Introduction

COMP215: Design & Analysis of Algorithms

KALAMAZOO COLLEGE

Today

- Introductions
- Syllabus
- Class Webpage & Kit
- Integer Multiplication

Introduction

- Tasnim Gharaibeh
  - *Dr. Tasnim*
  - She, her, hers
- CS Interests:
  - AI and Machine Learning Models.
  - Natural Language Processing.
  - Text Mining.
  - Information Retrieval.

Introduction

- Favorite Languages:
  - C/C++
  - Python
  - R
  - Java

Introduce yourself!

Name

Major

Fun Fact about you

Syllabus

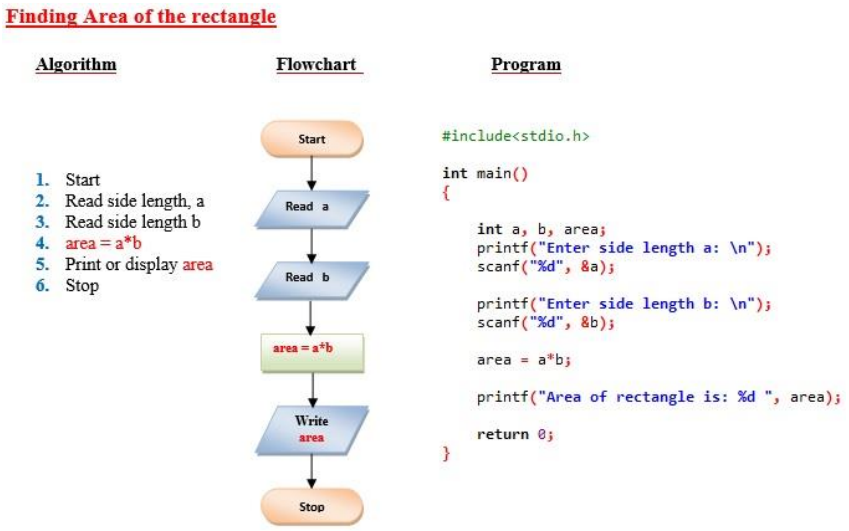
- Let's go to the class webpage:
  - www.cs.kzoo.edu/cs215

Teams

- Add yourself:
  - https://teams.microsoft.com/l/channel/19%3aNXygOKaYFQvX7dAtjkwQR7gAw2i5UmqNtHzJs-Z6KS01%40thread.tacv2/General?groupId=f9ec39dd-cf51-4f87-b550-4e93f4228cfb&tenantId=e214b458-c456-45b4-961a-7852355f177a
  - Using the code : **y2jj659**
- Channels:
  - General
  - Class Topics
  - Discussion Questions
  - Mini-Labs
  - Projects

Why Study Algorithms?

- **Algorithm?**
  - It's a set of well-defined rules, a recipe, in effect for solving some computational problem.
  - Examples:
    - Numbers arrangement
    - Shortest path



Why Study Algorithms?

- Important for all other branches of computer science.
- Driver of technological innovation.
- Lens on other sciences.
- Good for the brain
- Fun!

Why Study Algorithms?

- Important for all other branches of computer science.
  - Routing protocols in communication networks piggyback on classical shortest path algorithms.
  - Public-key cryptography relies on efficient number-theoretic algorithms.
  - Computer graphics requires the computational primitives supplied by geometric algorithms.
  - Database indices rely on balanced search tree data structures.
  - Computational biology uses dynamic programming algorithms to measure genome similarity

Why Study Algorithms?

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- Driver of technological innovation.

"Everyone knows Moore's Law — a prediction made in 1965 by Intel co-founder Gordon Moore that the density of transistors in integrated circuits would continue to double every 1 to 2 years. . . in many areas, performance gains due to improvements in algorithms have vastly exceeded even the dramatic performance gains due to increased processor speed."

Why Study Algorithms?

- Important for all other branches of computer science.
- Driver of technological innovation.
- Lens on other sciences.
  - The study of quantum computation has provided a new computational viewpoint on quantum mechanics.
  - Price fluctuations in economic markets can be fruitfully viewed as an algorithmic process.

Integer Multiplication

- Need to distinguish between two different things:
  - The **description of the problem** being solved, introducing a computational problem (the inputs and desired output),
  - The **method of solution** (that is, the algorithm for the problem), describing one or more algorithms that solve the problem

Integer Multiplication

- Input: 2 n digit numbers x and y
- Output: product x*y

- Primitive Operation add or multiply 2 single digit numbers

Integer Multiplication

- Try:

x * y= 2698 * 4263 = ?

  - How many multiplication operations for partial product?

    n multiplications / partial product

  - How many addition operations for partial product?

    at most 2n additions / partial product

  - How many operations in total for partial product?

    n + 2n / partial product

  How many operations in total?

  n (rows) * (3n)= $3n^2$

  We still have to add them all up to compute the final answer, but this takes a comparable number of operations ($3n^2$)

  $3n^2 + 3n^2 = 6n^2$

Integer Multiplication

Total number of operations <= constant.n^2

Thinking about how the amount of work the algorithm performs scales as the input numbers grow bigger and bigger

Can We Do Better?