Algorithm Foundations of Data Science

Lecture 0: Course introduction

MING GAO, Cheqing Jin, and Weining Qian

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Outline

1. Textbooks and References
2. Requirements and Assessment
3. Office Hour and Contact Information
4. Overview of This Course
   - What Is Data Science?
   - Course Schedule
5. Take-aways

Required sources

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- John Hopcroft and Ravindran Kannan, Foundations of Data Science.
- Anand Rajaraman and Jeffrey D. Ullman, Mining of Massive Datasets.

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References

- Daphne Koller and Nir Friedman, Probabilistic Graphical Models: Principles and Techniques.
- Gilbert Strang, Linear Algebra and Its Applications(Fourth Edition).
- Fan Chung Graham, Spectral Graph Theory.

Requirements

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2. Students are expected to

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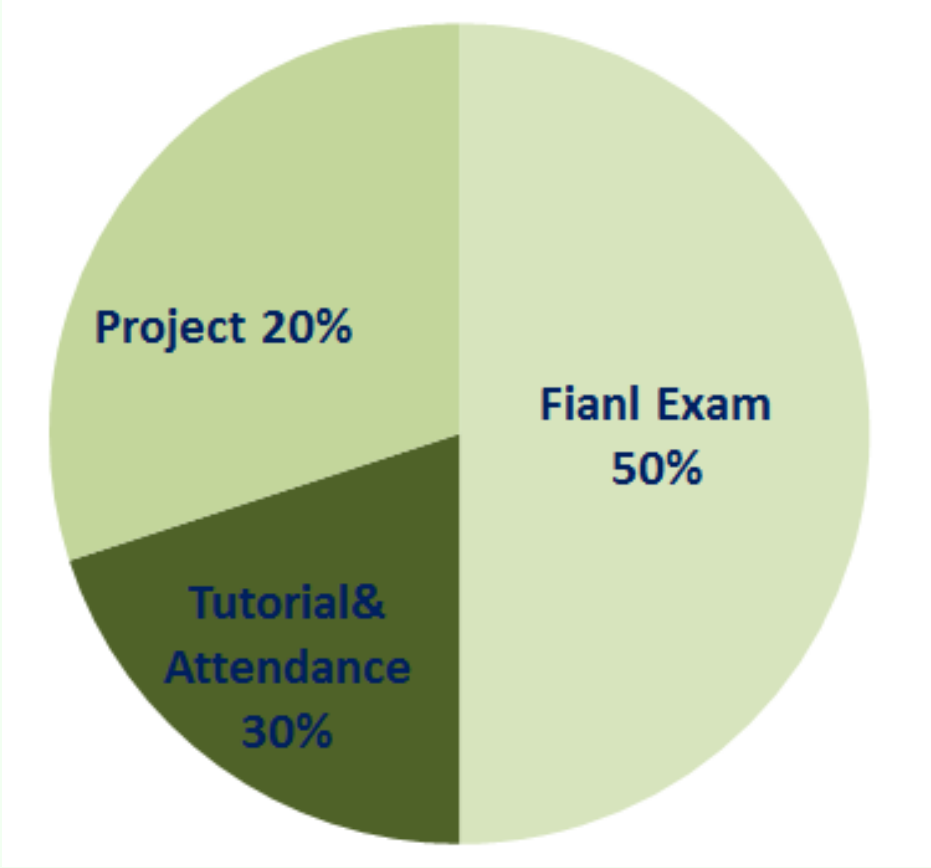
2. Students are expected to
   - take notes during lecture (no lecture notes will be provided)
   - read the assigned readings before and after the lecture
   - think through the answers of tutorial (a set of questions) every week
3. Write lecture notes

Assessment



Contact information

Lecturer: GAO Ming—– 高明

- Office: Rm. East 115, Math. Building
- Phone: 6223 2061
- Mobile: 189 1694 3299
- Email: mgao@dase.ecnu.edu.cn
- Course homepage: http://dase.ecnu.edu.cn/mgao/teaching/DataSci_2018_Spring/DS.html
- Research focus:
  - Social data mining
  - User profiling
  - Knowledge graph and knowledge engineering
  - Streaming data management and mining

Contact information

Lecturer: Cheqing Jin

- Office: Rm. 109, Geo. Building
- Mobile: 186 2130 6722
- Email: cqjin@dase.ecnu.edu.cn
- Research focus:
  - Location based services
  - Uncertain data management
  - Streaming data management and mining

Contact information

Lecturer: Weining Qian

- Office: Rm. 114, Math. Building
- Mobile: 186 2130 6719
- Email: wnqian@dase.ecnu.edu.cn
- Research focus:
  - In-memory database
  - Distributed data management system
  - Knowledge graph
  - Social network mining

What to be taught in this course?

Aim at helping students to provide the data-driven solution

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Aim at helping students to provide the data-driven solution

1. What is the course of data science?
2. Its components and available technologies
3. How to become a data scientist?
4. Some basic knowledge for a data scientist
5. Some advanced technologies that are related, or would be integrated into DS in the future

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- How to understand big data?

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  - Volume: 100PB and 20PB data daily processing for Baidu and Google, respectively; Alibaba and Tecent have data more than 100PB.
  - Velocity: Large Hadron Collider generates PB data in seconds; many streaming such as clickstream, log, RFID, Twitter, etc. #Trans. is almost 100,000 per second in Taobao during "Double 11".
  - Variety: structured, semi-structured and non-structured, including text, logs, video, voice and image etc.
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- Fragmentation of information:
  - Telecom
  - E-commerce
  - Social media
  - IoT
  - ...

Birth of data science

Reasons

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- Challenges of 4V

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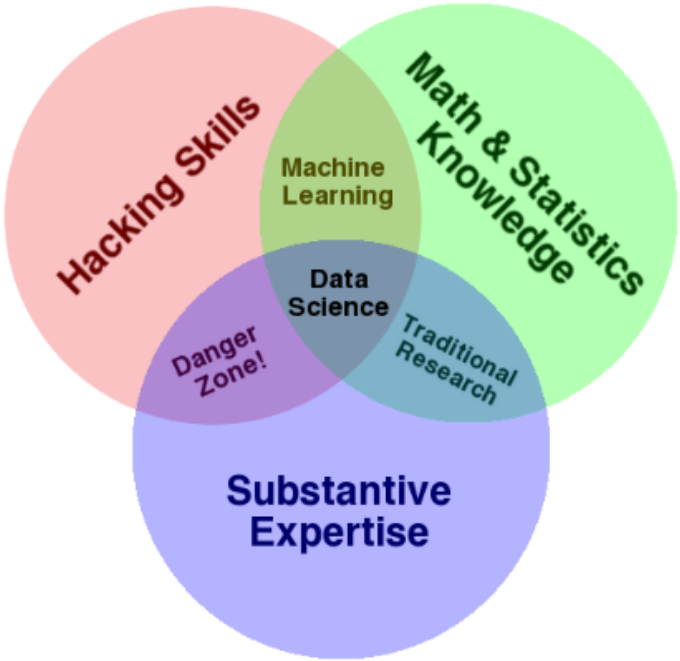
- Challenges of 4V
- Hardware updating
- Open sources, including Hadoop, Spark, Storm, and so on.
- Applications, such as E-commerce, sharing economy, industry 4.0, smart city, and intelligent education, etc.

What is data science?

Definition

Data science is an interdisciplinary field, which is a continuation of some of the data analysis fields such as mathematics, statistics, machine learning, data mining, and parallel computing, similar to Knowledge Discovery in Databases (KDD).



Objective

Data science goals to:

- extract knowledge
- insight from data in various forms, either structured or unstructured
- help users to understand massive data

DS co-evolution

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- Data scientist is the sexiest job in the 21st century (Hal Varian on Sep. 2012).

Types of data scientists

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- Data researcher: statisticians, social scientist, computer scientist, etc.
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- Data businessmen: project manager, Chief Data Officer (CDO)
- Mixed/Generic type: deep-understand in business, professional in technology, good at programming, etc.

Four paradigms of scientific research

- Experimental science

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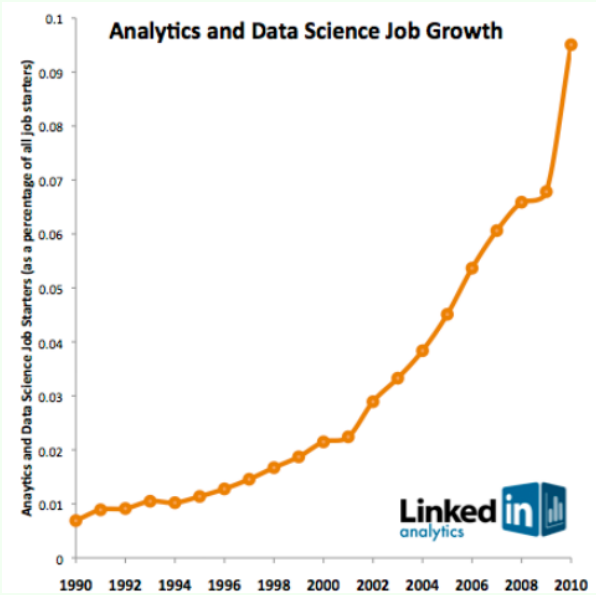
- Experimental science
- Theoretical science
- Computational science
- Data science?
  - It was firstly proposed by Jim Gray (a database researcher) in 2009.
  - The Forth Paradigm: Data-Intensive Scientific Discovery was wrote by Tony Hey (vice president of Microsoft) et al. in 2009.
  - Thus, the capability for big data processing is important to scientific researchers.

The shortage of data scientists



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Background (Ming Gao)

DS overview

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Probability and Sampling (Ming Gao)

- Markov Chain
- Sampling
- Probabilistic graph model

Schedule

Graph (Ming Gao)

- Graph and patterns
- Representations and modeling
- Centrality
- Proximity
- Link prediction and recommendation
- Information Cascade

Schedule

Probabilistic algorithm (Cheqing Jin)

- Probabilistic inequality
- Streaming data
- Sketch
- Hashing

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Data management techniques (Weining Qian)

- Data structure for concurrency
- Non-lock data structure
- Data compression
- Log and log-structured merge tree
- Bloom-filtering and locality sensitive hashing

Take-aways

Course homepage

http://dase.ecnu.edu.cn/mgao/teaching/DataSci_2018_Spring/DS.html

Advices to learning DS

- Not a reading course.
- More than a programming course, though it is project-heavy
- No *standard answers*