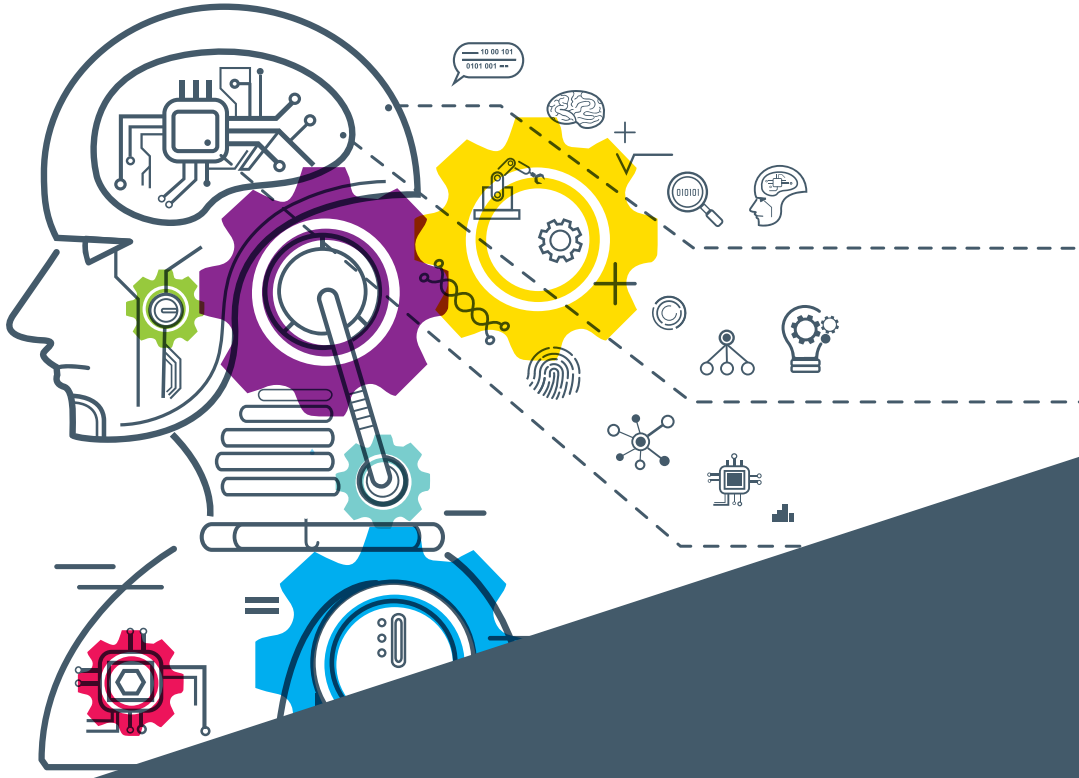
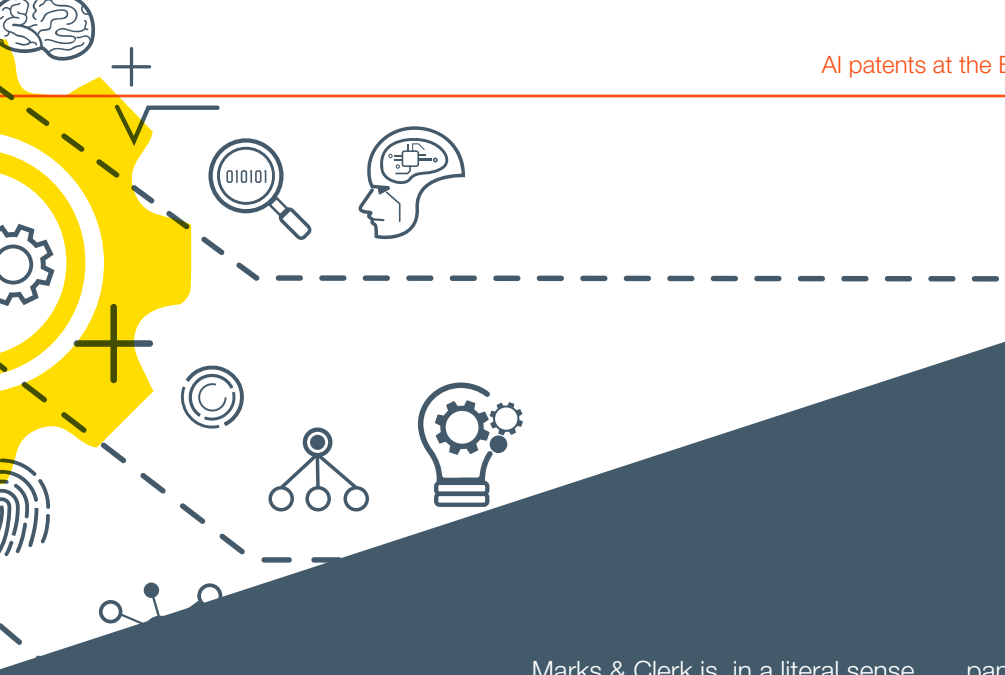


Marks & Clerk AI

AI patents at the EPO – a long-term trend analysis

Marks&Clerk

> Marks & Clerk is, in a literal sense, leading the way when it comes to filing artificial intelligence patents.



Marks & Clerk is, in a literal sense, leading the way when it comes to filing artificial intelligence patents. Our firm has the highest success rate of any firm of European patent law attorneys (excluding firms handling only a single case) with 83% of Core AI applications handled by our team granted. This compares to the overall success rate for all attorney firms of 49%. Our firm was also the second highest filer of Core AI patent applications, and, due to Marks & Clerk's very high success rate, obtained more granted patents than any other European patent attorney firm.

Our team have filed several boundary pushing AI patents in recent years and we are regularly invited to speak at industry events on the intersection of AI and intellectual property law, with Philip Martin for example having recently been invited to be part of a small panel of experts in a plenary session at an EPO conference on AI addressing the legal and IP issues thrown up by AI.

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.

Key findings:

- The number of AI patent applications filed at the EPO is increasing rapidly, with around 650 applications publishing each month through the first half of 2020.
- These applications are mainly filed by US and European applicants, however there has been a recent increase from Chinese applicants, who accounted for around 7% of AI applications published in 2019.
- European applicants are more successful at the EPO than US applicants. Applications from European applicants are generally prepared with European requirements in mind, and this may lead to the observed difference in allowance rate.
- The proportion of AI applications from larger filers is growing – for both smaller and larger filers however, the number of applications continues to rise steeply.

1 Introduction

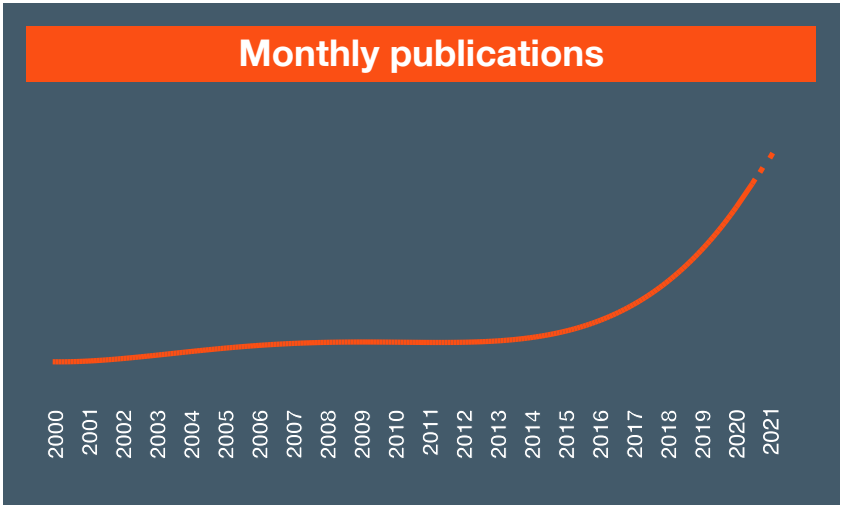
Artificial Intelligence (AI) has seen a huge surge in interest and investment in recent years. As computing power has grown, AI has found applications in a wide variety of areas, including speech recognition, autonomous vehicle control and drug discovery. This has led to large-scale investment into AI start-ups. More established companies across diverse sectors are also becoming increasingly active in the AI space.

As investment into research and development in AI has grown, it is unsurprising that investment in intellectual property protecting this technology has also risen. This is reflected in the patent filings at the European Patent Office (EPO). Figure 1 shows the number of publications of European patent applications each month for AI technology[1]. The dashed line is an extrapolation to the end of 2020 based on the number of publications at the end of June 2020.

Following the significant growth in AI applications at the EPO in recent years, Marks & Clerk has conducted a study of filing trends in this area. 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.

> AI has seen a huge surge in interest in recent years.

Figure 1



Box 1 – What is AI?

The EPO defines the term "artificial intelligence" as "reasoning and decision-taking by machines rather than humans or animals". In contrast to machines that are able to perform general tasks like a human (commonly known as "artificial general intelligence"), most recent AI developments focus on performance of a single task, such as classification.

Machine learning focusses on algorithms that improve their ability to perform a task by learning from experience. Generally, a machine learning model learns to perform a task by attempting the task, receiving feedback on the success of its attempt, and then adjusting the model parameters to improve performance. Recent advancements in computing power have allowed machine learning techniques to be applied effectively to a wide variety of fields, such as speech recognition, autonomous vehicle control and image analysis. Machine learning related applications made up 88% of the total AI applications published in 2019.

Neural networks are a class of machine learning models designed to mimic the functioning of the brain. In general, neural networking models are made up of a series of neurons that each perform a calculation on input data, and pass output data to a subsequent neuron. By passing data through the network, an overall calculation is performed. The neural network can be trained to improve performance by adjusting the parameters of each neuron.

1. 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.

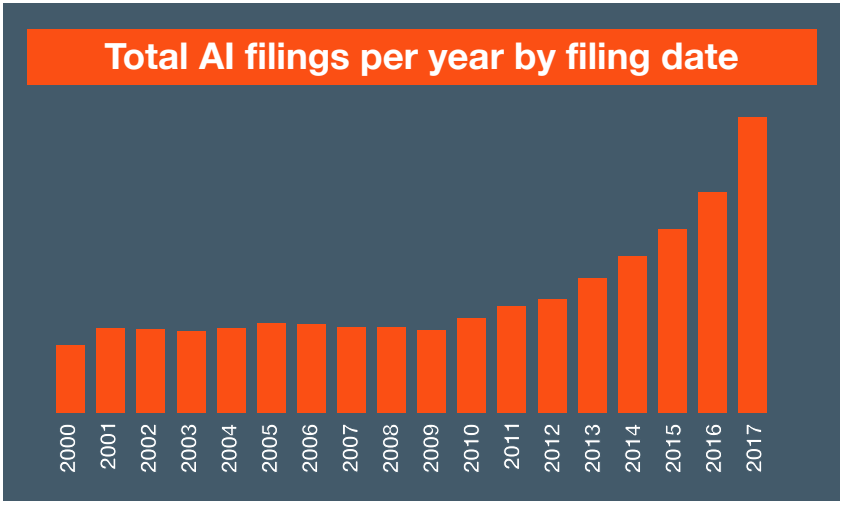
1.1 EPO Filing Trends

Whilst growth in AI filings was generally positive across the last 20 years, there was a clear slowing in the period 2006 to 2010. This may to some extent reflect a general trend in patent filings as a result of the economic downturn across this period. To put this into context, there were 34% more AI applications filed in 2017 than in 2016 – in contrast, there were actually 4.1% fewer AI applications filed in 2009 than in 2008.

Growth in AI filings has increased sharply year on year since 2010 however, and this reflects the growing prevalence of AI technology across sectors. The growth far exceeds any changes in overall filing numbers at the EPO – for instance, the 34% increase in AI filings in 2017 compares to a 4.7% increase in the overall number of patent applications filed at the EPO[2]. Whereas US and European applicants account for the largest proportion of AI applications, the proportion from Chinese applicants is increasing.

> “The 34% increase in AI filings in 2017 compares to a 4.7% increase in the overall number of patent applications filed at the EPO.

Figure 2

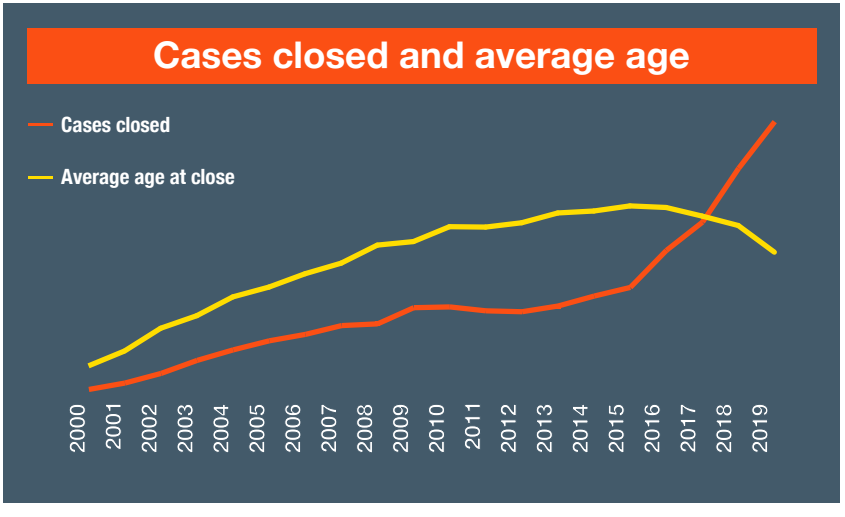


2. “Patent Index 2019 – European patent applications” published by the EPO.

1.2 Pending European applications

The EPO is cognisant of the recent increase in AI filings, and has taken steps to increase the speed of examination, resulting in an increase in the number of cases closed and a reduction in the average age of applications at close over the last four years. The average age of AI applications when closed peaked at 6.2 years in 2015, but has reduced down to 5.0 years in 2019. This trend has continued into 2020, with an average age at close of 4.6 years.

Figure 3



> The EPO is cognisant of the recent increase in AI filings, and has taken steps to improve the speed of examination.

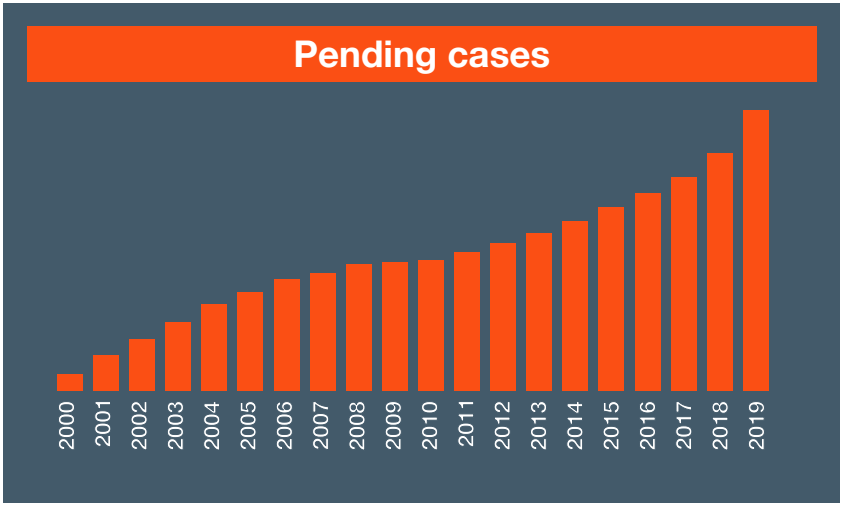
Although the EPO has increased the number of cases closed per year, this has not kept up with the increase in AI filings, and the number of pending AI applications has increased year on year for the last 20 years.

Figure 4 shows 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).

Given that the number of pending applications is increasing, it seems that the recent reduction in the average age of applications is largely driven by the EPO closing older applications. Whilst the EPO is training additional Examiners in assessing AI inventions, the experience of our attorneys is that the vast majority of "core AI" inventions for example (defined as applications assigned the IPC category G06N/3 – Computer systems based on biological models) are still handled by a relatively small number of Examiners.

The rising number of pending applications suggests that the recent decrease in the average age of AI applications may be difficult for the EPO to maintain. Nevertheless, applicants who may be concerned about potential delays have a number of options to help speed up examination of important cases, such as requesting accelerated examination.

Figure 4



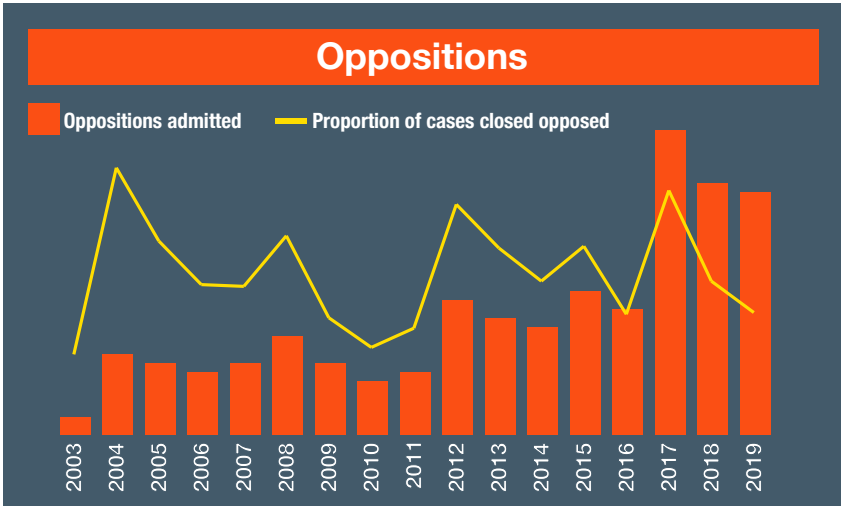
1.3 Oppositions

Figure 5 looks at oppositions filed against patents relating to AI technologies. There appears to be an increase in oppositions filed in 2012, and again in 2017. However, when measured against the number of cases closed, the proportion of patents relating to AI technologies which are opposed does not appear to be increasing (shown by the yellow line in the figure).

As shown, the opposition rate for AI patents is around 1%. This is relatively low compared to the opposition rate of 4% for all European patents (reported in the EPO Annual Report 2016).

> “…the opposition rate for AI patents is around 1%...compared to 4% for all European patents.

Figure 5



1.4 Allowance Rate

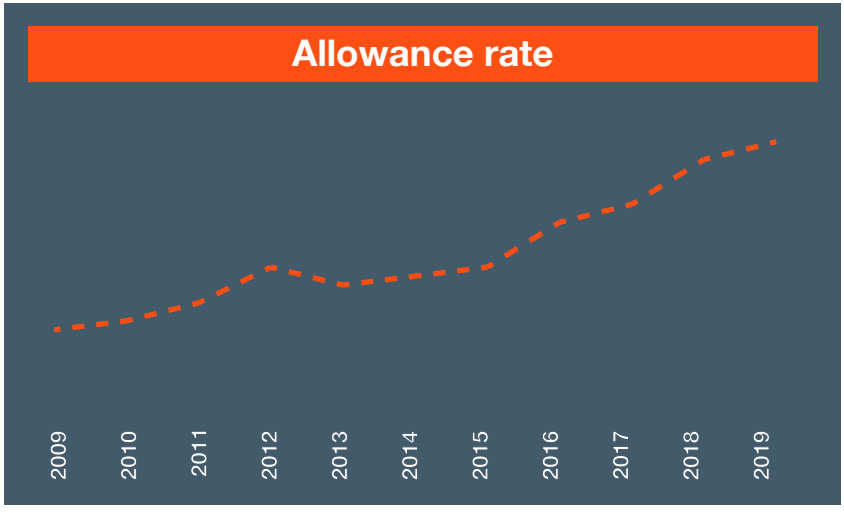
In recent years, the EPO has focussed on providing applicants with a framework for patenting AI inventions. In May 2018, the EPO hosted a conference on "Patenting Artificial Intelligence". In November 2018, the EPO Guidelines for Examination were updated to include a section on "Artificial intelligence and machine learning", which was itself updated in November 2019.

The allowance rate for AI applications at the EPO meanwhile has increased slowly over the past 10 years – Figure 6 shows the allowance rate based on date of closure[3]. Notably, the changes to the Guidelines in 2018 do not appear to have had an immediate impact on allowance rate.

The allowance rate based on date of closure was seen to jump significantly at the end of 2019, to nearly 90%. This appears to be a result of a delay at the EPO in updating the statistics for cases which are withdrawn or refused, however.

> Notably, the changes to the Guidelines in 2018 do not appear to have had an immediate impact on allowance rate.

Figure 6



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

Box 2 – The EPO focus on AI

Whilst the EPO approach to assessing computer implemented inventions is well-defined, they have looked to bring more clarity to applicants regarding the assessment of AI inventions in particular in recent years. In December 2017, the EPO presented a study that examined "4th Industrial Revolution" technologies, including AI. This was followed by a one-day conference on "Patenting AI" in May 2018.

Following this conference, the EPO published updated Guidelines for Examination in November 2018, including a section focussed on "Artificial intelligence and machine learning". This helped to clarify the EPO position on assessing the patentability of AI inventions (see Box 3 below).

Further updates to the Guidelines in 2019 included a softening on the EPO stance towards support vector machines, reasoning engines and neural networks (in short, that the context should be taken into account when assessing whether claims relating to such methods are considered to have sufficient technical character).

Since the EPO Guidelines define how EPO Examiners assess patent applications, the recent clarifications have greatly assisted applicants in predicting how certain types of AI invention may fare in Europe.

In January 2020, the EPO also published a Decision setting out the reasons for its recent refusal of two European patent applications in which an AI system was designated as the inventor. This was in line with the position taken by the US and UK patent offices on AI inventors.

76%

The success rate of Marks & Clerk for AI applications

For European patent attorneys handling more than 50 cases[4], the variation in success rate is surprising – from 27% up to 76% (Marks & Clerk).

In the last five years, Marks & Clerk has filed more AI applications than any other firm, and has a success rate that is 13% better than the average (76% compared to 63%).

Acceptance rate also varies significantly based on technology area, from around 26% for AI patent applications relating to "Business" and "Banking and Finance", to around 65% for "Transportation". This reflects the EPO approach to assessment of inventive step (outlined in Box 3 below), where AI inventions that have a "technical" application are more likely to be considered inventive.

Lower acceptance rates are generally found in fields more closely related to "non-technical" business methods, such as "Banking and finance". Further discussion regarding these technology areas can be found in Section 2.

> "For European patent attorneys, the variation in success rate is surprising – from 27% to 76%.

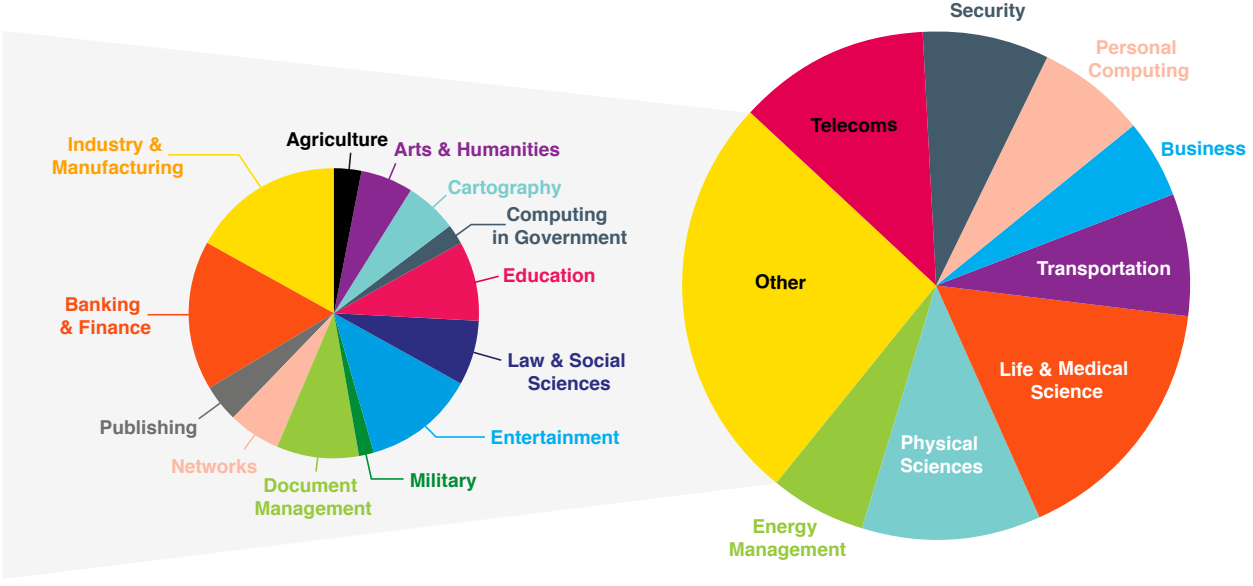
4. With an effective date since 2015.

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, most patent applications are directed towards the application of AI in a specific field. Figure 7 shows the breakdown of applications over the last 20 years based on technology sector[5].

Figure 7

2000–2020 publications



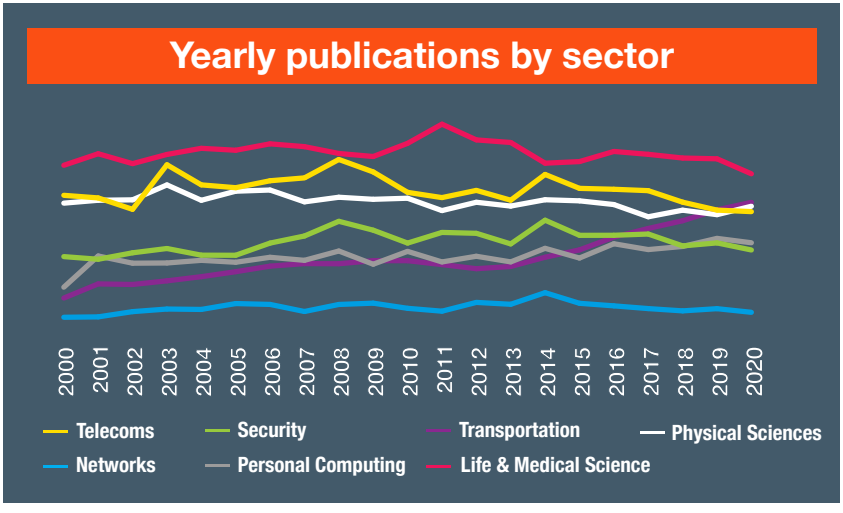
5. Based on classifications used in the WIPO Technology Trends report on AI, with some refinement of definitions based upon manual analysis of the data set.

The largest technology sectors were Life & Medical Science, Telecommunications and Physical Sciences, accounting for 16%, 12% and 11% of all AI publications, respectively. The large proportion of publications in Life & Medical Science reflects the diverse range of usages to which AI is being applied in this field.

There was a clear increase in AI publications across all categories over the last 20 years, however some technology areas are growing much faster than others, as shown in Figure 8. For instance, "Networks" appears to be falling behind other categories, with little change in growth rate over the last few years. Conversely, "Transportation" has shown a significant increase in publications over the last four years, rising from 13% of all AI publications in 2013, to 27% in 2020[6]. This likely reflects the growth of AI within the automotive sector, for instance, in autonomous vehicles and automated safety features within cars.

We also looked at how patent applications split between technology areas for applicants based in different countries. Whereas for European and US applicants, the largest sector was Life & Medical Science, this was not the case for Chinese applicants for example, where Telecoms was the largest sector – accounting for 20% of AI applications filed by Chinese applicants. This likely results from the significance of the Telecoms manufacturing industry in China. It was also noted that China filed a larger proportion of applications relating to "Core AI" (defined as applications assigned the IPC category G06N/3 – Computer systems based on biological models) than US or European applicants. This perhaps signals that Chinese applicants are investing in more speculative, longer term AI research.

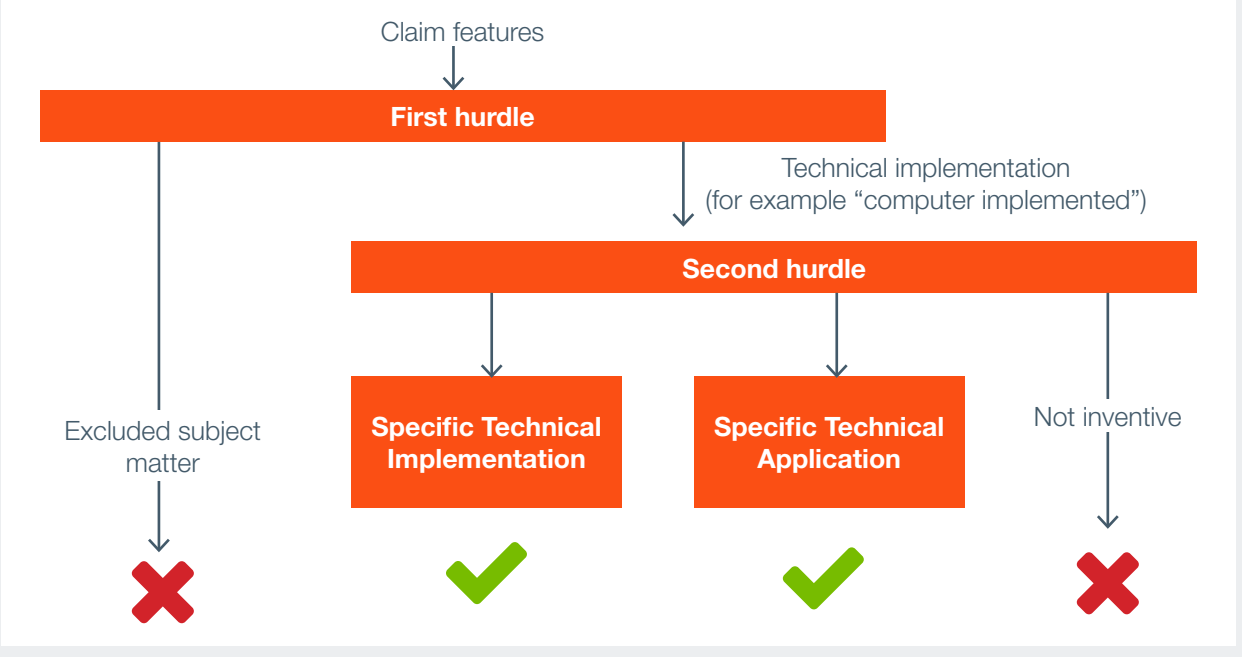
Figure 8



6. Data shown up to 30 June 2020.

Box 3 – How does the EPO examine AI patent applications?

As with other software based innovation, patent claims directed to AI inventions may comprise features which in Europe are considered to fall under the category of mathematical methods. The examination process in Europe involves overcoming two "hurdles", illustrated in the figure below:



The first hurdle is to show that the claims do not relate purely to excluded subject matter. In practice, all apparatus claims overcome the first hurdle. Similarly, the first hurdle can be overcome for any method claims which recite some kind of technical means (for instance claims directed to a computer-implemented method).

The second hurdle is examined as part of inventive step. To overcome this hurdle it must be shown that the differences over the prior art are technical. There are two "safe harbours" that can be used to overcome this second hurdle.

The first "safe harbour" is met by referring to a specific technical application in the claim. There are various examples of technical applications listed in the EPO Guidelines, including audio or image analysis, encrypting or signing electronic communications, and automated medical diagnosis by processing physiological measurements (amongst others).

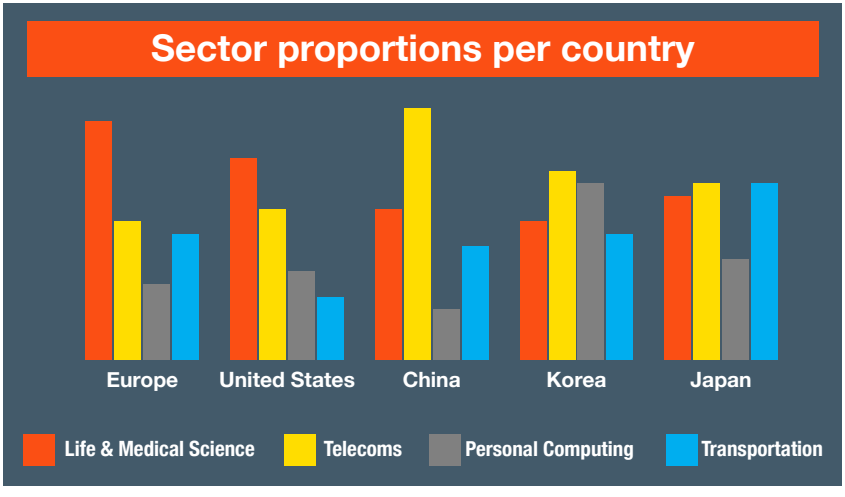
The second "safe harbour" is met by referring to a specific technical implementation. In practice, this means showing some interaction between the hardware and the software, for example how the processing is split across different processors or how data is cached. Inventions relating to "Core AI" developments will need to use the second "safe harbour" in order to meet the inventive step requirement at the EPO. Applications relating to these kind of inventions are explored in more detail in our second report, European Patents for Core AI.

For South Korean applicants, Telecoms was also the largest sector as illustrated in Figure 9, which shows the split across some key technology sectors for the period 2000 – 2020. However, for the applications published in 2019, Personal Computing had overtaken Telecoms as the largest sector for South Korea applicants, at 16%. For Chinese applicants on the other hand, Personal Computing remains a relatively smaller sector, at just 4%.

For Japanese applicants, Transport and Telecoms were the joint largest sectors across the period. A sharp increase in the number of publications in the Transportation sector in particular was seen from 2015 onwards for Japanese applicants.

> A sharp increase in the number of publications in the Transportation sector in particular was seen from 2015 onwards for Japanese applicants.

Figure 9

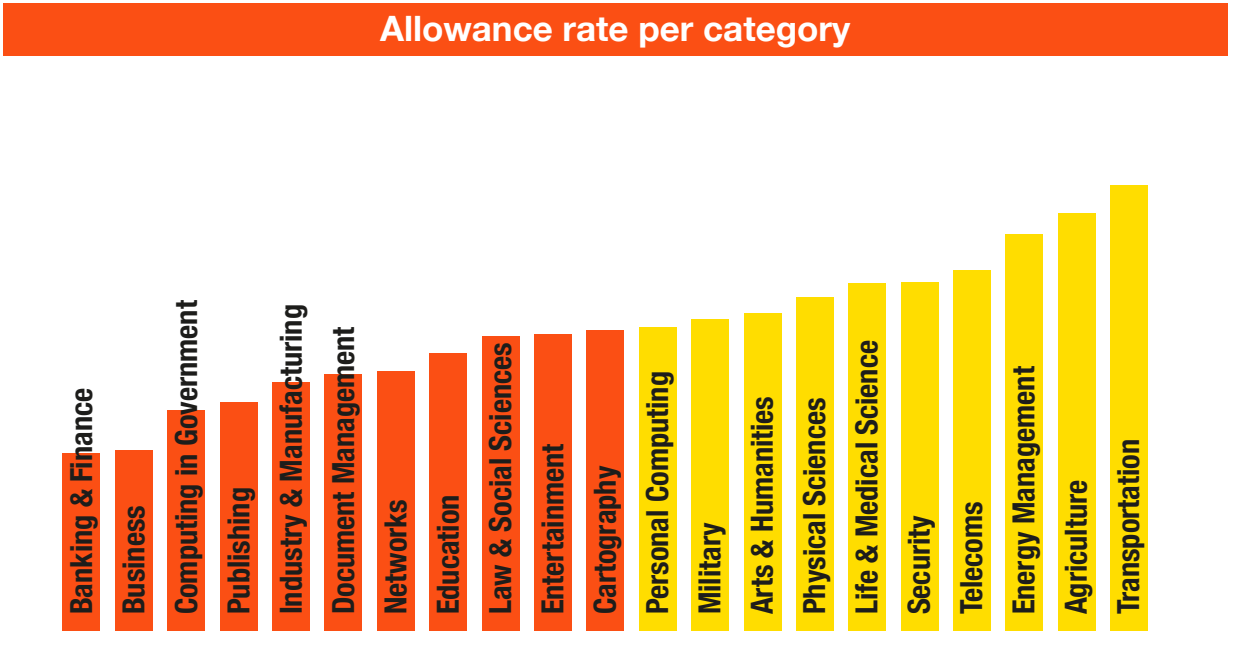


2.1 Technical and Non-Technical Sectors

The overall allowance rate between different categories varied widely, from 26% for "Banking and Finance" to 65% 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.

The following categories each had an above average allowance rate (shown in yellow in Figure 10): telecoms, security, personal computing, transport, life and medical science, physical sciences, energy management, agriculture, arts and humanities and military. The categories with a below average allowance rate (shown in orange in Figure 10) were: networks, publishing, document management, publishing, business, banking and finance, industry and manufacturing, cartography, computing in government, education, law and social sciences and entertainment.

Figure 10



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 was surprising to find "Industry and Manufacturing" had a relatively low acceptance rate of 36%. This is an area that we would expect to be considered "technical" under the EPO approach to inventive step. The low acceptance rate 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. It is noted that "Arts & Humanities" 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. The category "Networks" includes social networks, and this goes some way to explaining the relatively low acceptance rate – again such developments are likely to be considered "non-technical" by the EPO.

"It was surprising to find "Industry and Manufacturing" had a relatively low acceptance rate of 36%. This is an area that we would expect to be considered "technical" under the EPO approach to inventive step.

2.2 Type of AI technology

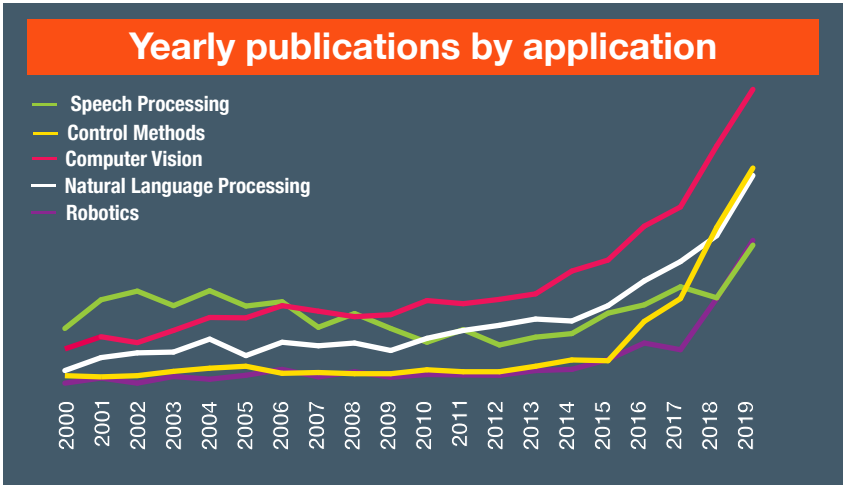
> “Speech processing was the clear front-runner in 2004, making up around 18% of all filings, but was quickly overtaken by computer vision in 2006.

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 11 shows the change in the number of filings year on year since 2000. Speech processing was the clear front-runner in 2004, making up around 18% of all filings, but was quickly overtaken by computer vision in 2006. Notably, “Speech Processing” shows a clear drop in the number of filings over the period of 2004-2012 – this may reflect AI techniques at this time not being sufficiently advanced for harder tasks such as speech processing. This is then followed by an increase from 2013, which is concurrent with an overall increase in AI filings.

However, the increase in filings for “Speech Processing” is less prominent than that for other technology areas, such as “Natural Language Processing” or “Control Methods”. This may reflect a movement away from “Speech Processing” to other applications of AI over the last 20 years.

Figure 11



Box 4 – A case study – how to show technical implementation

The EPO Guidelines for Examination section G.II.3.3.1 discusses "Artificial intelligence and machine learning". This section refers to a decision dated 2012 relating to a classification method – T 1784/06.

Claim 1 of this application defined a method for classifying records by means of a computer program product.

The method operates "by means of a computer program product" and therefore overcomes the first hurdle (see Box 3 of page 13).

However, the Board of Appeal considered that the automatic classification of data records according to the claim served only the purpose of classifying the data records, without implying any technical use of the classification. The first "safe harbour" (specific technical application) is therefore not met.

With respect to the second "safe harbour" (specific technical implementation), the Board found that the claimed algorithm may allow a data record to be processed in a parallel computer architecture, as the various fields of a data record can be judged separately in a first level of processing. However, the claim was not limited to an implementation on a parallel hardware structure. In this case, the second "safe harbour" was also not met, and the Board held that there was no inventive step.

It appears that limiting claim 1 to an implementation on a parallel hardware structure may have satisfied the second "safe harbour" however, since the claimed algorithm appeared suited to a parallel computer architecture – various fields of a data record could be judged separately in a first level of processing.

"

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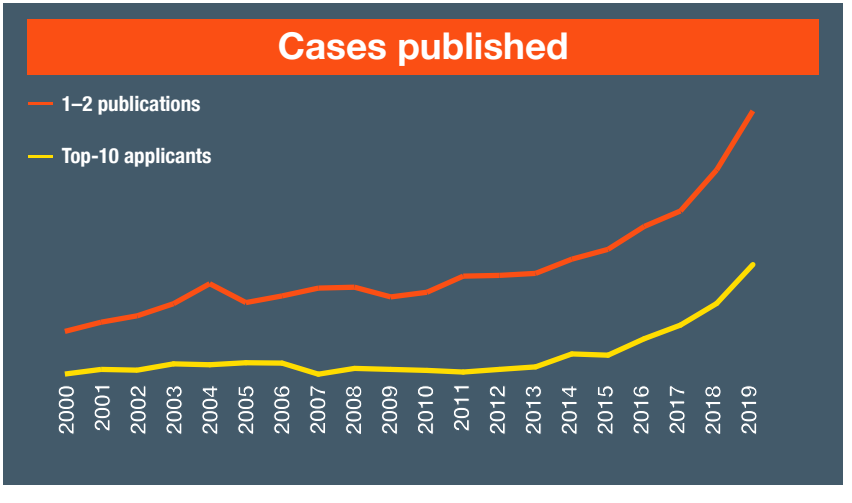
3 AI applicants

In this section, we look at the type of entities filing AI applications. In particular, we compare data for larger filers and smaller filers. We also look at how the filing numbers split between applicants from various countries.

Figure 12 shows a comparison of total number of AI applications published each year for the top 10 AI applicants that year (yellow line), and for applicants with one or two AI applications published that year (orange line).

As can be seen, in both cases, application numbers are increasing. Smaller applicants account for a large proportion of AI applications – applicants with one or two publications accounted for 38% of AI applications published in 2019.

Figure 12



7%

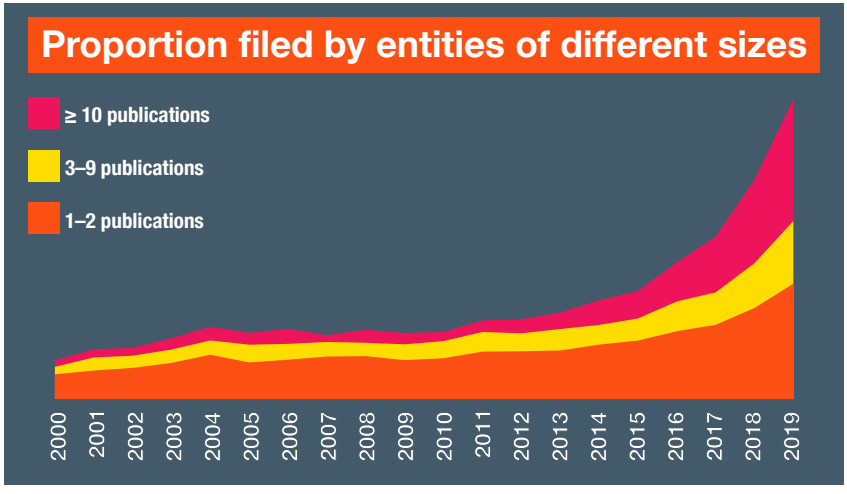
The proportion of AI applications filed by co-applicants.

Figures 13 and 14 illustrate the proportion of AI applications filed by entities with different sized AI filing programs.

In Figure 13, the orange section shows the number of AI applications published by applicants with one or two AI applications published that year (we term these 'smaller filers'). The yellow section shows the number of AI applications from applicants with 3 to 9 AI applications published that year (we term these 'mid filers'). The pink section shows the number of AI applications from applicants with 10 or more AI applications published that year (we term these 'large filers').

As shown, for all of these categories, the number of applications has risen steeply in recent years. An increase in funding available for start-ups in the AI space in particular may have driven the growth seen for the smaller filers.

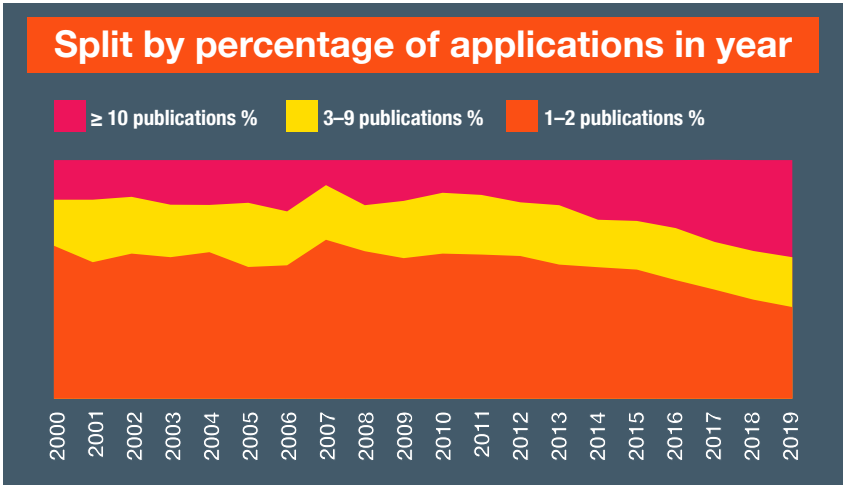
Figure 13



"As shown, for all of these categories, the number of applications has risen steeply in recent years. An increase in funding available for start-ups in the AI space in particular may have driven the growth seen for the smaller filers.

Figure 14 illustrates the split by percentage of total AI applications published that year. Since around 2010, the proportion of AI applications published by large filers has grown, so that by 2019, this category accounts for around the same proportion of total AI publications as the smaller filers. The increase from larger filers may reflect AI techniques being adopted across new sectors.

Figure 14



Since around 2010, the proportion of AI applications published by large filers has grown, so that by 2019, this category accounts for around the same proportion of total AI publications as the smaller filers.

To investigate any difference in the allowance rate, we took the number of closures as an indication of the AI portfolio size.

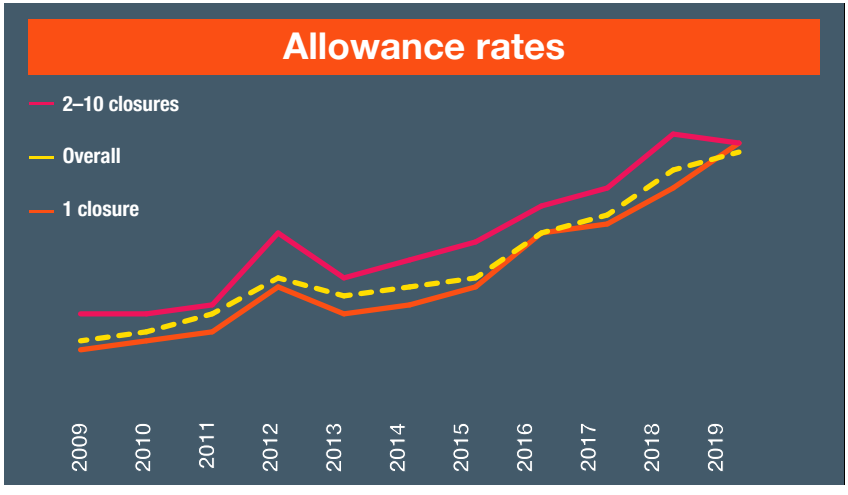
Figure 15 shows the allowance rate for applicants with different numbers of closures. There does appear to be a difference between applicants with one closure in the relevant year, and those with 2 to 10 closures in that year. As illustrated, the allowance rate for applicants with one closure is consistently lower than the overall allowance rate (shown by the dotted line). The allowance rate for applicants with 2 to 10 closures on the other hand is consistently higher.

In order to improve chance of success, smaller filers should look to use a European attorney firm with relevant experience in prosecuting AI applications.

The data for applicants with 10 or more closures was not included as a separate category in the figure, as no clear trend was shown – the number of applicants falling within the category is smaller, and so the data for this category may be heavily influenced by changes in behaviour of a relatively small number of applicants (for example one company making a high number of abandonments in one year).

“
In order to improve chance of success, smaller filers should look to use a European attorney firm with relevant experience in prosecuting AI applications.

Figure 15



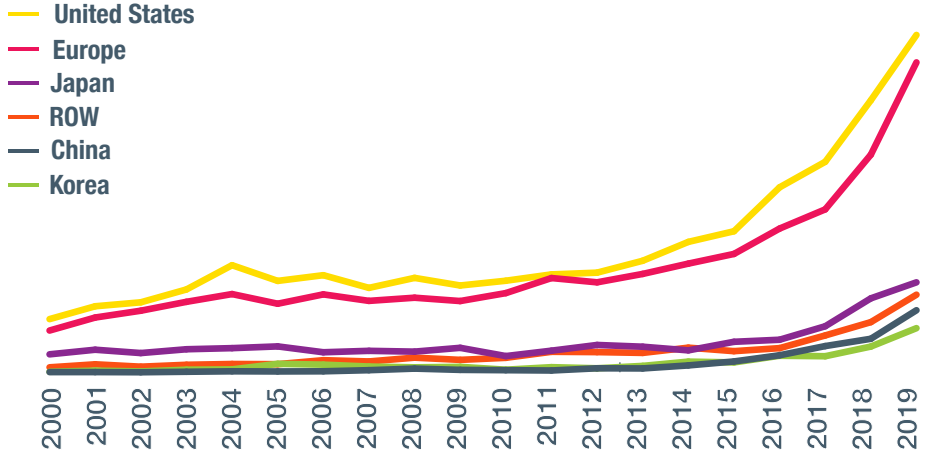
3.1 Applicants by country

In Figures 16 and 17, filing trends based on the country of applicant are considered.

Figure 16 shows the number of applications by country of applicant. AI patent publications in Europe are dominated by US and European patent applicants over the last 20 years. Nevertheless, all countries of origin show an increase in AI filings over recent years.

Figure 16

Publications by applicant's country



> AI patent publications in Europe are dominated by US and European patent applicants over the last 20 years. Nevertheless, all countries of origin show an increase in AI filings over recent years.

Figure 17 shows the proportion of the total AI applications by country of applicant over time. As shown, US applicants make up the largest proportion of AI filings, with 37% of AI publications in 2019 coming from US applicants. To put this in context, US applicants accounted for 26% of all European patent applications filed in 2017[7], and are therefore filing a larger proportion of applications in AI technologies.

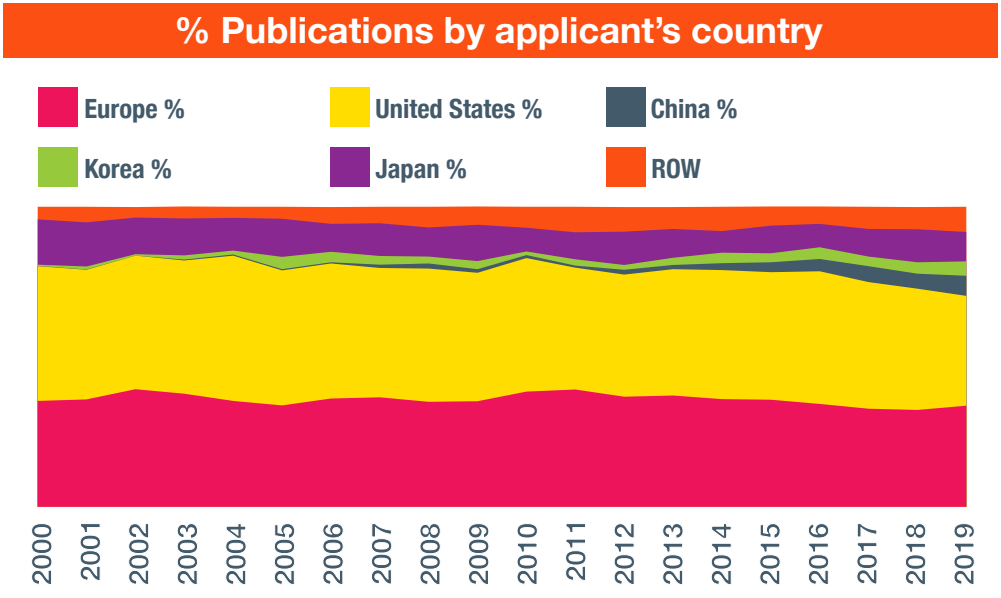
European applicants make up around 36% of total filings in AI technologies. This is lower than the proportion for all European applications – European applicants accounted for 47% of all European patent applications filed in 2017 .

In recent years, the proportion filed by Chinese applicants in particular has increased – in 2019, Chinese applicants accounted for 6.7% of total AI applications published, compared to 1.2% in 2009. Accordingly, of the countries considered, China has shown the largest growth in share of AI applications in recent years.

The proportion of applications from South Korean applicants is also increasing, and a significant number of filings also come from Japanese applicants – around 11% across the period studied.

7. Based on figures from the EPO Annual Report 2017.

Figure 17



> The allowance rate for US applicants is notably low, almost 10% below European applicants.

Figure 18 looks at how the allowance rate varies between applicants from different countries, for applications with a closure date in the period 2015 to 2019.

The allowance rate for US applicants is notably low, almost 10% below European applicants. As illustrated below, 57% of applications from European applicants are in technical sectors (i.e. sectors with a higher allowance rate than average – see section 2.1 above for further detail) – generally these are sectors where excluded subject matter objections are less likely to arise and are therefore more straightforward. This is compared with only 46% of applications from US applicants.

Cases may be classified with more than one sector and we defined "technical cases" as cases with only technical sector classifications, "non-technical cases" as cases with only non-technical sector classifications, and "mixed cases" as cases with at least one technical sector classification and at least one non-technical sector classification.

Figure 18

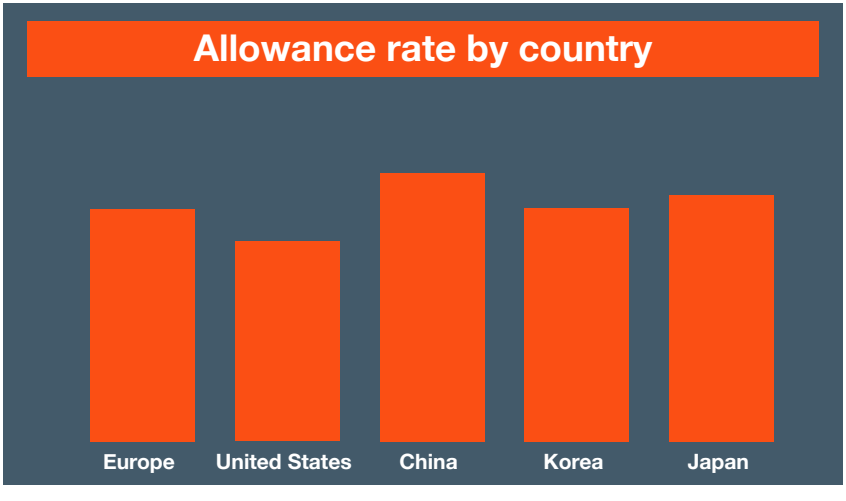


Figure 19

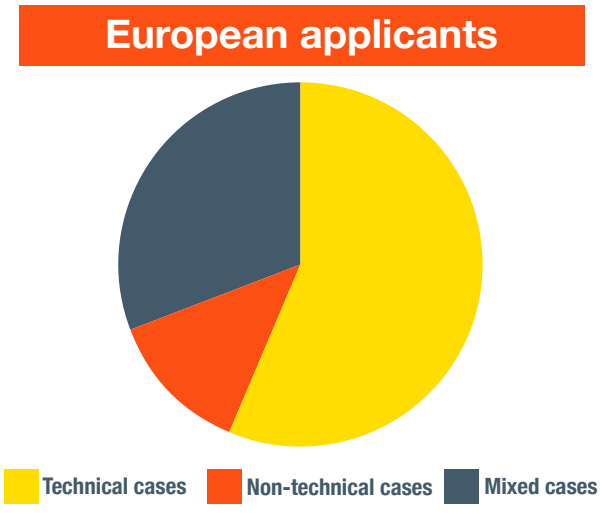
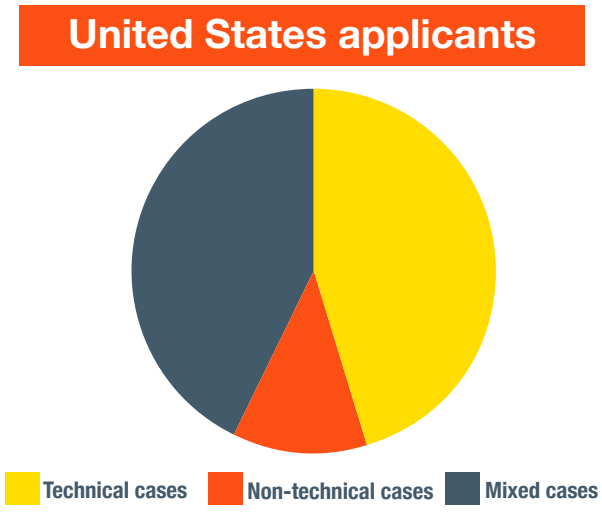


Figure 20



Given the variation in sector in which European and US applicants file, we also compared allowance rate for US and European applicants in technical and non-technical classifications. As can be seen, whilst there is variation in the extent to which European applicants have better allowance rates than US applicants, European applicants have better allowance rates even when normalising for different proportions of "technical" and "non-technical" cases.

The difference in allowance rate between European applicants and US applicants is greatest for non-technical cases at 11.5%, followed by mixed cases at 8.2% and technical cases at 7.3%. We see this as evidence of the value of applications being prepared with European requirements in mind and it is not surprising to us to see this value being greatest in more challenging non-technical cases where excluded subject matter is more likely to arise.

"

The difference in allowance rate between European and US applicants is greatest for non-technical cases.

Figure 21

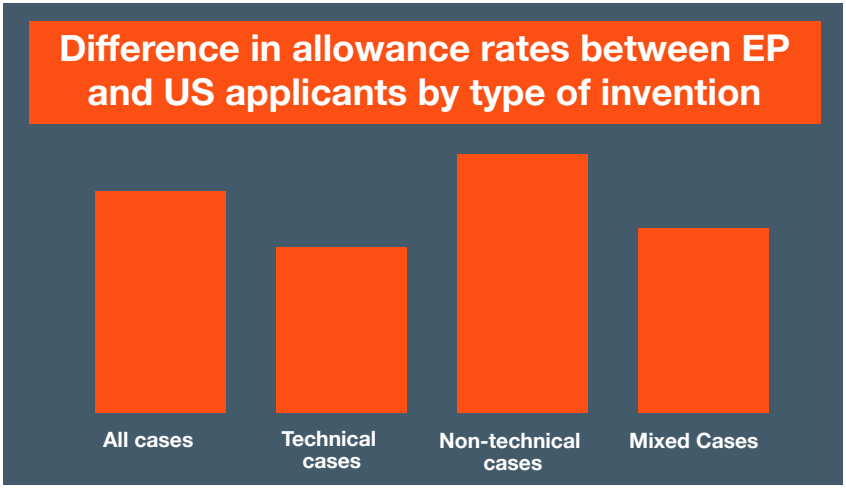
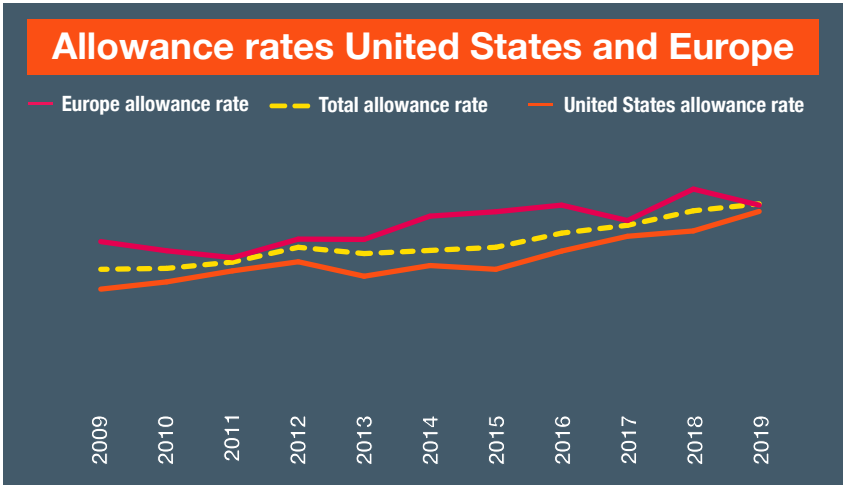


Figure 22 also looks at how the allowance rate varies between European and US applicants over time. As illustrated, the allowance rate for European applicants remains consistently above the overall allowance rate for the period, whereas that for US applicants remains consistently below the overall rate.

Figure 22



4 Conclusions

The number of AI patent applications is increasing rapidly in Europe, with around 650 applications publishing each month through the first half of 2020.

These applications are mainly filed by US and European applicants, however there has been a recent increase from Chinese applicants, who now account for around 7% of AI filings. A large proportion of these applications come from applicants with smaller AI filing programs, although the proportion from larger filers is growing.

European applicants are generally shown to be more successful at the EPO than US applicants, even when taking into account variation in the proportion of "technical" and "non-technical" cases. We see this as demonstrating the value of applications being prepared with European requirements in mind. Accordingly, improvements in grant-rate for non-European applicants could potentially be achieved by seeking input from a European patent attorney during drafting.

M&C leads the way in prosecuting AI applications in Europe. In particular, Marks & Clerk filed the largest number of AI applications with an effective date since 2015, and has a success rate for those cases that is 13% better than the average across the same period.

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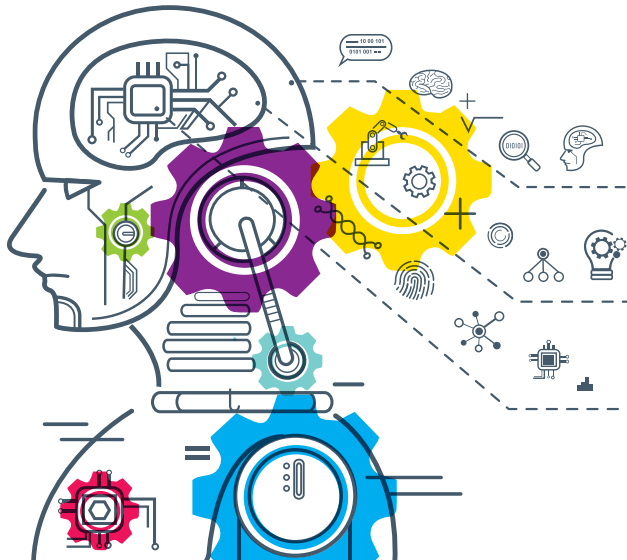


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