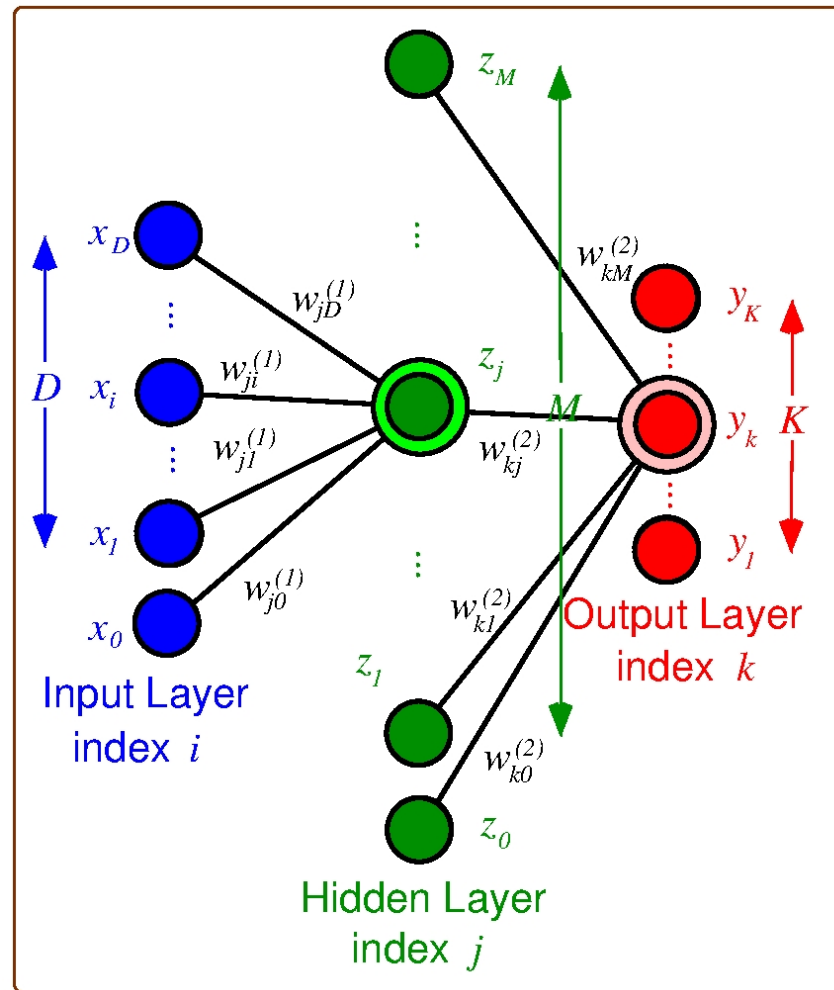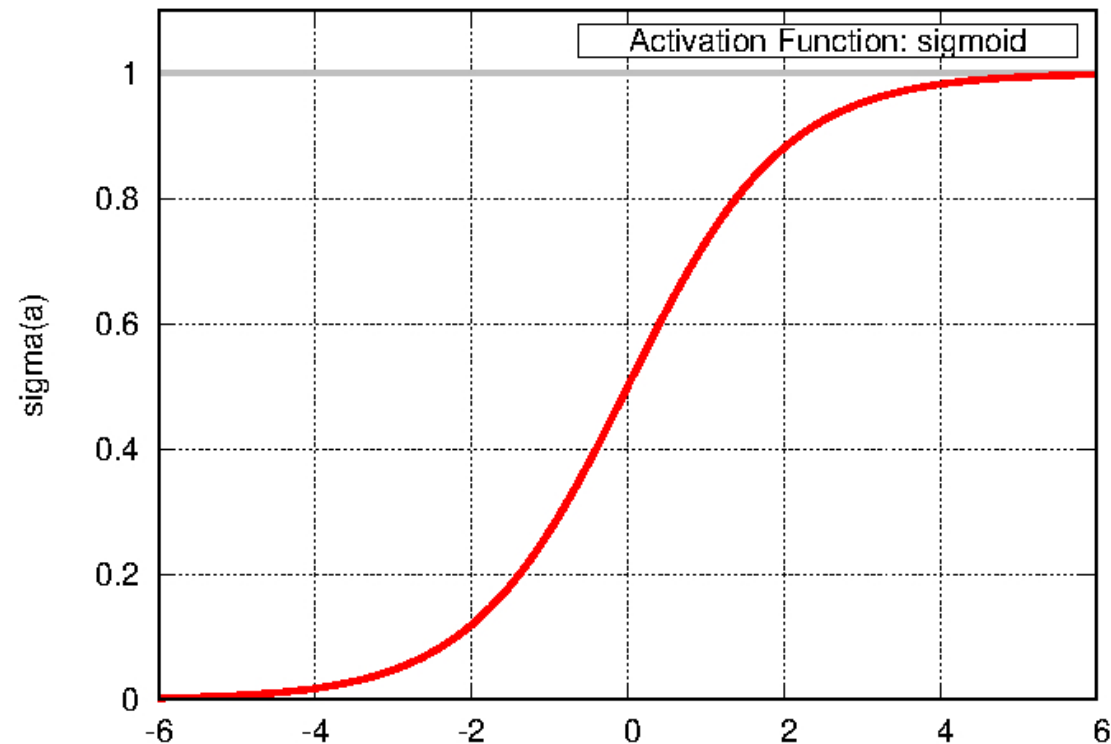# Multi-Layer Perceptron

- h'layer activ'n fn: z_j:
  $h(a_j^{(1)})$: sigmoid/tanh

- o'layer activ'n fn: y_k:
  $\sigma(a_k^{(2)})$: prob specs

- Regression: Identity
  $y_k = a_k^{(2)}$

- Classification:
  sigmoid/softmax;
  sigmoid: 2-class
  softmax: multi-class

- softmax $= \exp / \sum \exp$

- Sgn: harsh $\tanh(\cdot)$;
  0/1 step: harsh $\sigma(\cdot)$
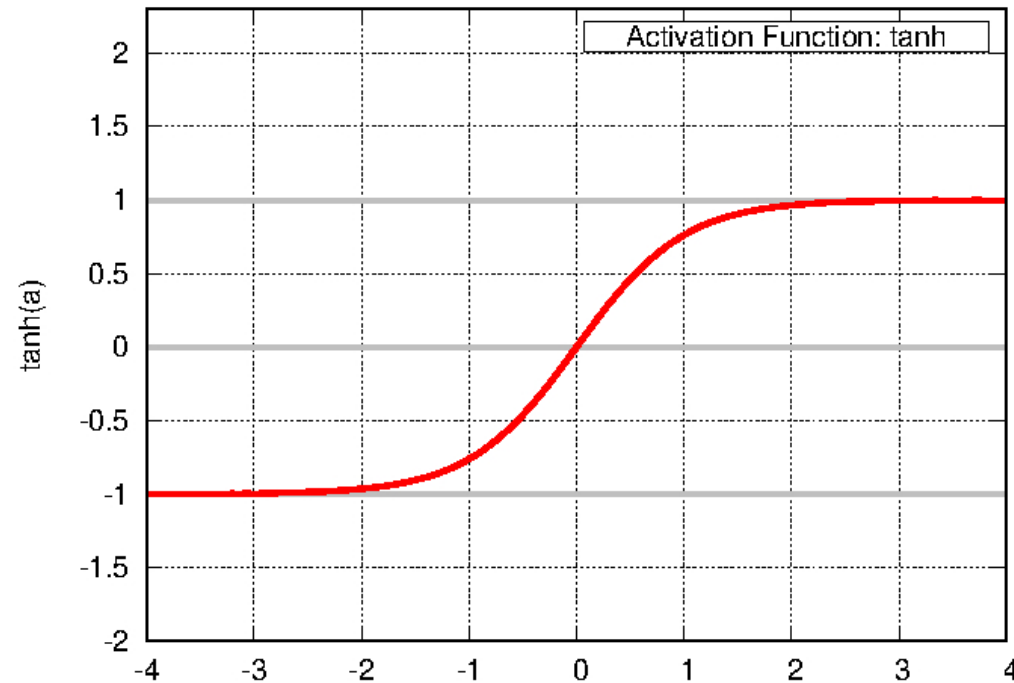
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Activation Fns: Logistic Sigmoid

- $\boxed{\sigma(a) \overset{\triangle}{=} \frac{1}{1+e^{-a}}}$ softer unit step; differentiable

- $a \to -\infty, \sigma(a) \to 0; \ a \to +\infty, \sigma(a) \to 1;$
  $a = 0, \sigma(a) = 0.5$

- (-) Computation with exponentials is difficult!

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Activation Fns: tanh

Activation Function: tanh
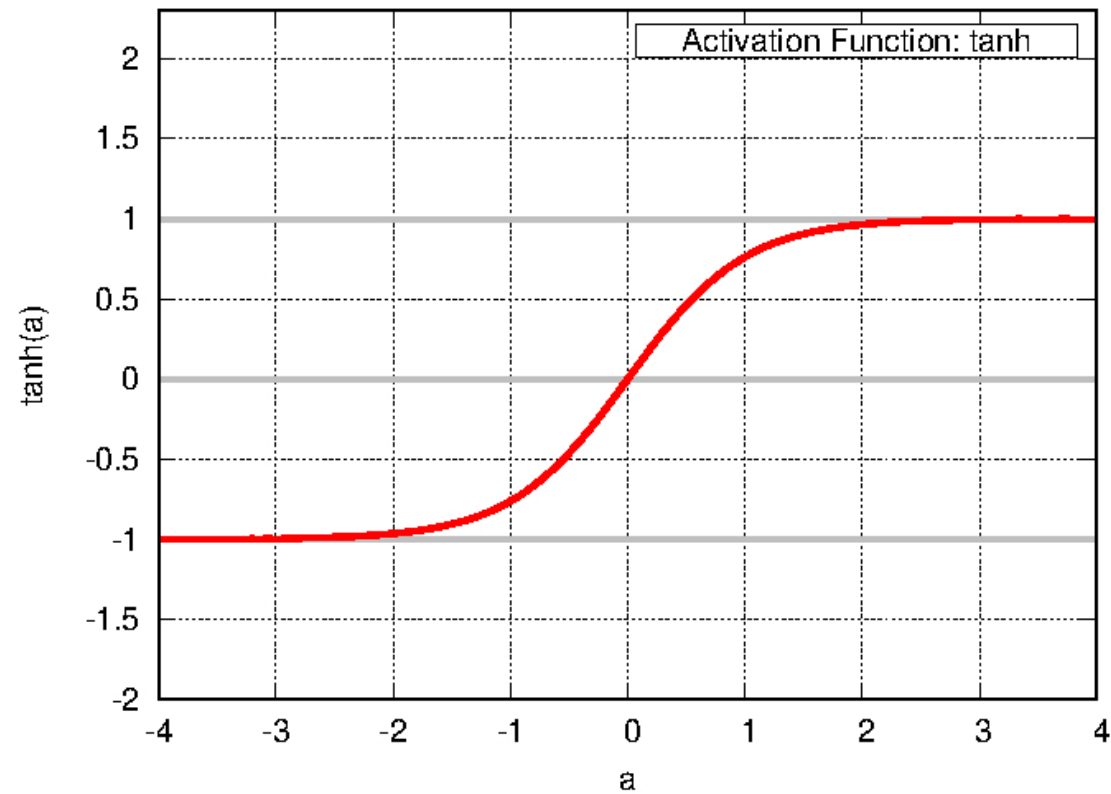
- $\tanh(a) \overset{\triangle}{=} \dfrac{e^{+a}-e^{-a}}{e^{+a}+e^{-a}}$ soft signum; differentiable

- $a \to -\infty, \sigma(a) \to -1;\ a \to +\infty, \sigma(a) \to +1;$
  $a = 0, \sigma(a) = 0$

- (-) computation with exponentials is difficult!

- (-) grad $\to 0$ as curve saturates! vanishing grad
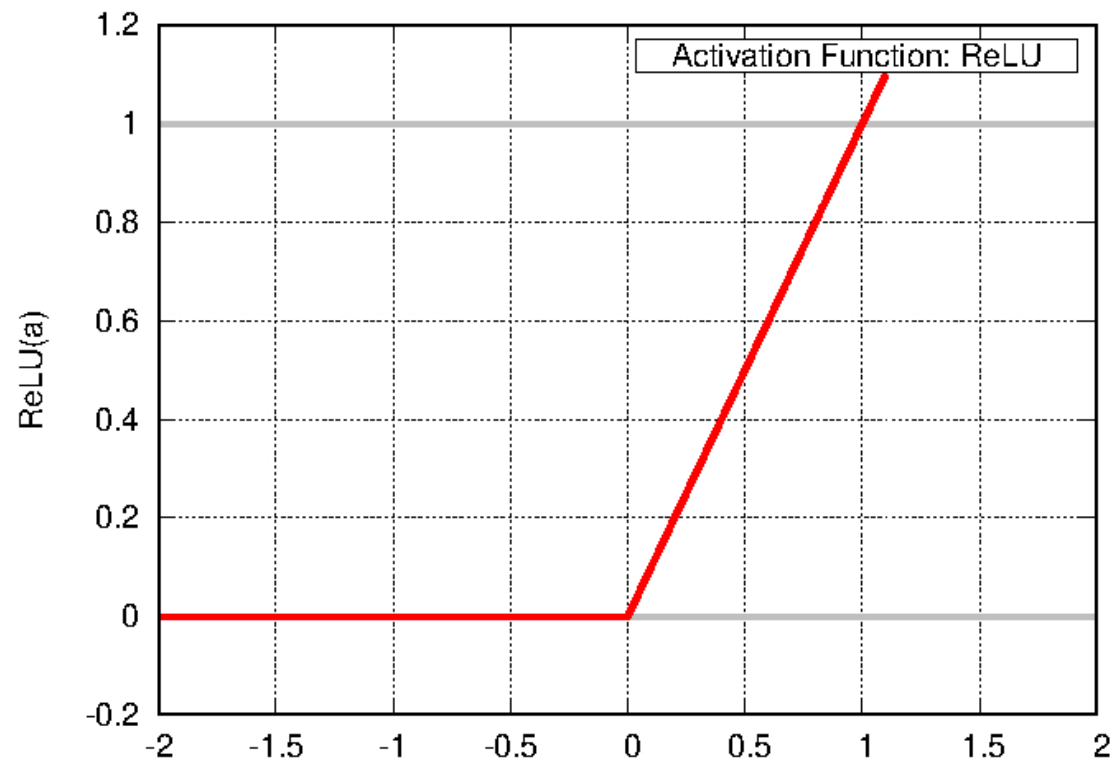
Activation Fns: tanh: Development

- $2\sigma(a) - 1$: stretch to [0, 2], then shift down by 1

- $\dfrac{2}{1+e^{-a}} - 1 = \dfrac{2-1-e^{-a}}{1+e^{-a}} = \dfrac{(1-e^{-a})e^{+a/2}}{1+e^{-a})e^{+a/2}} = \dfrac{e^{+a/2}-e^{-a/2}}{e^{+a/2}+e^{-a/2}} = \tanh\left(\dfrac{a}{2}\right)$

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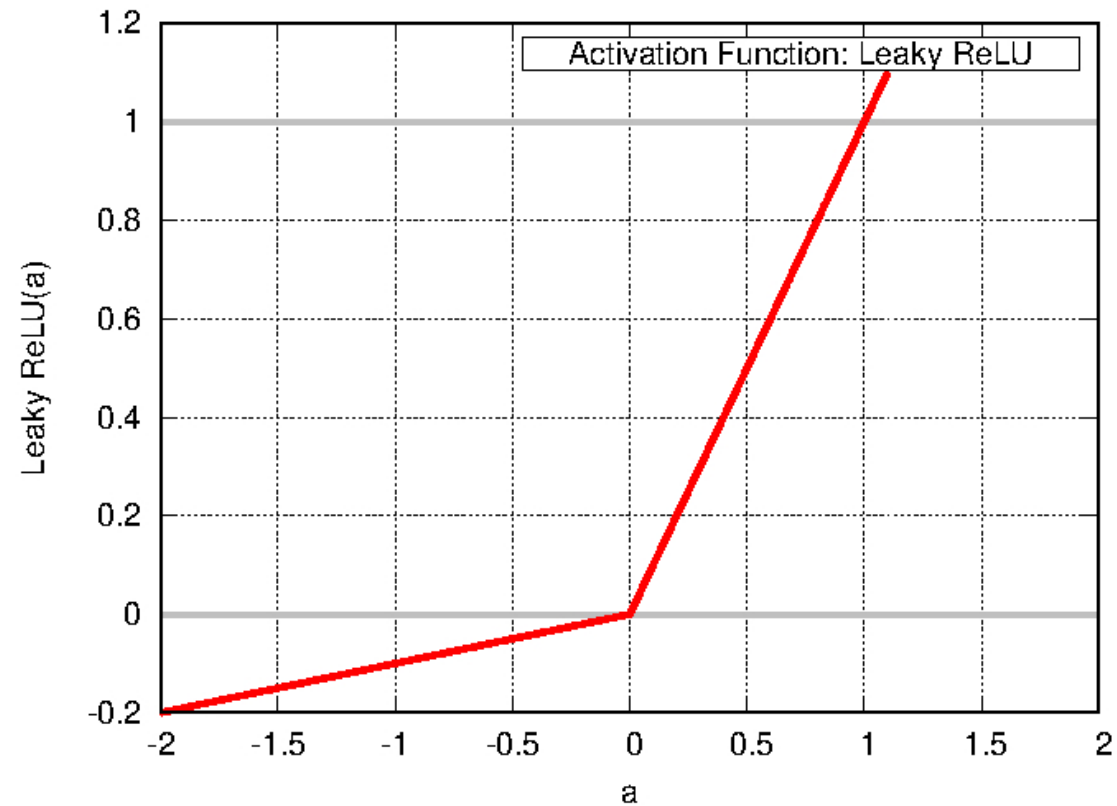
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Activation Fns: ReLU

- $ReLU(a) \stackrel{\triangle}{=} a, a \geq 0; 0, \text{otherwise}$ Easy to compute

- (+) no vanishing gradient as no saturation!
- (-) negative inputs, no gradient

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Activation Fns: Leaky ReLU

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