Instructions: The homework is due BEFORE CLASS on Wed Feb 19. Please hand in paper copies (either typeset or hand-written copies are fine, as long as the hand writing is clear).

Question 1 (30 points)

Consider a database schema with three relations:

- Employee (eid:integer, ename:string, age:integer, salary:real)
- Works (eid:integer, did:integer, pct_time:integer)
- Department(did:integer, dname:string, budget:real, managerid:integer)

The keys are underlined in each relation. Relation Employee stores employee information such as unique identifier eid, employee name ename, age and salary. Relation Department stores the department unique identifier did, department name dname, the department budget and managerid which is the eid of the employee who is managing the department. The managerid value can always be found in the eid field of a record of the Employee relation. The Works relation tracks which employee works in which department, and what percentage of the time s/he allocates to that department. Note that, an employee can work in several departments.

Write relational algebra expressions for the following queries:

(a) Find the ages of employees who earn at least $50,000 salary.
(b) Find the names of departments that have budget no higher than $100,000.
(c) Find the salaries of employees who work in a department named ‘Operations’.
(d) Find the salaries of employees that work at least 50% of their time in a department that has budget at least $500,000 (refers to 50% in same department, not cumulated across several departments that match the condition).
(e) Find the names of employees who work in the ‘Sales’ department or who spend more than half of their time in a single department.
(f) Find the names of employees who work for department ‘Catering’ but who do not work in any department that has budget higher than $500,000.
(g) Find the name of departments who employ only persons with salary $50,000 or higher.
(h) Find the ages of employees who work in exactly one department.
(i) [630 students only] Find the salaries of department managers.
(j) [630 students only] Find the age(s) of the manager(s) who earn the highest salary among all managers (note there may be several managers tied, find all their ages).
Question 2 (20 points)

Consider a database schema with three relations:

- Movies (movie_id:integer, title:string, year:integer, studio:string)
- Actors (actor_id:integer, name:string, nationality:string)
- StarsIn (actor_id:integer, movie_id:integer, character:string)

The keys are underlined in each relation. Relation Movies stores information such as unique movie identifier, title, year and producing studio. Actors contains unique actor identifier, actor name and nationality. Relation StarsIn tracks which actor starred in which movie, and the name of the character interpreted in that movie.

Write relational algebra expressions for the following queries:

(a) Find the titles of movies produced by ‘Universal’ studio.
(b) Find the names of actors who played a character named ‘Forrest Gump’ in some movie.
(c) Find the names of actors of nationality ‘German’.
(d) Find the nationality of actors who played a character named ‘Forrest Gump’ or who starred in a movie in year 1980.
(e) Find the name(s) of actor(s) who have the earliest debut year (i.e., earliest appearance in some movie).
(f) [630 students only] Find the names of actors who starred in some movie in or after year 1980, but who did not star in any role (ever) for a movie produced by “Universal” studio.