

COMM1822

Term 2 2022

Introduction to Databases for Business Analytics

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Week 2 Entity Relationship (ER) Modelling Part 2

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Lecturer-in-Charge: Kam-Fung (Henry) Cheung

Email: kf.cheung@unsw.edu.au

Tutors: Theresa Tran (Tutor-in-Charge)

Liam Li Chen

Kathy Xu

PASS Leader: Srilekha Chandrashekara Kolaki



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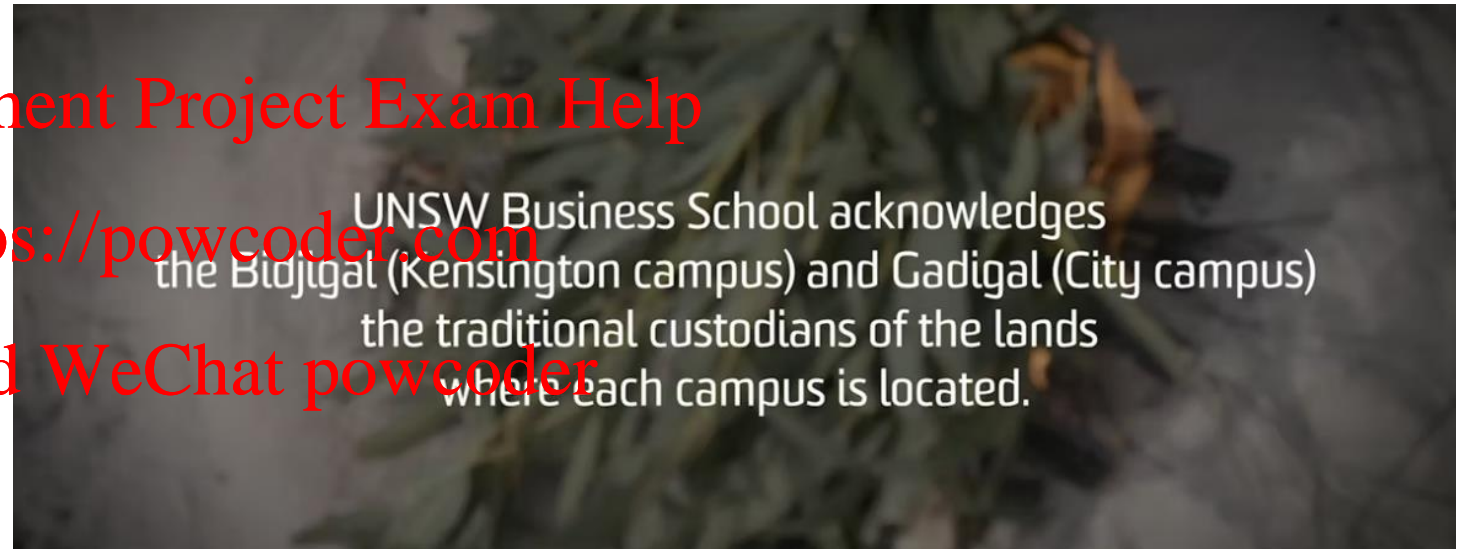
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UNSW Business School. (2022, May 7). *Acknowledgement of Country* [online video]. Retrieved from <https://vimeo.com/369229957/d995d8087f>

Agenda

Entity Relationship Modelling (from week 1)

- Recap
- Weak Entity

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Advanced Entity Relationship Modelling

- Supertype
- Subtype

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Convert from an Entity Relationship Model to a Relational Model

Recap: ER Modelling 1

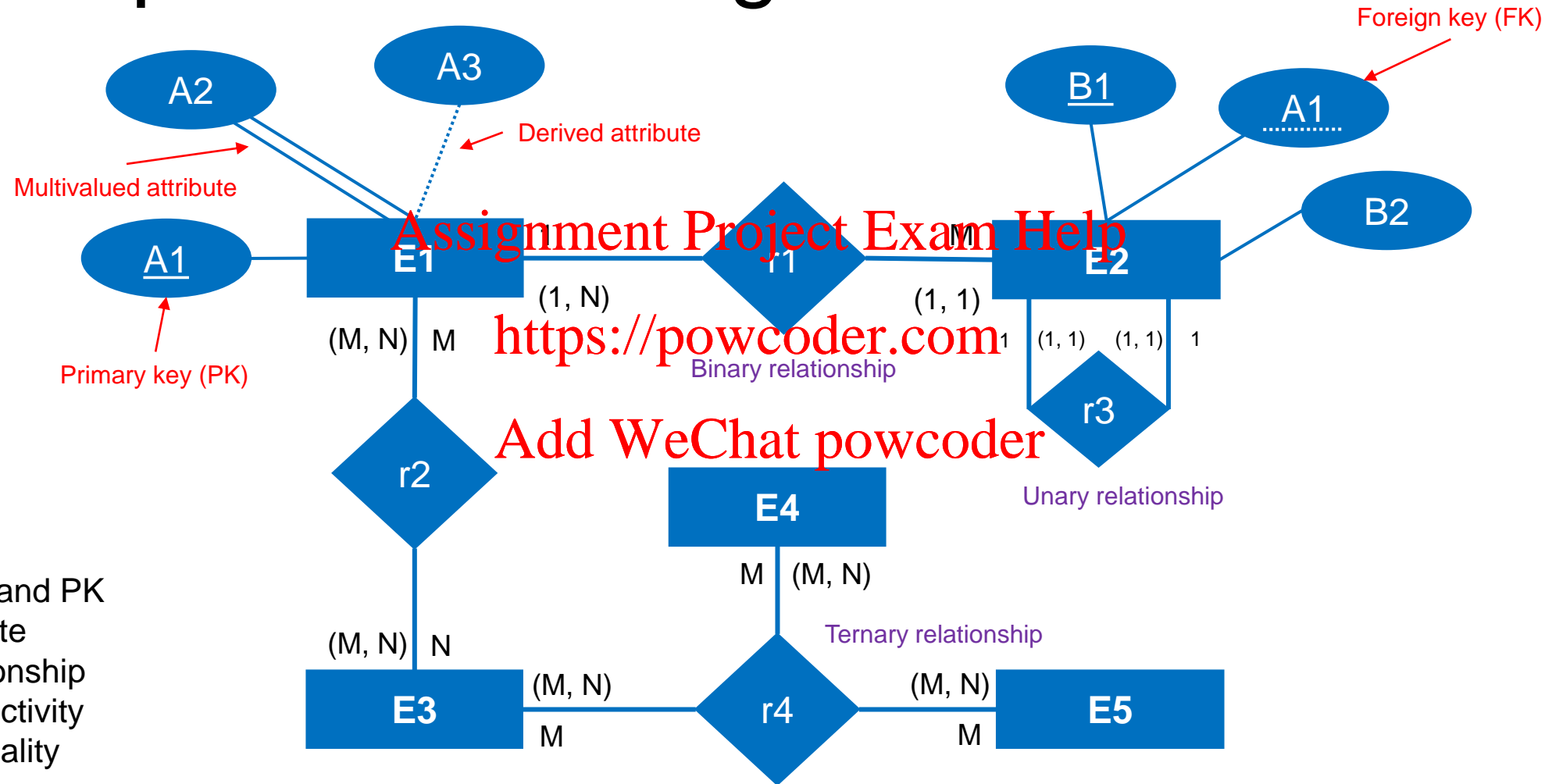
❑ Data Modelling:

- Data model as a (relatively) simple abstraction of the complex real-world.
- One modelling technique to design a database: Entity Relationship Modelling.

❑ Entity Relationship Modelling components:

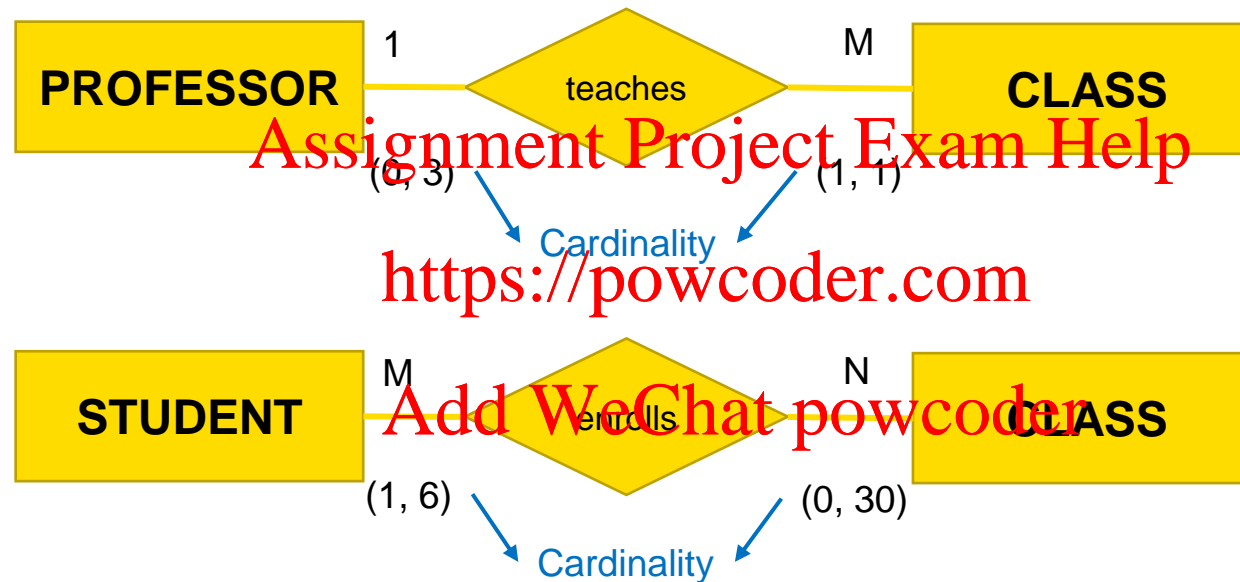
- Entity Types and Entity Instances
- Attributes and Values
- Keys
- Relationships
- Connectivity and Cardinality

Recap: ER Modelling 1



- Entity and PK
- Attribute
- Relationship
- Connectivity
- Cardinality

Connectivity and Cardinality



One-to-Many Relationship

Many-to-Many Relationship

How to read this?

- A professor teaches (0, 3) classes. A class is taught by (1, 1) professors.
- A student enrolls in (1, 6) classes. A class has enrolled in it (0, 30) students.

Existence Dependence and Independence

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Existence Dependence and Independence

Existence dependence: Entity exists in the database only when it is associated with another related Entity occurrence

e.g., parents & children

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Existence independence: Entity exists apart from all of its related entities, and referred to as a **strong entity** or **regular entity**

e.g., customer & product in a supermarket

Weak (Non-identifying) Relationship

Primary key of the related entity **does not** contain a primary key component of the parent entity.

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CRS_CODE is a **primary key** of Course table, and

CRS_CODE is a **foreign key** of Class table.

CRS_CODE is a foreign key, but it is **not part of the primary key** of Class table.

FIGURE 4.8 A WEAK (NON-IDENTIFYING) RELATIONSHIP BETWEEN COURSE AND CLASS

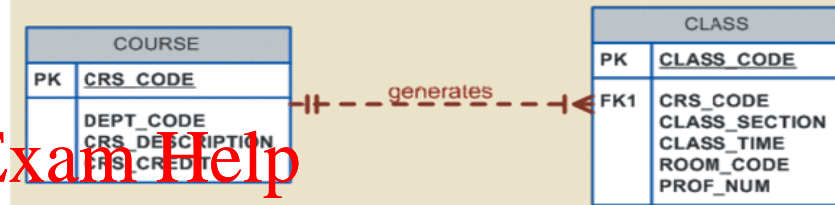


Table name: COURSE

CRS_CODE	DEPT_CODE	CRS_DESCRIPTION	CRS_CREDIT
ACCT-211	ACCT	Accounting I	3
ACCT-212	ACCT	Accounting II	3
CIS-220	CIS	Intro. to Microcomputing	3
CIS-420	CIS	Database Design and Implementation	4
MATH-243	MATH	Mathematics for Managers	3
QM-261	CIS	Intro. to Statistics	3
QM-362	CIS	Statistical Applications	4

Database name: Ch04_TinyCollege

Table name: CLASS

CLASS_CODE	CRS_CODE	CLASS_SECTION	CLASS_TIME	ROOM_CODE	PROF_NUM
10012	ACCT-211	1	M/W/F 8:00-8:50 a.m.	BUS311	105
10013	ACCT-211	2	M/W/F 9:00-9:50 a.m.	BUS200	105
10014	ACCT-211	3	TTh 2:30-3:45 p.m.	BUS252	342
10015	ACCT-212	1	M/W/F 10:00-10:50 a.m.	BUS311	301
10016	ACCT-212	2	Th 6:00-8:40 p.m.	BUS252	301
10017	CIS-220	1	M/W/F 9:00-9:50 a.m.	KLR209	228
10018	CIS-220	2	M/W/F 9:00-9:50 a.m.	KLR211	114
10019	CIS-220	3	M/W/F 10:00-10:50 a.m.	KLR209	228
10020	CIS-420	1	W 6:00-8:40 p.m.	KLR209	162
10021	QM-261	1	M/W/F 8:00-8:50 a.m.	KLR200	114
10022	QM-261	2	TTh 1:00-2:15 p.m.	KLR200	114
10023	QM-362	1	M/W/F 11:00-11:50 a.m.	KLR200	162
10024	QM-362	2	TTh 2:30-3:45 p.m.	KLR200	162
10025	MATH-243	1	Th 6:00-8:40 p.m.	DRE155	325

Strong (Identifying) Relationship

Primary key of the related entity contains a primary key component of the parent entity.

CRS_CODE is a primary key of Course table, and CRS_CODE is a foreign key of Class table.

CRS_CODE is also part of the primary key of Class table. CRS_CODE is part of the composite primary key for Class table.

FIGURE 4.9 A STRONG (IDENTIFYING) RELATIONSHIP BETWEEN COURSE AND CLASS

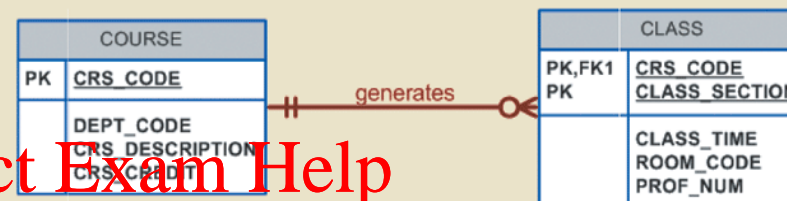


Table name: COURSE

CRS_CODE	DEPT_CODE	CRS_DESCRIPTION	CRS_CREDIT
ACCT-211	ACCT	Accounting I	3
ACCT-212	ACCT	Accounting II	3
CIS-220	CIS	Intro. to Microcomputing	3
CIS-420	CIS	Database Design and Implementation	4
MATH-243	MATH	Mathematics for Managers	3
QM-261	CIS	Intro. to Statistics	3
QM-362	CIS	Statistics Applications	4

Database name: Ch04_TinyCollege_Alt

Table name: CLASS

CRS_CODE	CLASS_SECTION	CLASS_TIME	ROOM_CODE	PROF_NUM
ACCT-211	1	MWF 8:00-8:50 a.m.	BUS311	105
ACCT-211	2	MWF 9:00-9:50 a.m.	BUS200	105
ACCT-211	3	TTh 2:30-3:45 p.m.	BUS252	342
ACCT-212	1	MWF 10:00-10:50 a.m.	BUS311	301
ACCT-212	2	Th 6:00-8:40 p.m.	BUS252	301
CIS-220	1	MWF 9:00-9:50 a.m.	KLR209	228
CIS-220	2	MWF 9:00-9:50 a.m.	KLR211	114
CIS-220	3	MWF 10:00-10:50 a.m.	KLR209	228
CIS-420	1	W 6:00-8:40 p.m.	KLR209	162
MATH-243	1	Th 6:00-8:40 p.m.	DRE155	325
QM-261	1	MWF 8:00-8:50 a.m.	KLR200	114
QM-261	2	TTh 1:00-2:15 p.m.	KLR200	114
QM-362	1	MWF 11:00-11:50 a.m.	KLR200	162
QM-362	2	TTh 2:30-3:45 p.m.	KLR200	162

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Weak Entity

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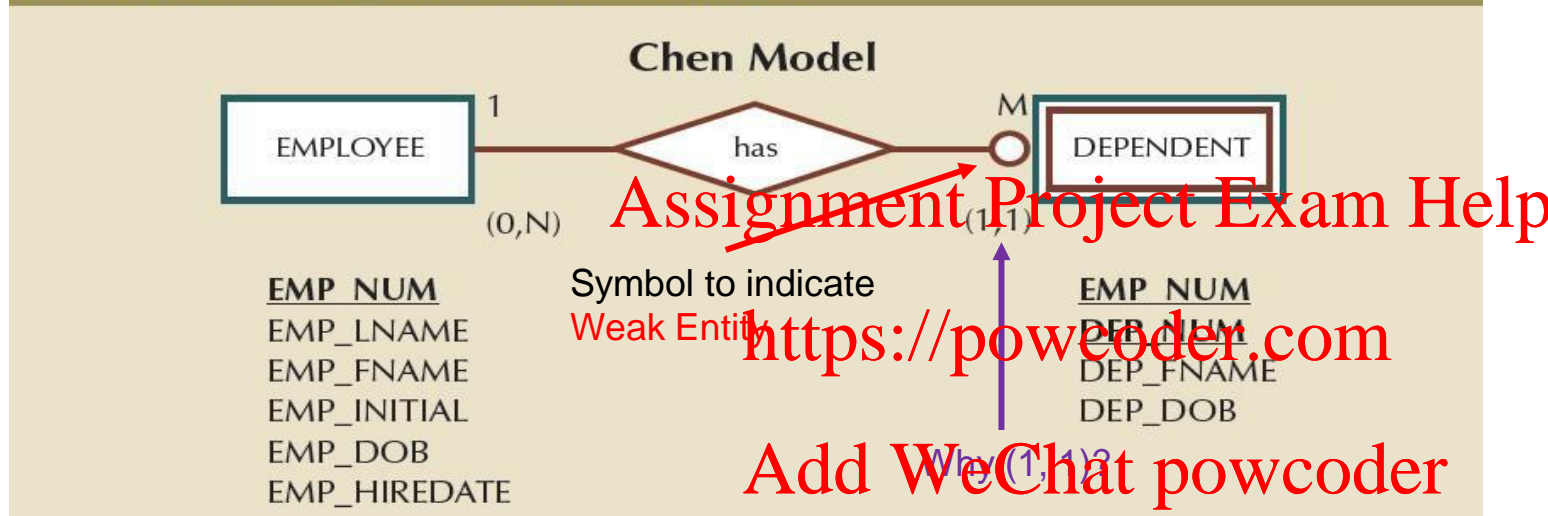
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Weak Entity

- ❑ **Weak entity** is an entity that **relies on the existence of another (strong or independent) entity**. It has a primary key (PK) that is partially or totally derived from the parent entity in the relationship.
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e.g., parents & children
- ❑ Weak entity meets two conditions:
 - **Existence-dependent:** Cannot exist without entity with which it has a relationship.
 - Has primary key that is **partially or totally derived from the parent entity** in the relationship.
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- ❑ Database designer usually determines whether an entity can be described as weak **based on the business rules**.

Example of a Weak Entity in an ERD

FIGURE 4.10 A WEAK ENTITY IN AN ERD



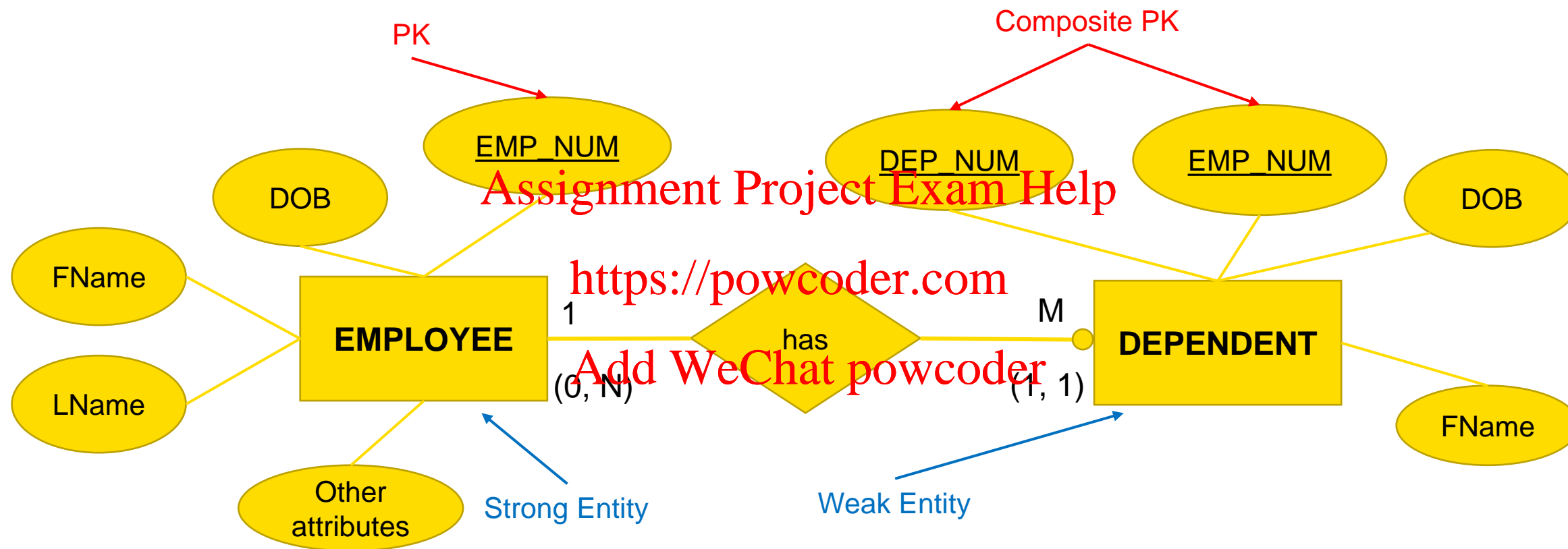
Weak Entity: DEPENDENT

As for fulfilling the conditions:

- Existence-dependent:** Cannot exist without entity with which it has a relationship – in this case it is the DEPENDENT entity. A child must exist with one of his/her parents.
- Has primary key that is **partially or totally derived from the parent entity** in the relationship – in this case, **EMP_NUM in DEPENDENT entity** is associated with EMP_NUM of the EMPLOYEE table.

- A child must have **one parent** working in the company.
- If both parents work in the company, you **only have to connect to one**. E.g., UNSW childcare: it is connected to the parent who will pay childcare fees 😊

Example of a Weak Entity (with Attributes)



Existent-Dependent Relationship between EMPLOYEE & DEPENDENT

Example of a Weak Entity

FIGURE 4.11 A WEAK ENTITY IN A STRONG RELATIONSHIP

Table name: EMPLOYEE

Database name: Ch04_ShortCo

EMP_NUM	EMP_LNAME	EMP_FNAME	EMP_INITIAL	EMP_DOB	EMP_HIREDATE
1001	Callifante	Jeanine	J	12-Mar-64	25-May-97
1002	Smithson	William	K	23-Nov-70	28-May-97
1003	Washington	Herman	H	15-Aug-68	28-May-97
1004	Chen	Lydia	B	23-Mar-74	15-Oct-98
1005	Johnson	Melanie		28-Sep-66	20-Dec-98
1006	Ortega	Jorge	G	12-Jul-69	25-Jan-02
1007	O'Donnell	Peter	D	10-Jun-71	23-Jun-02
1008	Brzenski	Barbara	A	12-Feb-70	01-Nov-03

Table name: DEPENDENT

EMP_NUM	DEP_NUM	DEP_FNAME	DEP_DOB
1001	1	Annelise	05-Dec-97
1001	2	Jorge	30-Sep-02
1003	1	Suzanne	25-Jan-04
1006	1	Carlos	25-May-01
1008	1	Michael	19-Feb-95
1008	2	George	27-Jun-98
1008	3	Katherine	18-Aug-03

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Desirable Primary Key Characteristics

Unique value **Cannot be null**

Non intelligent **Should not have embedded semantic meaning, e.g., use zID as PK rather than name**

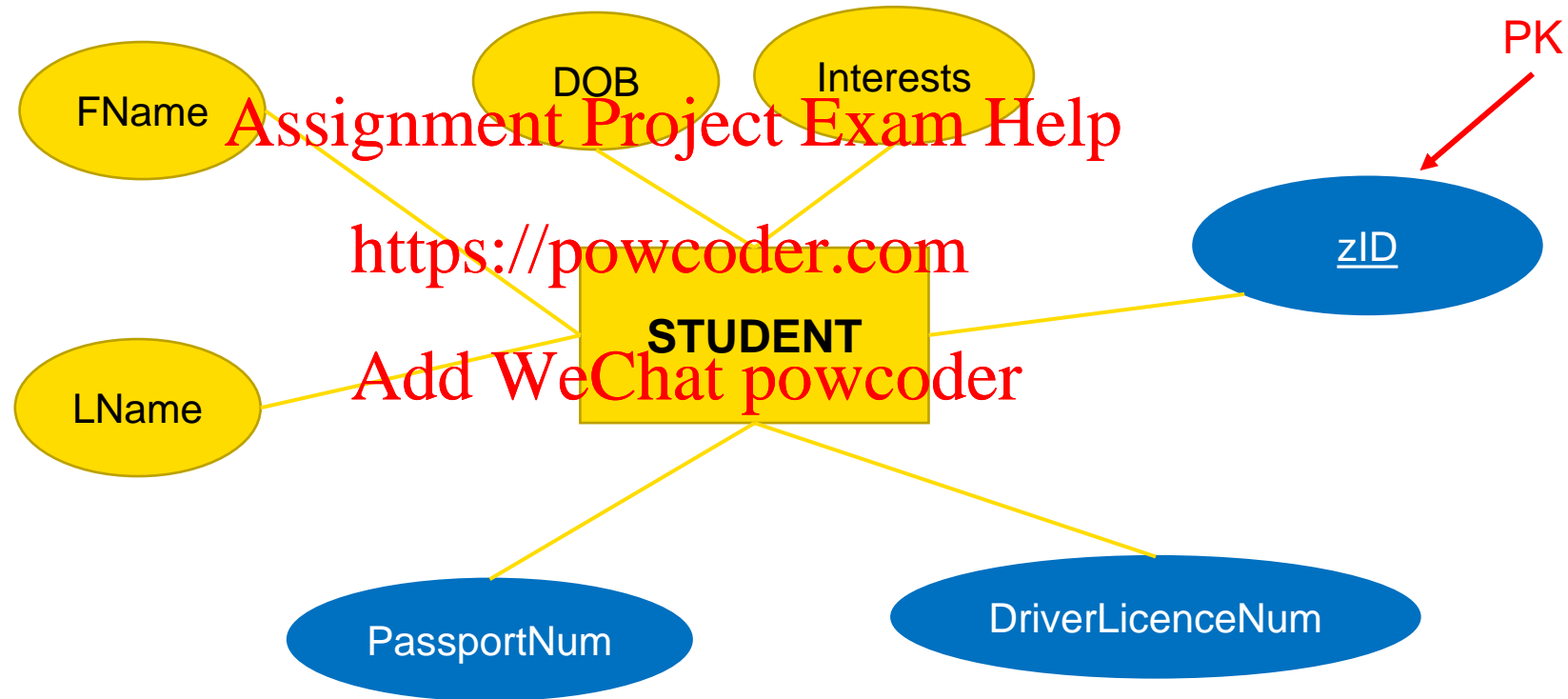
No change over time **Name, marital status may change**

Preferably single-attribute **Remember a PK can be someone's foreign key, multiple attributes make it hard to link tables**

Preferably numeric **To avoid typing errors; Can use auto-increment, e.g., zID**

Security-compliant **Using Social Security Number (SSN) as a SID is a bad idea.**

Candidate Key and Primary Key



Candidate Keys:

- zID
- PassportNum
- DriverLicenceNum

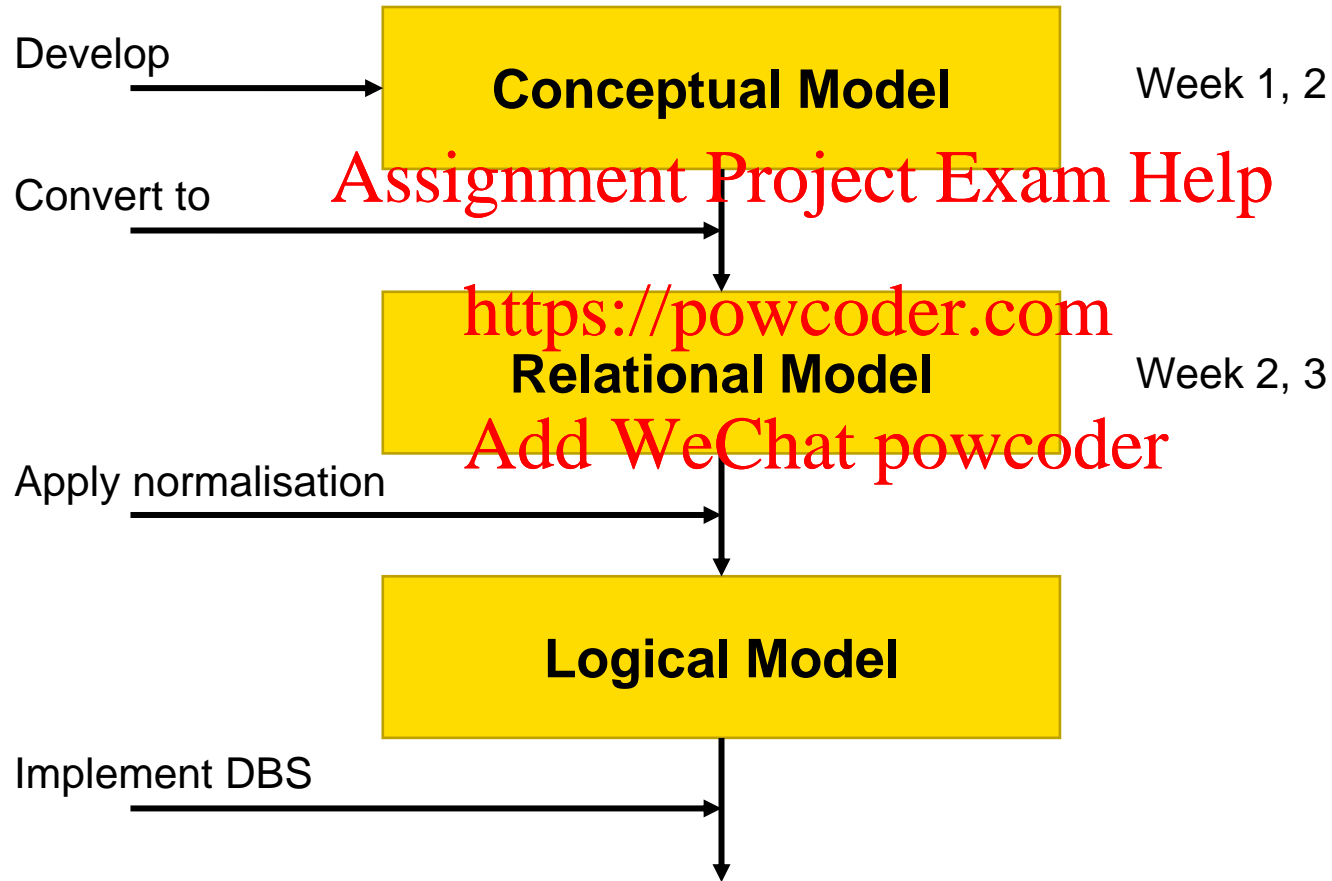
Plan: ER Modelling 2

□ Enhanced Entity Relationship Modelling

- **Composite entity** (bridge entity)
- **Supertype** and **subtype**
- **Generalisation** and **specialisation**
- **Constraints** (completeness, disjointness)

□ Exercise

Database Design Process Modelling



Composite Entity

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Composite Entity

A **composite entity** (bridge entity, associative entity) is an entity type that associates the instances of one or more entity types. It contains attributes that are peculiar (singular) to the relationship between those entity instances.

- ❑ The composite entity builds a **bridge** between the original entities.
- ❑ The composite entity is composed of the **PKs of the original entities**.
- ❑ The composite entity may contain **additional attributes**.

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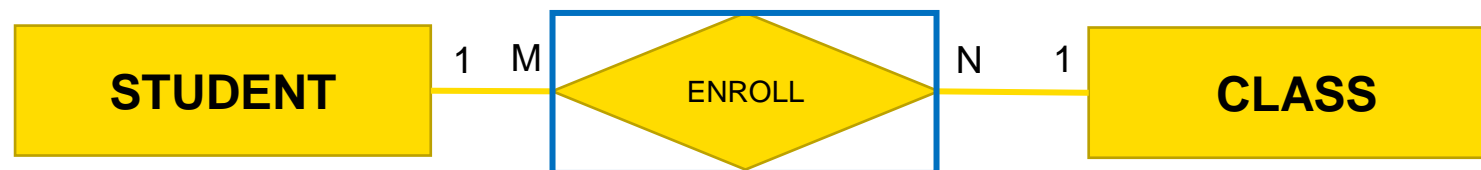
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e.g., enrolment grades

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A regular M:N Relationship



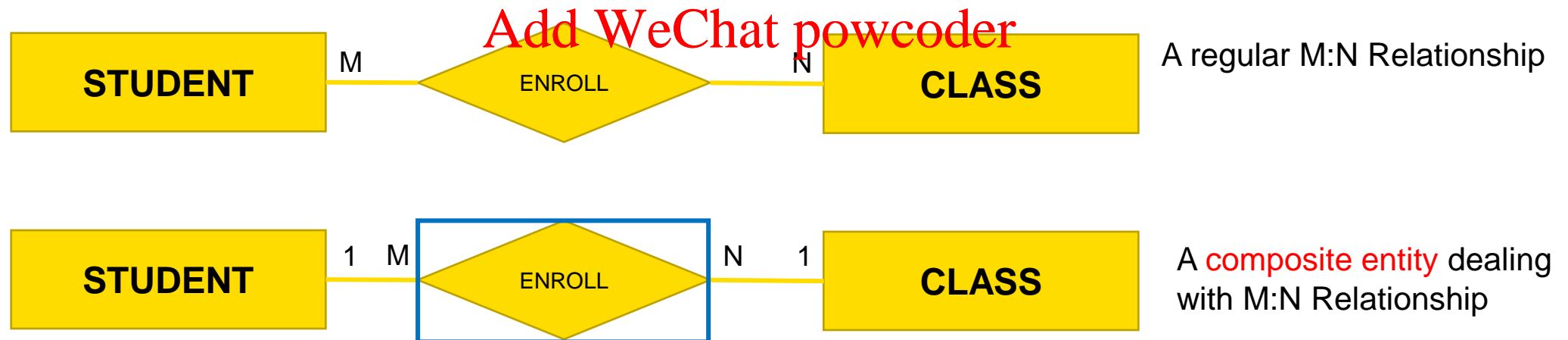
A **composite entity** dealing with M:N Relationship

Composite Entity

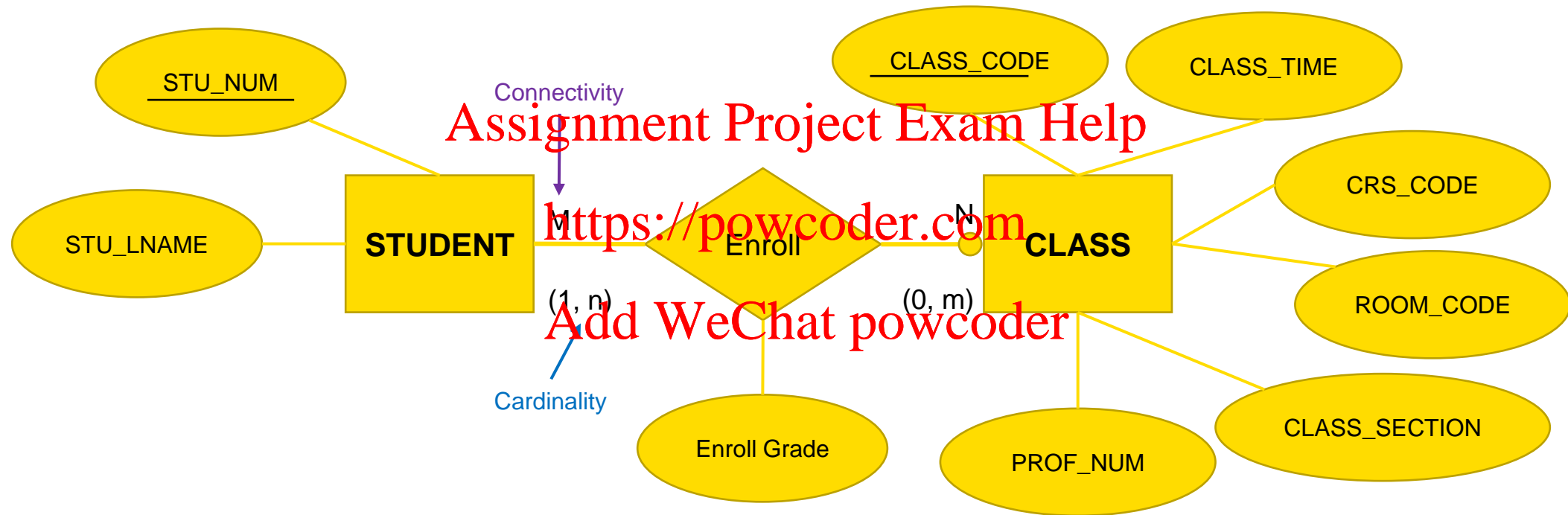
- ❑ **M:N relationships** (many-to-many relationships) should be **avoided**.
- ❑ **Relational databases** can only handle **1:M relationships** (one-to-many relationships).
- ❑ **M:N relationships** should be **decomposed** (broken down) to 1:M relationships by creating a **composite entity**.
- ❑ The composite entity builds a **bridge** between the original entities.
- ❑ The composite entity is composed of the **PKs of the original entities**.
- ❑ The composite entity is **existence-dependent** on the original entities.
- ❑ The composite entity may contain **additional attributes**.

Composite Entity

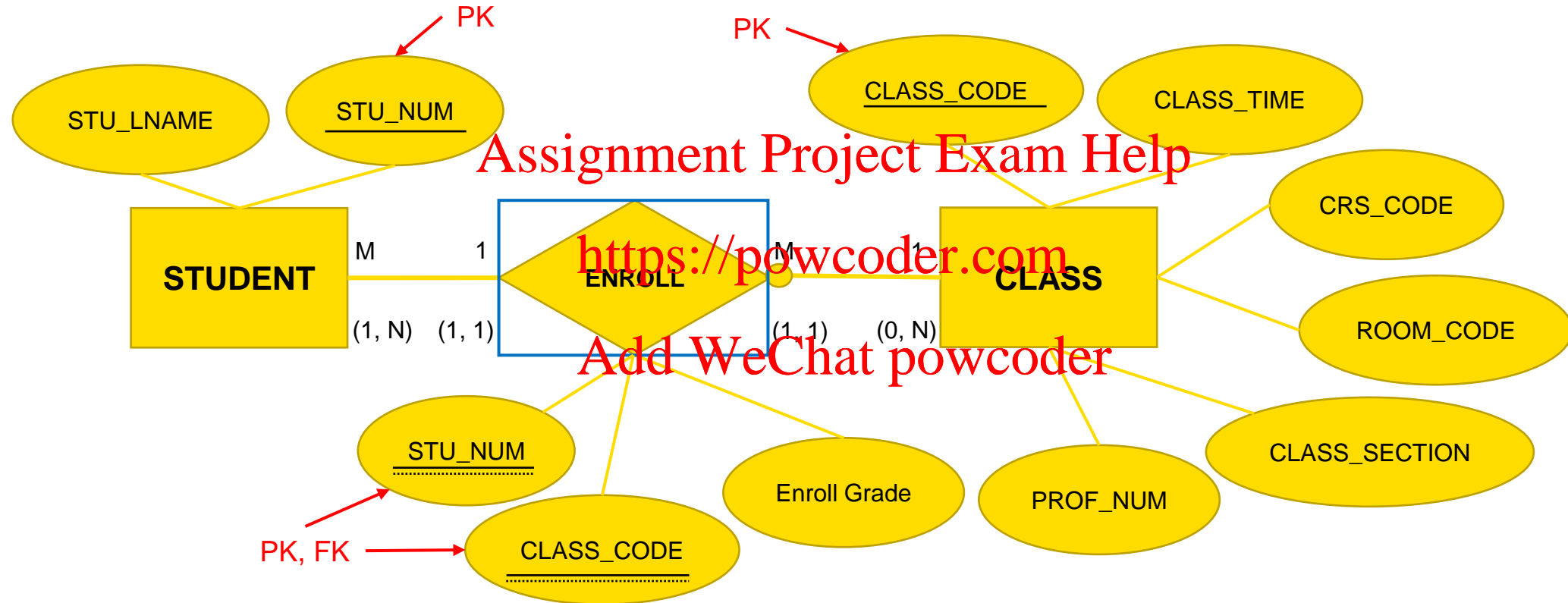
- **Relational databases** can only handle **1:N relationships** (one-to-many relationships) or **1:1 relationships**.
- **M:N relationships** (many-to-many relationships) should be **avoided** (via building composite entity).
- A **M:N relationship** should be **decomposed** (broken down) to **two** 1:M relationships by creating a **composite entity**.



Without Composite Entity (Original)



With Composite Entity



Inappropriate Approach

STUDENT		
STU_NUM	STU_LNAME	CLASS_CODE
001	Brown	1602, 1603
002	Pink	1602, 2603
003	Green	5992
004	White	5992, 5993

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CLASS		
CLASS_CODE	CRS_CODE	PROF_NUM
1602	CIS-200	700
1603	CIS-300	510
2603	SAD-100	240
5992	GM-200	350
5993	ADB-300	120

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STUDENT	
STU_NUM	STU_LNAME
001	Brown
002	Pink
003	Green
004	White

Correct Approach

ENROLS	
STU_NUM	CLASS_CODE
001	1602
001	1603
002	1602
002	2603
003	5992
004	5992
004	5993

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CLASS		
CLASS_CODE	ClassName	PROF_NUM
1602	CIS-200	700
1603	CIS-300	510
2603	SAD-100	240
5992	GM-200	350
5993	ADB-300	100

FIGURE 4.23 CONVERTING THE M:N RELATIONSHIP INTO TWO 1:M RELATIONSHIPS

Table name: STUDENT

STU_NUM	STU_LNAME
321452	Bowser
324257	Smithson

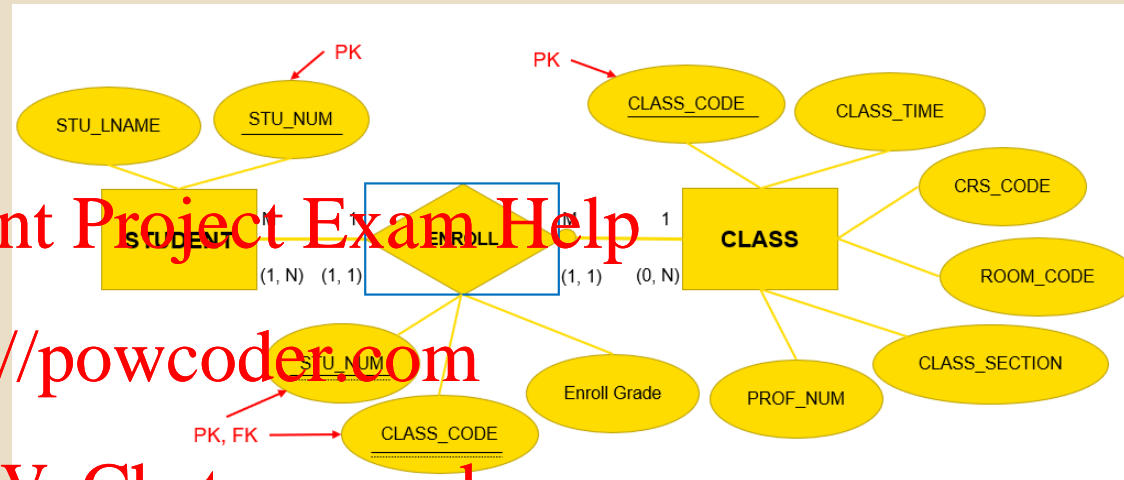
Table name: ENROLL

CLASS_CODE	STU_NUM	ENROLL_GRADE
10014	321452	C
10014	324257	B
10018	321452	A
10018	324257	B
10021	321452	C
10021	324257	C

Table name: CLASS

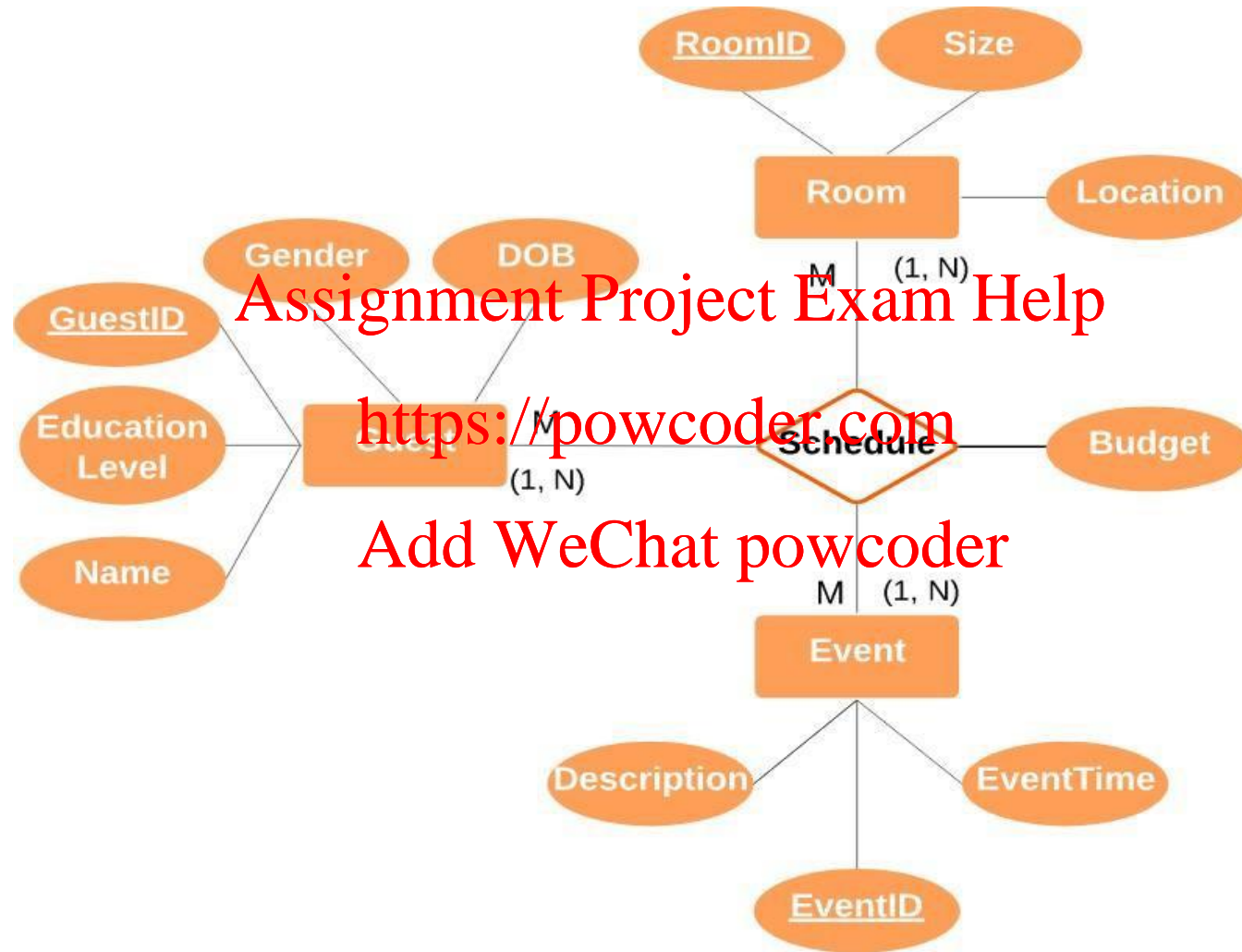
CLASS_CODE	CRS_CODE	CLASS_SECTION	CLASS_TIME	ROOM_CODE	PROF_NUM
10014	ACCT-211	3	TTh 2:30-3:45 p.m.	BUS252	342
10018	CIS-220	2	MWF 9:00-9:50 a.m.	KLR211	114
10021	QM-261	1	MWF 8:00-8:50 a.m.	KLR200	114

Database name: Ch04_CollegeTry



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Ternary Relationship Without Composite Entity



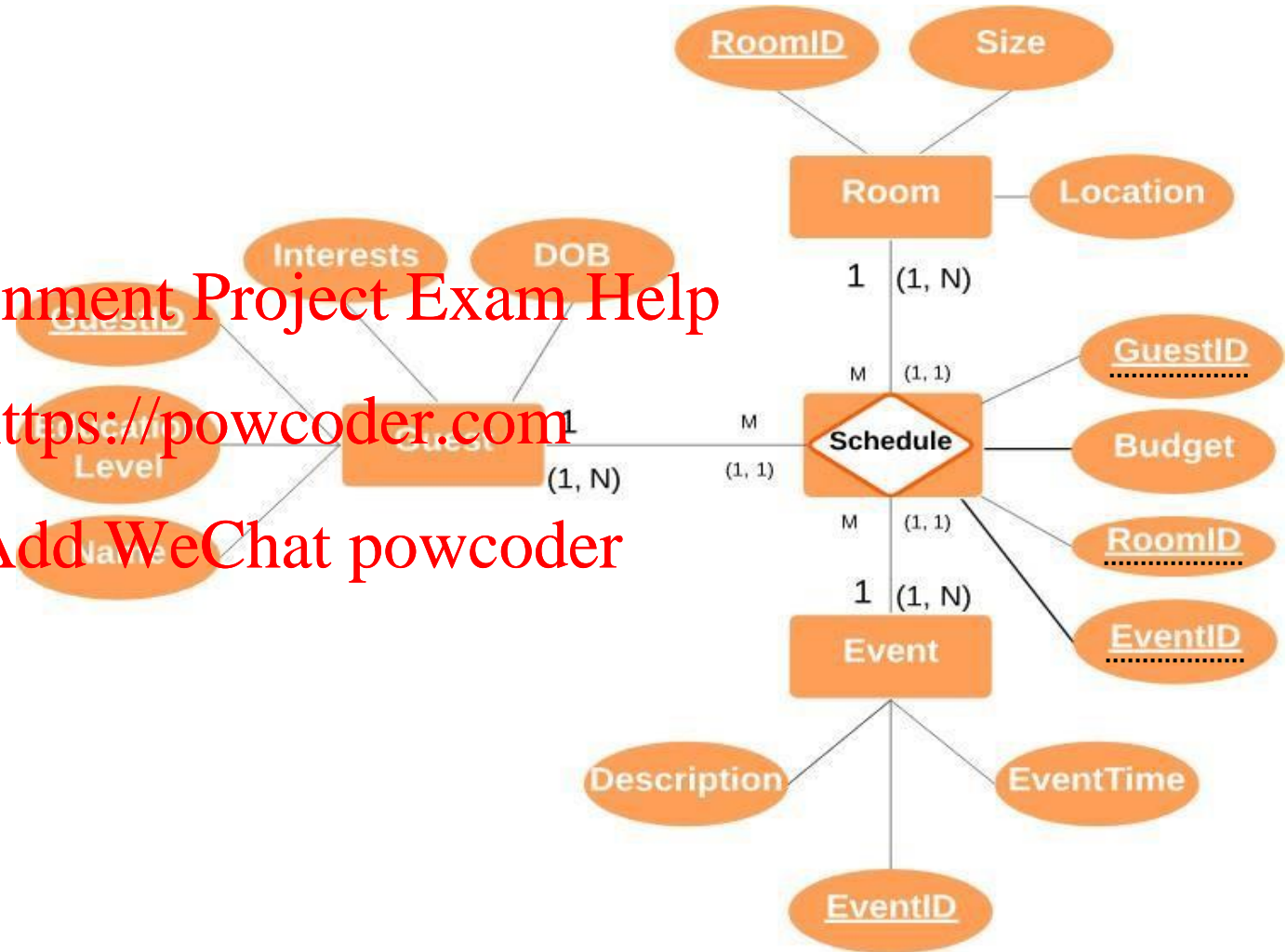
Ternary Relationship With Composite Entity

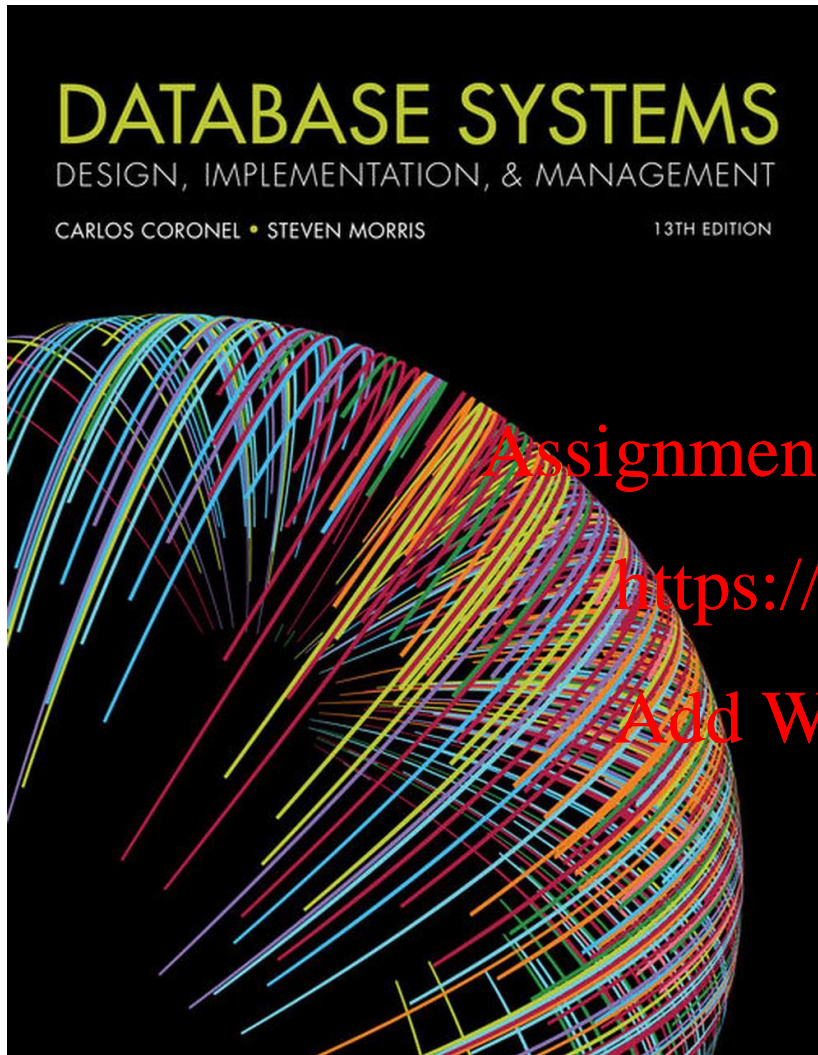
- ✓ A guest can be included in many schedule records;
- ✓ A schedule record includes only one guest;
- ✓ A room can be included in many schedule records;
- ✓ A schedule record includes only one room;
- ✓ An event can have many schedule records;
- ✓ A schedule record is only for one event.

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Chapter 5

Advanced Data Modeling

5-1 to 5-3

Supertype and Subtype

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Supertype and Subtype

“A **supertype** is a more **generic** entity type compared to its subtypes.”

“A **subtype** is a more **specific** entity type compared to its supertype.”

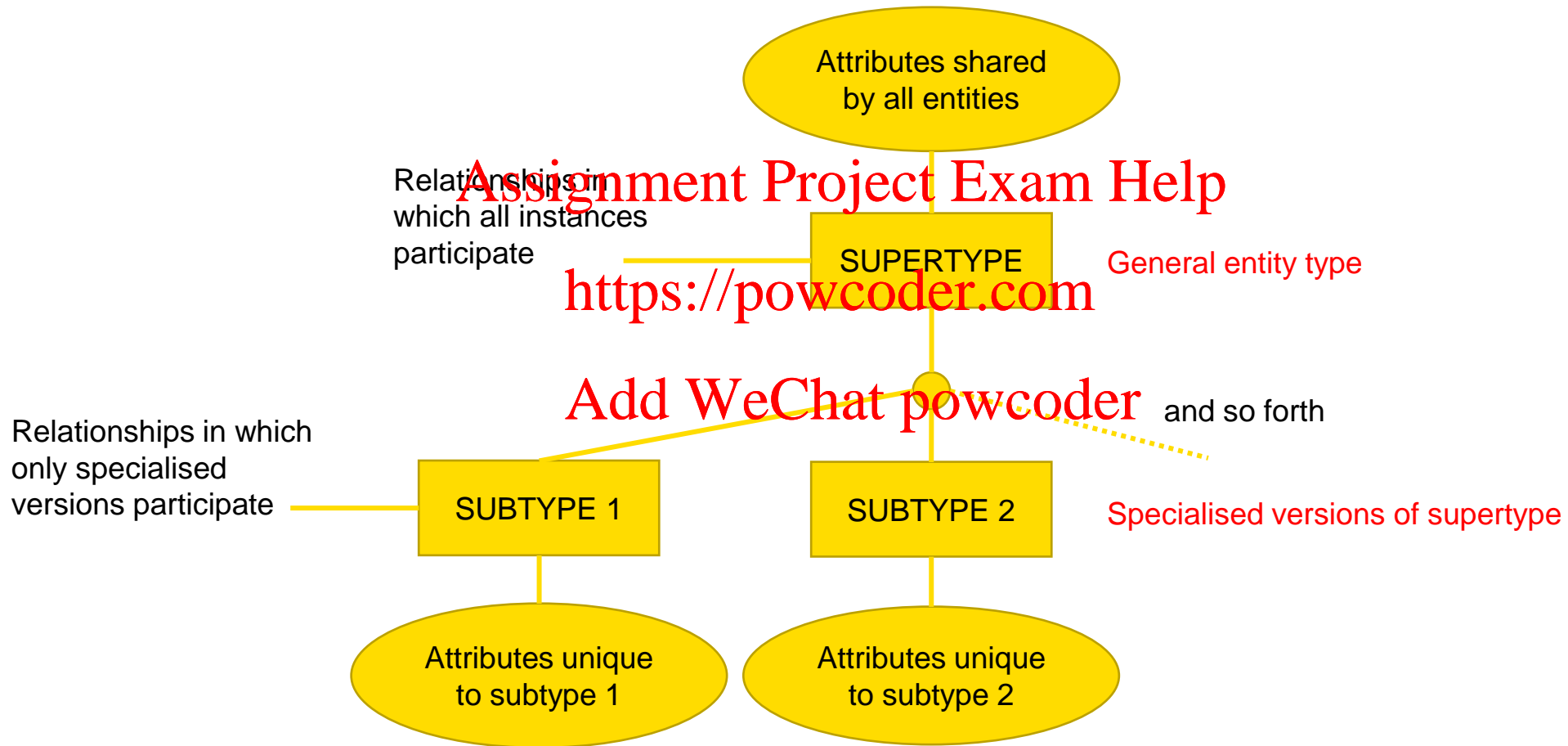
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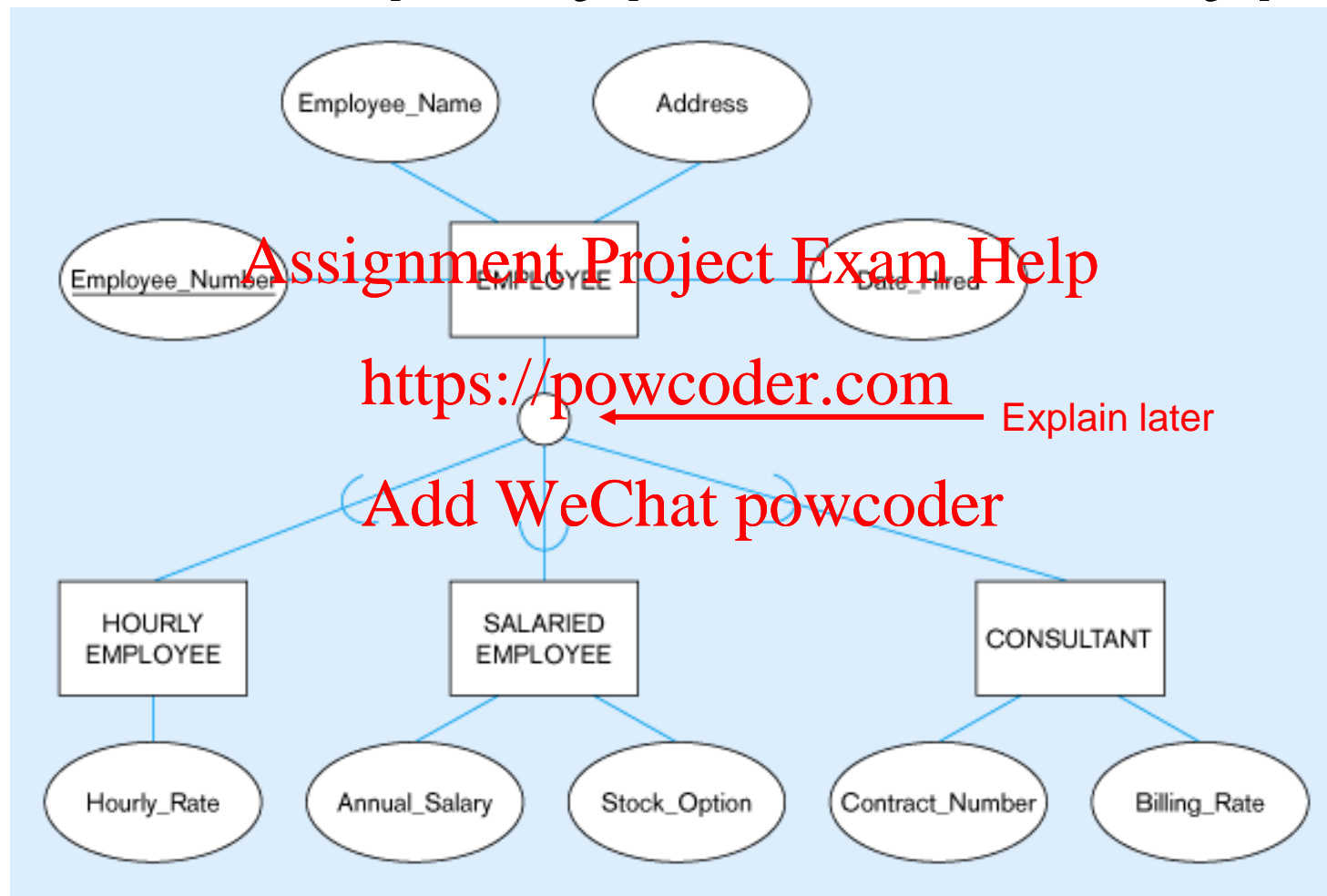
- A subtype entity inherits **all attributes of the supertype.**
- A subtype has additional, **specific attributes.**
- **An instance (occurrence) of a subtype is also an instance (occurrence) of the supertype.**

(The other way around, an instance of the supertype may or may not be an instance of one or more subtypes.)

Supertype and Subtype



Example of Supertype and Subtype



Generalisation and Specialisation

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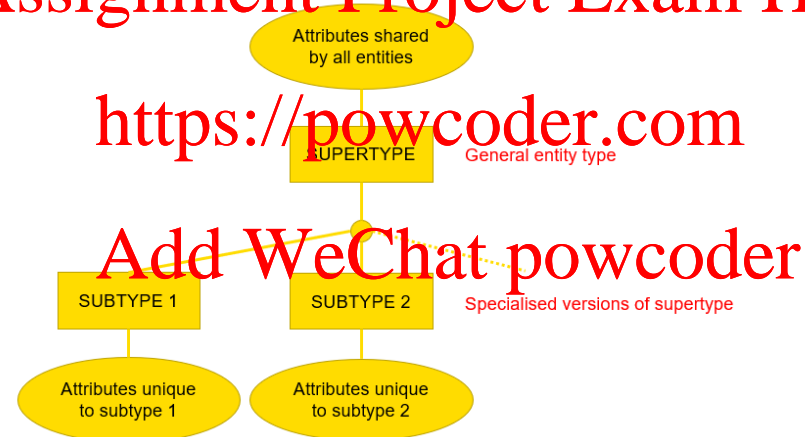
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Generalisation and Specialisation

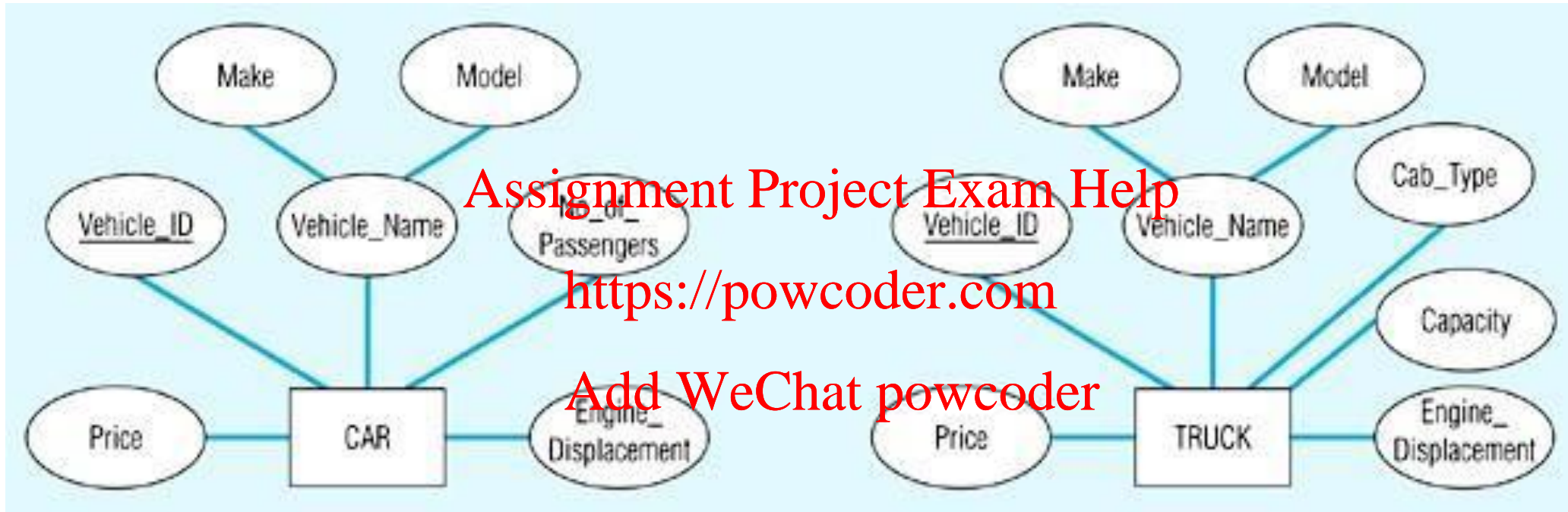
- **Generalisation:** The process of defining a general entity type from a set of specialised entity types. It is a **bottom-up** process **from subtypes to supertypes**.

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- **Specialisation:** The process of defining one or more subtypes of the supertype. It is a **top-down** process **from supertypes to subtypes**.

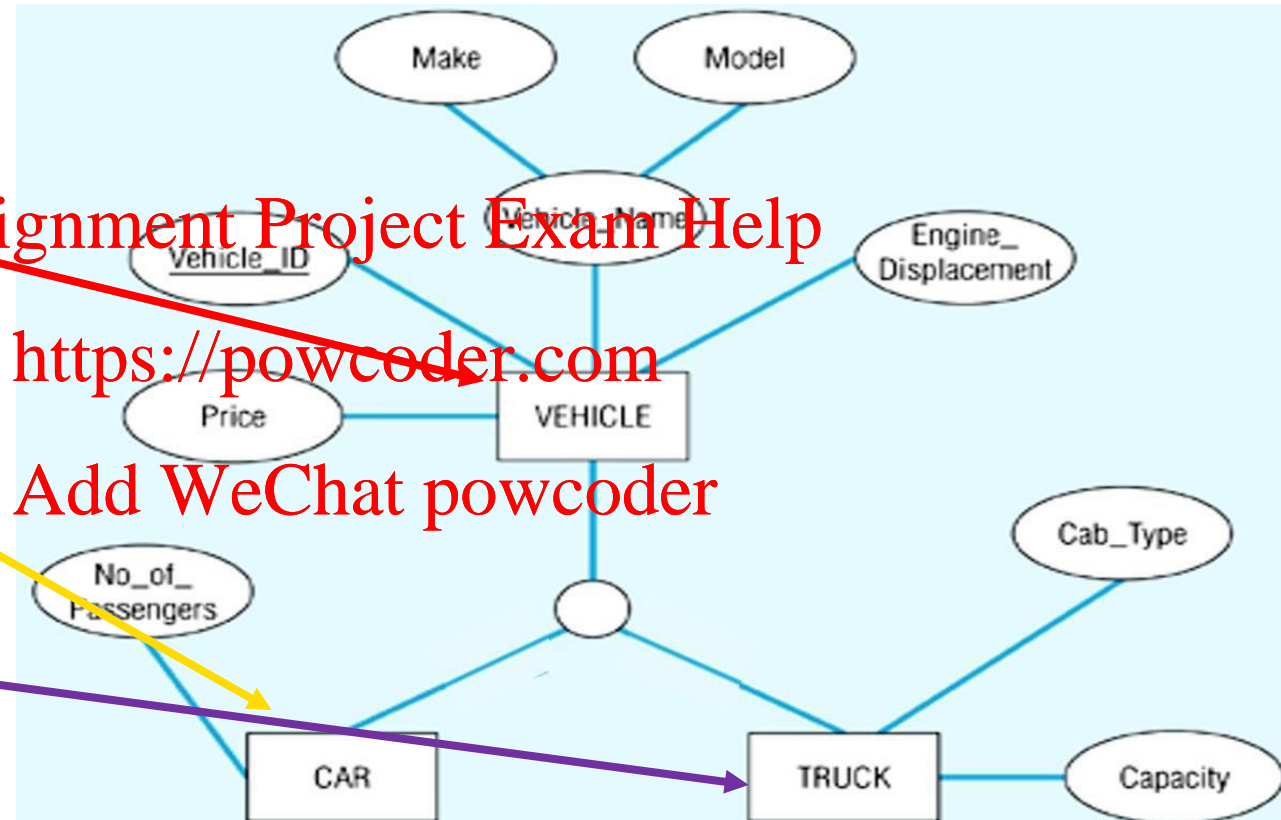
Generalisation



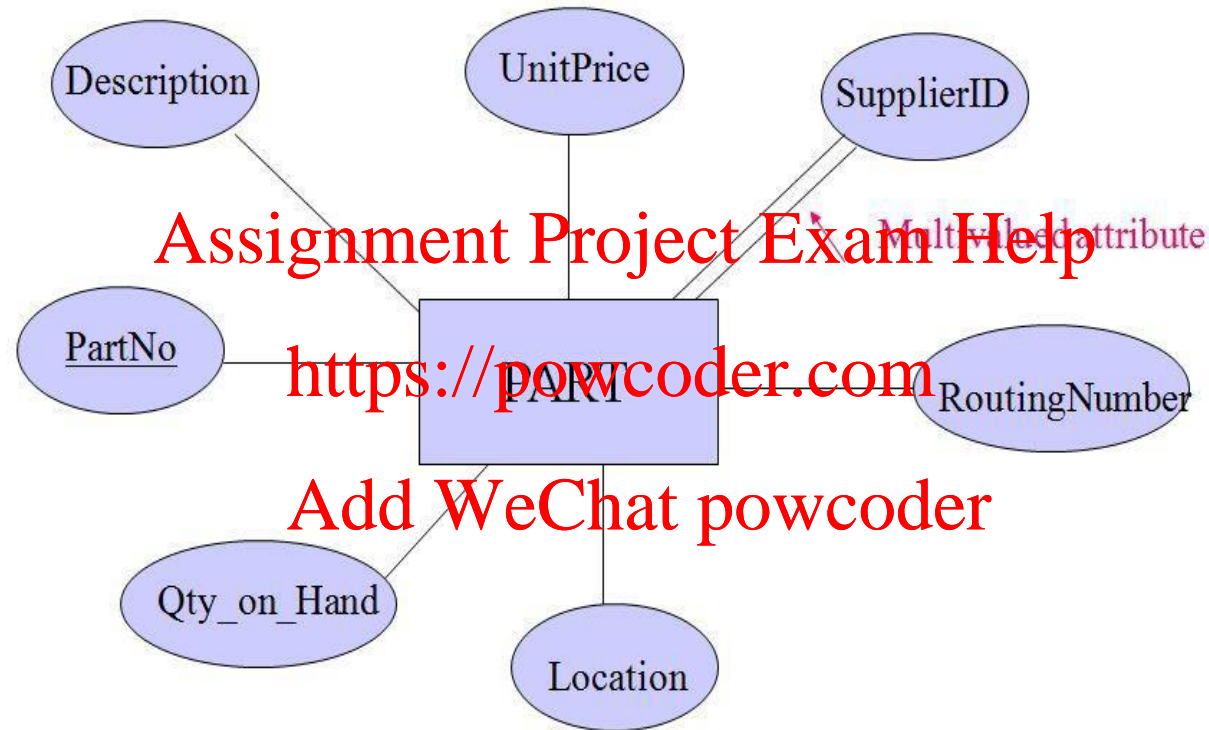
Question: How to generalise the listed two entity types: CAR and TRUCK?

Generalisation

- What are the common attributes?
 - Vehicle_ID
 - Vehicle_Name (Make, Model)
 - Price
 - Engine Displacement
- What are the specific attributes for Car?
 - No_of_Passengers
- What are the specific attributes for Truck?
 - Capacity
 - Cab_Type

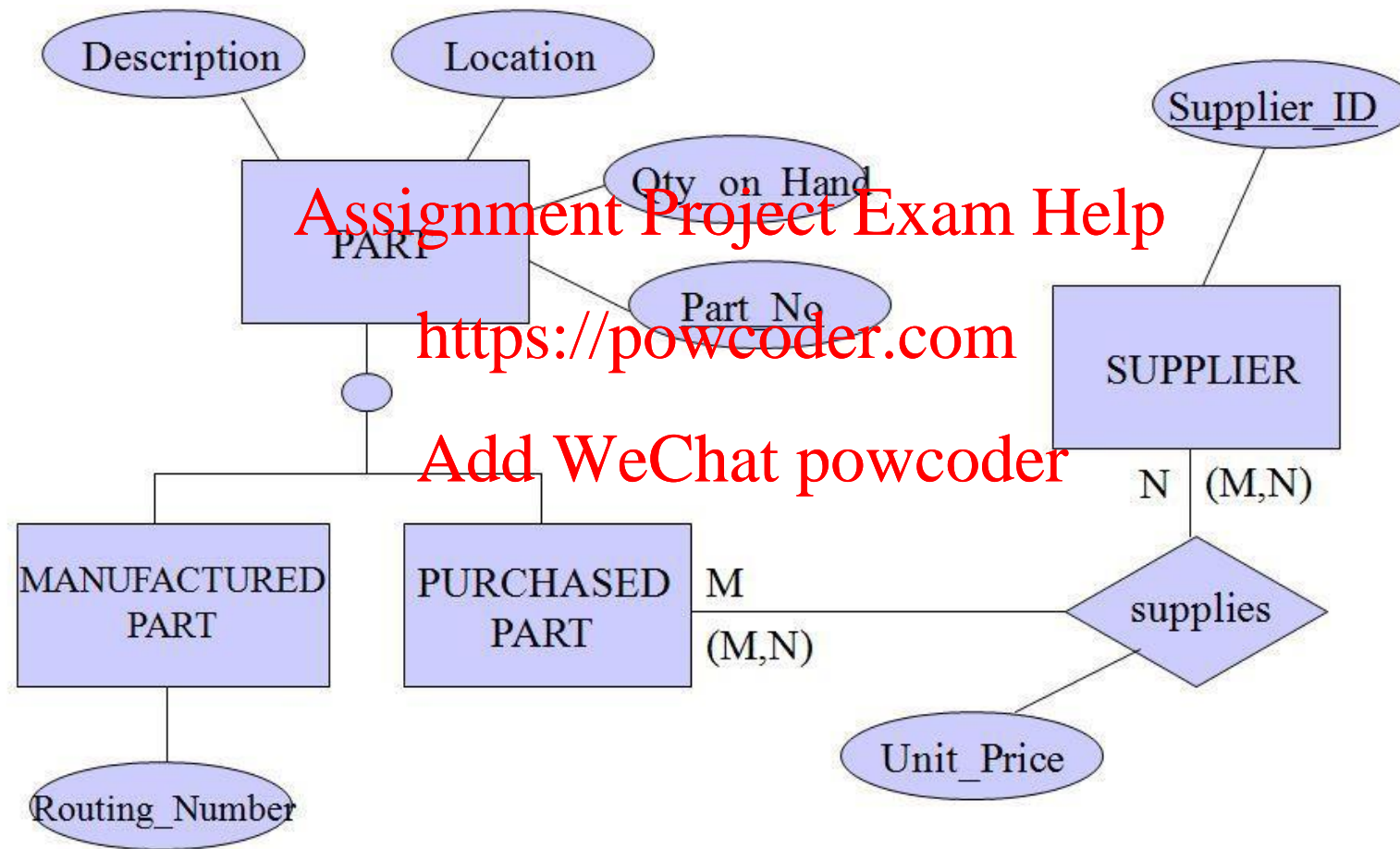


Specialisation

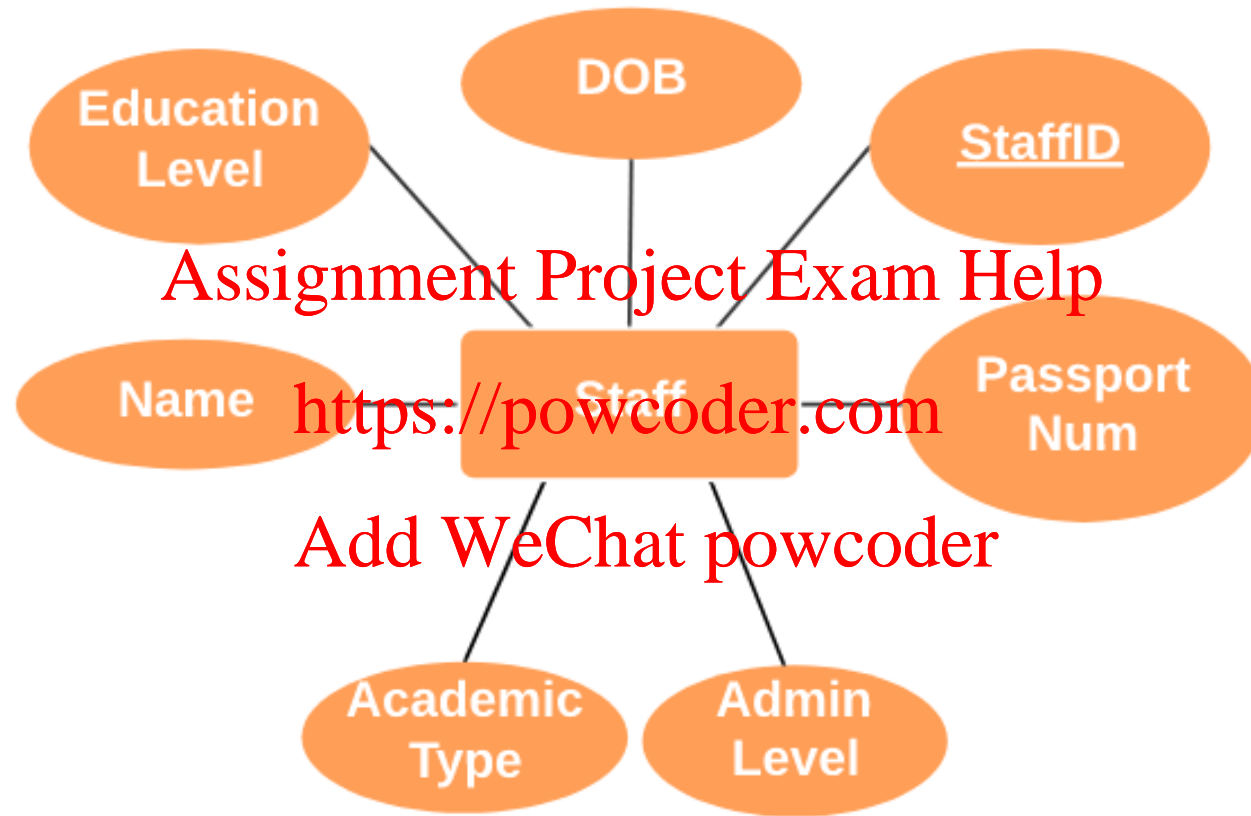


How to specialise the entity type PART??

Specialisation

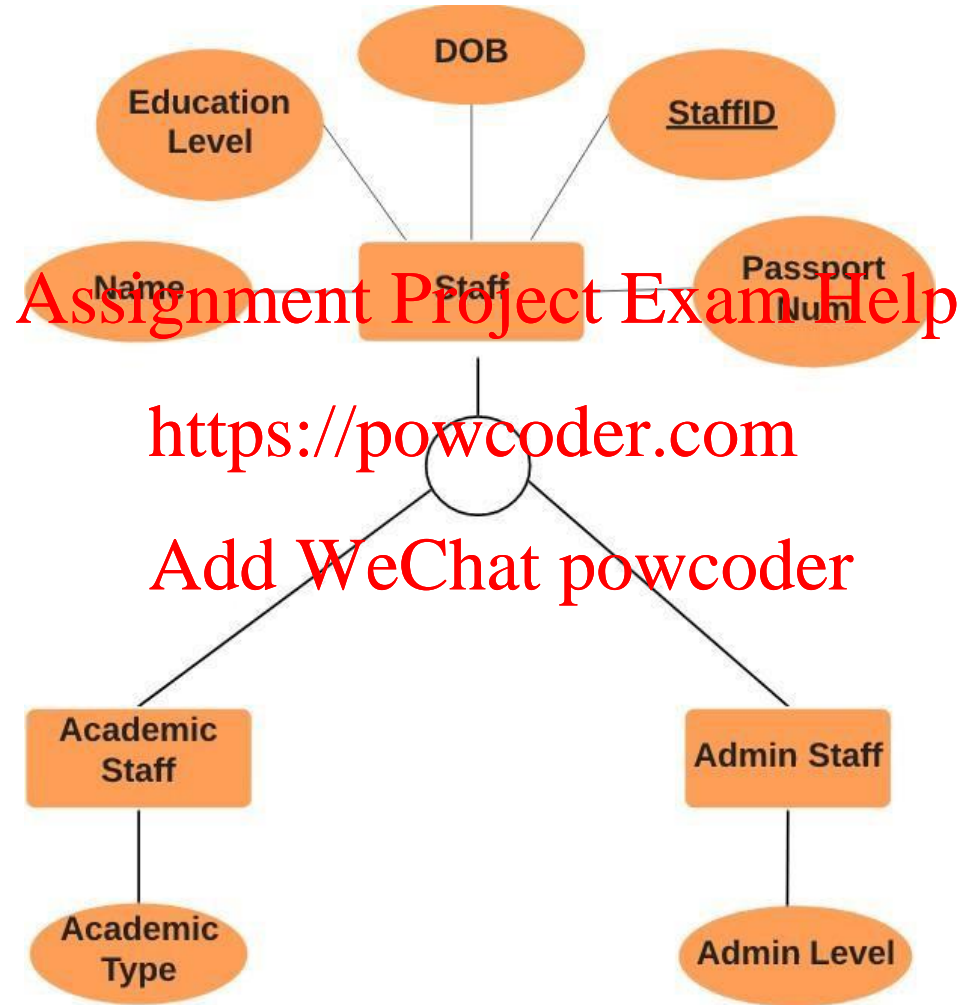


Specialisation



How to specialise the entity type Staff?

Specialisation



Constraints

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Constraints

- ❑ The **Completeness Constraint** describes **whether** an instance of a supertype must also be an instance of **at least one subtype**.

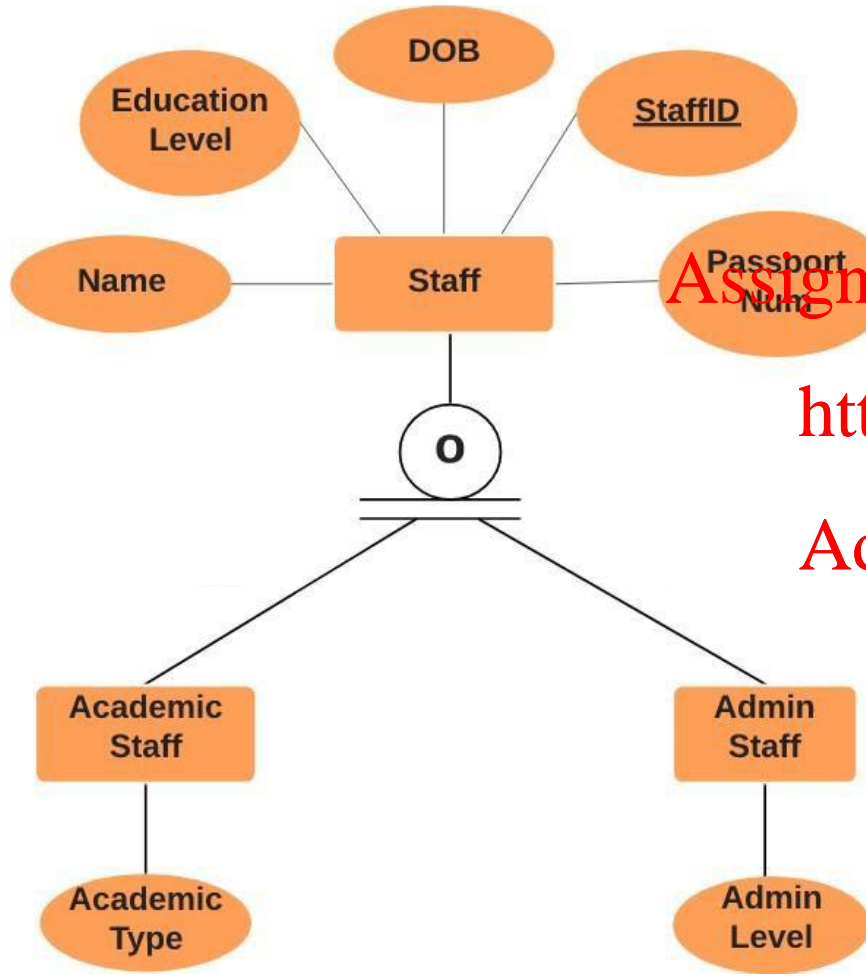
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- ❑ The **Disjointness Constraint** describes **whether** an instance of a supertype may **simultaneously** be a member of two (or more) subtypes.

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Constraints

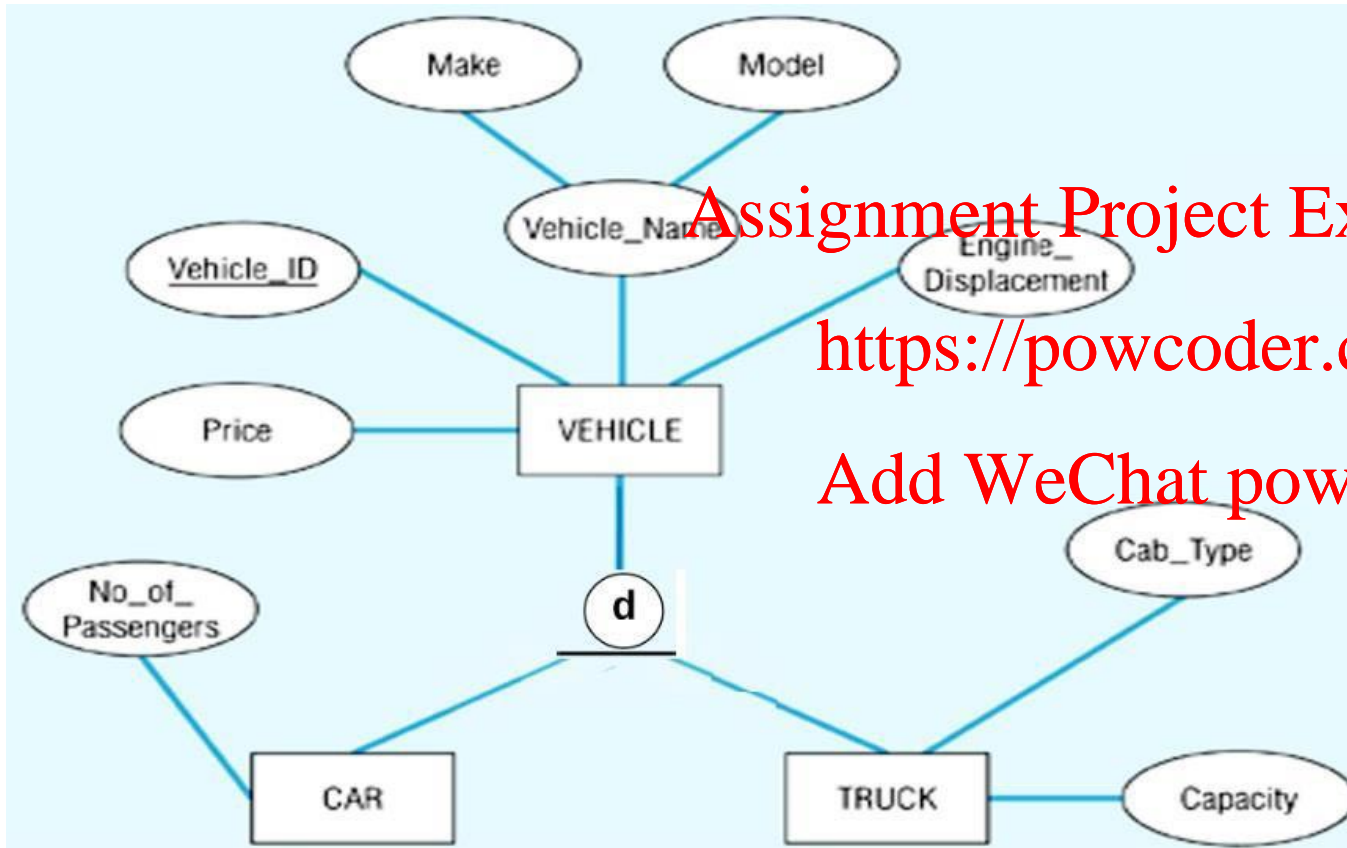


- A staff *must* be either an academic staff **or** admin staff (total specialisation rule): double line.

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- An academic staff **may also** be an admin staff (overlap rule): o.

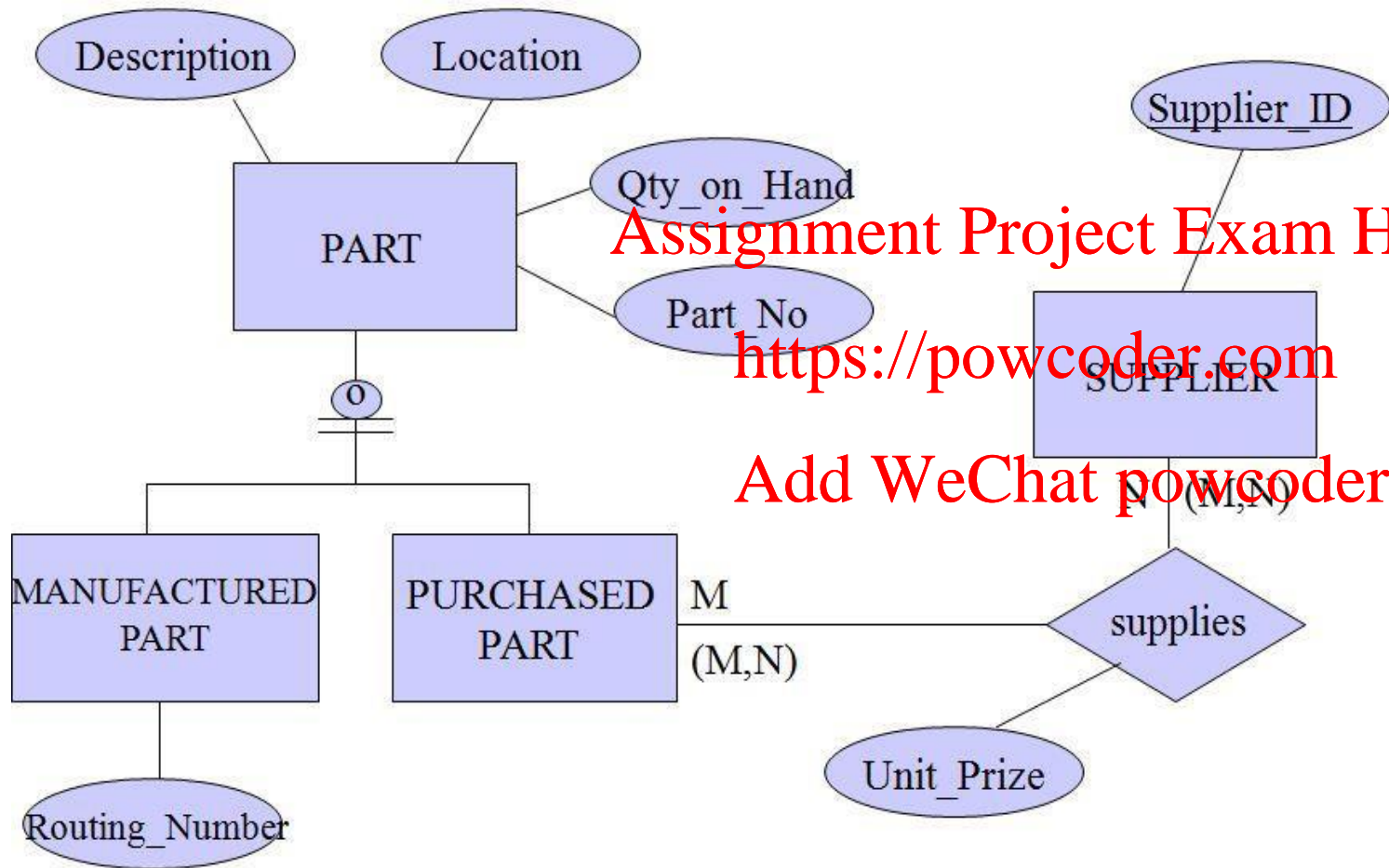
Constraints



Common sense tells us:

- A vehicle *may* be a car or truck or something else (partial specialisation): **single line**.
- A car *must not* (CANNOT) be a truck (disjoint rule): **d**.

Constraints



- A part *must* be purchased or manufactured (total specialisation rule): double line.
- A manufactured part *may* also be a purchased part (overlap rule): o.

Completeness Constraint

- ❑ Specifies whether each supertype occurrence must also be a member of at least one subtype

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- ❑ Types
 - **Partial completeness:** Not every supertype occurrence is a member of a subtype
 - **Total completeness:** Every supertype occurrence must be a member of any subtype

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VEHICLE – Car, Truck or something else such as Bus (which is not listed out)

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STAFF – Academic Staff & Admin Staff

Disjoint and Overlapping Constraints

❑ **Disjoint subtypes:** Contain a unique subset of the supertype entity set

VEHICLE – Car vs Truck

- Known as **nonoverlapping subtypes**
- Implementation is based on the value of the subtype discriminator attribute in the supertype

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❑ **Overlapping subtypes:** Contain nonunique subsets of the supertype entity set

STAFF – Academic Staff & Admin Staff

- Implementation requires the use of one discriminator attribute for each subtype

Subtype Discriminator(s)

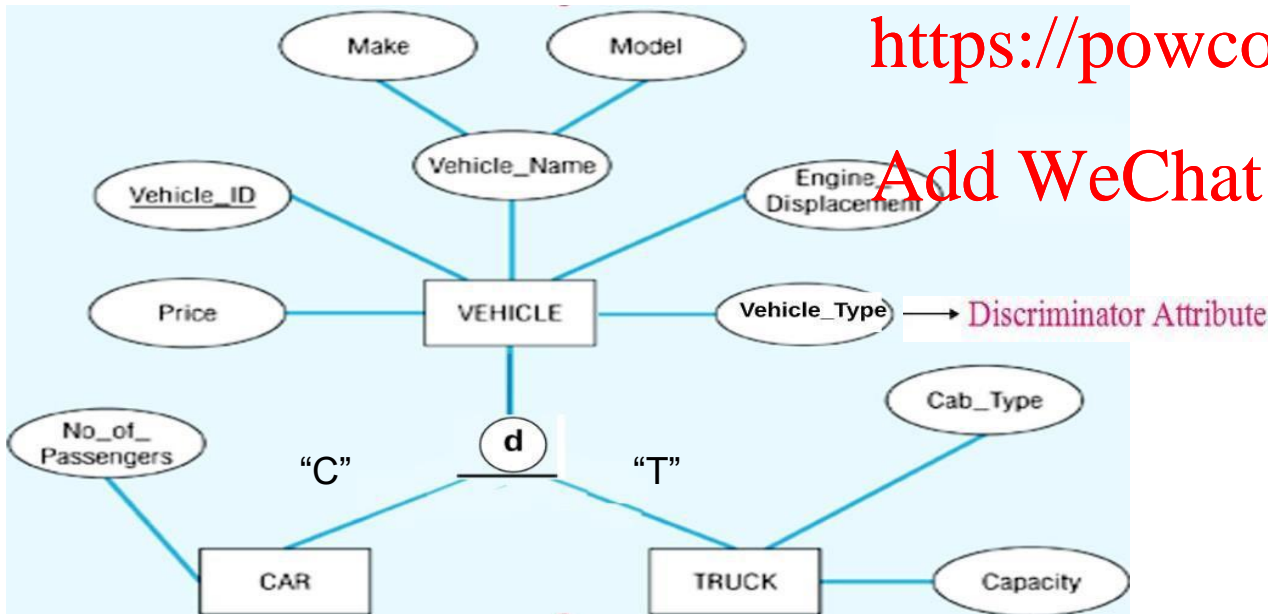
- **Subtype discriminator(s)** are the attribute(s) of the supertype that determine (code, note, identify) the target subtype.
 - Disjoint Constraint Rule: ~~One attribute~~
 - Overlapping Constraint Rule: ~~Composite attribute/several attributes~~

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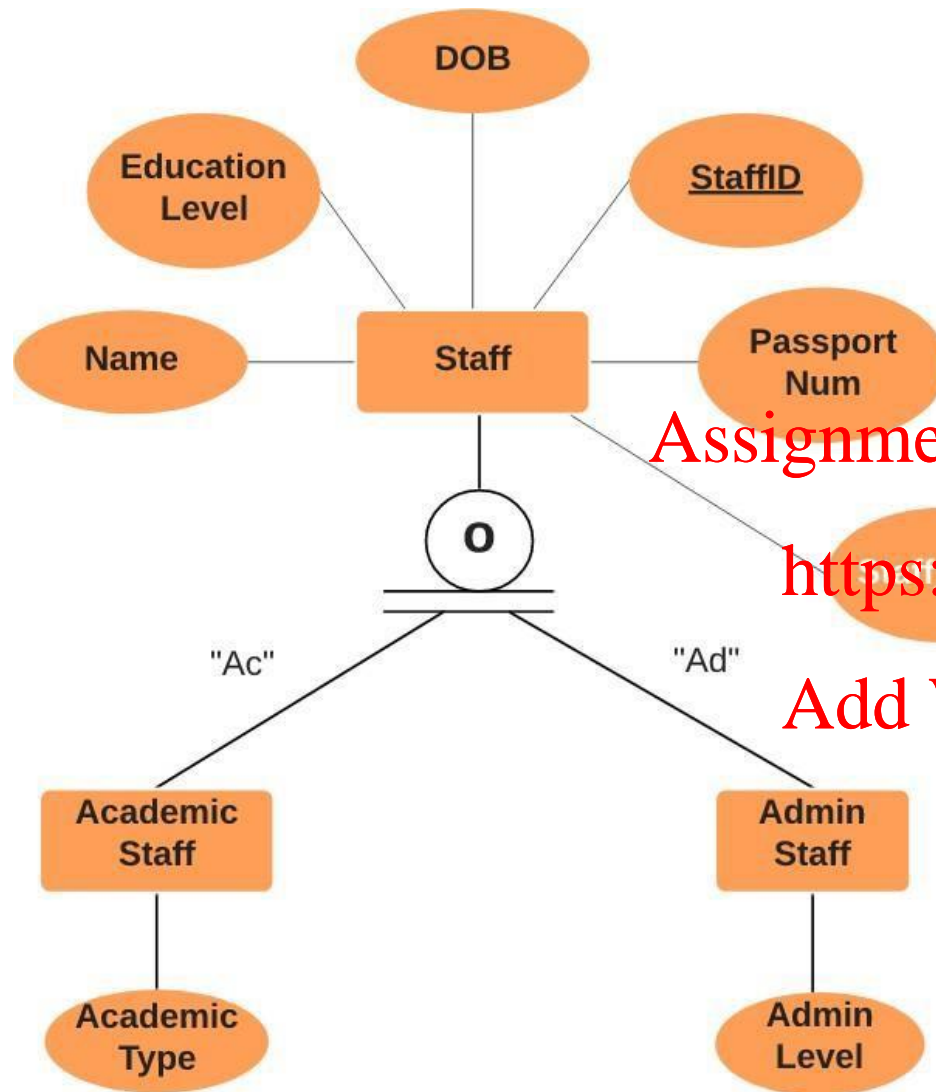
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A simple attribute (Vehicle_Type) with different possible values indicates the subtype (disjoint rule).



Vehicle_Type	Comment
C	The VEHICLE is a CAR.
T	The VEHICLE is a TRUCK.
Null	The VEHICLE is neither a CAR nor a TRUCK.



A composite attribute (Staff_Type) with sub-attributes (with "Yes"/"No" values) indicates the subtype (overlap rule).

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Staff_Type		Comment
Academic Staff	Admin Staff	
Yes	No	The Staff is a member of the Academic Staff subtype.
No	Yes	The Staff is a member of the Admin Staff subtype.
Yes	Yes	The Staff is both an Academic Staff and an Admin Staff.

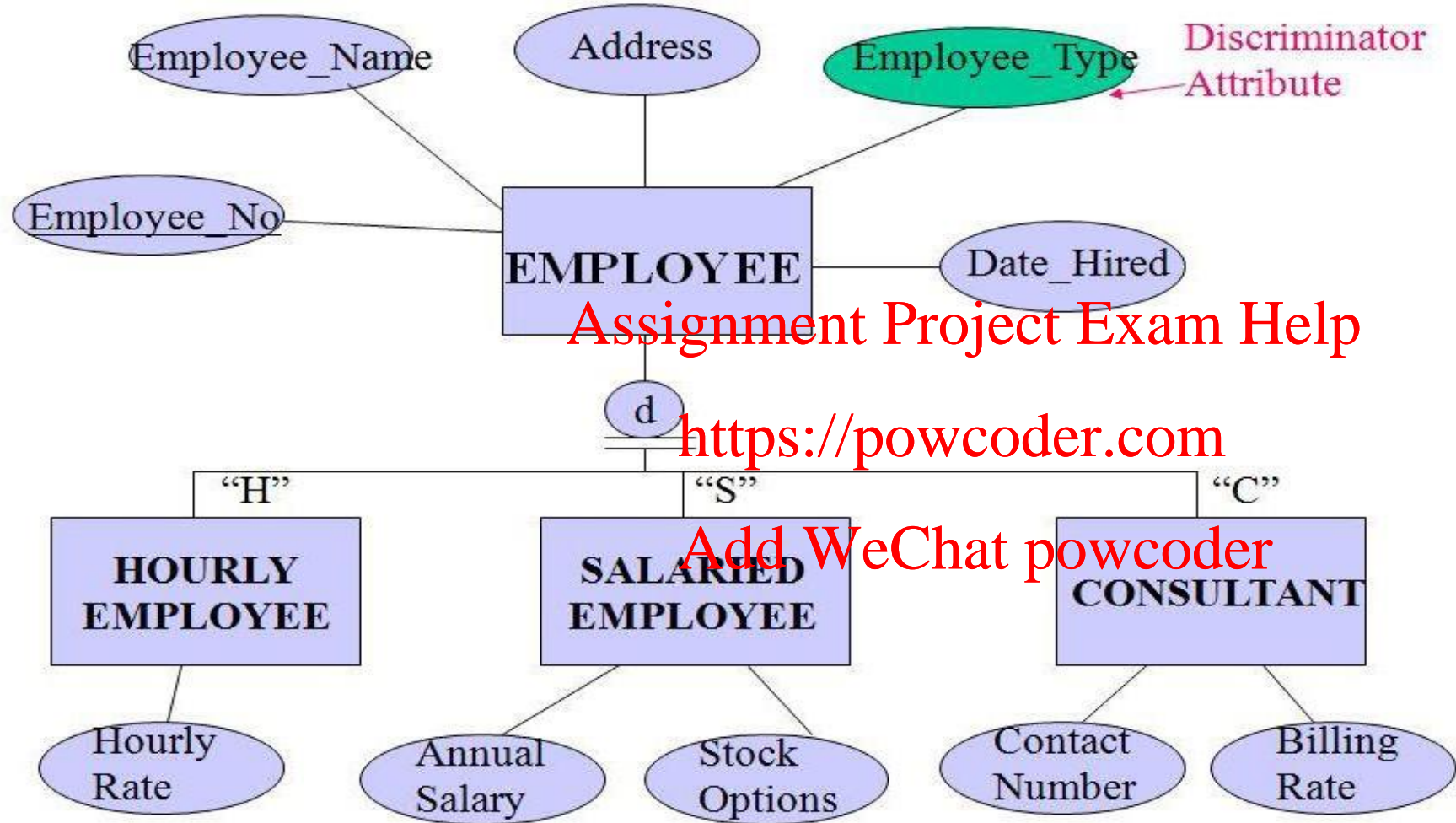
How about No / No?

Specialisation Hierarchy Constraint Scenarios

TABLE 5.2

SPECIALIZATION HIERARCHY CONSTRAINT SCENARIOS

TYPE	DISJOINT CONSTRAINT	OVERLAPPING CONSTRAINT
Partial 	Supertype has optional subtypes. Subtype discriminator <u>can be null</u> . Subtype sets are unique.	Supertype has optional subtypes. Subtype discriminators <u>can be null</u> . Subtype sets are not unique.
Total 	Every supertype occurrence is a member of only one subtype. Subtype discriminator <u>cannot be null</u> . Subtype sets are unique.	Every supertype occurrence is a member of at least one subtype. Subtype discriminators <u>cannot be null</u> . Subtype sets are not unique.



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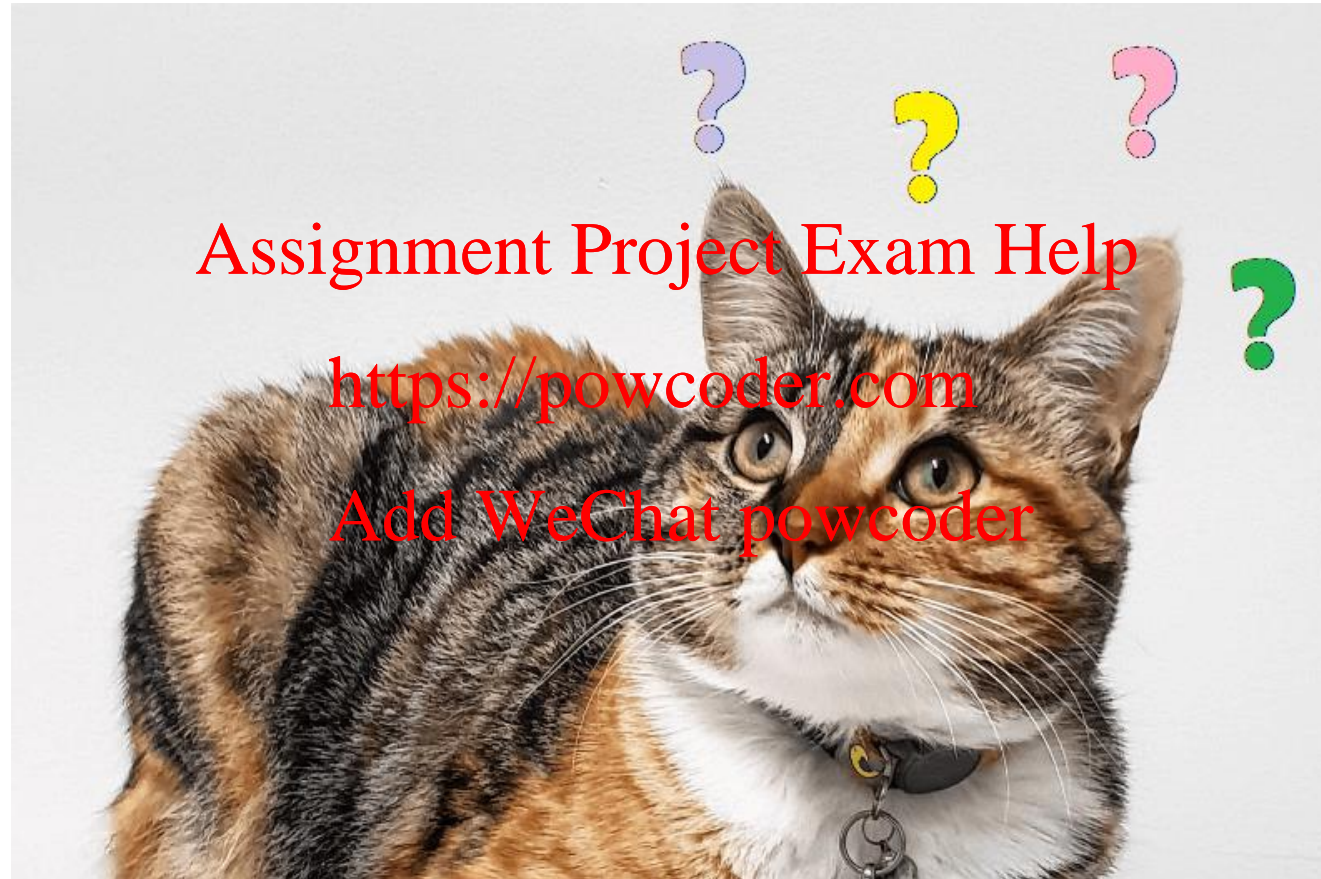
A simple attribute (Employee_Type) with different possible values indicates the subtype (disjoint rule).

Can the Employee_Type be null?

ER Modelling Guideline

- ☐ The data items should be put into **an entity (logical group)**.
- ☐ For each entity, there should be a Primary **key** that uniquely identifies individual members of entity type.
- ☐ There should be **no redundant data** in the model.
- ☐ Ask yourself the following questions:
 - What are the relevant entities here?
 - What are the relevant relationships here?
 - Can I generalise some entities?
- ☐ Document your **assumptions** as you go.
- ☐ Leave connectivity and **cardinalities** until the end.

Questions



Source: canningtonvet.com.au

Public Holiday Arrangement in Week 3

- ❑ No lecture on Queen's Birthday 13 June (Monday)!
- ❑ A lecture recording of Week 3 will be uploaded on 14 June by 12 pm.

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- ❑ Tutorials will go as usual

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Exercise

Draw an ER diagram for this situation (state any assumptions that you make). Based on the ER diagram, draw the relevant relational model.

- The firm has a number of sales offices in several states. Attributes of sales office include Office_number (identifier) and Location.
- Each sales office is assigned one or more employees. Attributes of employee include Employee_ID (identifier) and Employee_Name. An employee must be assigned one only one sales office.
- For each sales office, there is always one employee assigned to manage that office. An employee may manage only the sales office to which he or she is assigned.
- The firm lists property for sale. Attributes of property include Property_ID (identifier) and Location. Components of Location include Address, City, State, and Zip_Code.
- Each unit of property must be listed with one (and only one) of the sales offices. A sales office may have any number of properties listed or may have no properties listed.
- Each unit property has one or more owners. Attributes of owners are Owner_ID (identifier) and Owner_Name. An owner may own one or more units of property. An attribute of the relationship between property and owner is Percent_Owned.