Neural Style

Gatys, Ecker, Bethge. “A Neural Algorithm of Artistic Style” (http://arxiv.org/abs/1508.06576)

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Neural Style

- Task: given an input photo I and a painting P, produce a photo with the same contents as I, but with the style P
- Idea: use gradient descent again to change the input with the weights of the ConvNet constant, with a cost function that keeps x close to I (i.e., preserve the content) and makes the style of x close to the style of P
- Use a ConvNet that works for image classification
  - It knows how to represent images well

Cost function: content

- To keep the content close to the input I, make sure that $|x - I|^2$ stays small
  - Not the best idea! The pixels might be a completely different colour in the x, but x and I can still be similar in content
- Even better: make sure that all the activations in all the different layers for the original image and for x stay the same:
- Make sure that $\mathrm{L}_{content}(x, I) = \sum_{l,i,j}(F(x)^l_{i,j} - F(I)^l_{i,j})^2$ is small
  - $F(y)^l_{(i,j)}$ is the activation at layer *l* at location *j* in feature map *i*, for input *y*
- Will make sure that the high-level features in the image stay the same, too

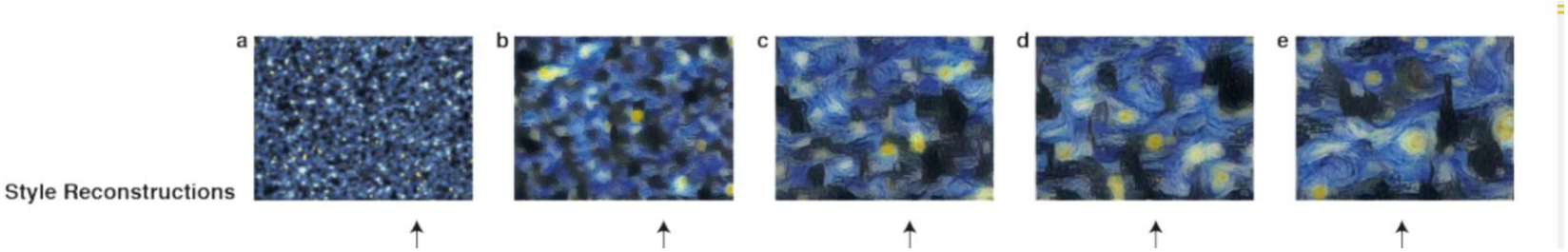
Style

- Define the Gram matrix at layer las

$$G_{ij}^{l}(y) = \sum_{k} F(y)^{l}{}_{ik} F(y)^{l}{}_{jk}$$

- Discovery: the Gram matrix represents the style
  - $G_{ij}^{l}(y)$ is large if at layer *l,* the i-th feature and the j-th feature tend to be discovered together a lot
    - (i.e., a lot of k's for which the product of both activations is large)

Style Reconstructions



- “Blue strokes at 40 degrees co-occur with blue strokes at 45 degrees?”

Cost function: style

Divide by the size of the layer to make sure every layer influences things equally for now

- $E_l(x, P) = \frac{1}{4N_l^2 M_l^2} \sum_{i,j} (G_{ij}^l(x) - G_{ij}^l(P))^2$
- $L_{style}(x, P) = \sum_l w_l E_l(x, P)$

Cost function: overall

- $cost(x, I, P) = \alpha L_{style}(x, P) + \beta L_{content}(x, I)$