COST FUNCTION

$J(G) = \alpha J_{content}(C,G) + \beta J_{style}(S,G)$ → HOW SIMILAR THE STYLE OF (G) TO THE STYLE OF IMAGE (S)

* find the generated image G:
  - (#1). initiate G randomly → 100 x 100 x 3
  - (#2). use gradient descent to minimize J(G)

$$G := G - \frac{\alpha}{\alpha G} J(G)$$

CONTENT COST FUNCTION

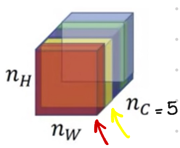
$J(G) = \alpha J_{content}(C,G) + \beta J_{style}(S,G)$

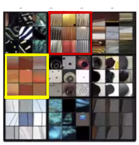
* say you use a hidden layer (L) to compute the content cost → NEITHER TOO SHALLOW NOR TOO DEEP IN THE (NN).
* use a pre-trained network (e.g. VGG)
* let $a^{[l](c)}$ and $a^{[l](g)}$ be the activation of layer l on the images
* if $a^{[l](c)}$ and $a^{[l](g)}$ are similar, both images have similar content.

$$\boxed{J_{content}(C,G) = \frac{1}{2} \| a^{[l](c)} - a^{[l](g)} \|^2}$$ → ELEMENT-WISE SUM SQ. DIFFERENCES (L2 NORM)

STYLE COST FUNCTION

* say you use a layer l to measure "style"
* define style as the correlation between activations across channels
  - how correlated are the activations across ≠ channels?





* the correlation tells you which of these high level texture components tend to occur or not to occur together in part of an image.

* if you use the degree of correlation between channels as a measure of the style, then you can measure the degree to which in your generated image, the first channel is correlated or uncorrelated with the second channel. And that will tell you in the generated image how similar is the style of the generated image to the style of the input style image.

* let $a^{[l]}_{i,j,k}$ = activation at (i,j,k) ; where $G^{[l]}$ is of size $n_c^{[l]} \times n_c^{[l]} = G^{[l]}_{kk'}$

$$\boxed{G^{[l](S)}_{kk'} = \sum_{i=1}^{n_H^{[l]}} \sum_{j=1}^{n_W^{[l]}} a^{[l](S)}_{ijk} \, a^{[l](S)}_{ijk'}}$$

STYLE MATRIX

$$\boxed{G^{[l](G)}_{kk'} = \sum_{i=1}^{n_H^{[l]}} \sum_{j=1}^{n_W^{[l]}} a^{[l](G)}_{ijk} \, a^{[l](G)}_{ijk'}}$$

GENERATED MATRIX

* if the activations are correlated, $G^{[l]}_{kk'}$ will be LARGE.

$$\boxed{J^{[l]}_{style}(S,G) = \frac{1}{(2n_H^{[l]} n_W^{[l]})^2} \left\| G^{[l](S)} - G^{[l](G)} \right\|^2_F = \frac{1}{(2n_H^{[l]} n_W^{[l]})^2} \sum_k \sum_{k'} \left(G^{[l](S)}_{kk'} - G^{[l](G)}_{kk'} \right)^2}$$

FORBENIUS NORM BETWEEN TWO STYLE MATRICES

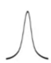
$$\boxed{J_{style}(S,G) = \sum_l \lambda^{[l]} J_{style}(S,G)}$$

OVERALL STYLE COST FUNCTION

1D AND 3D GENERALIZATION

* ECG example (1D data)

*

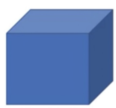


1	20	15	3	18	12	4	17

1	3	10	3	1

1D filter

* CT scan (3D data):



3D volume

14 x 14 x 14 x 1

*

3D filter

5 x 5 x 5 x 1