LECTURE 12: NORMALISATION EXAMPLE

COMP2004J: Databases and Information Systems

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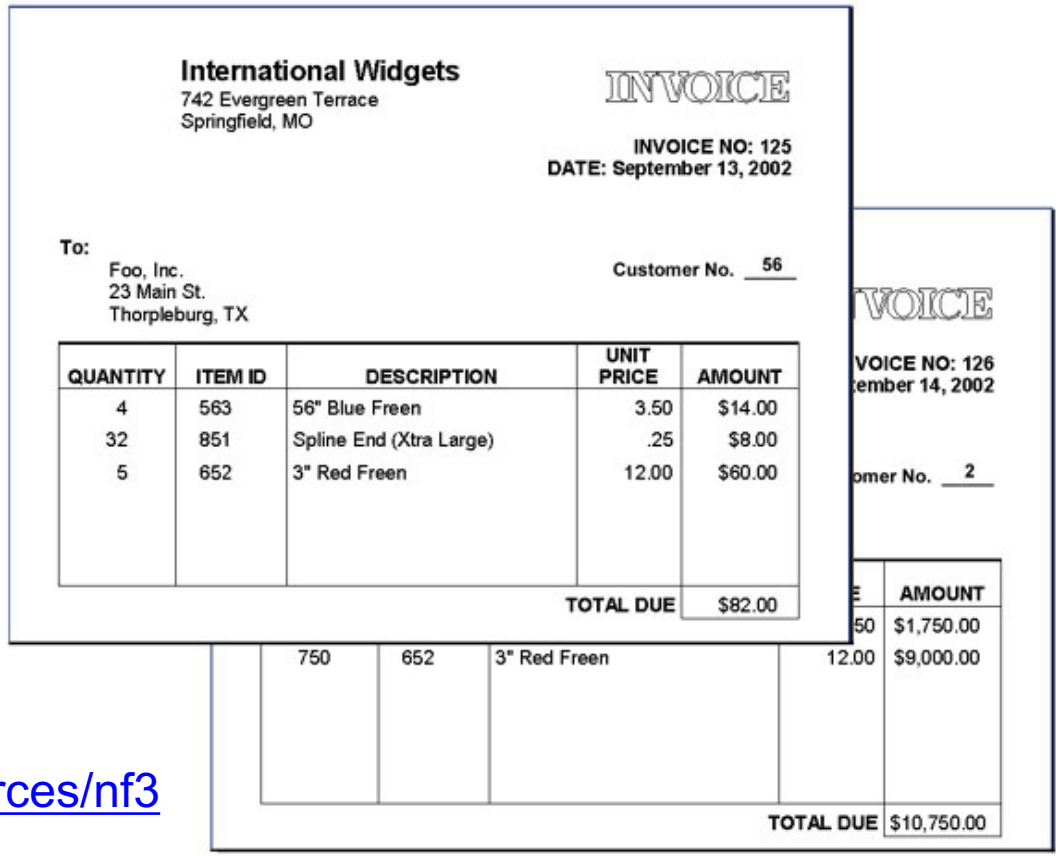
Normalisation Example

- A company wishes to keep track of sales invoices.
- Each invoice contains data about the sale of a number of items to a particular customer.



International Widgets
742 Evergreen Terrace
Springfield, MO

INVOICE

INVOICE NO: 125
DATE: September 13, 2002

To:
Foo, Inc.
23 Main St.
Thorpleburg, TX

Customer No. 56

QUANTITY	ITEM ID	DESCRIPTION	UNIT PRICE	AMOUNT
4	563	56" Blue Freen	3.50	$14.00
32	851	Spline End (Xtra Large)	.25	$8.00
5	652	3" Red Freen	12.00	$60.00
			TOTAL DUE	$82.00

VOICE

VOICE NO: 126
tember 14, 2002

omer No. 2

				AMOUNT
			50	$1,750.00
750	652	3" Red Freen	12.00	$9,000.00
			TOTAL DUE	$10,750.00

Based on the tutorial at:
http://www.phlonx.com/resources/nf3

Normalisation Example

- Previously, the company kept track of this data using a spreadsheet (below).
- Because the amount of data is getting large, they wish to record it in a database.
- This will allow them to do more complex calculations easily, using SQL.

orders.xls

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	**Invoice No.**	**Date**	**Cust. No.**	**Cust. Name**	**Cust. Address**	**Cust. City**	**Cust. State**	**Item ID**	**Item Descri**	**Item Qty.**	**Item Price**	**Item Total**	**Order Total Price**
2	125	9/13/2002	56	Foo, Inc.	23 Main St., Thorpleburg	Thorpleburg	TX	563	56" Blue Fre	4	$ 3.50	$ 14.00	$ 82.00
3								851	Spline End	32	$ 0.25	$ 8.00	$ 82.00
4								652	3" Red Free	5	$ 12.00	$ 60.00	$ 82.00
5	126	9/14/2002	2	Freens R Us	1600 Pennsylvania Avenu	Washington	DC	563	56" Blue Fre	500	$ 3.50	$1,750.00	$ 10,750.00
6								652	3" Red Free	750	$ 12.00	$9,000.00	$ 10,750.00

Normalisation Example

Is this Normalised?

orders.xls

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	**Invoice No.**	**Date**	**Cust. No.**	**Cust. Name**	**Cust. Address**	**Cust. City**	**Cust. State**	**Item ID**	**Item Descri**	**Item Qty.**	**Item Price**	**Item Total**	**Order Total Price**
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6								652	3" Red Free	750	$ 12.00	$9,000.00	$ 10,750.00

Why not?

Normalisation Example: 1NF

- First Normal Form (1NF) demands that there are no repeating groups.
- Here, there is data relating to **items** repeating for each invoice, so it's not in 1NF.
- To avoid this, one option is to "flatten" the table.

orders.xls

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	**Invoice No.**	**Date**	**Cust. No.**	**Cust. Name**	**Cust. Address**	**Cust. City**	**Cust. State**	**Item ID**	**Item Descri**	**Item Qty.**	**Item Price**	**Item Total**	**Order Total Price**
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6								652	3" Red Free	750	$ 12.00	$9,000.00	$ 10,750.00

Normalisation Example: 1NF

- We flatten the table by filling in all the fields in each row.
- There is now quite a bit of duplicated data (i.e. **redundancy**) in our table, but we can deal with that later.
- Since this is to go into a database, we need to identify a **primary key** for this table.

orders.xls

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Invoice No.	Date	Cust. No.	Cust. Name	Cust. Address	Cust. City	Cust. State	Item ID	Item Descri	Item Qty.	Item Price	Item Total	Order Total Price
2	125	9/13/2002	56	Foo, Inc.	23 Main St., Thorpleburg	Thorpleburg	TX	563	56" Blue Fre	4	$ 3.50	$ 14.00	$ 82.00
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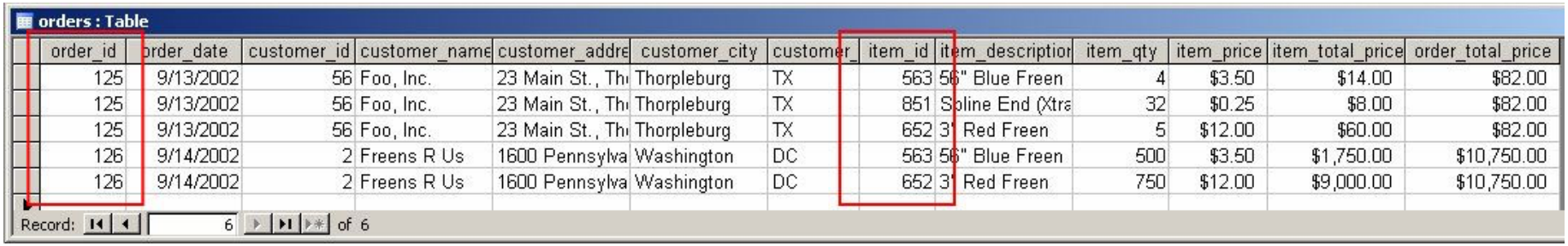
Normalisation Example: 1NF

- The `order_id` cannot be used by itself as a primary key, since each order is represented by several rows.
- Similarly, the `item_id` cannot be used by itself either, since each item occurs several times (for different orders).



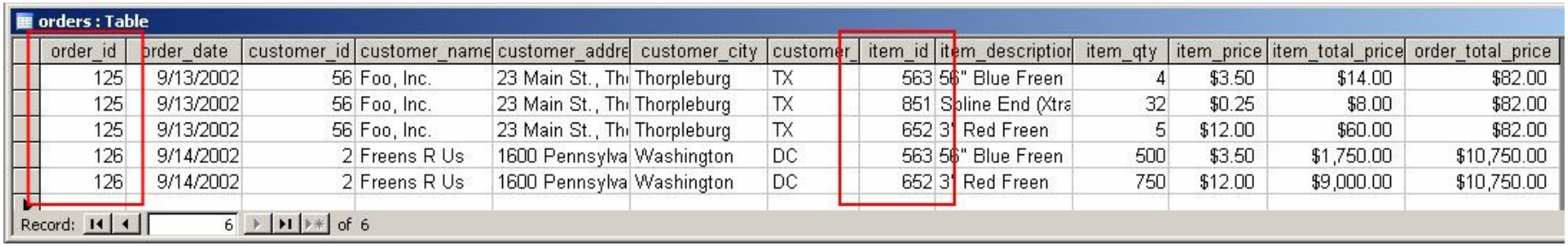
orders : Table

order_id	order_date	customer_id	customer_name	customer_addre	customer_city	customer_	item_id	item_descriptior	item_qty	item_price	item_total_price	order_total_price
125	9/13/2002	56	Foo, Inc.	23 Main St., Th	Thorpleburg	TX	563	56" Blue Freen	4	$3.50	$14.00	$82.00
125	9/13/2002	56	Foo, Inc.	23 Main St., Th	Thorpleburg	TX	851	Spline End (Xtra	32	$0.25	$8.00	$82.00
125	9/13/2002	56	Foo, Inc.	23 Main St., Th	Thorpleburg	TX	652	3" Red Freen	5	$12.00	$60.00	$82.00
126	9/14/2002	2	Freens R Us	1600 Pennsylva	Washington	DC	563	56" Blue Freen	500	$3.50	$1,750.00	$10,750.00
126	9/14/2002	2	Freens R Us	1600 Pennsylva	Washington	DC	652	3" Red Freen	750	$12.00	$9,000.00	$10,750.00

Record: 6 of 6

Normalisation Example: 1NF

- Instead, we can use both the `order_id` and `item_id` together as a **compound** (or **composite**) primary key.
- The combination of these two attributes uniquely identifies each row.



orders : Table

order_id	order_date	customer_id	customer_name	customer_addre	customer_city	customer_	item_id	item_description	item_qty	item_price	item_total_price	order_total_price
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125	9/13/2002	56	Foo, Inc.	23 Main St., Th	Thorpleburg	TX	652	3" Red Freen	5	$12.00	$60.00	$82.00
126	9/14/2002	2	Freens R Us	1600 Pennsylva	Washington	DC	563	56" Blue Freen	500	$3.50	$1,750.00	$10,750.00
126	9/14/2002	2	Freens R Us	1600 Pennsylva	Washington	DC	652	3" Red Freen	750	$12.00	$9,000.00	$10,750.00

Record: 6 of 6

Normalisation Example: 1NF

- We have now succeeded in converting our data into 1NF.

- This was done by:
  1. Flattening the table.
  2. Extending the primary key.

orders
order_id
order_date
customer_id
customer_name
customer_address
customer_city
customer_state
item_id
item_description
item_qty
item_price
item_total_price
order_total_price

Normalisation Example: 2NF

- What about 2NF?
- 2NF demands that there are no **partial key functional dependencies**.
  - This is only an issue where we have compound primary keys.
  - The use of `order_id` and `item_id` as a compound primary key in our example means that this is something we need to examine.

Normalisation Example: 2NF

- Key fields:
  - `order_id` – identifies the invoice
  - `item_id` – identifies the items that have been sold.
- We need to examine all the other attributes in the table to see if they have a functional dependency on one or both of these.

Normalisation Example: 2NF

- order_date
- customer_id
- customer_name
- customer_address
- customer_city
- customer_state
- item_description
- item_qty
- item_price
- item_total_price
- order_total_price

Normalisation Example: 2NF

- **Dependent only on `order_id`:**
  - `order_date`
  - `customer_id`
  - `customer_name`
  - `customer_address`
  - `customer_city`
  - `customer_state`
- **Dependent only on `item_id`:**
  - `item_description`
  - `item_price`
- **Dependent on both:**
  - `item_qty`
  - `item_total_price`
  - `order_total_price`

Normalisation Example: 2NF

- **Dependent only on `order_id`:**
  - `order_date`
  - `customer_id`
  - `customer_nam`
  - `customer_addres`
  - `customer_city`
  - `customer_state`

- **Dependent only on `item_id`:**
  - `item_description`
  - `item_price`

- **Dependent on both:**
  - `item_qty`
  - `item_total_price`
  - `order_total_price`

Anything strange here?

Normalisation Example: 2NF

- What about `item_total_price` and `order_total_price`?
- On first glance, it appears that these are both dependent on both `order_id` and `item_id`.
- However, we can see that these are **derived values**, which can be calculated using data that we are already storing (i.e. the price of items, and their quantity).
- Derived values in a database add **redundancy**!
- For this reason, they **should not be included**.

Normalisation Example: 2NF

- We now need to perform **decomposition**, to split this into multiple tables.
- We need to take every part of the compound key in turn, and split it (and any attributes that solely depend on it) into a different table.
- The key itself is left behind in the original table to act as a foreign key (and that is still part of the original table's primary key).
- This table has two parts to the compound key: `order_id` and `item_id`.
  - We need to deal with each of these.

Normalisation Example: 2NF

- We begin with `order_id` and get tables that look like this:

orders
order_id
order_date
customer_id
customer_name
customer_address
customer_city
customer_state

order_items
order_id
item_id
item_description
item_qty
item_price

- Everything that depends only on `order_id` has been moved to the `orders` table.
- Everything else is left behind in the original table (`order_items`).

Normalisation Example: 2NF

- Now we do the same with `order_id`:

orders
order_id
order_date
customer_id
customer_name
customer_address
customer_city
customer_state

order_items
order_id
item_id
item_qty

items
item_id
item_description
item_price

Normalisation Example: 2NF

- Are we now in 2NF?
- The `orders` and `items` tables only have 1 attribute as their primary key.
  - They **must** be in 2NF, because it is impossible to have a partial key dependency with a simple primary key.

orders
order_id
order_date
customer_id
customer_name
customer_address
customer_city
customer_state

items
item_id
item_description
item_price

Normalisation Example: 2NF

- Are we now in 2NF?
- The `order_items` table has a compound key.
- The only non-key attribute is `item_qty`, which is functionally dependent on both parts of the primary key.
- **We are now in 2NF.**

order_items
order_id
item_id
item_qty

Normalisation Example: 3NF

- What about 3NF?
- 3NF insists that we have no **transitive functional dependencies**.
- This is when one non-key attribute has a functional dependency on another non-key attribute.
  - This is not possible if there is only one non-key attribute.
- We must examine all three tables to see if they are in 3NF.

Normalisation Example: 3NF

- We begin with `order_items`.
- This has only one non-key attribute (`item_qty`) so it is in 3NF.

order_items
order_id
item_id
item_qty

Normalisation Example: 3NF

- The `items` table is next.
- This has two non-key attributes, so we need to be careful.
- Does `item_price` depend on `item_description` (or vice-versa)?
- No! They both depend only on `item_id` (which is the primary key) so this is also in 3NF.

items
item_id
item_description
item_price

Normalisation Example: 3NF

- Finally, we examine the `orders` table.
- Again, there are multiple non-key attributes, so we need to check for 3NF.
- `order_date` depends on `order_id` so that's OK.
- **BUT**, all the data about customers (name, address, city, state) depends on the `customer_id` rather than the `order_id`.

orders
order_id
order_date
customer_id
customer_name
customer_address
customer_city
customer_state

Normalisation Example: 3NF

- We need to split these attributes into another table (leaving the attribute they depend on behind as a foreign key).

orders
order_id
order_date
customer_id

customers
customer_id
customer_name
customer_address
customer_city
customer_state

Normalisation Example: 3NF

- Finally, we have a normalised database in Third Normal Form (3NF)

orders
order_id
order_date
customer_id

order_items
order_id
item_id
item_qty

items
item_id
item_description
item_price

customers
customer_id
customer_name
customer_address
customer_city
customer_state