Intervention Report for the WIPO Conversation on Intellectual Property and Artificial Intelligence (Third Session)

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Introduction

When computer science and technologies make a significant improvement in aspects of database and computational power, it brings a new wave of research in artificial intelligence (AI). More importantly, such a wave results in a smarter intelligence of AI systems than before and a widespread application of AI systems in a variety of sectors. The AI systems at present can respond to humans' needs, such as Apple Siri, provide a recommended list of music, produce works, such as painting and making music based on humans' requirements, and assist humans to deal with data, such as observing cyber-attacks. While human scientists are considering the next step of research in AI systems, humans working in creative and innovative sectors and legal sectors are discussing the consequence of AI systems in the above sectors. It is no doubt that the appearance of AI systems and their advanced development would reshape the whole creative and innovative sectors that are protected in the existing intellectual property system. Therefore, it is necessary to identify the AI systems at present and to map the direction of AI development in the context of intellectual property law.

Therefore, the World Intellectual Property Organisation (WIPO) leads a series of conversations and discussions in AI and intellectual property policy. In September 2019, WIPO held the first session of the WIPO Conversation on Intellectual Property and Artificial Intelligence and then the second session in July 2020 to discuss AI-related IP issues in a draft issues paper published by WIPO.[1] On 4th November 2020, WIPO will hold the third session of the Conversation. The issue of definition (please see below) is noticed and has been added to discuss from the second session.[2] Through the Conversation, WIPO tries to clarify the line lie between the two concepts: AI-assisted and AI-generated outputs, because they would lead to substantially different recognitions from an intellectual property perspective and thereby the following considerations: whether protection or not, and how.

Issue 1: Definitions

9. This paper uses a number of terms such as "AI", "AI-generated", "autonomously generated by AI", "AI-assisted" etc. Many submissions commented that it would be helpful to have agreed definitions of these terms in order to facilitate the conversation on AI and IP.

10. The following definitions have been used for the purpose of discussion:

11. "Artificial intelligence (AI)" is a discipline of computer science that is aimed at developing machines and systems that can carry out tasks considered to require human intelligence, with limited or no human intervention. For the purposes of this paper, AI generally equates to"narrow AI" which is techniques and applications programmed to perform individual tasks. Machine learning and deep learning are two subsets of AI. While the AI field is rapidly evolving it is not clear when the science will advance to higher levels of general artificial intelligence which is no longer designed to solve specific problems but to operate across a wide field of contexts and tasks.

12. "AI-generated" and "generated autonomously by AI" are terms that are used interchangeably and refer to the generation of an output by AI without human intervention. In this scenario, AI can change its behavior during operation to respond to unanticipated information or events. This is to be distinguished from "AI-assisted" outputs that are generated with material human intervention and/or direction.

In the purpose of responding to the issue of definition, the report analyses the substantial development of AI systems in the past and at present as well as the next step that is predicted by scientists, together with examples of AI systems applied at each stage, to define the concept of "AI-supported", "AI-assisted" and "AI-generated".

The Concept of "AI-supported"

The author submitted WIPO Conversation on Intellectual Property and Artificial Intelligence Response for the second session of the Conversation and suggested using

[1] Draft Issues Paper on Intellectual Property Policy and Artificial Intelligence (2019) WIPO/IP/AI/2/GE/20/1 <https://www.wipo.int/edocs/mdocs/mdocs/en/wipo_ip_ai_2_ge_20/wipo_ip_ai_2_ge_20_1.docx> accessed 21 October 2020.

[2] Revised Issues Paper on Intellectual Property Policy and Artificial Intelligence (2020) WIPO/IP/AI/2/GE/20/1 REV. <https://www.wipo.int/edocs/mdocs/mdocs/en/wipo_ip_ai_2_ge_20/wipo_ip_ai_2_ge_20_1_rev.pdf> accessed 21 October 2020.

the term "AI-supported" to point at outputs that embrace full material human intervention and/or direction.[3] In fact, the term "AI supported" seems to match the status of the first-wave AI systems.

The first-wave AI systems are to solve hard problems and they are characterised as systems based on "handcrafted knowledge" in the presentation made by John Launchbury, the Director of the Information Innovation Office (I2O) at the Defense Advanced Research Projects Agency (DARPA) in the United States Department of Defense.[4] Basically, the first-wave AI systems are rule-based systems and human engineers define the rules for AI systems to follow. An example is Turbo Tax that the tax lawyers or accountants convert the complex tax codes into rules so the AI systems just need work based on these rules. According to Launchbury's opinion, such AI systems do not have learning capability, are very poor in handling any uncertainties and could only reason those narrowly defined problems.[5] Therefore, it can be said the first-wave AI systems are just machines following rules that are defined by humans. They are no substantial difference from those electronic tools or equipment that humans utilise. The results made by AI are predictable by humans. From this perspective, the term "AI-supported outputs" is defined in the report as outputs produced by a rule-based computer system that fully follows the rules defined by humans, without the substantial intelligent ability (which embraces learning, perceiving, abstracting and reasoning). In this case, humans are authors/inventors of AI-supported outputs because the outputs are completely resulted from humans' full material intervention.

The Concept of "AI-assisted"

Launchbury characterised the second-wave in AI as systems based on "statistical learning".[6] Compared with the first-wave AI systems, the second-wave AI systems become more intelligent due to its capability of using statistical methods. There are three pillars that led to the success of the tide of AI, which are respectively data,

[3] Luo Li, WIPO Conversation on Intellectual Property and Artificial Intelligence Response (2020) <https://www.wipo.int/export/sites/www/about-ip/en/artificial_intelligence/conversation_ip_ai/pdf/ind_li.pdf> accessed 21 October 2020.
[4] John Launchbury, 'DARPA Perspective on AI' (Defense Advanced Research Projects Agency) <https://www.darpa.mil/about-us/darpa-perspective-on-ai> accessed 21 October 2020.
[5] ibid.
[6] ibid.

algorithms and computational power. The second-wave AI systems have significant development relying on the advanced improvement of the above two pillars: data and computational power as well as better models of algorithms than before. The rising big data and internet technology build up a giant database, which is a perfect machine learning hub. The more data the AI systems could obtain, the wider and depth knowledge AI systems could learn and therefore the more accurate outputs they produce. The second pillar of the success of AI systems is computational power, which means computational capacity. An improved computational capacity in the second-wave AI systems mainly relies on rapid development of computer hardware. In 2012, Alex Krizhevsky and Ilya Sutskever won Large Scale Visual Recognition Challenge 2012 by using Graphic Processing Unit (GPU) for model training of deep learning.[7] This revolutionary utilisation largely accelerates the efficiency of computer processing and breaks through the bottleneck of computer power. This is because the processing speed of GPU is super faster than that of the traditional central processing unit (CPU). Later, Google develops the Tensor Processing Unit (TPU) which is even faster than GPU.[8]

Besides, although the core of the algorithm has no substantial difference from the previous tide of AI in the 1980s as it is still the models based on neural networks, the algorithm at present is improved than before. The algorithm at present is characterised by deep neural networks achieving deep learning and a better understanding of the relationship among massive data. The second-wave AI systems have capabilities to define rules through clustering and classifications of massive data – this is significantly different from the first-wave AI system. Meanwhile, the present AI systems can use those defined models to predict and make decisions by themselves to some extent. Examples of applications include observing real-time cyber-attacks, Apple Siri, Google text analysis, image recognition and some AI music software such as Amper Score[9] and 哼趣.[10] These AI systems start to produce outputs that humans cannot predict exactly,

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[7] Nina Haikara, How to evaluate machine learning? U of T research supports latest benchmark initiative (2018) <https://www.utoronto.ca/news/how-evaluate-machine-learning-u-t-research-supports-latest-benchmark-initiative> accessed 25 October 2020.

[8] Tony Peng, Google's TPU Chip Goes Public in Challenge to Nvidia's GPU (12 February 2018) <https://medium.com/syncedreview/googles-tpu-chip-goes-public-in-challenge-to-nvidia-s-gpu-78ced56776b5> accessed 25 October 2020.

[9] Amber Score <https://www.ampermusic.com/> accessed 23 October 2020.

[10] An AI music software in China could generate music based on a short humming of the human users and then constitute a completed music embracing both human-made melody and AI-produced melody.

which result that humans have an impression that AI systems are intelligent and can "create" or "invent" things and therefore raise many fears about AI replacing humans in innovation and creations as well as many discussions on whether AI-produced outputs qualify intellectual property protection.

However, it can be seen that the second-wave AI systems at present are still in the statistical learning stage. In other words, they do not have the contextual capability, are not able to learn by understanding the real-world, have minimal reasoning ability and do not have the abstracting ability. The above four features that second-wave AI systems lack toward the ability of creativity and innovation required by the intellectual property system. Although artificial intelligence uses the word "intelligence" but it is not equivalent the same as human intelligence. In psychology and neuroscience, the term "intelligence" tends to 'converge around similar notions designed to capture the essence of this psychological factor'.[11] Humans can perceive the surrounded environment, communication, memorizing past as well as innovation and creation because of the ability to integrate them in some way. With this ability, humans can select, adapt and even change things when selection and adaptation are not available and 'explore novel tactics when reward contingencies change… and face unpredictable socioecological challenges over a long lifespan'.[12] The actions of selection, adaptation, changing and exploring novel ones toward an increased level of creativity and innovation. The theory of psychology identifies the two concepts of creativity and intelligence would overlap or interact.[13] AI systems at present with the ability of statistical learning based on provided data is not intelligent enough to do the equivalent creative/innovative tasks as that of humans. All resources that AI systems could learn and use for their selection, prediction and decision-making are data supplied by humans. In other words, AI systems could only rely on historical data to define the rules and then give their choices and predicted results but not able to do so beyond data. They do not have full freedom to select, predict and more importantly they are not able to really understand and explain the information in the data and then toward imagination in the

[11] Roberto Colom et al., 'Human Intelligence and Brain Networks', (2010) 12 Dialogues Clinical Neuroscience 4 <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3181994/> accessed 23 October 2020.
[12] Chet Sherwood et al., 'A Natural History of the Human Mind: Tracing Evolutionary Changes in Brain and Cognition', (2008) 212 Journal of Anatomy 4 <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3181994/> accessed 23 October 2020.
[13] Arthur Cropley, 'Definitions of Creativity' in Mark Runco and Steven Pritzker (eds), Encyclopaedia of Creativity (3rd, Elsevier 2020) 319–320.

whole limited decision-making process. This is also why many computer scientists call such AI systems narrow AI because they are good at specific and well-defined tasks but seems nothing else.

Furthermore, whether or not AI systems can make limited decision-making (or called as limited freedom of creativity/innovation) also depends on an algorithm designed by humans. If the algorithm designed by human engineers sets concrete parameters, then AI produced outputs would be the same as long as users input the same conditions; if the designed algorithm is set by abstract parameters, then AI produced outputs may be different while the same conditions are input each time but such outputs could only embrace features that AI learned from the provided data but would not embrace any feature outside of the data.

Obviously, in the first situation, outputs made by AI systems have no substantial difference from that of AI-supported outputs (the one the report discussed previously) except an added function of defining rules by themselves rather than defining by humans. This is because AI systems are restricted by concrete parameters setting in the algorithm, which results that AI systems are not allowed to give any other choices. It can imagine that three human authors may write different pieces of works when given a proposition composition, but technically AI systems cannot produce different outputs based on proposed conditions given by human users. The second situation is engineers set abstract parameters in the algorithm, so AI systems are given limited freedom to make their own decision and humans are not able to expect an exact resulting output in advance. For outputs made by AI systems in the second situation, the report calls them AI-assisted outputs. However, the process of creation is clumsy and degree of creativity is very limited. The following examples of AI systems applied in the creative industries may explain the ability that second-wave AI systems have in producing outputs.

<u>MuseNet:</u>

Open AI announced MuseNet that its users could create a piece of four-minute length music by utilising ten different musical instruments, combining different music styles from country to Beatles. However, its website states that 'MuseNet was not explicitly programmed with our understanding of music, but instead discovered patterns of harmony, rhythm, and style by learning to predict the next token in hundreds of thousands of MIDI files'.[14] This approach that AI uses is more like to produce outputs by embracing features of existing data (this is based on statistical learning and analysis), which is different from humans' traditional understanding that music creation is an expression of emotion and an export from human creators' understanding, feeling and responding to the surrounded environment and the real world (this refers to imagination and appearance of internal and mental activities).

Neural Style Transfer (NST)

Another example is the application of neural style transfer (NST) in images. NST is an optimization technique that blends a content image and a style reference image (eg. Vincent Van Gogh's The Starry Night) to make an image looking at the content image but with a style of The Starry Night for example.[15] Like the MuseNet, a key ability for NST is to pick up features from the style reference image and re-apply them into the content image to form an image with such artistic style. This newly formed image preserves the overall layout of the content image during the style transfer[16] but brings its audience a different artistic appreciation. For the details about the images applying NST, please check the links at footnotes 13 and 14.

Generative Adversarial Networks (GANs)

In February 2018, a Paris-based collective Obvious sold its AI-produced painting "Le Comte de Belamy" to an art collector Nicolas Laugero-Lasserre for 10,000 euro. Later, the Obvious sold another AI made painting "Portrait of Edmond Belamy" for 432, 500 dollars through Christie's in New York.[17] This is also the first auction for AI-produced works of art in the large auction house. The AI system that is applied to produce the above two paintings is called Generative Adversarial Networks (GANs), which are powerful generative models. The central idea of GANs is 'the joint optimization of two

[14] OpenAI, MuseNet <https://openai.com/blog/musenet/> access 23 October 2020.
[15] Amir Semmo, Tobias Isenberg and Jürgen Döllner, 'Neural Style Transfer: A Paradigm Shift for Image-based Artistic Rendering?' (NPAR'17: Proceedings of the International Symposium on Non-Photorealistic Animation and Rendering, Los Angeles, July 2017) <https://hal.inria.fr/hal-01527495/file/exp-meta2017_authors_version2_optimized.pdf> access 23 October 2020.
[16] Xiaochang Liu et al., 'Depth-aware Neural Style Transfer' (NPAR'17: Proceedings of the International Symposium on Non-Photorealistic Animation and Rendering, Los Angeles, July 2017) <https://users.cs.cf.ac.uk/Yukun.Lai/papers/depth_style_transfer.pdf> access 23 October 2020.
[17] 'Is Artificial Intelligence Set to Become Art's Next Medium?' (Christie's, 12 December 2018) <https://www.christies.com/features/A-collaboration-between-two-artists-one-human-one-a-machine-9332-1.aspx> access 23 October 2020.

neural networks with opposing goals'.[18] GANs embrace two networks: 'the first one is a generator network …[which] is jointly optimized with a second, adversarial network, called the discriminator network'.[19] The working model is that the generator needs to generate outputs that the discriminator is not able to 'distinguish from a dataset of real examples … if the discriminator can easily distinguish the generator's outputs from samples in the real dataset, the weights of the generator need to be adjusted accordingly'.[20]

Dr. Hugo Caselles-Dupré who is working with GANs introduced that the engineers insert 15,000 painting portraits between the 14th century to the 20th for GANs model training.[21] The generator makes painting based on data whereas the discriminator's mission is to point out the difference between human-made painting and the generator-made one. The generator learns from every single failure until produces an image that can fool the discriminator. From this perspective, the whole process is likely to make a painting by thousand times of modification until this painting looks like real-life portraits. To some extent, it can be said this resulting output is a new artwork but its producing process is clumsy and subverts human's imagination on how an image is painted.

Creative Adversarial Networks (CANs)

Ahmed Elgammal, the Director of the Art and Artificial Intelligence Lab at Rutgers University works with a system named Creative Adversarial Networks (CANs) which modifies 'GAN's objective to make it able to generate creative art by maximizing deviation from established styles while minimizing deviation from art distribution'.[22] Elgammal argued that GANs is emulative and not creative whereas their proposed CANs can create[23] by assessing three criteria: 'the ability to produce novel artifacts (imagination), the ability to generate quality artifacts (skill), and the ability to assess its

[18] Jelmer M.Wolterink et al., 'Deep learning: Generative adversarial networks and adversarial methods' in Kevin Zhou (eds), Handbook of Medical Image Computing and Computer Assisted Intervention (Elsevier 2020) 548.
[19] ibid.
[20] ibid.
[21] above n 17.
[22] Ahmed Elgammal et al., 'CAN: Creative Adversarial Networks Generating "Art" by Learning About Styles and Deviating from Style Norms' (Eighth International Conference on Computational Creativity, Atlanta, June 2017) <https://arxiv.org/pdf/1706.07068.pdf> accessed 25 October 2020.
[23] ibid 5–6.

own creation'.[24] Elgammal pointed out CANs can produce novel artifacts because 'the interaction between the two signals that derive the generation process is designed to force the system to explore creative space to find solutions that deviate from established styles but stay close enough to the boundary of art to be recognized as art'.[25] This shows that CANs try to abstract what they learned and then to explore space that they are given in the purpose of producing art outputs. However, CANs ability to abstract is still limited since they are still based on massive data feeding.

It can be seen that second-wave AI systems must rely on data to do the statistic learning and analysis but they are not able to produce things beyond the data even if they have limited decision-making ability. This betrays the principle of creativity and innovation: full freedom of creativity/innovation without restriction. Besides, the whole creation process of AI systems at present is through massive data analysis, rule defining and prediction as well as trial-error learning, which is more likely a substantial mechanical process rather than an expression of imagination, emotion and feeling or a responding and understanding to the surrounded environment. In other words, the AI systems in this stage do not have mature ability to abstract training data and explain them with their own understanding but still stay a narrowly defining. Material human intervention appears in every stage of the production process (from data that is for AI learning and selecting to algorithm settings that is to determine the resulting outputs). In this case, humans' contribution is still in the central status and AI's efforts are in an assisted status. Nevertheless, it is still worthy noticing AI systems' decision-making ability and those outputs that are not predictable exactly by humans made through such decision-making, because these show the outputs is in-and-out of human control to some extent, which may prove sort of substantial contributions from AI systems distinguishing them from AI-supported outputs. The question is, however, whether the feature of limited decision-making should be treated as limited degree of creativity or secondary creativity and if the answer is positive then how to give appropriate protection to such substantial contribution.

[24] ibid 20. see also Simon Colton, 'Creativity Versus the Perception of Creativity in Computational Systems' (AAAI Spring Symposium: Creative Intelligent Systems, Stanford, California, March 2008).
[25] ibid 20–21.

The Concept of “AI-generated”

In the third wave of research in AI systems, AI will be in a stage of “contextual adaptation” according to Launchbury’s presentation.[26] The computer scientists will create systems that ‘construct contextual explanatory models’[27] so AI systems in this stage would understand and perceive the real world by themselves; they are no longer to learn from massive data but learn more from an understanding of the real-world phenomena and reason with it. At that time, machines and people could communicate naturally. Launchbury concludes that the third-wave AI systems should have the ability to ‘perceive rich, complex and subtle information, learn within an environment, abstract to create new meanings and reason to plan and to decide’.[28] From this point of view, the third-wave AI systems’ intelligence would be much better than the previous ones and their thinking model starts to be closer as that of humans. The third-wave AI systems will learn from training data but they require fewer data samples for their training purposes, which has much improvement than that of second-wave AI systems. This is because they have the ability of explanation and understanding why or why not before making decisions. Furthermore, a key ability for AI systems at this stage is to abstract perceived information and more importantly “creates” new meanings by themselves based on their abstracting and explanation – this is no doubt substantially affect their reasoning and decision making. In the whole process, there will be a minimised human intervention. From this point of view, AI systems in this stage start thinking by themselves: they are seeking for an internal connection among perceived environment, their explanation and reasoning, and then integrate them in some way, which would open a door for AI systems to explore novel things and eventually towards a creation/innovation. Therefore, an output made by such AI systems as “AI-generated outputs”. Some scholars predict there will be a fourth-wave AI system which they call Artificial General Intelligence (AGI) and Artificial Super Intelligence (ASI).[29] AGI and ASI could perform any intellectual task that humans can. However, no matter the third-wave AI system or the predicted fourth-wave ones, the key is AI can abstract perceived information and start making themselves think about the meanings behind them. This is a sign of creativity/innovation.

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[26] above n 4.
[27] ibid.
[28] ibid.
[29] Waymond Rodgers, *Artificial Intelligence in a Throughput Model: Some Major Algorithms* (Routledge 2020) 3.

Conclusion

Overall, the report divides AI-produced outputs into three different categories based on the substantial development of AI systems in the past years, which are AI-supported outputs, AI-assisted outputs and AI-generated outputs.

The term "AI-supported outputs" is defined as outputs produced by a rule-based computer system that fully follows the rules defined by humans, without the substantial contribution and intelligent ability at all (which embraces learning, perceiving, abstracting and reasoning). The term "AI-assisted outputs" is defined as outputs produced by computer systems that can define rules without human intervention, have very limited freedom in decision-making and can contribute limited substantial efforts highly relying on human intervention, statistical analysis, and logic connection and matching. The term "AI-generated outputs" is defined as outputs made by computer systems that have the freedom to do decision-making during the output generation process through integrating the ability to perceive, abstract, explain and reason by themselves, with a minimised human intervention and embracing their own understanding of the real world.