Program	Type of studies (cycle)	Third cycle
	Name of the program	Doctoral Studies in Mathematical and Computer Science

COURSE

Course title	**Algorithmic techniques for intelligent and geometric systems**

Course code	Semester	Course status	ECTS credits	Contact hours
CS 611	II	elective	10	30

Aims and intended learning outcomes	The aim of the course is to deepen advanced knowledge of algorithmic methods, data structures, computational geometry, and intelligent systems, with an emphasis on their application to contemporary research problems in computer science. The course connects theoretical algorithmic concepts with geometric modeling, solution-space search, planning, coverage, and spatial data processing, while considering algorithmic complexity, implementation efficiency, and practical applicability. Upon successful completion of the course, the student is able to critically analyze contemporary algorithmic and geometric methods, select appropriate data structures, formally describe and evaluate algorithms, and develop research prototypes in a selected programming language. Particular emphasis is placed on applications involving triangulation, Voronoi diagrams, geometric search, path planning, spatial coverage, sensor and camera placement, and intelligent decision-making. The student is able to present research results through a scientific report, seminar paper, or prototype suitable for further development within a doctoral dissertation.

Course content/topics

- Analysis of algorithmic complexity, selection of data structures, memory hierarchy, cache-aware and cache-oblivious approaches;
- Advanced algorithmic paradigms: randomized algorithms, approximation algorithms, heuristic and hybrid methods;
- Graph algorithms and algorithms for networks, search, connectivity, coverage, and planning;
- Geometric objects and algorithms: points, segments, polygons, intersections, convex hulls, triangulations, Delaunay triangulations, and Voronoi diagrams;
- Geometric data structures: spatial trees, quadtrees, k-d trees, range searching, and nearest-neighbor search;
- Algorithmic problems in intelligent and geometric systems: the art gallery problem, optimal camera and sensor placement, path planning for robots/UAV systems, geometric coverage, and reassembly problems;
- Integration of deterministic algorithms with metaheuristics and machine learning methods for solving complex geometric and combinatorial problems;
- Development of a research prototype, experimental evaluation, comparison of methods, and preparation of a paper in the form of a scientific article.

LITERATURE

[1] A. Alihodžić, Exploring Computational Geometry: Theory and Python Implementations, Texts in Computer Science, Springer Cham, 2026.

[2] K. Erciyes, Guide to Graph Algorithms: Sequential, Parallel and Distributed, Texts in Computer Science, Springer Cham, 2026.

[3] T. H. Cormen, C. E. Leiserson, R. L. Rivest and C. Stein, Introduction to Algorithms, 4th ed., MIT Press, 2022.

[4] S. Skiena, The Algorithm Design Manual, 3rd ed., Springer, 2020.

[5] M. T. Goodrich, R. Tamassia and M. H. Goldwasser, Data Structures and Algorithms in Python, Wiley, 2013.

[6] M. de Berg, O. Cheong, M. van Kreveld and M. Overmars, Computational Geometry: Algorithms and Applications, 3rd ed., Springer, 2008.

[7] Selected contemporary scientific papers in the fields of algorithmic methods, computational geometry, intelligent planning, and geometric optimization, according to the student's research profile.

Grading

	Criterion	Points	Cut-off points
1.	Assignments	20	11
2.	Project	40	22
3	Final exam	40	22
	T o t a l	100	55