Graz University of Technology
Institute of Discrete Mathematics

Workshop “Discrete Mathematics”

Monday 20.08.2018

Seminarraum AE06

9:55 – 10:00	Opening
10:00 – 10:30	Raoul Müller **Combinatorial Optimization with Objectives aggregated by a norm**
10:35 – 11:05	Alisa Govzmann **Parameterized algorithms for bin packing and scheduling**
11:10 – 11:40	Julian Zalla **Kubilius’ theorem for algebraic number fields**
11:45 – 12:15	Beate Cemper **Flows on Networks and Graphs** **Basic Considerations on the Algorithm of Ford and Fulkerson and Tuttes 5-Flow-Conjecture**

Combinatorial Optimization with Objectives aggregated by a norm

Raoul Müller
(Technische Universität Dortmund)

10:00 – 10:30

We will look at the computational complexity of multidimensional combinatorial optimization problems. Given a combinatorial optimization problem from the class $\mathcal{P}$, the question is whether a more general formulation of the same problem becomes $\mathcal{NP}$-hard.

More general means that we have multiple linear objectives that we want to optimize simultaneously by aggregating them with a p-norm. The goal is to either minimize or maximize this norm.

We will look at the complexity for different numbers of objectives, different norms and different combinatorial optimization problems. We will see that even for one linear objective many problems turn out to be $\mathcal{NP}$-hard.

Parameterized algorithms for bin packing and scheduling

Alisa Govzmann
(Universität Bonn)

10:35 – 11:05

The main ideas from the paper "Polynomiality for Bin Packing with a Constant Number of Item Types" are outlined. In this paper the open question, whether for a constant number of different item sizes $d \geq 3$ bin packing can be solved in polynomial time, is answered affirmatively. Motivated by the introductory discussion a special class of scheduling instances is considered. A discussion of a kernelization algorithm follows. This algorithm allows to isolate one parameter, Δ, which denotes the biggest job size of a given instance, such that the reduced instance can be described by this parameter only. A result is presented, which shows that there is a kernel of size at most Δ^2, which is the minimal possible size with respect to the used technique. In the previously published work the size of the kernel was estimated to be bounded by $2^{O(\Delta \cdot \log(\Delta))}$.

Kubilius' theorem for algebraic number fields

Julian Zalla
(Universität Würzburg)

11:10 – 11:40

In my talk I want to illustrate the development of Probabilistic Number Theory with the focus to understand the classical theorem of Kubilius. I proved a number field generalization of this statement and elements of the proof of this new result will be shown.

Flows on Networks and Graphs

Basic Considerations on the Algorithm of Ford and Fulkerson and Tuttes 5-Flow-Conjecture

Beate Cemper
(Paris Lodron Universität Salzburg)

11:45 – 12:15

In order to describe the algorithm of Ford and Fulkerson, the terms *network* and *flows in networks* will be briefly outlined. Having shown how *minimal cuts* and *maximum flows* relate to each other, it will be demonstrated, based on the proof of the max-flow-min-cut theorem, how to get to a maximum flow constructively.

Subsequently *group-valued flows on graphs* will be introduced to generalize the flow theory. To understand the 5-flow conjecture it will be developed that it does not depend on the specific structure of an abelian group H but only on its quantity, whether a given graph has an H-flow or not, also that a graph has a so-called *k-flow* if and only if it has a *$\mathbb{Z}_k$-flow*. This leads to the *duality theorem* stating that the *chromatic number* of a plane graph and the *flow number* of its dual graph is equal. Thus it becomes apparent that the 5-flow conjecture is a generalization of the 5-color theorem, which no longer refers to planar graphs only.

On the one hand *flows on networks* don't seem to require a profound framework since many issues are easy imaginable and obvious to the reader. On the other hand *flows on graphs* demand a comprehensive notation system in order to deal with theoretical questions such as the search for a proof of Tutte's conjecture.