IS 3350 -Doctoral Seminar

focus:
Security and Privacy Assured Health Informatics

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Goals

- Develop research skills required for PhD. dissertation
  - Critical assessment of current state-of-the art
  - Develop skills for carrying out original research
  - Develop technical review and presentation skills
  - Develop writing proposal and planning research

Grading

- ## Presentation of assigned papers: 25%
  - Conference like presentation - prepare for questions
  - Prepare slides by Tuesday night for review

- ## Paper review: 25% (sometimes quiz)

- ## Class participation/Discussion: 10%

- ## Final project: 40% (<= 2/group)
  - Write a proposal (will use NSF guidelines)
  - Progress report (1-2) - Final write-up and presentation
  - I plan to organize a peer review process

Tentative Plan

- 6-7 Weeks
    - Presentations and reviews
    - Group Discussions

- 2 - 3 weeks
    - Interest Specific Presentation
        - Proposal and project definition
            - Reviews and Group/Subgroup discussions continue
            - Finalize project

- Review Panel

- Remaining time
    - Project work – Weekly progress report/presentations
   - Review continues

Focus Area

- **Security and Privacy in Health Information Systems**
  - Privacy sensitive data
    - Personalized healthcare is the future
  - Connected healthcare
    - Internet of Things, Mobile computing, ...
      - Medical devices interconnected to cyber infrastructure
        - Implantable devices
  - Health Informatics integration with Social Computing
    - Social Networks to support patients health and well being
  - Health Cloud & BigData issues
    - Huge volume of data to be stored / processed
  - Overall Management of Security and privacy
    - Regulations, Laws and Compliance issues

Let's begin by *Introductions*

- **Name and background**
  - Who is your advisor?
  - Security background? (Courses taken in security)
  - Research publication experience?

- **Research Interests and goals**
  - Theory? Practical?
  - System development and Experimental?

- **Proposal writing experience?**

- **Future goals? (Academia, Industry, Gov, ?)**

- **Any particular goal related to this course?**
  - Why are you taking it?
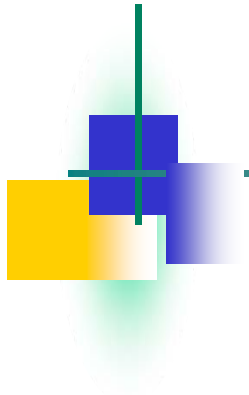
Some thoughts on …
Towards a PhD Degree

Towards aPhD degree – some thoughts

- Advisee + Advisor relationship
  - The most important !!!
    - Collaboration, Communication, Comfort
    - Mutual trust and expectations

  - Go after the professor for discussions – do not wait for him to call on you
  - Try to achieve milestones that you agree on
  - Never let go of a chance to engage in PROPOSAL WRITING
  - You will need each other for a long time afterwards !!

  - Do not say "I cannot do this" (atleast not too often ;-))
    - You will not be counted on when there is a really great opportunity

Towards a PhD degree – some advises

- **Do a lot of survey**
  - Maintain a brief note about each paper
- **Keep your mind open**
  - And don't neglect seemingly small problem
- **Be proactive and focus on creative thinking**
  - Taking risk may be an issue
  - "Problem identification and research vision"
- **Be prepared to mentor others (MS and PhD)**
  - Collaborate with fellow lab mates – joint work
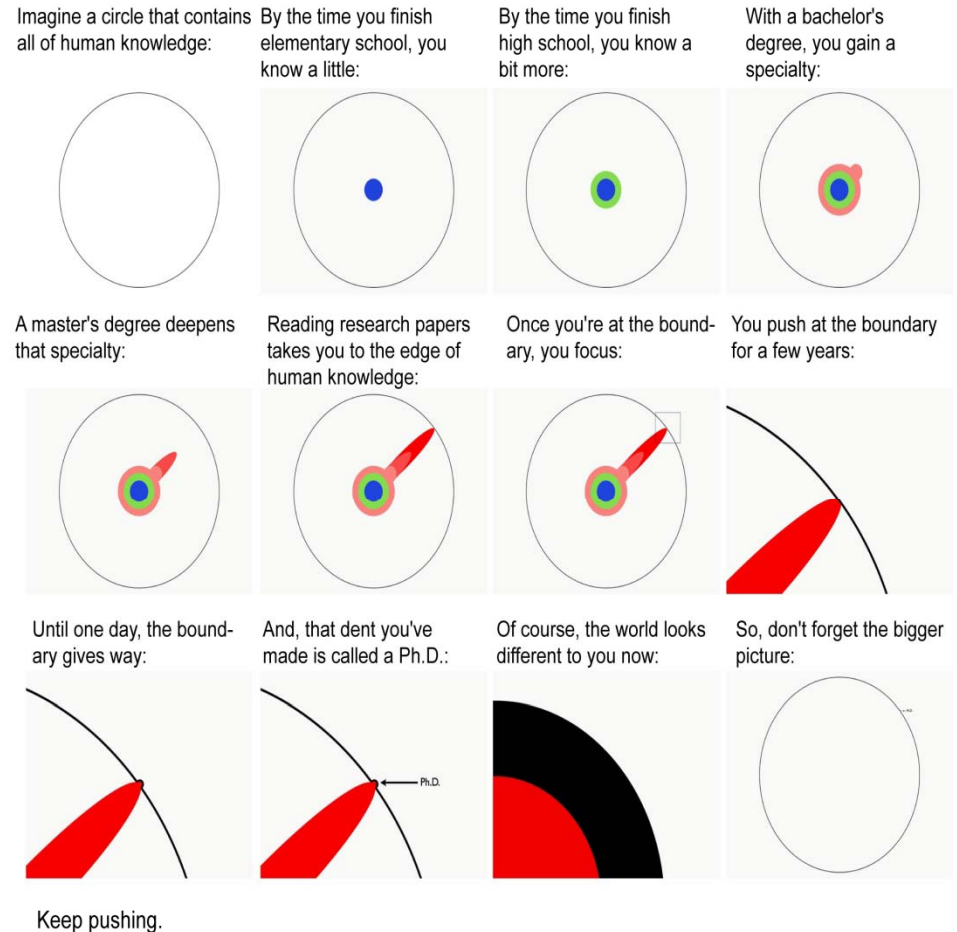 - Pipe line
- **Publish a lot !!**
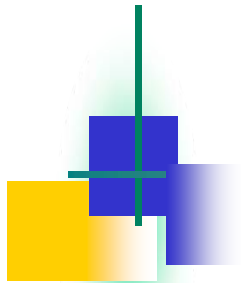
Towards a PhD degree ..

- Publish a lot .. of high quality conference/journal
  - Write your ideas from early on !!!
  - Do not easily discard small ideas / strange ideas
  - Do not leave an opportunity to write a paper
    - However short notice it might be !!
  - How to write: http://youtu.be/g3dkRsTqdDA
- Find a way to engage in proposal writing activity
  - When you are in field – there is no time to learn the art !!
  - Help with surveys and contribute ideas

Types of research: Some borrowed thoughts

- Contribute some new Knowledge !!
- Contributions should have some impact – immediate or long lasting !!
  - Positive citations and impact factor is looked at !!
- Trends and hot topics may change
  - Topic lifetime is crucial !!

Imagine a circle that contains all of human knowledge:

By the time you finish elementary school, you know a little:

By the time you finish high school, you know a bit more:

With a bachelor's degree, you gain a specialty:

A master's degree deepens that specialty:

Reading research papers takes you to the edge of human knowledge:

Once you're at the boundary, you focus:

You push at the boundary for a few years:

Until one day, the boundary gives way:

And, that dent you've made is called a Ph.D.:

Ph.D.

Of course, the world looks different to you now:

So, don't forget the bigger picture:

Keep pushing.

Borrowed from: https://kathrynluckett.files.wordpress.com/2014/04/illustrated-guide-to-a-phd1.jpg

Anytime, anywhere access to secure, Privacy-aware Healthcare Services: Issues, Approaches & Challenges

Mohd. Anwar, James Joshi, Joseph Tan

(Health Policy and Technology Journal)

Anywhere, Anytime Healthcare
Secure and privacy-aware

- **Enablers of this new paradigm**
  - E-health informatics
  - Sensor technologies
  - Mobile devices (including smart phones)
- Value added features
  - Monitoring devices and On-time intervention
  - Integrated Care
  - Self-care
  - Social Support

Monitoring devices and On-time intervention

- **Miniaturization of sensor devices + wireless**
  - "Remote monitoring cuts patient dealth by 45%" (Dept of Health, UK Report) – help intervene
    - Blood pressure, sugar, etc.
- **Monitoring beneficial for atleast**
  - Lifestyle and general well being monitoring
  - Chronic disease or condition management
    - Cardian arrhythmia, diabetes, ..
  - Clinical workflow mgmt
    - Telehealth, face-to-face care, in-patient care workflow, ..

Monitoring devices and On-time intervention

- **Health status monitoring device types;**
    - **In-body**: implantable devices
        - Pacemakers, defibrillators, neurostimulators (physiological conditions)
        - Wireless; implant reader receives data
    - **On-body**: wearable
   - Motion sensors, blood pressure meters
    - Additional monitory of environment is also important
        - Katz's ADL (Activities for Daily Living: bathing, dressing, toileting,..) – for Geriatic care (elderly patients)
- **RFID (Radio Frequency Identification)**
    - Can be used for monitory medical assets –
        - e.g., attach an RFID tag to an implantable device;
        - Use it to for device identification RFID reader can be in smart phone
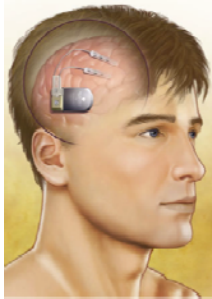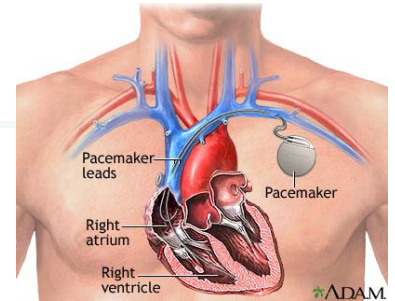
Integrated Care

- Typical patient treatment may involve
  - Physician → diagnostic lab → prescription
  - Physician need info generated by other care givers
    - Health records have info from several care givers; may relate to multiple diseases, ...
    - Maybe fragmented; dispersed across providers
    - COORDINATION is critical
  - Mobile lifestyle – services should be available
    - Integration needed :
      - Across the hospitals; cross-border, etc.
  - Nationwide health Information Network (NHIN)
    - Information sharing among federal agencies, hospitals, and doctors' offices

Integrated Care

Integration is key

- Consolidate healthcare services and workflow: horizontal & vertical integration
- Horizontal –
  - Among independent healthcare provides
  - e.g., integrate hospitals and nursing homes
- Vertical –
  - Combine/coordinate interdependent service providers
  - e.g., integrate primary care and specialty care

Self-Care

- **Self-care behaviors**
    - Seeking relevant health information and evaluation of options
    - Monitoring ones vital signs
    - Maintaining healthy lifestyle choices
    - Making informed decisions about one's health
    - Center piece of self management is: *Personal Health Record* (PHR) [may include Gene info in future]
- Decision support tools need to integrated with PHR
- Current PHR systems
    - Microsoft's Health Vault; The Patient Portal, MyChart, MyOscar
    - About 70M in US have access to PHR systems
- New Frontiers: SmartPhone Apps
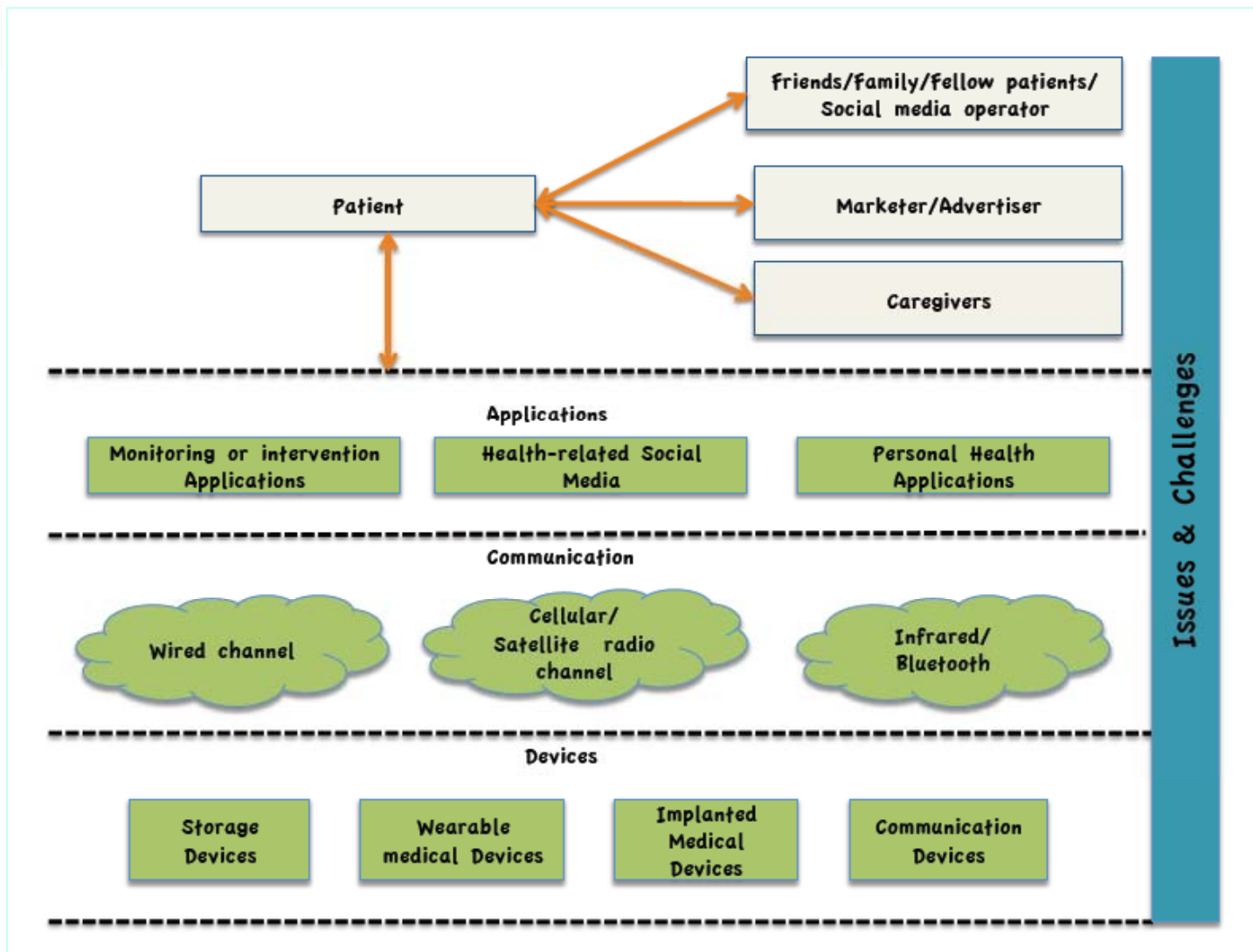   - BMI cal; RunKeeper, CDC Vaccine Schedule, SleepBot, etc.

Social Support

- ■ **Social connectedness/support**
  - ■ Provides mechanisms to help in health & wellbeing
    - ■ Collective sharing (patientslikeme.org)
    - ■ BodySpace – social fitness and weight-loss app
    - ■ Need to be careful about misinformation !
  - ■ Healthcare social network is on the rise
    - ■ Relevant research at LERSAIS:

      LEAF for IPV survivors (Intimate Partner Violence)
      - ■ Community of: Care providers, friends/family, legal and social entities, mentors (survivors)
      - ■ Privacy is key

      (Talk to Prof. Palanisamy and Me)

  YouTube: https://www.youtube.com/watch?v=YfsRJWgwncU&feature=youtu.be

Security and Privacy Issues/Challenges

		Issues	Security problems	Approaches	Challenges
Legacy / Mobile / Cloud Infrastructure	**User Plane** Demographics, Health condition, Physical ability, Mental ability	Demographic profiles and physical & mental abilities of patients are not the same.	- Attacks using non-technical and unintentional vulnerabilities - Targeted attacks on patients with certain characteristics	Human and social factor analysis	- Rich & diverse privacy & security requirements - Security solutions are challenged by human and social factors
	Application Plane EMR, Tele-Health apps, Personal Health Apps (PHR mgmt, tracking), Health-related social media (OSN, VC)	- Health records are fragmented and dispersed in many facilities - In Tele-Health, a mosaic of applications work with each other, creating a highly collaborative environment - Personal health apps collect extraneous personal info - Quality of information in social media is highly variable	- De-anonymization and inference attacks by linking different data trails - Many possibilities of unauthorized access and identity theft - Social engineering attacks cripple social support systems	- Testing and certification - Design-by-contract - Principle of least privilege - Access control - Data Masking - Cryptographic protocols - Education and training	- Closed systems are hard to analyze - "Break the glass" situations circumvent access control - Cryptographic solutions are computationally intensive and not flexible - "Big data" challenges protection mechanisms
	Communication Plane Wire (copper, coax, fiberoptics, etc.), bluetooth/Zigbee, Satellite/Cellular radio, Infrared wave	- Sensitive patient information is transmitted over public Internet - From monitoring devices to EHR, data travels through multiple vulnerable communication modalities - Wireless communication may cause electromagnetic interference to medical devices (disruption)	- Denial of service impacting monitoring, integrated care, self-care, and social support - Breach of confidentiality of patient info due to tapping or emanation - Loss of data integrity causing erroneous monitoring & wrongful intervention	- Virtual private networks - Intrusion detection - Message authentication - EMI testing	- Wireless, Ad-hoc and opportunistic networks are naturally vulnerable - Cryptographic solutions are computationally intensive and not flexible - Tele-health and emergency care rely on on-time data transmission
	Device Plane Embedded/wearable Medical Devices, Mobile/ Smartphone, Application Hosting Devices, Storage Devices	- Medical devices are resource-constrained - Implanted devices are sensitive to modification - Wearable devices are easily exposed, prone to interference - Healthcare providers have little or no control over the 3rd party cloud infrastructure	- Prone to sleep deprivation attacks - Attacks on patients' physical safety - Offline hardware attack - Failed or compromised devices impacting integration, self-care, and social support	- Device encryption - Fail-secure device design - Device-level access control	- Hardware is hard and expensive to analyze - Unrealistic trust on cloud provider & auditing in cloud is challenging - Researchers have limited or no access to device hardware and firmware

Epilepsy attacks
Phishing

Capture device id, location, demographic

Summary

- **Security HealthCare IT Environment**
  - S&P Issues from various domains/levels
  - IoT – medical devices – adds to safety issues
  - HealthCloud
  - Health SN
    - Cyber Physical Social systems environment