281 Live Session

Week 4 — 2023/2/1

Agenda

Final Project Overview

Intro to Feature Vectors & Convolution

Overview of Assignment 3

Final Project

Group project (three groups of 3, one group of 4)

Goal – build a custom image **classifier** using tools from this class

Step 1 – Choose an image dataset & classification problem

- Example topics: medicine, agriculture, architecture, satellite, etc
- Project proposal must be approved by instructors

Step 2 – Create feature vectors using filtering and decomposition methods

Step 3 – Build classifiers using multiple different techniques from class

Final Project Timeline

Feb 13 - submit ideas (video, link to dataset, etc) to pitch list

Feb 27 - team formation deadline (choose a dataset by this date)

March 13 - proposals due

Idea List: https://docs.google.com/spreadsheets/d/1wf-CSfX9zH0zHylNAmA-QgtC-7FHin0w6FH61V6-rOk/edit#gid=0

Feature Vectors

- What is a feature vector?

- Why do we hand-design feature vectors instead of learning them?

    -- efficiency of computation and memory

    -- explainability

    -- much less training data required

- How does convolution relate to feature extraction?

Convert to grayscale

Extract edges

Apply fur texture filter

Flatten & concatenate layers

[N x 1] vector of values

Source: Mathias Erhart, Flickr.com

Convolution

Applying a filter to an image

Each pixel in the output image is a linear combination of pixels in the input image

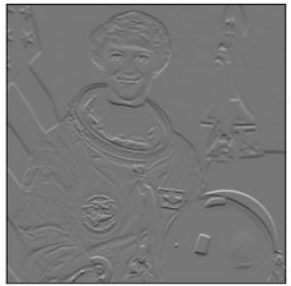
The filter/weights determine the purpose/outcome

Source: towardsdatascience.com

Types of Filters

$$\begin{bmatrix} -1 & -2 & -1 \\ 0 & 0 & 0 \\ 1 & 2 & 1 \end{bmatrix}$$

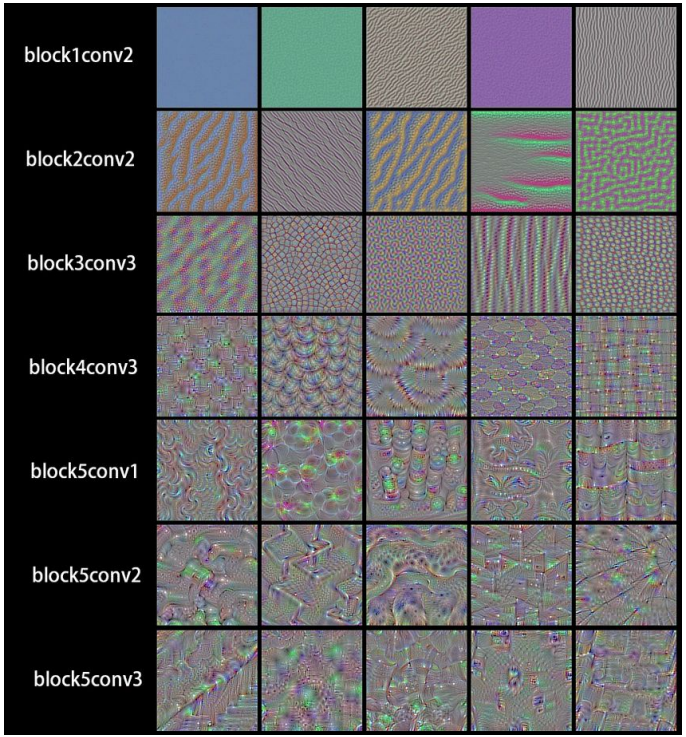
$$\begin{bmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{bmatrix}$$

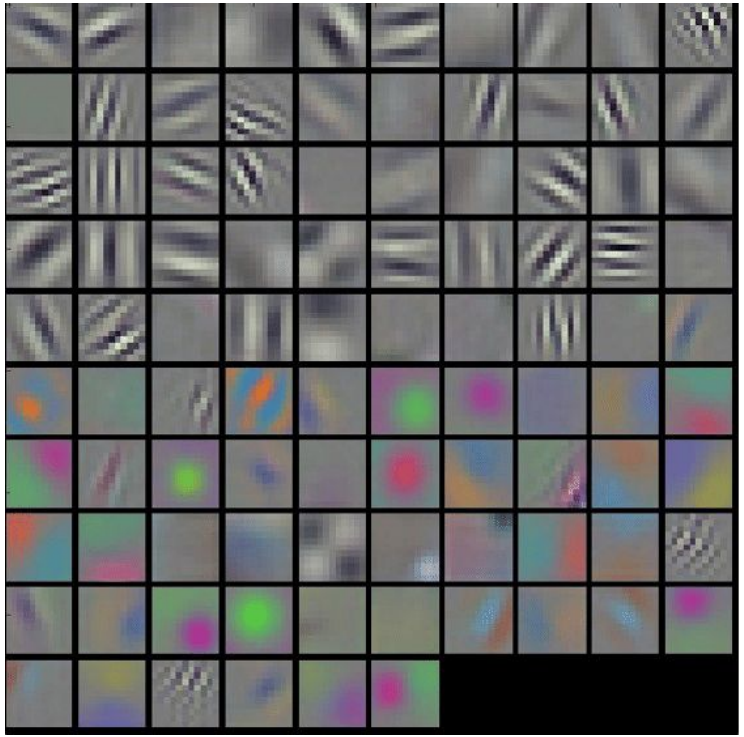


Name	Kernel	Image Result
Identity	$\begin{bmatrix} 0 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 0 \end{bmatrix}$	
Sharpen	$\begin{bmatrix} 0 & -1 & 0 \\ -1 & 5 & -1 \\ 0 & -1 & 0 \end{bmatrix}$	
Mean Blur	$\begin{bmatrix} 1/9 & 1/9 & 1/9 \\ 1/9 & 1/9 & 1/9 \\ 1/9 & 1/9 & 1/9 \end{bmatrix}$	
Laplacian	$\begin{bmatrix} 0 & 1 & 0 \\ 1 & -4 & 1 \\ 0 & 1 & 0 \end{bmatrix}$	
Gaussian Blur	$\begin{bmatrix} 1/16 & 2/16 & 1/16 \\ 2/16 & 4/16 & 2/16 \\ 1/16 & 2/16 & 1/16 \end{bmatrix}$	

Source: medium.com

Types of Filters

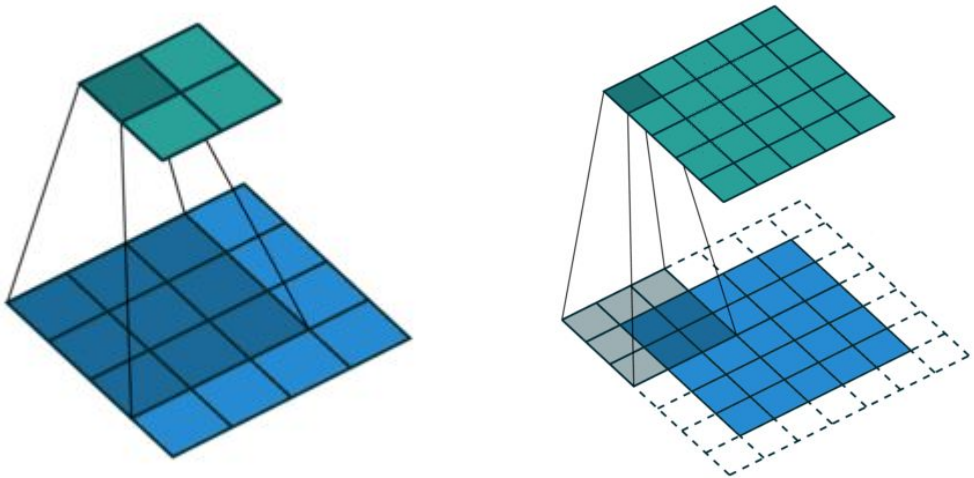




Sources: Yang, Zhuoqian, Tingting Dan, and Yang Yang. "Multi-temporal remote sensing image registration using deep convolutional features." *Ieee Access* 6 (2018): 38544-38555.
Garg, Isha, Priyadarshini Panda, and Kaushik Roy. "A low effort approach to structured CNN design using PCA." *IEEE Access* 8 (2019): 1347-1360.

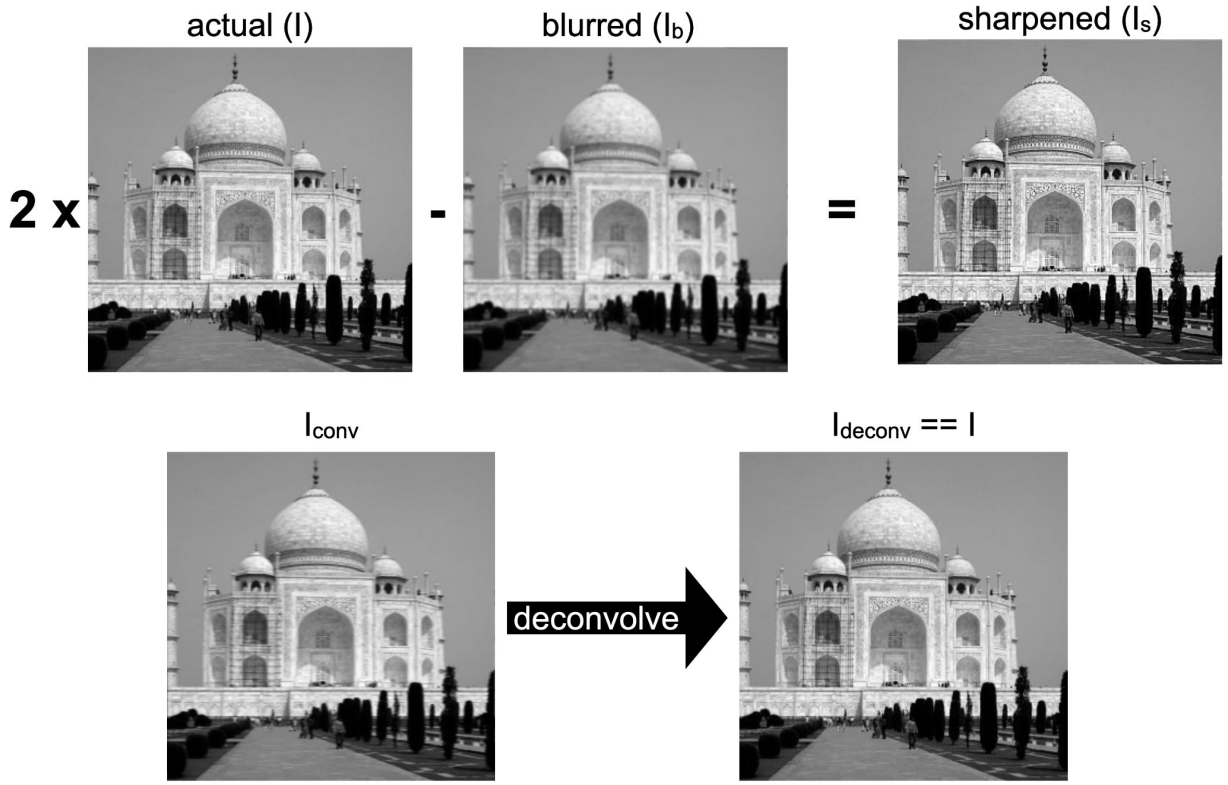
Convolution Padding

How do we get back an image of the same size as the original?



Source: medium.com

Assignment 3 – Convolution & Deconvolution



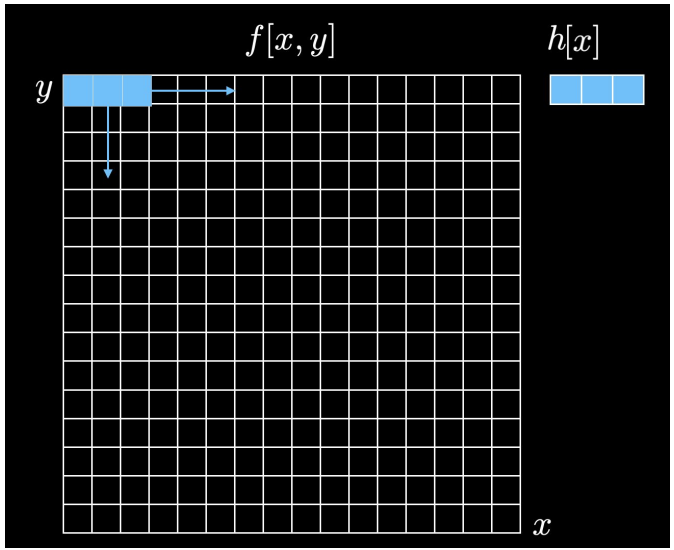
Deconvolution

Estimating the original image by reversing the kernel operation

$$y = Ax$$

Source: towardsdatascience.com

Constructing the Deconvolution Matrix (A)



$$\begin{pmatrix} g[0] \\ g[1] \\ g[2] \\ \vdots \\ g[n-2] \\ g[n-1] \\ g[n] \end{pmatrix} = \begin{pmatrix} h_0 & h_{-1} & 0 & 0 & \dots & 0 & 0 & 0 & h_1 \\ h_1 & h_0 & h_{-1} & 0 & \dots & 0 & 0 & 0 & 0 \\ 0 & h_1 & h_0 & h_{-1} & \dots & 0 & 0 & 0 & 0 \\ \vdots & & & & \ddots & & & & \vdots \\ 0 & 0 & 0 & 0 & \dots & h_1 & h_0 & h_{-1} & 0 \\ 0 & 0 & 0 & 0 & \dots & 0 & h_1 & h_0 & h_{-1} \\ h_{-1} & 0 & 0 & 0 & \dots & 0 & 0 & h_1 & h_0 \end{pmatrix} \begin{pmatrix} f[0] \\ f[1] \\ f[2] \\ \vdots \\ f[n-2] \\ f[n-1] \\ f[n] \end{pmatrix}$$

$$\vec{g} = M\vec{f}$$

$$\vec{f} = M^{-1}\vec{g}$$

Upcoming ToDo’s

Find a group and topic for Final Project

Finish Assignment 2 & start Assignment 3

Watch Async lectures for Unit 4