THE INCREDIBLE SHRINKING NEURAL NETWORK: PRUNING TO OPERATE IN CONSTRAINED MEMORY ENVIRONMENTS

Nikolas Wolfe, Aditya Sharma, Lukas Drude & Bhiksha Raj
School of Computer Science
Carnegie Mellon University
Pittsburgh, PA 15213, USA
{nwolfe, adityasharma, bhiksha}@cmu.edu
{drude@nt.upb.de}

1 2ND DERIVATIVE BACKPROP WEIGHT UPDATE RULE

Weight error (1st order approx):

$$E\left(w\right)=E\left(w_0\right)+\frac{\partial E}{\partial w}\left(w-w_0\right) \tag{1}$$

We want:

$$E\left(w\right)=0 \tag{2}$$

$$0=E\left(w_0\right)+\frac{\partial E}{\partial w}\left(w-w_0\right) \tag{3}$$

$$0=E\left(w_0\right)+\frac{\partial E}{\partial w}w-\frac{\partial E}{\partial w}w_0 \tag{4}$$

$$\frac{\partial E}{\partial w}w=\frac{\partial E}{\partial w}w_0-E\left(w_0\right) \tag{5}$$

$$w=w_0-\frac{E\left(w_0\right)}{\frac{\partial E}{\partial w}} \tag{6}$$

Weight error (2nd order approx):

$$E\left(w\right)=E\left(w_0\right)+\frac{\partial E}{\partial w}\left(w-w_0\right)+\frac{1}{2}\frac{\partial^2 E}{\partial w^2}\left(w-w_0\right)^2 \tag{7}$$

We want:

$$E\left(w\right)=0 \tag{8}$$

$$0=\underbrace{E\left(w_0\right)}_{c}+\underbrace{\frac{\partial E}{\partial w}}_{b}\left(w-w_0\right)+\underbrace{\frac{1}{2}\frac{\partial^2 E}{\partial w^2}}_{a}\left(w-w_0\right)^2 \tag{9}$$

$$0=ax^2+bx+c \tag{10}$$

$$x=\frac{-b\pm\sqrt{b^2-4ac}}{2a} \tag{11}$$

$$\left(w-w_0\right)=\frac{-\left(\frac{\partial E}{\partial w}\right)\pm\sqrt{\left(\frac{\partial E}{\partial w}\right)^2-4\left(\frac{1}{2}\frac{\partial^2 E}{\partial w^2}\right)E\left(w_0\right)}}{2\left(\frac{1}{2}\frac{\partial^2 E}{\partial w^2}\right)} \tag{12}$$

$$w=w_0+\frac{-\left(\frac{\partial E}{\partial w}\right)\pm\sqrt{\left(\frac{\partial E}{\partial w}\right)^2-2\left(\frac{\partial^2 E}{\partial w^2}\right)E\left(w_0\right)}}{\left(\frac{\partial^2 E}{\partial w^2}\right)} \tag{13}$$

We only need one of the zeros so...

$$w=w_0+\frac{\sqrt{\left(\frac{\partial E}{\partial w}\right)^2-2\left(\frac{\partial^2 E}{\partial w^2}\right)E\left(w_0\right)}+\left(\frac{\partial E}{\partial w}\right)}{\left(\frac{\partial^2 E}{\partial w^2}\right)} \tag{14}$$