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

• Associate (tenured) 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

• Mianlun Zheng

• Tuesday, 3:00-5:00pm

• Location: Online
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

http://run.usc.edu/cs520-s21

- 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/spring2021/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

source: Autodesk

www.learnartificialneuralnetworks.com
Character Rigging
Facial Animation
Crowd Animation
Crowd Animation

Continuum Crowds

Adrien Treuille
Seth Cooper
Zoran Popović
Maya
Fluids

Source: Stanford University
Deformations

Vertices: 45882
Triangles: 105788

Source: CMU
Cloth

Source:
ACM SIGGRAPH
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