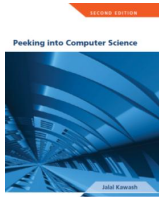


Databases & Data Modelling

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- Mandatory: Chapter 4 – Sections 4.4 & 4.5




Reading Assignment

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2



Mapping ERDs to Schema

3

At the end of this section, you will be able to:

1. Apply the mapping algorithm to translate an ERD to a database schema
2. Understand foreign keys

Objectives

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1. Each **entity type** is translated to a table; its attributes become columns
2. Each **many-to-many relationship** type becomes a table; the columns are the primary keys of the participating entity types
3. For each **one-to-many relationship** type, add the primary keys of the entity type on the one side as columns in the table corresponding to the entity type on the many side



Mapping Algorithm (4.1)

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5

1. Each entity type is translated to a table; its attributes become columns

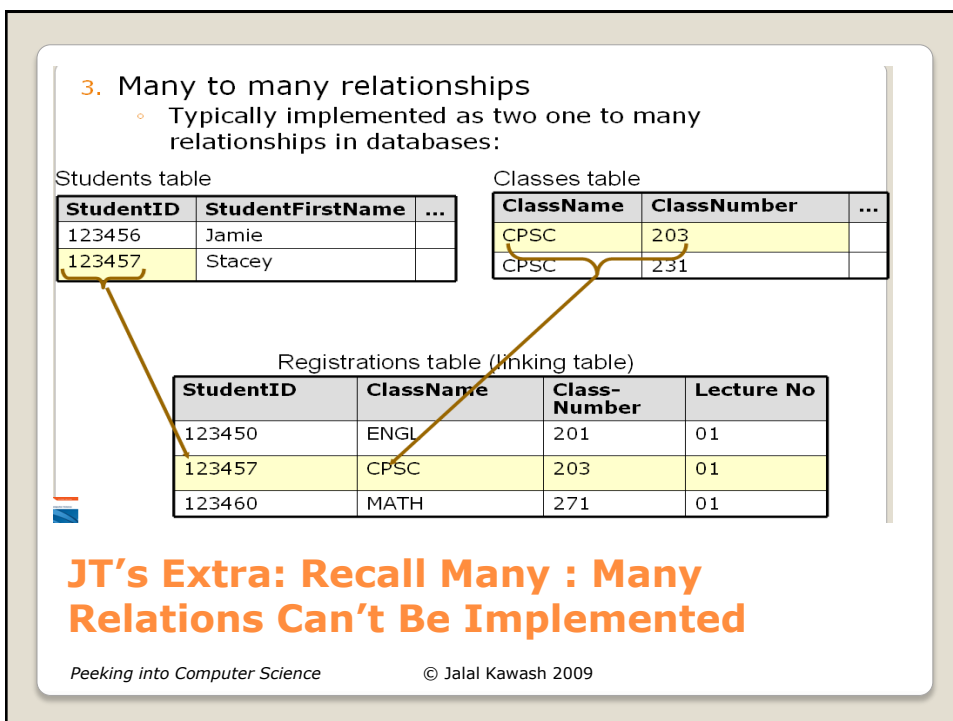
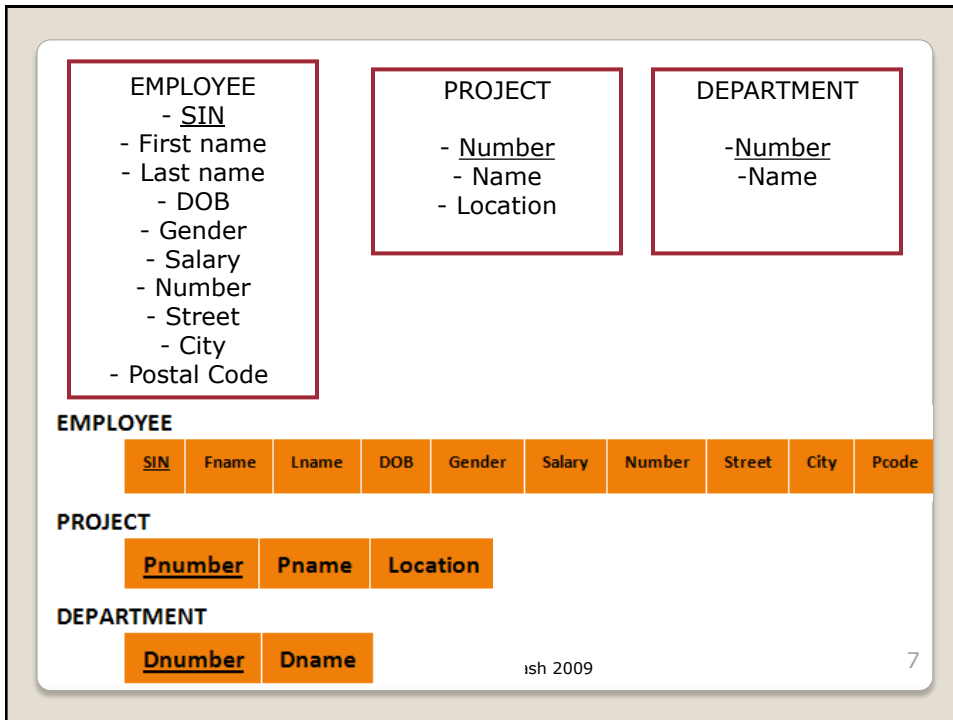


Mapping Entity Types

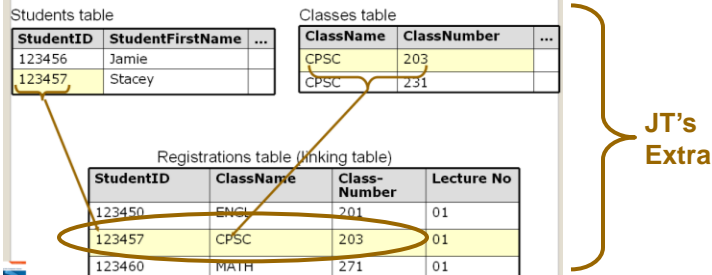
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6



2. Each many-to-many relationship type becomes a table; the **columns are the primary keys of the participating entity types**



Mapping Many-Many Relationship Types

EMPLOYEE

- SIN
- First name
- Last name
- DOB
- Gender
- Salary
- Number
- Street
- City
- Postal Code

PROJ_EMP

SIN

Pnumber

WORKS ON

PROJECT

- Number
- Name
- Location

CONTROLS

Participation Levels

- There will be no more tables
- Step 3 simply augments the existing tables

EMPLOYEE

<u>SIN</u>	Fname	Lname	DOB	Gender	Salary	Number	Street	City	Pcode
------------	-------	-------	-----	--------	--------	--------	--------	------	-------

PROJECT

<u>Pnumber</u>	Pname	Location
----------------	-------	----------

DEPARTMENT

<u>Dnumber</u>	Dname
----------------	-------

PROJ_EMP

<u>SIN</u>	<u>Pnumber</u>
------------	----------------

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- There will be no more tables
- Step 3 simply augments the existing tables

EMPLOYEE

<u>SIN</u>	Fname	Lname	DOB	Gender	Salary	Number	Street	City	Pcode
------------	-------	-------	-----	--------	--------	--------	--------	------	-------

PROJECT

<u>Pnumber</u>	Pname	Location
----------------	-------	----------

DEPARTMENT

<u>Dnumber</u>	Dname
----------------	-------

PROJ_EMP

<u>SIN</u>	<u>Pnumber</u>
------------	----------------

JT's Extra: (In case you missed it in Jalal's example)

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- For each one-to-many relationship type, add the primary keys of the entity type on the **one side** as columns in the table corresponding to the entity type on the **many side**

Mapping One-Many Relationship Types



- For each *one-to-many relationship* type, add the primary keys of the entity type on the **one side** as columns in the table corresponding to the entity type on the **many side**

JT's Extra



Mapping One-Many Relationship Types



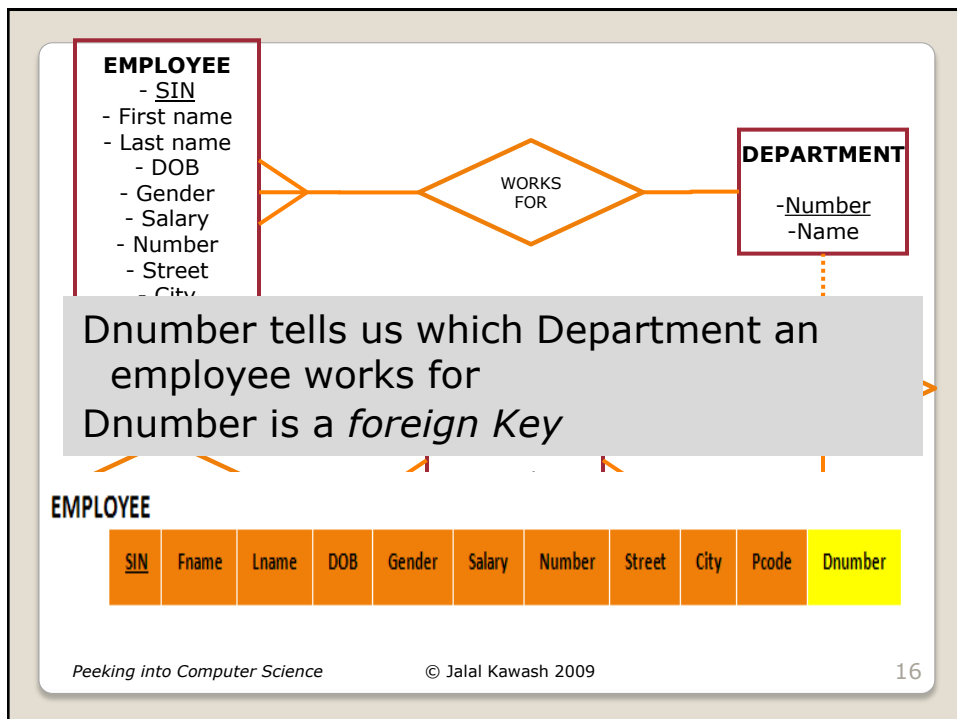
- A key in one table that refers to a key in another field.

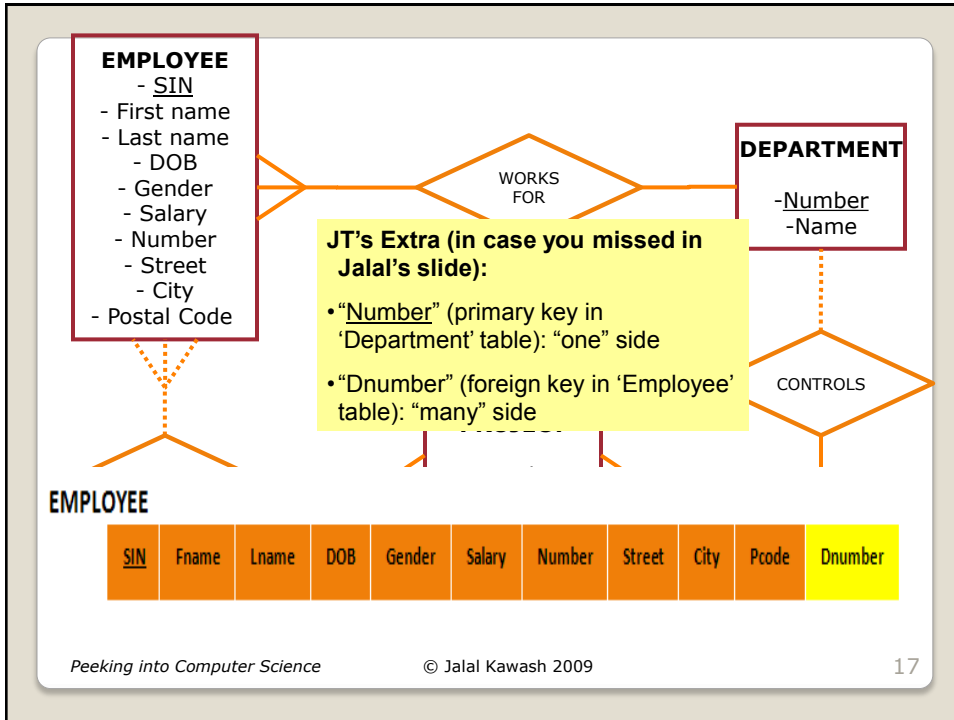


JT's Extra: Foreign Keys

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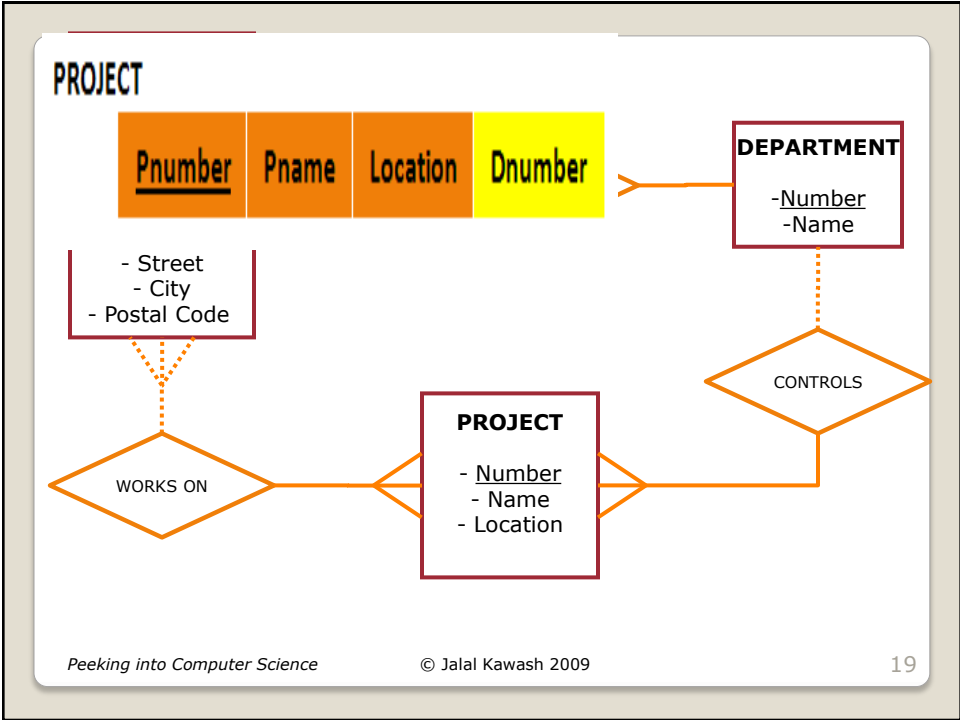




EMPLOYEE

SIN	Fname	Lname	DOB	Gender	Salary	Number	Street	City	Pcode	Dnumber
171717171	Debra	Beacon	15-Aug-1961	Female	70000	15	Bacon Hill	Ham Land	T2X Y0Y	1
181817178	Sam	Field	17-Feb-1978	Male	40000	15	Kick Way	Ball Land	Y2K K0K	1
12345679	Rajeet	Folk	30-Apr-1967	Male	78000	123	One Road	Banner	H1H J9J	2
987654321	Marie	Band	12-Jan-1985	Female	53500	2828	Exit Close	Tree Hill	K8O O8K	2
666333999	Saleh	Dice	25-Mar-1970	Male	90400	66	Straight Way	Bent Road	T4E T6B	3

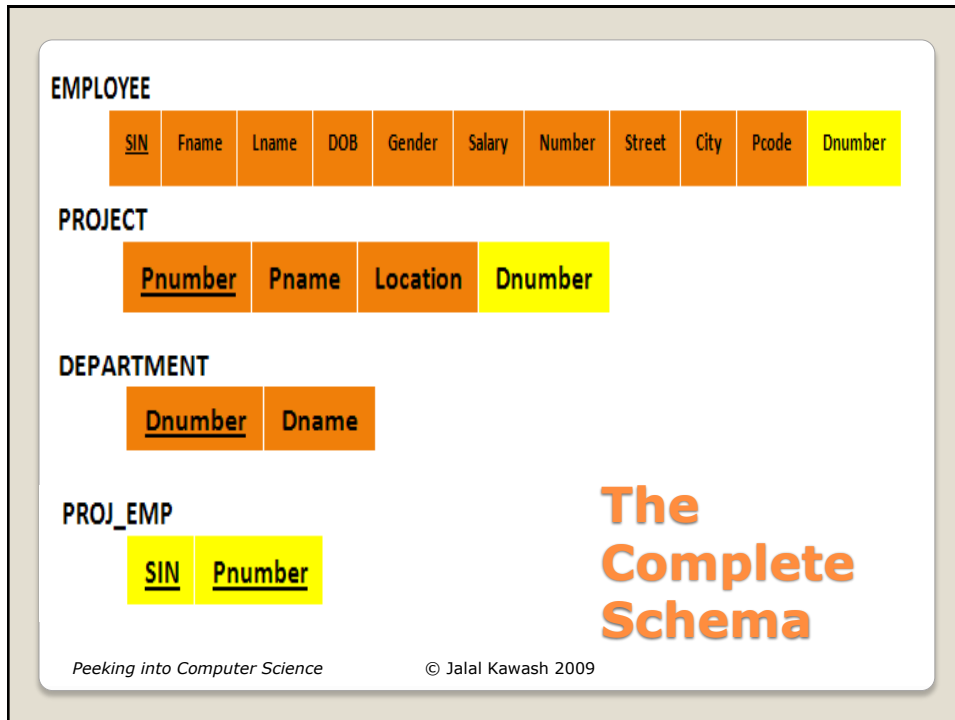
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PROJECT

Pnumber	Pname	Location	Dnumber
1	Web Shopping	Calgary	1
2	Backup	Calgary	1
3	New benefits	Toronto	2
4	XT345	Toronto	3

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- The mapping algorithm does not include one-to-one relationship types
 - We need to include these
- Sometimes, relationship types may need to have their own attributes
- Will revise ERDs and the mapping algorithm to include these.



Two Missing Things

- A department is **managed** by one employee
- Each department has a manager which is also an employee
- EMPLOYEE and DEPARTMENT are related by the MANAGES relationship type
- Each department can have only one manager, and each employee can manage at most one department. This is a one-to-one relationship

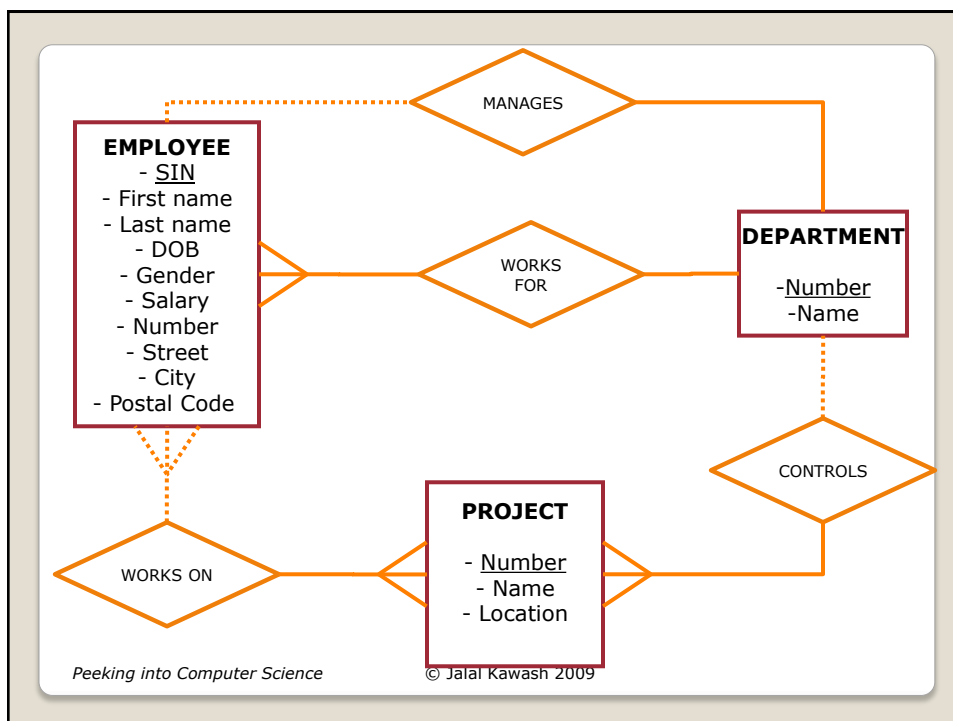


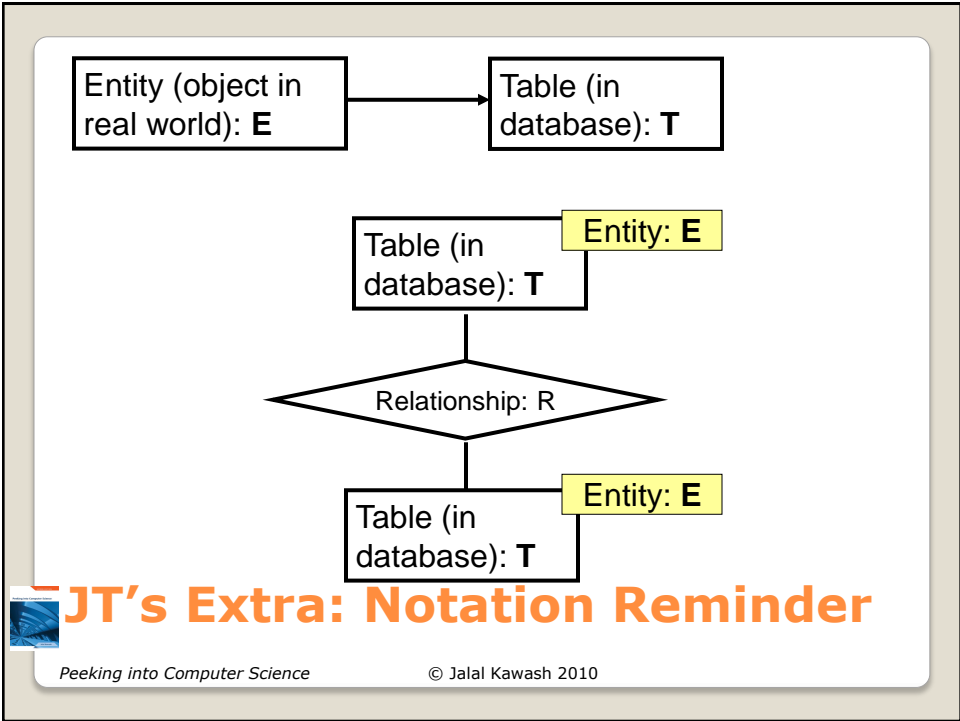
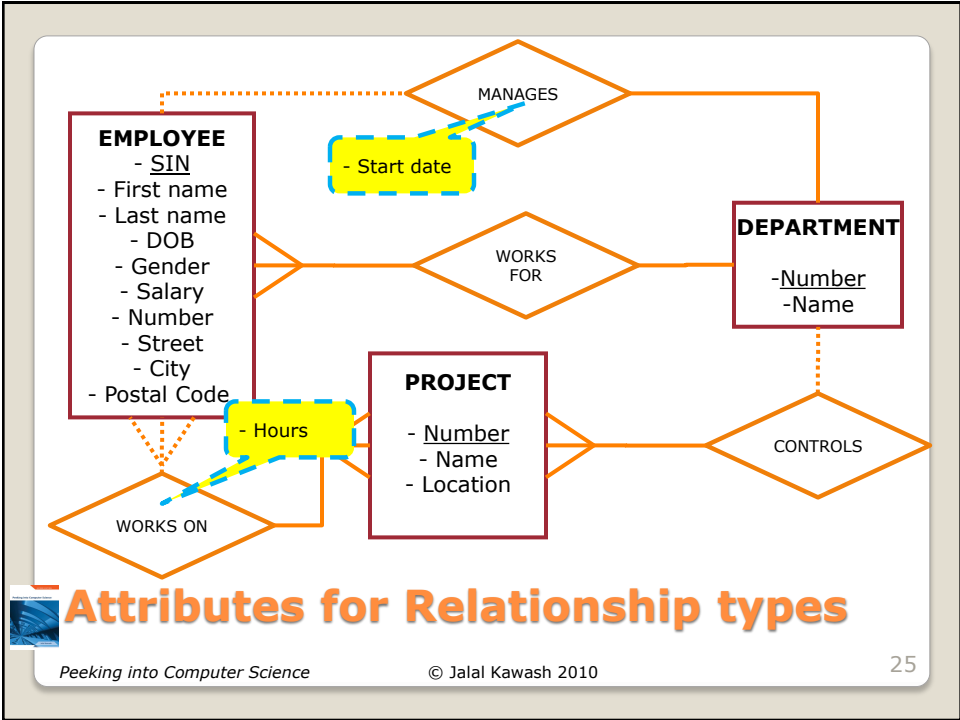
MANAGES Relationship Type

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23





1. Each entity type E is translated to a table T (to emphasize that T is a result of E , we write $T(E)$)
 - T 's columns are E 's attributes
2. Each many-to-many relationship type R , relating entity types $E1$ and $E2$, becomes a table T
 - **T 's columns are R 's attributes**
 - the primary key of $E1$ and $E2$ is added as columns in T



Complete mapping Algorithm

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27

3. For each one-to-many relationship type R , relating $E1$ to $E2$ with $E1$ on the "one" side:
 - add the primary key of $E1$ as columns in $T(E2)$
 - **any attributes that R has become columns in $T(E2)$**



Complete mapping Algorithm

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28

4. For each one-to-one relationship type R, relating E1 to E2 with E1 on a partial participation side or both E1 and E2 fully participate in R:
 - add the primary key of E1 as columns in T(E2)
 - any attributes that R has become columns in T(E2)



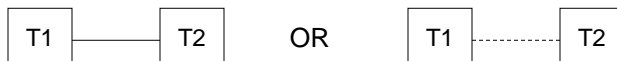
Complete mapping Algorithm

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- To ensure compliance with good design principles, examine participation levels when determining which table's primary key is used as the other table's foreign key.
 - If both tables participate equally (both partial or both full) then the choice is arbitrary.

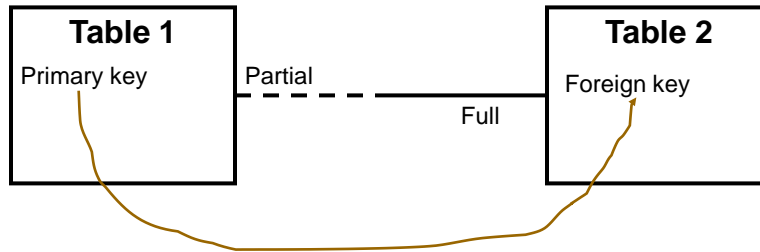


JT's Extra: 1 to 1 Relationships

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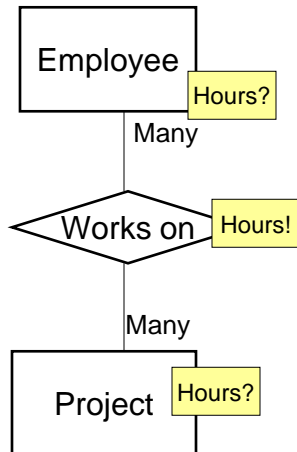
- If participation levels aren't equal: If one table partially participates in the relationship while the other table participates fully in the relationship.



JT's Extra: 1 to 1 Relationships (2)

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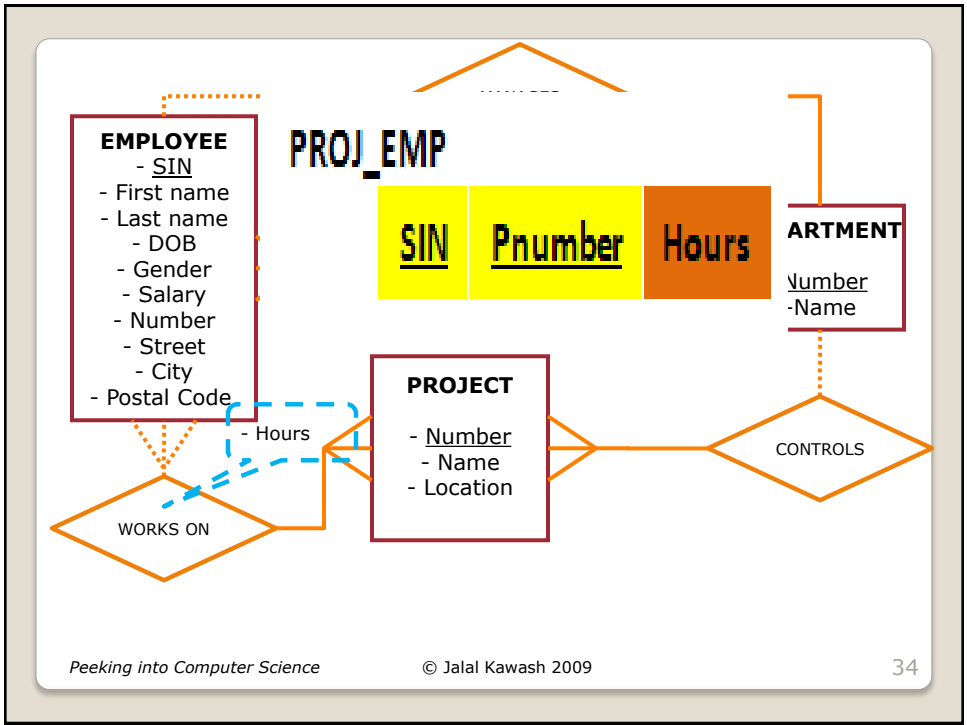
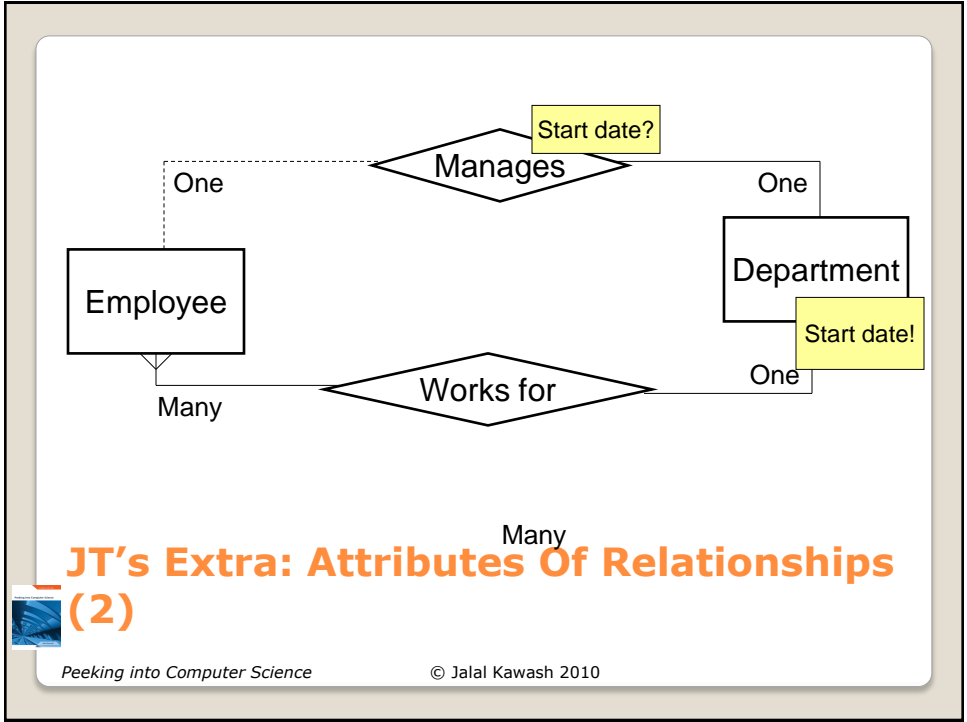
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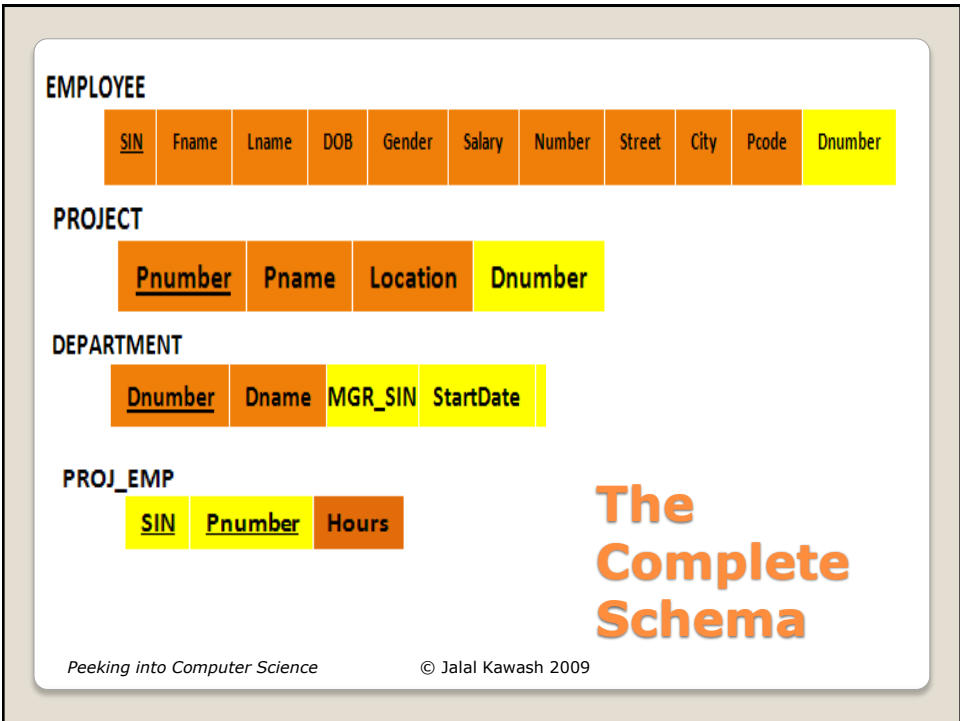
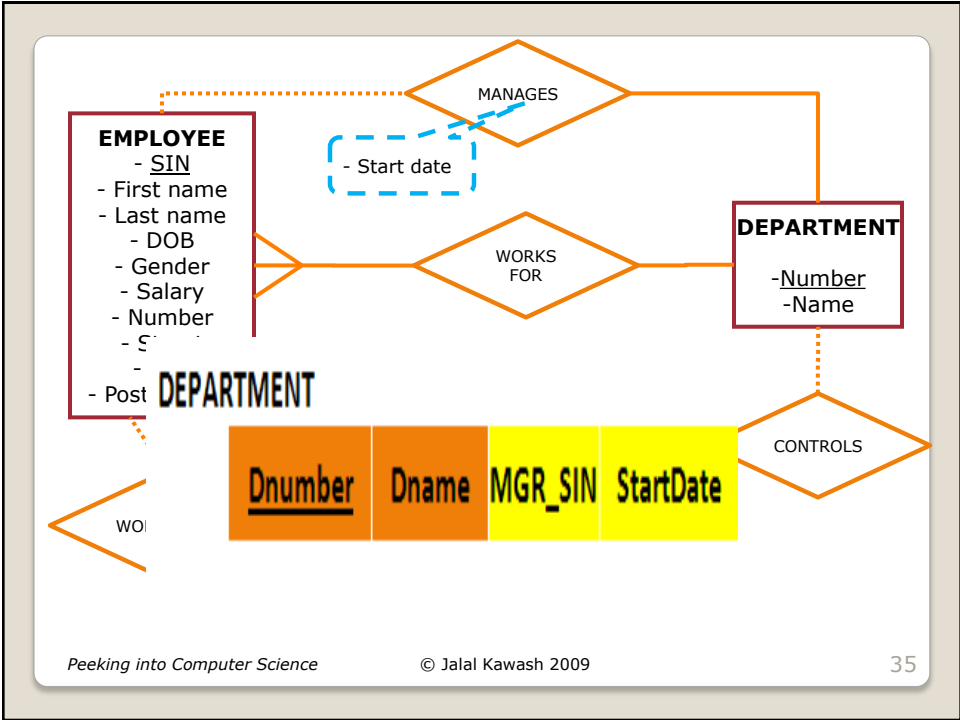


JT's Extra: Attributes Of Relationships

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Design Principles
What makes a Good Design?

37

At the end of this section, you will be able to:

1. List and entertain the three basic design principles
2. Understand how our mapping algorithm satisfies these three principles

Objectives

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1. Meaning of a Schema should be easily explained
2. Reduce Redundancy
3. Reduce NULL values



Basic Design Principles

1. Design a schema so that its meaning can be easily explained
- Do NOT combine attributes from different entity types into a single table



Design Principle (1)

<u>Dnumber</u>	Dname	MGR_SIN	StartDate	<u>Pnumber</u>	Pname	Location
----------------	-------	---------	-----------	----------------	-------	----------

- Project, department, or controls table?



A schema with no clear meaning

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2. Design a schema so that Redundancy is reduced

- Unnecessary Redundancy can lead to modification anomalies



Design Principle (2)

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42

- Assume the schema definition for Project and Department
 - migrating Pnumber to DEPARTMENT

PROJECT

<u>Pnumber</u>	Pname	Location
----------------	-------	----------

DEPARTMENT

<u>Dnumber</u>	Dname	MGR_SIN	StartDate	Pnumber
----------------	-------	---------	-----------	---------

**Unnecessary Redundancy****DEPARTMENT**

Dnumber	Dname	MGR_SIN	StartDate	Pnumber
1	IT	171717171	12-Feb-2008	1
1	IT	171717171	12-Feb-2008	2
2	Finance	123456789	1-Mar-2002	3
3	Marketing	666555	1-Jan-2005	4

More than one place to change IT

PROJECT

Pnumber	Pname	Location
1	Web Shopping	Calgary
2	Network Upgrade	Calgary
3	New Benefits	Toronto
4	Product XT345	Toronto

- ABC company decides to change the name of **IT** department to **Technology**

Modification Anomaly Example

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45

EMPLOYEE

SIN	Fname	Lname	DOB	Gender	Salary	Number	Street	City	Pcode	Dnumber
171717171	Debra	Beacon	15-Aug-1961	Female	70000	15	Baron Hill	Calgary	T2X Y0Y	1
181817178	Sam	Field	17-Feb-1978	Male	40000	15	Kick Way	Calgary	Y2K K0K	1
123456789	Rajeet	Folk	30-Apr-1967	Male	78000	123	One Road	Toronto	H1H J9J	2
987654321	Marie	Band	12-Jan-1985	Female	53500	2828	Exit Close	Toronto	K8O O8K	2
666333999	Saleh	Dice	25-Mar-1970	Male	90400	66	Straight Way	Toronto	T4E T6B	3

DEPARTMENT

Dnumber	Dname	MGR_SIN	Start Date
1	IT	171717171	12-Feb-2008
2	Finance	123456789	1-Mar-2002
3	Marketing	666333999	1-Jan-2005

The only place to change IT

PROJECT

Pnumber	Pname	Location	Dnumber
1	Web Shopping	Calgary	1
2	Network Upgrade	Calgary	1
3	New Benefits	Toronto	2
4	Product XT345	Toronto	3

SIN	Pnumber	Hours
171717171	1	15
171717171	2	20
171717171	4	5
181817178	1	30
181817178	2	10
123456789	3	40
666333999	4	40

No Anomalies Here

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46

DEPARTMENT

Dnumber	Dname	MGR_SIN	StartDate	Pnumber
1	IT	171717171	12-Feb-2008	1
1	IT	171717171	12-Feb-2008	2
2	Finance	23456789	1-Mar-2002	3
3	Marketing	66633399	2005	4

IT occurs in more than one place

PROJECT

Pnumber	Pname	Location
1	Web Shopping	
2	Network Upgrade	
3	New Benefits	
3	Product XT345	Toronto

Must change all occurrences of IT here and elsewhere

- Refers to empty fields of a record.
- Primary keys cannot be null but other fields may be null.

JT's Extra: Null Values

3. Design a schema so that NULL values are minimized as much as possible

- Waste space
- Result in confusion:
 - A NULL value could mean:
 - Does not apply
 - Unknown
 - To be recorded

Design Principle (3)

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49

PROJ_EMP

SIN	Pnumber	Hours
171717171	1	15
171717171	2	NULL
171717171	4	5
181817178	1	30
181817178	2	10
123456789	3	NULL
666333999	4	40

1. Arrangement to work until completion
2. We do not know the hours yet
3. Someone else will enter it (it is known)

NULL Values Confusion

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- We migrated the managers SIN (partial participation side) to the DEPARTMENT table (full participation side)



NULL Values Example

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- What if we migrated the department Number to the EMPLOYEE table?



NULL Values Example

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52

EMPLOYEE

SIN	Fname	Lname	DOB	Gender	Salary	Number	Street	City	Postcode	Dnumber
171717171	Debra	Beacon	15-Aug-1961	Female	70000	15	Baron Hill	Calgary	T2X Y0Y	1
181817178	Sam	Field	17-Feb-1978	Male	40000	15	Kick Way	Calgary	Y2K K0K	1
12345679	Rajset	Folk	30-Apr-1967	Male	78000	123	One Road	Toronto	H1H J9J	2
987654321	Marie	Band	12-Jan-1985	Female	53500	2828	Exit Close	Toronto	K8O O8K	2
666333999	Saleh	Dice	25-Mar-1970	Male	90400	66	Straight Way	Toronto	T4E T6B	3

DEPARTMENT

Dnumber	Dname	MGR_SIN	StartDate
1	IT	171717171	12-Feb-2008
2	Finance	123456789	1-Mar-2002
3	Marketing	666333999	1-Jan-2005

**Original Design**

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EMPLOYEE

SIN	Fname	Lname	DOB	Gender	Salary	Number	Street	City	Postcode	Dnumber	MGR_Dnumber	StartDate
171717171	Debra	Beacon	15-Aug-1961	Female	70000	15	Baron Hill	Calgary	T2X Y0Y	1	1	12-Feb-2008
181817178	Sam	Field	17-Feb-1978	Male	40000	15	Kick Way	Calgary	Y2K K0K	1	NULL	NULL
12345679	Rajset	Folk	30-Apr-1967	Male	78000	123	One Road	Toronto	H1H J9J	2	2	1-Mar-2002
987654321	Marie	Band	12-Jan-1985	Female	53500	2828	Exit Close	Toronto	K8O O8K	2	NULL	NULL
666333999	Saleh	Dice	25-Mar-1970	Male	90400	66	Straight Way	Toronto	T4E T6B	3	3	1-Jan-2005

DEPARTMENT

Dnumber	Dname
1	IT
2	Finance
3	Marketing

**Alternative Design**

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- JT's Extra (Null): Many to many relationships: directly modeled in a database.

Students table

<i>StudentID</i>	<i>StudentFirstName</i>	<i>StudentLastName</i>
123456	Jamie	Smyth
123457	Stacey	Walls
123458	Angel	Lam

Classes table

<i>ClassName</i>	<i>ClassNumber</i>	<i>Lecture No</i>	<i>ClassDescription</i>
CPSC	203	01	Introduction to Computers
CPSC	231	01	Introduction to Computer Science I
CPSC	233	01	Introduction to Computer Science II



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55

- JT's Extra (Null): Many to many relationships: directly modeled in a database.

Students table

<i>StudentID</i>	<i>StudentFirst Name</i>	<i>StudentLast Name</i>
123456	Jamie	Smyth
123457	Stacey	Walls
123458	Angel	Lam

Class 1	Class 2	Class 3	Class 4	Class 5	...	Class 'N'
CPSC 203	PSYC 205	MATH 221	MATH 251	SOCI 201		NULL
CPSC 203	ART 201	MATH 271	NULL	NULL		NULL
CPSC 203	CHIN 201	KINE 221	MGIS 323	OPMA 341		NULL

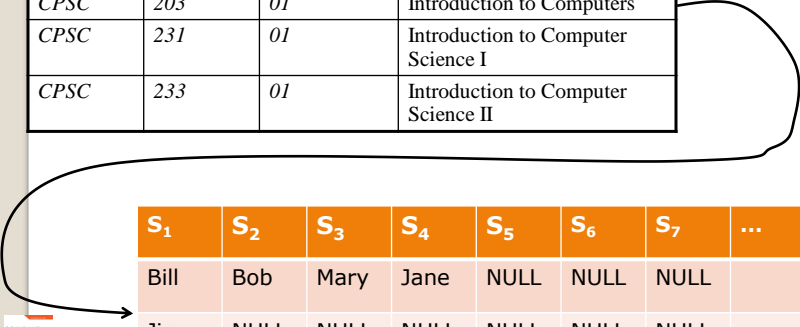


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- JT's Extra (Null): Many to many relationships: directly modeled in a database.

Classes table

<i>ClassName</i>	<i>ClassNumber</i>	<i>Lecture No</i>	<i>ClassDescription</i>
CPSC	203	01	Introduction to Computers
CPSC	231	01	Introduction to Computer Science I
CPSC	233	01	Introduction to Computer Science II



Peeking in

S ₁	S ₂	S ₃	S ₄	S ₅	S ₆	S ₇	...	S _N
Bill	Bob	Mary	Jane	NULL	NULL	NULL		NULL
Jim	NULL	NULL	NULL	NULL	NULL	NULL		NULL
Alice	Brett	Charlie	Deacon	Ernie	Edgar	Freda		NULL

7