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$$\frac{\partial y}{\partial x} = \gamma \left[\frac{\frac{d(x - \mu)}{dx} \cdot \sigma - \frac{\partial \sigma}{\partial x} (x - \mu)}{\sigma^2} \right]$$

$$\frac{\partial (x - \mu)}{\partial x} = 1 - \frac{1}{N}$$

$$\sigma^2 = \frac{\sum_{k=1}^N (x_k - \mu)^2}{N}$$

$$\frac{\partial \sigma^2}{\partial x} = \frac{2(x - \mu)}{N}$$

$\mu \rightarrow \text{const.}$

$$\frac{\partial \sigma}{\partial x} = \frac{1}{2} \cdot \frac{\frac{\partial \sigma^2}{\partial x}}{\sigma}$$

Batchnorm - alt

$$\frac{\partial y}{\partial \gamma} = \left(\frac{x - \mu}{\sigma} \right)$$

$$\frac{\partial y}{\partial \beta} = 1$$