Part I-Implicit regularization

Consider the model, $\vec{y} = \mathbf{X}\vec{w} + \vec{\xi}$ with least squares loss given as $\|\mathbf{X}\vec{w} - \vec{y}\|^2$ where $\vec{y}$ is the observed vector, $\mathbf{X}$ is the measurement vector, $\vec{w}$ is the coefficient vector and $\vec{\xi}$ made up of i.i.d. sub-Gaussian components with variance proxy σ^2. When the number of observations is small compared to the number of coefficients, the objective becomes ill-posed with saddle points. Hence, requiring some additional constraints to reach the critical point. A part of the research is to study how the inductive bias from optimization in over-parameterized cases can lead to different useful models.

This work mainly focuses on implicit regularisation in a Hadamard product paramterization to the model $\vec{y} = \mathbf{X}\vec{w} + \vec{\xi}$ for linear regression under group sparse conditions with $\vec{\xi}$ made up of i.i.d. sub-Gaussian components with variance proxy σ^2. Intriguingly, it was observed that the parametrization $\vec{w}^{(\ell)} = g^{(\ell)} \odot \left(\vec{u}^{(\ell)} \odot \vec{u}^{(\ell)} - \vec{v}^{(\ell)} \odot \vec{v}^{(\ell)}\right)$ for the ℓ^{th} group introduced group sparsity implicitly without giving explicit constraints, where $\odot$ denotes Hadamard product. A preliminary investigation shows that the parametrization is working in comparison with block OMP (BOMP) and better than group lasso with 5-fold cross validation.

This was done in collaboration with Dr. Sreejith Kallummil, Senior data scientist, Walmart.

Part II-LIS Optimization

In a communication network supported by the Intelligent Reflecting Surface (IRS) elements, it is important to understand how it affect the outage probability/information rate in an IRS-assisted system model.

Initially, aim of the work was to study the effect of number of elements in an IRS assisted SISO network and optimize N to guarantee that the outage probability is within some pre-defined threshold in a $\kappa - \mu$ fading channel, both in the presence and absence of an line of sight (LOS) link between the source and destination node. But an initial analysis shows that outage probability is a monotonically decreasing function of N and can be obtained by brute force method in this case. Currently, the effect of IRS in a Multi-User Assisted MISO system is being studied to better understand the optimum phase-shift model.

This work is being done in collaboration with Athira Subhash and Shashank Shekhar, Department of Electrical Engineering, Indian Institute of Technology Madras.