



Business Intelligence and Analytics

A Comprehensive Overview

IT 4713/7123 BI

Jack G. Zheng

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<http://zheng.kennesaw.edu/teaching/it4713>

<http://zheng.kennesaw.edu/teaching/it7123>

<https://www.edocr.com/v/r4dg6mjr/>

Overview



This lecture notes provides a high-level overview of business intelligence and analytics. This overview is comprehensive and covers as many aspects as possible, but it keeps them at a high level. More details are provided in more learning modules.

1. What is business intelligence (BI) and analytics?
 - Are they the same or different?
2. BI/Analytics process and technology
 - BI/Analytics as an information and *decision process*
 - BI/Analytics as a *computing and information system*
3. BI evolution and trend: traditional BI and modern BI
4. BI/Analytics education and career

Sections



What is BI and Analytics?

- Are they the same or different?
- How about data analytics, business analytics, data science, big data, etc.?

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BI/Analytics Process and Technology

- BI/Analytics as an information and decision process
- BI/Analytics as a computing and information technology

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Modern BI Trends

- Modern vs. traditional BI

More details of modern BI will be covered
in IT 7123 module 10.

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Market, Career, Education, and Resources

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What is BI and Analytics?

- Are they the same or different?
- How about data analytics, business analytics, data science, big data, etc.?

What is Business Intelligence?



Business Intelligence is a set of methods, processes, architectures, applications, and technologies that gather and transform raw **data** into meaningful and useful information used to enable more effective strategic, tactical, and operational **insights and decision**-making.

Adapted from Forrester Report

"Topic Overview: Business Intelligence", 2008

<https://www.forrester.com/report/Topic+Overview+Business+Intelligence/-/E-RES39218>

More BI from Forrester

<https://www.forrester.com/business-intelligence>

BI is an umbrella term for a set of methods, processes, applications, and technologies that focus on *analytical data processing*, which includes data gathering/ingestion, data storage, data analysis, reporting, and other tasks.

Business



- Does “business” only mean commercial entities and activities?
- Traditionally or narrowly speaking, “business” implies companies, corporates, and their operations and commercial activities.
- But now the term “business” has become more general and represents many types of entities and application domains
 - It refers to more like “activity” or “issue”
 - Think of “business” more like the “business” in “it’s none of your business!”
- BI/Analytics can be applied in all “business” entities (industries, functional areas, or domains) to drive “business” performance. These entities may include
 - Companies (for profit) and financially related
 - Retail, manufacture, real-estate, financial, sports, media, advertising, entertainment, healthcare, publication, energy, etc.
 - Non-profit organizations, institutions, associations, communities, etc.
 - Government: citizen service, city planning, crime, immigration, etc.
 - Individuals: personal health, exercise, learning, eating, power consumption, etc.

Data

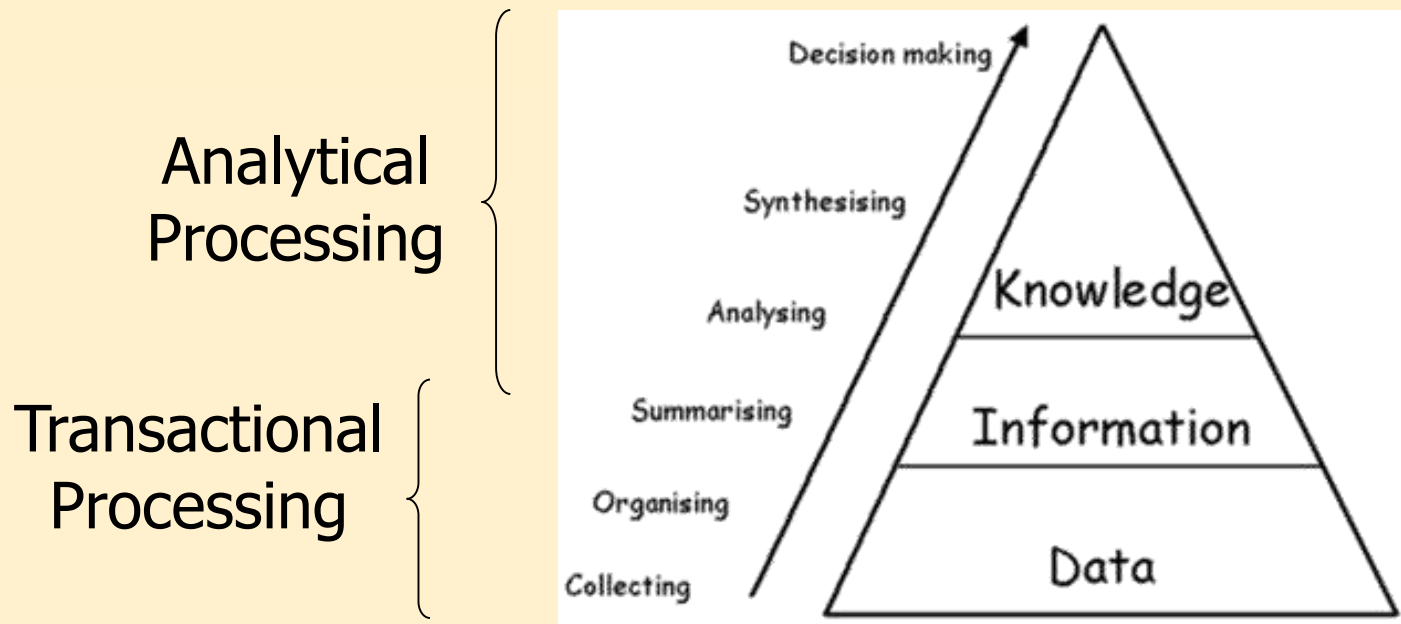


- Data is the source of insights and decision. The analysis is the essential part to transform data to information and knowledge. Many times, the process is complex, as have to deal with different types of data and all kinds of data use problems.
- Different types of data
 - Numeric vs. textual
 - Structured vs. unstructured
 - Standard format vs. proprietary format
 - Internal vs. external data, system stored vs. file-based data
 - Raw fact data vs. simulated/forecast/estimated data
 - Simple fact data vs. calculated metrics data
- Common data use challenges
 - Structured, unstructured, semi-structured
 - Information and knowledge management is the management of both structured data (15% of information) and unstructured data (85% of information), according to the Butler Group.
 - 80 percent of business is conducted on unstructured information (Gartner Group).
 - Information overloading
 - too much data and information with varied formats and structure
 - difficulty of data organization for effective access and retrieval
 - difficult to find useful information (knowledge) from them
 - Multiple copies of data exists sometimes with conflicts
 - Big data
 - Variety, Velocity, Volume, Veracity <https://www.ibmbigdatahub.com/infographic/four-vs-big-data>
 - Data everywhere
 - Data in separate systems and different sources; internal and external
 - Problem of spreadmart <http://en.wikipedia.org/wiki/Spreadmart>
 - Over 43 percent of organizations have more than six content stores. (Forrester Research).
 - Difficulty of access
 - We may have that data, but we cannot access it (or difficult to get it), because of technical issues or administrative issues.
 - Lack of data
 - The data is simply not available.
 - The collection of data may need additional process and is costly.

DIKW and Intelligence



- The DIKW hierarchy depicts relationships between data, information, knowledge (and wisdom).
 - Data: raw value elements or facts
 - Information: the result of collecting and organizing data that provides context and meaning
 - Knowledge: the concept of understanding information that provides insight to information, thus useful and actionable
 - Wisdom: the understanding of interactions and an integrated view, and the understanding of implications and indirect results beyond a target domain.
- The model can be loosely related to the levels of transactional processing (OLTP) and analytical processing (OLAP)



For more extensive reading: http://en.wikipedia.org/wiki/DIKW_Pyramid
Different opinion: <https://hbr.org/2010/02/data-is-to-info-as-info-is-not>

Analytical Data Processing



Two Types of Data/Information Processing

Transactional Processing

- Focus on data item processing (insertion, modification, deletion), transmission, and even some non-analytical query

- Change product price.
- Increase customer credit limit.
- Import data from another source

Analytical Processing

- Focus on queries, calculation, reporting, analysis, and decision support

- What are the top 10 most profitable products?
- Is there a significant increase of operational cost?

For a more detailed comparison of **OLTP** and **OLAP**:

<https://techdifferences.com/difference-between-oltp-and-olap.html>

*Narrowly speaking, intelligence comes from data (facts), based on DIKW. In this sense, BI focuses on **analytical data processing**.*

Note: transactional and analytical processing above refer to general concepts; OLTP and OLAP also refer to a specific type of technology and system.

Insights and Decision



- Insights and decisions are the intelligence part of BI. Intelligence also represents the techniques and methods.
- Insights is a bit different from decision.
 - Insights is the deep understanding and comprehension of the “business” and the data. It may not directly lead to actions.
 - Decision is more actionable.
- Decisions can be made based on
 - Facts, or data
 - Simulation (models)
 - Intuition, perception, sense
 - Group negotiation
- Problems in decision making
 - Management/operation by intuition
 - A gap between data and knowledge (useful information leading to a decision).
 - Lack of effective feedback and alignment systems, no improvement cycles
 - Need good analytical processing and models
- Evolving analytical needs in decision support
 - Real-time, most recent data
 - Business user driven, agile, instant
 - Exploratory and interactive

Extended reading – DSS

Traditionally BI has been also understood as Decision Support System (DSS) – known as data driven DSS (data directly contributes to decision without intensive and advanced analytical techniques).

Read about a brief history of DSS

<http://dssresources.com/history/dsshistory.html>

Performance



- A common goal of BI is to drive performance.
- Performance measures or indicators (known as KPI, key performance indicators) are defined and tracked using BI approaches and systems.
 - <https://kpi.org/KPI-Basics>
- Different businesses have different kinds of “performance”
 - Financial performance
 - Academic performance (institutional effectiveness)
 - Public service performance
 - Individual work performance
 - Sports performance

Sample BI/Analytics Applications

BI/Analytics can be applied in many “businesses” (functional areas, activities, or domains) to drive “business” performance.

- Business management
 - Strategic planning
 - Performance management
 - Process intelligence
 - Competitive intelligence
 - Project and program management
- Retail, marketing and sales
 - CRM
 - Customer behavior analysis
 - Targeted marketing and sales strategies
 - Customer profiling
 - Campaign management
 - Inventory management
- Human resource/capital
 - HR analytics
 - Talent management
- Work analytics
- Power and energy management
- Healthcare management
- Text analytics
- Location intelligence
- IT management
 - Web analytics
 - App analytics
 - Security management
- Supply chain and Logistics
 - Supplier and vendor management
 - Shipping and inventory control
- Financial sector
 - Portfolio management, stock analysis
 - Insurance
- Government
 - City/region planning, urban analytics, crime, demographic,
 - Traffic management, power usage
 - Citizen service, immigration
- Education
 - Learning analytics
 - Institutional research/effectiveness
 - Academic analytics
 - Student engagement and success
- Social analytics
- Sports and games analytics
- Personal
 - Personal health, exercise, learning, eating, power consumption, etc.

Evolution of BI/Analytics



- The evolution of BI resides in both “business” and “intelligence”
 - Expansion of entities, domains, and users that use BI
 - Evolution of processes, techniques, technologies and systems

1980s	Executive information systems (EIS), decision support systems (DSS)
1990s	Data warehousing (DW), business intelligence (BI)
2000s	Dashboards and scorecards, performance management
2010+??	Analytics, big data, data science, augmented BI, ...

The search for the perfect “business insight system”, from Performance Dashboard, by Wayne Eckerson
<http://download.101com.com/pub/tldwi/files/performance Dashboards.pdf>

“With each new iteration, capabilities increased as enterprises grew ever-more sophisticated in their computational and analytical needs and as computer hardware and software matured.”

Solomon Negash (2004), Business Intelligence, CAIS (13)
https://www.researchgate.net/publication/228765967_Business_intelligence

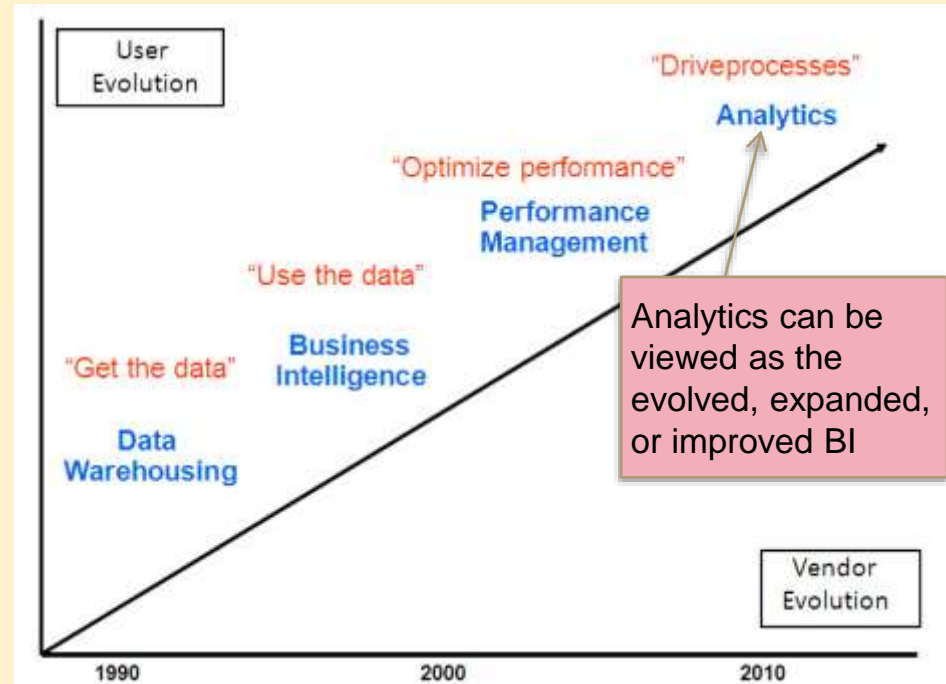
Analytics



- Analytics has emerged as a catch-all term for a variety of different business intelligence (BI) and application-related initiatives. ...it is applying the breadth of BI capabilities to a specific content area. In particular, BI vendors use the "analytics" moniker to differentiate their products from the competition. Increasingly, "analytics" is used to describe statistical and mathematical data analysis.
 - <https://www.gartner.com/en/information-technology/glossary/analytics>
- Analytics refers to a more systematical, automated, and flexible process of data analysis for revealing insights and decision support in more extensive application areas (beyond organizational contexts), e.g. sports, disease, network traffic, etc.
 - <http://pestleanalysis.com/differences-between-business-analytics-and-business-analysis/>
- Analytics initially referred to advanced statistical modeling using tools like SAS and SPSS. ... Now, analytics refers to the entire domain of leveraging information to make smarter decisions. In other words, reporting and analysis.
 - The Evolution of BI Semantics http://www.b-eye-network.com/blogs/eckerson/archives/2011/02/whats_in_a_word.php
- Analytics is geared more toward future predictions and trends, while BI helps people make decisions based on past data.
 - Christian Ofori-Boateng <https://www.forbes.com/sites/forbestechcouncil/2019/06/21/data-analytics-versus-business-intelligence-and-the-race-to-replace-decision-making-with-software/>

Depending on perspectives, Analytics

- is part of BI
- includes BI
- goes beyond (the traditional) BI
- = (the new) BI



The Evolution of BI Semantics

http://www.b-eye-network.com/blogs/eckerson/archives/2011/02/whats_in_a_word.php

Analytics or BI?



- We tend to call analytics rather than BI in the following scenarios. But their processes and technologies are very similar.
- Non-(traditional) business activities such as
 - Learning analytics: learning progress and performance
 - Talent analytics: human resources
 - Web/app analytics: web traffic or app usage analysis
 - Sports analytics: gaming strategies and performance
- Non-organizational contexts; mainly based on public data and for public communication.
 - Social media analytics
 - Election/voting analytics
- Individual or small group data monitoring/analysis
 - Personal health analytics
 - Communication analytics

BI/Analytics and Related Terms



- For BI, answer these questions as YES
 - Are the results intended to be repeatable?
 - Will the result be made operational?
 - Are you using the result to make decisions or monitor progress?

- Analytics and Data Science is more variable

- What is the level of experimentation?
- Is AI or machine learning involved?
- Are there algorithmic models involved?

<https://www.slideshare.net/Dataversity/analytics-business-intelligence-and-data-science-whats-the-progression>

- Data analytics = analytics
- Business analytics
 - Analytics used mainly for business (company) contexts.
 - Business analytics (BA) is the practice of iterative, methodical exploration of an organization's data with emphasis on statistical analysis and data mining. Common analysis techniques include regression, forecasting, correlation, factor analysis, and others.
 - <https://www.tableau.com/learn/articles/business-intelligence/bi-business-analytics>
- Big data
 - "Big Data is not a system; it is simply a way to say that you have a lot of data. <https://www.linkedin.com/pulse/big-data-silver-bullet-tomas-kratky>
 - Big data covers non-structure and various data formats including text, blob, multimedia, etc.
- Data science
 - An interdisciplinary field about processes and systems to extract knowledge or insights from data in various forms
 - Focus on advanced analytics and presentation models and methods
 - Using autonomous or semi-autonomous techniques and tools, typically beyond traditional BI to discover deeper insights, make predictions, or generate recommendation.
 - A good data scientist = data hacker + programmer+ analyst+ coach+ storyteller+ artist (<http://analyticsindiamag.com/data-science-the-most-desirable-job-in-the-21st-century/>)
 - "In some ways, data science is an evolution of BI." <https://www.linkedin.com/pulse/data-science-business-intelligence-whats-difference-david-rostcheck/>
- Knowledge management
 - *Broadly speaking*, intelligence, or knowledge, also comes from human experience and tacit knowledge, in various format like story, experience, practices, image, video, etc.
 - In this sense, BI is also related to *knowledge management* (either BI under KM or vice versa) http://capstone.geoffreyanderson.net/export/19/trunk/proposal/research/Knowledge_management.pdf
- All these new terms try to differentiate them from the (traditional) BI. However, if one considers BI is a dynamic and evolving field, then all these new terms can be viewed as extensions/expansions of BI; they all still fall under the umbrella of the general BI.
 - "In its more comprehensive usage, BI is all of the systems, platforms, software, technology, and techniques that are essential for the collection, storage, retrieval, and analysis of data assets within a given organization." – Dataversity 2015 Report on BI vs Data Science

More perspectives from the industry

- <http://www.dataversity.net/distinguishing-analytics-business-intelligence-data-science/> and <https://www.slideshare.net/Dataversity/analytics-business-intelligence-and-data-science-whats-the-progression>
- <https://www.betterbuys.com/bi/business-intelligence-vs-business-analytics/>
- <https://solutionsreview.com/business-intelligence/data-science-vs-data-analytics-whats-the-difference/>
- <https://www.sisense.com/blog/whats-the-difference-between-business-intelligence-and-business-analytics/>



BI/Analytics Process and Technology

- BI/Analytics as an information and decision process
- BI/Analytics as a computing and information technology

Process and Technology



- BI/Analytics can be viewed as both a process and a (set of) technology
- An information and *decision process (methodology)*
 - BI and analytics share similar process to transform data to insights
 - A process consists of multiple steps (or activities, corresponding to capabilities), arrange in varied order
 - Each process may be different depending on a number of factors, including data sources, quality, analytical needs, etc.
- A *computing and information technology*
 - The technology directly implements and supports BI capabilities and activities.
 - Technology can be in the form of applications, systems, architectures, platforms, tools, products, etc.



General BI Capabilities Conception

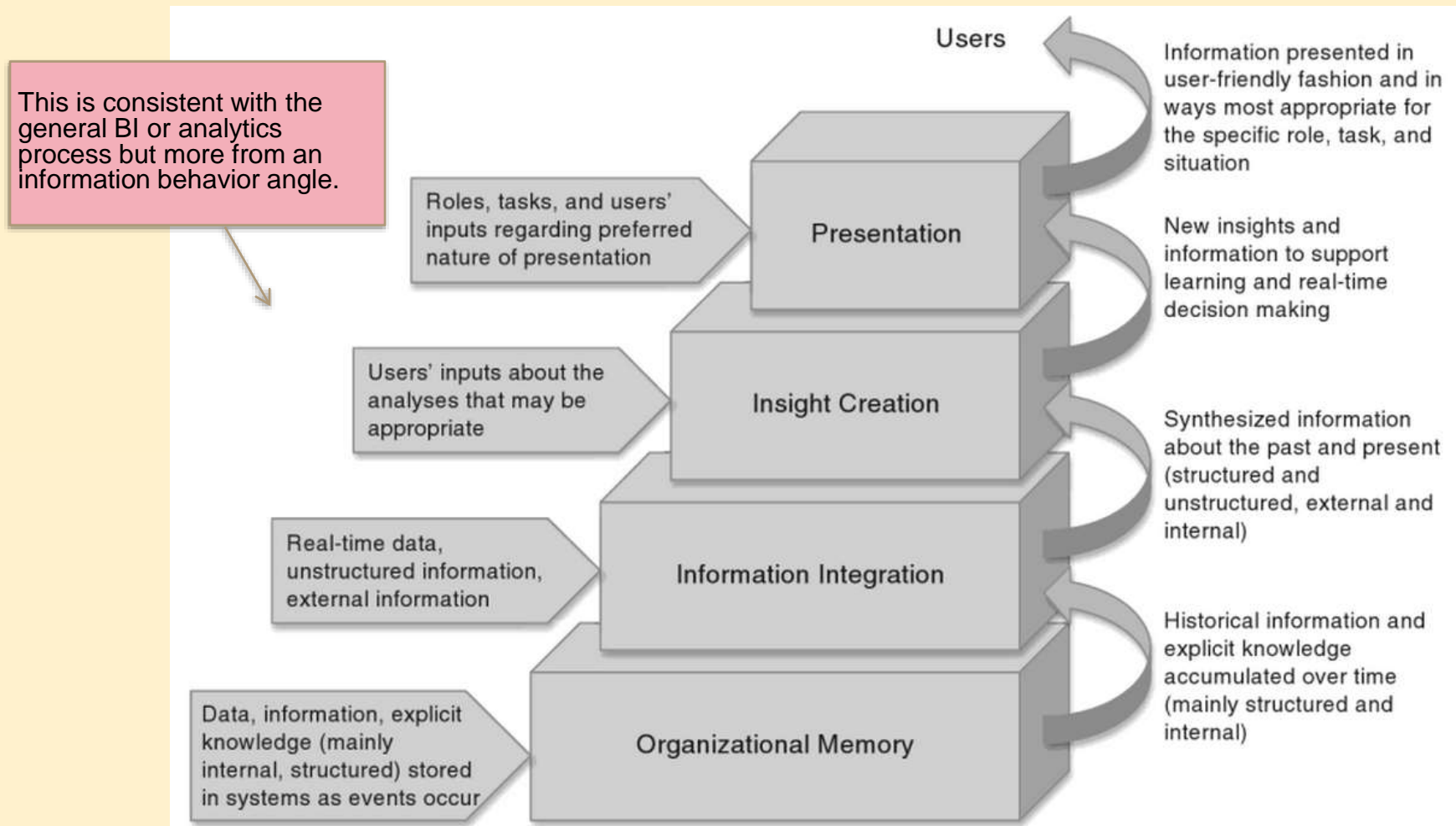


FIGURE 2.5 Inputs and Outputs of the Four Business Intelligence Capabilities

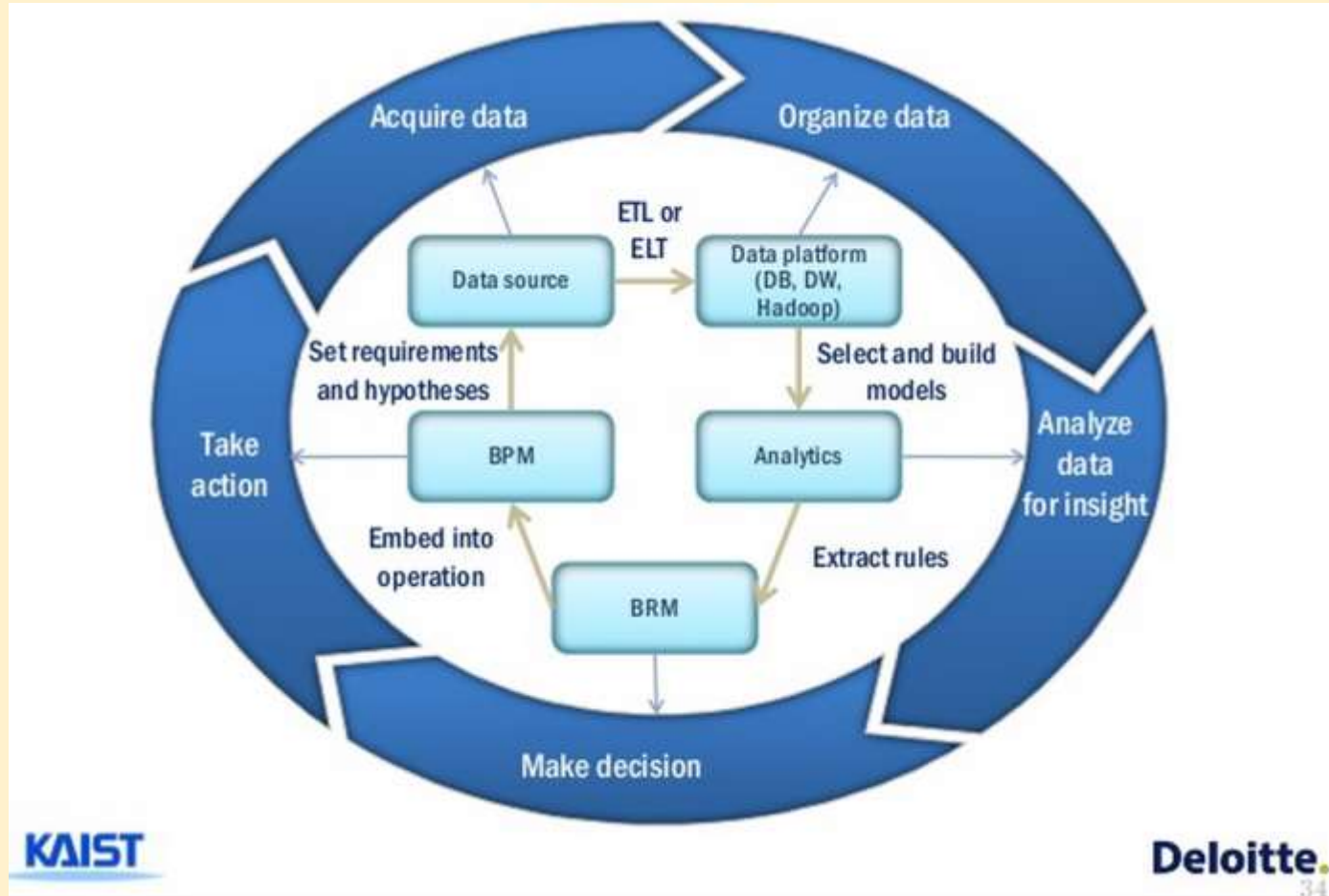
Figure from: Business Intelligence, Rajiv Sabherwal, Irma Becerra-Fernandez, John Wiley & Sons, 2011
<http://books.google.com/books?id=T-JvPdEcm0oC> – narrated slides <https://slideplayer.com/slide/5861482/>

BI in the Decision Process



Another view from the corporate decision perspective

<http://www.slideshare.net/junesungpark/business-process-based-analytics>



KAIST

Deloitte

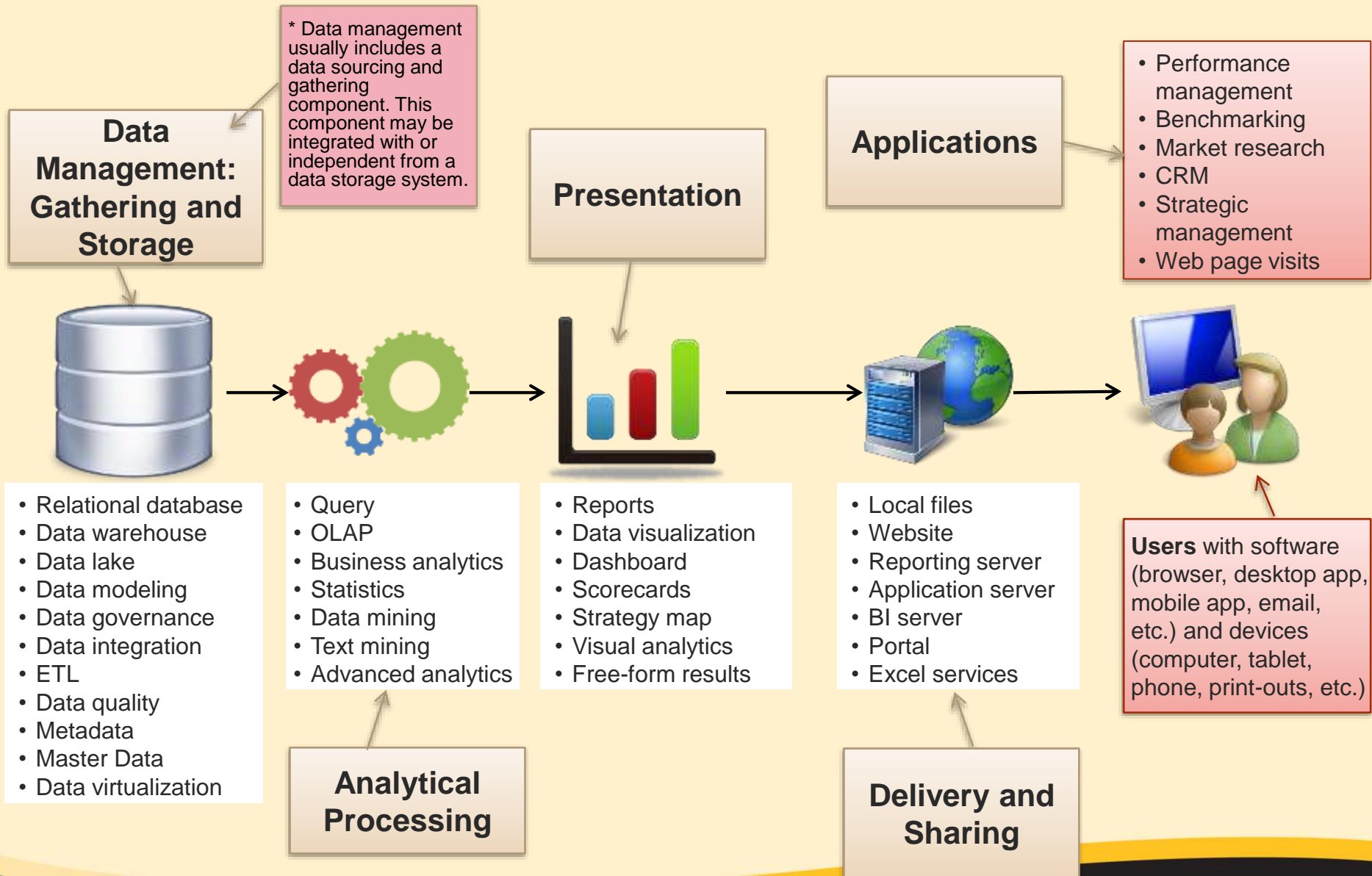
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BI/Analytics: Systems and Platforms



- A BI system is a computer information system that implements (part or whole) and *streamlines* BI capabilities and processes.
- BI or analytics can be done with multiple independent tools and technologies, but a complete system can greatly facilitate the process.
- The values of a BI/analytics system
 - Provides an integrated data (analytical) processing platform
 - Enables easy and fast access of data and information at all levels (raw data, analysis results, metrics, etc.)
 - Streamlines a controlled and managed process of data driven decision making
- Enterprise level vs. personal level system
 - An enterprise level BI system emphasizes more on control and performance.
 - While a more user-oriented analytics platform enables nontechnical users to autonomously execute full-spectrum analytic workflows from data access and preparation to interactive analysis and the collaborative sharing of insights.

BI System Components at a Glance



Critical Capabilities of a BI and Analytics Platform

Gartner Magic Quadrant Report 2021



- **Infrastructure**
 - Manageability: Capabilities that track usage of the ABI platform and manage how information is shared (and by whom).
 - Security: Capabilities that enable platform security, administering of users, auditing of platform access and authentication.
 - Cloud analytics/BI: The ability to support building, deployment and management of analytics in the cloud, based on data stored both in the cloud and on-premises (platform-as-a-service and analytic-application-as-a-service).
- **Data Management**
 - Data source connectivity: Capabilities that enable users to connect to, query and ingest data, while optimizing for performance.
 - Data preparation: Support for drag-and-drop, user-driven combination of data from different sources, and the creation of analytic models (such as user-defined measures, sets, groups and hierarchies).
 - Dropped or combined compared to previous reports: data storage, data model
- **Analysis and Content Creation**
 - Reporting: The ability to create and distribute (or “burst”) pixel-perfect, grid-layout, multipage reports to users on a scheduled basis.
 - Data visualization: Support for highly interactive dashboards and exploration of data through manipulation of visual properties and visual forms.
 - Data storytelling: The ability to combine interactive data visualization with narrative techniques in order to package and deliver analytic content in a compelling, easily understood form for presentation to decision makers.
 - Automated insights: A core attribute of augmented analytics, this is the application of ML techniques to automatically generate findings for end users (for example, by identifying the most important attributes in a dataset).
 - Natural language query (NLQ) or augmented analytics: This enables users to ask questions and query data and analytic content using terms that are either typed into a search box or spoken. Automatically finds, visualizes and narrates important findings without requiring users to build models or write
 - Notable missing compared to previous reports: Advanced Analytics.
- **Delivering and sharing of content**
 - Catalog: The ability to automatically generate and curate a searchable catalog of analytic content, thus making it easier for analytic consumers to know what content is available.
 - Publish and collaborate Analytic Content. Capabilities that allow users to publish, deploy and operationalize analytic content through various output types and distribution methods, with support for content search, storytelling, scheduling and alerts.
 - Notable missing compared to previous reports: Mobile Exploration; Embedding Analytic Content (APIs and support for open standards for creating and modifying analytic content, visualizations and applications, embedding them into a business process, and/or an application or portal.)

Additional resources:

<https://www.predictiveanalyticstoday.com/key-capabilities-of-business-intelligence-software/>
<https://www.selecthub.com/business-intelligence/list-bi-capabilities/>

A Practical Example: MSBI System Architecture



Business Intelligence system architecture with Microsoft BI stack

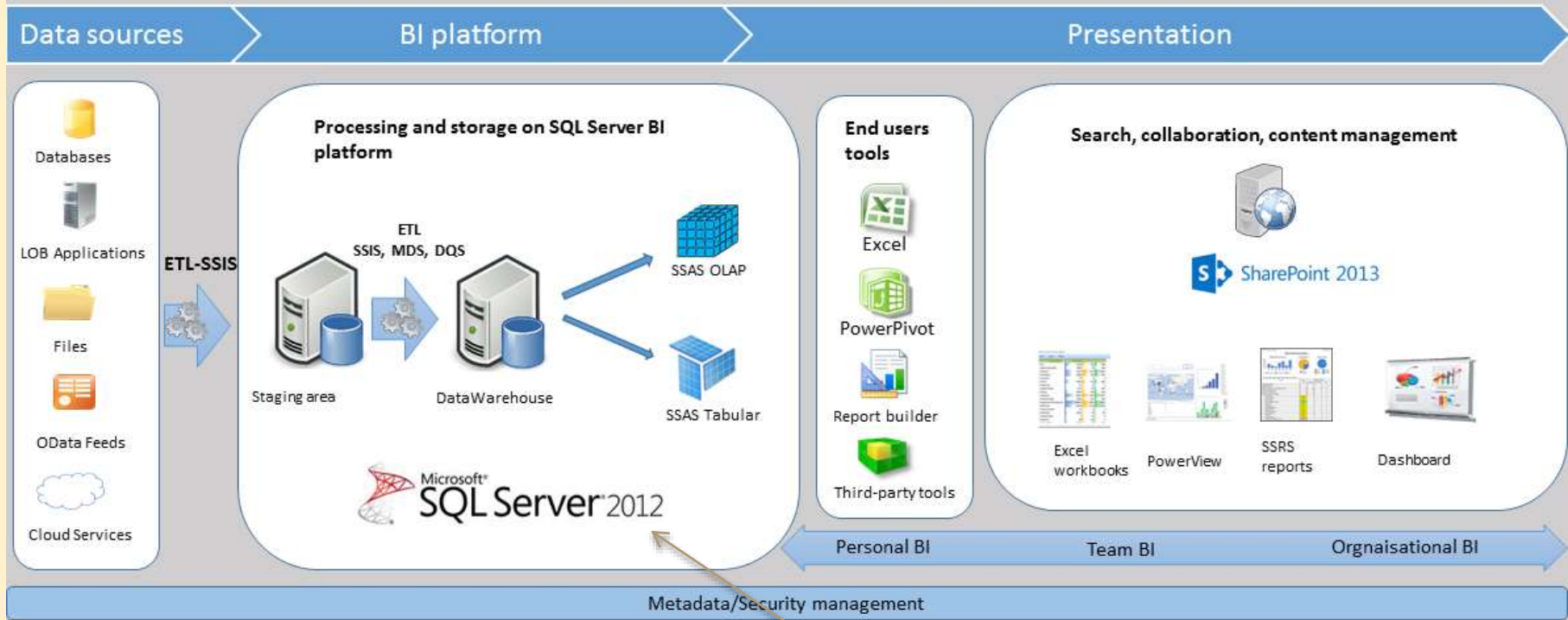


Image from
<https://bipointblog.wordpress.com/2014/05/28/implementation-of-a-bi-system-using-microsoft-bi-stack-introduction/>

Note: this is only one example of a typical and traditional BI system architecture. There are some more recent self-service oriented architectures.

Data Management/Storage



- Traditional (operational) relational databases facilitate data management and transaction processing. They have two limitations for data analysis and decision support
 - Performance
 - They are transaction oriented (data insert, update, move, etc.)
 - Not optimized for complex data analysis
 - Usually do not hold historical data
 - Heterogeneity
 - Individual databases usually manage data in very different ways, even in the same organization (not to mention external data sources which may be dramatically different).
- A special analytical database is needed for business intelligence and analytics.
- In traditional BI, a special database system called data warehouse or data mart is often used to store enterprise data
 - The purpose of a data warehouse is to organize lots of stable data for ease of analysis and retrieval.
 - Many data warehouses are build using the relational database systems.
 - The data warehouse approach is a centralized and structured approach for analytical data management. For more recent personal BI/analytics, data is also kept locally for easy access and manipulation, without much technical support.
- More recent developments utilized more forms of database, including
 - NoSQL databases for semi-structured data
 - Data lake approach which accommodates multiple models and structures of data
 - Cloud-based systems that hide the underlying structure complexity

Data storage for analytics will be covered in IT 7123 module 4.
Data warehouse/mart will be covered in IT 4713 module 4.

Data Integration and Preparation



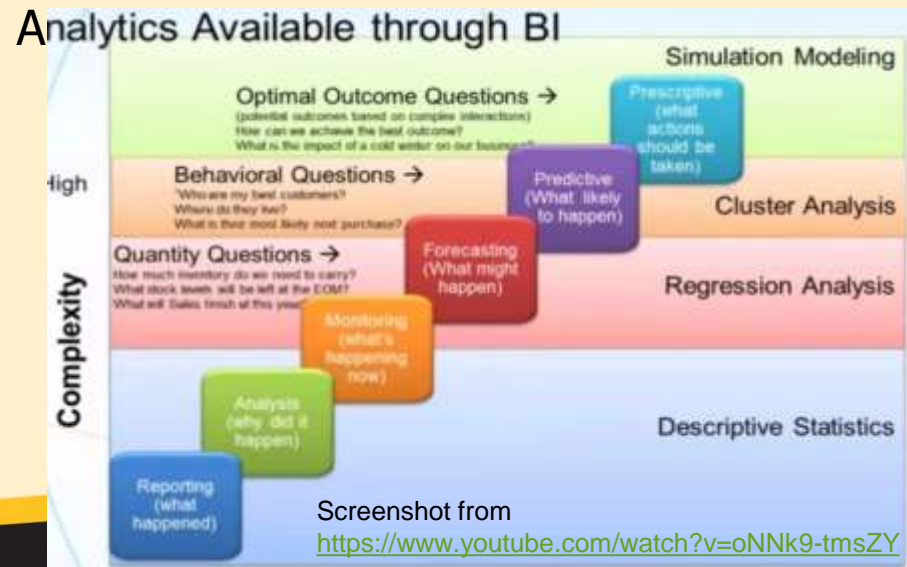
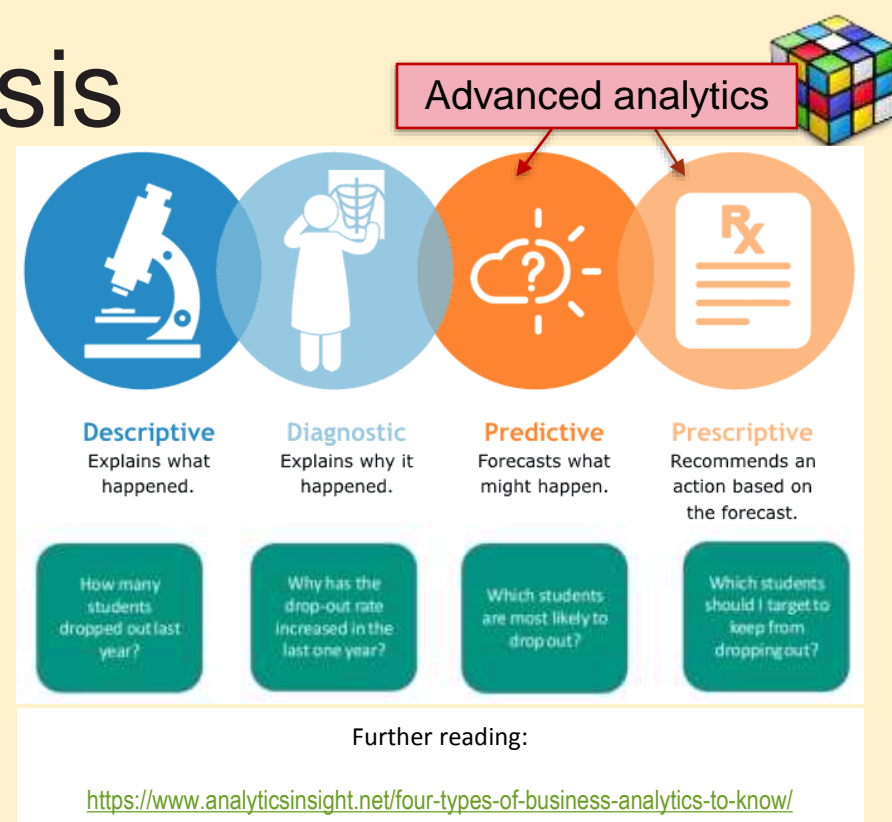
- Data may come from multiple different sources of different formats, but need to be combined and associated
 - Operational databases
 - Spreadsheets
 - Text, CSV
 - PDF, Paper
- The need to bring together different data/information
 - Autonomous (may not have the control and management of data)
 - Distributed (from different systems and places)
 - Different (in data model, format, or platform)
- General processing activities - ETL
 - **Extraction**: accessing and extracting the data from the source systems, including database, flat files, spreadsheets, etc.
 - **Transformation**: data cleanse, change the extracted data to a format and structure that conform to the destination data.
 - **Loading**: load the data to the destination database, and check for data integrity
- Traditional BI focuses on upfront separate ETL processes that load the data in a centralized storage. In modern BI and analytics, data cleanse and transformation may happen just-in-time with analysis.
 - Similar or related terms: data integration, acquisition, ingestion, wrangling, blending

Data is never clean!
You will spend most of your time
cleaning and preparing data!

ETL will be covered in IT4713 milestone 2 (module 5 and 6).
Self-service data preparation will be covered in IT 7123 module 6 and 7.

Four Levels of Analysis

- **Descriptive Analytics:** Describing or summarising the existing data using existing business intelligence tools to better understand what is going on or what has happened.
- **Diagnostic Analytics:** Focus on past performance to determine what happened and why. The result of the analysis is often an analytic dashboard.
- **Predictive Analytics:** Emphasizes on predicting the possible outcome using statistical models and machine learning techniques.
- **Prescriptive Analytics:** It is a type of predictive analytics that is used to recommend one or more course of action on analyzing the data.



Examples of Analysis



- Non-analytical query (search results based on certain conditions)
 - Get a list of students enrolled in in the IT 6713 class.
- Descriptive analysis (summarizing)
 - How many students are enrolled in online IT graduate courses for the past year?
- What if analysis
 - If inventory levels are reduced by 10%, what is the new cost of inventory storage?
- Reasoning (why) and correlation
 - What is the reason for a decrease of total sales this year?
 - How do advertising activities affect sales of different products bought by different type of customers, in different regions? (synthesizing)
- Forecast and prediction
 - How many students are likely to change degree next year?
- Fuzzy decision
 - What new advertising strategies need to be undertaken to reach our customers who can afford an expensive product?
 - Should we invest more on our e-business?

Descriptive Analytics



- Descriptive reporting has been the most common in all kinds of analysis
 - Structured and fixed format reports
 - Based on simple and direct queries
 - Usually involves simple descriptive analysis and transformation of data, such as calculating, sorting, filtering, grouping, and formatting
 - Aggregating results from multiple rows of data on multiple dimensions
 - Ad hoc query and reporting
- Multi-dimensional queries
 - A dimension is a particular way (or an attribute) of describing and categorizing data
 - Such queries are usually arithmetic aggregation operations (sum, average, etc.) on records grouped by multiple dimensions (attributes) at different aggregation levels.
 - A pivot table or crosstab is usually used for OLAP result view (aggregated data)
- Example analysis
 - "What is the total sales amount grouped by product line (dimension 1), location (dimension 2), time (dimension 3) and ... (other dimensions)?"
 - "Which segment of business provides the most revenue growth?"
- OLAP (Online Analytical Processing)
 - OLAP is a technology and system that is optimized to answer queries that are multi-dimensional
 - OLAP solutions traditionally heavily rely on backend processing and dedicated IT personnel

Dimensional queries and analysis will be covered in IT 4713 milestone 4 and in IT 7123 module 8.

Descriptive and operational report

More open and exploratory analysis

OLAP will be covered in IT 4713 milestone 3 (module 7 and 8).

Advanced Analytics



- Advanced Analytics is the autonomous or semi-autonomous examination of data or content using sophisticated techniques and tools, typically beyond those of traditional business intelligence (BI), to discover deeper insights, make predictions, or generate recommendations.
 - <https://www.gartner.com/it-glossary/advanced-analytics/>
 - Advanced analytics are usually computing intensive
- Advanced analytic techniques include:
 - Complex statistical methods
 - Machine learning
 - Data/text mining: using sophisticated statistical and mathematical techniques to find patterns and relationships among data. Data mining techniques are a blend of statistics and mathematics, and artificial intelligence and machine-learning.
 - Pattern matching, forecasting, visualization, semantic analysis, sentiment analysis, network and cluster analysis, multivariate statistics, graph analysis, simulation, complex event processing, genetic algorithm, neural networks, etc.

Presentation



- The last mile of BI is the presentation of data or analysis to human users
- Data presentation is the method by which people summarize, organize and communicate information using a variety of tools, including tables, diagrams/charts, and other visualization techniques
- Multiple ways to present results
 - Regular/periodical static reports
 - Interactive reports
 - Live and real time dashboard
 - Free form ad hoc analysis
 - Edited PowerPoint
- Presentation commonly utilizes data visualization techniques to assist interpreting and presenting data in a visual way.

“Presentation is key – be a master of PowerPoint.”

Reports and dashboards will be covered in IT 4713/7123 module 10, and IT 7113 Data Visualization.

Data Visualization



Data visualization is the visual representation and presentation of **data** for the purpose of sensory enhancement (perception), sense making (comprehension), exploration, analysis, and communication.

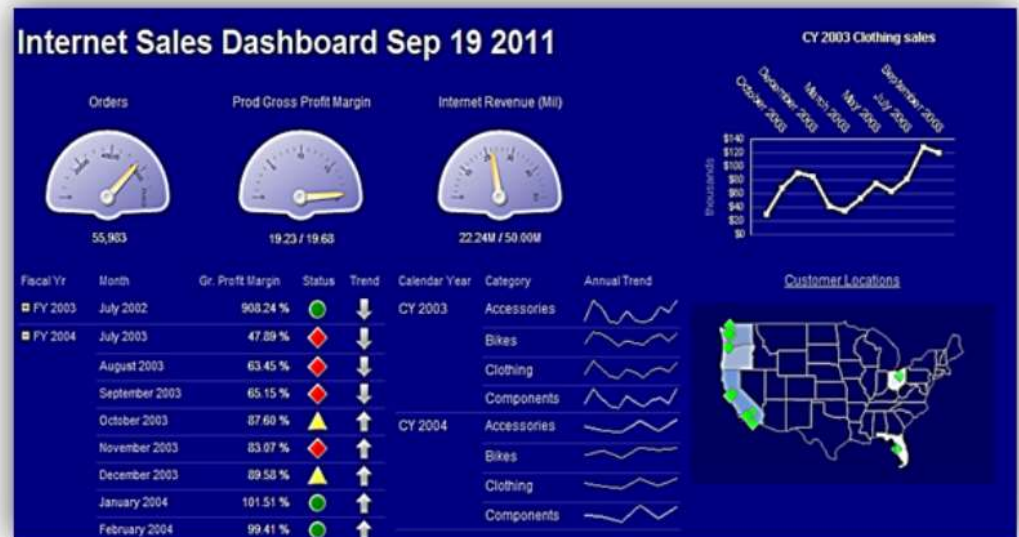
- Visualizing is basically a human physiological and psychological capability, and plays an important role in human information behavior and decision making
 - Recall or memorize data more effectively
 - Enable fast perception based on instinct (see the figure on the right)
 - Helps data comprehension and enhance problem solving capabilities (cognition)
 - Extract/provoke additional (implicit) perspectives and meanings
 - Ease the cognitive load of information processing and exploration
 - Help to shape the attention and focus
 - Effective communication (story telling)
- Data visualization in BI/Analytics
 - Data visualization is an important part of data exploration and decision making. Given the power of visualization, it is only natural to apply the rich communication techniques in the field of BI and analytics.
 - As organizations seek to empower non-technical users to make data-driven decisions, they must consider the powers of data visualization in delivering digestible insights.
 - Visualization tools have become increasingly important to business intelligence, in which people need technology support to make sense of and analyze complex data sets and all types of information.
 - Visualization can also be part of the analysis process (visual analytics)

Reports



- Reports
 - A report is the presentation of detailed data arranged in defined layouts and formats
 - Based on simple and direct queries: usually involves simple analysis and transformation of data (sorting, calculating, filtering, filtering, grouping, formatting, etc.)
- Traditional reports contain detailed data in a tabular format and typically display numbers and text only.
 - It is geared towards people who need data rather than a direct understanding or interpretation of data.
 - Its purpose is mainly for printing (with styling) or exporting (raw data).
- Modern reports can be interactive and visual, but the focus is still on detailed data. Sometimes the distinction is a bit blurred with dashboards in some practical cases.
 - A report style “dashboard” (or more like a visual intensive interactive report):
<https://www.cityhealthdashboard.com/ga/atlanta/city-overview>
 - Magic Quadrant report vs. <https://www.g2.com/categories/data-visualization?segment=all>
 - Dashboard or report? <http://www.crazybikes.com/mrc/CRAZYBIKES.R00090s>

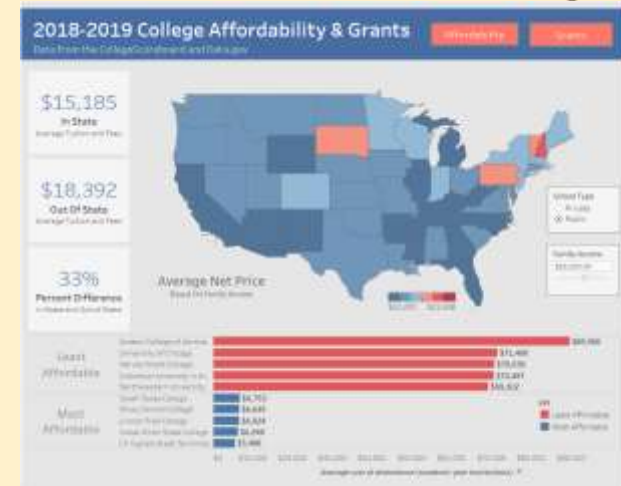
Cat/SubCat/Product	Product #	Color	Std Cost	List Price
Accessories				
Bike Racks				
Hitch Rack - 4-Bike	RA-HT23		\$44.00	\$120.00
Bike Stands				
All-Purpose Bike Stand	ST-1401		\$69.47	\$169.00
Bottles and Cages				
Mountain Bottle Cage	BC-M005		\$3.74	\$9.99
Road Bottle Cage	BC-R005		\$3.36	\$8.99
Water Bottle - 30 oz.	WB-H030		\$1.87	\$4.99
Cleaners				
Bike Wash - Discover	CL-9009		\$2.97	\$7.95
Fenders				
Fender Set - Mountain	FE-6654		\$8.22	\$21.99
Helmets				
Sport 100 Helmet, Black	HL-U509	Black	\$13.09	\$34.99
Sport 100 Helmet, Blue	HL-U509-B	Blue	\$13.09	\$34.99
Sport 100 Helmet, Red	HL-U509-R	Red	\$13.09	\$34.99
Hydration Packs				
Hydration Pack - 70 oz.	HY-1023-70	Silver	\$20.57	\$54.99



Dashboard

A dashboard is a visual-oriented display of the most important data and information needed to achieve defined goals and objectives; consolidated and arranged on a single screen so the information can be viewed at a glance.

Adapted from: Dashboard Confusion, Stephen Few,
http://www.perceptualedge.com/articles/ie/dashboard_confusion.pdf



- Elements of a dashboard

Dashboard = data/information + visual + UI

- Data/information: the most important element
- Visual: data visuals (charts, etc.) provide a high level at-a-glance view
- User interface
 - a clean UI that unifies all elements to work together as a whole
 - supporting interactions as needed

- The Values of Dashboard

- Provides a one-place presentation of critical information, so users can quickly understand data and respond quickly at one place.
 - Saves time over running multiple reports.
- Allows decision makers to see a variety of data that affects their divisions or departments
 - This allows decision makers to focus only on the items over which they have control
 - The dashboard is generally customized for each user
- Allows all users to understand the analytics. For non-technical users, dashboards allow them to participate and understand the analytics process by compiling data and visualizing trends and occurrences.
- More <http://www.bidashboard.org/benefits.html>

For more details, visit IT 7113 module on dashboard:
<https://www.edocr.com/v/oek131vr/jgzheng/Dashboard>

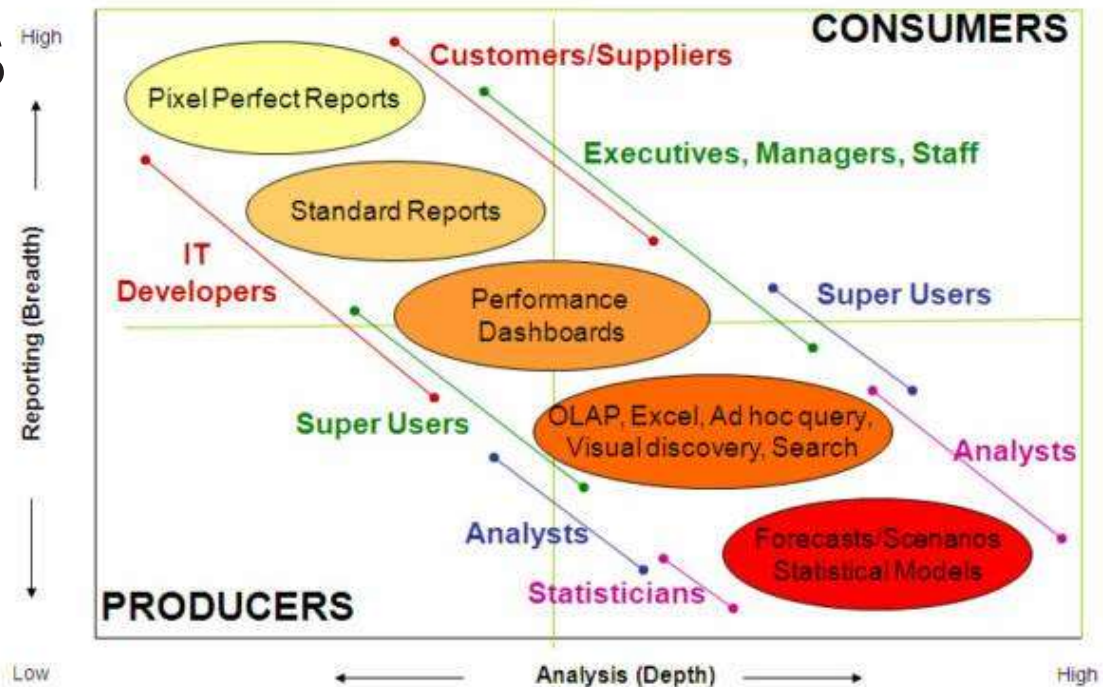
Delivery/Sharing Medium



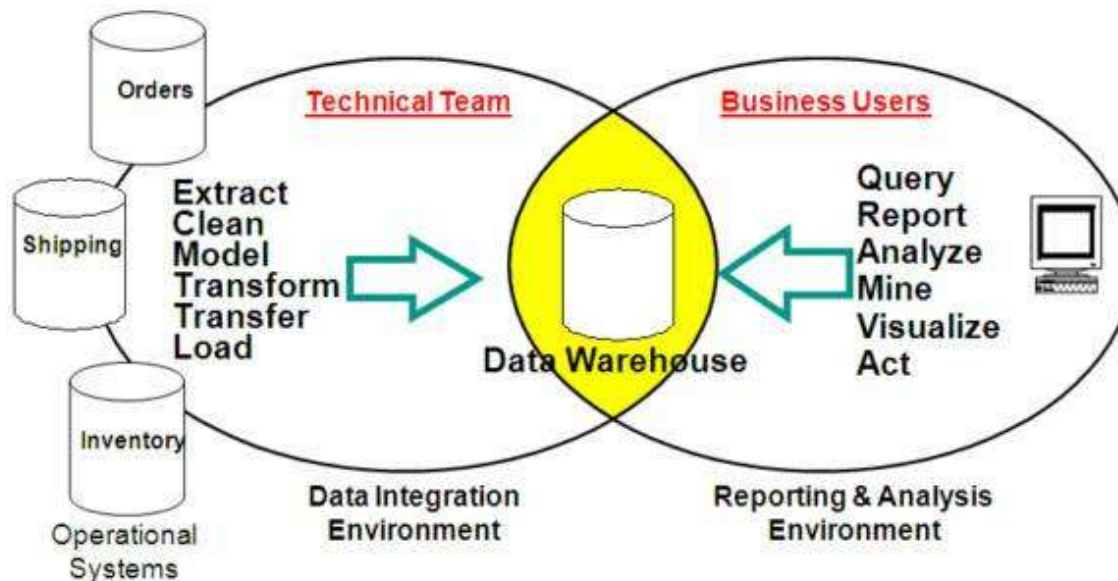
- Delivery is about managing and delivering data and analysis results to users
- Traditional delivery is more one directional and IT centric
 - BI portal, web app, email, etc.
 - Example: <https://reports.kennesaw.edu>
- Modern channels promotes peer sharing and embedding
 - Social sharing, cloud hosting, direct saving/uploading, etc.
 - Embedded in apps directly

BI Stakeholders

**Producers
vs.
Consumers
(at different levels)**





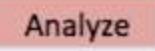

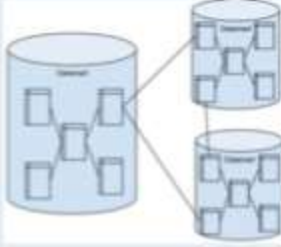



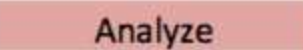
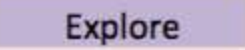

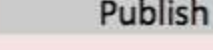










Technical vs. Business users



Figures originally from
<http://www.bileader.com/Dashboards.html>

Users Have Different Needs



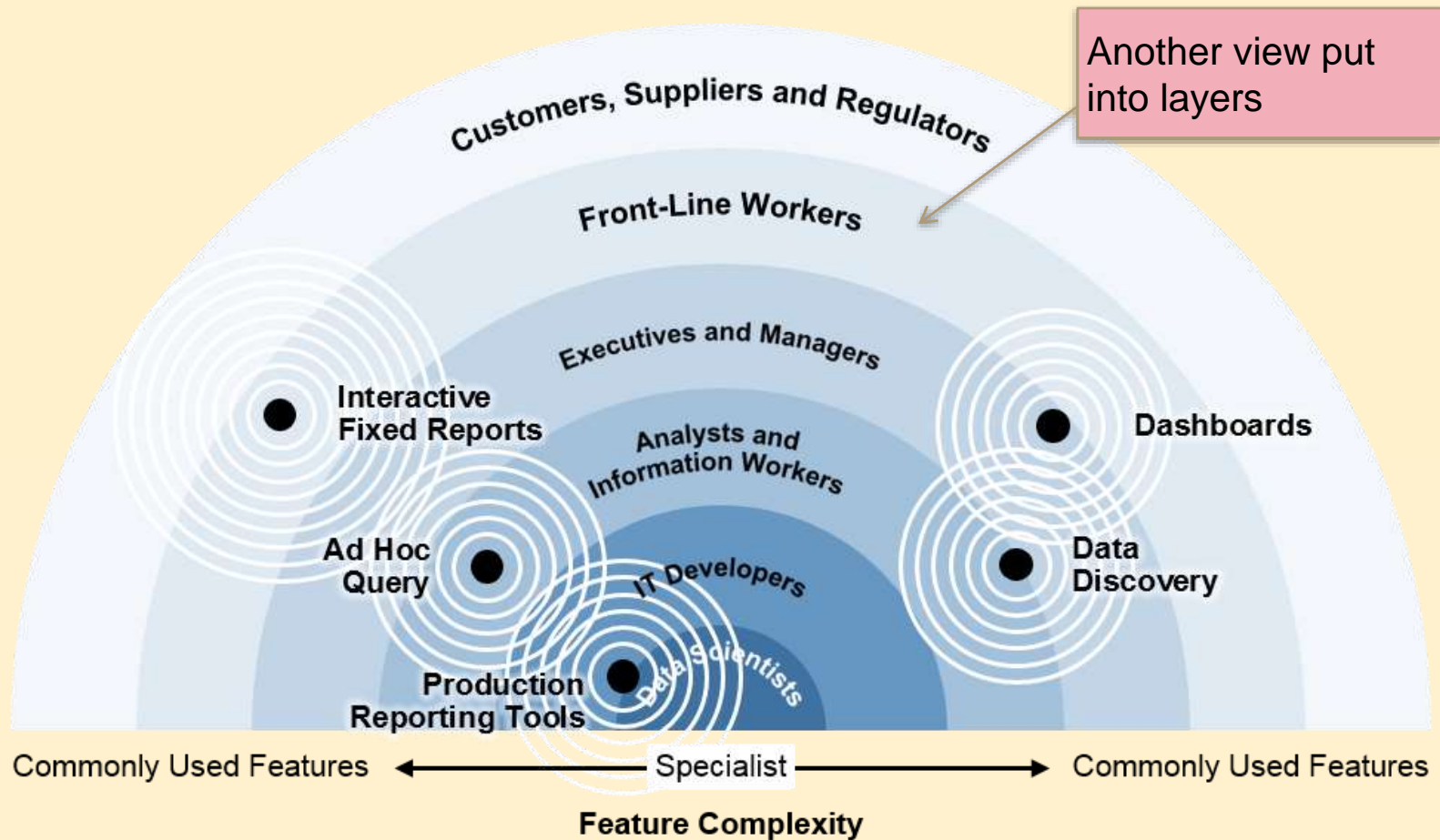
Users	Functions	Data Architecture	Tools
Casual Users 80% of employees  Executives Managers Front-line workers <i>Business users who use information to do their jobs</i>	80% of time*    Top-down BI	 Data warehouse with certified data Built by IT	 Interactive dashboards and reports  Text- and voice-based search tools Managed by IT
Power Users 20% of employees  Business Analysts Data scientists Statisticians Super Users <i>Business users who are hired to analyze information.</i>	Bottom-up BI 100% of time*     © Eckerson Group, LLC - 2014	 Data warehouse  Hadoop  Operational systems  External Data  NoSQL Systems  Text/Documents Sourced by BUs	 Mashup Tools  Visualization Tools  Data Mining Tools  Programming tools Managed by BUs

Casual users may not be as technical as power users.

Power users may also be technology savvy and capable of programming.

Figure from <http://eckerson.com/articles/part-iv-seven-keys-to-a-united-bi-environment>

The Fit between Tools and Users



Gartner Report,
Select the Right Business Intelligence and Analytics Tool for the Right User
Published: 23 May 2016 **Analyst(s):** Cindi Howson



Modern BI Trends

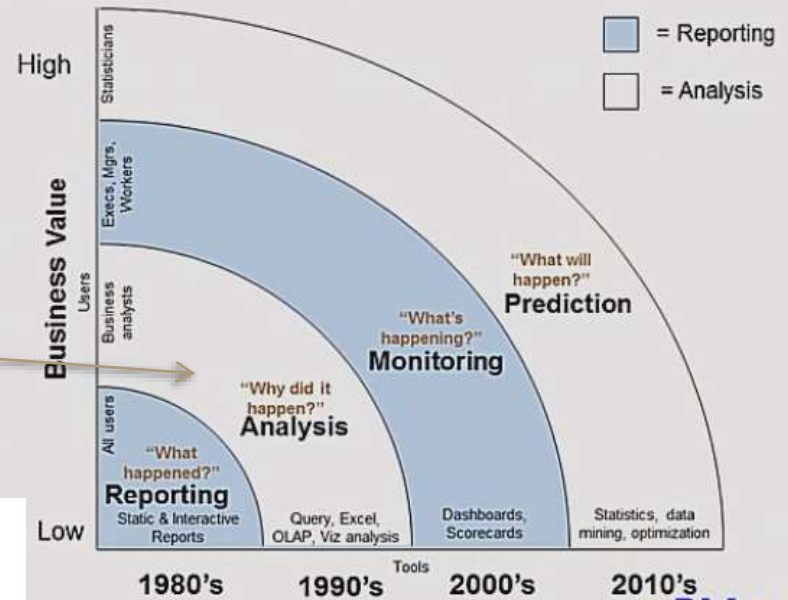
- Modern vs. traditional BI

More details of modern BI will be covered in IT 7123 module 10.

History and Trends

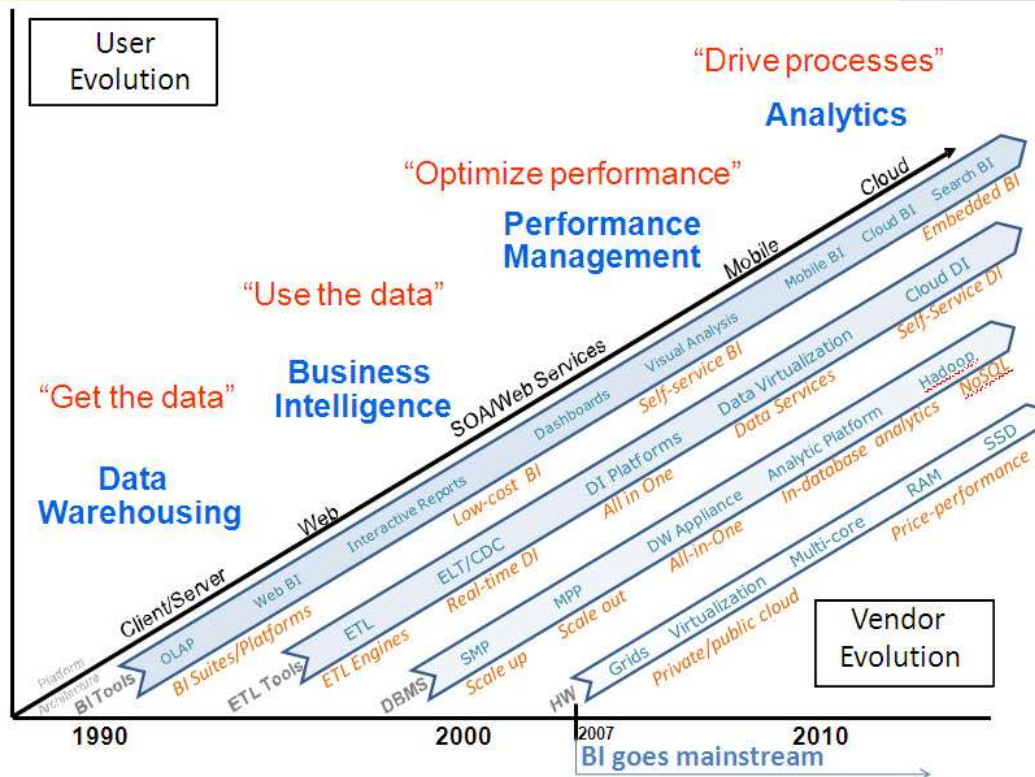
Traditional enterprise BI based on data warehouse and OLAP

Waves of BI



BI Leader Consulting

From Wayne Eckerson talk
<https://vimeo.com/68143902>



http://www.b-eye-network.com/blogs/eckerson/archives/2011/03/bi_market_evolu.php

The Modern/New BI



- A modern BI platform supports IT-enabled analytic content development. It is defined by a self-contained architecture that enables nontechnical users to autonomously execute full-spectrum analytic workflows from data access, ingestion and preparation to interactive analysis and the collaborative sharing of insights. It moves from passive collection and use of data (reporting driven) to proactive generation of data (business development driven).
- By contrast, traditional BI platforms are designed to support modular development of IT-produced analytic content, and specialized tools and skills and significant upfront data modeling, coupled with a predefined metadata layer, are required to access their analytic capabilities.
- <https://www.slideshare.net/Dataversity/analytics-business-intelligence-and-data-science-whats-the-progression>

Technology Insight for Modern Business Intelligence and Analytics Platforms
Gartner Report, October 2015

Analytic Workflow Component	Traditional BI Platform	Modern BI Platform
Data source	Upfront dimensional modeling required (IT-built star schemas)	Upfront modeling not required (flat files/flat tables)
Data ingestion and preparation	IT-produced	IT-enabled (business-led)
Content authoring	Primarily IT staff, but also some power users	Business users;
Analysis	Predefined and regular reporting, based on predefined model	Free-form exploration, ad hoc analytics
Insight delivery	Distribution and notifications via scheduled reports or portal; passive collection and use of data (reporting driven).	Sharing and collaboration, storytelling, open APIs

Notable Trends/Features of the Modern BI



- Self-service BI/Analytics: Business led, IT enabled
- Cloud BI and analytics: cloud computing is regarded as an ideal platform to provide business intelligence applications as it serves as a repository for structured and unstructured data.
- Other notable trends and developments – please do some research yourself
 - Embedded analytics: use of reporting and analytic capabilities directly in business applications <http://www.gartner.com/it-glossary/embedded-analytics/>
 - Augmented analytics and natural language processing: uses machine-learning automation to supplement human intelligence across the entire analytics life-cycle.
 - Search driven analytics: (aka clickless analytics) aims to build a report and charts on the fly, using web search style.
 - Incorporating natural language processing
 - A quick intro: <https://www.youtube.com/watch?v=868-pR-cxZo>
 - Location intelligence <http://sandhill.com/article/iot-and-the-growing-use-of-location-features-in-business-intelligence-software/>
 - Expanding application areas at all levels: in more extensive application areas, e.g. sports, disease, network traffic, etc.
- Capability specific trends (we will discuss these trends with the modules focusing on each component)
 - Data lake
 - Advanced analytics (machine learning, deep learning, AI, etc.)
 - Collaborative BI
 - Mobile BI: <https://bi-survey.com/mobile-bi>
 - Visual BI or visual analytics Visual oriented, - <http://www.perceptualedge.com> visual-based data discovery capabilities
 - In-memory processing (in-memory OLAP): emerging technology for processing of data stored in an in-memory database. <http://www.bi-dw.info/in-memory-olap.htm>
 - New data gathering techniques and technologies. New data sources and capability to capture more data. From passive collection and use of data (reporting driven) to proactive generation of data (business development driven)
 - Variety of visual medium and UI
- More trends
 - <https://bi-survey.com/top-business-intelligence-trends>
 - <http://www.zdnet.com/article/is-the-business-intelligence-market-finally-maturing/>
 - <https://www.slideshare.net/TableauSoftware/top-10-business-intelligence-trends-for-2017>
 - <https://www.mrc-productivity.com/blog/2019/01/5-business-intelligence-trends-to-watch-in-2019/>
 - <https://www.gartner.com/smarterwithgartner/gartner-top-10-data-and-analytics-trends-for-2021>

Self-Service BI



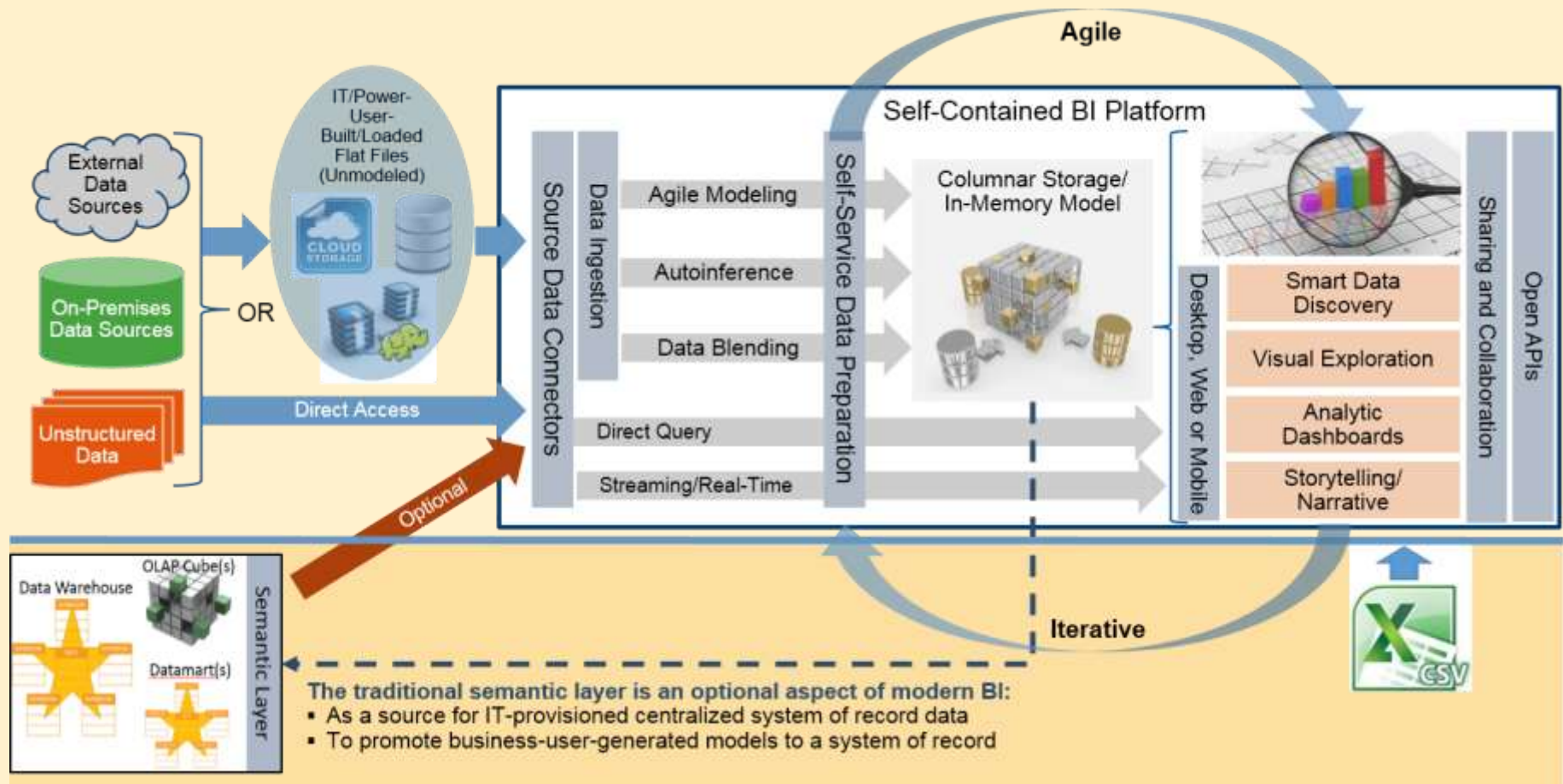
- [A solution for] end users designing and deploying their own reports and analyses within an approved and supported architecture and tools portfolio.
 - <http://www.gartner.com/it-glossary/self-service-business-intelligence>
- Key features
 - Shifting focus from IT back to the user: enables all kinds of users with varied skill levels to autonomously execute full-spectrum analytic workflows. These users include traditional power users, data professionals or data scientists, managers and business analysts.
 - A more distributed and collaborative environment.
 - The process is more flexible and agile, and it responds to user needs quickly. Supporting ad hoc analytic needs, hence more interactive and explorative.
 - Self-service BI tools still have fundamental BI components and provide BI capabilities, but they are more integrated (in one software package) than separated.
 - Independent but very often work with enterprise systems.
 - Good for individuals or non-corporate environments.
- Different levels of self-service
 - Started from client-oriented report building and data visualizations, and eventually extended to analysis models, and finally to data discovery, preparation, and cleanse.
 - <https://www.eckerson.com/articles/part-2-one-size-does-not-fit-all-customizing-self-service-analytics-for-business-users>
- Dashboards, reporting, end-user self-service, and advanced visualization are the top four most important technologies and initiatives strategic to BI in 2018.
 - <https://www.forbes.com/sites/louiscolumnbus/2018/06/08/the-state-of-business-intelligence-2018/#b2fca2878289>
- Tools and market
 - Best self-service tools: <https://www.pcmag.com/picks/the-best-self-service-business-intelligence-bi-tools>
 - The global self-service business intelligence market to grow from USD 3963.04 million in 2016 to USD 10992.96 million by 2023, at a CAGR of 15.69%. <http://www.nbc-2.com/story/38414064/global-self-service-business-intelligence-market-2018-size-share-growth-trends-type-application-analysis-and-forecast-by-2023>

IT Support in Self-Service BI



- The goal of self-service BI
 - NOT to eliminate the need for IT
 - Instead, to put data and results in the user's hands and reduce the burden on the IT department.
- “Self-service BI does remove much of the reporting burden from the IT department. The IT department must control the data and the user access. They're responsible for keeping the data clean, and ensuring that users can only access data they're authorized to see. The self-service BI tool only acts as a doorway for users to access the IT-controlled data.”
 - <https://www.mrc-productivity.com/blog/2015/08/6-common-misconceptions-of-self-service-bi/>
- IT's role
 - Data management and governance, including security, access control, data quality and accuracy, compliance, etc.
 - Technical support for the systems and platforms, especially cloud based

A Changing BI Platform



Technology Insight for Modern Business Intelligence and Analytics Platforms
Gartner Report, October 2015



Market, Career, Education, and Resources

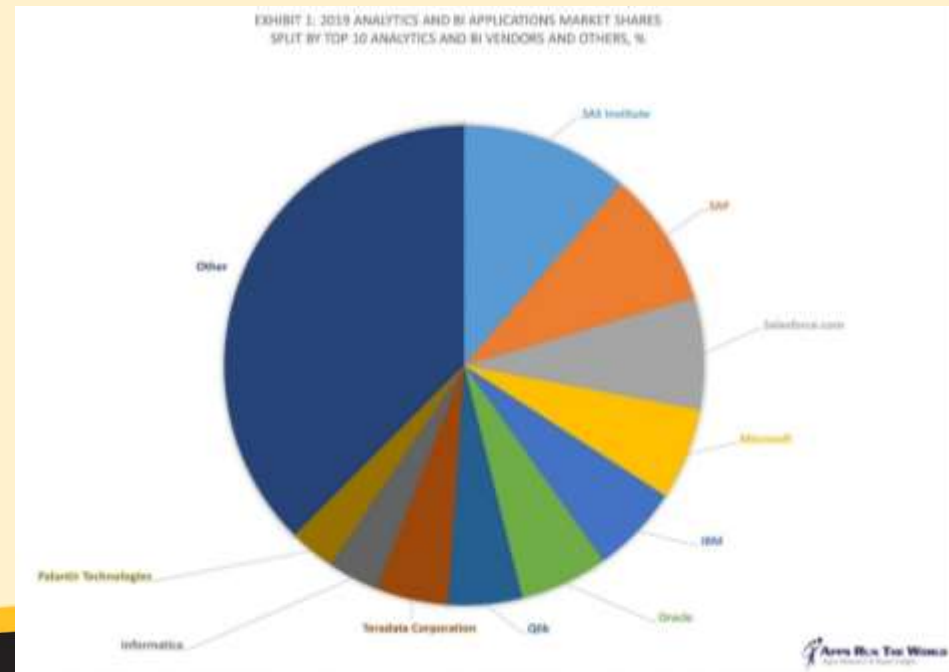
BI Market



- Commoditization and consolidation of multiple technologies
 - Forrester no longer sees reporting and querying, online analytical processing (OLAP), data visualization, dashboards, data exploration, and location analytics as separate market categories within BI. Rather, most enterprise BI platforms now provide these capabilities.
 - The same commoditization is happening in the cloud and mobile BI as most leading vendors now build their platforms on cloud-based multi-tenant architecture or offer a cloud version in addition to an on-premises one. Similarly mobile BI is now simply a feature of most BI platforms.
 - <https://www.zdnet.com/article/is-the-business-intelligence-market-finally-maturing/>
- Company has been going through consolidation
 - Many smaller products that target specific functional areas are consolidated into major BI/analytics suites and platforms.
 - 2007 Hyperion Solutions \$3.3bn → Oracle
 - 2008 Business Objects → SAP 6.8B
 - 2008 Cognos → IBM 5B
 - 2019 Tableau → Salesforce 15.7B
 - 2019 Looker → Google 2.6b
 - 2021 Information Builders → TIBCO

Major vendors

<https://www.appsruntheworld.com/top-10-analytics-and-bi-software-vendors-and-market-forecast/>



Vendors/Products



- Traditional big four: these are mega vendors that provide complete solutions that cover full spectrum of BI processes and related applications.
 - Microsoft: SQL Server, Power BI, SharePoint, Excel <https://www.microsoft.com/en-us/sql-server/>
 - SAP: SAP BusinessObjects BI, Lumira <https://www.sap.com/products/analytics/business-intelligence-bi.html>
 - IBM: Cognos, Watson <https://www.ibm.com/analytics/business-intelligence/>
 - Oracle: Oracle BI 12c <https://www.oracle.com/solutions/business-analytics/business-intelligence/>
- Other notable vendors/products
 - SAS: SAS Enterprise BI https://www.sas.com/en_us/solutions/business-intelligence.html
 - Salesforce Tableau
 - QlikTech
 - TIBCO
 - Cloud based
 - Google Data Studio
 - Amazon QuickSight
 - mode.com
 - Zoho
 - Open-source tools, including BIRT, Pentaho, Metabase, etc.
 - <https://blog.capterra.com/top-8-free-and-open-source-business-intelligence-software/>
- Integrated solutions for a specific industry
 - <https://www.datagear.com>
- More other analytics/BI tools list
 - <https://www.datanyze.com/market-share/business-intelligence--243>
 - <https://www.gartner.com/reviews/market/analytics-business-intelligence-platforms>
 - <https://www.techradar.com/best/best-bi-tools>
 - <https://www.g2.com/categories/business-intelligence>
 - <https://www.itcentralstation.com/categories/business-intelligence-bi-tools>
 - <http://www.capterra.com/business-intelligence-software/>
 - <https://www.pcmag.com/picks/the-best-self-service-business-intelligence-bi-tools>
 - Others
 - <https://www.softwareadvice.com/bi/>
 - <https://www.betterbuys.com/bi/reviews/>
 - <https://www.bitool.net/business-intelligence.html>

Vendor Positioning



In 2019 Gartner started to put “analytics” before “BI”.

Gartner Magic Quadrant for Analytics and Business Intelligence and Platforms 2021

Figure 1: Magic Quadrant for Analytics and Business Intelligence Platforms



Source: Gartner (February 2021)

G2 Grid for Analytics Platforms

<https://www.g2.com/categories/business-intelligence-platforms>

BI/Analytics Careers



- Typical BI/Analytics positions
 - BI analyst
 - BI solution architect and integration specialist
 - BI application developer and tester
 - BI system support specialist
 - Data warehouse specialist
 - Database analyst, developer and tester
 - Report/dashboard developer
- More about jobs and careers
 - <https://www.datapine.com/blog/bi-skills-for-business-intelligence-career/>
 - <https://www.discoverdatascience.org/career-information/>
 - <https://searchdatamanagement.techtarget.com/feature/Data-management-roles-Data-architect-vs-data-engineer-others>
 - <https://dzone.com/articles/five-data-tasks-that-keep-data-engineers-awake-at>
 - Data analyst: <https://www.investopedia.com/articles/professionals/121515/data-analyst-career-path-qualifications.asp>
 - <https://blog.udacity.com/2014/12/data-analyst-vs-data-scientist-vs-data-engineer.html>

Critical Knowledge and Skills



- Three competencies
 - Technical, Business (management), Analytical
- Technical knowledge
 - Knowledge of database systems and data warehousing technologies
 - Ability to manage database system integration, implementation and testing
 - Ability to manage relational databases and create complex reports
 - Knowledge and ability to implement data and information policies, security requirements, and state and federal regulations
 - Knowledge of client tools used by business users
 - Knowledge of data models
 - Knowledge of programming tools used in analytics
- Solution development and management
 - Working with business and user requirements
 - Capturing and documenting the business requirements for BI solution
 - Translating business requirements into technical requirements
 - BI project lifecycle and management
- Business and Customer Skills and Knowledge
 - Effective communication and consultation with business users
 - Understanding of the flow of information throughout the organization
 - Ability to effectively communicate with and get support from technology and business specialists
 - Ability to understand the use of data and information in each organizational units
 - Ability to train business users in information management and interpretation
- <https://www.datapine.com/blog/bi-skills-for-business-intelligence-career/>

Sample Roles (from real world job ads)



BI jobs in Atlanta

<https://www.dice.com/jobs?q=BI&l=Atlanta%2C+Ga+Metro+Area>

Business Intelligence Specialist

- Maintain or update business intelligence tools, databases, dashboards, systems, or methods.
- Provide technical support for existing reports, dashboards, or other tools.
- Create BI tools or systems, including design of related databases, spreadsheets, or outputs.

Business Intelligence Analyst

- Technical skill requirements
 - Works with business users to obtain data requirements for new analytic applications, design conceptual and logical models for the data warehouse and/or data mart.
 - Develops processes for capturing and maintaining metadata from all data warehousing components.
- Business skills requirements
 - Transform data into analytical insight and desire to leverage the best technique to arrive at the right answer.
 - Generate standard or custom reports summarizing business, financial, or economic data for review by executives, managers, clients, and other stakeholders.
 - Analyze competitive market strategies through analysis of related product, market, or share trends.
 - Collect business intelligence data from available industry reports, public information, field reports, or purchased sources.
 - Maintain library of model documents, templates, or other reusable knowledge assets.

Business Intelligence Developer

- Business Intelligence Developer is responsible for designing and developing Business Intelligence solutions for the enterprise.
- Key functions include designing, developing, testing, debugging, and documenting extract, transform, load (ETL) data processes and data analysis reporting for enterprise-wide data warehouse implementations.
- Responsibilities include:
 - working closely with business and technical teams to understand, document, design and code ETL processes;
 - working closely with business teams to understand, document and design and code data analysis and reporting needs;
 - translating source mapping documents and reporting requirements into dimensional data models;
 - designing, developing, testing, optimizing and deploying server integration packages and stored procedures to perform all ETL related functions;
 - develop data cubes, reports, data extracts, dashboards or scorecards based on business requirements.
- The Business Intelligence Report Developer is responsible for developing, deploying and supporting reports, report applications, data warehouses and business intelligence systems.

BI/Analytics Local Resources



- BI/Analytics Education at KSU
 - MSIT/BSIT - Graduate Certificate in Data Analytics and Intelligent Technology <https://msit.kennesaw.edu/future-students/program-requirements.php>, which includes my
 - IT 7123 Business Intelligence <http://jackzheng.net/teaching/it6713/>
 - IT 7113 Data Visualization <http://jackzheng.net/teaching/it7113/>
 - BSIT - the new concentration on “data analytics and technology”, including my
 - IT 3703 Intro to data analytics and technology
 - IT 4713 Business Intelligence <http://jackzheng.net/teaching/it4713/>
 - Other departments
 - Data Science Institute Ph.D. in Analytics and Data Science <https://datascience.kennesaw.edu>
 - ACS 8310 Data Warehousing
 - IS 8935 Business Intelligence - Traditional and Big Data Analytics
 - Certificate in High Performance Cluster Computing <http://ccse.kennesaw.edu/cs/programs/cert-hpcc.php>
 - Lecture notes on BI and Data Visualization
 - <https://www.edocr.com/user/jgzheng>
- Local organizations and events
 - <https://www.meetup.com/Atlanta-Society-for-Business-Intelligence/>
 - <https://www.meetup.com/Atlanta-Microsoft-Business-Intelligence-Users/>

Core Readings



- What Is Business Intelligence? A Beginner's Guide in 2020 <https://learn.g2.com/business-intelligence> - this is a very practical but not very comprehensive view of BI
- Distinguishing Analytics, Business Intelligence, Data Science: <https://www.dataversity.net/distinguishing-analytics-business-intelligence-data-science/>
- Data Analyst vs Data Engineer vs Data Scientist: Skills, Responsibilities, Salary <https://www.edureka.co/blog/data-analyst-vs-data-engineer-vs-data-scientist/> - from some job and career perspectives.
- Short video intro:
 - DIKW <https://www.youtube.com/watch?v=u9DoQ9gY4z4>
 - A quick, conceptual, and practical introduction of BI by Jared Hillam (Intricity), from a traditional perspective: <http://www.youtube.com/watch?v=LFnewuBsYiY>
 - BI intro video by LearnItFirst (focused more on the traditional BI; there are some good points which I do agree): <https://www.youtube.com/watch?v=LhZX0MAYKp8>
 - Data Analytics for Beginners Video Tutorial: <https://www.youtube.com/watch?v=mm2A5tKVlpg>
- Others
 - A Brief History of Decision Support Systems by D.J. Power: <http://dssresources.com/history/dsshistory.html>
 - An Overview of (traditional) BI Technology from CACM (premium magazine from ACM): <http://cacm.acm.org/magazines/2011/8/114953-an-overview-of-business-intelligence-technology/fulltext>
 - http://wps.prenhall.com/wps/media/objects/2519/2580469/addit_chmatl/TURBMC04_0131854615App.pdf
 - Advanced Analytics and Business Intelligence: <https://www.youtube.com/watch?v=oNNk9-tmsZY>
 - History of BI (casual video with wacky visuals): https://www.youtube.com/watch?v=_1y5jBESLPE

Good General BI/Analytics Resources



- General BI resource web sites
 - BI and DW resource directory: <http://www.bi-dw.info>
 - BeyeNetwork: <http://www.b-eye-network.com>
 - <https://solutionsreview.com/business-intelligence/>
 - DSS Resources: <http://dssresources.com/>
 - ACM techpack: <http://techpack.acm.org/bi/>
 - <http://blog.capterra.com/learn-about-business-intelligence-resources/>
 - <https://www.itprotoday.com/business-intelligence>
- General learning resources
 - <https://www.1keydata.com/datawarehousing/datawarehouse.html>
- Organizations, communities, and events
 - BI Bake Off <https://powerbi.microsoft.com/en-us/blog/tag/bi-bake-off/>
 - Dataversity: <http://www.dataversity.net/>
 - The Data Warehousing Institute: <http://tdwi.org>
- Paid industry reports: you may get some free reprints from some vendors after registration.
 - Gartner annual report on “Magic Quadrant for Analytics and Business Intelligence Platforms”
 - Gartner report “Technology Insight for Modern Analytics and Business Intelligence Platforms”
 - The Forrester Wave™: Enterprise BI Platforms (two versions, one for on-premise and one for cloud)
 - Forrester Playbook: <https://www.forrester.com/playbook/The+InsightsDriven+Business+Playbook/-/E-PLA940>
- Industry experts and influencers
 - Howard Dresner: <http://dresneradvisory.com>
 - Wayne Eckerson: <https://www.eckerson.com/blogs/the-new-bi-leader>
 - Gregory Piatetsky: <http://www.kdnuggets.com>
 - Ralph Kimball