EE-668: Massive MIMO for 5G Communications: Design and Analysis

Programming assignment 3

Question 1. Plot the closed-form lower bound of the per user uplink data rate as a function of the number of antennas at the base station (M). Given $K = 10, \beta_k = 1\ \forall k, \tau_p = K, \eta_k = 1\ \forall k$.

1. Plot 1: For zero forcing (ZF) combiner for four different values of uplink signal to noise ratios ρ_{ul}={-10,-5,5,10} dB.
2. Plot 2: For maximum ratio (MR) combiner for four different values of uplink signal to noise ratios ρ_{ul}={-10,-5,5,10} dB.
3. Summarize the observations from the above two plots.
4. For what parameters does the above plots match the performance of the downlink.

Question 2. Plot the lower bound on per user uplink data rate as a function of number of base station antennas (M) for the MMSE combiner. For $\rho_{\text{ul}} = -5$dB, $K = 10, \beta_k = 1\ \forall k, \tau_p = K, \eta_k = 1\ \forall k$. Use Monte-Carlo simulation as closed-form is not available.

Question 3. Performance Comparison: Compare the performance of MMSE, MR, and ZF combiners by plotting lower bound on per user uplink data rate as a function of number of base station antennas (M) for the MMSE, MR, and ZF combiners over high and low SNR separately. Given $K = 10, \beta_k = 1\ \forall k, \tau_p = K, \eta_k = 1\ \forall k$.

1. Plot 1: $\rho_{\text{ul}} = -5$dB.
2. Plot 2 $\rho_{\text{ul}} = 5$dB.
3. Summarize the observations from the above two plots

Question 4. Plot the lower bound of the per user uplink data rate as a function of number of users (K) for MR combiner. Given $\beta_k = 1\ \forall k, \tau_p = K, \eta_k = 1\ \forall k$. Plot the following two cases in the same plot: i) M=100 (fixed), ii) M=10K (M is varying with K). Summarize the observations.

Question 5. Plot the lower bound of the uplink rate summed over all users as a function of number of users (K) for MR combiner. Given $\beta_k = 1,\ \forall k, \tau_p = K, \eta_k = 1,\ \forall k$. Plot the following two cases in the same plot: i) M=100 (fixed), ii) M=10K (M is varying with K). Summarize the observations.