



DH2323 DGI16

COMPUTER GRAPHICS AND INTERACTION

INTRODUCTION

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First of all

Lectures today
Breaks and timing
Class composition

What is DH2323?

Introductory course on computer graphics
and interaction

Real-time rendering and animation

Focused on fundamentals

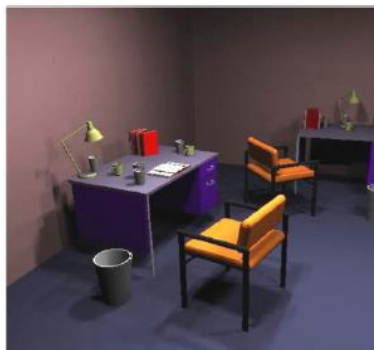
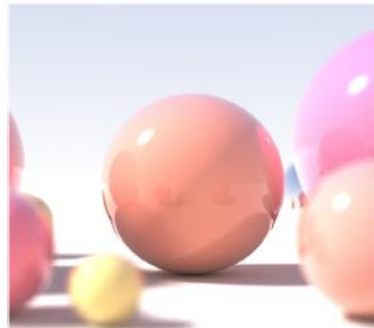
Two perspectives

- Bottom-up (basic OpenGL)
- Top-down (game engines)

Algorithms and programming

Adaptable to individual interests

Pretty pictures + fun



"Distant Shores" by Christoph Gerber



The (Awful?) Truth

Interactive computer graphics is essentially:

The (Awful?) Truth

Interactive computer graphics is essentially:

(wait for it...)

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:

Mathematics programming

“It's matrices all the way down!”



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*

Beware

Mathematics programming

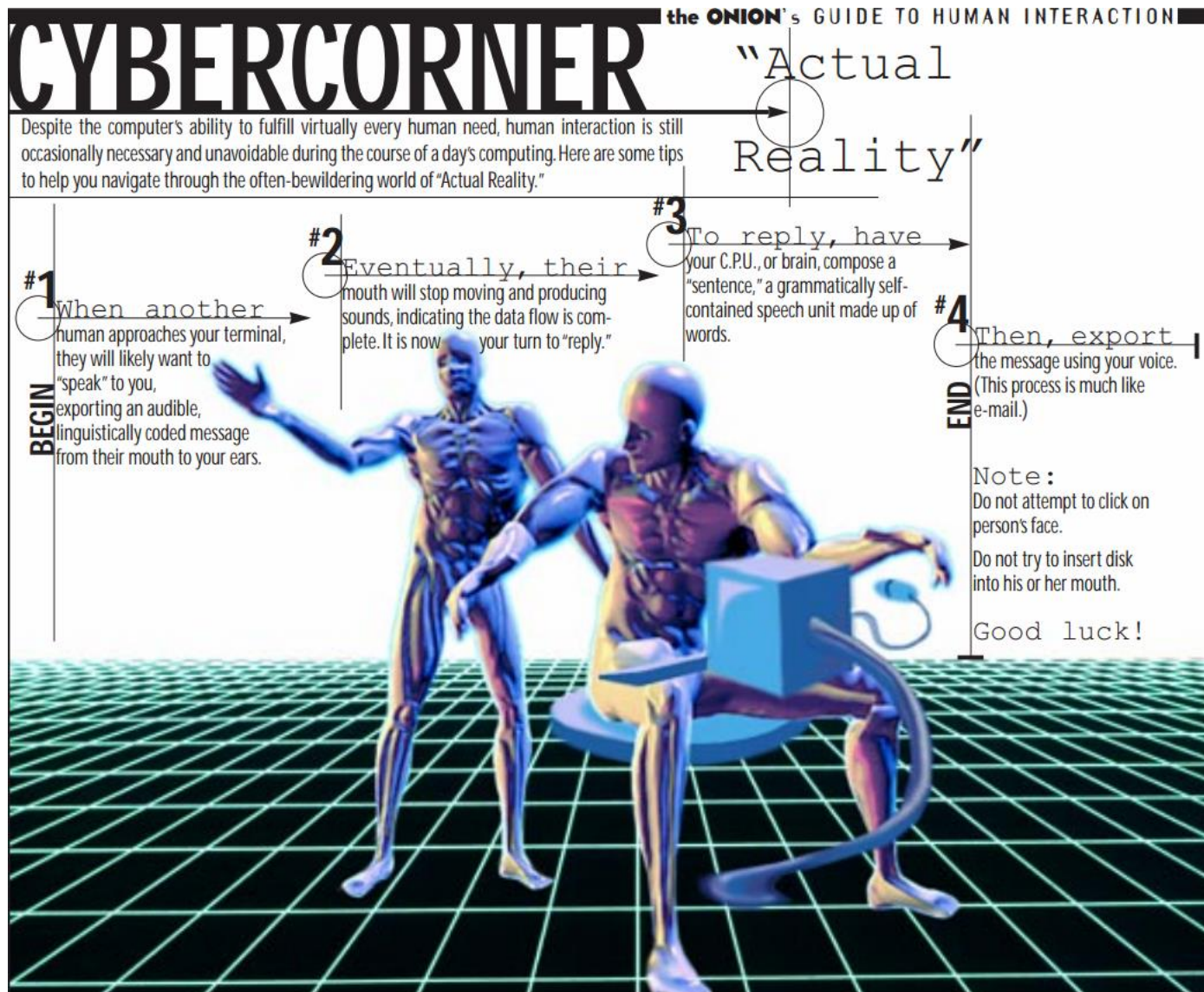
>

(Mathematics

+

programming)

What about interaction?



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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

Computer Games



ARMA 3, Bohemia Interactive

Hollywood FX



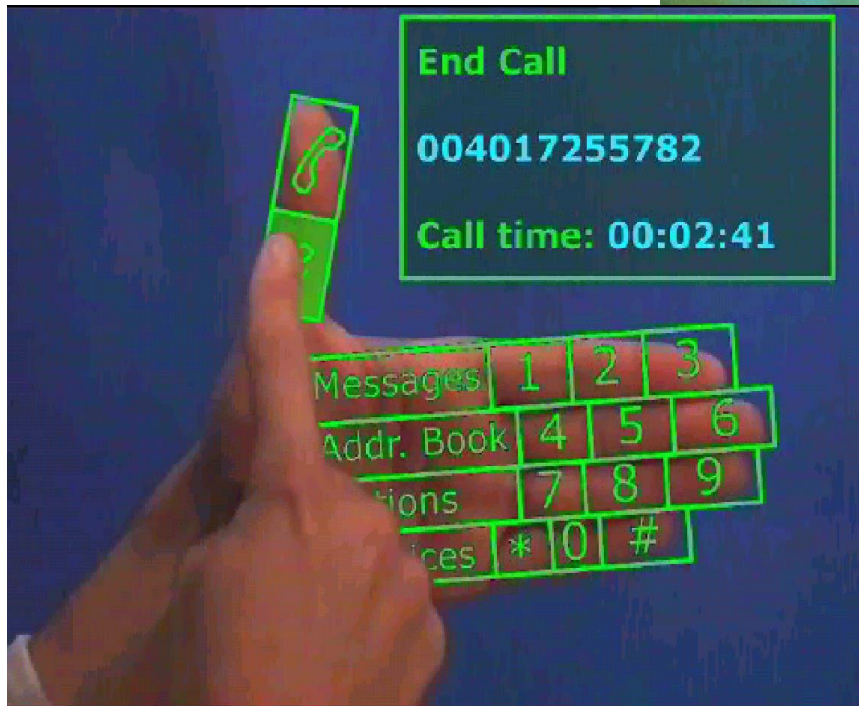
Information Visualisation



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



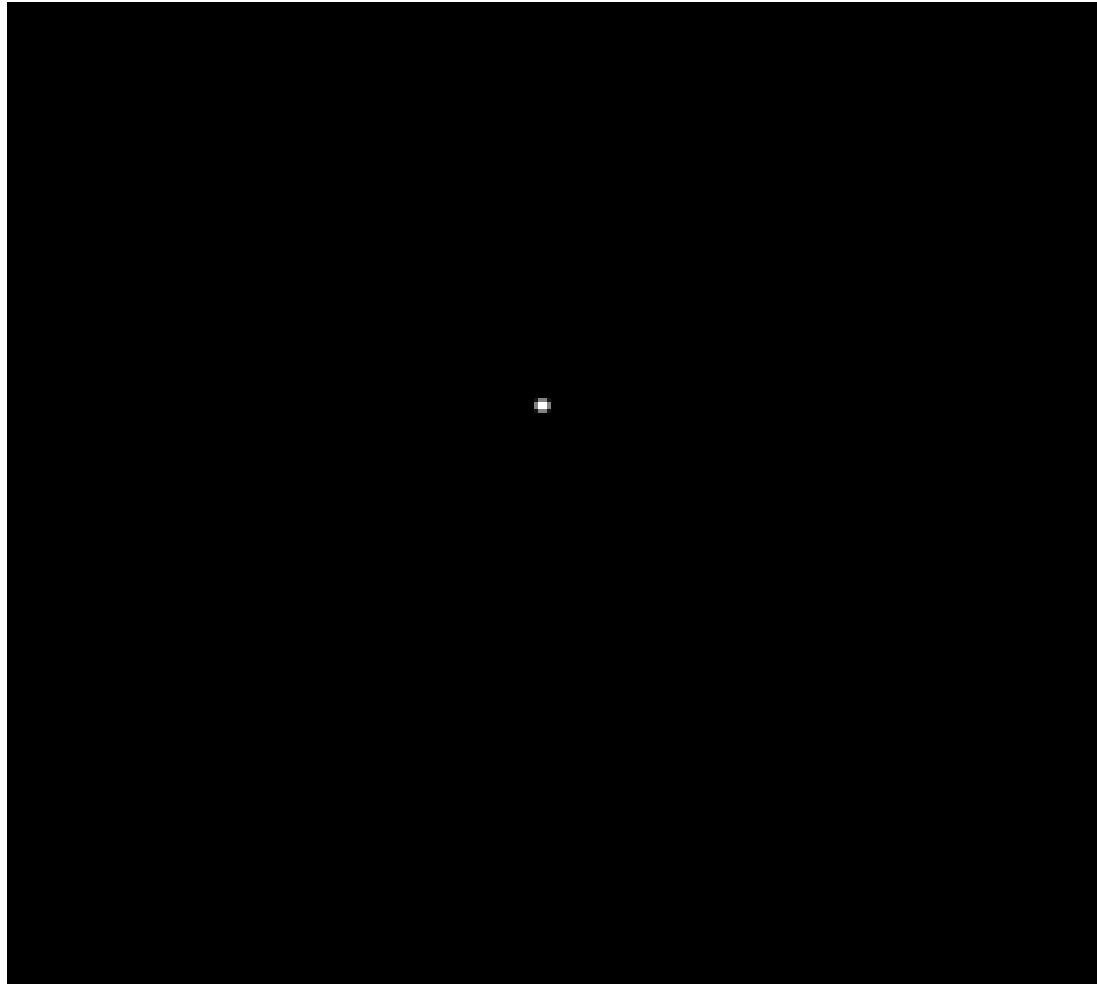
intuition-eunetwork.org

Where does it all lead?



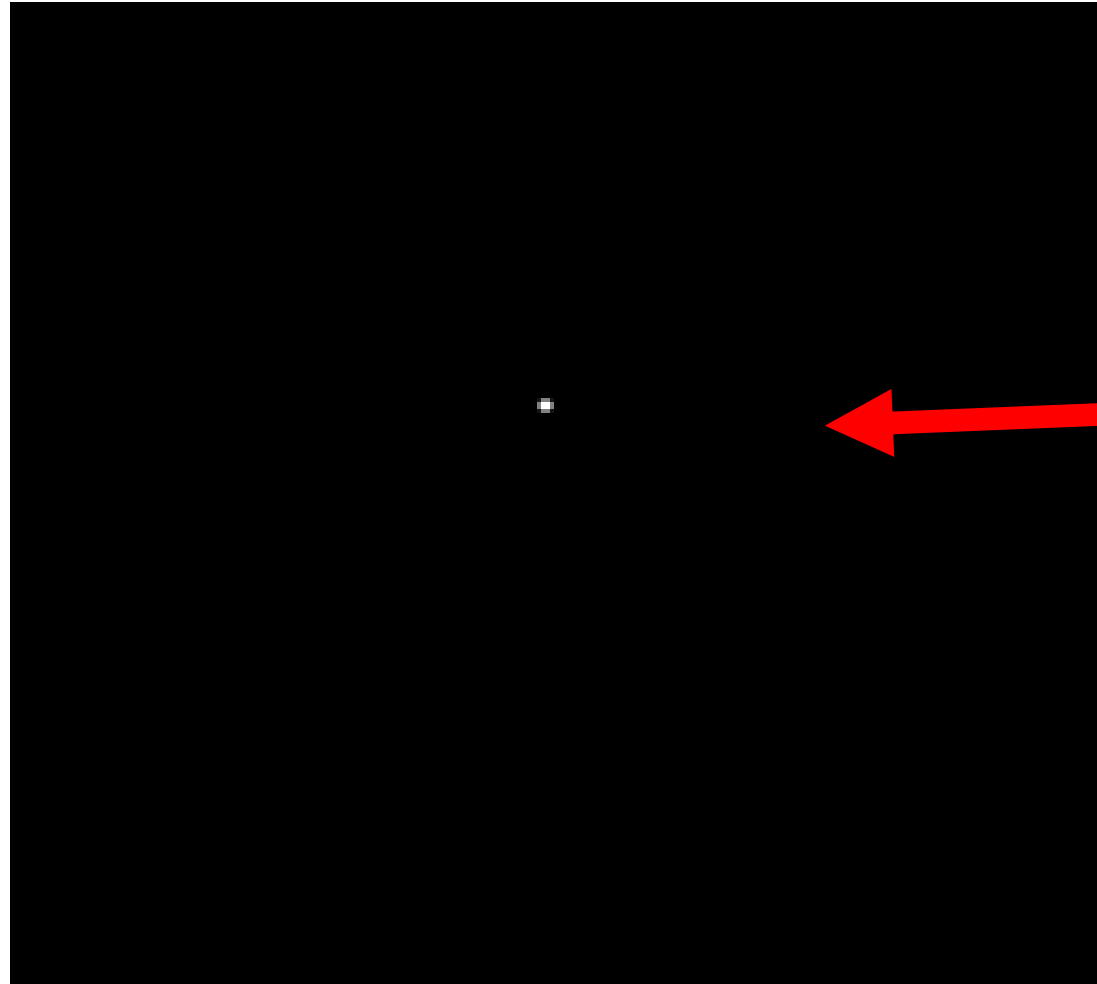
The Matrix, Warner Bros. Pictures

Be prepared



Likely output of your first program
(if you are lucky...)

Be prepared



Not the Matrix

Likely output of your first program
(if you are lucky...)

But remember

“A journey of a thousand miles begins with a single step”

Or in this case, “a single pixel”

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 (next lecture)

**This is not a programming course*

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

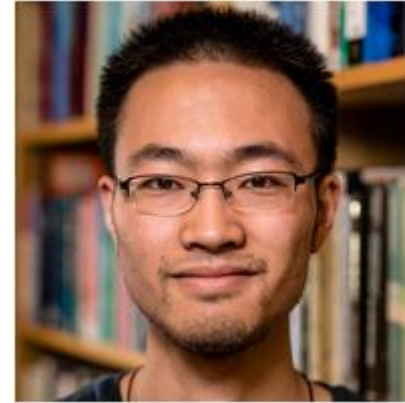
Who you will be

- 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 more to show for it beyond a grade

Course Team

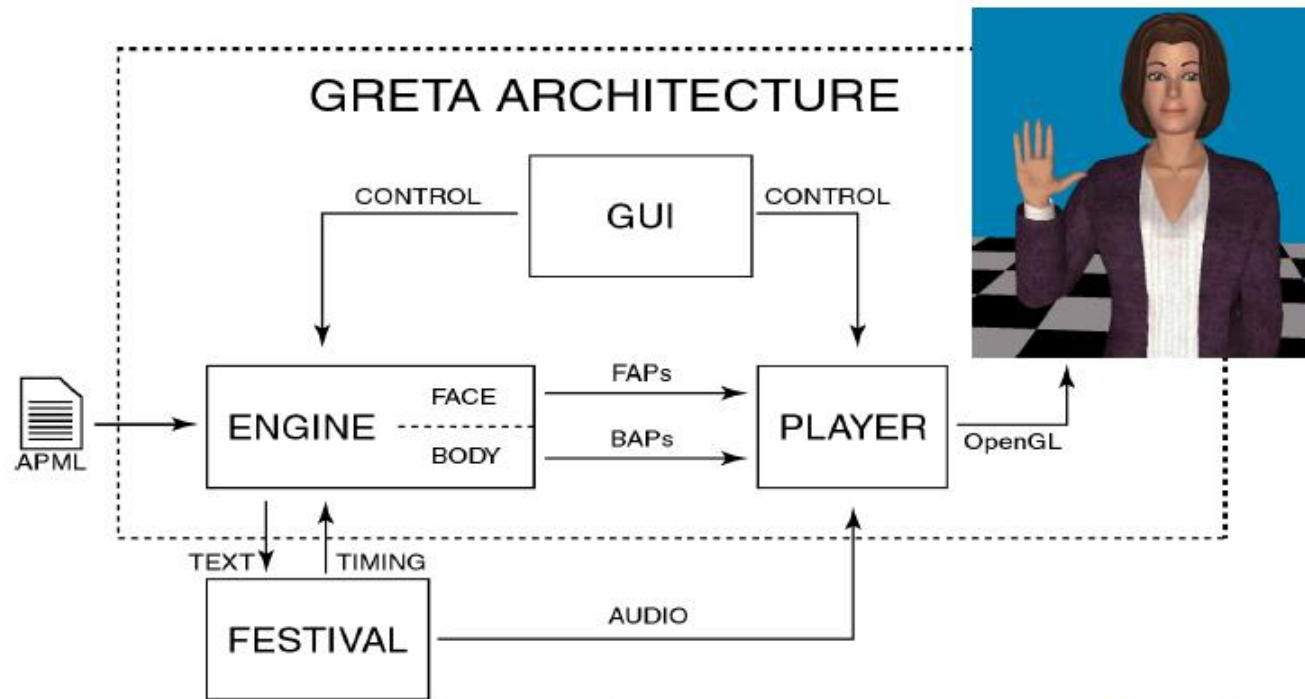


- Christopher Peters
 - email: chpeters@kth.se
 - <https://www.kth.se/profile/chpeters/>
- Associate Professor
- Character and crowd animation, games, perception, *Havok*, human-machine interaction (agents, social robots)



- Fangkai Yang
 - email: fangkai@kth.se
 - <https://www.kth.se/profile/fangkai/>
- PhD candidate
- Collision detection, character and crowd animation, games, *Avalanche game studio*

Real-time Computational Models



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

Example: Superposition of Sadness and Joy



Joy



Sadness

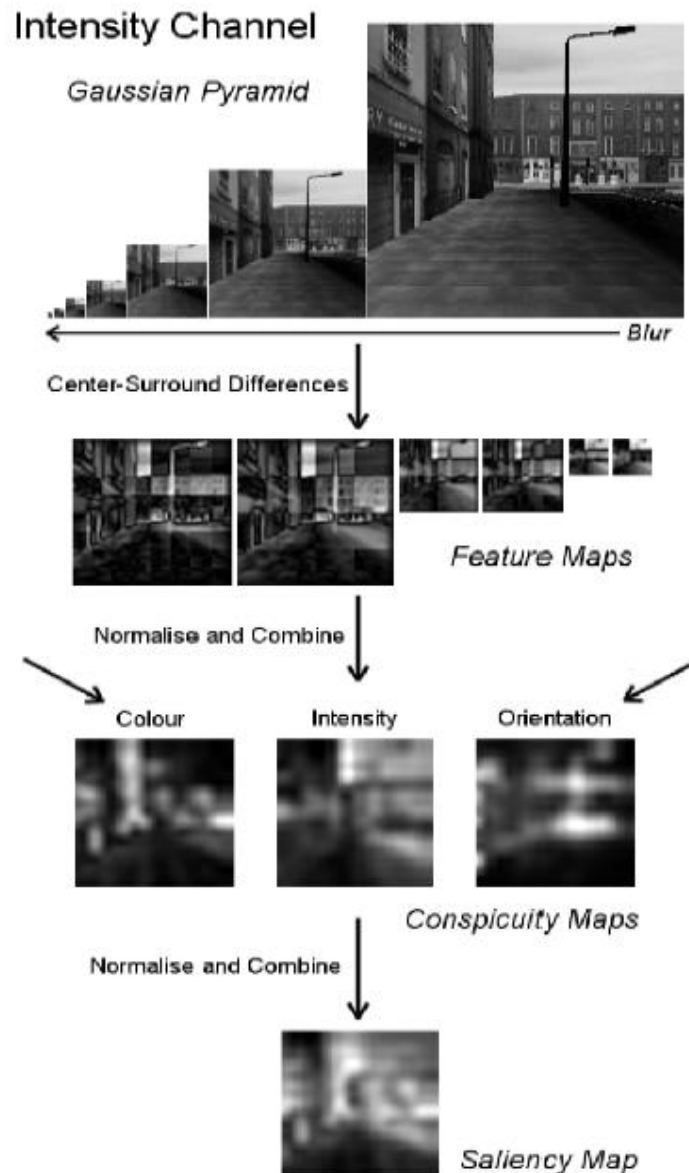


Original video

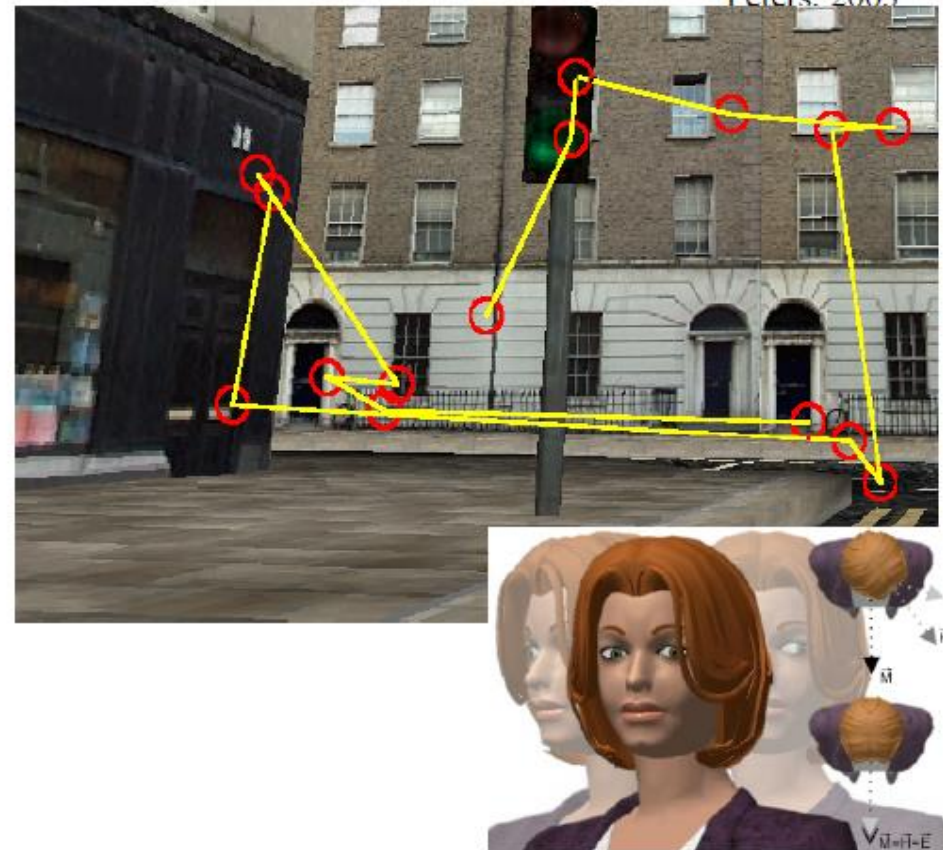


Sadness and Joy

Computational Visual Attention



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



Metropolis

Multisensory simulation of a populated city



Teaching

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

Related courses

- **DH2320**, Introduction to Visualization and Graphics
- **DD2257**, Visualization
- **DH2413**, Advanced Graphics and Interaction
- Visualization (VIC) Studio
4K screen, Oculus Rifts, eye-trackers, etc



This Course

Main webpage:

- KTH Social
- <https://www.kth.se/social/course/DH2323/>
- Everything that you need to know is there!

Bilda:

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



ROYAL INSTITUTE
OF TECHNOLOGY

Lecture overview

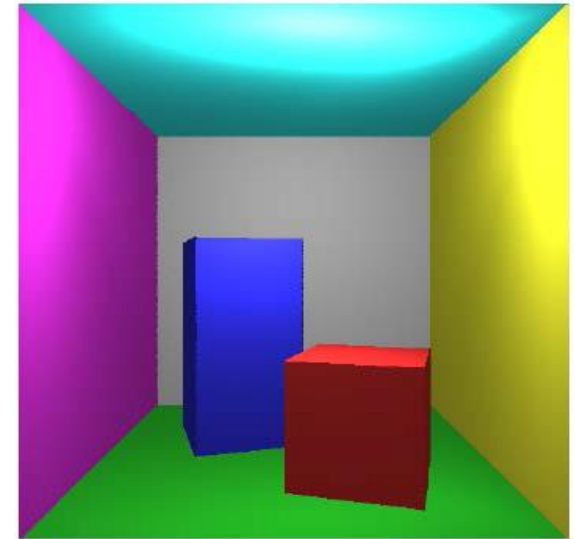
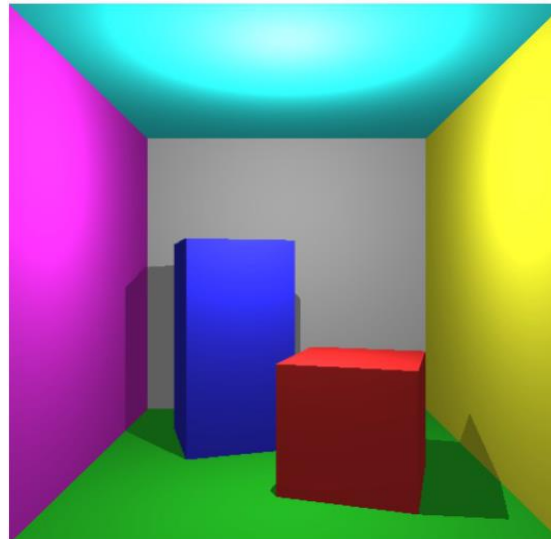
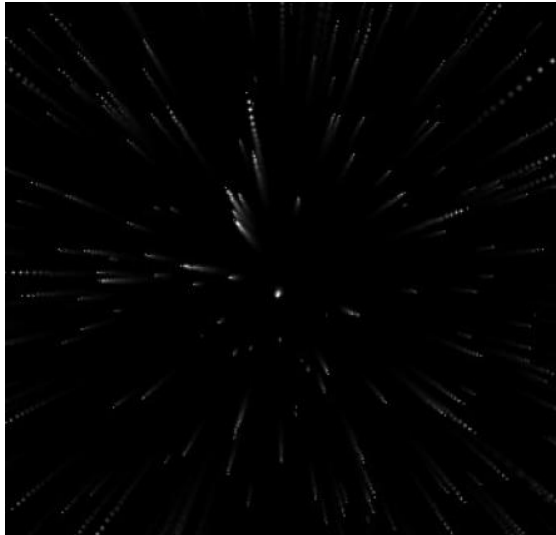
- Image modelling and rendering
- Mathematics for graphics
- Ray-tracing
- Rasterisation
- Real-time animation
- Lighting and shading

Assessment

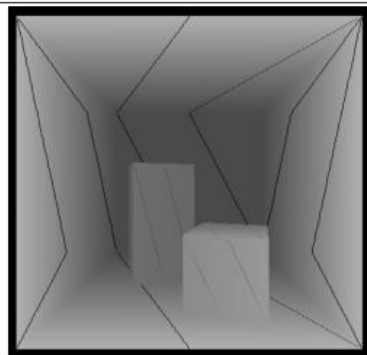
- Exam (replaced by project)
- Project
Individual or group project (1-3 members)
on a topic related to computer graphics and
interaction
- Lab work
Three practical assignments completed
individually or in groups of two

Lab work (bottom-up)

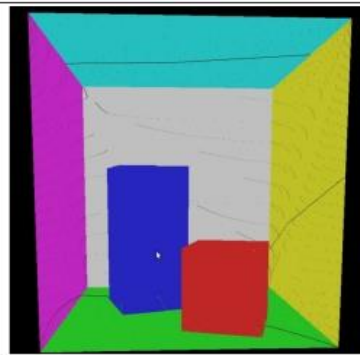
- Lab tracks
- There will be lab sessions (TBA)
- Attendance is *voluntary but recommended*
- Labs will be submitted to *Bilda* near the end of the course
 - Preliminary date: Friday 6th May 2016



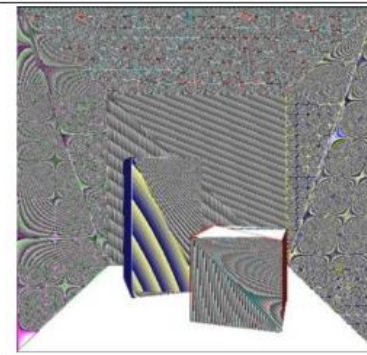
DGI Journal of Improbable Art



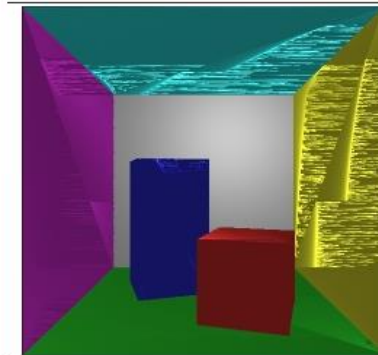
Jacob Florell, Sepehr Amoor Pour



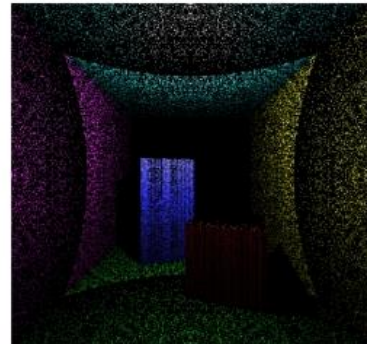
Jonathan Murray



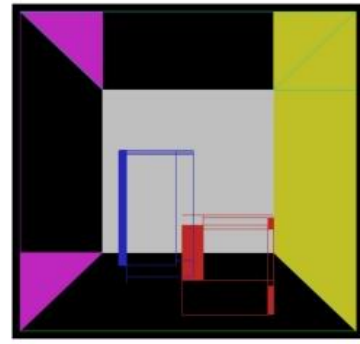
Jonathan Pellby



Ian Snow



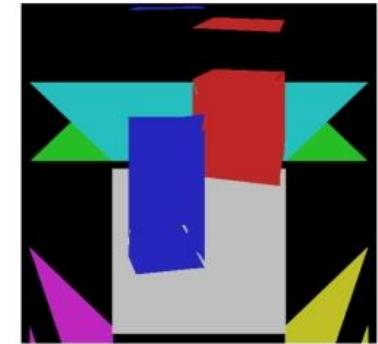
Magnus Olsson, Christoffer Wiss



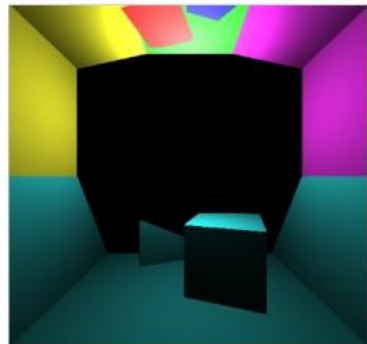
Petter Lundahl, Veronica Ginman



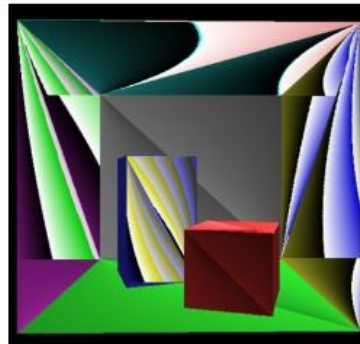
Philip Eliasson, Fredrik Lilkaer



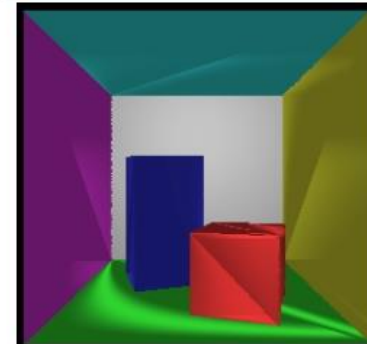
Iris Van Rooijen



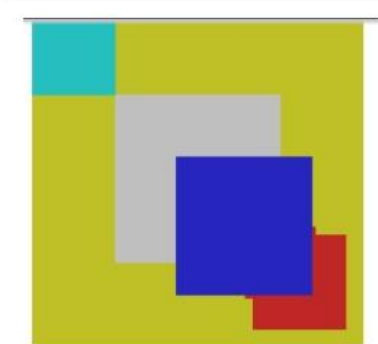
Terese Nothnagel



Viktor Collin, Simon Osterman



Vladimir Grozman



Carl Regardh

Projects

DGI15 Project Blogs



My Expressive Avatar: <https://myexpressiveavatar.wordpress.com>



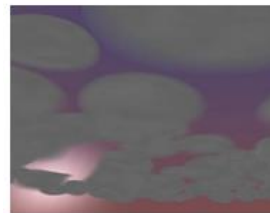
A short KTH student story: <https://campussimulation.wordpress.com/>



Virtual character animation with the Kinect: <http://graphics-project-dh2323.blogspot.se/2014>



Realistic skin shading: <https://portfolio-mskhan.rhcloud.com/my-custom-shader/>



Procedural clouds: <http://proceduralclouds.blogspot.de/>

Modelling a bus in Blender and exporting to the Unity game engine: <http://dh2323bus.wordpress.com/>



Stockholm terrain rendering from high res GIS data: <https://stockholmrender.wordpress.com/>

Tools and SDKs (top-down)



Incremental Projects + MSc Theses



E-motion, Miguel Ramos Carretero

Grading

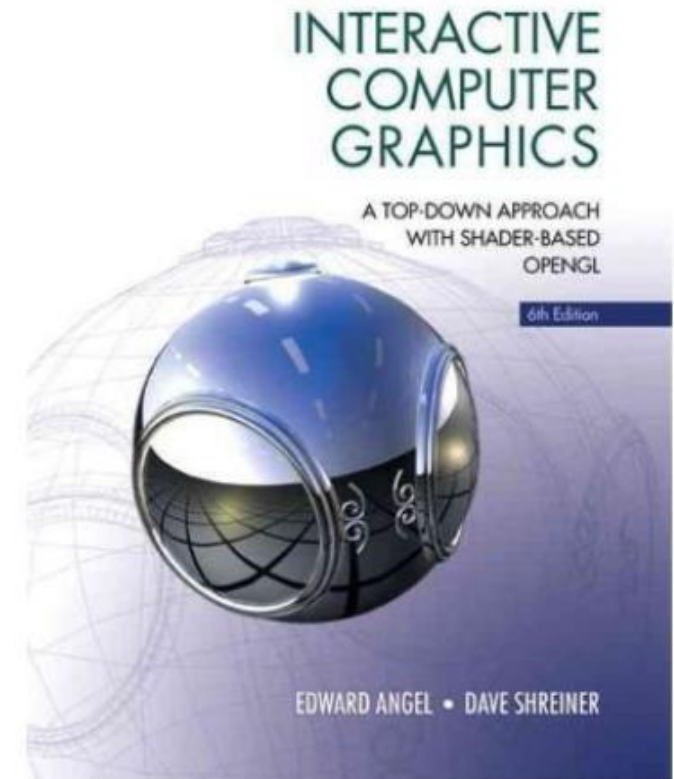
- To pass:
 - Labs are P/F
 - Must do all the labs and a small project
 - Labs: Lab 1 + one of the *lab tracks*
 - Example small project: extend the labs (the lab tasks contain suggestions)
 - Grade D

Grading

- To pass:
 - Labs are P/F
 - Must do all the labs and a small project
 - Labs: Lab 1 + one of the *lab tracks*
 - Example small project: extend the labs (the lab tasks contain suggestions)
 - Grade D
- To excel:
 - More substantial projects lead to higher grades

Course Literature

- Interactive Computer Graphics, Angels and Shreiner
- ~500kr (not so cheap...)



Note: book cover may differ from the above

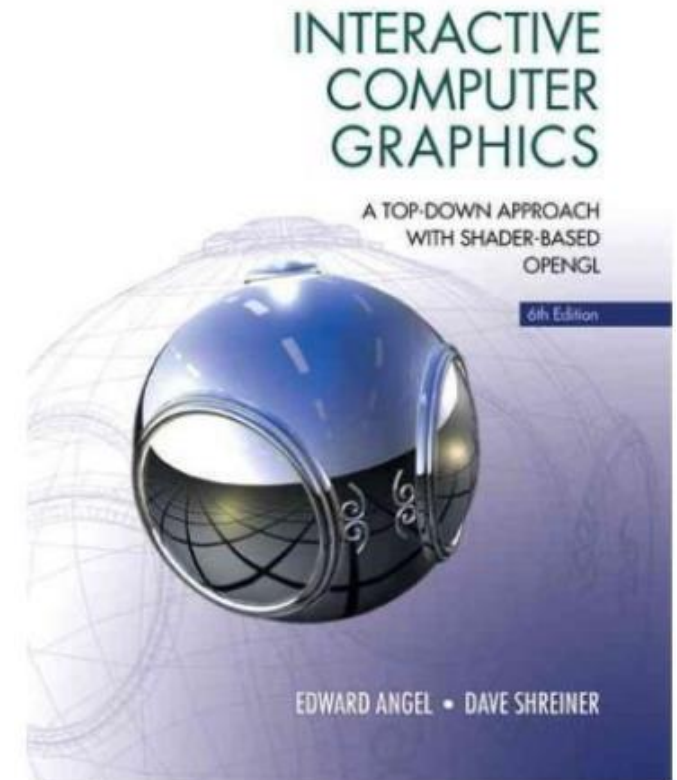
Course Literature

- Interactive Computer Graphics, Angels and Shreiner
- ~500kr (not so cheap...)

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



Note: book cover may differ from the above

Computer Graphics

Wordnet

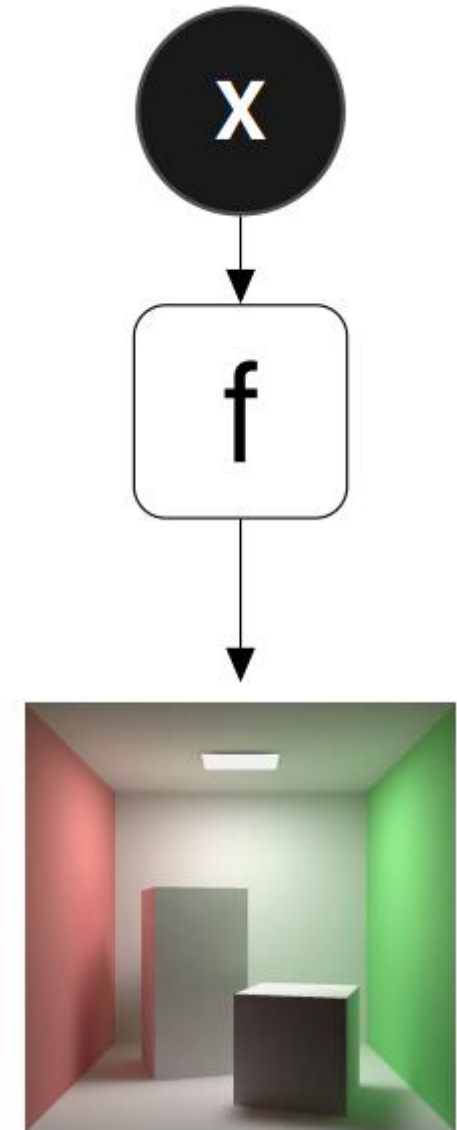
- *S: (n) computer graphic (an image generated by a computer)*
- *S: (n) computer graphics (the pictorial representation and manipulation of data by a computer)*

Wikipedia

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

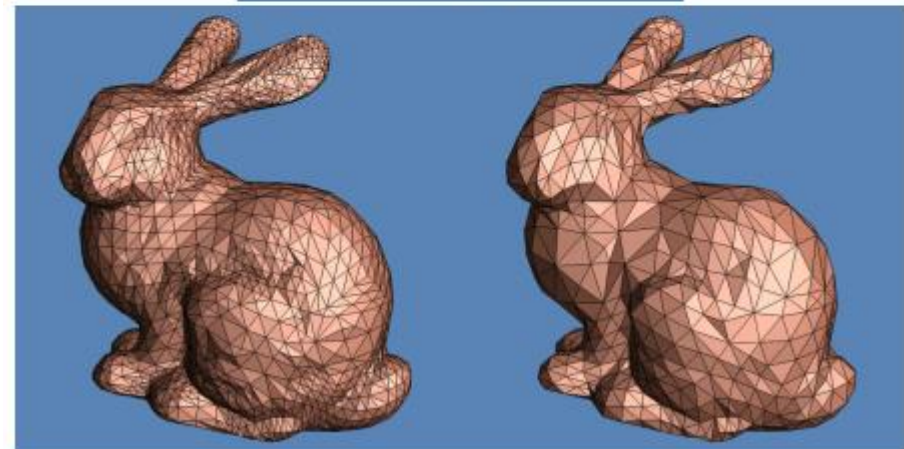
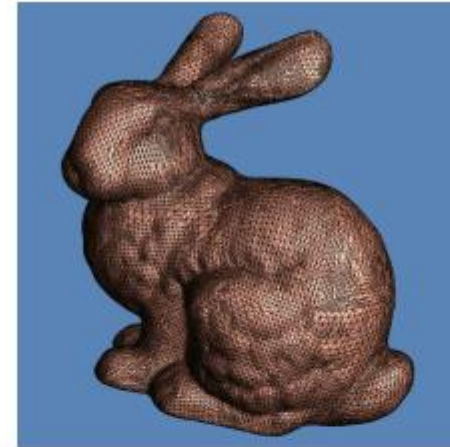
Modelling

- 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**

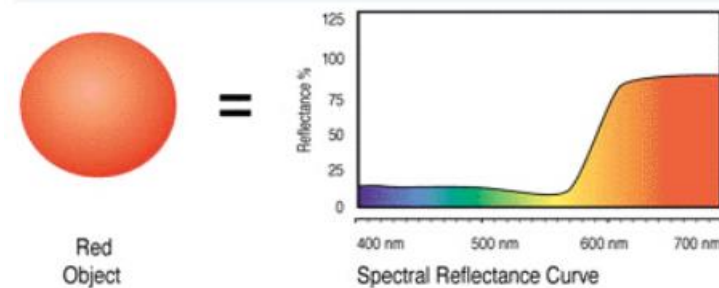
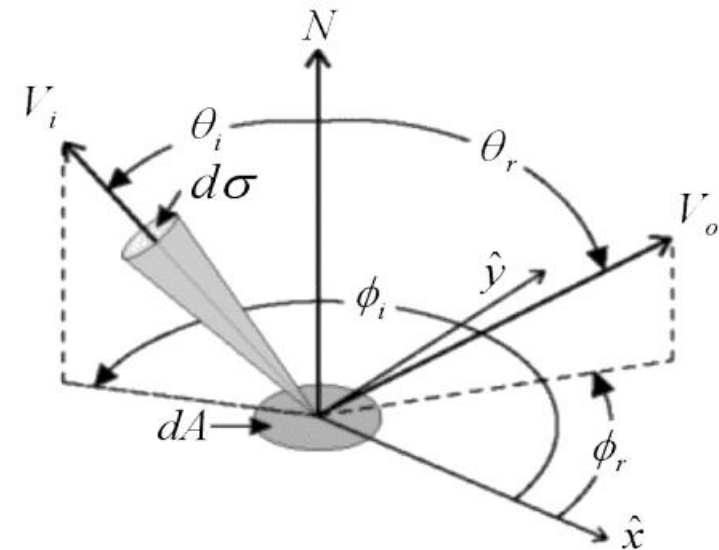
Related to geometry

Does/how does a
surface reflect light?

Texture

Bounce

Reflectance



Some Scene Constituents

- **Surface properties**

Related to geometry

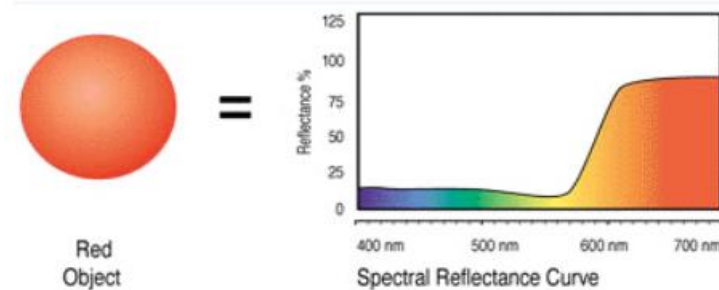
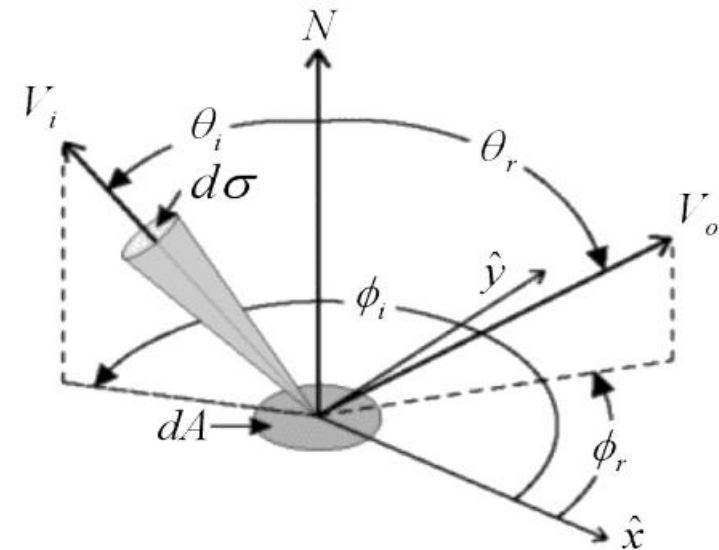
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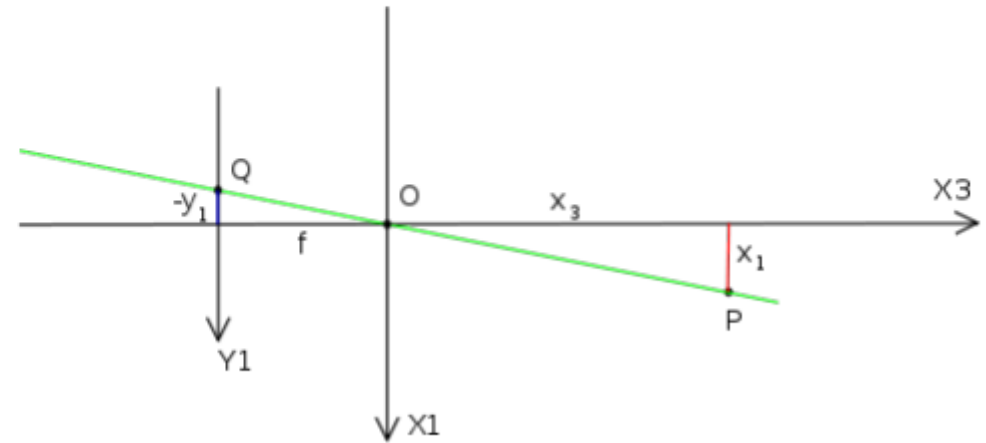
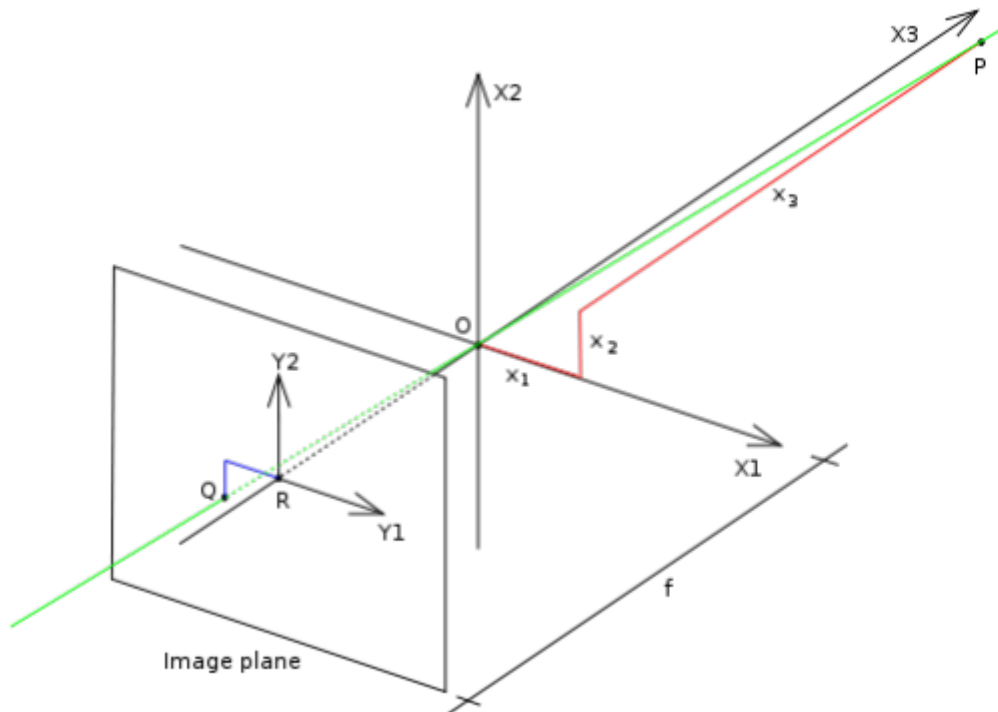
Reflectance

Light transport model



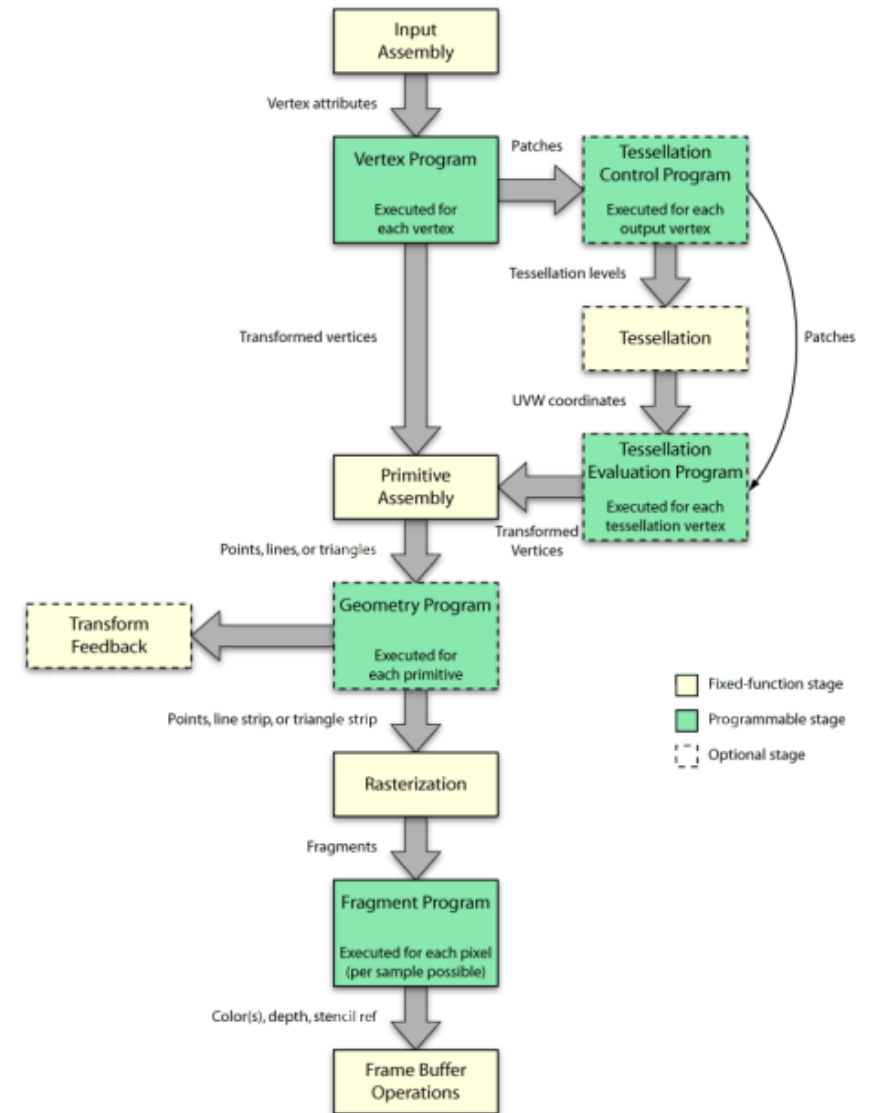
Perspectives

- **Camera Model**



Graphics Pipeline

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



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

Character Animation



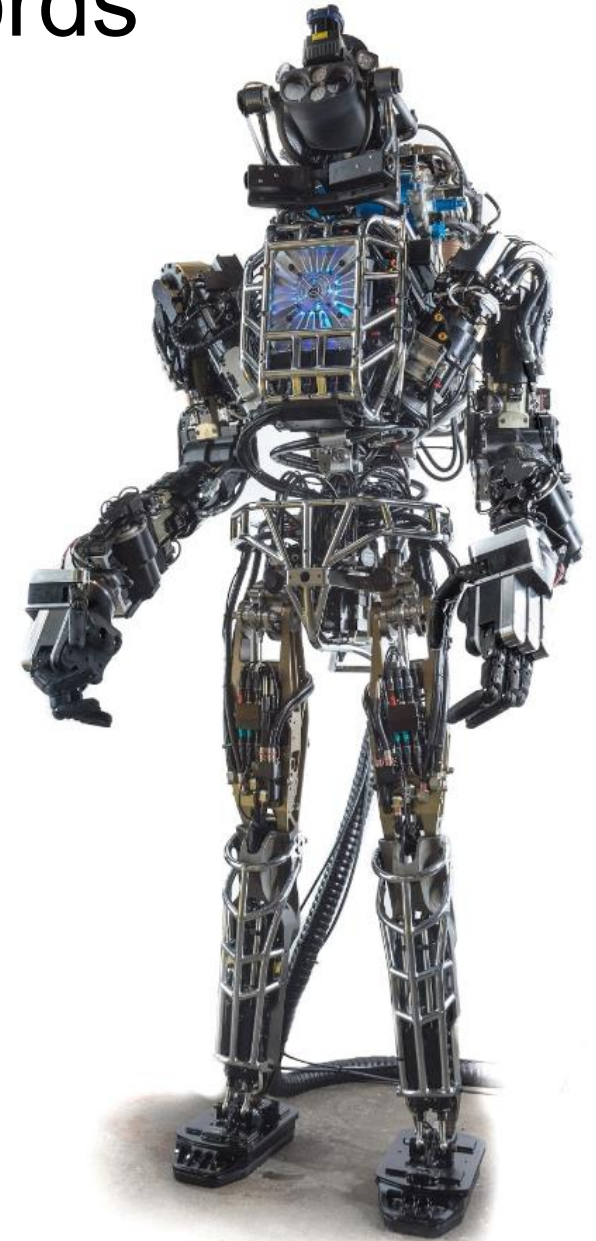
Toy Story



The Polar Express

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

“All hail our robot overlords”

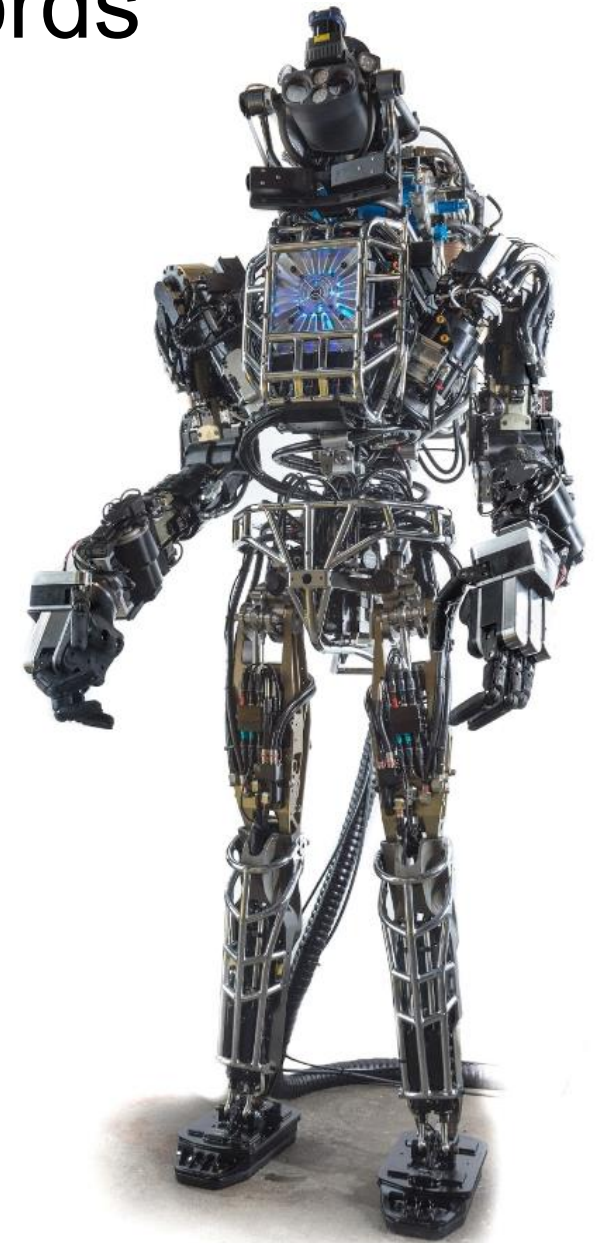


Atlas, Boston Dynamics

“All hail our robot overlords”



BigDog, Boston Dynamics



Atlas, Boston Dynamics

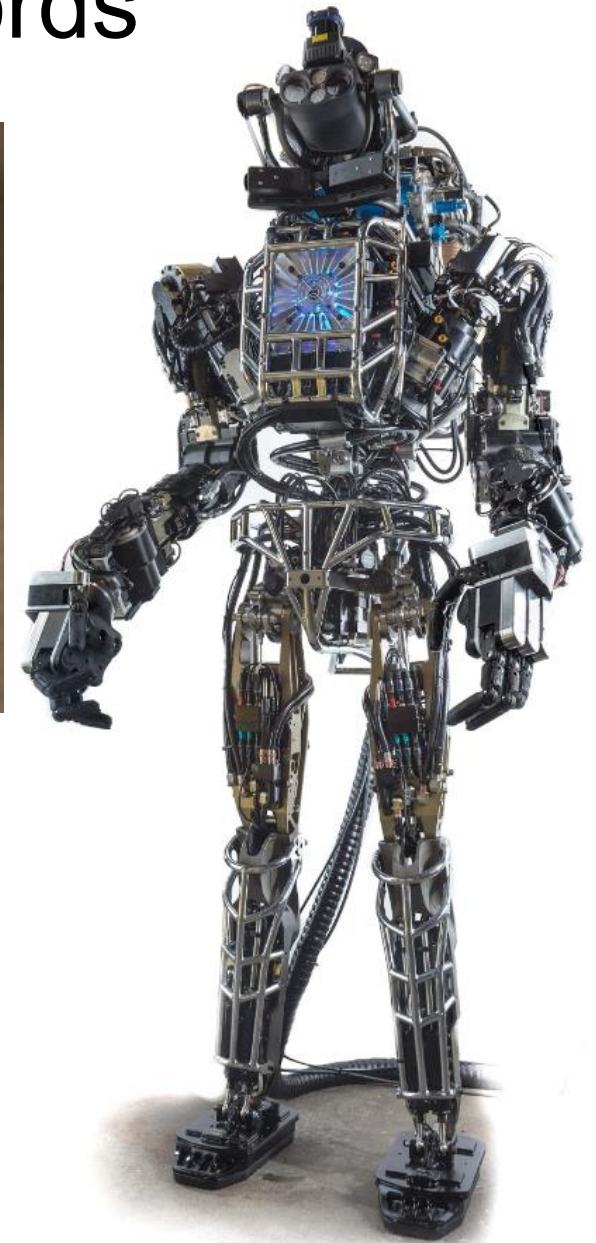
“All hail our robot overlords”



Geminoid F



BigDog, Boston Dynamics



Atlas, Boston Dynamics

“All hail our robot overlords”



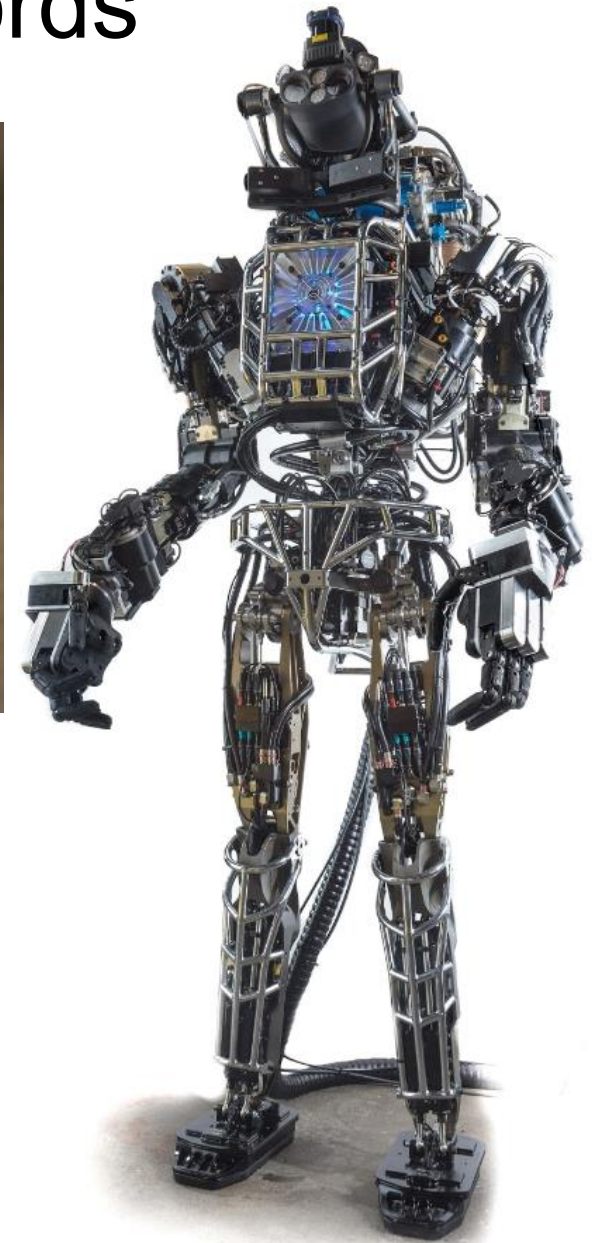
Paro



Geminoid F



BigDog, Boston Dynamics



Atlas, Boston Dynamics

Recommended to start soon

- 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 lab 1
- For Mac:
 - Options: use *VirtualBox* or *Bootcamp*

Next Lecture

- Next lecture is Wednesday 6th April
- 13:00 – 15:00
- Location TBA
- And...

Lab

- Monday 4th April
- 10:00 – 12:00
- 4V2Röd

Surname starting with A-M:

Attend the first hour of the lab (10-11a.m.)

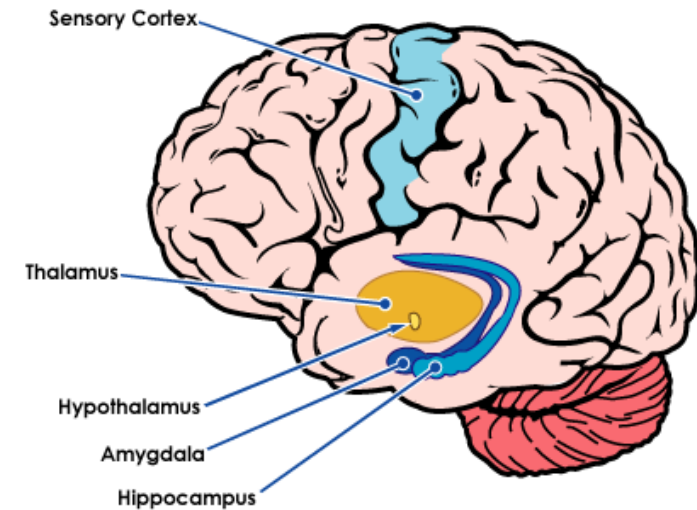
Others:

Attend the second hour (11-12)

And Remember...



Parts of the Brain Involved in Fear Response



©2005 HowStuffWorks

Don't panic!

Coming up now

C++ *Introduction*