

Computer Graphics

CSC 418/2504

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Topics

- Overview:
 - Computer Graphics
 - Images
 - Color
 - Line rasterization
- Course overview (dates, req's, etc.)

What is Computer Graphics?

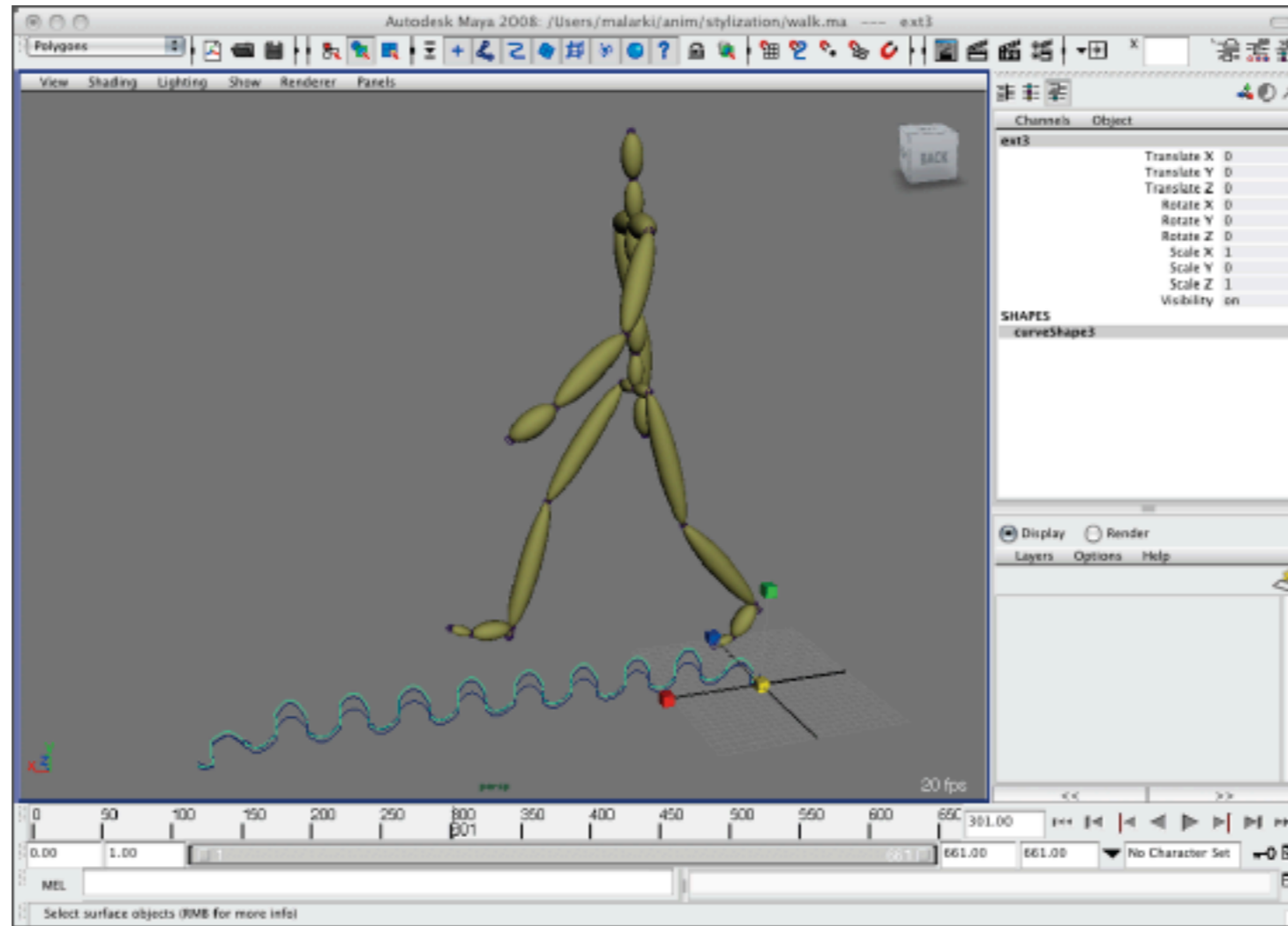
- *“Any use of computers to create or manipulate images” – Peter Shirley*
- Computational modeling: Data structures and algorithms
- Mathematics: Linear algebra, geometry, vector calculus...
- Physics: optics, dynamics, materials
- Perception: color theory, psychophysics

What is *not* in CSC 418



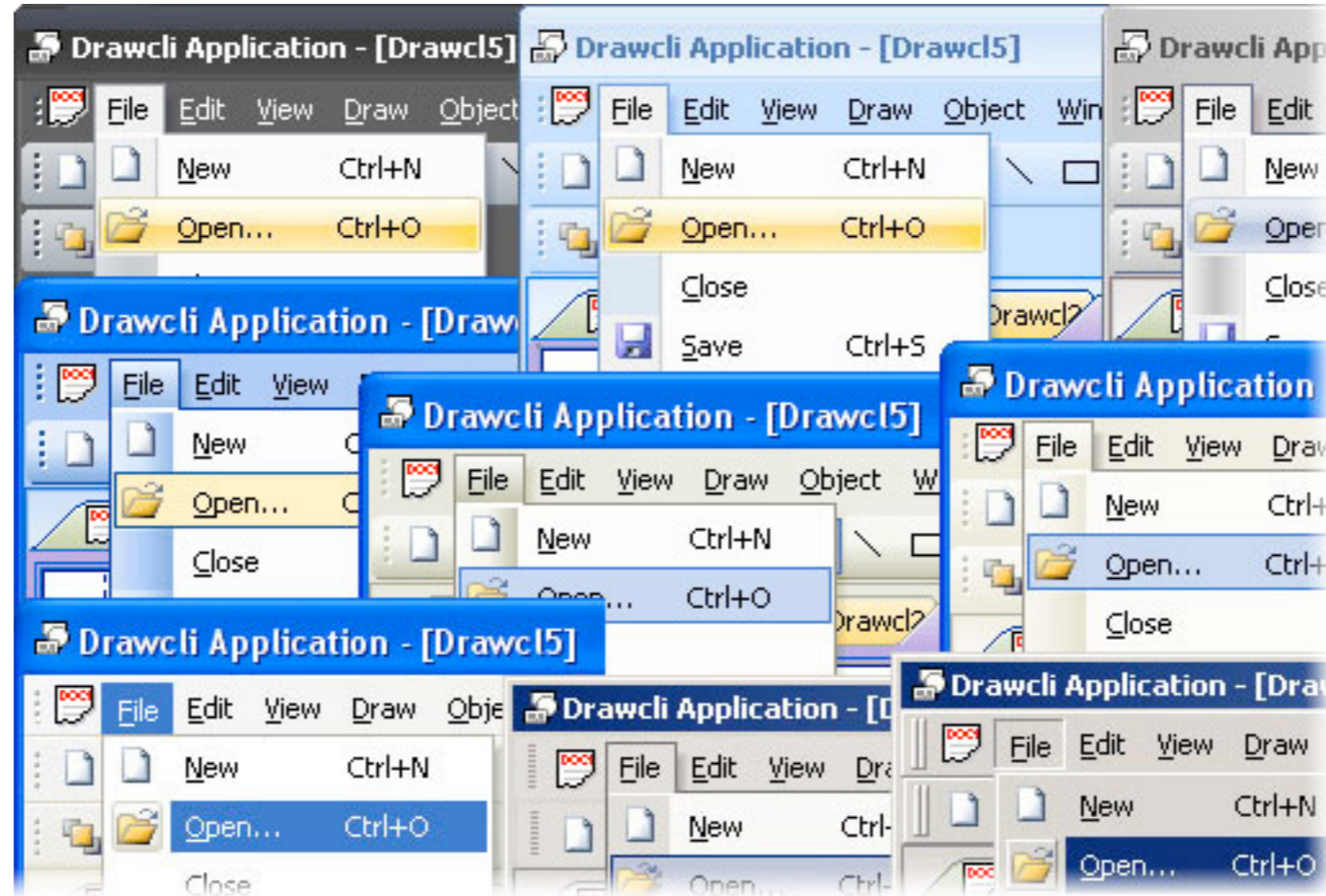
Image manipulation in Photoshop

What is *not* in CSC 418



How to use 3D software, e.g. Maya

What is *not* in CSC 418



How to design and create GUIs

CG application domains

CG application domains



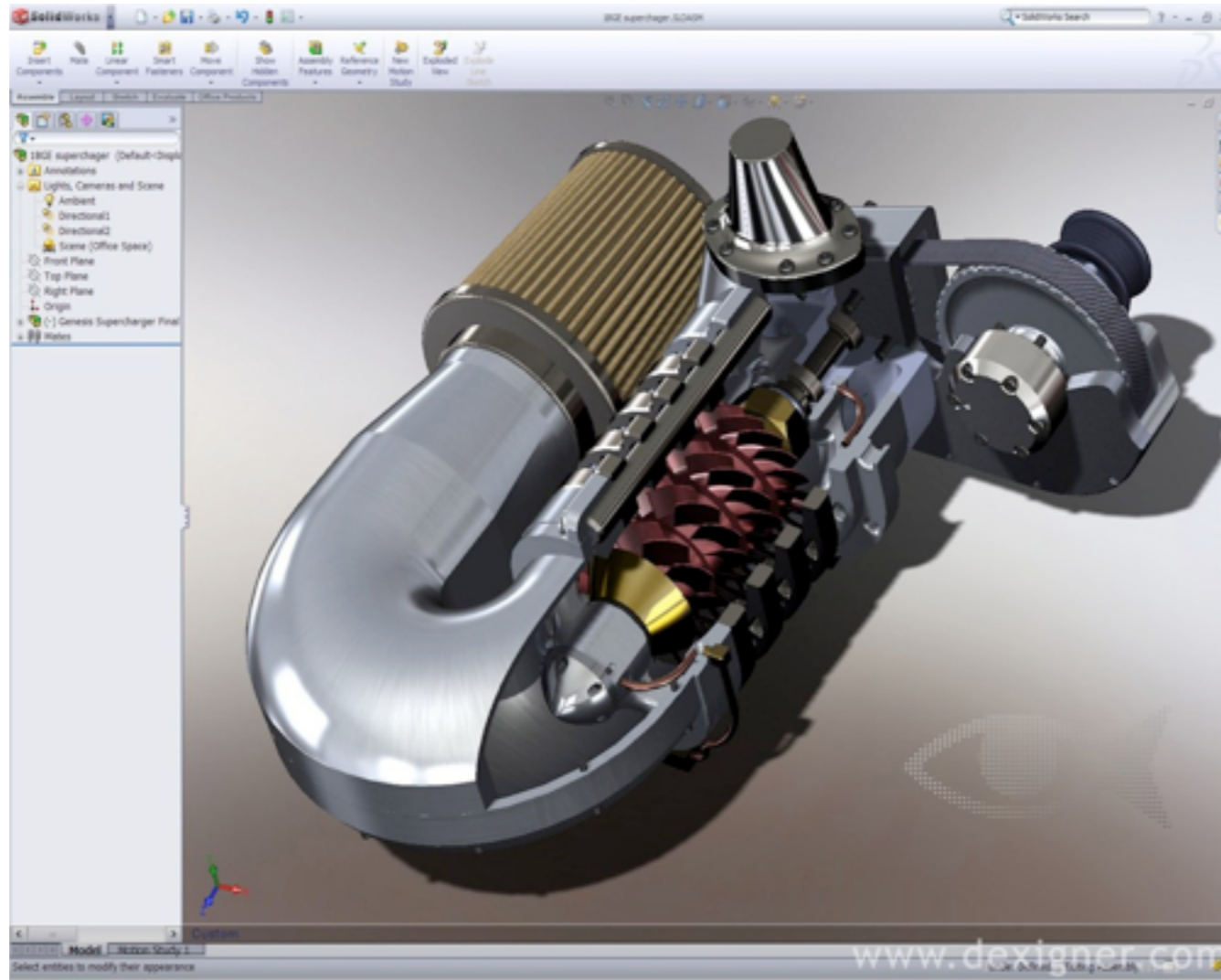
Film: visual quality

CG application domains



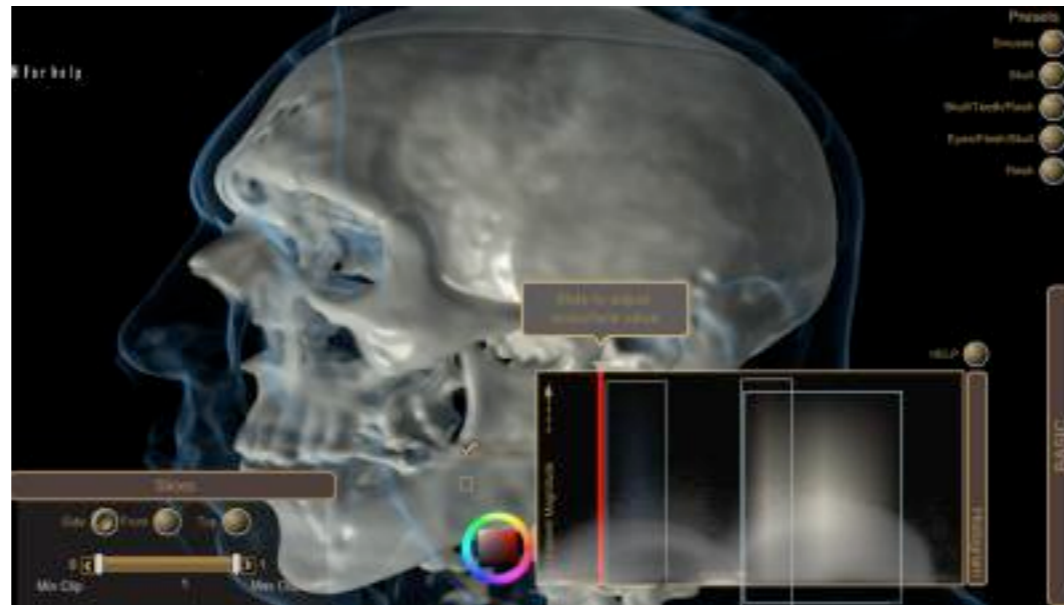
Games: Visual quality and real-time performance

CG application domains



Industrial design: modeling precision

CG application domains

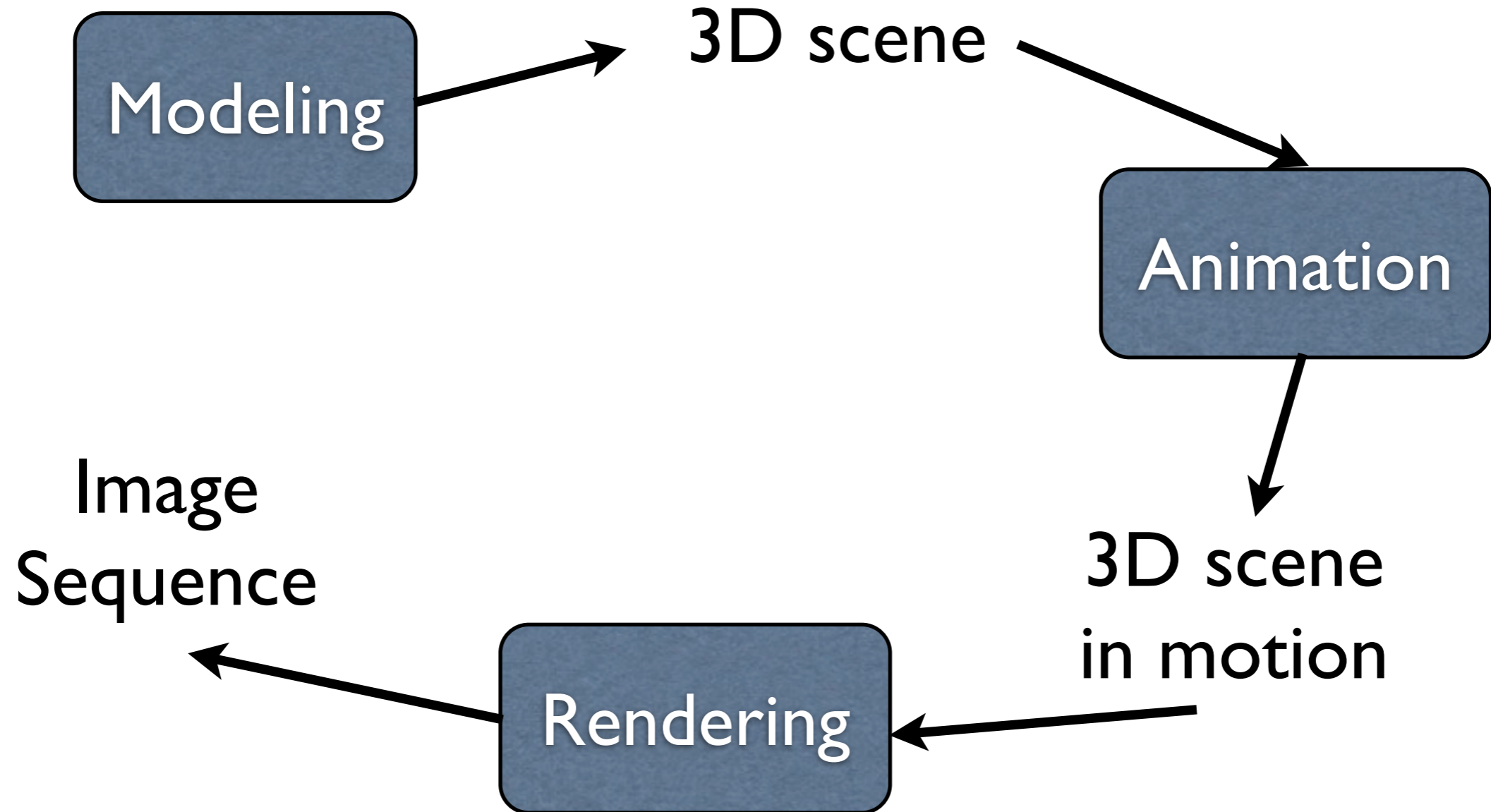


Scientific/medical visualization:
real world data, abstraction, large datasets

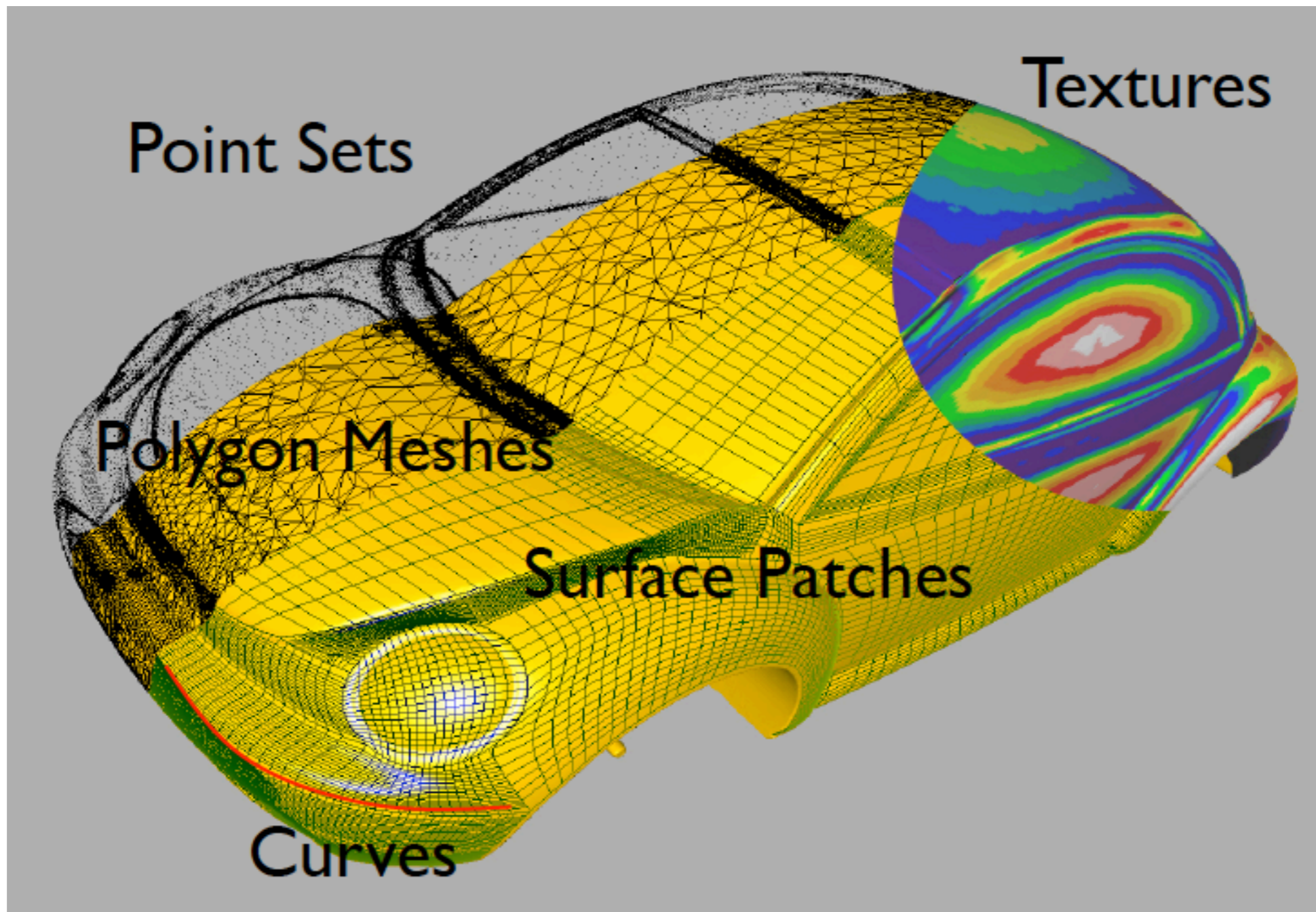
Areas of CG

- **Modeling:** defining the geometric form of 3D objects
- **Rendering:** math. modeling the appearance of 3D objects, converting generating 2D images
- **Animation:** modeling the motion and behavior of 3D objects over time.

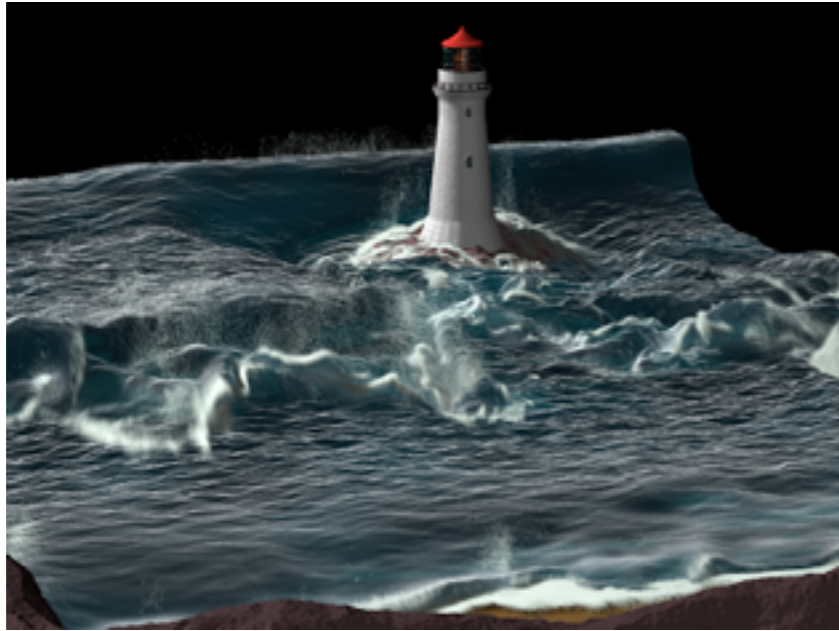
Graphics Pipeline



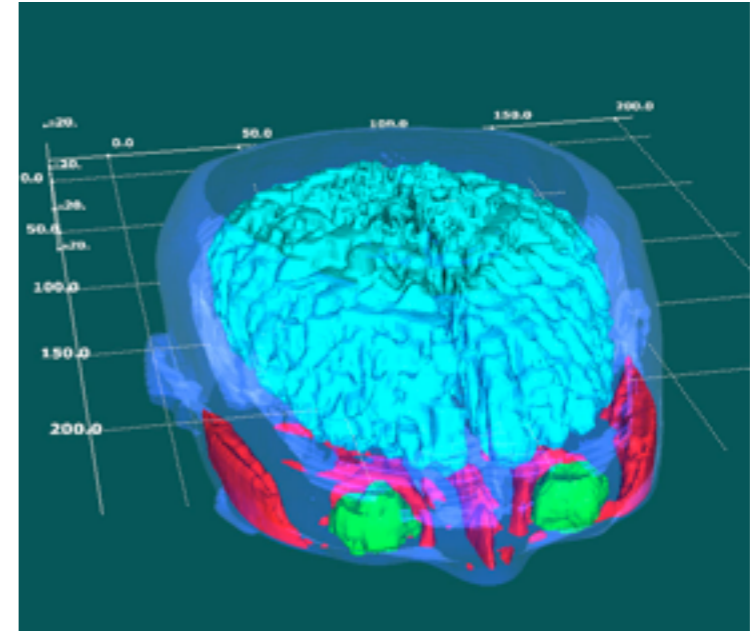
Modeling



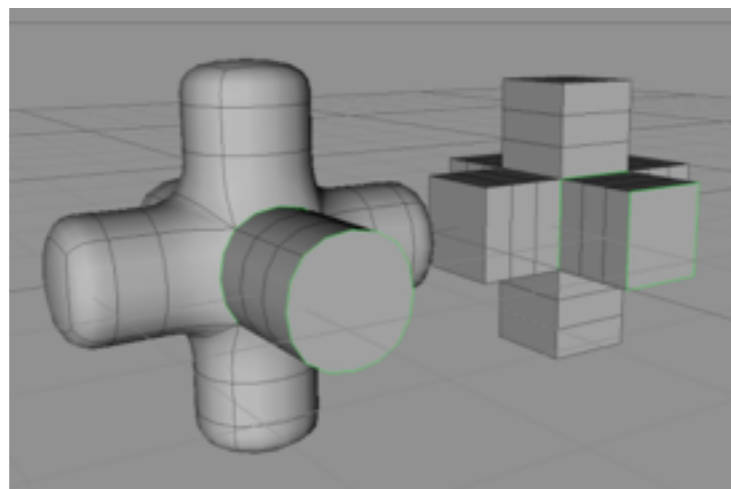
Modeling



Implicit Surfaces



Voxel Data



Subdivision Surfaces

Animation



Motion capture



Keyframes

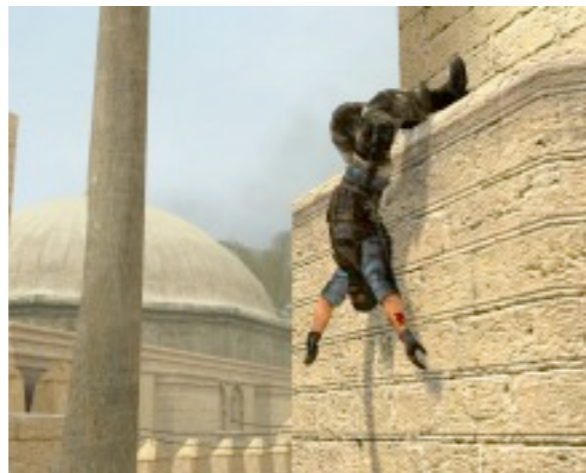


Behavior modeling

Animation



Procedural



Physical simulation

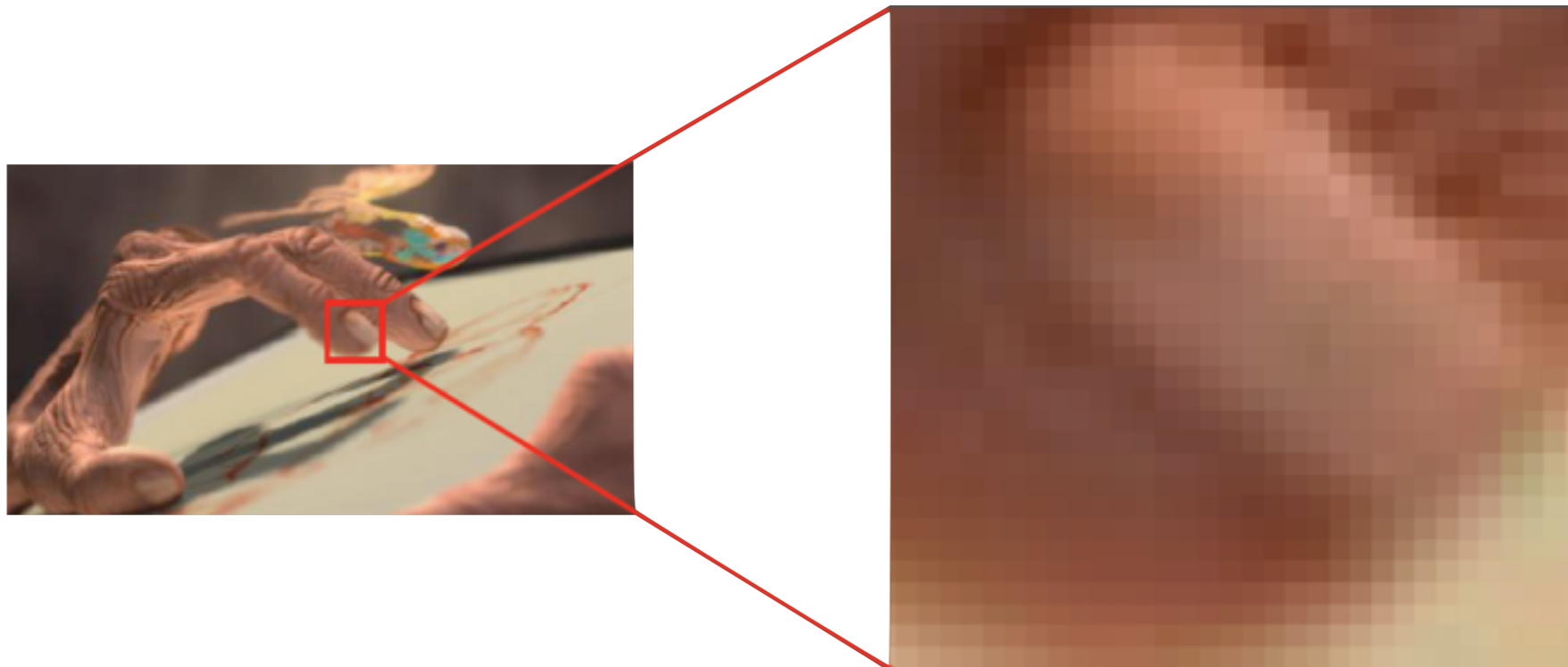
Rendering



Camera & Perspective
Projection
Visibility

Clipping
Rasterization/Scan Conversion
Texture Mapping
Light Transport

What is an image?



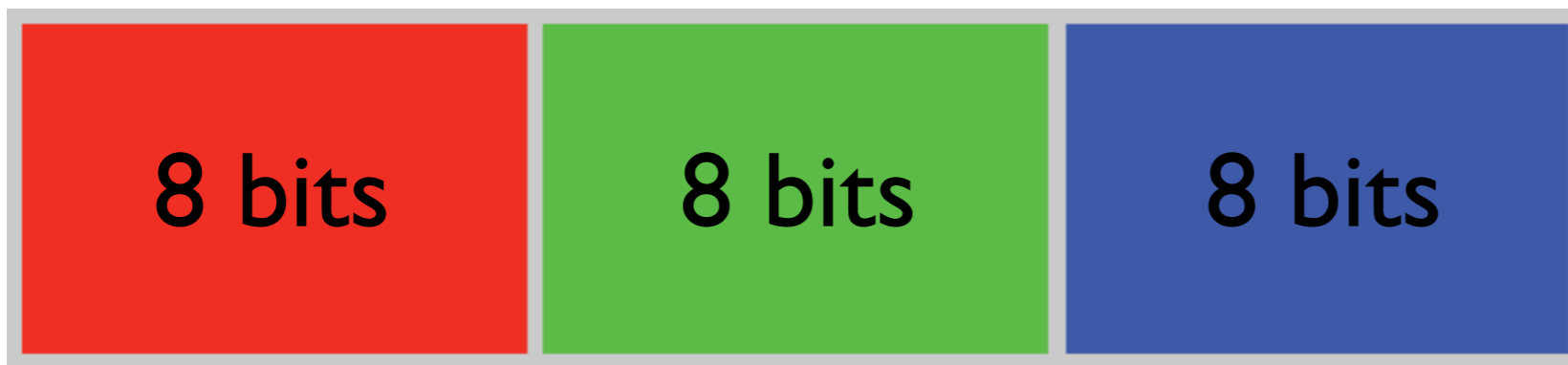
- A distribution of wavelength-dependent light energy stored on film or emitted by a display
- Raster displays discretize this distribution using a 3 dimensional color space and a grid of color samples called *pixels*
- Pixel: “picture element”

What is a pixel

- Color represented in (typically) three-dimensional color space
- RGB: red, green, blue.

Storing Color

In an image: 24-bit color



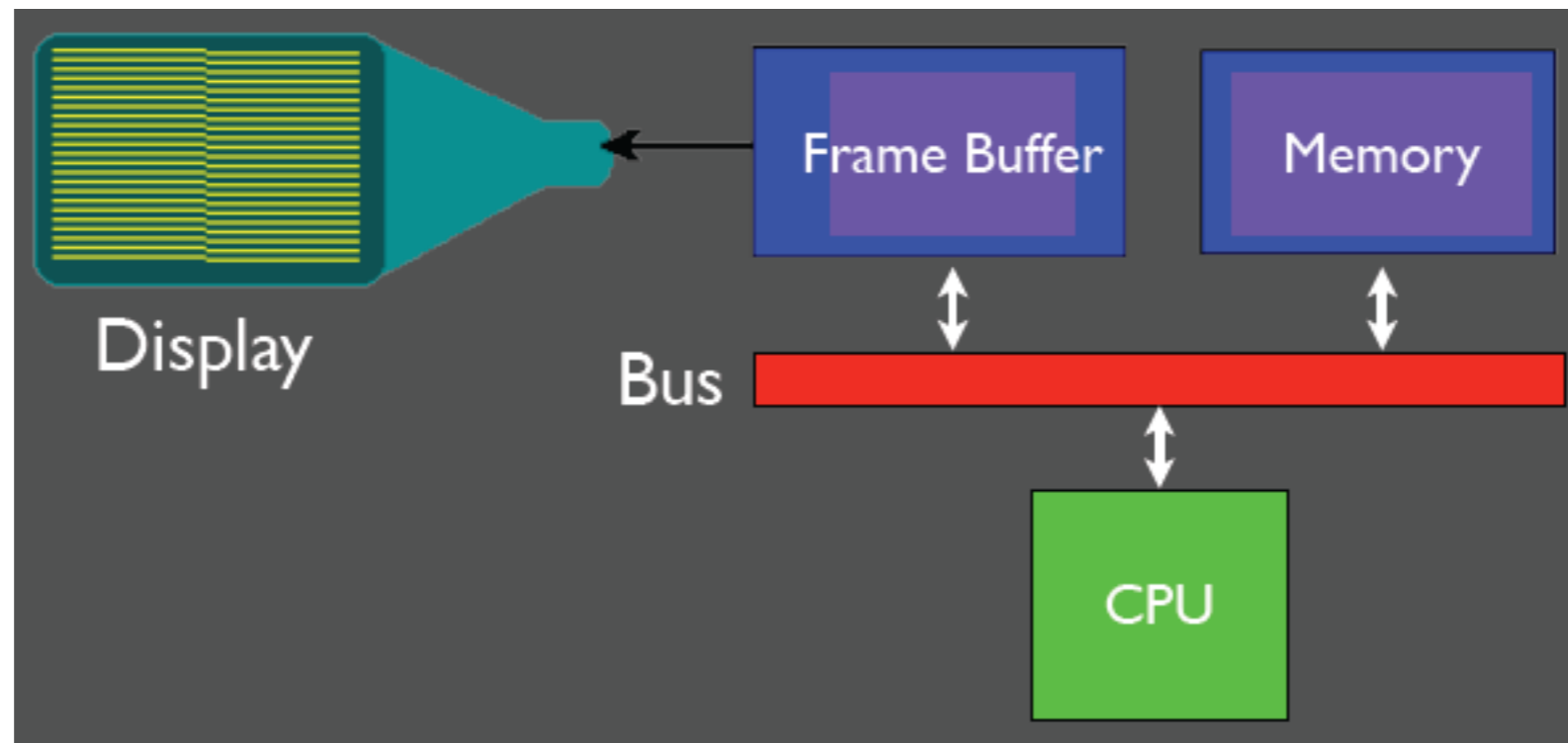
$r, g, b \in [0, 255]$

In software:

```
class RGBColor {  
    float r;  
    float g;  
    float b;  
};
```

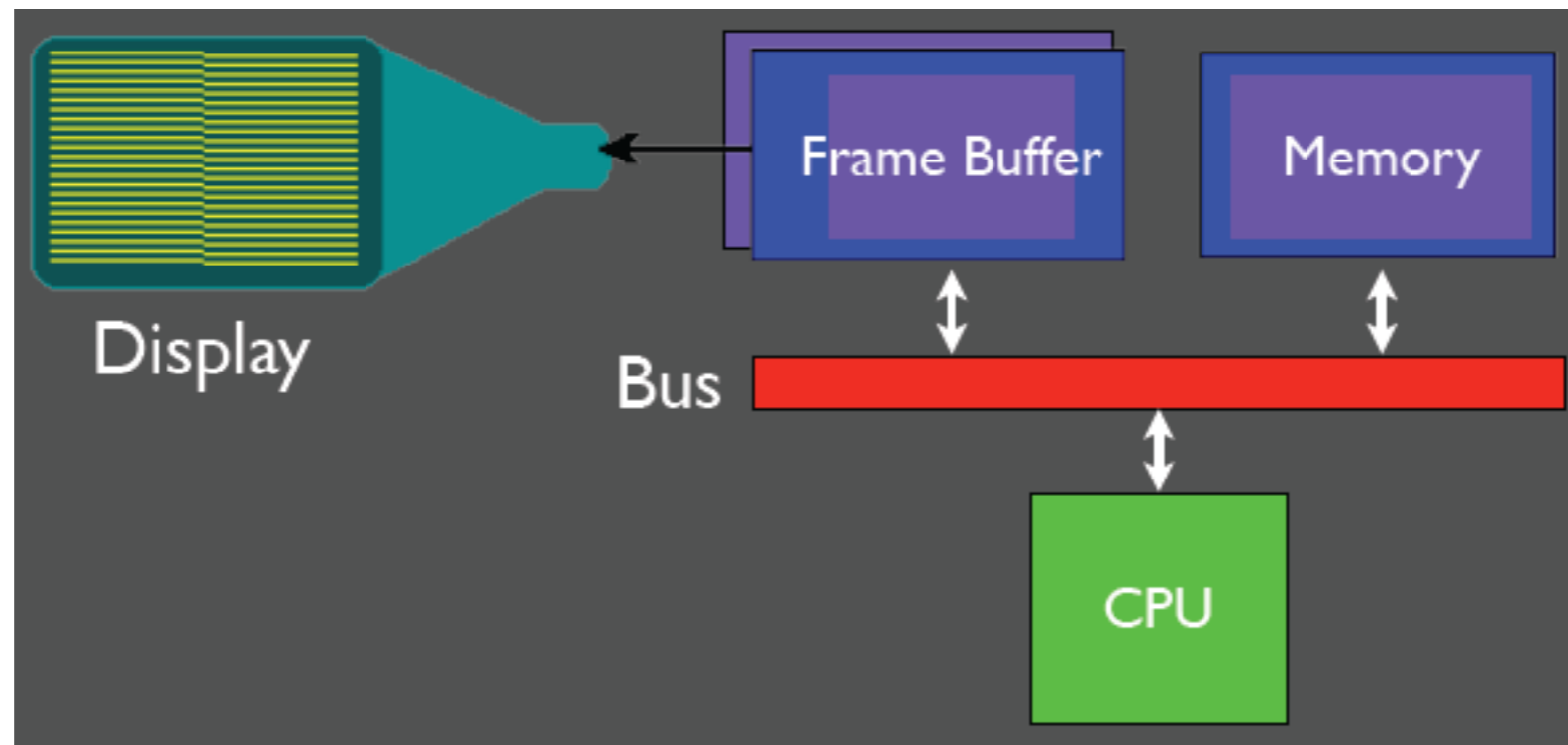
$r, g, b \in [0, 1]$

Conceptual display architecture



What happens while we write to the frame buffer?

Double buffering

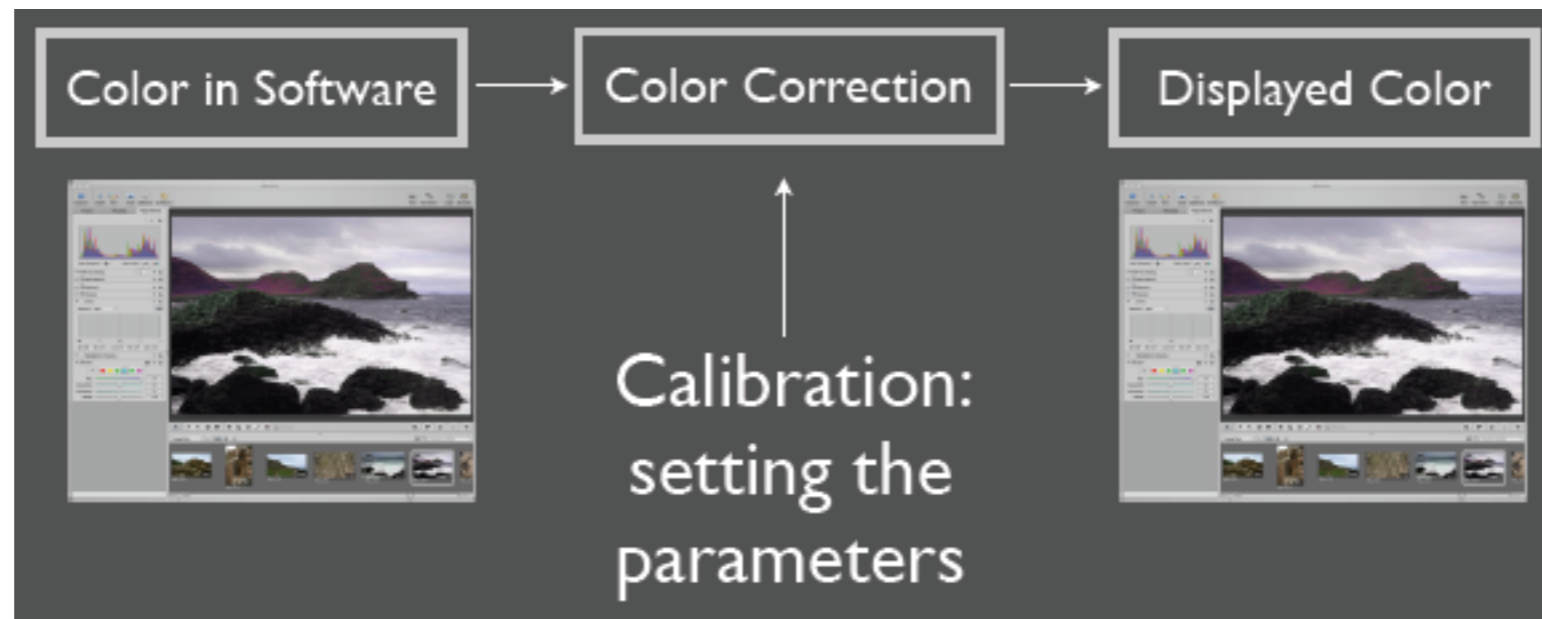


Color correction & calibration

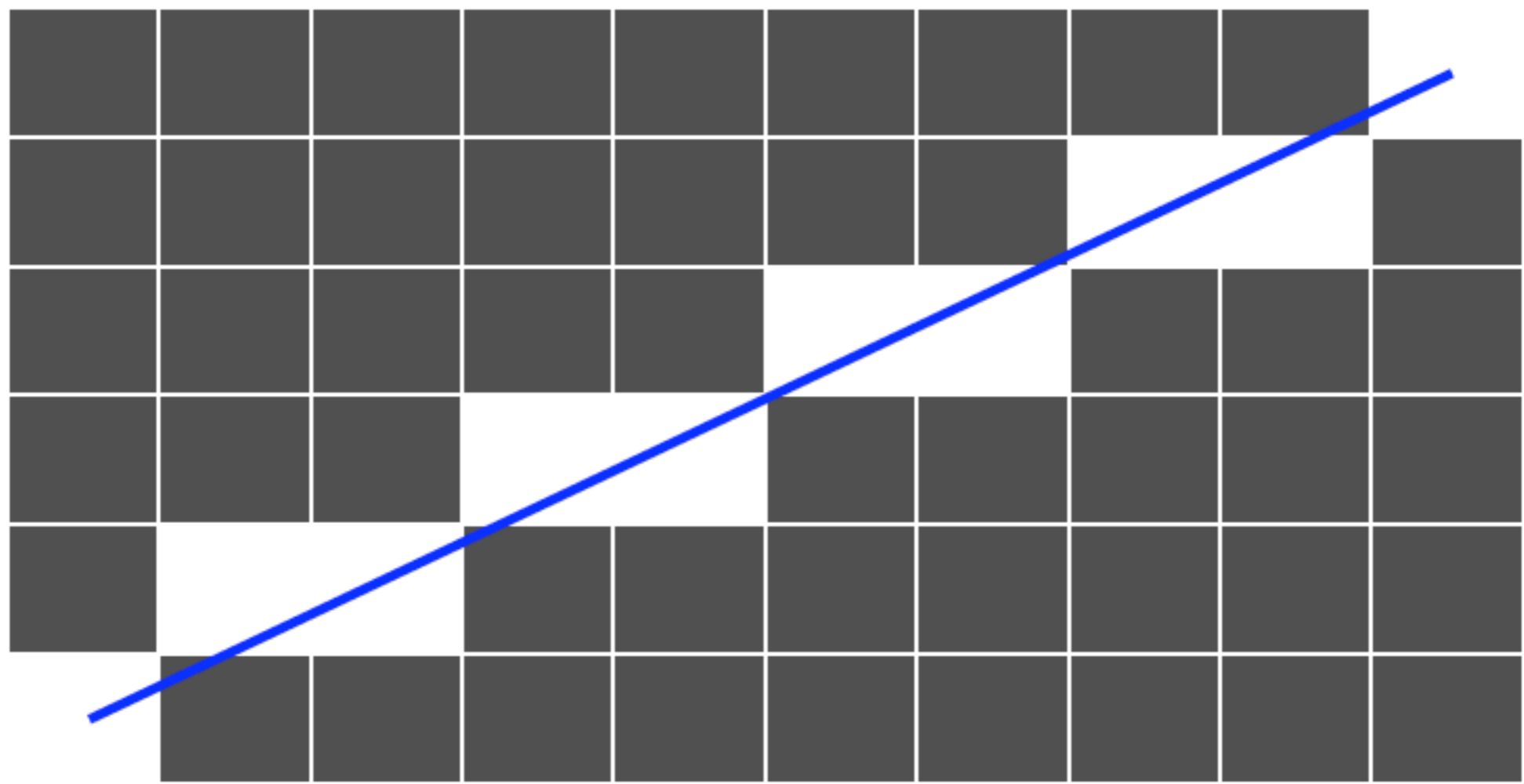


Getting the display colors right

Color correction & calibration

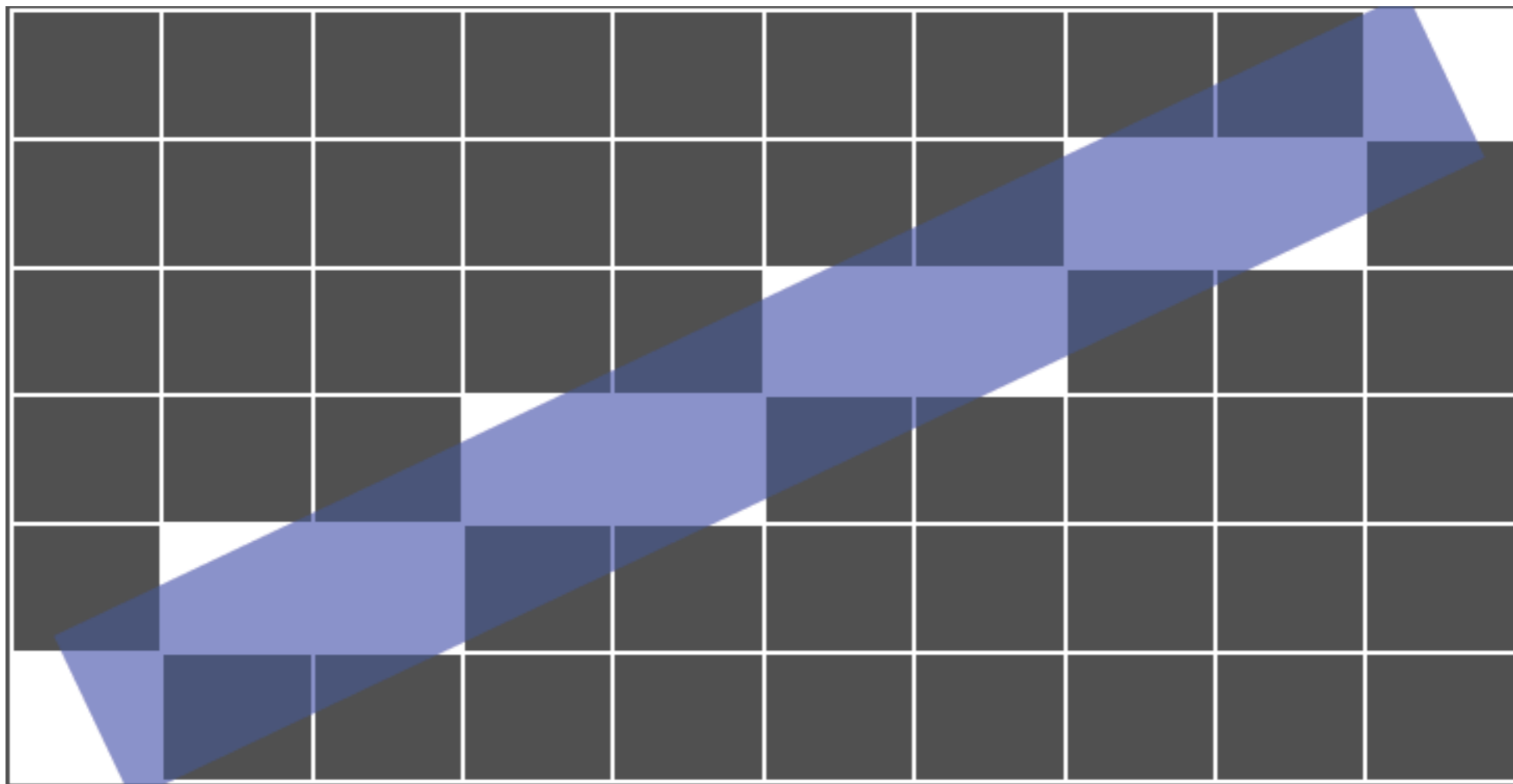


Line drawing



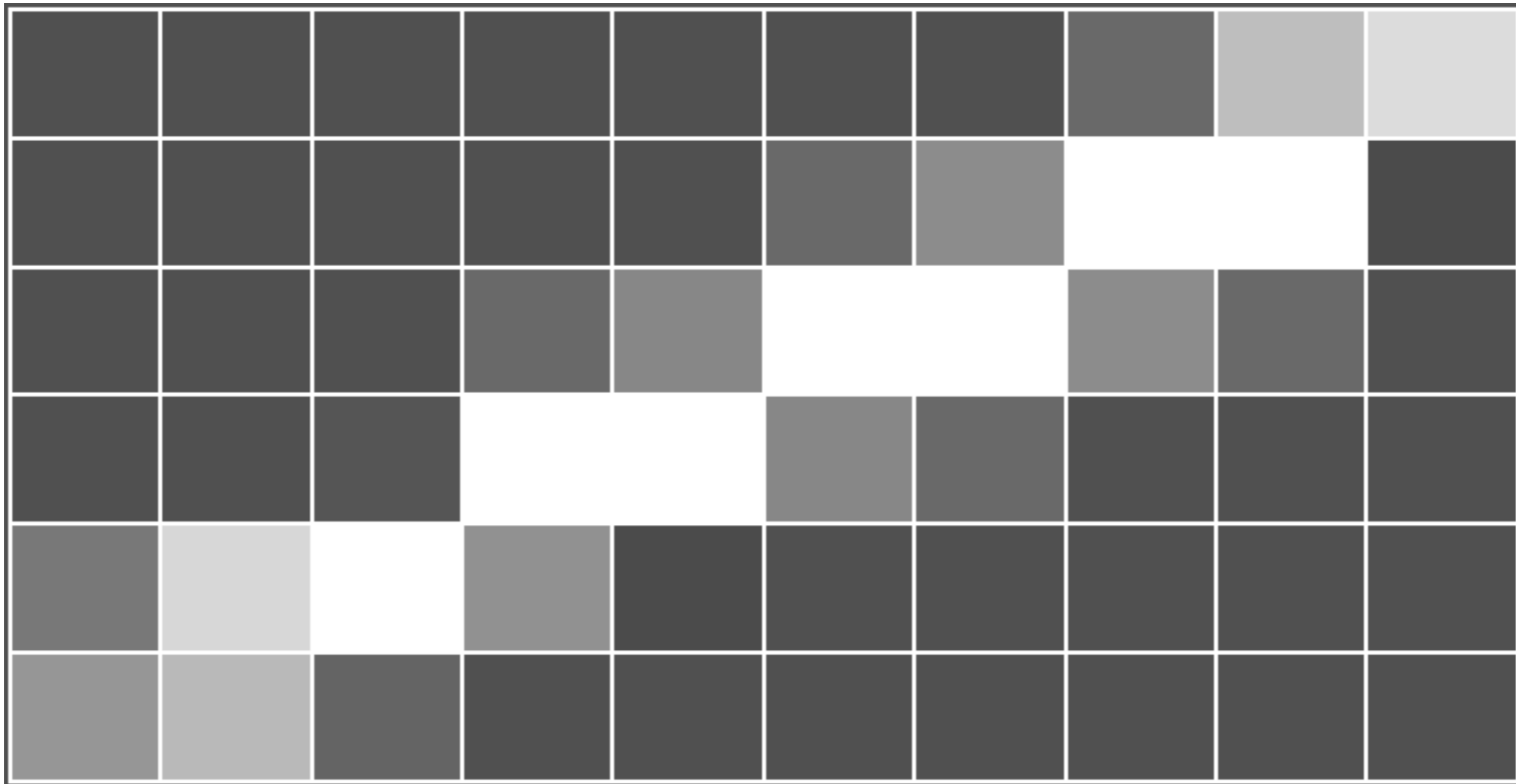
Jaggies

Line drawing



Make a thicker line...

Line drawing



... and set intensity to frac. value based on coverage

Course Topics: Subset of...

- Foundations: geometric primitives, rasterization, transformations
- 3D viewing: cameras, projection, perspective
- Rendering: Radiometry, Light Transport, Illumination, Ray Tracing
- Animation: Keyframe animation, physical models, behavior
- Modeling: curves, polygons, surface patches, subdivision surfaces, implicit surfaces

Requirements

- Course webpage for specifics
- Linear algebra
- Calculus
- Vector/Matrix operations
- Algorithms and data structures
- Basic C++ programming

Course Info

- <http://www.cs.toronto.edu/~psimari/418/>
- Announcements Section: Check twice/week
- Bulletin board (link on webpage)
- psimari@cs.toronto.edu
- Tutorials: V6, required for assignments, Math, C++, OpenGL, ...

Assignments/Midterm

- Assignment 1 (10%): October 5
- Assignment 2 (15%): November 2
- Assignment 3 (25%): November 30
- Midterm (15%): October 19
- Exam (35%): Period December 9–20

Marking Policies

- CDF Unix Machines
- Starter code
- Minimum of 35% on final exam
- Re-mark in writing within one week
- Late penalties: 15% per day, 3 day max
- Written part: 7pm, start of class
- Programming part: 11:59pm

Academic Offense

- Submit only your own work
- Acceptable to talk about general ideas
- Not acceptable to communicate about solutions
- A3 in pairs