LP1 Assignment AI&R 2

Date: 2nd November, 2020

Title: Expert System

Problem Definition:

Implement an Expert System for Medical Diagnosis of diseases based on adequate symptoms.

Learning Objectives:

● To learn and implement an expert system

Learning Outcomes:

● I will be able to learn and implement Expert System for Medical Diagnosis

S/W & H/W Packages:

● Operating System: 64-bit Ubuntu 18.04

● Programming Language: Python 3

● Jupyter Notebook Environment: Google Colaboratory

● Python3 Library: experta

Related Mathematics:

S = {s; e; X; Y; Fme; Ff; DD; NDD}

s = start state

- s = Set of Symptoms for a set of diseases each

e = end state

- e = Final diagnosis

X = {X1}

- X1 = {Di | 0<=i}
- Di is the set of symptoms for ith Disease

Y = {Y1}

- Y1 = {Final Diagnosis}

Fme = {function to perform Fact based classification}

Ff = {f1,f2,f3} where

- f1 = function to find input symptoms
- f2 = function to find states
- f3 = function to display diagnosis

DD = Set of Symptoms for a set of diseases each

NDD = No non deterministic data

Concepts Related to Theory:

Expert Systems:

● Diagnostic expert-based systems are computer systems that seek to emulate the diagnostic decision-making ability of human experts.

● Medical expert systems generally include two components:

a. Knowledge Base (KB) - It encapsulates the evidence-based medical knowledge that is curated by experts

b. Rule-based inference engine - It is devised by the expert, which operates on the knowledge base to generate a differential diagnosis.

● Diagnostic knowledge bases generally consist of diseases, findings (i.e. symptoms, signs, history, or lab results), and their relationships.

● In many cases, they explicitly lay out the relationships between a set of findings and the things that cause them (diseases).

● For example, a KB might include influenza and show its relationships with fever, coughing, and congestion.

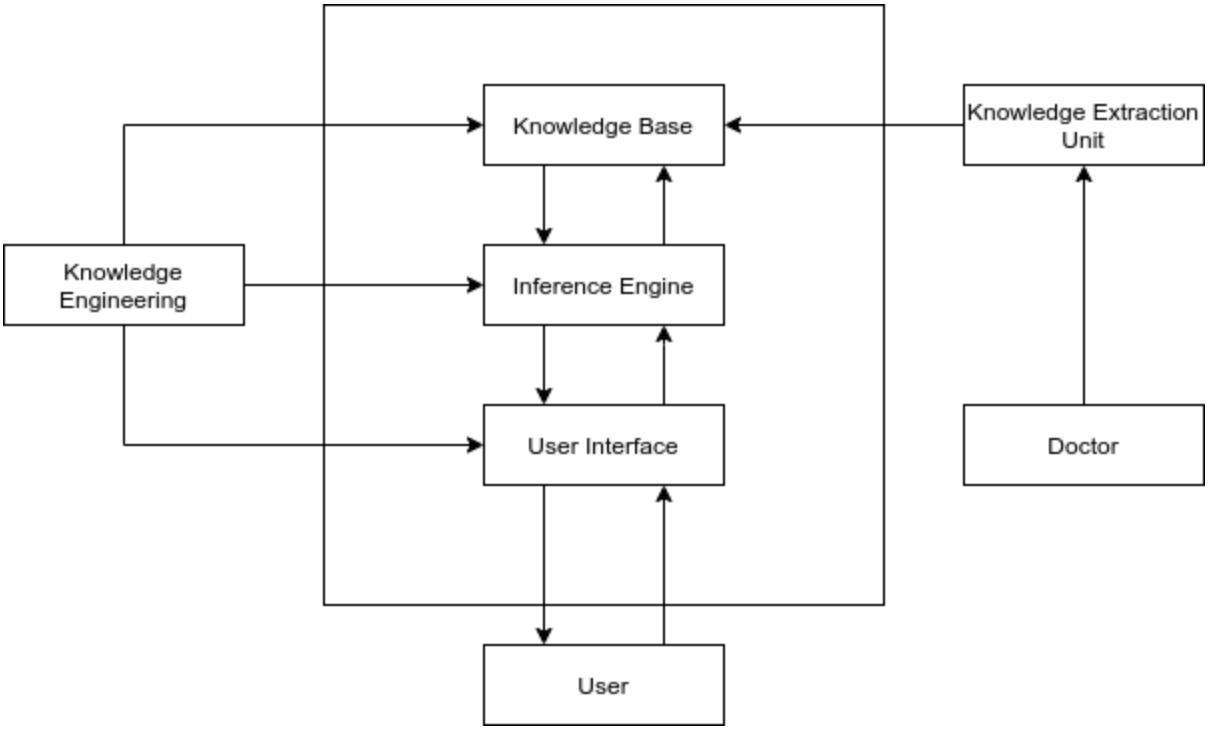
Inference Engine:

The inference engine is based on forward and backward chaining, examining the knowledge base (disease symptoms) for information that matches the user's query (kind of disease).

Knowledge Base Design:

The knowledge domain was got from facts of a collection of data about the types of symptoms and diseases to be isolated and identified, the identification methods, the expected results.

Data elicited for the isolation, identification of symptoms and possible recommendations on susceptibility patterns makes the knowledge base which was modeled into frames at the different levels of the decision trees and using the ”IF—THEN” production rules , quick deductions are made.



Perception

Representing Diseases and Symptoms

Label	Disease		Label	Symptom
x1	Jaundice		s1	Headache
x2	Alzheimers		s2	Back pain
x3	Arthritis		s3	Chest pain
x4	Tuberculosis		s4	Cough
x5	Asthma		s5	Fainting
x6	Sinusitis		s6	Sore throat
x7	Epilepsy		s7	Fatigue
x8	Heart Disease		s8	Restlessness
x9	Diabetes		s9	Low body temp
x10	Glaucoma		s10	Fever
x11	Hyperthyroidism		s11	Sunken eyes
x12	Heat Stroke		s12	Nausea
x13	Hypothermia		s13	Blurred vision

Truth Table

	s1	s2	s3	s4	s5	s6	s7	s8	s9	s10	s11	s12	s13
x1	0	0	0	0	0	0	1	0	0	1	0	1	0
x2	0	0	0	0	0	0	0	1	0	0	0	0	0
x3	0	1	0	0	0	0	1	0	0	0	0	0	0
x4	0	0	1	1	0	0	0	0	0	1	0	0	0
x5	0	0	1	1	0	0	0	1	0	0	0	0	0
x6	1	0	0	1	0	1	0	0	0	1	0	0	0
x7	0	0	0	0	0	0	1	0	0	0	0	0	0
x8	0	0	1	0	0	0	0	0	0	0	0	1	0
x9	0	0	0	0	0	0	1	0	0	0	0	1	1
x10	1	0	0	0	0	0	0	0	0	0	0	1	1
x11	0	0	0	0	0	0	1	0	0	0	0	1	0
x12	1	0	0	0	0	0	0	0	0	1	0	1	0
x13	0	0	0	0	1	0	0	0	1	0	0	0	0

Cognition

Example of Rule in Knowledge Base:

Disease (Patient, Jaundice): Symptom (Patient, Fatigue), Symptom (Patient, Fever), Symptom (Patient, Nausea)

s1 → ~x1 ∧ ~x2 ∧ ~x3 ∧ ~x4 ∧ ~x5 ∧ ~x6 ∧ x7 ∧ ~x8 ∧ ~x9 ∧ x10 ∧ ~x11 ∧ x12 ∧ ~x13

s2 → ~x1 ∧ ~x2 ∧ ~x3 ∧ ~x4 ∧ ~x5 ∧ ~x6 ∧ ~x7 ∧ x8 ∧ ~x9 ∧ ~x10 ∧ ~x11 ∧ ~x12 ∧ ~x13

s3 → ~x1 ∧ x2 ∧ ~x3 ∧ ~x4 ∧ ~x5 ∧ ~x6 ∧ x7 ∧ ~x8 ∧ ~x9 ∧ ~x10 ∧ ~x11 ∧ ~x12 ∧ ~x13

s4 → ~x1 ∧ ~x2 ∧ x3 ∧ x4 ∧ ~x5 ∧ ~x6 ∧ ~x7 ∧ ~x8 ∧ ~x9 ∧ x10 ∧ ~x11 ∧ ~x12 ∧ ~x13

s5 → ~x1 ∧ ~x2 ∧ x3 ∧ x4 ∧ ~x5 ∧ ~x6 ∧ ~x7 ∧ x8 ∧ ~x9 ∧ ~x10 ∧ ~x11 ∧ ~x12 ∧ ~x13

s6 → ~x1 ∧ ~x2 ∧ ~x3 ∧ x4 ∧ ~x5 ∧ x6 ∧ ~x7 ∧ ~x8 ∧ ~x9 ∧ x10 ∧ ~x11 ∧ ~x12 ∧ ~x13

s7 → ~x1 ∧ ~x2 ∧ ~x3 ∧ ~x4 ∧ ~x5 ∧ ~x6 ∧ x7 ∧ ~x8 ∧ ~x9 ∧ ~x10 ∧ ~x11 ∧ ~x12 ∧ ~x13

s8 → ~x1 ∧ ~x2 ∧ x3 ∧ ~x4 ∧ ~x5 ∧ ~x6 ∧ ~x7 ∧ ~x8 ∧ ~x9 ∧ ~x10 ∧ ~x11 ∧ x12 ∧ ~x13

s9 → ~x1 ∧ ~x2 ∧ ~x3 ∧ ~x4 ∧ ~x5 ∧ ~x6 ∧ x7 ∧ ~x8 ∧ ~x9 ∧ ~x10 ∧ ~x11 ∧ x12 ∧ x13

s10 → x1 ∧ ~x2 ∧ ~x3 ∧ ~x4 ∧ ~x5 ∧ ~x6 ∧ ~x7 ∧ ~x8 ∧ ~x9 ∧ ~x10 ∧ ~x11 ∧ x12 ∧ x13

s11 → ~x1 ∧ ~x2 ∧ ~x3 ∧ ~x4 ∧ ~x5 ∧ ~x6 ∧ x7 ∧ ~x8 ∧ ~x9 ∧ ~x10 ∧ ~x11 ∧ x12 ∧ ~x13

s12 → x1 ∧ ~x2 ∧ ~x3 ∧ ~x4 ∧ ~x5 ∧ ~x6 ∧ ~x7 ∧ ~x8 ∧ ~x9 ∧ x10 ∧ ~x11 ∧ x12 ∧ ~x13

s13 → ~x1 ∧ ~x2 ∧ ~x3 ∧ ~x4 ∧ x5 ∧ ~x6 ∧ ~x7 ∧ ~x8 ∧ x9 ∧ ~x10 ∧ ~x11 ∧ ~x12 ∧ ~x13

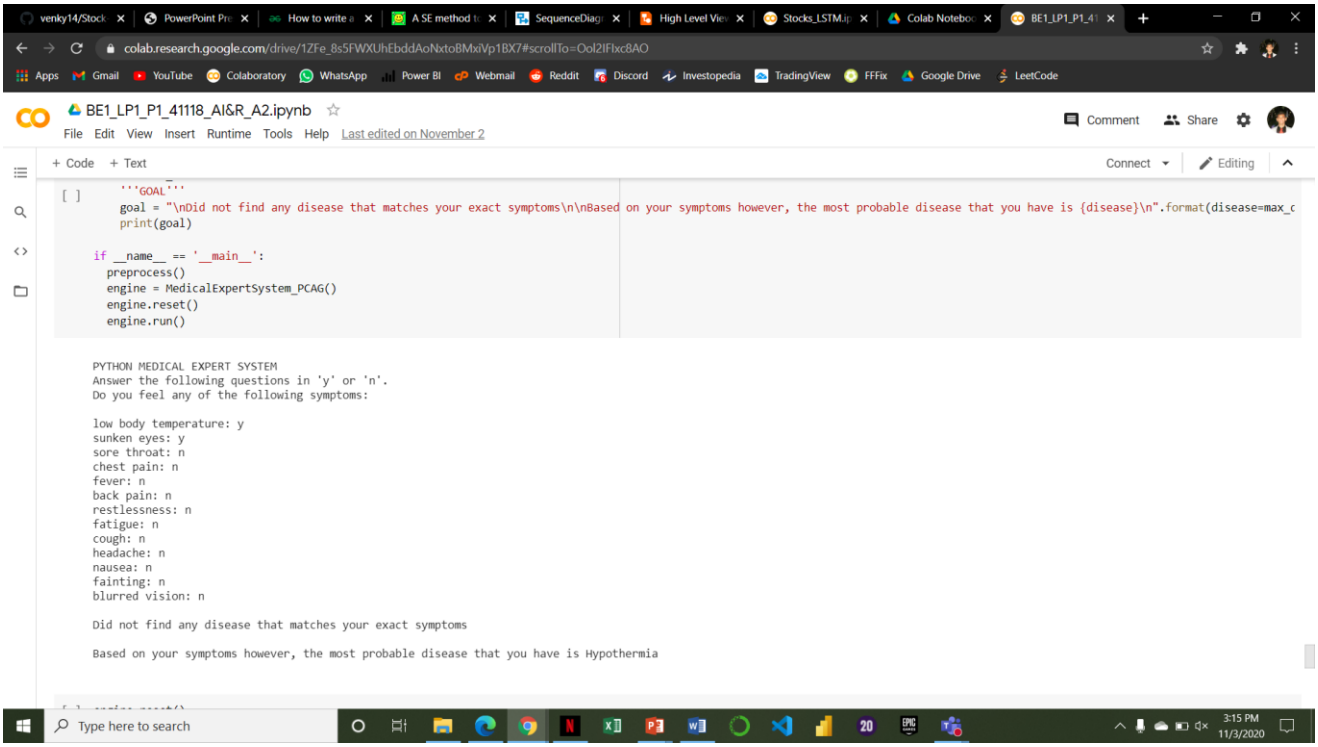
Action

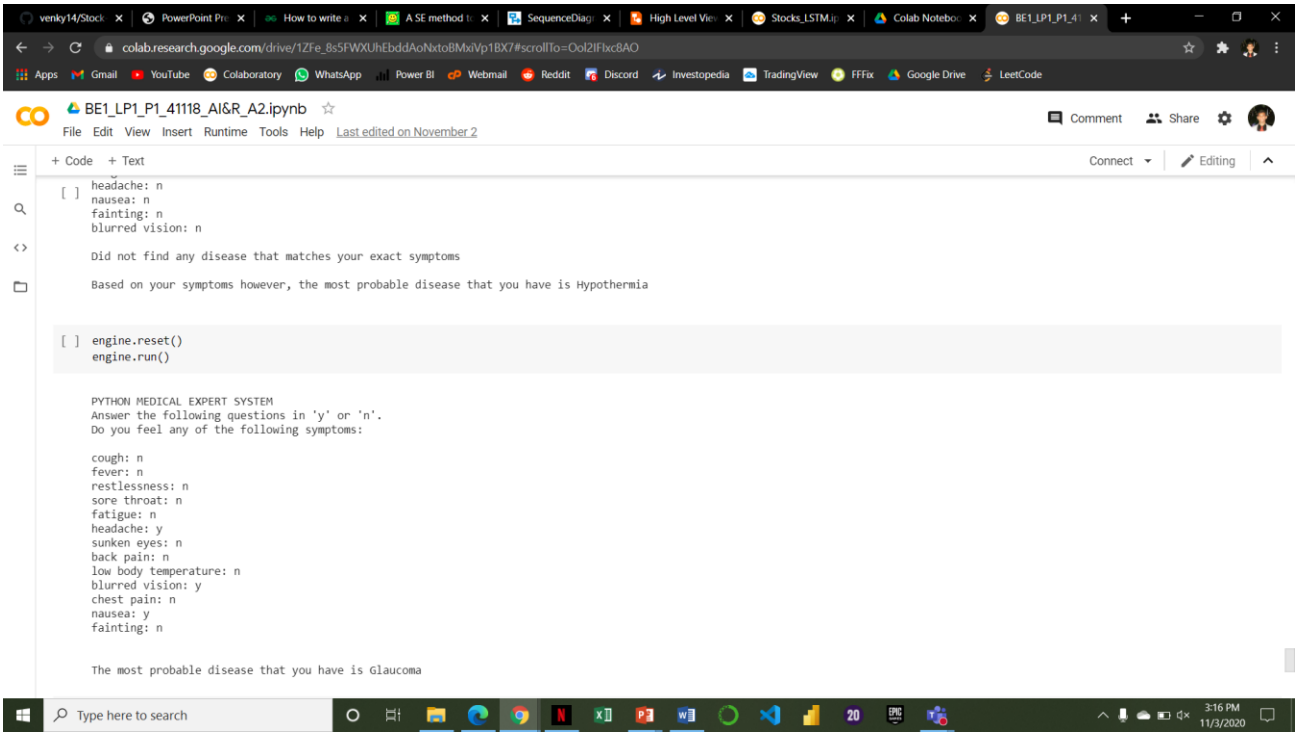
Fire Rule to Display Disease iff a Fact of Disease has been asserted in Cognition
Otherwise Fire Rule to display the most probable disease.

Goal State

Display Name of the disease or Display no disease along with most probable disease

Output:




BE1_LP1_P1_41118_AI&R_A2.ipynb
File Edit View Insert Runtime Tools Help Last edited on November 2
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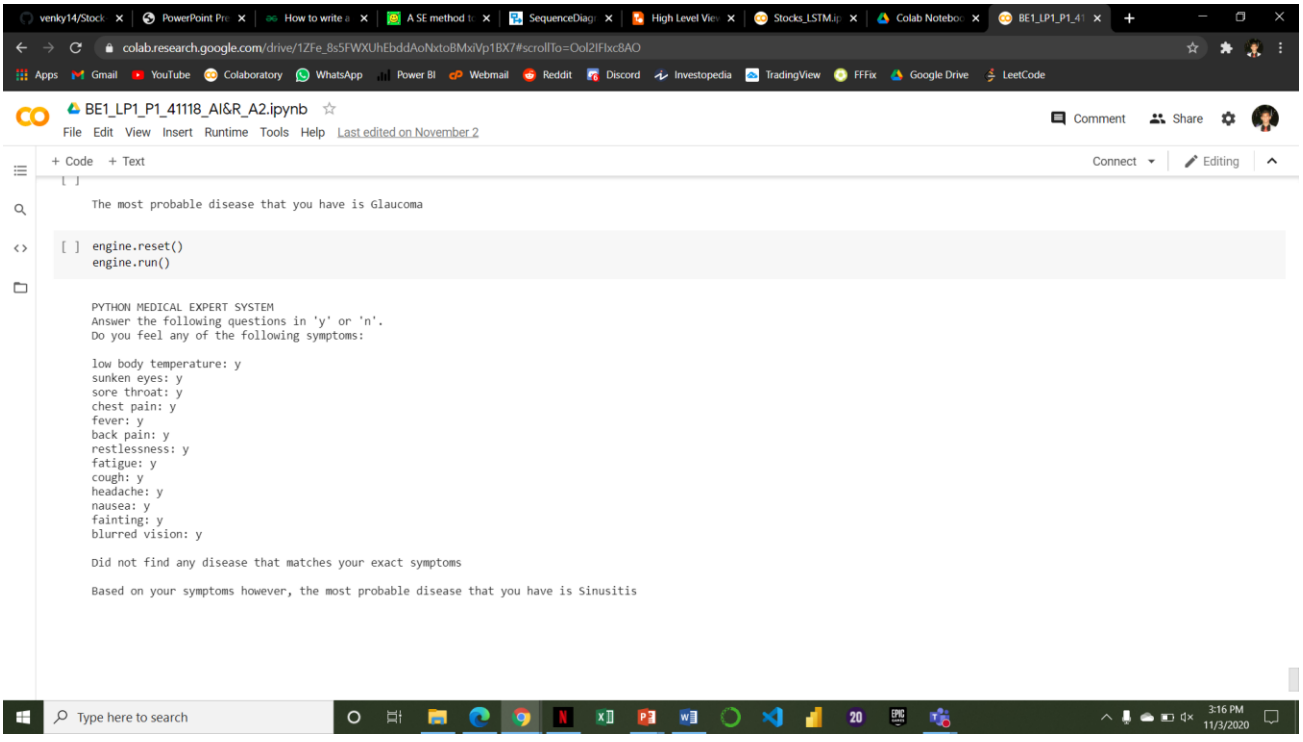
headache: n
nausea: n
fainting: n
blurred vision: n
Did not find any disease that matches your exact symptoms
Based on your symptoms however, the most probable disease that you have is Hypothermia
engine.reset()
engine.run()
PYTHON MEDICAL EXPERT SYSTEM
Answer the following questions in 'y' or 'n'.
Do you feel any of the following symptoms:
cough: n
fever: n
restlessness: n
sore throat: n
fatigue: n
headache: y
sunken eyes: n
back pain: n
low body temperature: n
blurred vision: y
chest pain: n
nausea: y
fainting: n
The most probable disease that you have is Glaucoma


BE1_LP1_P1_41118_AI&R_A2.ipynb
File Edit View Insert Runtime Tools Help Last edited on November 2
Comment Share
+ Code + Text
Connect Editing
The most probable disease that you have is Glaucoma
engine.reset()
engine.run()
PYTHON MEDICAL EXPERT SYSTEM
Answer the following questions in 'y' or 'n'.
Do you feel any of the following symptoms:
low body temperature: y
sunken eyes: y
sore throat: y
chest pain: y
fever: y
back pain: y
restlessness: y
fatigue: y
cough: y
headache: y
nausea: y
fainting: y
blurred vision: y
Did not find any disease that matches your exact symptoms
Based on your symptoms however, the most probable disease that you have is Sinusitis

Notebook Link:

https://colab.research.google.com/drive/1ZFe_8s5FWXUhEbddAoNxtoBMxiVp1BX7?usp=sharing

Conclusion:

I have successfully designed and implemented an Expert System for Medical System