COMP 4482A/9511A, Fall 2021
Game Programming
Syllabus

Course Information

Overview

This course will provide a high-level look at the design, implementation, and usage of video game engines. The primary goal of this course is to offer a basic understanding of (i) the requirements of programming for video games and (ii) the systems required to create a usable and *re*usable foundation for game development. Extra time will be spent examining and working in existing game engines in order to demonstrate good (or bad) design.

Some focus will be given to the graphical nature of game engines and will therefore include an introduction to computer graphics, (similar to and expanding on CS3388), shaders, animation techniques, and optimization algorithms. Depth will be given in selected areas, but the student will be expected to do a reasonable amount of independent reading and learning outside of the lecture hours.

Calendar Description

Core concepts and techniques of game programming, including the development and usage of game engines for the creation of games. Topics from: game engine architecture; real-time 2D and 3D rendering; character animation; shaders; real-time physics simulation, artificial intelligence, and networking; procedural methods; player input and controls; platform considerations; tools development.

Prerequisite Requirements

- CS 3307 (Basic Software Engineering) or SE3350.
- CS 3305 (Operating Systems) or SE3313.
- CS 3340 (Algorithms I) or (SE2205 and SE3310).
- Math 1600 (Linear Algebra I), or Applied Math 1411.

Useful (Not Mandatory) Background Knowledge

- Working knowledge of multivariate calculus and linear algebra.
- Ability to code well in Object-Oriented C-like languages (C#, C++, Java).
- Experience coding with graphics and/or the OpenGL graphics API.

Unless you have either the requisites for this course or written special permission from your Dean to enroll in it, you may be removed from this course and it will be deleted from your record. This decision may not be appealed. You will receive no adjustment to your fees in the event that you are dropped from a course for failing to have the necessary prerequisites.

Teaching Staff + Office Hours

Alex Brandt
abrandt5@uwo.ca
MC365
Mondays, 14:30 - 15:30, in-person (or Zoom by appointment)

Teaching Assistants

Mathias Babin	Caro Strickland
mbabin2@uwo.ca	cstrick4@uwo.ca
Thursdays, 13:30-15:00, in-person	Zoom by appointment

Email Contact

Students must use their Western (@uwo.ca) email addresses for communicating with teaching staff. Include "CS4482" in the subject line or else your email may receive a reply.

Course Materials and Website

There is no required textbook for this course. Students are responsible for checking the course OWL site on a regular basis for news and updates. This is the primary method by which information will be disseminated to all students in the class. Some interesting supplemental material:
- *Game Engine Architecture*, Second or Third Edition, by Jason Gregory.
- *GPUGems, GPUGems2, GPUGems3*: https://developer.nvidia.com/gpugems/.

Class Schedule

Monday	12:30 - 14:30	**HSB-35**
Wednesday	09:30 - 10:30	**FNB-1240**

There are 3 lectures hours per week. Notice the different locations for each session.
There is no class October 11, November 1, or November 3

In the event that in-class learning is cancelled for COVID restrictions, lectures will proceed synchronously via Zoom. Details to be announced, if required.

Students will be expected to wear triple layer non-medical masks at all times in the classroom as per Western policy and public health directives. Students who are unable to wear a mask for medical or religious reasons must seek accommodation through Accessible Education.

Students are expected not to eat or drink while in class to ensure masks stay in place. Students will be able to eat and drink outside of the classroom during scheduled breaks.

Students unwilling to wear a mask as stipulated will be referred to the Department, and such actions will be considered a violation of the student Code of Conduct.

Course Topics

This is a suggested a list of topics and we will likely cover a subset based on the interests of the class and time constraints. Topics will not necessarily be presented in the order listed here.

- History of Game Development
- Programming for the *Nintendo DS* console.
- Game Engine Development - Common Systems & Pitfalls
- Unity 3D - A Game Engine
- Real-time Rendering
  - The scene-graph model
  - Indoor and Outdoor real-time rendering
  - Character Animation: Explicit and Implicit
  - Shading: Lighting models, NPR, Shadows, Full-screen effects,
- Physics
  - Kinematics, Kinetics, Collisions.
  - Current Physics Engines
- Multiplayer Gaming

As there simply is not enough class time to teach the above topics in detail, the course will proceed in a "breadth-first" manner. For many of the topics, we will provide references to material you already know from your basic CS education, along with instruction on how to apply that knowledge to the domain of video games. The best we can do is provide a starting point and a helpful push; to get the most out of these topics, you will have to do much study on your own.

Student Evaluation

Most of a student's mark comes from applying what is learned in and out of class to a progressive series of assignments. There are three primary 'streams' of assignments: *Game Programmer*, *Engine Developer*, and *Tools Programmer*. Students may pick and choose which assignments they wish to complete according to their interests and career aspirations. The only constraint is that the student must have completed **and passed** all "pre-requisite assignments" before submitting another assignment. Assignments may *not* be completed concurrently. A graphical representation of the pre-requisite structure is given in Figure 1; it's a *skilltree*.

Each assignment has an "experience point value" (XP for short). Completing the assignment results in the student being awarded the associated amount of XP. *Note that there are no specific grades given for assignments, they are strictly pass/fail.* If you meet the specified requirements for the assignment, you pass, and are awarded the associated XP. In this case, **a "pass" corresponds to roughly an 80%** in a traditional marking scheme. Occasionally, a particularly awesome assignment may be awarded "bonus XP".

If you do not meet the requirements of the assignment, you will be informed which requirements were not met and you will receive no XP. However, you may continue to modify and resubmit your assignment until you pass, or until the final deadline, whichever comes first. **The *strict* final deadline is Wednesday, December 8th, at 23:55**, no re-submissions will be accepted after that time (see **Assignment Schedule** below). Any remaining failing submissions will be graded on a standard 0-100% scale for partial XP.

TOOLS

APP

ENGINE

OPTIONAL

Dialog System	Full Game	3D Engine	Shaders	Old School	*Really* Participate
3000 XP	*3000 XP*	*4250 XP*	*1000 XP*	*1500 XP*	*750 XP*

Localization System	Basic Game	3D DS			Participate
1500 XP	*1500 XP*	*2000 XP*			*250 XP*

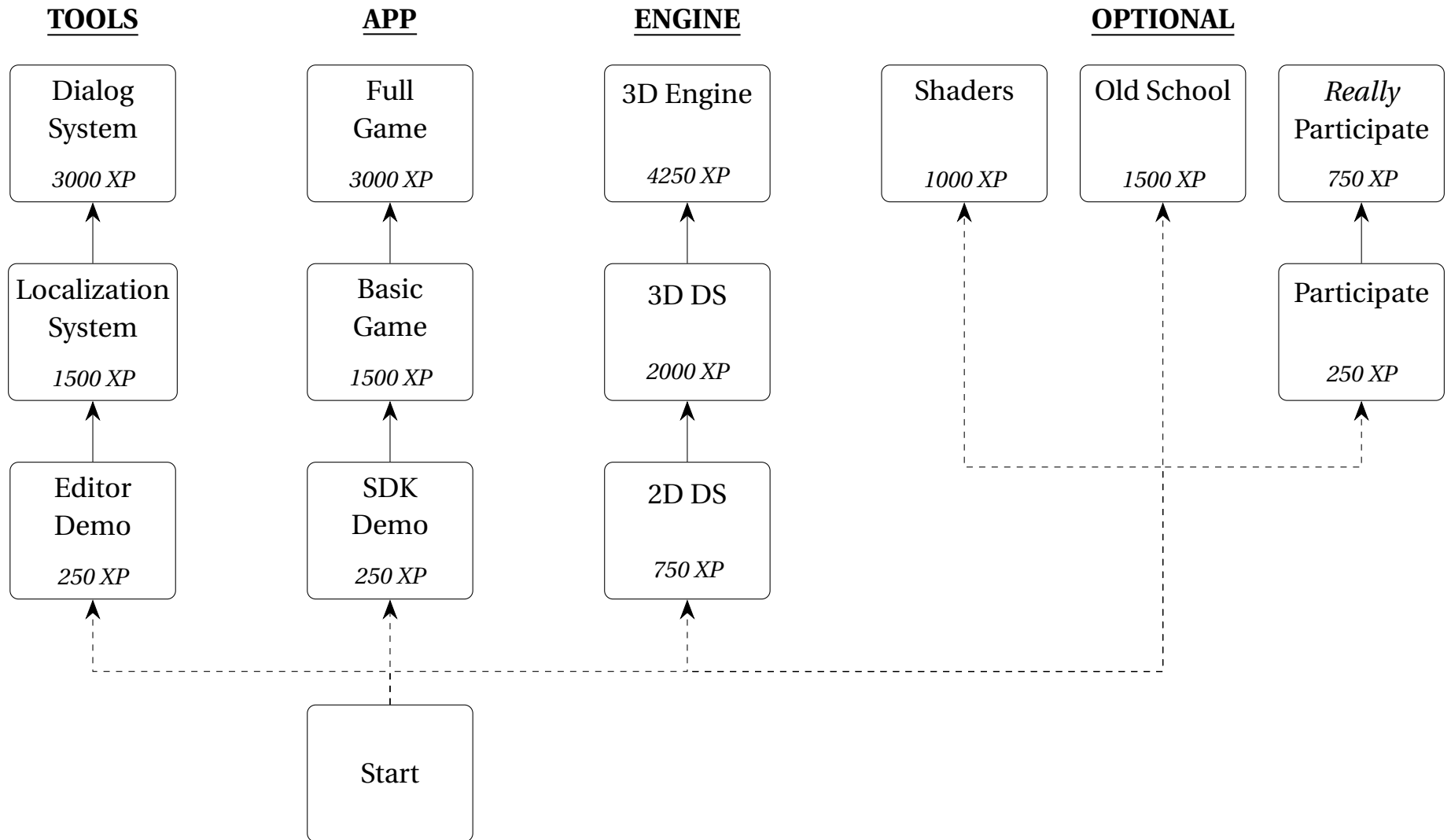| Editor Demo	SDK Demo	2D DS
250 XP	*250 XP*	*750 XP*

Start

Figure 1: CS 4482 Skill Tree.

Computing your final grade

Every good RPG has an "XP curve" and this course is no different. We use here a very simple XP curve (to make computing your grade simple):

$$\text{Current Grade} = \sqrt{XP}.$$

That's it. That's your mark in the course. You add up the XP you've earned so far and take the square root. There is no final exam and the assignments are all pass/fail. This means there is *no* nondeterminism in your grade. You can decide, right now, which assignments you're going to do and, if you put in the work, you know *exactly* what your final grade will be.

WARNING: READ THIS

Note that because your grade is computed as the *square root* of accumulated XP, the accumulation of 100XP at the beginning of the course will increase your final grade much more than 100XP at the end. As your total XP grows, you need ever larger amounts of XP to increase your grade by a fixed amount. All of this should be completely familiar to anyone who has played an RPG in the past 30 years.

The important consequence is this: make sure you plan to do (at least) one of the Tier-3 assignments at the end of a particular skill tree and proceed accordingly. The goal of the skill tree system is to provide flexibility for students with different interests. Under no circumstance should you plan to complete every assignment in the skill tree... unless you are independently wealthy, don't work, have absolutely no other classes, or really like learning under stress.

This non-traditional grading scheme is frightening to me. What can I do?

Ignore everything above and come see me. We can decide together which assignments are best for your interests and which will give you an overall great mark in the course.

Assignment Schedule

There is a great deal of flexibility in assignment choice in this course and with that flexibility comes great responsibility. Much like the real world, you must manage your time accordingly for the different tasks involved in completing your projects. The (not-so) secret evaluation mechanism of this course is time-management.

Due to the mix-and-match aspect of this evaluation approach there are no firm due dates (***except*** *December 8, 23:55*) you can attempt every assignment from day 1, submitting and re-submitting until you pass. **However**, it is expected that you submit assignments regularly throughout the term to show progression and engagement with the assignments. In particular, you must meet the following deadlines:

- Submit at least one "Tier 1" assignment (Editor Demo, SDK Demo, or 2D DS) by Friday, October 1, 2021, at 23:55. Additional Tier 1 assignments may be submitted after this date without late penalty.
- Submit at least one "Tier 2" assignment (Localization System, Basic Game, 3D DS) by Friday, October 29, 2021 at 23:55. Additional Tier 2 assignments may be submitted after this date without late penalty.
- All *first-time submissions* **must be made by Friday, December 3rd, 2021 at 23:55.**. Any *new* submission after this date *will* receive late penalties as described below. Submissions made after this date might not be eligible for re-submission.
- All *re-submissions* **must be made by Wednesday, December 8th, 2021 at 23:55.** No re-submissions or modifications will be permitted following this date.

Late Assignments

Based on the above schedule, late submissions will be penalized 20% of their potential XP for each day late. That is, 0-23 hours late: -20%, 24-47 hours late: -40%, 48-71 hours late: -60%, etc. Given the flexible nature of this course and evaluation scheme, accommodations for missing these deadlines must be requested sufficiently early. For example, it is *not* feasible to complain about an illness on October 1, 11:52pm, and ask for an extension. Contact the instructor **48 hours** before any deadline, except in truly exceptional circumstances, to discuss your options for extensions or otherwise.

Note that due to the time required in the marking process, *re-submissions* will not be penalized as late (except after December 8th, 25:55, when **no further submissions will be accepted**), provided that the original submission shows a reasonable attempt. "Place-holder" submissions will not be accepted. That is, making an empty or near-empty submission before the deadline to avoid a late penalty is unacceptable. Such a place-holder submissions will be considered void and late penalties will continue to be applied until a true submission is made.

Note that SRAs may only be used for Tier 1 and Tier 2 assignments. Tier 3 assignments are considered too highly-weighted for SRAs. See Academic Consideration for Student Absence below.

Academic Consideration for Student Absence

Students will have up to two (2) opportunities during the regular academic year to use an online portal to self-report an absence during the semester, provided the following conditions are met: the absence is no more than 48 hours in duration, and the assessment for which consideration is being sought is worth 30% or less of the student's final grade. Students are expected to contact their instructors within 24 hours of the end of the period of the self-reported absence, unless noted on the syllabus. Students are *not* able to use the self-reporting option in the following circumstances:

- for exams scheduled by the Office of the Registrar (e.g., December and April exams)
- absence of a duration greater than 48 hours,
- assessments worth more than 30% of the student's final grade,
- if a student has already used the self-reporting portal twice during the academic year

An SRA submitted to cover the Tier 1 or Tier 2 assignment deadlines must cover October 1 or October 29, respectively. The accommodation will be an extended deadline to 48 hours after the end of the SRA period. This will apply automatically, students do *not* need to email the instructor. An SRA **cannot** be used to cover Tier 3 assignments or the December deadlines.

If the conditions for a Self-Reported Absence are not met, students will need to provide a Student Medical Certificate if the absence is medical, or provide appropriate documentation if there are compassionate grounds for the absence in question. Students are encouraged to contact their Faculty academic counselling office to obtain more information about the relevant documentation.

Students should also note that individual instructors are not permitted to receive documentation directly from a student, whether in support of an application for consideration on medical grounds, or for other reasons. All documentation required for absences that are not covered by the Self-Reported Absence Policy must be submitted to the Academic Counselling office of a student's Home Faculty

For the policy on Academic Consideration for Student Absences - Undergraduate Students in First Entry Programs, see: https://www.uwo.ca/univsec/pdf/academic_policies/appeals/accommodation_illness.pdf and for the Student Medical Certificate (SMC), see: http://www.uwo.ca/univsec/pdf/academic_policies/appeals/medicalform.pdf

Religious Accommodation

Students should consult the University's list of recognized religious holidays, and should give reasonable notice in writing, prior to the holiday, to the Instructor and an Academic Counsellor if their course requirements will be affected by a religious observance. Additional information is given in the Western Multicultural Calendar: https://multiculturalcalendar.com/ecal/index.php?s=c-univwo

Policies, Accommodation, Accessibility

Mental Health

Mental and emotional well-being is highly important and should not be treated lightly. Students who are in emotional/mental distress should refer to Mental Health@Western at http://www.uwo.ca/uwocom/mentalhealth/ for a complete list of options about how to obtain help.

Accessibility

Students with disabilities work with Accessible Education (formerly SSD), which provides recommendations for accommodation based on medical documentation or psychological and cognitive testing. Please see the policy on Academic Accommodation for Students with Disabilities.
Please contact the course instructor if you require lecture or printed material in an alternate format or if any other arrangements can make this course more accessible to you. You may also wish to contact Accessible Education at (519) 661-2147 if you have any questions regarding accommodations.

Ethical Conduct

Scholastic offences are taken seriously and students are directed to read the appropriate policy, specifically, the definition of what constitutes a Scholastic Offence, at this web site.

All required assignment submission may be subject to submission for similarity review to open-source and commercial plagiarism detection software under license to the University for the detection of plagiarism. This may include MOSS and turnitin. All submissions for such checking will be included as source documents in the reference database for the purpose of detecting plagiarism of papers subsequently submitted to the system. Use of the service is subject to the licensing agreement, currently between The University of Western Ontario and Turnitin.com

Student Support

Please visit the Science & Basic Medical Sciences Academic Counselling webpage for information on adding/dropping courses, academic considerations for absences, appeals, exam conflicts, and many other academic related matters.

The Student Development Centre provides leaning skills services for students. Other services are also provided by the University Students' Council

Registration Services

Refer to the Registrar's website for information and services involving registration.