**FINAL EXAM TOPICS**

**JUNE 2024 and JANUARY 2025**

**COMPUTER SCIENCE MSC**

**COMPULSORY SUBJECT**

***Automata and formal languages***

1. The unicity and the algorithmic construction of the minimal automaton.
2. Parikh's theorem and its consequences.

***Application of Linear Programming***

1. Duality, dual simplex algorithm. Integer programming.
2. Assignment and transportation problem.

***Advanced Programming***

1. Generic programming, templates, expression templates, metaprogramming.
2. Standard Template Library implementation and usage: data streams, manipulators, generic
3. algorithms, predicates, function objects, generic containers and iterators.

***Advanced Image Processing***

1. Morphological operations on multiscale images; Skeletonization: distance transform, thinning, Voronoi-skeleton.

***On-line Algorithms***

1. Definition of competitive ratio and asymptotic competitive ratio. Ski rental problem, and algorithms for its solution. The paging problem, FIFO and the marking algorithms. Scheduling, list algorithm for scheduling.
2. The definition of the bin packing problem, algorithms NF, FF, BF. Proof: NF is 2-competitive. No online algorithm exists for bin packing with smaller asymptotic competitive ratio than 4/3. Multidimensional generalizations of bin packing. NFSr strip packing algorithm.
3. The online k-server problem and the double coverage algorithm. The potential method.

***Machine Learning***

1. The basic notions of machine learning: feature extraction, the curse of dimensionality, no free lunch theorem, Occams razor, generalization and overfitting, measuring the training error.
2. Bayes decision theory and the relates concepts. The maximum likelihood parameter estimation method for Gaussian curves and for Gaussian Mixture Models.
3. Supervised learning methods (non-parametric learning, neural nets, support vector machines, decision trees). )

***Advanced Approximate and Symbolic Computations***

1. Orthogonal transformations and their usage in numerical linear algebra (orthogonal-triangular decompositions, QR-algorithm).
2. Interpolation and approximation of continuous functions (spline and trigonometric interpolation, least-squares and uniform approximation).

***Program Systems Development***

1. Distributed system, issues, architectures.
2. Data persistence solutions (ORM, NoSQL, …)