

AE4M33RZN, Fuzzy logic: Assignment

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Scenario

Imagine that Amazon decides to extend their IMDB database to include music. They are not satisfied with *last.fm*-style textual description about musicians and decide to include structural knowledge, similarly to the IMDB database of actors, their roles, etc. As a clever company, they use linked data to easily extract information from other sources such as Wikipedia. In order to capture vagueness, *fuzzy description logic* becomes the language of choice.

Your job is to help them implement the prototype of the ontology and test it on two famous folk singers Bob Dylan and Joan Baez.



Bob Dylan and Joan Baez during the March on Washington for Jobs and Freedom (where Martin Luther King, Jr. had his famous speech). Source: Wikipedia

Task description

Your initial prototype of the ontology looks as follows:

```
1 # There was a close collaboration between Bob Dylan and
2 # Joan Baez during the American folk music revival.
3 (related BobDylan JoanBaez collaborated 0.9)
4
5 # Both musicians performed during the Freedom March...
6 (instance JoanBaez FreedomMarchPerformer)
7 (instance BobDylan FreedomMarchPerformer)
8 # ...but only Joan Baez went to Woodstock.
9 (instance JoanBaez WoodstockPerformer)
10 (instance BobDylan (not WoodstockPerformer))
11
12 # We all know there were 2 major folk events during 60's:
13 (implies (or FreedomMarchPerformer WoodstockPerformer) FolkSinger 0.9)
14
15
16 # Folk singers' collaborators are folk singers (to some degree).
17 (implies FolkSinger (some collaborated FolkSinger) 0.7)
18
19 # Have you ever seen a folk singer, who plays an electric guitar?
20 # (And if so, did you really believe him to be a genuine folk singer?)
21 (implies PlaysElectricGuitar (not FolkSinger) 0.3)
22
23 # Well, Bob Dylan, the icon of folk, in fact played the electric...
24 (instance BobDylan PlaysElectricGuitar)
```

1. **Get in the mood:** <https://www.youtube.com/results?q=joan+baez+bob+dylan>
2. **Convince yourself that the ontology is inconsistent. Explain the inconsistency and identify axioms which cause it. Use plain English, no formal proof is needed (though welcome). [1p.]**
3. **Repair the ontology and make it consistent. Replace OR by AND on line 13. State the fuzzyDL query to verify that Joan Baez is still a folk singer. [1p.]**

4. FuzzyDL reasoner should tell you that BobDylan is a FolkSinger by no more than 0.7:

Is BobDylan instance of FolkSinger ? ≤ 0.7

Prove this by simulating the fuzzyDL reasoner by hand. You may ignore axioms that are irrelevant to this computation.

- Translate the ontology into a mixed-integer-linear-programming problem. [2p.]
- Simulate the MILP solver. Using high-school algebra (and a bit of intuition), solve the inequalities to show

$$\text{lub}(\mathcal{H}, \langle \text{BobDylan} : \text{FolkSinger} \rangle) = 0.7.$$

Start by deciding which x_i variable to optimize. Will you maximize or minimize it? [3p.]

5. Compare the informal description on line 16 with the axiom on line 17. Do they correspond to each other?
- State the fuzzyDL axiom correctly. [1p.]
 - The min/max membership of individuals JoanBaez and BobDylan to some atomic concepts has changed. Which concepts are they? [1p.]
 - Support your answer by running the fuzzyDL reasoner on your computer. [1p.]
6. Support your answers from the previous point by a hand-written simulation of the reasoner. Focus on the difference between the correct and incorrect version of the axiom on line 17. [4p.]
7. Define the concept of a Multigenre singer, who is a “folk a singer” and “not a folk singer”. Compare the membership degree for $\hat{\mathfrak{S}}$ and $\hat{\mathfrak{A}}$. Why is there a difference? [1p.]

Additional information

- You are asked to submit one PDF document with your answers and a TXT file with the modified ontology. The deadline is 23/11/2014 at 23:59. Your work should be sent to the upload system.
- A detailed description of the LISP-like syntax can be found on the reasoner’s homepage: <http://gaia.isti.cnr.it/straccia/software/fuzzyDL/fuzzyDL.html>