Impact of artificial intelligence on patent law. Towards a new analytical framework – [ the Multi-Level Model]

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ABSTRACT

Inventions and new ideas are at the center of societal transformation. Inventions have been historically protected by a system of intellectual property law of which patents are at the heart. Whilst patent law is still deeply moored in its roots in the industrial revolution, to a greater extend it has been able to adapt to the successive revolutions like the computing albeit with some challenges. The world is now at an unprecedented threshold of the most far reaching revolution whose consequences to patent law in particular are so far reaching that its impact is still unknown. This is the AI revolution. This paper begins with an analysis of the AI revolution from available literature and research. It notes that there are divergent views among scholars about the impact of AI on various elements of patent law. It posits that this dissonance might be a result of most scholars treating AI as one homogeneous block without distinguishing the various phases in the evolution of AI. It thus proposes a new sui generis conceptual framework – [ the Multi-Level Model] as a suitable basis for insightful conceptual analysis of AI impact on patent law with focus on two key questions; patentability and inventorship.

1. Introduction

“Leader in artificial intelligence will rule the world.” – Russian President Putin. [1].

A number of terms ranging from AI revolution, 4th Industrial revolution (4IR) [2] and Industry 4.0 [3] have been used albeit loosely by different authors and organisations to describe similar phenomena of digital transformation currently underway throughout the world. Whilst there are differences in the meanings of the above terms, a closer analysis of research literature reveals that the differences are a matter of degree rather than content. What seems obvious is that purely academic papers often use the term AI revolution whilst organisations and consultancy reports prefer to use 4th industrial revolution or Industry 4.0. AI revolution is used in this paper to refer to all the technologies that are at the core of this revolutionary technological transformation.

The AI revolution is upon the world and while it is still a new area in terms of research in relation to intellectual property law, a lot of emerging and interesting research is being carried out with regards to its impact on patent law in particular. In 2016, the World Intellectual Property Organization (WIPO) published a research paper entitled, “Breakthrough technologies – Robotics, innovation and intellectual property.” [4] Furthermore, the European Patent Office (EPO) also published a paper on this subject in December 2017 entitled, “Patents and the Fourth Industrial Revolution: The inventions behind digital transformation.” [5] The EPO went further and hosted an Indo-European Conference between the European Patent Office and the Indian Patent Office under the banner of, “India and Europe explore the impact of Industry 4.0 on the patent system” to grapple with these questions [6]. This research and discussions coming from the leading patent offices of the world points out to the increasing prominence of AI patents within the patent ecosystem.

The Organisation for Economic Co-operation and Development (OECD) has also published a report entitled, “Technology and Industry Scoreboard 2017. The digital transformation.” [7] This points to the increasing importance in which the AI revolution as variously described is being treated in terms of both patent law and economic transformation by the most advanced economies of the world.

Leading consultancy firms have also not been left out among them McKinsey which has published a number of research papers focusing mainly on impact of AI on the future of work and productivity. These reports include, “A future that works: automation, employment, and productivity” [8] and “Industry 4.0 - How to Navigate a Changing Industrial Landscape” [9] among others. PwC has also published an acclaimed report, “Industry 4.0: Building the digital enterprise.” [3] Accenture added to this rich literature with a report entitled, “Why Artificial Intelligence is
the future of growth.” [10].

The reasons for these publications by the aforesaid patent offices and consultancy firms is not difficult to decipher. Figures provided in these studies attest to the fact that AI patent applications are increasing both in terms of numbers but also in terms of the economic value they represent. A perusal of the above publications shows some interesting statistics some of which are highlighted below. In terms of contribution to growth as measured by the Gross Domestic Product (GDP), one research paper has concluded that AI revolution should not only be treated as an enabler of growth but even as an additional factor of production at par with capital and labor. This is true in developed economies where growth has been flat lining [10]. The aforementioned study noted that the 12 developed economies studied that are presently encountering tepid growth are likely to double their growth by 2035 by harnessing the AI factor of production as shown by Fig. 1.

According to this research, the global AI market was valued at USD 126.4 billion in 2015 and is forecast to grow at a Compound Annual Growth Rate (CAGR) of 36.1% from 2016 to 2024 to reach a value of USD 3061.35 billion in 2024 [11]. The growth is also pronounced in terms of AI patents. At a global level, AI technologies as measured by inventions patented in the five top IP offices (IP5), increased by 6% per year on average between 2010 and 2015, twice the average annual growth rate observed for all patents. In 2015, 18,000 AI inventions were filed worldwide. Japan, Korea and the United States accounted for over 62% of those inventions. Up to 30% of patents filed on medical diagnostics include AI-related components [7].

The EPO gives figures showing increasing growth of AI patents since the 1990s (Fig. 2). Although the EPO uses the term 4IR revolution, as alluded earlier, all the facets of what they term 4IR revolution include aspects of AI at the core.

The numbers clearly show a huge increase year-on-year of patent applications in the AI field especially from the year 2000. Analysed on comparative basis with increase in patents in non-AI fields over a decade, this shows an exponential increase in AI patents. The growth trend is continuing at an accelerating pace as the AI era takes root in everyday life.

In light of the emerging research in this field and also the increasing projected growth and economic value of AI patents as already outlined above, this paper will first lay out a new conceptual analytic framework in legal literature namely the Multi-Level Model. It will then use this model as a basis for analysis of AI revolution impact on patent law for each level of the model with focus on 2 aspects namely patentability and inventorship. It will conclude by exploring other areas of research such as prior art which can also be analysed through this Multi-Level Model.

1.1. Towards a new analytical framework for AI

Leading research about the AI revolution has been underpinned by a number of theoretical frameworks that has led to recommendations at policy level as regards patent law that are widely different. Whilst this is expected in an emerging field whose fulsome impact and development trajectory is still unknown, most of it can be related to the most basic fact in research which is that the AI revolution is not yet completely baseline in terms of its definition.

Hence scholars use even different names to describe the same revolution. Due to various different meanings being used to define AI, it has led to situations where researchers are discussing different aspects of AI which naturally lends itself to different conclusions as it relates to patent law while headlining the discussion under the broad umbrella of AI. Therefore, the starting point towards the Multi-Level Model is by discussing how AI is defined in literature and see whether from the multiple definitions thereof, a baselining of AI revolution is possible.

1.2. What’s in a name? Defining AI

“Facebook CEO Mark Zuckerberg’s understanding of AI is limited.” – Elon Musk – CEO - Tesla, Solar City, SpaceX, Boring Company and Neuralinks. [12].

As a starting point in developing the Multi-Level Model, it is important to understand from literature, briefly, with regards to what AI systems are, how they work and what makes them intelligent. This understanding is crucial in laying the building blocks of the framework of the Multi-Level Model.

AI is not a new concept especially to the readers of science fiction. In recent times however, it is becoming more science and less fiction [13]. There are numerous definitions of AI and many types of AI systems (Table 1) [14].

The above definitions are demonstrative of the fact that defining AI is
Fig. 2. 4IR Patent applications at the European Patent Office (EPO). Source: European Patent Office. [2].

Table 1

<table>
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<tr>
<th>SCHOLAR</th>
<th>DEFINITION of AI</th>
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<tr>
<td>McCarthy (1989)</td>
<td>Coined the term “Artificial Intelligence.” He argued that AI is the science and</td>
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<td>engineering of making intelligent machines, especially intelligent computer programs. It is</td>
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<td>related to the similar task of using computers to understand human intelligence, but AI does not have to</td>
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<td>confine itself to methods that are biologically observable. Accordingly, he argued that there existed no “solid</td>
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<td>definition of intelligence that does not depend on relating it to human intelligence” because “we cannot yet</td>
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<td></td>
<td>characterize in general what kinds of computational procedures we want to call intelligent.” [15]</td>
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<tr>
<td>Turing (1950)</td>
<td>Proposed what has come to be known as the “Turing Test” for calling a machine “intelligent.” [16] The test states that</td>
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<td>a machine could be said to “think” if a human could not tell it apart from another human being in conversation.</td>
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<td>Schank (1987)</td>
<td>Laid down five attributes one would expect an intelligent entity to have namely communication, internal</td>
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<td>knowledge, external knowledge, goal-driven behaviour and creativity [17].</td>
</tr>
<tr>
<td>Hutter (2010)</td>
<td>Says an AI system can be defined based on its features as one capable of performing tasks that normally require</td>
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<td>human intelligence such as recognition, decision making, creativity, learning, evolving and communicating [18].</td>
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<tr>
<td>Poole and Mackworth (2010)</td>
<td>Defined AI as the field that studies the synthesis and analysis of computational agents that act intelligently [19].</td>
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</table>

no easy task. Hence, Russell and Norvig (2013) suggested almost ten different ones [20]. These definitions vary as different aspects of AI systems are emphasized [20]. Suffice to say that it is not in the scope of this paper to get lost in defining AI precisely but to say that the above has already demonstrated the multiplicity of approaches to AI by different scholars.

1.3. Finding the common denominator!

Due to the potpourri of definitions as described above, some scholars have adopted a different approach by trying to distil the AI definition by grouping the common cross cutting characteristics of AI. By so doing they have attempted to find the overarching characteristics of intelligent systems and then use that as a basis for conceptual analysis. Chief among them being Shlomit and Xiaoqiong (2017) who identified the following eight overarching characteristics that are explained briefly in Table 2 [21].

While this kind of distillation and categorisation based on features is quite informative and helpful especially in relation to analysis of impact on patent law, it is nevertheless inadequate in some ways. As has been noted is some examples given above, some of the features apply not only to AI systems alone but even normal computer software.

The authors allude in their concluding analysis of these common characteristics that all of these eight features characterize, to a certain degree, different AI applications. They therefore summarised the features into three broad categories they termed the 3A era (of advanced, automated and autonomous AI systems) [21]. After this important realisation however, the authors then continued to look at AI in broad terms (advanced, automated and autonomous) as one system and how this affects patent law. This is the approach that is taken by many other scholars who do not unbundle AI into homogenous segments for analysis of how each segment affects patent law [29].

This paper suggests that they could have narrowed their approach based on how patent law will be affected under the three broad categories that they had identified. For there is a difference between what they rightly summarised as advanced, automated and autonomous systems. Whilst these cannot be clearly delineated since in most cases an AI system may be a composite of both features, for a penetrating analysis, a differentiation of the three categories will be important in enriching the analysis and coming up with informed and practical policy recommendations.

In their recommendations, for example, they stated that;

In contrast to other scholars, we argue that traditional patent law is irrelevant and inapplicable to these situations, that these inventions should not be patentable at all and that other tools can achieve the same ends while promoting innovation and public disclosure. These other, non-patent incentives include commercial tools such as electronic and cyber controls over inventions, first-mover market advantages and license agreements [30].

They thus presented their findings as relevant to all the 3A categories (advanced, automated and autonomous AI systems) they had identified in their important summation as has been discussed. A closer look might
### Table 2  
Overarching Characteristics of AI.

<table>
<thead>
<tr>
<th>CHARACTERISTIC</th>
<th>DESCRIPTION</th>
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<tr>
<td>Creativity</td>
<td>They argue that AI systems create new products and processes and significantly improve existing ones by being able to copy and reproduce other products, processes and available data in order to create new outcomes [18].</td>
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<td>Unpredictable Results</td>
<td>They state that AI systems are based on algorithms capable of incorporating random mutations that result in unpredictable routes to the optimal solution and hence to unpredictable solutions (from software programmers’ points of view) [22].</td>
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<tr>
<td>Independent, Autonomous Operation (t-autonomy)</td>
<td>They define an independent AI system to the extent that it accomplishes a high-level task on its own without external (human) intervention [23]. Algorithms of the AI system may work independently without human intervention beyond defining goals [24]. They also consider an autonomous AI system by cognitive ability. The larger the cognitive task assigned to the AI system, the more it can be considered autonomous.</td>
</tr>
<tr>
<td>Rational Intelligence</td>
<td>They define an “intelligent machine” as a rational system that perceives data from the outside world and decides which activities to engage in or avoid to maximize its probability of success in achieving a certain goal [20]. Such AI systems, they argue, mimic human perception and cognitive functions such as learning and problem solving, thereby imitating intelligent human behavior [24].</td>
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<tr>
<td>Evolving</td>
<td>They outline that AI systems continue to evolve and change according to new data. This feature also contributes to the unpredictability mentioned above. AI systems may produce results that differ from the initial plan of the programmers or operators of the system [25].</td>
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<td>Capable of Learning, Collecting, Accessing and Communicating with Outside Data</td>
<td>They term this a significant feature of AI systems which is their ability to actively ‘search’ for data in the “outside” world. Based on the data gathered, an AI system can continue the process by receiving feedback and then improving the results [20]. However, a new generation of autonomous, network-centric applications can collect data incessantly from different sources [26].</td>
</tr>
<tr>
<td>Efficiency and Accuracy</td>
<td>They argue that AI systems can process vast volumes of data accurately, efficiently and rapidly, well beyond the capacity of the human brain [26]. They argue that this feature is also true for less sophisticated computer software but it exists also in AI complicated systems.</td>
</tr>
<tr>
<td>“Free Choice” Goal Oriented</td>
<td>This feature focuses on the capability of the AI system to choose between alternatives in order to achieve the best outcome [14]. They give an example of automated weapons which decide, for example, which targets should be attacked according to the surrounding data [27]. Moreover, they assert that specific AI systems implemented in driverless cars process data in order to choose from different alternatives and decide on routes, speed and accident avoidance [28].</td>
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### 2. The Multi-Level Model

It is this definitional analysis of contributions made by the various scholars discussed above that has led to the creation of a model which for the purposes of this paper has been named the Multi-Level Model. The assertion behind this model as a theoretical framework being that the AI revolution can be divided into constituent parts. While these parts are not mutually exclusive since they are not necessarily linear in evolution and overlap, such an approach provide a simple but yet insightful ways to analyse the impact of AI innovations and to come out with policy recommendations that takes into cognizance that different levels of AI will impact patent law in different ways. This thus help to give laser focused recommendations for any lacuna in patent law.

The model borrows from already existing analysis done by scholars who have been quoted in preceding section of this paper. Among them Shlomit and Xiaoqiong (2017) who identified eight overarching characteristics of AI. They then summarised the same in their analysis into 3 broad categories which they called the 3A era (of advanced, automated and autonomous AI systems) as already discussed. This therefore means broadly speaking, they are categorising AI systems into advanced, automated and autonomous systems. Furthermore, Keisner et al. (2015) in a report published by WIPO in the context of robotics identified the following levels namely, remote controlled, semi-autonomous, autonomous and artificial intelligence.

Firstly, the Multi-Level Model incorporated Shlomit and Xiaoqiong (2017) advanced and automated into semi-autonomous in Level 1 because such systems have both aspects of automation and autonomy to varying degrees. From both authors, autonomous is identified. This has been called fully-autonomous for this paper to try and draw the admittedly thin line with semi-autonomous. Fully autonomous is further categorised into soft and hard AI under Level 2 of the model. Finally, from the discussions inspired by Elon Musk’s idea of what he termed the cyborg, Level 3 termed neuro-autonomous has been identified. Neuro-autonomous is a novel term used in this paper to denote the idea of symbiosis between the biological (the brain) and AI driven algorithms and machines. Hence the levels of AI under this Multi-Level Model are semi-autonomous, fully autonomous and neuro-autonomous as shown in the diagrammatic representation in Fig. 3.

As shown in Fig. 3, the core product (which is the AI system) is categorised into three levels namely semi-autonomous, fully autonomous and neuro-autonomous. According to a report published by Microsoft (2018), there is general agreement that certain conditions have led to the present widespread adoption of AI: the increased availability of data, the development of sophisticated algorithms, and the increase in computing power provided by the cloud [31]. Hence, beginning at Level 1 (semi-autonomous), the level of connectivity increases as the AI system becomes more autonomous. This connectivity has been increasing due to such innovations as cloud computing, faster processors and faster networks.

The faster and more robust the connectivity, the more autonomous will the AI system become as shown by the diagram of the Multi-Level Model. At the same time as we move from Level 1 semi-autonomous, the component of software decreases as the component of data increases. This means that the component of software-based AI algorithms which some like EPO Chief Economist, Yann Mieniere, call “super-software AI algorithms” [32] decreases as the component of data-based AI algorithms increase. Data intensity becomes more pronounced relative to software intensity under Level 2 on the hard AI segment making it important to further categorise Level 2 into two segments namely soft
This is because as the level of connectivity increases as mentioned earlier, the AI core product is exposed and can process and learn from large amounts of data in most cases in real time hence data driven AI algorithms become the critical driver of the AI systems which become more autonomous since autonomy is a function of cognitive learning which is data driven. With the Level 3, neuro-autonomous, data driven AI algorithms powered by even more robust connectivity relative to Level 2 will mean that the AI core product becomes much more autonomous as to render the human being irrelevant hence at this level, there will be an attempt for human beings to solve the usefulness problem through machine-human symbiosis. All these components have a huge effect on the implications for patent law at each level as will be discussed in the section on recommendations for patent law.

Table 3 below explains each level of AI as defined in this Multi-Level Model.

3. Answering the patentability question

Patentability is the first and most important question that is considered in the patent grant process for if an invention does not meet the requirements for patentability, a patent cannot be granted. Various patent offices and international patent law regimes have legal requirements that must be met for an application to meet the patentability bar. Hence, this will be the first question of focus in this section. This discussion will be in the context of the leading patent offices in the world namely the US Patent Office and EPO. Where necessary and especially to reinforce the assertion that the AI revolution will require interoperability of legal systems also, examples will be drawn from other patent regimes like the Indian approach.

3.1. Impact on patent law for level 1 AI applications (semi-autonomous)

"Software is eating the world." Marc Andreessen - cofounder and general partner of Andreessen Horowitz. [33]

For Level 1 AI applications, AI (super)software algorithms to a greater extend play a more important role than data. However, the human role of the inventor is still quite crucial. Computers running AI algorithms can be used to more rapidly and efficiently generate, simulate and evaluate large numbers of potential solutions without the usual limitations imposed by human biases or time constraints although targets, parameters and success criteria are set by human inventors [34].

Whilst AI algorithms are much more complex than traditional software algorithms, the question of patentability of software implemented inventions which a relic of the computer software development is still relevant and instructive. At the height of the software era, legal questions about how to handle software in general and software implemented inventions in particular exercised the minds of the leading patent offices of the US and the EPO.

The patent law for all these regimes was written when the software development was still at the embryonic stage so the road for consistent interpretation and jurisprudence in this area had to evolve. The European Patent Convention (EPC) provides the legal framework under which European patents are granted [35]. For the EPO, the EPC in Art. 52 did not describe in positive terms what is patentable subject matter. However, in Art. 52 (2) describes explicitly subject matter that is not patentable, and this includes computer programs.

Generally, in statutory interpretation when a law states clearly what is to be excluded, it is viewed as an express intention of the legislature or administrative body that penned it whichever the case might be. It thus needed the Board of Appeals of the EPO to clarify this question about patentability of software.

As already noted, per Art. 52 (2) of the European Patent Convention, prima facie, software is one of the categories that are excluded specifically from patentability [36]. However, in subsection (3) of the same, it states that the exclusion related to inventions of such subject matter as such. This for a while created a lack of clarity as to whether software implemented inventions could be patented. The clear legal meaning of the term, as such was contested in patent law. The EPO Board of Appeals has now clarified in some seminal decisions that software implemented
inventions qualify for patentability as long as the invention has a technical character [37].

In the case of Computer program product II/IBM, the Technical Boards of Appeal of the EPO held that;

An invention consisting of a mixture of technical and non-technical features and having technical character as a whole is to be assessed with respect to the requirement of inventive step by taking account of all those features which contribute to said technical character whereas features making no such contribution cannot support the presence of inventive step [38].

However, still such claims would have to meet the requirements of Art.52 (1) which requires novelty, involvement of an inventive step and susceptibility of industrial application. The qualification in this section is only considered if the requirement of a technical character has been met first, otherwise without a technical step, such software implemented invention is not patentable.

On the other hand, the US approach has been difficult and has changed so much over the years. In 1968, the first software patent in the US was granted by the United States Patent and Trademark Office (USPTO) [39]. However, in a definitive case before the US Supreme Court in Benson, the US Supreme Court ruled that software and by implication software implemented inventions were not patentable [40]. However, in Diehl [41], the Supreme Court departed from its precedence of a blanket ban and allowed patents for traditionally patentable industrial processes which include a computer program as an element. This decision opened floodgates at the Federal Circuit (the highest court for patent matters other than the Supreme Court) from the 1990s where patentability of software was interpreted widely.

The critical turn then occurred in Alice [42] where the Supreme Court considered patent eligibility of computer software related patent claims under 35 U.S.C. § 101. The court noted that “the mere recitation of a generic computer cannot transform a patent-ineligible abstract idea into a patent-eligible invention.” This means that the first test is whether a patent is an abstract idea or not. If the answer is that it is not an abstract idea, then the test moves to determining whether a claim includes something more. A claim includes something more when there is no risk that the claim will impose a monopoly on an abstract idea [42]. Alice thus implies that something more may be found where a claimed invention will “improve the functioning of the computer itself” or “effect an improvement in any other technology or technical field.” [42].

The first step of Alice of whether a claim is an abstract idea or not compares with the European practice that tests whether a software-related claim involves a technical step or not. Secondly, the notion of something more requirement in the second step of the Alice test is analogous to the requirement of further technical effect in Europe.

3.1.1. Recommendations for patent law for level 1 (semi-autonomous AI)

This paper suggests that the treatment of Level 1 (semi-autonomous) AI systems be accorded the same treatment as software since generally speaking, Level 1 (semi-autonomous) AI systems are just AI (super) software with advanced AI algorithms. As we have noted in the Multi-Level Model, for this level, the intensity of AI software is higher than the data intensity.

Given the convergence described above between the EPO Board of Appeals and US Supreme Court and 9th circuit jurisprudence, this paper recommends the approach taken by the EPO to be adopted by the whole world for level 1 (semi-autonomous AI systems). Interoperability of the world legal systems, not only standards but also policy and legal practice is the only way lest if patent law is fragmented, it will be swept away by the tides of AI history.

The reason for recommendation of global adoption of patentability of the EPO as defined in Art. 52 (1) to S2 (3) and the accompanying EPO Boards of Appeal jurisprudence is that the use of qualifying legal term as such has already been litigated by the seminal legal cases decided by the EPO Board of Appeals as already outlined earlier.

In addition, the use of the legal phrase as such gives patent law the wiggle room to apply peculiarities of each situation to reach a reasoned decision. It is not mechanistic. This is important because under Level 1 semi-autonomous AI, there is also a wide spectrum of inventions of varying autonomy and the legal phrase as such has the ambit to cover such a wide gambit whilst sticking to the fundamental ratio at the core of the case law of the EPO Board of Appeal.

The other advantage of making the EPO Board of Appeals legal jurisprudence in this area other than the US is that the US and European standards are closer than they were pre-Alice in USA. This thus presents an opportunity for US patent practitioners. In the United States, post-Alice jurisprudence is immature. In Europe, there are better developed precedents than the US.
3.2. Impact on patentability for level 2 AI applications (fully-autonomous soft AI segment.)

As has already been described under the Multi-Level Model section, Level 2 fully-autonomous AI is far much more advanced than Level 1 semi-autonomous AI. The level of connectivity and data intensity in general becomes more than the Level 1 semi-autonomous. As already alluded earlier, fully autonomous AI can be further categorised into soft and hard AI.

Soft AI refers to those AI systems that are mainly focused on narrow AI tasks. Self-driving cars are a good example of soft AI since it is focused on the narrow task of achieving smart auto-mobility. Siri is also another example of narrow artificial intelligence. Siri operates within a limited pre-defined range, there is no genuine intelligence, no self-awareness and no cognitive ability. Trading algorithms also represent another example of narrow AI hence occasional market crashes divorced from fundamentals such as the May 2010 “flash crash” that caused a temporary but enormous dip in the market [43].

Therefore, for patentability, the most important question to ask about fully-autonomous soft AI systems is the fact that (super)software AI algorithms are the lifeblood of these applications since we realise that such systems are hardware and system agnostic. Whilst data is important as the example of Siri given that it is generally powered by data from the cloud, the level of data intensity is still fractionally lower than the level of AI (super)software intensity.

Therefore, on patentability, the question remains in the realm of AI algorithm (super)software. As was noted at the Indo-Europe summit where Ericsson’s Mohsle echoed the importance of predictability and said thus;

“The constant back and forth in practice with regard to software-related inventions and what is patentable or not has created a lot of uncertainty for applicants, and also for third parties. What I want to know is whether a company will be granted a patent for an invention or not. Hence we need predictability and clarity on what counts as software [6].

This paper therefore suggests that under the Level 2 fully-autonomous soft AI applications, decisive clarity about the patentability of software which is the currency for this level will have to be answered by patent law since such patent applications will be based on AI software that is hardware and systems agnostic as mentioned earlier.

It must also be noted that the EPO has recommended treating AI algorithms as mathematical methods [32]. Just like software, according to the EPC, mathematical methods are not patentable as such as per Art.52 (2) and Art.52 (3). However, an important distinction with software which is treated in a similar way in the EPC is that the EPO Board of Appeals has ruled that if a method which is not per se “technical” for example a mathematical method, is used in a technical process, and this process is carried out on a physical entity by some technical means implementing the method and provides as its result a change in that entity, it contributes to the technical character of the invention as a whole and is therefore patentable [37].

The EPO does not distinguish between various Levels of AI as the Multi-Level Model does. This demonstrates the importance of the Multi-Level approach for the EPO approach in this paper’s view can only apply to Level 1 semi-autonomous but not to Level 2 and Level 3. For treating AI algorithms as mathematical methods will only work for Level 1 semi-autonomous but not the other levels. As already noted, for Level 2 and beyond, AI systems will be hardware and systems agnostic yet the EPO Board of Appeals case law on mathematical methods emphasizes technical effect on a physical entity.

Other world systems especially in Asia which is the leading center in AI innovation generally follow the EPO approach. According to the Indian Patents Act 2005, computer and software programs are excluded from patentability only per se, and when it comes to defining per se, the Indian courts tend to look up the jurisprudence in Europe and interpret their cases in a similar manner [6].

However, the only point of departure in Indian Patent law is the Second Patent Examination Guidelines released in February 2016 which introduced a three-step test for software patentability. The first being to determine the claims’ scope, the second to identify their contribution and the third that, if that contribution lay in software, it must be accompanied by novel hardware to be patentable. These guidelines, especially the requirement for novel hardware must be repealed under the fully-autonomous soft AI era for AI algorithms will be hardware agnostic and interoperability is the sine qua non of this era.

3.2.1. Recommendations for patent law for level 2 (fully-autonomous hard AI segment.)

The European Patent Office will need to bring finality to this question by amending Art. 52 (2) of the EPC to remove programs for computers from the list of non-patentable inventions. This will bring clarity especially to small and medium enterprises who might not afford lawyers to explain the Board of Appeals legalistic decisions. As the EPO has noted, the main inventors in the AI field are small to medium enterprises [32]. However, EPO Board of Appeals jurisprudence that requires the computer implemented inventions to have a technical character and the other requirements as explained in earlier questions must remain.

Amending the EPC as proposed above is also in line with post-Alice developments in the US. As had already been explained, in Alice, there were 2 requirements for patentability. The first being that the invention must not be an abstract idea and the requirement for something more. The main issue with Alice was that there was no definition of what an abstract idea is. As White and Piroozi (2019) noted, “Alice left the very definition of “abstract idea” fairly abstract. It is much easier to describe what is not patent eligible under Alice than what it is.” [44] As they further noted, what is clear from Alice is that a claim that performs a pre-existing business practice using a computer will likely be ineligible. So will be a claim that can be performed in the human mind and most significantly, a claim that recites an algorithm that can be implemented on a regular computer. Unfortunately, the last carve out is a pit into which a great many AI inventions may fall.

This might have been what resulted in a more liberal approach to software patents in post-Alice cases like Enfish where the Federal Circuit found that “[s]oftware can make non-abstract improvements to computer technology just as hardware improvements can.” [45] Thus the mention of an algorithm in a claim no longer necessarily implies abstractness, as it seemingly did in the first couple of years after Alice.

Furthermore, the Federal Circuit decision in McRO recognises “a specific means or method that improves [a] technology” instead of “a result or effect that itself is the abstract idea and merely invoke[s] generic processes and machinery.” [46] This shows the requirement of bringing to finality in the US what the word abstract means and not what it does not mean as has been the case so far. Therefore, the US Supreme Court might need to step in and finally define in positive terms what the term abstract idea means at this level.

The question that then emerges, and rightly so is that since both the semi-autonomous Level 1 applications and fully-autonomous Level 2 soft AI applications are in existence at the same time period in reality, then which recommendation must supersede one another? This paper suggests that the amendment to the EPC must only be considered once Level 2 fully autonomous soft AI systems applications at the leading pertinent to the 80% threshold. Before this critical threshold, the recommendation proffered in the previous section for Level 1 semi-autonomous AI must remain in place. This must give European Patent Offices some breathing space to lobby their policymakers to push for the amendment of the EPC.

As for the US approach, 35 U.S.C. § 101 defines patentable subject matter as encompassing “any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof.” This broad general rule is subject to well established exceptions
that preclude patenting laws of nature, natural phenomena and abstract ideas [47]. This should remain and in terms of certainty in this era, the US is in a far much better position because traditionally, pre-Alice, it has been viewed as more liberal for software implemented patents. However, as has already been noted by valid criticisms of Alice and the new approaches in Enfish and McRO, either the US Supreme Court or the Congress might need to step in and finally define in positive terms what an abstract idea is and the approaches taken in Enfish and McRO might be helpful in this regard.

3.3. Impact on patentability for level 2 AI applications (fully-autonomous hard AI segment.)

“Today, data is a real wealth and it is being said that whoever acquires and controls the data will have hegemony in the future. The global flow of data is creating big opportunities as well as challenges.” India Prime Minister Modi - World Economic Forum. [48].

Hard AI refers to fully-autonomous AI systems with consciousness, sentience and mind and the ability to apply intelligence to any problem, rather than just one specific problem. Hard AI has the full depth and breadth of human understanding. Some modern fully-autonomous hard AI systems such as smart cities and self-driving cars are able to generalize well within specific contexts.

In its second iteration of development, hard AI can mature into Artificial General Intelligence (AGI) which are even far much sophisticated in its ability to collect data from various systems and subsystems and process it instantly in real time therefore can start “inventing” on its own. For example, in the field of advanced AI defense systems from both offensive and defensive systems, such AI weapon systems can process data and make decisions without human input and may launch preemptive strikes if their risk tolerance models reach a certain threshold. These are the kinds of AI systems that keeps Elon Musk awake when he warns about the dangers that will visit humanity if such systems are not controlled especially as they are being developed by nations like US, China and Russia.

Big data is the lifeblood of fully autonomous hard AI systems because without exposure to data, full autonomy might not be reached. This might explain in part the geo-political and strategic debate between the US and China over Huawaei. The US knows that if Huawei establishes global dominance particularly in 5G networks, they will be able to suck all world data asynchronously and use it to power fully autonomous hard AI defense systems. Given the critical nature of telecommunications systems in data, such dominance will make China the most powerful nation in the world. It is data that is processed from objects, people and other systems that has ushered the era of full-autonomous hard AI.

For example, Barclays estimates that a single autonomous car can generate as much as 100 GB of data every second. Applying this to the entire US fleet when they are fully autonomous equates to 5.8 billion terabytes of raw data per hour. Gaining visibility into this massive data to discover true insights is the only way to teach an AI to drive. This paper argues that the hard AI era in relation to the self-driving car example will be ushered in the US when about 20% of all US cars are self-driving.

As Debashis Dutta, Group Coordinator, Ministry of Electronics and Information Technology (MeitY), Government of India, argued at the Indo-Europe Conference;

Moreover, we will move from an algorithm-driven to a data-driven approach, which will raise several questions, such as: Who owns all the machine created data? What is the regime for protecting this data? And with this machine-created data, how do we answer the patentability question? [6]

All the above questions are relevant to the question of patentability for the Level 2 fully-autonomous hard AI segment but a detailed examination of the same is outside the focus of this paper and would need to be further examined in other instalments. Suffice to say that as noted above, with fully-autonomous hard AI systems, focus now shifts from AI software algorithms to AI data driven algorithms. How then will patent law answer the patentability of data driven approach? In other words, if an invention that meets all the other requirements for patentability but that is based on data or whose outcome will not be possible if this data was not present, then can a patent be claimed on the basis of data that is not owned by the patentee which is generated by other systems?

3.3.1. Recommendations for patent law for level 2 (fully-autonomous hard AI segment)

The fundamental issue facing fully autonomous hard AI systems in relation to patentability is the question of how data that powers these systems has to be treated since in most cases it will not be owned by the inventor. Broadly speaking, in this era, data will either be owned by private individuals, governments or corporates.

For data that relates entirely to objects, this paper proposes that it has to be liberated and treated as a common good and fully autonomous hard AI applications based on the same must be patentable as long as it meets the other bar for patentability.

For data owned by governments whether through legislation or generation by legitimate government bodies, this paper proposes, with exceptions to legitimate national security considerations that it must be treated as a public good and patentability must be allowed as long as the data meets security imperatives through such innovations as anonymization of that data especially if it relates to individuals.

On the other hand, as regards the data that is owned by private individuals or generated from private individuals, the question becomes more difficult. Should the inventor gain the right or consent to that data first before the patentability bar can be fulfilled? This delicate question is already being answered by other areas of law in particular data protection and privacy laws.

For example, Europe has already enacted the General Data Protection Regulations (GDPR) that seeks to protect personal data. We are already seeing early signs of emergence of convergence with the US approach which does not have laws as onerous as the GDPR. In re: Yahoo Inc Customer Data Security Breach Litigation, [49] US District Judge Lucy Koh, firstly ruled that Yahoo must face nationwide litigation brought on behalf of well over one billion users who said their personal information was compromised in three massive data breaches.

In a signal that the privacy approach is shifting across the pond, Yahoo was later found guilty and ordered to pay $50 million fine [50] hence a convergence with the GDPR soon is realistic.

Therefore Level 2 fully-autonomous hard AI segment that rely on personal private data, consent within the confines of the law as the emerging policy thrust like in both the US and Europe maybe a requirement for patentability of these systems.

The only issue from a patent law point of view in the fully autonomous hard AI era is that the patent law voice seems to be missing from this debate. If patent law practitioners are not robustly involved and with increasing data related scandals like the Facebook/Cambridge Analytica [51] and alleged Russian interference in elections [52], policymakers might overreact especially in US and Europe and over-legislate in ways that might slow or kill the transition to the fully autonomous hard AI era leaving countries like China and Russia that might be more liberal in data collection to win in this nascent fully autonomous hard AI era.
3.4. Impact on patentability for level 3 AI applications (neuro-autonomous.)

“Over time I think we will probably see a closer merger of biological intelligence and digital intelligence.” Elon Musk – Tesla, Solar City, SpaceX, Boring Company and Neuralinks CEO. [53].

The 3rd Level of the Multi-Level Model is a futuristic idea that unlike the 2nd Level fully-autonomous AI where machines develop the ability to mimic people and process data in real time and be smarter than human beings, we see the intersection of biological intelligence in humans with digital intelligence. This is what Elon Musk calls the cyborg. Whilst it might sound like unrealisable idea at scale in the foreseeable future, Elon Musk is leading such research with Neuralinks.

Ultimately, the idea is not new. Licklider (1960) wrote in Man-Computer Symbiosis about the theory of cooperative interaction between men and electronic computers. He put it thus:

The hope is that, in not too many years, human brains and computing machines will be coupled together very tightly and that the resulting partnership will think as no human brain has ever thought and process data in a way not approached by the information-handling machines we know today [54].

From a 1960s perspective, this sounded unrealistic because the technology required was still unavailable. The ability to collect massive amounts of data from the Internet of Everything as different systems are integrated in this era, for example when we have smart cities and process it and make decisions instantly was not yet there.

That is why Elon Musk summarised the requirements for this reality as;

It is mostly about the bandwidth, the speed of the connection between your brain and the digital version of yourself, particularly output. Machines communicate in a trillion bits per second and humans, who mainly communicate by typing on a smartphone, are limited to just 10 bits per second [53].

Various forms of Brain Computer Interfaces (BCI) are already available, from ones that sit on top of your head and measure brain signals to devices that are implanted into your brain tissue. However, the examples given above are termed one-directional BCI. These are grouped under Level 1 semi-autonomous AI systems in terms of the Multi-Level Model.

Under Level 3, we are talking of those that are bi-directional and are yet to be built although research towards the realisation of the same is in full throttle. For Level 3 we are looking at BCIs that by plugging in into a neural lace, a brain AI interface, could make human beings smarter, improve memory, help with decision-making and eventually provide an extension of the human mind.

These will then be connected with the Internet of Things to form an Internet of Everything. They will directly tap into the brain to read out thoughts, effectively bypassing low-bandwidth mechanisms such as speaking or texting to convey the thoughts and when connected via the Internet with the other Internet of Things devices and also other speaking or texting to convey the thoughts, effectively bypassing low-bandwidth mechanisms such as.

4. Who is the inventor?

An inventor is a person who contributed to the formulation of the inventive concept or concepts of a patent or application [57]. The prevalent view is that a new patentable concept is a “mental creation by a human being.” [58] Although not expressly stated in patent statutes, jurisprudence and patent office guidelines have interpreted “inventors” as being limited to natural persons [57]. If computers supplant humans in creating inventions, the proper identification of inventors would have to be considered.

This therefore means that the question of inventor is less critical for Level 1 semi-autonomous AI systems but becomes important starting with Level 2 fully-autonomous hence analysis of Level 1 for this topic will be skipped suffice to say for Level 1 semi-autonomous systems the human inventor still contributes substantially more than the AI algorithm software as outlined in the Multi-Level Model in preceding sections of this paper.

4.1. Impact on inventorship for level 2 AI applications (fully-autonomous soft AI segment.)

Examples that have been given in legal literature of situations where AI autonomously creates inventions and wherefor patents have been granted for the same include Thaler’s invention called the “Creativity Machine.” This is a computational paradigm that “came the closest yet to emulating the fundamental mechanisms responsible for idea formation.” [59] The Creativity Machine is able to generate novel ideas through the use of a software concept referred to as artificial neural networks—essentially, collections of on/off switches that automatically connect themselves to form software without human intervention [60]. Also like the human brain, the AI’s algorithms is not written by human beings, it is self-assembling [60].

The machine was the subject of his first patent, titled “Device for the
Autonomous Generation of Useful Information.” [61] The second patent filed in Thaler’s name was “Neural Network Based Prototyping System and Method.” [62] Thaler is listed as the patent’s inventor but he states that the Creativity Machine invented the patent’s subject matter (the “Creativity Machine’s Patent”) [63].

Thus, some legal analysts argue that the granting of the second patent to Thaler (who filed the application as the inventor) was a legal misnomer since it was autonomously created by the first invention.

4.1.1. Recommendations for patent law for level 2 (fully-autonomous soft AI segment)

As the example of the Creativity Machine demonstrates, this is an example of soft AI system under Level 2 of the fully-autonomous AI because while it can autonomously create, it is still within the narrow range of intelligence. Furthermore, the inventions autonomously created by the same machine can be easily traced to the inventor without much debate.

While it is true that in reality the Creativity Machine is the de facto inventor of invention 2, the law is based on de jure reality. In this case Thaler was listed and applied as an inventor and although the invention 2 was created autonomously as noted, there is a clear nexus between Thaler’s work and the invention number 2. Whilst a narrow interpretation is legally interesting, this example nevertheless demonstrates that for fully autonomous soft AI systems that can create inventions autonomously, tracing the creator of the original invention must be the feasible approach to answer the question of inventorship for this level of autonomously created AI inventions.

4.2. Impact on inventorship for level 2 AI applications (fully-autonomous hard AI segment.)

A human’s involvement is required in kick-starting the AI’s creative undertaking. However, the process to determine who the author/owner is when the AI steps in to play a pivotal role in the creation of the work continues to remain a grey area. As explained in the section on the Multi-Level Model, fully autonomous hard AI systems are more sophisticated and can autonomously create inventions “in the wild” [64] This means that the original inventor or inventors of fully-autonomous hard AI systems are likely to be a mesh of various different subsystems asynchronously sharing and processing data in real time. In such systems, it is difficult to trace an autonomously created invention to a single inventor since several diverse systems are involved. Therefore, the question to ask is whether the human inventor can survive as currently defined and if not, what are the innovations that are possible under statute to address this reality.

As noted by one scholar;

“Regarding ownership of the innovations, with the prospect of AI contributing to inventions or even “inventing”, a shift was conceivable from inventor-based ownership to investment protection systems for the companies and organisations from which the inventions came [32].

This recommendation is given by the EPO broadly for all AI systems. An analysis of the proposal shows that it can be relevant to Level 2 fully autonomous soft AI but may not be relevant for Level 2 hard AI segment. For level 2 hard AI segment, the full era of the Internet of Everything would have been ushered making it difficult to identify a single organisation or company from which the AI would have come from. This reinforces the importance of using an approach such as the Multi-Level Model rather than broad generalisations that treat AI like a homogenous block.

The final option as suggested by Fraser Erica (2016) is to eliminate the identification of an inventor altogether.

This option would be the simplest in the cases where there is no individual human inventor who can reasonably lay claim to an invention, such as where the invention is the result of a large team effort, or of a computer whose process of invention is not purposeful or directed and is without human oversight or control [65].

This is the same conclusion that was also reached by Shlomit & Xiaojiong (2017) who used a model that they called the Multi-Stakeholder Theory to argue that its complicated to pinpoint an inventor for such systems due to what they called the multiple stakeholders involved namely the software programmers, the data suppliers, the trainers/feedback suppliers, the owners of the AI systems, the operators of the systems, the new employers of other players, the public and the government.

However, this paper argues that it is still important to find an inventor or multi-inventors. For it is argued thus;
However, eliminating this requirement would obviate certain justifications for the patent system, such as the fair reward and moral benefit of recognition. This could have tangible impacts on scientists and engineers who gain professional credibility and even monetary benefits based on their status as a named inventor on patents [65].

The optimal balance between perceptions of morality and fairness and the impersonal realities of inventorship is likely to maintain the option of identifying one or more human inventors only where such a person can be reasonably identified.1

Therefore, this paper proposes a possible solution which is to apply novel new inventions and breakthrough technologies like serialisation and block chain technology where a number of different contributors to the autonomously created inventions as highlighted by Shlomit & Xiaoqiong (2017) and their proportional contributions can be identified. Quickly concluding that there is no solution to the inventorship problem is only to look at future problems through today’s lenses. Advances in serialisation and blockchain technology which is increasingly being adopted in many industries including by Patent Offices can be harnessed to determine who contributed what percentage to an autonomously created invention.

4.3. Impact on inventorship for level 3 AI applications (neuro-autonomous AI)

The major question would be whether biological-digital systems inventing autonomously can be defined as human beings especially when connected to the internet and the brains of other human beings in a global Internet of Everything. Who will be the inventor if in the breakthrough phase of the technology thousands or even millions of people’s brains are connected to one another in a network such that thoughts and ideas are asynchronously shared in real time as well as massive data from the connected internet? This will be more of a policy question than a technical legal question. With the rise of policymakers’ concern about AI ethics which so far have been wanting, it is likely that patentability of “cyborg” created inventions will be outlawed by legal fiat.

4.3.1. Recommendations for patent law for level 3 (neuro-autonomous AI)

This paper recommends that policymakers must not pre-empt the patentability of such inventions where technically and legally feasible by legislation. Instead they must allow the market to vote with its heads literally. As we have seen over and over again in technology cycles, the world will also witness very few cyborgs roaming around and hence the patentability question of their inventions will be moot.

5. Conclusion

As has been discussed in this paper, AI as a concept is quite wide. The Multi-Level Model can assist in unpacking the impact of this AI revolution to patent law in a more laser focused manner. This is quite practical but also helpful to policymakers who in most cases may not have a full understanding of the width, breadth and depth/height of AI to really come up with informed policy choices in as far as patent law is concerned.

This paper has demonstrated that sweeping broad generalisations of how patent law can cope with the AI revolution is half baked if the AI is not broken into its constituent parts. Interestingly, these parts that were represented by the different levels of the Multi-Level Model are a practical microcosm of how the AI revolution will evolve. Though the evolution is not strictly linear, there cannot be much debate that each level is a building block for the next level and Albert Einstein’s 4th dimension of spatial reality that is, time - is an important delimiter of each level. Thus the 2nd Level will come after the first and will so the third level after the second therefore suggested solutions for adaptation of patent law are married to a specific relevant level in a time bound span that can be defined to a greater extent.

This approach and model are novel in legal literature but can be a basis for analysis of other questions that Intellectual Property law in general and patent law in particular will have to grapple with at each historical epoch of the evolution of the AI revolution. These questions that require further research and might be susceptible to analysis via the Multi-Level Model include effect to prior Art, Person Skilled in the Art and also how the Patent Grant Process itself as currently configured across several Patent Offices will have to adapt and survive in this AI revolution.

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Appendix A. Supplementary data

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