Medical Informatics

Sponsored by the National Library of Medicine and the Marine Biology Laboratory, Woods Hole Massachusetts

Course Director: Daniel R. Masys, M.D., University of California, San Diego, School of Medicine.

Session Education Objectives and Outlines

Day 1 - Monday, June 1, 1998

Session 1: 8:30 - 10:00 AM

> *HPCC, NII, current issues in medical informatics*

Faculty

> Donald A.B. Lindberg, M.D.

Educational Objectives

This lecture will summarize the federal interagency High Performance Computing and Communications program accomplishments in non-medical and health related aspects and will enumerate some past, current, and future research funding sources.

At the completion of the session, participants will:

1. Understand the "interagency model" and the government-industry-university approach to the HPCC work.
2. Understand the initial opportunities in biomedical applications of the NII.
3. Have a beginning set of funding contacts.

Session Outline

1. High Performance Computing and Communications federal program
   - Background and Legislation
   - Objectives and Organization
   - Phase 1
     > Accomplishments - Grand Challenges
     > Progress on Grand Challenge Problems
   - Phase 2
     - National Information Infrastructure
     - National Challenge Applications
       - Non-medical
       - Medical
2. NLM Role in the NII

- Intramural Research
  - UMLS
  - Visible Human
- Extramural Research
  - NII medical testbed
  - Telemedicine
  - Computer-based patient record
3. Public Policy Issues
   - Medical Data Privacy
   - National Security
   - Intellectual Property Rights
     - Traditional Copyright Demands
     - Today's Revolution in Electronic Publishing
4. Federal Research Funding Sources for Medical Informatics
   - NLM Programs
   - Other HHS Programs
   - Other federal agency support

Session 2: 10:30 - 12:00 N

Principles of Database design

Faculty

Daniel R. Masys, M.D.

Educational Objectives

This lecture and lab session will introduce basic principles of organization of data in computerized systems. At the completion of the session, participants will:

1. Understand the historical evolution of computerized data handling methods
2. Know the relative strengths and weaknesses of hierarchical, relational, information network, and object-oriented database systems
3. Understand the process of development of a set-theory-based relational data model, including entity-relationship definitions, principles of fully normalized relational models, state transitions and data flow diagrams.
4. Understand the design principles involved in the transformation of a flat file record structure to a normalized relational structure (lab exercise).

Session Outline

1. Database definitions and paradigms
   - What is a Database?
   - Historical Evolution of data management techniques
   - General benefits of Database Management Systems (DBMSs)
   - DBMS types
     - Heirarchical
     - Information Network (linked lists and pointers)

Relational

Object-oriented

2. Principles of Relational database design
    - Representation of real world objects and their attributes
    - Relationships between objects
    - Table notation formalisms
    - Relationships: one-to-one, one-to-many, many-to-many
3. System design and building methods
    - Entity-relationship diagrams
    - State Transition Models
    - Data Flow Diagram
4. Transforming flat files to tables
5. A sample problem in database design

Session 3: 1:30 - 3:00 PM

The Internet Yesterday & Today

Faculty

[Richard P.C. Rodgers, M.D.](#)

Educational Objectives

This lecture and lab session will review the historical evolution and technical underpinnings of the Internet, with special emphasis on the World Wide Web and related developments. At the completion of the session, participants should:

1. Understand the nature and organization of the Internet, how it came into existence, and how it is currently evolving.
2. Understand the important role of open standards in the evolution of the Internet, and how these differ from proprietary standards.
3. Understand basic aspects of the major applications of the Internet, including electronic mail, file transfer, remote login, Usenet news, teleconferencing, and data retrieval.
4. Understand the historical evolution, current capabilities, current technological evolution, and social issues surrounding the currently most important Internet application, World Wide Web. The structure of a Web document will be reviewed, though the creation of actual WWW documents by the students will be left for the evening lab session.

Session Outline

- What is the Internet?
    - The Nature of the Internet
    - The Composition of the Internet
    - Associated Organizational Structures
    - The Physical Structure of the Internet
- Historical Evolution of the Internet
- Related Government Initiatives (HPCC & NII)
- Technical Underpinnings: Protocols & Open Standards

- Communications Issues
- Getting the User Connected
- Putting the Internet to Work
  - Electronic Mail
  - File Transfer
  - Remote Computer Access
  - Usenet News
  - Communications & Teleconferencing
  - Data Retrieval: *Grateful Med*, gopher, WAIS, World Wide Web

Session 4: 3:30 - 5:00 PM

Unified Medical Language System
Internet Grateful Med

Faculty

[Lawrence C. Kingsland, Ph.D.](#)

Educational Objectives

This lecture and lab session will introduce the National Library of Medicine's Unified Medical Language System (UMLS) and a major new application which uses it: Internet Grateful Med. At the completion of the session, participants will:

1. Understand the problem addressed by the Unified Medical Language System initiative
2. Know the major components of the Unified Medical Language System
3. Have been exposed to the breadth of content of the UMLS Metathesaurus
4. Receive an introduction to and concentrated lab time with NLM's new Internet Grateful Med program, using the UMLS Metathesaurus and other resources to provide assisted searching in MEDLINE and other NLM databases

Session Outline

1. Problem addressed by the Unified Medical Language System
   Multiplicity of vocabularies, classifications, naming systems
2. Major components of the Unified Medical Language System
   - Metathesaurus
   - Semantic Network
   - Information Sources Map
   - Lexicon, Lexical Tools
3. Breadth of the Unified Medical Language System Metathesaurus
   UMLS Knowledge Source Server
4. Internet Grateful Med
   - The problem addressed by Internet Grateful Med
   - The NLM Access Model
   - Assisted searching with an intelligent gateway system
   - Active use of the UMLS Metathesaurus
   - Search formulation; retrieval

- Search refinement
- Guided lab time (tutorial)
- Independent lab time; tutors on hand

Evening Personal Skills Workstop, Monday June 1, 1998

Digital Multimedia using PowerPoint

Faculty

[Adrian Smith, MBL staff](#)

Educational Objectives

Multimedia is becoming vital to the success of education and online presentations and new tools allowing the simple integration and display of multimedia files are now common on desktop computers. Using Microsoft PowerPoint 97, the class will explore the audio, image, and video file
formats available for multimedia presentations. The class will begin with of a short talk on analog vs. digital files, audio, video, and image file types, sizes, and quality, and the appropriate techniques for acquiring and presenting these materials, both from the Internet and from digital still and videocameras. This will be followed by a hands-on tutorial where students will be able to obtain representative multimedia files from the World Wide Web and incorporate them into a PowerPoint presentation, using the multimedia features of the application to present the materials to their best advantage.

At the completion of the session, participants will:

1. Understand the document model used by PowerPoint.
2. Be comfortable building presentations using PowerPoint's built-in "Wizards".
3. Have a better understanding of the processes involved in creating a multimedia presentation.

Session Outline

1. Why use computer-generated presentations?
2. What is PowerPoint?
   - Concepts
3. Wizards
   - Presentation Wizard
   - Auto-Content Wizard
   - Help Wizard
4. Creating a Presentation
   - Choosing a Wizard
   - Adding Information
   - Previewing the Presentation
5. Views
   - Slide View
   - Slide Sorter View
   - Outline View
   - Notes
6. Design Considerations

- Color
                    - Layout
                    - Effects
7. Multimedia elements
                    - Graphics
                    - Video
                    - Audio

Day 2 - Tuesday, June 2, 1998

Session 1: 8:30 - 10:00 AM

Molecular biology information resources

Faculty

[David Landsman, Ph.D.](#)

Educational Objectives

In this lecture and the accompanying lab session, Dr. Landsman will discuss methods developed at the National Center for Biotechnology Information, to extract information about chromosomes, genomes, molecular sequences and structures, and the associated information in the biomedical research literature. Students will get hands on experience of these tools.

Session Outline

1. Molecular biology data objects
     - Building blocks
     - Sequences
     - Folding
2. Databases of molecular objects
     - GenBank and its international collaborators
     - Molecular Modelling Database (MMDB) and Protein Data Base (PDB)
     - The Genomes Division of GenBank
3. Extracting data from these databases
     - Entrez
     - Network Entrez

Session 2: 10:30 - 12:00 N

Encryption and Public Policy Issues

Faculty

[Donald A.B. Lindberg, M.D.](#)

Educational Objectives

This lecture and discussion will present the theoretical and practical bases for recommendations concerning medical data privacy, data encryption technology, and some of the national security considerations.

At the completion of the session, participants will:

1. Know the issues facing the US regarding copyright and database protection world-wide
2. Know if they support or do not support federal privacy legislation, and its features
3. Understand the basis for current data encryption methods.
4. Will have tested at least two Security Token Authentication devices.
5. Know if they prefer to operate Challenge Response or Time Synchronous security devices.

Session Outline

1. Intellectual Property Rights
   - WIPO Treaty proposals
   - Pub Med Plans
2. Encryption
   - Basic concepts
   - DES
   - Public-Private Key
   - Implementation and Devices
   a) Data Encryption Technology
   - Private Key Encryption
     - Digital Encryption Standard
     - Kerberos
   - Public-Private Key Encryption
   b) System Considerations
   - Length of Cipher Keys
   - Security
   - Token Authentication
   c) Devices
   - Challenge - Response
   - Time Synchronous

3. Medical Data Privacy

   - Requirements
   - Legislation
     - Overview
     - Status of Federal Privacy Legislation
     - Contentious Issues
   - Initial Practical Experience with Medical Data Privacy Assurance

Session 3: 1:30 - 3:00 PM

The Internet Tomorrow: Emerging Technologies

Faculty

Richard P.C. Rodgers, M.D.

Educational Objectives

This lecture and lab session will discuss and demonstrate newer and more experimental applications for the Internet, including multicasting and teleconferencing, and various World Wide Web-related developments such as Virtual Reality Modeling Language (VRML) and downloadable software (Java, tcl/tk, and Python). Demonstrations will comprise live and taped material, including applications related to the NLM's Visible Human Project. At the completion of the session, participants should:

1. Understand current developments in advanced Internet applications, and how they might come to be applied within biology and medicine.
2. Understand the distinctions between unicasting and multicasting, the difference between UDP and TCP transmission protocols, and the major compression techniques and protocols as applied to teleconferencing over the Internet.
3. Understand the capabilities and limitations of VRML.
4. Understand the technical issues involved in downloadable software modules, and the comparative strengths and weaknesses of the various languages that have been proposed to support this capability.

Session Outline

- Multicasting and the MBONE
- Virtual Reality Modeling Language (VRML)
- Downloadable applications ("applets") for the World Wide Web
    - Java
    - tcl/tk
    - Python
- Issues in the Evolution of the World Wide Web
    - Security & Privacy
    - Tools for Commerce
    - Control of Access (PICS)
    - Open vs. Proprietary vs. "De Facto" Standards

Session 4: 3:30 - 5:00 PM

Principles of Web Page Design

Faculty

[David Remson, MBL staff](#)

Educational Objectives

At the completion of this session, participants will have an understanding of Hypertext Markup Language (HTML) and its application in the creation of World Wide Web pages.

Evening Personal Skills Workstop, Tuesday June 2, 1998

Class of '98 Personal Web pages

Faculty

[Daniel R. Masys, M.D.](#)

Educational Objectives

During this workshop, the HTML principles discussed in the afternoon session will be applied to creating personal web pages, and uploading those pages to a Web server.

Day 3 - Wednesday, June 4, 1997

Sessions 1-4

Mathematical Modeling

Faculty

[Carol Newton, M.D., Ph.D.](#)
[Bruce E. Shapiro, Ph.D.](#)

Educational Objectives/Session Outline

Models translate information and assumptions about how something works into a form that enables one to examine whether both are consistent with what is observed, to suggest values for numerical items that are as yet unknown, and, if the model proves to be acceptable, to explore its application to real world problems. Biomedical problems amenable to modeling include sharpening the design of experiments, optimizing treatment, or reassigning personnel to improve throughput of patients in a complex diagnostic clinic.

The objectives of this course will be to show participants:

- how to model;
- how to extract information by fitting models to data, and;
- how to use a more complex model to study ways to improve the design of a diagnostic clinic.

This lecture and lab session will introduce some basic principles of biomedical modeling and its uses, and skills for originating and studying one's own models.

At the completion of the session, participants will have:

- Seen examples of some biomedical models and what can be learned from studying them;
- Learned how to move from a statement of assumptions about a biological system to writing down a set of differential equations to study it;
- Developed and studied a model of their own;
- Studied several biomedical models (e.g., predator-prey, epidemic spread, pharmacokinetics, enzyme system, a library staffing model, a diagnostic clinic staffing model). If time permits, nonlinear regression software for fitting diferential equation models directly to data will be demonstrated.

Evening Personal Skills Workstop, Wednesday June 3, 1998

Building Web Intefaces to Databases

Faculty

[David Remson, MBL staff](#)

Educational Objectives

This workshop will give participants hands-on experience in serving databases to the web. In this session they will learn the different necessary components of a database web server. They will create their own interface to a database and learn how to conditionally format the results in HTML. They will get an understanding how HTML form elements translate to database calls, how an HTML form translates to a database query, and how a query is processed and the results are returned.

Session Outline

1. Present an overview of a generic database web serving system. This overview will consist of identifying and defining the function of the the different elements that compose a database server.
2. A brief introduction to a few of the different database solutions to show how different vendors address the model described in 1.
3. Create an interactive web database using Filemaker Pro 4.0 with a sample database which will address the following: Querying the database using FORM and embedded URLS
4. Editing a Record via the web
5. Adding/Deleting Records
6. Processing results with format files.
7. Understanding how HTML and database meta tags can interact by:

    a. Listing multiple records
    b. Formatting a single record
    c. Using conditionals to selectively format records
    d. Using color and graphics with numeric content

   8. Creating embedded links to Entrez, PubMed, others

Day 4- Thursday, June 4, 1998 and Day 5 - Friday, June 5, 1998

Sessions 1-4: 8:30 AM - 5:00 PM

Clinical Information Systems

This series of lectures and lab sessions will cover the design principles of large-scale clinical information systems that meet the needs of academic medical centers.

Faculty

[Paul Clayton, Ph.D.](#)
[George Hripcsak, M.D.](#)

[Soumitra Sengupta, Ph.D.](#)

Educational Objectives

At the completion of the session, participants will:

1. Understand the success factors in building and managing large-scale information systems in an academic medical center.
2. Know the design principles of clinical information systems, and understand the function of each component: patient database, controlled vocabulary, event monitor, and user interfaces.
3. Understand the cost/benefit issues involving health care information systems, in particular, the role of automated care plans and practice guidelines.

Session Outline

1. IAIMS (Integrated Academic Information Management System)
   IAIMS goals
   Success factors
   Institutional Commitment
   Leadership
   Network
   People
   Architecture
   Applications
   Demonstration
2. Clinical information system architecture
   Architectural issues
   Scale: from desktop to nation
   Heterogeneity: network, applications, users
   Centralization: quality control vs. flexibility
   Case study: large-scale, heterogeneous, system with centralized control
3. Data interchange standards
   ○ Goals
   ○ Seven layer ISO model
   ○ Medical standards organizations
   ○ Health Level Seven (HL7)
   ○ Limitations
4. Medical databases and vocabularies
   What is special about medical data?
   Large number of entities
   Complex naming
   Degrees of granularity
   Temporal nature
   Perspectives for classification
   Nesting of modifiers
   Medical databases
   Content: medical events
   Views: patient care, research, department
   Design issues: performance, availability, extensibility, ease of access
   ○ Clinical vocabularies

Goals: coding, translation, decision support
Methods
Maintenance issues
Established vocabularies
5. Clinical data acquisition and review
   - Types of clinical applications
   - Types of clinical users and working styles
   - Data acquisition
     - Input modalities (text, voice, pen, touch)
     - Design principles
   - Data review
     - Display modalities (graphics, text, sound, video)
     - Design principles
6. Decision analysis
   - Purpose
   - Judgment under uncertainty
   - Baysian approach
   - Decision trees
   - Assessing probabilities and utilities
   - Sensitivity analysis
7. Decision-support systems
   - Goals
   - Approaches to decision support
   - Types of decision-support systems
   - Knowledge representation and sharing
   - Architecture of an event monitor
   - Care plans and practice guidelines
8. Costs and benefits
   - Costs of building systems
   - Conclusions drawn from usage
   - The role of information systems

Evening Personal Skills Workstop, Thursday June 4, 1998

Java, JavaScript, and Database Access

Faculty

[Adrian Smith, MBL staff](#)

Educational Objectives & Outline

This session is intended to provide an introduction to Object Oriented concepts using Java. The lecture component of the class will consist of an overview of classes, objects, methods and variables as they are implemented in Java, followed by examples of Java and JavaScript in action. In the hands-on segment of the class the students will build and compile a simple Java applet using Symantec Visual Cafe. In addition, a demonstration will be given of using Visual Cafe and the associated dbAnywhere middleware tool to connect a Java applet to an SQL database residing on a remote server.

Day 6 - Saturday, June 6, 1998

Session 1: 8:30 - 10:00 AM

Introduction to Telemedicine

Faculty

[Charles Safran, M.D.](#)

Educational Objectives

This lecture will review the historical evolution and the technical underpinnings of Telemedicine. In addition, the current policy and regulatory issues will be explored.

Session Outline

1. Historical Background
2. Evolution of Care at a Distance
3. Technical Infrastructure
4. Policy and Regulatory Issues

Session 2: 10:30 - 12:00 PM

Telemedicine Applications

Faculty

[Charles Safran, M.D.](#)
Peter Macaulay

Educational Objectives

This lecture will review current telemedicine applications. Specific emphasis will be placed upon how these systems have been evaluated, what are the associated costs, what are the benefits, and what factors are associated with successful applications.

Session Outline

- Review of Current Applications
- Human factors and Workflow
- Costs of Telemedicine
- Measuring the Benefits of Telemedicine

Session 3: 1:30 - 3:00 PM

Case Study of the [Baby CareLink Project](#)

Faculty

[Charles Safran, M.D.](#)
Jim Gray, MD

Educational Objectives

This lecture will review one current home telehealth project in detail. The [Baby CareLink Project](#) uses telemedicine to provide educational and emotional support to families of high risk newborns both during their hospitalization and following discharge. This innovative use of this emerging technology will hopefully lead to shorter hospital stays and will also increase parental understanding and comfort, overall parental satisfaction with their baby's NICU care, improve the childís overall health status, improve clinician satisfaction, and provide a clear cost savings.

Session Outline

- From Concept to Application
- Organizing the Team
- Developing the Application
- Practical Choices
- Delivering Telemedicine in the Home
- Evaluation Strategies
- Live Demonstration

Session 4: 3:30 - 5:00 PM

> *Designing a Medical Informatics Curriculum*

Faculty

Educational Objectives

At the completion of this session, participants should have an understanding of issues attendant to the development and implementation of a medical informatics curriculum at the fellows' home institutions.

Session Outline

This session will be an interactive discussion among faculty and fellows. It will review the topics covered at the MBL course and promote discussion regarding future changes.

5:00 PM

> Course Wrap-Up and Farewell

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