

Artificial intelligence: policy paper

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Abstract—Artificial Intelligence (AI) has grown dramatically all over the world that makes the self-driving car, image recognition, and natural language processing possible. In this paper, the current trends of AI are discussed in a global and local context. Furthermore, the common facilitating factors that make AI adoption easy are also elaborated as well as the barriers of technology adoption. Then finally, we proposed policy recommendations that will improve and maximize the applications of AI in the economy, industry, society, and government.

Keywords— artificial intelligence, expert systems, machine learning, natural language processing, robotics

I. INTRODUCTION

There are many definitions of artificial intelligence (AI) in books, encyclopedias, and journals. In 1955, John McCarthy, one of the pioneers of AI, defined it as follows: The goal of AI is to develop machines that behave as though they were intelligent [1]. Another definition, according to [2], AI is a branch of computer science and technology aimed at developing the theories, methods, algorithms, and applications for simulating and extending human intelligence. He said that the goal of AI is to create technology that allows computational machines to function in a highly intelligent manner. The most critical capability of AI is learning, which enables automated machine algorithms to improve through experiences by themselves.

II. TRENDS IN ARTIFICIAL INTELLIGENCE

Artificial intelligence is an exciting field nowadays, due to a lot of applications such as image classification [3], speech recognition [4], robotics [5], and autonomous driving [6]. This led to the development of new algorithms in the field of computer vision, specifically convolutional neural networks (CNN) and natural language processing. Some trends in AI are the following:

A. Global Trends

a) *Deep Learning for image processing*: Deep learning is a subset of machine learning that uses a cascade of many computing layers commonly known as a hidden layer. Some applications of deep learning are pattern recognition, image classification, face recognition, and medical diagnosis. Fig.1 shows the sample detected objects using deep convolutional neural networks, also known as deep learning.

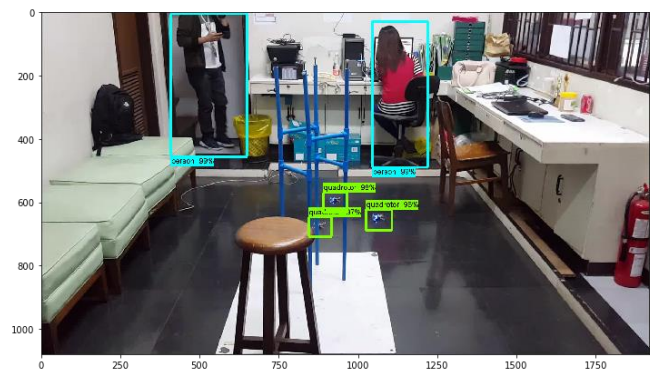


Fig. 1 Sample object detection using deep learning [7]

b) *Capsule Networks*: Capsule Network (CapsNet) is a new type of deep neural network that processes visual information and maintains a hierarchical relationship in much the same way as the brain. This technique solves the drawback of the Convolutional Neural Network (CNN) in which the orientation and relative spatial relationships are not necessary [8]. The development of this architecture can lead to better accuracy in image recognition than conventional CNN. Fig. 2 shows the simple CapsNet architecture.

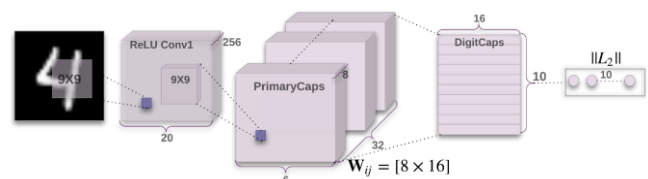


Fig. 2 CapsNet architecture with three layers [8]

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c) Deep Reinforcement Learning for human-level performance in playing games: Deep Reinforcement Learning (DRL) is a type of neural network that learns by interacting with the environment through observations, actions, and rewards. In DRL, the agent interacts and receives the state of the environment at each time step (t). Then, use its policy to choose an action. Once the action is executed, the environment transitions to the next state, giving feedback to the agent in the form of a reward. With this technique, the agent learns and improves its policy. The DRL was applied in the ATARI 2600 console to play a game [9]. At each time step, the agent observes the raw pixels on the screen, a reward signal corresponding to the game score, and selects a joystick direction. Another breakthrough for DRL happened when the AphaGo of Google's Deepmind defeated a world champion in Go, an abstract board game for two players invented in China. This is not the first time where a computer program beat a world champion in a match. In 1997, Garry Kasparov, a world chess champion defeated by IBM's supercomputer, Deep Blue.

d) Generative Adversarial Networks for unsupervised learning: Generative Adversarial Networks (GAN) is a type of unsupervised learning using two competing neural networks, such as generator and discriminator [10]. The generator creates fake data that will try to fool the discriminator. On the other hand, the discriminator will classify the data generated by the generator if it is fake or real data. In the paper of [11] presented a conditional GAN for age synthesis or commonly known as face aging.

e) Automated Machine Learning (AutoML): Automated Machine Learning (AutoML) is the automation of workflows such as data preparation, feature selection, model selection, training, and tuning of machine learning models using different deep learning techniques. This will benefit non-expert in machine learning. In [12] used AutoML to automate data analysis, which reduces the cost of paying experts.

f) Digital Twin: Digital twin is a virtual model used to facilitate detailed analysis and monitoring of physical and physiological systems. This is basically developing a digital profile of the physical system that will help to detect problems on the system and recommend a solution using machine learning. Paper [13] builds a digital twin of 3D printing machines. Digital twins are commonly used in manufacturing.

B. Local Trends

a) Chatbots as a virtual assistant: Chatbots are software robot that is used as a virtual assistant that interacts with humans online. In 2017, RCBC and Union bank launched their chatbots to assist its clients in managing their accounts. Facebook messenger is used as a platform because most of the Filipinos used this tool for communication.

a) AI for Text and Voice-based Searches: The Samsung's flagship phone like Galaxy S10 and iPhone of Apple is

equipped with personal assistants like Bixby and Siri, respectively. This feature is used for hands-free navigation, calling, and searching. Users take advantage of this feature to avoid typing long words when making a query.

III. PRIMARY AREAS OF ARTIFICIAL INTELLIGENCE

The four primary areas of AI are machine learning, natural language processing, robotics, and expert systems, as shown in Fig. 3.

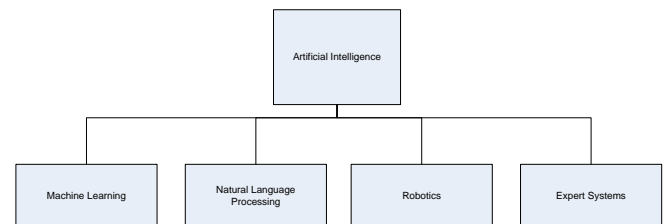


Fig. 3. Primary areas of AI

A. Machine Learning

Machine learning is concerned with the study of building computer programs that automatically improve and adapt their performance through experience [14]. Some applications of machine learning are handwriting recognition [15], language translation, speech recognition, image classification, and autonomous driving.

B. Natural Language Processing

Natural Language Processing (NLP) are technologies that enable computer systems to interact seamlessly with human languages. Example applications of NLP are speech recognition, translation, language generation, and understanding meaning within text/speech. The Cortana of Microsoft, Alexa of Amazon, and Siri of Apple are services that use NLP technology.

C. Robotics

Robotics is the science that studies the intelligent connection between perception and action [16]. It also deals with the design, construction, operation, and use of robots, as well as computer systems for their control, sensory feedback, and information processing.

D. Expert System

An expert system is an "intelligent" computer program based on Boolean logic that is designed to implant the expertise of a human being in a particular domain so that it can solve the problem replacing the human expert. Examples of an expert system are MYCIN and hearsay.

IV. TECHNOLOGY ADOPTION IN THE PHILIPPINES

A. Facilitating Factors

a) Applications: There are many applications of AI in healthcare [17] like cancer prediction [18] and classifying brain tumors [19]. In robotics, AI was used for robot grasp detection [20]. In the field of transportation, AI was used for traffic flow monitoring using unmanned aerial vehicles [21]. Currently, researchers are applying AI into image processing like image detection, classification, and tracking.

b) Developed Models: Many developed models can be used for image classification and detection like AlexNet [22], VGG [23], ResNet [24], Inception-v2 [25], Inception-v3 [26], Inception-ResNet-v2 [27], and MobileNet [28]. Some implementations are freely available across the internet like GitHub, a software development platform where researchers build and share projects that anyone can use for research and development.

c) Available Hardware: Many companies, like NVIDIA, Intel, are continuously developing powerful processors to enable computers to process complex calculations at a higher speed. They developed graphics processing units (GPU) for deep learning applications

d) Government Initiative: Part of the Harmonized National Research and Development Agenda 2017-2022 (HNRDA) priority is the artificial intelligence for industry, transport, and education application.

B. Barriers and Constraints for Adaption

a) Incomplete Digital Platform: In an industry like healthcare, patient's relevant data are not yet digitized that will help in diagnosing disease and provide treatment plans [18].

b) Limited Knowledge about AI: Not all people understand AI well. Some understand it as software that controls the robot, and others see it as a platform that can perform an in-depth analysis of data.

c) Lack of Financial Resources and Infrastructure: We don't have our own infrastructures that can store extensive data that are needed for AI applications. Most of these infrastructures are located outside the country, like the data center of Facebook and Google.

d) Lack of Skills: Our country does not have enough experts available in the field of AI [29]. Although there are some graduate students that are specializing in AI, they focus on different areas when they graduated, depending on their company.

e) Security Issues: One crucial component of AI to operate efficiently is data. Having enough data, the robot with AI will be able to perform its desired task. But the risk is on how to make the data private if the data contains confidential information. Another issue is that the robot may disrupt the environment while performing its mission.

f) Dataset availability: In implementing AI applications like image processing, an extensive set of data are needed for training. Although one can get its own data manually using a camera, it is not easy to reach thousands or millions of data for specific applications [30]. However, due to the growing technologies in big data [31], time will come that this barrier will become almost negligible.

V. IMPACTS OF THE TECHNOLOGY

A. Economy

Increased consumer demand because lots of firms will enter the market. As a result, the products will be more affordable. Furthermore, labor productivity improvements because of intelligent automation.

B. Industry and Manufacturing

Workers from some companies like in the business process outsourcing (BPO) will lose their jobs because they can be replaced by virtual assistants that can work faster and efficiently 24/7. Furthermore, AI assisting the food production industry will help farmers to monitor the crops to maximize crop yields and profits.

C. Society

Doctors can use AI as their assistants. It can accurately diagnose diseases by analyzing information from the patient's laboratory results. AI can also propose treatment plans for the patient. With this, mortality rates will lessen.

Low skilled workers should be trained and re-allocated to minimize the effect of AI in process automation. Furthermore, professionals like doctors, lawyers, and accountants could be replaced by AI in some predictable tasks.

Improvement in the transportation system can also be experienced due to intelligent transport systems. And soon, robots can be used as friends and improved elder care.

D. Government

Implementing an AI platform to the government will make a better decision in policymaking. The AI will help the government in determining an effective solution to

some problems like traffic, corruption, and pollution. The AI can also help the government in detecting fraudulent or unusual transactions.

VI. POLICY RECOMMENDATIONS

A. Labor and Employment

a) Training and scholarship for the low skilled worker: Low skilled workers should be trained or offered a scholarship so that if they are to be replaced by robots with AI, they can be easily re-allocated to a skilled job like management.

b) AI-related projects: The government should launch projects that take advantage of AI applications like pattern recognition, weather prediction, image classification, and detection. This will encourage data scientists to explore AI models and work with the government.

B. Human Resource Development/Education

a) Inclusion of AI in the curriculum: Higher Education Institutions (HEI's) should include AI in the curriculum like in engineering courses to introduce its basic concept and applications. Organizing seminars, roundtable discussions, and workshops that focus on AI will benefit students as well as professionals. It is also essential to encourage the academe to develop technologies to meet industry needs and to fund joint industry-academia projects.

C. Government Policies/Laws

a) Digitizing the data: The data in the government and private sector should be digitized and can be accessed by trusted professionals. This will help to quickly gather data that will be used for machine learning in AI because it cannot learn without access to a large dataset. The data will be secured and protected by the existing law, which is the Republic Act 10173 -Data Privacy Act of 2012.

b) Monitoring and maintenance of AI Systems: AI systems should be monitored and maintained only by a data scientist or AI experts. AI experts will help AI systems for better decision making and ensure that it is running smoothly according to its desired functions.

c) Ethical codes for AI: Ethical codes should be created that will help to develop a safe and fair AI system. Best practices must be established by experts. This will guide researchers and industry in developing risk-free AI systems.

d) Public Empowerment: The public should be informed about the advantages and disadvantages of using AI. This will ensure trust in technology. It is recommended that AI

literacy must be a fundamental skill for every people in society.

e) Humans must be in control: Intelligent robots must allow humans to shut down their system when there is a risk for individual privacy and safety.

f) Liability for malfunctioning AI systems: The government must determine who is accountable for defective AI systems and implement penalties depending on the level of offense.

g) Creation of infrastructures: Data storage is vital in AI systems because this is their foundation for learning. In our country, we rely on the built-in storage of our computers. The government should allot a budget for AI infrastructures like data centers. Facebook and Google have this infrastructure so that they are capable of creating reliable and sophisticated AI systems.

h) AI and Robotics Institute: The government should create an R & D institute under the Department of Science and Technology (DOST) that is composed of data scientists and experts from the academe. They will focus on the research and development of AI and robotic technologies. The institute can also provide policy recommendations to the government.

D. Research and Development

a) Ensuring the AI is tested before public use: Before releasing an AI system, companies should run rigorous pre-release trials to ensure that they will not amplify biases and errors due to any issues with the training data, algorithms, or other elements of system design.

b) Government support: Academe and industry should be supported by the government in developing AI systems. Few requirements for proposals will encourage them to proposed different ideas related to AI.

VII. CONCLUSION

In this paper, we saw that artificial intelligence has lots of applications in the field of machine learning, natural language processing, robotics, and expert systems. It offers positive impacts on the economy, society, industry, and government. To maximize this, the government must create a national policy that will focus on the security of AI systems and support for research and development. Informing the public about the AI will also help them to understand the technology and how to use it safely.

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