CS4620/5620: Introduction to Computer Graphics

Professor: Kavita Bala

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

Or, to paraphrase Ken Perlin...

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

Graphics Applications

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

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PDI Dreamworks

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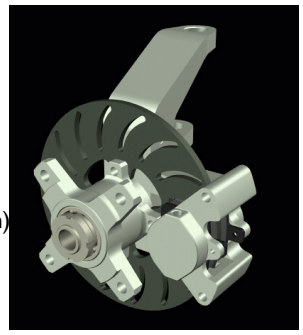

U. of Utah—Alpha 1

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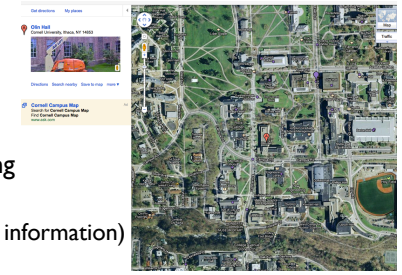

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NASA/Ames—ACFS

Army Research Lab—IES

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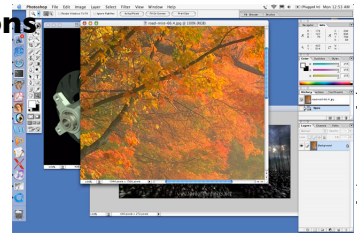
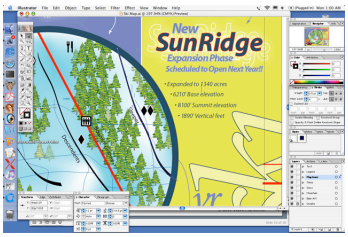


Adobe Photoshop [Photo: P. Greenspun]



Adobe Illustrator

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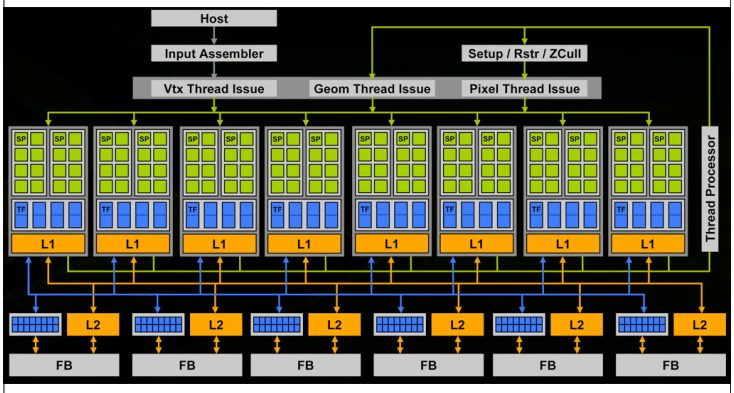
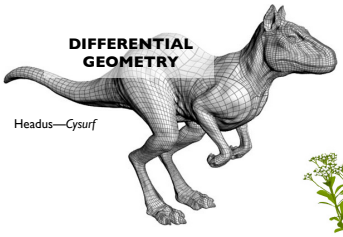
Computer aided sculptures
Ergun Akleman

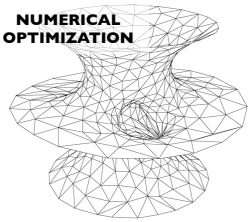
What is graphics about?



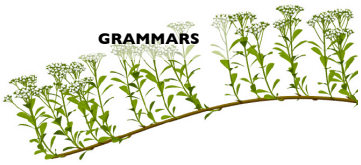
Problems in graphics CONT'D

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





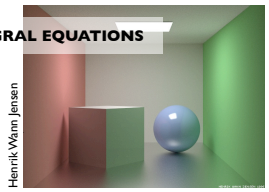
[Hoppe et al. 1993]

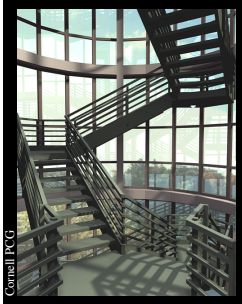


[Prusinkiewicz et al. 2001]

Problems in graphics CONT'D

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

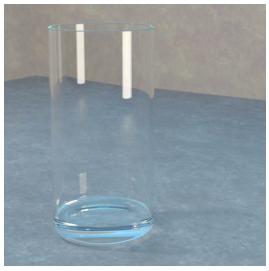




Problems in graphics CONT'D

- Animation
  - keyframe animation
  - physical simulation

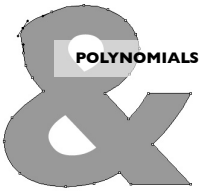
Pixar



Enright et al. SIGGRAPH 2003

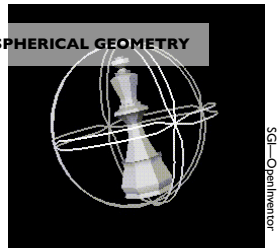
Problems in graphics

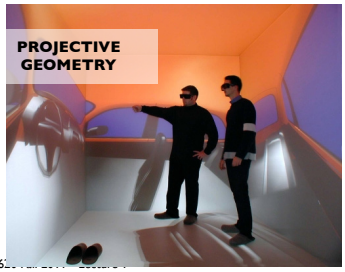
- 2D imaging
  - compositing and layering
  - digital filtering
  - color transformations
- 2D drawing
  - illustration, drafting
  - text, GUIs



Problems in graphics CONT'D

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





Computer graphics:
Mathematics made visible.

Course mechanics

Web http://www.cs.cornell.edu/Courses/cs4620

Teaching Assistants (3 Ph.D. TAs, 1 MEng, 3 ugrad TAs)

* Ivaylo Boyadzhiev
* Pramook Khungurn
* Shuang Zhao
* Yunfeng Bei
* Mark, Mohamed, Asher

Mailing lists, ... (TBA)

CS4620/5620

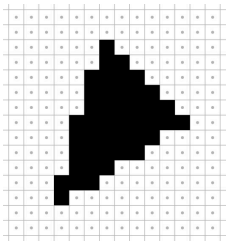
- You will:
  - explore fundamental ideas
  - learn math essential to graphics
  - implement key algorithms
  - write cool programs
  - learn a little about OpenGL (http://www.opengl.org)
- You will not:
  - write big programs

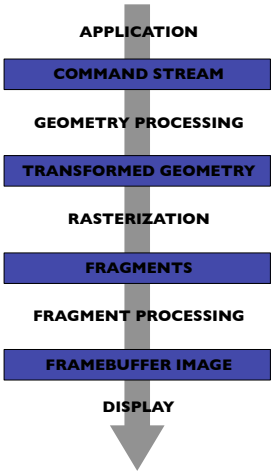
Topics

- Graphics pipeline
- Rendering 3D scenes
  - ray tracing
  - GPU
- Images and image processing
  (featuring sampling and reconstruction)
- Geometric transformations
- Modeling in 2D and 3D
- Animation
- Color science

Graphics pipeline

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





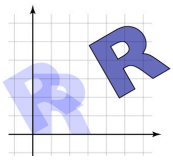
Rendering

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

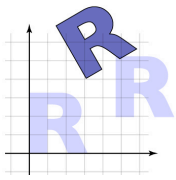
[Glassner 89]

Geometric transformations

- affine transforms
- perspective transforms
- viewing



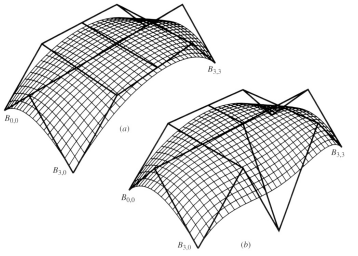
rotate, then translate



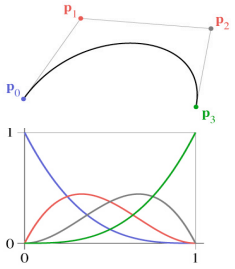
translate, then rotate

Modeling

- splines
- parametric surfaces
- triangle meshes

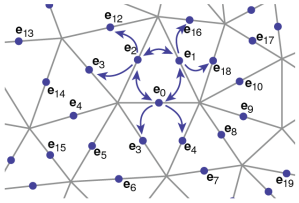


[Rogers]



winged edge table

	hl	hr	tl	tr
[0]	1	4	2	3
[1]	18	0	16	2
[2]	12	1	3	0
	⋮			

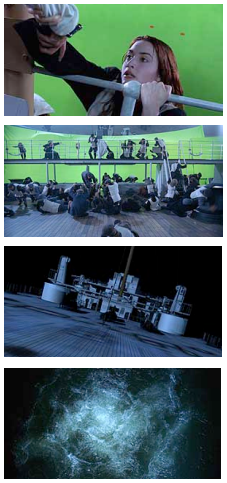


Animation

- key frame animation
- subdivision surfaces
- physics-based animation
- particle systems

Images

- What is an image?
- Compositing
- Resampling



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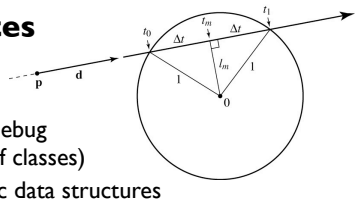
CS4620 Prerequisites



- 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 CS4621

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

Workload

- CS 4620/5620
  - 4-5 Homeworks
  - 2-3 programming assignments
  - No penalty for 1 late homework, then 10% per day
- CS 4621/5621
  - 4-3 programming assignments

Academic Integrity

Textbooks

Required Text:

Shirley & Marschner
Fundamentals of Computer Graphics
third edition

Optional:

OpenGL Programming Guide
(a.k.a. the "Red Book")
Older version available online:
http://www.opengl.org/documentation/red_book/

GLSL Shading Language
(a.k.a. the "Orange Book")

Course mechanics

Web http://www.cs.cornell.edu/Courses/cs4620

Mailing lists, ... (TBA)

Practicum
- Have to reschedule to Friday 3:30. Is that a problem? (Will also send email)