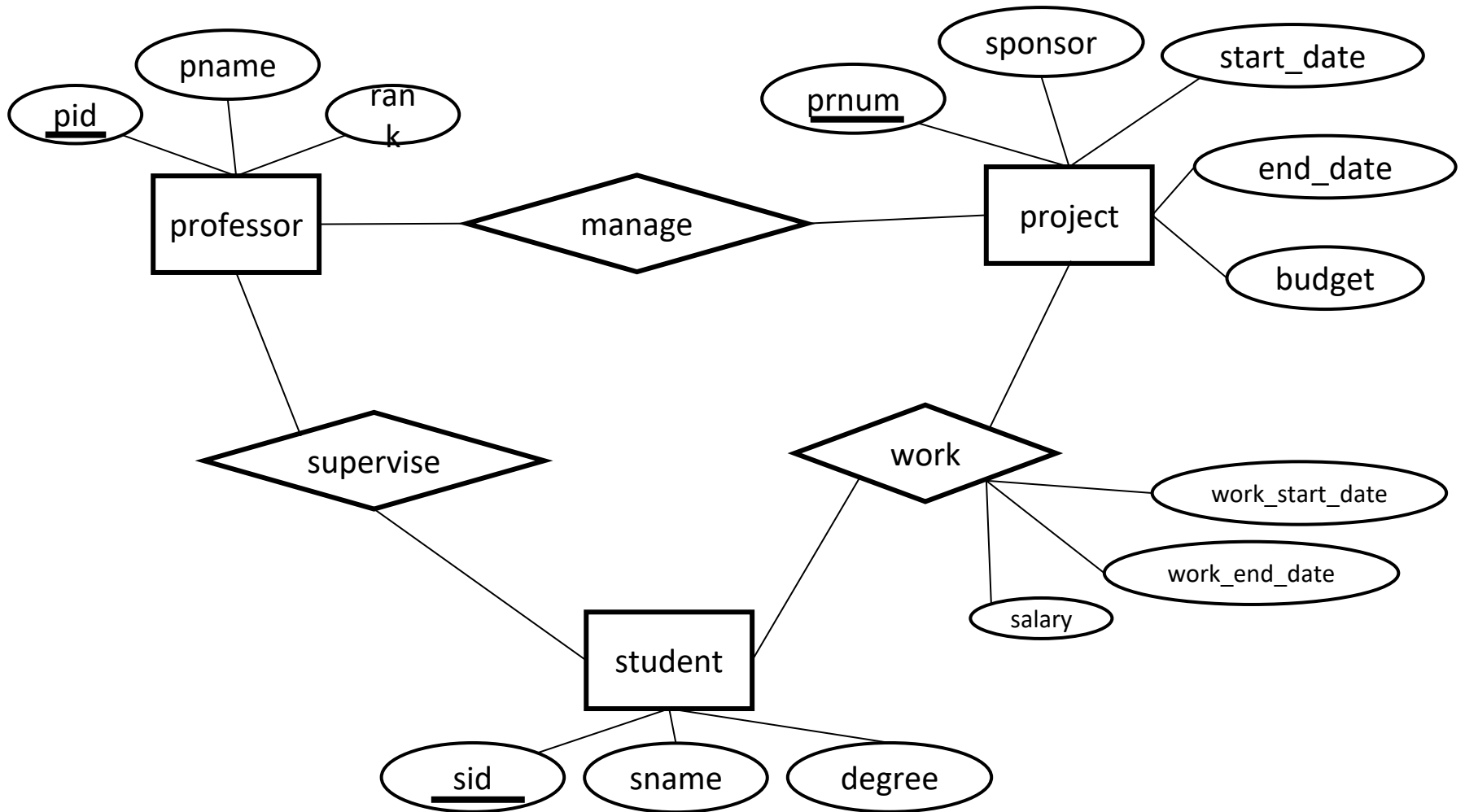# Assignment 1 Solution

Introduction to Databases, 2025 Spring

Datalab, NTHU

Problem 1 – ER-Model

Problem 1 – Relational-Model

```sql
CREATE TABLE profressors (
  pid      INTEGER,
  pname    VARCHAR(40),
  rank     VARCHAR(20),
  PRIMARY KEY (pid)
);
```

```sql
CREATE TABLE manage (
  pid      INTEGER,
  prnum    INTEGER,
  PRIMARY KEY (pid, prnum),
  FOREIGN KEY (pid) REFERENCES profressors,
  FOREIGN KEY (prnum) REFERENCES projects
);
```

```sql
CREATE TABLE projects (
  prnum       INTEGER,
  sponsor     VARCHAR(100),
  start_date  DATE,
  end_date    DATE,
  budge       REAL,
  PRIMARY KEY (prnum)
);
```

```sql
CREATE TABLE supervise (
  pid    INTEGER,
  sid    INTEGER,
  PRIMARY KEY (pid, sid),
  FOREIGN KEY (pid) REFERENCES profressors,
  FOREIGN KEY (sid) REFERENCES students
);
```

```sql
CREATE TABLE work (
  sid              INTEGER,
  prnum            INTEGER,
  work_start_date  DATE,
  work_end_date    DATE,
  salary           REAL,
  PRIMARY KEY (sid, prnum),
  FOREIGN KEY (sid) REFERENCES students,
  FOREIGN KEY (prnum) REFERENCES projects
);
```

```sql
CREATE TABLE students (
  sid      INTEGER,
  sname    VARCHAR(40),
  degree   VARCHAR(10),
  PRIMARY KEY (sid)
);
```

Problem 2

Request: Decompose this table to match the 3rd normal form

forum_name	popularity	post_id	title	article	reply
Gossiping	100	131	Girlfriend	How can I get girlfriend ?	["Haha", "I don't know"]
Gossiping	100	252	Friends	I don't have a friend...	["Haha", "I can be", "QQ"]
Joke	23	46	Knock	Knock! Knock! ...	["Then?", "What's the point ?"]
Joke	23	151	Santa Claus	Hold! Hold! Hold!	["XDD"]

Normal Form

- 1st normal form
  - No array
- 2nd normal form
  - No non-prime attribute that is *partially* dependent on any candidate key
- 3rd normal form
  - Every non-prime attribute is dependent on every candidate key

First Normal Form

- ## 1st normal form
  - No array
- ## 2nd normal form
  - No non-prime attribute that is *partially* dependent on any candidate key
- ## 3rd normal form
  - Every non-prime attribute is dependent on every candidate key

Step 1: To The 1ˢᵗ Normal Form

The 1ˢᵗ Normal Form: No array !!

forum_name	popularity	post_id	title	article	reply
Gossiping	100	131	Girlfriend	How can I get girlfriend ?	["Haha", "I don't know"]
Gossiping	100	252	Friends	I don't have a friend...	["Haha", "I can be", "QQ"]
Joke	23	46	Knock	Knock! Knock! ...	["Then?", "What's the point ?"]
Joke	23	151	Santa Claus	Hold! Hold! Hold!	["XDD"]

Step 1: To The 1st Normal Form

The 1st Normal Form: No array !!

forum_name	popularity	post_id	title	article	reply_id	reply_content
Gossiping	100	131	Girlfriend	How can I get girlfriend ?	1	Haha
Gossiping	100	131	Girlfriend	How can I get girlfriend ?	2	I don't know
Gossiping	100	252	Friends	I don't have a friend…	1	Haha
Gossiping	100	252	Friends	I don't have a friend…	2	I can be
Gossiping	100	252	Friends	I don't have a friend…	3	QQ
Joke	23	46	Knock	Knock! Knock! …	1	Then?
Joke	23	46	Knock	Knock! Knock! …	2	What's the point ?
Joke	23	151	Santa Claus	Hold! Hold! Hold!	1	XDD

Note: "reply_id" is necessary to identify each content

The Problems with This Table

- You cannot add a forum without a post and a reply
- You cannot add a post without a reply

forum_name	popularity	post_id	title	article	reply_id	reply_content
Gossiping	100	131	Girlfriend	How can I get girlfriend ?	1	Haha
Gossiping	100	131	Girlfriend	How can I get girlfriend ?	2	I don't know
Gossiping	100	252	Friends	I don't have a friend...	1	Haha
Gossiping	100	252	Friends	I don't have a friend...	2	I can be
Gossiping	100	252	Friends	I don't have a friend...	3	QQ
Joke	23	46	Knock	Knock! Knock! ...	1	Then?
Joke	23	46	Knock	Knock! Knock! ...	2	What's the point ?
Joke	23	151	Santa Claus	Hold! Hold! Hold!	1	XDD

Review: Candidate Key

- A candidate key is a set of attributes that
    - can uniquely identify each tuple
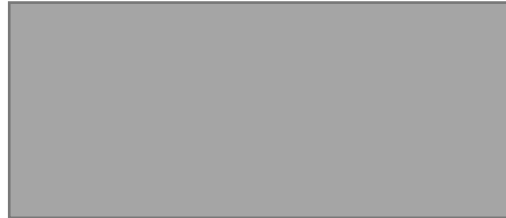   - is minimal

Review: Candidate Key

- A candidate key is a set of attributes that
    - can uniquely identify each tuple
    - is minimal

Find Candidate Key

forum_name	popularity	post_id	title	article	reply_id	reply_content
Gossiping	100	131	Girlfriend	How can I get girlfriend ?	1	Haha
Gossiping	100	131	Girlfriend	How can I get girlfriend ?	2	I don't know
Gossiping	100	252	Friends	I don't have a friend...	1	Haha
Gossiping	100	252	Friends	I don't have a friend...	2	I can be
Gossiping	100	252	Friends	I don't have a friend...	3	QQ
Joke	23	46	Knock	Knock! Knock! ...	1	Then?
Joke	23	46	Knock	Knock! Knock! ...	2	What's the point ?
Joke	23	151	Santa Claus	Hold! Hold! Hold!	1	XDD

Find Candidate Key

Forum_name →
Forum_name, Post_id →
Forum_name, Post_id, Reply_id →

forum_name	popularity	post_id	title	article	reply_id	reply_content
Gossiping	100	131	Girlfriend	How can I get girlfriend ?	1	Haha
Gossiping	100	131	Girlfriend	How can I get girlfriend ?	2	I don't know
Gossiping	100	252	Friends	I don't have a friend...	1	Haha
Gossiping	100	252	Friends	I don't have a friend...	2	I can be
Gossiping	100	252	Friends	I don't have a friend...	3	QQ
Joke	23	46	Knock	Knock! Knock! ...	1	Then?
Joke	23	46	Knock	Knock! Knock! ...	2	What's the point ?
Joke	23	151	Santa Claus	Hold! Hold! Hold!	1	XDD

Find Candidate Key

A candidate key

forum_name	popularity	post_id	title	article	reply_id	reply_content
Gossiping	100	131	Girlfriend	How can I get girlfriend ?	1	Haha
Gossiping	100	131	Girlfriend	How can I get girlfriend ?	2	I don't know
Gossiping	100	252	Friends	I don't have a friend...	1	Haha
Gossiping	100	252	Friends	I don't have a friend...	2	I can be
Gossiping	100	252	Friends	I don't have a friend...	3	QQ
Joke	23	46	Knock	Knock! Knock! ...	1	Then?
Joke	23	46	Knock	Knock! Knock! ...	2	What's the point ?
Joke	23	151	Santa Claus	Hold! Hold! Hold!	1	XDD

Forum_name → popularity
Forum_name, Post_id → title, article
Forum_name, Post_id, Reply_id → reply_content

Find Candidate Key

Is this a candidate key?

forum_name	popularity	post_id	title	article	reply_id	reply_content
Gossiping	100	131	Girlfriend	How can I get girlfriend ?	1	Haha
Gossiping	100	131	Girlfriend	How can I get girlfriend ?	2	I don't know
Gossiping	100	252	Friends	I don't have a friend...	1	Haha
Gossiping	100	252	Friends	I don't have a friend...	2	I can be
Gossiping	100	252	Friends	I don't have a friend...	3	QQ
Joke	23	46	Knock	Knock! Knock! ...	1	Then?
Joke	23	46	Knock	Knock! Knock! ...	2	What's the point ?
Joke	23	151	Santa Claus	Hold! Hold! Hold!	1	XDD

Review: Candidate Key

- A candidate key is a set of attributes that
  - can uniquely identify each tuple
  - is minimal

Find Candidate Key

The only candidate key in this table

forum_name	popularity	post_id	title	article	reply_id	reply_content
Gossiping	100	131	Girlfriend	How can I get girlfriend ?	1	Haha
Gossiping	100	131	Girlfriend	How can I get girlfriend ?	2	I don't know
Gossiping	100	252	Friends	I don't have a friend...	1	Haha
Gossiping	100	252	Friends	I don't have a friend...	2	I can be
Gossiping	100	252	Friends	I don't have a friend...	3	QQ
Joke	23	46	Knock	Knock! Knock! ...	1	Then?
Joke	23	46	Knock	Knock! Knock! ...	2	What's the point ?
Joke	23	151	Santa Claus	Hold! Hold! Hold!	1	XDD

Second Normal Form

- 1st normal form
  - No array
- 2nd normal form
  - No non-prime attributes that is *partially* dependent on any candidate key
- 3rd normal form
  - Every non-prime attribute is dependent on every candidate key

Forum_name $\rightarrow$ popularity
Forum_name, Post_id $\rightarrow$ title, article
Forum_name, Post_id, Reply_id $\rightarrow$ reply_content

The only candidate key in this table

forum_name	popularity	post_id	title	article	reply_id	reply_content
Gossiping	100	131	Girlfriend	How can I get girlfriend ?	1	Haha
Gossiping	100	131	Girlfriend	How can I get girlfriend ?	2	I don't know
Gossiping	100	252	Friends	I don't have a friend...	1	Haha
Gossiping	100	252	Friends	I don't have a friend...	2	I can be
Gossiping	100	252	Friends	I don't have a friend...	3	QQ
Joke	23	46	Knock	Knock! Knock! ...	1	Then?
Joke	23	46	Knock	Knock! Knock! ...	2	What's the point ?
Joke	23	151	Santa Claus	Hold! Hold! Hold!	1	XDD

The remaining fields are all non-prime attributes

Step 2: To The 2nd Normal Form

2nd Normal Form :No non-prime attributes that is *partially dependent on* any candidate key

Candidate key

forum_name	popularity	post_id	title	article	reply_id	reply_content
Gossiping	100	131	Girlfriend	How can I get girlfriend ?	1	Haha
Gossiping	100	131	Girlfriend	How can I get girlfriend ?	2	I don't know
Gossiping	100	252	Friends	I don't have a friend…	1	Haha
Gossiping	100	252	Friends	I don't have a friend…	2	I can be
Gossiping	100	252	Friends	I don't have a friend…	3	QQ
Joke	23	46	Knock	Knock! Knock! …	1	Then?
Joke	23	46	Knock	Knock! Knock! …	2	What's the point ?
Joke	23	151	Santa Claus	Hold! Hold! Hold!	1	XDD

Non-prime attributes

Step 2: To The 2nd Normal Form

2nd Normal Form : No non-prime attributes that is *partially dependent on* any candidate key

Forum_name → popularity
Forum_name, Post_id → title, article
Forum_name, Post_id, Reply_id → reply_content

forum_name	popularity	post_id	title	article	reply_id	reply_content
Gossiping	100	131	Girlfriend	How can I get girlfriend ?	1	Haha
Gossiping	100	131	Girlfriend	How can I get girlfriend ?	2	I don't know
Gossiping	100	252	Friends	I don't have a friend…	1	Haha
Gossiping	100	252	Friends	I don't have a friend…	2	I can be
Gossiping	100	252	Friends	I don't have a friend…	3	QQ
Joke	23	46	Knock	Knock! Knock! …	1	Then?
Joke	23	46	Knock	Knock! Knock! …	2	What's the point ?
Joke	23	151	Santa Claus	Hold! Hold! Hold!	1	XDD

Step 2: To The 2nd Normal Form

2nd Normal Form :No non-prime attributes that is *partially dependent on* any candidate key

forum_name	popularity	post_id	title	article	reply_id	reply_content
Gossiping	100	131	Girlfriend	How can I get girlfriend ?	1	Haha
Gossiping	100	131	Girlfriend	How can I get girlfriend ?	2	I don't know
Gossiping	100	252	Friends	I don't have a friend...	1	Haha
Gossiping	100	252	Friends	I don't have a friend...	2	I can be
Gossiping	100	252	Friends	I don't have a friend...	3	QQ
Joke	23	46	Knock	Knock! Knock! ...	1	Then?
Joke	23	46	Knock	Knock! Knock! ...	2	What's the point ?
Joke	23	151	Santa Claus	Hold! Hold! Hold!	1	XDD

Forum_name   →   popularity
Forum_name, Post_id   →   title, article
Forum_name, Post_id, Reply_id →   reply_content

Step 2: To The 2nd Normal Form

2nd Normal Form :No non-prime attributes that is *partially dependent on* any candidate key

One final dependency

forum_name	popularity	post_id	title	article	reply_id	reply_content
Gossiping	100	131	Girlfriend	How can I get girlfriend ?	1	Haha
Gossiping	100	131	Girlfriend	How can I get girlfriend ?	2	I don't know
Gossiping	100	252	Friends	I don't have a friend...	1	Haha
Gossiping	100	252	Friends	I don't have a friend...	2	I can be
Gossiping	100	252	Friends	I don't have a friend...	3	QQ
Joke	23	46	Knock	Knock! Knock! ...	1	Then?
Joke	23	46	Knock	Knock! Knock! ...	2	What's the point ?
Joke	23	151	Santa Claus	Hold! Hold! Hold!	1	XDD

Forum_name → popularity
Forum_name, Post_id → title, article
Forum_name, Post_id, Reply_id → reply_content

23

Step 2: To The 2nd Normal Form

Decompose the table to eliminate the first violation

forum_name	post_id	title	article	reply_id	reply_content
Gossiping	131	Girlfriend	How can I get girlfriend ?	1	Haha
Gossiping	131	Girlfriend	How can I get girlfriend ?	2	I don't know
Gossiping	252	Friends	I don't have a friend...	1	Haha
	252	Friends	I don't have a friend...	2	I can be
	252	Friends	I don't have a friend...	3	QQ
Joke	46	Knock	Knock! Knock! ...	1	Then?
Joke	46	Knock	Knock! Knock! ...	2	What's the point ?
Joke	151	Santa Claus	Hold! Hold! Hold!	1	XDD

forum_name	popularity
Gossiping	100
Joke	23

Forum_name   →   popularity
Forum_name, Post_id   →   title, article
Forum_name, Post_id, Reply_id   →   reply_content

Step 2: To The 2nd Normal Form

Decompose the table to eliminate the second violation

forum_name	post_id	title	article
Gossiping	131	Girlfriend	How can I get girlfriend ?
Gossiping	252	Friends	I don't have a friend...
Joke	46	Knock	Knock! Knock! ...
Joke	151	Santa Claus	Hold! Hold! Hold!

forum_name	popularity
Gossiping	100
Joke	23

forum_name	post_id	reply_id	reply_content
Gossiping	131	1	Haha
Gossiping	131	2	I don't know
Gossiping	252	1	Haha
Gossiping	252	2	I can be
Gossiping	252	3	QQ
Joke	46	1	Then?
Joke	46	2	What's the point ?
Joke	151	1	XDD

Forum_name → popularity
Forum_name, Post_id → title, article
Forum_name, Post_id, Reply_id → reply_content

Third Normal Form

- 1st normal form
  - No array

- 2nd normal form
  - No non-prime attribute that is *partially* dependent on any candidate key

- 3rd normal form
  - Every non-prime attribute is dependent on every candidate key

Step 3: To The 3ʳᵈ Normal Form

forum_name	post_id	title	article
Gossiping	131	Girlfriend	How can I get girlfriend ?
Gossiping	252	Friends	I don't have a friend...
Joke	46	Knock	Knock! Knock! ...
Joke	151	Santa Claus	Hold! Hold! Hold!

forum_name	post_id	reply_id	reply_content
Gossiping	131	1	Haha
Gossiping	131	2	I don't know
Gossiping	252	1	Haha
Gossiping	252	2	I can be
Gossiping	252	3	QQ
Joke	46	1	Then?
Joke	46	2	What's the point ?
Joke	151	1	XDD

forum_name	popularity
Gossiping	100
Joke	23

Step 3: To The 3ʳᵈ Normal Form

Every non-prime attribute is dependent on every candidate key

forum_name	popularity
Gossiping	100
Joke	23

Forum_name → popularity

Step 3: To The 3rd Normal Form

Every non-prime attribute is dependent on every candidate key

forum_name	post_id	title	article
Gossiping	131	Girlfriend	How can I get girlfriend ?
Gossiping	252	Friends	I don't have a friend...
Joke	46	Knock	Knock! Knock! ...
Joke	151	Santa Claus	Hold! Hold! Hold!

Forum_name, Post_id   →   title, article

Step 3: To The 3rd Normal Form

Every non-prime attribute is dependent on every candidate key

forum_name	post_id	reply_id	reply_content
Gossiping	131	1	Haha
Gossiping	131	2	I don't know
Gossiping	252	1	Haha
Gossiping	252	2	I can be
Gossiping	252	3	QQ
Joke	46	1	Then?
Joke	46	2	What's the point ?
Joke	151	1	XDD

Forum_name, Post_id, Reply_id → reply_content

The Final Result

forum_name	post_id	title	article
Gossiping	131	Girlfriend	How can I get girlfriend ?
Gossiping	252	Friends	I don't have a friend...
Joke	46	Knock	Knock! Knock! ...
Joke	151	Santa Claus	Hold! Hold! Hold!

forum_name	popularity
Gossiping	100
Joke	23

forum_name	post_id	reply_id	reply_content
Gossiping	131	1	Haha
Gossiping	131	2	I don't know
Gossiping	252	1	Haha
Gossiping	252	2	I can be
Gossiping	252	3	QQ
Joke	46	1	Then?
Joke	46	2	What's the point ?
Joke	151	1	XDD