentant des fonctions audio et vidéo, ceux liés à l'analyse de données ou à la gestion et à la communication, en plus de mots tels que « logiciel », « matériel » et « programme informatique ».
  - Dans la classe 35, en ce qui concerne les services liés à "Affaires et publicité", l'analyse commerciale, le conseil, la vente et le marketing en ligne figurent parmi les type de services les plus axés sur l'IA.
  - Les mots-clés liés à l'IA semblent également souvent figurer dans les marques de services protégées de la classe 41, liée à "Éducation et sport", avec la formation et l'éducation en tête de liste.
  - Enfin, en ce qui concerne la classe 42 de marques de services "R&D et logiciels", on trouve un large éventail de mots liés au développement et à la mise en œuvre de l'IA elle-même.
- Une analyse de réseaux évaluant la relation entre les mots les plus fréquents qui coexistent avec les mots-clés liés à l'IA dans les dépôts de marques montre que :
  - Les entreprises et autres organisations déposent principalement des marques liées à l'IA afin de protéger des produits et/ou services informatiques. Celles-ci concernent en particulier les logiciels, les dispositifs audiovisuels et les outils à fin d'analyse.
  - Une importante activité de marques liées à l'IA a lieu dans la sphère de l'éducation. Les mots-clés liés à l'IA y sont souvent associés à des services éducatifs, ainsi qu'à des cours, des publications et des ateliers, et enfin du contenu en ligne.
- Dans le domaine des produits, les développements liés à l'apprentissage supervisé et non supervisé et à la production de langage naturel sont utilisés dans des produits en rapport avec l'apprentissage statistique, l'analyse prédictive et le traitement graphique.
- Dans le domaine des services, les technologies d'apprentissage supervisé ou non supervisé et de production de langage naturel semblent souvent coexister avec des services et technologies en lien avec "apprentissage statistique", "jeu de puces informatiques" et "rendu d'image".

Les résultats de cette approche expérimentale montrent l'étendue des possibilités que permettent l'identification et la mesure des dépôts de marques liées à l'IA pour aider à éclairer le développement et l'adoption de l'IA.

Zusammenfassung

Künstliche Intelligenz (KI) bezieht sich auf Maschinen, die menschenähnliche kognitive Funktionen wie Lernen, Verstehen, Denken und Interagieren ausführen. KI verspricht, unter anderem die Produktion zu ändern, die Effizienz zu verbessern, die Kosten zu senken und das Produkt- und Serviceangebot zu vervielfachen.

Um zu verstehen, inwieweit KI Volkswirtschaften und Gesellschaften durchdringt, müssen KI-Entwicklungen, sowohl wissenschaftliche als auch technologische Fortschritte, identifiziert, klassifiziert, gemessen sowie KI-bezogene Waren und Dienstleistungen, die auf Märkten weltweit verkauft werden, beleuchtet werden.

In dieser Arbeit wird eine auf Schlüsselwörtern und Text Mining basierende Methodik vorgeschlagen, die sich auf Daten von Handelsmarken stützt, um KI-bezogene Waren und Dienstleistungen zu identifizieren und zu charakterisieren. Marken sind Unterscheidungsmerkmale (z. B. Namen, Bilder oder Kombinationen davon), die von Herstellern verwendet werden, um die Wahl der Kunden beim Identifizieren und Kaufen der Produkte, die ihren Bedürfnissen und Erwartungen im Bezug auf z. B. Art, Qualität und Preis entsprechen, zu leiten.

Diese erstmalige auf Markendaten basierte Analyse gibt Aufschluss darüber, ob und inwieweit die Waren und Dienstleistungen, die als Handelsmarken eingetragen sind und in Verbrauchermärkte gelangen, KI-bezogene Technologien und Komponenten enthalten oder anderweitig mit KI zu tun haben. Zu diesem Zweck werden KI-bezogene Marken mithilfe einer neuartigen schlüsselwortbasierten Strategie identifiziert, die auf früheren OECD-Studien (Baruffaldi et al., 2020) und auf Informationen aus Berichten des japanischen Patentamts (JPO, 2019), des britischen Amts für geistiges Eigentum (UK IPO, 2019) und der Weltorganisation für geistiges Eigentum (WIPO, 2019) basiert.

Die Studie stützt sich auf Markenanmeldungen, die entweder beim Amt der Europäischen Union für geistiges Eigentum (EUIPO), beim JPO oder beim Patent- und Markenamt der Vereinigten Staaten (USPTO) eingereicht wurden. Sie deckt den Zeitraum 2009-18 ab.

Die wichtigsten Ergebnisse sind:

- Es sieht so aus, dass die Verfügbarkeit von Waren und Dienstleistungen im Zusammenhang mit KI in den letzten Jahren auf den Verbrauchermärkten zugenommen hat. Die Anzahl der KI-bezogenen Marken hat sich im Zeitraum 2009-18 stetig erhöht und eine Wachstumsrate von etwa 100% nach 2016 erreicht.
- Von den 20 größten Antragstellern, die 2009/18 beim EUIPO, beim JPO oder beim USPTO die meisten KI-bezogenen Marken registriert haben, befinden sich über die Hälfte, nämlich 12, in den USA, etwa ein Drittel in Asien, 2 im Vereinigten Königreich und 1 in Kanada.
- Bei der Betrachtung gängiger Wortmarken, d.h. Markendaten mit derselben oder einer sehr ähnlichen Wortmarke in den drei betrachteten Ämtern (EUIPO, JPO und USPTO), zeigt sich, dass Top-Antragsteller von KI-bezogenen Marken dazu neigen, Markenportfolios abhängig vom betrachteten Zielmarkt zu differenzieren.
- Eine Analyse der Nizza-Klassifikation zeigt bei schutzsuchenden Marken der Waren- und/oder Dienstleistungsklassen, dass KI-bezogene Markendaten im Vergleich zu Marken im Allgemeinen tendenziell einen größeren Anwendungsbereich und eine relativ breitere Produktpalette haben.

- Wenn wir uns auf die Wörter konzentrieren, die am häufigsten zusammen mit KI-bezogenen Schlüsselwörtern in KI-bezogenen Marken vorkommen, sehen wir:
  - In Klasse 9 mit Marken von Waren wie „Apparate/Instrumente und Computer“ weisen viele Schlüsselwörter neben den Begriffen Computer Software, Hardware und Programm bei Waren bezogen auf Video- und Audiofunktionen, Datenanalyse sowie Management und Kommunikation auf den Gebrauch von KI hin.
  - Bei Dienstleistungen im Zusammenhang mit „Business und Werbung“ gehören in Klasse 35 Geschäftsanalysen, Beratung sowie Online-Verkauf und Marketing zu den Dienstleistungen mit der höchsten KI-Leistung.
  - KI-bezogene Schlüsselwörter scheinen auch häufig in Dienstleistungsmarken enthalten zu sein, die in Klasse 41 geschützt sind und sich auf „Bildung und Sport“ beziehen. Training und Bildung stehen dabei ganz oben auf der Liste.
  - In Klasse 42 „Forschung und Entwicklung (F&E) und Software“ finden wir eine Vielzahl von Wörtern, die sich auf die Entwicklung und Implementierung von KI selbst beziehen.
- Eine Netzwerkanalyse, die die Beziehung zwischen den häufigsten Wörtern gemeinsam mit KI-bezogenen Schlüsselwörtern in Markenregistrierungen bewertet, zeigt:
  - Unternehmen und andere Organisationen lassen hauptsächlich KI-bezogene Marken eintragen, um computerbezogene Produkte und/oder Dienstleistungen zu schützen. Diese beziehen sich insbesondere auf Software, audiovisuelle Geräte und Möglichkeiten der Analyse.
  - Wichtige Markenaktivitäten im Zusammenhang mit KI finden sich im Bildungsbereich, wobei KI-bezogene Schlüsselwörter häufig in Verbindung mit Bildungsdiensten sowie Klassen, Veröffentlichungen und Workshops sowie Online-Material gefunden werden.
- Bei Waren werden überwachtes und unbeaufsichtigtes Lernen sowie Entwicklungen im Bereich der Textgenerierung (Natural Language Generation) in Produkten verwendet, die sich auf statistisches Lernen, prädiktive Analysen und Grafikverarbeitung beziehen.
- Bei Dienstleistungen scheinen Technologien für überwachtes/unbeaufsichtigtes Lernen und für Textgenerierung (Natural Language Generation) häufig zusammen mit Diensten und Technologien im Bereich „statistischem Lernen“, „Computerchipsatz“ und „Bildwiedergabe“ aufzutreten.

Die Ergebnisse dieses experimentellen Ansatzes zeigen die vielfältigen Möglichkeiten zur Identifizierung und Messung von KI-bezogenen Marken. Dadurch kann die Entwicklung und Einführung von KI gut verfolgt werden.

1. Introduction

Artificial intelligence (AI) is a term used to describe machines performing human-like cognitive functions (e.g., learning, understanding, reasoning, and interacting). It refers to machine-based systems that are capable of influencing the environment by making recommendations, predictions, or decisions for a given set of objectives (OECD, 2019).

AI is reshaping economies and societies. It promises to overhaul production by e.g. improving efficiency, reducing costs, multiplying product and service offerings, and supporting decision-making. AI is also poised to contribute to scientific developments and to address societal challenge like health, education and the environment.

AI technologies are still in their infancy though, and much potential remaining to be fulfilled. To this end, and to get a better understanding of the state of the art and the possible directions that AI may take, it is of paramount importance to accurately identify, classify and measure AI developments, intended as both scientific and technological advances. Also, it is key to shed light on what constitutes AI core technological developments, i.e. developments advancing AI itself, and distinguish it from what can be considered as AI-related applications, i.e. the way AI permeates goods and services sold on the market.

To the best of our knowledge, the present work is the first one to show whether and to what extent new products and services that are trademarked and enter consumer markets embed AI-related technologies and components, or in any way relate to AI. . To this end, it proposes a keyword and text mining-based methodology that relies on trademark (TM) data to identify and characterise AI-related goods and services.

TMs are distinctive signs – that is, names, words, symbols, or images or a combination of these elements – used to identify goods or services produced or provided by a specific person, enterprise, or institution. TMs can guide customers' choice, as they help consumers identify and purchase products or services that meet their needs and expectations in terms of, for example, nature, quality, and price. TM have been found to be linked to innovative and marketing activities and studies show trademarks to represent good proxies for non-technological innovations and innovation in services (see Squicciarini et al., 2012, for more details).

Our trademark-based work builds upon and complements joint work by the OECD and the Max Planck Institute for Innovation and Competition (MPI). The OECD-MPI work identifies and measures scientific and technological developments related to AI through a three-pronged approach exploiting data related to: scientific publications and conference proceedings, to capture AI developments in science; patents, to identify and measure technological developments related to AI; and open source software commits, as AI-related developments get codified in software and algorithms[1]. The OECD-MPI work relies on a number of empirical strategies combined with expert advice in order to identify publications, patents and software that can be considered to be unambiguously related to Artificial Intelligence[2] (See Baruffaldi et al., 2020, for details).

The present analysis further exploits the AI-related keywords information contained in a number of recent reports, namely: the Japan Patent Office (JPO) report on "Recent Trends in AI-related Inventions" (JPO, 2019) [3]; the UK Intellectual Property Office (UK IPO)[4] report "Artificial Intelligence - a worldwide overview of AI patents" (UK IPO 2019); and the World Intellectual Property Organization's (WIPO) report "Technology Trends 2019 – Artificial Intelligence" (WIPO, 2019). In addition to exploiting the patent-based

information contained in the mentioned reports, it builds on the experimental identification of AI-related trademarks contained in Dernis et al. (2019).

The remainder of this report is as follows. Section 2 briefly outlines the data used in the study and methodology devised to identify AI-related trademarks. Section 3 offers a first characterisation of AI-related trademarks, and provides information about the number of AI-related trademarks registered over time, top TM applicants, and the range of good and services protected. Section 4 proposes an analysis aimed at shedding light on the type of specific goods and services embedding AI. Section 5 concludes.

2. Data and methodology

2.1. Data

The trademark data used in the present study encompass trademark applications filed either at the European Union Intellectual Property Office (EUIPO), the Japan Patent Office or the United States Patent and Trademark Office (USPTO) during the period 2009-18.

The EUIPO administers EU trademarks (EUTMs, formerly known as Community trademarks, CTMs) that are valid throughout the European Union and coexist with nationally granted trademarks.

The JPO and the USPTO are conversely national offices that guarantee protection on their country's markets only.

Trademarks applications generally contain a description of the good(s) and/or service(s) they relate to and are classified according to the International Classification of Goods and Services, also known as the Nice Classification[5]. The Nice Classification is subdivided into a total of 45 classes, of which 34 classes related to goods and 11 to services.

2.2. Identifying AI-related trademarks

In Baruffaldi et al. (2019) AI-related keywords were selected on the basis of: the frequency with which words emerge in AI-specialised journals; an analysis of co-occurrence patterns of such words; and on the basis of expert advice, including Intellectual Property Offices' (IPO) experts. In particular, it was agreed that when using keywords to identify AI-related patents or scientific publications, one would need to find at least two keywords for the relevant document to be considered as being AI-related.

In a similar fashion, we perform a text mining exercise on trademark applications to identify AI-related products and services[6]. To this end, we take into consideration the AI-related keywords identified in the OECD-MPI work and the ones contained in the JPO, UK IPO and WIPO's reports.

Thanks to the evidence gathered in the OECD-MPI work, i.e. that some AI-related keywords may also be used in non-AI settings, and aware that relying on one only keyword may lead to importantly overestimating the phenomenon at hand, we perform a sensitivity analysis. This aims to assess the possible size of type 1 and type 2 errors that different operational choices may entail, i.e. the extent to which we risk to either overestimating (and thus include "false positives") or underestimating (by excluding "false negative") the number of trademarks related to AI.

Table 1. AI-related keywords identified by at least two of four studies considered

Keyword	OECD	UKIPO	WIPO	JPO	Keyword	OECD	UKIPO	WIPO	JPO
Adaboost	-		-	-	inductive logic programming			-	-
adversarial network	-	-			Kernel learning	-	-		
ant colony	-	-			K-means	-	-		
artificial intelligence	-	-	-	-	latent dirichlet allocation	-		-	-
association rule	-	-			latent semantic analysis	-		-	-
Autoencoder	-	-		-	latent variable	-	-		
autonomic computing	-	-			learning algorithm			-	-
Backpropagation	-	-		-	learning model			-	-
bayesian network	-		-	-	link prediction	-	-		
bee colony	-	-			logistic regression			-	-
Chatbot	-		-	-	long short term memory	-			-
cognitive computing	-	-			machine intelligence	-	-		
collaborative filtering	-	-			machine learning	-	-	-	-
computational intelligence	-		-	-	MapReduce	-	-		
Connectionism			-	-	memetic algorithm	-	-		
Connectionist			-	-	multi-agent system	-		-	-
data mining	-		-		multi-label classification	-	-		
decision model			-	-	multi-layer perceptron	-		-	-
decision tree	-		-	-	multi-objective evolutionary algorithm	-	-		
deep belief network	-	-		-	multi-objective optimisation	-	-		
deep learning	-	-	-	-	natural gradient	-	-		
differential evolution algorithm	-	-			natural language generation	-		-	
dimensionality reduction	-	-		-	natural language processing	-		-	
ensemble learning	-	-		-	neural network	-	-	-	-
evolutionary algorithm	-	-			neural turing	-	-		
evolutionary computation	-	-			neuromorphic computing	-	-		
expert system			-	-	non negative matrix factorisation	-	-		
factorisation machine	-	-			object recognition	-	-		
feature engineering	-	-			particle swarm optimisation	-	-		
feature extraction	-	-			pattern recognition	-	-		
feature learning	-			-	policy gradient methods	-	-		
feature selection	-	-		-	Q-learning	-	-		-
firefly algorithm	-	-			random forest	-	-	-	-
fuzzy c	-	-			rankboost	-		-	-
fuzzy environment	-	-			recommender system	-	-		
fuzzy logic	-	-	-	-	reinforcement learning	-	-	-	-
fuzzy number	-	-			semi-supervised learning	-	-	-	-
fuzzy set	-	-			sentiment analysis	-	-		
fuzzy system	-	-		-	sparse coding	-	-		
gaussian mixture model	-	-		-	sparse representation	-	-		
gaussian process	-	-			spectral clustering	-	-		
generative adversarial network	-			-	stochastic gradient	-	-	-	-
genetic algorithm	-	-	-	-	supervised learning	-	-	-	-
genetic programming	-	-			support vector machine	-	-	-	-
gradient boosting	-			-	swarm behavior	-	-		
gradient tree boosting	-		-		swarm intelligence	-	-	-	-
hidden Markov model	-		-	-	topic model	-			-
high-dimensional data	-	-			transfer learning	-	-	-	-
high-dimensional feature	-	-			unsupervised learning	-	-	-	-
high-dimensional input	-	-			variational inference	-	-		
high-dimensional model	-	-			vector machine	-	-		
high-dimensional space	-	-			xgboost	-		-	-
high-dimensional system	-	-							

Source: OECD, STI Micro-data Lab: Intellectual Property Database, http://oe.cd/ipstats, February 2020.

Operationally, we pool together the keywords identified by the OECD-MPI, the JPO, the UK IPO and the WIPO work. Doing so we see that while some of the keywords identified by these reports are the same (15 keywords are identified by all the studies), others are not and there is a non-negligible part of these keywords (i.e. 297 in total) that are identified as being AI-related by one only study.

We then proceed to identify the AI-related trademarks selected on the basis of their description containing at least:

a) One AI-related keyword, irrespective of the study identifying the keyword;

b) Two AI-related keywords, irrespective of the study identifying the keywords;

c) Three AI-related keywords, irrespective of the study identifying the keywords;

d) One AI-related keyword identified by at least two of the four studies;

e) Two AI-related keywords identified by at least two of the four studies;

f) One AI-related keyword identified by all the four studies;

g) At least two AI-related keywords identified by the four studies.

Criteria (a) to (c) progressively restrict the AI-related TM subsample identified based on the co-occurrence of a progressively higher number of keywords, irrespective of the study identifying them. Criteria (d) and (e) identify AI-related trademarks based on the relevant keywords having been identified by at least 2 of the studies. Criteria (f) and (g) finally require that keywords are valid sources of identification of AI-related trademarks in so far as they have been recognised as being relevant keywords by all the study considered.

Table 1 lists the keywords identified by at least two of the four studies considered, whereas Table 2 displays the overall number of AI-related trademarks that gets identified using the empirical strategies (a) to (g) on data related to trademarks registered at the EU IPO, the JPO and the USPTO during the period 2009-18.

As can be noticed by looking at Table 1, OECD-MPI work and UK IPO study mostly identify the same sets of keywords related to Artificial Intelligence developments. Greater differences conversely emerge in terms of the AI-related keywords used by the JPO and the WIPO studies.

Table 2. Number of AI-related trademarks, identification strategy (a) to (g), trademarks registered at the EU IPO, the JPO and the USPTO, 2009-18

	EUIPO	JPO	USPTO	ALL
(a) At least one keyword found in any of the 4 studies	31063	25050	45359	101472
(b) At least two keywords found in any of the 4 studies	6385	2942	9254	18581
(c) At least three keywords found in any of the 4 studies	2436	805	3162	6403
(d) At least one keyword common to at least two of four studies	6038	1994	10317	18349
(e) At least two keywords common to at least two of four studies	803	279	2342	3424
(f) At least one keyword common to all four studies	2997	1814	6110	10921
(g) At least two keywords common to all four studies	460	155	1373	1988

Note: Data refer to trademarks registered at the EUIPO, the JPO or the USPTO in 2009-2018. AI-related trademarks refer to trademark applications identified by implementing the identification strategies (a)-(g) over the good and service descriptions. Data for 2018 are incomplete due to truncation.
Source: OECD, STI Micro-data Lab: Intellectual Property Database, http://oe.cd/ipstats, February 2020.

Table 2 clearly highlights that the number of keywords used to identify AI-related trademarks as well as the way in which these keywords are identified matters a lot. On the basis of the analysis performed in the context of the OECD-MPI work and of the textual analysis of a random subsample of trademarks identified following strategies (a) to (g), we conclude the best identification strategy to be strategy (e). This entails tagging as AI-related trademarks those featuring at least two AI-related keywords identified by at least two

studies (out of the four considered) in the trademark description. Overall, 105 keywords emerge as being useful for the purpose (see Table 1).

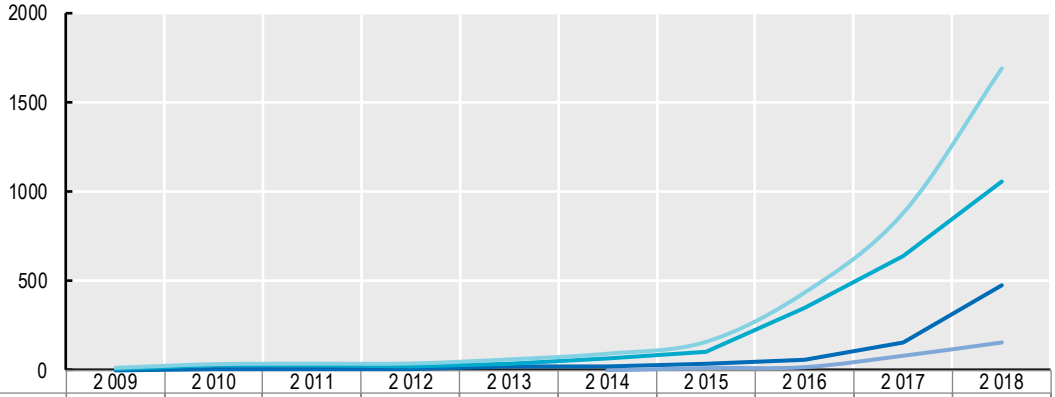
3. Analysis

3.1. Trends in AI-related trademark registrations

Figure 1 shows the number of AI-related trademarks registered at the EUIPO, the JPO or the USPTO during the period 2009-18. Interestingly the three offices display similar tendencies, while exhibiting different levels. As could be expected, the number of AI-related trademarks is found to increase over the period 2009-18, with growth rates of about 100% after 2016. This is indicative of an AI-related goods and service expansion in consumer markets in recent years.

Figure 1. AI-related trademark registrations, 2009-18

Number of AI-related trademarks registered at the EUIPO, the JPO or the USPTO



	2 009	2 010	2 011	2 012	2 013	2 014	2 015	2 016	2 017	2 018
EUIPO	2	4	4	11	23	24	37	63	158	477
JPO			3			2	15	20	83	156
USPTO	10	28	28	25	36	65	106	351	638	1055
ALL	12	32	35	36	59	91	158	434	879	1688

Note: Data refer to trademarks registered at the EUIPO, the JPO or the USPTO, by filing date. AI-related trademarks refer to trademark applications containing at least two AI-related keywords identified by at least two of the four studies considered (the JPO, the OECD, the UK IPO and the WIPO) in the goods and services' description. Data for 2018 are incomplete.
Source: OECD, STI Micro-data Lab: Intellectual Property Database, http://oe.cd/ipstats, February 2020.

3.2. Who owns AI-related trademarks?

It is not only interesting to see the extent to which AI is being embedded in products and services over time, but also to find out who are the leading AI-related trademark owners.

To this end, Table 3 shows the top 20 applicants registering the highest number of AI-related trademarks at the EU IPO, the JPO or the USPTO in 2009-18. More than half (i.e. 12) of them are located in the United States, roughly one third in Asia, 2 applicants in the United Kingdom and 1 applicant in Canada.

Table 3. Top 20 applicants registering AI-related trademarks, 2009-18

Number of AI-related trademarks registered at the EUIPO, the JPO or the USPTO, by applicants

Applicant		EUIPO	JPO	USPTO	ALL	Common in 3 offices	Common mark
NVIDIA Corporation	USA	28	8	51	87	8	NVIDIA DRIVE, NVIDIA HGX, NVIDIA ISAAC, NVIDIA ISAAC SDK, NVIDIA ISAAC SIM, NVIDIA OPTIX, NVIDIA ORIN, NVIDIA TURING
HUAWEI TECHNOLOGIES CO.,LTD.	CHN	46	3	2	51		
Baidu Online Network Technology (Beijing) Co., Ltd.	CHN	9	6	27	42	1	AUTODL
International Business Machines Corporation	USA	5	4	31	40		
DeepMind Technologies Limited	GBR	15	7	13	35	7	ALPHACHESS, ALPHAFOLD, ALPHAGO, ALPHAGO ZERO, ALPHASHOGI, ALPHAZERO, DEEPMIND
LG ELECTRONICS INC.	KOR	17	1	12	30	1	CLOI
Vodafone Group Public Limited Company	GBR	27		2	29		
FiNC Technologies Inc.	JPN		27		27		
NEC CORPORATION	JPN	4	7	14	25		
Preferred Networks, Inc.	JPN		14	11	25		
DeepBD	USA			24	24		
Fractal Industries, Inc.	USA			22	22		
Amazon Technologies, Inc.	USA	3	2	15	20	2	AMAZON SAGEMAKER, AWS
Google LLC	USA	3	2	15	20	2	AIY, GOOGLE
Plenty Unlimited Inc.	USA	8	6	6	20	2	LOVING PRODUCE FROM SEED TO SMILE, PLENTY FARMS
Uptake Technologies Inc	USA	2		17	19		
Nant Holdings IP, LLC	USA			18	18		
IPsoft Incorporated	USA	3	1	13	17	1	AMELIA
Sightline Innovation Inc.	CAN	8		8	16		
Intel Corporation	USA	3		12	15		
ORHub, Inc.	USA			15	15		

Note: Data refer to trademarks registered at the EUIPO, the JPO or the USPTO, by filing date and applicant name, using fractional counts. AI-related trademarks refer to trademark applications containing at least two AI-related keywords used by two of four organisations (the JPO, the OECD, the UK IPO and the WIPO) in the goods and services description. Data for 2018 are incomplete. Applicants' names are harmonised by manual checking. Common word marks are identified by manual checking.
Source: OECD, STI Micro-data Lab: Intellectual Property Database, http://oe.cd/ipstats, February 2020.

To see whether the identified AI-related goods and services of top applicants aim to penetrate one specific market or otherwise target international markets, Table 3 shows how many of these trademarks represent common word marks filed at the EUIPO, the JPO and the USPTO. Common word marks are defined as trademark featuring the very same word mark or a very similar one, with minimal differences that only exist, if so, in terms of font space or letters being uppercase or lowercase. For example, "AlphaGo"[7], which is one of the historical products in the fields of AI (UKIPO, 2019; WIPO, 2019), emerges among the common word marks.

In general, though, relatively few common word marks emerge. This suggests that top applicants of AI-related trademarks may tend to differentiate trademark portfolios

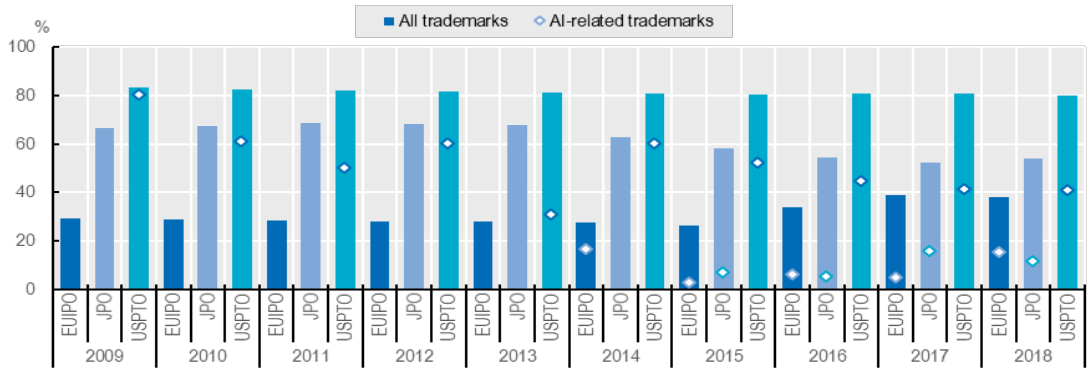
depending on the target market considered, a tendency already observed when looking at the trademark portfolio of world top corporate R&D investors (Dernis et al., 2015).

3.3. Breadth of trademark protection: are AI-related trademarks different?

When registering a trademark, applicants need to indicate which classes, i.e. which products and/ or services types, the trademark refers to. Registration fees are generally proportional to the number of classes protected[8] and in some jurisdictions, applicants need to demonstrate use of the relevant trademark, and may otherwise lose protection[9].

Figure 2. Share of single class filing in all trademarks and in AI-related trademarks, 2009-18

Share of single class filing in all trademarks or AI-related trademarks filed at the EUIPO, the JPO or the USPTO



Note: Data refer to trademarks filed at the EUIPO, the JPO or the USPTO, by filing date. AI-related trademarks refer to trademark applications containing at least two AI-related keywords used by two of four organisations (the JPO, the OECD, the UK IPO and the WIPO) in the goods and services description. Data for 2018 are incomplete.
Source: OECD, STI Micro-data Lab: Intellectual Property Database, http://oe.cd/ipstats, February 2020.

To shed light on whether and to what extent AI trademarks differ from other trademarks in terms of range of products and services they relate to, Figure 2 shows the proportion of single class filings in all trademarks and in AI-related trademarks. Compared to all trademarks, AI-related trademarks exhibit a relatively smaller share of single-class filings, i.e. AI-related trademarks tend to have a great scope and to protect a relatively wider range of products or services than other trademarks.

4. Co-occurrence or correlation words with AI-related common keywords

In addition to showing who owns AI-related trademarks and whether or not such trademarks protect a relatively larger set of goods and services, it is interesting to shed light on the type of products or services to which AI-related technologies are associated. To this end, we perform a simple co-occurrence exercise, whereby we look at the frequency with which any of the keywords used to identify AI-related trademark appears in the same text with other, non AI-related, words indicating different types of product and services.

The result of this exercise is shown in Table 4, which displays the 75 words that most frequently co-occur with AI-related keywords in AI-related trademarks. Because of the challenges inherent in translating text and expressions from Japanese, Table 3 displays the result of the co-occurrence exercise based on EUIPO and the USPTO data only. The data encompasses trademarks registered during the period 2009-18. Words are displayed in the table in so far as they co-occur with AI-keywords at least 50 times, and are displayed according to the Nice class the trademark belongs to.

As can be seen, in class 9, featuring trademarks related to goods such as "Instruments and computers", in addition to words such as computer software, hardware and program, we find many words signalling use of AI in goods related to video and audio functions, data analytics, and management and communication. In class 35, when it comes to services related to "Business and advertising", business analytics, consultancy and online sales and marketing appear among the most AI-powered type of services.

AI-related keywords appear to also often feature in service trademarks protected in class 41, related to "Education and sport", with words referring to training and education that top the list.

Finally, when it comes to TM service class 42 "R&D and software", we find a wide array of words related to developing and implementing AI itself.

While Table 4 already offers a flavour of what AI-related trademarks may look like, it can be interesting to see how the words contained in the text of AI trademarks relate among themselves, to get a better idea of the type of AI-related products and services that are made available on markets worldwide.

To this end, Figure 3 and 4 relies on network analysis to display the relationship that exist among the most frequent words that co-occur with AI-related keywords in trademark registrations. Networks are drawn using the Fruchterman-Reingold layout algorithm[10], with edge wides that indicate the frequency of the words. Figure 3 focuses on goods trademarks (i.e. Nice classes 1-34), while Figure 4 focuses on services trademarks (i.e. Nice classes 35-45).

To avoid image cluttering, only the top 50 words are shown in both Figure 4 and Figure 5.

Table 4. Top 75 frequent words co-occurring with AI-related common keywords, 2009-18

Words are included in the goods and services description filed at the EUIPO or USPTO

09_Instruments & computers		35_Business and advertising		41_Education and sport		42_R&D and software	
Word	Freq	Word	Freq	Word	Freq	Word	Freq
computer_software	1543	business	207	seminar	107	software	1648
software	1431	analysis	140	workshop	97	datum	1360
datum	1203	information	138	online	90	design	1161
computer	927	datum	130	train	86	software_as_a_service	1131
process	908	management	109	conduct	84	development	1129
information	821	business_management	108	conference	84	information	1063
computer_hardware	793	market	98	educational	84	computer_software	1040
record	693	online	98	educational_service	83	computer	886
analysis	689	conduct	93	technology	77	technology	860
monitor	682	technology	88	class	74	analysis	804
image	665	commercial	85	education	73	temporary_use	767
application	616	advertise	85	information	73	process	747
electronic	599	business_consulting_service	78	education_service	55	maintenance	741
management	598	market_research	76	publication	53	management	740
control	583	software	75	nature	52	research	699
downloadable	563	arrange	74	development	51	online	670
computer_program	557	consulting_service	72	arrange	51	website	670
enable	528	research	71	course	50	application	646
video	524	consultancy	70			user	617
user	520	computer	70			create	591
analyse	519	exhibition	70			model	590
communication	513	data_processing_service	67			computer_hardware	581
hardware	505	consumer	66			analyse	570
manage	503	business_administration	65			update	568
network	501	information_retrieval	63			test	555
digital	492	sale	63			business	535
access	491	information_technology	60			online_nondownloadable_software	535
transmission	486	product	60			monitor	531
model	472	understand	59			program	525
base	463	development	58			cloud_computing	524
audio	462	organisation	58			report	520
create	438	computer_database	57			base	517
integrate	428	human	56			computer_programming	515
nature	411	internet	55			manage	513
internet	408	trade	55			database	509
program	407	marketing_service	53			internet	509
text	405	compilation	52			enable	499
database	403	ir	52			platform_as_a_service	495
platform	390	global_computer_network	50			platform	493
mobile	388	track	50			information_technology	493
interface	387					access	488
downloadable_software	384					host	485
sound	383					application_service_provider	483
computer_application_software	381					consultancy	481
security	381					network	479
mobile_phone	379					consulting_service	463
business	377					integration	446
storage	377					technical	445
display	376					computer_service	438
operation	373					share	431
sensor	369					implementation	430
store	367					nondownloadable_software	422
share	356					computer_program	406
track	351					nature	402
interactive	346					image	401
graphic	343					analytics	396
report	339					digital	395
operate	339					control	385
voice	333					develop	383
computer_network	331					operation	382
time	326					software_development	382
connect	324					electronic	374
edit	324					algorithm	373
collect	321					compute	372
online	320					maintain	369
content	319					computer_software_design	364
automate	318					application_programming_interface	363
unit	314					computer_system	362
camera	311					computer_network	357
optical	310					hardware	356
search	309					automation	355
technology	309					content	354
visual	308					rental	353
human	307					video	349
vehicle	307					nondownloadable_computer_software	347

Note: Data refer to trademarks filed at the EUIPO or the USPTO, by filing date. AI-related trademarks refer to trademark applications containing at least two AI-related keywords used by two of four organisations (the JPO, the OECD, the UK IPO and the WIPO) in the goods and services description. Data for 2018 are incomplete. Class titles correspond to short labels based on the Nice Classification. For an exact description of the classes, see https://www.wipo.int/classifications/nice/nclpub/en/fr

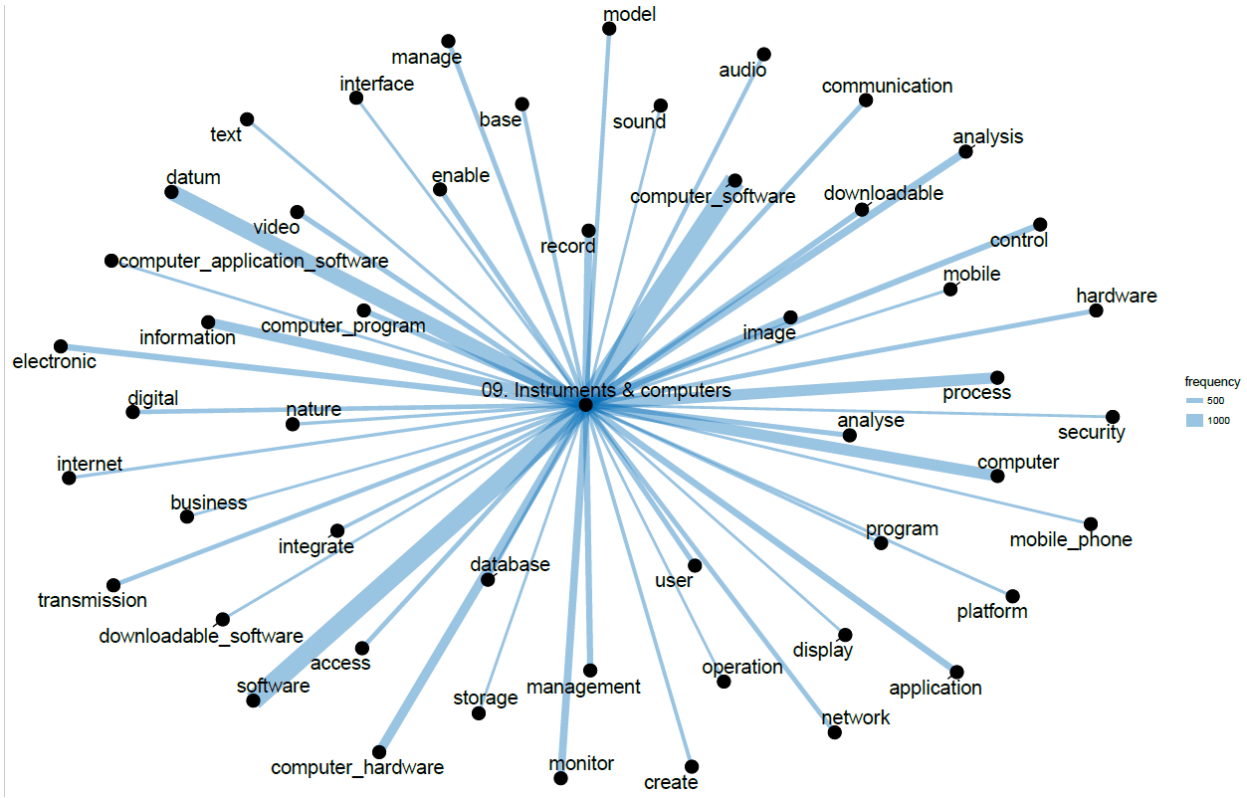
Source: OECD, STI Micro-data Lab: Intellectual Property Database, http://oe.cd/ipstats, February 2020.

Whether one looks at Table 4 or at Figures 4 and 5, the same picture emerges: companies and other organisations are mainly registering AI-related trademarks to protect computer related products and/or services, especially software, audio-visual devices and for analytical purposes.

It is also interesting to notice that there seem to be a lot of trademark activity related to AI in the education space, with AI-related keywords being found often associated to educational services, as well as classes, publications and workshops, and online material.

Figure 3. Network of words co-occurring with AI-related common keywords in good classes

Words included in the goods and services description of TM registered at the EUIPO or USPTO in 2009-18

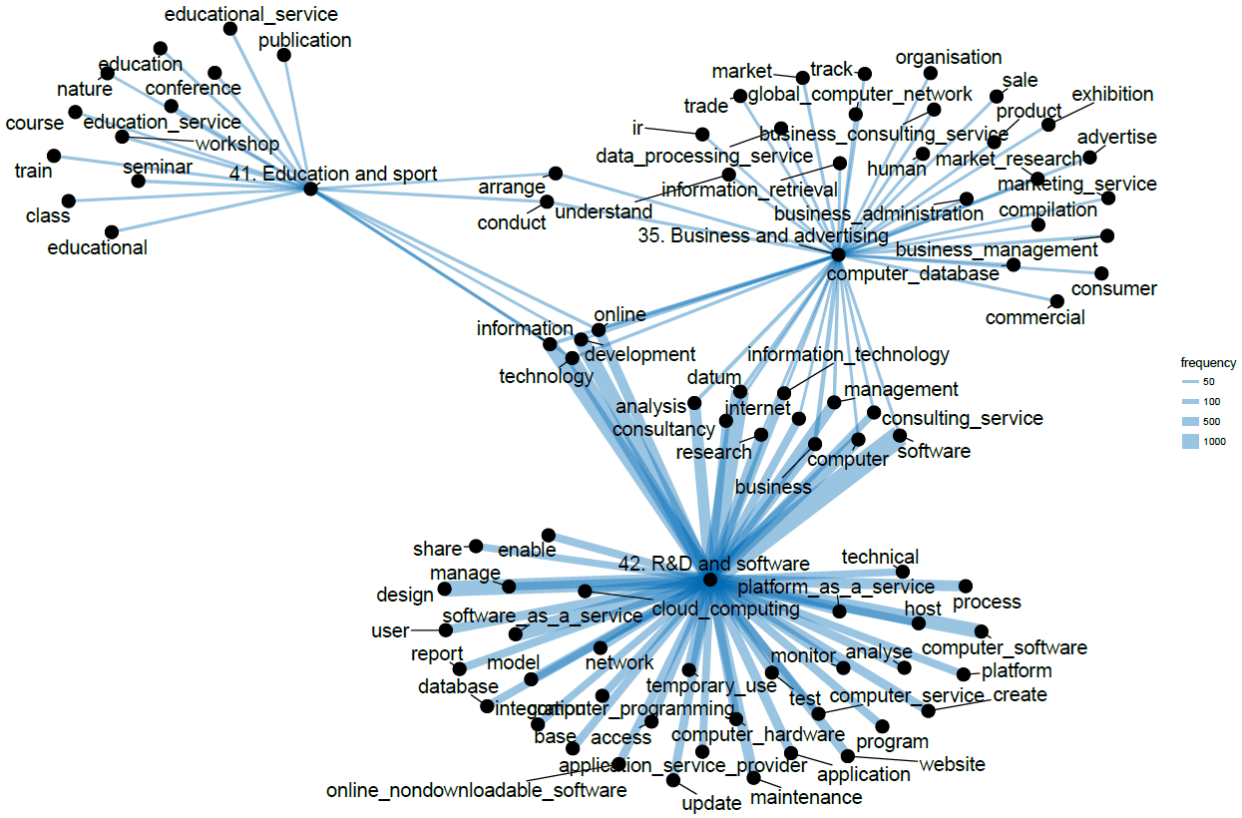


Note: Data refer to trademarks filed at the EUIPO or the USPTO, by filing date. AI-related trademarks refer to trademark applications containing at least two AI-related keywords used by two of four organisations (the JPO, the OECD, the UK IPO and the WIPO) in the goods and services description. Data for 2018 are incomplete. Class titles correspond to short labels based on the Nice Classification. For an exact description of the classes, see https://www.wipo.int/classifications/nice/nclpub/en/fr

Source: OECD, STI Micro-data Lab: Intellectual Property Database, http://oe.cd/ipstats, February 2020.

Figure 4. Network of words co-occurring with AI-related common keywords in service classes

Words are included in the goods and services description filed at the EUIPO or USPTO in 2009-18



Note: Data refer to trademarks filed at the EUIPO or the USPTO, by filing date. AI-related trademarks refer to trademark applications containing at least two AI-related keywords used by two of four organisations (the JPO, the OECD, the UK IPO and the WIPO) in the goods and services description. Data for 2018 are incomplete. Class titles correspond to short labels based on the Nice Classification. For an exact description of the classes, see https://www.wipo.int/classifications/nice/nclpub/en/fr

Source: OECD, STI Micro-data Lab: Intellectual Property Database, http://oe.cd/ipstats, February 2020.

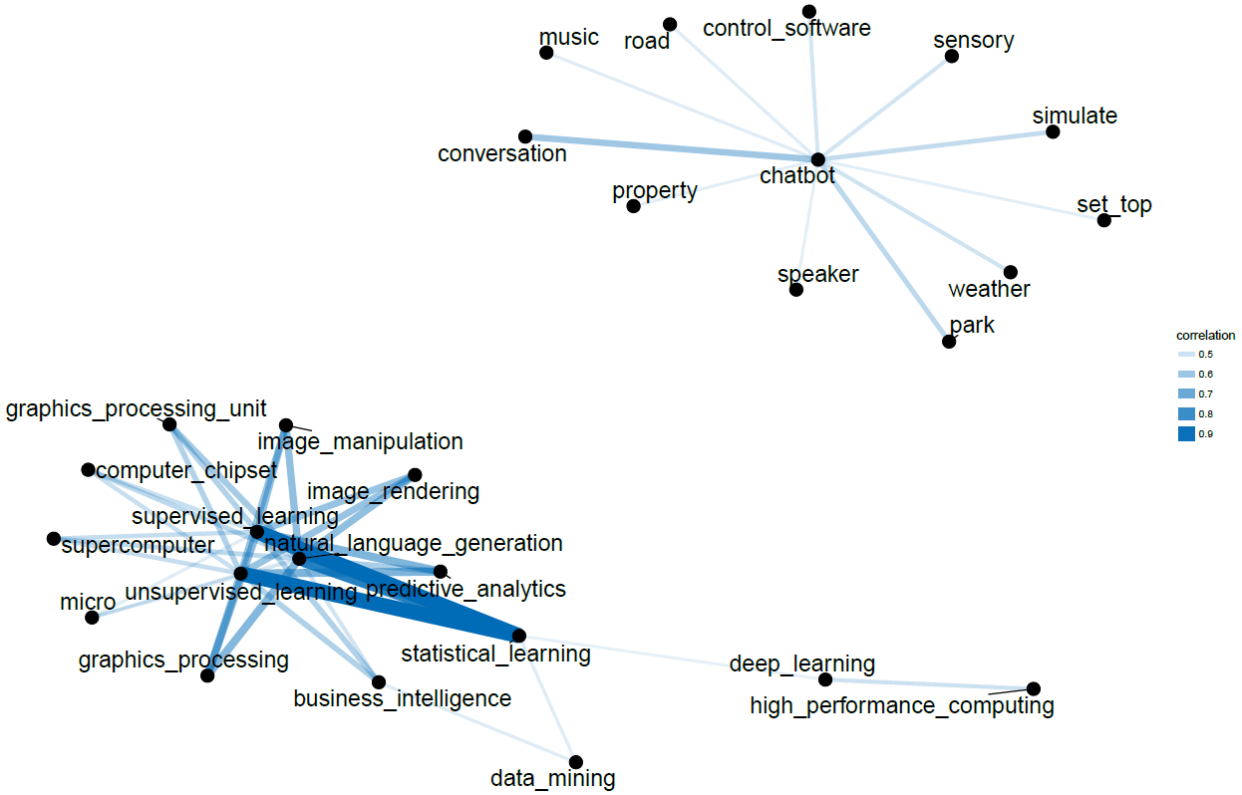
Figure 5 and 6 shows the network of words that appear most often together with AI-related keywords in trademark descriptions, in both good classes and in service classes. Similarly to Figure 3 and 4, we here rely on EUIPO and USPTO data related to trademarks registered in 2009-2018. Correlations are calculated in terms of the phi coefficient[11] emerging between the AI-related keywords used by two of four organisations considered, i.e. (the JPO, the OECD, the UK IPO and the WIPO) and other words. Words observed more than 100 times in good or service classes are considered for the purpose and to enhance the visualisation, we only display combinations of words featuring correlation values of 0.45 in Figure 5 and 0.55 in Figure 6. Networks are again drawn using the Fruchterman-Reingold layout algorithm and edge wides indicate the correlation between the words.

In the products space, "supervised / unsupervised learning" and "natural language generation" appear to occur jointly with "statistical learning", "predictive analytics" and "graphics processing" technologies. This means that supervised and unsupervised learning as well as natural language generation related developments are used in products related to statistical learning, predictive analytics and graphics processing.

In the services space, "supervised / unsupervised learning" technology and "natural language generation" technologies often appear to be co-occurring with "statistical learning", "computer chipset" and "image rendering"-related services and technologies.

Figure 5. Words network correlated with AI-related keywords in good classes

Words are included in the goods and services description filed at the EUIPO or USPTO in 2009-18

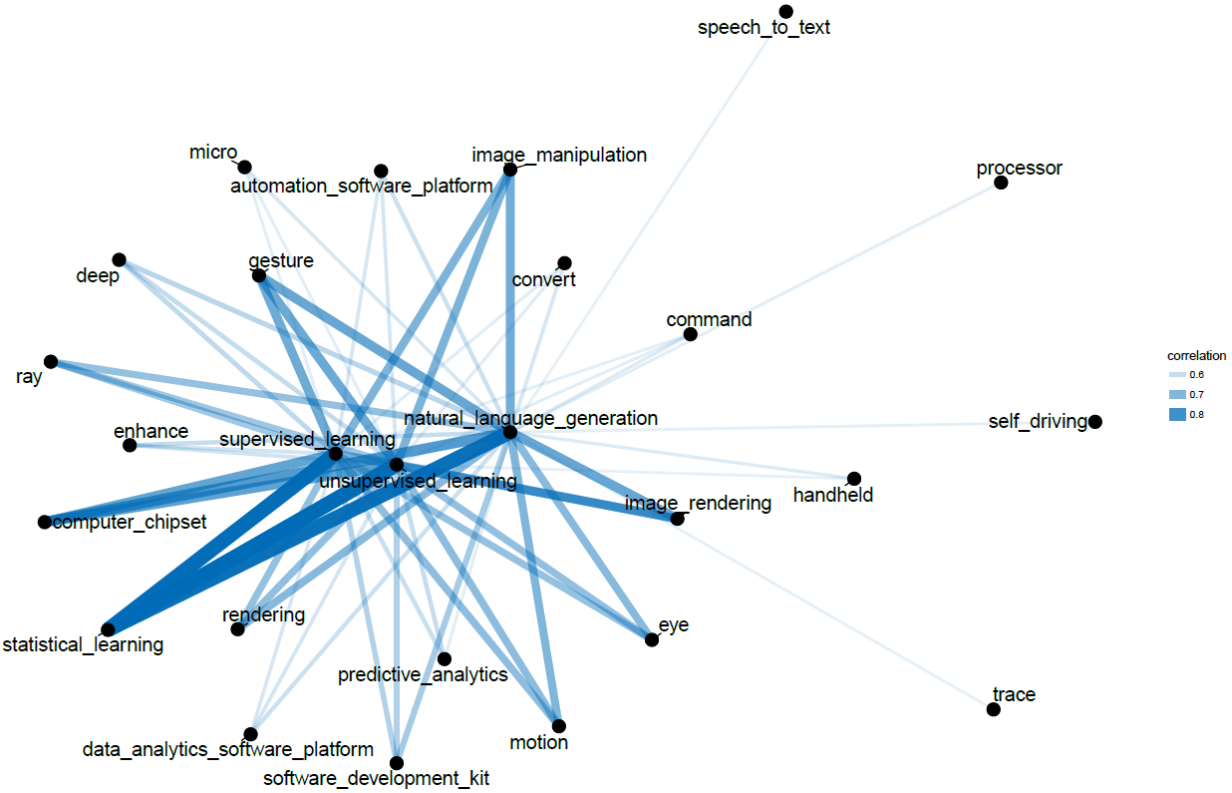


Note: Data refer to trademarks filed at the EUIPO or the USPTO, by filing date. AI-related trademarks refer to trademark applications containing at least two AI-related keywords used by two of four organisations (the JPO, the OECD, the UK IPO and the WIPO) in the goods and services description. Data for 2018 are incomplete. Class titles correspond to short labels based on the Nice Classification. For an exact description of the classes, see https://www.wipo.int/classifications/nice/nclpub/en/fr

Source: OECD, STI Micro-data Lab: Intellectual Property Database, http://oe.cd/ipstats, February 2020.

Figure 6. Words network correlated with AI-related keywords in service classes

Words are included in the goods and services description filed at the EUIPO or USPTO in 2009-18



Note: Data refer to trademarks filed at the EUIPO or the USPTO, by filing date. AI-related trademarks refer to trademark applications containing at least two AI-related keywords used by two of four organisations (the JPO, the OECD, the UK IPO and the WIPO) in the goods and services description. Data for 2018 are incomplete. Class titles correspond to short labels based on the Nice Classification. For an exact description of the classes, see https://www.wipo.int/classifications/nice/nclpub/en/fr

Source: OECD, STI Micro-data Lab: Intellectual Property Database, http://oe.cd/ipstats, February 2020.

5. Conclusions

This work proposes an experimental methodology for the identification and measurement of AI-related trademarks, to shed light on the way in which AI is penetrating products and services markets, and to identify the companies and organisations that are active in the AI space.

The method proposed to identify AI-related trademarks is simple. It relies on using the AI-related keywords identified in work by at least two of the four expert organisation considered, namely the JPO, the OECD, the UK IPO and the WIPO, to search the description of goods and services trademarks. The approach has the advantage of being simple in nature and easy to implement, and has proved to deliver robust results when randomly checking the full text of trademarks. Its accuracy has further been assessed against possible alternatives (e.g. different number of keywords, different keywords, etc.)

This report also proposes some first statistics related to the trademarks thus identified, and offers some first insights emerging from the text mining of AI-related trademarks. Statistics show that AI-related trademarks have been booming after 2016 and are being registered in a wide range of goods or services.

As could have been expected, the results of text mining exercise further suggest that computer related products and services appear to be strongly associated with AI-related technologies. They also show that, e.g. “supervised / unsupervised learning” and “natural language generation” technologies are often used, developed or implemented in relation to “statistical learning”.

Identifying and measuring AI-related trademarks opens a wide range of possibilities to help shed light on the development and adoption of AI-related technologies. Ongoing work has already started to identify and characterise AI-trademarking companies, their key characteristics and patenting activities, as a first step towards understanding the characteristics, behaviours and possible impact of economic actors active in the AI space.

Endnotes

[1] While potentially relevant, the study cannot rely on data related proprietary software as such data are not available.

[2] The patent-based approach initially developed by the OECD and the MPI was refined through work carried out under the aegis of the OECD-led Intellectual Property (IP) Statistics Task Force, and benefitting in particular from the advice of experts and patent examiners from: IP Australia, the Canadian Intellectual Property Office (CIPO), the European Patent Office (EPO), the Israel Patent Office (ILPO), the Italian Patent and Trademark Office (UIBM), the National Institute for Industrial Property of Chile (INAPI), the United Kingdom Intellectual Property Office (UK IPO), and the United States Patent and Trademark Office (USPTO).

[3] See https://www.jpo.go.jp/e/system/patent/gaiyo/ai/document/ai_shutsugan_chosa/report.pdf

[4] https://www.gov.uk/government/publications/artificial-intelligence-a-worldwide-overview-of-ai-patents .

[5] For more details, see: www.wipo.int/classifications/nice/en .

[6] In the case of trademarks, no NICE class-based approach could be devised or implemented, given that NICE classes are too general for the purpose.

[7] AlphaGo is a computer program playing the board game Go that was developed by DeepMind Technologies, which was later acquired by Google.

[8] Prior to 23 March 2016, the EUIPO offered the possibility to apply for up to three trademark classes with a unique binding fee, but from 23 March 2016 onwards the system became a one-class-per-fee, as in most other jurisdictions. For more info see https://euipo.europa.eu/ohimportal/en/eu-trade-mark-regulation-fees and Daiko et al. (2017) for a discussion about trademark class protection.

[9] On March 21, 2017, the USPTO issued a new rule concerning Section 8 and Section 71 trademark affidavits, whereby the USPTO will issue post-registration Office actions, requiring registrants to submit evidence demonstrating a mark's use in commerce for each good and/or service identified in the registration (see https://www.uspto.gov/trademarks-maintaining-trademark-registration/post-registration-audit-program). These types of provisions are generally aimed at avoiding trademark cluttering, i.e. the existence of registered trademarks that are partly or wholly unused by their owners. TM cluttering may make it harder for market newcomers to suitably protect their (novel) goods and services. See, e.g. UK IPO (2015).

[10]. The Fruchterman-Reingold layout algorithm belongs to a class of algorithms used to draw graphs in an aesthetically pleasing way known as "force-directed graph drawing algorithms". They position the nodes of a graph in two-dimensional or three-dimensional space, so that all the edges are of more or less equal length and there are as few crossing edges as possible. They assign forces among the set of edges and the set of nodes, based on their relative positions, and use these forces either to simulate the motion of the edges and nodes or to minimize their energy. One of the advantages of using force-directed algorithms is that, since they are physical simulations, they usually do not require special knowledge about graph theory. See Fruchterman and Reingold (1991) for details about the characteristics of the network structure.

[11] The phi coefficient is also known as the mean square contingency coefficient. It is a measure of association for two binary variables and is similar to the Pearson correlation coefficient in its interpretation (a Pearson correlation coefficient estimated for two binary variables gives the phi coefficient). Two binary variables are considered positively associated if most of the data falls along the diagonal cells. In contrast, two binary variables are considered negatively associated if most of the data falls off the diagonal.

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