CS798 - Advanced Applications of Monte Carlo Methods

Spring 2016

Course Outline

University of Waterloo, School of Computer Science
Instructor: Gladimir V. G. Baranoski, DC 3520
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Office Hours: Friday, 3:30-4:30pm, DC 3128
Lecture Times: Tuesday and Thursday, 3:00 to 4:20pm, DC2568.

Revised Schedule

Week	**Topic**	**Assignments/Project Deadlines**
1	Course Guidelines	
	Introduction	
2	Overview of Monte Carlo Integration Methods	
	Uniformed Monte Carlo Methods	
3	Informed Monte Carlo Methods	
	Light Propagation / Radiometric Quantities	Assignment 1, May 19^{th}
4	Bidirectional Scattering Distribution Functions	
	Light Transport Equation / Random Walk	
5	Ray Tracing Overview	
	Path Tracing	Assignment 2, June 2^{nd}
6	Directional Probability Densities	
	Radiosity Overview	
7	Radiosity via Ray Tracing	
	Multipass Methods Overview	Project Proposal, June 16^{th}
8	Information Transport	
	Biophysical Review	
9	Data Collection Issues	
	Model Design Issues	
10	Project Status Report	July 5^{th}
	Evaluation Issues	
11	Case Studies	
	Case Studies	
12	Project Presentations	July 19^{th}
	Project Presentations	July 21^{st}
	Conclusion	Project Written Report and Code, July 26^{th}

Important notes:

- **Take home final exam** will be available on the last day of classes, July 26^{st}, and it should be returned to the instructor on August 9^{th} at 16:30.
- Assignments, project report and final exam must be prepared using latex. Otherwise they will receive **ZERO** marks.
- Assignments, project report and final exam submitted after the corresponding deadlines will receive **ZERO** marks.

Course Website

`http://pedrinho.cs.uwaterloo.ca/~gvgbaran/cs798-S16.html`

Course Description

This course describes Monte Carlo techniques widely used for the numerical solution of integral equations in different fields, from software engineering and computer graphics to biomedical optics and astrophysics. The first module of the course provides theoretical background on Monte Carlo Methods, while the second and third modules are devoted to practical applications. The course closes with an overview of relevant interdisciplinary topics as well as research perspectives involving Monte Carlo methods.

Course Objectives

This course aims to provide the students with theoretical and practical knowledge on effective and reliable Monte Carlo algorithms used in the industrial and academic environments. Despite its emphasis on recent developments in image synthesis and biomedical fields, the concepts and techniques learned in this course can be also employed in other areas of computer science since the practical issues involving the energy transfer methods depicted in the course can be directly related to information transfer algorithms.

Reference Materials

Selected papers and complementary texts will be provided in class and in the course website.

Prerequisites

Students should have experience with programming languages (C++ or Java) or Matlab. Familiarity with radiometric terms and properties as well as Monte Carlo methods will be helpful, but not required.

Marking Scheme

- Participation in course activities (15%).
- Two programming assignments (each worth 15%).
- Course project: implementation (10%), presentation (10%) and written report (10%).
- Take home final exam (25%).

Rules for Group Work

Group work is not allowed.

University Mandatory Information

Academic Integrity: In order to maintain a culture of academic integrity, members of the University of Waterloo community are expected to promote honesty, trust, fairness, respect and responsibility. [Check *www.uwaterloo.ca/academicintegrity/* for more information.]

Grievance: A student who believes that a decision affecting some aspect of his/her university life has been unfair or unreasonable may have grounds for initiating a grievance. Read Policy 70, Student Petitions and Grievances, Section 4, *www.adm.uwaterloo.ca/infosec/Policies/policy*70.*htm*. When in doubt please be certain to contact the department's administrative assistant who will provide further assistance.

Discipline: A student is expected to know what constitutes academic integrity [check *www.uwaterloo.ca/academicintegrity/*] to avoid committing an academic offense, and to take responsibility for his/her actions. A student who is unsure whether an action constitutes an offence, or who needs help in learning how to avoid offences (e.g., plagiarism, cheating) or about 'rules' for group work/collaboration should seek guidance from the course instructor, academic advisor, or the undergraduate Associate Dean. For information on categories of offenses and types of penalties, students should refer to Policy 71, Student Discipline, *www.adm.uwaterloo.ca/infosec/Policies/policy*71.*htm*. For typical penalties check Guidelines for the Assessment of Penalties, at the following web site *www.adm.uwaterloo.ca/infosec/guidelines/penaltyguidelines.htm*.

Appeals: A decision made or penalty imposed under Policy 70 (Student Petitions and Grievances) (other than a petition) or Policy 71 (Student Discipline) may be appealed if there is a ground. A student who believes he/she has a ground for an appeal should refer to Policy 72 (Student Appeals) *www.adm.uwaterloo.ca/infosec/Policies/policy*72.*htm*.

Note for Students with Disabilities: The Office for persons with Disabilities (OPD), located in Needles Hall, Room 1132, collaborates with all academic departments to arrange appropriate accommodations for students with disabilities without compromising the academic integrity of the curriculum. If you require academic accommodations to lessen the impact of your disability, please register with the OPD at the beginning of each academic term.