

CISC 440/640 Spring 2015

Instructor: Jingyi Yu

TA: Scott Grauer-Gray

Lecture 1 Introduction

Why do you want to take this course



A picture is worth of a thousand words

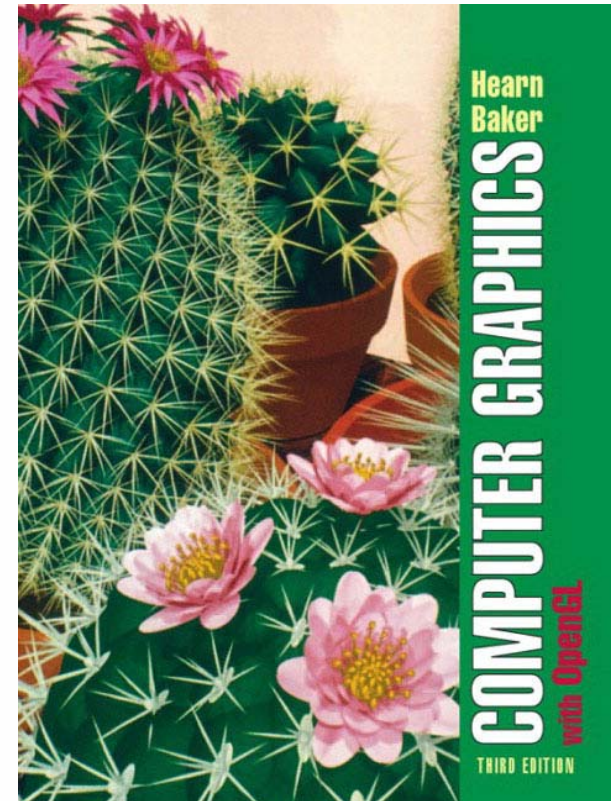
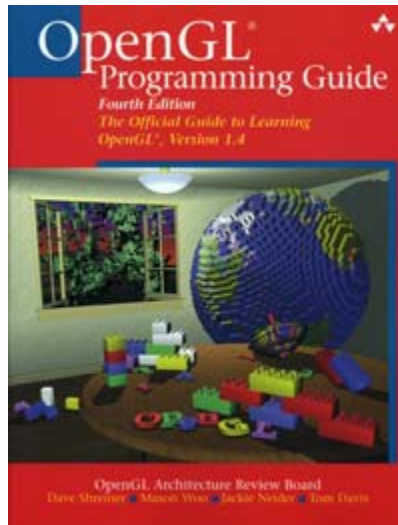
but it uses up three thousand times the memory,

and takes three weeks to program,

and, sometimes, forever to render

Text Books

- Required Textbook
- Optional Textbook
 - Older editions and on-line versions okay
 - Supplementary notes



The stuff you came for

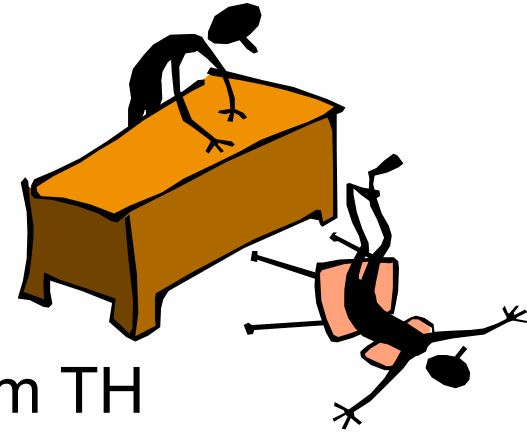
- Grading for CISC440
 - 4 programming assignments $4 \times 15\% = 60\%$
 - 1 midterm 20%
 - 1 Final Exam 20%
- Grading for CISC640
 - All undergraduates part
 - Additional part for each assignment



Student Feedbacks

- “Easily the most difficult class I have ever taken”
- “I spent 20+ hours on each assignment”
- “This course is truly exciting”
- “Project/Homeworks, though very hard, are fun and applicable.”
- “The instructor is awesome!”
- “The best course I have taken at UD!”

More Stuff



- Office Hours

- Jingyi: M, W 2 – 3pm
(and by appointment)

- Scott: 3 – 4pm T, 2 – 3pm W, 4 – 5pm TH

- Web Page

- http://www.eecis.udel.edu/~yu/Teaching/CISC440_S15/

- Prerequisites

- C and C++

- Linear algebra prerequisite
(assuming you know how to multiply matrices,
and know what an matrix inverse is)

- Four tutorials, one on VS .net, one on OpenGL, one on CxImage, one of Linear Algebra

Expectations

- Knowledge
 - Know C / C++
 - We will use Windows Visual Studio .Net
 - Linear Algebra (you HAVE TO know some basics)
- Academic Policies
 - Know the line between collaboration and cheating
 - Value knowledge more than grades
 - Probably know more than your instructor

Computer Graphics

- What computers do...
 - **Process, transform**, and **communicate** information
- Aspects of communication
 - Origin (where does information come from?)
 - Throughput (how frequent?)
 - Latency (how long do I have to wait)
 - Presentation (what does it look like?)
- Computer Graphics is ...
 - The technology for presenting information



Okay, but...

What is this course really about?

- **Not!**

- Paint and Imaging packages (Photoshop)
- CAD packages (AutoCAD)
- Rendering packages (Maya)
- Modeling packages (3D Max)
- Graphics Modeling and Languages (RenderMan)

- **We will cover...**

- Graphics programming languages (OpenGL)
- Graphics algorithms
- Graphics data structures
- Graphical User Interface (GLUT)
- Applied geometry and modeling
- Programming on Graphics hardware

Ugh... Sounds like Computer Science

Computer Graphics is about Movies

- If you can imagine it, it can be done with computer graphics.
- What really matters? Lighting, materials, textures.
- What really matters is time! (and electricity)!
- These days, not only movies, but more importantly, commercials.



The entertainment industry plays many other important roles in the field of computer graphics.

- Leaders in quality and artistry
- Not slaves to conceptual purity
- Big budgets and tight schedules
- Constant reminder that there is more to CG than technology.
- How did they do that?
- They define our expectations.



Games are okay here!



Games are an important driving force in computer graphics.

Realism is less important!

How the game's industry impacts computer graphics

1. Focus on interactivity
2. Cost-effective solutions
3. Avoiding computation and other tricks
4. Games drive the baseline



Architecture



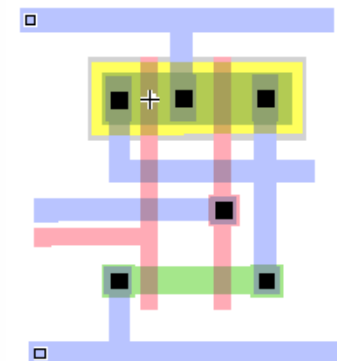
Computer Aided Design

Computer graphics has had a dramatic impact on the design process. Today, most mechanical and electronic designs are executed entirely on computer. Increasingly, architectural and product designs are also migrating to the computer. Automated tools are also available that verify tolerances and design constraints directly from CAD designs. CAD designs also play a key role in a wide range of processes from the design of tooling fixtures to manufacturing.



CAD has had the follow impact on computer graphics.

1. Drives the high-end of the HW market
2. Integration of computing and display resources
3. Reduced design cycles (faster systems sooner)



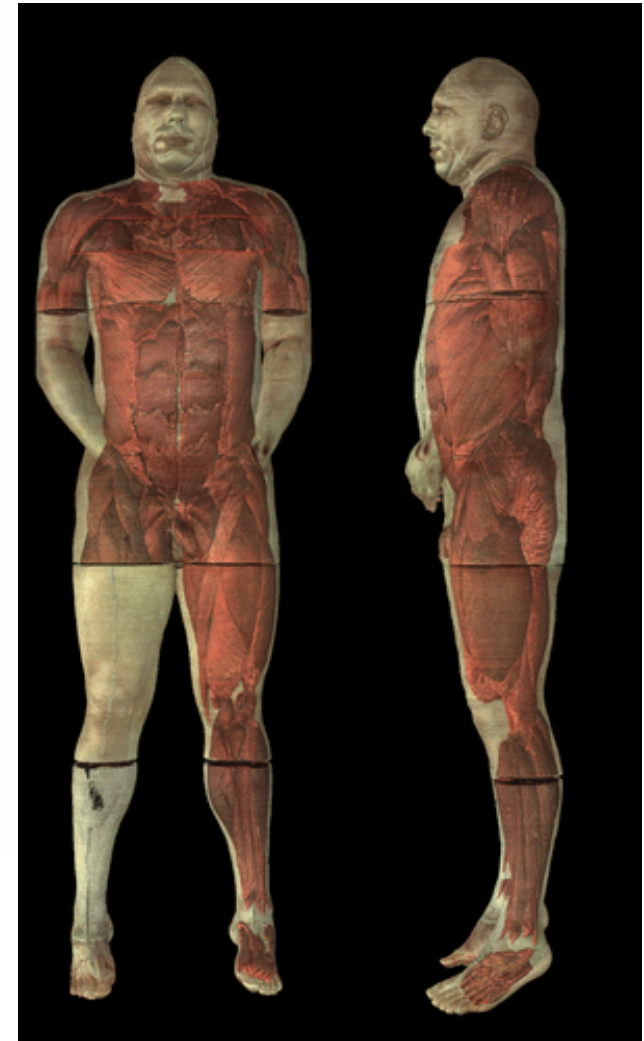
Medical Imaging

There are few endeavors more noble than the preservation of life. Today, it can honestly be said that computer graphics plays a significant role in saving lives. The range of application spans from tools for teaching and diagnosis, all the way to treatment. Computer graphics is *tool* in medical applications rather than an a mere artifact. No cheating or tricks allowed.



How medical applications influence computer graphics technology

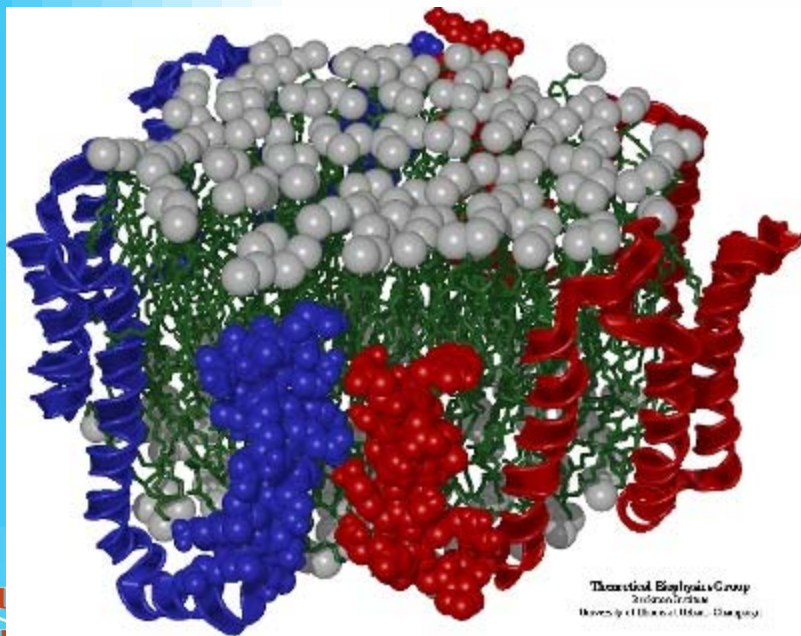
1. New data representations and modalities
2. Drive issues of precision and correctness
3. Focus on presentation and interpretation of data
4. Construction of models from acquired data



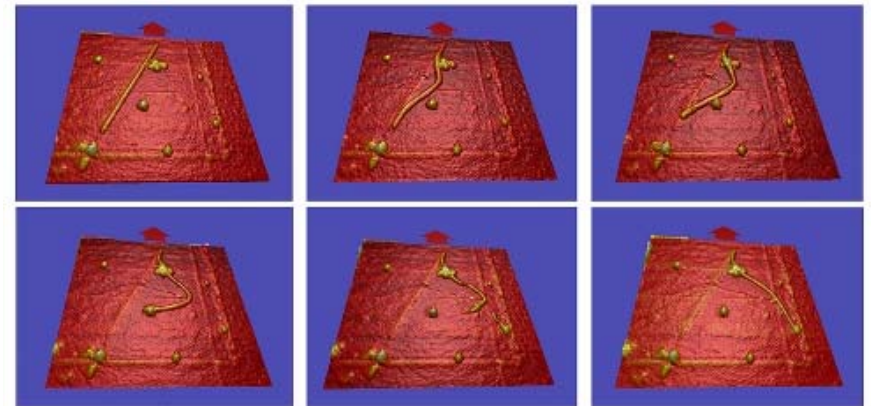
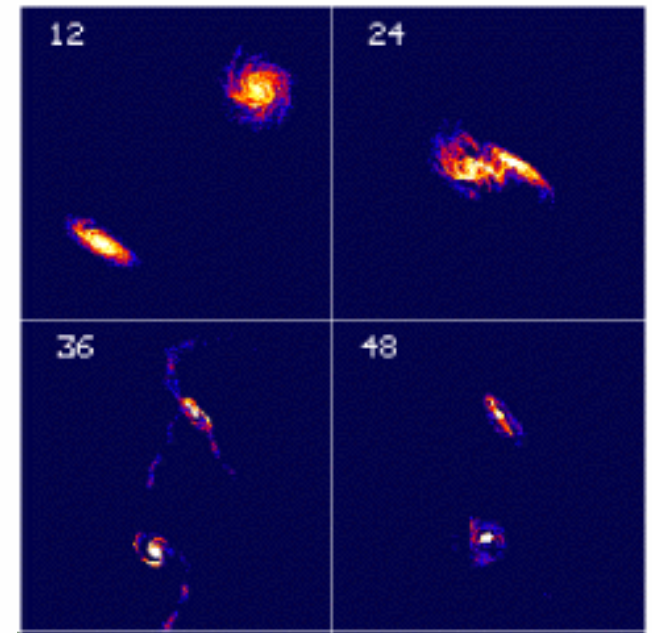
Scientific Visualization

Computer graphics makes vast quantities of data accessible.

- Bioinformatics Visualization
- Fluid Visualization
- Physical-based Simulation



Theoretical Biophysics Group
2010/01/10/15
University of Illinois at Chicago, Chicago



What is Computer Graphics?



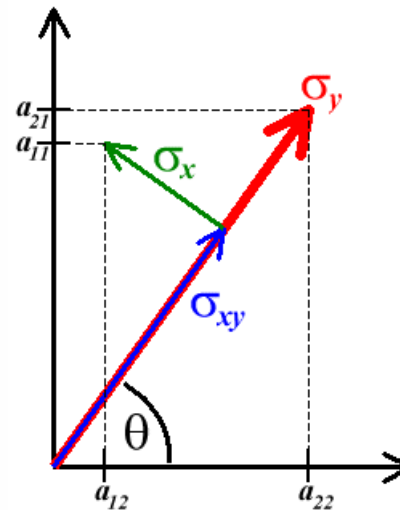
Computer Vision inverts this process!

Topics

- Mathematical tools
- 3D models and interactions
- Hidden surface removal
- Rasterization
- Lighting and shading
- Texture mapping
- Ray tracing
- Global Illumination
- Curves and surfaces
- Graphics hardware
- Animation

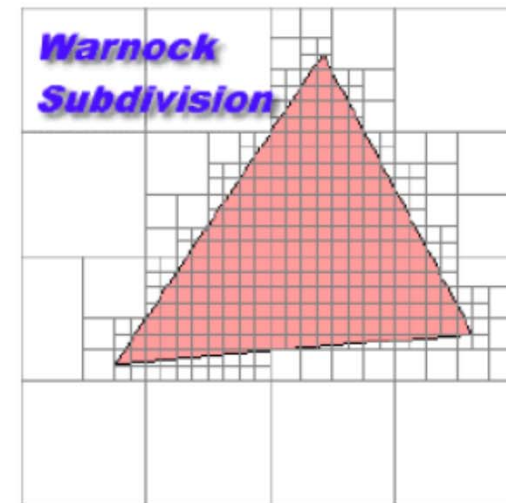
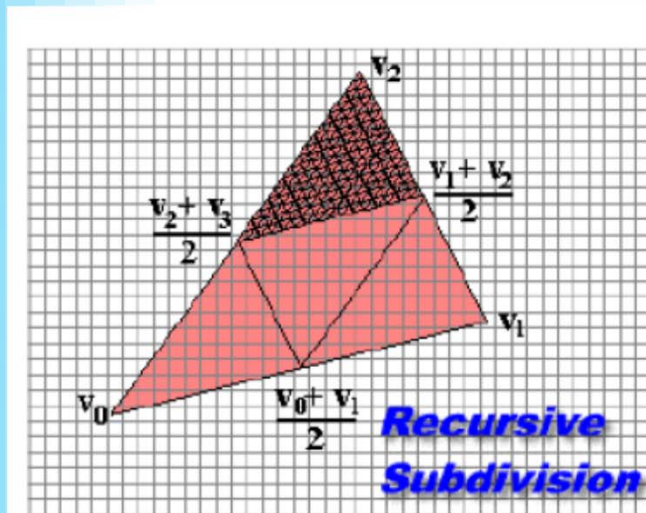
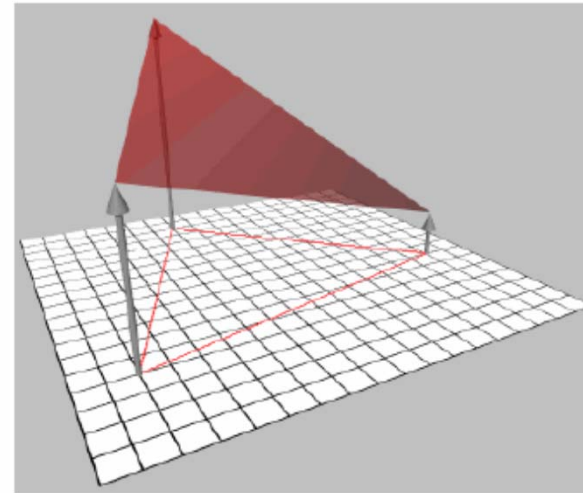
Transformation

- Homogeneous coordinates
- Vectors
- Planes
- Frames
- Transformations



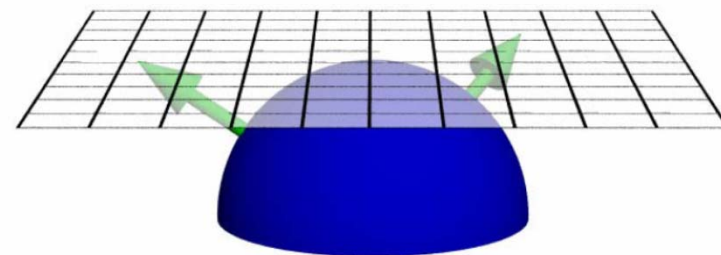
Rasterization

- Line Drawing
- Triangle Drawing
- Clipping
- Scan conversion



3D Modeling and Interaction

- Loading and view models
- Picking and selection
- Modeling a trackball
- Using a wii, maybe?



Lighting and Shading

- Flat, Gouraud, and Phong
- Physically-based Illumination



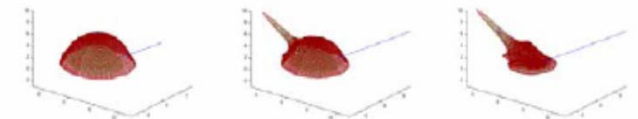
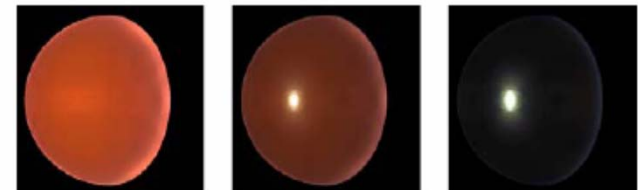
Nickel

Hematite



Gold Paint

Pink Felt



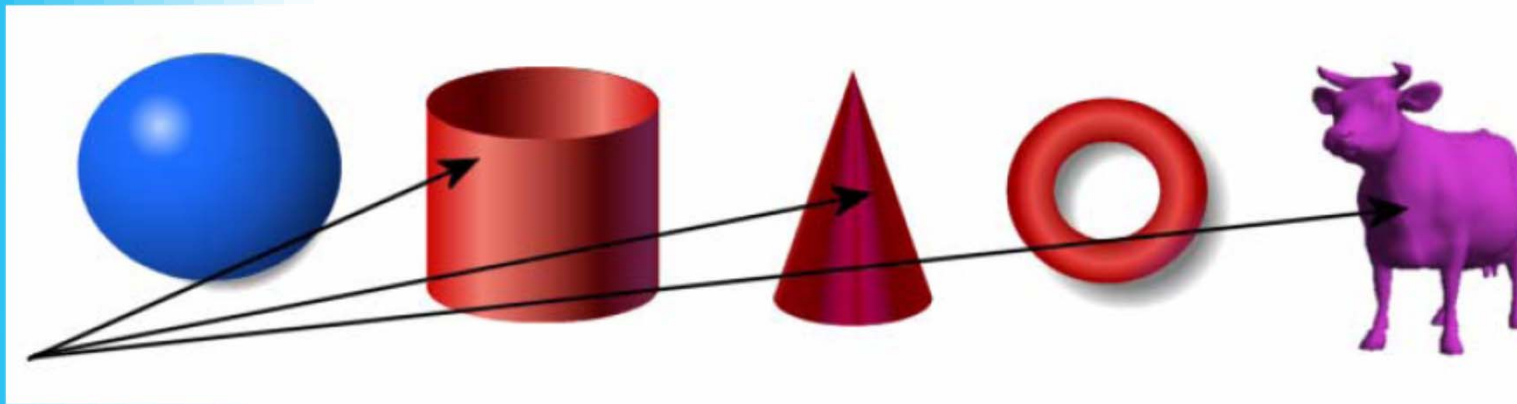
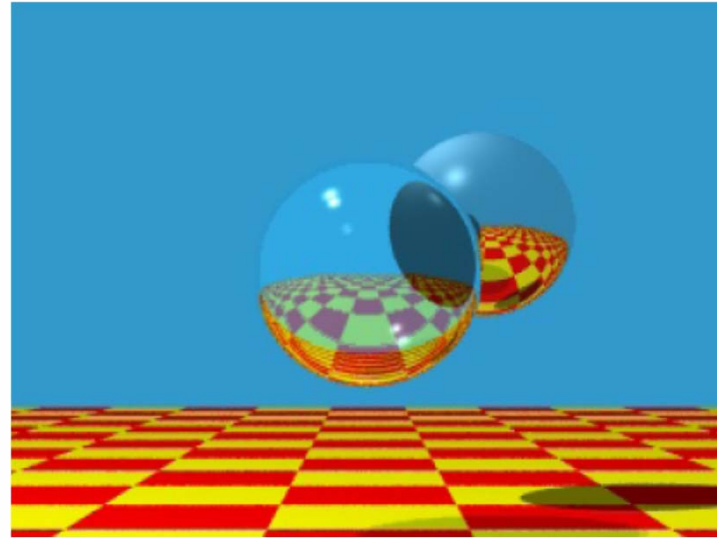
Texture Mapping

- What is a texture
- Mipmaps and filtering
- Reflection and environment mapping



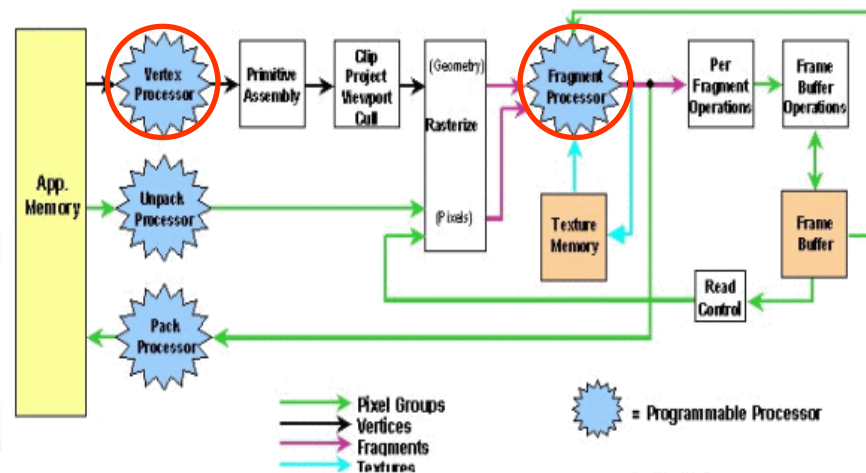
Ray tracing

- Ray-object intersection
- Reflection and Refraction
- Shadowing



Graphics Hardware

- History
- Architecture
- Shading languages
- Future

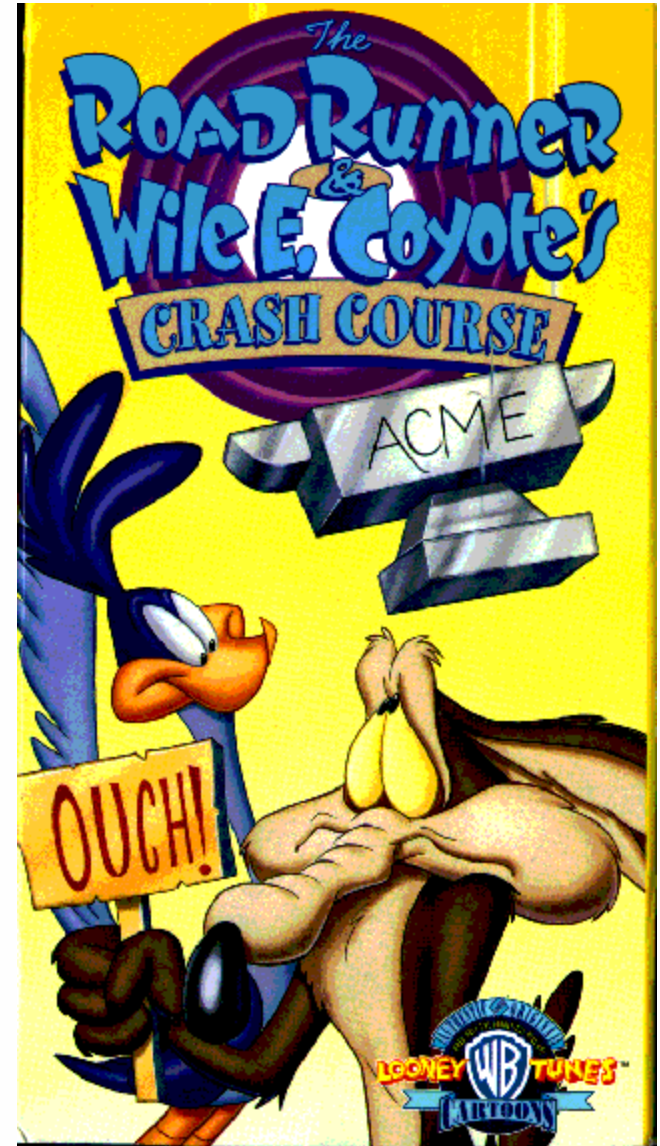


Animation

- Key framing
- Motion capture
- Simulation



Lecture 1



2/10/2015

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Graphical Toys



Spirograph -- from MathWorld - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Back Forward Stop Home Search Favorites Media

Address http://mathworld.wolfram.com/Spirograph.html Go

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ERIC WEISSTEIN'S world of MATHEMATICS

SEARCH go

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- Discrete Mathematics
- Foundations of Mathematics
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- Topology

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A [hypotrochoid](#) generated by a fixed point on a [circle](#) rolling inside a fixed [circle](#). It has parametric equations,

$$x = (R + r) \cos \theta - (r + \rho) \cos \left(\frac{R + r}{r} \theta \right) \quad (1)$$

$$y = (R + r) \sin \theta - (r + \rho) \sin \left(\frac{R + r}{r} \theta \right), \quad (2)$$

where R is the radius of the fixed circle, r is the radius of the rotating circle, and ρ is the offset of the edge of the rotating circle. The figure closes only if R , r , and ρ are [rational](#). The equations can also be written

$$x = x_0[m \cos t + a \cos(nt)] - y_0[m \sin t - a \sin(nt)] \quad (3)$$

$$y = y_0[m \cos t + a \cos(nt)] + x_0[m \sin t - a \sin(nt)], \quad (4)$$

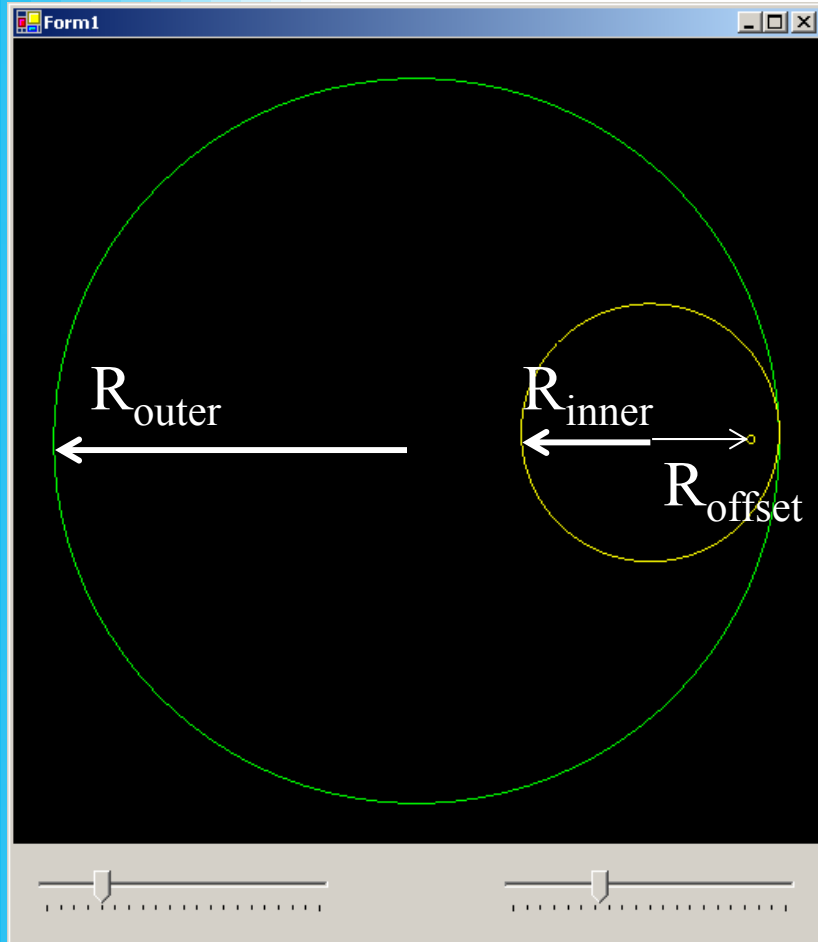
where the outer wheel has radius 1, the inner wheel a radius p/q , the pen is placed a units from the center, the beginning is at θ radians above the x -axis, and

$$m \equiv \frac{q-p}{q} \quad (5)$$

$$n \equiv \frac{q-p}{q} \quad (6)$$

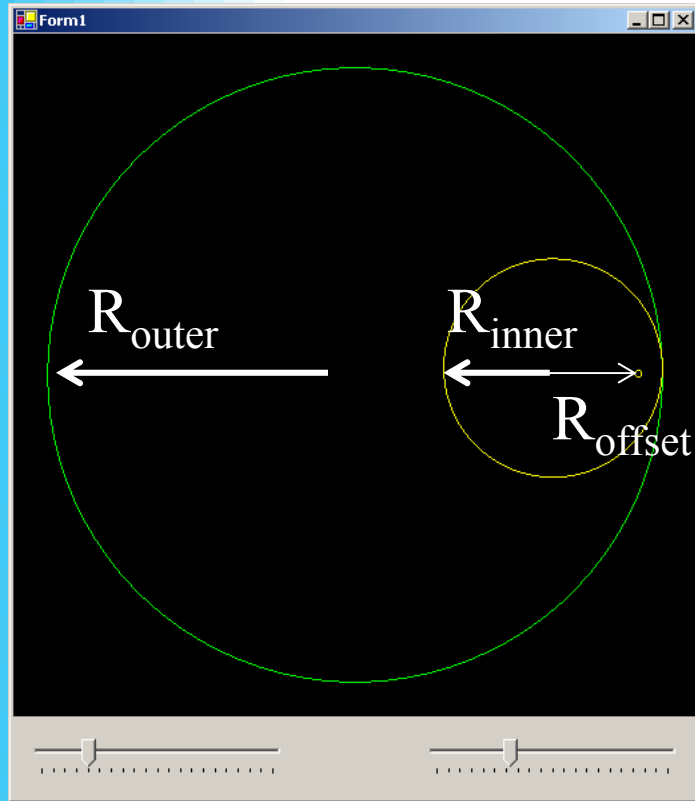
Internet

A circle rotating in a circle



- An outer circle with radius R_{outer}
- An inner circle with radius R_{inner}
- A hole where a pen goes offset R_{offset}
- The inner and outer circles rotate through the same arc lengths

A circle rotating in a circle



```
void display4() {  
    double angle = 0;  
    glClear(GL_COLOR_BUFFER_BIT);  
    glColor3d(1, 0, 0);  
    for (int i = 0; i < 36000; i++) {  
        glPushMatrix();  
        glRotated(angle, 0, 0, 1.0);  
        glTranslated(rOuter - rInner, 0, 0);  
        glRotated(-angle*rOuter/rInner,0,0,1);  
        glBegin(GL_POINTS);  
        glVertex2d(rOffset, 0);  
        glEnd();  
        glPopMatrix();  
        angle += 1.0;  
    }  
    glFlush();  
}
```

Reminder:

- Download Visual Studio/OpenGL before next class
- Bring your laptop with you for the next two lectures
- Readings: Redbook, Chapter 01