

COMP770: Computer Graphics

Professor: Dinesh Manocha

Introduction

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

Graphics Applications

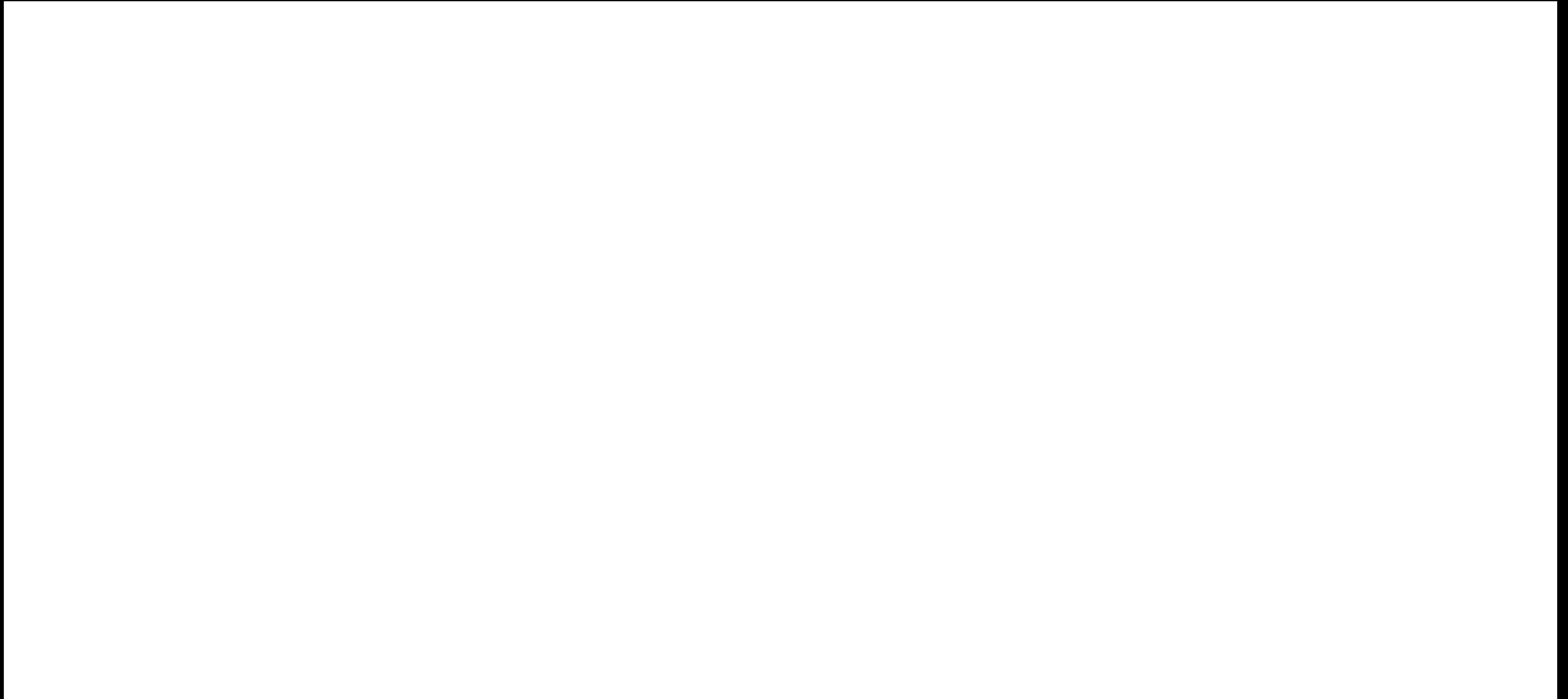
- Entertainment
 - film production
 - film effects
 - games
- Science and engineering
 - computer-aided design
 - scientific visualization
- Training & Simulation
- Graphic Arts
- Fine Art



Pixar—Toy Story



Pixar—Ratatouille (2007)



Pixar—*Ratatouille* (2007)



Pixar—*Ratatouille* (2007)



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



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



KING KONG

© 2005 Universal Studios. Used With Permission.



The Two Towers (New Line Cinema, 2002)—visual effects: WETA Digital

<http://www.youtube.com/watch?v=1wK1Ixr-UmM&feature=related>

Special Facial Effects in Avatar





Electronic Arts—NBA Live 07 (screenshot: gamespy.com)

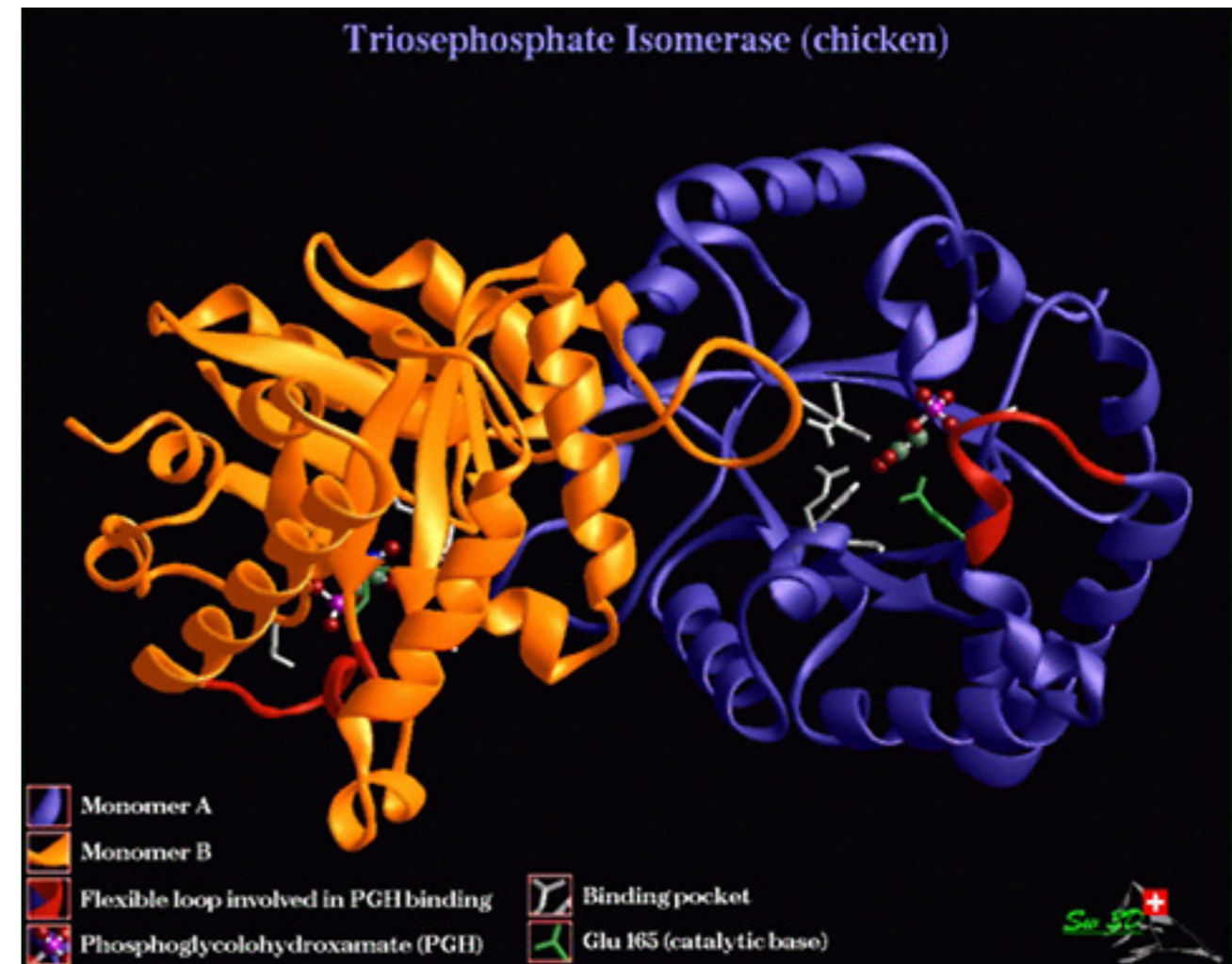
The image features the Crytek logo in a stylized, metallic, 3D font. The logo is centered horizontally. To the left of the logo, a thick blue curved arrow starts from the bottom left and points towards the top left. To the right of the logo, a thick yellow curved arrow starts from the bottom right and points towards the top right. Further to the right, a green arrow points horizontally to the left.

CRYTEK

Crytek GmbH—advertisement for CryEngine 2 game engine

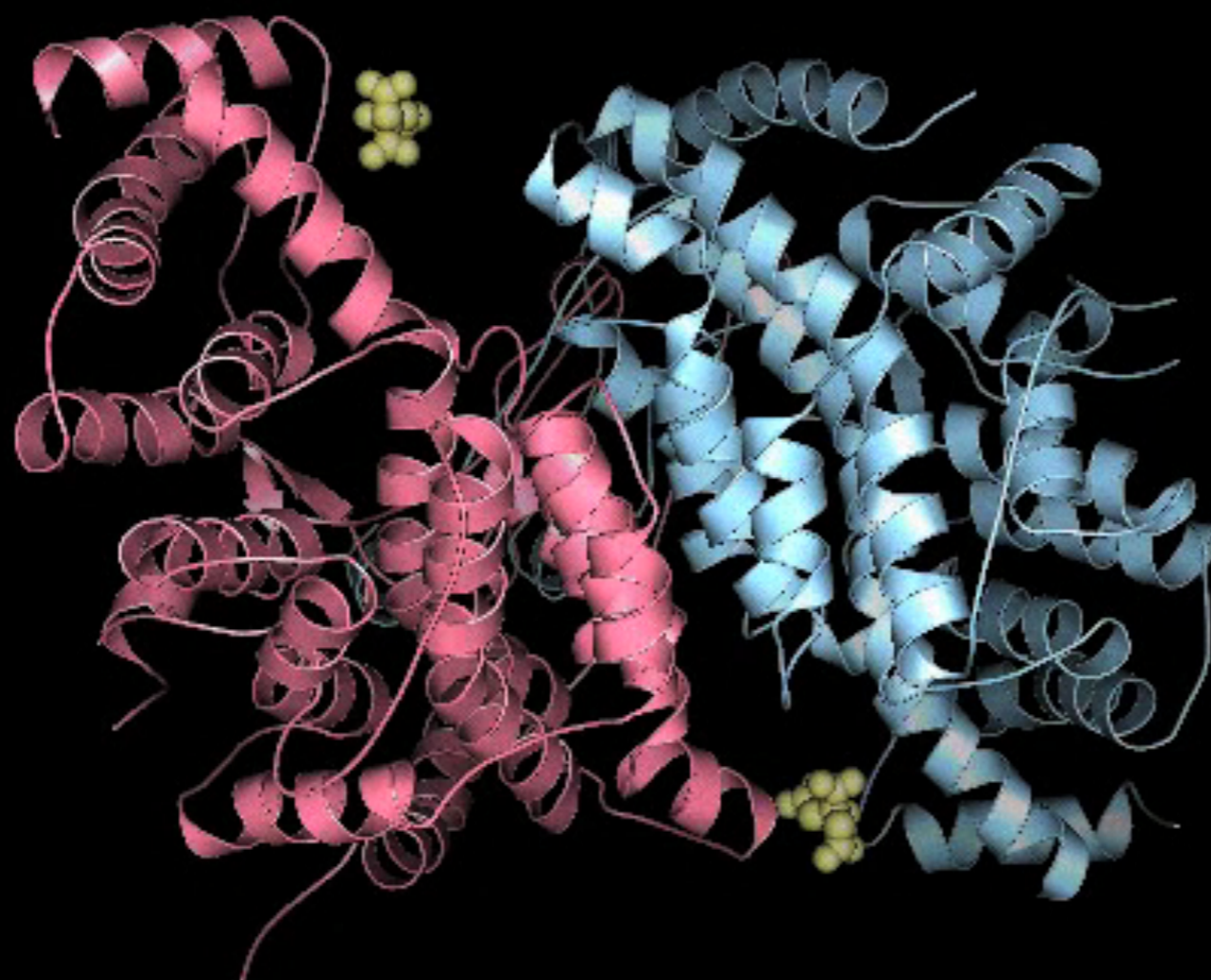
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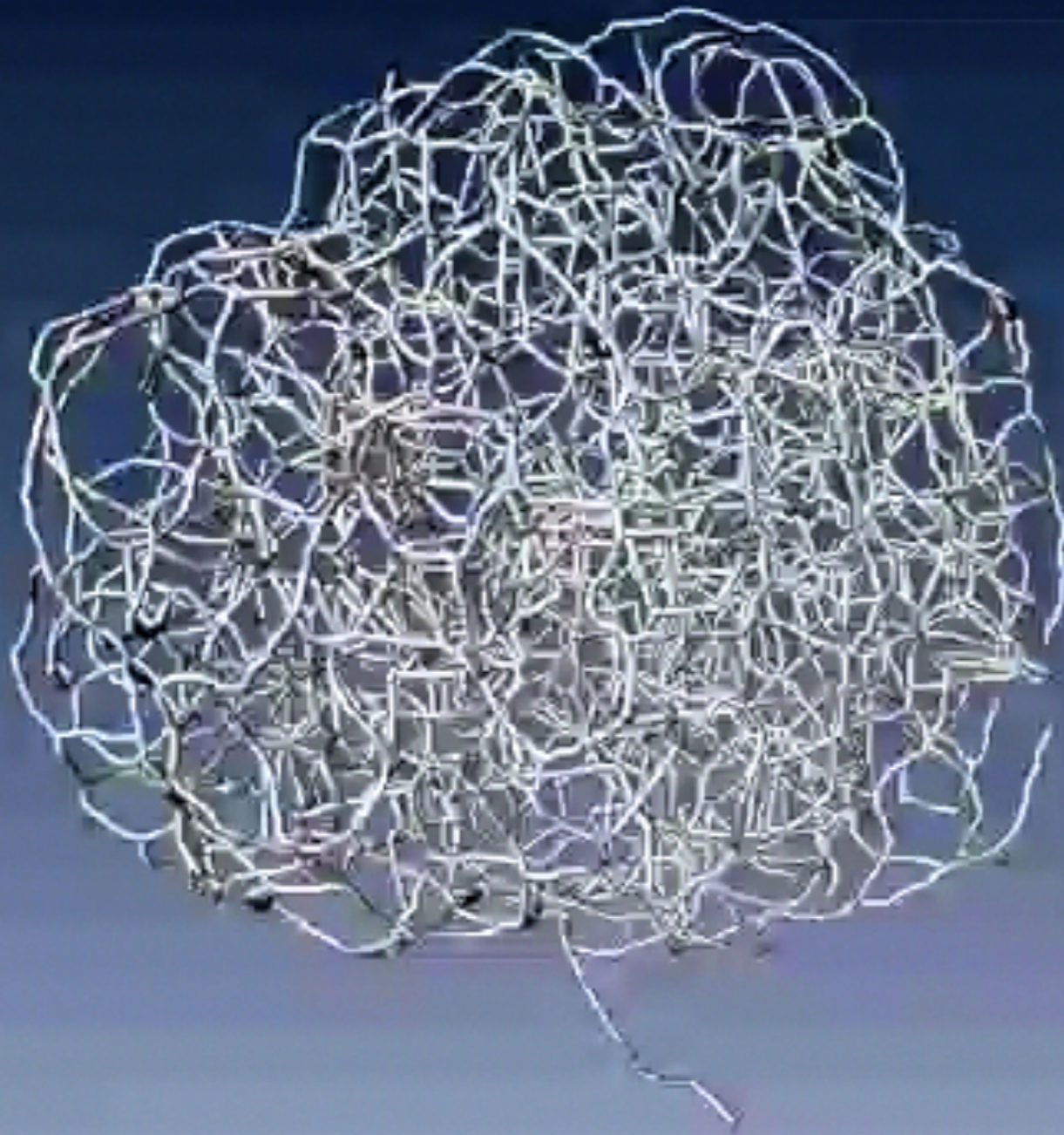
RIT Biochem. 502—Paul Craig

Simulated
deformation of
citrate synthase
during substrate
binding



Kalju Kahn, UCSB

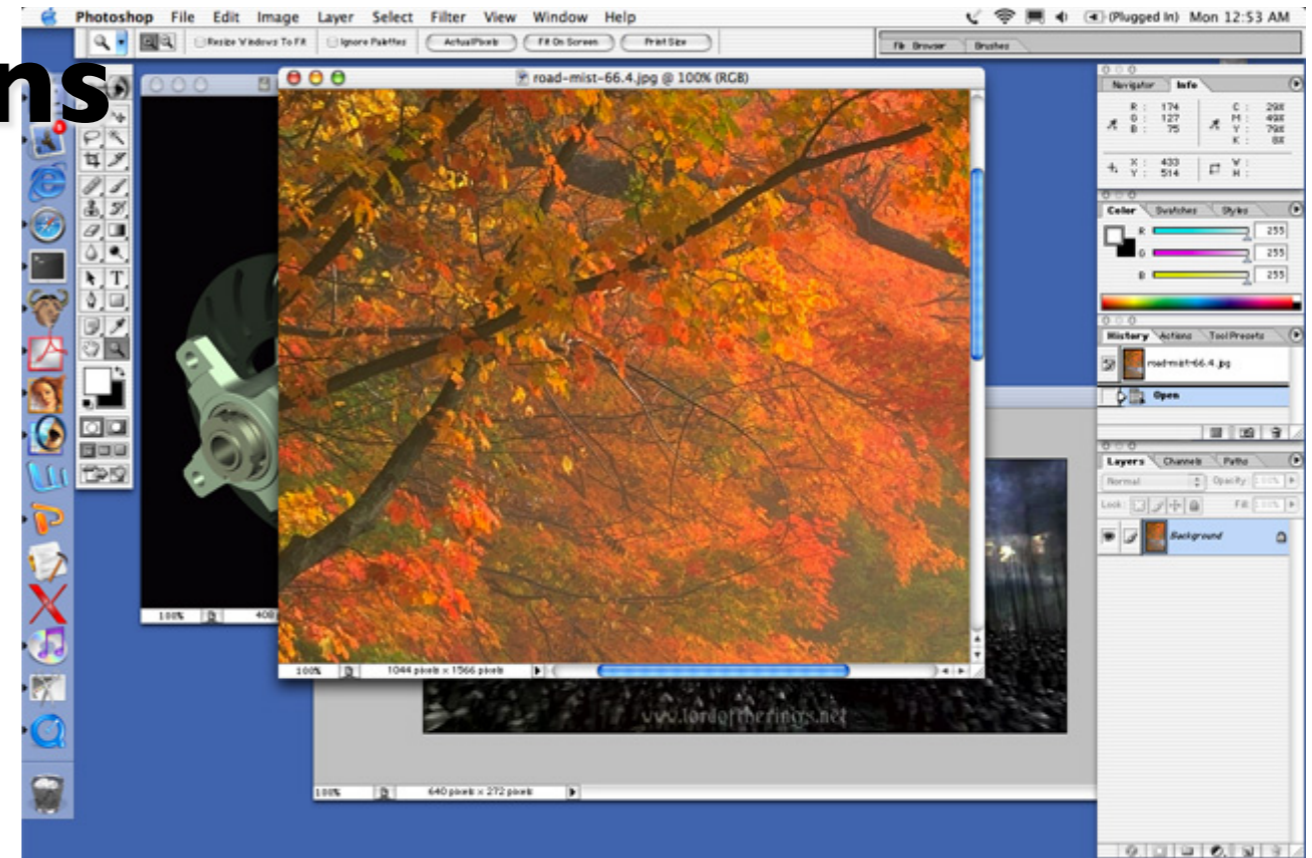
3D microscopy
of capillaries
in glomulerus of a
human kidney



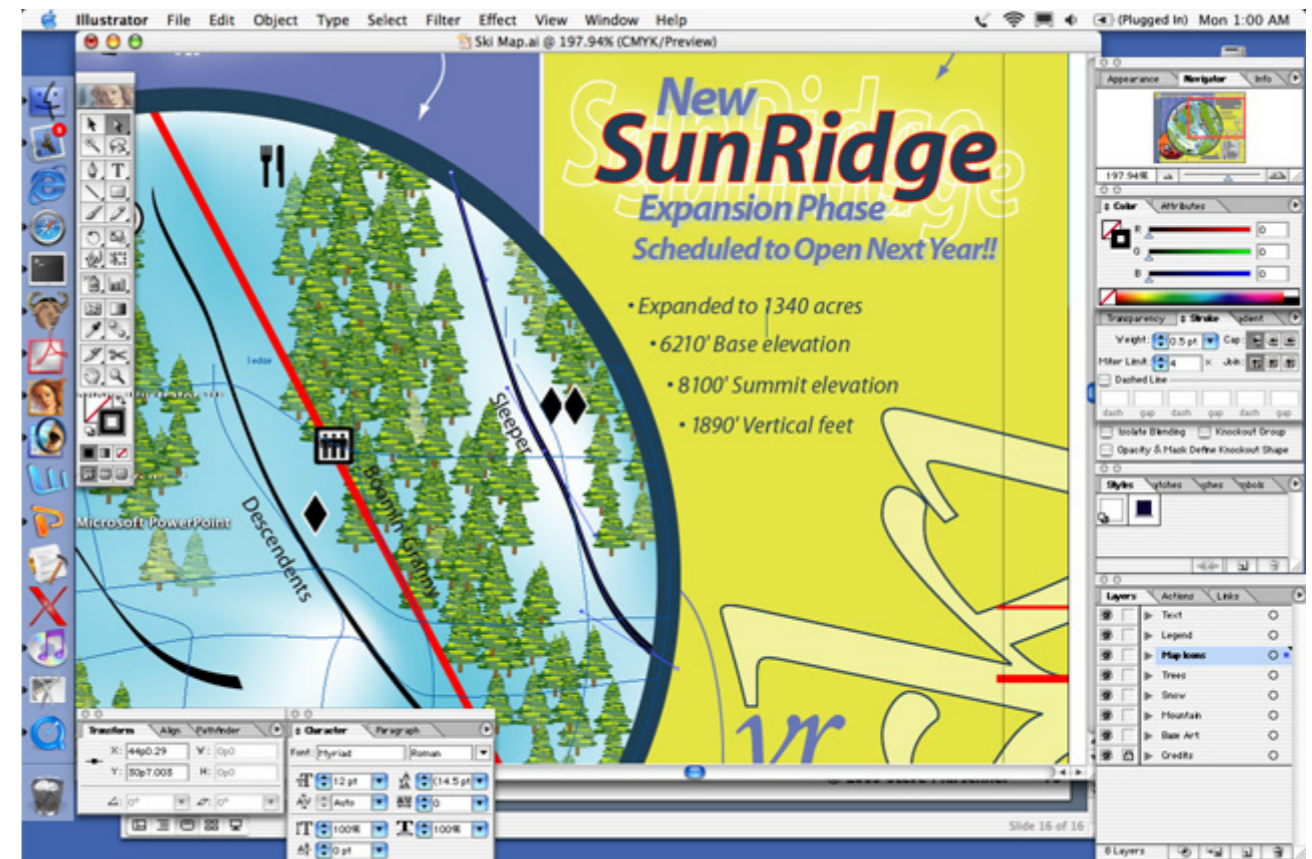
Roger C. Wagner, Univ. Delaware

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Adobe Photoshop [Photo: P. Greenspun]



Adobe Illustrator

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NASA/Ames—ACFS



Army Research Lab—IES



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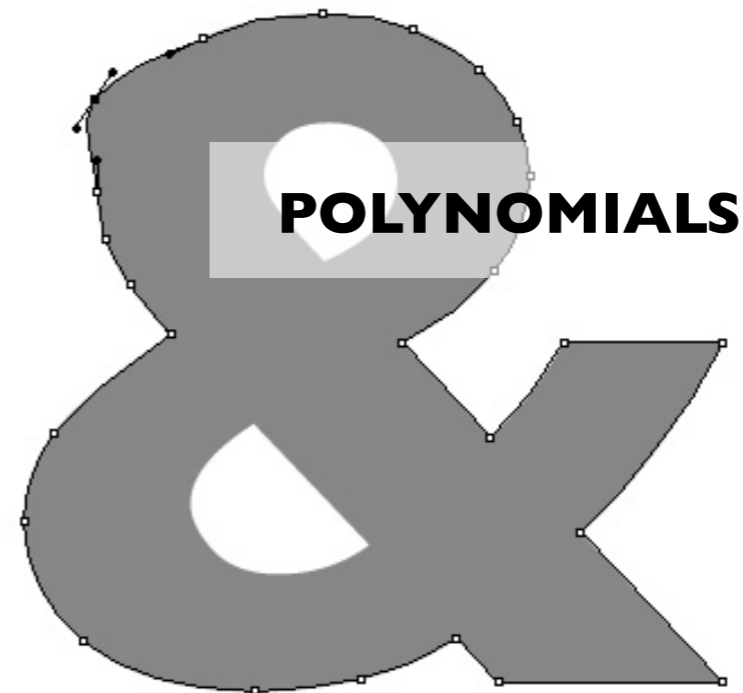
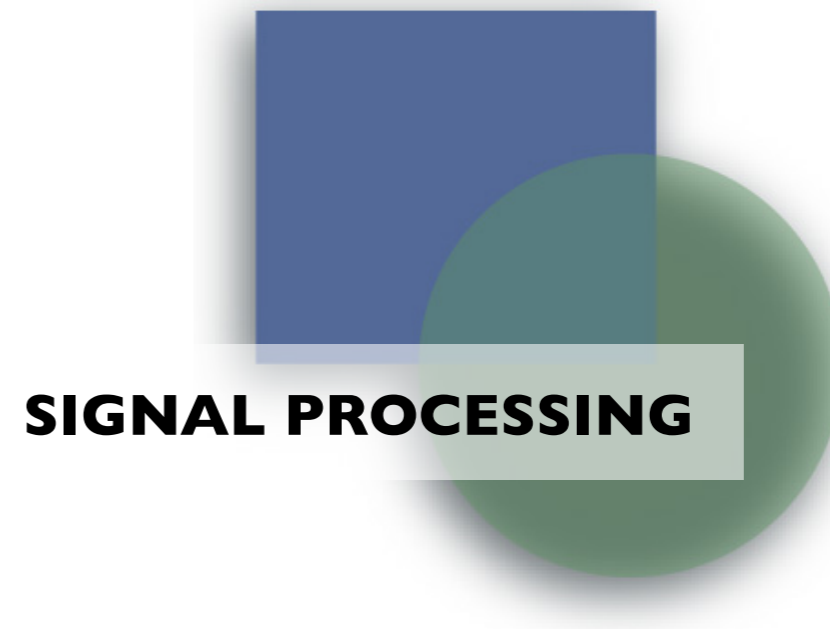
Computer aided sculptures
Ergun Akleman



Problems in graphics

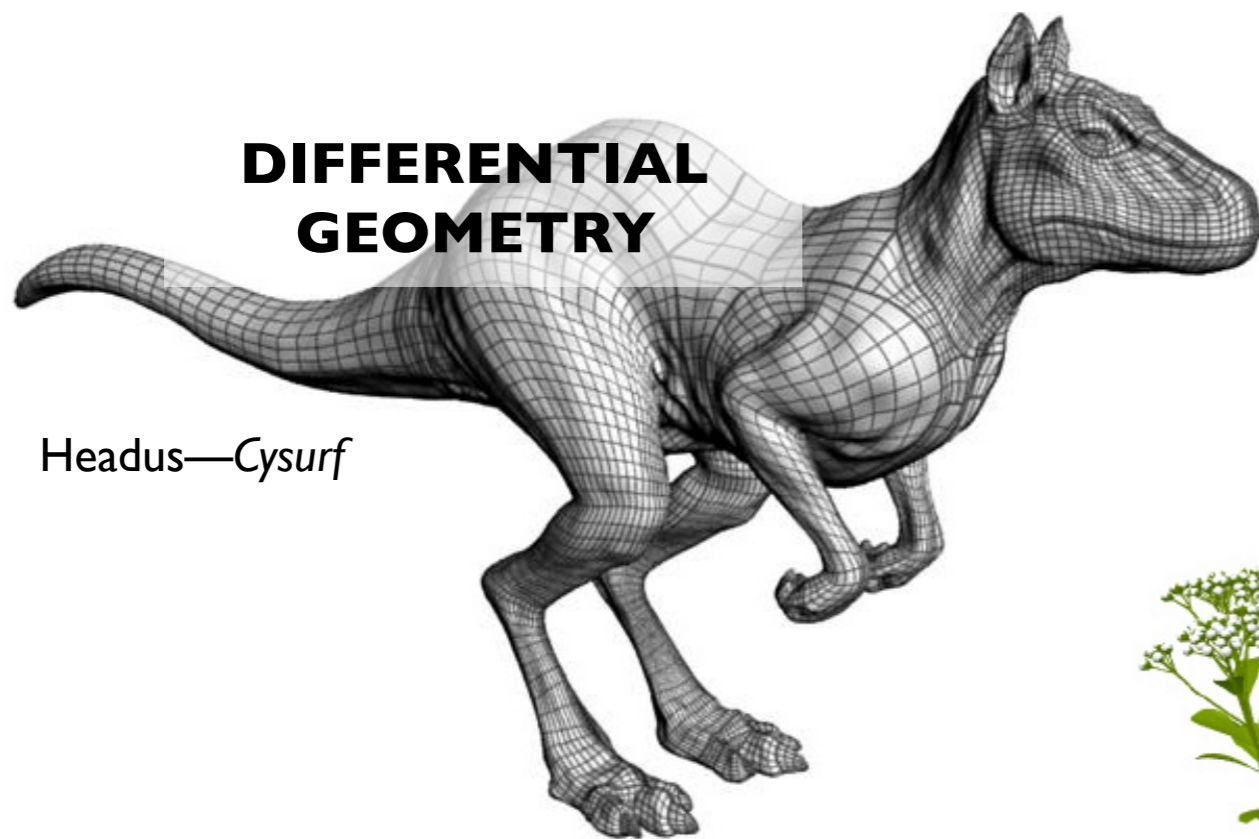
Problems in graphics

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

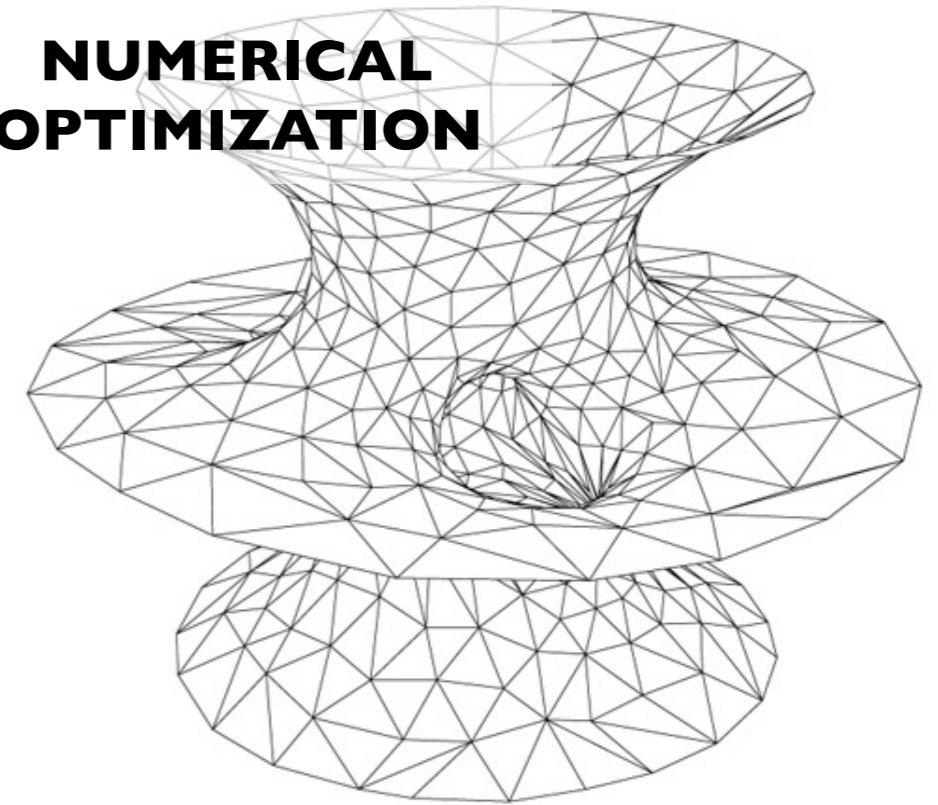


Problems in graphics CONT'D

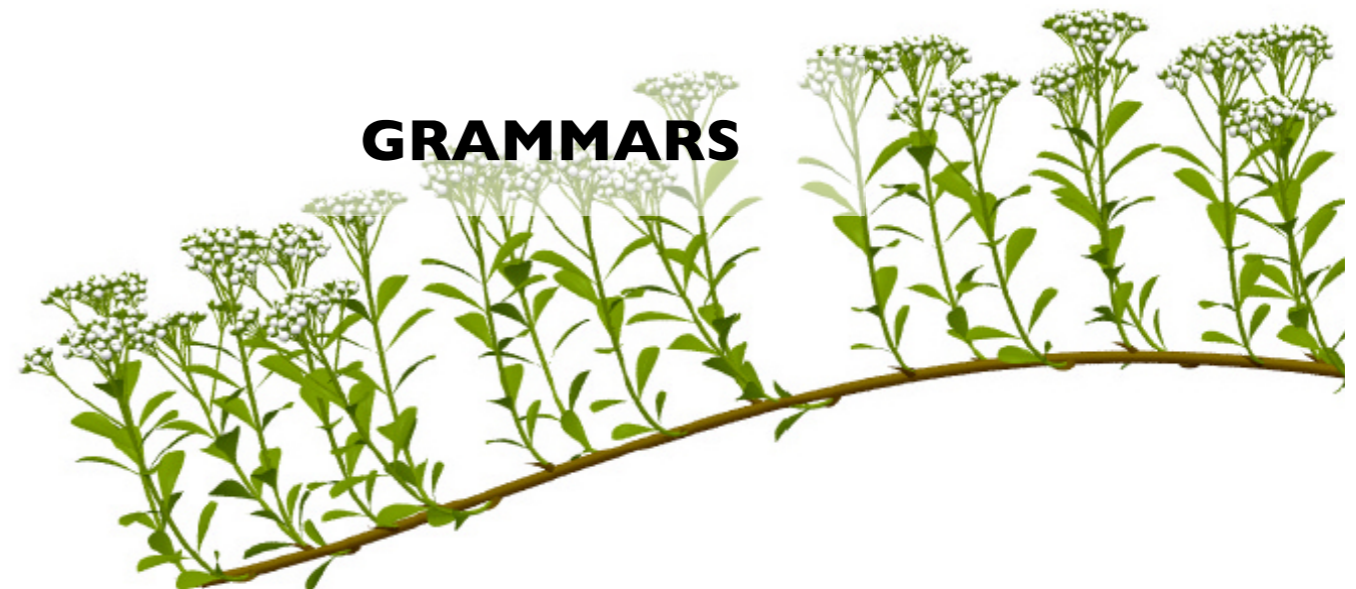
- 3D modeling
 - representing 3D shapes
 - polygons, curved surfaces, ...
 - procedural modeling



NUMERICAL OPTIMIZATION



GRAMMARS

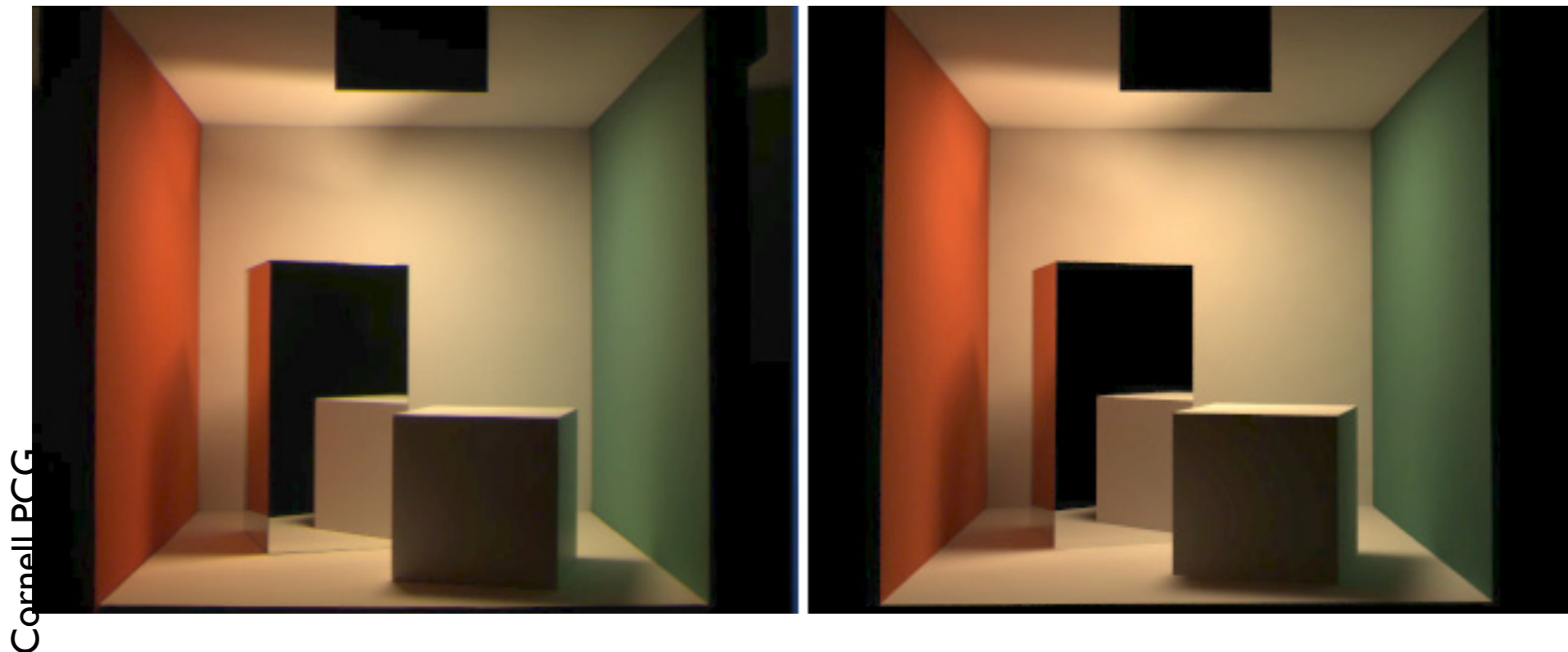
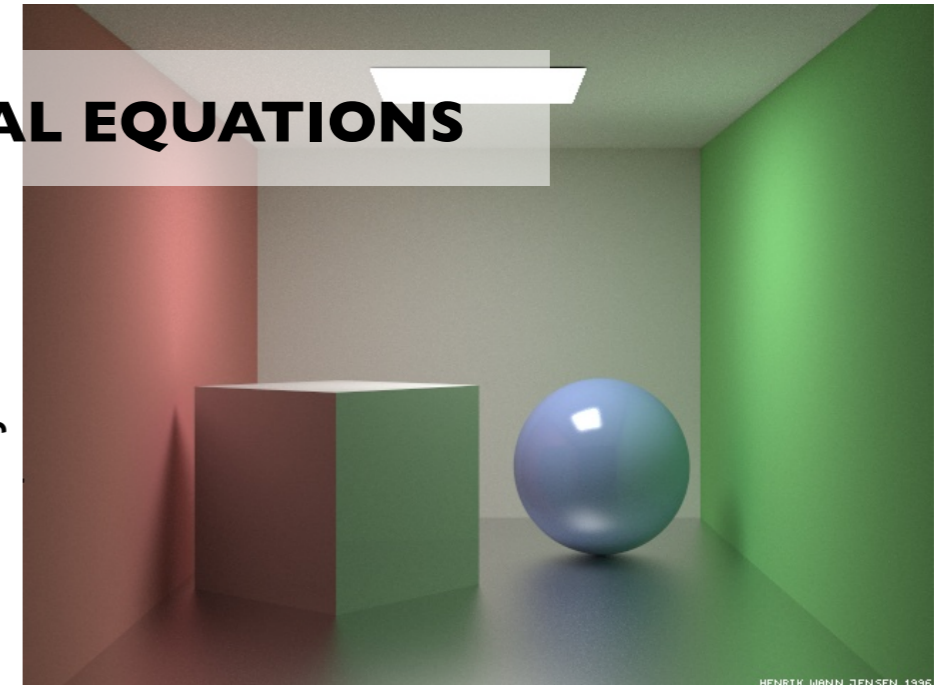


Problems in graphics

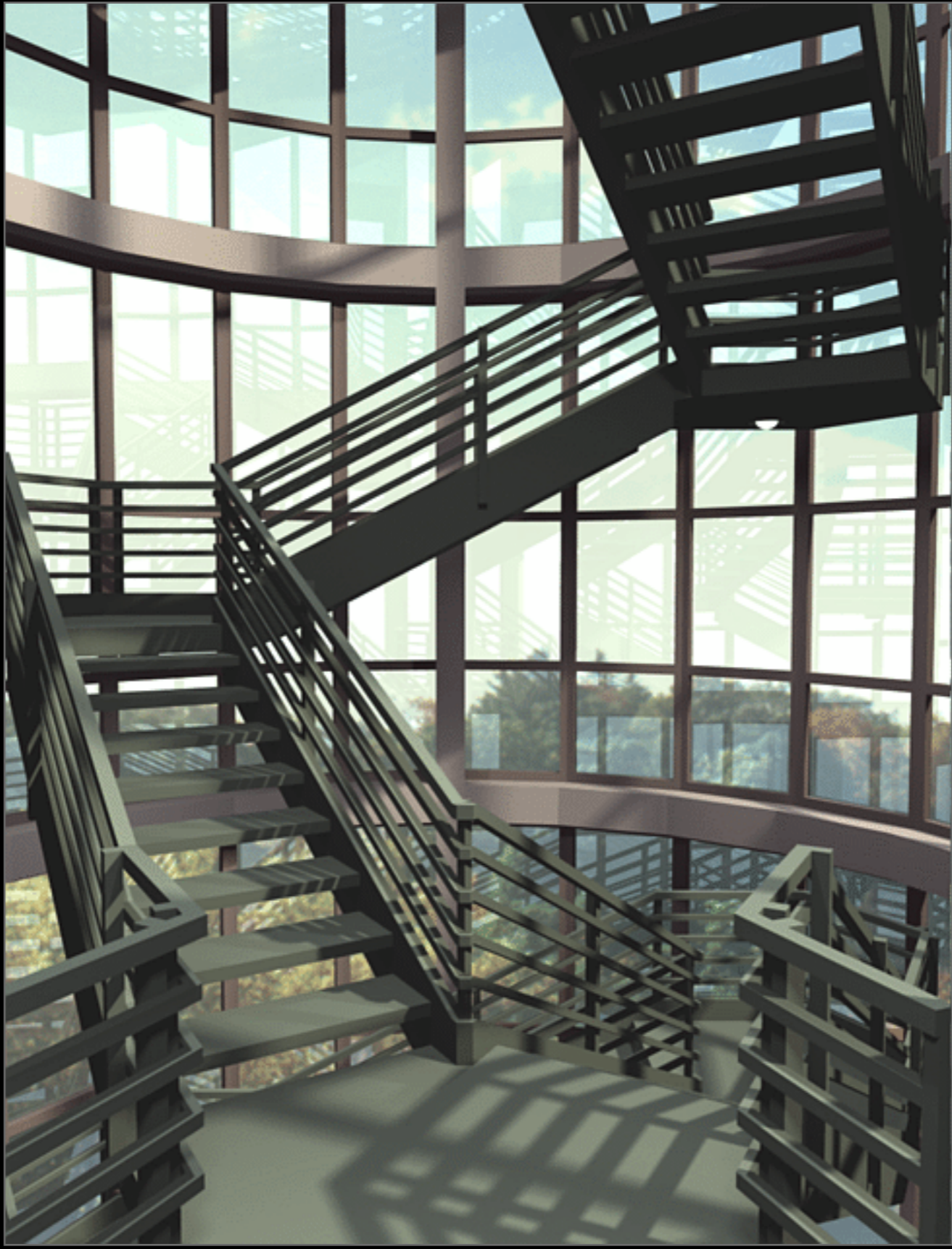
- 3D rendering
 - 2D views of 3D geometry
 - projection and perspective
 - removing hidden surfaces
 - lighting simulation

INTEGRAL EQUATIONS

Henrik Wann Jensen



Cornell PCCG



Henrik Wann Jensen



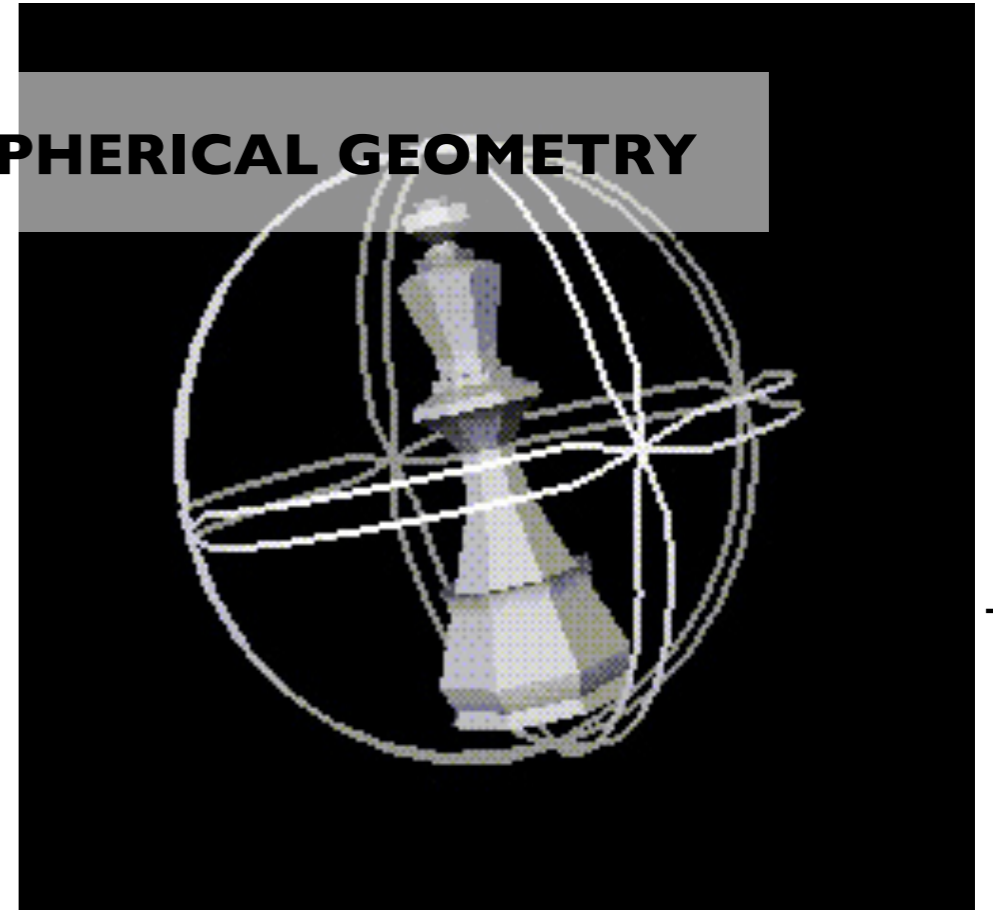
RENDERED USING DALI - HENRIK WANN JENSEN 2000

Problems in graphics



TU Berlin

SPHERICAL GEOMETRY

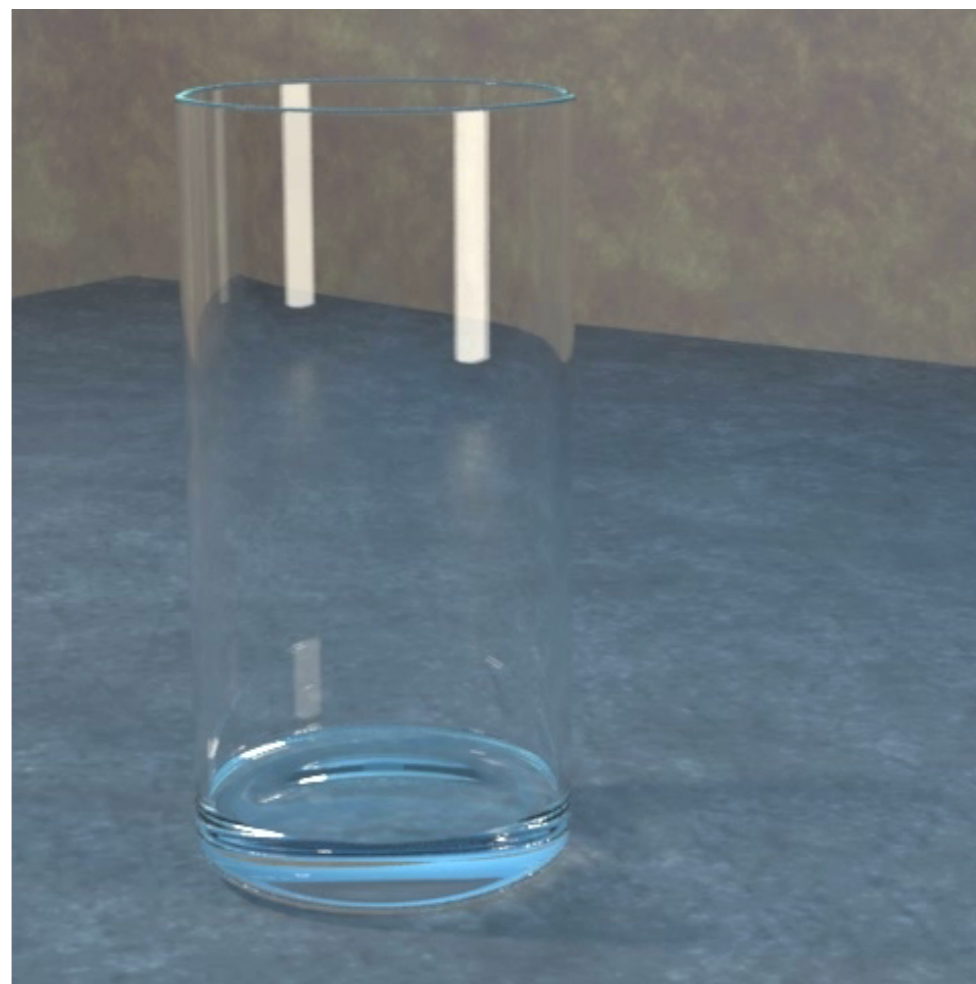


Problems in graphics

- Animation
 - keyframe animation
 - physical simulation



Pixar

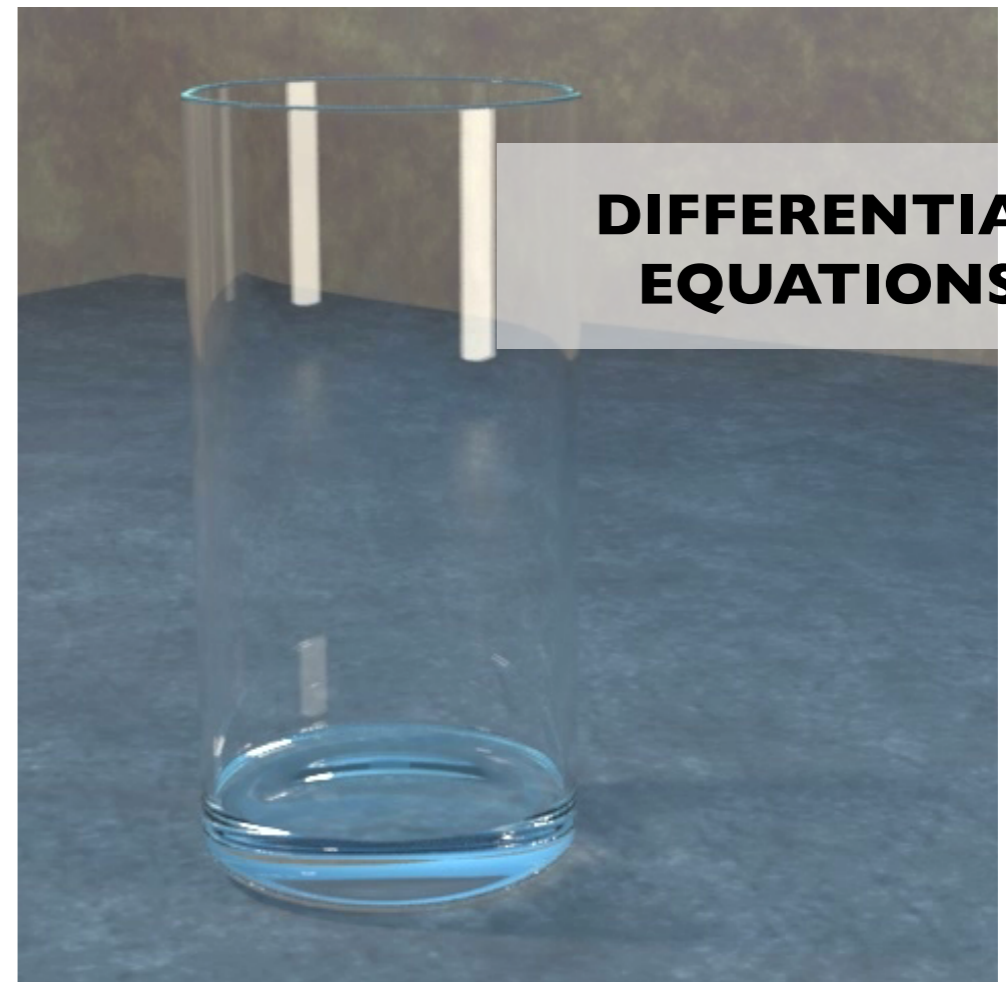


Enright et al. SIGGRAPH 2003

Problems in graphics



Pixar



Enright et al. SIGGRAPH 2003

Graphics hardware is becoming widespread



Desktop and Laptop GPUs

PowerVR GPU

Course Overview

COMP 770

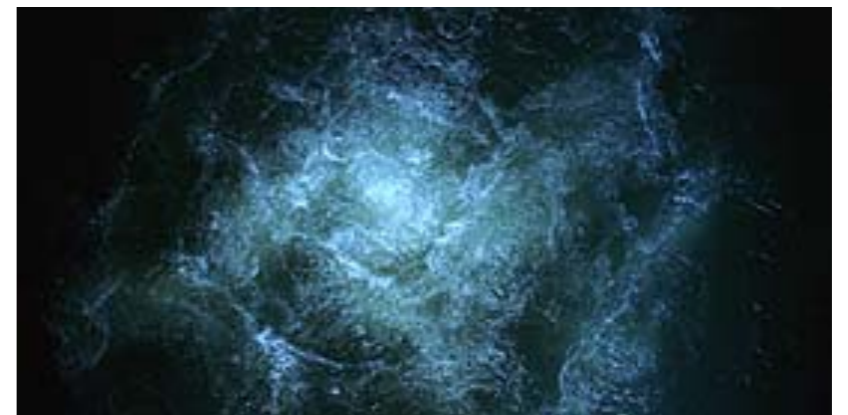
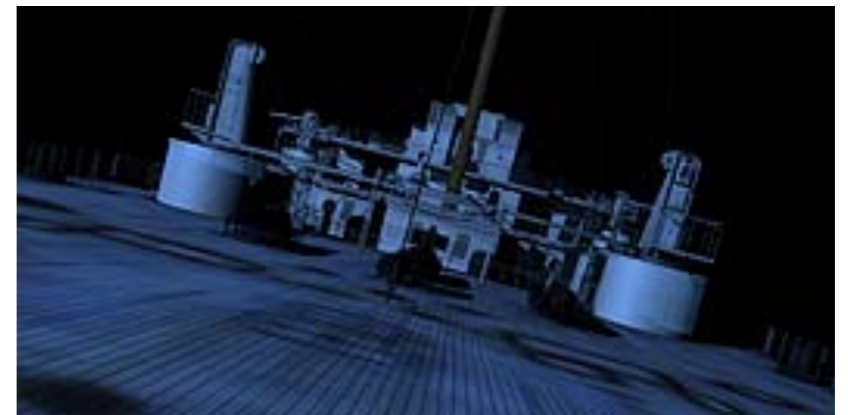
- You will:
 - explore fundamental ideas
 - learn math essential to graphics
 - implement key algorithms
 - write cool programs
- You will not:
 - learn a lot about OpenGL or DirectX
 - (though you will use some OpenGL)
 - write big programs

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

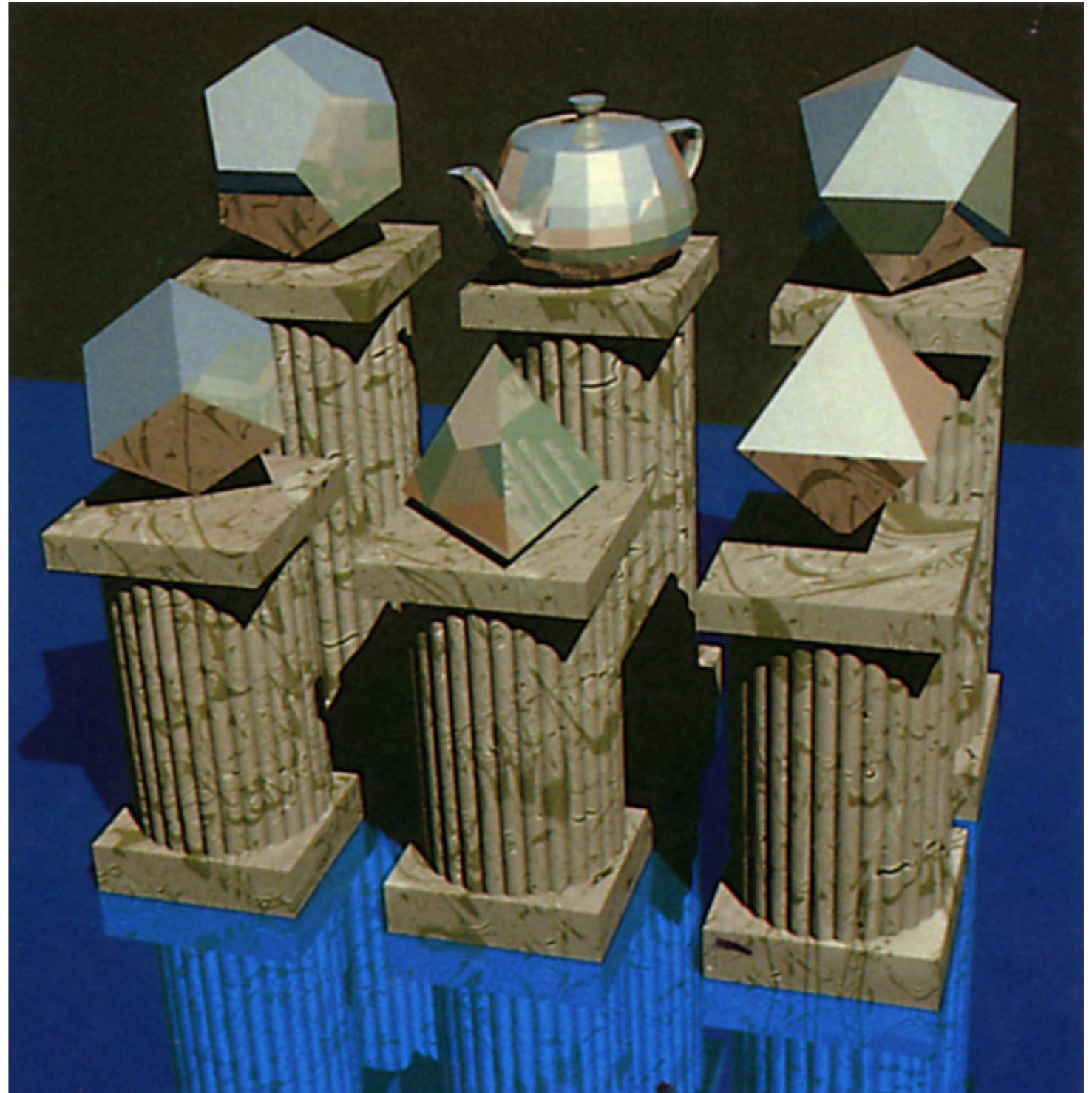
Images

- What is an image?
- Compositing
- Resampling



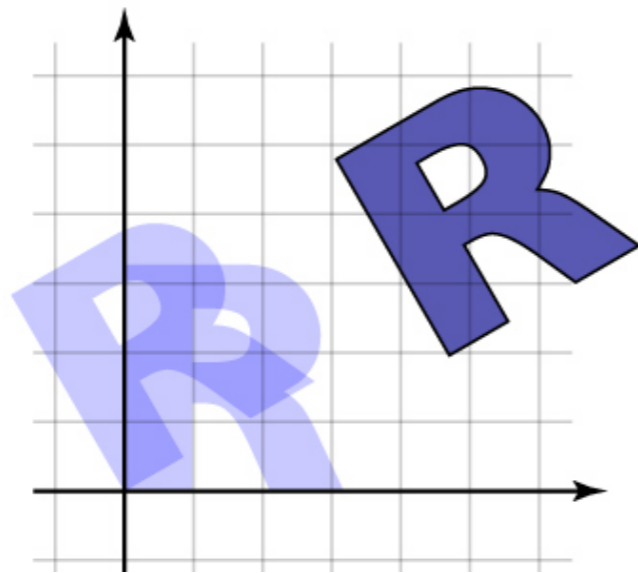
Rendering

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

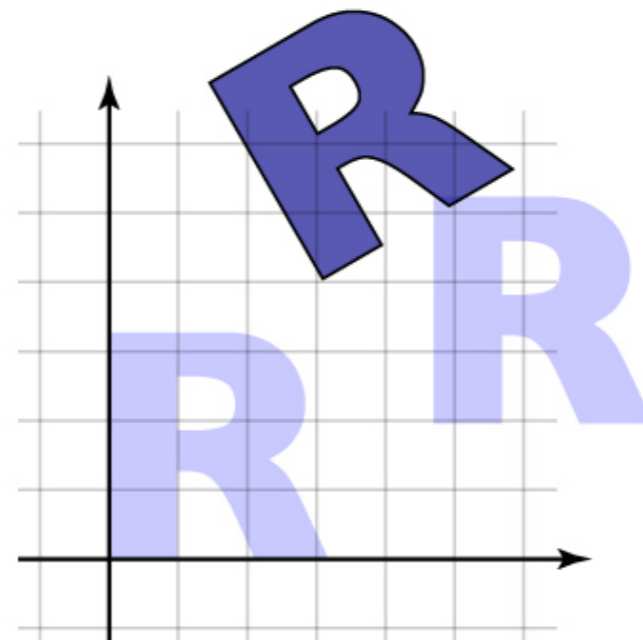


Geometric transformations

- affine transforms
- perspective transforms
- viewing



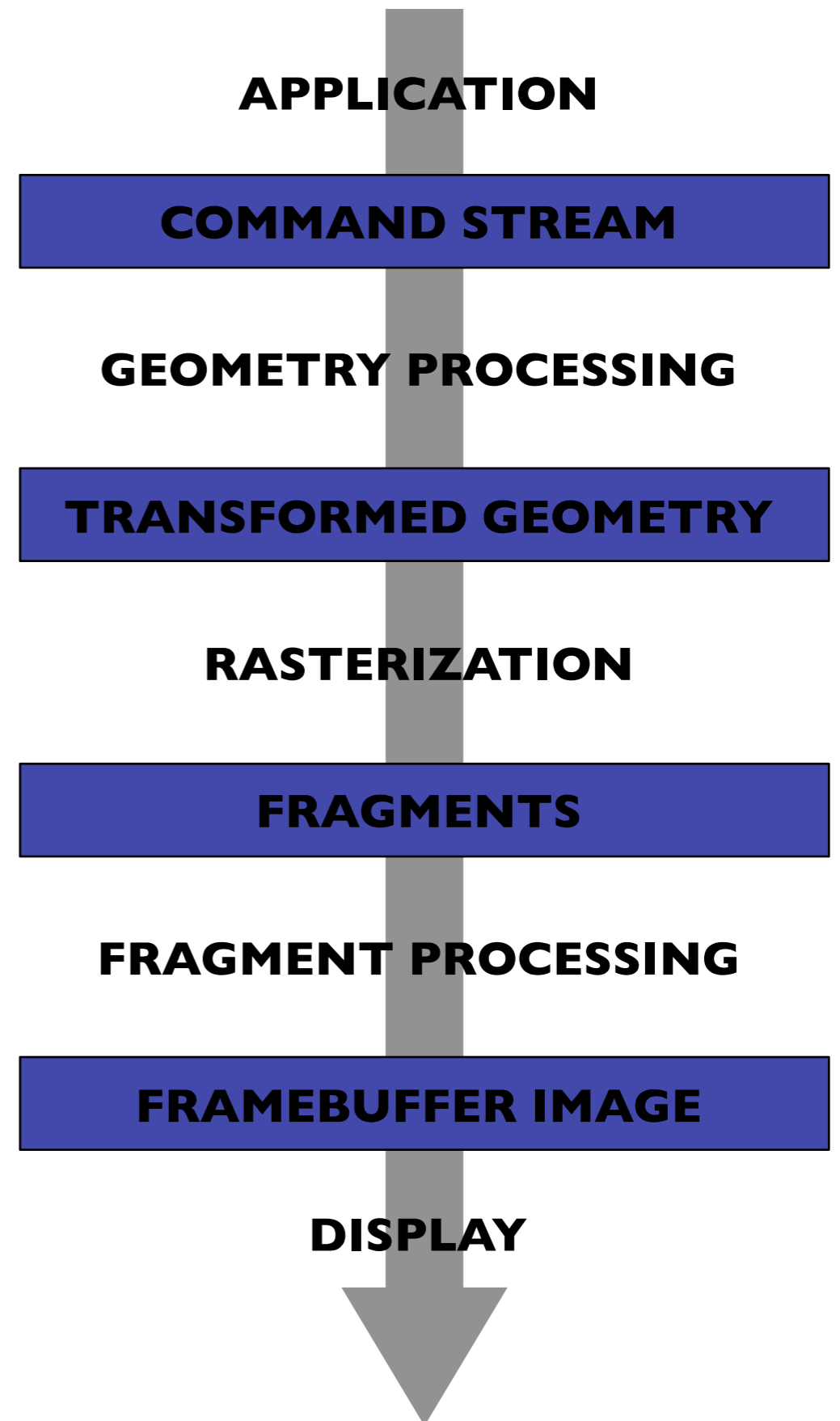
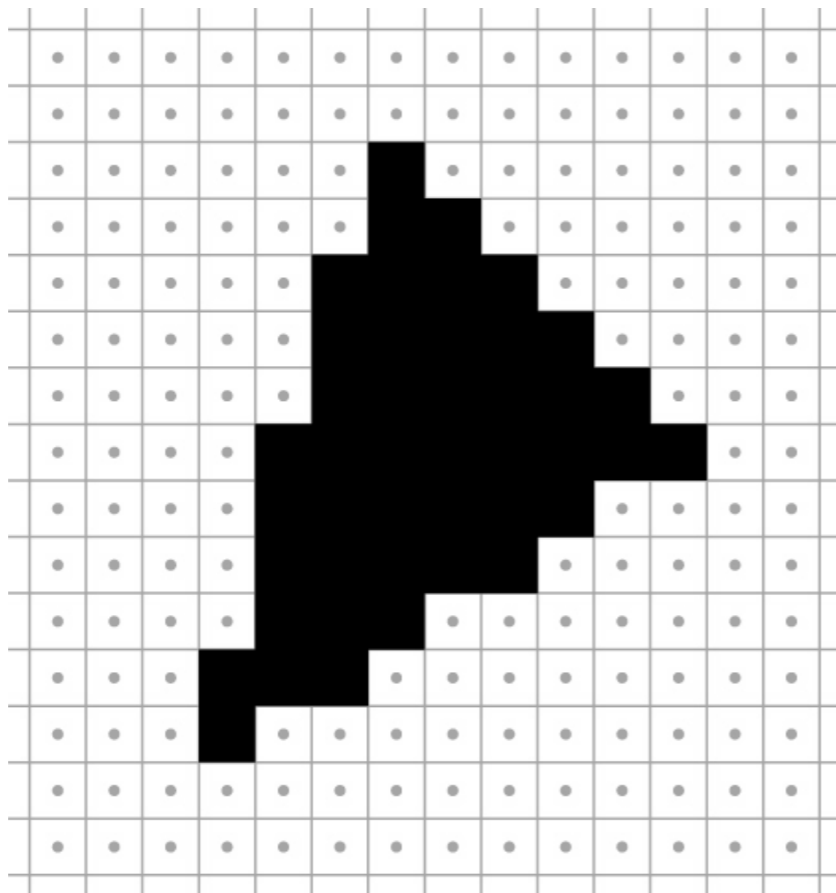
rotate, then translate



translate, then rotate

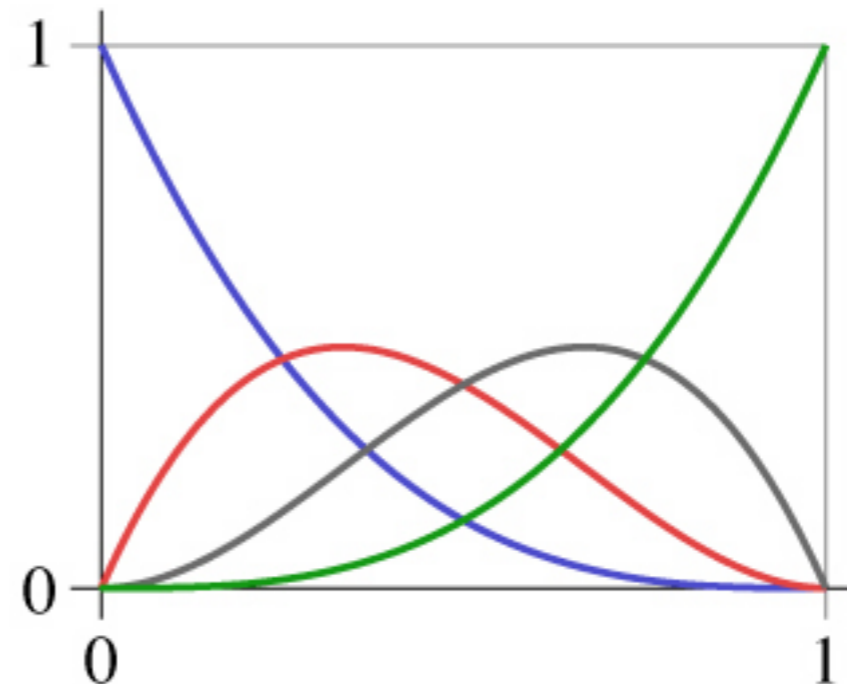
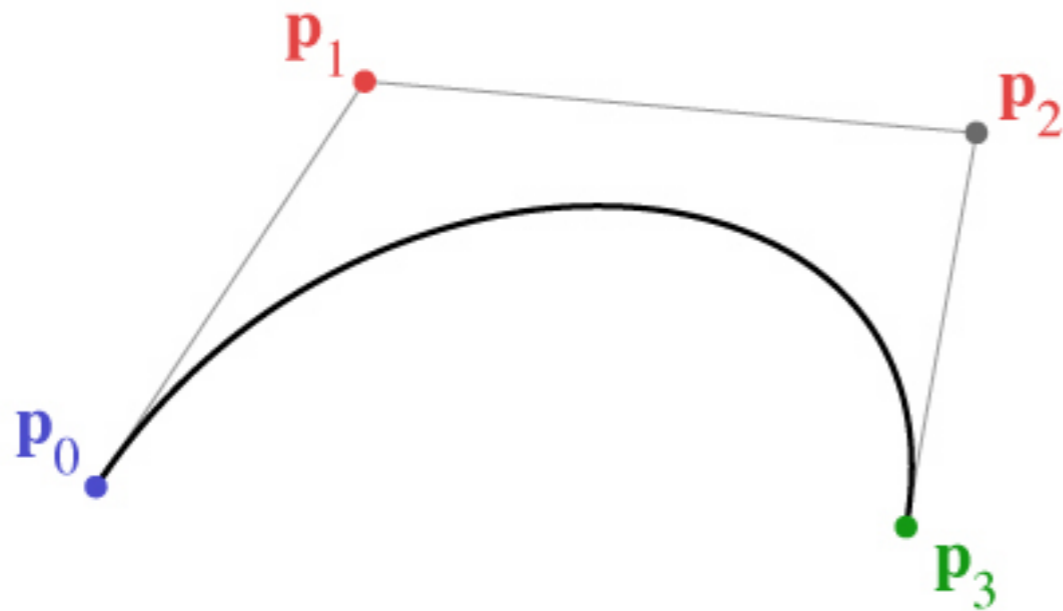
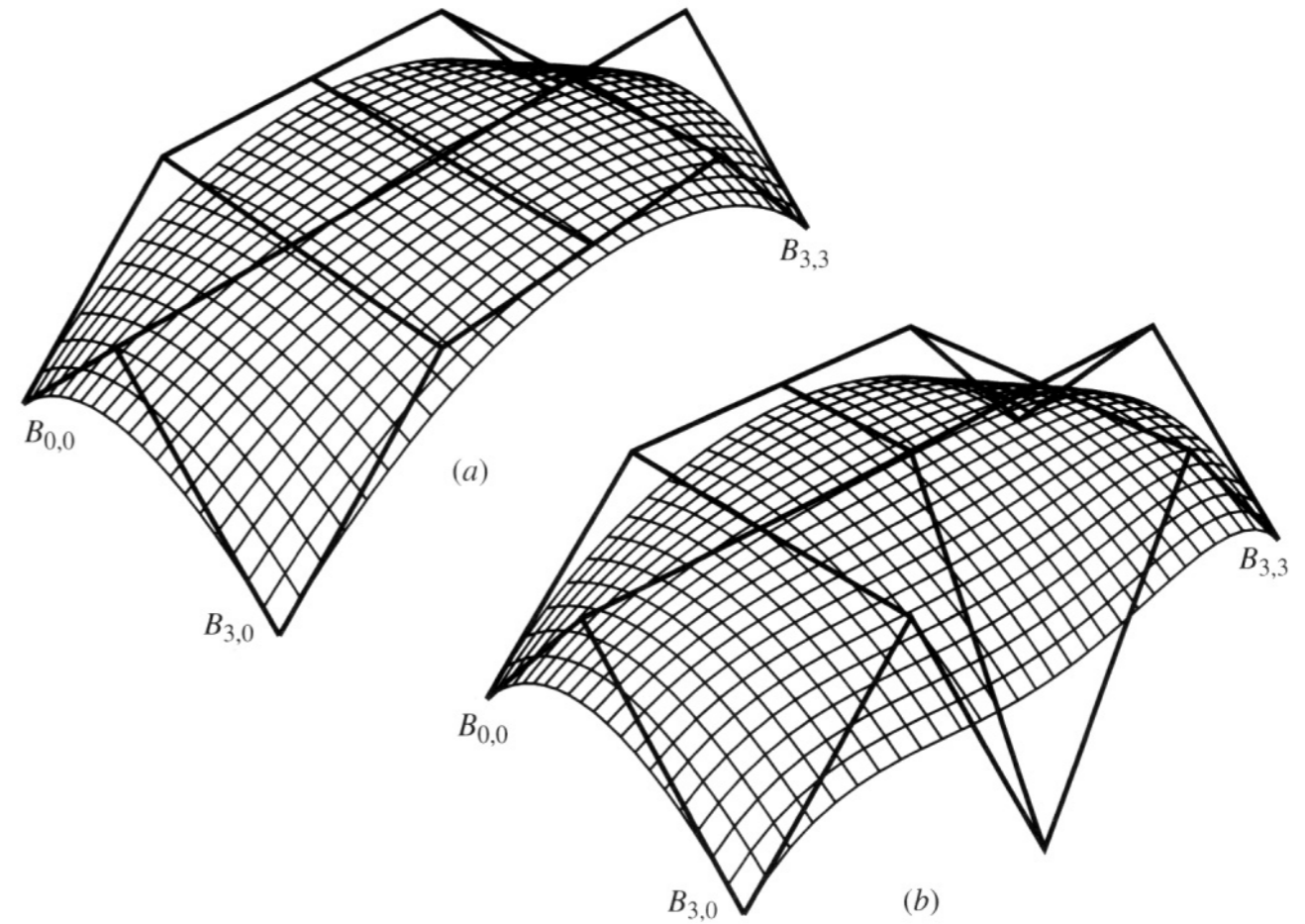
Graphics pipeline

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



Modeling

- splines
- parametric surfaces
- triangle meshes



[Rogers]

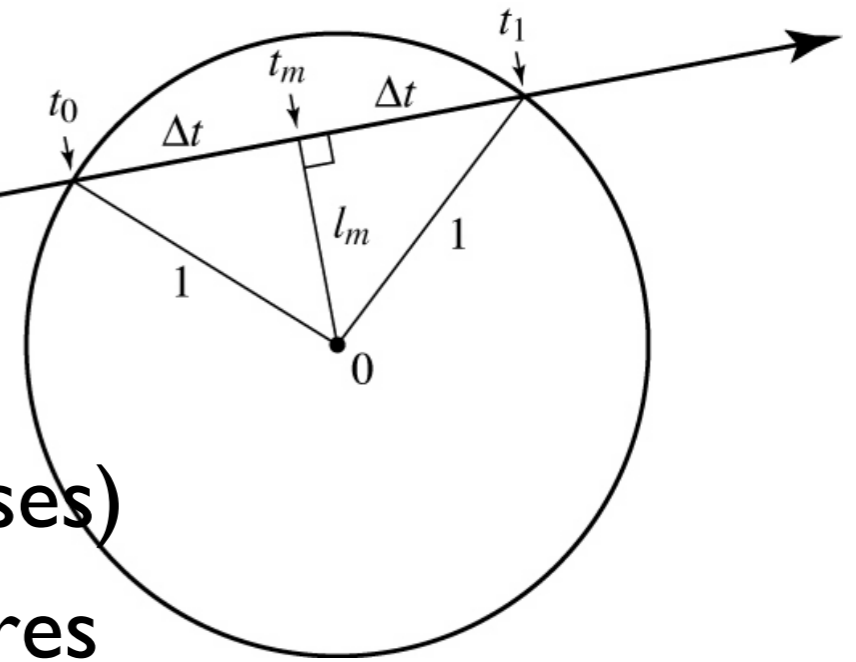
COMP 770 Prerequisites

- Programming & Data Structures

- ability to read, write, and debug small Java or C++ 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 this course

- You will also:
 - Work on 3-4 major programming assignments
 - Work on 3-4 problem sets
 - learn a lot about
 - surfaces
 - mesh data structures
 - scene data structures
 - architecting good-sized interactive programs
 - using OpenGL

Course Project

- Required for COMP770 (20% of your grade)
 - Work on any topic related to computer graphics
 - Can combine with your research
 - Can work in teams of 2-3 students
 - Talk to the instructor about the specific project topic

Other Details

- Office Hours:
 - M : 2:00 – 3:00pm (FB250)
 - Or send me an email at: dm@cs.unc.edu

Grading Policies

- **Grading Breakdown (770):** HW & Prog. Assignments 50%, Midterm 20%, Project 20%, Class Attendance & Participation 10%

More details at:

<http://gamma.cs.unc.edu/COMP770>

Course mechanics

see web site:

<http://gamma.cs.unc.edu/COMP770>