Experiment 2 - To perform various OLAP operations such as slice, dice, drilldown, rollup, pivot

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#Theory

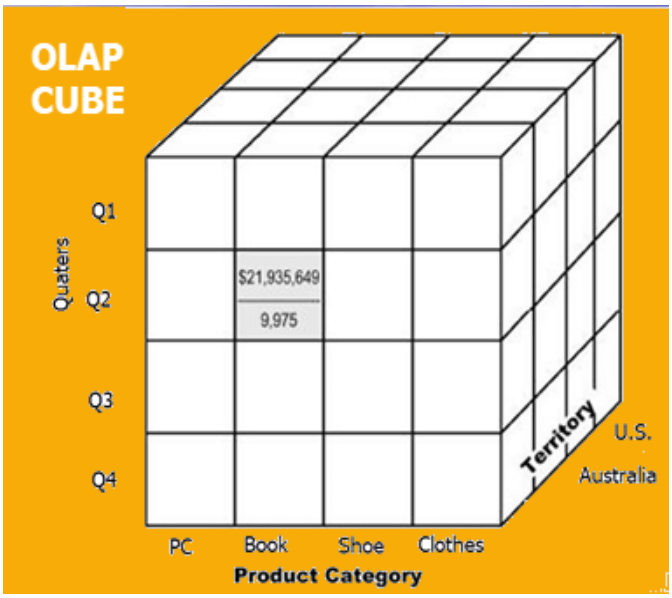
- **OLAP**

  OLAP stands for Online Analytical Processing. It is a technology that enables analysts to extract and view business data from different points of view. OLAP is a category of software that allows users to analyse information from multiple database systems at the same time

  Analysts frequently need to group, aggregate and join data. These operations in relational databases are resource intensive. With OLAP data can be pre-calculated and pre-aggregated, making analysis faster.

  OLAP databases are divided into one or more cubes. The cubes are designed in such a way that creating and viewing reports become easy.

- **OLAP cube**



At the core of the OLAP, concept is an OLAP Cube. The OLAP cube is a data structure optimized for very quick data analysis.

The OLAP Cube consists of numeric facts called measures which are categorized by dimensions. OLAP Cube is also called the hypercube.

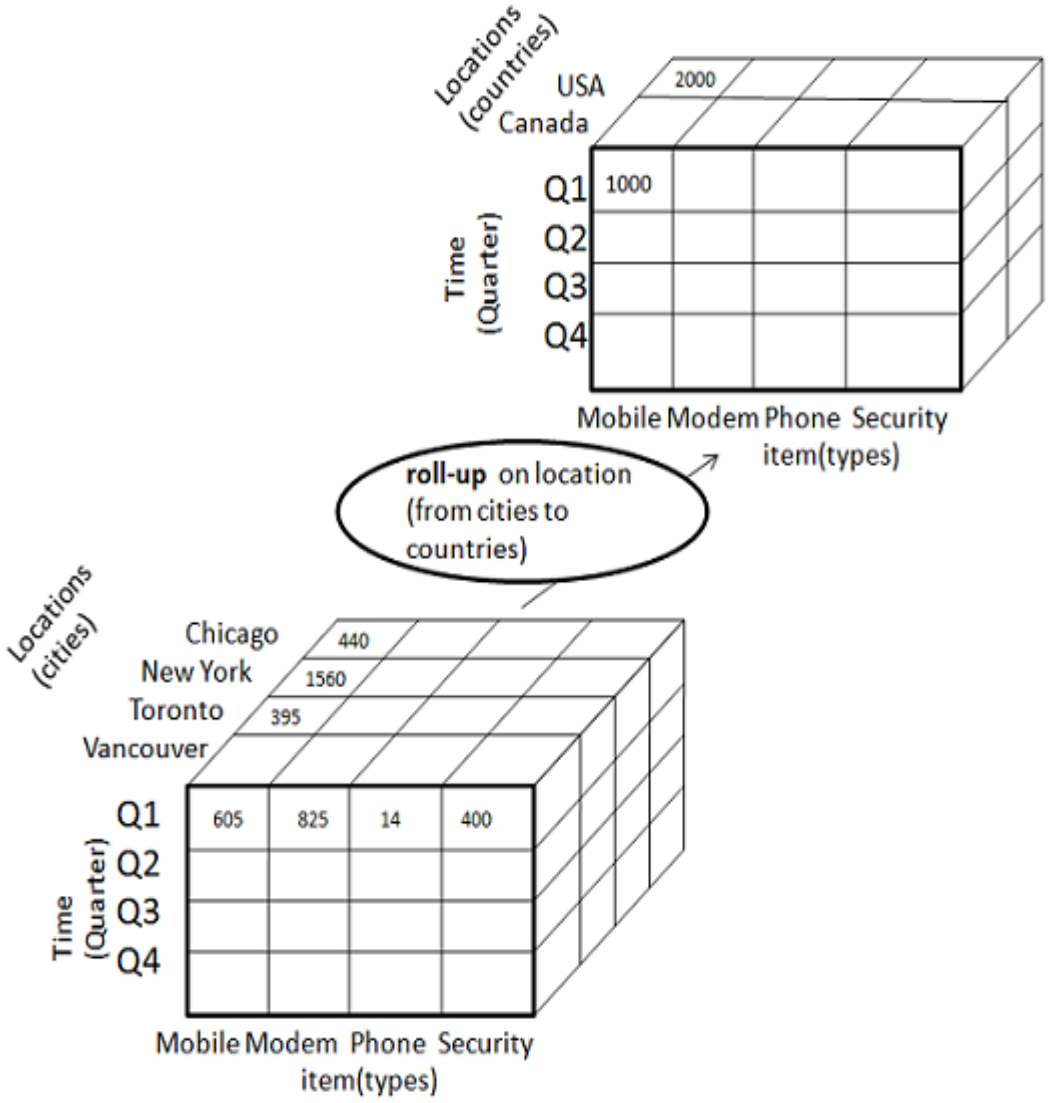
Usually, data operations and analysis are performed using the simple spreadsheet, where data values are arranged in row and column format. This is ideal for two-dimensional data. However, OLAP contains multidimensional data, with data usually obtained from a different and unrelated source. Using a spreadsheet is not an optimal option. The cube can store and analyse multidimensional data in a logical and orderly manner.

- **Operations of OLAP**
  1. **Roll-up**

     It performs aggregation on a data cube in any of the following ways:

     a. By climbing up a concept hierarchy for a dimension
     b. By dimension reduction

     The following diagram illustrates how roll-up works.



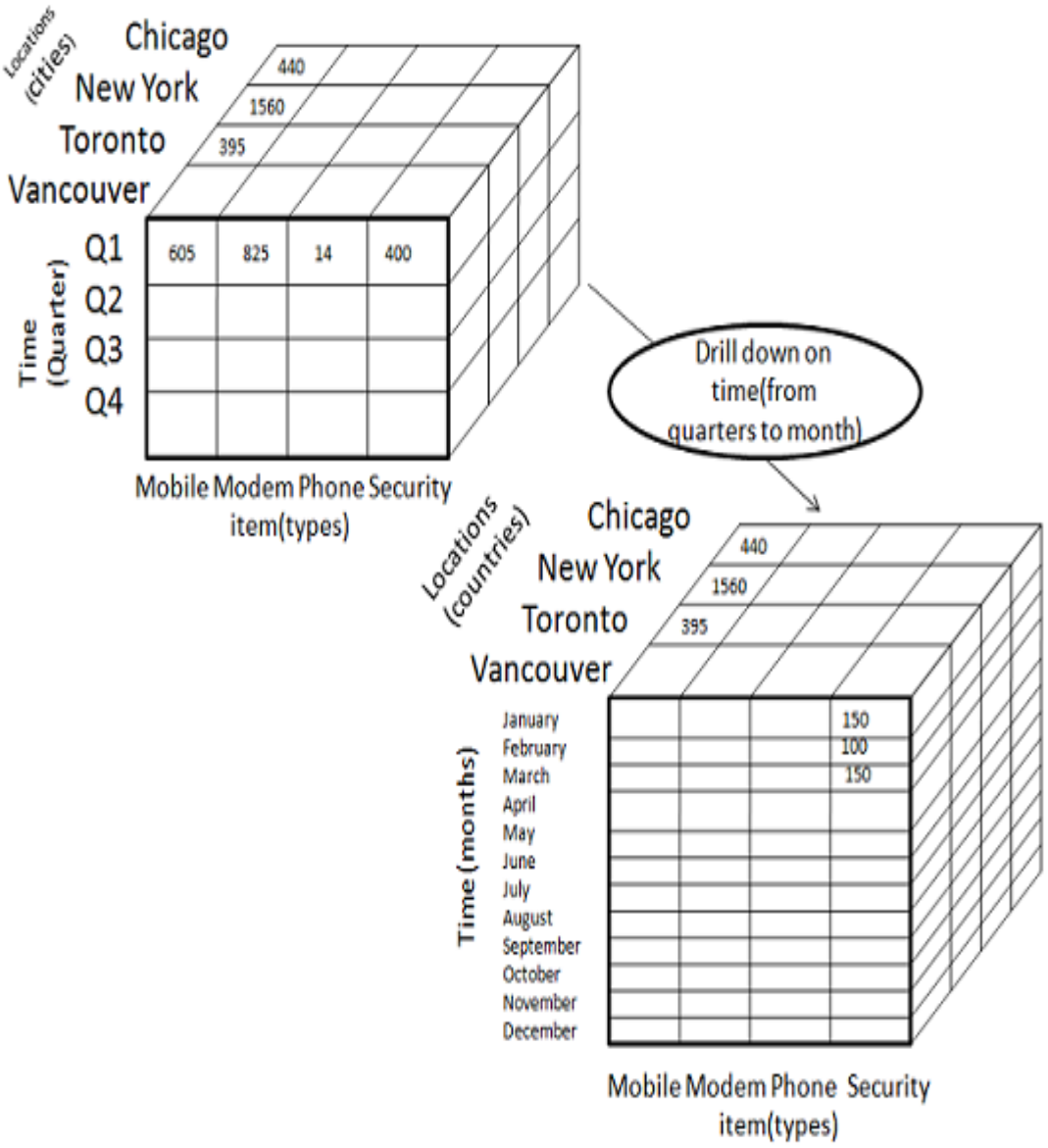
i. Roll-up is performed by climbing up a concept hierarchy for the dimension location.
ii. Initially the concept hierarchy was "street < city < province < country".
iii. On rolling up, the data is aggregated by ascending the location hierarchy from the level of city to the level of country.
iv. The data is grouped into cities rather than countries.
v. When roll-up is performed, one or more dimensions from the data cube are removed.

2. Drill-down

Drill-down is the reverse operation of roll-up. It is performed by either of the following ways:

a. By stepping down a concept hierarchy for a dimension
b. By introducing a new dimension.

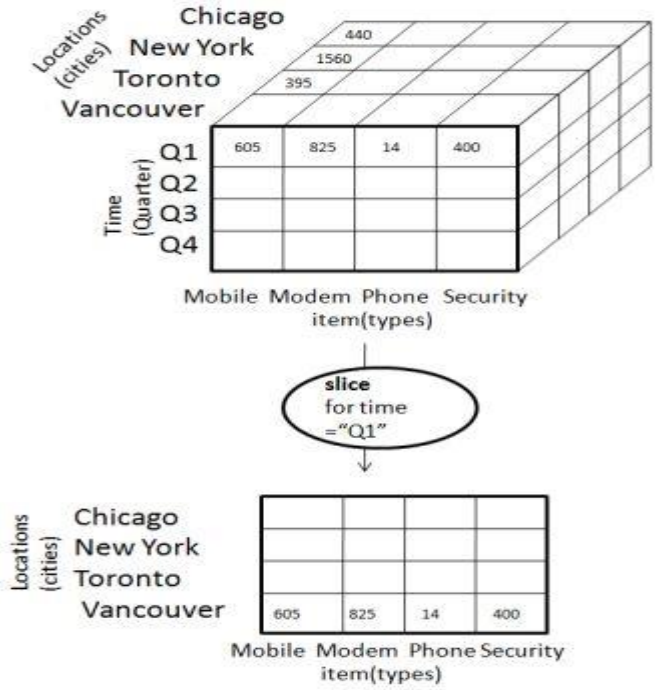
The following diagram illustrates how drill-down works



i. Drill-down is performed by stepping down a concept hierarchy for the dimension time.
ii. Initially the concept hierarchy was "day < month < quarter < year."
iii. On drilling down, the time dimension is descended from the level of quarter to the level of month.
iv. When drill-down is performed, one or more dimensions from the data cube are added.
v. It navigates the data from less detailed data to highly detailed data.

3. Slice

The slice operation selects one particular dimension from a given cube and provides a new sub-cube. Consider the following diagram that shows how slice works.

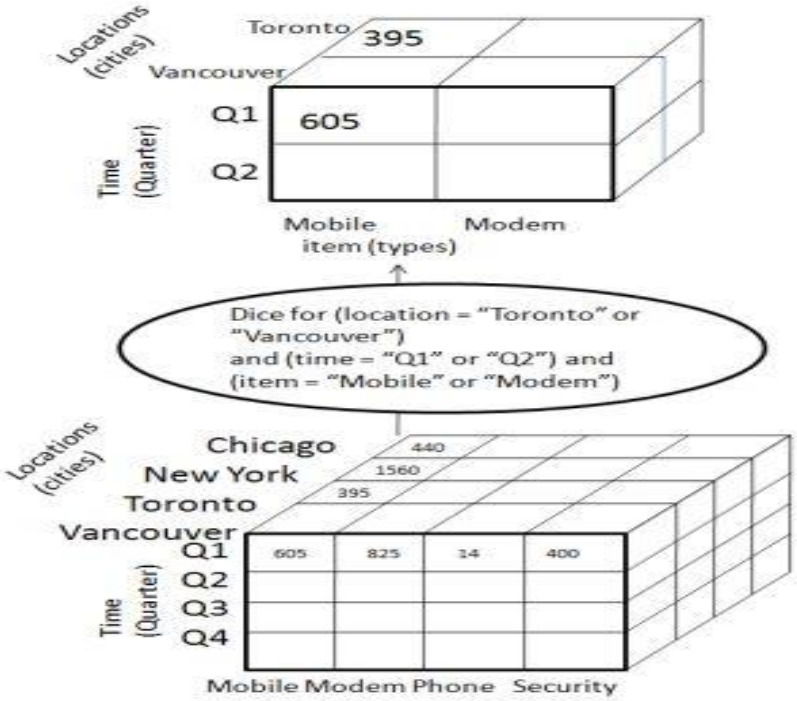


i. Here Slice is performed for the dimension "time" using the criterion time = "Q1".

ii. It will form a new sub-cube by selecting one or more dimensions.

4. Dice

Dice selects two or more dimensions from a given cube and provides a new sub-cube. Consider the following diagram that shows the dice operation.

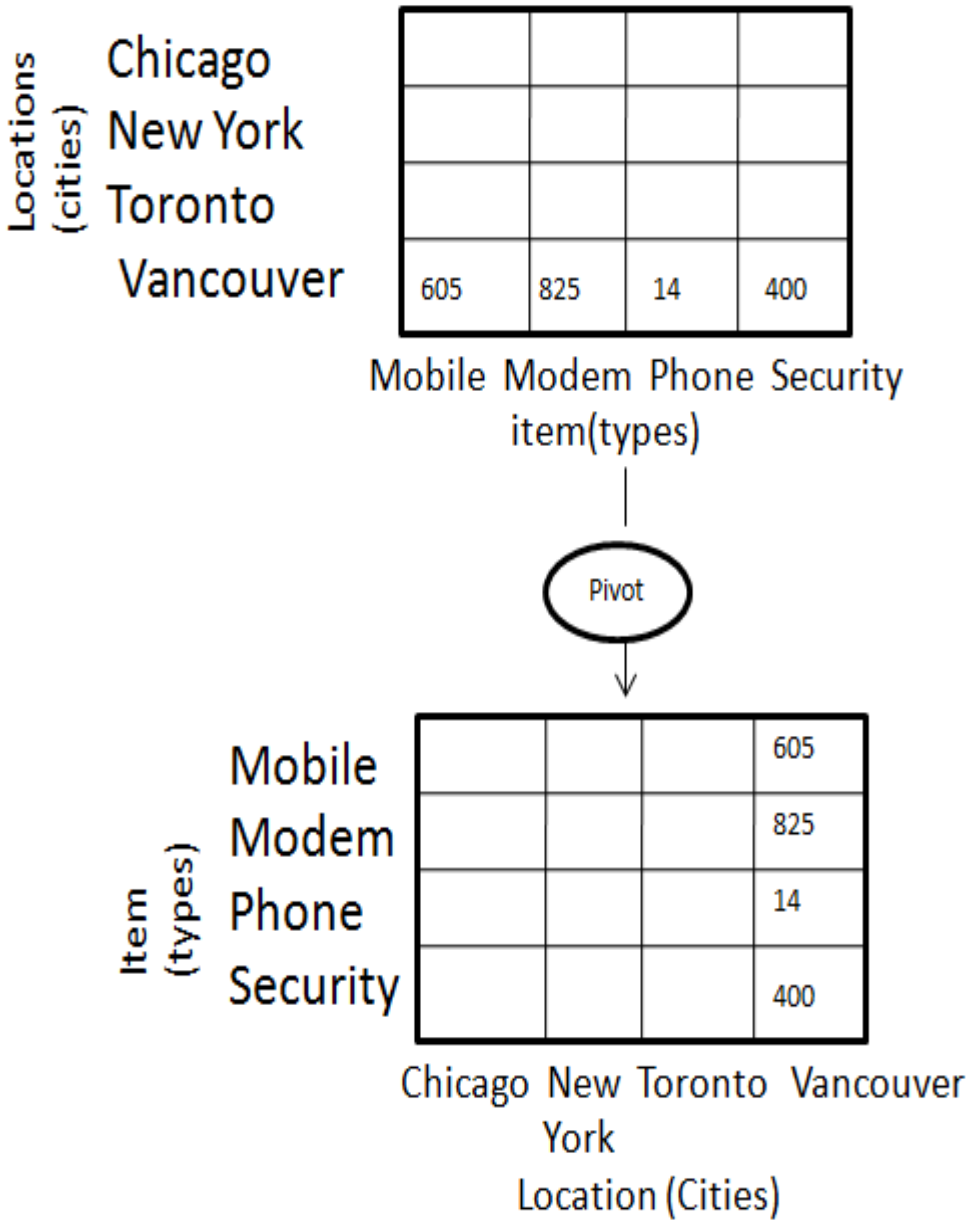


The dice operation on the cube based on the following selection criteria involves three dimensions.

i. (location = "Toronto" or "Vancouver")
ii. (time = "Q1" or "Q2")
iii. (item =" Mobile" or "Modem")

5. Pivot (rotate)

The pivot operation is also known as rotation. It rotates the data axes in view in order to provide an alternative presentation of data. Consider the following diagram that shows the pivot operation.



#Performing OLAP operations through MySQL

- **Creating Sales Table**

```
mysql>
mysql>
mysql> CREATE TABLE IF NOT EXISTS `OLAP`.`Sales` (
    ->   `year` INT NOT NULL,
    ->   `country` VARCHAR(50) NOT NULL,
    ->   `product` VARCHAR(50) NOT NULL,
    ->   `profit` VARCHAR(45) NULL,
    ->   PRIMARY KEY (`year`, `country`, `product`))
    -> ENGINE = InnoDB;
Query OK, 0 rows affected (0.37 sec)

mysql>
```

- **Describing Table Schema**

```
mysql>
mysql> desc Sales;
+---------+------------+------+-----+---------+-------+
| Field   | Type       | Null | Key | Default | Extra |
+---------+------------+------+-----+---------+-------+
| year    | int(11)    | NO   | PRI | NULL    |       |
| country | varchar(50) | NO   | PRI | NULL    |       |
| product | varchar(50) | NO   | PRI | NULL    |       |
| profit  | varchar(45) | YES  |     | NULL    |       |
+---------+------------+------+-----+---------+-------+
4 rows in set (0.00 sec)

mysql>
```

- **Inserting Values in table**

INSERT INTO `OLAP`.`Sales` (`year`, `country`, `product`, `profit`) VALUES (2019, 'India', 'Mobile', '50000');
INSERT INTO `OLAP`.`Sales` (`year`, `country`, `product`, `profit`) VALUES (2018, 'India', 'Computer', '80000');
INSERT INTO `OLAP`.`Sales` (`year`, `country`, `product`, `profit`) VALUES (2017, 'India', 'AC', '30000');

```
INSERT INTO `OLAP`.`Sales` (`year`, `country`, `product`, `profit`) VALUES (2016, 'India', 'Mixer', '15000');
INSERT INTO `OLAP`.`Sales` (`year`, `country`, `product`, `profit`) VALUES (2015, 'India', 'Fan', '60000');
INSERT INTO `OLAP`.`Sales` (`year`, `country`, `product`, `profit`) VALUES (2014, 'India', 'WashMachine', '12000');
INSERT INTO `OLAP`.`Sales` (`year`, `country`, `product`, `profit`) VALUES (2019, 'USA', 'Mobile', '30000');
INSERT INTO `OLAP`.`Sales` (`year`, `country`, `product`, `profit`) VALUES (2018, 'USA', 'Computer', '15000');
INSERT INTO `OLAP`.`Sales` (`year`, `country`, `product`, `profit`) VALUES (2017, 'USA', 'AC', '17000');
INSERT INTO `OLAP`.`Sales` (`year`, `country`, `product`, `profit`) VALUES (2016, 'USA', 'Mixer', '16000');
INSERT INTO `OLAP`.`Sales` (`year`, `country`, `product`, `profit`) VALUES (2015, 'USA', 'Fan', '13000');
INSERT INTO `OLAP`.`Sales` (`year`, `country`, `product`, `profit`) VALUES (2014, 'USA', 'WashMachine', '45000');
INSERT INTO `OLAP`.`Sales` (`year`, `country`, `product`, `profit`) VALUES (2019, 'China', 'Mobile', '32000');
INSERT INTO `OLAP`.`Sales` (`year`, `country`, `product`, `profit`) VALUES (2018, 'China', 'Computer', '31000');
INSERT INTO `OLAP`.`Sales` (`year`, `country`, `product`, `profit`) VALUES (2017, 'China', 'AC', '15000');
INSERT INTO `OLAP`.`Sales` (`year`, `country`, `product`, `profit`) VALUES (2016, 'China', 'Mixer', '38000');
INSERT INTO `OLAP`.`Sales` (`year`, `country`, `product`, `profit`) VALUES (2015, 'China', 'Fan', '51000');
INSERT INTO `OLAP`.`Sales` (`year`, `country`, `product`, `profit`) VALUES (2014, 'China', 'WashMachine', '12000');
INSERT INTO `OLAP`.`Sales` (`year`, `country`, `product`, `profit`) VALUES (2019, 'Korea', 'Mobile', '36000');
INSERT INTO `OLAP`.`Sales` (`year`, `country`, `product`, `profit`) VALUES (2018, 'Korea', 'Computer', '15000');
INSERT INTO `OLAP`.`Sales` (`year`, `country`, `product`, `profit`) VALUES (2017, 'Korea', 'AC', '41000');
INSERT INTO `OLAP`.`Sales` (`year`, `country`, `product`, `profit`) VALUES (2016, 'Korea', 'Mixer', '32000');
INSERT INTO `OLAP`.`Sales` (`year`, `country`, `product`, `profit`) VALUES (2015, 'Korea', 'Fan', '52000');
INSERT INTO `OLAP`.`Sales` (`year`, `country`, `product`, `profit`) VALUES (2014, 'Korea', 'WashMachine', '36000');
```

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```
mysql>
mysql>
mysql> INSERT INTO `OLAP`.`Sales` (`year`, `country`, `product`, `profit`) VALUES (2019, 'India', 'Mobile', '50000');
Query OK, 1 row affected (0.07 sec)

mysql> INSERT INTO `OLAP`.`Sales` (`year`, `country`, `product`, `profit`) VALUES (2018, 'India', 'Computer', '80000');
Query OK, 1 row affected (0.05 sec)

mysql> INSERT INTO `OLAP`.`Sales` (`year`, `country`, `product`, `profit`) VALUES (2017, 'India', 'AC', '30000');
Query OK, 1 row affected (0.06 sec)

mysql> INSERT INTO `OLAP`.`Sales` (`year`, `country`, `product`, `profit`) VALUES (2016, 'India', 'Mixer', '15000');
Query OK, 1 row affected (0.06 sec)

mysql> INSERT INTO `OLAP`.`Sales` (`year`, `country`, `product`, `profit`) VALUES (2015, 'India', 'Fan', '60000');
Query OK, 1 row affected (0.04 sec)

mysql> INSERT INTO `OLAP`.`Sales` (`year`, `country`, `product`, `profit`) VALUES (2014, 'India', 'WashMachine', '12000');
Query OK, 1 row affected (0.04 sec)

mysql> INSERT INTO `OLAP`.`Sales` (`year`, `country`, `product`, `profit`) VALUES (2019, 'USA', 'Mobile', '30000');
Query OK, 1 row affected (0.04 sec)

mysql> INSERT INTO `OLAP`.`Sales` (`year`, `country`, `product`, `profit`) VALUES (2018, 'USA', 'Computer', '15000');
Query OK, 1 row affected (0.04 sec)

mysql> INSERT INTO `OLAP`.`Sales` (`year`, `country`, `product`, `profit`) VALUES (2017, 'USA', 'AC', '17000');
Query OK, 1 row affected (0.04 sec)

mysql> INSERT INTO `OLAP`.`Sales` (`year`, `country`, `product`, `profit`) VALUES (2016, 'USA', 'Mixer', '16000');
Query OK, 1 row affected (0.04 sec)

mysql> INSERT INTO `OLAP`.`Sales` (`year`, `country`, `product`, `profit`) VALUES (2015, 'USA', 'Fan', '13000');
Query OK, 1 row affected (0.04 sec)

mysql> INSERT INTO `OLAP`.`Sales` (`year`, `country`, `product`, `profit`) VALUES (2014, 'USA', 'WashMachine', '45000');
Query OK, 1 row affected (0.05 sec)

mysql> INSERT INTO `OLAP`.`Sales` (`year`, `country`, `product`, `profit`) VALUES (2019, 'China', 'Mobile', '32000');
Query OK, 1 row affected (0.03 sec)

mysql> INSERT INTO `OLAP`.`Sales` (`year`, `country`, `product`, `profit`) VALUES (2018, 'China', 'Computer', '31000');
Query OK, 1 row affected (0.04 sec)

mysql> INSERT INTO `OLAP`.`Sales` (`year`, `country`, `product`, `profit`) VALUES (2017, 'China', 'AC', '15000');
Query OK, 1 row affected (0.05 sec)

mysql> INSERT INTO `OLAP`.`Sales` (`year`, `country`, `product`, `profit`) VALUES (2016, 'China', 'Mixer', '38000');
Query OK, 1 row affected (0.03 sec)

mysql> INSERT INTO `OLAP`.`Sales` (`year`, `country`, `product`, `profit`) VALUES (2015, 'China', 'Fan', '51000');
Query OK, 1 row affected (0.04 sec)

mysql> INSERT INTO `OLAP`.`Sales` (`year`, `country`, `product`, `profit`) VALUES (2014, 'China', 'WashMachine', '12000');
Query OK, 1 row affected (0.03 sec)

mysql> INSERT INTO `OLAP`.`Sales` (`year`, `country`, `product`, `profit`) VALUES (2019, 'Korea', 'Mobile', '36000');
Query OK, 1 row affected (0.04 sec)

mysql> INSERT INTO `OLAP`.`Sales` (`year`, `country`, `product`, `profit`) VALUES (2018, 'Korea', 'Computer', '15000');
Query OK, 1 row affected (0.03 sec)

mysql> INSERT INTO `OLAP`.`Sales` (`year`, `country`, `product`, `profit`) VALUES (2017, 'Korea', 'AC', '41000');
Query OK, 1 row affected (0.04 sec)

mysql> INSERT INTO `OLAP`.`Sales` (`year`, `country`, `product`, `profit`) VALUES (2016, 'Korea', 'Mixer', '32000');
Query OK, 1 row affected (0.04 sec)

mysql> INSERT INTO `OLAP`.`Sales` (`year`, `country`, `product`, `profit`) VALUES (2015, 'Korea', 'Fan', '52000');
Query OK, 1 row affected (0.03 sec)

mysql> INSERT INTO `OLAP`.`Sales` (`year`, `country`, `product`, `profit`) VALUES (2014, 'Korea', 'WashMachine', '36000');
Query OK, 1 row affected (0.04 sec)

mysql>
```

- **Displaying all values of table**

```
mysql>
mysql> select *from Sales;
+------+---------+-------------+--------+
| year | country | product     | profit |
+------+---------+-------------+--------+
| 2014 | China   | WashMachine | 12000  |
| 2014 | India   | WashMachine | 12000  |
| 2014 | Korea   | WashMachine | 36000  |
| 2014 | USA     | WashMachine | 45000  |
| 2015 | China   | Fan         | 51000  |
| 2015 | India   | Fan         | 60000  |
| 2015 | Korea   | Fan         | 52000  |
| 2015 | USA     | Fan         | 13000  |
| 2016 | China   | Mixer       | 38000  |
| 2016 | India   | Mixer       | 15000  |
| 2016 | Korea   | Mixer       | 32000  |
| 2016 | USA     | Mixer       | 16000  |
| 2017 | China   | AC          | 15000  |
| 2017 | India   | AC          | 30000  |
| 2017 | Korea   | AC          | 41000  |
| 2017 | USA     | AC          | 17000  |
| 2018 | China   | Computer    | 31000  |
| 2018 | India   | Computer    | 80000  |
| 2018 | Korea   | Computer    | 15000  |
| 2018 | USA     | Computer    | 15000  |
| 2019 | China   | Mobile      | 32000  |
| 2019 | India   | Mobile      | 50000  |
| 2019 | Korea   | Mobile      | 36000  |
| 2019 | USA     | Mobile      | 30000  |
+------+---------+-------------+--------+
24 rows in set (0.00 sec)

mysql>
```

- **Performing Rollup operation (getting sum of profit year-wise with rollup)**

```
mysql>
mysql>
mysql> select year,sum(profit) from Sales group by year;
+------+-------------+
| year | sum(profit) |
+------+-------------+
| 2014 |      105000 |
| 2015 |      176000 |
| 2016 |      101000 |
| 2017 |      103000 |
| 2018 |      141000 |
| 2019 |      148000 |
+------+-------------+
6 rows in set (0.02 sec)

mysql>
mysql>
mysql> select year,sum(profit) from Sales group by year with rollup;
+------+-------------+
| year | sum(profit) |
+------+-------------+
| 2014 |      105000 |
| 2015 |      176000 |
| 2016 |      101000 |
| 2017 |      103000 |
| 2018 |      141000 |
| 2019 |      148000 |
| NULL |      774000 |
+------+-------------+
7 rows in set (0.00 sec)

mysql>
mysql>
```

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```
mysql> select year,country,product,sum(profit) from Sales group by year,country,product with rollup;
+------+---------+------------+-------------+
| year | country | product    | sum(profit) |
+------+---------+------------+-------------+
| 2014 | China   | WashMachine |       12000 |
| 2014 | China   | NULL       |       12000 |
| 2014 | India   | WashMachine |       12000 |
| 2014 | India   | NULL       |       12000 |
| 2014 | Korea   | WashMachine |       36000 |
| 2014 | Korea   | NULL       |       36000 |
| 2014 | USA     | WashMachine |       45000 |
| 2014 | USA     | NULL       |       45000 |
| 2014 | NULL    | NULL       |      105000 |
| 2015 | China   | Fan        |       51000 |
| 2015 | China   | NULL       |       51000 |
| 2015 | India   | Fan        |       60000 |
| 2015 | India   | NULL       |       60000 |
| 2015 | Korea   | Fan        |       52000 |
| 2015 | Korea   | NULL       |       52000 |
| 2015 | USA     | Fan        |       13000 |
| 2015 | USA     | NULL       |       13000 |
| 2015 | NULL    | NULL       |      176000 |
| 2016 | China   | Mixer      |       38000 |
| 2016 | China   | NULL       |       38000 |
| 2016 | India   | Mixer      |       15000 |
| 2016 | India   | NULL       |       15000 |
| 2016 | Korea   | Mixer      |       32000 |
| 2016 | Korea   | NULL       |       32000 |
| 2016 | USA     | Mixer      |       16000 |
| 2016 | USA     | NULL       |       16000 |
| 2016 | NULL    | NULL       |      101000 |
| 2017 | China   | AC         |       15000 |
| 2017 | China   | NULL       |       15000 |
| 2017 | India   | AC         |       30000 |
| 2017 | India   | NULL       |       30000 |
| 2017 | Korea   | AC         |       41000 |
| 2017 | Korea   | NULL       |       41000 |
| 2017 | USA     | AC         |       17000 |
| 2017 | USA     | NULL       |       17000 |
| 2017 | NULL    | NULL       |      103000 |
| 2018 | China   | Computer   |       31000 |
| 2018 | China   | NULL       |       31000 |
| 2018 | India   | Computer   |       80000 |
| 2018 | India   | NULL       |       80000 |
| 2018 | Korea   | Computer   |       15000 |
| 2018 | Korea   | NULL       |       15000 |
| 2018 | USA     | Computer   |       15000 |
| 2018 | USA     | NULL       |       15000 |
```

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```
| 2015 | India   | NULL       |       60000 |
| 2015 | Korea   | Fan        |       52000 |
| 2015 | Korea   | NULL       |       52000 |
| 2015 | USA     | Fan        |       13000 |
| 2015 | USA     | NULL       |       13000 |
| 2015 | NULL    | NULL       |      176000 |
| 2016 | China   | Mixer      |       38000 |
| 2016 | China   | NULL       |       38000 |
| 2016 | India   | Mixer      |       15000 |
| 2016 | India   | NULL       |       15000 |
| 2016 | Korea   | Mixer      |       32000 |
| 2016 | Korea   | NULL       |       32000 |
| 2016 | USA     | Mixer      |       16000 |
| 2016 | USA     | NULL       |       16000 |
| 2016 | NULL    | NULL       |      101000 |
| 2017 | China   | AC         |       15000 |
| 2017 | China   | NULL       |       15000 |
| 2017 | India   | AC         |       30000 |
| 2017 | India   | NULL       |       30000 |
| 2017 | Korea   | AC         |       41000 |
| 2017 | Korea   | NULL       |       41000 |
| 2017 | USA     | AC         |       17000 |
| 2017 | USA     | NULL       |       17000 |
| 2017 | NULL    | NULL       |      103000 |
| 2018 | China   | Computer   |       31000 |
| 2018 | China   | NULL       |       31000 |
| 2018 | India   | Computer   |       80000 |
| 2018 | India   | NULL       |       80000 |
| 2018 | Korea   | Computer   |       15000 |
| 2018 | Korea   | NULL       |       15000 |
| 2018 | USA     | Computer   |       15000 |
| 2018 | USA     | NULL       |       15000 |
| 2018 | NULL    | NULL       |      141000 |
| 2019 | China   | Mobile     |       32000 |
| 2019 | China   | NULL       |       32000 |
| 2019 | India   | Mobile     |       50000 |
| 2019 | India   | NULL       |       50000 |
| 2019 | Korea   | Mobile     |       36000 |
| 2019 | Korea   | NULL       |       36000 |
| 2019 | USA     | Mobile     |       30000 |
| 2019 | USA     | NULL       |       30000 |
| 2019 | NULL    | NULL       |      148000 |
| NULL | NULL    | NULL       |      774000 |
+------+---------+------------+-------------+
55 rows in set (0.00 sec)

mysql>
```

- **Performing slice operation (getting 2014 year's product,country,year details)**

```
mysql>
mysql>
mysql> select product,country,year from Sales where year='2014';
+-------------+---------+------+
| product     | country | year |
+-------------+---------+------+
| WashMachine | China   | 2014 |
| WashMachine | India   | 2014 |
| WashMachine | Korea   | 2014 |
| WashMachine | USA     | 2014 |
+-------------+---------+------+
4 rows in set (0.00 sec)

mysql>
mysql>
mysql>
```

- **Performing dice operation (getting Indian, and Chinese country's 2014 to 2015 product,country,year details)**

```
mysql>
mysql>
mysql> select product,country,year,sum(profit) from Sales where (year=2014 or year=2015) and (Country="India" or Country="China") group by product,country,year order by year;
+------------+---------+------+------------+
| product    | country | year | sum(profit) |
+------------+---------+------+------------+
| WashMachine | China   | 2014 |      12000 |
| WashMachine | India   | 2014 |      12000 |
| Fan         | China   | 2015 |      51000 |
| Fan         | India   | 2015 |      60000 |
+------------+---------+------+------------+
4 rows in set (0.00 sec)

mysql>
```

- **Performing pivot operation (displaying product in title row, country in title column and the sum of profit in middle)**

```
mysql>
mysql>
mysql> select country as '',
    -> sum(IF(product='Mobile',profit,NULL))as Mobile,
    -> sum(IF(product='Mixer',profit,NULL))as Mixer,
    -> sum(IF(product='Fan',profit,NULL))as Fan,
    -> sum(IF(product='AC',profit,NULL))as AC,
    -> sum(IF(product='Mixer',profit,NULL))as Mixer,
    -> sum(IF(product='WashMachine',profit,NULL))as WashMachine
    -> from Sales group by country;
+-------+--------+-------+-------+-------+-------+-------------+
|       | Mobile | Mixer | Fan   | AC    | Mixer | WashMachine |
+-------+--------+-------+-------+-------+-------+-------------+
| China |  32000 | 38000 | 51000 | 15000 | 38000 |       12000 |
| India |  50000 | 15000 | 60000 | 30000 | 15000 |       12000 |
| Korea |  36000 | 32000 | 52000 | 41000 | 32000 |       36000 |
| USA   |  30000 | 16000 | 13000 | 17000 | 16000 |       45000 |
+-------+--------+-------+-------+-------+-------+-------------+
4 rows in set (0.00 sec)

mysql>
```

#Conclusion

From this experiment we learnt the essence of OLAP, what is meant by OLAP Cube and various OLAP operations. We have also implemented various OLAP operation such as roll-up, pivot, slice and dice using MySQL.