Design and Analysis of Algorithms
Course Information

1. Why Study Algorithm?
2. How to Study Algorithm?

Basic Course Information

课程名称: 算法设计与分析

课程号: sd046301400

- 1-16 周 (每周)　会文北楼 244　　周三上午: 1-2 (8:00-9:50)
- 1-16 周 (单周)　会文南楼 225　　周四上午: 1-2 (8:00-9:50)


Just one simple idea...
can change the world.
- Ranal Currie -
Image: Pixabay.com

Two ideas changes the world!

Typography

1448, German, Johann Guternberg: print Latin version Bible by putting together movable metallic pieces

Typography accelerates the process of civilization, triggers a chain reaction:

- literacy spread $\Rightarrow$ Dark Ages ended $\Rightarrow$ human intellect was liberated $\Rightarrow$ science and technology triumphed $\Rightarrow$ industrial revolution happened

Imagine a world in which only an elite could read lines, knowledge can not be rapidly accumulated and spread.

Other Voice

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

Algorithm

Origin: decimal system (thought to be natural in hindsight)

- 10 symbols $\Rightarrow$ 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)

Unique features of decimal system

- procedures are precise, unambiguous, mechanical, efficient, correct $\rightsquigarrow$ Algorithms (有效的计算)

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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 $\rightsquigarrow$ plays an enormous role in Western civilization (science and technology, commerce and industry)

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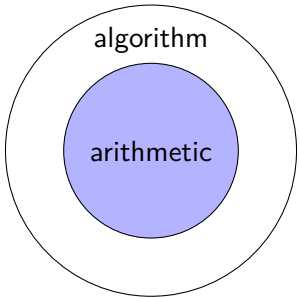

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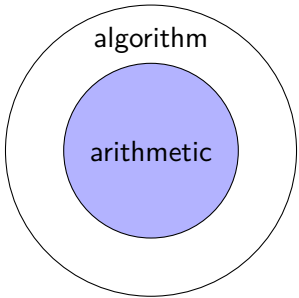


Computer Era

- traditional algorithm shrinks to arithmetic
- modern algorithm evolves to embody the positional system (位值系统) and arithmetic unit $\rightsquigarrow$ scientists develop algorithms for all kinds of problems $\rightsquigarrow$ 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

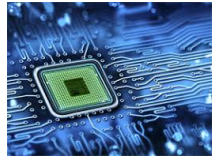
Social networks. recommendations, advertisements, ...

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

Biology. human genome project, vaccine manufacture, ...

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

Importance: Look Around You





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

A Detour

What is the connection between algorithm and cryptography?

Cryptographic Algorithms

Typically, algorithms only focus on solving problems efficiently

- make us live in a better world (compare 12306 now and 15 years ago)

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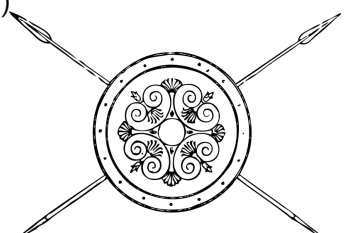
Cryptography is Algorithm in information security area

- 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 is the cornerstone of CS

- widespread applications
- fundamental and core part of computer science

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Many problems remain open

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

Expect you can solve it in the future.

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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

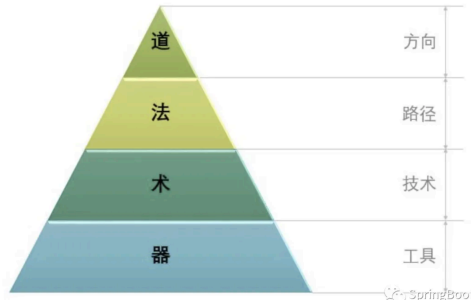
Quantum algorithms

Advanced data structures

- segment tree

The Essence of University Education

- Learn universal knowledge (器: 工具)
- Master special skills (术: 技术)
- Form short-term capability (法: 方法)
- Cultivate long-term attributes (道: 本质)



Goal of this Course In Details (器、术)

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

Goal of this Course In General (法、道)

Develop critical thinking (批判性思维)

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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.

Course Website

https://yuchen1024.github.io/teaching/SDU/2025/Algorithms/algorithms.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.
- 算法设计与分析 (第二版). 屈婉玲, 刘田, 张立昂, 王捍贫.

Figure: 屈婉玲

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