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
The (Awful?) Truth

Interactive computer graphics is essentially:
The (Awful?) Truth

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(wait for it...)

(quote)
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?

CYBERCORNER

"Actual Reality"

1. When another human approaches your terminal, they will likely want to "speak" to you, exporting an audible, linguistically coded message from their mouth to your ears.

2. Eventually, their mouth will stop moving and producing sounds, indicating the data flow is complete. It is now your turn to "reply."

3. To reply, have your CPU or brain compose a "sentence," a grammatically self-contained speech unit made up of words.

4. Then, export the message using your voice. (This process is much like e-mail.)

Note:
Do not attempt to click on persons' faces.
Do not try to insert disk into his or her mouth.
Good luck!
Computer Graphics *and Interaction*

You do have to consider the human user in the loop

Core themes:
Interactive graphics techniques
Real-time user input and feedback

*Ivan Sutherland, Sketchpad demo*
Hollywood FX
Information Visualisation

IBM Research - Almaden
See: http://www.wired.com/wiredscience/2013/01/science-visualization-winners/
AR and VR

End Call
004017255782
Call time: 00:02:41

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

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

Not the Matrix
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

GRETA ARCHITECTURE

Example: Superposition of Sadness and Joy

Joy
Sadness
Original video
Sadness and Joy

See: Pelachaud, et al
ParisTECH, France
Computational Visual Attention

Intensity Channel

Gaussian Pyramid

Center-Surround Differences

Feature Maps

Normalise and Combine

Conspicuity Maps

Normalise and Combine

Saliency Map

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)
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 6\textsuperscript{th} 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 Ronjien
Terese Nothnagel
Viktor Collin, Simon Österman
Vladimir Grozman
Carl Regardh
Projects

DGI15 Project Blogs

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

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

Realistic skin shading: https://portfolio-rskhan.rhcloud.com/my-custom-shader/

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

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://stockholrnrender.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 you 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
  Does/how does a surface reflect light?

- **Texture**
- **Bounce**
- **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

- Rendering and animation qualities
- Uncanny valley, human perception of artificial behaviour
“All hail our robot overlords”
“All hail our robot overlords”
“All hail our robot overlords”

Geminoid F

BigDog, Boston Dynamics

Atlas, Boston Dynamics
“All hail our robot overlords”
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 4\textsuperscript{th} 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

Don't panic!
Coming up now

C++ Introduction