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Database Design and
Development

Topic 2:
Enhancing Design (1)

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Enhancing Design (1) Topic 2 - 2.2

Scope and Coverage

This topic will cover:
- Introduction to normalisation
- The concept of functional dependency
- Data redundancy and update anomalies
- Overcoming anomalies with normalisation

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Learning Outcomes

By the end of this topic students will be able to:
- Explain the reason why the process of normalisation is carried out
- Normalise a document to third normal form

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Some Key Concepts

- Relational integrity

- Nulls

- Entity integrity

- Referential integrity

- General constraints

Question

- Why cannot any part of a primary key be null?

?

Answer

- Because a null value, being unknown, might be the same as the value in the primary key of another tuple.

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Properties of a Relation

- Relation Named
- Atomic values in cells
- Attribute Named
- Attribute value drawn from a domain
- No duplicate tuples (rows)
- No significance to order of tuples
- No significance to order of attributes

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Functional Dependence - 1

- A → B

- This is the notation

- If we know the value of A then we will know the value of B

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Functional Dependence - 2

- StudentID → StudentName

StudentID	StudentName
23	Singh
34	Smith
56	Smith
76	Singh

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Super-keys, Candidate Keys, Primary Keys - 1

StudentID	Activity	Cost
21	Dancing	$23
21	Swimming	$50
34	Dancing	$23
55	Fencing	$20

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Super-keys, Candidate Keys, Primary Keys - 2

StudentID	Activity	Cost
21	Dancing	$23
21	Swimming	$50
34	Dancing	$23
55	Fencing	$20

Activity → Cost

No other dependencies

Would need all the attributes to be a primary key

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Deletion and Update Anomolies

What happens if we change the price of Dancing?

StudentID	Activity	Cost
21	Dancing	$23
21	Swimming	$50
34	Dancing	$23
55	Fencing	$20

What happens if we delete this row?

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Splitting the Relation

StudentID	Activity	Cost
21	Dancing	$23
21	Swimming	$50
34	Dancing	$23
55	Fencing	$20

StudentID	Activity
21	Dancing
21	Swimming
34	Dancing
55	Fencing

Activity	Cost
Dancing	$23
Swimming	$50
Fencing	$20

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Customer Order Sheet for Art Supply Shop

Customer Order Sheet for an Art Supplier

Customer Number: 37
Customer Name: Jagpal Singh
Customer Type Code: RC
Customer Type Description: Retail Customer

Item Number	Item Name	Supplier ID	Price	Supplier Name	Quantity
099	Basic Paint Set	S1	£3	Smith and Co	1
0100	Sable Brush Set	S2	£3.50	Acro	1
0101	Extended Colour Set	S1	£3.75	Smith and Co	3
098	Metallic Paint Set	S1	£3.99	Smith and Co	1
078	Mixed Brush Set	S2	£3.99	Acro	2

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First Step

- Un-normalised Form. Identify repeating groups

UNF	Lev
Customer Number	1
Customer Name	1
Customer Type Code	1
Customer Type Name	1
Item Number	2
Item Name	2
Supplier ID	2
Price	2
Supplier Name	2
Quantity	

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First Normal Form (1NF)

UNF	Lev	1NF
Customer Number	1	Customer Number
Customer Name	1	Customer Name
Customer Type Code	1	Customer Type Code
Customer Type Name	1	Customer Type Name
Item Number	2	
Item Name	2	
Supplier ID	2	
Price	2	Customer Number*
Supplier Name	2	Item Number
Quantity		Item Name
		Supplier ID
		Price
		Supplier Name
		Quantity

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Second Normal Form (2NF)

1NF	2NF
Customer Number	Customer Number
Customer Name	Customer Name
Customer Type Code	Customer Type Code
Customer Type Name	Customer Type Name
Customer Number*	Customer Number*
Item Number	Item Number*
Item Name	Quantity
Supplier ID	
Price	
Supplier Name	Item Number
Quantity	Item Name
	Supplier ID
	Price
	Supplier ID
	Supplier Name

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Third Normal Form (3NF)

2NF	3NF
Customer Number	Customer Number
Customer Name	Customer Name
Customer Type Code	Customer Type Code
Customer Type Name	Customer Type Name
Customer Number*	
Item Number*	Customer Number*
Quantity	Item Number*
	Quantity
Item Number	
Item Name	Item Number
Supplier ID	Item Name
Price	Supplier ID*
Supplier ID	Price
Supplier Name	
	Supplier ID
	Supplier Name

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Third Normal Form (3NF) to Deriving Entities

2NF	3NF
Customer Number	Customer Number
Customer Name	Customer Name
Customer Type Code	Customer Type Code
Customer Type Name	Customer Type Name
Customer Number*	
Item_Number*	Customer Number*
Quantity	Item_Number*
	Quantity
Item Number	
Item Name	Item Number
Supplier ID	Item Name
Price	Supplier ID*
Supplier ID	Price
Supplier Name	
	Supplier ID
	Supplier Name

Customer

CustomerItem

Item

Supplier

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The Entity Relationship Diagram

Customer — 1 — 0...* — CustomerItem — 0...* — 1 — Item
                                                  |
                                                0...*
                                                  |
                                                  1
                                              Supplier

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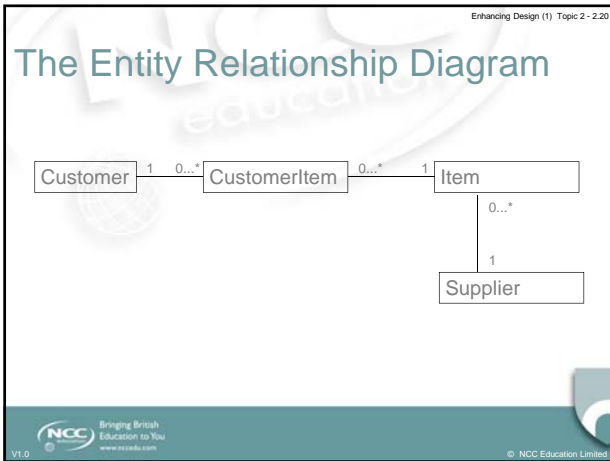
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Normalisation and Semantics - 1

- Normalisation depends on understanding the *meaning* of the data.

- For example the price of an item depends on just the item. If the same item could be supplied by different suppliers at different prices then the normalisation would look different. *How?*

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Normalisation and Semantics - 2

- **Answer:** there would be a separate group of attributes with the primary key of Supplier Number and Item Number. Price would be functionally dependent on both of these attributes and would therefore be an attribute of this entity.

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Extended Example

- To be used throughout the course

- Lots of different documents might be examined e.g.

  - Customer records
  - Sales sheets
  - Receipts and invoices

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Marlowe Interiors - 1

Interior Designer

Two Brothers

Makeovers

Index cards for customer records

Box file with paper invoices

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Marlowe Interiors - 2

Marlowe Interiors

1 Newington Green Road
London
N1 TYY
020 7888 1234
Job: Kitchen Makeover
Customer: Ivan Jones, 2 Digby Mansions. Highbury Park
Area: London North
Date: 02/03/00
Parts
1 sink, tin @ 130.00 including VAT.
1 u-pipe @ 20.00 ditto
3 x assorted plumbing fittings @ 33.00 total including VAT
1 thermostat @ 100.00 including VAT
Labour
Plumber 3 hours £150
Labourer 3 hours £60
Electrician 1 hour £50 (to fit thermostat)

TOTAL PARTS £283.00
TOTAL LABOUR £260.00

TOTAL £543.00

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Job	Customer	Area	Date	Part	Labour
Kitchen Makeover	Ivan Jones, 2 Digby Mansions. Highbury Park	North London	02/03/00	1 sink, tin @ 130.00	Plumber 3 hours £150
Kitchen Makeover	Ivan Jones, 2 Digby Mansions. Highbury Park	North London	02/03/00	1 u-pipe @ 20.00	Labourer 3 hours £60
Kitchen Makeover	Ivan Jones, 2 Digby Mansions. Highbury Park	North London	02/03/00	3 x assorted plumbing fittings	
Kitchen Makeover	Ivan Jones, 2 Digby Mansions. Highbury Park	North London	02/03/00	1 thermostat @ 100.00	Electrician 1 hour £50 (to fit thermostat)

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Self Study

- You will be asked to normalise this document.

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Learning Outcomes

By the end of this unit students will be able to:

- Explain the reason why the process of normalisation is carried out
- Normalise a document to third normal form

Have we met them?

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References

- Benyon-Davies, Paul *Database Systems* Palgrave Third Edition 2004 Chapter 18
- Connolly, Thomas M., and Begg, Carolyn E., *Database Systems: A Practical Approach to Design and Implementation* Addision-Wesley, Fourth Edition 2005 Chapter 13

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Topic 2 – Enhancing Design (1)

Any Questions?

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