Artificial Intelligence in Reproductive Medicine

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ABSTRACT

Artificial intelligence (AI) is intelligence demonstrated by machines that mimic cognitive functions associated with the human mind, such as learning or problem-solving. The standard Artificial machine-based Intelligence, which we know of today, is made up of cognitive function and problem solving and not related to consciousness and emotion. In the field of reproductive medicine, AI and ML are being increasingly used in administration, medical records keeping, research, laboratory, and Clinical practice practise. The in vitro fertilization (IVF) specialist in the USA is utilizing AI, to distribute the work in the clinics, so that every day there is the same number of patients for ovum pick up. AI has improved the work efficiency in the clinical laboratorys. AI can be used for stock-taking, inventory, quality control, etc. AI can be used to predict male factor infertility, to understand the impact of lifestyle and environmental factors on semen quality and fertility rates. The smartphone-based applications can be used for semen analysis as well as for analyzing sperm viability and DNA integrity. AI can be used to identify sperm with good morphology and sperm DNA integrity for IVF. While applications of AI have gained the most attention and shown the greatest promise, its use will widen to other aspects of reproductive medicine including precisely assessing patient characteristics such as age, endocrine status, etc. The clinical diagnostic steps will undoubtedly increase the efficiency of diagnoses in all areas of reproductive disorders.

Key words: IVF, Reproductive medicine, Artificial Intelligence, Assisted reproductive techniques

INTRODUCTION

Artificial intelligence (AI) is intelligence demonstrated by machines that mimic cognitive functions associated with the human mind, such as learning or problem-solving. Machine with AI does not possess the natural intelligence displayed by humans and animals, which involve consciousness and emotions.

The standard Artificial machine-based Intelligence, which we know of today, is made up of cognitive function and problem-solving, On the other hand, Artificial biological intelligence, which we humans do not want the machines to possess, is related to consciousness and emotion. The computers may keep on evolving, and at some point in time, they may start behaving like a human beings, with emotions and consciousness. This is the danger which

many people are worried about. If we can achieve a high level of machine intelligence without enhancing biological intelligence, then we will be able to achieve a lot!!

There are many applications of AI. One is automated reasoning, wherein, the computers can reason completely or near completely in an automatic fashion. The second application is of knowledge representation, in which a diagnosis of a medical condition using machines or having a dialogue in a natural language is possible. Examples are automatic planning including autonomous robots, unmanned vehicles, or driverless cars. The computers can also be capable of understanding the contents of documents, including the contextual nuances of language within them. Another application is Machine perception, in which there is a capability of a computer system to interpret data in a manner, that is similar to the way humans use their senses like vision, touch, smell, and hearing.

MACHINE LEARNING (ML)

ML, is a form of AI, in which a machine can learn and adapt to situations and undergo self-driven data training. Typically, a training data set is used to train a computer program by feeding images describing a series of features such as color, shape, and texture. For example, the machine

can see a skin lesion using a camera and then by using image analysis, can differentiate and diagnose cancer or a non-cancer lesion.

There are two main approaches to ML, viz supervised and unsupervised learning. In supervised learning, the data sets are known during training; but in unsupervised learning, hierarchal clustering is used to discover structure within classes, etc. In ML, the computers operate at high speed and thus need a great degree of the memory backup as well as energy consumption. This is possible with the use of cloud computing. ML, which is a study of computer algorithms can improve automatically through experience. The machine improves itself on its own as time goes by.

ARTIFICIAL NEURAL NETWORKS

The ML consists of artificial neural networks, which mimic the way, the brain works. A neural network typically consists of several layers of artificial neurons, fully connected to each other. Each neuron receives signals from multiple neurons from the previous layer, integrates these signals, and then fires these integrated signals, in all directions. The network is in digital space. For example, one of the types of artificial networks is the deep or convoluted neural network (CNN), which is an extended neural network, achieved by increasing the number of layers and the number of neurons per layer.[1] Increasing these layers will give rise to deeper neural networks, which can be trained to classify complex objects, images, or videos. When ML is used to analyze images or videos a deep neural network is required. They are very powerful for image classification in biomedical imaging domains.

One can understand ML by analyzing, how a computer identifies and enhances an image of an elephant. The computer will have a ML section where the machine will start analyzing multiple image variables in the elephant's photograph, such as the color of the skin, the greyscale areas, contours, etc.: it can analyze many thousands of such variables, which the naked human eye cannot see or assess. The variables are inputted by the machine and all these variables will be considered when the machine concludes that the

photograph is of an elephant. The computer, using its deep neural networks, will keep on training itself and refining itself so that it can quickly analyze the photograph of an elephant, faster and in a better way, every time it does so. This is known as unsupervised learning.
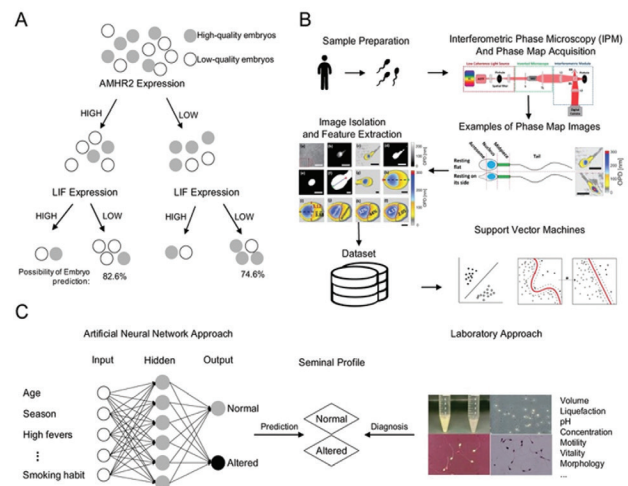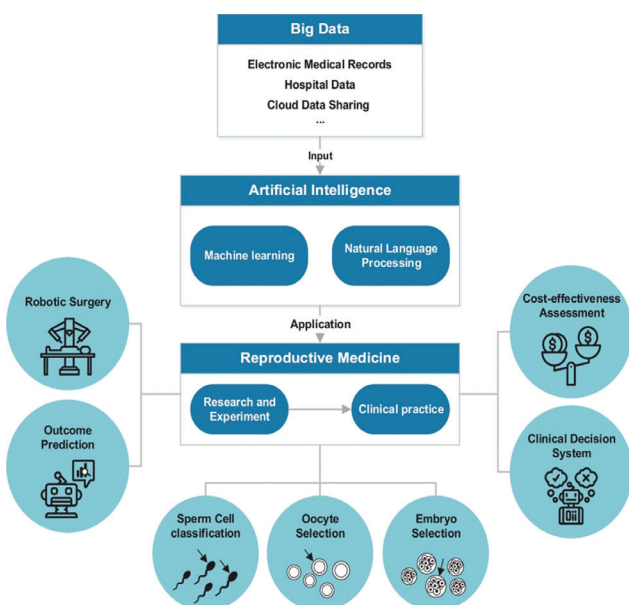
ECONOMIC BENEFITS OF AI

AI can improve health care, making diagnosis more precise, enable better prevention of disease, increase the efficiency of farming and contribute to climate change, mitigation, and adaptation. It will improve the efficiency of production systems through predictive maintenance, be able to operate drones, and self-driving cars, create art, write poetry, prove mathematical theorems, play games, operate search engines such as Google search, perform the role of online assistants like Siri. Etc.

With AI, image or photograph recognition is possible. Face recognizing technology for criminals, spam filtering, predicting flight delays, prediction of judicial decisions, targeting online advertisement, energy storage, answering service, robotic service devices, are the other benefits of AI. The machine chats or chatting with robotic friends, posting stories in digital media etc. is possible too.

AI in Medicine

The role of AI in medicine is immense. It can detect genetic variants from large genomic data sets, identify somatic genetic variants and predict responses to therapy based on genomic features, leveraging medical imaging, etc. There is a big database called "ImageNet" which has about 14,000,000 images.[2] Many people can access this image data, created through the ML systems. AI can help in diagnosing skin lesions, differentiate between malignant and non-malignant lesions, predict diabetes, predict abnormalities by looking at retina scans, and analysing pathological slides. At present, we need expert pathologists and radiologists for the diagnosis of disease using microphotographs, X-rays, CAT scans, and magnetic resonance imagings. However, in the future, AI with ML will be able to supplement if not replace such image-based diagnostic human expertise.

AI in Reproductive Medicine

In the field of reproductive medicine, AI and ML are being increasingly used in administration, medical records keeping, research, laboratory, and Clinical practice practise. The *in vitro* fertilization (IVF) specialist in the USA is utilizing AI, to distribute the work in the clinics, so that every day there is the same number of patients for ovum pick up. AI has improved the work efficiency in the clinical laboratorys. AI can be used for stock-taking, inventory, quality control, etc.

AI can be used to predict male factor infertility, to understand the impact of lifestyle and environmental factors on semen quality and fertility rates. The smartphone-based applications can be used for semen analysis as well as for analyzing sperm viability and DNA integrity.[3] AI can be used to identify sperm with good morphology and sperm DNA integrity for IVF.

Presently, research is ongoing, in enabling the embryologist to identify the best sperm during the procedure of Intra Cytoplasmic Sperm Injection (ICSI). A new system is being evolved, which connects the ICSI screen, in real time, to the internet and then to the AI server. The machine guides the embryologist, to identify, immobilize and inject the best possible sperm into the oocyte. [1] This helps in obtaining good fertilization rates, high-quality embryos, thus increasing the chances of a successful pregnancy outcome.

AI with ML, using image analysis, can be used to assess and grade the mature eggs prior to fertilization or cryopreservation. The system exports the images of the oocytes, to the server, which in turn, predicts whether the eggs will yield a good blastocyst and pregnancy, when thawed and fertilized, in the future. The data can be used to counsel patients undergoing elective egg freezing for fertility preservation. It can help the patient in deciding whether there is an adequate number of good quality eggs, to assure her of a future pregnancy. In case the good quality eggs are less in number, the patient can decide to undergo an additional cycle of oocyte retrieval and cryopreservation, thus improving her chances of a successful pregnancy, in the future.

AI with ML can be used to analyze and predict the implantation potential and genetic euploid status of the Blastocyst, prior to the embryo transfer. One can grade and rank the available blastocyst, thus selecting the best embryo for transfer. In the future, AI with ML, will be frequently used to predict genetic competence of the embryo. We will be able to correlate the genetic analysis of the embryo with actual visual analysis and the machine will slowly learn, identify, and guide the embryologist, in selecting the best embryo for transfer.[4] This will obviate the need to perform complex tests such as Next-gen sequencing on DNA obtained from the embryo.

EMBRYO TRANSFER

ML will help us in performing a perfect embryo transfer, resulting in a successful pregnancy outcome. It will help us to analyse the endometrial lining, thickness, the appearance of the lining and the endometrial blood flow. The machine can correlate these images and will guide us to decide whether the endometrial lining is ideal for transfer or not.[4] If the lining is not ideal, one can transfer in the next cycle.

DISADVANTAGES OF AI

Currently, multiple platforms are used for AI. There is a lack of standardization. It is possible that a machine can selectively analyze only the good data, by mistake, thus giving rise to wrong predictions. The machine must have a balance of good images and bad images to guide us correctly. Some laboratories are developing new programs, that can eliminate bad data, thus improving results.

The machine must have data based on ethnic diversity, for example, Indian people are different from Caucasian people; hence in ML too, the Indian data is required along with Caucasian data. If the analysis and application is done from in different countries, one may interpret data, wrongly. The pooling of information has to be done from multiple data sets, to help us make better predictions. The data sharing, implementation, and integration of information are important.

Algorithmic bias can create deep fake news, spam, and fraud.[4] People are fearing that ML may create a lot of job losses with a prediction of 9–47% job loss. The fields or jobs involving human-to-human contact will remain in the future, but the fields currently using a lot of automation will be taken over by ML. As the machines are trained, using CNNs to evolve their programs, there is a fear that AI will spell the end of the human race. Stephen Hawking said that "once Man develops artificial intelligence, AI will take off on its own and redesign itself at an ever-increasing rate. Humans, limited by slow biological evolution, will be unable to compete and will be superseded by Machines." However, the opinions of experts within the field of AI are mixed, both concerned and unconcerned by this eventual superhuman capacity. The danger of uncontrolled advance needs to be realized. However, AI will unlock a huge number of possibilities, like curing disease.

Many feel that AI will, create more jobs, not less. A group of prominent tech Titans, including Peter Thiel, Jeff Bezos, and Elon Musk have committed Hundreds of thousands of Dollars, to open a non-profit company aimed at championing responsible AI, creating jobs by using applications of AI, especially in cancer, infections, and reproductive medicine.

CONCLUSION

AI will usher in a new era in Reproductive Medicine. The standardization, automation, and precision of IVF driven by AI are likely to be more objective, more rapid, and more accurate. While applications of AI have gained the most attention and shown the greatest promise, its use will widen to other aspects of reproductive medicine including precisely assessing patient characteristics such as age, endocrine status, etc. The clinical diagnostic steps will undoubtedly increase the efficiency of diagnoses in all areas of reproductive disorders.

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