# COL 362 & COL 632

Relational 13 Jan 2023

### **Functional Dependencies**

- There are usually a variety of constraints (rules) on the data in the real world.
- Legal instance of a relation: an instance that satisfies all realworld constraints
  - A legal instance of a database = all relations are legal
- Require that the value for a certain set of attributes
  determines uniquely the value for another set of attributes.
  - A functional dependency is a generalization of the notion of a key.

### **Functional Dependencies**

Let R be a relation schema

$$\alpha \subseteq R$$
 and  $\beta \subseteq R$ 

• The functional dependency  $\alpha \rightarrow \beta$  holds on R if and only if

for any legal relations r(R), whenever any two tuples  $t_1$  and  $t_2$  of r agree on the attributes  $\alpha$ , they also agree on the attributes  $\beta$ .

That is, 
$$t_1[\alpha] = t_2[\alpha] \Rightarrow t_1[\beta] = t_2[\beta]$$

$$R(A_1, A_2, A_3, B_1, B_2, B_3)$$

$$A_1A_2A_3 \rightarrow B_1$$

$$A_1A_2A_3 \rightarrow B_2$$

$$A_1A_2A_3 \rightarrow B_1$$

$$A_1B_2B_3$$

### **Functional Dependencies**

• Example (let's figure out the right FDs)

```
Actor (Name, DOB, Address)

Movie (Title, Year, Language, StudioName)

PlaysIn (Name, DOB, Title, Year)

Name DOB → Address

Title Year → Language StudioName

Title → Language

Language → Title Year № 0

Name DOB → Title Year № 0

DOB Address MovieTitle Year → Name ×

DOB Address MovieTitle Year → Name ×

DOB Address MovieTitle Year → Name ×

DOB Address MovieTitle Year → Name ×
```

Can you figure out the functional dependencies from the data?

# **Functional Dependecies from Data**

	Name	DOB	Address	MovieTitle	Year	Language
	Ayushmaan Khurrana	1984	Mumbai	DoctorG	2022	Hindi
_	Ayushmaan Khurrana	1984	Mumbai	Andhadhun	2018	Hindi
	Henry Cavill	1983	Beverley Hills	Man of Steel	2013	English
	Leonardo DiCaprio	1974	Beverley Hills	The Revenant	2015	English

Address → Language
Name DOB → Address ✓

#### Trivial and non-trivial FDs

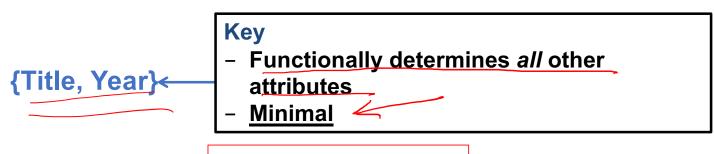
- Trivial: In general,  $\alpha \to \beta$  is trivial if  $\beta \subseteq \alpha$
- Non-trivial: partial overlap of attributes
- Completely non-trivial: no overlap of attributes

Name DOB -> Address
Name DOB -> Name
Name DOB -> Name Address
Name DOB -> Name Address

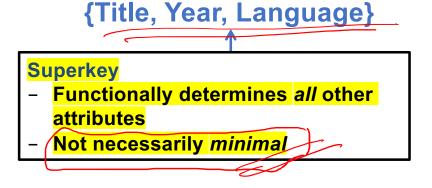


#### Keys and superkeys

Movie (Title, Year, Language, Length)



Keys need not be unique

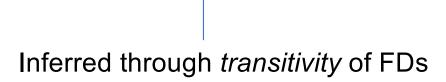


#### **Terminology**

- Key = Candidate Key
- Superkey
- Primary key
- Prime attribute

## Inferring FDs

- Given a set of FDs, which other FDs follow from it?
- Example:
  - Given: Name DOB → Address
    - Address → City
  - Inferred: Name, DOB → City



## **Armstrong's Axioms**

- Reflexivity
   If B is a subset of A, then A → B
- Augmentation
   If A → B, then AC → BC
- Transitivity
   If A → B and B → C, then A → C

#### Closure of FDs

- Given: Fthe set of FDs
- Output: F<sup>+</sup>, the *closure* of F, containing all FDs derivable from

