Artificial Intelligence—Spring 2011

Qualification Exam (Open Book and Notes)

Question 1 (35 points)

Assume that we have the predicates $Student(X)$, $Female(X)$, $Male(X)$, $Knows(X, Y)$, $Taken(X, Subject, Term)$, $Grade(X, Subject, Grade, Term)$, and $Friend(X, Y)$ and the constants

- Students: Ana and Bob
- Subjects: AI, OS, ... (the usual CS abbreviation for subjects)
- Terms: $SP11$, $F10$, ... (the usual NMSU abbreviation for terms)
- Grades: A, B, ... (the usual NMSU grade)

with the obvious meanings.

- Express the following sentences in first order logic.
  - Bob is a male student and Ana is a female student.
  - Ana and Bob are friend.
  - Friendship among students is transitive.
  - Not every pair of students, who know each other, are friend.
  - Some students took the AI class in Fall 2011.
  - Some students fail (get the grade D) in AI in Fall 2011.
  - Bob and Ana took AI in Fall 2011.
  - There is only one female student who took the AI course in Fall 2011 and fails.
- Use resolution to prove that Ana fails the AI class in Fall 2011. Present the steps in your proof.

Question 2 (15 points)

Show that the planning graph can be used in reachability analysis by proving that if a literal does not appear in the final level of the graph then it cannot be achieved.

Question 3 (25 points)

A simplified version of the class scheduling is as follows.

> Given a set of classes $\{c_1, \ldots, c_n\}$, a set of class rooms $\{r_1, \ldots, l_k\}$, and a set of constraints C of atoms of the form $not\_in\_room(c_i, r_j)$, a feasible schedule for the classes is defined as a set of atoms S of the form $in\_room(c_i, r_j)$ such that
>
> - for each i, $1 \leq i \leq n$, there exists exactly one $1 \leq j \leq k$ such that $in\_room(c_i, r_j) \in S$; and
> - if $not\_in\_room(c_i, r_j) \in C$ then $in\_room(c_i, r_j) \notin S$.
>
> Computes a feasible schedule for the classes.

Solve the simplified class scheduling problem using answer set programming. Provide justification for the correctness of your solution.

Question 4 (25 points)

- Formulate the simplified class scheduling problem (see Question 3) as a constraint satisfaction problem by specifying the set of variables, the set of domains, and the set of constraints.
- Given a concrete problem with $n = 3$, $k = 4$ and the following constraints:

  $$\begin{array}{lll} not\_in\_room(c_1, r_1) & not\_in\_room(c_1, r_2) & not\_in\_room(c_1, r_3) \\ not\_in\_room(c_2, r_1) & & \\ not\_in\_room(c_2, r_5) & & \\ not\_in\_room(c_3, r_2) & & \end{array}$$

  In what order will the variables of your problem be examined by a backtracking algorithm using the minimum remaining value (MRV) heuristic.