

**Neuroscience 299: Computing with High-Dimensional Vectors**  
**Assignment 12: Communications**  
**Due December 1, 1pm**

Reminder: Please do *either* the writing assignment *or* the programming assignment. Expected length for the writing assignment is approximately 250-500 words, but there is no strict minimum or maximum.

***Writing assignment:***

Pick either option A or option B (you need **not** and should **not** answer both).

*Option A:* Can you think of a scenario or an application that involves communication of any kind (wireless/wired, p2p/network) but can be formulated as a problem that HD computing is good at (e.g. classification, factorization, or reasoning, etc.)? Please describe the problem setup, define the variables and metrics to measure the performance, and formulate the problem (such as an objective function, etc.).

*Option B:* A group of  $m$  users, each with power  $P$ , is using a Gaussian multiple-access channel at capacity, so that

$$\sum_{i=1}^m R_i = \frac{1}{2} \log\left(1 + \frac{mP}{N}\right)$$

where  $N$  is the receiver noise power. A new user of power  $P_0$  wishes to join in.

- (a) At what rate can the new user send without disturbing the other users?
- (b) What should the new user's power  $P_0$  be so that the new user's rate is equal to the combined communication rate  $[\log(1+mP/N)]/2$  of all the other users?

***Programming assignment:***

In this assignment, you will implement hyperdimensional modulation (HDM) from “HDM: Hyper-Dimensional Modulation for Robust Low-Power Communications” and perform some experiments assessing its performance with respect to amount of noise and values of HDM's parameters. Similar to other assignments, you are provided with the Jupyter notebook (see course website) that includes all the functions necessary for HDM. The notebook, however, is missing a few steps (search for ToDo comments in the notebook), which are related to implementation of permutations for individual slices and interference cancellation. Finally, the notebook also provides additional details on HDM and describes the types of experiments that should be conducted so please refer to the notebook for further details on the assignment.