Computer Science at Swansea University

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Overview

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- Computer Science at Swansea University
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- An Introduction to Human-Computer Interaction and an Application
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Introduction: Who is Bob?

- July 2006: Joined Computer Science Department at Swansea University
- 2001-2006: worked at VRVis Research Center (VRVis.at)
- 2005: PhD from Vienna University of Technology
- 2000: MSc. from University of New Hampshire
- 1997: BSc. from University of Massachusetts

Specialized in
- Data Visualization, Flow Visualization
- Software Engineering, Human-Computer Interaction
Computer Science: What is it?

**Computer Science:** the science that deals with the theory and methods of processing information in digital computers, the design of computer hardware and software, and the applications of computers.

(dictionary.com)

Computer science involves:

- **Acceleration** - speeding things up
- **Automation** - getting computers to do the work
- **Derivation of new information and knowledge**
Why Computer Science?

- British Computer Society predicts demand for Computer Scientists will *double* over the next few years
- ...while the number of graduates has been *falling*
- But don’t do it *just* because there are jobs
- Study if you are interested in learning *how* things work
- Good if you are interested in solving problems with software
- Everyone needs computer scientists! Software is ubiquitous.
Why Computer Science at Swansea University?

- **Qualifications**: We offer BSc., MSc., MRes, M.Eng, MPhil, PhD degrees
- **Quality**: Ranked 2nd within Swansea University, Only 12 other Computer Science Departments rank higher throughout UK according to the RAE (Research Assessment Exercise) in 2008.
- **Quantity**: Very good student:staff ratio - about 1 staff member / 4 level one students (4:1)
- **Variety**: A large and varied selection of computer science modules
- **Location**: A great location on the coast
- **Jobs**: ITWales.com offers job placements to students
- **Enjoyment**: Swansea University was voted the best student experience in the UK (2008/2009).
- **See**: http://www.swansea.ac.uk/compsci/
Computer Science at Swansea University

- Programming (like writing at school..., Java and other languages)
- Technology (Computer hardware, Computer architecture, Hand-held Devices)
- Systems (Operating Systems, Compilers, Computer Networks)
- **Human-Computer Interaction** (Usability, Searching, Mobile Computing, Experiments)
- Computer Graphics (Video Games, **Data Visualization**, Computer Vision)
- Applications (Databases, Web Programming)
- Artificial Intelligence (Computer Games, Machine Learning, Algorithms)
- And much more!
Studying Computer Science

- Relatively independent study.
- Typically 12 lecture hours/week, 1-3 seminar/tutorial hours/week, 2-3 lab hours/week
- 8-12 modules per year, 2 semesters
- Coursework (assessed)
- Limited options in 1st year, sometimes in 2nd year, usually lots in 3rd year
- Large final-year project of your choosing

Achtung: biggest, most common mistake: skipping lectures!
Is Computer Science a Good Fit?

Are you a good candidate for Computer Science? A good candidate:

- works hard
- is ambitious
- is determined

- has **grit**: persist in the face of obstacles, to stick to the same direction stubbornly
- goes to lectures and does coursework!
A Well-Known Computer Science Application
Another Application: Data Visualization: What is it?

“The purpose of computing is insight, not numbers”
[Richard W. Hamming, 1962]

Visualization:
- A tool that allows the user to gain insight into data.
- To form a mental vision, image, or picture of (something not visible or present to the sight, or of an abstraction); to make visible to the mind or imagination [Oxford English Dictionary, 1989]
- The non-fiction version of computer graphics
User & Task

- What is the problem?
- User task / questions
- Visualization goals

Examples:
- Surgery planning
- Exhaust filter analysis
- Stock market vis.

[Oeltze et al., 2004]

[Shneiderman/Wattenberg, 2001]
Typical Visualization Tasks

Data Visualization is good at:

- exploration
  - find the unknown, unexpected
  - hypothesis generation
- analysis
  - confirm or reject hypotheses
  - information drill-down
- presentation
  - communicate/disseminate results

[Seo/Shneiderman 2004]
[Doleisch et al., 2003]
[Bruckner/Gröller 2005]
Project: Visualisation of Sensor Data from Animal Movement

Edward Grundy
Mark W. Jones
Robert S. Laramee
Rory P. Wilson
Emily L.C. Shepard

Visual Computing Group

Institute of Environmental Sustainability
Background

Biologists at Swansea have attached sensors...

...to animals in the wild...

To gather data on:
• acceleration,
• temperature,
• pressure,
• etc
Background

2D line plots of the acceleration data is difficult to interpret,

- Large time domain makes relating different periods difficult
- Three channels (possibly more) need to be correlated mentally by user
- Relating intensity plots to orientation or movement is difficult
Background

Understanding animal behaviour helps us to understand the environment, but animals are difficult to follow (for good reason).

We can follow them easily in some places...

Or not at all...

With more difficulty in others...
Objectives

Given accelerometry data, it is useful to:

a) identify extraordinary events,

b) identify similarity,

c) relate to other attributes to form hypotheses

d) identify commonly adopted postures

While reducing cognitive effort required by line plots.
Acceleration data can be correlated with other attributes.

- Replacing the magnitude of acceleration vector with pressure attribute improves readability of visualisation.

Visualisation now achieves objective (c); relating accelerometry to other attributes to form a hypothesis for behaviour.
Visualisation of Distribution

Frequently adopted orientations indicate common behaviours. These can be observed with a histogram over sphere; achieving objective (d) (identifying commonly adopted postures).
Visualisation of Data Distribution

Density based $c$-means clustering of the accelerometry produces a degree of membership value.

This can be used to decide whether a point is “in-posture” or not.

Allowing us to quantify the tortuosity of the transition between postures, and visualise this in a graph.
Domain Expert Review

Scatterplot and overlay are valuable tools for both exploration and communication of results.

Open research problem in marine biology: “Why don’t diving birds get decompression sickness (the bends)?”

Visual correlation of:

- Acceleration
- Pressure

Resulted in hypothesis: “Diving birds slow their ascent to prevent nitrogen bubbles building up in their blood.”
State Transition Diagrams

Data clustering gives further insight into postures and energy expenditure.

Posture spheres present new interaction possibilities for statistical analysis.
Results: Animal Tracking Video
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Any questions?

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Data Visualization: An Application

Medical Visualization

RTVR –
a flexible Java library for interactive volume rendering

Lukas Mroz and Helwig Hauser
VRVis Research Center,
Vienna,
Austria
Information Visualization Application: Financial smartmoney.com interaction semantic aggregation time dependent

Shneiderman & Wattenberg, [InfoVis 2001]
Information Visualization Application: Sociology

Map distorted according to population: worldmapper.org
What is Flow Visualization?

- a classic topic within scientific visualization
- depiction of vector quantities (as opposed to scalar quantities)
- applications include automotive, aerodynamics, turbomachinery, meteorology, oceanography medical visualization

Challenges:
1. to effectively visualize both magnitude + direction often simultaneously
2. large data sets
3. time-dependent data
4. What should be visualized? (data filtering/feature extraction)
Flow Visualization: An Application

- **swirl motion:**
  - characterized by motion about cylinder-aligned axis
  - more stable (easier)

- **tumble motion:**
  - characterized by motion about axis orthogonal to cylinder
  - unstable, more difficult
Flow Visualization: An Application

Achieving ideal patterns of motion leads to optimal mixing (of air and fuel) conditions

- e.g., higher exhaust/gas ratio (EGR)
- decrease in fuel consumption
- lower emissions

1. Can visualization provide insight into or verify characteristic shape/behavior of flow?
2. What tools help to visualize swirl/tumble motion?
3. Where (in the combustion chamber) are ideal ideal flow pattern not being realized?
Flow Visualization: An Application

Extraction and Visualization of Swirl and Tumble Motion from Engine Simulation Data

Christoph Garth
Robert S. Laramee
Xavier Tricoche
Jürgen Schneider
Visualization Application: Virtual Reality

VR² – Interactive Volume Rendering with PC-based Virtual Reality

A.L. Fuhrmann, B. Özer and H. Hauser

VRVis Research Center
www.VRVis.at

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