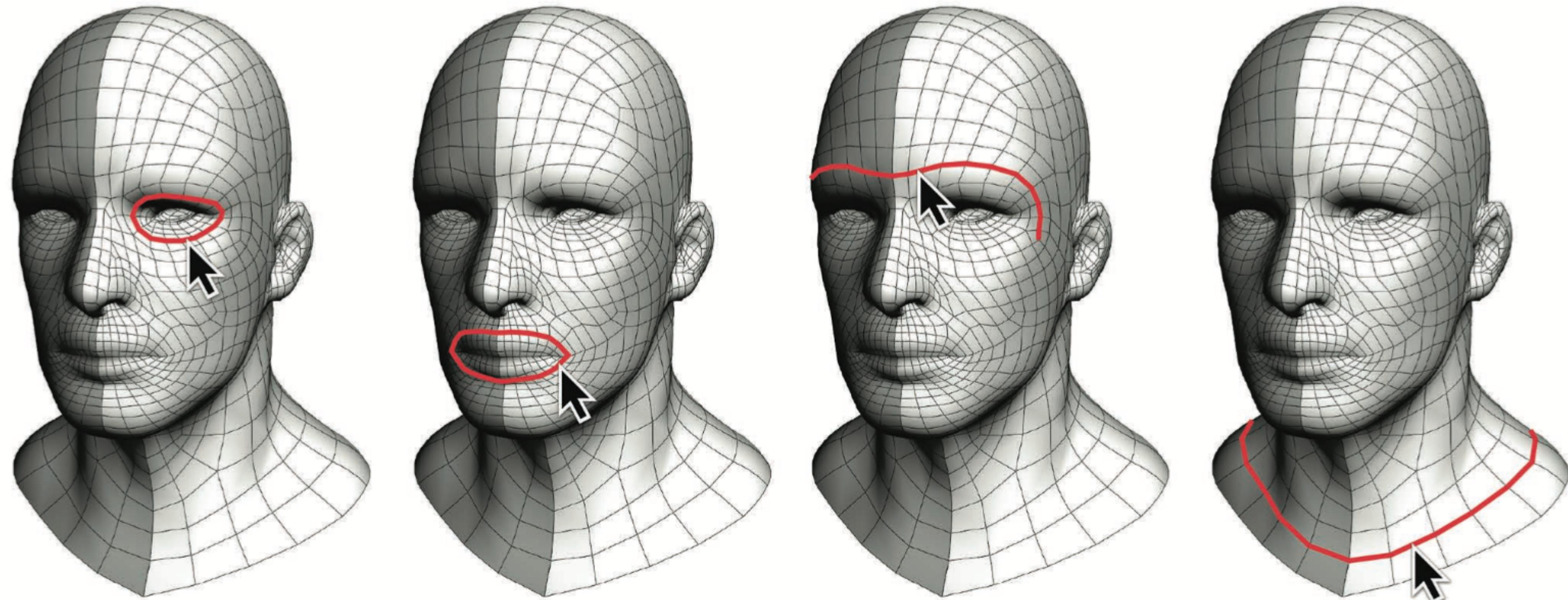


# Introduction to Computer Graphics

# What is Computer Graphics?

- In a broad sense is the use of a computer to create and manipulate images
  - It involves a combination of hardware (input, processing, output) and software
  - It can be 2D or 3D
  - It is used in most electronic devices

# Graphic Areas



## Modeling

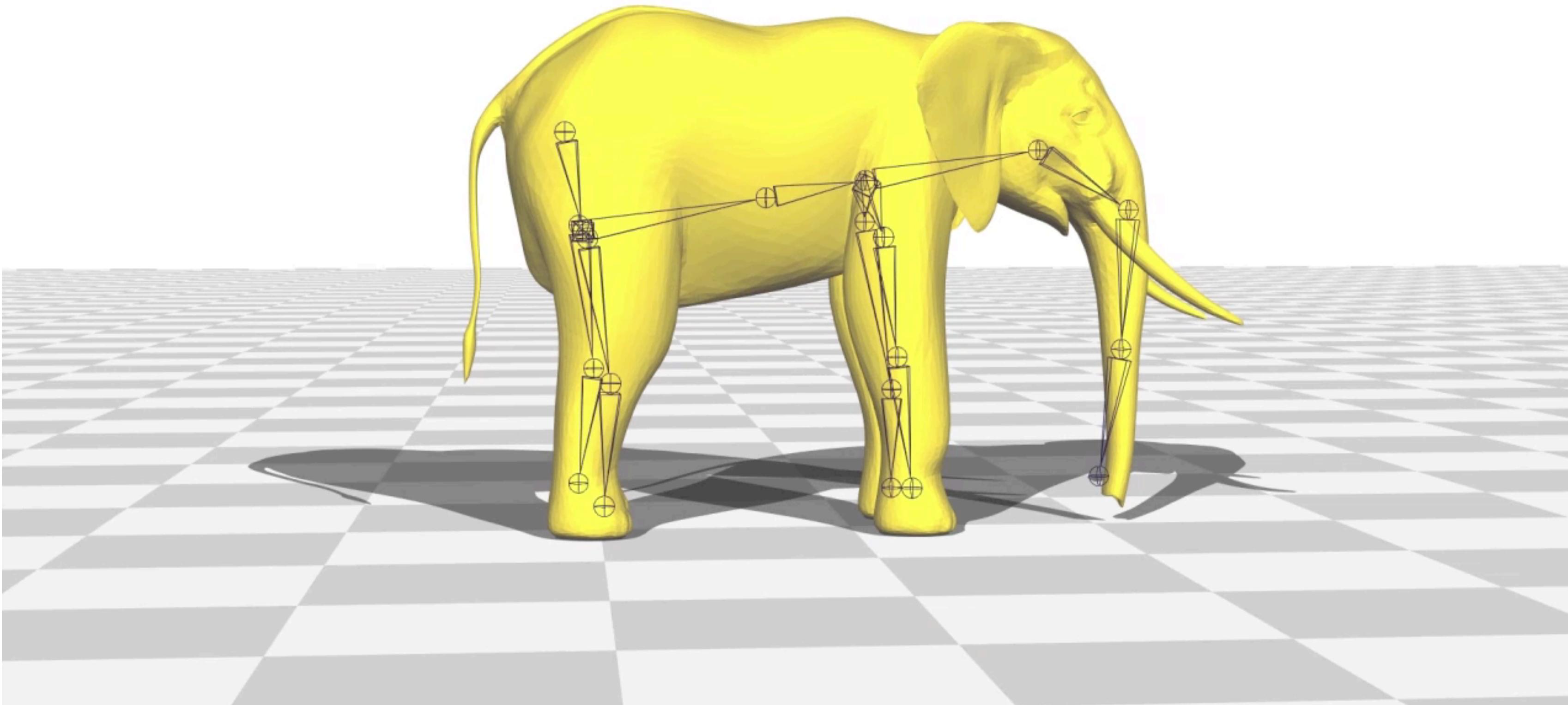
<https://www.youtube.com/watch?v=Udno6EA5lXY>

# Graphic Areas



## Rendering

# Graphic Areas



## Animation

# Graphic Areas



Copyright: Andrew Guyton

## User Interaction

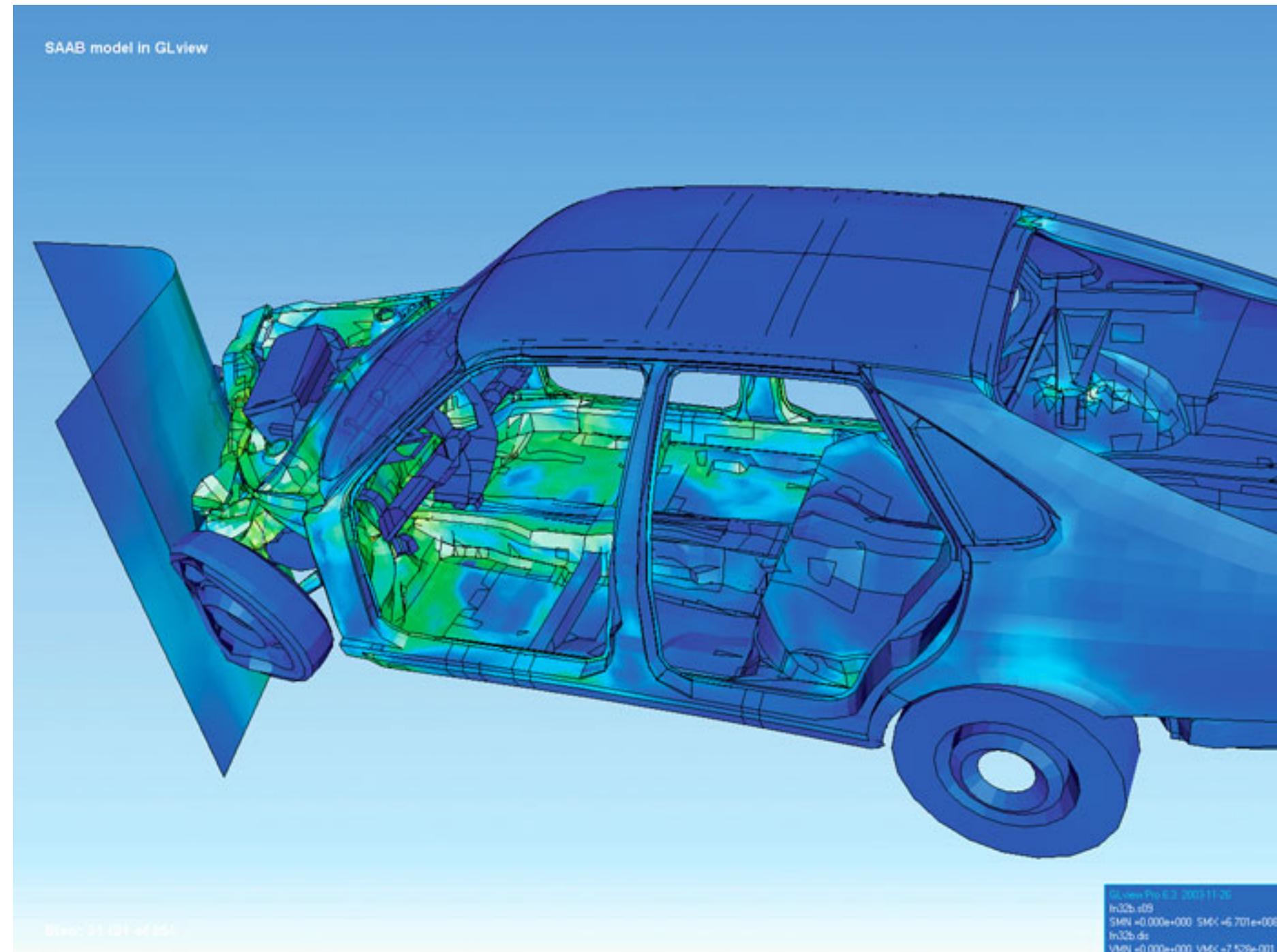
# Graphic Areas



Copyright: Maurizio Pesce

## Virtual Reality

# Graphic Areas



## Visualization

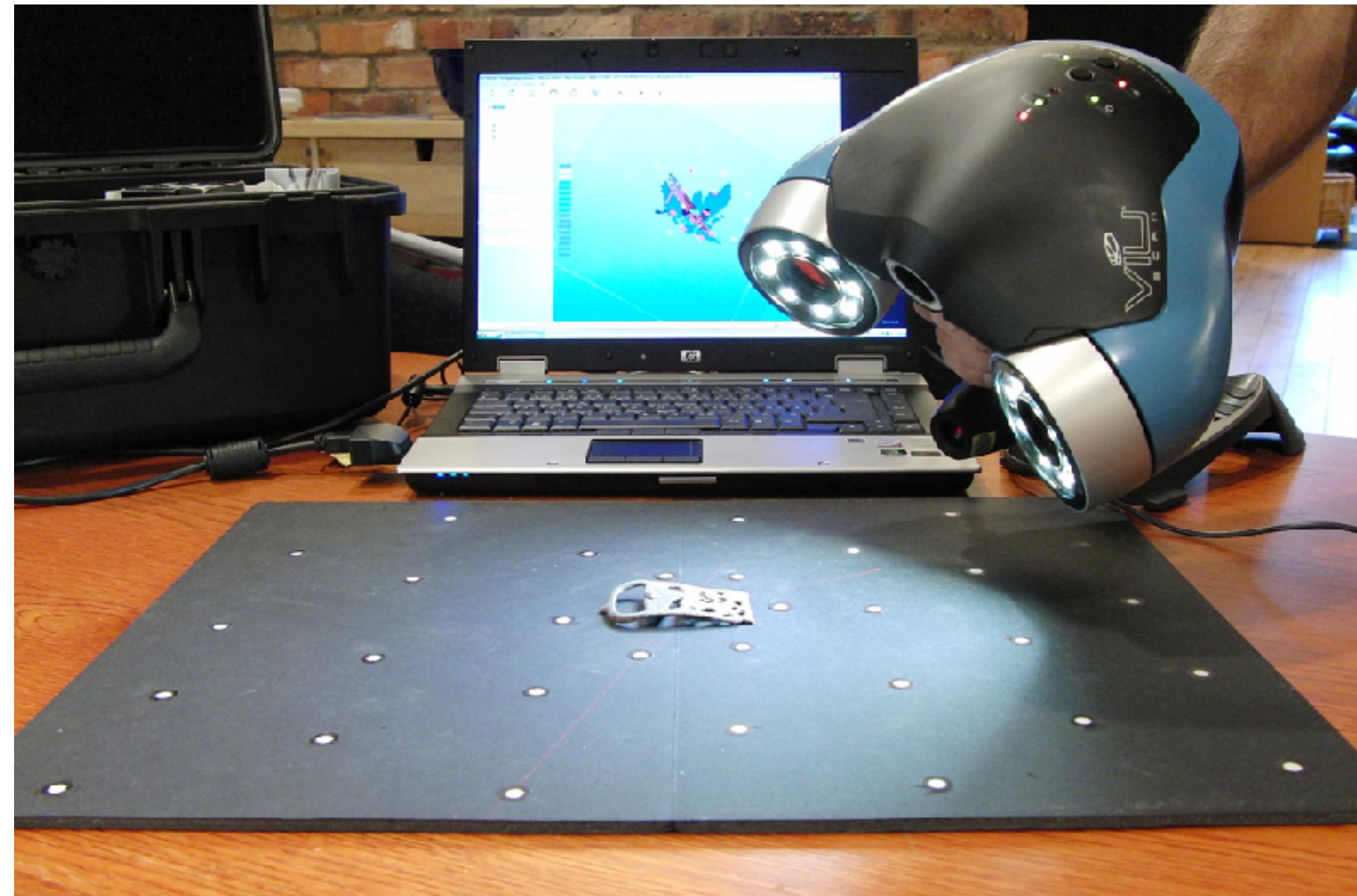
# Graphic Areas



By IkamusumeFan - Own work, CC BY-SA 4.0, <https://commons.wikimedia.org/w/index.php?curid=41790217>

## Image Processing

# Graphic Areas



By Creative Tools from Halmstad, Sweden - CreativeTools.se - VIUscan - Laser-scanned - ZPrinter - 3D printed -  
Viking Belt Buckle 24, CC BY 2.0, <https://commons.wikimedia.org/w/index.php?curid=12419129>

<http://www.agisoft.com>

## Geometry Acquisition



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# Applications

## Video Games



Copyright: Nintendo

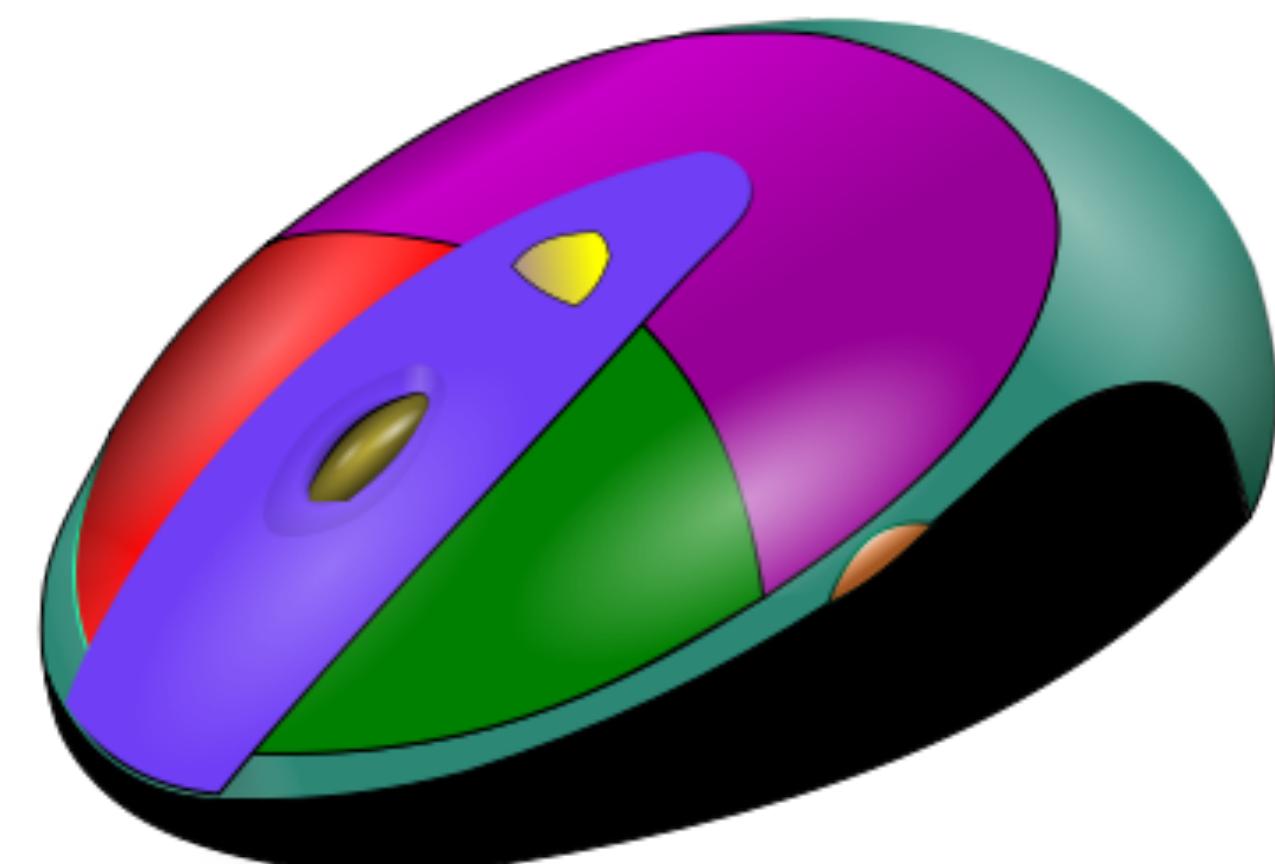
## Cartoons/Visual Effects/Films



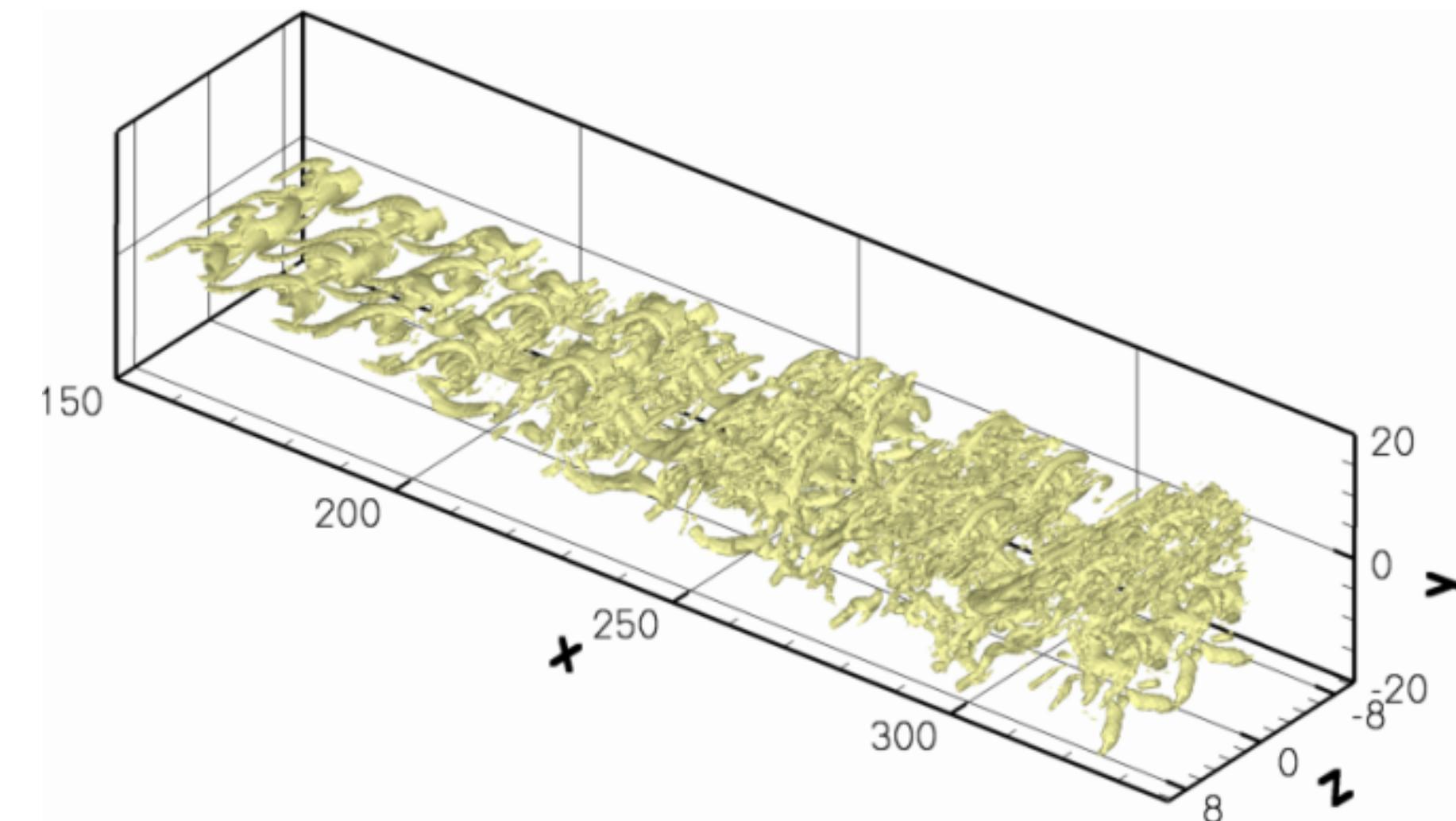
Copyright: Blender Foundation

# Applications

CAD/CAM



Simulation



By Andreas Babucke - self made with EAS3, original upload at [http://de.wikipedia.org/wiki/Bild:Lambda2\\_scherschicht.png](http://de.wikipedia.org/wiki/Bild:Lambda2_scherschicht.png), CC BY 3.0 de, <https://commons.wikimedia.org/w/index.php?curid=2999003>

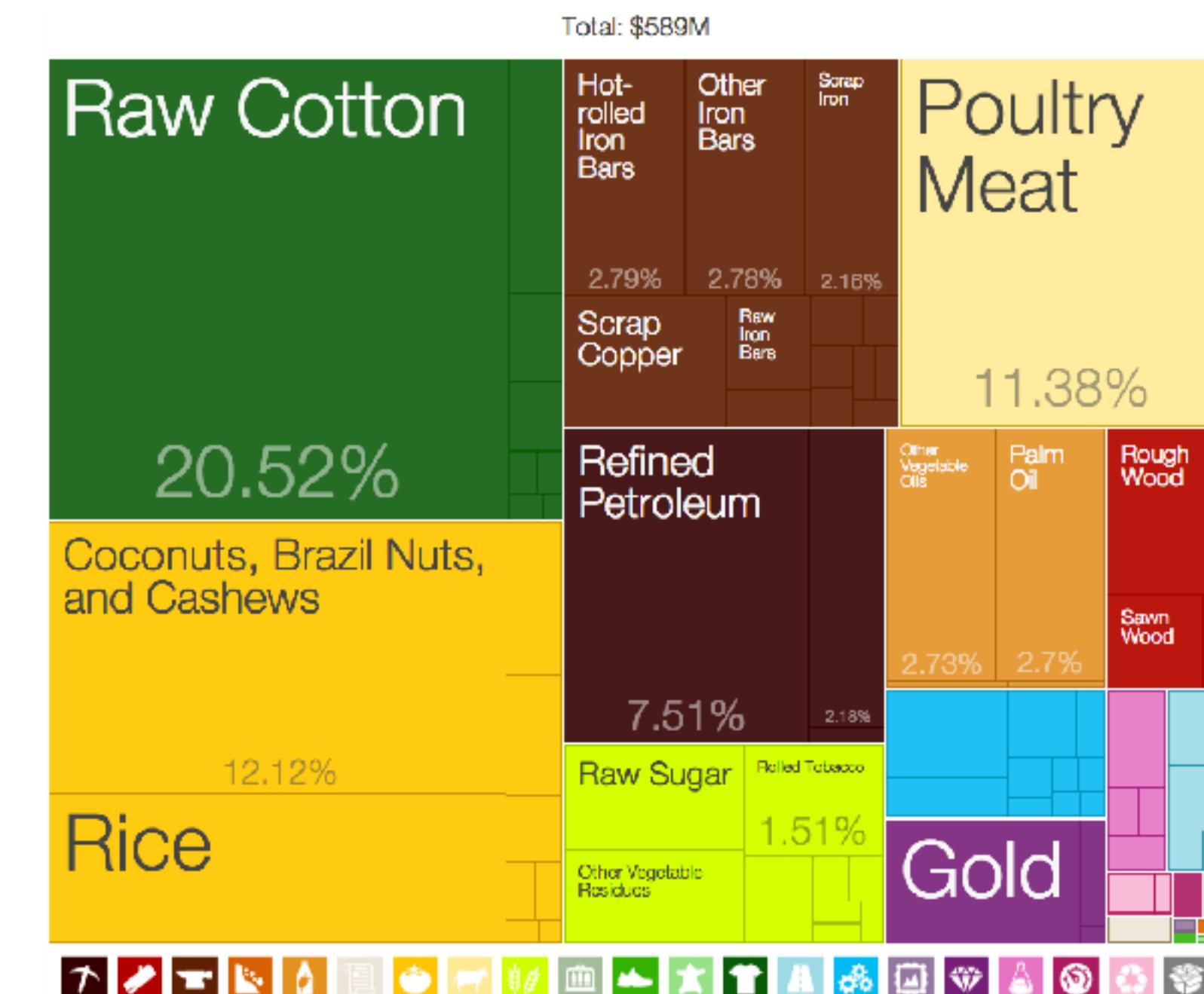
# Applications

## Medical Imaging



By Etan J. Tal - Own work, CC BY 3.0, <https://commons.wikimedia.org/w/index.php?curid=12743250>

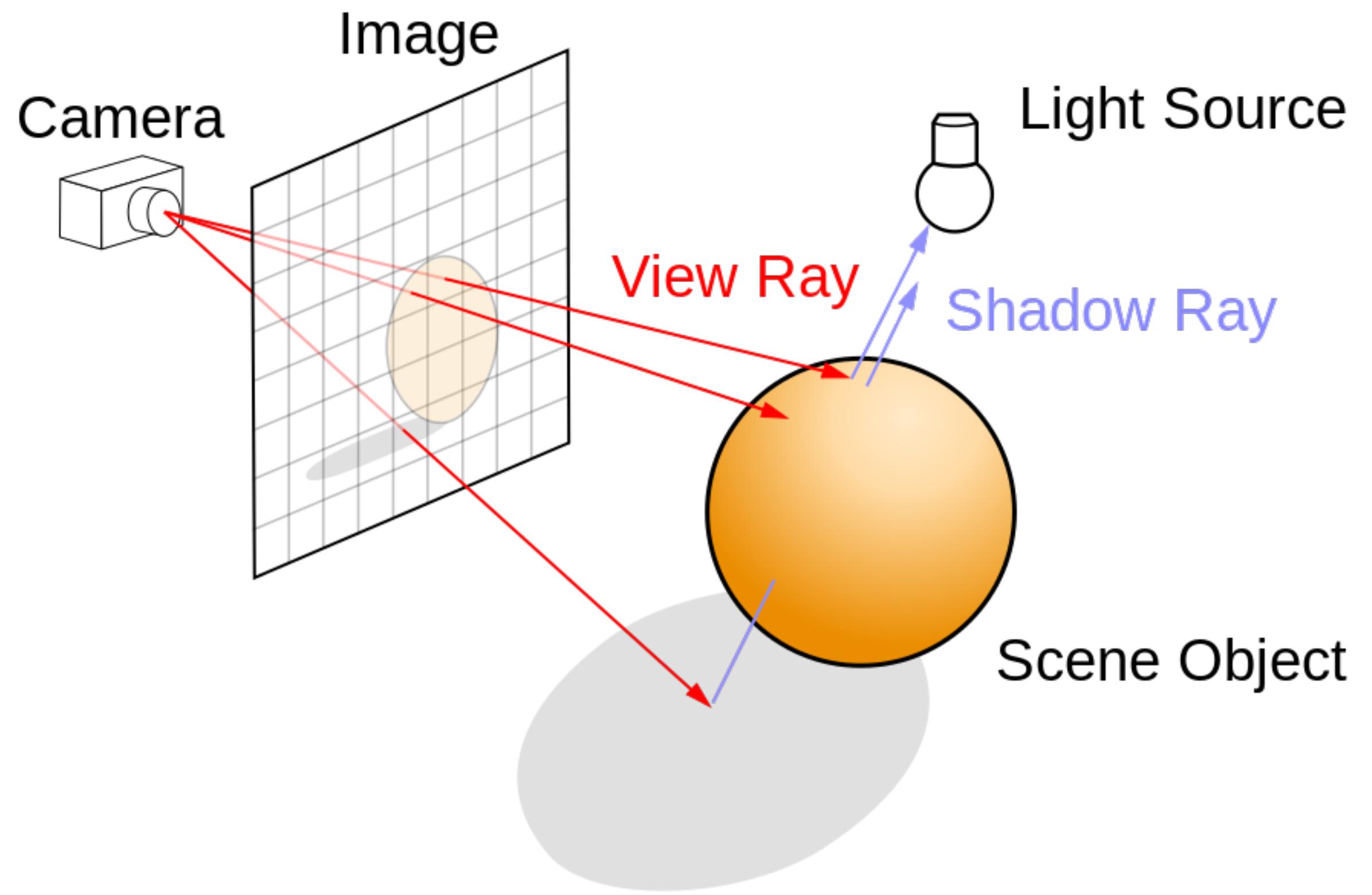
## Information Visualization



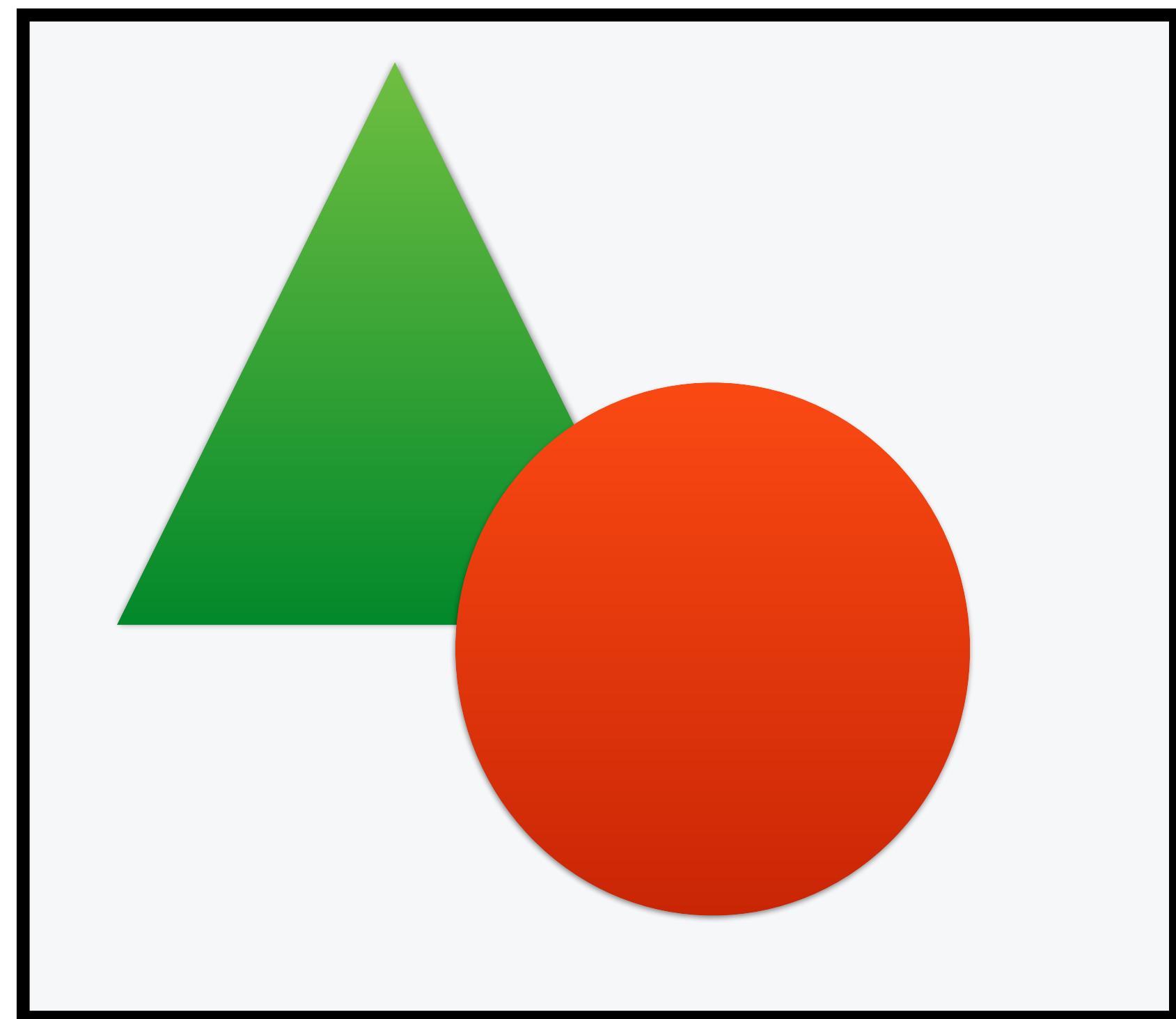
By Mcstol - Own work, CC BY-SA 3.0, <https://commons.wikimedia.org/w/index.php?curid=18553353>

# Two major approaches

## Per-pixel - "Raytracing"

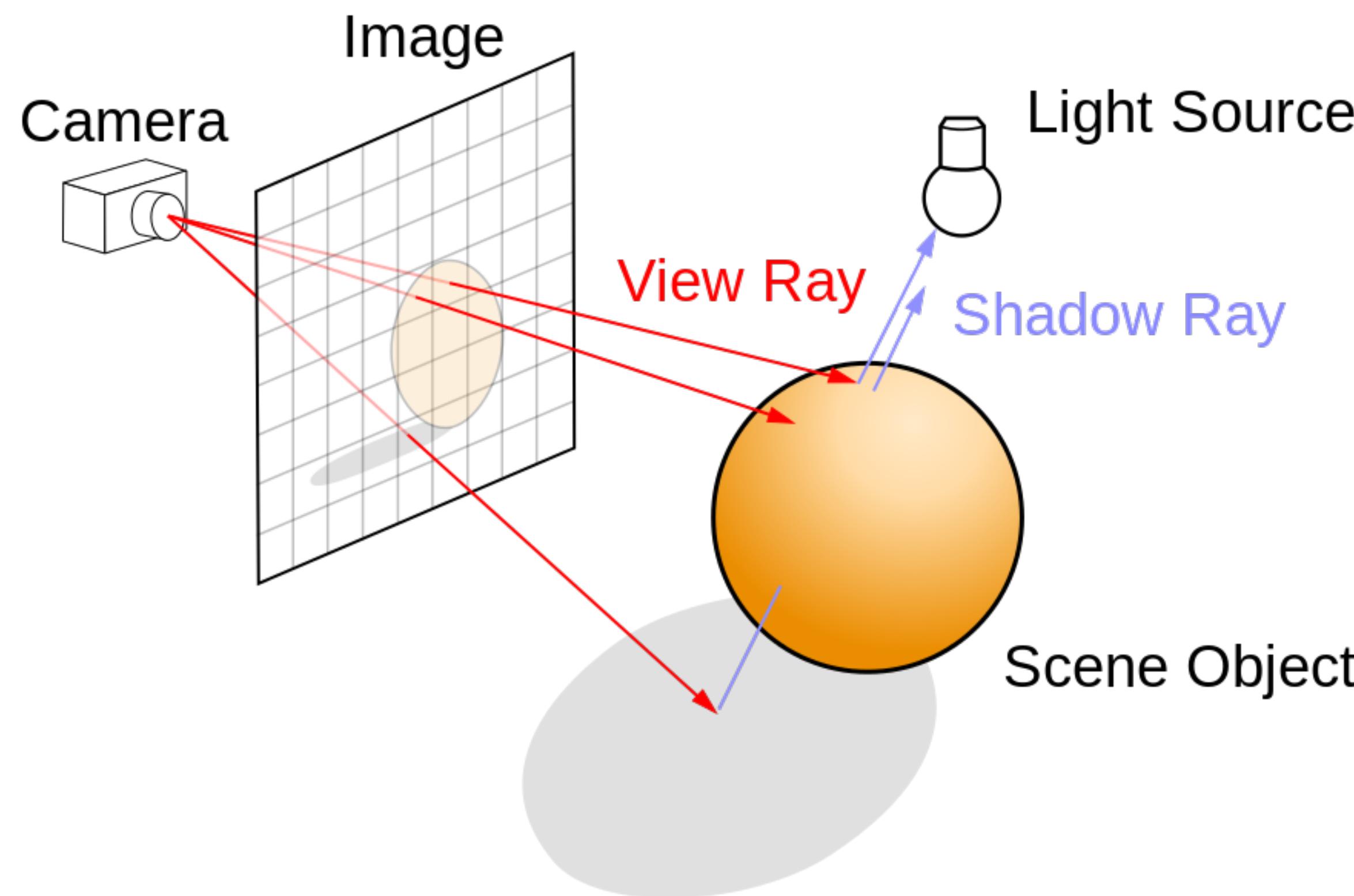


## Per-object - "Rasterization"



By Henrik - Own work, GFDL, <https://commons.wikimedia.org/w/index.php?curid=3869326>

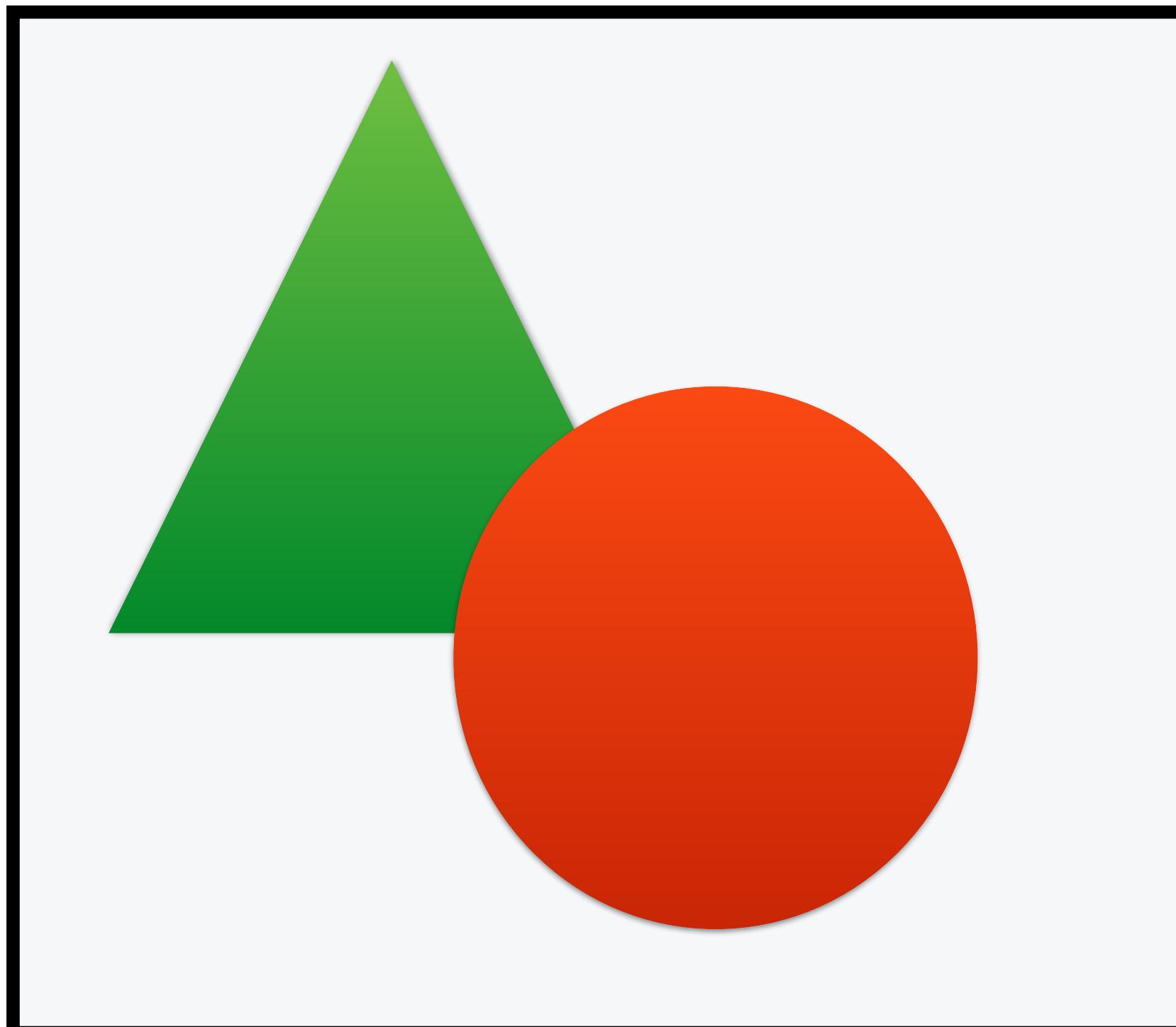
# Per-pixel



- Easy to parallelize but hard to map to hardware
- Expensive!
- It can be extended to model many physical phenomena such as internal scattering, diffraction, reflections, etc.
- Used to obtain high quality images

By Henrik - Own work, GFDL, <https://commons.wikimedia.org/w/index.php?curid=3869326>

# Per-object



- Easy to map to hardware
- While it cannot model directly complex effects, we can approximate them
- Used in interactive applications (mostly)

# Course Goals

- Study the fundamental mathematical concepts used in image synthesis algorithms
- Implement a rendering system based on ray tracing
- Implement a rendering system based on object-order rendering (rasterization)
- Apply these techniques in a final coding project

# Prerequisites

- Linear Algebra
- We will quickly review the concepts that you need, if you are not familiar with basis, points, vectors, matrices and linear systems, please review it on the textbook (Chapter 2, 5)
- C++
  - We will review the basic concepts of C++, comparing them with Java. Keep this reference at hand <http://www.cppreference.com>
  - Why C++?



# Organization

- Communication through the course repository/website:  
<https://github.com/teseoch/CG-Spring-2022>
- Brightspace
- Weekly lecture
- Microsoft Teams



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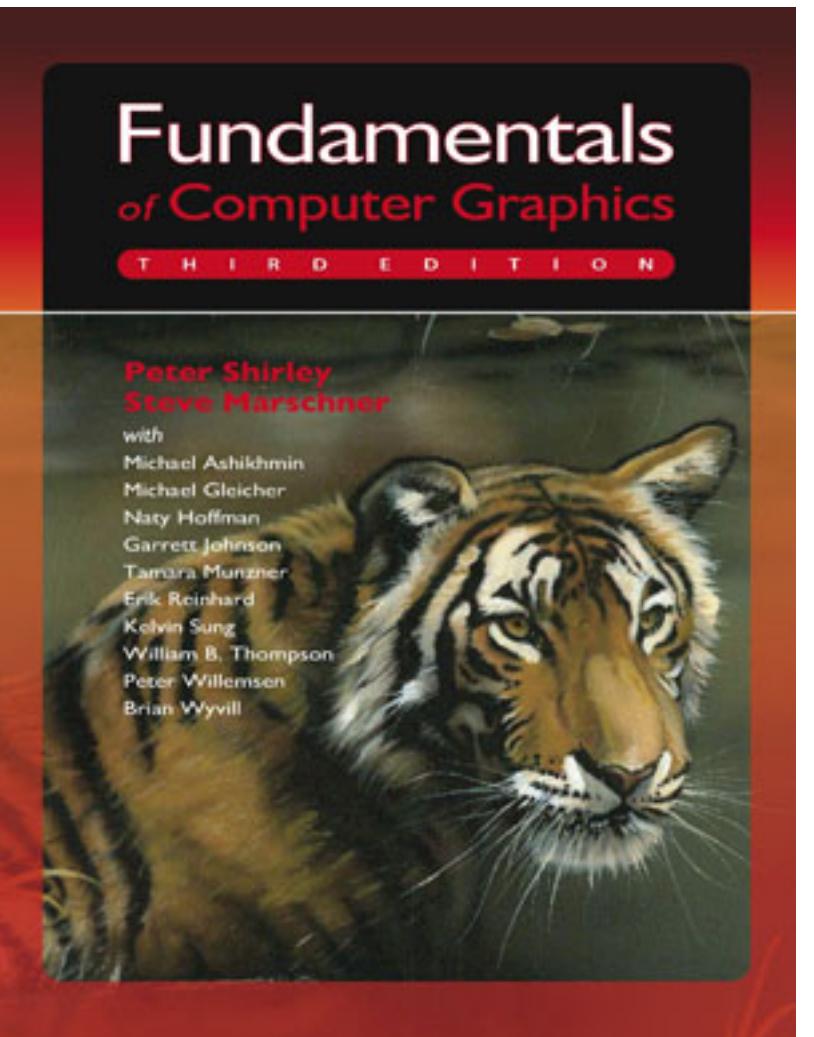
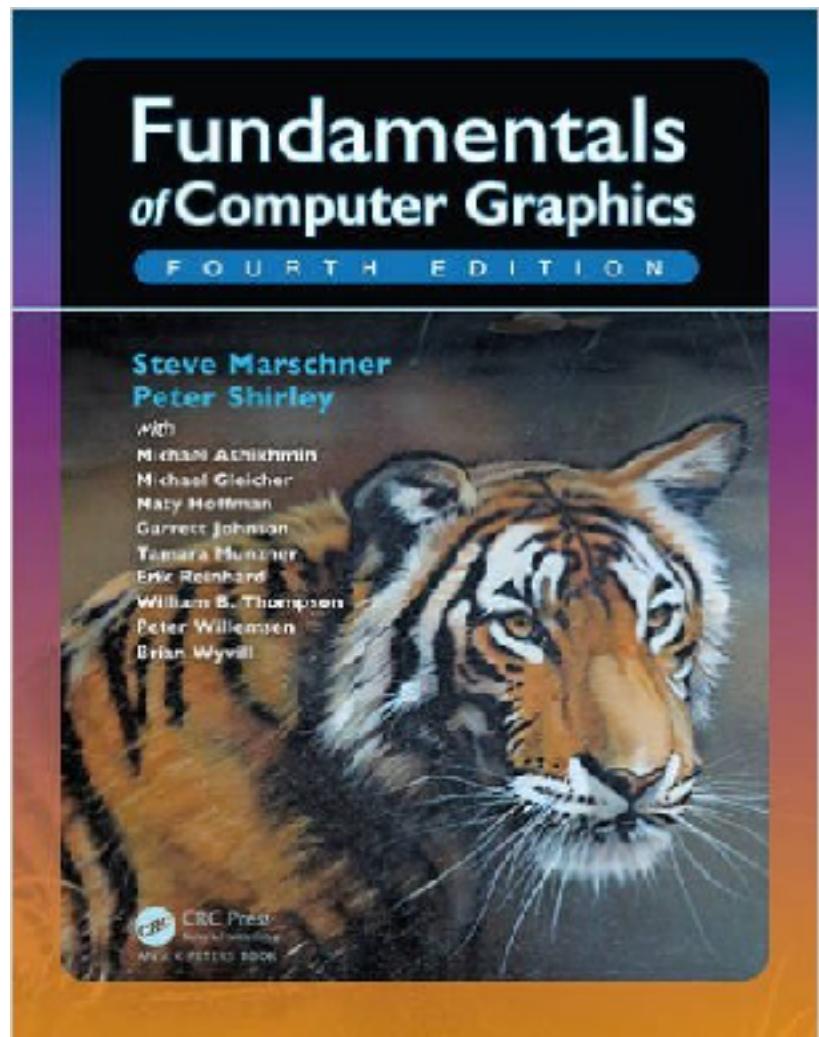
# Lectures

- I will upload the slides on the website before the class, so that you can directly annotate them
- For every class, I will always add references in the end to the textbook and/or external resources
- At the end of every lecture, I will quickly introduce the topic of the next lecture and give you pointers — you are encouraged to take a look at the material **before** I present it in class

# Lectures

- Please interrupt me at any time to ask questions

# Material



<https://www.wikipedia.org>

**Fundamentals of Computer Graphics, Fourth Edition**  
4th Edition by Steve Marschner, Peter Shirley

# Policy

- You are encouraged to consult with your classmates/friends but collaboration in the assignments is **not allowed**
- You are **not allowed** to copy code online
- You are **not allowed** to use external libraries (except those provided in the assignments)
- We will use plagiarism tools to validate all homework

# Basic Math

- Sets
- Functions/Maps
- Intervals
- Logarithm
- Solving Quadratic Equations
- Trigonometry
- Basic Linear Algebra

If you are not familiar with some of these topics,  
refresh them before the next class.