

CSE 4/563 Knowledge Representation
Professor Shapiro
Homework 4
Maximum Points: 27
Due: 1:30 PM, Thursday, October 14, 2010

Name(s)⟨user name(s)⟩: _____

October 7, 2009

You must turn in the answers to this homework set in a submitted file by 1:30 PM on the date shown above.

The submitted file must be named `hw4.ext`, for an appropriate value of `ext`. **Include your name(s) and user name(s) at the top of the file.** Submit that file by executing the Unix command

```
submit_cse463 hw4.ext
```

or

```
submit_cse563 hw4.ext
```

whichever is appropriate for you. The file can be a text file, or produced by some word processing software, but it must be formatted so it is easy to read.

1. (3) In modular arithmetic, there are only a finite number of distinct integers. For example in mod 3 arithmetic, the only integers are 0, 1 and 2, and two equations are $1+2=0$ and $2+2=1$. Translate $\forall x \exists y (hasSuccessor(x, y))$ into Ground Predicate Logic assuming that the only individual constants are 0, 1, and 2. Show every step.

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2. (24) In this question, you will investigate using decreasoner for model finding in Finite-Model Predicate Logic. We will use a version of CarPool World in which there are four people,

- [Tom] = Tom
- [Betty] = Betty
- [John] = John
- [Mary] = Mary

each with their own car,

- [TomsCar] = Tom's car
- [BettysCar] = Betty's car
- [JohnsCar] = John's car
- [MarysCar] = Mary's car

It will be convenient to have a unary function, `CarOf` that maps a person to that person's car, and we will use two binary predicates,

- `[DriverOf (person, car)] = [person] is the driver of [car]`
- `[PassengerIn (person, car)] = [person] is a passenger in [car]`

On each day in this version of CarPool World, the four people might each drive their own car, or they might team up in any combination of fewer than four cars.

The syntax of decreasoner's Propositional Logic is given on the System Documentation page of the course web site, but you also need to know the following.

- We will use two sorts: `person` and `car`.
- A variable is its sort followed by zero or more digits, such as `person` or `car56`.
- The universal quantifier is square brackets around its variable, such as `[person]`.
- The existential quantifier is curly brackets around its variable, such as `{car52}`.
- You may form an atomic formula with an infix "=", such as `(person = Tom)`, or, for inequality with an infix "!", such as `(car56 != BettysCar)`.
- Decreasoner will assume that each individual constant is equal to itself, and not equal to any other individual constant. This is called "the unique names assumption."
- When decreasoner finds models, it will only consider as atomic formulas formulas with individual constants as terms. Every functional term must have a defined value that is an individual constant.

- (a) (3) How many ground atomic formulas (not containing functional terms) are in this logical language?
- (b) (18) Make a copy of the file `/projects/shapiro/CSE563/Examples/Decreasoner/4pCarPoolWorld`.
e. Formalize the following domain rules in the syntax of decreasoner, add them to your copy of the file and put them in your answer file here.
- (3) Every person is either a driver of some car or a passenger in some car.
 - (3) No person is both a driver of some car and a passenger in some car.
 - (3) Someone drives a car only if it is their car.
 - (3) If someone is a passenger in some car, there is some driver of that car.

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- v. (6) One more domain rule is needed. Decide what it is by running `ubdecreasoner` on your copy of `4pCarPoolWorld.e` with the above domain rules, and see what is wrong with the models that are found.
- A. (3) Write that domain rule in English here, and add it as a comment in your copy of `4pCarPoolWorld.e`
 - B. (3) Write that domain rule in the syntax of `decreasoner` here and in your copy of `4pCarPoolWorld.e`.
- (c) (1) submit your copy of `4pCarPoolWorld.e`.
- (d) (2) Run your copy of `4pCarPoolWorld.e` by executing the following Linux commands on `timberlake` or `nickelback`.
- ```
cd /projects/shapiro/CSE563/decreasoner
python ubdecreasoner.py <full path-name of your copy of 4pCarPoolWorld.e>
```
- and put a copy of that run in your answer file here.