Unit 11
Online Analytical Processing (OLAP)
Basic Concepts

OLAP vs. OLTP

- We have focused until now on ***OLTP***: Online Transaction Processing
- This dealt with storing data both logically and physically and managing transactions querying and modifying the data
- We will now focus on providing support for analytical queries, essentially statistical and summary information for decision-makers, that is on ***OLAP***: Online Analytical Processing
- This may be accomplished by preprocessing, for efficiency purposes, and producing special types of views, which are also not necessarily up to date
  - Not up to date may not be a problem in OLAP
- Data for OLAP (and more generally for data mining) is frequently stored in a ***Data Warehouse***

Example

- Our company has several stores and sells several products
- The stores are in different locations
- The locations, identified by (city, state) pairs are grouped into several regions
- We divide the time of sale into four quarters
- The quarters are grouped into two half-years

Our Company

Store	Store#	City	State	Region
	Alpha	New York	NY	NE
	Beta	Albany	NY	NE

Quarter	Quarter#	Half_Year
	1	First
	2	First
	3	Second
	4	Second

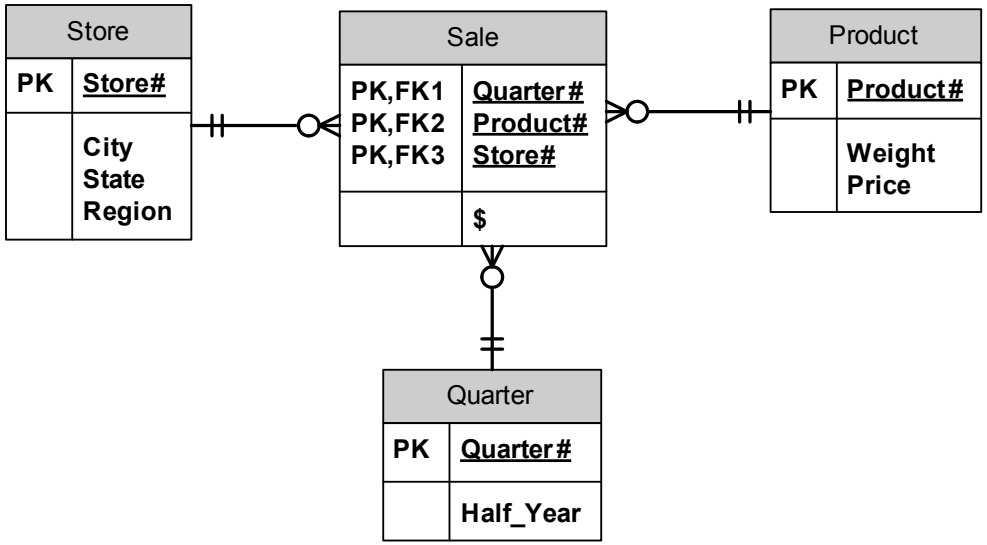
Product	Product#	Weight	Price
	Book	4	100
	Glass	15	200

Our Sales

Sale	Store#	Product#	Quarter#	$
	Alpha	Book	1	70,000
	Alpha	Glass	1	90,000
	Beta	Book	1	90,000
	Beta	Glass	1	80,000
	Alpha	Book	2	90,000
	Alpha	Glass	2	90,000
	Beta	Book	2	60,000
	Beta	Glass	2	50,000
	Alpha	Book	3	60,000
	Alpha	Glass	3	80,000
	Beta	Book	3	50,000
	Beta	Glass	3	90,000
	Alpha	Book	4	50,000
	Alpha	Glass	4	50,000
	Beta	Book	4	70,000
	Beta	Glass	4	70,000

Star Schema

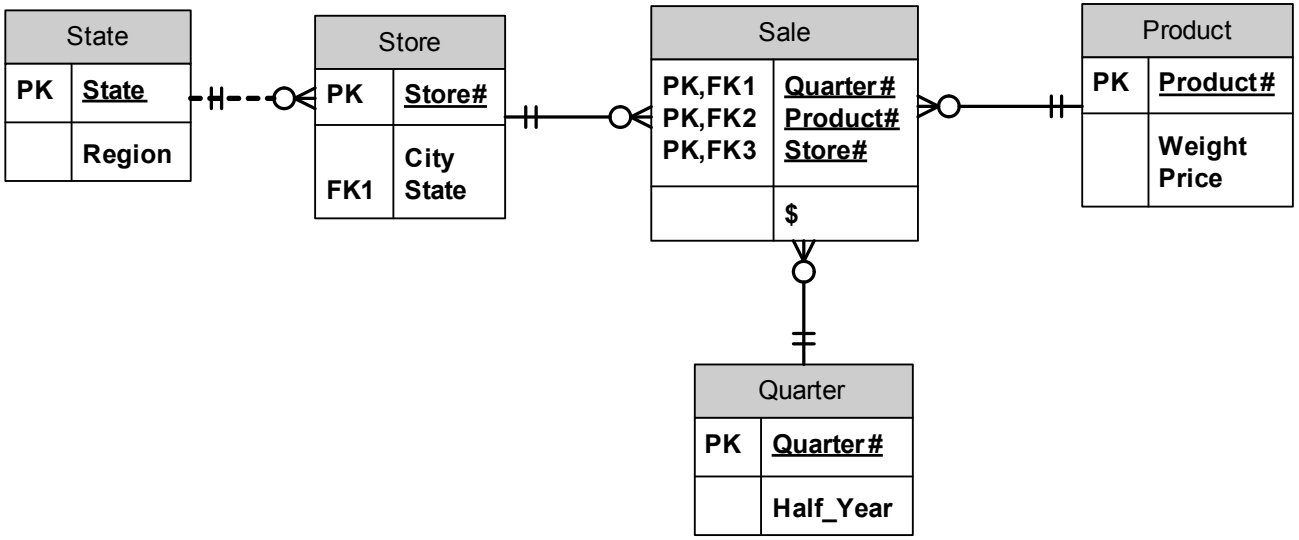
- We want to support queries useful for statistical analysis by computing various sums, averages, etc.
- The structure we have is a ***star schema***
- In the middle we have our ***facts table***



Snowflake Schema: Normalized Star Schema

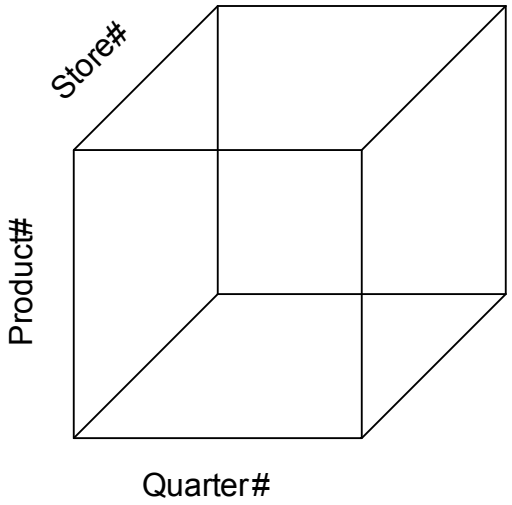
- One could also normalize, as table Store is not normalized, since State → Region

- Then, one could get, which we will not consider further, a ***snowflake schema***



Cube

- We could think of each row of fact table as occupying a voxel (volume element) in a ***cube***



- Cubes, in general, can have any number of dimensions; in our example there are three

- This cube can then be ***sliced and diced***

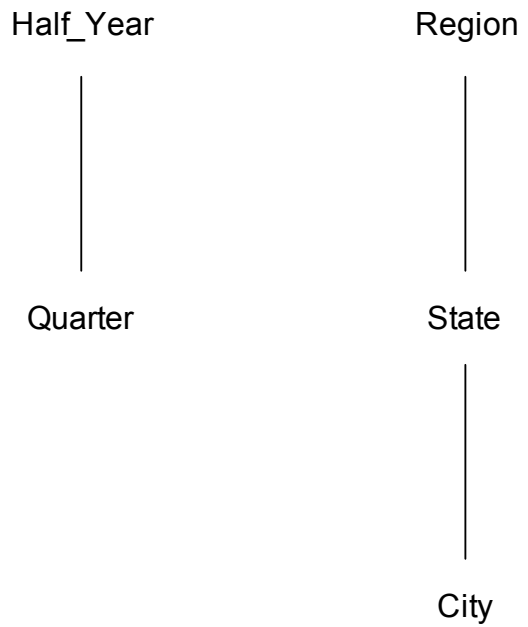
Slice

- SELECT Store#, Product#, SUM($)
  FROM Sale
  GROUP BY Store#, Product#

- We can do all kinds of such slices

Dimension Hierarchies

- Dimensions could have hierarchies (or more generally even lattices)
- We have two very simple hierarchies
  - One temporal: quarters are in half years
  - One geographical: cities are in states are in regions



Using Hierarchies

- SELECT Sale.Product#, Quarter.Half_Year, SUM($)
  FROM Sale, Quarter
  WHERE Sale.Quarter# = Quarter.Quarter#
  GROUP BY Half_Year;

- Will produce summaries by half years, not quarters

New Operator: CUBE

- SELECT Store#, Product#, SUM($)
  FROM Sale
  GROUP BY CUBE (Store#, Product#);

- Will produce all possible aggregations based on subsets of {Store#, Product#}, best explained by looking at what will come out

	Store#	Product#	$
	Alpha	Book	270,000
	Alpha	Glass	310,000
	Beta	Book	270,000
	Beta	Glass	290,000
	Alpha	NULL	580,000
	Beta	NULL	560,000
	NULL	Book	540,000
	NULL	Glass	600,000
	NULL	NULL	1,140,000

New Operator: ROLLUP

- ROLLUP produces only some of the aggregate operators produced by CUBE, best explained by example
- SELECT Store#, Product#, SUM($)
  FROM Sale
  GROUP BY ROLLUP (Store#,Product#);

	Store#	Product#	$
	Alpha	Book	270,000
	Alpha	Glass	310,000
	Beta	Book	270,000
	Beta	Glass	290,000
	Alpha	NULL	580,000
	Beta	NULL	560,000
	NULL	NULL	1,140,000

Key Ideas

- OLAP vs. OLTP
- Star schema
- Snowflake schema
- Cube
- Slicing and dicing
- Dimension hierarchies
- ROLAP
- MOLAP