Artificial Intelligence in Fighting Cancer

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ABSTRACT

The extraordinary advancement of Machine Learning (ML) and Artificial Intelligence (AI), specifically the ex - potential success achieved by artificial neural network architectures like Deep Learning (DL), algorithms used in fighting cancer have been evolving and present approaches that demonstrate a lot of potential from diagnosing, predicting tumors, to enabling drug development and gene - based personalized medication, making the target for cancer prognosis to get closer to stage zero. This review targets coverage of how AI is used as a powerful tool to attack cancer, where we propose four different ways in describing such evolution of AI in Cancer is taking place: sub - reviews by type of algorithms, by cancer and data type, and by AI's objective.

KEYWORDS
Health behavior, Breast cancer progression, Malignant cancer, Image visualization

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INTRODUCTION

There have been several attempts to compile the importance of artificial intelligence in fighting cancer but because of the exponential advances and progress of some types of AI in the last years, there is a need for not just an update but also an integrated way to apply the current trends of Artificial Intelligence (AI) and machine learning. Among the fast developments in AI, different algorithms have been used in assistance to classify cancer types, create new therapeutics, enable early cancer detection and predict prognosis, among other usages that leverage the work of clinicians, doctors and medical practitioners in cancer to a level equal, and arguably better, than human expert capabilities.[1-10]

LITERATURE REVIEW

The quick brown fox jumps over the lazy dog. The quick brown fox jumps over the lazy dog. The quick brown fox jumps over the lazy dog.[11-16] The quick brown fox jumps over the lazy dog. The quick brown fox jumps over the lazy dog. The quick brown fox jumps over the lazy dog.

AI Algorithm in Cancer

Artificial intelligence has been evolving pretty close to exponentially in the last years, and so the usage of its algorithms for different objectives in cancer research, medical and clinical. There is an always growing list of algorithms for applying learning and brain - based capabilities onto different medical activities in cancer. Table 1 enlists the most relevant AI algorithms that have been used in cancer research.[17-27]

Linear regression	Blind convolution
Logistic regression	MLPNN
Decision trees	CNN
Naive bayes	RNN
Support vector machines	LSTM
K - Nearest neighbors	Skip gram
K – Means 27,28	Encoder - decoder
Random forest	Boltzmann machine
Hopfield	Deep belief net- work
Dimensionality	Deconvolutional network
Adobos	GAN
PCA	Extreme learning machine
ICA	Deep residual network
Cosine similarity	Neural turing machine
Bag of words	Capsule network
Template matching	Attention network
Markov chain	Deep recurrent
Fuzzy algorithms	Deep LSTM
Evolutionary algorithms	Quantum machine learning
Artificial neural net- works	
Stochastic gradient descent	

Table 1. General List of the Most Relevant Ai Alga - Rhythms that have been used in Last 30 Years who are Specially Related with Cancer with References to Implementations of those.

From that list we understand that the very advanced

statistical models used during the 1990's started helping in pushing linear and logistic regression into diagnosis tools, molecular markers, image detectors and radiotherapy targeting tools. Other machine learning tools such as decision trees Bayes algorithms SVMs, K - nearest, K - means random forest, dimensionality reduction and Ada Boost have been demonstrating breast cancer prediction, as well as lung diagnosis and classification, and gene - based and tissue classifier for breast and other types of cancers. As most advanced ML algorithms on the 2000's, Principal Component Analysis (PCA) and Independent Component Analysis (ICA) looked for breast cancer progression, classification of benign or malignant cancer, and image visualization and cancer type classification. Other ML techniques such as cosine similarity and bag of words were used for finding mutational processes features and in early detection based on records of anastomosis leakage, as well as in skin cancer detection, where other ML techniques like template matching Markov chain and fuzzy algorithms gave tools to fight cancer such as detection, tumor motion in lung cancer, breast cancer screening and breast tumor progression, cancer cell interaction modeling and detection and diagnosis of prostate and brain cancer. Because of the great algorithm development, enabled by the exponential improvements in the computational capabilities, the most significant advance in classification systems with regards to application and research for cancer, inside the Machine Learning subset of AI algorithms, is the Artificial Neural Networks (ANN). Some of the initial attempts of ANN in cancer were related to predicting bladder cancer and the pretreatment and prediction of chemotherapeutic and outcome of brain cancer. The advent of Deep Learning (DL) towards end of 2000's enabled the sophistication of prediction and classification systems in help towards cancer, from algorithms like stochastic gradient used to find survival correlations of brain cancer, breast cancer diagnosis and data - mining of cancer literature to find new cancer - related knowledge to more advanced as Blind DE convolution, Multilayer Perceptron Neural Network (MLPNN), and Convolutional Neural Networks (CNN), which have been used in plenty of different application, but being really successful in finding features of imagery medical data to find features, classify, and predict, in almost all types of cancers. CNN has been positioning itself as a very used algorithm across the oncology filed. DL algorithms teamed with medical images data base have put in last year AI into a technique that enables quick understanding of patterns and elevates the power of prediction to at least human - expert level, giving clinicians and all medical experts dedicated to cancer a set of new tools to attack cancer by computational means. Towards the end of 2000, a special case of DL called Recurrent Neural Networks (RNN), helping in cancer from therapy decision modeling, to prostate and lung cancer detection, was created and pushed towards different new types of DL algorithms that have been vastly used in the last years. More advanced DL algorithms such as LSTM, skip gram, encoder - decoder, Hopfield network and Boltzmann machine triggered the advancement in lung cancer detection and tumor boundary detection, breast cancer detection from histopathological images, sentiment analysis and text categorization of cancer medical records, cancerous mutations representation, cancer

diagnosis, and, liver, brain and breast tumor, cancer subtypes

characterization, prediction of breast cancer recurrence, and personalized prediction segmentation, cancer subtypes characterization, prediction of breast cancer recurrence, and personalized prediction of cancer cells. Some of the latest evolutions of deep learning algorithms such as deep belief network deep convolutional network DE convolutional network are capable of breast cancer imaging and classification, early intestinal cancer prediction, prostate cancer stage characterization, skin lesion and lung nodule segmentation. While the most recent deep nets iterations like Generative Adversarial Network (GAN) extreme learning machine, deep residual network neural turing machine, capsule network attention network deep recurrent, deep LSTM have come with extraordinary capabilities such as prostate, brain, breast, colorectal tumor segmentation, microarray gene expression cancer diagnosis, pulmonary nodule and mammograms classification, breast cancer histology and histopathology images classification, lung cancer screening, breast cancer - related genes discovery based on multi - omics data, DNA base modifications detection, brain tumor detection, and anticancer peptides prediction.[81,82] In last years, most of the mentioned techniques have reached more than 99 % correct classification and detection accuracy. Finally, in a different kind of computation, applications related with cancer, quantum machine learning has been able to detect cancer, capable of classify non - small - cell lung cancer, and learning from genome - wide human cancer data.

Cancer Types and their AI - Related Literature

Comprehensive: In (Table 2).

Lung	Kidney
Breast	Lip, oral cavity
Colorectal	
Prostate	Brain, central nervous system
Stomach	Melanoma of skin
Liver	Multiple myeloma
Oesophagus	Non - Hodgkin lym – phoma
Cervix uteri	Testis
Thyroid	Salivary glands
Bladder	Anus
Pancreas [1]	Mesothelioma

Table 2. General List of Cancer Types that Affect Humanity, Presented as Level of Impact in the World.

By far breast and lung cancers literature related with AI are the largest among all other types of cancers. From breast cancer classification, prediction diagnosis, finding molecular markers, classification of medical images, recurrence prediction and probability relapse, tumor segmentation, to lung lesion and non - small cell lung cancer detection, lung cancer radiotherapy, lung cancer early prediction, screening, tumor motion management for lung cancer.[139–159] Following in level of cancer impact in the world Colorectal and Prostate, are found with research literature that embolic profiles comparison, readmission from colorectal cancer surgery, tumor segmentation, early detection, higher prognostic accuracy, outcome prediction, classification of tissue types in colorectal, and detection, grading, stage pathology, segmentation based on CT, optical diagnosis, classes and survival rate, precision treatment recommendations, assisted system, multi parametric imaging, MR image segmentation,

epithelium density estimation,

radiation oncology treatment planning, 3D multi parametric MRI, biopsy optimization for prostate cancer detection. For stomach cancer, AI - related research gives early cancer and microsatellite instability prediction among others, while about liver cancer. Explains with tumor segmentation, diagnosis, and histopathology and beniglesions classification. Relevant ML algorithms used in esophagus found in literature detail early screening technique, prediction of early recurrence after surgery, and biomarker dataset creation. While cervix uteri AI - related literature describes techniques such as image - based diagnosis, early recurrence prediction, subgrouping type's characterization, type of cancer classification, risk of factors analysis. All other types of cancer also have literature that proposes AI - based algorithms for similar effects.

AI Driven by Cancer Related Data

In order to have a broader understanding of the growing of air in the usage for solutions of cancer-related problems, it is worth to see the increment of different data enabled by new sensor devices: from CT scans to firm to mina, all different datasets that have been built and put together facilitates one of the most intrinsic elements of a training data to create learning models that correctly classify with great accuracy, underlines patterns, enables data prediction, and other data - enabled solutions for cancer. Table 3 enlists the different types of data that was found in literature of the created database.

CT scans	Proteomic
DHI	RNA - seq
MR / fMRI	Methy - seq
Hyperspectral	
Gene - expression	miRNA
	B Cells
	CD4 T Cells
DNA - seq	Medical records

Table 3. Selected Data Types that are Collected to be used in AI Algorithms Related with Cancer.

The quantity of digitation of molecules, images, echo, CT, hyperspectral data is growing exponentially, and there is also a constant improvement in quality of sensors and even creation of new sensor devices that enable obtain lots of data that can be used in AI systems. Among others, CT scans and DHI produce images that can be input in deep learning pipelines, with convolutional, encoders, transformers and other techniques so features are extracted so classification and prediction can be performed, being deep learning a very useful tool used in this data. Similarly, MR and fMRI data permit obtain visual information that can function as input in deep network configurations so they can be trained to obtain features for characterization and prediction models. Furthermore, a device that has been gradually becoming more affordable in last years is the hyper spectral cameras, where visual data of different spectra can be obtained to serve as training for finding features, characterizations, and in

predictions models. Similarly, reading biological molecules as digital data as in gene - expression DNA - seq proteomic and RNA - seq data permit the understanding of such molecules and how they express on specific circumstances, and also has been used as input in deep learning methods, mainly for characterization, classification and prediction models. On similar ways, other data such as digital reading of proteomic methylseq, B cells CD 4 T cells data can function as data input in neural networks models. Finally, by using strong Natural Language Processing (NLP) methods, medical records can represent a huge step towards medical individualization, as personalized treatment.

Ai Usages for Cancer

As a final quick inspection of the importance of AI in cancer, the understanding of the main usages of Artificial Intelligence algorithms is performed. A mathematical and statistical method that were originally created for numerical manipulation to the aim to simulate certain intelligence or brain processing characteristics infiltrated to other areas, and now is of so much great benefit to fields as in cancer. Table 4 shows a short list of the main usages that AI is serving to cancer prevention, classification, discrimination and prediction.

Cancer classification	Therapeutics
Early detection	Big data inferences
Predicted prognosis / outcome prediction	Simulation
Relapse	Drug discovery
	Enabling / building databases

Table 4. Distinctive Goals of usage of Ai Algorithms, all Related with Cancer.

One of the most basic functions of AI algorithms is to classify data. In cancer, classifying data from sampling molecules, imagery, to metadata can be done, especially in ANN, some ML techniques and most of the deep learning algorithms, has extensively been done in most types of cancer. Early detection of cancer has been one of the top applications developed with AI, where DL plays a role of enabling an even beyond expert level in different aspects related with cancer. The predicted prognosis and the outcome prediction is also a very powerful tool to develop with AI / DL, and if counting with data, it has been proven to be very effective. Relapsing is another usage of AI / ML techniques, in order to estimate a probability of this event for rightly estimating the needed medication or treatment. Training data from relatives in a big - data approach helps in doing inferences and estimations of cancer prognosis or even relapse. There are other objectives such as pretreatment prediction, simulation and drug discovery that can make more effective the treatments as well as more personalization for a faster elimination of cancer in patients.

Visualizations for Correlations and Trends

In order to grasp the current trends in cancer AI - related literature Circular layout visualizations of data relationships are presented. This data corresponds to the 494 entries of the most relevant research literature of AI in cancer. Visualizations were made with circus Figure 1 shows the yearly increment of AI algorithms including as many as possible (from Linear Regression to K - Nearest, to CNN and LSTM, among many others). It is easy to distinguish the increased trend of general ML over the year in cancer research while the trend of Deep Learning (DL) gets more used over last recent years.

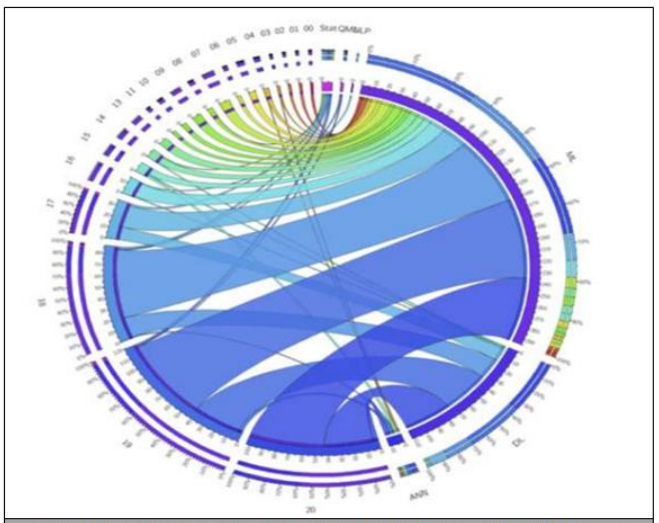

Figure 1. Data Relationships Showing the Type of Algorithm used Over the Years, from 2000 to 2020.

Figure 2 presents visualizations that illustrate how much AI was used in relation to cancer types (from Lung, Breast, Prostate to Skin, Brain and many others.

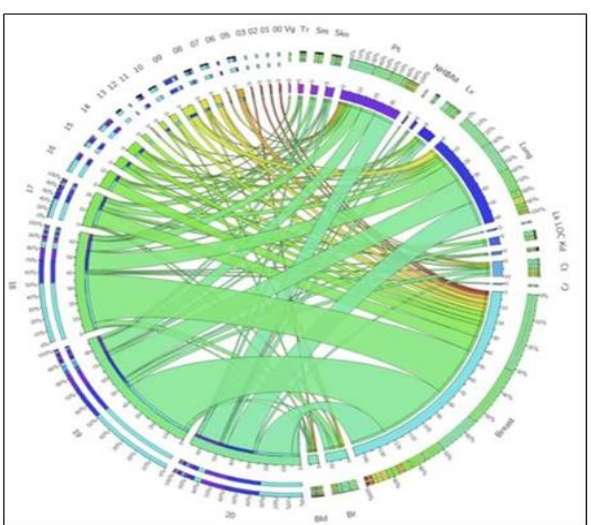

Figure 2. Circular Layout Visualizations of Data Relationship between Year and the Corresponding Cancer Researching Type from 2000 to 2020.

Figure 3 portraits the different objectives of using AI (like classifying type of cancer, early detection, prognosis / outcome, relapse possibility, for clinical trials, etc.) from 2000 to 2020. Figure 4 shows the research done of AI algorithms ICA, K - means, RNN, etc.) by attacking specific types of cancer (lung, stomach, liver, etc.).

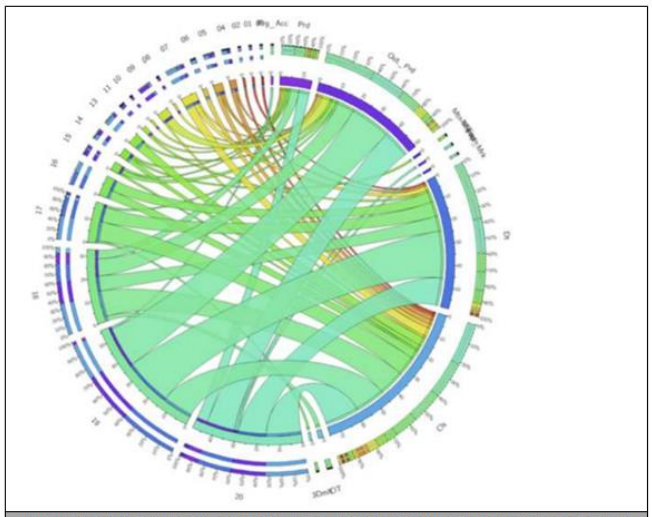

Figure 3. Circular Layout Visualizations of Data Relationships between Year of Publication and Medical Objective of using AI.

Beyond Reviewing Ai for Cancer

Furthermore, in an effort to provide a digital interface to our database, we launched fightingcancer.ai whose objective is to have an easy browsing of all the information and for the user to not just get to the reference of the literature, but also to provide other basic data and links, with the submission of inspiring AI enthusiasts, who have demonstrated to come out with AI solutions to solve big problems in cancer domain, such as a teenager using DL to create a pancreatic cancer diagnosis method (Figure 4).

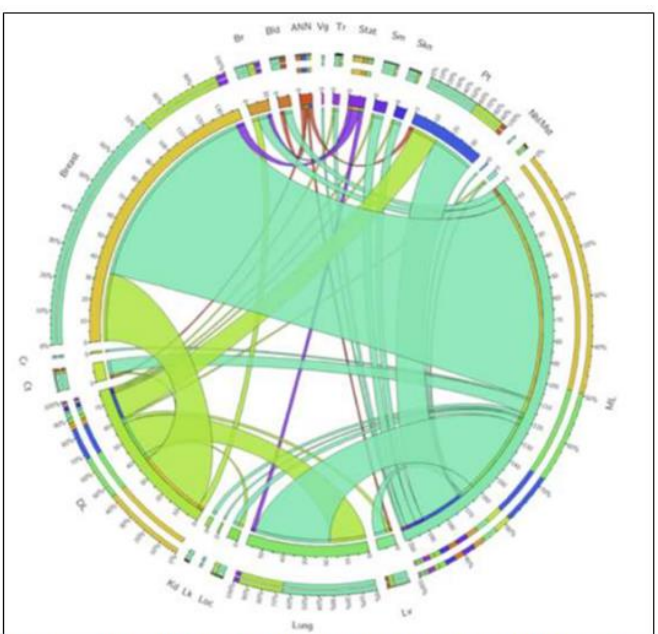

Figure 4. Circular Layout Visualizations of Yearly Data Relationship between Cancer Type and AI Algorithm in this Review Data Set.

Figure 5 shows a relationship between AI algorithm type (encoders, quantum ML, Fuzzy algorithms, etc.) and 178 the medical objective to achieve (prognosis, detection, etc.). Finally, Figure 6 is shows examples of the different 179 categories in which researches orient their objectives (by type of algorithm, by type of cancer, by type of data, 180 or by medical objective to achieve). The final intent of this review paper is to accelerate the usage and devel181 open of AI algorithms targeting Cancer research for solving problems in related in the cancer field by quickly 182 understanding all the efforts that have been made, from different angles of research (from data scientist / com183 putter scientist to medical researcher in cancer) (Figure 6).

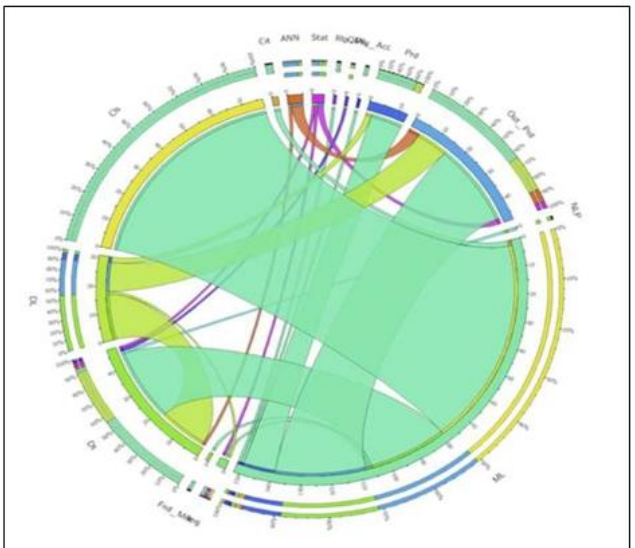

Figure 5. Circular Layout Visualizations of Data Relationships between Relationship between Type of Ai Algorithm and the Final Medical Objective To Conduct Such Research.

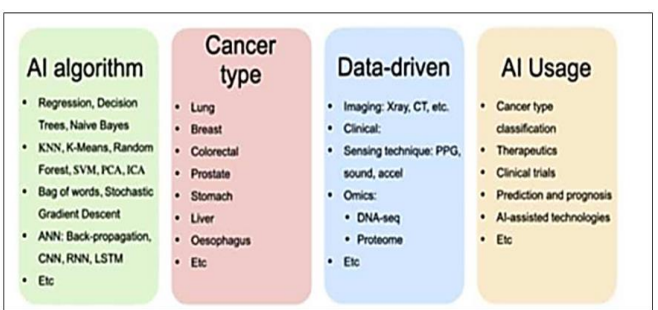

Figure 6. The four Different Categories in which all Work of AI Used in Cancer could be Indexed, few Examples, and more Detailed Listings are found in (Tables 1).

RESULTS

The trends illustrated in the figures could illustrate the degree of importance that those relationships have taken over time. This not indicate that it should be continue that way, on the contrary, it should inspire to inspire the finding of new relationship that either are very weak or non - existence: this could provide new ways in which either AI algorithms could be used, or data could be processed or results could be carried out, or combination of those new ways. The website eventually could be built up to offer close – to – real - time newer literature that comes out, also the graphics should be plotted automatically every certain time, also the website could serve as the connector to a reader's interest or need into the final data. These features of the website will be added eventually in a research project that will utilize NLP to agents to fully automate such described tasks.

DISCUSSION

In order to make an orderly review of the fast increasing pace of AI in cancer, we created a dataset from the top 494 most relevant entries appeared in Google scholar from September 10th to October 15th 2020. After careful filtering out literature

not relevant to AI in cancer, the dataset was indexed by year. A copy of the database can be found at Specific query and search was performed in the Title and Abstract fields of such dataset. Selection of data over the two search results was performed in order to obtain the results described here. Following sections depict the results of such filtering on the original created dataset. Furthermore, in order to get a comprehensive general macro view of the landscape in what AI has been involved last decades in fighting cancer focusing in DL, we propose four distinctive categories of how the review of AI in cancer can be done. The first introduced index is by the type of algorithm, where we mention which AI algorithm has been used mostly for which type of medical approach related with cancer, noticing the trends of algorithms approach giving clear view of Deep Learning as a common trend in imaging. The second proposed category is for the sort of cancers that exist, categorizing AI solutions by the potential of impact in society. The next suggested index is by type of data collected, where a more hands - on approach is given in describing the innovation of AI in fighting cancer. Finally, the objective the AI algorithms related to combating cancer is mentioned.

CONCLUSION

Finally, we introduce a website of Fighting Cancer with AI, such compiled information was built so as well as researchers in AI / ML and medical field researchers and practitioners as well as innovators in AI could consult to see the state – of – the - art in how AI is contributing to eradicate.

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