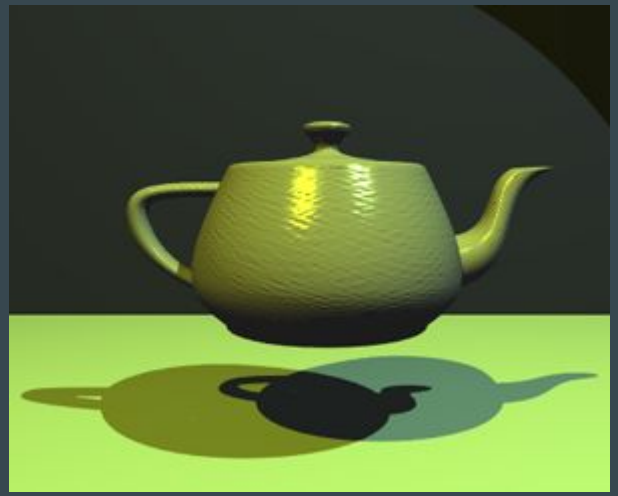
3D In Depth

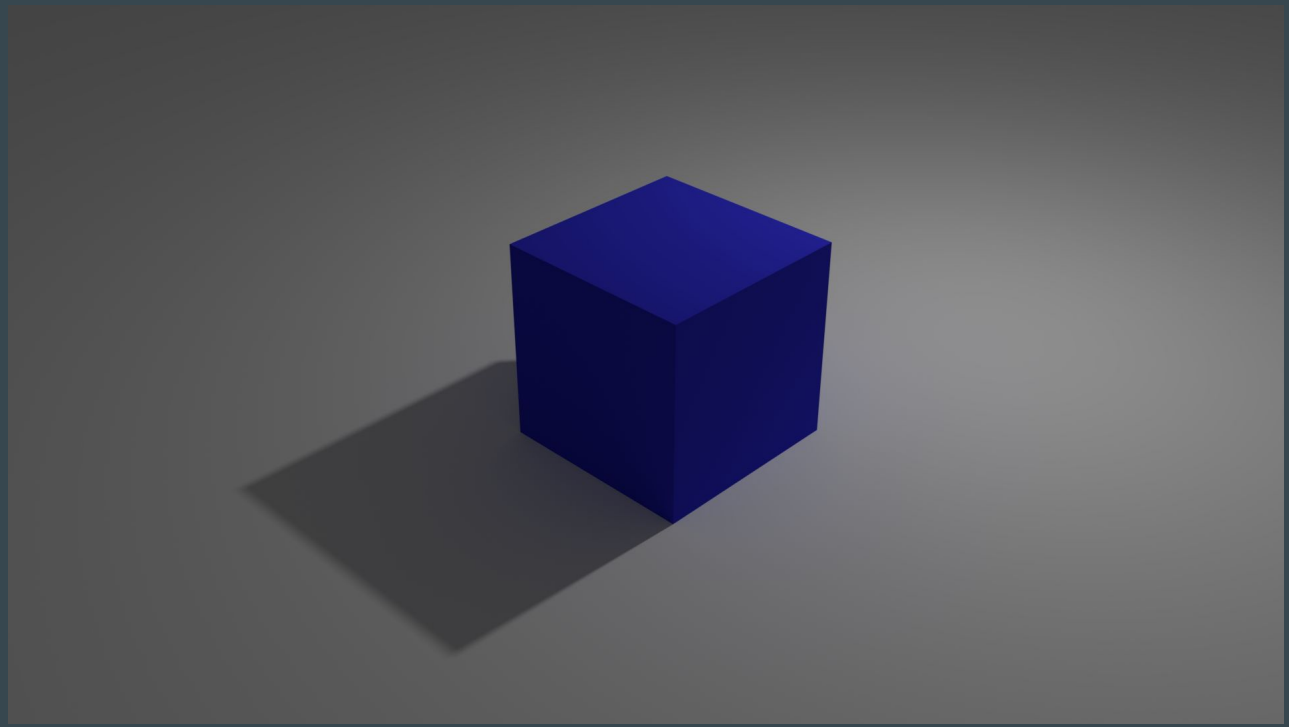
ElectronicArmory.com
3D Game Development Course

The Utah Teapot

- Mathematical model
  - Simple shape
  - Solid
  - Cylindrical
  - Convex
- Easy 3D scene with a non-trivial model for a basic scene and light setup
- The Utah teapot was created in 1975 by Martin Newell, computer graphics researcher at the University of Utah



Hello World



3D Concepts

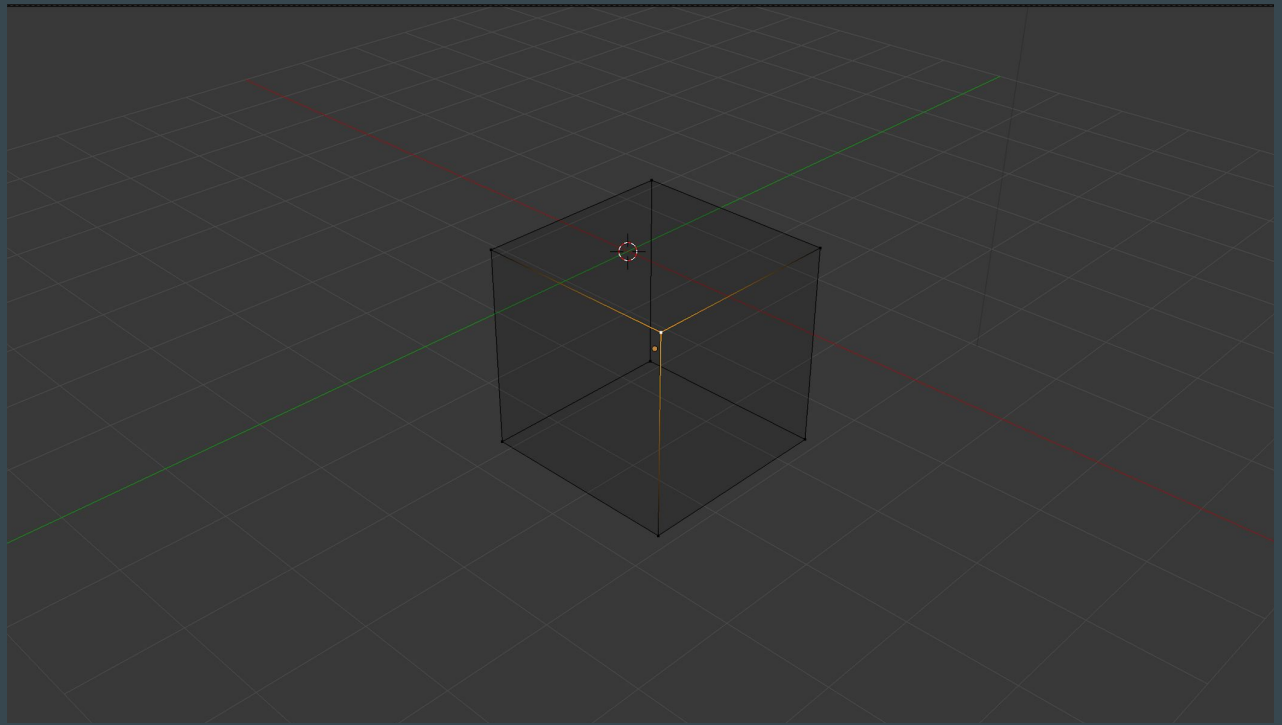
- Modeling Geometry (Meshes)
  - Vertices
  - Edges
  - Faces
- Lighting
- Texture/Material
- Rendering

Vertices

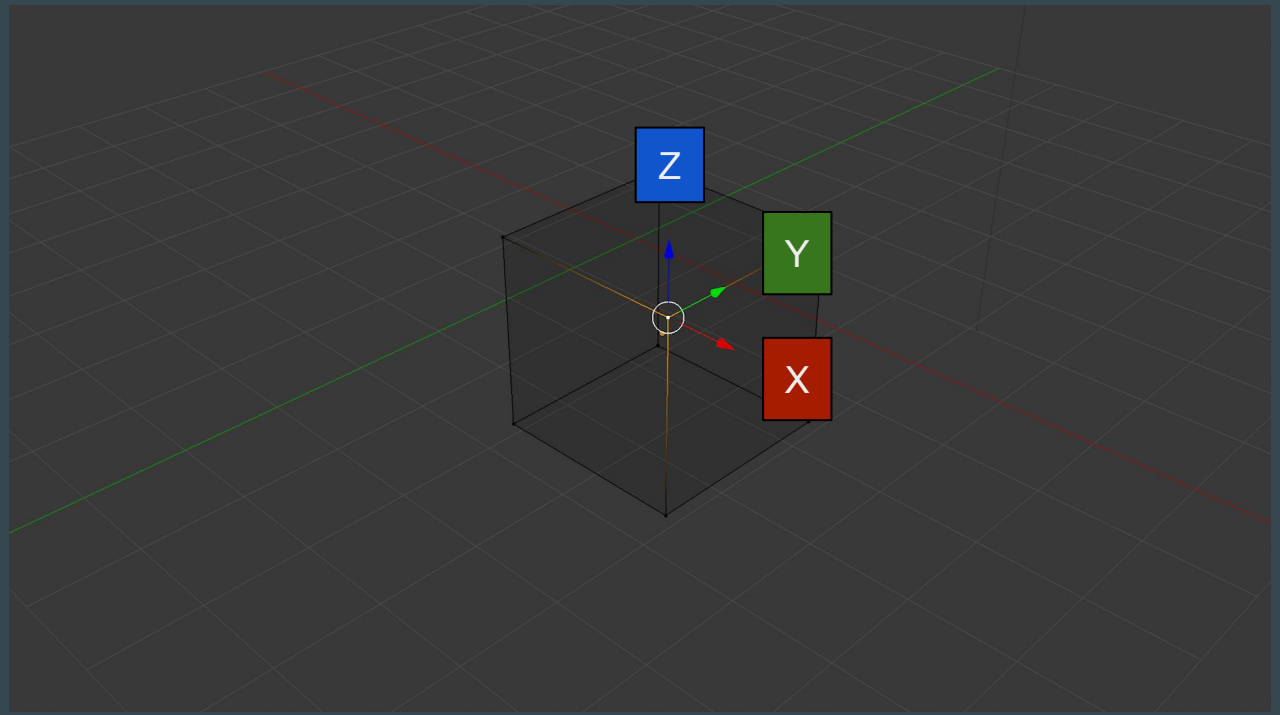
Points that occupy a specific coordinate in space.

In 3D space, vertices have an X, Y and Z coordinate:

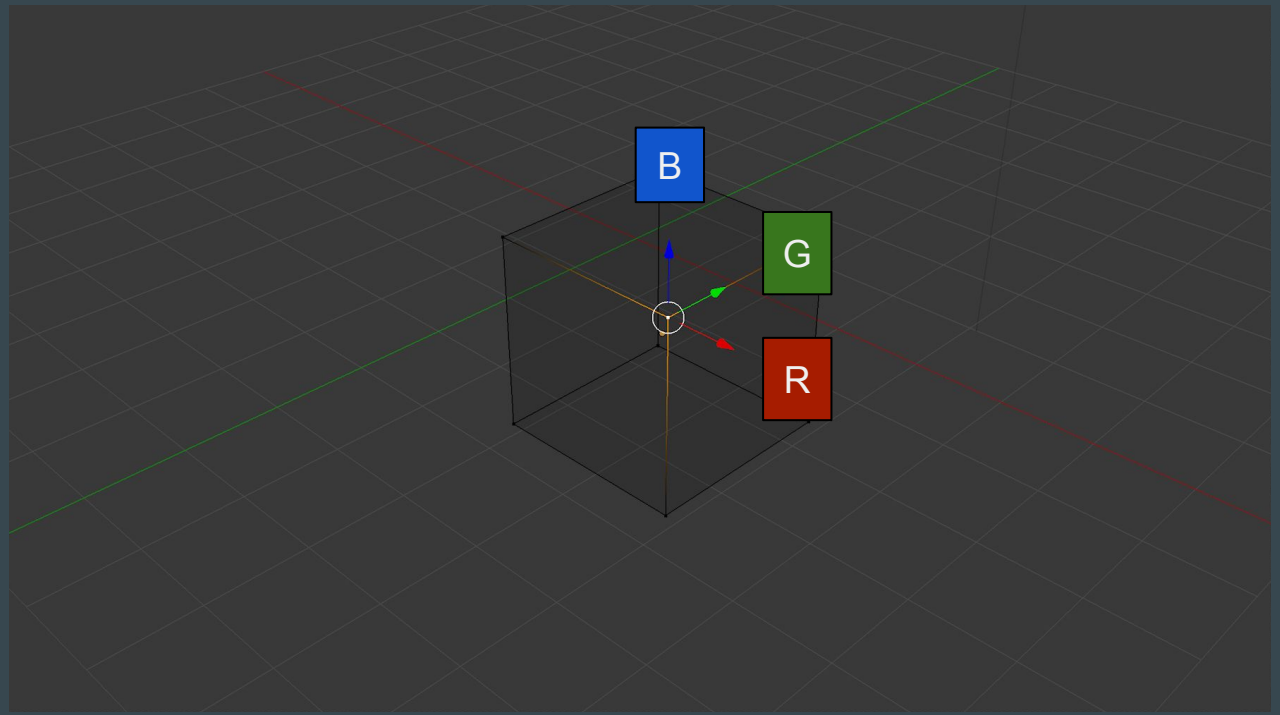
(3, 4, 19)



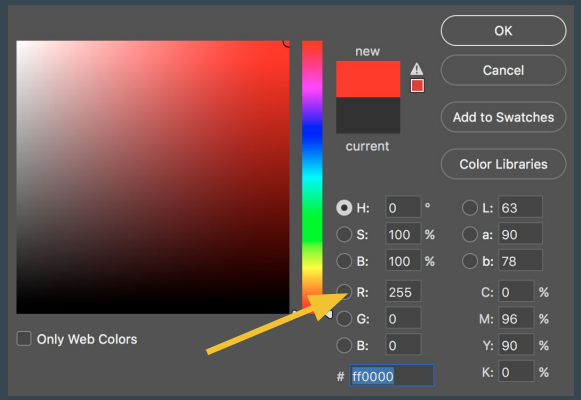
3D Axis

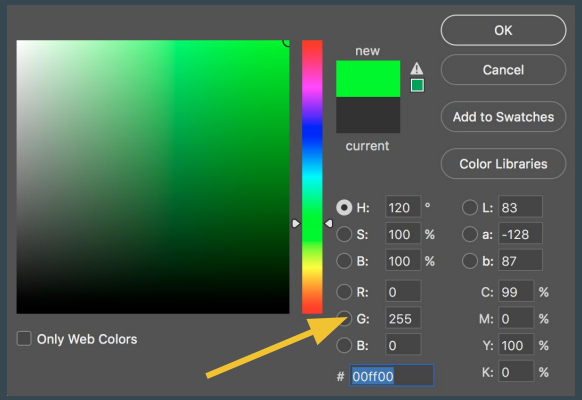


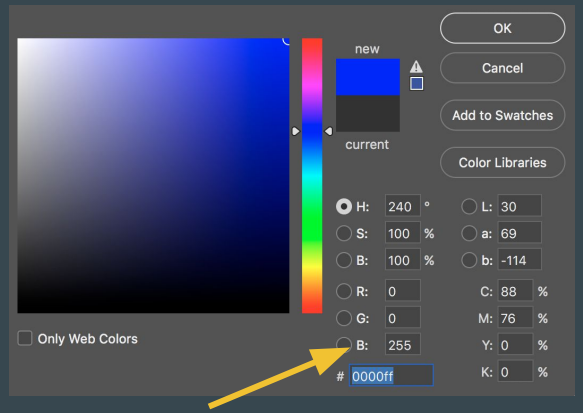
3D Axis - RGB



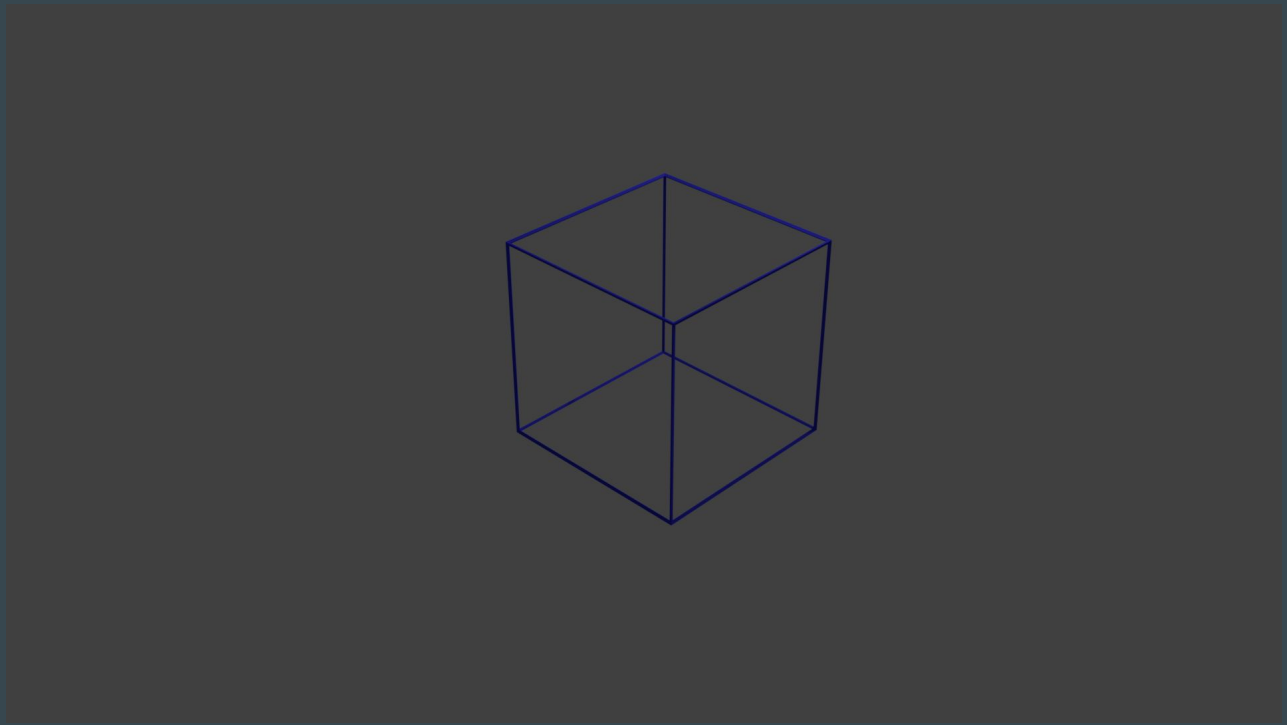
RGB in Color Pickers



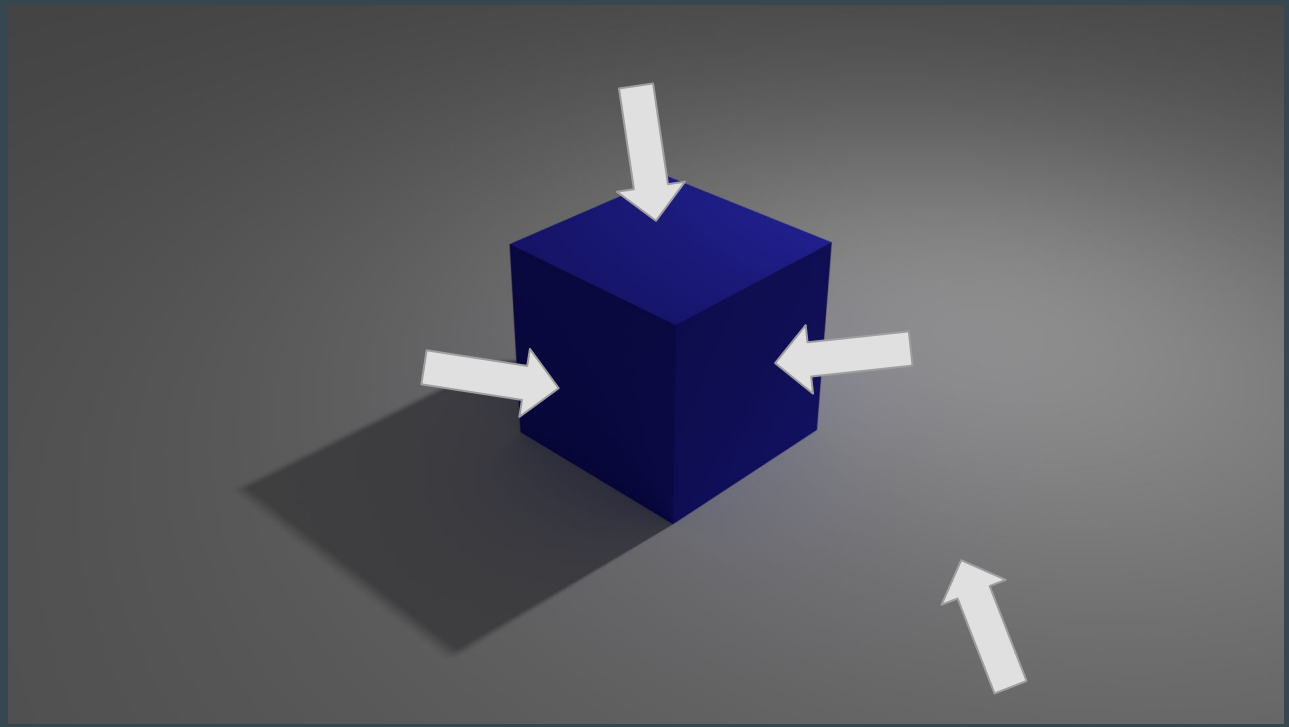




Edges

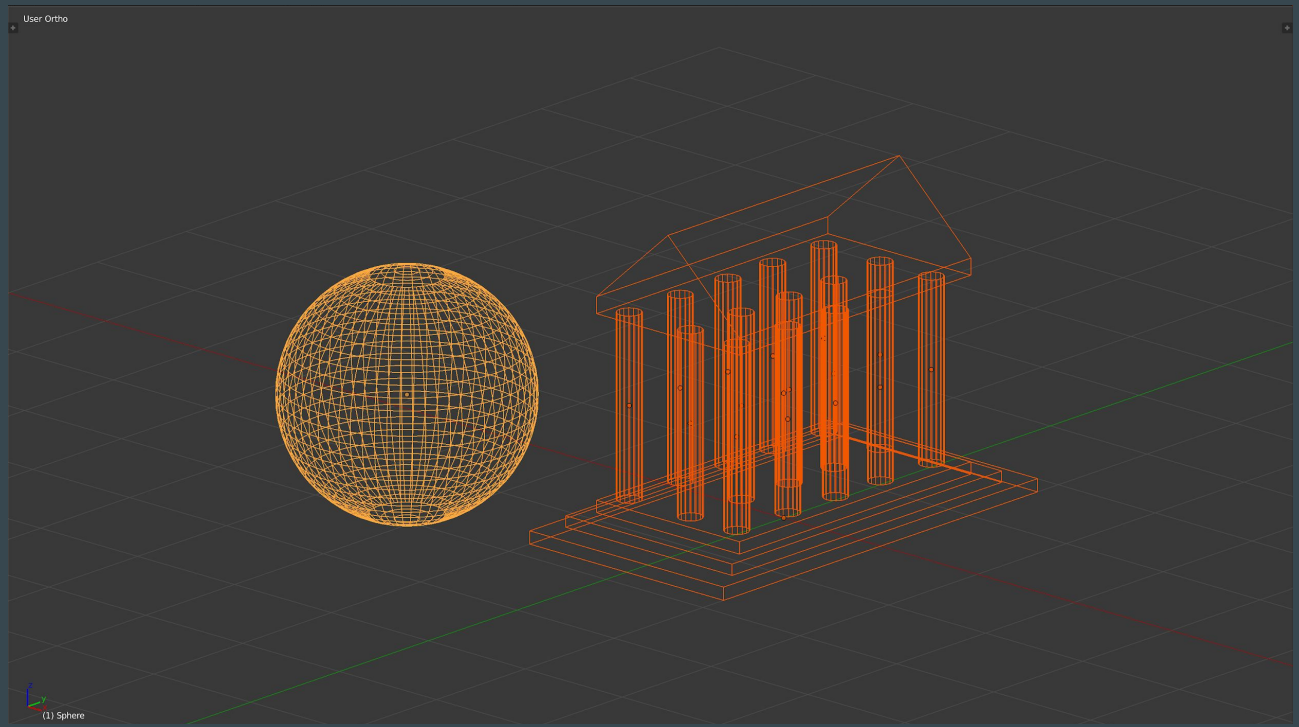


Faces

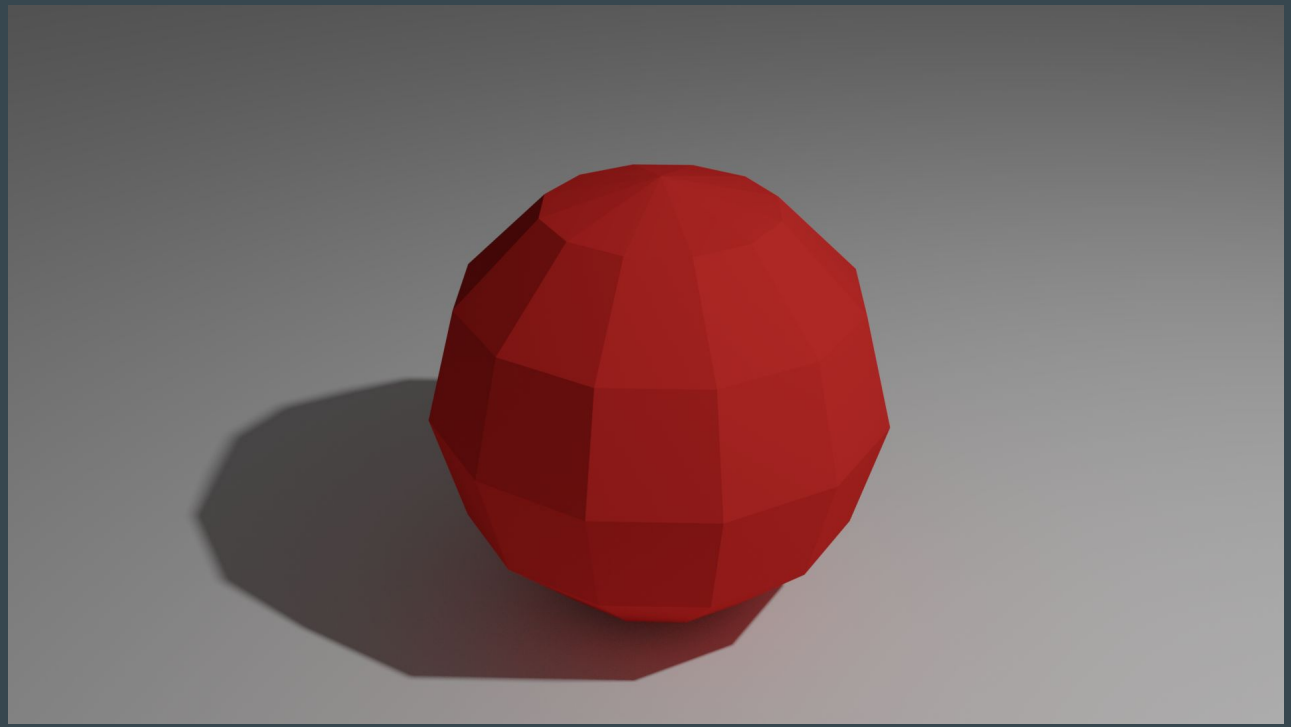


Modeling

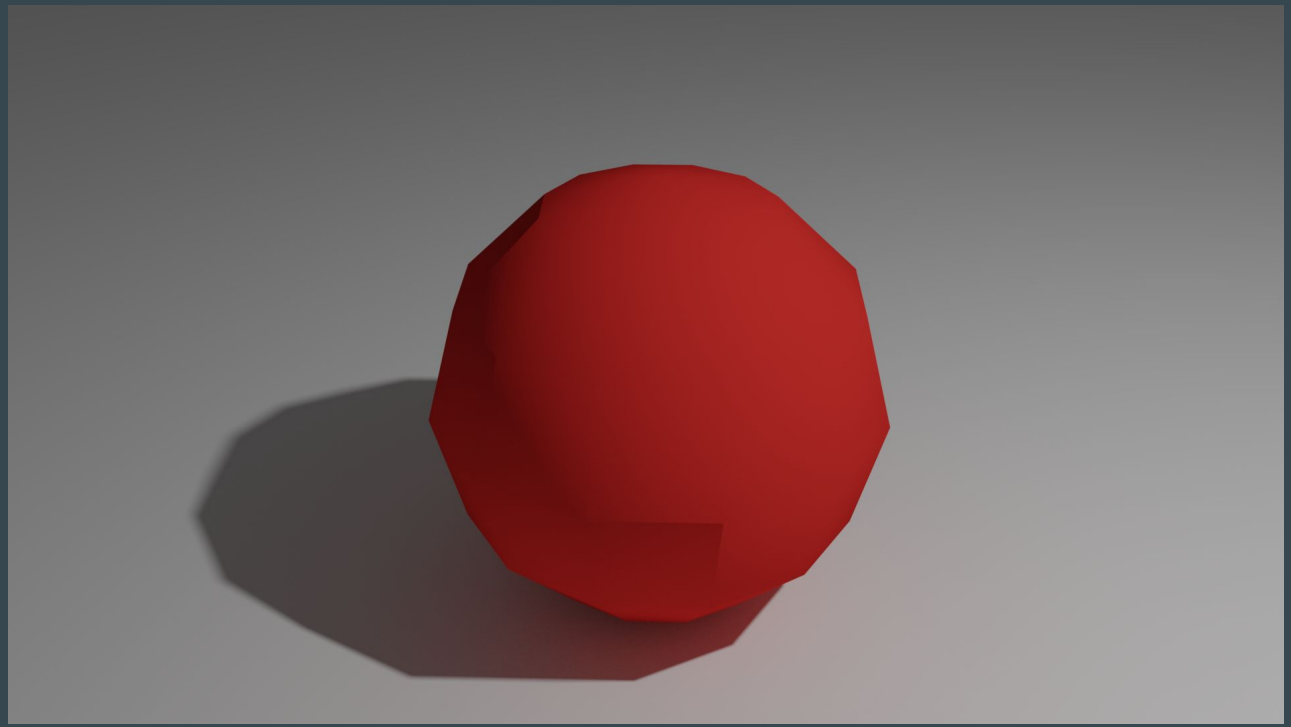
Modeling



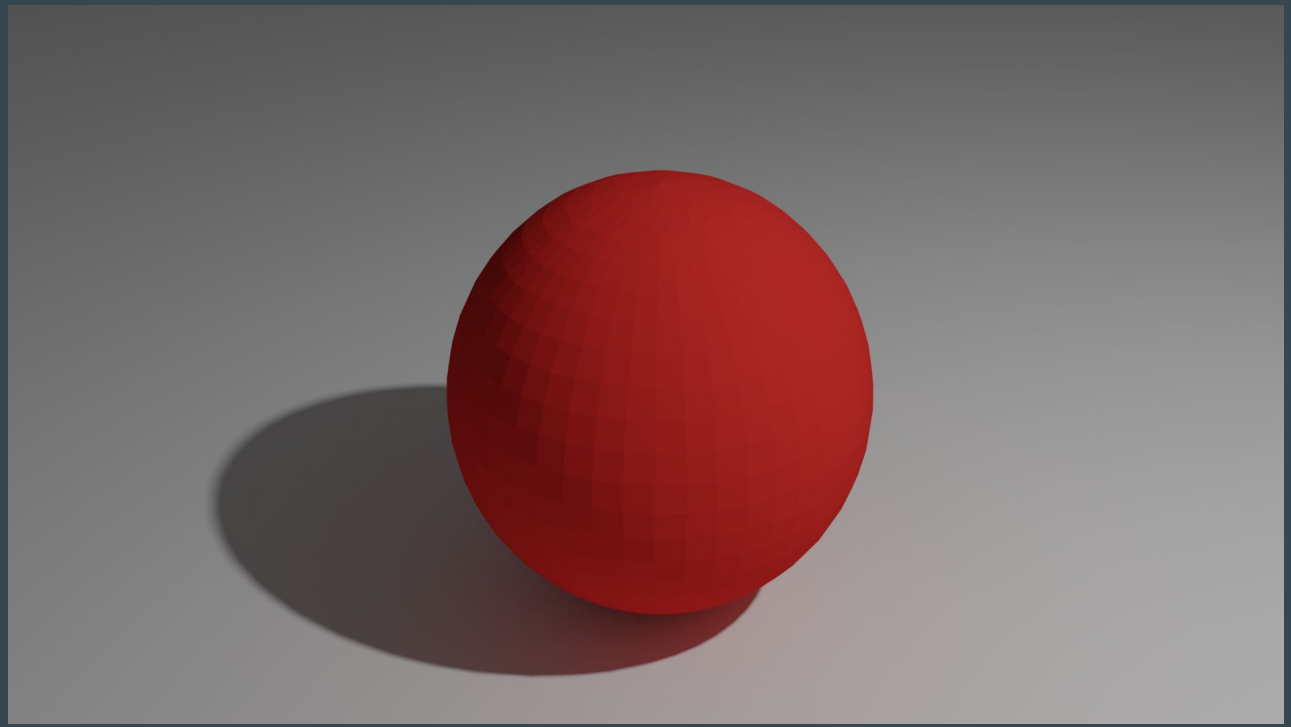
Low Poly - Flat Shaded



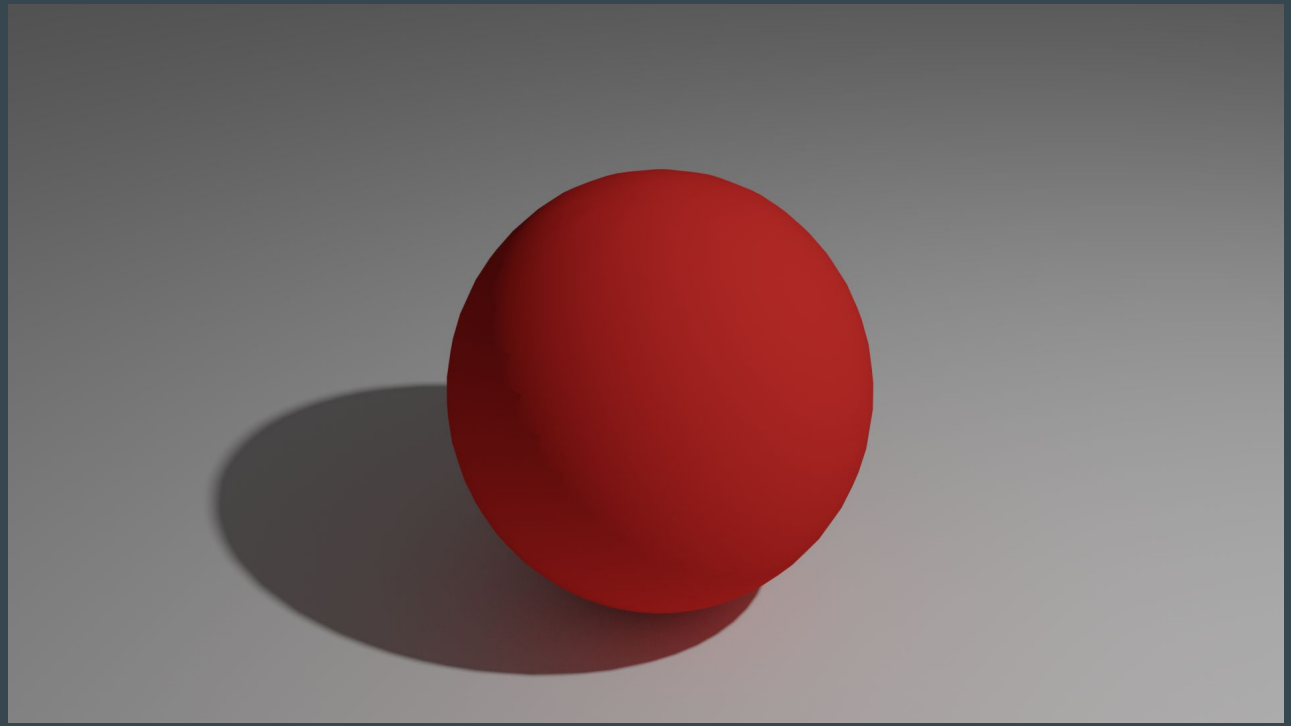
Low Poly - Smooth Shaded



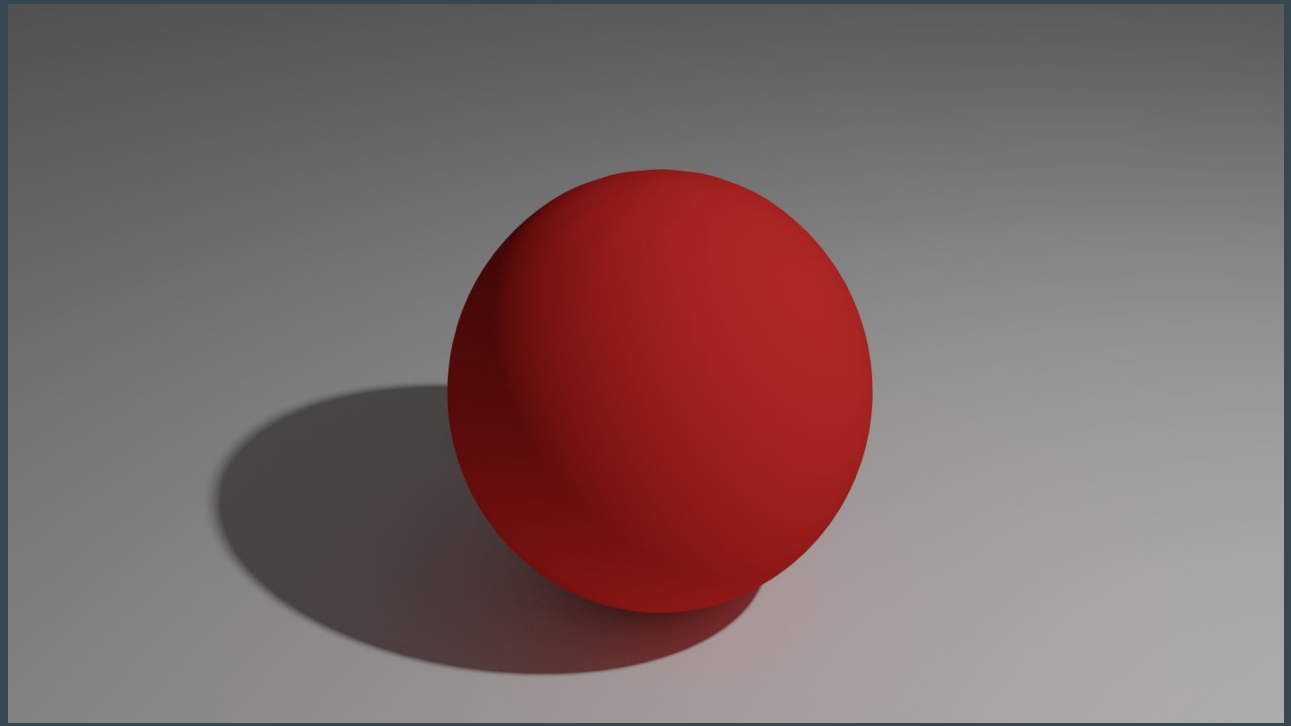
High Poly - Flat Shaded



High Poly - Smooth Shaded



Super High Poly - Smooth Shaded

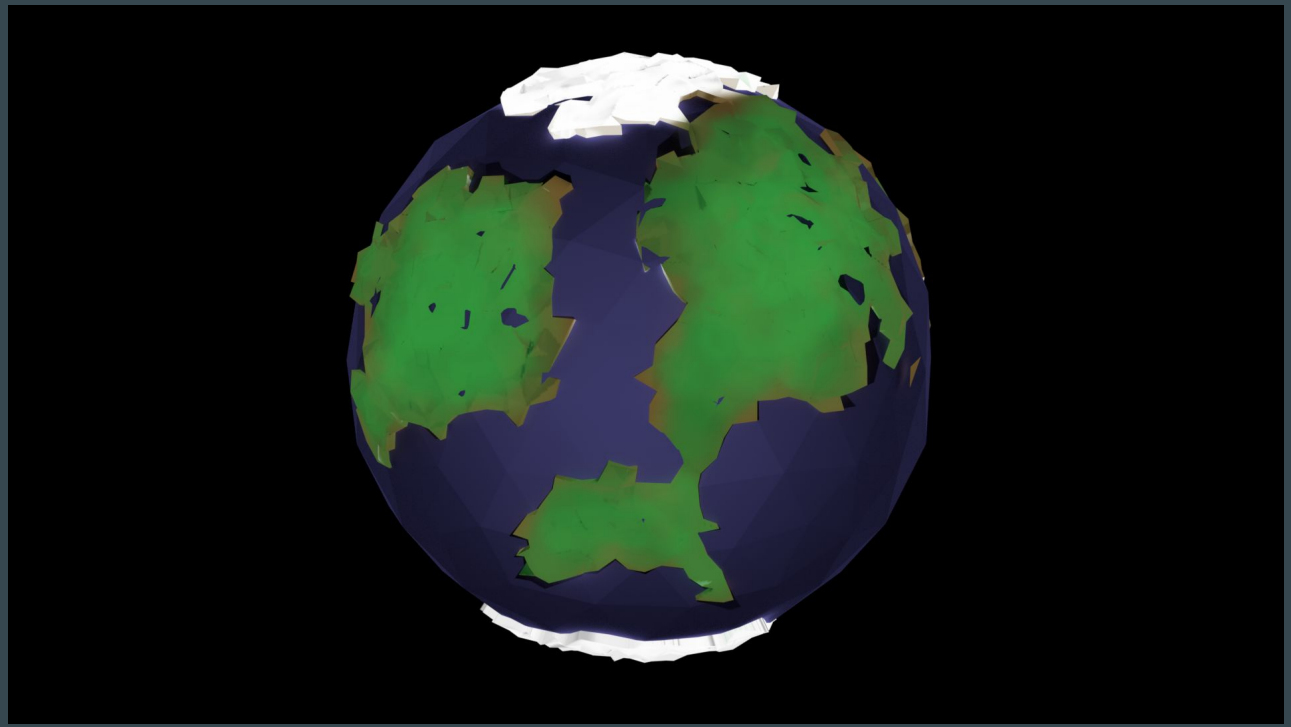


Level of Detail (LODs)

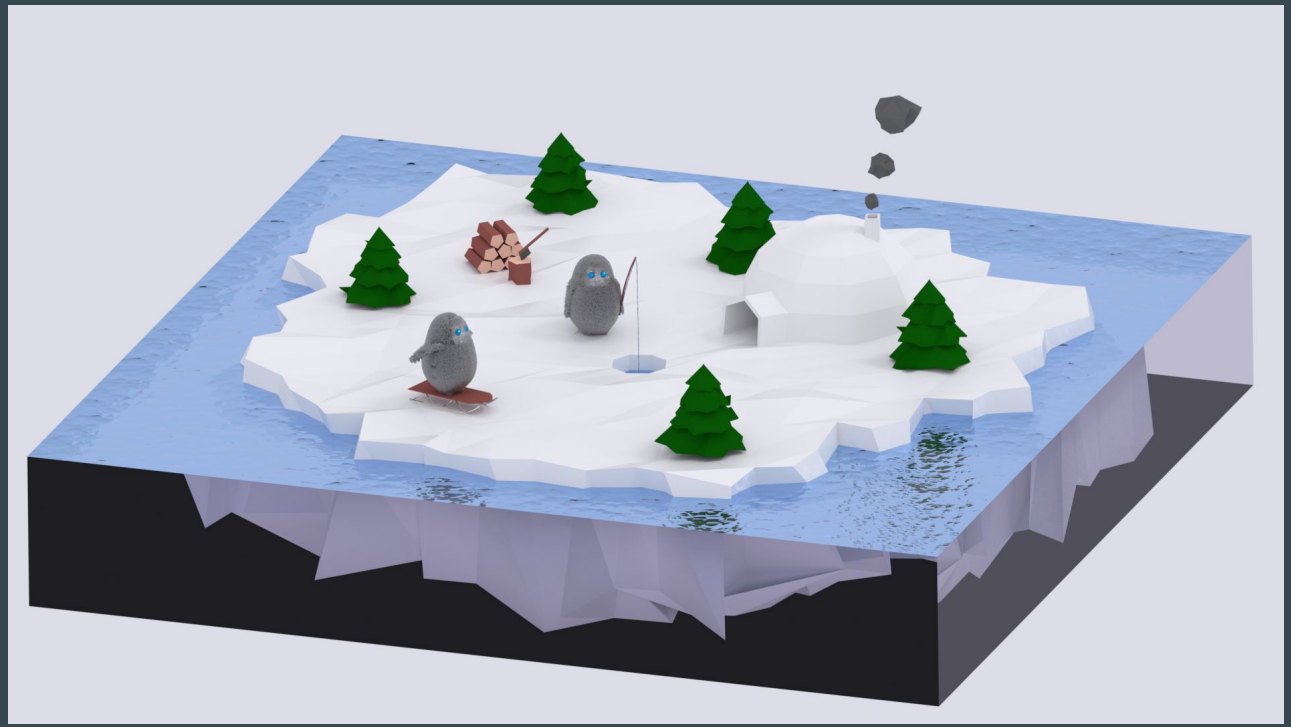
For efficiency, objects that are farther away can have few polygons since they lack the detail needed on objects that are closer to the camera.

Game engines allow for different LODs on meshes for efficiency.

Low Poly Scene

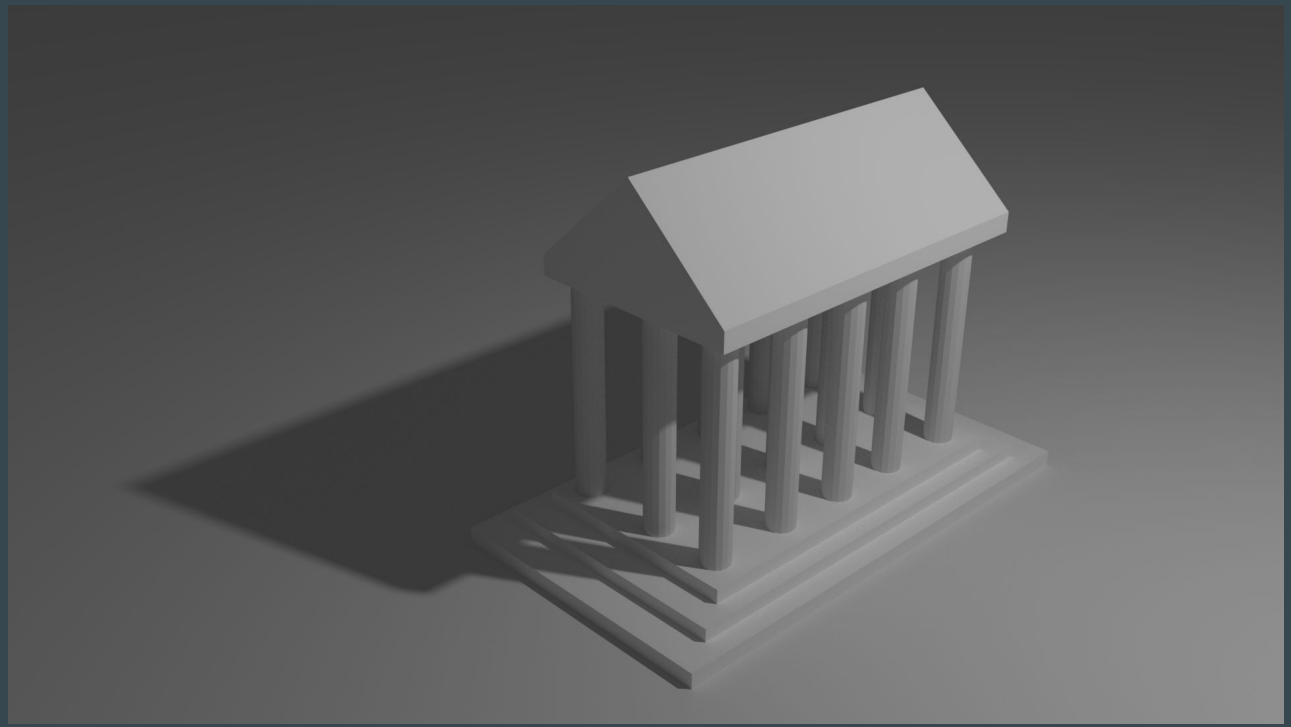


Low Poly Scene

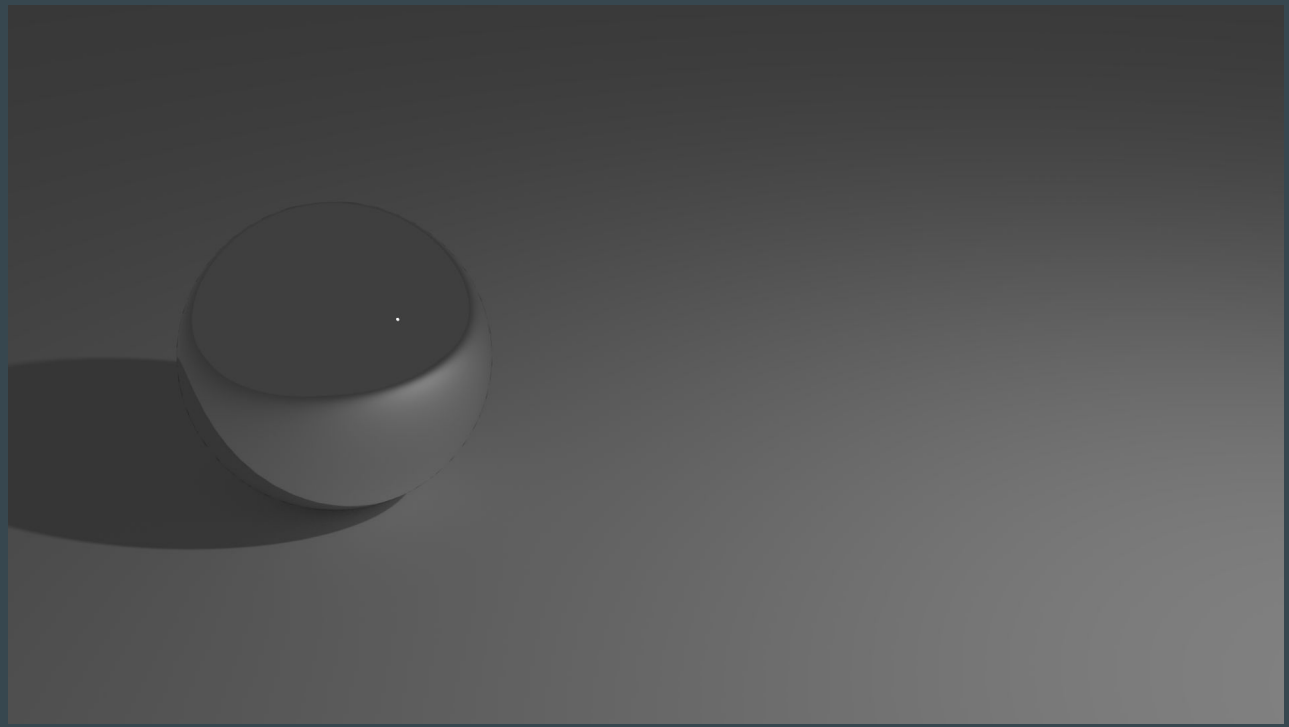


Textures and Materials

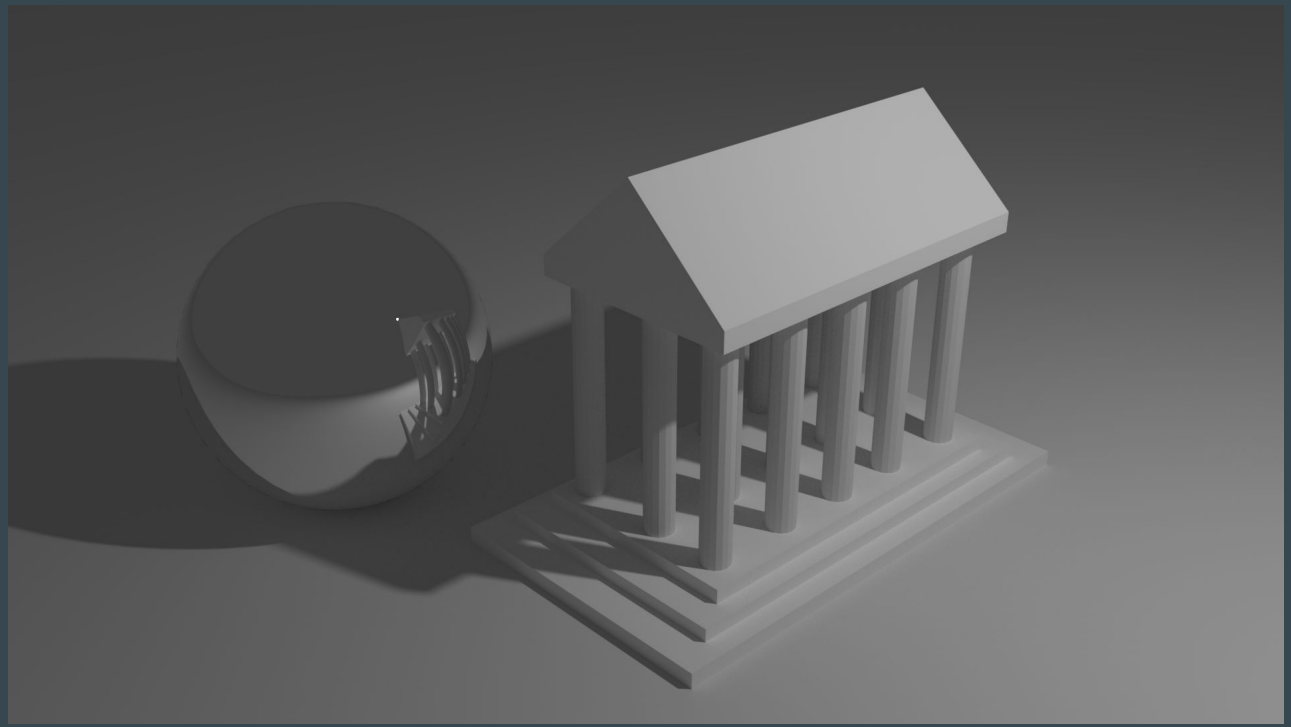
Diffuse Material



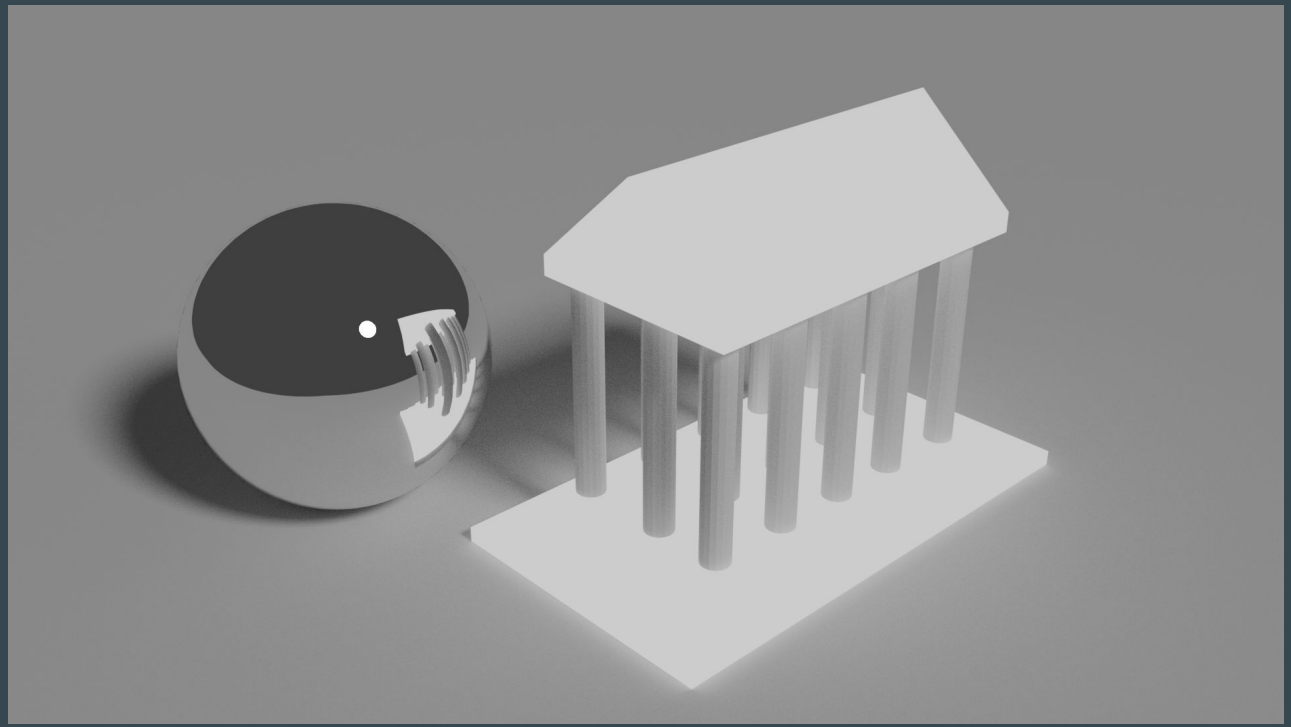
Gloss



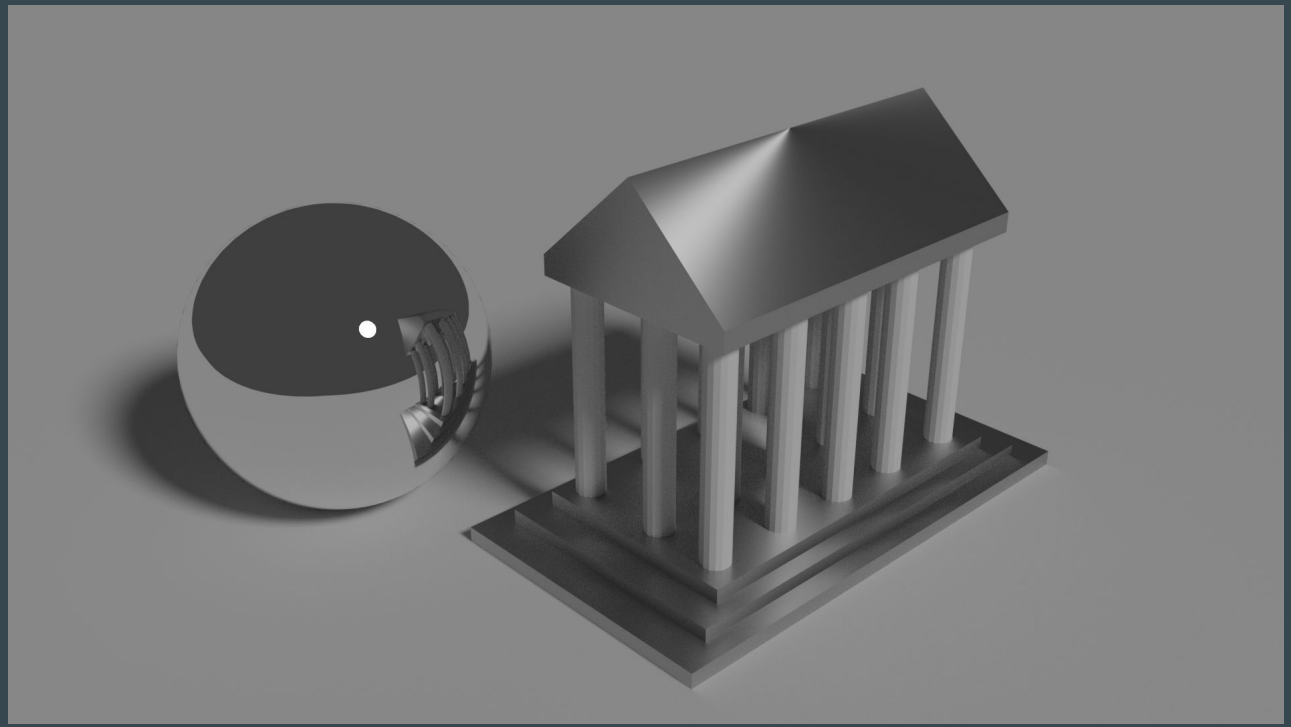
Gloss and Diffuse Shading



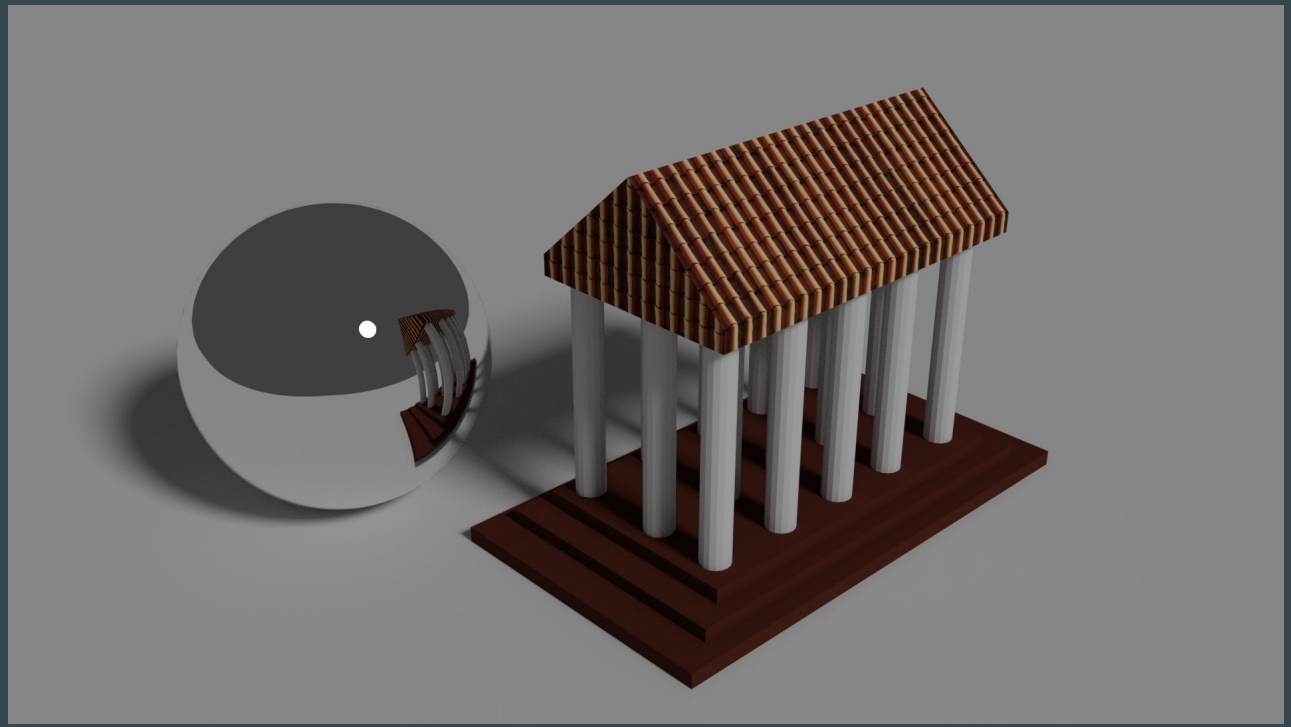
Emission



Anisotropic



Textures



UV Mapping

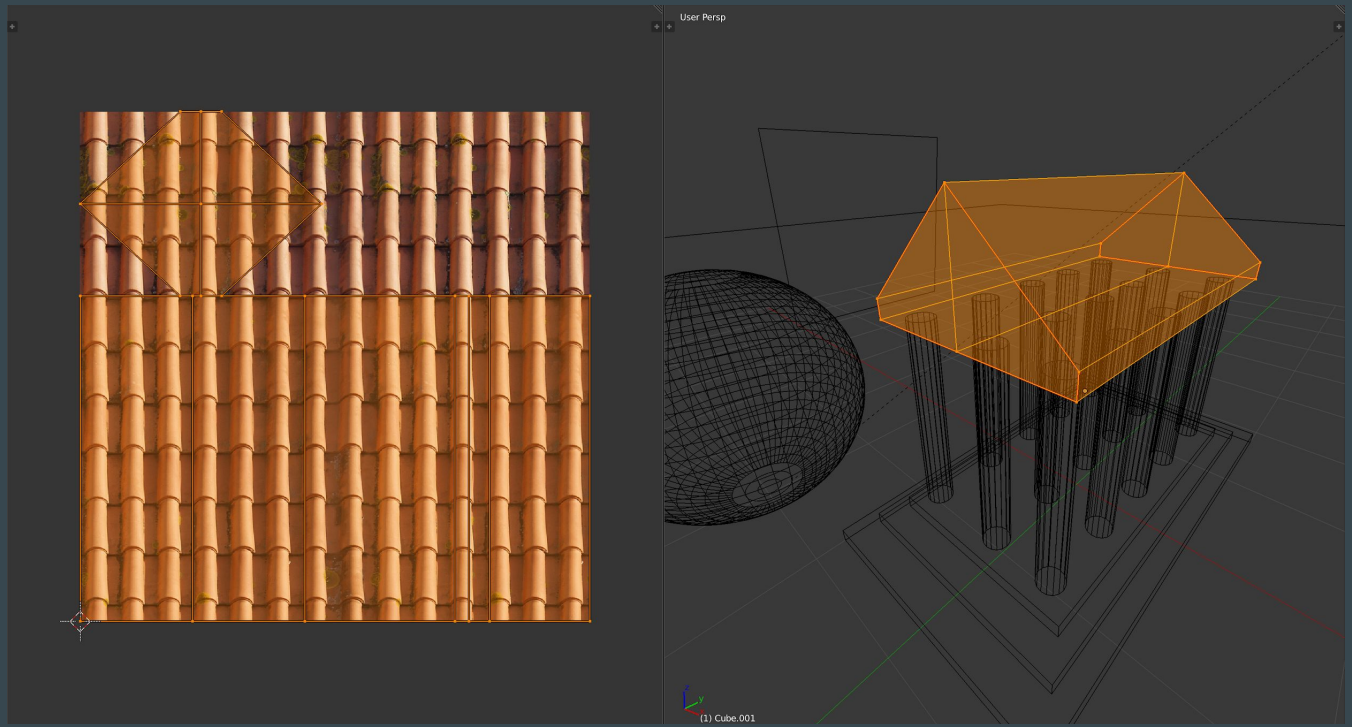
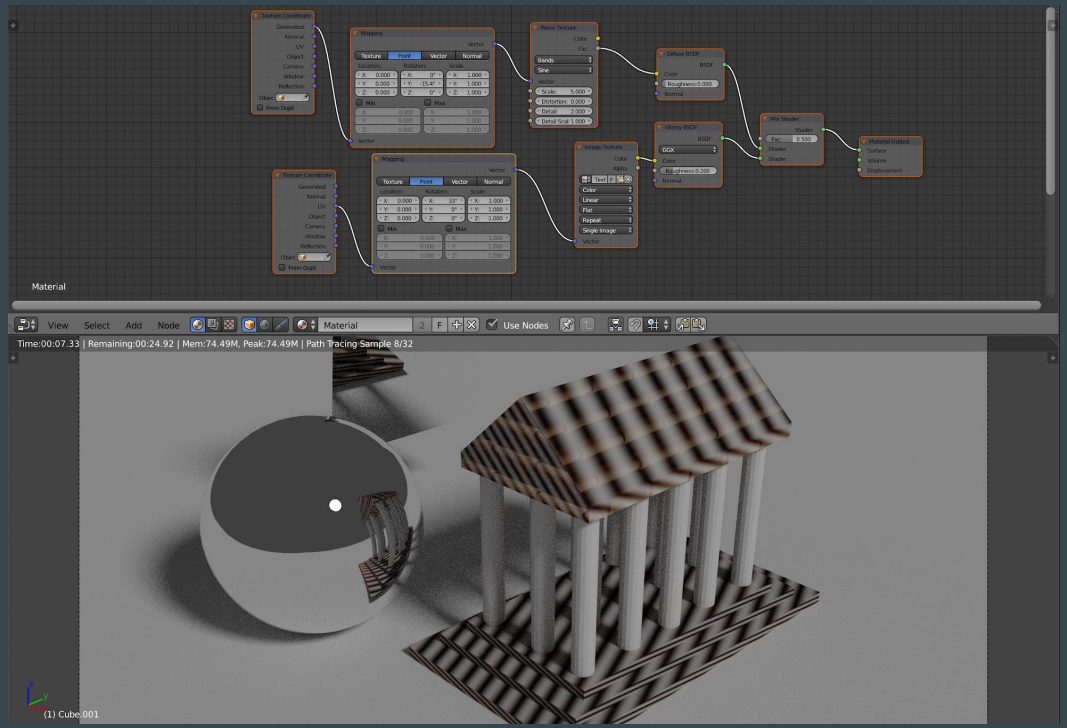


Image textures

Procedural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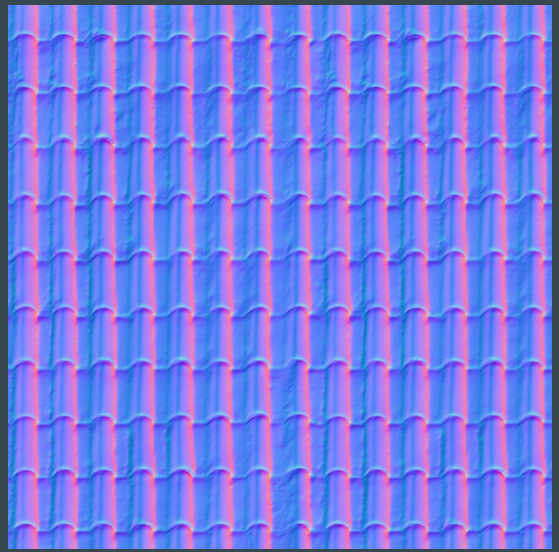
Normal Maps



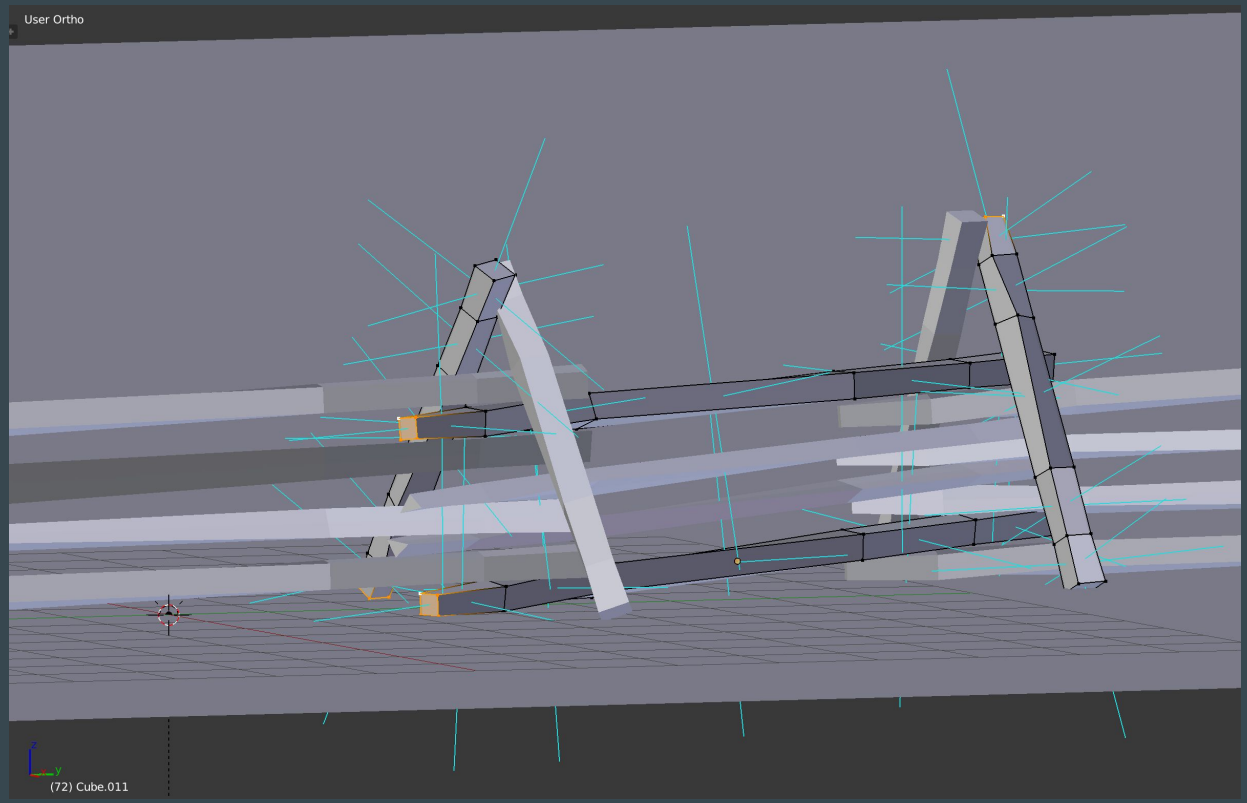
Normal Maps

Tells the renderer to bounce light off the surface differently than the geometry would normally.

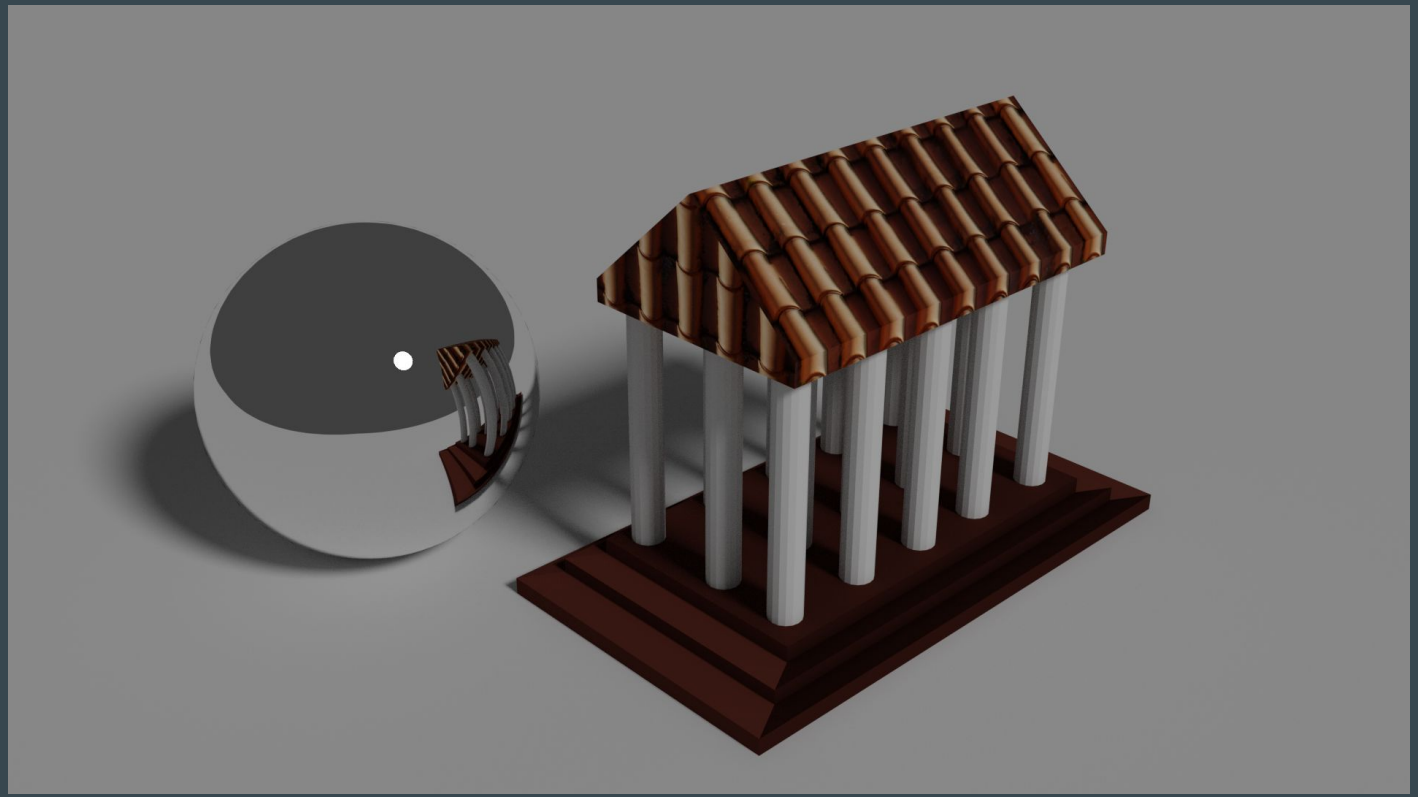
“Normals” refers to the line, perpendicular to the surface plane.

In almost all game engines, the back face of a plain is not rendered. This is the face opposite to the direction of the plain’s normal.

Normal Maps

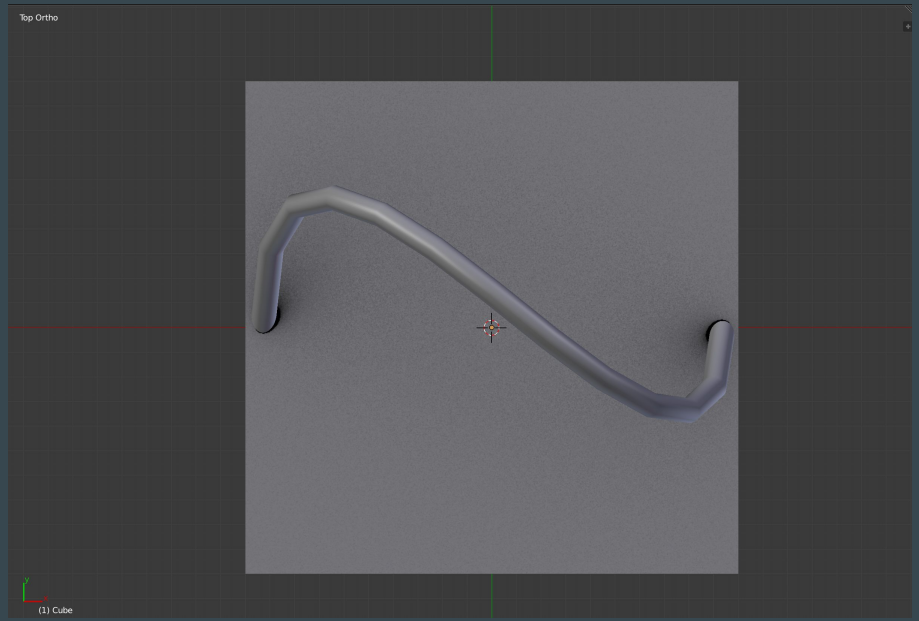


Normal Maps

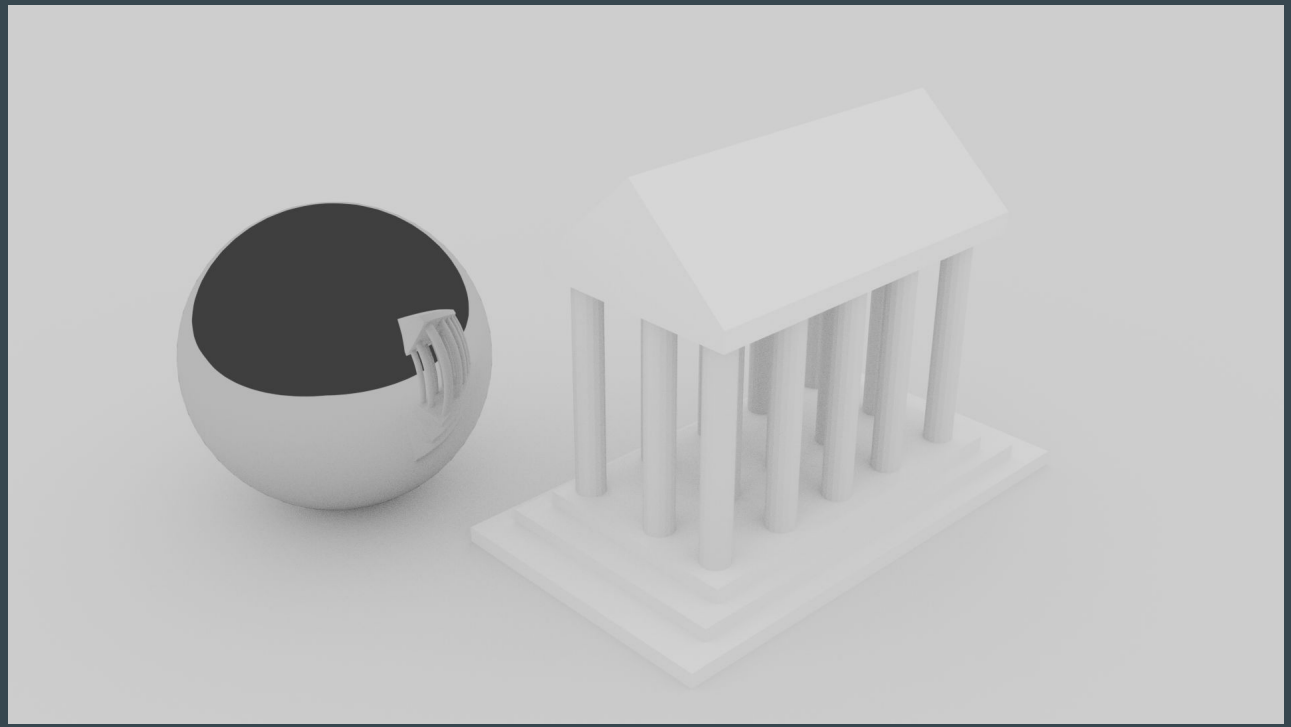


Ambient Occlusion (AC)

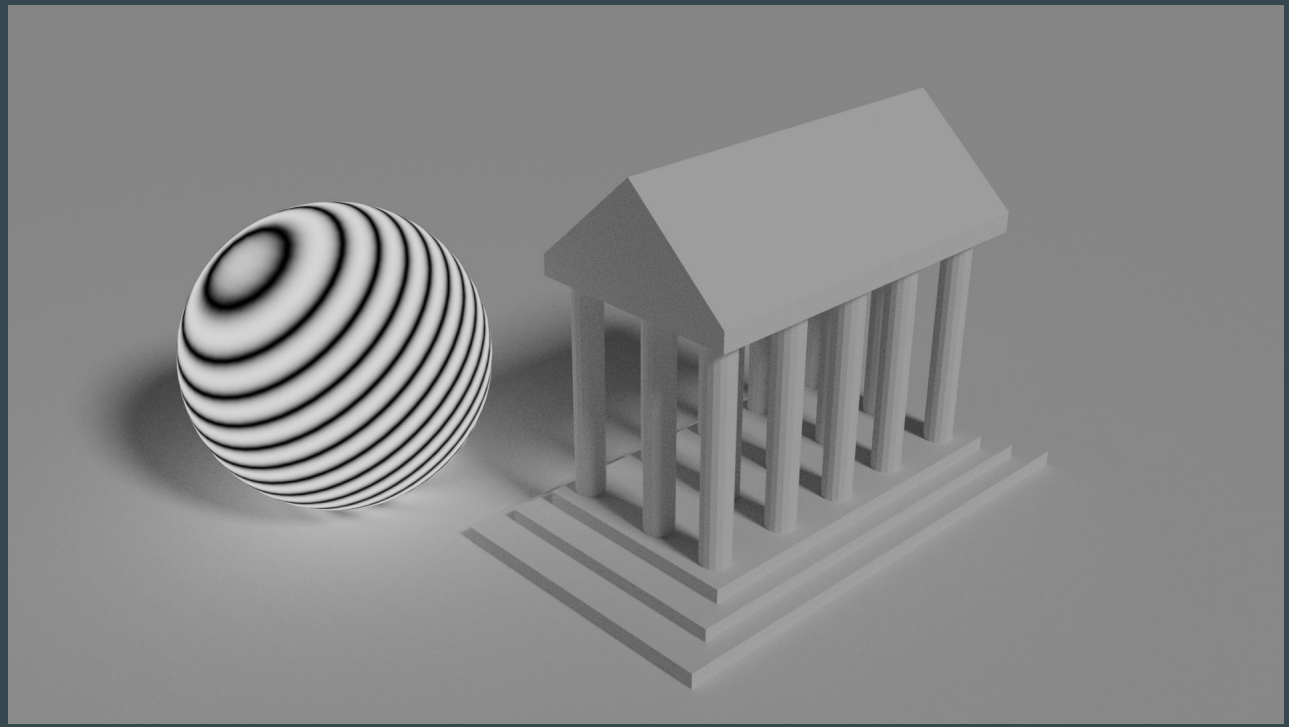
Ambient occlusion is a technique to approximate how light shines on different parts of an object's surface.



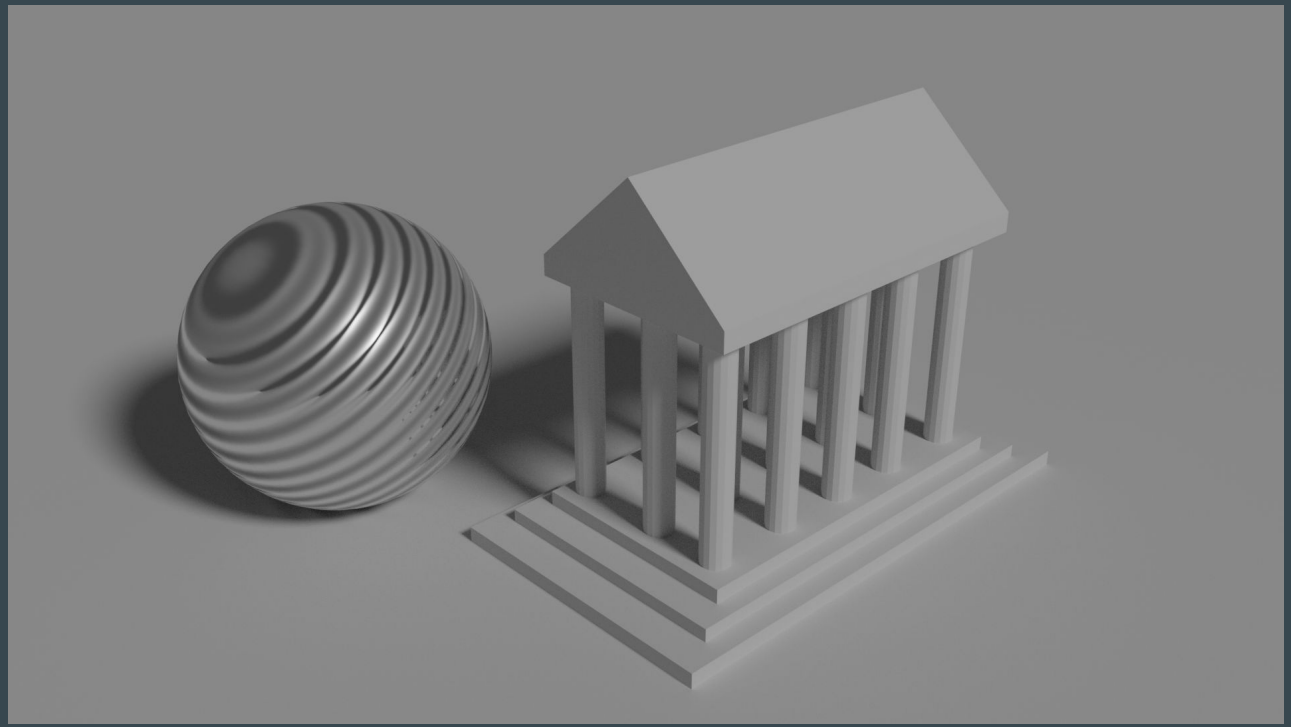
Ambient Occlusion



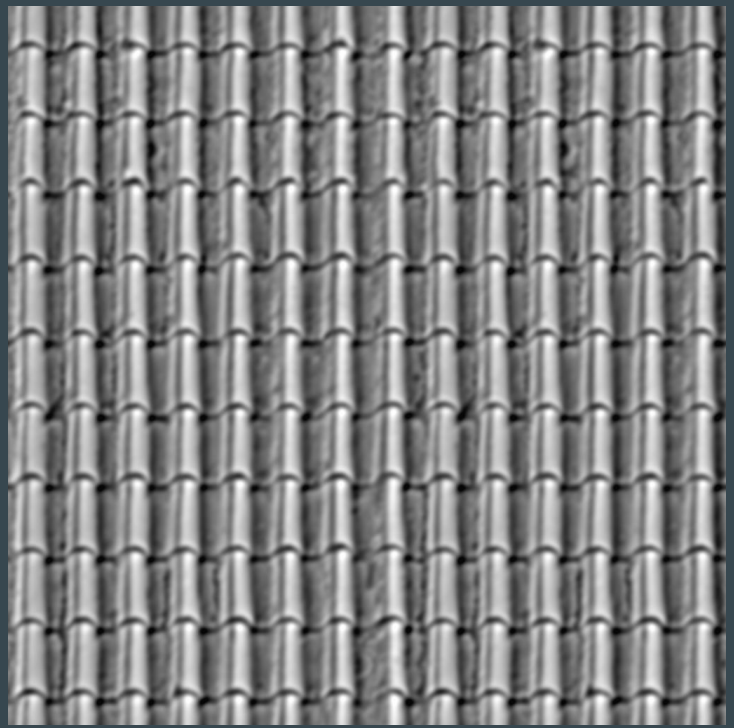
Roughness



Roughness



Height Maps

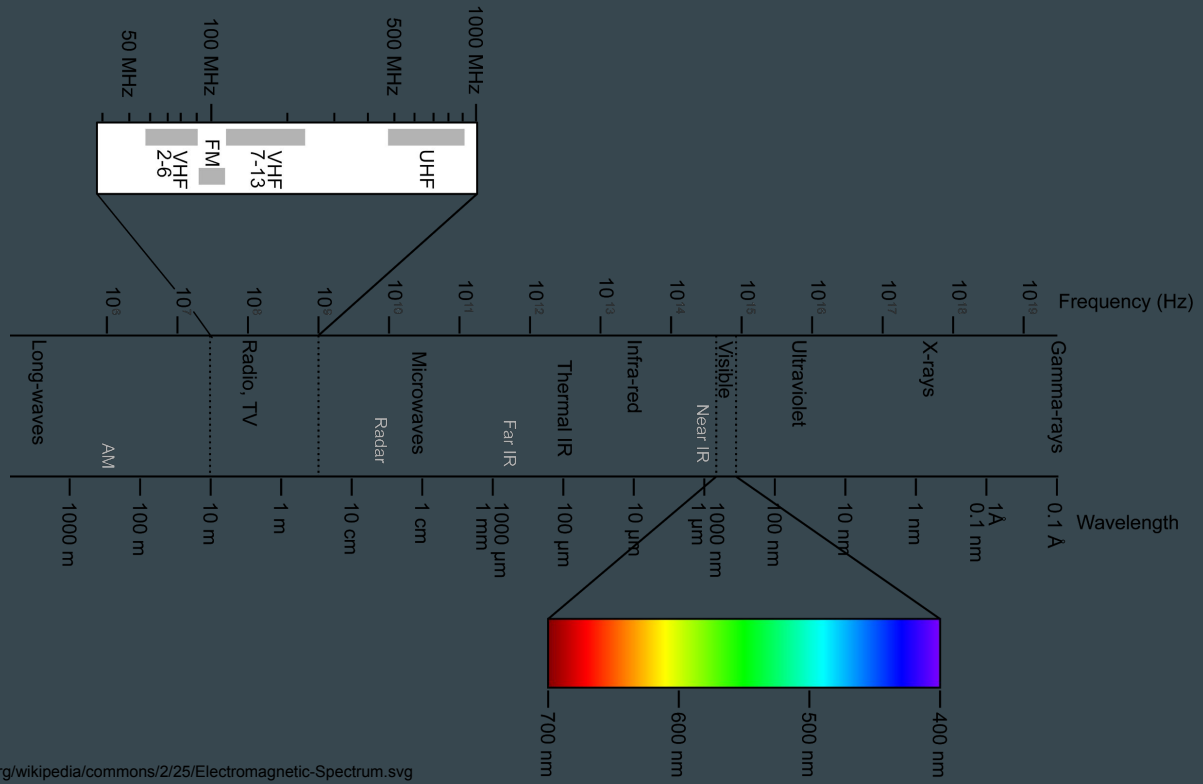


PBR Textures

- Base Color
- Roughness
- Metallic
- Specular

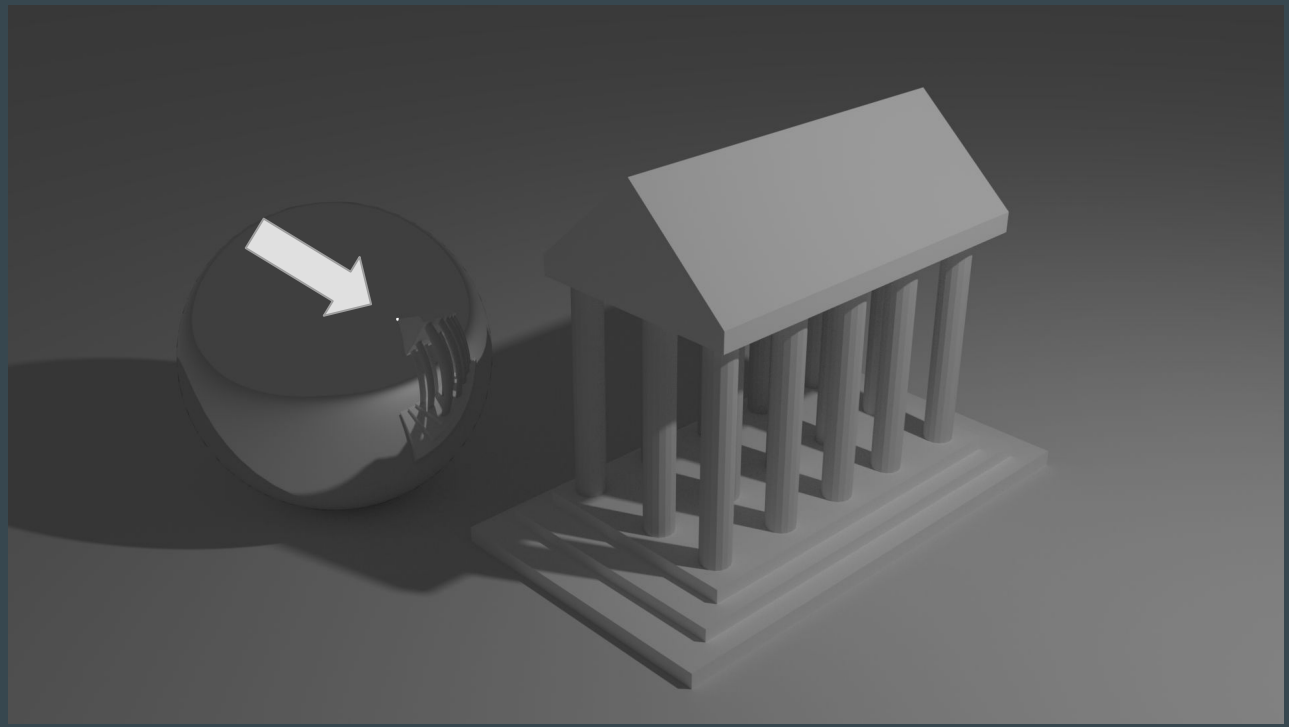
Lighting

Visible Light Spectrum

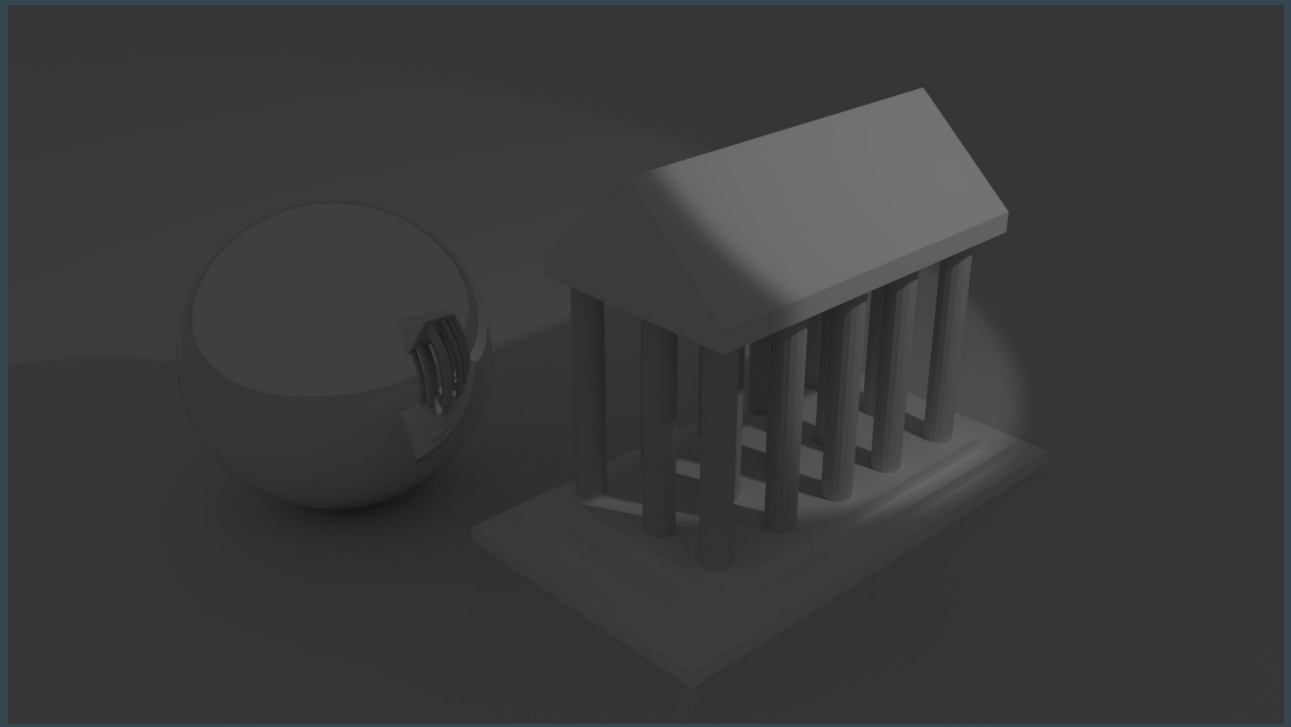


Source: https://upload.wikimedia.org/wikipedia/commons/2/25/Electromagnetic-Spectrum.svg

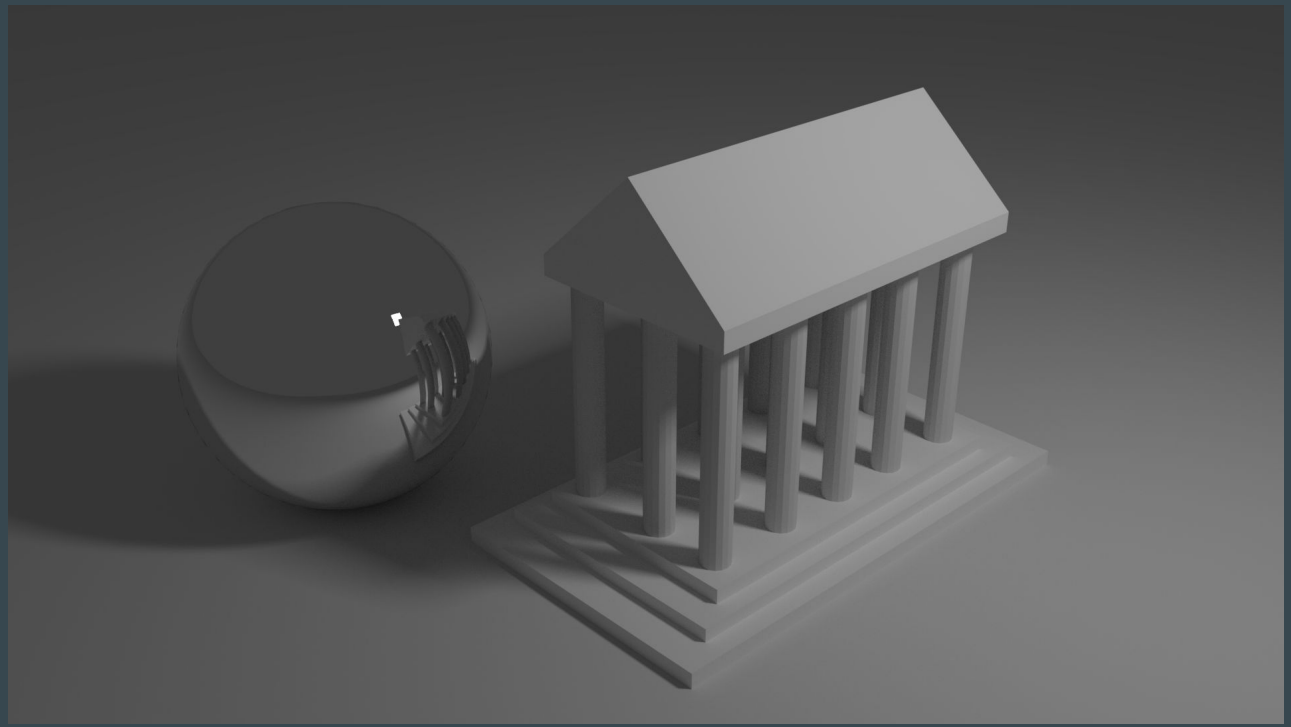
Point Light



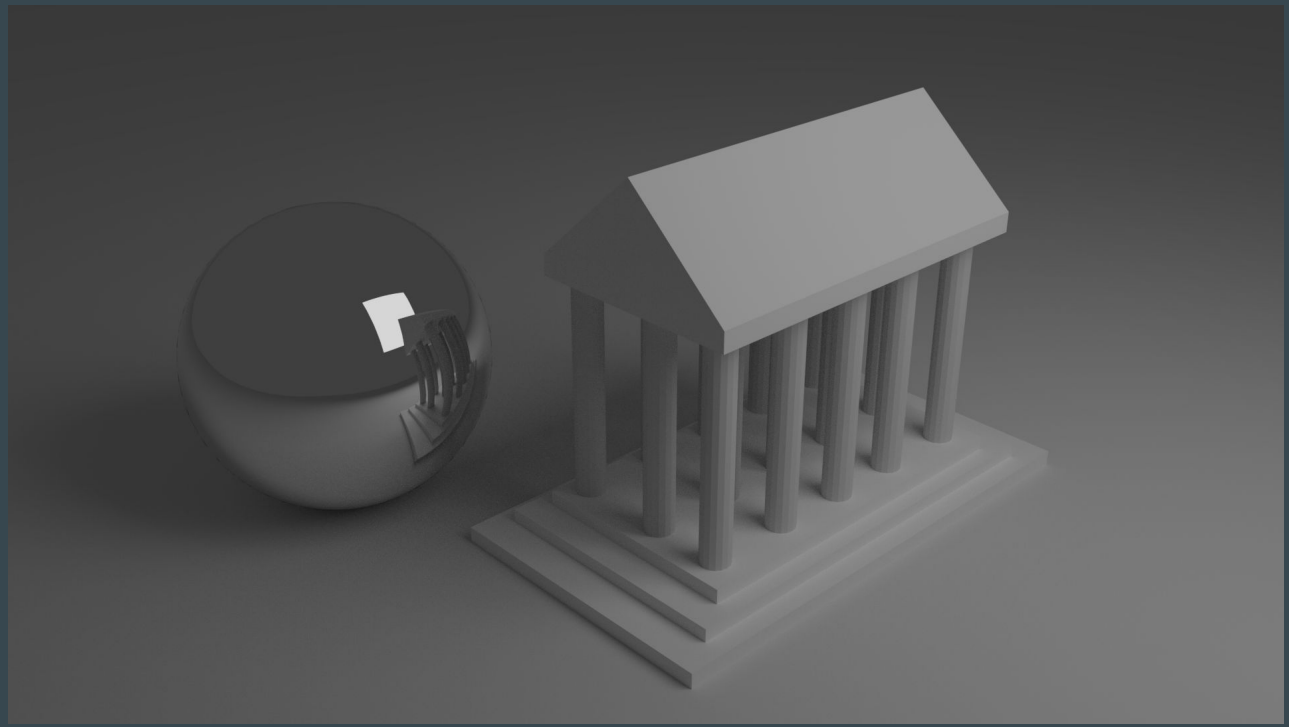
Spot Light



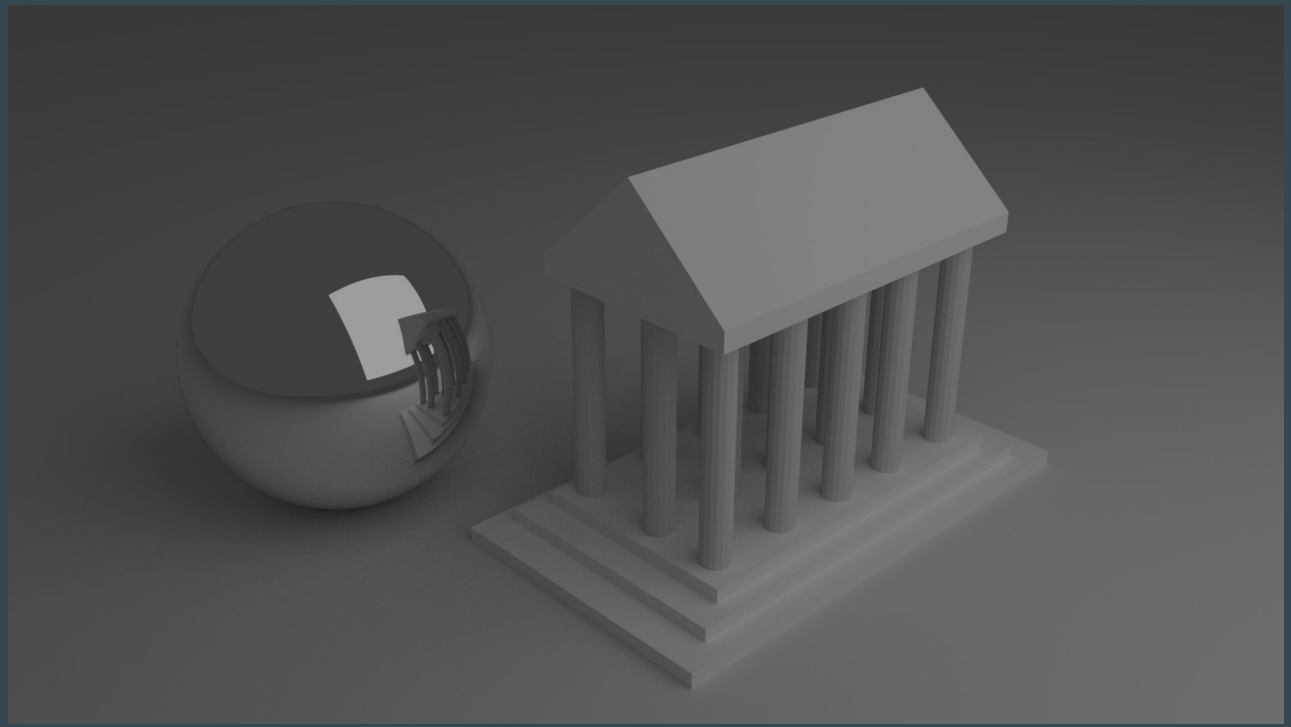
Area Light - Small



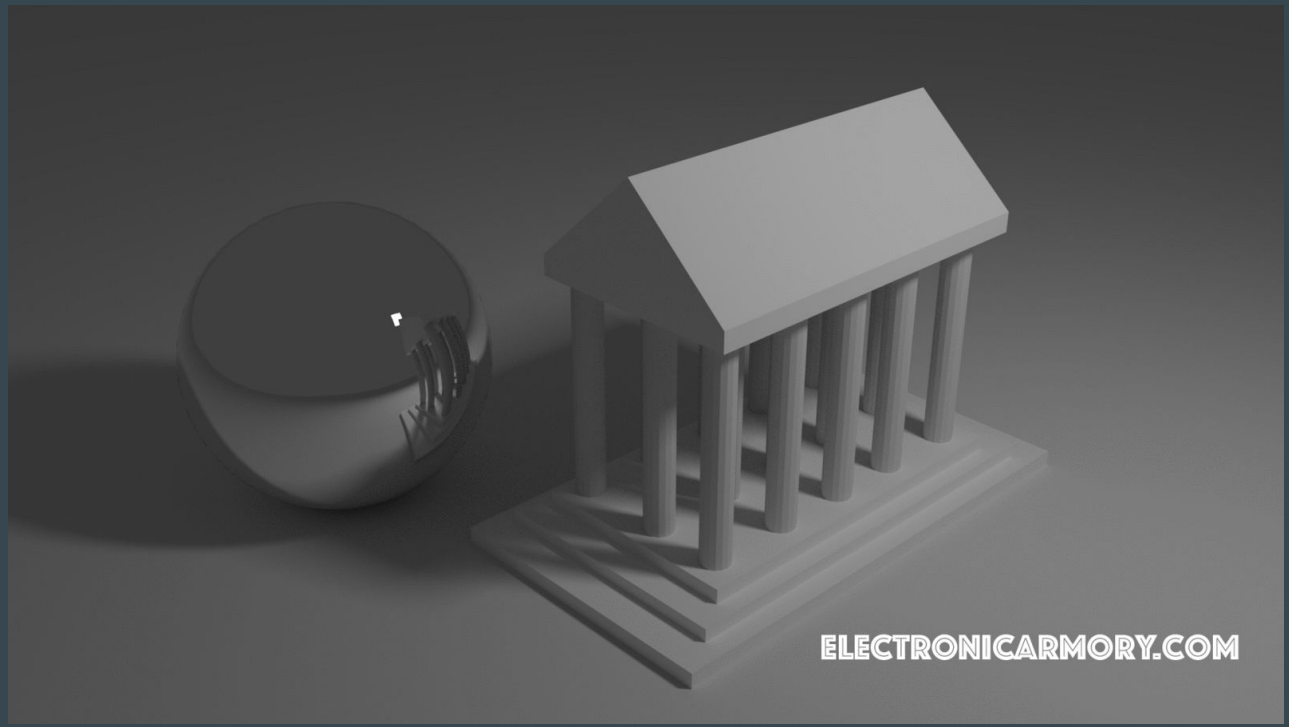
Area Light - Medium



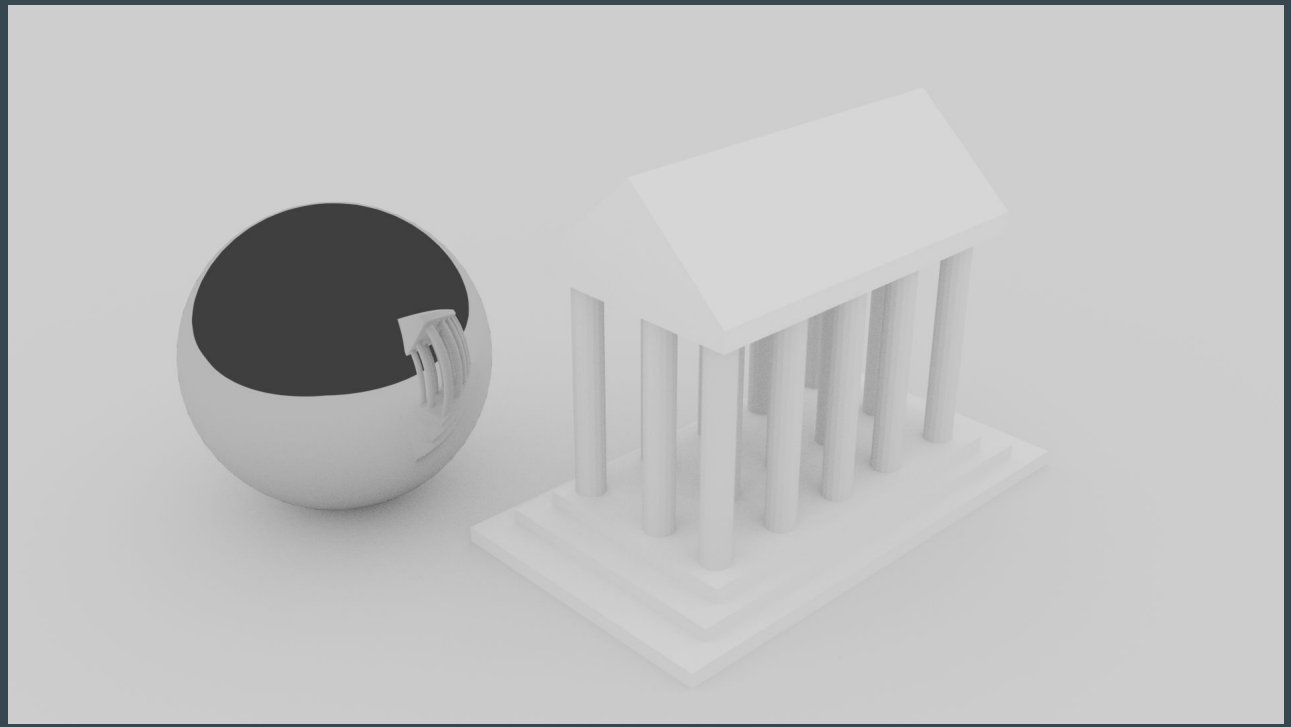
Area Light - Large



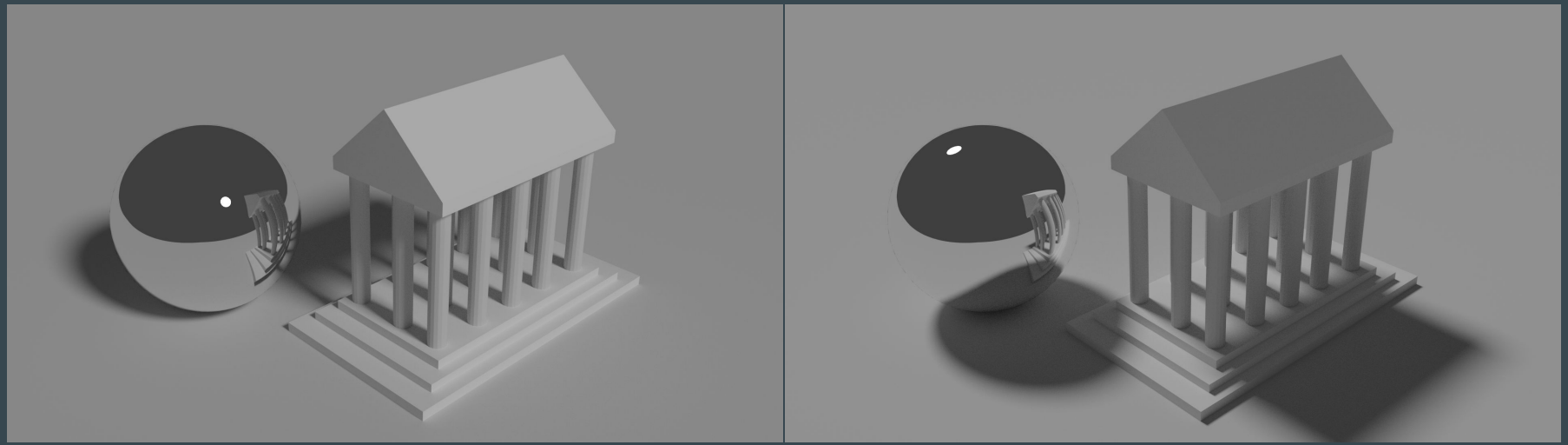
Area Light - Animation!



Global Illumination

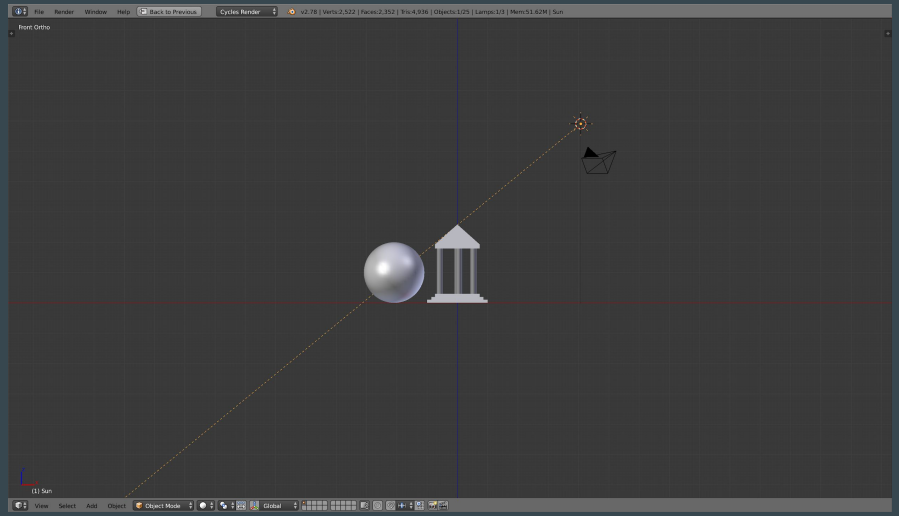


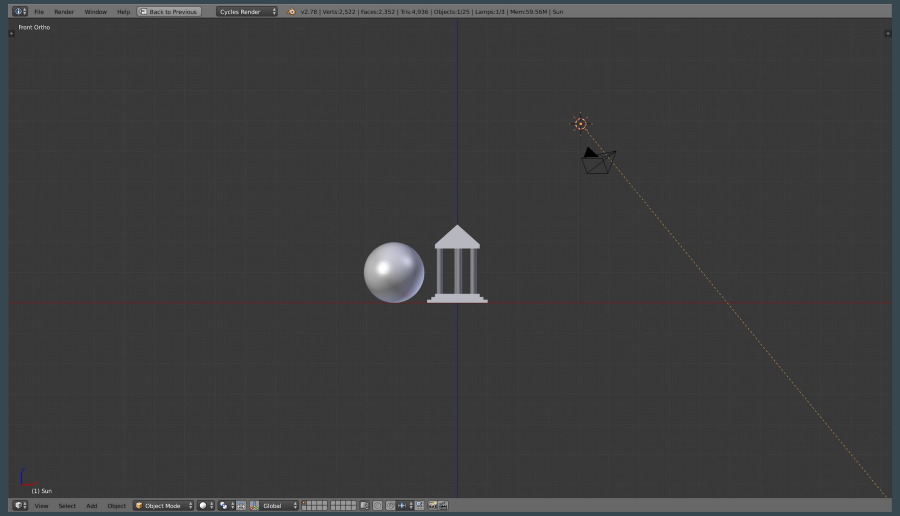
Sun



Sun lamps shine from all points in the same direction, independent of where the sun lamp is physically located. Image on the left is shining towards the left, while the image on the right is rotated 90s and shining to the right.

Sun





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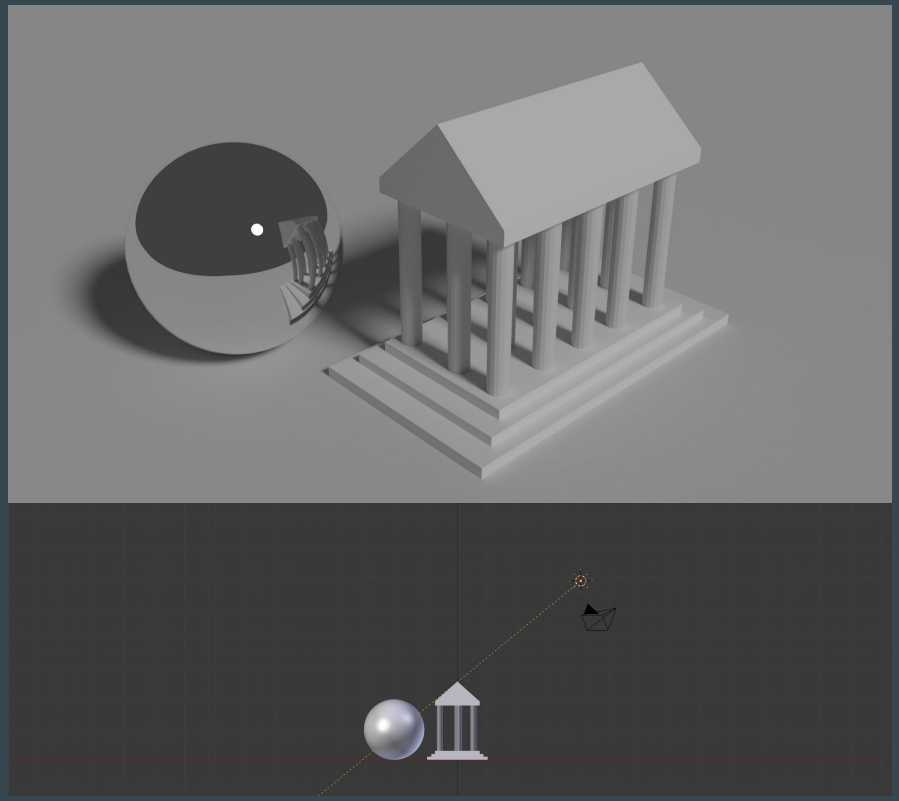
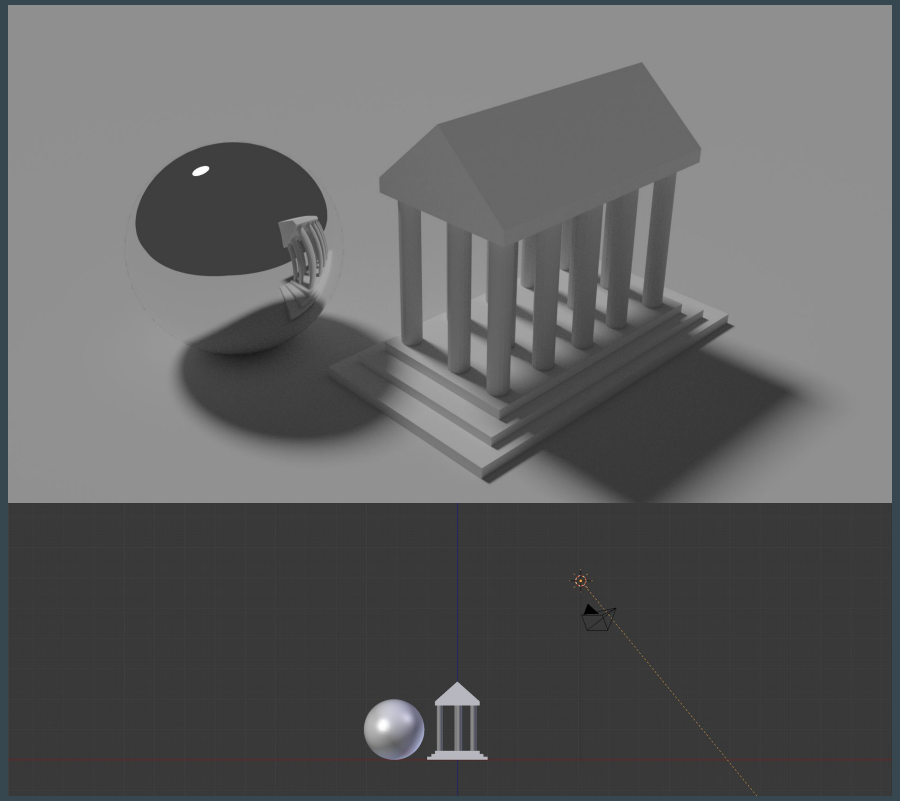
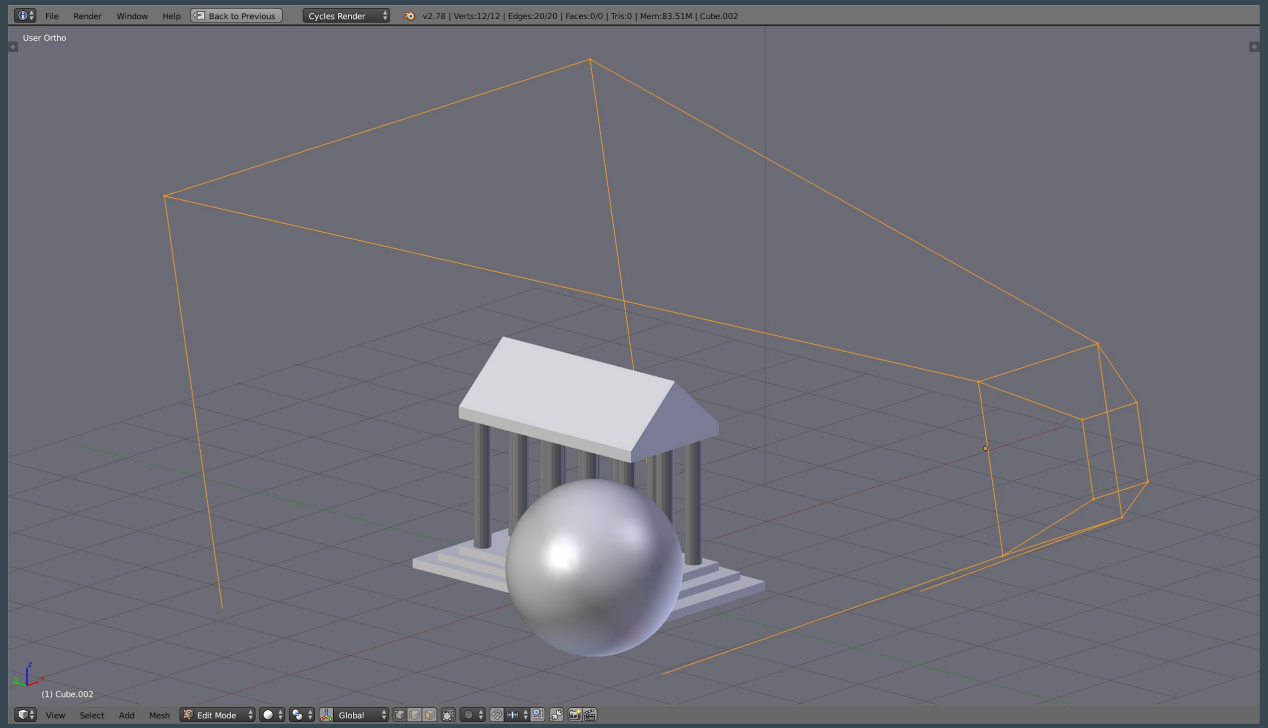
Sun





Rendering

Camera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User Ortho
(1) Cube.002
View
Select
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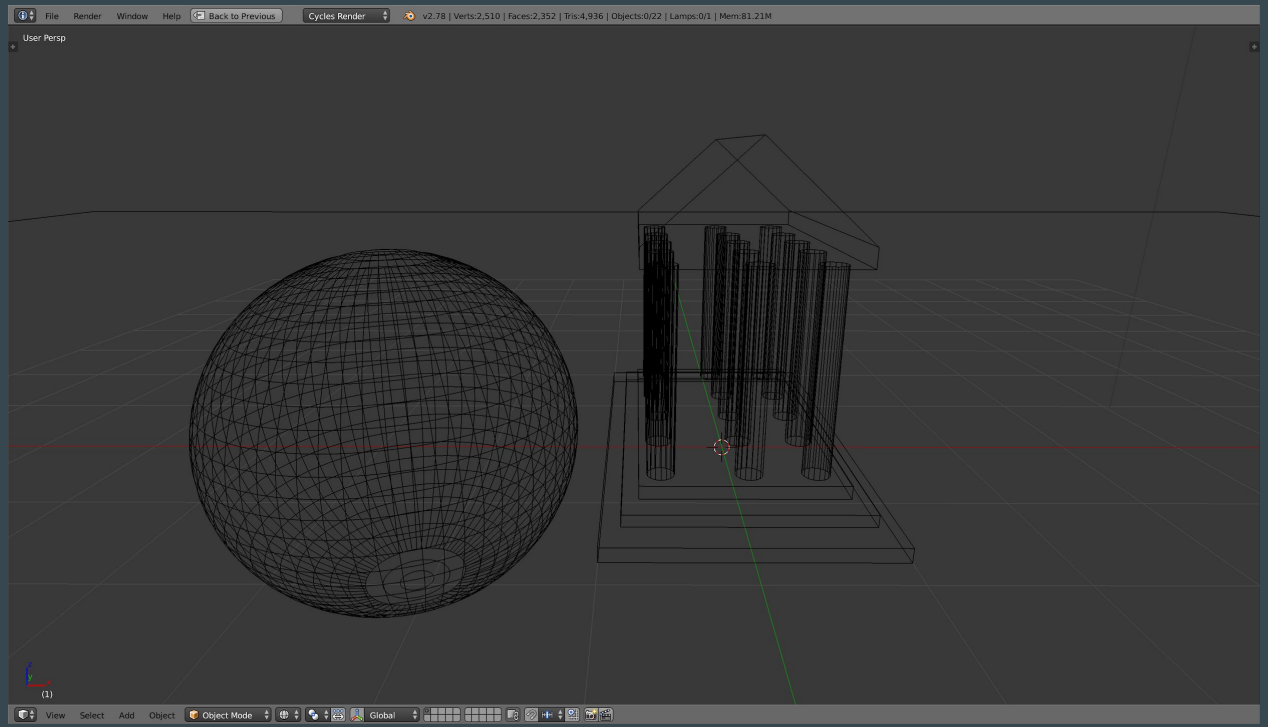
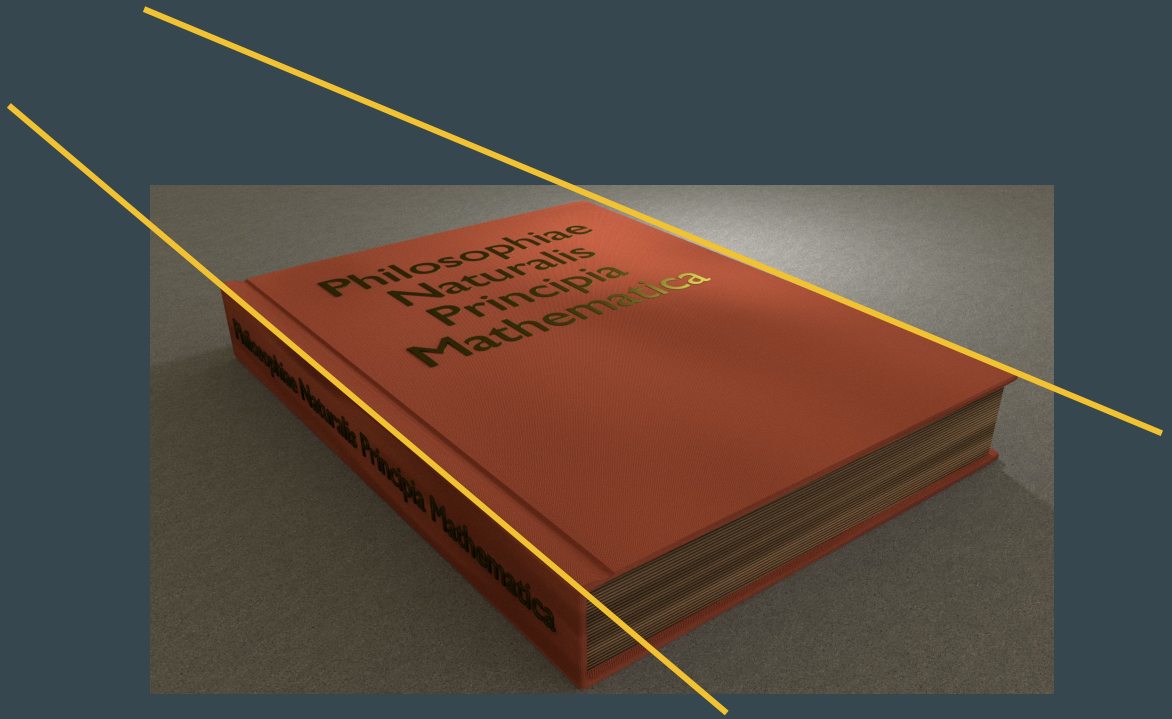
Mesh
Edit Mode
Global

Perspective

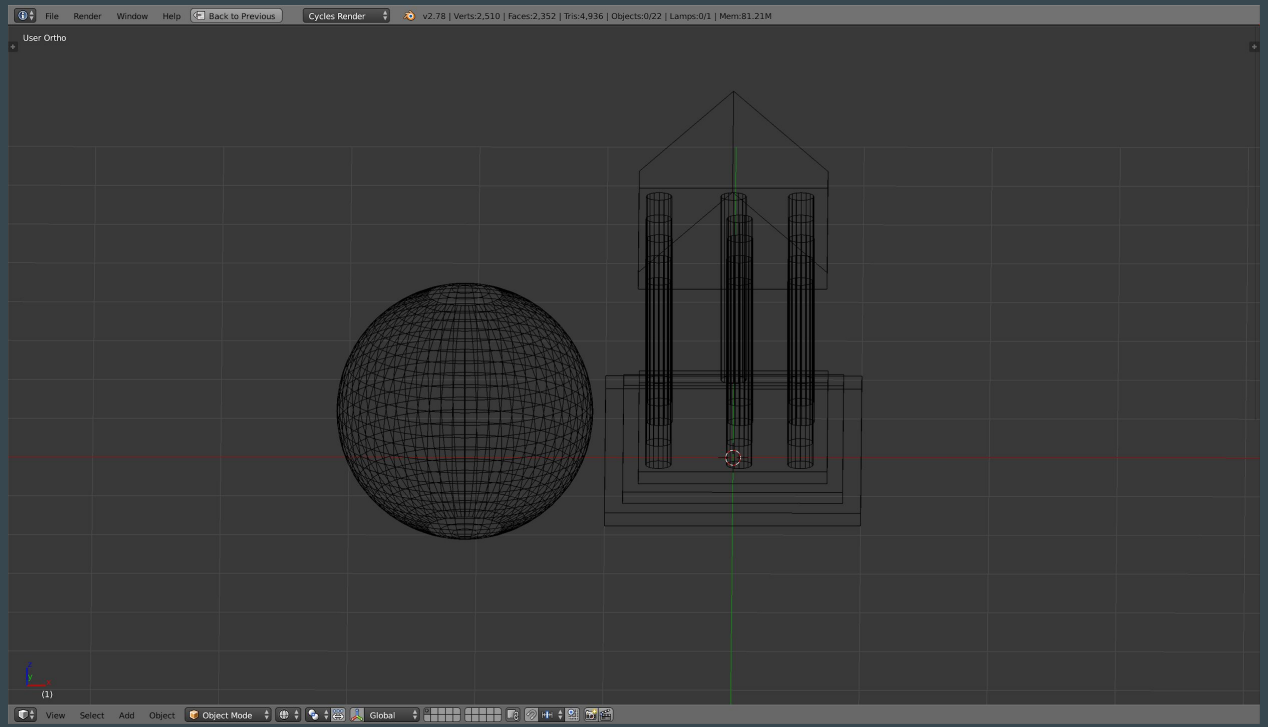


Perspective - Example

Lines converge

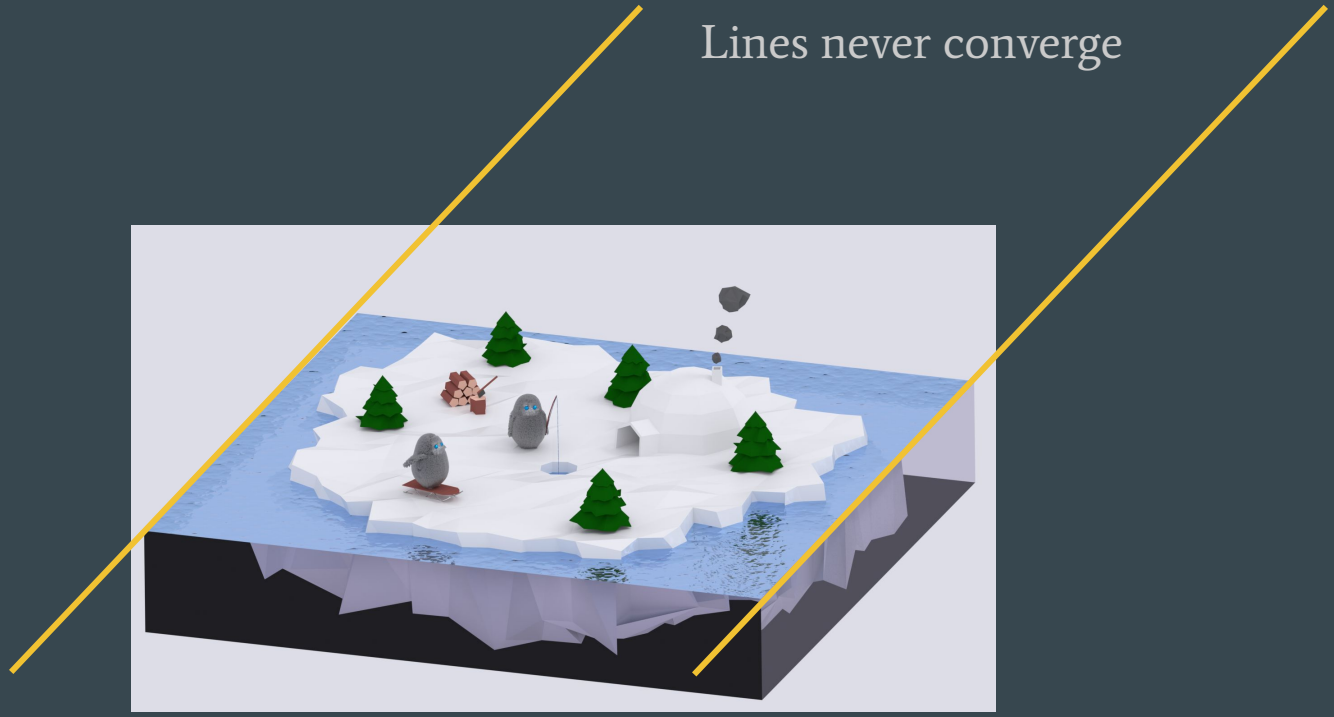


Orthographic



Orthographic - Example

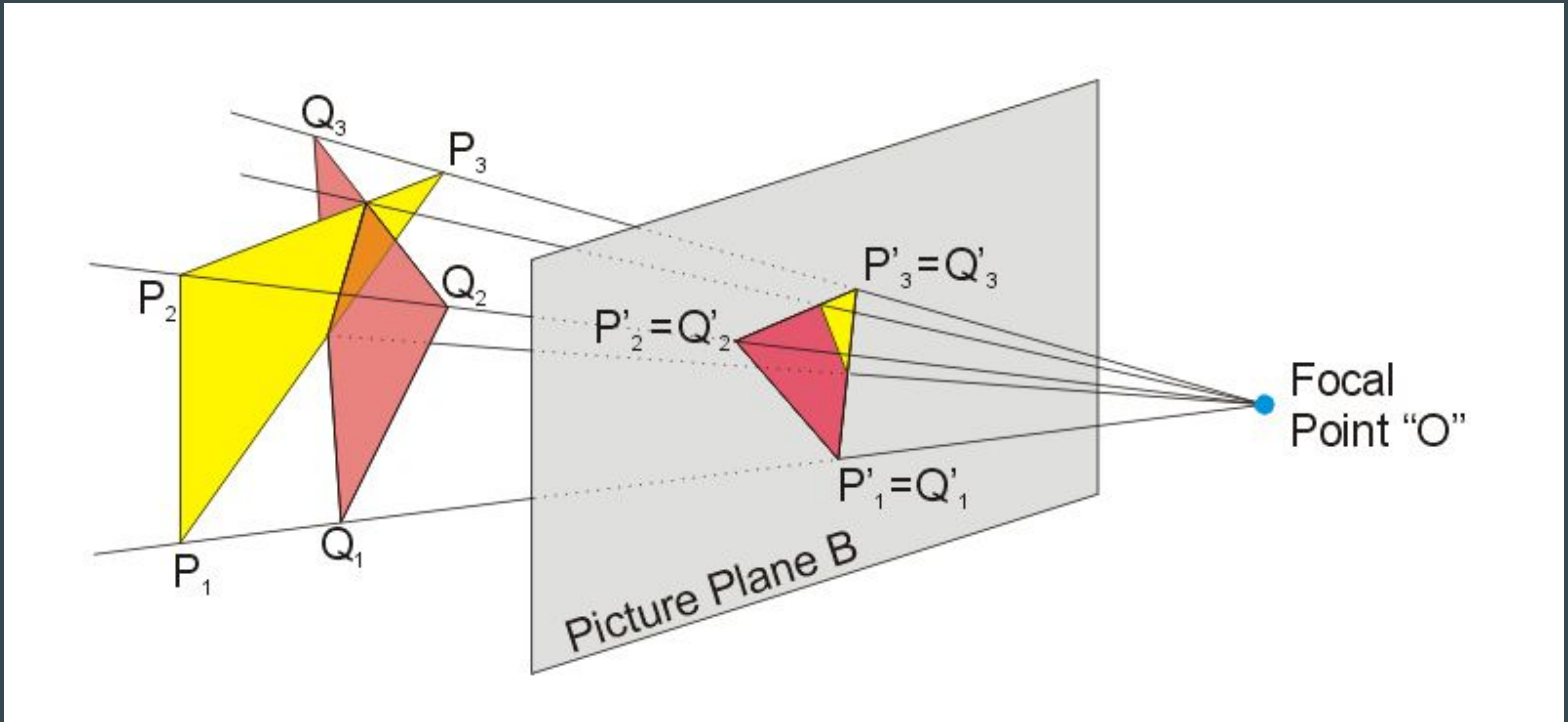
Lines never converge



Graphics Pipeline

- Vertex processing
  - Processes every vertex independently to determine location and color
- Clipping and primitive assembly
  - Eliminates shapes that are not seen by the camera because they’re hidden
- Rasterization
  - Primitives that make it through the clipper get translated to pixels
- Fragment processing
  - Combining the rasterized fragments into a final image

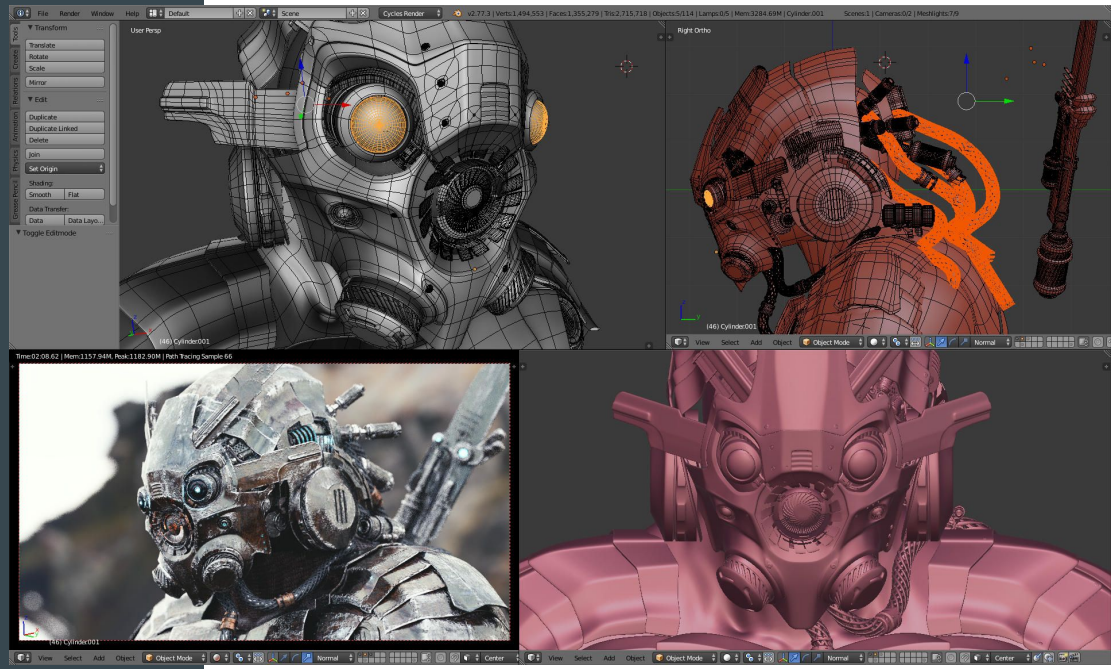
Fragment Processing



Source: https://upload.wikimedia.org/wikipedia/commons/9/90/Perspective_Projection_Principle.jpg

Object Culling

Source: Horizon Zero Dawn – The making of the game (2017) by vpro documentary https://www.youtube.com/watch?v=A0eaGRcdwpo



https://www.blender.org