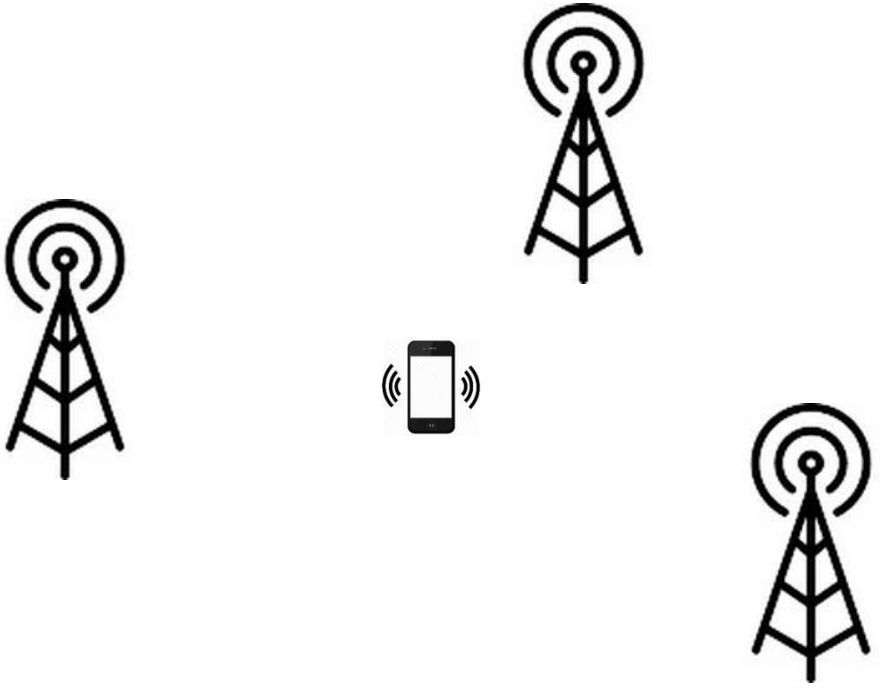
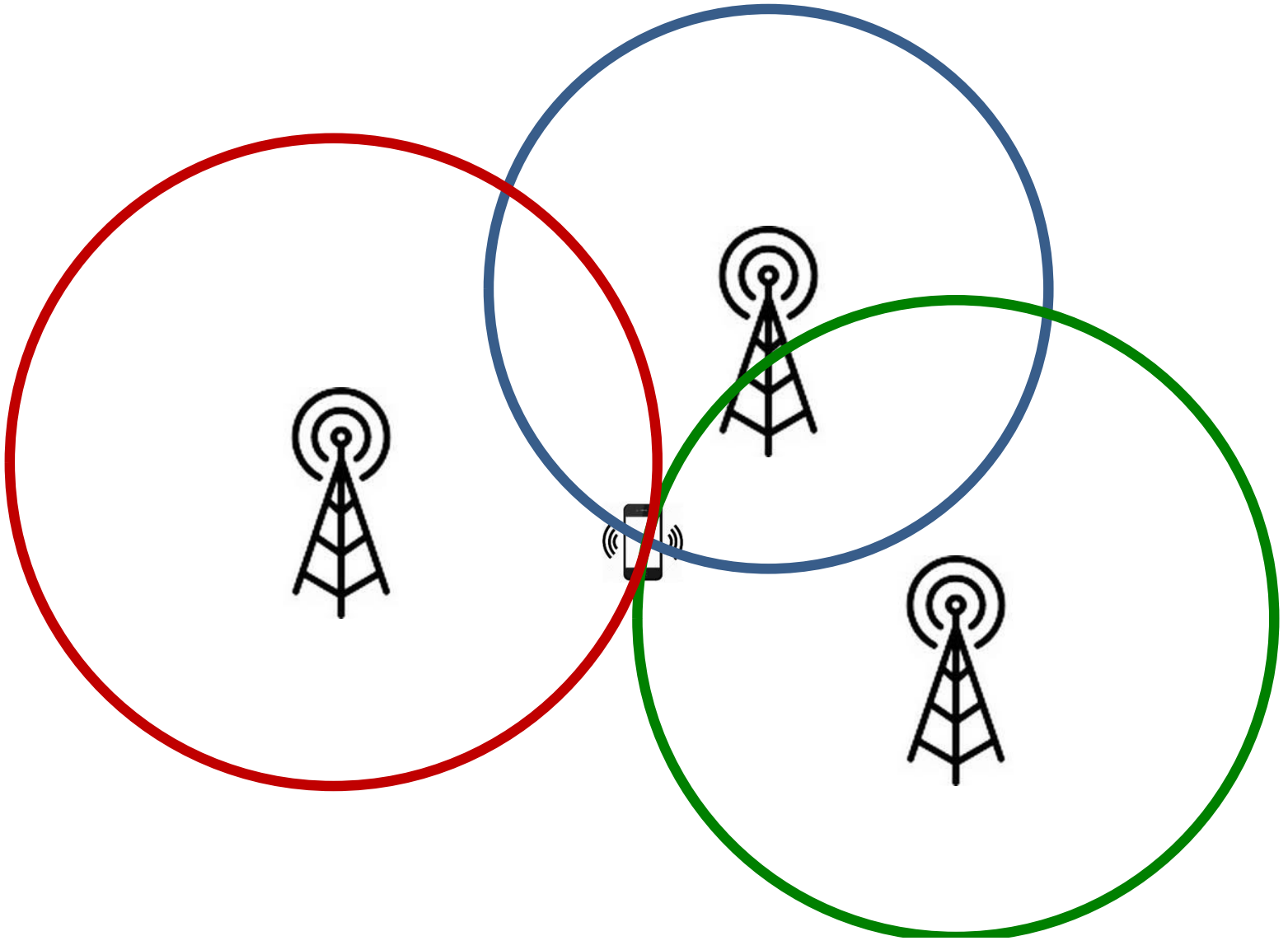
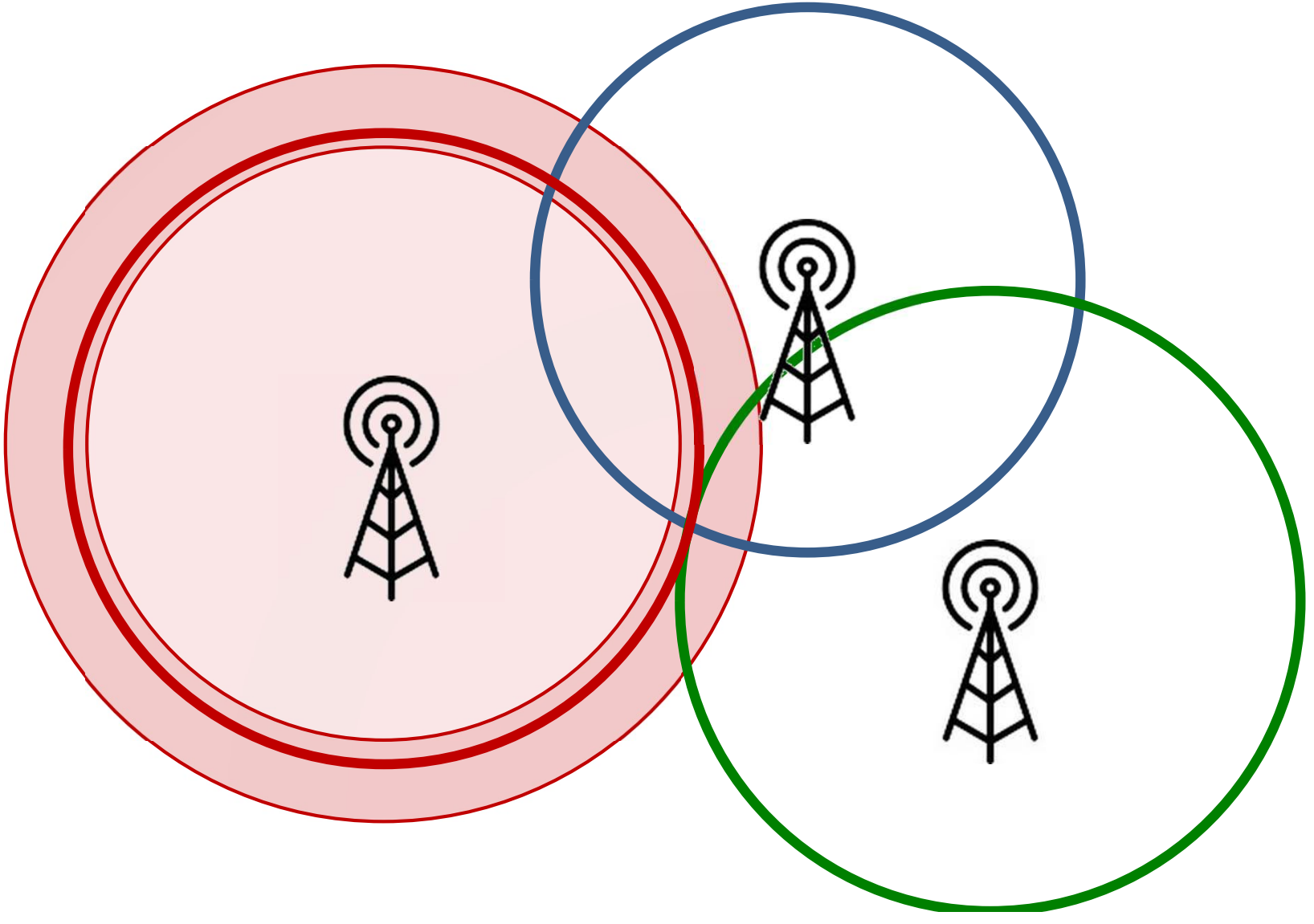
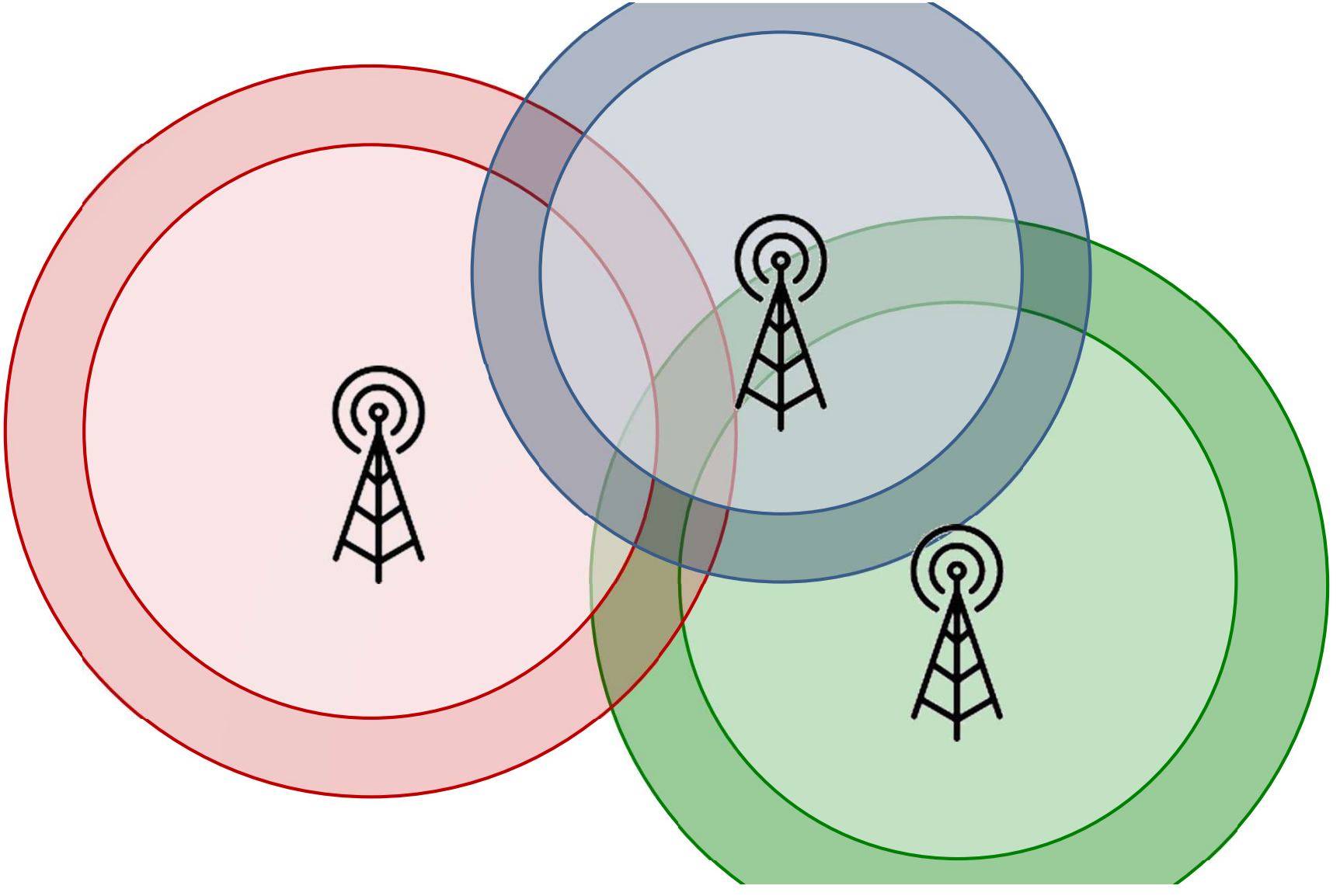
Optimization 1

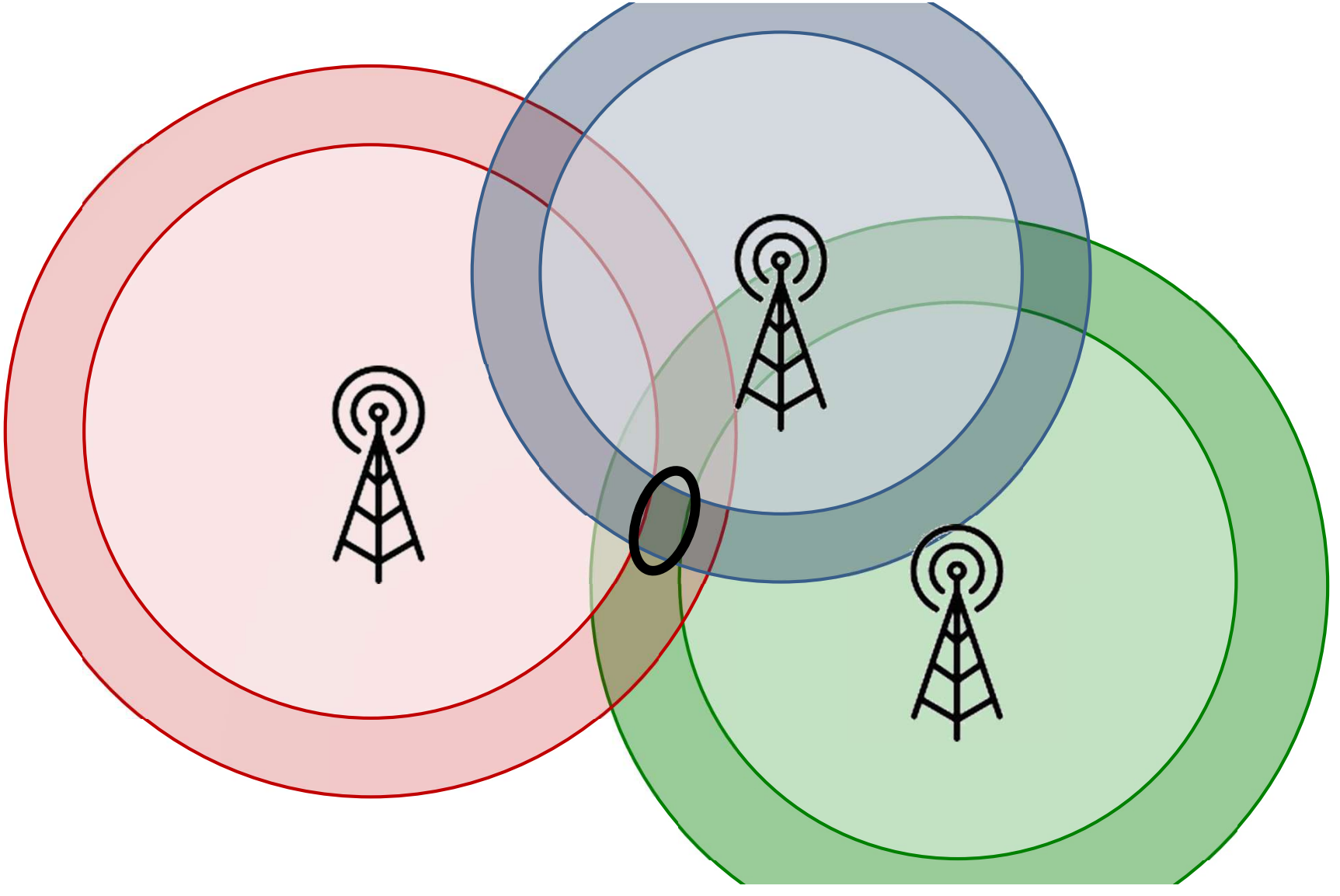
Winter 2020/2021











What is this course about?

- Gaining tools in order to solve non-linear problems:
  - Characterization of solutions
  - Duality
  - Iterative methods
- Understanding what optimization problems are easy/hard
- Hands on experience - coding
- Writing proofs:
  - Mathematical accuracy
  - Logic
  - Finding the “holes”

Optimization I - Topics

- Theory
  - Unconstrained optimization (optimality conditions, semidefiniteness)
  - Convex Analysis - convex sets, functions, separation and alternative theorems.
  - Convex Optimization
  - Stationarity
  - KKT conditions
  - Duality
- Applications such as: geometric fitting, portfolio optimization, robust regression, localization, signal estimation, clustering...
- Algorithms only a flavor:
  - gradient
  - projected gradient
  - Newton
  - Gauss-Newton
  - Dual-Based.
- Also, MATLAB, CVX...

Optimization II -Topics

- Theory
  - Nonsmooth analysis - subgradients.
  - Strong convexity/smoothness.
  - Proximal operator
  - Gradient Mapping.
- Algorithms Rigorous.
  - Classical algorithms (conjugate gradient, Newton, Quasi Newton).
  - Proximal Gradient Algorithms.
  - Fast Proximal Gradient Algorithms (FISTA)
  - Mirror Descent
  - Bundle
  - Stochastic Gradient
  - Dual-Based Methods
  - Alternating minimization
  - ADMM
  - and more...

Optimization under uncertainty

- Types of uncertainty
- Robust feasibility and optimality
- Robust optimization
  - Constructing uncertainty set
  - The robust counterpart
  - Adaptive optimization
  - Affine decision rules.
  - Multi-period robust optimization.
- Distributionally robust optimization
  - Stochastic programming
  - Ambiguity sets
  - Solution methods and approximations
- Data-driven robust methods
  - How can we utilize data to construct robust solutions

Books

1. "Introduction to Nonlinear Optimization: Theory, Algorithms, and Applications with MATLAB", Beck.
2. "Convex Optimization", Boyd and Vandenberghe.
3. "Nonlinear Programming" Bertsekas
4. "The Mathematics of Nonlinear Programming", Peressini, Sullivan, Uhl.
5. "Convex Analysis", Rockafellar.
6. "Convex Analysis and Optimization", Bertsekas.

Policies

- Grading
  - 45% HW given every week (11-12 assignments take best of 9-10)
    No solutions will be published.
  - 55% final

- Course staff and office hours
  - Lecturer : Dr. Shimrit Shtern, 409 Bloomfield/Zoom
    shimrits@technion.ac.il
    Thursdays upon appointment
  - TA: Eyal Gur,
    eyal.gur@campus.technion.ac.il
    Tuesdays 15:30-16:30 Location 426 Cooper Build./Zoom