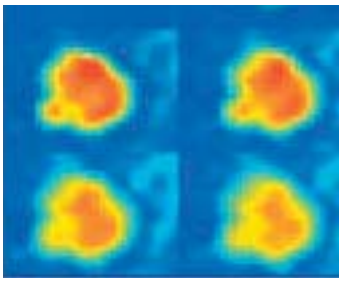
The impact of computing on medicine

The discipline of medicine, which is as old as history, is being heavily affected by a newcomer among disciplines: computer science. Simply keeping every patient's health records available in computer-readable form will have a major impact on society and the economy. The Institute of Medicine estimates that medical errors kill as many as 100,000 Americans per year, and many of these errors could be easily avoided using electronic health records.

Stored electronic health records would allow data mining techniques to be used to discover new truths. For example, suppose the majority of patients over 65 who show up in a given period in the ER with a fever above 102 turn out to have an infection that is vulnerable to a particular antibiotic. Data mining might be able to find this nugget of information and thus improve patient care.

CS professor Ramin Zabih, collaborating with radiologists at Cornell's Weill Medical College in New York City, is working on another area in which computing is having a significant effect: Magnetic Resonance (MR) and its use in radiology.



Rate of change: Color enhanced data analysis reveals the diffusion of a contrast agent through a breast tumor and into surrounding tissue.

The output of an MR scanner is incomprehensible until it is transformed into an image by a computer program. In fact, most MR scanners are simply an I/O peripheral (which costs millions of dollars and weighs up to 10 tons) connected to a PC. So, even to create an MR image requires computers. But there is more.

The major limitation of MR is in handling motion. A three-minute MR scan can be used only on parts of the body that can stay stationary for that long, but body motion is surprisingly common. Even parts that would seem easy to stabilize, like the feet, turn out to be difficult to keep still for very long. Moreover, obvious motion, such as of the heart and lungs, induces motion in nearby areas. If MR could be used to image the heart, it could screen for coronary disease long before symptoms develop (40% of heart attack deaths happen to people who had no prior symptoms of coronary disease).

Ramin Zabih works with radiologists to replace intuition with evidence-based diagnosis of vascular disease and breast cancer.

Dan Huttenlocher has made fundamental contributions in object recognition, including Hausdorff-based methods and a Bayesian approach, and in the development of end-to-end systems that apply visual matching and recognition techniques.

Zabih and his colleagues have created an automated computer algorithm for motion correction, and this algorithm has been surprisingly successful. A study found that their computer algorithm performed significantly better than an experienced board-certified radiologist could do with manual motion correction.

They are also investigating new computational techniques to substantially speed up MR imaging. These techniques are based on taking several images at the same time and using algorithms to create a kind of composite image. This approach has the potential to produce a roughly five-fold speed up, allowing a scan that currently takes three minutes to be performed in the time most patients can hold their breath.

In the long term, radiology will need to become much more quantitative, and computers will play a vital role in this transformation. Currently, a report by a radiologist may include phrases like "the gall bladder is somewhat enlarged". This differs from most medical tests, which produce numerical measures (imagine how useless a thermometer would be if it gave a vague opinion rather than a number). Zabih and his colleagues are developing sophisticated computational methods to produce accurate numerical measurements from images. By applying these kinds of new tools from computer science to long-standing problems in medicine, researchers expect to significantly improve patient care in the coming years.

The Game Design Initiative at Cornell

A multidisciplinary approach to teaching game design is attracting students from all over the Cornell campus —and even across town from Ithaca College — into CIS's introductory game-design course and an independent-study course.

GDIAC is the brainchild of CS professor David Schwartz and two CS alumni collaborators, Rama Hoetzlein and Mohan Rajagopalan. The interdisciplinary nature of the project has inspired collaborations with faculty across campus, like Todd McGrain and Xiaowen Chen from the art department and David Borden, former director of Cornell's Digital Music Program.

David Schwartz (top right) at the inauguration of the Cornell Library Collaborative Learning Computer Laboratory (CL)^3.

The courses integrate technical, artistic, and cultural aspects of game design. Topics include almost everything that goes into a computer game —software engineering, game physics, digital art, sound and music, genre analysis, gender issues, game balance, and more. Student teams include programmers, writers, artists, and musicians, all of whom participate in the design and implementation of the game, bringing a variety of skills to bear on the game they are creating. A big contribution of the courses is the experience in working with multidisciplinary teams.

GDIAC started with funding from the GE Fund and Microsoft. The initiative has worked with Electronic Arts and Vicarious Visions on internships and has involved them in the Engineering Cooperative program (which enables students to spend one semester working in industry but still graduate in four years). A community service component, the GDIAC Intern Program, started in the Fall 2003 through participation of the Tompkins County Learning Web, which provides educational and occupational opportunities for youth in need of guidance.

From the Gallery of Student Projects

No lab was flexible enough to meet the requirements of the course, so Schwartz worked with the Cornell University Library, the Faculty Advisory Board on Information Technology, and Cornell Information Technology to create a truly innovative lab: the Cornell Library Collaborative Learning Computer Laboratory, or just (CL)^3. In a novel design, each of the eight computers in (CL)^3 is mounted on a curved table with dual monitors and keyboards/mice. Groups of students collaborate at each station, taking turns typing. Students and instructors can rearrange the lab within minutes to accommodate groups of varying sizes. This shape-shifting lab, inaugurated by Cornell's Provost in September 2004, offers the ultimate in flexibility. It now supports digital artists throughout the campus.

Jon Kleinberg receives the 2001 National Academy of Sciences (NAS) Award for Initiatives in Research. Jon was cited for "his development of deep and innovative algorithms to solve fundamental problems in network, information extraction, and discrete optimization".

Bart Selman is elected Fellow of the AAAI.

Fred Schneider chairs the International Review of UK Computer Science Research. The review was sponsored by The Engineering and Physical Sciences Research Council, the UK Government's leading funding agency for research and training in engineering and the physical sciences.

The AFRL/Cornell Information Assurance Institute (IAI) is founded with a $1M/year grant from AFOSR. See www.cis.cornell.edu/iai/about.htm.

Former undergrads Greg Pass and Frank Wood sell their company, ToFish, to AOL.

Bill Arms publishes *Digital Libraries* (MIT Press).

Intelligent Information Systems Institute (IISI) is established, with Carla Gomes as director.

Rich Caruana, Daisy Fan, Thorsten Joachims, Jai Shanmugasundaram, Jeanna Matthews, Radu Rugina join.

2001

The national organization Engineers for a Sustainable World is started at Cornell (with a different name) under the inspiration of Regina Clewlow (CS 2001). There are now chapters in 21 universities.

Allegra Angus receives the CRA Outstanding Female Undergraduate Award.

Andrew Myers and students Steve Zdancewic, Lantian Zhen, and Nathaniel Nystrom receive the Best Paper Award at SOSP 2001 for their paper on secure program partitioning.

Kavita Bala, Steve Marschner join.

2002

Tim Roughgarden receives honorable mention in the ACM PhD thesis competition and receives the MPS Tucker Prize. His advisor was Eva Tardos.

PhD student Ioannis Vetsikas and his software "whitebear" wins first place in the Trading Agent Competition. Programs compete by bidding in over 25 simultaneous electronic auctions.