Contextualizing Computer Science & Software Engineering Education

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www.ics.uci.edu/informatics

an education for the future of computer science .. NOW!

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Outline

- Background: why contextualize Computer Science and Software Engineering?
- Informatics: Opportunity at UCI
- Objectives, philosophy and perspectives
- Current status, preliminary data
- Comparison to Computing Curriculum 2004
- Observations and reflections
- Conclusions

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A Crisis is Looming

According to a report ***"The Incredible Shrinking Workforce: Addressing Tomorrow's Issues Today"*** by people3, a Gartner Company (Feb 2005):

"…the rapid pace of technological changes and upcoming economic growth are expected to once again propel the demand for highly skilled workers..there will be increasing activity in IT staffing…in the next three to five years, there will not be enough IT workers in the U.S. to satisfy demand…Many economists and industry experts worry that the nation will soon be facing an incredibly shrinking, less-skilled workforce – a phenomenon like none we've seen and one that could severely dampen U.S. economic growth in every respect."

The Labor Department projects nearly 5 million new jobs will be created in computer and mathematical occupations by 2012.

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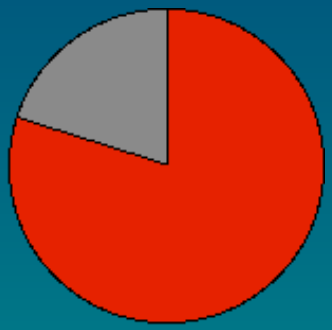
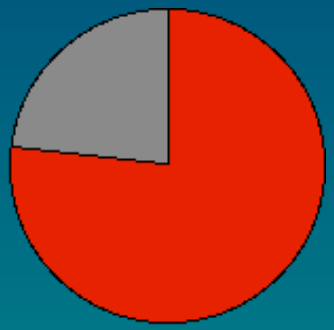
Employment Patterns by Discipline

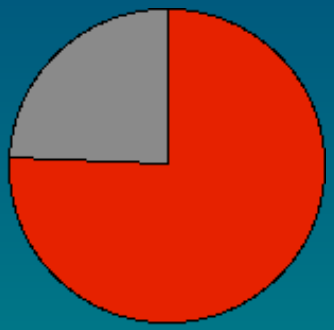
Fraction of professionals with degrees in that discipline:



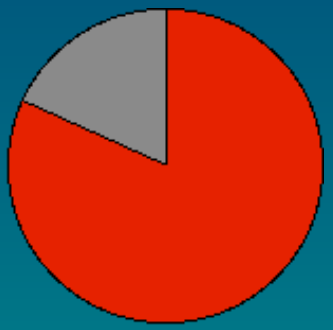
Life Sciences



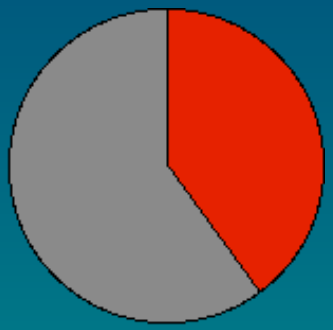
Chemical and Physical Sciences



Mathematics

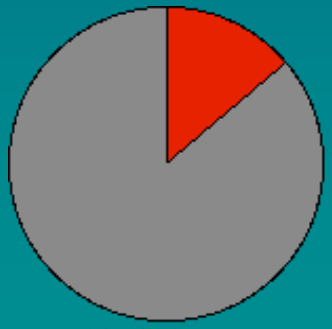


Engineering

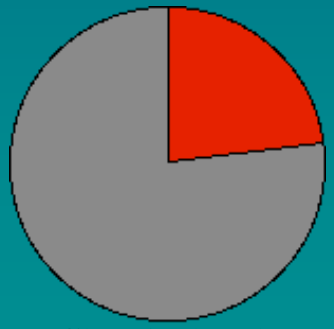


Computer and Info Sciences

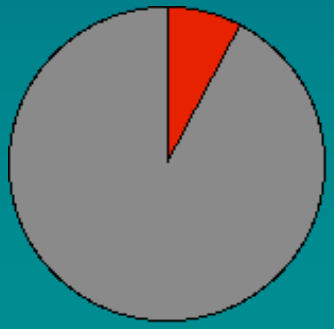
Fraction of disciplinary graduates employed in that profession:



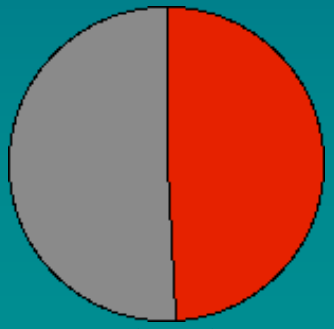
Life Sciences



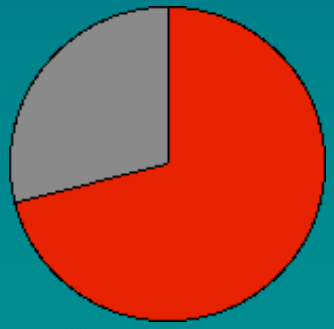
Chemical and Physical Sciences



Mathematics



Engineering



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National Science Foundation/Division of Science Resources Statistics, SESTAT (Scientists and Engineers Statistical Data System), 1999, as presented by Caroline Wardle at Snowbird 2002

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Education and Training Is Critical

- Clearly, the economy needs people with CS skills (despite what the media says)
- CS offers complementary academic skills
  - Students need computer science skills whether they want to be computer scientists or not
  - Students with more preparation go farther in college and beyond
- We need to start exciting students about the field again
  - high schools and middle schools are essential to promoting diversity
  - we also have to give them something more in college

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Crisis in CS/SE Education

- Decreasing enrollments in CS-related fields
- Continuing attrition of good students
- Increasing breadth of Computer Science

challenge = opportunity!

A partial solution is to contextualize CS&SE

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Partly it's an image problem

- Low enrollments due to
  - dot com crash
  - fear of off-shoring
  - geek image
  - lack of interest
  - misunderstanding of computer science
  - …
- High attrition due to
  - boredom with programming
  - loss of focus
  - appearance of irrelevance
  - …
- Recruitment and retention is proportionally lower for women and minorities
  - More likely to seek something socially-relevant and/or people-oriented

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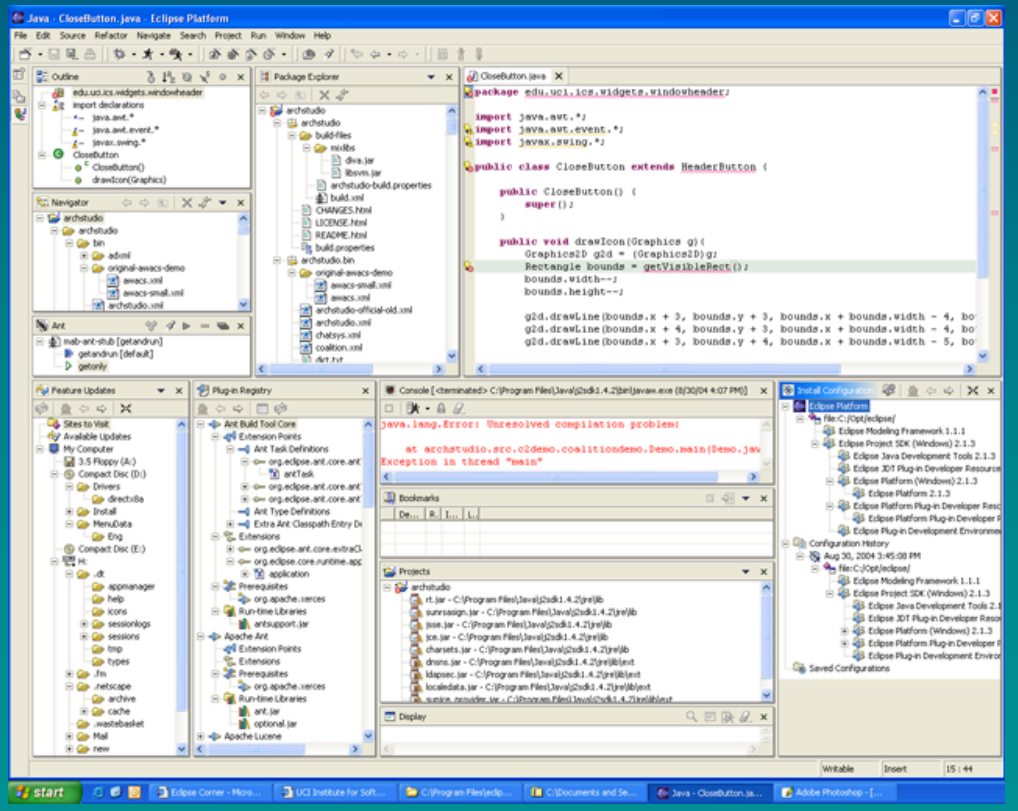
Computer Science?



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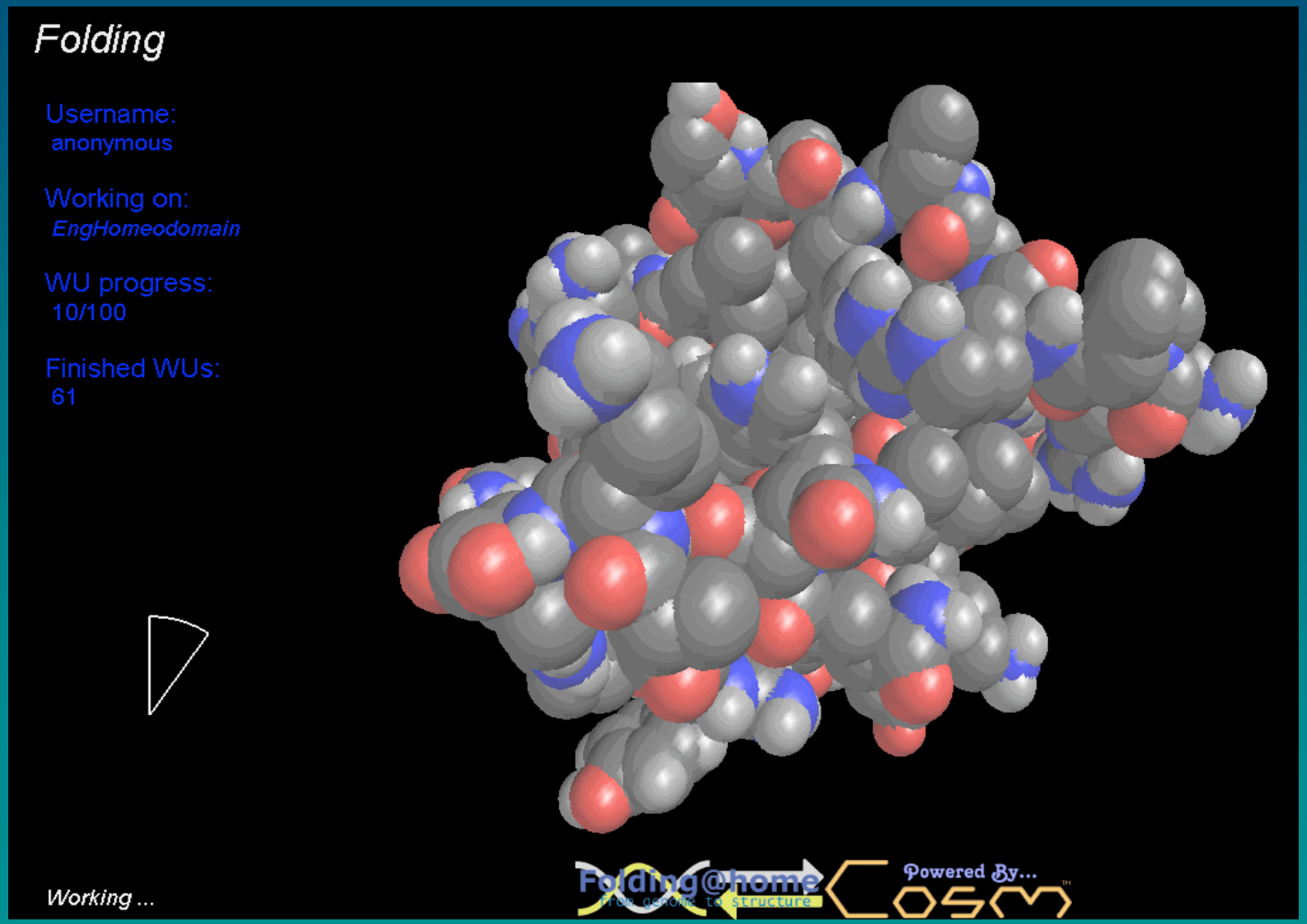

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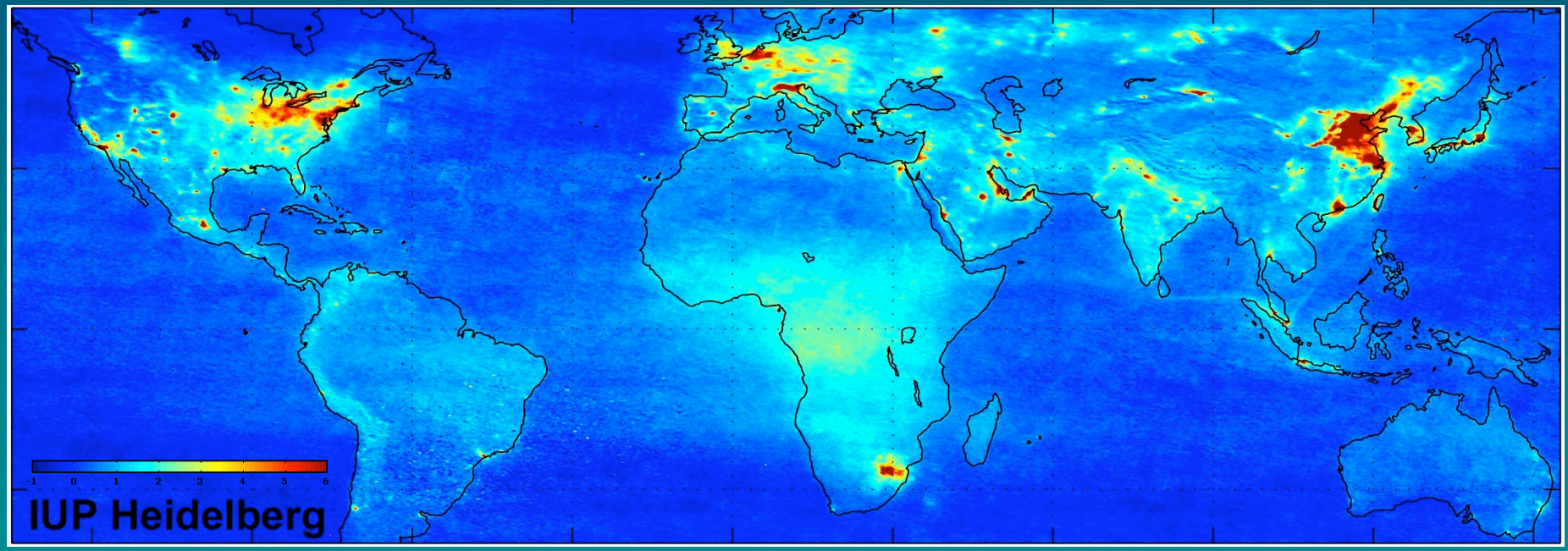
Computer Science!



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Still a challenge! and an opportunity!

- Undergraduate degree programs can no longer cover all aspects of the field comprehensively
- Alternative approaches:
  - survey the field at a high level
  - develop a more concentrated program
  - provide a more configurable program
  - lengthen the degree program
  - offer multiple focused degree programs
- Other goals and constraints:
  - represent faculty interests
  - promote timely degree completion
  - attract broader clientele with "more merchandise"
  - support underrepresented groups

The solution: contextualize

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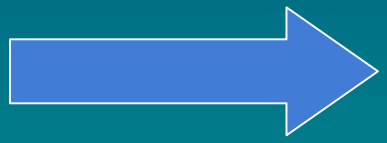
Opportunity: ICS Divides…

UCI's Department of Information and Computer Science



Donald Bren School of Information and Computer Sciences

- Informatics
- Computing
- Computer Systems

Bren School essentially departmentalized into these three tiers

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…and Grows

Donald Bren School of Information & Computer Sciences

=

- Informatics
- Computing
- Computer Systems
- Statistics

Department of Statistics added because of like perspectives

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Bren School of ICS Quick Facts

- 1700+ undergraduate students
- 300+ graduate students
- 58 tenured/tenure-track faculty

- $1.5M Dean's endowment
- $20M naming gift providing 10 endowed chairs to hire distinguished scholars

- Broad, modern set of courses
- Four coordinated undergraduate degree programs

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Opportunity: Informatics @ UCI

This new degree program responds to a problem of great national need: to educate the technological workforce that will create and maintain the software and information systems of tomorrow.

Current computer science (CS) degree programs do not meet this need—they try to cover the entire field from electrical engineering to human computer interaction, with a predictable lack of success.

A different approach is needed: creation of an undergraduate degree program in Informatics that is uniquely tailored to the multi-disciplinary needs of software and information design.

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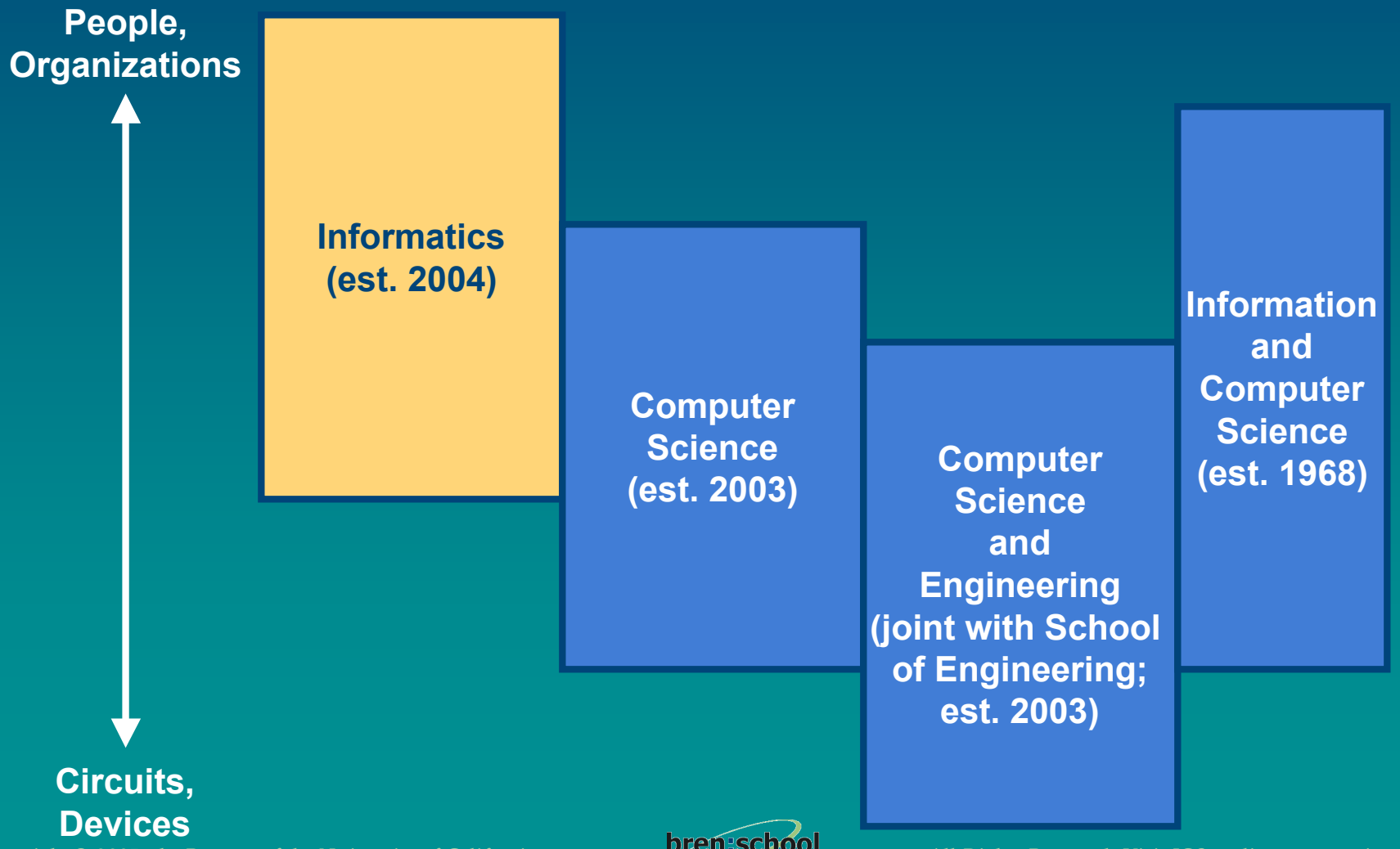
Bren School B.S. Degree Programs



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Informatics: What Do We Mean?

- Interdisciplinary study of the design, application, use, and impact of information technology
  - software but also information
  - development but also design
  - technical but also social
  - synthesis but also analysis
- Broadly speaking: computing and software engineering *in context*
  - inherently inter-disciplinary
  - Focus more on designing real-world solutions, less on building infrastructure

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Why a New B.S. in Informatics?

- Because (Information and) Computer Science is now too broad
- Because women and other underrepresented groups are turned off by many traditional computer science programs
- Because a new body of knowledge has emerged concerning Informatics
- Because 41% of polled ICS students would rather have an Informatics degree (29% undecided)
- Because 78% of polled ICS students believe UCI should have an Informatics degree program (18% undecided)

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Isn't this just … ?

- …a business/information technology degree?
  - Informatics is a technical degree, a B.S. with a focus on the concepts and techniques necessary for actually building systems
- …a software engineering degree?
  - Informatics is broader and, compared to most existing software engineering degrees, focuses more on on design principles and less on engineering principles
    - although some notable, good exceptions exist: Rochester being the primary one
- …just another version of the ICS degree?
  - Informatics has material in common with other degree programs @ UCI, but it specifies a focus on software design and human-computer (social) connections and it reduces courses that just emphasize building better computers

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It's a new alternative

- Alternative 1:
  - mathematics and engineering orientation
  - "Parnas-school" (McMaster)
- Alternative 2
  - SE 2004 recommended CS core with specialized software courses
  - Rochester and other schools
- Alternative 3
  - context-based software engineering
  - UC Irvine and others

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Objective: a B.S. that

- introduces the kinds of problems typically raised in software and information intensive environments
- teaches the fundamental principles, concepts, models, processes, techniques, and technologies that form the basis for solutions to those problems
- provides extensive practice in everything from theoretical underpinnings to human-centered interaction and interdisciplinary application of those solutions
- diversifies program offerings
- attracts new categories of students by promoting Informatics as experience-based computer science
- facilitates access, retention, and degree completion by women and other underrepresented groups

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Design Philosophy

- Create a novel, engaging, problem-based, and creativity-oriented integrated curriculum
  - Start from blank slate
    - we did look back "afterwards"
  - Integrated & coherent four-year curriculum
    - apply spiral approach ("just-in-time learning")
    - use multi-course sequences
  - Ensure students are adequately prepared for the work force
    - solid computer science fundamentals
  - Focus more on application than infrastructure
    - emphasize the "top half" of traditional CS
    - no network performance analysis, compiler optimization, implementing red-black trees, …
  - Balance theory and practice
    - solid conceptual framework
    - but no skimping on experience
    - end-of-year projects throughout

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Features

- Multi-course sequences
  - for depth and continuity
- Studio and design courses
  - practical experiences with realistic, socially relevant projects in a safe educational setting
- Creative and independent learning activities
  - collaborative, team-oriented assignments, innovative sequences, creative problem solving
- End-of-year capstone projects
  - showcase of projects done throughout the year, excellent internship preparation
- Year-long senior design project
  - project for an outside organization in a class setting
- Room to "play"
  - research, other courses of interest, a minor, double major, …

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Student-Centered

- A broad variety of students with diverse backgrounds
- The degree program moves away from the popular belief that computer scientists are "mad hackers", and instead welcomes students
  - who don't yet know how to program
  - who have an interest in creative design
  - who generally are curious about designing proper solutions, not just programs
  - who are ready to work with others in a team to solve problems
- Prepared to work as software and information system designers and developers
- Prepared for adaptability to new concepts and technologies
- Prepared for research and graduate study
- Supported and motivated through the program (if they leave, it's for the right reasons), including traditionally underrepresented groups

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Areas of Study

- Software engineering
- Human-computer interaction
- Project management
- Programming languages
- Databases
- Computer-supported collaborative work
- IT organizations
- User modeling
- Information retrieval, management, and visualization
- Ethics, privacy & security
- Computation-social relationships
- And others at the periphery
  - business, management, organizational computing, social science, cognitive science, anthropology, digital arts, game technology, medical informatics, and so on

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A Software Engineering Perspective

- A primary focus is software and information systems and how we can develop them properly
- Students are trained to have a "tool belt"
  - how to design
    - much more than the traditional "notation only" approach
  - how to program
  - larger lifecycle "picture"
  - role of methods and tools
  - …
- Students are trained to be creative, work in teams, and generally develop solutions, not just programs
- We cover, on top of traditional topics:
  - "little languages"
  - design techniques
  - design patterns
  - real-time issues
  - distributed and decentralized systems
  - design-to-code mappings
  - maintenance
  - project management
  - …

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A Context Perspective

- A primary focus is context, why we are developing software and information systems and where such systems are deployed
- Students are trained to have a "tool box"
  - ethnographic studies
  - user studies
  - design techniques
  - ethics, privacy, security
  - …
- Students are trained to know the technology available to realize their solutions

- We cover, on top of software engineering topics:
  - user interfaces
  - human-computer interaction
  - social analysis of computerization
  - organizational issues
  - project management
  - collaboration
  - computer-supported cooperative work
  - multiple views of information
  - …

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Curriculum

Fall Year 1	Winter Year 1	Spring Year 1
Informatics Core	Informatics Core	Informatics Core
		Informatics Research Topics
Writing	Writing	Writing
Critical Reasoning	Discrete Mathematics	Fundamental data structures
Fall Year 2	**Winter Year 2**	**Spring Year 2**
Statistics	Human-Computer Interaction	Project in HCI and User Interfaces
Concepts in Programming Lang. I	Concepts in Programming Lang II	Software Design I
Software Methods & Tools	Requirements Analysis & Engr.	SW Specification & Quality Engr.
Breadth	Breadth	Breadth
Fall Year 3	**Winter Year 3**	**Spring Year 3**
Social Analysis of Computerization	Organizational Information Systems	Proj in Social & Org Impacts of Comp
Software Design II	SW Arch, Dist Syst, & Interoperability	File and Database Management
Breadth	Breadth	Breadth
Breadth / Elective	Breadth / Elective	Breadth / Elective
Fall Year 4	**Winter Year 4**	**Spring Year 4**
Senior Design Project	Senior Design Project	Senior Design Project
Project Management	Computer-Supported Coop Work	Breadth / Elective
Proj. in File and Database Mgmt	Information Retrieval	Information Visualization
Breadth / Elective	Breadth / Elective	Breadth / Elective

U.S. Dept. of Ed. Fund for the Improvement of Post-Secondary Education

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Evaluation Plans

- An independent evaluator will perform formative and summative evaluation, throughout the project and beyond. The focus will be on our three goals:
  1. interviews, surveys, and controlled design experiments to measure the quality of our degree program as compared to traditional CS degree programs
  2. comparison of admission, retention, and completion data to local and national averages to measure our success with underrepresented populations
  3. surveys and advisory board assessments to determine the level of success in establishing a nationwide example

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Incrementally-delivered Curriculum

Fall Year 1	Winter Year 1	Spring Year 1
Informatics Core	Informatics Core	Informatics Core
		Informatics Research Topics
Writing	Writing	Writing
Critical Reasoning	Discrete Mathematics	Fundamentals of data structures
Fall Year 2	**Winter Year 2**	**Spring Year 2**
Statistics	Human-Computer Interaction	Project in HCI and User Interfaces
Concepts in Programming Languages I	Concepts in Programming Languages II	Software Design I
Software Methods & Tools	Requirements Analysis & Engineering	SW Specification & Quality Engineering
Breadth	Breadth	Breadth
Fall Year 3	**Winter Year 3**	**Spring Year 3**
Social Analysis of Computerization	Organizational Information Systems	Proj in Social & Org Impacts of Computing
Software Design II	SW Arch, Dist Syst, & Interoperability	File and Database Management
Breadth	Breadth	Breadth
Breadth / Elective	Breadth / Elective	Breadth / Elective
Fall Year 4	**Winter Year 4**	**Spring Year 4**
Senior Design Project	Senior Design Project	Senior Design Project
Project Management	Computer-Supported Cooperative Work	Breadth / Elective
Proj. in File and Database Mgmt	Information Retrieval	Information Visualization
Breadth / Elective	Breadth / Elective	Breadth / Elective

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Incrementally-delivered Curriculum

Fall Year 1	Winter Year 1	Spring Year 1
Informatics Core	Informatics Core	Informatics Core
		Informatics Research Topics
Writing	Writing	Writing
Critical Reasoning	Discrete Mathematics	Fundamentals of data structures
Fall Year 2	**Winter Year 2**	**Spring Year 2**
Statistics	Human-Computer Interaction	Project in HCI and User Interfaces
Concepts in Programming Languages I	Concepts in Programming Languages II	Software Design I
Software Methods & Tools	Requirements Analysis & Engineering	SW Specification & Quality Engineering
Breadth	Breadth	Breadth
Fall Year 3	**Winter Year 3**	**Spring Year 3**
Soc		
Sof		
Bre		
Bre		
Ser		
Pro		
Pro		
Bre		

First Year: Informatics Core Sequence

41: CS 0 + CS 1 (Scheme) [1.5 courses]

42: CS 2 (Java) [1.5 courses]

43: Intro to Software Design [1.5 courses]

44: Faculty speaker series [0.5 courses]

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Solid Computer Science Fundamentals

Fall Year 1	Winter Year 1	Spring Year 1
Informatics Core	Informatics Core	Informatics Core
		Informatics Research Topics
Writing	Writing	Writing
Critical Reasoning	Discrete Mathematics	Fundamentals of data structures
Fall Year 2	**Winter Year 2**	**Spring Year 2**
Statistics	Human-Computer Interaction	Project in HCI and User Interfaces
Concepts in Programming Languages I	Concepts in Programming Languages II	Software Design I
Software Methods & Tools	Requirements Analysis & Engineering	SW Specification & Quality Engineering
Breadth	Breadth	Breadth
Fall Year 3	**Winter Year 3**	**Spring Year 3**
Social Analysis of Computerization	Organizational Information Systems	Proj in Social & Org Impacts of Computing
Software Design II	SW Arch, Dist Syst, & Interoperability	File and Database Management
Breadth	Breadth	Breadth
Breadth / Elective	Breadth / Elective	Breadth / Elective
Fall Year 4	**Winter Year 4**	**Spring Year 4**
Senior Design Project	Senior Design Project	Senior Design Project
Project Management	Computer-Supported Cooperative Work	Breadth / Elective
Proj. in File and Database Mgmt	Information Retrieval	Information Visualization
Breadth / Elective	Breadth / Elective	Breadth / Elective

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Solid Computer Science Fundamentals

Fall Year 1	Winter Year 1	Spring Year 1
Informatics Core	Informatics Core	Informatics Core
		Informatics Research Topics
Writing	Writing	Writing
Critical Reasoning	Discrete Mathematics	Fundamentals of data structures
Fall Year 2	**Winter Year 2**	**Spring Year 2**
Statistics	Human-Computer Interaction	Project in HCI and User Interfaces
Concepts in Programming Languages I	Concepts in Programming Languages II	Software Design I
Software Methods & Tools	Requirements Analysis & Engineering	SW Specification & Quality Engineering
Breadth	Breadth	Breadth
Fall Year 3	**Winter Year 3**	**Spring Year 3**
Soci...	Organizational Information Systems	Proj in Social & Org Impacts of Computing
Sof...		
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Pro...		
Pro...		
Bre...		

Basic Math and CS: in addition to Informatics Core

- Discrete Mathematics, Statistics [2 courses]
- Fundamentals of Data Structures [1 course]
- Programming Languages [2 courses]
- Database Management, Information Retrieval [3 courses]

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Software Engineering Focus

Fall Year 1	Winter Year 1	Spring Year 1
Informatics Core	Informatics Core	Informatics Core
		Informatics Research Topics
Writing	Writing	Writing
Critical Reasoning	Discrete Mathematics	Fundamentals of data structures
Fall Year 2	**Winter Year 2**	**Spring Year 2**
Statistics	Human-Computer Interaction	Project in HCI and User Interfaces
Concepts in Programming Languages I	Concepts in Programming Languages II	Software Design I
Software Methods & Tools	Requirements Analysis & Engineering	SW Specification & Quality Engineering
Breadth	Breadth	Breadth
Fall Year 3	**Winter Year 3**	**Spring Year 3**
Social Analysis of Computerization	Organizational Information Systems	Proj in Social & Org Impacts of Computing
Software Design II	SW Arch, Dist Syst, & Interoperability	File and Database Management
Breadth	Breadth	Breadth
Breadth / Elective	Breadth / Elective	Breadth / Elective
Fall Year 4	**Winter Year 4**	**Spring Year 4**
Senior Design Project	Senior Design Project	Senior Design Project
Project Management	Computer-Supported Cooperative Work	Breadth / Elective
Proj. in File and Database Mgmt	Information Retrieval	Information Visualization
Breadth / Elective	Breadth / Elective	Breadth / Elective

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Software Engineering Focus

Fall Year 1	Winter Year 1	Spring Year 1
Informatics Core	Informatics Core	Informatics Core
		Informatics Research Topics
Writing	Writing	Writing
Critical Reasoning	Discrete Mathematics	Fundamentals of data structures
Fall Year 2	**Winter Year 2**	**Spring Year 2**
Statistics	Human-Computer Interaction	Project in HCI and User Interfaces

Software Engineering Courses:

- Software Methods & Tools [1 course]
- Advanced Programming Languages [1 course]
- Requirements Analysis & Engineering [1 course]
- Software Specification & Quality Engineering [1 course]
- Software Design [2 courses]
- Software Architecture, Distributed Systems & Interoperability [1 course]
- Project Management [1 course]
- Senior Design Project [3 courses]

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Informatics Context for CS & SE

Fall Year 1	Winter Year 1	Spring Year 1
Informatics Core	Informatics Core	Informatics Core
		Informatics Research Topics
Writing	Writing	Writing
Critical Reasoning	Discrete Mathematics	Fundamentals of data structures
Fall Year 2	**Winter Year 2**	**Spring Year 2**
Statistics	Human-Computer Interaction	Project in HCI and User Interfaces
Concepts in Programming Languages I	Concepts in Programming Languages II	Software Design I
Software Methods & Tools	Requirements Analysis & Engineering	SW Specification & Quality Engineering
Breadth	Breadth	Breadth
Fall Year 3	**Winter Year 3**	**Spring Year 3**
Social Analysis of Computerization	Organizational Information Systems	Proj in Social & Org Impacts of Computing
Software Design II	SW Arch, Dist Syst, & Interoperability	File and Database Management
Breadth	Breadth	Breadth
Breadth / Elective	Breadth / Elective	Breadth / Elective
Fall Year 4	**Winter Year 4**	**Spring Year 4**
Senior Design Project	Senior Design Project	Senior Design Project
Project Management	Computer-Supported Cooperative Work	Breadth / Elective
Proj. in File and Database Mgmt	Information Retrieval	Information Visualization
Breadth / Elective	Breadth / Elective	Breadth / Elective

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Informatics Context for CS & SE

Fall Year 1	Winter Year 1	Spring Year 1
Informatics Core	Informatics Core	Informatics Core
		Informatics Research Topics
Writing	Writing	Writing
Critical Reasoning	Discrete Mathematics	Fundamentals of data structures
Fall Year 2	**Winter Year 2**	**Spring Year 2**
Statistics	Human-Computer Interaction	Project in HCI and User Interfaces

Courses focusing on the broader context:

- Human-Computer Interaction [1 course]
- Project in HCI and User Interfaces [1 course]
- Social Analysis of Computerization [1 course]
- Organizational Information Systems [1 course]
- Project in Social and Organizational Issues in Computing [1 course]
- Project Management [1 course]
- Computer-Supported Cooperative Work [1 course]
- Information Visualization [1 course]

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Experience-based Capstone Projects

Fall Year 1	Winter Year 1	Spring Year 1
Informatics Core	Informatics Core	Informatics Core
		Informatics Research Topics
Writing	Writing	Writing
Critical Reasoning	Discrete Mathematics	Fundamentals of data structures
Fall Year 2	**Winter Year 2**	**Spring Year 2**
Statistics	Human-Computer Interaction	Project in HCI and User Interfaces
Concepts in Programming Languages I	Concepts in Programming Languages II	Software Design I
Software Methods & Tools	Requirements Analysis & Engineering	SW Specification & Quality Engineering
Breadth	Breadth	Breadth
Fall Year 3	**Winter Year 3**	**Spring Year 3**
Social Analysis of Computerization	Organizational Information Systems	Proj in Social & Org Impacts of Computing
Software Design II	SW Arch, Dist Syst, & Interoperability	File and Database Management
Breadth	Breadth	Breadth
Breadth / Elective	Breadth / Elective	Breadth / Elective
Fall Year 4	**Winter Year 4**	**Spring Year 4**
Senior Design Project	Senior Design Project	Senior Design Project
Project Management	Computer-Supported Cooperative Work	Breadth / Elective
Proj. in File and Database Mgmt	Information Retrieval	Information Visualization
Breadth / Elective	Breadth / Elective	Breadth / Elective

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Experience-based Capstone Projects

Fall Year 1	Winter Year 1	Spring Year 1
Informatics Core	Informatics Core	Informatics Core
		Informatics Research Topics
Writing	Writing	Writing
Critical Reasoning	Discrete Mathematics	Fundamentals of data structures
Fall Year 2	**Winter Year 2**	**Spring Year 2**
Statistics	Human-Computer Interaction	Project in HCI and User Interfaces
Concepts in Programming Languages I	Concepts in Programming Languages II	Software Design I
Software Methods & Tools	Requirements Analysis & Engineering	SW Specification & Quality Engineering
Bre		
Soc		
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Pro		
Bre		

Project Courses throughout the curriculum:

- Informatics Research Topics [0.5 course]
- Project in HCI and User Interfaces [1 course]
- Project in Social and Organizational Issues [1 course]
- Project in File and Database Management [1 course]
- Senior Design Project [3 courses]

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Current Activities

- Rolling out the program, year-by-year
- Outreach
  - community
  - current students
  - prospective students
- Managing growth
- Continuous evaluation
  - follow detailed evaluation plan
    - track students, numbers, performance, progress, skills
    - track dissemination
  - data collection as appropriate
- Coastline Community College
  - planned fully articulated program in Informatics
    - 2 year option
    - 3 year option
    - A.A. option
  - NSF ATE request jointly with UC Irvine
- Planning specializations
- Informatics minor proposed and approved by campus
  - open for enrollment in fall 2005

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Preliminary Data

- Enrollment: 31
  - (CS&E: 30, CS: 60, ICS: 60)
  - recruited from admitted CS & ICS students only
  - word got out on campus, so other students joined
  - attrition lower than in traditional freshman sequence
- Participation by women: 29%
  - already higher than the national average
- Reasons to join (22 respondents)
  - people-oriented: 17 (primary reason for 10 respondents)
  - interesting courses: 13
  - interdisciplinary: 12
  - job prospects: 10
  - …
- Other majors considered
  - CS&E, CS, ICS
  - film, psychology, criminology, chemistry, biology, math, political science, international studies, economics

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Introductory CS in Context

- Integration of topics
  - making explicit connections between programming and context
- Using available tools to solve realistic problems
  - everything isn't built from the ground up
  - instead the highest level tool available is used
- Real-world case studies in context
  - examples and assignments mimic real needs and real solutions
    - e.g., web store, a amusement park management system, travel agency system
  - students not only extend code, but also devise tests, propose new features, evaluate design tradeoffs, …
  - may not build all, but lessons translate from real human impact to choices in the design and code
- Group work, pair programming
  - students have become an extremely cohesive group

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Informatics Research Topics Seminar

- To present the students with an opportunity to learn about current research in Informatics and how it fits with the curriculum
- To introduce the Informatics faculty members to the students, so they know who to expect in their future courses and get familiar with them in a friendly setting
- To get them excited about research, so they will consider doing an independent study or honors research during their Informatics major
- To broaden the set of topics to which the students are exposed
- Ends with a mini project - the first capstone

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Future Integrated Specializations

- Software engineering
- Interactive & collaborative technologies (HCI/CSCW)
- Interaction design
- Ubiquitous computing
- Information management
- Research
- …

- Digital Arts
- Game culture & technology
- Business informatics
- Organizational computing
- Bioinformatics
- Medical informatics
- …

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Resulting Skills

- Able to design and coordinate implementation of software and information systems
  - not hackers, not just tool users or coders
  - instead, professionals who
    - write software but also do much more
    - design with expertise
    - listen to programmers and other people involved
    - interact with customers
    - analyze, compare, and discuss the quality of alternative designs
    - devise the best implementation techniques in every situation
    - understand the role of quality control
    - adapt to changing requirements
- Able to adapt to new concepts and technologies
- Able to act as agents of change

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After School

- Potential job titles
  - software engineer
  - system, software, information architect / designer / analyst
  - interface & interaction designer
  - software anthropologist / archaeologist
  - project manager
  - business organization / process analyst
  - intellectual property lawyer (after law school)
  - application to other areas
    - media art developer
    - game designer
    - bio-informatician
    - …
- Career choices
  - multi-national corporations
  - new start-ups
  - software / IT houses
  - consulting firms
  - as Informatics specialist (in any field/organization)
  - graduate study

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What Does Industry Think?

- "These are exactly the kinds of graduates we are looking for"
- Programming jobs may be moving overseas (and we have to see how long that lasts), but we won't move design
- Computer science is about computers, Informatics is about computers and people
  - can't move people
- Bill Gates
  - encouraging students to go into computing, because he is worried there will be a major shortfall of graduates
  - http://www.acm.org/technews/articles/2004-6/0301m.html#item1

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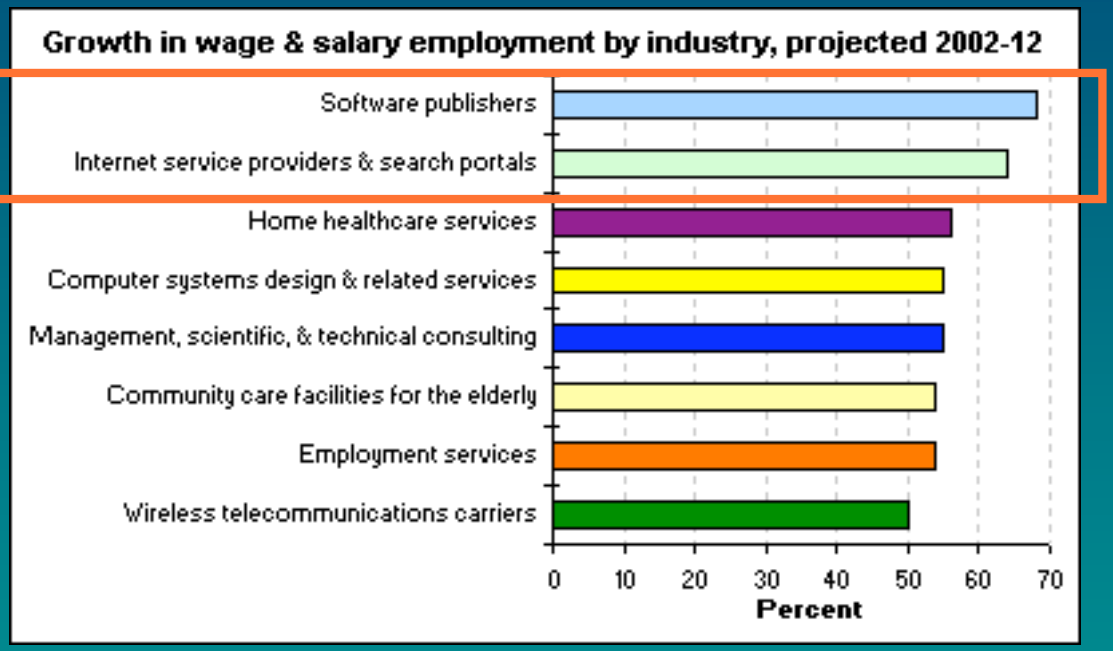
Jobs



U.S. Bureau of Labor Statistics Forecasts 2002 – 2012 (Feb 2004 report)

Fastest-growing occupations 2002-2012

(projected)

	GROWTH	# OF NEW JOBS
Medical assistants	59%	215,000
Network systems, data communications analysts	57%	106,000
Physician assistants	49%	31,000
Social and human service assistants	49%	149,000
Home health aides	48%	279,000
Medical records and health information technicians	47%	69,000
Physical therapist aides	46%	17,000
Computer software engineers, applications	46%	179,000
Computer software engineers, systems software	45%	128,000
Physical therapist assistants	45%	22,000

Source: BLS

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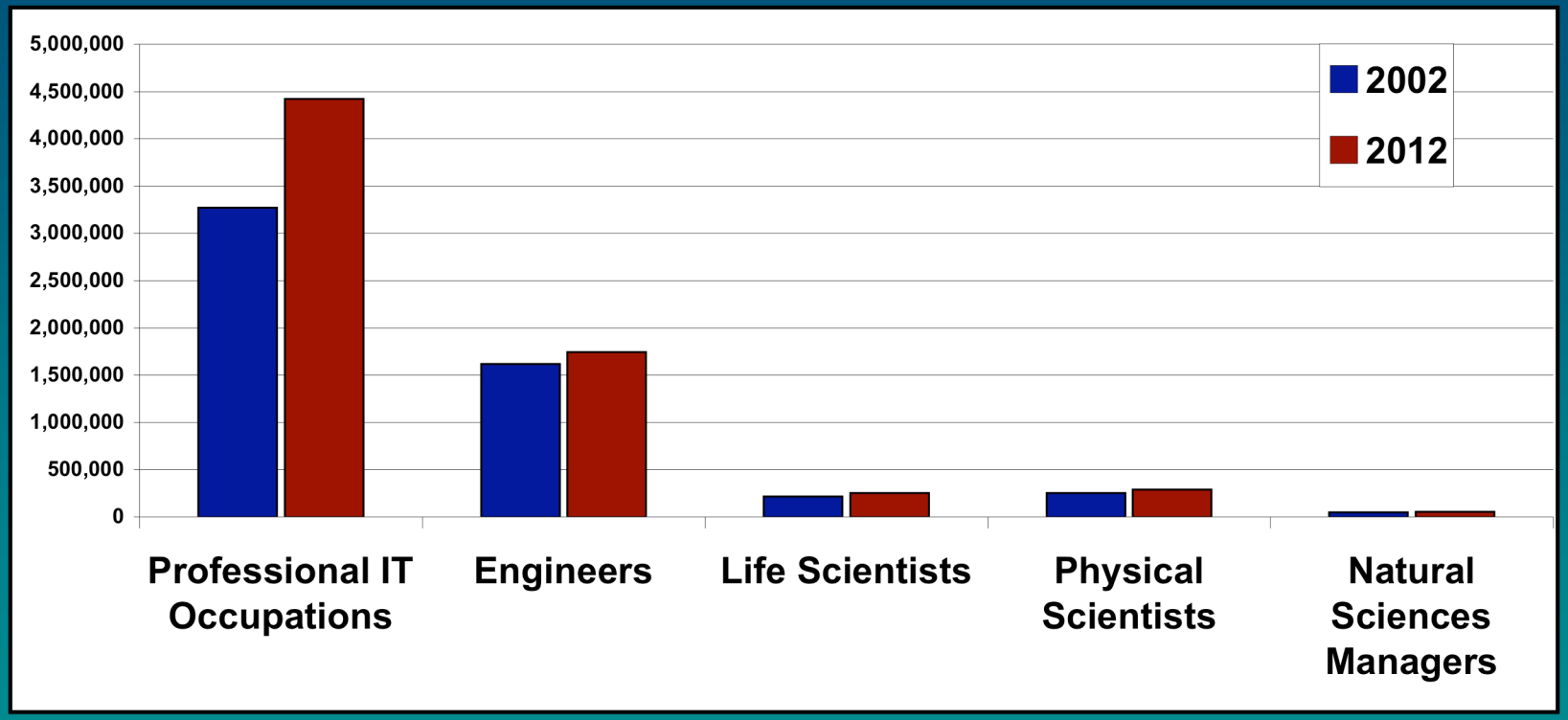
Jobs



U.S. Bureau of Labor Statistics Forecasts 2002 – 2012 (Feb 2004 report)

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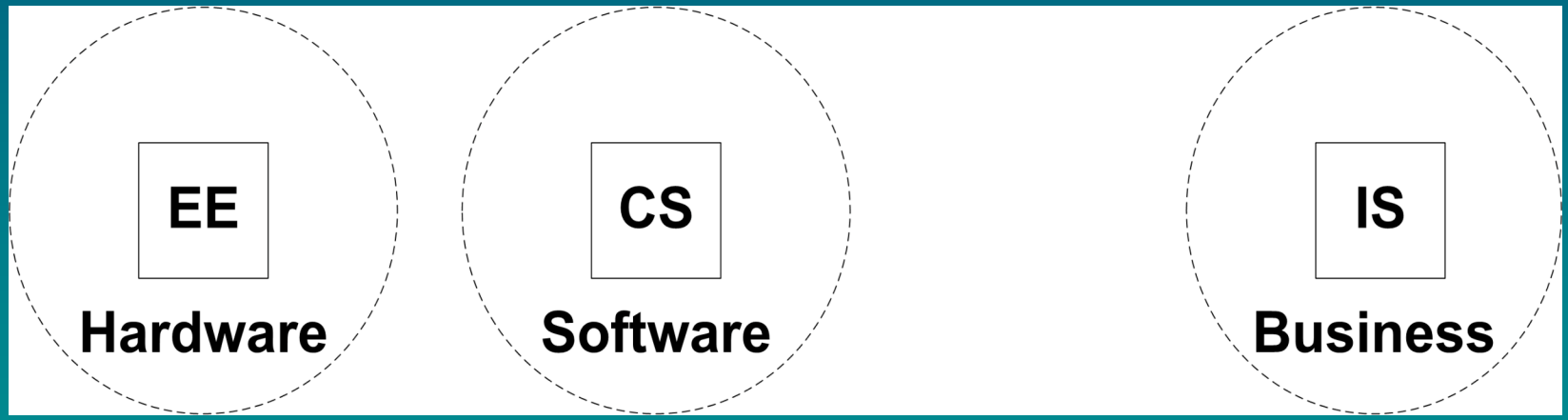
Computing Curricula 2004 – Pre 1990



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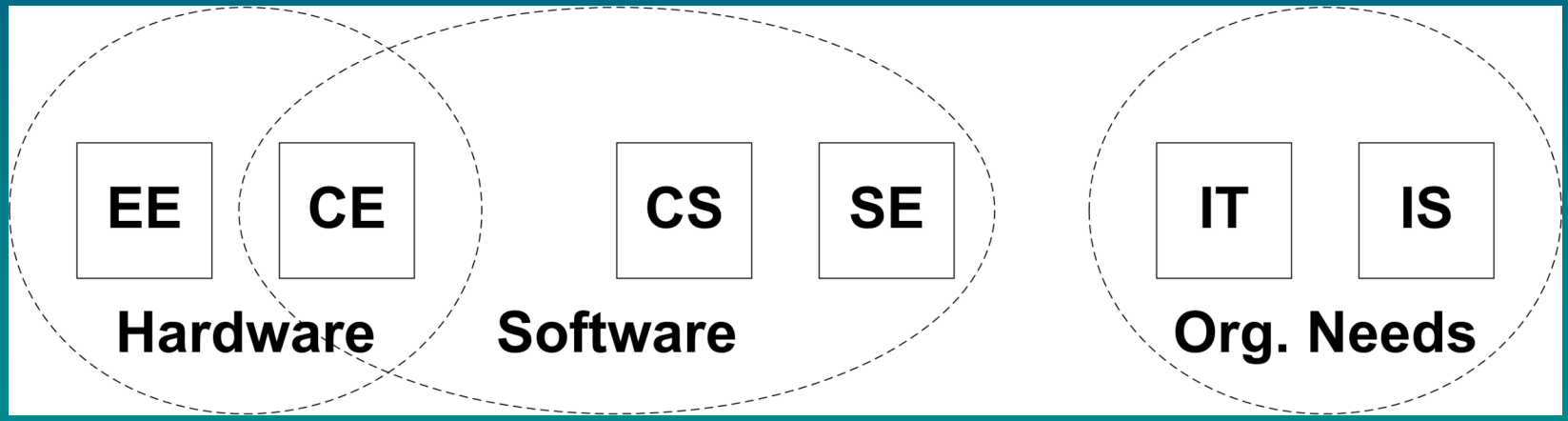
Computing Curricula 2004 – Post 1990



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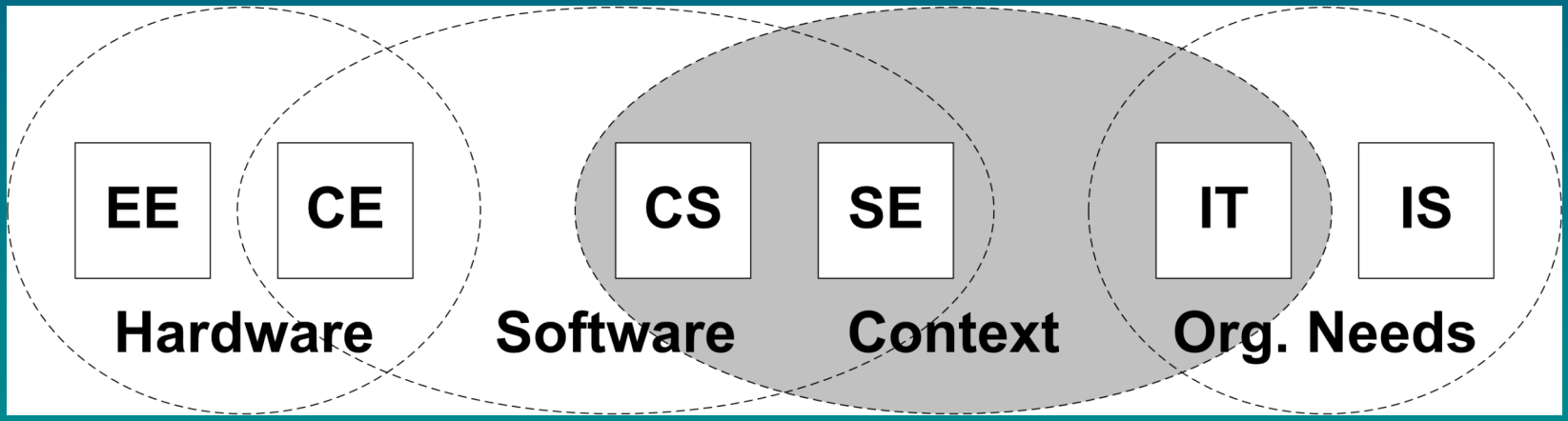
The Informatics Focus



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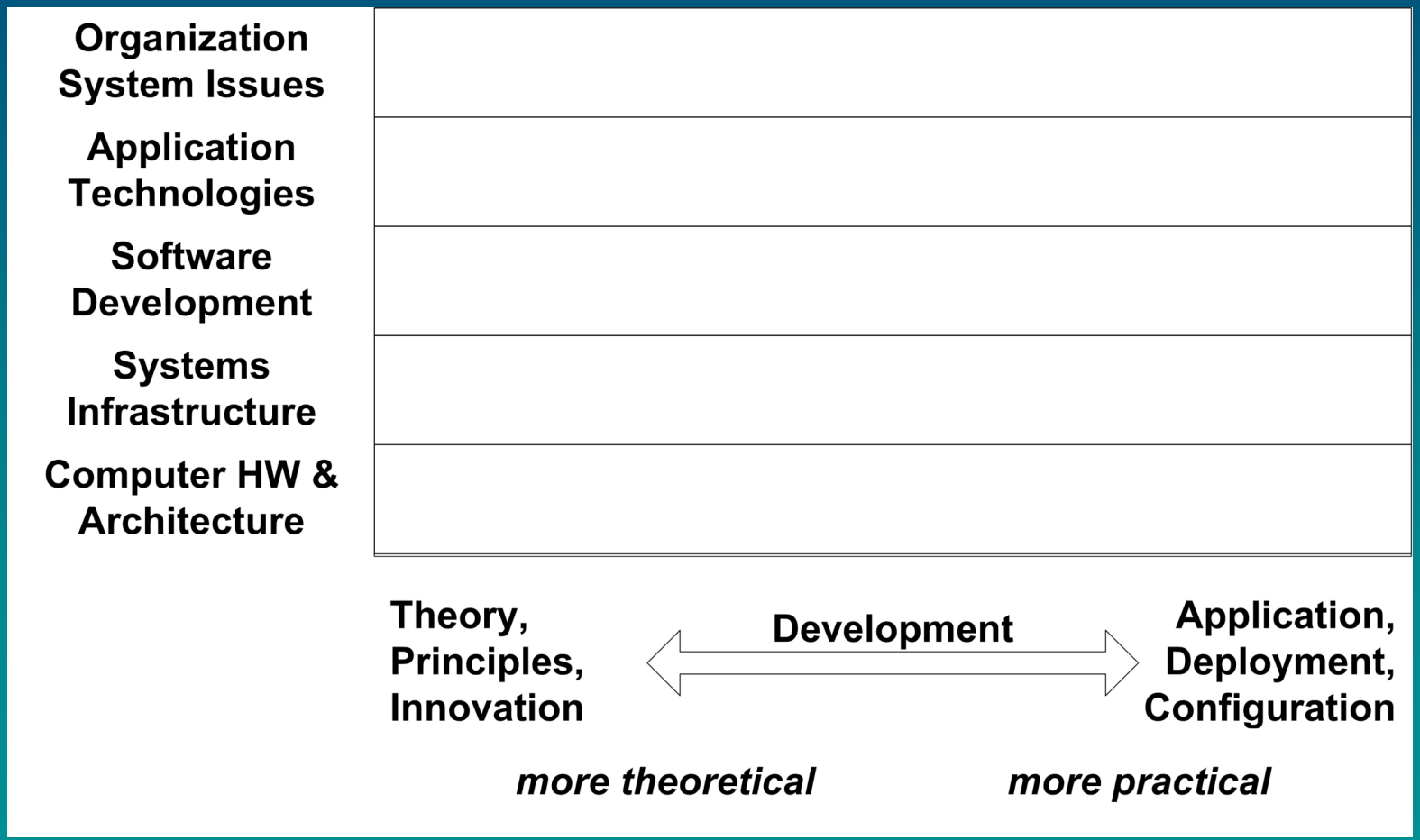
CC 2004: Visualization of the Field



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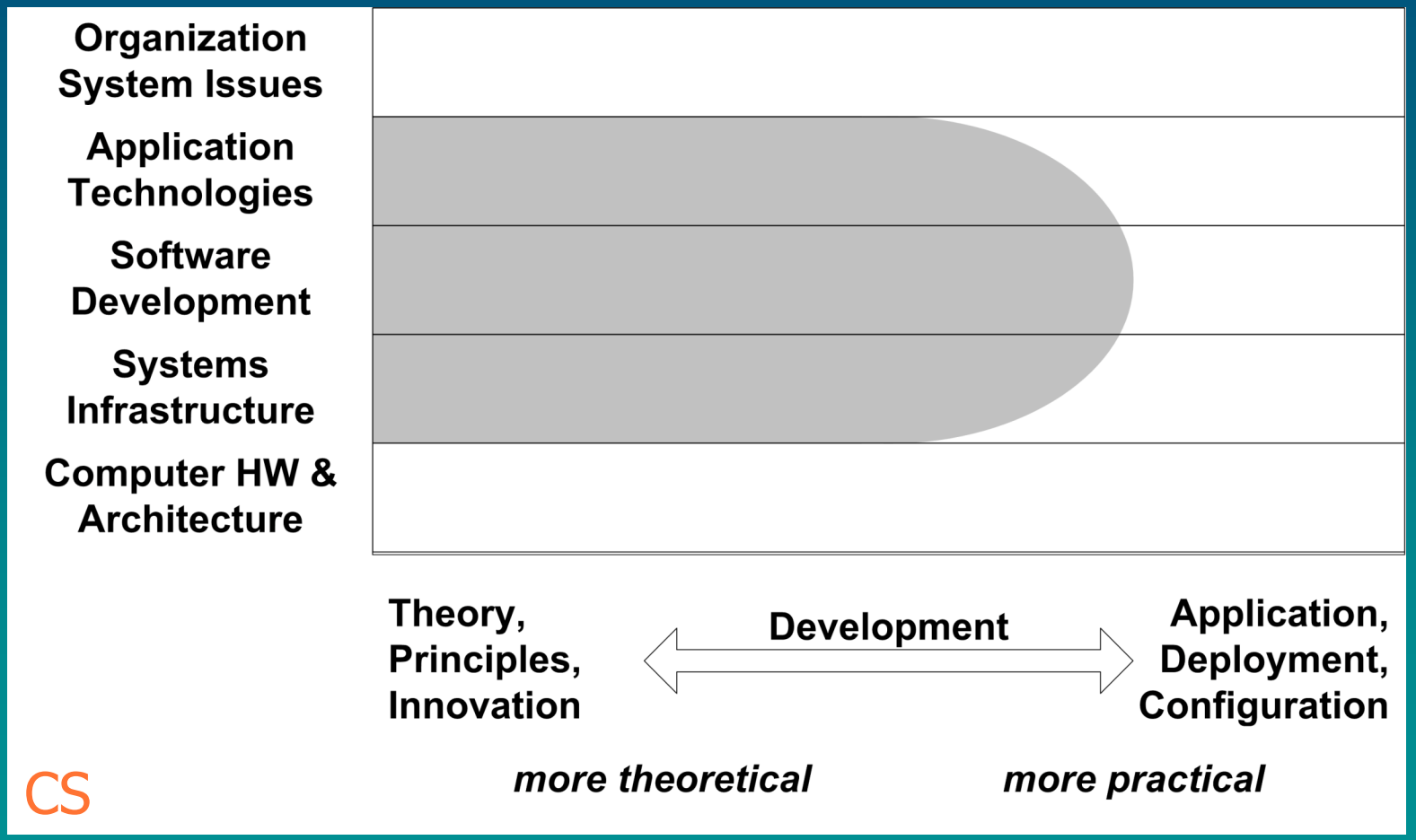
CC 2004: Computer Science



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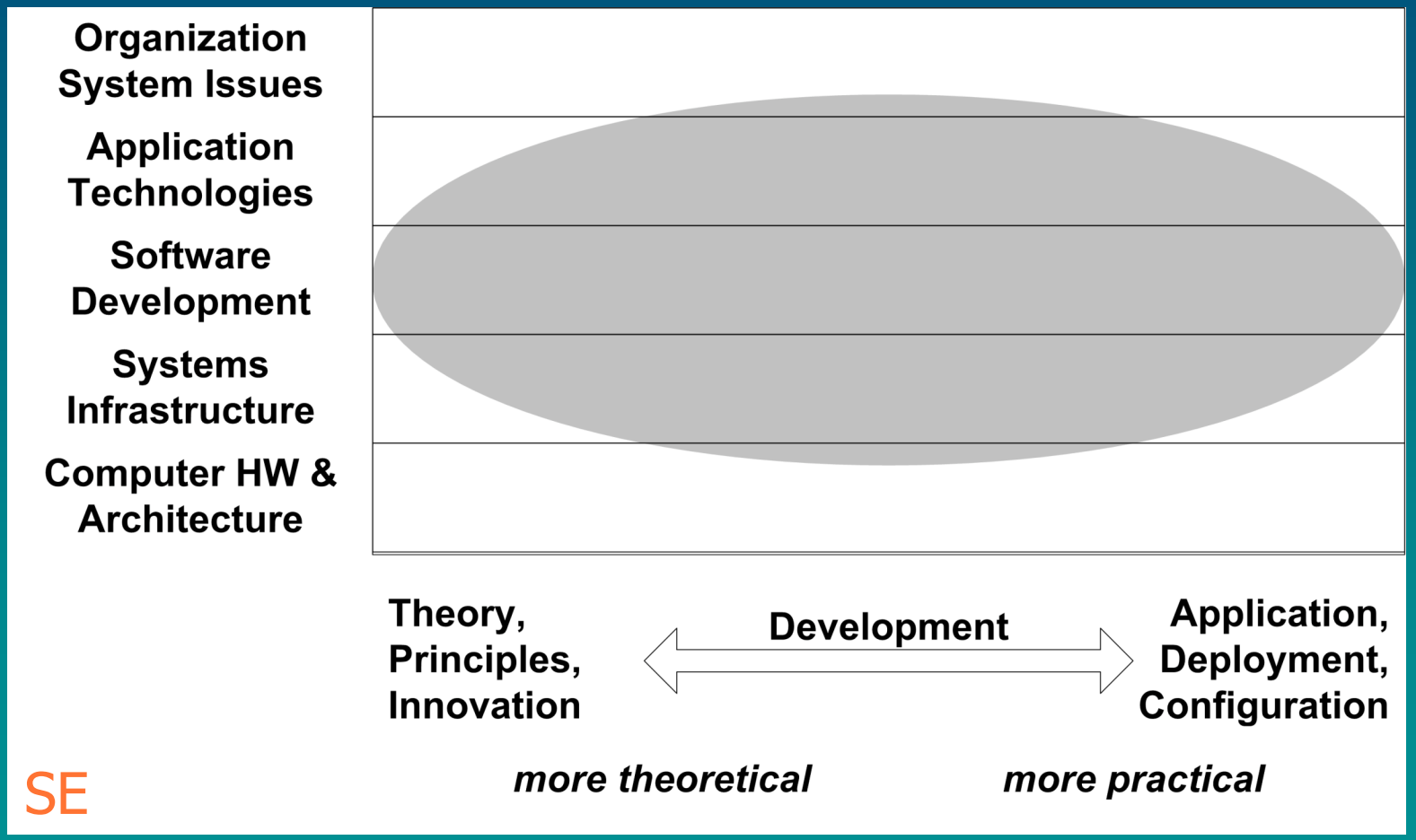
CC 2004: Software Engineering



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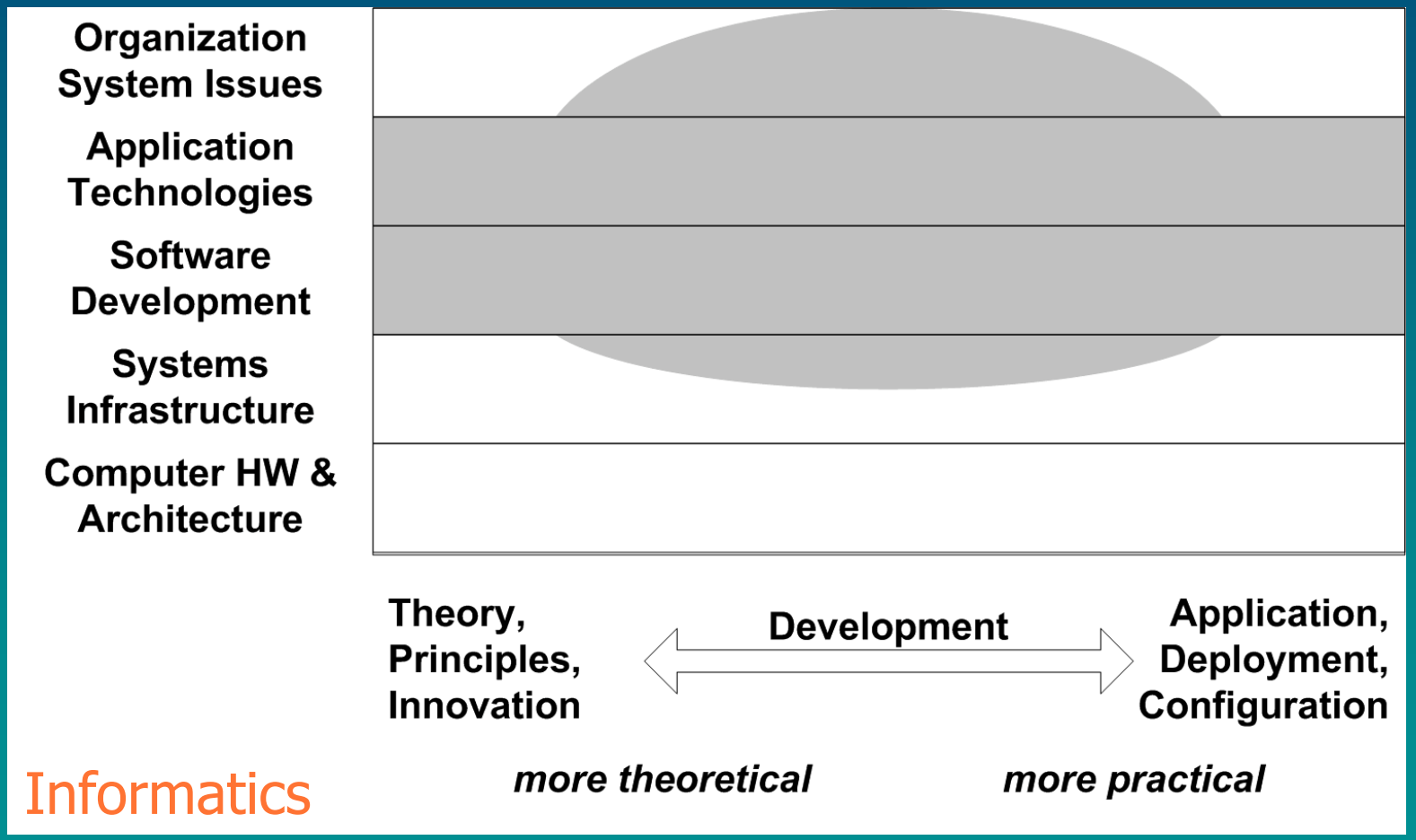
Informatics



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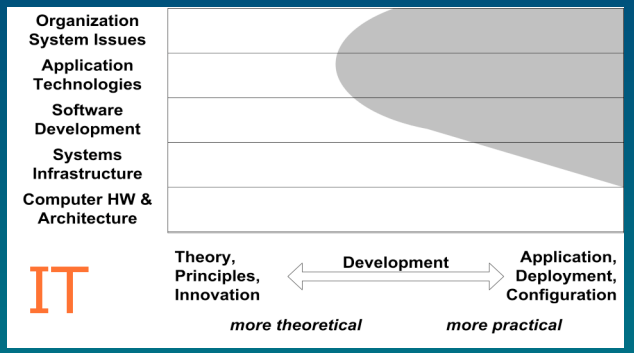
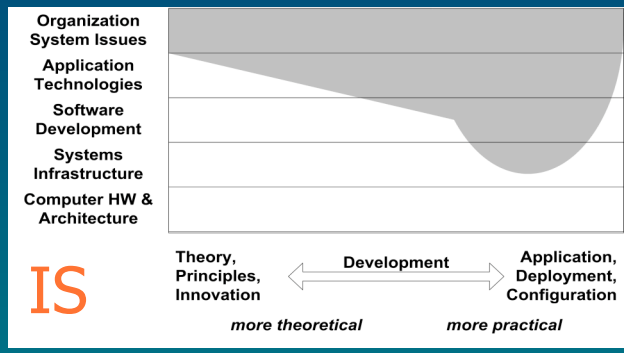
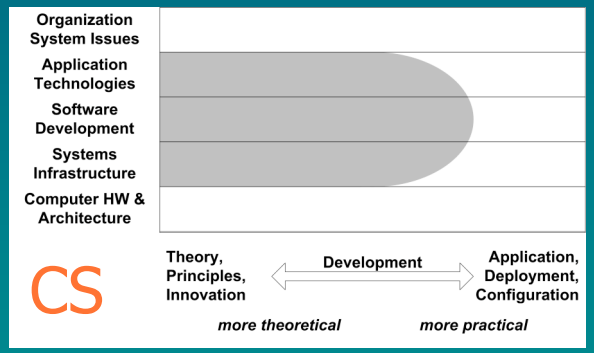
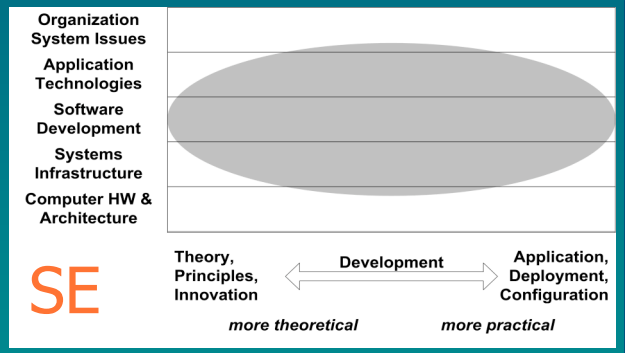
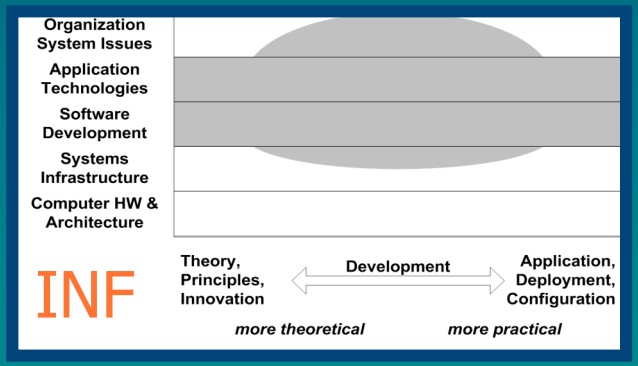
Informatics in CC 2004 Context

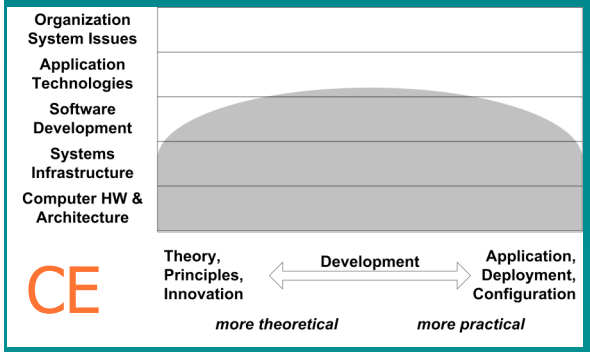












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Critical Decisions Made

- Should it have been a software engineering degree?
  - no, that would be too restrictive and miss "context"
- Should it have been upper-division only?
  - no, not enough room to cover all needed materials
- Should it have had the same introductory courses as the other majors in the Bren School?
  - no, students would settle into the "programming" mentality, not the "designing with context" mentality
  - declared equivalency allows change of majors

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Other Considerations

- Designed from the ground up to address known issues with existing CS programs regarding underrepresented groups
  - clear path and focus
  - relevancy
- "Programming jobs are moving overseas"
  - Informatics focuses on design
- Different and less math
  - but not necessarily easier!
- Basic skills necessary
  - listening, reading and writing
  - independent, critical thinking
  - innovation and creativity

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Other Considerations

- Women and underrepresented groups do not show up "just like that"
  - much effort in recruiting
  - however, sending the right message makes a huge difference
  - acting upon that message even more
  - ABRC affiliation
- Teaching Informatics requires a different mindset
  - spend effort on contextualized examples, all the time
  - real-life case studies, from year 1
  - engage, discuss, reflect, relate, …
    - focus on understanding
    - make the experience worthwhile
- Continuous evaluation

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Key Component: Clear Vision

- Encourages feedback and buy-in
  - whiteboard diagram of curriculum
  - faculty feedback and participation
  - student buzz
  - other departments in the Bren School
- Easy to talk about and sell

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Key Component: Faculty

- Broad variety of backgrounds
  - software engineering
  - human-computer interfaces
  - psychology
  - anthropology
  - machine learning
  - arts
- Focus and energy
  - curricular design
  - drafting help
  - course design
  - new student welcome
  - …

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Key Component: Administrative Support

- As Dean, I was a strong proponent
  - co-author of FIPSE grant
  - software engineer
  - understand broad offerings necessary
  - support change and a "can do" attitude
  - Facilitated rapid approval through the School
- Campus generally supportive of new degree programs
  - more offerings for different students
- Buzz on campus

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Key Component: External Support

- U.S. Department of Education FIPSE grant
  - money talks
    - on campus
    - summer salary / course release
    - recruitment
  - grant application had to be "right" (money talks, differently)
    - carefully crafted message
    - external advisory board
    - detailed project and evaluation plans
    - dissemination plan
- Bren School advisory boards

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Things That Went "Right"

- Monetary support from U.S. Department of Education FIPSE grant
- Degree program naturally fit with the department, so few objections (inside and outside)
- Momentum existed
- Students bought into the concept and were willing to try something unproven
  - our early survey of existing students helped in unexpected ways

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Things That Went "Wrong"

- Amount of work cannot be underestimated
  - proposal, campus proposal, courses, publicity, web site, …
- Interaction with other departments
  - wanted to control at least first-year courses, if not beyond
  - math
  - ownership of new courses
- Change of major and transfer hurdles
- Timing of recruiting effort for first year class
  - campus process is slow (even though it was fast)
  - approved in May, students were already admitted to UCI
- Barely sufficient faculty
  - planned specializations cannot be realized yet
  - program must be rolled out year-by-year

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Conclusion

- Informatics represents a different way of teaching computer science, with a focus on context
- In the midst of introducing our new degree program
  - initial results are highly encouraging
  - long-term results will be monitored
- The degree program as a whole represents a radical change
  - however, bits and pieces of varying sizes can easily be adopted
- Informatics is an up-and-coming discipline nationwide
  - Indiana U, Montclair State, SUNY Buffalo, York College (Pennsylvania), U of Washington, ...
  - Graduate programs, too: U of Michigan, …
- FIPSE support invaluable

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Materials Available for Adoption

- Mindset
- Experience
- Evaluation plan
- Assignments
- Individual courses
- Course sequences
- Entire curriculum
- Articulation with 2-year college (in progress)

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Further Information

- http://www.ics.uci.edu/
- http://www.ics.uci.edu/informatics
- http://www.ics.uci.edu/informatics/ugrad/

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What Is CSTA?

- High school computing teachers are at the start of the pipeline and, up until now, they have gotten very little help!
- The Computer Science Teachers Association is a membership organization that supports and promotes the teaching of computer science and other computing disciplines at the K-12 level by providing opportunities for teachers and students to better understand the computing disciplines and to more successfully prepare themselves to teach and to learn
- CSTA is a semi-autonomous organization under the auspices of the Association for Computing Machinery (ACM), with its own Board of Directors, Advisory Council, membership and distinct member benefits

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How to Join CSTA

Joining on-line on the CSTA website:

http://csta.acm.org

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1-800-401-1799, cstephenson@csta.acm.org

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bren:school Information and computer sciences

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Informatics

= computer science + people in context

B.S. in Informatics @UCI

- Focus: design, application, use, and impact of information technology, studying the social and technical aspects of design and development of software and information systems

Careers paths:
- software engineer
- software / information architect
- software / information analyst
- project manager
- interface / interaction designer

Comparison:
- new, emerging territory
- computers and people
- design and development
- technical and social
- creation and study

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B.S. in Computer Science @UCI

- Focus: operation of computers and the systems software facilitating operation, enabling more in-depth study in traditional topics such as algorithms and data structures, artificial intelligence, expert systems, and graphics, as well as modern topics such as computational biology

Careers paths:
- design and development of
  - embedded systems
  - programming languages
  - compilers
  - networks
  - operating systems
- artificial intelligence
- computational biology

Comparison:
- structured according to ABET (a bit less flexibility)
- conventional computer science major similar to those found at other institutions
- fair amount of math & science

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B.S. in Computer Science and Engineering @UCI

- Focus: fundamentals of computer science, both hardware and software, and the application of engineering concepts, techniques, and methods to both computer systems engineering and hardware/software systems co-design

Careers paths:
- building hardware infrastructure
  - computers
  - networks
  - embedded devices
- associated software infrastructure
  - operating systems
  - networking software
  - specialized compilers

Comparison:
- ABET accreditation in progress (strict set of courses)
- introductory computer science, math, science, digital devices and circuits

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B.S. in Information and Computer Science @UCI

- Focus: the broad variety of topics that constitute computer science, from detailing how modern computer hardware and networks operate on a day-to-day basis to how software should be structured to facilitate cooperative work among groups of people

Careers paths:
- most of the previous careers
- self-designed career paths
- bridge builders

Comparison:
- broad overview of the discipline (with specializations)
- flexible
- not as in-depth as the other degree programs

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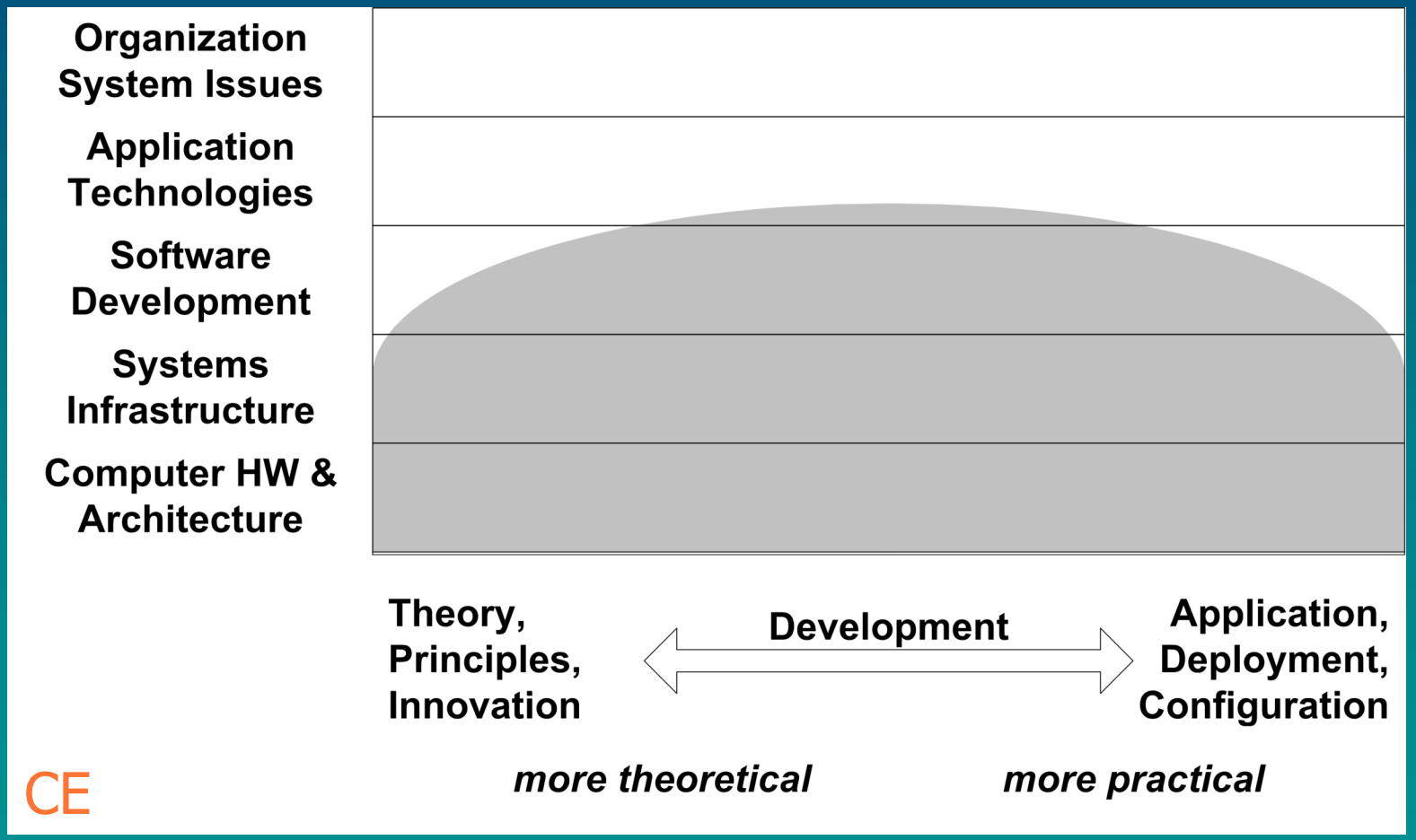

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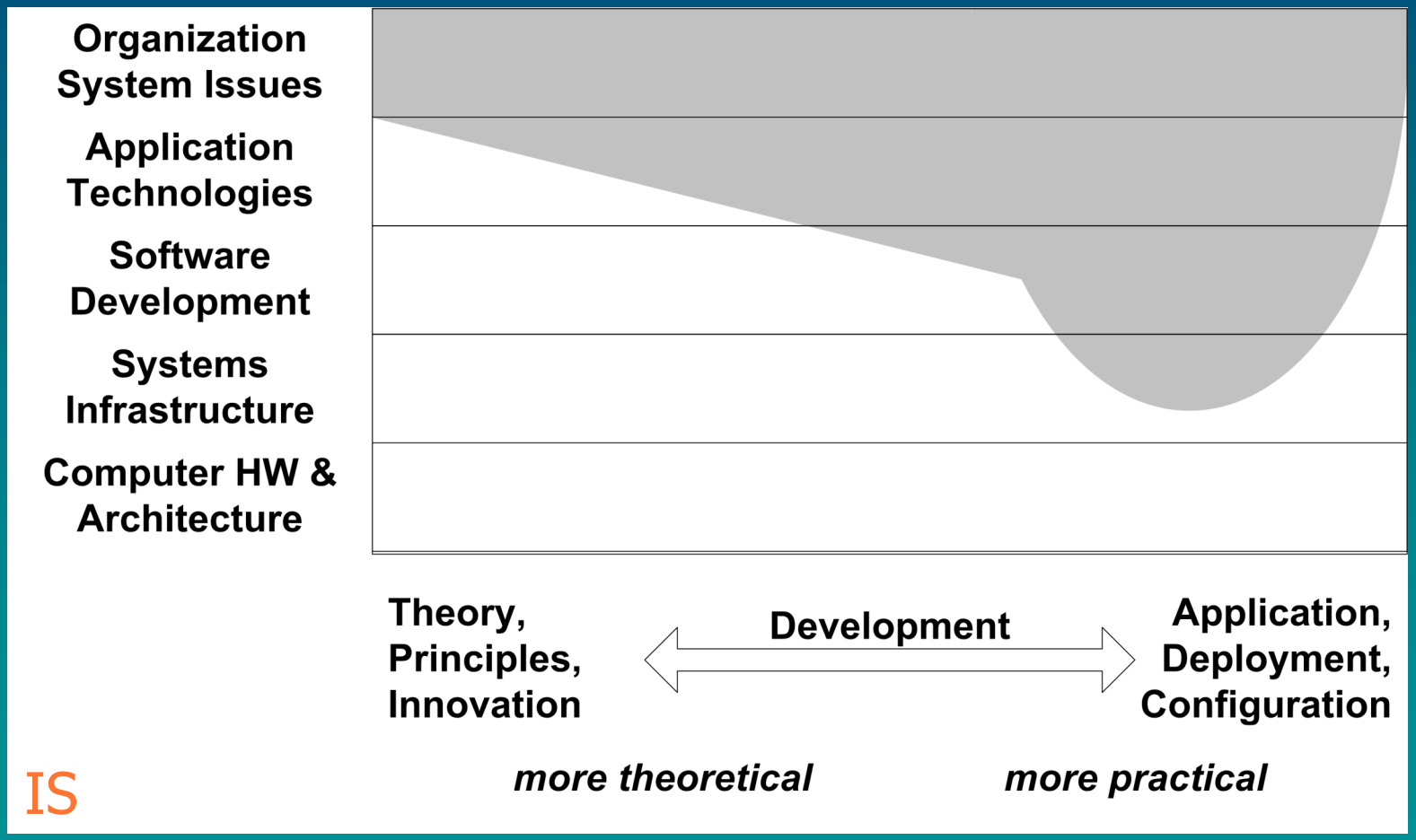

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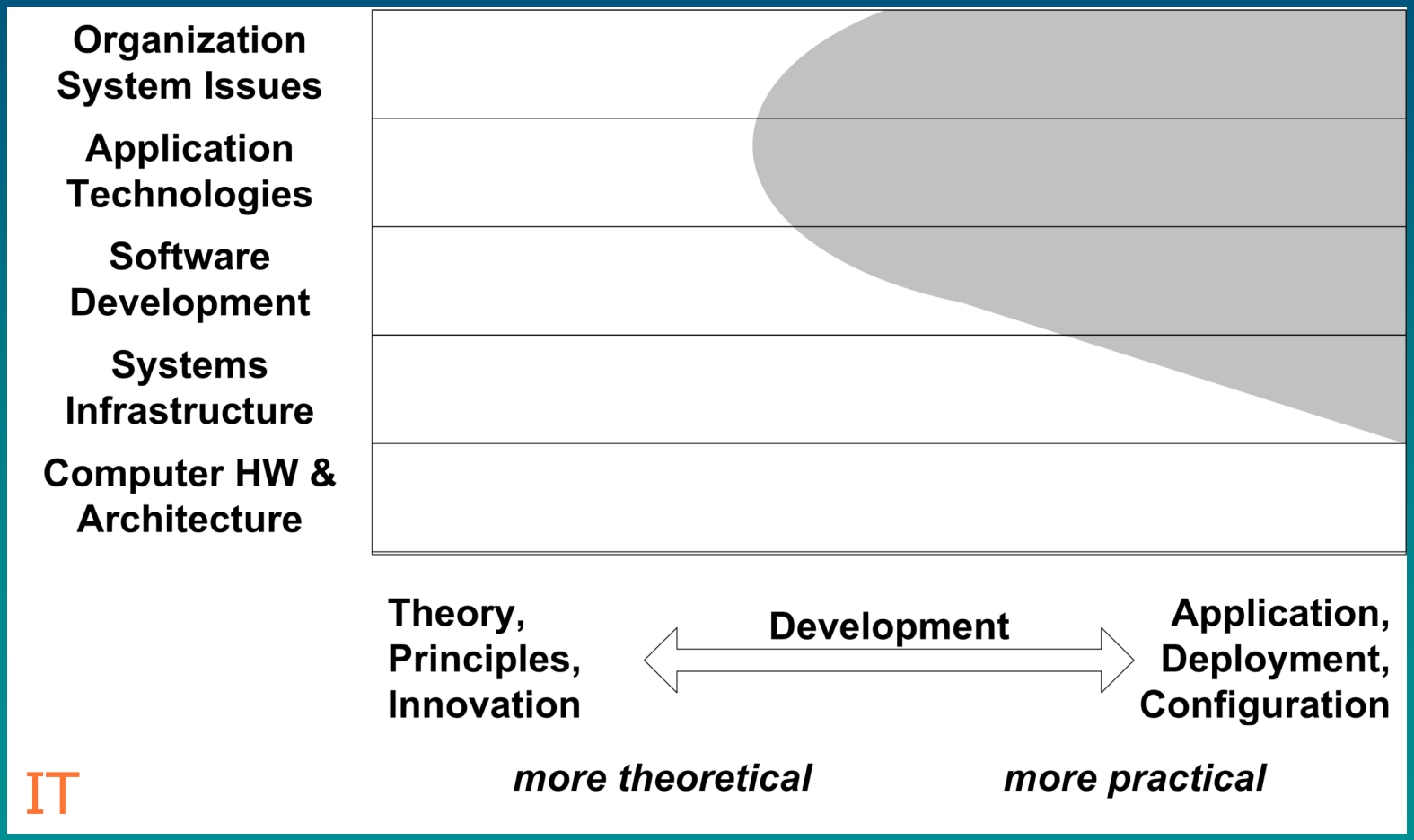

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