

CS371: Computer Graphics Fall 2010 Schedule

Revised November 22, 2010; the schedule will continue to adapt to student's interests.

Lecture:	MWF	12:00 – 12:50pm	TCL 206
Lab:	Thu.	1 – 4pm	TCL 216a
Office hours:	Mon.	1 – 2pm	TCL 216a
	Wed.	3 – 4pm	TCL 308

Projects are available online Tuesday morning, have check-points Thursday at noon, and are due Monday night at 10 pm, with no extensions. To help you schedule ahead, they are rated {*=Easy, **=Moderate, ***=Challenging}. Unless marked (solo), projects are pair programming with an assigned partner.

FCG = Shirley et al., *Fundamentals of Computer Graphics, 3rd Edition*, A K Peters, 2009; buy this at the bookstore.

P&P = Hughes et al., *Computer Graphics: Principles and Practice, 3rd Edition*, Addison Wesley, 2011; available on the course page.

RTR3 = Akenine-Möller et al., *Real-Time Rendering, 3rd Edition*, A K Peters, 2008; strictly optional and in the Schow library.

Reading references in parentheses are strictly optional, for cases where you want to see an alternative and deeper explanation for a topic. For example, if you're working on a final project in that area.

Hyperlinks are marked with “↗” in this document . Find other reading online or in the library from the citations.

MONDAY	WEDNESDAY	THURSDAY	FRIDAY
<div style="border: 1px solid black; padding: 2px; display: inline-block;">Sep 6th</div>	8th 1 Lab Session: Build your first graphics program, using G3D. Learn SVN, Doxygen, and C++. <i>Thursday Schedule</i> C++ Lab Session 1-4pm Reading: Tools Overview ↗ Start Cubes (solo)* Project ↗	9th <i>Rosh Hashanah (no class)</i>	10th 2 <i>First day of CS371</i> INTRODUCTION <ul style="list-style-type: none"> • what is computer graphics? • graphics vs. other CS • course policies • our first experiments with light Film: <i>Burning Safari</i> [1] Reading: <ul style="list-style-type: none"> • Welcome to CG ↗ • FCG 1 • (RTR3 1.2.2, 2.0-2)
13th 3 MODELING SURFACES <ul style="list-style-type: none"> • points • implicit and explicit geometry • triangles • indexed triangle meshes Reading: <ul style="list-style-type: none"> • FCG 2.5, 12.1 • (RTR3 12.1-4, 13.3) Cubes Project Due	15th 4 MODELING LIGHT <ul style="list-style-type: none"> • vectors and rays • the dot product • solid angle • power, irradiance, and radiance Reading: <ul style="list-style-type: none"> • FCG 2.3-4, 20 • (RTR3 1.2; 7.0-7.4) Start Meshes** Project ↗	16th Lab Session: Improving programmer workflow and working with a specification.	17th 5 MODELING CAMERAS <ul style="list-style-type: none"> • the light field • the rendering equation • a pinhole camera Reading: <ul style="list-style-type: none"> • FCG 4.7-8 • (RTR3 9.0)

MONDAY	WEDNESDAY	THURSDAY	FRIDAY
<p>20th 6</p> <p>RAY CASTING</p> <ul style="list-style-type: none"> • eye rays • ray-sphere intersection • ray-triangle intersection • barycentric coordinates <p>Code Handout ↗</p> <p>Reading:</p> <ul style="list-style-type: none"> • FCG 2.6-7, 4.4 • Light Transport Summary ↗ • (RTR3 16.5-9) <p>Meshes Project Due</p>	<p>22nd 7</p> <p>SCATTERING THEORY</p> <ul style="list-style-type: none"> • Definition of the BSDF • Measured models • Quantum mechanical model • Phenomenological models <p>Reading:</p> <ul style="list-style-type: none"> • Programmer Workflow ↗ • FCG 4.5, 20.1.6 • (RTR3 7.5-9) <p>Start Eye Rays (solo)* Project ↗</p>	<p>23rd</p> <p>Lab Session: Write a per-pixel graphics loop and structure the ray caster.</p>	<p>24th 8</p> <p>SCATTERING PRACTICE</p> <ul style="list-style-type: none"> • Lambertian scattering • Glossy scattering • BSDF Impulses <p>Reading:</p> <ul style="list-style-type: none"> • FCG 10.1-2 • (RTR3 7.5-9) <p>Film: Relighting Human Locomotion [9]</p>
<p>27th 9</p> <p>RECURSIVE CASTS</p> <ul style="list-style-type: none"> • Sampling impulses (Whitted) • Shadow rays • Path tracing (Kajiya) <p>Reading:</p> <ul style="list-style-type: none"> • FCG 4.7-8 • Whitted 1980 [11] • (RTR3 9.8) • (Kajiya 1986 [6]) <p>Film: Splitting the Atom [8]</p> <p>Eye Rays Project Due</p>	<p>29th 10</p> <p>SPATIAL DATA STRUCTURES</p> <ul style="list-style-type: none"> • Grids • BSP trees • k-d trees • Octtrees • BVH <p>Reading:</p> <ul style="list-style-type: none"> • FCG 12.2-4 • G3D::SuperBSDF documentation • (RTR3 14.1-6) <p>Start Recursive Rays* Project ↗</p>	<p>30th</p> <p>Lab Session: Midterm brainstorming.</p> <p><i>Start Midterm Preproduction</i></p>	<p>Oct 1st 11</p> <p>PHOTON MAPPING THEORY</p> <ul style="list-style-type: none"> • emission • forward tracing • scattering • radiance estimation • how to read a research paper <p>Reading: Jensen 1996 [4]</p>
<p>4th 12</p> <p>IMPORTANCE SAMPLING</p> <ul style="list-style-type: none"> • Monte Carlo integration • estimators • expected value and variance • importance sampling <p>Reading:</p> <ul style="list-style-type: none"> • FCG 14 • (Veach 1997, ch. 2 [10]) <p>Recursive Rays Project Due</p>	<p>6th 13</p> <p><i>Three 1-Paragraph Midterm Ideas Due</i></p> <p>PHOTON MAPPING PRACTICE</p> <ul style="list-style-type: none"> • rejection sampling • building a concrete algorithm • design • avoiding double counting • debugging strategies <p>Reading:</p> <ul style="list-style-type: none"> • (RTR3 9.6-7) • (Jensen 01 [5]) • Welcome to CG, pg. 2 ↗ <p>Start Photon Mapping*** Project ↗</p>	<p>7th</p> <p>Lab Session: Add a photon map data structure and pass.</p>	<p>8th</p> <p><i>Mountain Day (tentative)</i></p>

MONDAY	WEDNESDAY	THURSDAY	FRIDAY
11th <i>Fall Reading Period</i>	13th 14 VISUAL COMMUNICATION <ul style="list-style-type: none"> • Data Analysis • Visualizing Information • Scene Composition 	14th Lab Session: Office hours (mandatory). <i>Midterm Description Due</i>	15th 15 REFRACTION <ul style="list-style-type: none"> • Snel's law • Design considerations • Refractive caustics • Participating media • Crepuscular ("God") rays Reading: <ul style="list-style-type: none"> • FCG 13 • (RTR3 9.3-5) <i>Photon Mapping Project Due</i>
18th 16 TEXTURE MAPPING <ul style="list-style-type: none"> • Maps of BRDF parameters • Texture coordinates • Bump and normal maps • Interpolation • Aliasing and MIP-mapping Reading: 11.1-4 Film: Fiat Lux [2] Start Midterm** Project ↗	20th 17 <i>Midterm Checkpoint 1</i> TRANSFORMATIONS <ul style="list-style-type: none"> • Homogeneous vectors • Translation • Scale • Rotation • Inverses Reading: FCH 6	21st Lab Session: Office hours (mandatory).	22nd 18 <i>Midterm Checkpoint 2</i> RASTERIZATION <ul style="list-style-type: none"> • swapping the loops • a depth buffer • bounding boxes • amortizing barycentric computation Reading: <ul style="list-style-type: none"> • FCG 8.1 • (P&P Rasterization) • (RTR3 4.0-2)
25th 19 THE GRAPHICS PIPELINE <ul style="list-style-type: none"> • producer-consumer design • abstracting rasterization • state-based APIs Reading: <ul style="list-style-type: none"> • FCG 8 • (RTR3 2) 	27th 20 GPU ARCHITECTURE <ul style="list-style-type: none"> • task vs. data parallelism • caches vs. context swaps • state management Reading: <ul style="list-style-type: none"> • FCG 18 • Fatahalian 2010 [3] • (RTR3 3) Film: TBD Midterm Project Due <i>(no new project this week)</i>	28th Lab Session: Immediate mode graphics.	29th 21 THE ART OF CGI, PT. 1 <ul style="list-style-type: none"> • André and Wally B. (1984) • Luxo Jr. (1986) • Red's Dream (1987) • Tin Toy (1988) • Knick Knack (1989) • Geri's Game (1997) • For the Birds (2000) Reading: Lasseter 1987 [7]

MONDAY		WEDNESDAY		THURSDAY		FRIDAY	
Nov 1st	22	3rd	23	4th		5th	24
Midterm Presentations		Midterm Presentations Start Real-Time (solo)** Project ↗		Lab Session: Scoping specifications; final project ideas.		3 pm colloquium by <i>Dr. David Luebke, NVIDIA Research</i> DEFERRED SHADING <ul style="list-style-type: none"> • Geometry buffers • Design: Ubershaders • Bandwidth and coherence 	
8th	25	10th	26	11th		12th	27
INTERACTION <ul style="list-style-type: none"> • Simulation loops • User input • Follow camera • Forward Euler integration Reading: FCG 26 Real-Time Project Due		COLLISION DETECTION <ul style="list-style-type: none"> • Proxy geometry • Continuous vs. discrete tests • Sliding • Resolving interpenetration Start Interaction* Project ↗		Lab Session: Writing final project specifications. <i>Three 1-Paragraph Final Project Ideas Due</i>		THE ART OF CGI, PT. 2 <ul style="list-style-type: none"> • Mike's New Car (2002) • Boundin' (2003) • Jack-Jack Attack (2005) • One Man Band (2005) • Mater and the Ghostlight (2006) • Lifted (2005) 	
15th	28	17th	29	18th		19th	
SHADOW MAPS <ul style="list-style-type: none"> • amortizing visibility • working with projections • limitations • new research Reading: FCG 11.7 Interaction Project Due		EXPRESSIVE RENDERING <ul style="list-style-type: none"> • Motivation • Filters vs. geometry vs. shading • Contour case study • Temporal coherence Reading: Hertzmann, NPR and the science of art, <i>Proc. NPAR</i> , 2010 Film: Renaissance (excerpt) Start Final (Phase I)*** Project ↗		Lab Session: Field trip to MoCA		No class – Prof. McGuire is at U. Iowa.	
22nd	30	24th		25th		26th	
Office hours in lab (optional).		<i>Thanksgiving Recess</i>		<i>Thanksgiving Recess</i>		<i>Thanksgiving Recess</i>	
29th	31	Dec 1st	32	2nd		3rd	33
Office hours in lab (mandatory). Final (Phase I) Project Due		No class – Prof. McGuire is at Harvard. Start Final (Phase II)*** Project ↗		Lab Session: Field trip to Vicarious Visions (optional)		Office hours in lab (optional).	

MONDAY	WEDNESDAY	THURSDAY	FRIDAY
6th 34 HOW TO PRESENT Final (Phase II) Project Due	8th 35 Office hours in the lab during lecture period (mandatory)	9th Lab Session: Final project presentations.	10th 36 <i>Last Day of Classes</i> OPEN PROBLEMS <ul style="list-style-type: none"> • Hybrid and remote rendering • Passive stereo • Power and scalability • Expressive rendering revisited • Interaction revisited • Course evaluations

References

- [1] Goeblins L'Ecole de L'Image. Burning safari, 2007. Short film.
- [2] Paul Debevec. Fiat Lux, 1999. Short film shown at SIGGRAPH 99. <http://ict.debevec.org/debevec/FiatLux/>.
- [3] Kayvon Fatahalian. Running code at a teraflop. In *Beyond Programmable Shading, SIGGRAPH 2010 Course Notes*. July 2010.
- [4] Henrik Wann Jensen. Global illumination using photon maps. In *Proceedings of the eurographics workshop on Rendering techniques '96*, pages 21–30, London, UK, 1996. Springer-Verlag.
- [5] Henrik Wann Jensen. *Realistic image synthesis using photon mapping*. A. K. Peters, Ltd., Natick, MA, USA, 2001.
- [6] James T. Kajiya. The rendering equation. *SIGGRAPH Comput. Graph.*, 20(4):143–150, 1986.
- [7] John Lasseter. Principles of traditional animation applied to 3d computer animation. In *SIGGRAPH '87: Proceedings of the 14th annual conference on Computer graphics and interactive techniques*, pages 35–44, New York, NY, USA, 1987. ACM.
- [8] Edouard Salier. Splitting the atom, 2010. Music video.
- [9] USC Centers for Creative Technologies. Relighting human locomotion, June 2006. Short Film. <http://gl.ict.usc.edu/Films/RelightingHumanLocomotion/index.html> ↗.
- [10] Eric Veach. *Robust Monte Carlo methods for light transport simulation*. PhD thesis, Stanford, CA, USA, 1998. Adviser-Guibas, Leonidas J.
- [11] Turner Whitted. An improved illumination model for shaded display. *Commun. ACM*, 23(6):343–349, 1980.