E-R model, Relational model, SQL

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Introduction

Lecture topics

- E-R model.
- Relational model.
- SQL, and examples.

Data models

database design process

- Requirements analysis

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- Requirements analysis
- Conceptual database design

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- Conceptual database design
- Logical database design (sometimes conceptual and logical are merged into one step)

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- Schema refinement through normalization
- Physical database design

Data models

database design process

- Requirements analysis
- Conceptual database design
- Logical database design (sometimes conceptual and logical are merged into one step)
- Schema refinement through normalization
- Physical database design
- Application and Security Design

E-R model

Overview

- Highest level of database modelling.
- Model the conceptual aspect of the database.
- Far from the physical representation in the DBMS.

E-R model

Entity

- Anything which can exist on its own on the database
- Consider a database for a space shooter game
- Starships, asteroids are entities, they have a meaning on their own

E-R model

Attributes

- They model characteristics of the entity.
- **Starship:** velocity, shield, armour, weapon, [...]
- **Asteroid:** velocity, mass, integrity, [...]

E-R model

Relations

- They describe the associations among entities (two or more).
- They have a cardinality: number of participants for each side.

E-R model

Relations - 1 : 1

- Entity modelling a pilot and one modelling a starship.
- Related by “drives”.
- The cardinality is 1:1 : one pilot drives at most one starship, and one starship can contain only one pilot.

E-R model

Relations - 1 : N

- Entity modelling a starship and one modelling a weapon.
- Realted by “mounted”
- The cardinality is 1:N : a weapon can be mounted only on one starship, but a starship can mount more than one weapon.

E-R model

Relations - N : M

- Entity modelling a starship and one modelling an asteroid.
- Realted by “collides with”
- The cardinality is N : M : several starships can collide with several asteroids.

E-R model

Keys

- A way to uniquely identify an entity.
- A key is a set of attributes that have unique values among entities.
- **Starship:** Serial number.

E-R model

Weak entities

- Entities which do not have a key attribute.
- **Asteroids:** There can be two asteroids with the same position, same mass, velocity, etc.

Relational model

Overview

- Halfway between a conceptual model and the physical model.
- Contain an abstraction of physical elements.
- Can be easily mapped to a physical implementation in a DBMS.
- There are mapping rules from E-R model to the relational model.

Relational model

Relation

- A relation is a collection of tuples.
- Each element of a tuple is a value taken from an attribute set.
- Each attribute set is identified by a name

Ships				
<u>serial</u>	name	shields	armour	integrity

(38258269, "Battlestar Galactica", 3000, 5000, 1.0)

Relational model

Keys

- A *Primary key* is a set of attributes with unique values in each tuple.
- A *Candidate key* is the smallest set of attributes which form a superkey.

Example:
Primary key: (Serial, Name, Shield)
Candidate key: (Serial)

Relational model

Keys

- A *Primary key* is the chosen key for a relation among all the candidate keys.
- A *Foreign key* is a set of attributes in one relation which is a primary key in another relation.

Example (Foreign key):

Mounts	
shipSerial	weaponName

Ships				
serial	name	shields	armour	integrity

In the relation `Mounts` the attribute `shipSerial` is a foreign key to `Ship`.

SQL

Overview

- Used to create relations (tables).
- Used to insert/modify/extract data from relations (tables).
- Declarative language ("What" not "How").

Ships				
serial	name	shields	armour	integrity

Select all ships from the game

Ships				
serial	name	shields	armour	integrity

Select all ships from the game

```
SELECT *
FROM Ships
```

Ships				
serial	name	shields	armour	integrity

Select all ships in the game whose pilot is “William Adama”

Ships				
serial	name	shields	armour	integrity

Select all ships in the game whose pilot is “William Adama”

```
SELECT *
FROM Ships s
WHERE s.pilot = 'William␣Adama'
```

Ships				
serial	name	shields	armour	integrity

Find the name of the ships whose pilot is “Starbucks”

Ships				
serial	name	shields	armour	integrity

Find the name of the ships whose pilot is “Starbucks”

```
SELECT s.name
FROM Ship s
where s.pilot = 'Starbucks'
```

Ships				
serial	name	shields	armour	integrity

Mounts	
shipSerial	weaponName

Weapons		
name	damage	type

Find the serial of the ships mounting the weapon "Stealthblade MKII"

Ships				
serial	name	shields	armour	integrity

Mounts	
shipSerial	weaponName

Weapons		
name	damage	type

Find the serial of the ships mounting the weapon "Stealthblade MKII"

```
SELECT s.serial
FROM Ship s, Mounts m
WHERE s.serial = m.shipSerial AND
      m.weaponName = 'StealthBlade MKII'
```

Ships				
<u>serial</u>	name	shields	armour	integrity

Mounts	
<u>shipSerial</u>	<u>weaponName</u>

Weapons		
<u>name</u>	damage	type

Find the name of all the weapons mounted in the ships flown by "Apollo"

Ships				
serial	name	shields	armour	integrity

Mounts	
shipSerial	weaponName

Weapons		
name	damage	type

Find the name of all the weapons mounted in the ships flown by "Apollo"

```
SELECT w.name
FROM Ship s, Mounts m, Weapon w
WHERE s.Serial = m.ShipSerial AND
      m.weaponName = w.name AND
      s.pilot = 'Apollo'
```

Ships				
<u>serial</u>	name	shields	armour	integrity

Mounts	
<u>shipSerial</u>	<u>weaponName</u>

Weapons		
<u>name</u>	damage	type

Find the total damage output of the ships flown by "Athena"

Ships				
serial	name	shields	armour	integrity

Mounts	
shipSerial	weaponName

Weapons		
name	damage	type

Find the total damage output of the ships flown by "Athena"

```
SELECT SUM(w.damage) AS damage
FROM Ship s, Mounts m, Weapon w
WHERE s.derial = m.shipSerial AND
      m.weaponName = w.name AND
      s.pilot = 'Athena'
```

Ships				
serial	name	shields	armour	integrity

Mounts	
shipSerial	weaponName

Weapon		
name	damage	type

Count all the ships having more than 3 weapons

Ships				
serial	name	shields	armour	integrity

Mounts	
shipSerial	weaponName

Weapon		
name	damage	type

Count all the ships having more than 3 weapons

```
SELECT COUNT(*)
FROM (
 SELECT COUNT(*) AS ShipCount
 FROM Ship s, Mounts m, Weapon w
 WHERE s.serial = m.shipSerial AND
       m.weaponName = w.Name
 GROUP BY s.serial
 HAVING COUNT(*) > 3)
```