INTELLIGENCE OF THINGS

CSCI 7000-005/6
TUE/THU @5:30PM,

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Today’s goals

- Discovery: learning about each other (Family, Occupation, Recreation, Motivation)

- What is Pervasive Personalized Intelligence?
- Examples of Research themes on IoT

- How can I be successful in CSCI 7000-005/6?
Family
Change is the heart of software development

Programming is program transformation

Q1: **Analyze** what software changes occur in practice?
Q2: How can we **automate** them?
Q3: Can we **represent** programs as transformations? **Archive**, **retrieve**, and **visualize** them?
Q4: Can we **infer** higher-level transformations?

Automated changes in (i) upgrading library APIs, (ii) convert sequential to parallel code, (iii) improve responsiveness in mobile
Work in Your Strength Zone but Reinvent Yourself

Mobile ['13 - '18]
- add async
- fix async
- privacy

Parallelism & Concurrency ['08-'13]
- make thread-safe
- improve throughput
- improve scalability

Library migration ['02-'07]
- upgrade APIs

IoT and ML ['19– TBD]
- from deterministic to probabilistic

Principles for changing between different programming models
Refactoring

What is Your Dream?
Mine is Practical Impact on SW Development

Automating
- ship with official
- hundreds of accepted patches
- first open-source refactoring

Inferring
- used at Google
- dozen labs

Understanding
- shaped APIs in Java
- .NET official concurrency libraries

Testing
- learnparallelism.net
150,000+ visitors

Refactoring Workshop on Refactoring Tools, HotSwUp, Dagstuhl S.
Recreation
On Aug 5, 2015 …

From personal success to significance

From a ladder climber to a ladder holder
Quiz #1: About YOU

- Write down your name
- **FORM** (family, occupation, recreation, motivation)

- **Grad Program** (e.g., CS PhD, MS, etc.), year of study, who is your grad advisor

- Your **background** (e.g., industry experience, other CS background – such as strong ML, Systems, IoT, SE, etc.)

- What is the ONE Thing that you **expect** to take out of CSCI 7000-005/6?

- What are your plans **post graduation**?
What are your expectations from CSCI 7000-005?

A. How to communicate technical material to outsiders
B. ..
C. ..
D. …
E. …
F. ....
Theme: IoT

IoT revolution: digitization & connection of everything

In 15 years, smart infrastructure estimated to become $59T market

Q: What do you envision as some Killer Feature for IoT?
Q: What are the Killer Features for IoT?

K1: ...
K2: ...
K3: ...
K4: ...
K5: ...
K6: ...
K7: ...

Boulder
Q: What are the Killer Features for IoT?

Smart home:
- managing the home (monitoring energy and resources), scheduling family activities, housekeeping (auto-replenish consumables, cleaning, pet feeding), health monitoring (assistive care)

Smart City:
- transportation (find parking), environmental monitoring of pollution, manage resources (control street lighting), enhances perception of city activities (e.g., sporting events)

Smart Manufacturing:
- virtual chief foreman assisting managers
From IoT 1.0 to 2.0

V 1.0: sensors and actuators to collect data

V 2.0: augmenting our intelligence with knowledge to expedite decision-making, everyday activities, and processes
Center on Pervasive Personalized Intelligence

http://ppicenter.org
Listening to Industry during Discovery Visits
Pervasive Personalized Intelligence (PPI)

Connecting everything for remote monitoring and service

From Reactive to Predictive Analytics:
- Smart Energy: safe energy mode for e-cars
- Precision Ag: predict diseases, harvest
- Industry 4.0: preventive maintenance

Pervasive to the Edge

Personalized
Research Thrusts and Capabilities of PPI

- Smart City
- Smart Food
- Smart Home
- Smart Office
- Smart Manufacturing
- Smart Health & Fitness
- Precision Ag
- Smart Retail
- Shipping & Logistics

- Programmability
- Security & Privacy
- Human Users
- Energy-aware
- Data Science
- Edge Computing
Value that PPI Center brings to you, students in CSCI 7000-005/6

Connecting you with movers and shakers in IoT:
- access to thinking partners from industry
- broadens your perspective

Networking opportunities: internships, jobs

Practical impact for your projects:
- gives you a chance for significance, not only personal success
Check webpage:
https://danny.cs.colorado.edu/courses/csci7000-005_F21/

Work items due Thu (Aug 26):
- Familiarize with class webpage
- sign up on Piazza (all communications through Piazza, no email after this week)
- Read and write a critique for a research paper (see template on webpage)

Check prereqs: computing background (either practical experience or undergrad-level knowledge of SE, Systems, ML), please check with me after the class
Research-based course:
- at times it would feel it is not "organized"
- there are lots of choices, you need to select
- structure is fixed, but content is dynamic

Complete a research or industrial-novel project of your choice (teams of 2-3 students)
- follow the steps of open-ended/risky research (proposal, fit in literature, evaluate empirically)
- at the end of the term you would have produced a research paper that you can submit to conference

- WHY: equips you to conduct novel R&D
CS 7000-005/6 is Different!!!

Participate in class discussion and activities.

Read 1-2 research papers for every class meeting (11 pages each, double column => total of 500+ research pages)
  - later on, you choose papers that match your project
  - 1 book chapter /week (Put Your Dream to the Test)

Paper Critiques: for each class meeting, for each research paper, submit before class (by 11:59pm previous day)
  - WHY: equips you with critical thinking

Research presentation: you prepare and deliver for the selected research papers
  - WHY: equips you to communicate your ideas
Projects Focus on IoT-related topics

For new grad student, project gives ideas for dissertation

For experienced PhD student, project advances your research

Technological shifts/opportunities for IoT:
- constraints on memory/CPU/bandwidth/battery usage
- connectivity with the cloud
- rapid evolution of the platform
- reliance on ML/AI solutions

Industrial-innovation: availability of rich data from sensors (e.g., dataset from City of Denver)

Research projects (not an app), teams of 2-3 people
Example Transformations for IoT

What are the new transformations we need to automate?
- inspiration from explorative studies
- empirical studies to find performance or energy anti-patterns

Examples of transformations:
- candidate programs with trade-offs between performance & power consumption
  - adaptation to different display technologies
  - split functionality between the device and cloud
CS 7000-005/6 is Different! Lots of Guests

Interviews with C-level executives from PPI Center:
- e.g., Jason Shepherd, CTO of Dell Technologies
- Bob Wold, VP of Trimble
- Rahul Khanna (Lead ML architect Intel IoT Group)

Live from IoT World 2021 (Nov 2nd and 4th)
- Broadcast of keynote speakers
- Interviews with people on the booths

Faculty:
- E.g., Tom Dietterich, father of the ML field, ACM Fellow
1-hour Group Discussion

Soft Skills: leadership, creating a vision and plan for accomplishing

WHY: Soft Skills make a greater Difference in life than “Hard Skills”

WHAT: Take your dream through 10-step process to see, own, reach it

HOW: learning environment in a roundtable format