CISC/CMPE422, CISC835

Practice Questions for Midterm 2

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Question 1: Metamodels and satisfying instances

Consider the Alloy specification `Elevator` given below:

```
module Elevator

sig Person {}

abstract sig Door {}
one sig Open extends Door {}
one sig Closed extends Door {}

abstract sig Movement {}
one sig Up extends Movement {}
one sig Down extends Movement {}
one sig None extends Movement {}

sig Elevator {
        at : Floor,
        inside : set Person,
        movement : Movement,
        door : Door}
sig Floor {
        up : lone Floor,
        waiting : set Person}
one sig FirstFloor extends Floor {}
one sig TopFloor extends Floor {}
```

a) Draw the *metamodel* (also called *class diagram* in UML) of the Alloy specification `Elevator`. Make sure you include multiplicity constraints as appropriate.

b) Draw an *instance* satisfying all the constraints expressed in the Alloy specification `Elevator`. Your instance should contain at least one `Elevator` object and one `Person` object.

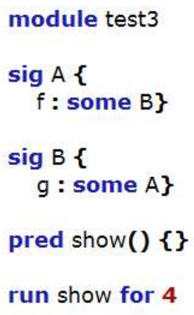
Question 2: Formalization in Alloy

Given the Alloy specification `Elevator` from Question 1 for each of the following statements, write down an Alloy formula (or a collection of Alloy formulas) that expresses that statement. Beware of implicit universal quantifications!

a) *"Relation* `up` *connects all floors in an acyclic, linked list starting with* `FirstFloor` *and ending in* `TopFloor`*".*
b) *"The door of an elevator is only open if it is not moving".*
c) *"A person cannot be inside an elevator and waiting at a floor at the same time".*
d) *"A person can only be inside at most one elevator".*
e) *"A person is either inside some elevator or waiting at some floor".*

Question 3: Alloy language

Consider the Alloy specification `test3` on the left and the instance satisfying all constraints in `test3` produced by the Alloy analyzer on the right.



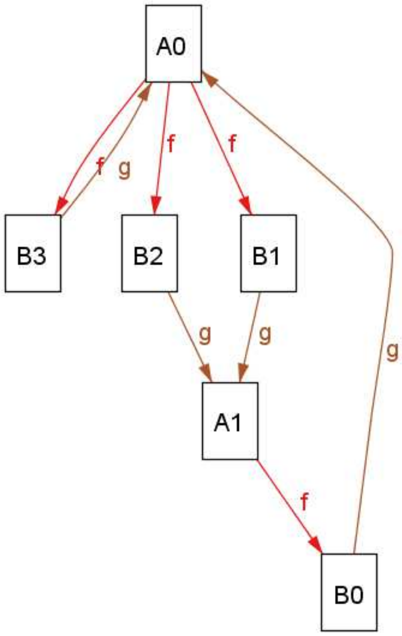
```
module test3

sig A {
  f : some B}

sig B {
  g : some A}

pred show() {}

run show for 4
```



For each of the following Alloy expressions and formulas, determine which value the expression or formula evaluates to in the instance on the right and write down that value.

a) `f.g` evaluates to:

b) `some a:A | no a.f` evaluates to:

c) `f = ~g` evaluates to:

d) `some a:A | one a.f` evaluates to:

e) `{a:A | a in f.g.a}` evaluates to:

f) `(A -> B) - f` evaluates to: