

Alaittin Kirtisoglu

Chicago — Istanbul

akirtisoglu.me · akirtisoglu@hawk.iit.edu · [GitHub](#)

ABOUT

My work spans discrete mathematics, data science, network science, and operations research — from redistricting with supply-demand balance to equitable healthcare access modeling. I am especially interested in problems that are not only present rich theoretical challenges, but also arise from real-world needs with significant social impact.

EDUCATION

Ph.D. in Applied Mathematics, Illinois Institute of Technology, Chicago July 2026

- Dissertation: Contributions to hierarchical facility location and districting problems
- Supervisor: [Hemanshu Kaul](#)

M.Sc. in Mathematics, Hacettepe University, Turkey 2021

- Dissertation: Variations of star coloring on graphs
- Supervisor: [Lale Özkahya](#), GPA: 3.93/4.00 (1st place)

B.Sc. in Mathematics, Mustafa Kemal University, Turkey 2018

- GPA: 3.45/4.00 (1st place)
- Exchange semester at Lublin University of Technology, Poland (Feb–July 2016)

POSITIONS

Graduate Teaching Assistant - Illinois Institute of Technology 2021–2026

- *Undergraduate*: calculus, linear algebra, differential equations, complex analysis, discrete mathematics, and computational mathematics.
- *Graduate*: linear optimization, regression, statistical learning, time series, mathematical modeling, and computational algebraic geometry.

Research Intern - Fermi National Accelerator Laboratory Summer 2022

- I was a part of the [Exa.TrkX project](#), working on hierarchical graph neural networks for particle trajectory reconstruction in 3D detector data

Graduate Teaching Assistant - TED University, Turkey 2019–2021

- Undergraduate courses in calculus, linear algebra, and differential equations.

MENTORSHIP

Research advisor - Illinois Institute of Technology current

- Advising two M.Sc. students on a project modeling [Divvy](#) bicycle-share station locations in Chicago.

Mentor - Directed Reading Program 2022–present

- Advised six undergraduate mathematics students on nine-week summer research projects in optimization, machine learning, graph theory, and statistical learning, each ending with a written report and a symposium presentation.

FELLOWSHIP

- [SoReMo \(Socially Responsible Modeling\)](#) Research Fellowship 2023
Awarded for socially equitable approaches in computation and modeling, for the FalCom paper.

Peer-reviewed

1. **A. Kirtisoglu** and L. Özkahya, *Coloring of Graphs Avoiding Bicolored Paths of a Fixed Length*, **Graphs and Combinatorics**, 40 (2024), Art. 11.

We study proper vertex colorings of graphs that avoid bicolored paths of a fixed length — that is, paths whose vertices alternate between exactly two colors. We introduce the P_k -chromatic number $s_k(G)$, the minimum number of colors needed for such a coloring. For any graph with maximum degree $d \geq 2$ and $k \geq 4$, we establish that $s_k(G) = O(d^{(k-1)/(k-2)})$. We also determine exact values of s_k for products of cycles and paths when $k = 5$ and $k = 6$. The problem generalizes classical star coloring and acyclic coloring and connects chromatic theory with Ramsey-type structural questions.

Preprint

2. **A. Kirtisoglu** and H. Kaul, *FalCom: A Sampling Method for Districting and Hierarchical Facility Location*, 2026.

We introduce FalCom, the first Markov chain Monte Carlo sampling framework for hierarchical capacitated facility location and districting problems. FalCom extends the spanning-tree proposal of ReCom from single-level political redistricting to multi-level service systems with capacity bounds, demand balance, and facility-aware cut selection. We demonstrate that it scales to graphs of 50,000 basic units — an order of magnitude beyond published hierarchical facility-location methods. Rather than returning a single optimum, FalCom samples ensembles of feasible plans, enabling boundary-robustness maps, essential-vs-substitutable facility analysis, and capacity-utilization distributions that no single-solution method can produce. The framework is validated on synthetic grids and a London Ambulance Service case study and released as an open-source Python library with an interactive visualizer.

3. **A. Kirtisoglu**, *A Diffusion Model for Political Redistricting*, 2026.

ReCom variants, the dominant MCMC methods for political redistricting, are computationally efficient but geometrically blind. We propose a hybrid sampler that complements ReCom with a kernel-aware local-refinement step, based on a graph-diffusion energy formulated as an integer quadratic program. Our results show that the hybrid model admits configurable Laplacian kernels (perimeter, density, demographic) plus a fidelity term that anchors refinement near the current partition. On Iowa precincts, the integer variant reduces mean cut edges by 23.9% vs. ReCom.

4. **A. Kirtisoglu**, M. Boran, and M. Tural, *UAV Routing for Maximum Information Collection under Time Windows and Energy Consumption*, 2026.

We develop an exact convex-optimization framework for UAV reconnaissance routing under time windows, time-dependent rewards, and a nonlinear energy budget. The model jointly selects which targets to visit, the order of visits, the travel speed on each arc, and a separate loitering time at the fixed minimum-power speed, capturing fixed-wing aerodynamics correctly. The resulting mixed-integer nonlinear program is reformulated exactly as a mixed-integer second-order cone program (MISOCP) via a chain of three rotated cones, and is solved at scale by an iterated-local-search metaheuristic whose evaluation oracle is a small SOCP. Calibrated on a real-world UAV platform, the approach scales to 200-node Solomon-derived instances.

In progress

5. **A. Kirtisoglu** and H. Kaul, *Optimization-Based Decision Support for Equitable Expansion of Federally Qualified Health Centers in Chicago*, 2026.

We identify four critical gaps in the current HRSA’s granting system for Federally Qualified Health Centers (FQHCs): the absence of location-evaluation tools; an outdated Index of Medical Underservice (IMU) formula; a limited Medically Underserved Area (MUA) designation process; and unmapped referral networks between FQHCs and hospitals. We show how optimization can address each. Integrating a flow-based model into the FalCom sampler, we design catchment areas and hospital-anchored health zones that satisfy HRSA’s compliance requirements while balancing demand and capacity, and improving real-time transportation accessibility. We also propose an updated IMU formula, and outline a follow-up effort to map Chicago’s physician referral network. To the best of our knowledge, this is the first paper bringing solutions from operations research to the location decisions of FQHCs.

EXTERNAL SERVICE

- European Symposium on Algorithms (ESA) - Sub-reviewer

TALKS

1. **Middle East Technical University, Industrial Engineering Departmental Seminars** May 2026
 - “FalCom: A Sampling Method for Districting and Hierarchical Facility Location.”
2. **International Symposium on Combinatorial Optimization (ISCO)** May 2026
 - “*FalCom: A Sampling Method for Districting and Hierarchical Facility Location.*”
3. **Illinois Institute of Technology, Discrete Math Seminars** Apr 2026
 - “UAV Routing for Maximum Information Collection under Time Windows”
4. **European Combinatorial Conference (online)** Aug 2021
 - “*Coloring of Graphs Avoiding Bicolored Paths of a Fixed Length.*”
5. **SIAM Conference on Discrete Mathematics (online)** July 2021
 - “*Coloring of Graphs Avoiding Bicolored Paths of a Fixed Length.*”
6. **British Combinatorial Conference (online)** June 2021
 - “*Coloring of Graphs Avoiding Bicolored Paths of a Fixed Length.*”

SOFTWARE AND DECISION TOOLS

- [FalCom dashboard](#) - Interactive visualization tool for ensemble analysis and policy comparison for hierarchical capacitated districting and facility location.
- [London Ambulance Service map](#) - Interactive visualization of the hierarchical districting of the London area and supply-demand balance for the LAS application of FalCom.
- [Chicago Healthcare Network dashboard](#) - Decision-support tool for equitable Federally Qualified Health Center expansion in Chicago with optimization, transit-time-aware accessibility, and scenario comparisons.
- [FalcomChain](#), [FalcomPlot](#), [FalcomTravel](#) - FalCom family of open-source Python libraries for running a Falcom chain, plotting spatial inputs and outputs of Falcom chains, and travel-time-matrix computations.

TECHNICAL SKILLS

Programming

- Python, R, Javascript, MATLAB, HTML

Optimization & modeling

- Gurobi, CPLEX, metaheuristics, flow and stochastic models, integer programming, Markov Chain Monte Carlo

Libraries for geospatial & scientific computing

- NetworkX, NumPy/SciPy, Pandas, Matplotlib, GeoPandas, OSMnx, Folium, ArcGIS, GerryChain

Machine learning

- PyTorch, TensorFlow, scikit-learn, graph neural networks, reinforcement learning, regression analysis

Spoken languages

- English, Turkish (native)