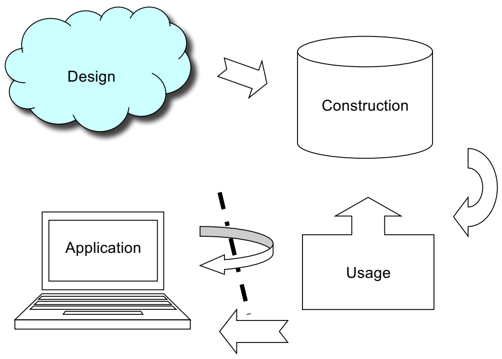
Lecture 1

Database design

Relations

Course Objectives



Design

Construction

Application

Usage

Course Objectives – Design

When the course is through, you should

– Given a domain, know how to design a database that correctly models the domain and its constraints

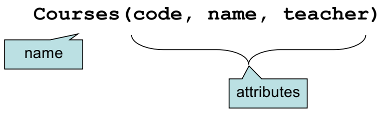
”We want a database that we can use for scheduling courses and lectures. This is how it’s supposed to work: …”

Designing a database

- ”Map” the domain, find out what the database is intended to model
  - The database should accept all data possible in reality
  - The database should agree with reality and not accept impossible or unwanted data
- Construct the ”blueprint” for the database – the database ***schema***

Database Schemas

- A database schema is a set of *relation schemas*
- A relation schema has a name, and a set of attributes (+ types):



```
Courses(code, name, teacher)
```

name

attributes

Schema vs Instance

- ***Schema*** – the logical structure of the relation (or database)
  - `Courses(code, name, teacher)`
- ***Instance*** – the actual content at any point in time

```
{ ('TDA357', 'Databases', 'Mickey'),
  ('TIN090', 'Algorithms', 'Donald') }
```

tuples

(like a blueprint for a house, and the actual house built from it.)

From schema to database

- The relations of the database schema become the tables when we implement the database in a DBMS. The tuples become the rows:

```
Courses(code, name, teacher)
```

relation schema

table instance

code	name	teacher
'TDA357'	'Databases'	'Mickey'
'TIN090'	'Algorithms'	'Donald'

Why relations?

- Relations often match our intuition regarding data
- Very simple model
- Has a good theoretical foundation from mathematics (set theory)
- The abstract model underlying SQL, the most important database language today

Keys

- Relations have keys – special attributes whose values uniquely determine the values of all other attributes in the relation.

```
Courses(code, period, name, teacher)
```

key

{('TDA357', 2, 'Databases', 'Mickey'),
~~('TDA357', 3, 'Algorithms', 'Tweety')~~}

Passport_ID   Telephone_No   No_Patent

Composite keys

- Keys can consist of several attributes

```
Courses(code, period, name, teacher)

{('TDA357', 2, 'Databases', 'Mickey'),
 ('TDA357', 3, 'Databases', 'Tweety')}
```

Quiz time!

What's wrong with this schema?

```
Courses(code, period, name, teacher)

{('TDA357', 2, 'Databases', 'Mickey'),
 ('TDA357', 3, 'Databases', 'Tweety')}
```

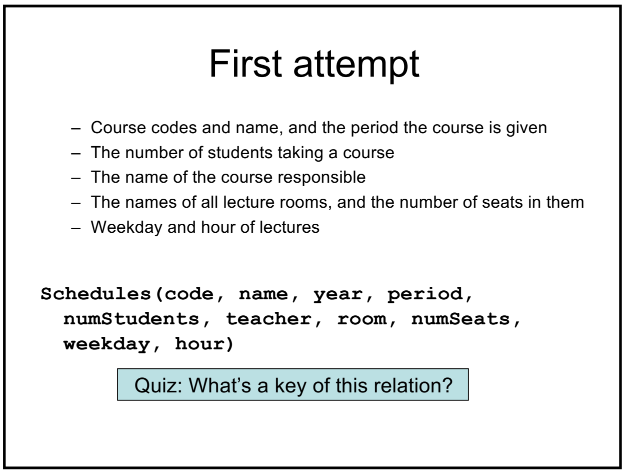
Redundancy!

```
Courses(code, name)
CourseTeachers(code, period, teacher)
```

"Schedules" database

"We want a database for an application that we will use to schedule courses. …"

- Course codes and names, and the period the courses are given
- The number of students taking a course
- The name of the course responsible
- The names of all lecture rooms, and the number of seats in them
- Weekdays and hours of lectures

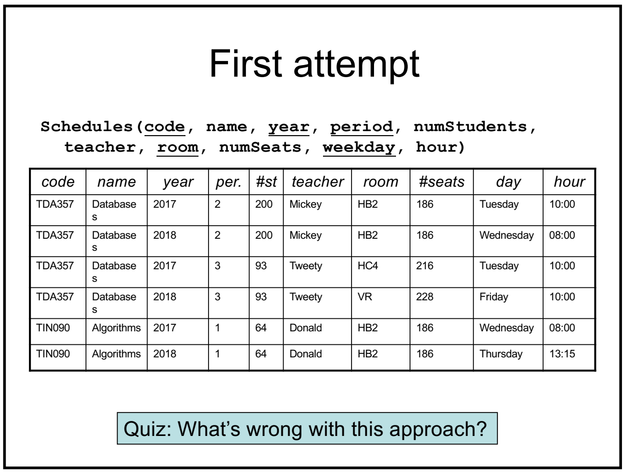


First attempt

- Course codes and name, and the period the course is given
- The number of students taking a course
- The name of the course responsible
- The names of all lecture rooms, and the number of seats in them
- Weekday and hour of lectures

Schedules(code, name, year, period,
numStudents, teacher, room, numSeats,
weekday, hour)

Quiz: What's a key of this relation?

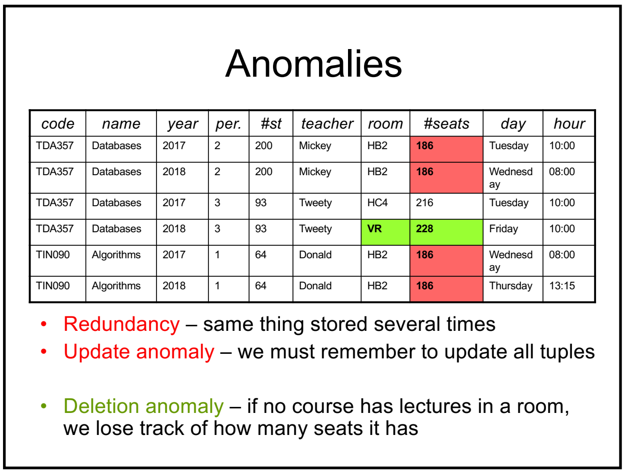


First attempt

Schedules(code, name, year, period, numStudents,
teacher, room, numSeats, weekday, hour)

code	name	year	per.	#st	teacher	room	#seats	day	hour
TDA357	Databases	2017	2	200	Mickey	HB2	186	Tuesday	10:00
TDA357	Databases	2018	2	200	Mickey	HB2	186	Wednesday	08:00
TDA357	Databases	2017	3	93	Tweety	HC4	216	Tuesday	10:00
TDA357	Databases	2018	3	93	Tweety	VR	228	Friday	10:00
TIN090	Algorithms	2017	1	64	Donald	HB2	186	Wednesday	08:00
TIN090	Algorithms	2018	1	64	Donald	HB2	186	Thursday	13:15

Quiz: What's wrong with this approach?

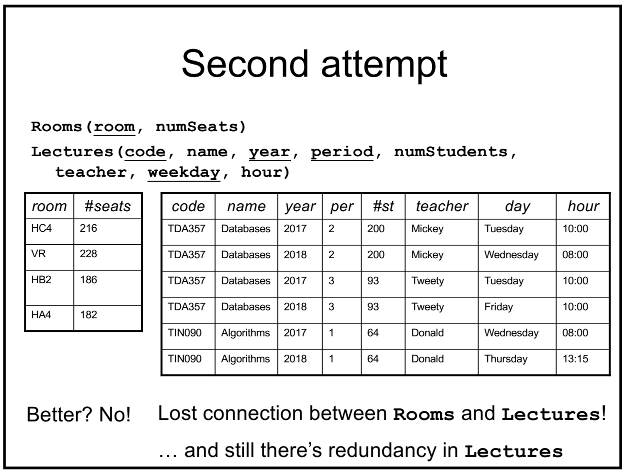


Anomalies

code	name	year	per.	#st	teacher	room	#seats	day	hour
TDA357	Databases	2017	2	200	Mickey	HB2	186	Tuesday	10:00
TDA357	Databases	2018	2	200	Mickey	HB2	186	Wednesday	08:00
TDA357	Databases	2017	3	93	Tweety	HC4	216	Tuesday	10:00
TDA357	Databases	2018	3	93	Tweety	VR	228	Friday	10:00
TIN090	Algorithms	2017	1	64	Donald	HB2	186	Wednesday	08:00
TIN090	Algorithms	2018	1	64	Donald	HB2	186	Thursday	13:15

- Redundancy – same thing stored several times
- Update anomaly – we must remember to update all tuples

- Deletion anomaly – if no course has lectures in a room, we lose track of how many seats it has



Second attempt

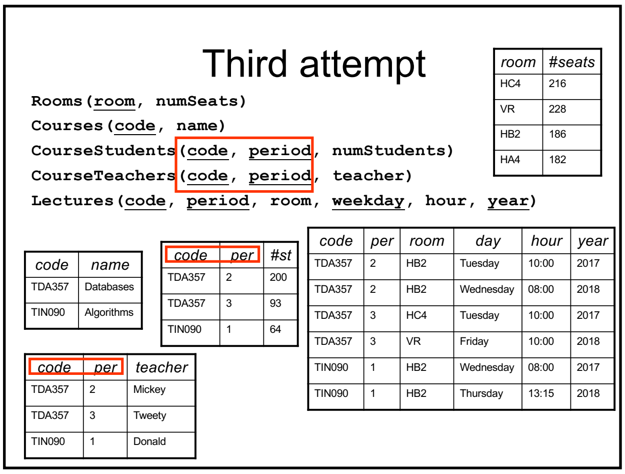
Rooms(room, numSeats)
Lectures(code, name, year, period, numStudents,
teacher, weekday, hour)

room	#seats
HC4	216
VR	228
HB2	186
HA4	182

code	name	year	per	#st	teacher	day	hour
TDA357	Databases	2017	2	200	Mickey	Tuesday	10:00
TDA357	Databases	2018	2	200	Mickey	Wednesday	08:00
TDA357	Databases	2017	3	93	Tweety	Tuesday	10:00
TDA357	Databases	2018	3	93	Tweety	Friday	10:00
TIN090	Algorithms	2017	1	64	Donald	Wednesday	08:00
TIN090	Algorithms	2018	1	64	Donald	Thursday	13:15

Better? No! Lost connection between **Rooms** and **Lectures**!

… and still there's redundancy in **Lectures**



Third attempt

Rooms(room, numSeats)
Courses(code, name)
CourseStudents(code, period, numStudents)
CourseTeachers(code, period, teacher)
Lectures(code, period, room, weekday, hour, year)

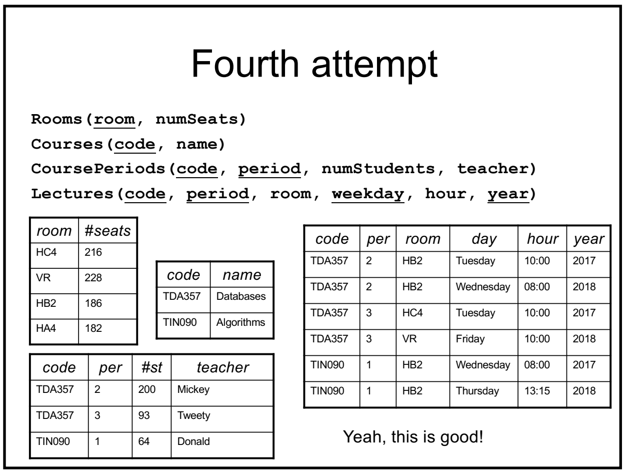
room	#seats
HC4	216
VR	228
HB2	186
HA4	182

code	name
TDA357	Databases
TIN090	Algorithms

code	per	#st
TDA357	2	200
TDA357	3	93
TIN090	1	64

code	per	teacher
TDA357	2	Mickey
TDA357	3	Tweety
TIN090	1	Donald

code	per	room	day	hour	year
TDA357	2	HB2	Tuesday	10:00	2017
TDA357	2	HB2	Wednesday	08:00	2018
TDA357	3	HC4	Tuesday	10:00	2017
TDA357	3	VR	Friday	10:00	2018
TIN090	1	HB2	Wednesday	08:00	2017
TIN090	1	HB2	Thursday	13:15	2018



Fourth attempt

Rooms(room, numSeats)
Courses(code, name)
CoursePeriods(code, period, numStudents, teacher)
Lectures(code, period, room, weekday, hour, year)

room	#seats
HC4	216
VR	228
HB2	186
HA4	182

code	name
TDA357	Databases
TIN090	Algorithms

code	per	#st	teacher
TDA357	2	200	Mickey
TDA357	3	93	Tweety
TIN090	1	64	Donald

code	per	room	day	hour	year
TDA357	2	HB2	Tuesday	10:00	2017
TDA357	2	HB2	Wednesday	08:00	2018
TDA357	3	HC4	Tuesday	10:00	2017
TDA357	3	VR	Friday	10:00	2018
TIN090	1	HB2	Wednesday	08:00	2017
TIN090	1	HB2	Thursday	13:15	2018

Yeah, this is good!

Things to avoid!

- Redundancy
- Unconnected relations
- Too much decomposition

Take away!

- Not using a structured design method means it’s easy to make errors.
- Learn from the mistakes of others, then you won’t have to repeat them yourself!

Summary

- A database schema is a blueprint
  - Consists of a set of relations e.g. Courses(code, name, teacher) where “Courses” is the relation name and code, name and teacher are attributes.
- A database instance holds actual data
  - Tuples are instances of a relation.
    - E.g. (‘TDA357’, ‘Databases’, ‘Mickey’)
- In a DBMS, a table holds relations where:
  - Each row holds a tuple
  - Each column stores a different attribute
- Keys uniquely identify the other values of a tuple in a relation
  - Composite keys combine several attributes
- Avoid
  - Redundancy
  - Unconnected relations
  - Too much decomposition

Next time, Lecture 2

More on Relations
Entity-Relationship diagrams