# CSE-4411M

## Assignment #2 & #3

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1. (15 points) **Join Enumeration.** *Down for the count.* [Short Answer]

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a. (3 points) Name two advantages of left-linear join trees compared with join trees generally.

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b. (3 points) Name a disadvantage of left-linear join trees when many joins are involved.

Consider a query with five tables, **A**, **B**, **C**, **D**, and **E**, such that there is a join condition between each pair.

c. (3 points) How many left-linear join trees are possible?

d. (3 points) At least how many plans involving three tables are carried forward from stage 3 to stage 4 of System R's join enumeration algorithm?

e. (3 points) At least how many plans will System R have enumerated before choosing the final one?

2. (10 points) **Query Planning I.** *Sign up!* [Exercise]

**Schema:**

**Student**(id, name, major)
**Enrol**(id, course#, section, term, grade)
FK (id) refs **Student**
FK (course#, section, term) refs **Class**
**Class**(course#, section, term, instructor, room, time)

**Statistics:**

- **Student**: 100,000 records on 2,000 pages
  - major: 100 distinct values
- **Enrol**: 4,000,000 records on 40,000 pages
  - course#: 1000, ..., 4999 (so 4000 values)
- **Class**: 200,000 records on 6,000 pages
  - instructor: 8,000 distinct values

**Indexes:**

- **Student**:
  - hash index on id (linear hash, 200 data entries per page)
- **Enrol**:
  - clustered tree index on id, course#, section, term (50 data entries per page)
  - unclustered tree index on course#, section, term, id (50 data entries per page)
- **Class**:
  - clustered tree index on course#, section, term (60 data entries per page)
  - unclustered tree index on instructor# (200 data entries per page)

All indexes are of alternative #2. For each tree index, the index pages are 3 deep.

**Query:**

```
select name, instructor, C.term
    from Student S, Enrol E, Class C
    where S.id = E.id
      and E.course# = C.course# and E.section = C.section
      and E.term = C.term
      and instructor = 'Dogfurry';
```

a. (3 points) How many records should the query produce?

b. (12 points) Devise a good query plan for the query. Show the query tree, *fully* annotated with the chosen algorithms and access paths.

You have an allocation of 20 buffer-pool frames.

Estimate the cost of your plan. For full credit, you should have a plan that costs less than 2,000 I/O's.

3. (15 points) **Query Planning II.** *Of course a course is par for the course.* [EXERCISE]

**Schema:**

**Student**(<u>sid</u>, sname, startdate, major, advisor)
FK (advisor) refs **Prof** (pid)
**Class**(<u>cid</u>, dept, number, section, term, year, room, time, pid, ta)
FK (pid) refs **Prof**
FK (ta) refs **Student** (sid)
**Enrol**(<u>sid</u>, <u>cid</u>, date, grade)
FK (sid) refs **Student**
FK (cid) refs **Class**
**Prof**(<u>pid</u>, pname, pdept, office)

Assume no attribute is nullable. The attribute pid in **Class** refers to the the professor / instructor for the class. The attribute ta in **Class** refers to the teaching assistant for the class. The attribute advisor in **Student** refers to the student's academic advisor.

**Statistics:**

- **Student**: 50,000 records on 1,000 pages
  - advisor: 2,500 distinct values
- **Enrol**: 2,000,000 records on 20,000 pages
  - sid: 50,000 distinct values
  - cid: 80,000 distinct values
- **Class**: 80,000 records on 1,600 pages
  - pid: 4,000 distinct values
  - ta: 5,000 distinct values
- **Prof**: 4,000 records on 40 pages

**Indexes:**

- **Student**:
  - clustered tree index on sid (200 data entries per page)
- **Enrol**:
  - clustered tree index on cid, sid (167 data entries per page)
  - unclustered tree index on sid, cid (167 data entries per page)
- **Class**:
  - clustered tree index on cid (200 data entries per page)
- **Prof**:
  - clustered tree index on pid (200 data entries per page)

All indexes are of alternative #2. For each tree index, the index pages are 3 deep, except for the index on **Prof**.pid which is 2 deep.

```
select sid, sname, dept, number, section, term, year, pid
    from Student S, Enrol E, Class C
    where S.sid = E.sid and E.cid = C.cid
      and S.advisor = C.pid;
```

a. (2 points) Estimate the number of rows the query returns.

b. (8 points) Devise the best query plan for the query. Show the query tree, *fully* annotated with the chosen algorithms and access paths.

Assume you have an allocation of 50 buffer-pool frames.

Estimate the cost of your plan.

c. (5 points) Name an additional index that would allow a less expensive query plan than in 3b, and sketch briefly that query plan using the index.

4. (5 points) **Index Usage.** *The DBA playoffs.* [analysis]

   Consider the following schema.

   **Employee**(e#, name, salary, d#)
   FK (d#) refs **Department**
   **Department**(d#, name, location, budget)

   It is important that the following queries be fast to be evaluated.

   **A.** Find the location where a user-specified employee works.

   **B.** List all the departments such that the sum of the employees' salaries who belong to the department exceeds the department's budget.

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What indexes would you make to benefit queries **A** and **B**? Indicate which are clustered and their types (B+ tree, hash).

Briefy explain how they would be useful.