Exercise 04 – Normalization

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The invoice given us to normalize the data and put into a relational database is not naturally in a normalized form. Several different tables need to be split off in order to accurately model the data while also making it simple to work on.

1 First Normal Form

The tenets of first normal form include:

1. Atomic values for any given field of any given tuple. In more plain English, for any intersection of row and column, therein will be only one value of the attribute's type or domain.

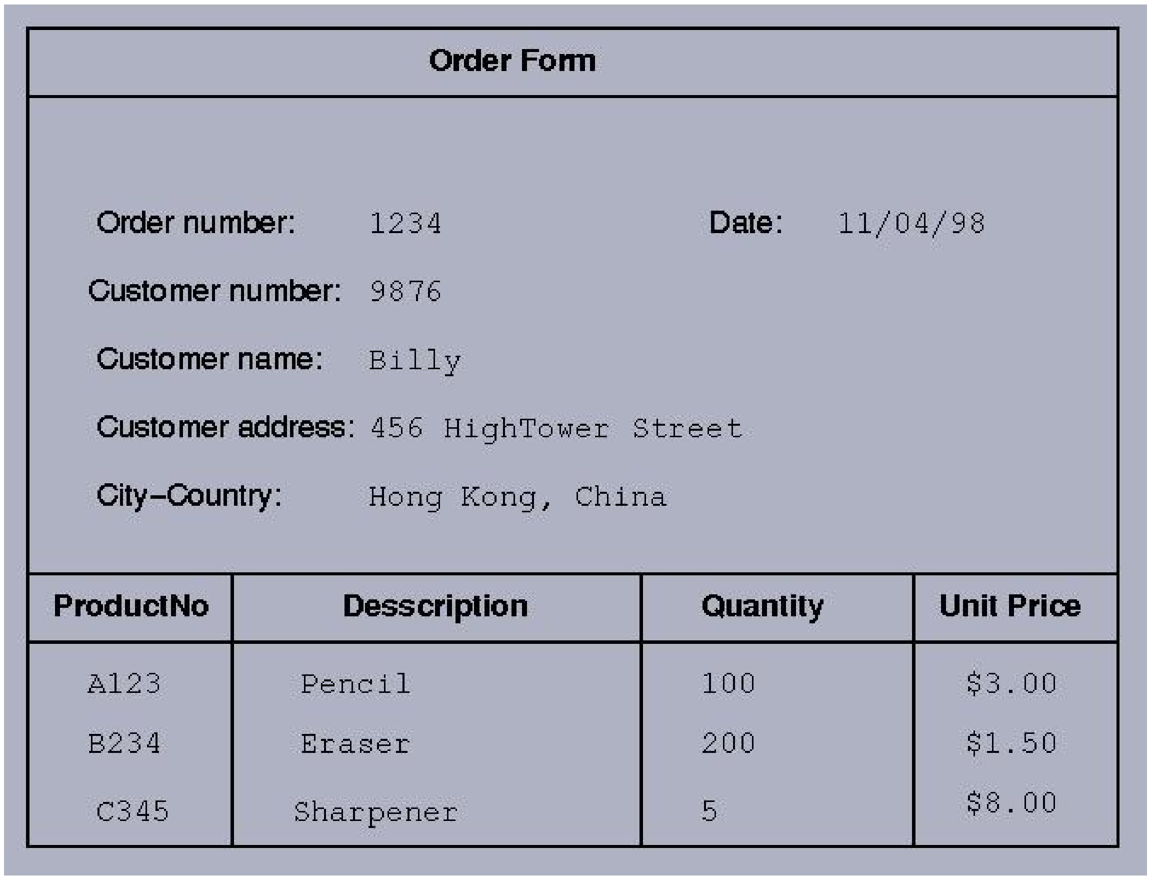
   It is often phrased as having "No Repeating Groups". The important part of this is consideration is that if multiple pieces of data are introduced with the same type/domain, they must be uniquely identifiable in the row without asking for the nth instance of that attribute. "Address_1" and "Address_2", for example, would not be appropriate. However, "shipping_address" and "billing_address" may be appropriate, depending on the business rules and the cardinality of the relationship.

   A 1:n cardinality, for instance, would not be appropriate to denormalize in this way. If any one entity had an exact number of named variants of the same domain (e.g. work and cell number), pulling them into the main relation may be appropriate. Your mileage may vary.

2. Each tuple in the relation must be uniquely identifiable with a primary key. A primary key can be an arbitrary auto-incrementing value, which is quite often the case. A primary key can be composed of multiple pieces of a tuple's data, as long as this data will never collide on multiple tuples. It is recommended that this primary key be composed of values which are likely never to change but also do not have confidentiality/security requirements. (e.g., a birth date in combination with other data may be appropriate, but a social security number would not be).

3. Groups of similar data should be wrapped in their own tables, *especially* if they have any cardinality other than 1:1 with any other data belonging to the same entity.

   In the exercise, individual products have a many:many cardinality with order forms, so products are best stored in their own table. The quantity of any given product on any given order



Order Form

Order number:	1234	Date:	11/04/98
Customer number:	9876		
Customer name:	Billy		
Customer address:	456 HighTower Street		
City–Country:	Hong Kong, China		

ProductNo	Desscription	Quantity	Unit Price
A123	Pencil	100	$3.00
B234	Eraser	200	$1.50
C345	Sharpener	5	$8.00

Figure 1: Order Form serving as source document for analysis

form is best stored as an attribute of an associative table between the order form primary key and the product primary key, since those are the determinants of the quantity.

To meet this criteria for first normal form, I examined only the cardinality between pieces of data and how they related as entities to the order form as an entity.

2 Second Normal Form

Second Normal Form requires firstly that data be in First Normal Form, and additionally that non-key data be completely functionally dependent on the primary key. A Functional Dependency occurs between two attributes when for any given value of the determinant, the dependent will only have one possible value at any given time. So to say, Functional Dependency is like a one-way 1:1 cardinality between individual attributes of a relation. The reverse need not be true; a duplicate value of dependent can occur in many places, being referenced by different determinants, but for any value of determinant, only one value of dependant exists.

A Transitive Dependency is like the transitive property in logic or algebra. E.g, if A implies B, which implies C, then by the transitive property means A implies C.

Transitive Functional Dependencies are legal in 2NF, so no structural changes need to be made to the tables. However, it is useful to recognize where transitive functional dependencies are, which can be seen in the Second Normal Form subgraph. Any node which has arrows into and out of it is a point of transitive dependency.

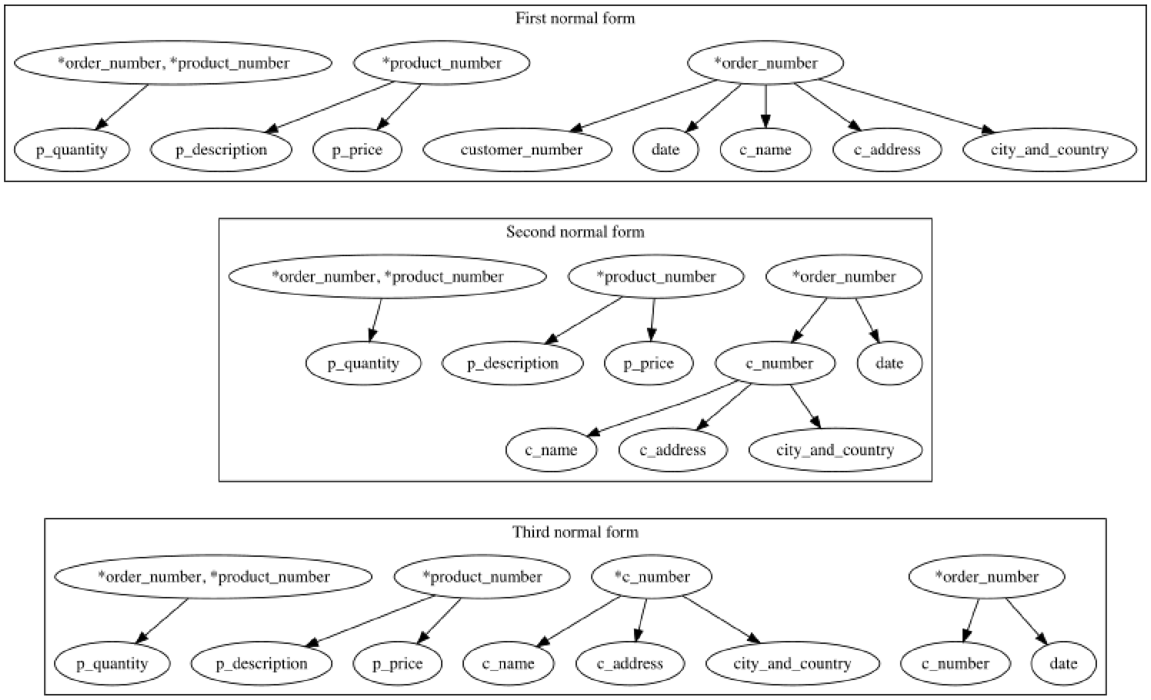


Figure 2: Dependency graph for First, Second, and Third normal forms

3 Third Normal Form

Third Normal Form, like the normal forms before it, requires that data satisfy the prior Normal Form, and that no attributes which are not part of the primary key have a Transitive Dependency on the primary key. To that end, the changes made to the structure of the data to make it comply with 3NF are to move any transitive dependencies into their own relations. In the Exercise, this can be done by splitting off the customer number and its dependents – name, address, and city/country – into their own relation. Then the customer number becomes the primary key for its own relation, and it is referenced as a foreign key by the order form relation.