VISUALIZING CNNs
[intepreting CNN decisions]

Attribution techniques

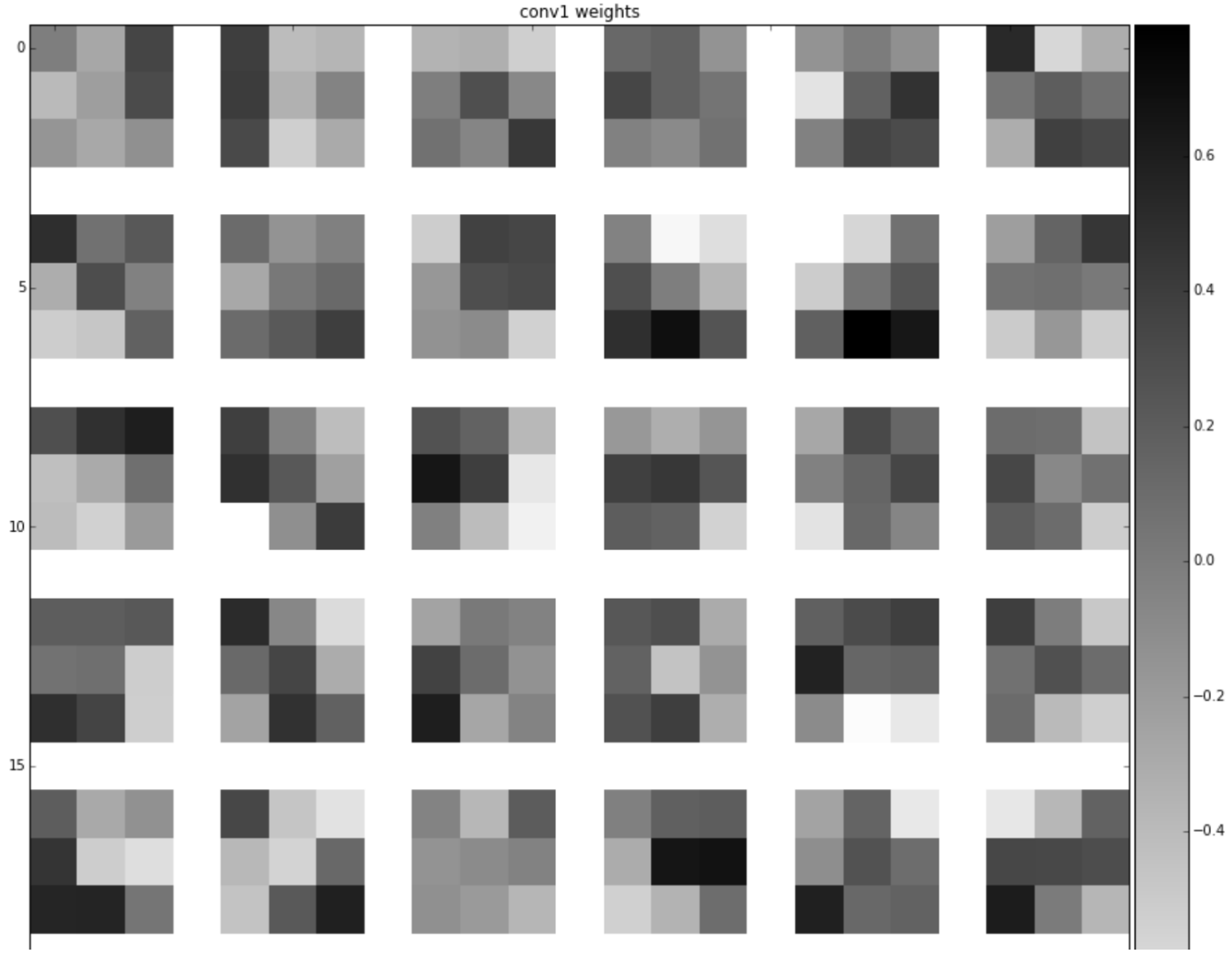
DEEP NETWORKS ARE “BLACK BOXES”?

INTERPRETING THE RESULTS IS
EXTREMELY DIFFICULT

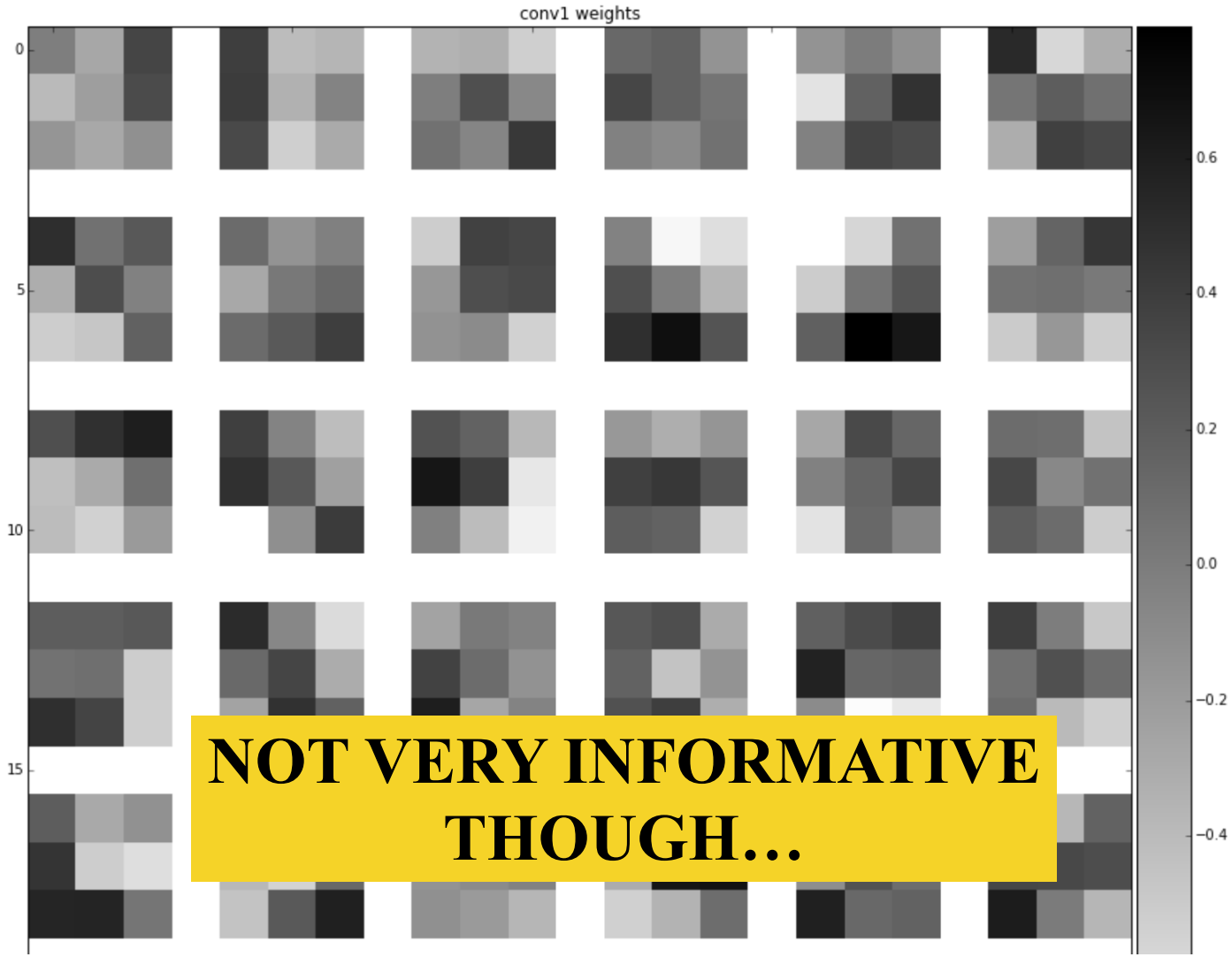
THIS IS TRUE BUT A LOT OF WORK
IS DONE TO UNVEIL THEIR BEHAVIOR

EXPLORING THE FEATURE MAPS

THE SIMPLEST APPROACH IS TO VISUALIZE THE LEARNED WEIGHTS AT INTERMEDIATE LAYERS

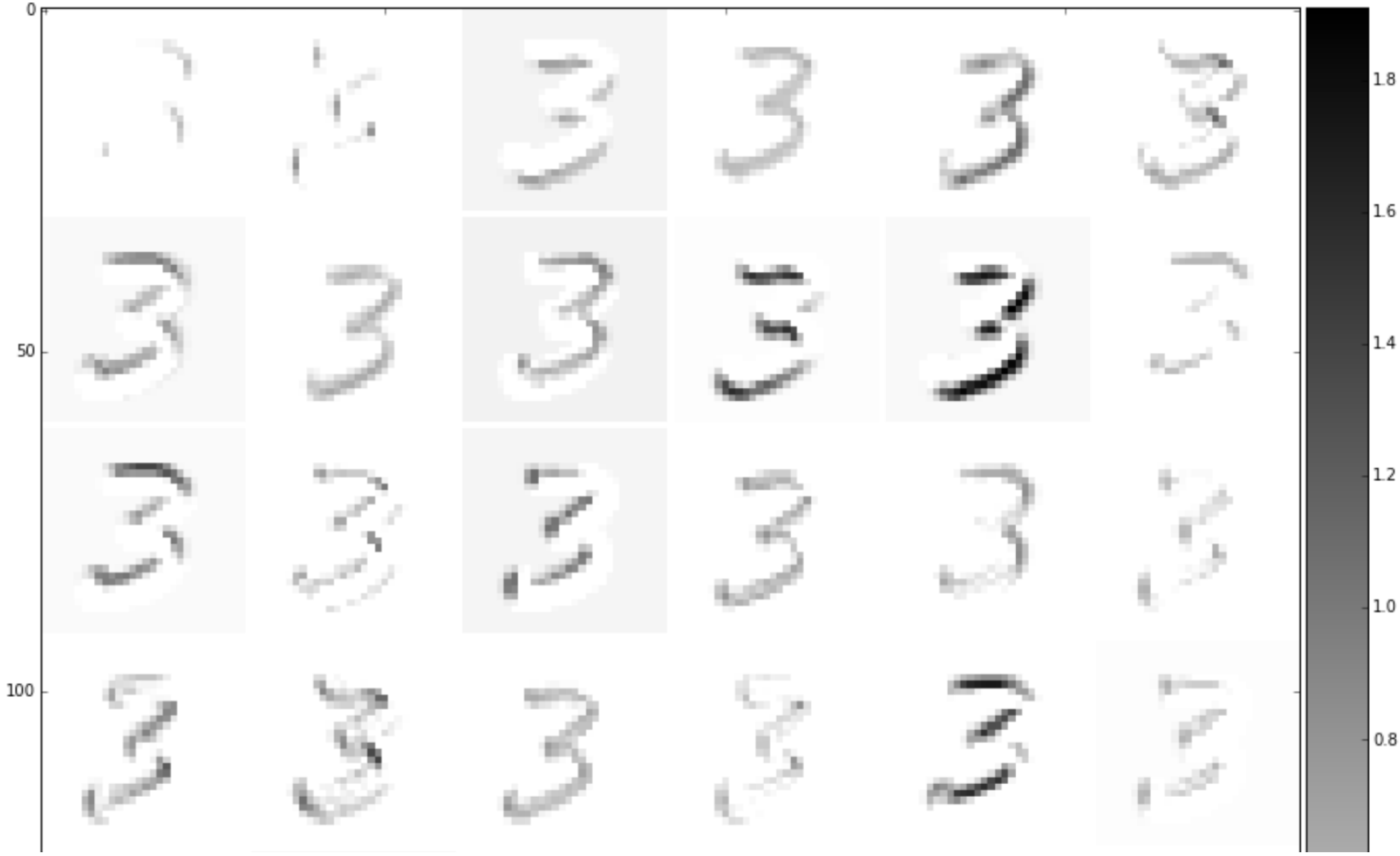


THE SIMPLEST APPROACH IS TO VISUALIZE THE LEARNED WEIGHTS AT INTERMEDIATE LAYERS

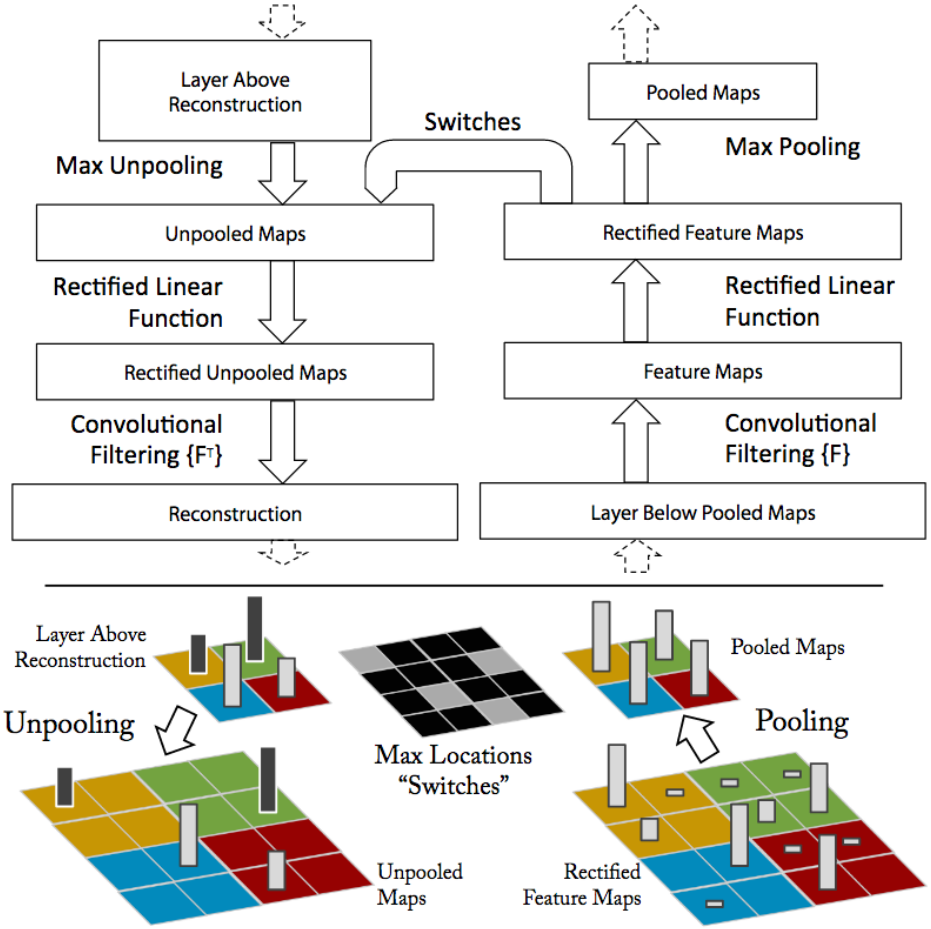


USING THE SAME IDEA, ONE CAN ALSO VISUALIZE THE FEATURE MAPS AT INTERMEDIATE LAYERS

THIS HELPS TRACING THE FEATURES LEARNED BY THE NETWORK

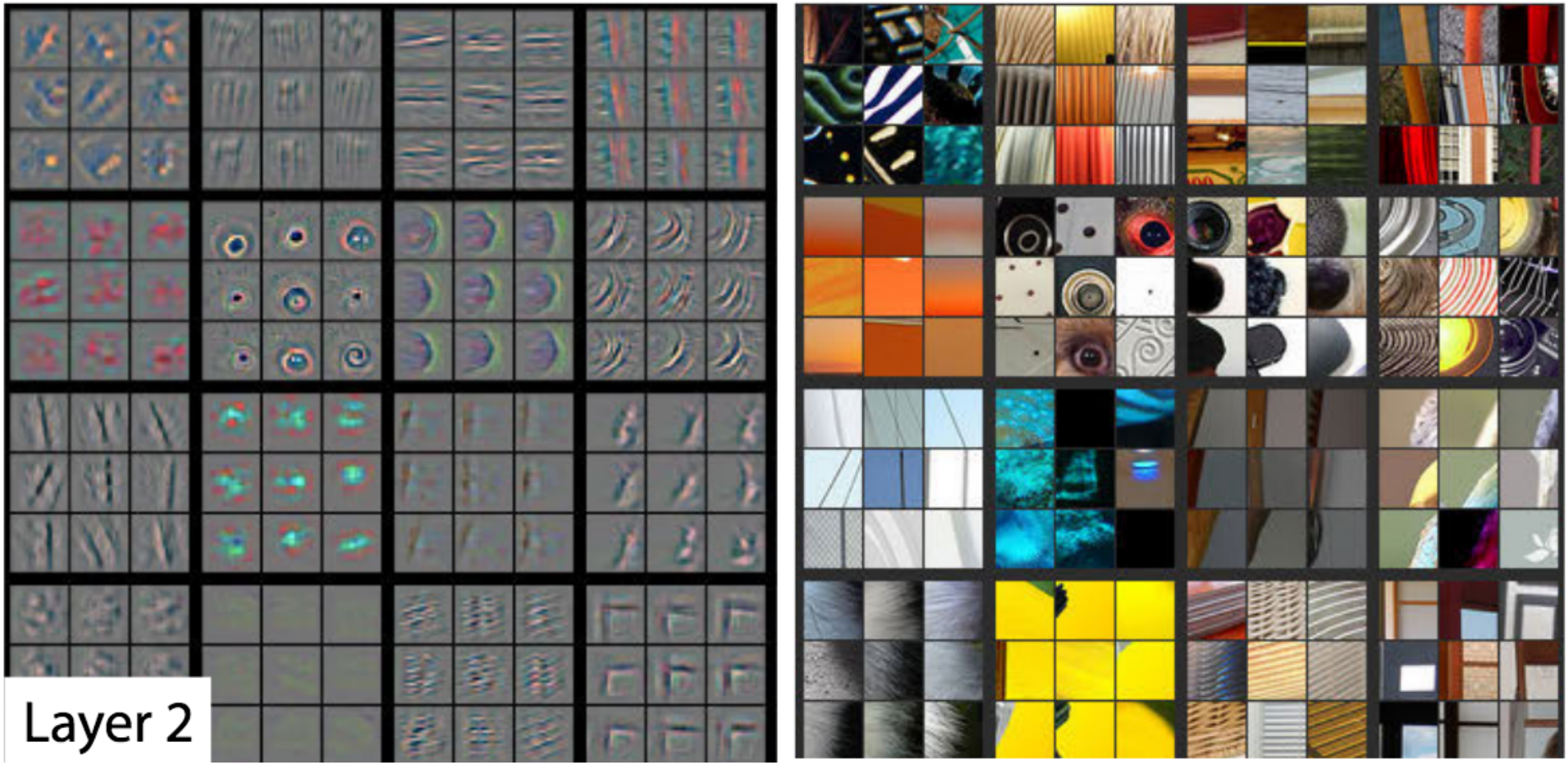

0
50
100
1.8
1.6
1.4
1.2
1.0
0.8

USE “DECONVNETS” TO MAP BACK THE FEATURE MAP INTO THE PIXEL SPACE



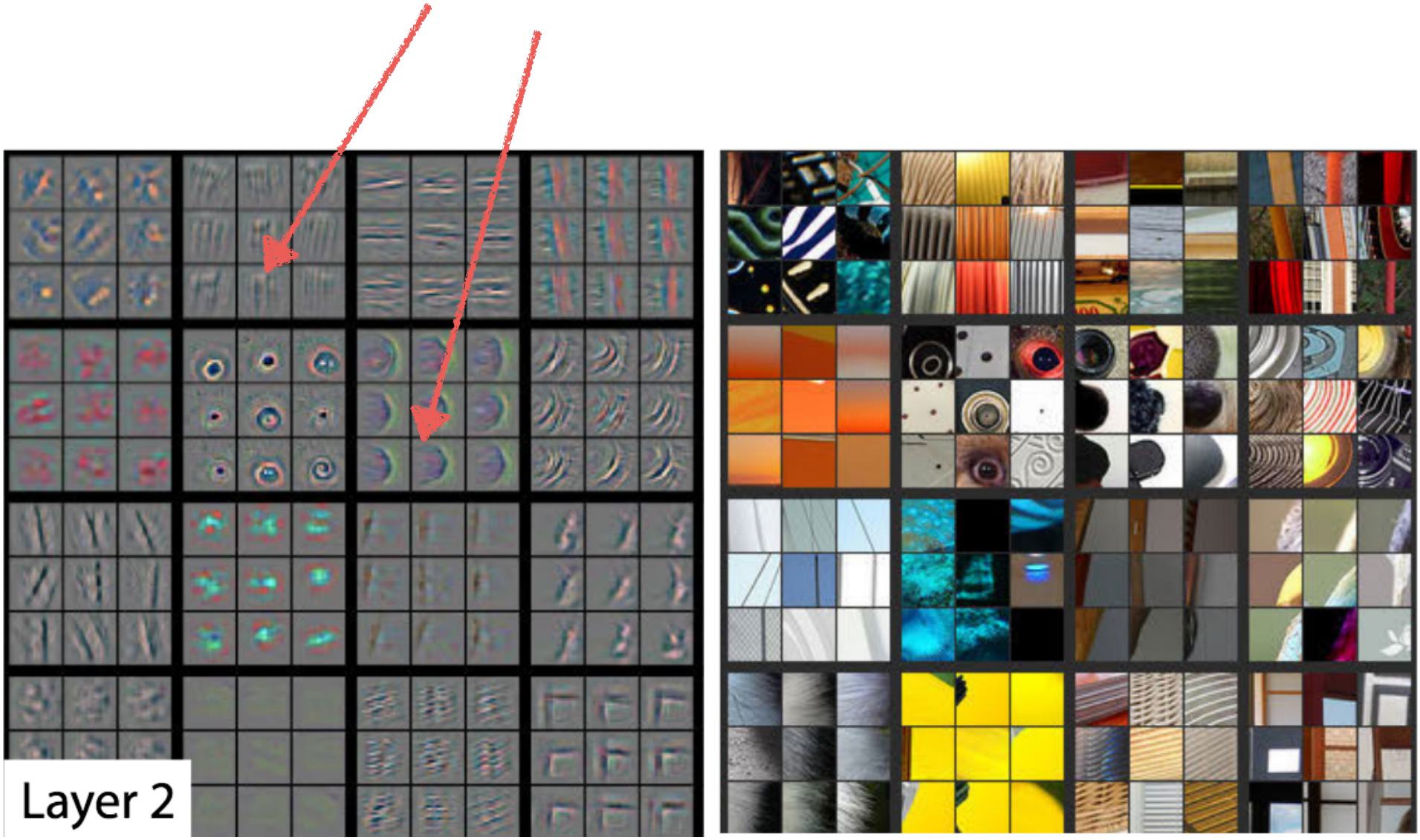
IT ALLOWS TO SEE
WHICH
REGIONS OF THE INPUT
GENERATED
A MAXIMUM RESPONSE
IN A NEURON

Zeiler+14



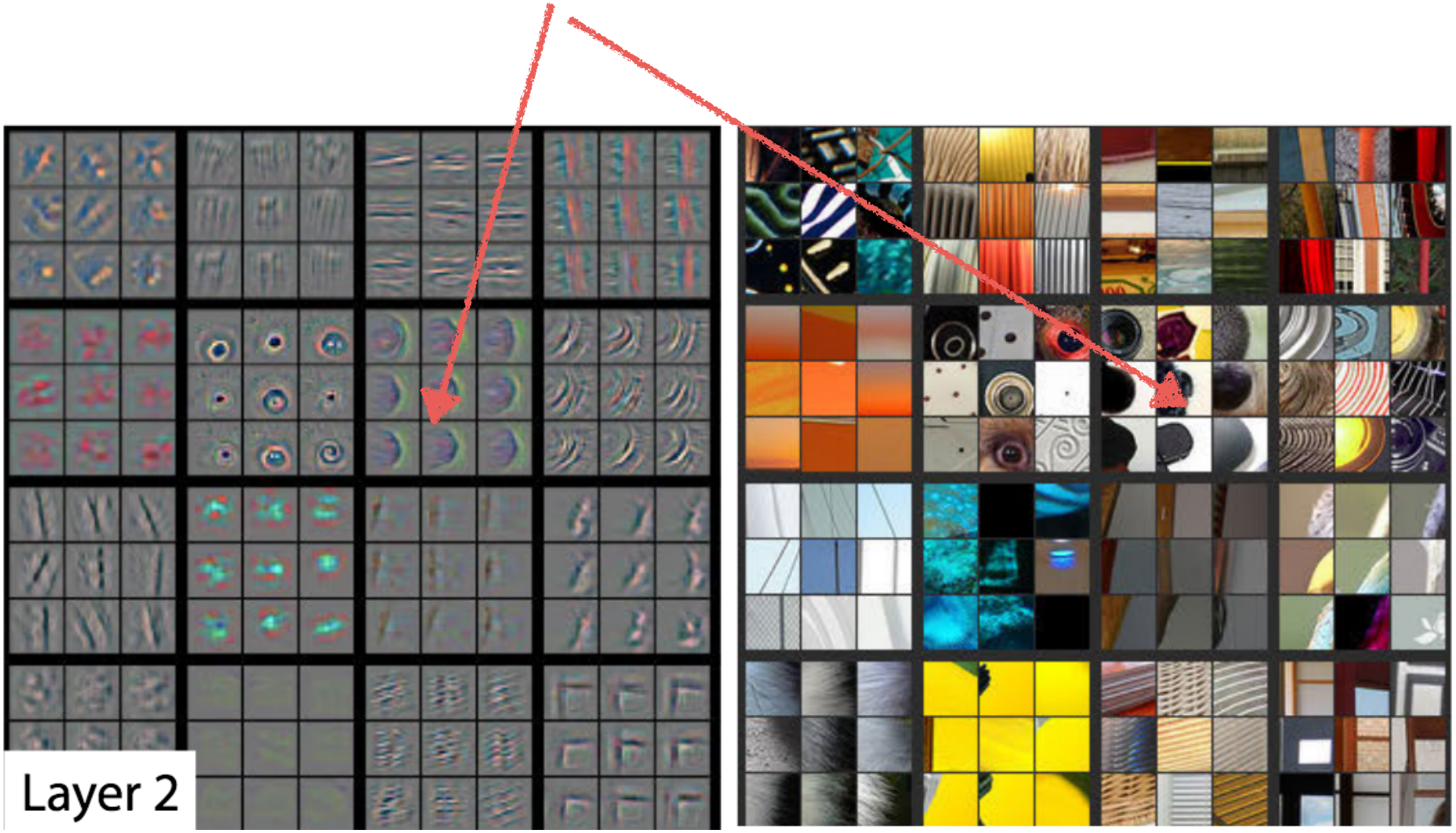
Zeiler+14

EVERY BLOCK OF 9 SHOWS
THE 9 STRONGEST RESPONSES TO A GIVEN FILTER OF LAYER2



Zeiler+14

THE CORRESPONDING REGIONS OF IMAGES THAT GENERATED THE MAXIMUM RESPONSE



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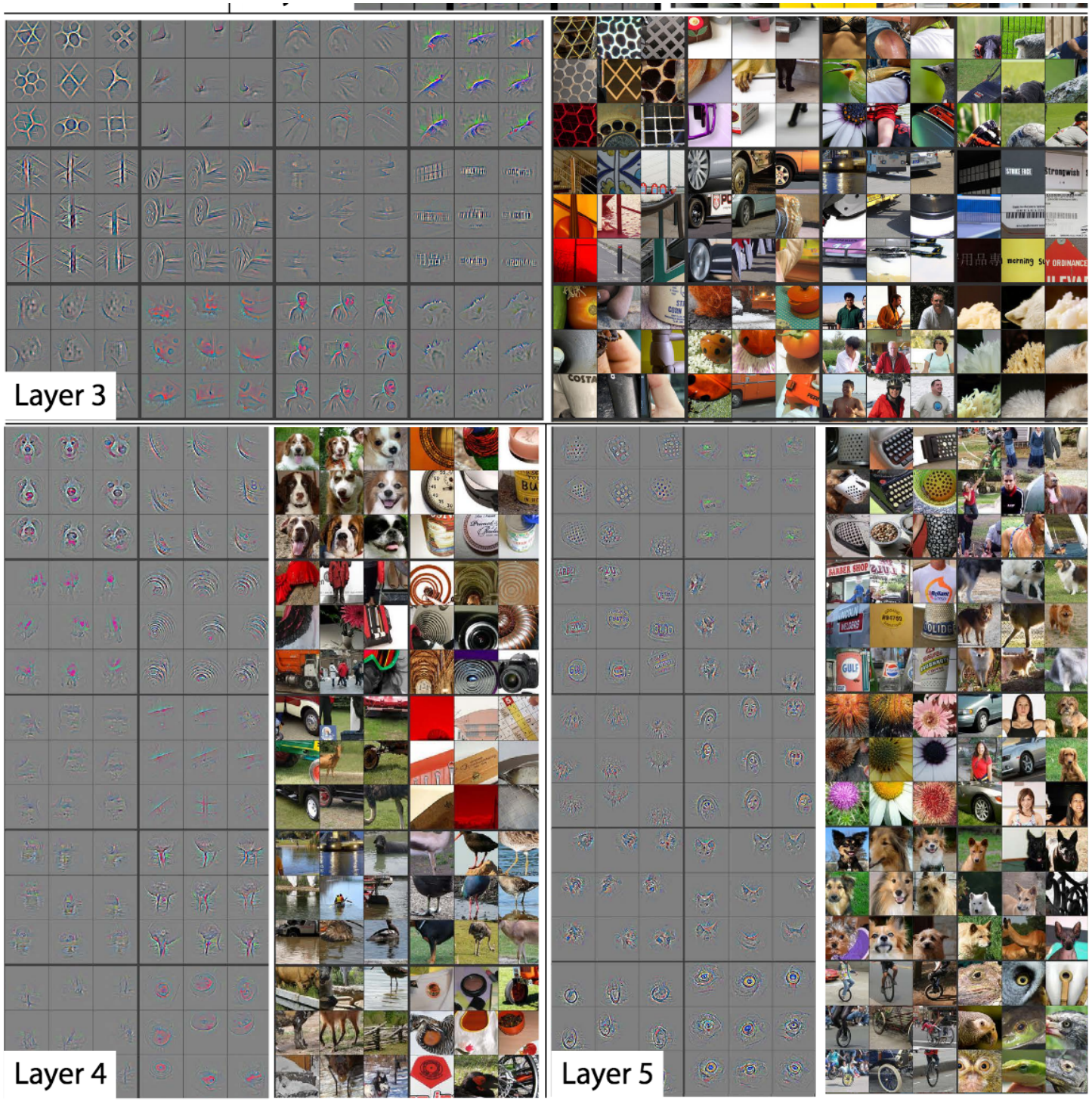
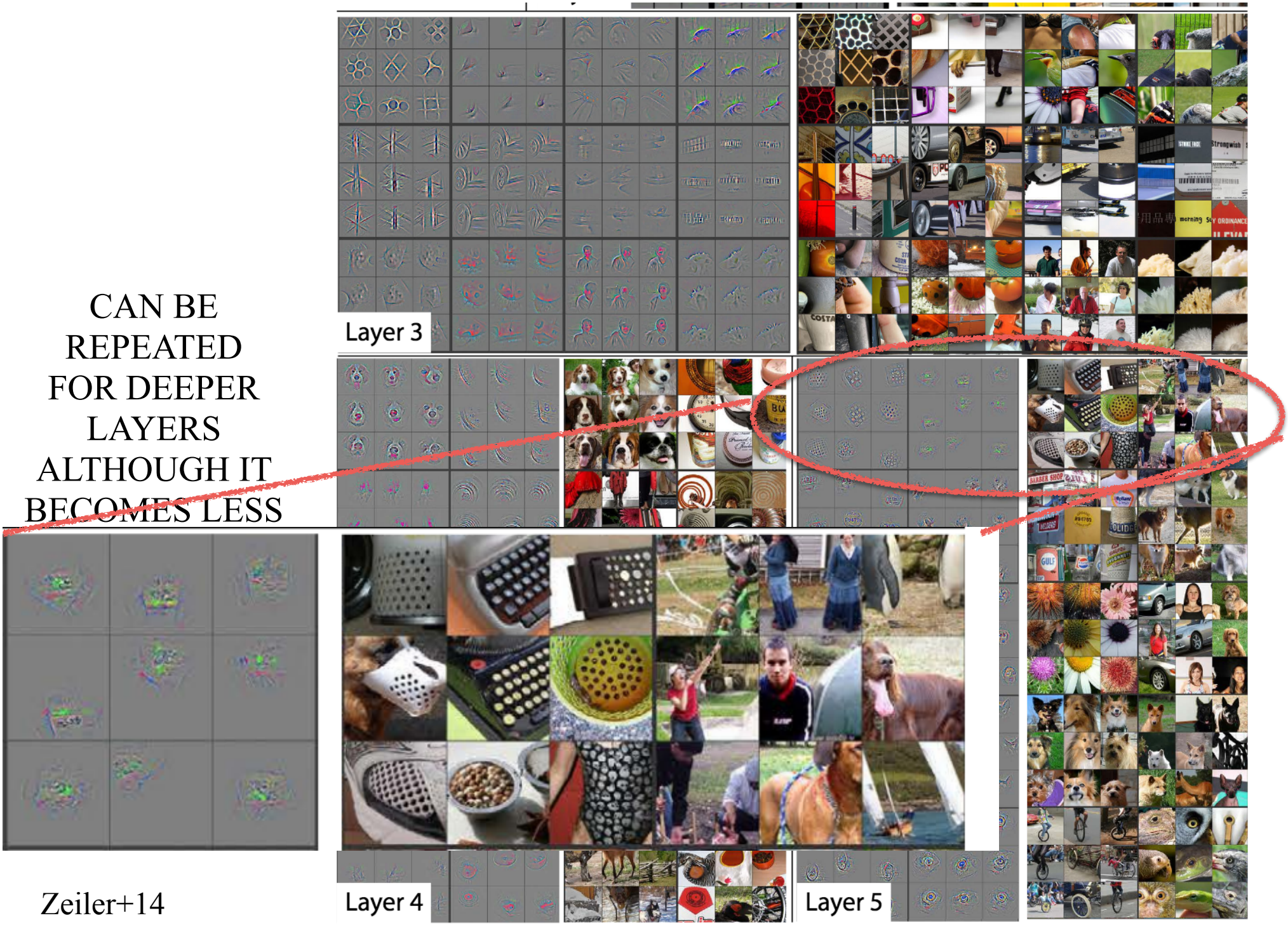
CAN BE REPEATED FOR DEEPER LAYERS ALTHOUGH IT BECOMES LESS INTUITIVE



Zeiler+14

CAN BE REPEATED FOR DEEPER LAYERS ALTHOUGH IT BECOMES LESS



Zeiler+14

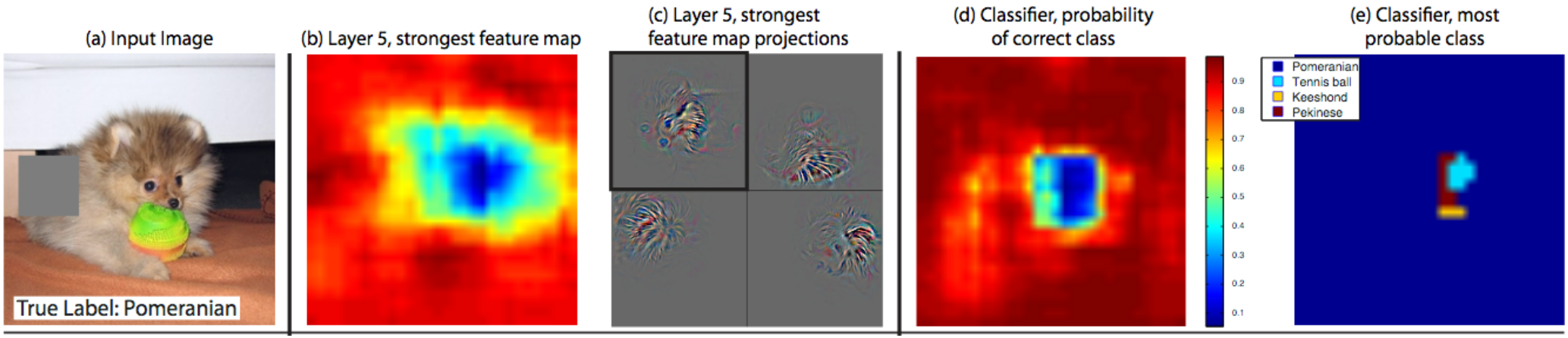
OCCLUSION SENSITIVITY

THE BASIC IDEA IS TO
PERTURB / MODIFY AN INPUT
IMAGE AND SEE THE EFFECT ON
THE PREDICTIONS

OCCLUSION SENSITIVITY TRIES ALSO TO FIND THE REGION OF THE IMAGE THAT TRIGGERED THE NETWORK DECISION BY MASKING DIFFERENT REGIONS OF THE INPUT IMAGE AND ANALYZING THE NETWORK OUPUT

IT ALLOWS TO IF THE NETWORK IS TAKING THE DECISIONS BASED ON THE EXPECTED FEATURES

<u>VERY TIME CONSUMING!</u>



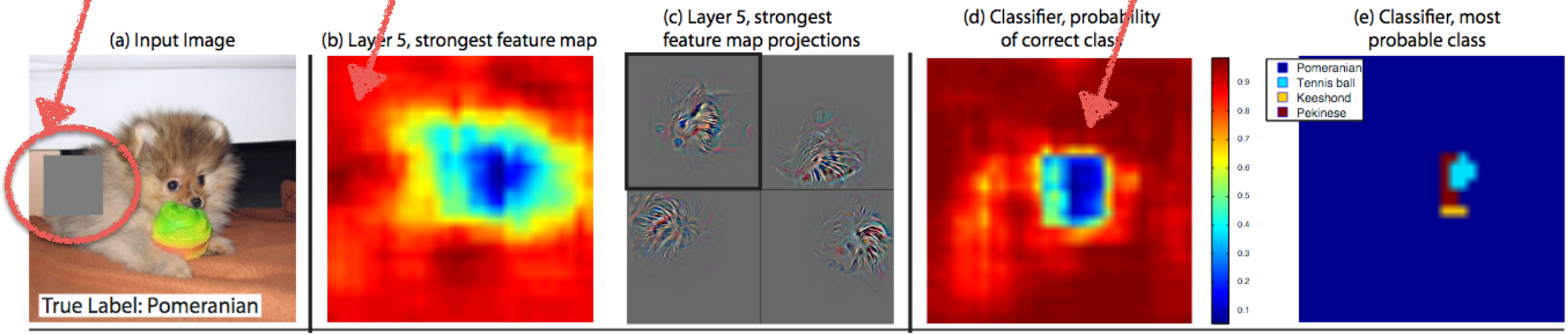
Zeiler+14

OCCLUSION SENSITIVITY TRIES ALSO TO FIND THE REGION OF THE IMAGE THAT TRIGGERED THE NETWORK DECISION BY MASKING DIFFERENT REGIONS OF THE INPUT IMAGE AND ANALYZING THE NETWORK OUPUT

for every position
of the square the maximum response of a given layer
is averaged

occluded region

the output probability as a
function of the occluding square
position



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“INCEPTIONISM” TECHNIQUES

THE IDEA BEHIND INCEPTIONISM TECHNIQUES
IS TO INVERT THE NETWORK TO GENERATE AN IMAGE
THAT MAXIMIZES THE OUTPUT SCORE

Score of class c for image I

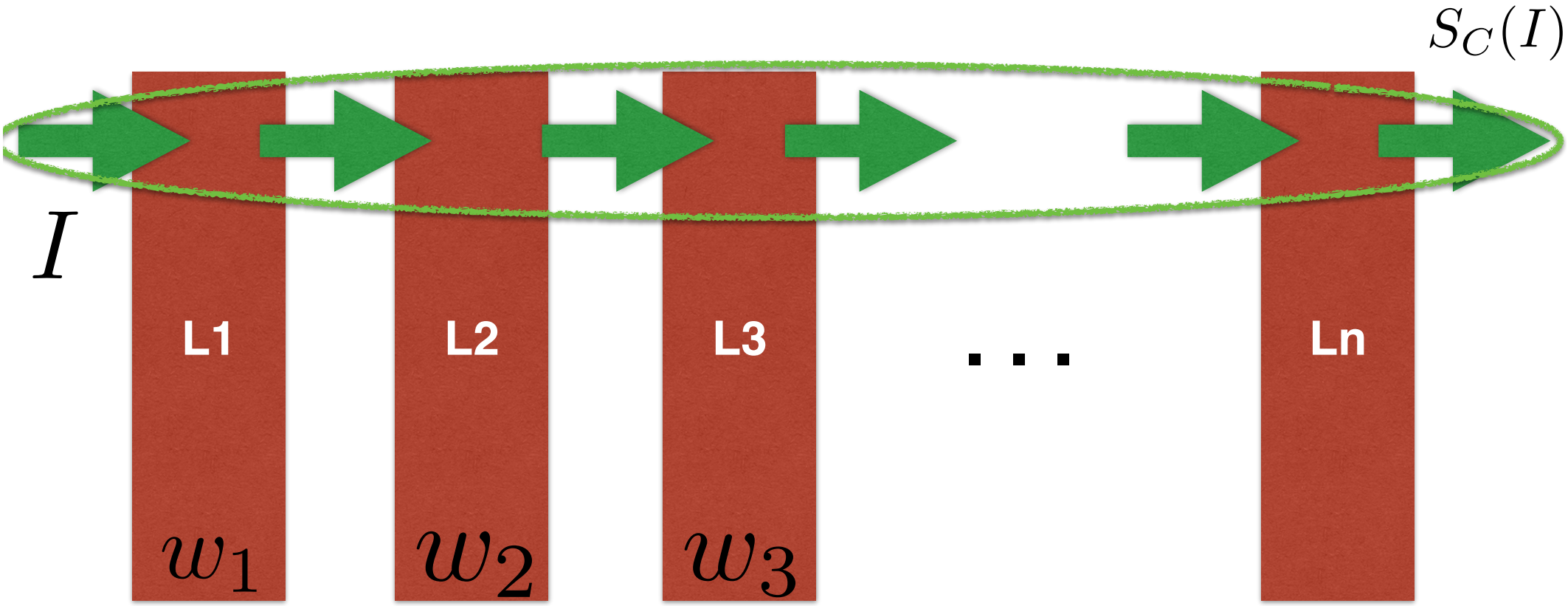
image I

$$arg\,\max_{I} S_c(I) - \lambda||I||_2^2$$

TRY TO FIND AN IMAGE THAT GENERATES A
HIGH SCORE FOR A GIVEN CLASS

Simonyan+14

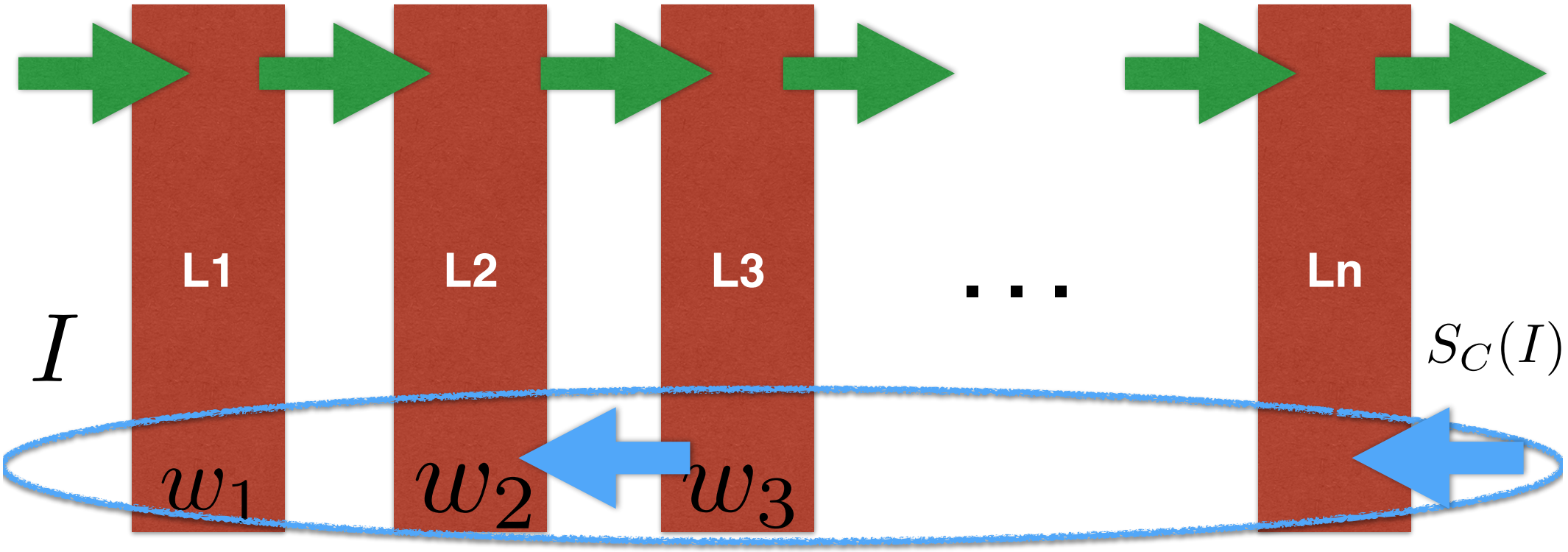
INCEPTIONISM - DEEP DREAM



DURING THE TRAINING PHASE THE WEIGHTS ARE LEARNED TO MAP I INTO Sc

Simonyan+14

INCEPTIONISM - DEEP DREAM



DURING THE RECONSTRUCTION PHASE, I IS LEARNT TRHOUG BACKPROPAGATION KEEPING THE WEIGHTS FIXED

Simonyan+14

SEE SLIDES ON ACTIVATION ATLAS FOR AN EXAMPLE

GRADIENT BASED ATTRIBUTION

“what pixels in the image are responsible of this classificaiton?”

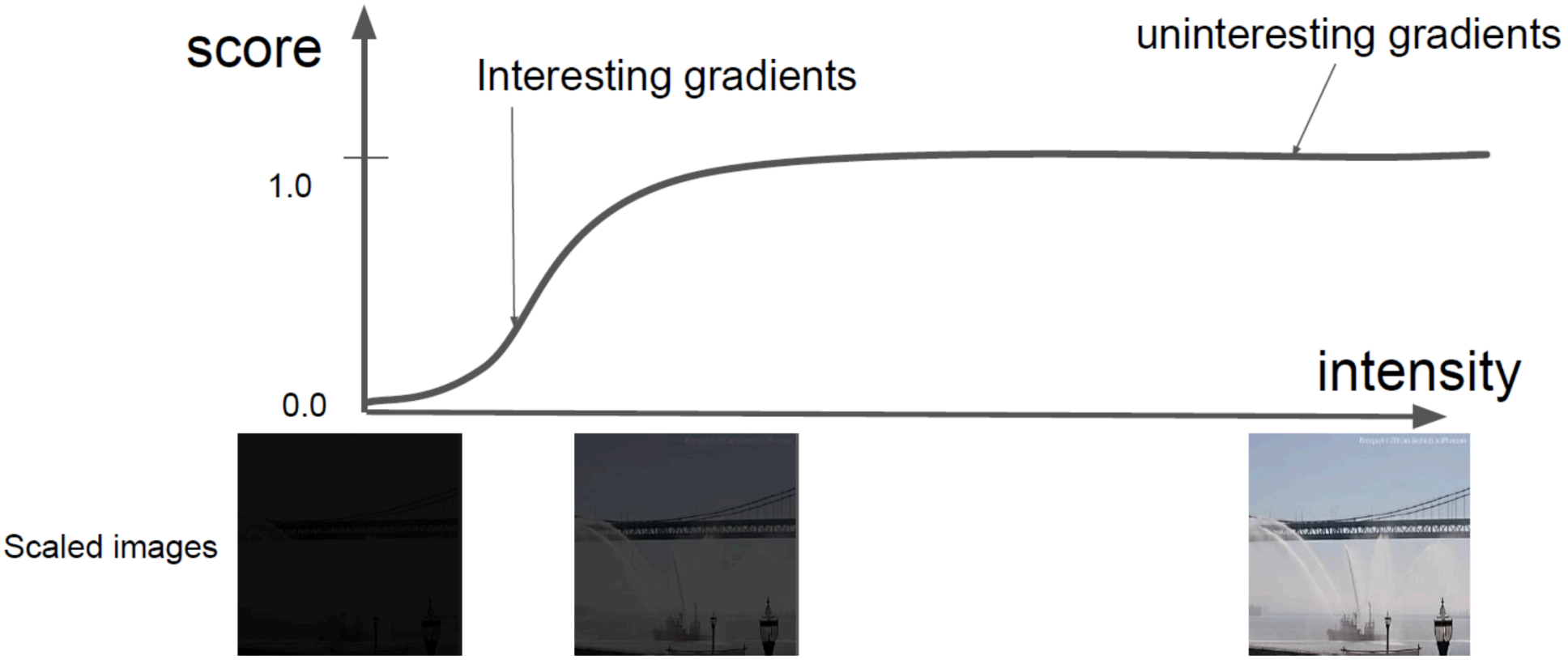
Attribute using gradient of the output w.r.t each input feature

$$x_i \frac{\delta F_w(x)}{\delta x_i}$$

We try to find the importance of each feature (pixel) by computing the gradient w.r.t to that feature (Taylor approximation of the network function)

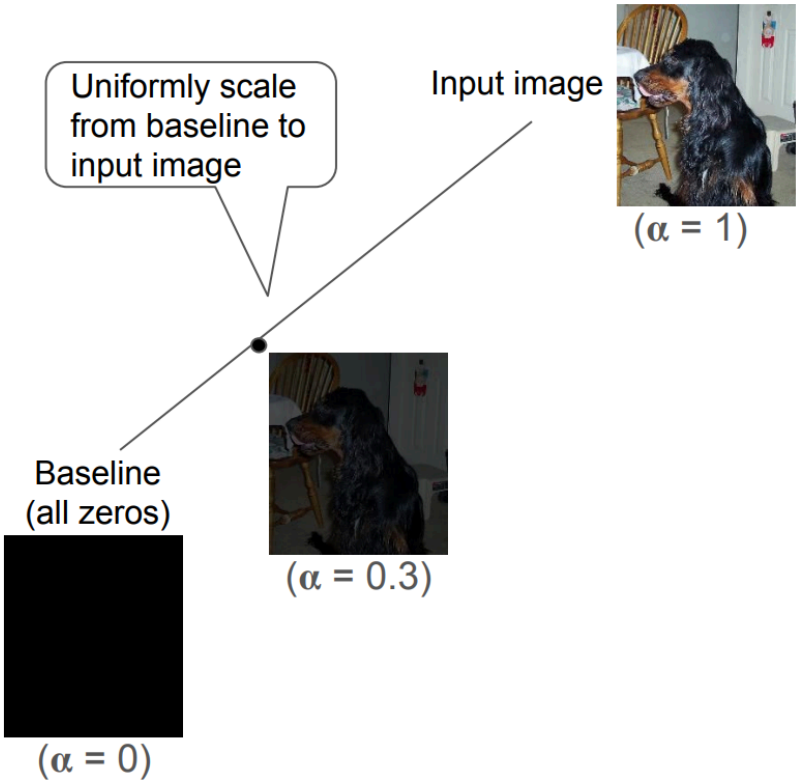
Does not work super well…

http://theory.stanford.edu/~ataly/Talks/sri_attribution_talk_jun_2017.pdf



https://medium.com/@kartikeyabhardwaj98/integrated-gradients-for-deep-neural-networks-c114e3968eae

INTEGRATED GRADIENTS



Construct a sequence of images interpolating from a baseline (black) to the actual image

Average the gradients across these images

Sundararajan+17

INTEGRATED GRADIENTS

Original image (**Drilling platform**)

Gradient at image

Integrated gradient

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INTEGRATED GRADIENTS

Human label: accordion
Network's top label: toaster

Integrated gradient

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