|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Customer N.** | **Model** | **Shipping Address** | **Producer** | **Phone** | **Price(x100$)** |
| Alan Smith | Golf | 35 Palm St, Miami | Volkswagen AG | (090) 555 6688 | 250 |
| Roger Banks | Fiesta | 47 Camp. Road, Boston | Ford MC | (090) 600 9090 | 300 |
| Evan Wilson | Golf, Focus | 28 Rock Av, Denver | Volkswagen AG, Ford MC | *Both* | 450 |
| Alan Smith | Fiesta | 47 Camp. Road, Boston | Ford MC | (090) 600 9090 | 300 |

*The relation above records the info of car producer company and the sale operations.*

Considering that relation perform:

1. **1NF decomposition**

* Each cell should be atomic
* Entries in an attribute should be same type
* Rows should at least one attribute that uniquely identifies it.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Cust ID\*** | **Customer N.** | **Model** | **Shipping Address** | **Producer** | **Phone** | **Price(x100$)** |
| 1 | Alan Smith | Golf | 35 Palm St, Miami | Volkswagen AG | (090) 555 6688 | 250 |
| 2 | Roger Banks | Fiesta | 47 Camp. Road, Boston | Ford MC | (090) 600 9090 | 300 |
| 3 | Evan Wilson | Golf | 28 Rock Av, Denver | Volkswagen AG | (090) 555 6688 | 250 |
| 3 | Evan Wilson | Focus | 28 Rock Av, Denver | Ford MC | (090) 600 9090 | 200 |
| 4 | Alan Smith | Fiesta | 47 Camp. Road, Boston | Ford MC | (090) 600 9090 | 300 |

1. **2NF (but not 3NF) decomposition**

To be in 2NF, each attribute (except non-key attributes) in the relation has to be dependent on only keys not any subset of keys.

Here attributes, *Cust ID* and *Model* can be a super key. In this case, attribute *Producer* is dependent on *Model*, which breaks the 2NF rule.

|  |  |  |  |
| --- | --- | --- | --- |
| **Cust ID\*** | **Customer N.** | **Model** | **Shipping Address** |
| 1 | Alan Smith | Golf | 35 Palm St, Miami |
| 2 | Roger Banks | Fiesta | 47 Camp. Road, Boston |
| 3 | Evan Wilson | Golf | 28 Rock Av, Denver |
| 3 | Evan Wilson | Focus | 28 Rock Av, Denver |
| 4 | Alan Smith | Fiesta | 47 Camp. Road, Boston |

|  |  |  |  |
| --- | --- | --- | --- |
| **Model\*** | **Producer** | **Phone** | **Price(x100$)** |
| Golf | Volkswagen AG | (090) 555 6688 | 250 |
| Fiesta | Ford MC | (090) 600 9090 | 300 |
| Focus | Ford MC | (090) 600 9090 | 200 |

|  |  |
| --- | --- |
| **Cust ID\*** | **Model\*** |
| 1 | Golf |
| 2 | Fiesta |
| 3 | Golf |
| 3 | Focus |
| 4 | Fiesta |

1. **3NF decomposition**

All attributes can be dependent on only key not other attribute.

Here there is a dependency between *Producer* and *Phone* so those should be placed in another table and referred in the table of interest.

|  |  |  |  |
| --- | --- | --- | --- |
| **Cust ID\*** | **Customer N.** | **Model** | **Shipping Address** |
| 1 | Alan Smith | Golf | 35 Palm St, Miami |
| 2 | Roger Banks | Fiesta | 47 Camp. Road, Boston |
| 3 | Evan Wilson | Golf | 28 Rock Av, Denver |
| 3 | Evan Wilson | Focus | 28 Rock Av, Denver |
| 4 | Alan Smith | Fiesta | 47 Camp. Road, Boston |

|  |  |  |
| --- | --- | --- |
| **Model\*** | **Producer -FK** | **Price(x100$)** |
| Golf | Volkswagen AG | 250 |
| Fiesta | Ford MC | 300 |
| Focus | Ford MC | 200 |

|  |  |
| --- | --- |
| **Producer\*** | **Phone** |
| Volkswagen AG | (090) 555 6688 |
| Ford MC | (090) 600 9090 |

|  |  |
| --- | --- |
| **Cust ID\*** | **Model\*** |
| 1 | Golf |
| 2 | Fiesta |
| 3 | Golf |
| 3 | Focus |
| 4 | Fiesta |

1. A decomposition {R1, R2} is a lossless-join decomposition if R1 ∩ R2 → R1 or R1 ∩ R2 → R2. Let R1 = (D, A, E), R2 = (D, B, C), and R1 ∩ R2 = D. Since D is a candidate key, therefore R1 ∩ R2 → R1.
2. result : = {R};

F+ = {D → ABCDE, A → B, AE → ABCDE, EB → ABCDE, C → ABCDE, …}.

R is not in BCNF. A → B is a non-trivial f.d. that holds on R, A ∩ B = ∅, and A → ABCDE is not in F+ .

Therefore, result := (result – R) ∪ (R – B) ∪ (A, B), i.e.

(D, A, B, C) ∪ (A, B).

(D, A, E, C) and (A,B) are in BCNF. So this is a decomposition of R into BCNF.