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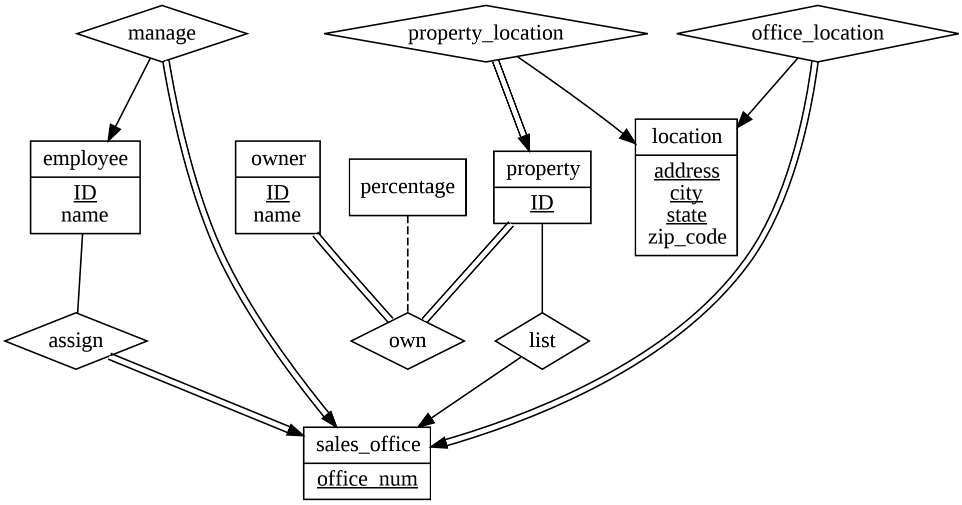
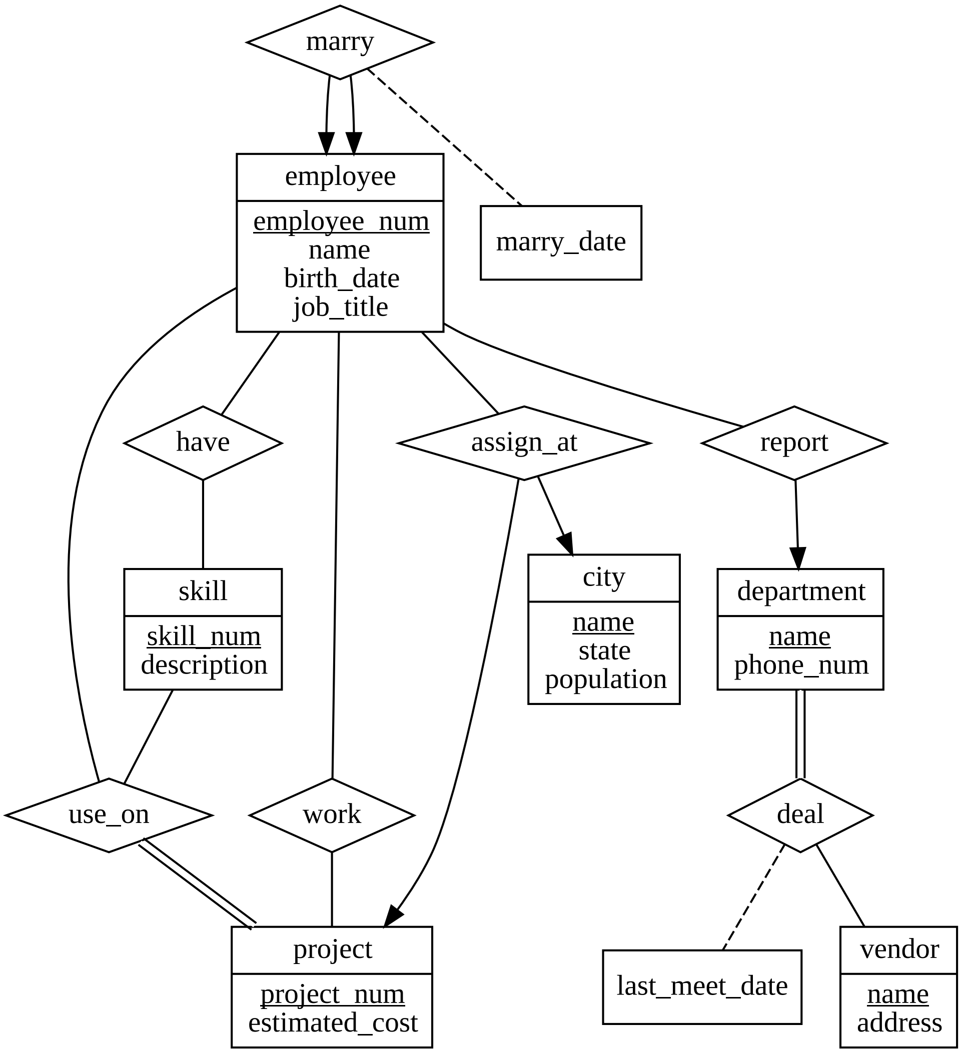
Homework 2

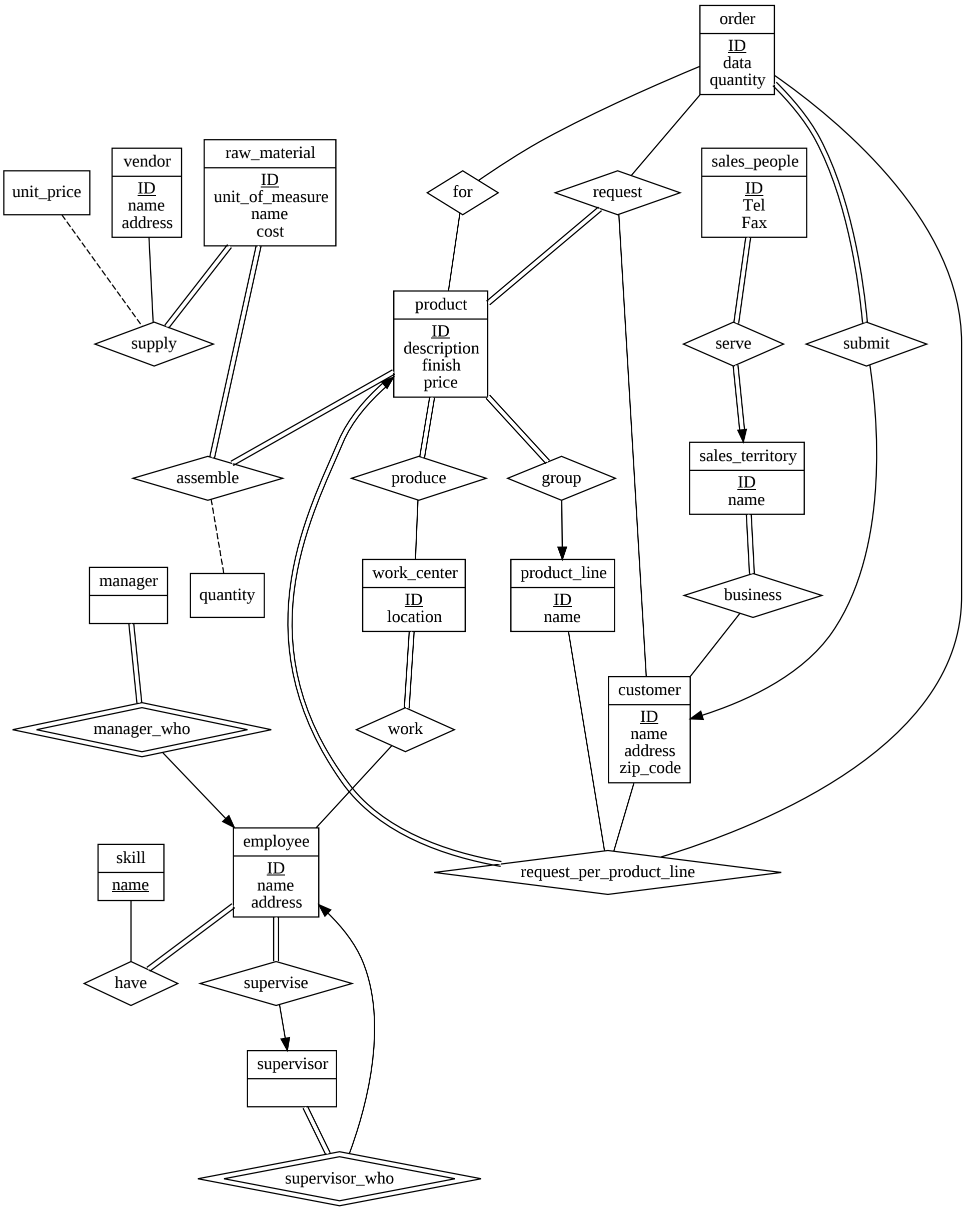
E-R diagrams



Problem 1



Problem 2



Problem 3
(Assume "order line" is a typo, and a given customer order must request at least one product and only one product per product line)

Problem 4

1. Define relations for each entity set:

employee(ID, name)
owner(ID, name)
sales_office(office_num)
property(ID)
location(address, city, state, zip_code)

2. Define relations for each relationship set (all pointers are defined as foreign key):

manage(e_ID, office_num)
assign(e_ID, office_num)
own(o_ID, p_ID, percentage)
list(p_ID, office_num)
property_location(p_ID, address, city, state)
office_location(office_num, address, city, state)

3. Modify keys to capture mapping constraints:

modified: manage(e_ID UNIQUE, office_num)
modified: assign(e_ID, office_num)
no change: own(o_ID, p_ID, percentage)
modified: list(p_ID, office_num)
modified: property_location(p_ID, (address, city, state) UNIQUE)
modified: office_location(office_num, (address, city, state) UNIQUE)

4. Eliminate Redundancy:
(Nothing can be done in this step)

5. Merge relations to capture participation constrains:
(1). Relations with same primary key:
employee & assign
sales_office & manage
property & list
sales_office & office_location
property & property_location

(2). Merge relations with total participation and define foreign key not NULL:
merge: sales_office & manage & office_location
=> sales_office(office_num, foreign key manager_ID references to employee(ID) UNIQUE NOT NULL, foreign key (address, city, state) references to location(address, city, state) UNIQUE NOT NULL)

merge: property & property_location
=> property(ID, foreign key (address, city, state) references to location(address, city, state) UNIQUE NOT NULL)

final results:
employee(ID, name)
owner(ID, name)
sales_office(office_num, foreign key manager_ID references to employee(ID) UNIQUE NOT NULL, foreign key (address, city, state) references to location(address, city, state) UNIQUE NOT NULL)
property(ID, foreign key (address, city, state) references to location(address, city, state) UNIQUE NOT NULL)
location(address, city, state, zip_code)
assign(e_ID, office_num)
own(o_ID, p_ID, percentage)
list(p_ID, office_num)

Cardinality and Participation Constraints
For the tree constraints below:

1. Each sale office must be assign greater than 1 employee(s).
2. Each owner has at least one property.
3. Each property has at least one owner.

We cannot ensure their total participation because the only way to ensure this (at least as much as we have learnt) is to define a foreign key in its relation references to another, with NOT NULL constrain. To do this, they should eventually be merged together, however, because they either have a many-to-many or one-to-many relationship, none of them can be merged.

As for the constraint the co-owners has their percentages sum to be 100, we cannot ensure this cardinality constraints either. Because the percentage of ownership unit is associated with particular "own" relationship, which

For the following tree constraints:

Given one sales_office, there is exact one employee being manager.
An employee can only be assign to one sales_office.
Each property be listed with only one sales_office.

SQL statements to implement the relational schema:

```
CREATE TABLE `employee` (
  `ID` int(11) NOT NULL,
  `name` varchar(30),
  PRIMARY KEY (`ID`)
) ENGINE=InnoDB;

CREATE TABLE `owner` (
  `ID` int(11) NOT NULL,
  `name` varchar(30),
  PRIMARY KEY (`ID`)
) ENGINE=InnoDB;

CREATE TABLE `location` (
  `address` varchar(120) NOT NULL,
  `city` varchar(30) NOT NULL,
  `state` varchar(30) NOT NULL,
  `zip_code` int(11),
  PRIMARY KEY (`address`,`city`,`state`)
) ENGINE=InnoDB;

CREATE TABLE `sales_office` (
  `office_num` int(11) NOT NULL,
  `manager_ID` int(11) NOT NULL,
  `address` varchar(120) NOT NULL,
  `city` varchar(30) NOT NULL,
  `state` varchar(30) NOT NULL,
  PRIMARY KEY (`office_num`),
  UNIQUE (manager_ID),
  UNIQUE (address, city, state),
  FOREIGN KEY (`manager_ID`) REFERENCES `employee` (`ID`),
  FOREIGN KEY (`address`, `city`, `state`)
  REFERENCES `location` (`address`, `city`, `state`)
) ENGINE=InnoDB;

CREATE TABLE `property` (
  `ID` int(11) NOT NULL,
  `address` varchar(120) NOT NULL,
  `city` varchar(30) NOT NULL,
  `state` varchar(30) NOT NULL,
  PRIMARY KEY (`ID`),
  UNIQUE (address, city, state),
  FOREIGN KEY (`address`, `city`, `state`)
  REFERENCES `location` (`address`, `city`, `state`)
) ENGINE=InnoDB;

CREATE TABLE `own` (
  `o_ID` int(11) NOT NULL,
  `p_ID` int(11) NOT NULL,
  `percentage` int(11),
  PRIMARY KEY (`o_ID`,`p_ID`),
  FOREIGN KEY (`o_ID`) REFERENCES `owner` (`ID`),
  FOREIGN KEY (`p_ID`) REFERENCES `property` (`ID`)
) ENGINE=InnoDB;

CREATE TABLE `assign` (
  `e_ID` int(11) NOT NULL,
  `office_num` int(11) NOT NULL,
  PRIMARY KEY (`e_ID`),
  FOREIGN KEY (`e_ID`) REFERENCES `employee` (`ID`),
  FOREIGN KEY (`office_num`) REFERENCES `sales_office` (`office_num`)
) ENGINE=InnoDB;

CREATE TABLE `list` (
  `p_ID` int(11) NOT NULL,
  `office_num` int(11) NOT NULL,
  PRIMARY KEY (`p_ID`),
  FOREIGN KEY (`p_ID`) REFERENCES `property` (`ID`),
  FOREIGN KEY (`office_num`) REFERENCES `sales_office` (`office_num`)
) ENGINE=InnoDB;
```

Problem 6

- List all the course titles from math department with greater than or equal to 3 credits:

  ```
  select title from course where credits >= 3 and dept_name = 'Math';
  ```

- List the ID and name of students who take CISC437:

  ```
  select ID, name from student natural join takes
         where course_id = 'CISC437';
  ```

- List the ID and name of students who take CISC437:

  ```
  select * from (select ID from takes where course_id = 'CISC437') X
  ```

```
          natural join (select ID, name from student) Y;
```

- Calculate the average classroom capacity of all course sections from each department:

  ```
  select dept_name, avg(capacity) as average_capacity from
         (select dept_name, capacity from classroom
         natural join section natural join course) X
         group by dept_name;
  ```

-

  ```
  select title from course join teaches using (course_id)
         join instructor using (ID) where name = 'Wu';
  ```

  $$\pi_{\text{title}}\,\sigma_{\text{name=Wu}}\,(\text{course} \bowtie_{\text{course\_id}} \text{teaches} \bowtie_{\text{ID}} \text{instructor})$$

-

  ```
  select distinct(s.name) from student s join
         takes using (ID) join course c using (course_id)
         where c.dept_name = 'Math';
  ```

  (Assume the "Math course" means courses from Math department)

  $$\pi_{\text{student.name}}\,\sigma_{\text{course.dept\_name=Math}}\,(\text{student} \bowtie_{\text{ID}} \text{takes} \bowtie_{\text{course\_id}} \text{course})$$

-

  ```
  select ID, name from instructor i left outer join
        (select distinct(ID) from teaches join instructor
         using (ID) where year < 2009 or
          (year = 2009 and (semester='Summer' or semester='Spring'))
        ) X using (ID) where X.ID is not NULL;
  ```

  $$\pi_{\text{ID,name}}\left(\text{instructor} ⟕_{\text{ID}} \left(\sigma_{\text{year<2009 or (year=2009 and (semester=Summer or semester=Spring))}}\,(\text{teaches} \bowtie_{\text{ID}} \text{instructor})\right)\right)$$

-

  ```
  select dept_name, avg(salary) from instructor group by dept_name;
  ```

  $${}_{\text{dept\_name}}\mathcal{G}_{\text{average(salary)}}\,\text{instructor}$$

-

  ```
  select capacity - count(ID) as open_seat from takes natural join
         section natural join classroom where
          course_id = 'CISC637' and semester= 'Spring' and year=2015
         group by course_id, semester, year;
  ```

  (Assume no two different sec_id s for CISC637 in Spring 2015)

  $${}_{\text{course\_id,semester,year}}\mathcal{G}_{\text{capacity}-\text{count(ID)}}\left(\sigma_{\text{course\_id=CISC637 and semester=Spring and year=2015}}\,(\text{takes} \bowtie \text{section} \bowtie \text{classroom})\right)$$