Computational Photography

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

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Why Study Computational Photography?

* The Context of the Field of Computational Photography and Its Future

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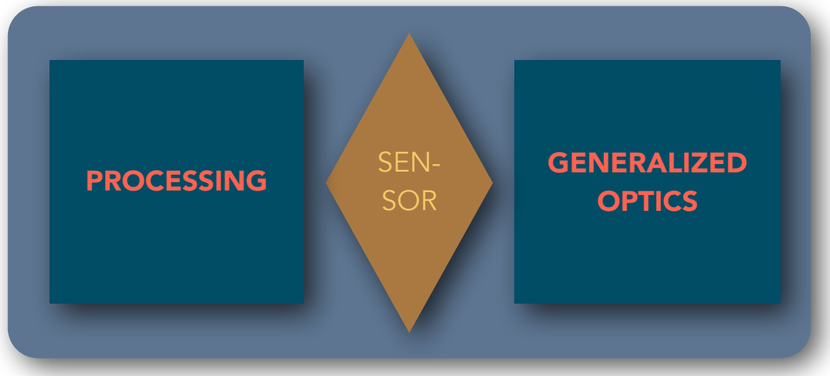
Lesson Objectives

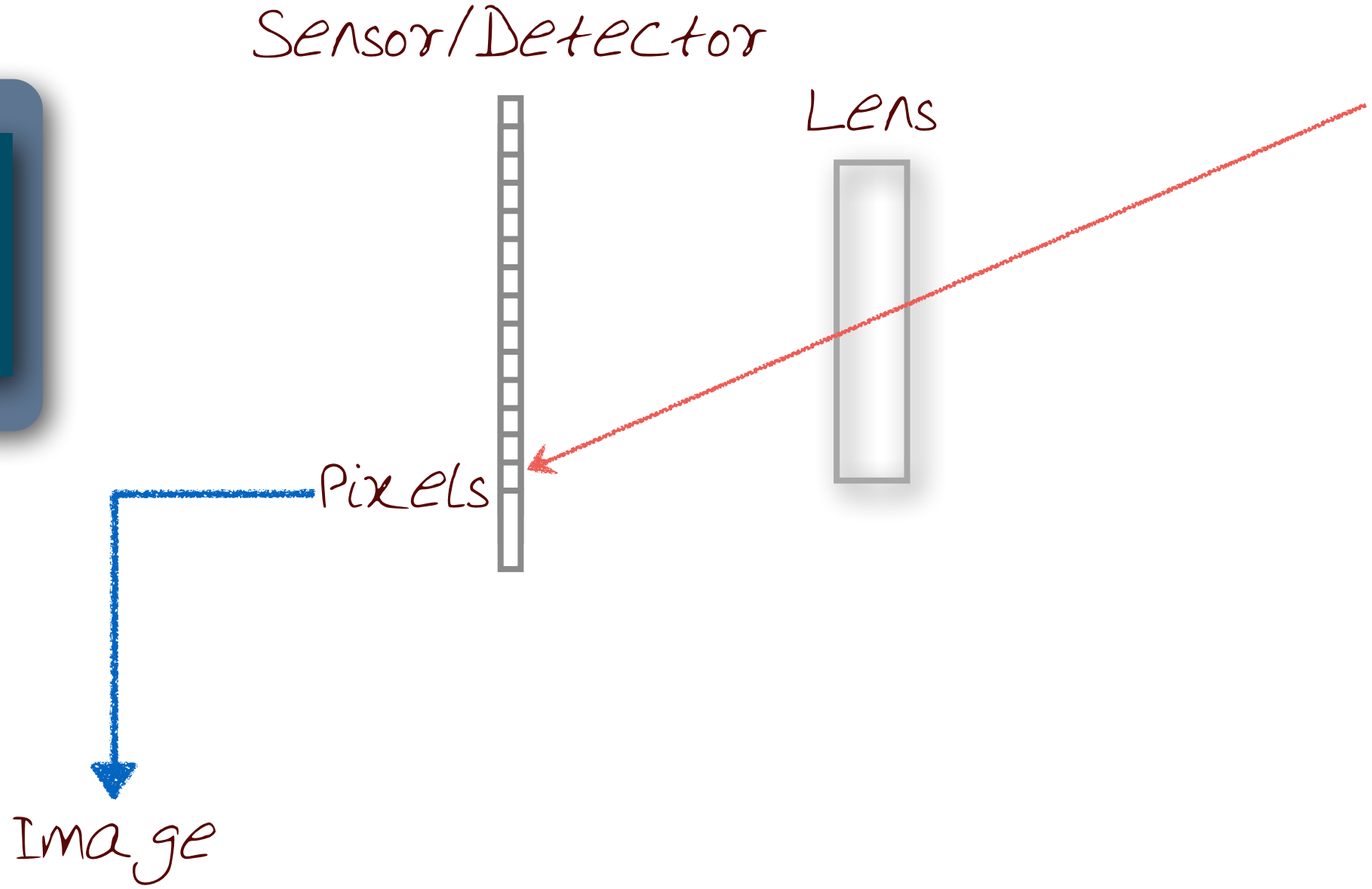
1. Pervasiveness of Photography
2. Computational photography as it relates to other disciplines
3. Computational photography vs. photography

Traditional Film/Digital Camera Processes



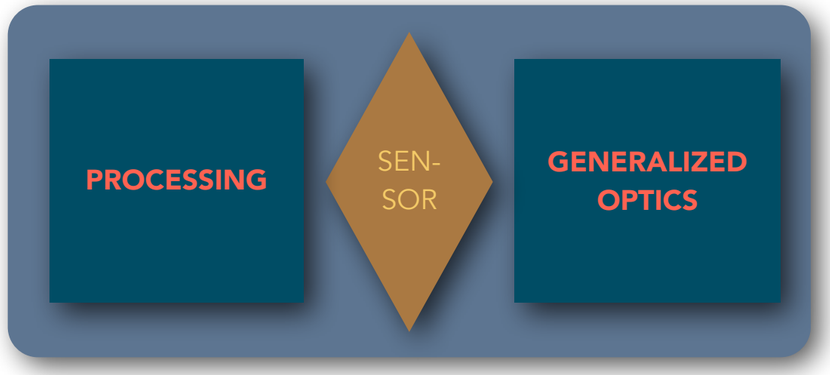
Novel Camera

Not sure what this diagram indicates, and why does it need to disappear?

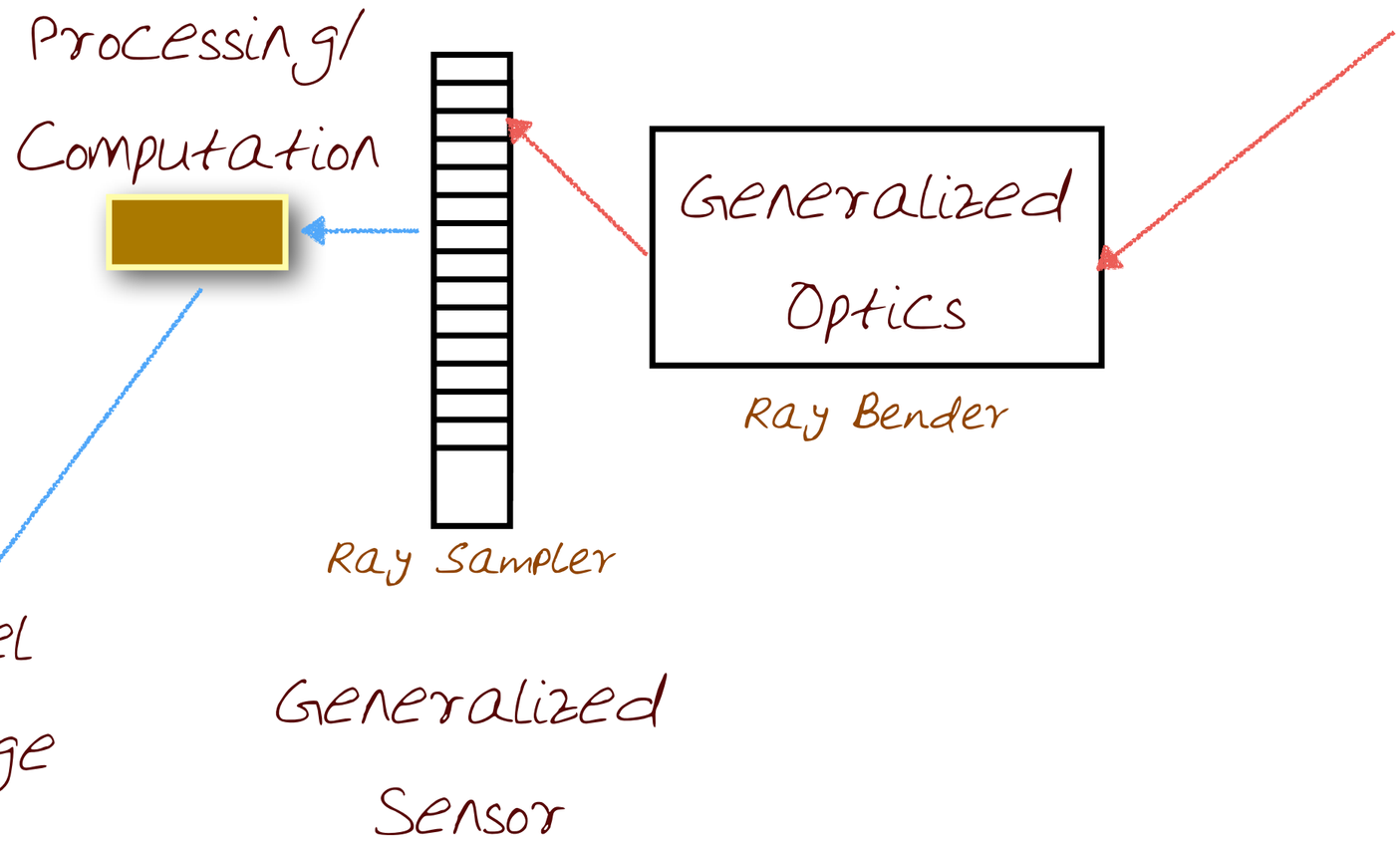


Schematic Similar to one used by Shree Nayar and Ramesh Raskar

Computational Camera Process



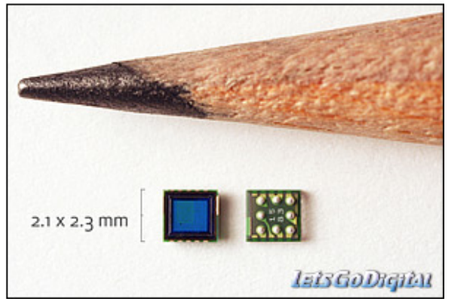
Novel Camera



Slide schematic based on slides by Raskar and Tumblin

So Why Study Cameras?

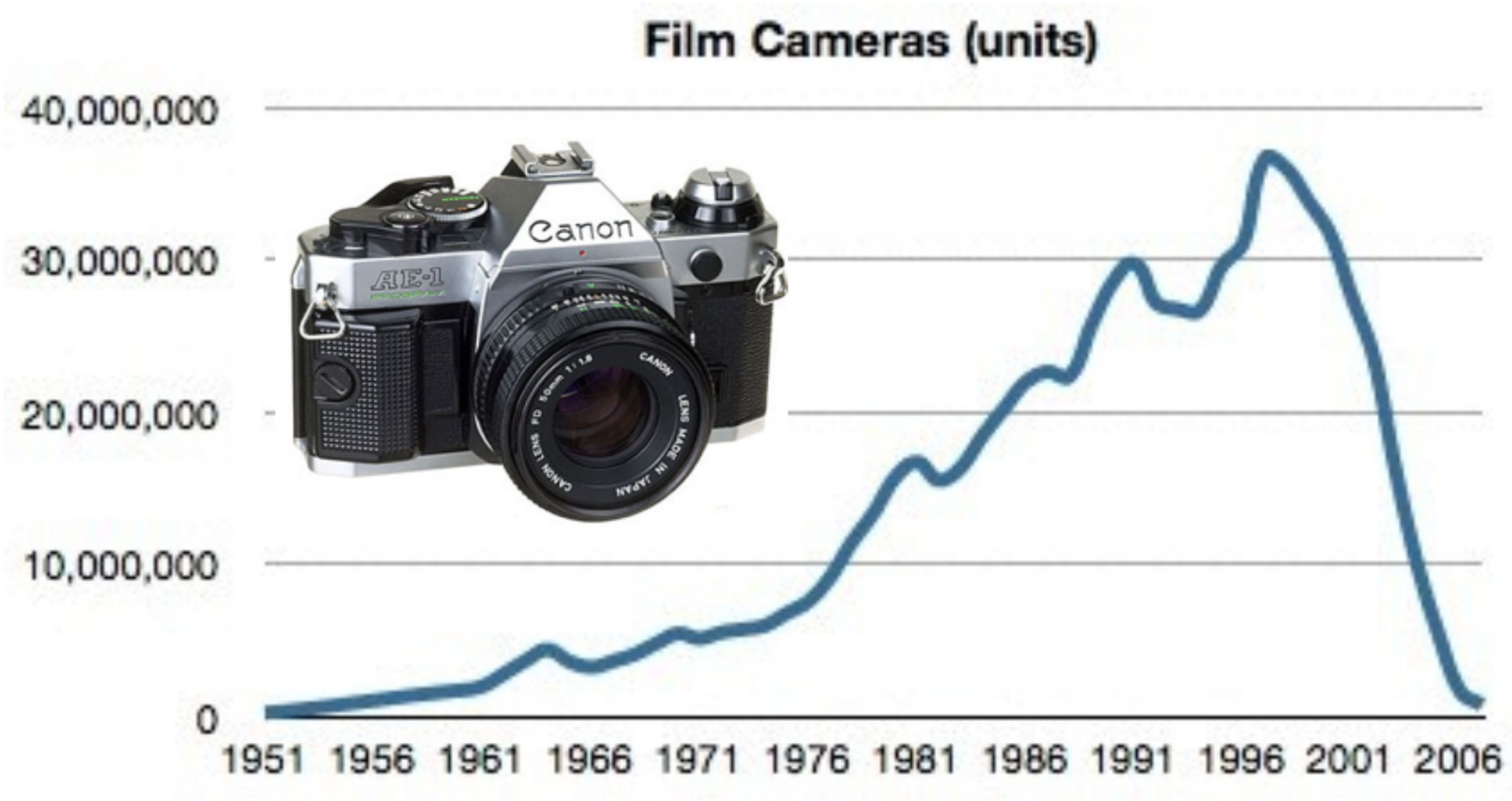
- Almost Everyone has a Camera
  - e.g., Smaller, Ubiquitous
- Significant Improvements in Optics
  - Field of Applied Optics has studied every aspect of the Lens
- Better, Cheaper Sensors (CCD/CMOS)
  - Sensor Electronics has its own Field



Cameras are Everywhere

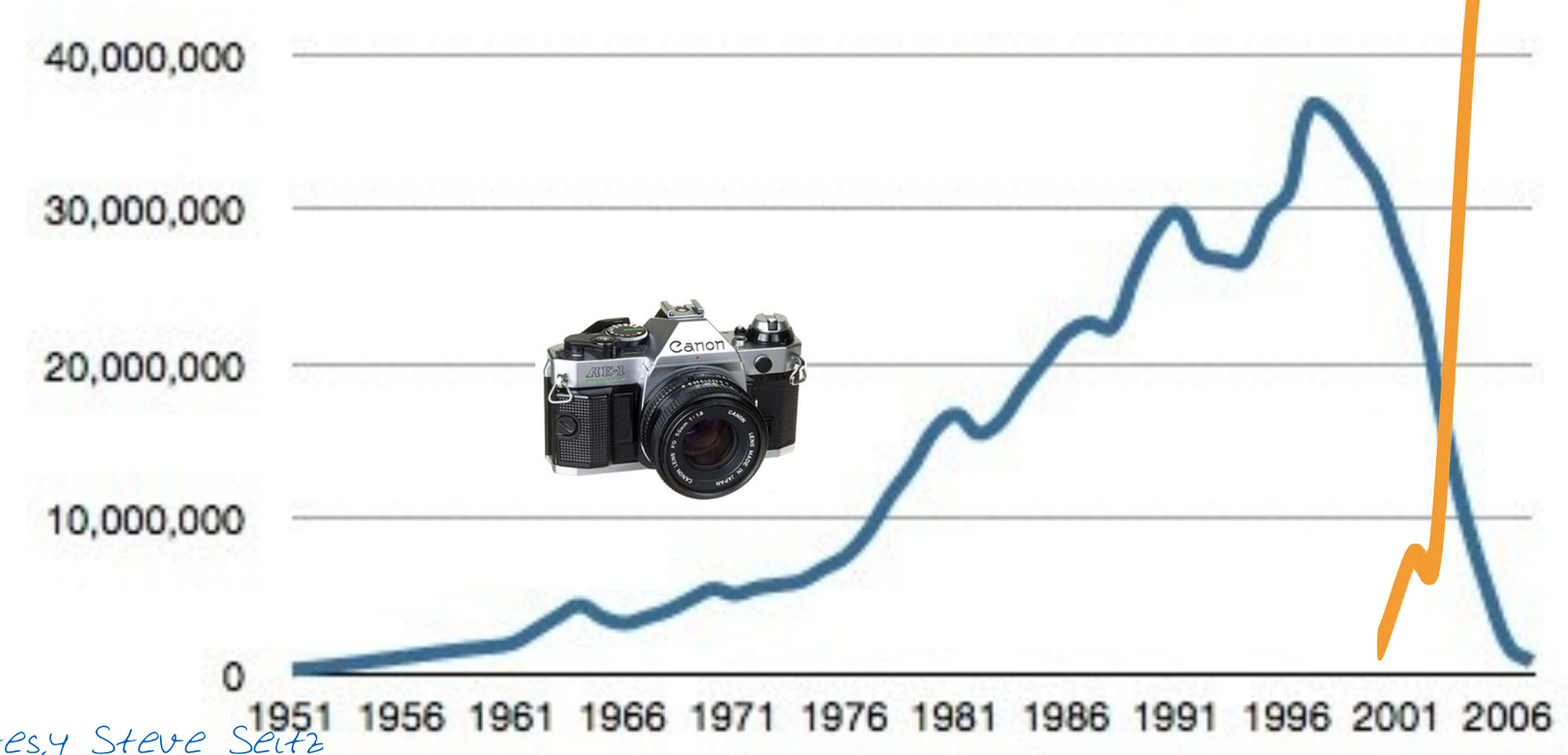
- Camera phones
  - Widest selling electronic platform
- Further expanded by new platforms:
  - Google Earth, YouTube, Flickr . . .
  - Text, Speech, Music, Images, Video, 3D, . . .
- Key element for art, research, products, social-computing . . .

SLR (film)



Slide: Courtesy Steve Seitz

SLR (film)

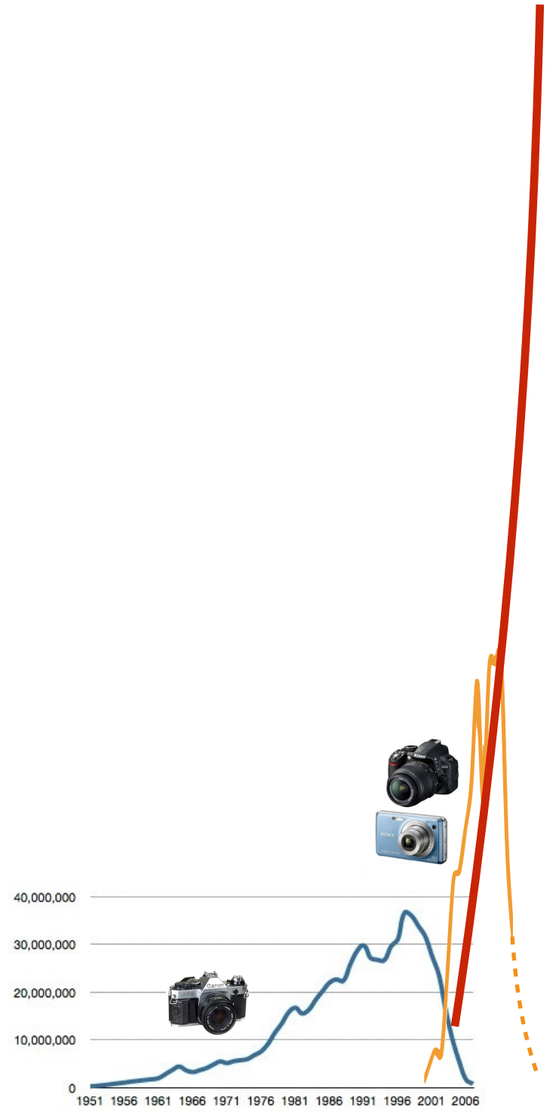


Slide: Courtesy Steve Seitz

Digital Camera

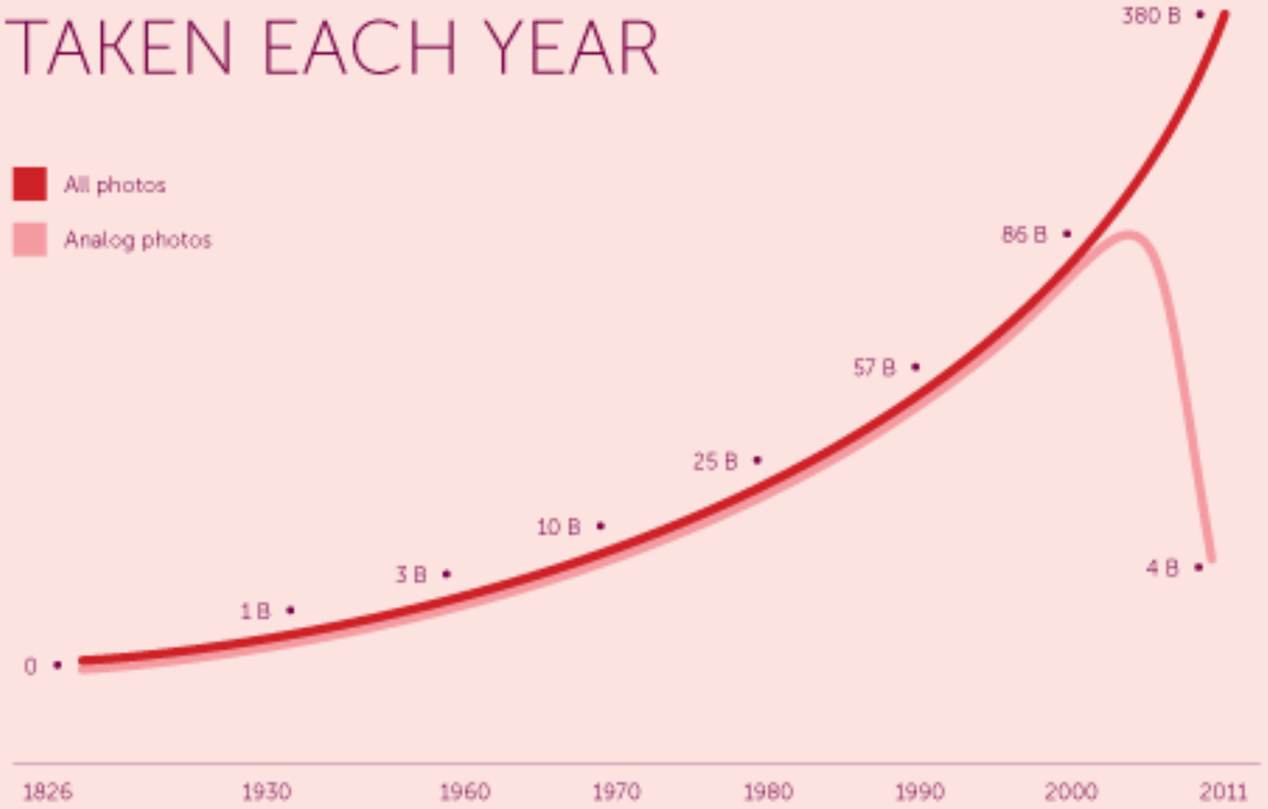
Slide: Courtesy Steve Seitz

Smart Phone Camera



Slide: Courtesy Steve Seitz

NUMBER OF PHOTOS TAKEN EACH YEAR



1000memories.com, Sep 2011

SLR to Camera Phones?

* <u>DSLR advantages</u>
  * more light
  * depth of field
  * shutter lag
  * control field of view
  * better glass
  * others (flash, man. modes, ...)

* <u>phone advantages</u>
  * computation
  * data
  * programmers

Comparison of Film and Digital Cameras/Photography

* Film and Digital Cameras have roughly the same Features and Controls:

* Zoom and Focus
* Aperture and Exposure
* Shutter Release and Advance
* One Shutter Press = One Snapshot

Computational Photography Extends FP/DP

* For FP/DP we can USE, but CP allows us to CHANGE!

* Optics, Illumination, Sensor, Movement
* Exploit Wavelength, Speed, Depth, Polarization, etc.
* Probes, Actuators, Network

Computational Photography Extends FP / DP

* Compared to FP/DP, CP has Better Specification and Support for:
  * Dynamic Range
  * Vary Focus Point-by-Point
  * Field of View vs. Resolution
  * Exposure Time and Frame Rate
  * Bursts

Evolution of the Cameras I

1839

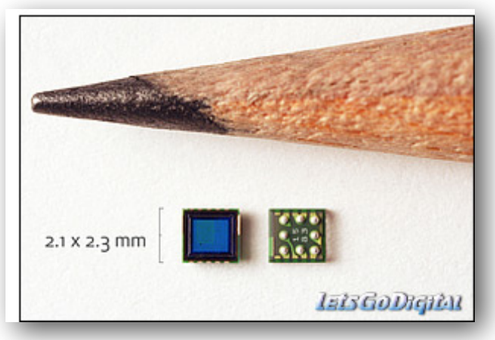
1907

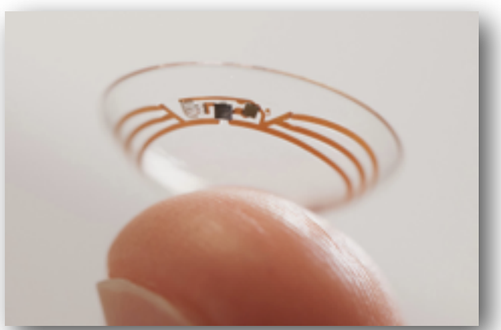
1948

1986

1991

2000





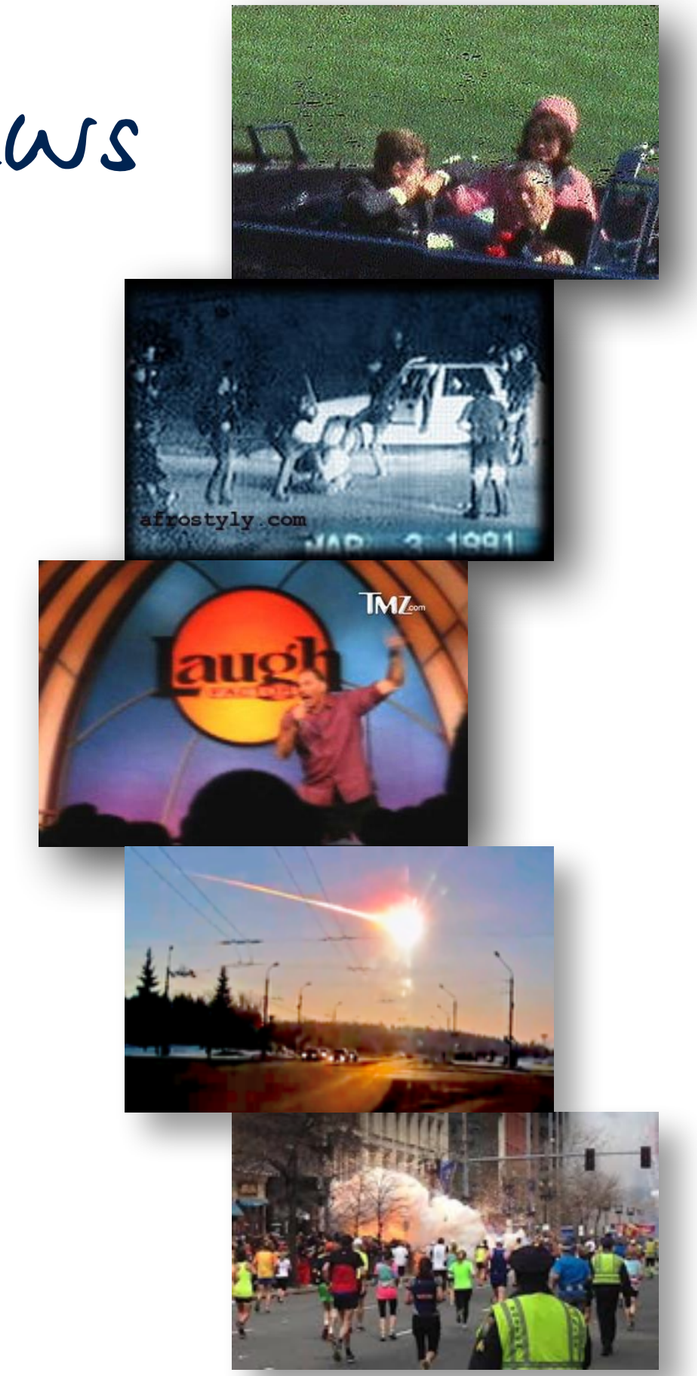
http://ericwilliamcarroll.com/blog/?p=23
http://simplevideoproduction.blogspot.com/
http://webdesign.njit.edu/2012/248/evolution.html

Evolution of the Cameras II

Evolution of the Cameras III

Joaquin Phoenix in Her (2013) by Annapurna Pictures

Images in News



- Kennedy Assassination (Zapruder Film)
- Rodney King Beatings in LA
- 9/11 Images
- 7/7 London Bombings
- Virginia Tech
- Michael Richards . . .
- Russian Meteor
- Boston Bombings . . .
- Beast with a Billion eyes (Literally!)

What kinds of IMAGES are out there?

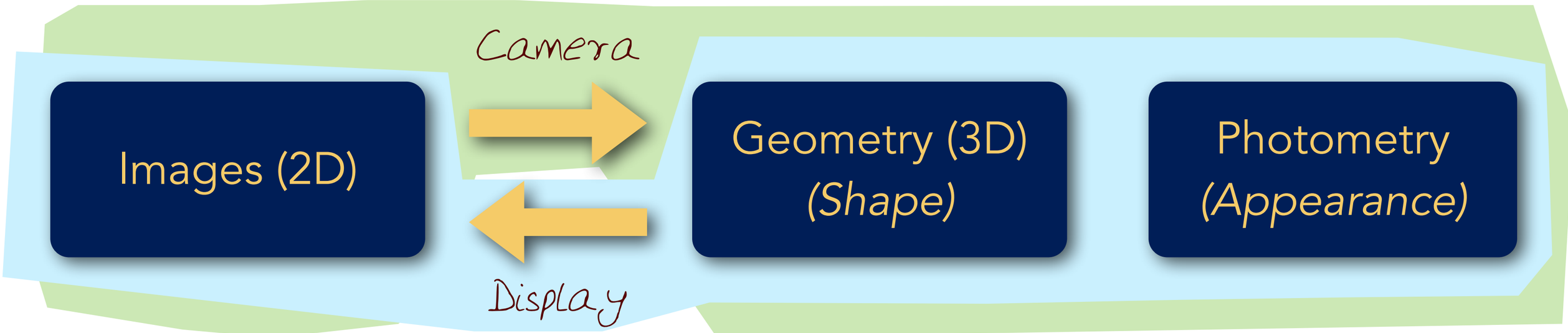
- Participatory Data
  - Handheld, citizen, etc.

- Institutional Imagery
  - Satellite, Airborne, Recon, UAV etc.

- Incidental
  - Security cameras, ATMs, etc.

http://www.ebay.com/itm/270804690527?
http://www.crishammond.com/
http://en.wikipedia.org/wiki/Photo_manipulation

Computer Vision and Computer Graphics



Computer Graphics

Computer Vision

Image Processing and Optics/Sensors

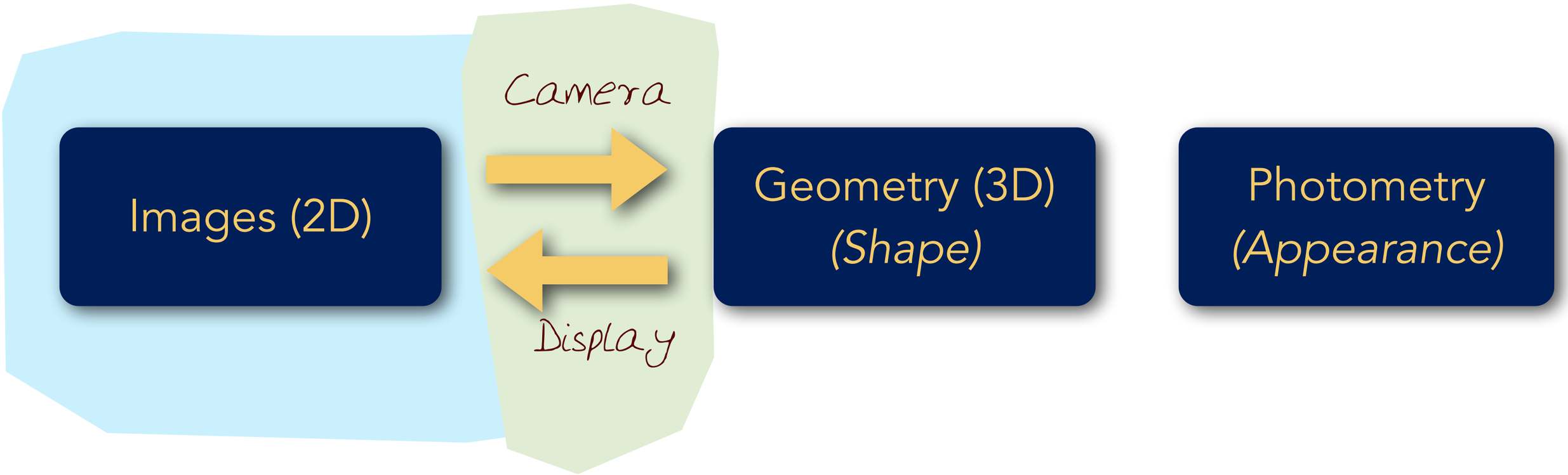
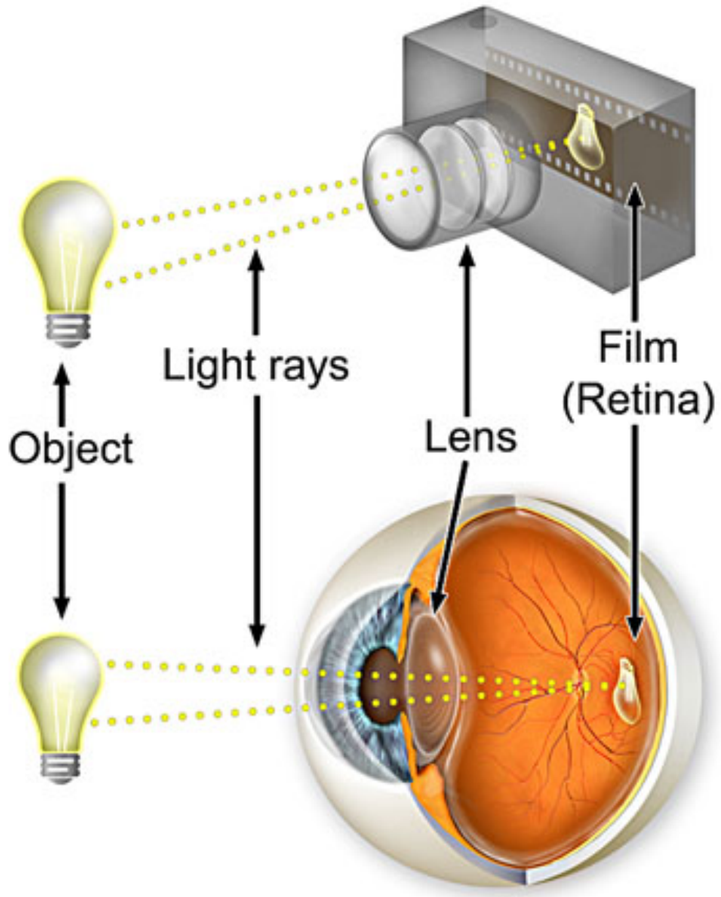


Image Processing

Optics / Sensors

Ultimate Camera?



Emerging Field of Computational Photography

* What will a camera look like in 10 years? 20 years?
* What novel images can we get? What are their Uses?
* How will the next billion cameras change the social culture?
* How can we augment the camera to support best "image search" ?

Emerging Field of Computational Photography

* How will ultra-high-speed/resolution imaging change our usage?
* How will autonomous and robotic cameras impact the photographic pipeline
* What are the opportunities in pervasive, experiential recording?
* How should we change cameras for movie-making, news reporting?

Summary

* Pervasiveness of Cameras
* Computational Photography in the context of computer graphics, computer vision, image processing and optics/sensors
* Computational Photography vs. traditional photography and digital photography
* A need to study Computational Photography

Next Class

* What is an Image?
* Creation of Digital Representation of Images.
* To compute with them
* To process them

Computational Photography

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

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