1. Hierarchical Database Model



1. Supertype and Subtype



1. Data Normalization
2. A list of all functional dependencies

{ Customer ID -> First name, Customer ID -> Last name, customer ID -> Address,

Customer ID -> phone

Customer ID -> account number, customer ID -> account type, customer ID -> Start Date, customer ID -> End Date, customer ID -> Due Date, customer ID -> Last Payment Amount , customer ID -> Last Payment Date

customer ID ->Voice PlanID #, customer ID -> Minutes , customer ID -> Amount

customer ID -> Internet PlanID# , customer ID -> MB used , customer ID -> Amount

customer ID -> Text PlanID# , customer ID -> No of Texts , customer ID -> Amount }

customer ID -> total

{Account no-> Account type, Account no -> start date, Account no -> end date,

Account no ->due date, Account no -> last payment amt, Account no -> last payment date, , Account no -> Voice PlanID #, Account no -> Minutes , Account no -> Amount

, Account no -> Internet PlanID# , Account no -> MB used , Account no -> Amount

, Account no -> Text PlanID# , Account no -> No of Texts , Account no -> Amount, Account no -> total }

{VoicePlanID-> per minute charge}

{internetPlanID ->per minute charge}

{TextPlanID ->per minute charge}

Candidate keys : customerID, Account no, voicePlanID, internetPlanID,TextPlanID

## **First normal form (1NF)**

As per the rule of first normal form, an attribute (column) of a table cannot hold multiple values. It should hold only atomic values.

The address field is a composite field and needs to be decomposed into fields with atomic values. It is divided into state, zipcode, streetaddress



**Second normal form (2NF)**

A table is said to be in 2NF if both the following conditions hold:

Table is in 1NF (First normal form)

No non-prime attribute is dependent on the proper subset of any candidate key of table.

As all the attributes are dependent on the customer ID except for the Per Minute Charge, Per MB Charge, Per Text Message Charge which are dependent on the VoicePlanID, InternetPlanID and TextPlanID respectively hence the composite table must be divided into 4 different tables



Now all the non-prime attributes in the tables are dependent the whole primary key

## **Third Normal form(3NF)**

A table design is said to be in 3NF if both the following conditions hold:

* Table must be in 2NF
* [Transitive functional dependency](https://beginnersbook.com/2015/04/transitive-dependency-in-dbms/) of non-prime attribute on any super key should be removed.

The account\_type, billing\_start,billing\_end, due\_date, last\_payment\_amt, last\_payment\_date,voice\_minutes, voice\_amount, mb\_used, data\_amount, no\_of\_texts,text\_amt and total wireless amt are dependent on the account\_no which is dependent on the customer\_id. This transitive dependency needs to be removed and hence the a new entity is created with the account\_no as the primary key.

