Optimization for Signal Processing and Communication

- **Statistical plus Dictionary Learning Approach for Speech Enhancement**
  - Speech Model: \( Y = S + W \)
  - Estimate the clean speech signal (S) from a given noisy speech (Y)
- **Proposed Approach**
  - Combine both statistical approach and dictionary learning approach
  - Statistical approach (classically): Use the statistical difference between speech and noise to do enhancement, such as Wiener, MAP, etc.
  - Dictionary learning approach (modern): Use the spectrogram structure difference between speech and noise to do enhancement

- **User Grouping in Modern Cellular Networks**
  - Fair utility function of the users
  - Congestion in the network
  - Schedule/Group the users in different time slots
  - Optimization problem with no binary/discrete variables
  - Numerical experiments:
    - Proportional fairness utility
    - 3GPP (TR 36.814) evaluation methodology
    - Throughput: 75% improvement
    - Cell edge users: 195% improvement

- **Simulation Results**
  - • Proposed Approach
  - • Maximum total DoF = \( \frac{K}{2} \)
  - • DoF of a user = \( \frac{1}{K} \)
  - • Introduced to maximize the total DoF (Maddahali, Jafar, Tse, …)
  - • Binary/discrete variables
  - • Time slots
  - • Approximation

- **Interference Alignment and Limitations**
  - Introduced to maximize the total DoF (Maddahali, Jafar, Tse, …)
  - DoF of a user = \( \frac{1}{K} \)
  - Maximum total DoF = \( \frac{K}{2} \)
  - Achievability through interference alignment
  - Distributed Algorithm
    - First stage: find a BS assignment by solving a max weighted matching problem
    - Second stage: find power by solving a power allocation problem
    - In distribution, and globally optimal if optimal min-rate > 1
  - Simulation results
    - The proposed algorithm achieves 50%-80% higher min-rate than other widely used algorithms

- **Optimal Joint BS Assignment and Power Allocation in a Cellular Network**
  - **Motivation**
    - Power allocation is easy to solve
    - How about joint BS assignment and power allocation?
  - **Model**
    - K BSs and K users, single antenna
    - Jointly optimize BS assignment and power allocation, to maximize min-rate, under constraints \( \text{SINR} > 1 \)
  - **Main Result**
    - The problem is polynomial time solvable.
  - **Simulation Results**
    - • Proposed Approach
    - • Maximum total DoF = \( \frac{K}{2} \)
    - • DoF of a user = \( \frac{1}{K} \)
    - • Introduced to maximize the total DoF (Maddahali, Jafar, Tse, …)
    - • Binary/discrete variables
    - • Time slots
    - • Approximation

- **Optimal Joint BS Assignment and Power Allocation in a Cellular Network**
  - **Motivation**
    - Traditional wireless network is migrating to the Heterogenous Network (HetNet)
    - In HetNet, Base Stations (BSs) are densely deployed
  - **Problem**
    - Jointly optimize the transceivers and user-BS assignment
  - **Model**
    - • Q BSs and N users in the network
    - • The users and BSs are all equipped with multiple antennas
    - • All users and BSs interfere with each other

- **Joint Linear Precoder Optimization and Base Station Assignment for MIMO Network**
  - **Approach**
    - We use a game theoretical approach
    - • The users and BSs are players of the game; they optimize some properly designed utility functions
    - • The resulting algorithm is distributed and efficient
  - **Simulation results**
    - • The proposed algorithm achieves greater throughput as well as higher fairness level, compared with algorithms that only consider transceiver design