

MATHEMATICAL PROGRAMMING

Course of the PhD Program in Mathematics

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- Professor: R. Rizzi (Univ. di Verona)
- Title: Mathematical Programming
- Outline: The first aim of the course is to offer a motivated introduction to Linear Programming (LP) also exploring some of the links with other fields like Combinatorial Optimization (CO). Our approach will be algorithmic. Basic and fundamental techniques and methodologies for mathematical investigation will be underlined and rediscovered also taking inspiration from Computational Complexity theory. We also intend to present a few combinatorial games of pertinence in the design, synthesis and formal verification of systems and in the quantitative validation of workflows.
- Program:
 - Good characterizations, recursion, and Dynamic Programming (DP).
 - 1 tiling problems and puzzles: YES and NO certificates and their role
 - 2 good conjectures and how to prove them
 - 3 from recursion/induction to dynamic programming.
 - Introduction to graphs and Combinatorial Optimization (CO)
 - 1 graphs and digraphs as models
 - 2 a few good characterizations (connectivity, Eulerian graphs, bipartite graphs, DAGs)
 - 3 Bellman-Ford's algorithm. Simple Temporal Networks (STNs) and scheduling.
 - Introduction to Linear Programming (LP)
 - 1 what is an LP problem
 - 2 modeling your problem as a linear program
 - 3 the simplex method
 - 4 duality theory
 - 5 complementary slackness
 - 6 economic interpretation.
 - Combinatorial games on graphs
 - 1 from scheduling to dynamic controllability
 - 2 parity games
 - 3 mean-payoff games
- Period: January 25 - February 6, 2021. More details at the home page for the course.
- Venue: the meetings of the course will take place in telematic. They will go out in streaming and also get recorded to remain available. A Telegram group will help not only keeping in contact but it will also offer an effective channel for communicating among us. <https://cms.di.unipi.it/phd>

- Assessment Method: besides participating to the meetings, you are required to approach the homework exercises and solve them writing running code (just a few lines, in C/c++, or Pascal, or Python, or essentially any language you might prefer. Otherwise, if this could be more interesting to you, you can make up problems on the same competences in our new TAlight framework. The programming will not be your problem even if you are new to it. If so, it will be a good occasion to get it). You will have the opportunity to submit these small codes to our system which will test and assess your solutions and provide you with immediate validation and feedback. You'll need to solve problems employing recursion, dynamic programming, hints and/or proofs discussed during the class. Exercises can be done in group (which is actually encouraged so that this first course will also serve as an occasion for you to get to know each other). As such, it is good if you submit your solutions already during the course so that we have occasions to discuss them or offer hints or to do some troubleshooting, settle ambiguities, or provide the missing pieces. However, we will also allow for a longer submission window after our meetings have come to their end. In this way, everyone will follow his pace and take his best time to go through the exercises.