Syllabus

ICS 491 / 691 – Foundations in Medical Science and Computing

Professor:

Julia Patriarche, Ph.D.

julia4@hawaii.edu

Course Description:

The field of computers in medicine is a burgeoning one. We are situated at a perfect intersection in time. Governments are strapped for cash. The boomers are starting to retire. The way people live has been very rapidly and radically transformed, such that the prevalence of obesity and related disorders such as diabetes have reached epidemic proportions. The United States is over spending on health care compared with other industrialized nations by a factor of 2-to-1 per capita, but among the industrialized nations, we have one of the lowest life expectancies. Our health-care expenditures are so great, that they threaten our government and nation with bankruptcy, and still 50 million Americans are uninsured. This problem is only going to get worse, as more people retire, placing greater financial demands on the government, the health-care system, and on society.

Simultaneously, human lifespan has never been longer. In 1900, life expectancy which had already been increasing year over year, had reached 47 years. Today, life expectancy is 78.7 years in the United States, and in spite of our health care concerns, it is still increasing. Most people have an insatiable desire for health, and in connection with this, for health-care, but our current method for health-care delivery involves tailor-made provisioning by some of the most skilled people of our society. What we want is: immediate access, for very little money, with very high efficacy, and involving very few errors. We want our health (and our health-care) to run like a finely tuned technological instrument.

Computer technology offers to provide us with that instrument. In our lifetimes, available computing power will reach such proportions, that it will offer us the opportunity to radically transform both what health-care is, and how our bodies function. In this course, we will discuss the many ways in which these changes are likely to take place, and what opportunities will be available for students interested in this burgeoning field. We will cover a tremendous amount of material at the intuitive level, and try to make it as interesting and thought-provoking as possible.

Grading:

(Subject to adjustment, depending on the needs and interests of the particular student group)

Most of the work in this course will involve essays; please be prepared to express yourself. In most cases, there will be no right or wrong answers. Your goal should be to have a carefully considered position, and to be able to articulate and defend that position.

Homework: 33.3%

Midterm: 33.3%

Final exam: 33.3%

Materials:

The sources of information for this course will primarily be: the lecture notes, materials from the University of Hawaii library (typically accessible on-line), and materials from various non-UH Internet sources.

Student Learning Objectives:

Students will gain a foundational understanding of current and burgeoning opportunities involving the application of computers to medicine and human health. Students will understand how computers currently fit into this field, and how healthcare is likely to become imbued with computer technology in the near and intermediate future. Students will be exposed to a preliminary knowledge set, relating to a broad array of topics involved in this highly interdisciplinary field (e.g. statistics, medical study design, diagnostic medicine, etc.). Students will be able to find information on medical topics they are interested in, understand the fundamental science, technology, and statistics of what they are reading, and speak intelligently regarding the reliability of information they find. Students will have a keen sense of whether this area of computer science is one which they are interested in pursuing. Students will acquire an understanding of how the health-care system works, and this will help them to become more informed patients and voters.

Outline:

(This will likely be adjusted to suit the needs and interests of the particular student group)

Unit 1:

The forces which will bring about the upcoming transformation

Information technology increases in sophistication exponentially

What is medicine?

Unit 2:

Compare and contrast: working in mainstream computers, versus computers in medicine.

Things which look static, are actually very dynamic:

The body in motion (homeostasis)

Evolution, and genetics over time

What does it mean to be sick?

What are some of the ways in which a body can malfunction?

Can you really state what constitutes a disorder?

Mother Nature's grand experiment.

Are humans as homogeneous as we think? Yes and no.

Can you always say that a particular trait is adaptive?

Do we have the perfect design? Compared to other life forms? Compared to what is possible?

How many ways can you fix a squeaky door?

Unit 3:

The literature: what it is, and how to find what you're looking for

All about creativity

Lies, damn lies, and statistics.

Unit 4:

Automation

Can we take something which seems inherently complex and risky, and make it safe?

How do people tolerate putting their very lives in the hands of automation?

Are there any examples we can draw upon; disciplines which have already been through this?

Unit 5

The diagnostic process: How do doctors think when they're making a diagnosis?

Unit 6

Biostatistics and the diagnostic process

Screening: why or why not?

Common statistics: sensitivity, specificity, positive predictive value, negative predictive value

Unit 7

More biostatistics: histograms, probability density functions, Gaussian distributions, measures

of central tendency, statistical significance, equivalence, confidence intervals.

Unit 8

More biostatistics:

Approximate randomization test

Statistical significance versus clinical relevance

Sampling

Stratification

Outliers

Interquartile range

Relative Risk

Odds ratio

Study designs:

Prospective, cross-sectional, case-control, data mining

Blinding, randomization

Problems in study designs: causality, multiple comparisons, disease clusters

Unit 9

More biostatistics: ROC curves, survival curves, correlation and regression

Unit 10

Ethics in medicine

Unit 11

Ethics in medicine

Unit 12

Algorithms in common usage in medicine: optimization

Exhaustive search

Semi-exhaustive search

Hill-climbers

Genetic algorithms

Hybrid approaches

Unit 13

Evolution as an optimization algorithm

Natural and artificial genetics

Just how similar are we to each other?

Just how similar are we to various other species?

How common are mutations? Is evolution still happening?

We don't have genes; genes have us (Richard Dawkins)

The relationship between evolution, an organism's genome , the brain, a computer, and ?

Unit 14

Using computers to expand human capabilities in medicine

What are the opportunities?

What is being done, today?

Unit 15

Everything is fuzzy in medicine

Fuzzy logic, scatter plots, and multispectral classification

Unit 16

Wrap up and review