Utrecht, April 23rd 2019

Business Intelligence

Lecture 01 - Introduction & Course Organization

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With particular thanks to

- Armel Lefebvre (tutor, A.E.J.Lefebvre@uu.nl)
- Koen Niemeijer (student teaching assistant)
- Jordan v. Dijk (student teaching assistant)
- and Marco Spruits (previous BI lecturer)

Course Structure and Organisation

- Course Structure
- Course Organisation

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Structure of the Course: Textbook Structure

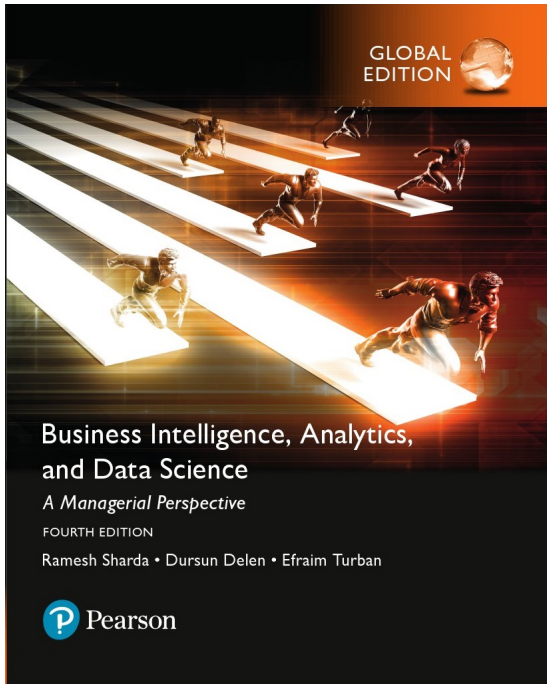

Figure: Textbook [Sharda et al., 2018]
Sharda, Delen, Turban & King (2018)
Business Intelligence, Analytics & Data Science: A Managerial Perspective
4th Global Edition, Pearson
ISBN-13: 9781292220567

- Available as ebook (single user licence) in the library
- Previous editions are mostly okay
  Main Differences:
  - Chapter 2 (Descriptive Statistics)
  - Chapter 6 (Prescriptive Analytics)
  - Chapter 7 (Big Data, Ethics, Managerial Considerations)
- [Sherman, 2015]
- Further reading: scientific papers
  Announced before each lecture
- Further textbooks
  (recommended when specializing therein):

Structure of the Course: Textbook Structure

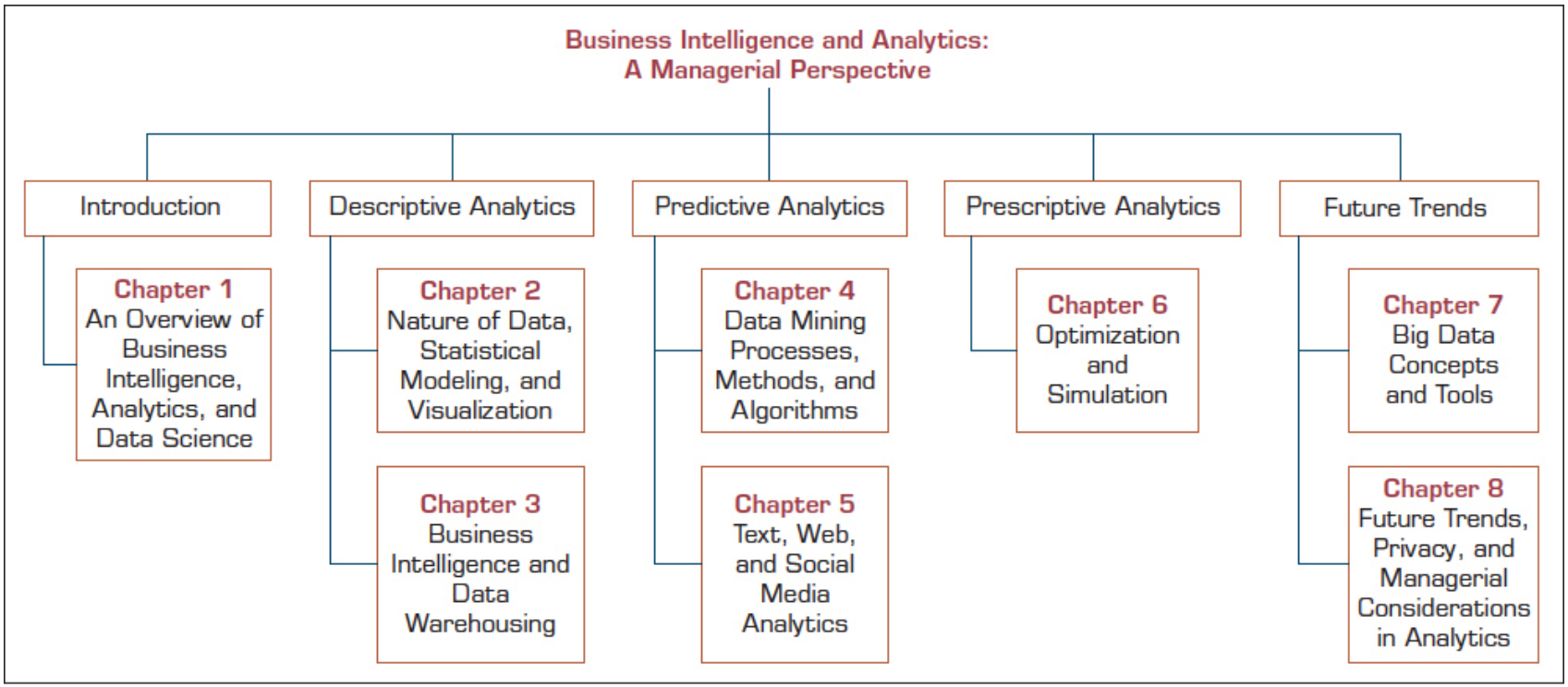

Figure: Structure of the Book (Source: [Sharda et al., 2018, page 73])

Structure of the Course

Similarly partitioned as Sharda et al.

1. Introduction (chapter 1, today)
2. Descriptive Analytics (chapters 2,3)
3. Predictice Analytics (chapters 4,5)
4. Prescriptive Analytics (chapter 6)
5. Ethics, Privacy, Legal, and Managerial Aspects (chapter 8)

Tentative Schedule

1. Today
2. April 30th – May 2nd
3. May 7th – May 28th
4. June 4th – June 6th
5. June 11th – June 18th
   with guest lecture

Limitations of Sharda et al.

- The book is a bit shallow, the course provides often more profound knowledge
  Thus, other complementary resources are used,
  in particular [Sherman, 2015] for Data Warehousing
- While the book has an appendix chapter on Big Data,
  we discuss it where appropriate
- Regression and Time Series Analysis are moved from
  Descriptive to Predictive Analytics

Course Structure and Organisation

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Course Organisation

Weekly Structure

- Tue 09:**15** – 10:45 Lecture
- Tue 11:00 – 12:30 Exercises (and consultation for project assignment)
- Thu 15:**15** – 16:45 Lecture
  Sometimes till 19:00, in case of tutorials, project presentations, etc.

Notes on the first week

- today: no exercise class
- this Thursday: First tutorial and presentation of project assignment
- next Tuesday: lecture, afterwards first exercise class

Course Organisation: Grading

Deliverables

- written final exam (CLOSED book, 1-A4-page cheat sheet)
  on ALL topics covered in lecture, tutorial and exercises
- taking at least 4 out of 5 tests
  (the best four of the five are considered in grading)
- project deliverables: (BI strategy, final report, ETL with analytics and dashboard, presentation, peer-grading, discussion and individual contribution)
- recommended (but not mandatory) in preparation for the above:
  prepare the weekly exercises!

Grading

- Exams: 5 tests, one final exam

  $$Finalgrade = (4*(0.025*Test))+(0.4*Exam)+(0.5*Project)+(OptionalParticipationBonus$$

- Retake: There is one second-chance exam opportunity for the exam in July, before the summer break.
- Minimum effort: In order to pass this course, you need to have scored at least a 5.0 for (a) the written Exam and (b) the Project.

Course Organisation: Participation

Means of Participation

- Creating and sharing original lecture notes (not only copy-pasted material!)
  Note: Copyright restrictions apply when published at course website
- Active support of other students (of other teams!) in Slack etc.
- Active participation in all lectures and presentations
- Creation of suitable test and exam question suggestions
  In particular, multiple choice, calculation, or fill-in questions
  Need to be clear but challenging. See
  `https://uwaterloo.ca/centre-for-teaching-excellence/teaching-resources/teaching-tips/developing-assignments/exams/questions-types-characteristics-suggestions` and
  `http://kaner.com/?p=34`
  Your suggestions are welcome (deadlines: 3 days before tests, 2 weeks before exam)
- Peer review of colleagues' projects

Participation Bonus

For significant contributions like

- Creation and sharing of original notes
- Active support of other students, confirmed by them or in Slack
- Suggestion of suitable questions

Key Dates (tentative![1])

- 28. April: Team registration via Blackboard
- 02. May: **1st Test (Focus: Introduction)**
- 05. May: Focus specification submission via Blackboard
- 14. May: **2nd Test (Focus: Descriptive Analytics)**
- 15. May: Submit slides for Kick-Off Presentation via Blackboard
- 16. May: **Kick-Off Presentation**
- 23. May: **3rd Test (Focus: Descriptive/Predictive Analytics)**
- 06. June (?): **4th Test (Focus: Predictive Analytics)**
- 06. June: Submit draft report via Peergrade
- 13. June: Review via Peergrade
- 18. June (?): **5th Test (Focus: Predictive/Prescriptive Analytics)**
- 20. June: **Final Presentation**
- 28. June: Exam
- 30. June: **Submit final report** via Blackboard

[1] These dates and content foci of tests are tentative and will be adjusted as necessary, in particular for tests 4 and 5 alignments with guest lectures will be sought.

Setting the Scene

Opening Questions

- What is this course about?
- What is business intelligence?
- Tasks - What do we need to do?
  Why is it relevant for a business?
- Competences - How do we do this?
  Which competences do we need?

Business Intelligence and Data Science

Analytics Tasks

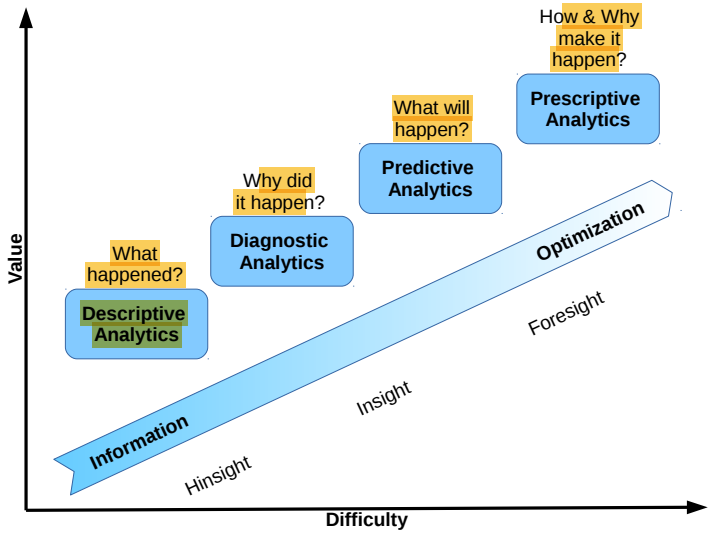


Figure: Analytic Ascendancy Model
(based on Gartner's model [Laney, 2012])

"What we want to do in BI"

Data Science Competences

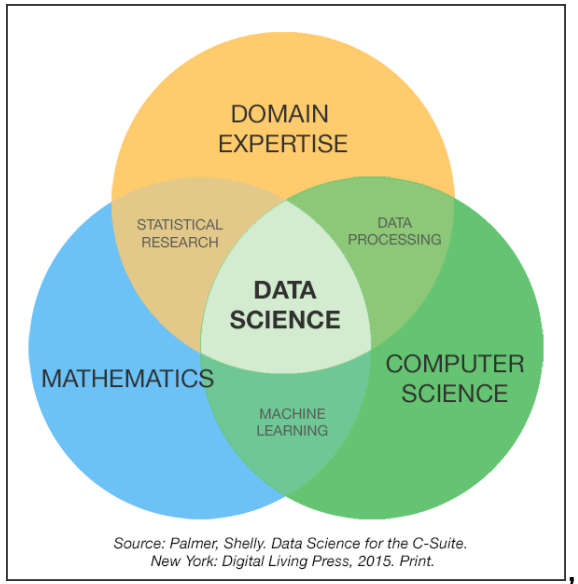


Figure: Data Science Venn Diagram
(Interpretation and Source: [Palmer, 2015]

"What Data Science provides"

- Note: Many varying interpretations of *Business Intelligence* & *Data Science* exist[2]

[2] See, e.g., *The Battle of Data Science Venn Diagrams*, David Taylor, KDnuggets 2016: https://www.kdnuggets.com/2016/10/battle-data-science-venn-diagrams.html/2

Business Intelligence and Data Science: Tasks and Competences

Business Intelligence

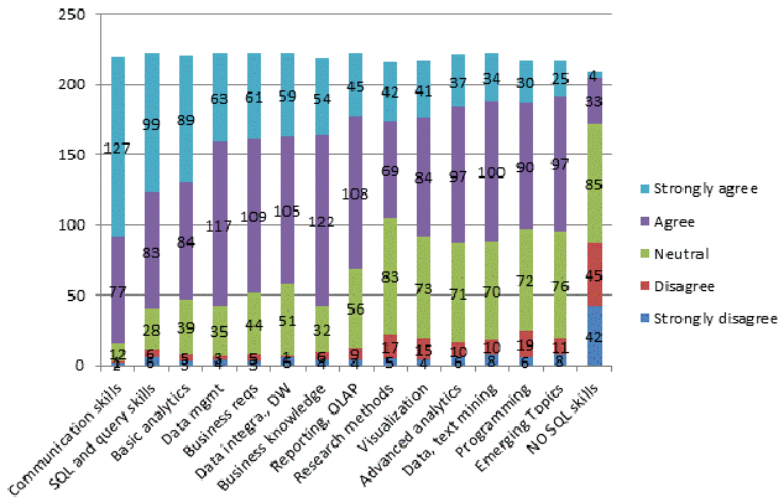


Figure: What are the BI/BA content that students need for BI/BA Roles? (Source: BI Congress Survey, cited in [Wixom et al., 2014, page 10])

Data Science

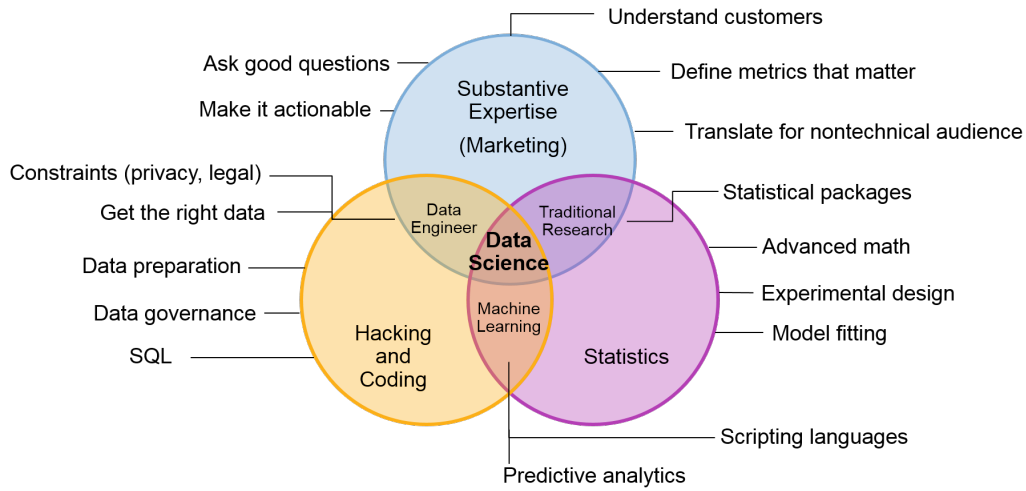
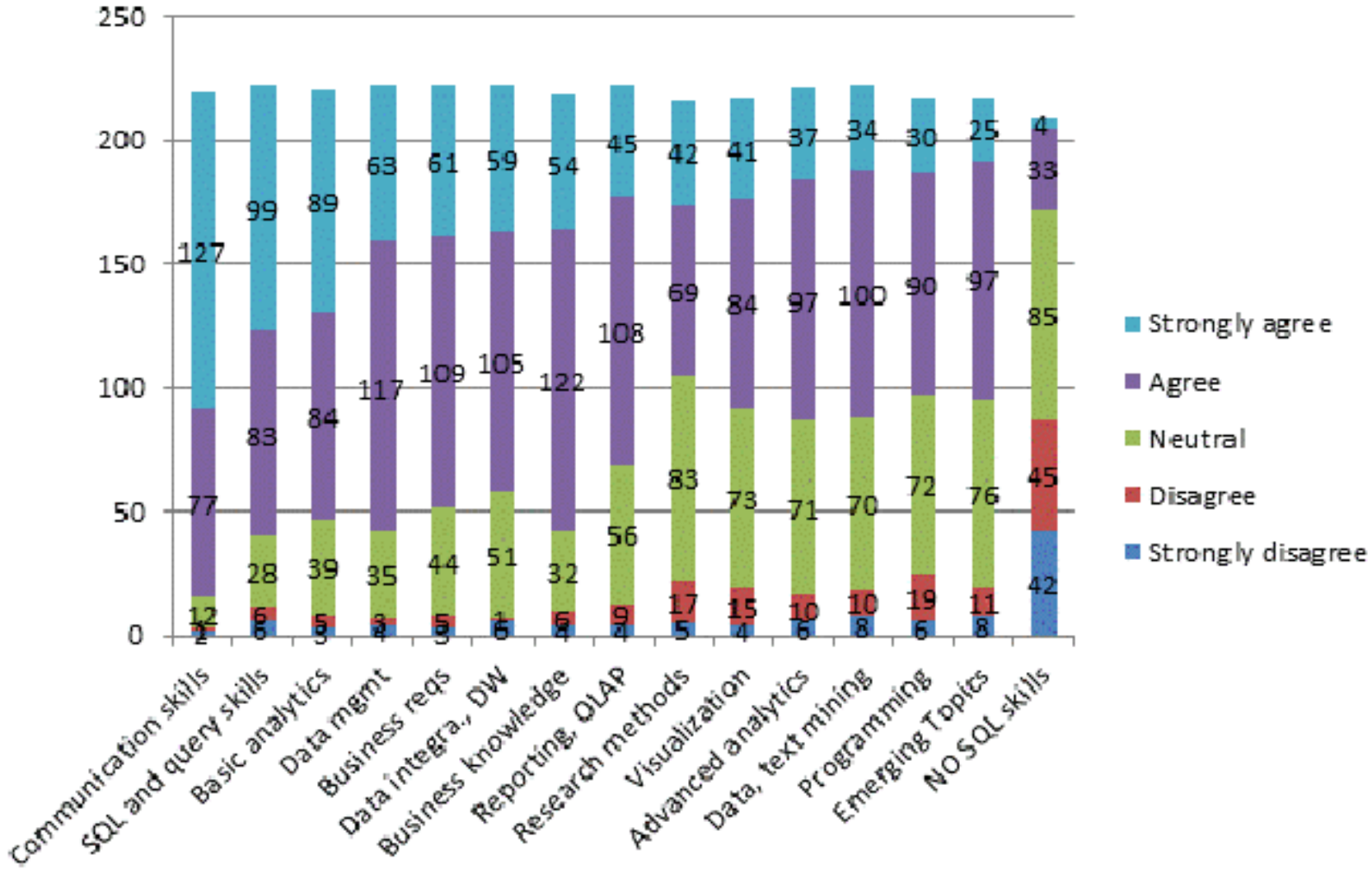


Figure: Data Science Venn Diagram (Interpretation and Source: Christi Eubanks, Gartner, 2016)

Business Intelligence Competences as Desired by Industry



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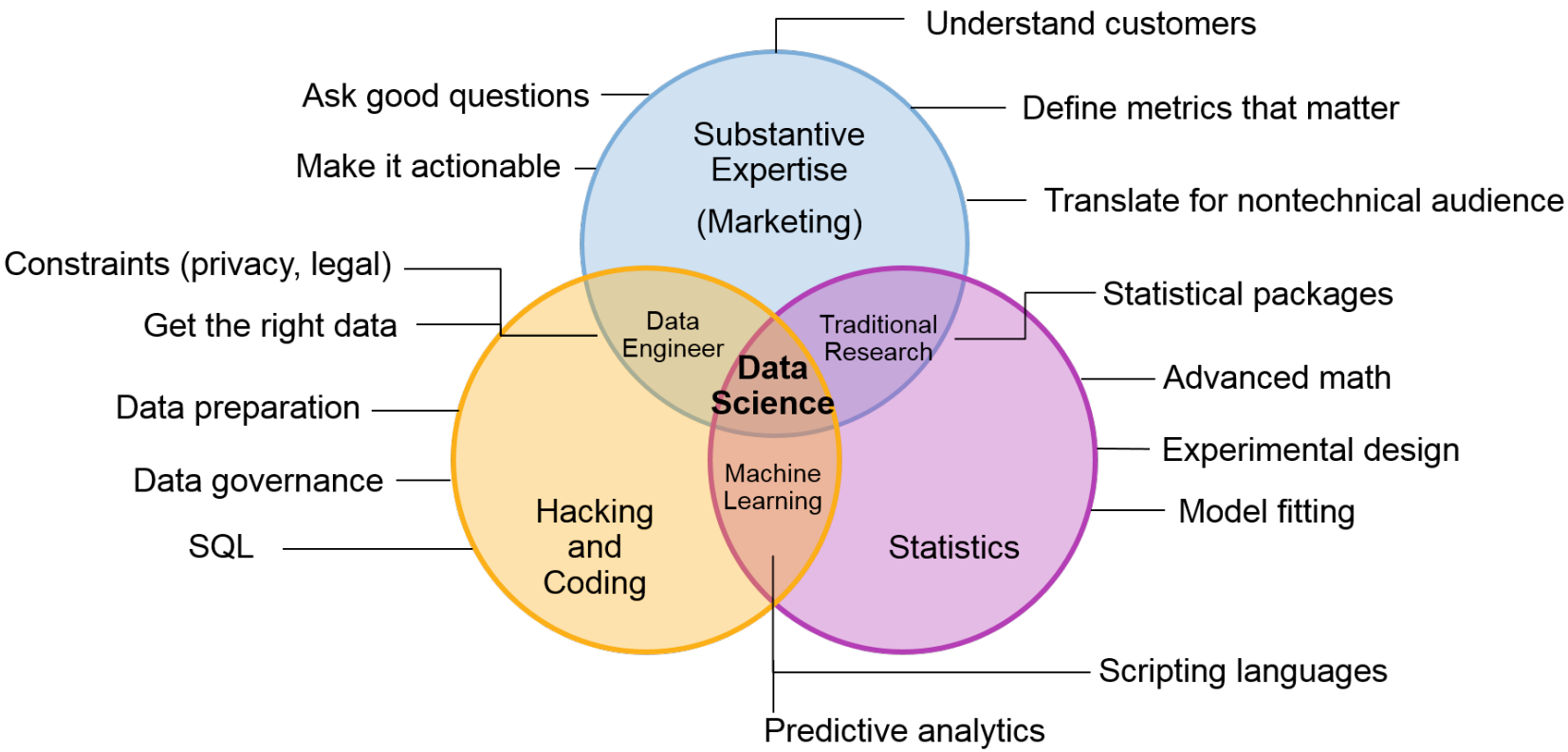
Data Science Tasks and Competences



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Business Intelligence *versus* Data Science

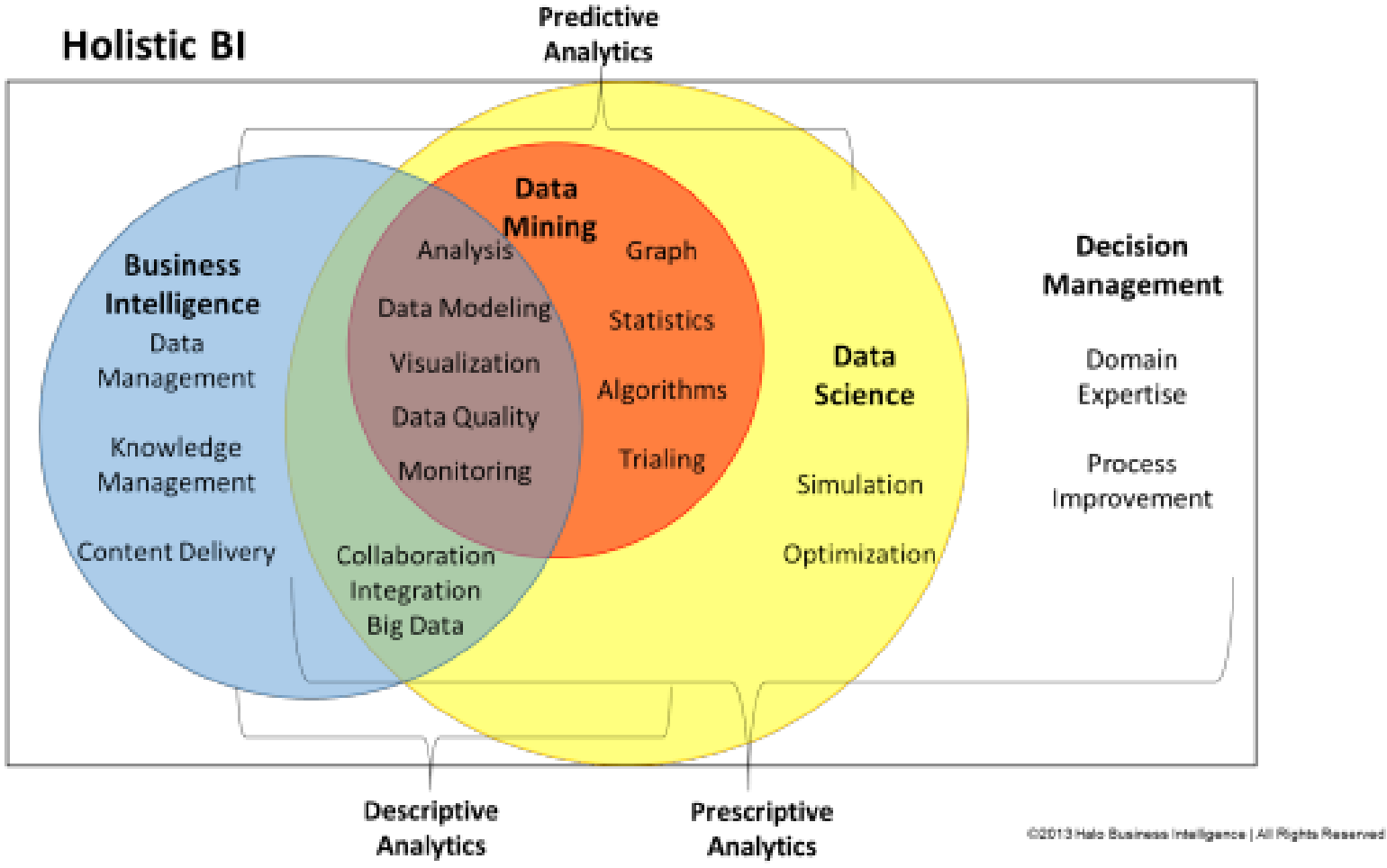

Figure: Business Intelligence vs. Data Science
(Source: `halobi.com` [Halo Business Intelligence, 2013])

Business Intelligence: Examplary Applications

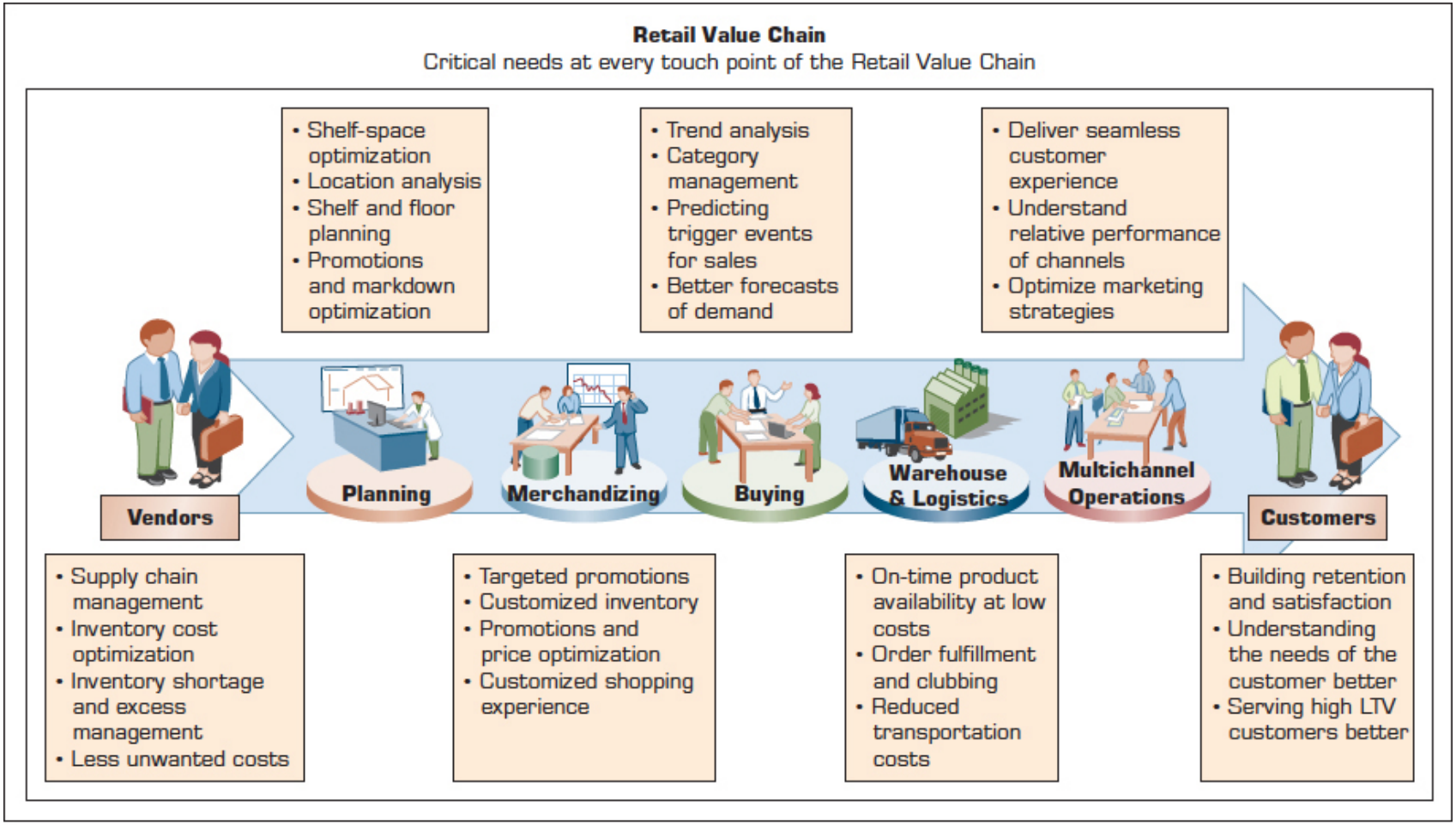

Figure: Examplary Analytics Applications in a Retail Value Chain (Source: [Sharda et al., 2018, page 59])

Business Intelligence: Examplary Applications

TABLE 1.1 Examples of Analytics Applications in the Retail Value Chain

Analytic Application	Business Question	Business Value
Inventory Optimization	1. Which products have high demand? 2. Which products are slow moving or becoming obsolete?	1. Forecast the consumption of fast-moving products and order them with sufficient inventory to avoid a stock-out scenario. 2. Perform fast inventory turnover of slow-moving products by combining them with one in high demand.
Price Elasticity	1. How much net margin do I have on the product? 2. How much discount can I give on this product?	1. Markdown prices for each product can be optimized to reduce the margin dollar loss. 2. Optimized price for the bundle of products is identified to save the margin dollar.
Market Basket Analysis	1. What products should I combine to create a bundle offer? 2. Should I combine products based on slow-moving and fast-moving characteristics? 3. Should I create a bundle from the same category or different category line?	1. The affinity analysis identifies the hidden correlations between the products, which can help in following values: a) Strategize the product bundle offering based on focus on inventory or margin. b) Increase cross-sell or up-sell by creating bundle from different categories or the same categories, respectively.
Shopper Insight	1. Which customer is buying what product at what location?	1. By customer segmentation, the business owner can create personalized offers resulting in better customer experience and retention of the customer.
Customer Churn Analysis	1. Who are the customers who will not return? 2. How much business will I lose? 3. How can I retain them? 4. What demography of customer is my loyal customer?	1. Businesses can identify the customer and product relationships that are not working and show high churn. Thus can have better focus on product quality and reason for that churn. 2. Based on the customer lifetime value (LTV), the business can do targeted marketing resulting in retention of the customer.

Figure: Table of Examplary Analytics Applications in a Retail Value Chain, part 1 (Source: [Sharda et al., 2018, page 60])

Business Intelligence: Examplary Applications

TABLE 1.1 Examples of Analytics Applications in the Retail Value Chain

Analytic Application	Business Question	Business Value
Channel Analysis	1. Which channel has lower customer acquisition cost? 2. Which channel has better customer retention? 3. Which channel is more profitable?	1. Marketing budget can be optimized based on insight for better return on investment.
New Store Analysis	1. What location should I open? 2. What and how much opening inventory should I keep?	1. Best practices of other locations and channels can be used to get a jump start. 2. Comparison with competitor data can help to create a differentiator/USP factor to attract the new customers.
Store Layout	1. How should I do store layout for better topline? 2. How can I increase my in-store customer experience?	1. Understand the association of products to decide store layout and better alignment with customer needs. 2. Workforce deployment can be planned for better customer interactivity and thus satisfying customer experience.
Video Analytics	1. What demography is entering the store during the peak period of sales? 2. How can I identify a customer with high LTV at the store entrance so that a better personalized experience can be provided to this customer?	1. In-store promotions and events can be planned based on the demography of incoming traffic. 2. Targeted customer engagement and instant discount enhances the customer experience resulting in higher retention.

Figure: Table of Examplary Analytics Applications in a Retail Value Chain, part 2 (Source: [Sharda et al., 2018, page 60])

The History and Current Context of BI

- The History of BI (and related fields)
  Based on [Sharda et al., 2018, section 1.3]
- The Current Context and Framework of BI
  Based on [Sharda et al., 2018, sections 1.2 and 1.4]
- The Implementation of BI
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- The Analytics Ecosystem
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The History of BI:
Evolution of Decision Support, Business Intelligence, and Analytics

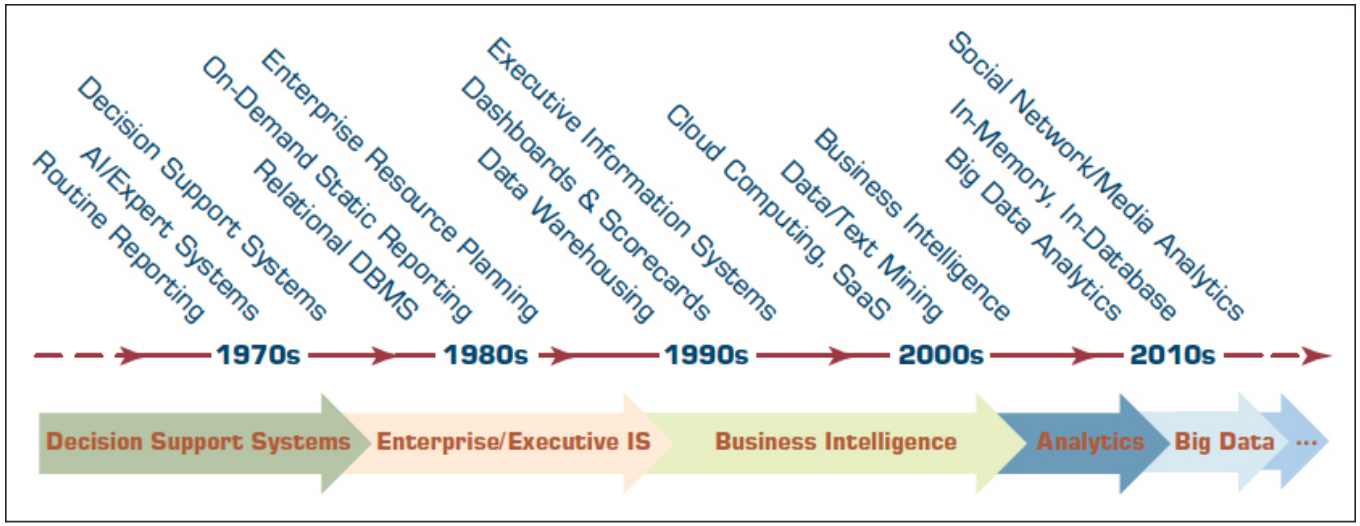

Figure: Evolution of Decision Support, Business Intelligence, and Analytics (Source: [Sharda et al., 2018, page 39])

The History of BI: Origins and Drivers

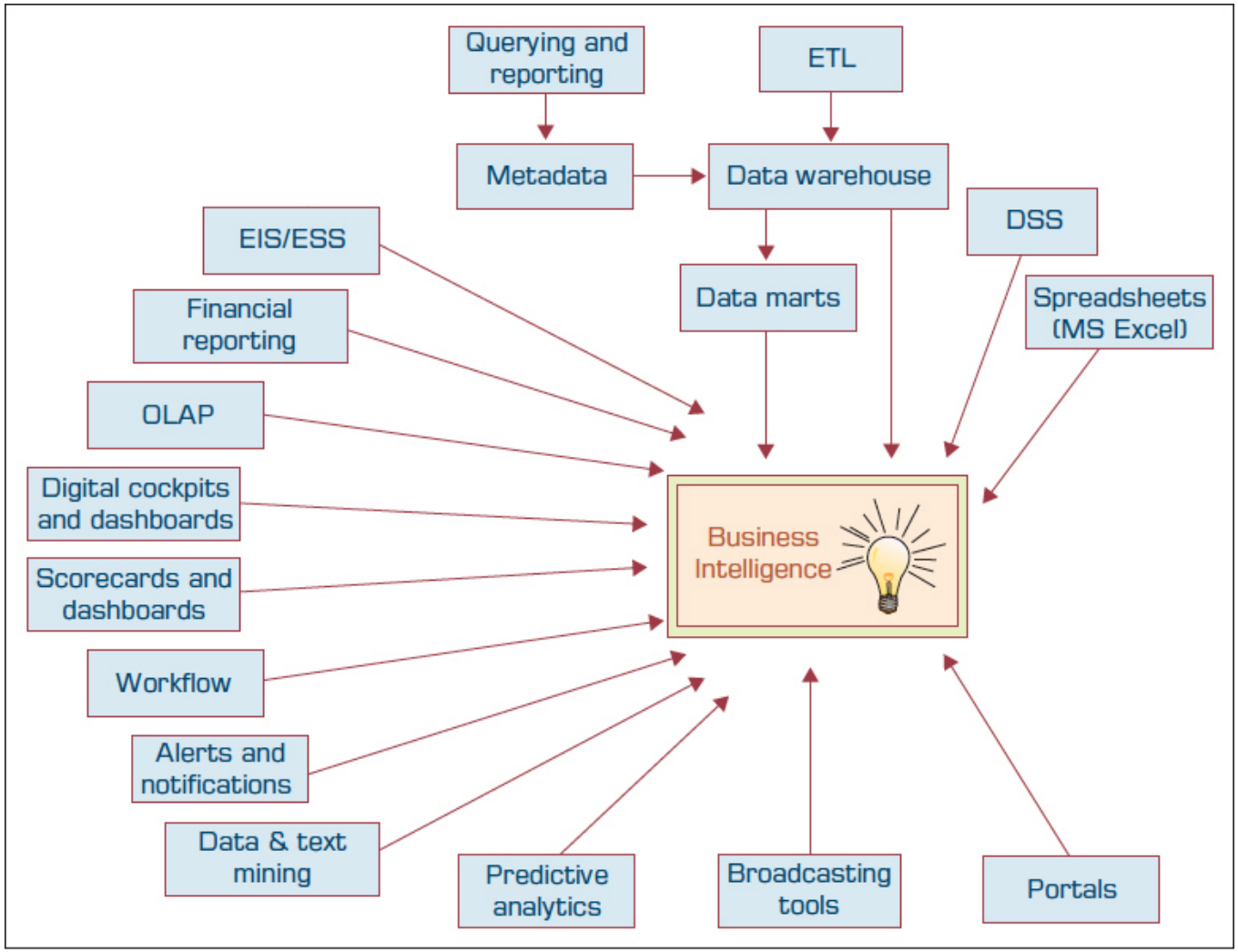

Figure: Origins and Drivers of Business Intelligence(Source: [Sharda et al., 2018, page 43])

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Decision Support and Analytics[3]

Changing Business Environments and Evolving Needs

- Increased capabilities in hardware, software, and networks
- Group communication and collaboration
- Improved data management
- Managing giant data warehouses and Big Data
- Analytical support
- Overcoming cognitive limits in processing and storing information
- Knowledge management
- Anywhere, anytime support

[3] Based on [Sharda et al., 2018, section 1.2]

Definitions of Business Intelligence

A *Broad* Definition of BI

An umbrella term that combines architectures, tools, databases, analytical tools, applications, and methodologies

A *Narrow* Definition of BI

Descriptive analytics tools and techniques (i.e., reporting tools)

Analytics

- a relatively new term/buzz-word
- the process of developing actionable decisions or recommendations for actions based on insights generated from historical data
- Definition by the Institute for Operations Research and Management Science (INFORMS):

> *Analytics represents the combination of computer technology, management science techniques, and statistics to solve real problems.*

Summary of the Previous Lecture

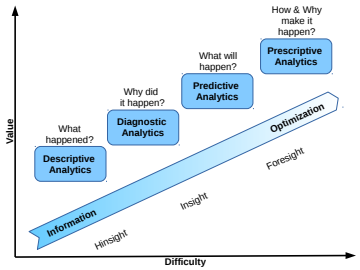


Figure: Analytic Ascendancy Model (Source: [Laney, 2012])

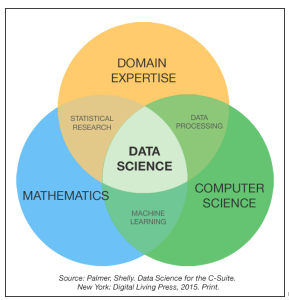


Figure: Data Science Venn Diagram (Source: [Palmer, 2015]

Business Intelligence and Data Science

- Analytics Tasks / The Analytic Ascendancy Model
- Data Science Competences
- Applications

The History and Current Context of Business Intelligence

- The History of BI
- The Current Context and Framework of BI
- Implementing BI
- The Analytics Ecosystem

Types of Business Analytics

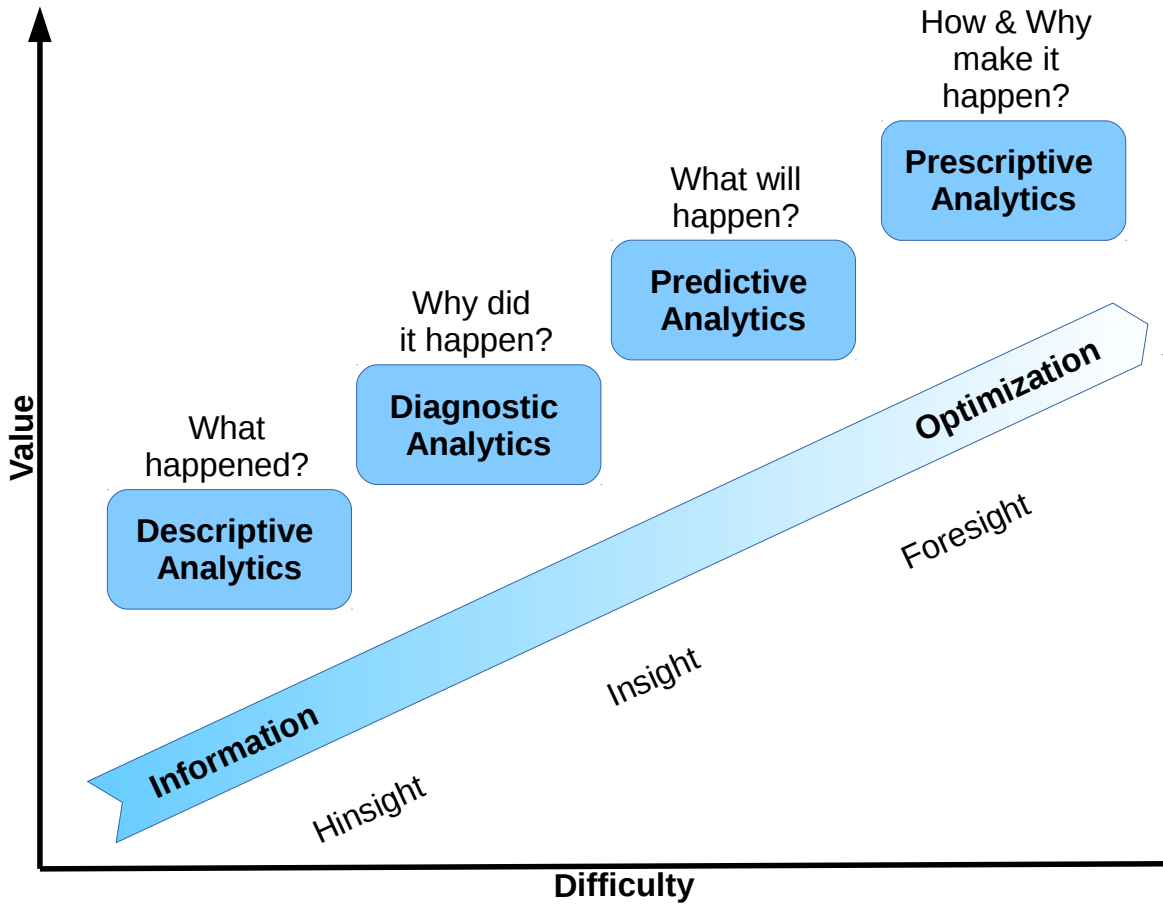


Figure: Analytic Ascendancy Model(based on Gartner's model [Laney, 2012])

Types of Business Analytics

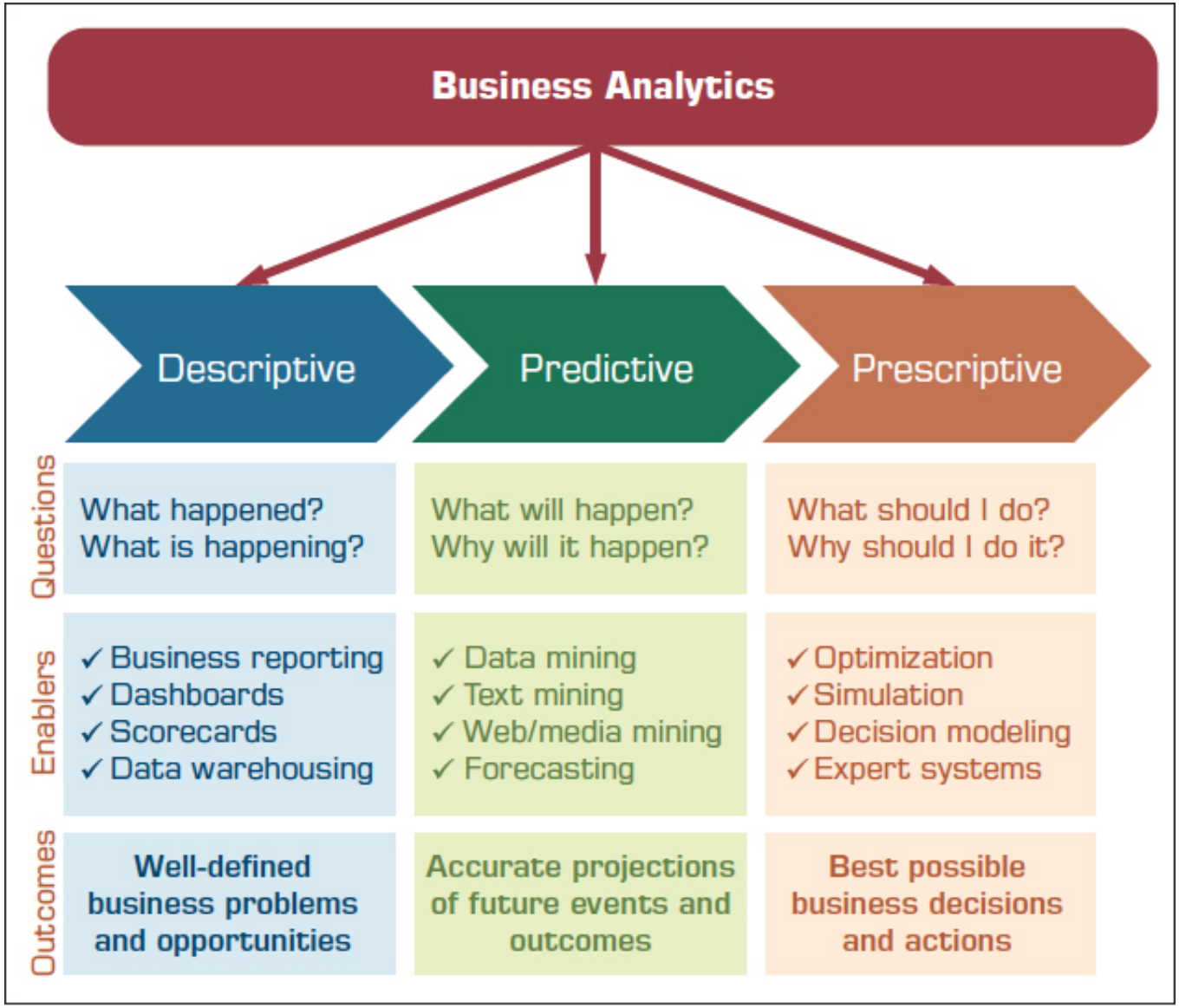


Figure: Analytic Ascendancy Model (Source: [Sharda et al., 2018, page 43])

Types of Business Analytics

Descriptive Analytics

- Descriptive or reporting analytics
- Answering the question of what happened
- Retrospective analysis of historic data
- Enablers
  - OLAP / DW
  - Data visualization
  - Dashboards and Scorecards
  - Descriptive statistics

Predictive Analytics

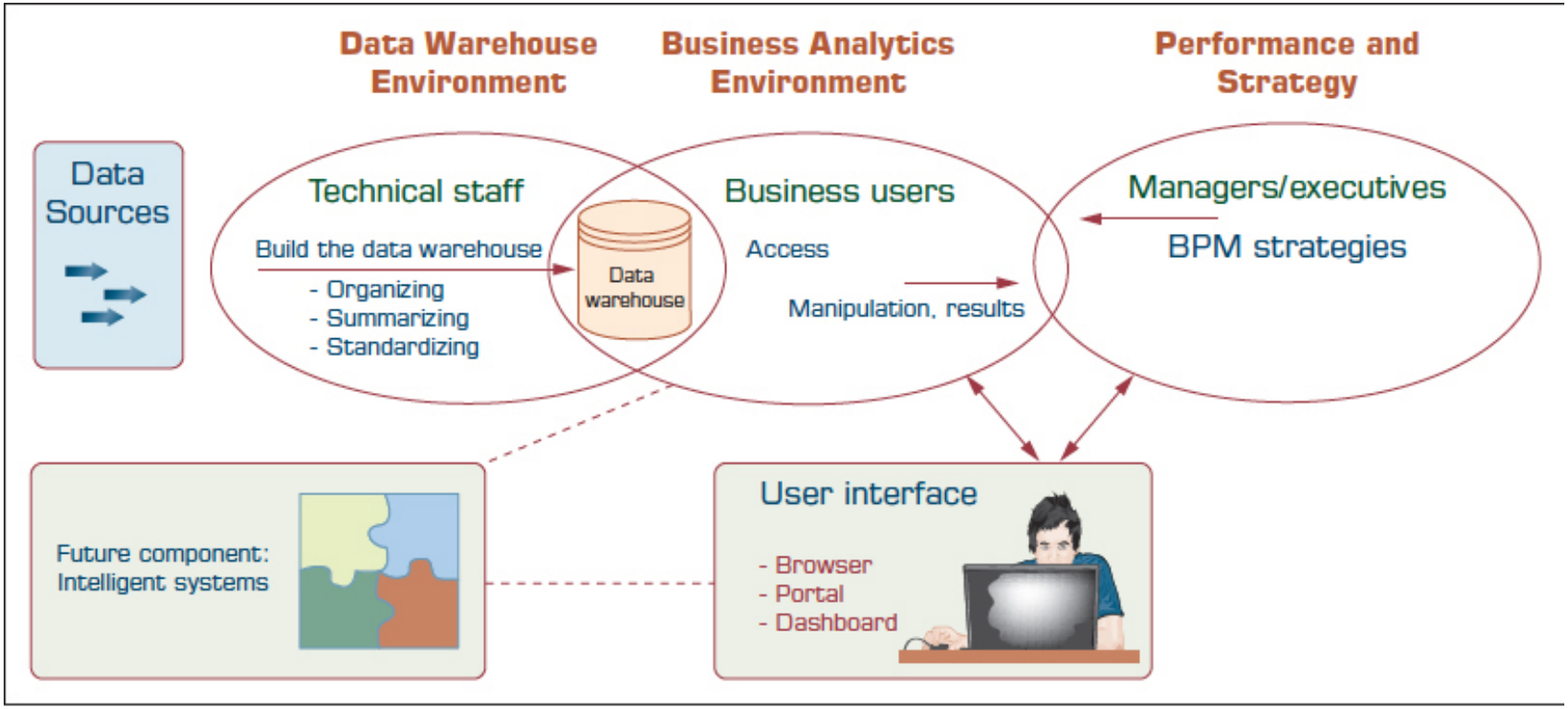
- Aims to determine what is likely to happen in the future (foreseeing the future events)
- Looking at the past data to predict the future
- Enablers
  - Data mining
  - Text mining / Web mining
  - Forecasting (i.e., time series)

Types of Business Analytics

Prescriptive Analytics

- Aims to determine the best possible decision
- Uses both descriptive and predictive to create the alternatives, and then determines the best one
- Enablers
  - Optimization
  - Simulation
  - Multi-Criteria Decision Modeling
  - Heuristic Programming

The Architecture of Business Intelligence:



(*Source:* Based on W. Eckerson, *Smart Companies in the 21st Century: The Secrets of Creating Successful Business Intelligent Solutions.* The Data Warehousing Institute, Seattle, WA, 2003, p. 32, Illustration 5.)

Figure: BI Architecture (Source: [Sharda et al., 2018, page 43])

Application Case 1.1: Discussion Questions[4]

- What is traditional reporting? How is it used in the organization?
  - ad hoc manual aggregation of information (e.g., financial) before decision making
- How can analytics be used to transform the traditional reporting?
  - Automating the process: integrating data in a data warehouse, performing analytics, reporting results (e.g., in Dashboards)
- How can interactive reporting assist organizations in decision making?
  - User (decision maker) can adjust selection and representation of information to its current needs
    Example: Partitioning of customers into segments

[4] See [Sharda et al., 2018, page 44–45]

Transaction versus Analytic Processing

Online Transaction Processing (OLTP)

- System for operational use
- Working mostly with transactional Databases
- Optimized for *efficiency* and *consistency*
- ERP (Enterprise Resource Planning),
  SCM (Supply Chain Management),
  CRM (Customer Relationship Management), ...
- Goal: data capture

Online Analytical Processing (OLAP)

- System for supporting decision making
- Data warehouses
- Working mostly with non-normalized data
- Optimized for *accuracy* and *completeness*
- Goal: decision support

- What is the relationship between OLTP and OLAP?

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Business Performance Management Decision Lifecycle

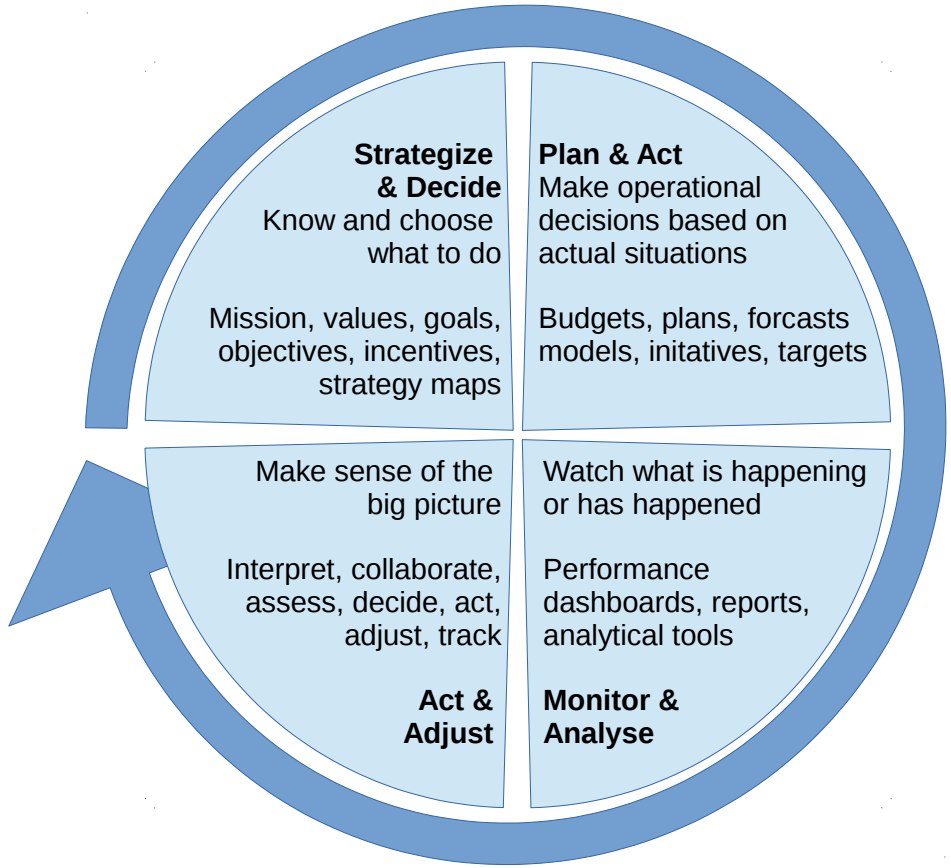

Figure: Business Performance Management Decision Lifecycle
(Based on the decision lifecycle in [Taylor, 2012, page 54]
and the closed-loop BPM cycle in [Sharda et al., 2018, page 197])

Implementing BI: Planning and Alignment with the Business Strategy[5]

Components of Planning and Execution

- Business: strategic and operational objectives
- Organization: organisational culture, prepare the organization for change
- Functionality: which functionality is needed
- Infrastructure: which infrastructure, how to integrate among existing and emerging infrastructure

- How to achieve the above?
  E.g., how to ensure a central point for collecting and sharing information?

[5] Recommended further reading: [Sherman, 2015, Chapter 17. People, Process and Politics].

Implementing BI: Building a BI Competence Center

Functions served by BI Competency Center

- How BI is linked to strategy and execution of strategy
- Encourage interaction between the potential business user communities and the IS organization
- Serve as a repository and disseminator of best BI practices between and among the different lines of business.
- Standards of excellence in BI practices can be advocated and encouraged throughout the company
- Interaction with BI users to learn, e.g., about needed analytical tools
- Better awareness at users and BI providers for BI requirements, e.g., for flexibility
- Target central stakeholders (e.g., high-level executives) for support

Implementing BI: Important Considerations

Critical Considerations when Implementing a BI

- Developing or Acquiring BI Systems
  Make versus buy
  BI shells: completely pre-programmed
- Justification and CostBenefit Analysis
  Challenging - Why?
- Security
- Protection of Privacy
- Integration to Other Systems and Applications
- Traditional (batch-oriented) vs. Real-Time BI
- Big Data?

Implementing BI: Real-Time, On-Demand Availability

State-of-the-Art

- Emergence of real-time BI applications
- Fueled by demand (e.g., just-in-time production and delivery, reducing maintenance costs)
  and technical possibilities (e.g., RFID, sensor networks, internet of things (IoT))

Cost-Benefit Analysis

- Traditional BI: static, works in batches
  (e.g, nightly Extract-Transform-Load ETL update)
- Is there a need for real-time (is it worth the additional expense)?

Enabling Real-time BI

- Alternative 1: populate warehouse in (near) real-time
- Alternative 2: *Business Activity Management (BAM)* by using Web services
  (bypassing traditional data warehouses)
  Intelligent Agents: software monitors, use event-/process-based approaches

Implementing BI: Big Data

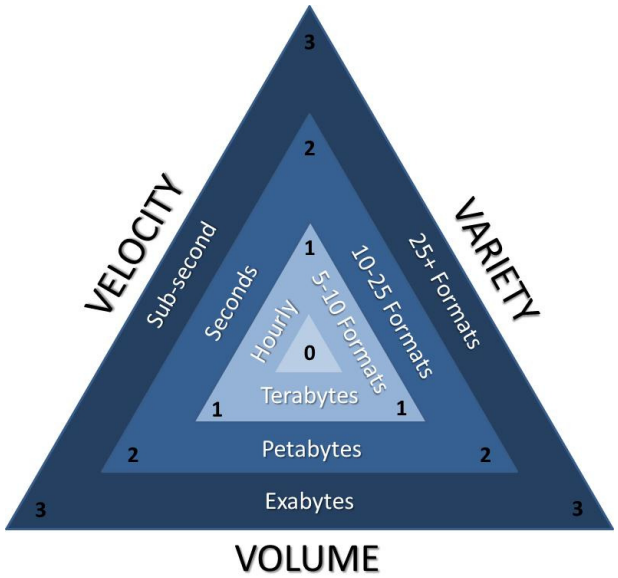

Figure: Gartner's Big Data Magnitude Index (Source: [Laney, 2012])

- Is it just "big"?
- Data that cannot be stored or processed easily using traditional tools/means
- Data that comes in many different forms: large, structured, unstructured, continuous
  3Vs Volume, Variety, Velocity
- Data (Big Data or otherwise) is worthless unless it provides business value
  (and for it to provide business value, it has to be analyzed)

- Note: In the book, this is discussed in [Sharda et al., 2018, chapter 7].
  In the lecture, the view on big data will be added when and wherever adequat.

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The Analytics Ecosystem

Questions for Discussion

- What are the key players in analytics industry?
- What do they do?
- Is there a place for you to be a part of it?

Motivation for classification

- Identify providers (as an analytics consumer)
- Identify roles to play (as a potential provider)
- Identify job opportunities
- Identify investment/entrepreneurial opportunities
- Understand the landscape and the future of computerized decision sport systems

The Analytics Ecosystem: Visualization

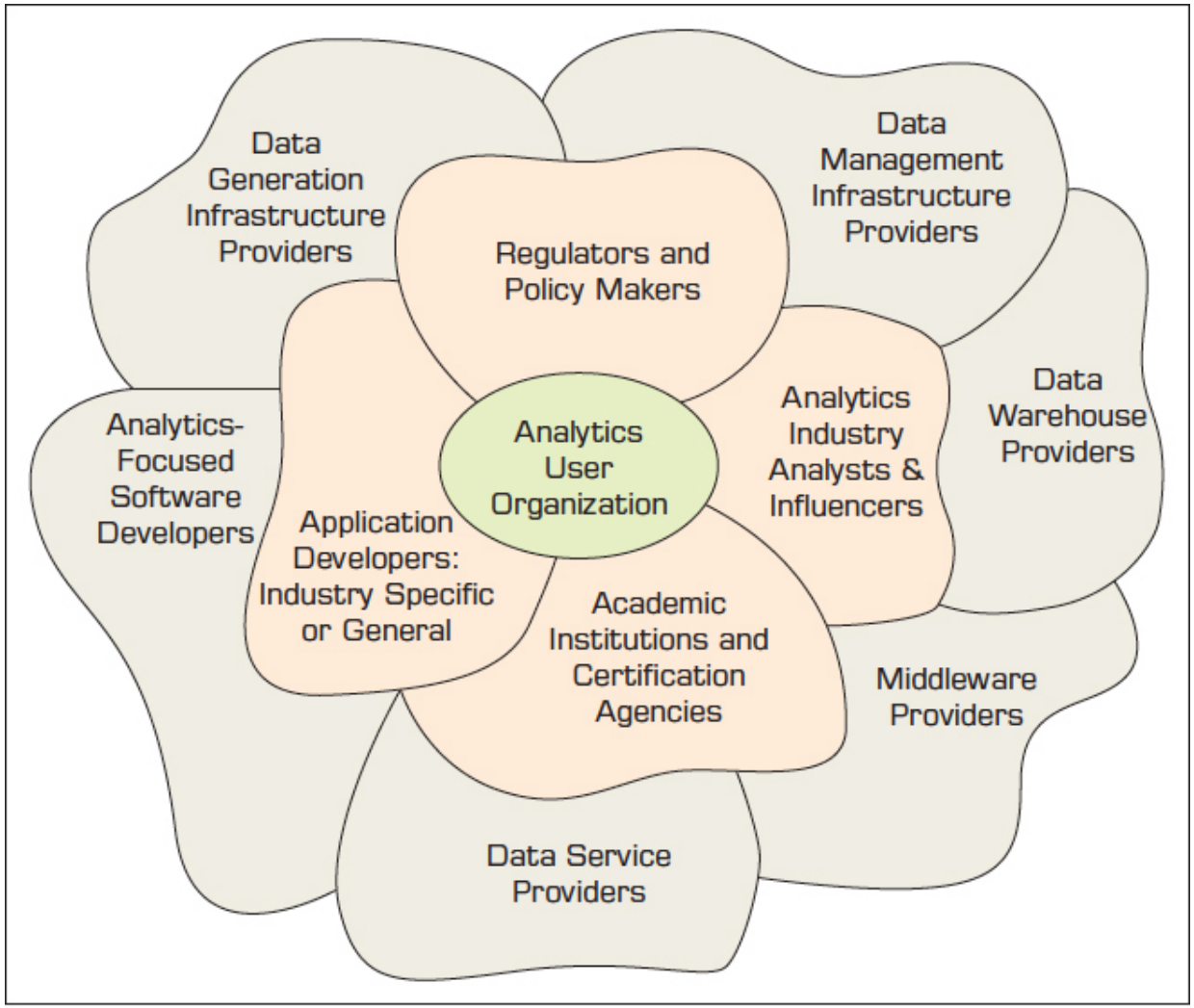

Figure: The Analytics Ecosystem (Source: [Sharda et al., 2018, page 64])

The Analytics Ecosystem: Key Players

Data Generation Infrastructure Providers

- Companies creating infrastructure for collecting data from different sources
- Example: sensor manufacturers (e.g., Fitbit)

Data Management Infrastructure Providers

- Companies providing hard-/software for data management solutions
- Examples: database computing providers (e.g., Oracle),
  storage solution providers (e.g., EMC),
  data solution provider offering hardware and platform independent DBMS (e.g., parts of Microsoft, SAP)
- Includes providers of network infrastructure that enables cloud computing (e.g., Amazon)
- Includes providers for Big Data infrastructure/service (e.g., Cloudera)

Data Warehouse Providers

- Companies providing technology for integrating data of various sources
- Examples: IBM, Teradata
- Includes data warehousing in the cloud

The Analytics Ecosystem: Key Players (2)

Middleware Providers

- Companies providing easy-to-use tools for reporting or descriptive analytics
- Examples: Microstrategy, parts of SAP, IBM etc.

Data Service Providers

- Companies providing data as a service
- Such data collections might include, e.g., demographic or weather data
- Examples: Dun & Bradstreet, Google

The Analytics Ecosystem: Key Players (3)

Analytics-Focused Software Developers

- Companies developing software for analytics, including specialized software for Big Data
- Further separation into types of analytics possible
- Examples: SAS (descriptive), RapidMiner, KNIME, R (mostly predictive), ILOG (prescriptive)

Application Developers

- Develop custom (industry or domain-specific) analytics software solutions
- Examples: IBM, SAS, Teradata

Analytics Industry Analysts and Influencers

- Professional organizations, providing whitepapers, training, . . . ; e.g., Gartner Group, McKinsey
- Professional societies, e.g., INFORMS
- Analytics Ambassador Influencers, i.e., individuals; e.g., Tom Davenport

The Analytics Ecosystem: Key Players (4)

Regulators and Policy Makers

- Examples: Federal Communications Commission (FCC), National Institute of Standards and Technology (NIST), ...

Analytics User Organisations

Academic Institutions and Certification Agencies

- Certificates
- Study programs of all levels
- Offered by
  - MIS, Engineering
  - Marketing, Statistics
  - Computer Science

Summary

Business Intelligence and Data Science

- Analytics Tasks / The Analytic Ascendancy Model
- Data Science Competences
- Applications

The History and Current Context of Business Intelligence

- The History of BI
- The Current Context and Framework of BI
- Implementing BI
- The Analytics Ecosystem

Further Reading

- Wixom et al. (2014). The Current State of Business Intelligence in Academia: The Arrival of Big Data. [Wixom et al., 2014]
- Davenport (2006). Competing on Analytics. [Davenport, 2006]

This Course in the context of BI/Data Science and your studies

Analytics Tasks

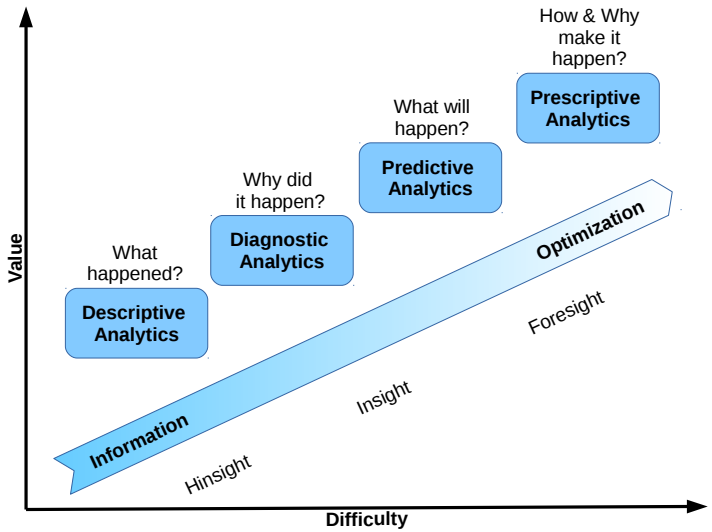

Figure: Analytic Ascendancy Model
(based on Gartner's model [Laney, 2012])

Data Science Competences

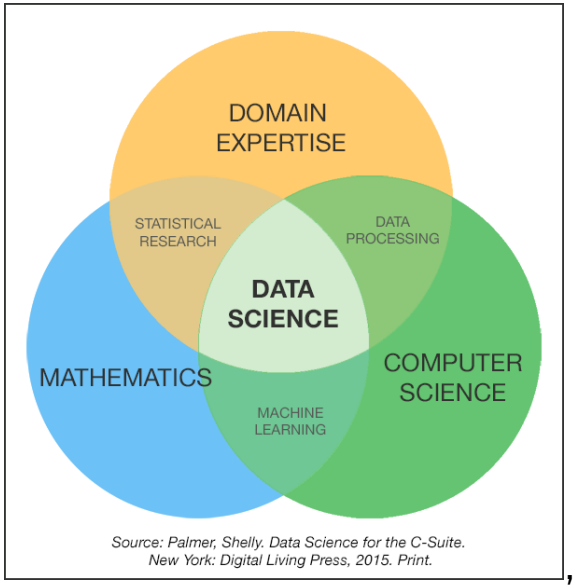

Figure: Data Science Venn Diagram
(Interpretation and Source: [Palmer, 2015]

Questions?

Some notes on the pre-test

- Prerequisites are databases/SQL,
  foundations in mathematics/statistics,
  understanding for business decision making
- Data Mining, Graph Theory, and on courses are NOT prerequisites
- Neither BI as black-box, nor development of new BI approaches
- Rather: solid understanding of BI
  Aim: Enabling you to select, adopt and adapt approaches

Outlook: Descriptive Analytics

Lecture Thursday

- **15:15 – 16:45** and **17:00 – 16:30**
- Descriptive Analytics: [Sharda et al., 2018, chapter 2]

Preparation

In preparation, please read

- Opening Vignette: [Sharda et al., 2018, section 2.1, pages 80–83]
- Application Case 2.2: [Sharda et al., 2018, section 2.4, pages 94–100]
  Or the corresponding paper:
  Thammasiri, Delen, Meesad, Kasap (2014). A critical assessment of imbalanced class distribution problem: The case of predicting freshmen student attrition. Expert Systems with Applications, 41(2), p. 321–330.
- (good but not mandatory):
  Application Case 2.1: [Sharda et al., 2018, section 2.3, pages 89–91]
- For a compact introduction/repetition on statistics see: [Hand, 2008, chapters 1–4]

Introductions on Statistics

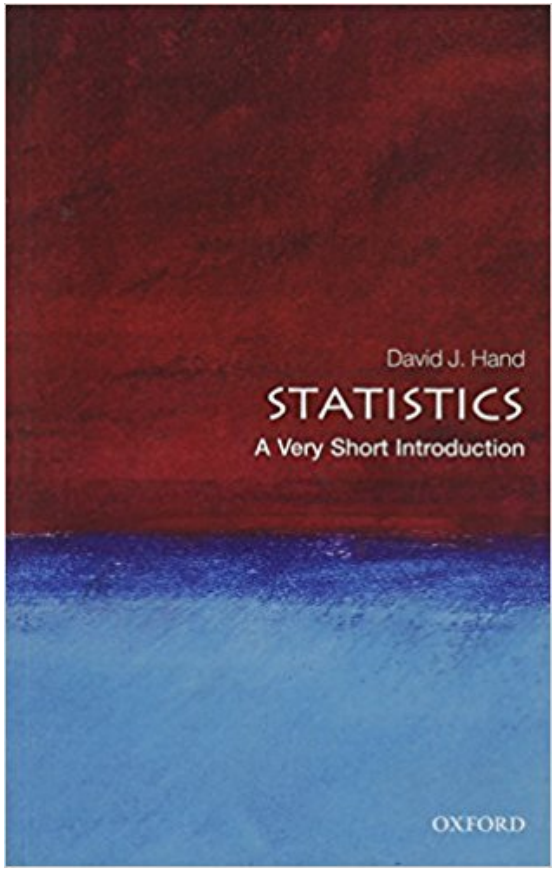

Figure: Textbook [Hand, 2008]
Hand (2008)
Statistics: A very short introduction
Oxford University Press
978-0-19-923356-4

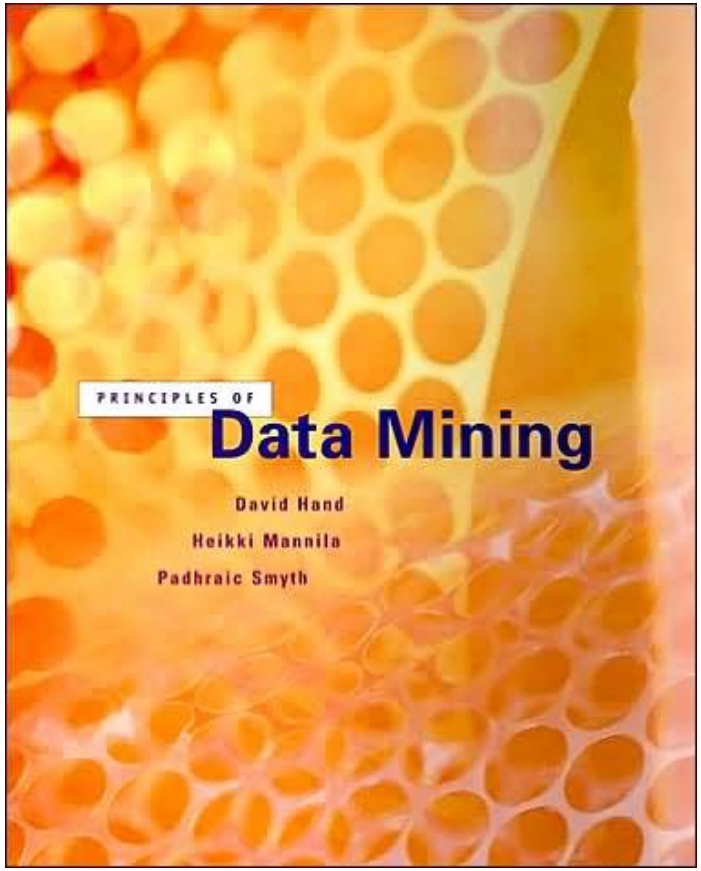

Figure: Textbook [Hand et al., 2001]
Hand, Mannila, Smyth (2001)
Principles of Data Mining
The MIT Press
ISBN 978-0262082907

Any More Questions?

Thank you!

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