UNIVERSITAT ROVIRA i VIRGILI

# Exam: Approximate Reasoning

**January, 12th, 2022**

*Time: 2 h. You cannot use any printed materials nor any communication device.*
*Calculators are allowed if they are without communication possibility.*
*Use a black or blue ball pen for answering the exam.*
*Please give clear and detailed explanations (with examples, if appropriate).*
*You must leave your personal identifier (DNI, NIE, student card…) in the table during the exam*

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1. **(1.5 points) Question.** Explain the disadvantages of using the classical probabilistic model for managing uncertainty.

2. **(2 points) Exercise on Certainty Factors.**

Given the following network of inference with the corresponding Certainty Factors of the rules, solve the following case where the initial evidences about 4 facts are:

CF(A)= 0.4, CF(B)= 0.9, CF(C)=0.7 and CF(D)= 0.8.

The rules are:

**If ((A and B) or C) then E (CF = 0.8)**
**If (C or D) then E (CF = 0.9)**

a. Write the calculations in detail and explain the conclusion you reach about the truth of the fact E and the certainty of your conclusion.
b. Invent a third rule that concludes about E and has in the premises the fact G with CF(G)=0.5 and some other of the previous initial facts. The final CF(E) when adding this new rule must be smaller than the previous one (obtained in question a).

3. **(2 points) Exercise on Evidence Theory by Dempster-Shaffer.**

We have three possible suspects of a burglary: Ann, Bob and Carol.
The current mass assignment is the following:

| Ann | Bob | Carol | Ann, Bob | Ann, Carol | Bob, Carol | Ann, Bob, Carol |
|---|---|---|---|---|---|---|
| 0.1 | 0.05 | 0.3 | 0.1 | 0.3 | 0.15 | 0.0 |

a. Calculate the Belief and Plausability of each of these subsets in the table.
b. Explain which is the uncertainty of each of these subsets.
c. With this information, can you affirm who is the person that made the burglary?

4. **(1.5 points) Question.** Explain the propagation algorithm we studied for linear Bayesian Networks. Indicate the purpose of the values λ and π in this algorithm and how they are used.

**Name and surname:**

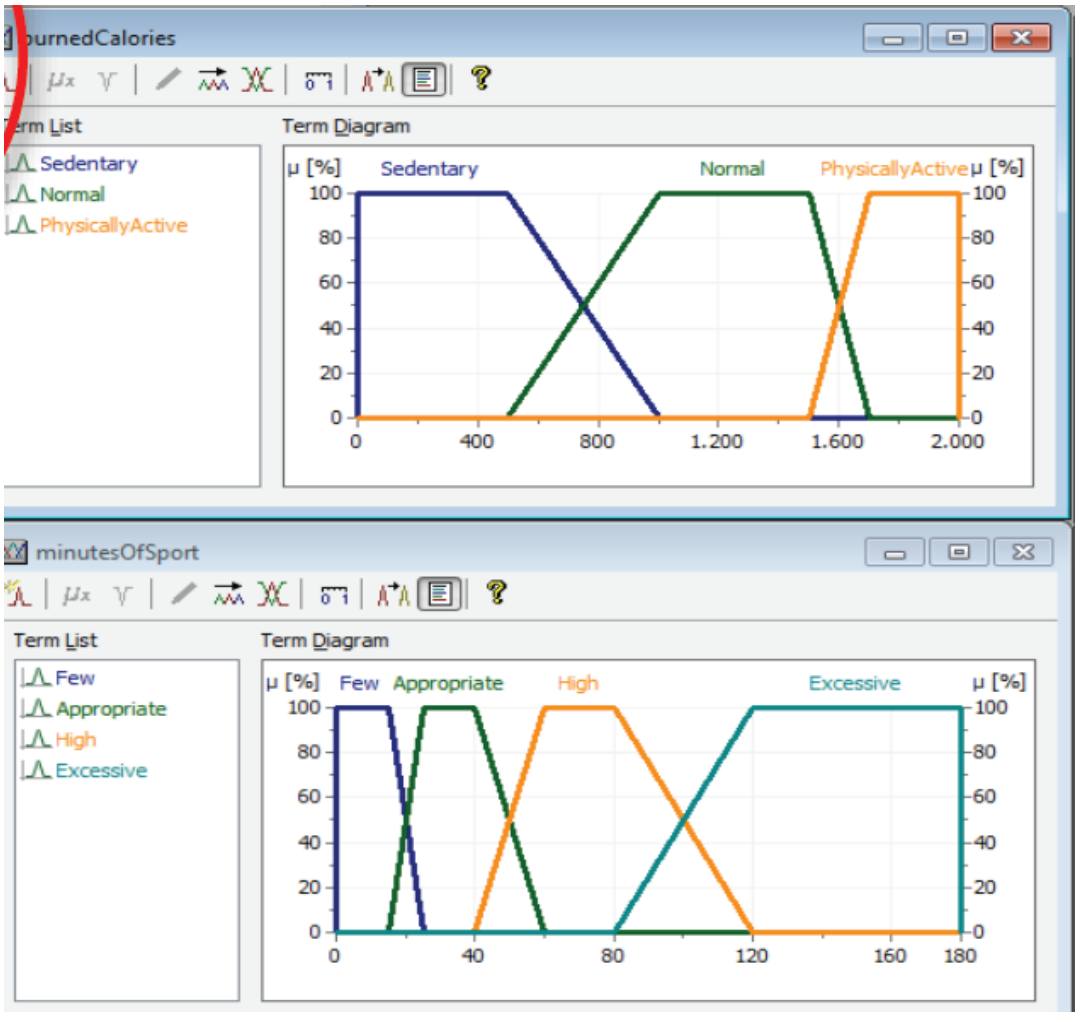
**WRITE YOUR NAME IF YOU ANSWER HERE IN THIS DOCUMENT.**

**5. (3 points) Exercise on Fuzzy Systems**

Here you have a Fuzzy Expert System for calculating the number of burnt calories using three indicators obtained from a smart watch: (1) minutes of sport, (2) number of climbed stairs and (3) number of steps made.

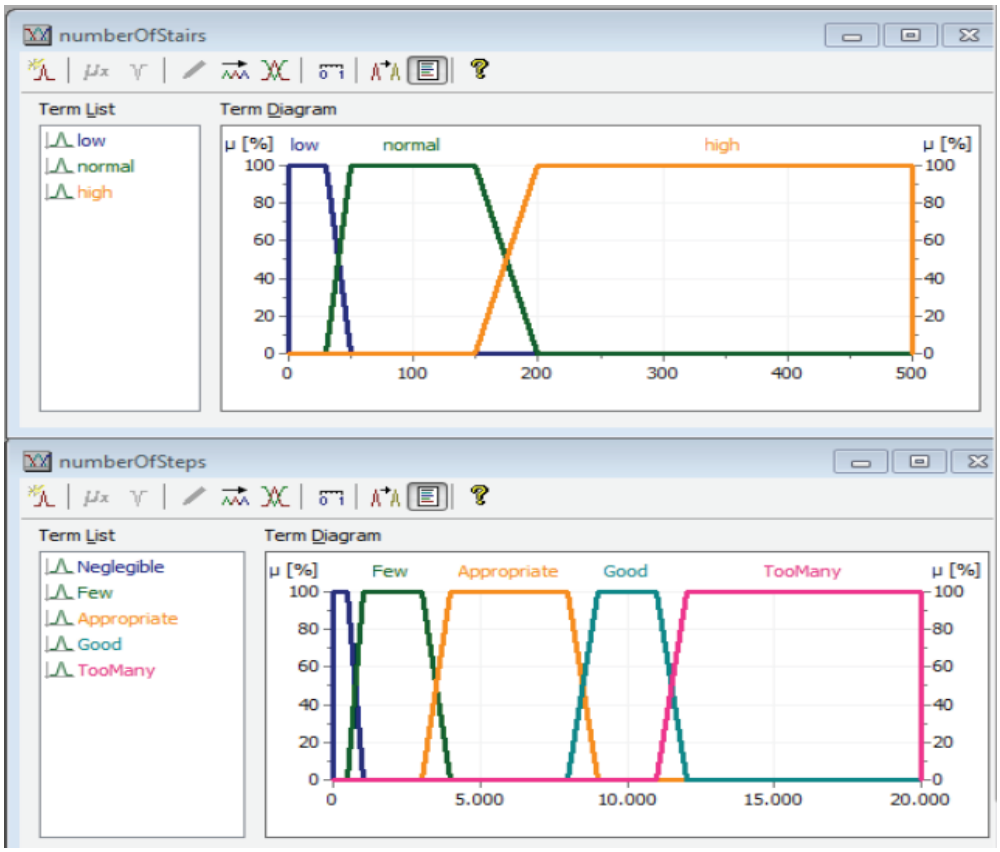
Calculate and answer:

a. Calculate the conclusion of the rules using the Mamdani procedure (min and max) and indicate the degree of activation of each label. Inputs: minutes= 20, stairs=35 , steps=800.
b. Calculate the final defuzzified value of the conclusion using the method of Mean of Maximums.
c. Considering the same number of minutes and stairs, how many steps should this person make to activate only the answer PhysicallyActive?




| minutesOfSport | a | b | c | d |
|---|---|---|---|---|
| Few | 0 | 0 | 15 | 25 |
| Appropriate | 15 | 25 | 40 | 60 |
| High | 40 | 60 | 80 | 120 |
| Excessive | 80 | 120 | 180 | 180 |

**Name and surname:**




| numberOfStairs | a | b | c | d | | | NumberOfSteps | a | b | c | d |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Low | 0 | 0 | 30 | 50 | | | Negligible | 0 | 0 | 400 | 1000 |
| Normal | 30 | 50 | 150 | 200 | | | Few | 400 | 1000 | 3000 | 4000 |
| High | 150 | 200 | 500 | 500 | | | Appropriate | 3000 | 4000 | 8000 | 9000 |
| | | | | | | | Good | 8000 | 9000 | 11000 | 12000 |
| | | | | | | | TooMany | 11000 | 12000 | 20000 | 20000 |

| | If | And | And | Operators | Then | With |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | Min / Max | 1 | |
| | minutesOfSport | numberOfStairs | numberOfSteps | | burnedCalories | DoS [%] |
| 1.R1 | minutesOfSport.*High* | | | => | burnedCalories.*PhysicallyActive* | 100 |
| 1.R2 | | | numberOfSteps.*TooMany* | => | burnedCalories.*PhysicallyActive* | 100 |
| 1.R3 | minutesOfSport.*Excessive* | | | => | burnedCalories.*PhysicallyActive* | 100 |
| 1.R4 | | | numberOfSteps.*Good* | => | burnedCalories.*PhysicallyActive* | 100 |
| 1.R5 | minutesOfSport.*Appropriate* | | numberOfSteps.*Appropriate* | => | burnedCalories.*PhysicallyActive* | 100 |
| 1.R6 | minutesOfSport.*Few* | numberOfStairs.*high* | numberOfSteps.*Appropriate* | => | burnedCalories.*PhysicallyActive* | 100 |
| 1.R7 | minutesOfSport.*Few* | numberOfStairs.*normal* | numberOfSteps.*Appropriate* | => | burnedCalories.*Normal* | 100 |
| 1.R8 | minutesOfSport.*Few* | numberOfStairs.*low* | numberOfSteps.*Appropriate* | => | burnedCalories.*Normal* | 100 |
| 1.R9 | minutesOfSport.*Appropriate* | numberOfStairs.*high* | numberOfSteps.*Few* | => | burnedCalories.*Normal* | 100 |
| .R10 | minutesOfSport.*Appropriate* | numberOfStairs.*normal* | numberOfSteps.*Few* | => | burnedCalories.*Normal* | 100 |
| .R11 | minutesOfSport.*Appropriate* | numberOfStairs.*low* | numberOfSteps.*Few* | => | burnedCalories.*Sedentary* | 100 |
| .R12 | minutesOfSport.*Few* | | numberOfSteps.*Few* | => | burnedCalories.*Sedentary* | 100 |
| .R13 | minutesOfSport.*Appropriate* | numberOfStairs.*low* | numberOfSteps.*Negligible* | => | burnedCalories.*Sedentary* | 100 |
| .R14 | minutesOfSport.*Appropriate* | numberOfStairs.*normal* | numberOfSteps.*Negligible* | => | burnedCalories.*Normal* | 100 |
| .R15 | minutesOfSport.*Appropriate* | numberOfStairs.*high* | numberOfSteps.*Negligible* | => | burnedCalories.*Normal* | 100 |
| .R16 | minutesOfSport.*Few* | | numberOfSteps.*Negligible* | => | burnedCalories.*Sedentary* | 100 |