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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 phrase "artificial intelligence" was originally used in 1955 by American computer technologist John McCarthy (1927-2011) to describe a research project that took place out over the next years at Dartmouth College, which is located in Hanover, New Hampshire. [1, 2]. Artificial intelligence (AI), an area of computer science aimed at imitating thought processes, learning capacities, and knowledge management, is increasingly finding uses in experimental and clinical healthcare. In recent decades, applications of artificial intelligence in medicine and biological sciences have grown significantly. Artificial intelligence has rapidly expanding applications in medical diagnostics, risk prediction, and therapeutic approach support. AI's application in ophthalmology, radiology, and cardiac diagnostics has resulted in demonstrable clinical advantages. AI was applied to the study of novel medications [3]. In terms of diagnosis, prediction, and data explanation, artificial intelligence (AI) is becoming more and more important in nutrition practice and research (offering what is required to increase growth, development, and prevent chronic diseases) [4]. The majority of dietary issues, including those pertaining to obesity, diabetes, cancer, and cardiovascular disease, as well as their causes and possible therapies, may be handled by AI [5]. Significant developments in artificial intelligence (AI) have resulted in the creation of potent AI systems that can be applied to the field of nutrition to improve overall health and well-being and increase individualized dietary advice.

Defining Artificial Intelligence

Alan Turing wrote a paper titled Computing Machinery and Intelligence in the 1950s. He talked about how to construct intelligent devices and how to assess their intelligence. This test, which has been referred to as the "Turing test" up until now, is a benchmark for figuring out how intelligent artificial systems are [6].

What is artificial intelligence?

AI has a long history in computer science, with the overarching objective of developing "intelligent" machines [7], however the term intelligence is not well defined, and evaluating "intelligence" is highly difficult [8].

McCarthy [10] defined AI as "the engineering and science of creating intelligent machines, particularly computer programs," in 1955. It is comparable to the task of employing computers to grasp human intelligence" (p2). The definition of AI needs awareness of its multidisciplinary character, as its conception differs throughout fields [9].

AI, ML, and DL are all interconnected but separate. Here are some important contrasts between these fields:

- Artificial intelligence (AI) is a broad phrase that refers to the development of intelligent systems capable of doing activities like learning, solving problems, and making decisions that often call on human intelligence.
- Machine learning (ML) is a branch of AI that uses data pattern analysis to teach digital computers how to perform jobs without explicit instructions.
- Deep learning (DL) is a branch of machine learning that makes use of multi-layered artificial neural networks for learning and decision-making. It is particularly useful for activities that call for analyzing large amounts of data, such text (ChatGPT) or images (DALL-E2).

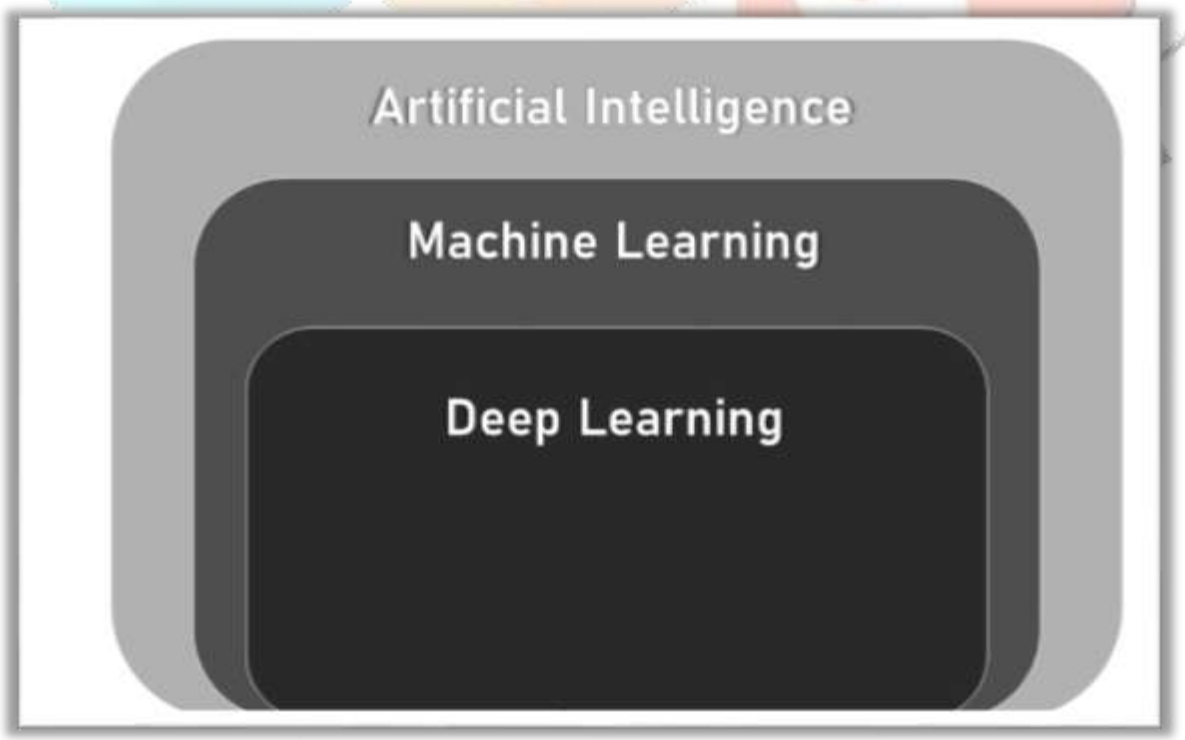

Figure 1. Relationship among Deep Learning, Machine Learning, and Artificial Intelligence

Different Artificial Intelligence Networks and Tools:

1. Machine Learning (ML):

The process of using algorithms and finding patterns in data to help make decisions. Patterns in a batch of data that has undergone additional classification are found using algorithms. ML is a subfield of AI that

is sometimes separated into three categories: supervised learning, unsupervised learning, and reinforcement learning [11].

a) Supervised learning: It makes use of variables that are anticipated from a set of input variables to determine the output or target. A function of the input vs. expected output will be generated during the training phase, yielding the required degree of precision. Several supervised learning techniques, such as decision trees, K-Nearest Neighbors (KNN), Random Forest, XGBoost, LightGBM, and Support Vector Machine, have been heavily utilized in the development of solid dosage formulations. [12].

b) Unsupervised learning: This method of feature extraction and grouping only modifies the input variables.

c) Reinforcement learning: This method relies on certain choices made in a predetermined setting where the computer will either be rewarded or penalized for its actions in order to teach the model to perform as well as possible [13].

2. Deep Learning (DL)

It is a subfield of machine learning that is usually represented by artificial neural networks (ANNs), which are layered-structure algorithms. Deep learning algorithms incorporate an extremely intricate model structure in order to provide predictions [13].

Artificial Neural Networks (ANN)

These are a group of highly interconnected computer components that use "perceptons"—which resemble real human neurons to mimic the electrical impulse transmission seen in the human brain. In an artificial neural network (ANN), every node is given a distinct input, and they all collaborate or operate independently to generate output, using algorithms to solve problems. ANNs come in various forms, some of which can be trained in a supervised or unsupervised manner. These include convolutional neural networks (CNNs), recurrent neural networks (RNNs), and multilayer perceptron (MLP) networks [14].

3.Convolutional Neural Networks (CNNs)

A class of dynamical systems with local relationships known as CNNs is distinguished by its topology. It is employed in many different applications, such as pattern recognition, sophisticated signal processing, biological system modeling, processing intricate brain functions, and processing images and videos.

4.Recurrent Neural Networks (RNNs)

Similar to Hopfield networks and Boltzmann constants, RNNs are closed-loop networks that have the capacity to learn and retain data.

5.Multilayer Perceptron Networks (MLP)

The MLP network can be utilized as a general-purpose pattern classifier and can be created utilizing one-way supervised training techniques. Pattern recognition, optimization tools, process identification, and controls are a few of its uses [15].

6. Natural Language Processing (NLP)

The goal of natural language processing (NLP) is language processing that is similar to that of humans (Liddy, 2001). Among other things, it is used for translation, text analysis, and speech recognition. More precisely, NLP may examine spoken or written materials to interpret, paraphrase, provide context or

meaning, or respond to queries (Liddy, 2001). Information from social media, medical records, and blog articles, among other sources, can be extracted and organized with great benefit (Lavigne et al., 2019).

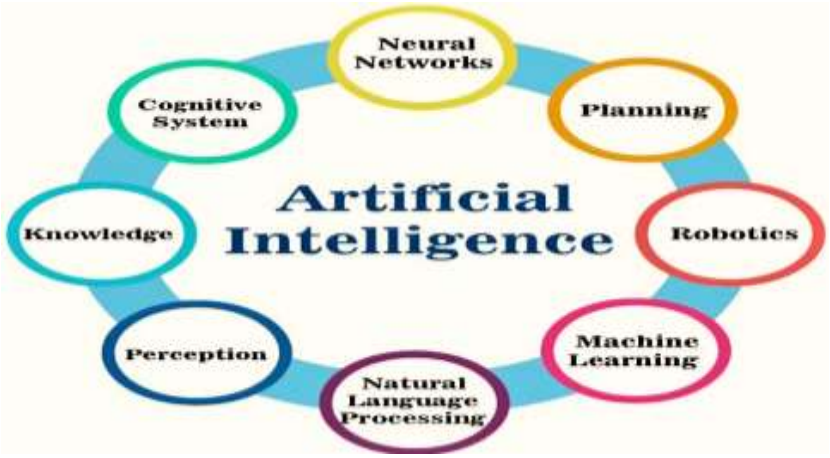

Figure 2. Various Networks and Tools of AI

Applications of Artificial Intelligence

Artificial intelligence (AI) has the potential to offer a variety of applications in the healthcare area due to its rapid progress and algorithms that can comprehend complicated interactions [16]. The way nutrition is currently provided is changing significantly as a result of artificial intelligence (AI). Instead of using traditional methods, more advanced software is being used to assess body weight, food intake, and diseases related to diet, and cutting-edge data storage systems are being used to meet current demands through chatbots and mobile applications [17].

To the best of our knowledge, no study has explicitly examined the applications, advantages, and disadvantages of artificial intelligence in nutrition research. Therefore, this article's four goals are as follows: (i) to look into how AI is utilized in nutrition research; (ii) to pinpoint the nutrition-related fields where AI is being applied; (iii) to comprehend any prospective future effects; and (iv) to look into any potential issues with AI's use in nutrition research.

Applications of AI in nutrition

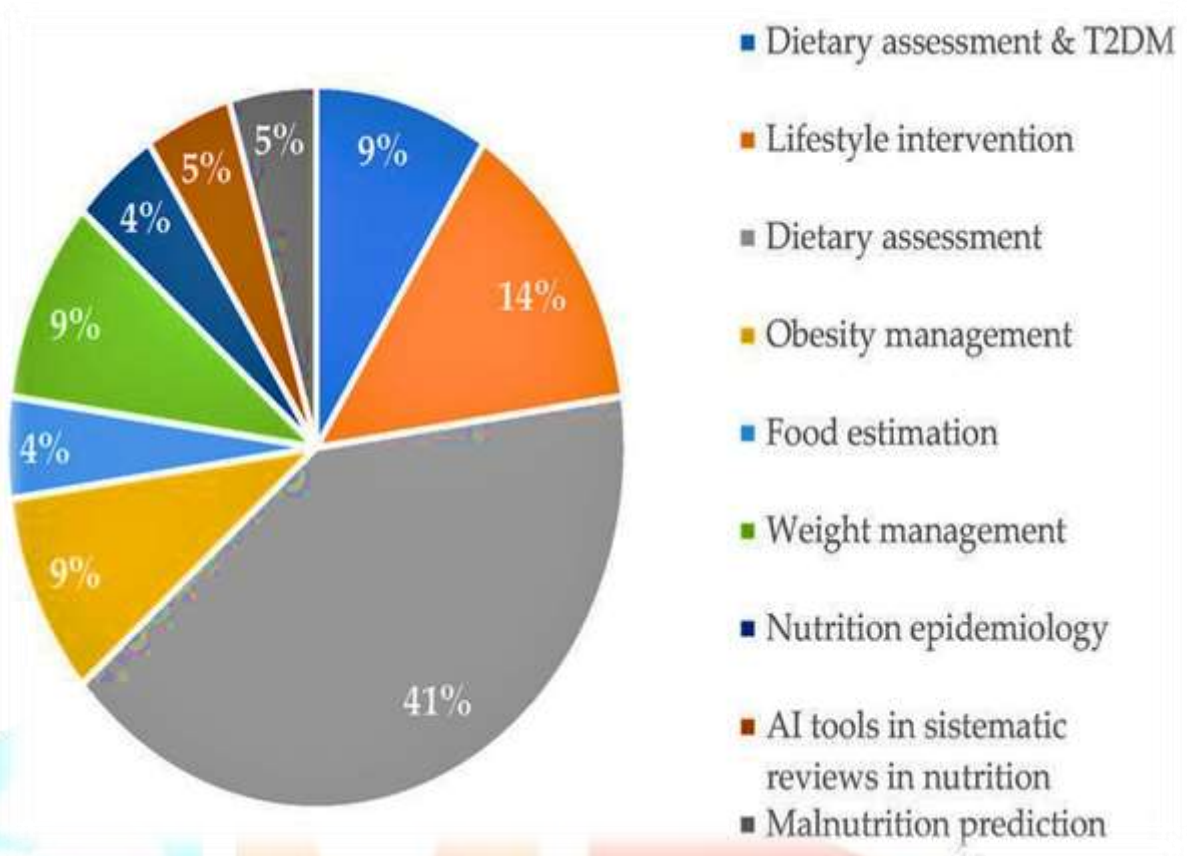

Figure 3. Nutritional categories in which the included publications used artificial intelligence.

Diet and gut microbiota

Notably, research on a variety of probiotic effects can aid in the development of probiotics and probiotic combinations that are more effective [18]. Additionally, a number of refined customized models have been created, including the "enbiosis model," which is thought to be sufficiently successful in creating customized diets to enhance microbiota [19]. Compared to a control diet, an AI-assisted dietary plan successfully improved symptoms associated with irritable bowel syndrome in a clinical pilot investigation [19].

Nutrigenomics and personalized nutrition

Large biological datasets, such as those connected to nutrition, genetics, and other topics, can be gathered, arranged, and analyzed with the use of helpful tools and methods offered by the application of artificial intelligence in bioinformatics [20]. Additionally, by considering genetic variations linked to the metabolism of nutrients, AI can suggest dietary treatments that are personalized and catered to the genetic profile of each individual. Therefore, to generate individualized nutrition, bioinformatics and AI can incorporate genetic data, nutritional assessments, lifestyle factors, and health data.

Personalized nutrition

AI can assist in creating customized diet programs for nutrition. A personalized approach suggests that phenotypic changes to certain therapies may be explained by individual differences in gut flora, metabolic, biochemical, and genetic variables [21]. The information above can direct the creation of more focused interventions and aid in understanding the molecular pathways causing problems connected to nutrition. Researchers can create tailored interventions, improve individual health and well-being, and gain a deeper understanding of nutrition-related phenomena by combining the computational power of bioinformatics with the sophisticated algorithms and learning capabilities of AI. The Nutri-Educ algorithm, which is designed to facilitate dietary modifications, is an illustration of a personalized nutrition database [22]. These establish connections between molecular occurrences and health consequences by: (i) data integration at all relevant scales; (ii) advanced machine learning (ML) models are used to combine multiple

models with health outcomes; (iii) non-intuitive hypotheses are generated; and (iv) experimental validation using clinical and preclinical studies with standardized nutritional interventions.

Food composition

For the creation of new products, general nutrition, and food safety, precise food component prediction is essential. Conventional techniques for figuring the food composition can be costly, time-consuming, and necessitate a lot of laboratory testing. Recent developments in AI, however, point to a great chance to get over these restrictions and offer accurate and efficient food component forecasts. Artificial neural networks (ANN) successfully predicted the chemical makeup of peach fruit in a recent study, showing that AI application in the food industry is both practical and efficient [23]. In line with these findings, ANN outperforms response surface approach in terms of accuracy when predicting the phenolic and flavonoid content of garlic [24].

AI chatbots for lifestyle intervention

As previously discussed, chatbots may improve physical activity, but there is currently a lack of reliable information about diet and weight loss [25].

Artificial Intelligence Applications to Public Health Nutrition

A distinct niche exists for public health nutrition within the broader fields of disease prevention and health promotion, distinct from individual-level nutritional research. Public health nutrition seeks to comprehend and impact the dietary practices of entire communities, while the latter explores the subtleties of individual nutritional demands, metabolic reactions, and genetic predispositions. Together, these initiatives hope to not only guarantee that people eat healthfully but also to establish conditions that make choosing a healthier option simpler for everyone.

In recent years, the capabilities and use of artificial intelligence (AI) have increased at a rate never seen before. This quick development has impacted and transformed a wide range of human endeavors and social sectors, propelled by breakthroughs in machine learning algorithms and the exponential rise in processing power [26]. AI's promise is being fulfilled in the fields of nutrition and public health in a number of creative ways. The mapping and analysis of food environments, which includes the identification of "food deserts"—areas with restricted access to nutrient-dense foods—has been made possible in large part by AI algorithms [27].

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

As Stephen Hawking has stated, "Our future is a race between the increasing influence of technology and the wisdom that comes from how we use it" [28], he is hinting to the significance of ethics in science and technology. Table 1 provides an overview of some general ethical considerations for AI as put out by the Association for the Advancement of Artificial Intelligence [29]. These and other aspects are currently being further examined in relation to nutrition research and practice. AI systems may overlook the absence of human judgment and emotional intelligence [28].

Artificial intelligence systems are very good at identifying patterns, but they have difficulty comprehending the subtleties of patient care that need for the treating physician to make subjective decisions and show empathy.

Both the potential "dehumanization" of healthcare and the potential benefits of AI are highlighted in a recent document on the Code of Ethics of the Professional Practice Committee of the European Federation of the Associations of Dietitians (EFAD) in the field of artificial intelligence [30]. Additionally, it's possible that technical solutions that seem promising are overvalued and cause other issues [28].

Patients' private and sensitive information is gathered and examined. These details need to be kept private and safe [28]. Controlling who gets access to a person's data is essential. Moreover, subjects should not be discriminated against based on this data when determining insurance premiums or employment status [31].

AI should be implemented with consideration for human rights protection [30]. AI could benefit high-risk people as well as society if it can identify those who are more likely to contract 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 contribute to society and to human well-being. ▪ AI should do no harm. ▪ AI professionals should be honest and trustful. ▪ Persons engaged in AI should be fair and not discriminate. ▪ Persons engaged in AI should respect the work required to produce new ideas, inventions, creative works, and computing artifacts. ▪ Privacy and confidentiality should be protected.

It is concerning that while technology is developing and evolving at an alarming rate, political and ethical issues are only slowly being taken into account by the law. This implies that "technology will guide policy if policy is not built to guide technology" [33]. To fully reap the benefits of technology's practical application, a number of challenges must be simultaneously resolved. These include striking a balance between privacy and the public's use of technology and copyright and public health [34]. Figure displays the most recent agreements and laws from the US, Europe, and other countries.

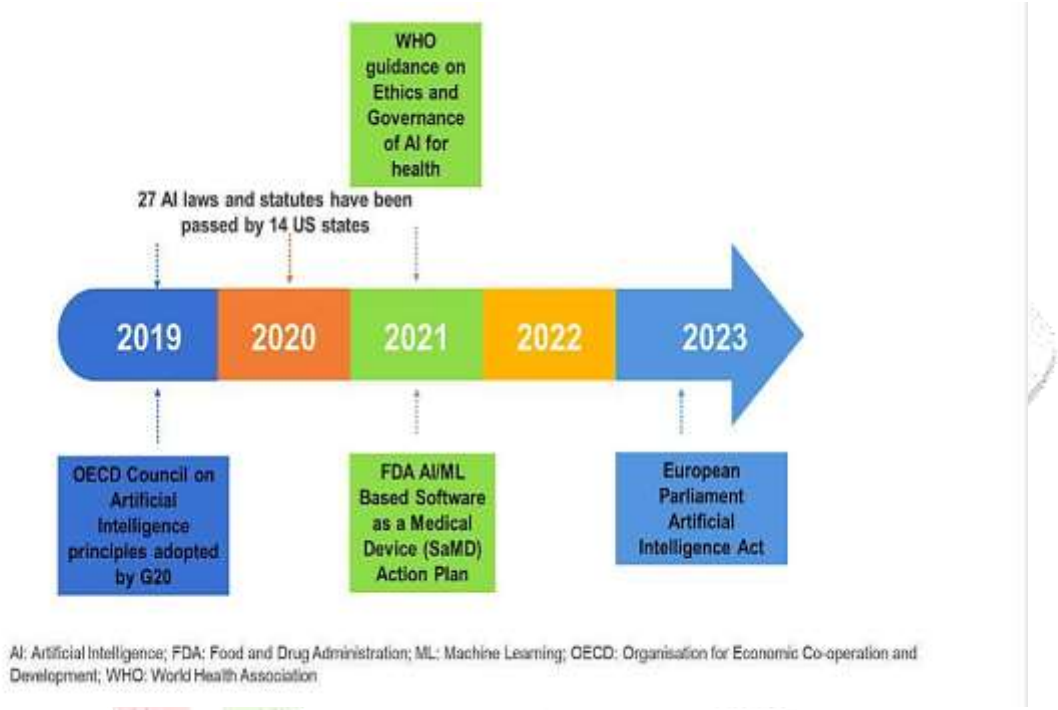

Figure 4. Legislation and commitment steps in US, Europe and Internationally

AI in Malnutrition

Artificial intelligence (AI) has made it possible for automated methods to identify malnutrition early on and stop long-term effects. In order to provide comprehensive information on the patient groups, screening tools, machine learning algorithms, data types, and variables that are being used, as well as the present limitations and implementation stage of these AI-based tools, a systematic literature review was conducted for this study. Researchers can use this study as a resource to choose future directions for their investigation into the application of AI to malnutrition. Certain jobs are completed with assistance thanks to recent developments in artificial intelligence (AI). Decision support systems (DSS) are a technique that has lately benefited from advancements in AI. DSS helps professionals make complex judgments. The result of this was the development 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).

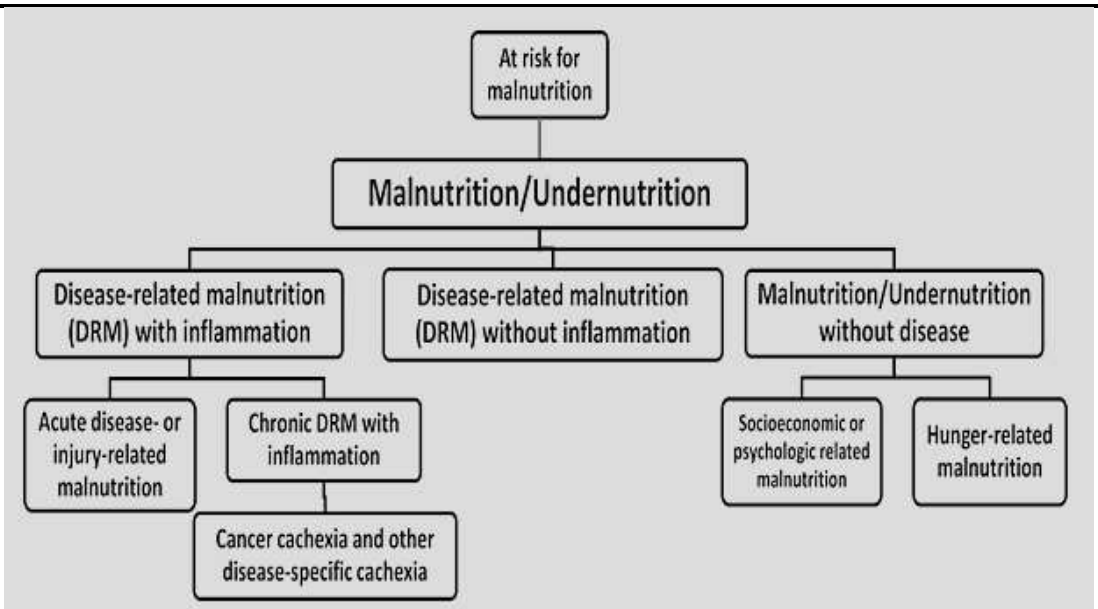

Figure 5. The malnutrition taxonomy

Positive aspects of ai in nutrition

By conceptualizing patterns that humans are unable to recognize, AI can transform complicated facts into "simpler" and "deeper" ones [35]. Indeed, the architecture and modes of operation of AI systems and brains differ [91]. Big data is useful to AI, which operates in a feed-forward fashion, starting with an input and working its way forward to produce findings and a more nuanced depiction of them [36]. In contrast, the human brain has developed to assist us deal with specific problems that we are likely to face in real life, therefore it acts in a more predictive manner [36]. This would enable the effective use of AI-achieved data reformulation for human health and other uses. Furthermore, mistakes that are a part of human nature can be reduced [37]. For instance, "smart systems" that adjust insulin dosages help lower hypo- and hyperglycemia in individuals with type 1 diabetes [38].

The idea of customized nutrition can be made a reality with the use of artificial intelligence. Using AI-assisted approach as a first step can lead to a more accurate dietary evaluation [39]. Then, in a variety of interactions, a wealth of genetic, gut microbiota, nutritional, and other data can be combined to provide the optimum results for a certain patient. Nevertheless, the outcomes of the clinical trials that are now available do not appear to be very encouraging in this regard [40]. Personalized nutrition is a reflection of precision medicine, which uses cutting-edge scientific techniques to solve health issues. AI can also help patients, caregivers, and society as a whole take charge of their issues [41] and anticipate requirements in the future [28].

Challenges with artificial intelligence

One of the primary difficulties in Artificial Intelligence has been to develop robust models capable of producing correct results for a wide range of inputs [42]. While we have made significant progress in detecting items using deep learning, it has also been discovered that it is equally easy to fool a deep learning Artificial Intelligence model into inaccurately identifying objects. Several times, researchers were able to fool the Artificial Intelligence model into producing false findings by providing deceptive inputs. Researchers demonstrated that a deep learning computer may be tricked into misidentifying an object by altering just one pixel in a picture [43].

In another case, McAfee researchers were able to deceive Tesla automobiles by putting a strip of black tape to the speed limit sign, causing the vehicle's autonomous driving model to accelerate by 50 mph [44]. Adversarial machine learning refers to approaches for fooling a machine learning algorithm by providing deceptive inputs, and such deceptive examples are known as adversarial instances.

Second, artificial intelligence algorithms have difficulty generalizing from pre-trained instances [42]. A baby, for example, can identify a giraffe even if it has only seen it once or twice, due to the human ability to correlate the salient feature of a giraffe with that of other living species. Similarly, transfer learning refers to an artificial intelligence model's capacity to reuse knowledge obtained from earlier rounds of training to train for a similar job. However, transfer learning has its own limitations. As a result, a system

that has developed competence in one activity may lose its capacity to perform successfully on that task in an attempt to master a related task using transfer learning.

Another issue that affects AI models is algorithmic bias [45]. Supervised Machine Learning algorithms create prediction models based on the labeled data they receive. When algorithms start getting biased data, it leads to the development of Artificial Intelligence systems that generate biased predictions. Such prejudices can be particularly damaging in social situations because they accentuate pre-existing racial and gender biases. Combating such algorithmic bias can be difficult because the data provided to the algorithm is not always verified by experts to be truthful and unbiased.

Future possibilities in artificial intelligence

The discipline of medicine has a great deal of room for advancement in artificial intelligence. Personalized nutrition planning, medicine discovery and analysis, fitness tracking, diagnosis and monitoring of mental health disorders, and other healthcare-related professions are just a few of the areas where artificial intelligence can grow [46]

As previously mentioned, breast tumor detection using Computer Aided Detection (CAD) methods has been shown to be ineffective. Faster Deep Convolutional Neural Networks (Faster R-CNN), one of the most effective object detection frameworks, can be used to enhance the state of CAD systems currently in use. This will allow for the development of systems that can accurately detect and classify benign and malignant lesions without the need for human intervention [47].

In the aerospace industry, systems are being developed that can copy human pilots in following Flight Emergency Procedures in cases such as engine failure, rejected takeoff, and emergency landing, utilizing the Learning by Imitation technique [48].

Artificial Intelligence can be employed in the field of education [49] with the implementation of Artificial Intelligence graders, deployment of Artificial Intelligence tutors for students with social anxiety, usage of Virtual Reality technology as a part of immersive learning, etc.

Though Artificial intelligence is being implemented in most of the fields related to agriculture, there is still a lot to be explored in its application in the fields of horticulture and greenhouses [50]. Efforts are being made to develop autonomous greenhouses with control set points for standard actuators being remotely determined using Artificial Intelligence algorithms. Initial experimentations have proven that Artificial Intelligence may outperform humans in controlling a greenhouse.

Artificial Intelligence has been successful in rivaling and sometimes superseding human expertise in various domains [51] right from playing games like Chess, Poker, Jeopardy, etc. to predicting schizophrenia, detecting skin cancer, facial 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:

Rapid advances in the field of artificial intelligence are widely discussed nowadays. Artificial intelligence is viewed as a game-changing technology that will revolutionize all aspects of human life. As a result, we are frequently left wondering whether this ever-changing sector will meet its extraordinarily high expectations. Some even wonder if Artificial Intelligence will evolve from a tool for human advancement to a threat to human existence.

Artificial intelligence has come a long way, from being envisioned as a machine that could be indistinguishable from a human, to being implemented in a variety of disciplines in our daily lives. Some of the breakthroughs in AI mentioned in this paper, such as market research and medical imaging, are applied utilizing Machine Learning ideas include supervised learning, reinforcement learning, and unsupervised learning.

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