Slide 1

Interaction & Information Visualization

What is it all about ...

Fons J. Verbeek, LIACS, Leiden University

Interactive Information Visualization

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Slide 2

December 1st, 2023

**LECTURE 1
INTRODUCTION
PRINCIPLES & KEY CONCEPTS**

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Slide 3

Content

- *What is* **HCI**
- Historical context
- What are the scientific disciplines involved
- Interaction & Interactive Systems

- *What is Information Visualization* (**IV**)
- What are the scientific disciplines involved

- Systems & Examples
- 1st Key Technology: Design
- 1st Key Concept: Usability

- Why are we teaching this course ...

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Slide 4

BITS AND PIECES IN HCI

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Human Computer Interaction

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Computer Interaction

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What is it about ...

- Humans
  - Working
  - Routines-Workflows
  - Capabilities ~ Limitations
- Machines
  - Used
  - Mode of Operation
  - Possibilities ~ Limitations
- INTERFACE,
  - Man-Machine Interaction
  - Human-Computer Interaction
  - Embedded Systems

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It is about system development

Nearly half of entire software development effort relates to the user interface.
(Myers and Rosson, 1992)

- This statement is still very true
- Not only user interface
- Interaction Architecture, Product Design
- Connectivity
- Service Design

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Human Computer Interaction

- As a Science
  - Methods
  - Formalisms
  - Relations and Overlap diciplines
  - Measurement
- As a Product – Interactive Software Products
  - Recipes
  - *Design*
  - Technology
  - Measurement
- Strategies for Development

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Human Computer Interaction

Interface	Interaction
Present Instructions to Human	Offer mode of operation
Translate Instruction from Human to Machine	Connect with Interface
Present results on output Device	**Complete a Task**

What "things" are important to understand interaction …

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HISTORICAL CONTEXT

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Early Human Computer Interaction

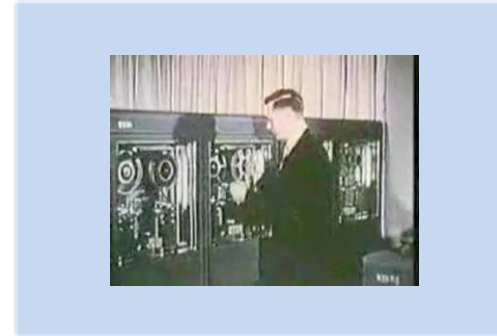Universiteit Leiden
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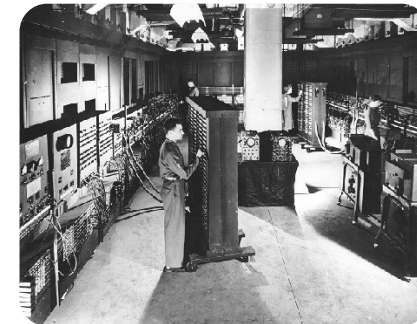
Beginnings – Computing in 1945

- Harvard Mark I
  - ASCC: IBM Automatic Sequence Controlled Calculator (aka Mark 1)
- 55 feet long, 8 feet high, 5 tons

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Learn about NORC …

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What Interactions did we See …

- Mechanical
- Poor feedback
- Specialist use
- Process control
- Calculations
- No intention to address the mass market

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What is HCI …

- Early computers: extremely difficult to use
  - large & expensive
  - by comparison: "people time" (labour) cheap
  - used by specialists
  - no knowledge about how to make use easier
- Today (This era)
  - None of these conditions hold
  - Development of PC's major landmark
- Shift to other interaction paradigms
  - Small & Handheld - Devices
  - Internet & Cloud
  - Robots

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PARADIGMS

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Interaction Paradigms

- Batch processing
- Timesharing
- Networking (1972 1st email)
- Graphical display
- Microprocessor
- WWW
- Ubiquitous Computing
- Grid/Cloud Computing
- Human Robot Interaction
- Touch Screen/Table Top Computing/VR

- 1950's
- 1960's
- 1970's

- 1980's

- 1990's
- 1995's
- This era …

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Initial outlook of Human Interaction

- Wide acceptance of computers (as of 1980ties)
- Consequence:
  - Computers must be well-designed
  - Interactions must be well-designed
- Users should not have to think about its use
  - Intuitive
  - Logical responses
  - Safe
- Two crucial concepts
  - Design
  - Interaction

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Not thinking about its use …

- For example compare:
  - CD-players

  - Cars

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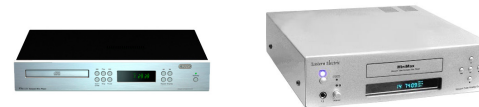
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Interactions with Small Devices

Imagine what these devices can do compared to Mark I
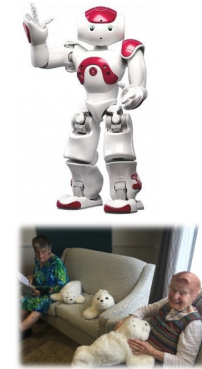
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Interaction With Computers

- Beyond computers
- Artificial creatures
- Responses are
  - Logical
  - In context
  - Emotive
- How to interact with a Robot
  - Component of learning
  - We accept it is (just) a robot

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Directions in HCI, bot-interaction

Q1

Japan 2005, by Hiroshi Ishiguro, Osaka University.

- Human Robot Interaction
- Human Android Interaction
- Whole new range of interactions

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Machine Personal Relations

- Robots get more human
  - Android
  - Geminoid
  - Ubiquitous phenomena

- Interaction will be more human
  - Emotive respons
  - Personal relations (e.g. Mariage ...)
    - *"If the alternative is that you are lonely and sad and miserable, is it not better to find a robot that claims to love you and acts like it loves you?"*

Geminoid HI-1

David Levy

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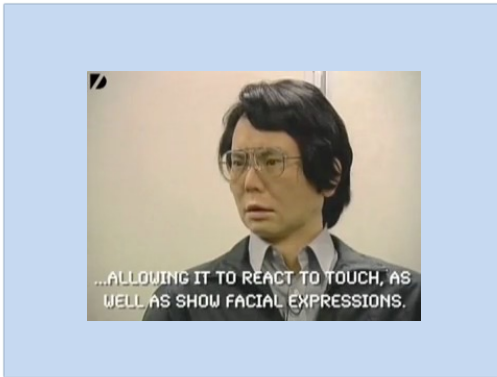
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What Interactions did we See ...

- Sensor based
- Intention of rich feedback
- Specialist use
- Multi-purpose
- Intention to address the mass market
- Ubiquitous

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MULTI DISCIPLINARY FIELD

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HCI: Interdisciplinary Field

- HCI combines knowledge and methods associated with professionals including:
  - Computer Scientists
  - Psychologists
    - Experimental, Educational, Social and Industrial
  - Designers
    - Instructional and Graphical
  - Technical Writers
  - Human Factors and Ergonomics Experts
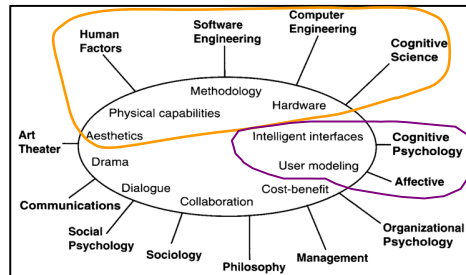 - Anthropologists and Sociologists
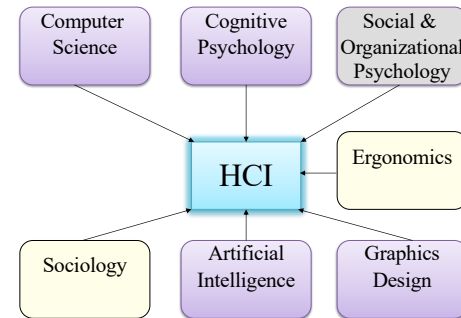
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HCI: Multi-disciplinary

Booth, 1989, Preece et al, 2002; Zhang & Li 2004

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Disciplines contributing to HCI

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DEVELOPMENT OF HCI

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Development of HCI

- Beyond and more than system's capabilities
- 1970s: notion of User-Interface arises
- Also known as Man-Machine Interface
  - "*those aspects of the system that the user comes in contact with*" [Moran, 1981]

  - "*input language for user, an output language for machine and a protocol for interaction*" [Chi,1985]

  - Man-Machine Interface: implies gender bias

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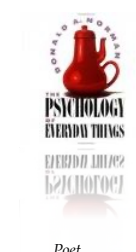The Netherlands

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Early concepts in HCI

- Companies started to call their products:
  - "user-friendly" [today this is a Curse]
- In practice:
  - Just tidy up the screens
  - Make them more aesthetically pleasing
  - No Design decisions nor Interaction plan
- Meanwhile: Different thing!
  - Research focus on capabilities/limitations of people
  - Important focus on psychological factors
  - Focus on aspects of ergonomics

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Design – Capabilties - Humans

Poet   *Doet*

Donald A. Norman - Psychologist

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User Friendly – End User

- What is User Friendly ?
- Can we measure it ?
- Criteria adhering to some standard ?

- Prototyping, Prototyping styles
- Usability, Usability criteria
- Evaluations, Evaluation techniques

- All are based in getting the **User** involved!

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Definitions of HCI

- A workable definition is:

  "a set of processes, dialogues and actions through which a human employs and interacts with a computer"
  (comment: visa versa ?)

- A focus on the research themes:

  "a discipline concerned with the design, evaluation, and implementation of *interactive* computing systems for human use and with the study of major phenomena surrounding them"

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Dissect HCI definition

- **Human**,
  - Users, single, group working together, sequence
  - User(s) tries to complete a task.
- **Computer**,
  - Technology, not just Desktop computer
  - Systems:
    - Large-scale computers,
    - Process control,
    - Embedded systems.
- **Interaction**,
  - Communication, direct/indirect
  - IO devices, mapping
  - Dialogue + feedback/batch
  - Task oriented

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DESIGN

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Development Attitude

- Computing paradigms have shifted
  - Early computing had no end users.
  - "end users" are extremely important
  - Natural focus is on the needs and capabilities of these end users
  - Interface Design
  - Interaction Design

- "*Nearly half of entire software development effort relates to the user interface.*" [Myers and Rosson, 1992]

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Design, what is it …

Design is where you stand with a foot in two worlds :

– the world of technology and

– the world of people and human purposes

The purpose of design is trying to bring the two together'.

Interpreted (fjv) from *Mitch Kapor* (*1996*)

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Design and Interactive Systems

- Examples
  - Mobile phones:
    transmit, store and transform information
  - Websites:
    store and display information and respond to people's actions
  - Computer game controllers
    dynamic response to actions
  - Interactive Installations, Information displays
    transmit information, generate dynamic response

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People and Technologies

- People and interactive systems are different:
  this entails the fundamental challenge for interactive systems designers is to deal with.

Machine- and people-centred views

View	People are	Machines are
Machine-centred	Vague Disorganised Distractible Emotional Illogical	Precise Orderly Undistractible Unemotional Logical
People-centred	Creative Compliant Attentive to change Resourceful Able to make flexible decisions based on content	Dumb Rigid Insensitive to change Unimaginative Constrained to make consistent decisions

Source: Adapted from Norman (1993), p. 224

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Interface

- The interface to an interactive system is all those parts of the system with which people come into contact with; physically, perceptually and conceptually.
- Physically
  - Pressing buttons, moving levers
  - Interactive device might respond by providing feedback
- Perceptually
  - Display things on a screen which we can see
  - Make noises which we can hear.
- Conceptually
  - Trying to work out what it does
  - What we should be doing.
  - Messages/Indicators designed to help us do this.
- The interface consists of
  - Input
  - Output
  - HCI needs a (conceptual) model for this

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Usability

- The interface to an interactive system is all those parts of the system with which people come into contact with; physically, perceptually and conceptually.

- For Interaction we need a (conceptual) model

- For Interaction we need a means for evaluation
  - Effectiveness
  - Efficiency
  - Satisfaction
- This is defined in the concept of usability
  - **Not** user-friendliness
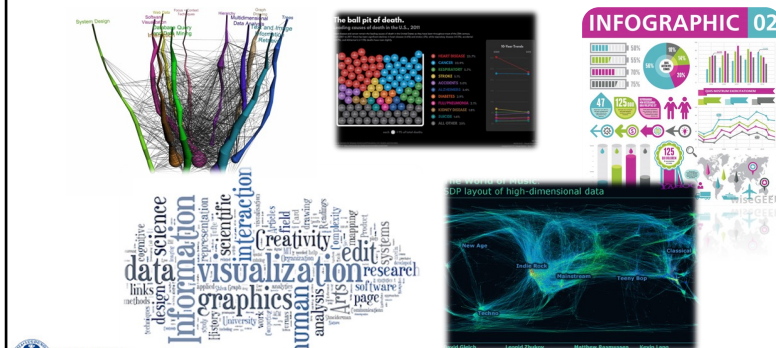 - Objective manner of assessment design

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Paradigm of Information

- Information is ambient in the environment
- Information can be complex.
- Information can be explored
  - Simplified by emphasizing aspects
  - Generate quick understanding
  - Disclosed and explored
- Crucial to Information or "data"
  - Visuzalization, transform to understand
  - Interaction, transform to explore/disclose

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Information Visualization

What is it all about ...

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Information Visualization

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Visualization

- Visualize:
  - To form a *mental model* or *mental image* of something
  - To make something visible to the mind or imagination
  - To provide support in understanding relations

- New concepts
  - Mental model, Mental image
  - Abstractions

- Presenting Information

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Visualization

- Visualization
  - Human activity, not perse with computers
  - Visual, Auditory or other sensory modalities
  - Creation of visual images in aid of understanding of complex, data rich, representations of data

- Information Visualization
  - Data transformed to graphical representation
  - The study of (interactive) visual representations of abstract data to reinforce human cognition.

- Abstract data include both numerical and non-numerical data. *text and geographic information*.

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Visualization Process

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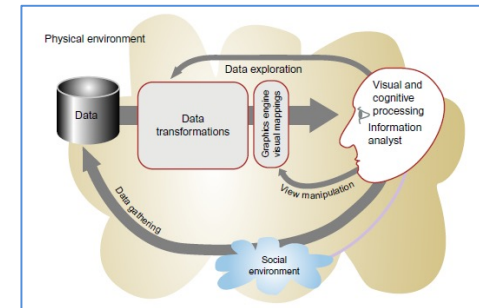
Information Visualization

- Data, dimensionality of the data
- Presentation of the data
- Processing of the data
- Interaction with the data
- Dynamical view updating

- Information Visualization: InfoVis
- Scientific Visualization: SciVis
- Differences InfoVis ⟷ SciVis

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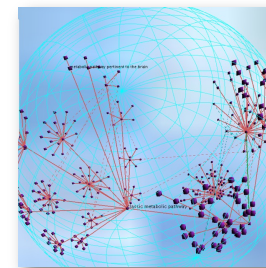
InfoVis vs SciVis (1)

Dmitrieva & Verbeek, 2010

Coordinate space no relation with data
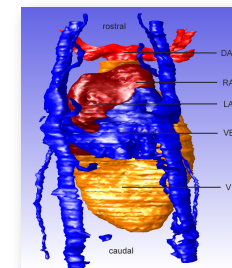
Bertens, Richardson & Verbeek, 2010

True spatial coordinates, xyz, 3D Model

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InfoVis vs SciVis (2)

- Information Visualization
  - Coordinate space no relation with data
  - Design a space in which content can be understood
  - Data are transformed to a grid

- Scientific Visualization
  - True spatial coordinates, xyz, 3D Model
  - Measurements are taken on a Grid
  - Grid and measurement related

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VISUAL INTERACTION

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Information Visualization - flow

After de Heer et al, CHI 2005

Interaction Design
Interaction Model

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Disciplines contributing to InfoVis

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Beyond standard computing ...

- Control in modern cars - navigation systems

Tesla, car-console; How well tested ?

Direct and Indirect Interaction

Information visualization

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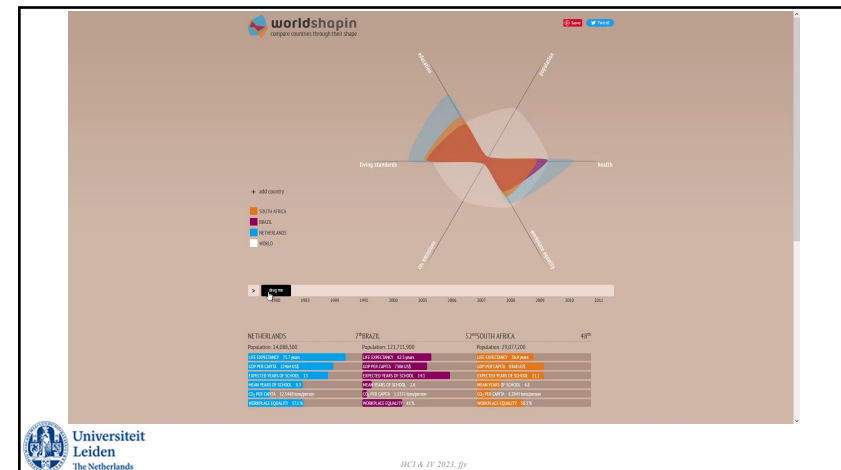
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Important Concepts HCI/InfoVis

- Concepts important to HCI and InfoVis
  - Cognetics
  - Affordance
  - Visibility
  - Design
  - Task Abstraction
  - Usability, Evaluation, Prototyping
- Concepts important to HCI
  - Design context, Social context
- Concepts important to InfoVis
  - Data, Data transformations, Design

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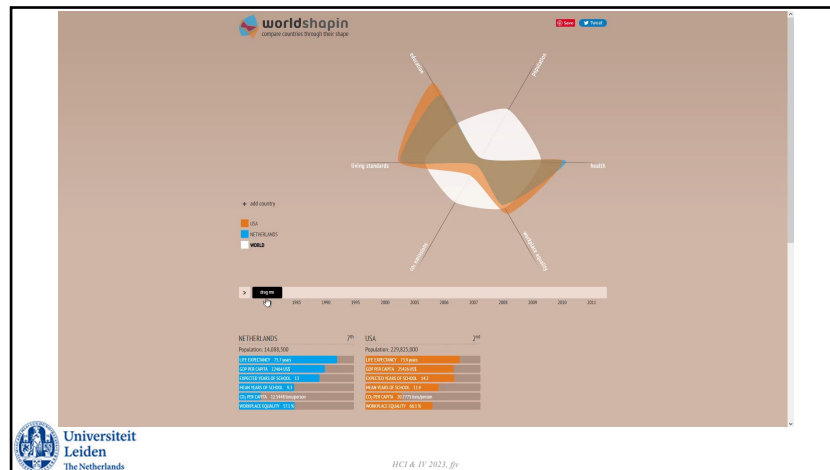
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A disaster story – HCI & IV related

1988 :

Iran Air Flight 655 shot down by USS Vincennes

- F-14?? - 290 casualties
- Conclusion: 'Aegis had provided accurate data.
  The crew had misinterpreted it.'
- Different radar screens displayed different aspects of airplane
- Correlating information was difficult
- Vital data cluttered by trivial data - InfoViz

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Interactive Information Visualization

HCI & IV COURSE

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Aim – Approach for this Course (1)

- Learn the major principles of HCI /InfoVis
  - Cognetics
  - Affordance/Visibility
  - Usability, Evaluation
- Learn how people think, react, acquire
  - Perception
  - Cognetics
- Learn how to evaluate a system - interaction
  - Development track, Design
  - Envisioning, **Prototyping**, Evaluating
  - Research Based Approach – Empirical !

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Review #1

- What is Interaction about
- Design - Interaction
- HCI is multi-disciplinary
- Different interaction paradigms

- **InfoVis** is multi-disciplinary
- Interactivity and dynamics are major issues
- Different user groups

- Usability is a key concept for evaluation of system

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