

A Case Study of EXPERT Formalism
--- An approach to a Design of Medical Consultation
System through EXPERT Formalism ---

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Abstract

The present paper is based upon case studies of EXPERT formalism. The studies aim to accomplish two goals; 1) Acquisition of knowledge from specific domain expert through a design of a small scale medical consultation system. 2) Evaluation of the system's performance through various case data. The prototype models on Glaucoma medical consultation system is running at DEC-20 under TOPS-20 operating system. There is a discussion which is based upon these case studies through EXPERT formalism.

1. Introduction

Recently, a programming system for medical consultation system called EXPERT (Kulikowski, C.A., 1979) is developed along the current context of knowledge engineering or applied artificial Intelligence. That is, the features of knowledge representation and reasoning strategies in EXPERT have converged from the different specific programs developed in the past (Shortliffe, 1976, Pople, 1975).

Thus, the EXPERT system facilitates a user to developed a medical consultation system without further consideration of AI techniques. But rather, the user concentrates his efforts on how to describe the medical knowledge that is used for the consultation system.

In this paper, we focus on the case studies that aim to accomplish two goals through the experience of using EXPERT system;

- I) Acquisition of knowledge from specific domain expert through a design of a small scale medical consultation system.
- II) Evaluation of the system's performance through various case data.

2. Knowledge Representation

In order to design a medical consultation system, the knowledge is represented in the

form of programs or data structure. For this purpose, the procedure for acquiring the knowledge is made by an analysis of an expert's explanation on a particular problem domain. The expertise is described in terms of verbal expression. This kind of explanation is not well structured, but rather loosely expressed. Therefore, the expertise must be reformulated according to a format of a programming language. In case of EXPERT, the knowledge is structured in a taxonomic classification scheme. If we select Glaucoma as medical domain, the taxonomy of diseases in Glaucoma is represented in the following lists which are shown in Fig.1.

**** HYPOTHESES**

*** TAXONOMY**

RY RYOKUNAISYOU

(Glaucoma)

HGR .HEISOKU-GUKAKU RYOKUNAISYOU

(Angle Closure Glaucoma)

ZHR ..ZOKUHATSU HEISOKU-GUKAKU RYOKUNAISYOU

(Primary Angle Closure Glaucoma)

Fig.1 Taxonomic Representation

This knowledge source is derived from Dr.Kitazawa audio instructional materials on Glaucoma. From the tape, the descriptions of glaucoma consists of three topics; 1) disease taxonomy 2) treatments 3) disease syndromes

and diagnosis. Therefore, the lists in Fig.1 are correspond to the first topics of disease taxonomy.

The second which deals with medical treatment plan is transformed into the following lists in Fig.2. The expert's explanation is focussed on global treatment plans which are further divided into a small chunk of medical care, such as sequence of miotic therapies. This parts is made by the use of taxonomic scheme in the Fig.2.

```
* Treatment
/ RYOKUNAISHOU NO CHIRYOU PLAN
(Glaucoma medical treatments Plan)
KK .SYUJUTSU
(Surgery)
SS .SYUJUTSU GA KONPON DE ARU.
XX .YAKUBUTSU CHIRYOU GA OMO TO NARU.
(Miotic therapies)
..Pilocarpine 1%
..Pilocarpine 2%      further taxonomic
..Pilocarpine 3%      treatment plans
..Epinephrine 1%
```

Fig.2 Treatment descriptions

The third which is the most important topic is composed of two parts; a) syndromes b) diagnosis. In EXPERT formalism, syndromes are considered as findings. Diagnosis is correspond to hypothesis which represents a reasoning strategy. Therefore, the third topic is to deal with a set of possible findings and a separate set of hypotheses. Finding are facts about the patient with the particular physiological state. These facts are acquired from the expertise. The lists are shown in Fig.3 indicating the syndromes of Glaucoma.

```
** FINDINGS
* BEGIN
* NUMERICAL
PATNO PATIENT ID NUMBER:
* NUMERICAL/MIN=1/MAX=100
.
* CHECKLIST
SYOUJOU:
(Syndromes)
ZU ZUTU, ZUJUKAN
(Headaches in dim light)
GAN GANTU
(Ocular/head pain)
KOS KOUSI
(rainbow vision)
```

Fig.3 Checklists for Findings

The findings are obtained from the checklist which can be reported in the form of yes, no or associated with an observation. Hypotheses are inference rules which combine the findings into the associated physiological or disease state. In the EXPERT formalism, there are

three types of rules for describing logical relationships among findings and hypotheses: 1) FF--(finding to finding rules) 2) FH--(finding to hypothesis rule) 3) HH--(hypothesis to hypothesis rules). Thus, the finding must be interpreted by a set of inference rules. These examples are shown in Fig.4.

** RULES

* FF Rules

```
F(SIK,F)→ F(KOD,F)
means;
IF (complaints of decreased visual
    acuity)
is false, then Shallow an chamber depth
is false.
```

* FH Rules

```
F(ZU,T)→ H(RY,0.5)
means;
IF Ocular/Head pain is reported, then
consider the hypothesis of Glaucoma
with a confidence of 0.05.
F(KOS,T)→ H(RY,0.08)
means;
IF Rainbow vision is reported, then
consider the hypothesis of Glaucoma
with a confidence of 0.08.
```

Fig.4 Inference rules

The above examples show the rule of findings that are used for FF and FH rules. For the case of HH rule, the following lists in Fig.5 are one of the examples. Here, left hand side of HH rules contain assertions about findings. In the example, (F(IOP,20:*)&F(KAI,T)&F(KZY,F)) is the left hand side.

* HH Rules

```
* IF
(F(IOP,@:*)&F(KAI,T)&F(KZY,F))
* THEN
(1:F(BJH,T),F(BJZ,T),F(BOT,T)
F(BJB,T))→ H(GKR,.99))
```

IF-part means;

```
F(IOP,20:*) : Intraocular pressure is more
               than 20
F(KAI,T) : Open angle is observed
F(KZT,T) : Iris abnormalities is
           observed
```

THEN-part means;

```
F(BJH,T) : Disc margin hemorrhage
F(BJZ,T) : Central Retinal Occlusion
F(BOT,T) : Central Retinal Artery Occlusion
The right hand side of THEN-parts means;
H(GKR,.99) ;
```

then consider hypothesis of primary open angle Glaucoma with a confidence of 0.99.

Fig.5 HH rules

Therefore, once IF-part conditions are satisfied, then, the system will determine an

expected FH rule which is associated with hypothesis. This behavior is similar to human expert's diagnostic process. That is, the expert will diagnose a patient without a rigid order of checklist. But rather, doctor will proceed in a wholistic way. This process will be also true in the consultation system. Global inference deals with the entire view of the diagnostic inferences. In this case, the use of HH rule will facilitate the inference system with dual characteristics of both global and local views. One is FH rule which combines directly finding to hypothesis, and another is HH rule which finds out a proper hypothesis for a associated finding.

3. System Implementation

In order to improve the level of diagnosis and performance of the consultation system, the rule must be evaluated by the medical expert. This procedure is accomplished by gradual process through hand on experience of small scale working system. The system is implemented under the TOPS-20 operating system of DEC-20. The EXPERT system is transferred from Rutgers AIM group. The present model is stored by the use of interactive editing program of DEC-20. The preliminary results of model are shown in Fig.6 which indicates protocols of the final consultation.

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--Summary--
Case 1: Visit 1 Date: 5/30/79

SYOUJOU: Symptoms
ZUTU,ZUJUKAN Ocular/Head pain
KOUSI Rainbow vision
SIRYOKU-SYUGAI Decreased visual
acuity
KUSURI NO SIYOU : Drug intolerance
NOTHING
BYOREKI:
TOUNIYOU-BYO Patient history of systemic
Disease Glycosuria

GUKAKU-IJOU: Angles abnormality
KAIHOU-GUKAKU Open
GUKAKU-YUTYAKU

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-- Conclusions --
DIAGNOSES:
GKR 0.99 GENPATU KAIHOU-GUKAKU RYOKUNAISSYOU
(primary open angle Glaucoma)
.....
TREATMENTS:
KK 0.41 SYUJUTSU (surgery)
.....

```

Fig.6 Summary and conclusions

For the above conclusion, HYPO command guides us a detail process of the maximum weighted hypothesis which is shown in Fig.7. In this case, HH rule supports the consultation of "Primary Open Angle Glaucoma". Therefore, the medical expert can ask the reasoning process of the consultations through the use of EXPERT commands. The rationale of EXPERT is referred to other paper (Weiss & Kulikowski,1979).

```

:HYPO
.....
GKR GENPATU KAIHOU-GUKAKU RYOKUNAISSYOU
Direct confidence weight: 0.990 set by
HH-Rule Table

1:
IF.....
CHOOSE 1:
Y ... INTRAOCULAR PRESSURE (MMHG) (IOP,20:1000)
THEN.....
CHOOSE 1:
Y ... SISINKEI-SENISOKU-SYUGAI:
BJERRUM-RYOKUIKI NO HIKAKUANTEN (BJH,
TRUE)
(Abnormality visual nerve system)

Y → GENPATU KAIHOU-GUKAKU RYOKUNAISSYOU
(GKR, 0.99)
(PPrimary Open Angle Glaucoma)
Final weight: 0.993

```

Fig.7 Reasoning process

4. Summary and conclusions

We have developed two types of medical consultation systems; one for small scale system that the medical expert can identify the whole structure so as to modify and check the knowledge, and another for large scale system that accepts various kinds of data from real clinical cases. The model that we focussed on this study is the former model, but simultaneously, we are constructing the CASNET-type large scale consultation system, which is further put forward through the experiences of EXPERT case studies.

Reference

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