Contextually-Aware Analysis, Decision-Support, and Informed Response

CCC Workshop on Discovery and Innovation in Smart and Pervasive Health

December 5-6, 2016

CCC
Computing Community Consortium
Catalyst

Contextually-Aware Analysis, Decision-Support, and Informed Response

- Sensors, sensors, sensors everywhere
- Increasing availability of data: text, images, audio, video, motion, gesture, physiology, and geo-exposure, among others
- New algorithms and techniques needed: data analytics, visualization, computational intelligence, machine perception, and human-centric computing

Contextually-Aware Analysis, Decision-Support, and Informed Response

- Providing personalized diagnosis and treatment plans,
- Contextual info to healthcare providers for more informed decision and more rapid response
- Enabling discovery of new knowledge about health at system and community scale
- Supporting telemedicine and individualized medicine
- Engaging patients in managing their own health and wellness

Panel Chair: Ming C. Lin (UNC Chapel Hill)

- **Jim Rehg (Georgia Tech)**
- **Noémie Elhaddad (Columbia University)**
- **Scott Levin (Johns Hopkins University)**
- **Ida Sim (UC San Francisco)**

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Grand Challenge: Putting Behavior in Context

James M. Rehg – Georgia Tech College of Computing





- How can we measure key environmental variables such as exposure to cues and triggers for adverse health-related behaviors?
- How can we infer a comprehensive characterization of the context for behavioral decision-making from noisy sensor data?
- How can we model the effect of environmental and social factors on behavior regulation in order to support behavior change?

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holistic, meaningful, actionable models of health

Noemie Elhadad
Columbia University

holistic, meaningful, actionable models

healthcare clinical
patient-generated clinical
behavior
social environment
environment
…

heterogeneous
temporal
sampled at different
resolutions
biased, incl. uncertain

holistic, meaningful, actionable models

- Scalable
  - Gather evidence from small and large cohorts
  - Capture interactions amongst outcomes
- Computationally feasible
- Adaptable
- Interpretable?

- Evaluation
  - From validating to understanding added value

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“The good physician treats the disease; the great physician treats the patient who has the disease.”

- Sir William Osler

Data vs Knowledge differences

Great Med Student/Average Intern

- knows more facts/book knowledge, i.e., physiology, basic biomedicine
- more up-to-date, e.g., on literature, subspecialty approaches
- often knows detailed facts about each patient (e.g., their heart ejection fraction)

Experienced doc (e.g., me)

- can't pass med school Boards anymore
- can't keep up, can't pronounce the latest drug names
- knows clinical states of patients and their trajectories (e.g., what kind of pump their heart is and how it got to this state)

Doctor-patient communication differences

Great Med Student/Average Intern

- Just as empathetic, caring
- More fact-based questions
- Asks mostly about currently active diseases/problems

Experienced doc

- Just as empathetic, caring
- More affective questions
- More clinical-context questions
- More life-context questions

Cognitive differences

Great Med Student/Average Intern

- Thinks in chapters
  - –cliffs of knowledge
- Pattern recognition is basic
- Rule-based thinking, more deterministic
- Patient values and preferences are secondary to the “right” thing to do

Experienced doc

- Thinks in whole people
- Deep rich patterns and pattern matching (but not always)
- Multiple decision points and comfortable with uncertainty
- Dominant decision factors are often patient values and preferences

Beyond “med student” computing….

- Open Research Challenge
  - –building and reasoning on individualized integrated models of biology, physiology, behavior, psychology, socioeconomic and social contexts
- What innovative applications can provide a paradigm shift to smarter care?
  - –“Big data” enhanced decision-theoretic approaches
    - Diagnosis: treat as a process, trade-offs in sequencing of tests, Value of information
    - Treatment: explicit handling of uncertainty, probability, value-based outcomes; explicit handling of multiple disease conditions
- What domains might be opportunistic for the community to explore?
  - –find an easy version of the right problem: treating the whole patient over time
  - –concierge primary care: holistic yet technically savvy doctors taking care of educated, insured patients with multiple chronic diseases in a less pressured reimbursement environment

"The good physician treats the disease; the great physician treats the patient who has the disease."

- Sir William Osler

"The good computer provides data about the disease; the great computer guides the physician whose patient has the disease"