Biomedical Informatics: Computer Applications in Health Care and Biomedicine

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Today’s Topic

Academic Biomedical Informatics
• Definitions and scope
• Terminology
• Textbook of Biomedical Informatics
• Education of Biomedical Informatics professionals
• Education of Biomedical Informatics researchers
  – Scientific papers
  – Doctoral dissertations
• Education of health professionals about informatics
• Creation of new academic units
  – Graduate training and recruitment of faculty
• Anticipating the future

What is Biomedical Informatics?

• Is it a “real” academic discipline?
  – Scientific base?
  – Here to stay?

• Is it needed both in universities and in the world beyond?
  – Job opportunities?
  – Are people filling those roles now?
  – Are there enough of them?

• How does it relate to other disciplines?
  – Duplicative?
  – Interdisciplinary?
Historical Perspective

- Computers in medicine emerged as a young discipline in the 1960s
  - Most applications dealt with clinical issues
- No consistency in naming the field for many years
  - “Computer applications in medicine”
  - “Medical information sciences”
  - “Medical computer science”
- Emergence in the 1980s of a single, consistent name, derived from the European (French) term for computer science: informatique
  - Medical Informatics

The Last 25 Years

- US Govt-supported medical informatics training programs at several universities (now 18 programs)
  - Application areas broadened in recent years to include biological sciences, imaging, and other biomedical domains
- Creation of professional societies, degree programs, quality scientific meetings, journals, and other indicators of a maturing scientific discipline
- Broadening of applications base, but with a growing tension between the field’s service role and its fundamental research goals
An Overview of Biomedical Informatics

Issues For Academic Informatics

• Conveying the fundamental issues in the field to colleagues who equate “true science” with life-science discoveries, typically in the wet-bench laboratory
• Finding the right mix between research/training and service requirements
• Dealing with the challenges of an interdisciplinary field that demands peer relationships with individuals in the computer science and biomedical fields as well as in biomedical informatics itself

Biomedical Informatics

**Biomedical informatics** is the scientific field that deals with the storage, retrieval, sharing, and optimal use of biomedical information, data, and knowledge for problem solving and decision making.

**Biomedical informatics** touches on all basic and applied fields in biomedical science and is closely tied to modern information technologies, notably in the areas of computing and communication.
An Overview of Biomedical Informatics

Relationship of Medical Informatics and Bioinformatics

- Biological and Clinical Applications of Interrelated Techniques and Methods
- Anticipation of their Future Clinical Interdependencies

Biomedical Informatics in Perspective

- Basic Research
- Applied Research

Biomedical Informatics Methods, Techniques, and Theories
- Bioinformatics
- Imaging Informatics
- Clinical Informatics
- Public Health Informatics
An Overview of Biomedical Informatics

Biomedical Informatics in Perspective

Basic Research

Biomedical Informatics Methods, Techniques, and Theories

Bioinformatics

Imaging Informatics

Clinical Informatics

Public Health Informatics

Biomedical Informatics in Perspective

Contribute to...

Biomedical Informatics Methods, Techniques, and Theories

Draw upon...

Clinical Informatics

Clinical Practice

Contributes to...

Other Component Sciences

Draws upon...

Molecular and Cellular Processes

Tissues and Organs

Individuals (Patients)

Populations And Society

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Biomedical Informatics Textbook
(3rd edition)

Springer - 2006

Unit I: Recurrent Themes in Biomedical Informatics

1. The Computer Meets Medicine and Biology: Emergence of a Discipline
2. Biomedical Data: Their Acquisition, Storage, and Use
3. Biomedical Decision Making: Probabilistic Reasoning
4. Cognitive Science in Support of Biomedical Informatics
5. Essential Concepts for Biomedical Computing
6. System Design and Engineering
7. Standards in Biomedical Informatics
8. Natural Language and Text Processing in Biomedicine
9. Imaging Informatics
10. Ethics and Health Informatics: Users, Standards, and Outcomes
11. Evaluation and Technology Assessment
Biomedical Informatics

Basic Research

Applied Research

Biomedical Informatics Methods, Techniques, and Theories

Bioinformatics

Imaging Informatics

Clinical Informatics

Public Health Informatics

Unit II: Biomedical Informatics Applications

12. Electronic Health Record Systems
13. Management of Information in Healthcare Organizations
14. Consumer Health Informatics and Telehealth
15. Public Health Informatics and the Health Information Infrastructure
16. Patient-Care Systems
17. Patient Monitoring Systems
18. Radiology Systems
19. Information Retrieval and Digital Libraries
20. Clinical Decision-Support Systems
21. Computers in Health Science Education
22. Bioinformatics
Unit III: Biomedical Informatics in the Years Ahead

23. Healthcare Financing and Information Technology: A Historical Perspective
24. The Future of Computer Applications in Biomedicine

Glossary
References
Name Index
Subject Index
**Education of Biomedical Informatics Researchers**

- **Basic Research**
- **Education and Experience at Both Levels**
- **Applied Research**

**Biomedical Informatics Methods, Techniques, and Theories**

- Bioinformatics
- Imaging Informatics
- Clinical Informatics
- Public Health Informatics

**Contributions Expected**

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**Fundamental Research in Informatics**

- Although projects are inspired by biomedical application goals, basic research in biomedical informatics typically:
  - offers methodological innovation, not simply interesting programming artifacts
  - generalizes to other domains, within or outside biomedicine
- Inherently interdisciplinary, biomedical informatics provides bridging expertise and opportunities for collaboration between computer scientists and biomedical researchers and practitioners
Biomedical Informatics Basic Research

Basic Research

Biomedical Informatics Methods, Techniques, and Theories

Contributions Expected

Biinformatics Imaging Informatics Clinical Informatics Public Health Informatics

Messages to Students

- Individual projects will always be applications-motivated
- Solutions often require informatics innovation rather than “off-the-shelf” software or tools
- Researchers must ask what general lessons can be derived from the work that they do
  - Of what class of applications is the project an example?
  - What is the range of applicability of the methods developed?
  - How can the work be described generically, independently of the application that motivated it
- There is a role for applications papers and evaluations, but the science of informatics requires that we identify and describe the generalizability and reusable lessons of a piece of work
Chapter 1: Introduction and Overview
Chapter 2: Literature Review
Chapter 3: Overview of Methodological Innovation
Chapter 4: System Component #1
...
...
Chapter 4+K: System Component #K
Chapter N-2: Examples of Total System’s Operation
Chapter N-1: Formal Evaluation of Method in the Context of the Application
Chapter N: Summary of Contributions and Future Work
Typically N = 8 or 9
Education of Health Professionals

Basic Research

Education and Experience at Applied Level

Biomedical Informatics Methods, Techniques, and Theories

Bioinformatics

Imaging Informatics

Clinical Informatics

Public Health Informatics

Limited Exposure to Methods

Applied Research

Issues in Teaching Medical Students About Biomedical Informatics

- Columbia experience starting in Autumn 2005
- How to make the topic seem relevant?
- Learning climate: students need to want to learn about the topic
- Lack of role models in clinical training settings
- Curriculum design: How to integrate informatics topics throughout training?
- Emphasize teaching by physicians who are cross-trained in informatics
Student Reactions

- Mixed and bimodal
- Extreme example of negative:

  "I still don’t think informatics is relevant to my becoming a surgeon. I will have nothing to do with any of the stuff taught. I don’t want to. I am 100% against computerized medicine, and I don’t want doctors to turn into robots. I don’t want to use a computer to make decisions. And nobody should. If you need a computer to become a competent doctor, then you shouldn’t become one because you’re not cut out for it."

Student Reactions

- Example of positive:

  "Content of presentations was strong. Demonstrated the relevance of informatics to everyday clinical decisions. The presentations were definitely worthwhile preparing for and listening to."

To-Do List for a New Program

• Attract faculty who understand biomedical informatics as science, not just as means to reach pragmatic ends
  – Joint (secondary) appointments for faculty from other units
  – Primary appointments only for informaticians
• Attract faculty committed to education as well as research, well-trained in informatics, and who embrace the notion that BMI spans applied disciplines across all of biomedicine
• Include graduate education as soon as possible, and do not wait to include doctoral training as well as masters
• Build diversified financial base: institutional, government, industrial, and foundations

To-Do List for a New Program - 2

• Link the department to transformation of modern knowledge dissemination in universities (i.e., to the library of the future)
• Seek diversity across the areas of application so that training does not become too narrow, even though students may be specializing in one of the application areas
• Seek to build and maintain visibility within the institution:
  – Collaborations
  – Some (limited) service activities
  – Presentations that educate others about the field and its relevance to modern biomedicine
Trends In The USA (and beyond?)

- Creation of several new biomedical informatics departments or independent academic units
- Strong job market for graduates of informatics degree programs
- Government investment in training and research is reasonably strong, especially for applications and demonstrations
- Increasing acceptance of biomedical informatics as a subspecialty area by biomedical professional societies
- Increasing recognition that biomedical problems can drive the development of basic theory and capabilities in information technology research