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AI POWERED NUTRITION

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Abstract

Artificial intelligence (AI) is the ability of computer systems to do tasks that normally require human intelligence. AI is rapidly developing and changing every facet of healthcare, including diet. This review has four goals in mind: The objectives are as follows: (i) to investigate the role artificial intelligence (AI) plays in nutrition research; (ii) to identify nutrition-related domains where AI is being applied; (iii) to understand the possible impact of AI in the future; and (iv) to investigate possible issues with the application of AI to nutrition research. The primary findings demonstrated that artificial intelligence's role in nutrition is still in its infancy, with a focus more on dietary assessment and less on lifestyle modifications, predicting malnutrition, and comprehending illnesses linked to diet. Clinical study is necessary to determine the efficacy of AI intervention. The ethics of employing AI is a significant topic that has not yet been addressed and has to be considered in order to prevent collateral harm to particular communities. The review's focus on specific dietary areas was limited due to the variety of the available evidence. Future study should prioritize specialized evaluations in nutrition and dieting in order to better grasp AI's potential in human nutrition.

Keywords: artificial intelligence in nutrition, chatbots, machine learning, dietary assessment, malnutrition.

Introduction

The expression “artificial intelligence” was first used in 1955 by the American computer technologist John McCarthy (1927-2011) to describe a research project that would be played out over the ensuing years at Dartmouth College, which is situated in Hanover, New Hampshire. [1, 2]. In experimental and clinical medicine, artificial intelligence (AI), a field of computer science targeting the mimicry of thought processes, acquisition and storage of new information, is being applied ever more widely. The applications of AI in medicine and biological science have matured over the past few decades. Artificial intelligence tools are increasingly being employed in medical diagnosis, risk prediction and decision support. The use of AI in ophthalmology, radiology and cardiac diagnostics has led to well-established clinical benefits. AI was used for drug discovery [3].

When it comes to diagnosis, prediction and data interpretation; artificial intelligence (AI) is increasingly playing a prominent role in nutrition practice and research (providing the means necessary for promoting growth, development while preventing chronic diseases [4]. The majority of nutritional challenges (obesity, diabetes, cancer, cardiovascular diseases) as well as aetiology and therapy is to address can be solved with the help AI [5]

Advances in artificial intelligence (AI) have led to the development of powerful AI systems, that are capable of contribution to nutrition and health, contributing to enhancement of individualized dietary advice.

Defining Artificial Intelligence

In the 1950's, Alan Turing published a paper – Computing Machinery and Intelligence. He discussed how you might build smart machines and how to measure them.This test itself has previously been called the "Turing test" and it serves as a point of reference to judge how intelligent artificial systems are [6].

What is artificial intelligence?

AI has a rich history in computer science and is motivated by the general aim of creating "intelligent" machines [7], although what it means to be intelligent is notoriously ill-defined and challenging to measure. [8]

McCarthy [10] coined the term AI as "the science and engineering to make intelligent machines, especially intelligent computer programs" in 1955. It is like the goal of using computers to understand human intelligence" (p2). AI definition requires the understanding of its multidisciplinary nature, since the conception of AI is different across sectors [9].

AI, ML, DL; Everything is related but everything is different. The following are some of the key differences between these domains:

• Artificial intelligence (AI) is a general term for any systems that exhibit humanlike performance on cognitive tasks, such as learning to solve problems and make decisions.

• Machine learning (ML) is AI subfield which, as the name suggests, teaches digital computers from pattern data analysis to perform tasks without being given a set of instructions.

Deep learning (DL) is the sub-field of artificial intelligence using multi-layered artificial neural network for learning and representation. It's especially useful for tasks that involve poring over tons of data, such as text (ChatGPT) or images (like DALL-E2).

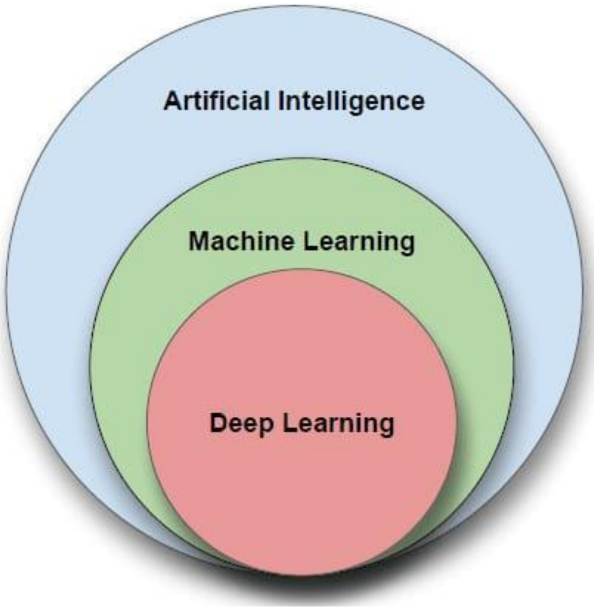

Figure 1. Relationship among Deep Learning, Machine Learning, and Artificial Intelligence

Different Artificial Intelligence Networks and Tools:

1.Machine Learning (ML):The practice of applying algorithms and searching for patterns in data to help make decisions. Algorithms are then used to identify clusters in batch of classified data. ML falls under AI and can be broken down into three categories: supervised learning, unsupervised learning and reinforcement learning [11].

a) Supervised learning: It is based on a target or an output which must be expected from an input variable. A function between the input and expected output will be formed during the training process to obtain a desired degree of precision. Many types of supervised learning algorithms, e.g., decision trees, K-Nearest Neighbors (KNN), Random Forest, XGBoost, LightGBM and Support Vector Machine have been extensively exploited in the application of solid dosage formulations. [12].

b) Unsupervised learning: The input variables are the only one affected by this feature extraction and clustering approach.

c) Reinforcement learning – This technique is based on selecting options in a pre-set environment where the computer will be either rewarded or punished for the decisions that it makes to teach the model to act optimally [13].

2.Deep Learning A subset of machine learning, called ANN which are layered-structure algorithms. The deep learning algorithms have very complex model structure to make predictions [13].

Artificial Neural Networks (ANN)

These are a system of very interconnected computer elements that can use "perceptons"—it functions like the real human neurons to replicate electric impulses transmission observed in the biological human brain. In an ANN, there are numerous nodes at which inputs arrive; these can work together or in isolation, with the help of automation algorithms to produce output that helps in achieving some goal. 2. ANNs can be divided into different types and trained (supervised or unsupervised).

These include convolutional neural networks (CNNs), recurrent neural networks (RNNs), and multilayer perceptron (MLP) networks [14].

3.Convolutional Neural Networks (CNNs) :Topology indeed makes the difference for a well-defined class of local interaction dynamical systems, known as CNNs. It is used in various applications including pattern recognition, advanced signal processing, modeling biological systems, complex computations of the brain functions and image or video processing.

4.Recurrent Neural Networks (RNNs): Looped network RNNs such as Hopfield and Boltzmann [2], also with looped networks, are capable of learning and storing data.

Multilayer Perceptron Networks (MLP): The MLP network can also function as a universal pattern classifier and it is learnable in the forward only learning schemas. Some applications of them are in pattern recognition, process identification and control and optimization [15].

6. Natural Language Processing (NLP) :Natural language processing (NLP) aims to enable the same kind of semantic interpretation as humans are capable of (Liddy, 2001). It is used, among other things, for translation text analysis and speech recognition. To be more specific, NLP can analyze spoken or written language by interpreting, reformulating in a different mode (e.g., summarizing), providing the right context (given response to a query) or meaning, and expressing it (Liddy, 2001). Data from social media, medical records, blog posts aspects (to name a few) can be harvested and organized with tremendous dividends (Lavignetal., 2019).

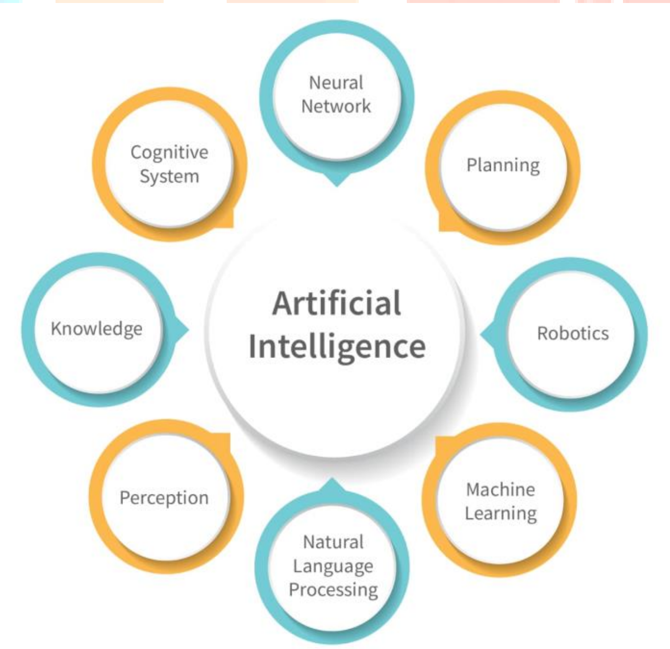

Figure 2. Various Networks and Tools of AI

Applications of Artificial Intelligence: As one of the fastest-growing fields, artificial intelligence (AI) can provide numerous applications to be applied in the healthcare field and no exception is presented with it as well within this area, for its progress and algorithms ability to understand complex relationships [16].AI is rapidly transforming how nutrition is delivered. State-of-the-art software is being used, rather than conventionalmethods,to evaluate body weight and food intake as well as diet-related diseases, while ultra-modern data storage is employed to cater for the data requirements of today [17].

As far as we know, no study has specifically investigated the uses of AI and its pros and cons in nutritional research. Hence, the objectives of this article are fourfold: (i) to investigate how AI is used in nutrition research; (ii) to identify the areas related to nutrition exposure receiving the applications of AI; (iii) to understand the prospect and future impact(s); and (iv) To explore any potential challenges surrounding the use, thus far experienced by users, in relation to AI applied across nutritional studies.

Applications of AI in nutrition

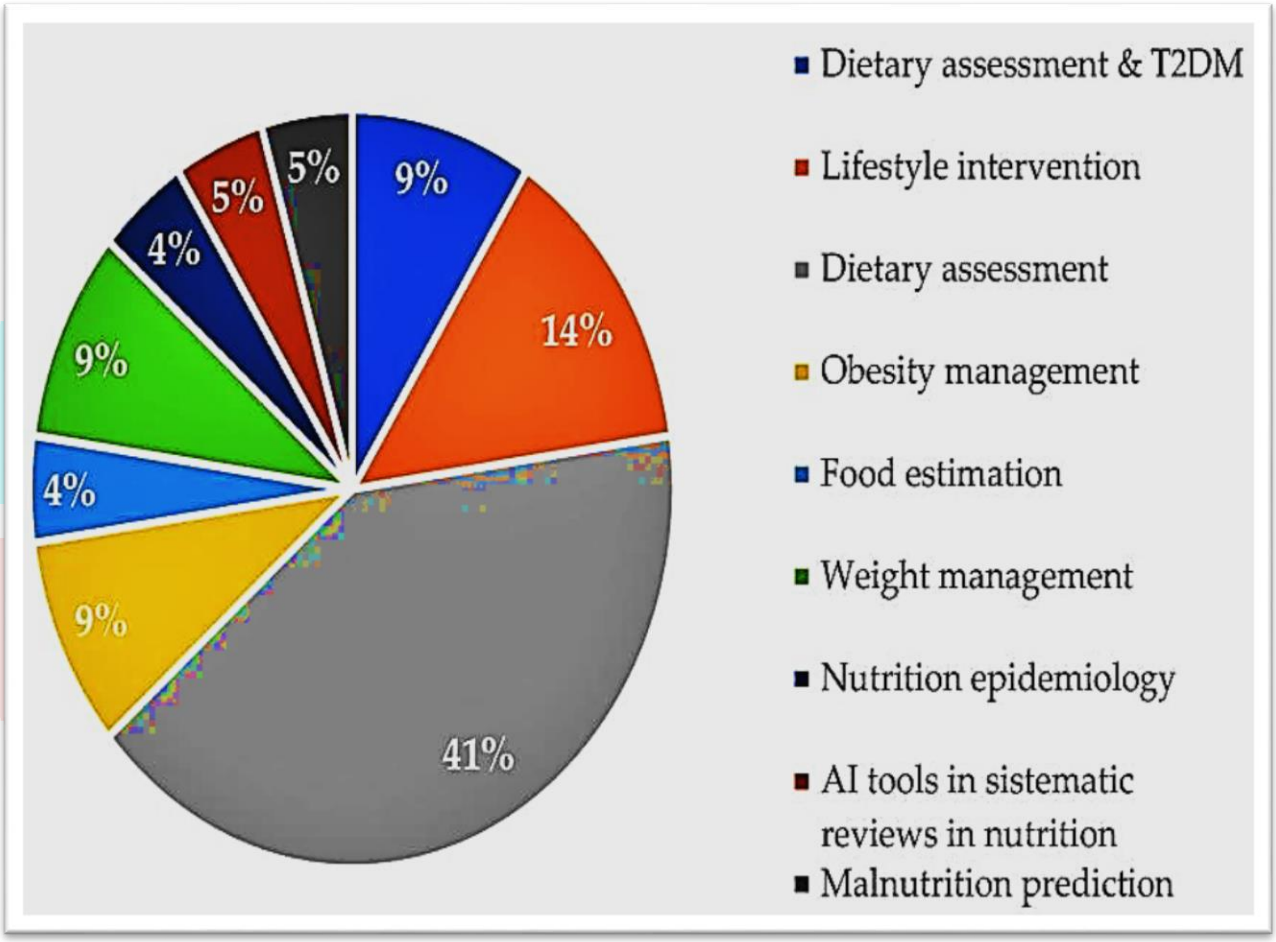

Figure 3. Nutritional categories in which the included publications used artificial intelligence.

Diet and gut microbiota: In fact, the study of other effects of probiotics can also help to develop better probiotics and better combinations of them [18]. A few more sophisticated custom models have also been proposed, such as the “enbiosis model”, deemed successful enough in dins creating a customized diet that can improve microbiota [19]. An AI-guided diet effectively reduced symptoms of irritable bowel syndrome in clinical pilot study vs. a control diet [19].

Nutrigenomics and personalized nutrition : Large biological dataset, including nutrition, genetics and so forth as well as the beneficial instruments and models of artificial intelligence can be collected, structured and processed [20]. Furthermore, accounting for nutrient metabolism-related genetic variations through AI would allow personalized dietary treatments to be recommended on the basis of personal genetic profile. Thus, to produce personalized nutrition bioinformatics and AI can integrate genetic information with dietary evaluation, lifestyle factors, and health data.

Personalized nutrition : Customized nutrition – AI can help for diet recommendations. A targeted strategy indicates that phenotypic alterations in responses to specific drugs are possibly due to host-dependent interindividual variation of the gut microflora, metabolic, biochemical and genetic factors [21]. The above information can be used to guide the development of more targeted interventions and inform on molecular pathways implicated in nutrition-related health problems.

By integrating the computational speed of bioinformatics with the advanced features and learning capabilities of AI, it is possible for researchers to develop personalized interventions, enhance individual health and well-being, and achieve a better understanding of nutritional outcomes. Nutri-Educ is an algorithm providing customized dietary advice, and can be considered as a personalized nutrition database [22]. They link molecular events to health outcome by : (i) data integration at several related scales; (ii) the proposed modeling approach implements advanced machine learning (ML) models that integrate multi-omic approaches with health outcomes; (iii) non-intuitive hypotheses are created for further experimental validation and exploration and (iv) assays will be performed in clinical and preclinical studies where all nutritional interventions are standardized.

Food composition: Accurate assignment of food components is critical for developing new products, and informing general nutrition and food safety. Traditional ways of determining food composition can be expensive, time-consuming and require extensive laboratory testing. Advances in AI recently, however suggest there is a significant opportunity to overcome these constraints, to provide precise, timely and efficient food component predictions

A recent study reported the successful prediction of peach fruit chemical composition by ANN, demonstrating that AI is feasible and efficient in the food sector [23]. Similarly, ANN performs better than response surface methodology in term of accuracy towards the prediction of phenolic and flavonoid content in garlic [24].

AI chatbots for lifestyle intervention: As described above, chatbots could promote physical activity, but there is no consistent evidence for dietary intake and weight loss [25].

Artificial Intelligence Applications to Public Health Nutrition: There is a unique place for public health nutrition with the general field of preventing disease and promoting health and that to be out in front of one subject or imbedded in another at individual level nutritional research. Public health nutrition is aimed at understanding and influencing the dietary habits of entire populations, whereas the latter examines fine points of individual nutritional requirements, metabolic responses and genetic susceptibilities. Together, the efforts aim to not just ensure that people are eating healthfully but create conditions are opting for something healthier becomes a little easier for everyone.

There has been unprecedented growth in capabilities of artificial intelligence (AI) and its usage in the past few years. This rapid progress has had an impact of a number of aspects of human life and society, enabled by advances in machine learning algorithms and the exponential increase in computational power [26]. AI's potential is being realized in the sectors of nutrition and public health through a series of innovative approaches.

Mapping and characterization of food environments, including the identification of "food deserts"—areas with limited access to foods high in nutrients—has been enabled, no small part as a result of AI algorithms [27].

Ethical problems and other aspects of ai's use in nutrition

When Stephen Hawking says, ‘’Our future is a race between the growing impact of technology and the wisdom with which we use it’’ [28], he is pointing to the importance of ethics in science and technology. Some general ethical considerations for AI are summarized in Table 1 as presented by the Association for the Advancement of Artificial Intelligence [29]. These, and many other considerations, are now being explored when it comes to nutrition science and practice.

Artificial intelligence systems can be brilliant pattern recognizers, but they have a harder time with context and the sort of nuanced approach that many patient-care decisions require the treating physician to make: subjective considerations that often depend on understanding a patient’s experience and showing empathy.

Both the risk of the “dehumanization” of care and the potential advantages of AI is mentioned in a recent Paper on Artificial Intelligence from EFAD Professional Practices Committee in Dietetic Practice Code of Ethics [30].

Personal and sensitive data from patients is collected and analysed. This information should be private and secure [28]. Indeed, determining who can access someone’s data is critical. Furthermore, the data should not be used to discriminate subjects regarding rates of insurance premiums or employment [31].

AI should be deployed with a view to honour human rights safeguards [30]. AI could be used to help protect both individuals at high risk and the community if it can predict those most likely to catch a disease [32]. Nonetheless, there may be a link between this information and product marketing, over-medicalization, tension, and anxiety [32].

Table 1: General ethical aspects regarding AI

▪ AI should benefit society and human well-being.
▪ AI should do no harm.
▪ AI practitioners should be ethical, honest and trustful.
▪ Those involved in AI should act fairly and not discriminate.
▪ Those working with AI should demonstrate respect for the effort that goes into creating new ideas, inventions, and creative works as well as innovative computing artifacts.
▪ Privacy and confidentiality must be maintained."

It is troubling, then, that whilst technology develops and changes at an incredible pace, the law seems to be slowly catching up on some of the political and value issues flowing from it. This suggests "policy will follow technology unless policy is constructed to lead technology" [33]. Several problems must be tackled in order to fully exploit the practical application of technology. These involve a balance of privacy against the public interest in utilizing technology and copyright v. public health [34].

Figure displays the most recent agreements and laws from the US, Europe, and other countries.

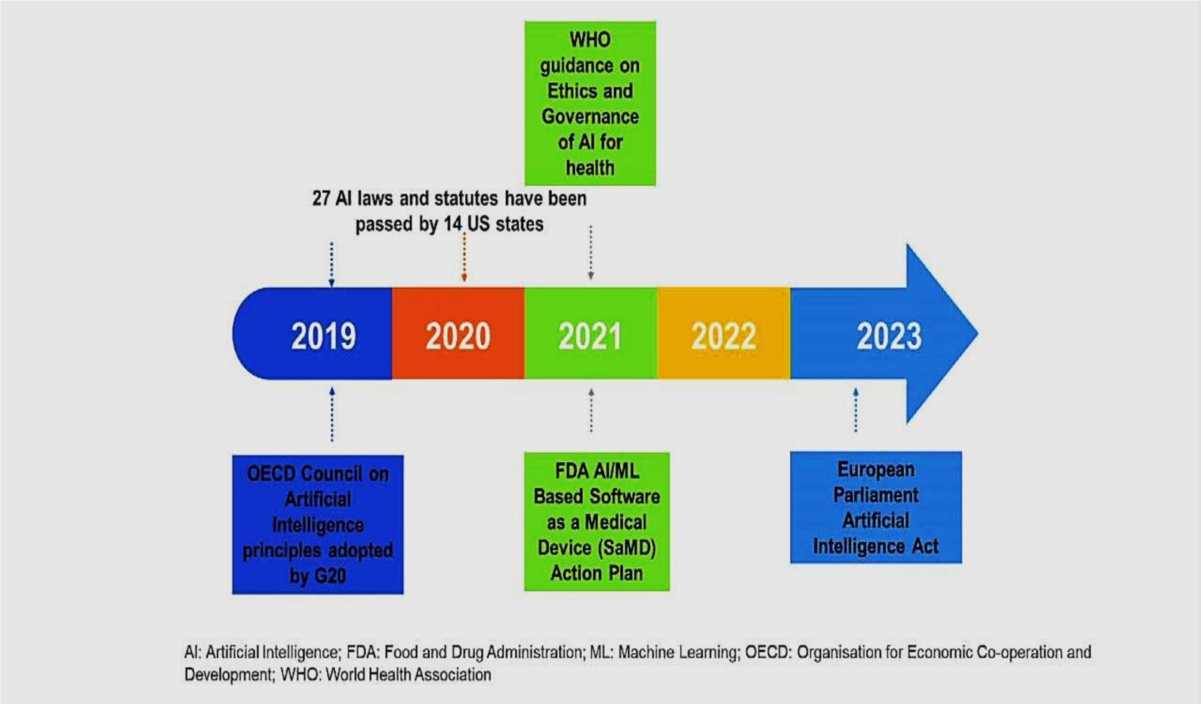

Figure 4. Legislation and commitment steps in US, Europe and Internationally

AI in Malnutrition

Automation through artificial intelligence (AI) enables early identification of malnutrition and preventing chronic consequences. With an aim to give a full report on the patient populations, screening tools, machine learning algorithms, data and variables used by these AI-based tools; as well as the current limitations and where on the implementation ladder these tools are sitting at present; we undertook for this study a systematic literature review.

This study can assist investigators to be inspired in the selection of any further investigation on AI applied to malnutrition. Some jobs are performed with help, however not to the extent it is today due to recent advances in AI. One method that has recently benefited from AI advances is that of decision-support systems (DSS). The DSS assists practitioners in coming to difficult judgments. This resulted in the creation of Clinical Decision Support Systems which have shown to be beneficial but have not yet been widely adopted. Health care providers may utilize these to help them make decisions about diagnostic or treatment options (e.g., to cure malnutrition or malignancy).

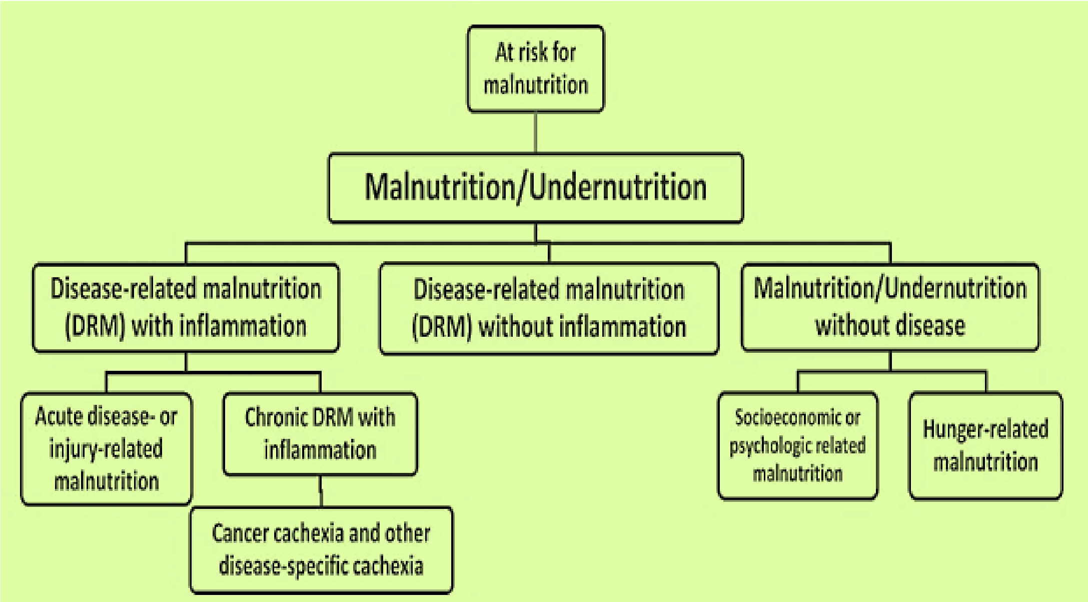

Figure 5. The malnutrition taxonomy

Positive aspects of ai in nutrition

AI can make complex facts to be "simpler" and "deeper" by modelling patterns that humans cannot perceive [35]. After all, the architecture and the way functioning of AI systems and brains are not the same [91]. AI and Big Data AI is relevant for big data processing, which runs in a feed-forward fashion: from the input that eventually leads to insights and more fine-grained description of findings [36].

This would make it possible to capitalize on AI-reformulated data for human health and other applications. Another issue that could be addressed is that, because humans make the "human nature" part of a mistake, this type of mistake should be diminished [37]. For example, Smart systems that adjust insulin dosage can reduce both hypo- and hyperglycemia in people with type 1 diabetes [38].

Artificial intelligent is the key to personalized nutrition. An AI-assisted routine investigation as an early step can avoid biased dietary assessment [39]. Instead, all sorts of genetic, gut microbiota, nutritional and other data can be mashed up in a variety of interactions to give the best result for one particular patient. However, the results of the trials that are available to us now do not seem promising at all in this regard [40]. Individualized nutrition is an offshoot of evidence-based practice, a scientific approach to solving health issues. (It can help such patients, caregivers and the society at large to) take over their problems so that they are able to predict future needs [28]

Challenges with artificial intelligence :One of the major challenges in Artificial Intelligence has been the construction of robust models that are able to give correct, accurate outputs for a wide range of inputs [42]. We have come a long way in finding things using deep learning, but similarly it has also been found that it is easy to trip up a deep learning AI model into incorrectly identifying objects. There were numerous instances in which researchers generated false predictions from the A.I. model by feeding it deceptive inputs. Researches showed that by changing only one pixel in a picture, a deep learning computer can be fooled into 'seeing' an object differently [43].

For example, McAfee researchers tricked Tesla vehicle to accelerate by 50 mph [44] using a piece of black tape placed on the speed limit sign.

Adversarial machine learning is the method of attacking a machine learning model by feeding it with benign-looking inputs that are specially crafted to succeed in mislead the model, referred as adversarial examples individual for given learnable models.

Second, it is awfully challenging to generalize and learn from pre-trained instances due the noise in artificial intelligence algorithms [42]. For example, even a baby can tell various animals like Giraffe as identical with the help of correlation decoupling (Gorrell 1989) rather than closely match them in the same manner as human read giant with man on hearing it for more than once. Likewise, transfer learning is the ability of an AI model to leverage hard-learned knowledge from previous training jobs to train for a similar job. But transfer learning has its drawbacks too. As a consequence, a system that has achieved competency on one task may forfeit its ability to perform well on that task when it tries to learn a related task through transfer learning.

Learning algorithms generate prediction models from the labelled samples. When algorithms Another problem challenging AI models is algorithmic bias [45]. Supervised Machine start training biased data, you end up getting AI systems that produce biased predictions. In social encounters, these biases may be especially pernicious because of their amplifying effects on pre-existing race and gender stereotypes. Taking on such algorithmic bias is tough, as algorithms aren't always checked by the data that powers them by experts to be truthful and unbiased.

Future possibilities in artificial intelligence :Artificial intelligence holds much potential for the field of medicine. Personalized nutrition planning, medicine creation and analysis, fitness monitoring, and diagnosis/monitoring of mental health disorders are all just some professions which artificial intelligence could expand in [46] As stated before the breast tumor detection using Computer Aided Detection (CAD) is non-effective.

One of the successful object detection frameworks, Faster Deep Convolutional Neural Networks (Faster R-CNN), can be applied to improve the state-of-the-art in CAD systems that have been used. This will enable building systems that detect and precisely classify benign and malignant lesions, free of human intervention [47].

In the aviation industry systems are being developed that can mimic human pilots in executing Flight Emergency Procedures such as engine failure, rejected take off and emergency landing, utilizing the Learning by Imitation technique [48].

AI can be used in the education domain [49] by developing AI graders, designing AI tutors for students with social anxiety, using VR as a tool of immersive learning etc.

Even though artificial intelligence has been used for nearly all agriculture areas, there is still a huge potential in their s utilisation in the horticulturer and greenhouse field [50]. There are also some initiatives towards autonomous greenhouses where the control set points for generic actuators are determined remotely based on Artificial Intelligence techniques. Preliminary experimentations have revealed that AI is capable of performing better than human in running a greenhouse.

AI has proven its mettle in terms of competing with the human intellect and at times outperforming them on a myriad of domains [51] from playing games like Chess, Poker, Jeopardy etc. to predicting schizophrenia, detect skin cancer, face recognition, voice recognition etc

Ray Kurzweil, an American inventor and futurist, has predicted that humans would be able to achieve Artificial Intelligence systems with human capabilities by 2029 [52].

Conclusion:Artificial intelligence is a hot topic of discussion in recent years. Artificial intelligence is touted as a new technology with the potential to transform human society. So often, then, we have to ponder whether that constantly shape-shifting industry can ever live up to the unrealistically high expectations placed upon it. Some even speculate that AI will turn from a tool for human development into a menace to human survival.

A.I. has progressed from a machine that could be indistinguishable from a man to being used in many disciplines in our everyday world. Some of the AI breakthroughs mentioned in this paper, e.g., market research and medical imaging are employed that employ ML concepts including supervised learning, reinforcement learning, unsupervised learning.

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