A brief introduction to the ICS Department

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Table of Contents

The importance of Computer Science 3

A brief history of the Department of Information and Computer Sciences 3

The ICS Department today 4

Curriculum proposal examples 5

Information assurance and computer security 6

Distance learning 6

Curriculum design and learning objectives 6

Social media and student assessment 7

Faculty and research areas 8

Digital democracy 9

Computer vision 9

Artificial intelligence and medicine 9

Socio-technical network analysis 9

User modeling 10

Undergraduate education 10

Space exploration 10

High performance computing 10

Wireless networking and security 10

Studio-based learning 11

STEM education 11

Renewable energy and sustainability 11

Bioinformatics 11

Research and teaching laboratories 11

Initiatives to improve student quality 12

# The importance of Computer Science

About one-third of the economic growth in the U.S. in the last decade has been in information and computing technology. While the Internet and the Web are perhaps the most visible aspects of this change, the revolution is pervasive, touching nearly every field and discipline, from computational techniques in the physical and biological sciences, to new interactive media in the fine arts. The impact of the digital and information revolution upon society is profound. The evolution of computing and information technology will continue to be a driving force behind the creation of new industries, careers, and academic disciplines. As a result, there is a genuine and increasing need for workers with an interdisciplinary background who understand the social and organizational uses of technology and who are literate and articulate. They require knowledge of computing systems, global communications networks, and interactive information resources. The requisite proficiencies go beyond being comfortable with computing tools. They require the ability to apply computational ways of thinking to design, to writing, to experimentation, to artistic expression, and to problem solving.

# A brief history of the Department of Information and Computer Sciences

The ICS Department was founded in the late 1960's by two illustrious University of Hawaii professors: Wesley Peterson (winner of the Japan Prize for his work on error correcting codes, a fundamental technique for reliable digital information transmission) and Norman Abramson (principal designer of ALOHAnet, a pioneering network system whose principles informed the design of Ethernet). Additional faculty soon joined the Department, including David Pager, Stephen Itoga, William Gersch, and Art Lew.

During the 1970's the Department awarded only the B.S. and M.S. degrees. In the 1980's, the Department joined with three other programs (Communications, School of Business, and School of Library and Information Sciences) to provide an interdisciplinary Ph.D. degree in "Communication and Information Sciences". In the late 1990's, the Department moved from Bilger Hall to the newly constructed Pacific Ocean Sciences and Technology (POST) building. Soon after, the School of Library and Information Sciences was merged into ICS, and both a B.A. in ICS and a Ph.D. in Computer Science were established.

Since 2000, the Department has grown substantially. By 2003, the six degree programs[[1]](#footnote-1) associated with ICS at that time accounted for a total of 888 majors, making our Department larger than the entire College of Engineering and the largest Department in the University of Hawaii system. This explosive growth motivated a special legislative allocation of $1M per year specifically to ICS in order to support its mision and students. During this past decade, we have used these additional resources to establish strong research and educational programs in areas including networking, human computer interaction, software engineering, high performance computing, bioinformatics, and information assurance.

Today, the Department continues to aggressively develop its role as a premier educational and research program in Information and Computer Science. The mission of the Department of Information and Computer Sciences (ICS) is to: (1) develop leading edge research that fuels economic and entrepreneurial advances, prepares information and technologically literate citizens, and drives technological improvements in curriculum and teaching and (2) provide professional education for students specializing in computer science and basic computer science education for all interested students.

# The ICS Department today

The Department of Information and Computer Sciences is part of the College of Natural Sciences at the University of Hawaii at Manoa. The Information and Computer Sciences (ICS) Department is solely responsible for six academic degrees:

* Bachelor of Arts in Information and Computer Sciences (approved as provisional in 1998)
* Bachelor of Science in Computer Science (approved in 1974)
* Master of Science in Information and Computer Sciences (approved in 1968)
* Master of Science in Computer Science (approved 1974)
* Professional Master Degree Program in Library and Information Science (approved 1969)
* Ph.D. in Computer Science (approved as provisional in 1997)

The ICS Department participates in two other joint degree programs with other departments on campus:

* Bachelor of Science in Computer Engineering (approved as provisional in 2009)
* Ph.D. in Communication and Information Sciences, Interdisciplinary (approved in 1986)

Figure 1 below shows the enrollment numbers and graduation rates associated with each of these eight programs over the past five years.

  
Figure 1: Enrollment and graduation rates for all ICS degree programs

Figure 1 shows that our department enjoys a strong and significant enrollment of over 450 declared majors every year for the past five years. Out of this pool of declared majors, we have graduated between 70 and 126 students per year. Dividing these two numbers provides a rough sense of the "throughput" of our department, which varies between 15% and 25%. We believe that our throughput is currently resource constrained, and that we could improve both the total number of ICS graduates per year as well as the number of semesters required to progress through our program with additional resources.

In addition to these eight majors, we also provide a minor in Computer Science for students who would like to develop a solid foundation in Computer Science in conjunction with their major degree program.

Collaborations such as the minor in Computer Science and the two joint degree programs are vital for the department’s mission, for service to the students, as well as for campus collaboration and support.

For example, the Bachelor of Science in Computer Engineering (BSCE) was approved by the Board of Regents as a provisional program in November 2009 through the College of Engineering. For this degree, ICS provides the Discrete Math curriculum and up to 6 credits of technical electives. This illustrates the importance of the service courses offered by ICS to other departments.

The ICS department also offers hundreds of seats each year to students looking to fulfill one or more of their general education and/or focus requirements through the ICS program. These course offerings are large and serve a diverse campus population. The department has also created Honors sections for select students in various disciplines.

# Curriculum proposal examples

Students seeking a B.A. must write a proposal, of one page or less, specifying the seven courses they will use for their ICS and area concentration electives. Some recent curriculum proposals provide a sense for the range of opportunities available to ICS students:

I want to work in computer games programming, which requires art/drawing, computer graphics, and software engineering skills. ICS electives: ICS 481 Intro. to Computer Graphics, ICS 413 Software Engineering I, ICS 414 Software Engineering II. Area electives: ART 313 Advanced Drawing, ART 322 Advanced Color, ART 363 Design: Studio 2, ART 309 Image in Motion Studio II.

I want to do machine translation of Japanese and English, which requires artificial intelligence, cognitive science, and Japanese language skills. ICS electives: ICS 361 Artificial Intelligence I, ICS 461 Artificial Intelligence II, ICS 464 Intro. to Cognitive Science. Area electives: JPN 301 Third-Year Japanese, JPN 302 Third-Year Japanese, JPN 350 Intro. to Japanese Linguistics, JPN 425 Japanese Translation.

I want to create web pages, which requires hypermedia, databases, and graphic design skills. ICS electives: ICS 465 Intro. to Hypermedia, ICS 665 User Interfaces & Hypermedia (3.0 GPA required), ICS 421 Database Systems. Area electives: ART 363 Design: Studio 2, ART 364 Design: Studio 3, ART 465 Design: Typography 3, ART 322 Advanced Color.

I want to use computers to predict the stock market, which requires statistics, databases, and business skills. ICS electives: ICS 442 Analytical Models & Methods, ICS 471 Probability, Statistics, & Queuing, ICS 421 Database Systems. Area electives: BUS 310 Statistical Analysis for Business Decisions, BUS 311 Information Systems for Global Business Environment, BUS 316 Quantitative Business & Economic Analysis, BEC 389 Applied Business Economics: Forecasting.

# Information assurance and computer security

One outgrowth of our information assurance and computer security curriculum is a student group called the “ICS Greyhats” that competes in regional and national collegiate cyberdefense competitions. In its first year, the Greyhats placed first in a virtual regional competition that included the University of Alaska Fairbanks and several colleges on the islands. In its second year, the ICS students placed second, losing to students from the Air Force Academy. Membership in the Greyhats is open to all ICS undergraduate students, though those in this focus area take a leadership role.

Part of the GreyHats mission is to reach out to local high schools that want to participate in similar exercises. The GreyHats have been enthusiastically embraced by our students, and the group also exposes local high school students to some of the opportunities available through the ICS department.

# Distance learning

The ICS department is committed to expanding access to the University through distance learning. We have focused on Asynchronous Learning Network (ALN) media for learning. Asynchronous classes have no class meetings. Students learn the material “anytime, anywhere” by reading books, handouts, or Web pages and interacting with other students and the instructor via electronic media. Employing ALN enables us to provide educational offerings for the non-traditional student, the working professional and populations such as the military and neighbor island business people who cannot attend campus-based classes, whether due to scheduling conflicts such as job or childcare responsibilities, or because they are residents of neighbor islands or living outside of Hawai‘i.

In 1998, the Department received WASC approval for distance delivery of its bachelor and master programs. In 1999, while collaborating with the Outreach College, we secured a $405,000 grant from the Alfred P. Sloan Foundation to support this initiative. The UH Manoa Outreach College has marketed our online B.A. degree to students looking for non-traditional methods for completing their computer science degrees. The department is meeting our commitment to offer courses online by expanded ALN and hybrid course offerings each semester. Since the Department began offering online classes, we have steadily increased the number of students enrolling in ALN courses each academic year.

# Curriculum design and learning objectives

The curriculum of the ICS department is influence by a variety of sources, including the Association of Computing Machinery (ACM) and by the Accreditation Board for Engineering and Technology (ABET).

As one of the oldest professional organizations for computer science, ACM has prepared recommendations[[2]](#footnote-2) for computer science curriculum since the 1960's. Our Department is also guided by ABET curriculum and standards for applied science, computing, engineering, and technology.

In particular, we use ABET objectives as a basis for the development of the ICS curriculum and course syllabi. These 9 objectives include:

1. An ability to apply knowledge of computing and mathematics appropriate to the discipline.
2. An ability to analyze a problem, and identify and define the computing requirements appropriate to its solution.
3. An ability to design, implement, and evaluate a computer-based system, process, component, or program to meet desired needs.
4. An ability to function effectively on teams to accomplish a common goal.
5. An ability to use current techniques, skills, and tools necessary for computing practice.
6. An understanding of professional, ethical, legal, security and social issues and responsibilities
7. An ability to communicate effectively with a range of audiences.
8. An ability to analyze the local and global impact of computing on individuals, organizations, and society.
9. Recognition of the need for and an ability to engage in continuing professional development.

We are planning assessment procedures to directly assess the ability of our students to achieve these objectives. At the current time, however, we can say that our curriculum is designed to require all of our B.A. students to gain proficiency with these concepts in order to obtain their degree. As one example, all B.A. students are assessed with respect to their performance in a capstone experience, such as :

* Collaborative work on a software engineering project with a team of peers. A key objective is to learn how to plan, design, implement, and test an original software project.
* Development of an advanced programming project. This includes a proposed “original” programming exercise to meet goals set between the student and faculty mentor. In this situation, the student is expected to completely document the process of the project, including end-user meetings and training sessions.

Successful completion of either capstone experience verifies achievement of the first 7 objectives. Achievement of the remaining learning objectives is accomplished through other courses, such as ICS 290 (Computer Science Careers: An Exploration of the Specialties of Computer Science) and ICS 390 (Computing Ethics for Lab Assistants).

# Social media and student assessment

Since 2008, we have been making use of social media to obtain feedback from our students about our program. The social networking site TechHui[[3]](#footnote-3) is designed to support the high technology community in Hawaii. We have created a forum there for ICS students, and as part of the software engineering curriculum, we ask that they join TechHui and use two specially created discussion lists to provide their personal perspective on both positive[[4]](#footnote-4) and negative[[5]](#footnote-5) aspects of the ICS program. Over 600 positive and negative experiences have been recorded so far, providing an informative perspective on what our department does well and the challenges we face.

While students have provided a wide variety of responses, some general themes have emerged. On the positive side, many students state that ICS provides:

* Modern software technology in its labs, and through programs such as MSDNAA, software at low cost to students for their educational use;
* High quality faculty and advisors who are committed to student education;
* Opportunities for students to engage in industry related projects, networking, and mentorship.

On the negative side, recurrent complaints include:

* The rigor of and time required to complete ICS project work;
* The high cost of text books;
* An insufficient number of "focus" courses (i.e. Ethics, Oral, and Writing Intensive focus areas)

# Faculty and research areas

The ICS faculty is a diverse and well qualified group. As indicated by responses in the TechHui forum discussed in the previous section, students recognize and value the strength and the quality of faculty in the department. A brief listing of our faculty and their areas of expertise follows.

#### Professors

* M. Crosby, Ph.D. (Chair)—human-computer interaction, augmented cognition, computer science education
* D. Chin, Ph.D.—artificial intelligence, natural language processing, cognitive science
* P. Johnson, Ph.D. (Associate Chair)—renewable energy, software engineering
* D. Suthers, Ph.D.—human-computer interaction, computer-supported collaborative learning, technology for education, socio-technical networks and online communities

#### Associate Professors

* E. Biagioni, Ph.D.—networks, systems, languages
* K. Binsted, Ph.D.—artificial intelligence, human-computer interaction, cognitive science, natural language processing
* H. Casanova, Ph.D.—high performance computing, distributed systems
* G. Poisson, Ph.D.—cognitive informatics, bioinformatics, machine learning
* L. Quiroga, Ph.D. (ICS/LIS)—information retrieval, databases, library systems, website design
* N. Reed, Ph.D.—artificial intelligence, autonomous agents
* S. Robertson, Ph.D.—human-computer interaction, digital government and digital democracy
* J. Stelovsky, Dr.Tech.Sc.—computer-hypermedia, human-computer interaction
* S. Still, Ph.D.—bioinformatics/theoretical biology, information theory, machine learning
* K. Sugihara, Dr.Eng—algorithms, distributed computing, visual languages

#### Assistant Professors

* K. Baek, Ph.D.—computer vision, neural computation, machine learning
* R. Gazan, Ph.D. (ICS/LIS)—social aspects of information technology
* C. Ikehara, Ph.D.—biometrics and physiological sensors, adaptive human-computer interfaces
* L. Lim, Ph.D.—database systems
* J. Patriarche, Ph.D.—applications of computers to medicine

#### Assistant Specialists

* G. Lau—student advising, professional software engineering
* M. Ogawa, Ph.D.—multimedia course design

#### Emeritus Professors

* S. Itoga, Ph.D.—database systems, expert systems, logic programming
* D. Pager, Ph.D.—compiler theory, theory of computability, artificial intelligence

Two of the faculty above, Dr. Gazan and Dr. Quiroga, hold dual appointments and are assigned half load to ICS and LIS.

The following sections provide a flavor for the range of research and development initiatives pursued by our faculty.

## Digital democracy

Professor Scott Robertson and his students have developed projects to understand the way participation in public debate and deliberation is influenced by emergent social media such as Facebook. The research includes user-centered design of enhancements to search engine tools, laboratory studies of how potential voters browse, and longitudinal studies through at least three election cycles. This research has been funded by multiple NSF grants totalling over $1.3M.

## Computer vision

Professor Kyungim Baek and her students designed and implemented a traffic density estimator which provides traffic monitoring information by analyzing images from Hawaii state traffic cameras. Other students implemented a wrist pose estimator for robotic surgical instrument that helps human-robot interaction in minimally invasive robotic surgery environment. Students also have worked on annotation of metagenomic DNA fragments, prediction of phosphorylation sites in proteins, and population clustering using human SNPs (single nucleotide polymorphism) data. This research has been funded through the COBRE (Pacific Center for Emerging Infectious Disease Research) and INBRE (IDeaA Network of Biomedical Excellence).

## Artificial intelligence and medicine

Professor Julia Patriarche and her students have developed a system for the detection of change in serial magnetic resonance imaging studies of brain tumor patients. The system is a multi-level AI system, which demonstrates how such systems can augment patient care by performing routine tasks and thus elevating the role of the clinician to the more interesting and less routine parts of patient care. Dr. Patriarche's work has resulted in a diagnostic system that has been adopted as a standard part of patient care for brain tumor patients at the Mayo Clinic. This research has been funded by multiple grants from NIH and has resulted in two patent applications.

## Socio-technical network analysis

Professor Dan Suthers and his students are studying the new emergent forms of socio-technical systems enabled by modern communication and information technologies. A recent project called Traces provides a theoretical foundation for analysis, a data model, and software tools to trace out the movements, confluences, and transformations of people and ideas in online social networks. Professor Suther's recent research is funded by the National Science Foundation for over $500K.

## User modeling

Professor David Chin and his students perform research to create models of user to improve information systems. A recent project involves a prototype agent-based simulation system that will allow analysis of the long-term effects of policy on culture, and to predict the effects of cultural change on the level of violence in various localities. The goal is to better predict which policy alternatives are likely to minimize long-term violence. Professor Chin's recent research has been funded by a variety of grants totalling over $1M.

## Undergraduate education

Professor M.B. Ogawa supervises a variety of research projects related to undergraduate education. As one example, four undergraduate students were semi-finalists in the 2009 ImagiNations Competition sponsored by Walt Disney Corporation. These students designed a mobile device to enhance the experience of Walt Disney park goers with live data feeds to determine ride wait times, GPS mapping, and historical information about the park. This is part of an overall research program on student learning that has been funded by multiple grants totalling over $500K.

## Space exploration

Professor Kim Binsted manages a NASA-funded 4-month simulated space-exploration mission using an environment on the Big Island. Six crewmembers will live in a habitat for four months, while researchers study their diet, psychology, teamwork, etc. ICS graduate students will work on automated tools for data collection, as well as on advanced communication strategies for long-term space missions. In addition, Professors Binsted and Rich Gazan are applying computational methods to the search for life in the universe, funded by a 5-year, $8M NASA Astrobiology Institute grant. They work with a cross-disciplinary team at UH including researchers from Astronomy, SOEST, Physics and Chemistry, and NASA researchers nationwide, using information-theoretic clustering methods to relate the work of researchers in diverse fields, and to model the galactic habitable zone.

## High performance computing

Professor Henri Casanova and his students have developed a novel method for sharing compute resources among competing users. This approach, called Dynamic Fractional Resource Scheduling, makes both theoretical and practical advances, and outperforms state-of-the-art techniques by orders of magnitude. Among its benefits are a higher level of user satisfaction, a quantifiable and optimized measure of fairness among users, and enhanced resource economy both in terms of hardware and electrical power expense. This research has been funded by multiple grants from the National Science Foundation totalling over $500K.

## Wireless networking and security

Professor Edo Biagioni and his students have developed a seamless voting system that lets voters vote from home, verify that their vote has been counted, yet remain anonymous. Another project involves a virtual machine system that detects attacks on the operating system. In embedded systems, a student designed a wireless system that can track buses, similar in function but different in technical details from the system that TheBus is currently using.

## Studio-based learning

Professor Martha Crosby and her students perform research in studio-based learning, an innovative paradigm for science education that adapts concepts from architectural education including "design crits". Professor Crosby's recent research has been funded by multiple grants from the National Science Foundation totaling over $2M.

## STEM education

Professors Violet Harada and Dan Suthers are principal investigators of the Hawai‘i Networked Learning Communities (HNLC) Initiative, which is a partnership of the Hawai‘i Department of Education and the University of Hawai‘i to improve science, mathematics and technology learning in K-12 rural schools. It directly supports the effort to form a seamless connection between UH and the State DOE. This initiative has been funded by grants from the Department of Education totalling over $1M.

## Renewable energy and sustainability

Professor Philip Johnson and his students designed and implemented "The Quest for the Kukui Cup", an energy challenge for all 1,000 first year students living in the Hale Aloha residence halls. The project involves novel information technology, pedagogy, and game design techniques that are designed to raise student awareness of the energy challenges facing Hawaii, help them to learn how to use energy more efficiently, and connect them with organizations and curriculum if they decide to pursue energy studies at the University. Professor Johnson's recent research is funded by grants from the National Science Foundation totalling over $400K.

## Bioinformatics

Professor Guylaine Poisson and her students perform bioinformatics research through the COBRE Pacific Center for Emerging Infectious Diseases Research. Research projects include metagenomics tool development, design of biosensors for efficient pathogen detection, and large-scale annotation of proteomes. Professor Poisson's research is funded by multiple grants from the National Institute of Health totalling over $2M.

# Research and teaching laboratories

The department has developed a number of research labs to support both research and teaching. These include:

The Adaptive Multimodal Interaction (AMI) lab studies user behavior. Typical experiments collect eye movements, pressure grasping, and other physiological input to develop novel and effective interactive systems. Research in the AMI lab produces new design principles, user interfaces, multimedia interaction systems, and visualizations of complex information.

The Bioinformatics (BIL) Lab pursues research in bioinformatics and metagenomics. For example, a recent project studied the diversity and ecology of marine RNA viruses.

The Collaborative Software Development Lab (CSDL) performs research and development in a variety of areas including renewable energy technology, software engineering, and computer supported cooperative work. A current focus of CSDL is the Kukui Cup project, in which 1,000 first year students living on-campus participate in a three week energy challenge.

The Concurrency Research Group (CORG) performs research in parallel and distributed computing, computer system simulation, and high-performance computing. For example, CORG is part of an international research consortium developing SimGrid, a toolkit for simulation of distributed applications in heterogeneous distributed environments.

The Hawai’i Computer-Human Interaction (HI’CHI) lab focuses on understanding how people use information systems based on human performance data. Current research includes digital government applications and how people use the Internet including Facebook to make political decisions.

The Laboratory for Interactive Learning Technologies (LILT) partners with the Department of Education and other local educational agencies to support innovative uses of high technology in education. A recent project, Traces, will develop a theoretical foundation for analysis, a data model, and software tools to trace out the movements, confluences, and transformations of people and ideas in online social networks.

The Machine Learning (ML) lab pursues research and development in machine learning, robotics and computational neuroscience. A recent project involves the use of clustering methods to better understand whale songs.

The Research Center for Information Assurance (RCIA) provides a learning laboratory and test bed for investigations and applications related to the generation, organization, access, preservation, and secure use of digital information

# Initiatives to improve student quality

In recent years, we have improved our outreach and advising activities in order to improve student quality and retention. The following table lists some of these activities.

|  |  |  |
| --- | --- | --- |
|  | **Impacting: Incoming, Undergrad & Grad** | **Project Description** |
| 1 | Incoming | ICS Science Fair Awards - Five $200 awards for computer science project. One for the best project from each class level from 8th grade, freshman, sophomore, junior and senior. Status: On going from 2009. |
| 2 | Incoming | Fred and Annie Chan Scholarship for incoming Freshmen. First, this requires organizing a publicity campaign to students, counselors and parents. Second, collection and organizations of applicants. Third, the assembly of a selection committee. Finally, the implementation and follow-up with the recipient.  Status: On going from 2008. |
| 3 | Incoming | ICS Minor promotion – This is a promotion to recruit more undergraduates to minor in ICS requires the printing and disbursement of over 500 flyers on the ICS minor program. Status: Ongoing from 2007. |
| 4 | Undergrad | ICS 290 - Computer Science Careers: An exploration of the specialties of computer science – Spring 2009. A class designed to provide students with information to help define and achieve their goals in computer science. Status: Ongoing from 2010. |
| 5 | Undergrad & Grad | W. Wesley and Hiromi Peterson Scholarship – To encourage research and scholarship among students. Status: Will start once funds become available. |
| 6 | Incoming, Undergrad & Grad | Bachelor’s packet, thanking graduates for selecting our department, informing of alumni services and requesting they send thank you notes to their high school mentors. The thank you notes increases awareness of the ICS program and will hopefully motivate more high school mentors to send their best students to our department. Status: Ongoing since 2008. |
| 7 | Undergrad | Promotion to encourage high end undergraduates to take a few graduate courses before graduating. This will provide high end students with transcript that stands out and confidence in their academic ability. This requires organizing a publicity campaign to students. Status: Ongoing since Fall 2009. |
| 8 | Undergrad & Grad | ICS Software Engineering Competition for undergraduate student where graduate student may mentor undergraduates. First, this requires coordinating with the faculty on the notification and incentive systems to increase student participation. Second, conducting the competition and awarding of the winners. Status: Competition held Fall 2009. |
| 9 | Undergrad | Promoting the hiring of lower division CS students by commercial CS organizations as entry level help. This will provide students who cannot do CS work with the experience of working in a CS environment. Status: Started 2011. |
| 10 | Undergraduate & Graduate | Graduation and awards ceremony.  Status: Spring 2011 graduates completed |
| 11 | Undergraduate & Graduate | Short Skill Set Classes - Creating special non-credit classes to fill-out the specific skill sets requested by the local computer companies. Status: Organizing in progress – currently communicating with local companies. |
| 12 | Undergraduate | GRE Award – This award is to encourage high performing undergraduate computer science majors to prepare for graduate school. A full-time undergraduate ICS student who takes the Graduate Record Exam (GRE) and scores above the 80% percentile for two categories can apply for a $200 award. A student can only receive this award once. Status: Organizing in progress. |
| 13 | Undergraduate | Help promote the department of Information and Computer Sciences at the university open house, high school counselors meeting, and high school events. Since 2007. |
| 14 | Undergrad & Grad | ICS 40th Alumni Lunch with alumni, faculty and their best students. Status: Completed 2008 |

1. B.A., B.S., and M.S. in ICS; M.S. in LIS; and Ph.D. degrees in both CIS and CS. [↑](#footnote-ref-1)
2. http://www.acm.org/education/curricula-recommendations [↑](#footnote-ref-2)
3. http://www.techhui.com [↑](#footnote-ref-3)
4. http://www.techhui.com/group/uhicsstudents/forum/topics/1702911:Topic:20091 [↑](#footnote-ref-4)
5. http://www.techhui.com/group/uhicsstudents/forum/topics/1702911:Topic:20093 [↑](#footnote-ref-5)