NARS Project 1: "Fuzzy Logic"

Fuzzy logic is a form of many-valued logic in which the truth values of a proposition may be any real number between 0 and 1. It is employed to handle concepts of graded membership and proposition of partial truth with completely true and completely false.

NAL is not a fuzzy logic in the conventional sense, though shares certain intuitions and ideas with it. In NAL, fuzziness typically comes from the diversity in the *intension* of a term, that is, an instance may have some, but not all, properties that are usually associated with the concept. For example, “Penguins are birds" is true to a degree, because penguins do not have all the common properties of birds, but only some of them. This distinguishes it from the other common forms of uncertainty, randomness, as randomness typically comes from the diversity in the *extension*. For example, “birds fly" is true to a degree, because some birds fly, and some do not. These two types of uncertainty are uniformly represented and processed in NAL, as different ways for a categorical statement to get (positive and negative) evidence.

In the following, you will see an example about how NARS handles fuzzy concepts in two approaches.

John is a boy whose height is 180cm. The statement “John is a tall boy” is true to a degree because John is not the tallest guy in this world, but in some groups he is considered as “tall” relative to the other heights in that group. He could also be considered as “not tall” if he is in a group such as the NBA, where the average height is much higher than normal. It really depends on the amount of positive evidence (data that support the statement) versus the amount of negative evidence (data does not support the statement).

Approach No.1:

The first approach can be used when we know the exact value for everyone’s height

We have a set of data about heights of football players

John	Mike	Bill	Patrick	Dan	Dylan	Dante	Robert	Peter	Edward	Joe
178cm	182cm	189cm	192cm	175cm	168cm	183cm	178cm	179cm	188cm	187cm

The question is if Dante is tall?

First, let see our positive evidence for this statement. Dante's height is 183cm, and the player in the table down below are shorter than Dante which support the statement that Dante is tall,

John	Mike	Dan	Dylan	Robert	Peter

178cm	182cm	175cm	168cm	178cm	179cm

and the negative evidence for this statement is:

Bill	Patrick	Edward	Joe
189cm	192cm	188cm	187cm

From the table of positive evidence, the amount of positive evidence is the total of differences between Dante's height and the heights of players who is shorter than Dante.

Dante's Height - John's Height = 183 - 178 = 5
Dante's Height - Mike's Height = 183 - 182 = 1
Dante's Height - Dan's Height = 183 - 175 = 8
Dante's Height - Dylan's Height = 183 - 168 = 15
Dante's Height - Robert's Height = 183 - 178 = 5
Dante's Height - Peter's Height = 183 - 179 = 4

Total = 5 + 1 + 8 + 15 + 5+ 4 = 38

From the table of negative evidence, the amount of negative evidence is the total of absolute value of differences between Dante's height and the heights of players who is shorter than Dante.

Dante's Height - John's Height = |183 - 189| = 6
Dante's Height - Mike's Height = |183 - 192| = 9
Dante's Height - Dan's Height = |183 - 188| = 5
Dante's Height - Dylan's Height = |183 - 187| = 4

Total = 6 + 9 + 5 + 4 = 24

Hence positive evidence $w^+ = 38$, negative evidence $w^- = 24$, total amount of evidence = 62

The truth values of the statement are

$$f = \frac{w^+}{w} = \frac{38}{62} = 0.61$$

$$c = \frac{w}{w+1} = \frac{62}{62+1} = 0.98$$

The representation of the statement in Narsese is <Dante --> [Tall]>. %0.61;0.98%

This approach does not require you to do it with the system, you can do it manually.

Approach No.2:

When we don't know the exact number of everyone's height, then how do we define if someone is tall? If we know some of the relative relations between members of the group, we can use these to infer the 'height status' of a given member. In this approach, we can represent relations between everyone's height and use the reasoning system to do inference. For example, here is a set of possible relations between group members.

```
//John is a boy
<{John} --> boy>.
//Tom is taller than John
<{John} --> (/,taller_than,{Tom},_)>.

//Tom is a tall boy?
<{Tom} --> (/,taller_than,_,boy)>?

//David is a boy
<{David} --> boy>.
//Tom is not taller than David
(--,<{David} --> (/,taller_than,{Tom},_)>).

//Karl is a boy
<{Karl} --> boy>.
//Tom is taller than Karl
<{Karl} --> (/,taller_than,{Tom},_)>.
```

If you try those input in the system, you will see following display

```
IN: <{John} --> boy>. %1.00;0.90% {0 : 1}
IN: <{John} --> (/,taller_than,{Tom},_)>. %1.00;0.90%
5
IN: <{Tom} --> (/,taller_than,_,boy)>?
246
//Answer: Tom is tall a tall boy with frequency 1.00 and confidence 0.45
OUT: <{Tom} --> (/,taller_than,_,boy)>. %1.00;0.45%
5
IN: <{David} --> boy>. %1.00;0.90%
IN: (--,<{David} --> (/,taller_than,{Tom},_)>). %1.00;0.90%
113
//Now the truth value of if Tom is a tall boy changes to frequency 0.50, confidence 0.62
```

OUT: <{Tom} --> (/,taller_than,_,boy)>. %0.50;0.62%
22
IN: <{Karl} --> boy>. %1.00;0.90% {391 : 6}
IN: <{Karl} --> (/,taller_than,{Tom},_)>. %1.00;0.90%

141
//Now the truth value of if Tom is a tall boy update to frequency 67, confidence 0.71
OUT: <{Tom} --> (/,taller_than,_,boy)>. %0.67;0.71%.

YOUR TASK

Now you have learned two ways about how NARS/NAL handles fuzzy concepts. The assignment is to design your own fuzzy logic problem that can be handled by NARS/NAL. This will require creating your own set of data, as well as your own set of relations.