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DM204 – Scheduling, Timetabling, Routing

Study Plan for the Oral Exam, Fall 2013

This is a list of questions that can be posed at the oral exam.

The exam will last up to a maximum of 40 minutes, grading included. The first part of the exam will focused on one of the first two questions from the list. Other questions will be picked up at random from a subset of 5 questions decided by the examinee. The list of 5 questions must be communicated to the lecturer before exam.

It is allowed to bring hand written notes but not course material (slides, textbook, articles). The notes will lay on the table and can be consulted if needed. At each question there are 2-3 minutes to prepare the answer. Refinement questions on the topics presented should be expected.

1. **Public Transports, Vehicle Scheduling**: models, relaxations, solution algorithms (Lagrangian relaxation), practical experience, results, reflections.
2. **Public Transports, Crew Scheduling**: models, solution algorithms (column generation), resource constrained shortest path, practical experience, reflections.
3. **Scheduling problems, Single Machine**. Put in the context of scheduling problem classification and discuss:
   - Three alternative models for formulating single machine problems by Mathematical Programming. Advantages and disadvantages of the models. The question implies a definition of scheduling problems.
4. **Single machine scheduling problem**. Define and discuss the two cases below:
   - Describe the dynamic programming algorithm for the case $1|prec|h_{max}$.
   - Describe the branch and bound algorithm for the case $1|r_i|L_{max}$.
     $1||\sum_j w_j T_j$.
5. **Flow shop scheduling problem**. Define it and describe the digraph representation and the procedure for obtaining the makespan from a permutation of jobs when changes at machines are not allowed. Moreover describe:
   - Johnson's rule for the case $F2||C_{max}$.
   - How the insert neighrobhoor can be reduced in the local search
6. **Job shop scheduling problem**. Define it and describe the disjunctive graph model and
   - Describe the Shifting Bottleneck heuristic for $Jm||C_{max}$ (Adams, Balas and Zawack 1988).
7. **Reservation Systems** Which model of scheduling problem can be used to formalize reservation problems? Which cases are NP-hard? Can MIP be used to solve NP-hard cases?
8. **Timetabling and graph models** University Course timetabling. Problem definition, IP approaches with 3 and 2 indices, Heuristic approaches (solution representation, strategies).
9. **Workforce scheduling**. Discuss set partitioning/covering models and solution approaches to these models.
10. **Capacitated Vehicle routing problem**. Define it and discuss different mathematical programming models by stating variables and constraints.

11. **Branch and Price for VRPTW**. Describe the mathematical model, the decomposition, the master and the subproblems and sketch the branch and price procedure

12. **Heuristics for VRP**. Treat one of the following:

    - Give a general classification of construction heuristics for CVRP, describe two at choice and mention how they can be adapted to the VRPTW (in particular, how time windows constraints can be checked efficiently).
    - Discuss local search procedures for CVRP and VRPTW and mention how constraints such as capacity and time windows can be treated in constant time.