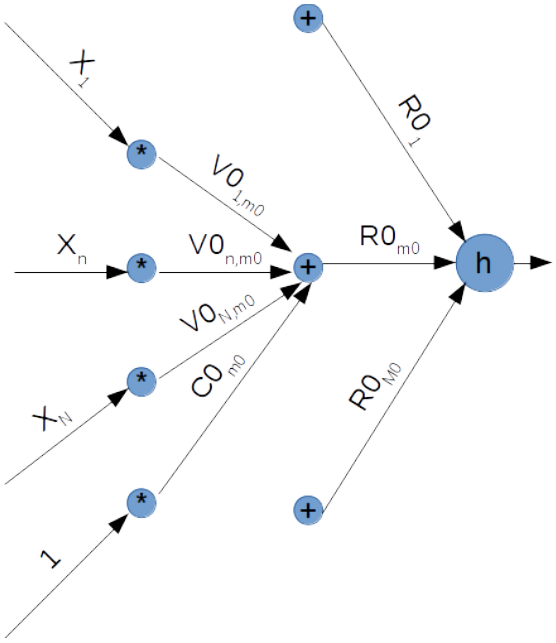
« Réseau de neurones » à zéro couche cachée (i.e. régression linéaire)



$(\text{ shape } XP) \text{ match } (P, N)$

$(\text{ shape } YP) \text{ match } (P, M0)$

$R0 =: (XP \; mp \; V0) \; add\_row \; C0$

$(\text{ shape } R0) \text{ match } (P, M0)$

$h(R0) = (R0 - YP)^2$

On cherche à minimiser $sum \; h(R0)$

$$\frac{\partial h}{\partial C0_{m0}} = \frac{\partial h}{\partial R0_{m0}} \frac{\partial R0_{m0}}{\partial C0_{m0}} = h'(R0_{m0})$$

$DC0 =: 2 * (R0 - YP)$

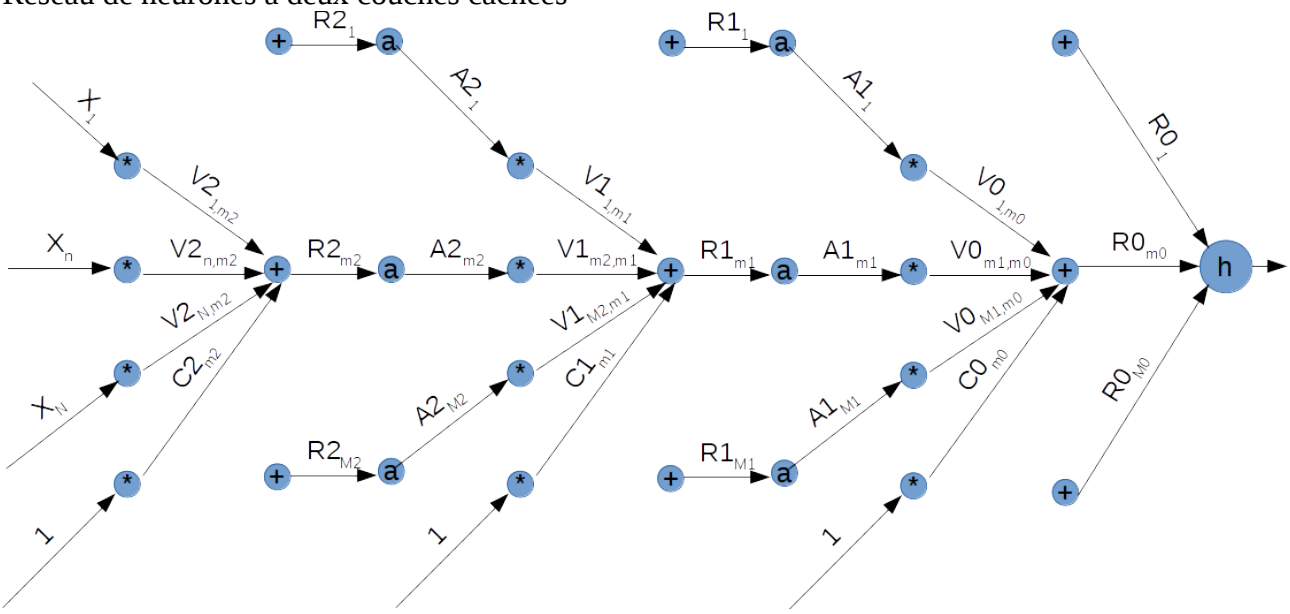
$(\text{ shape } DC0) \text{ match } (P, M0)$

$$\frac{\partial h}{\partial V0_{n,m0}} = \frac{\partial h}{\partial R0_{m0}} \frac{\partial R0_{m0}}{\partial V0_{n,m0}} = h'(R0_{m0}) X_n$$

$DV0 =: XP \text{ cp } DC0$

$(\text{ shape } DV0) \text{ match } (P, N, M0)$

Réseau de neurones à deux couches cachées



$(\text{ shape } XP) \text{ match } (P, N)$ $(\text{ shape } YP) \text{ match } (P, M0)$

$a(x) =: max(0, x)$

$R2 =: (XP\ mp\ V2)\ add\_row\ C2$ $(\text{ shape } R2) \text{ match } (P, M2)$

$A2 =: a(R2)$ $(\text{ shape } A2) \text{ match } (P, M2)$

$R1 =: (A2\ mp\ V1)\ add\_row\ C1$ $(\text{ shape } R1) \text{ match } (P, M1)$

$A1 =: a(R1)$ $(\text{ shape } A1) \text{ match } (P, M1)$

$R0 =: (A1\ mp\ V0)\ add\_row\ C0$ $(\text{ shape } R0) \text{ match } (P, M0)$

$h(R0) = (R0 - YP)^2$

$$\frac{\partial h}{\partial C0_{m0}} = \frac{\partial h}{\partial R0_{m0}} \frac{\partial R0_{m0}}{\partial C0_{m0}} = h'(R0_{m0})$$

$DC0 =: 2 * (R0 - YP)$ (shape $DC0$) match $(P, M0)$

$$\frac{\partial h}{\partial V0_{m1,m0}} = \frac{\partial h}{\partial R0_{m0}} \frac{\partial R0_{m0}}{\partial V0_{m1,m0}} = h'(R0_{m0}) A1_{m1}$$

$DV0 =: A1 \text{ cp } DC0$ (shape $DV0$) match $(P, M1, M0)$

$a'(x) =: 1 \; if \; x > 0, \; 0 \; otherwise$
$DA1 =: a'(R1)$ (shape $DA1$) match $(P, M1)$

$$\frac{\partial h}{\partial C1_{m1}} = \left(\sum_{m0=1}^{M0} \frac{\partial h}{\partial R0_{m0}} \frac{\partial R0_{m0}}{\partial A1_{m1}} \right) \frac{\partial A1_{m1}}{\partial R1_{m1}} \frac{\partial R1_{m1}}{\partial C1_{m1}} = \left(\sum_{m0=1}^{M0} h'(R0_{m0}) V0_{m1,m0} \right) a'(R1_{m1})$$

$DC1 =: (V0 \text{ mp2 } DC0) * DA1$ (shape $DC1$) match $(P, M1)$

$$\frac{\partial h}{\partial V1_{m2,m1}} = \left(\sum_{m0=1}^{M0} \frac{\partial h}{\partial R0_{m0}} \frac{\partial R0_{m0}}{\partial A1_{m1}} \right) \frac{\partial A1_{m1}}{\partial R1_{m1}} \frac{\partial R1_{m1}}{\partial V1_{m2,m1}} = \left(\sum_{m0=1}^{M0} h'(R0_{m0}) V0_{m1,m0} \right) a'(R1_{m1}) A2_{m2}$$

$DV1 =: A2 \text{ cp } DC1$ (shape $DV1$) match $(P, M2, M1)$

Etc. Etc.