# CSCI 580: 3D Graphics and Rendering

Spring 2021

Overview

This course has a straightforward, but highly instructive goal: to teach you, from first principles, using 'just' math (linear algebra, to be specific), how to 'fill' 3D triangles that have been projected on to an image, with RGB pixel values. In terms of the following diagram (from davrous.com), you'll learn how to go from left to right, ie. start with 3D geometry (and lights, materials and camera), and end up with 2D pixels that are rendered (ie. 'lit/shaded and textured'):
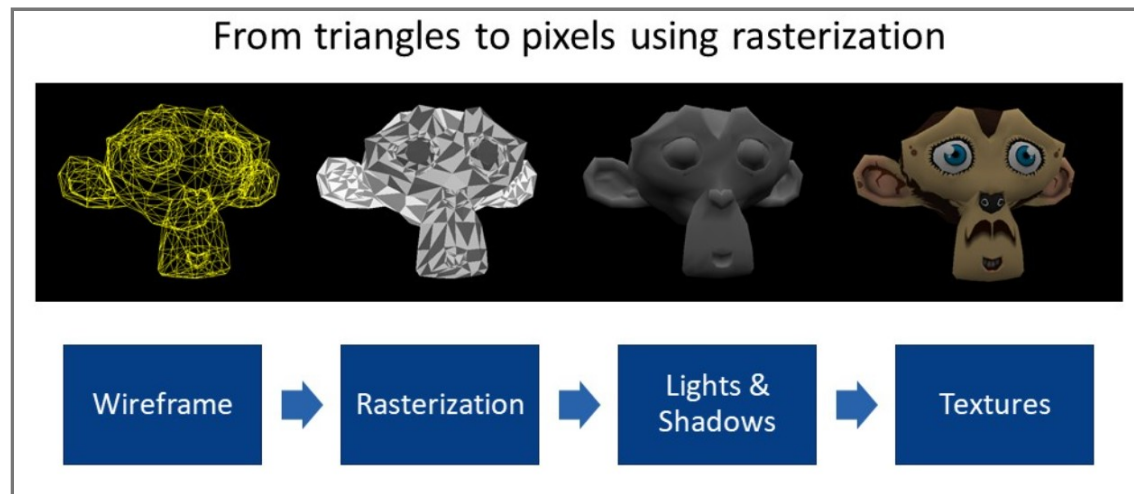
In addition to covering the core topics (where we build up a simple 'renderer'), we will also look at geometry types, alternative rendering algorithms, the history of 3D graphics, its endless variety of applications, and consider where the field might be headed.

Also, I intend providing you with a lot of 'extra' material that will link the course content to the real-world applications of CG in visual effects, animation, games, and more (eg. VR, AR).

Pre-requisites

You need to be proficient in a language such as C/C++, Python, JavaScript, Java, C#, or, Processing/p5. All the homeworks are coding-related (and they build on each other). The project will also be coding related.

Topics

Here are topics we'll cover:

- Introduction to 3D graphics
- Rasterization
- Hidden surface elimination (HSE)
- Transformations
- Shading
- Texture mapping
- Procedural texturing
- Sampling, reconstruction
- Shadows
- Raytracing
- Radiosity
- NPR (Non Photoreal Rendering)
- Commercial and other renderers
- (Animation) Production
- Curves
- Surfaces
- the OpenGL API
- GPUs (hardware acceleration)
- Browser-based and cloud-based CG

I'm thinking of adding these topics to the mix - possibly to bring up during discussions, at the least:

- more types of surface rendering algorithms
- volume rendering

- stereo rendering
- more rendering APIs
- point clouds
- rendering + machine learning
- computer vision
- AR, VR, holographic displays
- ...

There is/are no formal textbook(s) for this class.

As we progress through the course, there might be content (PDFs, links to sites, etc) that will be made available to you, to serve as reference or background knowledge.

Course structure

This term, the course will be entirely online/remote. Lectures will be streamed via WebEx, be recorded, and posted on DEN/D2L. You'll submit HWs via D2L. Exams will be online, too. We will make heavy use of Piazza, to communicate with each other throughout.

The course will have **six assignments** (the first one isn't graded), plus a **group project**. The assignments are to be completed individually [no collaboration allowed!]. And, there will be a **final exam**.

The following weightage scheme will be used in determining letter grades for the course at the end of the term:

• assignments: 5*8% = 40%

• project: 30%

• exam: 30%

Questions?

Do feel free to ask: saty@usc.edu.