EDAN30
Photorealistic
Computer Graphics

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Lund university

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Introduction to Photorealistic Graphics

- Lund University Graphics Group
- What is Photorealistic Graphics?
- Course overview
- Background

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Graphics Group

- Lund University Graphics Group
  - Magnus Andersson - Teaching Assistant for PG
  - Rasmus Barringer - Teaching Assistant for PG
  - Michael Doggett - Lecturer for PG
  - Per Ganestam
  - Björn Johnsson
  - Carl-Johan Gribel
  - Tomas Akenine-Möller - Professor/Intel

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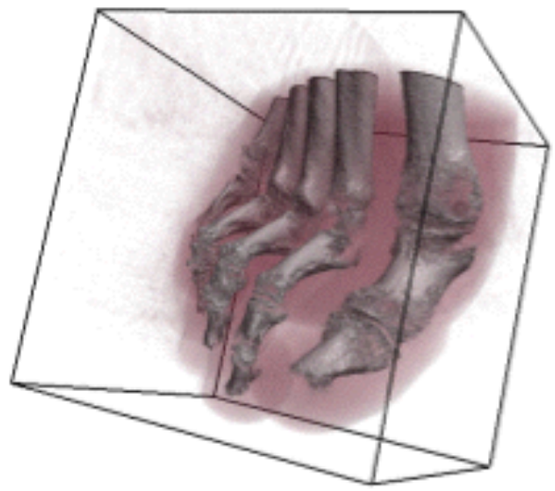
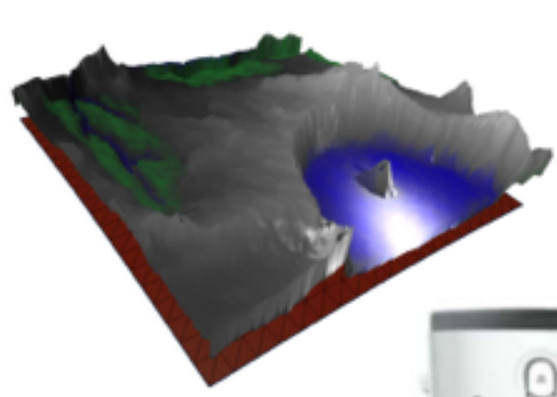
My Background



- Designing Computer Hardware for 3D Computer Graphics
- Ph.D., UNSW, Sydney, Australia
  - Volume Rendering HW
- **1.5 years at Special Effects company**
  - **TV & Film**
- Post doc - University of Tübingen
- designing GPUs - ATI (AMD)
- Docent



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Photorealistic Graphics Applications

- Film
- TV, advertising
- Design previews
- Architecture
- Products

www.digitaldomain.com

http://www.youtube.com/user/ILMVisualFX

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How to make an image that looks like a photo?

Bottles-phials2.0 by Vlad Miller http://www.luxrender.net/forum/gallery2.php?g2_itemId=12426

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What makes a photo?

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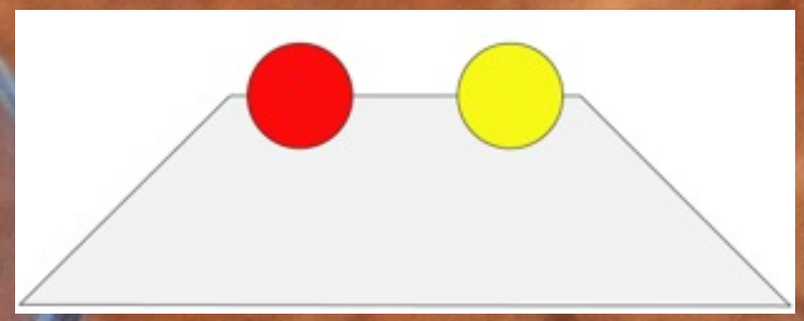
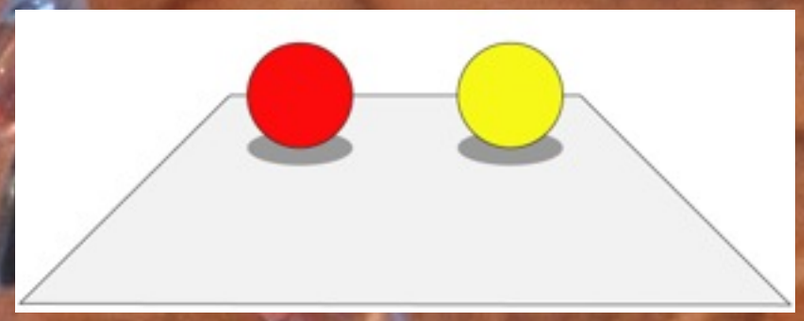
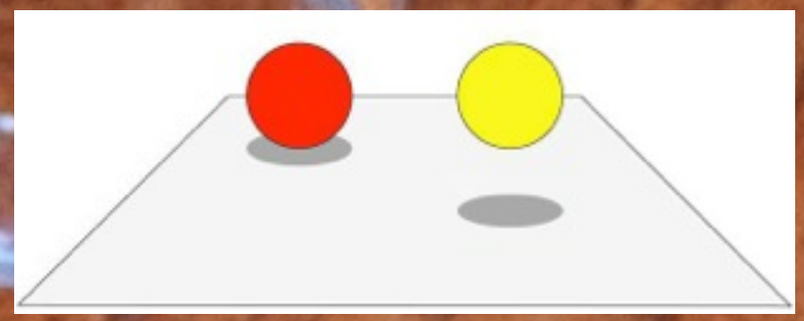
Reflections





Refraction



Caustics

Procedural Wood
Wood can be procedurally computed....

Shadows

Motion Blur

Computer Graphics

- The science of computer graphics is about:
  - Creating images from 3D scene descriptions
  - Try to be photorealistic (usually)
    (or physically realistic)
  - Your job : come up with clever algorithms to render images fast with good quality
    - You can ‘cheat’ physics

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Solve the rendering equation!

$$L(x \rightarrow \Theta) = L_e(x \rightarrow \Theta) + \int_{\Omega_x} f_r(x, \Psi \rightarrow \Theta) L(x \leftarrow \Psi) \cos(N_x, \Psi) d\omega_\Psi$$

- Once you can solve it
  - Or some approximation of it ...
  - you can ...

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HYBRID
luxrender

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EDAN 30
Photorealistic Graphics

- Algorithms and principles for rendering
  - How to sample a 3D scene
  - How light interacts with objects
- Writing your own C++ ray tracer!

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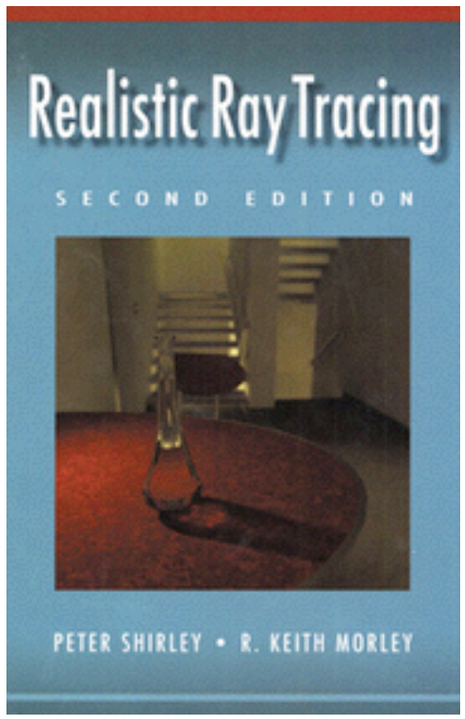
Course contents

- 8 lectures
- 5 seminars, 5 programming assignments
- 1 written exam
- Literature:
  - Textbook : Realistic Ray Tracing, Peter Shirley, R. Keith Morley (2nd edition)
- To pass you must:
  - complete all programming assignments
  - pass exam



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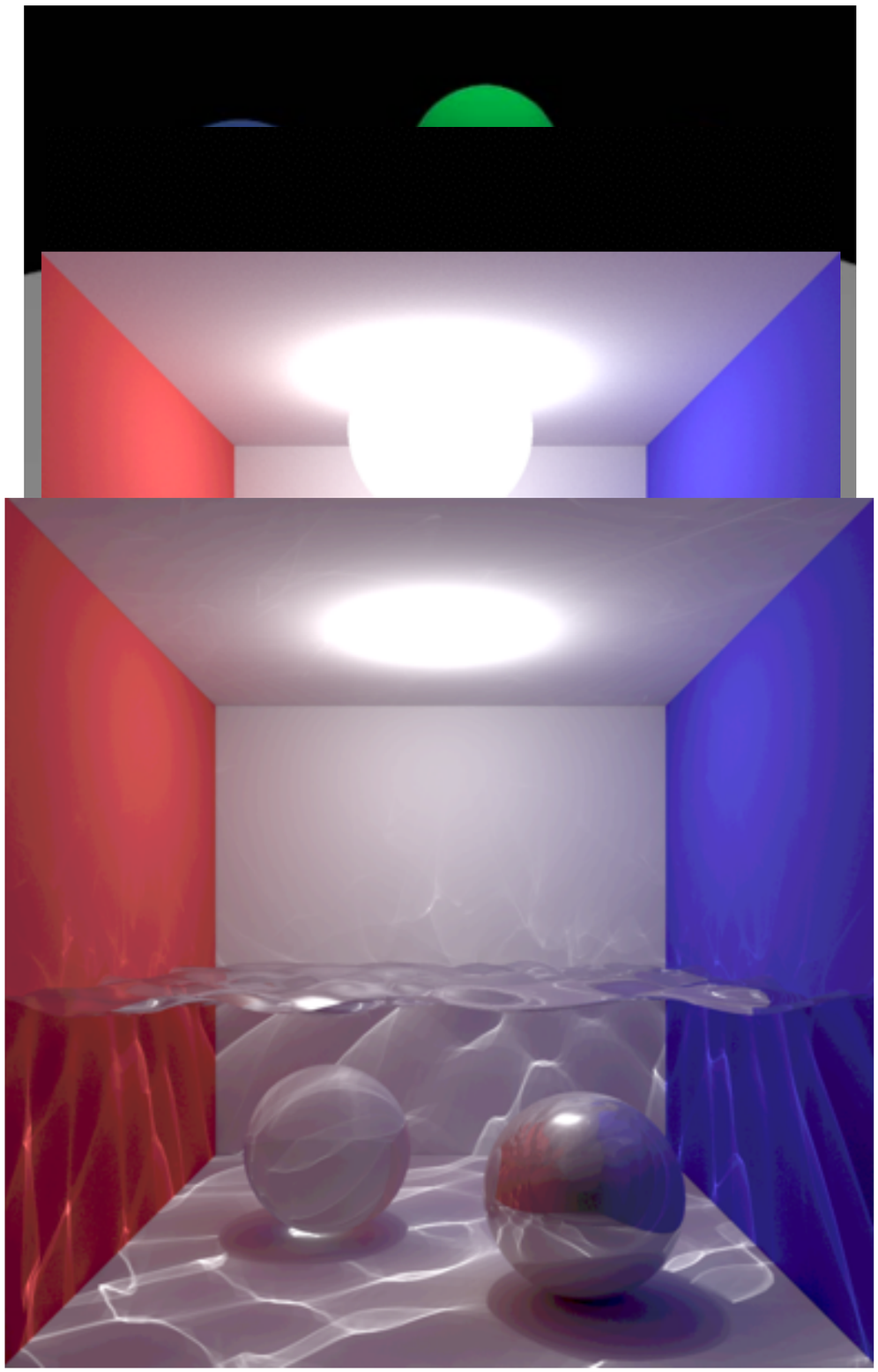
Writing your own ray tracer

- 5 programming assignments
  1. Whitted ray tracer
  2. Acceleration data structure
  3. Diffuse inter-reflection
  4. Progressive Photon Mapping
  5. Elective - Presentation
- C++ (cross-platform)
- Work in pairs
- Show solutions in Uranus lab



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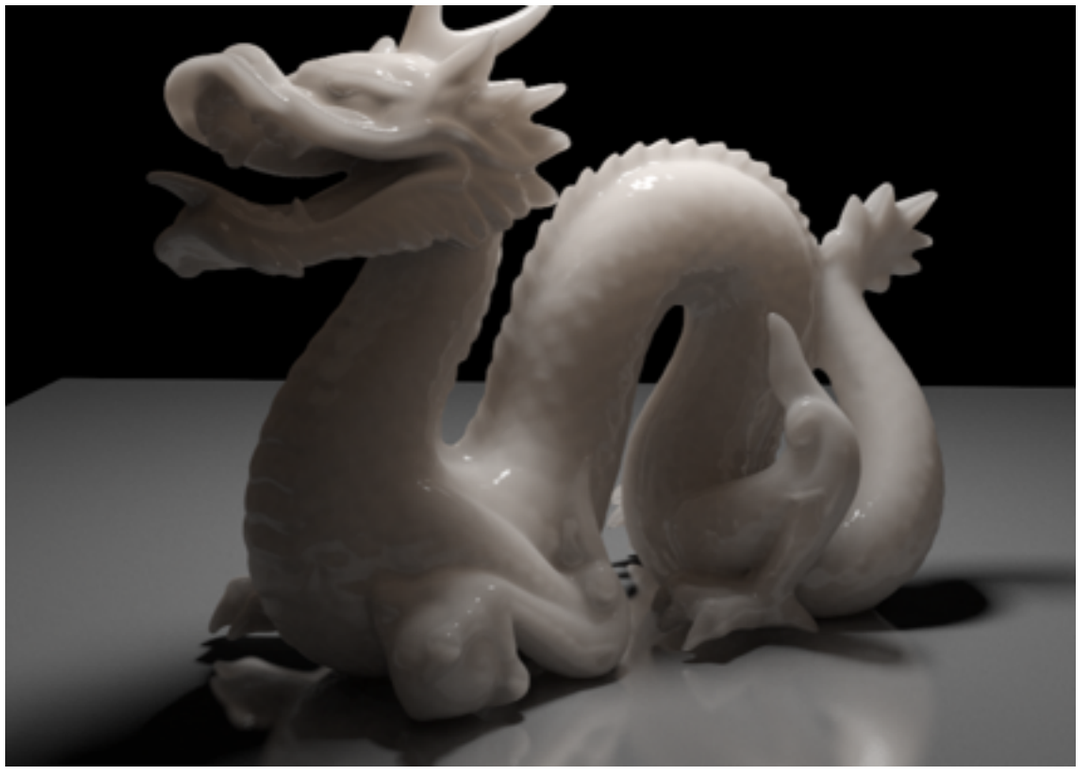
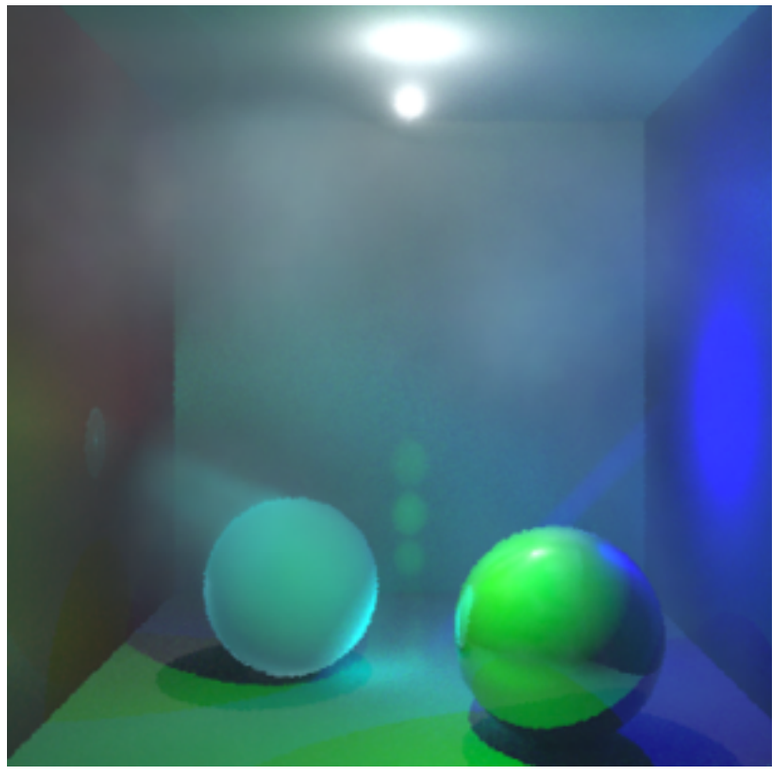
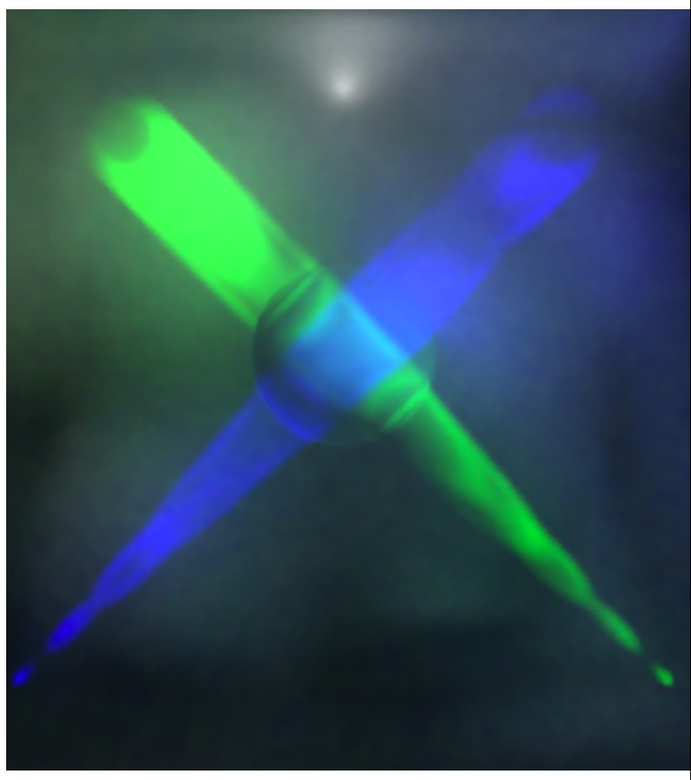
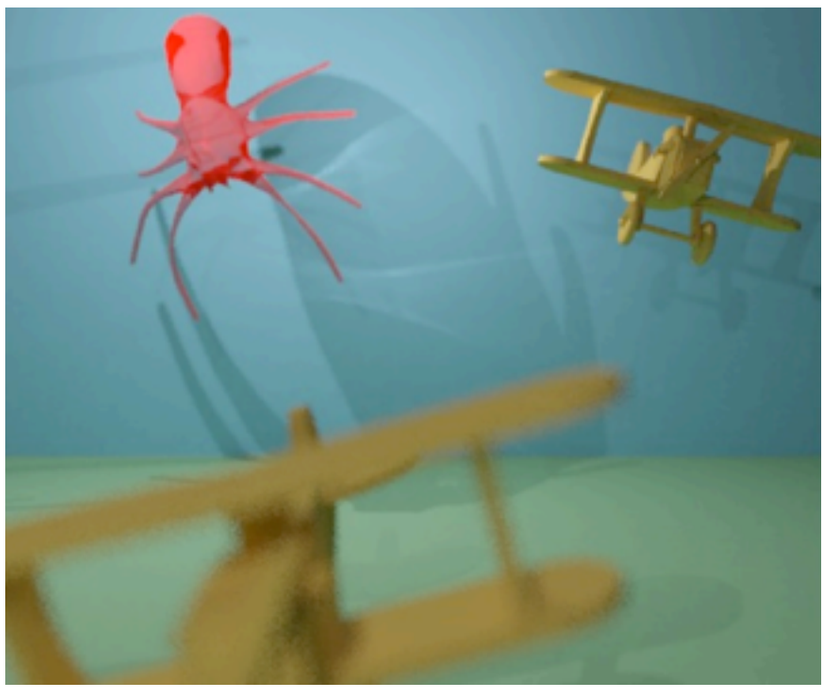
Elective from 2011









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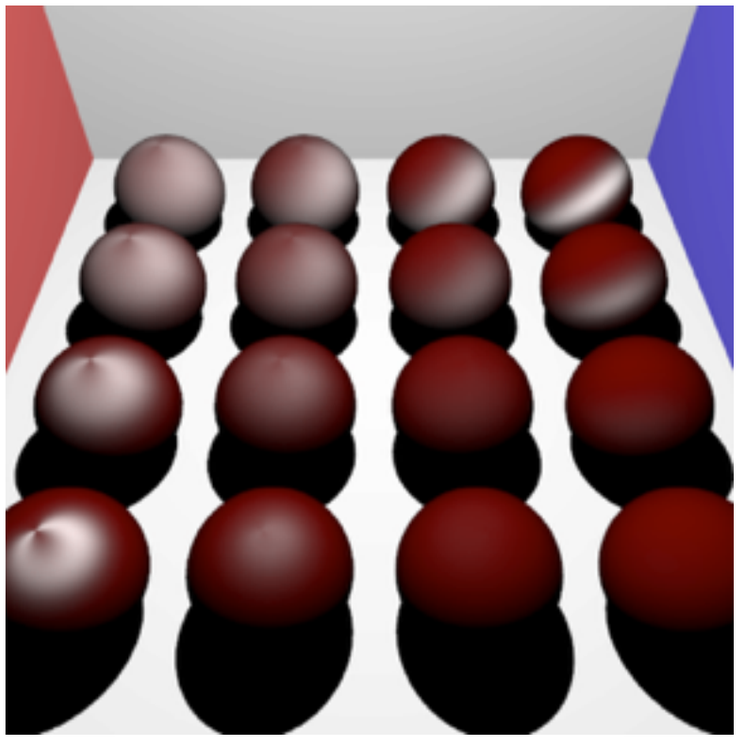
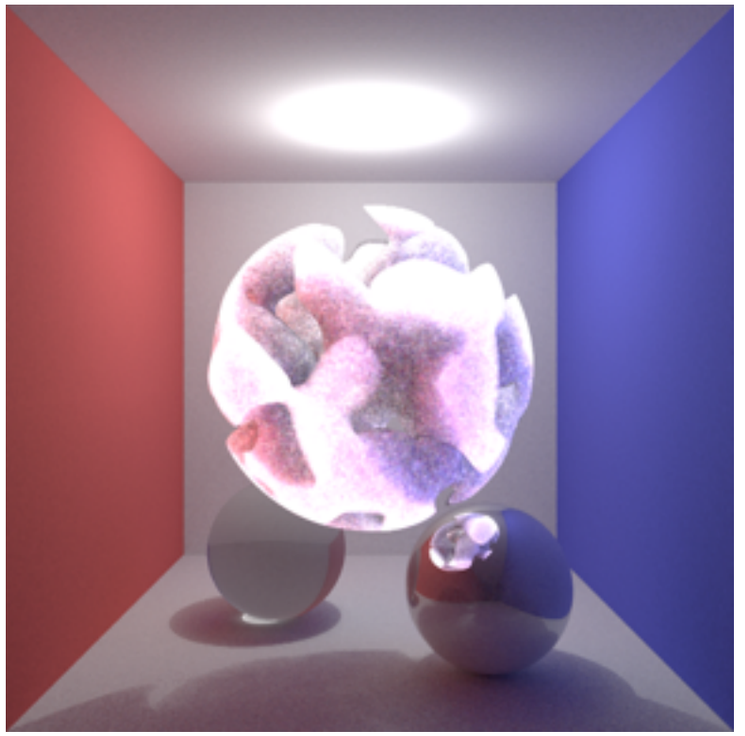
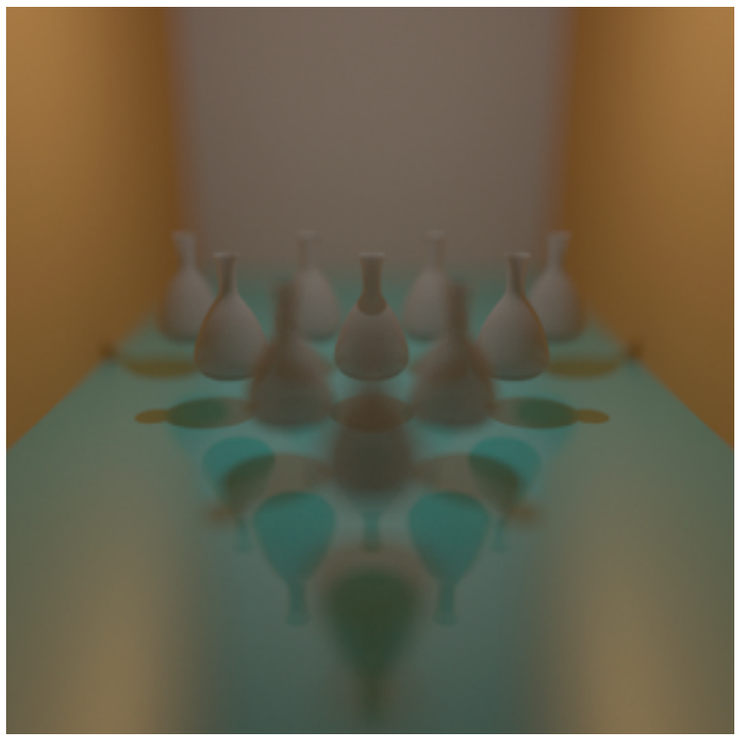
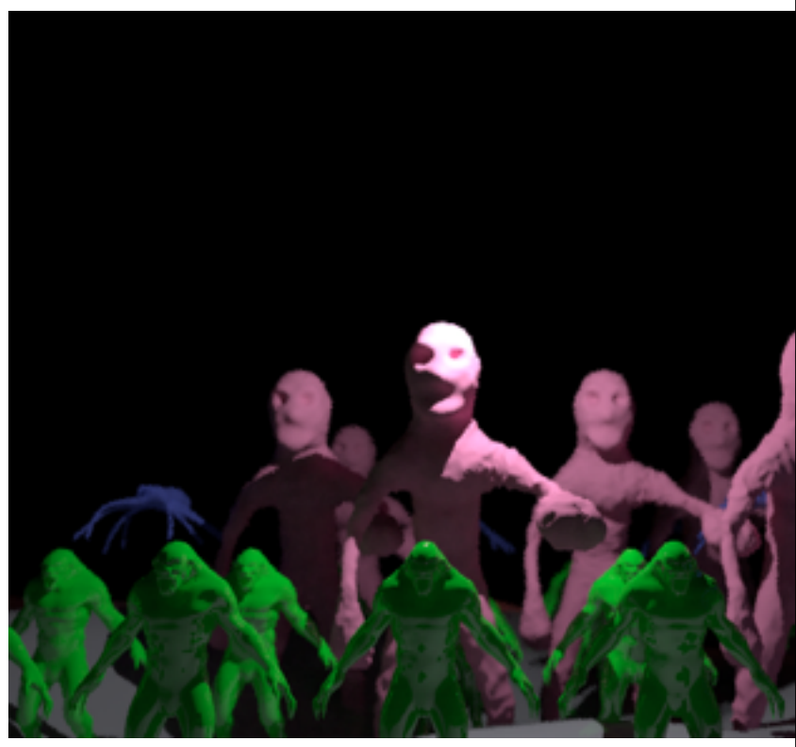
Elective from 2012









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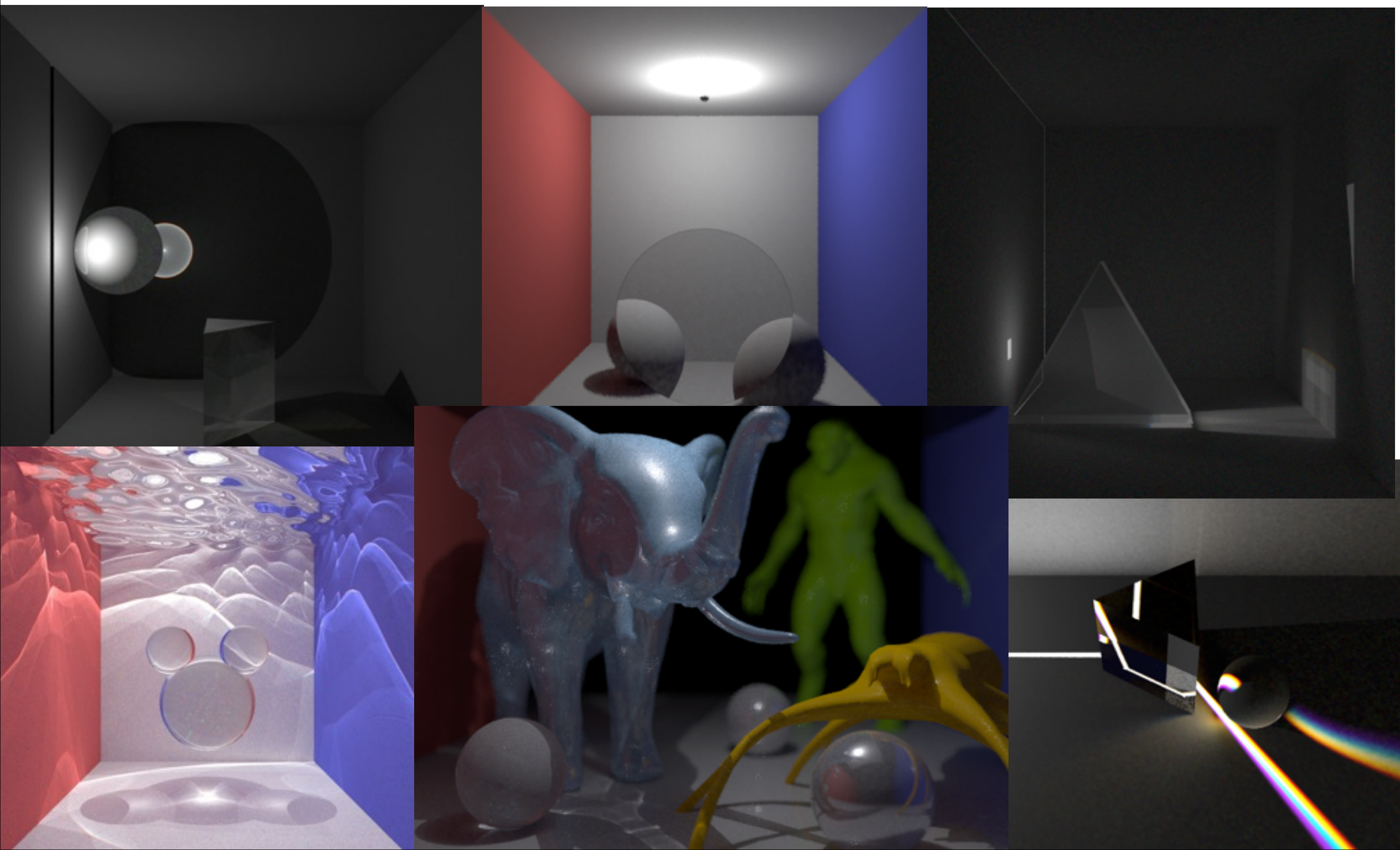
Elective from 2013



Course schedule

- Week 1
  - Intro, Ray tracing, C++
  - Sampling, Object intersections
- Week 2
  - Seminar 1: RenderPet (Magnus)
  - Acceleration Data Structures — Lab: Assignment 1 due
- Week 3
  - Seminar 2: BVH (Magnus)
  - Path Tracing, IBL — Lab: Assignment 2 due
- Week 4
  - Seminar 3: Path tracing (Rasmus)
  - Photon Mapping — Lab: Assignment 3 due
- BREAK + EXAMS
- Week 5
  - Seminar 4: Progressive Photon Mapping (Rasmus)
  - Advanced topics — Lab: Assignment 4 due
- Week 6
  - Guest Lecture : Jonas Gustavsson, Sony
- Week 7
  - Summary and Elective presentation

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How do we make an image?

- **Recursive ray tracing**
  - Trace rays from the eye, then through and around the scene

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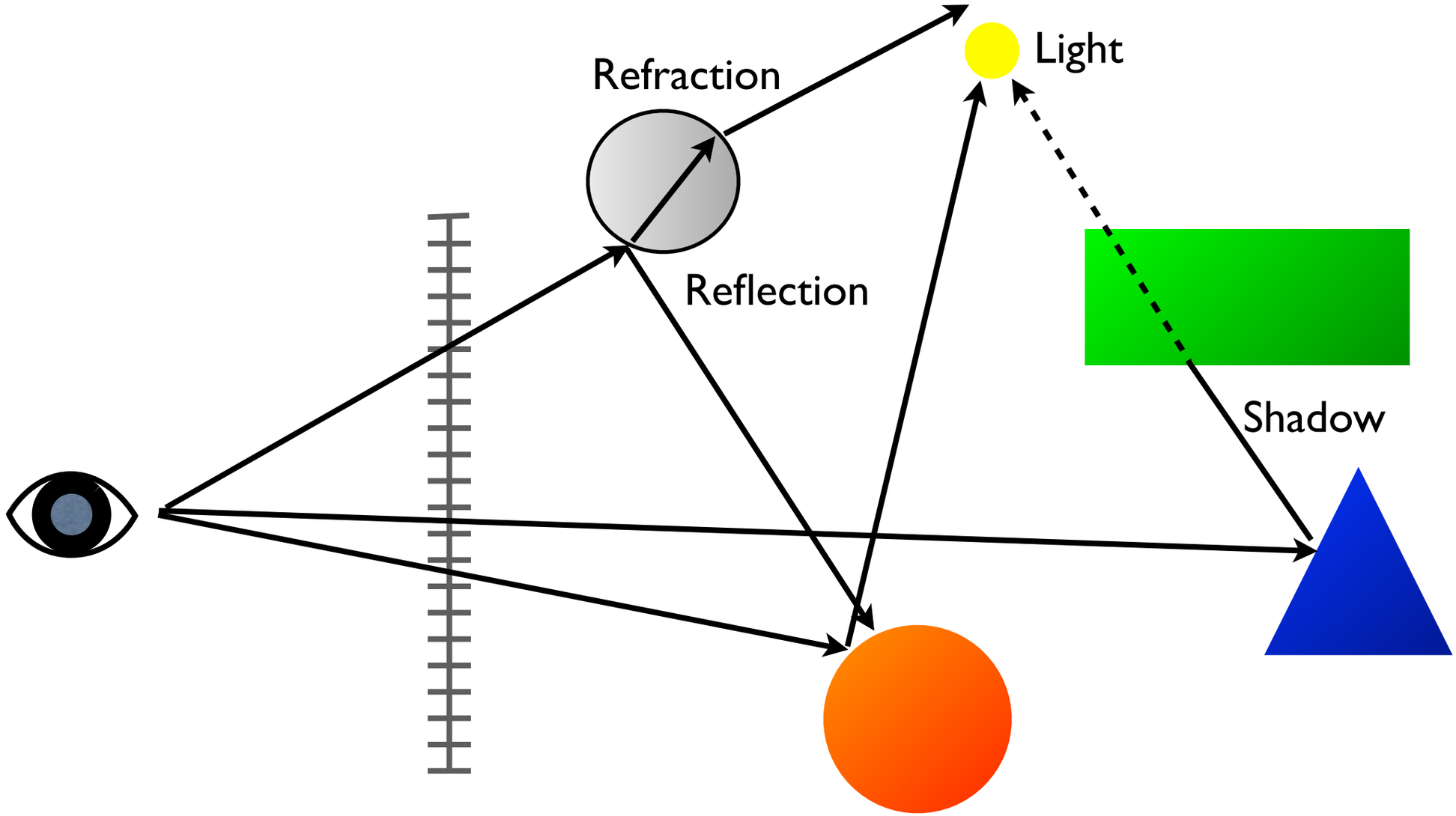
Recursive Ray Tracing



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How do we make an image?

- **Sampling**
  - How many rays?
  - Where do they start?
  - Computing direction
- **Object intersections**
  - Find the point on a surface where the ray hits it

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How do we find intersections quickly?

- **Acceleration Data Structures**
  - Group objects and work out if the ray hits the group first
  - ie, put the scene into a Hierarchy

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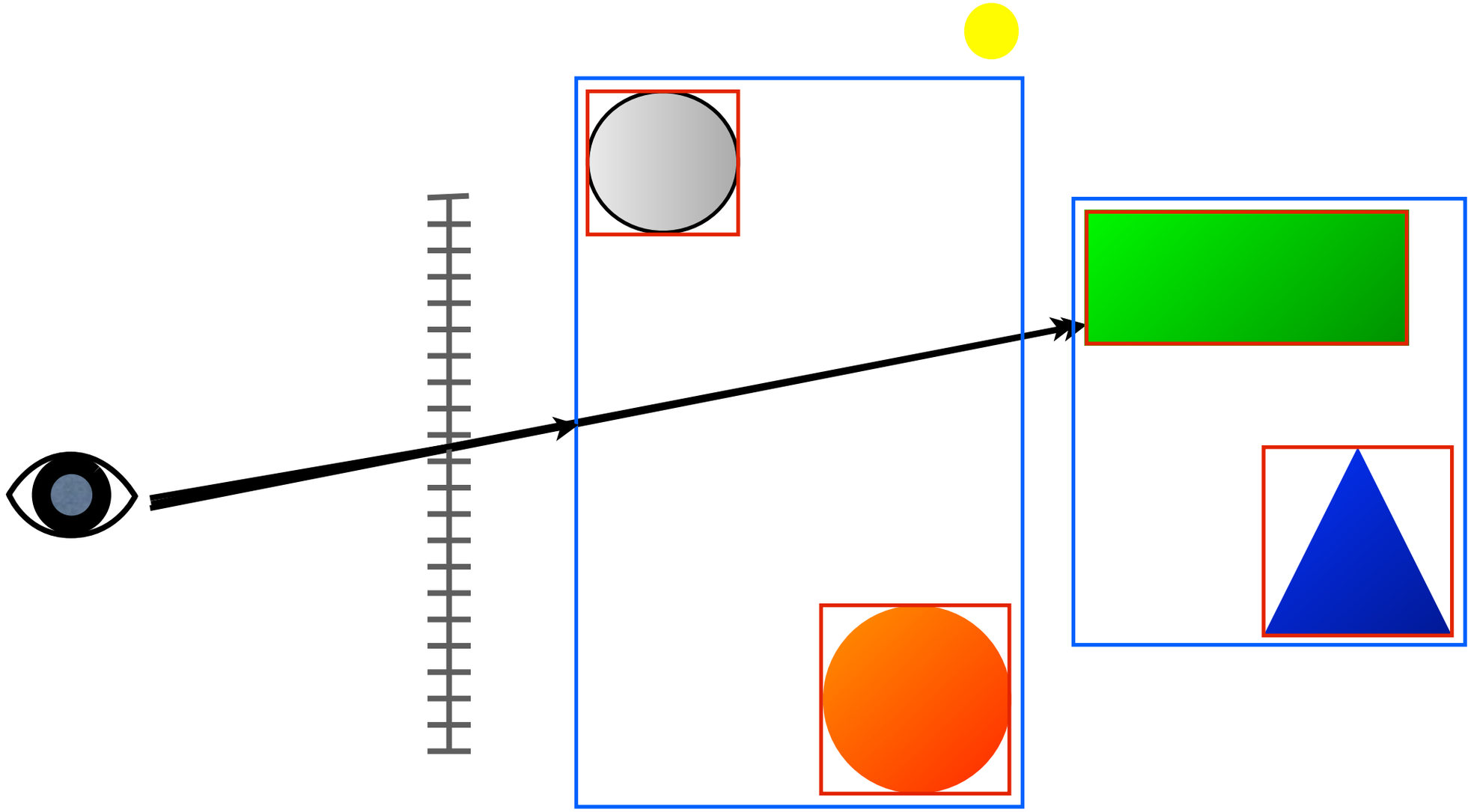
Hierarchical data structure



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How to model light physically?

- **Radiometry**
  - Compute how much light there is at that point
- **Diffuse Inter-reflection**
  - Where is light coming from?
  - Global Illumination
  - Path tracing
- **Photon Mapping**
  - How can we find the light faster?

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Progressive Photon Mapping

Image courtesy Toshiya Hachisuka from
"Progressive Photon Mapping", T. Hachisuka, S. Ogaki and H. W. Jensen
ACM Transactions on Graphics (SIGGRAPH Asia 2008), 2008

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Background Knowledge

- EDA221 Computer Graphics
- 3D Scene
- Camera
- Transformation and Viewing Projection
- Simple shading and lighting models (Phong)
- Environment mapping

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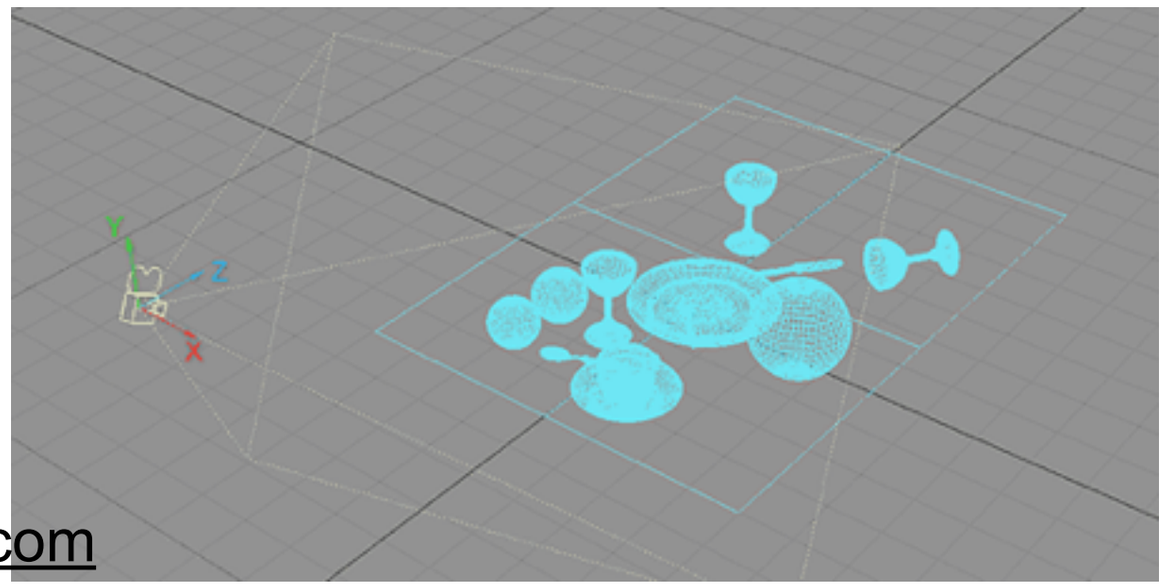
Image-based Lighting

Photo of a room

Photo a highly reflective sphere in the room

Computer-generated objects



Images from www.blochi.com

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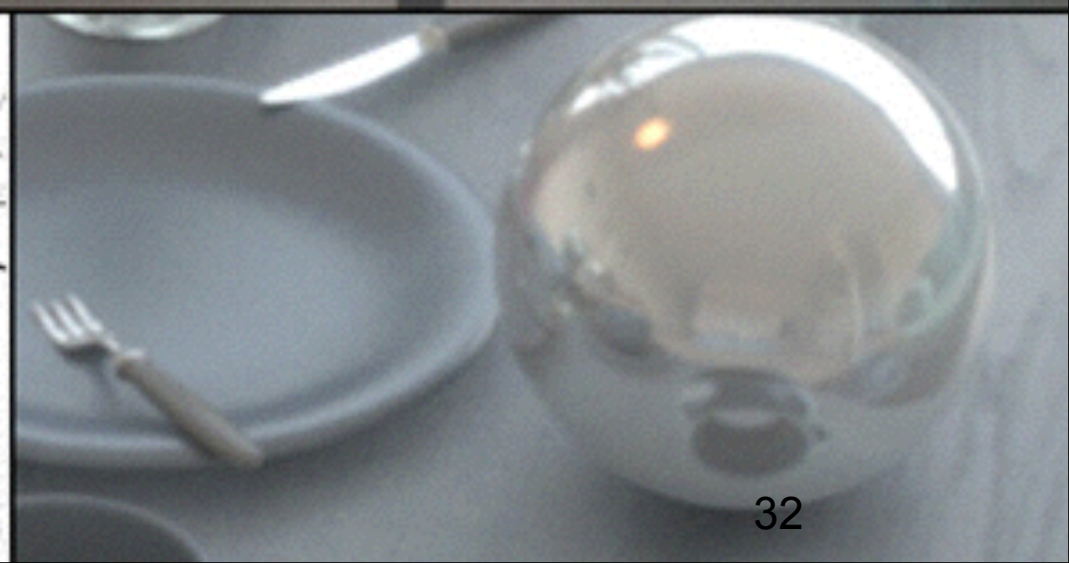
Image-based lighting

- Now, render computer-generated objects with lighting from light probe



Diffraction using SPPM

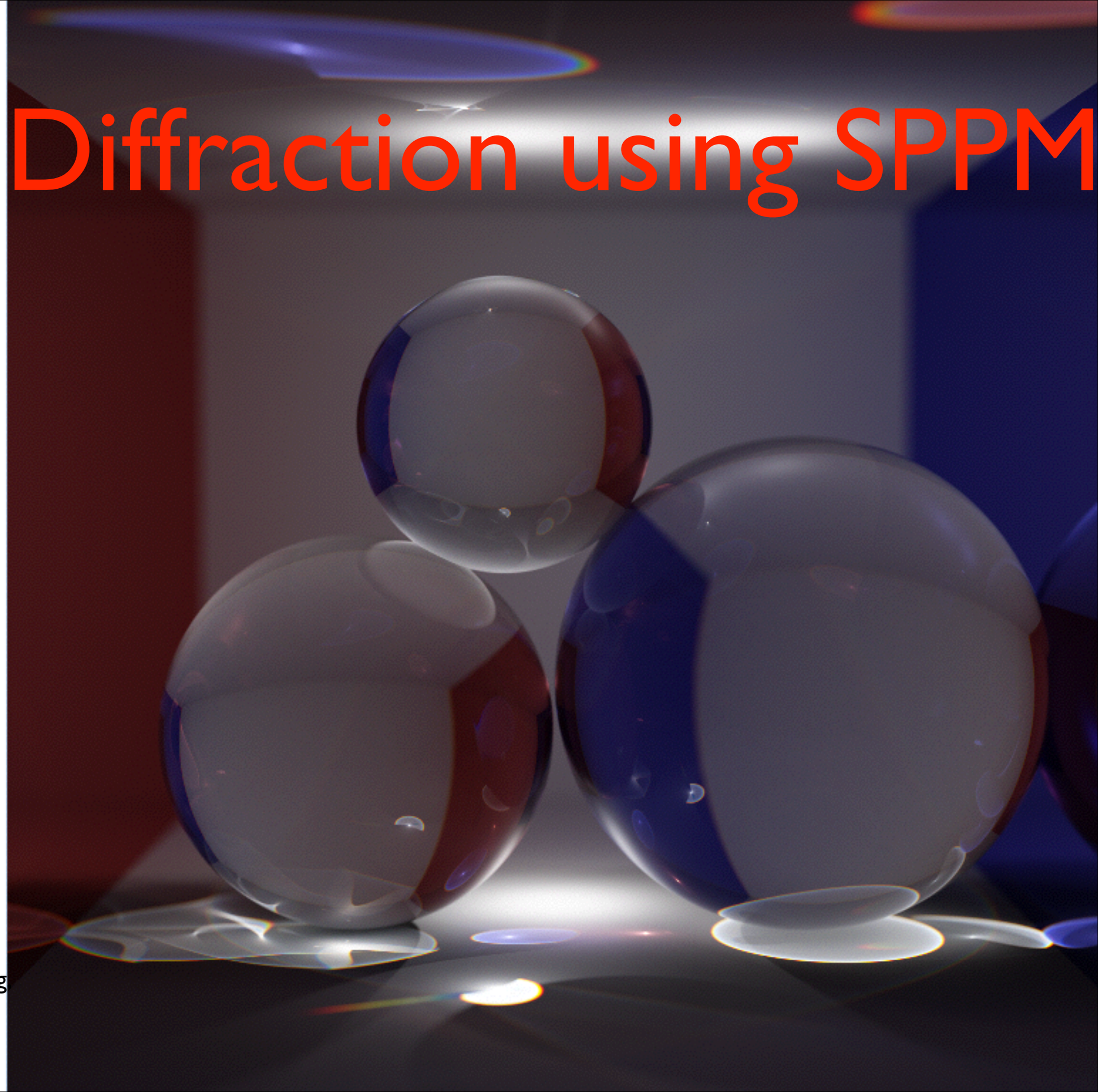
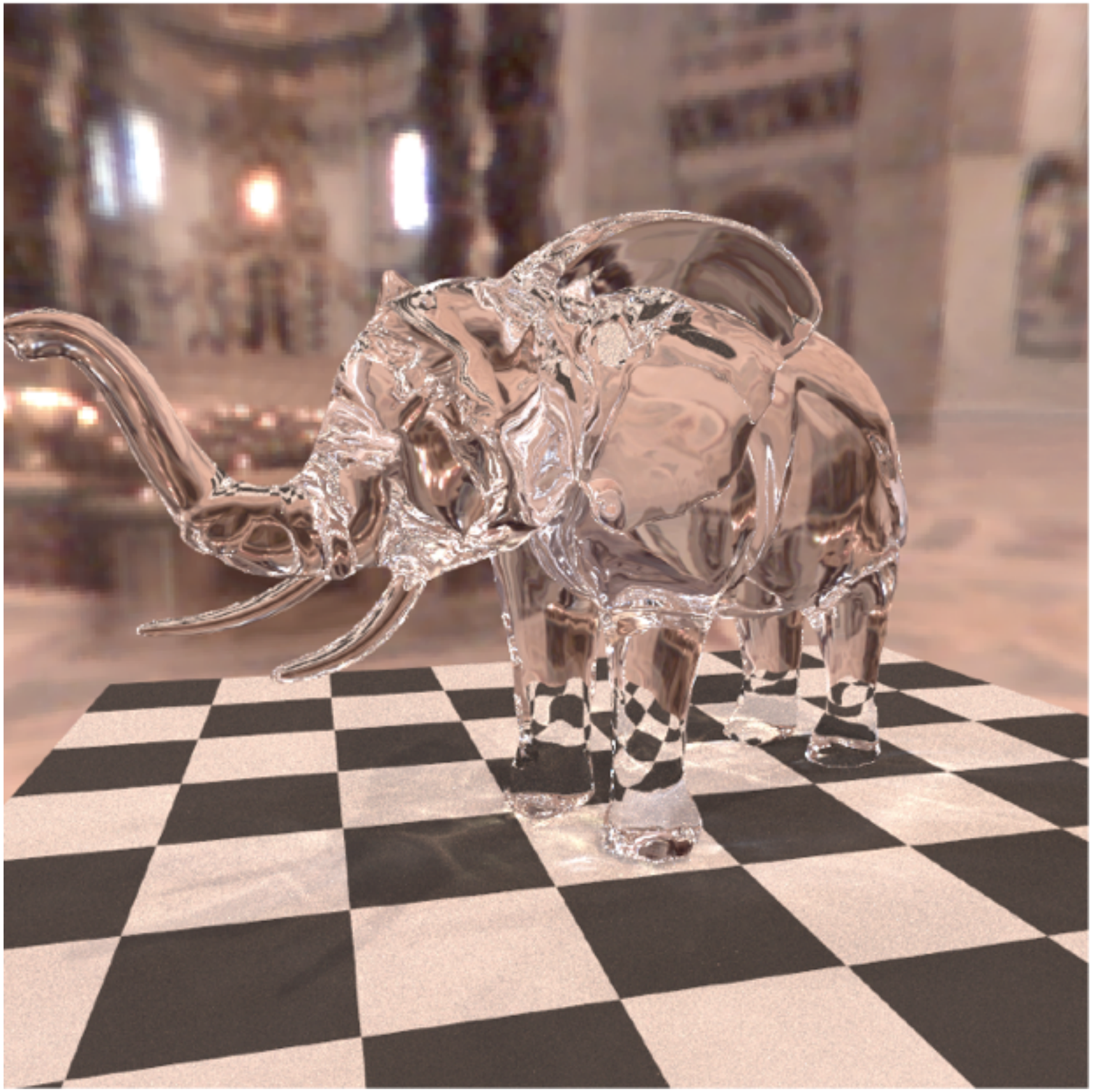
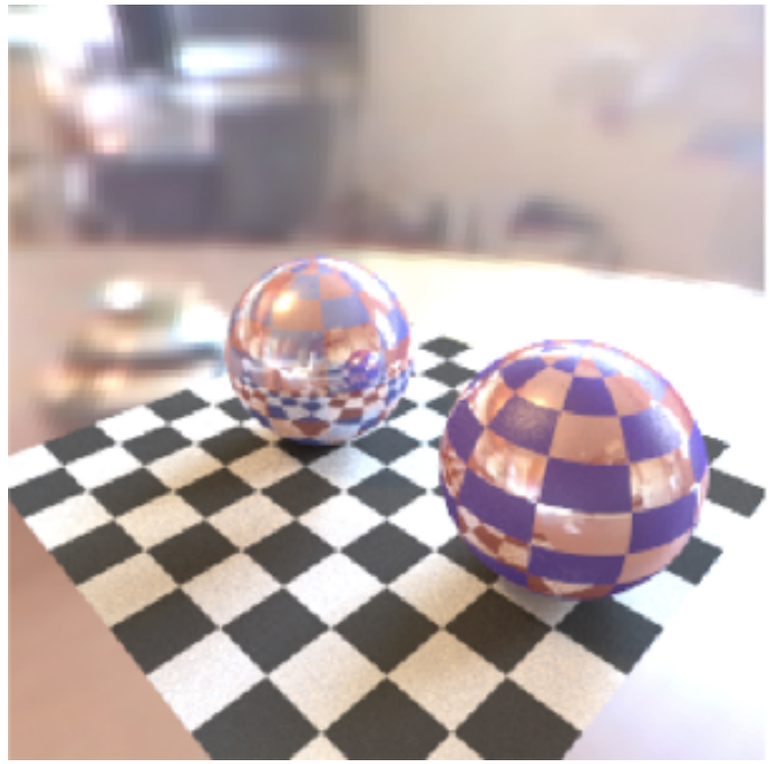


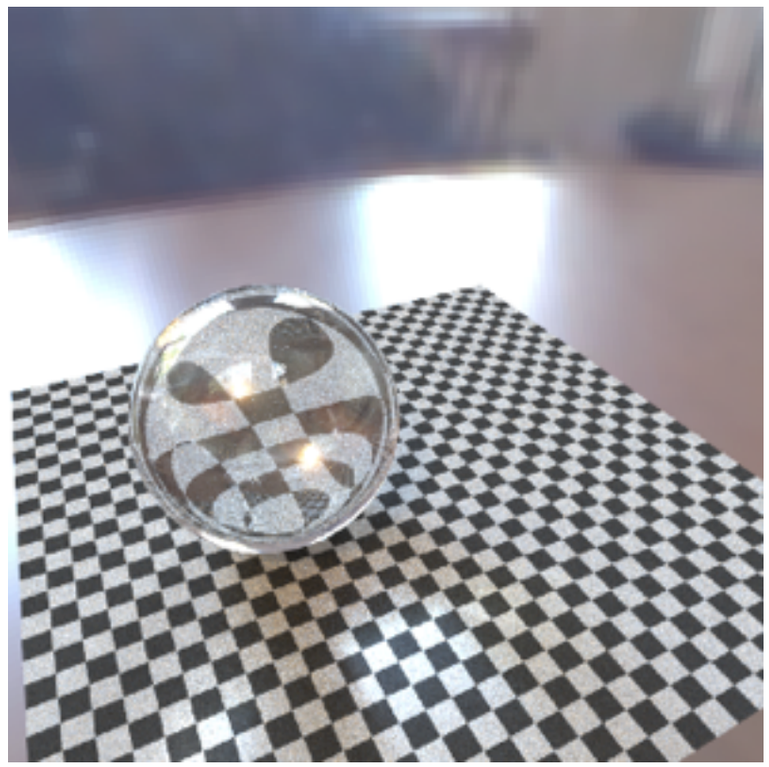
Image courtesy Kristofer Carlberg from his Masters Thesis, "Stochastic Progressive Photon Mapping Using Parallel Hashing"

NVIDIA
NVIDIA
DESIGN GARAGE

3rd programming assignment







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