EFIT Assignment Applied Logic

Tue 19 Jan 2021

16:30 - 18:00, R10

Teachers: Geurts, Andova

For all exercises:

- upload the smt file (i.e. the z3-input text file) with ***explanation of the clauses***
- upload the output file (this can also be a screen shot of the cmd-window)

<u>Exercise 1 (10 points)</u>

We play a game with marbles.
Initially, we have 4 marbles.
We play 5 steps.
In every step either the number of marbles is doubled, is incremented by 7, or is decreased by 5.
Use z3 to see whether it is possible to end up with 5 marbles after doing exactly 5 such steps.
If it is possible: give the action for that step (doubling, incrementing, decreasing) and the number of marbles at that moment.
If it is not possible: give a short description why.

Proposal for a model, where `(M i)` represents the number of marbles at the i^{th} step:

```
(declare-fun M (Int) Int))
```

<u>Exercise 2 (10 points)</u>

In this 9x9 Logic Equation you have to find unique integer values for the variables (ranging from 1 to 9) to make all statements true.

Variables: A, B, C, D, E, F, G, H

$4 \cdot F = E$

$I = G \cdot H$

if $C + E \neq 12$ then $G = D + E + 2$

$B = A + H$

$A + G \neq C$

Exercise 3 (20 points)

After the introduction, 3 questions follow. Each question has two answers, one is correct, the other is wrong. Find the correct ones.

Take care about the following:

- Give an explanation of your model: use meaningful names and describe what they represent
- If you use functions (like `(define-fun Abc …)`), describe their functionality
- For *all* clauses in your smt-file, write the corresponding English text above, for example as a comment (i.e. preceded with a ';')
- For each question, only the clauses of the introduction hold (so *not* the clauses of the preceding question).
  You may put those preceding clauses in a comment such that they are de-activated, or: you can start a new file for each question.

Introduction:

During the weeklong grand opening of a new antique shop, the antique dealer will auction exactly one antique per day for six consecutive days—June 1st through June 6th.
The antiques to be auctioned are: a harmonica, a lamp, a mirror, a sundial, a table, and a vase.
The following conditions apply:

- The sundial is not auctioned on June 1st.
- If the harmonica is auctioned on an earlier date than the lamp, then the mirror is also auctioned on an earlier date than the lamp.
- The sundial is auctioned on an earlier date than the mirror and also on an earlier date than the vase.
- The table is auctioned on an earlier date than the harmonica or on an earlier date than the vase, but not both.

Questions:

a) Which one of the following could be an accurate list of the six antiques, in the order in which they are auctioned, from June 1st through June 6th?
   i) harmonica, sundial, table, mirror, lamp, vase
   ii) sundial, lamp, harmonica, mirror, table, vase
b) Which one of the following could be true?
   i) The table is auctioned on June 2nd and the lamp is auctioned on June 3rd.
   ii) The sundial is auctioned on June 2nd and the vase is auctioned on June 3rd.
c) If the table is auctioned on a date that is later than both the date on which the mirror is auctioned and the date on which the vase is auctioned, then which one of the following could be true?
   i) The mirror is auctioned on an earlier date than the vase.
   ii) The sundial is auctioned on an earlier date than the lamp.