INFO20003 Database Systems

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Dr Renata Borovica-Gajic

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Lecture 19

Data Warehousing

Week 10

Coverage

By the end of this class you should be able to:

- Articulate the differences between **transactional** (operational) and **informational** (dimensional) databases
- Explain the **characteristics of a DW**
- Understand and explain the **overall architecture of a DW**
- Design **Star Schemas**

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Part 1: Introduction to Data Warehousing

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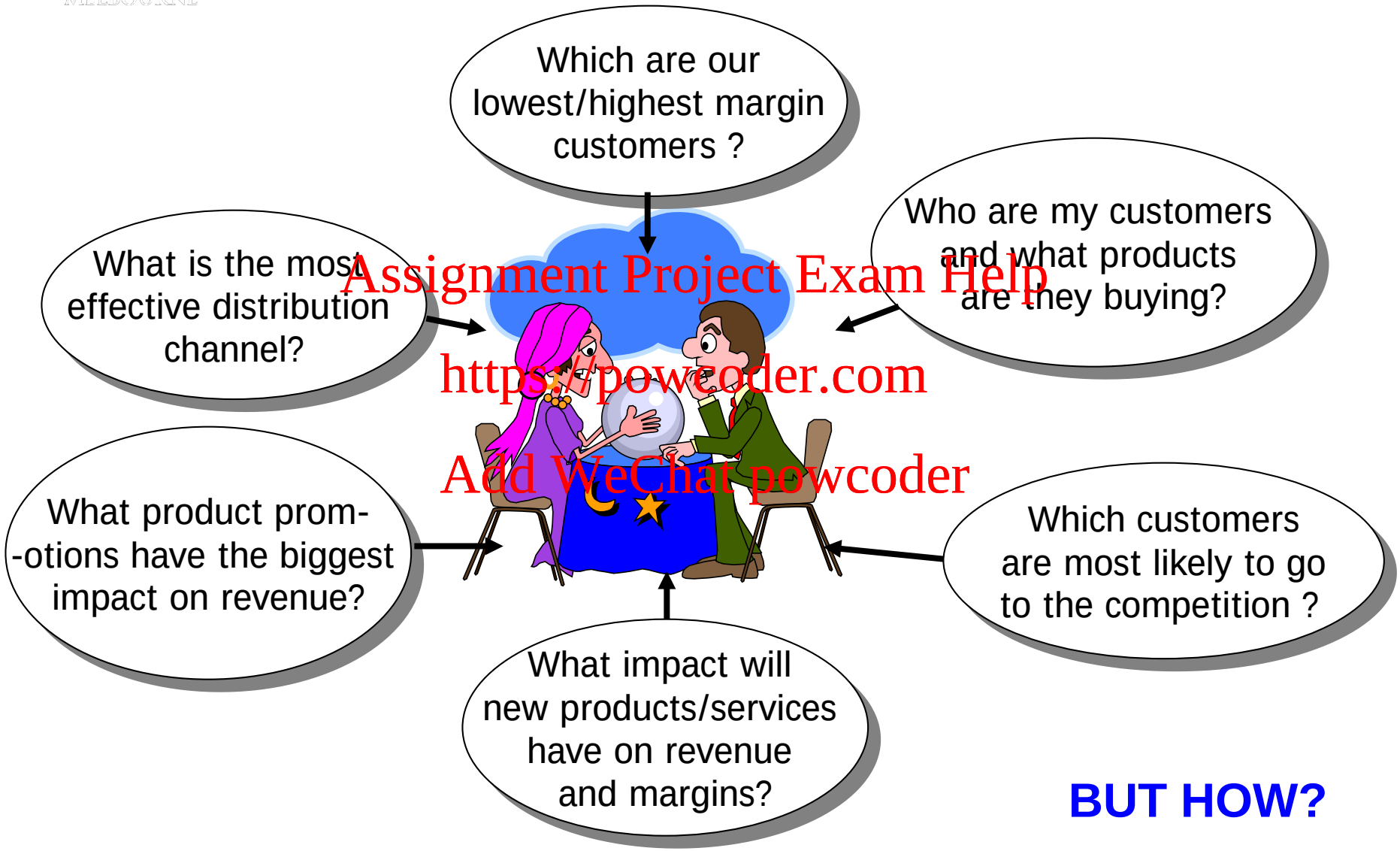
Motivations: A manager wants to know….



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Relational Databases for Operational Processing

- Used to run day to day business operations
- Automation of routine business processes
  - Accounting
  - Inventory
  - Purchasing
  - Sales
- Created huge efficiencies

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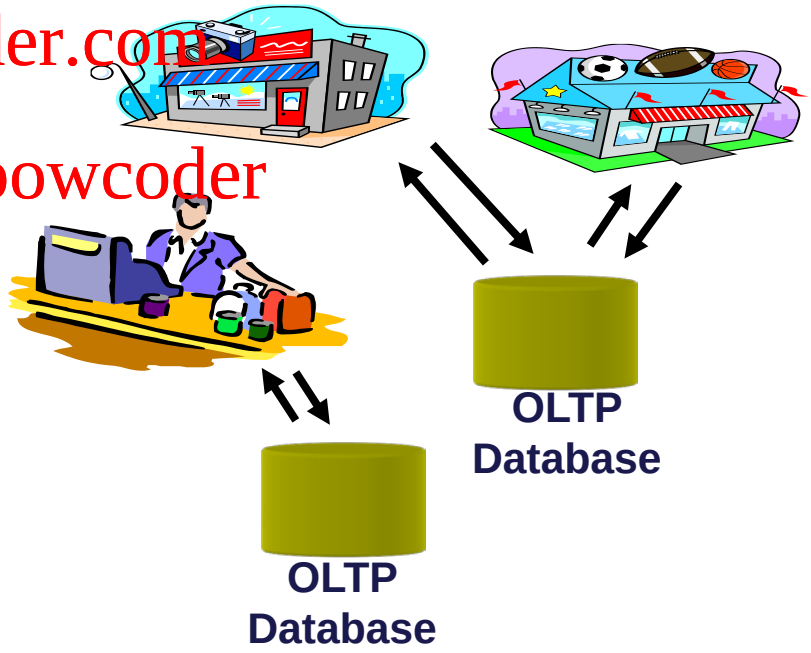

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Databases are great, BUT for business…

- Too many of them
  - Everybody wanted one, or two, or more
  - Production, Marketing, Sales, Accounting …
- Everybody got what was best for them
  - IBM, Oracle, Access, Microsoft
- Eventually this re-created the problem databases were meant to solve
  - Duplicated data
  - Inaccessible data
  - Inconsistent data

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But data is useful for analysis and decision making

What can we do about it?

- Need an integrated way of getting the ENTIRE organisational data

- Its really an Informational Database, rather than a Transactional Database
  - A single database that allows *all* of the organisations data to be stored in a form that can be used to support organisational decision processes

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Warehouse: An Informational Database

- **Data Warehouse:**
  - A single repository of organisational data
  - Integrates data from multiple sources
    - Extracts data from source systems, transforms, loads into the warehouse
  - Makes data available to managers/users
  - Supports analysis and decision-making
- Involve a large data store (often several Terabytes, Petabytes of data)

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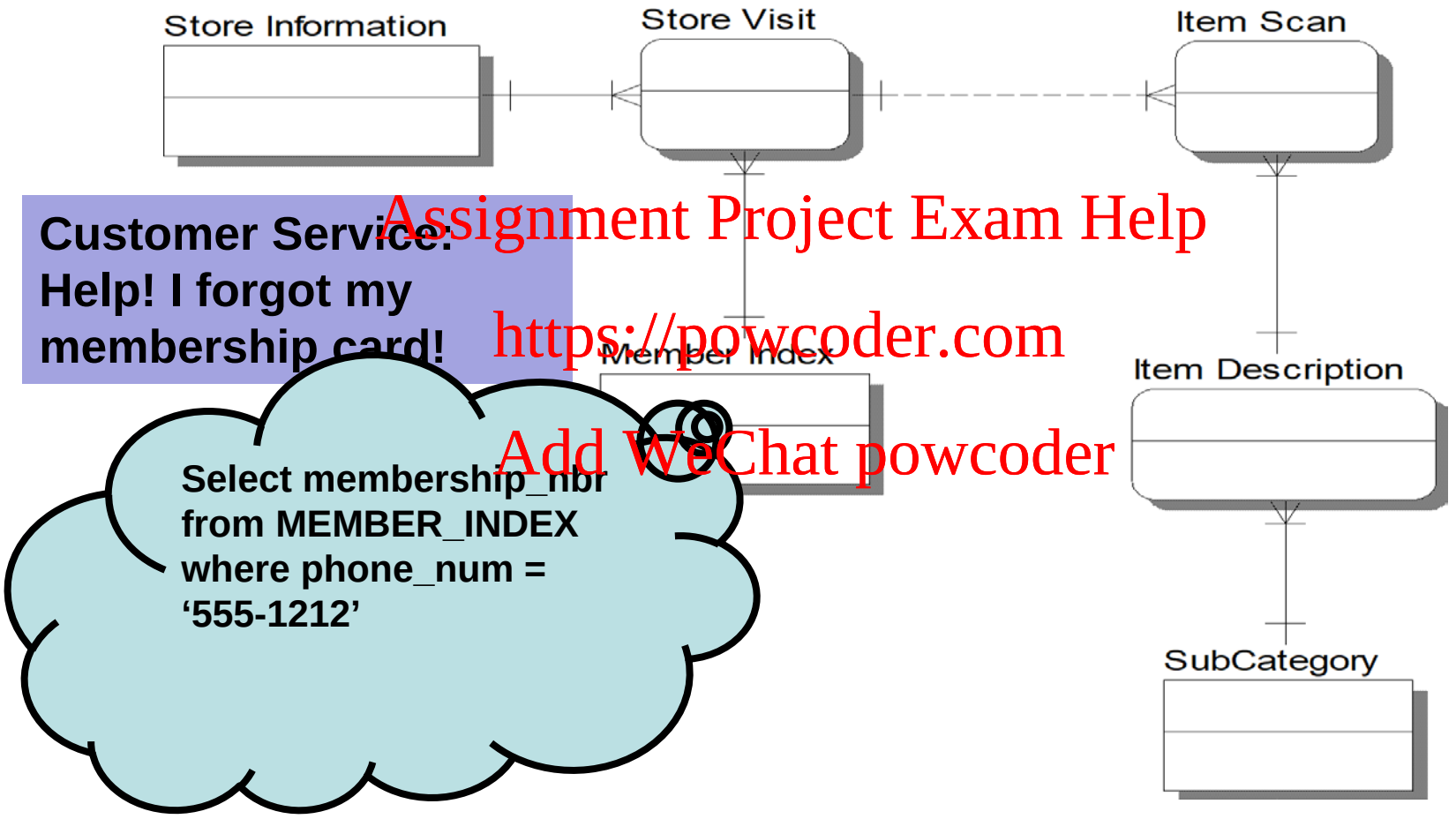
Transactional (Operational) Questions



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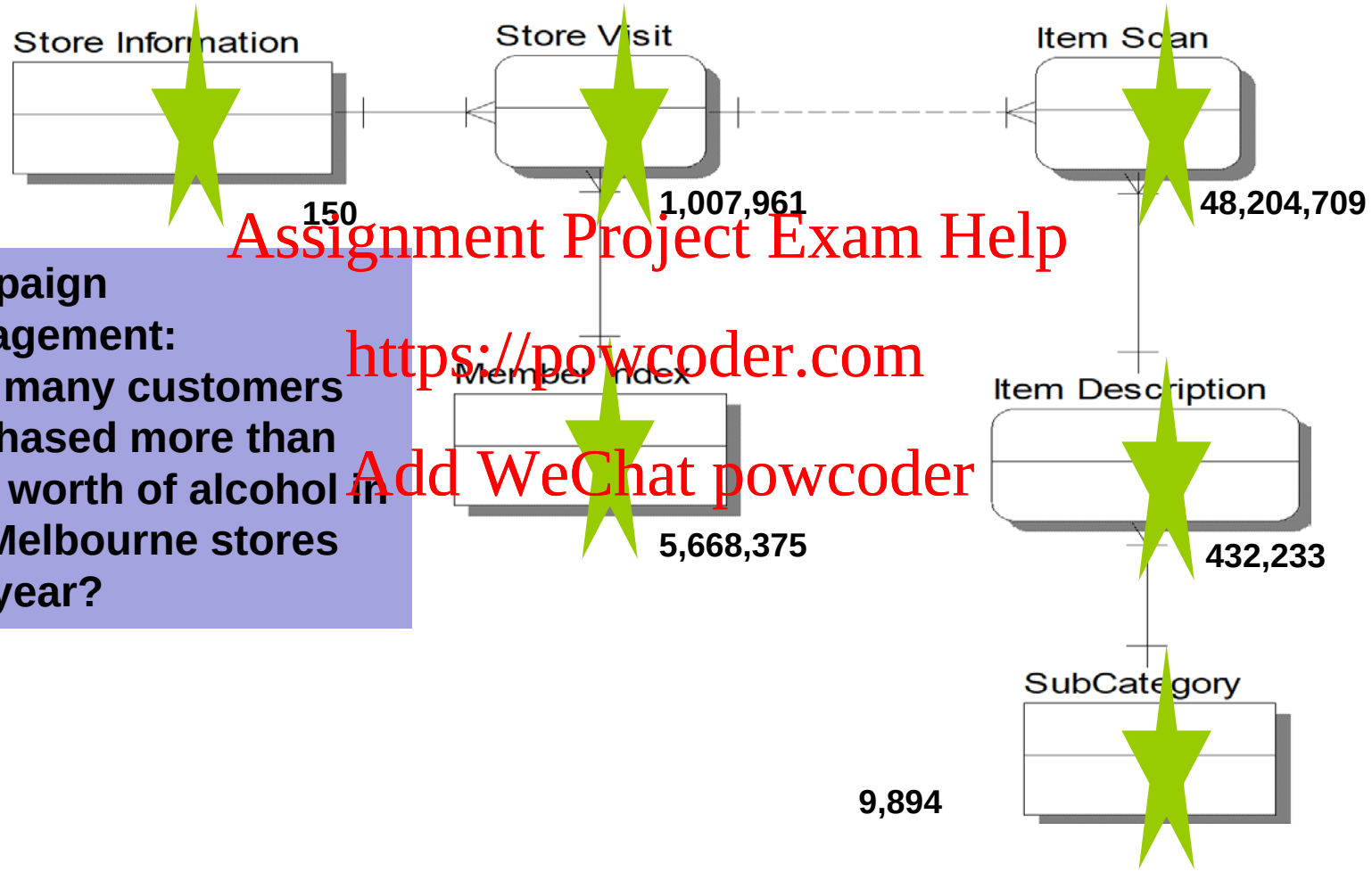
Analytical Questions



Campaign Management:
How many customers purchased more than $500 worth of alcohol in our Melbourne stores this year?

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DW Supports Analytical Queries

- One is interested in numerical *aggregations*
  - How **many**?
  - What is the **average**?
  - What is the **total cost**?
- One is interested in understanding *dimensions*
  - Sales **by state by customer type**
  - Sales **by product by store by quarter**

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DW will help answer these questions

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Characteristics of a DW

- Subject oriented
  - Data warehouses are organised around particular subjects (sales, customers, products)
- Validated, Integrated data
  - Data from different systems converted to a common format: allows comparison and consolidation of data from different sources
  - Data from various sources validated before storing it in a data warehouse

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Characteristics of a DW

- Time variant
  - Historical data
  - Trend analysis crucial for decision support: requires historical data
  - Data consists of a series of “snapshots” which are time stamped
- Non-volatile
  - Users have read access only – all updating done automatically by ETL process and periodically by a DBA

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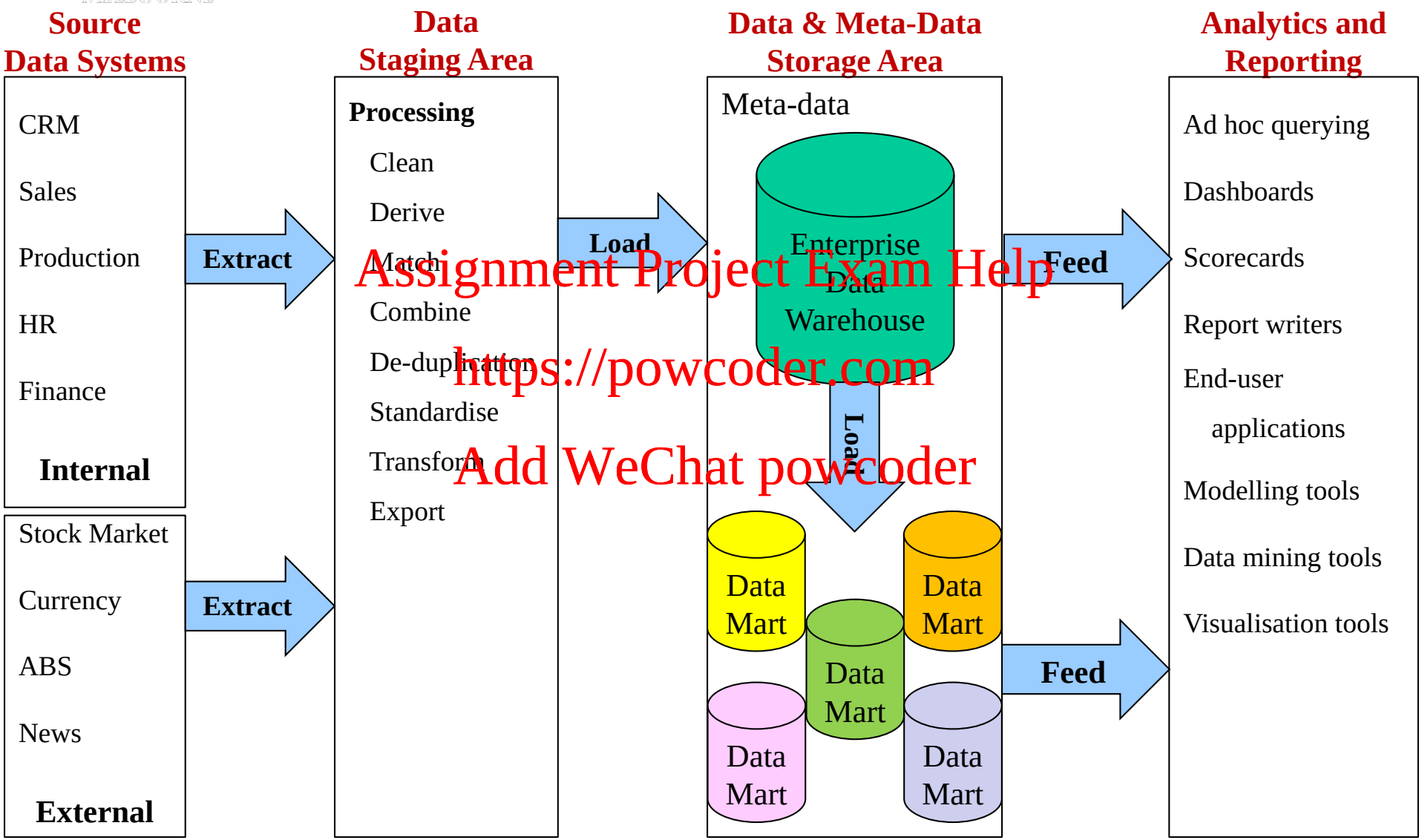
A DW Architecture



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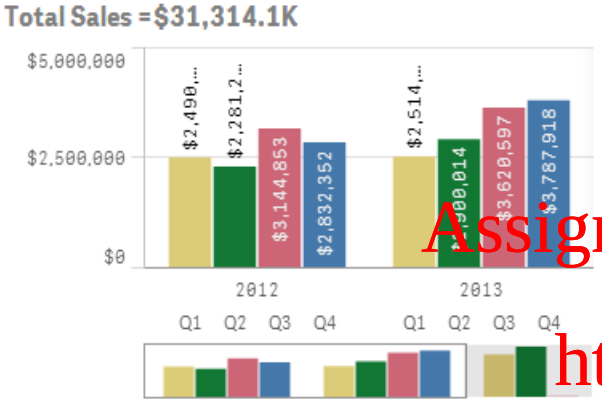
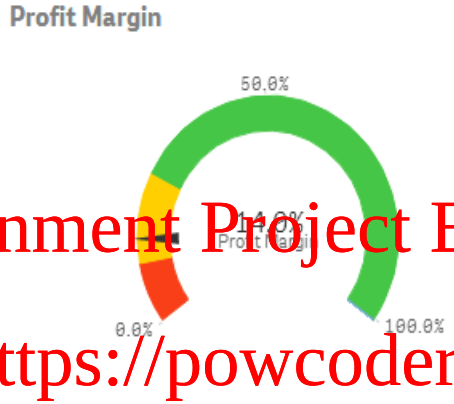
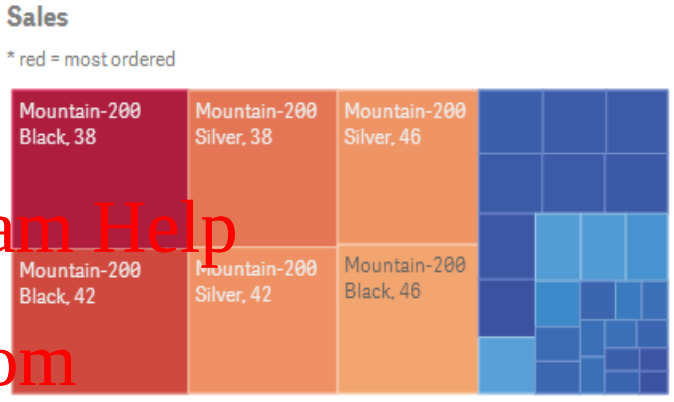
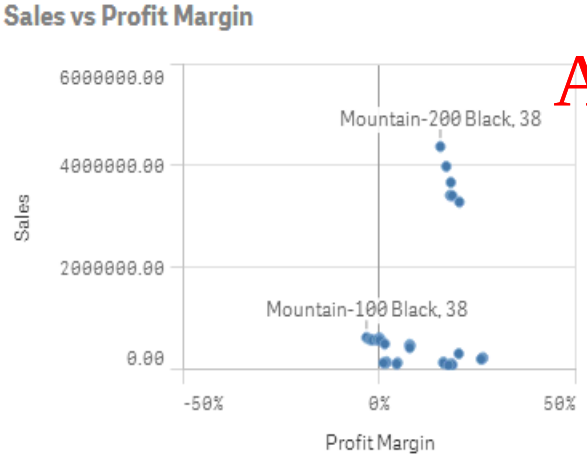
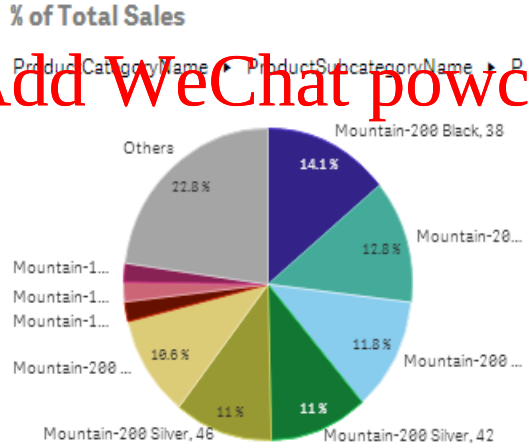
Business Intelligence Dashboard

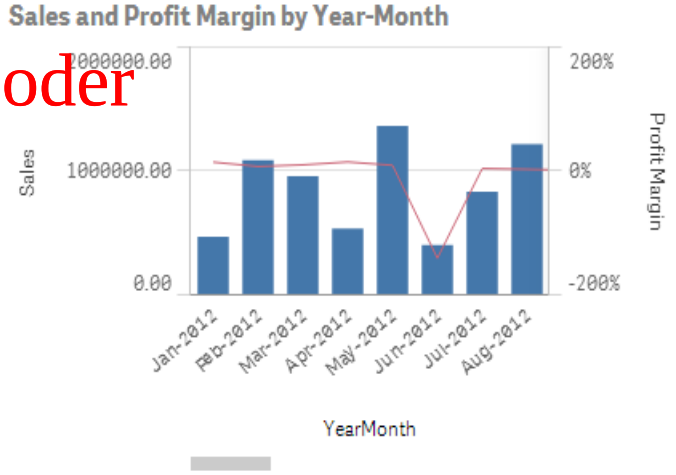












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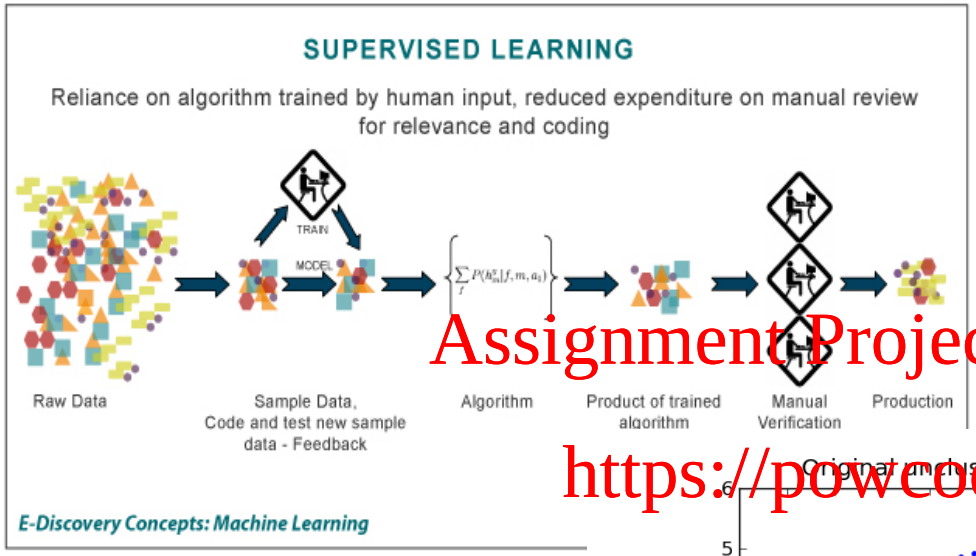
DW Supports Advanced Analytics



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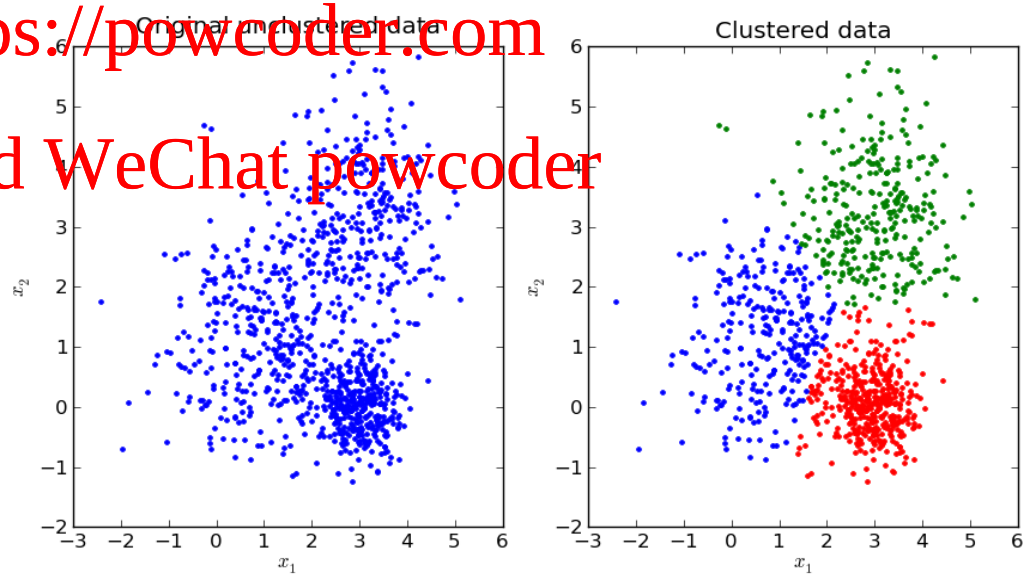

http://us.hudson.com/legal/blog/postid/513/predictive-analytics-artificial-intelligence-science-fiction-e-discovery-truth
http://pypr.sourceforge.net/kmeans.html

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Part 2- Dimensional Modelling

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Business Analyst World

- How much **revenue** did the **product G** generate in the **last three months**, broken down by month for the south eastern sales **region**, by individual **stores**, broken down by **promotions**, compared to estimates and to the previous version of the product
  - Analysis starts usually with a single indication of something strange, then goes deep into the data, left to a new dimension, right to another, up to the summary, back down and left and right again, until the problem is identified…
  - Dimensional Analysis: To support business analysts view
    - Revenue per product per customer per location?

Fact Dimension Dimension Dimension

Fact Dimension Dimension
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Introduction to Dimensional Modelling

- Popularised by Ralph Kimball in the 1990s
- Based on the *multi-dimensional* model of data and designed for retrieval-only databases
- Very simple, intuitive, and easily understood structure
- Also known as *star schema* design

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Dimensional Modelling

- A dimensional model consists of:
  - Fact table
  - Several dimensional tables
  - (Sometimes) hierarchies in the dimensions
- Essentially a simple and restricted type of ER model

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Fact Table

- A fact table contains the actual business measures (additive, aggregates), called *facts*
- The fact table also contains *foreign keys* pointing to *dimensions*

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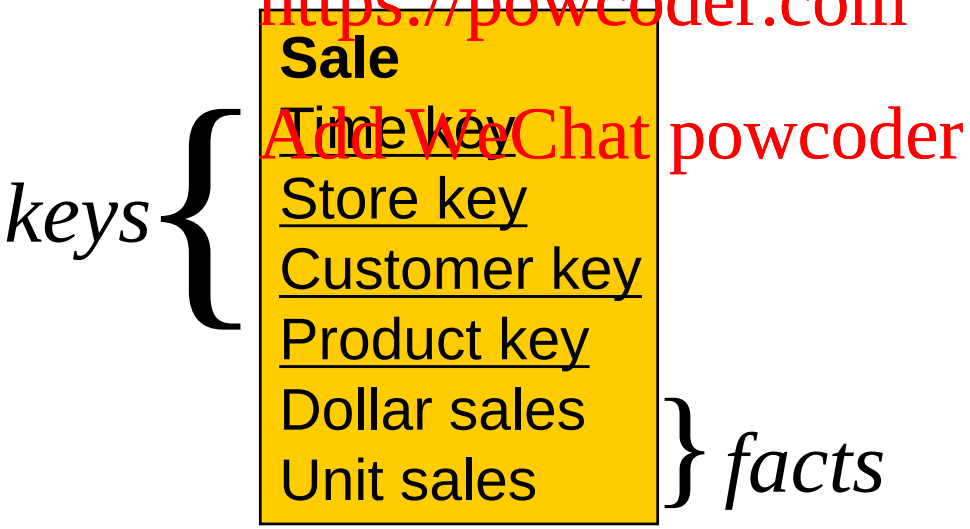

Fact Table - example

- Actual data might look like this
- Granularity, or level of detail, is a key issue
  - Finest level of detail for a fact table, determined by the finest level of each dimension

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Time-id	*Store-id*	*Cust-id*	*Prod-id*	*Dollar sales*	*Unit Sales*
T100	S303	C101	P98	$120,000	5,000
T101	S303	C256	P98	$240000	10,000
T102	S387	C101	P10	$456,000	27,899
T100	S234	C400	P56	$100,200	5,600

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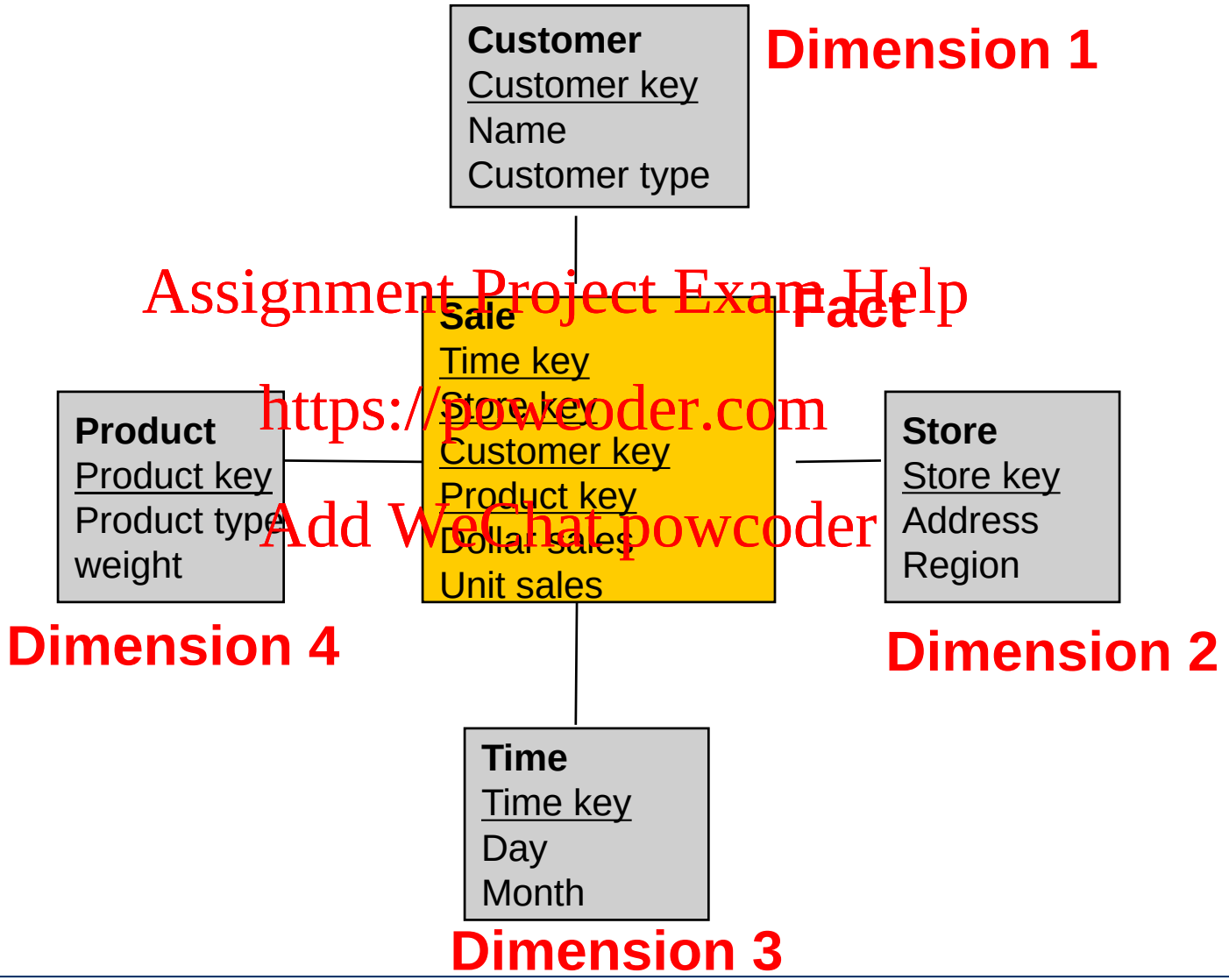
Star schema – dimensional model



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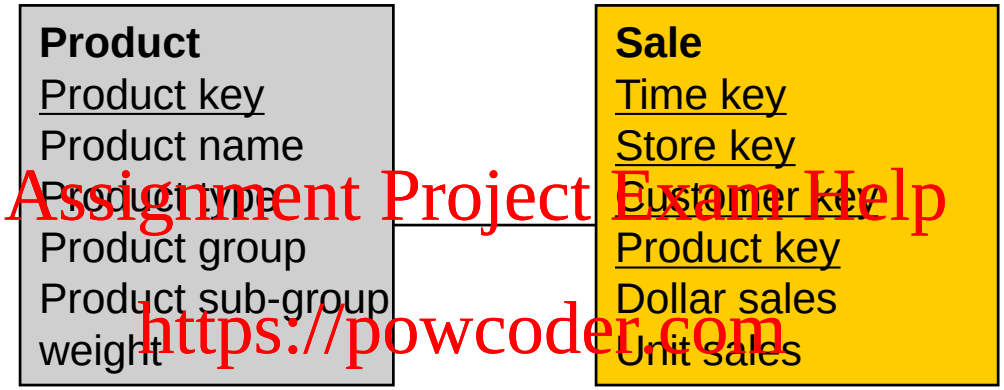
Dimension Hierarchies



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Product name e.g. Hammer
- Product type e.g. Tool
  - Product group e.g. Hardware

Dimension Table - example

- Captures a factor by which a fact can be described or classified
- Actual data might look like this
- Hierarchy evident in data

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Prod-id	*Prod-Name*	*Prod-Group*	*Prod-Subgroup*	*Weight*
P10	Hammer	Hardware	Tool	5kg
P56	10cm Nails	Hardware	Nails	1kg
P98	Plastic Pipe	Plumbing	Pipe	1kg

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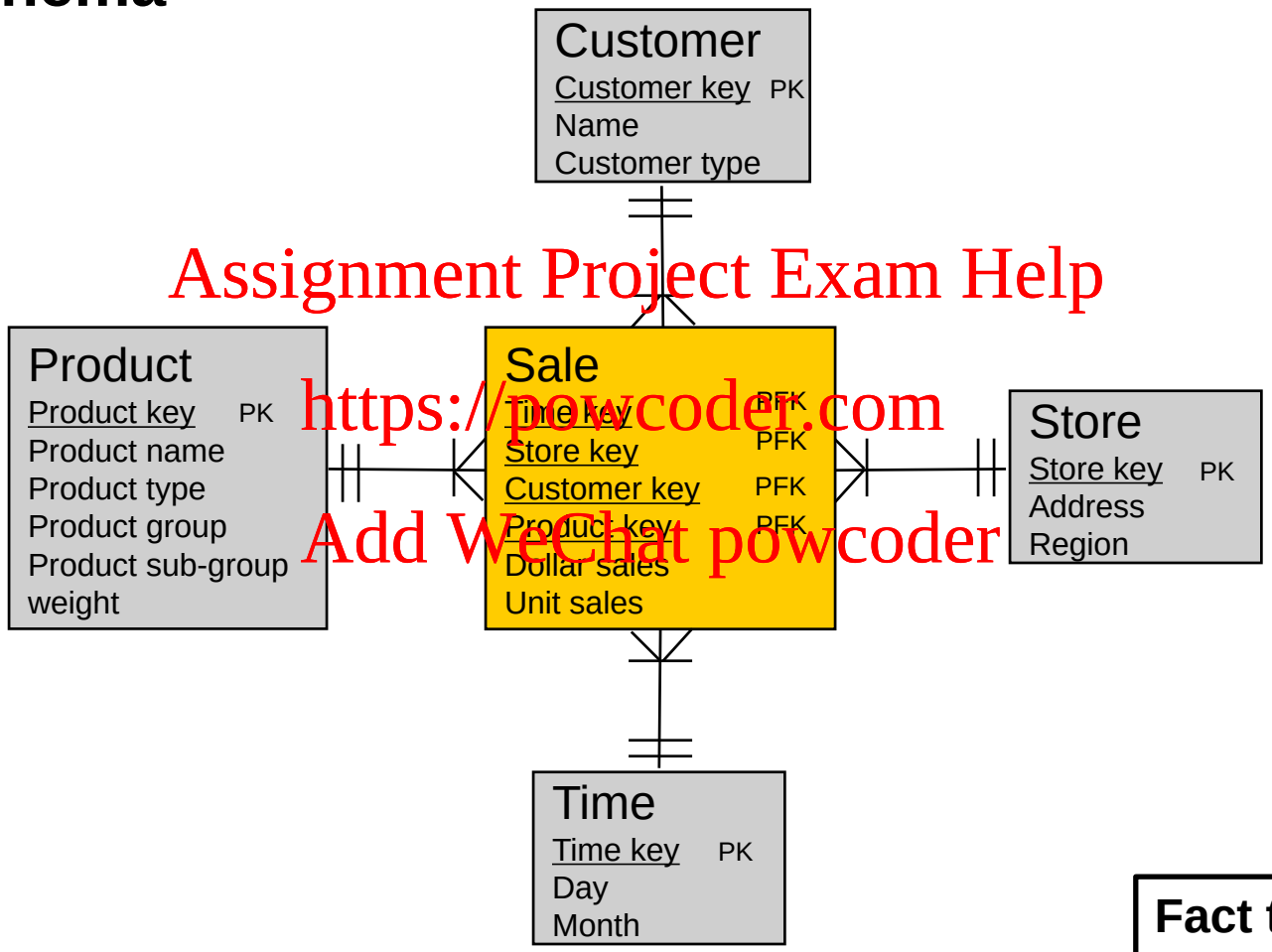
Dimensional model as an ER model

Star schema



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Fact table is an intersection table

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Designing a Dimensional Model

Steps:

1. Choose a Business Process
2. Choose the measured facts (usually numeric, additive quantities)
3. Choose the granularity of the fact table
4. Choose the dimensions
5. Complete the dimension tables

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(Kimball, 1996)

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Embedded Hierarchies in Dimensional Tables

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Customer-id
Customer name
Market segment
Market sector
Industry class
Industry sector
Industry group
City
State
Country

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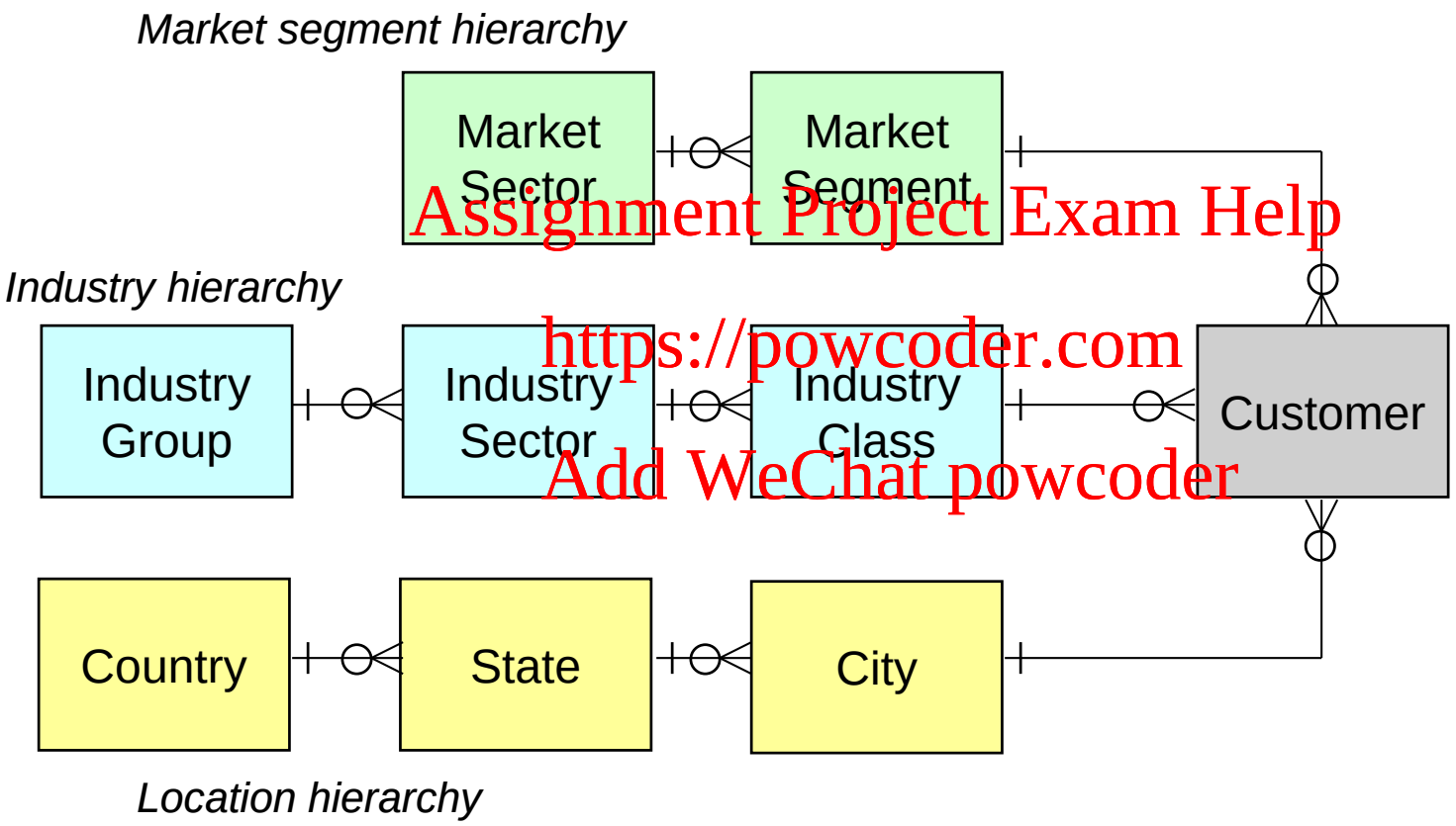
Embedded Hierarchies in Dimensional Tables



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Customer-id
Customer name
Market segment
Market sector
Industry class
Industry sector
Industry group
City
State
Country

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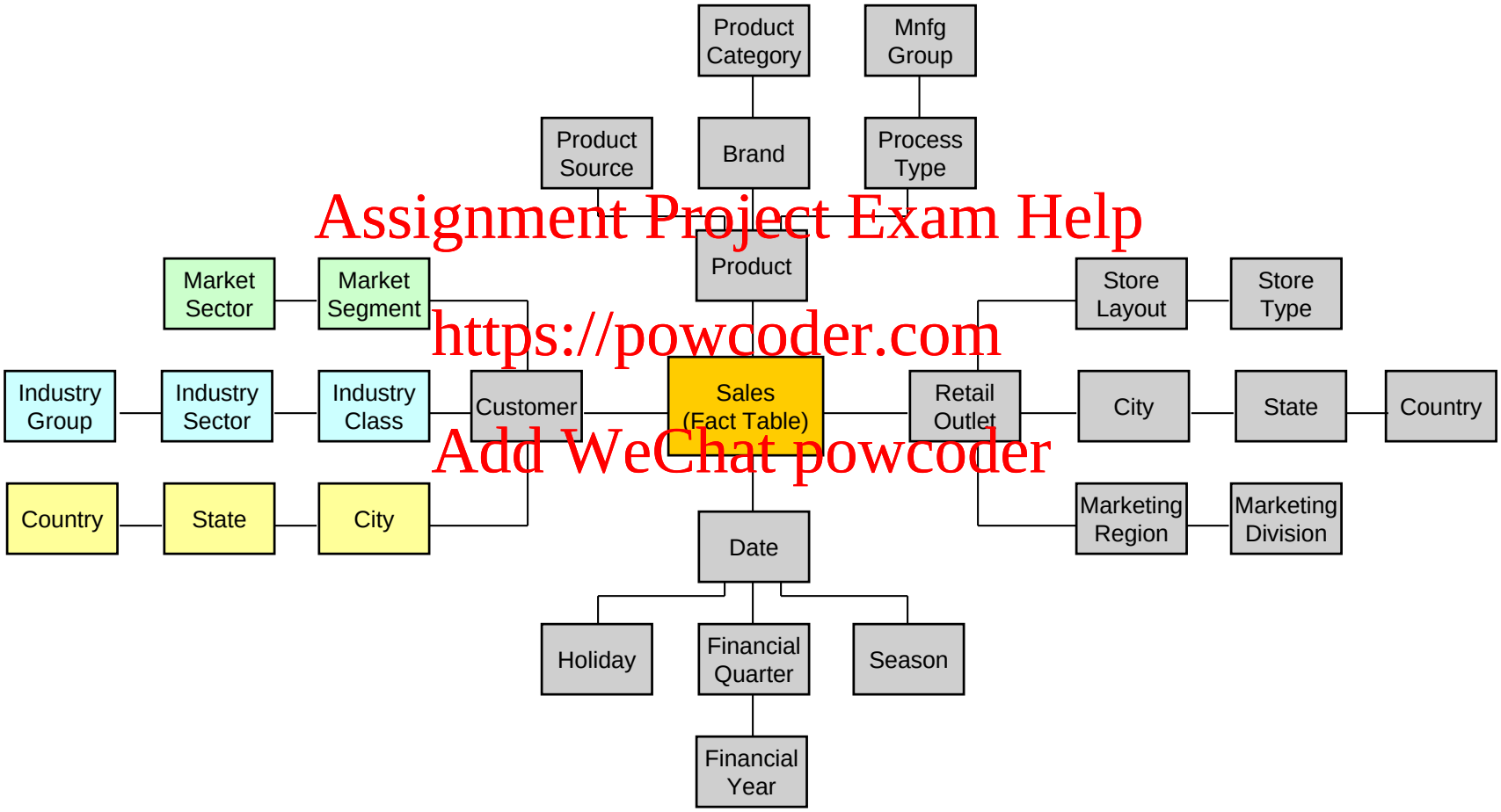
Snowflake Schema: hierarchy in dimensions



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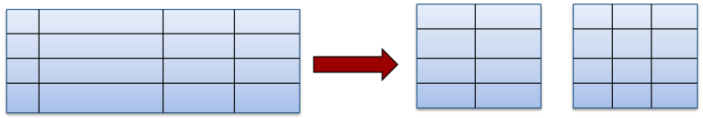
Design Outcomes: Normalised or Denormalised?

- Normalisation
  - Eliminates redundancy
  - Storage efficiency
  - Referential Integrity



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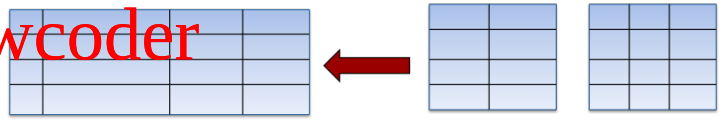
- Denormalisation
  - Fewer tables (fewer joins)
  - Fast querying
  - Design is tuned for end-user analysis



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Let's try it …

- We are making a data warehouse for a real estate agency. The company wants to track information about the **selling** of their properties. This warehouse keeps information about the **agents** (license#, first name, last name, phone #), **buyers** that come in (buyer id, first name, last name, phone #), and **property** (property#, property address, price). The information managers want to be able to find is **the number of times a property is viewed**, **sales price**. The information needs to be accessible **by rental agent, by buyer, by property** and **for different time** (day, week, month, quarter and year).
- Draw a star schema to support the design of this data warehouse.

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What is Examinable?

- Differences between transactional and informational databases
- Designing a star schema
- Defining facts and dimension tables

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If you want to know more

More technical details (I won't ask you these things):

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https://www.youtube.com/watch?v=w-S0fj0fmqg&list=PLdQdqgMB3WzHcEN9PrhADq3CBColhY2hl&index=17

Next Lecture

- Distributed Databases

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