LECTURE 3 EXERCISES
ENTITY-RELATIONSHIP (E-R) MODEL
AND DATABASE DESIGN
**EXERCISE 1: UNIVERSITY APPLICATION**

We want to record information about students, departments, courses and course teaching teams.

- For each student we store the student id, name and majors.
- For each department we store a unique code and name.
- For each course we store a unique course id, name, department and prerequisites.
- For each offering of a course we store the section, semester and year.
- Each student must enroll in one to five course offerings.
- Each course offering can enroll zero to sixty students.
- For each course offering that a student takes we store the grade.
- Each course offering’s teaching team has one or more staff, who is either an instructor or a TA.
- For each staff assigned to a course offering’s teaching team we store the hkid, name, department and office number.
- For each instructor we store their academic title (e.g., professor).

For the university application E-R diagram, identify keys and discriminators of entities, weak entities and their identifying relationship(s) and show relationship cardinality and participation constraints.
EXERCISE 1: UNIVERSITY APPLICATION—E-R DIAGRAM

Offering

Department

Student

Course

Staff

Instructor

TA

Course

HasPrerequisite

Has

EnrollsIn

Staff

Appoints

AssignsTo

Student

Course prerequisite

Department

Has

Offering

grade

section semester

year

hkid

name

officeNumber

title

studentId

name

{major}

courseId

course name

section semester

year

hkid

name

officeNumber

instructor

TA
For each student we store the student id, name and majors.
For each department we store a unique code and name.
For each course we store a unique course id, name, department and prerequisites.
For each offering of a course we store the section, semester and year.
Each student must enroll in one to five course offerings.
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For each course offering that a student takes we store the grade.
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For each staff assigned to a course offering’s teaching team we store the hkid, name, department and office number.
For each instructor we store their academic title (e.g., professor).
EXERCISE 1: UNIVERSITY APPLICATION—KEYS OF ENTITY TYPES

For each offering of a course we store the section, semester and year.

What kind of entity is Offering?
⇒ Weak entity dependent on Course.

Is there a discriminator for Offering?
⇒ Yes — section, semester, year.
EXERCISE 1: UNIVERSITY APPLICATION—ENTITY GENERALIZATION COVERAGE

- Each course offering’s teaching team has one or more staff, who is either an instructor or a TA.

![Staff diagram]

**What should be the completeness constraint?**  
⇒ total

**What should be the disjointness constraint?**  
⇒ disjoint
EXERCISE 1: UNIVERSITY APPLICATION—RELATIONSHIP CARDINALITY & PARTICIPATION

- For each course we store a unique course id, name, department and prerequisites.

What should be the **cardinality constraint (max-card)** for **Department**?
⇒ many (A department can offer many courses—domain knowledge.)

What should be the **participation constraint (min-card)** for **Department**?
⇒ unknown (Could be partial or total; need to verify with client. Leave unspecified.)

What should be the **cardinality constraint (max-card)** for **Course**?
⇒ unknown (Could be 1 or N; need to verify with client. Leave unspecified.)

What should be the **participation constraint (min-card)** for **Course**?
⇒ total (Every course must be offered by some department—domain knowledge.)
**EXERCISE 1: UNIVERSITY APPLICATION—RELATIONSHIP CARDINALITY & PARTICIPATION**

- For each course we store a unique course id, name, department and prerequisites.

![Diagram](image)

What should be the cardinality constraints?

- Course (prerequisite) many (A course can be a prerequisite for several courses.)
- Course (course) many (A course can have several prerequisites.)

What should be the participation constraints?

- Course (prerequisite) partial (A course does not have to be a prerequisite.)
- Course (course) partial (A course can have no prerequisites.)
EXERCISE 1: UNIVERSITY APPLICATION—RELATIONSHIP CARDINALITY & PARTICIPATION

- For each offering of a course we store the section, semester and year.

What should be the **cardinality constraint (max-card) for Offering**?

⇒ 1 (Every offering is for at most one course—domain knowledge.)

What should be the **participation constraint (min-card) for Offering**?

⇒ total (Every offering must be for some course—domain knowledge.)

**What about for Course?**

⇒ (?) many min-card most likely 0, but need to verify with client. Leave unspecified.
EXERCISE 1: UNIVERSITY APPLICATION—RELATIONSHIP CARDINALITY & PARTICIPATION

- Each student must enroll in one to five course offerings.
- Each course offering can enroll zero to sixty students.

Does the participation constraint for Student make sense?

Is Offering dependent on Student?
⇒ No.

What should be the cardinality constraint (max-card) for Student?
⇒ 5 (A student can enroll in at most 5 course offerings.)

What should be the participation constraint (min-card) for Student?
⇒ total (A student must enroll in at least 1 course offering.)

What about for Offering?
⇒ (0, 60)

Is a student required to enroll in an offering as soon as the student’s record is created?  No!
(domain knowledge)

Does the participation constraint for Student make sense?
EXERCISE 1: UNIVERSITY APPLICATION—RELATIONSHIP CARDINALITY & PARTICIPATION

- Each course offering’s teaching team has one or more staff, who is either an instructor or a TA.

Is Offering dependent on Staff?
⇒ No.

What should be the cardinality constraint (max-card) for Offering?
⇒ many (An offering can have several staff assigned to it.)

What should be the participation constraint (min-card) for Offering?
⇒ total (An offering has at least one staff assigned to it.)

What about for Staff?
⇒ (?,many) min-card most likely 0, but need to verify with client. Leave unspecified.

Does the participation constraint for Offering make sense?

Need to verify with client!
**EXERCISE 1: UNIVERSITY APPLICATION—RELATIONSHIP CARDINALITY & PARTICIPATION**

- For each staff assigned to a course offering’s teaching team we store the hkid, name, department and office number.

What should be the **cardinality constraint (max-card)** for Staff?

⇒ 1 (For each staff … we store the … department ….)

What should be the **participation constraint (min-card)** for Staff?

⇒ total (Every staff must be appointed in some department—domain knowledge.)

What should be the **cardinality constraint (max-card)** for Department?

⇒ many (A department can appoint several staff—domain knowledge.)

What should be the **participation constraint (min-card)** for Department?

⇒ unknown (Could be partial or total; need to verify with client. Leave unspecified.)
EXERCISE 1: UNIVERSITY APPLICATION—E-R DIAGRAM

- Student
  - studentId
  - name
  - {major}

- Department

- Course
  - courseId
  - name

- Offering
  - section
  - semester
  - year

- Staff
  - hkid
  - name
  - officeNumber

- TA

- Instructor
  - title

- EnrollsIn
  - grade

- HasPrerequisite

- Offers

- AssignedTo
  - disjoint, total

- Appoints

Diagram:

- Department
- Course
- Offering
- Staff
- TA
- Instructor
- Student

Relationships:
- Staff Appoints Student
- Staff AssignedTo Offering
- Offering HasPrerequisite Offering
- Offering Has Course
- Offering Has Department
- Student EnrollsIn Offering
- Instructor Offers Offering
- Instructor Appoints Staff
- TA AssignedTo Offering
EXERCISE 2: BUS COMPANY

We want to keep track of bus routes and schedules for a bus company.

- Each bus route has a unique route number, a departure station and a destination station.
- For each bus route, there is a schedule, which records the departure times of buses.
- For each departure time of each route, a driver and a bus can be assigned; however, information about the driver or the bus may sometimes be missing.
- A driver has a unique employee id, a name and a phone number.
- A bus is identified by its license number and has a maximum seating capacity.

For the bus company application E-R diagram, identify keys and discriminators of entities, weak entities and their identifying relationship(s) and show relationship cardinality and participation constraints.
EXERCISE 2: BUS COMPANY—E-R DIAGRAM

Route
- routeNo

Schedule
- departureTime

Driver
- empId
- name
- phoneNo

Bus
- licenseNo
- maxSeating

Station
- name

HasDestination
HasDeparture

Has

Driver

AssignedTo

Uses

Route

Schedule

Station

Bus
EXERCISE 2: BUS COMPANY—KEYS OF ENTITIES

- Each bus route has a unique **route number**, a departure station and a destination station.
- For each bus route, there is a schedule, which records the departure times of buses.
- A driver has a unique **employee id**, a name and a phone number.
- A bus is identified by its **license number** and has a maximum seating capacity.
EXERCISE 2: BUS COMPANY—RELATIONSHIP CARDINALITY & PARTICIPATION

Each bus route has a unique route number, a departure station and a destination station.

For each bus route, there is a schedule, which records the departure times of buses.

What type of entity is Schedule?  ⇒  Weak entity dependent on Route.

Is there a discriminator for Schedule?  ⇒  Yes — departureTime.

What should be the cardinality constraint (max-card) for Schedule?  ⇒  1

What should be the participation constraint (min-card) for Schedule?  ⇒  total

What about for Route?  ⇒  cardinality many; participation unknown.

Does every route have to have a schedule? Verify with client.
EXERCISE 2: BUS COMPANY—RELATIONSHIP CARDINALITY & PARTICIPATION

- For each departure time of each route, a driver and a bus can be assigned; however, information about the driver or the bus may sometimes be missing.

Does every driver/bus have to be assigned to/used by a schedule? Verify with client.

- Each bus route has a unique route number, a departure station and a destination station.
EXERCISE 2: BUS COMPANY—E-R DIAGRAM

- Route
  - routeNo

- Schedule
  - departureTime

- Driver
  - empId
  - name
  - phoneNo

- Bus
  - licenseNo
  - maxSeating

- Station
  - name

- AssignedTo

- HasDestination

- HasDeparture

- Has