

感情・心

知覚・認識

学習・記憶

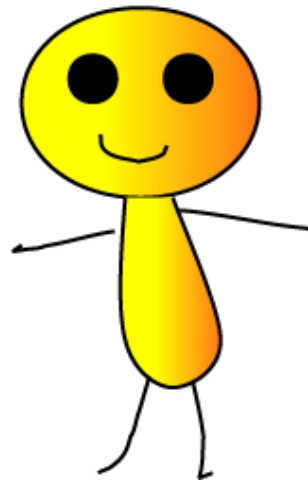
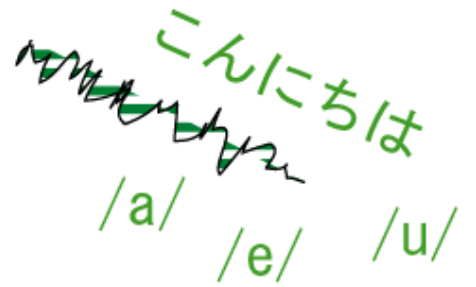
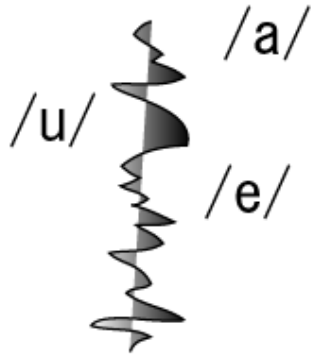
匂い

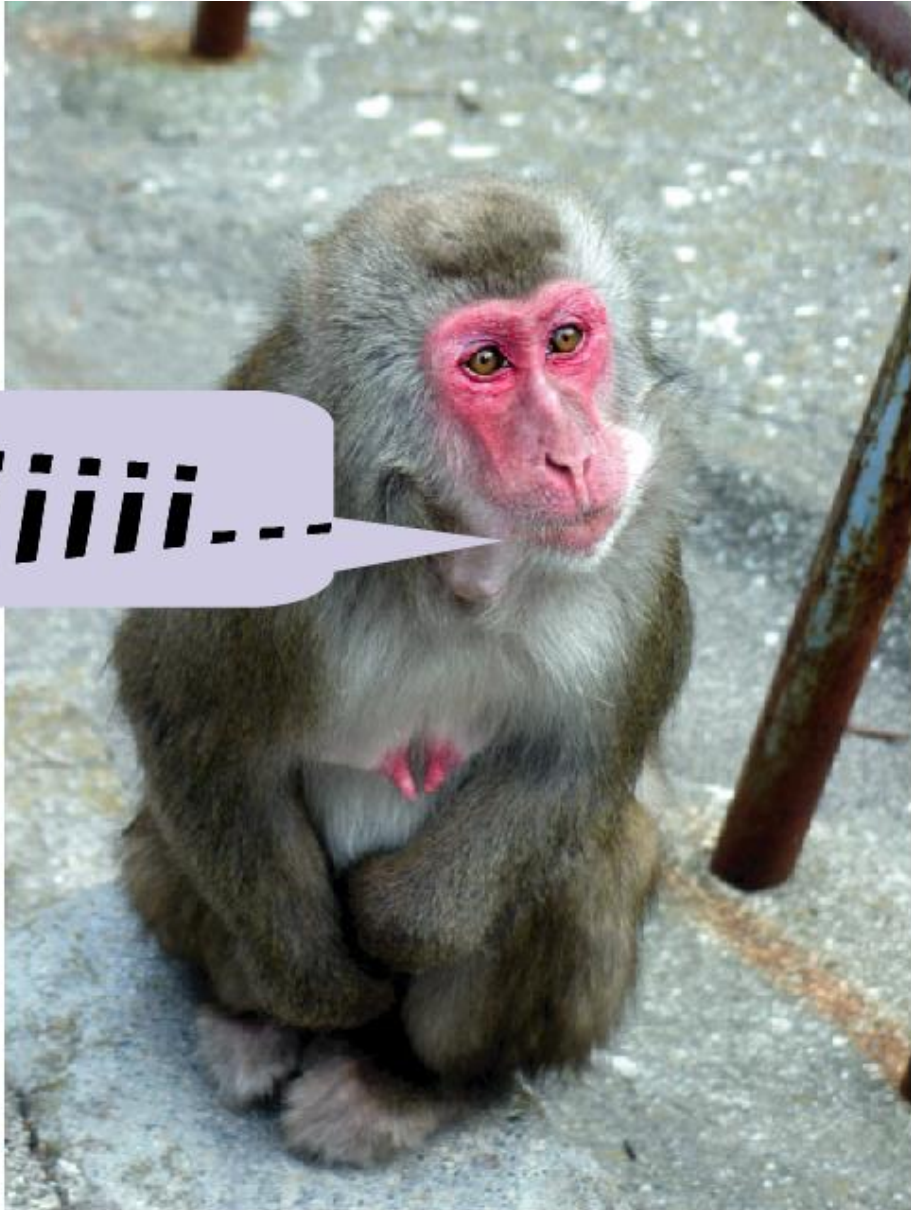
音

色

味

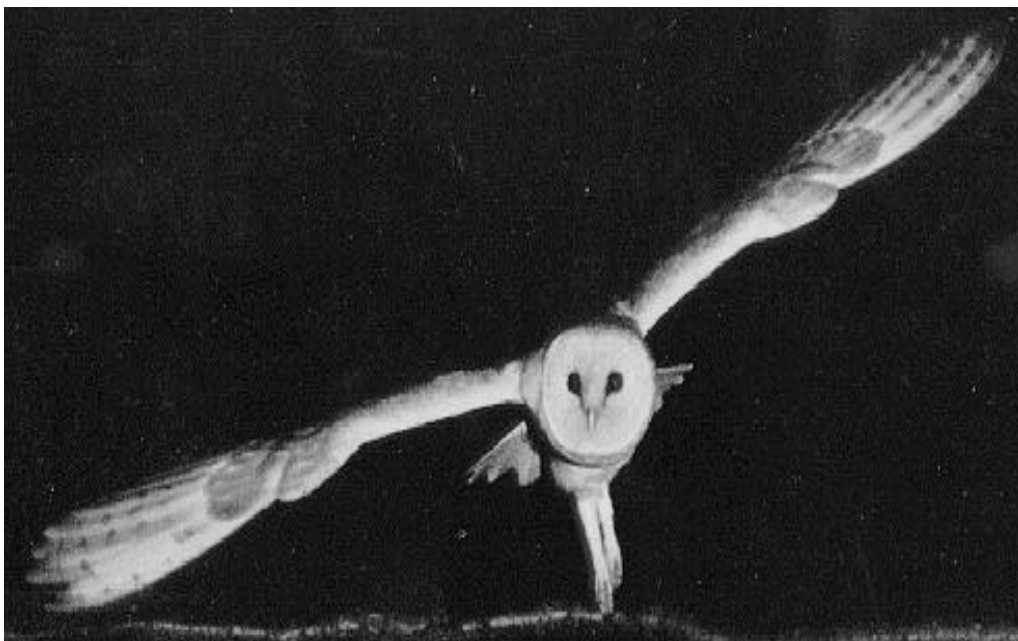
こんにちは





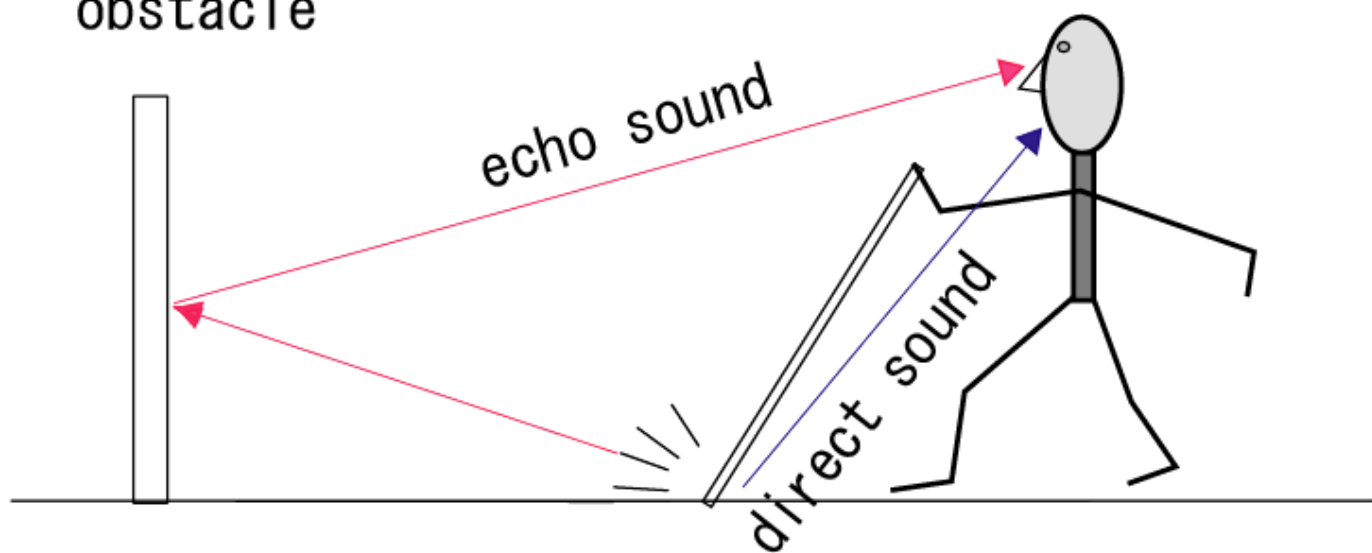
kiiiiii...

面フクロウの音源定位

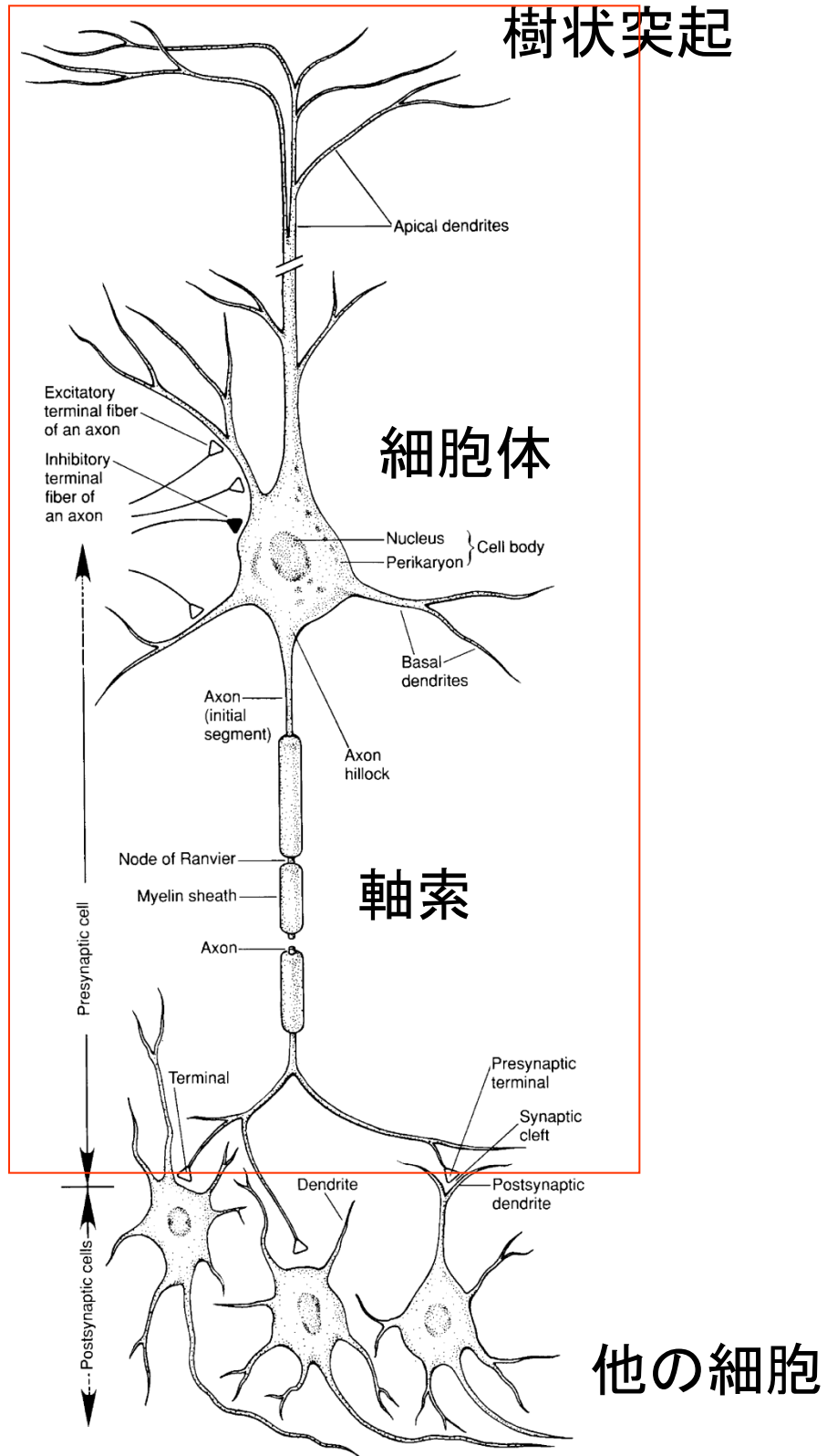


Detection of an obstacle with the aid of long-cane tapping sounds

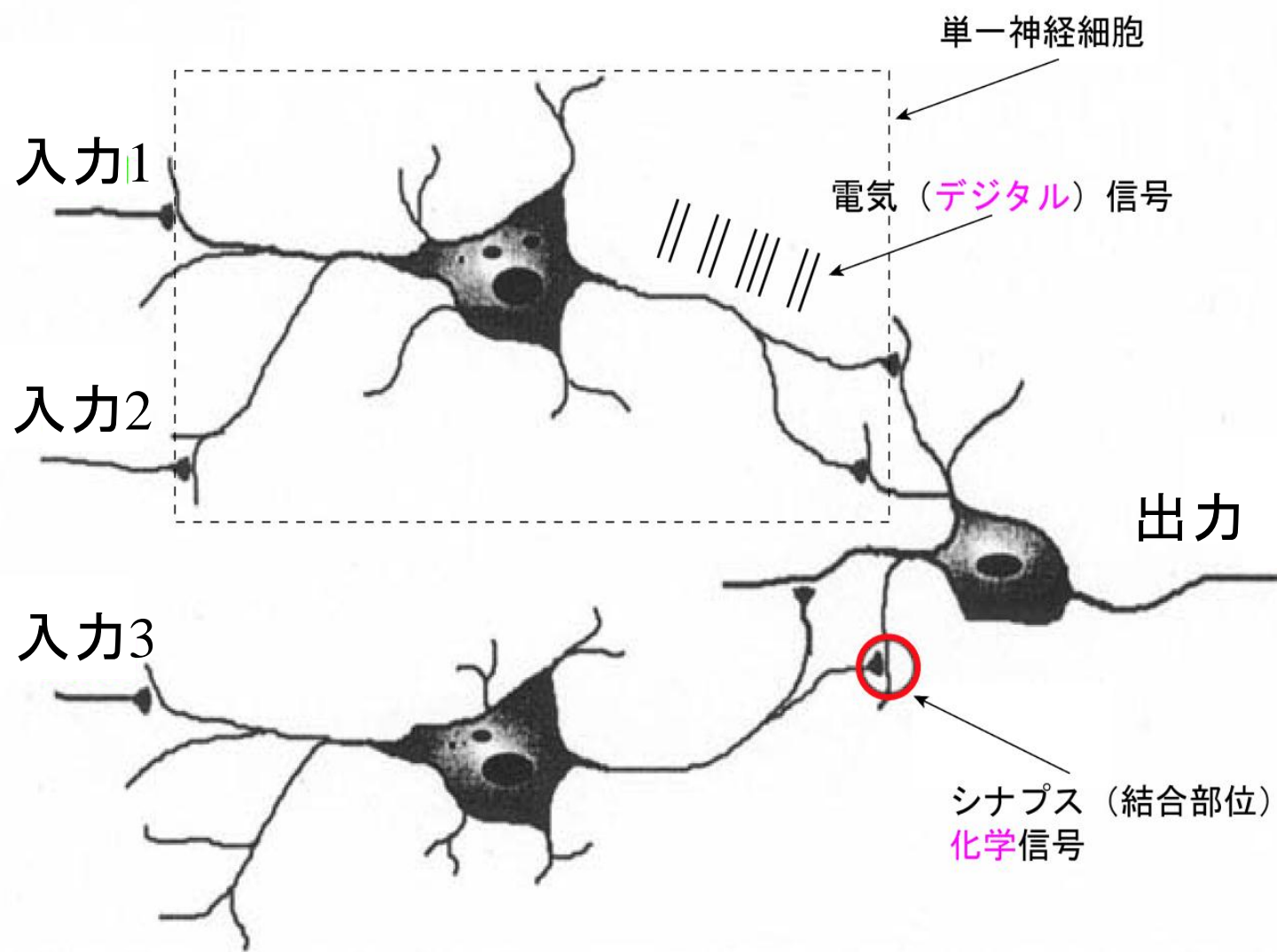
obstacle



神経細胞の構造

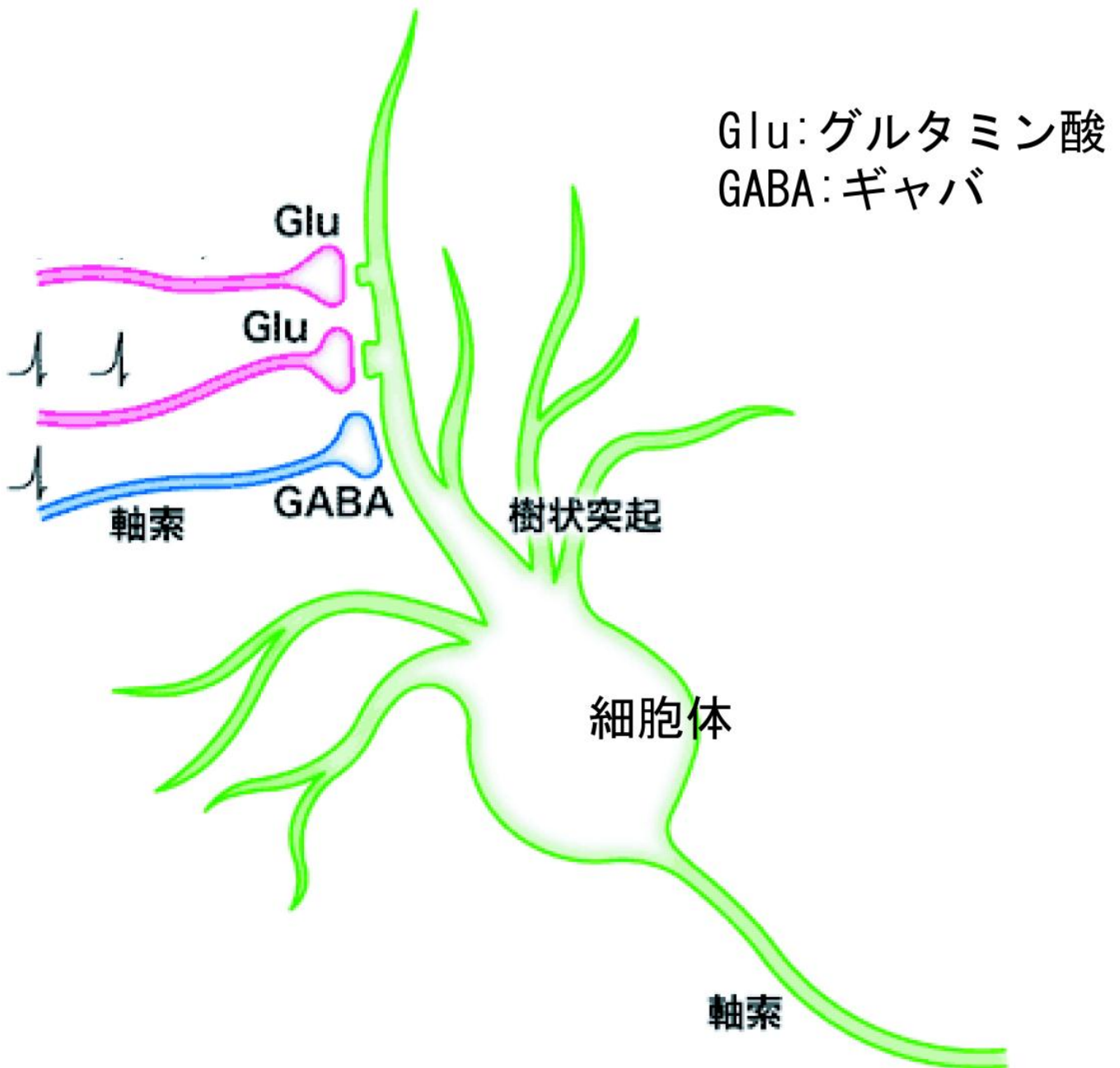


神経細胞ネットワークの構成

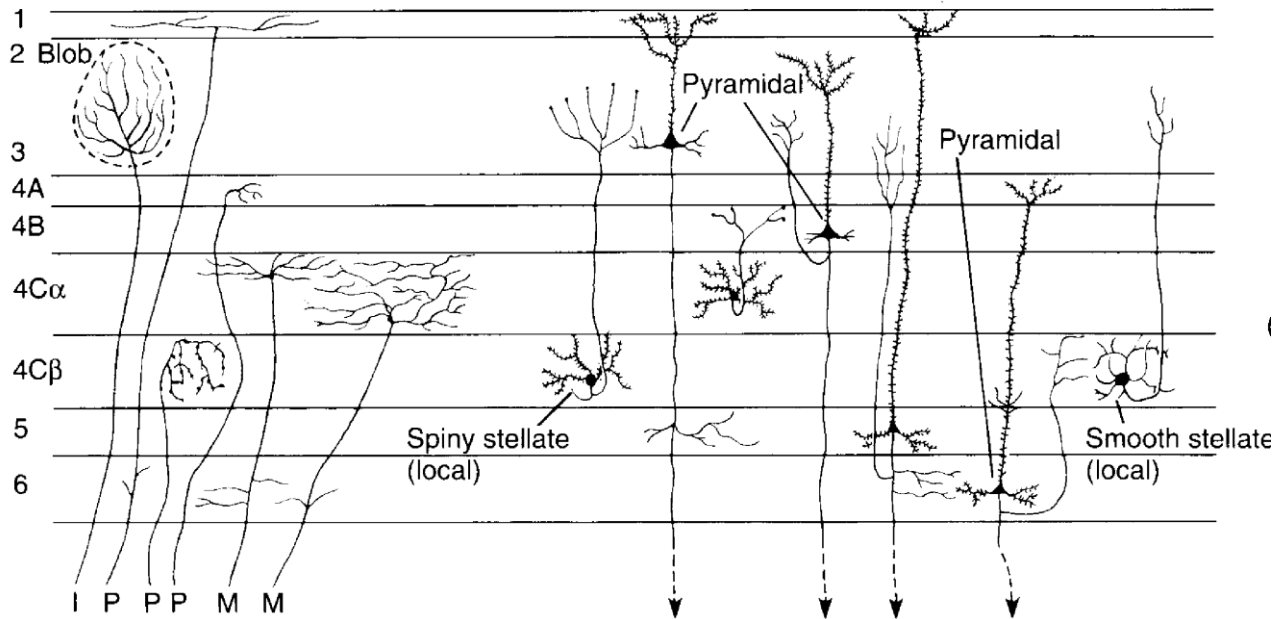


我々の脳は電気・化学回路である。

興奮性 (Glu) と抑制性 (GABA) シナプス結合



大脳皮質における神経細胞ネットワーク



脳は 10^{11} 個程度の神経細胞が蜜にネットワークを形成したもの

Question: 昆虫の脳は何個程度の神経細胞からなるか？

数理神経科学

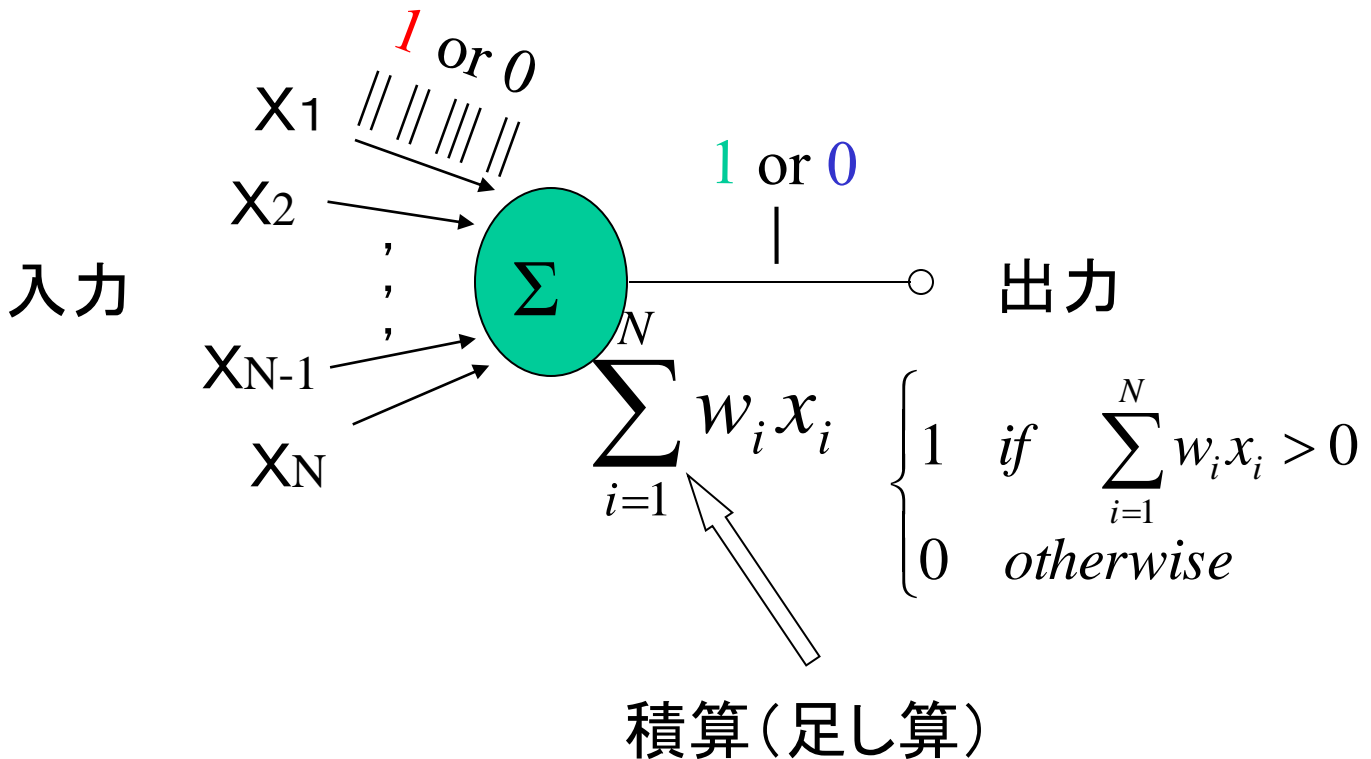
- 生物がもつ様々な脳機能（例えば、学習、記憶、認知・認識、感情・心）について、その神経機構を、コンピュータシミュレーションなどの数学的手法を用いて明らかにする学問

Question:

- ・眠りの定義は？
- ・動物はなぜ眠るのか？

脳は身近な宇宙みたいな存在である。

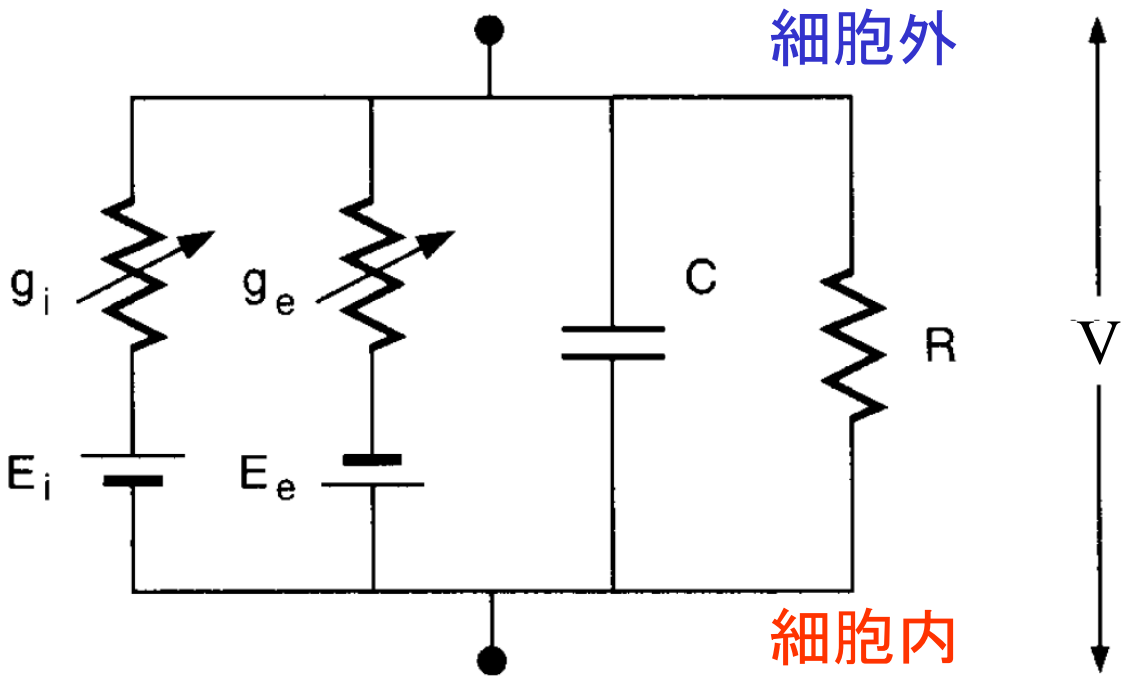
神経細胞の数理モデル(簡易版)



“1 (ON)”がたくさん入力されるとき、
“1”が出力される割合が高くなる。
“0”は“OFF”を意味する。

我々の脳はデジタル処理器である。

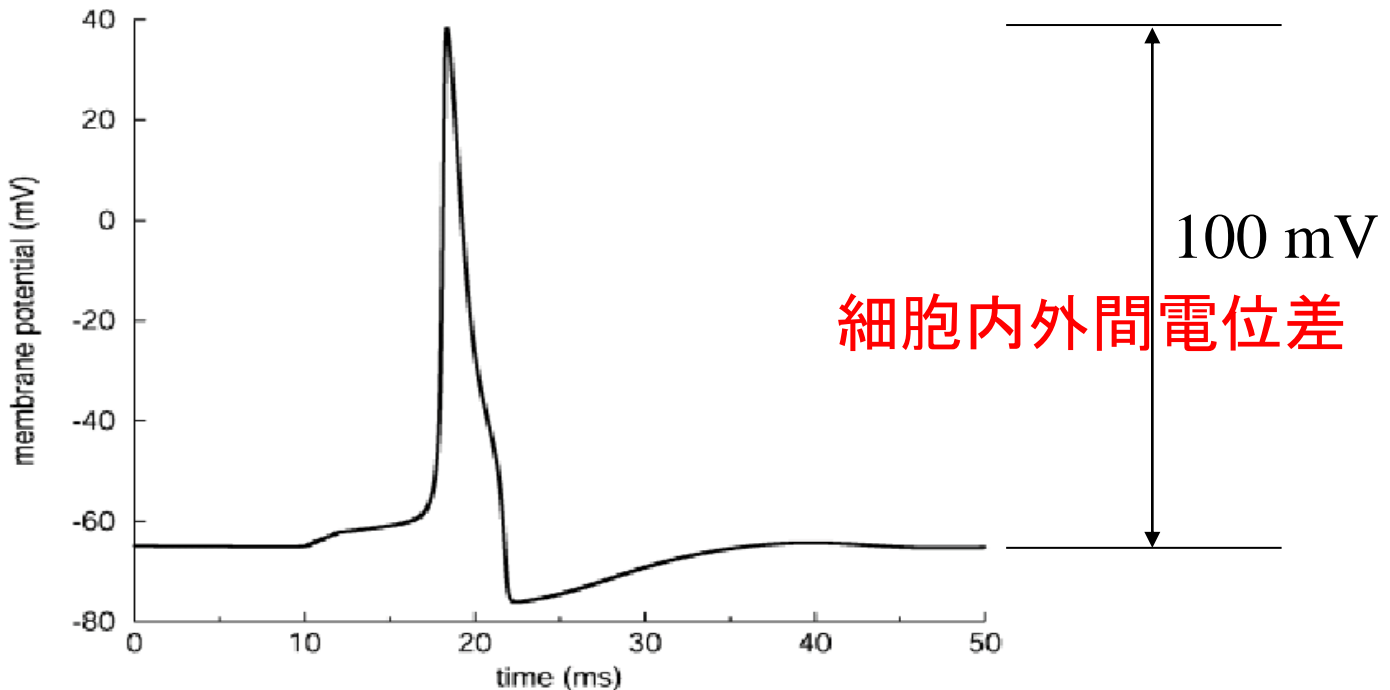
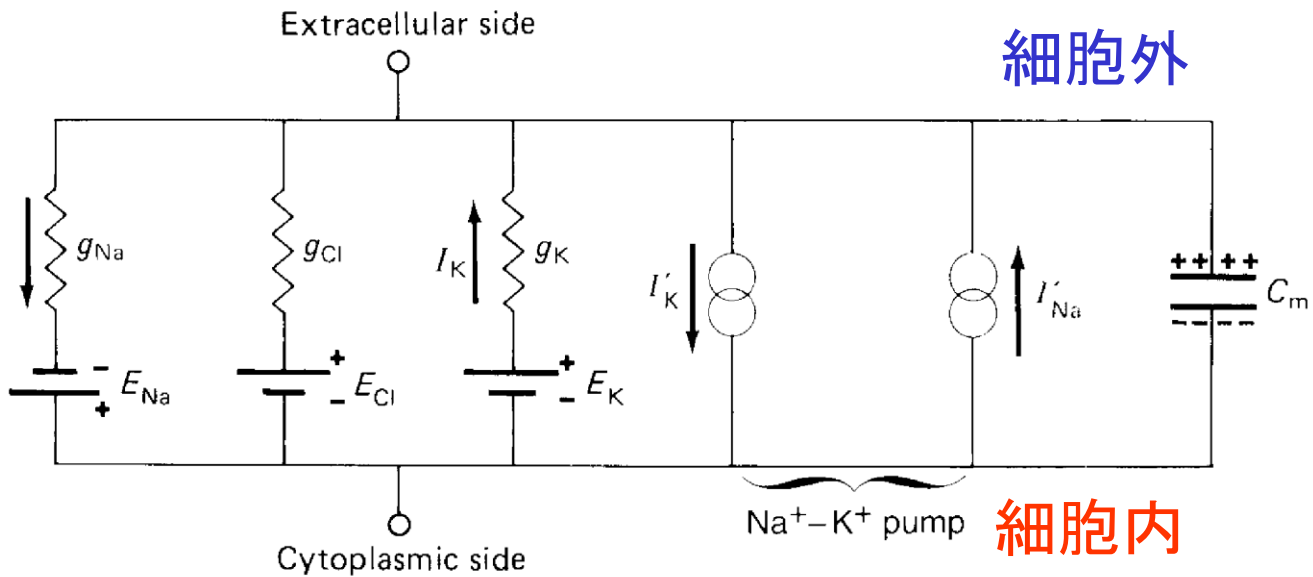
神経細胞の数理 モデル(詳細)



$$C \frac{dV}{dt} = g_e(E_e - V) - g_i V - \frac{V}{R}$$

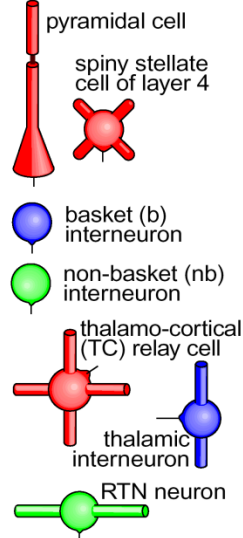
$$E_e = 80mV, E_i = 0mV$$

神経細胞の数理モデル(詳細版)

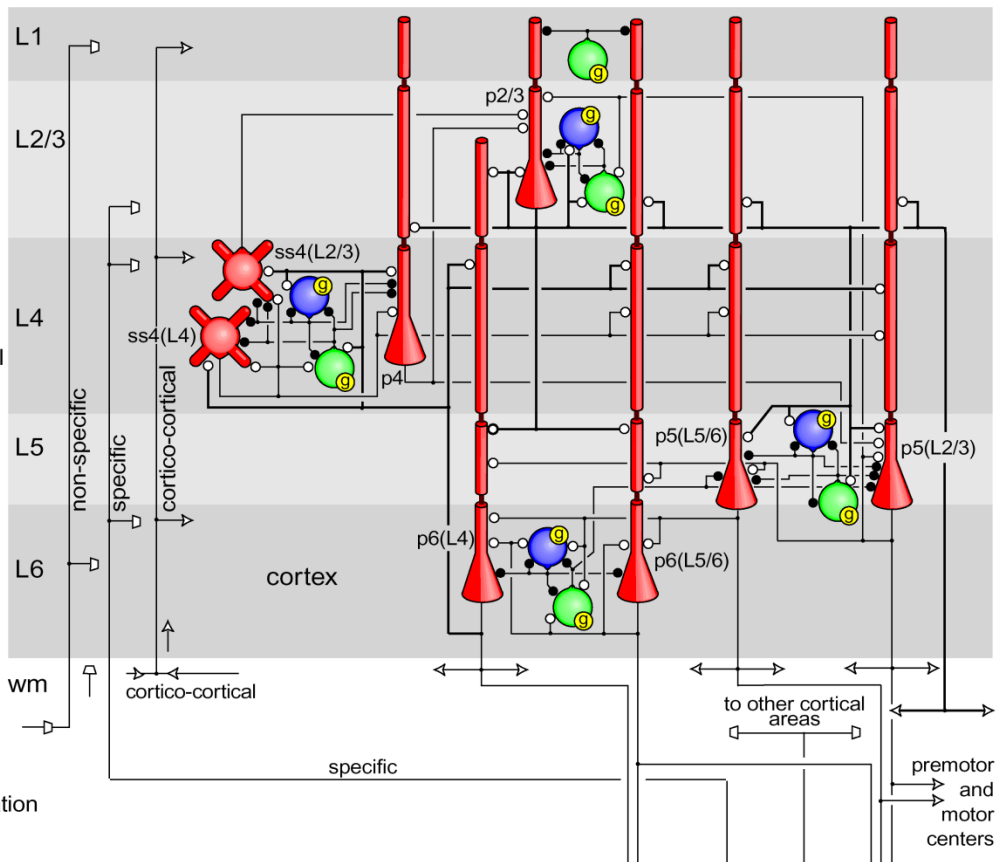
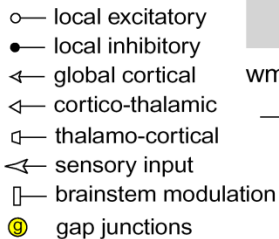


大脳皮質の神経回路網 (ニューラルネットワーク) モデル

types of neurons

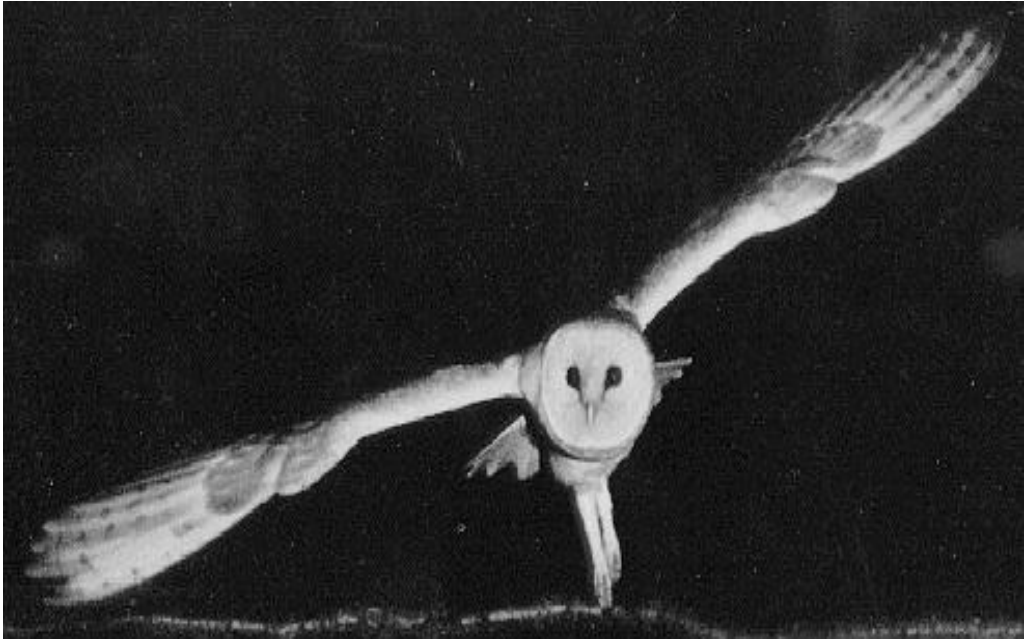


types of synapses

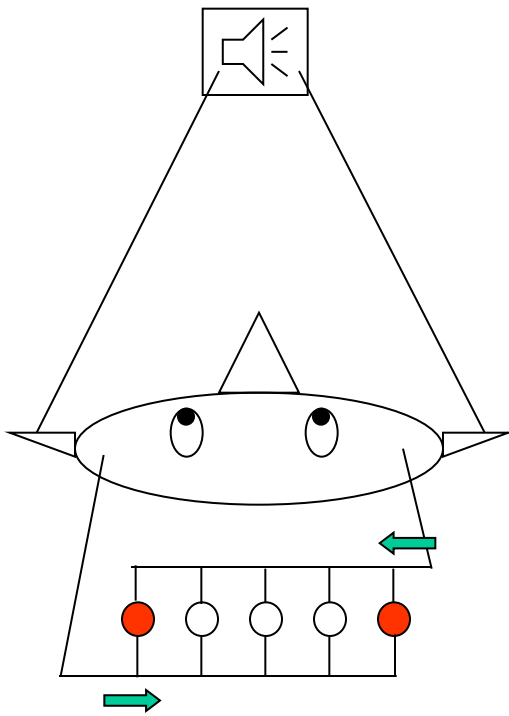


(Izhikevich and Edelman, 2008)

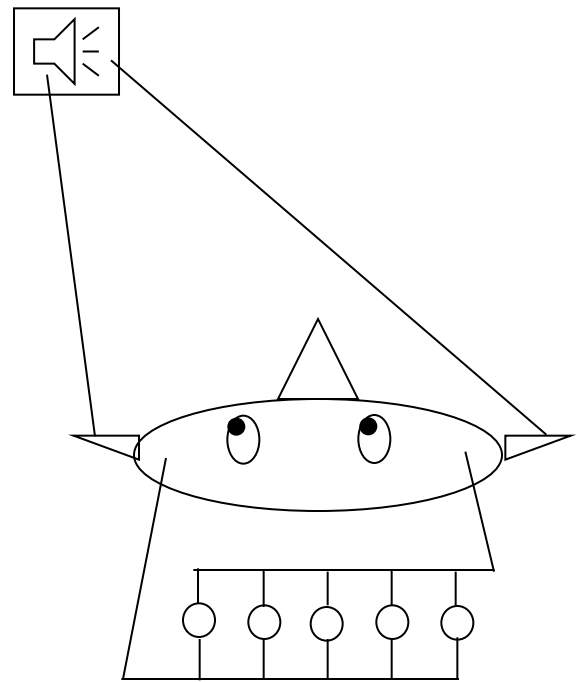
面フクロウの音源定位



音源定位(水平方向)

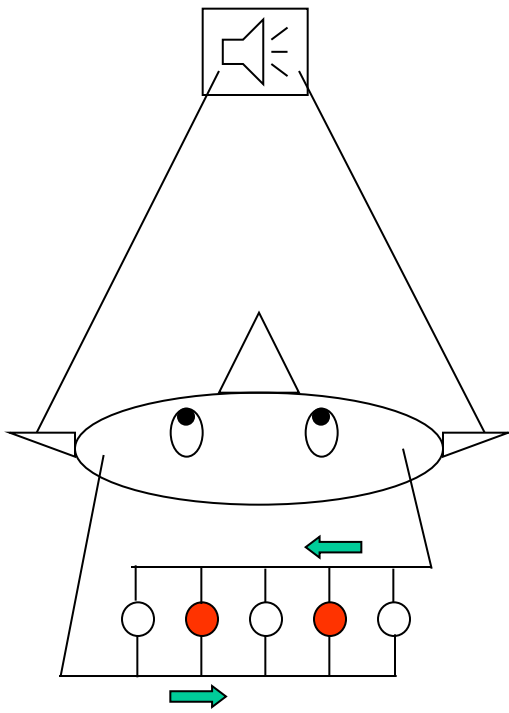


音源(中央)

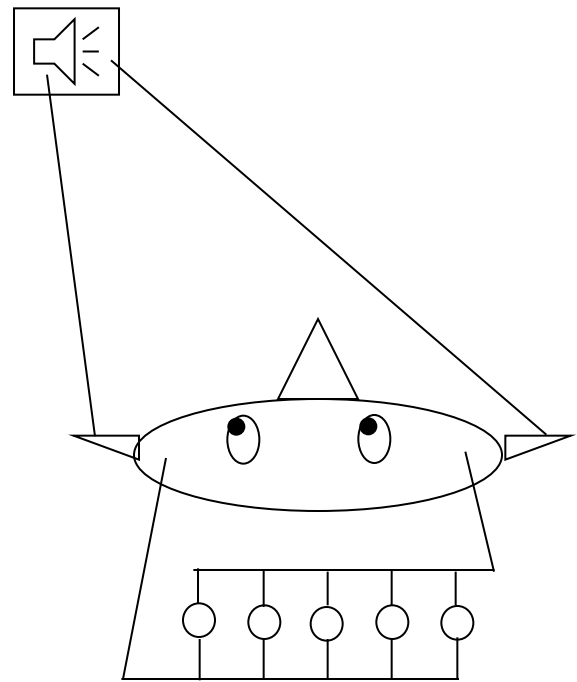


音源(左)

音源定位(水平方向)

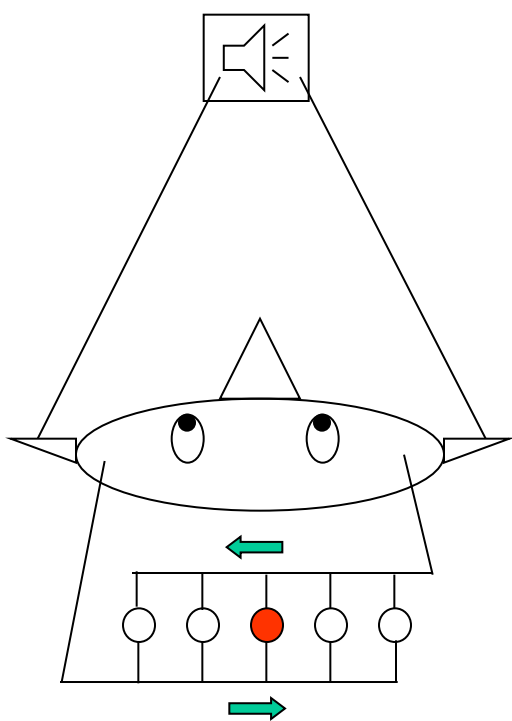


音源(中央)

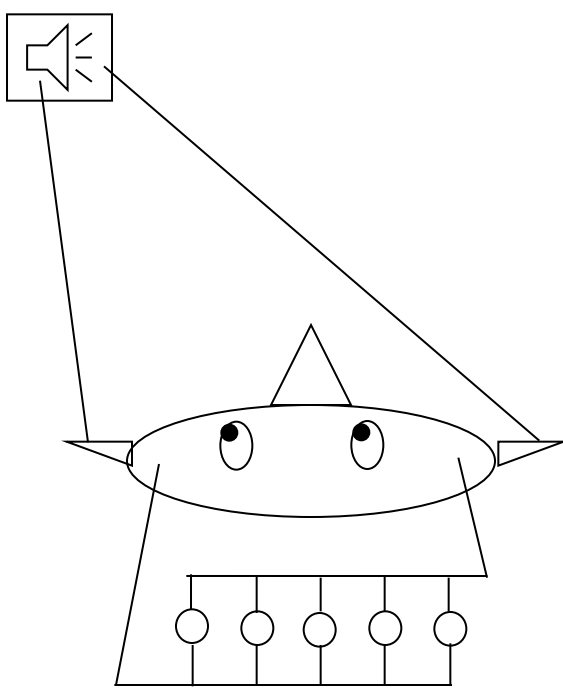


音源(左)

音源定位(水平方向)

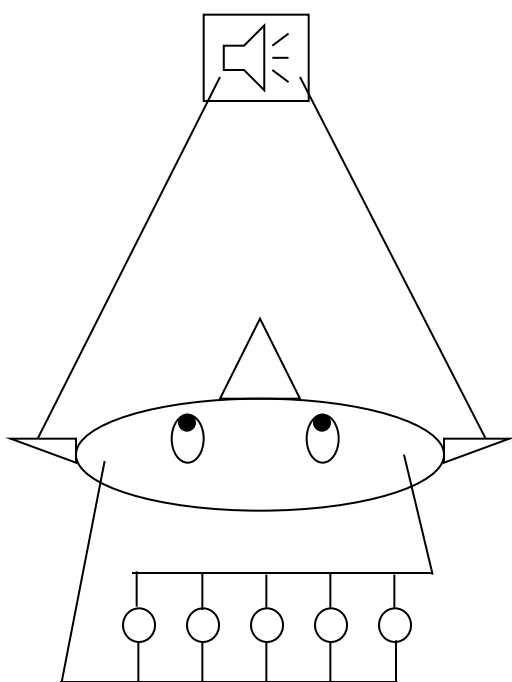


音源(中央)

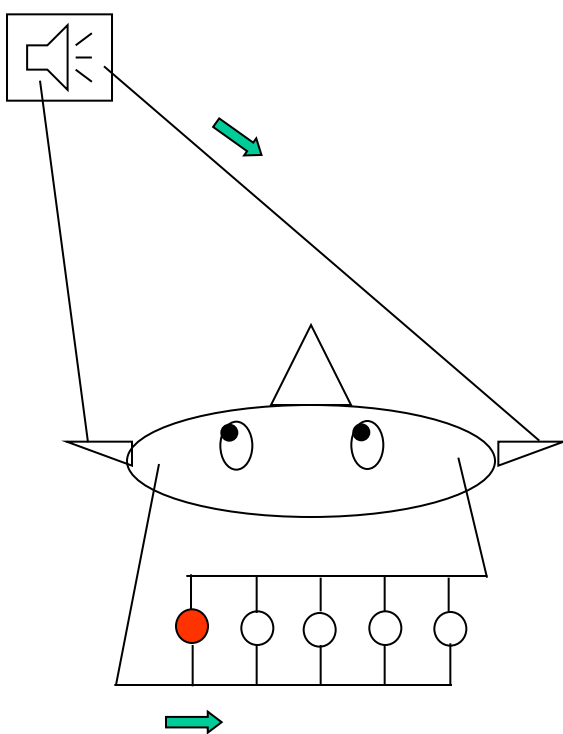


音源(左)

音源定位(水平方向)

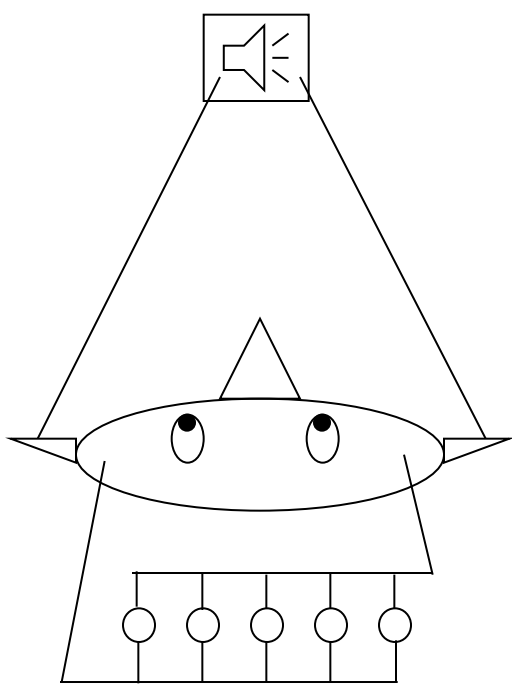


音源(中央)

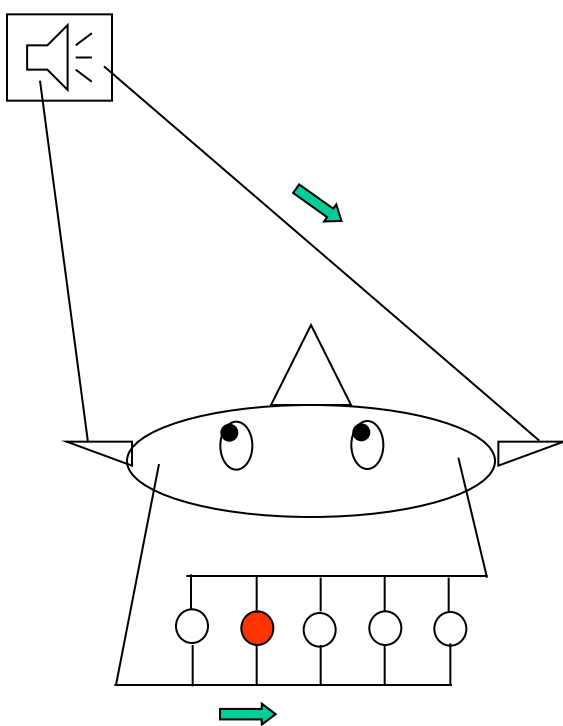


音源(左)

音源定位(水平方向)

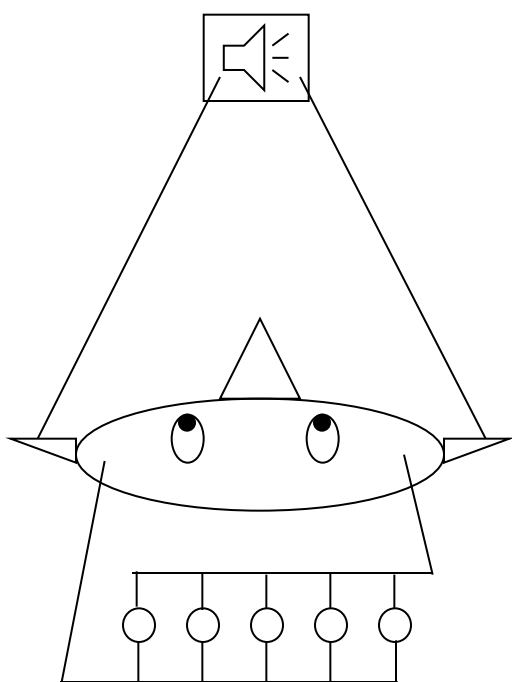


音源(中央)

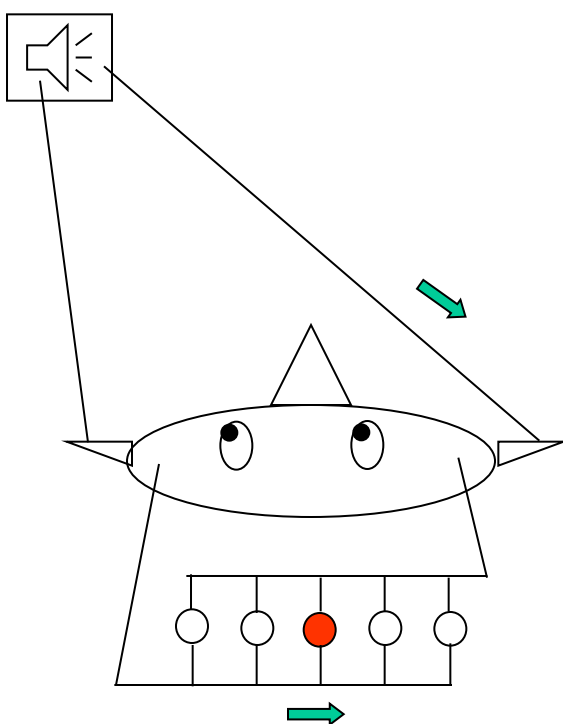


音源(左)

音源定位(水平方向)

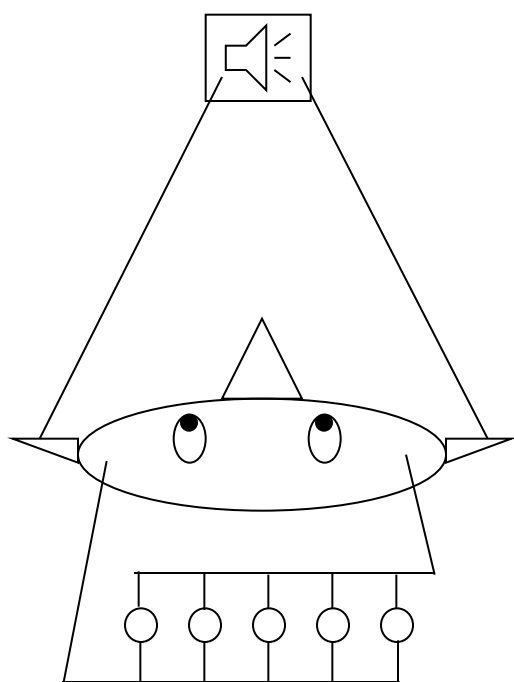


音源(中央)

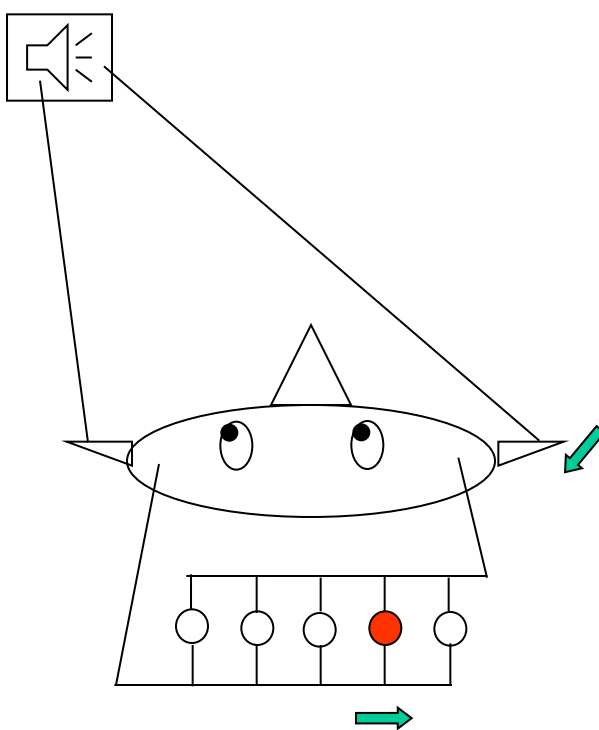


音源(左)

音源定位(水平方向)

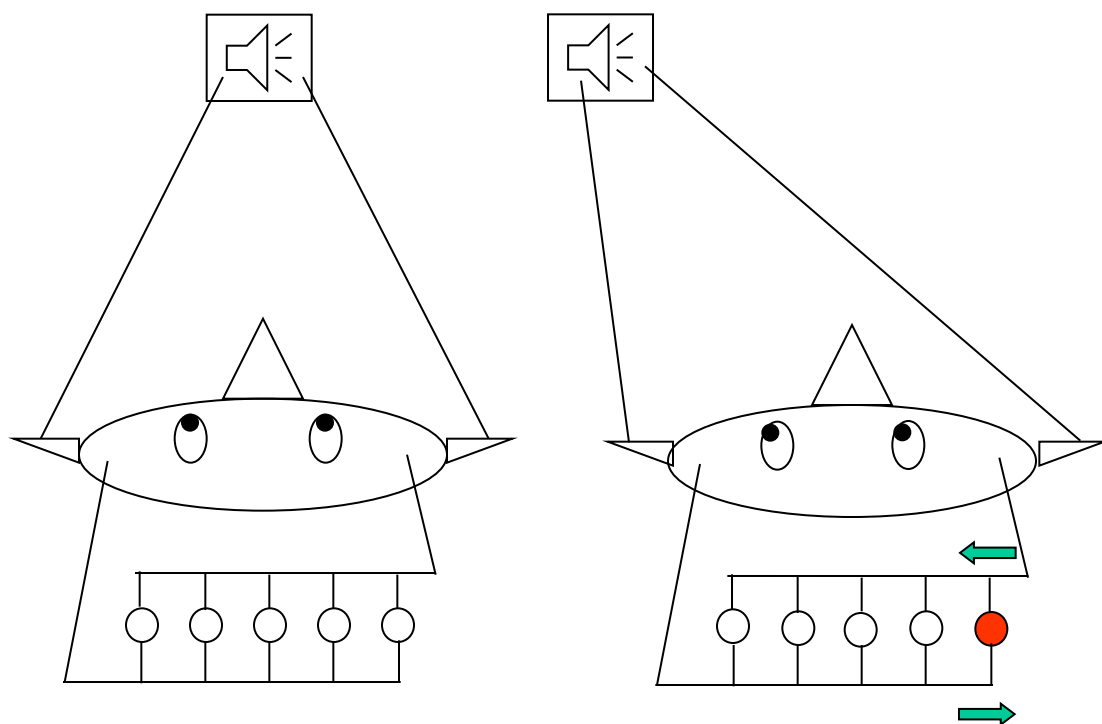


音源(中央)



音源(左)

音源定位(水平方向)

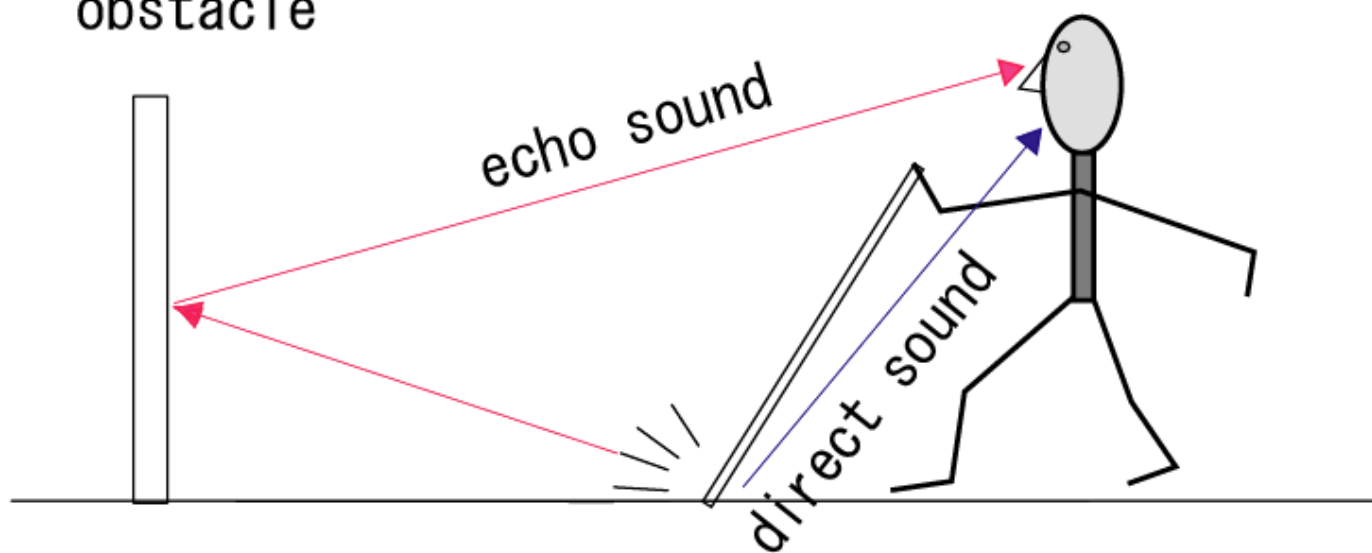


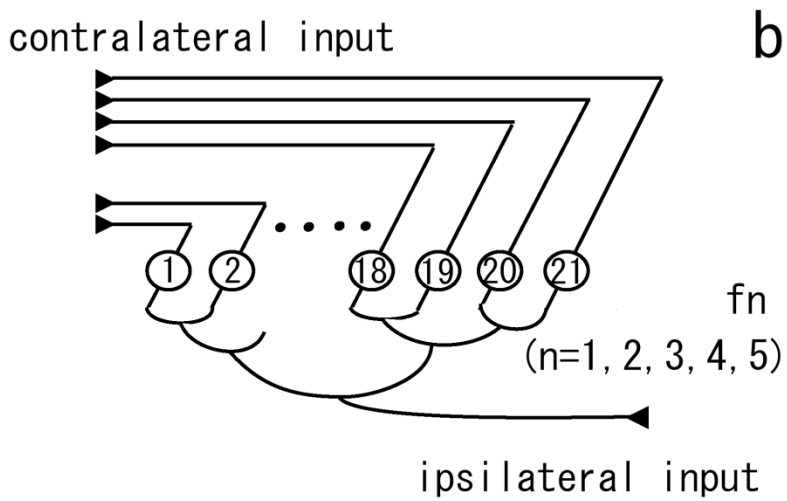
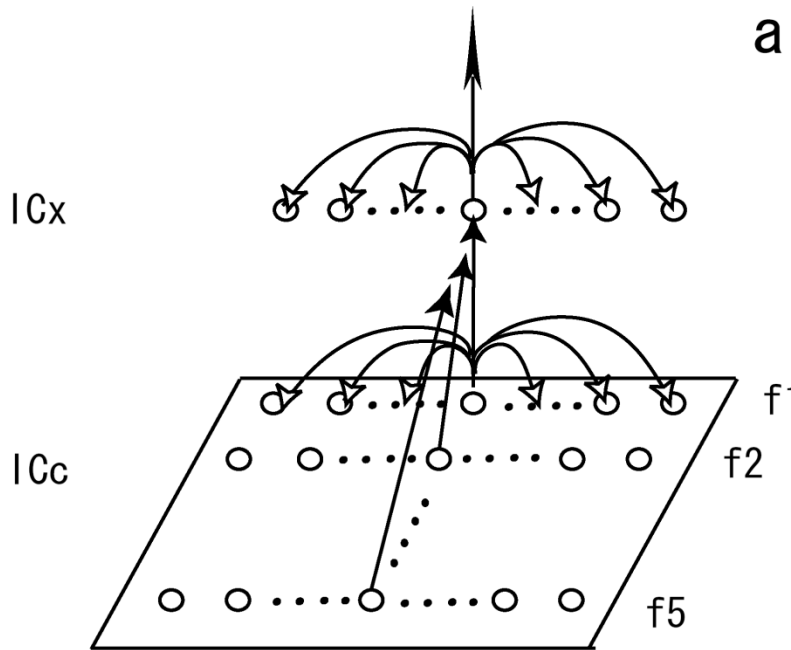
音源(中央)

音源(左)

Detection of an obstacle with the aid of long-cane tapping sounds

obstacle

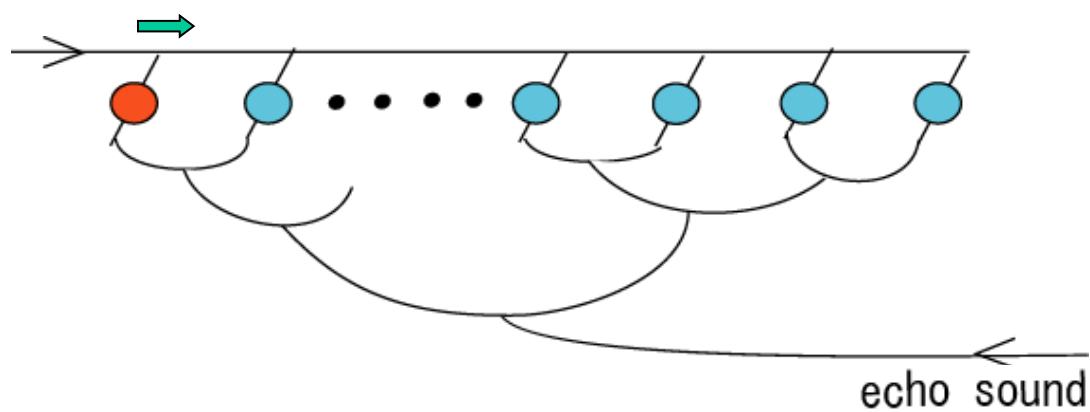




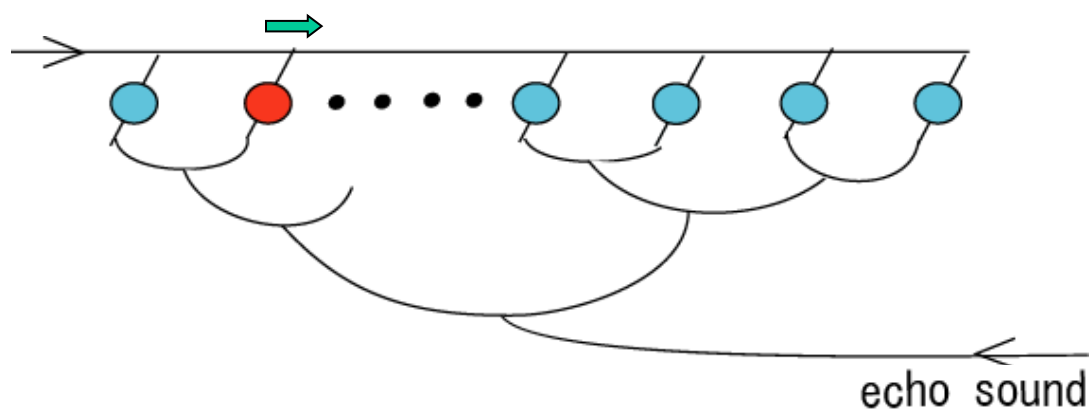
$$\begin{aligned}
\tau_C \frac{du_{k-i}^C(t)}{dt} = & -u_{k-i}^C(t) + \sum_{j=1}^N E_{\text{syn}} w_{k-i,k-j}^C(t) \cdot V_{k-j}^C(t) \\
& + I_{\text{ipsi}}^k(t) + I_{\text{contra}_i}^k(t) \quad (k = f1, f2, f3, f4, f5) ,
\end{aligned} \tag{1}$$

$$\begin{aligned}
\tau_X \frac{du_i^X(t)}{dt} = & -u_i^X(t) + \sum_{k=f1}^{f5} w_{i,k-i}^X \cdot V_{k-i}^C(t) \\
& + \sum_{j=1}^N E_{\text{syn}} w_{i,j}^X(t) \cdot V_j^X(t) ,
\end{aligned} \tag{2}$$

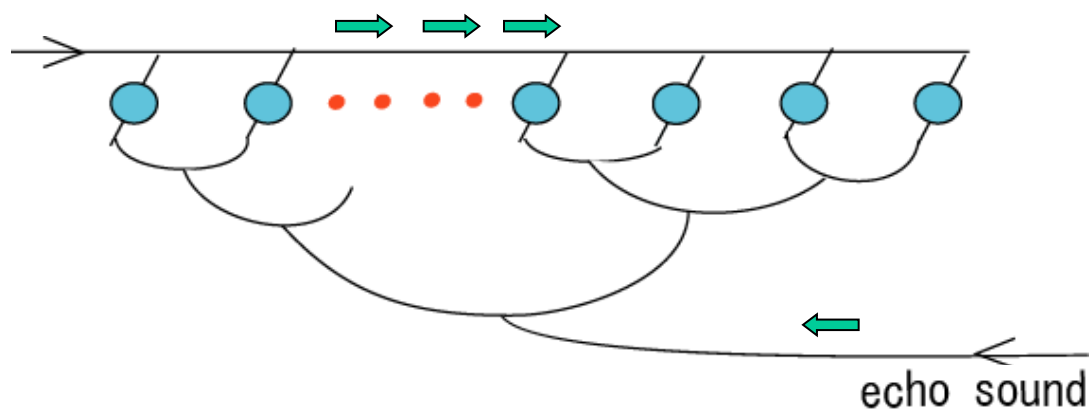
direct sound



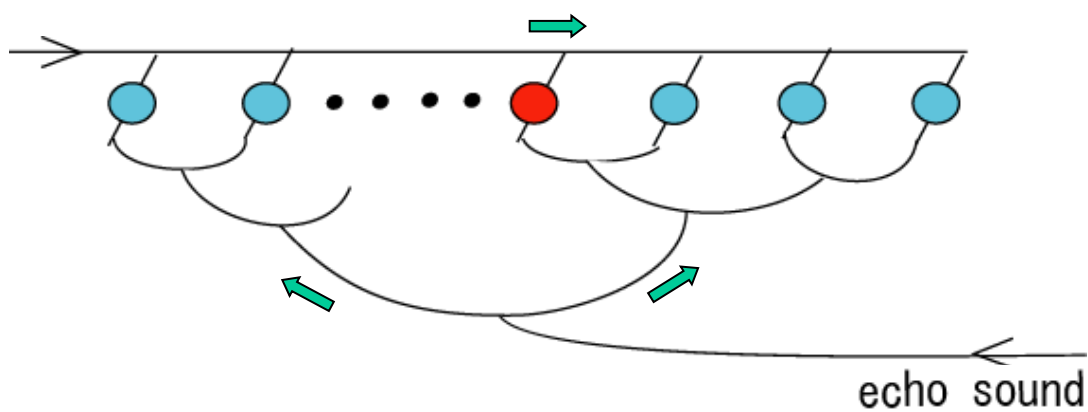
direct sound



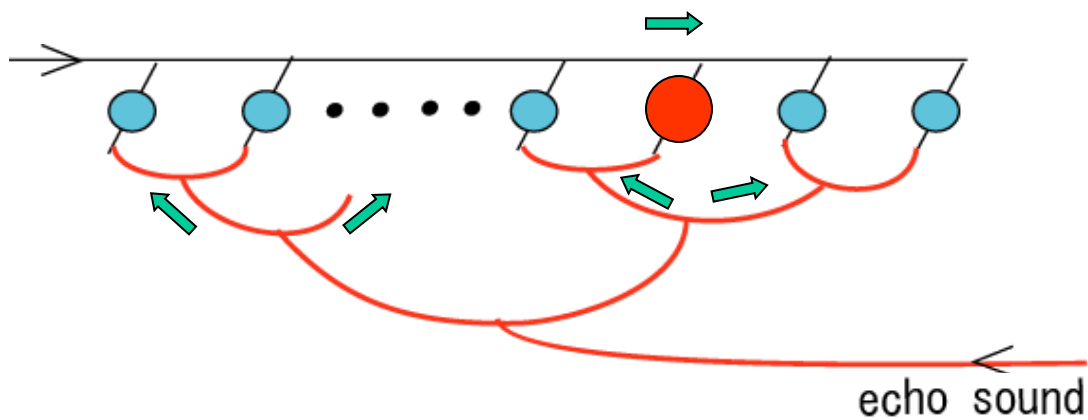
direct sound



direct sound

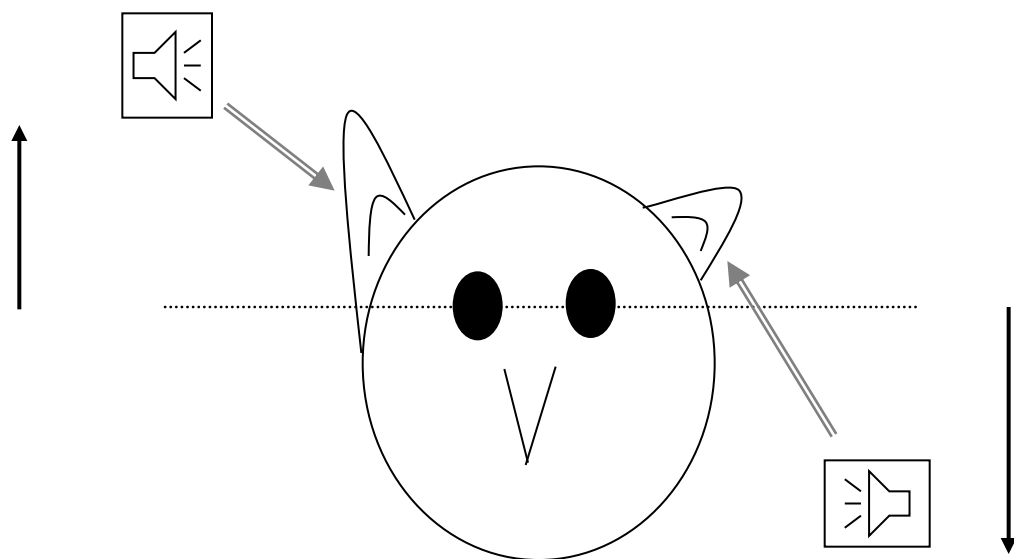


direct sound

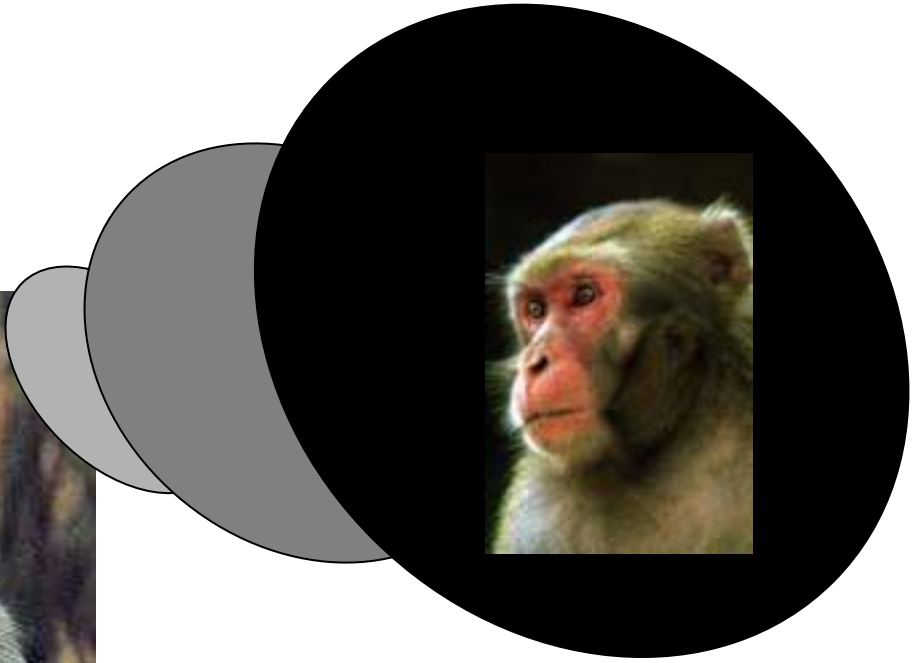


音源定位(垂直方向)

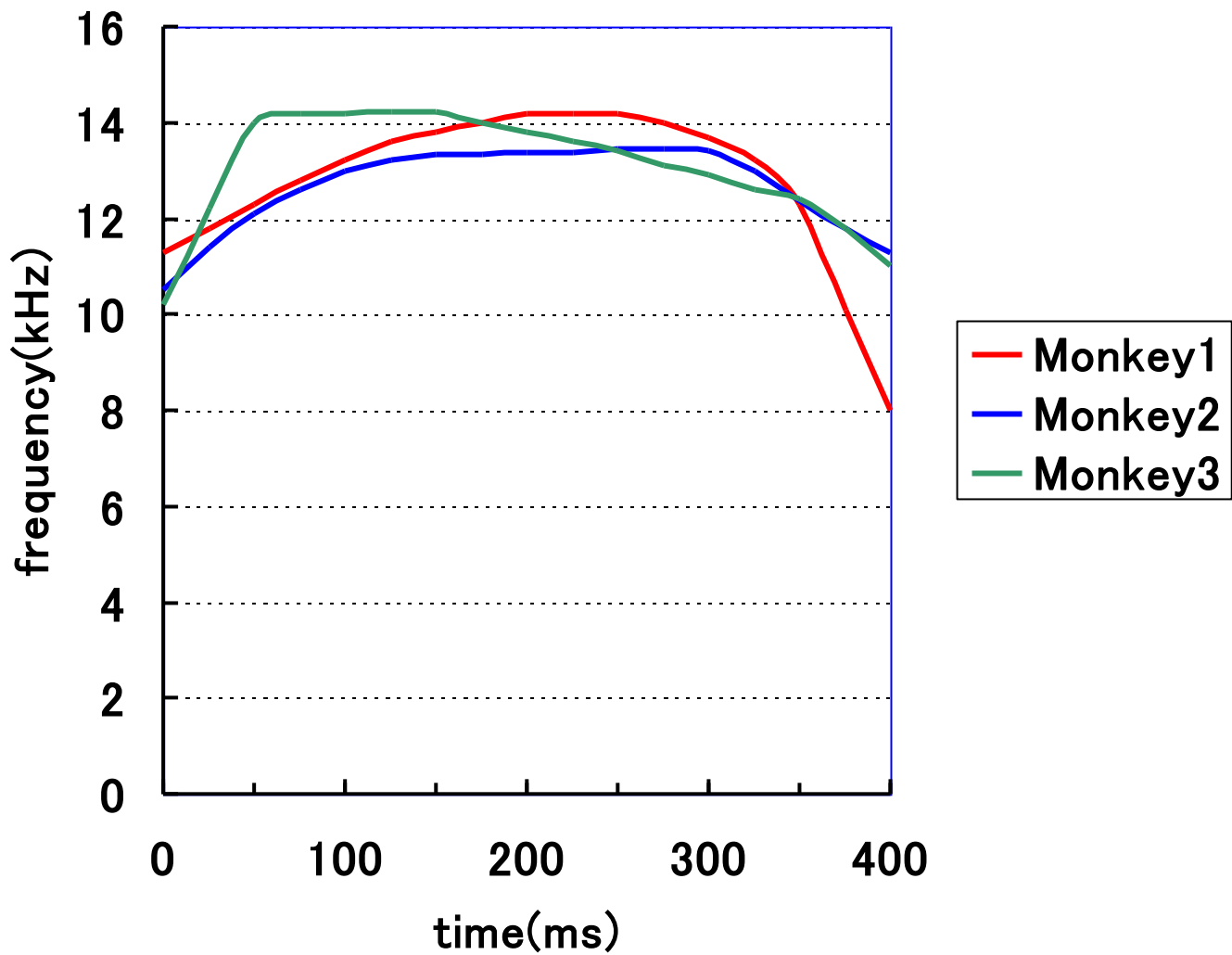
右耳

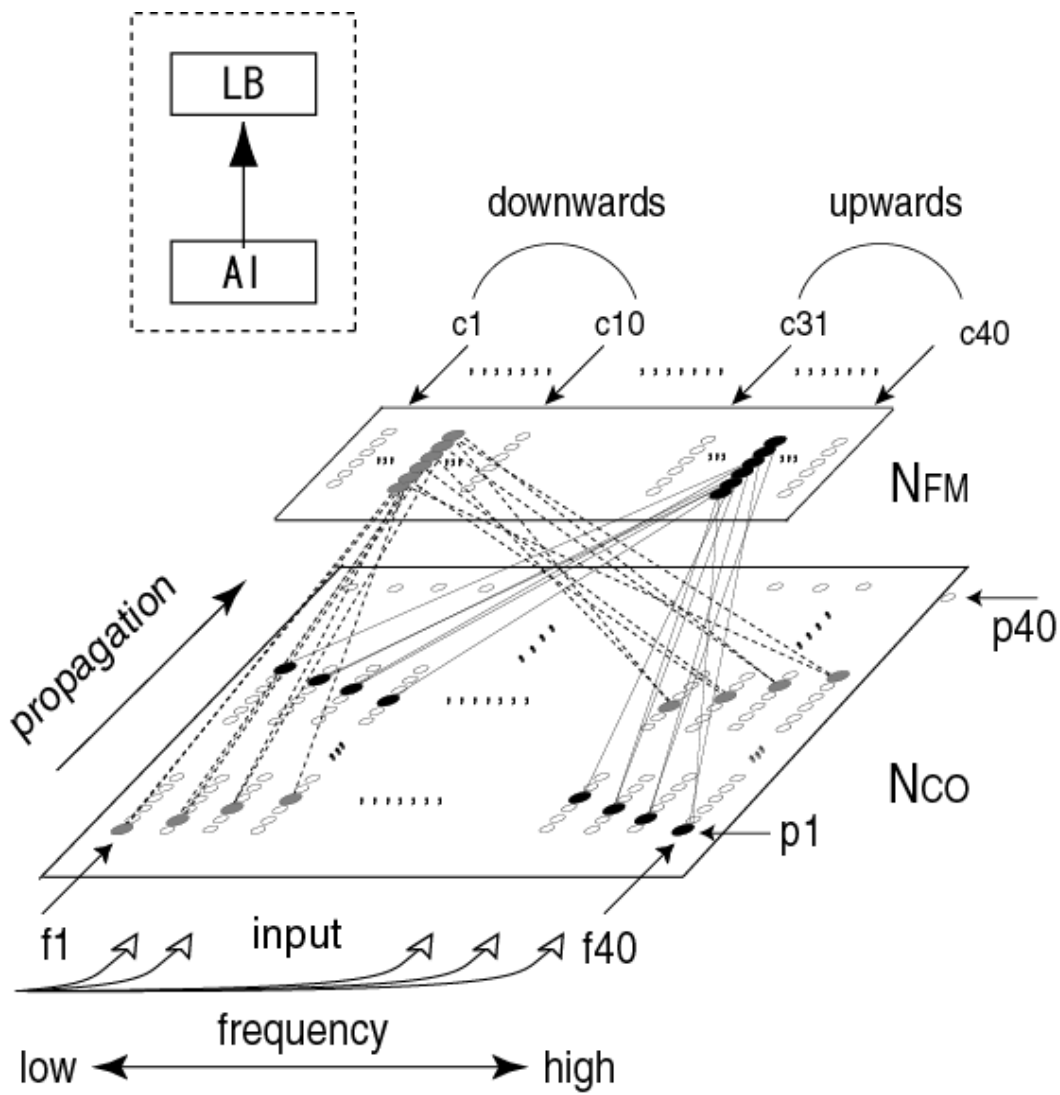


左耳



kiiiiii.....



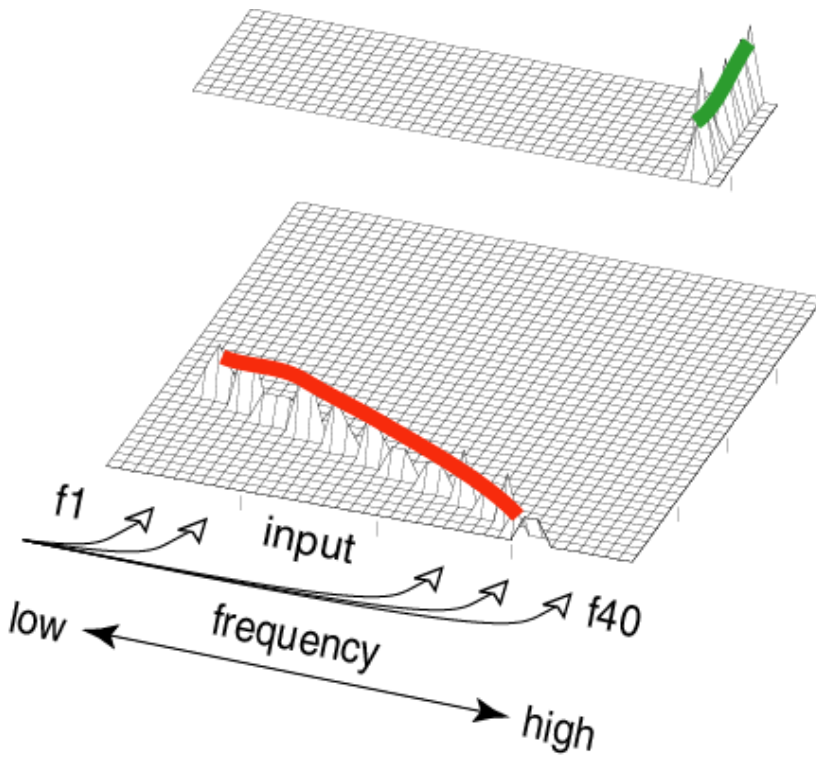
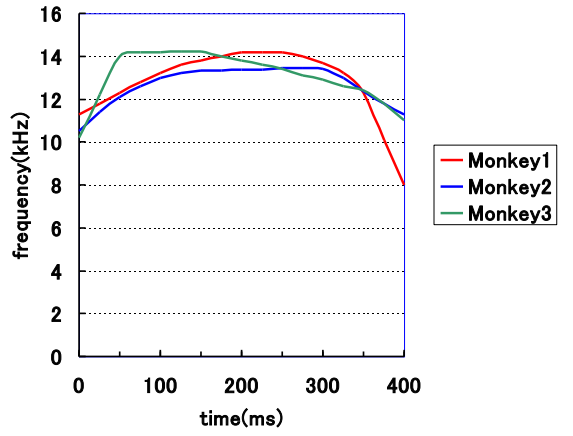


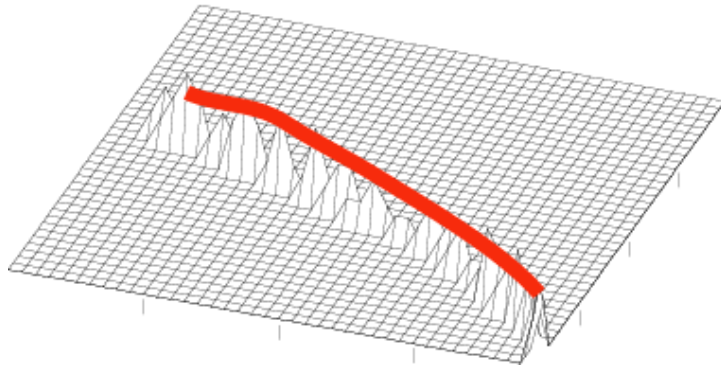
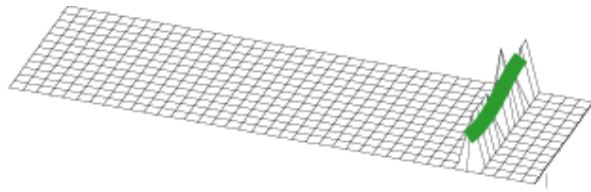
$$\begin{aligned} \tau_{CO} \frac{du_{k-i}^{CO}(t)}{dt} = & -u_{k-i}^{CO}(t) + \sum_{j=1}^{M_D} [w_{k-i,k-(i-j)}^{ex} S_{k-(i-j)}^{CO}(t-j\Delta t) \\ & + w_{k-i,k-(i+j)}^{ih} S_{k-(i+j)}^{CO}(t-j\Delta t)], \end{aligned} \quad (2.1)$$

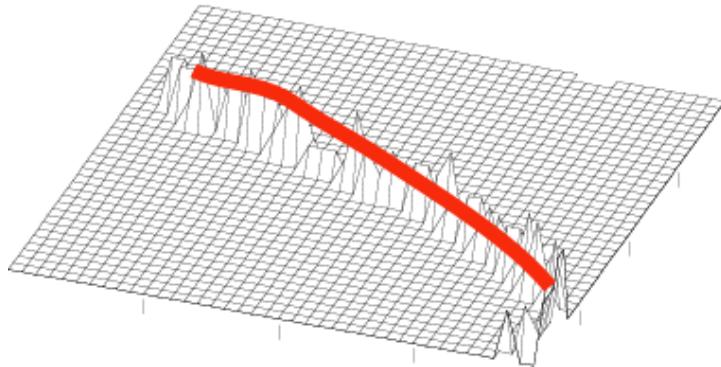
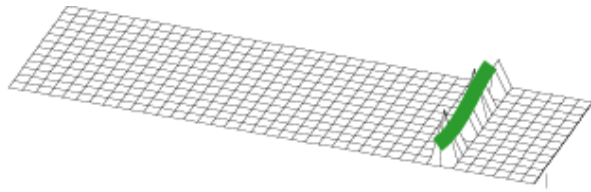
$$\begin{aligned} \tau_{FM} \frac{du_i^{FM}(t)}{dt} = & -u_i^{FM}(t) + \sum_{k=f1}^{f40} \sum_{j=p1}^{p40} L_{i,k-j} S_{k-j}^{CO}(t-\Delta t_{FM}) \\ & + \sum_{j=1(j \neq i)}^{M_{FM}} w_{ij}^{FM} S_j^{FM}(t), \end{aligned} \quad (2.2)$$

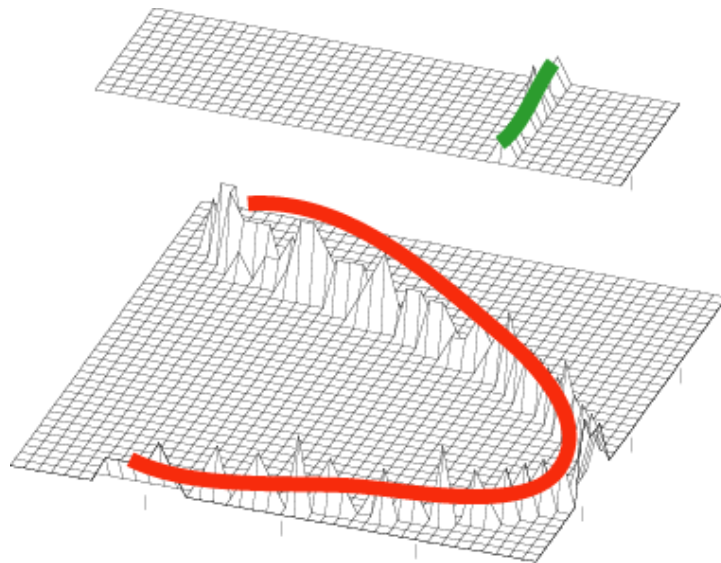
where

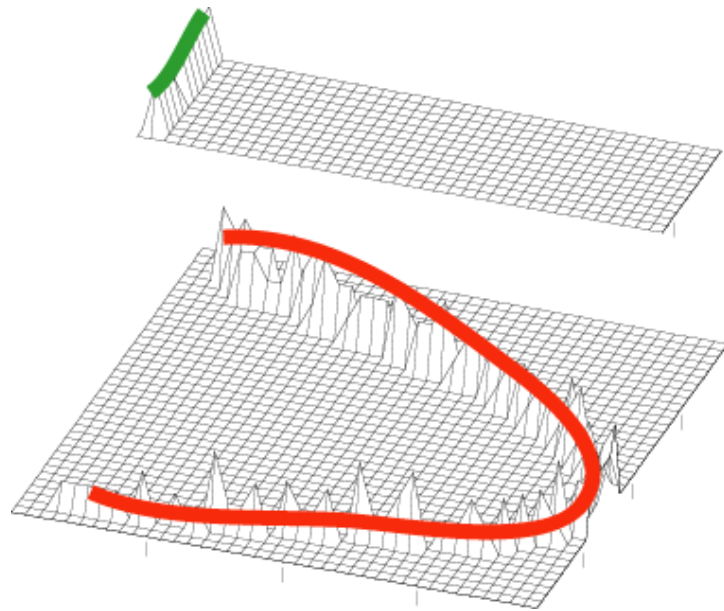
$$\begin{aligned} \text{Prob}[S_i^Y(t) = 1] = & f_Y[u_i^Y(t)] \quad (Y = CO, FM), \\ f_Y[u] = & \frac{1}{1 + e^{-\eta_Y(u-\theta_Y)}}. \end{aligned} \quad (2.3)$$

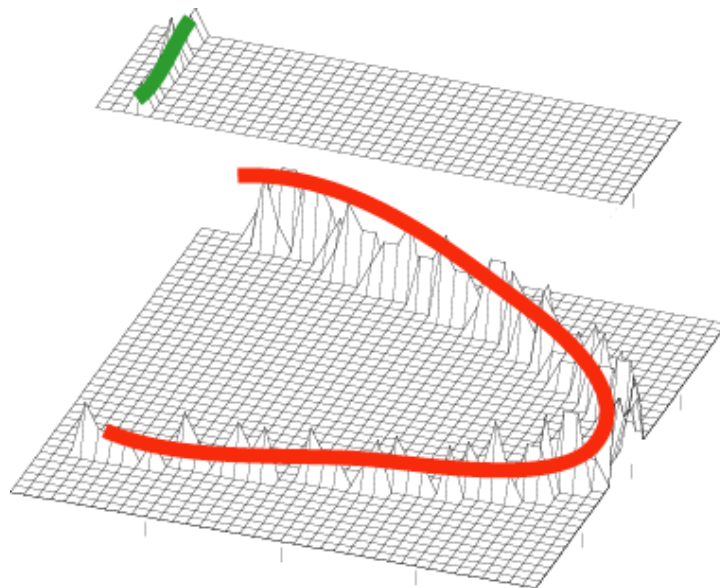


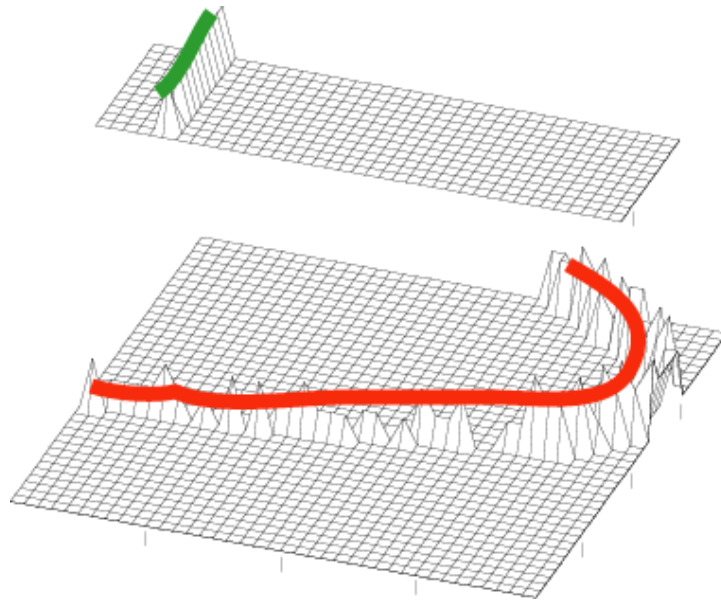












はたして脳は脳 を理解できる か？

- 人間を越える高等生物(宇宙人)のみが、人間の脳を理解できるの???