Convolutional Neural Networks

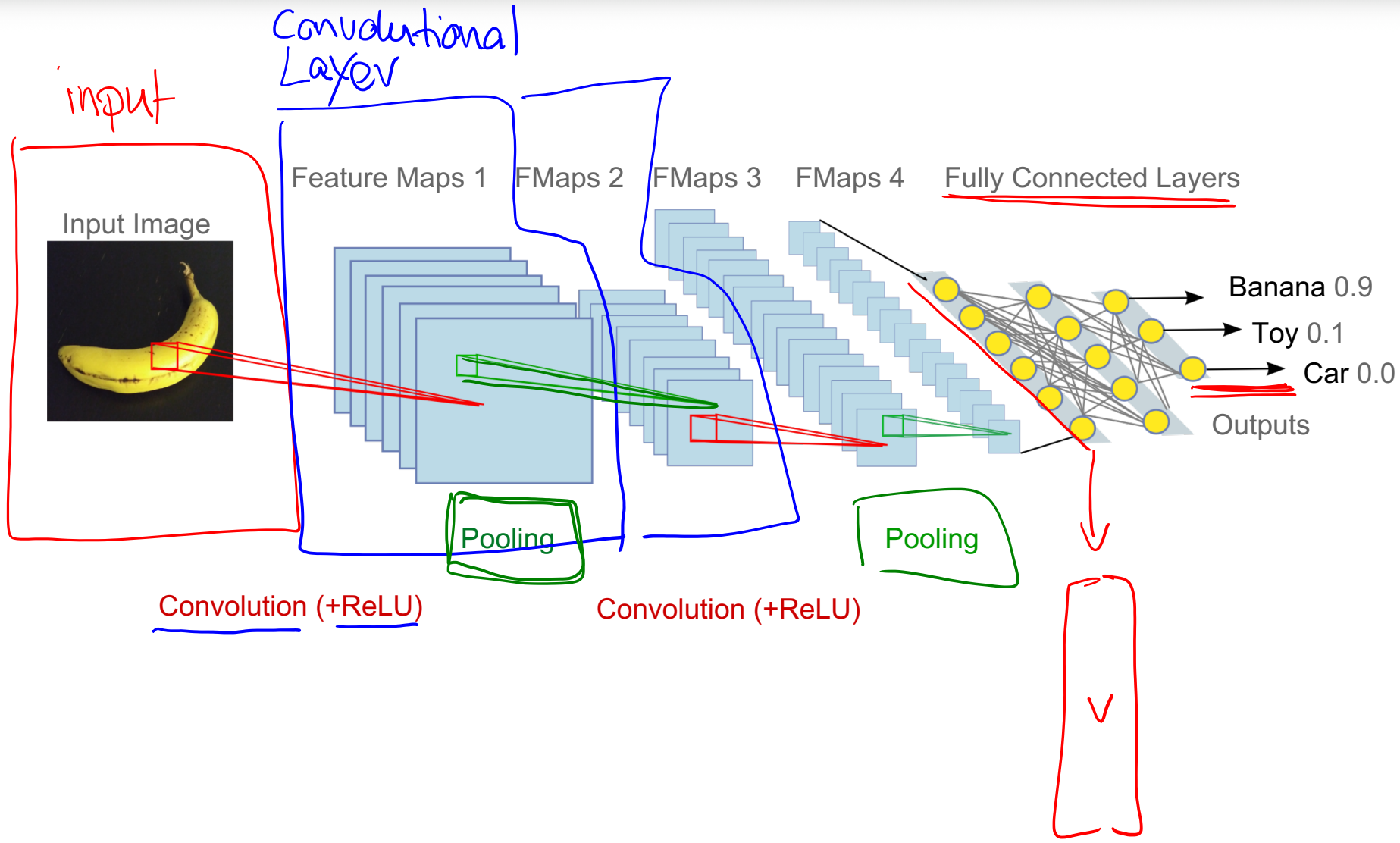
Heni Ben Amor, Ph.D.
Assistant Professor
Arizona State University

ASU Ira A. Fulton Schools of Engineering
Arizona State University

Neural Networks for Computer Vision

- **Process images using neural networks**
- **Detection of faces, objects, etc.**
- **Recognition of specific instances**
- **Image modification, clean-up, synthesis**
- **Many challenges:**
  - Pose
  - Noise
  - Illumination
  - Occlusion...

Convolutional Neural Networks



RGB Images

- Image representation as matrices
- Three channels for red, green, blue
- Additive model producing wide range of colors

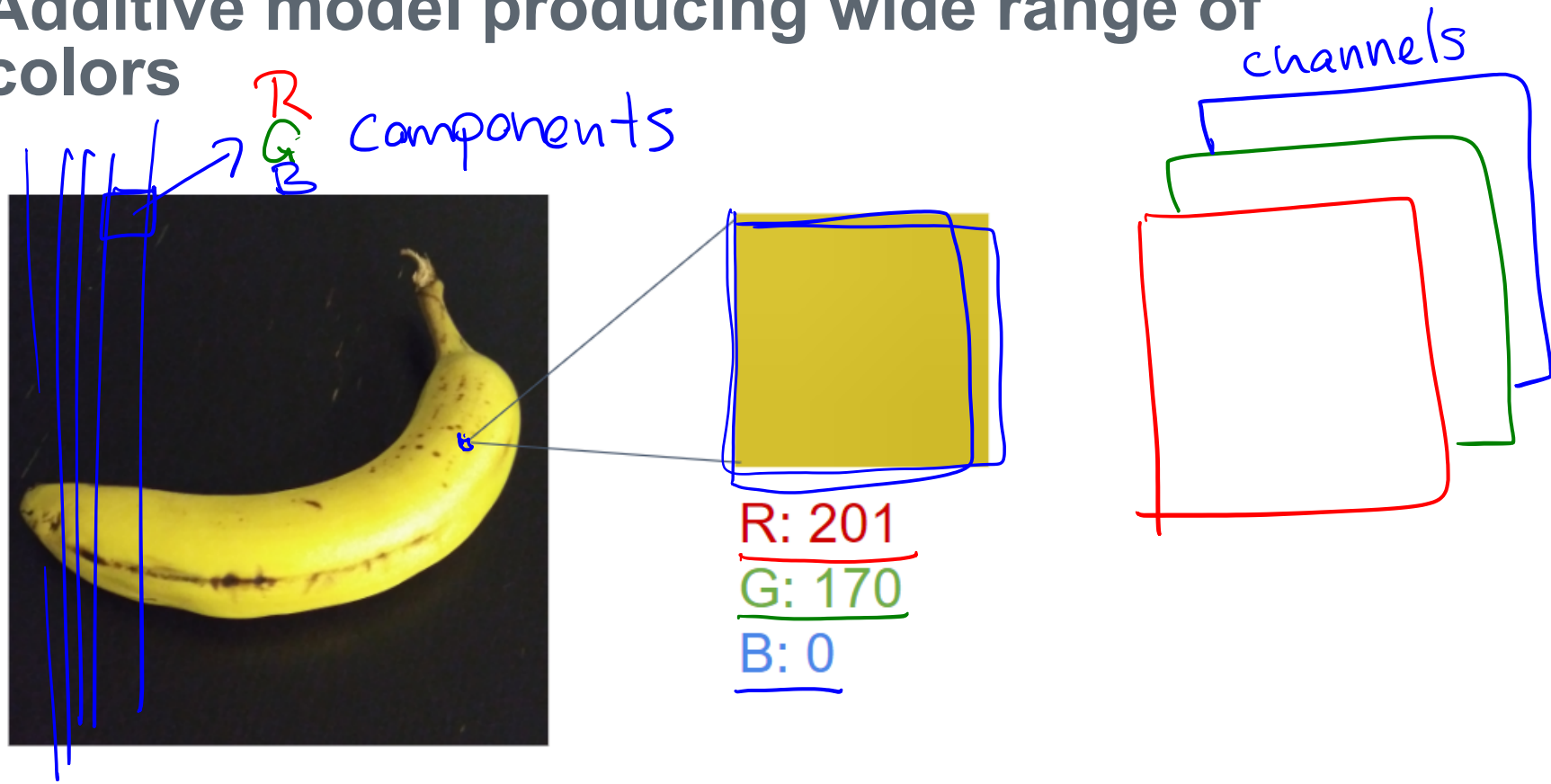
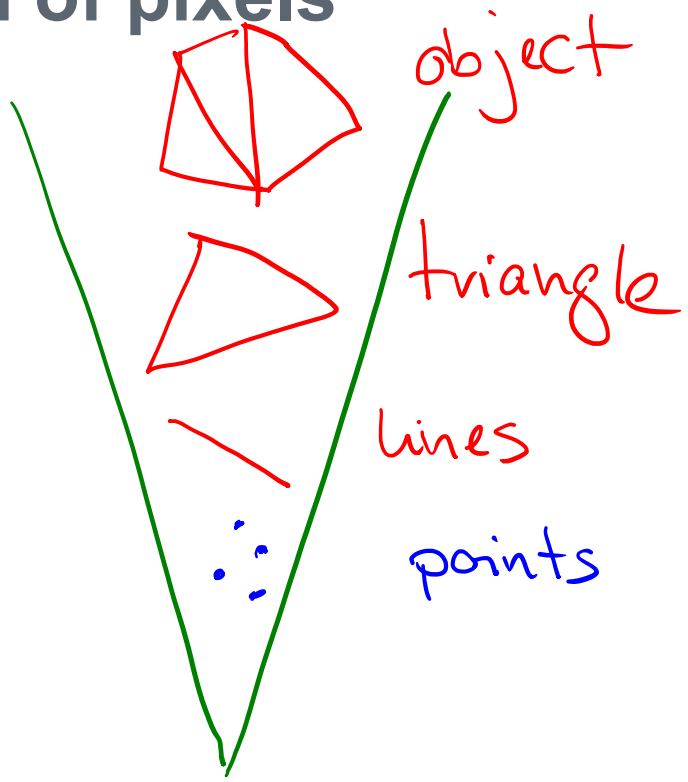


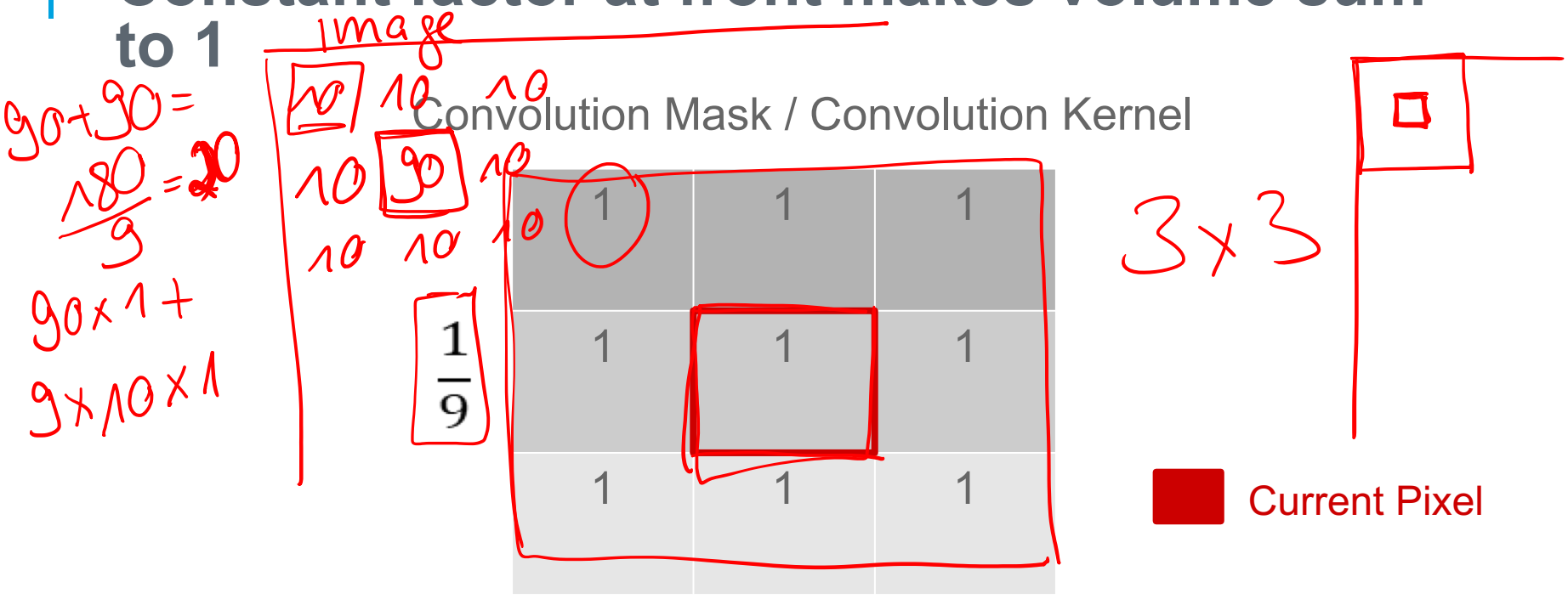
Image Filtering in Computer Vision

- **Process image at local level**
- **Function of neighborhood of pixels**
- **Depending on function:**
  - Blurring
  - Sharpening
  - Denoising
  - Edge Detection
  - Points of interest
  - Template matching



Convolutions

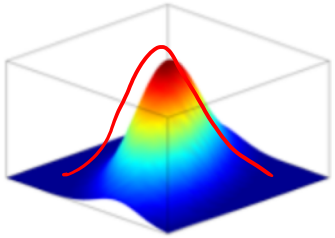
- Mask with positive entries that sum to 1
- Replaces each pixel with average of neighborhood
- If all weights are equal, we call it a box filter
- Constant factor at front makes volume sum to 1



Gaussian Blur

- Influence of pixels according to Gaussian
- Nearby pixels larger weight than remote pixels
- Generates a gentler blur effect on image

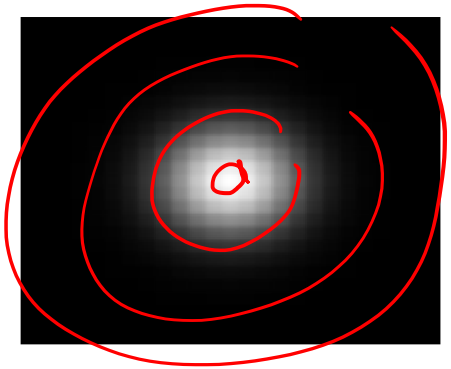
2D Gaussian



Gaussian Convolution Kernel

0.003	0.013	0.022	0.013	0.003
0.013	0.059	0.097	0.059	0.013
0.022	0.097	0.159	0.097	0.022
0.013	0.059	0.097	0.059	0.013
0.003	0.013	0.022	0.013	0.003

5 x 5, σ = 1



Gaussian Blur

Original

Blurred Image

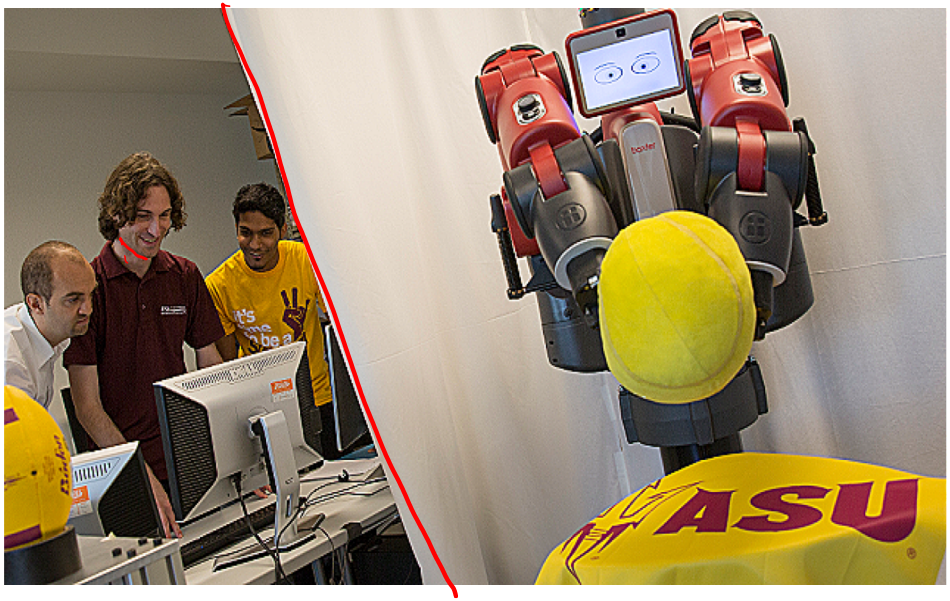
Convolution Kernel = mask

1	2	1
2	4	2
1	2	1

Current Pixel

Sharpen Filter

Original



Sharpened Image

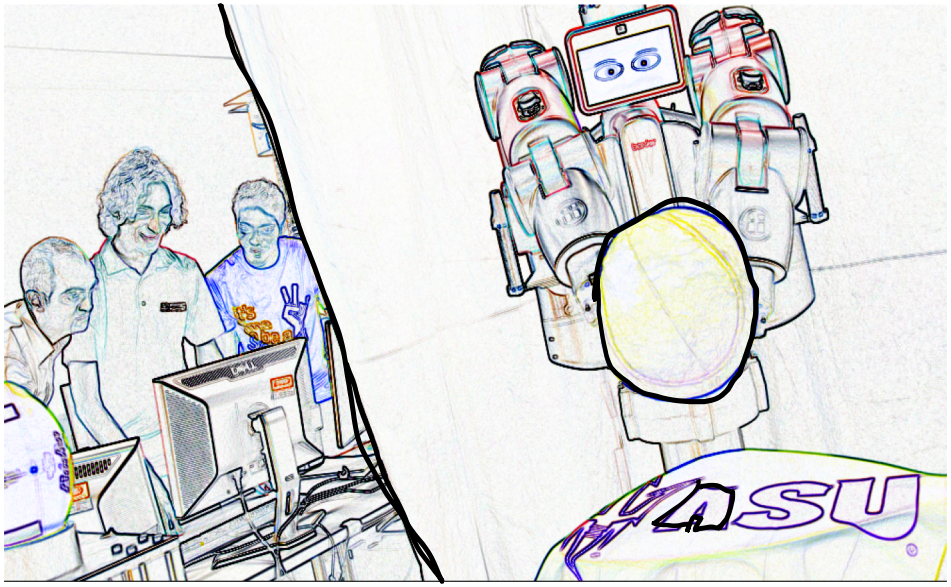
Convolution Kernel

0	-1	0
-1	5	-1
0	-1	0

Current Pixel

Edge Detection

Original



Edge Detection

Convolution Kernel

1	0	-1
2	0	-2
1	0	-1

+

Convolution Kernel

1	2	1
0	0	0
-1	-2	-1

Current Pixel