CS 245 — Assignment #7
Spring 2006

Due Date: Tuesday, July 11 at 5pm.

Use `makeCover` to produce a cover page for your assignment and hand in your assignment in the CS 245 assignment box. Assignments are to be done individually.

1. (15 points) Formalize the following sentences in set theory. Do not use types, quantifiers, or set comprehension. Use only the following sets and relations in your formulas:

$People$	– the set of all people
CS	– the set of all CS students
$Books$	– the set of all books
$SciFi$	– the set of all science fiction books
$Poetry$	– the set of all poetry books
$owns : People \leftrightarrow Books$	– the relationship between people and the books they own
$reads : People \leftrightarrow Books$	– the relationship between people and the books they read

   where $CS \subset People$, $SciFi \subset Books$, $Poetry \subset Books$

   Sentences to formalize:

   1. Fred owns "War and Peace" but hasn't read it.

      $$(\text{Fred}, \text{WarAndPeace}) \in owns \ \wedge \ (\text{Fred}, \text{WarAndPeace}) \notin reads$$

   2. Not every CS student reads books that are not science fiction.

      $$\text{dom}((CS \lhd reads) \rhd (Books - SciFi)) \subset CS$$

   3. Some CS students read poetry books, but not all of them do.

      $$(\text{dom}((CS \lhd reads) \rhd Poetry) \neq \emptyset) \wedge (\text{dom}((CS \lhd reads) \rhd Poetry) \subset CS)$$

   4. Everyone who is not a CS student and doesn't own science fiction books reads some poetry books.

      $$(People - CS) \cap (People - \text{dom}(owns \rhd SciFi)) \subseteq \text{dom}(reads \rhd Poetry)$$

   5. Some people have read all of the books that they own.

      $$\text{dom}(owns) - \text{dom}(owns - read) \neq \emptyset$$

2. (15 points) Specify the following graduate student contact management system for a professor using Z.

A professor meets with her graduate students at least once each week. Each of her meetings is with an individual graduate student. She can have multiple meetings with the same graduate student each week, but there is a maximum number of meetings that she can have in a week. Each graduate student is either a Master's student or a PhD student. The following operations can be carried out on her schedule. Describe a schema for each operation:

1. Schedule a meeting with a graduate student at a certain time provided the professor does not already have a meeting at that time.
2. Cancel a meeting with a graduate student at a certain time provided the professor is meeting with that graduate student at another time during the week.
3. Output a list of the times the professor meets with her graduate students. The times for the Master's students should be listed separately from the times for the PhD students.

For each operation that might not succeed, write one or more appropriate exception handling schema.

Solution:

There are two generic types used in this specification:

$[Time]$
$[GradStudent]$

and two enumerated types:

$$\begin{array}{ll} DegreeProgram ::= & Masters \mid PhD \\ Report ::= & MeetingAlreadyScheduledForThatTime \mid \\ & NoMeetingScheduledForThatTime \mid \\ & NoOtherMeetingScheduledForStudent \end{array}$$

A constant representing the maximum number of meetings the professor can have in a week:

$$MaxMeetings : \mathbb{N}$$

Because the professor must meet with every graduate student, the function *sched* is surjective.

Schedule

$$sched : Time \pfun GradStudent$$
$$status : GradStudent \fun DegreeProgram$$

$$\#sched \leq MaxMeetings$$
$$\#GradStudent \leq MaxMeetings$$

ScheduleMeeting

$$\Delta Schedule$$
$$time? : Time$$
$$grad? : GradStudent$$

$$time? \notin \mathrm{dom}(sched)$$
$$sched' = sched \cup \{(time?, grad?)\}$$
$$status' = status$$

Cancel_Meeting

$\Delta Schedule$
$time? : Time$
$grad? : GradStudent$

$(time?, grad?) \in sched$
$grad? \in \mathrm{ran}(sched - \{(time?, grad?)\})$
$sched' = sched - \{(time?, grad?)\}$
$status' = status$

Lookup

$\Xi Schedule$
$reportMasters! : \mathbb{P}\, Time$
$reportPhD! : \mathbb{P}\, Time$

$reportMasters! = \mathrm{dom}(sched \rhd \mathrm{dom}(status \rhd \{Masters\}))$
$reportPhD! = \mathrm{dom}(sched \rhd \mathrm{dom}(status \rhd \{PhD\}))$

Erroneous_Schedule_Meeting

$\Xi Schedule$
$time? : Time$
$grad? : GradStudent$
$out! : Report$

$time? \in \mathrm{dom}(sched)$
$out! = MeetingAlreadyScheduledForThatTime$

Erroneous_Cancel_Meeting1

$\Xi Schedule$
$time? : Time$
$grad? : GradStudent$
$out! : Report$

$(time?, grad?) \notin sched$
$out! = NoMeetingScheduledForThatTime$

Erroneous_Cancel_Meeting2

$\Xi Schedule$
$time? : Time$
$grad? : GradStudent$
$out! : Report$

$(time?, grad?) \in sched$
$grad? \notin \mathrm{ran}(sched - \{(time?, grad?)\})$
$out! = NoOtherMeetingScheduledForStudent$