Overview – Data Science at IMD

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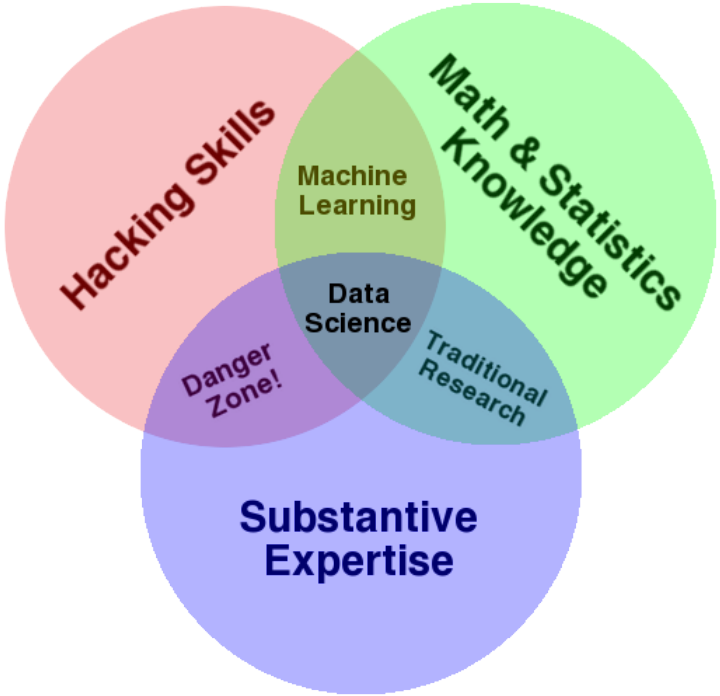
What is Data Science

- Data Science is a multidisciplinary field that combines information technology (IT), statistics and management study.
- Due to the rapid advancement of IT, much more data and new analytic techniques became available.
- We need to balance it with sound statistical knowledge and business expertise to create useful insights.

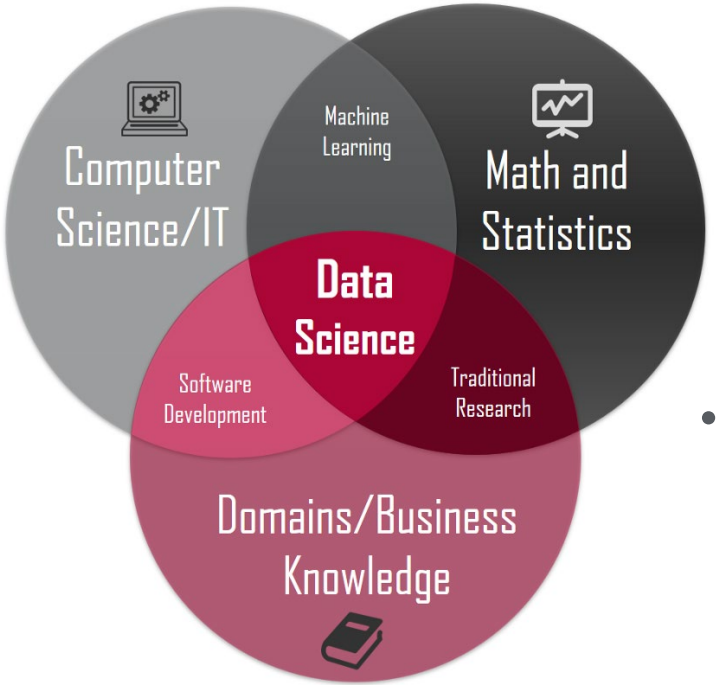
Multidisciplinary field



Data science venn diagram
Source: http://drewconway.com/zia/2013/3/26/the-data-science-venn-diagram

- This diagram is often refered to show which knowledge is needed for data science
- “Hacking skills” is eye-catching but too narrow

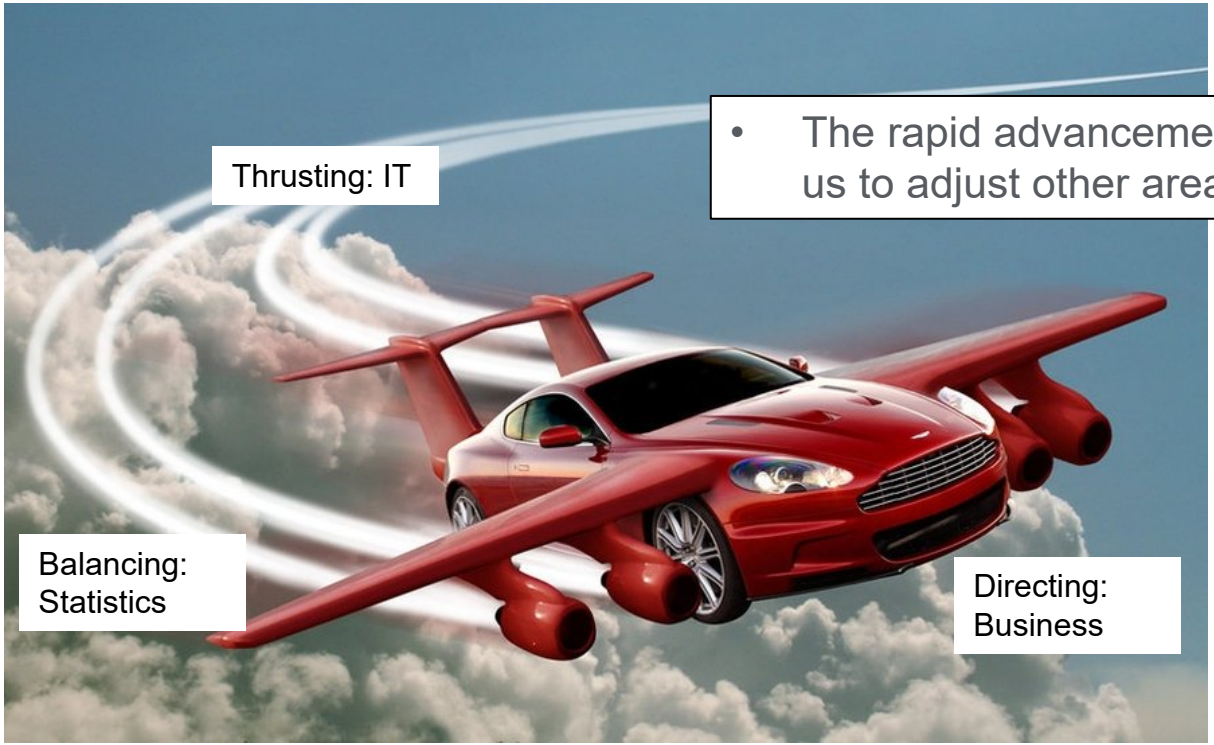
Multidisciplinary field – alternative description



- This alternative diagram is less popular but shows more acceptable description

https://towardsdatascience.com/introduction-to-statistics-e9d72d818745

Data Science: analogy to a flying vehicle



- The rapid advancement of IT forces us to adjust other areas accordingly

Source: https://sourceable.net/degree-in-flying-cars-coming-soon/

Five processes in Data Science

We will document knowledge using these five processes as a category

Big Data Challenges and Solutions

Process	Challenges	Solutions	Key references
Data access and collection	• Easy access to data offered in standardized formats. No practical limit to the size of these data offering unlimited scalability • Efficiently obtain detailed data for a large number of agents • Protocols on security, privacy, and data rights	• Sensors • Web scraping • Web traffic and communications monitoring	• Chaffin et al. (2015) • Sismeiro and Bucklin (2004)
Data storage	• Tools for data storage, matching and integration of different big datasets • Data reliability • Warehousing	• SQL, NoSQL, Apache Hadoop • Save essential information only and update in real time	• Varian (2014) • Prajapati (2013)
Data processing	• Use non-numeric data for quantitative analyses	• Text mining tools to transform text into numbers • Emotion recognition	• Manning, Raghavan, and Schütze (2009) • Teixeira, Wedel, and Pieters (2012)
Data analysis	• Large number of variables • Causality • Find latent topics and attach meaning • Data too large to process	• Ridge, lasso, principal components regression, partial least squares, regression trees • Topic modeling, latent Dirichlet allocation, entropy-based measures, and deep learning • Cross-validation and holdout samples • Field experiments • Parallelization, bags of little bootstrap, sequential analysis	• Hastie, Tibshirani, and Friedman (2009) • George and McCulloch (1993) • Archak, Ghose, and Ipeirotis (2011) • Tirunillai and Tellis (2012) • Blei, Ng, and Jordan (2003) • LeCun, Bengio, and Hinton (2015) • Lambrecht and Tucker (2013) • Wang, Chen, Schifano, Wu, and Yan (2015) • Wedel and Kannan (2016)
Reporting and visualization	• Facilitate interpretation, representation with external partners and knowledge users • Difficult to understand complex patterns	• Describe data sources • Describe methods and specifications • Bayesian analysis • Visualization and graphic interpretations	• Loughran and McDonald (2011) • Simonsohn, Simmons, and Nelson (2015)

Data Collecting

- Web scraping from public websites
  - How to collect information from websites
  - 10K reports from SEC.gov
  - EU Open Data
  - Open data Swiss
- Collecting data using API
  - Tweeter
  - Facebook
- Database in IMD library
  - Bloomberg
  - Thomson One
  - Datastream
  - Factiva: news media
- IoT (Internet of Things)
  - Smart building
  - Wearable devices
  - Web traffic

Data Storing

- Distributed computing
  - Do I need it?
  - What is Apache Hadoop
  - What is Apache Spark

- Other relevant information
  - SQL and NoSQL
  - Cloud technolgy

Data Processing

- Data wrangling
  - Merging the unstructured data
  - Text data
  - Images
  - Audios

- Contents analysis
  - NPL (Natural Language Processing)

Data Analysing

- Big data specific (list from McKinsey Global Institute 2011)
  - A/B testing
  - Cluster analysis
  - Data fusion and integration
  - Data mining, genetic algorithms, machine learning
  - Natural language processing
  - Neural networks
  - Network analysis
  - Signal processing and spatial analysis, simulation
  - Time series analysis
  - Visualisation
- Econometrics
  - Time series analysis
  - Score matching techniques
  - Two-stage models for endogeneity problems
- Artificial Intelligence and Machine Learning
  - History of Artificial Intelligence
  - Supervised Machine Learning
  - Unsupervised Machine Learning/ Deep learning/ Neural networks

Data Reporting

- Data Reporting
  - Robustness check
  - Information for reproducibility

- Related information
  - Open science
  - Ethics and privacy
  - GDPR (General Data Protection Regulation)

Distinct Research Fields in Data Science

Attitude to AI	AI as a goal	AI as a tool	AI as a phenomenon
Expertise	Computer science	Statistics	Social science
Roles	Develop AI and machine learning algorithms Advance IT technologies for higher computing power and connectivity	Use big data and machine learning techniques to solve research questions Add values/ create insights using data	Discuss the impact of AI on the society and organizations Understand the potential changes in ethics and policies

References

- George, G., Haas, M. R., & Pentland, A. (2014). FROM THE EDITORS BIG DATA AND MANAGEMENT. *Academy of Management Journal*, *57*(2), 321-326.
- Drew Conway's data science venn diagram, accessed 5 Aug 2019 at http://drewconway.com/zia/2013/3/26/the-data-science-venn-diagram
- Michael Barber, accessed 5 Aug 2019 at https://towardsdatascience.com/introduction-to-statistics-e9d72d818745