# Combinatorial Algorithms (104291)
# Programming Assignment: Backtracking and Heuristics

---

Instructions. This is a group assignment. Read and follow the instructions for the programming assignments on Moodle. It should be possible to easily run your code with different values of the parameters, which are provided as input during the run (not hard-coded in your program). Start on all exercises early enough, so that there is time for questions. Some students may be less versed on algorithmic aspects, while others may need a deeper understanding of the material covered in class before applying them in a different context. Use our classes on Mondays, Thursdays, and Fridays for these purposes! You are expected to understand and uphold high standards of academic integrity. Copying and/or trying to pass someone else work as your will not be tolerated.

## Q1 [50 points] Knapsack: Bounding Functions and Branch and Bound

Implement in `Python` the algorithm that makes use of the fractional knapsack as a bounding function to further prune the decision tree of the 01-knapsack. Moreover, using the same bounding function, implement the branch and bound strategy for the 01-knapsack. Provide test cases to ensure the correctness of your programs. Report on the comparison of the running times of the backtracking, the bounding, and the branch and bound implementations.

## Q2 [50 points] TSP: Branch and Bound and Approximation

Implement in `Python` the branch and bound and the approximation algorithms for the traveling salesman problem. Provide test cases to ensure the correctness of your programs. Report on the comparison of the running times of the backtracking with bounding, the branch and bound, and the approximation implementations.