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Normalisation – Part 3

Summary and Discussion

Summary of Normal Forms

- 1NF, 3NF and BCNF are popular in practice. Other normal forms are rarely used.

  1NF: only atomic values for attributes (*part of the definition for the relational data model*);

  2NF: an intermediate result in the history of database design theory;

  3NF: lossless and dependencies can be preserved;

  BCNF: lossless but dependencies may not be preserved.

- 3NF can only **minimise (not necessarily eliminate) redundancy**. So a relation schema in 3NF may still have update anomalies.
- A relation schema in BCNF **eliminates redundancy**.

Why Denormalisation?

- **Do we need to normalize relation schemas in all cases** when designing a relational database?
- The normalisation process **may degrade performance** when data are frequently queried.
- Since relation schemas are decomposed into many smaller ones after normalisation, queries need to **join many relations together** in order to return the results.
- Unfortunately, **join operation is very expensive**.
- When data is **more frequently queried rather than being updated** (e.g., data warehousing system), a weaker normal form is desired (i.e., **denormalisation**).

Denormalisation

- **Denormalisation** is a **design process** that
  - happens after the normalisation process,
  - is often performed during the physical design stage, and
  - reduces the number of relations that need to be joined for certain queries.
- We need to distinguish:
  - **Unnormalised** – there is no systematic design.
  - **Normalised** – redundancy is reduced after a systematic design (to minimise data inconsistencies).
  - **Denormalised** – redundancy is introduced after analysing the normalised design (to improve efficiency of queries)

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Trade-offs

- A good database design is to **find a balance** between desired properties, then normalise/denormalise relations to a desired degree.

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Trade-offs – Data Redundancy vs. Query Efficiency

- Normalisation: **No Data Redundancy but No Efficient Query Processing**
- Data redundancies are eliminated in the following relations.

STUDENT		
Name	StudentID	DoB
Tom	123456	25/01/1988
Michael	123458	21/04/1985

COURSE	
CourseNo	Unit
COMP2400	6
COMP8740	12

ENROL		
StudentID	CourseNo	Semester
123456	COMP2400	2010 S2
123456	COMP8740	2011 S2
123458	COMP2400	2009 S2

- However, the query for "list the names of students who enrolled in a course with 6 units" requires 2 join operations.

```
SELECT Name, CourseNo FROM ENROL e, COURSE c, STUDENT s WHERE
e.StudentID=s.StudentID and e.CourseNo=c.CourseNo and c.Unit=6;
```

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Trade-offs – Data Redundancy vs. Query Efficiency

- Denormalisation: **Data Redundancy but Efficient Query Processing**
- If a student enrolled 15 courses, then the name and DoB of this student need to be stored repeatedly 15 times in ENROLMENT.

ENROLMENT					
Name	StudentID	DoB	CourseNo	Semester	Unit
Tom	123456	25/01/1988	COMP2400	2010 S2	6
Tom	123456	25/01/1988	COMP8740	2011 S2	12
Michael	123458	21/04/1985	COMP2400	2009 S2	6

- However, the query for "list the names of students who enrolled a course with 6 units" can be processed efficiently (no join needed).

```
SELECT Name, CourseNo FROM ENROLMENT WHERE Unit=6;
```

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Discussion

- Both normalisation and denormalisation are useful in database design.
  - **Normalisation**: obtain database schema avoiding redundancies and data inconsistencies
  - **Denormalisation**: join normalized relation schemata for the sake of better query processing
- Some problems of (de-)normalisation:
  - FDs **cannot handle null values**.
  - To apply normalisation, FDs must be **fully specified**.
  - The algorithms for normalisation **are not deterministic**, leading to different decompositions.