

CS371: Computer Graphics Fall 2012 Schedule

Revised November 29, 2012; the schedule will adapt to student's interests.

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

Projects are generally available online Tuesday afternoon, have checkpoints Thursday at noon, and are due Monday at noon, with no extensions. Consider the variable workload of projects when planning your semester: they are rated {*=Easy, **=Moderate, ***=Challenging}. Except for the individual Project 0, you will have (different) lab partners for each project. These are assigned early in the semester; later you choose the groups.




GC = McGuire, *The Graphics Codex* , 1.7+ Apple App Store, 2012 (Required)






FCG = Shirley et al., *Fundamentals of Computer Graphics, 3rd Edition* , A K Peters, 2009 (Required)

(P&P) = Hughes et al., *Computer Graphics: Principles and Practice, 3rd Edition*, Addison Wesley, 2013 (Optional, on Web Page)


(RTR3) = Akenine-Möller et al., *Real-Time Rendering, 3rd Edition*, A K Peters, 2009. (Optional, Amazon and in Schow)



Reading references in parentheses are 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 to web pages from this document are marked with “” (web), “” (PDF), and “” (GC-iPad only). Find other reading online or in the library by following the citations.

MONDAY	WEDNESDAY	THURSDAY	FRIDAY
Sep 3rd	5th	6th Lab Session: Build your first graphics program, using G3D. Learn SVN, Doxygen, and C++. Reading: <ul style="list-style-type: none"> Tools Overview  GC: Preface  Start Cubes (solo)* Project 	7th 1 <i>First day of CS371</i> INTRODUCTION <ul style="list-style-type: none"> what is computer graphics? graphics vs. other CS course policies your artistic vision our first experiments with light Film: <i>Burning Safari</i> [1] Reading: <ul style="list-style-type: none"> Welcome to 371  GC: Introduction  (FCG 1) (RTR3 1.2.2, 2.0-2)


MONDAY	WEDNESDAY	THURSDAY	FRIDAY
<p>10th 2</p> <p>MODELING SURFACES</p> <ul style="list-style-type: none"> • points • implicit and explicit geometry • triangles • indexed triangle meshes <p>Reading:</p> <ul style="list-style-type: none"> • GC: Surface Geometry 📖 • GC: C++ 📖 • (FCG 2.5, 12.1) • (RTR3 12.1-4, 13.3) <p>Cubes Project Due</p>	<p>12th 3</p> <p>MODELING LIGHT</p> <ul style="list-style-type: none"> • vectors and rays • the dot product • solid angle • power, irradiance, and radiance <p>Reading:</p> <ul style="list-style-type: none"> • GC: A Model of Light 📖 • GC: The Rendering Equation 📖 • (FCG 2.3-4, 20) • (RTR3 1.2; 7.0-7.4) <p>Start Meshes** Project 📄</p>	<p>13th</p> <p>Lab Session: Improving programmer workflow and working with a specification.</p>	<p>14th 4</p> <p>MODELING CAMERAS</p> <ul style="list-style-type: none"> • the light field • the Rendering Equation • a pinhole camera <p>Film: <i>Raymond</i></p> <p>Reading:</p> <ul style="list-style-type: none"> • GC: A Camera Model 📖 • (FCG 4.7-8) • (RTR3 9.0)
<p>17th 5</p> <p>RAY CASTING</p> <ul style="list-style-type: none"> • eye rays • ray-sphere intersection • ray-triangle intersection • barycentric coordinates <p>Reading:</p> <ul style="list-style-type: none"> • SphereCaster.cpp 📄 • GC: Ray Casting 📖 • (FCG 2.6-7, 4.4) • (RTR3 16.5-9) <p>Meshes Project Due</p>	<p>19th 6</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* Project 📄</p>	<p>20th</p> <p>Lab Session: Write a per-pixel graphics loop and structure the ray caster.</p>	<p>21st 7</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"> • GC: Direct Illumination 📖 • (FCG 10.1-2) • (RTR3 7.5-9) <p>Film: Relighting Human Locomotion [9]</p>
<p>24th 8</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"> • GC: Materials 📖 • (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>26th 9</p> <p>SPATIAL DATA STRUCTURES</p> <ul style="list-style-type: none"> • Grids • BSP trees • k-d trees • Octrees • BVH <p>Reading:</p> <ul style="list-style-type: none"> • GC: Rendering Algorithms 📖 • FCG 12.2-4 • (RTR3 14.1-6) <p>Start Recursive Rays** Project 📄</p>	<p>27th</p> <p>Lab Session: Spatial data structures & rigging scenes.</p>	<p>28th 10</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 • (Cevher's Notes 📄) • (Veach 1997, ch. 2 [10])

MONDAY	WEDNESDAY	THURSDAY	FRIDAY
<p>Oct 1st 11</p> <p><i>Start Midterm Preproduction</i></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:</p> <ul style="list-style-type: none"> • Jensen 1996 [4] • FCG 13 • (RTR3 9.3-5) <p>Recursive Rays Project Due</p>	<p>3rd 12</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]) <p>Start Photon Mapping*** Project </p>	<p>4th</p> <p>Lab Session: Add a photon map data structure.</p>	<p>5th</p> <p><i>Mountain Day (tentative)</i></p>
<p>8th</p> <p><i>Fall Reading Period</i></p>	<p>10th 13</p> <p><i>Midterm Description Due</i></p> <p>VISUAL COMMUNICATION</p> <ul style="list-style-type: none"> • Data Analysis • Visualizing Information • Scene Composition 	<p>11th</p> <p>Lab Session: Office hours (mandatory).</p>	<p>12th 14</p> <p>LAB DURING LECTURE</p>
<p>15th 15</p> <p>TEXTURE MAPPING</p> <ul style="list-style-type: none"> • Maps of BRDF parameters • Texture coordinates • Bump and normal maps • Interpolation • Aliasing and MIP-mapping <p>Reading: 11.1-4 Film: Fiat Lux [2]</p> <p>Photon Mapping Project Due Start Midterm** Project </p>	<p>17th 16</p> <p>TRANSFORMATIONS</p> <ul style="list-style-type: none"> • Homogeneous vectors • Translation • Scale • Rotation • Inverses <p>Reading: FCH 6</p>	<p>18th</p> <p>Lab Session: Office hours (mandatory). <i>Midterm Checkpoint 1</i></p>	<p>19th 17</p> <p>RASTERIZATION</p> <ul style="list-style-type: none"> • swapping the loops • a depth buffer • bounding boxes • amortizing barycentric computation <p>Reading:</p> <ul style="list-style-type: none"> • FCG 8.1 • (P&P Rasterization) • (RTR3 4.0-2)

MONDAY		WEDNESDAY		THURSDAY		FRIDAY	
22nd	18	24th	19	25th		26th	20
<p><i>Midterm Checkpoint 2</i></p> <p>THE GRAPHICS PIPELINE</p> <ul style="list-style-type: none"> Review Transformations producer-consumer design abstracting rasterization state-based APIs <p>Reading:</p> <ul style="list-style-type: none"> FCG 8 (RTR3 2) 		<p>GPU ARCHITECTURE</p> <ul style="list-style-type: none"> task vs. data parallelism caches vs. context swaps state management <p>Reading:</p> <ul style="list-style-type: none"> FCG 18 Fatahalian 2010 [3] (RTR3 3) <p>Film: TBD</p> <p>10 pm: Midterm Project Due <i>(no new project this week)</i></p>		<p>Lab Session: Immediate mode graphics.</p>		<p>THE ART OF CGI, PT. 1</p> <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) <p>Reading: Lasseter 1987 [7]</p>	
29th	21	31st	22	Nov 1st		2nd	23
<p>Midterm Presentations</p>		<p>Midterm Presentations</p> <p>Start Real-Time* Project </p>		<p>Lab Session: Scoping specifications; final project ideas.</p>		<p>DEFERRED SHADING</p> <ul style="list-style-type: none"> Geometry buffers Design: Übershaders Bandwidth and coherence 	
5th	24	7th	25	8th		9th	26
<p>INTERACTION</p> <ul style="list-style-type: none"> Simulation loops User input Follow camera Forward Euler integration <p>Reading: FCG 26</p> <p>Real-Time Project Due</p>		<p>COLLISION DETECTION</p> <ul style="list-style-type: none"> Proxy geometry Continuous vs. discrete tests Sliding Resolving interpenetration <p>Start Interaction** Project </p>		<p>Lab Session: Writing final project specifications.</p>		<p>THE ART OF CGI, PT. 2</p> <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) 	

MONDAY	WEDNESDAY	THURSDAY	FRIDAY
<p>12th 27</p> <p>EXPRESSIVE RENDERING</p> <ul style="list-style-type: none"> • Motivation • Filters vs. geometry vs. shading • Contour case study • Temporal coherence <p>Reading: Hertzmann, NPR and the science of art, <i>Proc. NPAR</i>, 2010</p> <p>Film: Renaissance (excerpt)</p> <p>Reading: FCG 11.7</p> <p>Interaction Project Due</p>	<p>14th 28</p> <p>FILM SCREENING</p> <ul style="list-style-type: none"> • <i>Excerpt:</i> Skhizein (Jean Francois Sarazin) • <i>Excerpt:</i> The Mysterious Geographic Explorations of Jasper Morello (Anthony Lucas) • rebel with a cause (Stuttgart Media University) • Barcode (iL Luster) • The Tale of How (Blackheart Gang) • cinÔtique (Maxime Causeret) • BBC iPlayer 'Penguins' (Passion Pictures) • Minamita District (Nagoya City University) • Friends? (Vancouver Film School) <p>Start Final (Phase I)*** Project</p> 	<p>15th</p> <p>Office hours in lab:</p> <ul style="list-style-type: none"> • 1pm: Starfox • 2pm: Metropolis • 2:30pm: Cody • 2:45pm: Fading • 3:00pm: Jonathan • 3:15pm: Model • 3:30pm: Minecraft 	<p>16th 29</p> <p>Office hours in lab:</p> <ul style="list-style-type: none"> • 12pm: Movie <p>Final (Phase I) Project Due</p>
<p>19th 30</p> <p>Office hours in lab (general).</p> <p>Start Final (Phase II)*** Project</p> 	<p>21st</p> <p><i>Thanksgiving Recess</i></p>	<p>22nd</p> <p><i>Thanksgiving Recess</i></p>	<p>23rd</p> <p><i>Thanksgiving Recess</i></p>
<p>26th 31</p> <p>REAL-TIME PHOTON MAP</p> <p><i>Guest Lecturer: Michael Mara</i></p> <ul style="list-style-type: none"> • Systems research in graphics • CUDA • Fast photon gathering 	<p>28th 32</p> <p>Office hours in lab (mandatory, general)</p>	<p>29th</p> <p>Office hours in lab (general)</p>	<p>30th 33</p> <p>Office hours in lab (general).</p>
<p>Dec 3rd 34</p> <p>Presentation rehearsal in lab:</p> <ul style="list-style-type: none"> • Movie • Starfox • Metropolis • Magic <p>Final (Phase II) Project Due</p>	<p>5th 35</p> <p>Presentation rehearsal in lab:</p> <ul style="list-style-type: none"> • Minecraft • Jonathan • Fading • Cody • Model 	<p>6th</p> <p>Lab Session:</p> <p>Final project presentations.</p>	<p>7th 36</p> <p><i>Last Day of Classes</i></p> <p>OPEN PROBLEMS</p> <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.