Project Proposal
on:

"Neurology Diagnosis System"

by

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Abstract

*Our proposal on '***Neurology Diagnosis System***' is concerned about the construction of a web-based expert system. The objective of the system is to help the diagnosis process of neurology doctors. Neurology is a medical specialty that deals with disorders of the nervous system. Doctors will use the website as a helpful tool to diagnose their patients. The web application will collect rules of the neurology domain and cases of the patients. Integrating the techniques of rule-based reasoning and case-based reasoning a hybrid system will be constructed. The system will use the rules and cases to achieve the objective of assisting the decision making process of the domain experts.*

Acknowledgement

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1. Introduction

Our mental capacities are so important to our everyday lives and our sense of self that humankind has given itself the scientific name homo-sapiens; man the wise. The field of artificial intelligence (AI) attempts to understand these capacities better known as intelligent entities. AI being a broad topic combines computer science, physiology and philosophy. One of the large scale applications of the field of AI is the development of expert systems. An expert system is a knowledge-based computer program containing knowledge of human experts in a particular domain. Among the various types of expert systems, we intend to develop hybrid expert system which integrates rule-based reasoning and case-based reasoning techniques.

Rule-based system is used when problem area is narrow and for well-understood domain theory. To overcome these limitations, case-based reasoning technique is also integrated. This solves new problems based also on the solutions of similar past problems rather than merely using rules. These expert systems are extensively used in the various fields of medicine, especially for diagnosis purposes. They are already implemented to help the diagnosis process relating to blood infections, heart problems and kidney disorders. We intend to implement this system in the domain of neurology. Neurology deals with disorders of the nervous system to diagnose and treat all categories of disease involving the central, peripheral, and autonomic nervous systems, including their coverings, blood vessels, and all effectors tissue, such as muscle.

It requires a long learning process for a health professional to be an expert from a novice. Such experts are not readily available in local hospitals and rural areas. The use of expert system can fulfill such requirements. An expert system for the purpose of neurological diagnosis can achieve the requirements at least in the domain of neurology. Hence, the purpose is to develop a **Neurology Diagnosis System** as a flexible decision support system.

2. Objectives and Scope

Following are the main objectives of our project.

- To develop a web based hybrid expert system to help the neurology diagnosis process.
- To review Artificial Intelligence literature in Expert Systems and estimate the Expert System model that fits in field of neurology.
- To focus only on specific category of diseases belonging to the neurology domain and provide a decision support system tool to assist doctors.

3. Research Questions

We raise the following critical questions as research questions.

- Can a Medical Hospital effectively utilize an expert system in its neurology department?
- To what extent do expert systems prove useful to help the diagnosis process of a medical expert?
- What differences do we observe in rule-based reasoning technique and case-based reasoning techniques to store and use the knowledge of domain experts?

4. Literature Review

During mid 20th century, the question "can machines think?" became intriguing and popular among scientists, primarily to add humanistic characteristics to machine behavior. John McCarthy, who was one of the prime researchers of this field, termed this concept of machine intelligence as "artificial intelligence" (AI) during the Dartmouth summer in 1956. AI is usually defined as the capacity of a machine to perform operations that are analogous to human cognitive capabilities (Berk, 1985). Today's technology provides tremendous amounts of information at incredible speeds. The Expert System (ES) technology of Artificial Intelligence (AI) is one of the intelligent computer systems to make this information useful for more complex, significant problem solving applications. Expert systems have contributed to decision making through their representation of knowledge and reasoning for users (Cascante, 2002) and have played a strategic role as a source of competitive advantage for many companies (Gill, 1995).

Dendral was an influential pioneer project in artificial intelligence (AI) of the 1960s, and the computer software expert system that it produced. The software program Dendral is considered the first expert system because it automated the decision-making process and problem-solving behavior of organic chemists (Lederberg, Palo Alto). It was done at Stanford University by Edward Feigenbaum, Bruce Buchanan, Joshua Lederberg, and Carl Djerassi (Lindsay, 1980). Many systems were derived from Dendral, including MYCIN, MOLGEN, MACSYMA, PROSPECTOR, XCON, and STEAMER. Mycin was the early rule based expert system developed in the early 1970s at Stanford University. Rule-based systems handle problems with well-defned knowledge bases, which limit the flexibility of such systems. To overcome this inherent weakness of rule-based systems (RBS), case-based reasoning (CBR) has been adopted. CASEY, developed as a doctoral thesis by Phyllis Koton (Koton, 1988), is a case-based diagnostic reasoning operator to the Heart Failure Program.

SHYSTER-MYCIN is a hybrid legal expert system, combining two other expert systems: SHYSTER (a legal expert system) and MYCIN (a medical expert system). SHYSTER-MYCIN was developed by Tom O'Callaghan as part of his honours research at the Department of Computer Science, Faculty of Engineering and Information Technology at the Australian National University at 2003.

4.1 The Neurology Domain

Neurology is a medical specialty dealing with disorders of the nervous system. Specifically, it deals with the diagnosis and treatment of all categories of disease involving the central, peripheral, and autonomic nervous systems, including their coverings, blood vessels, and all effectors tissue, such as muscle. Physicians who specialize in neurology are called **neurologists**, and are trained to investigate or diagnose and treat neurological disorders. Pediatric neurologists treat neurological disease in children (Halperin JJ, 1990).

Neurological disorders are disorders that can affect the central nervous system (brain and spinal cord), the peripheral nervous system, or the autonomic nervous system. Major conditions of disorder include (Halperin JJ, 1990):

- behavioral/cognitive syndromes
- headache disorders such as migraine, cluster headache and tension headache
- epilepsy
- traumatic brain injury
- sleep disorders
- infections of the brain (encephalitis), brain meninges (meningitis), spinal cord
- infections of the peripheral nervous system
- neoplasms – tumors of the brain and its meninges (brain tumors), spinal cord tumors, tumors of the peripheral nerves (neuroma)

- spinal cord disorders – tumors, infections, trauma, malformations (e.g., myelocele, meningomyelocele, tethered cord)
- disorders of peripheral nerves, muscle and neuromuscular junctions
- exciting injuries to the brain, spinal cord and peripheral nerves
- altered mental higher status, encephalopathy, stupor and coma
- speech and language disorders

4.2 Hybrid Expert Systems

Hybrid expert systems are the integration of rule-based and case-based systems. Rule-based systems handle problems with well-defined knowledge bases, which limit the flexibility of such systems. To overcome this inherent weakness of rule-based systems (RBS), case-based reasoning (CBR) will be adopted to improve the performance of the expert system by incorporating previous cases in the generation of new cases.

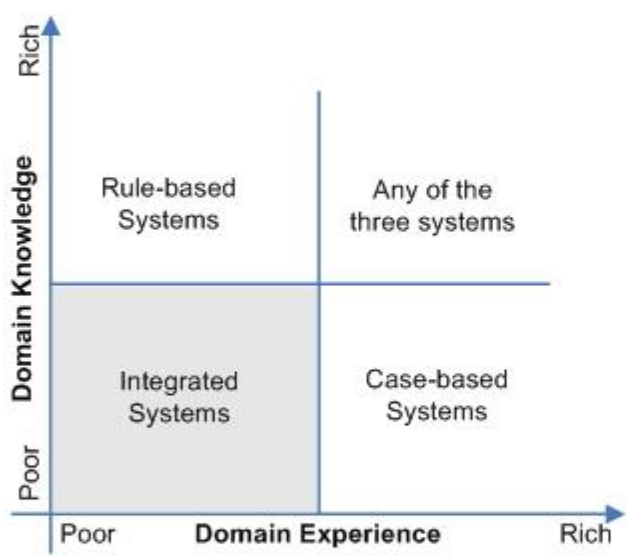


Figure 1 Integration of rule based and case based reasoning

By applying this new approach shown in the diagram above (Robert T.H. Chi, 1991), we will be able to capture both explainable and unexplainable expertise from these two reasoning mechanisms and generate more effective plans for diagnosis support.

4.2.1 Rule-based Reasoning

The idea of rule-based systems is to represent a domain expert's knowledge in a form called rules. In a typical rule-based expert system, a rule consists of several premises and a conclusion. If all the premises are true, then the conclusion is considered true. The components of a rule-based expert system include the knowledge base, inference engine, knowledge acquisition component, and explanation system as illustrated in Figure 2 (Nomusa Dlodo, 2007, pp. 43-44).

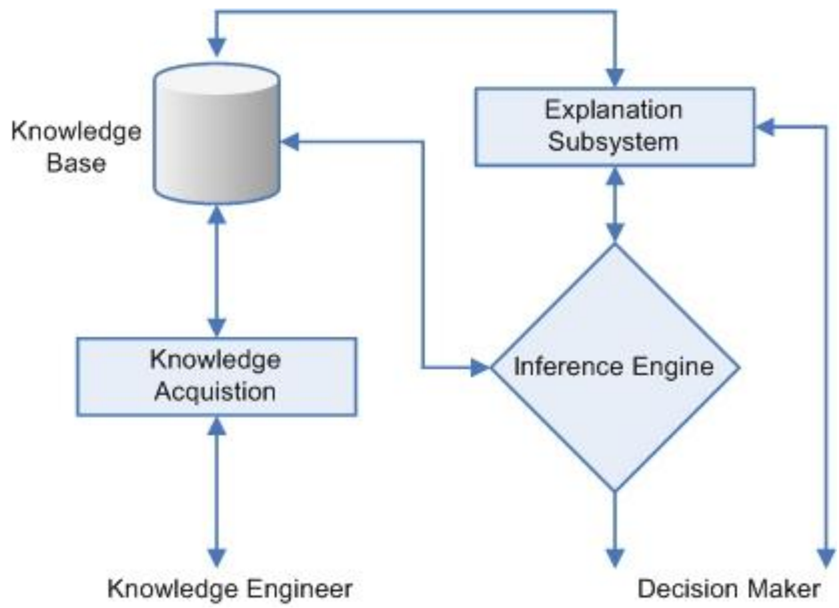


Figure 2 Rule Based Expert System

Knowledge base: a declarative representation of the expertise, often in IF THEN rules.

Inference engine: the code at the core of the system, which derives recommendations from the knowledge base and problem-specific data in working storage.

Knowledge acquisition: new rules can be added to the knowledge base by using the knowledge acquisition sub-system.

Explanation sub-system: is its ability to explain its advice or recommendations, and even to justify why a certain action was recommended.

4.2.2 Case-based Reasoning

A general CBR cycle may be described by the four basic processes (Claus-Dieter Althoff, 2008). An initial description of a problem defines a new case. This new case is used to RETRIEVE a case from the collection of previous cases. The retrieved case is combined with the new case - through REUSE - into a solved case. Through the REVISE process this solution is tested for success, e.g. by being applied to the real world environment or evaluated by a doctor, and repaired if failed. During RETAIN, useful experience is retained for future reuse (Shankar K. Pal, 2004). The cycle is shown below (Leake, 1996).

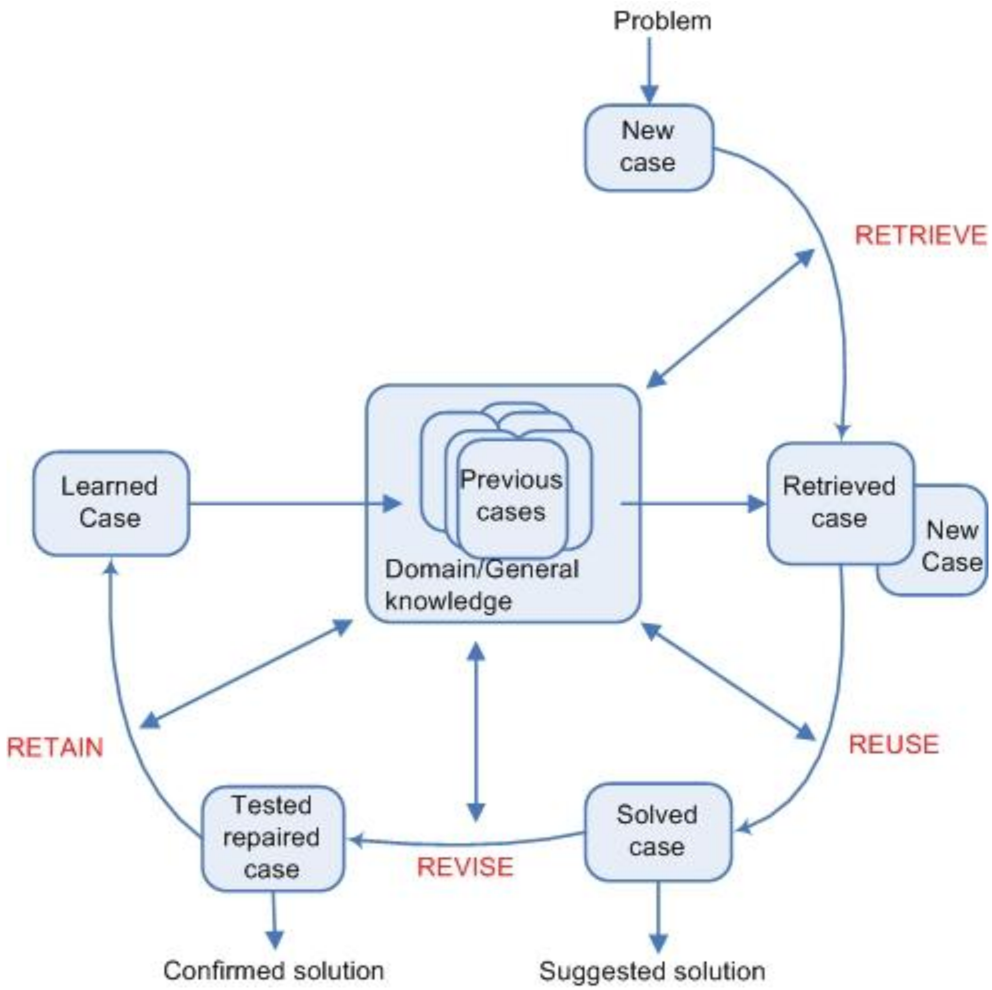


Figure 3 Case-based Reasoning Life Cycle

4.3 Expert systems for Medical Diagnosis

Expert systems have already been applied in a number of different applications in medicine. Expert systems are not really replacing doctors but are being used to help them. Some real expert systems for medical diagnostic support are:

1. CaDet (http://www.abdn.ac.uk/ims/imaging/research/CADET/index.php).
2. Dxplain(http://lcs.mgh.harvard.edu/projects/dxplain.html).
3. Germwatcher(http://www.openclinical.org/aisp_germwatcher.html).
4. PEIRS (www.openclinical.org/aisp_peirs.html).
5. MYCIN(http://www.mycin.com).

SHYSTER-MYCIN(http://cs.anu.edu.au/software/shyster/tom/)

The advantages of using an expert system over the mere dependence on doctors are mentioned below.

- A large database of knowledge can be added to and kept up-to-date - it can store more knowledge than a person.
- The system cannot 'forget' or get facts wrong.
- It survives forever. There is no loss of knowledge as there is when a doctor retires.
- The computer can access specialist knowledge that a doctor may not have.

5. Methodology

5.1 Hybrid Expert System Architecture

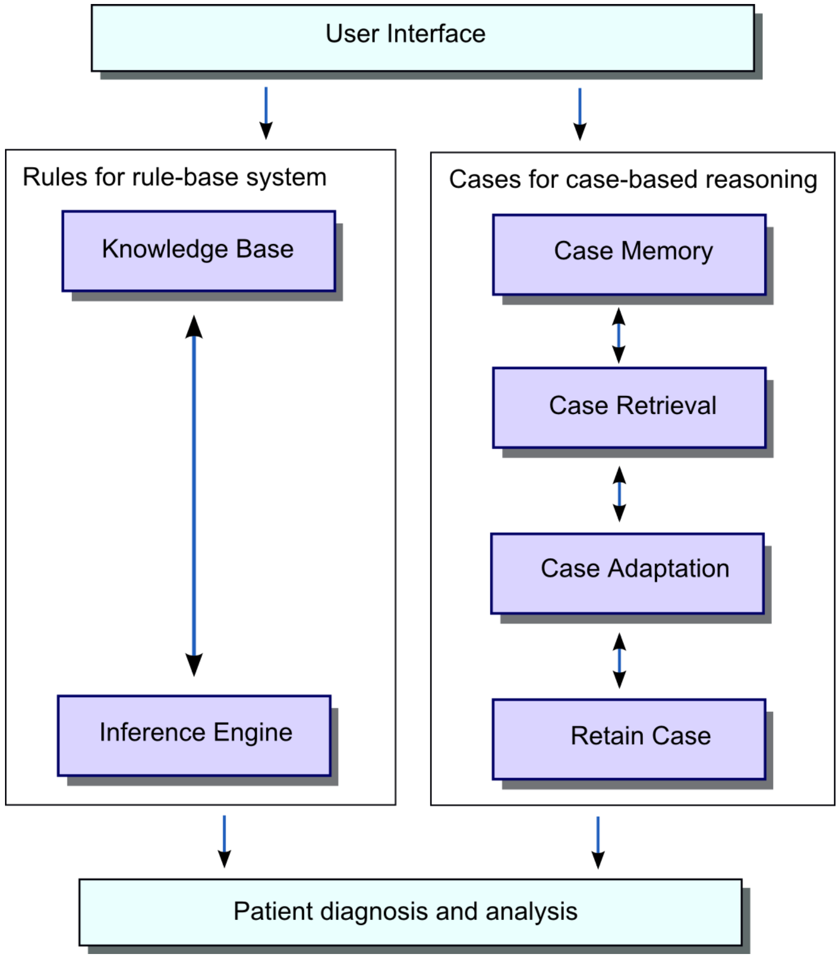


Figure 4 Hybrid expert system architecture

The architectural goal is to improve rule-based reasoning by augmenting it with case-based reasoning (Nomusa Dlodo, 2007, p. 47). This augmentation is done by taking the rules as a starting point of problem-solving, i.e. using rules to generate a first approximation to the diagnosis for a neurological case and then invoking case-based reasoning to handle exceptions to the rules. The idea is to fine-tune the performance of the rules. Another advantage is that if the case-based reasoning misses a similar case, the architecture will at least have a reasonable default answer generated by the rule-based system. The architecture of the hybrid expert system is shown in Figure above.

5.2 JSF Framework for User Interface

Different requests and responses result in three possible lifecycle scenarios that can exist for a JavaServer Faces application (SunMicrosystems, 2003):

- **Scenario 1: Non-Faces Request Generates Faces Response.** An example of this scenario is when clicking a hyperlink on an HTML page opens a page containing JavaServer Faces components.
- **Scenario 2: Faces Request Generates Non-Faces Response.** Sometimes a JavaServer Faces application might need to redirect to a different Web application resource or generate a response that does not contain any JavaServer Faces components.
- **Scenario 3: Faces Request Generates Faces Response.** This is the most common scenario for the lifecycle of a JavaServer Faces application. It is also the scenario represented by the standard request processing lifecycle shown in the diagram below.

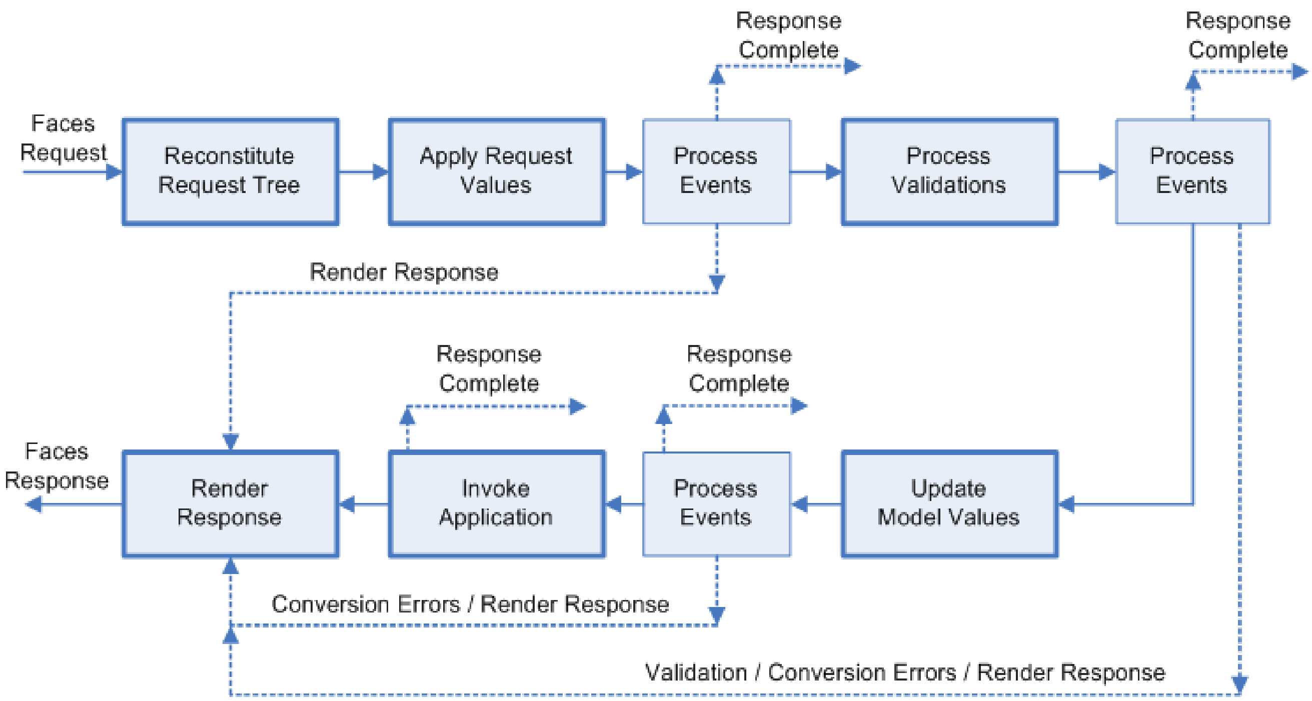


Figure 5 JavaServer Faces request-response lifecycle.

5.3 Spring as the Application Framework

Typical full-fledged Spring web application framework is shown below (Rod Johnson, 2004-2008).

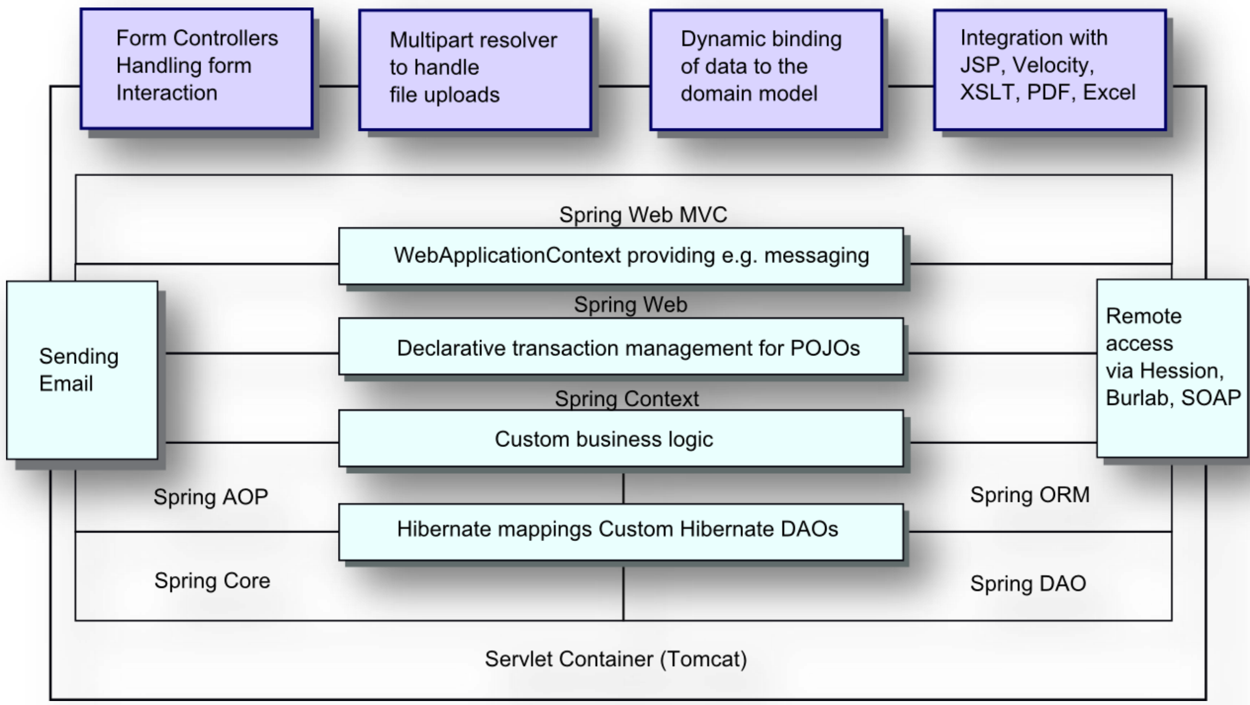


Figure 6 Typical full-fledged Spring web application

5.4 Context Diagram

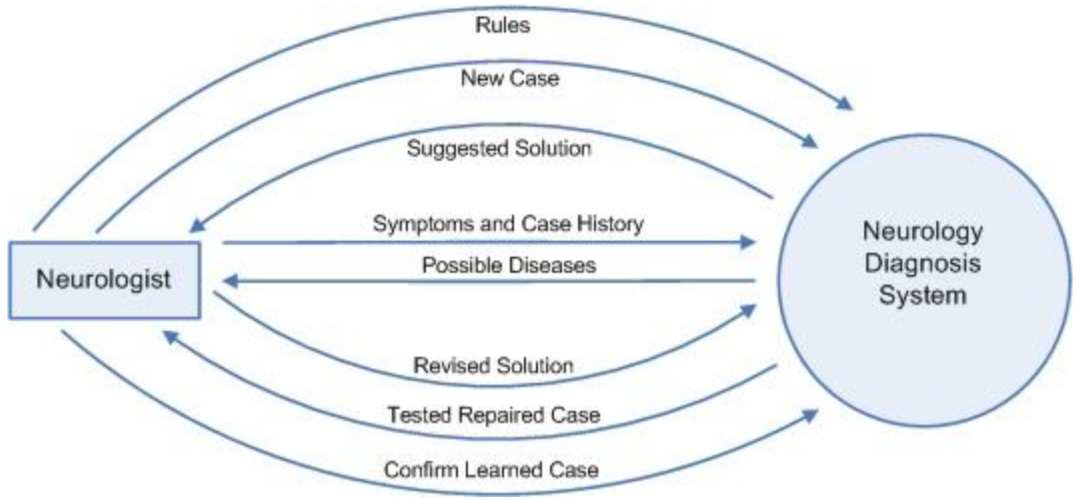


Figure 7 Context diagram of the system

5.5 UML Use Case Diagram

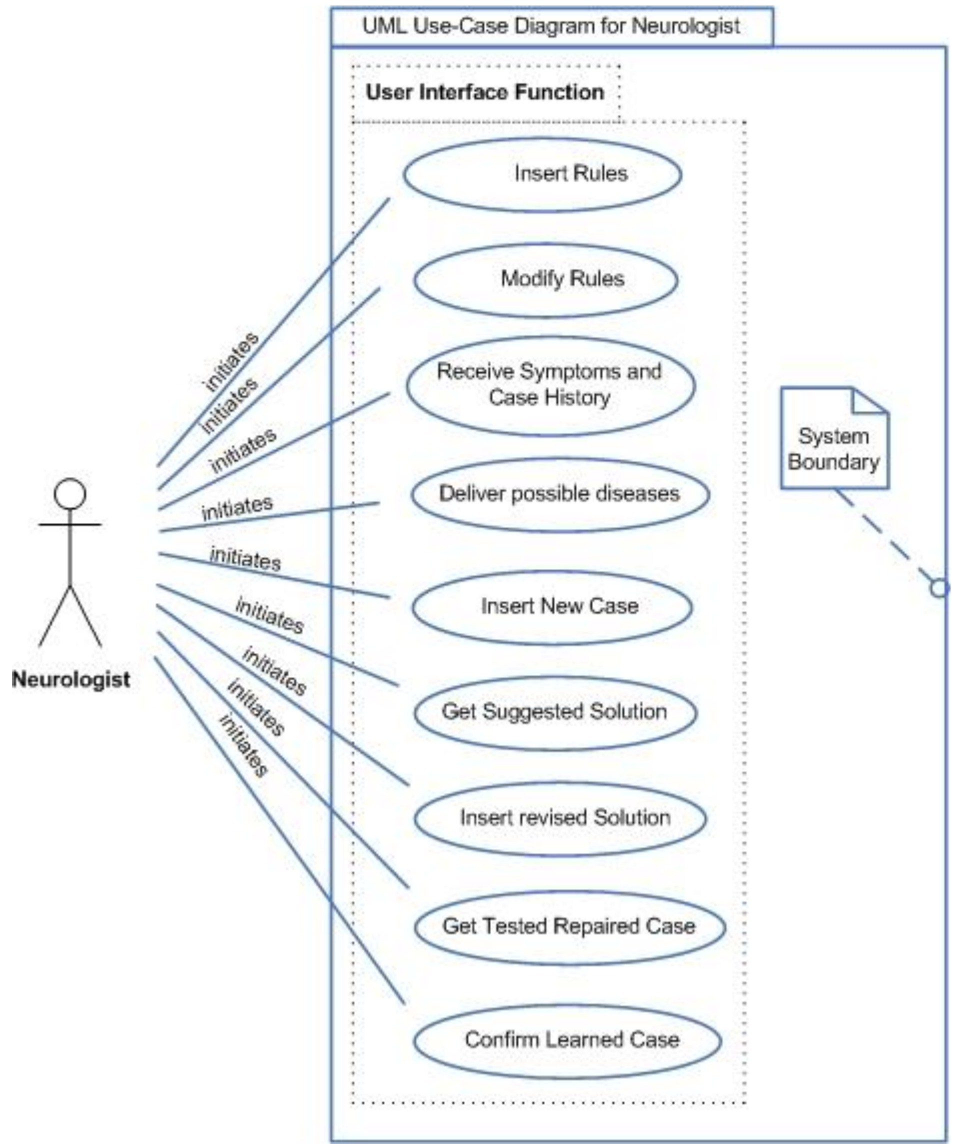


Figure 8 UML USE case diagram for a neurologist

5.6 System Development Model and Development Tools

- System Development Model to be exercised - Waterfall Model

Serial	Tool/Language	Purpose
1	JDK	Programming Language
2	JSP	UI Programming
3	Internet Explorer	Default Browser
4	Apache Tomcat	Application Server
5	Windows XP	Platform
6	Oracle	Database Management Tool

- CASE Tools for the project development

Serial	CASE Tool	Purpose
1	Eclipse	Programming
2	MS Word	Documentation
3	Latex	Documentation
4	Adobe Dreamweaver	Interface Design and Development
5	Inkscape	Web Development
6	SQL Tool	Programming
7	Sourceforge.net	Configuration & Management

6. System Operation Concept

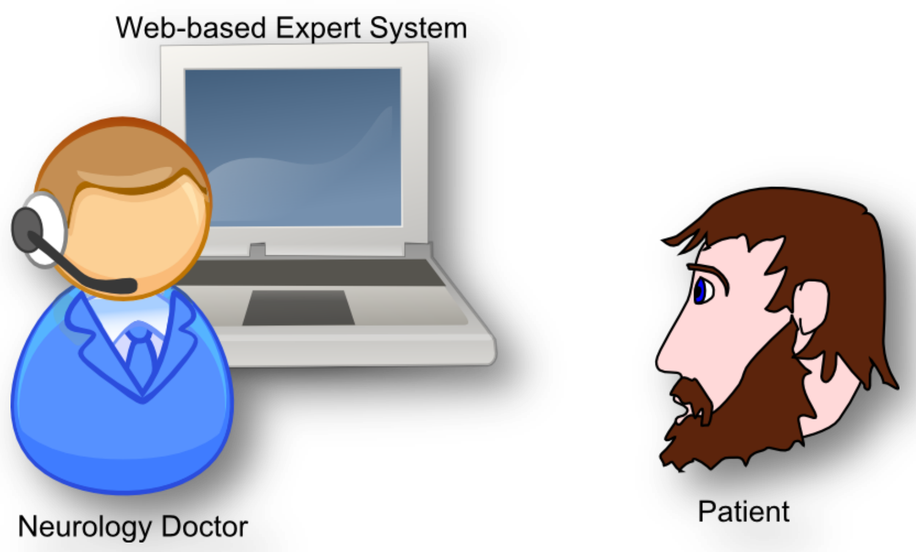


Figure 9 A neurology expert uses the proposed system to diagnose a patient.

7. Cost Estimation

The cost estimation is presented in the table below.

Purpose	Amount in Rs.
Developers' salary assuming provisional period (Rs.6000 per month * 3 months * 4 persons)	72,000
Cost of 4 PCs for system development (35,000 * 4)	140,000
Electricity cost (4 units operating 8 hours per day * Rs. 8 per unit * 4 computers * 3 months)	11,520
Internet connection cost (1800 per month * 3 months)	5,400
Reports print	2,500
Travelling costs for 3 months (to visit doctors and other health professionals)	5,000
Total	236,420

8. Feasibility Analysis

8.1 Technical Feasibility

Technical feasibility involves determining whether or not a system can actually be constructed to solve the problem at hand. The following points are considered for the project's technical feasibility.

- The required technologies (rule based and case based reasoning techniques, programming languages and architecture) exist.
- The database management tool (Oracle) is technically capable to hold data required to use the new system.
- The proposed system will provide adequate response to inquiries regardless of the number or location of users. This is because the system is web enabled and the application server is considerably sufficient to support the number of users.
- Ease of access is guaranteed but the technical guarantees of accuracy and reliability will depend upon the data that will be collected.

8.2 Operational Feasibility

Operational feasibility asks if the system will work when developed and installed. The following points are taken into account for operational feasibility of the proposed system.

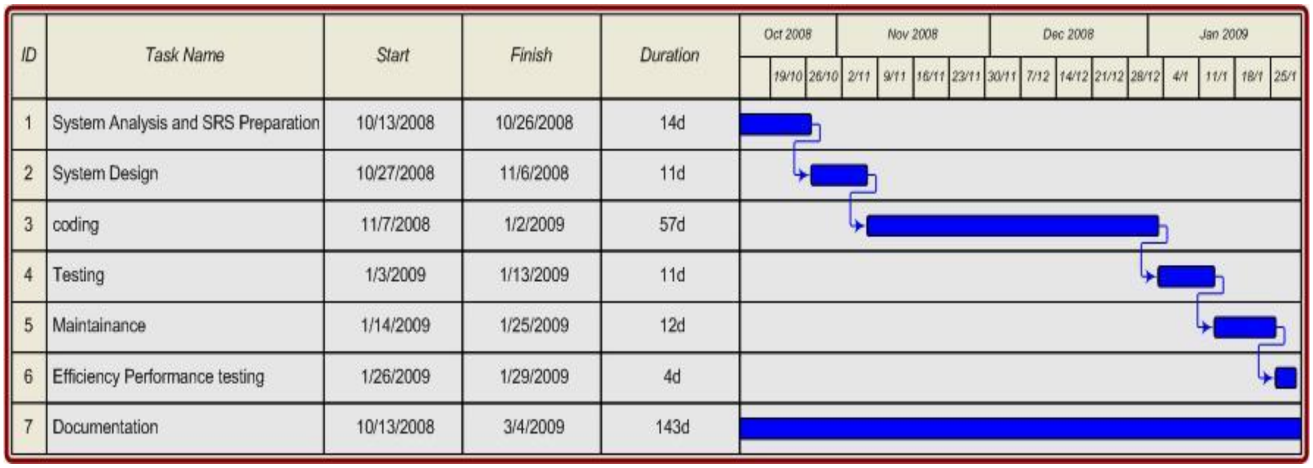
- The proposed system will cause no harm because it will only help the decision making process of domain experts.
- Fresh neurology doctors will use the system with high enthusiasm because the system will be user-friendly.
- The system is affordable and has low operational cost because it requires no special equipments other than a normal computer.

8.3 Economic Feasibility

The economic feasibility of the project can be shown through the following points.

- The tools and technologies used for the system are free for non commercial development purposes. Most of them are licensed under GNU GPL.
- Since the project will be implemented in service sector, the quality of information and the ease of access becomes the main concern. The proposed system will prove effective and efficient and will establish itself as a valuable asset of the department and the hospital.
- Precise analysis of Return of Investment (ROI) and breakeven analysis is difficult at this proposing stage of an academic project. It can be assured that the project will prove economically feasible because the system will be used and maintained by doctors. Doctors won't require quick return because the system is developed to help them and not to fulfill their urgent requirements.

9. Project Schedule



ID	Task Name	Start	Finish	Duration
1	System Analysis and SRS Preparation	10/13/2008	10/26/2008	14d
2	System Design	10/27/2008	11/6/2008	11d
3	coding	11/7/2008	1/2/2009	57d
4	Testing	1/3/2009	1/13/2009	11d
5	Maintainance	1/14/2009	1/25/2009	12d
6	Efficiency Performance testing	1/26/2009	1/29/2009	4d
7	Documentation	10/13/2008	3/4/2009	143d

Figure 10 Gantt chart

Holidays:

Tihar holidays - 5 days (10/26/2008-10/30/2008)

Eid-ul Ajha - 1 day (12/12/2008)

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