

Lecture slides (CT4201/EC4215 – Computer Graphics)

Graphics Pipeline

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So far...

- We studied the following:
 - Basic programming with OpenGL
 - Transformations with some mathematical background

- Now you are ready to study a graphics pipeline

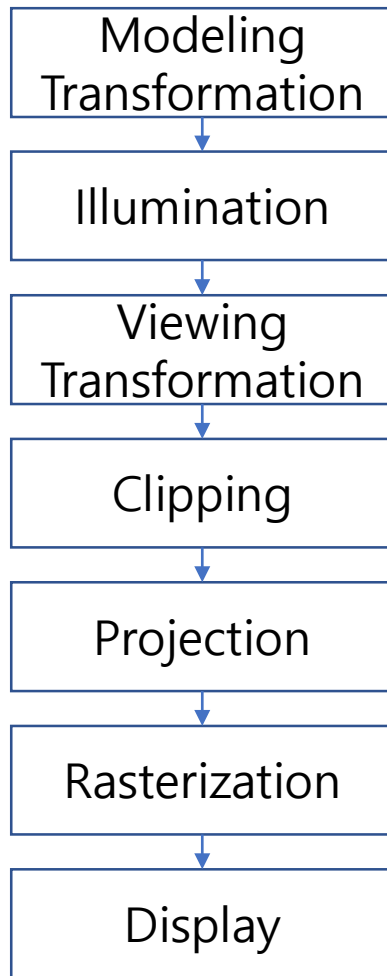
Why Graphics Pipeline?

- Graphics (Rendering) Pipeline
 - Objective: draw virtual objects (3D) in your screen (2D)
 - Commonly used for real-time applications
 - Consists of multiple transformations

- Scope for graphics pipeline in this class
 - Classic graphics pipeline for understanding basics of computer graphics

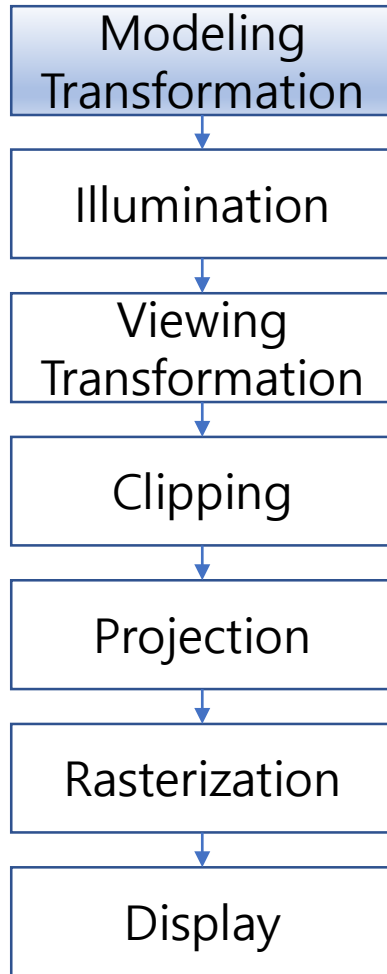
- Example applications

Traditional Rendering Pipeline

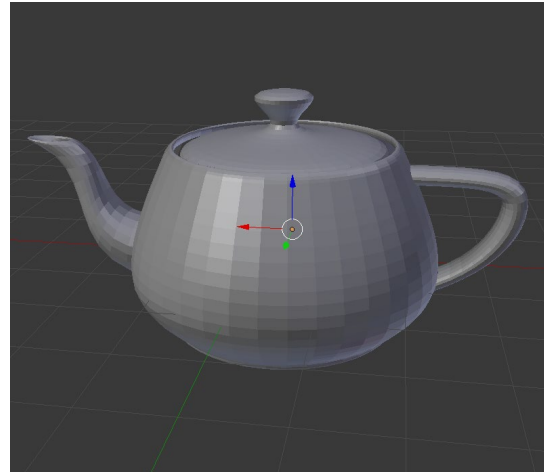


- Input:
 - Geometric model
 - e.g., primitives
- Output:
 - Colors (e.g., 24-bit RGB value at each pixel)

Modeling Transformation

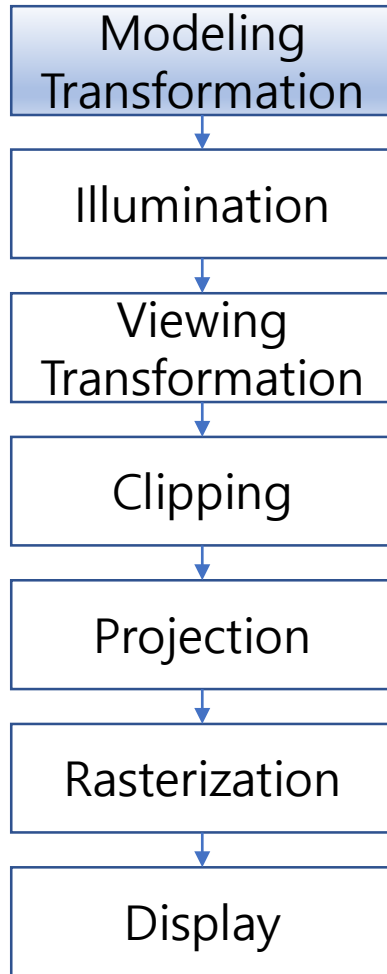


- 3D models are defined in a object space



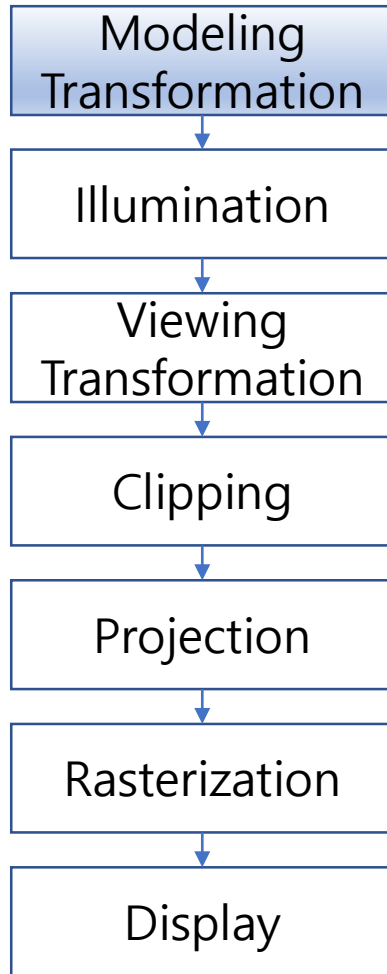
- How do we design each model?
 - Usual modeling tools: 3DS MAX and Maya (commercial), Blender (free to use)
- Where do we get 3D models?
 - e.g., pbrt.org and many websites (free for your research), TurboSquid (commercial)

Modeling Transformation



- 3D models are defined in *object spaces*
- We usually want to render a scene that contains multiple objects
 - Need to arrange all your 3D models in a unique space (*world space*)
- In the world space
 - All 3D models
 - Light sources
 - Camera

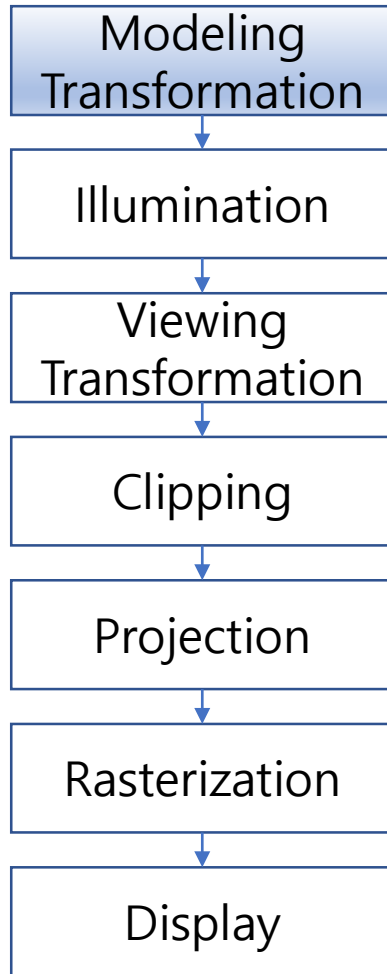
Modeling Transformation



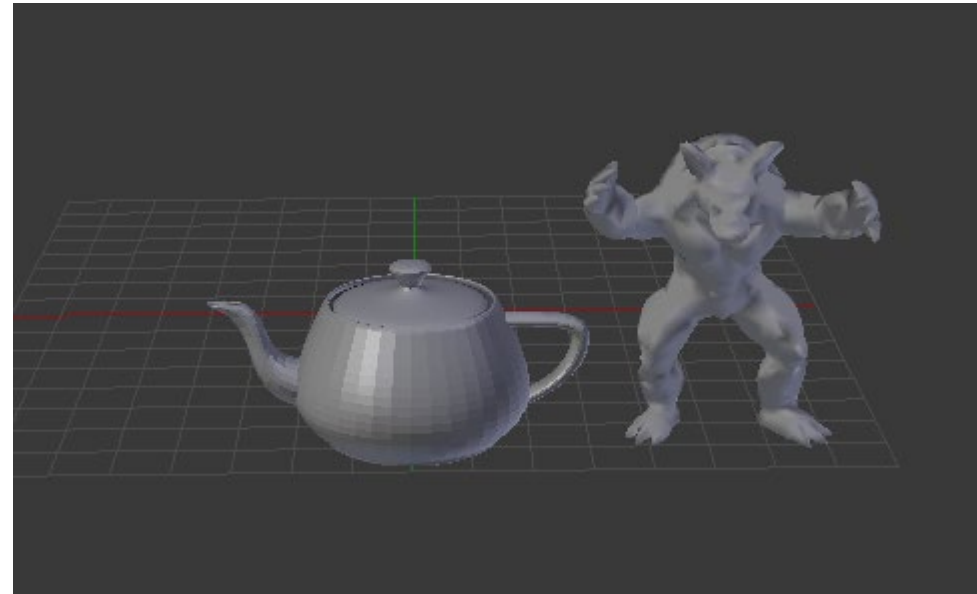
- Why do we need to use modeling transformation?
 - Example scene that does not perform a proper modeling transformation



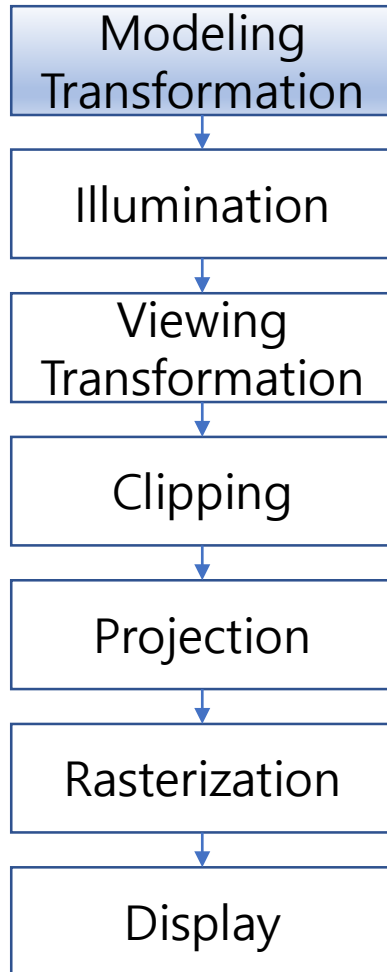
Modeling Transformation



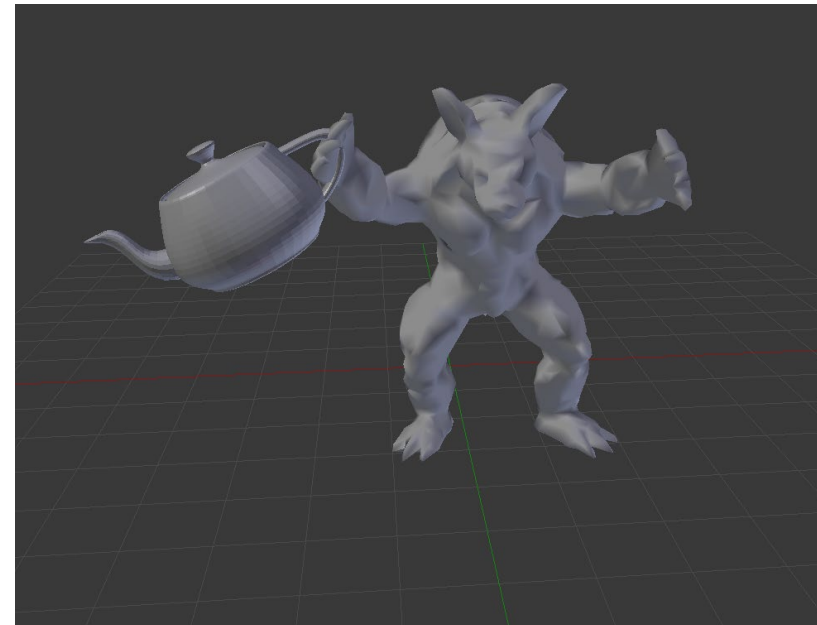
- Why do we need to use modeling transformation?
 - Example scene that does not perform a proper modeling transformation
 - After
 - Some modeling transformations (e.g., scaling, translation)



Modeling Transformation

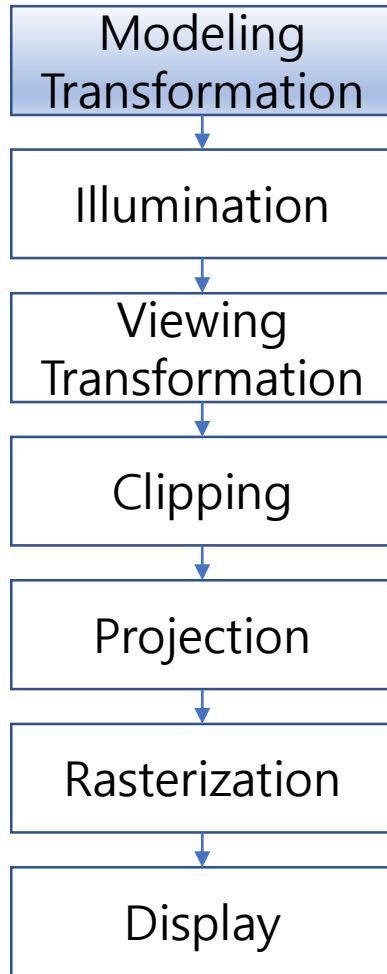


- Why do we need to use modeling transformation?
 - Example scene that does not perform a proper modeling transformation
 - After
 - Some modeling transformations (e.g., scaling, translation)
 - More modeling transformations

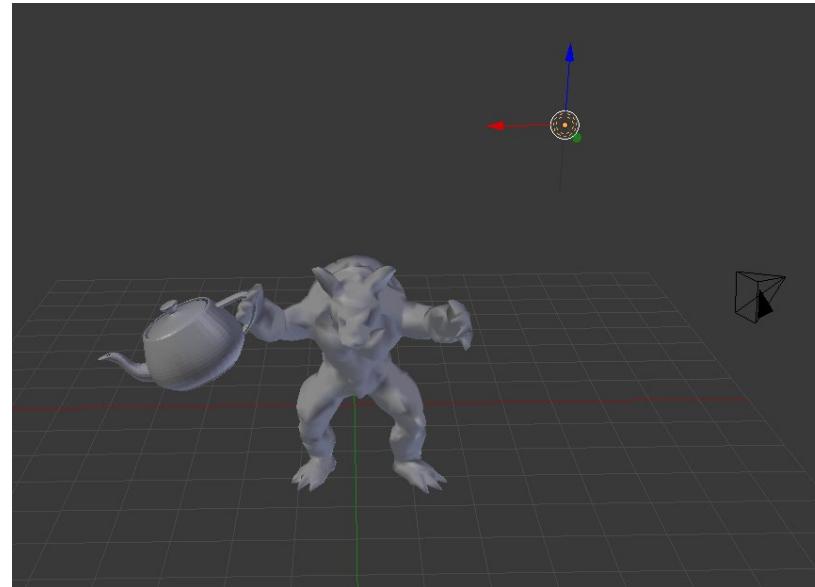


I designed it based on two existing models!

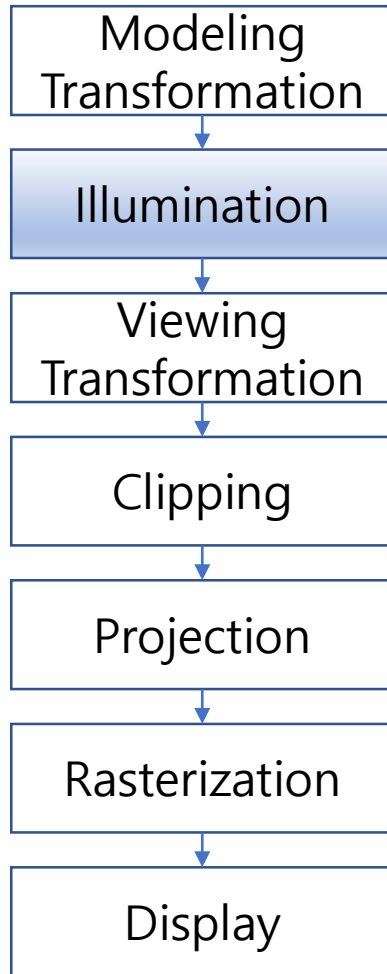
Modeling Transformation



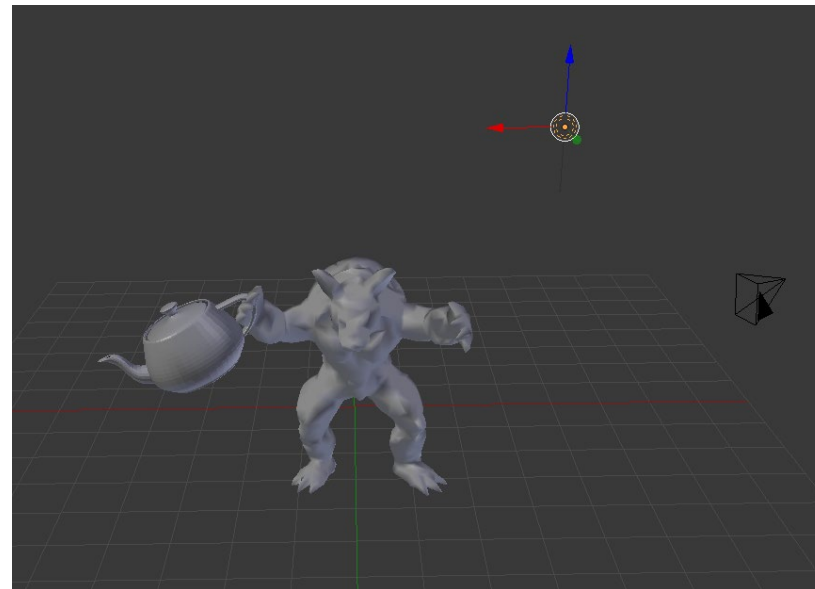
- Need to arrange:
 - All models in world space
 - Light sources
 - Camera



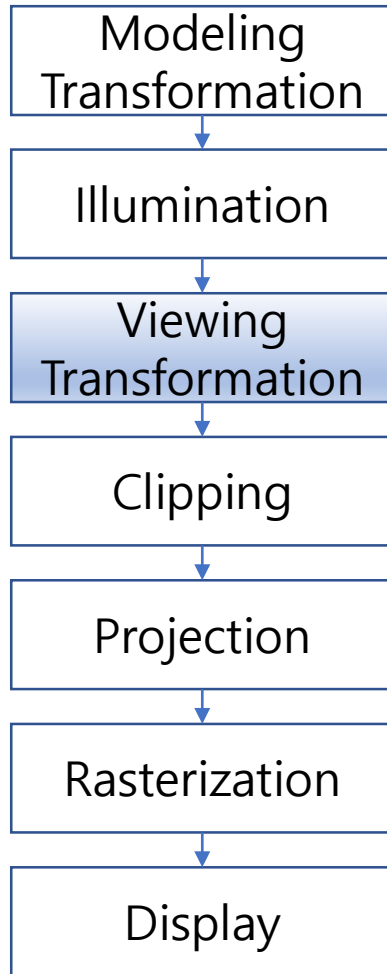
Illumination



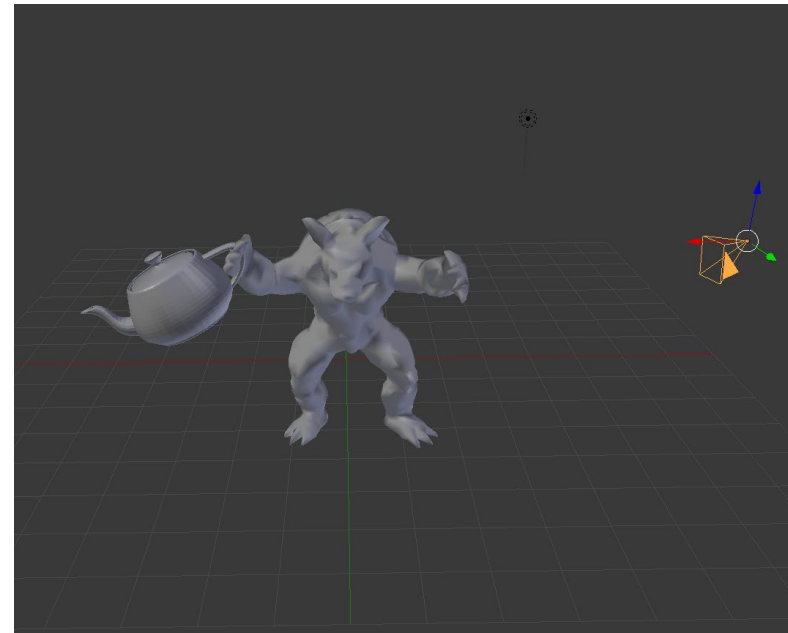
- Illuminate 3D objects according to lighting and reflectance
 - Q. When do we need to define materials of 3D objects?
 - Generally define materials of each object when designing models



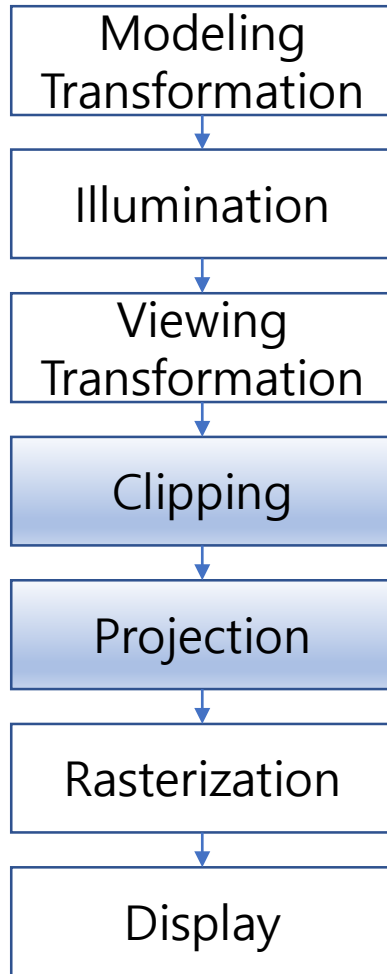
Viewing Transformation



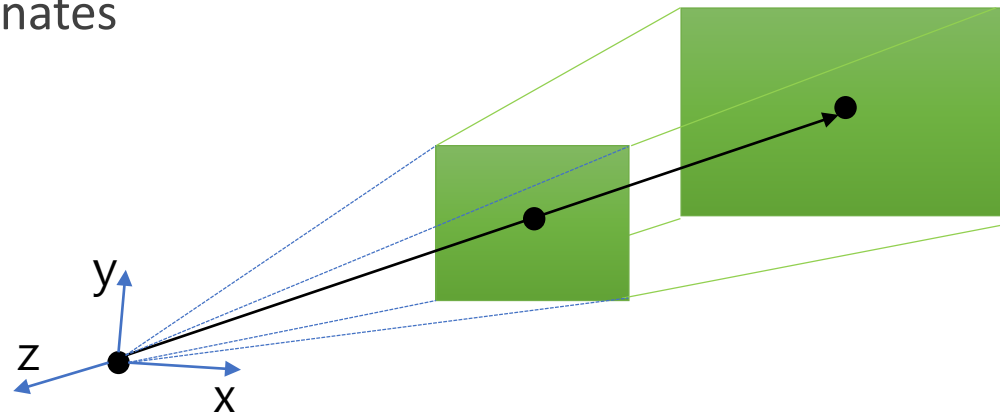
- Transform all points from world space to *eye space*
 - Camera position transforms into the origin



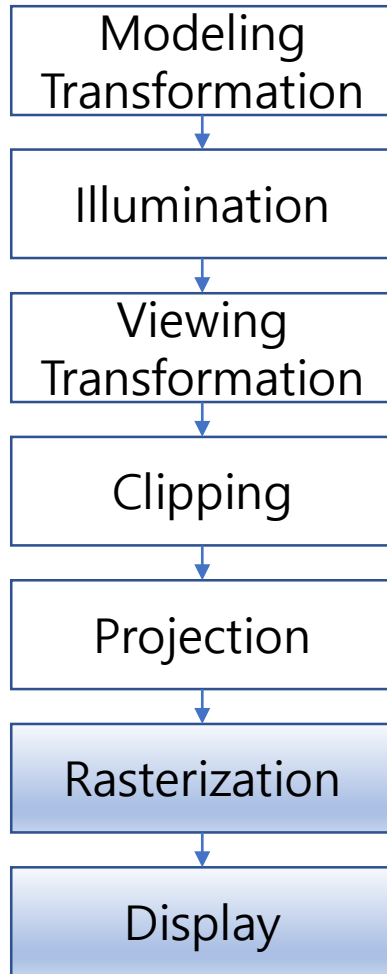
Clipping and Projection



- A volume, *viewing frustum*, is specified from the camera
- Map the frustum to the unit cube
- Clip objects against the volume (remove non-visible geometry from your eye)
- Project objects into 2D plane
- Transform from eye space to normalized device coordinates



Clipping and Projection



- Transform normalized device coordinates to screen space
- Rasterize the objects to fill color values at pixels
- We have observed:
 - Most components in the graphics pipeline are transformations.