Advancement in Precision Medicine and Recommendation System for Clinical Trials Using Deep Learning Methods

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Abstract:
The arena for precision medicine has made vast development in progress with big data, deep learning. The personalized health information provides more insight on patient care in all directions which gives better treatment. Many researchers and peoples accept personalized provides more quality of diagnosis and medicine. This paper provides an overview various methods, algorithms, frameworks developed for personalized healthcare. In this article focus on two main accept one is recommendation system for personalized healthcare which provides more data insight mechanism and approach to diagnosis a patient, second it focus deep learning mechanisms in various fields of healthcare, bioinformatics and genomics to deliver accurate results based on advancements in algorithm. This article reveals both combination of recommendation system along with deep learning quality of precision healthcare achieved to patients.

Keywords: Deep learning, Precision medicine, Recommendation System, Personalized Healthcare

1. Introduction

The precision medicine plays an important role to provide quality treatment and individually care for each patient may maximize their health status[1]. Every individual has their own characteristics and life style the precision medicine will suit for them to give better care [2]. The precision also well suit for demographic treatment, because the nature of human and diseases has various origin factors vary on place to place. In growing healthcare industry and data identifying the normal values based on normal clinical straight is not good. It should be from normal people and their demographic place[3]. The role of automation impact gradually in medicine industry also due to more research activities in bioinformatics and advancements in the algorithmic development in computer science centric building activities[4]. The precision medicine for patient is always based many factors[5]. The diagnostic of patient have three possibilities they are internal, external and behavioral constraints of treatment. The regular treatment and continuous medicine is followed on severe cases otherwise it will cause other effects[6].

The statistics provided by Global Market Insights[7] provides various insights on recent advancements, future directions, global market across the country in precision medicine. It sates about following importance of Big Data Analytics in processing patient data, Bioinformatics for clinical diagnosis, Gene Sequencing to know the heredity information of patient, Drug Discovery for better treatment, Companion Diagnostics scientific advancements. This website provides information about market value of precisions medicine industry and the same shown in Figure 1.2. It provides pathway to
various Oncology, Immunology, CNS, and Respiratory. It also states about end users like Pharmaceutical Companies, Diagnostic Companies, and Healthcare IT companies to acquire their markets. The deep learning algorithms at different levels of classification and clustering in genomic and bioinformatics system may personalize the effects and impact on medicines and treatment for patients to improve the quality of medical recommendation system. The particular exclusive framework for precision medicine using deep learning[8] may play a vital role in medicine for better treatment of patients.

The various internal factors are blood type, genomic sequence, various clinical diagnosis value compared with standard values, external factors such as gender, age, demographic, life style, habits and job, behavior factors are allergy, side effects and severity of medicine they taken etc., and most importantly demographic features their pollution like water contamination they intake, air they heal, nutrition’s in the food they have. All above should play an important role when giving treatment to a patient.

The recommendation system for each patient based on their identity[9] (Biometric or visual) and software using analytics to examine the clinical data based on the factors may give suitable diagnosis or medicine to patients. Using handheld devices like mobile phones and suitable apps recommendation system must suit for each patients to treat them based on their life style[10]. The evolutionary algorithms[11] for transactional database of patient may find patterns which suits for particular disease.

The Figure 1.1 shows the overview of personalized precision medicine recommendation system. In this article methods and recent approaches by various researchers has described. The various researchers and their contribution and enhancements, results and comparison and their unique statement in their work are revealed.

2. Deep Learning Approaches for Personalized medicine

This paper[12] provides the overview of Deep Learning in Personalized medicine gives the high accuracy and multi-model prediction while implementing clinical setting. A specialized approach in
machine learning with algorithms of neural networks in collection of data is Deep learning. It can solve the needs of the patients by predicting treatments. It opens computational frameworks with large amount of healthcare data. It helps to predict the needs by using the large amount of information from the patients. Electronic health records (HER) is have a great role in Deep Learning. It helps in diagnosis various diseases and analysis of various healthcare data and performing traditional statistical models with high accuracy rate. The Figure 2.1 Shows the suggested model for deep learning based recommendation system.

![Figure 2.1 Suggested Model for Deep Learning based Recommendation System](image)

Here the author states the obstacles and opportunities[13], for various biomedical problems the classification, process and treatments. The techniques in the deep learning are improving day by day, although all these methods are not fully solved all the problems. Anyway it reduces the error rate. In most of the cases like skin diseases and diabetic diseases, it gives accurate results than professionals. The neural networks contains hidden layers which is incorporated in deep learning in which each layer has some special feature. These can be refined and customize for specific tasks. Deep learning methods can be applied to patients phenotype to categorize the patient. Optimization of medicine and biology encourage the revolution in these domains. This paper highlights prediction improving and training for patients.

This paper[14] conveys the incorporation of artificial intelligence in the retinal diseases. The author states that the deep learning in healthcare techniques are increasing day by day, in this ophthalmology has been the first and it will set some changes in other field too. In future the tools will be improved for screening, diagnosis and treatment for retinal diseases. Personalized health care (PHC) has stepped forward by using the predictive algorithm for practicing the suitable retinal care. A trial has been conducted from set of patients. Healthcare researchers and the experts in artificial intelligence should involve by using a real datasets to develop further treatments.

This paper explain [15] some features involved in the medical imaging focusing on MRI in deep learning.in this paper he enhanced the advances in healthcare. He also mentioned the diagnosis and challenges in images processing and analysis. He delivered the three aims of his paper and the paper was fully concentrated by these strategies. The imageNet large visual recognition challenge (ILSVRC) in 2012 [16] in this a deep learning model that is convolutional neural network had set a benchmark by best error rate on image. Then the objects in natural images recognition task was performed by computers until thought to be difficult but now convolutional neural network has made the work easier. This paper stated the all these software systems such as computer science, physics and other
engineering will have a great impact on deep learning, then a new medical paradigm transition will occur that is predictive preventive personalized participatory P4 medicine. The paper about the cardiovascular care[17] enabled the personalized medicine practically spoken about the treatments and diagnosis. Cardiovascular disease causes of death worldwide mostly. Here they collected the recent data in personalized cardiovascular medicine to give an overview of the work done in the past of cardiology. They focused on the diagnostic or therapeutic strategies which gives impact on clinical decision support systems. Authors have, provide a glimpse of all the past data in personalized cardiovascular care. Incorporated the deep learning techniques make the simplified clinical system to encourage the healthier world.

The practice of medicine is increasing day by day. Discovery of drug methods are mentioned in the paper[18] describes invention of new chemicals includes drug discovery. Several medical terms are combined for designing drugs by algorithm with the help of and neural networks finally. Drug discovery includes precision medicine plays a vital role in patient clinical system to improve the stability and health of patients’ Much advancement in drug discovery will be improved. This paper briefly explains how to predict the risk in the gastric cancer patient. The patient details were taken as data set. It is DL model based on neural network. Patients are treated according to the risk of diseases like high to low using DL model. Here the risk prediction of overall survival of patients in gastric cancer.

Personalized Medical Prescription System gives a defined knowledge prescription in medical system [19]. Here the ALC description logic and artificial algorithm. For any disease to achieve an accurate prescription the algorithms are defined by using the same patients details the trail gone from this the accurate prescription has made to provide accurate results.

| Author                      | Method                                         | Accuracy                        |
|-----------------------------|------------------------------------------------|---------------------------------|
| GZ Papadakis, AH Karantanas[12] | multi-modal technique                          | 92.3%                           |
| RW Filice                   | Modern deep-learning language-modeling approaches | 73.7%                           |
| J Yoon, C Davtyan[20]       | EHR based learning                             | 16.6% and 4.20 % improvement over existing in the personalized Chemotherapy regimens and diagnostic predictions. |

The article[21] discuss about various modern deep learning modeling approaches its shows 73.7% improvement in accuracy results. It proposes a novel framework using radiology and pathology reports. It uses anatomic of artificial intelligence concept radiology with pathology combined correlation system for classification of patient details. This paper deals with fine tuning of text classification of patient details.

The approach proposed by (J Yoon, C Davtyan) [20] uses the relevant information from the electronic health records(HER) to better analysis of best clinical decision to which suits for a patient. It provides 16.6% improvement over existing in the custom-made chemotherapy regimens. For analytic predictions, the DE method gives a 2.18% and 4.20% improvement over previous method. It used deep learning based approach to read relevant information from EHR and recommend suitable diagnostic approach.
The method proposed in this paper[22] and based on that approach provides improvement needed in service oriented architecture for physician and patient interaction over software to software interaction through API(Application Programming Interface) which used recommendation system of precision medicine to provide data pipeline through optimized software interfaces.

The approaches stated in journals[23, 24] provides more comprehensive approach using modern technologies. The method provides collect and analyze and make benchmark of the data then it uses apps in mobile phones to diagnosis the results given by patients and test with backend analysis and provides suitable medications and suggestions to improve their health.

3. Recommendation systems for Personalized Medicine

The following paper [25] briefly talks about biomarkers which play a significant role within the treatment of respiratory functionalities. It is stated that over 10% of patients hospitalized in critical care are affected by Acute Lung Injury. The most intense type of ALI is Acute respiratory distress syndrome (ARDS) in which 40% fatality rate is observed. The contribution of biomarkers to the pathophysiology of ARDS is considerably very less. Nevertheless, a major problem is that ARDS is such a diverse, multi-factorial, termination condition that the techniques for “lumping and splitting” are severe.

However, the appliance of network biology to ARDS is made possible with the help of human genome sequencing and the provision of improved techniques for the analysis purpose of transcription to mRNA (gene expression), and also due to the development of sensitive immunoassays. In the field of molecular phenotypic is to identify the patients who at the danger to develop ARDS, biomarker panels have gained prospective applications. This composite disease continues to be serious and deadly event even though the process of dealing and controlling of ARDS has been developed. Monoclonal antibodies (anti-TNF) and TNFR fusion protein have given uncompromising results. However, with the advancement in the techniques of mechanical ventilation, a neuromuscular blocker has shown some positive result, and somatic cell therapy is being well developed. In the future, it is expected that this could give logical remedial targets, and eventually improve clinical care since the comprehension role of biomarkers are incorporated into the pathophysiology of ARDS and lung problems.

This paper [26] briefly discusses the approach that though there are many clinical benefits specifying the importance to produce treatment for sparse diseases and cancer but the impact on the dealing and control of quite composite diseases, like type 2 diabetes, remains too low. This paper primarily specifies the ways by which people fall as a prey to poor health through the appliance of diagnostic labels. This review suggests a different, ‘palette’ model, center placed on a molecular taxonomy that aims on positioning an individual in accordance to the most pathophysiological processes that put-up to the risk and development of diabetes.

This model anticipates that several individuals having diabetes will surely have multiple other defects that would affect enormous of those kinds of processes. It's clearly laid out in this paper that why the palette model could be a more faithful way of finding out the pathogenesis of diabetes. First, the palette model is clearly in line with the prerequisite knowledge of type 2 diabetes as a multisystem disease with evident and effective abnormalities within the pancreas, fat, muscle, liver, and, importantly the brain. Second, the new emerging genetic analysis is in full support of this approach. Third, this perspective of diabetes pathogenesis is consistent with the growing portfolio of obtainable therapies.

This paper [27] briefly discusses the pain prevalence in cancer patients. Its evident that though the cancer pain is being discussed widely but, the prevalence of pain still lags on. Patients suffer from serious pains even after rummaging anticancer therapy and advanced diseases. In this review, the
possible causes which are likely to be the symptoms for the continuing high extensiveness of cancer pain and possible future directions for improvement in controlled pain dealing have been explored and discussed.

There are various reasons which are being a threat to improvement. Patients hesitate to debate about the pain with the therapists spontaneously; the instruments utilized to measure pain aren't routinely utilized in daily practice; knowledge regarding the assessment of under treatment is limited; changes in patient's characteristics, lack of serious improvement in the treatment of chronic pain are all considered the most important issues. To boost cancer pain treatment, it's recommended that: (1) Physicians actively ask about pain and measure the patients' pain using assessment instruments; (2) the development of an efficient tool to measure the under treatment; (3) educational and efficient interventions to boost health care workers' skills in pain control diagnosis and management; (4) effective, simple and personalized drugs and non-pharmacological pain treatment can be developed. From this, we conclude that the clinician must finally assure to start measuring pain in cancer patients within the least number of visits and find effective ways to decrease the “unskilled and unaware” status in health care workers.

Presently, educational efforts have proved to be limited effects and new and/or earlier interventions probable to be sought. Additionally, research into new and more personalized pain management and treatment must continue to prolong, in genetics also as in drug related and non-pharmacological treatment.

The paper written using EHR based[28] mentioned improved in quality of healthcare by using predictive modeling with EHR for personalized medicine. Its uses FHIR (Fast Healthcare Interoperability Resources) format which helps accurately predictive medical events from centers.

The article using medical records[29] developed a DeepCare dynamic NN model uses records of patients, previous patient history, current and future state of patients. Its uses LSTM (Long-Short-Term-Memory) to maintain and analysis the patient details in memory as vector were care episode and state of patient health records in memory. It achieves 79 % in diabetics and 75.4 % in mental health healthcare records of patients

The genomic based approach proposed in this paper[30] tells about EHR and their importance which is widely accepted in current scenario. The EHR records collected globally along with genomic records and clinical data it provides good pathway to widely do the research and importance of personalized medicine. But the problem with interoperable healthcare records will be sorted by patents like platform[31] based interchange of records where globally all EHR records interchanged. Currently[32] there are many issues in EHR.

The Internet of Things based smart products development and their impact and advantages proposed a smart mirror approach[33] which incorporates smart hardware with software and their implant intelligence techniques for healthcare will open an new era in healthcare which involves curing the patients with personalized information and clinical settings.

| Author | Method |
|--------|--------|
| Ravi, D., et al | biomarkers |
| Rajkomar, A., et al | HER Based Predictive Modeling |
| Pham, T., et al. | Deepcare |
| Abul-Husn, N.S. and E.E. Kenny | Genomic based approach |
The article on review of deep learning in healthcare[34] says the importance of deep learning and its recent advancement brings the analyzing the types of EHR records with their complex homogeneous and heterogeneous records and its poor representation. The processing of those records and incubating patient information may bring healthcare records more knowledgeable resource which makes personalized healthcare and medicine visible to current worlds within minimum spanning time.

4. Conclusion

Thus this article reveals about various researchers and their focus in precision medicine and recommendation system for patients diagnosis for treatment. This paper discussed on various concerns consider for personalized medicine in terms of different parameters consider for treatment. It discusses various methods and approach developed in recommendation system and deep learning methods. The combination of recommendation system along with deep learning and big data may reach the high quality of results in personalized medicine. Still more researches need focus on demographic based patient data collection, analysis and healthcare mechanisms to deliver better results.

[1] Kosorok MR, Laber EB. Precision medicine. Annual review of statistics and its application. 2019;6:263-86.
[2] Psaty BM, Dekkers OM, Cooper RS. Comparison of 2 treatment models: precision medicine and preventive medicine. Jama. 2018;320:751-2.
[3] Manrai AK, Patel CI, Ioannidis JP. In the era of precision medicine and big data, who is normal? Jama. 2018;319:1981-2.
[4] Yu K-H, Beam AL, Kohane IS. Artificial intelligence in healthcare. Nature biomedical engineering. 2018;2:719-31.
[5] Zhang X, Yang H, Zhang R. Challenges and future of precision medicine strategies for breast cancer based on a database on drug reactions. Bioscience Reports. 2019;39.
[6] Kroschinsky F, Stölzel F, von Bonin S, Beutel G, Kochanek M, Kiehl M, et al. New drugs, new toxicities: severe side effects of modern targeted and immunotherapy of cancer and their management. Critical Care. 2017;21:89.
[7] https://www.gminsights.com/industry-analysis/precision-medicine-market.
[8] Grapov D, Fahrmann J, Wanichthanarak K, Khoomrung S. Rise of deep learning for genomic, proteomic, and metabolomic data integration in precision medicine. Omics: a journal of integrative biology. 2018;22:630-6.
[9] Bhatti UA, Huang M, Wu D, Zhang Y, Mehmood A, Han H. Recommendation system using feature extraction and pattern recognition in clinical care systems. Enterprise information systems. 2019;13:329-51.
[10] Shakhovska N, Fedushko S, Shvorob I, Syrov Y. Development of mobile system for medical recommendations. Procedia Computer Science. 2019;155:43-50.
[11] Logeswaran K, Suresh P, Savitha S, KR PK. Optimization of Evolutionary Algorithm Using Machine Learning Techniques for Pattern Mining in Transactional Database. Handbook of Research on Applications and Implementations of Machine Learning Techniques: IGI Global; 2020. p. 173-200.
[12] Papadakis GZ, Karantanas AH, Tsiknakis M, Tsatsakis A, Spandidos DA, Marias K. Deep learning opens new horizons in personalized medicine. Biomedical reports. 2019;10:215-7.
[13] Ching T, Himmelstein DS, Beaulieu-Jones BK, Kalinin AA, Do BT, Way GP, et al. Opportunities and obstacles for deep learning in biology and medicine. Journal of The Royal Society Interface. 2018;15:20170387.
[14] Hopkins JJ, Keane PA, Balaskas K. Delivering personalized medicine in retinal care: from artificial intelligence algorithms to clinical application. Current Opinion in Ophthalmology. 2020;31:329-36.
[15] Lundervold AS, Lundervold A. An overview of deep learning in medical imaging focusing on MRI. Zeitschrift für Medizinische Physik. 2019;29:102-27.

[16] Imran H. ImageNet Classification with Deep Convolutional Neural Network.

[17] Niazi S, Khattak HA, Ameer Z, Afzal M, Khan WA. Cardiovascular Care in the Era of Machine Learning enabled Personalized Medicine. 2020 International Conference on Information Networking (ICOIN): IEEE; 2020. p. 55-60.

[18] Dana D, Gadihya SV, St Surin LG, Li D, Naaz F, Ali Q, et al. Deep learning in drug discovery and medicine; scratching the surface. Molecules. 2018;23:2384.

[19] Hijazi S, Obeid N, Sabri KE. On the Logical Foundation of a Personalized Medical Prescription System. IEEE Access. 2019;8:6471-83.

[20] Yoon J, Davtyan C, van der Schaar M. Discovery and clinical decision support for personalized healthcare. IEEE journal of biomedical and health informatics. 2016;21:1133-45.

[21] Filice RW. Deep-learning language-modeling approach for automated, personalized, and iterative radiology-pathology correlation. Journal of the American College of Radiology. 2019;16:1286-91.

[22] AllamehAmiri M, Derhami V, Ghasemzadeh M. QoS-Based web service composition based on genetic algorithm. Journal of AI and Data Mining. 2013;1:63-73.

[23] A.P.Ponselvakumar, S.Anandamurugan, K.Logeswaran, R.Niveda, G.Nibhashini, K.V.Salaignanaprabha. Prediction of Hypertension using an Android Application and Feature Selection Scheme. International Journal of Advanced Science and Technology. 2020;29:12.

[24] Logeswaran K, Suresh P, Savitha S, Kumar KRP, Ponselvakumar AP, Kannan AR. Data Driven Diagnosis of Cervical Cancer using Association Rule Mining with Trivial Rule Expulsion Approach. International Journal on Emerging Technologies. 2020;11:6.

[25] Ravi D, Wong C, Deligianni F, Berthelot M, Andreu-Perez J, Lo B, et al. Deep learning for health informatics. IEEE journal of biomedical and health informatics. 2016;21:4-21.

[26] McCarthy MI. Painting a new picture of personalised medicine for diabetes. Diabetologia. 2017;60:793-9.

[27] den Beuken-van Everdingen V, Marieke H, Van Kuijk SM, Janssen DJ, Joosten EA. Treatment of pain in cancer: towards personalised medicine. Cancers. 2018;10:502.

[28] Rajkomar A, Oren E, Chen K, Dai AM, Hajaj N, Hardt M, et al. Scalable and accurate deep learning with electronic health records. NPJ Digital Medicine. 2018;1:18.

[29] Pham T, Tran T, Phung D, Venkatesh S. Predicting healthcare trajectories from medical records: A deep learning approach. Journal of biomedical informatics. 2017;69:218-29.

[30] Abul-Husn NS, Kenny EE. Personalized medicine and the power of electronic health records. Cell. 2019;177:58-69.

[31] Myers S, Celi J, Quinn J, Thompson G, Kelly B, Ruffin M, et al. Platform for interoperable healthcare data exchange. Google Patents; 2008.

[32] Borycki E, Joe RS, Armstrong B, Bellwood P, Campbell R. Educating health professionals about the electronic health record (EHR): Removing the barriers to adoption. 2011.

[33] Miotto R, Danieletto M, Scelza JR, Kidd BA, Dudley JT. Reflecting health: smart mirrors for personalized medicine. NPJ digital medicine. 2018;1:1-7.

[34] Miotto R, Wang F, Wang S, Jiang X, Dudley JT. Deep learning for healthcare: review, opportunities and challenges. Briefings in bioinformatics. 2018;19:1236-46.