Comparative Study of Intelligent Systems for Management of GIT Cancers

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Abstract. Intelligent Systems contribute in the management of different GIT cancer types. The paper discusses different types of intelligent systems, classified according to the medical task achieved, such as early detection, diagnosis and prognosis. It is found out that these types include rule-based and case-based expert systems, artificial neural networks, genetic algorithms, machine learning, in addition to data mining techniques and statistical methods. The study focuses on comparing between different techniques and tools used. The comparison results in identifying the benefits of using data mining techniques for the diagnosis task, since it is based on huge amounts of data in order to discover new patterns hence new predisposing factors. It also points out the use of expert systems in the prognosis task, since this task is mainly based on the specialist experience that should be transferred to less- experienced medical professionals. Based on the previous results, it is recommended to develop an Intelligent Tutoring System (ITS) that focuses on the early diagnosis of GIT cancers, since managing the disease depends mainly on proper diagnosis, and also to build an expert system that helps transferring GIT cancers management knowledge to medical doctors in different hospitals.

Keywords: Intelligent Systems, Data Mining, GIT Cancer, Cancer Management, Expert System, Machine Learning, Artificial Neural Networks, Artificial Intelligence

1 Introduction

1.1 Background

Nowadays, Healthcare systems are focusing on the management of Cancer since it is spreading enormously. However, based on the World Health Organization (WHO), nearly one third of the cases may be prevented and another third may be treated successfully [1]. This needs the contribution of Information technology specialists so as to provide the decision makers with data, information, and knowledge, in order to have insights that help them with discovering risk factors, early detection of the disease, proper diagnosis, treatment, prognosis, and survival rate prediction.

Managing cancer requires huge amounts of accurate and updated clinical data. This is only made possible by using IT tools and techniques [2].

The study focuses on Gastro-Intestinal (GI) cancers, since they are the most common cancers. GIT cancer indicates different types of cancer that affect the digestive system; they include "cancers of the esophagus, gallbladder, liver, pancreas, stomach, small intestine, bowel (large intestine or colon and rectum), and anus" [3].

1.2 Problem Definition

The Health care forum of 2016 declared "War on Cancer" [1]. It requires more efforts to design strategies that work on decreasing cancer burden. These strategies require assembling government and industry key persons, in addition to academic professionals to work on finding measures to fight this wide spreading disease.

To deal with different types of GIT cancer management, healthcare professionals need to have sufficient data related to patient and disease details and knowledge management techniques related to new algorithms. Moreover, there is a need for intelligent systems to support different medical tasks.

Although there are several types and techniques related to management of GIT cancer, there is no clear-cut definition of the most suitable type and

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technique based on the required task, whether it is diagnosis, treatment or prognosis

1.3 Importance

Cancer management consumes huge amounts of funds in any country. The main cost is for treating the disease [4] Economic **Impact of Cancer**, American Cancer Society). Therefore, governments are working on strategies that deal with this disease in order to reduce the costs and improve the quality of life of cancer patients.

1.4 Objectives

Based on the problem definition, the study aims at achieving the following objectives:

a-Discussing the current intelligent systems of the GIT cancer domain.

b- Comparing between various techniques used to decide on the suitable technique related to the medical task.

1.5 Structure of the paper

The paper will discuss the various types of intelligent systems, such as Expert Systems, Case-based learning, Intelligent Decision Support Systems, and others. Then it will discuss recent studies related to the domain, classified based on the medical task they are achieving, then make a comparison among them based on technique and tool used. Finally, results are presented and conclusions and recommendations are drawn.

2 State of the Art

2.1 Intelligent Systems

"Intelligent System (IS) can be defined as the system that incorporates intelligence into applications being handled by machines. Intelligent systems perform search and optimization along with learning capabilities. Different types of machine learning such as supervised, unsupervised and reinforcement learning can be modeled in designing intelligent systems. Intelligent systems also perform complex automated tasks which are not possible by traditional computing paradigm. Various diagnostic, robotics and engineering systems are results of intelligent procedures implemented in Intelligent System Design"

"An intelligent system is a system that can imitate, automate some intelligent behaviors of human being. Expert systems, intelligent agents and knowledge-based systems are examples of intelligent systems. Currently, intelligent systems is a discipline that studies intelligent behaviors and their implementations as well as their impacts on human society". [5]

2.2 Gastrointestinal (GIT) Cancer

GIT cancer is found out to be one of the most commonly diagnosed malignancies and a major cause of mortality [6]. Some of the problems related to this major health problem worldwide are poor prognosis and limited treatment options. Hence, the main focus is on preventing this serious disease in order to reduce its incidence and mortality.

Some of the predisposing factors are diet such as eating dried fish and meat and refined carbohydrates, genetic factors, infectious diseases such as H. pylori infection, in addition to alcohol consumption and smoking [3].

3 Comparison from IS perspective

The following table show the different types in IS used in the field of GI cancer, classified by the three different tasks (Algorithm, Diagnosis, Prognosis)

Table 1. Comparative of different types of IS systems according to tasks.

Task	Type of IS	Technique used	Tools	Results
Algorithm	Data Mining	Association rules	MATLAB	data mining algorithm based on ontology makes rules more intuitive, appealing and understandable [8]

	Decision Support System	Machine learning	N/A	The outcome of the specific implementation is a set of clinico-genomic profiles, which are employed for decision support, automated diagnosis, prognosis, treatment and follow-up in colon cancer. [9]
	Expert systems	Genetic Algorithms	C-MANTEC algorithm	Better cancer outcome prediction results were obtained using the GA framework noting that this approach, in comparison to the SFS [10]
Diagnosis	Decision Support System	knowledge base	C ++ &MySQL	creation of the computer knowledge base containing the data of histological, cytologic, and clinical researches. The system is focused on improvement of diagnostics quality of stomach cancer [11]
	Expert systems	Case-Based Reasoning (CBR) Rule-Based Reasoning (RBR).	Java object-oriented	this approach would be useful for general practitioners. [12]
	Artificial Intelligence	Artificial Neural Network (ANNs),	N/A	The ANN model built with the six serum tumor markers could distinguish lung cancer, not only from lung benign disease and normal control, but also from other common gastrointestinal cancers, [13]
	Artificial Intelligence	Image processing	Vector Machine Algorithm	The suggested system by using a combination of mentioned methods was succeeded to achieve 91.8% accurate diagnosis. Although available methods are accurate but they are expensive and time consuming, by comparing this method with those mentioned above are will have a better understanding of its accuracy and usefulness. [14]
	Data Mining	Artificial Neural Network (ANNs), decision trees, and logistic regression	N/A	present a new validated discriminative GERD questionnaire using data mining techniques. The questionnaire is useful, friendly, and short, and therefore can be easily applied in clinical practice for choosing the appropriate diagnostic workup for patients with upper gastrointestinal complaints. [15]
	Machine Learning	Decision Tree, Majority, Nearest Neighbors, and Best Z-Score	Python	the Decision Tree would perform best simply because it is a very widespread machine learning algorithm. [16]
	Decision Support System	Image analysis & decision fusion	N/A	The objective of this research is to improve the overall abnormality detection ability and provide the decision support by using artifcial intelligent techniques [17]
	Expert systems	genetic algorithm	N/A	the algorithm provides a list of biomarkers that play the most important role in this lethal disease as a by-product. [18]
	Artificial Intelligence	Artificial Neural Network (ANNs)	Maruyama computer program	Using an ANN, LNM in each LNG can be accurately predicted. Additional knowledge about one lymph node

			(MCP)	improves the results [18]
	Data Mining	Cluster analysis	SAS Enterprise Miner 6.1	Enterprise Miner predictive modeling nodes were great at easily and quickly implementing classification models for colorectal cancer [19]
Prognosis	Artificial Intelligence	Artificial Neural Network (ANNs) Cox regression models	Utilizing R 2.12.0	This study showed that ANN model is a more powerful tool in survival prediction and influential factors of the CRC patients compared to the Cox regression model [20]
	Knowledge-based system	Bayesian model, Artificial Neural Network (ANNs)	MATLAB	This study focused on the classification problem of high-dimensional patterns and especially of socio-demographic cancer questionnaires [21]
	Artificial intelligence	Machine Learning	N/A	the use of machine learning classifier will become much more commonplace in many clinical and hospital settings. [22]
	Decision Support System	decision-theoretic model	N/A	The model has been incorporated into a computer-based system, that can be used as a decision-support system. Preliminary evaluation results indicate that the performance of the model in its present form matches the performance of experienced clinicians. [23]
	Expert systems	artificial neural network (ANN) and Cox regression hazard (CPH) models	N/A	study demonstrated that the ANN model is a more powerful tool in determining the significant prognostic variables for GC patients, compared to the CPH model. Therefore, this model is recommended for determining the risk factors of such patients [24]
	Artificial intelligence	Machine-learning	MATLAB	Machine learning applied to information from a disease-specific (cancer) database and the EAR can be used to predict clinical outcomes. [25]
	Expert systems	Artificial Neural Network (ANNs)	N/A	The performance of ANN model in predicting the probabilities of death is consistently high for all time points according to the accuracy and the area under the receiver operating characteristic curve. [26]
	Expert systems	Artificial Neural Network (ANNs)	N/A	by using trained ANN, we can prognosis cancer with least clinical and laboratory features and without requirement of much time. [27]

4 Discussion and Future Work

4.1 Discussion

Based on the results extracted from the table, it was found out that Expert Systems, Machine Learning and statistical methods are used for both diagnosis and prognosis. However, data mining techniques are mainly used for diagnosis since they are good in the classification and clustering tasks.

Regarding algorithms, data mining, machine learning and expert systems are used.

Therefore, although there is no single technique or tool that is used to perform a specific medical task, expert systems are mainly used for prognosis because GIT cancers follow many protocols to be treated and the prognosis relies mainly on the expertise of oncologists whereas data mining techniques

contribute to the diagnosis since they mainly rely on big amounts of data in order to discover new patterns.

5. Conclusion and Future Work

Regarding the recommendations for future work, the following projects are suggested:

a) Developing an Intelligent Tutoring System that teach and train junior medical doctors on the early diagnosis of GIT cancer since all of the other medical tasks depend on the right diagnosis.

b) Designing an Expert System that incorporates different protocols used to treat GIT cancers in order to transfer such important knowledge from senior Oncologists to others less experienced in various governmental and private hospitals.

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