EECS 371
HW 1
Due 1/17/2019 1:59 p.m.

In this assignment, you are going to represent knowledge in first-order logic (FOL). All of the knowledge you will be representing relates to undergraduate CS degree requirements.

You will begin by defining objects, then atomics sentences for types, attributes, relationships, and functions, and finally complex sentences. For each of the prompts below, you will be asked to describe your representation and write statements in first-order logic. Be sure to include quantifiers (where applicable) and definitions of all terms. For consistency and to make it easier to read, make variables a single lower-case letter and all objects and predicates start with a capital letter.

You will submit your assignment via Canvas. The submitted document must be a PDF. You can work in whatever environment you want (MS Word, Google Docs, Latex, etc.), but be sure to use the proper symbols (i.e., $\land$, $\lor$, $\Rightarrow$, $\forall$, $\exists$). All of these environments support these symbols and generating PDFs.

1. Objects
First, we will define the objects of the domain, including persons, places, physical objects, and conceptual objects.
We are considering the undergraduate CS degree requirements, in general and not specific to any person. Thus, we do not need any objects that represent individual people. However, in the following steps, you will be defining knowledge and how it relates to a person.

1. Courses are the primary object that you need to represent. Define an object for the following courses:
   (Don't overthink this, you are simply defining a few constants. Name the constant and tell us what the constant represents.)
   a. CS 111
   b. CS 211
   c. CS 321
   d. CS 330
   e. CS 335
   f. CS 338
   g. CS 348
   h. CS 371

2. Types and attributes
You need to represent some types and attributes for the courses.
1. Represent that a course is a CS course.
    a. What is the name of the type?
    b. Use the type to represent each of the following:
        a. CS 111 is a CS course
        b. CS 211 is a CS course
        c. CS 348 is a CS course
        d. CS 371 is a CS course

2. For each of the courses you have defined, represent that courses can have an attribute defining whether the course qualifies as an AI, Systems, Theory, Interface, or Software Development course. For each of the following, name and define the attribute and represent the listed courses as having that attribute:
    a. AI
        ■ CS 348 is an AI course
        ■ CS 371 is an AI courses
    b. Systems
        ■ CS 321 is a Systems course
    c. Theory
        ■ CS 335 is a Theory course
    d. Interfaces
        ■ CS 330 is an Interface course
    e. Software development
        ■ CS 338 is a Software development course

3. Relations
You are now ready to define relations between courses and students. In order for a student to get credit for a course, a student needs to pass the course. Define a relation between a student and a course to represent a student passing the course.
1. What is the name of the relation? What is the arity of the relation?
2. Give three examples of how it is used. For example, represent that student XYZ123 has passed CS 371.

4. Functions
Each CS course is worth some number of credits. We want to represent the number of credits as a function of the course. Define a function to represent the number of credits for the course.
1. What is the name of the function? What is the arity of the function?
2. Demonstrate how the function is used by representing the following:
    a. CS 371 is a 1 credit course.
    b. CS 371 and CS 348 are worth the same number of credits.
    c. All CS courses are worth 1 credit

5. Complex sentences
For each of the following, define a complex sentence in FOL that represents the stated degree requirement. Use the constants, properties, relations, and functions defined above where applicable. You will also want to define additional representation (e.g. to represent meeting a degree requirement). Before using any new representation, define it first (name it, describe what it represents and how it is used).

1. To meet the credits requirement, students need to earn 16 credits in CS courses.

2. To meet the breadth requirement, students need to take at least one course from each category: AI, Systems, Theory, Interfaces, and Software Development.

3. To meet the depth requirement, students need to take six technical electives.

4. To be granted a CS degree, a student needs to complete the credits requirement, the breadth requirement, and the depth requirement.