What this BOF is about and what we want to accomplish

In this session, we plan to discuss a number of questions and issues that are raised when developing these courses and programs. What types of courses should be included in degree programs? What role do curricular standards, especially in healthcare, play? What topics belong in interdisciplinary bioinformatics courses? How do we cope with students who may have differing backgrounds and prerequisites? How do we develop relationships with clinicians, biologists, healthcare IT specialists and other domain experts? How do we find curricular resources? What kinds of software support are necessary? Are there textbooks that are appropriate for our students? How can we establish internships and research opportunities for students who are interested in one of these areas as a career? The hope is that we can create an informal network for sharing ideas which will persist after the session. To this end, we will also discuss ways for maintaining a community, perhaps as a mailing list, blog, or website.

Definitions

One of the biggest problems is simply defining our terms. It is hard to know what to teach if we don’t have standard meanings for all the terms out there.

• Healthcare informatics
  o National Health Service (UK) “The knowledge, skills and tools which enable information to be collected, managed, used and shared to support the delivery of healthcare and to promote health”.
  
  o Bill Hersch prefers the term Biomedical and health informatics (BMHI), which he defines as “the field concerned with the optimal use of information, often aided by technology, to improve individual health, healthcare, public health, and biomedical research.”. He has posted an entire lecture on this topic at What is Biomedical and Health Informatics?” He sees bioinformatics as a subfield of Biomedical and Health Informatics
  
  o Medical informatics, according to AMIA, has to do with all aspects of understanding and promoting the effective organization, analysis, management, and use of information in health care. While the field of medical informatics shares the general scope of these interests with some
other health care specialties and disciplines, medical informatics has
developed its own areas of emphasis and approaches that have set it apart
from other disciplines and specialties. For one, a common thread through
medical informatics has been the emphasis on technology as an integral tool
to help organize, analyze, manage, and use information. In addition, as
professionals involved at the intersection of information and technology and
health care, those in medical informatics have historically tended to be
engaged in the research, development, and evaluation side, and in studying
and teaching the theoretical and methodological underpinnings of data
applications in health care.

- **Bioinformatics**
  - Bioinformatics, since at least the late 1980s, has been to describe the
    application of computer science and information sciences to the analysis of
    biological data, particularly in those areas of genomics involving large-
    scale DNA sequencing. (source: Wikipedia)
  - According to the NIH, Bioinformatics: Research, development, or application
    of computational tools and approaches for expanding the use of biological,
    medical, behavioral or health data, including those to acquire, store,
    organize, archive, analyze, or visualize such data.
  - Also according to the NIH, Computational Biology: The development and
    application of data-analytical and theoretical methods, mathematical
    modeling and computational simulation techniques to the study of biological,
    behavioral, and social systems.
    
    (developed by the BISTIC Definition Committee and released on July 17,
    2000.)

- Other terms: Nursing informatics, Health Information Technology

**Organizations concerned with health and biomedical informatics**

- American Medical Informatics Association - [www.amia.org](http://www.amia.org)
- Office of the National Coordinator for Health IT - [healthit.hhs.gov](http://healthit.hhs.gov)
- Agency for Healthcare Quality and Research - [www.ahrq.gov](http://www.ahrq.gov)
- International Medical Informatics Association - [www.imia.org](http://www.imia.org)
- Health Information Management Systems Society - [www.himss.org](http://www.himss.org)
- Association of Medical Directors of Information Systems - [www.amdis.org](http://www.amdis.org)
- American Health Information Management Association - [www.ahima.org](http://www.ahima.org)
- eHealth Initiative - [www.ehealthinitiative.org](http://www.ehealthinitiative.org)
Careers in health and medical informatics

William Hersh divides up the health informatics workforce into these categories:

1. **IT professionals** – those who install, maintain, and optimize the hardware and software.

2. **HIM professionals** – those who bring their knowledge and skills to bear on increasingly electronic medical records, especially in areas of documentation, coding, and legal and compliance issues.

3. **Clinical informaticians** – those who bring expertise at the intersection of health care and IT to assure successful adoption and use of HIT and the information within it.

More on Hersh’s insights may be found at Hersh, W. A stimulus to define informatics and health information technology. *BMC Medical Informatics and Decision Making.* 9, 1, 24, 2009.

The Office of the National Coordinator for Health Information Technology, University Based Training Roles, They have defined university-based training roles at [http://www.healthit.gov/policy-researchers-implementers/university-based-training-roles](http://www.healthit.gov/policy-researchers-implementers/university-based-training-roles) and funded certain exemplary programs at [http://www.healthit.gov/policy-researchers-implementers/program-information-prospective-students-0](http://www.healthit.gov/policy-researchers-implementers/program-information-prospective-students-0) The roles they defined are:
(1) **Clinician or Public Health Leader** who combines knowledge of Health IT with clinical or public health

(2) **Health Information Management and Exchange Specialist** who specializes in collection, management, retrieval, and exchange or analysis of data in electronic form

(3) **Health Information Privacy and Security Specialist**

(4) **Research and Development Scientist**

(5) **Programmers and Software Engineers**

(6) **Health IT – Subspecialist** a relatively few people who combine knowledge of health care, and IT and a supporting discipline (e.g. systems engineering, cognitive psychology, etc).

Of these roles, (2), (3), and (5) are within the area of computer science.

**Careers in bioinformatics**

Most jobs in bioinformatics will demand biological knowledge as well as computer science ability. Most jobs will require an advanced degree. Most major universities offer graduate programs in Bioinformatics.

Where the jobs are:

1. **Pharmaceutical/Biotech companies**
2. **Federal Labs**.
3. **Universities**.

**Why are computer science departments suddenly aware of bioinformatics and healthcare informatics?**

- It seems relevant and popular (and maybe exciting?), there is money in it, CS students need a broader perspective, we need enrollment

**Curriculum models**

These are questions to consider

- Bioinformatics
  - What courses make up a major?
  - What courses make up a minor?
If you only had one elective, what would you cover?

- Healthcare informatics
  - Are we focusing on healthcare IT, healthcare information management, or medical informatics?
  - Comparison of HIM programs and medical informatics programs
    
    HIM programs are quite standardized because of the need for CAHIM accreditation.

    On the other hand, the programs in health or medical informatics tended to be more strongly oriented to computer science, most requiring multiple programming courses, database courses and networking courses.

  - Accreditation issues for healthcare information management
  - Articulation with associate’s programs and with graduate programs

Currently AMIA's 10x10 courses cover the following topics in the field of informatics:
- Clinical or health informatics
- Clinical research informatics
- Translational bioinformatics
- Nursing informatics
- Public Health informatics

**Online courses**
- Coursera is offering a MOOC that is run from Georgia Tech called Healthcare Informatics in the Cloud, taught by Mark Braunstein

**Textbooks and software**

**Healthcare informatics books for introductory course**
- *Information Technology for the Health Professions (3rd Edition)*
  Lillian Burke, Barbara Weill 2008
- Health Information Technology and Management, Richard Gartee, 2010
- Handbook of Informatics for Nurses and Health Care Professionals, Toni Lee Hebda and Patricia Czar, (5th Edition), Pearson 2012
Health Information Management books

- Health information: management of a strategic resource, Abdelhak, Grostick, Hanken, Jacobs, 2011
- Information Management for Health Professionals, Merida Johns, 2006 (published by AHIMA)

Books in bioinformatics

- An Introduction to Bioinformatics Algorithms, by Neil Jones and Pavzner
  Good introduction for a diverse audience: those who are less experienced with algorithms, especially; some introduction to biology for the computer scientists; fairly gentle introduction to algorithms.
- Algorithms on Strings, Trees and Sequences: Computer Science and Computational Biology, by Dan Gusfield
  More quantitative / algorithmic approach to computational biology; could even be used a textbook for a more general algorithms course
- Computational Biology: A Practical Introduction to BioData Processing and Analysis with Linux, MySQL, and R, by Robbe Wunschiers
  More implementation-focused in terms of applications; could be a good book for even a statistics course (applying analysis to biological data) or an applied algorithms course
- Algorithms in Bioinformatics: A Practical Introduction, by Wing-Kin Sung
  Algorithmic approach for the main topics in a computational biology course; book seemed to work well for a mixed audience of computer scientists and biologists
- Bioinformatics and Functional Genomics, by Jonathan Pevsner
  Very thorough treatment of techniques in computational biology; not sure if this is an ideal textbook for a course, but it is a great reference guide for the professor and students who want more depth.
- Exploring Bioinformatics, St Clair and Visick, 2009
  Very good introduction to regular expression matching in Perl, for parsing data and pattern matching within large datasets. Levels the playing field for students with different backgrounds (CS/Biology) in an interdisciplinary course.
  Very good introduction to Bioinformatics through gorgeous illustrations of the Central Dogma (“DNA makes RNA makes protein.”) and primary, secondary, and tertiary structures.

Software and online tools
**VistA**: (The very famous, original, electronic medical record system from the VA) - [http://www.medsphere.com/](http://www.medsphere.com/) has a version called OpenVista

**PracticeFusion**: (online medical record system, great for students to practice with) - www.practicefusion.com

**OpenMRS**: (open source medical record system) - [http://openmrs.org/](http://openmrs.org/)

**Unified Medical Language System (UMLS)** - medical ontology


**Resources for DICOM?** We used a free DICOM viewer called DICOMViewer which wasn’t very satisfactory


**LinkedLifeData** (repository of numerous medical and biological datasets, coded in RDF and presented as a Linked Open Data cloud) - [http://linkedlifedata.com/](http://linkedlifedata.com/)

**Learning about DNA and the central dogma** - [http://www.dnalc.org/resources/3d/central-dogma.html](http://www.dnalc.org/resources/3d/central-dogma.html)

**Bioconductor** (open source software for bioinformatics using the R language) - [http://www.bioconductor.org](http://www.bioconductor.org)

**Biopython** (Python code for computational biology) - [http://biopython.org/wiki/Biopython](http://biopython.org/wiki/Biopython)

**Java for computational biology** (several computational biology projects in Java) - [http://mybio.wikia.com/wiki/Java_for_computational_biology](http://mybio.wikia.com/wiki/Java_for_computational_biology)

**Multiple sequence alignment** (ClustalW2) - [http://www.ebi.ac.uk/Tools/msa/clustalw2/](http://www.ebi.ac.uk/Tools/msa/clustalw2/)

**Yeast genome database** (there are other databases like this that focus on a particular organism) - [http://www.yeastgenome.org/](http://www.yeastgenome.org/)

**Java Tree View** (to view relationships based on sequence similarity) - [http://jtreeview.sourceforge.net/](http://jtreeview.sourceforge.net/)

**Other advice for designing a computational biology course:**
Audience: choose resources that are accessible by computer science students and biology students
Prerequisites: I have been successful with students who have taken the introduction to computer science course (Java) and either data structures or the introductory biology course.

Inter-disciplinary projects: Students in my course complete a semester-long project. The teams are intentionally composed of biology and computer science students. The biology students have more background in the analysis of results and what the data means. The CS students have more background in developing software and algorithms.

Biology/CS: If you are a CS faculty member, try to find a partner in biology to help you develop the course or at least someone with whom you can consult. Biology spans a lot of fields. The Biology faculty who are most interested in evolution, cellular structure, or genetics will be your best partners.

Topics: I view the course as an applied algorithms course. The algorithmic development process is just like in any other CS course, but the algorithms just happen to focus on biological data, such as DNA, RNA, proteins, and expression data. Classic algorithms include sequence alignment via dynamic programming. The textbooks will give you guidance on what topics you choose to focus.

Structure: If you are lucky enough to team-teach a bioinformatics course with a Biology professor, I highly recommend you model the collaborative process. Each time we teach the course, we find newer and better ways to set an example for our students. Our students see we need each other to teach the class, and it helps them realize they need to collaborate with a partner across disciplines, too. Bioinformatics is an interdisciplinary endeavor.

Challenge: bring the Biology students up to speed on understanding the language of CS, without boring the CS students; while bringing the CS students up to speed on understanding the language of Biology, without boring the Biology students. What we will try next time we teach the course: making the students responsible for teaching their partner across disciplines about their own discipline. We’ll let you know how this works out! (Marc Smith, Vassar College. Team-teaches with Jodi Schwarz, Biology)
Computer scientists put the informatics into bio, health, and medical informatics education (abstract only). Share on. Authors

There has been an explosion of interest in bioinformatics, medical informatics, and healthcare informatics in the past decade. As a result, many computer science departments are developing courses or degree programs in bioinformatics and/or health informatics. The discussion leaders all have experience teaching courses in healthcare informatics and/or bioinformatics within computer science departments. We will share our expertise and experience on such issues as effectively team teaching interdisciplinary courses, developing case studies and projects, and developing links with biologists and clinicians.