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Case-Based Reasoning System for the Diagnosis and Treatment of Breast, Cervical and Prostate Cancer

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Abstract *- Case-based reasoning (CBR) has the problem and solution part, this method has being one of the currently used method to problem solving and learning of new cases. Therefore, CBR is seen as a method for problem solving and also as a method to capture new experience and make it immediately available for problem solution. CBRs technique have being used in many fields of studies in medical diagnosis. This research on case-based reasoning system was able to diagnosis and perform therapies for breast cervical and prostate cancer using CBR. The system was built to represent meaningful cases for fast matching in the knowledge base, collecting data's form medical experts and to give comparative analysis with GA. Data mining (clustering technique) was used to aid diagnosis and treatment of Breast, Cervical and Prostate Cancers i.e. the system was able to differentiate between diseases. The development stage was done using some sets of software tools: PHP programming language, HTML and MySQL database system.*

Keywords - *Retreival, Diagnosis, Breast, Cervical, Prostate, Reasoning, Treatmentand Case-based*

I. INTRODUCTION

Case Based Reasoning (CBR) is an artificial intelligence (AI), problem-solving approach that focuses more on similar cases in the past to solve problems, modify and analyse current solutions, and describes irregular circumstances [1].
CBR is a rich and knowledge-intensive way of acquiring previous experience, enhancing current methods of problem solving and improving the general learning capabilities of machines [2] It is also a study model that discusses memory, learning, planning and problem solving issues [3]. Therefore, it is both a method of problem solving and a thinking model of the manner in which human beings learn and recall. With great enthusiasm, the artificial intelligence community has earned CBR because it offers smart solutions to tough problems in the real world.
Case-based reasoning systems (CBRs) result from the artificial intelligence community's attempts to base the system on the human brain reasoning model. If rules are insufficient to convey the riches, CBRs are selected over the expert system.
The unit, alternatively referred to as the problem solver or reasoner, has an inner structure split into two main sections in most CBR systems: the case retriever and the case reasoner.
The role of case retrievers is to locate the correct cases in the case, while the case reasoner uses the retrieved case to find an answer to the interpretation of the problem given. This logic largely incorporates all determinations.

The development of the intended knowledge base is challenging and time-consuming, due to complexity and the time-consuming elicitation of expert knowledge. This is particularly the case for problem domains that span a wide spectrum of information.
The inability to fix concerns that are not explicitly addressed by the rule base used. In general, if the built-in structures are useful, rule-based expert systems are useful.
In order to strengthen creation trends, information modelling languages and ontologies, and advanced processes and resources for upholding structures, solutions to these issues have been pursued through improved elicitation practices and tools. However, an alternative reasoning paradigm and computational problem-solving methodology have gained a lot of attention in the last decade: case-based reasoning [4]

- CBR does not need an explicit domain model, so elicitation becomes an assembly case history obligation.
- Implementation is compact in classifying essential characteristics that characterize an event, a process that is simpler than constructing an explicit model.
- By gaining new understanding as instances, CBR systems may research. This and the introduction of database procedures make it possible to manage large sizes of information.

The field of artificial intelligence involved in case-based reasoning brings the model of memory-based reasoning into effect. CBR is logic in a nutshell by remembering: previously solved problems (cases) are used to propose solutions for novel yet comparable problems. [1] lists four assumptions that are the foundation of the CBR process about the environment around us:

1. Regularity: the same actions executed under the same conditions will tend to have the same or similar outcomes
2. Typical: events appear to be replicated.
3. Consistency: minor changes in the situation entail only minor changes in the perception and the solution.
4. Adaptability: The variations appear to be minor as things are replicated, and the small differences are easy to adjust for.

The CBR working cycle can be best defined in terms of four processing stages, according to Kolodner**:** Fig 1.1: Below shows the CBR working cycle.

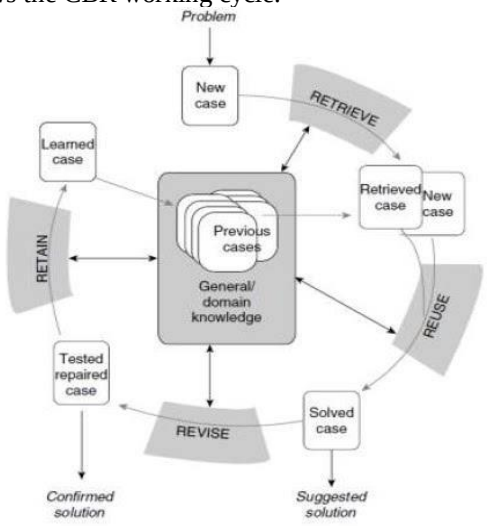

Figure: 1.1 Case Based Reasoning Working Circle.

1 Case Retrieval: This is gathering from the memory an experience closest to the current problem.
2 Reuse: This suggests a solution based on the experience and adapting it to meet the demands of the new situation.
3 Revise: Evaluating the use of the solution in the new context.
4 Retain: Storing this new problem solving method in memory system.

[4] give these four processes a slightly different CBR working cycle scheme.

1. RETRIEVE the case(s) most similar;
2. To try to solve the current problem, REUSE the case(s);
3. REVISE, if applicable, the suggested solution;
4. RETAIN, as part of the new situation, the new solution.

These characteristics may include data such as patient data(s), cancer causing factors, etc. Then this information is preserved for retrieval in a database. Retrieve is the database search method for identifying correlations between cases based on the indexed data. The retrieved case combined with the new case through reuse into the solved case. The suggested solution for the initial problem. Adaptation is the changing of the retrieved information to best fit the new problem. Revise is the verifying step of the fitness of the proposed solution and determining if the proposed solution is success or the process needs to be started over again. The final move is to maintain the valuable experience retained for future reuse and update the case based on a new case solved or updated by some existing cases.

II. RELATED WORKS

This research is particularly concerned with the diagnosis of dysfunctions associated with stress. Since there are wide differences between individuals. This is a worthwhile challenge for individuals when looking at sensor signals. The thesis is mainly focused on the Integrated Personal Health Optimizing System (IPOS) research project sponsored by the KunskapochKompetensStiftelsen (KKS) Swedish Information Foundation, [5]

[6] have put forward a protocol for the diagnosis stress-related disorders under the Artificial Intelligence in Medical Application (AIM) project at Mälardalen University, Sweden. Based on the diagnosis of stress-related disorders by classifying the heart rate patterns, both cardio and pulmonary signals are analysed. Physiological time series and is used in psychophysiological medicine as a research tool. In a previously unexplored domain, such as psycho-physiological medicine, this was an initial attempt to use a decision support system (DSS). This system is more fitting for use in clinical settings. Case-based reasoning provides assistance in diagnosing stress is proposed, using data from the finger temperature sensor readings. The calibration phase helps to establish a number of individual parameters. The system uses a case-based reasoning approach to facilitate experience reuse and decision explanation by retrieving previous similar temperature profiles. Further, fuzzy technique is also incorporated into the case-based reasoning system to handle vagueness, uncertainty inherently existing in clinicians reasoning. This case-based system may help the clinician to make a diagnosis, classification and treatment plan. The case may also be used to follow the treatment progress. The individual cases including calibration may also be used in an autonomous system at home or in work environment for treatment programs for individuals often under high stress.

For over three decades, case-based reasoning (CBR) has been an area of great interest to academics, entrepreneurs, as well as clinicians. [7],[8],[9]. In order to include a theoretical model that is very similar to many disciplines of a heterogeneous nature, such as cognitive science, artificial intelligence (AI) and information science. The key benefit is that the normally detailed and complex formalization of the problems to be solved is not mandatory with CBR. Unlike various other AI methods that produce abstract representations from a collection of training instances, such as rule-based reasoning or neural networks, CBR

methodology adapts instance-based learning and uses previous comparable cases as the basis for decision-making. In particular, in the medical field, clinicians not only use the rules set out in the guidelines for clinical practice, but also use their knowledge and experience to diagnose the disease and provide treatment. The experience can be integrated as cases in the case-base in a CBR model, which may involve not only standard simple scenarios, but also complex and exceptional scenarios. Therefore, when reasoning, the model considers them and automatically enriches the case-base as a new case with parts of changeable knowledge and allows it to perform better with usage. Therefore, as the clinical choices made by doctors improve with experience, CBR model performance would also improve with use, which is not feasible in a rule-based model.

Therefore, the fact that the CBR methodology closely resembles the clinicians' thinking process and the gradual adoption of advanced decision support systems in clinical practice suggests the success of CBR in medicine [10]. CASEY Koton (1989) for the diagnosis of patients with heart failure, MNAOMIA [11], for the diagnosis and treatment of eating disorders, PROTOS[12] for hearing disorder diagnosis,[13] for radiology image classification, [14] for the management of Alzheimer's disease, and GOCBR for breast cancer diagnosis are some of the CBR systems developed so far in the fields of medicine and health science. The key challenge when designing a CBR framework is to build the representation of the case base and implement an efficient case retrieval algorithm.

Acquiring and maintaining a complete and consistent case base in a medical application, covering a large number of resolved patient cases with varying diagnosis performance, becomes the basis for creating a reliable CB-DSS in a medical application. A supervised learning algorithm, trained on resolved cases, stored in the case base, would then be adapted by CBR. Therefore, a new case is solved by first identifying the most similar cases from the case base and then adapting the solution of the retrieved cases to create the solution for the new query case. Taking into account of various algorithmic strategies [15] such as root mean square distance, geometrical matching, consensus shapes, weighted Euclidean distance etc., in developing similarity analysis and case retrieval algorithm, which would accurately measure the clinical distance between two patient cases, becomes a part of the problem- solving paradigm. We propose an ontology-based scheme in the present work to conceptualize, classify, and incorporate broad clinical data into a case-base knowledge of breast cancer patients. Subsequently, we integrate semantic similarity steps to implement the case retrieval algorithm, taking advantage of the information codified in ontology.

III. MATERIALS AND METHODS

Research methodology is a systematic method applied to a field of study, a procedure how project are arrange. In this work we will be using the qualitative method based of the uniqueness

A. Design Methodology

In fields such as sociology, history, and anthropology, qualitative analysis has historically been employed. [16] said that in recognizable local contexts, qualitative data is a source of well-founded, rich descriptions and explanations of processes. You can maintain historical flow with qualitative data, see exactly what events lead to what results, and extract fruitful explanations. In the sense of the social systems in which the behaviour takes place, qualitative approaches are concerned with how human behaviour can be explained.[17],for example, researchers may investigate how patients feel about their treatment, about their medications, or even about "being a patient" in the sense of health care and hospital pharmacy, in particular.[18] defined methodology as the "explanation with some justification for their selection of the approach, methods and procedures." It is important that researchers have coherent theories that underpin the way they perform their study, called "methodology."To ensure consistency between their own positionality (i.e. bias or stance), research questions, and goals, it is also important for researchers to have a detailed understanding of different methodologies. Given their expectations that it is inherently subjective or biased, that it does not aim to be reproducible across different contexts, and that it does not yield generalizable outcomes, clinicians may express concerns about the importance or impact of qualitative research. Other clinicians may express nervousness or uncertainty about using qualitative methods, stating that they have not been trained for the complexity and interpretative nature of qualitative data analysis by their previous "scientific" training and experience.

B. System Analysis

The proposed system is a system that will diagnose and recommend treatment for patients that has Breast, Cervical and Prostate Cancer, using the CBRs. It is an improved diagnoses system that shows Symptoms, Diagnosis, Stages and Treatments. This will be carried out by gathering data of patients that has visited the hospital for check-up. Data mining technique (clustering) will be used to group symptoms and diseases from the Knowledge Base. Utilizing K-means algorithm of clustering technique, the system is trained to store the activities of only patients that visited the hospital for the said work. The proposed system will have username and password for security reasons of reports.

a) Method of Data Collection

i. Collection of raw or primary data: data obtained from the source. Surveys, observations or interviews are among their sources.

ii. Secondary collection of data: this is information obtained by someone other than the user, i.e. the data is already accessible and processed by someone else. Their sources include various published or unpublished knowledge, books, periodicals, etc [19]

In collecting the data during the collection process, the two methods were applied because each person has different symptoms in each disease, even though it is the same disease, so both methods had to be used. Users with in-depth knowledge of the diagnosis and treatment of breast, cervical and prostate cancer should improve the proposed method. Physician on medical domain were interviewed and they contributed to this work with different experiences about the human anatomy. [20]

Table 3.1: Breast Cancer data's

Disease	Symptoms	Diagnosis	Stages	Treatment
Breast Cancer	Nipple discharge	Breast exam.	I	Radiation therapy
	A breast lump or thickening	Mammogram	IIB	Chemotherapy
	Peeling, scaling, crusting	Removing a sample of breast cells for testing (biopsy).	IIIA	Hormone therapy
	Swelling of the breast	**Breast magnetic resonance imaging (MRI).**	IVC	Surgery
	Skin irritation or dimpling	Breast ultrasound.	IVA	Targeted therapy drugs
		Medical history	IIC	Immunotherapy
			IIIA	Supportive care
			0	

Table 3.2: Cervical Cancer Data's

Disease	Symptoms	Diagnosis	Stages	Treatment
Cervical Cancer	Pain in pelvis	Pelvic examine	I	Surgery
	Pain during sex	Scan	II	Chemotherapy
	Menstrual pain	HPV DNA test	IVC	Radiation therapy
	Groin	Pap test	III	Immunotherapy
	Weight loss		II	Targeted therapy
	Fatigue		0	Palliative care
	Nausea		III	

Table 3.3: Prostate Cancer Data's

Disease	Symptoms	Diagnosis	Stages	Treatments
Prostate Cancer	Frequent urinating	Ultrasound	III	Surgery
	Painful ejaculation	MRI	IV	Palliative care
	Bone pain		I	Radiation therapy
	Loss of weight		IVA	Chemotherapy
	Loss of appetite		IIB	Immunotherapy
	Blood in the urine		IIC	
			IIIB	

b) Data Set

Information were properly gathered from patient's data's and listed for the proposed system.

Characteristics of Participants

Location University of Port Harcourt Teaching Hospital (UPTH) Choba Campus, Rivers State.

Department Medical Department

No. of Patients Fifty Three (53) in total of the three cancers in this work

Gender Adult (Male and Female)

Table 3.4: Shows data collection of sample question and summary responds

Sample Questions	Summary responds
What symptoms do you have?	Pain in my breast**,** Swelling breast
Do you have discomfort?	Yes, I do
Where do you have discomfort?	My left breast
How often do you have dis comfort?	Once i take of my bra
During what activities?	During sex & if i sleep facing down
What other symptoms happen when you feel discomfort?	Dimpling on my breast
Has anyone in your family ever had cancer problem	No
Do you smoke?	Yes

In the Case Base Reasoning model, these sample questions and summary answers will be used to communicate with the method to diagnose the patient to see the best match of the identified symptoms to get an answer to the care.

c) System Requirement Specification

An authorized patient that has registered a problem or records stored from experience by the expert.

d) Diagnosis and Treatment Security Level

User Identification: It is the name, email address, phone number or nickname that identifies you on the page when creating your database account.

Password: The password may be numbers or alphabets of symbols in a combination that you won't forget.

e) Diagnosis

The diagnosis is based on when the doctor/expert runs a check on you either by test, mammogram or interview, from your response which are the symptoms you gave, he recalls other experience that has happened in the past and gives possible sickness from the symptoms.

e) Treatments

The treatment is archived also from other medications or surgery etc, that was administered as successfully for similar patient that complained of same symptoms.

The research builds on the CBR system for diagnosis and treatment of Breast Cervical and Prostate cancer which was developed in collaboration with the University of Port Harcourt Teaching Hospitals (UPTH). Each case in the case base consists of the case attributes that describe the relationship between the tumour and organs art risk OARs of that patient and the treatment plan that was used to treat the patient. The treatment plan consists of six (6) different methods and they are;

1. Surgery
2. Radiation therapy
3. Chemotherapy
4. Immunotherapy
5. Targeted therapy
6. Supportive care

The CBR method measures the similarity between the characteristics of the new case and the cases in the case base, given a new patient case, and returns the most comparable case along with its treatment plan. Medical physicists may then modify this treatment plan to meet the unique requirements of the new patient.[21]

C. System Design

Object-oriented modelling (OOM) is a common design technique for illustrating the program, framework and business areas by using it as a paradigm during the life cycles of enhancement. In today's software construction, OOM is the approach used by Object Oriented Analysis (OOA) and Object Oriented Design (OOD) exercises. Object-oriented method analysis and design are essential for the achievement of software projects that integrate, understand the application, obtain design requirements that satisfy the way of creating.

This approach is an applicable framework for object-focused software development, with a focus on creating useful models that are understandable, consistent and recyclable. The built structure must have the ability to communicate with consumers or end users of inventors, etc.

***D*. Genetic Algorithm**

A genetic Algorithm (GA) is a search investigative that is moved by Charles Darwin's theory of accepted growth. This steps replicates the process of normal selection where the fittest distinct are nominated for reproduction in order to produce offspring of the next generation. We can assume the binary codes which are 0's as Gene, 1's as Chromosome and when we have the 0's and 1's all together in the column it is called Population.

E. Data Mining

In order to predict results, data mining is the method of identifying anomalies, trends and similarities within large data sets. Using a wide variety of methods, this knowledge can be used in various fields of research to boost sales, cut costs, strengthen consumer relationships, minimize risks, and more.

IV. IMPLEMENTATION AND RESULTS

A. Results

Table 4.1: Shows the attributes of Breast Cancer using the GA.

S/N	#Attributes	Domain (Range of samples)	Range sample Value (x)
1	Clump Thickness	1-10	8.9
2	Uniformity of cell size	1-10	8.7
3	Uniformity of cell shape	1-10	8.5
4	Marginal adhesion	1-10	9.4
5	Single epithelial cell size	1-10	9.7
6	Bare nuclei	1-10	9.5
7	Bland chromatin	1-10	9.4
8	Mitoses	1-10	9.6
9	Normal nucleoli	1-10	4.5

Summation of the range values(x) gives us 78.1% accuracy.

Table 4.2: Shows the Performance of Methylated Genes and HPV test for CIN3+ detection.

Test	Sensitivity (%) (95%) C1	Specificity(%) (95%) C1	AUC (%) (95%) C1
PAX1	**69.62(62.05 – 76.26)**	**81.79(76.95 – 85.80)**	**75.5(70.8 - 80.6)**
ZNF582	**76.58(69.40 – 82.51)**	**86.94(82.58 – 90.34)**	**81.8(77.3 – 86.2)**
PAP	**68.97(61.40 – 74.68)**	**90.72(86.84 – 93.54)**	**79.9(75.1 - 84.6)**
hrHPV	**98.10(94.57 – 99.35)**	**46.05(40.41 – 51.94)**	**72.1(71.4 – 81.4)**
HPV-16/18	**65.19(57.84 - 72.18)**	**87.63(83.4 – 90.93)**	**76.4 (71.4 – 81.4)**

Table 4.3: CBR for Breast Cancer and Possible Treatment

S|N	Query	Similarity	Treatment	Outcome	Cases
1	nipple retraction, lump	95%	trastuzumab (Herceptin) along with pertuzumab (Perjeta)	Retain	Breast cancer
2	swollen lymph nodes, breast skin redness	100%	chemotherapy before surgery	Retrieve	Breast cancer
3	mass in the breast, nipple discharge, breast pain	100%	chemotherapy before surgery	Retrieve	Breast cancer

V. DISCUSSION

In case-based reasoning, there are four components that are important during the prediction which are Retrieve, Reuse, Revise and Retain. We have used three out of four components of case base reasoning which are focus on Retrieve, Retain and Reuse in developing the system. Retrieve is referring to given a target problem, retrieve cases from memory that are relevant to solve it. A case consists of a problem, its solution and about how the solution is derived. Case retrieval refers to process of finding the nearest case, which includes the solution for the new case within the case-based. After the nearest case is retrieve, the solution from the previous case is reused to solve the new case.

The Graphical User Interface (GUI) of the system is depicted in Appendix B. This interface is used by the user to interact between one interface with another interface. The interface consists of one main interface with many panels inside the interface. First panel is symptoms; second panel is treatment. The symptom panel has a 'textarea' where user input symptoms and 'button' which when clicked calculates the similarity of the attributes to that stored in the database. Treatment panel consists of breast, cervical and prostate. The validated treatments are retained. The panel for the diagnosis of breast cancer is shown in Figure B.1, panel for the diagnosis of cervical cancer is shown in Figure B.2 and panel for the diagnosis of prostate cancer is shown in Figure B.3. However, panel for earlier treatment of breast cancer is

depicted in Figure B.4, retain cases for the treatment of cervical cancer is shown in Figure B.5 and retain cases for treatment of prostate cancer is shown in Figure B.6. Thus, the reuse cases are shown in Figure B.7; in reuse cases, the user retrieves earlier treatments

VI. CONCLUSION AND RECOMMENDATION

A. Conclusion

Cervical cancer, as well as breast and prostate cancers are more invasive and deadly in advanced stages, having a more efficient treatment when detected in the early stages. Cervical cancer screening programs promote early diagnosis and assessment of cancer risk, providing early treatment and follow up of patients with suspicious test results. Cervical cancer detection is helpful for the pathologist to effectively foresee the disease organizes and incline toward treatment and treatment in like manner.

The aim for this application is to help the medical staffs doing their breast, cervical and prostate cancers diagnosis. The purpose of this algorithm is to serve as doctor diagnostic assistant and aid the young physicians to check their diagnosis.

The methodology used in the application is object-oriented design methodology; this technique is used in analysis, design and implementation.

Case Based Reasoning (CBR) seems to be a suitable technique for medical knowledge based application. It can improve accuracy and problem solving performance through the reuse of the previous similar situation and knowledge that accelerated the application development process in diagnosis breast cancer. The classification of class of tumours either benign or malignant group can be done using this algorithm and this algorithm has a great potential to be implementation in diagnosis of breast cancer as well as cervical and prostate cancers.

B. Recommendation

There are some suggestions that should be done in order to improve the application as follow:

i. Screening of breast, prostate and cervical cancers based on image model.
ii. Meet more expertise in the medical domain about the breast, cervical and prostate cancers to find out the most important attributes that they used in doing the diagnosis of breast, cervical and prostate cancers.

C. Contribution to Knowledge

Decision support system has very clear target and the target will affect by algorithm and used database. The results of this dissertation is summarized as follows:

i. CBR algorithm in this application bring more than 80% accuracy of diagnose of breast, cervical and prostate cancers.
ii. The similarity provides a case-matching behavior using the similarity calculation to find the relationship between two cases.

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