CS 599
Physically Based Modeling for Interactive Simulation and Games

Spring 2011, 3 units
Mon Wed 2:00pm-3:20pm

CS 599
Physically Based Modeling for Interactive Simulation and Games

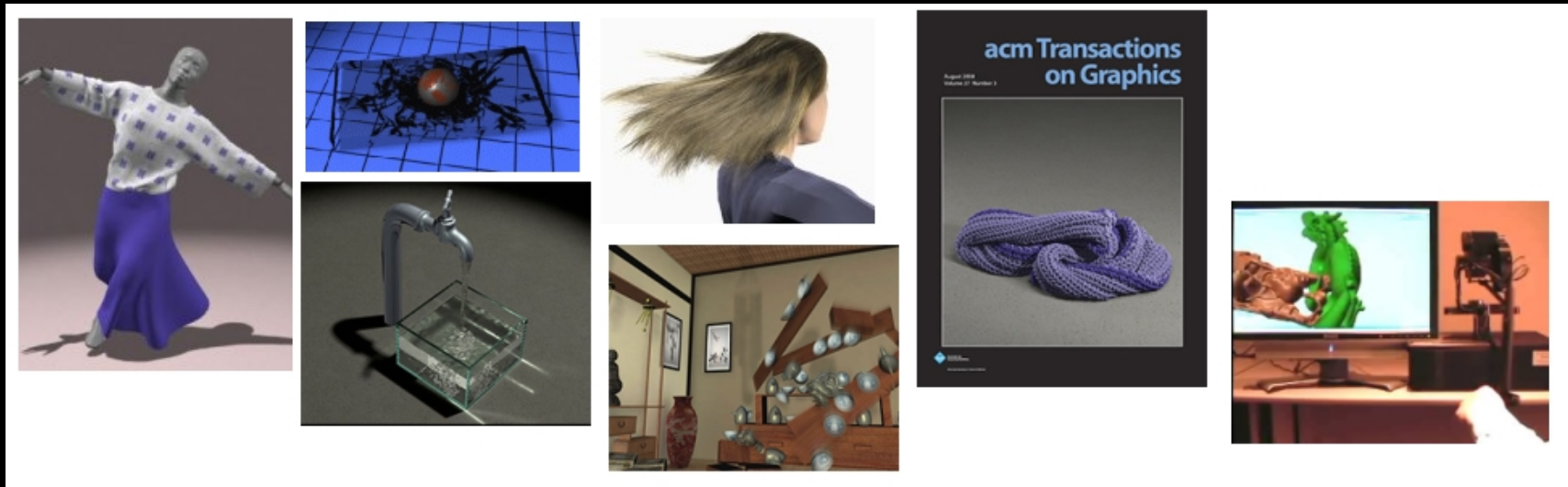http://www.jernejbarbic.com/cs599-s11/

Physically Based Modeling for Interactive Simulation and Games

About the teacher

- Assistant professor in CS

- Post-doc at MIT (2 years)

- PhD, Carnegie Mellon University

- jnb@usc.edu

About the teacher

- Background:
  BSc Mathematics
  PhD Computer Science

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

Who is the course for

- PhD students

- MSc students

- Advanced undergraduates

- CS 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
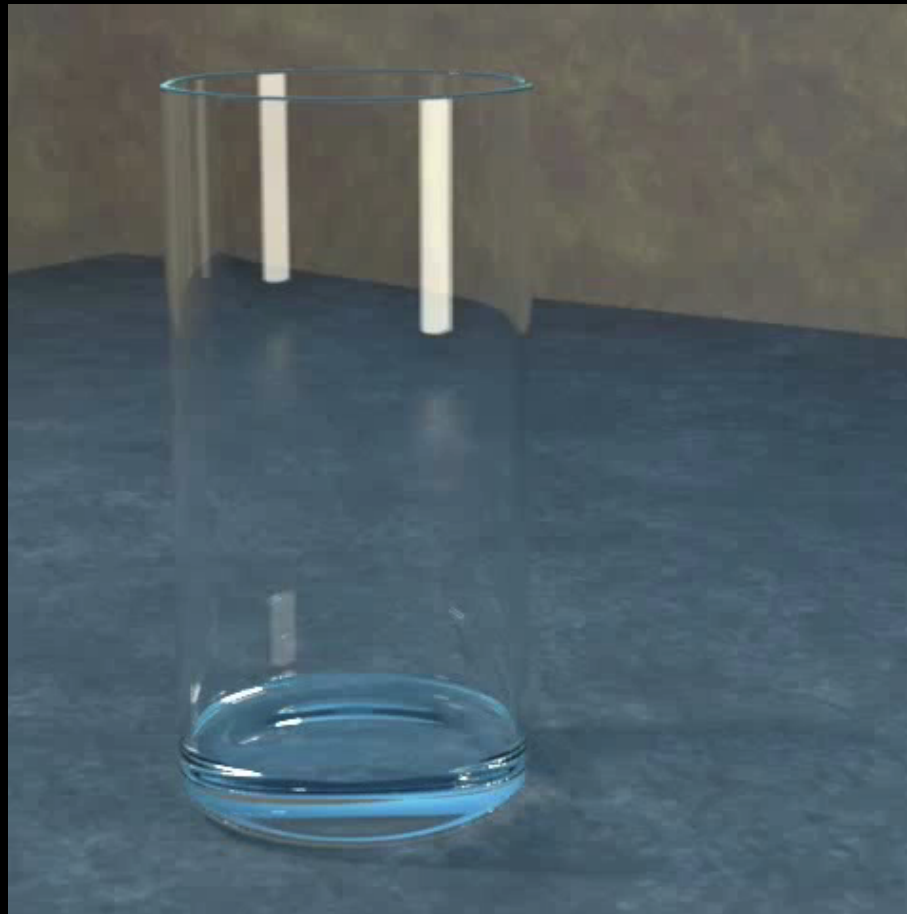
- Impress your friends with demos

Applications

- Virtual reality
- Interactive computer animation
- Surgical simulation; preoperative planning
- Computational robotics; manipulation
- Video games
- Assembly planning
- Scientific visualization
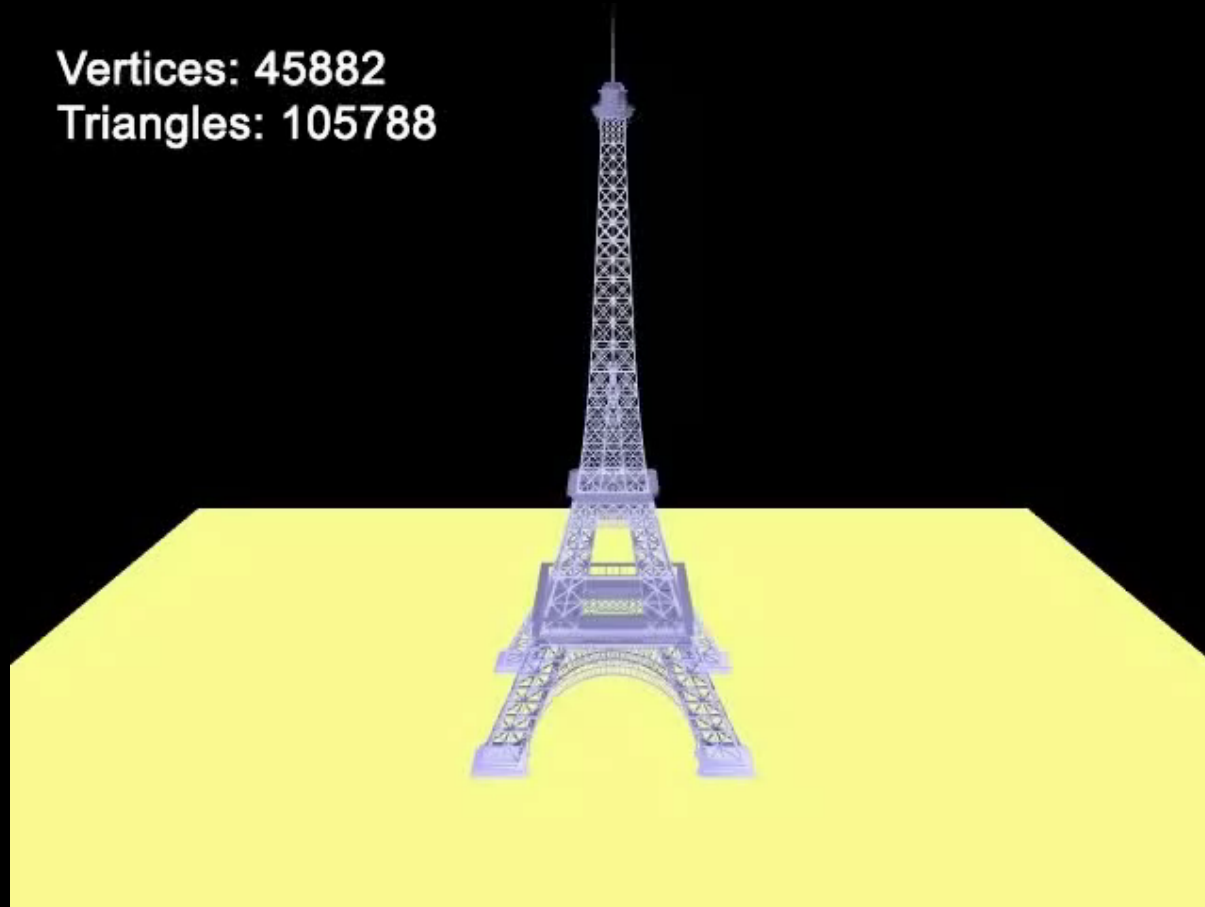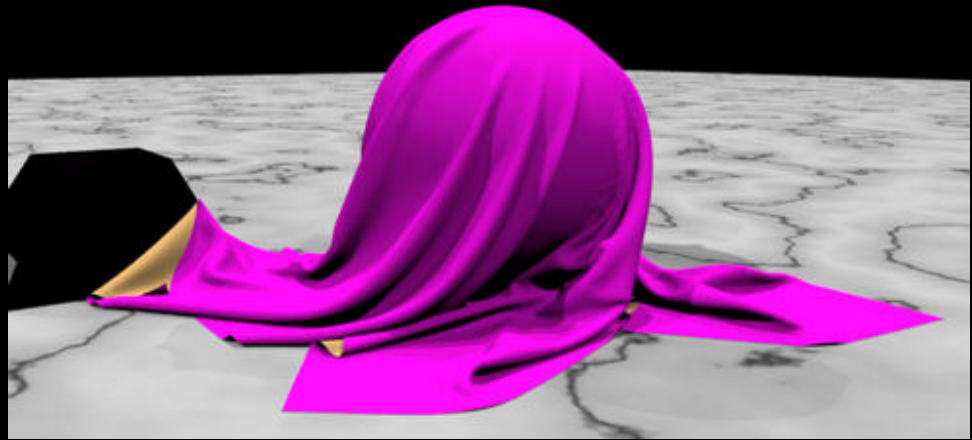- Education
- E-commerce

Fluids
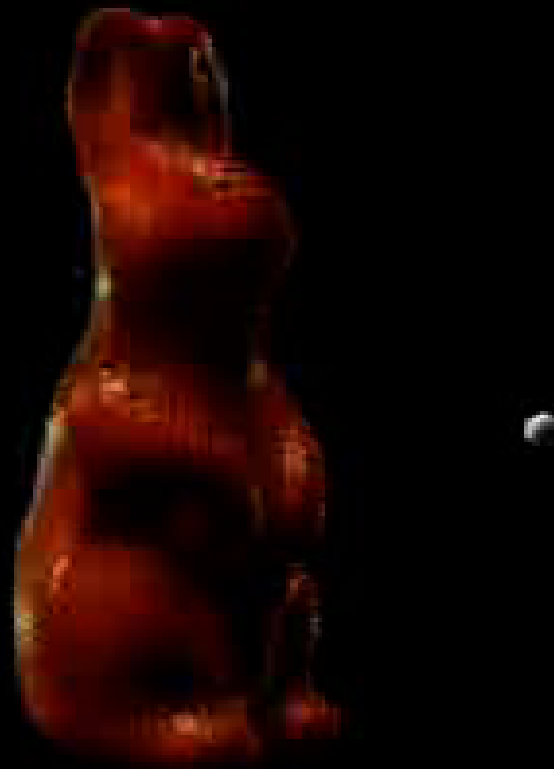
9

Deformations

Vertices: 45882
Triangles: 105788

Cloth
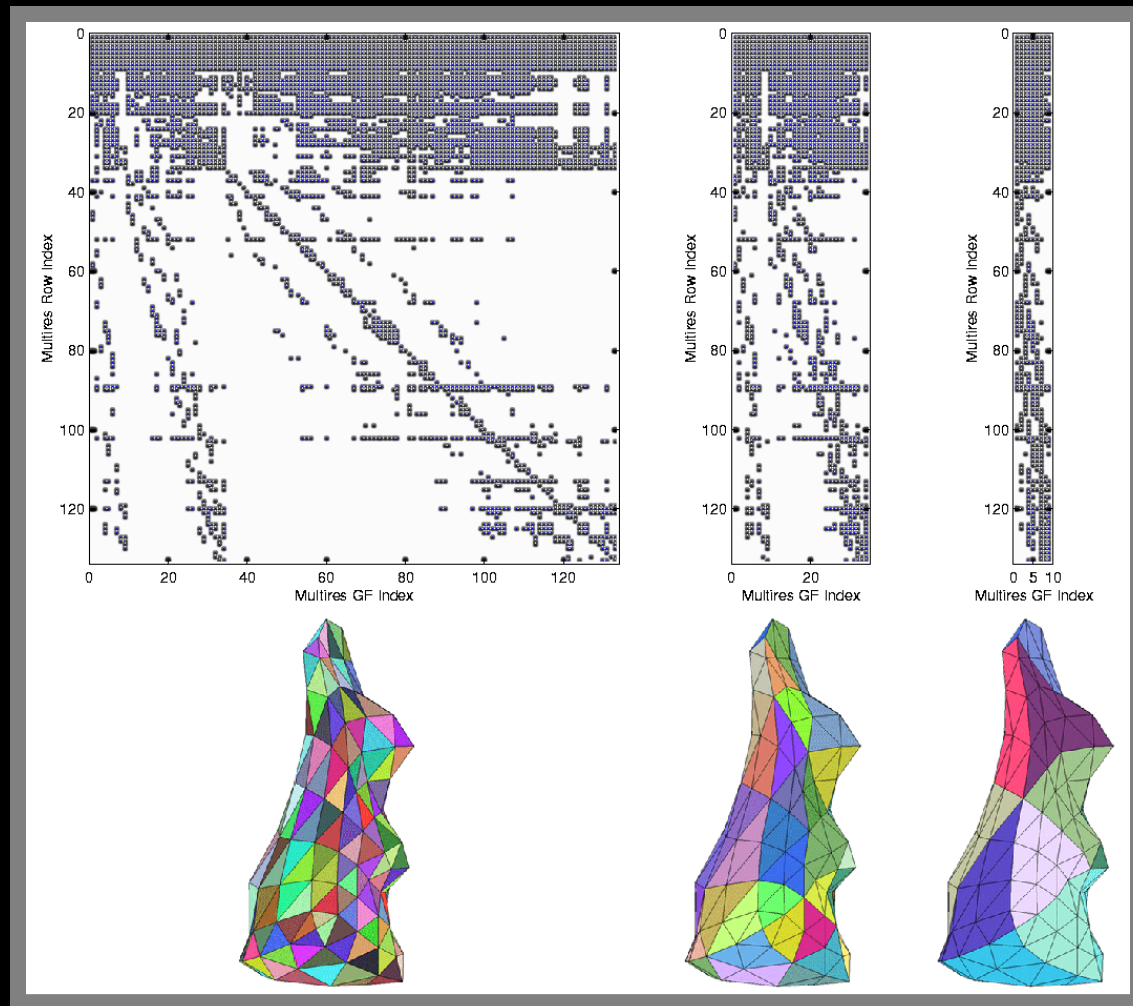
Simulating Large Models

12

Simulating Large Models

Sound

Modal renderer

Source:
CMU

14

GPU programming

- Vertex shader

- Fragment shader

- CUDA

- OpenCL

Physics in games

Real-Time Deformation and Fracture
in a Game Environment

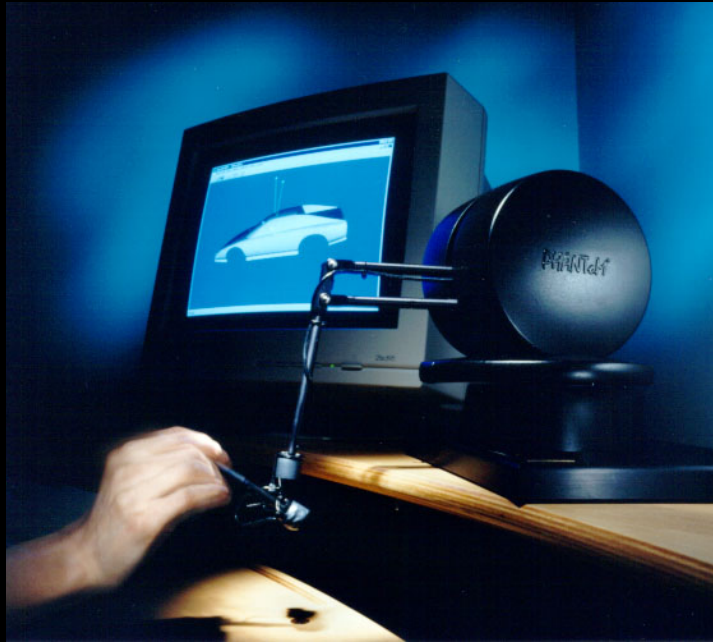Eric Parker
Pixelux Entertainment

James O'Brien
U.C. Berkeley

Video Edited by Sebastian Burke
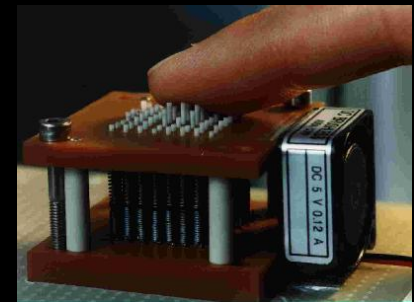
From the proceedings of SCA 2009, New Orleans
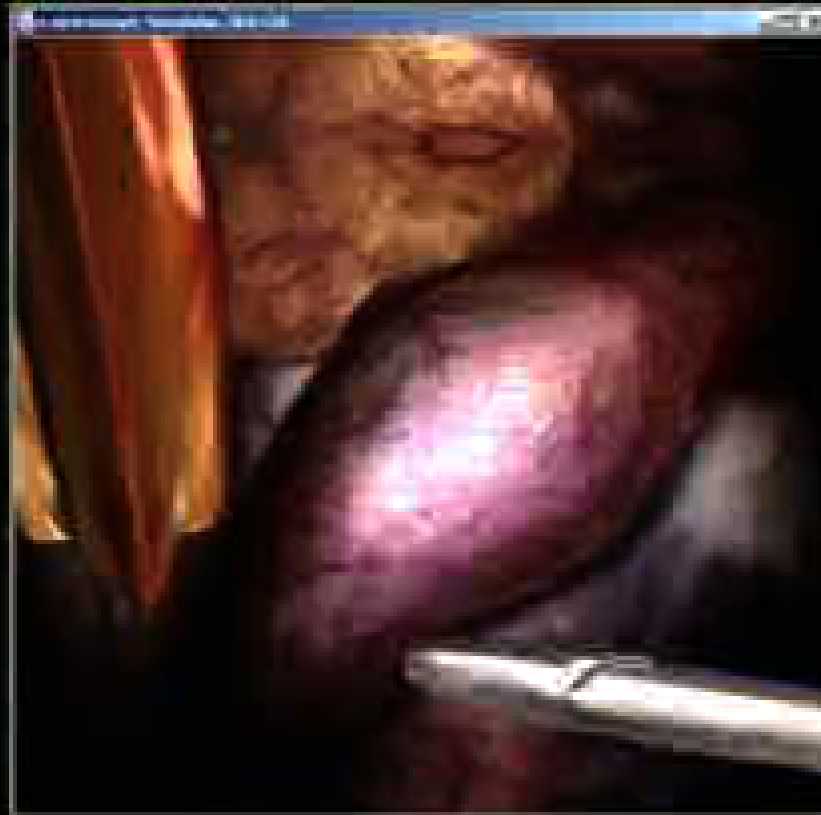
Source:
Symposium on
computer animation

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Force-feedback Rendering

Haptic Interfaces

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

Surgical Simulation

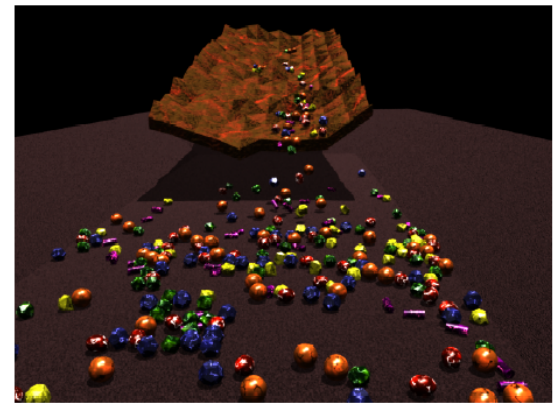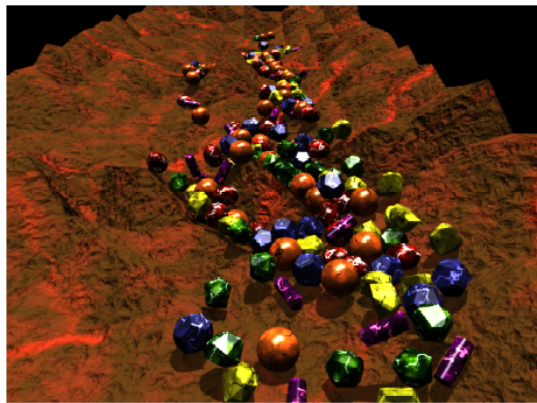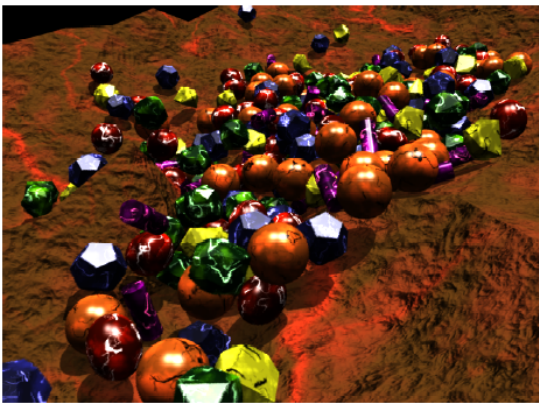# Motion Capture

Multibody dynamics

Figure 1: *Avalanche:* 300 rocks tumble down a mountainside.

TOPICS TO BE COVERED:
Depending on time and class interest we will cover topics from:

- Overview of physical simulation in
  computer graphics and interactive applications
- Primer on numerical linear algebra
- Dynamical systems, numerical integration of ODEs
- Constraints and contact
- Rigid body dynamics
- Collision detection
- Structured deformable objects (solids, cloth, hair)
- Fracture and cutting
- Fluids (Navier-Stokes)
- Multiresolution geometric and physical modeling
- Haptics
- Sound simulation (acoustics)
- Programmable graphics hardware (GPUs)
- Case study: Havok engine for physics in games
- Data-driven approaches to simulation (motion capture)

Evaluation

- Assignments: 2 x 20%

- Project: 50%

- Class participation: 10%

Class goals

- Gain ability to create interactive 3D simulations

- Learn how to read research papers

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

- Improve code optimization skills

The project

- Implement a SIGGRAPH paper of your choice

- Implement an elaborate demo using a physics game engine (e.g., Havok)

- Fluid solver

- Collision detection algorithm

The project

- Robotic rigid multi-body system

- Real-time sound simulator

- Fast FEM deformable object simulation

- Simulation in CUDA

The project

Majority of grade!

Schedule:
- Immediately: Start researching possible project areas
- Feb 16: Project proposal
- Mar 23: Progress report
- Mar 28: Progress milestone
- Apr 27: Project due; presentations

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