CS 514 Applied Artificial Intelligence Project 1 report

# A BLOOD SUGAR DETERMINING EXPERT SYSTEM.

# DIABETES DIAGNOSER

# INDEX



***Note:*** *Suitable links have been provided for additional information wherever necessary in RULES and DESCRIPTION.*

## Abstract:

A blood sugar determining system is a rule based expert system built on JESS that is designed to take certain test related parameters from the patient's blood test and infer certain vital parameters to diagnose blood sugar level and makes recommendations to the user of the system. The system advices user on diet, workout and food intake plans based on the various components in the person's test results. To determine blood sugar level the system considers the Fasting blood glucose and Post prandial blood glucose. The system is also capable of recommending any further tests required by the user based on the ratio of glucose, electrolytes and lipid profiles.

## Features:

1. The patient's blood test details are required by the system requires like the Fasting blood glucose, Post prandial blood glucose, Electrolytes and Lipid profiles.
2. The result of every biochemical component are considered by the system and based on these results it advises the user if further steps are required.
3. The blood glucose level before as well as after the intake of food are analyzed by the system.
4. Then the various electrolyte levels like sodium, potassium, chlorides and creatinine are checked.
5. If these components are found to be either high or low the it advices the user on further appropriates steps to be taken.
6. The lipid profiles present in the user's bio chemistry are analyzed by the system.
7. The lipid profiles include Cholesterol, HDL Cholesterol, Triglycerides, non-HDL Cholesterol, VLDL Cholesterol. Except, HDL Cholesterol all other Cholesterol are dangerous for health. If there is an increase in the level of these cholesterols above the normal range, then the system advices the user on the necessary actions to be taken.
8. High levels of HDL cholesterol are beneficial for health. The system is also capable of identifying these and encourages the user to keep up this level
9. If the urea in the blood is high as this might cause kidney problems the system advices the user to undergo BUN test.
10. If the user has high cholesterol the system recommends regular exercise.
11. The system determines if the user has high sugar, low sugar or no sugar based on the Fasting blood glucose and Post prandial blood glucose levels.
12. All the attributes considered in tests are independent. Hence, will not have any influence on each other.

## Rules and descriptions:

There are 2 templates described in the code:

**test_report**

```
(deftemplate test_report
    (slot report_serum_sodium(type float))
    (slot report_fasting_glucose_blood(type float))
    (slot report_cholestrol(type float))
    (slot report_VLDL_Cholestrol (type float))
    (slot report_post_prandial_glucode_blood(type float))
    (slot report_blood_urea(type float))
    (slot report_serum_potassium(type float))
    (slot report_HbAlc(type float))
    (slot report_HDL_Cholestrol(type float))
    (slot report_serum_creatinine(type float))
    (slot report_direct_LDL(type float))
    (slot report_S_Triglycerides(type float))
    (slot report_sample (type integer))
    (slot report_Non_HDL_Cholestrol (type float))
    (slot report_serum_chloride(type float))
```

**patient_details**

```
(deftemplate patient_details
    (slot name)
    (slot age(type integer))
    (slot sex)
    (slot diabetes_in_family)
)
```

There are total 17 rules in the program:

| # | Rule Name | Description | References and detailed explanations |
|---|---|---|---|
| 1 | `initial` | Prints all the information in the test report. | |
| 2 | `Fasting Glucose check` | Checks the fasting glucose levels in the blood. | 60-120 mg/dl |
| 3 | `Post Prandial Glucose check` | Checks the glucose level in blood after the intake of food | <150 mgs/dl |
| 4 | `Serum sodium check` | Checks the serum Sodium level and advises the user in case of any inconsistency. | 135.0-145.0 mEq/L |

| | | | |
|---|---|---|---|
| 5 | serum potassium check | Checks the serum Potassium level and advises the user in case of any inconsistency. | 3.5 – 4.5 mEq/L |
| 6 | Serum chloride check | Checks the serum Chloride level and advises the user in case of any inconsistency. | 96 – 106 mEq/L |
| 7 | HbAlc check | Checks the HbAlc level and advises the user in case its high. | <6% |
| 8 | blood urea check | Checks the blood urea level and advises the user in case of any inconsistency. | 15-45 mg/dl |
| 9 | Serum creatinine check | Checks the serum Creatinine level and advises the user in case of any inconsistency | 0.7 – 1.2 mgs/dl |
| 10 | Cholestrol check | Checks the Cholesterol level and advises the user in case its high. | <200 mgs/dl |
| 11 | HDL Cholestrol check | Checks the HDL_Cholesterol level and advises the user in case its low. | >35 mgs/dl |
| 12 | direct LDL check | Checks the VLDL_Cholesterol level and advises the user in case its high. | <100 mgs/dl |
| 13 | Triglycerides check | Checks the S_Triglycerides level and advises the user in case its high. | <150 mgs/dl |
| 14 | Non HDL Cholestrol check | Checks the Non-HDL Cholesterol level and advises the user in case its high. | <130 mgs/dl |
| 15 | VLDL Cholestrol check | Checks the VLDL Cholesterol level and advises the user in case its high. | <30 mgs/dl |
| 16 | diagnose test | Determines if the user has diabetes. | |
| 17 | printFacts | To print all facts. | |

# Usage Manual:

## Instructions:

Copy the file diabetes_diagnosis.clp to the BIN folder under the JESS directory.

Open JESS and execute the below commands:

```
(batch diabetes_diagnosis.clp)
```

# Sample runs:

## Run #1

Condition where the user do not have diabetes or any other risks.

```
(assert (test_report(report_fasting_glucose_blood 160)
        (report_post_prandial_glucode_blood 140)
      (report_serum_sodium 125.0)
        (report_serum_potassium 3.0)
        (report_serum_chloride 98)
        (report_HbAlc 2)
        (report_blood_urea 30)
        (report_serum_creatinine 0.5)
        (report_cholestrol 150)
        (report_HDL_Cholestrol 56)
        (report_direct_LDL 110)
        (report_S_Triglycerides 90)
        (report_Non_HDL_Cholestrol 80)
        (report_VLDL_Cholestrol 25)))


(assert (patient_details (name "Mike")
            (age 40)
            (sex "Male")
            (diabetes_in_family "N")))
```

```
********************Your test report is ready*********************
Name Mike
Age: 40
Sex: Male
********************test_report********************
Fasting Blood Glucose: 160
Post Prandial Blood Glucose: 140
Serum Sodium: 125.0
Serum Potassium: 3.0
Serum Chlorides: 98
report_HbAlc: 2
Blood Urea: 30
Serum Creatinine: 0.5
report_cholestrol: 150
HDL Cholestrol: 56
Direct LDL: 110
S Triglycerides: 90
Non HDL Cholestrol: 80
VLDL Cholestrol: 25

You are pre-diabetic

Have dinner on time. High Fasting glucose is high.
Serum sodium is low, include sufficient pulses in your diet.
Please undergo blood pressure test. Serum potassium is low.
Include protiens in your diet. Else, it might cause muscular dystrophy. Serum Creatinine is low.
Reduce the intake of trans fat and saturated fat. Direct LDL cholestrol is high.
f-0    (MAIN::initial-fact)
f-1    (MAIN::patient_details (name "Mike") (age 40) (sex "Male") (diabetes_in_family "N"))
f-2    (MAIN::test_report (report_serum_sodium 125.0) (report_fasting_glucose_blood 160) (report_cholestrol 150)
For a total of 3 facts in module MAIN.
```

## Run #2

Condition where the user has high diabetes and other risks.

```
 (assert (biochemistry(fasting_blood_glucose 180)
        (post_prandial_blood_glucose 250)
        (serum_sodium 150.0)
        (serum_potassium 6.0)
        (serum_chloride 108)
        (HbAlc 9)
        (blood_urea 55)
        (serum_creatinine 1.3)
        (cholestrol 250)
        (HDL_Cholestrol 56)
        (direct_LDL 110)
        (S_Triglycerides 180)
        (Non_HDL_Cholestrol 140)
        (VLDL_Cholestrol 40)))


(assert (patient (name "Tom")
            (age 55)
            (sex "Male")
            (diabetes_in_family "Y")))
```

```
**********Your test report is ready**********
Name Mike
Age: 40
Sex: Male
**********test_report**********
Fasting Blood Glucose: 180
Post Prandial Blood Glucose: 250
Serum Sodium: 150.0
Serum Potassium: 6.0
Serum Chlorides: 108
report_HbAlc: 9
Blood Urea: 55
Serum Creatinine: 1.3
report_cholestrol: 250
HDL Cholestrol: 56
Direct LDL: 110
S Triglycerides: 180
Non HDL Cholestrol: 140
VLDL Cholestrol: 40

Take insulin shots after consulting the doctor. You have high sugar.

Have dinner on time. High Fasting glucose is high.
Control the intake of carbohydrates. Post prandial glucose is high.
Drink lot of water. Serum sodium is high.
Please undergo EKG test as soon as possible. Serum potassium is high. This causes HYPERKALEMIA.
Control the intake of salty foods. Serum chloride is high.
Reduce your weight. HbAlc is high.
Please undergo BUN test. Blood Urea is high.
Undergo, Creatinine blood test. Serum Creatinine is too high.
Indulge in fibre diet. Cholestrol is high.
Reduce the intake of trans fat and saturated fat. Direct LDL cholestrol is high.
Use mono or poly saturated fats. S Triglycerides is high.
Exercise regularly. Non HDL Cholestrol is high.
Avaoid sugary food and alcohol. VLDL Cholestrol is high.
f-0    (MAIN::initial-fact)
f-1    (MAIN::patient_details (name "Mike") (age 40) (sex "Male") (diabetes_in_family "N"))
f-2    (MAIN::test_report (report_serum_sodium 150.0) (report_fasting_glucose_blood 180) (report_cholestrol 250)
For a total of 3 facts in module MAIN.
```

## Run #3

Condition where the user has low blood sugar and other risks.

```
 (assert(biochemistry(fasting_blood_glucose 55)
        (post_prandial_blood_glucose 150)
        (serum_sodium 135.0)
        (serum_potassium 2.0)
        (serum_chloride 80)
        (HbAlc 5)
        (blood_urea 10)
        (serum_creatinine 0.5)
        (cholestrol 150)
        (HDL_Cholestrol 30)
        (direct_LDL 70)
        (S_Triglycerides 90)
        (Non_HDL_Cholestrol 80)
        (VLDL_Cholestrol 25)))


(assert (patient (name "Tom")
            (age 55)
            (sex "Male")
            (diabetes_in_family "Y")))
```

```
This copy of Jess will expire in 1460 day(s).
**********Your test report is ready**********
Name Mike
Age: 40
Sex: Male
**********test_report**********
Fasting Blood Glucose: 55
Post Prandial Blood Glucose: 150
Serum Sodium: 135.0
Serum Potassium: 2.0
Serum Chlorides: 80
report_HbAlc: 5
Blood Urea: 10
Serum Creatinine: 0.5
report_cholestrol: 150
HDL Cholestrol: 30
Direct LDL: 70
S Triglycerides: 90
Non HDL Cholestrol: 80
VLDL Cholestrol: 25

Increase the intake of carbohydrates. You have low sugar.

Have dinner on time. Fasting glucose is low
Please undergo blood pressure test. Serum potassium is low.
Include sea food in your diet. Serum chloride is low.
Please undergo BUN test. Blood Urea is low.
Include protiens in your diet. Else, it might cause muscular dystrophy. Serum Creatinine is low.
Eat salmon and excersise regularly. HDL Cholestrol is low.
f-0    (MAIN::initial-fact)
f-1    (MAIN::patient_details (name "Mike") (age 40) (sex "Male") (diabetes_in_family "N"))
f-2    (MAIN::test_report (report_serum_sodium 135.0) (report_fasting_glucose_blood 55) (report_cholestrol 150)
For a total of 3 facts in module MAIN.
```

## Run #4

Condition where the user is prediabetic.

```
 (assert(biochemistry(fasting_blood_glucose 130)
        (post_prandial_blood_glucose 150)
        (serum_sodium 135.0)
        (serum_potassium 2.0)
        (serum_chloride 98)
        (HbAlc 2)
        (blood_urea 30)
        (serum_creatinine 0.5)
        (cholestrol 150)
        (HDL_Cholestrol 56)
        (direct_LDL 110)
        (S_Triglycerides 90)
        (Non_HDL_Cholestrol 80)
        (VLDL_Cholestrol 25)))


(assert (patient (name "Tom")
            (age 55)
            (sex "Male")
            (diabetes_in_family "Y")))
```

```
**********Your test report is ready**********
Name Mike
Age: 40
Sex: Male
**********test_report**********
Fasting Blood Glucose: 130
Post Prandial Blood Glucose: 150
Serum Sodium: 135.0
Serum Potassium: 2.0
Serum Chlorides: 98
report_HbAlc: 2
Blood Urea: 30
Serum Creatinine: 0.5
report_cholestrol: 150
HDL Cholestrol: 56
Direct LDL: 110
S Triglycerides: 90
Non HDL Cholestrol: 80
VLDL Cholestrol: 25

You are pre-diabetic

Have dinner on time. High Fasting glucose is high.
Please undergo blood pressure test. Serum potassium is low.
Include protiens in your diet. Else, it might cause muscular dystrophy. Serum Creatinine is low.
Reduce the intake of trans fat and saturated fat. Direct LDL cholestrol is high.
f-0    (MAIN::initial-fact)
f-1    (MAIN::patient_details (name "Mike") (age 40) (sex "Male") (diabetes_in_family "N"))
f-2    (MAIN::test_report (report_serum_sodium 135.0) (report_fasting_glucose_blood 130) (report_cholestrol 150)
For a total of 3 facts in module MAIN.
```