Computer Graphics
3080, GV10

Course Lecturers

- Tobias Ritschel
- Anthony Steed
- David Swapp

Course information

- Moodle
  - You need to register on Moodle:
    - COMP3080 or COMPGV10
  - Slides and Assignments can be found there

- Assessment
  - Written Examination (2.5 hours, 75%)
  - Coursework Section (4 pieces, 25%)

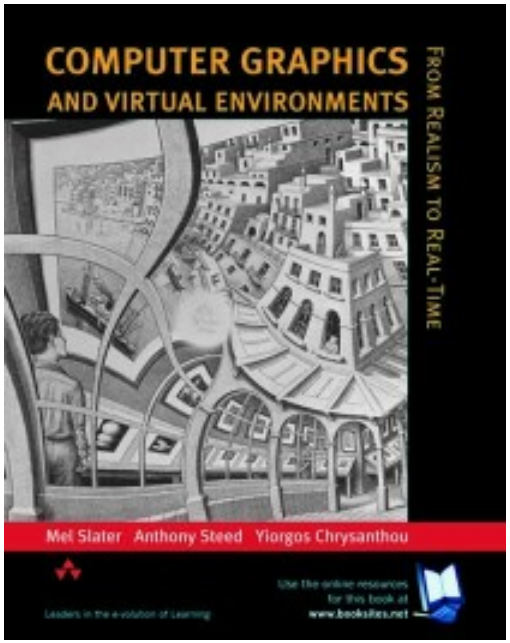
Timetable

- **Lecture Times**
  - Mondays, 10:00-11:00, Roberts 508
  - Thursdays, 11:00-13:00, Roberts G08

- **Lab Times**
  - 3080/3080A: Tuesdays 13:00-15:00 in MPEB 1.21
  - GV10: Fridays, 16.00-18.00 in MPEB 1.21

Course Book

- The book supporting the lectures is
  - *Computer Graphics And Virtual Environments - From Realism to Real-Time.* Mel Slater, Yiorgos Chrysanthou, Anthony Steed, ISBN 0201-62420-6, Addison-Wesley, 2002.



Course content (1)

- Introduction
- Linear Algebra
- Light & Sensors
- Projection
- Ray tracing
- Ray-tracing Efficiency
- Shading
- Physically-based rendering

Course content (2)

- Physically-based rendering methods
- Monte Carlo ray-tracing
- Rasterization and OpenGL
- Graphics Hardware
- Shaders
- Worlds and animation
- Splines
- Geometry

Introduction to 3D Graphics

Lecture 1: Illusions and the Fine Art of Approximation

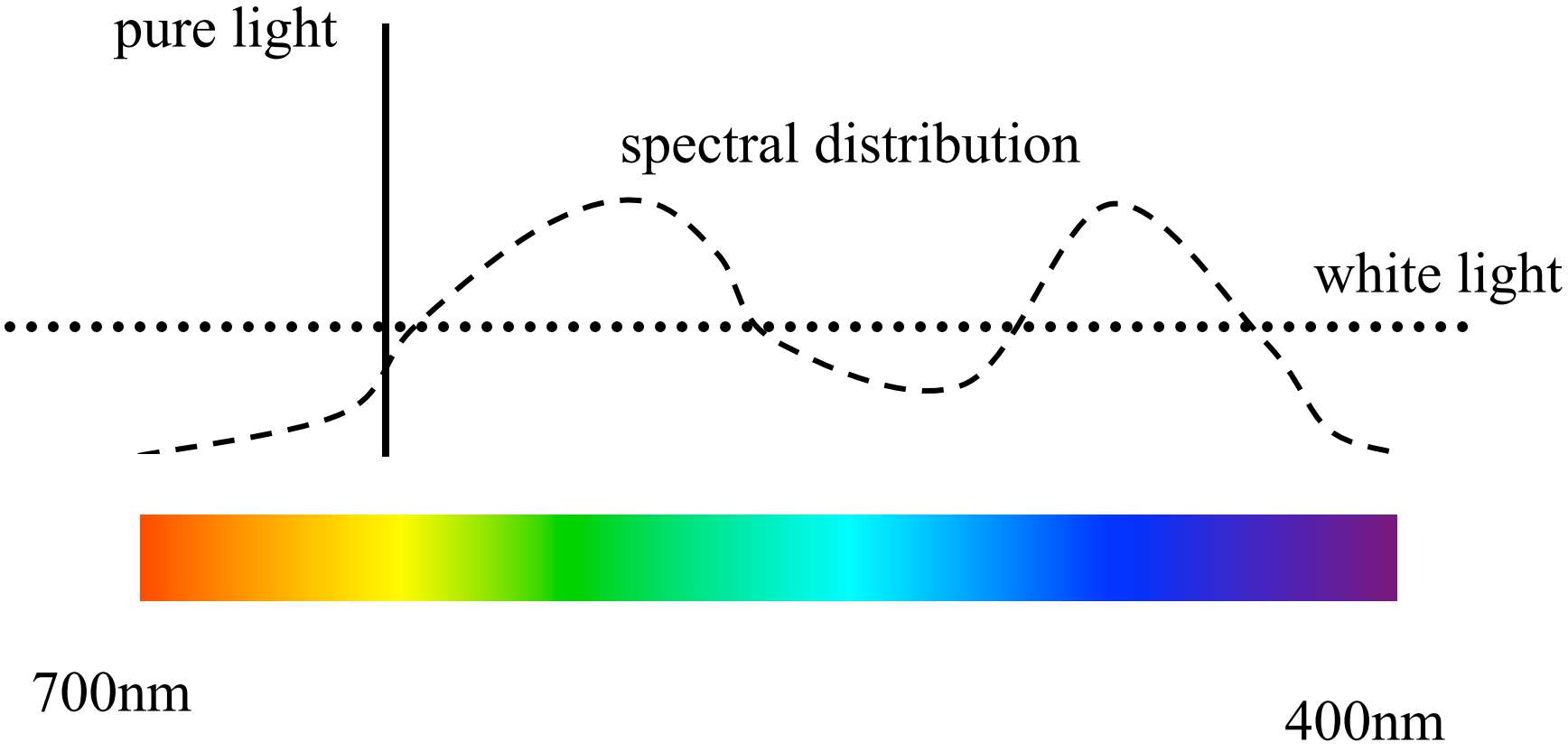
Outline

- Anatomy of an Illusion
  - Environment
  - Light transport and interaction
  - Reception at the eye
- The Painter's Method
  - Ray-casting
  - Approximations

Environment

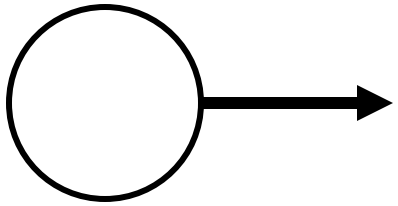
- A description of a space consisting of *objects*
- Objects have *description* and *state*
- Description consists of *behaviour*, *geometry* and *appearance*
- Geometry must be described relative to a *co-ordinate frame*
- State defines the object at a particular moment in time

Radiometry - How does light propagate in the real world?

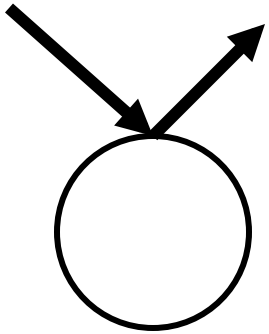


Life and Death of a Photon

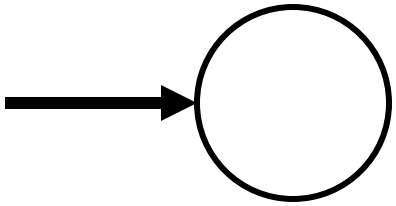
- Emission



- Reflection

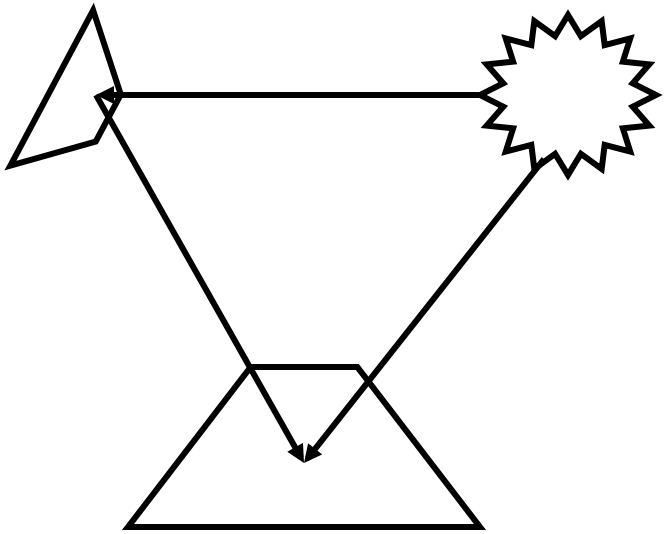


- Absorption



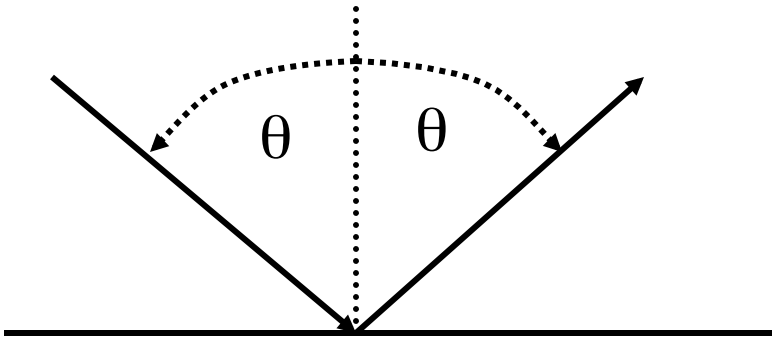
Lighting is a Global Problem

- That is, if you consider any point in the environment, it receives light from all around

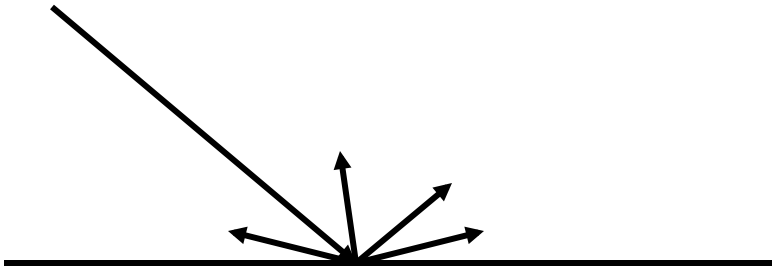


Surfaces are Rarely Mirrors

- Specular surface



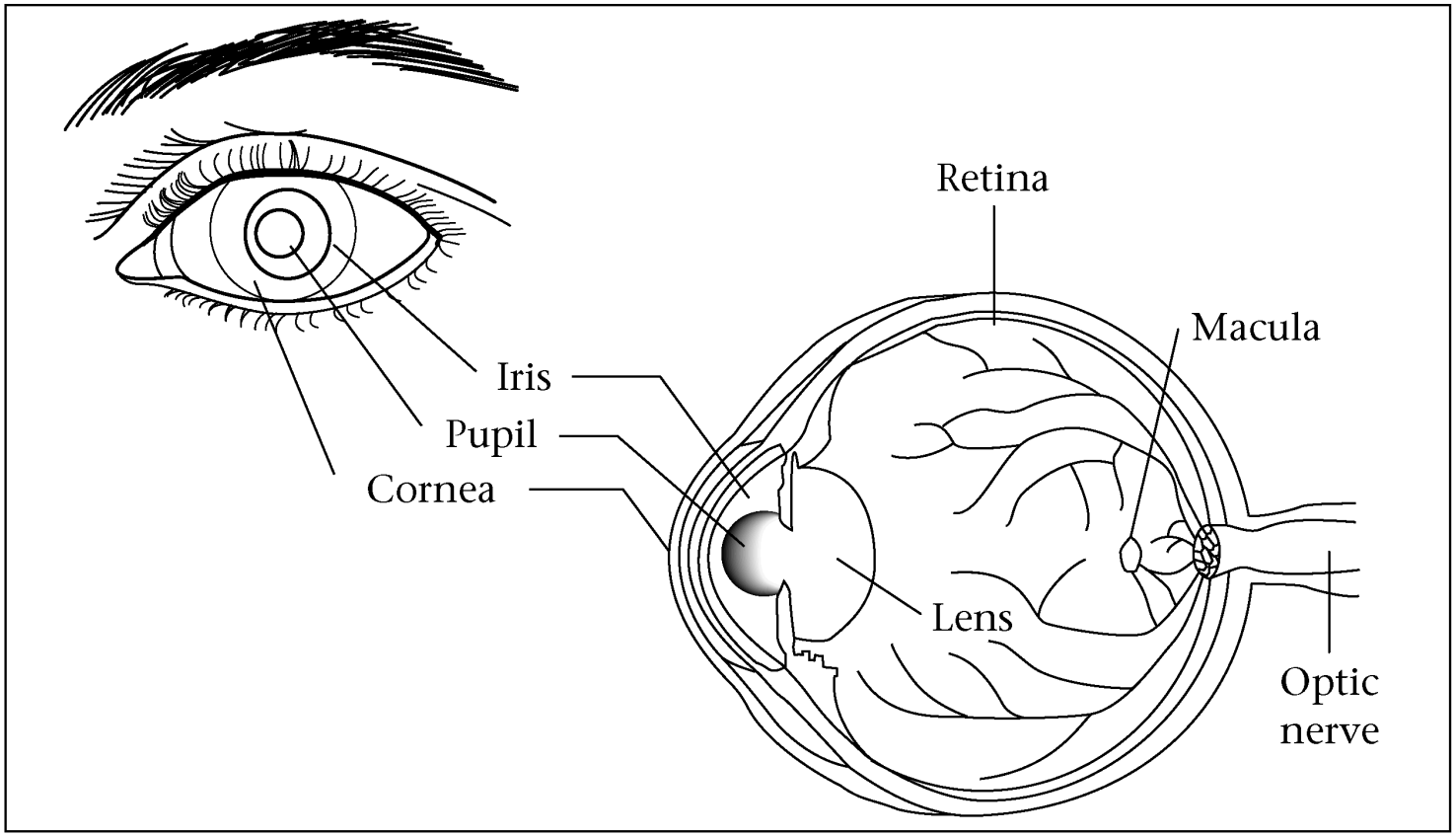
- Diffuse Surface



Some Simplifying Assumptions

- Wavelength independence
  - No fluorescence
- Time invariance
  - No phosphorescence
- Light transport in a vacuum
  - No participating media
- Objects are isotropic
  - Reflectance characteristics are constant over the surface

Photometry - How do we see light?



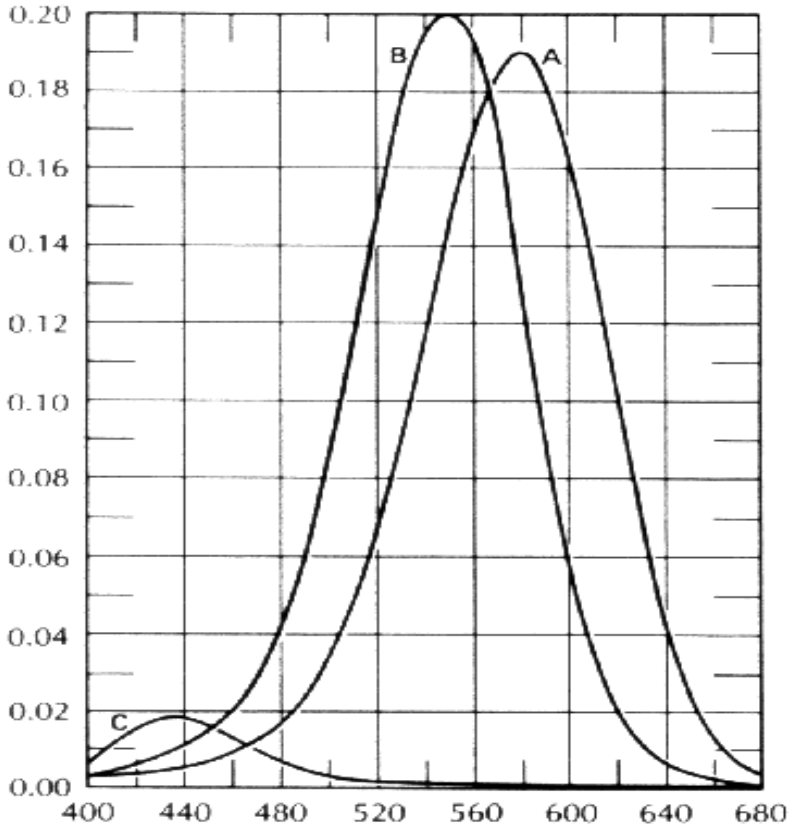
Physiology of Eye Response

- 6 million cones in the fovea
  - cones sense red green or blue light
  - colour perception region is very small
- 120 million rods over the whole eye
  - peripheral vision
  - motion sensitive

Colour Response

Cones

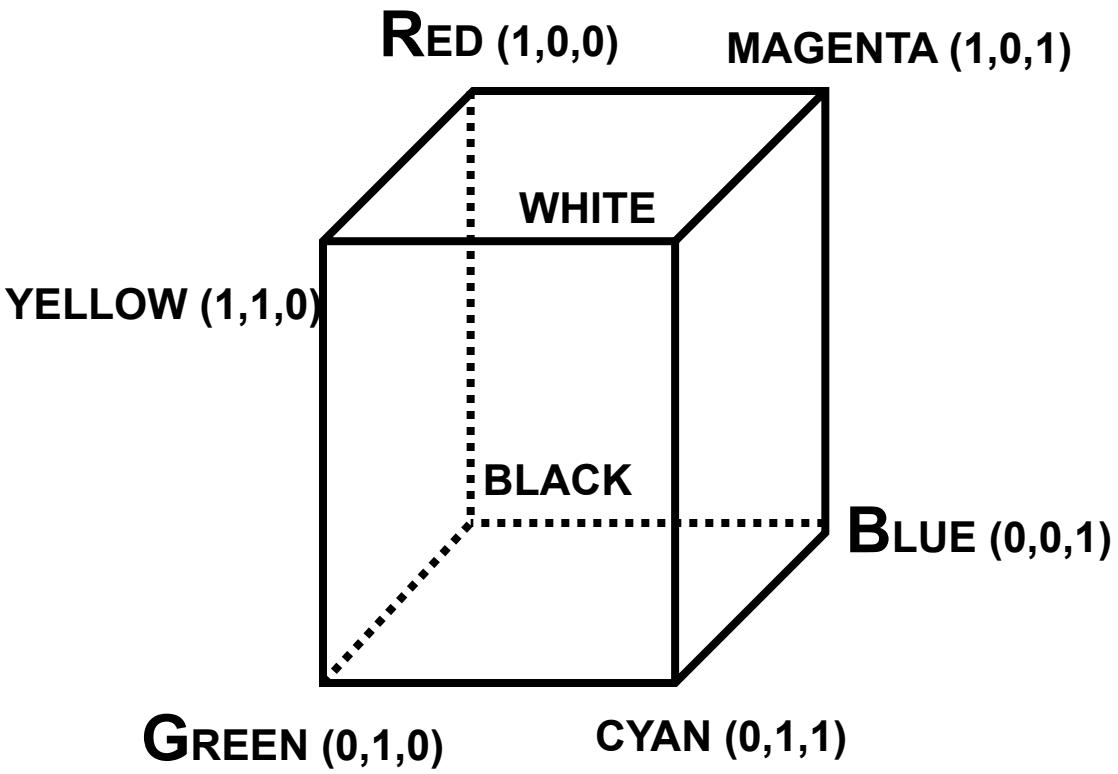
- A = “Red”
- B = “Green”
- C = “Blue”

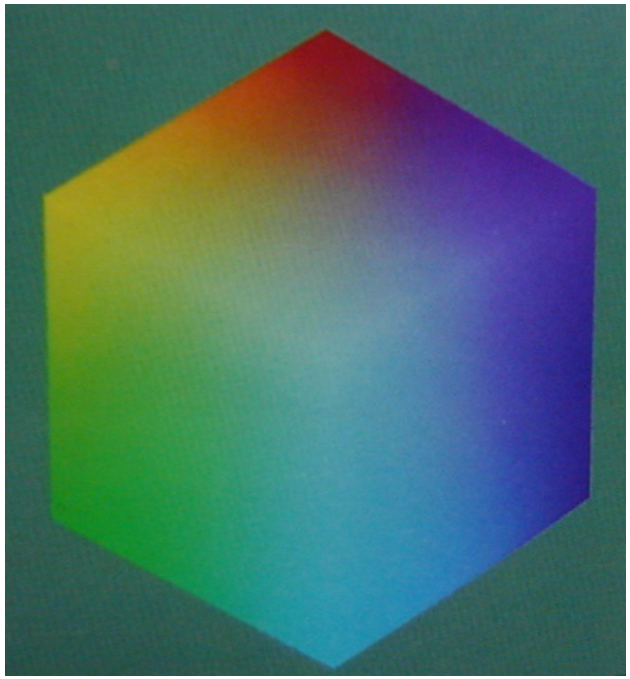


Assumption for Real-Time Graphics

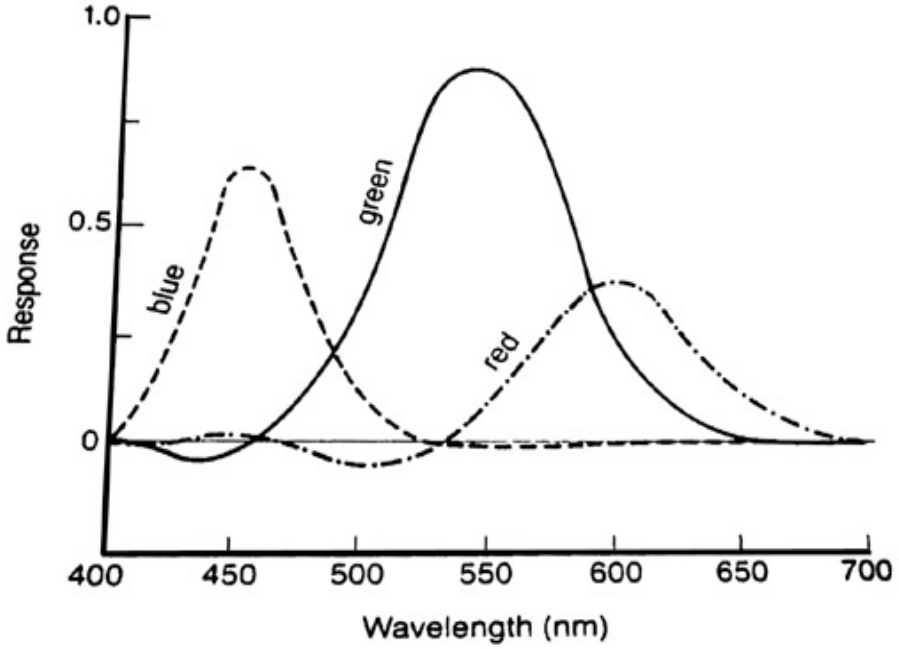
- Ignore “real” spectral distributions
- Instead calculate at three wavelengths, Red, Green and Blue that display devices provide
- Obviously this is a gross approximation

RGB Colour Model





Colour Matching

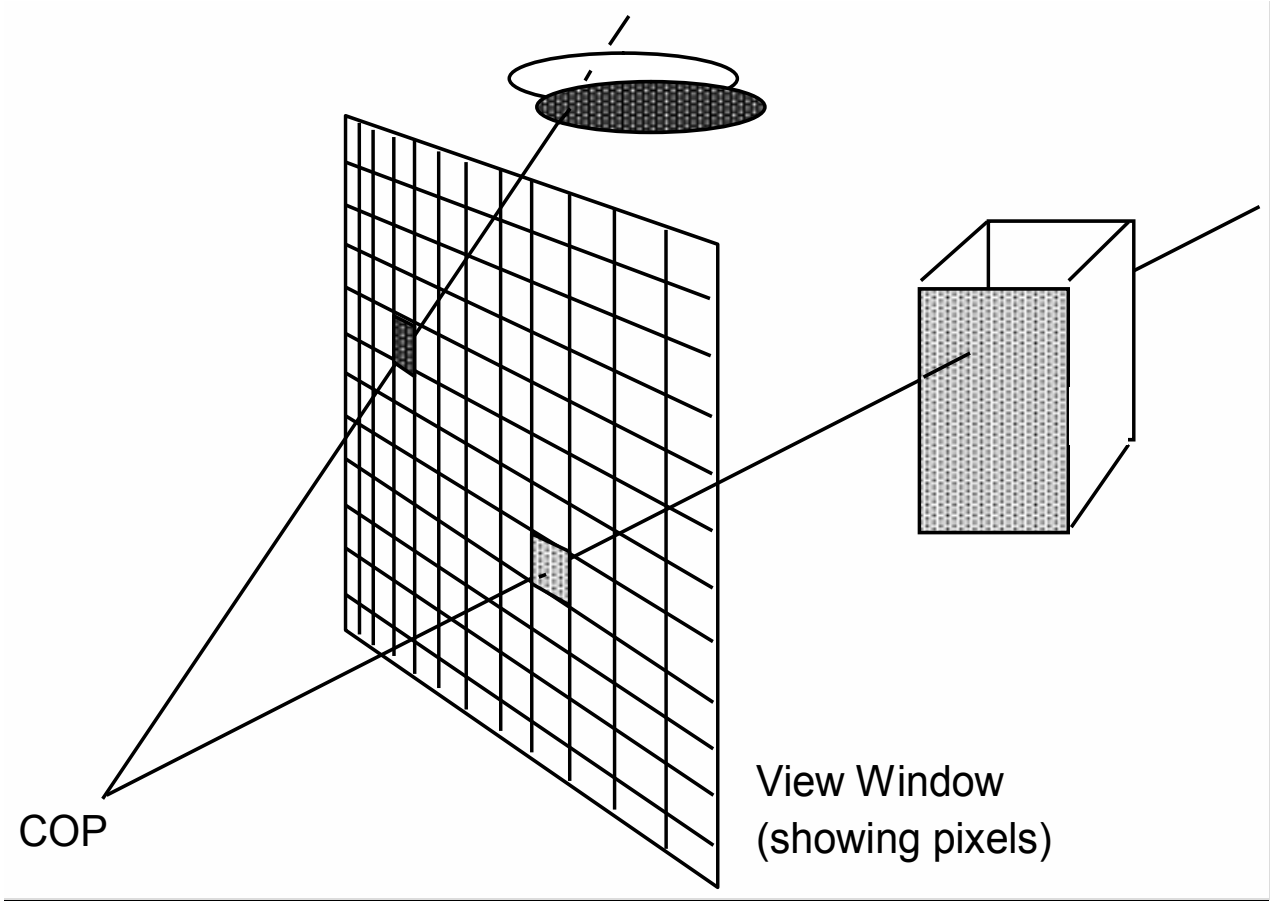


How much R,G,B do you need to make a particular “pure” colour?

Outline

- About the Course
- Anatomy of an Illusion
  - Environment
  - Light transport and interaction
  - Reception at the eye
- The Painter's Method
  - Ray-casting
  - Approximations

Painting Through a Window



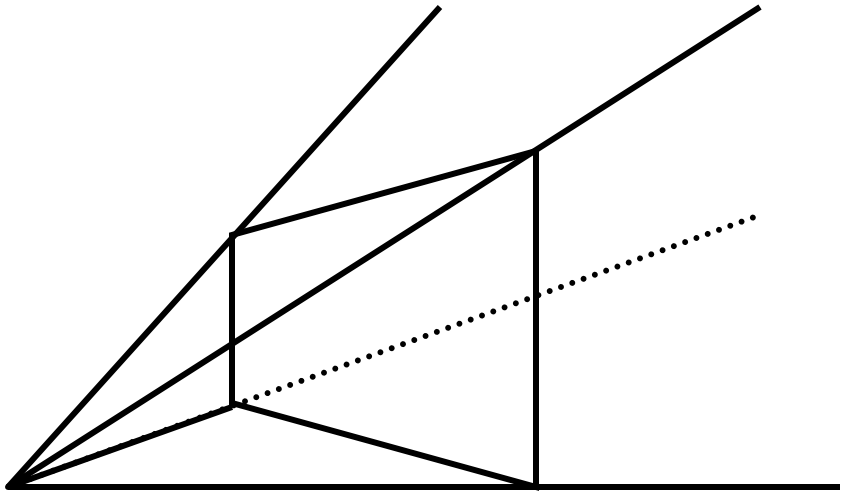
COP = Centre of Projection

Major Concepts of Graphics

- Separation of Scene Specification, Viewing and Rendering
  - Scene is modelled independent of any view
  - Views are unconstrained
  - There are many possible rendering methods given a scene and a view

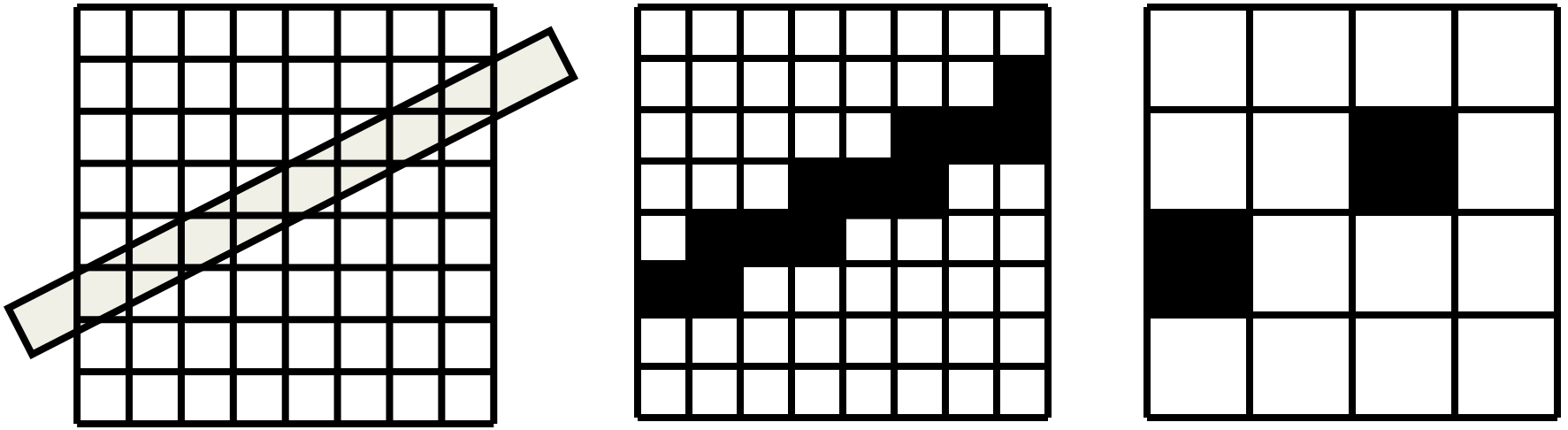
Major Concepts of Graphics

- View volume
  - The extent of the pixels on the screen and the COP define a pyramid
  - *Clipping* is the process of removing anything from the scene that is not in the view volume



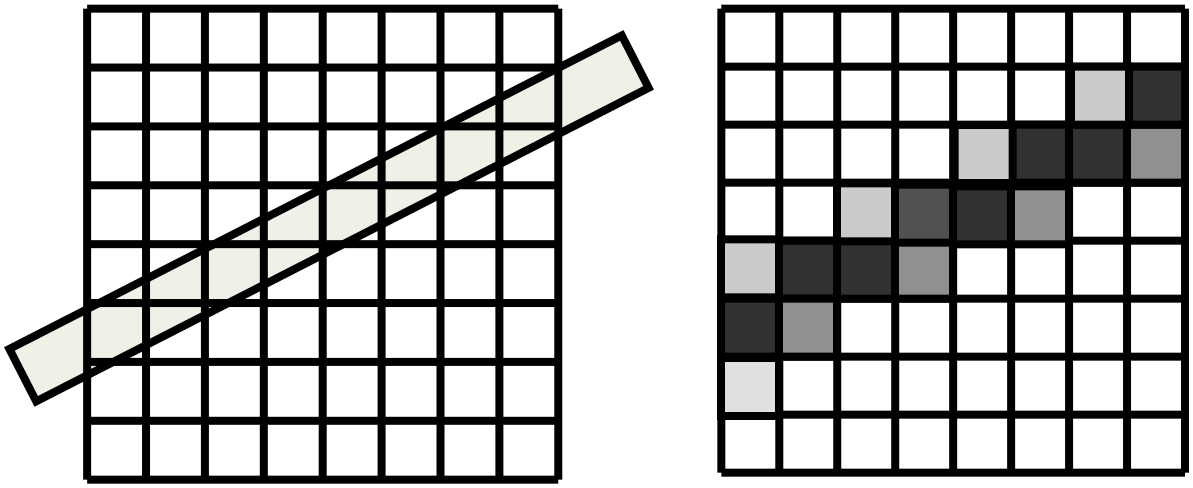
Major Concepts of Graphics

- Aliasing
  - Pixels are square and only *sample* the actual light



Combating Aliasing

- Shade pixels according to proportion of object that overlaps

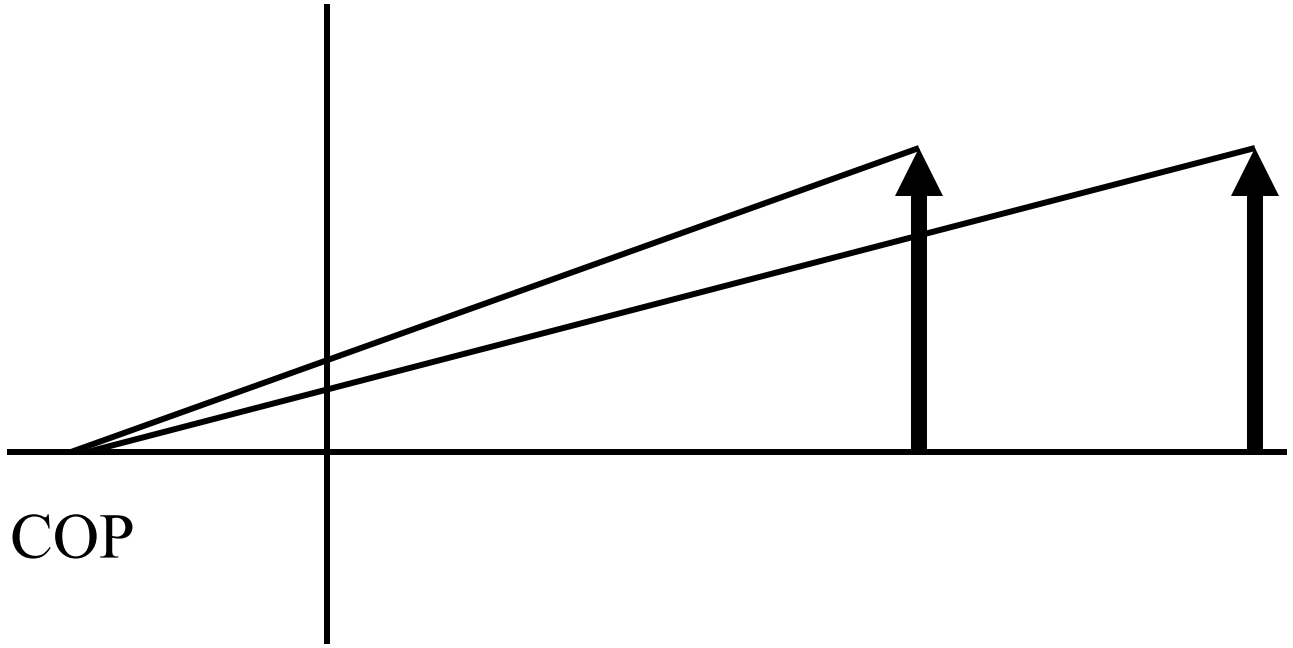


Combating Aliasing

- Send several rays through each pixel
  - Stochastic sample
  - Regular sample (full-screen anti-aliasing)
- Stochastic sample is “correct” since it removes regularity
- But only regular sample is easy with the rendering pipeline

Major Concepts of Graphics

- Perspective Projection
  - Image size depends on distance



Major Concepts of Graphics

- Lighting
  - Ray-casting is the simple part
  - Determining the colour of the pixel is hard for all the reasons described earlier
  - Theoretically we have to calculate all incoming light
  - In practice we will initially consider only *local illumination* - light received directly from light sources

Summary

- Taken a brief look at the general problem of doing visual simulation
- Reviewed the limits of human response
- Given an overview of the simulation process and the concepts of
  - Scene, view, rendering
  - Aliasing
  - Projection
  - Lighting

Future Work

- To Develop
  - Mathematics of scene description
  - Geometric descriptions
  - Lighting models
  - Move from ray-casting to forward projection
  - Stages in the graphics pipeline