Multivalued Dependencies

Designing Schemas

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Learning Objectives

By the end of this video, you will be able to:

- Define multi-valued dependencies.
- Describe why MVD may cause redundancies.
- Explain why FD is a special case of MVD.

More Than Functional Dependencies

- There are other kinds of dependencies than FDs.
 - Multivalued dependencies (MVD)
 - Inclusion dependencies (IND)
 - Join dependencies (JD)

- We will take a look at MVD.
 - So you can say you know about (multiple kinds of) dependencies!

Consider Our Academic World

We know that id determines birthday,
 id → birthday.

- But, doesn't id also determine majors?
 - Donald Duck? Majors = {Bio}.
 - Bugs Bunny? Majors = {CS, Music}.

id	name	major	birthday
1	Bugs Bunny	CS	2004-11-06
1	Bugs Bunny	Music	2004-11-06
2	Donald Duck	Bio	1997-02-01
3	Peter Pan	Econ	1998-10-01
3	Peter Pan	Social	1998-10-01
3	Peter Pan	ME	1998-10-01
4	Mickey Mouse	CS	1995-04-01

Example Students relation

- So, id determines major as a set of majors instead of a unique value.
- We call this determination a multivalued dependency:
 id → major.

MVD Is "Tuple Generating"

- Students(id, name, major, gpa, hobby, level)
- Suppose id → major, gpa: Do you think this table is "complete"?

id	name	major	gpa	hobby	level
1	Bugs Bunny	CS	3.0	Tennis	Beginner
1	Bugs Bunny	Music	3.5	Tennis	Beginner
1	Bugs Bunny	CS	3.0	Chess	Advanced
2	Donald Duck	Bio	3.2	Basketball	Intermediate
3	Peter Pan	Econ	2.8	Piano	Beginner
3	Peter Pan	Social	3.0	Reading	Advanced
3	Peter Pan	ME	3.6	Swimming	Advanced
•••	•••	•••	•••	•••	•••

Example Students relation

Multivalued Dependency (MVD)

- Notation: $A_1, ..., A_m \rightarrow B_1, ..., B_n$
- We say: A_1, \dots, A_m multidetermines B_1, \dots, B_n
- Meaning:
 - If two tuples agree on $A_1, ..., A_m$ values, then swapping their $B_1, ..., B_n$ values will result in two tuples that are also in the relation.
 - I.e., B depends only on A, and is independent of the remaining attributes.
- Ex: id → major, gpa

id	name	major	gpa	hobby	level
1	Bugs Bunny	CS	3.0	Tennis	Beginner
1	Bugs Bunny	Music	3.5	Tennis	Beginner
1	Bugs Bunny	CS	3.0	Chess	Advanced
1	Bugs Bunny	Music	3.5	Chess	Advanced
2	Donald Duck	Bio	3.2	Basketball	Intermediate
3	Peter Pan	Econ	2.8	Piano	Beginner
3	Peter Pan	Social	3.0	Reading	Advanced
3	Peter Pan	ME	3.6	Swimming	Advanced
•••	•••	•••		•••	•••

FD: Special Case of MVD

- FD is a special case of MVD.
- id \rightarrow birthday \Longrightarrow id \Longrightarrow birthday

id	name	major	birthday
1	Bugs Bunny	CS	2004-11-06
1	Bugs Bunny	Music	2004-11-06
2	Donald Duck	Bio	1997-02-01
3	Peter Pan	Econ	1998-10-01
3	Peter Pan	Social	1998-10-01
3	Peter Pan	ME	1998-10-01
4	Mickey Mouse	CS	1995-04-01

Example Students relation

FD/MVD Are Domain Knowledge

• What FDs/MVDs hold is your knowledge of the domain.

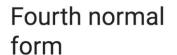
id → birthday? id → birthday?

• id → major? id → major?

• age → major? age → major?

How do you suggest to normalize the problematic Students relation to eliminate MVDs?

Yes, you probably have (re-)invented 4NF!



Fourth normal form is a normal form used in database normalization. Introduced by Ronald Fagin in 1977, 4NF is the next level of normalization after Boyce–Codd normal form. Wikipedia

Abbreviation: 4NF

Developed by: Ronald Fagin

Year introduced: 1977

You need a magnifier to view it (Pixabay, 2017)



Google search result of 4NF

Sample answer for this FoT

References

• Pixabay, 2017. *Image of a magnifier*[Online image]. Retrieved from https://pixabay.com/en/inspector-man-detective-male-160143/.