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

CCC Workshop on Discovery and Innovation in Smart and Pervasive Health
December 5-6, 2016
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”