CSE-217: Theory of Computation

Introduction

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Overview

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Three traditionally central areas of the theory of computation.

- Automata
- Computability
- Complexity

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- Complexity

What are the fundamental capabilities and limitations of computers?

Complexity Theory

Computer problems come in different varieties

- Easy
- Hard

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- Easy
- Hard

What makes some problems computationally hard and others easy?

Comparability Theory

Again Computer problems come in different varieties

- Solvable
- Unsolvable

Comparability Theory

Again Computer problems come in different varieties

- Solvable
- Unsolvable

What makes some problems computationally solvable and others unsolvable?

Complexity Theory vs Comparability Theory

The theories of computability and complexity are closely related. In complexity theory, the objective is to classify problems as easy ones and hard ones, whereas in computability theory the classification of problems is by those that are solvable and those that are not. Computability theory introduces several of the concepts used in complexity theory.

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Example 1

The Finite Automaton
used in text processing, compilers, and hardware design.

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Example 2

The Context-Free Grammar
used in programming languages and artificial intelligence.

MATHEMATICAL NOTIONS AND TERMINOLOGY

SETS

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$$S = \{2, 13, 4, 256\}$$

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- Elements or members
- Subset / Proper subset
- Multiset
- Finite / Infinite Set
- Empty/Singleton set
- Unordered Pair
- Union
- Intersection
- Complement
- Venn diagram

SEQUENCES AND TUPLES

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Finite sequences often are called tuples.
A sequence with k elements is a k-tuple.

FUNCTIONS AND RELATIONS

A function is an object that sets up an input–output relationship.

$$f(a) = b$$

A function also is called a mapping.

$$f : A \to B$$

GRAPS

An undirected graph, or simply a graph, is a set of points with lines connecting some of the points. The points are called nodes or vertices, and the lines are called edges

STRINGS AND LANGUAGES

An alphabet to be any nonempty finite set. The members of the alphabet are the symbols of the alphabet.

$$\Sigma_1 = \{0, 1\}$$
$$\Sigma_2 = \{a, b, c, \ldots, x, y, z\}$$
$$\Gamma = \{0, 1, x, y, z\}$$

STRING AND LANGUAGES

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A language is a set of strings.

Thank You