

# Borderline Personality Disorder Expert System with the Inclusion of Severity Level

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**Abstract:** *The personality of a man determines how an individual deal with situations or gets along in life, thus, instability of personality is referred to as Personality Disorder. The focus of this research is on borderline personality disorder (BPD) in cluster B of Personality Disorder. Early diagnosis of BPD can prevent more serious mental health disorders; thus, researchers have developed a BPD expert system for early detection of BPD. Previous BPDs expert systems did not indicate the severity level of a person disorderliness. This makes decision-making by a human expert using the BPD expert system for treatment or therapy proportionally impaired and conclusive. Nevertheless, severity can be used as a flag that determines the type of treatment a patient needs such as the use of a drug or psychotherapy, thus aiding human experts in a better decision-making process. Two expert systems were built, one for diagnosis and the other for indicating severity level based on the symptoms diagnosed.*

**Index Terms:** *Borderline Personality Disorder, Decision-making, Expert system, Severity level*

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## I. INTRODUCTION

Borderline Personality Disorder (BPD) is classified into Cluster B personality disorder. It is a psychiatric illness under which you have a rigid and dysfunctional habit of thought, functioning, and behaving [1]. Borderline personality disorder (BPD) is a psychiatric condition that makes it difficult for a person to feel at ease with their skin, makes it difficult to suppress thoughts and desires, and makes it difficult to relate to others [2]. Also, Borderline personality disorder is defined by a pattern of instability and impulsivity that is widespread and persistent [3]. BPD patients may experience distressing thoughts and perceptions about themselves and others. This can create problems at work, in their families, and their social lives [2].

Expert systems (ES) are artificial intelligence systems that have been trained with real cases to perform a complex task at the level of a human expert [4]. There are four types of expert systems: Rule-based expert systems, fuzzy expert systems, frame-based expert systems, and hybrid expert systems are the four types of expert systems [5]. Human experts are perishable, but an expert system is not. An expert system aids in the distribution of a human's expertise, one expert system may incorporate information

from several human experts, resulting in more effective answers and a reduction in the expense of contacting a human expert in diverse disciplines such as medical diagnostics. Expert systems may handle complicated issues by deducing new facts from current facts of knowledge, which are generally expressed as if-then rules rather than procedural code. Expert systems were one of the first kinds of artificial intelligence (AI) software to be fully successful [6]. Expert systems are used in a variety of areas, the most notable application is in the area of medical and clinical diagnosis, monitoring systems, process control, scheduling and planning. They are several successful diagnostic and management systems available today, one of such is the BPD expert system [4].

Previous Borderline Personality Disorder (BPD) includes information on causes, symptoms, diagnosis process, consequences and methods of treatment but does not include an indication of the severity level of a patient. The severity level of an incident or problem is an indicator of how much of an effect it has on a system or person, understanding the severity rate of injuries aids in the identification and prioritization of incidents with a quicker response or remedy to the problem [7]. Inclusion of severity levels will make a better diagnosis of a BPD expert system because it will identify the level of which a

patient needs to urgently seek a psychologist or therapist, immediately after all selected symptoms have been diagnosed by the BPD expert system. BPD severity levels are level indicators that can be Mild, Severe, or Critical for a person. The severity level of BPD is determined by the combination of symptoms a patient is being diagnosed with. From previous literature, knowledge engineers have not built a BPD expert system to capture, identify, and represent the severity level of BPD in the medical report of a patient which leaves psychologists with an unexceptional clue and low-level insight to tackling the BPD stage or severity level peculiar to a patient at any point in time.

## II. RELATED WORKS

Reference [8] carried out research that aimed at designing an Expert System for Corona Diagnosis (ESCD). The Methodology of the current system was done utilizing cognitive automation and production rules for predicting Covid-19. ESCD inference engine was implemented using Python tools for the disease's first diagnosis. To deduce a proper diagnosis, an inference engine is created utilizing efficient processes and a prediction process. ESCD employs two inferencing algorithms: Forward Chaining and Backward Chaining. ESCD is a technology that uses social media to forecast who could be infected with Corona. This method has the potential to be one of the most important instruments for identifying Covid-19 and protecting individuals. Reference [9] did research that aimed at developing an expert system based on a hybrid inference method and extensive integrated information to help professionals diagnose spinal diseases quickly and accurately. First, accurate and integrated knowledge about each spinal abnormality was gathered from relevant specialists and resources. Second, each symptom was assigned a unique numerical value known as the certainty impact value based on probability distributions and relationships between symptoms of each abnormality. Third, a novel hybrid inference method incorporating Backward Chaining Inference and Theory of Uncertainty was created to achieve outstanding performance. Reference [10] developed a definitive online procedural rule-based expert system framework that helps brain research experts and specialists to analyse the state of a patient productively and in a brief timeframe. Also, it is helpful for the patients who cannot go to a specialist since they cannot bear the cost of the cast, or they do not have a

mental centre in their general vicinity, or they are embarrassed about examining their circumstance with a specialist. The work combined the benefits of modern-day Internet technology with an expert system shell. Reference [11] carried out research that uses forward chaining and the certainty factor approach to creating an expert system for diagnosing tomato illnesses. These approaches are utilized to provide accurate identification results, to achieve the outcome of illness detection, forward chaining is employed as a reasoning approach. This expert system is Android-based, allowing it to be utilized by a large number of individuals at any time and from any location. Internal testing has revealed that the tomato expert system is functional and compatible with a variety of Android devices. The complexity of the problems that arise in the diagnosis of personality disorders might be handled by powerful computation in an expert system using the Certainty Factor. Certainty Factor is the Measure of belief (MB) over disbelief (MD) being weighed using Probability (P) and Evidence (E). Application of the method of Certainty Factor can simplify and provide settlement calculation of how sure the user or patient suffering from a personality disorder is going to fare. The user's trust is increased by assigning a weight to each symptom. This method of calculating the certainty factor generates trust value [12]. This current research would support the forward chaining inference approach and integrates severity level into Facts acquired are stored in the knowledge base and inference will be made from the facts to derive or gets to an end goal which is the diagnosis. Therefore, before a conclusion or a diagnosis of borderline personality disorder can be achieved the inference engine will analyse and evaluate the facts to reach a goal.

## III. METHODOLOGY

The following steps were taken in the development of an expert system with the inclusion of severity levels.

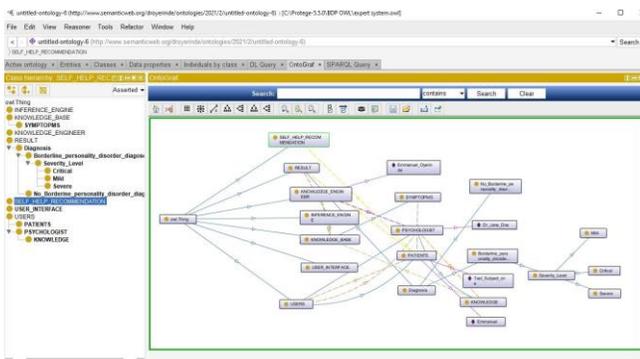
**Knowledge Acquisition:** Knowledge on the causes, symptoms, severity levels, diagnosis process, consequences, severity levels and methods of treatments were acquired from domain experts such as psychiatrists and psychologists. Information about severity level is in Table I.

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**Table I: Severity Level Information**

Severity Levels	Degree of Severity Level	Conclusive advice
Mild	<= 40%	The patient just needs to take the right drugs at the right time
Severe	>= 41% - <=69%	Patients need psychotherapy
Critical	>= 70 - <=100	Patients need both drugs and psychotherapy

**Conceptualization:** Knowledge acquired about the diagnosis process and severity level of borderline personality disorder are conceptualized using web ontology language (Owl) called Protege. This is shown in Figure 1.



**Fig. 1: Web Ontology Diagram**

**Knowledge base System Development:** This work develops a rule-based expert system. Firstly, SWI-Prolog was used for developing the knowledge base system. SWI-Prolog contains the inference engine and the logic chosen to feed knowledge into the inference engine is called forward chaining. This forward chaining is a form of reasoning in which inference rules are applied to current data to extract new data until an endpoint (goal) is reached [13]. It contains rules about the causes which will lead to a diagnosis of symptoms. Secondly, Python was used to develop another rule-based system that takes in the symptoms deduced by SWI-Prolog and determines the severity level. A screenshot of SWI-Prolog logic development is in Fig. 2

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File Edit Browse Compile Prolog Pce Help
medical-diagnosis.pl
go:-start,
write('PLEASE ANSWER THE FOLLOWING QUESTIONS:'),
nl,nl,
hypothesis(Disease),
write('RESULT: The Patient has '),
write(Disease),
nl,nl,nl,
write('ADVICE AND SUGGESTIONS:
Patients need both drugs and psychotherapy if BPD severity level is critical'), nl,nl,
write('Patients need psychotherapy if BPD severity level is severe'), nl,nl,
write('patient just needs to take the right drugs at the right time'),nl,nl,
end,
undo.

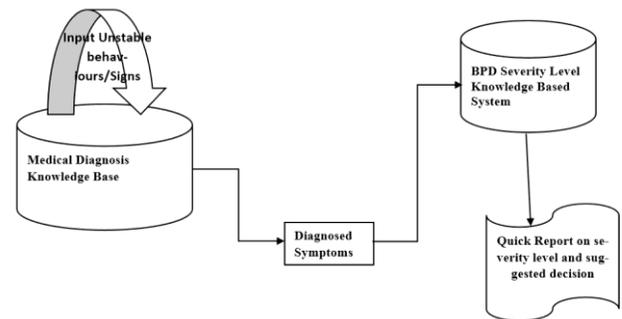
/*Hypothesis that should be tested*/
hypothesis(depression) :- depression,!,write("It's bpd."),nl,nl,nl.
hypothesis(anxiety) :- anxiety, !.
hypothesis(post_traumatic) :- post_traumatic, !.
hypothesis(unsafe_sex) :- unsafe_sex, !.
hypothesis(reckless_driving) :- reckless_driving, !.
hypothesis(suicidal) :- suicidal, !.
hypothesis(self_harming) :- self_harming, !.
hypothesis(emptiness_feelings) :- emptiness_feelings, !.
hypothesis(paranoid) :- paranoid, !.
hypothesis(intense_anger) :- intense_anger, !.
hypothesis(mood_swing) :- mood_swing, !.
hypothesis(unstable_relationship) :- unstable_relationship, !.
hypothesis(fear) :- fear, !.
hypothesis(unstable_self_image) :- unstable_self_image, !.
hypothesis(boredom) :- boredom, !.
hypothesis(severe_dissociative) :- severe_dissociative, !.
hypothesis(lack_self_of_identity) :- lack_self_of_identity, !.
hypothesis(excessive_self_criticism) :- excessive_self_criticism, !.
hypothesis(hypersensitivity) :- hypersensitivity, !.
hypothesis(vulnerability) :- vulnerability, !.
    
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**Fig. 2: SWI-Prolog Logic**

**Test and Maintenance:** Test the BPD expert system to diagnose and also indicate severity level.

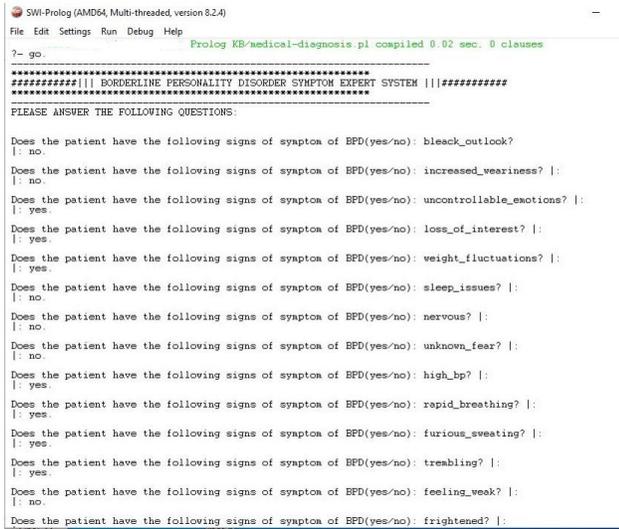
**Implementations and results**

Fig. 3 shows the implementation process of the medical diagnostic knowledge-based system and BPD severity level knowledge-based system. The process starts with input of unstable behaviors and signs.

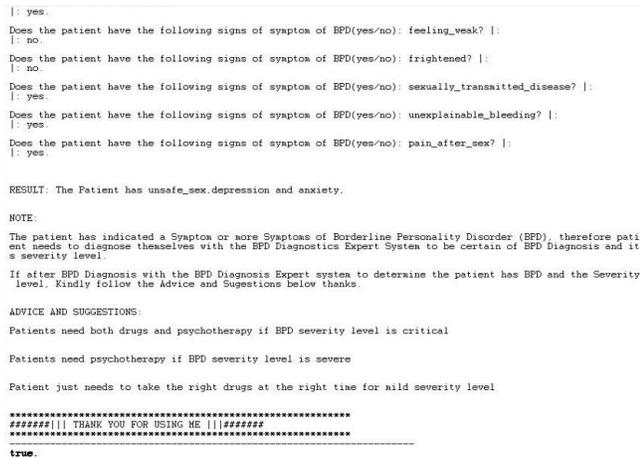


**Fig. 3: Implementations and Results Process**

Fig. 4(a) and fig. 4(b) followings are the screenshots of a diagnosis process in SWI-Prolog knowledge base after input. Fig. 4(b) also shows the diagnosed symptoms.

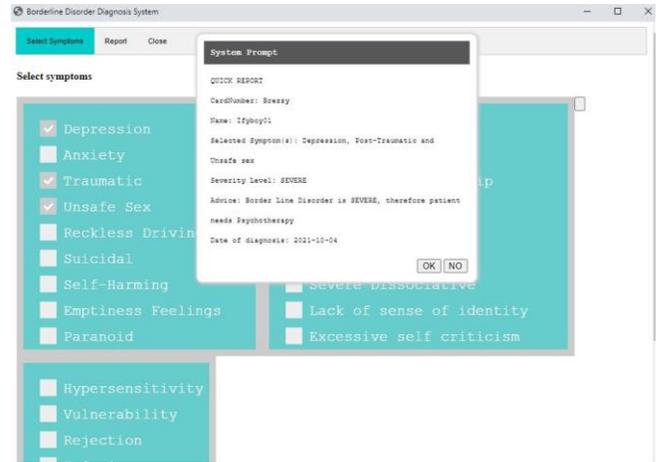


**Fig.4(a): Screenshot of SWI-Prolog Medical diagnosis Process**



**Fig. 4(b): Continuation of the Medical Diagnosis Process and diagnosed results**

Fig. 5 is the generation of a quick report based on symptoms diagnosed by the medical diagnostic knowledge-based system.



**Fig. 5: Severity Level Quick Report**

**CONCLUSION**

A borderline personality disorder is a specific and well-bounded domain that needs a specialist to diagnose and administer treatment and therapy. Research and improved technology have made it possible for scientists to invent expert systems that can draw conclusions from evidences and reasoning about information in a knowledge base. This current work provides severity level indicators in the result of the BPD diagnosis expert system. In the future, the two knowledge-based systems will be integrated and there will be the inclusion of certainty factor.

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