Data Structures and Algorithms

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My Background

- **Name: Rao Muhammad Umer**
- **Teaching Experience**
  - Oct. 2016 till now
  - PF-I, DLD, ITC,…
- **MS (Computer Science)**
  - PIEAS (2014-2016)
  - PIEAS Fellowship
  - Area of Research: Data Science and Machine Learning
- **BS (Computer System Engineering)**
  - UCET, IUB (2010-2014)
  - National ICT Scholarship
  - Area of Research: AI, Parallel & Distributed Computing, and Digital Image Processing
- Visit my personal website for more information about me on following link:

  raoumer.github.io

Course overview

What is this course?

- Intermediate-level survey course.
- Programming and problem solving, with applications.
- Data structure: method to store information.
- Algorithm: method for solving a problem.

topic	data structures and algorithms	
data types	stack, queue, bag, union-find, priority queue	part 1
sorting	quicksort, mergesort, heapsort	
searching	BST, red-black BST, hash table	
graphs	BFS, DFS, Prim, Kruskal, Dijkstra	part 2
strings	radix sorts, tries, KMP, regexps, data compression	
advanced	B-tree, suffix array, maxflow	

Why study algorithms?

Their impact is broad and far-reaching.

- Internet. Web search, packet routing, distributed file sharing, ...
- Biology. Human genome project, protein folding, ...
- Computers. Circuit layout, file system, compilers, ...
- Computer graphics. Movies, video games, virtual reality, ...
- Security. Cell phones, e-commerce, voting machines, ...
- Multimedia. MP3, JPG, DivX, HDTV, face recognition, ...
- Social networks. Recommendations, news feeds, advertisements, ...
- Physics. N-body simulation, particle collision simulation, ...

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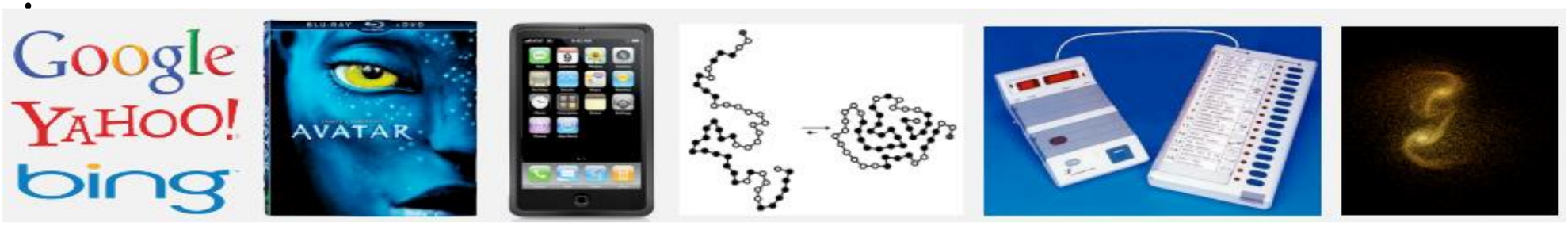
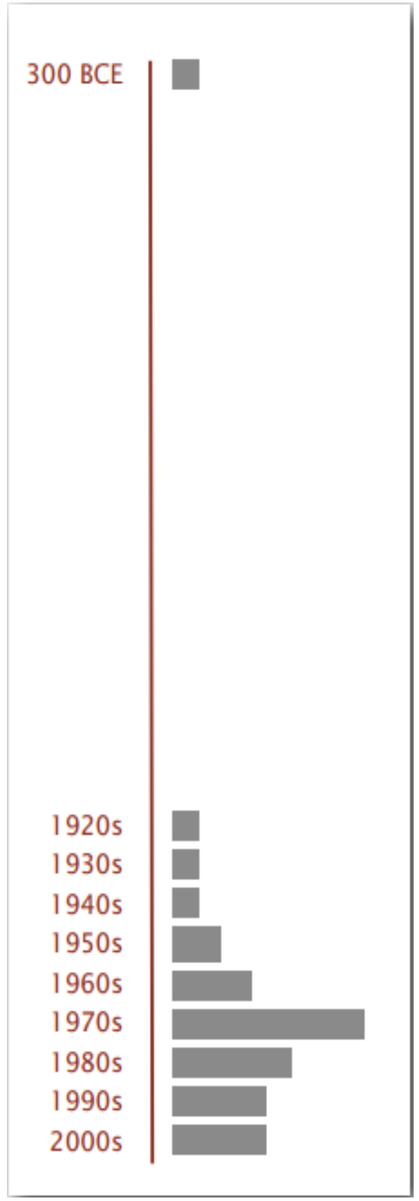


Why study algorithms?

Old roots, new opportunities.

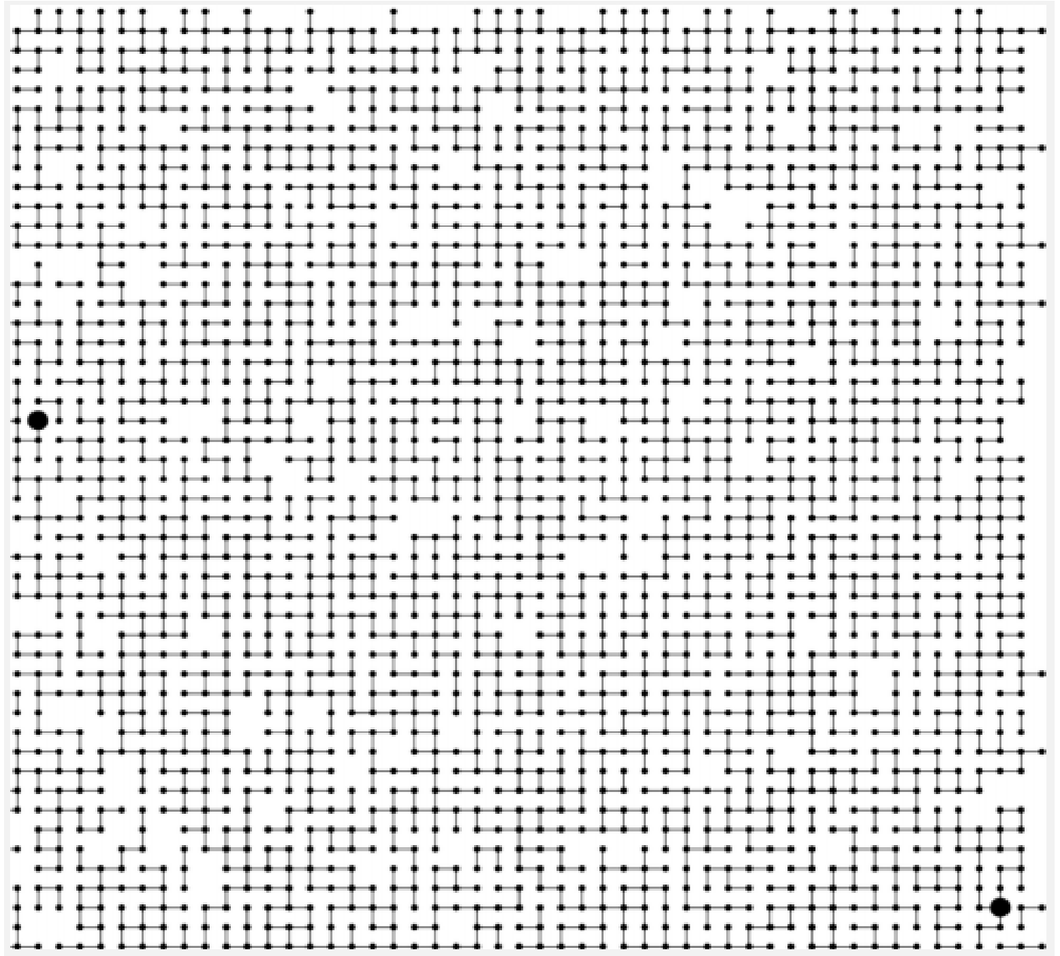
- Study of algorithms dates at least to Euclid.
- Formalized by Church and Turing in 1930s.
- Some important algorithms were discovered by undergraduates in a course like this!



Why study algorithms?

To solve problems that could not otherwise be addressed.

Ex. Network connectivity. [stay tuned]



Why study algorithms?

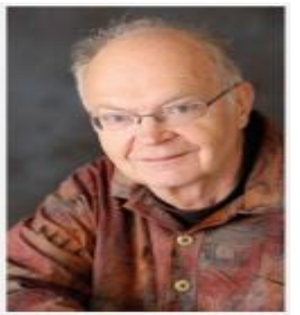
For intellectual stimulation.

> *" For me, great algorithms are the poetry of computation. Just like verse, they can be terse, allusive, dense, and even mysterious. But once unlocked, they cast a brilliant new light on some aspect of computing. "* — *Francis Sullivan*


FROM THE EDITORS

THE JOY OF ALGORITHMS

> *" An algorithm must be seen to be believed. "* — *Donald Knuth*

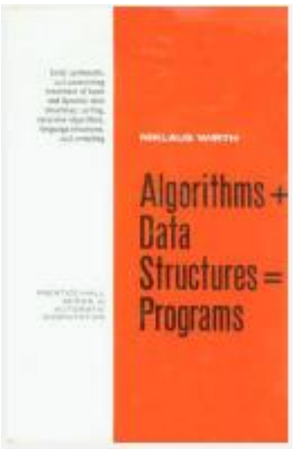


Why study algorithms?

To become a proficient programmer.

> *" I will, in fact, claim that the difference between a bad programmer and a good one is whether he considers his code or his data structures more important. Bad programmers worry about the code. Good programmers worry about data structures and their relationships. "*
>
> *— Linus Torvalds (creator of Linux)*

> *" Algorithms + Data Structures = Programs. "* *— Niklaus Wirth*



Why study algorithms?

They may unlock the secrets of life and of the universe.

Computational models are replacing math models in scientific inquiry.

$$E = mc^2 \qquad F = \frac{Gm_1m_2}{r^2}$$

$$F = ma$$

$$\left[-\frac{\hbar^2}{2m}\nabla^2 + V(r)\right]\Psi(r) = E\,\Psi(r)$$

20th century science

(formula based)

```
for (double t = 0.0; true; t = t + dt)
   for (int i = 0; i < N; i++)
   {
      bodies[i].resetForce();
      for (int j = 0; j < N; j++)
         if (i != j)
            bodies[i].addForce(bodies[j]);
   }
```

21st century science

(algorithm based)

" Algorithms: a common language for nature, human, and computer. " — *Avi Wigderson*

Why study algorithms?

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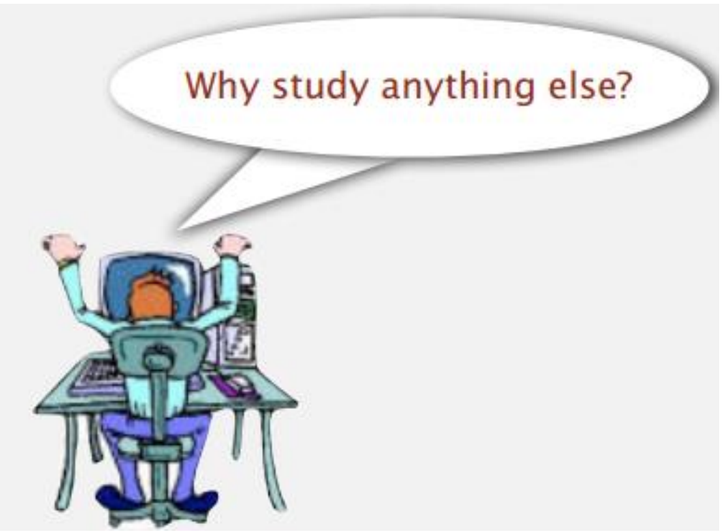
- Their impact is broad and far-reaching.
- Old roots, new opportunities.
- To solve problems that could not otherwise be addressed.
- For intellectual stimulation.
- To become a proficient programmer.
- They may unlock the secrets of life and of the universe.
- For fun and profit.



Resources (Web)

Course Website.

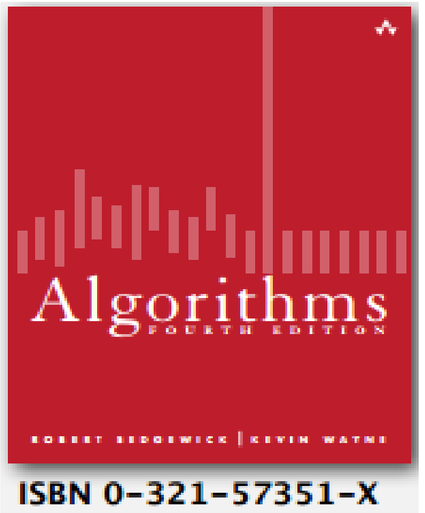
- Course Info. / Content .
- Lecture slides.
- Programming Assignments.
- Exercises.
- Exams.
- Instructor's Email: **muhammad.umer@cs.uol.edu.pk**

piazza

https://piazza.com/uol.edu.pk/summer2017/cs2112/home

Textbook.

- Algorithms, 4th edition by Sedgewick and Wayne.
- More extensive coverage of topics.
- More topics.



Prerequisites

Prerequisites.

- Programming: loops, arrays, functions, objects, recursion.
- C/C++: we use as preferred language. (But you can code in any your favorite programming language, like Python, Java, C#, etc.)
- Mathematics: high-school algebra.

Review of prerequisite material.

- Quick: Sections 1.1 and 1.2 of Algorithms, 4th edition.
- In-depth: How to Program in C/C++, by Deitel & Deitel

Programming environment.

- Use your own, e.g., Visual Studio, Borland, Dev-C++, Eclipse, etc.

Quick exercise. Write a C/C++ program.

Acknowledgement

- Mostly Slides taken from Book: “Algorithhms” 4th Edition by Robert Sedgewick, Kevin Wayne

Any Query?

Thank You for Your Patience!!!