ARTIFICIAL INTELLIGENCE TOOLS AND TECHNIQUES IN CANCER DATA ANALYSIS

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ABSTRACT

Artificial Intelligence has become the need of the hour in all the aspects of Cancer Data Analysis. Cancer is a disease that has claimed millions and millions of lives and waiting to drive mankind to the verge of extinction. It is a forever developing, altering and dynamic disease which could affect anyone and everyone unless a proper, definite answer is found on what causes it, how to diagnose, how soon we can identify it. AI has the capability and capacity to solve this impending danger. Through the use of AI tools and Techniques Cancer can definitely be conquered in future. All over the world people are battling cancer with various AI and Machine Learning techniques and methods. This paper provides an overall review on AI tools and techniques used in Cancer Research and Data Analysis which also includes Cancer Diagnosis, Cancer Treatment, Cancer Drug Discovery and Repurposing and so on.

Keywords: *Artificial Intelligence, Machine Learning, Cancer Diagnosis, Cancer Drug Discovery, Cancer Drug Repurposing*

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INTRODUCTION

“Cancer is a deadly disease where the normal cells in the human body grows uncontrollably and this abnormality spreads to other organs.” [1]. This abnormality in the cells is caused by changes in the DNA, specifically in the "Gene" part of the DNA and hence Cancer is at times referred to as a Genetic Disease. Genetic changes that lead to cancer can be caused by Heredity, Viruses, UV Radiation, Smoking, Chemicals or Cell Dividing. Generally, these genetic changes build up over time in the human body and they will start showing only in the later stages of the disease. Cancer is a very serious and mortal disease, but it is treatable only if it is identified in its early stage. The Cancer diagnosis at an early stage is near to impossible because the chance of exhibiting cancer symptoms varies from person to person and sometimes cancer get misdiagnosed. Artificial Intelligence (AI) and its techniques are employed to overcome the challenges faced by doctors in cancer diagnosis and treatment.

Artificial Intelligence

Artificial Intelligence (AI) is a method of replicating human intelligence through machines using mathematical algorithms. AI has grown quite powerful in the past decade that it has become indispensable in almost every walks of human life. AI has improved quite well from guiding self-driving cars to diagnosing a serious disease like cancer at its early stage. AI is capable of learning and training on large datasets in a matter of time.

AI comprises of concepts like Machine Learning (ML) and Deep Learning (DL). Machine Learning contributes a vast number of algorithms to choose from to train and test the data. Deep Learning deals with Artificial Neural Networks (ANN), a concept borrowed from Biological Neural Network – the human brain.

ANN is a series of networked layers where each layer learns something new from the data and passes it on to the next layer and the final layer gives the desired output. Some of the achievements of AI include Self-Driving cars, Speech Recognition apps like Siri, Ok Google, Natural Language Generation that converts structured data into the native language, Virtual Agents like Chabot to help people, Enterprise-level decision-making applications, Biometrics and biomedical research with Deep Learning and Artificial Neural Networks, Banking and financial sectors use Machine Learning for algorithms and statistical models for investment options, e-commerce like Amazon, Flipkart, Netflix uses AI for consumer and customer preference prediction, Robotic Automation Process (RPA) to automate robots and many more [2].

Cancer Diagnosis and Treatment

Cancer is not only a fast-growing but also an ever-evolving disease from an individual to another individual. Commonly cancer is treated through surgically removing the tumour or by chemotherapy or radiotherapy and so on. Sometimes cancer cells turn out to be resistant to some drugs, therefore in cases like this doctors come up with a treatment plan that combines chemotherapy with radiotherapy and other kinds of therapy which will eventually kill the cancer cells or if the existing drugs do not work they invent a new drug to fight that particular type of cancer cell. Scans like CT, PET, MRI and Ultrasound help identify tumours and the location of the tumour but it does not state if the tumour is malignant or benign. 90 % of lung cancer cases are misdiagnosed due to chest X-rays and error in observation and decision making part of the Radiologists. This is mainly due to less experience of the radiologist in interpreting the scans and X-rays and also the X-rays are more often not clear enough [3].

`Global Cancer Statistics has estimated 10.0 million cancer deaths worldwide for 36 cancers in 185 countries (including India) Female Breast Cancer has become the most commonly diagnosed cancer with 2.3 million new cases and Lung Cancer close behind it at 2.2 million new cases worldwide [4]. In India majority of the cancer patients were diagnosed with Breast and Lung cancer at an advanced stage in a study where population-based cancer registries (PBCRs) and hospital-based cancer registries (HBCRs) data were collected by National Cancer Registry Program [5]. AI and its concepts were implemented on medical data, the results given by AI promised the possibility of diagnosing and treating cancer at an early stage thereby saving lives. NitiAayog – Indian Government initiative has proposed an AI - Radiomics project called “Imaging Biobank for Cancer” as an inexpensive alternative approach for treatment research in cancer [6]. Researchers have collected, processed, cleansed Liver Cancer data and applied Machine Learning algorithms – Random Forest, Multilayer Perceptron and Logistic Regression. In which Logistic Regression yielded a highest accuracy of 91.46%, Random Forest – 82.93% and MLP – 49.19%. The proposed method is a Hybrid Classification method based on Voting by each of the above mentioned model. The Proposed method gave an accuracy of 99.83% and when tested on another dataset it gave an accuracy of 98.26% [53].

Scope of the Paper

The main focus of this study is to identify the best suited AI Technique for Cancer diagnosis using CT, PET, MRI Scan images or images of Biopsy of the tumour and so on. Many types of ML and DL algorithms have been employed by doctors and researchers and received varied results from them. The importance of analysing the existing AI techniques is to improve the methods of early detection of cancer so that the patient will have a fighting chance against the disease and might be able to survive. The cancerous tumour is constantly evolving and becoming drug-resistant, therefore the sooner it's diagnosed the better are the chances of survival. Most of the time the Cancer becomes evident only in its later stage – where saving the patient’s life becomes difficult and sometimes impossible. Hence it is paramount that there must be a way to identify the chances of Cancer occurrence from scan images or biopsy and this is possible through Artificial Intelligence.

Computational Techniques in Cancer Data Analysis

A pathologist generally uses CT, PET, MRI scans and take a sample of the tumour – biopsy and analyse it under a microscope and run some tests on it to ensure if the tumour is Benign or Malignant. Before the treatment, coming up with a treatment plan is the most critical part. Image-Guided Radiotherapy (IGRT) is employed for target delineation of the tumour area and set the patient in the right position so that only the tumour is targeted by the radiation, target delineation helps in identifying the dose of radiation and treatment required for the tumour [7].

A combination of Statistical Learning and Computational, mathematical approaches were applied to bio-molecular data to create a network and establish connections between organs, cells and organ systems. A molecularly based prognostic test called “Mammaprint” which involves 70 genes was used to predict 5-year recurrence of Breast Cancer in both male and female patients, the depth of molecular structure and gene expression was studied for better cancer treatment [8].

Computer-Aided Detection systems (CADs) are used to help radiologists in finding normal as well as abnormal tissues from mammography, ultrasound, MRI, and biopsy histopathological images for detecting Breast Cancer, the process comprises Pre-Processing, Segmentation, Feature Extraction and Classification [9]. Tumour Staging data analysis in clinical research are done by using data analysis and statistical techniques like Categorical data analysis and other modelling techniques to determine a treatment plan for the patient [10].

Clustering

Clustering is a method of grouping similar items or data into specific category. Here, we could consider the objects as cancerous tissue, where the clustering algorithms identifies and groups malignant and non-malignant tissues separately. Clustering techniques allows us to group the given data based on Age, Sex, Cancer Stage and so on. Some of the types of clustering techniques applied on Cancer data are shown in Figure -1.

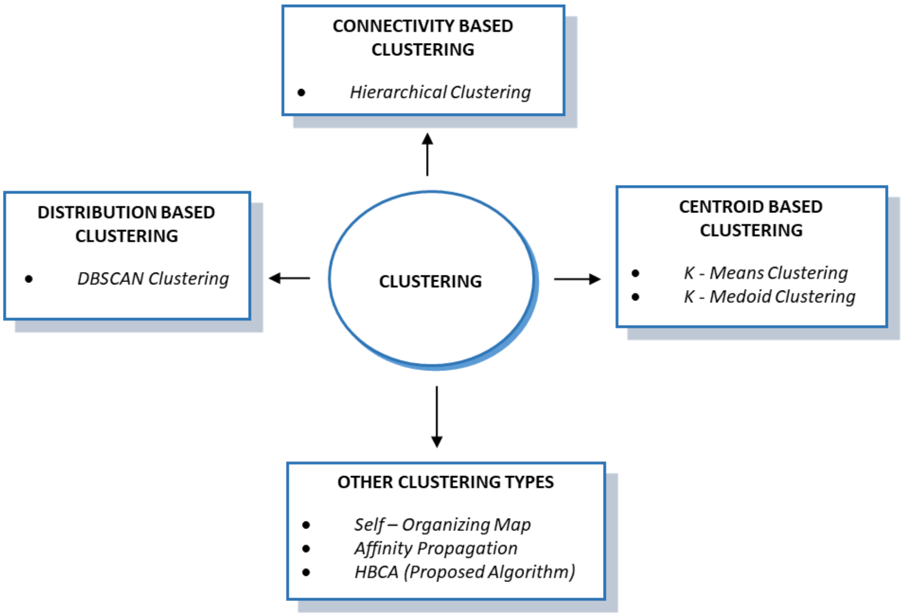

Figure-1: Clustering Techniques used in Cancer Research

Researchers applied Clustering Analysis on four different types of cancer datasets – Brain, Breast, Kidney and Stomach to identify how the sample size, distribution of subtypes and sample heterogeneity affect the performance of the data mining technique. They yielded higher performance results for cluster analysis when the dataset is homogeneous (i.e.) when the dataset is focused on single sex – female or male instead of both. The algorithms applied were Hierarchical clustering, k-means Clustering, Self-organizing map and Affinity Propagation, all put together in a Cluster Ensemble. The supervised classification resulted in 99.1% for Brain, 97.1% for breast, 73.6% for stomach and 86.9% for kidney [11]. HBCA – an algorithm which combines the features of B-Tree and Partitioning Clustering algorithm – K Means algorithms, proposed by the researchers, gave good results for less number of iterations when compared to k-means and k-medoid algorithms on a dataset of 11 types of cancer [12]. Researchers were able to identify Microcalcifications in breast cancer tumour images using a number of clustering techniques – K-Means, K-Medoid, CLARANS and DBSCAN. Among which DBSCAN gave 92% efficiency [13].

Classification

Classification can be defined as a categorization or assignment of data to different categories or classes based on specific criteria. For a given dataset with Age, Sex and Malignant tumour cell images, we could classify it into different classes like class A – Female over 50 yrs. with malignant tumour, Class B – Male over 50 yrs. with malignant tumour. Various Classification algorithms are employed to classify Cancer and its features are described in Figure-2.

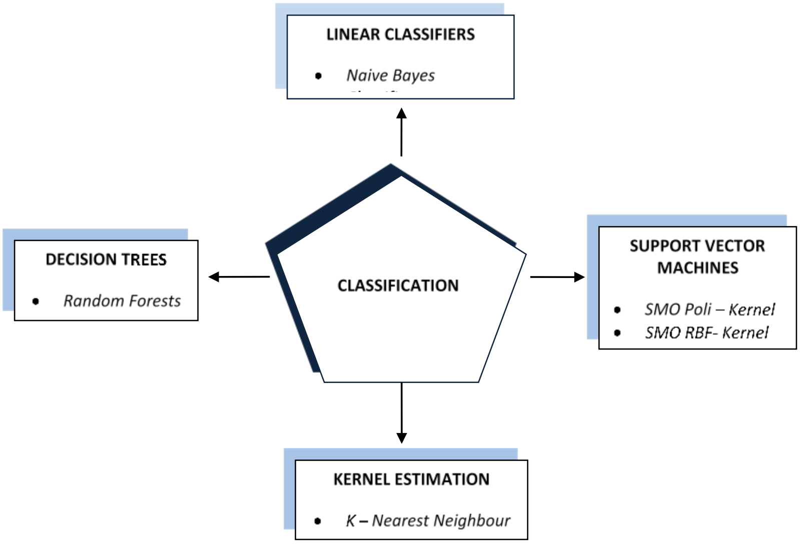

Figure-2: Classification Techniques used in Cancer Research

Researchers conducted a comparison between some of the classification algorithms – J48, Naïve Bayes and SMO Poli – Kernel, SMO RBF- Kernel integrated with K- Means Clustering to identify Breast Cancer recurrence in patients who had undergone surgery previously. They found that SVM with SMO polikernel with K-means clustering achieved 98.5% Precision in identifying breast cancer recurrence [14]. SVM yielded ground breaking results when applied on Serum Proteomic Profiling MS Data of Ovarian Cancer, in which the combination of SVM and Genetic Algorithm gave 100% accuracy in identifying cancerous and non-cancerous cells [15]. Researchers compared Decision Tree algorithm and K- Nearest Neighbour on a Breast Cancer dataset for classifying cancerous and non-cancerous tissues of which Decision Tree has been successful in classification with a True Positive rate of 95% than K- nearest neighbour [16]. Even though there have been good results with clustering and classification techniques, adding AI to these methods will further improve its performance.

Significance of AI techniques

AI and ML are important because this technology takes all the aspects of a problem the reasoning, planning, perception, increased productivity into consideration and provides us with low-cost but effective solutions. Various tools are available for learning and building AI applications. These tools are so simplified that anybody can work with and learn quickly.AI applications are superior to Classical computational models in many ways. Classical computational models cannot accept a large amount of data and process multi-class attribute as results. On the other hand, AI is capable of learning from Big Data, sift through the data learn and store each finding and give a detailed result. The classical computational models give fewer accuracies and have only statistical and mathematical techniques. AI has a very large algorithm base including statistical, mathematical and data analytics with which AI can recognize hidden relations in the given data.

AI in Cancer Data Analysis

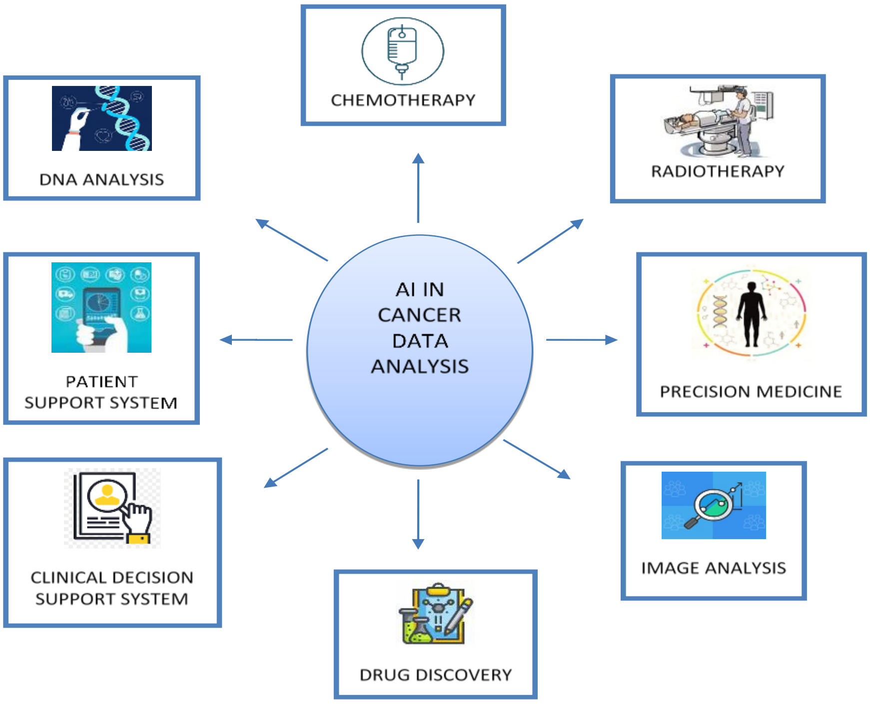

Figure-3: AI in Cancer Data Analysis

AI applications are utilised in almost all facets of Cancer disease, not only early identification of cancer but also, prediction of chances of cancer occurrence in a person, provides support for a cancer patient through their treatment and more, suggests the amount of chemical drug required for a patient's tumour for chemotherapy, Maps target areas of the tumour for equal dose distribution of radiation in radiotherapy, AI Clinical Decision Support Systems for doctors to make an informed decision on a patient's condition, discover new drugs to treat differently behaving tumours – Drug Discovery, Image Analysis of CT, PET scans, tissues density images, tumour segment images to identify the area and size of the tumour, Analysis of DNA samples of the patient to find out if they have cancer, Precision Medicine – taking all the factors regarding a patient into account and creating appropriate treatment plan is depicted in Figure-3.

Researchers found that Breast Cancer can be identified from a digital scan of FNA (Fine-Needle Aspirate) slides with a 95.78% of accuracy by using KNN [17]. FocalNet an AI system to identify Prostrate Cancer, researchers applied a multi-class CNN on multi-parametric magnetic resonance imaging (mp-MRI) scans of prostrate to detect prostate cancer and predict their aggressiveness using Gleason score. [18]. Deepmind and Google Health has devised an AI system to detect Breast Cancer at its nascent stage using mammogram images of UK and US female patients. They trained the algorithm on UK patient data and tested it on US patient data and found that the AI system has outperformed Radiologists [19]. This review paper talks about, AI identification of high-risk breast lesions that are likely to become cancer, thereby reducing unnecessary surgery and cancer overtreatment. Random Forest – Machine Learning algorithm identified malignant and benign lesions in a dataset of 1006 high risk breast lesions to advice on whether surgery is required or not [20]. Researchers have built Augmented Reality Microscope (ARM) with AI, where the AI provides real-time information on the Sample of the tissue under the microscope. The ARM was able to detect metastatic breast cancer and prostate cancer [21]. Researchers explored various supervised ML and AI models required for Drug Repurposing that involves predictions in biochemical activity of cancer cells, tissue-based response profile, identified protein targets and combinations of various existing drugs giving rise to Polypharmacological effects [22]. A patient was diagnosed with a recurrent medulloblastoma initially, on the suspicions of the neuropathologist- Matija Snuderl, the patient was subjected to full-genome methylation analysis, which checks for small hydrocarbon molecules attached to DNA, and he fed the results to an AI system developed by a consortium including researchers at the, and the tumour came as “Glioblastoma" (brain tumour) – the new tumour seemed to be the result of radiation used to fight first cancer [23].

AI in Cancer Diagnosis

The main goal of applying AI in Cancer Diagnosis is to identify existing cancer at an early stage and predict the chances of cancer occurring in a patient by analysing the scan images. More often than not Cancer gets misdiagnosed, some of the reasons are unclear scanned images or mistake on the part of the Radiologist. AI has the capability and capacity of taking in a vast amount of data learn it, train on it and find hidden meaning in it. AI can recognize patterns and changes that most of the time missed by doctors. AI is applied to analyse the CT, PET or MRI digital scans and also biopsy images of lungs, breasts, cervix and so on. Image Analysis comprises collecting the relevant data required, data pre-processing, training the data using any of the AI, ML and DL techniques, prediction and statistical analysis for results. A list of tools and organizations actively working towards cancer diagnosis with the help of AI is given in Table-1.

Table-1: AI Tools in Cancer Diagnosis

Tool/ Organization	**Description**	**Open Source/ Proprietary**	**Algorithm**	**Reference/ Website**
Niramai [24]	Breast cancer screening product, where high-resolution thermal images of breasts of the patient are taken using a thermal sensing device and these images are analysed to predict the occurrence of breast cancer even before a lump is formed.	Proprietary	Patented ML algorithm tool called “SMILE Tool” and “Thermalytix” – a diagnostic engine that is powered by AI uses a SaaS platform.	https://www.niramai.com/
Project Inner Eye [25]	AI deep learning tool from Microsoft Research Cambridge, identifying tumours on patient’s scans and for cancer radiotherapy research, and also provides researchers with an open-source InnerEye Deep Learning toolkit.	Open-Source InnerEye Deep Learning toolkit	Deep Learning	https://www.microsoft.com/en-us/research/project/medical-image-analysis/
Data Science Institute (DSI) by the American College of Radiology (ACR)	DSI provides several FDA approved AI algorithms for medical image analysis of Breast, Brain, Lung, Cervix, Heart, Liver, Wrist, Prostrate, Coronary Arteries and other types of cancers, it's main focus is to provide AI tools for Radiologists to learn and develop world-class AI healthcare system directly.	-	AI	https://www.acrdsi.org/ https://models.acrdsi.org/

[26][27]				
LGI-Flag [28]	An AI software being in use since 2015, specializes in analysis of medical data which includes blood tests so as to identify patients that benefit from deeper assessment.	Proprietary	AI	https://hitconsultant.net/2019/07/11/geisinger-selects-earlysign-to-apply-algorithms/
Enlitic [29]	Provides specific and customized AI – solutions with Radiologists in mind. The Enlitic Curie™ – platform for various research purposes.	Proprietary	AI	https://www.enlitic.com/
Freenome [30]	Uses Molecular Biology and Machine Learning to detect cancer by Analysing fragments of DNA, RNA, proteins, and other biomarkers circulating in blood plasma and helping physicians to treat cancer effectively.	Proprietary	ML	https://www.freenome.com/

AI in Treatment Planning

Cancer treatment is not so simple; each tumour in each cancer affected individual behaves differently. The same treatment plan cannot be followed for all types of cancer patients. Every detail regarding the tumour and the particular individual must be taken into account before coming up with a treatment plan. Importantly cancer treatment involves not one type of drug or therapy but a combination of drugs and chemotherapy and radiotherapy or immunotherapy or other kinds of therapy based solely on the behaviour and resistance of the cancer cells. AI is capable of detecting how quickly cancer cells become resistant to anti-cancer drugs and thereby improving the drug development and drug usage of the patient. AI helps in predicting the tolerance and amount of chemotherapy drugs required for an individual. AI employs 3D to map the target areas of the tumour to measure its density and determine the required dose of radiation for Radiotherapy. AI tools in cancer treatment planning is given in Table-2.

Table-2: AI Tools in Cancer Treatment Planning

Tool/ Organization	Description	Open Source/ Proprietary	Technology / Algorithm	Reference/ Website
CanAssistBreast – product by Oncostem [31]	AI-based statistical model to identify the patient's risk of a Breast Cancer recurrence over five years, the test analyses the tumour and tells if the patient is high-risk or low-risk and to provide personalized treatment options.	Proprietary	AI	https://www.oncostem.com/
CancerLinQ – A subsidiary of the American	A Big Data initiative providing more than 1 million Electronic Health Records of cancer patients and representing 2000 oncologists, uses a set of data analytics and automated	Proprietary	Big Data	https://www.cancerlinq.org/

Society of Clinical Oncology [32]	systems to provide better care for patients.			
Watson for Oncology (WFO) [33]	WFO is an artificial intelligence clinical decision-support system with treatment options for oncologists used by various hospitals around the world. It evaluates specific details of patient's medical information against a huge amount of medical records, medical journals, textbooks, drug information and cancer treatment guidelines. Apollo Hospitals in India uses the services of WFO for cancer treatment of its patients.	Proprietary	AI	https://www.apollohospitals.com/departments/cancer/ibm-watson-for-oncology/
CloudMex [34]	Using a combination of data, machine learning, and predictive analysis, "The Clinical Analyzer" evaluates the medical records of the patients and helps the doctors and other care givers to make better decisions for better results. It directly connects the patients to the health care providers.	Proprietary	Data, Machine Learning, Deep Learning and Predictive Analysis	https://cloudmedxhealth.com/about/
Oncora [35]	Developed Machine Learning Applications for predicting adverse events following Breast Radiotherapy. Predicting unplanned hospitalization after multimodal therapy for all types of Cancer, to improve the treatment plan of the patient.	Proprietary	Machine Learning	https://www.oncora.ai/machine-learning
ConcertAI [36]	Combines "Real-World Evidence" (RWE), "Real World Data" (RWD) and AI to provide better treatment procedures, diagnoses, tumour-related observations, histology reports, medications, cost and much more in Lung, Liver, Melanoma, Breast, Pancreatic, Prostate, Bladder and other types of cancer.	Proprietary	AI	https://www.concertai.com/

AI in Every Step with Doctors

AI and its techniques are used in every step of Cancer like Prognosis, diagnosis, treatment plan, drug discovery, tumour staging, tumour recurrence. Researchers from the Institute for Cancer Research (ICR) and the University of Edinburgh have developed an AI technique to pick out mutation patterns within the tumour and use this information to predict future genetic mutations [37]. National Institutes of Health (NIH) of the US has introduced an innovative and transformative program called Big Data to Knowledge (BD2K), a platform for creating software tools, methods for biomedical research [38]. Some of the AI tools that helps doctors in fighting against cancer is listed in Table-3.

Table-3: AI Tools in Every Step with Doctors

Tool/ Organization	Description	Open Source/ Proprietary	Technology / Algorithm	Reference
AI Medical Service Inc. (AIM) [39]	Developed Endoscopic AI for detecting GI cancers at an early stage. The AI examines the images of the gastric cancer and provides observations to the doctors, who will make a diagnosis based on the result.	Proprietary	AI, Neural Networks	https://www.ai-ms.com/en
Hospido [40]	Hospido a Gurgaon based start-up has come up with a Chabot called Cancer Dost for patients to learn about cancer and its treatments free of cost, it also connects the patients with leading cancer specialists in India, who also provides opinions on treatment planning and home care.	Proprietary	AI	https://www.hospido.in/
Zebra Medical Vision [41]	AI application to support Radiologists in Medical Image Analysis for cancer patients, identify high-risk patients and improve the work flow through prioritization.	Proprietary	AI	https://www.zebra-med.com/
RaySearch Laboratories [42]	Provides clinics with a number of Machine Learning algorithms from their reservoir called “RayStation”, which provides end-to-end services like identification of disease, diagnosis, treatment planning, after care and organ segmentation.	Proprietary	Machine Learning, AI	https://www.raysearchlabs.com/machine-learning-in-raystation/
Sophia Genetics [43]	A global data sharing AI platform for genomic and radiomic analysis of genomic and phenotypic datasets for many hospitals. The “SOPHiA DDM” platform contributes better understanding of various diseases including oncology.	Proprietary	AI, Big Data	https://www.sophiagenetics.com/
Arterys [44]	Arterys MICA provides an Oncology AI tool for the users to track their morphological activity for the doctors examinations and therapy related to that lesion.	Proprietary	Medical Imaging Cloud AI	https://arterys.com/clinicalApp/lungapp
Behold.AI [45]	Developed Red Dot – patented deep learning algorithm for efficiently processing images to identify abnormalities within seconds and support end – to – end workflows of the Radiologists.	Proprietary	Deep Learning	https://behold.ai/how-it-works/

The Library of Integrated Network-Based Cellular Signatures (LINCS) Program by NIH [46]	This program aims to create a network-based understanding of biology by cataloguing changes in gene expression and other cellular processes that occur when cells are exposed to different disturbing agents. LINCS also provides us with many tools to work with its data.	-	Big Data	https://lincsproject.org/

AI in Drug Discovery and Repurposing

Drug Discovery is a process through which new Drugs are discovered for specific treatment of specific diseases. Forever changing cancer cells requires drugs that inhibits the mutation and decrease it's resisting power. AI helps in identifying the particular genetic mutation in the cells and targets those cells with drugs formulated from prediction on the cell's mutation under the given circumstances and thereby either stopping the further growth of the cells or killing the cancer cells entirely. Thus to cure a particular type of tumour cell, a drug is discovered. Drug Repurposing can be defined as exploration of existing drugs for treatment of new and different kinds of disease. Researchers used a dataset containing 500 instances of DNA and drugs utilised for both cancerous and non-cancerous diseases and formulated an effective architecture using the proposed FCMGSO algorithm with Fuzzy C-means Clustering with Glowworm Swarm Optimization method. The research was to develop an accurate algorithm to optimize the binding energy to identify the suitable DNA and ligand interaction [54]. The existing drugs can be repurposed as anti-cancer drugs by targeting the biomarkers and mapping every small detail of the disease, it is also a cost-effective method in battle against cancer. Various tools and organizations that use AI in drug discovery and repurposing is given in Table-4.

Table-4: AI Tools in Drug Discovery and Repurposing

Tool/ Organization	Description	Open Source/ Proprietary	Technology / Algorithm	Reference
Atomwise [47]	Developed a Deep Learning method for "Structure-based Small Molecule" drug discovery spanning across multiple disease areas.	Proprietary	Deep Learning, AI	https://www.atomwise.com/
Phenomic AI [48]	They have developed a machine learning software for image processing and RNA Sequencing to understand the cell system to target the tumour stroma with new medicine and thereby improving the patients chance at fighting cancer.	Proprietary	Machine Learning	https://phenomic.ai/
Exscientia [49]	AI-based drug discovery for treatment of diseases under oncology, immune-oncology and various other diseases. It involves Precision medicine, targeted therapy and experiment.	Proprietary	AI	https://www.exscientia.ai/precision-target
PathAI [50]	This company is focused on assisting pathologists in making decision regarding diagnosis and helps patients with developing novel therapies and	Proprietary	AI	https://www.pathai.com/

	personalized medicine.			
Turbin.AI [51]	Developed a machine learning platform for targeting the right biomarkers for the tumour according to the conditions of specific patients. The Simulated Cell™ - software platform studies the cell and its process and generates hypotheses.	Proprietary	Machine Learning	https://turbine.ai/
SEngine Precision Medicine [52]	This company uses organoid version of the patients tumour to test more thn 200 cancer drugs against it and segregate the results using AI to develop new drugs.	Proprietary	AI	https://senginemedicine.com/

AI Frameworks for Medical Data Analysis

In the medical field, data such as images or X-Rays are stored in formats such as Neuroimaging Informatics Technology Initiative (Nifti), Minc, or as Digital Imaging and Communications in Medicine (Dicom). The AI frameworks given in Table-5 facilitates and helps the research using the medical data as such without requiring it to convert it to any other format.

Table-5: AI Frameworks for Medical Data Analysis

Tool	Purpose	Website
Tensorflow	Tensorflow is an end-to-end open source platform for machine learning. It allows easy build and deployment of ML powered applications with a wide variety of libraries and API resources.	https://www.tensorflow.org
Pytorch	An open source machine learning framework used for Computer Vision and Natural Language Processing machine learning applications for research and production.	https://pytorch.org/
Keras	A Deep Learning API used for various purposes from image processing to augmentation, built using Python and a part of Tensorflow platform.	https://keras.io/
Scikit Learn	A free software machine learning library built on numpy, scipy and matplotlib. It comes with features like classification, regression, clustering algorithms and predictive data analysis.	https://scikit-learn.org/
Weka	Weka is an open source software and has a list of machine learning algorithms for data mining. It consists of tools for data preparation, classification, regression, clustering, association rules mining, and visualization.	https://www.cs.waikato.ac.nz/ml/weka/
DLTK	Deep Learning ToolKit is specifically developed for using medical image as data, its open source and built on Tensorflow.	https://dltk.github.io/
SITK	Developed by Insight Toolkit community to facilitate image analysis on multiple language platforms like Python, R, Java, C# and so on, with medical images and it is open sourced.	https://simpleitk.org/
NLTK	NLTK is an open source platform for processing human language data for applying natural language processing (NLP).	https://www.nltk.org/
scikit-image	Open source image processing library with numerous algorithms for segmentation, geometric transformations, colour space	https://scikit-image.org/

	manipulation and more.	
Pymia	Pymia is an open-source Python package for deep learning-based medical image analysis. The package deals with data handling and evaluation. The package itself is independent of the deep learning framework but can be easily integrated with Tensorflow and Pytorch pipelines.	https://pymia.readthedocs.io/en/latest/
MedPy	A Python library used for medical image processing and script collection. It provides the facility to read, write and manipulate large images.	https://pypi.org/project/MedPy/
OpenCV	Open-source library for computer vision, machine learning and image processing.	https://opencv.org/

CONCLUSION

Cancer is one of the mortal diseases which could affect anyone at any time. Detection of cancer at an early stage is nearly impossible as the symptoms show only during the final stage. In this paper, various AI techniques were discussed in detecting and treating common cancers. AI has the capacity and capability of analysing, training and testing very large amount of data, there is so much to learn from AI and with the technological advancements, conquering Cancer is possible in very near future. With the help of AI there will be a future where with a single drug the entire Cancer will be cured completely. AI in drug discovery and repurposing shows a promise of treatment and cure of very rare forms of cancers, which will help the future generation's fight against cancer in a very cost-effective way.

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REFERENCES

[1] What is Cancer. Available at https://www.cancer.gov/about-cancer/understanding/what-is-cancer#definition, accessed May 2021.

[2] Top 10 Artificial Intelligence Technologies. Available at https://mindmajix.com/artificial-intelligence-technologies, accessed June 2021.

[3] Del Ciello, Annemilia et al, Missed lung cancer: when, where, and why?. Diagnostic and interventional radiology, 2017.

[4] Hyuna Sung, Jacques Ferlay, Rebecca L. Siegel, Mathieu Laversanne, Isabelle Soerjomataram, Ahmedin Jemal and Freddie Bray, Global Cancer Statistics 2020: GLOBOCAN Estimates of Incidence and Mortality Worldwide for 36 Cancers in 185 Countries. ACS Journals, 2021.

[5] Mathur P, Sathishkumar K, Chaturvedi M, Das P, Sudarshan KL, Santhappan S, Nallasamy V, John A, Narasimhan S, and Roselind FS; ICMR-NCDIR-NCRP Investigator Group, Cancer Statistics, 2020: Report from National Cancer Registry Programme, India. JCO Glob Oncol. 2020.

[6] NITI Aayog Centre Initiatives. Available at https://indiaai.gov.in/ministries/niti-aayog, accessed June 2021.

[7] Lin, Robert, Target volume delineation and margins in the management of lung cancers in the era of image-guided radiation therapy. Journal of medical radiation sciences, 2014.

[8] Winslow, Raimond L et al, Computational medicine: translating models to clinical care. Science translational medicine, 2020.

[9] Jalalian A, Mashohor S, Mahmud R, Karasfi B, Saripan MIB, RamliARB, Foundation and methodologies in computer-aided diagnosis systems for breast cancer detection. EXCLI Journals, 2017.

[10] Hu, Z., Zhou, Z., &Qian, S., How to analyze tumour stage data in clinical research. JournalOf Thoracic Disease, 2015, DOI:10.3978/j.issn.2072-1439.2015.04.09.

[11] Vidman L, Källberg D, and Rydén P, Cluster analysis on high dimensional RNA-seq data with applications to cancer research - An evaluation study, PLoS One, 2019.

[12] Dr.Gurpreet Singh, and Karan Jamla, Implementation & Analysis of Clustering Techniques in Bioinformatics:Cancer Research, IJESC, 2018; 8, 18630 – 18632.

[13] Sandhya G, D Vasumathi, G T Raju, A Novel DBSCAN Approach to Identify Microcalcifications in Cancer Images with Noise. Intl. Journal of Computer Applications Technology and Research, 2014; 3, 245 – 249.

[14] Roberto Cesar MO. et al, Method Based on Data Mining Techniques for Breast Cancer Recurrence Analysis. Springer, 2020.

[15] Lihua Li, Hong Tang, Zuobao Wu, Jianli Gong, Michael Gruidl, Jun Zou, Melvyn Tockman, and Robert A.Clark, Data mining techniques for cancer detection using serum proteomic profiling. Artificial Intelligence in Medicine, 2004.

[16] Dr. C Nalini, and T.Poovozhi, Data Mining Classification Technique Applied for Breast Cancer, International Journal of Pure and Applied Mathematics, 2018; 119, 10935-10945.

[17] H. K. Silman and A. E. Ali, Breast cancer identification based on artificial intelligent system. Sustainable Engineering and Innovation, 2020.

[18] R. Cao et al, Joint Prostate Cancer Detection and Gleason Score Prediction in mp-MRI via FocalNet. IEEE Transactions on Medical Imaging, 2019.

[19] McKinney, S.M., Sieniek, M., Godbole, V. et al, International evaluation of an AI System for breast cancer screening. Nature, 2020.

[20] Manisha Bahl, Regina Barzilay, Adam B. Yedidia, Nicholas J. Locascio, Lili Yu, and Constance D. Lehman, High-Risk Breast Lesions: A Machine Learning Model to Predict Pathologic Upgrade and Reduce Unnecessary Surgical Excision. Radiological Society of North America, Radiology, 2017.

[21] Chen, PH.C., Gadepalli, K., MacDonald, R. et al, An augmented reality microscope with real-time artificialintelligence integration for cancer diagnosis, Nat Med, 2019.

[22] ZiaurrehmanTanoli, Markus Vähä-Koskela and TeroAittokallio, Artificial intelligence, machine learning, and drug repurposing in cancer, Expert Opinion on Drug Discovery, 2021.

[23] How AI is improving Cancer Diagnostics. Available at https://www.nature.com/articles/d41586-020-00847-2, accessed June 2021

[24] Niramai. Available at https://www.niramai.com/, accessed June 2021.

[25] Project InnerEye – Democratizing Medical Imaging AI. Available at https://www. microsoft. com /en-us/research/project/medical-image-analysis/, accessed June 2021.

[26] Data Science Institute, American College of Radiology. Available at https://www.acrdsi.org/, accessed June 2021.

[27] FDA Cleared AI Algorithms. Available at https://models.acrdsi.org,accessed June 2021.

[28] Geisinger Selects EarlySign to Apply AI Algorithms to Identify Patients At Risk of Lower GI Disorders. Available at https://hitconsultant.net/2019/07/11/geisinger-selects- earlysign-to-apply-algorithms/, accessed June 2021.

[29] Enlitic. Available at https://www.enlitic.com/, accessed June 2021.

[30] Freenome. Available at https://www.freenome.com/, accessed June 2021.

[31] Oncostem. Available at https://www.oncostem.com/, accessed June 2021.

[32] CancerLinQ. Available at https://www.cancerlinq.org/, accessed June 2021.

[33] IBM Watson for Oncology. Available at https://www.apollohospitals.com/

departments/ cancer/ ibm-watson-for-oncology/, accessed June 2021.

[34] Cloud Mex. Available at https://cloudmedxhealth.com/about/, accessed June 2021.

[35] Oncora. Available https://www.oncora.ai/machine-learning, accessed June 2021.

[36] ConcertAI. Available at https://www.concertai.com/, accessed June 2021.

[37] Artificial Intelligence can predict how cancers will evolve and spread. Available at https://www.icr.ac.uk/news-archive/artificial-intelligence-can-predict-how-cancers-will-evolve-and-spread, accessed June 2021.

[38] Big Data to Knowledge.Available at https://commonfund.nih.gov/bd2k,accessed June2021.

[39] AI Medical Service. Available at https://www.ai-ms.com/en, accessed June 2021.

[40] Hospido. Available at https://www.hospido.in/, accessed June 2021.

[41] Zebra Medical Vision. Available at https://www.zebra-med.com/, accessed June 2021.

[42] RaySearch Laboratories. Available at https://www.raysearchlabs.com/machine-learning-in- raystation/, accessed June 2021.

[43] Sophia Genetics. Available at https://www.sophiagenetics.com/, accessed June 2021.

[44] Arterys. Available at https://arterys.com/clinicalApp/lungapp, accessed June 2021.

[45] Behold.AI. Available at https://behold.ai/how-it-works/, accessed June 2021.

[46] NIH LINCS program. Available at https://lincsproject.org/, accessed June 2021.

[47] Atomwise. Available at https://www.atomwise.com/, accessed June 2021.

[48] Phenomic AI. Available at https://phenomic.ai/, accessed June 2021.

[49] Exscientia. Available at https://www.exscientia.ai/precision-target, accessed June 2021.

[50] PathAI. Available at https://www.pathai.com/, accessed June 2021.

[51] Turbine. Available at https://turbine.ai/, accessed June 2021.

[52] Data4Cure. Available at https://www.data4cure.com/#start, accessed June 2021.

[53] Orasa Patsadu, Pongsakorn Tangchitwilaikun and Supanut Lowsuwankul, Liver Cancer Patient Classification on a Multiple-Stage using Hybrid Classification Methods. Walailak J. Sci. & Tech. 2020.

[54] E Kiruba Nesamalar, J. Satheeshkumar and T. Amudha, Efficient DNA-ligand interaction framework usingn fuzzy C-means clustering based glowworm swarm optimization (FCMGSO) method. Journal of Biomolecular Structure and Dynamics. 2022.