Normalization of Database Tables

관계형 데이터베이스의 설계에서 중복을 최소화하게 데이터를 구조화하는 프로세스
이상이 있는 관계를 재구성하여 작고 잘 조직된 관계를 생성

갱신이상**:** 보험기록에 에이젼트 번호와 이름이 중복해서 들어가 있을 경우 에이젼트가 결혼하여 **Last Name**이 바뀌면 모든 레코드를 수정해야 함**.**

삽입 이상**:** 교수와 강의라는 테이블에 교수 **ID,** 교수 이름**,** 교수 고용일자**,** 강의 코드가 있다고 했을 때 새로운 교수를 고용하면 그가 맡은 강의가 없을 수 있어 강의코드가 **NULL**이 됨**.**

삭제이상**:** 위의 교수와 강의 테이블에서 강의를 일시적으로 중단하고자 할 때 교수 자체가 사라지는 현상이 발생함**.**

1NF: Eliminate the repeating groups, Identify PK and all dependencies

2NF: Minimize partial dependencies

3NF: Minimize transitive dependencies

From Rob and Coronel (2004), Database Systems: Design, Implementation, and Management

Database Tables and Normalization

- Normalization
  - Process for evaluating and correcting table structures to minimize data redundancies
    - helps eliminate data anomalies
  - Works through a series of stages called normal forms:
    - First normal form (1NF)
    - Second normal form (2NF)
    - Third normal form (3NF)
    - ...

From Rob and Coronel (2004), Database Systems: Design, Implementation, and Management

Database Tables and Normalization

- 2NF is better than 1NF; 3NF is better than 2NF
- For most business database design purposes, 3NF is the highest we need to go in the normalization process
- Highest level of normalization is not always most desirable ***Accuracy VS Speed***

From Rob and Coronel (2004), Database Systems: Design, Implementation, and Management

The Need for Normalization

Table name: RPT_FORMAT **Database name: Ch05_ConstructCo**

PROJ_NUM	PROJ_NAME	EMP_NUM	EMP_NAME	JOB_CLASS	CHG_HOUR	HOURS
15	Evergreen	103	June E. Arbough	Elect. Engineer	$84.50	23.8
		101	John G. News	Database Designer	$105.00	19.4
		105	Alice K. Johnson *	Database Designer	$105.00	35.7
		106	William Smithfield	Programmer	$35.75	12.6
		102	David H. Senior	Systems Analyst	$96.75	23.8
18	Amber Wave	114	Annelise Jones	Applications Designer	$48.10	24.6
		118	James J. Frommer	General Support	$18.36	45.3
		104	Anne K. Ramoras *	Systems Analyst	$96.75	32.4
		112	Darlene M. Smithson	DSS Analyst	$45.95	44.0
22	Rolling Tide	105	Alice K. Johnson	Database Designer	$105.00	64.7
		104	Anne K. Ramoras	Systems Analyst	$96.75	48.4
		113	Delbert K. Joenbrood *	Applications Designer	$48.10	23.6
		111	Geoff B. Wabash	Clerical Support	$26.87	22.0
		106	William Smithfield	Programmer	$35.75	12.8
25	Starflight	107	Maria D. Alonzo	Programmer	$35.75	24.6
		115	Travis B. Bawangi	Systems Analyst	$96.75	45.8
		101	John G. News *	Database Designer	$105.00	56.3
		114	Annelise Jones	Applications Designer	$48.10	33.1
		108	Ralph B. Washington	Systems Analyst	$96.75	23.6
		118	James J. Frommer	General Support	$18.36	30.5
		112	Darlene M. Smithson	DSS Analyst	$45.95	41.4

From Rob and Coronel (2004), Database Systems: Design, Implementation, and Management

The Need for Normalization (2)

- Structure of data set in the previous figure does not handle data very well
  - PROJ_NUM is apparently intended to be a primary key, or at least a part of a primary key, but it contains nulls
  - Data inconsistencies (e.g.: Database Designer, DB Designer
  - Data redundancies (e.g.: update, insertion, and deletion anomalies) ***Possible redundant inputs***

From Rob and Coronel (2004), Database Systems: Design, Implementation, and Management

Conversion to First Normal Form (1NF)

- Step 1: Eliminate the Repeating Groups
- Step 2: Identify the Primary Key
- Step 3: Identify all Dependencies

From Rob and Coronel (2004), Database Systems: Design, Implementation, and Management

1NF Step 1: Eliminate Repeating Groups

- Present data in a tabular format, where each cell has a single value and there are no repeating groups
- Eliminate repeating groups by eliminating nulls, making sure that each repeating group attribute contains an appropriate data value

From Rob and Coronel (2004), Database Systems: Design, Implementation, and Management

1NF Data Organization

Table name: DATA_ORG_1NF **Database name: Ch05_ConstructCo**

PROJ_NUM	PROJ_NAME	EMP_NUM	EMP_NAME	JOB_CLASS	CHG_HOUR	HOURS
15	Evergreen	103	June E. Arbough	Elect. Engineer	$84.50	23.8
15	Evergreen	101	John G. News	Database Designer	$105.00	19.4
15	Evergreen	105	Alice K. Johnson *	Database Designer	$105.00	35.7
15	Evergreen	106	William Smithfield	Programmer	$35.75	12.6
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18	Amber Wave	104	Anne K. Ramoras *	Systems Analyst	$96.75	32.4
18	Amber Wave	112	Darlene M. Smithson	DSS Analyst	$45.95	44.0
22	Rolling Tide	105	Alice K. Johnson	Database Designer	$105.00	64.7
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From Rob and Coronel (2004), Database Systems: Design, Implementation, and Management

1NF Step 2: Identify the Primary Key

- Primary key must uniquely identify attribute value

  PROJ_NUM & EMP_NUM

- New key must be composed

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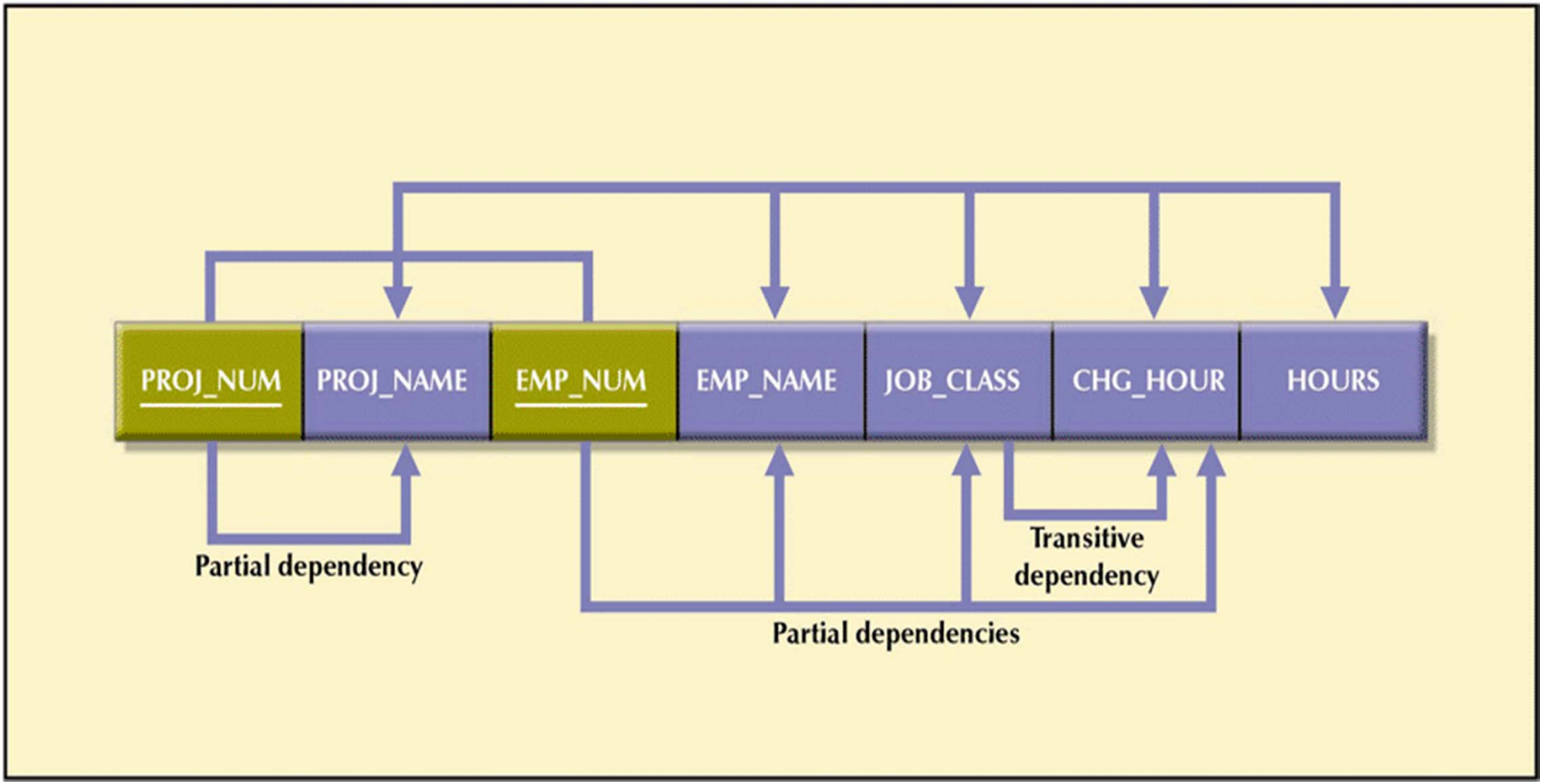
1NF Step 3: Identify all Dependencies

- Dependencies can be depicted with the help of a diagram
- Dependency diagram:
  - Depicts all dependencies found within a given table structure
  - Partial dependencies: based on only a part of a composite primary key
  - Transitive dependencies: dependency of one nonprime attribute on another nonprime attribute.
  - Partial and transitive dependencies are not desirable.

From Rob and Coronel (2004), Database Systems: Design, Implementation, and Management

A Dependency Diagram: 1NF



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First Normal Form: Summary

- Tabular format in which:
  - All key attributes are defined
  - There are no repeating groups in the table
  - All attributes are dependent on primary key
- All relational tables satisfy 1NF requirements
- Some tables contain partial dependencies
  - Dependencies based on only part of the primary key
  - Sometimes used for performance reasons, but should be used with caution
  - Still subject to data redundancies

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Conversion to Second Normal Form

- Relational database design can be improved by converting the database into second normal form (2NF) ***To minimize partial dependencies***

- Two steps:
  - 2NF Step 1: Identify All Key Components
  - 2NF Step 2: Identify the Dependent Attributes

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2NF Step 1: Identify All Key Components

- Write each key component on separate line (table), and then write the original (composite) key on the last line (table)
- Each component will become the key in a new table

From Rob and Coronel (2004), Database Systems: Design, Implementation, and Management

2NF Step 2: Identify Dependent Attributes

- Determine which attributes are dependent on which other attributes
- At this point, most anomalies have been eliminated

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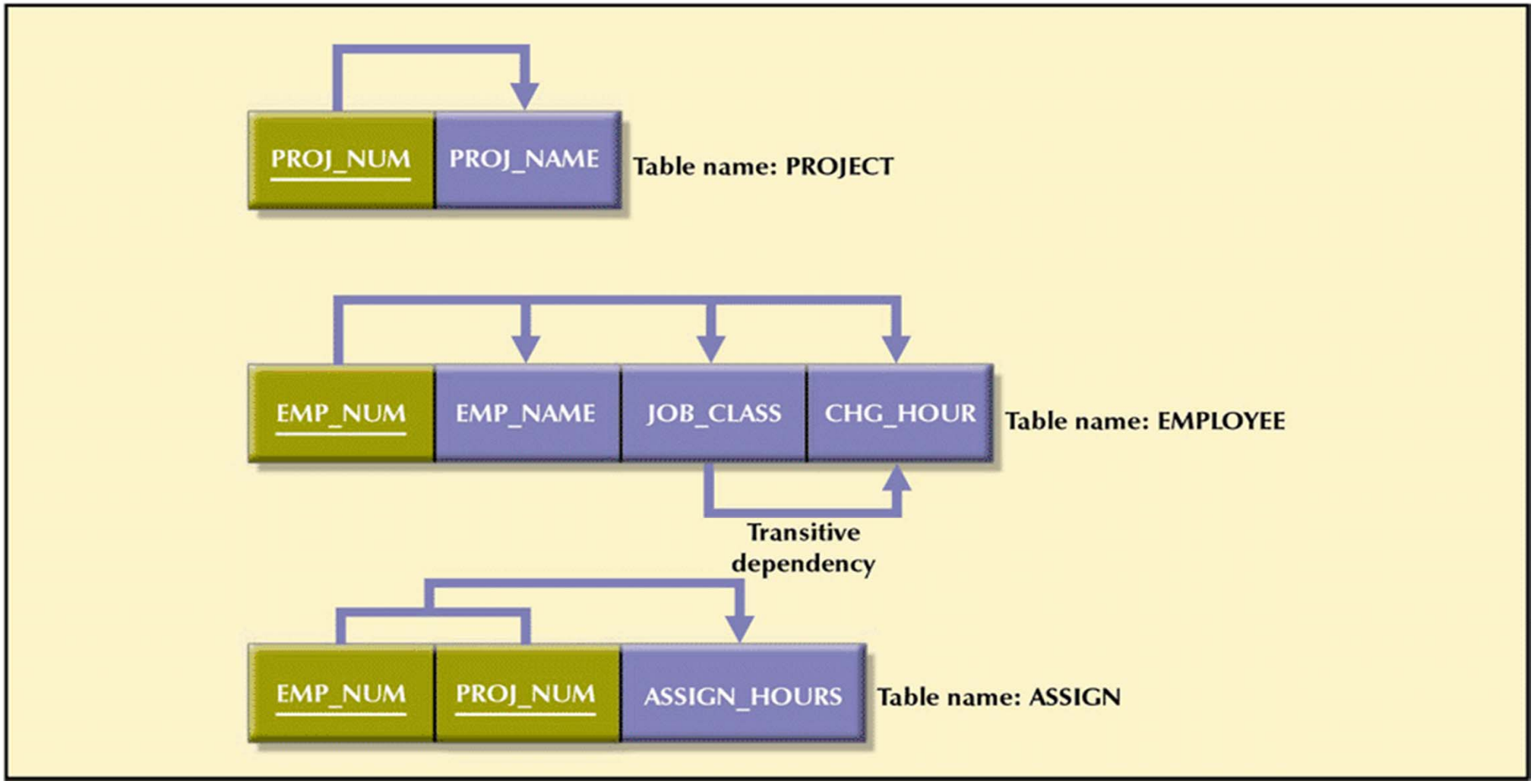
Second Normal Form (2NF) Conversion Results



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Second Normal Form

- Table is in second normal form (2NF) if:
  - It is in 1NF and
  - It includes no partial dependencies:
    - No attribute is dependent on only a portion of the primary key

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Conversion to Third Normal Form (3NF)

To minimize transitive dependencies

- Data anomalies created are easily eliminated by completing three steps
  - 3NF Step 1: Identify Each New Determinant
  - 3NF Step 2: Identify the Dependent Attributes
  - 3NF Step 3: Remove the Dependent Attributes from Transitive Dependencies

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3NF Step 1: Identify Each New Determinant

- For every transitive dependency, write its determinant as a PK for a new table
  - Determinant:
    - Any attribute whose value determines other values within a row

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3NF Step 2: Identify the Dependent Attributes

- Identify the attributes dependent on each determinant identified in Step 1 and identify the dependency
- Name the table to reflect its contents and function

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3NF Step 3: Remove the Dependent Attributes from Transitive Dependencies

- Eliminate all dependent attributes in transitive relationship(s) from each table that has such a transitive relationship
- Draw a new dependency diagram to show all tables defined in Steps 1–3
- Check new tables and modified tables from Step 3 to make sure that each has a determinant and does not contain inappropriate dependencies

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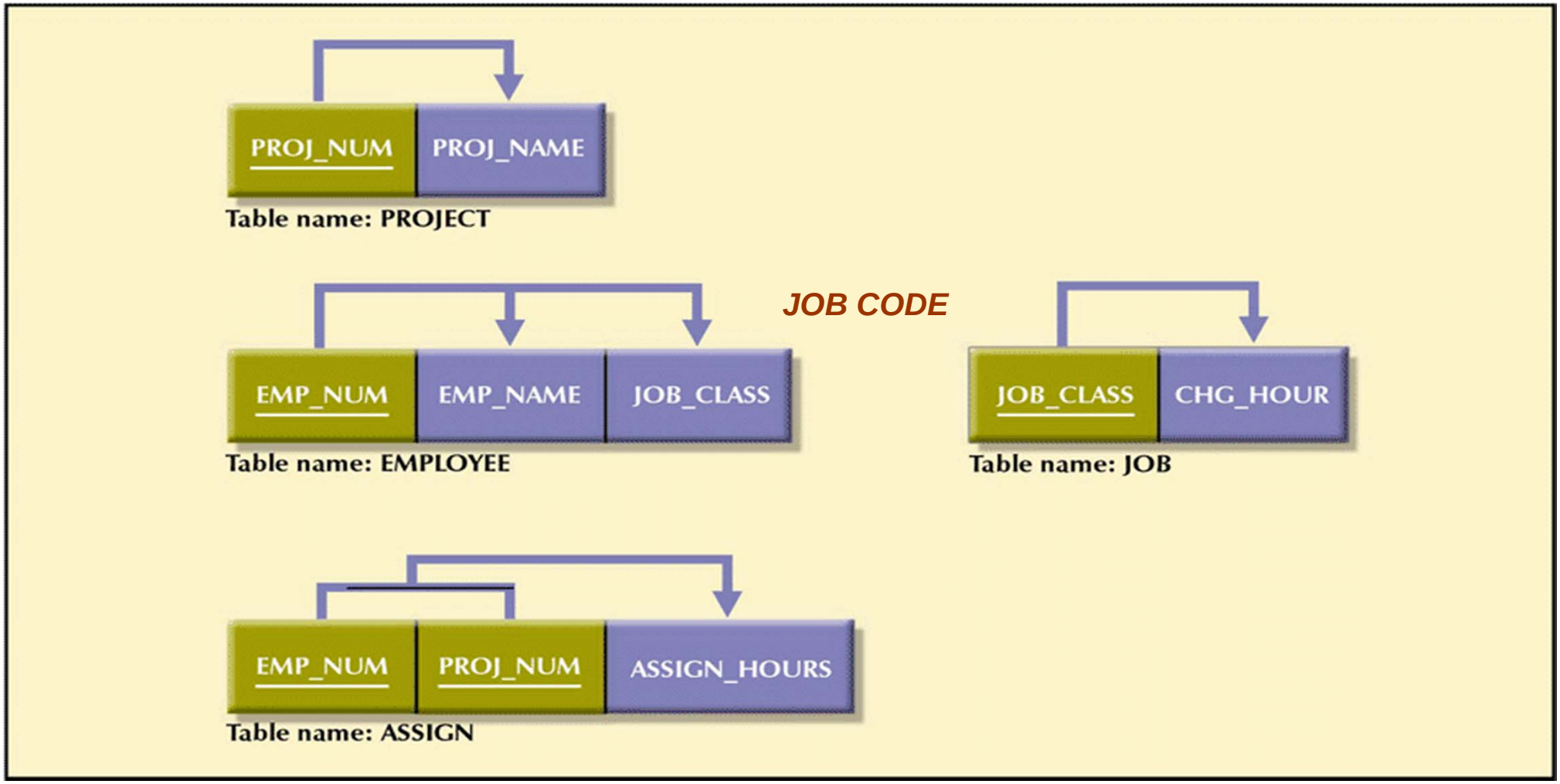
Third Normal Form (3NF) Conversion Results



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Third Normal Form

- A table is in third normal form (3NF) if:
  - It is in 2NF and
  - It contains no transitive dependencies

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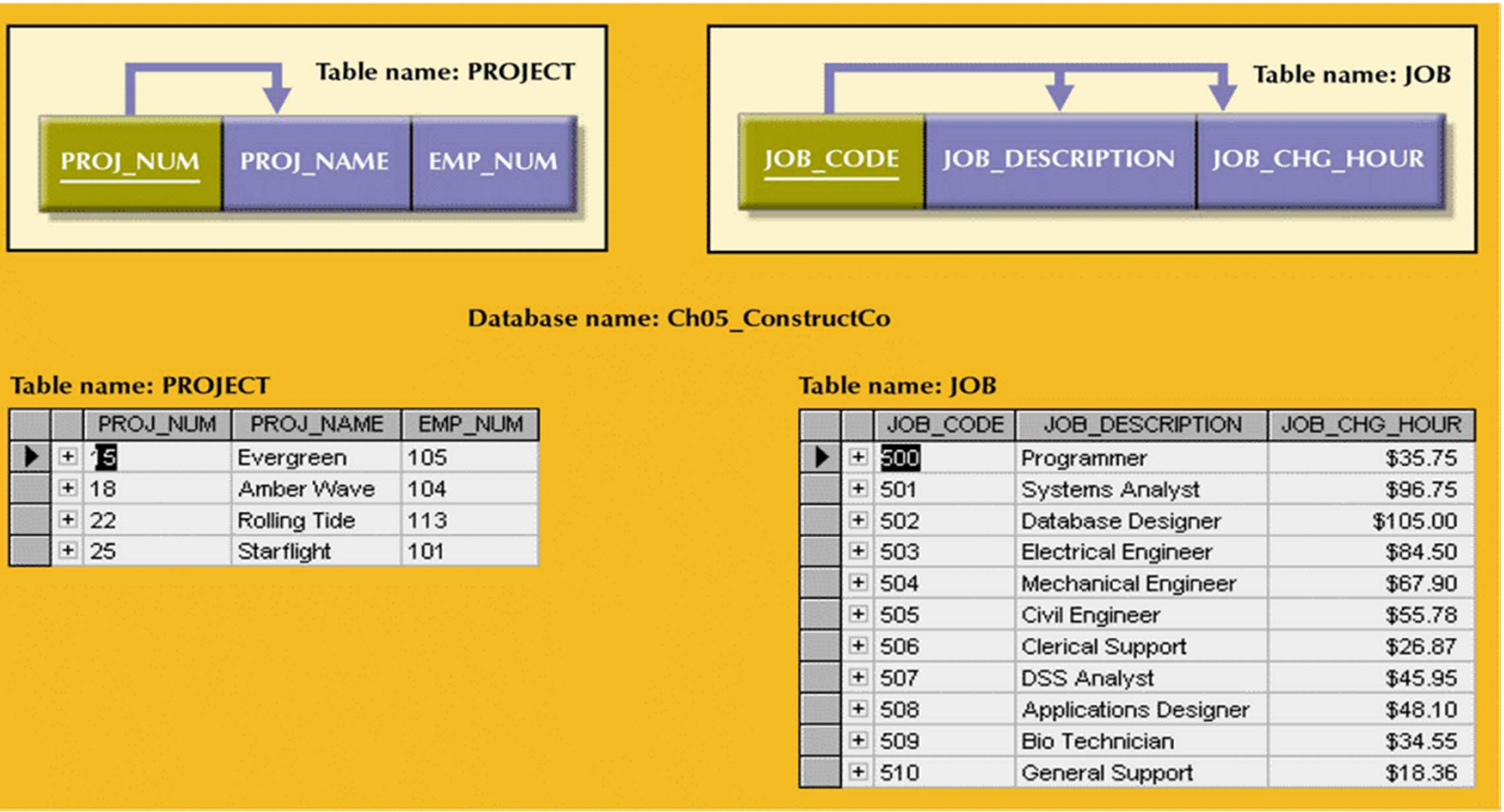
The Completed Database



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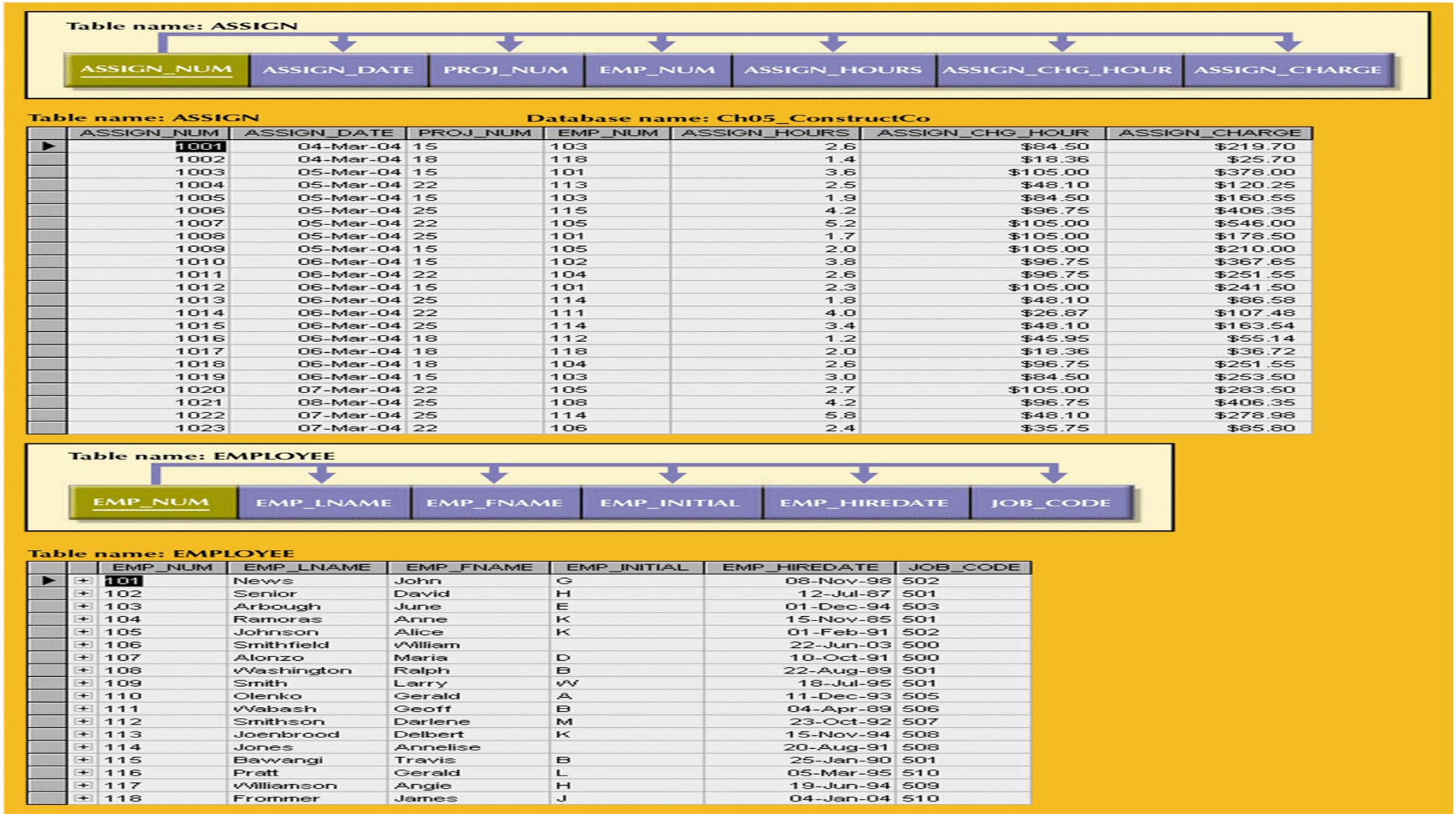
The Completed Database (continued)



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Improving the Design

- Table structures are cleaned up to eliminate the troublesome initial partial and transitive dependencies
- Normalization cannot, by itself, be relied on to make good designs
- It is valuable because its use helps eliminate data redundancies

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Improving the Design (2)

- The following changes are usually made:
  - PK assignment
  - Naming conventions
  - Attribute atomicity
  - Adding attributes
  - Adding relationships
  - Refining PKs
  - Maintaining historical accuracy
  - Using derived attributes

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Normalization and Database Design

- Normalization should be part of design process
- Make sure that proposed entities meet required normal form before table structures are created
- Many real-world databases have been improperly designed or burdened with anomalies if improperly modified during course of time
- You may be asked to redesign and modify existing databases

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Normalization and Database Design

- ER diagram
  - Provides the big picture, or macro view, of an organization's data requirements and operations
  - Created through an iterative process
    - Identifying relevant entities, their attributes and their relationship
    - Use results to identify additional entities and attributes

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Normalization and Database Design

- Normalization procedures
  - Focus on the characteristics of specific entities
  - A micro view of the entities within the ER diagram
- Difficult to separate normalization process from ER modeling process
- Two techniques should be used concurrently

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Denormalization

- Creation of normalized relations is important database design goal
- Processing requirements should also be a goal
- If tables decomposed to conform to normalization requirements
  - Number of database tables expands

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Denormalization (2)

- Joining larger number of tables takes additional disk input/output (I/O) operations and processing logic
  - Reduces system speed
- Conflicts among design efficiency, information requirements, and processing speed are often resolved through compromises that may include denormalization

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Normalization Exercises

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1. To keep track of office furniture, computers, printers, and so on, the FOUNDIT Company uses the table structure shown in the table below.

Attribute Name	Sample Record	Sample Record
ITEM_ID	231-678	254-449
ITEM_LABEL	HP Deskjet 670	HP Scanner
ROOM_NUMBER	325	123
BLDG_CODE	NTC	TF
BLDG_NAME	Nottooclear	Toofar
BLDG_MANAGER	I. Right	M. Next

Given this information, draw the dependency diagram. Make sure you label the transitive and/or partial dependencies.

2. Starting with the dependency diagram drawn for Question 1, create a set of dependency diagrams that meet 3NF requirements. Rename attributes and create new entities and attributes as necessary.