CS203 DB Principals

Normalization

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Reference:

“Normalization**”** **by** Jason Park , Fall 2005 CS157A

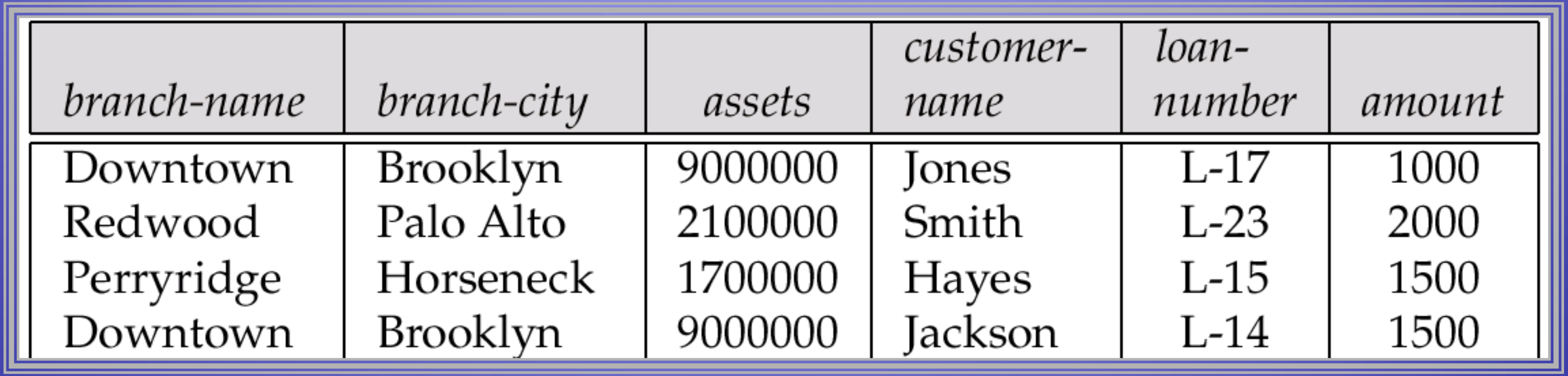
Pitfalls in Relational Database Design

- Relational database design requires that we find a "good" collection of relation schemas. A bad design may lead to
  - Repetition of Information.
  - Inability to represent certain information.
- Design Goals:
  - Avoid redundant data
  - Ensure that relationships among attributes are represented
  - Facilitate the checking of updates for violation of database integrity constraints.

Example

- Consider the relation schema:

  Lending-schema = (*branch-name, branch-city, assets,*
  customer-name, loan-number, amount)



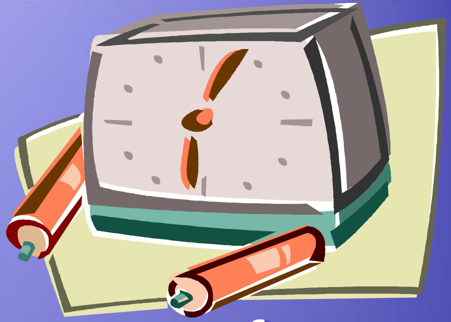
branch-name	*branch-city*	*assets*	*customer-name*	*loan-number*	*amount*
Downtown	Brooklyn	9000000	Jones	L-17	1000
Redwood	Palo Alto	2100000	Smith	L-23	2000
Perryridge	Horseneck	1700000	Hayes	L-15	1500
Downtown	Brooklyn	9000000	Jackson	L-14	1500

- Redundancy:
  - Data for *branch-name, branch-city,* assets are repeated for each loan that a branch makes
  - Wastes space
  - Complicates updating, introducing possibility of inconsistency of *assets* value
- Null values
  - Cannot store information about a branch if no loans exist
  - Can use null values, but they are difficult to handle.

Database Normalization

- **Database normalization** is the process of removing redundant data from your tables in to improve storage efficiency, data integrity, and scalability.
- In the relational model, methods exist for quantifying how efficient a database is. These classifications are called **normal forms** (or **NF**), and there are algorithms for converting a given database between them.
- Normalization generally involves splitting existing tables into multiple ones, which must be re-joined or linked each time a query is issued.

History



- Edgar F. Codd first proposed the process of normalization and what came to be known as the **1st normal form** in his paper *A Relational Model of Data for Large Shared Data Banks* Codd stated:

  “There is, in fact, a very simple elimination procedure which we shall call normalization. Through decomposition nonsimple domains are replaced by ‘*domains whose elements are atomic (nondecomposable) values.*’”

Normal Form

- Edgar F. Codd originally established three normal forms: 1NF, 2NF and 3NF. There are now others that are generally accepted, but 3NF is widely considered to be sufficient for most applications. Most tables when reaching 3NF are also in BCNF (Boyce-Codd Normal Form).

Table 1

Title	Author1	Author2	ISBN	Subject	Pages	Publisher
Database System Concepts	Abraham Silberschatz	Henry F. Korth	0072958863	MySQL, Computers	1168	McGraw-Hill
Operating System Concepts	Abraham Silberschatz	Henry F. Korth	0471694665	Computers	944	McGraw-Hill

Table 1 problems

- This table is not very efficient with storage.
- This design does not protect data integrity.
- Third, this table does not scale well.

First Normal Form

- In our Table 1, we have two violations of First Normal Form:
- First, we have more than one author field,
- Second, our subject field contains more than one piece of information. With more than one value in a single field, it would be very difficult to search for all books on a given subject.

First Normal Table

- Table 2

Title	Author	ISBN	Subject	Pages	Publisher
Database System Concepts	Abraham Silberschatz	0072958863	MySQL	1168	McGraw-Hill
Database System Concepts	Henry F. Korth	0072958863	Computers	1168	McGraw-Hill
Operating System Concepts	Henry F. Korth	0471694665	Computers	944	McGraw-Hill
Operating System Concepts	Abraham Silberschatz	0471694665	Computers	944	McGraw-Hill

- We now have two rows for a single book. Additionally, we would be violating the Second Normal Form…
- A better solution to our problem would be to separate the data into separate tables- an Author table and a Subject table to store our information, removing that information from the Book table:

Subject Table

Subject_ID	Subject
1	MySQL
2	Computers

Author Table

Author_ID	Last Name	First Name
1	Silberschatz	Abraham
2	Korth	Henry

Book Table

ISBN	Title	Pages	Publisher
0072958863	Database System Concepts	1168	McGraw-Hill
0471694665	Operating System Concepts	944	McGraw-Hill

- Each table has a primary key, used for joining tables together when querying the data. A primary key value must be unique with in the table (no two books can have the same ISBN number), and a primary key is also an index, which speeds up data retrieval based on the primary key.
- Now to define relationships between the tables

Relationships

Book_Author Table

ISBN	Author_ID
0072958863	1
0072958863	2
0471694665	1
0471694665	2

Book_Subject Table

ISBN	Subject_ID
0072958863	1
0072958863	2
0471694665	2

Second Normal Form

- As the First Normal Form deals with redundancy of data across a horizontal row, Second Normal Form (or 2NF) deals with redundancy of data in vertical columns.
- As stated earlier, the normal forms are progressive, so to achieve Second Normal Form, the tables must already be in First Normal Form.
- The Book Table will be used for the 2NF example

2NF Table

Publisher Table

Publisher_ID	Publisher Name
1	McGraw-Hill

Book Table

ISBN	Title	Pages	Publisher_ID
0072958863	Database System Concepts	1168	1
0471694665	Operating System Concepts	944	1

2NF

- Here we have a one-to-many relationship between the book table and the publisher. A book has only one publisher, and a publisher will publish many books. When we have a one-to-many relationship, we place a foreign key in the Book Table, pointing to the primary key of the Publisher Table.
- The other requirement for Second Normal Form is that you cannot have any data in a table with a composite key that does not relate to all portions of the composite key.

Third Normal Form

- Third normal form (3NF) requires that there are no functional dependencies of non-key attributes on something other than a candidate key.
- A table is in 3NF if all of the non-primary key attributes are mutually independent
- There should not be transitive dependencies

Boyce-Codd Normal Form

- BCNF requires that the table is 3NF and only determinants are the candidate keys