

CS4620: Introduction to Computer Graphics

Professor: Doug James

Introduction

Computer graphics: The study of creating, manipulating, and using visual images in the computer.

Or, to paraphrase Ken Perlin...

Computer graphics: The tool you need to show other people your dreams.

Graphics Applications

- Entertainment
 - film production
 - film effects
 - games
- Science and engineering
 - computer-aided design
 - scientific visualization
- Training & Simulation
- Graphic Arts
- Fine Art



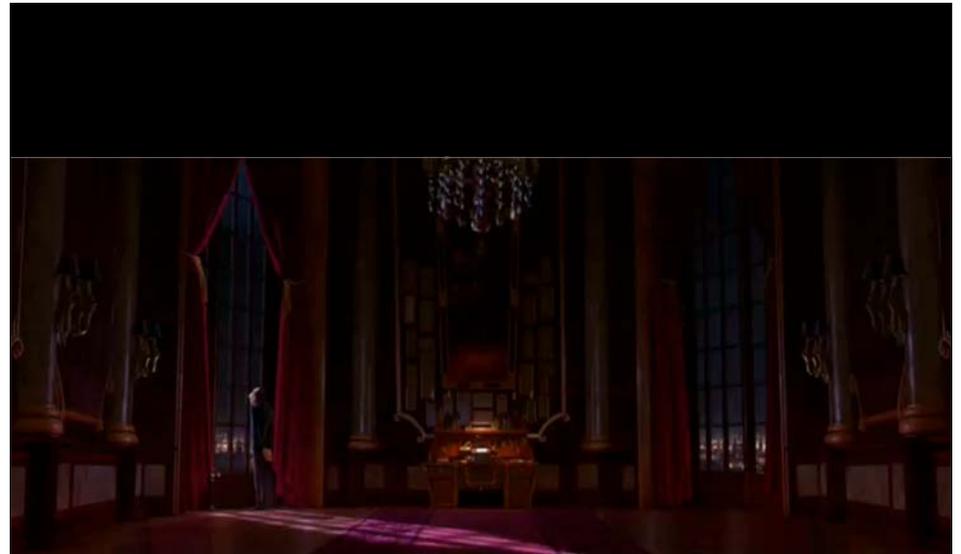
Pixar—Toy Story (1995)



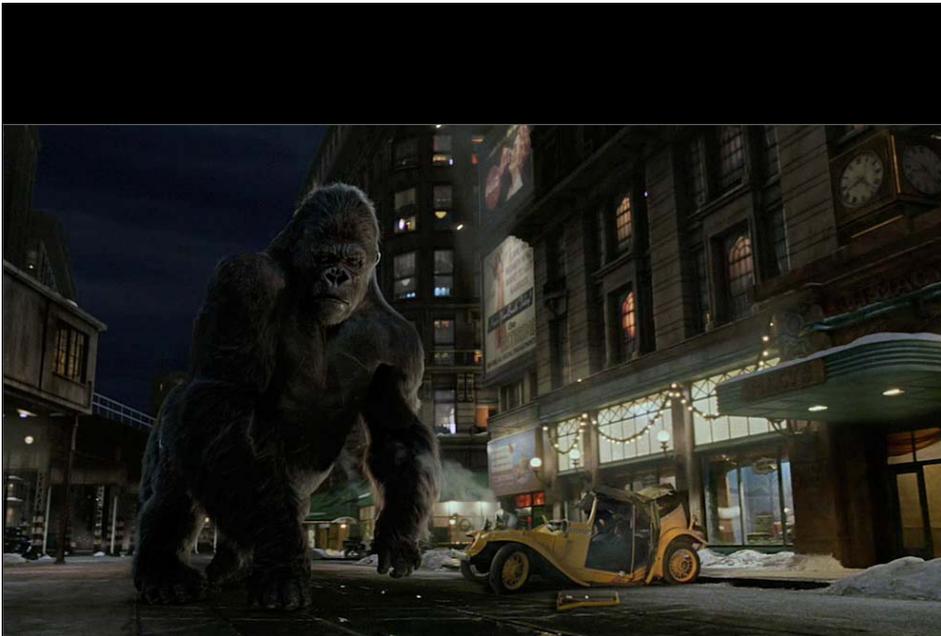
Pixar—Ratatouille (2007)



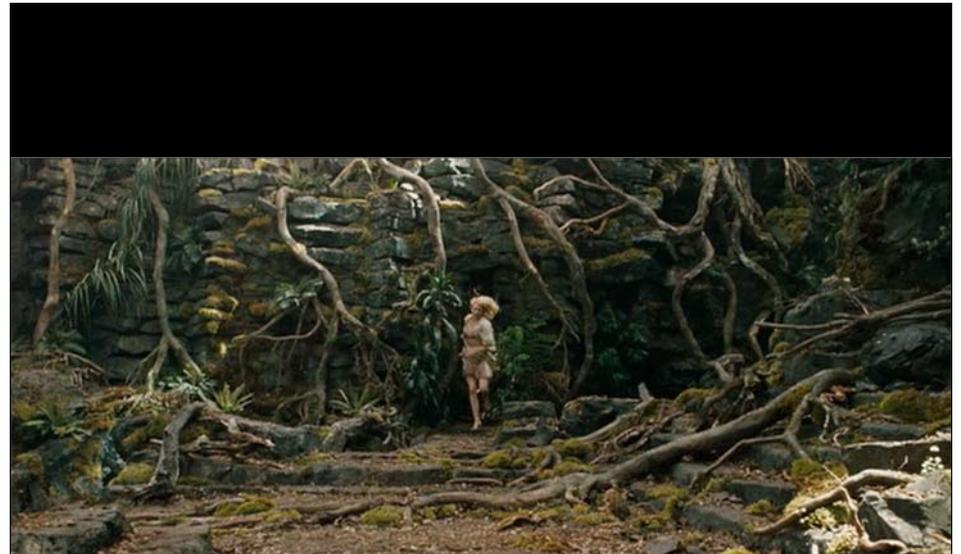
Pixar—Ratatouille (2007)



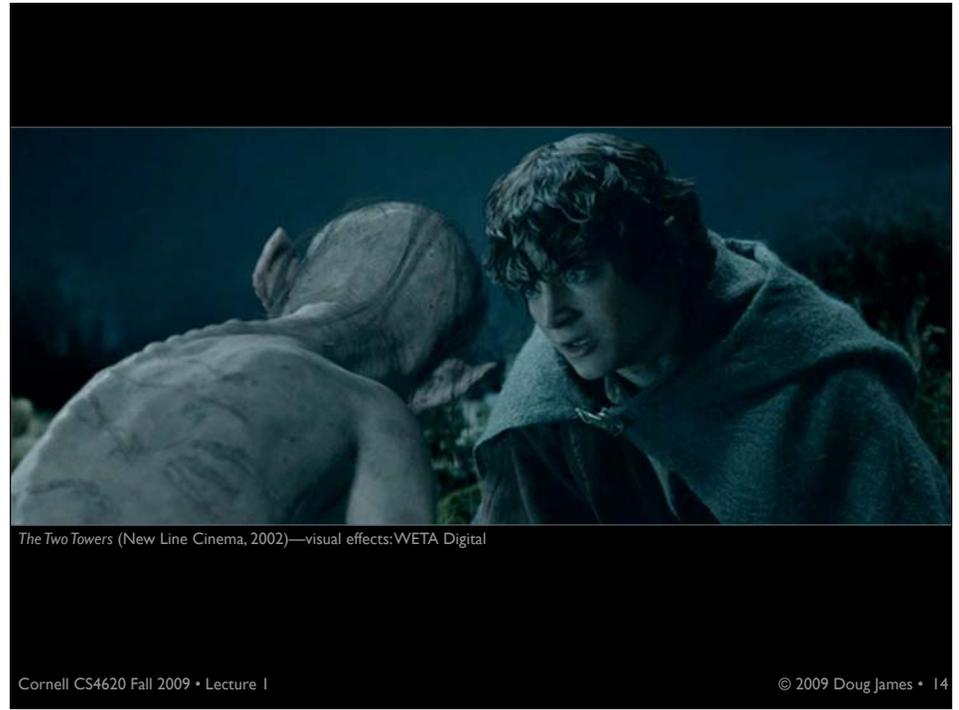
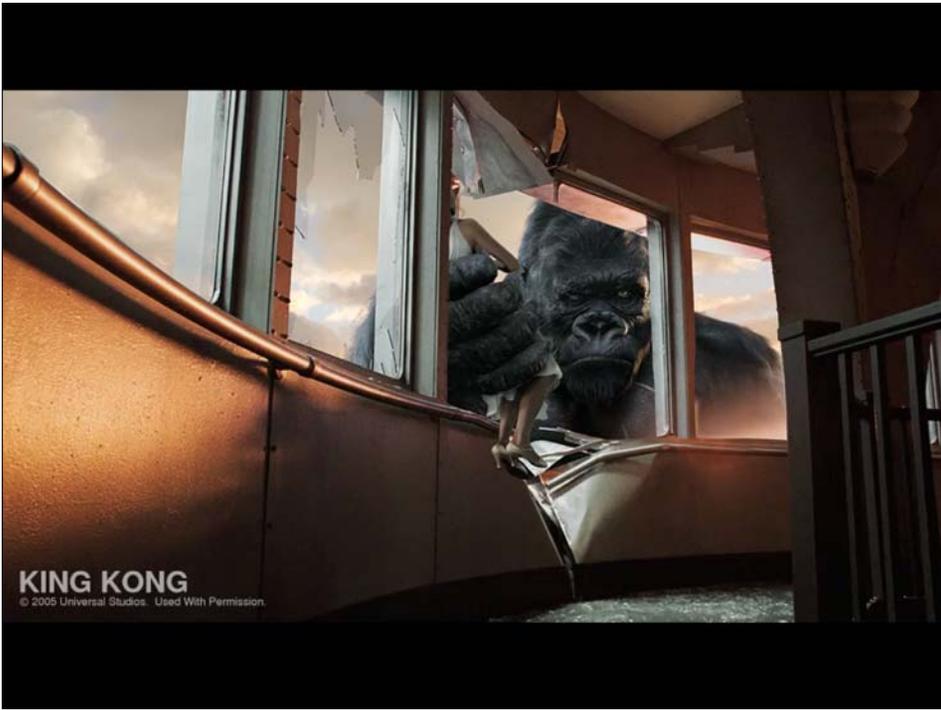
Pixar—Ratatouille (2007)



King Kong (Universal Pictures, 2005)—visual effects:WETA Digital



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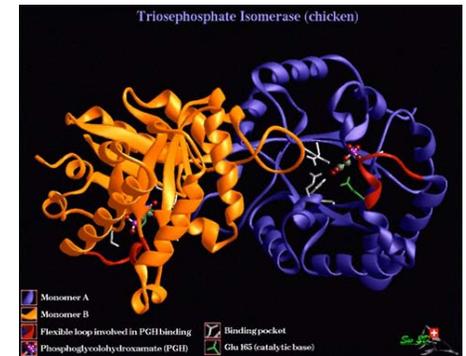




Crytek GmbH—advertisement for CryEngine 2 game engine

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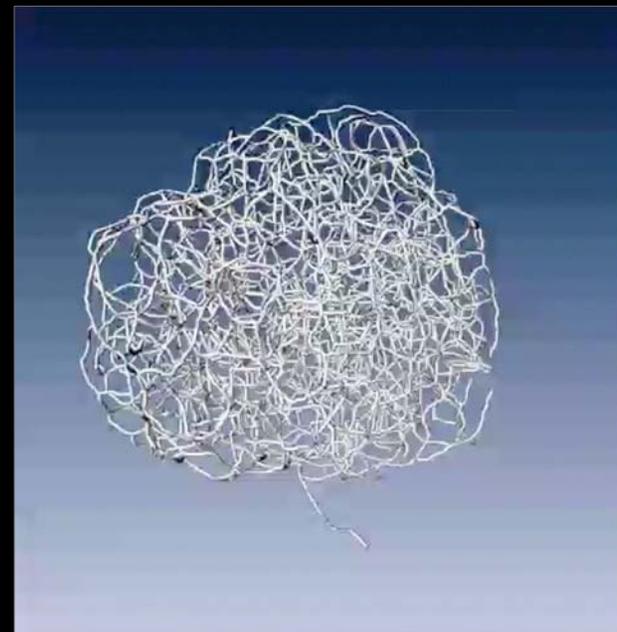


RIT Biochem. 502—Paul Craig



Simulated deformation of citrate synthase during substrate binding

Kalju Kahn, UCSB



3D microscopy of capillaries in glomerulus of a human kidney

Roger C. Wagner, Univ. Delaware

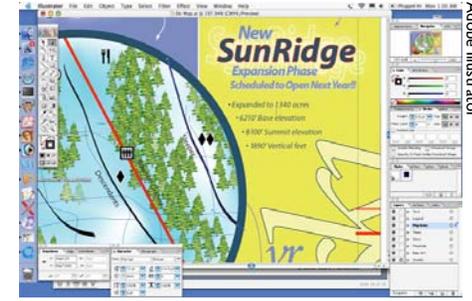
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Problems in graphics

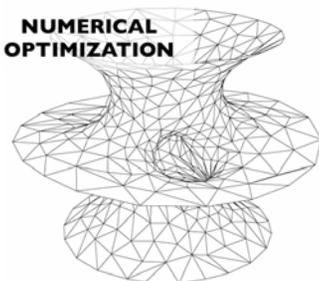
Problems in graphics

- 2D imaging
 - compositing and layering
 - digital filtering
 - color transformations
- 2D drawing
 - illustration, drafting
 - text, GUIs

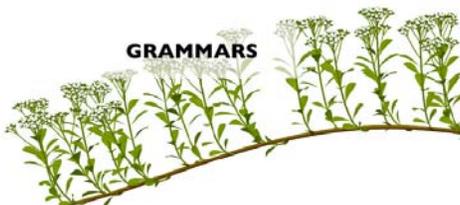
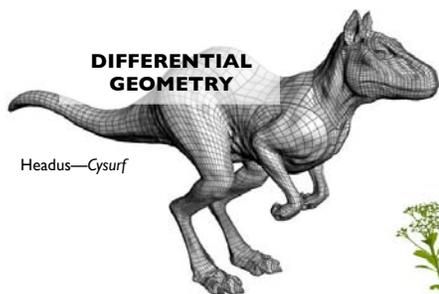


Problems in graphics CONT'D

- 3D modeling
 - representing 3D shapes
 - polygons, curved surfaces, ...
 - procedural modeling



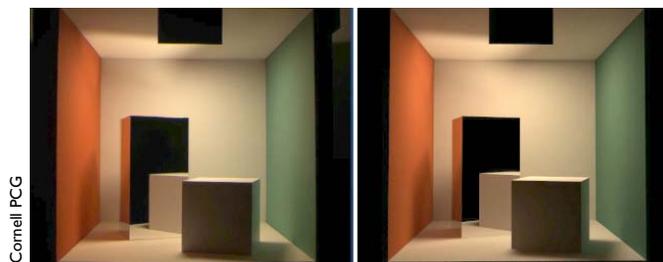
[Hoppe et al. 1993]

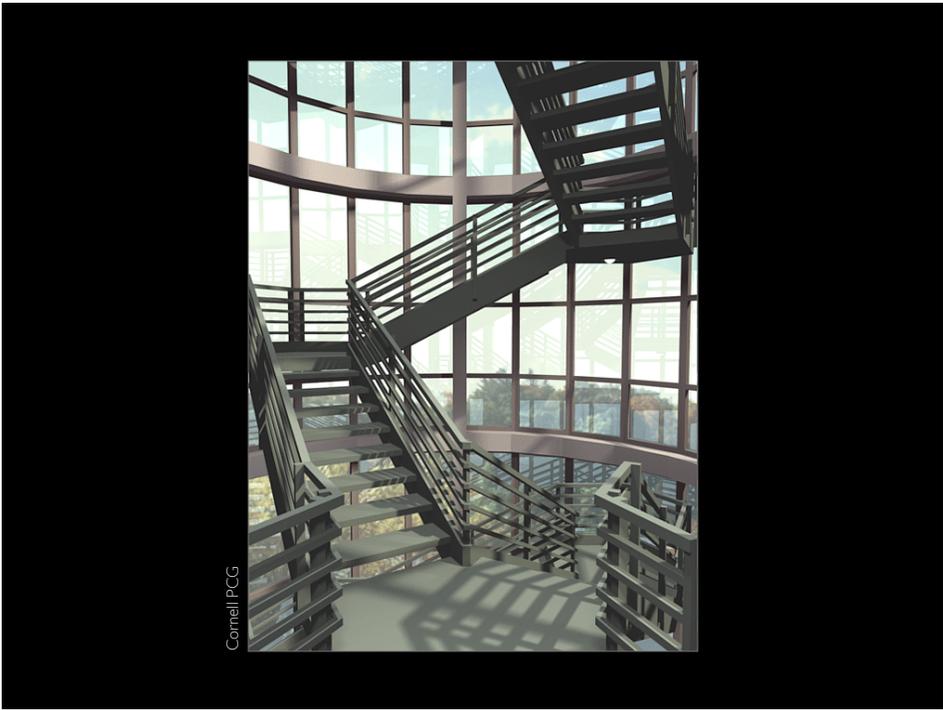


[Prusinkiewicz et al. 2001]

Problems in graphics CONT'D

- 3D rendering
 - 2D views of 3D geometry
 - projection and perspective
 - removing hidden surfaces
 - lighting simulation





Problems in graphics CONT'D

- User Interaction
 - 2D graphical user interfaces
 - 3D modeling interfaces
 - virtual reality

PROJECTIVE GEOMETRY

TU Berlin

SPHERICAL GEOMETRY

SGL—OpenInventor

Cornell CS4620

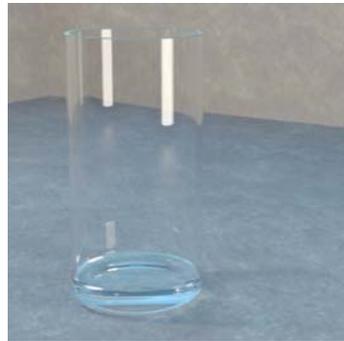
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Problems in graphics CONT'D

- Animation
 - keyframe animation
 - physical simulation



Pixar



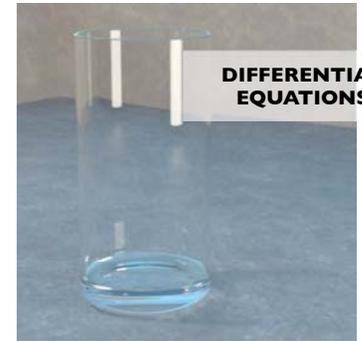
Enright et al. SIGGRAPH 2003

Problems in graphics CONT'D

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Pixar



Enright et al. SIGGRAPH 2003

Computer graphics:
Mathematics made visible.

Course Overview

In CS4620

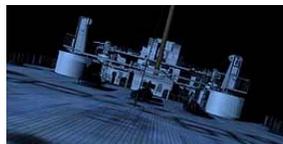
- You will:
 - explore fundamental ideas
 - learn math essential to graphics
 - implement key algorithms
 - write cool programs
- You will not:
 - learn a lot about OpenGL or DirectX
(though you will use some OpenGL)
 - write big programs---try CS4620 Practicum for that

Topics

- Rendering 3D scenes
(ray tracing as the basic model)
- Images and image processing
(featuring sampling and reconstruction)
- Geometric transformations
- The graphics pipeline
(with a slant toward understanding graphics hardware)
- Modeling in 2D and 3D
- Color science

Images

- What is an image?
- Compositing
- Resampling



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Rendering

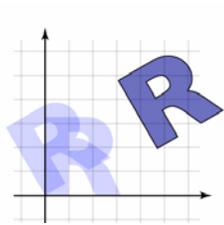
- ray tracing
- shading & shadows
- transparency
- texture mapping



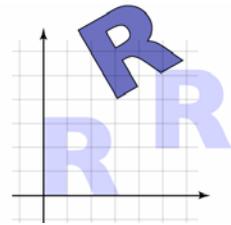
[Glassner 89]

Geometric transformations

- affine transforms
- perspective transforms
- viewing



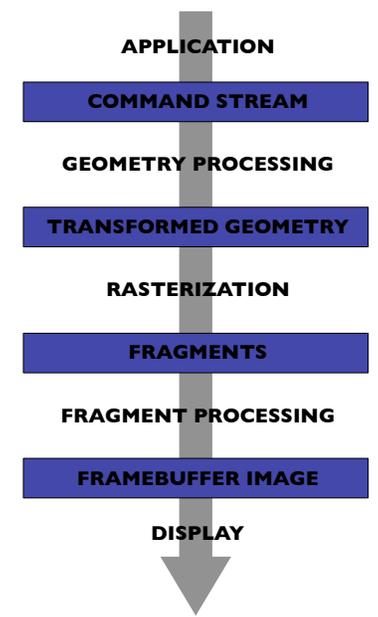
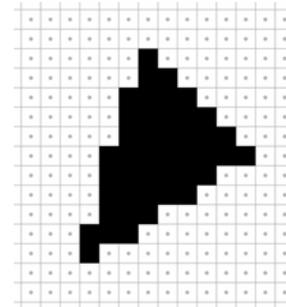
rotate, then translate



translate, then rotate

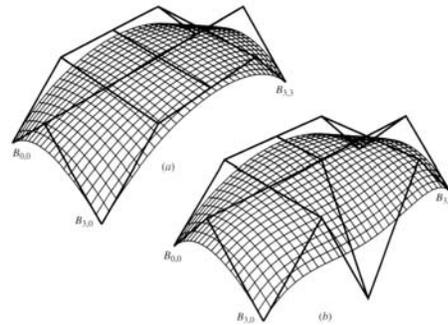
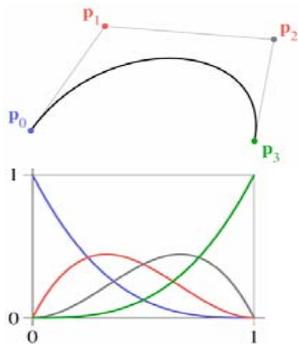
Graphics pipeline

- rasterization
- interpolation
- z-buffer
- vertex and fragment ops



Modeling

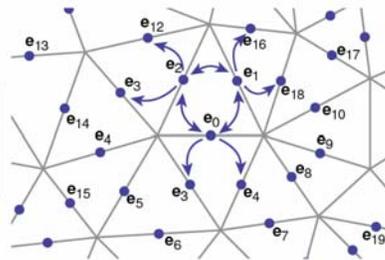
- splines
- parametric surfaces
- triangle meshes



[Rogers]

winged edge table

	h1	hr	tl	tr
[0]	1	4	2	3
[1]	18	0	16	2
[2]	12	1	3	0
				!



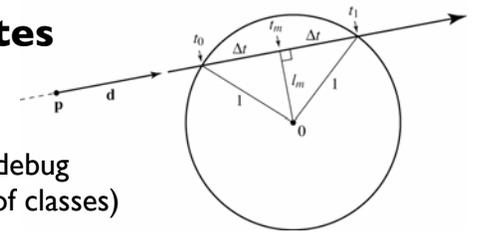
Deformation

- articulated characters
- free-form deformation
- blend shapes
- subdivision surfaces





CS4620 Prerequisites



- Programming
 - ability to read, write, and debug small Java programs (10s of classes)
 - understanding of very basic data structures
 - no serious software design required
- Mathematics
 - vector geometry (dot/cross products, etc.)
 - linear algebra (just basic matrices in 2-4D)
 - basic calculus (simple derivatives)
 - graphics is a good place to pick up some, but not all, of this

In CS462I

- You will also:
 - implement a modeling and animation system, in groups of ~4
 - learn a lot about
 - subdivision surfaces
 - mesh data structures
 - scene data structures
 - architecting good-sized interactive programs
 - using OpenGL



Pixar—Geri's Game

Course mechanics

See web site:

<http://www.cs.cornell.edu/Courses/cs4620>