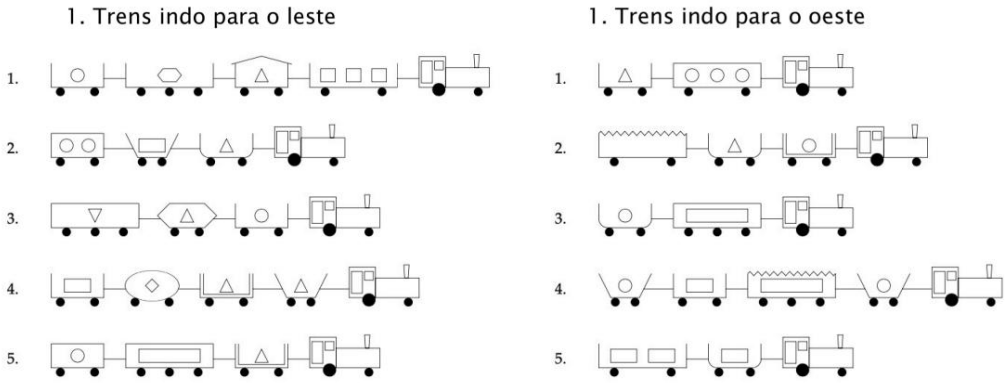
Poder Executivo
Ministério da Educação
Universidade Federal do Amazonas
Instituto de Computação - IComp

UFAM

Subject: Artificial Intelligence	3rd Assessment and Final work	Date: 7/3/23
Teachers: Edjard Mota	Class:	

Example of the Michalski train. The goal is to classify which trains go east and which go west.



For each train we have the following attributes:

1.number of wagons *(car* in English) (value between 3 to 5)
2.number of different loads it can carry (value between 1 to 4)
3.for each wagon of a train:
a) the number of axles with wheels (value between 2 and 3)
b) the length (short or long value)
c) the shape of the wagon body, and it can be 1.closed-rectangle, 2.open-rectangle
3.double rectangle-open
4. ellipse
5. locomotive
6. hexagon
7.toothed top
8.open trapeze
9. triangular-closed top
d) number of loads in the wagon (0 to 3)
e) the shape of the load (circle, hexagon, rectangle or triangle)

Then, 10 boolean (propositional) variables describe whether or not any pair of cargo types are in adjacent train cars (since each car carries a single type of cargo).

charge).
Information that may be useful in your model: We have the following relations with respect to the cars of a train, whose logical value varies between -1 (False) and 1 (True).

1. there is a rectangle next to a rectangle (V or F)
2. there is a rectangle next to a triangle (V or F)
3. there is a rectangle next to a hexagon (V or F)
4. there is a rectangle next to a circle (V or F)
5. there is a triangle next to a triangle (V or F)
6. there is a triangle next to a hexagon (V or F)
7. there is a triangle next to a circle (V or F)
8. there is a circle next to a circle (V or F)

There is a single class attribute that defines the direction of a train: *east* or *west.*
Note that for multivalued attributes you must assign numerical values in the order in which they appear. For example, the payload type should be 1 to denote circle, 2 for hexagon, 3 for rectangle, and so on. Corresponding neurons must use linear activation function, ie *h(x)* = x.

Question1. Implement a neural network **that classifies when a given train goes east or west.** You use as output layer activation function a hyperbolic tangent and use output “1” for east and “-1” for west.
Perform the following experiments:

1. Repeatedi=1 tonumMAX_East(in this case numMAX_East=5)
The. Leave out of network training: one shivering for west and two(2) cases for east, sei<5 **so** take casei
and casei+1
else getcasocasoi ecasoi-4 **b.** (first and last cases)
train your network with the remaining cases
w. testyournetworkwithselectedcases(case3)
2. Compare effectiveness to home experiment.
3. Repeat steps one and two except that now train the network by removing two train going west and a train going east.
4. Compare test effectiveness and report.

Question2. Implement a solution based on the relational learner model containing meta-networks to connect assumptions concepts. This models should contain 11 networks, one for each of the following concepts as defined on pages 136 and 137:

1. *num_cars(t,* nc), where *t* ÿ [1..10] and *nc* ÿ [3..5].
2. *num_loads(t, nl)* where *t* ÿ [1..10] and *nl* ÿ [1..4].
3. *num_wheels(t, c,* w) where *t* ÿ [1..10] and *c* ÿ [1..4] and *w* ÿ [2..3].
4. *length(t, c,* l) where *t* ÿ [1..10] and *c* ÿ [1..4] and *l* ÿ [-1..1] (-1 denotes short and 1 long)

5.shape(t, c, s) where *t* ÿ [1..10] and *c* ÿ [1..4] and *s* ÿ [1..10] (one number for each shape).

6. *num_cars_loads(t, c, ncl)* where *t* ÿ [1..10] and *c* ÿ [1..4] and *ncl* ÿ [0..3].

7. *load_shape(t, c, ls)* where *t* ÿ [1..10] and *c* ÿ [1..4] and *ls* ÿ [1..4].
8. *next_crc(t, c,* x) where *t* ÿ [1..10] and *c* ÿ [1..4] and *x* ÿ [-1..1], where wagon *c* of the train *t* has an adjacent wagon with loads in a circle.
9. *next_hex(t, c,* x) where *t* ÿ [1..10] and *c* ÿ [1..4] and *x* ÿ [-1..1], where wagon *c* of the train *t* has an adjacent car with hexagon loads.
10. *next_rec(t, c,* x) where *t* ÿ [1..10] and *c* ÿ [1..4] and *x* ÿ [-1..1], where wagon *c* of train *t* has an adjacent boxcar with rectangle loads.
11. *next_tri(t, c,* x) where *t* ÿ [1..10] and *c* ÿ [1..4] and *x* ÿ [-1..1], where wagon *c* of train *t* has an adjacent car with triangle loads

COMPARE your model results from question 1 with this question (2 in this case), and

The. explain the reason for the differences based on the architectural characteristics of the two models and numerical results.

B. Check, if it is possible to extract from the two models the following generic rule that classifies trains going east (east), just describe how the extraction would be based on the extraction algorithm seen in the room (and in the class material). : **car(T,C)ÿshort(C)ÿclosed_top(C) ÿ east(T)**

If not, what is missing from the description?

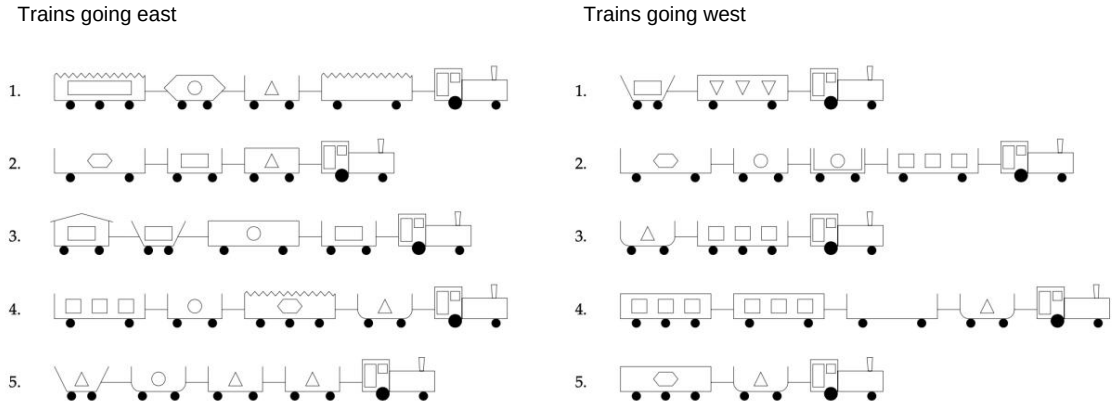
Question3. Extend your templates from questions 1 and 2 to more case types as shown in Figure 2.

The. Repeating the same experiment, now for numMAX_Leste = 10.

B. Mix the two sets of data (from the two Figures), and repeat the experiments and make the same analysis.

w. Analyze whether it is possible to apply your rule extraction description to derive the generic rule raised in question 2.b. Explain your conclusions with arguments based on your experiments and purpose of extracting rules and explaining the network as seen in the provided material on extraction (Article by Garcez, Borda and Gabbay KnowledgeExtraction.pdf file)

Note that in both scenarios the trains going east have the same number of cases as those going east,



What must you deliver?

Your solution available on github, code and data: **DON'T SEND COMPACT FILE!!!** Leave everything on git hub, and **if you use Colab indicate it** on github.

What must you deliver?

1. The overleaf report in tex format and a txt file with **a HOW TO on how to execute your solution for the 3 questions.** Do not put files that are in local post!!!!! Leave everything in git folders that can be read from the paste itself or when cloned locally.

2. Report in the tex template similar to the example work provided, which contains the sections:
   1. A Theoretical Reference that briefly describes neuro-symbolic learning systems (use chapter 4 of the book as a basic reference, but get other references - see the list of articles on the course website), 2. Description of the
   train problem **(write the description), including pictures for each metanet,**
   3.Check that your solution classifies correctly according to the following theories
      A. If a train has a short closed car, then it goes east, otherwise it goes west (note that this is a textual description of the logical rule in question 2.b)

      B. If a train has two cars, or has a car with an uneven roof, then it goes west, otherwise it goes east C. If a train has more than
      two different types of cargo, then it goes east. east, otherwise go west