Competencies and Curricula Across the Spectrum of Learners for Health Informatics

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Competencies and Curricula Across the Spectrum of Learners for Health Informatics

IEEE ICHI First International Workshop on Health Informatics Education
William Hersh

Oregon Health & Science University

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Outline

- Overview of field in context of education
- Competencies for health informatics
- Some curricular activities
- Future directions

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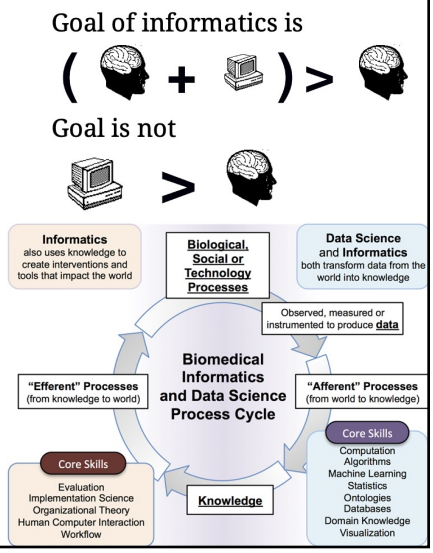
Health informatics in context of education

- An interdisciplinary field requiring some level of knowledge and skills in
  - Biomedicine
  - Healthcare
  - Computer science (CS)
  - Math
  - Data science
  - Machine learning (ML)
- With practitioners/ professionals at different levels
  - Researchers
  - Developers
  - Implementers
  - Users
    - Clinicians
    - Consumers/patients/citizens

Informatics is not just the sum of math, CS, biomedicine, healthcare, etc.

- While no single aspect of informatics is impertinent to any other field, the interactions of them give rise to unique aspects
- Despite interdisciplinary nature of field, there are unique aspects
- Friedman
  - Fundamental Theorem (2009)
  - What Is and Isn't Informatics (2013)
- Differences from data science (Payne 2018)



Some of my writings along the way

- JAMA overview (2002), progress and barriers (2004)
- Who are the informaticians? (JAMIA, 2006)
- A stimulus to define informatics (BMC, 2009)
- Workforce estimates and demands (ACI, 2010)
- Competencies for medical education (APME, 2014)
- A passion and a calling (IMIA History Book, 2021)

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Many learners, with needs and activities

- Informaticians
- Clinicians
- Researchers
- Patients/Consumers/Citizens

- And students in all of the above

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Competencies of informatics professionals – over a decade of work

- Core content of clinical informatics (Gardner, 2009)
- IMIA educational recommendations (Mantas, 2010)
- Core competencies for graduate education in biomedical informatics (Kulikowski, 2012)
- Foundational domains of applied health informatics (Valenta, 2018)
- Domains, tasks, and knowledge for clinical informatics subspecialty practice (Silverman, 2019)
- Domains, tasks, and knowledge for health informatics practice (Gadd, 2020)
- UK Clinical Informatics Core Competency Framework (Moulton, 2020)

AMIA informatics practice workforce analysis

Health Informatics

Domains	Task statements	KS statements
Domain 1. Foundational Knowledge and Skills	NA	31
Domain 2. Enhancing Health Decision-making, Processes, and Outcomes	11	21
Domain 3. Health Information Systems	26	36
Domain 4. Data Governance, Management, and Analytics	17	28
Domain 5. Leadership, Professionalism, Strategy, and Transformation	20	28
Total	74	144

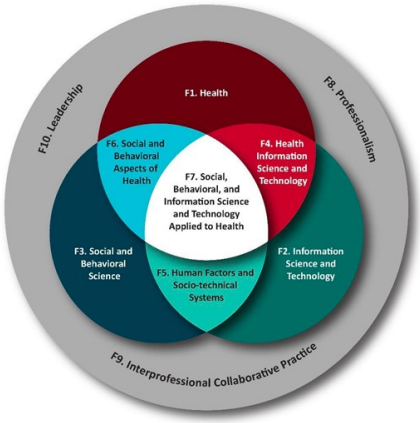
Clinical Informatics Subspecialty (CIS)

Domains	Task statements	KS statements
Domain 1. Foundational Knowledge and Skills	NA	26
Domain 2. Improving Care Delivery and Outcomes	7	28
Domain 3. Enterprise Information Systems	16	33
Domain 4. Data Governance and Analytics	10	27
Domain 5. Leadership and Professionalism	9	28
Total	42	142

(Silverman, 2019; Gadd, 2020)

Fundamental knowledge and skills

- Fundamental knowledge and skills that provide health and clinical informaticians with a
  - Common vocabulary
  - Basic knowledge across all informatics domains
  - Understanding of the environment in which they function, including
    - Individual health
    - Healthcare
    - Public health
    - Research



(Valenta, 2018)

Role for individual certification?

- Probably more important for implementers than researchers
- Board certification of physicians is important
  - Clinical informatics certification is recognition of field; probably more important for younger entrants
- Role/value of AMIA Advanced Health Informatics Certification (AHIC) – TBD

Deeper dive into specific curricula

- OHSU Biomedical Informatics Graduate Program
- Introductory course – including 10x10
- Applied machine learning for clinical informatics students
- Others who “do” informatics and must have competence

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OHSU Biomedical Informatics Graduate Program

- Among oldest and largest programs in field – since 1996
- Two majors (formerly tracks)
  - Health & Clinical Informatics (HCIN)
  - Bioinformatics & Computational Biomedicine (BCB)
- Degrees and certificates
  - PhD
  - Master of Science – with and without thesis
  - Graduate Certificate (HCIN only)
- Two fellowships
  - NLM T15 Training Grant
  - Clinical Informatics Subspecialty
- Early adopter of distance learning (in HCIN)

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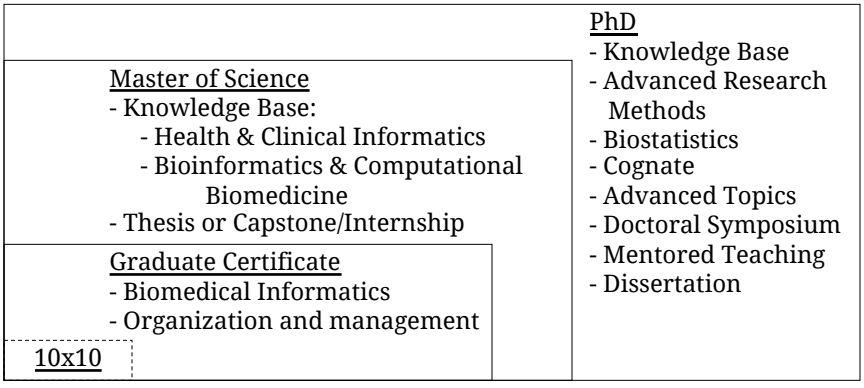
OHSU biomedical informatics core curriculum domains

High-Level Competency	Domain Names for Health & Clinical Informatics (HCIN)	Domain Names for Bioinformatics & Computational Medicine (BCB)
Apply core concepts of using data, information, and knowledge to advance health and biomedicine	Health & Clinical Informatics	Bioinformatics & Computational Biomedicine
Apply knowledge of appropriate area(s) of health and biomedicine to informatics practice and research	Health Care	Biomedical Science
Apply computing skills to biomedical informatics	Computer Science	Computer Science
Apply quantitative methods to biomedical informatics	Evaluative Sciences	Biostatistics
Apply people and organizational knowledge to informatics	Organizational Behavior and Management	N/A
Apply advanced scholarship to biomedical and health informatics	Thesis/Capstone/Dissertation Requirements	Thesis/Capstone/Dissertation Requirements

Program has "building block" approach



http://www.ohsu.edu/informatics-education

Places and numbers

Degree	Total	BCB	HCIN
Grad Cert	483	0	483
MS	422	71	351
PhD	38	15	23
Total	943	86	857

International students from: Argentina, Singapore, Egypt, Israel, Saudi Arabia, Zimbabwe, Thailand, China, South Africa, and others

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Introductory course

- Have always enjoyed introducing people to informatics within and outside of field
- Initial effort was graduate-level course
  - 1993 – overview course for Master of Public Health (MPH) Program, PH 549
  - 1996 – became entry course for Master of Science in Medical Informatics Program, MINF 510
  - 2001 – changed prefix when program name changed to Biomedical Informatics, BMI 510

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Then came "10x10"

- https://dmice.ohsu.edu/hersh/10x10.html
- Started when Dr. Charles Safran, former AMIA Chairman, stated need to train one physician and one nurse from each of America's 6,000 hospitals in informatics (Safran, 2005)
- Original aim to train 10,000 individuals in informatics by the year 2010 (Hersh, 2007)
  - OHSU is largest and most successful offering, with 1000 completing program by end of 2010 and over 3000 by 2022
  - Program continued beyond 2010 based on continued interest and need in US and abroad
  - About 10-15% pursue graduate study, mostly at OHSU

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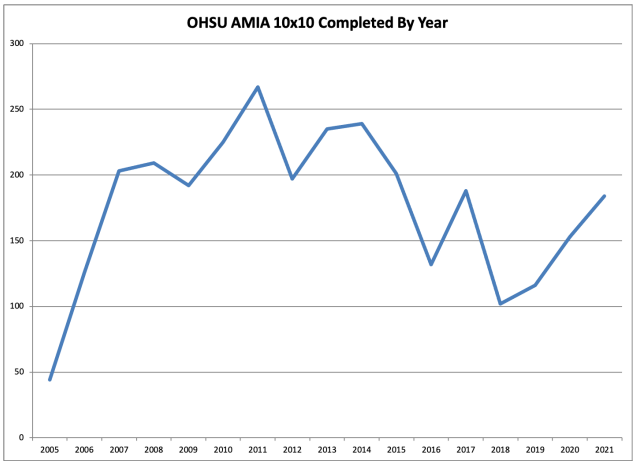
10x10 – milestone of 3000 by 2022



Organization	Course Offerings	People Completing
AMIA	48	1953
American College of Emergency Physicians	14	221
American College of Physicians	1	25
Academy of Nutrition and Dietetics	7	126
Centers for Disease Control	1	18
California Health Care Foundation	1	16
Gateway Consulting (Singapore)	26	377
Ministry of Health (Israel)	1	11
King Saud University (Saudi Arabia)	4	83
Mayo Clinic	2	87
New York State Academy of Family Practice	3	22
Abu Dhabi Health Services (United Arab Emirates)	1	54
Scottsdale Institute	1	15
Society for Technology in Anesthesiology	1	5
Total	111	3013

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Also translated into Spanish and delivered in Latin America (Otero, 2010)

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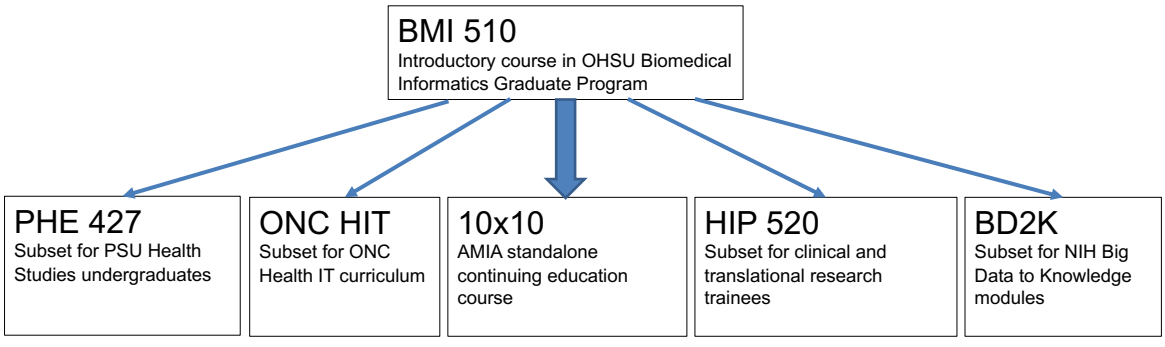
Lineage and offshoots



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Other numbers – mid-2022

- BMI 510 and predecessors – 1598 since 1996
- Other customized offerings – Mayo Clinic, Kaiser Permanente, Bangkok Hospital, H3ABionet
- Course for medical students early in pandemic – 222 students from 17 medical schools in early-mid 2020
  - Still available to OHSU medical students as an elective

Portions of course material adapted for

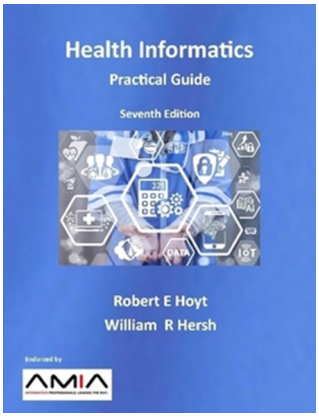
- Curriculum development projects
  - ONC Health IT Curriculum
  - BD2K
  - Bridge2AI (?)
- Other courses
  - Undergraduate course in public health program at Portland State U, PHE 427
  - Introductory course for OHSU Human Investigations Program, HIP 520

Content of introductory course

Unit	Topic
1	Overview of Field and Problems Motivating It
2	Computing Concepts for Biomedical and Health Informatics
3	Electronic and Personal Health Records (EHR, PHR)
4	Standards and Interoperability
5	Data Science and Artificial Intelligence
6	Advanced Use of the EHR
7	EHR Implementation, Security, and Evaluation
8	Information Retrieval (Search)
9	Research Informatics
10	Other Areas of Informatics

Teaching modalities

- Lectures
  - Voice over Powerpoint – many tools over the years; currently use just Powerpoint exported to MP4
  - Units broken down into 5-8 segments of 20-30 minutes duration
  - Served via Echo360 allowing viewing on computer and mobile devices
  - Also provide PDF handouts of slides and references cited
- Homework
  - Multiple-choice questions that aim to apply material
- Readings
  - Optional readings from textbook mapped to units (Hoyt and Hersh, 2018)



Discussion forums

- Think of as an online classroom: Speak up, do not feel intimidated, and everyone has something to say
- Instructor "seeds" discussion with 1-2 questions but students encouraged to post their own, including asking about things they do not understand (rather than emailing, at least initially)
- Simple etiquette
  - Messages should be neither too short nor too long
  - Be constructive and respectful
  - Reply to messages in their respective threads
  - Do not copy and paste from Web sites; use own words and provide a link if desired
  - Do not discuss homework questions until one week after due date

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Expectations of students

- Complete lectures
  - Course focus is on content in lectures but optional readings provide additional perspective
- Participate in discussion
  - Observe proper etiquette, but do not be afraid to speak up
  - Ask questions about anything unclear in lectures or reading materials
  - Challenge the instructor!
- Complete all assignments by due dates
  - Can occasionally be late but warned not to fall too far behind

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Expectations for instructor (cont.)

- Create an environment of learning and objective inquiry
- Maintain high availability
  - I am there to serve; students are not wasting my time
  - Best method of initial contact is email
  - Can talk via video or phone as needed
- Lectures
  - Quality is very good but not perfect
  - I am not a talking head
  - I try to convey my view of informatics, getting into the details but never losing the big picture
  - One of my best compliments ever
    - "I like that Dr. Hersh pauses and makes mistakes and corrects himself … It shows he is thinking about what he is saying instead of reading off a paper."
- Discussion
  - I will read (and reply if appropriate) to all postings

Course in applied data science and machine learning for clinical informatics students

- Growing need for all to understand data science and ML beyond the "wranglers and modelers"
  - Including those without math and programming background for traditional ML courses
- Especially
  - Informaticians who implement and evaluate systems
  - Clinicians whose work will be impacted by them
  - Patients and consumers, especially those impacted by biased data and algorithms
- Elective now but likely to become a required course

New course for clinical informatics students with modest math and programming background

Course Material

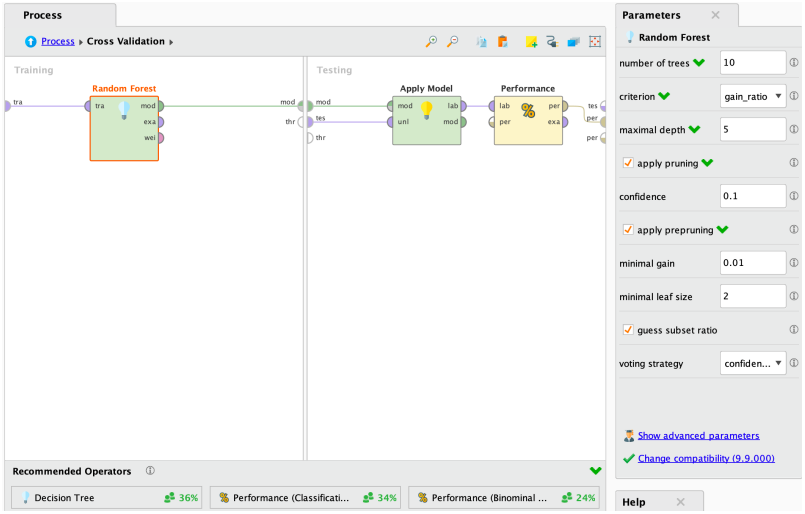
Broad Survey of Topics Related to the Machine Learning Model Lifecycle in Health Care

Hands On Class Project (Concurrent with course material)

Data Preparation (Python programming)

Model Development (RapidMiner)

Future belongs to visual programming tools? Using RapidMiner, considering Orange



Course outline

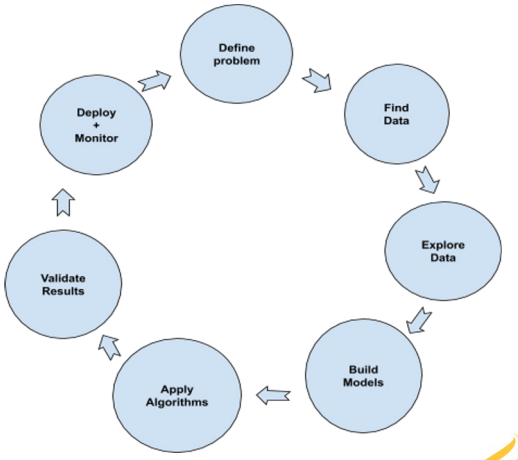
- Overview of biomedical data science
- Overview of biostatistics, ML, and AI
- Critical assessment of machine learning literature – both development and implementation
- Introduction to data sources and programming languages
- Data preparation
- Data exploration
- Using RapidMiner: 6 ML algorithms (kNN, logistic regression, decision trees, random forest, support vector machines and simple neural networks)
- Model implementation
- Ethical considerations

Learning activities

- Weekly voice-over-Powerpoint lectures
- Readings
  - Hoyt and Muenchen, *Introduction to Biomedical Data Science*, Lulu.com, 2019
  - Hoyt and Muenchen, *Data Preparation and Exploration: Applied to Healthcare*, Lulu.com, 2019
  - Selected articles
- Programming and modeling skills development
  - Weekly assignments in Python or RapidMiner
  - Necessary skill development for application to each phase of class project

Class project

- Longitudinal project starting early in course
- Choice among datasets
  - Synthea
  - NHANES
  - MIMIC
  - Or bring your own – with caveats
- Incrementally explore, develop model, and evaluate performance



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Others who "do" informatics

- Physicians and medical students – first addressed by AAMC Medical School Objectives Project (1998)
- Patients – 58% of US adults look online for health information and 35% attempt to diagnose illness in that manner (Fox, 2013)
- Clinical and translational scientists (Valenta, 2016)
- Next-generation research scientists (Moore, 2019)
- Nurses (Forman, 2020)

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Informatics and health professions education

- "Search engine as essential as stethoscope" for clinical practice (Glasziou, 2008)
- "Informatics training for clinicians is more important than hardware and software" (Safran, 2009)
- Health informatics is a "required skill for 21st century clinicians" (Fridsma, 2018)
- Competencies (Hersh, 2014; Hersh, 2020), curricula (Hersh, 2017), and challenges (Welcher, 2018)

1. Find, search, and apply knowledge-based information to patient care and other clinical tasks.
   a. Information retrieval/search—choose correct sources for specific task, search using advanced features, apply results.
   b. Evaluate information resources (literature, databases, etc.) for their quality, funding sources, biases.
   c. Identify tools to assess patient safety (e.g., medication interactions).
   d. Utilize knowledge-based tools to answer clinical questions at the point of care (e.g., text resources, calculators).
   e. Formulate an answerable clinical question.
   f. Determine the costs/charges of medications and tests.
   g. Identify deviations from normal (labs/x-rays/results) and develop a list of causes of the deviation.
2. Effectively read from, and write to, the electronic health record for patient care and other clinical activities.
   a. Graph, display, and trend vital signs and laboratory values over time.
   b. Adopt a uniform method of reviewing a patient record.
   c. Create and maintain an accurate problem list.
   d. Recognize medical safety issues related to poor chart maintenance.
   e. Identify a normal range of results for a specific patient.
   f. Access and compare radiographs over time.
   g. Identify inaccuracies in the problem list/history/medications list/allergies.
   h. Create useable notes.
   i. Write orders and prescriptions.
   j. List common errors with data entry (drop-down lists, copy and paste, etc.).
3. Use and guide implementation of clinical decision support (CDS).
   a. Recognize different types of CDS.
   b. Be able to use different types of CDS.
   c. Work with clinical and informatics colleagues to guide CDS use in clinical settings.
4. Provide care using population health management approaches.
   a. Utilize patient record (data collection and data entry) to assist with disease management.
   b. Create reports for populations in different health care delivery systems.
   c. Use and apply data in accountable care, care coordination, and the primary care medical home settings.
5. Protect patient privacy and security.
   a. Use security features of information systems.
   b. Adhere to Health Insurance Portability and Accountability Act (HIPAA) privacy and security regulations.
   c. Describe and manage ethical issues in privacy and security.
6. Use information technology to improve patient safety.
   a. Perform a root cause analysis to uncover patient safety problems.
   b. Maintain familiarity with safety issues.
   c. Use resources to solve safety issues.
7. Engage in quality measurement selection and improvement.
   a. Recognize the types and limitations of different types of quality measures.
   b. Determine the pros and cons of a quality measure, how to measure it, and how to use it to change care.
8. Use health information exchange (HIE) to identify and access patient information across clinical settings.
   a. Recognize issues of dispersed patient information across clinical locations.
   b. Participate in the use of HIE to improve clinical care.
9. Engage patients to improve their health care delivery though personal health records (PHRs) and patient portals.
   a. Instruct patients in proper use of a PHR.
   b. Write an e-message to a patient using a patient portal.
   c. Demonstrate appropriate written communication with all members of the health care team.
   d. Integrate technology into patient education (e.g., decision-making tools, diagrams, patient education).
   e. Educate patients to discern quality of online medical resources (websites, apps, patient support groups, social media, etc.).
   f. Maintain patient engagement while using an electronic health record (EHR) (eye contact, body language, etc.).
10. Maintain professionalism through use of information technology tools.
    a. Describe and manage ethics of media use (cloud storage issues, texting, cell phones, social media professionalism).
11. Provide clinical care via telemedicine and refer patients as indicated.
    a. Be able to function clinically in telemedicine/telehealth environments.
12. Apply personalized/precision medicine.
    a. Recognize growing role of genomics and personalized medicine in care.
    b. Identify resources enabling access to actionable information related to precision medicine.
13. Participate in practice-based clinical and translational research.
    a. Use EHR alerts and other tools to identify patients and populations eligible for participation in clinical trials.
    b. Participate in practice-based research to advance medical knowledge.
14. Apply machine learning applications in clinical care.
    a. Discuss the applications of artificial/augmented intelligence in clinical settings.
    b. Describe the limitations and potential biases of data and algorithms.

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OHSU MD clinical informatics curriculum

Strategies

- EHR from Day One
  - Routine part of learning, practice
  - Weekly case info in EHR
- "Boards or wards" mantra
  - Preclinical only if needed for the boards or the wards
- Tailor to weekly curriculum content
  - Relevant and necessary
  - EHR data, knowledge sources
- Blend material into weekly content
  - Cotton ball in water glass
- Spiraling – return periodically to build on earlier material

Methods

- Early lecture – Information is Different Now That You're a Doctor
- Weekly Clinical Informatics Pearls
  - Incremental skill building
- Clinical Skills Labs
  - Combine skills into clinical tasks
- Traditional large group lectures
- Embedding and stealth teaching
- Informatics assessments
  - Weekly homework
  - Simulation lab
- Clinical experiences applications
  - Telemedicine, population health
- Intersession focused activities

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Parting words of wisdom

- No matter how focused your work in informatics (e.g., machine learning or NLP researcher), it is important to have big picture, e.g.,
  - Operations of healthcare system – good and bad
  - EHR – alert fatigue, burnout, etc.
  - Clinical decision support – benefits and shortcomings
  - Data standards and interoperability
  - Data and algorithm bias
- Likewise if you are an informatics "generalist," still must understand what new methods and technologies aim to do, e.g., ML, AI, etc.

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Parting words of wisdom (cont.)

- We must teach the right knowledge and skills to the appropriate audience
- We "own" the downsides to the EHR, biased data and algorithms, etc. – so we must teach about the good and bad
- Teaching is fun and rewarding!

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Thank you!

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