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

- 2002.9–2006.7: 合肥工业大学, 信息安全系, 学士 (专业第一)
- 2006.9–2011.7: 北京大学, 信息科学技术学院, 博士

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
- 2019.12-至今: 山东大学网络空间安全学院, 教授/博导

其它经历

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

研究方向

- 理论与应用密码学 (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 Latin version Bible 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 (thought to be natural in hindsight)

- 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)

كتاب الخوارزمي

[illegible]

These procedures are precise, unambiguous, mechanical, efficient, correct ⇝ Algorithms (有效的计算)

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كتاب الخوارزمي

ما شكاله وصنفه الشيخ الأجل ابو عبد الله

محمد بن موسى الخوارزمي رضي الله عنه وارضاه ورحمه

These procedures are precise, unambiguous, mechanical, efficient, correct ⇝ Algorithms (有效的计算)

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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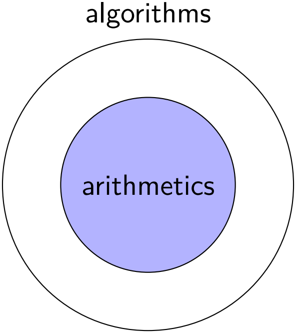

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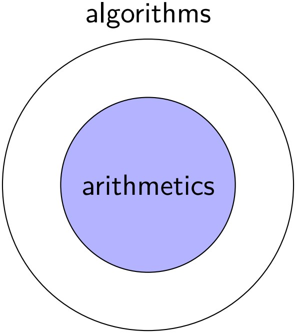


Computer era: evolve to embody the positional system and arithmetic unit $\leadsto$ scientists develop algorithms for all kinds of problems — ultimately change the world

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

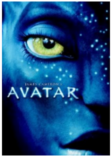
Social networks. recommendations, news feeds, advertisements, ...

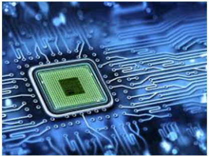
Computers. circuit layout, databases, caching, compilers, ...

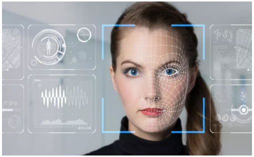
Biology. human genome project, protein folding, ...

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

Importance: Look Around You







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

Cryptographic Algorithms

Typically, algorithms only focus on solving problems efficiently

- make us live in a better world

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

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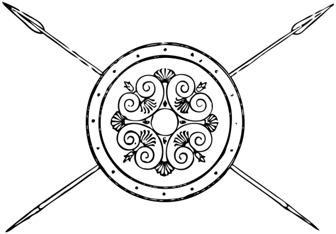
Cryptography is Algorithm in information security area

- 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
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- algorithm design: 11
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$\mathcal{P} \overset{?}{=} \mathcal{NP}$ is one of the most important questions in this century

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- mathematical background
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- greedy strategy
- dynamic programming
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Advanced topics

- complexity theory
- randomized algorithms

What are not covered in this course?

Linear programming and reductions

- bipartite matching
- flows in networks

Quantum algorithms

Advanced data structures

- segment tree

The Essence of University Education

- Teach/Learn universal knowledge (器)
- Master special skills (术)
- Form short-term capability (法)
- Cultivate long-term attributes (道)

Goal of this Course In General

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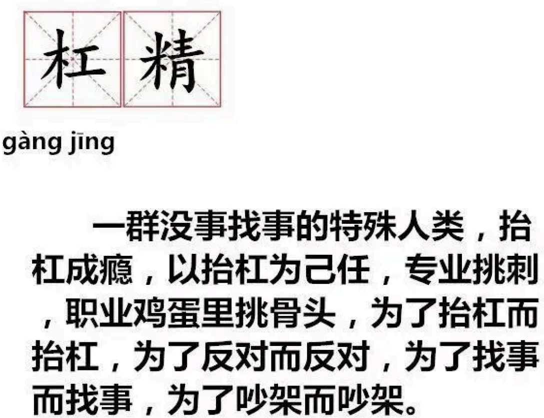
The benefits of critical thinking

- Think is productivity (Thomas J. Watson)
- Defend against bully and mind control.
- Not be dominated by advertising or conventional wisdom.

Remark

Exams lay down conformity of expression and knowledge.



杠精

gàng jīng

一群没事找事的特殊人类，抬杠成瘾，以抬杠为己任，专业挑刺，职业鸡蛋里挑骨头，为了抬杠而抬杠，为了反对而反对，为了找事而找事，为了吵架而吵架。

Goal of this Course In Details

> 学而不思则罔, 思而不学则殆.
>
> — 孔子

Algorithm design: Master problem-solving method

1. abstract and formalize problem
2. solve it efficiently and correctly using algorithms
3. prove its correctness

Algorithm analysis: Develop rigorous analysis skills

- know how to evaluate the performance of algorithms

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/2023/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

...

$$\text{总成绩} = 0.1\times \text{平时成绩} + 0.1\times \text{编程实践} + 0.3 \times \text{课后作业} + 0.5 \times \text{考试成绩}$$

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

https://zhuanlan.zhihu.com/p/193792826