COMP575/COMP770: Computer Graphics

Professor: Dinesh Manocha

http://gamma.cs.unc.edu/graphicscourse/

Teaching Team

- Instructor
  - Dinesh Manocha: dm@cs.unc.edu

- Teaching Assistant
  - Tanmay Randhavane: tanmay@cs.unc.edu

Introduction

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

Why should I learn computer graphics?

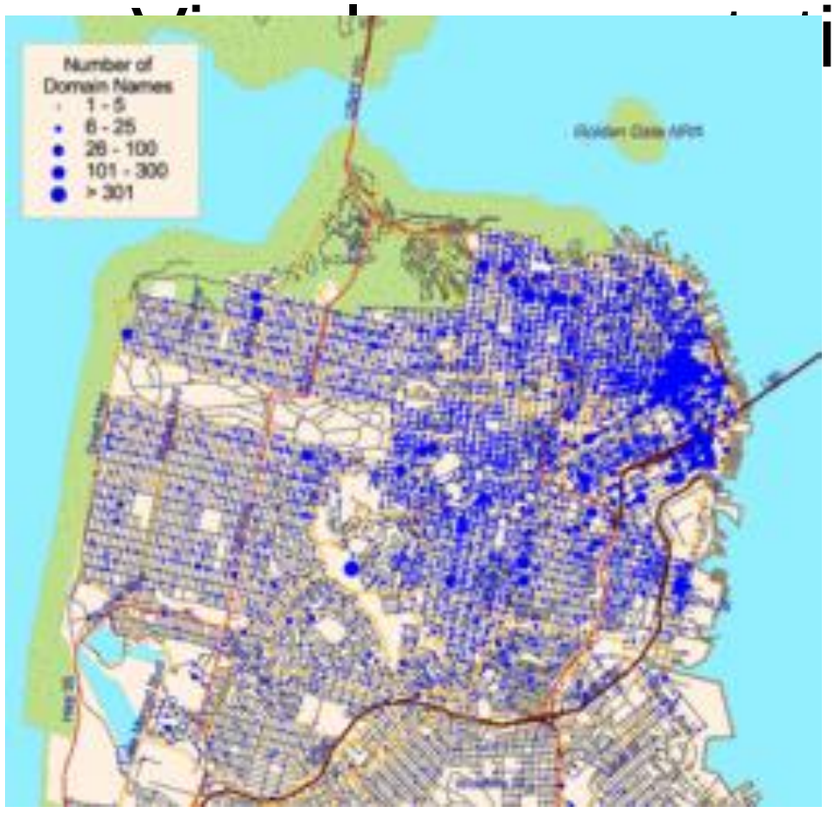
- Interested in games, movies, scientific applications, computer-aided, etc.
  - Can get me a nice paying job.
- Am interested in winning a (technical) Oscar

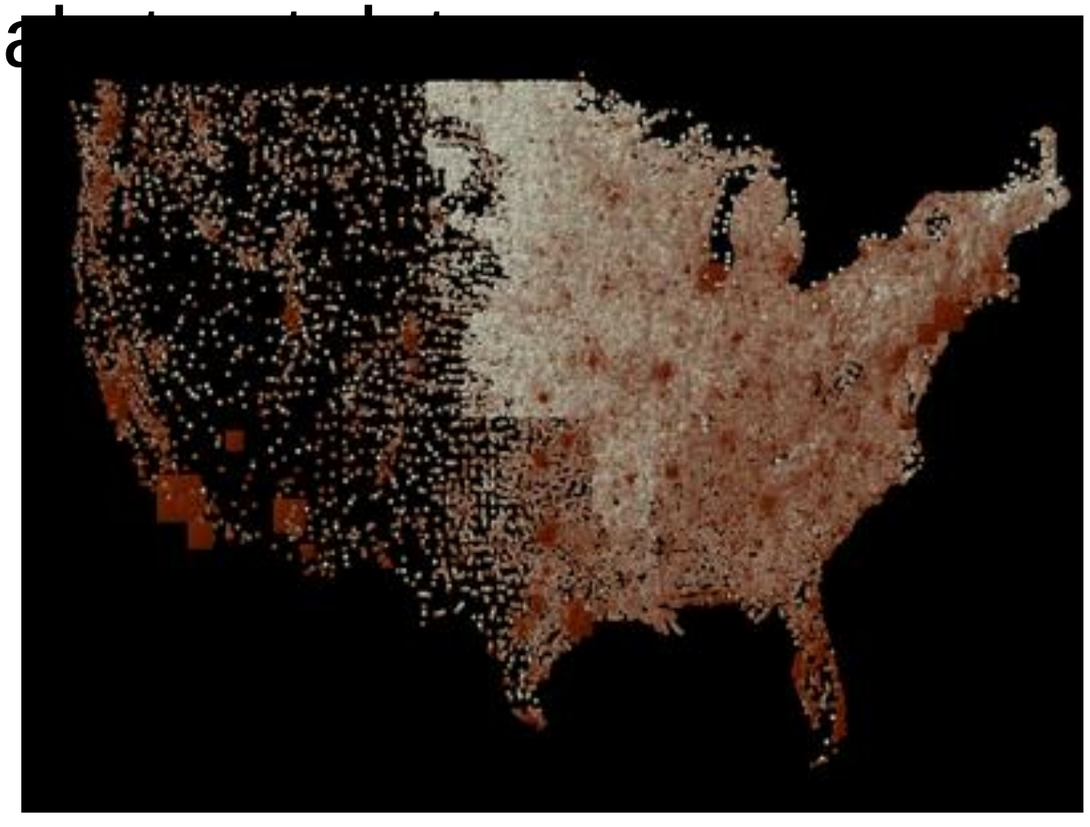
“Technical Achievement Award from The Academy of Motion Picture Arts & Science”

http://www.oscars.org/press/pressreleases/2013/20130103.html

Why should I learn computer graphics?

- We are living in a visual era
  - Displays of computers, cell phones and mobile devices
  - Computing interfaces are becoming more visual (iOS, Windows 8)
  - More information is communicated visually
    - A picture is worth a thousand words: images, videos…
    - Visual representations of abstract data





Graphics Applications

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

Special Effects in Movies

- History

http://www.cinemablend.com/new/How-Avatar-Happened-Lightcycles-And-Giant-Lizards-On-The-Path-To-Innovation-16162.html

Pixar—*Toy Story*

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

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

http://www.youtube.com/watch?v=5HghLB7Gcqc

Visual Effects in Avatar

http://cginstructorslab.blogspot.com/2012/11/life-of-pi-exclusive-interview-with.html

Visual Effects in “Life of Pi”

id Software—*Quake 4* (screenshot: Planet Quake)

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

Crytek GmBH—*advertisement for CryEngine 2 game engine*

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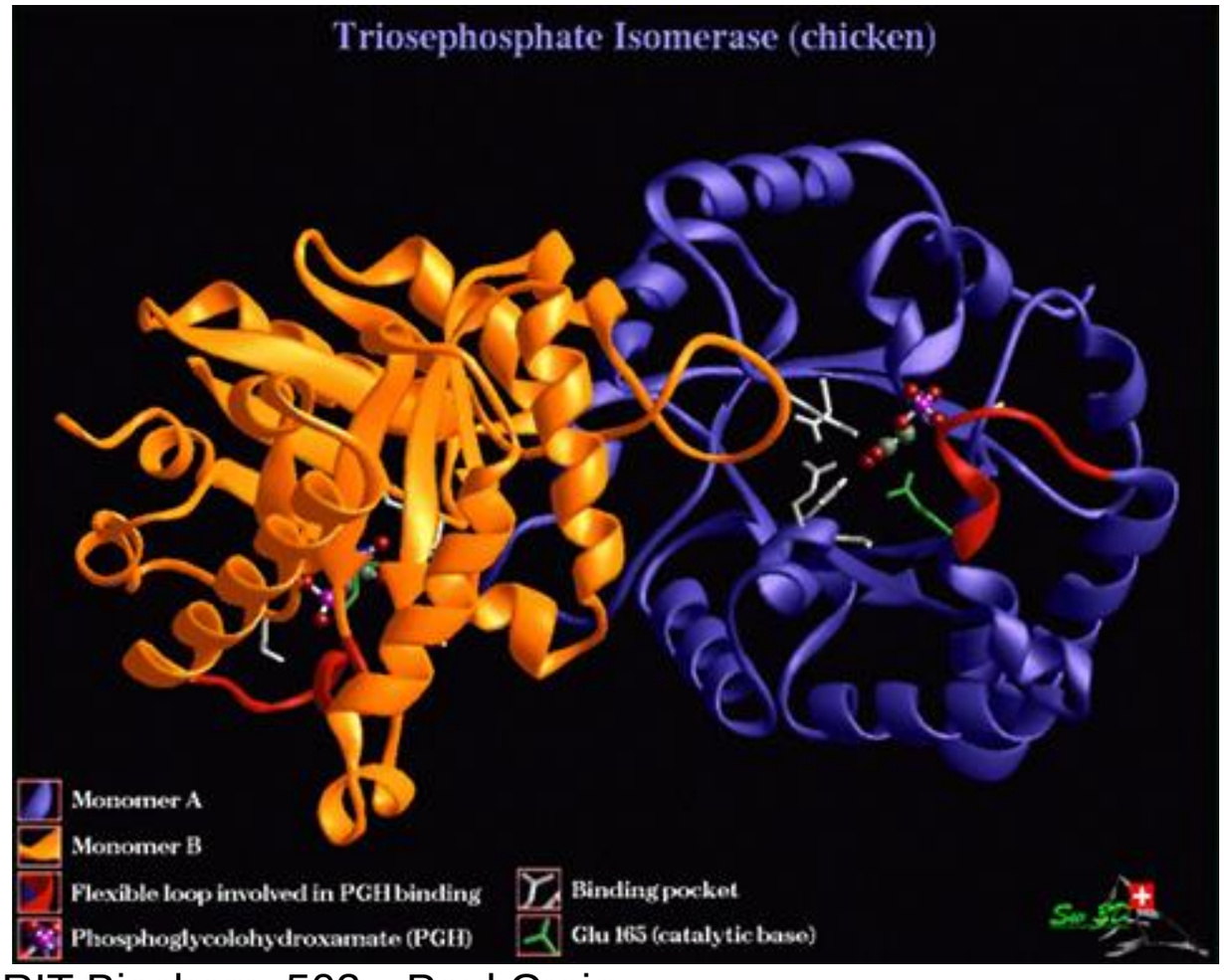
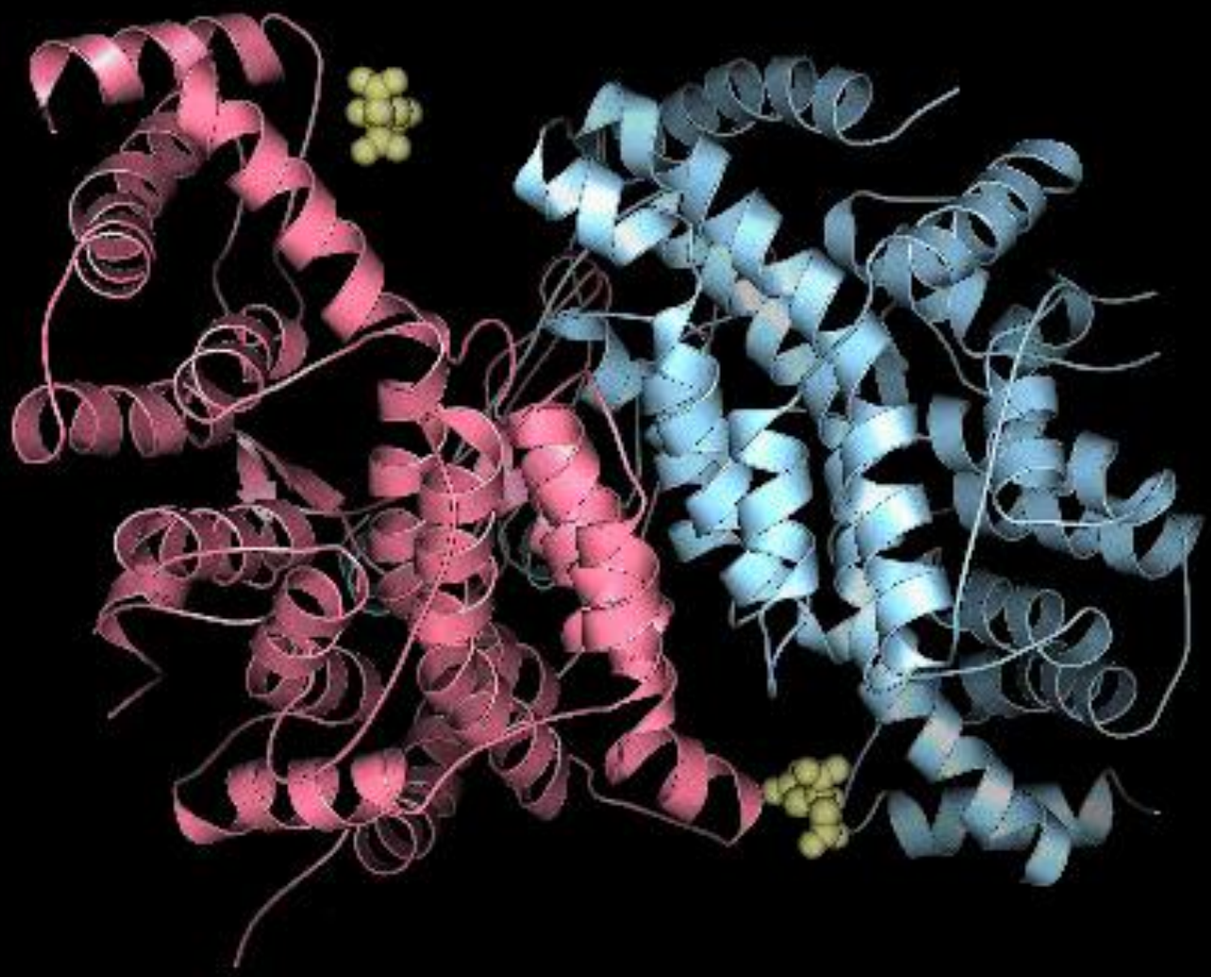
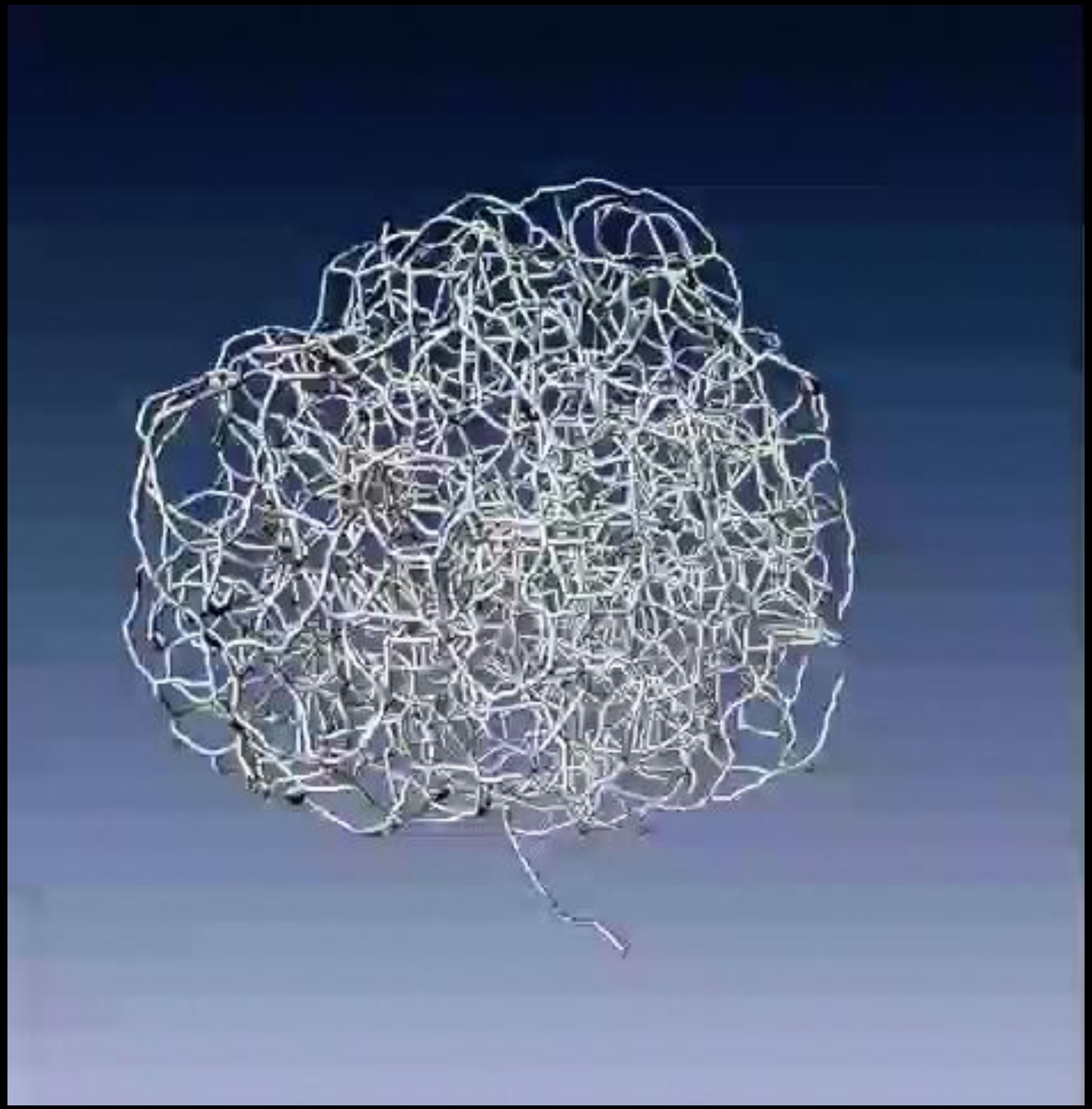


RIT Biochem. 502—Paul Craig



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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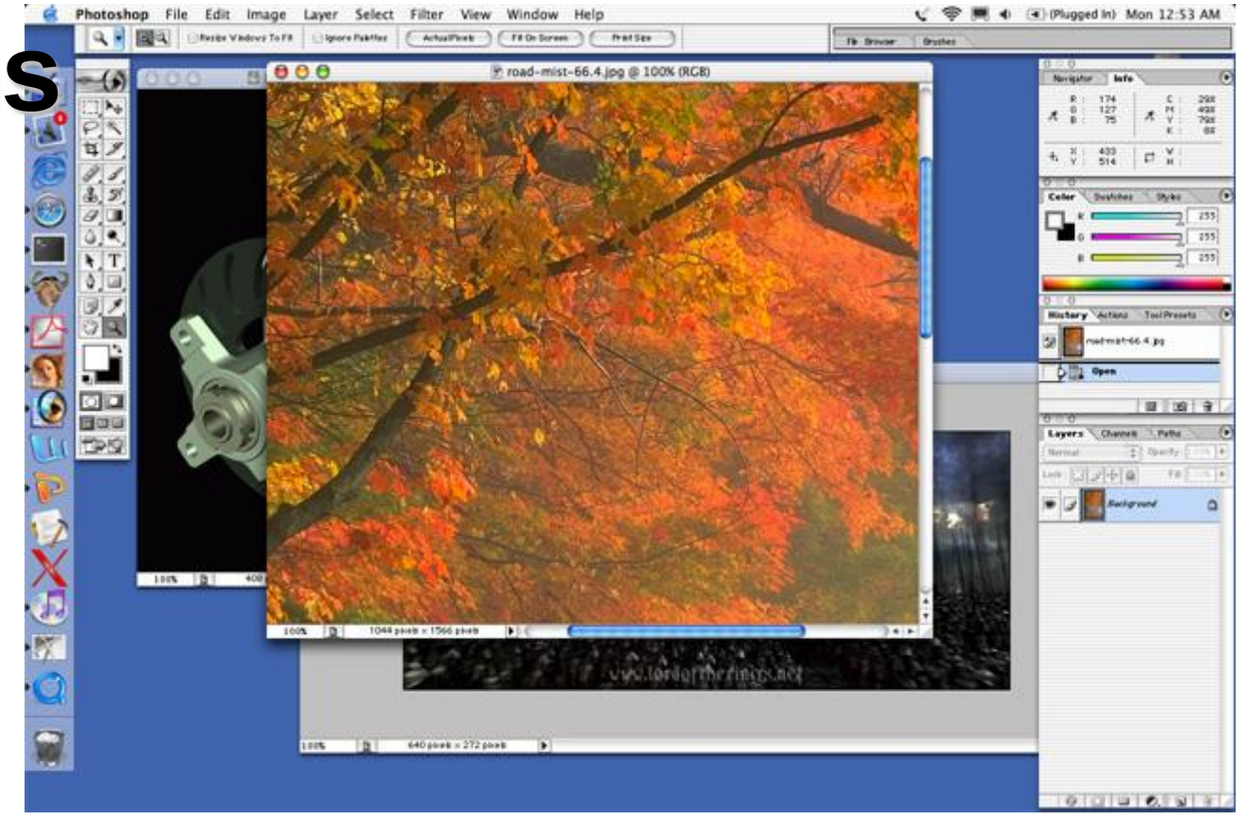
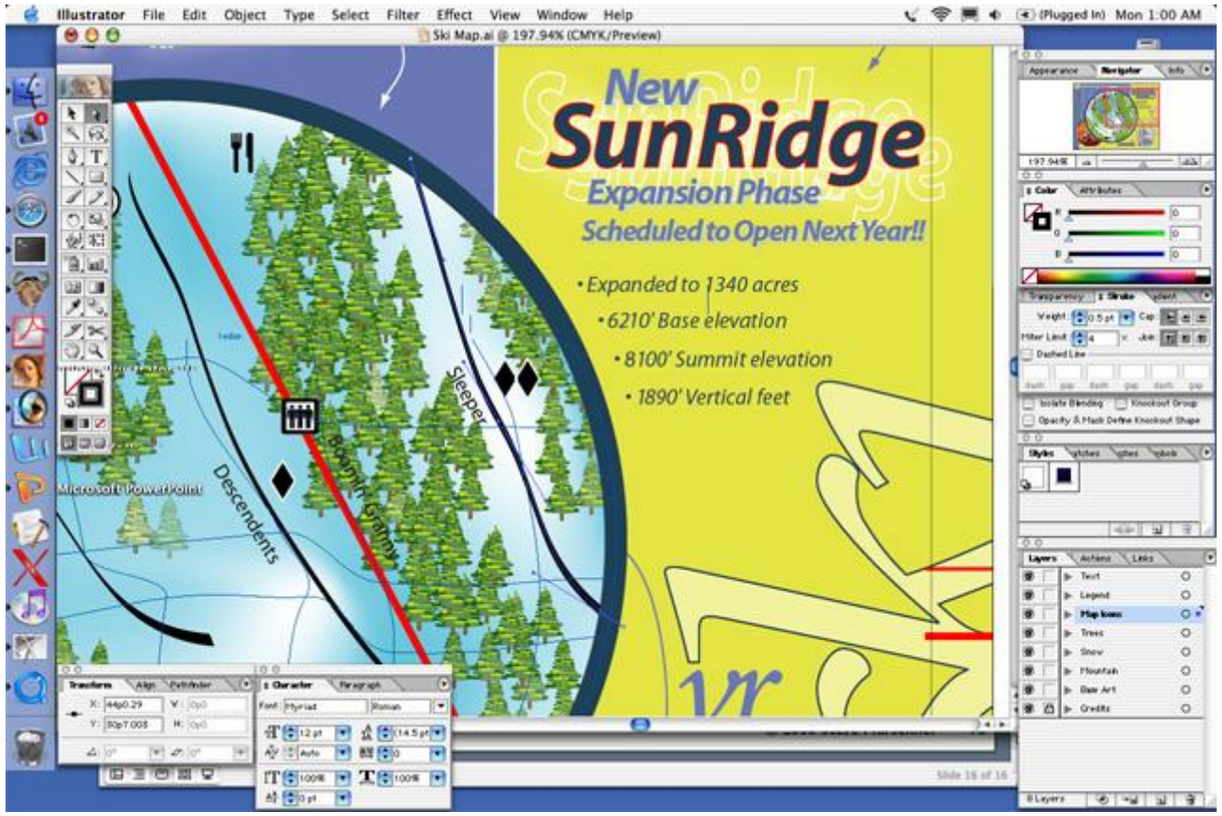


Adobe Photoshop [Photo: P. Greenspun]



Adobe Illustrator

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NASA/Ames—ACFS

Army Research Lab—IES

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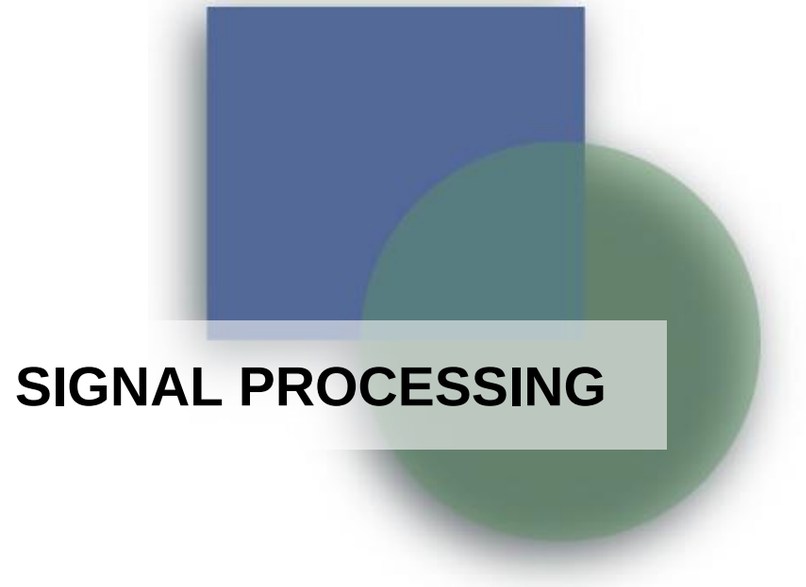
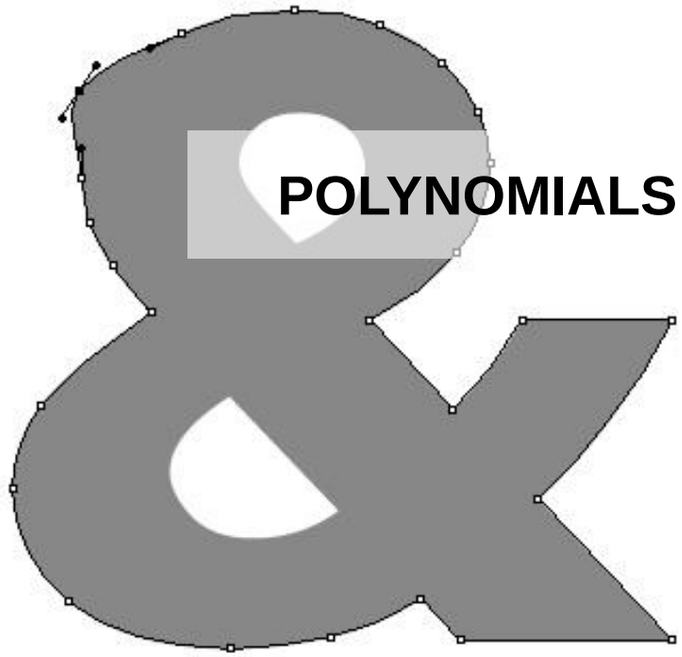
Computer aided sculptures
Ergun Akleman

Problems in graphics

Problems in graphics

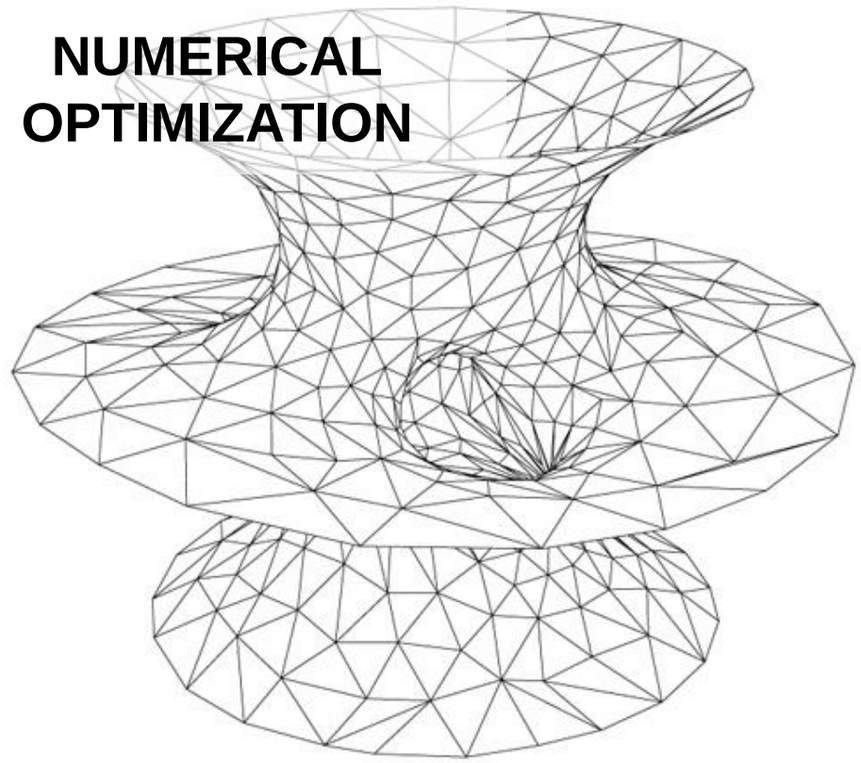
- 2D imaging
  - compositing and layering
  - digital filtering
  - color transformations
- 2D drawing
  - illustration, drafting
  - text, GUIs



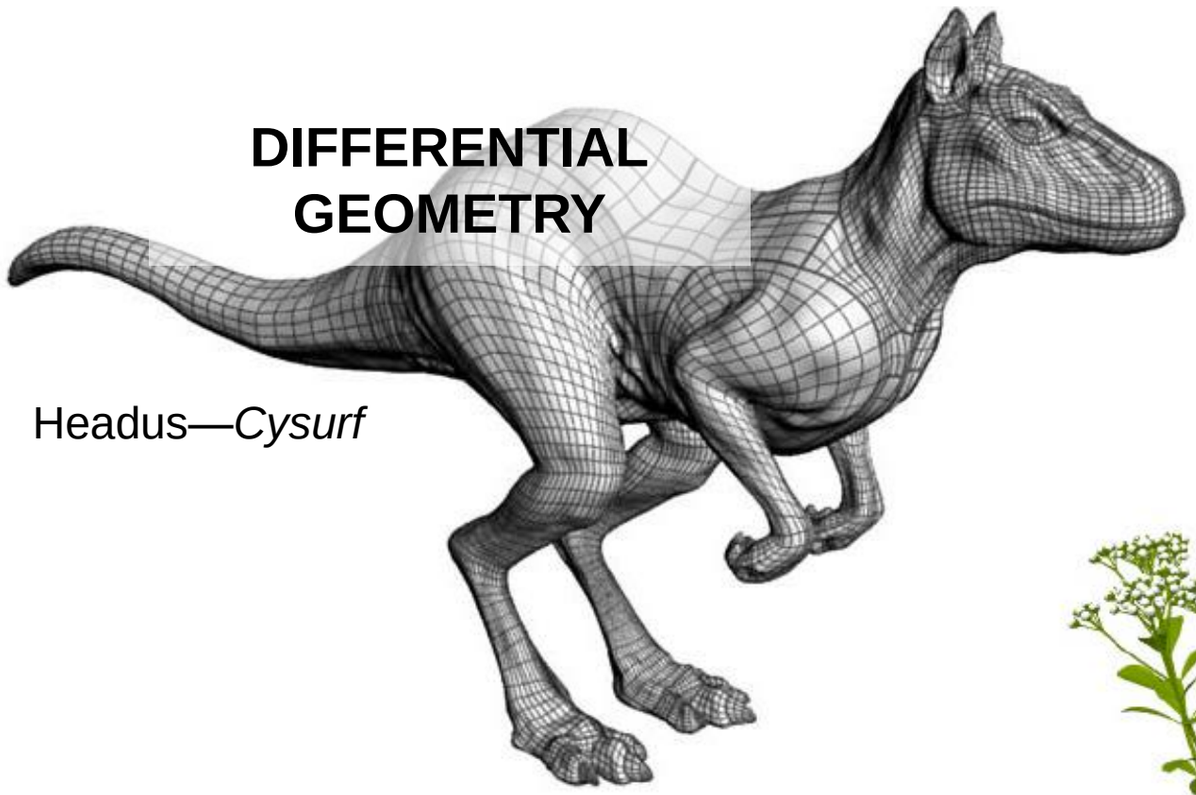


Problems in graphics CONT'D

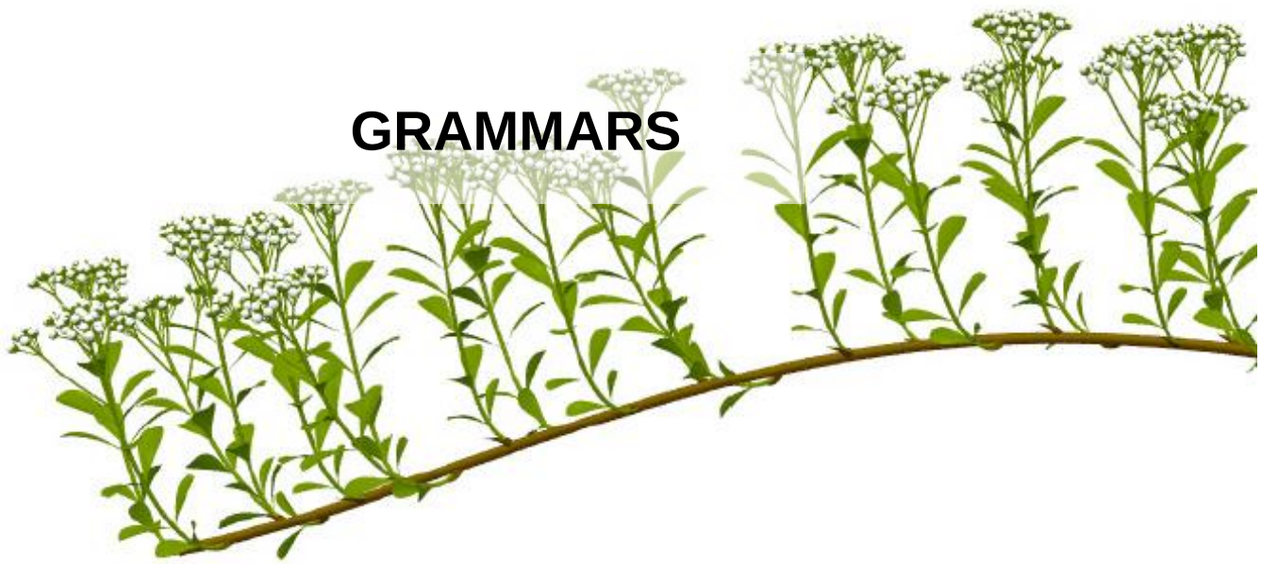
- 3D modeling
  - representing 3D shapes
  - polygons, curved surfaces, …
  - procedural modeling



[Hoppe et al. 1993]



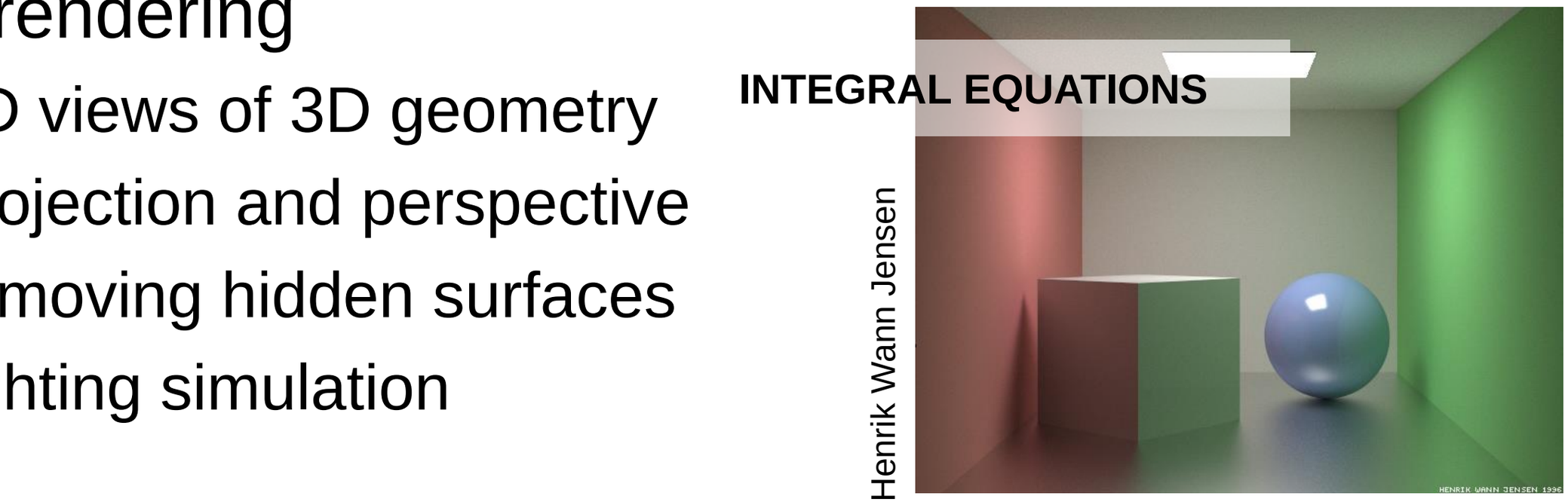
Headus—*Cysurf*



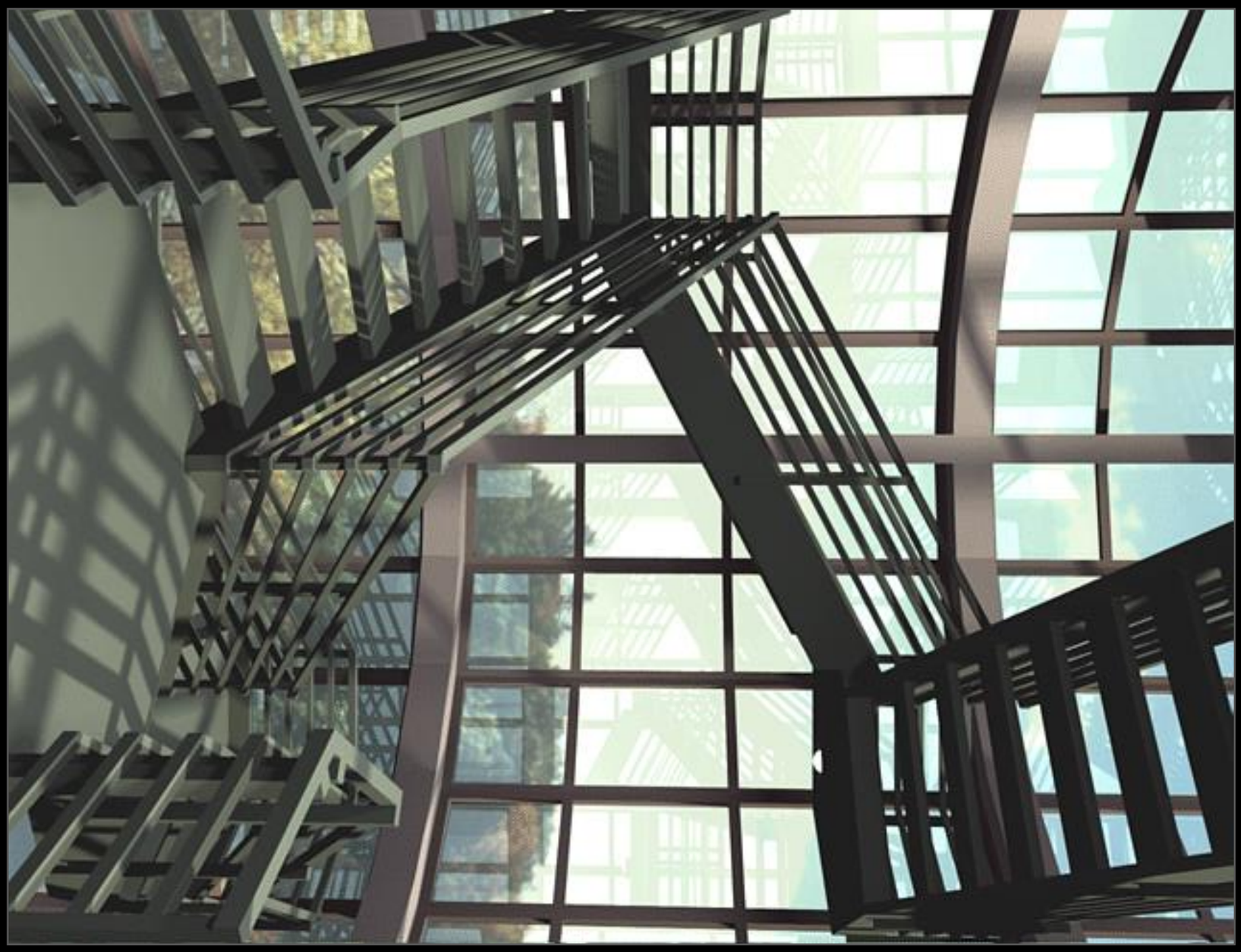
[Prusinkeiwicz et al. 2001]

Problems in graphics

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

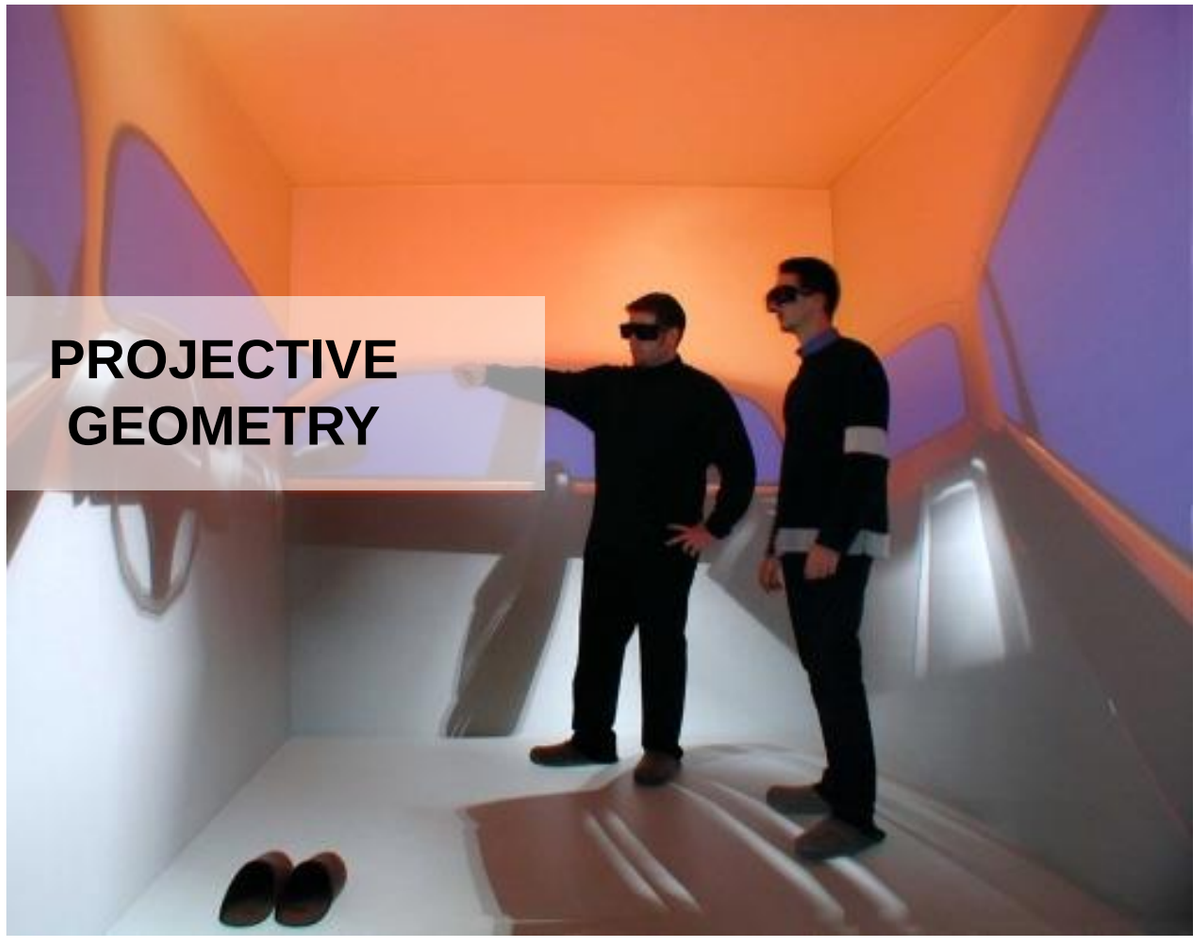


Cornell PCG

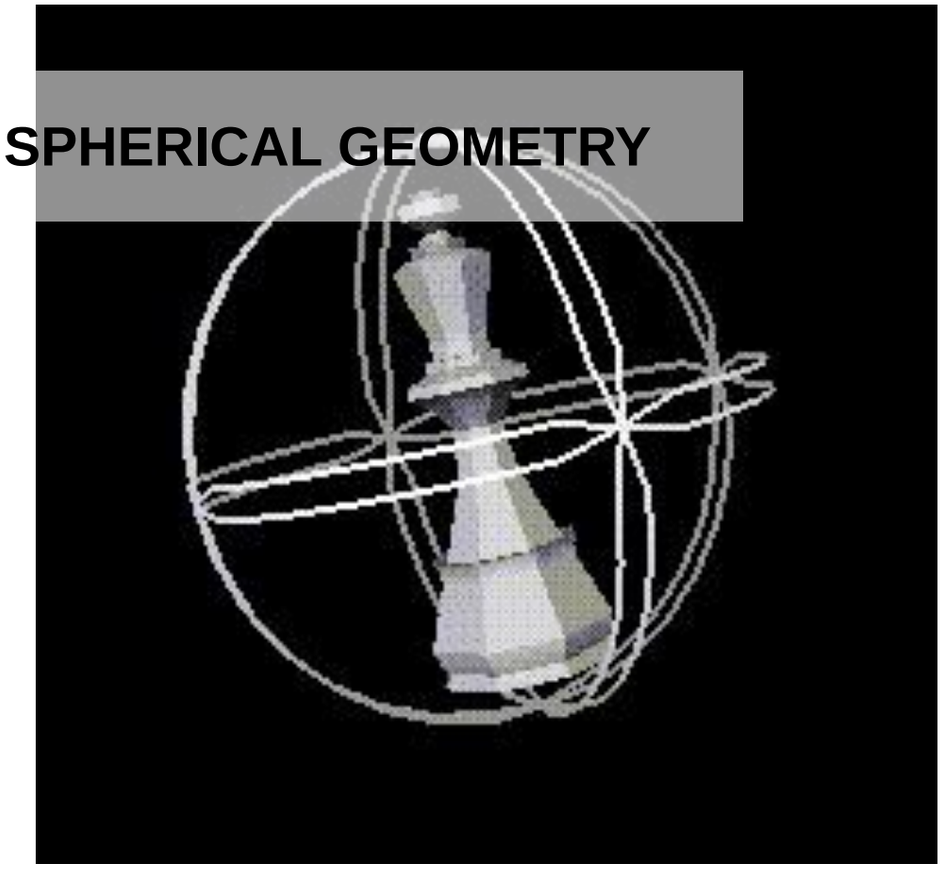


Henrik Wann Jensen

Problems in graphics



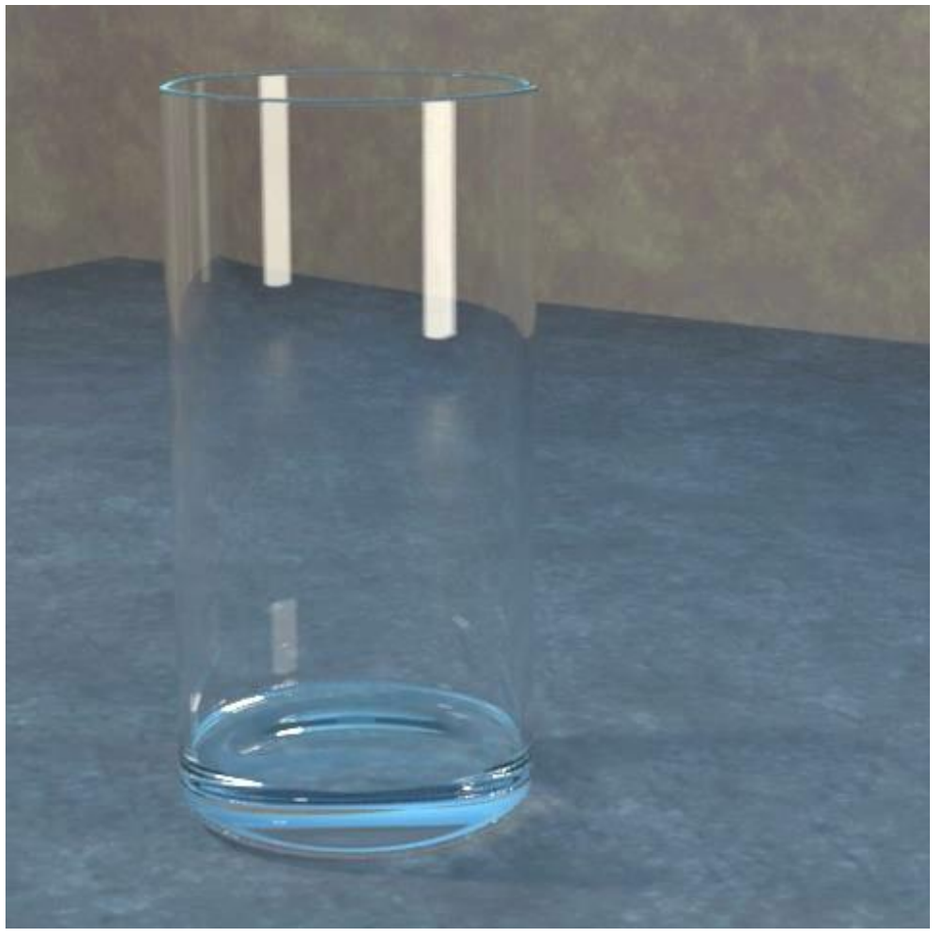
TU Berlin



SGI—OpenInventor

Problems in graphics

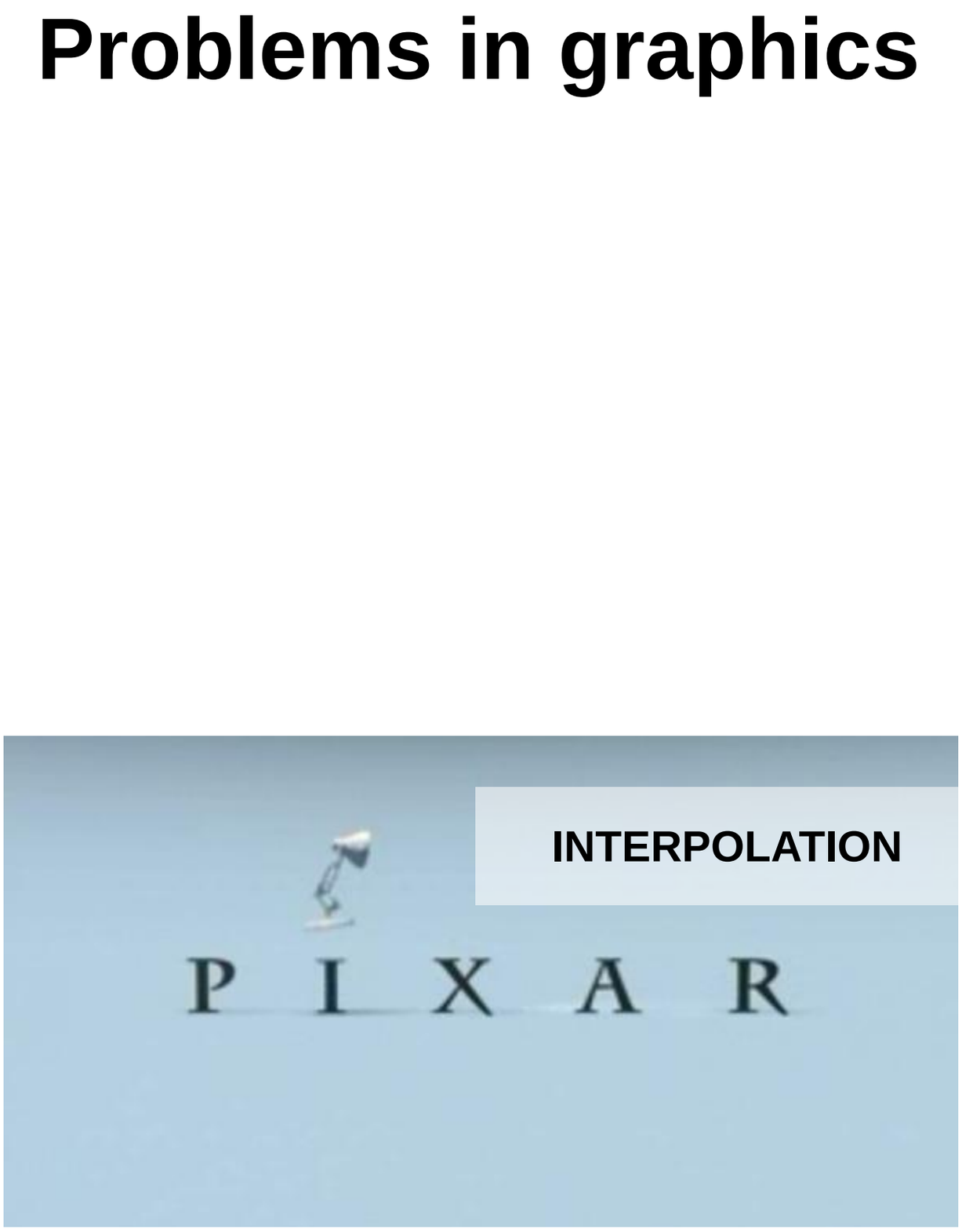
- Animation
  - keyframe animation
  - physical simulation



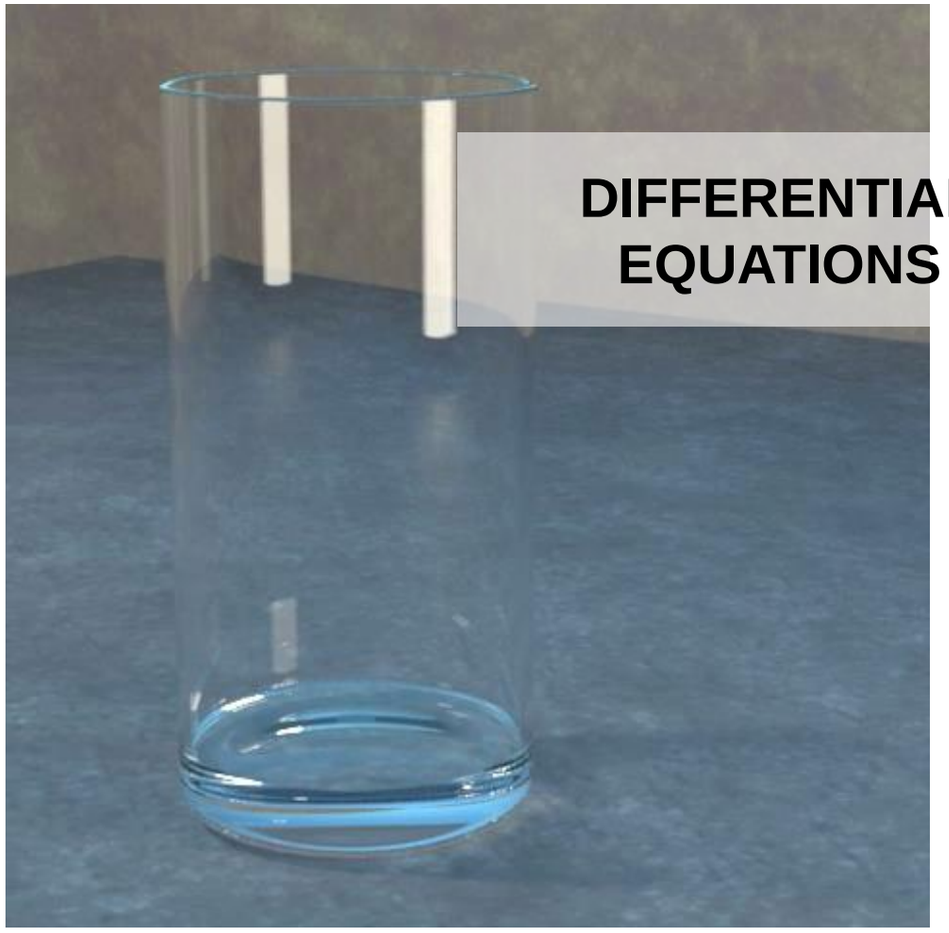
Enright et al. SIGGRAPH 2003

Pixar

Problems in graphics



Pixar



Enright et al. SIGGRAPH 2003

Graphics hardware is becoming widespread

Desktop and Laptop GPUs

PowerVR GPU

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Desktop and Laptop GPUs

PowerVR GPU

Virtual Reality

http://www.forbes.com/sites/sap/2015/12/14/virtual-reality-might-go-mainstream-in-2016/

Lets try some VR demos!

WHAT YOU WILL (or WILL NOT) LEARN

- 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

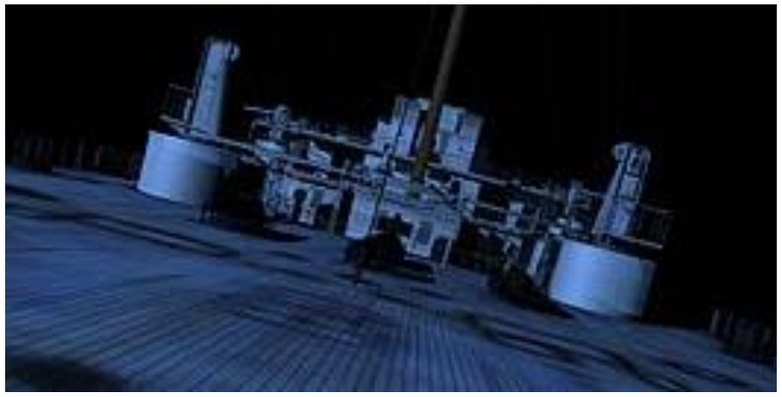
    (though you will use some OpenGL)
  - write very big programs
  - Advanced topics (global illumination, VR, simulation, etc.)

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



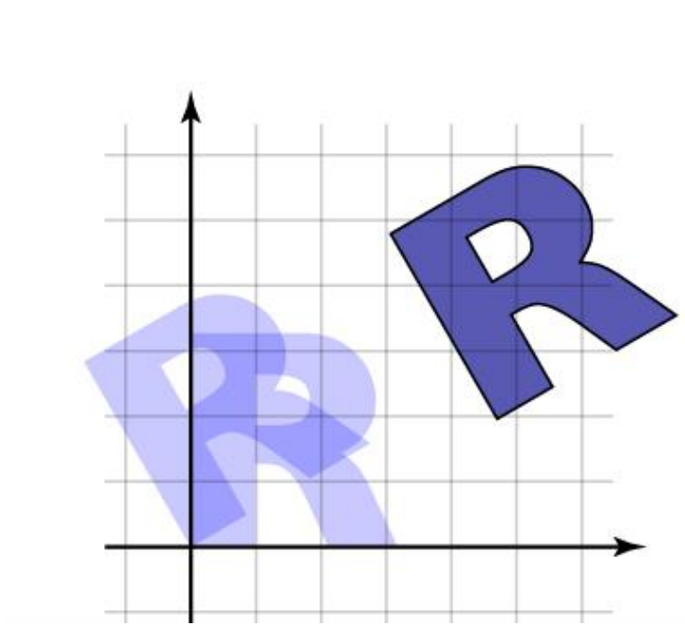
Rendering

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

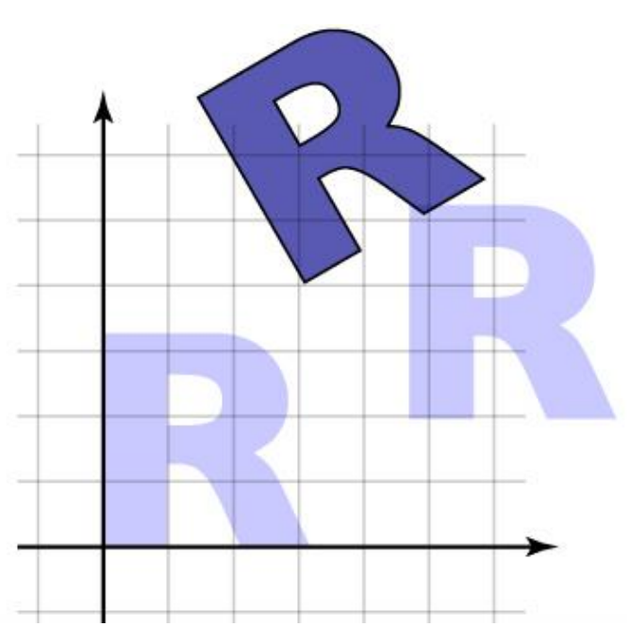
[Glassner 89]

Geometric transformations

- affine transforms
- perspective transforms
- viewing



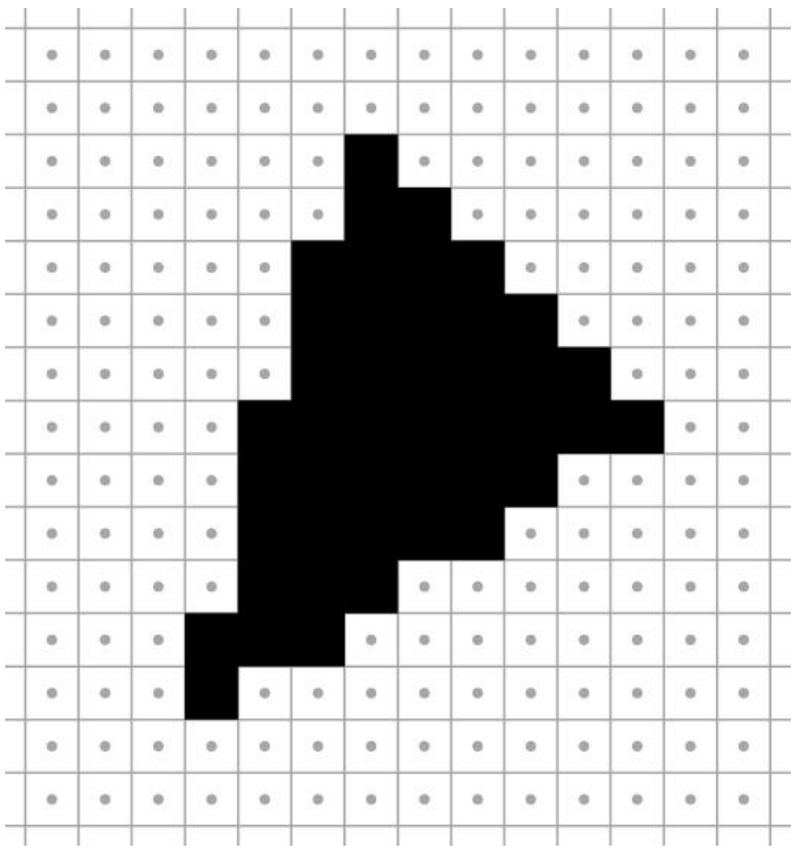
rotate, then translate

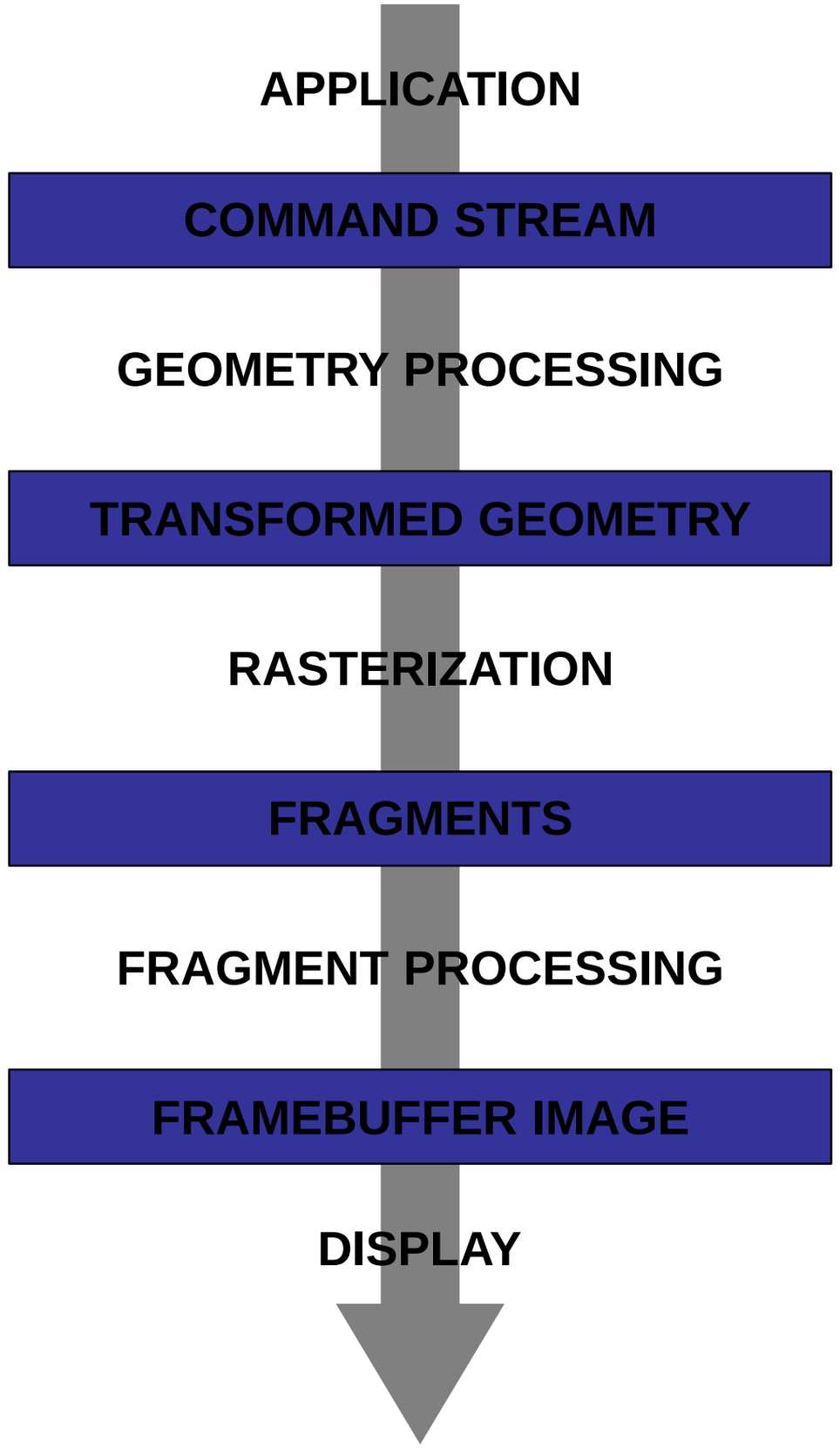


translate, then rotate

Graphics pipeline

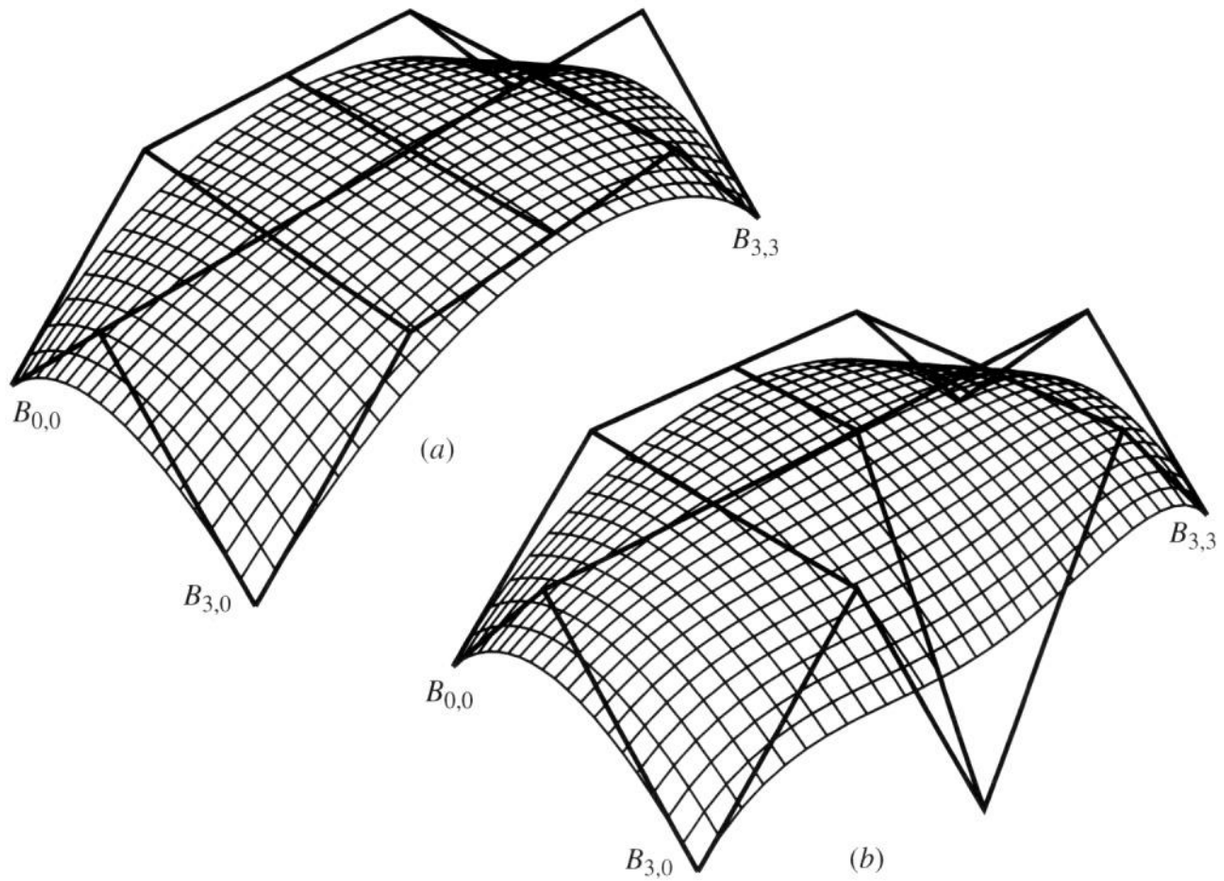
- rasterization
- interpolation
- z-buffer
- vertex and fragment ops



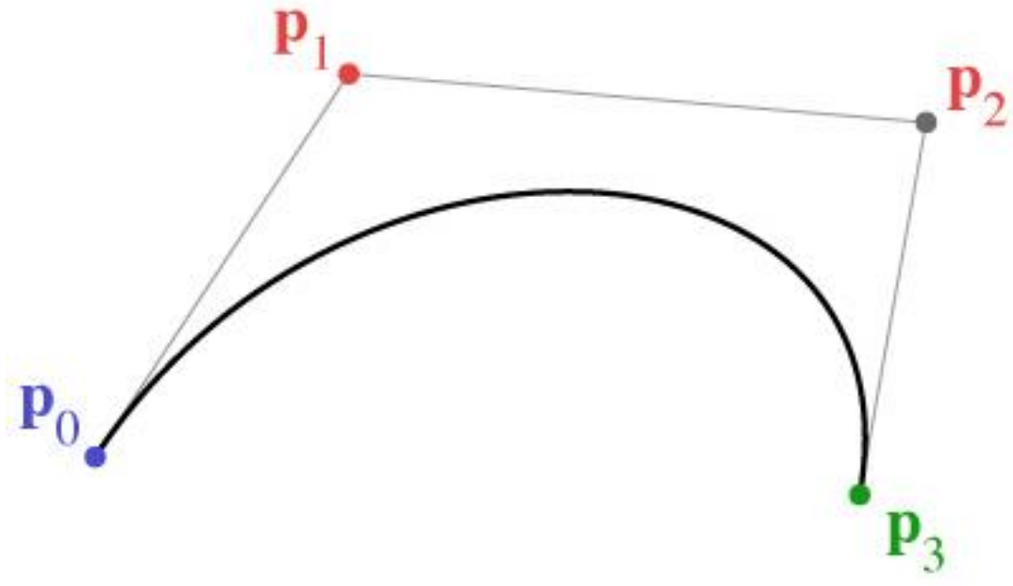


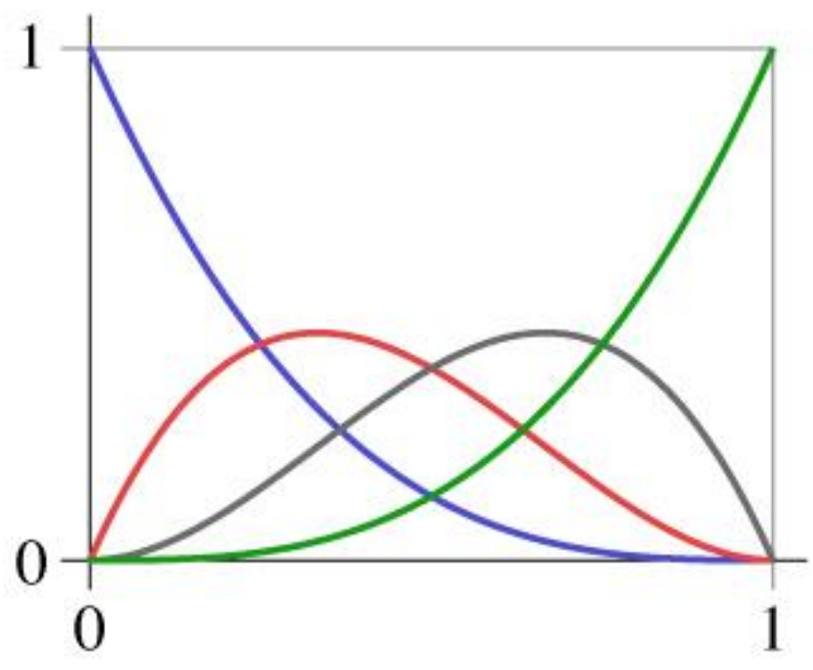
Modeling

- splines
- parametric surfaces
- triangle meshes

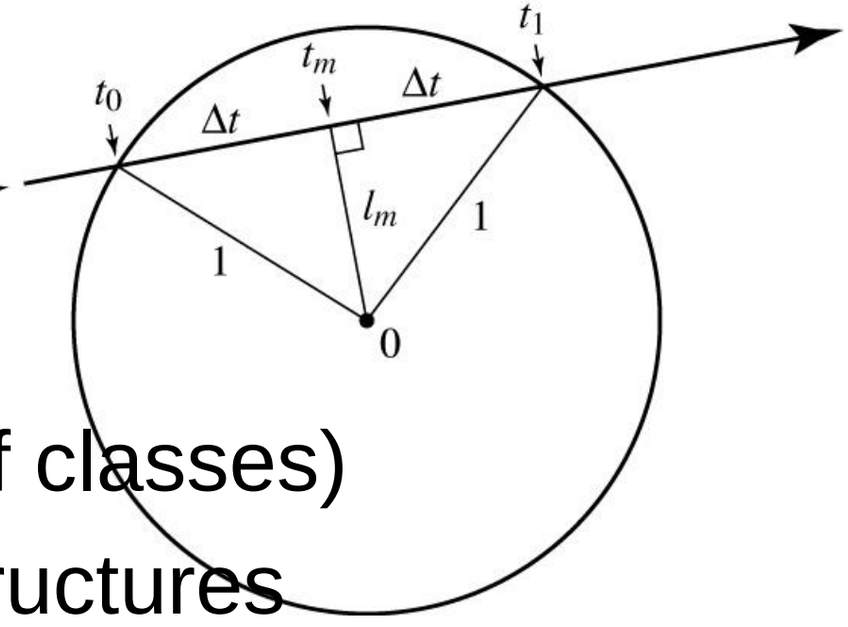


[Rogers]





Course 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 4-5 major programming assignments
  - Some programming assignments are time consuming
  - Work on 4 problem sets (HW)
  - 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)
- Optional for COMP575 (extra credit)

  - 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

Grading Policies

- **Grading Breakdown (575):** HW & Prog. Assignments 50%, Midterm 20%, Final 20%, Class Attendance & Participation 10%
- **Grading Breakdown (770):** HW & Prog. Assignments 50%, Midterm 20%, Project 20%, Class Attendance & Participation 10%

More details at:

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