Design and Analysis of Algorithms, Honors

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Lecture 1: Intro and Review

1 Intro to Algorithms

1.1 Properties of Algorithms

What kind of properties can an algorithm even have?

Property. Algorithms can be categorized by speed, memory, readability (simple to understand), accuracy (approximation quality), and requirements for the input.

The focus of this class will be on **speed**. We will also talk about accuracy, and algorithms will be mostly readable (but not always). We need some language that will allow us to describe algorithms.

1.2 Describing Algorithms

> **Example.** Let's take for example selection sort.

> **Proof.** Using plain english, selection sort is: reapeatedly finding the smallest element and appending it to the output.

Algorithms can be described at different levels of detail. One extreme is very informally, like the sentence above. This type helps convey the **key concepts**, but can be rather vague, ambiguous, and hard to understand.

The other extreme could be posting the source code of the program. This would be a complete description of an algorithm, because even the computer and execute it. However, source code includes details that **only the computer needs**, such as types, etc.

So, when talking about algorithms, it makes sense to use a middleground, known as **pseudocode**.

> **Definition 1.** **Pseudocode** is a descriptive, step by step set of instructions that detail the structure of a program. English is allowed, and the level of detail depends on the context and the audience.

Selection Sort 1 Pseudocode for Selection Sort

Any array of elements *input*
A sorted array *output*
1: **for** $i \leftarrow 1 \dots n$ **do**
2: Find $j \geq i$ with smallest $arr[i]$
3: Swap $arr[i]$ and $arr[j]$
4: **end for**

1.3 Runtime of Algorithms