
Scalable Rendering for Graphics and Game Engines

Antonio Chica Calaf
achica@cs.upc.edu

Marc Comino Trinidad
mcomino@cs.upc.edu

PROJECT STATEMENT

Students must deliver one or multiple C++ projects implementing a series of functionalities. During each laboratory session we will introduce one basic and one advanced functionality (amounting to a total of 6 + 5). To achieve the maximum grade, each student will have to implement all 6 basic and at least 3 advanced functionalities.

All project must support reading from PLY (<http://paulbourke.net/dataformats/ply/>) format and exporting the generated models to PLY or OBJ format. You can find some test models on the path /assign/rrmm-miri/models.

Session 1

Basic

- Load and draw models using OpenGL 3 (**vertex arrays, vertex buffer objects, vertex array objects, ...**)
- Implement an interface element to allow drawing $N \times N$ copies of the same object.
- Implement an interface element to be able to display the **framerate**.

http://www.songho.ca/opengl/gl_vertexarray.html

http://www.songho.ca/opengl/gl_vbo.html

https://www.khronos.org/opengl/wiki/Vertex_Specification#Vertex_Array_Object

Session 2

Basic

- Use **vertex clustering** on a **regular grid** to compute simplified version of a loaded model.
 - Take the mean as the representative vertex for each cell.
 - Generate and store at least 4 different **level of details**.

Advanced

- Use an **octree** to generate all the **level of details** at the same time.



Session 3

Basic

- Improve the **vertex clustering** algorithm by picking the vertex representative using **quadric error metrics**.

<http://eigen.tuxfamily.org/>
<https://dl.acm.org/citation.cfm?id=258849>

Advanced

- Improve the **vertex clustering** algorithm by implementing the shape preserving algorithm described in the section 4.1 of Willmott *et al*.

<https://dl.acm.org/citation.cfm?id=2018347>

Session 4

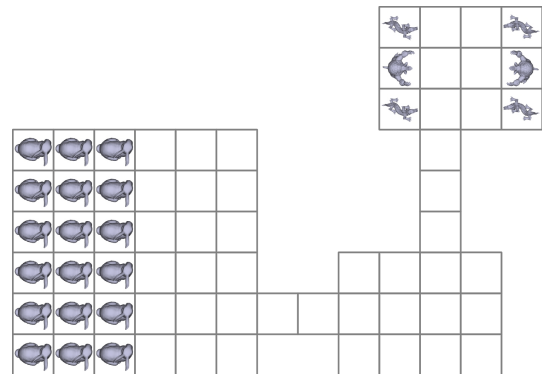
Basic

- Implement a scene with multiple model instances. Dynamically select the **level of detail** for each model using the **time-critical** rendering algorithm to ensure a target frame-rate.
 - Estimate your graphics card **maximum throughput** (triangles per second).
 - Compute maximum number of triangles that your graphics card can process while **ensuring 30 fps**.
 - Estimate the benefit of each model as $2^L D / d$, where L is the **level of detail**, D is the distance between the object and the viewpoint and d is the diagonal of its bounding box.
 - Maximize the total benefit while ensuring the target frame-rate.

<https://dl.acm.org/citation.cfm?id=319365>

Advanced

- Implement **hysteresis transition**.



Session 5

Basic

- Implement a scene representing a museum using a tile-based representation. It must have at least three rooms.

Advanced

- Design a complex floorplan.



Session 6

Basic

- Precompute cell-to-cell visibility using **random visibility sampling** on a separate application. Use this information during museum visualization.

Advanced

- Optimize the process using **octree ray traversal** and/or **supercover bresenham**.



DELIVERY

Please upload a single zip file by **June 1st**, named after your username. For instance: marc.comino.zip

The zip file should contain:

- A compilable and executable project. This includes:
 - All the required .c, .cc, .cpp, .h, .hpp, .ui, etc. files needed to compile your application.
 - A Makefile, CMakeLists or similar script that is able to compile and generate an executable file out of your source files.
 - For **windows** submissions: All the .dll and include files for the libraries used by your code.
 - For **linux** submissions: A list of the dependencies needed to compile your application.
- A short report explaining the implemented functionalities.
 - The report must describe which functionalities have been implemented and which of the different projects contain them. It should be clear which classes implement the different functionalities.
 - I personally recommend to elaborate the report using Microsoft Word or Latex or Google Docs.
- A live presentation of your project. This must take place on either the laboratory class on June 1st.