Syllabus for CS 601R (will be CS 658)
Computer Generated Natural Phenomena
Winter 2008

In this class, you will learn how to design computer algorithms which mimic natural phenomena. You will learn this by studying a few classic algorithms, studying a few recent promising algorithms and by designing your own algorithms. The study of natural phenomena is supposed to fun and exciting. The class should change the way you appreciate and look at nature—both in the real world and in film.

There are two reasons why you should learn to mimic nature with an algorithm. First, it will improve your ability to design algorithms which solve problems in other application domains. Second, it will improve your ability to design natural phenomena algorithms. Algorithms that mimic natural phenomena are useful in a wide variety of fields including CG animation, games, forestry, architecture, botany and other sciences. We will emphasize CG animation and image generation.

Staff

Professor: Michael Jones, Department of CS, BYU, 801 422-2217, jones@cs.byu.edu, 3328 TMCB
Office Hours: Mostly by appointment (I actually prefer hours by appointment, but feel free to come during posted hours as well) and Monday 2pm-3pm, Tuesday 9 am – 10 am, Wednesday 11 am – noon.

TA: Jie Long (PhD Student), Department of CS, BYU, 3325 TMCB
Office Hours: TBA

Webpage: http://cs658.wikidot.com/ and Blackboard for grades.
Textbook: Digital Design of Nature by Oliver Duessen published by Springer. Journal and conference papers as assigned in class.

Class Objectives

Three years after taking CS 658, you should still…

- Know a few enduring algorithms based on solid science and solid algorithmics which mimic natural phenomena. These include L-systems, midpoint displacement and other fractal methods.
- Understand that complex but non-random processes can be decomposed into computer algorithms by correctly recombining fundamental building blocks.
- Know that for users of computer graphics technology, in the end, it's all about appearance. The process that gets the final image isn't as important to end users as the final image.
- Have a deeper respect for what you see in nature.

Learning Activities

Most of your learning in this class will happen, not surprisingly, outside of the classroom. In this class, that learning will come from reading, studying, writing code and thinking.

The primary reading for the course will be about ½ of the textbook and a collection of recent papers. You will likely need to read beyond the required reading in order to understand the required reading. Reading is a bit of misnomer because reading for a graduate CS class is more than passively turning pages it more like paper in one hand, pen and paper in the other and actively working to understand the paper.

The course will consist of a make-an-image assignments, a few smaller projects and a single semester-long project,. The smaller projects will require coding up simplified versions of existing algorithms. The point of those projects is to help you understand the classic algorithms by implementing them. This will give you new insights into those algorithms and take you through concrete examples of mimicking nature with an algorithm.

Make-an-image

For the make-an-image projects, you need to find and download a freee tool demo and then use the tool to make an image. Turn in the image, a paragraph saying what you were going for in your image and the image itself. Two of these planned. One in which you make a plant using something like XFrog and one in which you make some terrain using something like Vue.

Smaller Projects

The smaller projects are:

1. Implement 2D terrain generation using midpoint displacement.

2. Implement 2D L-systems

The semester project gives you a chance to think more constructively and creatively about how an algorithm might mimic a natural phenomena. This is the kind of practice that will build your algorithm design skills.

Semester Project

Semester projects will go a lot better if you and I both find the topic interesting. Rather than have you submit topics and guess what I think is interesting, I've prepared a list of project topics which I think are interesting. You get to pick[1] one of those projects.

1. Tree motion.
2. Feedback control in parameter value tuning
3. Editable 3D terrain using voxel grids.
4. Image-based reconstruction of rock formation shape and reflectance.
5. Image-based reconstruction of the reflectance of the Buckhorn Wash pictograph panel.
6. Time and weather sensitive relighting of terrain
7. Directable interactive clouds for animation.

The process for picking your semester project has the following rules:

1. No more than 2 people per project. 2 people may combine into 1 partnership and a partnership counts as 1 person on a project.
2. Project assignments will be made in several rounds of voting.
3. In each round, you will get $n - 1$ votes in which n is the number of unclaimed projects.
4. If you decide to work with a partner, then you and that partner may combine your votes into a single entity called a "partnership." The votes from either partner in a partnership are counted together.
5. In each round, we will assign people or partnerships (hereafter collectively referred to as "people" for simplicity) to projects based on the allocation of votes per project according to the following rules:
    a. If one person has the most votes for a given project, then that person gets that project. If that person is the 2nd person to get matched to a project, then the project is removed from future rounds of voting.
    b. If two people have cast the same number of votes for a given project and those two people were the top vote casters for that project, then those two people may either choose to work together on the project (unless either is already a partnership) or may both decide to work separately on the project. That project is removed from future rounds of voting.

[1] Subject to availability and the picking algorithm outlined herein.

c. If three or more people have cast the same number of votes for a given project and those people are the top vote casters for the project, then those votes are discarded and the project is open in the next round.

6. Rounds of voting continue until every person or partnership is matched up with a project.

The semester project will be broken into several parts:

1. Literature review: find and summarize the 2 most significant papers related to your project area. List 5 other papers which didn't make the final set of 2 and say why they weren't as significant (for your work) as the other 2. Describe how your work will be influenced by the two most significant papers. Note that you should read and study the two most important papers but that you might not read the other 5 as closely. You'll present one of these papers in class.
2. Proposal. Answer the 5 proposal questions in the BYU CS MS proposal guidelines.
3. Progress reports. Tell what you've done on your project and how long you've spent. It should be clear from your report that you spent at least 6 hours per week on the project.
4. Demo. We'll have a demo session near the end of the semester
5. Final report. Write about what you did. What went well? How does your work compare to the state of the art?

Exams

There will be a midterm and a final. See class schedule for details.

The midterm will be in the testing center. Open book with 1 page of notes.

The final will be take-home with a 3 hour time limit. See class schedule due date and time for the final.

Grading

Points will be assigned based on the following:

Small Projects	10 % divided equally
Make-an-image	5 % divided equally
In-class paper presentations	15 % divided equally among number of papers you present
Semester Project	40 % total
Literature review	8 %
Proposal	~~10 %~~ 5%
Progress reports	8 %
Demo	4 %
Final report	~~10 %~~ 15%
Midterm	10 %
Final	20 %

Grades will be assigned according to the following scale and I reserve the right to adjust this scale in your favor:

100-93	A	80-77	C+	63-60	D-
93-90	A-	77-73	C	60-	E
90-87	B+	73-70	C-		
87-83	B	70-67	D+		
83-80	B-	67-63	D		

Policy Statements

Special circumstances arise for students during the semester. In this class, ***special circumstances can be accommodated by prior arrangement*** . If you anticipate you need some kind of accommodation to handle a special circumstance, talk to your instructor as soon as possible. In all but the most dire circumstances, special circumstances will not be accommodated after the fact. For example, if you are planning to get married during the semester, arrange with your instructor to make up missed work, extend deadlines etc. If you got married the third week of classes and missed a project, but did not make prior arrangements, then no accommodations will be made. If you were in a car accident and at the Emergency Room and could not make prior arrangements, then of course we can make accommodations after the fact.

The Honor Code includes a statement of standards regarding academic honesty. Academic honesty includes writing your own programs, properly citing sources in reports and doing your own work on tests. Examples of academic dishonesty include sharing code for projects with other students, turning in someone else's writing as your own report and cheating on an exam. The first violation of academic honesty standards will result in your course grade being lowered 1 grade level and you will be required to either redo the work or receive a 0 on the assignment. The second violation will result in failing the class. All violations of academic honesty are documented and reported to the Honor Code office.

Harassment of any kind is inappropriate at BYU. Specifically, BYU's policy against sexual harassment extends not only to employees of the university but to students as well. If you encounter sexual harassment, gender-based discrimination, or other inappropriate behavior, please talk to your professor, contact the Equal Employment Office at 422-5895 or 367-5689, or contact the Honor Code Office at 422-2847.

BYU is committed to providing reasonable accommodation to qualified persons with disabilities. If you have any disability that may adversely affect your success in this course, please contact the University Accessibility Center at 422-2767. Services deemed appropriate will be coordinated with the student and instructor by that office.

The serious study of the physical and mathematical sciences requires uninterrupted concentration and focus in the classroom. Having small children in class is often a distraction that degrades the educational

experience for the entire class. Please make other arrangements for child care rather than bringing children to class with you. If there are extenuating circumstances, please talk with your instructor in advance.