

# A DESIGN OF DIAGNOSIS SYSTEM FOR MENTAL DISORDER

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**Abstract:** We propose a web application system which helps experts to make a diagnosis of mental disorders. We construct a knowledge base from DSM and SCID which are diagnosis manuals made by psychiatrists. We have two stages in our diagnosis system. In the first stage, our application picks up suspicious disorders. In the second stage, the application checks the suspicious disorders according to a flow chart generated by the knowledge base. We discuss problems gained by our experiment of constructing the knowledge base.

## 1 INTRODUCTION

Diagnosis can be included an area of knowledge engineering. This view is supported by the existence of many medical expert systems (Phuong et al., 2000; Starita et al., 1995).

In this paper, we present an experiment system to construct a prototype system for assisting to make a diagnosis of a mental disorders. Diagnosis of mental disorders is difficult because of a lack of objective biological markers. Therefore, to make a diagnosis, psychiatrists are required a great deal of knowledge of disorders and symptoms.

To assist to make an accurate diagnosis, we construct a system by rearranging knowledge from DSM (Diagnostic and Statical Manual of Mental Disorder) and SCID (The Structured Clinical Interview for DSM), which are manuals to make a diagnosis of mental disorder. DSM and SCID are a kind of knowledge base constructed by experts: psychiatrists. The original DSM or SCID are designed for checking all disorders' criteria. The process is time-consuming. In order to decrease the time, our system is designed to make a diagnosis by two stages. In the first stage, the system lists up suspicious disorders from symptoms. In the second stage, the system assists an expert in making a diagnosis of the selected disorders from the result of the first stage. In this stage, the expert checks the criteria of suspicious disorders according to the description of SCID, which are displayed on the computer screen. To implement the system, we have to reconstruct the knowledge of DSM for the first stage.

In Section 2, we introduce the details of DSM and SCID. In Section 3, we describe the knowledge base we constructed. In Section 4, we show the prototype system we developed. In Section 5, we discuss problems we find out during our experience, and in Section 6, we give a conclusion.

## 2 DIAGNOSIS MANUAL OF MENTAL DISORDER

In this section, we mention the details of DSM (American Psychiatric Association, 2000) and SCID (First et al., 2002) which are basis of our knowledge base.

### 2.1 DSM

Diagnosis of mental disorders has difficulties because most of symptoms are subject of patients and not objective. Psychiatrists must give a diagnosis which disorder a patient has by major complaints and an observation of the patient. Therefore, the different patients used to be given different diagnosis to the same symptoms.

American Psychiatric Association organizes the relation of symptoms and the names of disorder as a manual called "Diagnostic and Statical Manual of Mental Disorder" (DSM). In this manual, psychiatrists give the same disorder to the same symptoms. The latest version of DSM is DSM-IV-TR published in 2000.

Table 1: DSM example : a part of criteria of panic disorder without Agoraphobia.

<p>A. Both (1) and (2):</p> <p>(1) recurrent unexpected Panic Attacks</p> <p>(2) at least one of the attacks has been followed by 1 month (or more) of one (or more) of the following:</p> <p>(a) persistent concern about having additional attacks</p> <p>(b) worry about the implications of the attack or its consequences (e.g., losing control, having a heart attack, “going crazy”)</p> <p>(c) a significant change in behavior related to the attacks</p> <p>B. Absence of Agoraphobia.</p> <p>(The rest is omitted.)</p>
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In DSM, a diagnostic criteria is given to each disorder in a natural language.

Table 1 shows a part of criteria of panic disorder. The criteria are declarative description. To judge whether symptoms of a patient satisfy the criteria, the knowledge of experts is needed. Therefore, only expert psychiatrists should be permitted to make a diagnosis using DSM.

## 2.2 SCID

“The Structured Clinical Interview for DSM-IV” (SCID) is a semi-structured interview for the forth version of DSM.

SCID is a list of questions which are constructed like a flowchart. An expert can make a diagnosis following SCID. SCID has same contents of DSM but the contents are described in a procedural way. It shows a procedure of a diagnosis.

Table 2 shows a part of list of panic disorder criteria. Some questions in the list need specialized knowledge to answer. SCID also needs expert psychiatrists to perform.

The two problems for SCID have been pointed out. DSM also has the problems because SCID and DSM are same essentially. The first problem is that it is time-consuming to deliver, because it is designed to check all disorders’ criteria in order. The second problem is that the quality of the diagnosis depends on the expert who uses it, because some questions in SCID needs expert knowledge to answer.

Table 2: SCID example: a part of list of panic disorder without Agoraphobia.

No.	Questions	Next question
F1	recurrent unexpected panic attacks	if negative goto F25, else goto F2
F2	at least one of the following: (b) worry about the implications of the attack; (a) concern about having additional attack; (c) a significant change in behavior	if negative goto F25, else goto F3
F3	Four (or more) of the following panic attack symptoms developed abruptly and reached a peak within 10 minutes	if negative goto F25
F4	(1) palpitations	
F5	(2) sweating (The rest is omitted.)	

## 3 A DESIGN OF KNOWLEDGE STRUCTURE

Both DSM and SCID aim to diagnose a specified disorder. Usually, a psychiatrist may see a patient, and check a criteria of the disorder of DSM or SCID. The problem of DSM or SCID is time-consuming to deliver, because they are constructed for checking all disorders’ criteria.

Therefore, we divide a process of diagnosis into two stages. The first stage based on declarative knowledge, DSM, is used to find suspicious disorders. The second stage based on procedural knowledge, SCID, is used to diagnose the disorders.

### 3.1 The First Stage

In the prototype system we developed, the first stage is implemented simply.

1. The system lists up all symptoms related disorders.
2. An expert decides a threshold rate.
3. An expert checks all symptoms that a patient has.
4. If the number of checked symptoms related to a disorder goes over the threshold rate, the system picks up the disorder.
5. All disorders the system picked up are displayed on the screen for the second stage.

### 3.2 The Second Stage

The second stage will start at a disorder that is listed up by the first stage of the system. The expert looks the list of the suspicious disorders at first, then picks up a disorder that seems to be the possibly true disorder of the patient. Then the verification stage (the second stage) starts on here.

The system asks a question that follows SCID, and then the expert answers. This answer includes a thought of the expert. The expert interacts with the patient, and judges how to answer to the question from the system. This means the expert interacts with the system also, not only with the patient. The system stored the answer to the database, then shows a new question to the expert. The system shows also the process of the flow. This helps the expert to judge the disorder of the patient. The expert is possible to think about the answer of the question from the system too.

The cycle is continued until the flow reaches to the end. At the end of the flow, the system shows if the suspicious disorder of the patient would truly match to the symptoms, or not.

The questions in the second stage of SCID have 3-valued logic. The answer for the question is one of ?, -, or +. The answer is interpreted in : ? means inadequate information, - means absent or sub-threshold (negative), and + means present (positive). If the answer is +, the patient has the symptom asked by the question.

The questions of SCID can be categorized into two types following:

**Type 1.** The next question is decided by the answer of the this question.

**Type 2.** The next question is decided by the answers of the previous questions including this question. In this type of question, sometimes more than 10 previous questions are related to decide the next question.

The system supports these two types of nodes and controls flows of questions in the second stage.

## 4 SYSTEM DESIGN

The proposed system aims to assist psychiatrists in making a diagnosis. It is designed as a Web-based system. The architecture of the system is shown in Figure 1.

The system consists of four parts: Back End DB, Suspicious Disorders List Up Engine, SCID engine

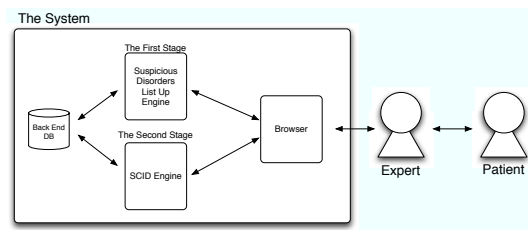


Figure 1: The system architecture.

## Diagnosis Engine

select your answers:

- cardiac
- respiratory
- vestibular
- gastrointestinal
- markedly diminished interest or pleasure
- significant weight loss or gain
- intense fear of gaining weight

Submit

Figure 2: The first step.

and Browser. Back End DB keeps knowledge for diagnoses and records of diagnoses. Suspicious Disorders List Up Engine is an implementation of the first stage mentioned in subsection 3.1. SCID engine is an implementation of the second stage described in subsection 3.2. Browser is an interface between the system and psychiatrists. Any popular web browser can be used as the Browser.

Figures 2, 3 and 4 show snapshots of the system. Figure 2 is a snapshot of the first stage. A psychiatrist asks and observes symptoms of a patient and checks in boxes of present symptoms. Figure 3 show the result of Figure 2: a list of suspicious disorders. When the psychiatrist click the “go” button in Figure 3, the second stage starts. Figure 4 is a snapshot of the second stage. In the second stage, questions are displayed on the screen in sequence. The psychiatrist inputs answers for the questions by checking an appropriate item, then the result flows: the patient has the suspicious disorder or not.

## 5 DISCUSSION

By constructing the system, we find the following problems in DSM and SCID.

1. Knowledge for diagnosis described in DSM or SCID has ambiguity. In DSM or SCID, the am-

**the result of checking rules**

**Panic Disorder**

cardiac   
 respiratory   
 vestibular   
 gastrointestinal   
 matching ratio: 0.75  
 disease "Panic Disorder" TRUE

**Anxiety Disorder**

cardiac   
 respiratory   
 vestibular   
 gastrointestinal   
 matching ratio: 0.75  
 disease "Anxiety Disorder" TRUE

Figure 3: The suspicious disorders.

**answer against question: 2**

at least one of the following: (a) worry about the implications of the attack; (b) concern about having additional attacks; (c) a significant change in behavior

?  
 -  
 +

**Result**

seq	patient num	disease	question	answer
2	17	Panic Disorder 1		2

Figure 4: The second step.

biguity should be resolved by psychiatrists when they make a diagnosis for a patient. That is a reason why only psychiatrists should be permitted to make a diagnosis using DSM or SCID.

- Knowledge for diagnosis is still growing and changing. DSM has been upgraded in three times from the first published year, 1952, the second:1968, the third:1980 and the forth:1994. And next upgrade is under contemplation.
- Knowledge described in DSM and SCID is strict and exhaustive. Therefore the most serious problem of DSM or SCID for making a diagnosis is time-consuming to deliver.

For the problems, our system can provide a partial answer.

- For 1, the system does not resolve the ambiguity, because the ambiguity is involved the knowledge we use.
- For 2, the system should be designed flexibly for

the change of knowledge. We will try to solve this problem.

- For 3, we design two stages diagnosis so that the system is expected to be shorten time for diagnosis. Our next work will verify this point.

For the first stage of the system, we extract symptoms from the description of DSM by hand. In future, we would like to extract them by computer. There are problems in DSM to extract symptoms by computer. They are natural language processing problems.

- Too many symptoms are mentioned so that it is hard to distinguish which symptoms are "main" or "critical".
- Sometimes the same or similar symptoms are described different representations. Therefore, for the first stage, we have to reduce them to representative symptoms.

At first, we will check whether our manual procedures work well in practical cases, then, consider how the work is done automatically.

**6 CONCLUSIONS**

We propose a web-based system which assists psychiatrists in making a diagnosis. We design a knowledge base by reconstructing knowledge organized in manual, DSM and SCID. We divide a process of making a diagnosis in two stages. In the first stage, a psychiatrist selects suspicious disorders from the list provided by the system. In the second stage the psychiatrist makes a diagnosis of the selected disorders. We also discuss problems we find out during our experience.

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