E-R model, Relational model, SQL

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Lecture topics

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

Overview

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

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

Attributes

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

Relations

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

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.

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.

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.

Keys

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

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				
serial	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`.

Overview

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

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

Select all ships from the game

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

Select all ships from the game

```
SELECT *
FROM  Ships
```

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

Select all ships in the game whose pilot is "William Adama"

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

Select all ships in the game whose pilot is "William Adama"

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

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

Find the name of the ships whose pilot is "Starbucks"

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

Find the name of the ships whose pilot is "Starbucks"

```sql
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				
<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"

```sql
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"

```sql
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

```sql
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)
```