Introduction to Computer Science

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1 Course Logistics

2 Introduction to Computing

- What is computing?
- Computation in STEM and Humanities
- Example of a Computation
- Understanding the Computational Process

3 Computers, Languages, Algorithms

- The Long Multiplication Problem

Course Logistics

- All announcement through the course webpage https://subodhvsharma.github.io/course/col100. **So regularly visit and check for updates!**
- All **content-specific discussions on Piazza**. You will be added to COL100's Piazza shortly. No individual emails will be entertained.

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We shall work with Python (possibly with **browser as an editor as well as the interpreter!**)

Unix it is!

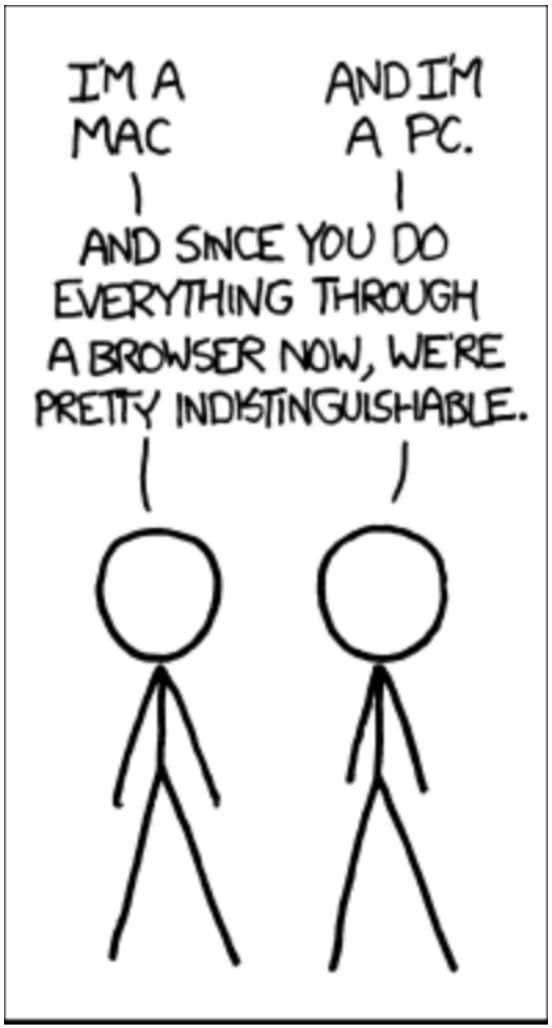

Figure: MAC/PC

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  - History of computing is *older* than the history of computing technology
    - One of the oldest algorithms – Euclid's method to compute gcd

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- **Humanities/Management**: Linguistics, Cognitive science, Politics, etc.

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  - **Compass**: Can define arcs and circles; Can specify **arbitrary non-zero** lengths.

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- Doubling a Square: Given a square ABCD of side $a > 0$
- Computation steps:
  1. Draw a diagonal $\overline{AC}$.
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- Step (1) above is a primitive operation.
- However step (2) is a complex operation that requires further computation (called the *refinement* of the computational process).

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  4. Join the points of intersection of the two circles.

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- Diagonal $\overline{AC}$ length = $\sqrt{2}a$
- Area of ACEF = $2a^2$
- Where the two circles drawn from Y and Z of radius $2c$ is perpendicular to YZ.

Understanding the Computational Process: Essential Ingredients

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  2. Avoiding repetitions in specifying solutions. Eg: drawing perpendiculars from two separate points are instances of the same computational process.

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- **Computing Tool**: A programming langauage and the computer together form a computing tool.
- Thus, each program uses *only* the primitives of the computing tool.

The Long Multiplication Problem

- Notation: Let $a = \Sigma_{i=0}^{m} 10^i a_i$ and $b = \Sigma_{j=0}^{n} 10^j b_j$ be two numbers with m and n digits, respectively.

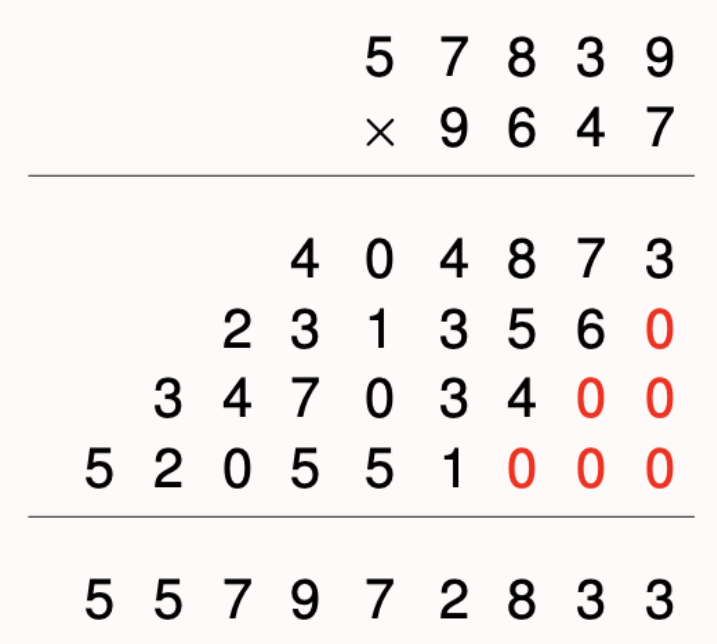

Figure: Long Multiplication

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$$= ab_0 + ab_1.10 + \ldots + ab_n.10^n$$

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- How does one guarantee that the method is correct?
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$$\begin{aligned} a \times b &= a \times \Sigma_{j=0}^{n} 10^j b_j \\ &= ab_0 + ab_1.10 + \ldots + ab_n.10^n \end{aligned}$$

Algorithm:

$$\text{LongMult}(a, b) = \begin{cases} ab_0 & \text{if } b < 10 \\ ab_0 + \text{LongMult}(a, b').10 & \text{if } b \geq 10 \end{cases}$$

where $b_0 = b \, mod \, 10$ and $b' = b \, div \, 10$

- Note carefully the application of abstraction and combination in the above algorithm!

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- **Induction Step**:

$$\begin{aligned}
\text{LongMult}(a, b) &= ab_0 + \text{LongMult}(a, b\,div\,10) \\
&= ab_0 + ab'.10 \quad \text{(by I.H.)} \\
&= a(b_0 + b'.10) \\
&= a \times b \quad \text{(by definition of b)}
\end{aligned}$$