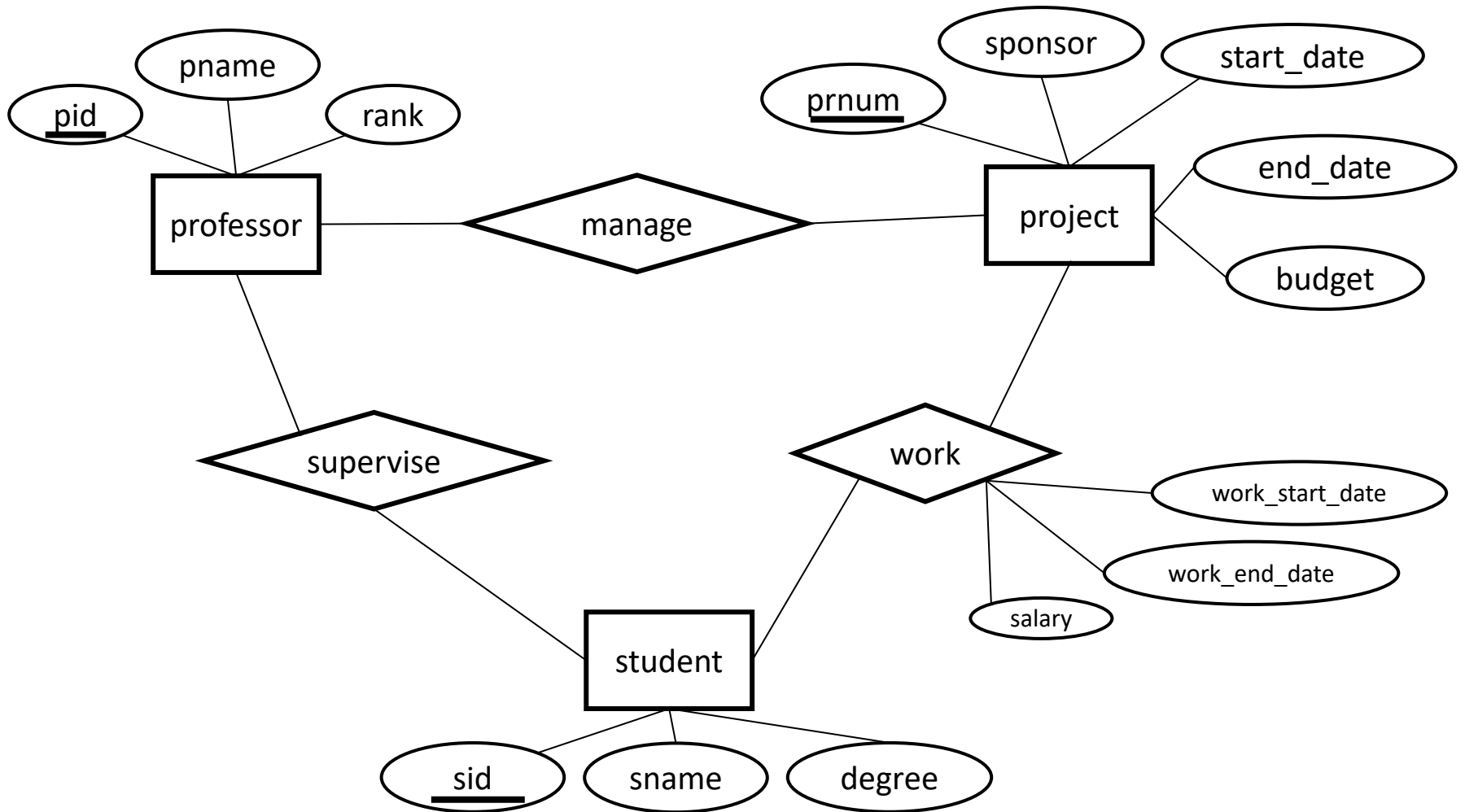


# Assignment 1 Solution

Introduction to Databases, 2021 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 students (  
  sid      INTEGER,  
  sname    VARCHAR(40),  
  degree   VARCHAR(10),  
  PRIMARY KEY (sid)  
);
```

```
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"]

# 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

# First 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 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



# 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 → 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	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

- 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

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 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 → 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	<del>111</del>	Girlfriend	How can I get girlfriend ?	<del>1</del>	Haha
Gossiping	100	<del>131</del>	Girlfriend	How can I get girlfriend ?	<del>2</del>	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  
Forum\_name, Post\_id, Reply\_id → reply\_content

# 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

Forum\_name, Post\_id, Reply\_id

→

reply\_content

# Step 2: To The 2<sup>nd</sup> 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
<b>forum_name</b>	<b>popularity</b>	252	Friends	2	I can be
Gossiping	100	252	Friends	3	QQ
Joke	23	46	Knock	1	Then?
Joke		46	Knock	2	What's the point ?
Joke		151	Santa Claus	1	XDD

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



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

# 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

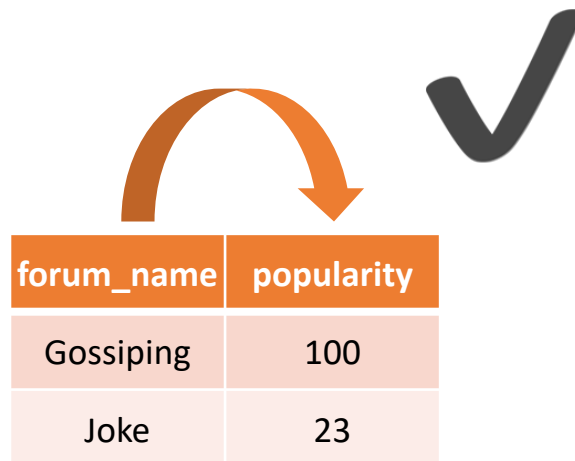
forum_name	post_id	title	article
Gossiping	131	Girlfriend	How can I get girlfriend ?
Gossiping	252	Friends	I don't have a friend...
Joke	46	Knock	Knock! Knock! ...
Joke	151	Santa Claus	Hold! Hold! Hold!

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

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

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