Theoretical Neuroscience II
Computational Neuroscience II
Networks
(10 points)

1 Stability analysis of fix-points (3P)

Given the matrix $\underline{M} = \begin{pmatrix} 2.5 & 2.5 \\ 0 & 2.5 \end{pmatrix}$ and the vectors $\underline{v} = \pm \begin{pmatrix} 1 \\ 1 \end{pmatrix}$, where $\underline{v} = \underline{v}_\infty$.

According to the example in lecture (slide 19..), perform the stability analysis for the two fix-points. **Hint:** $tanh'(x) = \frac{1}{cosh^2(x)}$ and $cosh(x) = cosh(-x)$.

2 Discrete Evolution (4P)

1. Write a Matlab program which performs the discrete evolution in time for the following firing rate equation:

   $\tau(v^{t+1} - v^t) = -v^t + F(M\, v^t)$
   with weights M= $\begin{pmatrix} 0.5 & 0.5 \\ 0 & 0.5 \end{pmatrix}$ and $F(x) = tanh(x)$.

   For τ =[0.5 1 2 4]
   visualize the networks output by plotting v^t for 50 time steps. Therefore, generate at least 5 runs from different start positions which are sufficiently away from
   $v_\infty = \begin{pmatrix} 0 \\ 0 \end{pmatrix}$. Describe the output and explain the role of τ.
   Do the results match those from the mathematical analysis (lecture/previous task)?

2. Repeat the same experiments with the matrix from task 1!

3 Types of Networks (3P)

Describe the differences between *feedforward networks*, *recurrent networks*, and *autoassociative networks* with special focus on the structure and the *Firing Rate Equation*.