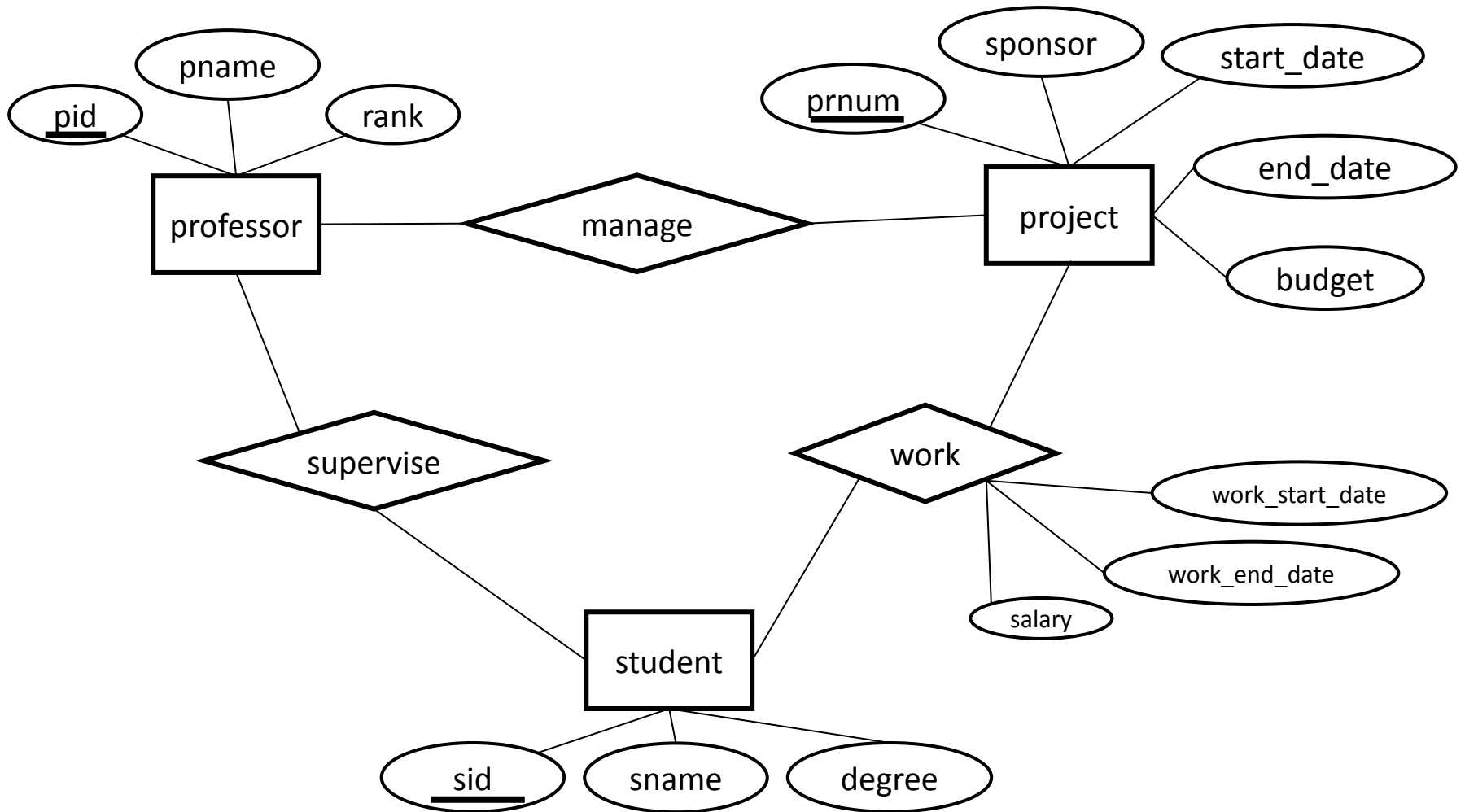


Assignment 1 Solution

Introduction to Databases, 2026 Spring
Datalab, NTHU

Problem 1 – ER-Model



Problem 1 – Relational-Model

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

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

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

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

```
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  
);
```

```
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 !!

<u>forum_name</u>	popularity	<u>post_id</u>	title	article	<u>reply_id</u>	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

<u>forum_name</u>	popularity	<u>post_id</u>	title	article	<u>reply_id</u>	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

<u>forum_name</u>	popularity	<u>post_id</u>	title	article	<u>reply_id</u>	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



<u>forum_name</u>	popularity	<u>post_id</u>	title	article	<u>reply_id</u>	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



<u>forum_name</u>	popularity	<u>post_id</u>	title	article	<u>reply_id</u>	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?




<u>forum_name</u>	popularity	<u>post_id</u>	title	article	<u>reply_id</u>	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



<u>forum_name</u>	popularity	<u>post_id</u>	title	article	<u>reply_id</u>	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 → popularity
- Forum_name, Post_id → title, article
- Forum_name, Post_id, Reply_id → reply_content

The only candidate key in this table



<u>forum_name</u>	popularity	<u>post_id</u>	title	article	<u>reply_id</u>	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



<u>forum_name</u>	popularity	<u>post_id</u>	title	article	<u>reply_id</u>	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

<u>forum_name</u>	popularity	<u>post_id</u>	title	article	<u>reply_id</u>	reply_content
Gossiping	100	1	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



<u>forum_name</u>	popularity	<u>post_id</u>	title	article	<u>reply_id</u>	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



<u>forum_name</u>	popularity	<u>post_id</u>	title	article	<u>reply_id</u>	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

Decompose the table to eliminate the first violation

<u>forum_name</u>	<u>post_id</u>	title	article	<u>reply_id</u>	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
forum_name	popularity	252	Friends	2	I can be
Gossiping	100	252	Friends	3	QQ
Joke	23	46	Knock	1	Then?
Joke	46	46	Knock	2	What's the point ?
Joke	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

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	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

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