1

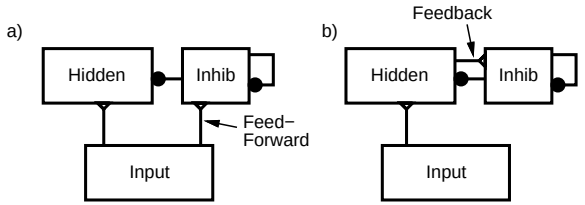
Inhibition

- Controls activity (bidirectional excitation).
- Competition -> selection (Darwin!).

1. Biology: Feedforward and Feedback.
2. Critical Parameters.
3. kWTA Simplification.

2

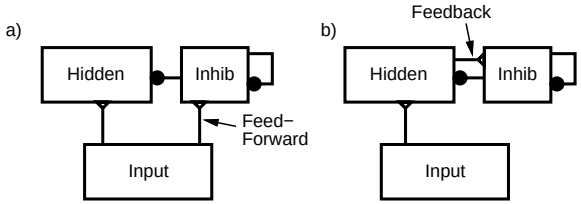
Types of Inhibition



Anticipates excitation Reacts to excitation

3

Critical Parameters



- Inhib conductance into hidden units (`g_bar_i.hidden`)
- Inhib conductance into inhib units (`g_bar_i.inhib`)
- Strength of feedforward weights to inhib (`scale.ff`)
- Strength of feedback weights to inhib (`scale.fb`)

4

Approximating Inhibitory Interneurons

Computationally expensive to simulate inhibitory interneurons:

- Extra units and connections.
- Slower rate constants (dt) required to avoid oscillations (many cycles of updating to process inputs).

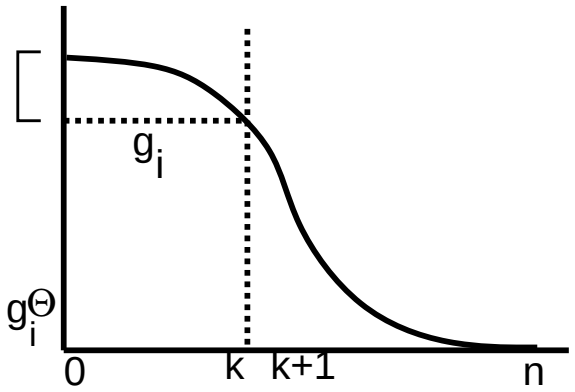
Thus, we approximate inhibition by only activating k units.

Approximates *set point* behavior.

k-Winners-Take-All (kWTA): Compute g_i such that k units are above threshold, rest below.

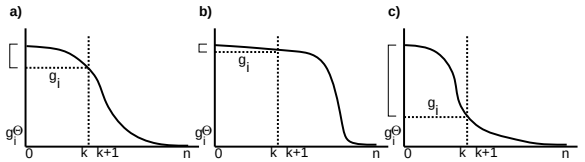
5

kWTA Idea



6

kWTA: Simple



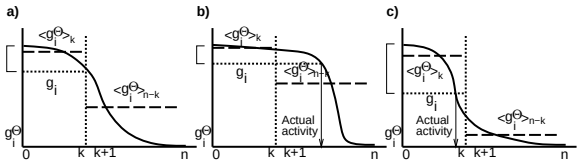
$$V_m = \frac{g_e \bar{g}_e E_e + g_i \bar{g}_i E_i + g_l \bar{g}_l E_l}{g_e \bar{g}_e + g_i \bar{g}_i + g_l \bar{g}_l} \quad (1)$$

$$g_i^\Theta = \frac{g_e \bar{g}_e (E_e - \Theta) + g_l \bar{g}_l (E_l - \Theta)}{\Theta - E_i} \quad (2)$$

$$g_i = g_i^\Theta(k+1) + q(g_i^\Theta(k) - g_i^\Theta(k+1)) \quad (3)$$

7

kWTA: Average-Based



$$\langle g_i^\Theta \rangle_k = \frac{1}{k} \sum_{i=1}^{k} g_i^\Theta(i) \quad (4)$$

$$\langle g_i^\Theta \rangle_{n-k} = \frac{1}{n-k} \sum_{i=k}^{n} g_i^\Theta(i) \quad (5)$$

$$g_i = \langle g_i^\Theta \rangle_{n-k} + q(\langle g_i^\Theta \rangle_k - \langle g_i^\Theta \rangle_{n-k}) \quad (6)$$

8

Simulations

1. kWTA approximates set point behavior.
2. Allows for faster updating.