CSCI 520
Computer Animation
and Simulation
Computer Animation and Simulation
About the teacher

• Full professor in CS

• Post-doc at MIT

• PhD, Carnegie Mellon University

• jnb@usc.edu
• **Background:**  
  BSc Mathematics  
  PhD Computer Science

• **Research interests:**  
  graphics, animation,  
  real-time physics, control, sound, haptics

• **Practice:**
  
  • Tech transfer, startup companies  
    (Ziva Dynamics)
Teaching Assistant

• Huanyu Chen

• Tuesday, 3:00-5:00pm

• Location: TBA
Who is the course for

- PhD students
- MSc students
- Advanced undergraduates

- CS 420 or 580 background will be very helpful!!
Why take this course

- Opens the door to jobs in computer graphics
- Make better games
- Put math and physics to use in the real world
- Real-time graphics is cool
- Impress your friends with demos
Course Information Online

https://viterbi-web.usc.edu/~jbarbic/cs520-s23/

- Schedule (slides, readings)
- Assignments (details, due dates)
- Software (libraries, hints)
- Resources (books, tutorials, links)

Submit assignments on Blackboard:
https://blackboard.usc.edu

Forum for questions is on Piazza:
https://piazza.com/usc/spring2023/csci520/home
Prerequisites

• Grade of at least B in CS420 or CS580, or explicit permission of instructor

• Familiarity with calculus, linear algebra and numerical computation

• C/C++ programming skills

• See me if you are missing any and we haven’t discussed it
Recommended Textbooks


- OpenGL Programming Guide ("Red Book")
  Basic version also available on-line (see Resources)
Evaluation

• Assignments: 3 x 21%

• Final Exam: 37%
Academic integrity

• No collaboration!

• Do not copy any parts of any of the assignments from anyone

• Do not look at other students' code, papers, assignments or exams

• USC Office of Student Judicial Affairs and Community Standards will be notified
Assignment Policies

• Programming assignments
  - Hand in via Blackboard by end of due date
  - Functionality and features
  - Style and documentation
  - Artistic impression

• 3 late days, usable any time during semester
• Academic integrity policy applied rigorously
Class goals

• Gain ability to create animations and 3D simulations

• Learn a 3D graphics API (or improve skills)

• Improve code optimization skills
Applications

• Virtual reality
• Interactive computer animation
• Surgical simulation; preoperative planning
• Computational robotics; manipulation
• Video games
• Assembly planning
• Scientific visualization
• Education
• E-commerce
Keyframe Animation
Motion Capture
Inverse Kinematics

www.learnartificialneuralnetworks.com

source: Autodesk
Character Rigging
Facial Animation
Crowd Animation
Crowd Animation

Continuum Crowds

Adrien Treuille
Seth Cooper
Zoran Popović
Maya
Deformations

Vertices: 45882
Triangles: 105788

Source: CMU
Simulating Large Models

Source: Cornell University
Simulating Large Models
Sound

Modal renderer

Source: CMU
Self-collision detection

Source: USC
GPU programming

- Vertex shader
- Fragment shader
- CUDA
- OpenCL
Physics in games

Real-Time Deformation and Fracture in a Game Environment

Eric Parker
Pixelux Entertainment

James O'Brien
U.C. Berkeley

Video Edited by Sebastian Burke

From the proceedings of SCA 2009, New Orleans

Source:
Symposium on computer animation
Force-feedback Rendering
Haptic Interfaces

• hap·tic ('hap-tik) adj.
  Of or relating to the sense of touch; tactile.
Surgical Simulation

Source:
Cornell University
Multibody dynamics

Figure 1: *Avalanche*: 300 rocks tumble down a mountainside.
TOPICS TO BE COVERED:

- Overview of computer animation
- Primer on numerical linear algebra
- Dynamical systems, numerical integration of ODEs
- Constraints and contact
- Character Rigging
- Inverse Kinematics
- Maya
- Crowds
- Rigid body dynamics
- Collision detection
- Structured deformable objects (solids, cloth, hair)
- Fracture and cutting
- Fluids (Navier-Stokes)
- Haptics
- Sound simulation (acoustics)
- Programmable graphics hardware (GPUs)
- Case study: Havok engine for physics in games
- Motion capture
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http://www.jernejbarbic.com