CS206 Final Project
Spring 2022

Starting today (Tues Mar 29), you will have a little over a month to complete your final project: you will present it orally, for 2.5 minutes, during the exam period:

Monday Apr 4, 11:59pm:	Submit deliverable 1 (**2%**)
Monday Apr 11, 11:59pm:	Submit deliverable 2 (**2%**)
Monday Apr 18, 11:59pm:	Submit deliverable 3 (**2%**)
Monday Apr 25, 11:59pm:	Submit deliverable 4 (**4%**)
Monday May 2:	[No submission; last week of classes]
Sunday May 9, 11:59pm:	Submit the written report (**10%**) and oral presentation
Monday May 10, 7:30am-10:15am:	Present your final project orally (**10%**)

Summary:

Deliverables 1-3: Since there are students with differing comfort levels when it comes to coding, there are two paths moving forward. You may choose to complete three, one-week mini-projects over the next three weeks. Or, you may tackle one, more challenging, three-week project. The former is less risky: if something goes wrong, you can start fresh the following week. The latter is more risky, but higher reward, as you'll have more room to explore your own ideas and it will end up being more rewarding. Students will not be penalized for choosing the "easy" path. If you choose the "easy" path, you must choose easy options from **here**. If you choose the "hard" path, you may choose one of the hard options from **here**, or you may formulate your own. If you formulate your own, please email Josh a three-sentence-maximum email of your idea to ascertain whether it is feasible in pyrosim.

Deliverable 4: Regardless of the path you choose, you will then spend the rest of the course performing an A/B test: you will demonstrate which of two slightly different evolutionary robotics experiments ("A" and "B") produces a better robot. For example, you might evolve gaits for a quadruped or hexapod: which evolves to move faster? Or, you may compare the parallel hill climber with another evolutionary algorithm: which evolves faster gaits for the quadruped? Do robots with or without CPGs evolve to move faster? In deliverable 4 you will create visualizations (e.g. fitness curves, footprint graphs, phylogenetic trees) from one run of "A" and one run of "B".

Exam period: In the final project, you will compare "A" and "B": you will show data and visualizations from multiple runs of "A" and "B", showing which (if any) variant was better.

Deliverable 1

If you choose one of the “easy” projects from **here**, submit one video demonstrating that it was achieved. When submitting make sure to describe, in your BlackBoard submission, what your project is (one sentence) and what we’re supposed to see in the video (maximum three sentences).

Like for the assignments, upload all videos to YouTube; embed the YouTube URL in a ludobots reddit post, and copy and paste the reddit URL into BlackBoard.

If you choose one of the “hard” projects from **here**, submit one video demonstrating that you are one third of the way toward completing it. When submitting make sure to describe, in a few sentences in your BlackBoard submission, what your project is, what we should see in the video, what you plan for next week, and what you plan to do to complete the project.

For example, imagine you choose the following project:

“Evolve a robot that avoids objects in its environment.”

You might break this down into the following three pieces:

- *Deliverable 1*: I modified the parallel hill climber side of my code base so that the same solution is written out twice, but two different world.sdf files are written out. The first time, the block is placed directly in front of the robot. The second time, the block is placed directly behind the robot.

- *Deliverable 2*: I modified the parallel hill climber so that it reads in two fitness files for each solution, and combines them into a single fitness value for that solution. (Video shows search.py stopping just after reading in both fitness files. The video ends by showing the file directory, with the two fitness files sitting in it.)

- *Deliverable 3*: I worked on the fitness function to reward -y movement in the first case and +y movement in the second case. As you can see in the video, this led to the evolution of a robot that moves backward when it hits an object placed in front of it, and moves forward when it hits an object placed behind it.

Deliverable 2

If you completed one of the one-week projects last week, pick another one week project to complete this week. You can either add it to what you did last week, or you may create a new branch from your quadruped assignment and “start again”. For example, if you evolved jumping last week, you might add to it by evolving pronking this week: jumping while moving forward. Or, if you did jumping last week, you may discard jumping, and instead evolve a quadruped that walks through a debris field of cubes.

If you are doing one of the three-week projects, remind us in your BlackBoard submission of what you did last week, describe your progress this week, and upload one video showing you are two thirds of the way to completion.

Deliverable 3

If you did a one-week project last week, do a third one this week.

If you are doing a three-week project, remind us in your BlackBoard submission of what you did last week, describe your progress this week, and upload one video showing you have completed the project.

Deliverable 4

You will submit preliminary results from your A/B testing. A/B testing is described here. For those who implemented only one project, split it into an “A” and “B” variant. For those who implemented more than one project, if two of them are comparable as explained here, treat them as “A” and “B”. If they are not, pick one of your projects and split it into an “A” and “B” variant.

Perform one run of “A” and one run of “B”. Submit two fitness curves, drawn inside the same figure, corresponding one curve from each variant. Create one other way to visualize results from A and B, and submit a visualization for the A run and the B run. You might attempt a footprint graph (slide 14 here), a phylogenetic tree (slide 9 here), or a visualization of how your best evolved robot does in environments not experienced during evolution (slide 5 here or slide 16 here).

Written report.

Between now and the oral presentation period, you will perform **A/B testing** by performing multiple runs of your “A” and “B” variant, allowing each run to evaluate the same number of robots. You will then generate visualizations to visually prove which, if either, variant produced better robots.

As you are performing your A/B testing, write it up as a report as follows.

The report should contain **four** sections, about one page per section. Points will be taken off for poor writing quality.

1. The first section should describe your goals: What project(s) did you tackle during the deliverables? How did you create “A” and “B” variants from them? What was the question you tried to answer?

2. The second section should describe implementation details: how did you code up your deliverables and A/B test? What was your strategy?

3. The third section should provide some results from the A/B test. Most importantly, you should demonstrate that evolution did in fact occur: show that an evolved robot did better than a randomly-generated robot (hint: the mean fitness curve should help you here), within a variant. Then, show that one variant did better than another, or that both produced about the same quality of robot. You may want to include fitness curve graphs here, footprint graphs, phylogenetic trees, visualizations of how robust evolved robots are to new environments, and/or screenshots of the robot in its virtual environment.

4. In the final section, you should demonstrate that you've thought carefully about your deliverables and A/B test. What was surprisingly difficult? What was surprisingly easy? If you had another year to work on this project, how would you expand your project? What new features would you want Pyrosim to have to achieve this? Which aspects of the expanded project do you think would be relatively easy, and which difficult?

Due: **11:59pm, Monday May 9** (0% if late).

Submit to: BlackBoard / CS206 / Final Project / Written Report

Submission format: 1 pdf document (0% if other format)

Minimum length: 4 pages, double-spaced, 12-point font.

Oral presentation.

Like the report, the oral presentation should contain four sections. Part of your grade for the oral presentation will be clarity of communication.

In the results section of your video, you will likely want to show the video of an evolved behavior and a random behavior to communicate to your audience that evolution actually improved behavior, and what that behavior is. You will want to show a second video, comparing the best robot from "A" and the best robot from "B". You will also want to show your visualizations comparing "A" and "B" performance.

Ensure that your video has no sound. (During the presentations, when it's your turn, you will come to the front of the room and talk over your video while it plays.)

If you do not have any screen capture software, just record your screen using your phone. No points will be deducted for poor video. However, if the video is so poor that we cannot see what we are supposed to see in the video, then points may be deducted.

Upload your 2:30m video to YouTube. Make the link public and "Not for kids"

Then, copy and paste the YouTube URL (no other text need be supplied) to

BlackBoard / CS206 / Final Project / Oral Presentation

The T.A. will stitch the videos together into a single YouTube playlist. So, your video link must be submitted to BlackBoard no later than **Mon May 9 at 11:59pm**. If you are late, you will receive 0% for your oral presentation and you will not be able to present the following day.

We will all meet in class at **7:30am on Tues May 10**. At that time, the instructor will start playing a YouTube playlist containing all student-submitted videos. An oral presentation schedule will be made available in the course schedule beforehand. When the student before you begins speaking, please come up to the front of the room and stand next to the screen. When your video starts, please narrate your video, and then reseat yourself. (You may bring your preferred device to class.)

In order to keep on time, all the videos will play one after the other, with no pause in between. However, two 10-minute breaks will be inserted to give everyone a chance to rest. This means that when your video starts, you should start speaking immediately. If you run long, you will be cut off so that the next student has time to present their work. So: be sure to practice.

1. Submit to: BlackBoard / CS206 / Final Project / Oral Presentation
2. Submission format: URL pointing to a public YouTube video.
3. Video length: 2 minutes and 30 seconds (0% if longer).

Questions: Unfortunately, due to time constraints, there will not be time for presenters to field questions. However you are encouraged to ask your fellow students questions about how they did what they did, or for clarification, during the breaks and after the presentations.

Collegiality: There will be a temptation to “tune out” during the presentations, as we all have many demands on our attention at this time of year. However, each of you have put a lot of work into your final projects, and there is much creative work to see and learn about. So, please practice collegiality: please extend your fellow students --- especially those presenting toward the end of the presentation period --- the respect they deserve by watching and engaging with their presentations.