CONCEPT HIERARCHIES

In the multidimensional model, data are organized into multiple dimensions, and each dimension contains multiple levels of abstraction defined by concept hierarchies. This organization provides users with the flexibility to view data from different perspectives.

For example, we have attributes as day, temperature and humidity, we can group values in subsets and name these subsets, thus obtaining a set of hierarchies as shown in figure below.

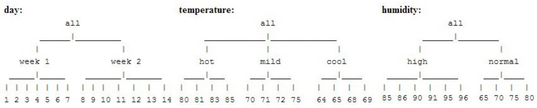

Fig 6: Concept hierarchy.

OLAP OPERATIONS

OLAP provides a user-friendly environment for interactive data analysis. A number of OLAP data cube operations exist to materialize different views of data, allowing interactive querying and analysis of the data.

The most popular end user operations on dimensional data are:

Roll up

The roll-up operation (also called drill-up or aggregation operation) performs aggregation on a data cube, either by climbing up a concept hierarchy for a dimension or by climbing down a concept hierarchy, i.e. dimension reduction. Let me explain roll up with an example:

Consider the following cube illustrating temperature of certain days recorded weekly:

temperature	64	65	68	69	70	71	72	75	80	81	83	85
week 1	1	0	1	0	1	0	0	0	0	0	1	0
week 2	0	0	0	1	0	0	1	2	0	1	0	0

Fig 7: Example.

Assume we want to set up levels (hot(80-85), mild(70-75), cold(64-69)) in temperature from the above cube. To do this we have to group columns and add up the values according to the concept hierarchy. This operation is called roll-up.
By doing this we obtain the following cube:

temperature	cool	mild	hot
week 1	2	1	1
week 2	1	3	1

Fig 8: Rollup.

The concept hierarchy can be defined as hot-->day-->week. The roll-up operation groups the data by levels of temperature.

Roll Down

The roll down operation (also called drill down) is the reverse of roll up. It navigates from less detailed data to more detailed data. It can be realized by either stepping down a concept hierarchy for a dimension or introducing additional dimensions. Performing roll down operation on the same cube mentioned above:

	cool	mild	hot
day 1	0	0	0
day 2	0	0	0
day 3	0	0	1
day 4	0	1	0
day 5	1	0	0
day 6	0	0	0
day 7	1	0	0
day 8	0	0	0
day 9	1	0	0
day 10	0	1	0
day 11	0	1	0
day 12	0	1	0
day 13	0	0	1
day 14	0	0	0

Fig 9: Rolldown.

The result of a drill-down operation performed on the central cube by stepping down a concept hierarchy for temperature can be defined as day<--week<--cool. Drill-down occurs by descending the time hierarchy from the level of week to the more detailed level of day. Also new dimensions can be added to the cube, because drill-down adds more detail to the given data.

Slicing

Slice performs a selection on one dimension of the given cube, thus resulting in a subcube. For example, in the cube example above, if we make the selection, temperature=cool we will obtain the following cube:

	cool
day 1	0
day 2	0
day 3	0
day 4	0
day 5	1
day 6	0
day 7	1
day 8	0
day 9	1
day 10	0
day 11	0
day 12	0
day 13	0
day 14	0

Fig 10: Slicing.

Dicing

The dice operation defines a subcube by performing a selection on two or more dimensions. For example, applying the selection (time = day 3 OR time = day 4) AND (temperature = cool OR temperature = hot) to the original cube we get the following subcube (still two-dimensional):

	cool	hot
day 3	0	1
day 4	0	0

Fig 11: Dice

Pivot

Pivot otheriwise known as Rotate changes the dimensional orientation of the cube, i.e. rotates the data axes to view the data from different perspectives. Pivot groups data with different dimensions. The below cubes shows 2D represntation of Pivot.

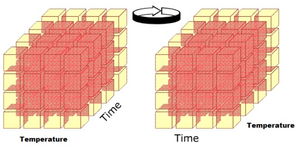

Fig 12: Pivot

Other OLAP operations

Some more OLAP operations include:

SCOPING: Restricting the view of database objects to a specified subset is called scoping. Scoping will allow users to recieve and update some data values they wish to recieve and update.

SCREENING: Screening is performed against the data or members of a dimension in order to restrict the set of data retrieved.

DRILL ACROSS: Accesses more than one fact table that is linked by common dimensions. COmbiens cubes that share one or more dimensions.

DRILL THROUGH: Drill down to the bottom level of a data cube down to its back end relational tables.

In Summary:

- Concept hierarchies organize the values of attributes or dimensions into abstraction levels. They are useful in mining at multiple abstraction levels.
- Typical OLAP operations include roll-up, and drill-(down, across, through), slice-and-dice, and pivot (rotate), as well as some statistical operations.
- OLAP operations can be implemented efficiently using the data cube structure.