

# Results and research directions in the Mathematics and Optimization research group

Tibor Jordán

Department of Operations Research, Institute of Mathematics, Faculty of Science,  
and the MTA-ELTE Egerváry Research Group on Combinatorial Optimization

Thematic Excellence Program, on-line conference, 2020.



PROGRAM  
FINANCED FROM  
THE NRDI FUND

# Mathematics and optimization: research areas and researchers

◇ Mathematical results, models, and methods form an important component in most of the research problems of this program

◇ Complex solution is a joint effort: may involve mathematics, informatics, and possibly other areas

◇ Another major target of the group is to further develop the results and methods within mathematics

# Mathematics and optimization: research areas and researchers

- ◇ Mathematical results, models, and methods form an important component in most of the research problems of this program
- ◇ Complex solution is a joint effort: may involve mathematics, informatics, and possibly other areas
- ◇ Another major target of the group is to further develop the results and methods within mathematics

# Mathematics and optimization: research areas and researchers

- ◇ Mathematical results, models, and methods form an important component in most of the research problems of this program
- ◇ Complex solution is a joint effort: may involve mathematics, informatics, and possibly other areas
- ◇ Another major target of the group is to further develop the results and methods within mathematics

# Mathematics and optimization: research areas and researchers

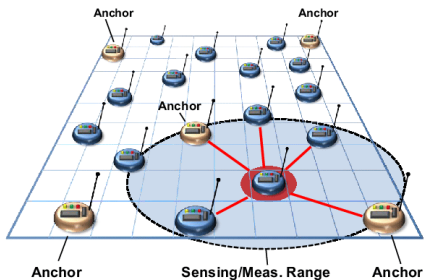
◇ The Mathematics and Optimization research group has approximately twenty members, affiliated with the Institute of Mathematics, Faculty of Science, and its associated research groups.

◇ The research areas they represent include *optimization, computer science, applied analysis, statistics, algebra, and geometry.*

# Mathematics and optimization: research areas and researchers

- ◇ The Mathematics and Optimization research group has approximately twenty members, affiliated with the Institute of Mathematics, Faculty of Science, and its associated research groups.
- ◇ The research areas they represent include *optimization, computer science, applied analysis, statistics, algebra, and geometry.*

# Localization in wireless sensor networks

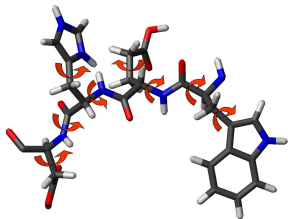


A subset of the pairwise distances and some known positions may be enough to localize all sensors.

Results: mathematical analysis of the unit disk model, classification of new families of sparse localizable networks

Future work: three-dimensional models

## Molecular graphs with a unique conformation



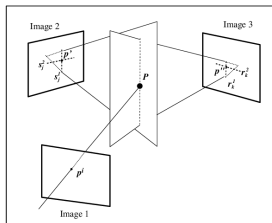
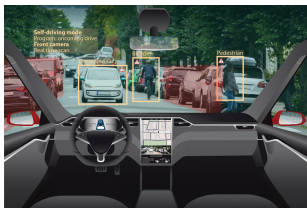
Is the shape of a molecule unique, given the fixed interatomic distances and angles?

Results: new sufficient conditions and efficient algorithms

Future work: complete structural characterization



# Multiple view geometry for autonomous vehicles

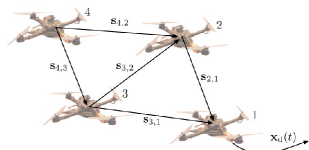


Three-dimensional image is created from several two-dimensional snapshots

Results: refined mathematical models and algorithms for obtaining 3D images from multiple camera views

Future work: enhancing the mathematical background and obtaining improved results

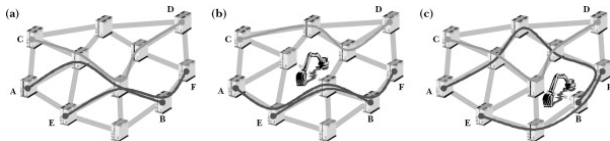
# Stability of formations of autonomous vehicles



Maintaining a subset of pairwise distances may be sufficient to guarantee the stability of the formation

Partial results and plans: new mathematical tools and methods for analysing stability, based on algebraic properties of associated matrices

# Network design: survivable routing and data flow protocols



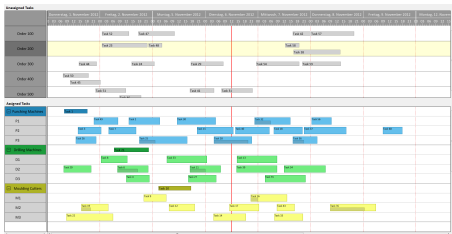
Determine routes as well as spare routes between pairs of points in order to maintain connection in case of link loss

Results: algorithms for minimum cost survivable routing for the diversity coding model

Future work: fair and verifiable data flow protocols for complex networks

# Scheduling, sequencing, and production planning

Assign tasks to machines (or workers), in specified time intervals, minimizing cost (or time, or energy, etc.)



Results: fast algorithms that give close-to-optimal solutions for resource constrained problems

Future work: solutions to other versions arising in the projects of this program as well as in other applications

# Mathematics and optimization: further topics - keywords

◇ Fair allocation algorithms

◇ Cryptography, coding theory, secret sharing protocols

◇ Deep learning in medical image processing

◇ Numerical methods in air pollution modeling and chemical mechanics

# Mathematics and optimization: further topics - keywords

◇ Fair allocation algorithms

◇ Cryptography, coding theory, secret sharing protocols

◇ Deep learning in medical image processing

◇ Numerical methods in air pollution modeling and chemical mechanics

# Mathematics and optimization: further topics - keywords

◇ Fair allocation algorithms

◇ Cryptography, coding theory, secret sharing protocols

◇ Deep learning in medical image processing

◇ Numerical methods in air pollution modeling and chemical mechanics

# Mathematics and optimization: further topics - keywords

- ◇ Fair allocation algorithms
- ◇ Cryptography, coding theory, secret sharing protocols
- ◇ Deep learning in medical image processing
- ◇ Numerical methods in air pollution modeling and chemical mechanics



# Results and excellence targets

◇ Nearly 40 research papers in the first year

◇ New collaborations: within the excellence program and international

◇ Increased international visibility

◇ Research grants,

◇ More young researchers and students in the project

## Results and excellence targets

◇ Nearly 40 research papers in the first year

◇ New collaborations: within the excellence program and international

◇ Increased international visibility

◇ Research grants,

◇ More young researchers and students in the project

## Results and excellence targets

◇ Nearly 40 research papers in the first year

◇ New collaborations: within the excellence program and international

◇ Increased international visibility

◇ Research grants,

◇ More young researchers and students in the project

## Results and excellence targets

- ◇ Nearly 40 research papers in the first year
- ◇ New collaborations: within the excellence program and international
- ◇ Increased international visibility
- ◇ Research grants,
- ◇ More young researchers and students in the project

## Results and excellence targets

- ◇ Nearly 40 research papers in the first year
- ◇ New collaborations: within the excellence program and international
- ◇ Increased international visibility
- ◇ Research grants,
- ◇ More young researchers and students in the project

Thank you

e-mail: `tibor.jordan@ttk.elte.hu`



PROGRAM  
FINANCED FROM  
THE NRDI FUND