Article 11

H. Hu and R. Sotirov, Special cases of the quadratic shortest path problem, preprint, 2016.

- The quadratic shortest path problem (QSPP) is a variant of the shortest path problem, in which there is a cost C_{ij} for using both arcs i and j in a path.
- In general, the problem is NP-hard. One of the only known easy cases is when the graph is acyclic, and $C_{ij} = 0$ for all pairs (i, j) of non-adjacent edges.
- This article studies new "easy-cases" of the QSPP: first, when the cost matrix $\{C_{ij}\}$ has a special structure, and second, for some particular grid graphs.

Article 12

A. Pessoa, L. Di Puglia Pugliese, F. Guerriero and M. Poss, Robust constrained shortest path problems under budgeted uncertainty, Networks 66(2):98-111, 2014.

- In a constrained shortest path problem, a minimum-cost path that satisfy certain requirements must be found. For example, an additional resource gets consumed over the arcs of the graph, so a path is feasible if $\sum_{a\in P} r_a \leq R$, where r_a is the amount of resource consumed on arc a, and R is the available quantity.
- This article studies a robust variant of some constrained shortest-path problems, in which the resource consumption is uncertain. The authors search a path minimizing the worst-case solution, with respect to some uncertainty set of the form

$$\{\boldsymbol{r} \in \mathbb{R}^{|A|} |\ \exists \boldsymbol{\epsilon} \in [0,1]^{|A|} : \quad r_a = \bar{r}_a + \hat{r}_a \epsilon_a, \quad \sum_a \epsilon_a \leq \Gamma\}, \tag{1}$$

  where $\bar{r}_a$ is the *nominal value* of the resource consumption on a, and $\hat{r}_a$ is its maximal allowed deviation. Roughly speaking, Γ indicates the number of arcs where r_a can simultaneously take the worst value.
- The authors propose algorithms based on dynamic programming to solve this problem, the runtime is pseudo-polynomial when Γ is fixed.

Article 13

M. Bougeret, A. Pessoa and M. Poss, Robust scheduling with budgeted uncertainty, preprint, 2016.

- The authors study robust variants of scheduling problem on parallel machines, where the vector of processing times lies in an uncertainty set of a form similar to (1).
- It is known that the problem of minimizing a weighted sum of the completion times on a single machine can be solved efficiently, by using Smith's rule (sort the jobs according to their duration to weight ratio). However, the robust variant of the problem is shown to be NP-hard.
- Approximation algorithms and FPTAS are studied for the case of minimizing the robust makespan (latest completion time) on m parallel machines.

Article 14

A. Agra, M. Santos, D. Nace and M. Poss, A dynamic programming approach for a class of robust optimization problems, SIAM Journal on Optimization, 26(3):1799-1823, 2016.

- This article deals with robust optimization problems, in which the uncertain data r lies in a *budgeted uncertainty set* R of the form (1). More precisely, the problem is

$$\begin{aligned} \min_{x\in X} \quad & c^T x \\ s.t. \quad & f(x; r) \leq d^T x \quad (\forall r \in R), \end{aligned} \tag{2}$$

where f has a special structure and depends on the uncertain data r. This problem has applications in lot-sizing, scheduling, inventory routing,...

- One technique to solve these problems is to use a decomposition approach, in which scenarios are successively added to a *restricted master problem* by solving an *adversarial problem*, i.e., the problem of finding the worst-case scenario $r \in R$ for a candidate solution $x \in X$. The article propose a new approach based on dynamic programming to solve the adversarial problem.
- If the deterministic version of Problem (2) is convex (i.e., when R is a singleton), then this method yields a FPTAS for the robust problem (2).

Article 15

A. Ardestani-Jaafari and E. Delage, Linearized Robust Counterparts of Two-stage Robust Optimization Problems with Applications in Operations Management, preprint, 2016.

Warning: IMHO this is a very nice article, but the student will probably need to read a lot of other articles to understand it.

- In two-stage robust optimization problems, the decision variables are split in two categories. The first-stage variables must be decided at time $t = 0$, before the uncertainty is revealed, while the second-stage variables can be adapted after the realization of the uncertainty has been observed. A popular, tractable relaxation to these hard problems is to assume that the second-stage variables are linear functions of the uncertainty. Then, the problem is to decide, at $t = 0$, both the first-stage variables and the coefficients of the linear functions that define the 2d stage variables.
- This article proposes an alternative linearization scheme, which does not require to assume that the recourse function is linear. Then, it is shown that the new linearization is a natural extension of the former state-of-the-art strategy, and that it can be further refined by using semidefinite-programming inequalities.
- Finally, examples are presented for robust versions of a multi-item newsvendor problem, a location-transportation problem, a product-assembly problem, and a surgery-block allocation problem.

Article 16

I. Ashlagi, P. Jaillet, V. Manshadi and M. Rees, Kidney Exchange in Dynamic Sparse Heterogenous Pools, preprint, 2014.

- Many patients need a kidney exchange. Sometimes a patient has a donor who is ready to give a kidney (e.g. in his/her family), but the donor might be not compatible. Therefore, nowadays medical doctors also search pairs of couples donor-receiver, which are mutually compatible (D_1 gives a kidney to R_2, while D_2 gives a kidney to R_1). The approach can be extended to cycles of length $k \geq 2$, but in practice it is rarely done for $k > 3$ for organizational reasons.
- The static version of this problem hence tries to maximize the number of covered nodes in a directed graph, where the graph must be covered by non-overlapping cycles (of length bounded by k).
- But in practice, the problem is dynamic, new couples of donor/receiver arrive over time, and request for an exchange. This article studies the opportunity to wait a little bit before assigning a couple to an exchange, and then to select the cycles that cover the largest number of patients.
- When only $2-$cycles are allowed, it is shown that waiting does not increase much the number of patient who can get a kidney. However, waiting for a short period before doing the matchings can increase the number of matches considerably if $3-$cycles are allowed.

Article 17

C. Buchheim and J. Kurtz, Minmaxmin robust combinatorial optimization subject to discrete uncertainty. epub ahead of print, Mathematical Programming, 2016.

- In two-stage robust optimization problems, the decision variables are split in two categories. The first-stage variables must be decided at time $t = 0$, before the uncertainty is revealed, while the second-stage variables can be adapted after the realization of the uncertainty has been observed.
- This article proposes to use $k-$adaptability, when there is no first-stage variable: this means that a set of k (2d stage) solutions must be computed *before the uncertainty is revealed*. Then, it is assumed that the decider can choose the best of the k pre-computed solutions after the uncertainty is observed.
- A typical application is for parcel delivery. For organizational reasons and stability, it might be good for the company to use only a small fixed number of delivery tours. Each day, after the customers to be served are revealed, the company can choose which tour to execute.
- The problem reduces to solving m min-max problem when the uncertainty set consists of $m \leq k$ scenarios. Otherwise, it is NP-hard, even in some cases where each min-max problem can be solved in polynomial time (shortest path, matchings), but in this case a pseudo-polynomial algorithm is proposed.

Article 18

L. Castelli, M. Labbé and A. Violin, Network Pricing Problem with Unit Toll, Networks, 69(1):83-93, 2016.

- The authors study a network pricing problem. This problem consists in setting the toll prices of a transportation network, in order to maximize the revenue from the authority owning the network. In general, this can be formulated as a NP-hard bilevel optimization problem, because network users react to prices and might use a set of alternative arcs if the tolls are too high.
- In this article, two cases are studied: first, unit-toll arcs, and second, a toll proportional to the length of each arc. It is shown that these two cases can be solved in polynomial time and pseudo-polynomial time, respectively.
- Robust versions of the unit-toll arc problem are also studied, and can be solved in polynomial time, too.

Article 19

D. Bertsimas and A. Thiele, A Robust Optimization Approach to Inventory Theory, Operations Research, 54(1), 150-168, 2006.

- This article studies the inventory management problem for a supply chain, in which items must be ordered, in order to face an uncertain demand.
- Traditionally, this problem can be solved by dynamic programming, but this approach suffers from "the curse of dimensionality". Instead, here a robust optimization approach is used (with an uncertainty set of a form similar to (1) for the demands).
- It is shown that this problem can be solved even for complex supply chain networks, and that in a number of situations, the optimal solution are "base-stock policies" (i.e., items must be ordered as soon as the stock reaches a certain threshold).

Article 20

S. Agrawal, Y. Ding, A. Saberi and Y. Ye, Price of Correlations in Stochastic Optimization, Operations Research, 60(1), 150-162, 2012.

- In Stochastic Optimization, there is a trend to ignore correlations between uncertain events, because these correlations can be hard to quantify, and because they yield to more difficult problems. This article studies the impact of ignoring these correlations, by means of the "distributionally robust framework". This assumes that the distribution of the uncertain parameters is not known, but lies in a collection of possible distributions.
- The authors characterize a class of objective functions for which the "price of correlation" (POC) is bounded from above by a constant, in particular for uncapacited facility location and Steiner tree problems. On the other hand, they show examples where the POC can be large, in particular for supermodular functions.
- It is also shown that the distributionally robust model to handle correlations can be reformulated to a convex optimization problem when the objective function is convex with respect to the decision variable, and supermodular with respect to the uncertainty.