# Geospatial algorithms P

**Purpose of education**

**a) knowledge**

- Comprehensive knowledge of the principles, methods and procedures for the design, development and operation of geoinformatics, in particular in the following areas: operating systems and database management, design and development of web-based geoinformatics tools and services, geoinformatics-related programming principles, geospatial application development.
-Knowledge of the specific tools of the field of cartography and geoinformatics, the mathematical and cartographic principles of editing maps for different purposes, the ability to apply survey procedures, representational solutions and various reproduction technologies.
- Ability to create maps and geoinformatics systems that can be used by economic sectors or clients in the desired field.

**b) abilities**

- Ability to interpret and formalise complex professional problems in the field of cartography and geoinformatics, to identify the necessary theoretical and practical background and to solve the problem. Ability to provide consultancy, problem-solving, design, development, operation and management of cartographic and geoinformatics systems, decision support systems and expert systems.
- Ability to interpret, plan, organise, manage and control processes in the field of cartography and geoinformatics.
- Ability to learn and apply new problem-solving methods and procedures in the field.

**c) attitude**

- It monitors professional and technological developments in the field of cartography and geoinformatics and the opportunities that will enable it to work in the public sector, in various companies or to set up and run its own business.
- Shares his/her own knowledge and values the dissemination of professional results in cartography and geoinformatics.
- It is committed to meeting and enforcing quality standards (accuracy, commitment).

**d) autonomy and responsibility**

- Able to work independently in IT, carrying out tasks, thinking through and developing technical issues in a self-directed manner and at a pace.
- Responsible for meeting and enforcing deadlines. Assumes responsibility for his/her own work and that of his/her colleagues working under his/her direction and with him/her (in a project).
- In the case of mission-critical mapping and geoinformatics systems, may be given development and operational responsibility appropriate with his/her professional competences.

**Content of education:**

The practical part of the course introduces students to fundamental algorithms and data structures in computer science, which are also widely used in geoinformatics. The second half of the course focuses on the geospatial field and takes an outlook on well-known geospatial algorithms and data structures.

- Introduction to Python. Literals and variables, data types, User input management. Control structures (sequences, conditional executions, iterations). Exception handling (try & except).
- Functions: built-in functions, function definition, arguments & parameters, return value.
- Collection data structures in Python: lists, dictionaries, tuples, sets.
- Basic algorithms: summation, counting, maximum selection, conditional variants, linear search, logarithmic search.
- Sorting: bubble sort, insertion sort, maximum sort, quicksort, merge sort, complexity analysis.
- Tabular data processing (CSV, Excel files), pandas library. Plotting and diagram visualization of scalar data (matplotlib library).
- Spatial data management: vector formats (geopandas library), raster formats (rasterio library)
- Graph representation (adjacency matrix, edge list). Graph traversal (BFS, DFS).
- Minimum cost path graph algorithms (Dijkstra, Bellman-Ford). Priority queue, heap data structure.
- Minimum spanning trees (Red-Blue rules, Prim algorithm, Kruskal algorithm)
- Scalar indexing: binary tree, search tree, AVL-tree, B (2-3) tree

- Spatial indexing: grid index, kd-tree, adaptive kd-tree, quadtree, R-tree
- Topological algorithms: Crossing Number, Shamos-Hoey, Bentley-Ottman, Greiner-Hormann.
- Topological data structures: winged-edge, half-edge.
- Convex hull algorithms: Jarvis's march, Graham's scan, Quickhull, Chan's algorithm
- Clustering and classification: K-means, ISODATAA

**Evaluation system:** practical course mark.

**Literature:**
**Obligatory:**

- Fekete István–Hunyadvári L. (szerk.): Algoritmusok és adatszerkezetek, ELTE, 2015, ISBN: 9789632484565, http://tamop412.elte.hu/tananyagok/algoritmusok/index.html
- T. H. Cormen, C. E. Leiserson, R. L. Rivest, C. Stein: Új algoritmusok, Scolar kiadó, 2008, ISBN: 9789639193901

**Recommended:**

- Elek István: Adatbázisok, térképek, információs rendszerek, ELTE, 2010, https://mcserep.web.elte.hu/data/reference/elek_adatmodellek_2010.pdf
- P. Rigaux, M. O. Scholl, A. Voisard: Spatial Databases: With Application to GIS, Morgan Kaufmannn, 2001, ISBN: 9781558605886
- H. Samet: The Design and Analysis of Spatial Data Structures, Addison-Wesley, 1994, ISBN: 9780201502558