1. [2 questions] Contextual knowledge

1.1. The field of "Artificial Intelligence" has grown significantly in the last decade, in a self-reinforcing relationship with two other areas of Computer Science.

➔ What are these two other areas? Explain and comment the “self-reinforcement”.

1.2. Imagine a dataset of mushrooms, all classified by experts according to their “culinary suitability”. The classification is made on a discrete scale of 10 levels, for example from 0/completely NOT suitable for culinary use, to 9/perfect for culinary use.

Each mushroom is a sample structured in 22 measurements, it doesn't matter exactly which ones, but you can imagine attributes such as “cap area”, “odor intensity”, etc.

Of these measurements, some are not direct observations, but the result of computations made using the entire data collection, such as average and/or normalization ops. For example, one of the measurements may indicate the factor by which the sample exceeds the average in “odor intensity”.

➔ When a model is trained with part of this dataset, do you see [yes or no?] a problem/advantage [what?] arising from the structure of the samples? Explain.

2. [2 questions] Distance Algorithms in Python

In this question you will work with hypothetical samples from a dataset, whose values depend on your own student number.

From the student number, 4 samples (o, r, d2, s) can be obtained, as lists:
o = list of digits of your student number;
r = list of the digits of your student number, in reverse order;
d2 = list, parallel to the lists o and r, where each component is the sum of the corresponding components in o and r, divided (integer division) by 2;
s = synthetic list, parallel to the lists o and d2, where each component is the sum of the corresponding components in o and d2, in even positions (indexing starting at zero), otherwise it is their difference (subtraction).
Example for the student with number “125”:
o = [1, 2, 5]
r = [5, 2, 1]
d2 = [3, 2, 3]
s = [4, 0, 8]

Consider that we intend to use a distance algorithm "minkowski_distance_no_root", which is identical to the Minkowski distance of order 2, except that the square root operation is not calculated.

➔ 2.1. Using your own student number, compute: minkowski_distance_no_root(o, s) ?

➔ 2.2. Code the Python function with signature:
def student_number_to_tuples(p_student_number:str)->tuple
that can be used to obtain the mentioned lists:
- it must receive a string corresponding to a student number;
- it must build the lists o, r, d2, s;
- it must return a tuple of those lists.

3. [2 questions] Bayesian approaches

A "new" system is being tested to replace another system, considered "perfect", but unacceptably expensive.
There are 4 variants of the "new" system, with very different costs: V1, V2, V3, V4.
The "perfect" system produces a large set of measurements per day. Over the course of several days, it was recorded how many times the variants V1, V2, V3, V4 worked exactly according to the "perfect" system.
When a variant coincides perfectly with the "perfect" system, there is a "P" situation; otherwise, there is a "NOT P" situation.
Here is a textual description of the results obtained:
There were, in total, 60 uses of the "new" system, 12 of the V1 type, 14 V2, 16 V3, 18 V4.
11 V1 reached P, 1 did not. 10 V2 reached P, 4 did not.
10 V3 reached P, 6 did not. 6 V4 reached P, 12 did not.

In total, 37 units achieved "P", 23 units did not.

➔ 3.1 Complete the table that summarizes the observed reality, in order to correspond to the textual description:

Variant	Number of installations of the variant with result "NOT P"	Number of installations of the variant, with result "P"	Relationship
V1	1	11	12/60
V2			
V3			
V4			
Totals	23	37	
Relationship	23/60	37/60	

➔ 3.2 What is the probability that the "new" system will not reach P, under the condition of using the V3 variant?

You don't have to do the math, just express the values that would be included in the calculation.

4. *[3 questions] Logic*

4.1 Answer T (True) or F (False), depending, respectively, on whether the following model M satisfies the Boolean expression that appears to the right of the satisfaction operator |=

➔ 4.1.1

M = {a/False, b/True, c/True}

M |= (a<=>b) or (a<=>c)

➔ 4.1.2

M = {a/False, b/False, c/False}

M |= (a<=>b) or not(a=>b)

➔ 4.2 Let a, b, c be any Boolean propositions.

Answer T (True) or F (False), depending, respectively, on whether or not there is a logical implication. If the answer is F, indicate ALL possible models that invalidate the logical implication:

(a<=>b) or (a<=>c) |= a

5. *[3 questions] Search*
Remember the search algorithms you studied.

➔ 5.1 What does it mean for an uninformed search algorithm if the "frontier"/"frontier" data structure becomes empty?

➔ 5.2 True (T) or False (F)?
The BFS (Breadth-First Search) algorithm will, always and guaranteed, find the optimal path/solution [assuming the studied scenario of a maze with unitary cost and the absence of situations that lead to infinite cycles].

➔ 5.3 True (T) or False (F)?
The DFS (Depth-First Search) algorithm never finds the optimal path/solution [assuming the studied scenario of labyrinths with unit cost and the absence of situations that lead to infinite cycles].

6. *[4 questions] Interpretation of NN-related solutions*

6.1 In multi-class classification problems, it is very common to encounter Python code like the following:

```
from sklearn import model_selection
X_train, X_test, y_train, y_test =\
model_selection.train_test_split (samples, labels)
```

In the context of this code, answer T (True) or F (False)

➔ 6.1.1 len(y_train)>len(X_train)

➔ 6.1.2 Typically, len(y_test)>len(y_train)

➔ 6.1.3 X_test represents a function that performs tests on samples.

6.2 A programmatic model/neuronal network based on the Keras framework, for image classification, was created as follows:

```
from keras.models import Sequential
from keras.layers import Dense

iUnits = 16
model = Sequential( [
    Dense(iUnits, activation="relu", input_shape=(64*64,)),
    Dense(iUnits, activation="relu"),
    Dense(16, activation="softmax")] )
```

➔ What is the number of parameters in the first layer of the network? Just present the mathematical expression, there is no need to calculate the value.