

Computational Photography



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Study the basics of computation and its impact on the entire workflow of photography, from capturing, manipulating and collaborating on, and sharing photographs.

Image Processing and Filtering



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Point-process Computations on an Image

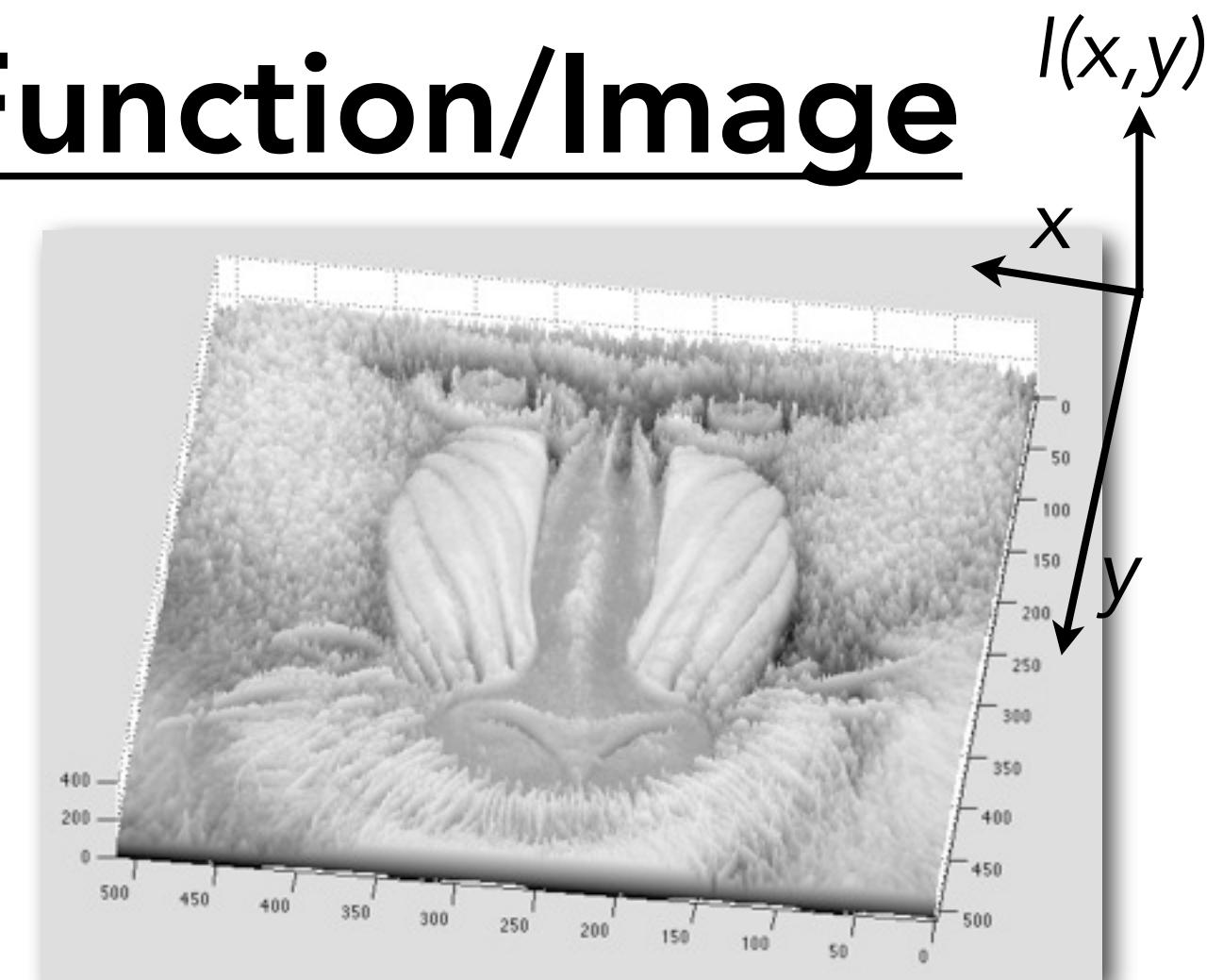
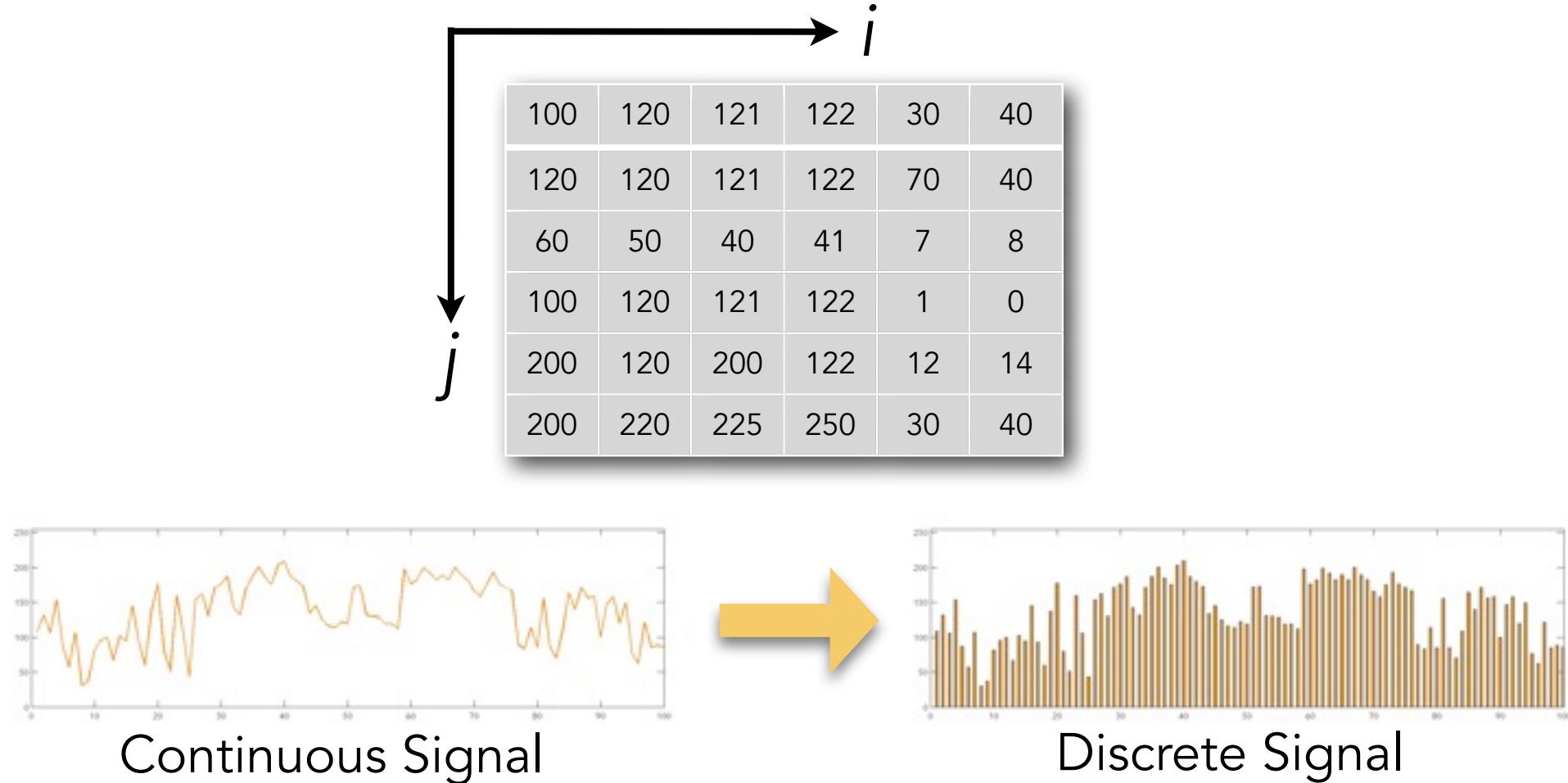


Lesson Objectives

- ★ Given an example of Pixel/Point Arithmetic for an Image, correctly explain how to apply Point-process Computations on that Image to:
 - Add Images; and
 - Subtract Images.
- ★ Describe in your own words what is α -blending.
- ★ Identify one reason for why α -blending is used in Computational Photography.
- ★ Identify one reason for how Image Histograms are used in Computational Photography.



Review: Digital Image is a Function/Image



- ★ Typically, the functional operation requires discrete values
 - Sample the two-dimensional (2D) space on a regular grid
 - Quantize each sample (rounded to “nearest integer”)
- ★ Matrix of integer values (Range: 0-255)

Slide adapted from Steve Sietz and Aaron Bobick

Point-Process: Pixel/Point Arithmetic

| | | | | |
|-----|-----|-----|-----|-----|
| 120 | 122 | 140 | 142 | 143 |
| 121 | 120 | 141 | 144 | 147 |
| 122 | 121 | 144 | 146 | 11 |
| 125 | 121 | 144 | 145 | 10 |
| 126 | 121 | 145 | 147 | 13 |

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| | | | | |
|-----|-----|-----|-----|-----|
| 120 | 122 | 140 | 142 | 143 |
| 121 | 80 | 40 | 144 | 10 |
| 122 | 81 | 40 | 0 | 151 |
| 125 | 80 | 40 | 0 | 152 |
| 126 | 70 | 40 | 0 | 153 |

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|-----|-----|-----|-----|-----|
| 120 | 122 | 140 | 142 | 143 |
| 121 | 120 | 141 | 144 | 147 |
| 122 | 121 | 144 | 146 | 11 |
| 125 | 121 | 144 | 145 | 10 |
| 126 | 121 | 145 | 147 | 13 |

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|-----|-----|-----|-----|-----|
| 120 | 122 | 140 | 142 | 143 |
| 121 | 80 | 40 | 144 | 10 |
| 122 | 81 | 40 | 0 | 151 |
| 125 | 80 | 40 | 0 | 152 |
| 126 | 70 | 40 | 0 | 153 |

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Point-Process: Pixel/Point Arithmetic

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|-----|-----|-----|-----|-----|
| 120 | 122 | 140 | 142 | 143 |
| 121 | 120 | 141 | 144 | 147 |
| 122 | 121 | 144 | 146 | 11 |
| 125 | 121 | 144 | 145 | 10 |
| 126 | 121 | 145 | 147 | 13 |

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| | | | | |
|-----|-----|-----|-----|-----|
| 120 | 122 | 140 | 142 | 143 |
| 121 | 80 | 40 | 144 | 10 |
| 122 | 81 | 40 | 0 | 151 |
| 125 | 80 | 40 | 0 | 152 |
| 126 | 70 | 40 | 0 | 153 |

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| | | | | |
|-----|-----|-----|-----|-----|
| 240 | 244 | 280 | 284 | 286 |
| 121 | 200 | 181 | 288 | 157 |
| 122 | 202 | 184 | 146 | 162 |
| 125 | 201 | 184 | 145 | 164 |
| 126 | 191 | 185 | 147 | 166 |

| | | | | |
|-----|-----|-----|-----|-----|
| 120 | 122 | 140 | 142 | 143 |
| 121 | 120 | 141 | 144 | 147 |
| 122 | 121 | 144 | 146 | 11 |
| 125 | 121 | 144 | 145 | 10 |
| 126 | 121 | 145 | 147 | 13 |

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|-----|-----|-----|-----|-----|
| 120 | 122 | 140 | 142 | 143 |
| 121 | 80 | 40 | 144 | 10 |
| 122 | 81 | 40 | 0 | 151 |
| 125 | 80 | 40 | 0 | 152 |
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Point-Process: Pixel/Point Arithmetic

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|-----|-----|-----|-----|-----|
| 120 | 122 | 140 | 142 | 143 |
| 121 | 80 | 40 | 144 | 10 |
| 122 | 81 | 40 | 0 | 151 |
| 125 | 80 | 40 | 0 | 152 |
| 126 | 70 | 40 | 0 | 153 |

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| | | | | |
|-----|-----|-----|-----|-----|
| 240 | 244 | 280 | 284 | 286 |
| 121 | 200 | 181 | 288 | 157 |
| 122 | 202 | 184 | 146 | 162 |
| 125 | 201 | 184 | 145 | 164 |
| 126 | 191 | 185 | 147 | 166 |

| | | | | |
|-----|-----|-----|-----|-----|
| 120 | 122 | 140 | 142 | 143 |
| 121 | 120 | 141 | 144 | 147 |
| 122 | 121 | 144 | 146 | 11 |
| 125 | 121 | 144 | 145 | 10 |
| 126 | 121 | 145 | 147 | 13 |

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|-----|-----|-----|-----|-----|
| 120 | 122 | 140 | 142 | 143 |
| 121 | 80 | 40 | 144 | 10 |
| 122 | 81 | 40 | 0 | 151 |
| 125 | 80 | 40 | 0 | 152 |
| 126 | 70 | 40 | 0 | 153 |

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| | | | | |
|---|-----|-----|-----|------|
| 0 | 0 | 0 | 0 | 0 |
| 0 | 40 | 101 | 0 | 137 |
| 0 | 40 | 104 | 146 | -140 |
| 0 | 40 | 104 | 145 | -142 |
| 0 | 191 | 185 | 147 | -140 |

Pixel/Point Arithmetic: An Example



Image 1



Image 2

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NOTE: This image is a result of a rushed job to get the "mask" ... With better planning and shooting, it would have been better

Pixel/Point Arithmetic: An Example



Image 1

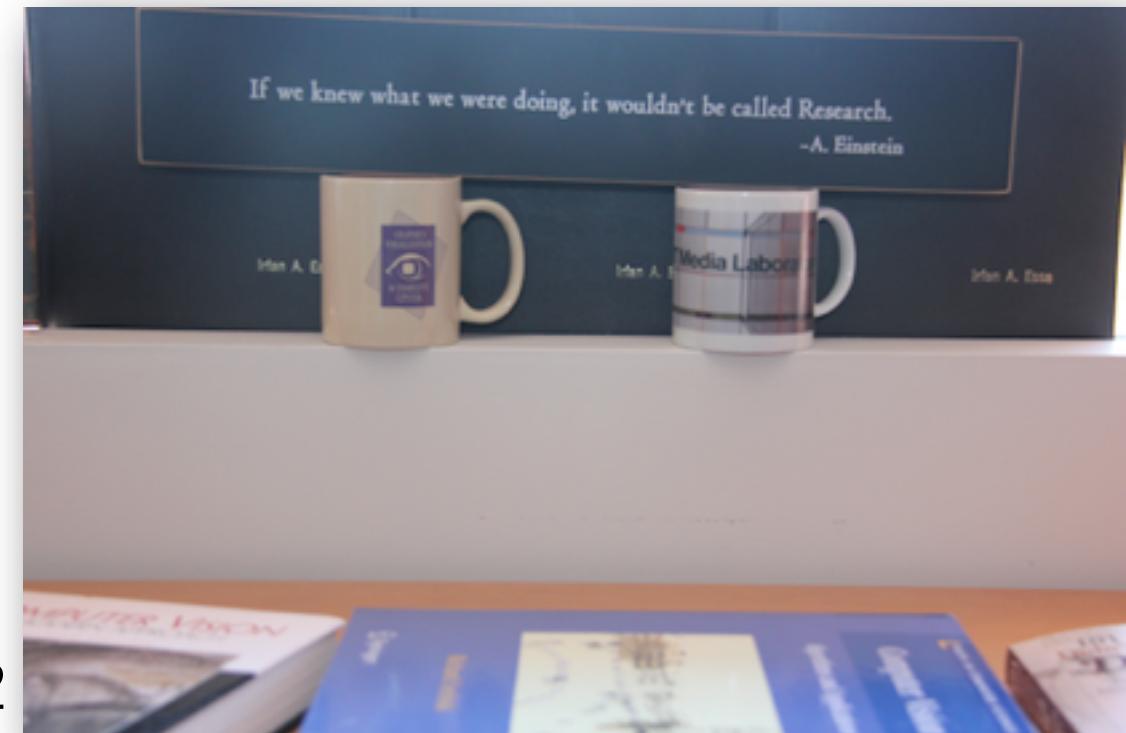
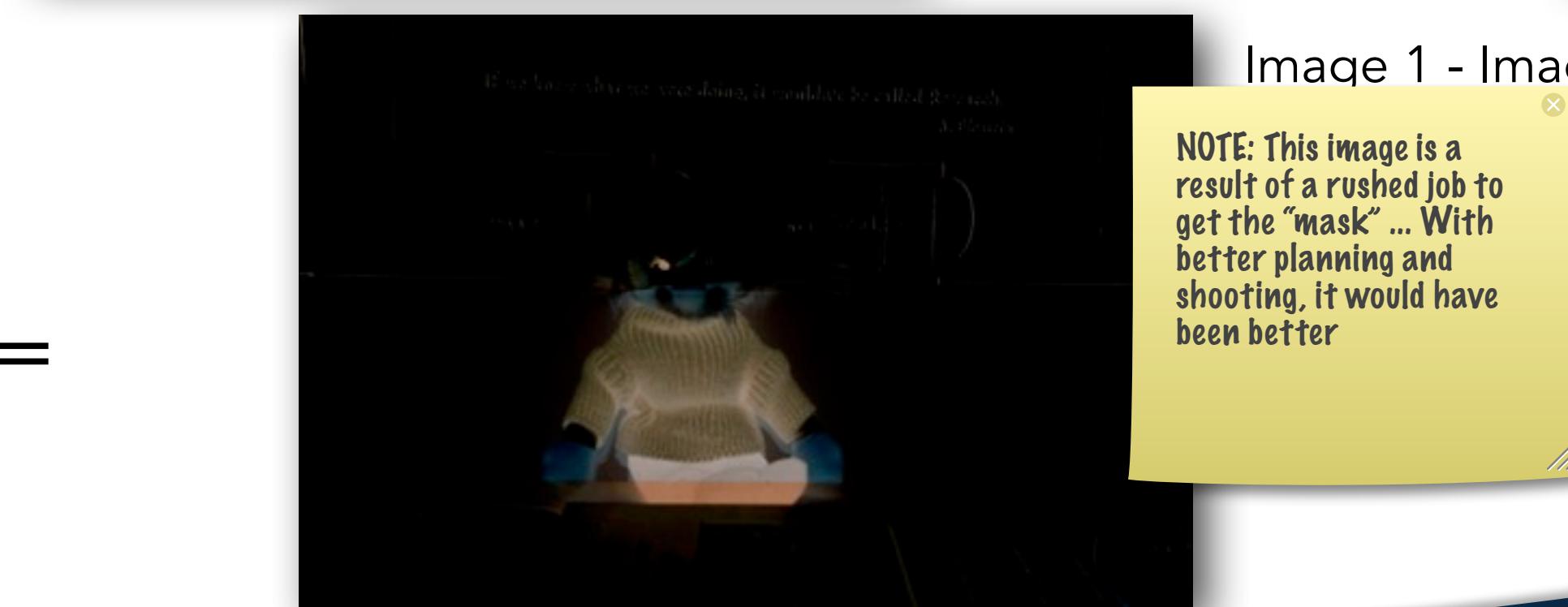


Image 2



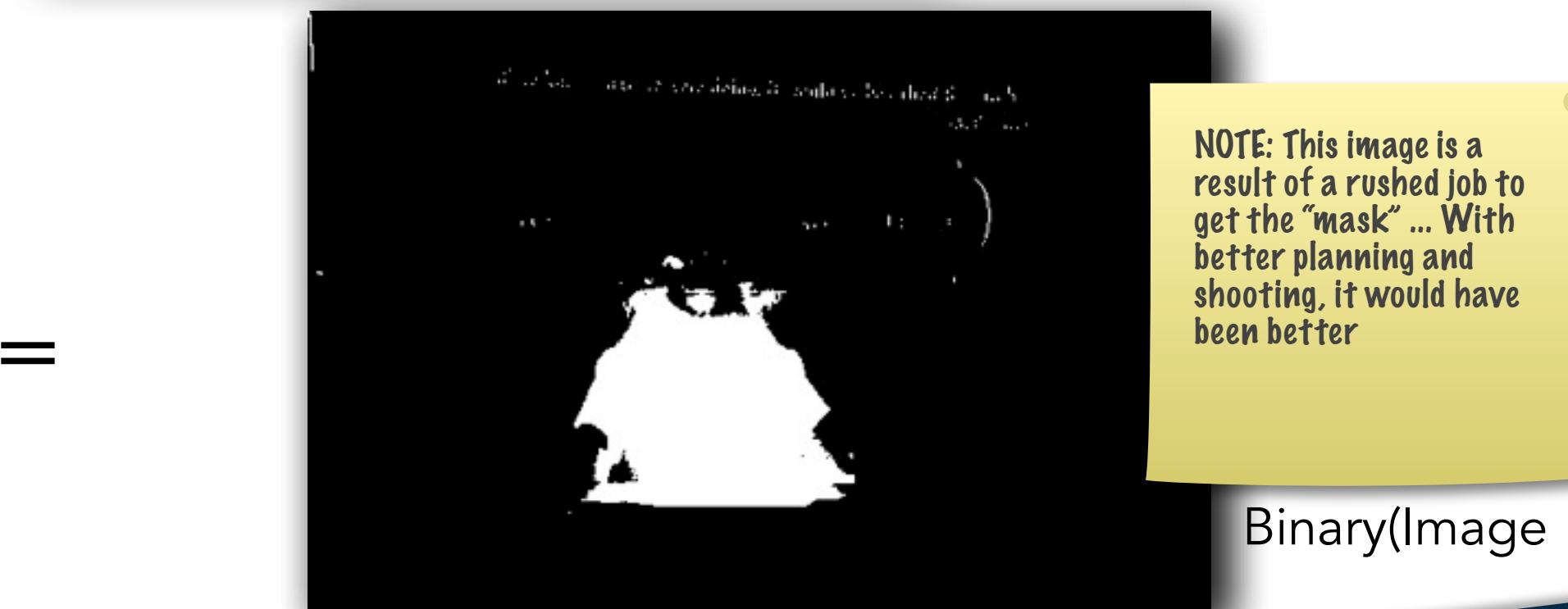
Pixel/Point Arithmetic: An Example



Image 1



Image 2



Binary(Image 1 - Image 2)

Pixel Operations: Another Example

CD

AE

LD

Pixel Operations: Another Example



CD



AE



LD

Pixel Operations: Another Example



CD

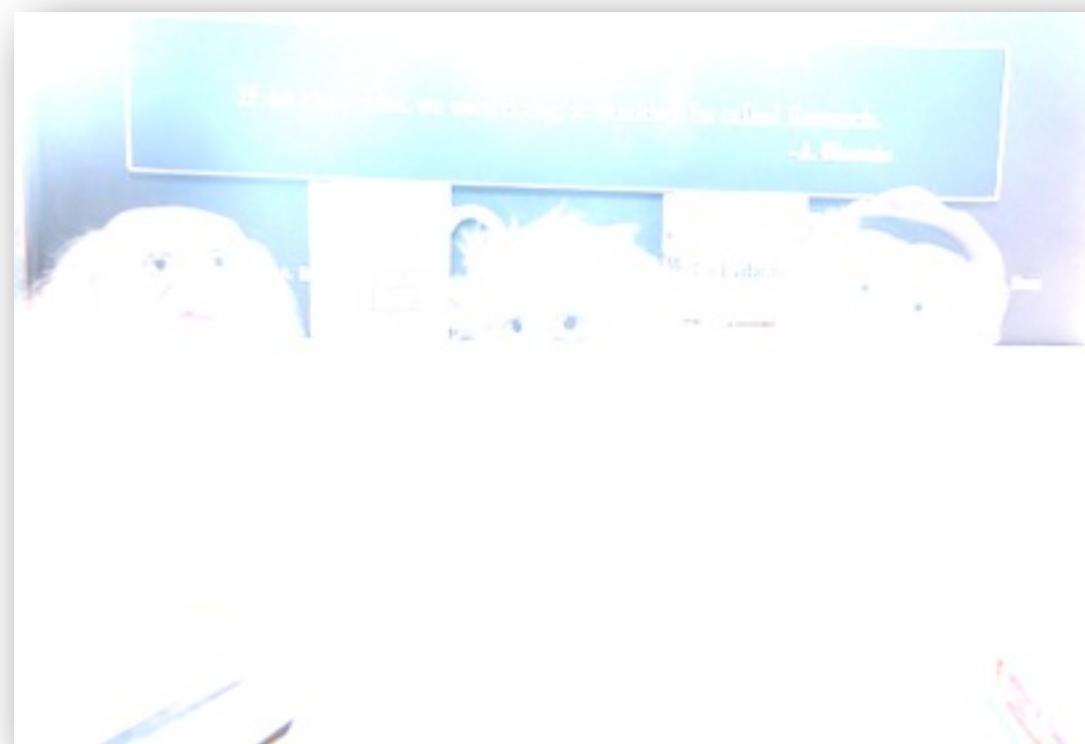


AE

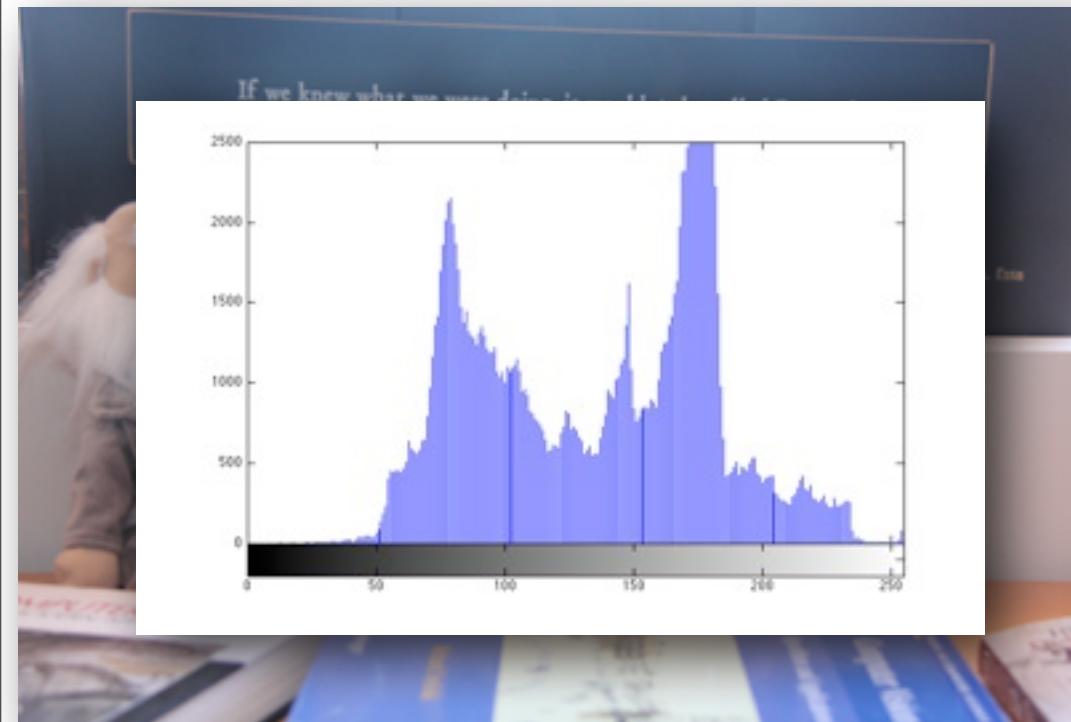


LD

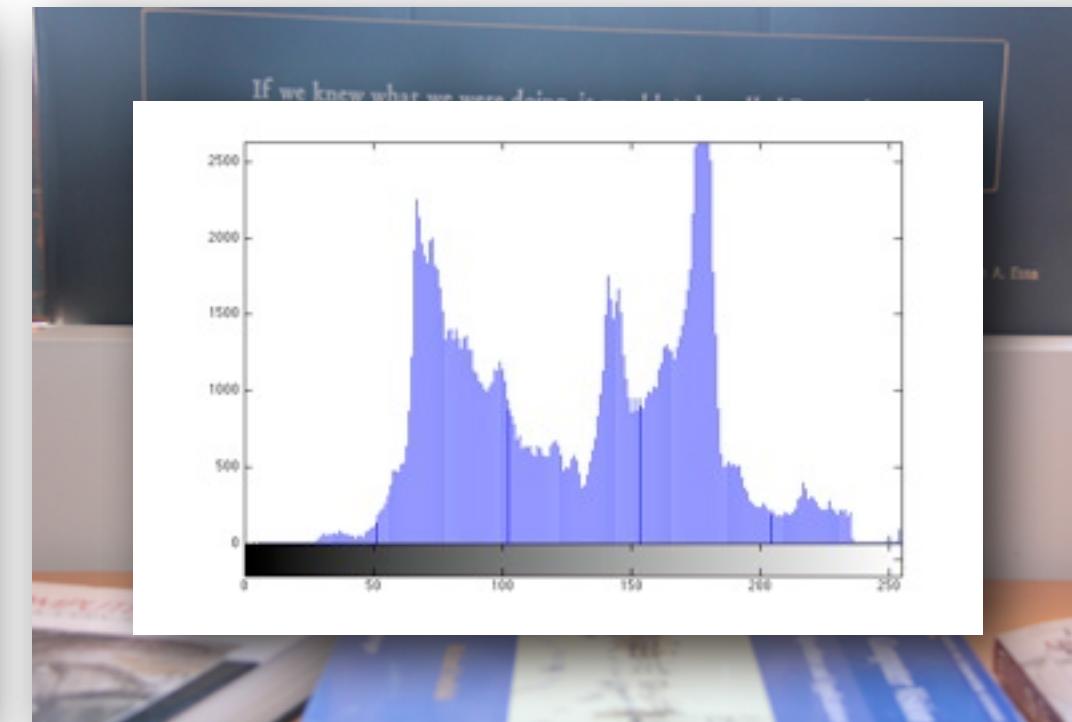
CD+AE+LD=



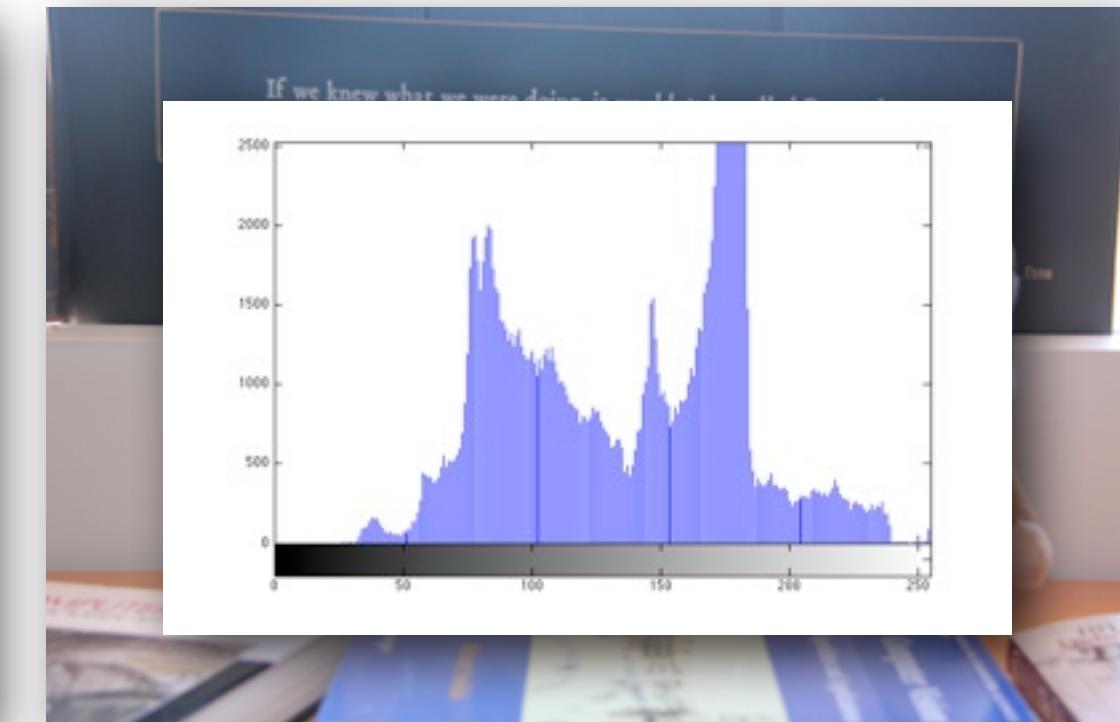
Pixel Operations: Another Example



CD

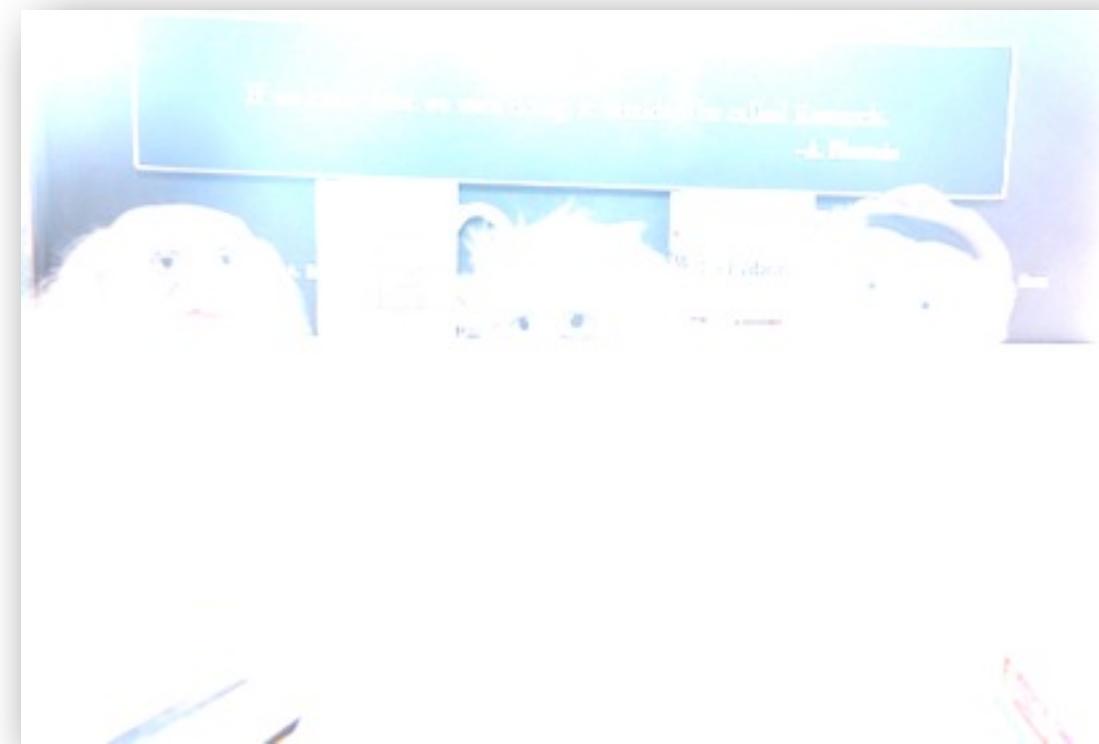


AE

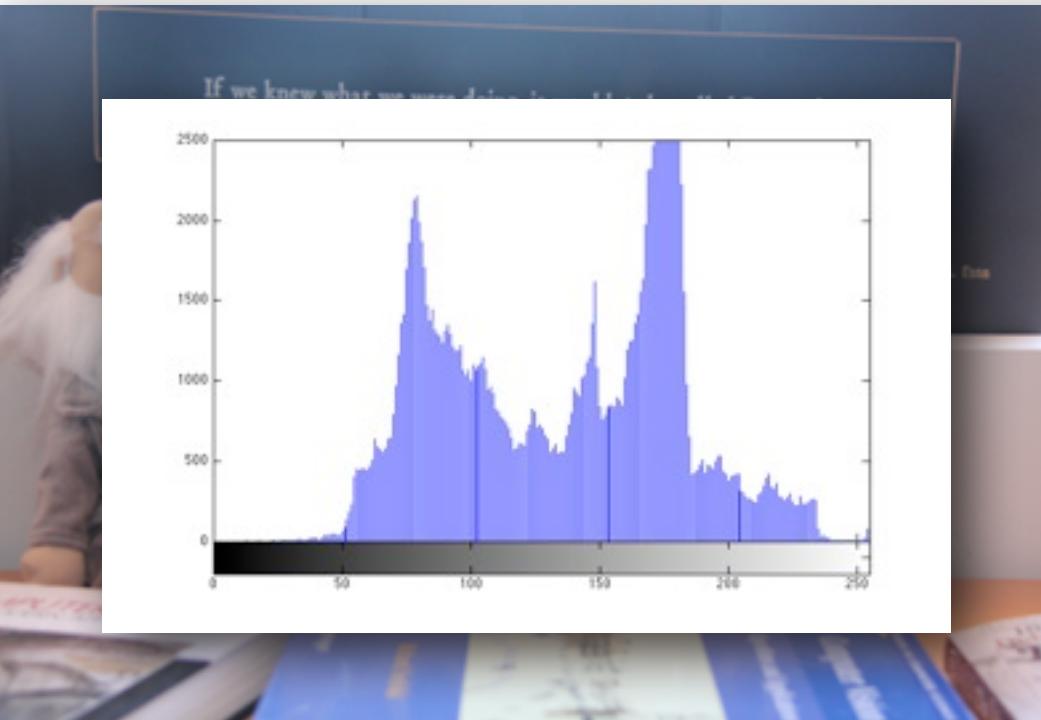


LD

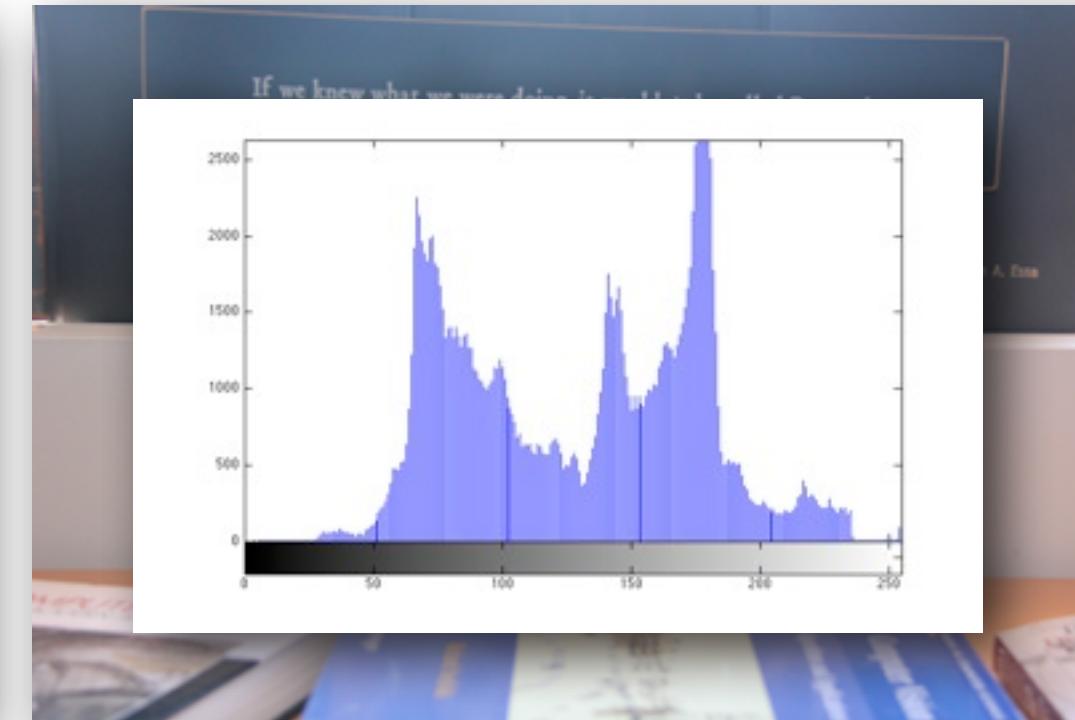
CD+AE+LD=



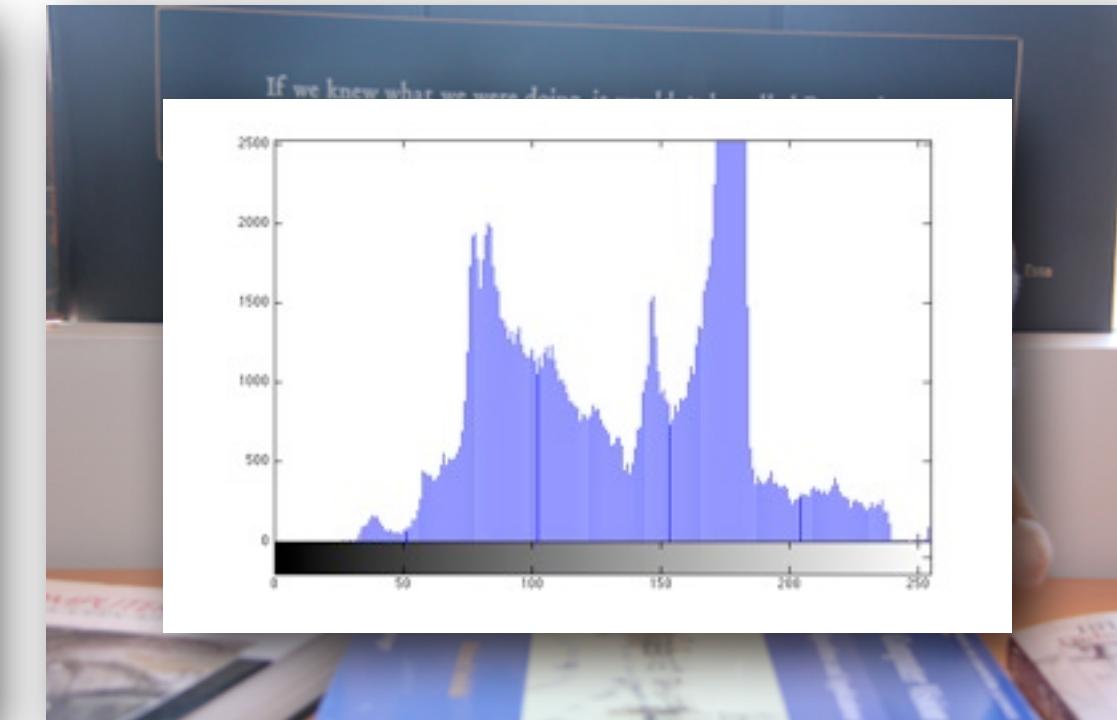
Pixel Operations: Another Example



CD

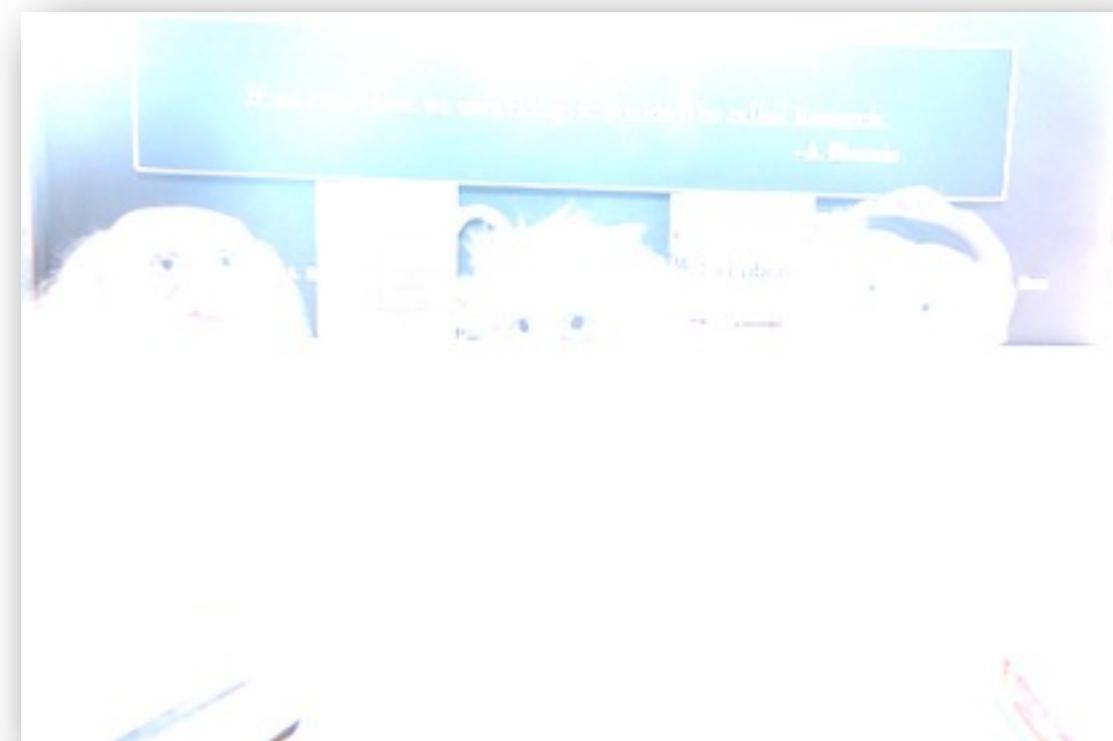
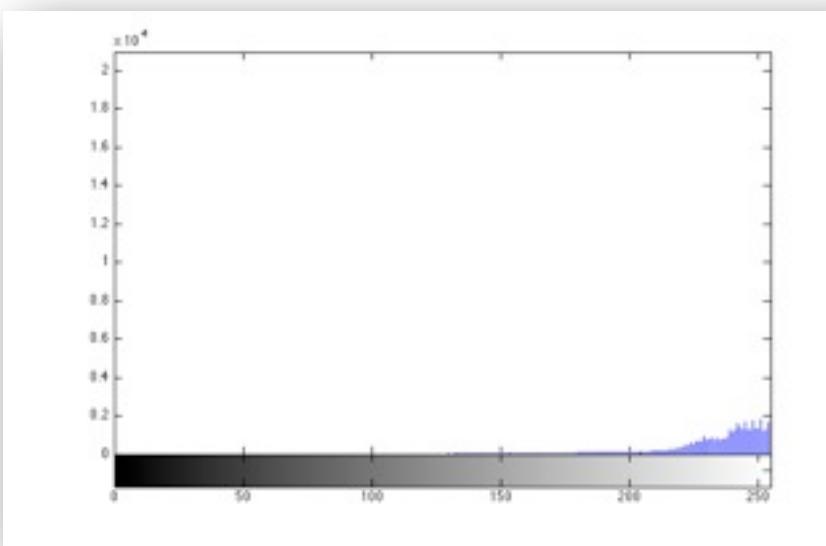


AE

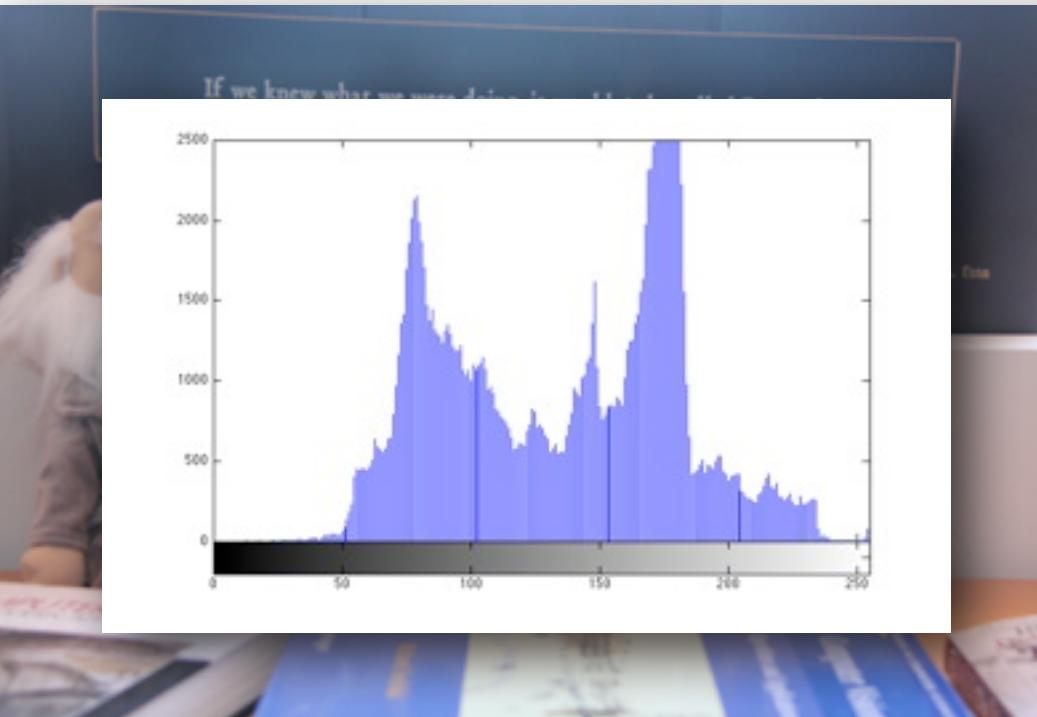


LD

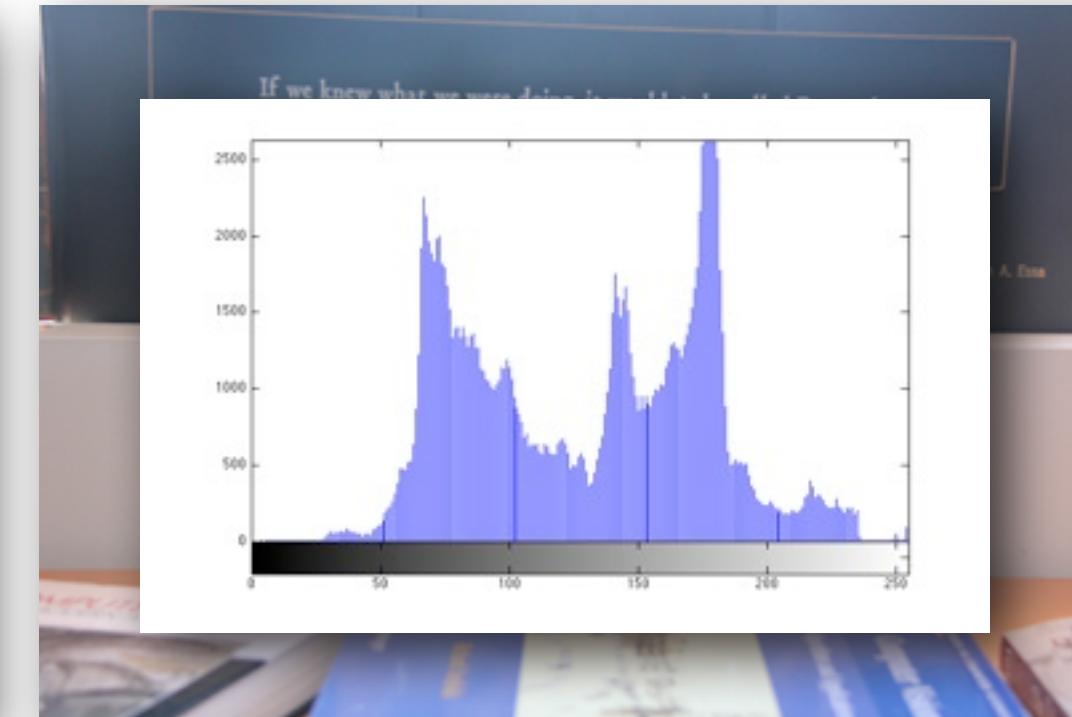
CD+AE+LD=



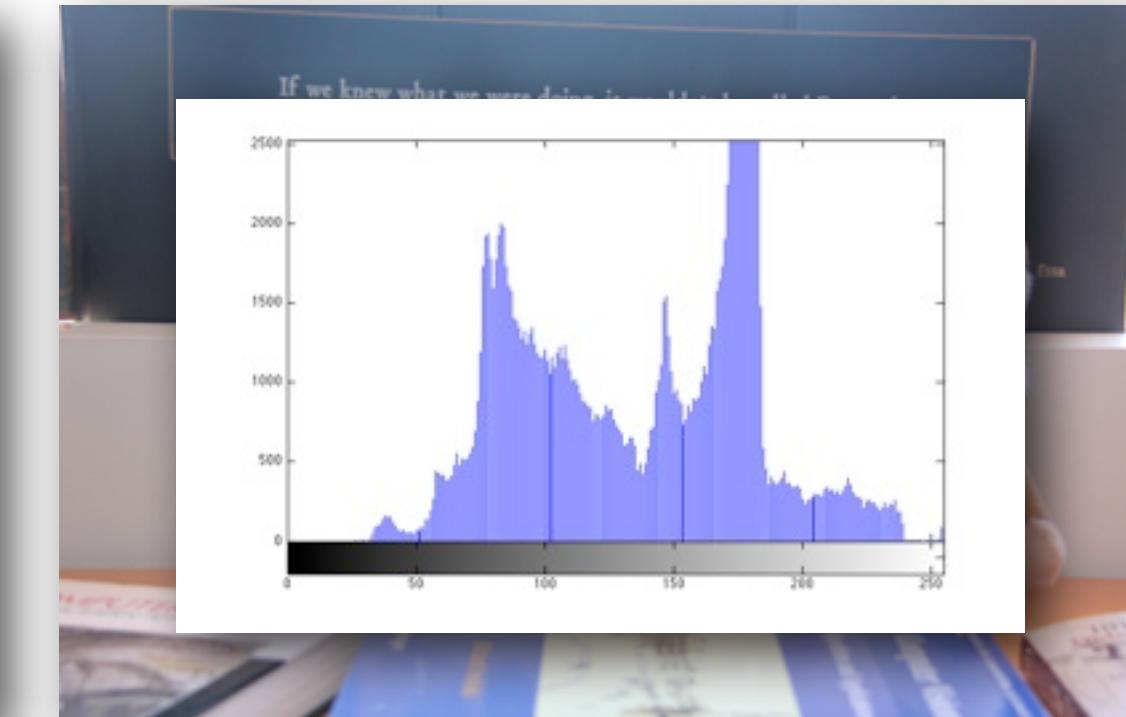
Pixel Operations: Another Example



CD



AE

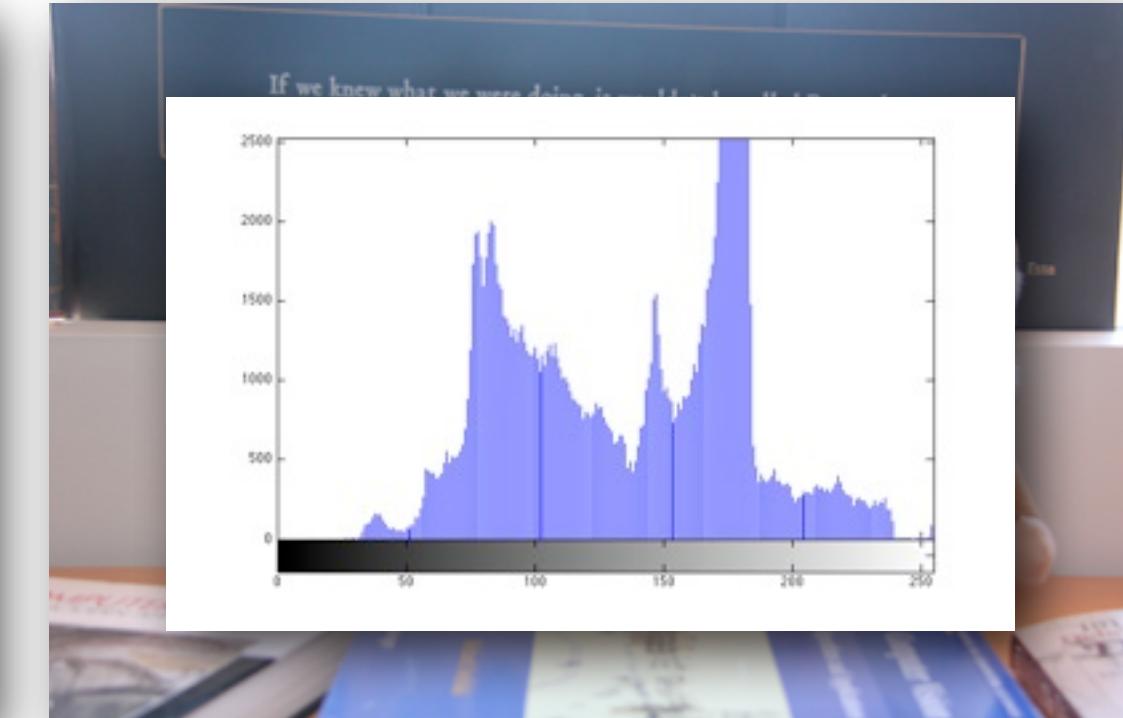
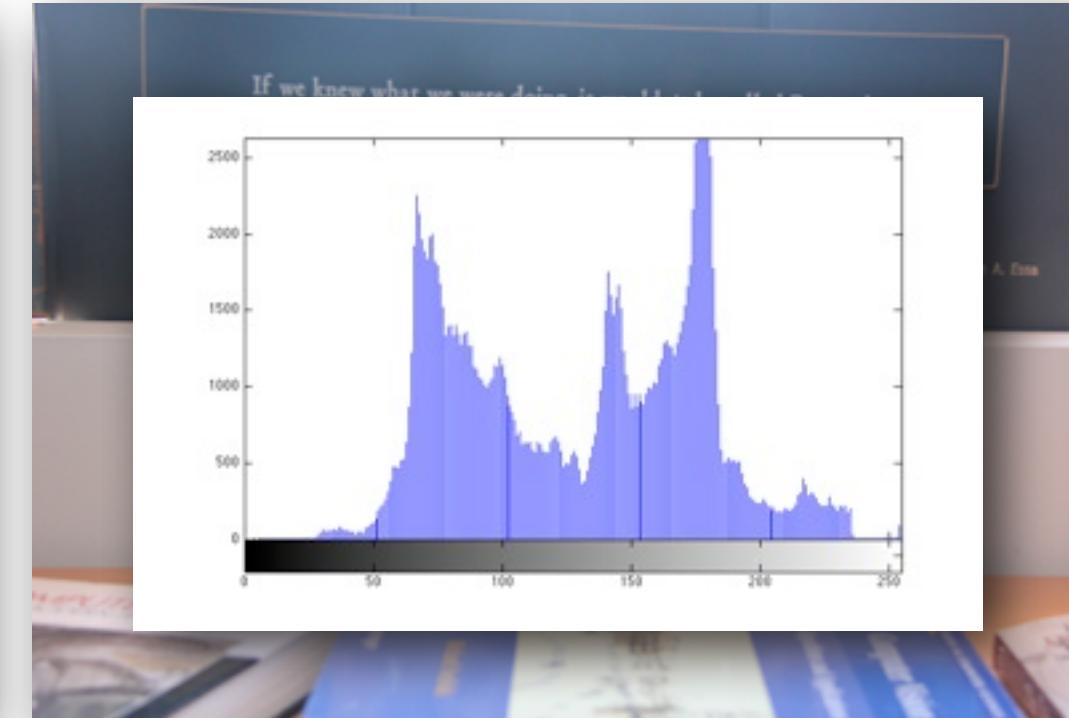
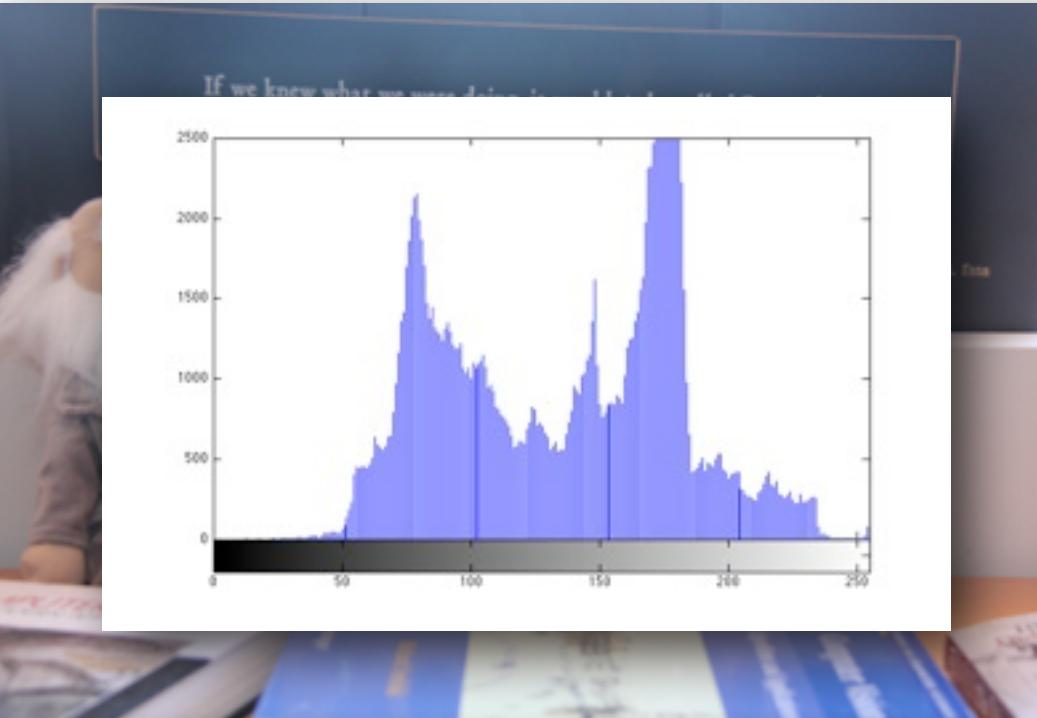


LD



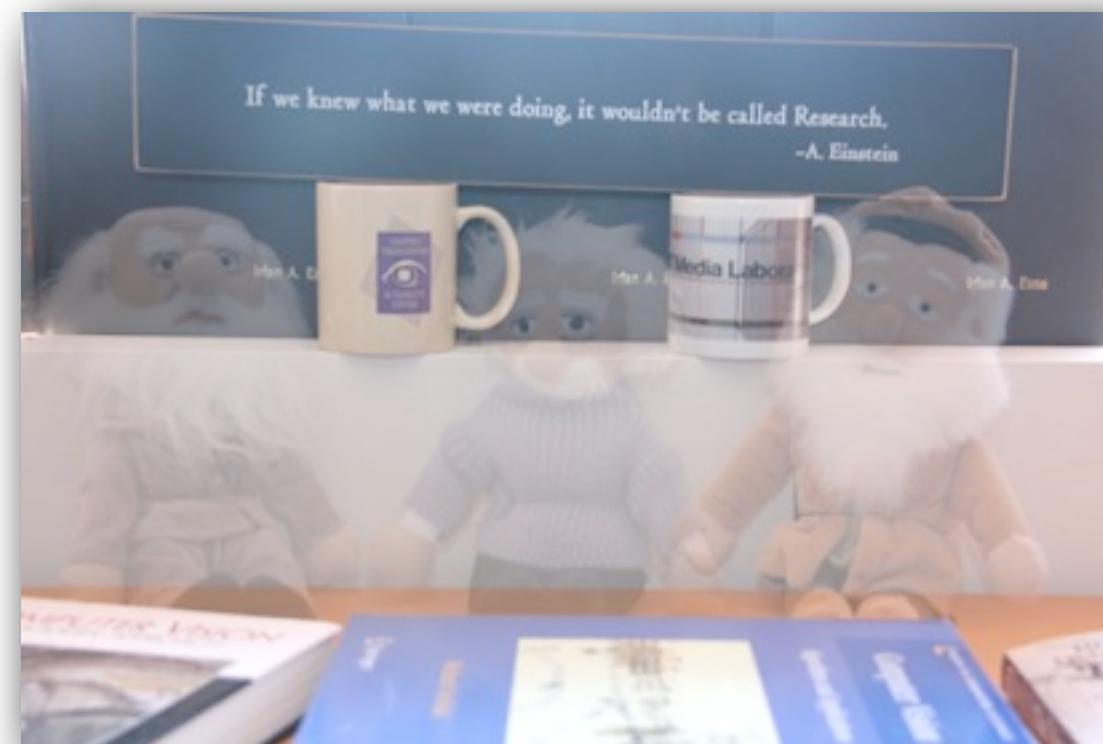
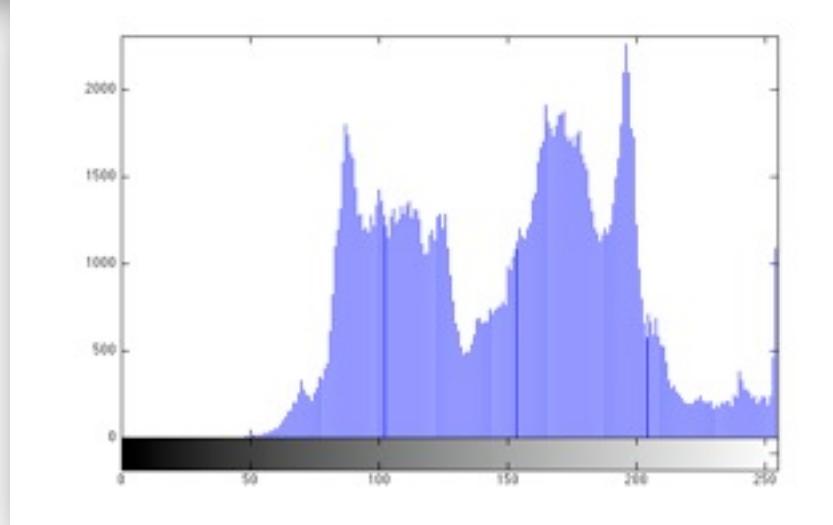
$$.34 \cdot CD + .34 \cdot AE + .34 \cdot LD =$$

Pixel Operations: Another Example



AE

LD



$$.34 \times CD + .34 \times AE + .34 \times LD =$$

Alpha-blending (α -blending)

$$.34 \cdot CD + .34 \cdot AE + .34 \cdot LD =$$



- ★ Transparency (Conversely, Opacity!)
- ★ Usually represented as: α
- ★ α varies from 0 to 1.0 (0=invisible, 1.0=fully visible)
- ★ $RGB \rightarrow \alpha RGB$

Summary

- ★ Modeled how to apply Point-process Computations on Images to Add and Subtract images.
- ★ Showed an example of α -blending commonly used in Image Processing.
- ★ Showcased the use of Image Histogram in Image Processing.



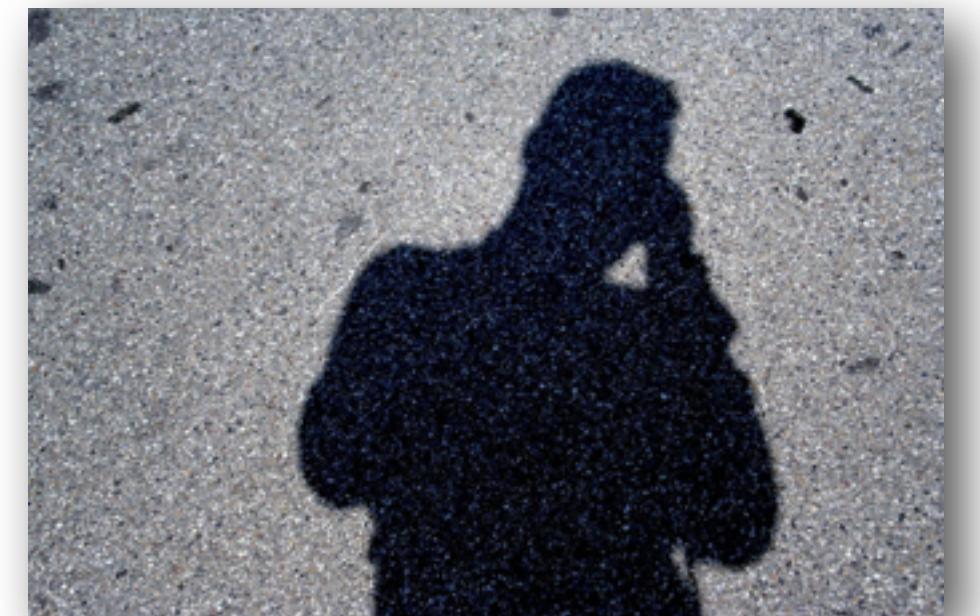
Next Class

★ Image Processing and
Filtering, via Convolution and
Correlation



Credits

- ★ Matlab™ software by Mathworks Inc.
- ★ Some slides adapted from Steve Seitz and Aaron Bobick
- ★ Images by Irfan Essa
- ★ See [Credits] on the website for other images



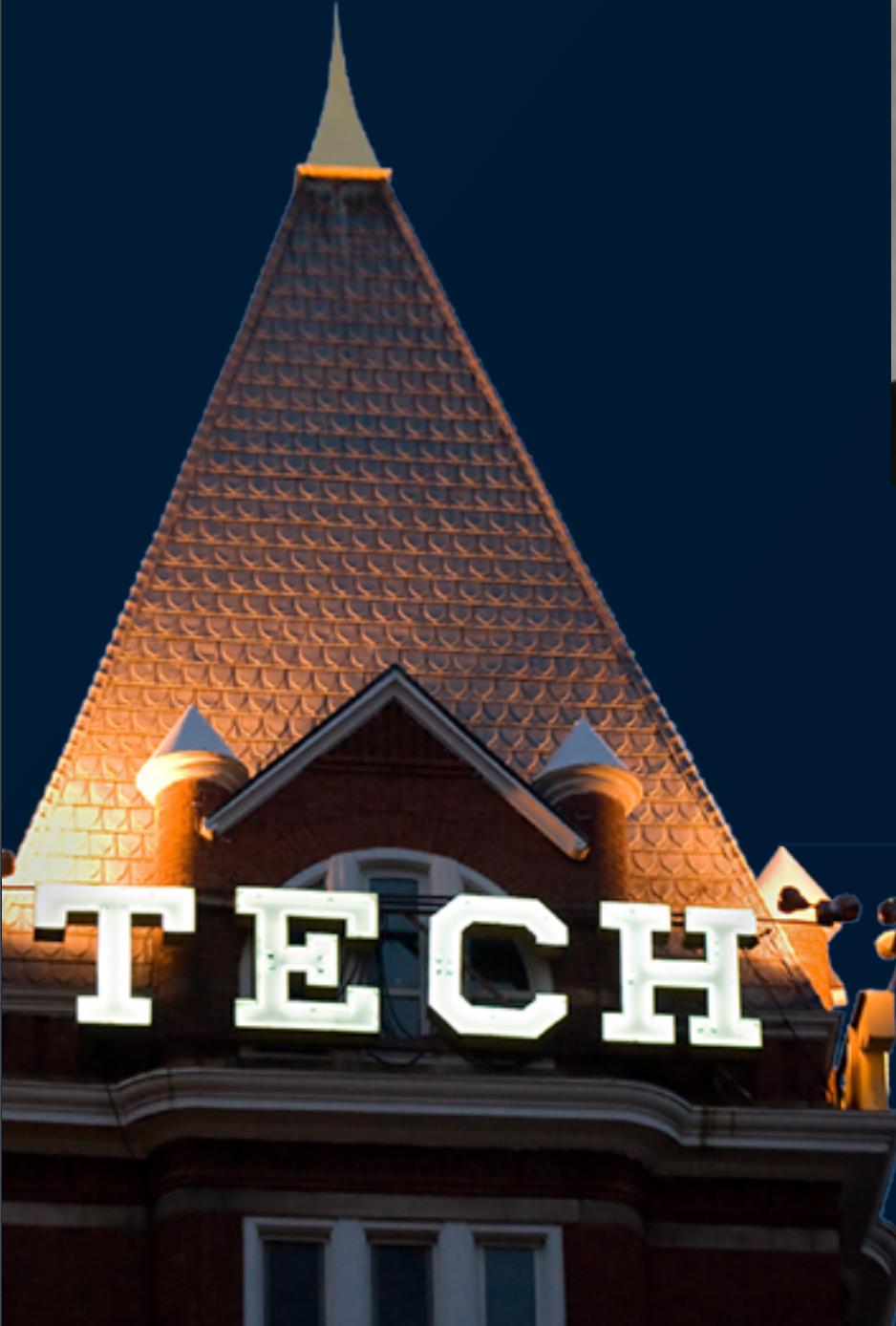
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