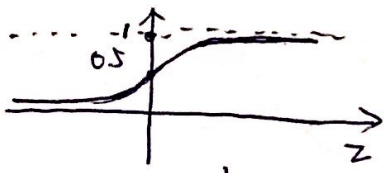
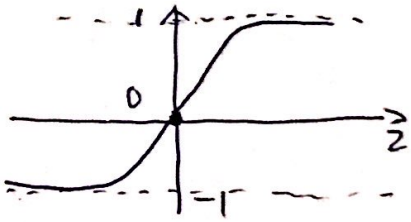
Activation Function 激活函数

① sigmoid: $\sigma(z) = \frac{1}{1+\exp(-z)} \in (0,1)$



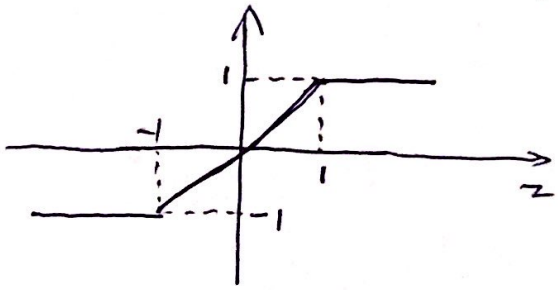
$\sigma'(z) = \sigma(z)(1-\sigma(z))$ $\quad 1-\sigma(z) = \sigma(-z) = \frac{1}{1+\exp(z)}$

② $\tanh(z) = \frac{e^z - e^{-z}}{e^z + e^{-z}} = 2\sigma(2z) - 1 \in (-1,1)$



$\tanh'(z) = 1 - \tanh^2(z)$

③ $\text{hardtanh}(z) = \begin{cases} -1, & z < -1 \\ z, & -1 \le z \le 1 \\ 1, & z > 1 \end{cases}$

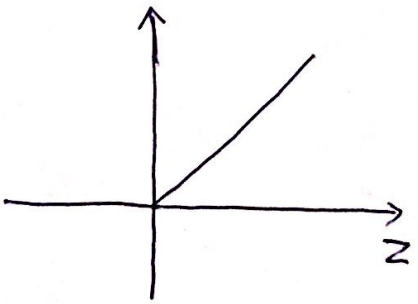


$\text{hardtanh}'(z) = \begin{cases} 1, & -1 \le z \le 1 \\ 0, & \text{otherwise} \end{cases}$

④ ReLU: Rectified Linear Unit

$\text{rect}(z) = \max(z, 0)$

$\text{rect}'(z) = \begin{cases} 1, & z > 0 \\ 0, & \text{otherwise} \end{cases}$



⑤ Leaky ReLU: $z \le 0$ 依旧能传递梯度

$\text{leaky}(z) = \max(z \cdot k, z)$, where $0 < k < 1$

$\text{leaky}'(z) = \begin{cases} 1, & z > 0 \\ k, & \text{otherwise} \end{cases}$