CIT, DEPARTMENT OF COMPUTING

COMP9016 Lab #4 (DRAFT)

Dr Ruairi O'Reilly

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1 LOGIC

It is critical for the successful completion of the first assessment that you have a competent understanding of Propositional Logic, First-Order Logic and Inference in First-Order Logic. Launch your IDE, Jupyter Notebook. Navigate to and click on "logic.ipynb" - You are to review this notebook as it will provide you with a grounding in the practical implementation of logic using python.

1.1 FIRST-ORDER LOGIC

1. A logical knowledge base represents the world using a set of sentences with no explicit structure. An analogical representation, on the other hand, has physical structure that corresponds directly to the structure of the thing represented. Consider a road map of your country as an analogical representation of facts about the country—it represents facts with a map language. The two-dimensional structure of the map corresponds to the two-dimensional surface of the area.
    - Give five examples of symbols in the map language.
    - An explicit sentence is a sentence that the creator of the representation actually writes down. An implicit sentence is a sentence that results from explicit sentences because of properties of the analogical representation. Give three examples each of implicit and explicit sentences in the map language.
    - Give three examples of facts about the physical structure of your country that cannot be represented in the map language.
    - Give two examples of facts that are much easier to express in the map language than in first-order logic.

- Give two other examples of useful analogical representations. What are the advantages and disadvantages of each of these languages?

2. Consider a knowledge base containing just two sentences: P (a) and P (b). Does this knowledge base entail $\forall_x P(x)$? Explain your answer in terms of models.

3. Is the sentence $\exists_{x,y}\ x = y$ valid? Explain.

4. Which of the following are valid (necessarily true) sentences?

   a) $(\exists_x\ x = x) \implies (\forall_y \exists_z\ y = z)$

   b) $\forall_x\ xP(x) \vee \neg P(x)$

   c) $\forall_x\ Smart(x) \vee (x = x)$

5. Consider a vocabulary with the following symbols:

   Occupation(p, o): Predicate. Person p has occupation o.

   Customer (p1,p2): Predicate. Person p1 is a customer of person p2.

   Boss(p1,p2): Predicate. Person p1 is a boss of person p2.

   Doctor , Surgeon, Lawyer , Actor : Constants denoting occupations.

   Emily, Joe: Constants denoting people.

   Use these symbols to write the following assertions in first-order logic:

   a. Emily is either a surgeon or a lawyer.

   b. Joe is an actor, but he also holds another job.

   c. All surgeons are doctors.

   d. Joe does not have a lawyer (i.e., is not a customer of any lawyer).

   e. Emily has a boss who is a lawyer.

   f. There exists a lawyer all of whose customers are doctors.

   Every surgeon has a lawyer.

1.2 Review

Congrats on having completed your lab on first order logic, this is a necessary topic for pursuing some of our later work as part of COMP9016!