Università degli Studi di L'Aquila - Dipartimento di Ingegneria e Scienze dell'Informazione e Matematica

Course catalogue

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Programme of Integrated course "Network design"

This course is composed of 2 Modules: 1) Network Flows, 2) Network Optimization

Programme of Module "Network Flows"

- Code: DT0059
- Type of course unit:
- Level of course unit:
- Semester: 2

Number of ects credits: (Master Degree in Computer Science) 6 (workload 150 hours)

Teachers: Fabrizio Rossi (fabrizio.rossi@univaq.it)

1	**Course objectives**	Ability to recognize and formulate network flow problems Knowledge of basic and advanced network flow algorithms Ability to design resolution approaches to solve non standard network flow problems
2	**Course content and learning outcomes (dublin descriptors)**	Topics of the module include: • Network Flows Problem: introduction and definitions • Maximum Flows and the path packing problem. Flows and cuts: Max-Flow/Min-Cut theorem. Augmenting path algorithms: Ford and Fulkerson algorithm, Edmonds and Karp algorithm. Generic Preflow-Push algorithm. Flows with lower bounds. • Maximum Flows: additional topics and applications. Flows in Unit Capacity Networks. Flows in Bipartite Networks. Network Connectivity. • Minimum Cuts. Global Minimum Cuts. Node Identification Algorithm. Random Contraction. Applications. • Minimum-Cost Flow Problems. Definition and applications. Optimality Conditions. The Ford-Bellman algorithm for the shortest path problem. Primal algorithms: Augmenting Circuit Algorithm for the Min Cost Flow Problem. • Network Simplex Algorithms. Applications of Min Cost Flows. On successful completion of this module, the student should : • Know and formulate network flow problems • Model decision problems as network flow problems Use base and advanced algorithms to solve network flow problems • Ability to identify network flow models scope • Ability to explain network flows models and algorithms • Ability to learn state-of-art algorithms for network flow problems
3	**Course prerequisites**	Basic knowledge of: Discrete Mathematics, Linear Programming, Algorithms and Data Structures, Computational complexity
4	**Teaching methodsand language**	Lectures **Language**: English **Reference textbooks** • Cunningham, Pulleyblank, Schrijver , ***Combinatorial Optimization***. • Ahuja, Magnanti, Orlin, ***Network Flows***.
5	**Assessment methods**	Written text exam

Programme of Module "Network Optimization"

- Code: DT0060
- Type of course unit: Compulsory (Master Degree in Computer Science curriculum SEAS)
- Level of course unit: Postgraduate Degrees
- Semester: 2

Number of ects credits: (Master Degree in Computer Science) 6 (workload 150 hours)

Teachers: Fabrizio Rossi (fabrizio.rossi@univaq.it)

1	**Course objectives**	Ability to recognize and model network optimization problems as Integer Linear

		Programming problems. Knowledge of fundamental algorithmic techniques for solving large scale Integer Linear Programming problems. Knowledge of commercial and open source Integer Linear Programming solvers.
2	**Course content and learning outcomes (dublin descriptors)**	Topics of the module include: • Formulations of Integer and Binary Programs: The Assignment Problem; The Stable Set Problem; Set Covering, Packing and Partitioning; Minimum Spanning Tree; Traveling Salesperson Problem (TSP); Formulations of logical conditions. • Mixed Integer Formulations: Modeling Fixed Costs; Uncapacitated Facility Location; Uncapacitated Lot Sizing; Discrete Alternatives; Disjunctive Formulations. • Optimality, Relaxation and Bounds. Geometry of R^n: Linear and affine spaces; Polyhedra: dimension, representations, valid inequalities, faces, vertices and facets; Alternative (extended) formulations; Good and Ideal formulations. • LP based branch-and-bound algorithm: Preprocessing, Branching strategies, Node and variable selection strategies, Primal heuristics. • Cutting Planes algorithms. Valid inequalities. Automatic Reformulation: Gomory's Fractional Cutting Plane Algorithm. Strong valid inequalities: Cover inequalities, lifted cover inequalities; Clique inequalities; Subtour inequalities. Branch-and-cut algorithm. • Software tools for Mixed Integer Programming • Lagrangian Duality: Lagrangian relaxation; Lagrangian heuristics. • Network Problems: formulations and algorithms. Constrained Spanning Tree Problems; Constrained Shortest Path Problem; Multicommodity Flows; Symmetric and Asymmetric Traveling Salesman Problem; Vehicle Routing Problem Steiner Tree Problem; Network Design. Local Search Tabu search and Simulated Annealing MIP based heuristics • Heuristics for network problems: local search, tabu search, simulated annealing, MIP based heuristics. On successful completion of this module, the student should : • Know and define single objective network optimization problems • Use and design exact or heuristic algorithms to solve single objective network optimization problems • Ability to judge models and methods to tackle network optimization problems • Ability to explain the models, the algorithms and the computational complexity needed to solve network optimization problems • Ability to learn state-of-art algorithms for network optimization problems
3	**Course prerequisites**	Basic knowledge of: Discrete Mathematics, Linear Programming, Algorithms and Data Structures, Computational complexity. Knowledge of at least one programming language.
4	**Teaching methodsand language**	Lectures and software training **Language**: English **Reference textbooks** • L.A. Wolsey, ***Integer Programming***. Wiley. 1998.
5	**Assessment methods**	Written text exam and assignment