

Computer Graphics

Prof. Fabio Pellacini
[original slides by Prof. Steve Marschner]

Computer Graphics

The study of creating, manipulating
and viewing digital images.

Topics in Computer Graphics

- Imaging
 - 2D: image editing, video processing, tone mapping
- Modeling
 - 2D: page descriptions (PDF, SVG), typography
 - 3D: representation of shapes, materials, scenes
- Rendering
 - 2D: drawing shapes, simulating art materials
 - 3D: realistic and non-realistic rendering
- Animation:
 - 2D: rotoscoping, shape interpolation, 2D physics
 - 3D: character animation, 3D physics simulation

Topics in Computer Graphics

- Systems
 - Hardware: GPUs
 - Software: domain-specific languages and libraries
- Interfaces
 - 2D: shape manipulators, layers, artist-friendly painting
 - 3D: scene editors, digital sculpting, specialized gizmos
- Physical Reproduction
 - 2D: photo printing
 - 3D: additive manufacturing, CAD

Imaging



[Elisa Zwingenberger]



The Docks - Palermo, Italy (HDR) - Before and After

<http://www.flickr.com/photos/farbspiel/5147905361/>

© klaus heim



1ev

-1ev

-3ev



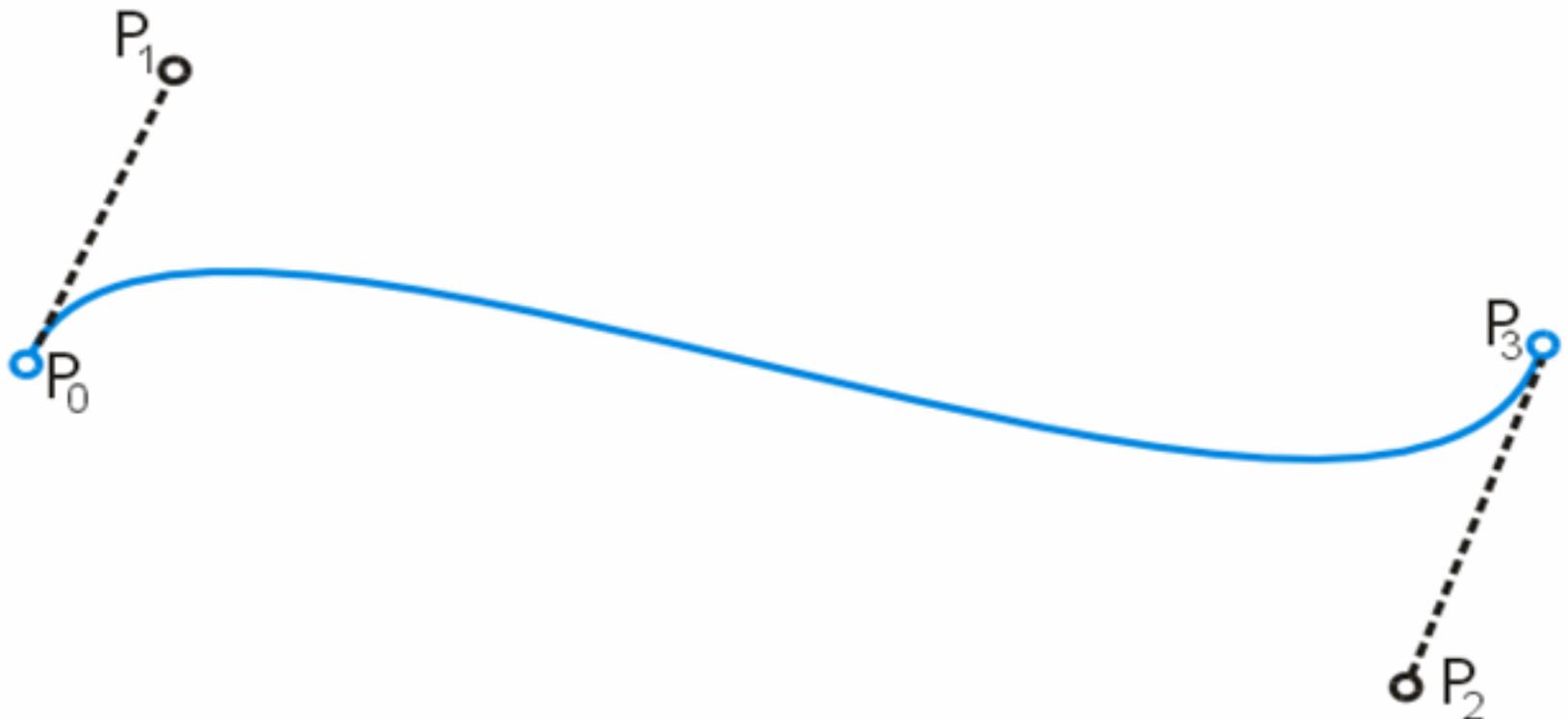
Tone-mapped HDR

Final image after post-processing



[NASA]

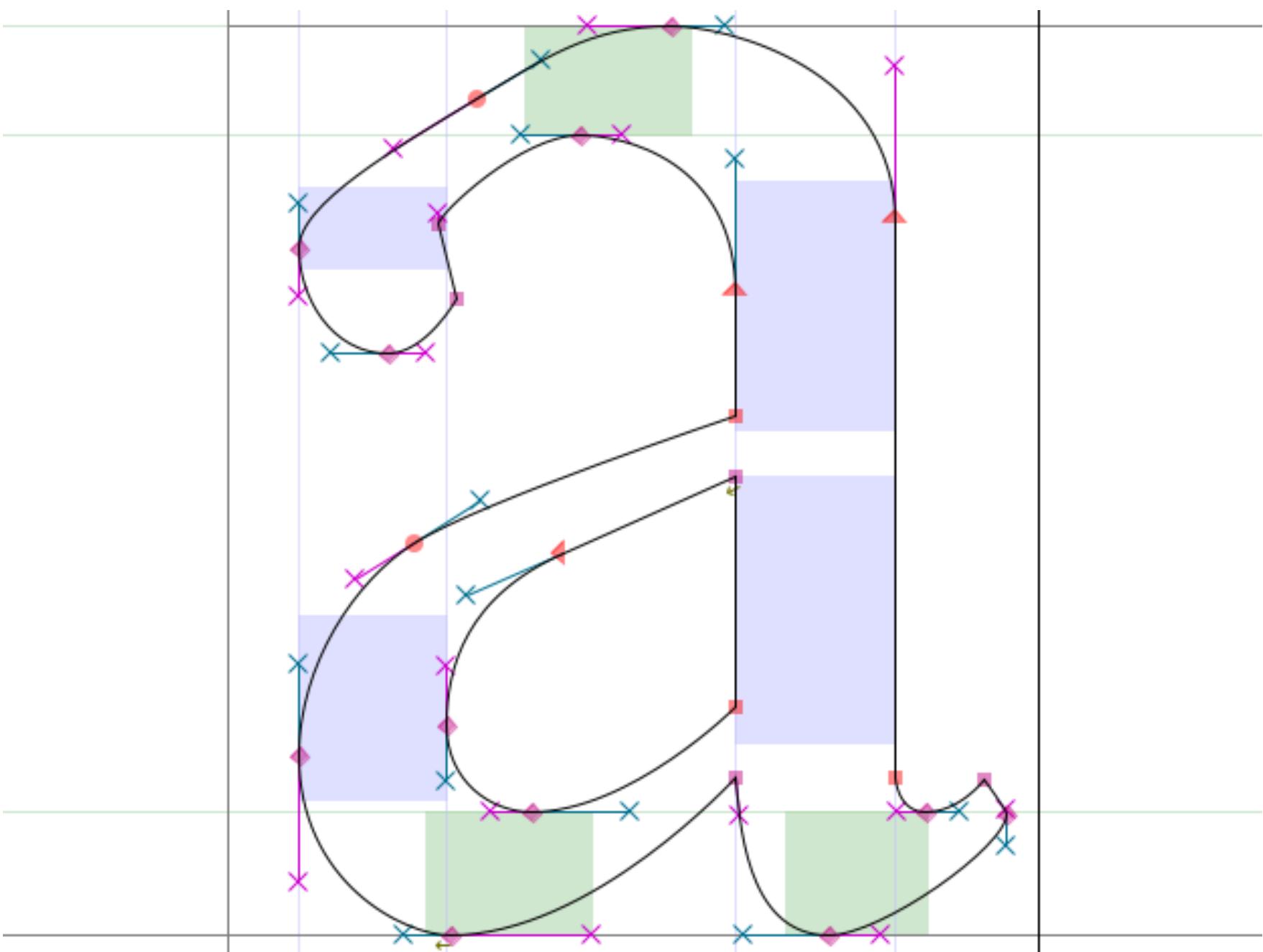
2D modeling



$$R(t) = P_0(1-t)^3 + P_1t(1-t)^2 + P_2t^2(1-t) + P_3t^3, \quad \text{where } 0 < t < 1$$



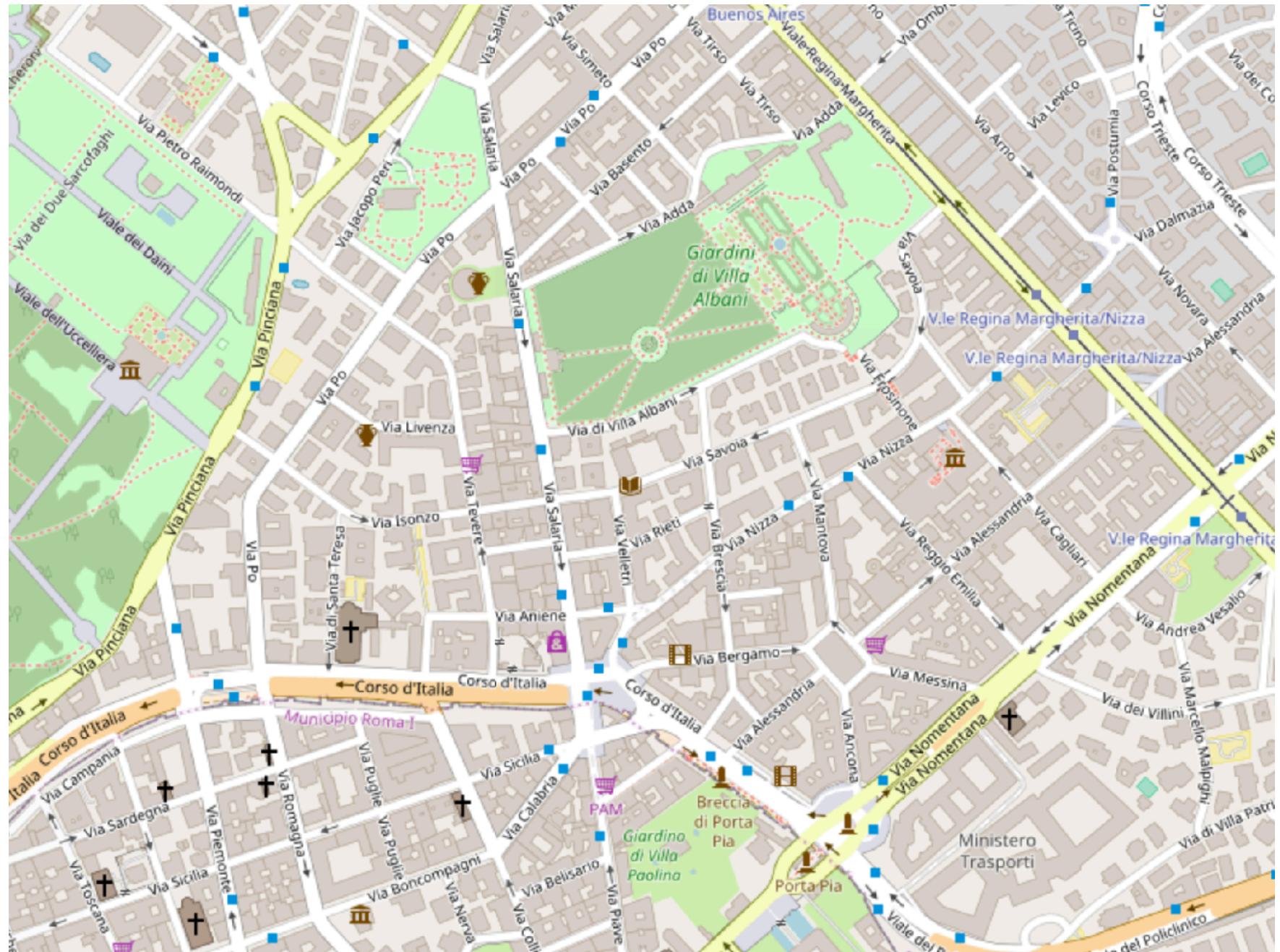
[Wikimedia Commons]

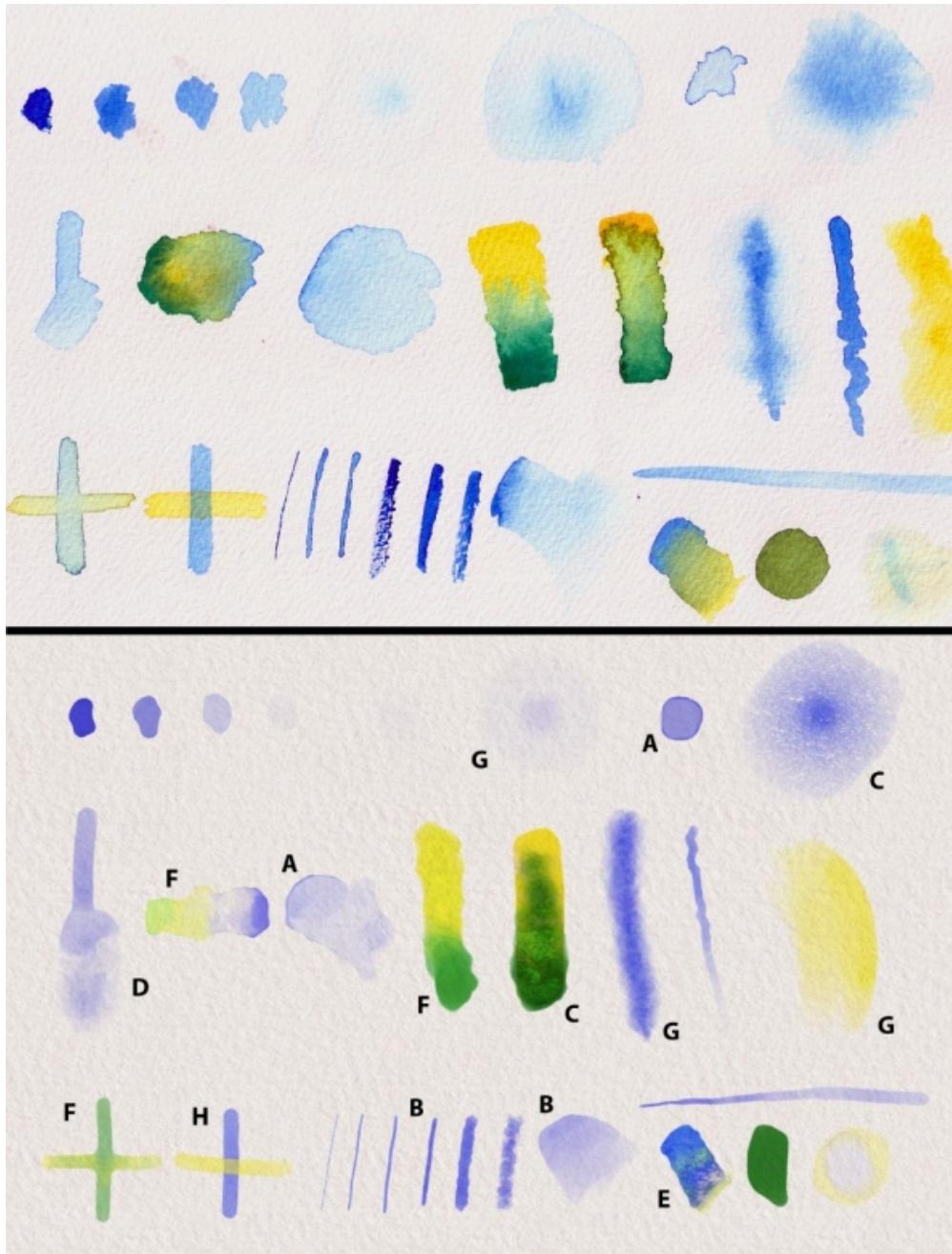




[Wikimedia Commons]

2D rendering

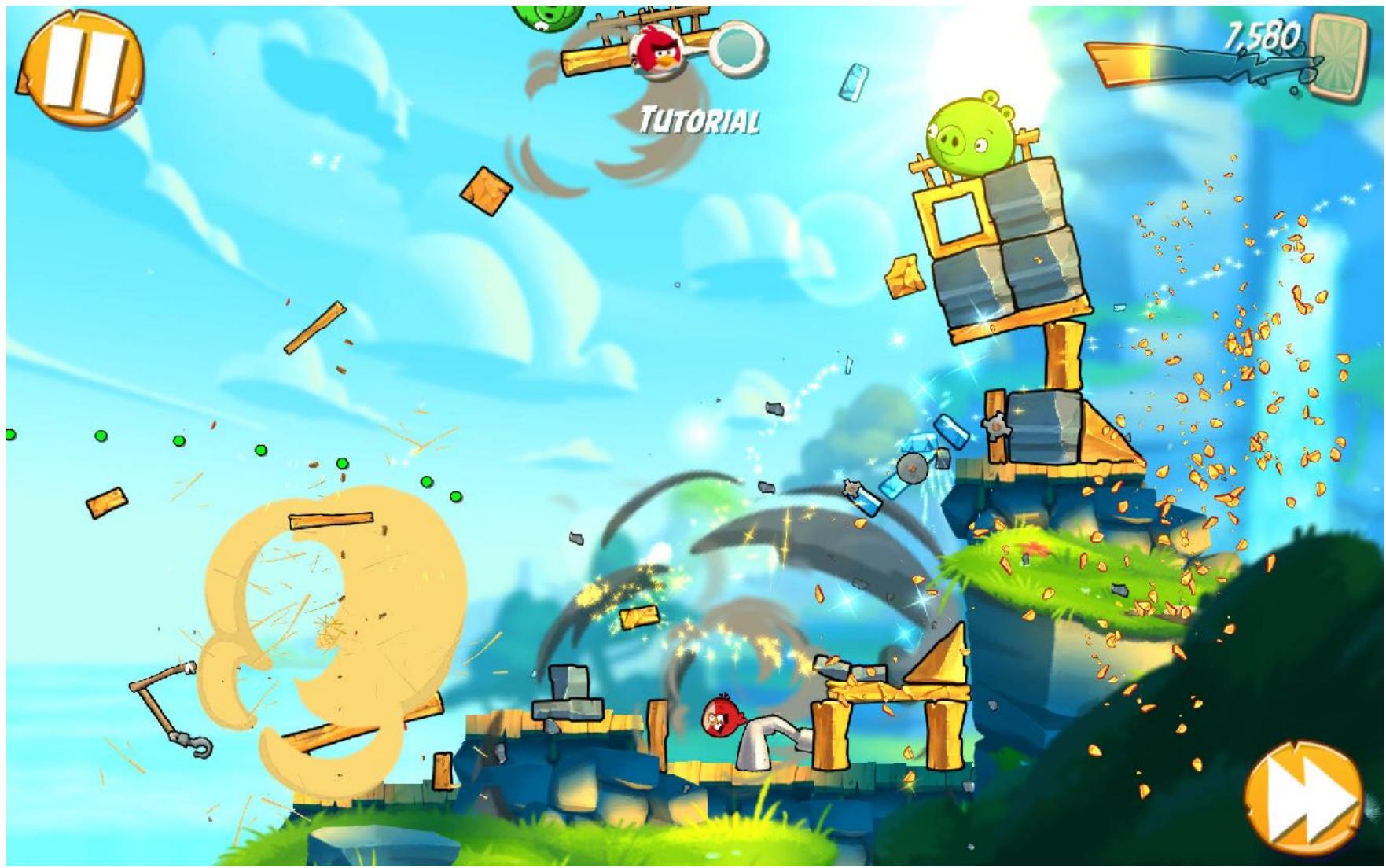




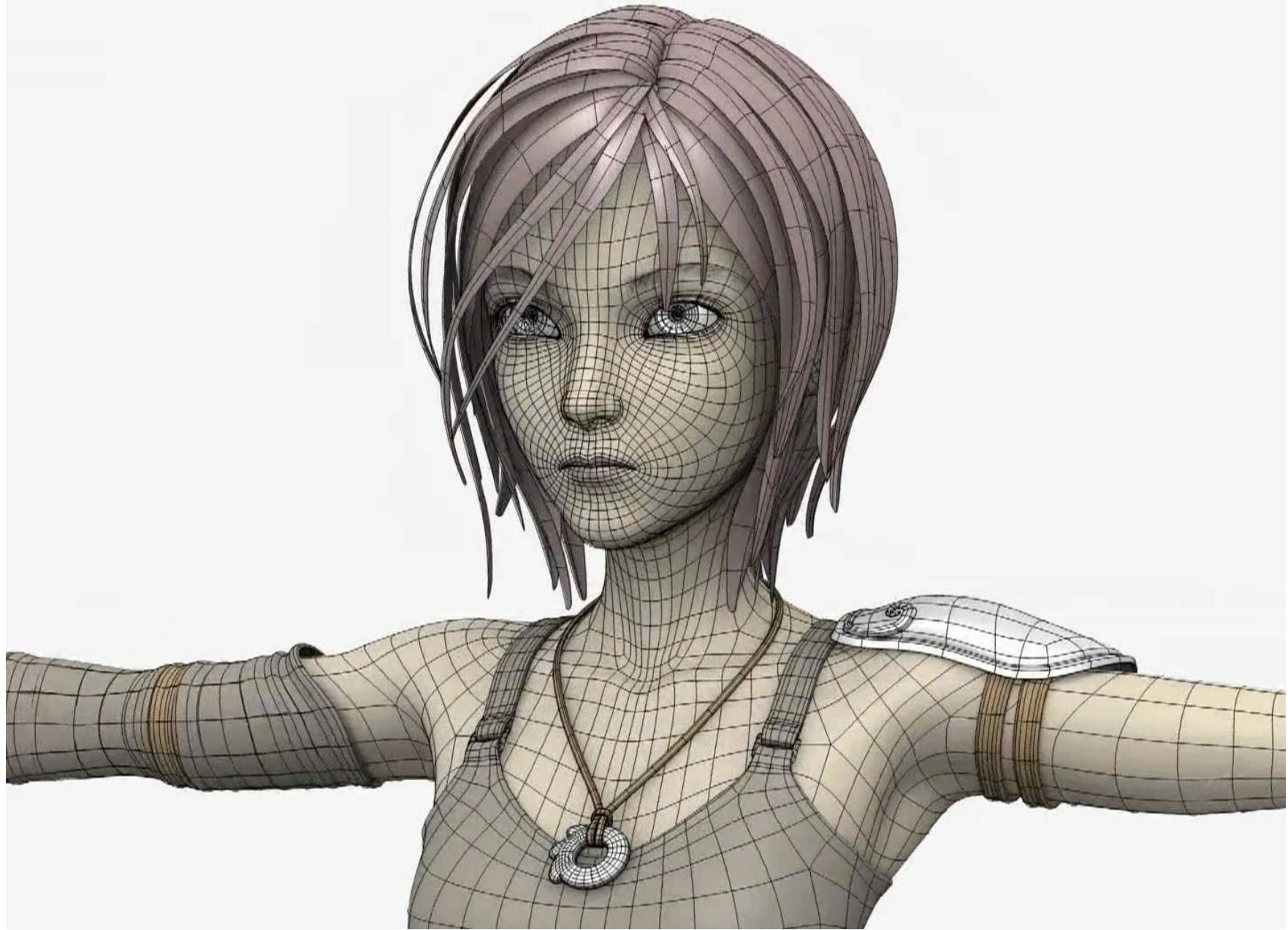
2D Animation

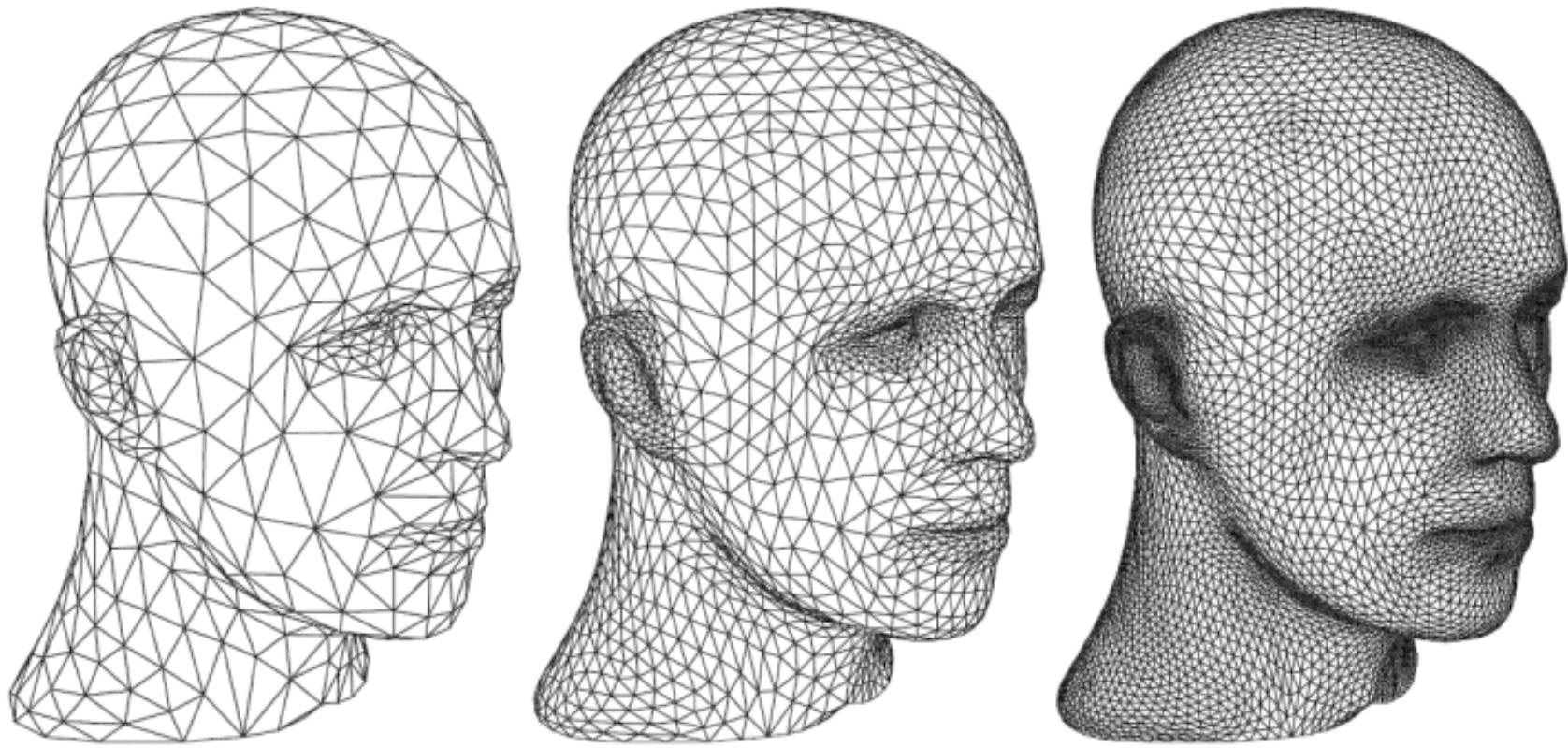


[A Scanner Darkley]

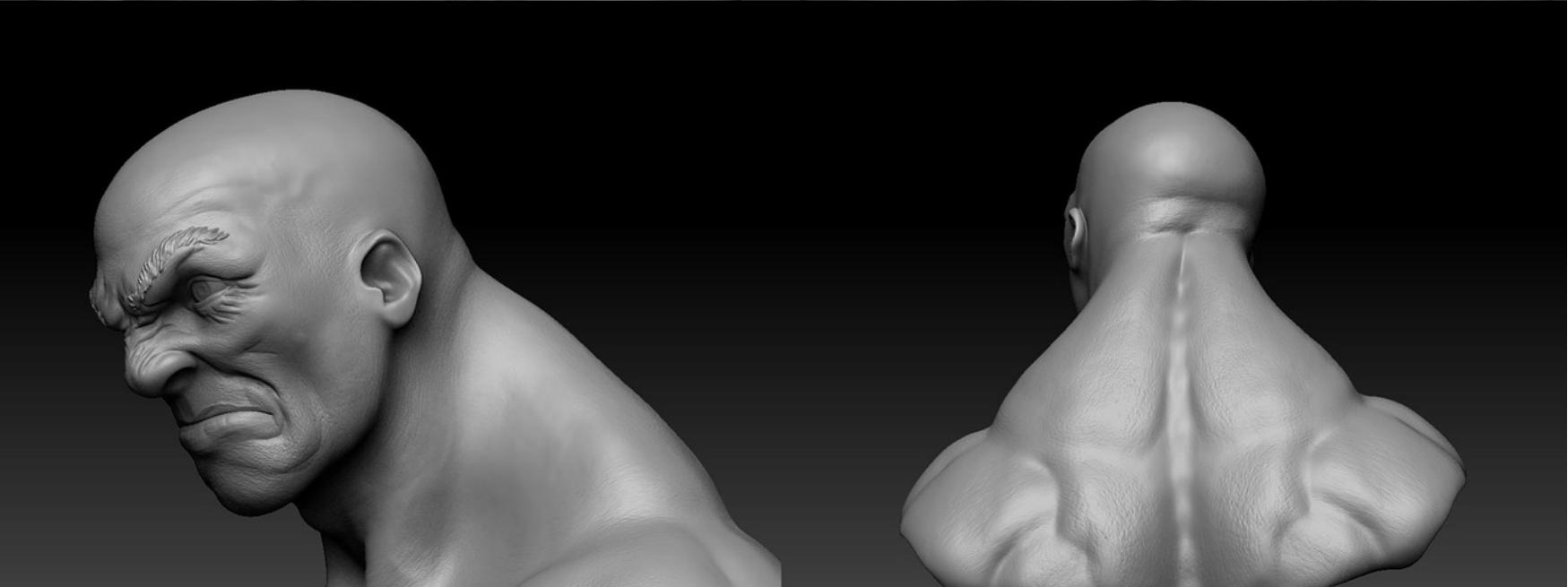
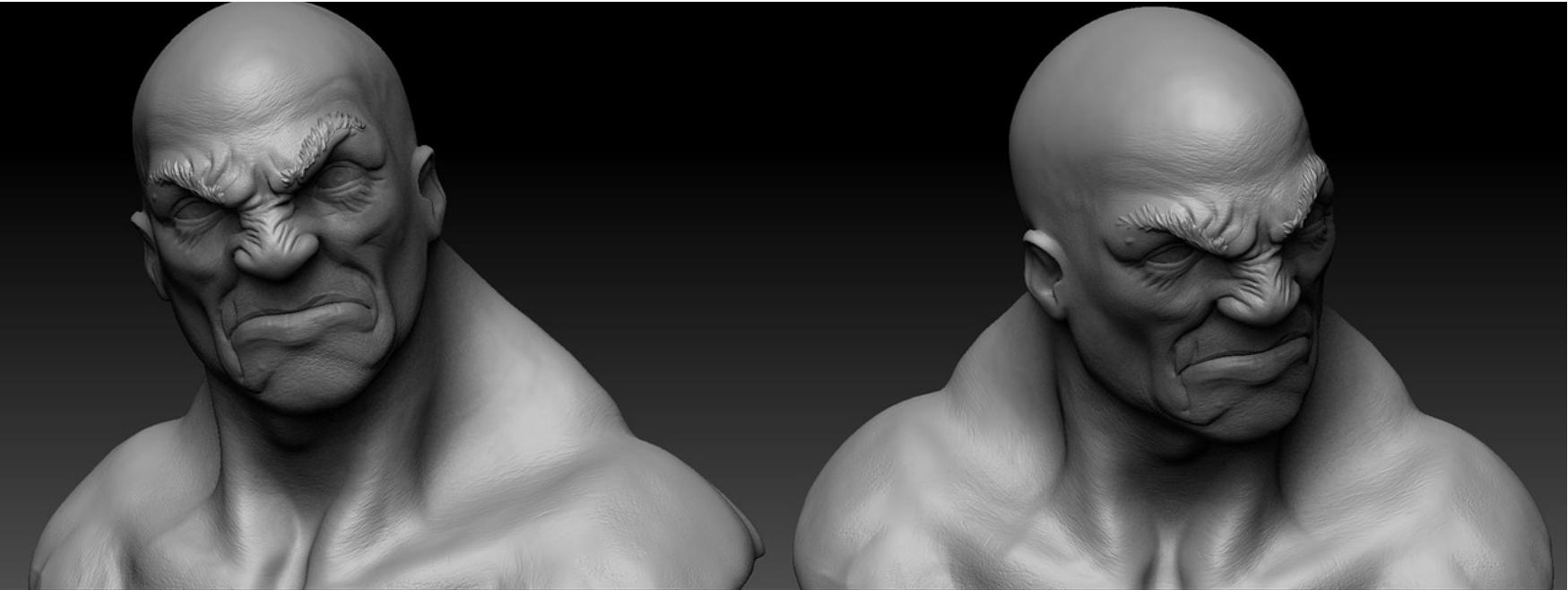


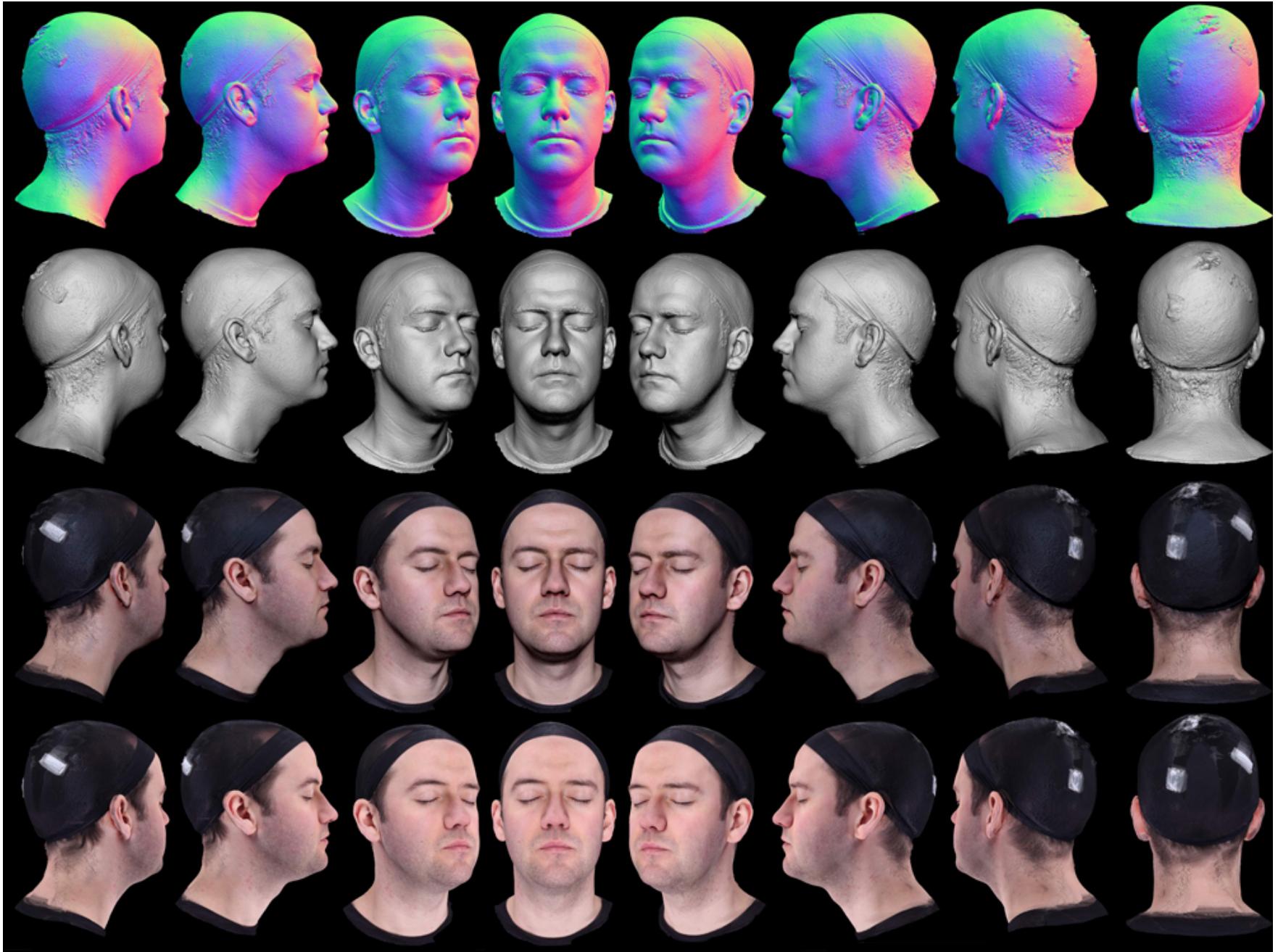
3D Modeling

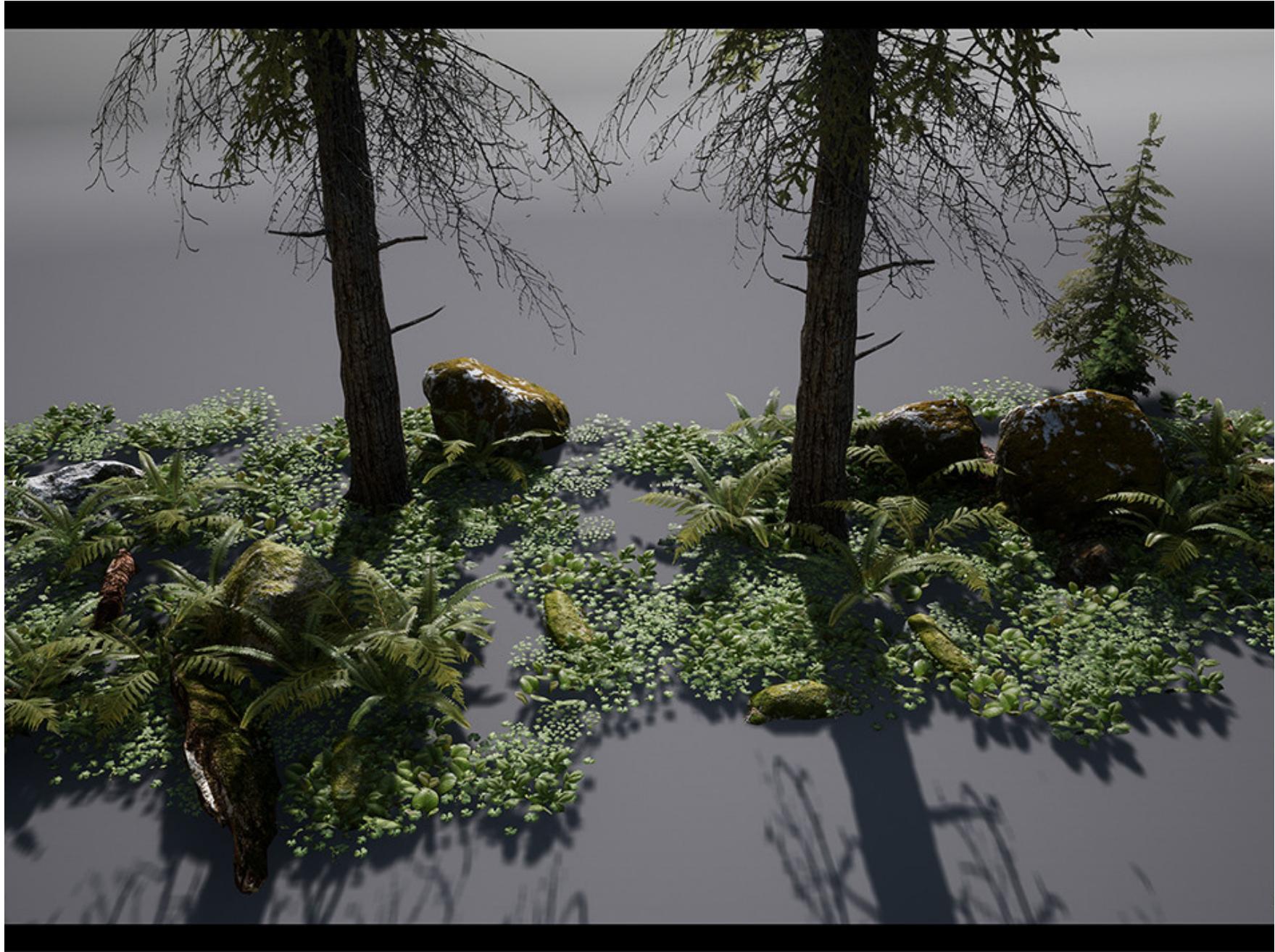




[Zorin et al]







3D Rendering



[BlenderOpenMovies]





[Activision]

Activision R&D. Property of Activision Publishing. N



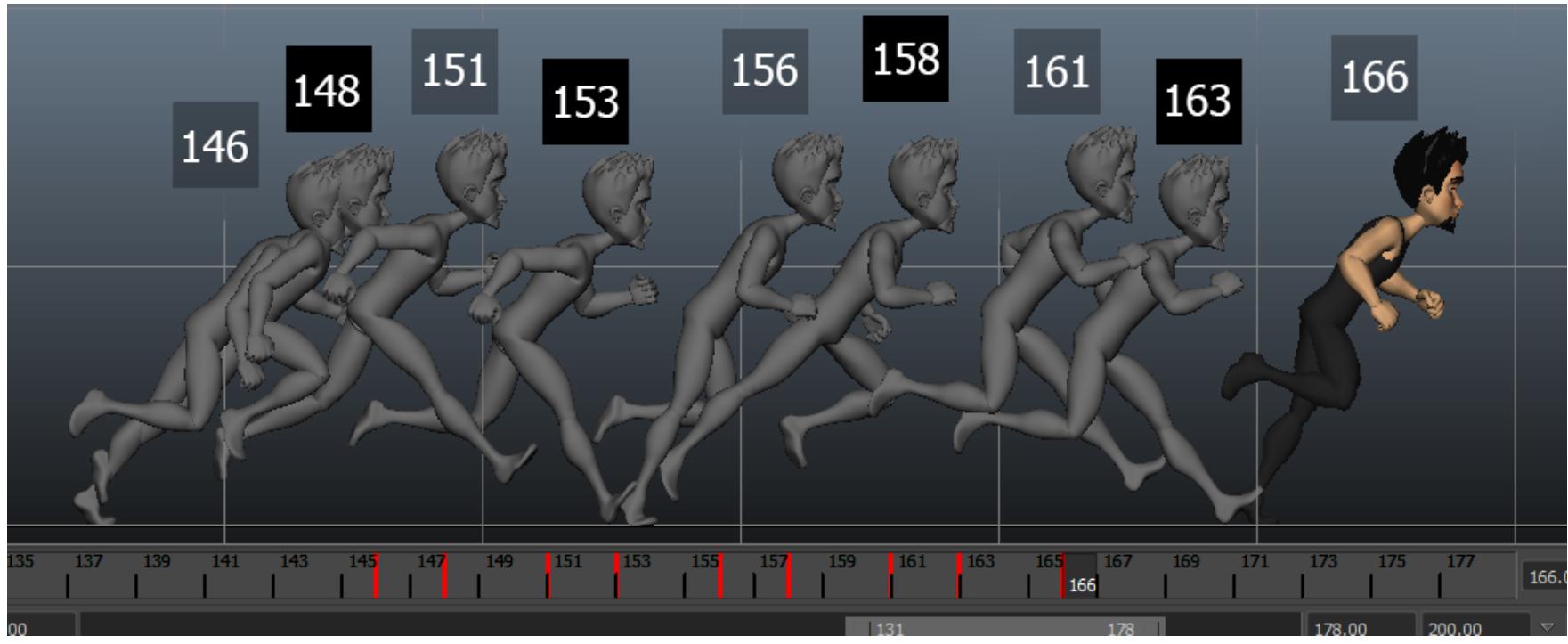


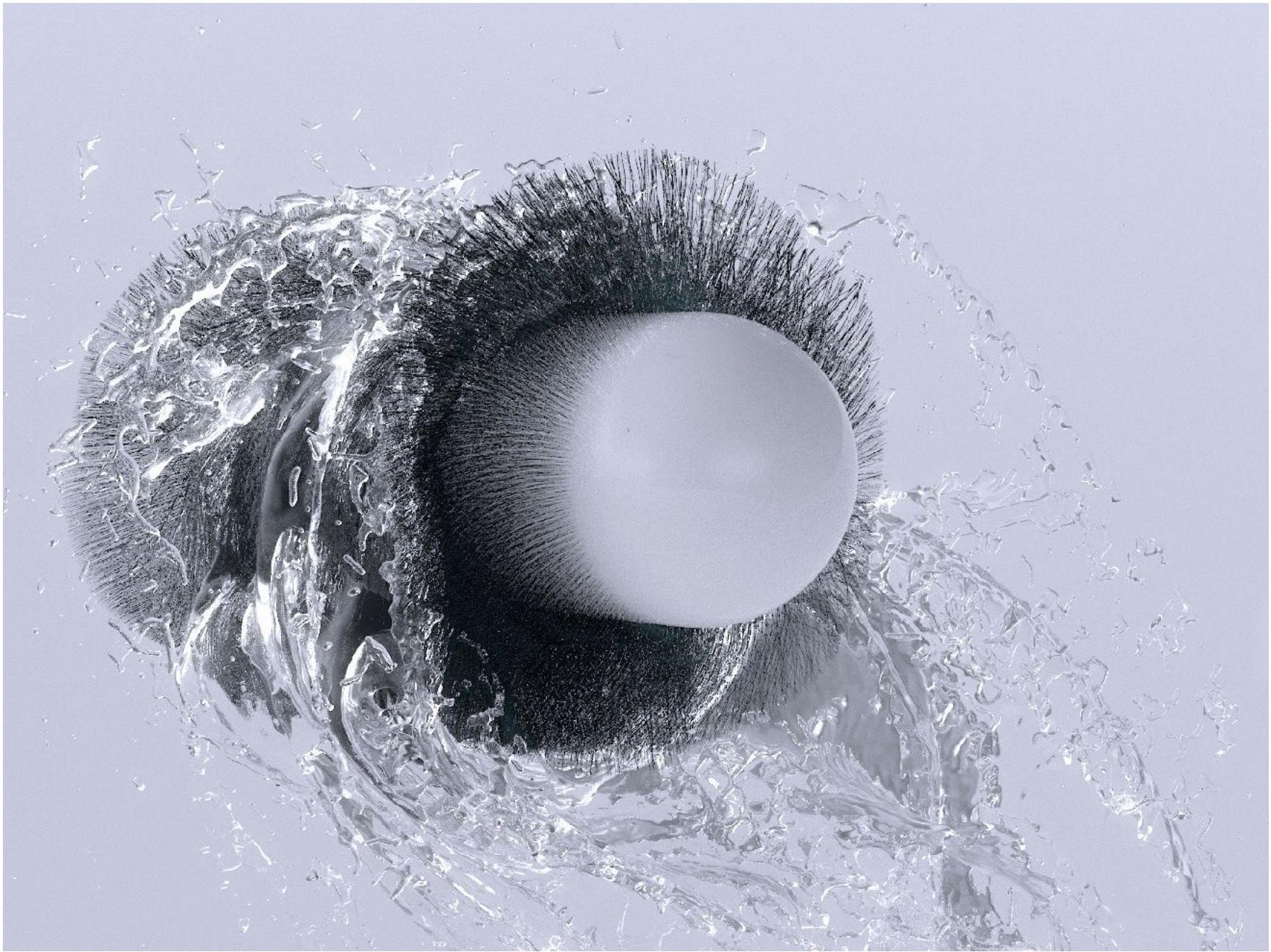
CALL OF DUTY[®]
WWII

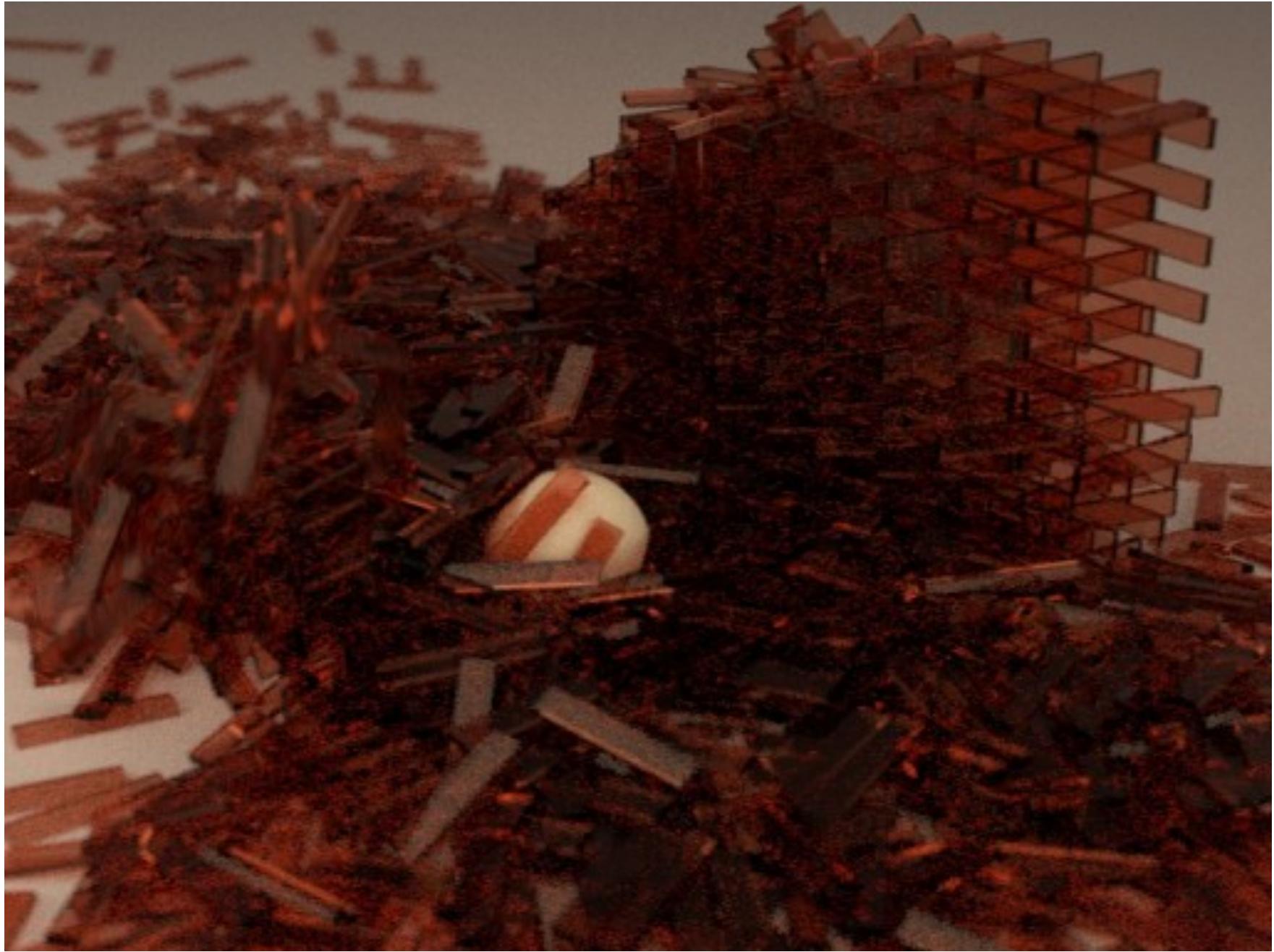
[Activision]



3D Animation









[Lord of The Ring]



[Dawn of the Planet of the Apes]

Graphics Systems

SM

Instruction Cache

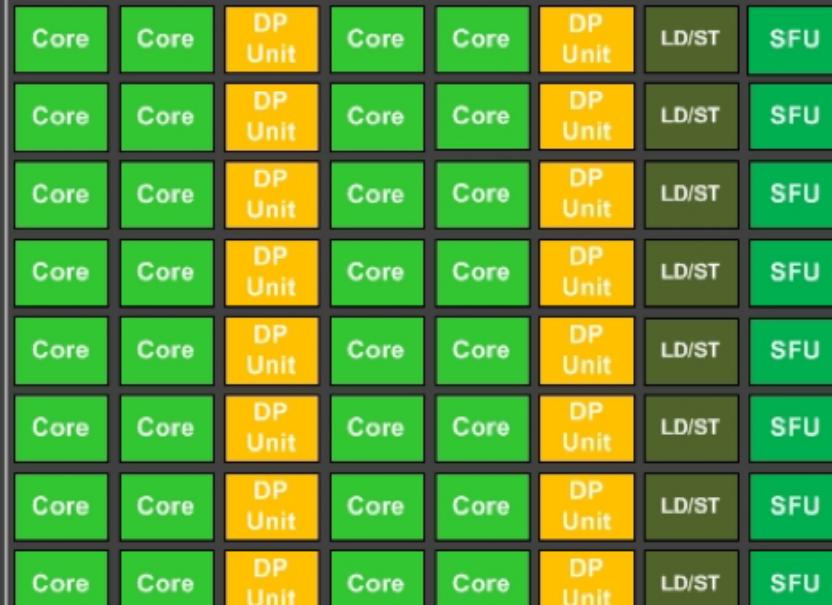
Instruction Buffer

Warp Scheduler

Dispatch Unit

Dispatch Unit

Register File (32,768 x 32-bit)



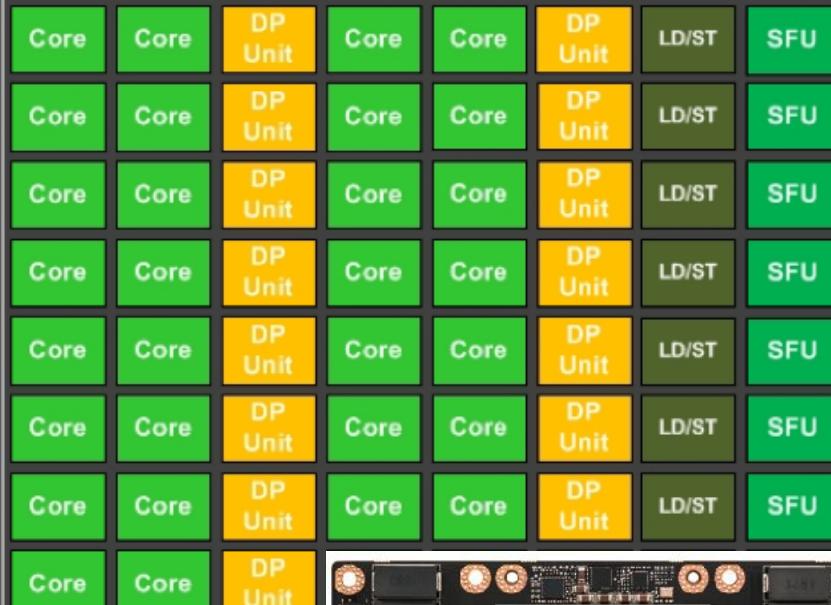
Instruction Buffer

Warp Scheduler

Dispatch Unit

Dispatch Unit

Register File (32,768 x 32-bit)



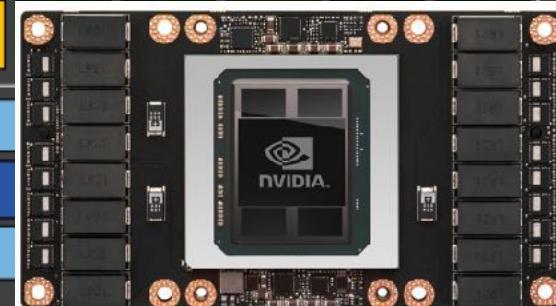
Texture / L1 Cache

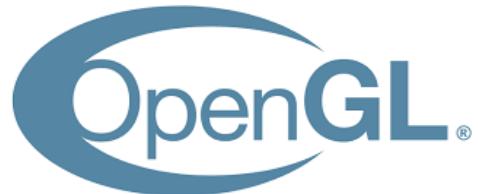
Tex

Tex

Tex

64KB Shared Memory



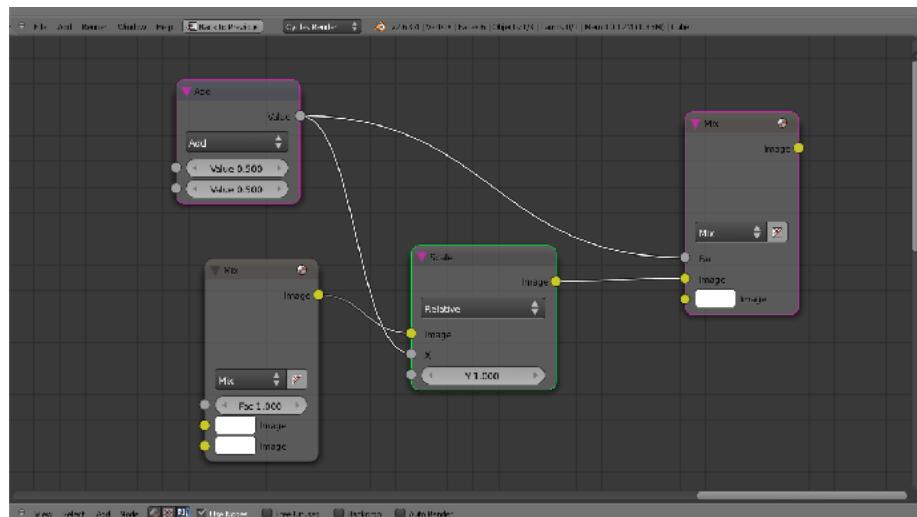


```
layout(location = 0) in vec3 vert_pos;
layout(location = 1) in vec3 vert_norm;
layout(location = 2) in vec2 vert_texcoord;
layout(location = 3) in vec4 vert_color;
layout(location = 4) in vec4 vert_tangsp;

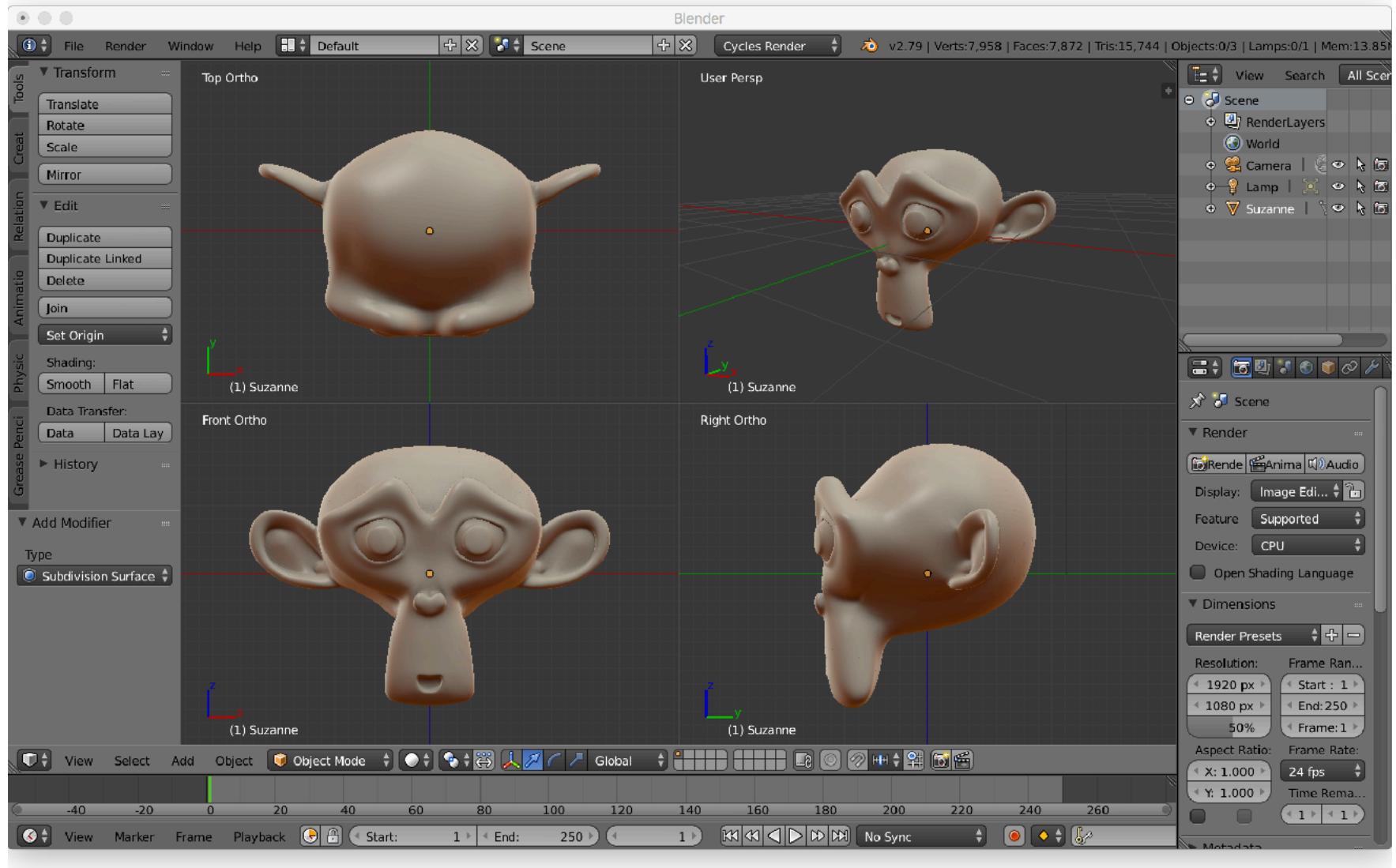
uniform mat4 shape_xform;

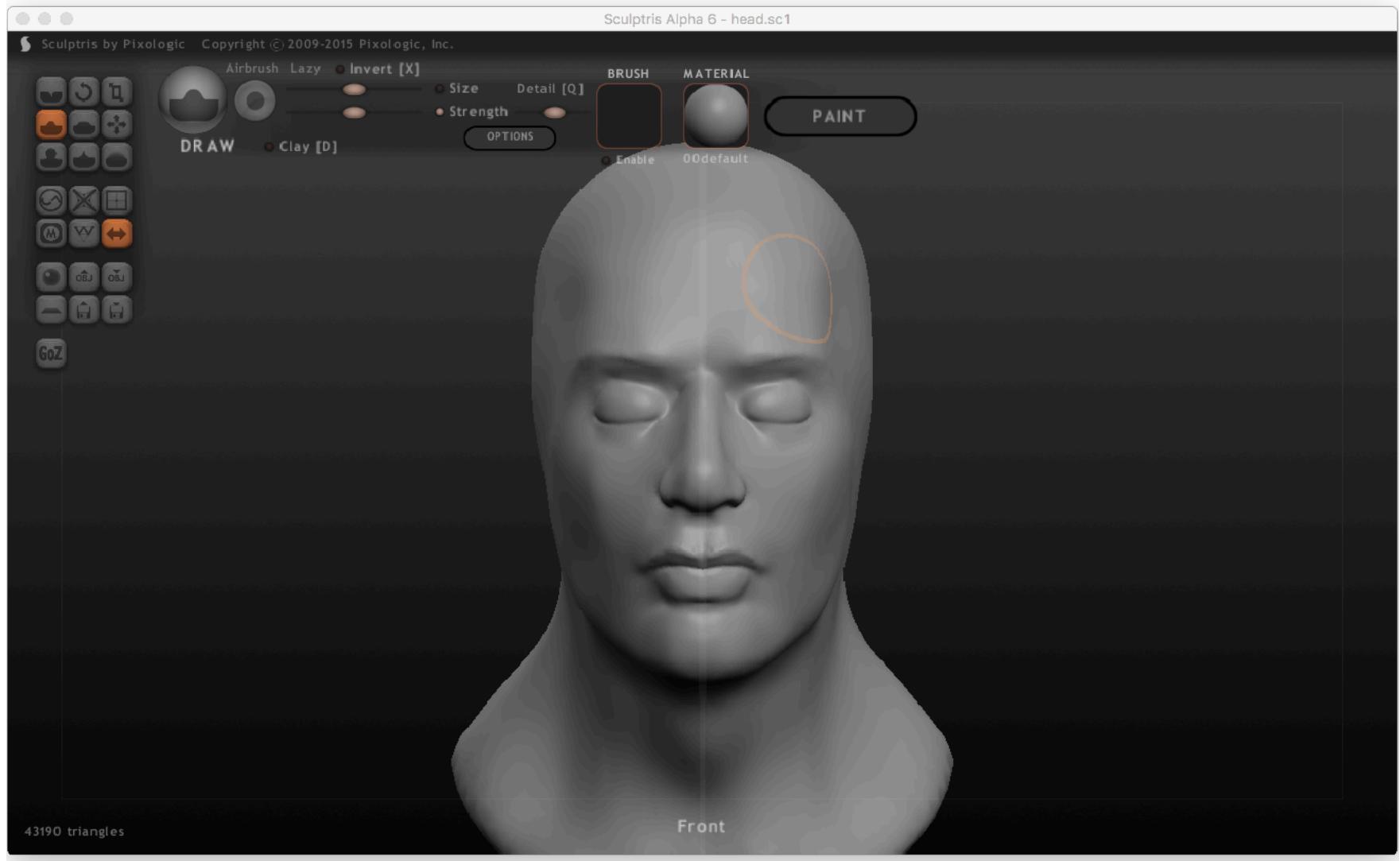
struct Camera {
    mat4 xform;
    mat4 xform_inv;
    mat4 proj;
};

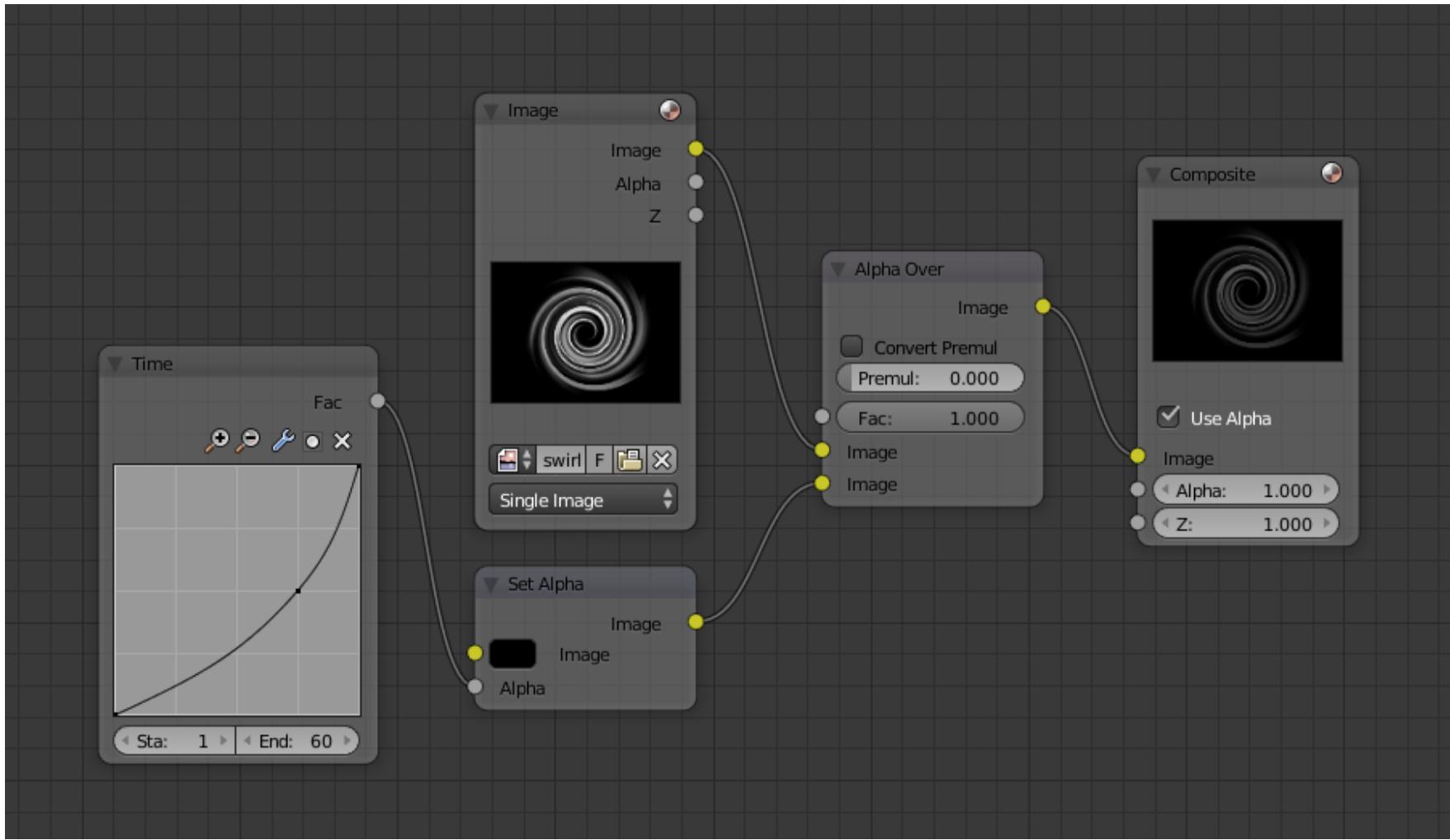
uniform Camera camera;
```



Graphics Interfaces







This Course Perspective



Create Images that are
Indistinguishable from Reality



[Wikimedia Commons]

... but Reality is complex

To handle all this complexity,
Computer Graphics uses
sophisticated math,
high performance systems,
and some physics

Instructor



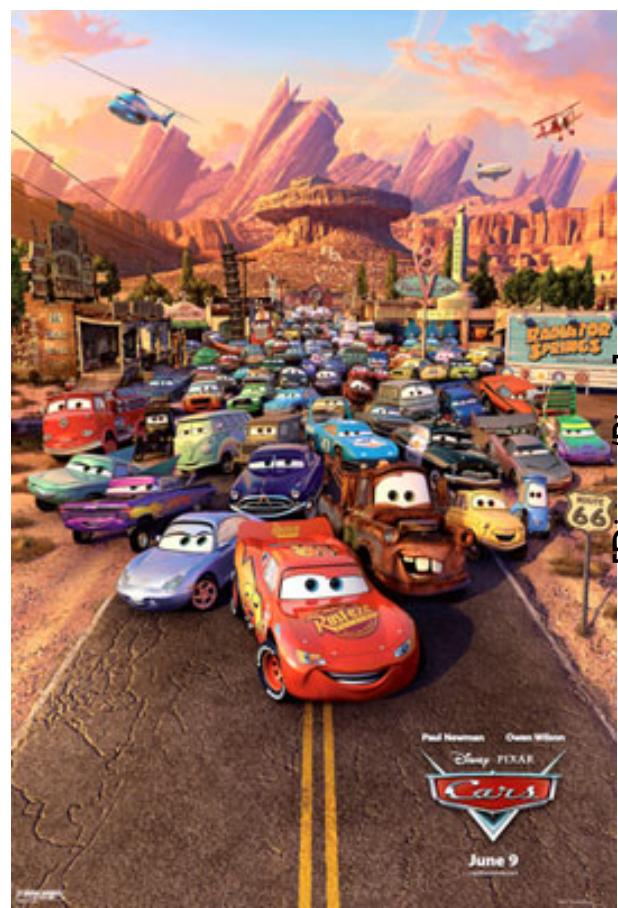
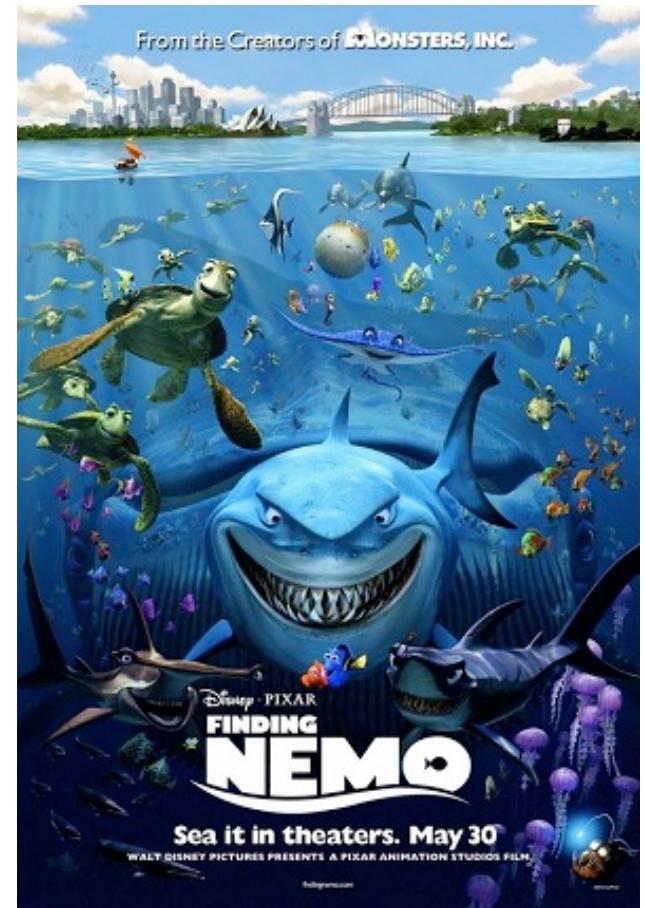
NSF CAREER Award



Alfred P. Sloan
FOUNDATION

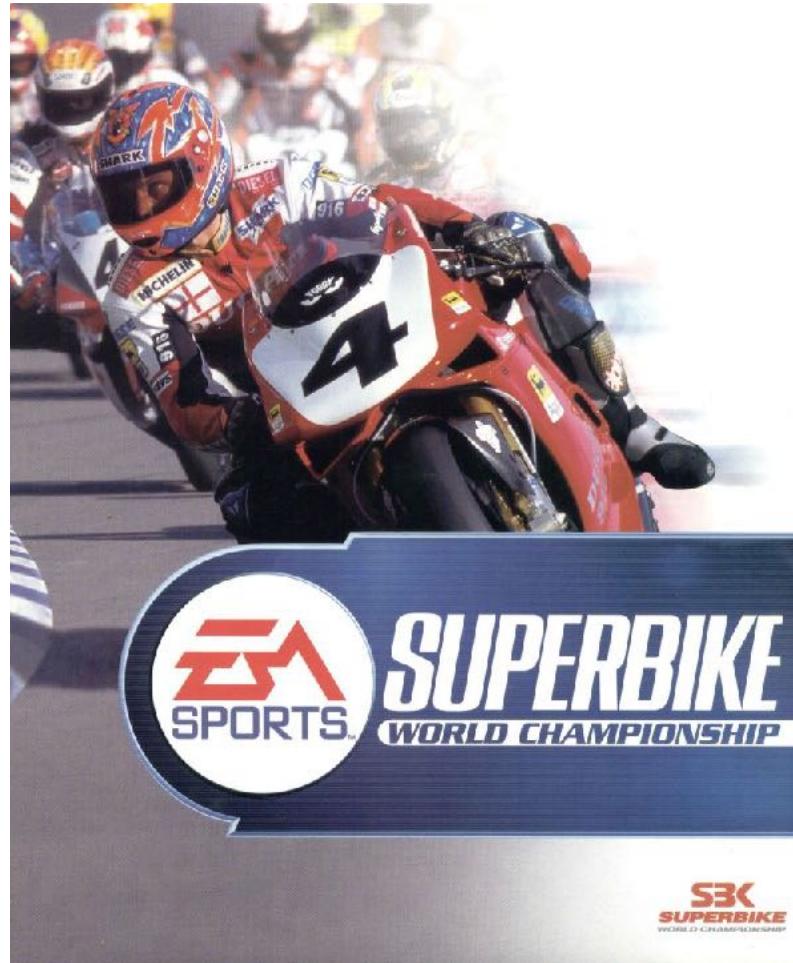
Alfred P. Sloan Fellowship

My Background



[Disney Pixar]

My Background



My Background



SIGGRAPH



My Research: Content Creation Systems

Course

Course Topics

- What you will learn:
 - Main Computer Graphics algorithms
 - Introduction to Graphics APIs (OpenGL/GLSL)
 - Demos with Software (Blender, Unity, Research Code, ...)
 - How to implement Computer Graphics algorithms
 - With C++/Git/CMake/Debuggers
- What you will not learn:
 - Building large system
 - Creating Art Assets
 - Designing Games

Course Prerequisites

- Vector Geometry: points, vectors, and their products
 - Basic understanding of Linear Algebra: 2×2 to 4×4 matrices
 - Basic understanding of Calculus: simple derivates and integrals
 - C or C++
-
- We will review all this material in class.

Course Mechanics

- All information on the course website
 - Teaching Material
 - Schedule
 - Homeworks
 - Grading Policies
- Communication
 - Before and after class
 - Office hours
 - Direct email for personal questions