Consider the following university dataset, where In.pno is a foreign key for Prof(pno), In.dno is a foreign key for Dept.dno, In.percent is an integer (representing a percentage time of appointment) in the range from 1 to 100, and Dept.chairno is a foreign key for Prof(pno). Assume that names and colleges are strings, salaries are given in dollars (per year), and ages are given in years. Write each query that follows in the requested query language(s).

**Prof** (pno, pname, salary, age) -- the usual info about professors

**In** (pno, dno, percent) -- profs can be in multiple departments

**Dept** (dno, dname, college, chairno) -- the usual info about departments

Gist ID for data to query: d1dc9d60e35a596f784229b6a121313d

1. *(4 points)* Print the numbers and names of all professors who earn more per year than one of their department chairs:

   a) *(2 pts) Relational algebra:*

   \[
   \pi \text{ pno,pname} (\sigma \text{ salary}>\text{chairsalary} ((\text{Prof} \bowtie \text{In}) \bowtie \\
   \pi \text{ chairsalary,dno} (p \text{ chairsalary} \leftarrow \text{salary (Prof} \bowtie \text{pno=chairno Dept}))))
   \]

   or

   \[
   \text{Query1} = p \text{ chairsalary} \leftarrow \text{salary (Prof} \bowtie \text{pno=chairno Dept)}
   \]

   \[
   \text{Query2} = \pi \text{ chairsalary,dno} (\text{Query1})
   \]

   \[
   \text{Query3} = \text{Prof} \bowtie \text{In}
   \]

   \[
   \text{Query4} = \sigma \text{ salary}>\text{chairsalary} (\text{Query3} \bowtie \text{Query2})
   \]

   \[
   \pi \text{ pno,pname} (\text{Query4})
   \]

   b) *(2 pts) Relational calculus:*

   \[
   \{t(pno,pname) | \exists p \in \text{Prof} (t.pno = p.pno \land t.pname = p.pname \land \\
   \exists n \in \text{In}(p.pno = n.pno \land \exists d \in \text{Dept}(n.dno = d.dno \land \\
   \exists cp \in \text{Prof} (p.salary > cp.salary \land cp.pno = d.chairno))))\}
   \]
2. (4 points) Print the names of professors who have some percentage of appointment in departments in at least two different Departments.

a) (2 pts) Relational algebra:
\[
\pi \ p\text{name} (\text{Prof} \Join \sigma \ d\text{no} \neq d\text{no2} \\
(p \ d\text{no2} \leftarrow d\text{no,percent2} \leftarrow \text{percent (In}) \Join \text{In}) \\
\text{or}
\]
Query1 = p \ d\text{no2} \leftarrow d\text{no,percent2} \leftarrow \text{percent (In)} \\
Query2 = \text{Query1} \Join \text{In} \\
Query3 = \sigma \ d\text{no} \neq d\text{no2} \ (\text{Query2}) \\
Query4 = \text{Prof} \Join \text{Query3} \\
\pi \ p\text{name} (\text{Query4})
\]

b) (2 pts) Relational calculus:
\[
\{t(p\text{name}) | \exists \ p \in \text{Prof} (t.p\text{name} = p.p\text{name} \land \\
\exists \ n1 \in \text{In}(p.p\text{no} = n1.p\text{no} \land \\
\exists \ n2 \in \text{In}(n1.p\text{no} = n2.p\text{no} \land n1.d\text{no} \neq n2.d\text{no}))\}
\]

3. (2 points) Print the names of professors who have some percentage of appointment in all of the departments in the 'College of Fine Arts'.

a) (2 pts) Relational algebra\(^1\):
\[
\pi \ p\text{name} (\text{Prof} \Join (\pi \ p\text{no},d\text{no} (\text{In}) \div \pi \ d\text{no} (\sigma \ \text{college}='\text{College of Fine Arts'} (\text{Dept})))) \\
\text{or}
\]
Query1 = \pi \ p\text{no},d\text{no} (\text{Prof} \Join \text{In}) \\
Query2 = \sigma \ \text{college}='\text{College of Fine Arts'} (\text{Dept}) \\
Query3 = \pi \ d\text{no} (\text{Query2}) \\
Query4 = \text{Query1} \div \text{Query3} \\
Query5 = \text{Prof} \Join \text{Query4} \\
\pi \ p\text{name} (\text{Query5})
\]

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\(^1\) Note: By exam time you should also be prepared to write this query in the relational calculus!