Fifth Normal Form

Watch video: https://youtu.be/rFMEZG3UZM8?t=1h16m00s

Fifth Normal Form (5NF)

- A relation that decomposes into two relations must have the lossless-join property, which ensures that no spurious tuples are generated when relations are reunited through a natural join operation.

- However, if there are requirements to decompose a relation into more than two relations. Although rare, these cases are managed by join dependency and fifth normal form (5NF).

- 5NF arises when a table has a composite key made up of at least 3 attributes.

5NF – Example One

- Consider the table below.
  AGENTCOMPANYPRODUCT (Agent, Company, Product)
  Primary key Agent, Company, Product

- This table lists agents, the companies they work for and the products they sell for those companies. 'The agents do not necessarily sell all the products supplied by the companies they do business with'. An example of this table might be:

Agent	Company	Product
Suneet	ABC	Nut
Suneet	ABC	Screw
Suneet	CDE	Bolt
Raj	ABC	Bolt

5NF – Example One

- The table is necessary in order to show all the information required. Suneet, for example, sells ABC's Nuts and Screws, but not ABC's Bolts. Raj is not an agent for CDE and does not sell ABC's Nuts or Screws. The table is in 4NF because it contains no multi-valued dependency. It does, however, contain an element of redundancy in that it records the fact that Suneet is an agent for ABC twice. But there is no way of eliminating this redundancy without losing information.

5NF – Example One

- Now, if an agent is an agent for a company and that company makes a product, then the agents always sells that product for the company. An example of this table might be:

Agent	Company	Product
Suneet	ABC	Nut
Suneet	ABC	Bolt
Suneet	CDE	Bolt
Raj	ABC	Nut
Raj	ABC	Bolt

- Now we can see that if we add another Agent such as Jake for company ABC, then we must insert 2 tuples:
  - 1 to specify that Jake sells Nuts for ABC, and
  - 1 to specify that Jake sells Bolts for ABC.

5NF – Example One

- Fifth normal form is based on the concept of join dependence. If a relation has a join dependency then it can be decomposed into smaller relations such that one can rejoin these relations to reproduce the original relation.

- A 5NF relation does not have any join dependencies.

- This example table (AGENTCOMPANYPRODUCT) has a join dependency.

5NF – Example One

- Suppose the table is decomposed into its three relations P1, P2, and P3.

Agent	Company
Suneet	ABC
Suneet	CDE
Raj	ABC

P1

Agent	Product
Suneet	Nut
Suneet	Bolt
Raj	Bolt
Raj	Nut

P2

Company	Product
ABC	Nut
ABC	Bolt
CDE	Bolt

P3

5NF – Example One

- From the above tables if we perform a natural join between any of the two above relations, then extra rows can be added so this decomposition is called **lossy decomposition**.
- Join P1 and P2

Agent	Company	Product
Suneet	ABC	Nut
Suneet	ABC	Bolt
Suneet	CDE	Nut
Suneet	CDE	Bolt
Raj	ABC	Nut
Raj	ABC	Bolt

- A spurious tuple results.

5NF – Example One

- But if we perform a natural join between the above three tables then no extra rows are added so this decomposition is called **lossless decomposition**.

Agent	Company	Product
Suneet	ABC	Nut
Suneet	ABC	Bolt
Suneet	CDE	Bolt
Raj	ABC	Nut
Raj	ABC	Bolt

- So, the above three tables P1, P2, and P3 are in 5NF.

Fifth Normal Form (5NF)

- **A relation is in the *fifth normal form* (5NF) if every join dependency in it is implied by candidate keys**.

- A join dependency implies there is a lossless non-additive decomposition into smaller relations.
  - lossless: no loss of tuples when relations are joined
  - non-additive: no spurious tuples generated when relations are joined.

5NF – Example Two

- If a property requires an Item and a Supplier supplies that item and the supplier already supplies at least one item to that property then the supplier will also supply the item to the property.
- Therefore there is a join dependency.

5NF – Example Two

PropertyItemSupplier (Illegal state)

propertyNo	itemDescription	supplierNo
PG4	Bed	S1
PG4	Chair	S2
PG16	Bed	S2

When this tuple is added to relation.

PropertyItemSupplier (Legal state)

propertyNo	itemDescription	supplierNo
PG4	Bed	S1
PG4	Chair	S2
PG16	Bed	S2
PG4	Bed	S2

This new tuple must also be added to exist in any legal state of the relation.

When tuple 3 is added we can see that supplier S2 supplies a Bed to property PG16, then we need to add a tuple (record) indicating that supplier S2 can also supply a Bed to property PG4.

5NF – Example Two

PropertyItem

propertyNo	itemDescription
PG4	Bed
PG4	Chair
PG16	Bed

ItemSupplier

itemDescription	supplierNo
Bed	S1
Chair	S2
Bed	S2

PropertySupplier

propertyNo	supplierNo
PG4	S1
PG4	S2
PG16	S2