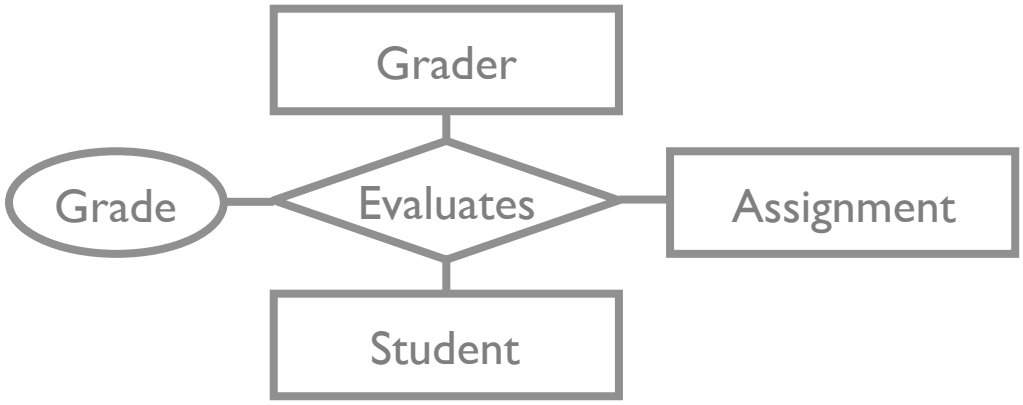
Relational Model

Announcements

- Waiting list: full with 110 students, sorry
  - Some minor shift expected until Fri/Sat
- Project 1: You should have a team and should have signed up for an advising section
- Part 1: Due next Thursday morning in class
  - Late submissions: Under Eugene Wu's door (421 Mudd in the DSI space)

Ternary relationship and constraints



Grader
Jane
Neha
Lin
…

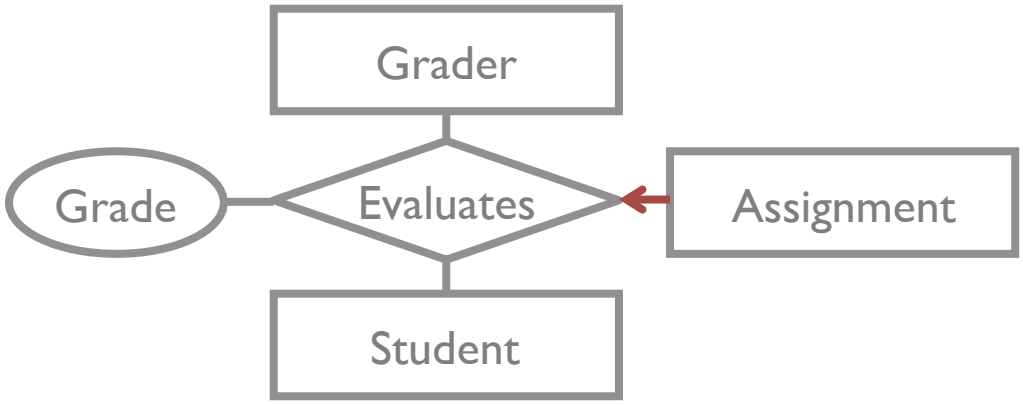
Student
Alice
Jinyang
Sarah
…

Assignment
Homework 0
Project 1
…

Assignment	Student	Grader	Grade
Homework 0	Jinyang	Jane	8
Homework 0	Alice	Jane	7
Homework 1	Jinyang	Neha	7
Homework 0	Alice	Lin	8
Homework 0	Sarah	Neha	6

Part of class syllabus, *not* a specific submission

Ternary relationship and constraints



At most one grader per assignment?

HW0 can appear at most once! Also at most one student

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~~Homework 0~~	~~Alice~~	~~Jane~~	~~7~~
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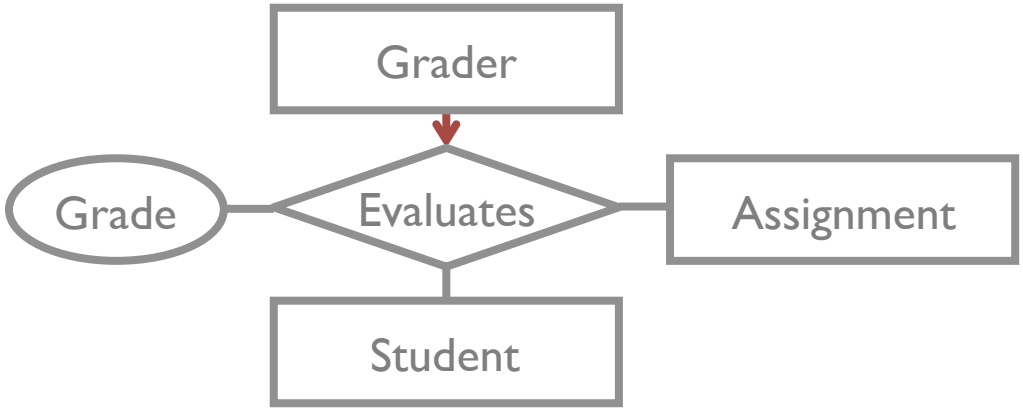

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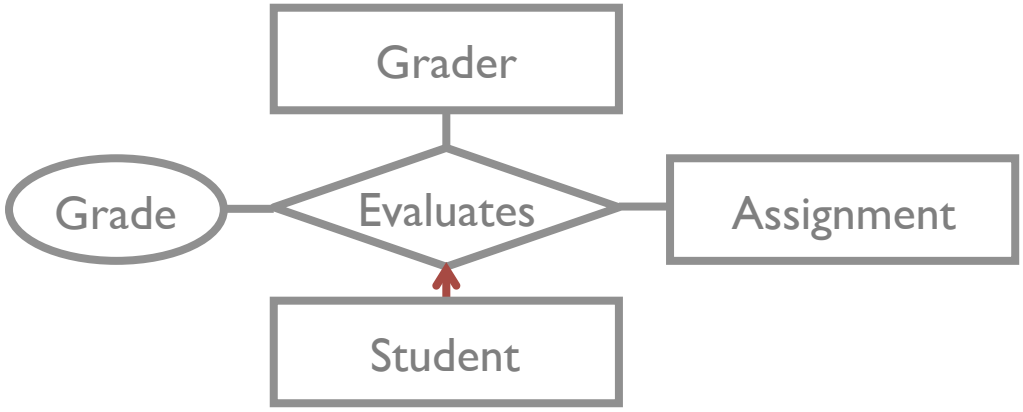

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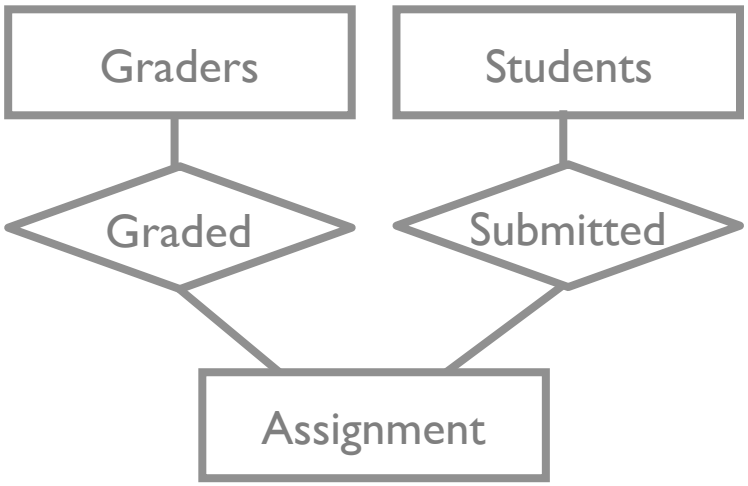
Ternary relationship and constraints



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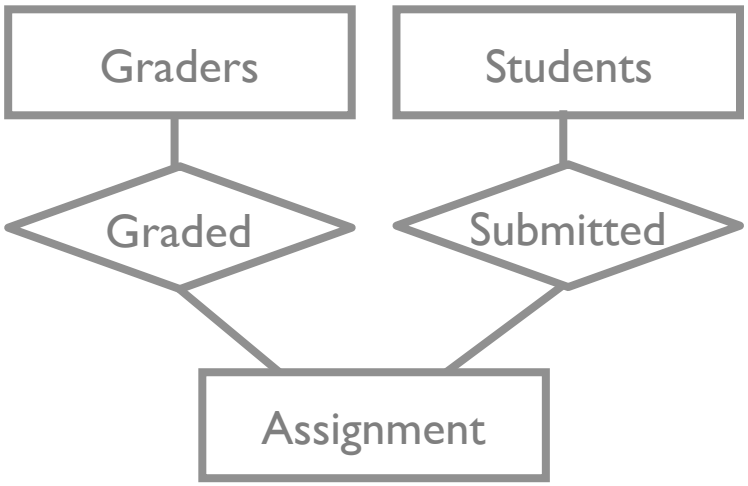
Ternary relationship and constraints



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At most one grader per assignment?

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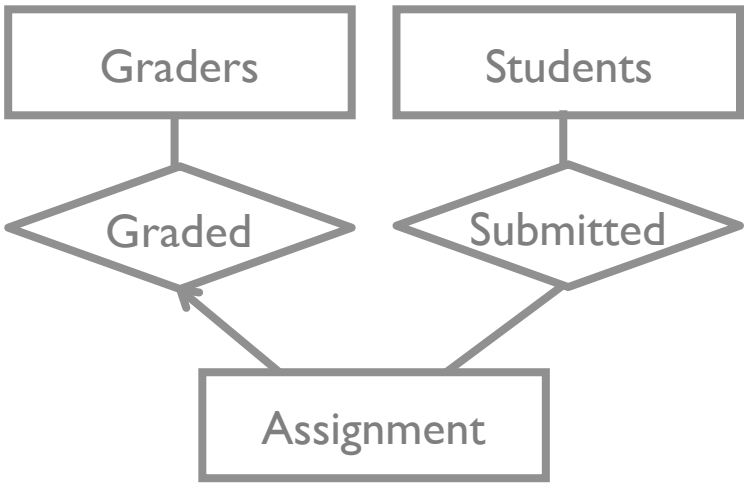

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Homework 0	Alice
Homework 1	Jinyang
Homework 0	Sarah

At most one grader per assignment?

Students can only submit a given assignment once?

Enforced: relationships are sets

No weak entities here

Roadmap

- History lesson
- DDLs: Data definition language
- Integrity Constraints
- DMLs: Data Manipulation Language Selection Queries
- ER → Relational Model

Relational History

70s Big debate: network vs relational model

IBM: IMS powered all “real” apps on mainframes

Oracle, Ingres: DBs for minicomputers (VAX)

1984: IBM DB/2 with SQL for mainframes

    Killed other models and languages

Still a huge industry: Oracle, IBM, Microsoft,

    HP Vertica, Teradata, others

Basic Definitions

Database a set of relations

Relation a table with rows and columns

- Schema name of relation + name & type of each column
- Instance specific set of rows
- e.g., Students(sid: int, name: string, login: string, age: int)

Think of relation as a *set* (no duplicate rows)

Relation colored glasses

- Everything (data, relationships, query results) is a relation

Terminology

Formal Name	Synonyms
Relation	Table
Tuple	Row, Record
Attribute	Column, Field
Domain	Type
Cardinality	# of tuple
Degree	# of attributes

Example *Instance* of Students Relation

sid	name	login	age	gpa
1	eugene	ewu@cs	20	2.5
2	neha	neha@cs	20	3.5
3	lin	lin@math	33	3.9

Cardinality 3
Degree 5

Do rows have to be distinct? (Yes)
Do columns have to be distinct? (No)

Integrity Constraints (ICs)

def: a condition that is true for *any* instance of the database

Often specified when defining schema
DBMS enforces ICs at all times

An instance of a relation is legal if it satisfies all declared ICs
Programmer doesn't have to worry about data errors!
    e.g., data entry errors

Don't Repeat Yourself (DRY)
PostgreSQL documentation great resource
    www.postgresql.org/docs/8.1/static/ddl-constraints.html

SQL DDL: CREATE TABLE

```
CREATE TABLE Name(
   columnName columnType,
   …
)
```

Domain Constraints (attr types)

```
CREATE TABLE Students(
   sid int,
   name text,
   login text,
   age int,
   gpa real
)
```

SQL DDL: CREATE TABLE

Create the Students Relation

```
CREATE TABLE Students(
    sid int,
    name text,
    login text,
    age int,
    gpa real
)
```

Note: attribute domains are defined & enforced by DBMS

Adding data

```
INSERT INTO Students VALUES
    (1, “Evan”, “ej”, 34, 3.1),
    (2, “Jinyang”, “jinyang”, 18, 3.9);
```

NULL Constraints

Default: Columns can contain the special value NULL (no value, optional)

Exception: Primary keys (soon)

```
CREATE TABLE Students(
   sid int NOT NULL,
   name text,
   login text,
   age int,
   gpa float
)
```

Candidate Keys

Set of fields is a *candidate key (or just Key)* for a relation if:

1. Two distinct valid tuples cannot have same values
2. This is **not** true for any subset of the key (minimal)

If (2) is false, called a superkey what's a trivial superkey?

If >1 candidate keys in relation, admin assigns primary key:
Used to identify tuples elsewhere in the database

sid is key for Students
is name a key?
what is (sid, gpa)?

Primary and Candidate Keys

UNIQUE & PRIMARY KEY key words

Be careful with integrity constraints:

Each student can enroll in a course only once

```
CREATE TABLE Enrolled(
    sid int,
    cid int,
    grade char(2),
    PRIMARY KEY (sid, cid)
)
```

What does this say?

```
CREATE TABLE Enrolled(
    sid int,
    cid int,
    grade char(2),
    PRIMARY KEY (sid),
    UNIQUE (cid, grade)
)
```

Foreign Keys

def: set of fields in Relation R_i used to refer to tuple in R_j via R_j's primary key (logical pointer)

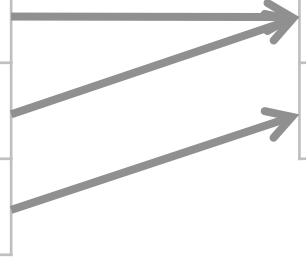
```
CREATE TABLE Enrolled(
    sid int,   cid int,   grade char(2),
    PRIMARY KEY (sid, cid),
    FOREIGN KEY (sid) REFERENCES Students
)
```

Enrolled

sid	cid	grade
1	2	A
1	3	B
2	2	A+

Students

sid	name
1	eugene
2	luis



Referential Integrity

A database instance has *referential integrity* if all foreign key constraints are enforced no dangling references

Examples where referential integrity is not enforced

- HTML links
- Yellow page listing
- Restaurant menus
- Some relational databases!

How to Enforce Integrity Constraints

Run checks anytime database changes

On INSERT

what if new Enrolled tuple refers to non-existent student?
Reject insertion

On DELETE (many options)

what if Students tuple is deleted?

delete dependent Enrolled tuples

reject deletion

set Enrolled.sid to default value or null

(null means 'unknown' or 'inapplicable' in SQL)