



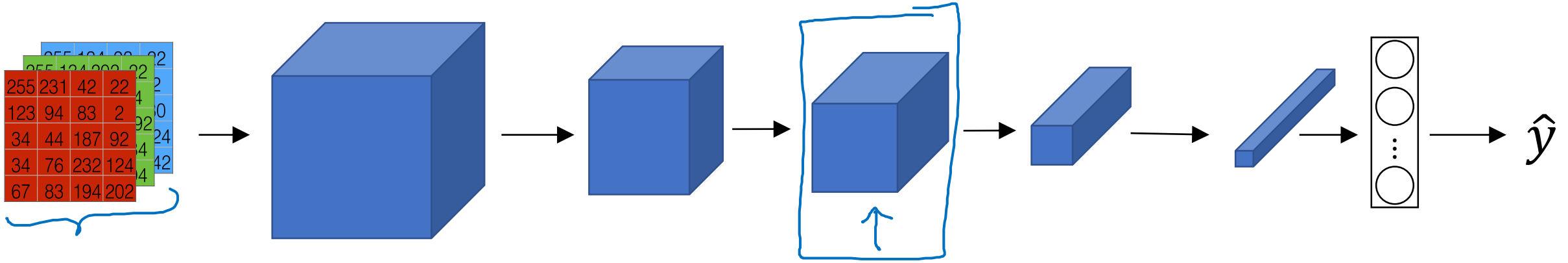
deeplearning.ai

# Neural Style Transfer

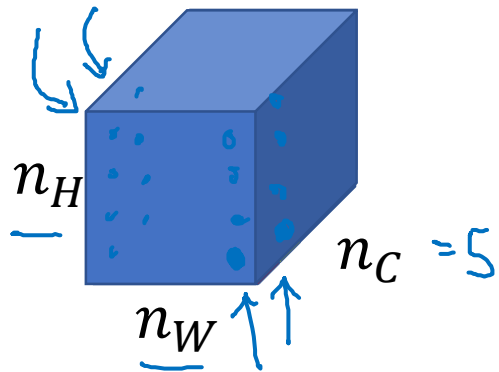
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## Style cost function

# Meaning of the “style” of an image



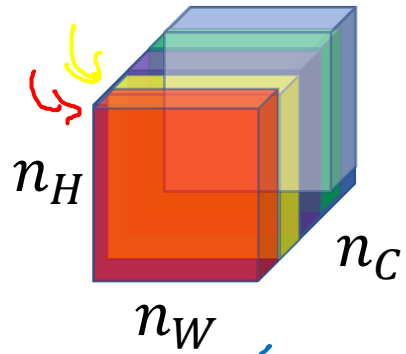
Say you are using layer  $l$ 's activation to measure “style.”  
Define style as correlation between activations across channels.



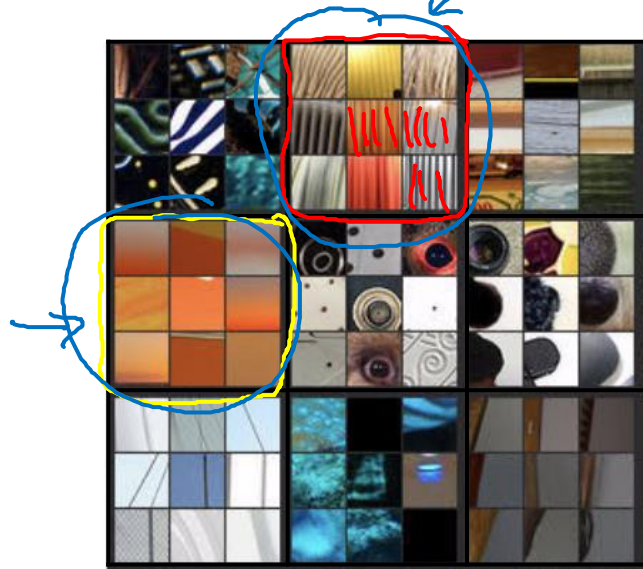
How correlated are the activations  
across different channels?

# Intuition about style of an image

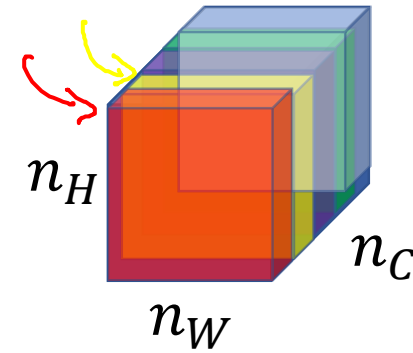
Style image



Correlated?  
Uncorrelated



Generated Image



# Style matrix

Let  $a_{i,j,k}^{[l]}$  = activation at  $(i, j, k)$ .  $\underline{G}^{[l]}$  is  $\underline{n}_c^{[l]} \times \underline{n}_c^{[l]}$

$$\begin{aligned} \rightarrow \underline{G}_{kk'}^{[l](S)} &= \sum_{i=1}^{n_H^{[l]}} \sum_{j=1}^{n_W^{[l]}} a_{ijk}^{[l](S)} a_{ijk'}^{[l](S)} \\ \rightarrow \underline{G}_{kk'}^{[l](G)} &= \sum_{i=1}^{n_H^{[l]}} \sum_{j=1}^{n_W^{[l]}} a_{ijk}^{[l](G)} a_{ijk}^{[l](G)} \end{aligned}$$

$$\begin{aligned} & n_c \\ & G_{kk'}^{[l]} \\ & \uparrow \uparrow \\ & k = 1, \dots, n_c \end{aligned}$$

"Gram matrix"

$$\begin{aligned} \beta \uparrow J_{\text{style}}^{[l]}(S, G) &= \frac{1}{(\dots)} \left\| \underline{G}^{[l](S)} - \underline{G}^{[l](G)} \right\|_F^2 \\ &= \frac{1}{(2 n_H^{[l]} n_W^{[l]} n_c^{[l]})^2} \sum_k \sum_{k'} \left( G_{kk'}^{[l](S)} - G_{kk'}^{[l](G)} \right)^2 \end{aligned}$$

# Style cost function

$$\|G^{TL(S)} - G^{TL(G)}\|_F^2$$

$$J_{style}^{[l]}(S, G) = \frac{1}{\left(2n_H^{[l]}n_W^{[l]}n_C^{[l]}\right)^2} \sum_k \sum_{k'} (G_{kk'}^{[l](S)} - G_{kk'}^{[l](G)})^2$$

$$J_{style}(S, G) = \sum_l \lambda_l J_{style}^{TL_l}(S, G)$$

$$\underbrace{J(G)}_G = \alpha J_{content}(G) + \beta J_{style}(S, G)$$