



UNIVERSITY
OF TRIESTE

Algorithmic Design

University of Trieste – a.a. 2026/2027

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a.a. 2026/2027

About me



Prof. Antonio Emanuele Cinà

Tenure-track Assistant Professor @ University of Trieste, Italy

Research focus

Security & reliability of machine learning systems in adversarial and real-world settings.

Email

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Appointments

Please email me to schedule an appointment.

Course Overview

A road map of algorithmic design

Course at a glance

Part A: Foundations

1. Algorithmic Problems & Notation
2. Recurrences
3. Sorting
4. Priority Queues & Heapsort
5. Divide and Conquer
6. Sorting Lower Bounds & Linear Sorting
7. Graphs & Graph Traversal

Part B: Data Mining

9. Algorithmic Data Mining
10. Weighted Shortest Paths
11. Minimum Spanning Trees & Clustering
12. Exact Indexing
13. Exact String Matching
14. Suffix Indexes & Edit Distance
15. Clustering Algorithms

Part C: Adv. algorithms & Planning

17. Computational Complexity
18. Polynomial Reductions
19. Approximation Algorithms
20. Formal Planning
21. A* & Heuristic Search
22. Planning via SAT & CSP
23. Genetic Algorithms

What you will learn

Course goal

Design **correct** and **efficient** algorithms, prove their properties, and understand the fundamental **limits of computation**.

By the end of this course, you will be able to:

- **Analyze** algorithms using asymptotic notation, recurrences, and amortization.
- **Design** solutions via dynamic programming, greedy strategies, divide and conquer, and graph algorithms.
- **Apply** data-mining algorithms to indexing, clustering, string search, and similarity.
- **Reason** about hardness (NP-completeness) and construct polynomial reductions.
- **Approximate** intractable problems and bound the quality of approximate solutions.
- **Plan** intelligently using heuristic search, SAT, and metaheuristic methods.

Part A: Foundations – Motivation & outcomes

Why study algorithmic foundations?

Every advanced technique in Parts B and C rests on a small set of core ideas: how to measure efficiency, how to break a problem into sub-problems, and how to exploit structure.

Part A outcomes – you will:

- State and apply asymptotic notation ($\mathcal{O}()$, $\Theta()$, $\Omega()$).
- Solve recurrences using substitution and the Master theorem.
- Design correct algorithms for sorting, searching, and graph traversal.
- Implement priority queues, heaps, and balanced structures.

Part B: Data Mining – Motivation & outcomes

Why algorithmic data mining?

Modern datasets are large, messy, and high-dimensional. Efficient algorithms for indexing, searching, and clustering are the machinery behind search engines, recommendation systems, genomic databases, and intrusion detection.

Part B outcomes – you will:

- Apply shortest-path and MST algorithms to weighted graphs.
- Choose and analyze index structures (trees, hash tables).
- Design and validate data mining algorithms (e.g., clustering and matching).

Part C: Hardness, Approximation & Planning – Motivation & outcomes

Why study hardness and planning?

Not every problem can be solved efficiently. Recognizing NP-hard problems saves wasted effort on exact polynomial algorithms. Approximation theory tells us *how close* to optimal we can get efficiently.

Part C outcomes – you will:

- Classify problems as P, NP, or NP-hard using reductions.
- Design and analyze ρ -approximation algorithms.
- Encode planning problems as SAT/CSP and solve with A*.
- Select among portfolios of algorithms, local search, and genetic methods.

Assessment: Modules A and B

Written examination

Held in the computer laboratory, the written examination assesses your ability to:

- implement, complete, or debug algorithms studied in class;
- analyze their time complexity;
- interpret results and explain algorithmic choices.

Scoring and three-point buffer

Exercises total **30 points**, with a maximum written grade of **27/30**. Raw scores from 27 to 30 are recorded as 27. This three-point buffer allows room for minor errors or incomplete answers.

Oral examination

Students who earn **27/30** in the written examination are eligible for an oral examination to demonstrate deeper conceptual understanding. It may lead to a final grade from **28/30** to **30/30 cum laude**.

Please contact the instructor by email to arrange the oral examination.

Course material

Team code: **hro0fkt**

Moodle: **298SM - ALGORITHMIC DESIGN 2026**

Rooms and schedule

Monday: Room 3B, building H2bis, 4-6pm

Tuesday: Room 5C, building H2bis, 11am-1pm

Tuesday: Room 3A, H2bis, 5-7pm
(exception: 06/10/2026, Room 4 INF01, building D, 5-7pm)

Thursday: Room 5A, building H2bis, 1-3pm.

Thank you!



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