Project: Hopfield like learning and forgetting

- Read up on the two main theories of forgetting:
  https://en.wikipedia.org/wiki/Interference_theory
  https://en.wikipedia.org/wiki/Decay_theory

- If you are interested you can read up on time- and interference dependent drift:
  Geva et al., 2023 (separate pdf)

- Implement a linear firing rate network using

$$\frac{dr_i}{dt} = -r_i + \sum_{j=1}^{N} M_{ij} r_j + s_i + \xi$$

- The steady state solution for a given stimulus x can be computed via

$$\mathbf{r}_\infty = \sum_i \frac{\mathbf{v}_i^T \mathbf{x}}{1 - \lambda_i} \mathbf{v}_i$$

where v_i and λ_i are ith eigenvector and eigenvalue of the matrix M.

- Implement two methods of forgetting memories in the network: Hopfield like overwriting and random changes via an Ornstein Uhlenbeck process.

- Hopfield like overwriting: $$\mathbf{M}_{\text{new}} = (1-\gamma)\mathbf{M}_{\text{old}} + \gamma \frac{\alpha}{N_{\text{Stim}}} \sum_{k=1}^{N_{\text{Stim}}} \mathbf{s}_k \mathbf{s}_k^T$$

- Ornstein Uhlenbeck process: $$dX = \frac{\omega^2}{2\sigma^2}(\mu - X)dt + \omega dW$$

(also see https://en.wikipedia.org/wiki/Ornstein%E2%80%93Uhlenbeck_process)

- Plot forgetting curves as the correlation of the network response to a given stimulus at time t to the response to the same stimulus at time 0.
- Which of the two processes would be associated to which of the theories of forgetting?
- Can you think of a (computational) experiment to reproduce figure 3 b-c from Geva et al., 2023?