Introduction to Computer Graphics

Lecture 1

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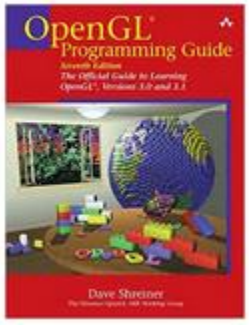
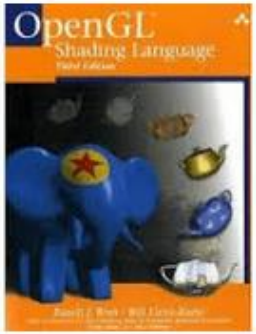
Grading

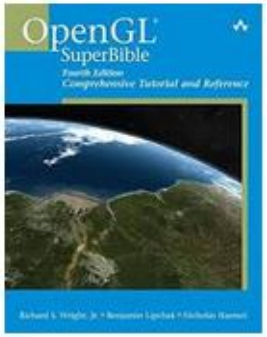
- The final grade depends on
  - Lab and homework: 40%
  - Term project: 20%
  - Mid-term exam: 20%
  - Final exam: 20%

Books

- OpenGL Red book
- GLSL Orange book
- OpenGL SuperBible
- Development cookbook (for lab use)





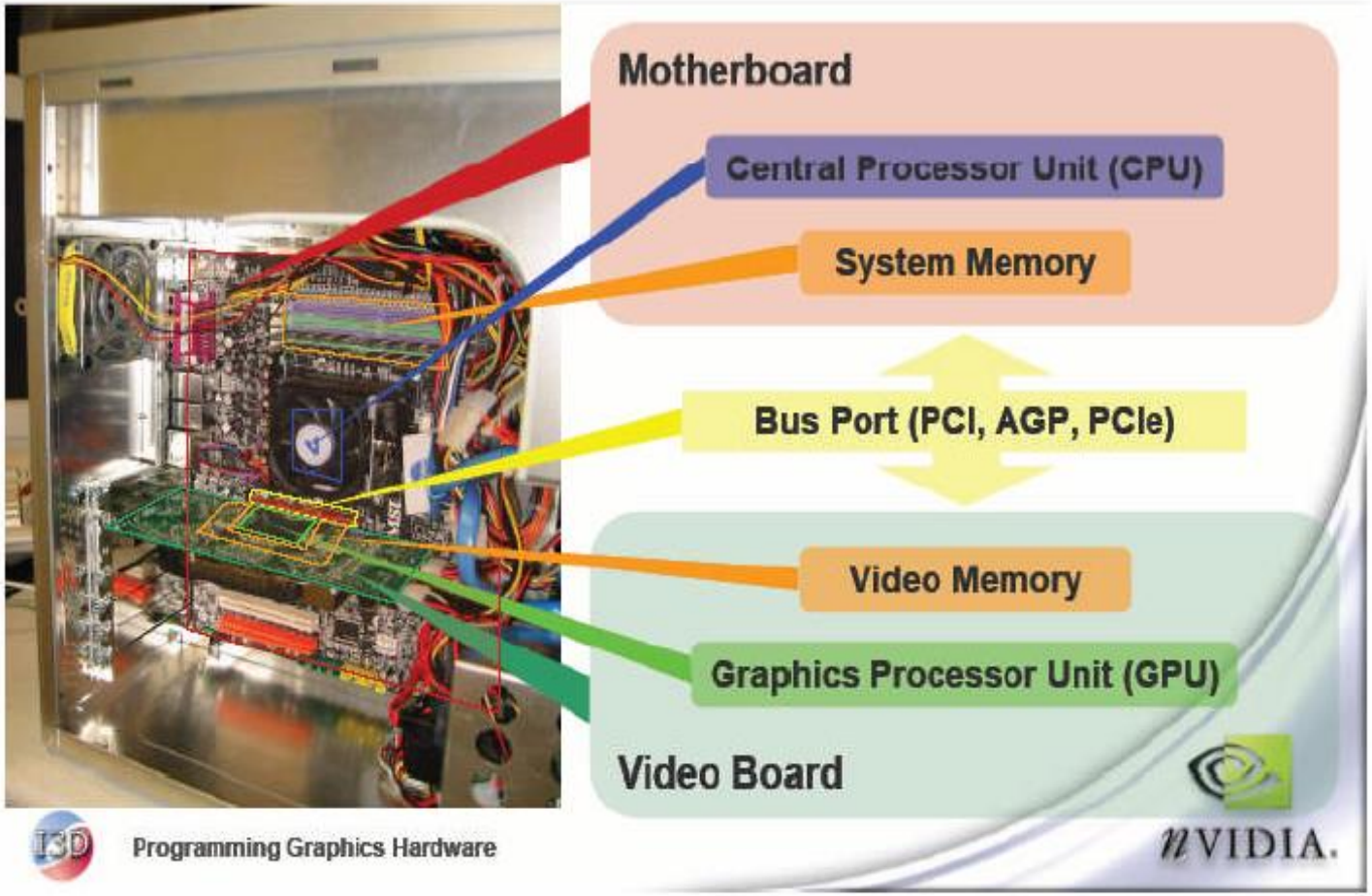


- Official website: www.opengl.org
- Youtube: siggraph, siggraph asia
  - technical papers trailer
  - emerging technologies trailer

Software

- Open Graphics Library
- Microsoft Visual C++
- Your finished programs must compile and run on Windows OS

PC Architecture



Hardware

- You need graphics card

GeForce Product Lineup

GeForce GTX	GeForce GT	GeForce
The ultimate GPU for gamers. Delivers fastest performance and all the latest gaming technologies.	Supercharged performance for your HD videos and photos, immersive 3D movies, and entry level gaming.	Get stunning picture clarity, smooth video, accurate color, and precise image scaling for movies and video with NVIDIA PureVideo® HD technology.
Desktop	Desktop	Desktop
NVIDIA TITAN X GeForce GTX 1080 GeForce GTX 1070 GeForce GTX 1060 GeForce GTX 1050 (new!) GeForce GTX TITAN X GeForce GTX 980 Ti GeForce GTX 980 GeForce GTX 970 GeForce GTX 960 GeForce GTX 950	GeForce GT 730 GeForce GT 710	
Laptop	Laptop	Laptop
GeForce GTX 10-Series Notebooks GeForce GTX 965M GeForce GTX 960M GeForce GTX 950M		GeForce 945M GeForce 940MX GeForce 940M GeForce 930MX GeForce 930M GeForce 920MX GeForce 920M GeForce 910M

Hardware

AMD

For Desktops

Radeon Pro Duo

AMD Radeon™ R9 series graphics

AMD Radeon™ R7 series graphics

AMD Radeon™ HD 8000 series graphics (OEM)

AMD Radeon™ HD 7000 series graphics

View all desktop GPUs

Find a desktop with AMD graphics

Radeon™ RX Series Graphics Cards

For Laptops

AMD Radeon™ HD 8900M series graphics

AMD Radeon™ HD 8800M & 8700M series graphics

AMD Radeon™ HD 8600M & 8500M series graphics

AMD Radeon™ HD 7900M series graphics

AMD Radeon™ HD 7800M series graphics

AMD Radeon™ HD 7700M series graphics

AMD Radeon™ HD 7600M & 7500M

For Workstations

Radeon™ Pro WX-Series

AMD FirePro™ W-Series for Desktop Workstations

AMD FirePro™ W-Series for Mobile Workstations

Dell and AMD FirePro™

HP and AMD FirePro™

For Servers

AMD FirePro™ S-Series for HPC

AMD FirePro™ S-Series for Virtualization

Dell and AMD FirePro™

What is this course about?

- Fundamentals for writing your own graphics applications
  - Understand fundamental computer graphics concepts
  - Understand GPU concepts
  - Learn how to program in OpenGL
  - Have some fun!

What is Computer Graphics?

- Computer graphics are pictures that are generated by computer.

- There are samples to be found, especially in magazines and on the television.

Where computer-generated pictures are used?

- Art, Entertainment, and Publishing
- Computer Graphics and Image Processing
- Monitoring Process
- Displaying Simulation
- Computer-aided Design
- Scientific Analysis and Visualization

- 3D Printing
- 3D Reconstruction
- Affective Computing
- Big Data Visualization
- City Modeling
- Computational Fabrication
- Computational Geometry
- Computational Photography
- Computer Animation
- Computer Vision for Computer Graphics and HCI
- Crowd Simulation
- Data Compression for Graphics
- Deep Learning for Graphics
- Geometric Algebra Computing
- Geometric Algebra for Graphics
- Geometric Processing
- Geometric Modeling
- Global Illumination
- Human-Computer Interaction
- Human Modeling
- Image and Video Processing
- Image-based Rendering
- Information Visualization
- Interactive Graphics
- Medical Imaging
- Meshing and Remeshing
- Non-photorealistic Rendering
- Physically Based Modeling
- Point-based Graphics
- Rendering Techniques
- Saliency Methods
- Scientific Visualization
- Shape Analysis and Image Retrieval
- Shape and Surface Modeling
- Shape Matching
- Sketch-based Modeling
- Solid Modeling
- Stylized Rendering
- Textures
- Virtual and Augmented Reality
- Visual Analytics
- Virtual Geographical Environments
- Volume Rendering
- Web Graphics

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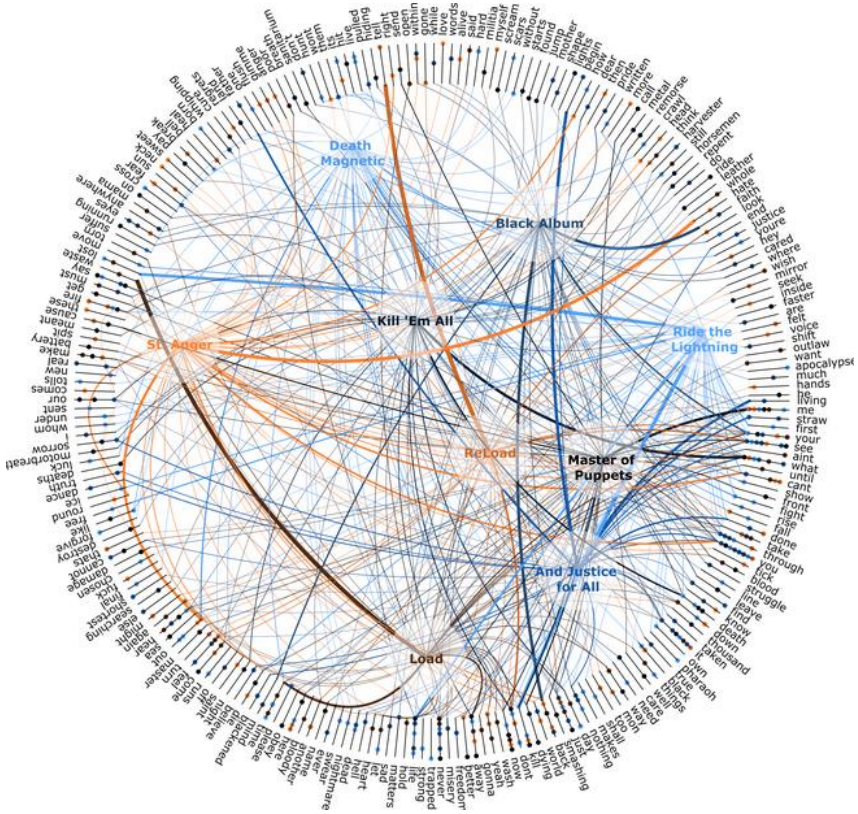
3D Printing

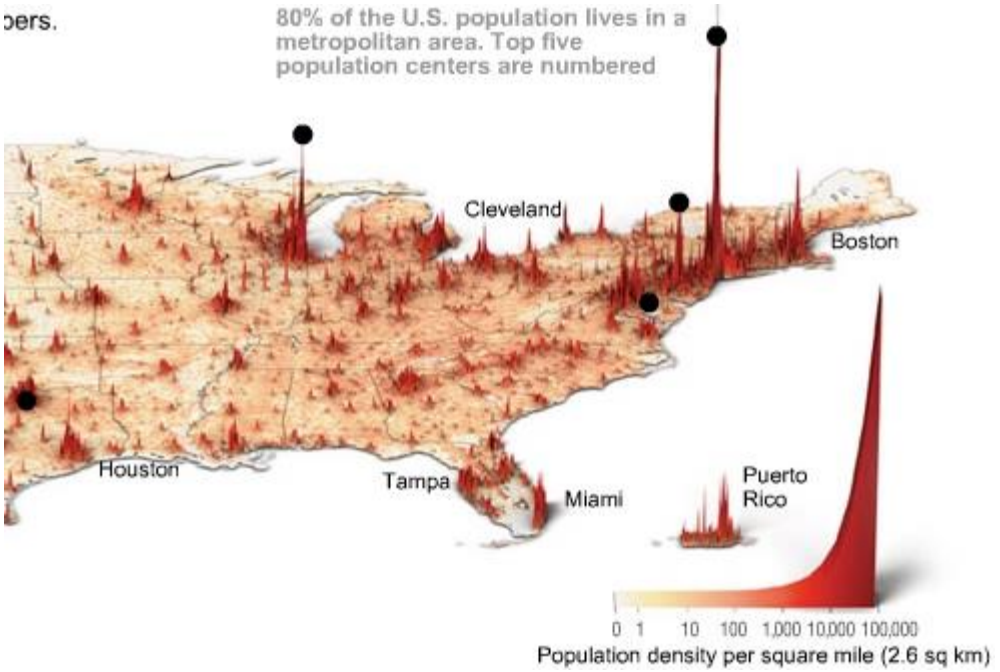
3D Reconstruction

- 3D reconstruction from images

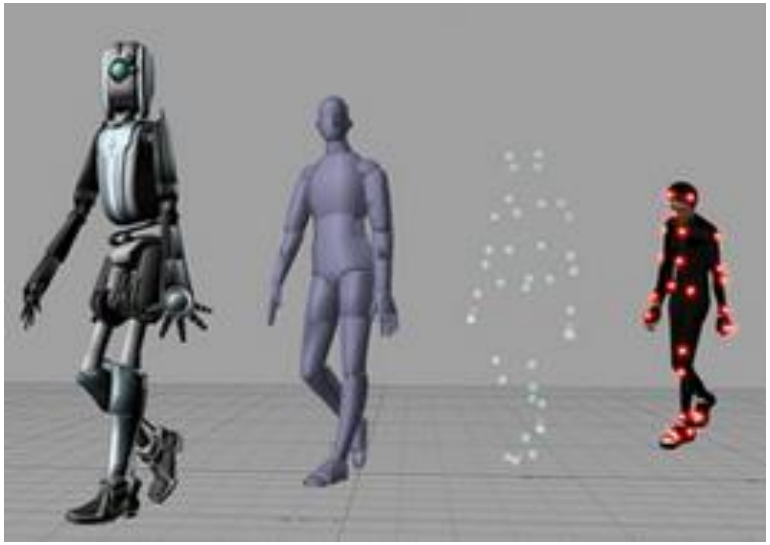
3D Reconstruction

Big Data Visualization





Computer Animation

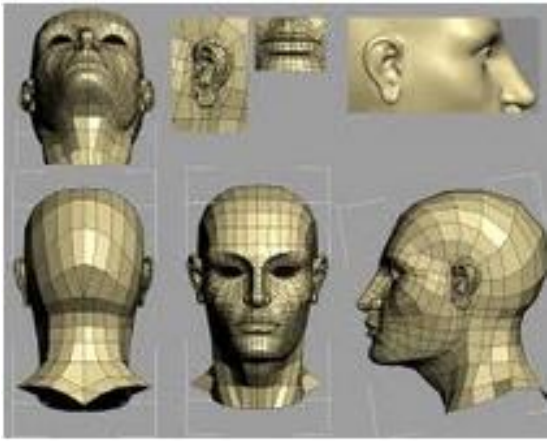


Crowd Simulation

Global Illumination

Human computer interaction

Human modeling



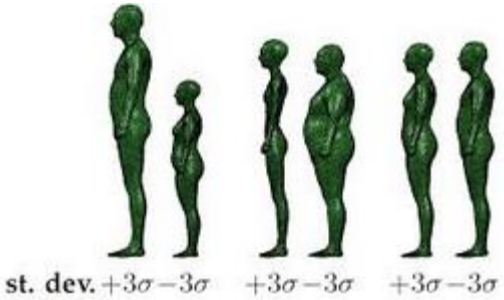
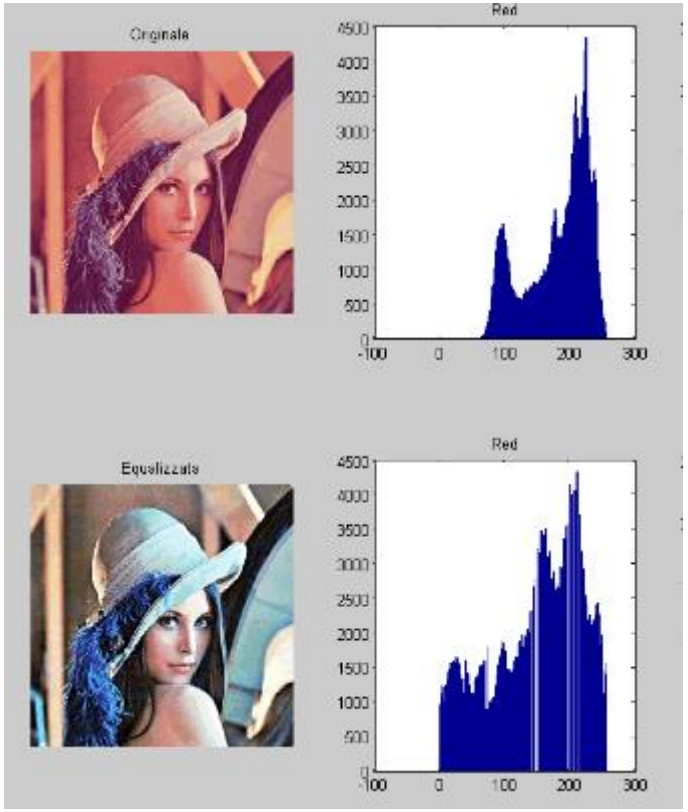
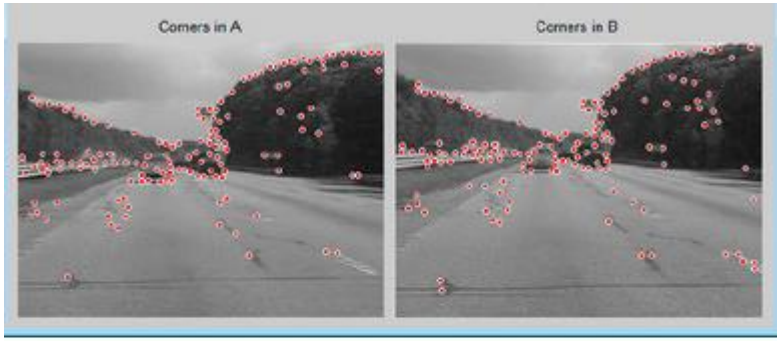
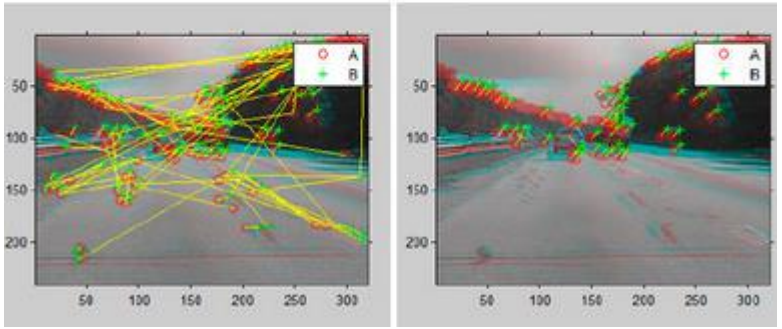
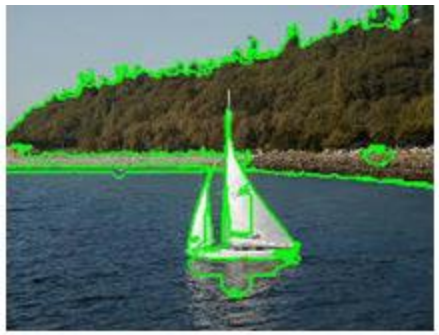


Image and video processing

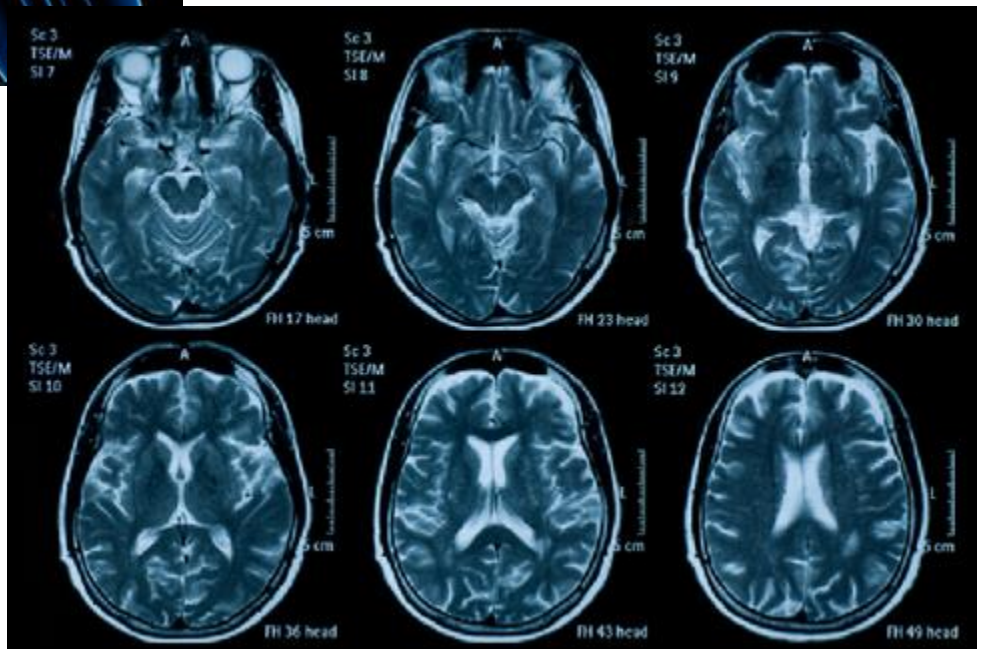




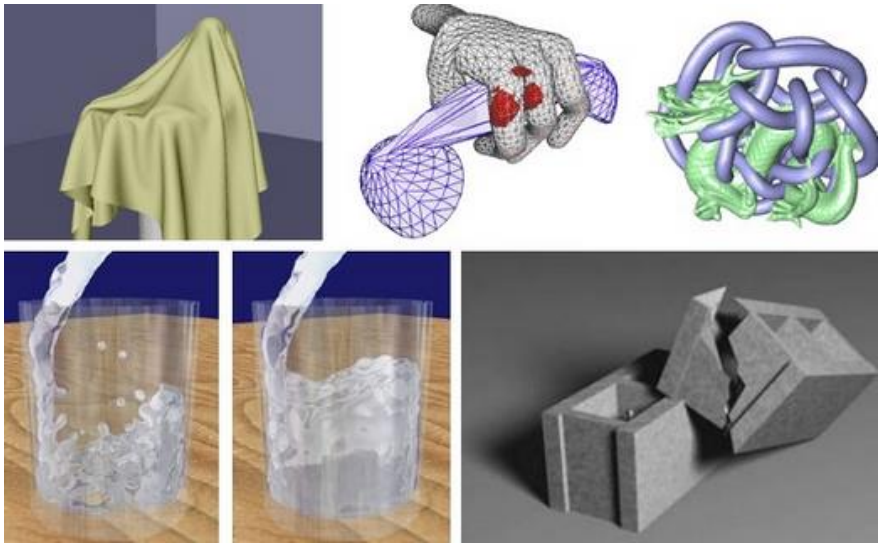


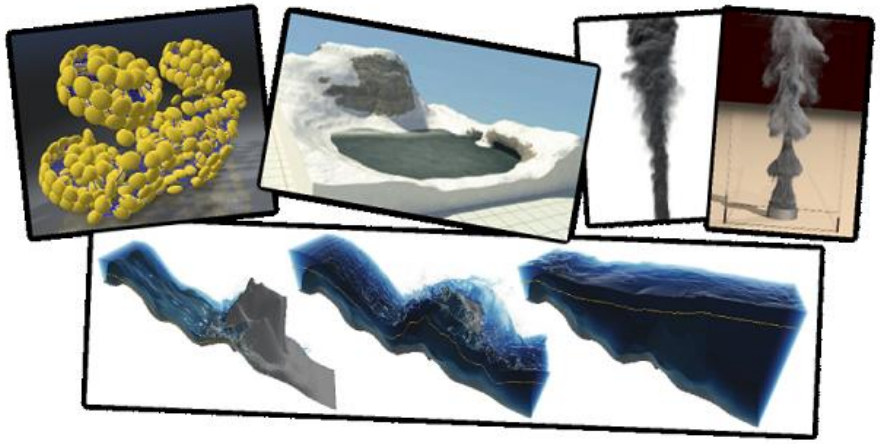


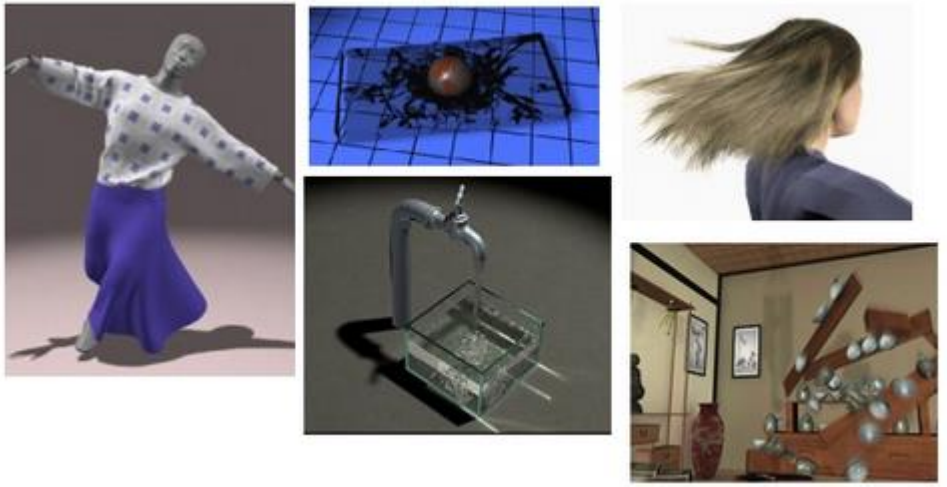
Medical imaging



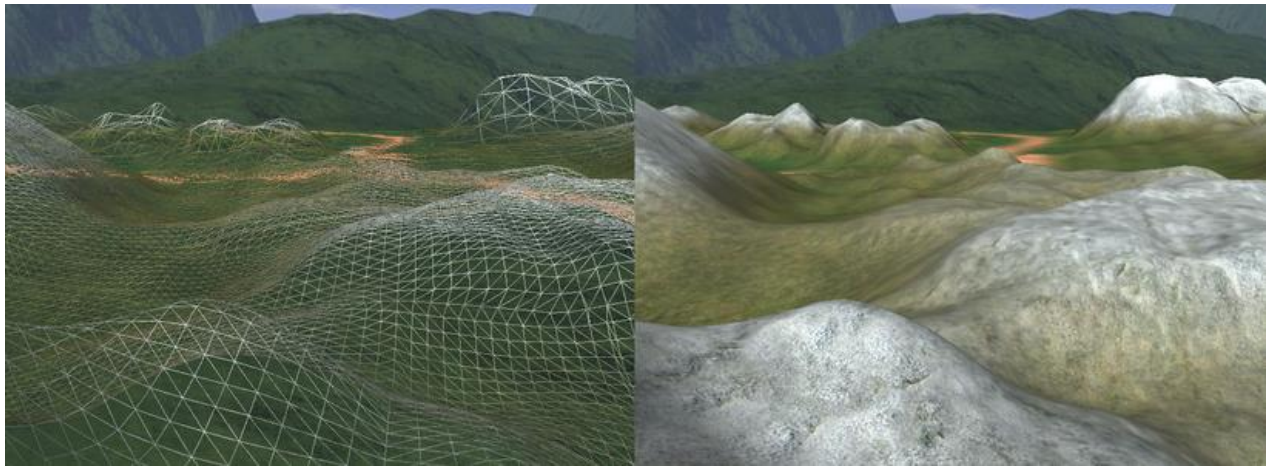
Physically based modeling



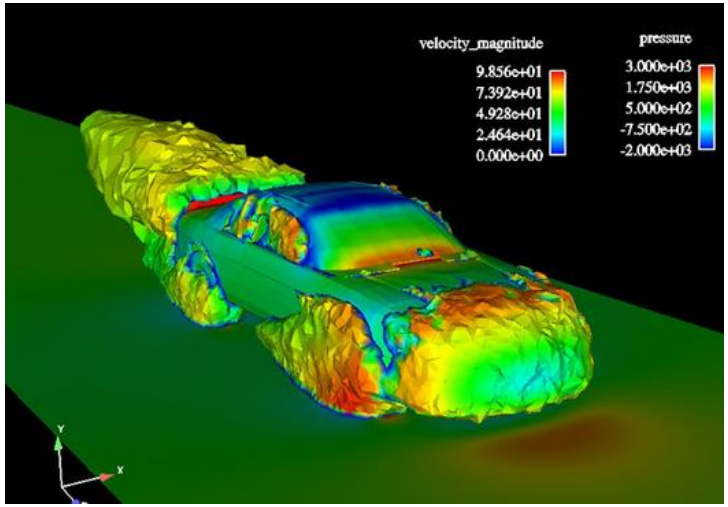


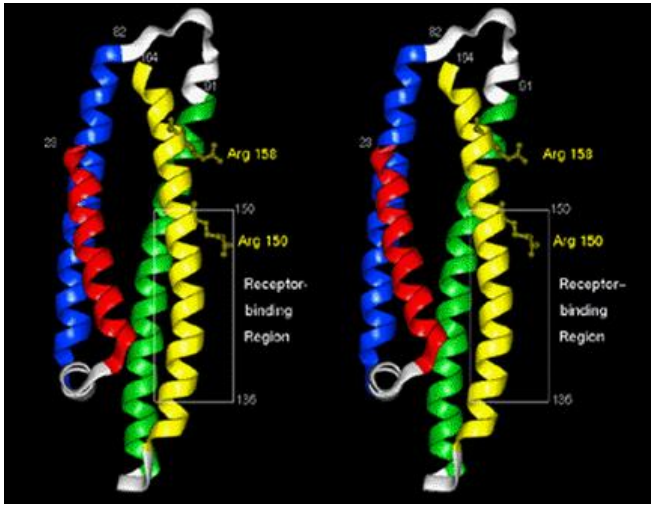


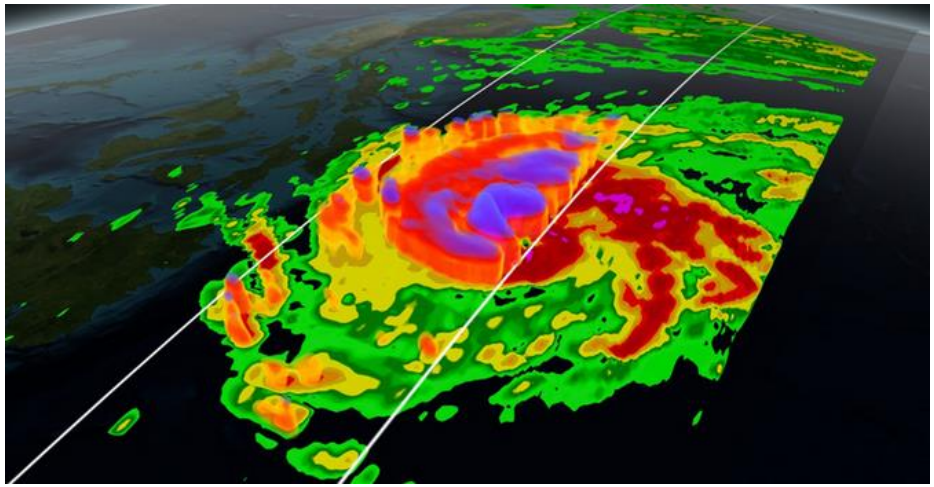
Rendering Techniques



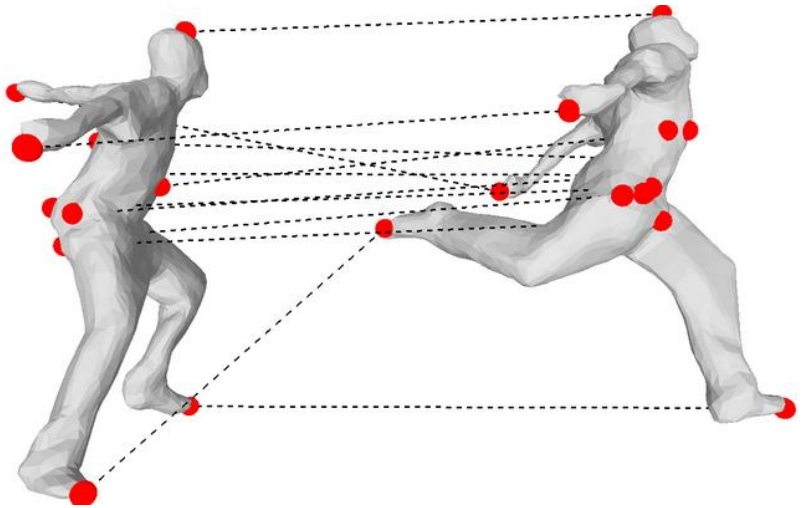
Scientific Visualization

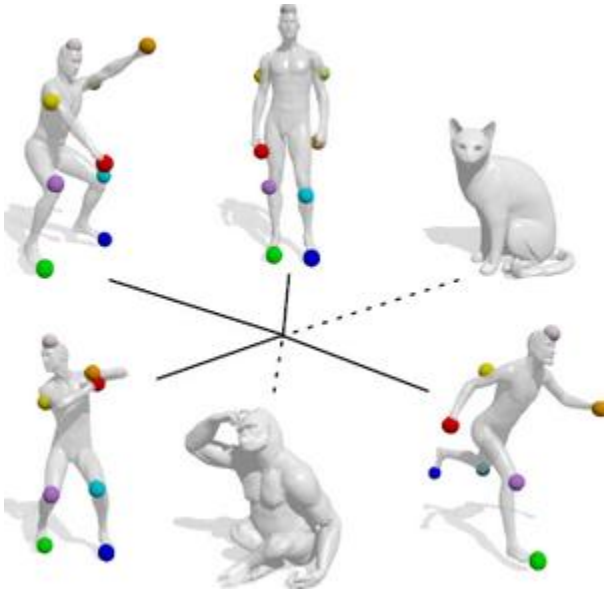


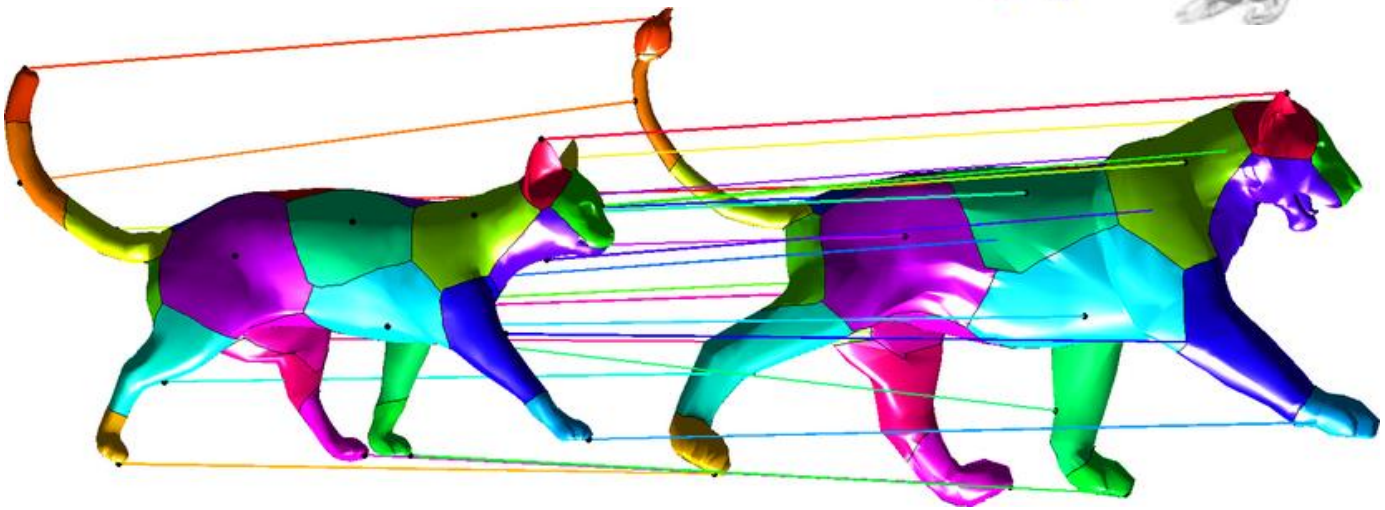




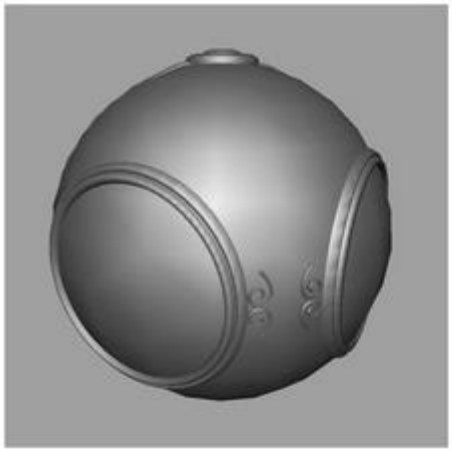
Shape matching

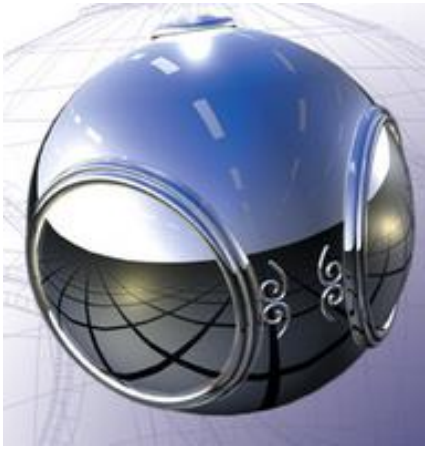




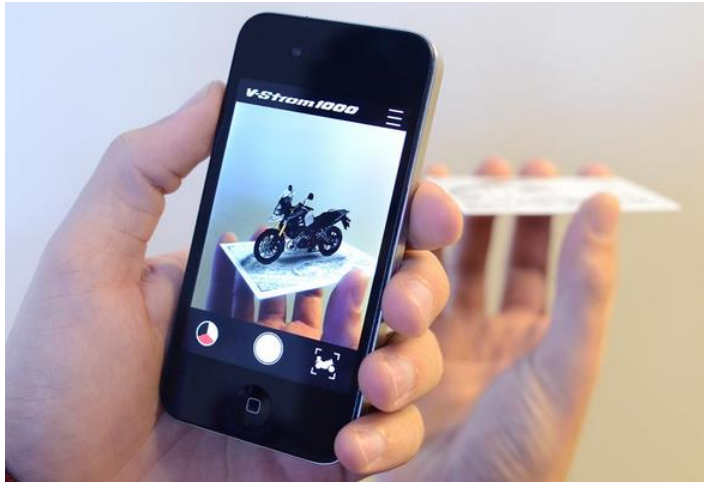


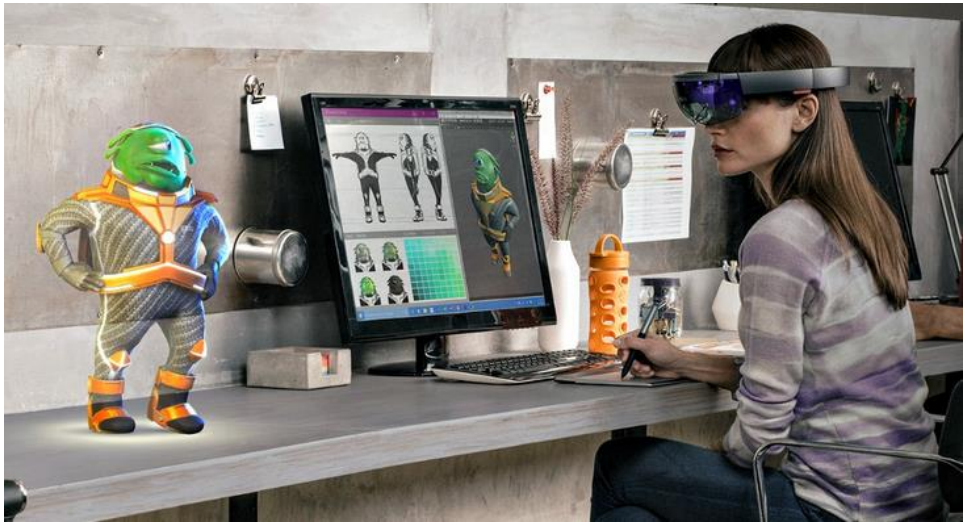
Textures



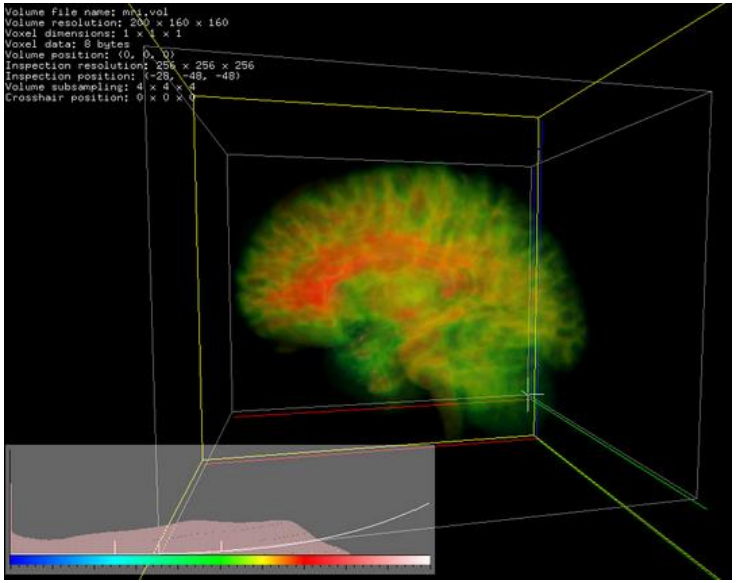


Virtual and augmented reality

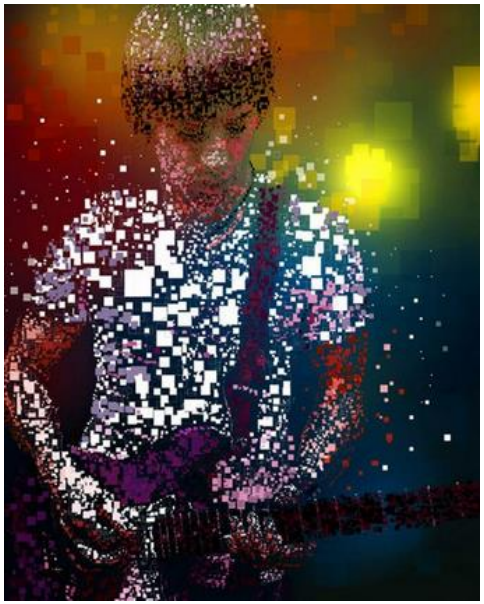




Volume Rendering



Web graphics



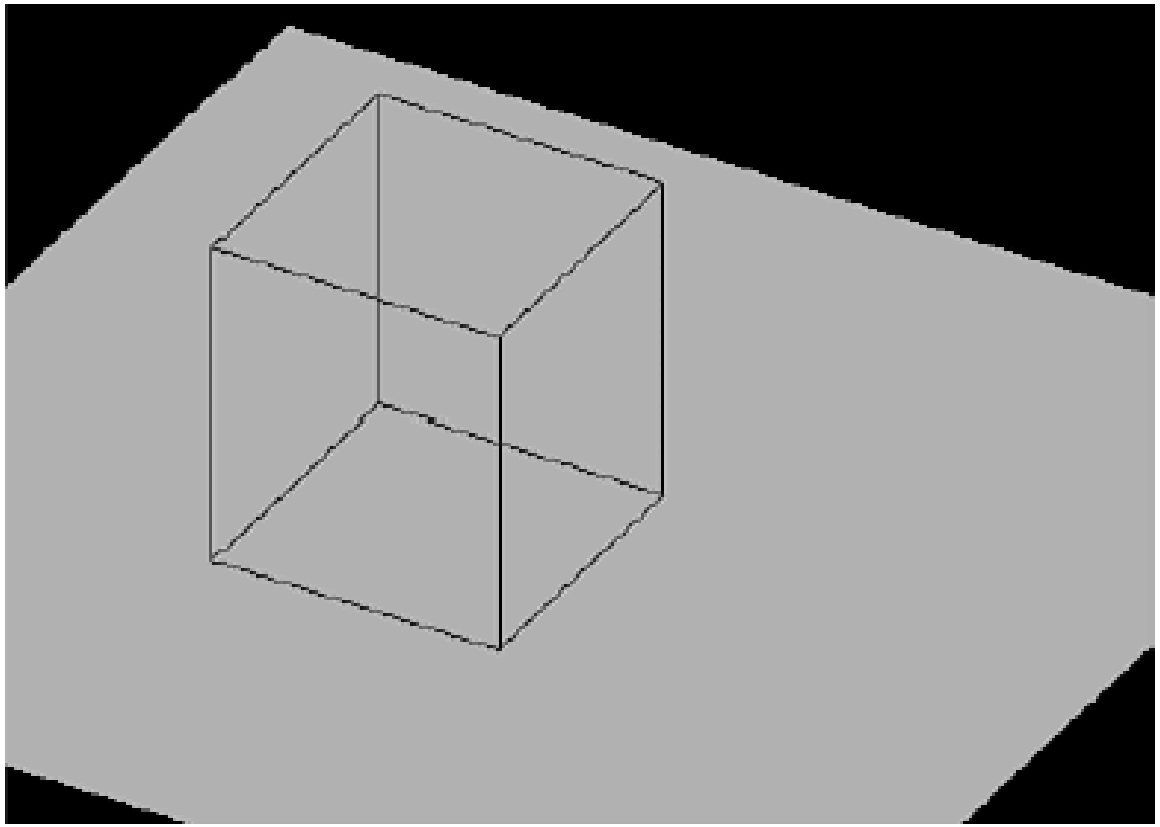
Learning Objectives

- an understanding of the design issues for creating 2D and **raster graphics**.
- an ability to apply **rendering techniques** to an actual computer graphics problem and associated datasets.
- an understanding of **object transformations**, **representations**, **transformations** and **perspective projections**.
- an understanding of **color**, **illumination**, and **shading techniques**.
- an understanding of the **rendering and rasterization techniques**.
- an understanding of the application of computer graphics techniques to **visualization**, **animation**, and **computer aided design**.

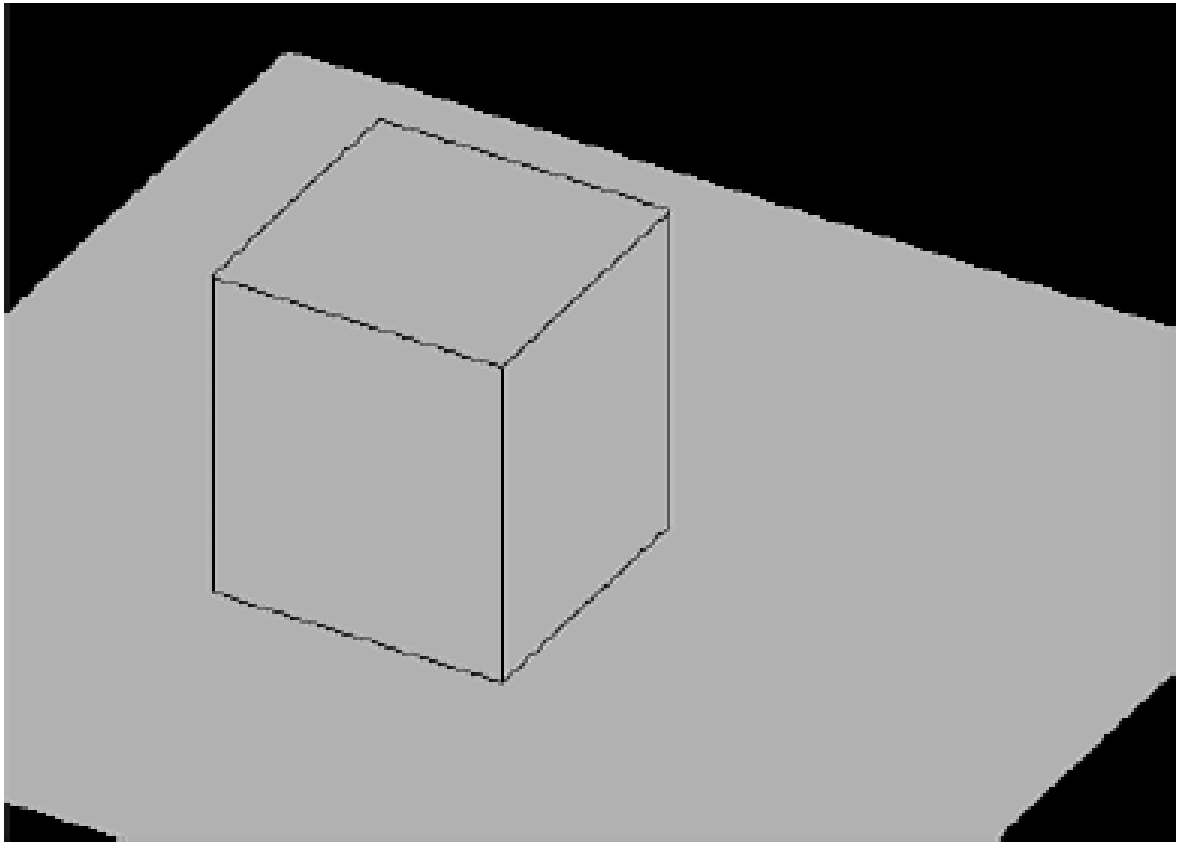
Week(s)	Topics
1-2	Brief overview of computer graphics and architecture (rendering pipeline), graphics software, and graphics applications. Introduction to the OpenGL library, example programs.
3	Raster basics: drawing lines and circles, clipping algorithms, polygon intersection. Alias effects, techniques to counter them.
4-5	From scene to image: Objects, transforms, color and illumination models, polygonal object representation, texture maps, view port clipping, rasterization.
6-7	Perspective and projection, affine and projective coordinates, rigid body motions. Object manipulation, concepts from projective geometry.
8-9	Color perception and color models, local illumination, ambient, diffuse and specular light models. Material properties. Gouraud and Phong shading.
10-11	Basic ray tracing, direct and indirect illumination, reflection and refraction. Constructive Solid Geometry (CSG), ray tracing CSG models.
12-13	Object geometry: polygon mesh, implicit surfaces, parametric curves and surfaces. Modeling with implicit surfaces. Construction of polygon meshes.
14-15	Survey of basic tools and techniques for animation, scientific visualization, and computer-aided design.

3D EFFECTS

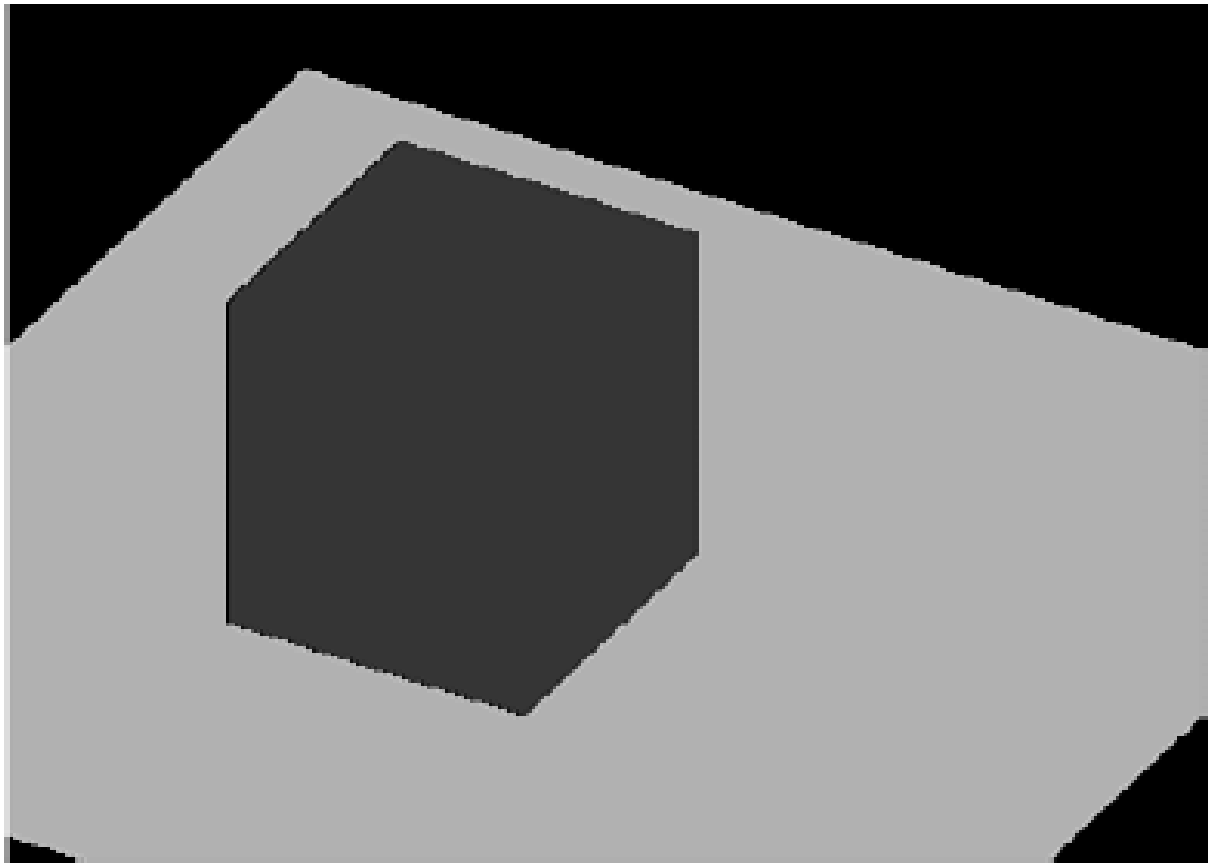
A line-drawn 3D cube



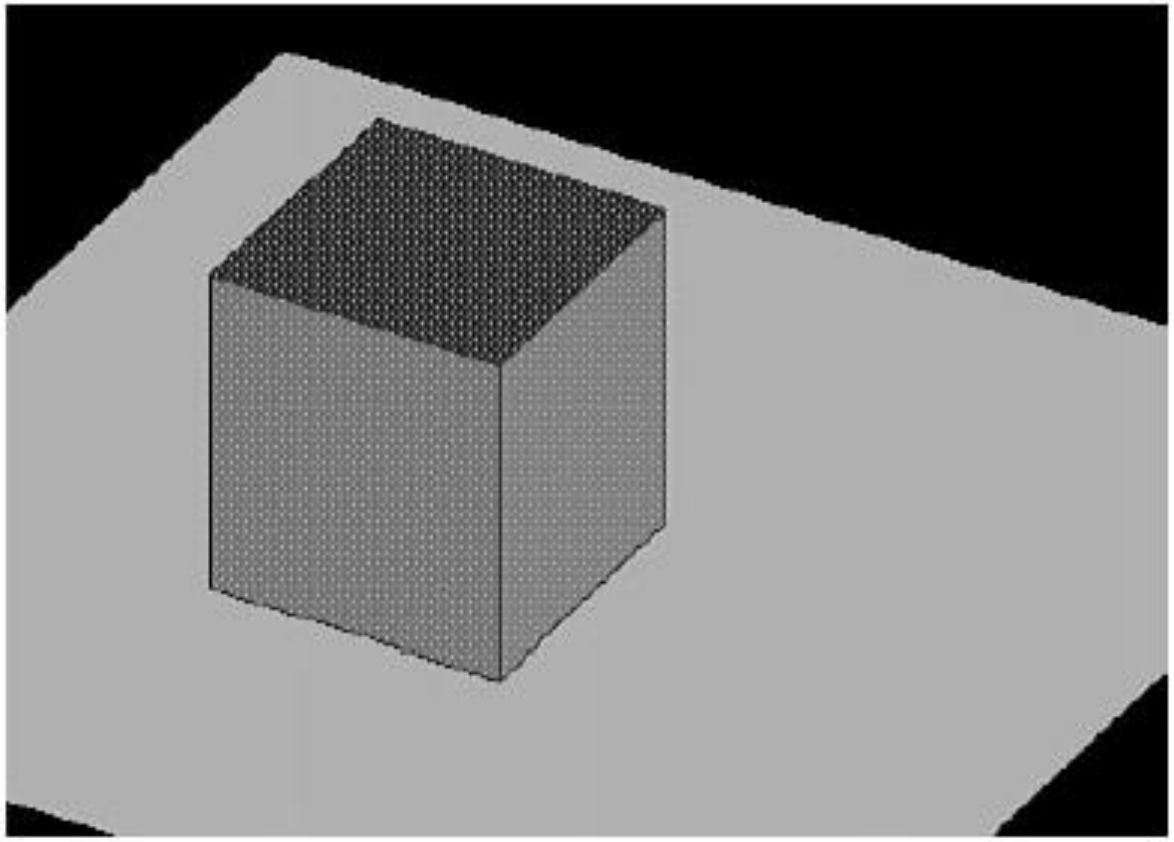
A more convincing solid cube



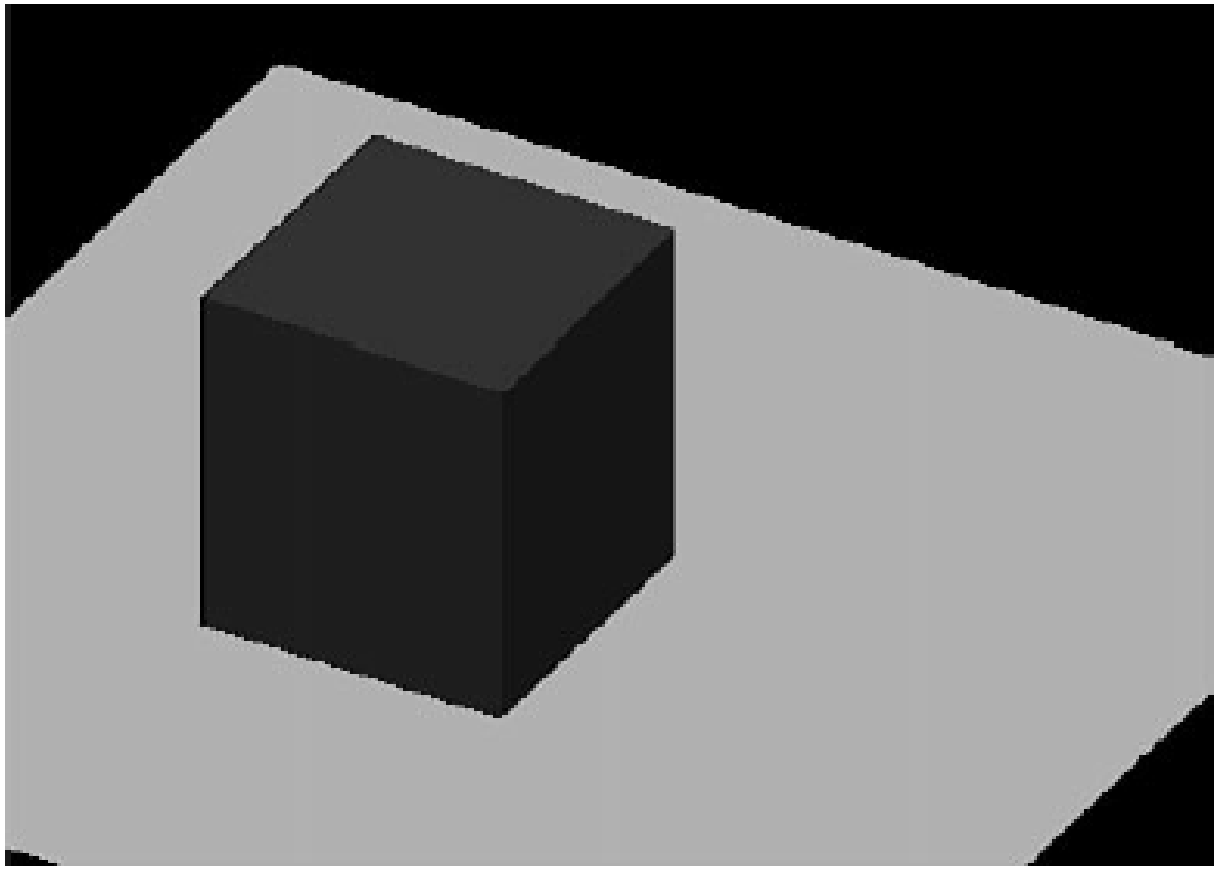
Adding color alone can create confusion



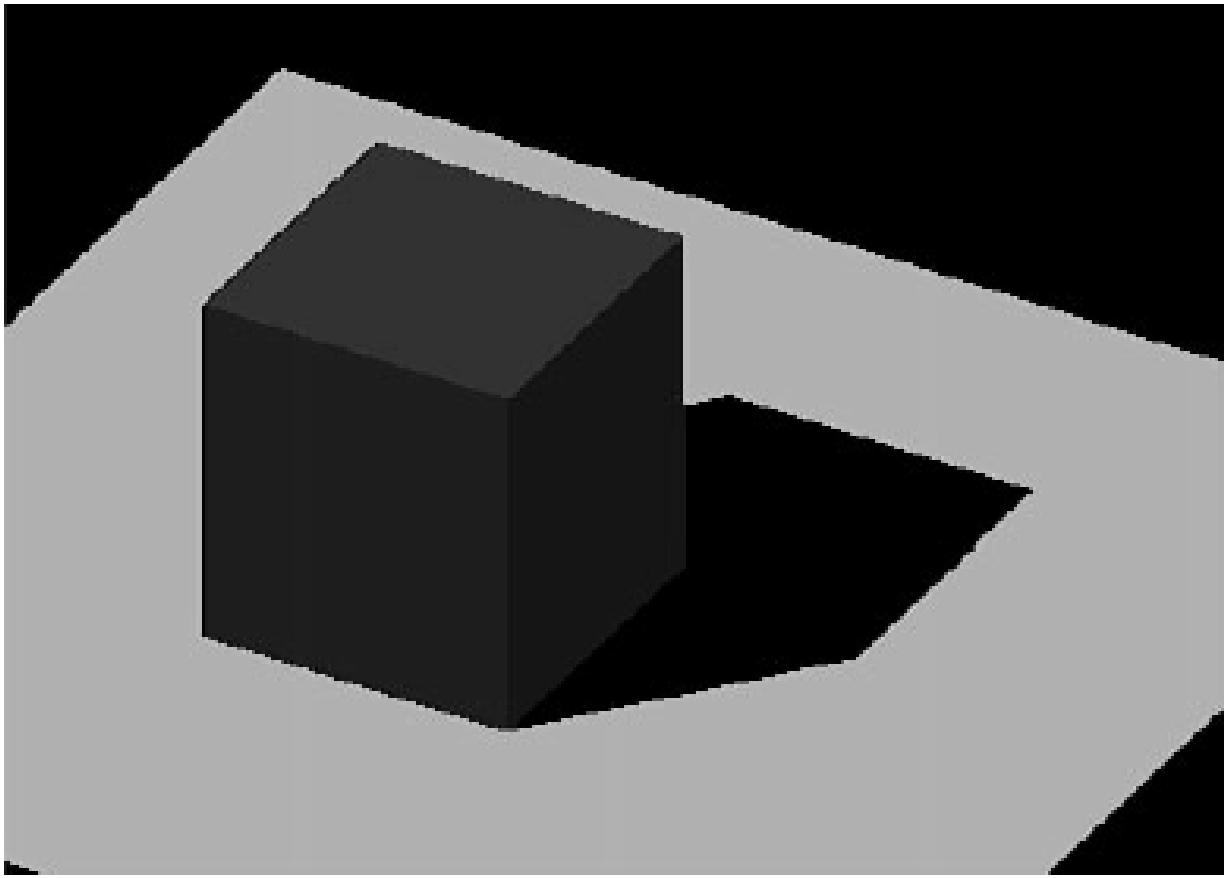
Adding different colors increases the illusion of three dimensions



Proper shading creates the illusion of illumination



Adding a shadow to further increase realism



Texture mapping adds detail without adding additional geometry