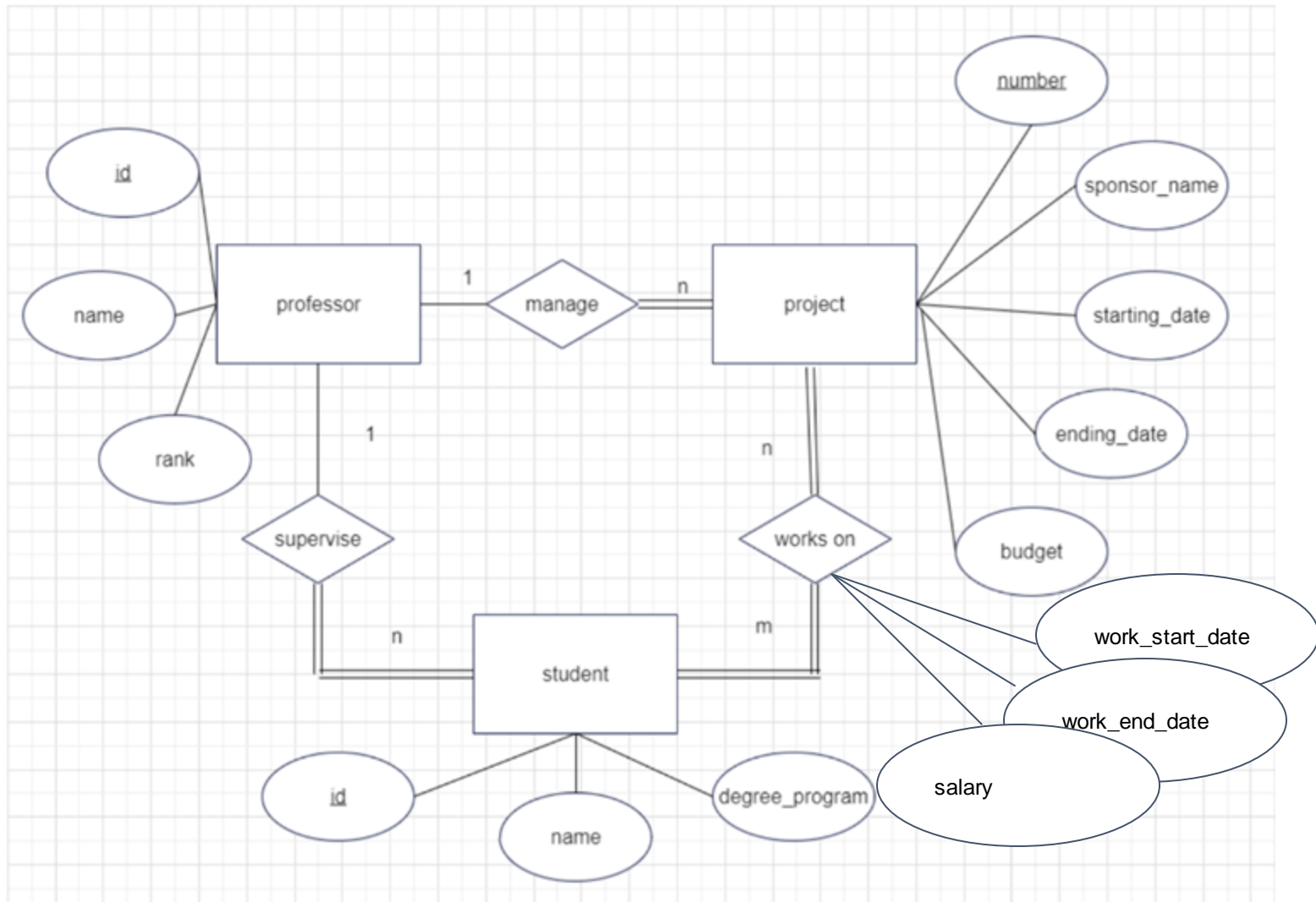


# Assignment 1 Solution

Introduction to Databases , 2023 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 projects (  
    prnum     INTEGER,  
    sponsor   VARCHAR(100),  
    start_date DATE,  
    end_date  DATE,  
    budget    REAL,  
    PRIMARY KEY (prnum)  
);
```

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

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

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

```
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  
);
```

# Problem 2

Request: Decompose this table to match the 3<sup>rd</sup> 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"]

# First Normal Form

- 1<sup>st</sup> normal form
  - No array or as one string
- 2<sup>nd</sup> normal form
  - No non-prime attribute that is *partially* dependent on any candidate key
- 3<sup>rd</sup> normal form
  - Every non-prime attribute is dependent on every candidate key

# First Normal Form

- 1<sup>st</sup> normal form
  - No array or as one string
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  - No non-prime attribute that is *partially* dependent on any candidate key
- 3<sup>rd</sup> normal form
  - Every non-prime attribute is dependent on every candidate key

# Step 1: To The 1<sup>st</sup> Normal Form

The 1<sup>st</sup> 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 1<sup>st</sup> Normal Form

The 1<sup>st</sup> 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





# Step 1: To The 1<sup>st</sup> Normal Form

The 1<sup>st</sup> Normal Form: as one string !!

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"]



# The Problems with This Table

- You cannot add a forum without a post and 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

# 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

→ popularity

Forum\_name, Post\_id


→

title, article

<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

# Second Normal Form

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

Forum\_name



popularity

Forum\_name, Post\_id



title, article

The only candidate key in this table

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	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 2<sup>nd</sup> Normal Form

2<sup>nd</sup> 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 2<sup>nd</sup> Normal Form

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



Forum\_name

popularity

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

# Step 2: To The 2<sup>nd</sup> Normal Form

2<sup>nd</sup> 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

# Step 2: To The 2<sup>nd</sup> Normal Form

2<sup>nd</sup> 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

# Step 2: To The 2<sup>nd</sup> 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
forum_name	popularity	252	Friends	I don't have a friend...	1	Haha
Gossiping	100	252	Friends	I don't have a friend...	2	I can be
Joke	23	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

Forum\_name, Post\_id

→

title, article

Forum\_name, Post\_id, Reply\_id

→

# Step 2: To The 2<sup>nd</sup> 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

Forum\_name, Post\_id, Reply\_id

→

→

→

title, article

# Third Normal Form

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

# Step 3: To The 3<sup>rd</sup> 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 3<sup>rd</sup> 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 3<sup>rd</sup> Normal Form

Every non-prime attribute is dependent on every candidate key



The diagram illustrates functional dependencies. A green bracket under the first two columns (forum\_name and post\_id) has two green arrows pointing to the last two columns (title and article). A large green checkmark is positioned to the right of the table.

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 3<sup>rd</sup> 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

# The Final Result 1

<u>forum_name</u>	<u>post_id</u>	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!

<u>forum_name</u>	popularity
Gossiping	100
Joke	23

<u>forum_name</u>	<u>post_id</u>	<u>reply_id</u>	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

# The Final Result 2

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

<u>forum_name</u>	popularity
Gossiping	100
Joke	23