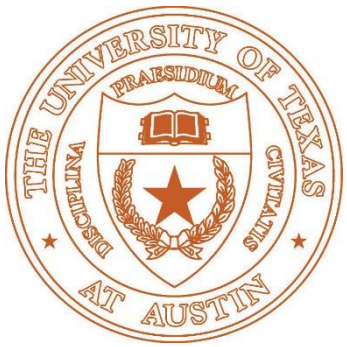
CS354 Computer Graphics Introduction

Qixing Huang

Januray 17^{8h} 2017



CS 354– Computer Graphics

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  - Office Hours: TBD
- Location: GDC 1.304
- Lectures: MW 3:30 pm to 4:45 pm

What is Computer Graphics?

3D Modeling

Rendering

First 3D model (1972)

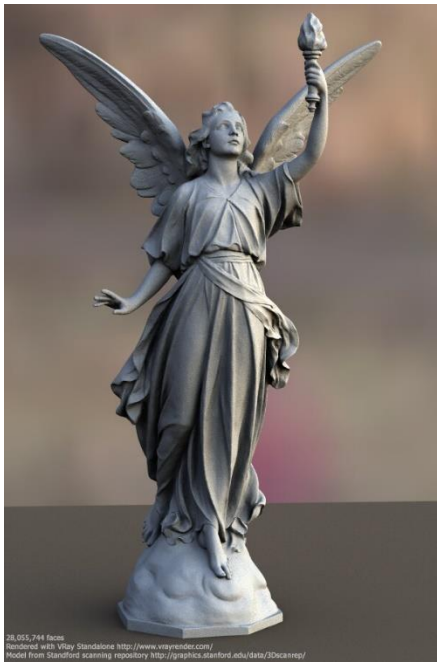
(45 year old 3d computer graphics pixar 1972)


Smart3D
perception

Stanford Model Repository (1994-2000)

69451 triangles

Stanford Model Repository (1994-2000)

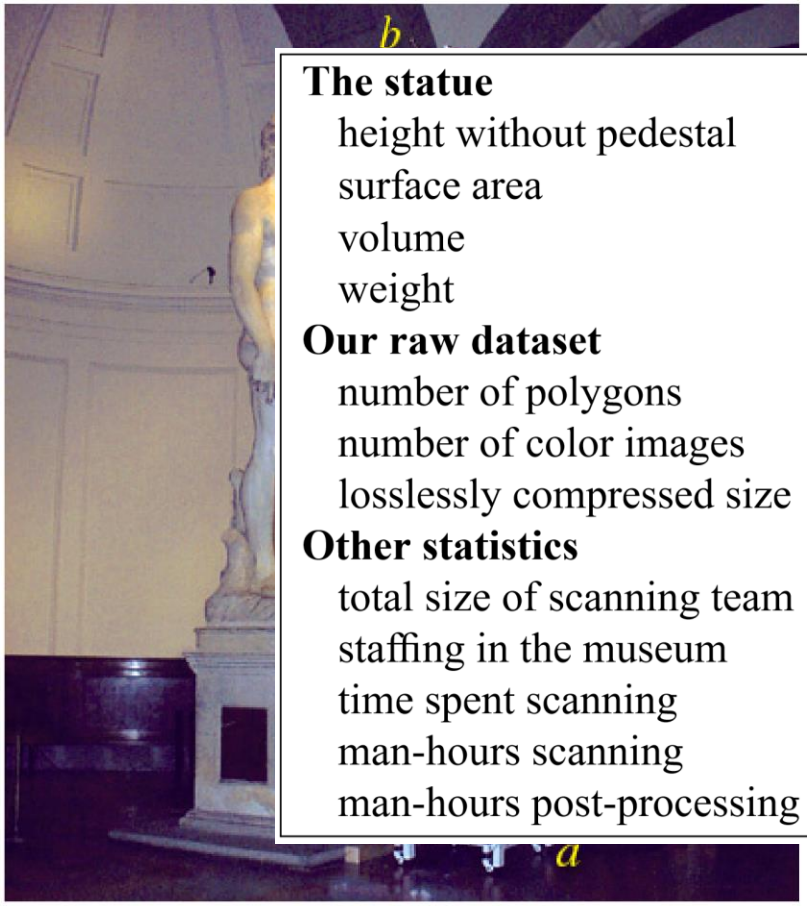


28,055,742
triangles

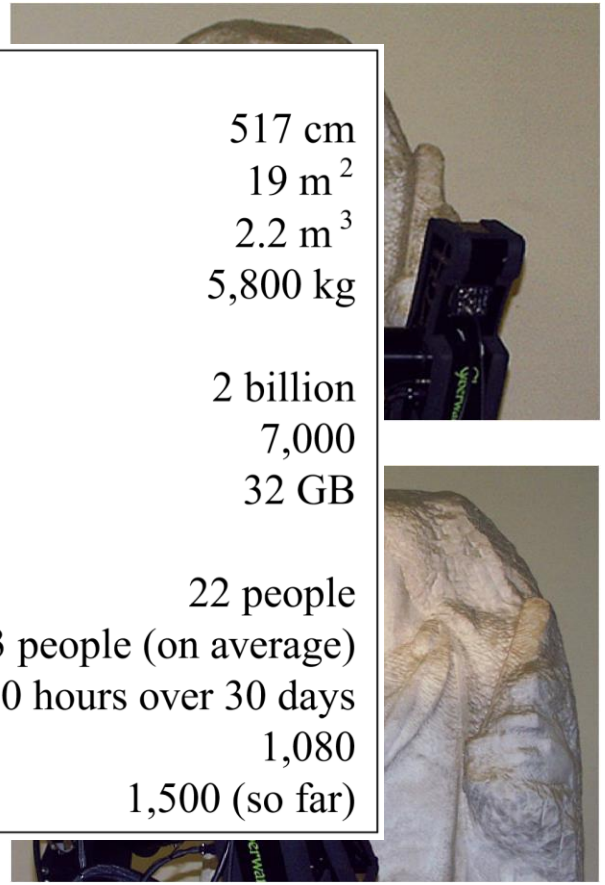
7,218,906
triangles

10,000,000
triangles

The Digital Michelangelo Project (2000)



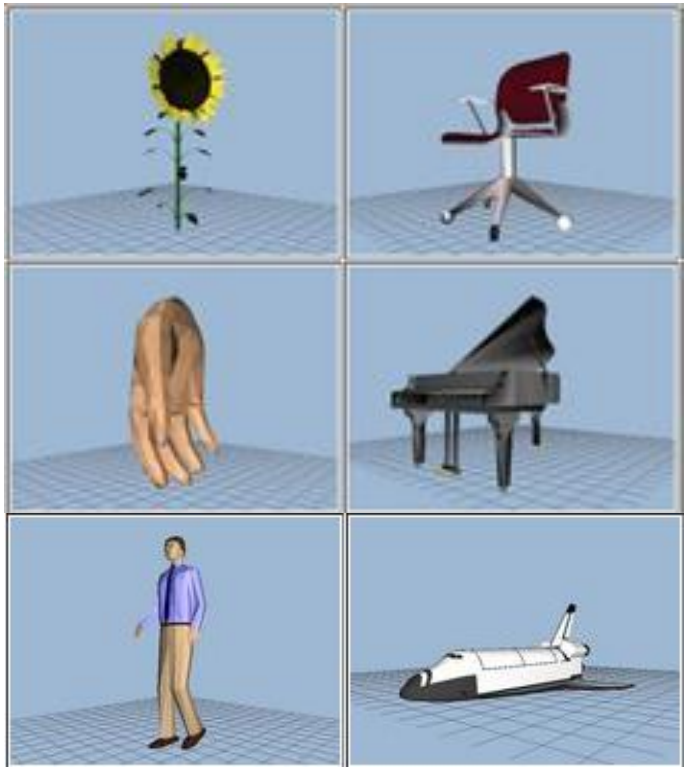
The statue	
height without pedestal	517 cm
surface area	19 m^2
volume	2.2 m^3
weight	5,800 kg
Our raw dataset	
number of polygons	2 billion
number of color images	7,000
losslessly compressed size	32 GB
Other statistics	
total size of scanning team	22 people
staffing in the museum	3 people (on average)
time spent scanning	360 hours over 30 days
man-hours scanning	1,080
man-hours post-processing	1,500 (so far)



[Takeo Igarashi' 99]

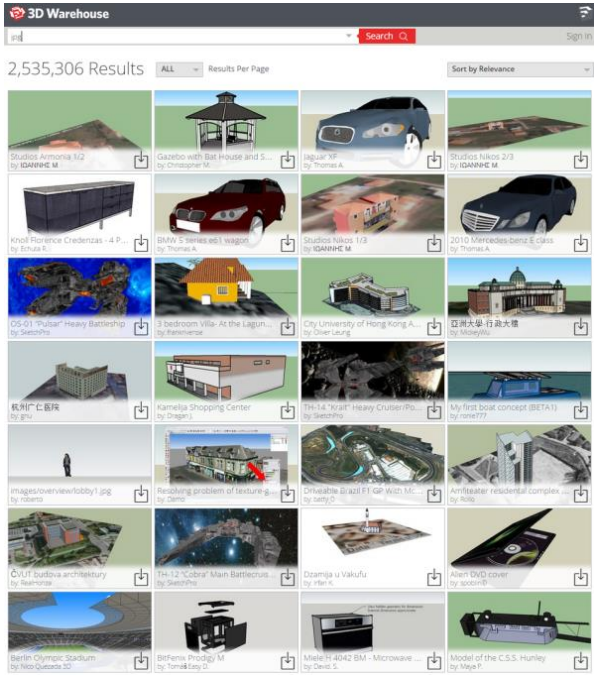
Princeton Shape Benchmark

1800 models in **90** categories

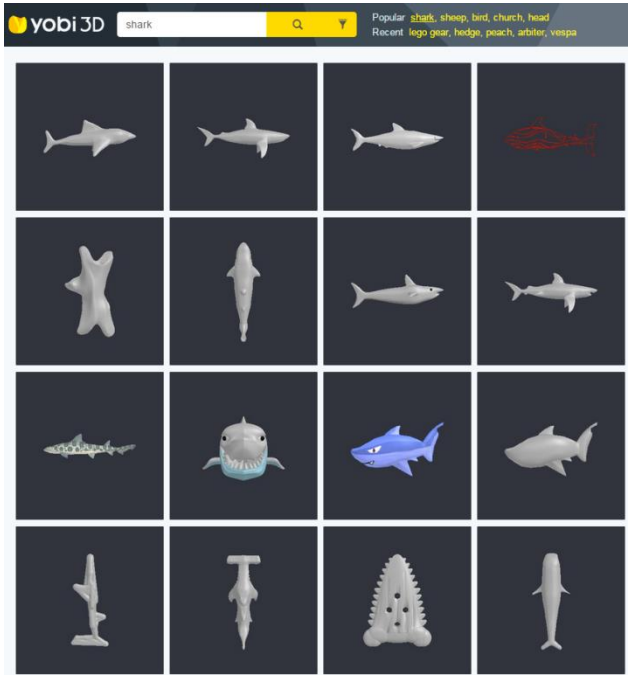


Shilane et al. 04

Large-scale online repositories



3D Warehouse



Yobi3D

3M models in more than 4K categories

Rendering

3D Modeling

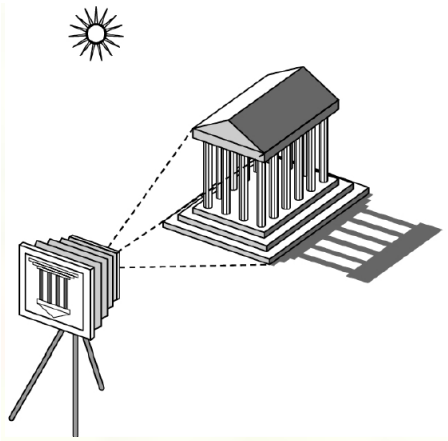
Rendering

Image Formation

- In computer graphics, we form images which are generally two dimensional using a process analogous to how images are formed by physical imaging systems
  - Cameras
  - Microscopes
  - Telescopes
  - Human visual system

Elements of Image Formation

- Objects
- Viewer
- Light source(s)



- Attributes that govern how light interacts with the materials in the scene
- Note the independence of the objects, the viewer, and the light source(s)

Light

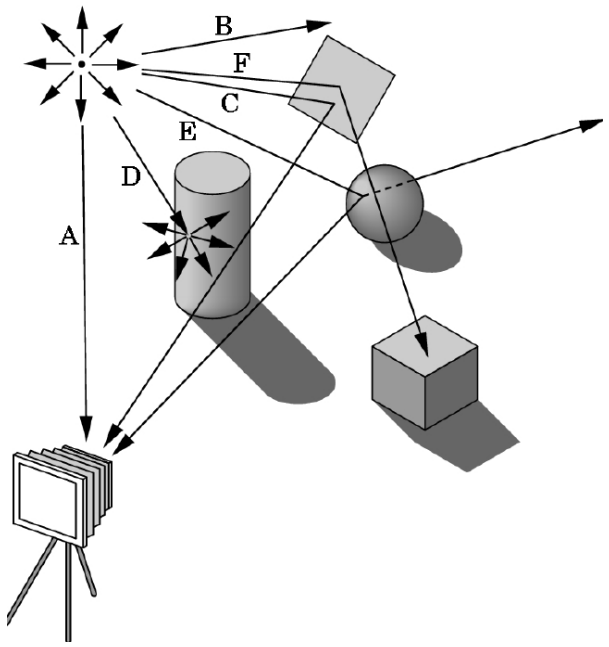
- *Light* is the part of the electromagnetic spectrum that causes a reaction in our visual systems

- Generally these are wavelengths in the range of about 350-750 nm

- Long wavelengths appear as reds and short wavelengths as blues

Ray Tracing and Geometric Optics

- One way to form an image is to follow rays of light from a point source finding which rays enter the lens of the camera. However, each ray of light may have multiple interactions with objects before being absorbed or going to infinity



Rendering

- Spatial data structure
  - Cannot compute color and shade of each object independently
- Physics
  - The interactions between light and objects
- Probability
  - Integration as sampling

Two Other Topics

Computational Photography

[Kalantari et al. 15]

Animation/Simulation

[CMU Mocap]

Animation/Simulation

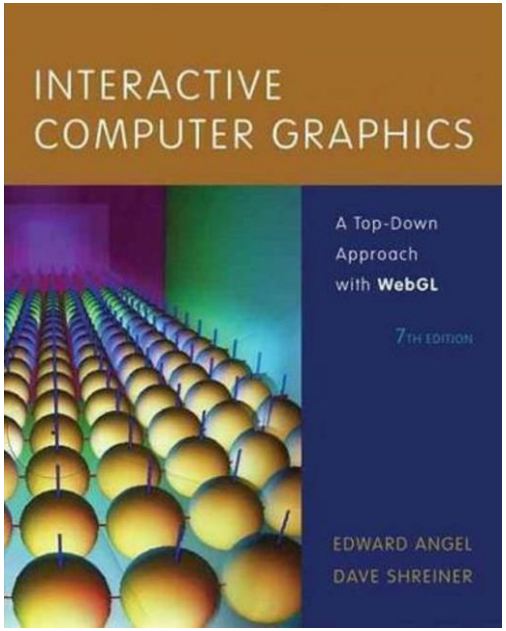
[Stanford, Fedikw Lab]

Sub-Fields of Computer Graphics

- **Modeling**
- **Rendering**
- **Animation/Simulation**
- **Computational Photography**

Textbook

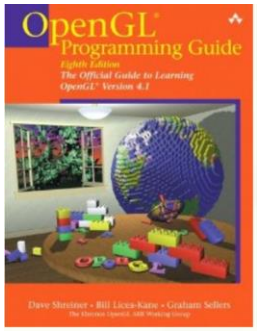
- *Interactive Computer Graphics: A Top-Down Approach with WebGL – 7/E*
  - By Edward Angel and Dave Shreiner
  - Pearson, 7th edition
- Currently only recommended
  - It costs $147 list
  - Very helpful, but we don't require it
  - Older editions also useful

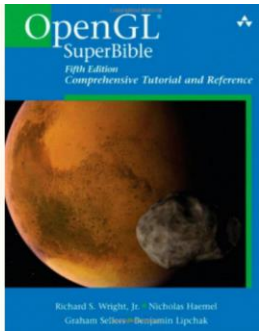


Other Useful Resources

- OpenGL
  - See links on course webpage

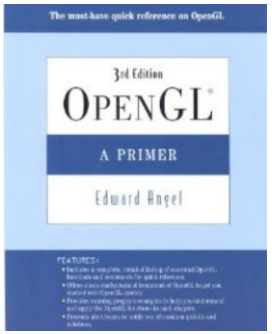
OpenGL Programming Guide "the red book"





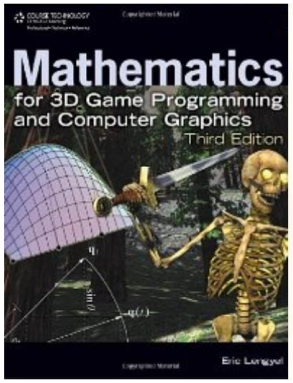
OpenGL SuperBible

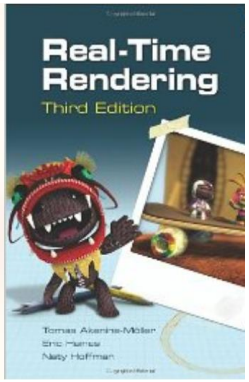
OpenGL A Primer



- Supplemental books

Eric Lengyel Mathematics for 3D Game Programming and Computer Graphics





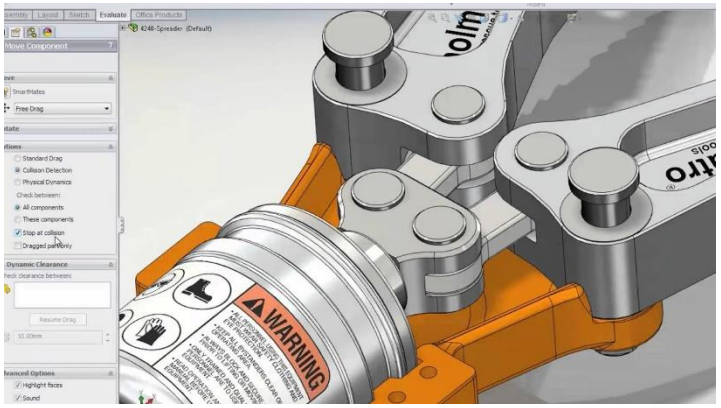
Real-Time Rendering Eric Haines, Tomas Akenine -Moller, Naty Hoffman

Why Computer Graphics

Computer Graphics Applications

Movie, television

Product design



[Solidworks 2014]

Computer Graphics Applications

Video Games

Training

Computer Graphics Applications

GUIs

[Android 4.0]

Apps

[Audi]

Computer Graphics Applications

2d and 3d printing

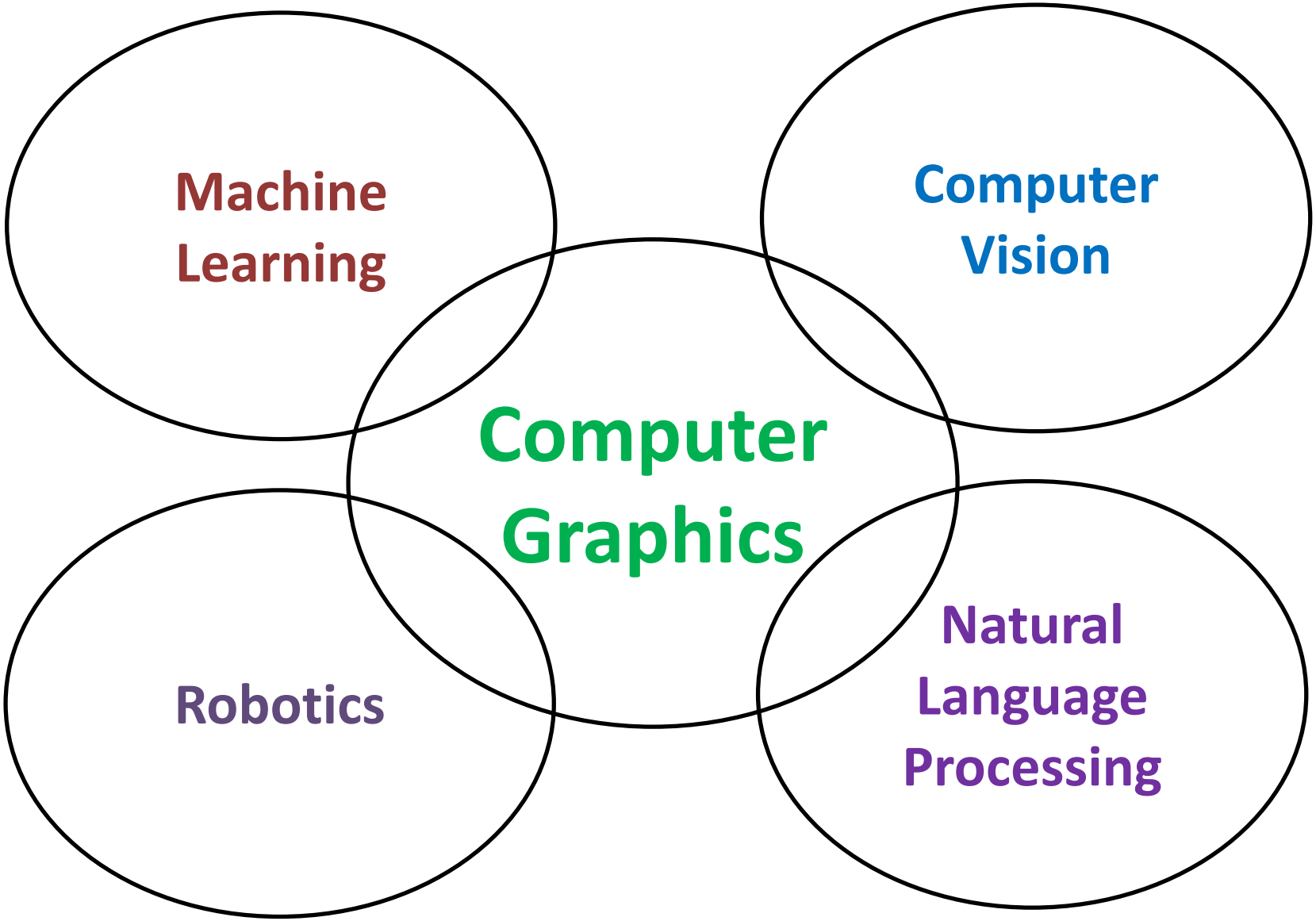
[HP]

[MakerBot]

Digital imaging,
Computational photography

[Canon]

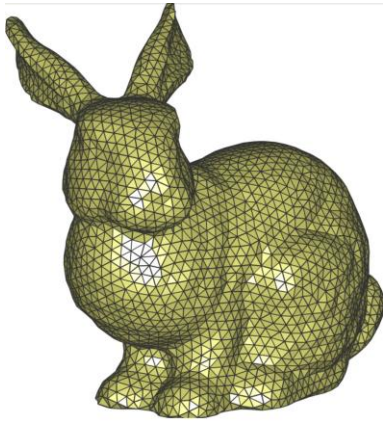
Graphics @AI


Machine Learning
Computer Vision
Computer Graphics
Robotics
Natural Language Processing

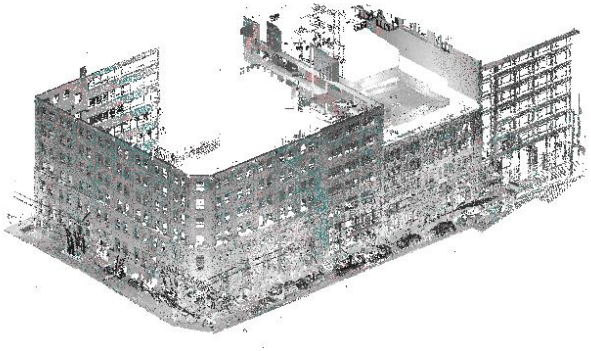
Computer Graphics/Machine Learning

A Probabilistic Model for Component-Based Shape Synthesis
[Kalogerakis et al. 12]

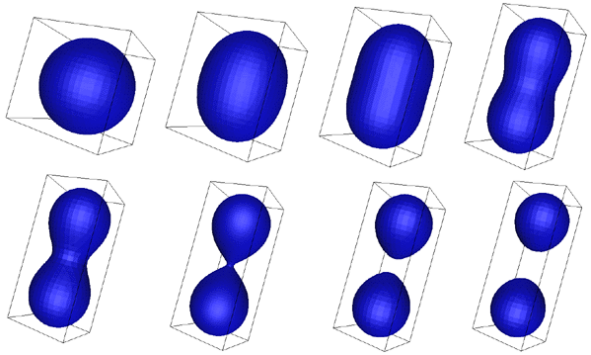
Computer Graphics/Machine Learning



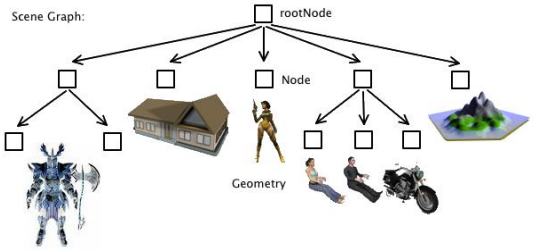
Triangular mesh



Point cloud

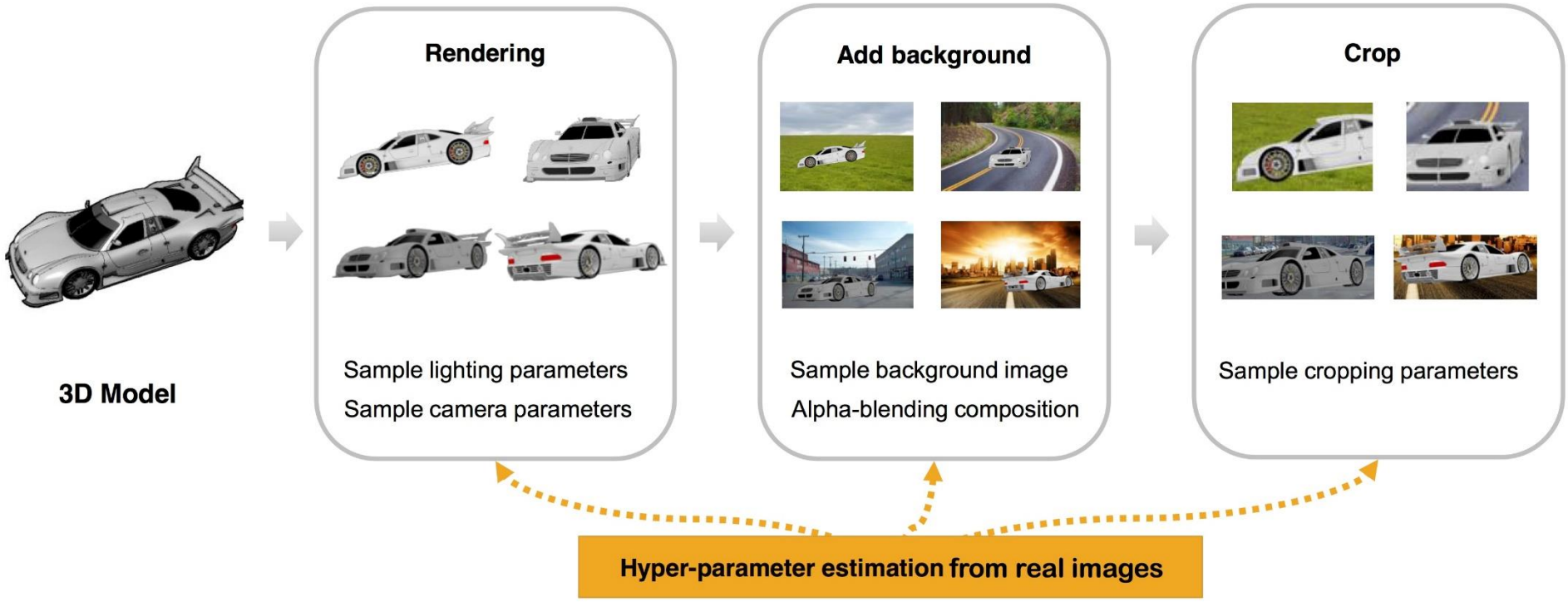


Implicit surface



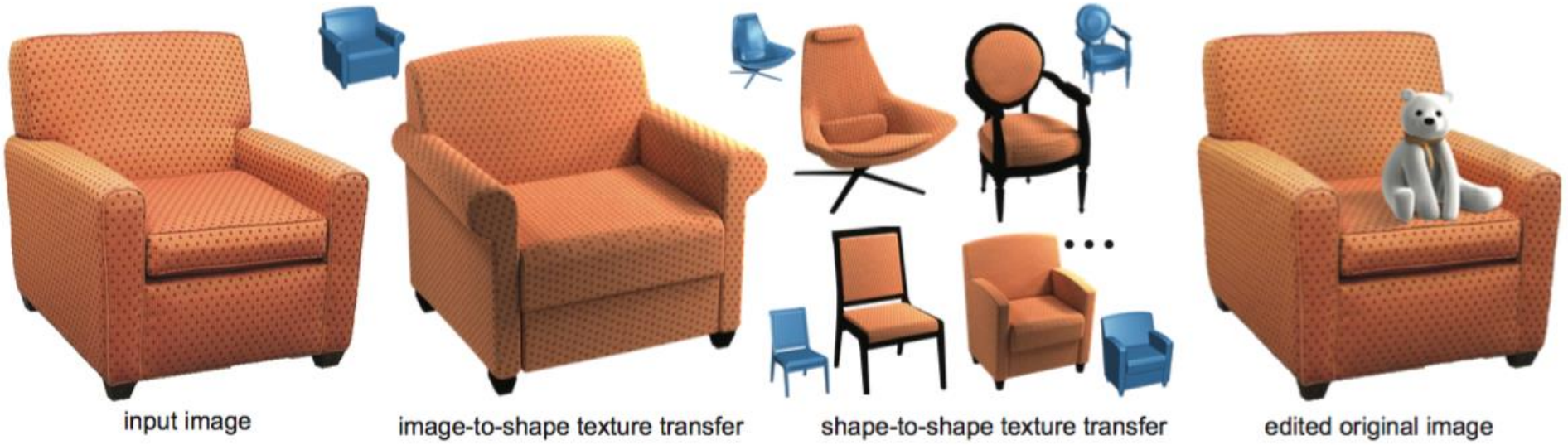
Part-based models

Graphics + Vision



[Su et al. 15]

Graphics + Vision



Graphics + NLP

[Chang et al. 15]

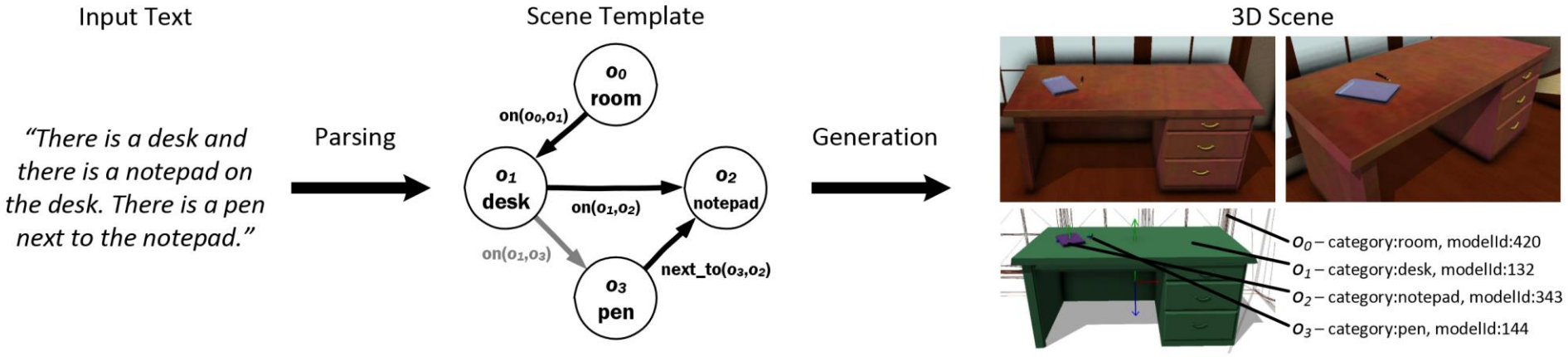


Figure 2: Illustration of the text to 3D scene generation pipeline. The input is text describing a scene (left), which we parse into an abstract scene template representation capturing objects and relations (middle). The scene template is then used to generate a concrete 3D scene visualizing the input description (right). The 3D scene is constructed by retrieving and arranging appropriate 3D models.

What you will learn in this class?

- Fundamentals of Computer Graphics
- Geometry/Geometric Representations
  - Which will be useful for Vision and Robotics
- System building

Fundamentals of computer graphics

- Transformations and viewing
- Rasterization and ray tracing
- Lighting and shading
- Graphics hardware technology
- Mathematics for computer graphics

- OpenGL programming
- Shader programming

Course Expectations

- You should
  - Attend regularly and keep up – in class short quizzes
- Do the programming assingments
  - Nearly everything you learn in this course will come from these
  - You need to know C/C++
  - Use office hours if you need help
  - No cheating (see syllabus and UT Austin policy)
  - Let us have fun, and you are motivated to do the homeworks
- Tests and homework
  - Less fun, and useful, than programming projects
  - Good for covering math and concepts

Grading – (Subject to minor changes)

- Programming projects 60%
- Homework and quizzes 10% (if relevant, otherwise this 10% goes to programming projects)
- Exams 30%
  - 2 exams – Middle semester and end of class 15% each
  - No final

Next Lecture

- Vector and affine math

- Assignments
  - Make sure your CS Unix account is active

- Thanks to Mark Kilgard, Ed Angel and Don Fussell for material in many of these slides

Questions?