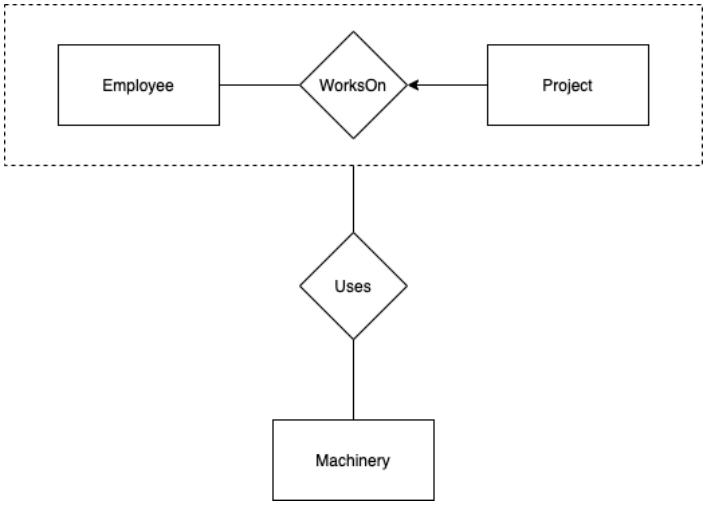
CPSC 304: Introduction to Relational Databases
In-Class Exercise Solution

1. Consider the following E-R diagram with aggregation. Assume that we have identifiers like EID, PID, and MID. Suppose further that we don't want to create unnecessary tables.



a) What is the primary key of the WorksOn relationship?
   - PID because once you know the Project, you will know which employee (if any) works on that project.
     - When you translate this diagram to relational schemas, you do not need a separate table for WorksOn and for Project. That's one unnecessary table. You can simply call it Project or possibly ProjectWorksOn or WorksOn.

b) How many projects can an employee work on?
   - 0 or more

c) How many employees can work on a given project?
   - At most one

d) What is the primary key of the ProjectWorks Aggregation?
   - Just PID

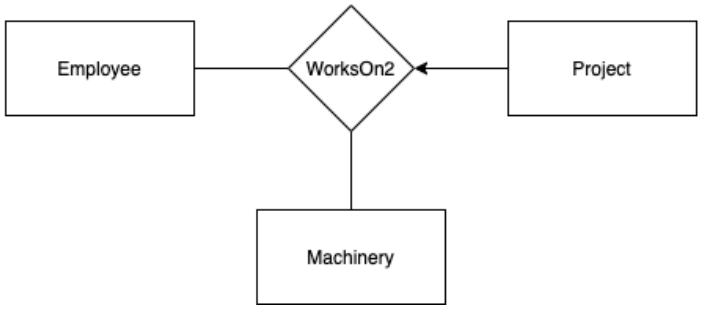
e) What is the purpose of the aggregation?
   - To equate a project with the employee (if any) that works on that project.

f) What would be the primary key of the Uses relationship?
   - It is a many-to-many relationship so it would be (PID, MID).

g) Provide an example of two tuples that would violate the WorksOn relationship.
   - For Project(<u>PID</u>, EID, …) or WorksOn:
     - (ProjectX, Angela, …) or equivalently (ProjectX, 1580, …)
     - (ProjectX, Andrew, …) or equivalently (ProjectX, 1736, …)
   - For Employee(<u>EID</u>, …) – no violations here
     - (Angela, …)
     - (Andrew, …)

h) Provide an example of two tuples that would satisfy the WorksOn relationship, and then provide an example of two or more tuples that would satisfy the Uses relationship.
- For Project(PID, EID, …) or WorksOn:
  - (ProjectX, Angela, …)
  - (ProjectY, Bob, …)
- For Uses(PID, MID)
  - (ProjectX, Forklift)
  - (ProjectX, Explosives)
  - (ProjectY, Forklift)
  - (ProjectY, Battery Charger)
  - Note that ProjectX, ProjectY, and Forklift can appear multiple times.
  - It would be incorrect to put (ProjectX, Angela, Forklift) as a relationship as Uses is a binary relationship without any attribute attached to it (i.e., there should only be two values associated with each relationship in this relationship set– the key of Project and the key of Machinery).

2. Suppose we were to do all 3 of these things: remove the aggregation (and its dotted line), remove the Uses relationship, and just have Machinery go directly into WorksOn2 (to make a ternary relationship). The rest of the lines and arrow would remain, as is.



a) What would be the primary key for the WorksOn2 ternary relationship?
- Just PID – Since a project has at most one employee working on it and at most one piece of machinery associated with it, we just need PID.

b) Explain what the ternary relationship means, and what the arrow means.
- It means that an employee, a project, and a piece of machinery are all associated together, that is, they all come together in one "package" or relationship. The arrow would mean that a given project could only be associated with at most one employee, and at most one piece of machinery.

c) Provide 3 tuples that would be valid for this ternary relationship.
- (ProjectX, Angela, Forklift)
- (ProjectY, Angela, Battery Charger)
- (ProjectZ, Bob, Battery Charger)

d) Provide 2 pairs of tuples, where each pair would violate this ternary relationship in a different way.
   - (ProjectX, Angela, Forklift) and (ProjectX, Andrew, Forklift)
     - Violation: Only one person can work on ProjectX.
   - (ProjectY, Bob, Battery Charger) and (ProjectY, Bob, Photocopier)
     - Violation: Only one piece of machinery can be associated with Project Y.

3. Suppose in the aggregation of Question 1, the line from the Uses diamond goes directly to the Project entity—and *not* to the aggregation. Explain how this would change the business requirements (application). Suggest a potential use case.
   - This would mean that a piece of machinery could be associated with a project that has no employee associated with the project. Previously, we needed to have an employee associated with the project to qualify for using machinery.
   - Presumably, the business requirement for the aggregation is: we don't want to assign any equipment to a project that does not have one of our employees working on it. Perhaps there are insurance/liability reasons, or perhaps the company needs to assign responsibility for a piece of machinery to an authorized person before lending it out.
   - Note that it would still be a many-to-many relationship.