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① class-imbalance

a) use weighted accuracy because some patterns require more data samples

OR

b) Resampling, up-sampling, down-sampling, synthetic data samples

② Backpropagation in neural network

$$h_1 = f_1(w_1x + b_1)$$

$$h_2 = f_2(w_2 + b_2)$$

$$n=1,2,3$$

$$g = f_3(w_3h_1 + w_4h_2 + b_3)$$

$$f' = \frac{dfn(v)}{dv}$$

$$\frac{dL}{dw_1} = \frac{dL}{dh_1} f'_1 x$$

$$\frac{dL}{dw_2} = \frac{dL}{dh_2} f'_2 x$$

$$\frac{dL}{dw_3} = \frac{dL}{dh_3} f'_3 x$$

$$\frac{dL}{dw_4} = \frac{dL}{dh_4} f'_4 x$$

$$\frac{dL}{db_1} = \frac{dL}{dz} = \frac{dz}{db_1} = \frac{dL}{dz} \quad \text{bc } \frac{dz}{db_1} = 1$$

$$\frac{dL}{db_2} = \frac{dL}{dz} = \frac{dz}{db_2} = \frac{dL}{dz}$$

$$\frac{dL}{db_3} = \frac{dL}{dz} = \frac{dz}{db_3} = \frac{dL}{dz}$$

$$\frac{dL}{dx} = \frac{dL}{dh_1} \frac{dh_1}{dx} + \frac{dL}{dh_2} \frac{dh_2}{dx}$$

③ graph

$$h = 2x + 1$$

$$z = x^2$$

$$y = \frac{1}{1+e^{-h}}$$

$$x \Rightarrow h = 2x+1 \Rightarrow y = \frac{1}{1+e^{-h}} \Rightarrow y$$

$$x \Rightarrow z = x^2 \Rightarrow z$$

②  $\frac{dy}{dz}$  = DNE because  $y$  is not a function of  $z$

③ The math:  $y = \frac{1}{1+e^{-x}} = \frac{dy}{dz} = \frac{e^{-x}}{(1+e^{-x})^2}$

④ classification using NN

Net 1

Binary cross entropy loss: output layer has only one unit  
vs - sigmoidal

Net 2

cross entropy loss: - Net 2 output has  $k$  output units for  $k$ -classes  
- softmax function

⑤ yes, MSE is scale-sensitive. This means that the variability of each target relative to others can effect net learning

↳ now, use  $z$  normalization