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DH2323 DGI15

INTRODUCTION TO

COMPUTER GRAPHICS AND INTERACTION

INTRODUCTION

Christopher Peters

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Some material used from DGI12 notes by Carl Henrik Ek

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What is DH2323?

Introductory course on computer graphics and interaction

Focused on fundamentals

- Bottom-up (basic OGL) and top-down (game engines)

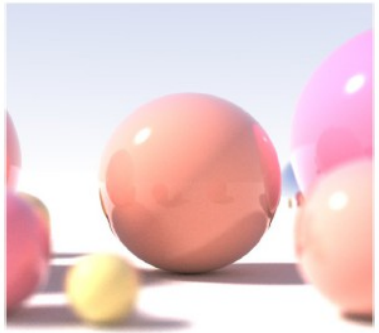
Real-time rendering

Algorithms and programming

Adaptable to individual interests

To summarise...

Pretty pictures + fun



"Distant Shores" by Christoph Gerber

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The (Awful?) Truth

Interactive computer graphics is essentially:

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The (Awful?) Truth

Interactive computer graphics is essentially:

(wait for it...)

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The (Awful?) Truth

Interactive computer graphics is essentially:

Mathematics programming

“It's matrices all the way down!”

The (Awful?) Truth

Interactive computer graphics is essentially:

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“It's matrices all the way down!”




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The (Awful?) Truth

Interactive computer graphics is essentially:

Mathematics programming

“It's matrices all the way down!”

Quite possibly the most fun and rewarding maths programming you will ever do*

**disclaimer: you'll get from it what you put in*

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Beware

Mathematics programming

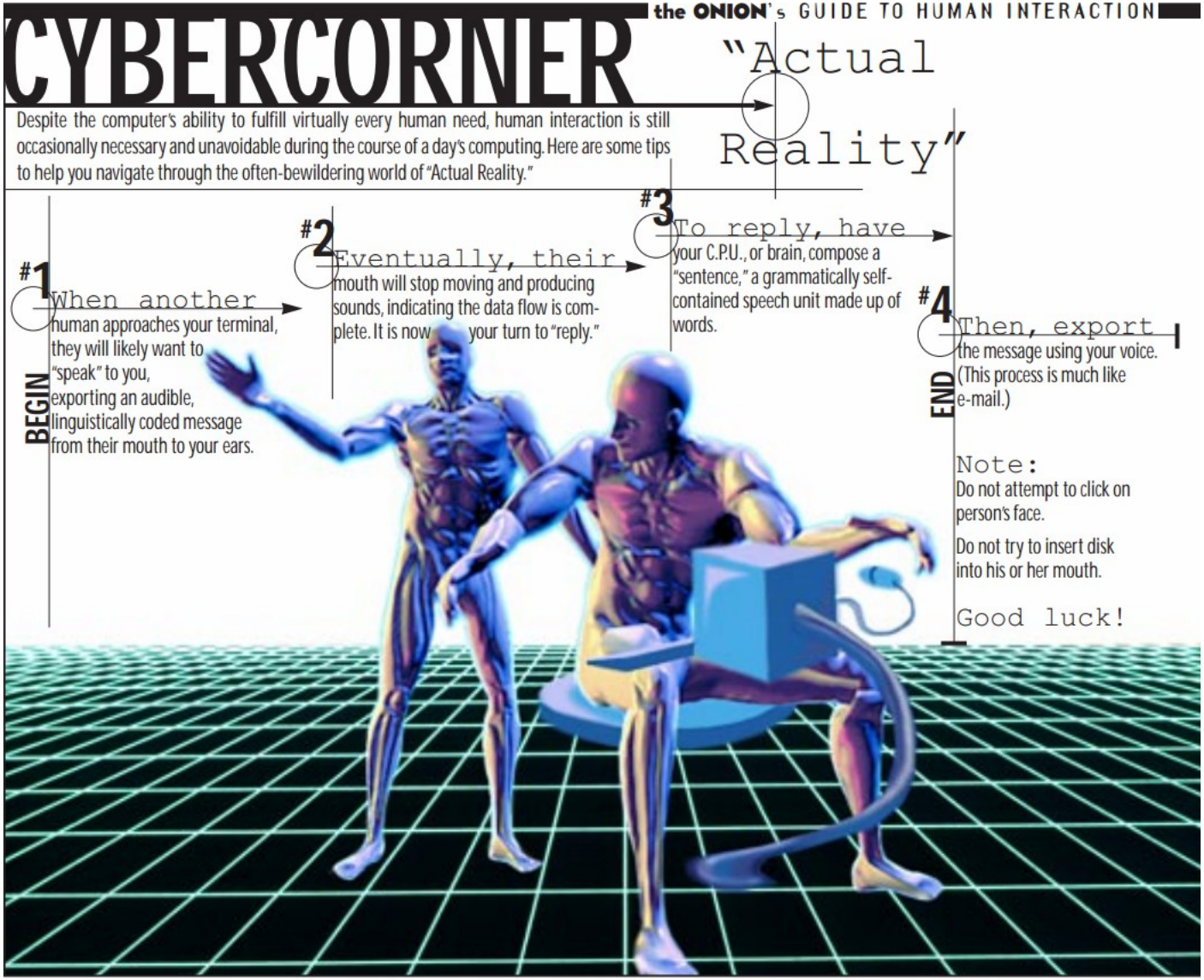
>

(Mathematics

+

programming)

What about interaction?



Computer Graphics *and Interaction*

You do have to consider the human user in the loop

Ivan Sutherland, Sketchpad demo

Core themes:

Interactive graphics techniques

Real-time user input and feedback

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Computer Games

ARMA 3, Bohemia Interactive

Hollywood FX

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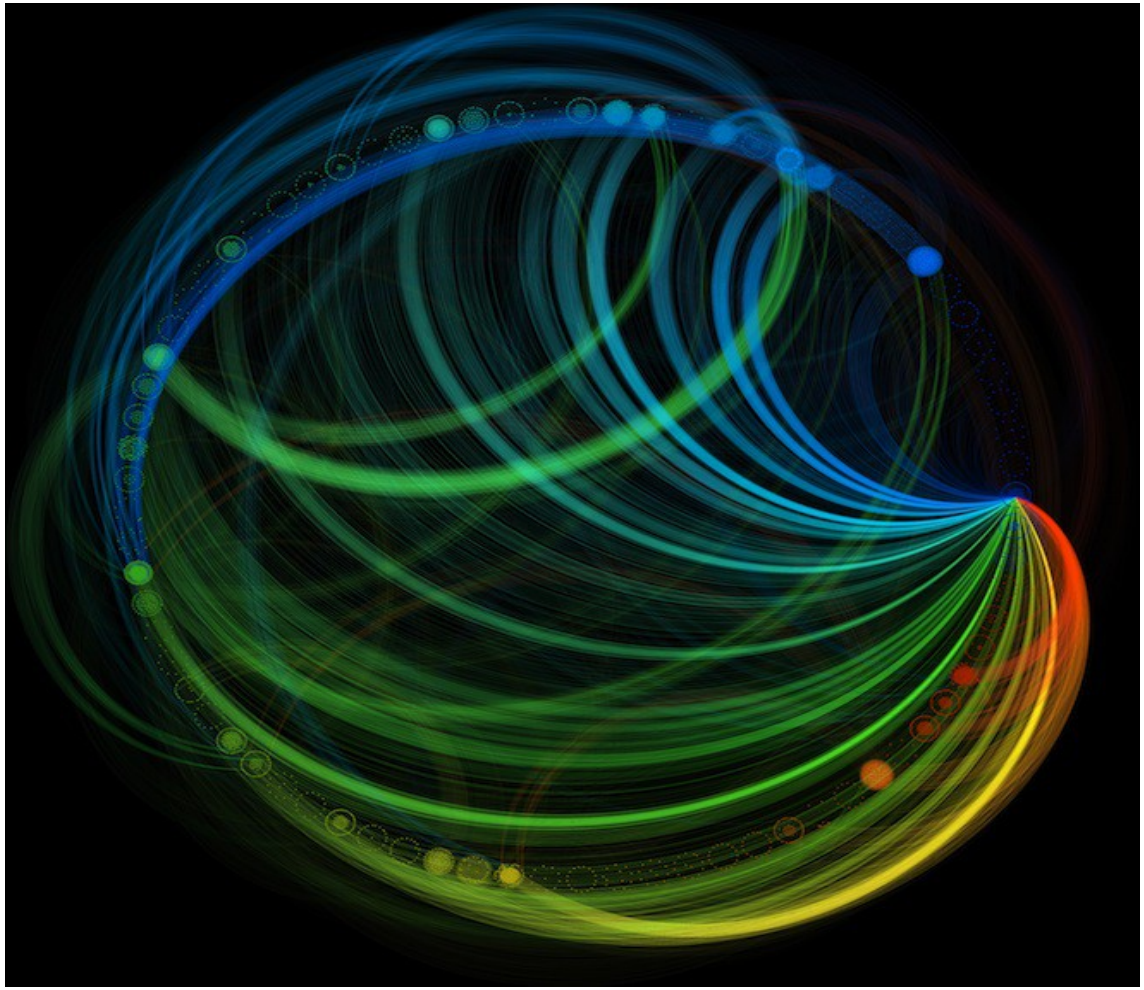
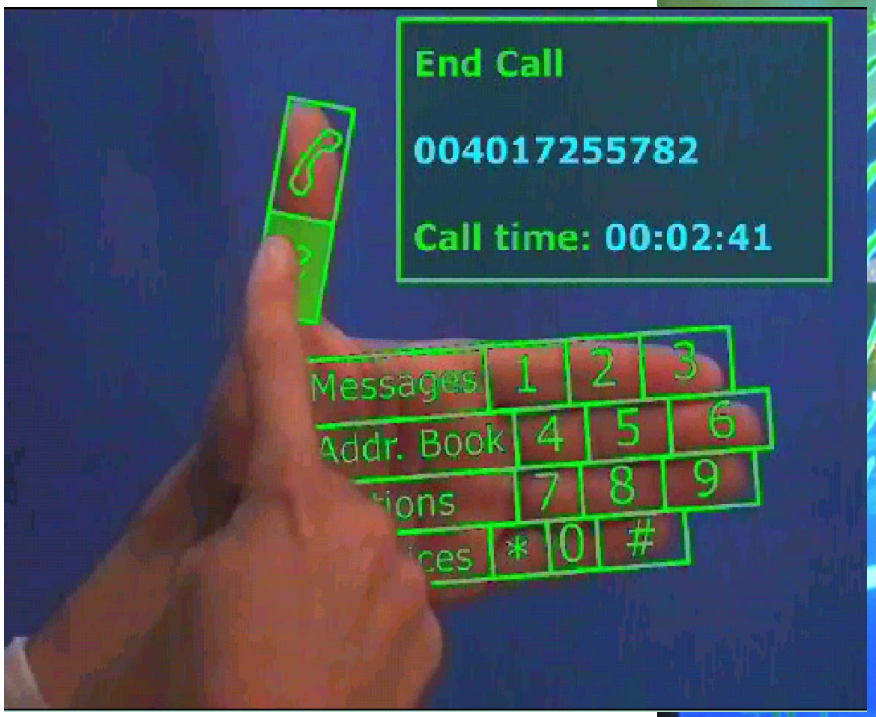
Information Visualisation



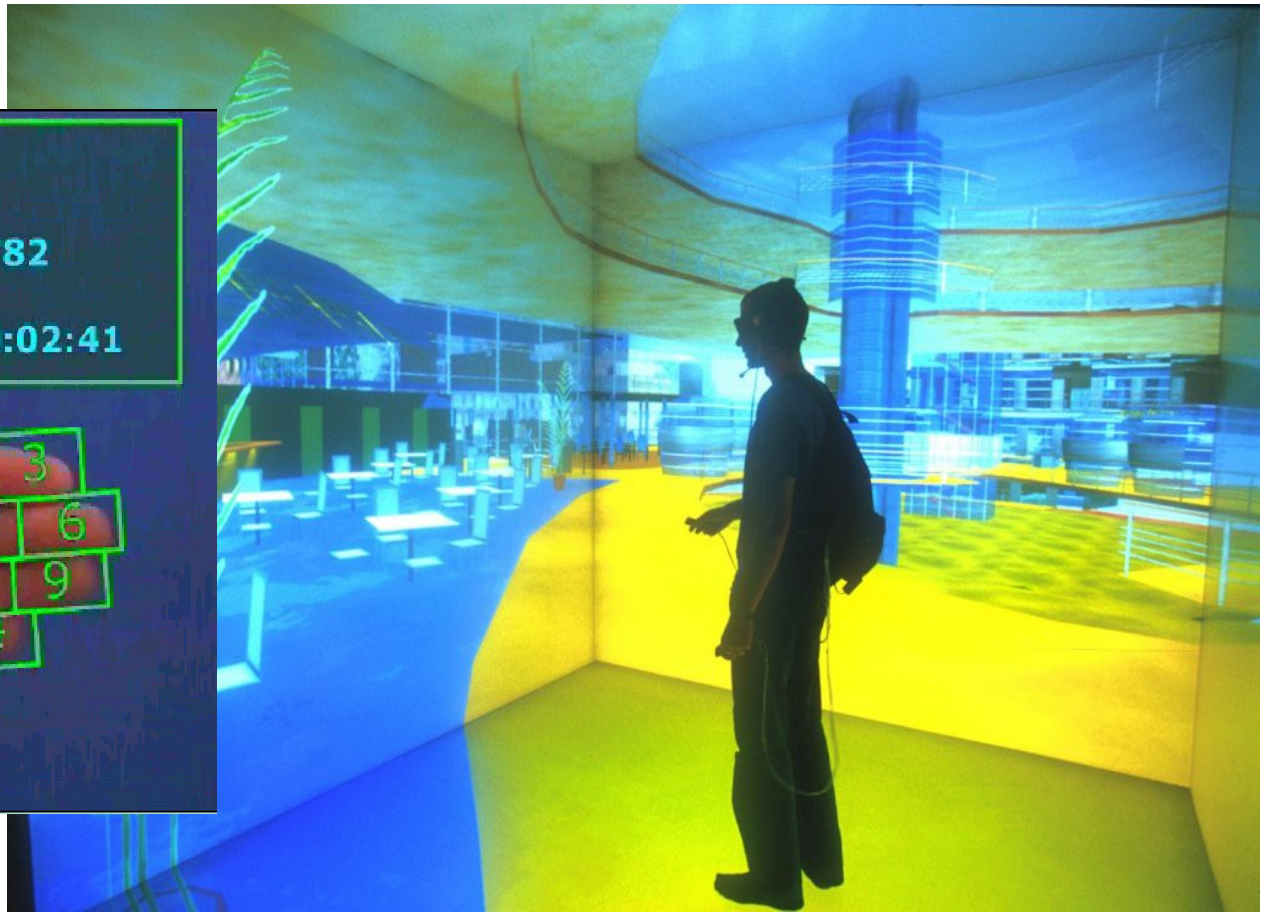
E. McQuinn, T.M. Wong, P. Datta, M.D. Flickner, R. Singh, S.K. Esser, R. Appuswamy, W.P. Risk, and D.S. Modha;
IBM Research - Almaden

See: http://www.wired.com/wiredscience/2013/01/science-visualization-winners/

AR and VR



www.infotech.oulu.fi



intuition-eunetwork.org

Where does it all lead?

The Matrix, Warner Bros. Pictures

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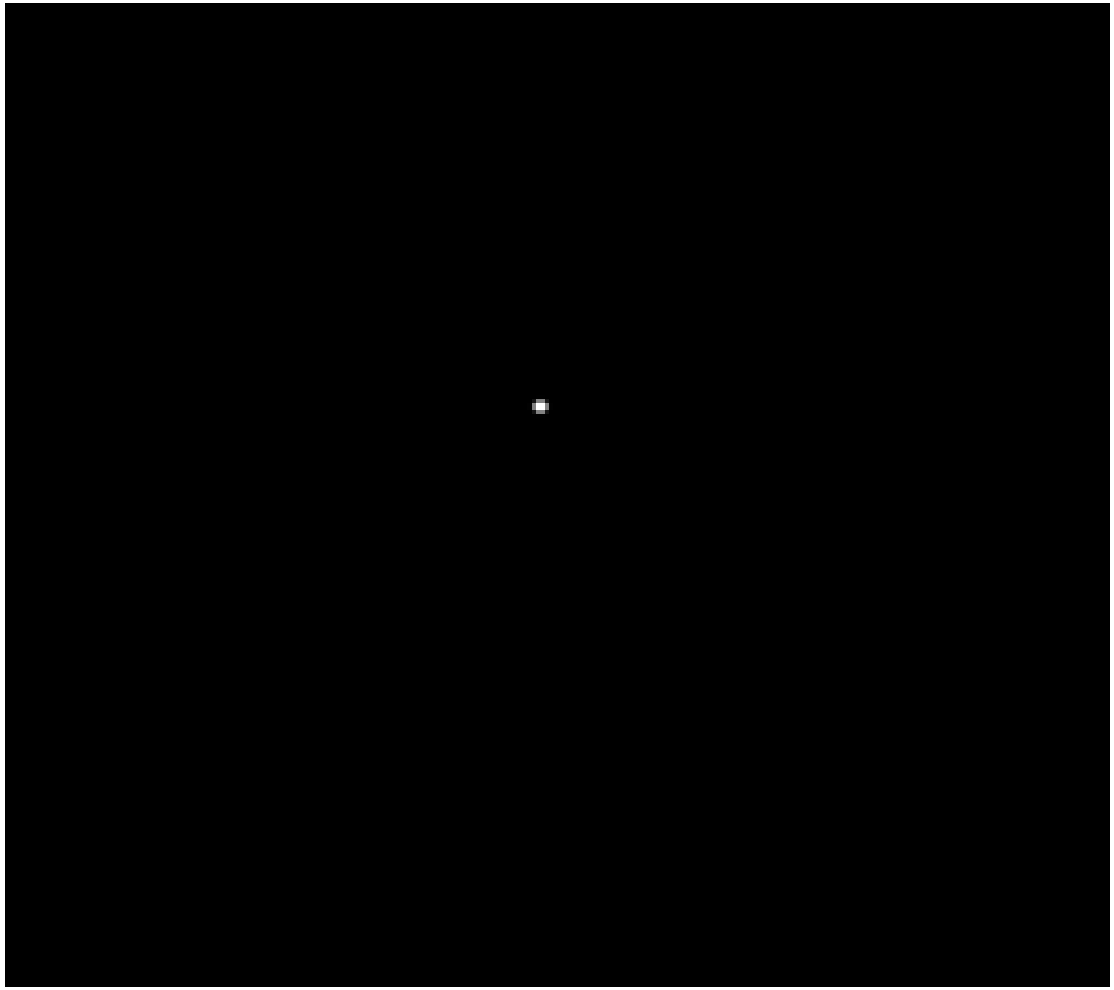
Be prepared



Likely output of your first program

(if you are lucky...)

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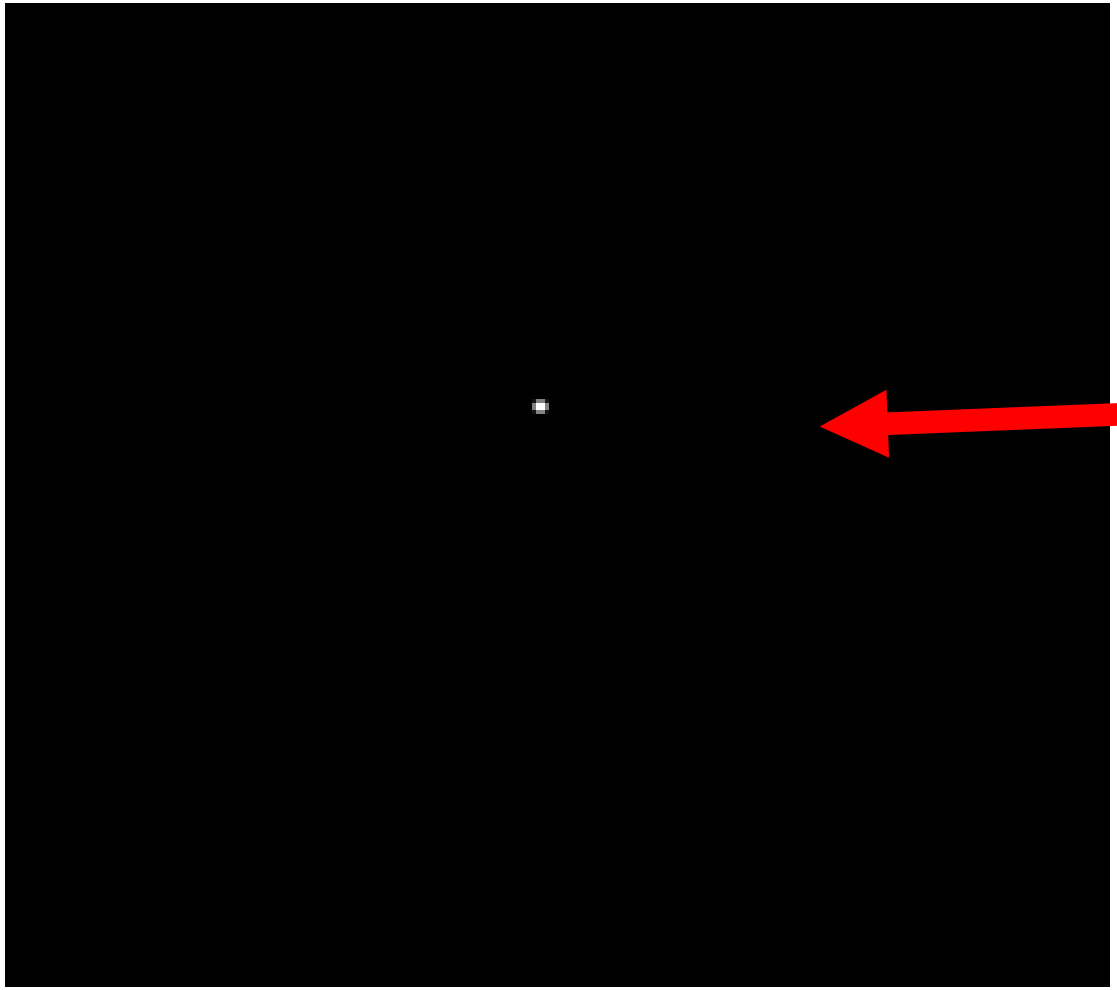
Be prepared



Not the Matrix

Likely output of your first program

(if you are lucky...)

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But remember

"A journey of a thousand miles begins with a single step"

Or in this case, "a single pixel"

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Who you are

- A quite diverse group of individuals
- Interested in fundamental principles of computer graphics
- Comfortable programmers*
- Willing to do some math
- Eager to learn
- Hard working
- Questionnaire

**This is not a programming course*

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Who you will be

- Understand (at least) the fundamentals of interactive computer graphics
- Better programmers
- Appreciate practical applied mathematics through visualisation

  and vice-versa...
- Capable of applying your knowledge beyond this course

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Who you will be

- Understand (at least) the fundamentals of interactive computer graphics
- Better programmers
- Appreciate practical applied mathematics through visualisation

  and vice-versa...
- Capable of applying your knowledge beyond this course
- With something to show for it beyond a grade

Who am I?

- Christopher Peters
  - email: chpeters@kth.se
  - https://www.kth.se/profile/chpeters/
- Associate Professor
- Research:

Computer graphics

Character and crowd animation

Games

Perceptual computing

Human-machine interaction (agents, social robots)

By John Turesson, DH2320

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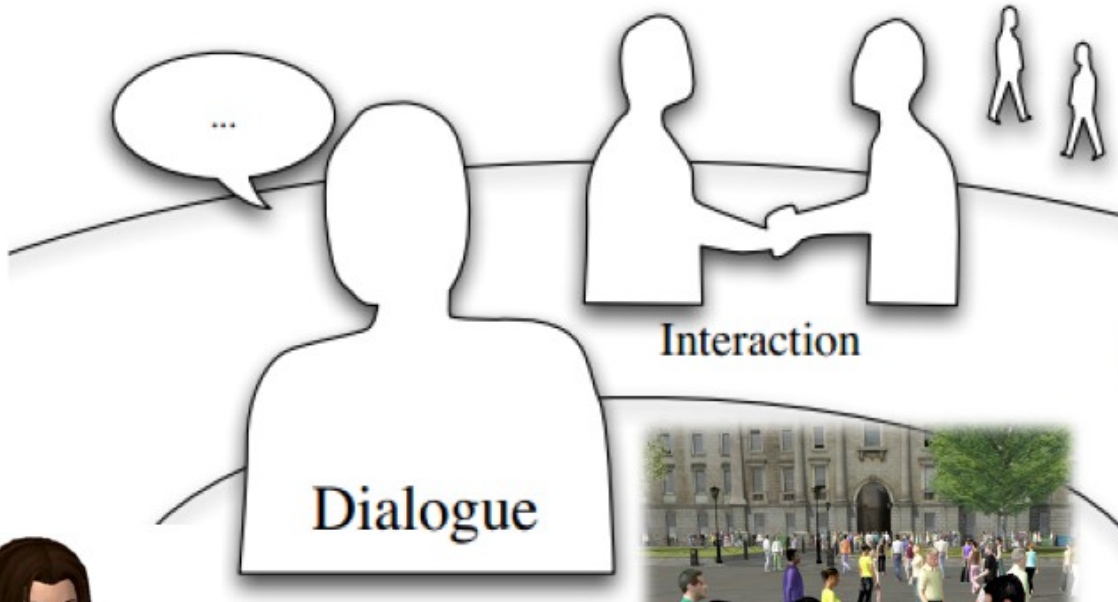
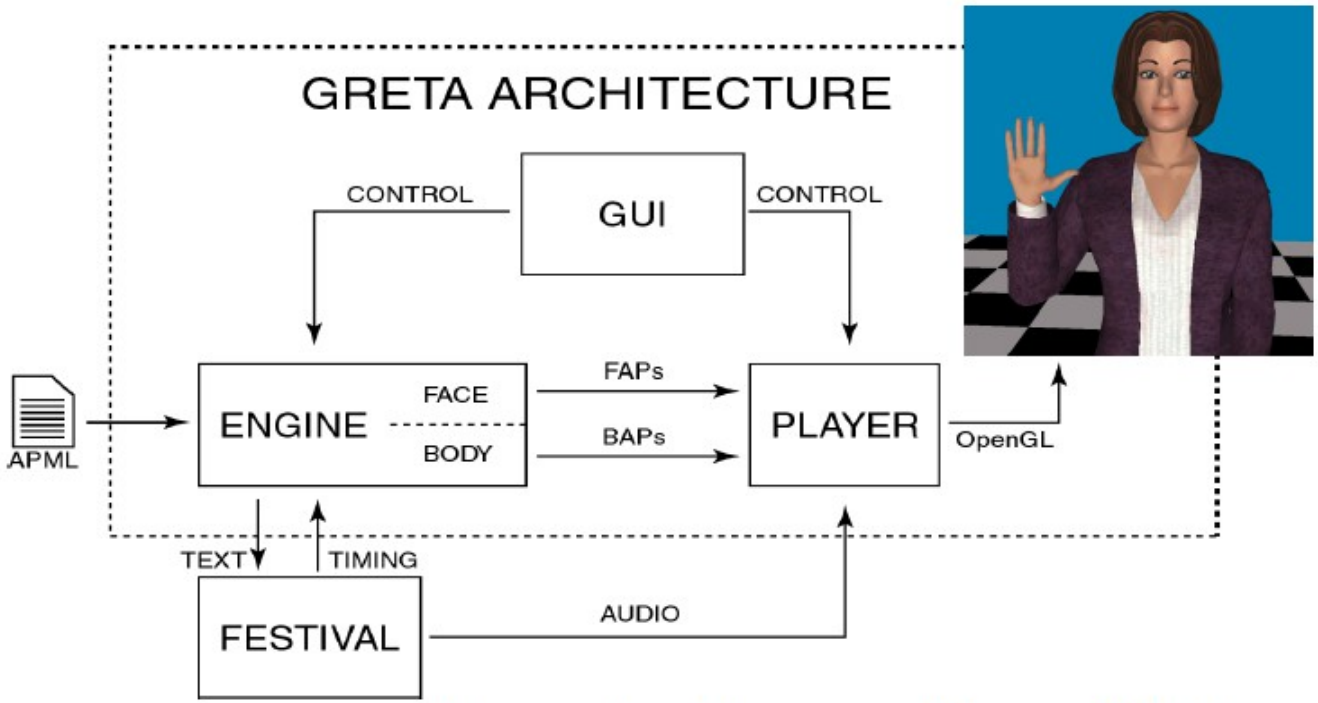
Levels of Interaction



Metropolis Project, Trinity College Dublin

Greta ECA, ParisTECH

Real-time Computational Models



See: **Pelachaud, et al**
ParisTECH, France

Example: Superposition of Sadness and Joy

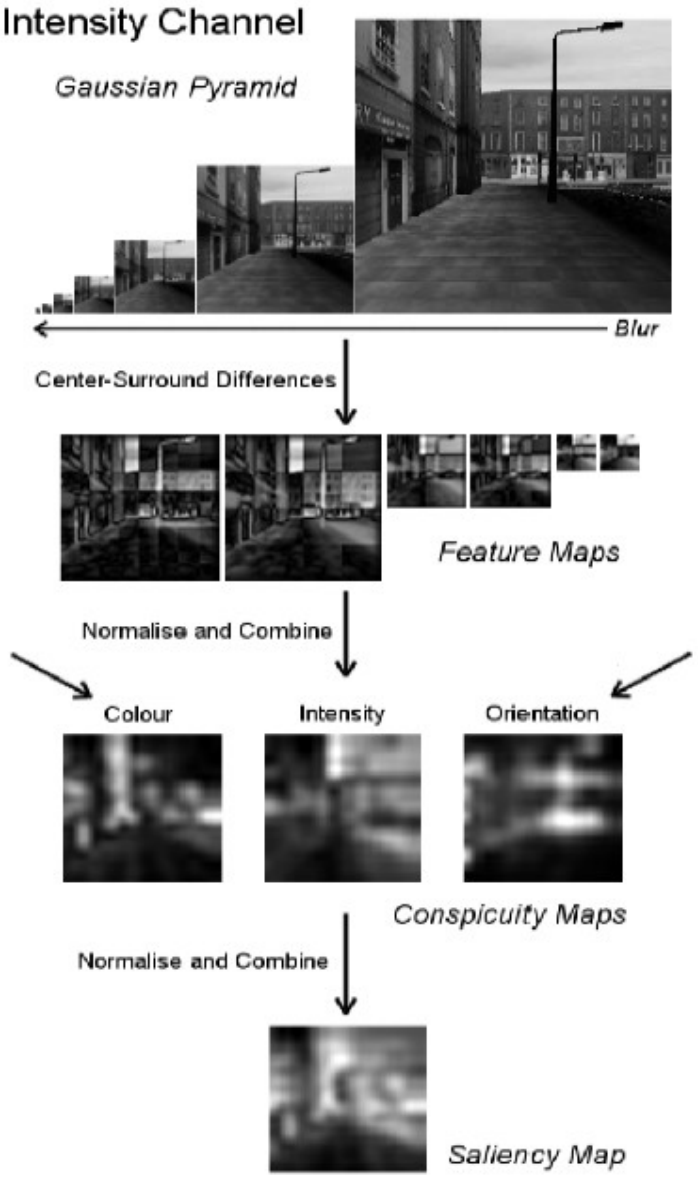
Joy

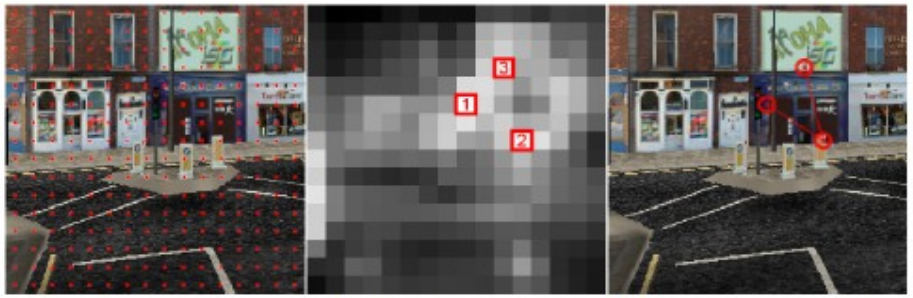
Sadness

Original video

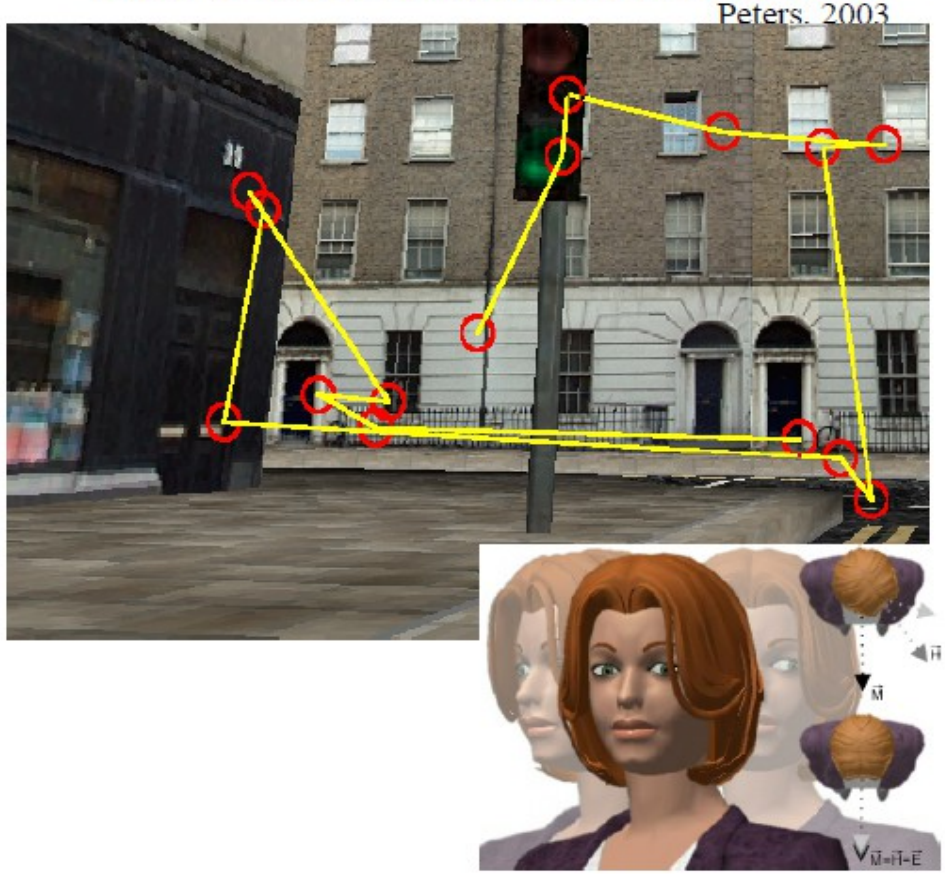
Sadness and Joy

Computational Visual Attention





Bottom-up visual attention for virtual human animation, Peters, 2003



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Metropolis

Graphics Vision and Visualisation Group
Trinity College Dublin

Multisensory simulation of a populated city

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Teaching

- **DD3336**, Interactive Entertainment Technologies (PhD level)
- **DH2650**, Computer Games Design
- **DT2350**, Human Perception for Information Technology
- **DH2323**, Computer Graphics and Interaction
- **DH2320**, Introduction to Visualization and Graphics
- **DD1354**, Modeling and Simulation (game physics)

- Visualization (VIC) Studio

  4K screen, Oculus Rift, eye-trackers, etc

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Course Webpages

Main webpage:

- KTH Social
- https://www.kth.se/social/course/DH2323/

Bilda:

- For lab and project submission
- https://bilda.kth.se/courseId/12410/
- (note that you do not have access yet)

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Lecture overview

- Image modelling and rendering
- Mathematics for graphics
- Ray-tracing
- Rasterisation
- Lighting
- Animation

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Assessment

- Exam (replaced by project)
- Project

  Individual or group project (1-3 members) on a topic related to computer graphics and interaction
- Lab work

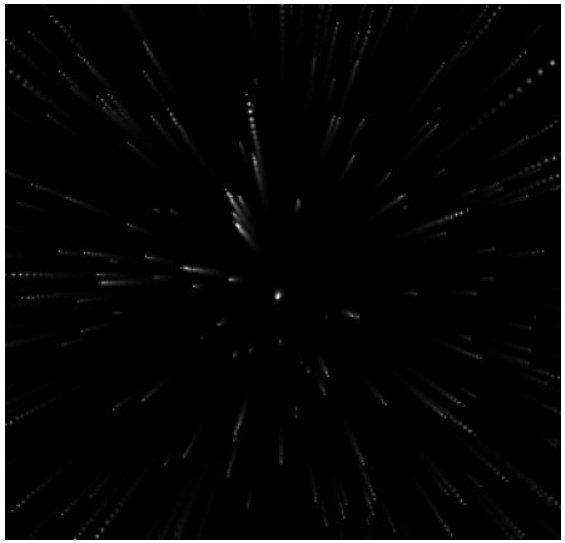
  Three practical assignments completed individually or in groups of two

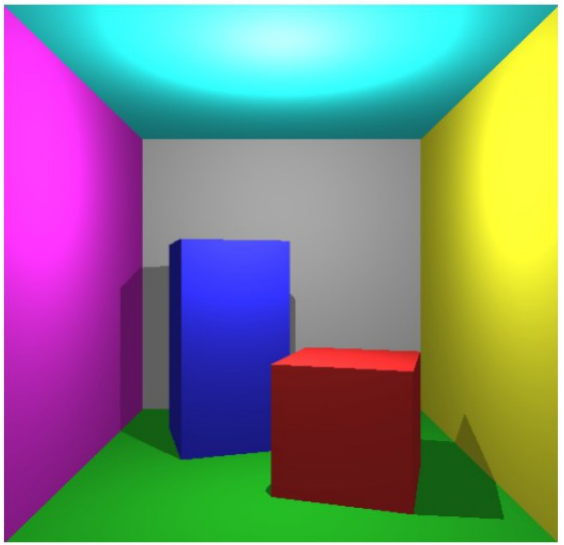
Lab work (bottom-up)

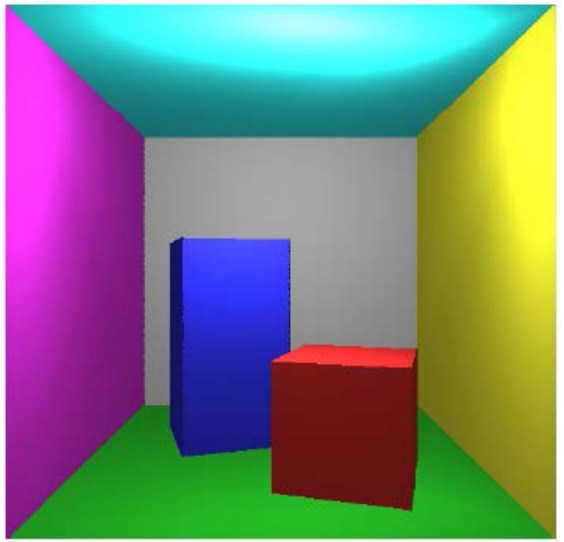
- There will be physical labs (TBA)

  Attendance is voluntary

  Labs will be submitted to *Bilda* near the end of the course
  - See 'Labs' section on course website
  - Preliminary date: Friday 8th May 2015







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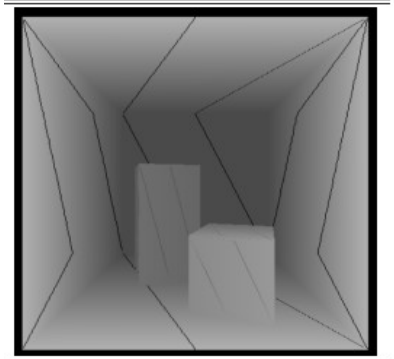
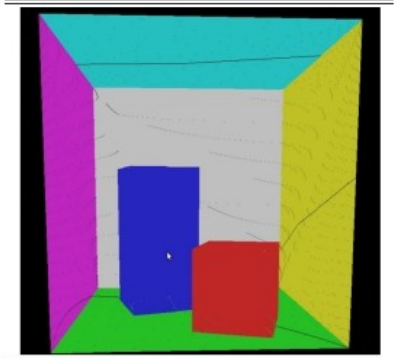
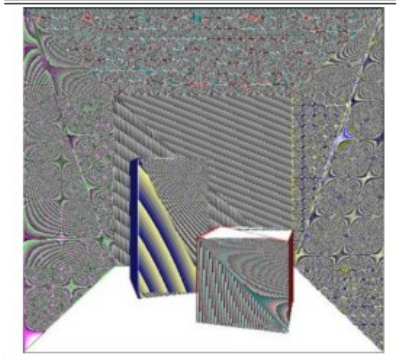
DGI Journal of Improbable Art



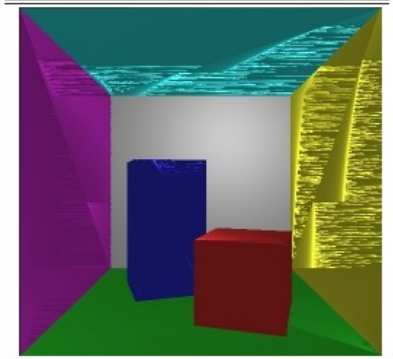
Jacob Florell, Sepehr Amoor Pour



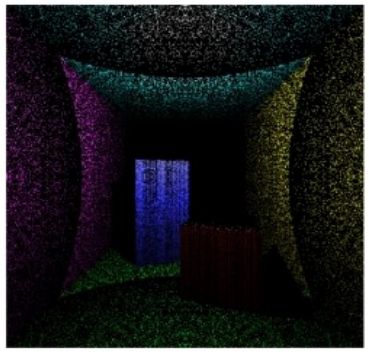
Jonathan Murray



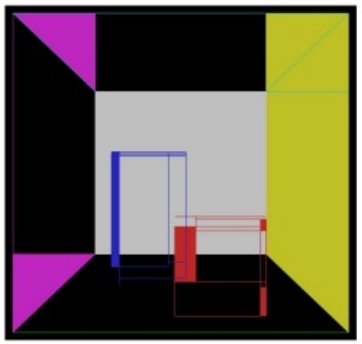
Jonathan Pellby



Ian Snow

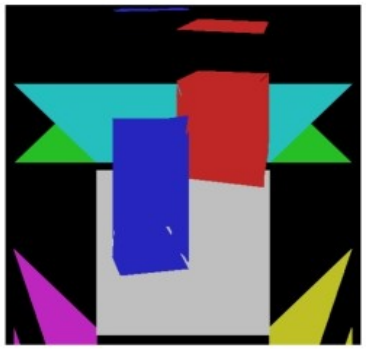


Magnus Olsson, Christoffer Wiss

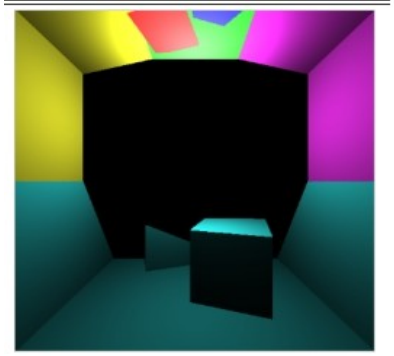


Petter Lundahl, Veronica Ginman

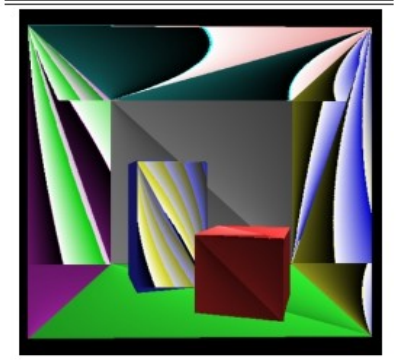
Philip Eliasson, Fredrik Lilkaer



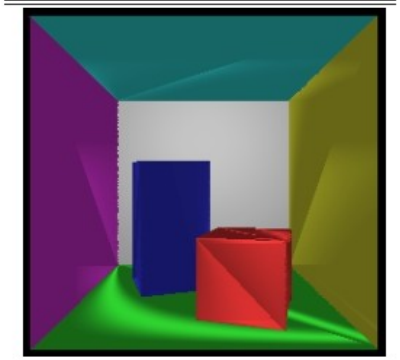
Iris Van Rooijen



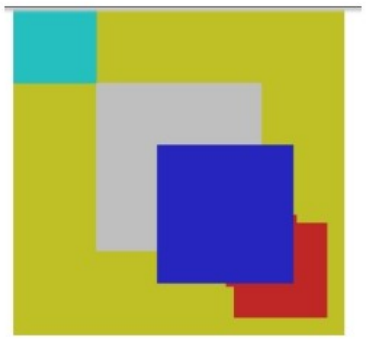
Terese Nothnagel



Viktor Collin, Simon Osterman



Vladimir Grozman



Carl Regardh

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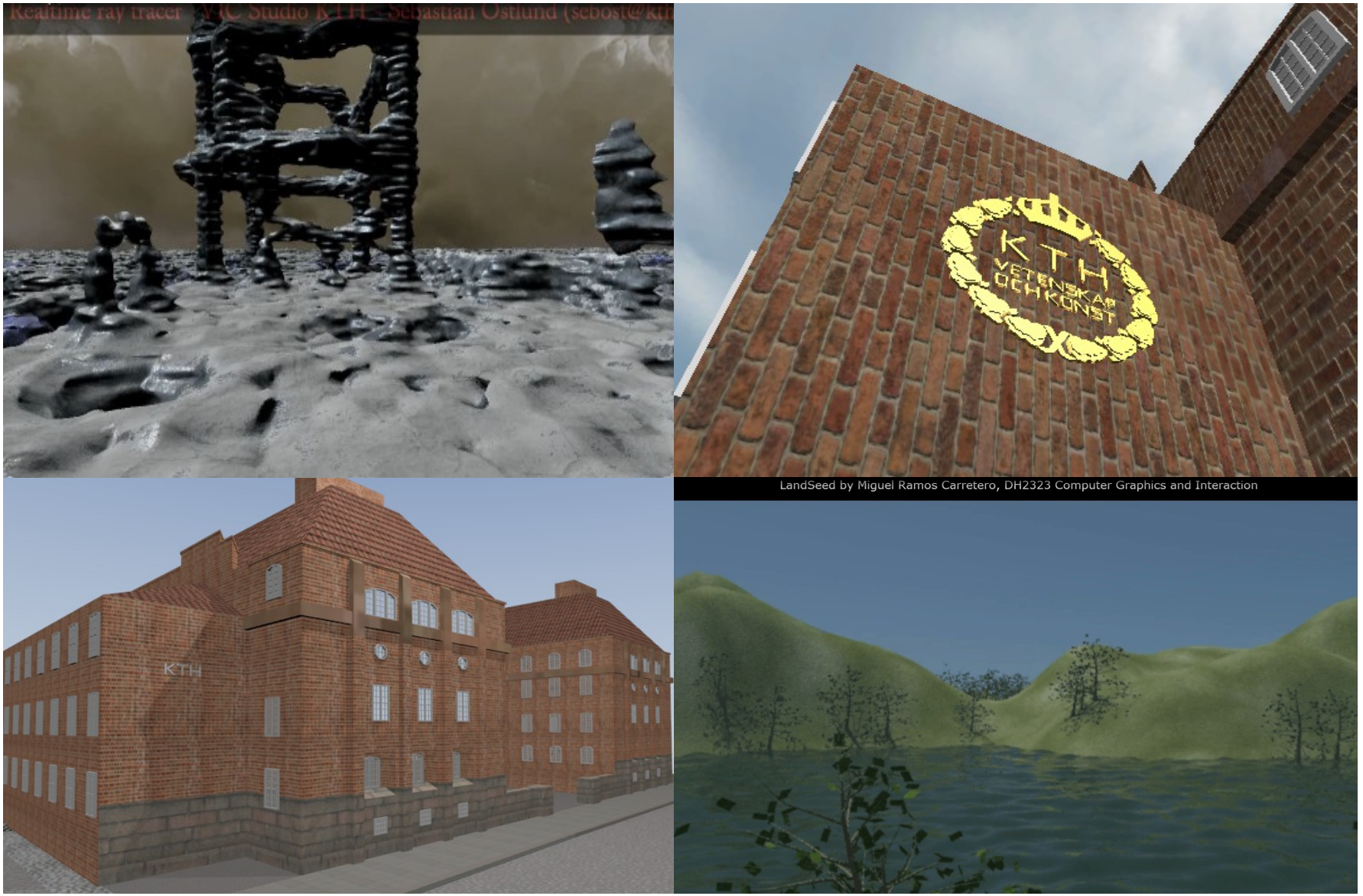
Grading

- To pass:
  - Must do all the labs and a small project
    - Example small project: extend the labs (the lab tasks contain suggestions)
    - Grade D
- To excel:
  - More substantial projects lead to higher grades
    - See project requirements and blogs from previous year

Projects


KTH
VETENSKAP
OCH KONST
LandSeed by Miguel Ramos Carretero, DH2323 Computer Graphics and Interaction
KTH

Tools and SDKs (top-down)

Incremental Projects + MSc Theses

E-motion, Miguel Ramos Carretero

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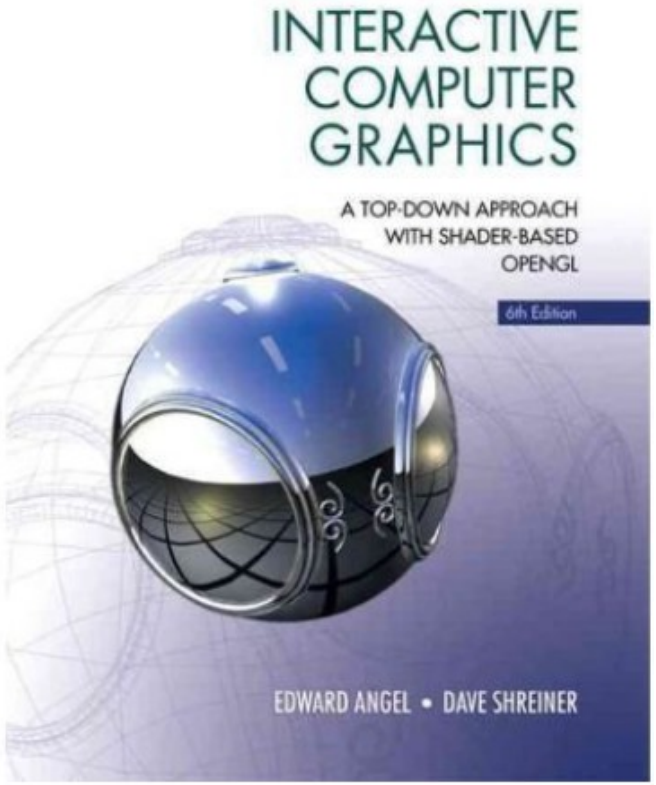
Course Literature

- Interactive Computer Graphics, Angels and Shreiner
- 651kr (link: not so cheap...)



Note: book cover may differ from the above

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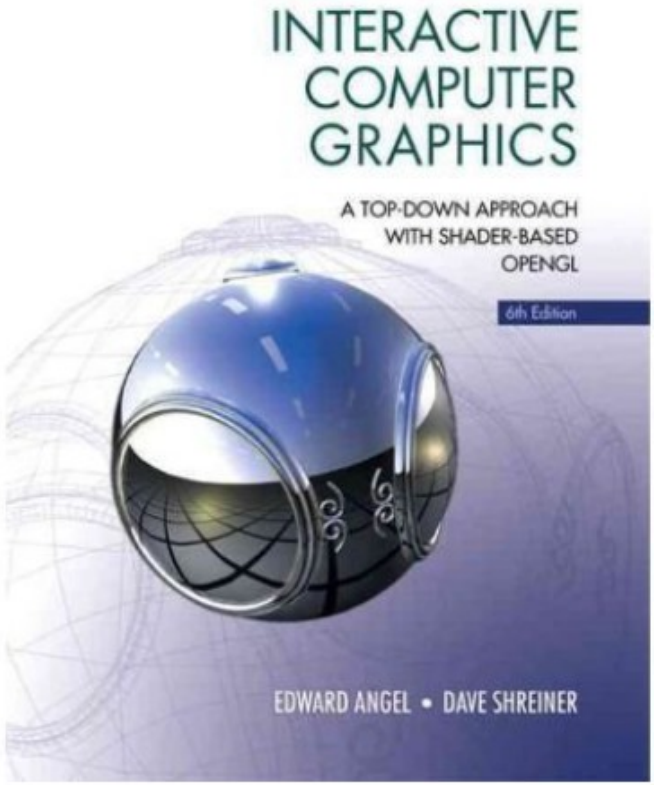

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Advice:

You do not need to buy if you are prepared to search

But you could if would like a good all-in-one reference

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Computer Graphics

Wordnet

- *S: (n) computer graphic (an image generated by a computer)*
- *S: (n) computer graphics (the pictorial representation and manipulation of data by a computer)*

Wikipedia

- *Computer graphics are graphics created using computers and, more generally, the representation and manipulation of image data by a computer...*

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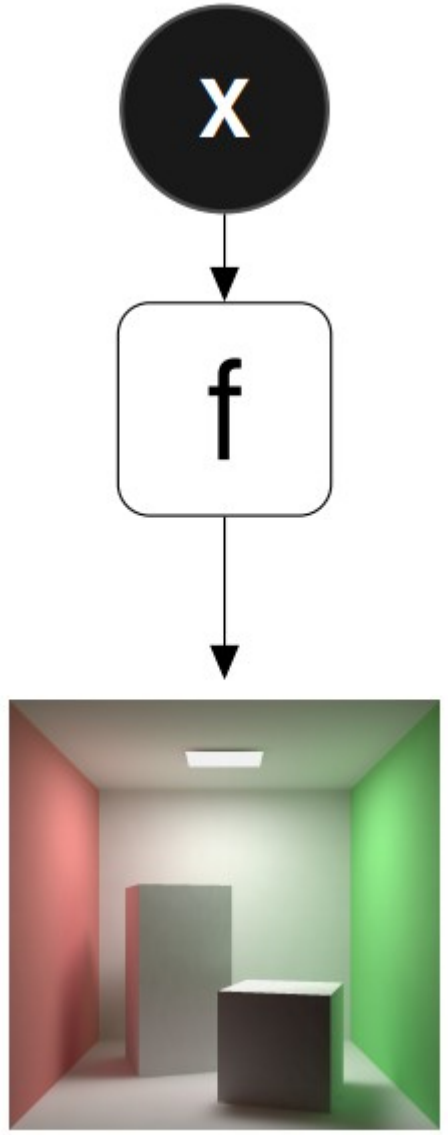
Modelling

- An underlying process generates observations
- Describe the observations (i.e. images) through *parameterising* the process
- Parameters can be varied to vary the output observation
- Can control generation



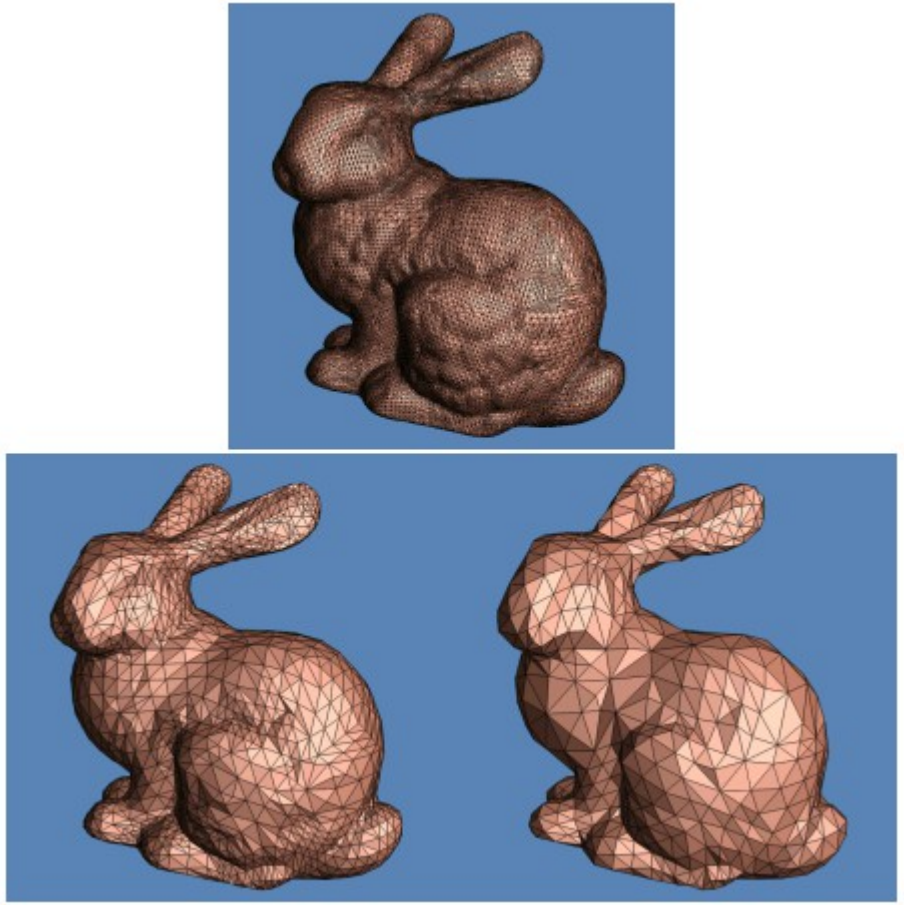
Some Scene Constituents

- **Geometry**

Defines objects

Triangle meshes

Implicit surfaces



Some Scene Constituents

- **Surface properties**

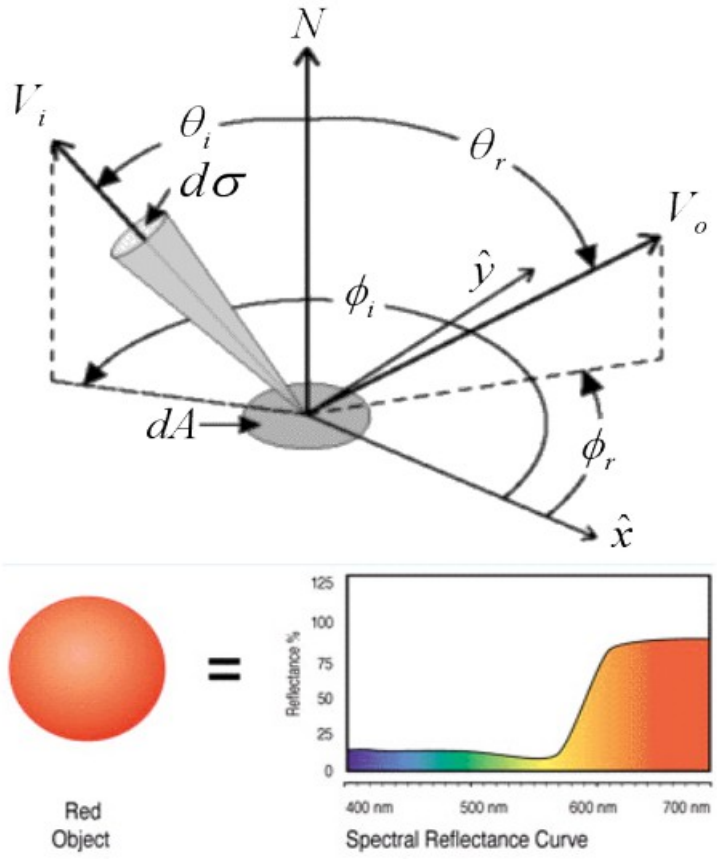
Related to geometry

Does/how does a surface reflect light?

Texture

Bounce

Reflectance



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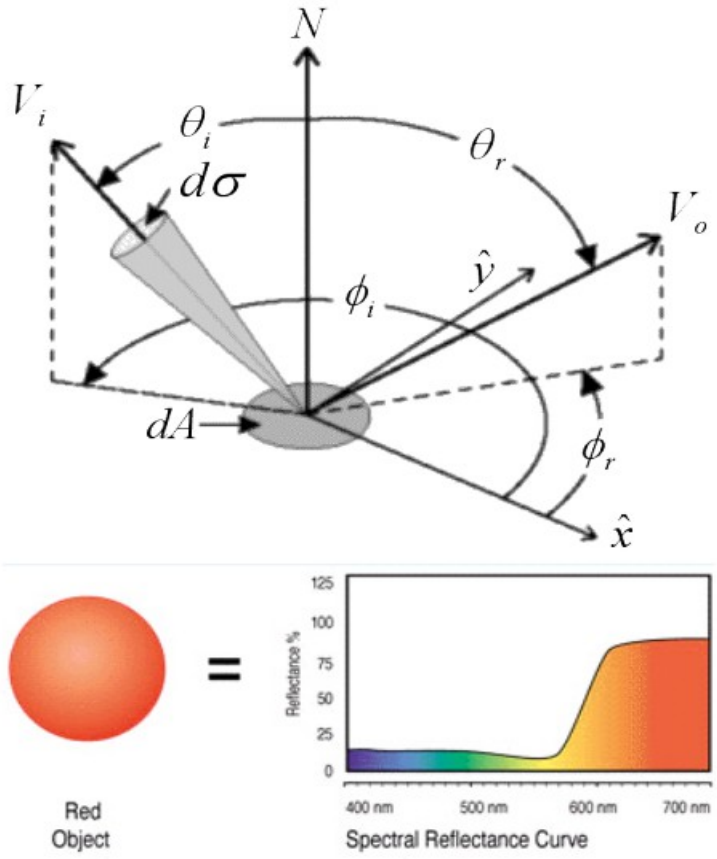
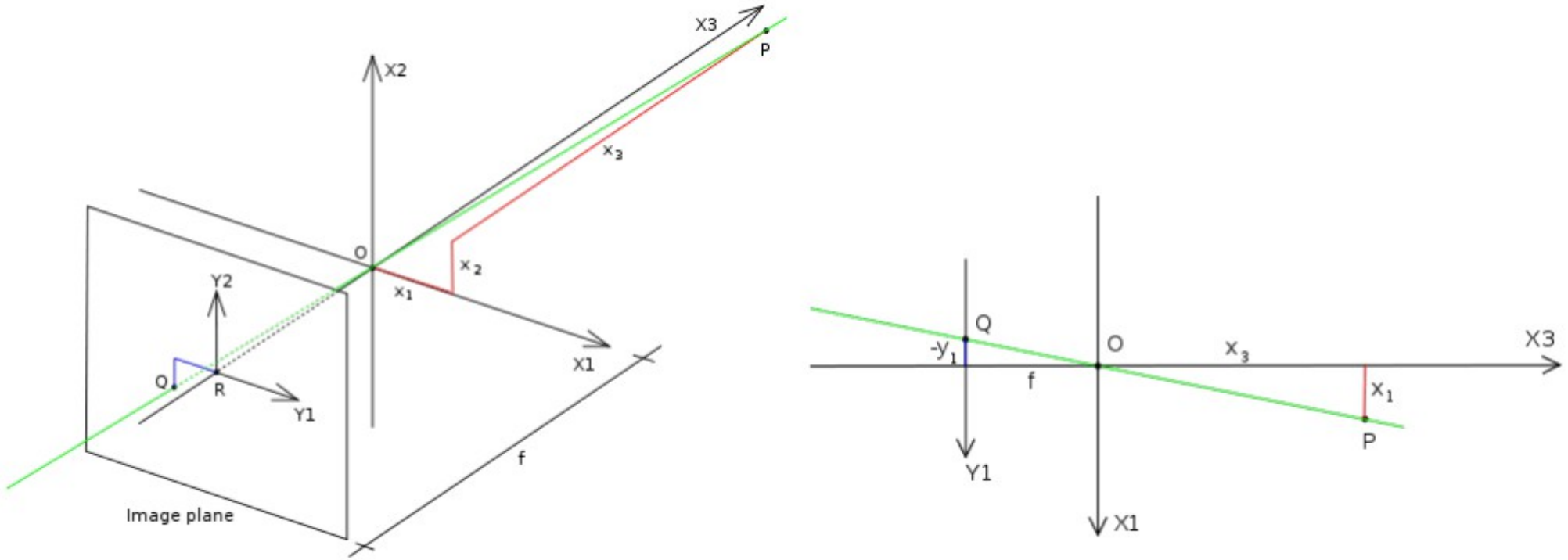


Light transport model

Perspectives

- **Camera Model**



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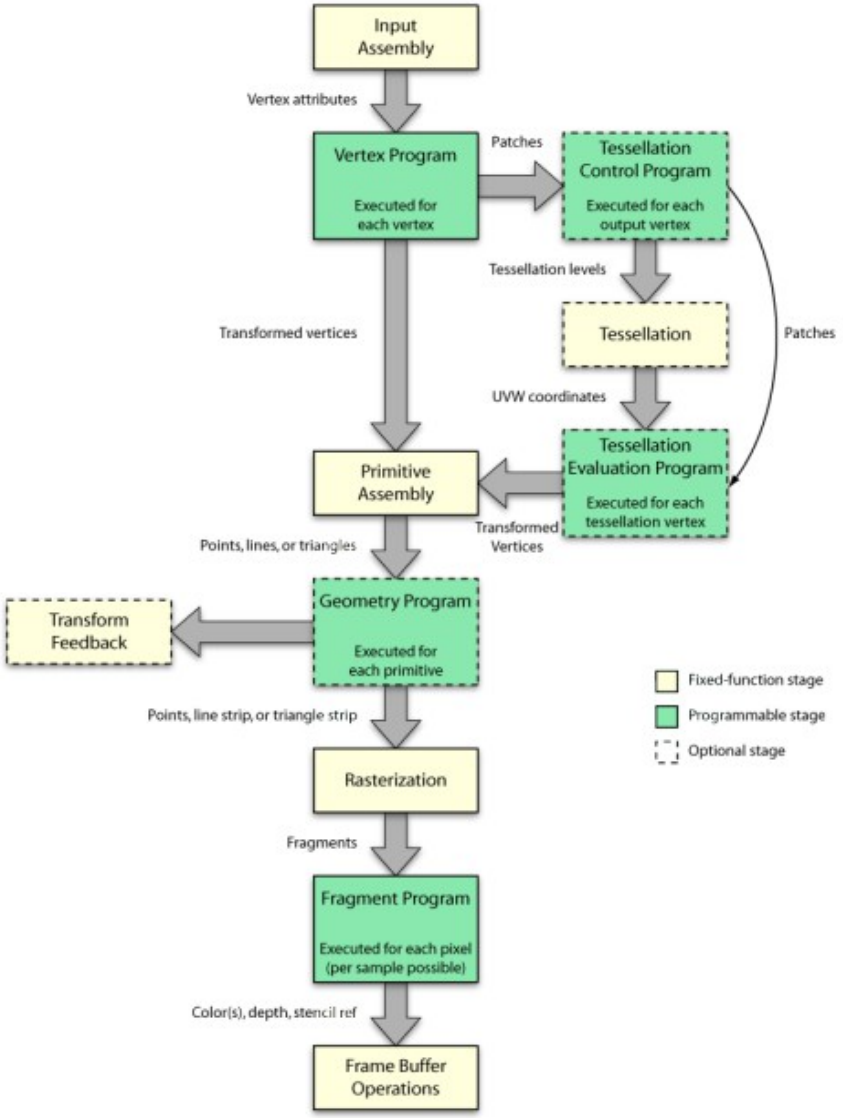
Graphics Pipeline

- Computer graphics API's
  - OpenGL
  - DirectX
- Hardware vs Software
- Shaders



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Modelling Issues

- Assumptions and approximations underpin all models
- Theory of Relativity vs. Newtonian Physics models
- Why are approximations necessary for interactive computer graphics?
- Important to understand exactly what assumptions/approximations are being made

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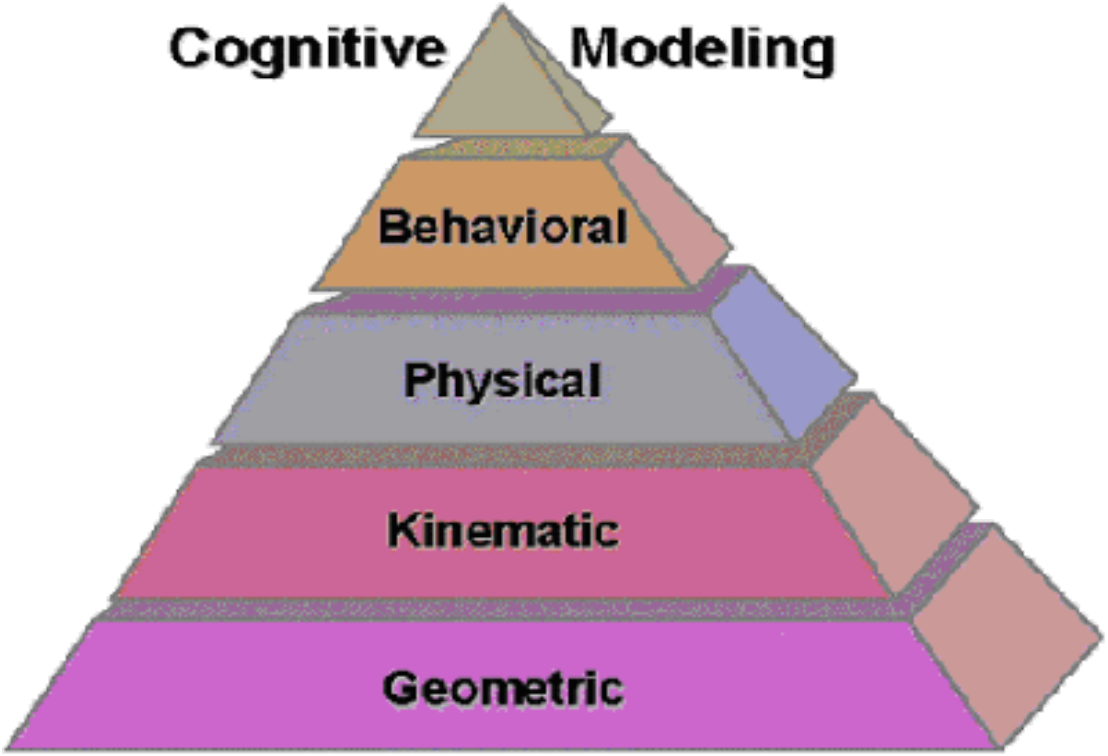
Computer Graphics Pyramid

- Rendering and animation
- Quality
- Speed



Cognitive Modelling: Knowledge Reasoning and Planning for Intelligent Characters, Funge, Tu and Terzopoulos

Character Animation

Toy Story

The Polar Express

- Rendering and animation qualities
- Uncanny valley, human perception of artificial behaviour

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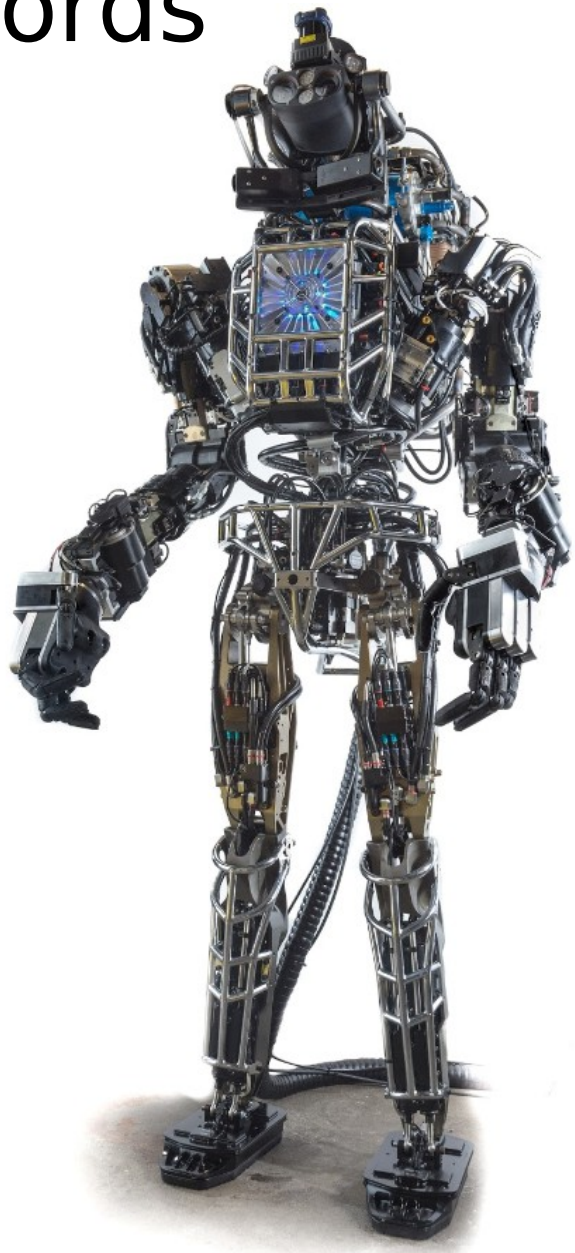
“All hail our robot overlords”



Atlas, Boston Dynamics

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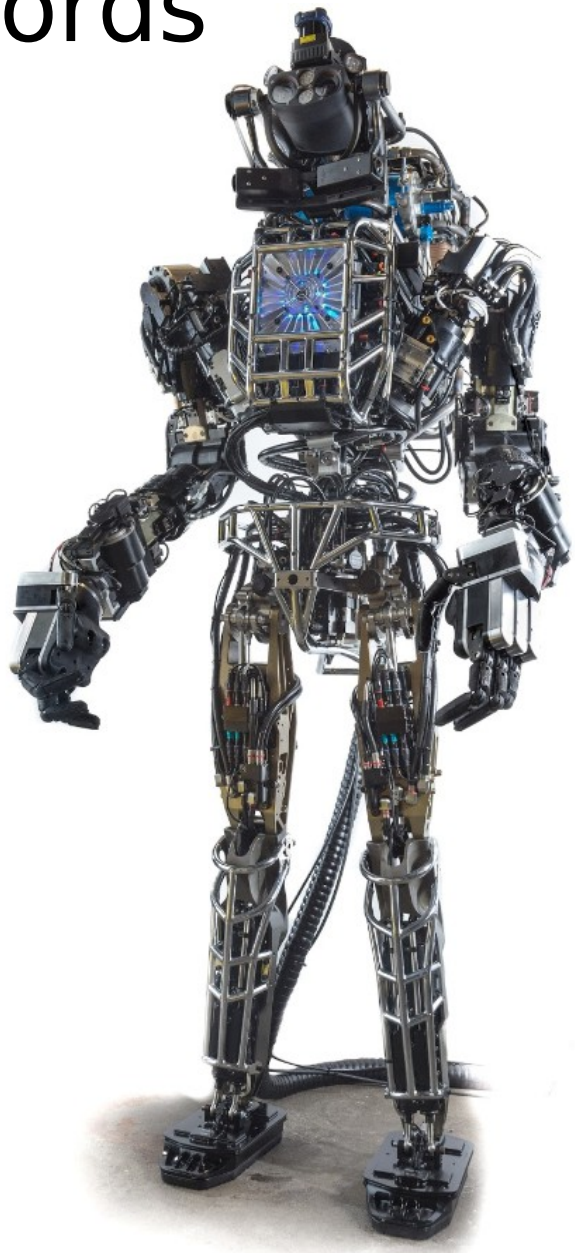
“All hail our robot overlords”

BigDog, Boston Dynamics



Atlas, Boston Dynamics

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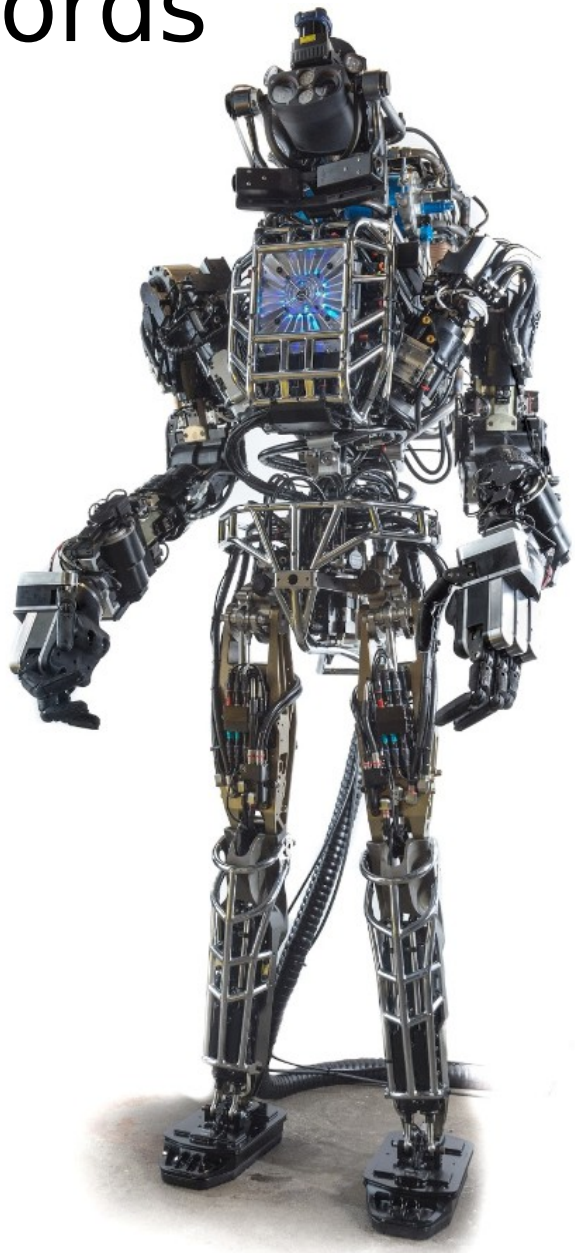
“All hail our robot overlords”

Geminoid F

BigDog, Boston Dynamics



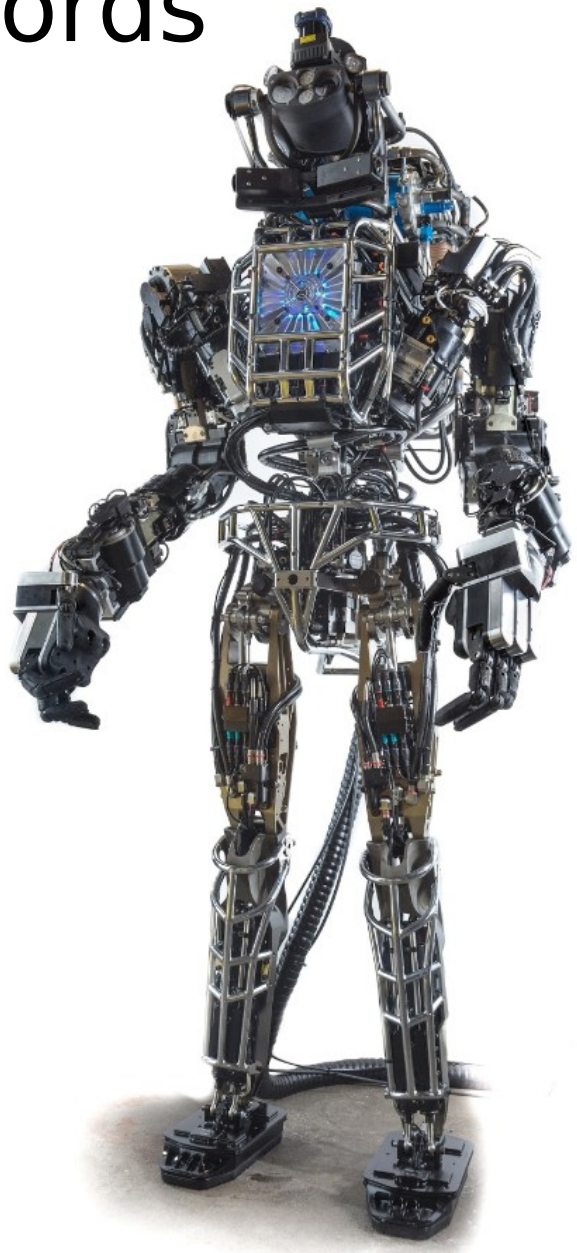
Atlas, Boston Dynamics

“All hail our robot overlords”

Paro

Geminoid F

BigDog, Boston Dynamics



Atlas, Boston Dynamics

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Recommended for next week

- Make sure that you are actually registered for the course
  - See if you can access KTH Social
- Attempt to get a basic C/C++ programming environment set up
  - Look at the first lab assignment
  - All have been posted
- For Mac:
  - Options: use *VirtualBox* or *Bootcamp*

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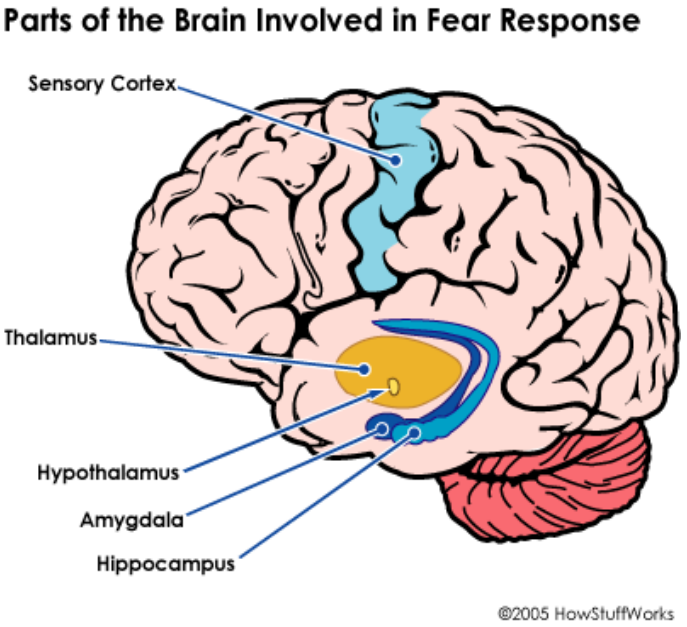
Remember

- Next lecture is Wednesday 25th March
- 15:00 – 17:00 L1
- And...

Remember

- Next lecture is Wednesday 25th March
- 15:00 – 17:00 L1
- And...



Don't panic!