Summary Backpropagation

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Dipelajari dari *https://mattmazur.com/2015/03/17/a-step-by-step-backpropagation-example/*

Desain contoh:
2 input, 2 hidden neuron, 2 output neuron

Forward Pass Hidden layer dan Output layer

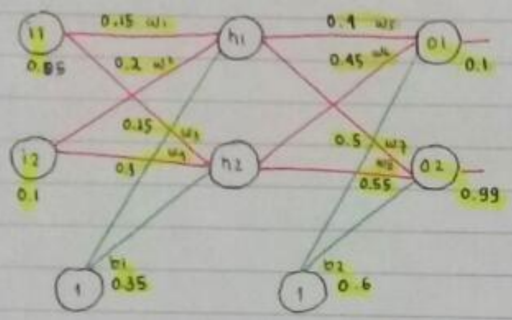
Menghitung total error dengan MSE

Backprop - Step by Step

Matmazur

Neural Network dengan 2 input, 2 hidden neuron, 2 output neuron

Hidden dan output memiliki bias.



Yg diolah di atas adalah single training set (1 data sample, 2 attribut) diberikan input 0,05 dan 0,1, NN ditrain u/ menghasilkan output 0,01 dan 0,99

Forward Pass

menghitung total net input pd tiap neuron di hidden layer, menerapkan fungsi aktivasi logistic function, ulangi u/ neuron pd layer output

- net input u/ h_1

$net\ h_1 = w_1 * i_1 + w_2 * i_2 + b1 * 1 = 0.15 * 0{,}05 + 0.2 * 0.1 + 0.35$

$= \cancel{0.445}\ 0.3775$

- fungsi aktivasi logistik ($e = 2{,}71828$)

$out\ h_1 = \dfrac{1}{1+e^{-net\ h_1}} = \dfrac{1}{1+0.68557} = 0{,}593269992 1$ } h_1 out

- $net\ h_2 = w_3 * i_1 + w_4 * i_2 + b_1 * 1 = 0.25 * 0.05 + 0.3 * 0.1 + 0.35 * 1$

$= 0.3925$

- $out\ h_2 = \dfrac{1}{1+e^{-0.3925}} = \dfrac{1}{1{,}6753663} = 0{,}59688437826$ } h_2 out

HIDDEN LAYER ↑

OUTPUT LAYER ↓

- $net\ o_1 = w5 * h_1 + w6 * h_2 + b_2 * 1$ (h_1, h_2 out → hasil stlh aktivasi)

$= 0.4 * 0.593269 + 0.45 * 0.596884 + 0.6$

$= 1{,}10590596706$

- $out\ o_1 = \dfrac{1}{1+e^{-net o_1}} = \dfrac{1}{1{,}33091095198} = 0{,}75136506955$ } o_1 out

- $net\ o_2 = w7 * h_1 out + w8 * h_2 out + b_2 * 1$

$= 0.5 * 0.593269 + 0.55 * 0.596884 + 0.6$

$= 1{,}22492140409$

- $out\ o_2 = \dfrac{1}{1+e^{-net o_2}} = \dfrac{1}{1{,}29378078938} = 0{,}77292846532$ } o_2 out

Menghitung Total Error

hitung error untuk tiap output neuron dengan Squared Error

$$E_{total} = \sum \tfrac{1}{2}(target - output)^2$$

$$E = \tfrac{1}{2}(target - actual)^2$$

- wikipedia -

- Error o_1

$E_{o1} = \frac{1}{2}(0.01 - 0.75136506955)^2 = \frac{1}{2} * 0{,}54962216634 = 0.27481108317$

- Error o_2

$E_{o2} = \frac{1}{2}(0.99 - 0.77292846532)^2 = \frac{1}{2} * 0.04712005116 = 0.02356002558$

- Total Error

$E_{total} = E_{o1} + E_{o2} = 0{,}29837110875$

Backward Pass dan update bobot

Backward Pass

Tujuan dari backpropagation adlh meng-update tiap bobot dlm jaringan/network, sehingga nilai yg dihasilkan model mendekati nilai aslinya, dengan demikian meminimalkan error pd tiap output dan scr keseluruhan arsitektur.

OUTPUT LAYER ⇩

* perhatikan w5

seberapa banyak w5 mempengaruhi total ERROR ,
↳perubahan

atau ditulis $\frac{\partial Etotal}{\partial w5}$

dibaca **"derivatif partial dari Etotal terhadap w5"** atau bisa juga **" gradien w5 "**

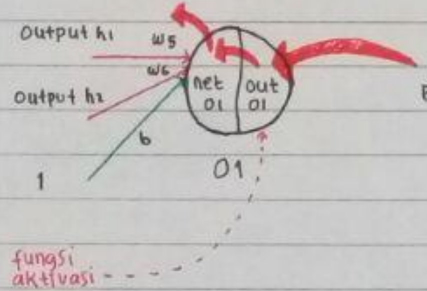
dengan chain-rule dapat ditulis

$$\frac{dz}{dx} = \frac{dz}{dy} * \frac{dy}{dx}$$

- wikipedia -

$$\frac{\partial Etotal}{\partial w5} = \frac{\partial Etotal}{\partial out\, o1} * \frac{\partial out\, o1}{\partial net\, o1} * \frac{\partial net\, o1}{\partial w5}$$

secara visual jika dilihat neuron pada network :



$$Eo1 = \frac{1}{2}(target\, o1 - out\, o1)^2$$

$$Etotal = Eo1 + Eo2$$

$$\frac{\partial net\, o1}{\partial w5} * \frac{\partial out\, o1}{\partial net\, o1} * \frac{\partial Etotal}{\partial out\, o1} = \frac{\partial Etotal}{\partial w5}$$

Perhitungan turunannya :

* $Etotal = \underbrace{\frac{1}{2}(target\, o1 - out\, o1)^2} + \underbrace{\frac{1}{2}(target\, o2 - out\, o2)^2}$

* $\frac{Etotal}{\partial out\, o1} = 2 * \frac{1}{2}(target\, o1 - out\, o1)^1 * (-1) + 0$

$= -(target\, o1 - out\, o1) \longrightarrow$ dapat juga ditulis out - target

$= -(0{,}01 - 0.75136506955)$

$= 0.74136506955$

* $out\, o1 = \frac{1}{1+e^{-net\, o1}}$

* $\frac{\partial out\, o1}{\partial net\, o1} = out\, o1(1 - out\, o1)$

$= 0.75136506955\,(1 - 0.75136506955)$

$= 0.18681560181$

derivative log function

$$f(x) = \frac{1}{1+e^{-x}} = \frac{e^x}{1+e^x}$$

$$\frac{d}{dx}f(x) = \frac{e^x(1+e^x) - e^x e^x}{(1+e^x)^2}$$

$$= \frac{e^x}{(1+e^x)^2}$$

$$= f(x)\,(1 - f(x))$$

- wikipedia -

* $net\, o1 = w5 * out\, h1 + w6 * out\, h2 + b2 * 1$

* $\frac{\partial net\, o1}{\partial w5} = out\, h1$

$= 0.593269992$1

** balik ke chain rule

$$\frac{\partial Etotal}{\partial w5} = \frac{\partial Etotal}{\partial out\, o1} * \frac{\partial out\, o1}{\partial net\, o1} * \frac{\partial net\, o1}{\partial w5}$$

$= 0{,}74136506955 * 0{,}18681560181 * 0{,}593269992 1$

$= 0{,}082167041$

update bobot

dengan eta = 0,5 (learning rate)

learning rate, eta = η bisa juga dengan alfa α, atau epsilon ϵ.

* $w5^+ = \boxed{w5 - \eta * \frac{\partial Etotal}{\partial w5}}$

$= 0{,}4 - (05 * 0{,}082167041)$

$= 0{,}35891648$

Backward Pass dan update bobot (2)

* w_6^+

No.

Date

* w_7^+

* w_8^+

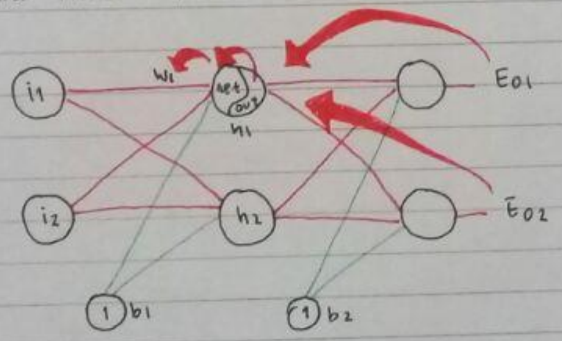
Hidden layer

Setelah backward pass melalui output layer, sekarang dilanjut ke hidden layer, untuk update w1, w2, w3, w4.

misal untuk w1,

$$\frac{\partial Etotal}{\partial w_1} = \frac{\partial Etotal}{\partial out\, h_1} * \frac{\partial out\, h_1}{\partial net\, h_1} * \frac{\partial net\, h_1}{\partial w_1}$$

secara visual :



Etotal = Eo1 + Eo2

$$\frac{\partial net h_1}{\partial w_1} * \frac{\partial out h_1}{\partial net h_1} * \frac{\partial Etotal}{\partial out h_1} = \frac{\partial E total}{\partial w_1}$$

↓

$$\frac{\partial Etotal}{\partial out h_1} = \frac{\partial E_{o1}}{\partial out h_1} + \frac{\partial E_{o2}}{\partial out h_1}$$

Update w1, w2, w3, w4

Date :

dengan rumus update bobot sebelumnya

Mohon maaf Bu, perhitungannya belum selesai ...

Mohon maaf Bu karena belum lengkap dan berupa foto catatan karena baru faham.
Semoga dapat diterima, terimakasih.