

Computer Graphics, SCS Concentration

Nancy Pollard, Concentration Director
Location: EDSH 227

Amy Weis, Concentration Coordinator
Location: GHC 4115

Computer Graphics Concentration

This concentration is available to SCS students only.

The SCS Computer Graphics Concentration provides an opportunity for SCS undergraduate students at Carnegie Mellon to learn Computer Graphics foundations and specialties from a variety of application and research areas. Students gain a broad view of Computer Graphics in an introductory course and in-depth experience from a choice of topic areas, including the option of independent research. Courses include computational photography, computer games, computer animation, computational geometry, and physics-based rendering. This concentration provides an excellent introduction to the area for students considering industry and the opportunity for research experience for those considering graduate study.

Learning Objectives

Students completing this concentration will be able to demonstrate the following skills and learning:

- Create geometric representations for objects and natural phenomena.
- Develop software systems that work with these representations to capture, manipulate, and create artistic and real-world scenes.
- Discuss the pros and cons of alternative models of light transport.
- Develop software systems that utilize these models to create graphical images.
- State the key principles of animation and computer game development.
- Work with kinematic and physically simulated representations of motion to create animations of characters and natural phenomena.
- List key features of camera design, including for the modern camera.
- Work with images and video to perform common operations or generate new creative content.
- Execute common mathematical operations of computer graphics, including geometric transformations, projections, sampling algorithms, modeling of physical processes, optimization, and behavior-based modeling.
- Produce event-driven programs of moderate to large size with constantly evolving graphical / visual display.
- Sketch the layout of a typical massively parallel graphics processing unit (GPU).
- Write software to program the GPU for real-time graphics tasks.

Curriculum

Prerequisites

The following courses must be completed before the concentration can be started:

	Units
15-213 Introduction to Computer Systems	12
21-241 Matrices and Linear Transformations	11
or 21-242 Matrix Theory	

Course Requirements

The curriculum consists of one required course and at least three elective courses. The three elective courses must sum to at least 30 units. The elective courses will vary from year to year.

Required Course:

	Units
15-362 Computer Graphics	12

Electives (at least three courses with a total of 30 units or more):

15-418	Parallel Computer Architecture and Programming	12
15-458	Discrete Differential Geometry	12
15-463	Computational Photography	12
15-464	Technical Animation	12
15-466	Computer Game Programming	12
15-468	Physics-Based Rendering	12
15-472	Real-Time Graphics	12
15-473	Visual Computing Systems	12

Special permission required:

16-726	Learning-based Image Synthesis	12
16-823	Physics-based Methods in Vision (Appearance Modeling)	12

Students can apply one semester of a senior honors research thesis or research-based independent study in a topic related to this concentration, as approved by the concentration director/advisor, as one of the elective courses for this concentration. This research must have a significant communication component, including a paper or technical report, and a poster presentation. Any research course can count for at most 12 units toward the concentration and can count for at most one elective.

RELATION TO OTHER PROGRAMS

The Computer Graphics Concentration overlaps slightly in course offerings of the IDeATE minors in Game Design and Animation and Special Effects, and interested students may also want to investigate these minors. What distinguishes the Computer Graphics Concentration is its focus on the fundamental theory, algorithms, and systems that are relevant to graphics. As such, this is an ideal choice for students who wish to get more in-depth, e.g., in preparation for graduate study or a career in Computer Graphics research.

Other courses to be aware of include:

- 21-344 Numerical Linear Algebra
- 10-725 Convex Optimization

Although they are not a core part of the concentration, these can be valuable courses for additional preparation for the mathematics that runs throughout computer graphics, as well as to prepare for future research and exploration in the field.

Double Counting

At most one course taken for the concentration may be double counted towards any major, minor or other concentration being pursued by the student. No other double counting is permitted.