UH Course COSC 4370

Computer Graphics

Lecture 2

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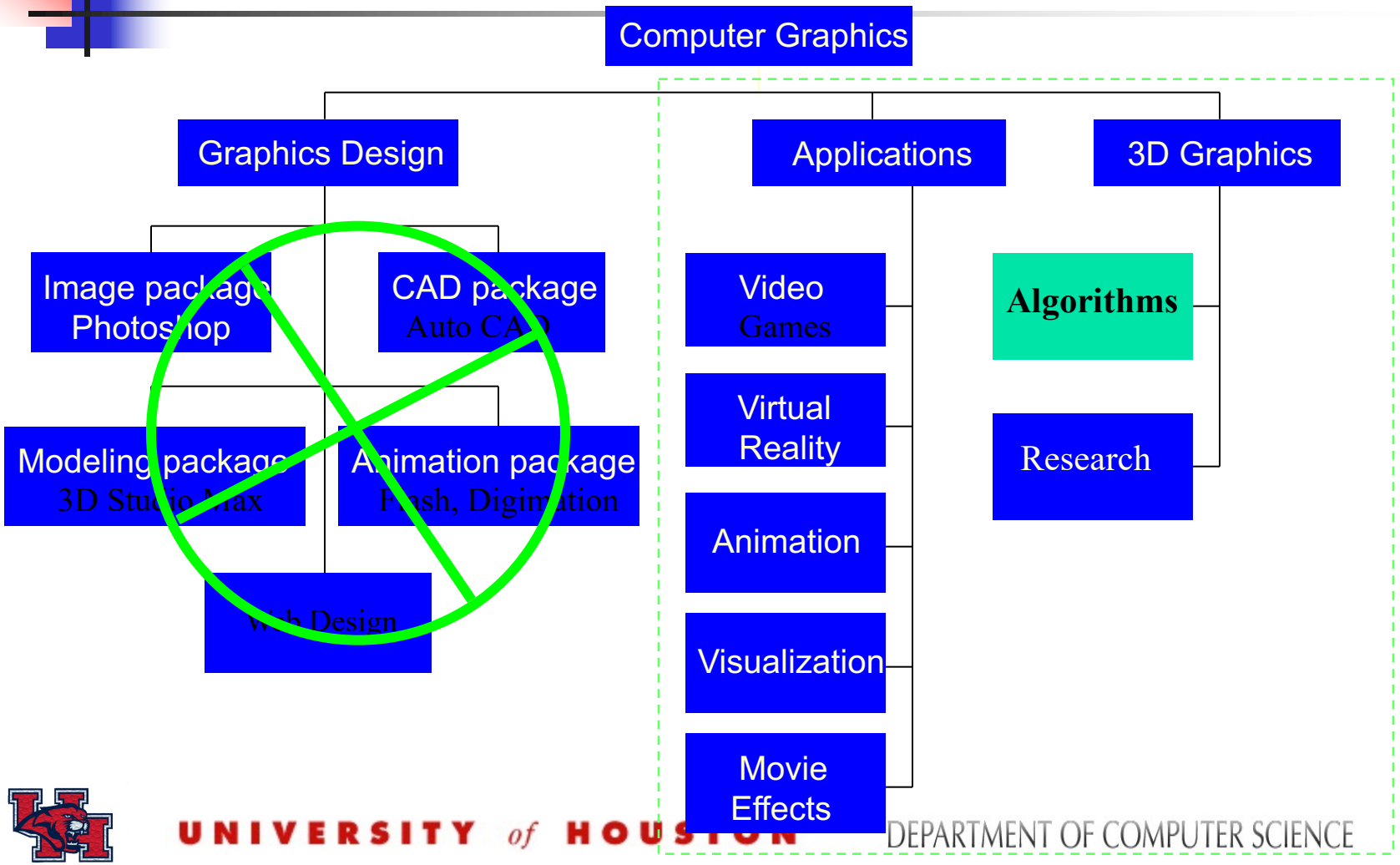
What Will be Covered?



Video Games

Sekiro: Shadows Die twice (2019 Game of the Year)

Video Games

Borderlands 3 (2019)

Movies

The Matrix (1999)

Movies

Avatar (2009)

Animations

Zootopia (2016)

Animations

Frozen 2 (2019)

Design

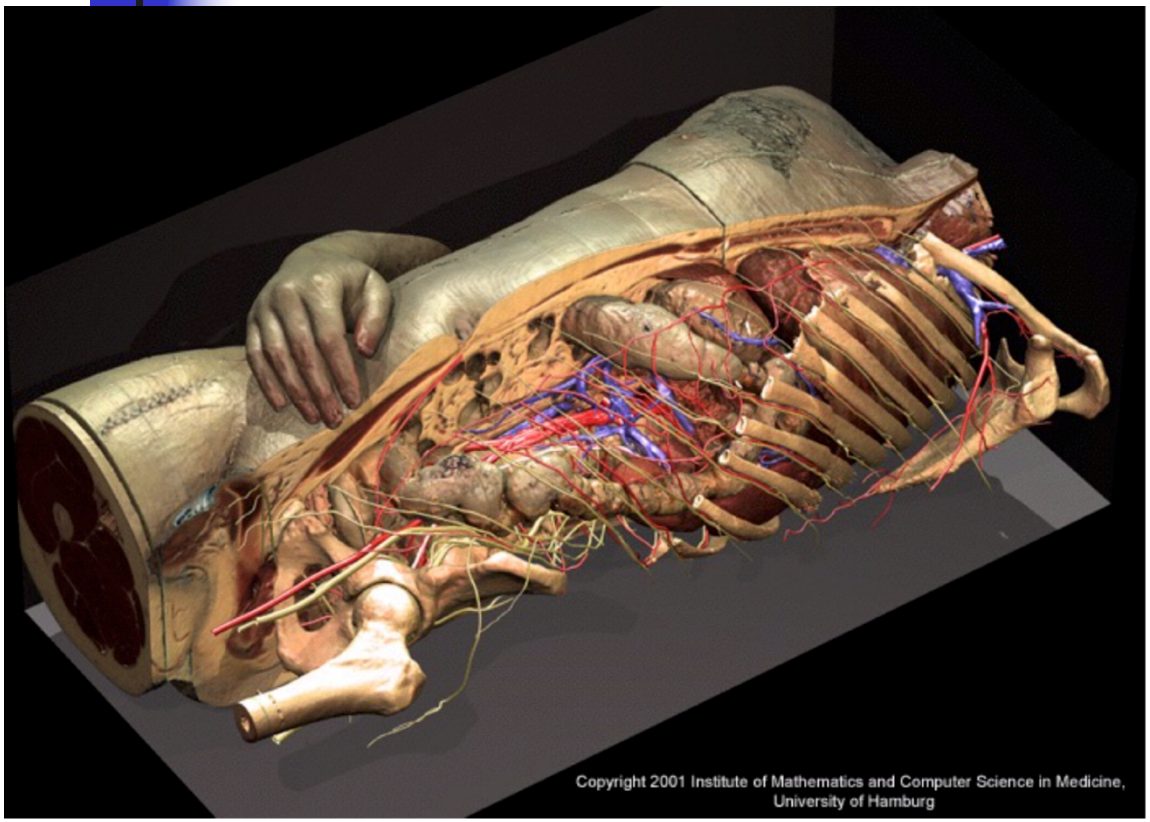
CG

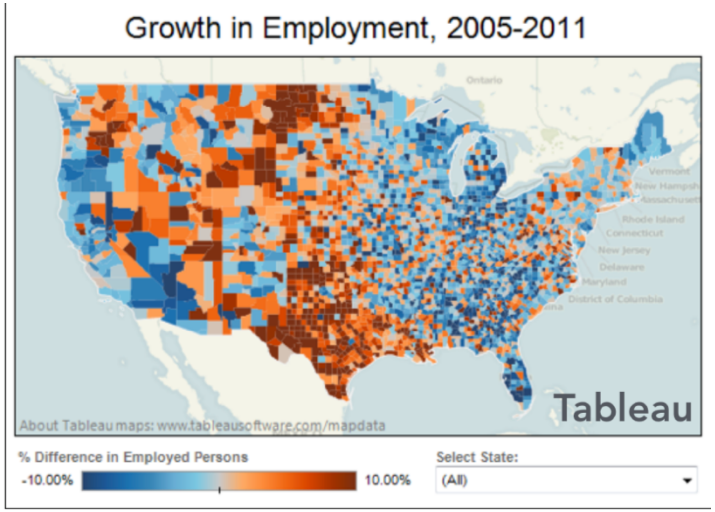
Photo

Autodesk Gallary

Design

Visualization



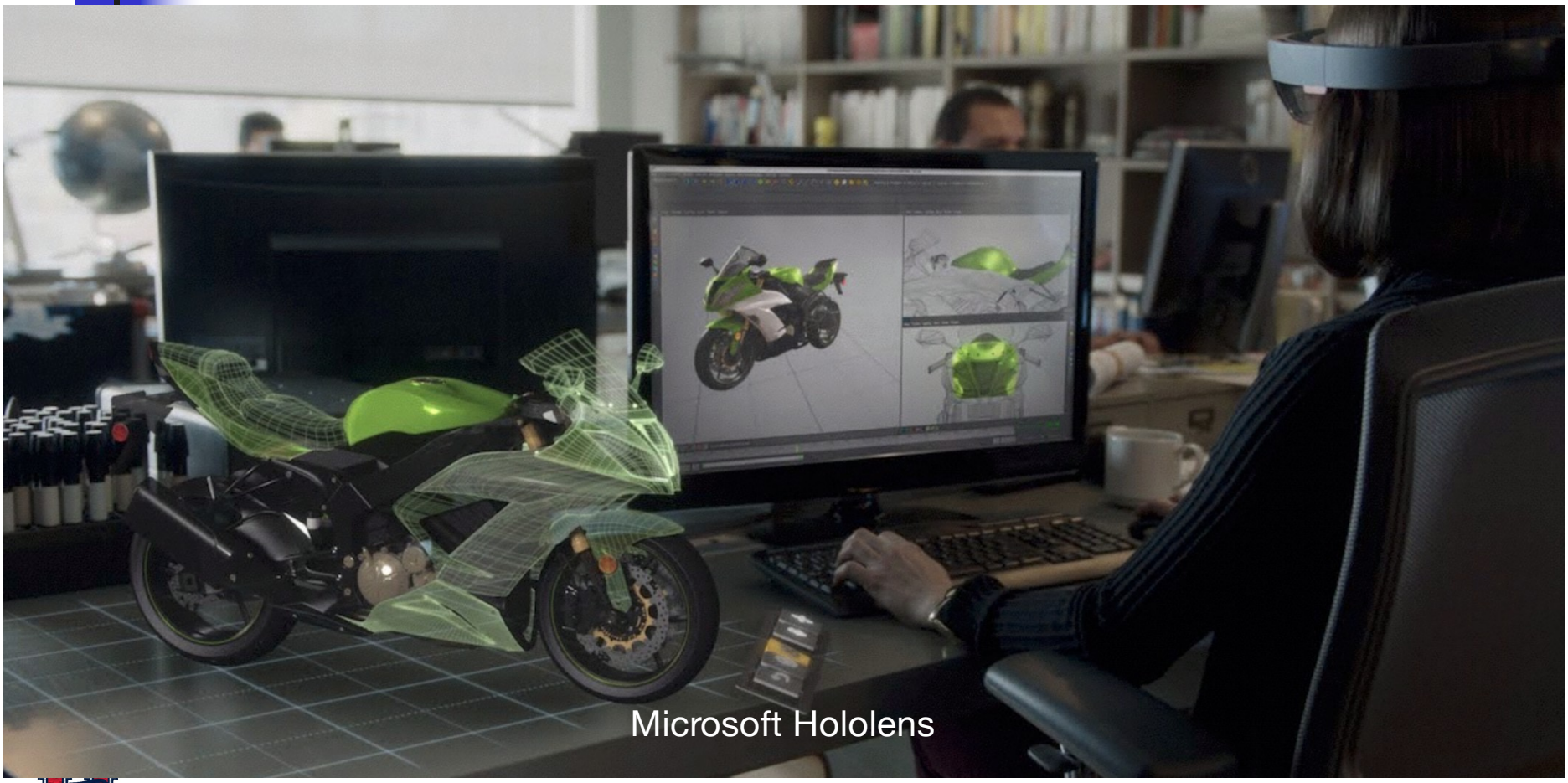


Science, engineering, medicine, journalism, etc.

Virtual Reality

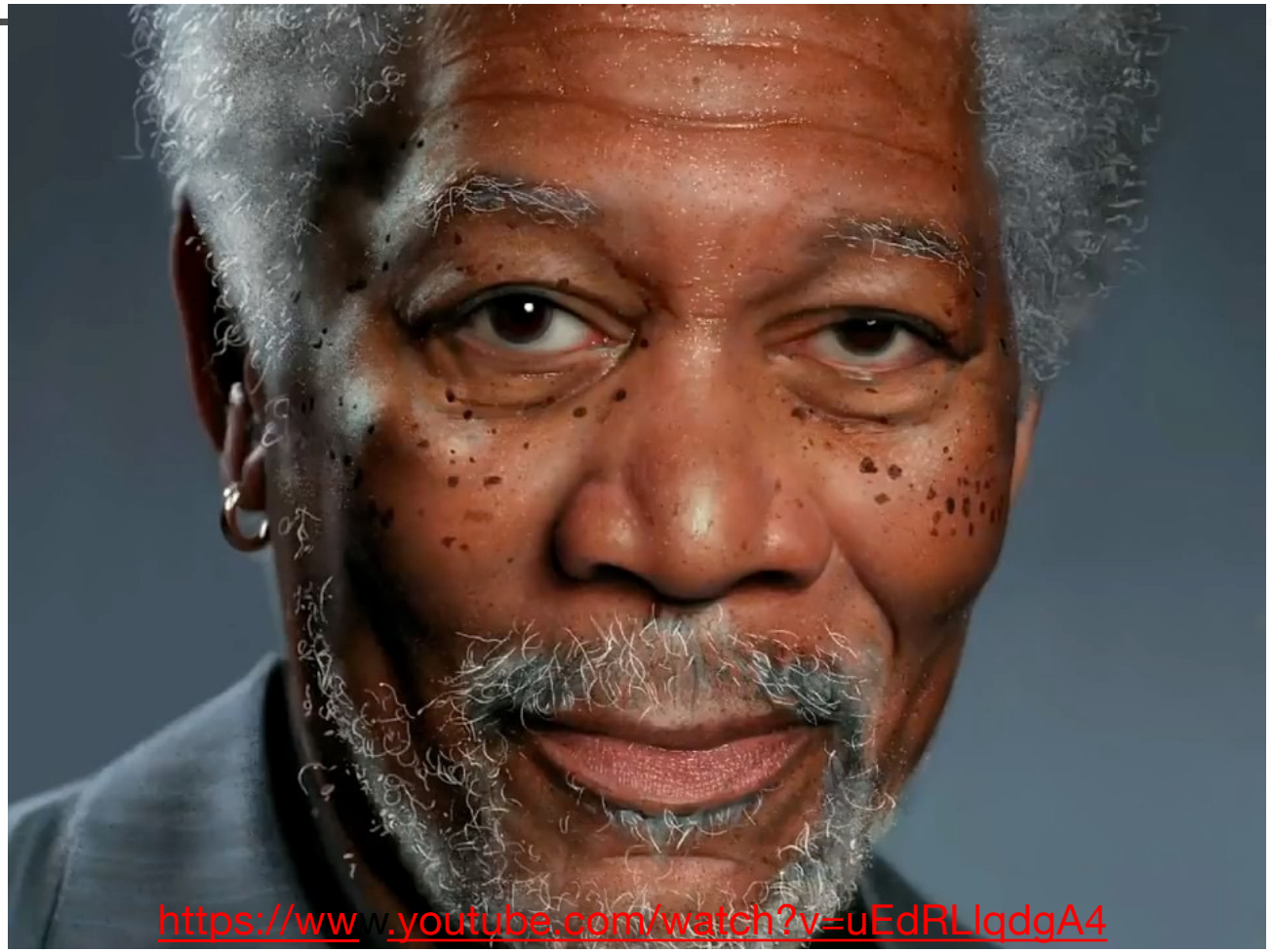
Oculus VR

Augmented Reality



Microsoft Hololens

Digital Illustration



https://www.youtube.com/watch?v=uEdRLlqdgA4

Simulation

The Dust Bowl phenomena

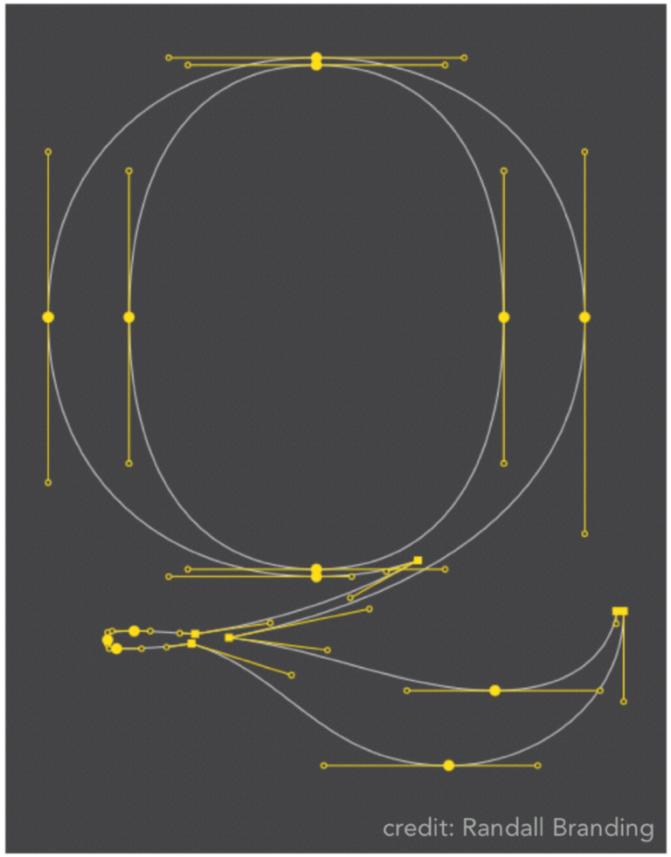
Black hole from Interstellar

Graphical User Interfaces

Typography

The Quick Brown
Fox Jumps Over
The Lazy Dog

ABCDEFGHIJKLMNOPQRSDTUVWXYZ
abcdefghijklmnopqrstuvwxyz 01234567890



The font Baskerville

Why Study Computer Graphics?

- Fundamental Intellectual Challenges
  - Creates and interacts with realistic virtual world Requires
  - understanding of all aspects of physical world New
  - computing methods, displays, technologies

Why Study Computer Graphics?

- Technical Challenges
  - Math of (perspective) projections, curves, surfaces
  - Physics of lighting and shading
  - Representing / operating shapes in 3D
  - Animation / simulation
  - ~~3D graphics software programming and hardware~~

Why Study Computer Graphics?

- Forget about the previous reasons

Computer Graphics is AWESOME!

Introduction to CG

- **Define Computer Graphics…**

  The technology associated with the use of computer technology to convert created or collected data into visual representations

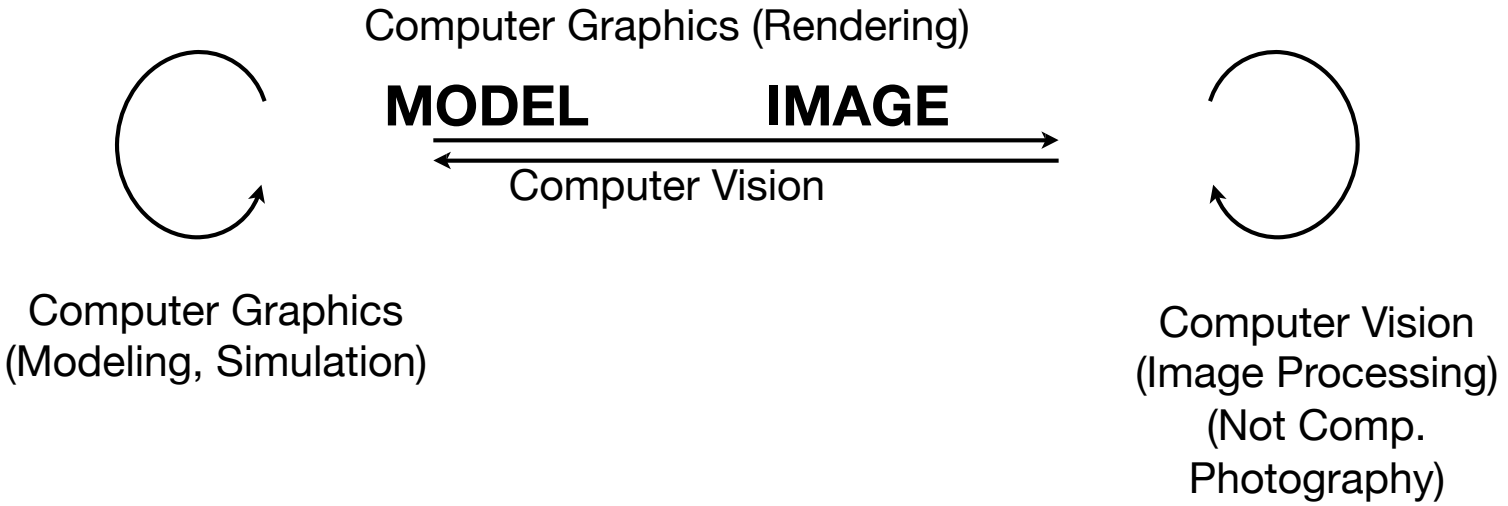
  Model

  Rendering → focus of course

  Display

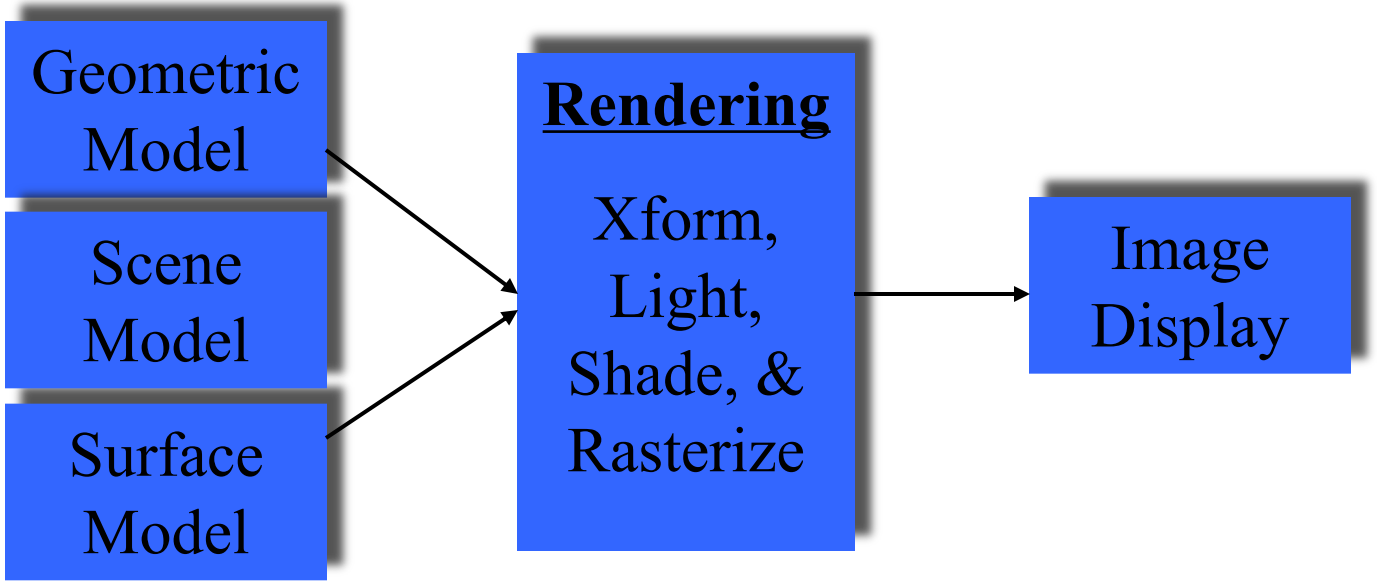
Differences?

- Personal Understanding



- No clear boundaries

Graphics Process



Geometry Modeling

There are many ways to describe geometry

- Explicit geometry:

  Triangle meshes, Patches, Subdivision surfaces,…

- Implicit geometry:

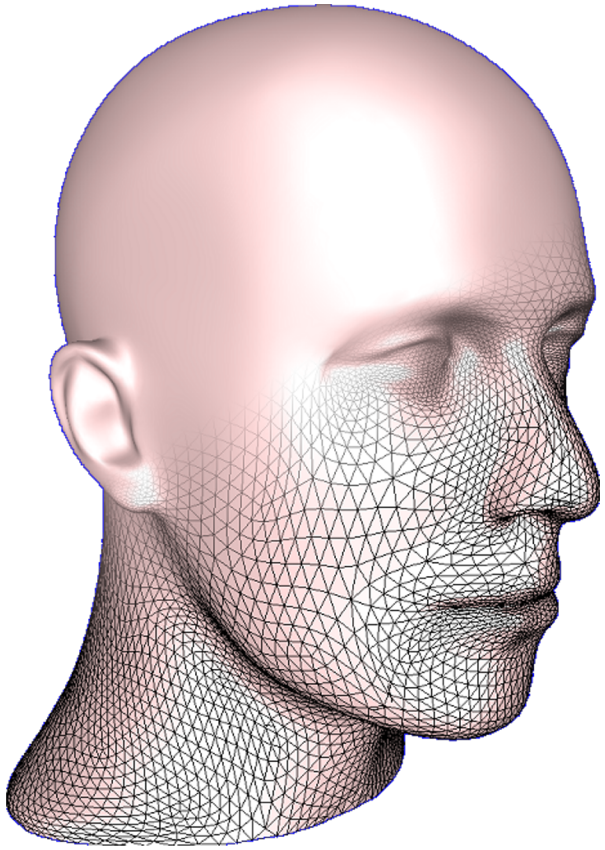
  Surface defined by $x^2 + y^2 + z^2 = 10$

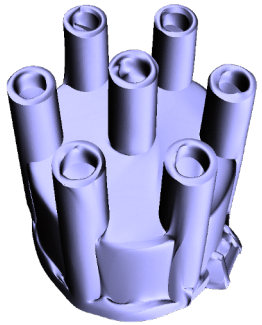
  Fractal sets, procedural definition, …

- Volume data

  Samples from MRI, ultra-sound, simulation…

Example of Triangle Meshes





Making Models

3D scanner

Model libraries

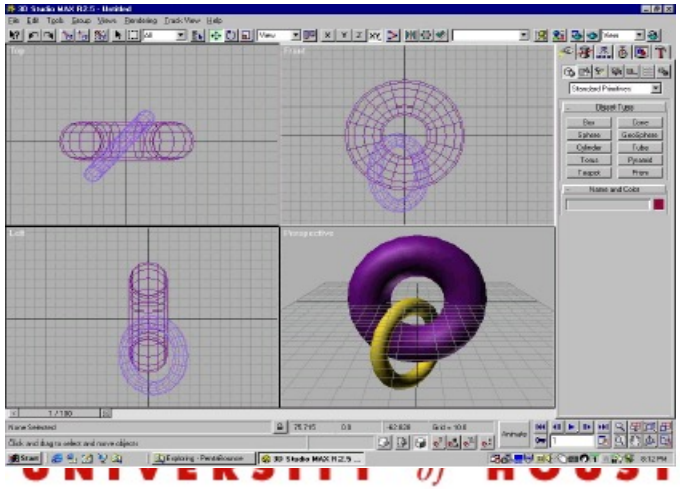
Interaction

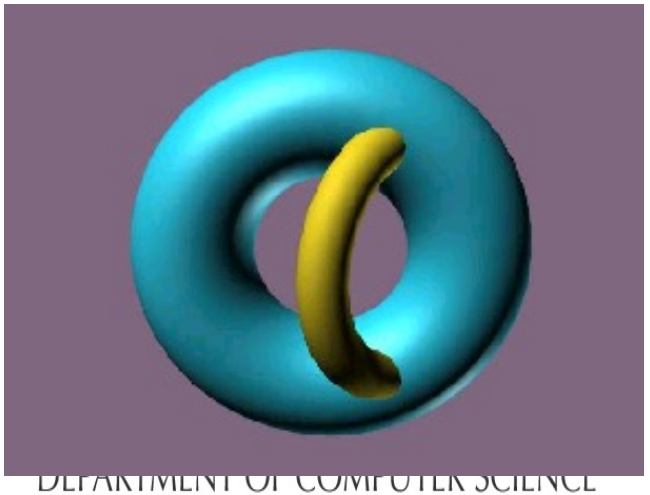
Computer vision

Geometric Modeling

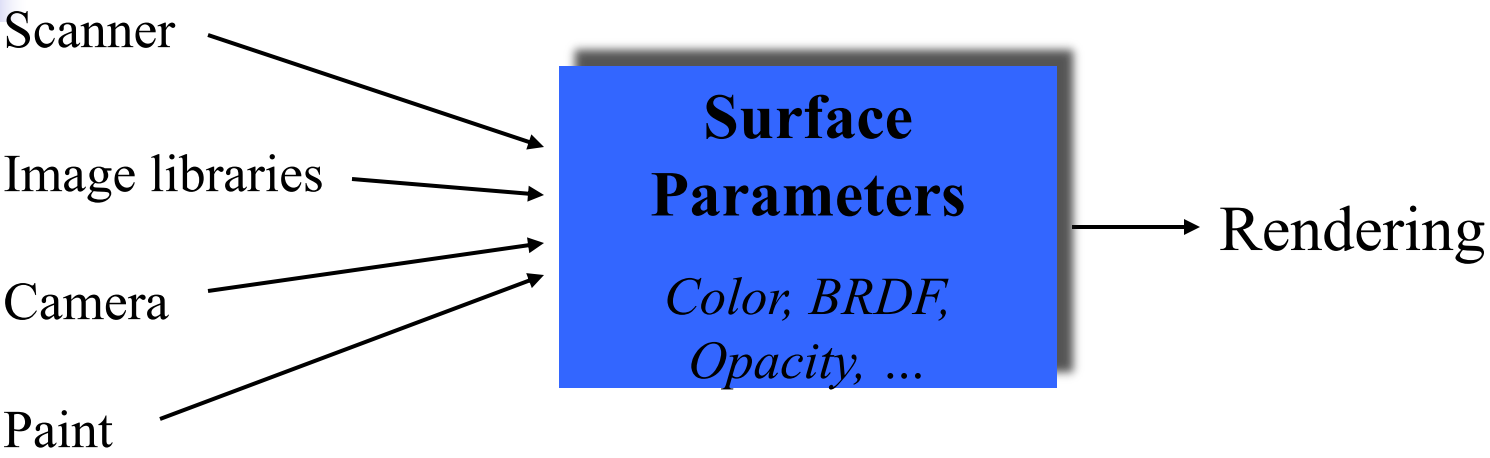
Points, Lines, Surfaces, …

→ Rendering





Making Surface Models



Rendering

Geometric Model

Surface Model

Rendering

Transformation

Image generation

IG = (lighting, shading, scan conversion)

Image Display

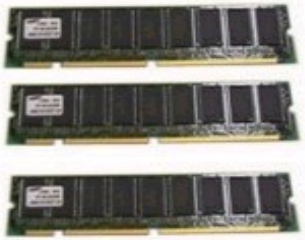
Image Display

Rendering → **Image Representation**

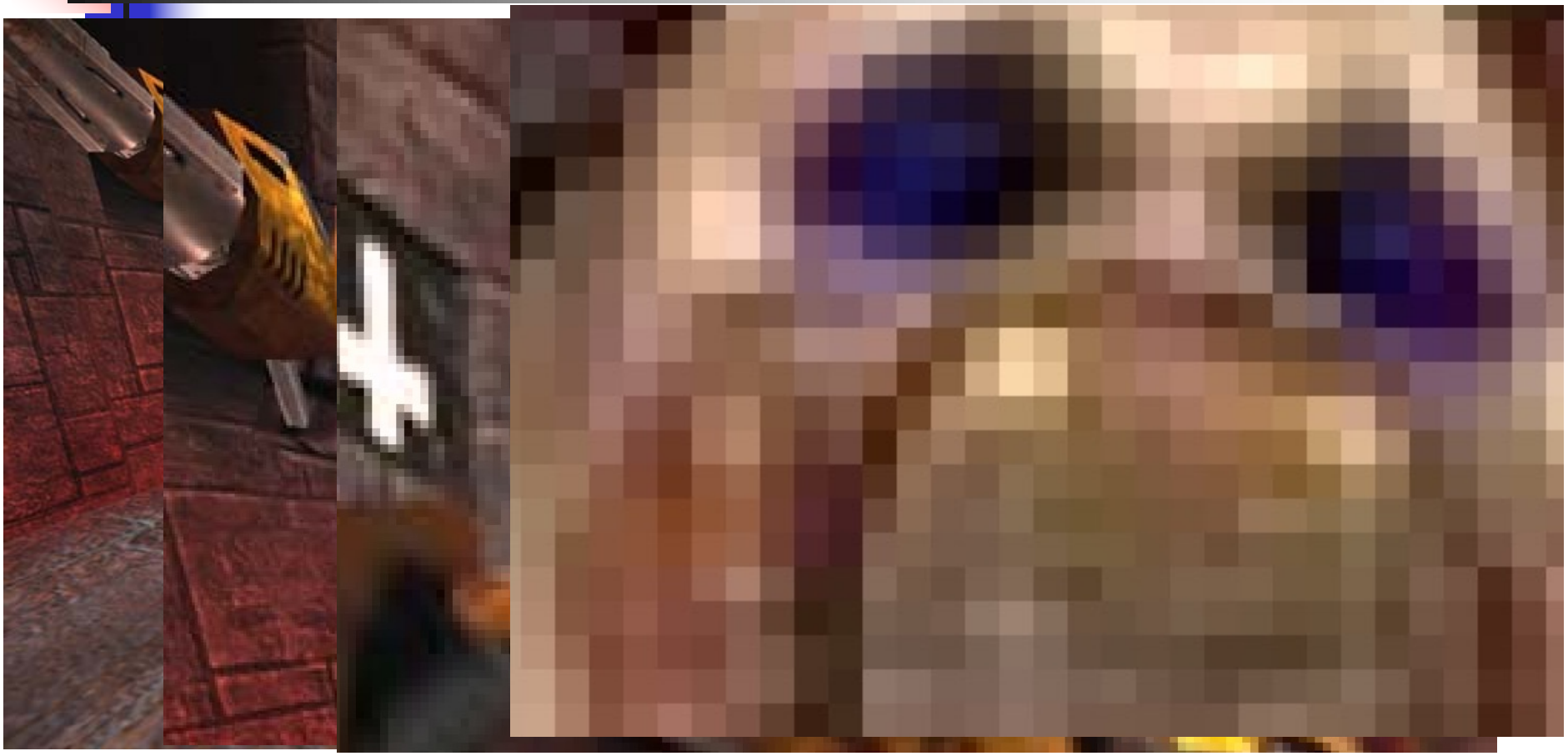
Pixel array,
Stroke list, NC cut list,
…

→ **Optical Modulation**

CRT, LCD, Plasma,
Ink, Solid material



Digital Images: pixels

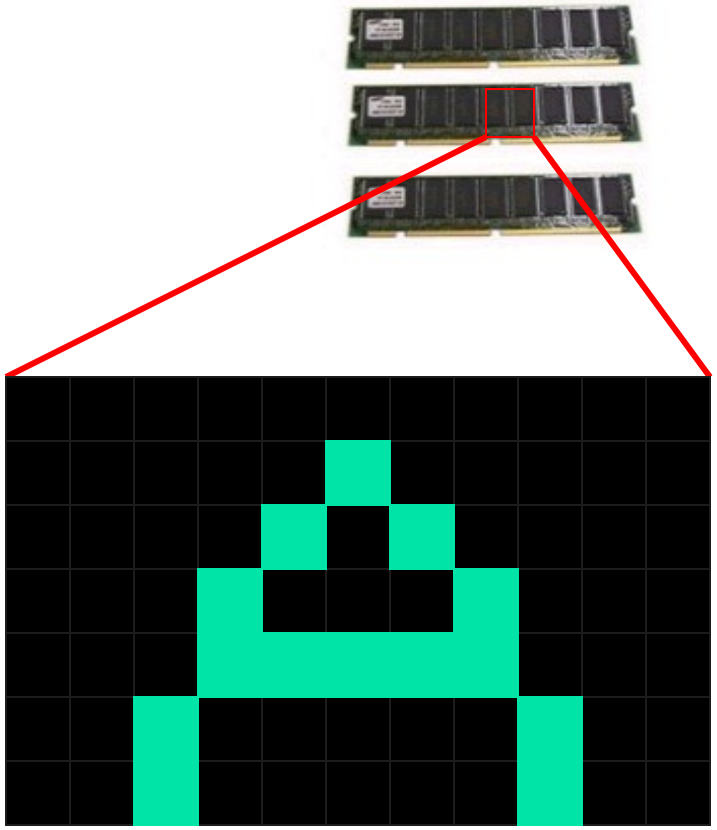


Frame Buffer

Frame Buffer

A block of memory, dedicated that contains the pixel array to be passed to the optical display system

Each pixel encodes color or other properties (e.g., opacity)



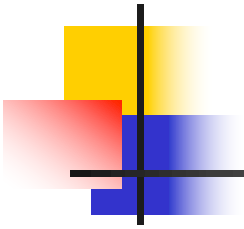
Frame Buffer Concepts

Pixel: One element of frame buffer
- uniquely accessible point in image

Resolution: Width x Height (in pixels)
- 640x480, 1280x1024, 1920x1080

Color depth: Number of bits per-pixel in the buffer
- 8, 16, 24, 32-bits for RGBA

Buffer size: Total memory allocated for buffer



Frame Buffer Opacity

Alpha

Used for compositing or merging images

Alpha channel – added to color

Holds the alpha value for every pixel

8 bit range: 0 (transparent) – 255 (opaque)

How Much Memory?

Buffer size = width * height *color depth

For example:

If width=640, height=480, color depth=24 bits

Buffer size = 640 * 480 * 3 = 921,600 bytes

If width=1920, height=1080, color depth=24 bits

Buffer size = 1920 * 1080 * 3 = 6,220,800 bytes

Display Device

- CRT (Cathode Ray Tube)
- LCD (Liquid Crystal Displays)
- Plasma, Projection, HMD, Volumetric, …

Important Features:

size, resolution, field of view, pixel-pitch, color range, brightness, refresh-rate, black level, update mode (e.g., interlacing, …), distortion

Interaction

- Interaction is an important component of graphics applications
- Think about input devices in two ways:

  Physical device – that can be described by their real-world physical properties

  (mouse, keyboard, joystick…)

  Logical Device – application abstraction

Physical Device

3D Interaction Device