CS412 Exercise sheet 2

Relations

1. Suppose the following represent the subjects taken by various school children:
   $CHILD = \{Anna, Ben, Carol, Dave\}$
   $SUBJECT = \{maths, french, physics, history\}$
   $reg = \{Anna \mapsto maths, Anna \mapsto history, Ben \mapsto maths,$
   $Ben \mapsto physics, Ben \mapsto history, Dave \mapsto maths\}$
   What is the value of each of the following:

   (a) $dom(reg)$
   (b) $ran(reg)$
   (c) $reg \cup (\{Ben\} \times SUBJECT)$
   (d) $\{Ben\} \lhd reg$
   (e) $reg - (\{Ben\} \times SUBJECT)$
   (f) $\{Ben\} \lhd\!\!\!- reg$
   (g) $reg \rhd \{maths, physics\}$
   (h) $reg \rhd\!\!\!- \{french\}$
   (i) $reg[\{Carol, Dave\}]$
   (j) reg^{-1}
   (k) $reg;\ reg^{-1}$
   (l) $reg \cup \{Ben \mapsto french\}$
   (m) $reg <\!\!+ \{Ben \mapsto french\}$

2. Suppose that in a university the students' module registrations are recorded using:

   $$register : STUDENT \leftrightarrow MODULE$$

   (a) Write expressions for:
      i. the set of modules with no registrations;
      ii. the set of students who have registered for cs400;
      iii. the registrations for CBS students (where CBS is a subset of STUDENT);
      iv. the number of CBS students who are not registered for any modules.

   (b) Write B operations:

i. to represent a student enrolling for a module;

ii. to find out what modules a student is taking;

iii. to remove all student registrations for a particular module and to find out who is affected by this;

iv. to query the differences between the current registrations and those predicted by preregistration (the results of which are stored as $prereg : STUDENT \leftrightarrow MODULE$).

3. A course includes a number of lab sessions which have been set up to cover the various topics studied. Each lab session may address more than one topic, and topics may be covered by any number of labs (including none).

   Write a specification of the lab system in which *attendance* is a relation recording students' lab attendance so far, and *lab_topics* is a relation recording the coverage of topics in the labs. Specify operations to:

   (a) output the labs attended by a given student;

   (b) output the labs which no student has so far attended;

   (c) output the students who have not attended a given lab;

   (d) output all topics a given student has covered in labs;

   (e) record a student attending a lab.

4. (a) Suppose in Q2 a further requirement is added. $Lab1$ addresses the topic *safety*. It is obligatory for students to attend this lab before they attend any other. How can the specification be altered to reflect this?

   (b) Suppose only students registered for the course can attend lab sessions. Modify your specification to reflect this and to allow students to register and deregister from the course. Which of the old operations need to be changed?

5. Check out the machines from Q2 and 3 in the BToolkit.