

## Database Schema

The questions are based on the following application about a company's operation. Its ER data model is shown below with the following constraints.

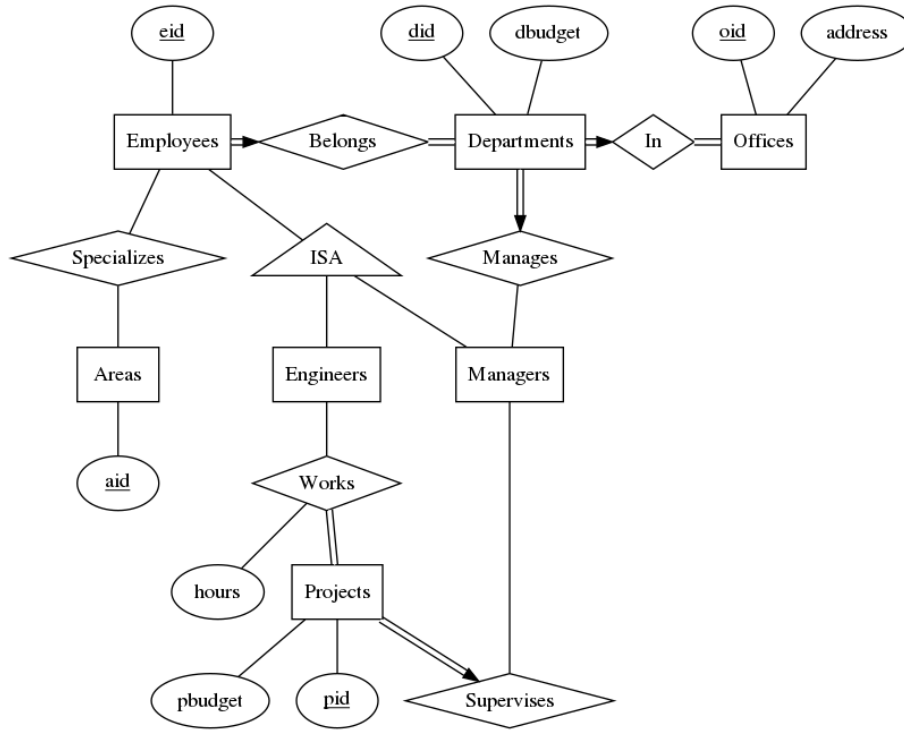


Figure 1: ER Model

The company has at least one office. Each office (identified by oid with location specified by address) consists of one or more departments. Each department (identified by did with a budget dbudget) is located in one office and has one or more employees. Each employee (identified by eid) must belong to a department. The application focuses on two subclasses of employees: engineers and managers. An employee can be neither an engineer nor a manager, and no employee can be both an engineer and a manager. Each employee can specialize in 0 or more areas (identified by aid). Each department must be managed by exactly one manager, and each manager can manage 0 or more departments. Each engineer can work in 0 or more projects, and there must be at least one engineer working in each project. For each project P that an engineer E works on, the number of hours per week that E spends on P is given by hours. Each project (identified by pid with a budget pbudget) must be supervised by exactly one manager. A manager can supervise 0 or more projects. Attributes hours, dbudget and pbudget have non-null values.

## Relational Schema

The following is the relational schema for this application.

```
CREATE TABLE Offices (  
    oid            INTEGER,  
    address        VARCHAR(60),  
    PRIMARY KEY (oid)  
);  
  
/* eid = eid of department's manager */  
CREATE TABLE Departments (  
    did            INTEGER,  
    dbudget        INTEGER NOT NULL,  
    oid            INTEGER NOT NULL,  
    eid            INTEGER NOT NULL,  
    PRIMARY KEY (did),  
    FOREIGN KEY (oid) REFERENCES Offices  
);  
  
CREATE TABLE Employees (  
    eid            INTEGER,  
    did            INTEGER NOT NULL,  
    PRIMARY KEY (eid),  
    FOREIGN KEY (did) REFERENCES Departments  
);  
  
CREATE TABLE Engineers (  
    eid            INTEGER,  
    PRIMARY KEY (eid),  
    FOREIGN KEY (eid) REFERENCES Employees  
);  
  
CREATE TABLE Managers (  
    eid            INTEGER,  
    PRIMARY KEY (eid),  
    FOREIGN KEY (eid) REFERENCES Employees  
);
```

```

/* eid = eid of project's supervisor */
CREATE TABLE Projects (
    pid            INTEGER,
    pbudget        INTEGER NOT NULL,
    eid            INTEGER NOT NULL,
    PRIMARY KEY (pid),
    FOREIGN KEY (eid) REFERENCES Managers
);

CREATE TABLE Works (
    pid            INTEGER,
    eid            INTEGER,
    hours          INTEGER NOT NULL,
    PRIMARY KEY (pid,eid),
    FOREIGN KEY (eid) REFERENCES Engineers,
    FOREIGN KEY (pid) REFERENCES Projects
);

CREATE TABLE Areas (
    aid            VARCHAR(5),
    PRIMARY KEY (aid)
);

CREATE TABLE Specializes (
    eid            INTEGER,
    aid            VARCHAR(5),
    PRIMARY KEY (eid,aid),
    FOREIGN KEY (eid) REFERENCES Employees,
    FOREIGN KEY (aid) REFERENCES Areas
);

```