CSCI 7500 Theory of Computation

School of Computer and Cyber Sciences, Augusta University

Spring 2022 Syllabus

Class Time: Tuesday & Thursday 11:30 am – 12:45 pm.

Room: Hull McKnight GA Cyber Center 2201

Instructor: Konstantin Busch, kbusch@augusta.edu

Textbooks:

Introduction to the Theory of Computation, by Michael Sipser, 3rd edition.

Description: In this course we will seek to understand what is and is not possible with modern day computers by using mathematical models to fine-grain study various forms of computation. We will study languages, Turing machines, undecidability, the time complexity classes such as P, NP, NP-complete, space complexity classes such as L and NL, the Cook-Levin theorem, reductions, poly-time hierarchy, randomized algorithms and randomized complexity classes such as BPP, approximation algorithms and hardness of approximation. Strong understanding of undergraduate-level mathematical structures in computer science and theory of computation are expected.

Student Learning Outcomes

- Construct and analyze various flavors of Turing machines.
- Identify undecidable problems.
- Differentiate time and space complexity.
- Prove which time/space complexity class an algorithm belongs to.
- Explain randomized algorithms and their complexity classes.
- Explain approximation algorithms and their complexity classes.

Tentative Schedule:

Week 1 - Introduction

Week 2 – Turing machines

Week 3 – Variations of Turing machines (e.g., multi-tape, non-deterministic) Turing machines

Week 4 – Diagonalization proofs

Week 5 – Reductions

Week 6 – Running time of Turing machines and an introduction to the basic complexity classes (P and NP)

Week 7 – More running time complexity, e.g. NP-hard, and NP-complete

Week 8 – Cook-Levin Theorem and it's applications

Week 9 – Introduction to Space complexity

Week 10 – Savitch's Theorem and PSPACE

Week 11 – Quantified Boolean formula satisfiability is PSPACE-complete

Week 12 – Introduction to Log space (L (deterministic log space) and NL (non-deterministic log space)),

Week 13 – Log space reductions and NL-completeness; Introduction to RL (randomized log space)

Week 14 – The space hierarchy and the time hierarchy theorems; Randomized algorithms and randomized complexity classes

Week 15 – Approximation algorithms

Grading Components:

- Homework Assignments: 40%
- Midterm Exam 30%
- Final Exam 30%

Grading Scale:

A ≥ 90, B ≥ 80, C ≥ 70, D ≥ 60
F < 60

Academic Honesty: The Augusta University academic honesty guidelines governs all work in this course. Unless indicated otherwise, all written work that is handed in must be prepared only by the individual whose name appears on the document. Your instructor is authorized to give you help on all work (help will not be given if it provides unfair advantage). More details on academic honesty: https://www.augusta.edu/compliance/policyinfo/policy/academic-honesty.pdf