

# Algorithm Design and Analysis



## LECTURE 1

### Analysis of Algorithms

- Course information
- Why study algorithms?
- Stable matching problem

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S. Raskhodnikova; based on slides by E. Demaine, C. Leiserson, A. Smith, K. Wayne



## Course information

1. Staff
2. Course website
3. Prerequisites
4. Lectures
5. Textbook
6. Syllabus
7. Homework
8. Grading policy
9. Collaboration policy
10. Exams and grading

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## Course Objectives

- classical algorithms
- analysis of algorithms
- standard design techniques

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## Etymology of “Algorithm”

*Abu Abdullah Muhammad ibn Musa  
al-Khwarizmi (c. 780 -- 850 AD)*

- Persian astronomer and mathematician
- lived in Baghdad, father of algebra
- “On calculating with hindu numerals”  
a treatise in Arabic, 825
- “Algoritmi de numero Indorum”  
translation into Latin, 12th century
- author’s name, mistaken for a plural noun, came to mean “calculation methods”

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## Algorithm Design and Analysis

*Theoretical study of how to solve computational problems*

- sorting a list of numbers
- finding a shortest route on a map
- scheduling when to work on homework

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## Performance

- Typical goal: Find most space- and time-efficient algorithm for given problem.
- What else is important?
  - modularity
  - correctness
  - maintainability
  - functionality
  - robustness
  - user-friendliness
  - programmer time
  - simplicity
  - extensibility
  - reliability
- Performance is the currency of computing

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## Why study algorithms?

- a *language* for talking about program behavior
- standard set of algorithms and design techniques
- feasibility (what can and cannot be done)
  - halting problem, NP-completeness
- analyzing correctness and resource usage
- successful companies (Google, Mapquest, Akamai)
- computation is fundamental to understanding the world
  - cells, brains, social networks, physical systems all can be viewed as computational devices
- IT IS FUN!!!

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## Matching Residents to Hospitals

- **Goal:** Given a set of preferences among hospitals and medical school students, design a **self-reinforcing** admissions process.
- **Unstable pair:** applicant  $x$  and hospital  $y$  are **unstable** if
  - $x$  prefers  $y$  to its assigned hospital, and
  - $y$  prefers  $x$  to one of its admitted students
- **Stable assignment:** no unstable pairs.
  - Individual self-interest will prevent any applicant/hospital deal from being made.

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