Internet of Things

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Let’s get to know each other....
Introduction

- Course website: http://www.ittc.ku.edu/~aveekd/EECS700_Spring16/index.html
- Blackboard - https://blackboard.ku.edu/
  - Use blackboard for HW and project submissions
  - Communications and discussion groups
- Special Topics - no Textbook
  - I will define the scope and you choose how much you want to learn
  - Some reference books are in class website. Lecture slides are adapted from these books
- Largely a self-taught / self-exploration course - Highly interactive
- Relies on EECS 563 material - will be reviewed, although very briefly
  - Previous offerings - http://www.ittc.ku.edu/~aveekd/EECS563_Fall15/EECS563_Fall15_index.html
- Academic Integrity and Plagiarism
Course Goals

- Understand what makes Internet of Things (IoT) unique and interesting to study
- Prepare yourself to articulate the nuances of IoT to the outside world
  - What are components of IoT and how are those related
  - Gauge the spectrum of applications and their properties
  - Also understand what IoT is not about
- It is really a problem solving class
  - You define your problem, propose a convincing solution and defend your work
- Expose you to some of the tools and techniques widely used in IoT domain
  - Opportunity to learn things that you wouldn’t have learnt otherwise
- Prepare for jobs, grad school, entrepreneurship, etc.
Course Structure

- Week 1 - Intro and Week 15 - Fun stuff, TBD
- 4 weeks on each topic containing 3 lectures (MWF):
  - IoT Applications, Networks Architecture, Protocols, Business models (Weeks 2, 5, 9, 12)
  - IoT Sensors, Devices, Programming, Prototyping (Weeks 3, 6, 10, 13)
  - IoT Analytics, Data Sciences, Visualization (Weeks 4, 7, 11, 14)
- Three guest lectures (sometime during weeks 5, 9, 13)
  - IoT Standards and Devices (Mitch Troppe - Garmin)
  - Indoor localization (Prof. Dola Saha @ Rutgers/ITTC)
  - IoT Security (Prof. Fengjun Li @ KU/ITTC)
- Mid-term presentations on Week 8
This course is not about ..........

- Networking principles (EECS has 13 courses)
- Communication and Signal Processing (EECS has 11 courses)
- Programming (EECS has 9 courses)
- Statistics, Data Science (EECS has 3 courses, Many more in Math and Statistics)
- Other - Database, Cloud Computing, Embedded systems

This course is about utilizing all of the above branches of knowledge to build intelligent systems. The topics covered in this course should encourage you to pick any of these paths and explore in further depth. Use this course as a launching pad for something BIG.
Course Deliverables

- A project defined by you or pick one from the choices provided
  - Project executed in groups of “Three”, “Two” or “One”
  - Submit a project idea report and mid-term progress report along with very short presentation
  - Final submission includes report and in-class presentation (on the date of Final Exam)

- Homework - assigned every two weeks
  - TWO homeworks each on IoT Paper summary or survey report, Analytics and Android

- I will grade based on the “effort” put in by each student
  - Quality of work, attendance, class participation and excitement about IoT are strong indicators of effort and that will be reflected on grade.

- Instructor expectation - Lots of enthusiasm and don’t be lazy, carefree or casual
Grading

- Project - 50 pts
  - Idea (how it touches 3 areas of Networks, Sensors and Analytics) - 20
  - Writing - 15
  - Application, Results and Visualization - 15
- Homework - 20 pts
- Project Presentation and Demo (if required) - 20 pts
- Attendance and Class Participation - 10 pts

*Expectation and quality bar is higher for graduate students*
Project Guideline

- Everyone will be given a Nexus 5X phone (for the semester only)
  - Checkout from the EECS store. Feel free to add any other hardware or software (talk to me first)

- Start thinking about ideas from now - PROPOSALS ARE DUE - Friday, Feb 12
  - Talk to me if required, bounce ideas with teammates for insightful, non-trivial ideas.
  - Project **must** demonstrate the following:
    - What makes the project a component of Internet of Things?
    - You’ve learnt to utilize sensors in Android phones and record physical events
    - You’ve learnt methods to analyze and visualize the data to build intelligence
    - You’ve learnt to write a professional technical report and defend your work
  - The project should add to your existing knowledge

- Ideally should include an Android APP (or a simple UI)
  - Humans are the bridge between the Cyber and the Physical world (until we have AI)
Project Report Guideline

- Use **LaTeX** for report for full points on writing
  - Title page (include your name and student number)
  - Table of contents
  - Abstract
  - Introduction
    - Describe what you are trying to do; Pose it as a problem statement
    - Describe the motivation; who is interested in the solution
    - Summarize the main results and their significance
  - Narrative
    - Methodology: overview of methods used, including associated theory, system model, block diagrams, and/or system parameters as appropriate
    - Discussion of results, plots, screenshots, tables etc.
  - Related work and Citations (very important)
  - Conclusions and lessons learned
- Basically, provide strong answers to **Heilmeier Catechism**
- Examples of good reports - [Link1], [Link2]
Project Ideas - My wishlist

● Blockchaining the IoT
  ○ Use the now-famous Blockchain algorithm used in Bitcoin to build secure IoT applications

● Multihop airborne wireless adhoc network for video streaming
  ○ Use phones (3 or more), mounted on drones to stream real-time video over multiple hops
  ○ Starting point - [http://tinyurl.com/yrxgz6](http://tinyurl.com/yrxgz6)

● Network migration using VPN (replica of Google Fi with deeper analytics)
  ○ Starting point - [https://fi.google.com/about/faq/#network-and-coverage-1](https://fi.google.com/about/faq/#network-and-coverage-1)

● Spectrum sensing using ZedBoard/USRP SDR and mobile phone
  ○ Wardriving, Crowdsourced Radiomaps (or signal strength along with some other contextual data)
  ○ Starting point - [http://tinyurl.com/z23x9pc](http://tinyurl.com/z23x9pc)
Project Ideas - My wishlist

● Monitoring human brain with OpenBCI, OpenVibe
  ○ Use Android phone to run analytics of EEG signals
  ○ Starting point - http://dl.acm.org/citation.cfm?id=2799659

● Arduino based sensing and prediction
  ○ Use sensor kit to gather variety of data and produce correlation, clustering etc.
  ○ Starting point - http://tinyurl.com/gt3wzap and http://tinyurl.com/ht49k2k

● Some cool gesture/gait/movement controlled application
  ○ Starting point - http://tinyurl.com/bsyr5ur

● Location based augmented reality
  ○ Why open Yelp for reviews - make it proactive, intuitive, context aware notifications
Generic Ideas

- Projects based on software development only without the use of any external hardware (Virtualization, SDN, Cloud based services)
  - Few starting point - Ethereum, Smart Contracts, ORI

- Other places to look for impactful work (research):
  - [http://www.iswc.net/iswc15/program/accepted-papers.html](http://www.iswc.net/iswc15/program/accepted-papers.html)
  - [http://ubicomp.org/ubicomp2015/program/accepted-papers.html](http://ubicomp.org/ubicomp2015/program/accepted-papers.html)
  - [http://mobihealth.name/2015/show/program-preliminary](http://mobihealth.name/2015/show/program-preliminary)

- Avoid designing games unless it has the three core elements
Don’t like what you see…

Pitch your own project idea as long as it fits the scope defined in Slide 8. It is absolutely okay to work on topics that will help you to progress in your career or may augment your thesis, projects, papers, job search etc. Cross-disciplinary work is always encouraged as it can be challenging and fun.

Now, let’s move on to the rest of the course…
Course Outline - Networks

- **Part 1 - What’s new about IoT networks**
  - IoT Taxonomy - technology domains, business models
  - Applications - Smart Cities, V2X, Smart Home, Mobile Health, Smart Grids

- **Part 2 - Physical and MAC layers for IoT and M2M**
  - 802.15, PowerLine, ZigBee
  - Low Power protocols - 6LoWPAN, Zigbee Smart Energy 2.0, M2M architecture

- **Part 3 - Introduction to Cloud Based services**
  - Software Defined Networking, Virtualization, Clouds and Fog

- **Part 4 - Prototyping and Entrepreneurship**
  - Hardware, Software, Business models, Ethics
Course Outline - Things

● We will focus on sensors in mobile devices
  ○ Goal - Invoke sensors and acquire data from physical world using Android SDK

● Part 1 - Location Services - GPS, Indoor Positioning, Context, Augmented Reality

● Part 2 - Inferring Information From Physical Sensors

● Part 3 - Sensing the Pattern-Rich External World

● Part 4 - Speaking to Android, Fingerprint
Course Outline - Analytics

- Process information to build intelligence and represent data
- Part 1 - Introduction to Data Science and information lifecycle
- Part 2 - Data analysis using R, R-studio and Visualization
- Part 3 - Clustering and Regression
- Part 4 - Classification and Time-series analysis