Temporal Reasoning and Planning in Medicine
Homework #1

To answer questions 1 and 2, refer to the class notes on predicate calculus (First Order Logic), on Prior’s Tense Logic, and on Allen’s temporal logic, as well as to the Allen 1984 and Allen and Hayes 1985 papers.

1. Using Prior’s notation, we can write the two following predicates:

- \( P \exists patient \ (\text{diagnosis}(patient, \text{tuberculosis})) \)
- \( \exists patient \ P(\text{diagnosis}(patient, \text{tuberculosis})) \)

1.1. Explain in your own words exactly what each expression means, and why is their meaning different in Prior’s logic. Create two convincing examples to demonstrate that there might be two mutually exclusive interpretations.

1.2. Explain why the distinction between the two expressions is meaningless in standard First Order Logic (predicate calculus).

1.3. Write, using Tense Logic notation, an expression that means “Patient Jones will have had the operation.” – use expressions such as “procedure(Jones, Operation)”.

2. Explain how, using only the “meet” relation between temporal intervals, and one or more interval variables and existential quantifiers, we can define the following relations:

2.1. The relation “A includes B”
2.2. The relation “A overlaps B.”

2.3. If you answered parts 1 and/or 2, answer the following: What is the computational advantage of using 13 different temporal relations as opposed to only one relation? Think about applications such as theorem proving, planning, temporal queries, storage and retrieval of data.

To answer questions 3 to 5, refer to your class notes on the situation calculus and Shoham’s temporal logic.

3. Create a set of situation calculus axioms to express the following facts:

3.1. The effect of the action of entering the room by a robot, when the robot is at the door, is that the robot is inside the room. Use expressions such as At(Door, Robot), Enter(Robot, Room), Within(Room, Robot).

3.2. Explain the semantics of the predicates and/or functions you are using in terms of sets of states.

3.3. Can we express in the situation calculus the fact that the robot is looking at the road while moving from one building to another? How, or Why?

4. What is the representational advantage of a reified logic, in which temporal arguments are explicitly separated from the rest of the predicate?

5. Consider the following 4 propositions:

A  Mark had a complete removal of the appendix on January 15 1988 between 6 to 9 PM.
B  Joe has earned $3000 during February 1999.
C  Mary had mild anemia during March to May 1997
D  Peter was occasionally using insulin shots during July and August 1995.

5.1. Indicate in a small table what are the temporal-proposition properties of each proposition with respect to the properties Downward-hereditary(DH), Upwards-hereditary(UH), Gestalt (G), Concatenable [C], and Solid (S), as defined by Shoham.

5.2. What is the ontological type of each proposition according to Allen.

5.3. What is the ontological type of each proposition according to McDermott.

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