Vector and Raster Graphics

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SCOPE VIT-AP

Two kinds of computer graphics

- Raster Graphics
- Vector graphics

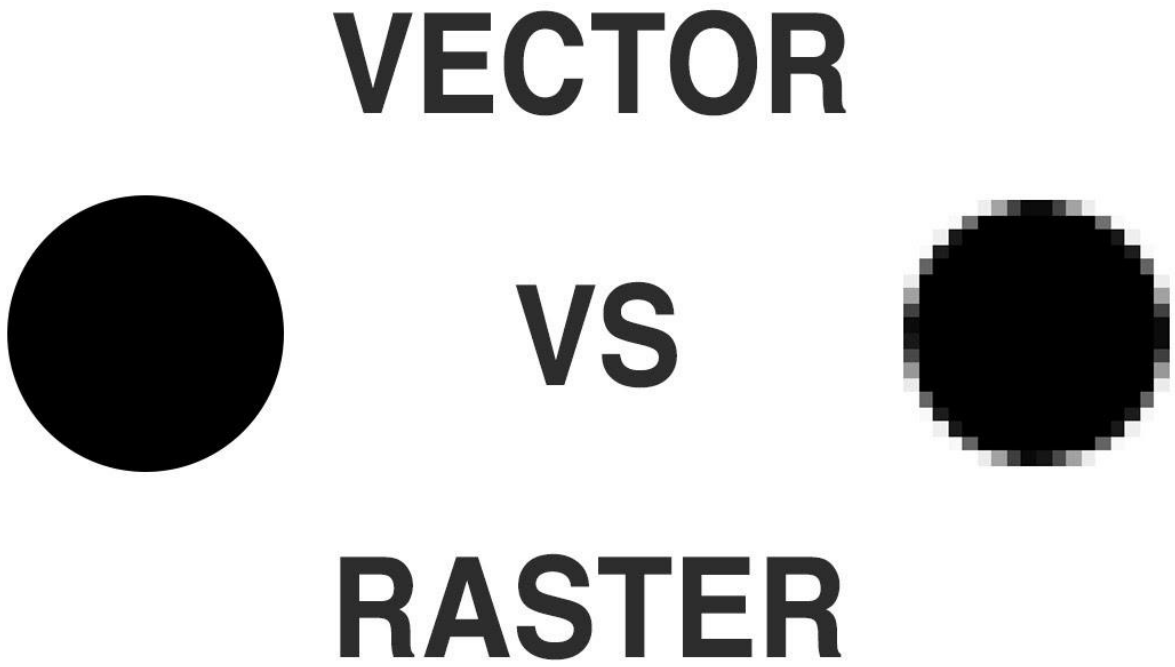
Raster graphics vs Vector graphics

- What is a raster graphics?
  - Raster graphics are more commonly called **bitmap images**.
  - A **bitmap** image uses a grid of individual pixels where each pixel can be a different color or shade.
  - Bitmaps are composed of pixels

Raster graphics vs Vector graphics

- What is a vector graphics?
  - Composed of points and paths
  - Uses mathematical relationships between points and paths, connecting them to describe an image.

Vector vs Raster



Coordinate Systems

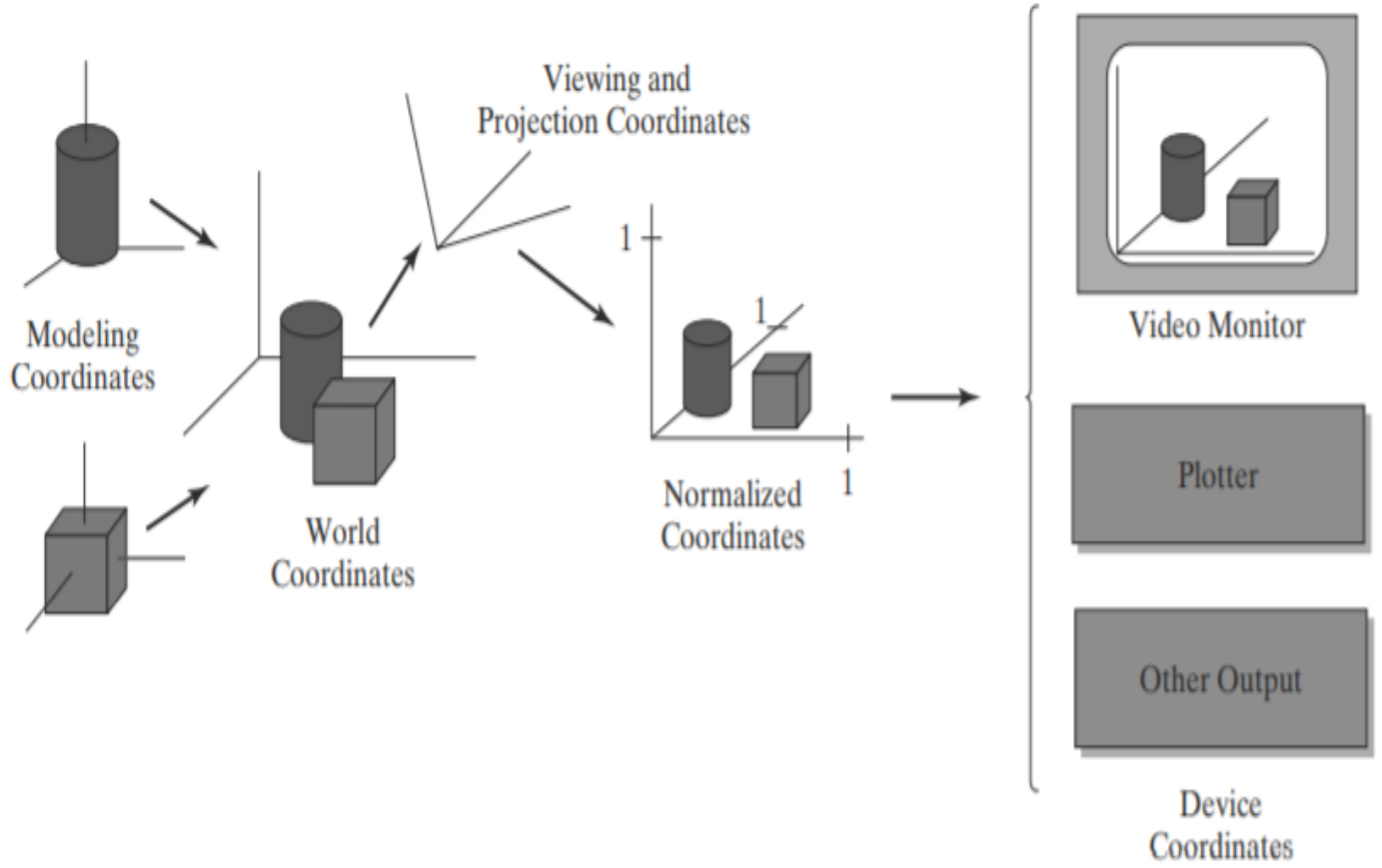
Model coordinates

World coordinates

Viewing coordinates

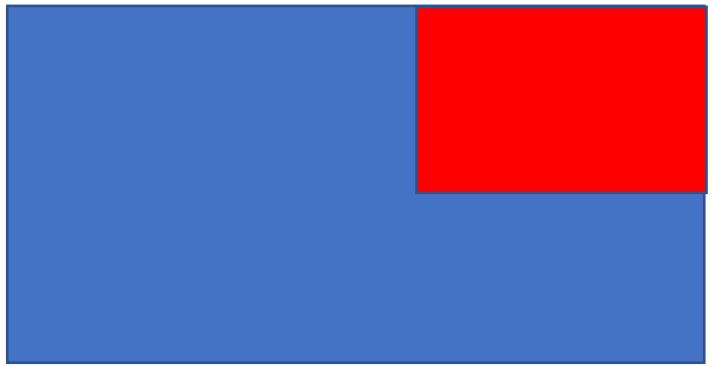
Normalized coordinates

Device coordinates



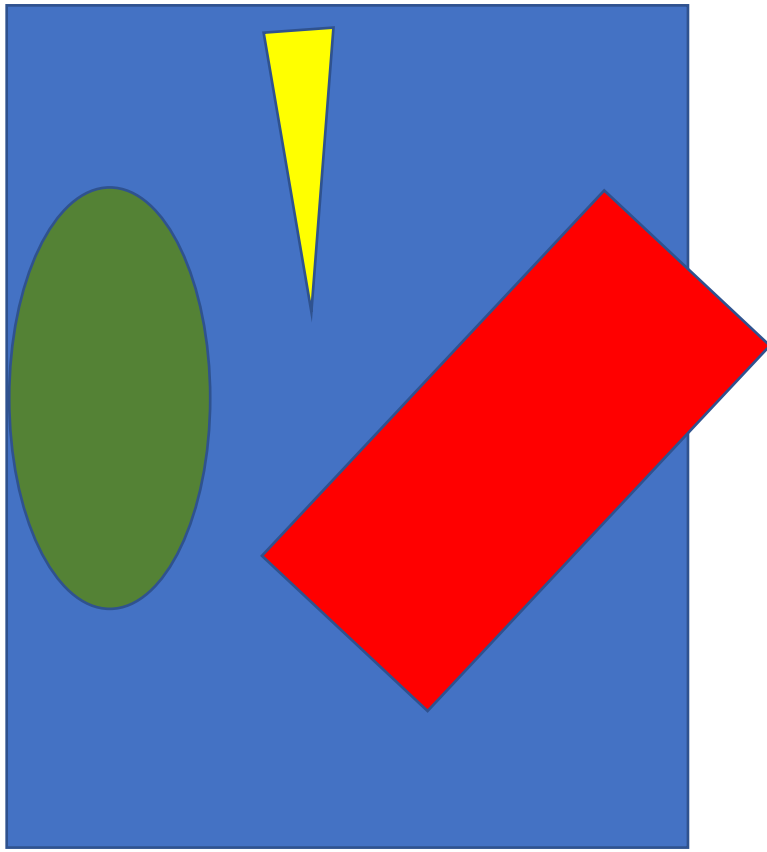
Modelling coordinates

- To generate the picture, geometric descriptions of the objects that are to be displayed are needed.
- These descriptions determine the locations and shapes of the objects.
- Defines the shapes of individual objects, such as trees or furniture, within a separate reference frame.
- These reference frames are called modeling coordinates, or sometimes local coordinates or master coordinates



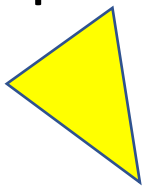
World coordinates

- Once the individual object shapes have been specified a scene is constructed by placing the objects into appropriate locations within a scene reference frame called world coordinates.
- This step involves the transformation of the individual modeling-coordinate frames to specified positions and orientations within the world-coordinate frame.
- For a repeating object only one modelling coordinate is created.
- Translate,rotate,scale..etc

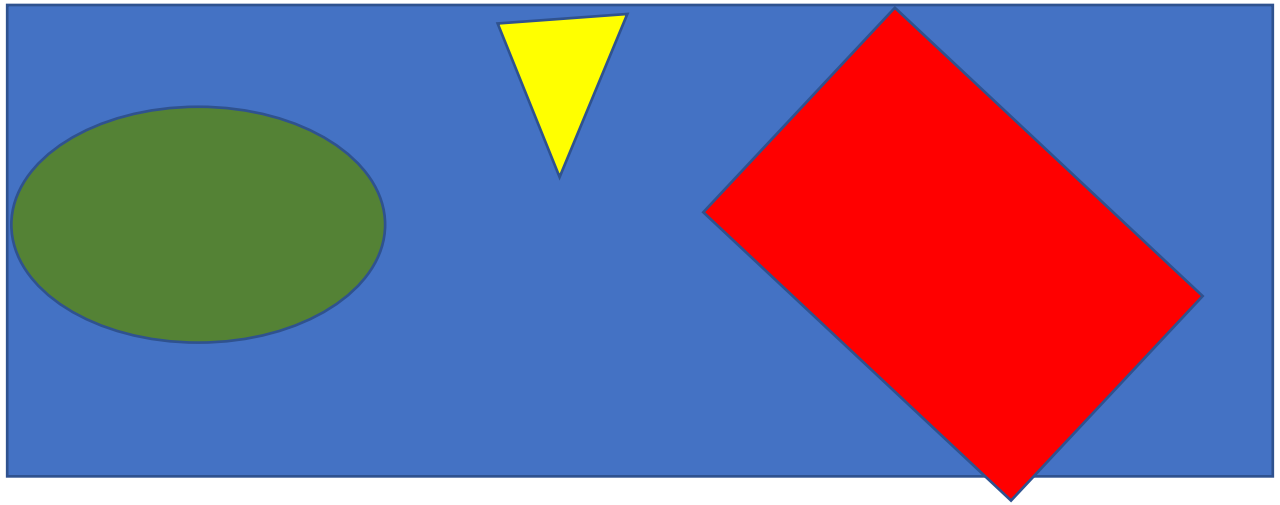


Viewing Coordinates

- World coordinate positions are first converted to viewing coordinates corresponding to the view we want of a scene, based on the position and orientation of a hypothetical camera.
- Then object locations are transformed to a two-dimensional (2D) projection of the scene, which corresponds to what we will see on the output device.

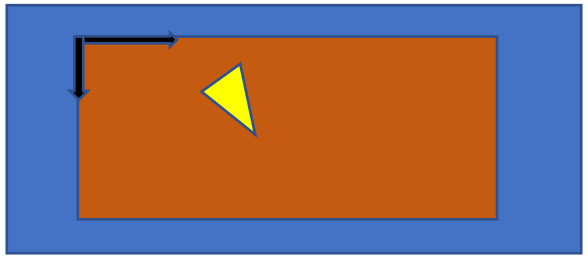


Camera View



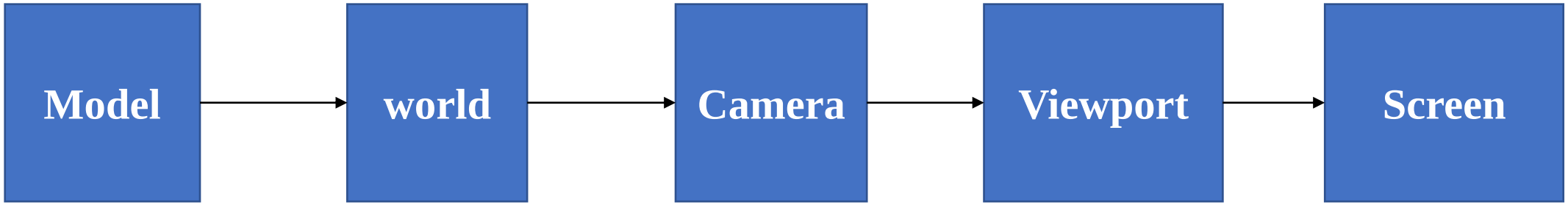
Normalized coordinates

- The scene is then stored in normalized coordinates, where each coordinate value is in the range from −1 to 1 or in the range from 0 to 1, depending on the system.
- Normalized coordinates are also referred to as normalized device coordinates, since using this representation makes a graphics package independent of the coordinate range for any specific output device
- We also need to identify visible surfaces and eliminate picture parts outside the bounds for the view we want to show on the display device.



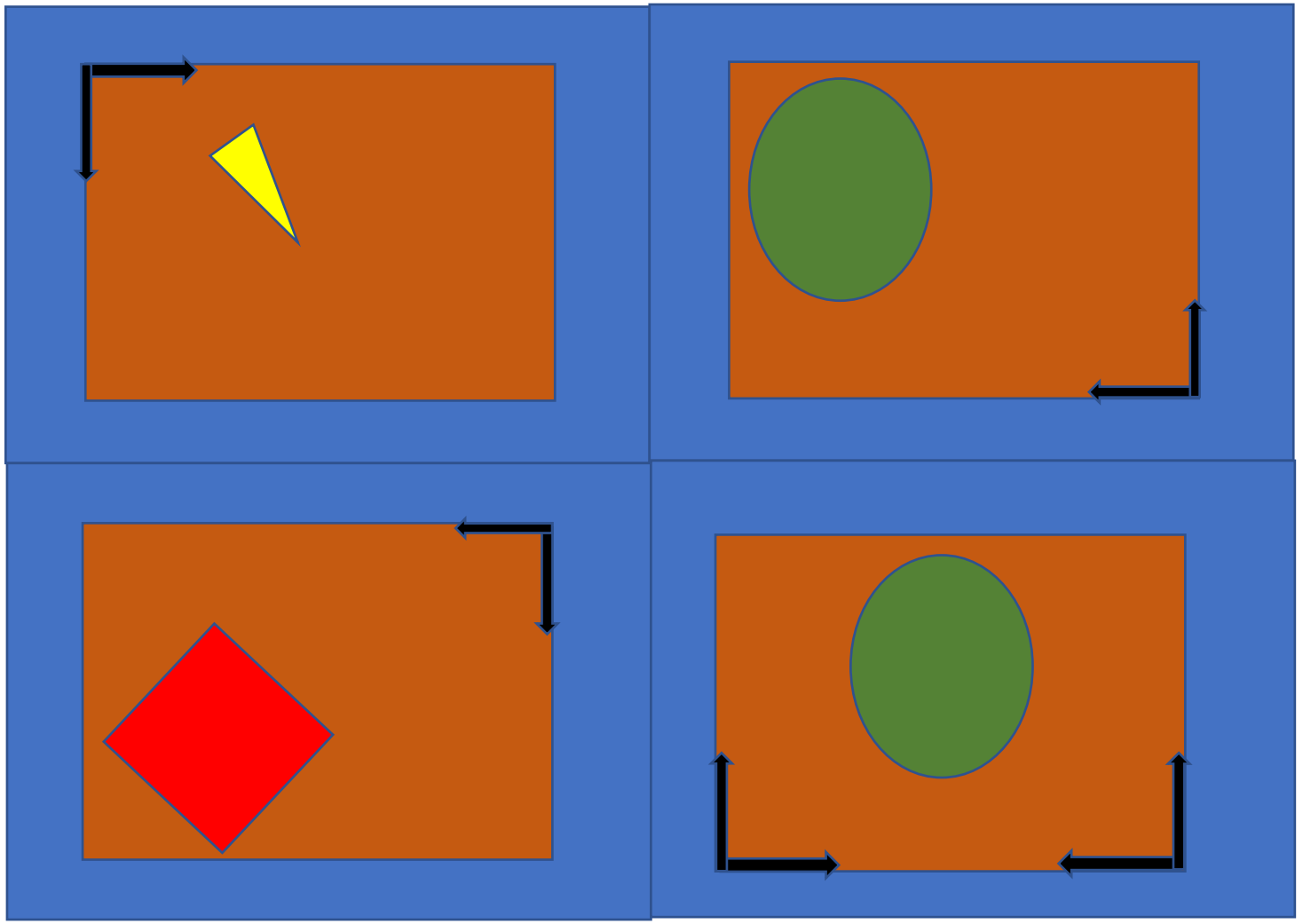
Device coordinates

- Finally, the picture is scan-converted into the refresh buffer of a raster system for display.
- The coordinate systems for display devices are generally called device coordinates, or screen coordinates in the case of a video monitor.



(xmc , ymc , zmc) → (xwc , ywc , zwc) → (xvc , yvc , zvc) → (xpc , ypc , zpc) → (xnc , ync , znc) → (xdc , ydc)

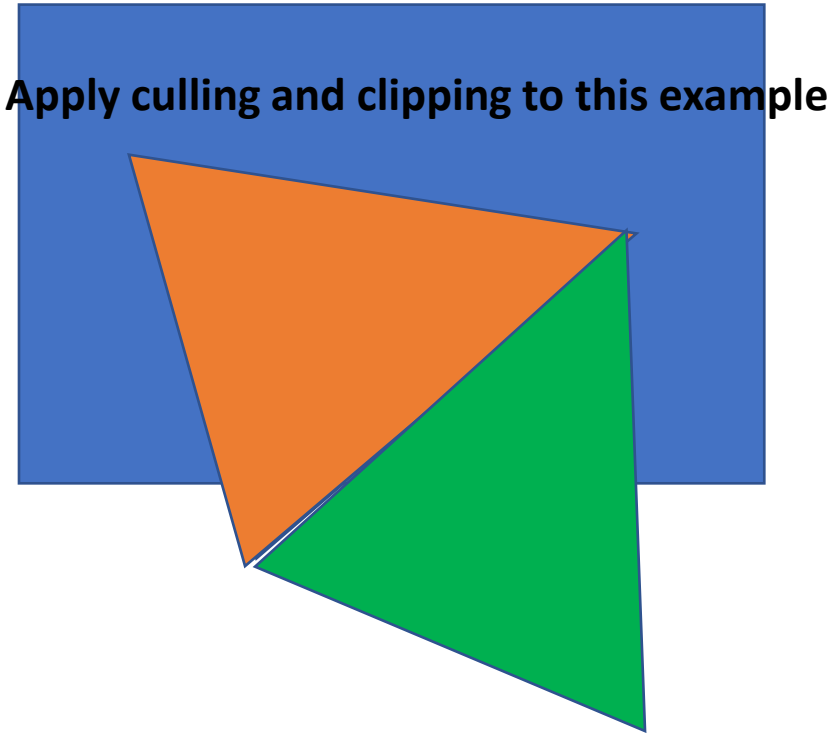
Screen



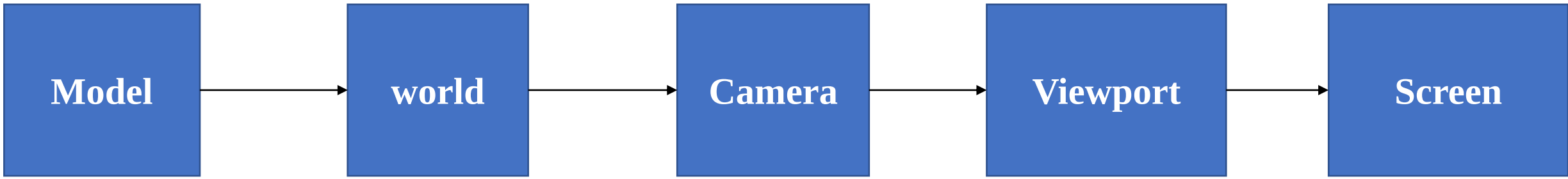
Common properties

- Multi cameras in the world.
- Multi view ports in the screen space.
- Culling
  - Act of excluding entire object from the pipeline.
- Clipping
  - Act of cutting out a portion of an object.

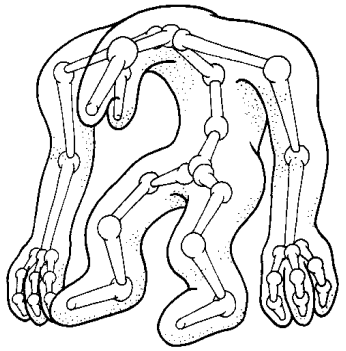
- **Note:**
  - Clipping and culling takes place in world space

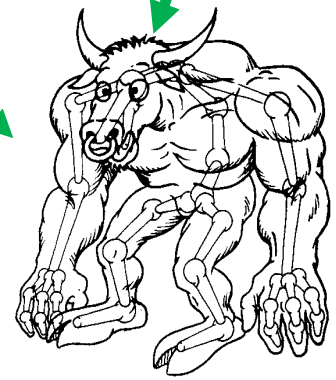


T-rex in Real world



Modelling – 3D





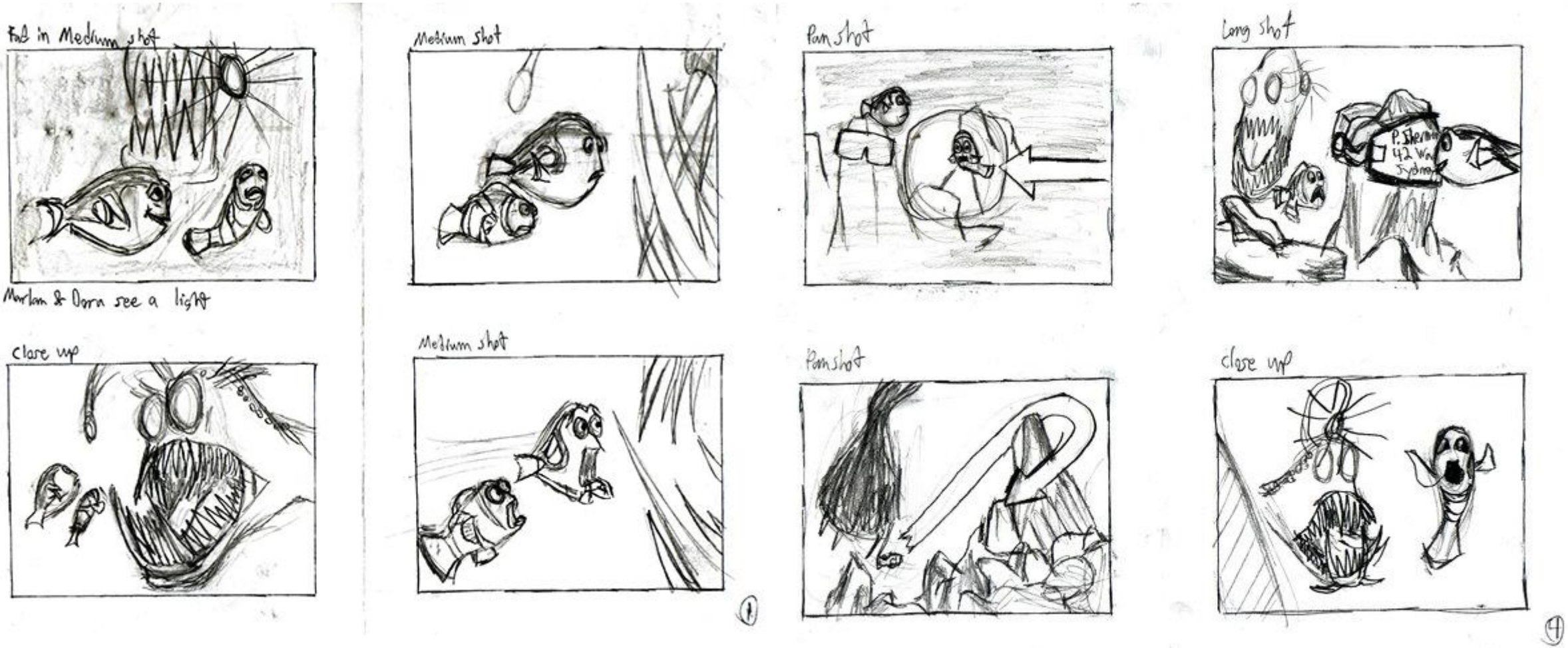
Animation

- Process used for generating animated images
- Application
  - Video games
  - Cartoons/movies
  - Mobile applications

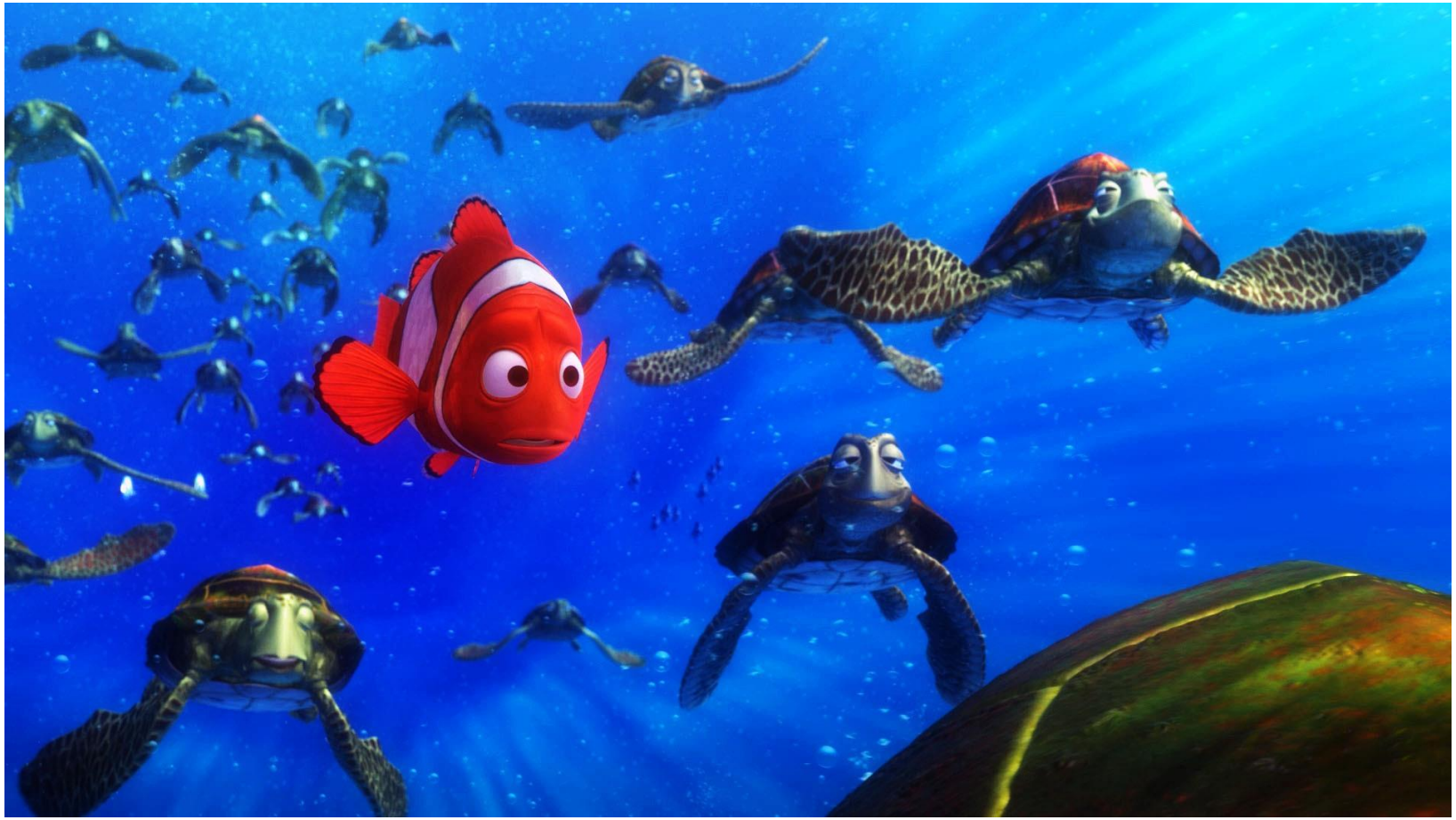
Designing animation sequence

- Story board layout
- Object and path definition
- Key frame specification
- Generation of in-between frames

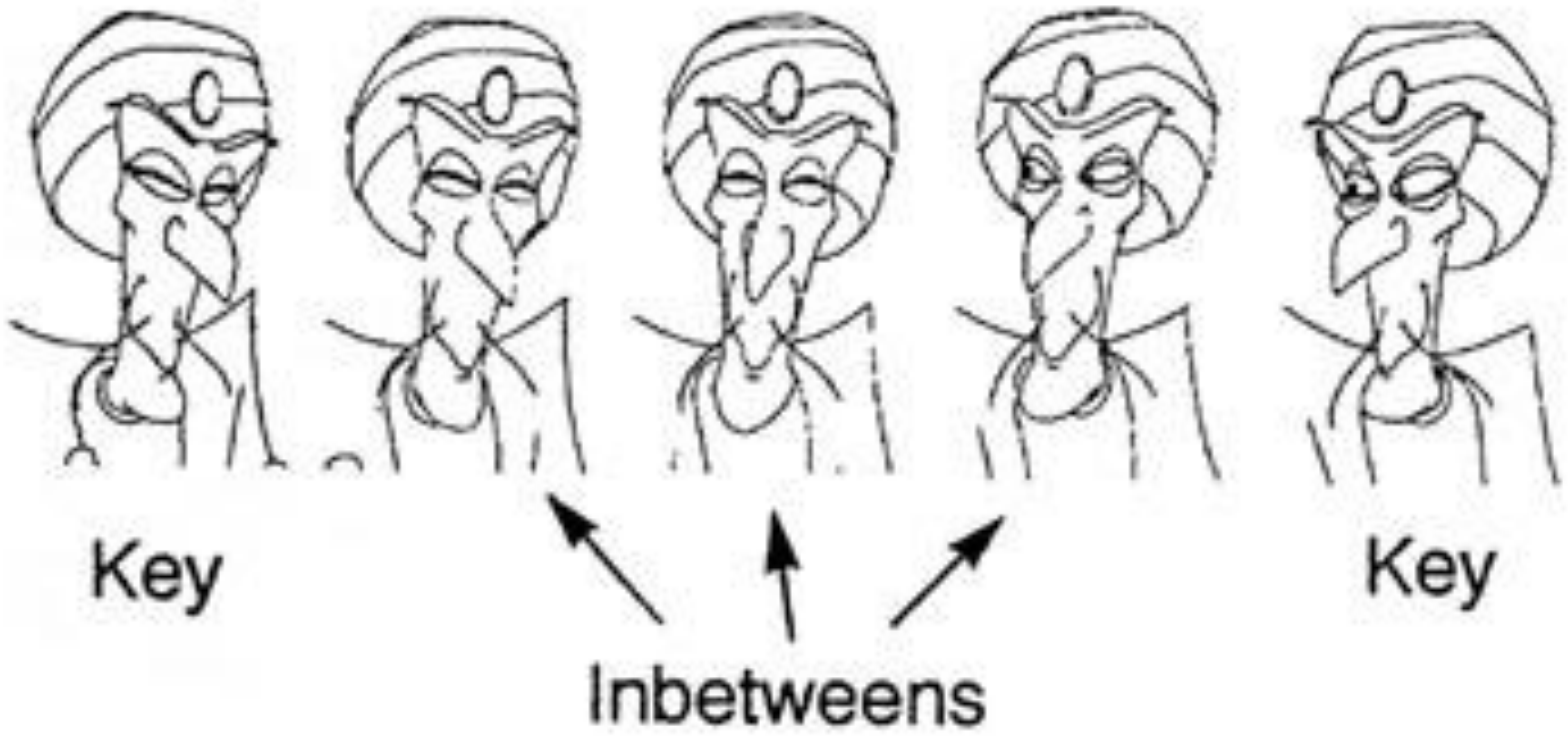
Story board


Fade in Medium shot
Marlon & Dorn see a light
Medium shot
Pan shot
Long shot
close up
Medium shot
Pan shot
close up

Object and path definition

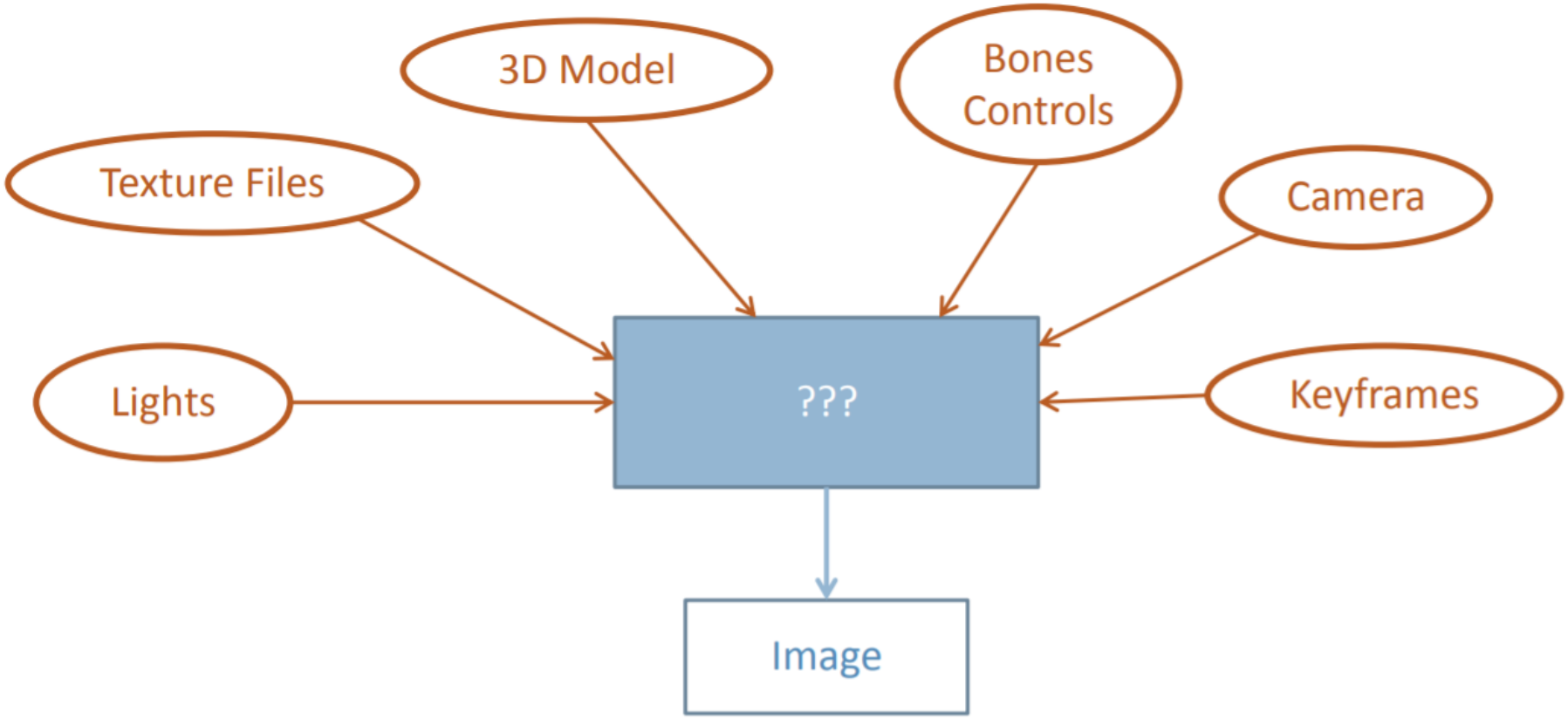


Key frames and in-between frames generation



Animation

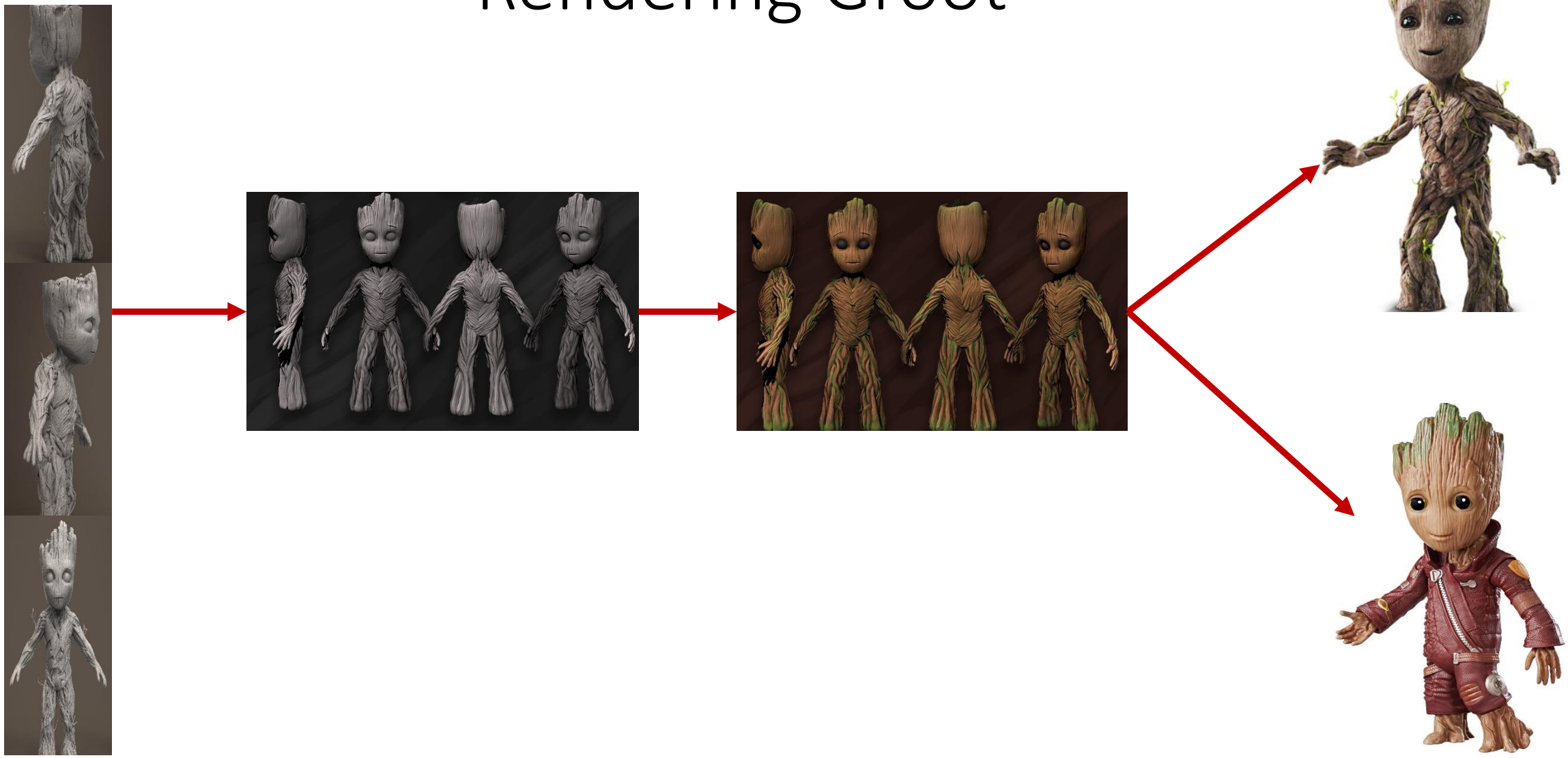
Rendering


3D Model
Bones
Controls
Texture Files
Camera
Lights
???
Keyframes
Image

Making of Groot

3D Model + Bones Controls + Keyframes = Geometry

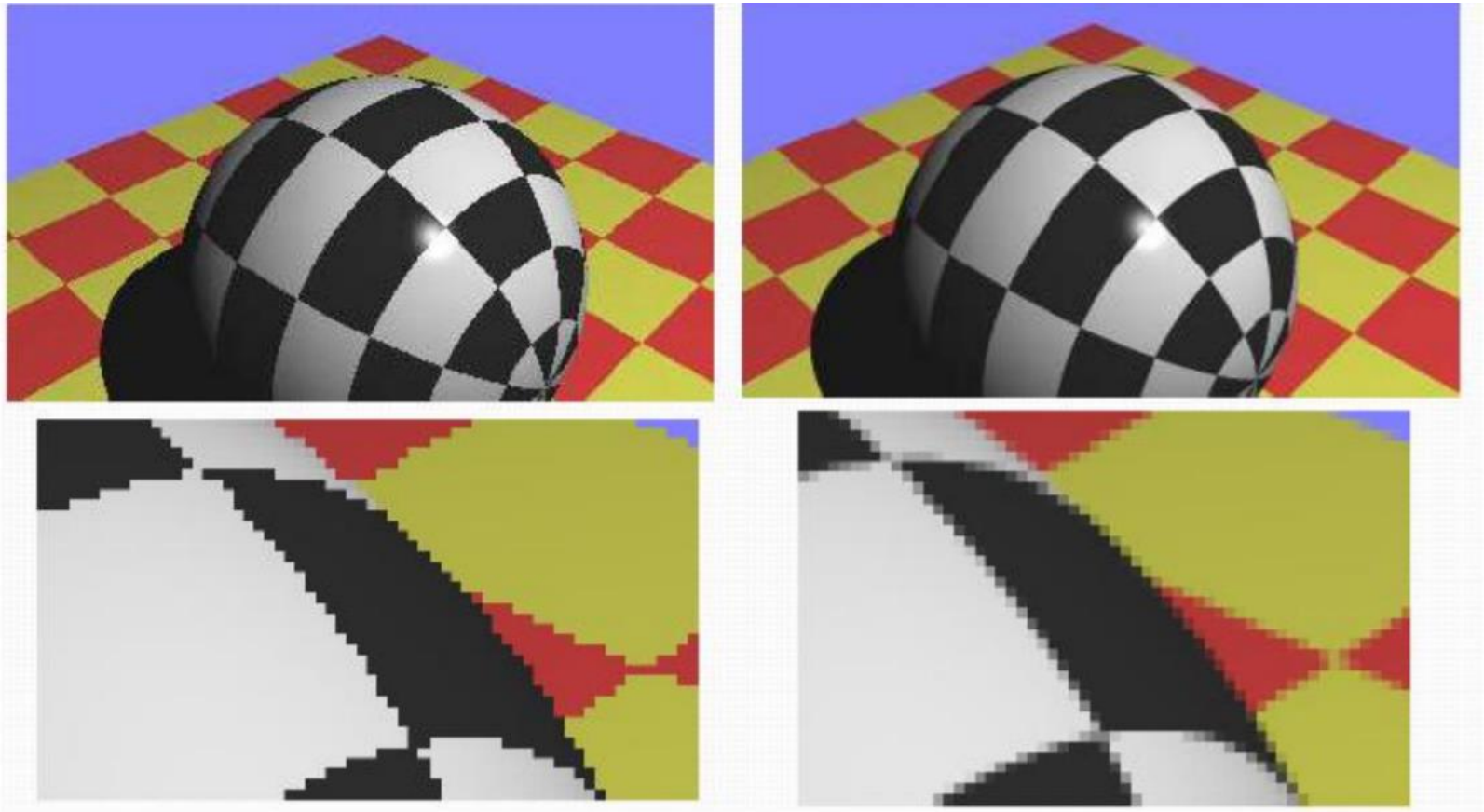
Rendering Groot



Rendering - Factors to be considered

- Projection
- Occlusion (technique used to calculate how each point in a scene is exposed to lighting)
- Color / Texture
- Lighting
- Shadows
- Reflections / Refractions (reflected rays/ transmitted rays)
- Indirect illumination (techniques used to add more realistic lighting to 3D scenes)
- Sampling / Antialiasing (technique used to reduce the visual defects that occur when high-resolution images are presented in a lower resolution)

Sampling / Antialiasing



Computer vision vs Image processing

- ***Computer Vision:***
- **Input**: Images
  Output: Knowledge of the scene (recognize objects, people, activity happening there, distance of the object from camera and each other, ...)
  Methods: Image processing, machine learning, ...
- ***Image Processing:***
- **Input**: Images
  Output: Images (Might be in different formats, for example compressed images). No knowledge of the scene is given.
  Methods: Different filtering, FFT,

Mathematical object models – A review

- **Algebra and Trigonometry (**Vectors and matrix)
- **Linear Algebra (**numerical representations of geometry)
- **Calculus/ Differential Geometry (**smooth curves and surfaces**)**
- **Numerical Methods (**represent and manipulate numbers**)**
- **Sampling Theory and Signal Processing (**Image processing(2D/3D)**)**
- **Physics (**animation/particles/model dynamics**)**
- **Optimization (**gaming**)**

Art is also an important aspect of Graphics.