

# **IT in Construction**

Lecture #4

## **Construction Management Information System Conceptual Design**

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**Construction Engineering and Management**



# Outline

2

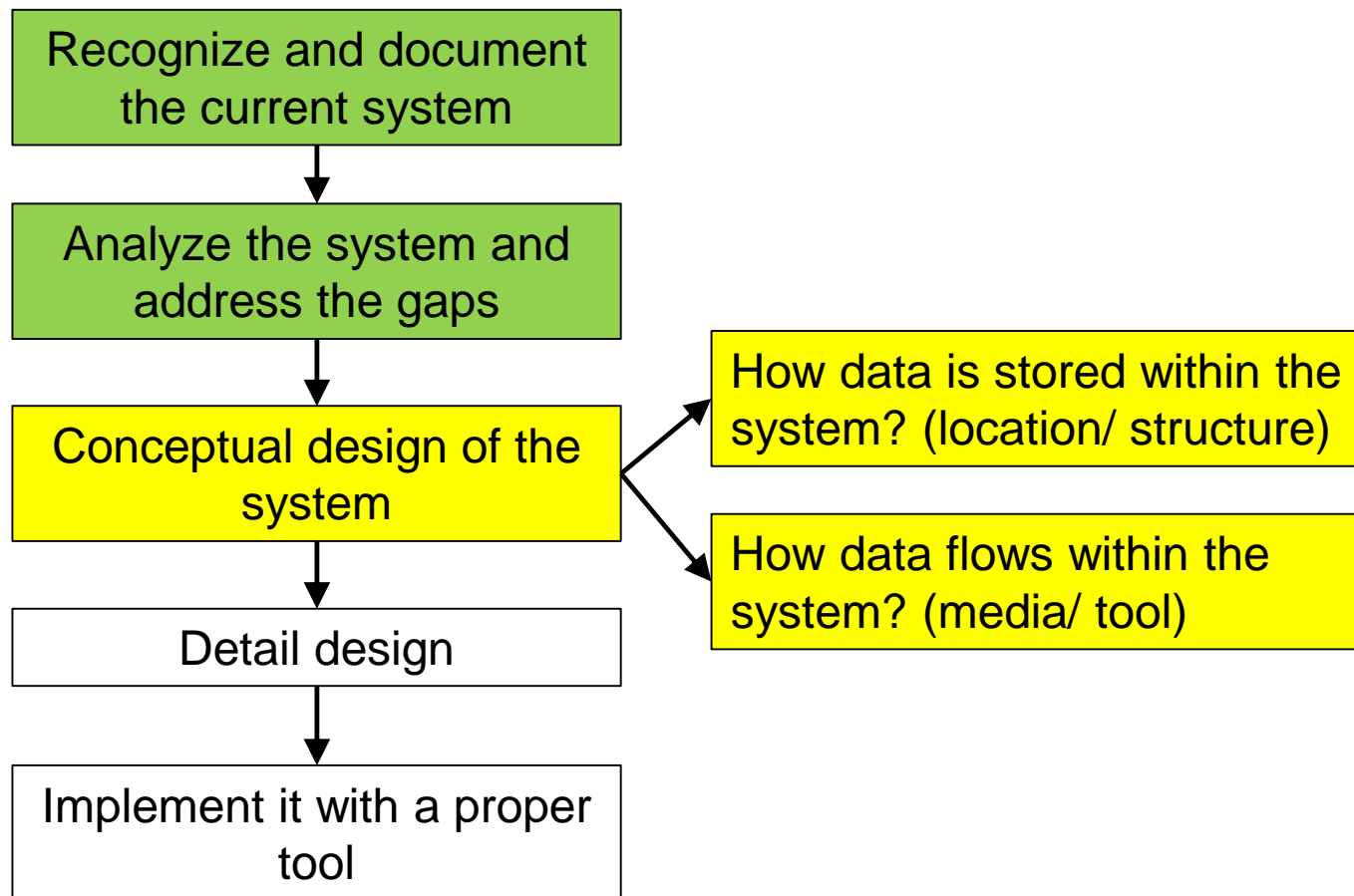
- Introduction
- Storing data within a system
  - ▣ Database concept
  - ▣ Entity
  - ▣ Entity relationship diagram (ERD)
  - ▣ Entity attributes
  - ▣ Data tables (entities) in MS Access
  - ▣ Data record
  - ▣ Entity relationship types
  - ▣ Tracking records in ERD
  - ▣ Normalized ERD
- Data flow media

# Introduction

# Introduction

4

- Development phases of an MIS system:



# Storing data within a system

# Database concept

6

- To facilitate data flow in our system we need to consider data store or database within the system.



What is a database?

- A **database** is an organized collection of data. It can be ***physical*** or ***computer base***.
- Computer databases include set of related data tables usually with a set of *rules* determining *who* and *how* can access the data.
- After recognizing and analyzing data flow in our system (using dfd) we need to support this data with databases to support *storage*, *maintenance* and *retrieval* of data.
- Entity relationship diagram (ERD) provides a conceptual view to our system's database structure

# Entity

7

- What is an entity?
  - ▣ In MIS terminology, an entity is an ***independently existing*** element which we need to collect data for it. An entity might exist either physically or logically.
  - ▣ An entity may be a physical object such as a construction project or a worker (they exist physically), an event or activity such as an inspection or equipment maintenance, or a concept such as a dispute or an order (they exist logically-as a concept).



Name some existing entities in a bidding system?

- We are going to use dfd developed for the system to identify entities.



Where should we look into?

# Entity

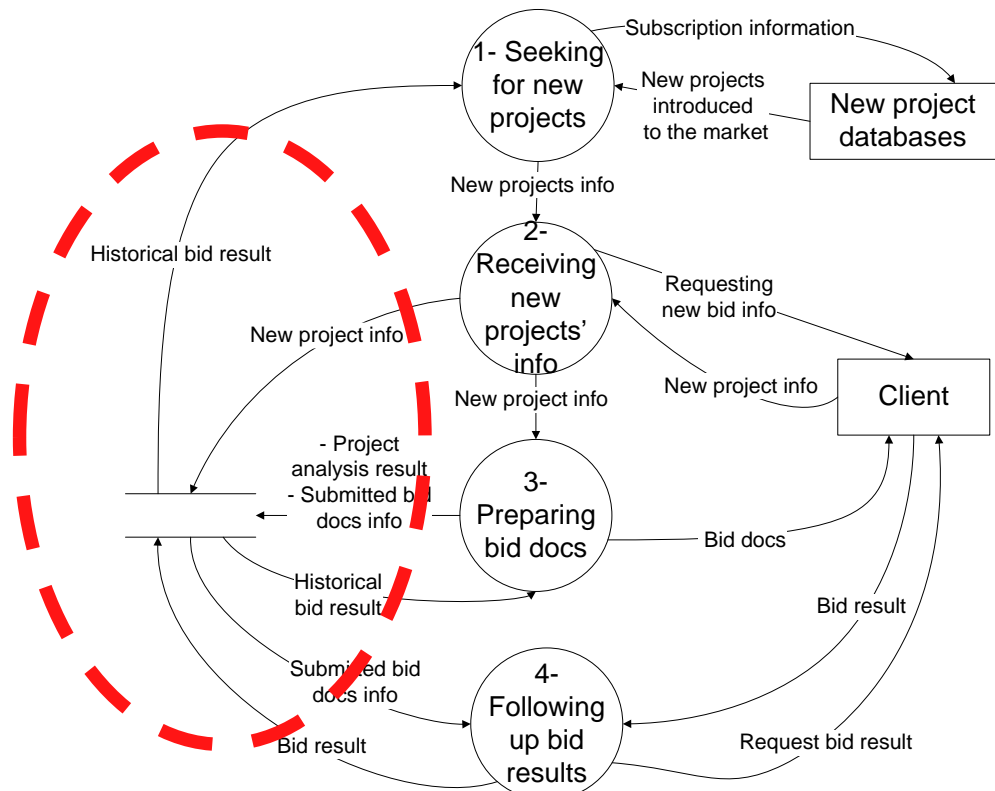
8

- Data stores are places where data related to entities are stored. See what data items are stored and what are retrieved

- **Example:**

- New project's data
- Project analysis data
- Submitted Bid data
- Bid result data

Bidding system in a construction company – dfd – L1



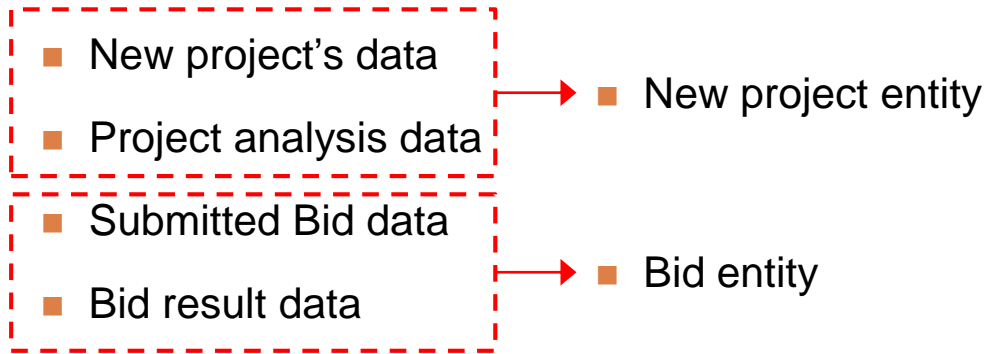


# Entity

9

## □ Example (cont'd)

- Check if data items can gather under a similar entity or form separate entities

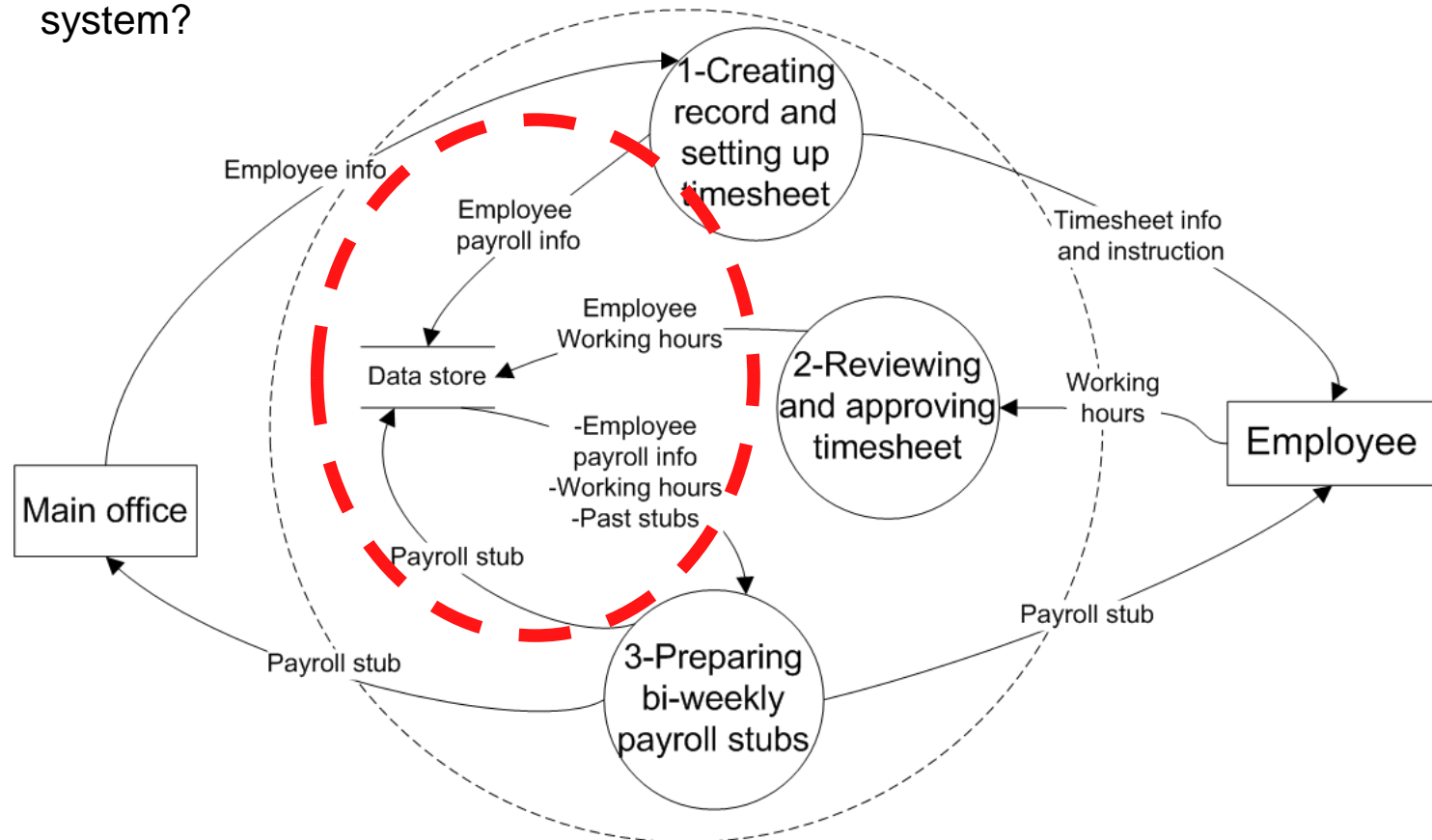


# In class practice 1

10



Remember our site payroll example (its dfd is in below). What are main entities (important elements we need to collect information about them) in the system?



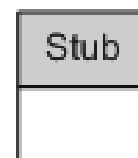
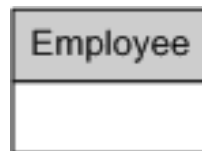
# In class practice 1

11



Remember our site payroll example (its dfd is in below). What are main entities (important elements we need to collect information about them) in the system?

- New employee payroll info
  - Employee working hours
  - Payroll stub
- Employee entity
  - Timesheet entity
  - Stub entity

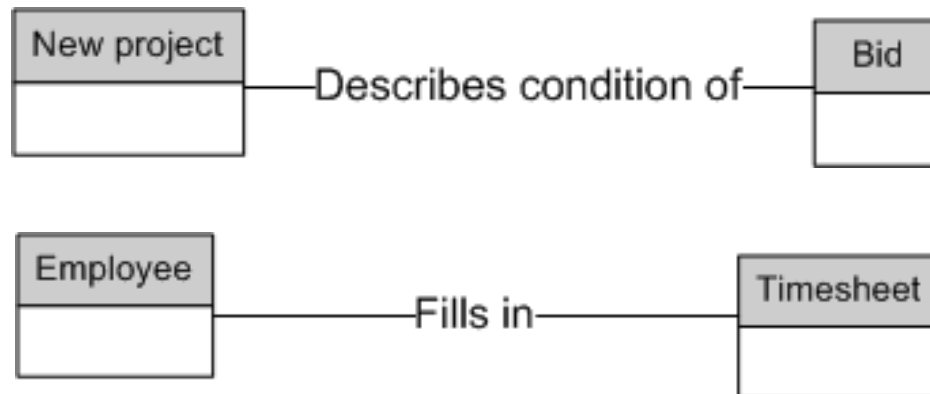


# Entity relationship diagram

12

- Entities are important elements within our system which we collect data for them. Entities contain data from different aspects of the system. Data collected for entities are related to one system and describe different aspects of the same system. We expect them to be related to each other and form entity relationship network or entity relationship diagram (ERD)!

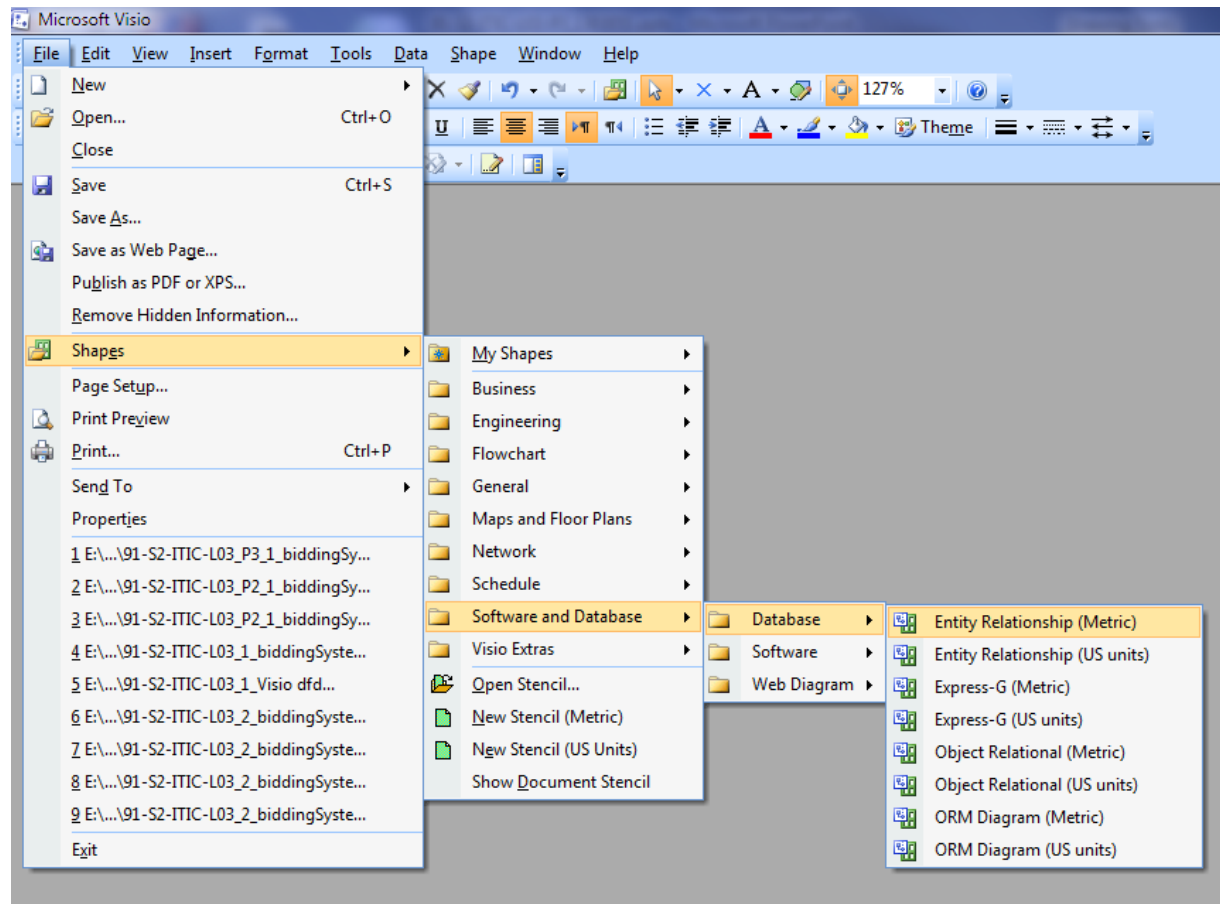
- **Example:**



# Entity relationship diagram



13

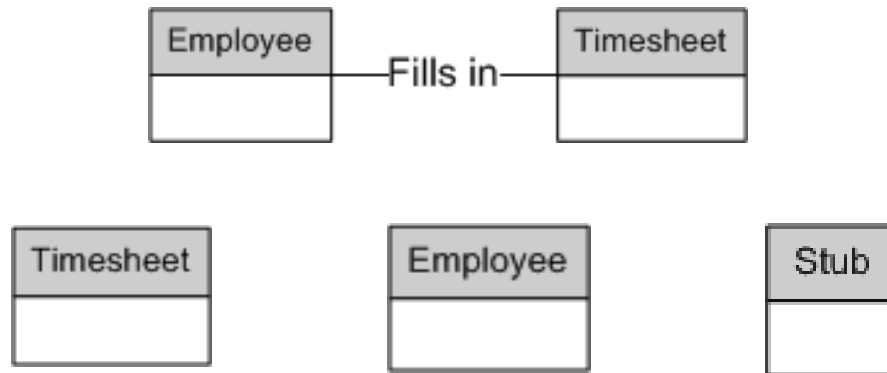
- Note: there are many CASE tools which can be used for drawing ERDs, in this course we use ERD shape set from Visio.



# In class practice 2



14

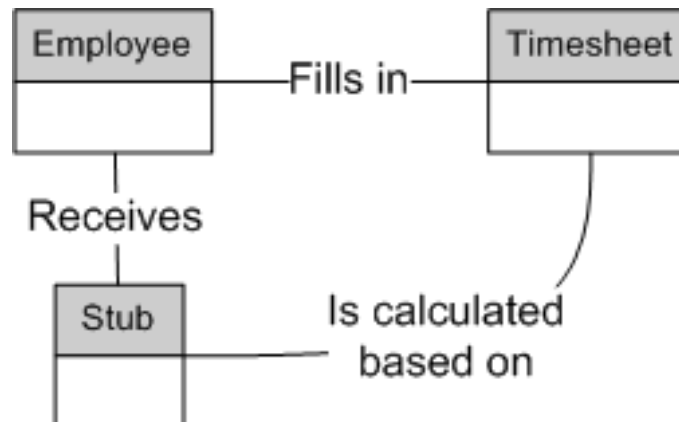
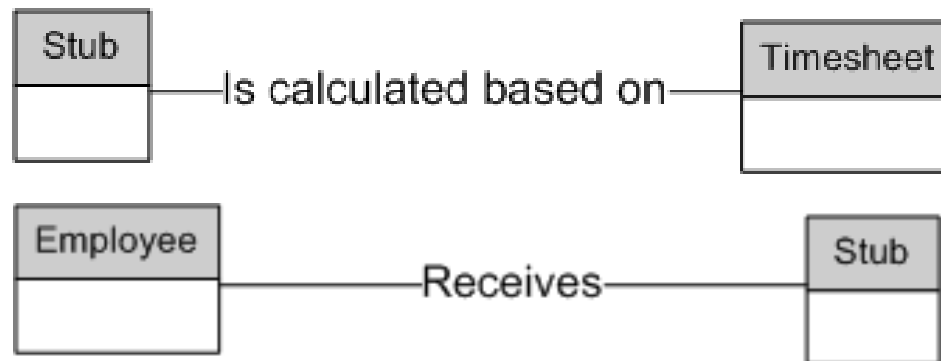
 Can you identify any other entity relationship in our construction payroll example? Try to  link single relationships with shared entities and build your Entity Relationship Diagram (ERD).



# In class practice 2

15

 Can you identify any other entity relationship in our construction payroll example? Try to  link single relationships with shared entities and build your Entity Relationship Diagram (ERD).



# Entity attributes

16

- Returning to the Entity definition: *an entity is an element which we need to collect data for it.*
- Entity attributes are data item *titles* we need to collect for an entity.
- Attributes characterize entities, i.e., entities are distinguishable from their attribute values.
- Only important attributes to our MIS systems are captured.
- For recognizing Entity attributes we again need to go back to the dfd and look into data items stored in data stores (why?). Data item titles go into/return from data stores also can be used to for identifying Entity attributes!



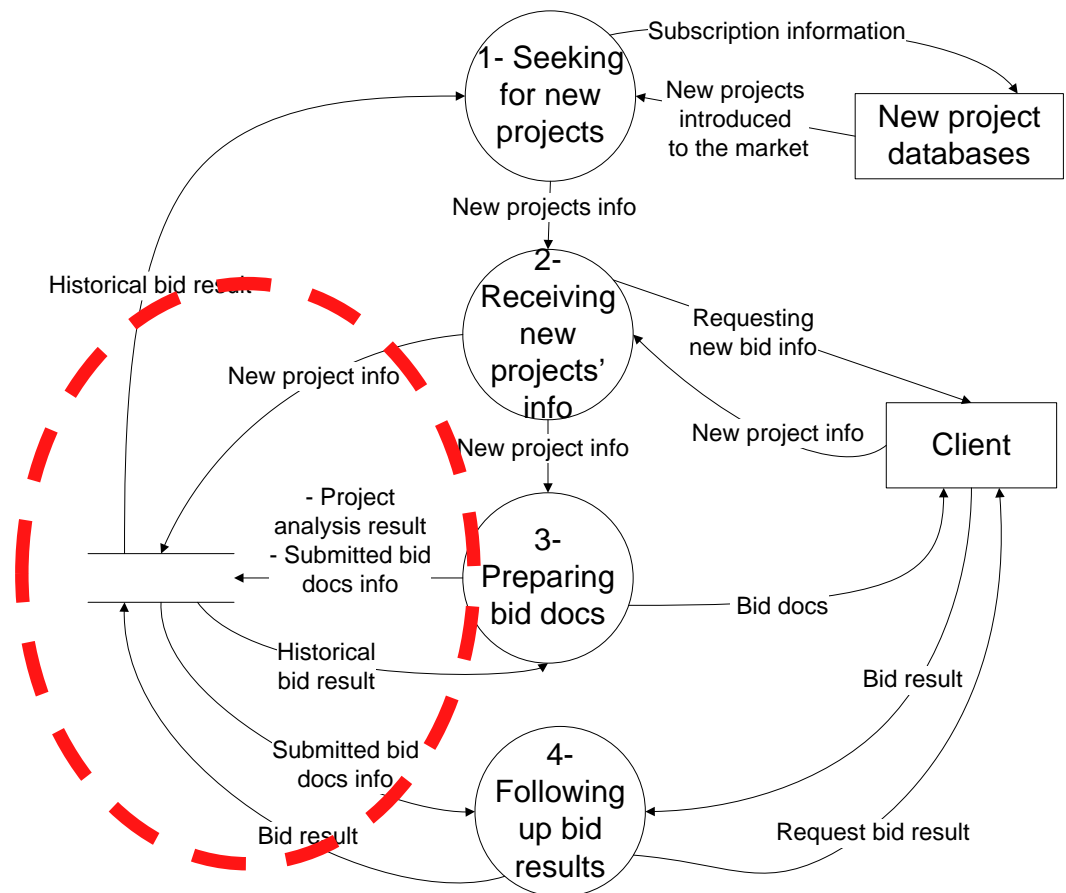
# Entity attributes

17



**Questions:** Name attributes of *New project* and *Bid* entities in our bidding system! In another word name data item titles of *New project* and *Bid* entities which we collect their data in our bidding system?

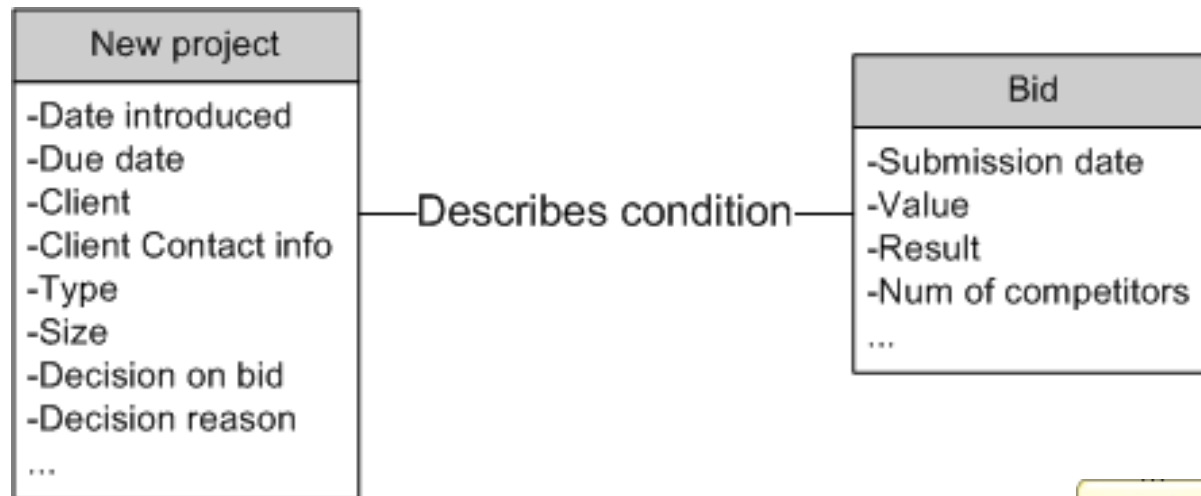
Bidding system in a construction company – dfd – L1





# Entity attributes

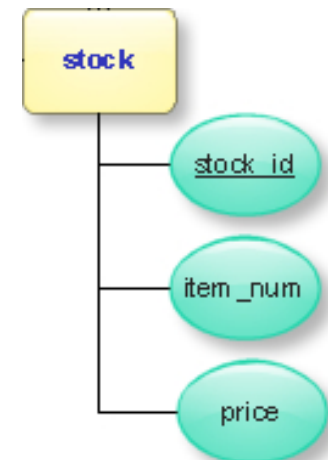
18

- Some entity attributes we can name are:



 **Note:** There are other conventions for presenting Entity attributes as well.

 **Note:** Entities with attributes represent ***data tables*** with the column headings of entity attributes!



# In class practice 3

19

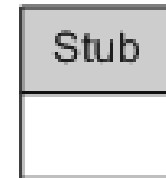


What are entity attributes (or data items) for Timesheet, Employee and Stub entities



which we need to collect data for them in our on site payroll system? How does system

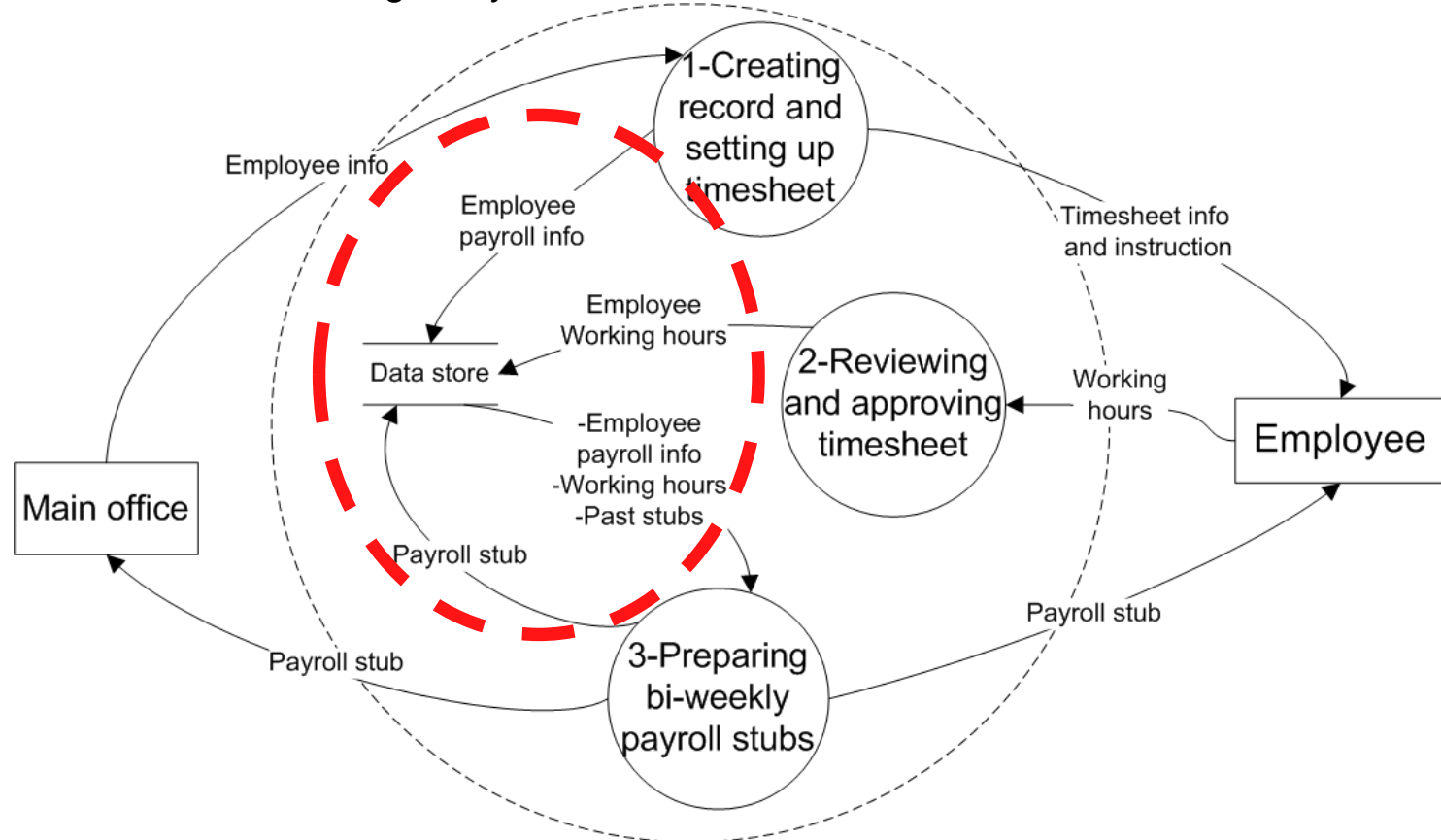
ERD look like after adding entity attributes?



# In class practice 3


20

- What are entity attributes (or data items) for Timesheet, Employee and Stub entities which we need to collect data for them in our on site payroll system? How does system ERD look like after adding entity attributes?



# In class practice 3

21

 What are entity attributes (or data items) for Timesheet, Employee and Stub entities which we need to collect data for them in our on site payroll system? How does system ERD look like after adding entity attributes?



Timesheet
-Employee name -Day -Hours worked -Job worked

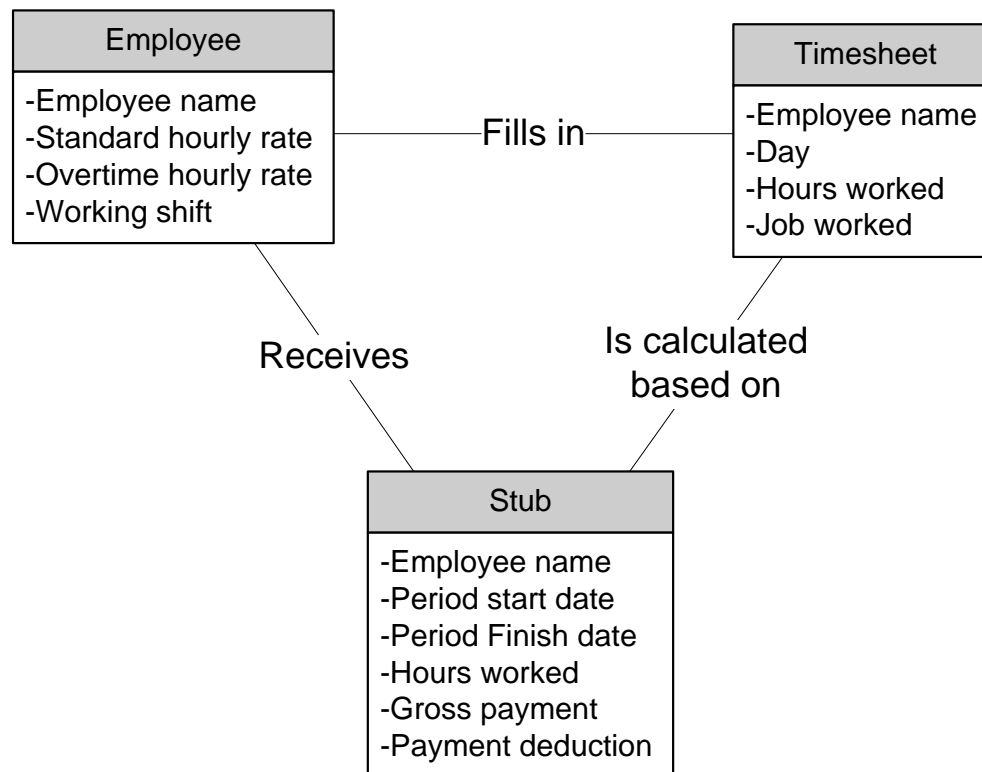
Employee
-Employee name -Standard hourly rate -Overtime hourly rate -Working shift

Stub
-Employee name -Period start date -Period Finish date -Hours worked -Gross payment -Payment deduction

# In class practice 3

22

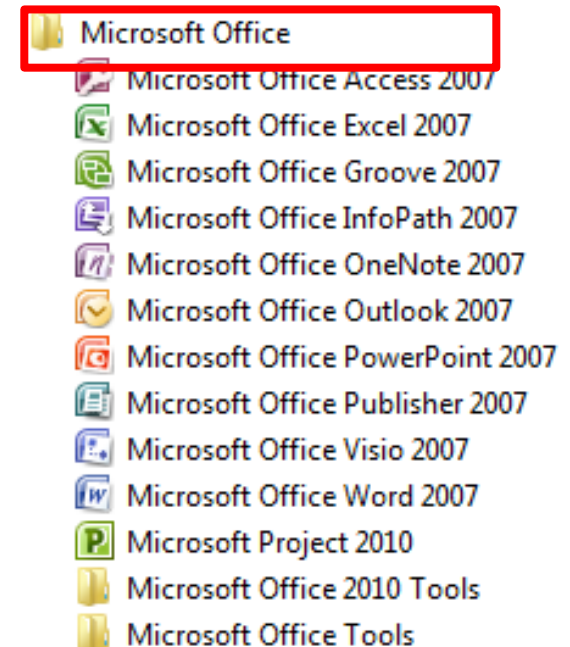
-  What are entity attributes (or data items) for Timesheet, Employee and Stub entities which we need to collect data for them in our on site payroll system? How does system ERD look like after adding entity attributes?
-  which we need to collect data for them in our on site payroll system? How does system ERD look like after adding entity attributes?



# Data tables (entities) in MS Access

23

- M.S. Access comes with Microsoft Office programs.
- Its main application is for developing small size information systems.
- It encompasses both database and programming engines required for development of an information system.
- It comes with a set of visual program development tools and supports SQL for running database operations and M.S. Visual Basic for Applications (VBA) programming languages for developing interfaces.
- Some of its *advantages* are: It has an integrated environment, it is very user friendly, runs on the network, it can communicate with main database programs (SQL server, Oracle) and programming tools (.NET framework)
- Some of its *disadvantages* are: It does not create executable files (needs M.S. Access to be installed on the machine), its size is limited to 2GB, it becomes very slow when data size grows up.



# Data tables (entities) in MS Access

24

## □ First view of MS Access





# Data tables (entities) in MS Access

25

- First view of MS Access

**Reopen  
previously  
opened  
files**

**Categories of  
prepared  
templates**

**Getting Started with Microsoft Office Access**

**Start with a blank file**

**Featured Online Templates**

- Assets
- Contacts
- Issues
- Events
- Marketing projects
- Projects
- Sales pipeline
- Tasks
- Faculty
- Students

**Prepared simple office information system templates for general uses**

**Open Recent Database**

- More...
- Contacts.accdb 06/04/2013
- \\...\\2\_91-S2-ITIC- 06/04/2013
- \\...\\91-S2-ITIC-L0 06/04/2013
- \\...\\91-S2-ITIC-L0 19/02/2013
- F:\\...\\NCR\_120419 12/02/2013
- \\...\\08\_2\_Control 02/02/2013
- E:\\...\\04\_Tunnel\_t 02/02/2013
- E:\\...\\5\_2\_InsertD 12/12/2012
- E:\\...\\2\_2\_InsertD 19/10/2012

**Microsoft Office Online**

**What's new in Access 2007?**

The new Access 2007 contains more powerful tools to help you quickly track, report, and share information in a manageable environment. Learn more about the new features and improvements.

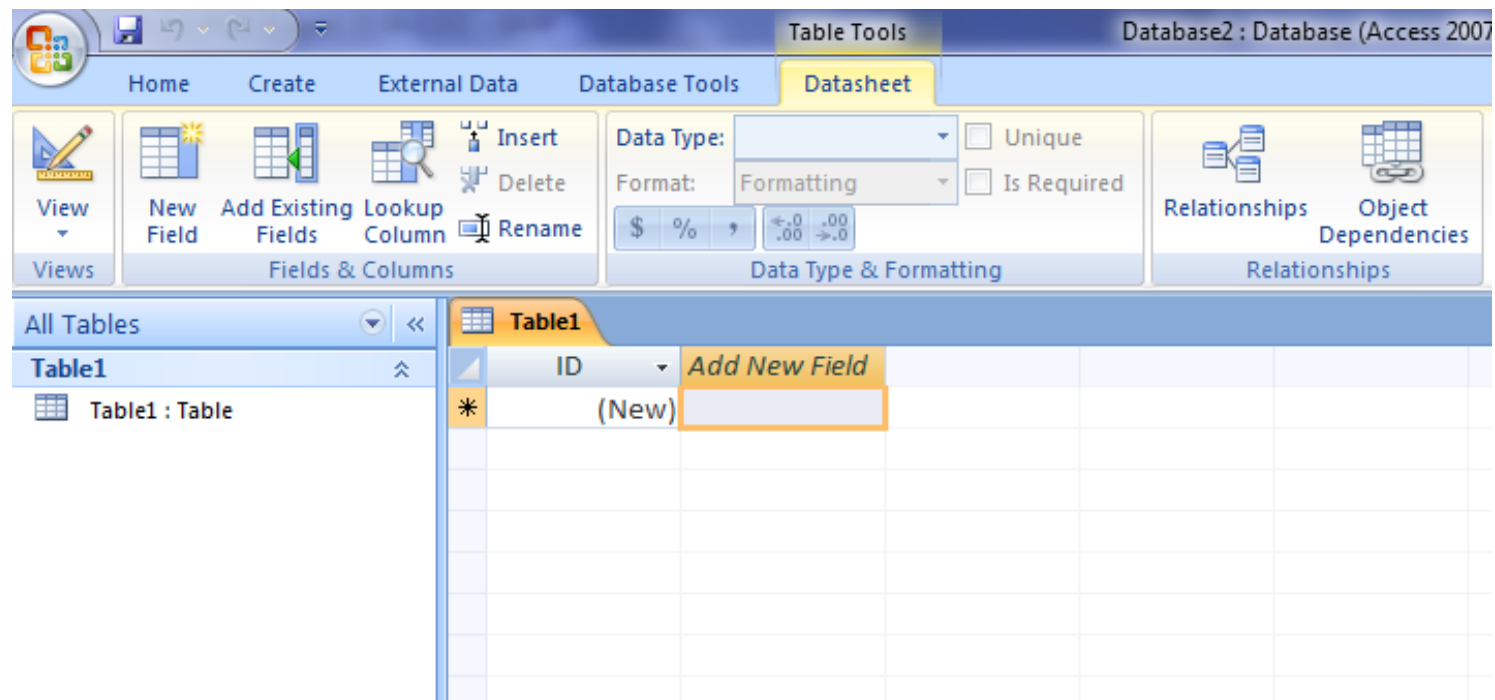
**More on Office Online:**

- Training | Templates | Downloads
- Get the latest content while working in the 2007 Microsoft Office system
- Guide to Access 2007 User Interface
- Organize all your objects using the new, easy access Navigation Pane

# Data tables (entities) in MS Access

26

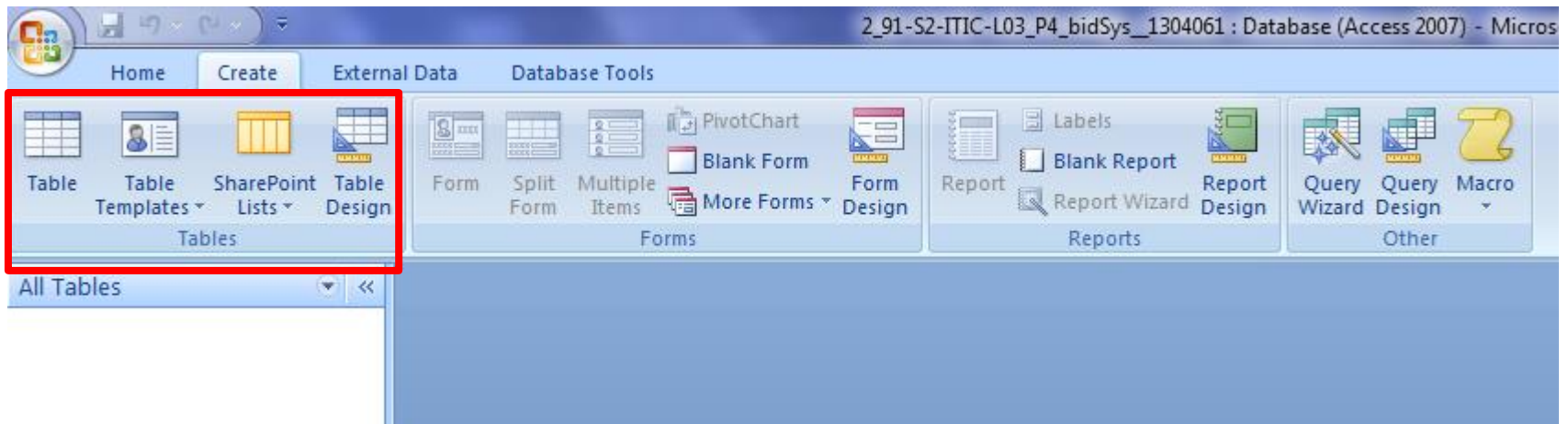
- Start with the blank MS Access file takes you to *create a new table* mode!



# Data tables (entities) in MS Access

27

- **Example 1 (cont'd):** Start creating data tables!



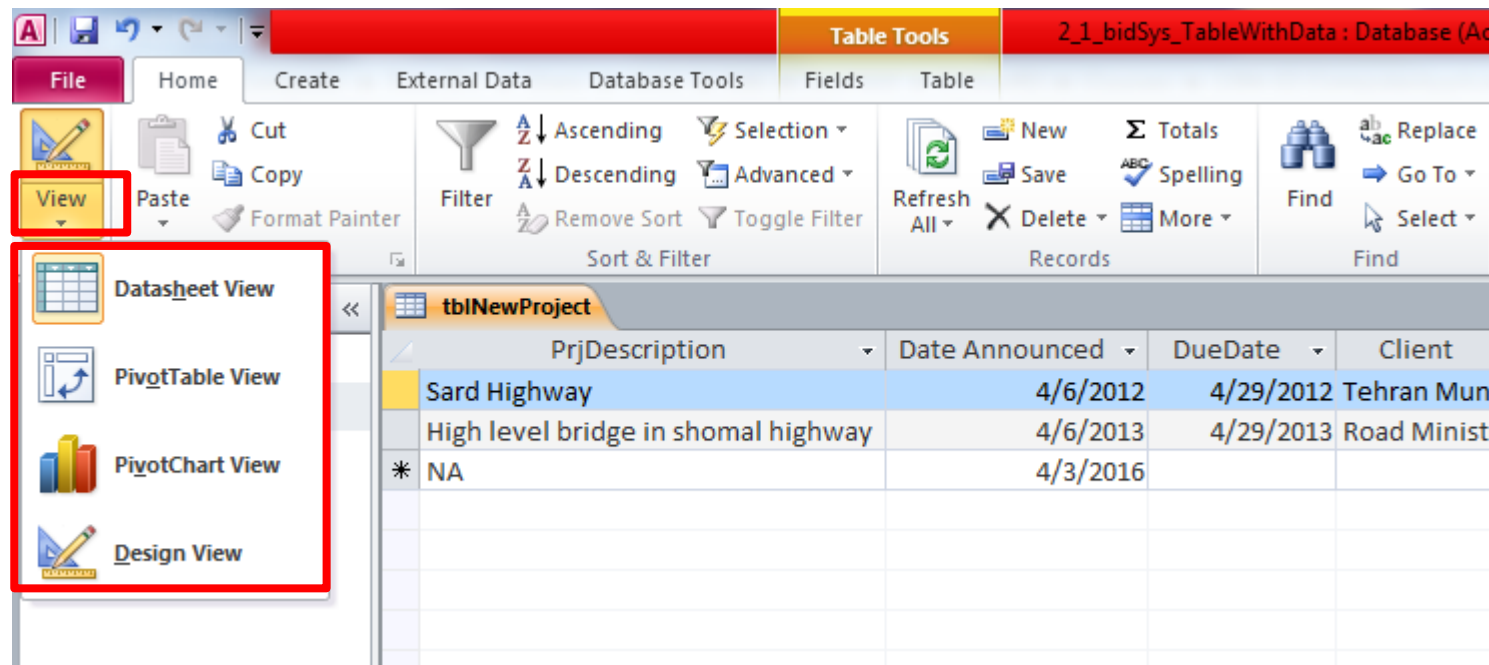
Hands on software (MS Access):

- We are going to create data tables for our bidding system

# Data tables (entities) in MS Access

28

- Every table can get four different views:
  - ▣ Datasheet view
  - ▣ PivotTable view
  - ▣ PivotChart view
  - ▣ Design view



# Data tables (entities) in MS Access

29

- Datasheet view is the view allows us to enter data directly to the data table
- We can directly enter data into the table using keyboard
- We can copy and paste available data from other data tables as well as spreadsheets (e.g., M.S., Excel)



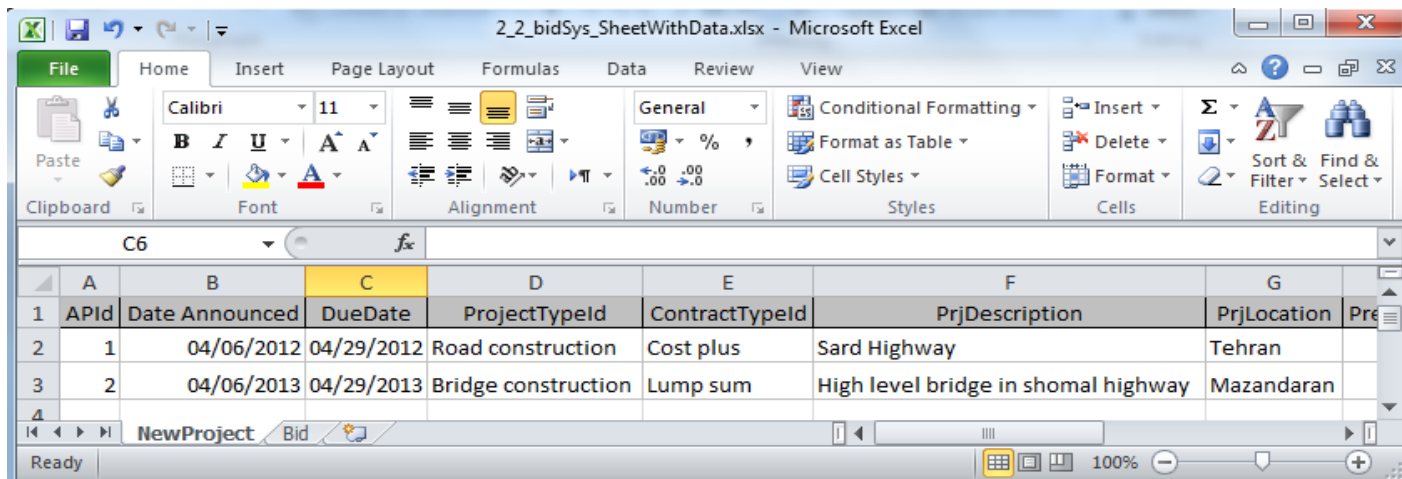
Hands on software (MS Access):

- Entering data manually
- Entering data from spreadsheet
- Entering data from other tables

# Data tables (entities) in MS Access

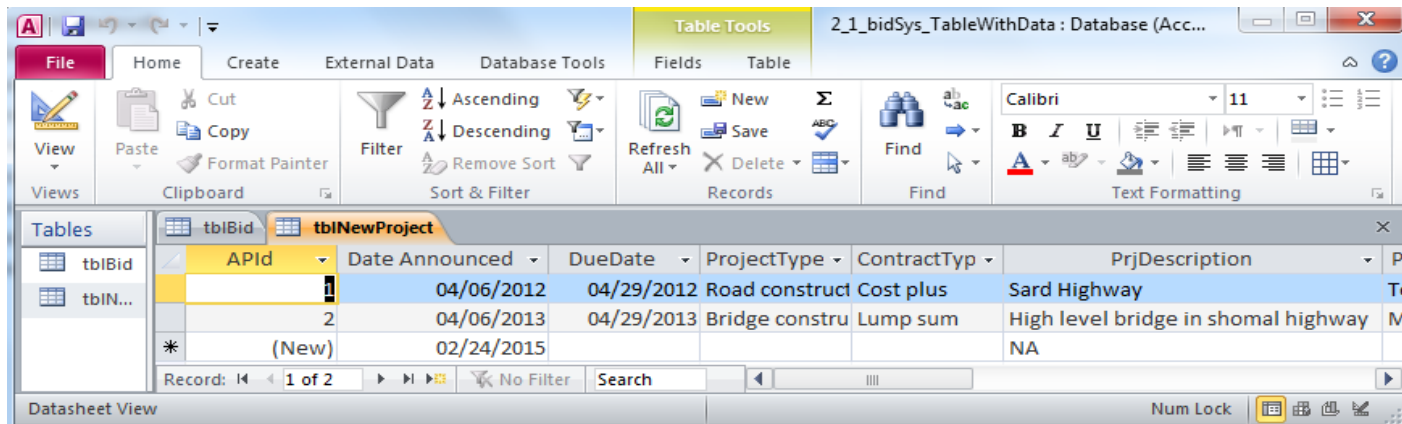
30

- Every data table in MS Access is comparable with a spreadsheet in MS Excel:



The screenshot shows the Microsoft Excel interface with the file '2\_2\_bidSys\_SheetWithData.xlsx'. The ribbon includes File, Home, Insert, Page Layout, Formulas, Data, Review, and View. The 'Home' ribbon is active, showing options for Clipboard, Font, Alignment, Number, Styles, Cells, and Editing. The spreadsheet data is as follows:

	A	B	C	D	E	F	G
1	APId	Date Announced	DueDate	ProjectTypeId	ContractTypeId	PrjDescription	PrjLocation
2	1	04/06/2012	04/29/2012	Road construction	Cost plus	Sard Highway	Tehran
3	2	04/06/2013	04/29/2013	Bridge construction	Lump sum	High level bridge in shomal highway	Mazandaran



The screenshot shows the Microsoft Access interface with the database '2\_1\_bidSys\_TableWithData : Database (Acc...'. The ribbon includes File, Home, Create, External Data, Database Tools, and Table Tools. The 'Table Tools' ribbon is active, showing options for Fields and Table. The data table is displayed in Datasheet View:

tblNewProject	APId	Date Announced	DueDate	ProjectType	ContractType	PrjDescription
	1	04/06/2012	04/29/2012	Road construct	Cost plus	Sard Highway
	2	04/06/2013	04/29/2013	Bridge constru	Lump sum	High level bridge in shomal highway
	(New)	02/24/2015				NA

Record: 1 of 2. Search: No Filter.

# Data tables (entities) in MS Access

31



Data tables have bunch of other capabilities such as linking to other databases, spreadsheets, importing XML file which are beyond the scope of this course and we are not including them here!

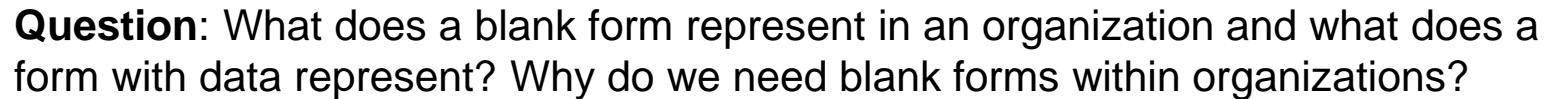
# Data record

32

- A *data record* is data collected for one **instance** of an entity:  
record ~ entity instance
- Data collected for an instance of an entity (or *Record*) describes different aspects of the entity instance as mentioned in entity *Attribute*!
- **Example:** New Project Entity

		Attributes						
		Attribut 1	Attribut 2	Attribut 3	Attribut 4	Attribut 5	Attribut 6	Attribut 7
		Date introduced	Due Date	Client	Type	Size (MT)	Decision on bid	Decision reason
Records	New Project-1 →	91-10-20	In 2 month(s)	City of Karaj	Road construction	245.8	Not to bid	Project Not well defined
	New Project-2 →	91-11-18	In 2 month(s)	City of Tehran	Swedge system	75.7	Not to bid	Project Not well defined
	New Project-3 →	91-11-19	In 3 month(s)	City of Karaj	Tunneling	479.4	Bid	Past experience
	New Project-4 →	91-2-6	In 2 month(s)	City of Tehran	Swedge system	446.4	Not to bid	Project Not well defined
	New Project-5 →	91-3-19	In 2 month(s)	Kish free zone	Tunneling	14.5	Bid	Past experience



[illegible]

# Data record

34



**Question:** Data items flow within organization are attributes or records?

CIRCA Employee Management System ver 2.0.2 Employees

[View Employees](#) | [Add Employee](#) | [Edit Employee](#) | [Departing Employee](#) | [Comment / Problem Log](#) | [Employee-of-the-Month](#)

**UPDATE EMPLOYEE**

Select Employee: Reckard, Gary [View](#)

---

UF-ID: 8935-8670

GateLink: garyedi

First Name: Gary

Last Name: Reckard

Status: ☒ Active ☐ Inactive

Email: garyedi

Works Overnight: ☐ Yes ☒ No

Date Hired: 8 / 16 / 1999

Salary: 9.25

Last Raise: 0.25

Last Raise Date: 1 / 13 / 2006

Title: ☐ Senior ☒ Sup ☐ Lead TC  
☐ TS ☐ Trainee

Other Title: Supervisor

Vest Size: ☐ XXL ☐ XL ☒ L  
☐ M ☐ S ☒ Unknown

Departure Date: - / - / -

Eligible for Retire: ☐ Yes ☒ No

Departure Reason:

Employee Image



garyreckard.jpg

Sample Company Name, Sample Company Address, 95220

EARNINGS STATEMENT					
EMPLOYEE NAME	SOCIAL SEC. ID	EMPLOYEE ID	CHECK No.	PAY PERIOD	PAY DATE
James Robert	XXX-XX-6565	454545	259248	01/23/14-01/29/14	01/31/14
INCOME	RATE	HOURS	CURRENT TOTAL	DEDUCTIONS	CURRENT TOTAL
GROSS WAGES			1,000.00		
				FICA MED TAX	14.50
				FICA SS TAX	62.00
				FED TAX	159.50
				CA ST TAX	44.26
				SDI	10.00
					72.50
					310.00
					797.48
					221.31
					50.00
YTD GROSS	YTD DEDUCTIONS	YTD NET PAY	TOTAL	DEDUCTIONS	NET PAY
5,000.00	1,451.28	3,548.72	1,000.00	290.26	709.74

## TIMESHEET

Staff Member to submit one form, fortnightly, for work done in each job and hand to the supervisor.

Family Name: SAMPLE Other Names: CASUAL

Employee Number: 12345678 Level:  Step:

Job Number:  Faculty/Office: LIBRARY - SAMPLE DEPT.

STAFF MEMBER TO COMPLETE:

Day	Date Worked	ACTUAL Start Time	ACTUAL Finish Time	Less Break(s)	= Actual Hours Worked *
Thu	5/04/12	9:00	5:00	1:00	7:00
Fri	6/04/12	:	:	:	:
Sat	7/04/12	10:00	5:00	0:30	8:30
Sun	8/04/12	:	:	:	:
Mon	9/04/12	10:00	5:00	0:30	8:30
Tue	10/04/12	:	:	:	:
Wed	11/04/12	9:00	8:00	1:00	8:00

1-Creating record and setting up timesheet

2-Recording hours and time

Employee payroll info

Preparing weekly payroll stubs

Payroll stub

# Entity relationship type

35

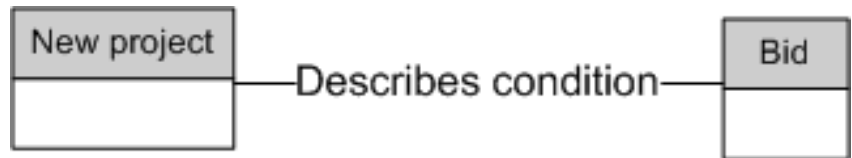
- 🔊 Identifying entity relationship is our first step to scheme our MIS data model and Entity relationship diagram (ERD) is our main tool to capture and gradually improve and finalize our MIS ***data model***.
- 🔊 Almost all operational databases are relational databases and uses concepts we are going to discuss in this lecture.
- 🔊 By following ***relational data model*** development rules we guaranty minimum amount of data storage within our system and maximize our search.
- In terms of ***number of entity instances*** (or *entity data records*) that can relate to each other in two sides of an entity relationship, ***entity relationship types*** are defined as follows:

# Entity relationship type

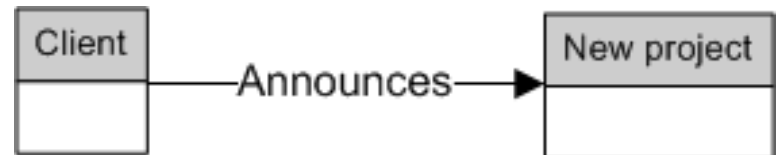
36

## □ Types of entity relationship:

- **One to one relationship:** Two entities have one to one relationship when for both entities, at most, one entity instance is only related to one instance of the other entity.
  - Example: New project and bid: Every “New project” describes condition of only one “Bid” AND every “Bid” condition is described by only one “New project”



- **One to many relationship:** An entity has one to many relationship with another entity when an instance of the first entity *can* relate to several instances of the second entity And in return every instance of the second entity can only relate (*at most*) to one instance of the first entity.
  - Example: Client and New project: One “Client” can announce several “New projects”, BUT, every “New project” is announced only by one “Client”.



# Entity relationship type

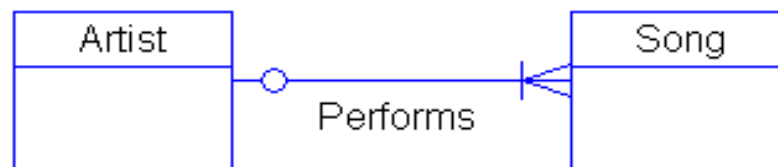
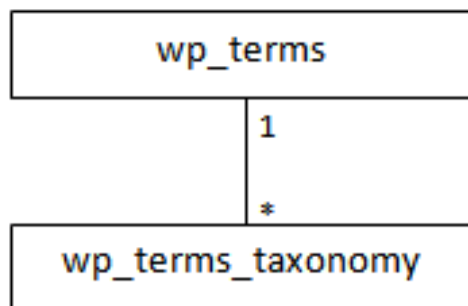
37

- **Many to many relationship:** Two entities have many to many relationships when for each entity, one entity instance *can* related to several instances of other entity.
  - Example: New project and Competitor: In our bid system suppose (in addition to *New Project* and *Bid* entities) another entity that we are interested in collecting data for is *Competitor*, under which we collect information of our competing companies in different new projects. In this case, every “New project” may be competed by several “Competitors”, AND one “Competitor” can compete with us in several “New projects”



- **Note:** There are other conventions for presenting different types of relationships.

Examples:



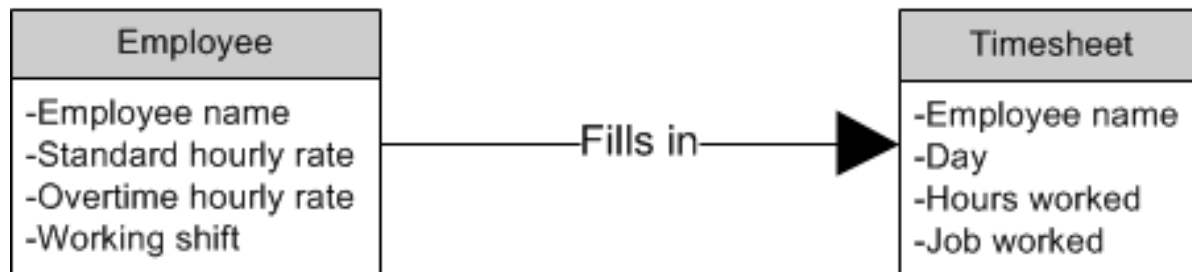
# Entity relationship type

38

- Making the relationship type concept more clear:

💡 After all what really do entity relationship types mean? How can we see the effects of these relationships on the data collected for entity instances?

- **Example:** one-to-many relationship



# Entity relationship type

39

## □ Example (cont'd): one-to-many relationship

Sample Data Collected for Employee Entity

Attributes

Employee name	Standard hourly rate (tt)	Overtime rate	Working shift
...			
Ali Aliani	5.5	8	Day shift
Naser Naseri	7	11	Day shift
Sadegh Sadeghi	4	6	Day shift
Saeed Saeedi	15	20	Night shift
...			

Sample Data Collected for Timesheet Entity

Attributes

Employee name	Day	Hours worked	Job
...			
Ali Aliani	92-12-01	8 (8am-16pm)	92-105 (5); 92-70(3)
Naser Naseri	92-12-01	8 (8am-16pm)	92-101
Sadegh Sadeghi	92-12-01	8 (8am-16pm)	92-105
Saeed Saeedi	92-12-01	8 (17pm-1am)	92-101 (7); 92-70(1)
Ali Aliani	92-12-03	7 (8am-15pm)	92-70
Ghader Ghaderi	92-12-03	8 (8am-16pm)	92-101
Sadegh Sadeghi	92-12-03	8 (8am-16pm)	92-105
Saeed Saeedi	92-12-03	10 (17pm-3am)	92-70
Ali Aliani	92-12-04	8 (8am-16pm)	92-106 (7); 92-107(1)
Naser Naseri	92-12-04	8 (8am-16pm)	92-101
Sadegh Sadeghi	92-12-04	0	92-105
Nader Naderi	92-12-04	8 (17pm-1am)	92-107
Ali Aliani	92-12-05	9 (8am-17pm)	92-107
Naser Naseri	92-12-05	8 (8am-16pm)	92-108
Sadegh Sadeghi	92-12-05	8 (8am-16pm)	92-109
Saber Saberi	92-12-05	8 (17pm-1am)	92-109 (3); 92-110 (5)
...			



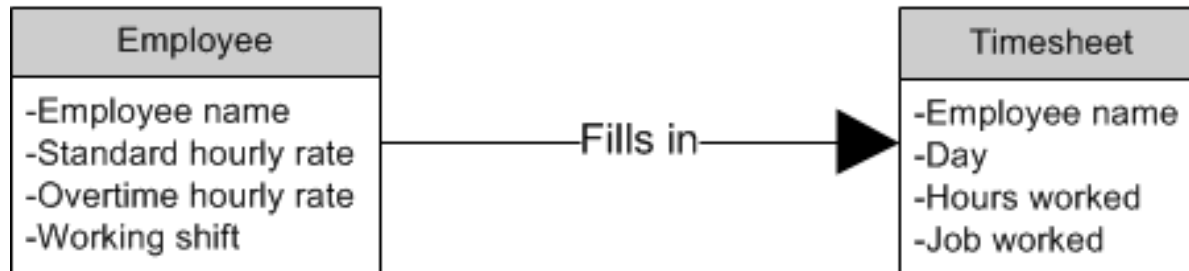
What is the benefit of determining entity relationship?

# Entity relationship type

40

With determining entity relationships we are trying to minimize amount of data records.

- Following an entity relationships with other entities we can retrieve required *complementary* information under those entities with no need for maintaining those information.
- Example (relationship for minimizing number of records stored!):** Consider Employee and Timesheet entities and one-to-many relationship:





# Entity relationship type

41

## □ Example (relationship for minimizing number of records stored!) (cont'd):

Every time we ask employee to record its Timesheet we just ask him to write a minimum information of him/her self on Timesheet (e.g., name). By having this minimum data on Timesheet we can retrieve all other information related to employee by referring to Employee records!

Entities are related through **Linking** data title or **Attributes** which their values represent a unique record within the related entity!

Employee			
Employee name	Standard hourly rate (tt)	Overtime rate	Working shift
...			
Ali Aliani	5.5	8	Day shift
...			

Timesheet			
Employee name	Day	Hours worked	Job
...			
Ali Aliani	92-12-01	8 (8am-16pm)	92-105 (5); 92-70(3)
Ali Aliani	92-12-03	7 (8am-15pm)	92-70
Ali Aliani	92-12-04	8 (8am-16pm)	92-106 (7); 92-107(1)
Ali Aliani	92-12-05	9 (8am-17pm)	92-107
...			



**Question:** What would happen if we did not have relationship concept for entities and wanted to use employee information?

# Entity relationship type

42

- Example (relationship for minimizing number of records stored!) : Employee and Timesheet one-to-many relationship Records when determining relationships:

**Employee**

Employee name	Standard hourly rate (tt)	Overtime rate	Working shift
...			
Ali Aliani	5.5	8	Day shift
...			

**Timesheet**

Employee name	Day	Hours worked	Job
...			
Ali Aliani	92-12-01	8 (8am-16pm)	92-105 (5); 92-70(3)
Ali Aliani	92-12-03	7 (8am-15pm)	92-70
Ali Aliani	92-12-04	8 (8am-16pm)	92-106 (7); 92-107(1)
Ali Aliani	92-12-05	9 (8am-17pm)	92-107
...			

Records when do not have relationships:

Employee name	Day	Hours worked	Job	Standard hourly rate (tt)	Overtime rate	Working shift
...						
Ali Aliani	92-12-01	8 (8am-16pm)	92-105 (5); 92-70(3)	5.5	8	Day shift
Ali Aliani	92-12-03	7 (8am-15pm)	92-70	5.5	8	Day shift
Ali Aliani	92-12-04	8 (8am-16pm)	92-106 (7); 92-107(1)	5.5	8	Day shift
Ali Aliani	92-12-05	9 (8am-17pm)	92-107	5.5	8	Day shift
...						

Extra records maintained

# Entity relationship type

43

- **Example (relationship for minimizing number of records stored!):** If for every timesheet we need to know related job information and we do not want to follow relationship concept we again need to increase size of our data table to be able to retrieve job information related to every record.

Employee name	Day	Hours worked	Job	Standard hourly rate (tt)	Overtime rate	Working shift
...						
Ali Aliani	92-12-01	8 (8am-16pm)	92-105 (5); 92-70(3)	5.5	8	Day shift
Ali Aliani	92-12-03	7 (8am-15pm)	92-70	5.5	8	Day shift
Ali Aliani	92-12-04	8 (8am-16pm)	92-106 (7); 92-107(1)	5.5	8	Day shift
Ali Aliani	92-12-05	9 (8am-17pm)	92-107	5.5	8	Day shift
...						

Extra records maintained

## Job

Job number	Job client	Job description	Job location
...			
92-70	Ministry of road	Haraz Bayjaan Bridge	Km 70 Haraz highway
92-105	City of Tehran	Sadr Bridge	North-east Tehran
92-106	City of Tehran	Parkway Bridge	North Tehran
92-107	Sharif University	New Civil Eng Building	West Tehran
...			

# Entity relationship type

44

- Example (relationship for minimizing number of records stored!):

Employee name	Day	Hours worked	Job	Standard hourly rate (tt)	Overtime rate	Working shift	Job number	Job client	Job description	Job location
...										
Ali Aliani	92-12-01	8 (8am-16pm)	92-105 (5); 92-70(3)	5.5	8	Day shift	92-70	Ministry of road	Haraz Bayjaan Bridge	Km 70 Haraz highway
Ali Aliani	92-12-01	8 (8am-16pm)	92-105 (5); 92-70(3)	5.5	8	Day shift	92-105	City of Tehran	Sadr Bridge	North-east Tehran
Ali Aliani	92-12-03	7 (8am-15pm)	92-70	5.5	8	Day shift	92-70	Ministry of road	Haraz Bayjaan Bridge	Km 70 Haraz highway
Ali Aliani	92-12-04	8 (8am-16pm)	92-106 (7); 92-107(1)	5.5	8	Day shift	92-106	City of Tehran	Parkway Bridge	North Tehran
Ali Aliani	92-12-04	8 (8am-16pm)	92-106 (7); 92-107(1)	5.5	8	Day shift	92-107	Sharif University	New Civil Eng Building	West Tehran
Ali Aliani	92-12-05	9 (8am-17pm)	92-107	5.5	8	Day shift	92-107	Sharif University	New Civil Eng Building	West Tehran
...										



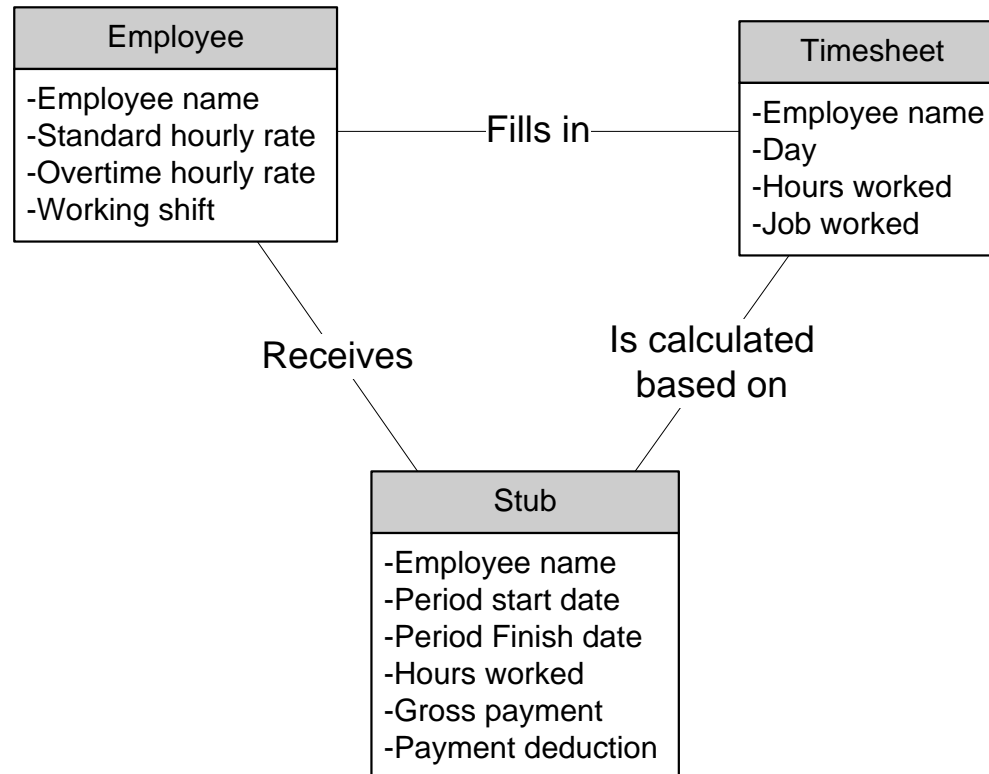
Without following relationship concept we are going to come up with inefficient gigantic tables which are very difficult to find any information out of them!

# In class practice 4

45

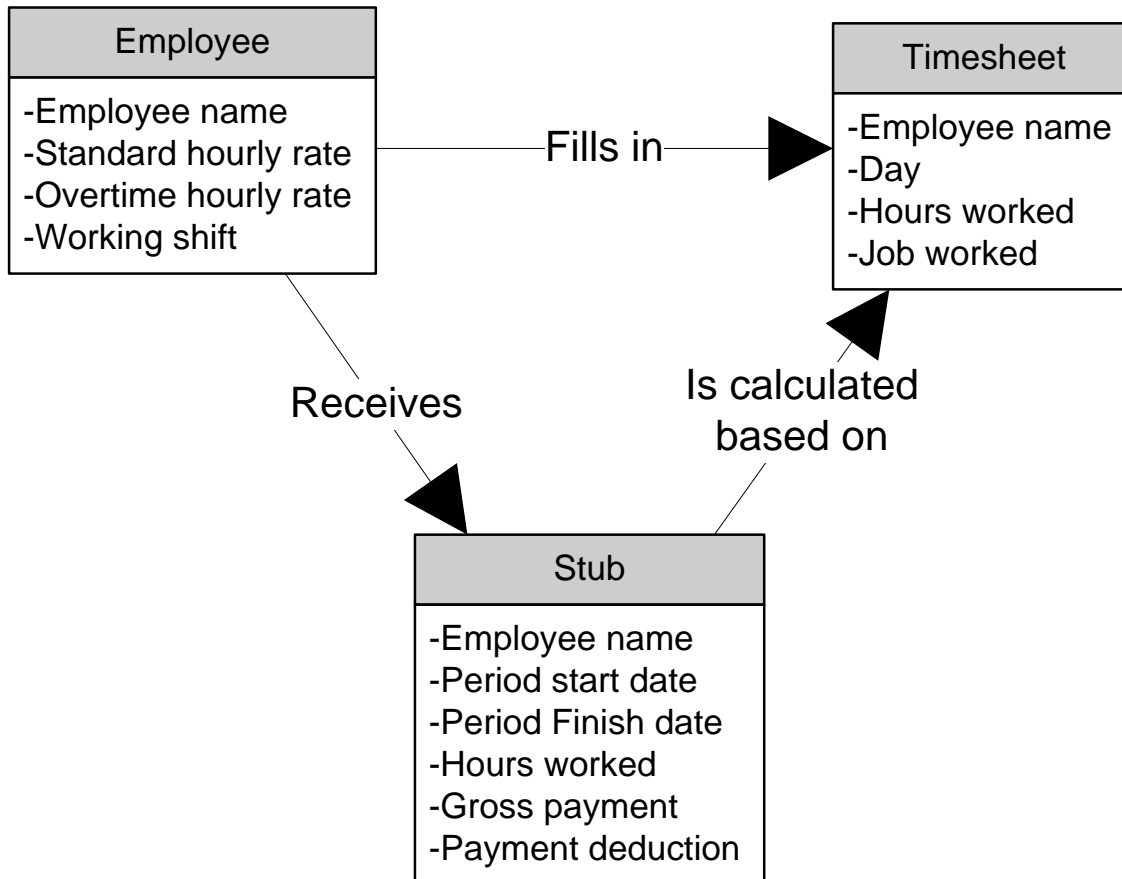


What are entity relationship types in ERD recognized for our on site payroll system example? After identifying relationships, describe how entity instances (or entity data records) from each side can relate to the entity instances (or entity data records) to the other side?



# In class practice 4

46

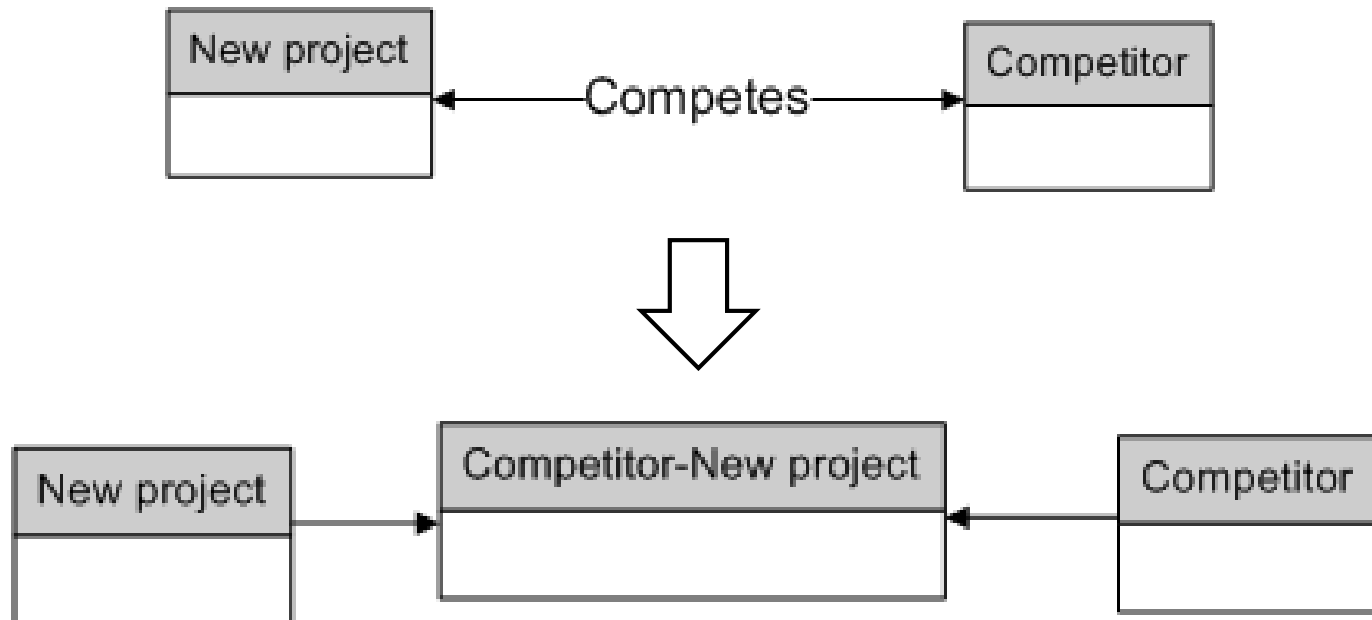


# Entity relationship type

47

- **Rule:** When you face *many to many* relationships you need to break them down to two *one to many* related entities.

**Example:**



# In class practice 5

48



Sample data records for many-to-many relationship between *New project* and *Competitor*

entities are presented in below.

1) How can we track *competitor names* bided on City of Karaj's New project announced on 91-10-20?

How can we extract *Size* of New project's Sharif Construction has bided on?

2) Add a new middle data table (entity) to divide records from this many to many data relationship to two one-to-many relationships. What are **linking attributes**?

Date introduced	Due Date	Client	Type	Size (MT)	Decision on bid	Decision reason
91-10-20	In 2 month(s)	City of Karaj	Road constr.	245.8	Not to bid	Project Not well defined
91-11-18	In 2 month(s)	City of Tehran	Swedge system	75.7	Not to bid	Project Not well defined
91-11-19	In 3 month(s)	City of Karaj	Tunneling	479.4	Bid	Past experience
91-2-6	In 2 month(s)	City of Tehran	Swedge system	446.4	Not to bid	Project Not well defined
91-3-19	In 2 month(s)	Kish free zone	Tunneling	14.5	Bid	Past experience



Competitor name	Contact info	New projects compete	Bids won
Sharif Construction	021-6616	City of Karaj/ Road construction/ 91-10-20 City of Tehran/ Swedge system/ 91-11-18 City of Tehran/ Swedge system/ 91-2-6 Kish free zone/ Tunneling/ 91-3-19	Yes Yes No Yes
Tehran Construction	021-6000	City of Karaj/ Road construction/ 91-10-20 City of Tehran/ Swedge system/ 91-11-18 City of Karaj/ Tunneling/ 91-11-19	No Yes No
AmirKabir Construction	021-7000	City of Karaj/ Tunneling/ 91-11-19 City of Tehran/ Swedge system/ 91-2-6 Kish free zone/ Tunneling/ 91-3-19	No No No

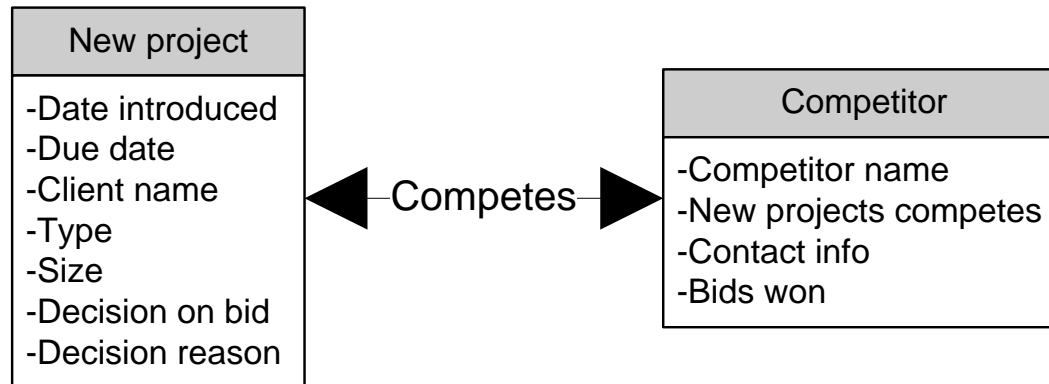


# In class practice 5

49



- Many to many entity relationships do not let us to simply track data records from one entity to the related entity!



# In class practice 5

50



- Many to many entity relationships do not let us to simply track data records from one entity to the related entity!

- We need to search inside a record!

Date introduced	Due Date	Client	Type	Size (MT)	Decision on bid	Decision reason
91-10-20	In 2 month(s)	City of Karaj	Road constr.	245.8	Not to bid	Project Not well defined
91-11-18	In 2 month(s)	City of Tehran	Swedge system	75.7	Not to bid	Project Not well defined
91-11-19	In 3 month(s)	City of Karaj	Tunneling	479.4	Bid	Past experience
91-2-6	In 2 month(s)	City of Tehran	Swedge system	446.4	Not to bid	Project Not well defined
91-3-19	In 2 month(s)	Kish free zone	Tunneling	14.5	Bid	Past experience

- For finding “competitor names” bided on City of Karaj’s road construction “New project” announced on 91-10-20 we need to search inside every competitor’s record (or instance).

Competitor name	Contact info	New projects compete	Bids won
Sharif Construction	021-6616	City of Karaj/ Road construction/ 91-10-2	Yes
		City of Tehran/ Swedge system/ 91-11-18	Yes
		City of Tehran/ Swedge system/ 91-2-6	No
		Kish free zone/ Tunneling/ 91-3-19	Yes
Tehran Construction	021-6000	City of Karaj/ Road construction/ 91-10-20	No
		City of Tehran/ Swedge system/ 91-11-18	Yes
		City of Karaj/ Tunneling/ 91-11-19	No
AmirKabir Construction	021-7000	City of Karaj/ Tunneling/ 91-11-19	No
		City of Tehran/ Swedge system/ 91-2-6	No
		Kish free zone/ Tunneling/ 91-3-19	No

# In class practice 5

51



For extracting Size of New project's Sharif Construction, as a competitor, has bided on again we need to search inside a record!

Date introduced	Due Date	Client	Type	Size (MT)	Decision on bid	Decision reason
91-10-20	In 2 month(s)	City of Karaj	Road constr.	245.8	Not to bid	Project Not well defined
91-11-18	In 2 month(s)	City of Tehran	Swedge system	75.7	Not to bid	Project Not well defined
91-11-19	In 3 month(s)	City of Karaj	Tunneling	479.4	Bid	Past experience
91-2-6	In 2 month(s)	City of Tehran	Swedge system	446.4	Not to bid	Project Not well defined
91-3-19	In 2 month(s)	Kish free zone	Tunneling	14.5	Bid	Past experience

Competitor name	Contact info	New projects compete	Bids won
Sharif Construction	021-6616	City of Karaj/ Road construction/ 91-10-2	Yes
		City of Tehran/ Swedge system/ 91-11-18	Yes
		City of Tehran/ Swedge system/ 91-2-6	No
		Kish free zone/ Tunneling/ 91-3-19	Yes
Tehran Construction	021-6000	City of Karaj/ Road construction/ 91-10-20	No
		City of Tehran/ Swedge system/ 91-11-18	Yes
		City of Karaj/ Tunneling/ 91-11-19	No
AmirKabir Construction	021-7000	City of Karaj/ Tunneling/ 91-11-19	No
		City of Tehran/ Swedge system/ 91-2-6	No
		Kish free zone/ Tunneling/ 91-3-19	No

# In class practice 5

52



Is there any other better way to search?



Linking attributes

## New Project-Competitor

New projects compete	Competitor name	Bids won
City of Karaj/ Road construction/ 91-10-2	Sharif Construction	Yes
City of Tehran/ Swedge system/ 91-11-18	Sharif Construction	Yes
City of Tehran/ Swedge system/ 91-2-6	Sharif Construction	No
Kish free zone/ Tunneling/ 91-3-19	Sharif Construction	Yes
City of Karaj/ Road construction/ 91-10-20	Tehran Construction	No
City of Tehran/ Swedge system/ 91-11-18	Tehran Construction	Yes
City of Karaj/ Tunneling/ 91-11-19	Tehran Construction	No
City of Karaj/ Tunneling/ 91-11-19	AmirKabir Construction	No
City of Tehran/ Swedge system/ 91-2-6	AmirKabir Construction	No
Kish free zone/ Tunneling/ 91-3-19	AmirKabir Construction	No

## New Project

Client	Type	Date introduced	Due Date	Size (MT)	Decision on bid	Decision reason
City of Karaj	Road constr.	91-10-20	In 2 month(s)	245.8	Not to bid	Project Not well defined
City of Tehran	Swedge system	91-11-18	In 2 month(s)	75.7	Not to bid	Project Not well defined
City of Karaj	Tunneling	91-11-19	In 3 month(s)	479.4	Bid	Past experience
City of Tehran	Swedge system	91-2-6	In 2 month(s)	446.4	Not to bid	Project Not well defined
Kish free zone	Tunneling	91-3-19	In 2 month(s)	14.5	Bid	Past experience

Linking attribute: *Competitor name*

## Competitor

Competitor name	Contact info
Sharif Construction	021-6616
Tehran Construction	021-6000
AmirKabir Construction	021-7000

# In class practice 5

53



**Linking attribute:**  
***New Project ID***

## New Project-Competitor

New Projects ID	Competitor name	Bids won
1	Sharif Construction	Yes
2	Sharif Construction	Yes
4	Sharif Construction	No
5	Sharif Construction	Yes
1	Tehran Construction	No
2	Tehran Construction	Yes
3	Tehran Construction	No
3	AmirKabir Construction	No
4	AmirKabir Construction	No
5	AmirKabir Construction	No

**What if  
changing  
linking  
attribute  
for this  
relation?**



## New Project

New Project ID	Client	Type	Date introduced	Due Date	Size (MT)	Decision on bid	Decision reason
1	City of Karaj	Road constr.	91-10-20	In 2 month(s)	245.8	Not to bid	Project Not well defined
2	City of Tehran	Swedge system	91-11-18	In 2 month(s)	75.7	Not to bid	Project Not well defined
3	City of Karaj	Tunneling	91-11-19	In 3 month(s)	479.4	Bid	Past experience
4	City of Tehran	Swedge system	91-2-6	In 2 month(s)	446.4	Not to bid	Project Not well defined
5	Kish free zone	Tunneling	91-3-19	In 2 month(s)	14.5	Bid	Past experience

**Linking attribute:**  
***Competitor name***

## Competitor

Competitor name	Contact info
Sharif Construction	021-6616
Tehran Construction	021-6000
AmirKabir Construction	021-7000

# In class practice 5

54



**New Project-Competitor**

New Projects ID	Competitor ID	Bids won
1	1	Yes
2	1	Yes
4	1	No
5	1	Yes
1	2	No
2	2	Yes
3	2	No
3	3	No
4	3	No
5	3	No

**Linking attribute:**  
**New Project ID**

**New Project**

New Project ID	Client	Type	Date introduced	Due Date	Size (MT)	Decision on bid	Decision reason
1	City of Karaj	Road constr.	91-10-20	In 2 month(s)	245.8	Not to bid	Project Not well defined
2	City of Tehran	Swedge system	91-11-18	In 2 month(s)	75.7	Not to bid	Project Not well defined
3	City of Karaj	Tunneling	91-11-19	In 3 month(s)	479.4	Bid	Past experience
4	City of Tehran	Swedge system	91-2-6	In 2 month(s)	446.4	Not to bid	Project Not well defined
5	Kish free zone	Tunneling	91-3-19	In 2 month(s)	14.5	Bid	Past experience

**Linking attribute:**  
**Competitor ID**

**Competitor**

Competitor ID	Competitor name	Contact info
1	Sharif Construction	021-6616
2	Tehran Construction	021-6000
3	AmirKabir Construction	021-7000

# Normalized ERD

55


- So far we have come up with an ERD of our system. The only rule we applied on our ERD is removing Many-to-Many relationships.
- By Normalizing our ERD in three stage or form we are going to make sure that we have correct set of entities with entity attributes and relationships!
- After completing Normalization of our ERD, our conceptual data model design is complete. After this stage, i.e., during the detail design stage, we are going to exchangeable use term Data Table instead of Entity; term Data Field instead of Entity Attribute; Data Row instead of Data Records!

# Normalized ERD

56

- *First Normal Form (1NF)*: The first normal form ERD should follow rules in mentioned in below:

1- Every data-table should contain one or set of key attribute(s) which is representative of the every record and makes the row unique among all data rows in the table (so called **primary key**). Use this primary key attribute(s) as the Linking Attribute in entity relationships.

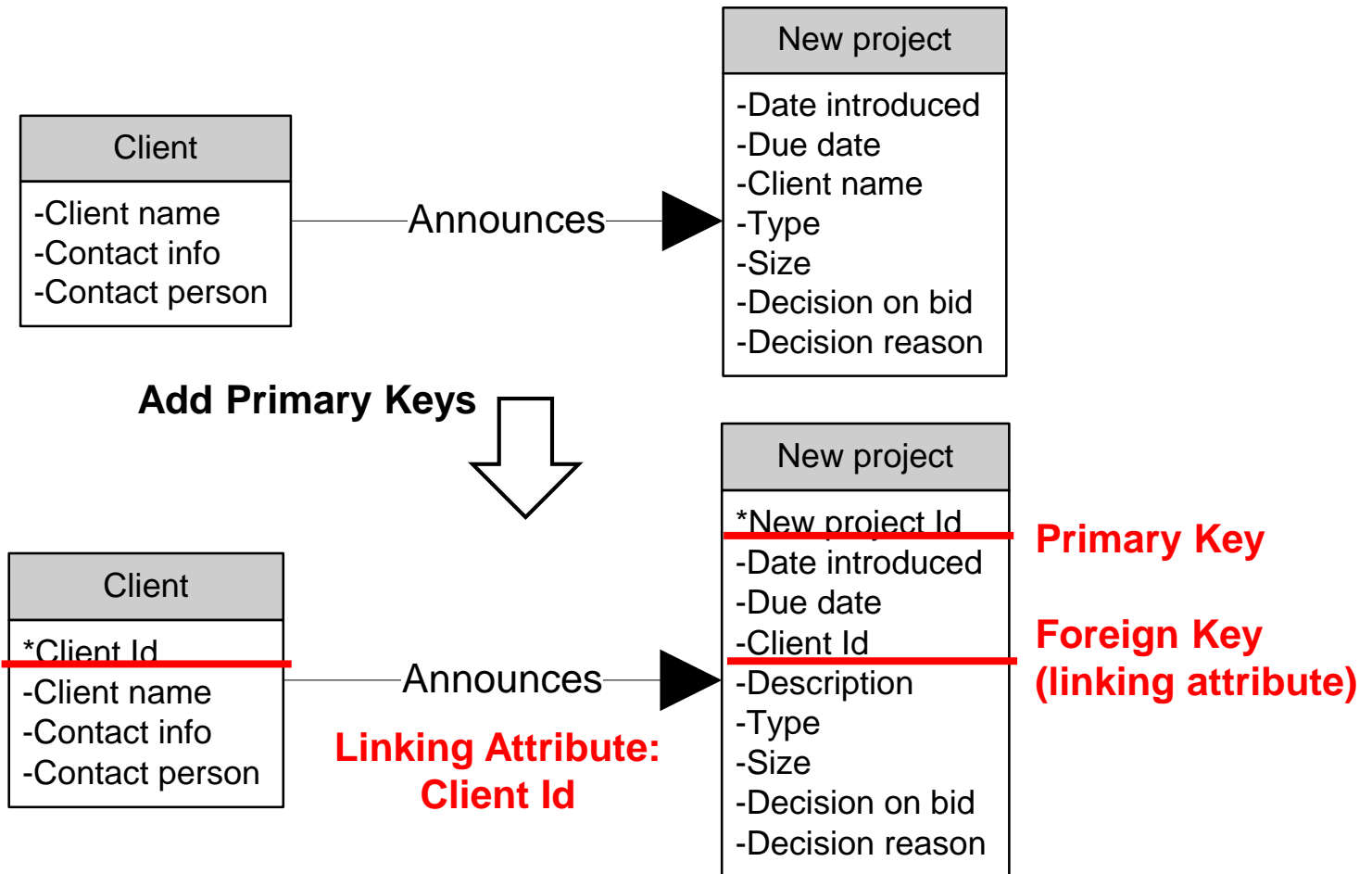
 In computer databases it is preferred that key attribute(s) get integer values. If an entity cannot be represented with one or a combination of integer valued attributes we are going to create a new attribute usually called Id. This new attribute is going to assigned unique number (e.g., serial number increased by one with every new record) and represent entity as linking attribute (or also called as **foreign key**) when ever required!



# Normalized ERD

57

## □ Example:



# Normalized ERD

58

## □ Example:

Linking attribute:  
*New Project ID*

**New Project**

**Primary Key**

<u>New Project ID</u>	Client	Type	Date introduced	Due Date	Size (MT)	Decision on bid	Decision reason
1	City of Karaj	Road constr.	91-10-20	In 2 month(s)	245.8	Not to bid	Project Not well defined
2	City of Tehran	Swedge system	91-11-18	In 2 month(s)	75.7	Not to bid	Project Not well defined
3	City of Karaj	Tunneling	91-11-19	In 3 month(s)	479.4	Bid	Past experience
4	City of Tehran	Swedge system	91-2-6	In 2 month(s)	446.4	Not to bid	Project Not well defined
5	Kish free zone	Tunneling	91-3-19	In 2 month(s)	14.5	Bid	Past experience

**Partial Key & Foreign Key**

**Partial Key & Foreign Key**

<u>New Projects ID</u>	<u>Competitor ID</u>	Bids won
1	1	Yes
2	1	Yes
4	1	No
5	1	Yes
1	2	No
2	2	Yes
3	2	No
3	3	No
4	3	No
5	3	No

**New Project-Competitor**

Linking attribute:  
*Competitor ID*

**Competitor**

**Primary Key**

<u>Competitor ID</u>	Competitor name	Contact info
1	Sharif Construction	021-6616
2	Tehran Construction	021-6000
3	AmirKabir Construction	021-7000

# Normalized ERD

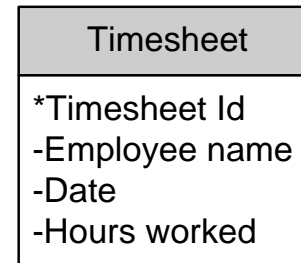
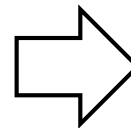
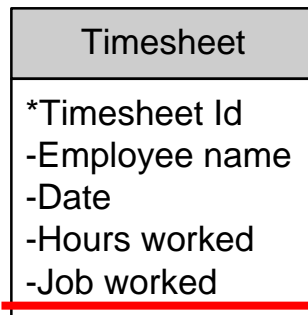
59

## □ First Normal Form (1NF):

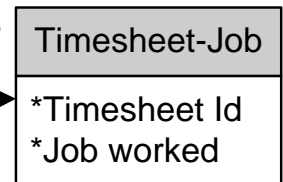
2- There should be no nesting or repeating groups of attributes within entities. Take our repeating attributes from the entity and form a new entity with one to many relationship with the main entity.

### Example 1 (cont'd):

**Attribute with repeating data**



Contains



Timesheet Id	Employee name	Day	Hours worked	Job worked
...				
1125	Ali Aliani	92-12-01	8 (8am-16pm)	92-105 (5); 92-70(3)
1170	Ali Aliani	92-12-03	7 (8am-15pm)	92-70
1215	Ali Aliani	92-12-04	8 (8am-16pm)	92-106 (7); 92-107(1)
1260	Ali Aliani	92-12-05	9 (8am-17pm)	92-107
...				

**Attribute with repeating data**

# Normalized ERD

60

**Example 1 (cont'd):** Repeating data:

Timesheet Id	Employee name	Day	Hours worked
...			
1125	Ali Aliani	92-12-01	8 (8am-16pm)
1170	Ali Aliani	92-12-03	7 (8am-15pm)
1215	Ali Aliani	92-12-04	8 (8am-16pm)
1260	Ali Aliani	92-12-05	9 (8am-17pm)
...			

**What is the  
foreign key  
or linking  
attribute?**

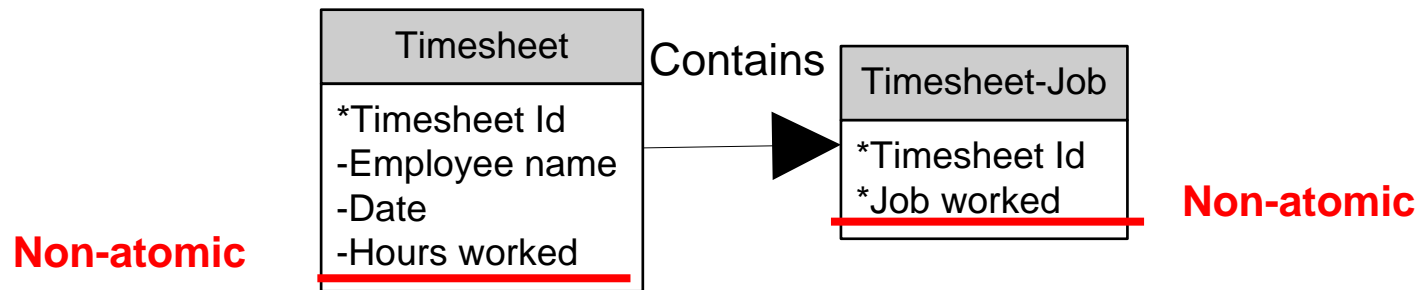
Timesheet Id	Job worked
...	
1125	92-105 (5)
1125	92-70(3)
1170	92-70
1215	92-107(1)
1215	92-107(1)
1260	92-107
...	

- 3- The domain of Entity attributes should only contain atomic values (booleans, integers, characters and floats, date and time). In none atomic values different parts of data represent a relevant meaning to the system. Break down none atomic attributes to several atomic attributes.

# Normalized ERD

61

**Example 2:** Non- atomic attribute:



Timesheet Id	Employee name	Day	Hours worked
...			
1125	Ali Aliani	92-12-01	8 (8am-16pm)
1170	Ali Aliani	92-12-03	7 (8am-15pm)
1215	Ali Aliani	92-12-04	8 (8am-16pm)
1260	Ali Aliani	92-12-05	9 (8am-17pm)
...			

**Non atomic  
values**

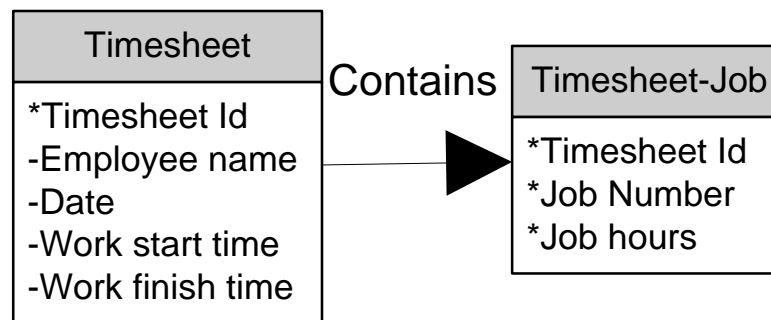
Timesheet Id	Job worked
...	
1125	92-105 (5)
1125	92-70(3)
1170	92-70
1215	92-106(7)
1215	92-107(1)
1260	92-107
...	

**Non atomic  
values**

# Normalized ERD

62

**Example 2:** Non- atomic attribute (cont'd):



Timesheet Id	Employee name	Day	Work start time	Work finish time
...				
1125	Ali Aliani	92-12-01	8	16
1170	Ali Aliani	92-12-03	7	15
1215	Ali Aliani	92-12-04	8	16
1260	Ali Aliani	92-12-05	9	17
...				

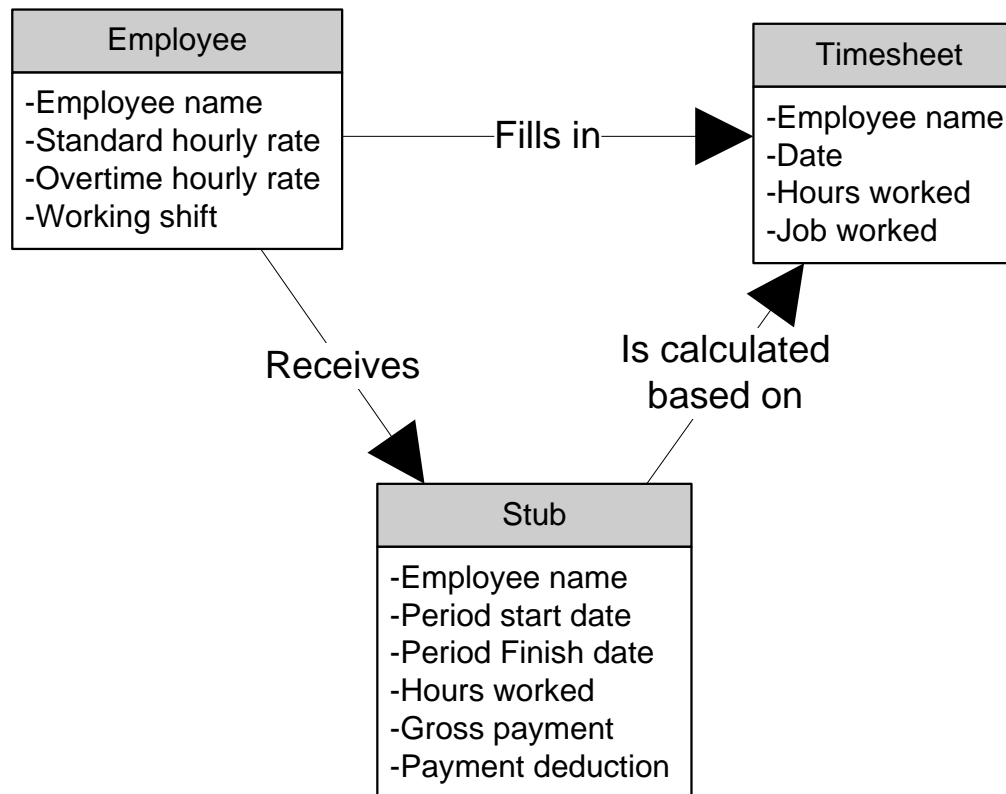
Timesheet Id	Job Number	Job hours
...		
1125	92-105	5
1125	92-70	3
1170	92-70	8
1215	92-106	7
1215	92-107	1
1260	92-107	8
...		

# In class practice 6

63

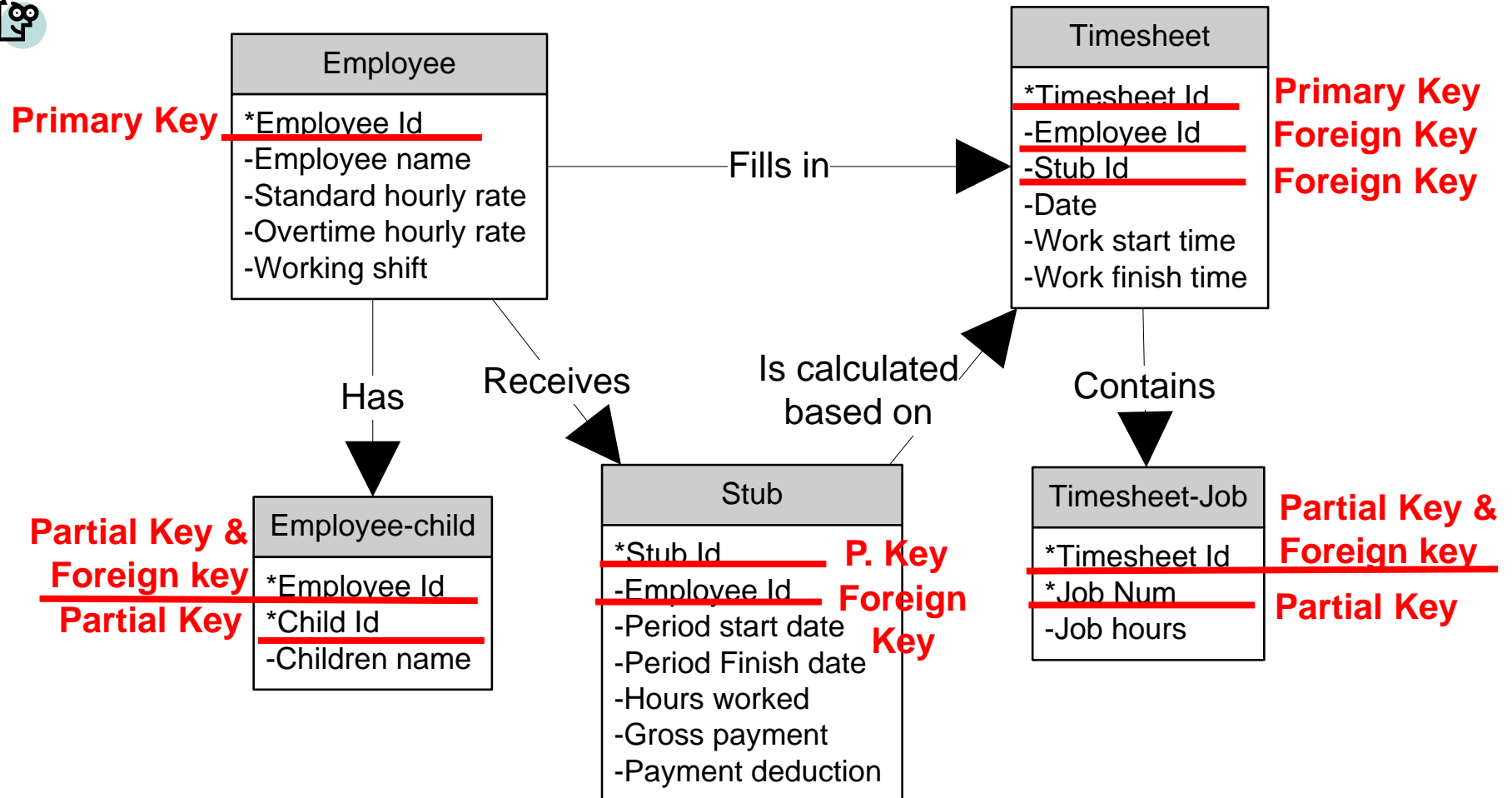


- Apply first normal form of ERD (1NF) on ERD created for our on-site payroll system example. Determine entity key and entity foreign key attributes.



# In class practice 6

64



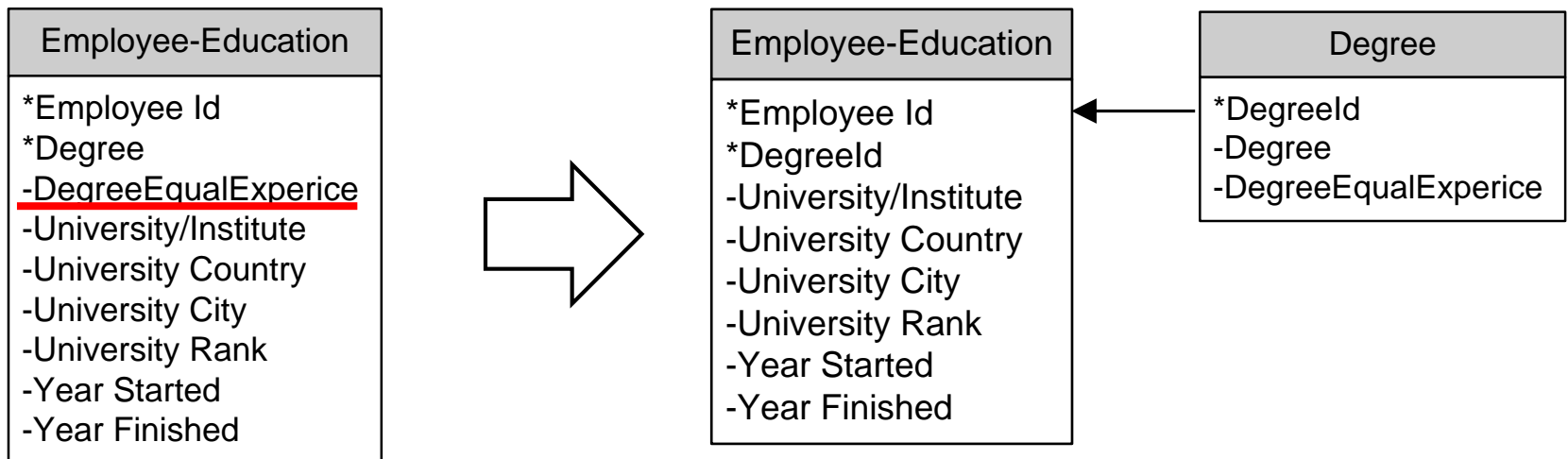


# Normalized ERD

65

## □ Second Normal Form (2NF)

The second normal form rule is that the key attributes should determine all non-key attributes. A violation of second normal form occurs when there is a composite key (*more than one attribute forms the key*), and a part of the key determines some non-key attributes. The second normal form deals with the situation when the entity identifier contains two or more attributes, and the non-key attribute depends on a part of the entity identifier.

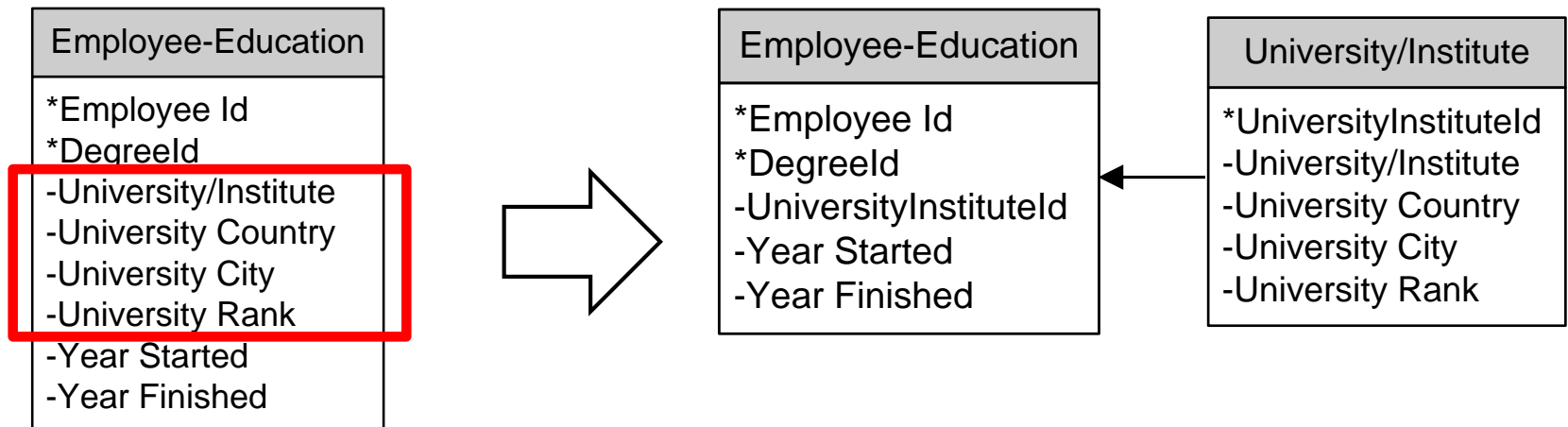


# Normalized ERD

66

## □ *Third Normal Form (3NF)*

The third normal form rule is that the non-key attributes should be independent. This normal form is violated when there exists a dependency among non-key attributes when by knowing a value in one attribute values in some other attributes will be known.



# In class practice 7

67



Following Entities are recognized for our bid management system.

Develop ERD of the system and apply 3 forms of normality on them!

New project
-Date introduced -Due date -Client name -Type -Size -Decision on bid -Decision reason

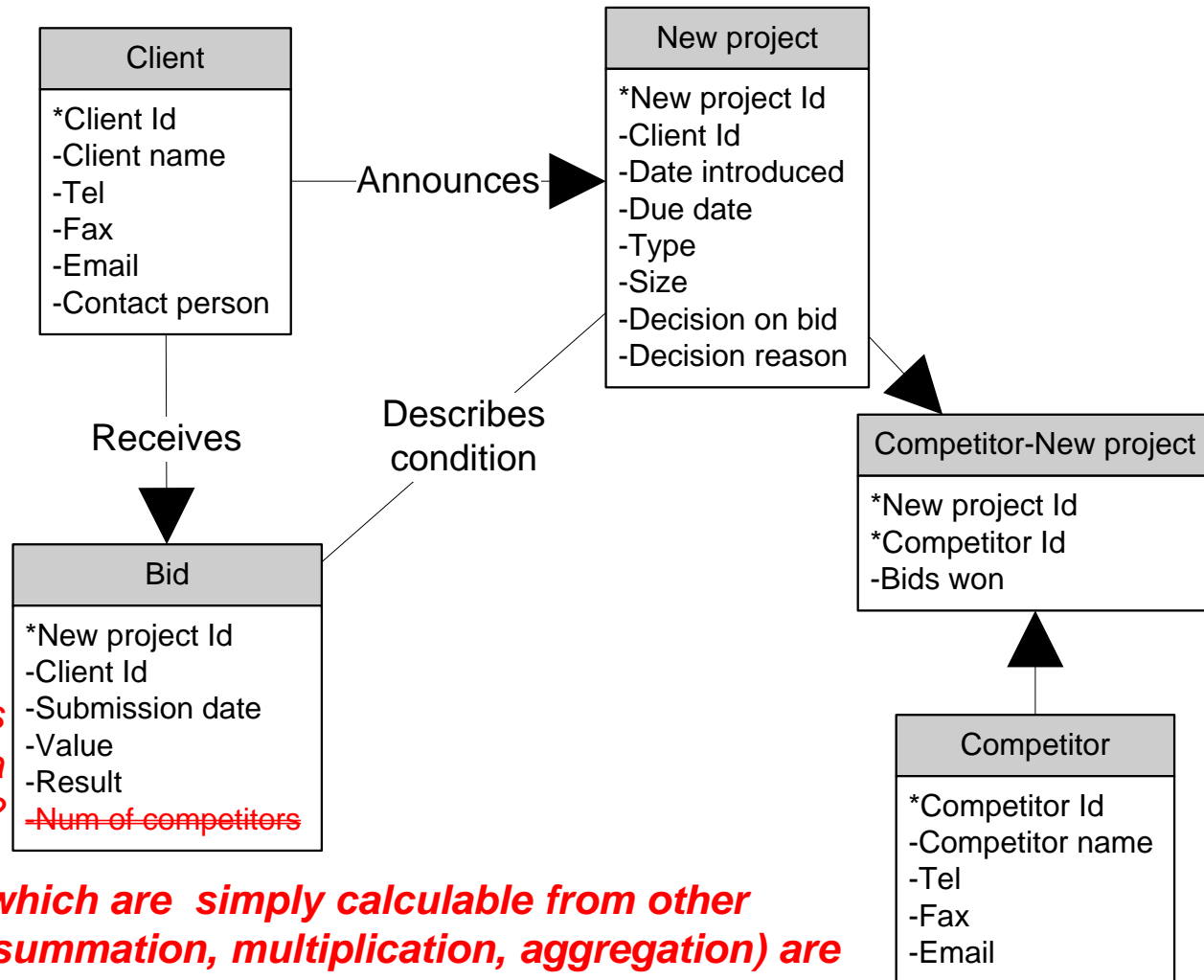
Bid
-Submission date -Value -Result -Num of competitors

Client
-Client name -Contact info -Contact person

Competitor
-Competitor name -New projects competes -Contact info -Bids won

# In class practice 7

68



*Why it is  
extra  
attribute?*

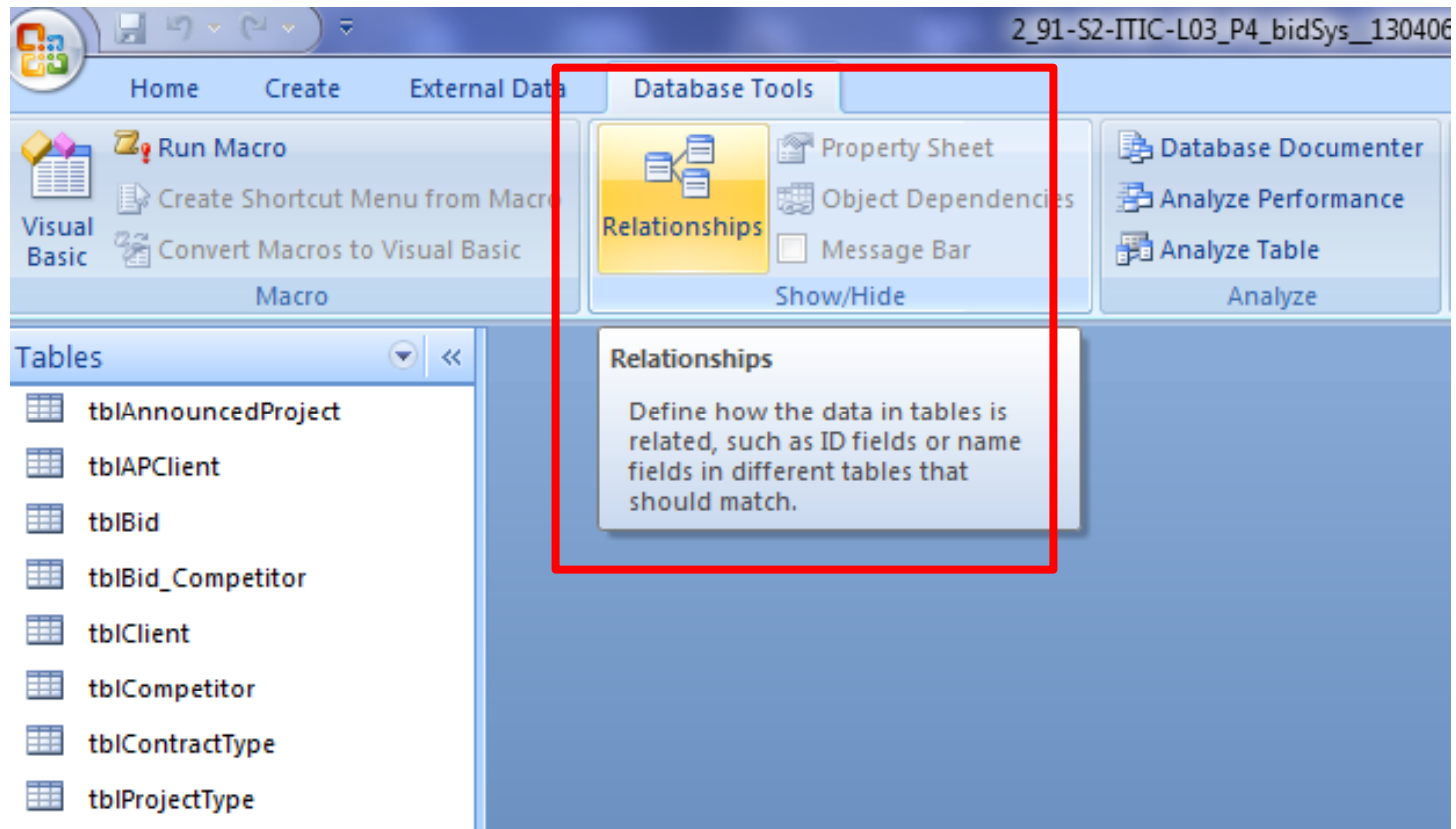
~~-Num of competitors~~



**Attributes which are simply calculable from other attributes (summation, multiplication, aggregation) are removed!**

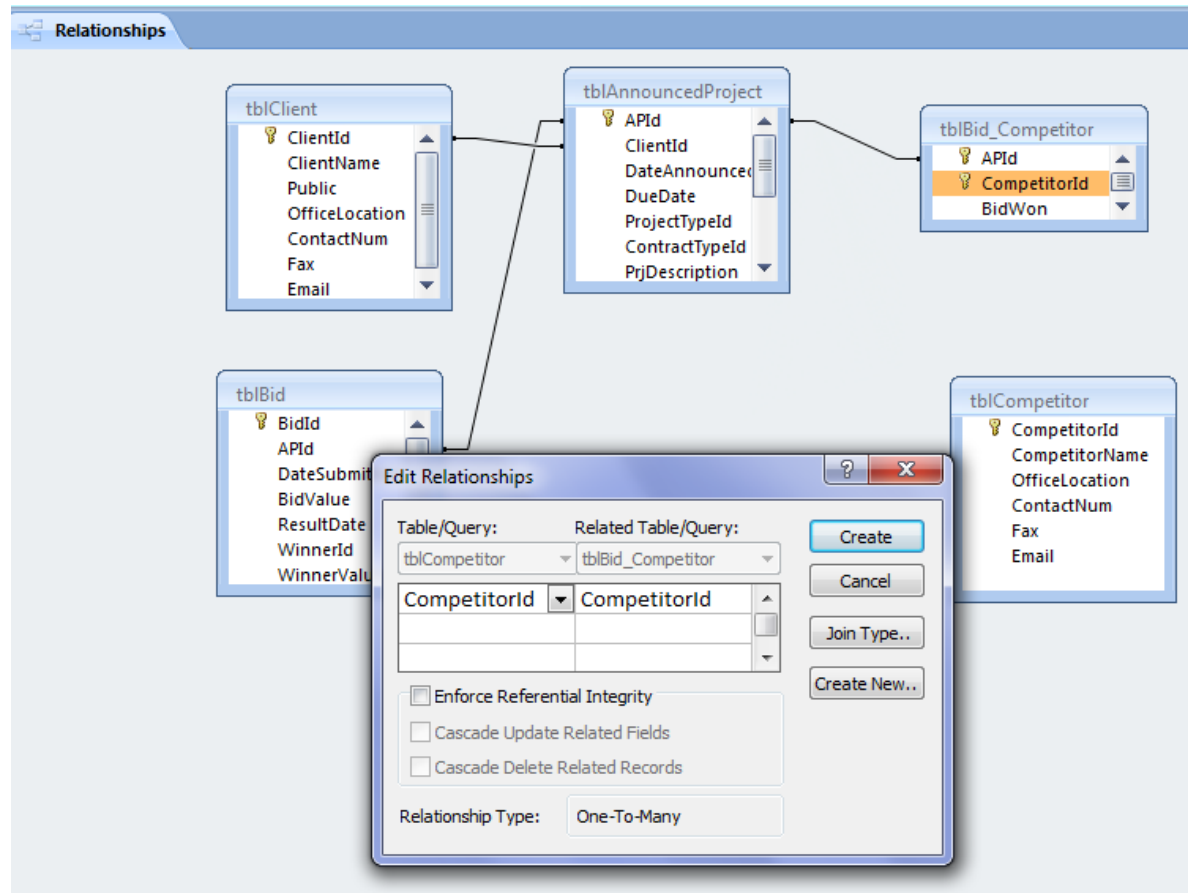
# Relationship in M.S. Access

69



# Relationship in M.S. Access

70



 Hands on software (MS Access):

# Data flow media

# Analysis of communications media

72

- In real world there are physical tools for flowing information within the system such as:  
Paper and electronic forms, *e.g. material order form, maintenance request and vacation request form.*

Paper and electronic letters/ mails, *e.g.*, letter sent client for payment request, letter sent to designer for clarification on design.

Reports, *e.g.*, accident report, inspection report, decision report, performance report.

Fax, *e.g.*, fax sent to supplier requesting a quote, fax sent to the client requesting information.

Phone call, *e.g.*, announcing winner of a bid, announcing receipt of material.

...



# Analysis of communications media

73

- At the conceptual design level we need to determine types of tools required for manipulating data within our system; then at the detail design step we determine detailed specification of the tools; and finally at the implementation phase we create tools required.
- Among different communication tools system **forms** are the most structured communication tools; their data items need to be accurately specified; system database is mainly fed by data collected through system forms; and usually play a major role in data communication.



How can we figure out what kinds of physical communication media we do need in our system for data flow?

# Analysis of communications media

74

- Dfd is our main tool for modeling data flow (including data creation, update, transfer, archive and removal).
- We need to determine proper medium (tool) for data manipulation of every data flow determined in our system dfds!
- Before we determine data communication tools, we need to get a good understanding on physical specifications of the locations in which data flow occurs!
- **Example:** What are the main tools we need to manipulate data in different parts of our bidding management system?
  - We need to list all data flows and determine how they are (or are going to be) handled in our system. We can then develop the list of tools (including forms) that we need to support.

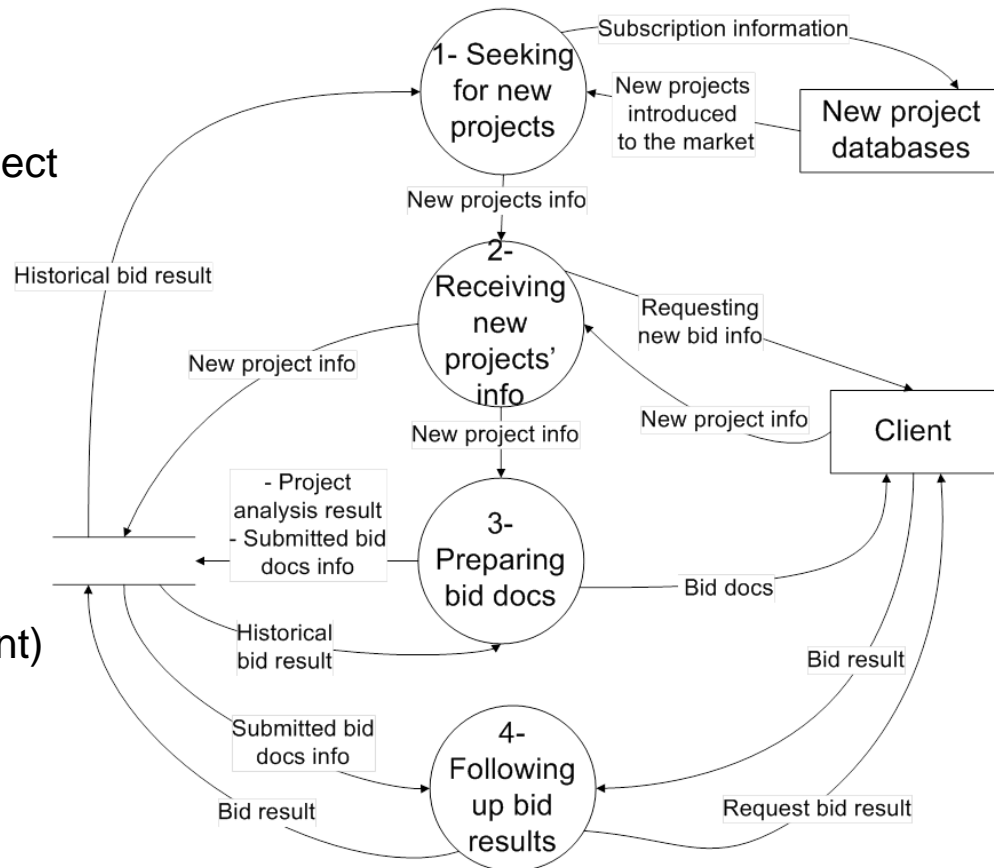
# Analysis of communications media

75

## □ **Example (cont'd):** List of data flows

required according to our dfd are:

- Sending subscription information
- Receiving new projects info (from project data base)
- Using historical bid results
- Sending new projects' info
- Storing new projects' info
- Storing project analysis result
- Storing submitted bid docs info
- Requesting new bid info
- Receiving new projects info (from client)
- Submitting bid documents
- Requesting bid results
- Storing bid results



# Analysis of communications media

76

## □ Example (cont'd): Data flow media analysis

Data flow	Media
Sending subscription information	Email; Using provider's online form; Using provider's tel-lines; filling in client's form and sending by mail
Receiving new projects info (from data providers)	By Email; Letter; Directly reading from online account
Using historical bid results	A database-form ( <b>historical result form</b> )
Sending new projects' info	A database-form ( <b>announce project form</b> )
Storing new projects' info	A database-form ( <b>announce project form</b> )
Storing project analysis result	Copy of documents on the contracting manager's computer/ shelf; Info record on a database-form ( <b>announced project form</b> )
Storing submitted bid docs info	Original documents of documents on the contracting manager's computer/ shelf; Info record on a database form ( <b>bid form</b> )
Requesting new bid info (from client)	Verbally; phone; through email
Receiving new projects info (from client)	Verbally; phone; through email; letter
Submitting bid documents	Envelope; client's online website
Requesting bid results	Verbally; phone; through email
Receiving bid results	Verbally; phone; through email; letter
Storing bid results	Info record on a database form ( <b>bid form</b> )

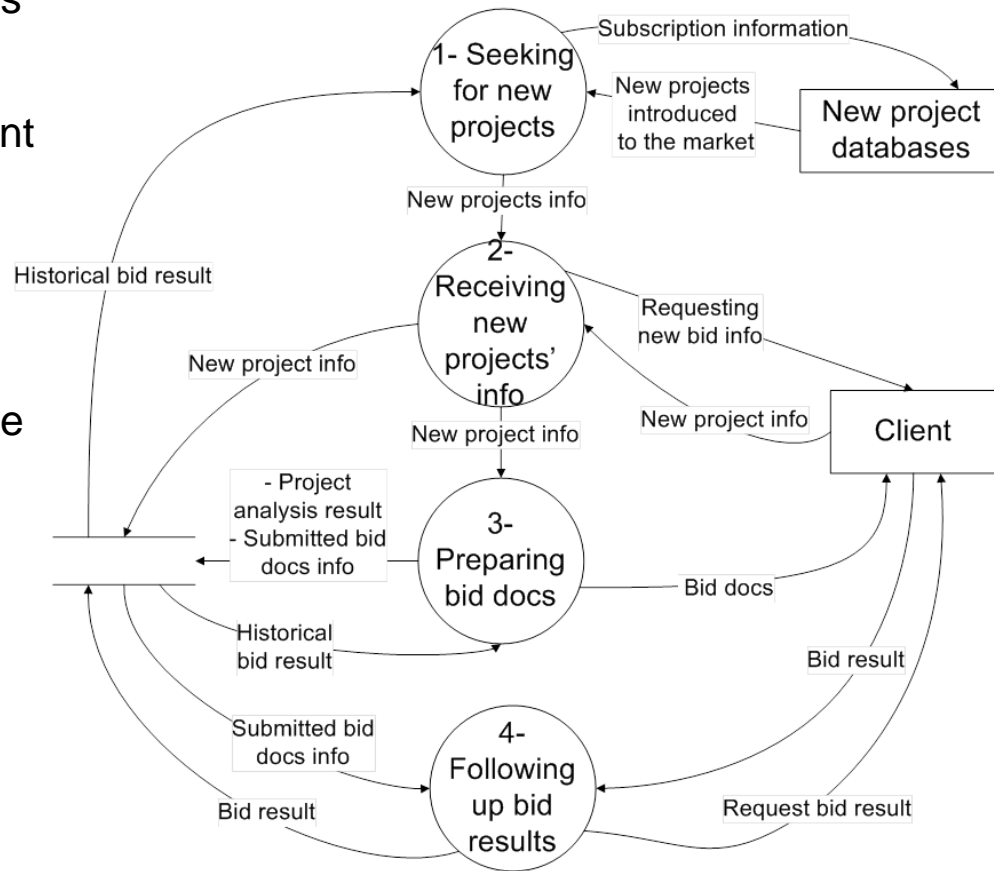
# Analysis of communications media

77

## □ Example (cont'd):

According to the data flow media analysis we need to have three main Forms

- **Historical bid result form:** To present past bid results grouped by client name, type of project and type of contract
- **Announce project form:** To enter new announced projects, to announce the new bid to the contract manager and the president
- **Bid form:** To enter basic bid information prepared, to be updated based on bid result

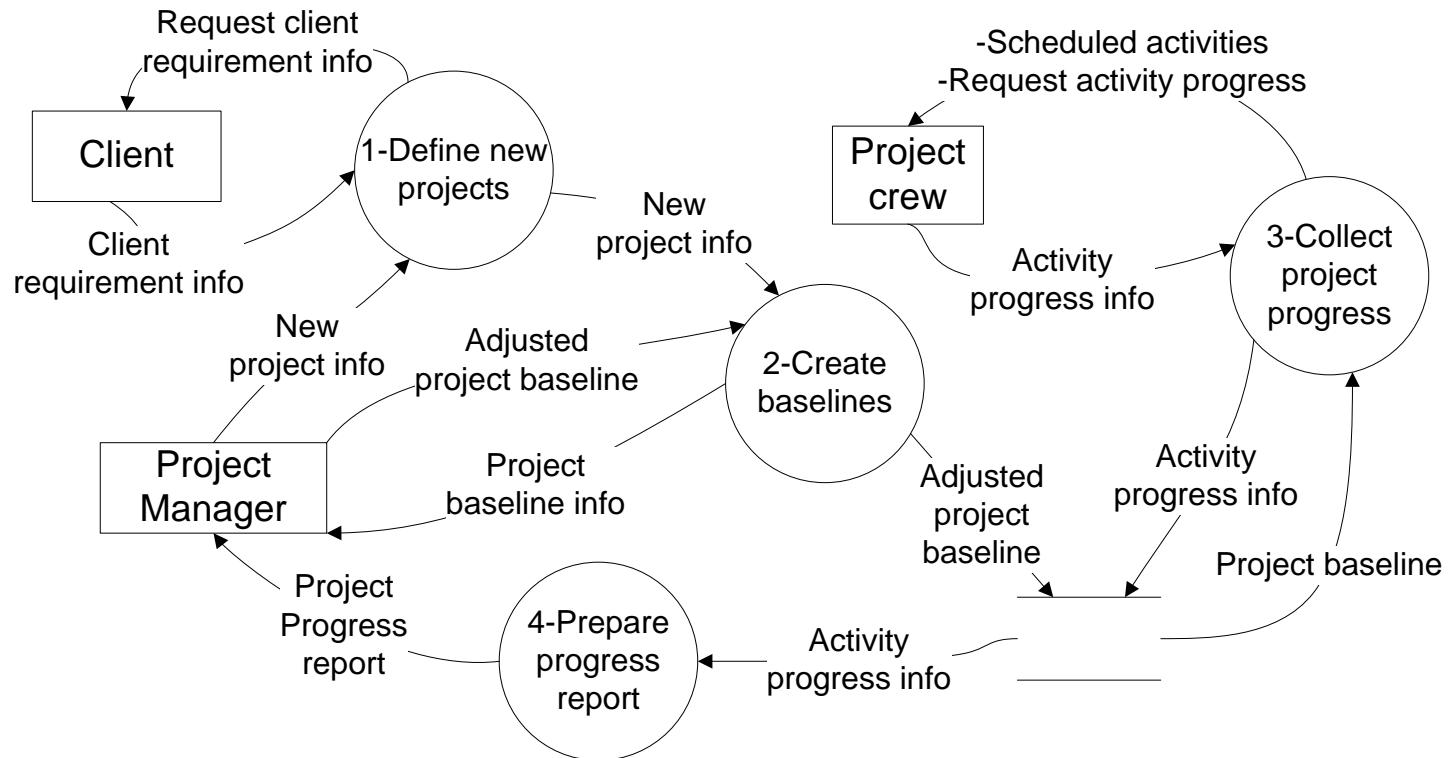


# In class exercise 8

78



Do *data flow media analysis* for the project planning and control system with the dfd as presented in below. What are the main forms required for the system? What kind of information and features are required to be included on each form?



# In class exercise 8

79



Data flow	Media
Request client requirement info	Verbally; phone; through email; letter
Client requirement info sent	Through email; envelope
New project info	Info record on a database form ( <b>project definition form</b> )
Project baseline info	Info record on a database form ( <b>project baseline form</b> )
Adjusted project baseline	Info record on a database form ( <b>project baseline form</b> )
Project Progress report	Info record on a database form ( <b>project progress form</b> )
Activity progress info	Info record on a database form ( <b>project progress form</b> )
Scheduled activities	Paper report printed from a database form ( <b>project schedule print form</b> )
Request activity progress	Paper report printed from a database form ( <b>project progress print form</b> )

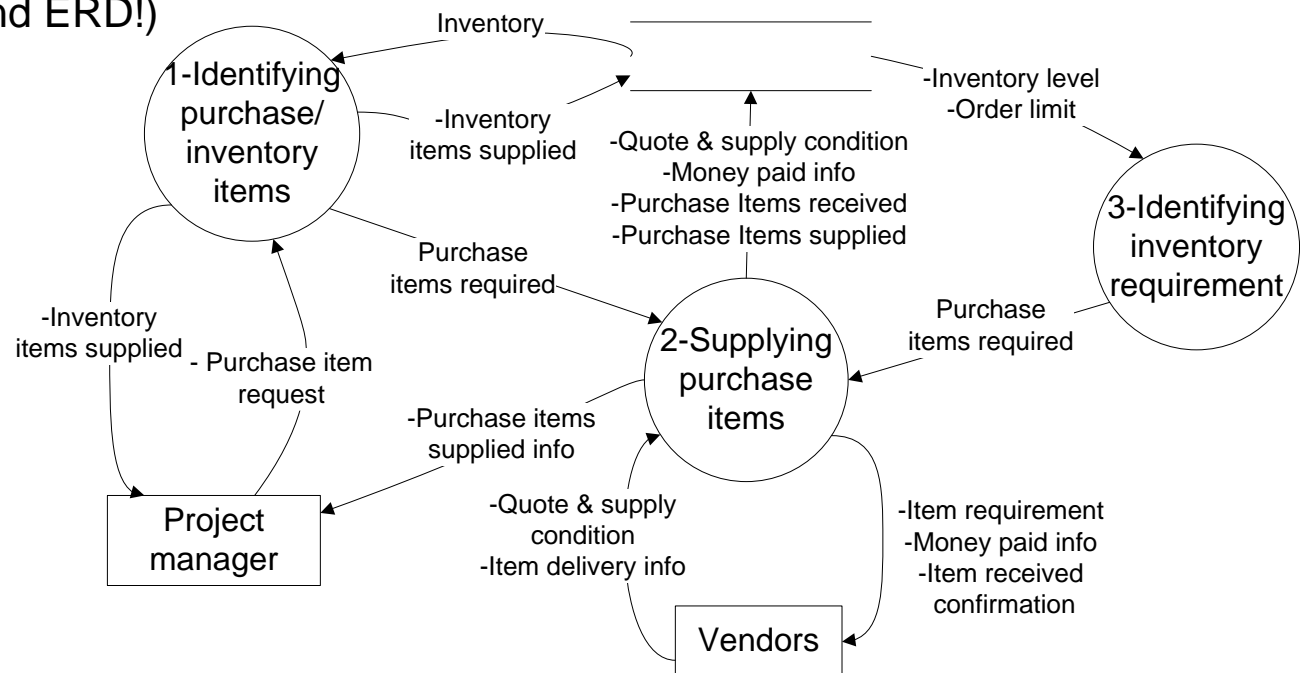
# Home assignment 2

80



Dfd in below presents data flow in a procurement system of a construction company. Check dfd rules to avoid any violation (20 marks). Break down the dfd model at the next level for “1- Identifying purchase/ inventory item” process to the next level (20 marks). Get help from the dfd to develop 3NF ERD diagram (20 marks) and develop related tables and their relations in MS Access (20 marks). Do data flow media analysis for the data flow (20 marks). (Use Visio for drawing dfd and ERD!)

(in two weeks)







**Thank you!**