CSE 457: Computer Graphics

Offered: Fall 2020
Instructor: Adriana Schulz

Objectives:
• Broad introduction to the field of computer graphics
• Combination of
  • underlying theoretical principles
  • technical implementation
  • artistic expression
• Many demonstrations of concepts in class
Great Group of TAs

Peter Michael
My Tran
Xiao Liang
Carla Tjung
Dalton Hildreth
Dao Yi
Lily Zhao
Phillip Quinn
What is Computer Graphics?
Probably an image like this comes to mind:
Q: ...ok, but more fundamentally: what is computer graphics (and why do we need it)?
Early computer (ENIAC), 1945

punch card (~120 bytes)
There must be a better way!
Credit: PC World, “A Brief History of Computer Displays”
Sketchpad (Ivan Sutherland, 1963)
2018: Dell 8k monitor
7680x4320 (~95MB)
Coming down the pipe...

2018 Google/LG display: 2x 2160 x 2160@ 90Hz => 2.3 GB/s
What is computer graphics?

computer graphics /ˌkɒmpjʊtər ˈɡrɑːfɪks/ n.
The use of computers to synthesize visual information.

digital information

computation

visual information
Graphics has evolved a lot since its early days... no longer just about turning on pixels!
What is computer graphics?

com•put•er  gra•ph•ics  /kəmˈpyooərˌɡrafiks/  n.
The use of computers to synthesize visual information.

Why only visual?

digital  information

computation

visual information
Information into sensory stimuli

Sound

Touch
Information into physical matter
Definition of Graphics, Revisited

Computer graphics /ˈkɒmˈpjuːtər ˈɡræfɪks/ n.
The use of computation to turn digital information into sensory stimuli.
Even this definition is too narrow...
SIGGRAPH Technical Papers Trailer
Computer graphics is everywhere!
Entertainment (movies, games)
Entertainment

Not just cartoons!
Art and design
Industrial design
Computer Aided Engineering (CAE)
Architecture
Scientific/mathematical visualization
Medical/anatomical visualization
Navigation
Communication
Interdisciplinary!

- Algorithms
- Hardware
- Compilers
- HCI
- Visualization
- Image processing
- Computer vision
- Machine learning
- Computer Science
- Mathematics
- Physics
- Engineering
- Biology
- Psychology
- Art
Plan for the Quarter
Displays
Image processing

Original

Smoothed

Sx + 128

Sy + 128

Magnitude

Threshold = 64

Threshold = 128
Project 1: Impressionist
Geometric transformations

Model or object space

scale, translate, rotate, ...

World space

rotate, translate

Eye or camera space

Projective transformation, scale, translate

Normalized projection space

Project, scale, translate

Normalized device space (Screen space)

scale

Image space (Window space) (Raster space) (Screen space) (Device space)
Hierarchical modeling
Shading
Project 2: Modeler
Rendering

Uniform subdivision in 2D
Quadtree in 2D
Uniform subdivision in 3D
Octree in 3D
Project 3: Trace
Animation

- Keyframing
- Physical simulations
Principles of character animation
Project 4: Animator
Surfaces
Some Administrative Things...
Prerequisites

• Data structures
• C (C++) programming
• Linear algebra (very basic)
• Some mathematical sophistication
• No prior knowledge of graphics is assumed
Communication

• Announcements: email
• Everything else: **main website**
  • Ed Discussion Board (link on website)
  • Canvas for Lectures/Grades/Submitting Homeworxs (link on website)
  • Gitlab for Projects (sent to your email)
  • Calendar (link on website)

• Need to reach us?
  • For fast response: cse457-staff@cs.washington.edu
  • Individual emails (not recommended)
Deliverables

• 4 Projects + Artifacts
• 8 HWs (new! goal: make it easier)
• No final
• Check calendar (main website)
• Late Policy (note: no late days)

All assignments (projects, artifacts, and homework) must be submitted by 10pm on the due date. Late assignments are marked down at a rate of 25% per day (not per lecture), meaning that if you fail to turn in an assignment on time it is worth 75% for the first 24 hours after the deadline, 50% for the next 24 hours, 25% for the next 24 hours, and then it is worth nothing after that. Exceptions will be given only in extreme circumstances with prior instructor approval.
Grades

• 70% Projects
• 25% Homework
• 5% Participation

1 point for each class you are **actively** present.

Being actively present means you engage in the class in some form: you say something out loud with audio, type something on the chat, or simply keep your video throughout the class and engage by nodding/shaking your head/smiling/looking skeptical... **Anything that gives the instructor feedback on your understanding.**

2 points for Ed **response**

Ed participation will be given **every time** a student responds to a question in a way that is helpful to the student who asked the question, but please make sure to **never completely give away the answer to a graded problem**. So if you can’t attend the class because of internet problems, you still have a chance to get participation credit!

>=15 points = 100% score
Projects

• Done in Pairs
  • You can pick or be auto-assigned
    Exceptions will be given only in extreme circumstances with prior instructor approval.

• Help Session (will be recorded)
• Virtual “in person” grading
• Artifact
• Opportunity for extra credit
Ethics, Diversity, Equity and Inclusion

• How do these topics relate to computer graphics?
• As we go through the topics in this course, let’s ask ourselves:
  • Are specific algorithms or applications biased in certain ways?
  • Any environmental impact concerns?
  • Or more positively, how we use these ideas to drive invasions that will help address some of the existing issues we face in the world?

Let’s think together and learn from each other!
Making our course inclusive

You all belong in this class and as such should expect to be treated by your classmates and the course staff with respect. It is our goal, as the course staff, to provide an interesting and challenging environment that is conducive to your learning. If any incident occurs that challenges this commitment to a supportive and inclusive environment, please let the instructor know so the issue can be addressed.
A personal Story from my undergrad

I once asked in a Control Theory class:
“Excuse me professor, what is a joystick?”

We all have different backgrounds! Let us know if we use any expressions that just don’t feel right to you.
Summary

• Broad view of graphics
• Hands-on experience with focus on ideas and algorithms
• Structured to allow you to budget time according to your interests and constraints
• Balance of technical and artistic expression
• You will see the world in a different way, I guarantee it!