CS 491 -- *CS Skills for Simulation and Game Programming*

Fall Quarter 2019

http://cs.oregonstate.edu/~mjb/cs491


Handouts

Classes

Grades

VHR

Piazza

This page was last updated: December 9, 2019

Announcements:

- The answers to Quiz #10 can be found here.
- Prof. Baiey's Finals Week Office Hours are:

Monday	12:00 - 2:00
Tuesday	12:00 - 2:00
Wednesday	12:00 - 2:00

- Please listen to the two videos on Functional Animation and Modeling the World as a Mesh of Springs while I'm gone.
- Alert student Zach Thompson found this awesome video. It's like the ones we looked at on Monday, only it's real. Go to https://www.youtube.com/watch?v=IvUU8joBb1Q.
- OSU maintains a service called Handshake that is meant to connect you and potential employers. Find it at: https://career.oregonstate.edu/handshake . Then go to **Student Login Handshake**.
- The OSU Game Development Club is designed to give students a chance to collaboratively learn and create games. Anyone with an interest in video game development is welcome, from any skill level and any major. We meet in the Computer Graphics Education Lab (CGEL) in Batcheller Hall and work on game prototypes with the goal of participating in Game Jams later this year.
  Email Nathan De Stafeno if you have any questions. If you are interested in joining, follow the links below to follow the club and be notified of future meetings.
  Email: gamedev@oregonstate.edu
  Link: https://apps.ideal-logic.com/osusli?key=F3T9-25VWY_5878-CZ4R_ac1fd82b
  Discord: https://discord.gg/6MtNcvJ
- Interviewing this year? Check out the resources at the OSU Career Development Center.
- Here's a great resource for you. Check out the 2016 Game Career Guide. (all 105 pages of it)
- For those of you job-interviewing this year:
  There is a *great* book called: *Programming Interviews Exposed: Secrets to Landing Your Next Job*

It prepares you for CS interview questions by revealing strategies and giving a nice review of data structures, recursion, and other programming information you might be asked about.
Best of all, the OSU library has it in electronic form. Click here and then click on "Read Online".
(I have a paper copy of it if you'd like to see it. Also, it's around $20 on Amazon

- You can get some of the Microsoft packages for free. This includes Visual Studio. To do this, go to: https://azureforeducation.microsoft.com/devtools. Click the blue **Sign In** button. Login using your ONID@oregonstate.edu username and password.

What We Will Be Doing (and Not Doing) This Quarter

This is not a game-design course. It is also not a game-creation course. We will not be *creating* any games. Game and simulation programming is very much a data-, math-, and physics-intensive activity. A certain number of actions must be produced, and producing them by hand is hard. Also, producing them by hand often leads to sucky-looking content.

It's much easier, and produces better-looking results, if we can convince the computer to do the right things for us. But, it takes special knowledge to do that.

That's why you are here. This is a middleware CS course that will fill in many of those special knowledge missing pieces.

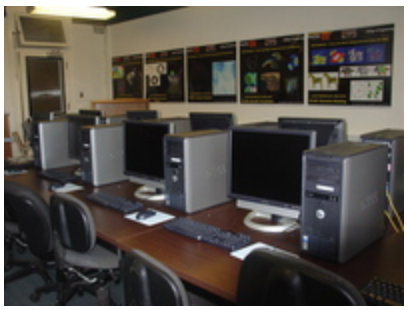
Even if you aren't looking for a job in one of these fields, you will likely find these varied topics useful and enjoyable anyway.

CS 491 topics include:

- Parametric lines
- Vectors: dot product, cross product, uses for dot and cross products
- Matrices: definition, multiplication, transpose, determinant, inverse
- C++ vector and matrix classes and methods
- 3D coordinate systems, transformations
- Forward kinematics (hierarchical transformations)
- Newton's method for solving for roots of nonlinear equations
- Inverse kinematics using Cyclic Descent
- Rigid-body constant-acceleration kinematics, projectiles
- Rigid-body dynamics, integrating equations of motion
- Keyframe animation
- Functional Animation (Collision avoidance)
- Collisions, impulse-momentum, rebounding
- Particle systems
- Modeling the world as a mesh of springs (e.g., chains, strings, cloth, jello)
- Guest Lectures

By the way, this is only a little bit a computer graphics course. We will not be writing graphics programs, but you will sometimes be given graphics program skeletons to test your coding. If you want computer graphics, either in addition to this course or instead of, CS 450 is the class you want.

If you need a place to do your programming assignments, you can get access to the Windows 10-based graphics systems in OSU's Computer Graphics Education Lab (CGEL) in Batcheller Hall 244.



Access to the CGEL is by your OSU ID card, which also acts as a card key. The first full week of classes, I will give the EECS Main Office a list of who is in this class, so that they can enable your cards for the CGEL.

Warning! Every so often, I reserve the CGEL for a grades 2-12 outreach activity. (Why? Because I want more "you"s in our major!) I will let you know when one of these is coming up.

Prerequisites

- C programming
- Data Structures
- Calculus

Yes, we will be using calculus!

Professor

The class is being taught by Professor Mike Bailey.

Office:	Kelley 2117 (2nd floor, south side)
E-mail:	mjb@cs.oregonstate.edu
Phone:	541-737-2542

Office Hours:

Mondays	2:00 - 4:00	Kelley 2117
Tuesdays	10:00 - 12:00	Kelley 2117
Wednesdays	10:00 - 11:00 and 2:00 - 3:30	Kelley 2117
Fridays	11:30 - 12:30	Kelley 2117
	or, anytime my office door is open	
	or, by appointment -- send email	

TA

Our TA for this class is Jian Tang. tangjian@oregonstate.edu . He is a computer graphics graduate student and has a lot of experience writing his own game engine. We are lucky to have him!

Combined Office Hours

	
Jian Tang	Prof. Bailey
tangjian@oregonstate.edu	mjb@cs.oregonstate.edu
Mondays, 12:30-5:30	Mondays, 2:00-4:00
	Tuesdays, 10:00-12:00
Wednesdays, 11:00-12:30	Wednesdays, 10:00 - 11:00 and 2:00 - 3:30

Fridays, 11:00-3:30	Fridays, 11:30-12:30
CGEL (Batcheller 244)	**Kelley 2117**

The Virtual Hand Raise (VHR)

I recognize that it takes a certain amount of courage to ask a question or express an opinion in class. But, the worst thing of all is to not say anything! So, this class has a feature called the *Virtual Hand Raise*. Click here to get into it. It will allow you to send me a question or comment, *completely anonymously*. I will answer questions submitted this way at the start of the next class, or if it's urgent, I will email to the entire class.

Textbook

There is no purchased textbook for this class. Instead, the material will consist of notes and web pages.

Warning! Warning! Warning! Just because you have notes doesn't mean you can skip class! The notes are just enough so that you can listen and discuss more, and write less. They are not meant to be complete. We will add to them in class! Tests will include material not written in the notes, but covered in class.

Every year, some people get an embarassingly bad grade in this class because they don't come to class. That is especially sad for those who envision a career in the gaming world, as this is our only CS class with the actual word "Game" in the title.

Class Note Handouts

Most notes are given in one, two, four, or six slides per page formats. This is so that you can make the readability vs. print-pages trade-off yourself.

2016 Game Career Guide	PDF			
The Premise Behind CS 491 Topics	PDF			
Parametric Lines	1pp	2pp	4pp	6pp
Vectors	1pp	2pp	4pp	6pp
GLM	1pp	2pp	4pp	6pp
A short GLM primer	Here			
Matrices	1pp	2pp	4pp	6pp
Transformations	1pp	2pp	4pp	6pp
Forward Kinematics	1pp	2pp	4pp	6pp
Kinematic Physics	1pp	2pp	4pp	6pp
Inverse Kinematics	1pp	2pp	4pp	6pp
Newton's Method	1pp	2pp	4pp	6pp
Particle Systems	1pp	2pp	4pp	6pp
Keyframe Animation	1pp	2pp	4pp	6pp
Dynamic Physics	1pp	2pp	4pp	6pp
Collision Avoidance	1pp	2pp	4pp	6pp

Meshes of Springs	1pp	2pp	4pp	6pp
Collision Physics	1pp	2pp	4pp	6pp
Collision Detection	1pp	2pp	4pp	6pp
More Information	PDF			
Making a Kaltura Video	Here			

Guest Speaker Note Handouts

- 10/23/2019 Here are Brian Apgar's slides: 1pp, 2pp, 4pp, 6pp.
- 10/30/2019 Here are Dan White's slides: 1pp, 2pp, 4pp, 6pp.

Videos

- The extraordinary musical instrument
- Kinematic musical instrument video (04:31).
- Honda Physics
- *Star Trek II: The Wrath of Khan* Genesis Demo (particle system, fractals) (1:25)
- Wow! Drone 3D pixels! Go here to see it.
  I've taken to calling these "droxels". :-)
- MythBusters -- Fun with Newton's Cradle, Part I (01:39).
- MythBusters -- Fun with Newton's Cradle, Part II (02:17).
- MythBusters -- Newton's Cradle After-show (05:12).
- Kittens-Newtons-Cradle video (1:28)

Class Schedule

To see an academic year calendar, click here.

Class time is: **Monday, Wednesday, and Friday, 9:00 - 9:50**. Unless otherwise specified, all classes will be held in **Owen 103**.

Cancelled dates: Oct 9, Oct 16, Oct 18, Nov 11, Nov 13, Nov 15, Nov 18, Nov 20, Nov 27, Nov 29

Note: this schedule is my best guess on where we'll be -- it is only approximate.

1	Sept 25	Introductions. Discussion of class objectives and how we will go about it. Project #1. Using the parametric line equation.
2	Sept 27	Vectors, I Project #1
3	Sept 30	Vectors, II GLM Here is a short GLM primer
4	Oct 2	Matrices

		Project #2
5	Oct 4	Transformation matrices Project #2
6	Oct 7	Forward Kinematics
7	Oct 9	**Prof. Bailey out of the office -- no class today** Kinematic acceleration physics -- projectile motion
8	Oct 11	Kinematic acceleration physics, II
9	Oct 14	Inverse Kinematics
10	Oct 16	**Prof. Bailey out of town -- no class today**
11	Oct 18	**Prof. Bailey out of town -- no class today**
12	Oct 21	Inverse Kinematics, II Videos! **The Networking Night is tomorrow tonight!**
13	Oct 23	**Brian Apgar, Zynga-Eugene, speaking on:** **"How Running A Live Game Impacts Your Code"** Confirmed. **The Engineering Career Fair is today!**
14	Oct 25	Solving nonlinear equations -- Newton's Method
15	Oct 28	Test #1 review. Particle systems
16	Oct 30	**Dan White, Pipeworks, speaking on:** **"Engineering at a Games Company: What do we do?"** Confirmed.
17	Nov 1	**Test #1**
18	Nov 4	Go over test answers Particle systems
19	Nov 6	Keyframe Animation
20	Nov 8	Keyframe Animation, II Mechanical dynamics
21	Nov 11	**OSU Veterans Day observance -- no class today**
22	Nov 13	**Prof. Bailey out of town -- no class today**
23	Nov 15	**Prof. Bailey out of town -- no class today** Video on Mechanical Dynamics
24	Nov 18	**Prof. Bailey out of town -- no class today** But, I'm leaving you a video on Functional Animation
25	Nov 20	**Prof. Bailey out of town -- no class today** But, I'm leaving you a video on Meshes of Springs.
26	Nov 22	Meshes of Springs
27	Nov 25	Collision Physics
28	Nov 27	**Thanksgiving Holiday -- no class today**
29	Nov 29	**Thanksgiving Holiday -- no class today**
30	Dec 2	Collision Detection
31	Dec 4	Class Evaluations. Test #2 review. Where to find More Information.
32	Dec 6	**No class today**
T2	Dec 10	**Test #2 Tuesday, December 10, 6:00 - 7:30 PM.** (You can confirm this for yourself by going here.)

Projects

Project #	Points	Title	Due Date
1	60	Using GLM to manipulate 3D Vectors	October 7
2	80	Using GLM to Manipulate Matrices and Transformations	October 14
3	100	Forward Kinematics	October 23
4	100	Collisions and Bouncing	November 4
5	100	Particle system	November 14
6	100	Keytime Animation	November 26
7	100	Mesh of Springs	December 9, 23:59:59 -- No Bonus Days

Projects are due at 23:59:59 on the listed due date.

Project Turn-In Procedures

- Your electronic turnin will be done at http://engr.oregonstate.edu/teach and will consist of:
  1. Source files of everything (.cpp)
  2. A one-page PDF file with your name, email address, and perhaps a link to a video that you create (I will let you know when the video is required).

  Electronic submissions are due at 23:59:59 on the listed due date.

  You can create the videos any way you want. But, Kaltura is quick, easy, and OSU has a site license for it. Here is how to use Kaltura.

- Your project will be graded and the score posted to the class web page.
  If you disagree with the score, or want to know why you did not receive full credit, come ask me about it.
  You have one week after the grades are posted to do this!

- Some of your projects will be auto-graded by a script that will append a main program to your functions, compile the combination, run the executable, and see if your functions produce the right numbers. I will tell you exactly how the script will compile your functions. ***If your functions do not compile, your grade on that project will be a zero.***

Bonus Days and Late Assignments

"I love deadlines. I like the whooshing sound they make when they fly by."
-- Douglas Adams

Each of you has been granted **five** Bonus Days, which are no-questions-asked one-day extensions which may be applied to any project, subject to the following rules:

1. Up to **2** Bonus Days may be applied to any one project
2. Bonus Days cannot be applied to tests
3. Bonus Days cannot be applied such that they extend a project past the start of Test #2 during Finals Week

Click here to get a copy of the Bonus Day Submission Form. Fill this out and turn it in the next class period after turning in your project.

Grading

Grades will be posted through this web page. To protect your privacy, they will be posted by your alias that you give me in Project #1.

Click here to see the current grade posting. CS 491 will be graded on a fill-the-bucket basis. There will be 7 projects, 10 quizzes (weeks 0-8, 10), and two tests. You get to keep all the points you earn.

The quizzes will be done via Canvas. They will open each Friday morning at 10:00 AM and close Sunday night at 23:59:00. Canvas is very unforgiving about due times -- don't push it.

... with the exception of Weeks #0 and #9:

Quiz #0 is due to me by **4:00 PM on Friday, October 4**. Fortunately, it is not too hard:

1. Get a 3"x5" index card (I'll give you one the first day of class).
2. Print your name *neatly* at the top (holding the card horizontally).
3. Print the course number (CS 491) *neatly* next to your name.
4. Also, printing *neatly*, tell me why you are taking this class. What do you hope to get out of being here?
5. Be honest -- no sucking up!
6. Bring the card to my office (Kelley 2117: second floor, south side) *sometime when I am there*. (Don't throw it under the door.)

If you are taking both of my classes this quarter, please fill out an index card for each.

There is no quiz for Week #9 (the week of Thanksgiving).

There are 2 Guest Speakers, and you get 5 points each for attending their lectures.

Your final grade will be based on your overall class point total. Based on an available point total of **950** grade cutoffs will be no higher than:

Points	Grade
925	A
900	B+
875	B
850	C+
825	C
800	C-
775	D+
750	D

You will notice that these cut-offs are not 90-80-70-... This is because I am going to do a "soft-grade" on your programming projects, i.e., if it works, you get full credit. A "hard-grade" would look at your programming style, etc., which would allow more of a traditional grading scale.

Class Rules

- **Lab Rules:** No propping the CGEL doors open. No food in the lab, drinks only in closed containers. (I am not being a jerk about the no-food requirement -- ask to see my shrine to the cockroaches that once inhabited the CGEL. Their friends are no doubt waiting for a reason to come back.)

- Keep the air conditioning in the CGEL running -- we have had problems with systems in that room failing when the temperature gets too high.

- **Computer Security:** We take computer security very seriously. Please use intelligently-chosen passwords and protect them. Anyone caught abusing the system or causing deliberate damage will be asked to drop the class and the matter will be turned over to the Dean's Office.

- **Academic Dishonesty:** You are expected to do your own work. Helping each other, with explanations or clarifications, is OK. Sharing code, however, is considered cheating. Anyone caught cheating will fail this class, and the matter will be turned over to the Dean's Office.

You are expected to read and understand Oregon State University's Statement of Expectations for Student Conduct, found here: http://studentlife.oregonstate.edu/studentconduct/offenses-0

If there is any parts of this document that you don't understand, ask me!

Students With Disabilities

Accommodations for students with disabilities are determined and approved by Disability Access Services (DAS). If you, as a student, believe you are eligible for accommodations but have not obtained approval please contact DAS immediately at 541-737-4098 or at http://ds.oregonstate.edu. DAS notifies students and faculty members of approved academic accommodations and coordinates implementation of those accommodations. While not required, students and faculty members are encouraged to discuss details of the implementation of individual accommodations.

Religious Holidays

Oregon State University strives to respect all religious practices. If you have religious holidays that are in conflict with any of the requirements of this class, please see me immediately so that we can make alternative arrangements.

Life Events

As {John Lennon? Allen Saunders?} has said: "Life is what happens to you while you're busy making other plans". I care about you as a person. When life happens to you, send me an email and come see me. I might be able to help, I might not. But I surely can listen. You are not alone.

Reach Out for Success

University students encounter setbacks from time to time. If you encounter difficulties and need assistance, it's important to reach out. Consider discussing the situation with me or an academic advisor. Learn about resources that assist with wellness and academic success at http://oregonstate.edu/ReachOut. If you are in immediate crisis, please contact the Crisis Text Line by texting OREGON to 741-741 or call the National Suicide Prevention Lifeline at 1-800-273-TALK (8255)

Basic Needs

Any student who has difficulty affording groceries or accessing sufficient food to eat every day, or who lacks a safe and stable place to live, is urged to contact the Human Services Resource Center (HSRC) for support: hsrc@oregonstate.edu, 541-737-3747. The HSRC has a food pantry, a textbook lending program, and other resources to help. Furthermore, if you are comfortable doing so, please come talk with me. I will do everything I can do to help you.

Other Useful URLs Related to Simulation and Game Development:

- Game Development:
  - Game Developer: http://www.gamedev.net
  - Gamasutra: http://www.gamasutra.com
- Local Companies:
  - Zynga-Eugene: http://www.zynga.com
  - Pipeworks: http://www.pipeworks.com
- Regional Discussion Groups:
  - Corvallis Gaming Special Interest Group: https://groups.google.com/forum/?hl=en#!forum/sao-corvallis-gaming-sig
  - PAGDIG: Portland Area Game Developer Interest Group: http://www.pagdig.org
- Different Ways of Interpolating: http://sol.gfxile.net/interpolation/
- Conferences:
  - Game Developers Conference (GDC): http://www.gdconf.com

    - E3Expo http://www.e3expo.com
    - PAX http://prime.paxsite.com/
    - SIGGRAPH http://www.siggraph.org

- OpenGL:
    - Industry-wide OpenGL Information: http://www.opengl.org
    - OpenGL 4.6 Reference Card opengl46-quick-reference-card.pdf
    - OpenGL specifications: http://www.opengl.org/documentation/specs
    - OpenGL Man Pages: http://www.opengl.org/sdk/docs/man
    - OpenGL SDK: http://www.opengl.org/sdk
    - OpenGL Tutorials: http://www.lighthouse3d.com/opengl/tutorials.shtml

- The GLUT Library:
    - HTML GLUT Documentation: https://www.opengl.org/resources/libraries/glut/spec3/spec3.html
    - PDF GLUT Documentation: https://www.opengl.org/resources/libraries/glut/glut-3.spec.pdf

- The GLUI Library:
    - OpenGL User Interface (GLUI) Documentation
      http://www.cs.unc.edu/~rademach/glui/src/release/glui_manual_v2_beta.pdf
    - Original GLUI Information http://www.cs.unc.edu/~rademach/glui
    - Latest GLUI Information http://glui.sourceforge.net

- A perfect example of the Uncanny Valley:
  http://www.slate.com/blogs/bad_astronomy/2008/03/23/i_will_never_watch_the_simpsons_again.html