Scientific Theory in Informatics A1N

UNIVERSITY OF SKÖVDE

Lecture 01

Overview of the course & introduction to informatics

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Lecture Overview

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- Course organization
  - SCIO website & course handbook
  - Course objectives
  - Course content
  - Student instruction
  - Student assessment
    - » Assignment
    - » Case Study
    - » Presentations
- The discipline of informatics

Course Website

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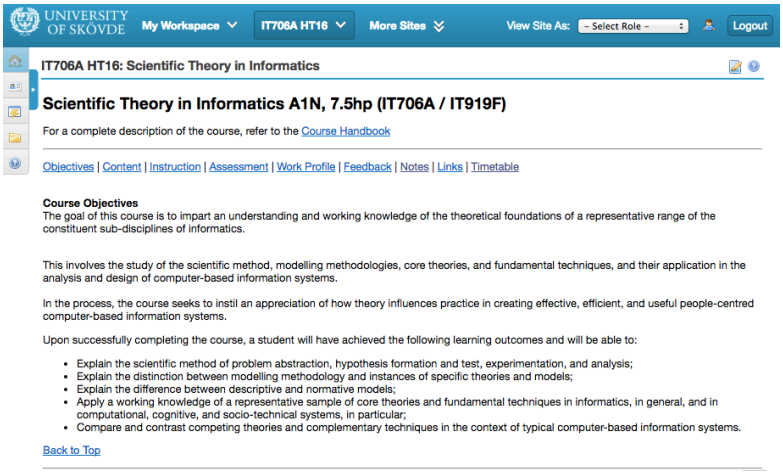
- SCIO https://scio.his.se/portal/site/IT706A-20162-01



Course Organization

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- Course objectives

"To impart an understanding and working knowledge of the theoretical foundations of a representative range of the constituent sub-disciplines of informatics."

- Scientific method & modelling methodologies
- Core theories
- Fundamental techniques
- Application in the analysis and design of information systems

Understand *how theory influences practice* in creating *effective*, *efficient*, and *useful* people-centred computer-based information systems

Course Organization

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- Course objectives

"There is nothing more practical than a good theory"

Immanuel Kant
1724-1804

"He who loves practice without theory is like the sailor who boards ship without a rudder and compass and never knows where he may cast."

Leonardo da Vinci
1452-1519

Course Organization

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- Course objectives

  - Explain the scientific method of problem abstraction, hypothesis formation and test, experimentation, and analysis;
  - Explain the distinction between modelling methodology and instances of specific theories and models;
  - Explain the difference between descriptive and normative models;

Course Organization

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- Course objectives
  - Apply a working knowledge of a representative sample of core theories and fundamental techniques in informatics, in general, and in computational, cognitive, and socio-technical systems, in particular;
  - Compare and contrast competing theories and complementary techniques in the context of typical computer-based information systems

Course Organization

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- Course content
  - Computing vs. Informatics
  - Computing
    - » Computer engineering
    - » Computer science
    - » Software engineering
    - » Information systems
    - » Information technology

Course Organization

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- Course content
  - Informatics
    - » Different approach
    - » Design and development of systems that provide information for *individuals*, *organizations*, and *society* in a timely, effective, and efficient manner
    - » how this information is *represented, processed*, and *communicated* in *natural* and *artificial* systems
    - » Three complementary perspectives:
      - Computation
      - Cognition
      - Socio-technology

Course Organization

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- Course content
  - Computing vs. Informatics

    More in a moment ….

Course Organization

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- Course content
  - Each of these three perspectives (computation, cognition, socio-technology) draws on a broad body of knowledge and principles that can be categorized under three headings:
    1. Modelling methodologies
    2. Core theories
    3. Fundamental techniques

Course Organization

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- Course content
  - Modelling methodologies
    - » The scientific method of (problem abstraction, hypothesis formation and test, experimentation, and analysis) & how scientific theories are formed, formulated, and adopted
    - » Not specific to some domain … general applicability
    - » Determines what a theory can and cannot claim
    - » A theory:
      a well-validated model with a some degree of quantitative and qualitative formalism and with some degree of explanatory or predictive value
    - » Different types of model and different approaches to modelling

Course Organization

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- Course content
  - Core theories
    - » e.g. complexity theory in computational systems
    - » e.g. organizational theory in socio-technical systems

  address particular domains but in a manner that has general applicability

Course Organization

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- Course content
  - Fundamental techniques
    - » Specific methodologies, mechanisms, and algorithms for bringing about a required result within any given core theory
    - » A way of realizing a given computational theory
    - » Can be implemented as an operational information system
    - » Produce a specific model of some product, process, or organization

Innovation

Modelling Methodology

Complexity Theory

Serious Games

Automata & Computabilty Theory

Scientific Theory in Informatics

Management Theory

Discrete Probability & Information Theory

Algorithmic Strategies

Organizational Theory

Cognitive Psychology

Decision Processes

Embodied Cognition

Cognition as Computation

Course Organization

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- Student Instruction
  - Four phases
    1. Introduction to informatics
    2. Preview of the material that comprises the remainder of the course
    3. Detailed treatment of each topic individually
    4. In-depth treatment of certain topics (supervised case study)
  - Informatics is a team-based discipline
    - » Students work in groups in seminars and assignments
    - » Peer evaluation and review in the seminars and tutorials

Course Organization

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- Student Instruction
  - Three modes of delivery
    - » 15 Lectures
      - 1 Introduction
      - 1 preview
      - 1 Modelling methodologies
      - 4 Core theories / fundamental techniques for each perspective (computation, cognition, and socio-technology)
    - » 6 Seminars

Course Organization

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IT706A / IT919F, Scientific Theory in Informatics, 7.5hp IT706A / IT919F, Vetenskaplig teoribildning inom informationsteknologi, 7.5hp					
Date	**Time**	**Room**	**Code**	**Title**	**Lecturer**
35: 2016-09-01	08:15 - 10:00 10:15 - 12:00	G316 G316	L1 L2	Course overview: introduction to informatics Course overview: preview of all material	D. Vernon D. Vernon
36: 2016-09-08	13:15 - 15:00 15:15 - 17:00	A101 A101	L3 L4	Modelling methodology Computation: complexity theory	S. Thill D. Vernon
37: 2016-09-15	08:15 - 10:00 10:15 - 12:00	G109 G109	L5 L6	Computation: automata theory and computability Computation: discrete probability	D. Vernon D. Vernon
38: 2016-09-22	13:15 - 15:00 15:15 - 17:00	A101 A101	S1 L7	Seminar: complexity, automata, probability Computation: algorithmic strategies	D. Vernon G. Falkman
39: 2016-09-29	13:15 - 15:00 15:15 - 17:00	A201 A201	S2 L8	Seminar: algorithmic strategies Cognition: paradigms of cognitive science	G. Falkman P. Hemeren
40: 2016-10-06	13:15 - 15:00 15:15 - 17:00	A201 A201	L9 L10	Cognition: cognitive architectures Cognition: decision theory	A. Montebelli P. Hemeren
41: 2016-10-13	13:15 - 15:00 15:15 - 17:00	A201 A201	S3 L11	Seminar: cog. science & cognitive architectures Cognition: embodied and social cognition	P. Hemeren & A. Montebelli A. Montebelli
42: 2016-10-20	08:15 - 10:00 10:15 - 12:00	A202 A202	S4 L12	Seminar: decision theory & embodied/social cog. Socio-technical systems: organizational theory	P. Hemeren & A. Montebelli J. Rose
43: 2016-10-27					
44: 2016-11-03			L13 L14	Socio-technical systems: management theory Socio-technical systems: games	J. Rose P. Backlund
45: 2016-11-10			S5 L15	Seminar: organizational and management theory Socio-technical systems: innovation	J. Rose J. Rose
46: 2016-11-17			S6 P1	Seminar: games & innovation Assignment presentation	P. Backlund & J. Rose All
47: 2016-11-24					
48: 2016-12-01					
49: 2016-12-08					
50: 2016-12-15			P2 P3	Case study presentation Case study presentation	All All

Course Organization

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- Student Instruction
  - Seminars
    - » Two each for computation, cognition, and socio-technology
    - » Each seminar will comprise two halves, one for each of the topics covered in that perspective in the previous week

Course Organization

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- Student Instruction
  - Seminars
    - » Prior to each seminar
      - Students work in small groups
      - On an exercise set at the end of each topic lecture
        - – Assess the use of a particular theory/technique in a given application domain, or
        - – Comparative analysis of two or three complementary theories or techniques based on a small amount of extra reading (tutorial article, review, or survey)

Course Organization

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- Student Instruction
  - Seminars
    - » Assuming a class size of 27 students: nine groups of three students
      - Two groups will be selected during the seminar
      - One each for the two topics addressed in the previous lectures in the perspective of informatics covered by the seminar
    - » Both of the selected groups will make a presentation on the exercise announced in the topic lecture
    - » Followed by a short class discussion, moderated by the instructor

Course Organization

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- Student Instruction
  - Seminars
    - » The seminar is a learning exercise, not an assessment one
      - *All groups, whether they were selected or not to give their presentation, must hand up a printed copy of the presentation they prepared for each seminar*
      - *Those who fail to do so will be targeted for selection in subsequent seminars*
      - *Do not forget to put the group number and names of group members on the first page of the presentation*

Course Organization

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- Student Assessment
  - 7.5 hp course load
    - » 2.0 are allocated to the assignment
    - » 5.0 hp to the case study
    - » 0.5 to an oral presentation on the case study

Course Organization

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- Student Assessment
  - Assignment
    - » Use of informatics in a selected application domain
    - » Addressing all three perspectives in the body of knowledge:

1. Computation
2. Cognition
3. Socio-technology

Course Organization

UNIVERSITY OF SKÖVDE

- Student Assessment
  - Assignment
    - » Goal:
      - Select and justify appropriate modelling methodologies, core theories, or fundamental techniques required for the effective deployment of a solution strategy addressing **all three aspects** of computation, cognition, and socio-technology in a given application area
    - » This is a horizontal theoretically-oriented study, targeting a comprehensive treatment of some information system

Course Organization

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- Student Assessment
  - Assignment
    - » Conducted as a group project
    - » On the website:
      - Assignment
        - – Submission deadline 17:00, Wednesday Week 46
        - – Presentation Week 46
      - Marking scheme
      - Skeleton report and guidelines

Course Organization

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- Student Assessment
  - Case Study
    - » Narrower spectrum of issues in just one of the perspectives of informatics
    - » Deeper treatment
    - » Vertically-oriented investigation (cf. horizontal investigation in assignment)

Course Organization

UNIVERSITY OF SKÖVDE

- Student Assessment
  - Case Study
    - » Given a selected application domain
      - Critical appraisal and comparative analysis of two or more competing solutions strategies (modelling methodologies, core theories, or fundamental techniques) deployed in either the computational, cognitive, or socio-technical aspect of that application area
    - » Carried out individually rather than in a group
    - » Produce a printed report for the case study;
      may reuse any of the work for the assignment in the report

Course Organization

UNIVERSITY OF SKÖVDE

- Student Assessment
  - Case Study
    - » The assessment of the case study does not focus on the quality or extent of the research (cf. Ph.D. thesis)
    - » It will focus on the critical appraisal of the advantages and disadvantages of various modelling methodologies, core theories, and fundamental techniques as they relate to the informatics problem being investigated in the case study

Course Organization

UNIVERSITY OF SKÖVDE

- Student Assessment
  - Case Study
    - » On the website:
      - Case study description
        - – Submission deadline 17:00, Wednesday Week 50
        - – Presentation Thursday Week 50
      - Marking scheme
      - Skeleton report and guidelines

Course Organization

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- Student Assessment
  - Presentations
    - » The purpose of the oral presentation is to convey the main findings in the case study in an accessible, instructive, and engaging manner
    - » It is mandatory for every student to attend the presentations
    - » As many members of staff as possible will also attend
    - » This will provide students with an opportunity to engage well-founded principled debate with their peers on the work they have done in their respective case studies

Course Organization

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- Student Assessment
  - Grades
    - » Masters students are awarded one of three grades: a pass with distinction (VG), pass (G) or a fail (U)
    - » PhD students are awarded a grade of pass (G) or a fail (U)
    - » Students will be awarded marks for the three modes of assessment: assignment, case study, and presentation

Course Organization

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- Student Assessment
  - Grades
    - » Overall mark for the course is calculated as:

      $(2.0 \times m_1 + 5.0 \times m_2 + 0.5 \times m_3) / 7.5$

      where m_1, m_2, and m_3 are the individual marks awarded for the written assignment, case study report, and oral presentation, respectively

Course Organization

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- Student Assessment
  - Grades
    - » The overall mark is converted to the final grade as shown below

Overall Mark	Final Grade
≥ 70%	VG
≥ 40% and < 70%	G
< 40%	U

    - » **Note, however, that students must pass all three components of the assessment**
    - » In the event that a student fails to achieve a passing grade, they need only re-submit those components of the assessment that received a mark below 40%

Course Organization

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- Student Assessment
  - Deadlines and Number of Attempts
    - » If you do not pass a given component on the first attempt, you will be given a second opportunity to submit
    - » In this event, your final result will be withheld until you have made your second submission
    - » There is no provision for a third attempt
    - » If you miss a deadline for submission (or decide not to submit for that deadline) then you use up one of the two available attempts

      i.e. missing a submission deadline = not passing on that attempt

Course Organization

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- Student Assessment
  - Grades
    - » To facilitate consistent marking, a standard marking scheme is used for both assignment and case study
    - » The case study will be marked by two people
      - Supervisor
      - Second-reader
    - » The final mark is the average of the two marks, provided they do not differ by more than a given amount (10-20%)

Course Organization

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- Student Assessment
  - Grades
    - » In that case, a third reader may be asked to mark the report
    - » When marking the oral presentation of the case study, the focus is the content and the effectiveness of how the information is communicated, weighted in favour of content

Course Organization

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- Work profile

Week	Lectures	Seminars	Self-study	Assignment	Case Study Report	Presentation	Total
35	4		10				14
36	4		10				14
37	4		5	4			13
38	2	2	5	4			13
39	2	2	10				14
40	4		10				14
41	2	2	5	4			13
42	2	2	10				14
43			10				10
44	4		5	4			13
45	2	2		4	6		14
46		2			10	2	14
47					10		10
48					10		10
49					10		10
50					6	4	10
Total	30	12	80	20	52	6	200

Course Organization

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- Quality Assurance
  - Input for this quality assurance process is a student questionnaire to be completed by each student at the end of the semester
    - » The student feedback form is available on the Scio website

Questions

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?

The Discipline of Informatics

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- Computing comprises several disciplines

1. Computer Engineering (CE)
2. Computer Science (CS)
3. Information Systems (IS)
4. Information Technology (IT)
5. Software Engineering (SE)

Computing Curricula 2005: The Overview Report, ACM and IEEE, ISBN 1-59593-359-X, 2006.

The Discipline of Informatics

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- Other possibilities:
  1. Bioinformatics
  2. Medical informatics
  3. …

Computing Curricula 2005: The Overview Report, ACM and IEEE, ISBN 1-59593-359-X, 2006.

The Discipline of Informatics

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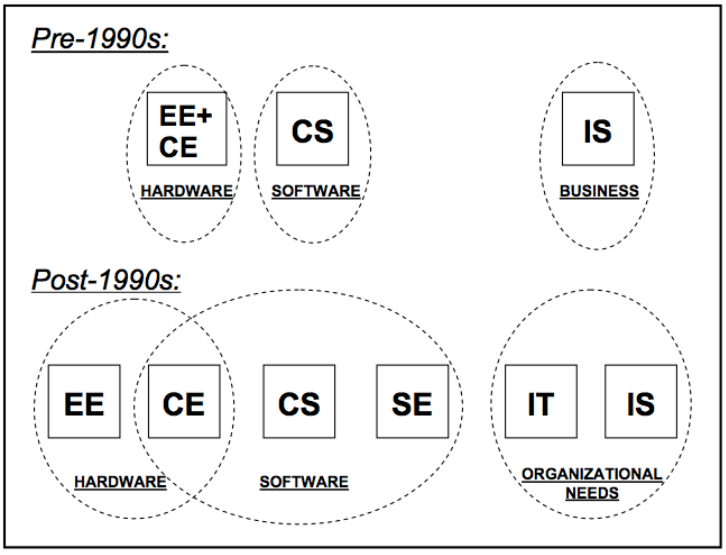

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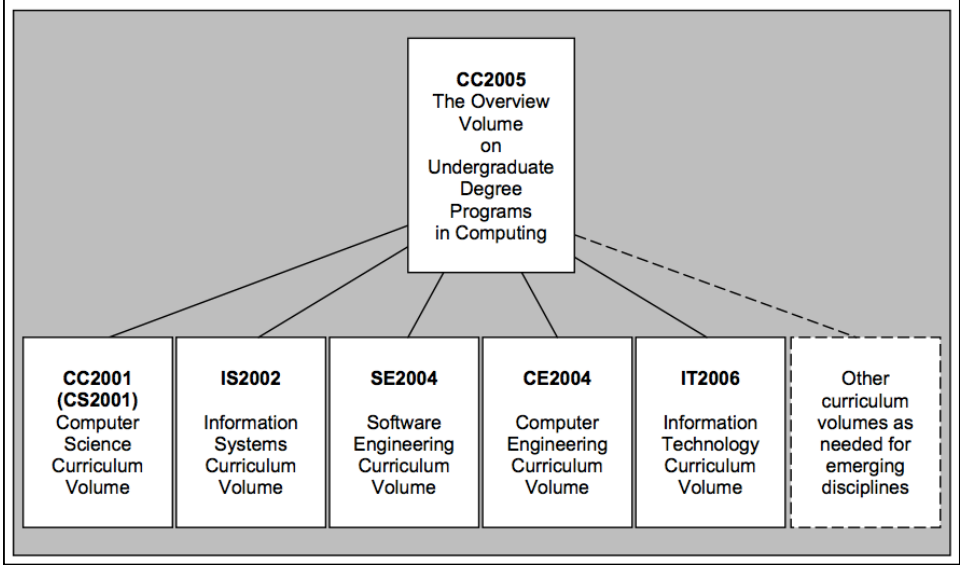

The Discipline of Informatics

- Computer Engineering (CE)
  - The design and construction of computers & computer-based systems
    - » hardware, software, communications, and the interaction among them
    - » theories, principles, and practices of traditional electrical engineering and mathematics
  - Software development
    - » digital devices and their interfaces with users and other devices
    - » hardware more than software or there may be a balanced emphasis
  - Embedded systems
    - » e.g. cell phones, digital audio players, digital video recorders, alarm systems, x-ray machines, and laser surgical tools

The Discipline of Informatics

UNIVERSITY OF SKÖVDE

- Computer Science (CS)
  - theoretical and algorithmic foundations of computing
  - cutting-edge developments in robotics, computer vision, intelligent systems, bioinformatics, ...
  - challenging programming, especially using new approaches
  - effective ways to solve computing problems
    - » Best possible ways to process, analyse, communicate, visualise, and store information
    - » Optimal performance

The Discipline of Informatics

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- Information Systems (IS)
  - Integrating information technology and business processes to meet the information needs of business
  - Focus on information
    - » Technology as a tool for generating, processing, and distributing information
  - Defining and achieving organisational goals
    - » Determine how information and technology-enabled business processes can provide a competitive advantage
    - » IS specialists act as an effective bridge between the technical and management communities within an organisation,

The Discipline of Informatics

UNIVERSITY OF SKÖVDE

- Information Systems (IS)

  also known in the USA by the following titles (2008)

  Management Information Systems (41% of programs)
  Information Systems (21%)
  Computer Information Systems (18%)
  Remaining 21%:
  Information Systems Management
  [Business] Information Systems
  [Business] Computer Systems
  [Business] Computer Information Systems
  [Business] Information Technology Management
  [Business] Informatics
  Information Resources Management
  Information Technology
  Information Technology Systems
  Information Technology Resources Management
  Accounting Information Systems
  Information Science
  Information and Quantitative Science

The Discipline of Informatics

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- Information Technology (IT)

  - Focus on the technology more than on the information it conveys
  - Providing systems that work properly: secure, upgraded, maintained, and replaced as appropriate
  - Combination of knowledge and practical, hands-on expertise to take care of an organisation's IT infrastructure *and* the people who use it
    - » Select, install, customize, and maintain software and hardware that match needs of computer users and the organisation as a whole
    - » Network installation, administration, and security; the design of web site; the development of multimedia resources; the installation of communication components; the oversight of email systems

The Discipline of Informatics

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- Software Engineering (SE)
  - The discipline of developing and maintaining (large) software systems that
    - » behave reliably and efficiently,
    - » are affordable to develop and maintain,
    - » satisfy all the requirements that customers have defined
  - Seeks to integrate the principles of mathematics and computer science with the engineering practices developed for tangible, physical artifacts
  - Assess customer needs and develop usable software that meets those needs

The Discipline of Informatics

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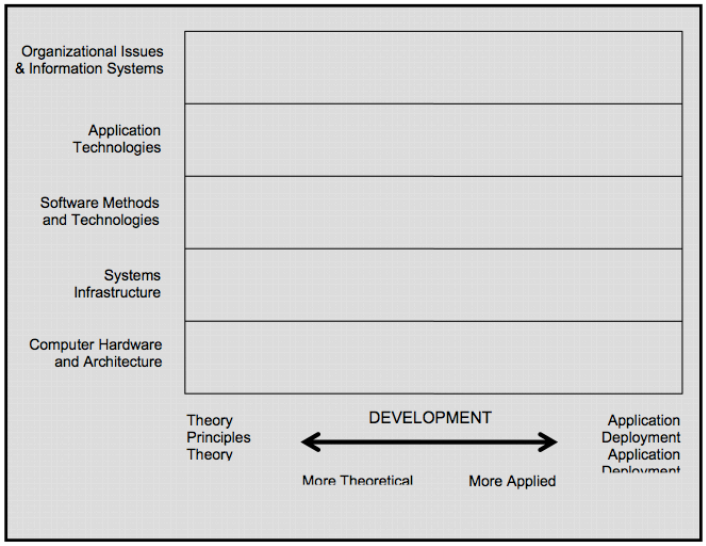

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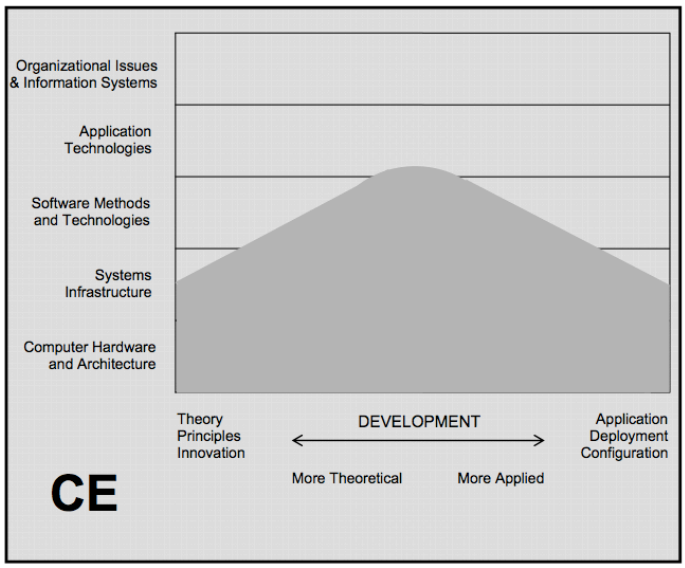

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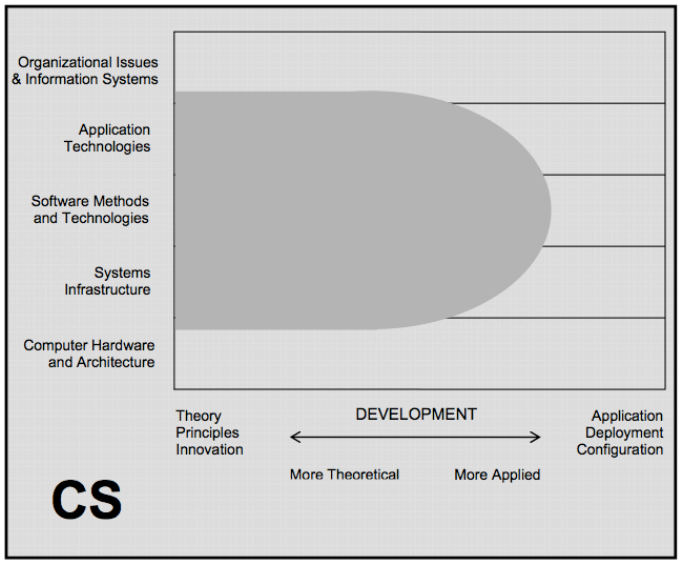

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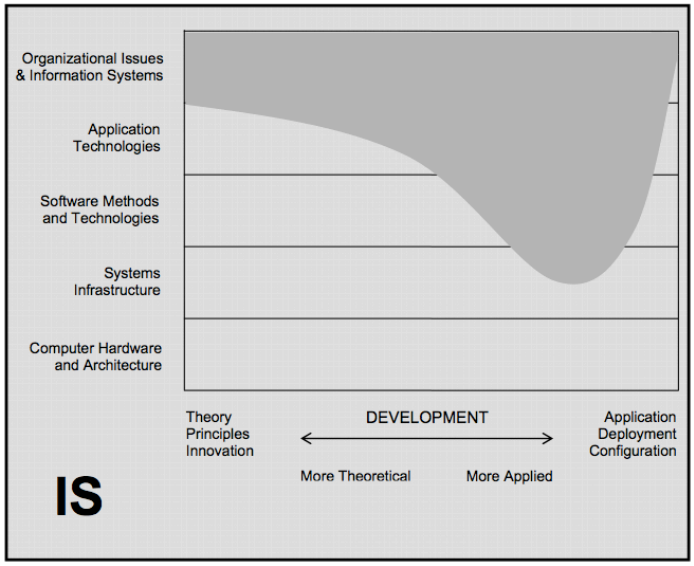

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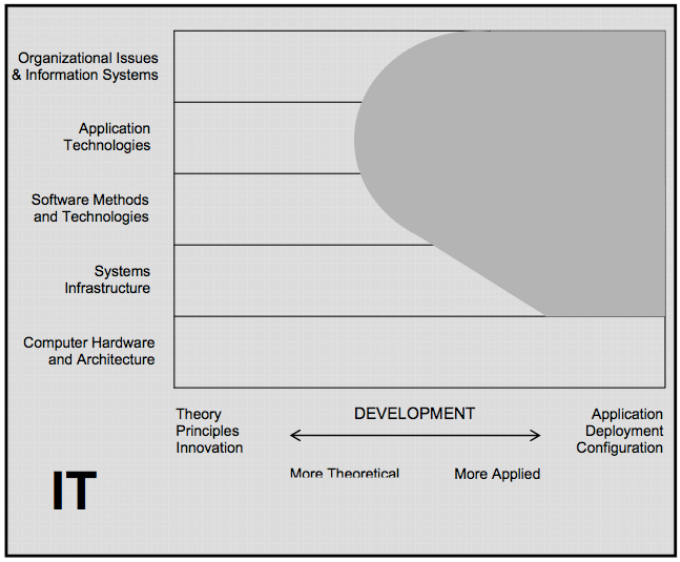

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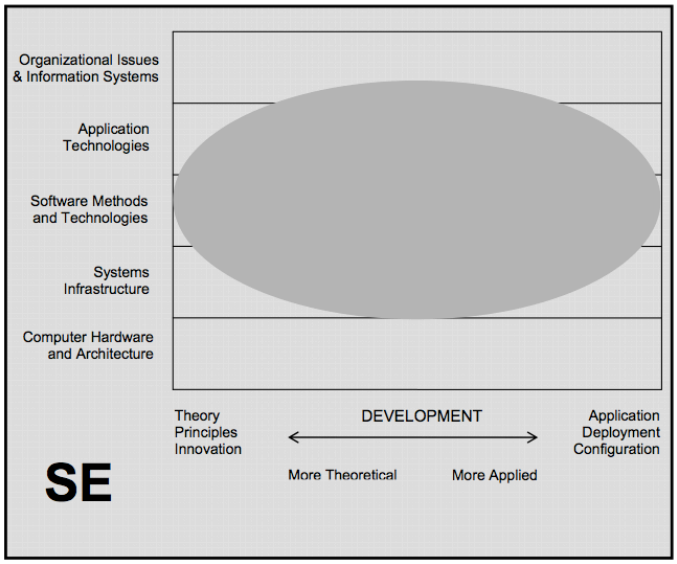

The Discipline of Informatics

- *Computer engineers* should be able to **design** and **implement systems** that involve the **integration** of **software** and **hardware** devices;
- *Computer scientists* should be able to work in a broad **range of positions** involving tasks from **theoretical** work to **software development**;
- *Information systems specialists* should be able to **analyze information requirements** and **business processes** and be able **specify** and **design systems** that are aligned with organisational goals;

The Discipline of Informatics

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- *Information technology professionals* should be able to work effectively at **planning**, **implementation**, **configuration**, and **maintenance** of an organisation's **computing infrastructure**
- *Software engineers* should be able to **perform** and **manage** activities **at every stage of the life cycle** of **large-scale software systems.**

The Discipline of Informatics

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- But what about *Informatics*?
- A very broad discipline
  - computer science
  - human-computer interaction
  - information science
  - information technology
  - information systems
  - algorithmics
  - mathematics
  - social sciences
  - …

The Discipline of Informatics

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- University of Skövde definition of informatics:

  "Informatics is the science that addresses how information is represented, processed and communicated

  in artificial and natural systems,

  and how such systems are developed in order to achieve usable and effective applications and solutions."

The Discipline of Informatics

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- University of Skövde definition of informatics:

  "The following aspects of informatics are addressed in our research:

  - **Computational** …
  - **Cognitive …**
  - **Socio-technical …**

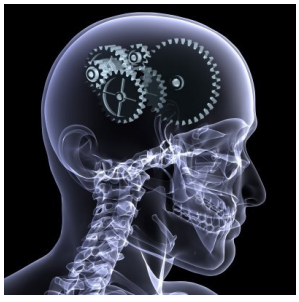
  The integration of these aspects is essential for achieving usable and effective applications and systems."

The Discipline of Informatics

"Computational …

Fundamental theory and methodology for how information is processed, represented and communicated in computer systems"

The Discipline of Informatics



Cognitive

The Discipline of Informatics

"Cognitive …

How information is processed, represented and communicated in natural systems, and how humans interact with different types of information technology."

The Discipline of Informatics

"Cognitive …

How information is processed, represented and communicated in natural systems, and how humans interact with different types of information technology."

The Discipline of Informatics

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"Cognitive …

How information is processed, represented and communicated in natural systems, and how humans interact with different types of information technology."

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The Discipline of Informatics

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Socio-technical

The relationship between people and technology

The Discipline of Informatics

"Socio-technical …

How IT systems are used and developed IT systems are used and developed to ensure usability for individuals, organisations, or society."

The Discipline of Informatics

Systems View

Joint optimization of the performance of all components

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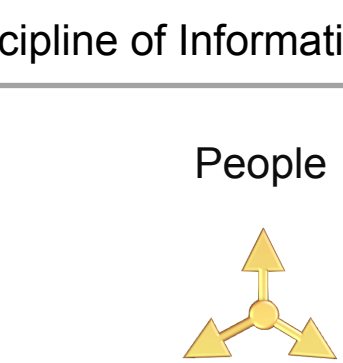
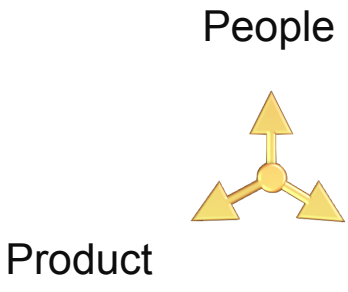


The 3 Most Important Things in Informatics

The Discipline of Informatics



The other 3 Most Important Things in Informatics!

Theory & Practice

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- We use theory
  - To model the problem and find a solution
  - To understand peoples information needs and preferences
  - To design efficient and effective algorithms
  - To build innovative high quality systems