

CS206: Evolutionary Robotics Final Project Instructions

Instructor: Josh Bongard (josh.bongard@uvm.edu)

Final Project Description:

The final project is worth **30%** of your final grade for the course. There are three deliverables for the final project:

1. five weekly reports ($2\% \times 5 = 10\%$ of your final grade);
2. an oral presentation (10% of your final grade) (video is due at **11:59pm, Wed May 6**);
3. a written report (10% of your final grade) (report due at **11:59pm, Wed May 6**).

In summary: you will be creating a project in Reddit that enables future students to conduct the same project. Thus, if you decide to evolve robots that jump as high as possible, you need to not only evolve a robot that does so but create a project in Reddit that helps another student evolve a robot to do so. In essence, you're creating an 'Assignment 11'.

1 The weekly reports

You will submit five weekly reports to the `reddit.com`, very much like you did for the assignments.

1. Weekly report 1: Choosing your project (due **Thurs, Mar 26 at 8:29am**)
2. Weekly report 2: Breaking your project into milestones (due **Thurs, Apr 2 at 8:29am**)
3. Weekly report 3: Screenshots of milestone 1 (due **Thurs, Apr 9 at 8:29am**)
4. Weekly report 4: Instructions for how to reach milestone 1 (due **Thurs, Apr 16 at 8:29am**)
5. Weekly report 5: Screenshots of milestone 2 (due **Thurs, Apr 23 at 8:29am**)

1.1 Weekly report 1

Here, you will indicate on Reddit which project you will work on. You can pick one from the following list, or come with your own idea. Take some time to think about which project interests you, and whether you can finish that project before the end of the semester.

Potential project ideas:

1. Create a robot with [whegs](#), and evolve it to use its wheels on flat ground and its legs on rough terrain.
2. Create two quadrupeds that, together, push a large object as far as possible.
3. Create a robot that can [climb stairs](#).
4. Add a [gripper](#) to the quadruped such that it can grasp and lift objects.
5. Create a (simplified!) version of Hans Moravec's [fractal robot](#).
6. Turn the quadruped into a wheeled robot, and evolve it to chase a moving object.

7. Evolve a robot to [brachiate](#).
8. Evolve a [bipedal robot](#).
9. Evolve a bipedal robot that exhibits [passive dynamic walking](#).
10. [Project ideas from last year's students](#).

Once you have chosen one of these projects, or come up with an idea for your own, create a new project in Ludobots by doing the following:

1. Go to www.reddit.com/r/ludobots.
2. Click 'Make a Post' to the right.
3. In the 'title' box, type '[Project]' and then a one sentence description of your project, such as 'Evolve a robot that can jump as high as possible.'
4. In the 'text' box, type four or five sentences describing in a bit more detail how you will carry out this project. Continuing the example of the jumping robot, you might type: "In this project you will create a robot that jumps as high as possible. You will do this by modifying the fitness function such that it detects the maximum height reached by the robot during its evaluation. You will also need to add some velocity and acceleration sensors so that the robot is better able to prepare for the jump, and then do so at exactly the right moment."
5. Click 'submit'.
6. Copy the URL of the resulting page.
7. Go to 'Course Materials' / 'Final Project' in BlackBoard.
8. Click on 'Weekly Report 1'.
9. Click on 'Write Submission'.
10. Paste your URL here.

1.2 Weekly report 2: Break your project into milestones.

In this weekly report, you will embed some content into the wiki page associated with your project: you will state and briefly describe **at least three milestones** that you will implement, one after the other, between now and the end of the semester.

A video tutorial outlining what you need to do for this weekly report is available [here](#).

1.3 Weekly report 3: Screenshots of milestone 1

In this weekly report, you will implement the first deliverable you listed last week.

You must then submit one or more screenshots that demonstrates that you have successfully implemented your milestone. It is up to you to decide how to provide visual documentation that your milestone was implemented correctly. For some of you, your added functionality may be 'invisible', such as new sensors or a strengthened evolutionary algorithm. In such cases, you will have to be creative to make what is invisible visible. For inspiration, go back to projects six and eight, which rendered joints and sensors visible.

Once you have implemented your milestone and captured your screenshots, you will embed those screenshots in the wiki page associated with your project as follows:

1. Upload the screenshots to imgur.com.
2. Record the URLs of the resulting uploaded images.
3. Go to the wiki page associated with your project and click 'edit' at the top of the page.
4. Click 'formatting help' below the text box to see how to embed a URL in the wiki page.
5. Embed the URLs that point to your images in the text box, below your first milestone and above your second milestone.
6. Click 'save page'.
7. Go to BlackBoard, and submit the URL that points to your wiki page into your submission for Weekly Report 3.

1.4 Weekly report 4: Instructions for how to reach milestone 1.

This week, you will embed a number of instructions between milestones 1 and 2 in your wiki page. These instructions should guide a student through to the successful re-creation of the screenshot(s) you submitted last week.

Writing good tutorial instructions can be challenging. The idea is to provide guidance to the student that is not too easy and not too difficult. Too easy instructions would be, for example, "Drop this code snippet at this place in your current code. Drop this other snippet at this other place..." The student will not learn anything from blindly following these instructions. On the other hand, instructions such as "Implement an acceleration sensor" are too vague, and thus too difficult: how should the student get started implementing this milestone?

Have a look at the tutorial instructions from assignments one through 10. Note how these instructions try to reach some middle ground: the student is given the basic idea, and may be given a bit of code, but is challenged to formulate some code of their own. Your instructions will be judged based on their ability to hit this 'sweet spot'. It is up to you to decide how many or how few individual instructions are needed to accomplish this.

When you are finished, submit weekly report 4 by copying and pasting the URL that points to your wiki page into BlackBoard's 'Weekly Report 4'.

1.5 Weekly Report 5: Screenshots of milestone 2

See weekly report 3 instructions above.

2 The Oral Presentations

Each student will create a five-minute video, without audio. Then, during the final exam period (Thursday May 7, 7:30am - 10:15am), each student will speak over their video, presenting their project. The presentation schedule is listed at the end of the course's [syllabus](#).

1. Create a short video using any video editing software you have at hand. If you don't have any, you can shoot video with your phone, upload it to YouTube, and assemble your video using their [Video Editing](#) system.
2. Your video should start with a list of your milestones, highlighting which ones you were able to successfully implement.

3. Your video should contain a few slides introducing your method: how did you go about building your robot and/or its environment? How did you change the fitness function, artificial neural network, and/or hill climber? As a rule of thumb, it's always better to create a visual than include large amounts of text. Think of all of the ANN visualizations we saw in class. **(about 1 minute)**
4. Your video should then show a few video clips. **(about 2 minutes)**
5. Depending on your project, you might show a robot behaving with a random ANN and an evolved ANN. If a difference can be observed between these two behaviors, then this serves as proof that you have managed to evolve the desired behavior.
6. You might show several evolved behaviours: do these behaviors all share something in common, or does evolution find different behaviors?
7. You should also include at least one static image representing some results: this could be a fitness curve (see the Hillclimber project), or a footprint graph (see Lecture 12: Legged Locomotion), or the kinds of visualizations we saw when we discussed Minimal Cognition (Lecture 10). **(about 1 minute)**
8. You should include one slide outlining what aspects of the final project you found particularly challenging, and what you learned from overcoming them. **(about 30 seconds)**
9. The final slide should outline how you would expand your project if you had another semester to work on it. **(about 30 seconds)**
10. Your video should last exactly **five minutes** total.
11. Mount your video in YouTube. Title your video as follows: 2015_CS206_UVM_Firstname_Lastname.
12. Submit the URL that points to your YouTube video to BlackBoard / Final Project / Oral Presentation **by 11:59pm on Wednesday, May 6**. If your video is not present by then, you will not be allowed to present on Thursday and you will receive a zero for your oral presentation.
13. The instructor will stitch all 25 videos into a YouTube playlist Thursday morning. This playlist will start running at 7:30am on Thursday May 7, in Votey 209.
14. When your video starts, come up to the front of the class and talk over your video. When your video ends, please take your seat again. If you have never talked over a silent video, practice this several times. You will not be allowed to pause or rewind the video.
15. Be prepared to answer questions about your project during the 10 minute breaks.
16. Your oral presentation will be assessed based on: the creativity of your project, how much of it you implemented, the depth of thought you put into why particular parts failed and other parts succeeded, the presence of all the materials described above, and the quality of your oral presentation.

3 The Written Report

The written report is simply the completed wiki page for your project. Be sure that you submit the URL that points to your wiki page to BlackBoard / Course Materials / Final Project / Written Report **by 11:59pm on Wed May 6**. This report should contain the following components. Consult this [project](#), as it contains examples of all of these components.

1. The top of your wiki page should contain a pointer back to the project 'Connecting the Hill Climber to the Robot' (i.e. project core10). **(1 point)**
2. The top of the project core10 page should contain a 'Next Steps' link to your project. **(1 point)**
3. Your wiki page should contain a short paragraph under 'Project Description'. This should introduce the student to what the project involves, and what they can expect to achieve if they complete the project. **(1 point)**
4. You should list, in bulleted form, the milestones that make up your project. For each milestone there should be an indented bullet list that presents each numbered instruction. If it's helpful, break your milestones down into sub milestones (milestone 1.1, 1.2, ...) The instructions themselves should not be overly vague (e.g. 'evolve a jumping robot') or overly specific (e.g. 'Drop this piece of code here, and this piece of code there'). The instructions should be designed to guide the student through the project such that they learn something along the way, and have to demonstrate some independence of thought. **(3 points)**
5. At the end of the instructions, you should include a 'Food for thought' paragraph. This is where you demonstrate to the grader that you have thought about the results you obtained from completing your project. For example: did the evolved behaviors turn out like you thought they would? Do the behaviors remind you of any behaviors exhibited by biological organisms? If they have no biological counterpart, why do you think this is so? How might the evolved behaviors have been different if you used a different fitness function, or robot, or environment, or evolutionary algorithm? **(1 point)**
6. You should conclude with a 'Ideas for future extensions' paragraph. This is where you challenge the student to come up with ways to build upon your project. You should list a few ideas for project extensions yourself here. **(1 point)**
7. Clarity and writing quality of the entire wiki page. **(2 points)**