Design and Analysis of Algorithms
Course Information

1. Why Study Algorithm?

2. How to Study Algorithm?

课程名称: 算法设计与分析

课程号: sd046301400

自我介绍 - 陈宇

教育背景

2006.9–2011.7: 北京大学, 信息科学技术学院, 博士

- 2009.9–2010.9: Ireland DCU, 密码组, CSC 博士生联合培养

工作情况

2011.7–2019.6: 中科院信息工程研究所, 信息安全国家重点实验室, 助研/副研/博导; 中国科学院大学, 网安学院, 岗位教师

- 2015.8–2016.1: 香港中文大学, 信息工程系, 博士后

2019.6–2019.12: 蚂蚁金服区块链团队, 高级技术专家

2019.12-至今: 山东大学网络空间安全学院, 教授/博导

研究方向: 理论密码学及其应用 (高功能加密、零知识证明、多方安全计算)

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2. How to Study Algorithm?

Two ideas changes the world!

Typography

1448, German, Johann Guternberg: print books by putting together movable metallic pieces

- literacy spread ⇒ Dark Ages ended ⇒ human intellect was liberated ⇒ science and technology triumphed ⇒ Industrial Revolution happened

imagine a world in which only an elite could read lines

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But others insists that the key development was not typography, but *algorithm*

Algorithm

Origin: decimal system

- 10 symbols ⇒ even large numbers can be expressed compactly (invented in India around AD 600)
- basic methods for add, mul, div, even square roots and π (9th century, Arabic, Baghdad, Al-Khwarizmi)

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Back to 1448: imaging how to add/mul two Roman numbers: MCDXLVIII+DCCCXII? fingers are not enough

Algorithm Etymology

Spread to Europe around 12th century → plays an enormous role in Western civilization (science and technology, commerce and industry)

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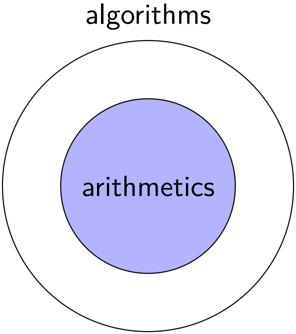

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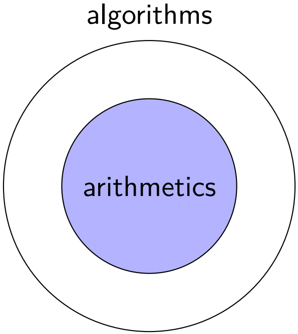


Computer era: evolute to embody the positional system and arithmetic unit $\rightsquigarrow$ scientists develop algorithms for all kinds of problems — ultimately change the world

Why Study Algorithms

Internet. Web search, packet routing, distributed file sharing, ...

Computer graphics. movies, video games, virtual reality, ...

Multimedia. MP3, JPG, DivX, HDTV ...

Artificial Intelligence. face recognition, PS, more AI algorithms

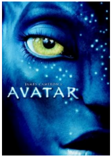
Social networks. recommendations, news feeds, advertisements, ...

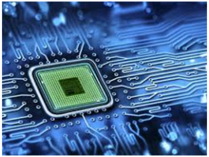
Computers. circuit layout, databases, caching, compilers, ...

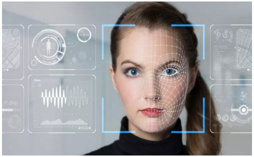
Biology. human genome project, protein folding, ...

Physics. N-body simulation, particle collision simulation, ...

Importance: Look Around You







Algorithms interesting and useful.
We live in the algorithm world!

Cryptographic Algorithms

Typically, algorithms only focus on solving problems efficiently

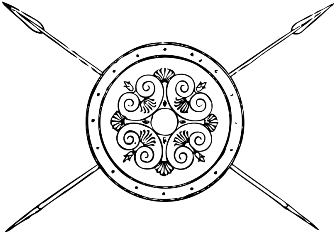
- make us live in a better world

Good man and bad man live in the same world

- good man need *cryptographic algorithms* to protect them from bad man: enjoying the benefits in a secure manner

Cryptography is Algorithm in information security area

- honest parties can perform cryptographic algorithms efficiently
- malicious adversaries are unable to solve some problems (no efficient algorithms against the security goal)



Fundamental of Computer Sciences

Algorithm design and analysis

- widespread applications
- fundamental and core part of computer science

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- algorithm design: 10
- computing and complexity theory: 7
- cryptography: ≥ 8

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$\mathcal{P} \overset{?}{=} \mathcal{NP}$ is one of the most important questions in this century

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- greedy strategy
- dynamic programming
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Advanced topics

- complexity theory
- randomized algorithms

The Essense of University

- Knowledge
- Skills
- Short-term attitude
- Long-term attributes

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Emphasize critical thinking: believe your own reasoning, do not easily repeat or follow

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Algorithm design: Master problem-solving method

1. abstract and formalize problem
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3. prove its correctness

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Tips

- theory: think rigorously and keep ask yourself why
- practice: implement algorithms using your favorite programming languages

Course Website

https://yuchen1024.github.io/teaching/SDU/2022/Algorithms/algorithms(autumn).html

Syllabus

Assignments

- electronic submission
- graded for correctness, clarity, conciseness, rigor, and efficiency
- recommendation: using LaTeX template for writing solutions
- no collaboration, no Google

Lecture slides

...

$$\text{总成绩} = 0.2 \times \text{平时成绩} + 0.2 \times \text{课后作业} + 0.6 \times \text{考试成绩}$$

References and Resources

Online resources

- leetcode
- online judging system: ZOJ, POJ

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Textbooks

- Algorithms. Sanjoy Dasgupta, Christos Papadimitriou, and Umesh Vazirani. The McGraw-Hill Companies,2008.
- 算法设计与分析 (第二版). 屈婉玲, 刘田, 张立昂, 王捍贫. 清华大学出版社,2016.2.

Figure: 屈婉玲