Marks&Clerk

AI report 2022

Patents at the EPO – a long-term trend analysis

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1 Introduction

As investment into research and development in AI has grown, it is unsurprising that investment in intellectual property protecting this technology has also risen. Following a significant growth in AI applications at the EPO in recent years, Marks & Clerk published the report “AI patents at the EPO – a long-term trend analysis” in 2020. We have now produced an updated report, looking at whether these trends have continued over the last two years.

This new report shows the artificial intelligence (AI) market is entering a new phase of growth as the recent gold rush starts to show signs of slowing. Whilst the number of AI filings per year at the European Patent Office (EPO) continues to rise at a convincing rate, with a 24% rate of growth in 2019, the pace of growth has slowed, suggesting that the AI industry is beginning to mature. However, the continued growth along with a wave of exciting developments mean that the market is far from another AI winter. Further supporting this is the fact that new countries are emerging as frontrunners when it comes to patent applications, with the Republic of Korea coming out top per capita.

Our detailed analysis has also shown that patents have become an increasingly key part in defending business strategy, with the number of EPO oppositions filed against patents relating to AI technologies increasing in 2020 (25) and then again in 2021 (27). In fact, there has been a decrease in the overall opposition rate across all technology areas, suggesting that AI patents in particular are increasingly becoming integral to businesses’ commercial strategies.

Looking more closely at the number of applicants on a country-by-country basis, Chinese applicants at the EPO overtook Japanese applicants in 2020, making it the third largest filer of AI applications, behind the United States and Europe. However, as mentioned, between 2015 and 2020, per capita, applicants from the Republic of Korea have overtaken that of Japan, the United States and Europe to become the largest filers on a per capita basis.

When looking at individual sectors, the “manufacturing and industry” sector has risen by three places into the top 10 sectors by number of patent filings, which is indicative of AI being applied more in the physical economy.

At a technology level, computer vision technology has seen an accelerated increase in patent applications in the last five years, up from 1,590 to 1,939 publications in 2021. Conversely, speech processing applications have been in decline, falling from 45% of all publications in 2000 to only 7% of publications in 2021. As such, it appears that after a period of heavy investment, speech processing as a technology has reached a maturity commensurate with the current market opportunities, while the heavy increase in computer vision likely indicates a still significant runway of potential applications indicating a shift in focus away from detecting speech and towards understanding the underlying meaning of language.

This report summarises some key takeaways from the study, including variations in grant rates based on technology area and country of origin, as well as looking at trends in publication numbers.

How has AI developed since the last report?

Our previous report on AI filing trends was published in 2020. At that time, AI technologies had reached the point of outperforming humans at complex classification and regression tasks, and even beating humans at some of the world's most complicated games. The period since our last report has seen a bigger push to demonstrate AI's ability to help solve real-world problems in science and industry, including some that have up to now eluded good solutions.

At the end of 2019, where the data for our last report ended, it could be argued that AI was less adept in natural language understanding and reasoning, and indeed these are the areas that have seen some of the largest focus of research over the last few years. The steady release of increasingly large natural language models from GPT-3 (175 billion parameters) to PaLM (540 billion parameters) is a clear example of research priorities.

Large language models have demonstrated some astonishing capabilities: as well as the ability to create convincing completions of natural language text (albeit reflecting human biases), they can automatically generate code to solve previously unseen problems[1] and, more surprisingly, can perform tasks that they have not explicitly been trained to perform, such as translating from one language to another or performing simple arithmetic. The same underlying mechanisms which have been used in these very large natural language models are also seeing application in computer vision tasks, in the form of spatial attention transformers. Multimodal models are also beginning to appear, incorporating both language reasoning and image processing[2]. These can generate, reason about, and modify images, even though these do not appear in the training data. One example of this is the DALL-E system[3], which is able to generate images from short text-based descriptions, such as "a baby daikon radish in a tutu walking a dog". There are clear potential impacts here for society, both positive and negative.

In other spheres, AI is helping to tackle some fundamental problems in science and technology. For example, the ability of AlphaFold[4] to accurately predict protein structures is a huge contribution to advancing the understanding of biology, and in the field of energy AI is also helping advances in battery technology[5] and nuclear fusion[6]. AI is being successfully applied to develop novel chemistry, for example discovering new materials or reactions, such as hydrolases to break down plastic waste[7]. The period since our last report has felt like a tipping point, where some of the early promise of AI has begun to be felt across more sectors and industries and as we discuss below, this is reflected in the filing trends that we see in our data.

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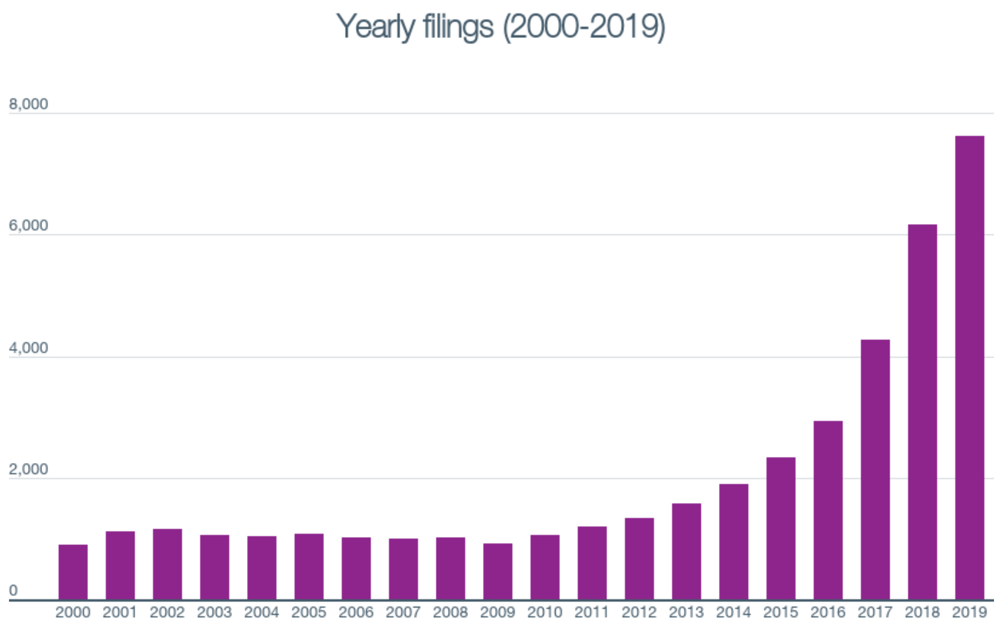
1. https://www.deepmind.com/blog/competitive-programming-with-alphacode
2. https://www.deepmind.com/blog/tackling-multiple-tasks-with-a-single-visual-language-mode
3. https://openai.com/dall-e-2/
4. https://www.nature.com/articles/d41586-021-02025-4
5. https://www.nature.com/articles/s41524-022-00713-x
6. https://www.nature.com/articles/s41586-021-04301-9
7. https://www.nature.com/articles/s41586-022-04599-z

1.1 Filing trends

The strong growth in AI filings has continued, with the yearly number of AI filings increasing by 24% between 2018 and 2019. Again, this significantly outstrips the overall patent filing growth of 4% at the EPO over the same period[8]. Having said this, the rate of growth in AI filings appears to be slowing, with previous years seeing materially higher growth rates.

As overall patent filings at the EPO in 2020 fell by 0.7% (likely due to the COVID-19 pandemic), it will be interesting to see how AI filings hold up over this period[9]. Note that, due to the 18 month delay in applications publishing, we do not yet have the data for the whole of 2020 available for analysis.

Figure 1.1.1



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8. Source: EPO Patent Index 2020
9. Source: EPO Patent Index 2020

1.2 Pending applications

Over the last few years, the EPO has attempted to increase the speed of examination and therefore reduce the average age of applications at closure[10]. Whilst this has seen recent improvements, 2021 saw the first drop in the number of AI applications closed since 2012. Whilst the average age of closure continues to decrease, the rate of decrease slowed over this year (4.0 years, down 4.8% from 4.2 years in 2020).

This slowdown was predicted in our last AI Report and likely reflects the EPO approaching an equilibrium after closing a number of older outliers.

Figure 1.2.1

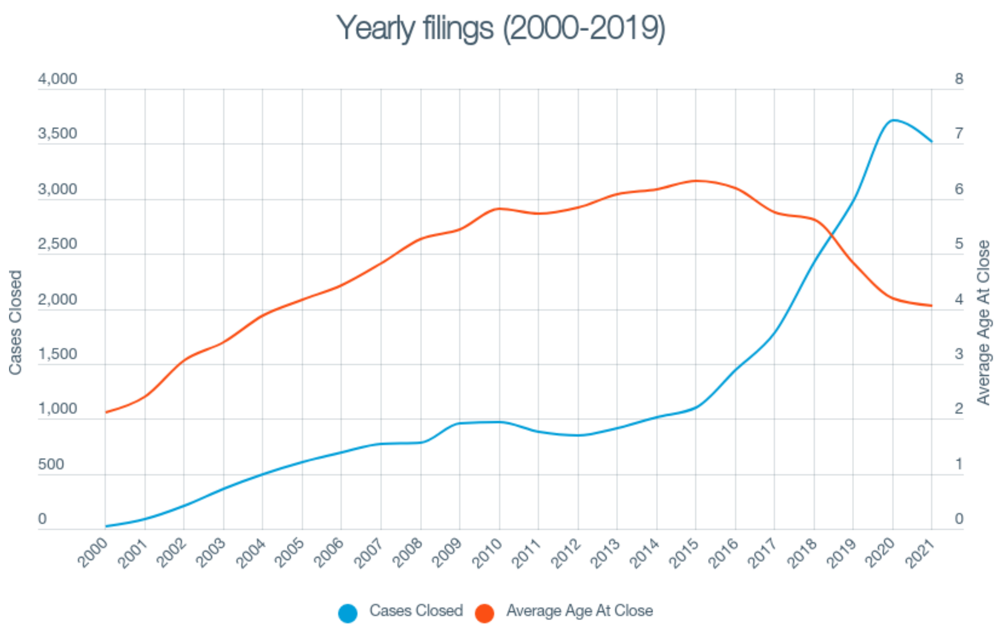

Figure 1.2.2 shows the number of pending AI applications, defined as the difference between the number of applications filed and the number of applications closed each year (where the number of applications is relative to the number of applications on file at the start of 2000). The number of pending AI cases nearly doubled between 2016 and 2019. Due to the 18 month delay in publishing newly filed applications, we are only able to assess the number of pending cases up until 2019 at the publication of this report. It will be interesting to see how the slowdown in the rate of closure affects the overall number of pending cases once the new filings for 2021 have published.

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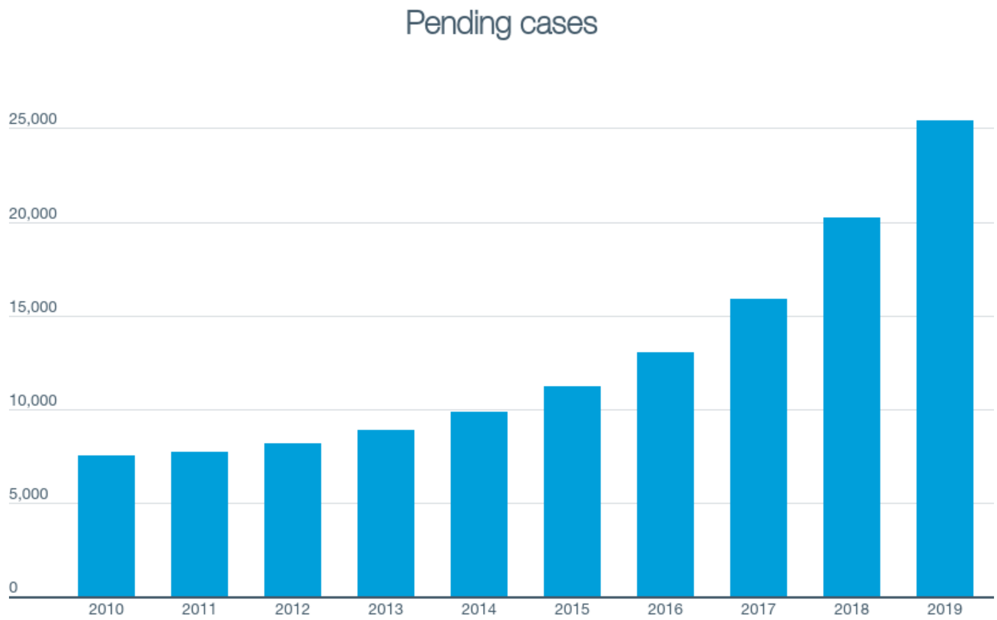
10. Closure is defined as any act that causes an application to stop pending, such as grant, withdrawal or rejection

Figure 1.2.2


Pending cases
25,000
20,000
15,000
10,000
5,000
0
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019

1.3 Oppositions

Opposition is a post grant procedure, which allows a third party to centrally challenge the validity of a European patent at the EPO. An opposition must be filed within 9 months from the publication of the mention of the grant of the patent in the European Patent Bulletin. Following their Early Certainty objective, the EPO then aims to give a decision on straightforward opposition cases within 15 months of expiry of the opposition period – in 2020 the mean time period was close to this, at 15.4 months[11]. The EPO opposition procedure can therefore be an efficient route for attacking a granted European patent.

Figure 1.3.1 looks at the number of EPO oppositions filed against patents relating to AI technologies. When measured against the number of cases closed, the proportion of AI patents which are opposed (indicated by the blue line in the figure) appears to be relatively low – the EPO reports that 2.4% of all patents for which the opposition period expired in 2020 were opposed for example[12], whereas the rate we see for AI patents varies around 1%. However, the rate for AI patents does appear to be in line with the figure of 0.7% reported by the EPO for patents in the electrical engineering field (which includes computer technology, for example)[13].

> "Patents in the AI space are becoming increasingly important to commercial strategy."

There appears to be an increase in the number of oppositions filed in 2020, and again in 2021 in the AI space – a small increase is also seen in the opposition rate for 2020 and 2021. This compares to a slight decrease in the figure reported by the EPO for patents across all technology areas – from 2.7% in 2019 to 2.4% in 2020[14]. This suggests that patents in the AI space are becoming increasingly important to commercial strategy.

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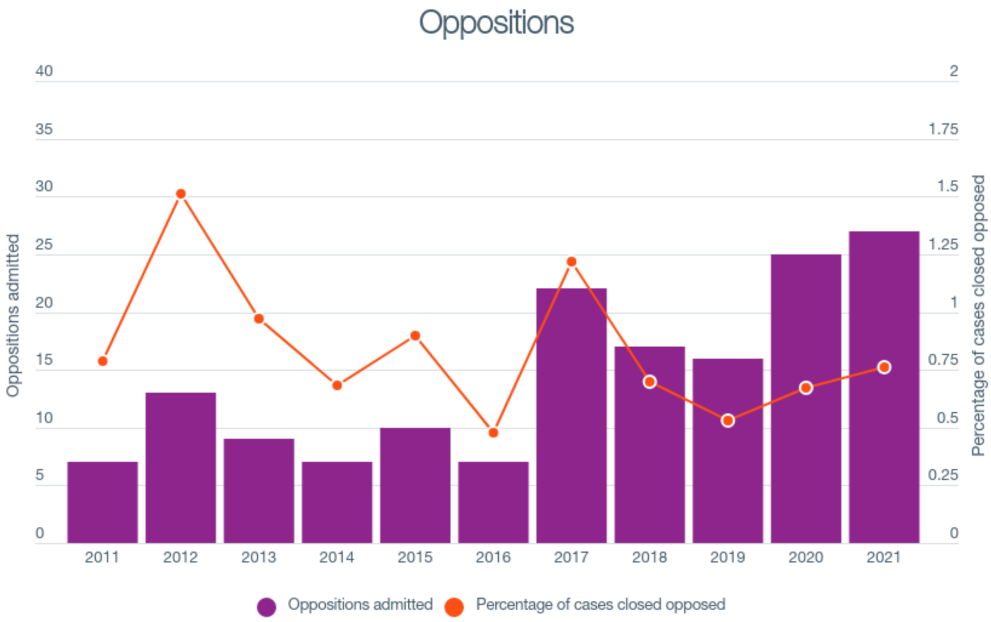
11. Source: https://www.epo.org/modules/epoweb/acdocument/epoweb2/521/en/CA-F_5-21_en.pdf)
12. Source: https://www.epo.org/modules/epoweb/acdocument/epoweb2/521/en/CA-F_5-21_en.pdf)
13. Source: https://www.epo.org/modules/epoweb/acdocument/epoweb2/521/en/CA-F_5-21_en.pdf)
14. Source: https://www.epo.org/modules/epoweb/acdocument/epoweb2/521/en/CA-F_5-21_en.pdf)

Figure 1.3.1

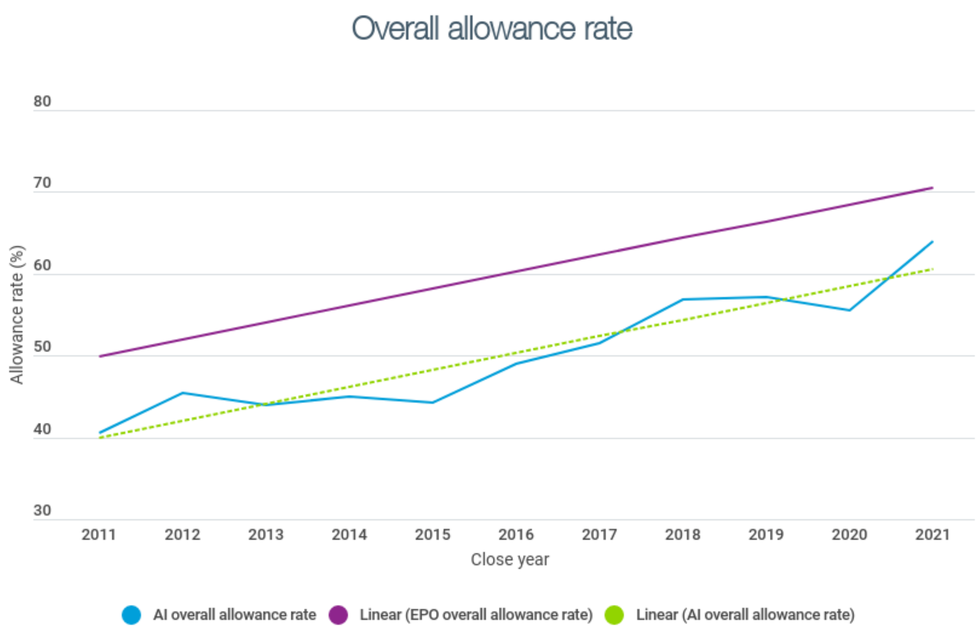


Under the current system, the alternative to the EPO opposition procedure is to commence separate national revocation proceedings. However, once the Unified Patent Court (UPC) regime takes effect, the UPC will have exclusive jurisdiction over both Unitary Patents and, subject to a transitional “opt-out”, existing and future (non-unitary) European patents in force in the participating countries. It will then be possible to bring revocation actions in the UPC without initiating any opposition procedure before the EPO. Companies will need to consider whether to invalidate at the UPC, oppose at the EPO, or both. It will be interesting to see what impact this has on the number of oppositions filed, and whether parties in the AI space will make use of the new court.

1.4 Allowance rate

The allowance rate for AI applications has continued to increase over the past ten years. There was a particularly large jump in allowance rate in 2021 to 64% (an increase of 9% on the 2020 allowance rate of 55%). Whilst this jump in AI allowance rate represents a relatively large change compared to 2020, it is notable that there was a drop of 2% in allowance rate in 2020. Nevertheless, the allowance rate for AI applications appears to be consistently below the average for all applications at the EPO. For instance, the overall allowance rate for all applications at the EPO was 69% in 2020[15]. The lower allowance rate for AI related applications likely reflects the additional difficulties associated with protecting computer-implemented inventions at the EPO.

Figure 1.4.1



"The allowance rate for applications filed by Marks & Clerk outperformed those filed by other European firms from 2015 onwards. Applications filed in 2019 by Marks & Clerk had a 78% allowance rate, relative to 54% for all other AI applications. Of the AI applications closed in 2021, Marks & Clerk had an allowance rate of 75%. This is 20% greater than the allowance rate for other AI applications not handled by Marks & Clerk (55%)."

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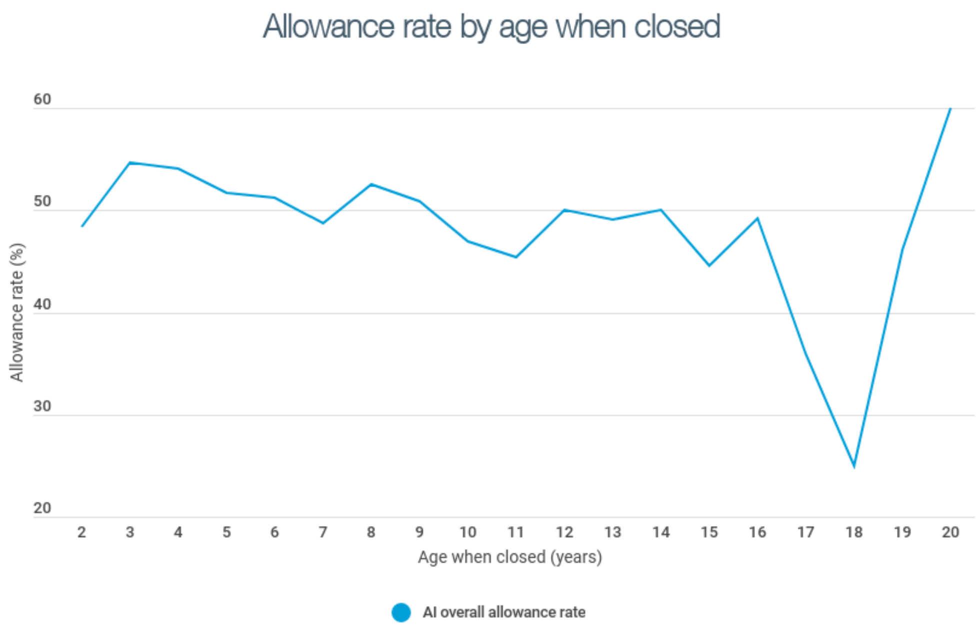
15. Source: https://www.mondaq.com/uk/patent/1167944/the-european-patent-office-the-story-in-numbers-part-2

Figure 1.4.2 shows how the allowance rate changes with the age of closure. Whilst the allowance rate is relatively stable, there is a slight decrease in allowance rate for applications that undergo examination for a longer period. This likely reflects the fact that borderline unallowable applications are more likely to undergo additional rounds of examination and are potentially more likely to be involved in appeals, which can delay the date of closure. Note that the number of applications still pending after 16 years is small, and therefore a larger variation is seen in these data points. Despite the variation, it is pleasing to see that applicants who persist with examination are able to obtain grant in many cases.

The allowance rate for applications closed at the two year point (48%) is lower than the allowance rate for the subsequent four years. This likely reflects a relatively large proportion of applications that are abandoned after the issuance of the search report.

Figure 1.4.2



Implications of G 1/19 decision for patenting AI in Europe

The EPO Enlarged Board of Appeal issued a decision on 10 March 2021 on a case (G 1/19) relating to computer implemented simulations. The Enlarged Board of Appeal is the highest judicial authority at the EPO, and decides on questions that are of fundamental importance to the application of the European Patent Convention by the EPO. Very few cases are heard by the Enlarged Board, and cases are typically only referred to the Enlarged Board when, for example, case law has become inconsistent or a point of law of fundamental importance has arisen. G 1/19 is particularly important since there has only been one previous referral to the Enlarged Board relating directly to patentability of software, and that referral (by the president of the EPO at the time) was found inadmissible.

The application in question (EP 03793825.5) in G 1/19 concerned a computer-implemented method of modelling pedestrian crowd movement in an environment. A brief timeline of the case is given below. The application was refused by the Examining Division in August 2013 and the Applicant subsequently appealed the refusal decision. The Board of Appeal charged with hearing the appeal case concluded that a referral to the Enlarged Board of Appeal was necessary on the basis of a potential inconsistency between the present Board's view that a technical effect requires, at a minimum, a direct link with physical reality (such as a change in or a measurement of a physical entity) and a previous case highlighted at the time in the EPO Guidelines for Examination (T 1227/05 – the "Infineon" decision), where a claim was allowed to a numerical simulation of a noise affected circuit (i.e. a pure simulation without the need for a physical circuit to exist).

09 September 2003	PCT application filed
30 April 2013	Oral Proceedings of Examining Division
26 August 2013	Decision to refuse application
4 November 2013	Notice of Appeal filed
11 April 2018	Oral Proceedings of Board of Appeal
22 February 2019	Referral to Enlarged Board of Appeal
15 July 2020	Oral Proceedings of Enlarged Board of Appl
10 March 2021	Decision Issued

In the referral, the Board of Appeal asked the Enlarged Board three questions relating to patentability of computer implemented simulation. The Enlarged Board separated the second question into a Question 2A and a Question 2B, and provided answers to the Questions 1, 2B and 3 as follows:

1. A computer-implemented simulation of a technical system or process that is claimed as such can, for the purpose of assessing inventive step, solve a technical problem by producing a technical effect going beyond the simulation's implementation on a computer.

2B. For that assessment it is not a sufficient condition that the simulation is based, in whole or in part, on technical principles underlying the simulated system or process.

3. The answers to the first and second questions are no different if the computer-implemented simulation is claimed as part of a design process, in particular for verifying a design.

Question 2A (If the answer to the first question is yes, what are the relevant criteria for assessing whether a computer-implemented simulation claimed as such solves a technical problem?), was found inadmissible.

In the decision, the Enlarged Board provides guidelines for the assessment of patent applications pertaining to computer-implemented simulations. In particular, in its answer to Question 1, the Enlarged Board defined the notion of a "further technical effect", and considered that the criterion "technical effect going beyond the simulation's implementation" is understood to mean any "further technical effect" going beyond the "normal" physical interactions between the program and the computer on which the simulation is run. In points 85 and 86 of the Decision, the Enlarged Board further noted that technical effects could occur within a computer-implemented process (e.g. by specific adaptations of the computer or of data transfer or storage mechanisms, which result in technical effects such as better use of storage capacity or bandwidth) and at the input and output of this process (e.g. through a measurement or as a control signal used for controlling a machine). Although G 1/19 related specifically to simulations, these principles may be applied more generally to prosecution of other computer-implemented inventions at the EPO, including those in the AI space. In particular, by demonstrating a technical effect based on the guidance set out in G 1/19, it may be possible to convince the EPO of the allowability of a claim to AI technology.

It is also of note that in points 127 and 128 of the Decision, the Enlarged Board of Appeal referred to the specific circumstances of the previous “Infineon” decision, and noted that the approach applied in that case should not be taken as a generally applicable criterion (point 133).

2 AI technologies

In this section, we look at how the AI applications break down by technology sector, and by the type of AI technology. Whilst some inventions are directed solely to improvements in AI methods themselves, most patent applications are directed towards the application of AI in a specific field.

The below chart shows the breakdown of applications published over the last 21 years based on technology sector[16].

The largest technology sectors were Life & Medical Science (15%), Telecommunications (12%) and Physical Sciences (11%). Interestingly, Industry and Manufacturing has jumped into the ranks of the top sectors (moving from 4% of total filings at the time of our last report, to 6% of total filings) as AI technologies are increasingly applied in the physical economy.

The trend of increasing numbers of AI applications was maintained across all but one category since our last report. In particular, having enjoyed remarkable growth since 2000 to 2020, Transportation was the only sector to see a notable decrease in the number of publications in 2021. It is too soon to say whether the decrease in Transportation AI publications sets a new trend (perhaps as a result of increasing difficulty of progress in autonomous vehicles), or if the pace of publications will again pick-up in 2022.

> "Industry and Manufacturing has jumped into the ranks of the top sectors reflecting the increasing application of AI in the physical economy."

While Transportation was the only sector to experience a decrease in publications, a number of other sectors have experienced a reduction in the rate of growth of publications in recent years, including Telecommunications, Security and Energy Management. Life Sciences, Physical Sciences and Industry and Manufacturing are the only three sectors to see a continuation of their growth rates from the last few years.

16. Based on classifications used in the WIPO Technology Trends report on Artificial Intelligence, with some refinement of definitions based upon manual analysis of the data set

Figure 2.1

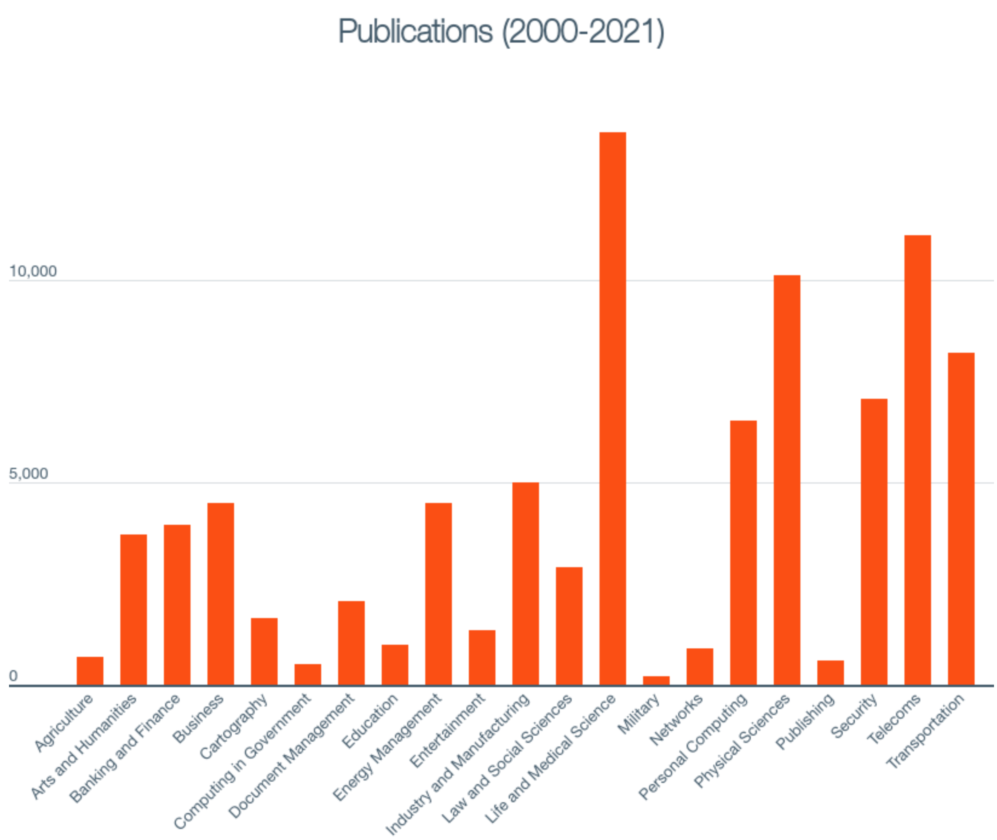
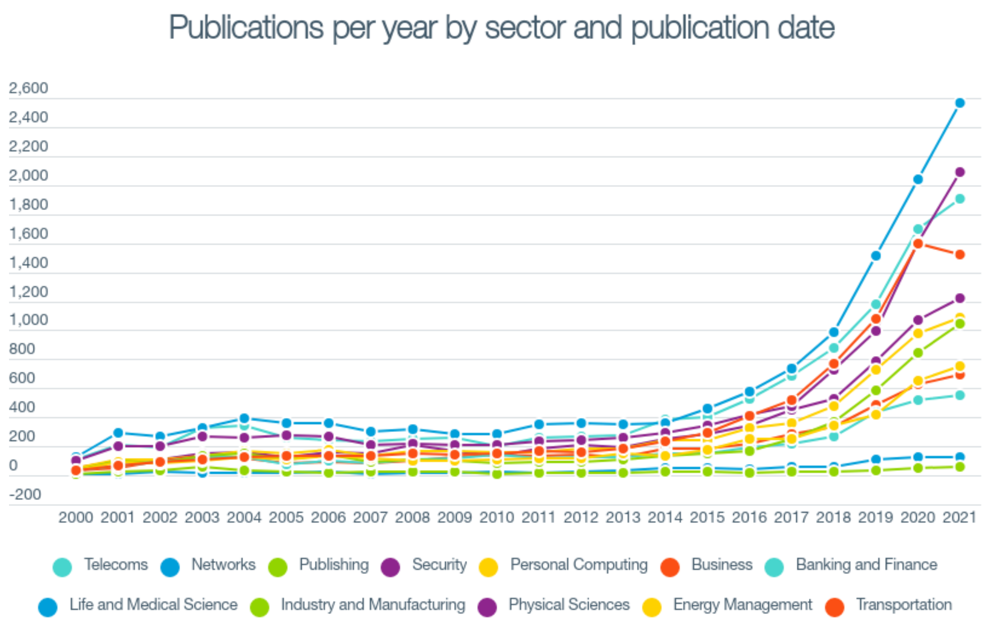


Figure 2.2

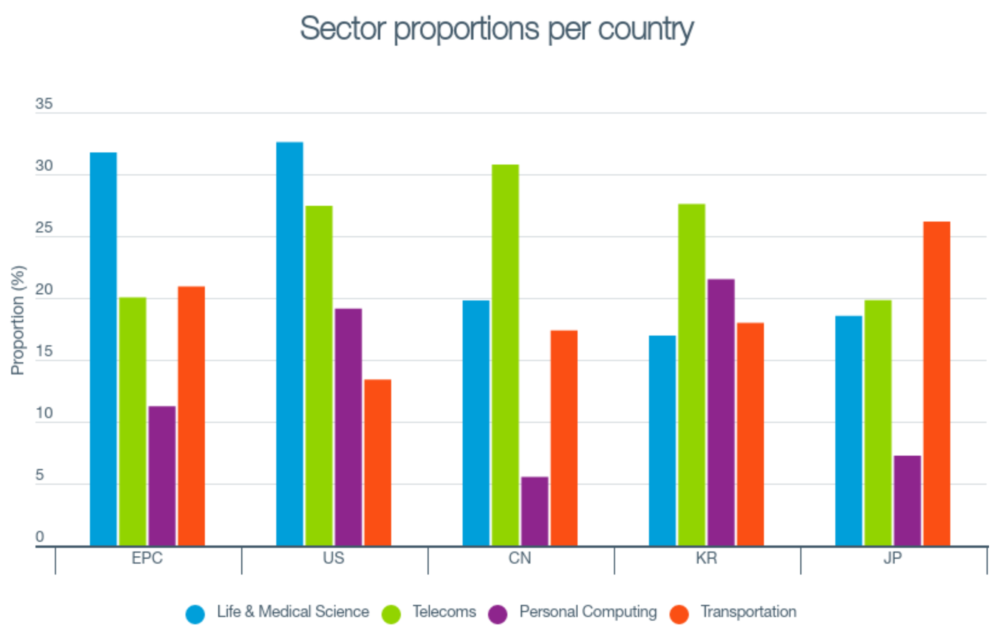


We also looked at the technology area split for applicants based in different countries. Whereas for European[17] and US applicants, the largest sector was Life & Medical Science, this was not the case for Chinese applicants for example, where Telecoms was by far the largest sector – accounting for 30% of AI applications filed by Chinese applicants. This is perhaps unsurprising given the significance of the Telecoms manufacturing industry in China.

For South Korean applicants, Telecoms was also unsurprisingly the largest sector as illustrated in Figure 2.3 below, which shows the split across some key technology sectors for the period 2000-2021.

At the time of our last report, Transport and Telecoms were the joint largest sectors for Japanese applicants. However, a continuing sharp increase in the number of publications in the Transportation sector has seen Transportation become the largest sector for Japanese applicants. Applying AI appears to be a key focus of the Japanese automotive industry and they are keen to protect their innovations in Europe. This may result in part from a relatively favourable policy environment[18] in Europe to testing and deploying automated transport technologies.

Figure 2.3



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17. We define European applicants as applicants from member states of the European Patent Convention (EPC). This is a larger group than just EU member states and for example includes Great Britain.
18. https://www.gov.uk/government/news/government-paves-the-way-for-self-driving-vehicles-on-uk-roads https://www.gov.uk/government/news/britain-moves-closer-to-a-self-driving-revolution

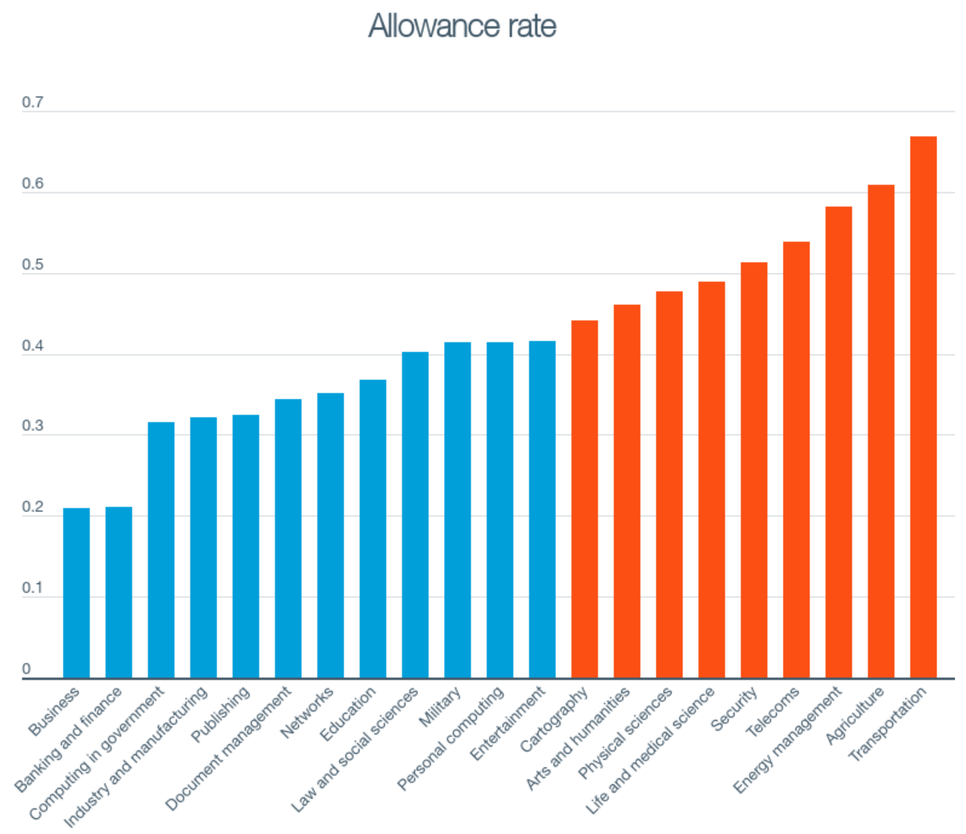
2.1 Technical and non-technical sectors

The allowance rate between different technology sectors varied widely, from 21% for “Business” to 67% for “Transportation”. The categories with higher allowance rates tend to fall into areas that the EPO considers “technical”, whereas the categories with lower allowance rates tend to be considered “non-technical”, such as Banking & Finance or Business methods.

> "Even in sectors such as Finance, where obtaining patent protection is more challenging, around 20% of patent applications are allowed. This demonstrates that it is possible to obtain a European patent in these areas if applications are prepared with European requirements in mind."

The following categories each had an above average allowance rate (shown in orange in Figure 2.1.1): transportation, agriculture, energy management, telecoms, security, life and medical science, physical sciences, arts and humanities, and cartography. The categories with a below average allowance rate (shown in blue in Figure 2.1.1) were: entertainment, personal computing, military, law and social sciences, education, networks, document management, publishing, industry and manufacturing, computing in government, banking and finance, and business.

Figure 2.1.1



Generally, the sectors with above average allowance rates are those which the EPO has historically deemed to be “technical”, while the sectors with below average allowance rates are those the EPO has deemed “non-technical.” It is noted that “Industry and Manufacturing” had a relatively low acceptance rate, which may be due to a large number of AI applications relating to planning and scheduling in this field – such aspects are more likely to be deemed “non-technical” by the EPO. “Arts & Humanities” on the other hand includes applications related to music, and this probably contributes to the relatively high acceptance rate for this category – digital audio enhancement is considered a technical application by the EPO, for example.

In recent years, some sectors have seen a relatively large increase in allowance rate – for example, the Security sector has shown a significant increase in allowance rate since 2016. Applications in the Military sector show a below average allowance rate in the overall data, but an above average allowance rate when only the data from 2016 onwards is considered. The Networks sector also sees an increasing allowance rate in recent years. It is noted that Networks includes applications relating to social networks, which are likely to be considered “non-technical” by the EPO. The recent increase in allowance rate may reflect a change in the type of technology being protected in this sector, moving towards areas that the EPO considers more technical. The allowance rate for the Transportation sector on the other hand has remained relatively flat – most applications in this area would generally be considered technical by the EPO.

The variation in allowance rates between sectors shows the importance of focusing the patent application on aspects of the invention that the EPO considers “technical”. It is also notable that even in sectors such as Banking and Finance, around 20% of applications are allowed – demonstrating that it is possible to obtain grant of a patent in these areas, if applications are prepared with European requirements in mind.

Updates to the EPO Guidelines for Examination in 2022

The EPO Guidelines for Examination are updated on annual basis. After the major update to the Guidelines covered in our previous report on AI filing trends, the Guidelines were updated in 2022 with the inclusion of a number of examples where technical character can arise. By drawing analogies with these examples, it can be possible to convince EPO Examiners of the technical character of an invention, and therefore to obtain grant of the patent application. The inclusion of these further examples is therefore a welcome addition, which provides additional guidance on what may be considered technical for AI applications.

In a first example, the invention relates to control of an infrared camera used to image a temperature distribution of a surface to predict condensation on the surface. The EPO considers that, in isolation, all features except the control of the infrared camera are non-technical and relate solely to mathematical methods or the presentation of information. However, because the algorithmic steps of the claim are used to predict the physical state of an existing real object, the claim does have technical character. Only features which provide such a technical contribution can support an inventive step – which reasoning is supported by the G 1/19 decision.

In a second example, the invention is a method of thermal spray coating controlled by an image processing system consisting of a neural network and fuzzy logic. According to the EPO's approach, the neural network and fuzzy logic are mathematical methods and therefore non-technical. However, as the neuro-fuzzy controller is controlling a specific technical process (in this case spray coating) the neuro-fuzzy controller can contribute to the technical character of the invention. This means that when it comes to assessing obviousness over prior disclosures, the features relating to the neuro-fuzzy controller can be taken into account.

A third example shows how technical character can be provided through a technical implementation of an AI method. This means that the AI method can be protected, regardless of the specific application to which it is applied, by virtue of the model being specifically designed to exploit particular technical properties of the system on which it runs. The example now given in the Guidelines is of a method that assigns the execution of data-intensive training steps of a machine-learning algorithm to a graphical processing unit (GPU) and assigns preparatory steps to a standard central processing unit (CPU). In this manner, the method is specifically adapted to take advantage of the parallel architecture of the computing platform. Accordingly, the method is considered to have technical character, regardless of the particular task to which the machine-learning algorithm is applied.

In addition, and as expected, the EPO has removed their previous guidance with respect to computer implemented simulations, in line with the G 1/19 decision.

2.2 Type of AI technology

We also determined the type of AI technology (in particular: computer vision, natural language processing, speech processing, control methods or robotics) for each application based on keyword searching of the text of the applications themselves. Figure 2.2.1 below shows the absolute number of filings each year since 2000. Figure 2.2.2 shows the percentage of the overall yearly patent publications for each technology.

From the first graph, the most striking feature is the remarkable increase in publications of applications in the computer vision field since our previous report (which covered up to 2019). This is almost certainly driven in part by the change to the EPO’s Guidelines in 2019 leading to more applicants describing computer vision applications of their inventions in order to fall into the EPO’s “technical application” safe harbour. However, this is not the only story. While computer vision is undoubtedly a technical application, it is not the only one. While speech processing is also an accepted technical application, the second graph illustrates the precipitous decline in the proportion of speech processing applications over the time-period. From technology du jour in 2000, at around 45% of all publications, Speech Processing makes up only 7% of publications in 2021. This likely suggests that after a period of heavy investment, Speech Processing as a technology has reached a maturity commensurate with the current market opportunities, while the heavy increase in computer vision likely indicates a still significant runway of potential applications. For example, as highlighted above, the share of filings in the “Industry and Manufacturing” sector has increased, and these likely benefit from developments in computer vision more than speech processing.

While it is not yet evident in the data, as the trend of applying AI to difficult real-world environments continues and as Computer Vision matures, we might expect to see an increase in the number of applications concerned with Robotics to begin to increase over the coming years.

Figure 2.2.1

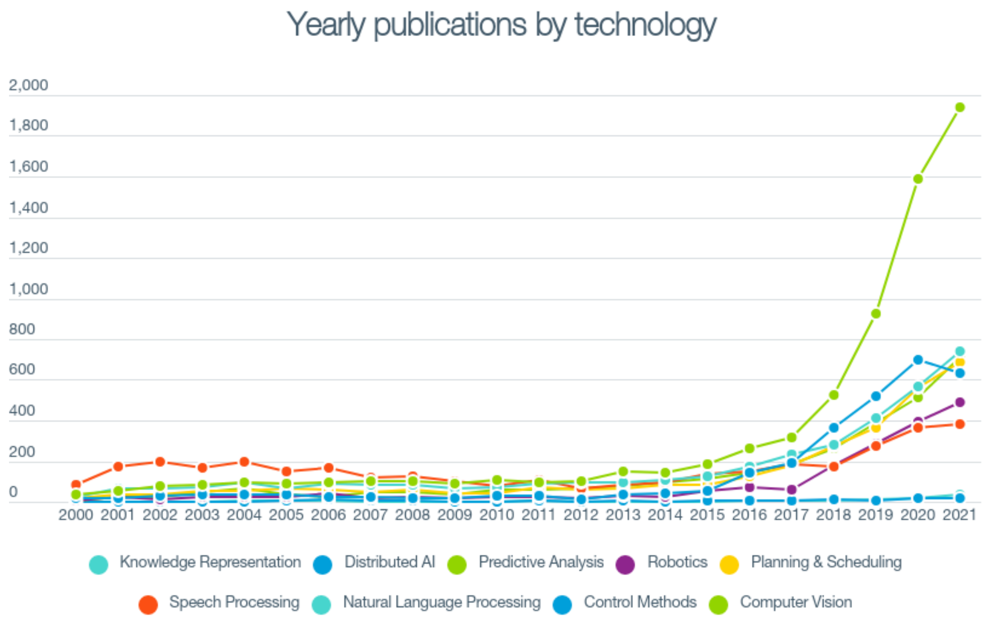
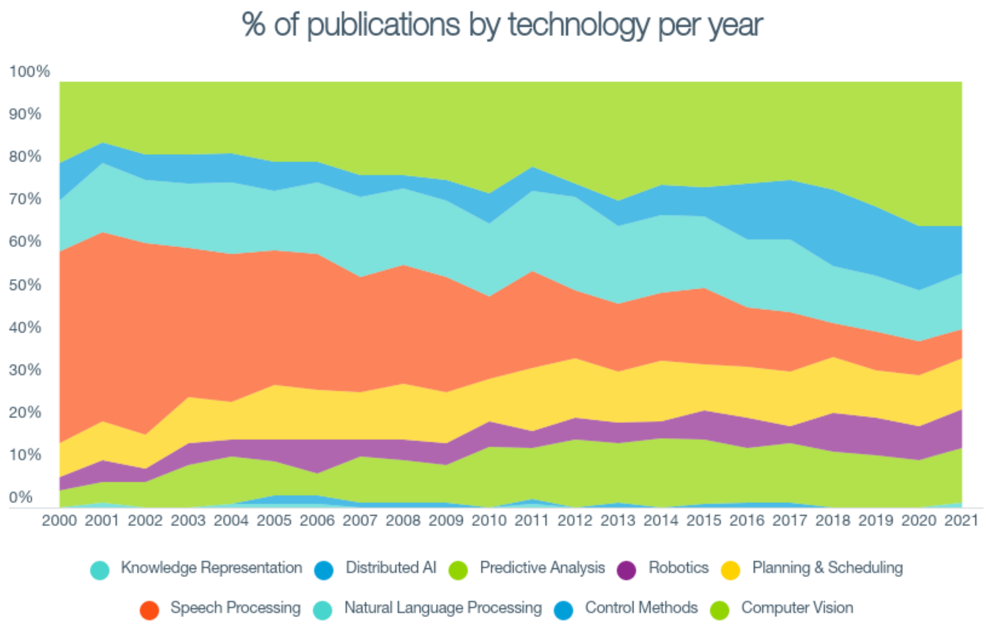


Figure 2.2.2

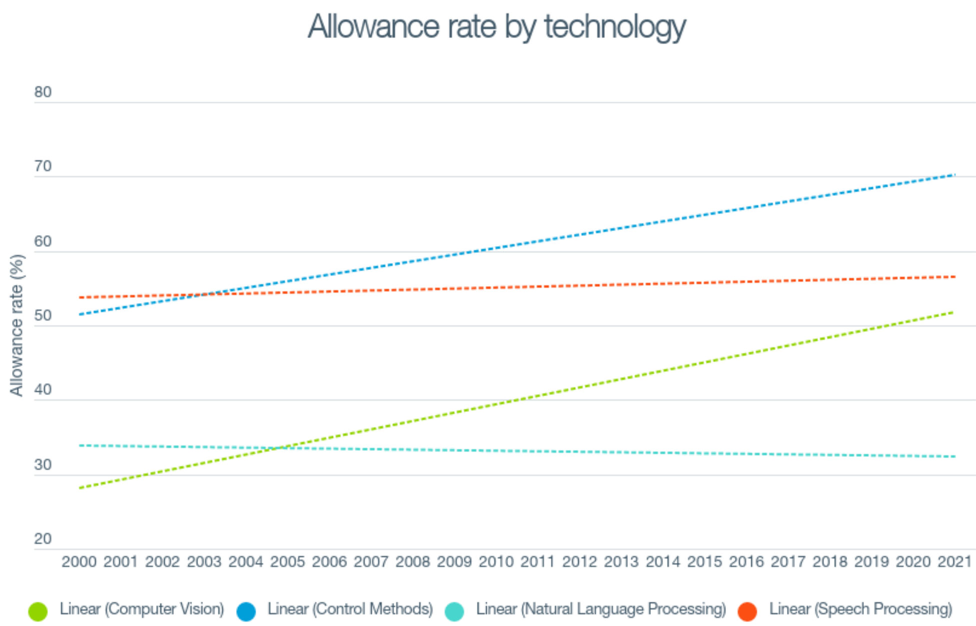


Where Speech Processing might be thought of as processing sound signals to detect speech, the related area of Natural Language Processing is the process of understanding what language means. Speech Processing is often considered by the EPO to be "inherently technical" and therefore patentable, while Natural Language Processing can often present more challenges, with "non-technical subject-matter" objections common. It is therefore interesting that despite these challenges, the decline in the proportion of Speech Processing applications is not seen in Natural Language Processing. Again, this could mean that Speech Processing is now sufficient for most applications, or that despite the EPO's current view that the sector is "less technical", applicants are placing more value on being able to understand the meaning of language than in detecting it. Natural Language Processing finds many uses, for example, in smart assistants, search and machine translation. As suggested by our analysis below, the increasing empirical accuracy in AI methods in correctly determining meaning does raise questions of the validity of the EPO's different treatment of these two sectors.

> "The proportion of NLP applications has not declined in the same way as Speech Processing: "Despite the EPO's current view that [Natural Language Processing] is "less technical" [than Speech Processing], applicants are placing more value on understanding the meaning of language than in detecting it.""

In the below graph we demonstrate allowance rates[19] across a number of AI technology designations. Both control methods and speech processing had a relatively high allowance rate in 2000, and since then they have both continued to increase, following the overall trend in allowance rates for AI applications at the EPO. Allowance rates for applications related to computer vision have seen the sharpest increase, and this likely reflects the EPO's stance in regard to image processing. It is clear that in the case of natural language processing (NLP), the allowance rate remaining fairly stable between 2000 and 2021 is a reflection of the EPO's consistently negative position on the technical nature of NLP.

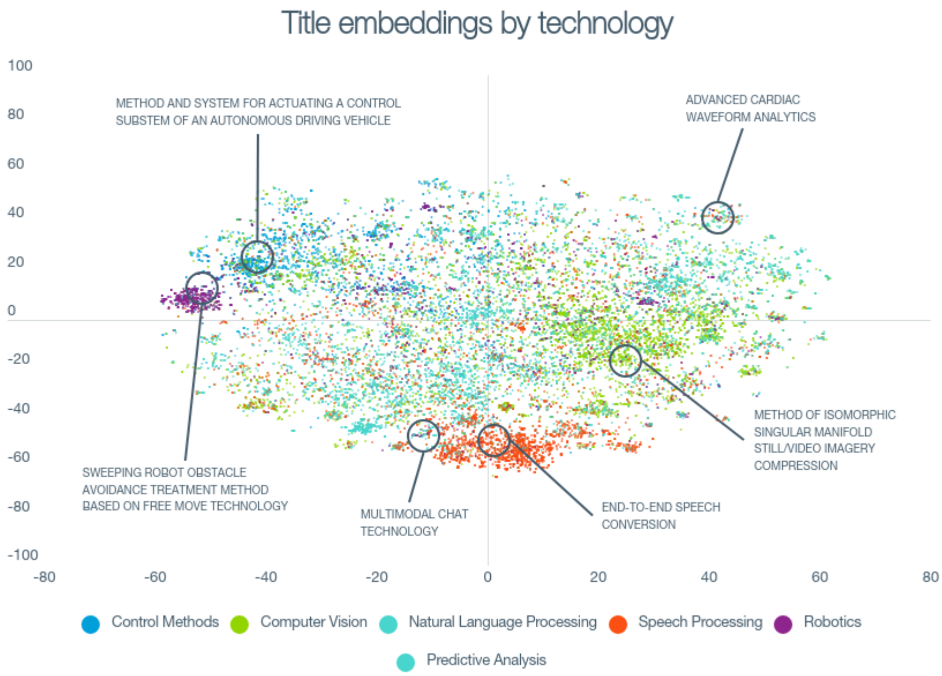
Figure 2.2.3



19. *We have shown linear trend lines of the allowance rates for each technology*

Patent Title Analysis

In order to better understand the distribution of patent publications and their corresponding AI technology designation we have employed the use of a Sentence-BERT (s-BERT) model to produce the chart below.



The relative position of each data point indicates how similar or dissimilar each publication is with respect to each other. The s-BERT model takes as input the title of a publication and outputs an embedding vector which represents the relative meaning of the text within an embedding space. Embedding vectors which are highly clustered represent text which have a high degree of similarity. These embedding vectors can be compared with one another in order to quantify their semantic similarity.

When embedding text using a BERT model, the resulting vector has high dimensionality, in this case 384 dimensions. As it is difficult to visually represent 384 dimensions, we perform dimensionality reduction on the resulting embedding vectors. In this case we used a standard stochastic method known as t-distributed Stochastic Neighbour Embeddings (t-SNE) to enable visualisation in two dimensions. An interesting observation is just how well t-SNE appears to perform in reducing very high dimensionality patent title vectors to two dimensions.

The embedding vectors produced by our model in combination with the technology designations we have assigned to them seem to cross validate one another. In other words, we can see patterns in the embedding vectors that reflect what we would expect to see based upon their technology designation. Robotics and Control Methods are related fields and we might expect these to cluster near one-another – this is what we see towards the upper left quadrant. Similarly, Speech Processing and Natural Language Processing applications tend to cluster around the bottom centre of the embedding space. Computer vision seems to be more evenly distributed, perhaps representing its wide applicability to other fields and technologies, but still forms a distinct cluster towards the right of the embedding space. Finally, predictive analysis seems to be distributed throughout the embedding space. Intuitively this makes sense because predictive analysis can be applied across a wide variety of technology areas.

Advancements in AI, in particular natural language understanding, have improved significantly over recent years to the point where the meaning of text can be accurately assessed with the assistance of very large and complex models. To our minds, there is certainly a question as to whether accurately determining intended meaning of language should be viewed as being any less technical than processing of speech signals.

3 AI applicants

In this section, we look at the type of entities filing AI applications. In particular, we look at how the filing numbers are split between applicants from various countries.

Dabus update

As generative AI methodologies develop, the question arises as to whether an AI algorithm that develops a patentable invention can be deemed an "inventor". As most jurisdictions state that the first owner of an invention is the inventor, this then opens up questions as to who (or what) should be deemed the owner of such inventions. These issues were the centre of a number of decisions on patent applications which list an AI machine – referred to as "DABUS" – as an inventor. The "Device for Autonomous Bootstrapping of Unified Sentience" (DABUS) is an AI generative algorithm developed by Stephen Thaler. A set of patent applications have been filed for two inventions reportedly conceived by DABUS; a food container, and an emergency beacon. In each application, Stephen Thaler was listed as the applicant and DABUS was listed as the inventor.

The applications have been rejected in multiple jurisdictions on the basis that an inventor must be a natural person and that in any case there are no legal provisions allowing the transfer of rights from an AI inventor to another entity (in this case, Stephen Thaler).

Whilst a number of cases are currently on appeal, at present the following jurisdictions have deemed patent applications listing an AI inventor to be invalid: EPO, UK, Germany, US, Australia, and New Zealand. The South African IP Office has allowed an application listing DABUS as the inventor (ZA 2021/03242B). It remains to be seen if this decision will be challenged in the courts.

Whilst at present there appears to be questionable legal basis for listing AI algorithms as inventors of patents, this may change in the future. In September 2020, the UKIPO instigated a consultation on "Artificial intelligence and intellectual property", which included a number of questions relating specifically to the topic of AI inventors. This also follows a public consultation launched by WIPO in December 2019 around AI and IP policy. It may be that in time, patent laws are reviewed as the importance of AI generated innovation increases.

Jurisdiction	Patent Office Decision	First Court Decision	Appeal Decision
EPO	✕	N/A	TBD
UK	✕	✕	✕
Germany	✕	✕	
US	✕	✕	TBD
Australia	✕	✓	✕
New Zealand	✕		
South Africa	✓		

✓ = accepted ✕ = rejected

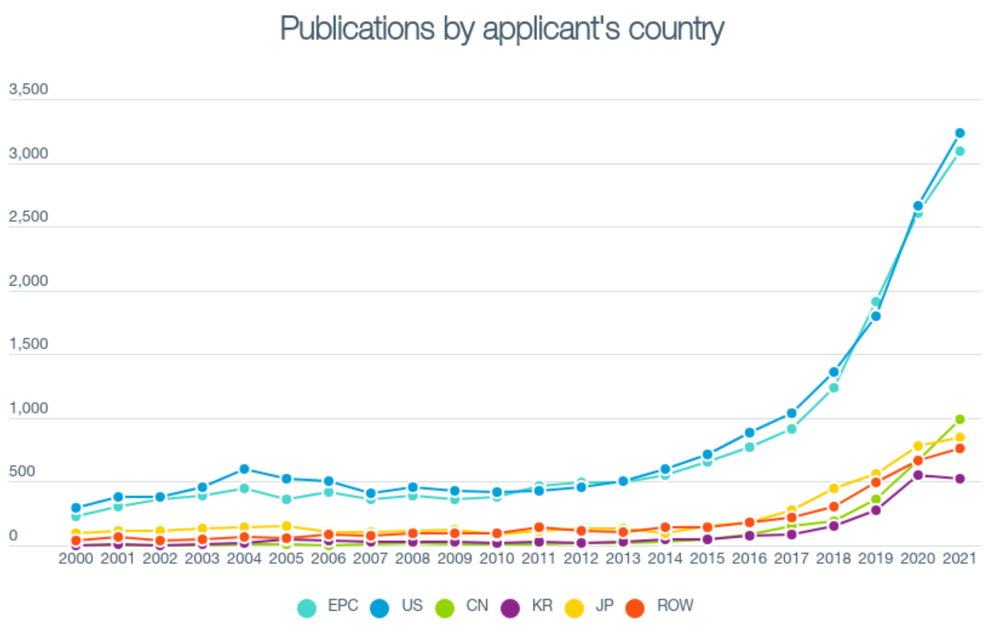
3.1 Applicants by country

In the below figures, filing trends based on the country of applicant are considered.The first figure shows the number of applications by country of applicant. In each of the countries we considered, there has been a continued increase in the number of European patent applications in the AI space in recent years, with some countries seeing this growth accelerating. The US continues to be, by far, the individual country filing the most AI applications at the EPO. However, if the member states of the European Patent Convention (EPC) are viewed as a block ("EP applicants"), we can see that the gap between the number of applications filed by EP applicants and by US applicants is narrow.

Interestingly, Chinese applicants overtook Japanese applicants in 2020 to become the third largest filer of AI applications at the EPO.

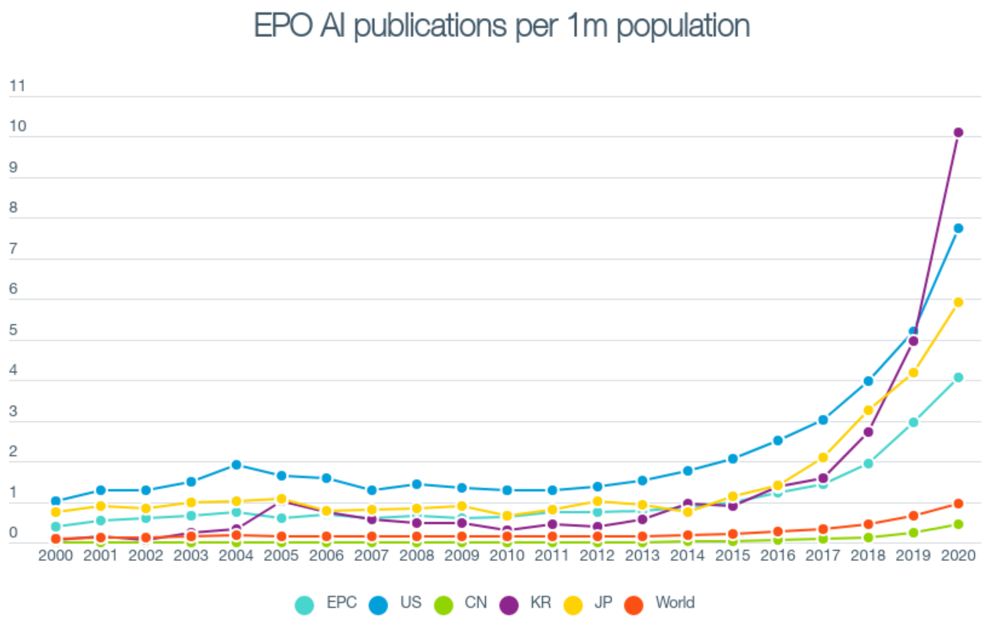
"Chinese applicants overtook Japanese applicants in 2020 to become the third largest filer of AI applications at the EPO."

Figure 3.1.1



This analysis looks quite different when adjusting for population size. While, out of the top 5 countries, South Korean applicants file the smallest absolute number of AI applications at the EPO, they are filing an increasingly large number of applications per head of population. In fact, between 2015 and 2020 applicants from the South Korea (Republic of Korea) have overtaken Japanese, US and EP applicants to become the largest filers of AI applications on a per-capita basis. However, as can be seen from the graph above, 2021 saw a decrease in the absolute number of applications coming from South Korea, so they may cede this lead to the USA in 2021.

Figure 3.1.2



The below figure shows the proportion of the total AI applications by country of applicant over time. While US applicants make up the largest proportion of AI filings at the EPO, the proportion of applications from other countries is increasing. Indeed, while US applicants made up 41.4% of AI filings in 2010, this dropped to 34.2% by 2021. We predicted in our last AI report that China's share of applications would continue to increase and this is indeed what we see. In 2021, Chinese applicants accounted for 10.5% of total AI applications published, compared to 1.3% in 2010. Accordingly, of the countries considered, China continues to enjoy the largest growth in share of AI applications in recent years.

To put these numbers in context, US applicants accounted for 26% and Chinese applicants accounted for 9.4% of all European patent applications filed in 2021[20]. Both countries are therefore filing a larger proportion of applications in AI technologies. In contrast, EP applicants make up 47.1% of total filings at the EPO in 2021, but only 32.7% of AI applications.

The proportion of applications from South Korean applicants also continues to increase, and a significant number of filings also come from Japanese applicants, although a smaller proportion of the total AI filings than in 2000.

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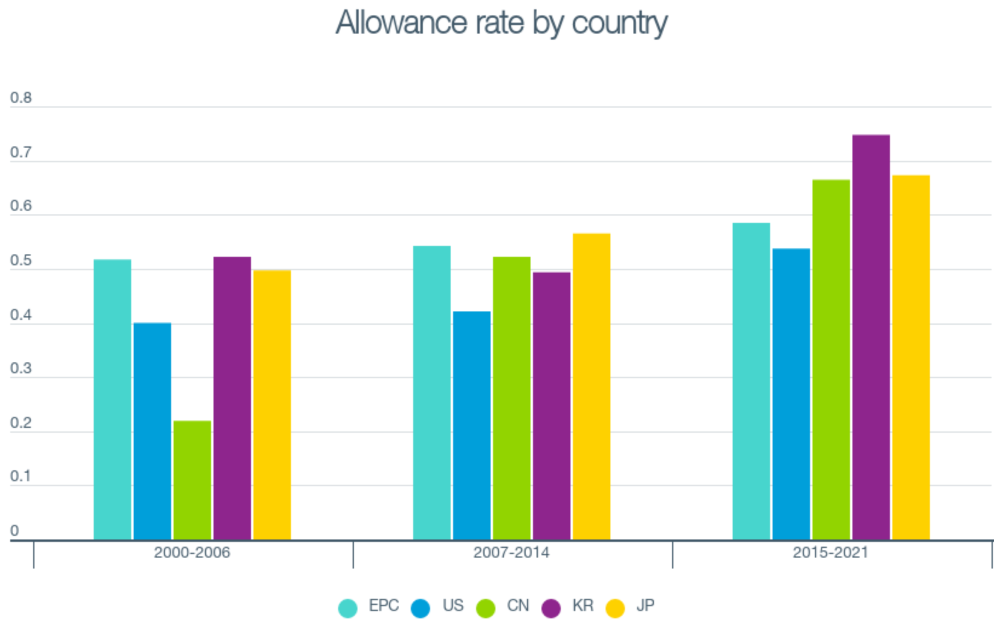
20. Based on figures from the EPO's Statistics Centre

The below figure looks at how the allowance rate varies between applicants from different countries. We have grouped the closure date into three periods to show how different countries' performance has changed over time. Most striking is the overall improvement in success rates and the remarkable improvement in performance of Chinese applicants in particular. In the period 2000-2006, the success rate of all applications was far lower than it is today, but Chinese applicants had a notably low success rate of around 20%, compared to 50% for applicants from South Korea. By 2007-2014, however, Chinese applicants were enjoying the highest success rate, at over 50%, of each of the top 5 source countries. In 2015-2021, while Chinese applicants no longer have the highest success rate, they still enjoy higher success rates than EP and US applicants, and are broadly similar to Japanese applicants at 65%.

In the period 2015-2021, South Korean applicants are significantly more likely to obtain a granted European AI patent than any other country in the top 5.

Figure 3.1.3



We remarked in our last report that US applicants had a lower success rate than applicants from any of the other top 5 countries. As illustrated in the above chart, this has been the case at least from the 2007-2014 period. In the latest 2015-2021 period, US applicants have a success rate of 52% compared to success rates of 57% for EP applicants, 65% for Chinese and Japanese applicants and 73% for South Korean applicants.

4 Conclusion

The number of AI patent applications continues to increase in Europe – the number of pending AI applications at the EPO nearly doubled over the period 2016-2019. Chinese applicants became the third largest filer of AI applications at the EPO in 2020, behind the US and the EPC member states. It is notable that between 2015 and 2020 however, applicants from South Korea (Republic of Korea) have overtaken Japanese, US and EP applicants to become the largest filers of AI applications on a per-capita basis.

Looking at the kinds of AI technologies for which protection is being sought in Europe, it is notable that computer vision has shown a striking increase in patent publications over the last five years. Conversely, speech processing publications have been in decline. This likely suggests that after a period of heavy investment, Speech Processing has reached a maturity commensurate with the current market opportunities, while the heavy increase in computer vision likely indicates a still significant runway of potential applications. The proportion of Natural Language Processing applications has not declined in the same way as Speech Processing, and applicants are still filing large numbers of applications in this area, demonstrating the real value and challenges in understanding the meaning of language.

The EPO has been effective in reducing the average length of examination for applications in the AI space in recent years, which is now down to around 4 years. This is starting to reach an equilibrium however, and if filing numbers continue to rise, it will be interesting to see if the EPO can maintain this timescale for examination. It is notable that the allowance rate for European patent applications in the AI space varies widely between different sectors – with nearly 70% of patent applications being granted in the Transport space. Even in sectors such as Finance, where obtaining patent protection is more challenging, around 20% of patent applications are allowed – this demonstrates that it is possible to obtain a European patent in these areas if applications are prepared with European requirements in mind.

5 Methodology

To produce the data analysed in this report we used as a starting point IPC code and keyword definitions used for patent data in the “WIPO Technology Trends 2019: Artificial Intelligence” report (as defined in the “Data collection method and clustering scheme: Background paper” for the same report). Cases matching the definitions used for the WIPO report were identified using the Derwent Innovation database, and data from Derwent Innovation was combined with data from EP Patent Bulletin. The WIPO definitions were refined based upon manual analysis of the data. We then wrote custom formulae using the raw data to generate our own fields for the analysis. For some sectors, we have used slightly different classifications than were used in our last report. For example, for the “Education” sector, we have further refined our keyword definitions to remove a number of false positive classifications. This has resulted in a number of changes to absolute numbers of cases classified as AI applications or classified as belonging to a particular sector. While having an impact on absolute numbers, these changes have not had a major impact on trends or distributions. Where comparisons between time periods have been made, data used for the comparisons are based consistently on our improved classifications.

Mike Williams

Patent Attorney

Mike is an expert in patent matters relating to digital technologies, and in particular artificial intelligence (AI). Mike is the lead partner on our AI Reports, in which we studied the impact of the spectacular growth in AI on patent filings at the European Patent Office (EPO) over the last two decades.

Mike's background in Computer Science, in which he holds a master's degree from University of Manchester, gives him the ideal technical foundation to understand his client's inventions in all matters of digital technologies. In addition to artificial intelligence, Mike has extensive experience of patent matters relating to all aspects of computer science, including signal processing, image analysis, communications protocols, computer graphics. Mike also is also an expert in the area of lithographic systems, analogue and digital electronics.

Mike's uses his technical expertise and commercial focus to advise a broad range of clients from large multinational companies to universities and SMEs. Mike's international practice means that he is fluent in drafting and prosecuting patent applications throughout the world, and advising clients to navigate contentious matters.

Lara Sibley

Patent Attorney

Lara advises clients across the world on patenting AI innovations, and she has particular experience with applications in areas such as natural language processing, medical imaging and home automation. Lara has completed the Stanford University certificate in Machine Learning on Coursera and has given numerous presentations in Japan on the EPO approach to AI. Alongside her work in the AI space, Lara also works across a range of technologies in the software and electronics sectors, including in particular cryptography, agritech, video coding (including standards essentiality evaluations), medical devices, wireless networking, optical devices and semiconductor devices.

Lara qualified as a UK Chartered Patent Attorney in 2016, having been awarded the Moss Prize for the highest aggregate mark in the Basic UK Patent Law and Basic Overseas Patent Law papers. She also qualified as a European Patent Attorney in 2016, having achieved the highest mark in Europe for the English language Opposition paper. Lara has a first class degree in physics from Durham University, and went on to obtain a PhD in solid state physics from the University of Cambridge before joining Marks & Clerk in 2012.

Matthew Jefferies

Patent Attorney

Matthew advises a wide range of clients in high tech fields, with particular expertise in computing and medical devices. Since joining Marks & Clerk in 2011, he has been active in protecting innovations within the fields of telecommunications, machine learning, medical devices and non-volatile semiconductor memory.

Matthew has drafted and prosecuted a wide variety of UK, European and International patents across a diverse range of technologies. He has also assisted clients with appeals and oppositions before the European Patent Office. His telecommunications experience, particularly in wireless networks and video codecs, has led to him advising on the applicability of technical standards and the validity of patents within litigation proceedings and European oppositions.

Matthew has experience in neural networking across a variety of programming languages and represents a number of clients in the AI and machine learning space. Matthew continues to ensure that his knowledge is up to date and to this end has completed the Stanford University certificate in Machine Learning on Coursera.

Matthew graduated from Durham University with a first class Masters degree in Physics. His research focussed on methods of producing cheap magnetic sensors via the control of the giant magnetoresistive properties of spintronic nanostructures. In 2012, Matthew received the Certificate in Intellectual Property Law from Queen Mary University. In 2014, he was awarded the Strode Prize for achieving the highest mark in the UK Advanced Patent Agent Practice Examination. Matthew qualified as a UK and European patent attorney in 2015 and has completed the Intellectual Property Litigation Certificate to gain advocacy rights at the IPEC and the High Court.

Jeremy Russ

Trainee Patent Attorney

Jeremy joined Marks & Clerk in October 2021 as a Trainee Patent Attorney in the Manchester office. He graduated from the University of Liverpool in 2020 with a Bachelor's degree in Computer Science.

Before joining the firm, Jeremy worked on many applied AI projects involving, for instance, sentiment analysis, signal classification, image generation, speech synthesis, semantic similarity analysis, algorithmic trading with reinforcement learning, and patent analysis.