ECS275 Syllabus Spring 2017

Instructor: Nelson Max
Office: 3108 Kemper (in a side corridor through two successive doors at the north end of the main hall)
Phone: 752-3798
home phone: 510-482-5558 (do not call after 10:00 PM)
e-mail nlmax@ucdavis.edu (Please use this directly for any e-mails, rather than the Canvas mail tools.)

office hours: Monday 11:00 – 11:50 AM, Wednesday 1:30 – 2:30 PM

This course is on ray tracing to render photo-realist computer graphic images. To get effects like motion blur, depth of field, and smooth-appearing object edges, we use multiple viewing rays for each pixel, to do Monte-Carlo integration over the pixel area, the lens area, and time. We account for the effects of multiple bounces of light from the light sources across shiny or diffuse surfaces in the scene, and finally into the eye or camera. This is called "Global Illumination".

Textbook: Advanced Global Illumination, second edition, by Dutre, Bala, and Bekaert, CRC Press, ISBN 978-1-56881-307-3

Grading:
40% programming assignments
20% open book / open notes midterm
13% online quizzes in Canvas
2% project proposal
25% final project

Programming homework with code and output images is to be sent by e-mail to nlmax@ucdavis.edu. Please include “ECS275” in the subject line, so that I can identify and group such e-mails. In most cases I will only look at your output images, but perhaps at your source code to locate the bug that made the rendering incorrect. You are invited to base your code on the package reference.tar.gz in the Files on the class Canvas page, in which case please only e-mail the source code files you have added or modified. The images should be of a type displayable by the Linux “eog” utility on the CSIF machines. These types are

* ANI - Animation
* BMP - Windows Bitmap
* GIF - Graphics Interchange Format
* ICO - Windows Icon
* JPEG - Joint Photographic Experts Group
* PCX - PC Paintbrush
* PNG - Portable Network Graphics
* PNM - Portable Anymap from the PPM Toolkit
* RAS - Sun Raster
* SVG - Scalable Vector Graphics
* TGA - Targa
* TIFF - Tagged Image File Format
* WBMP - Wireless Bitmap
* XBM - X Bitmap
* XPM - X Pixmap

The first three programming assignments and the project proposal are due at 11:59 PM on the due date (the final project is due at 3:10 PM in class), and all will lose one point for every weekday that they are late. So homework turned in on a Saturday or Sunday will have the same late point count as if they had been turned in by 11:59 PM on the following Monday. Partial credit will be given if your program partially meets the

specifications; explain in a README file what works and what doesn't. Programs working partially may also be turned in later working better, and will earn the maximum of the on-time grade, and the more complete grade less any late points.

The lectures (except the last) were videotaped when this course was taught in 2011, and can be viewed via http://itunes.ucdavis.edu or via http://www.youtube.com (search for Advanced Global Illumination). Please disregard all discussion of due dates in the online lectures; they are superseded by the dates in this syllabus. I will go over the same material in class this year, but you may use the videos for review, or if you need to miss a class. Some errors in the video lectures that were not corrected later in the lecture are noted in the online text description of that lecture. Please see the 2011 Syllabus in the Files on Canvas for the dates that identify the corresponding lectures. Topics have been added this year to that syllabus (after our midterm), so the final few lectures may not correspond well to the videos.

You are expected to have read the book sections before the class in which they will be discussed, as listed below. To enforce this, there will be an online quiz before some classes, in the Quizzes group in the Assignments section of the class Canvas page, to be completed by 3:10 PM the day of the class. When there is such a quiz, it will be available by 5:00 PM the day before the class, and I will try to broadcast e-mail pointing to it.

Tentative schedule of lectures, readings and programming assignments (Revisions, if any, will be uploaded to the syllabus on the Files section of the course Canvas page, and if they are major, an e-mail about them will be broadcast.) All page number references except those to published papers refer to pages in our textbook "Advanced Global Illumination".

Monday April 3 Introduction to recursive "Whitted" ray-tracing.

Wednesday April 5 Ray - object intersections for spheres and convex polygons.

Assignment 1 due Wednesday April 19 (10 points). Write a recursive ray tracer that can render scenes with diffuse and specular surfaces made from spheres and polygons, including shading and shadows from point light sources. Specular reflection is required, but not refraction. The program should be capable of reading an input scene description file, and writing the output to a file of a type displayable by the Linux "eog" utility on the CSIF machines. You should include an input file and rendered images in the files you hand in.

For this and all other programming assignments, you may use the source code in the reference.tar.gz file at the Files section of the Canvas web pages for our course. This was code written by Steven Parker when he was teaching a similar course at the University of Utah. It is given in the spirit of the fourth paragraph on page 13 of our textbook. If you choose to use it, there will be very little work for you in completing this assignment. Please include in the handin files only the source to files you have added or modified from this library.

Friday April 7 Definition of radiance and radiosity, pp. 19 – 31

Monday April 10 The Bidirectional Reflection Distribution Function (BRDF), pp. 31 – 35

Wednesday April 12 BRDF examples, pp. 35 – 41

Friday April 14 The rendering equation, pp. 41 – 45 and 333 – 338

Monday April 17 Probability theory, pp. 47 – 54

Wednesday April 19 Monte Carlo Integration, pp. 55 – 63

Friday April 21	Sampling random variables, pp. 63 – 73
Monday April 24	"Distributed Ray Tracing", by Robert Cook, Thomas Porter, and Loren Carpenter, SIGGRAPH 1984 Proceedings, pp. 137 – 145, doi>10.1145/800031.808585

Assignment 2, due Monday May 8 (20 points). Write a distributed ray tracing program that can produce (a) anti-aliasing, (b) depth of field, and (c) motion blur, but only with point light sources and without global illumination effects. Provide an input file in a format which specifies the samples per pixel, the lens parameters for the depth of field effect, and the motion for the motion blur. Hand in several output images with different settings for these parameters, with a README file explaining the parameters and effects in each image. Please include a file with none of these three effects, at least one showing each effect in isolation, and at least one with all three of them enabled.

Wednesday April 26	Rendering equation formulations, pp. 81 – 86
Friday April 28	Stochastic path tracing, pp. 107 – 114
Monday May 1	Direct Illumination, pp. 114 – 127
Wednesday May 3	Indirect illumination, pp. 134 – 143

Assignment 3, due Wednesday May 17 (20 points) Add shadow penumbra and global path tracing effects to your ray tracing code, and provide several images illuminated by area light sources and showing color shading effects from diffuse reflections of neighboring colored surfaces.

Also due Wednesday May 17 (2 points) by e-mail to nlmax@ucdavis.edu: Proposal for your final project. The final project itself (25 points) is due for presentation in class on Wednesday June 7. Also due then is a 2 or 3 page printed summary of what you did, including images. Take a look at the later chapters of this textbook for ideas on what to propose.

Friday May 5	Flux, pp. 86 – 87, and anti-aliasing filters (See AntialiasingNotes in "Files" on Canvas)
Monday May 8	Light tracing, pp. 143 – 148
Wednesday May 10	Radiosity, pp. 151 – 159
Friday May 12	Form factors by sampling, pp. 159 - 164
Monday May 15	"The Hemicube: a radiosity solution for complex environments" by Michael Cohen and Donald Greenberg, SIGGRAPH 1985 proceedings, pp. 31 – 40, doi>10.1145/325334.325171
Wednesday May 17	Final gathering and multi-pass methods, pp. 219 – 226
Friday May 19	Open book, open notes Midterm
Monday May 22	Bidirectional path tracing, pp. 227 - 230
Wednesday May 24	Irradiance caching and Photon Mapping, pp. 234 – 240

Friday May 26	Instant radiosity and light cuts, pp. 240 - 249
Monday May 29	Memorial Day Holiday
Wednesday May 31	Participating Media, pp. 254 – 263
Friday June 2	Global illumination in participating media pp. 263 – 273
Monday June 5	Precomputed radiance transfer, pp. 293 – 300
Wednesday June 7	Project presentations