Neural Dynamics approaches to Cognitive Robotics

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Exercise: neural dynamics simulations

The neuronal dynamics simulated in the lectures is

$$\tau_u \dot{u}(t) = -u(t) + h_u + S_u(t) + c_{uu}\sigma(u(t)) + c_{uv}\sigma(v(t))$$
$$\tau_v \dot{v}(t) = -v(t) + h_v + S_v(t) + c_{vv}\sigma(v(t)) + c_{vu}\sigma(u(t))$$

The sigmoidal function is given by

$$\sigma(u) = \frac{1}{1 + \exp[-\beta\ u]}$$

where $\beta = \beta_u$ or $= \beta_v$, respectively. Use the interactive neural simulator `singleNeuronInteractiveSim.m` to explore this equation.

1. First set all coupling parameters $c_{..}$ and inputs $S_{u,v}$ to zero. Examine relaxation to the resting level.

2. Next vary the inputs and observe how the system tracks the shifting attractor.

3. Introduce self-stabilization $c_{uu} > 0$ and $c_{vv} > 0$ and examine how a positive solution arises for increasing input strength. Explore the two instabilities for increasing and decreasing input strength.

4. Finally, activate the coupling terms: $c_{uv} < 0$ and $c_{vu} < 0$. Vary input strengths to establish selection. Also vary input strengths asymmetrically to probe the stability of the selected state.

5. Examine the effect of noise in the absence and the presence of interaction.