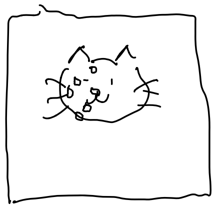
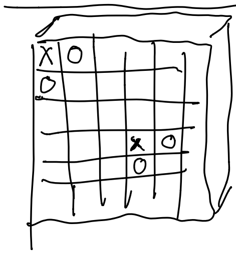
$X =$ 

Total Variation Loss



$$X_{i,j,c} \approx X_{i+1,j,c}$$

$$X_{i,j,c} \approx X_{i,j+1,c}$$

$$J_{TV}(X) = \sum_{i=1}^{n_h-1} \sum_{j=1}^{n_w-1} \sum_{c=1}^{n_c} \left\{ \left| X_{i,j,c} - X_{i+1,j,c} \right| + \left| X_{i,j,c} - X_{i,j+1,c} \right| \right\}$$

minimized if all pixels have same value.

$$J_{TV}(X) = \sum_{i=1}^{n_{h-1}^{[0]}} \sum_{j=1}^{n_{w-1}^{[0]}} \sum_{c=1}^{n_c^{[0]}} \left\{ \left(X_{i,j,c} - X_{i+1,j,c}\right)^2 + \left(X_{i,j,c} - X_{i,j+1,c}\right)^2 \right\}^{1.25}$$

$$J_{content}(X) = \sum_{i=1}^{n_h^{[l]}} \sum_{j=1}^{n_w^{[l]}} \sum_{c=1}^{n_c^{[l]}} \left(a_{i,j,c}^{(content)[l]} - a_{i,j,c}^{(X)[l]} \right)^2$$

$$J_{style}(X) = \sum_{l} w^{[l]} \sum_{c_1=1}^{n_c^{[l]}} \sum_{c_2=1}^{n_c^{[l]}} \underbrace{\left\{ F_{c_1}^{(S)[l]} \cdot \left(F_{c_2}^{(S)[l]}\right)^T - F_{c_1}^{(X)[l]} \cdot \left(F_{c_2}^{(X)[l]}\right)^T \right\}^2}_{\text{sum of squared differences of corresponding entries of Gram matrix for Style and X in layer } l}$$

more normalizing constants here

sum over a specified set of layer early in the network.

$$J(X) = w_{content} J_{content}(X) + w_{style} J_{style}(X) + w_{TV} J_{TV}(X)$$

For estimation, need

$$\frac{\partial}{\partial X} J(X) = \underbrace{\frac{\partial}{\partial a^{[L]}} J(X)}_{\text{new}} \cdot \underbrace{\frac{\partial a^{[L]}}{\partial a^{[L-1]}} \cdot \frac{\partial a^{[L-1]}}{\partial a^{[L-2]}} \cdot \cdots \cdot \frac{\partial a^{[2]}}{\partial a^{[1]}}}_{\text{backpropagation as usual}} \cdot \frac{\partial a^{[1]}}{\partial X}$$

new: need to find $\underline{\dfrac{\partial J(X)}{\partial a^{[L]}}}$

we haven't done this before

but: $\dfrac{\partial a^{[1]}}{\partial x} = \dfrac{\partial a^{[1]}}{\partial a^{[0]}}$