CIS4930/6930 Special Topics in Mobile Networking (Network Analytics and IoT)
Instructor: Prof. Ahmed Helmy
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- Instructor office hours: virtual. Tues. 10:30am-11:30, Wed. 12:00-2:00am [sign up via email for office hour slots for a virtual meeting]
  [Note: office hours subject to change due to travel, faculty meetings, etc. Updates will be posted on the class website reflect such change.]
- Lecture meeting place/time: virtual, Tues. 8:30-10:25am, Thur. 9:35-10:25am
- TA: TBA.
- TA office hours: TBA.

- ***Goals/Objectives:***

The purpose of the course is to expose students to emerging networking protocols and technologies in the field of wireless mobile networks, with focus on Internet-of-Things (*IoT*) networking, mobile network measurement, mobility modeling and data analytics, connected vehicles, and mobile applications (apps). It also involves semester-long projects by groups of students to identify challenging problems in mobile networked applications and services through extensive reading and discussion, to propose solutions to those problems, then conduct high quality projects (through extensive simulations, analysis and implementation) to produce a term project report, and a mobile application that is the final product of their work.

More precisely, the objectives of this course are for the students:
- To acquire hands-on experience of wireless and mobile networking technologies. To experiment with state-of-the-art networking technologies and tools that enable students to diagnose and perform measurements on a mobile device or network.
- To get involved in projects on advanced topics in Internet-of-Things (*IoT*) as a general concept, including mobile ad hoc and sensor networks (*MANets*, *VANETs*, *DTNs*), and be able to present and write high quality technical reports on protocol design, analysis, simulation and implementation.
- To be part of a team and to tackle challenging problems in a semester-long project. To suggest solutions to these problems and to be able to demonstrate the feasibility and performance of the solution.
- To learn how to read and review publications in the wireless networking field from selected journal articles and conference proceedings.

- ***Course description:***

The overarching theme of this course is the systematic approach to understanding emerging mobile networking technologies, as pertains to measurement, analysis, mining, modeling, design and implementation of future mobile services and applications.

Topics covered: Emerging peer-to-peer and infrastructure-less mobile technologies, Internet-of-Things (*IoT*), mobile device and smartphone measurements, mobility modeling, mobile social networks, data-driven modeling and design, mobile adhoc and sensor networks, adhoc and geographic routing, mobile resource discovery, trust and privacy, participatory/opportunistic sensing and mobile crowd sourcing, case studies for development of networked app services and its analysis, vehicular networks and opportunistic delay tolerant networking (*DTN*).

Major term project required.

Skills acquired in this class should emphasize and supplement deep understanding of protocol and network behavior. Students develop and enhance their understanding of the basics of wireless networking, mainly at the network layer and above, the behavior of the fundamental and evolving network protocols (e.g., ad hoc routing protocols, geographic routing, among others). Students also study that the network behavior is a collective behavior of all such protocols (and others), their interaction among themselves, and with the 'faulty' and dynamic network environment. By integrating network dynamics, such as packet losses, link/node failures and mobility, and through diagnostic and measurement tools, students study and analyze the effects of various network conditions on the overall behavior of the network.

Such deep practical understanding, along with strong analytical skills, are essential for future networking research and industry, that would greatly help in understanding today's networks, and designing networks of the future.

The lecture series starts by a set of lectures on fundamentals of mobile ad hoc networks, mobility models, wireless network measurements, network analysis and mining, data-driven modeling and design, trust and privacy, geographic routing, location based services, *DTN* routing, mobile resource discovery, mobile social networks, and hierarchical architectures for peer-to-peer mobile networks. This is followed by lectures on challenges and research directions in those fields, in addition to mobile platform programming and application development. During those initial weeks the students will form project and experiment groups, and every group gets to choose a topic to formulate a problem for the project. Also, each group is assigned a project presentation and demo slots. The weeks that follow cover specific topics and problems based on lists of readings (provided by the instructor and proposed by the students) and based on the projects progress. The last lecture of class usually includes slots for students to demo their projects and results.

Project: The term project has four main milestones: (1) an initial project proposal (~2 pages) due around the first ¼ of class, (2) a final project proposal (3~4 pages) due around the mid point of the semester, (3) an initial draft of the project report (~8 pages) due around the ¾ point of class, and (4) the final project report (~12 pages) due during the last lecture.

This course relies heavily on students' own effort and experimentation. It is a hands-on course where assignments and experiments are conducted by the students. The students are also involved in working in teams on a semester project.

- ***Pre-requisites:***

   In general, very good knowledge of fundamentals of computer networks is required. In addition, very good programming skills are also a requirement, along with knowledge of operating systems (e.g., Unix/Linux, Android). Knowledge of network simulation (e.g., using a network simulator such as *NS*, *Glomosim/QualNet, SUMO*), in addition to data analytics skills can be a plus.

   Specifically, the pre-requisite courses that are *very strongly recommended* (with good standing) before this course include: computer networking, or computer communications course (undergrad level for undergrad students, and graduate level for grad students).

Format: the normal format for this class is synchronous on-line lectures/classes. Attendance will count. If you cannot make it to class for a medical or emergency reasons, please send me email describing and supporting your situation. Occasionally, lectures will be recorded ahead of time, and posted for the students to see. Students should view these lectures before class time, then attend class to ask questions and contribute to the class. Also, synchronous lectures/classes will be recorded as needed, so if you do not want to be recorded please turn off your camera or let me know.

- Assignments and experiments:
Students perform experiments on measurements of mobile networks; for example access and mobility patterns, or signal power strength, throughput, and delays of a wireless network using handheld PCs or laptops connected to base stations around the University of Florida campus.
Depending on suitability, students may also perform experiments for ad hoc routing in a multi-hop wireless network and experiments for a network of wireless sensor nodes/motes. Large-data libraries will be made available for network analytics, using statistical and sometimes machine learning analysis.

Examples of experiments/assignments include: (to be determined on a per-class basis)
- Inference of mobility models and characteristics based on analysis of network access patterns for various users and buildings (access points) on campus.
- Simulation of vehicular mobility in a city using SUMO/OMNET++/VEINS, and analysis of shared transportation and other mobility services.
- Drawing a wireless coverage map and measurements (cross validation through various measurement techniques, GPS, encounters, etc.)
- Encounter based networks (discovering devices, building ad hoc net, increasing the coverage of the wireless net, using static or mobile nodes, etc.)
- The 'socializer' experiments: establishing friendship and interest group links in mobile societies (through analysis of traces, mobile device experiments, surveys, etc.)

- Simulation of disaster scenarios and establishment of networks for the relief and search/rescue missions.

The over-arching themes for the class for the project and experiments will be: - mobile social networking, location-based services, mobile health, mobile education, and disaster relief or emergency management. Emphasis should given to projects on timely projects, such as encounter analytics for epidemic contact tracing,

The experiments are carried out in groups of '~4' students with combined reports. Each individual should understand and be able to perform the experiments on his/her own (there may be random pop quizzes to test this ability). Students will also be required to design parts of new experiments. The students will also be asked to write reviews for papers that will be presented in class.

- Student responsibilities:
  - Attendance, class discussions, weekly reviews, paper readings
  - Participate in two presentations: topic presentation, project presentation
  - *High quality* final project report and demo
  - Team work, assignment and experiments evaluation

Instructions for the project proposal and report will be posted on the web in as much detail as possible. Similarly, instructions for performing experiments and samples of reviews will be posted.

- Grading:Class participation (attendance, discussion) and 4 paper reviews (15%)
  Experiments and assignments (~2 experiments) (20%)
  Project and Presentations (65%):
    - Topic presentation (15%)
    - Project presentation & demo (20%)
    - Written Proposal, Report, Demo (30%)

- Readings/books:
  Lightly Recommended (but not required) Book: Ad Hoc Networking, edited by Charles Perkins, Addison Wesley, 2001, ISBN 0-201-30976-9.

  Some related websites:
    - For updated links and news visit http://www.cise.ufl.edu/~helmy
    - MobiLib (Community-wide Library of Mobility and Wireless Networks Measurements): http://nile.cise.ufl.edu/MobiLib/ (or nile.usc.edu/MobiLib)
    - The VINT project; NS (Network Simulator) and NAM (Network Animator): http://www.isi.edu/nsnam/vint
    - The TVC and profile-cast websites through A. Helmy's website.

  Other related reading materials, in terms of conference papers, journal articles, and book chapters will be available through the class website. There will be a reading list for this class.

- ***Note:***
  - \- Starting summer 09 UFL has introduced the '-' in the letter grades (A-, B-, C-, D-) in addition to the previous ones. Please visit the following website for more information:
  - http://www.registrar.ufl.edu/catalog/policies/regulationgrades.html
  -
  - \- For more information on grades and grading policies, please visit:
    "https://catalog.ufl.edu/ugrad/current/regulations/info/grades.aspx"

Students Requiring Accommodations

Students with disabilities requesting accommodations should first register with the Disability Resource Center (352-392-8565, https://www.dso.ufl.edu/drc) by providing appropriate documentation. Once registered, students will receive an accommodation letter which must be presented to the instructor when requesting accommodation. Students with disabilities should follow this procedure as early as possible in the semester.

Course Evaluation

Students are expected to provide professional and respectful feedback on the quality of instruction in this course by completing course evaluations online via GatorEvals. Guidance on how to give feedback in a professional and respectful manner is available at https://gatorevals.aa.ufl.edu/students/. Students will be notified when the evaluation period opens, and can complete evaluations through the email they receive from GatorEvals, in their Canvas course menu under GatorEvals, or via https://ufl.bluera.com/ufl/. Summaries of course evaluation results are available to students at https://gatorevals.aa.ufl.edu/public-results/.

University Honesty Policy

UF students are bound by The Honor Pledge which states, "We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honor and integrity by abiding by the Honor Code. On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied: "On my honor, I have neither given nor received unauthorized aid in doing this assignment." The Honor Code (https://sccr.dso.ufl.edu/policies/student-honor-code-student-conduct-code/) specifies a number of behaviors that are in violation of this code and the possible sanctions. Furthermore, you are obligated to report any condition that facilitates academic misconduct to appropriate personnel. If you have any questions or concerns, please consult with the instructor or TAs in this class.

Commitment to a Safe and Inclusive Learning Environment

The Herbert Wertheim College of Engineering values broad diversity within our community and is committed to individual and group empowerment, inclusion, and the

elimination of discrimination. It is expected that every person in this class will treat one another with dignity and respect regardless of gender, sexuality, disability, age, socioeconomic status, ethnicity, race, and culture.

If you feel like your performance in class is being impacted by discrimination or harassment of any kind, please contact your instructor or any of the following:
• Your academic advisor or Graduate Program Coordinator
• Robin Bielling, Director of Human Resources, 352-392-0903, rbielling@eng.ufl.edu
• Curtis Taylor, Associate Dean of Student Affairs, 352-392-2177, taylor@eng.ufl.edu
• Toshikazu Nishida, Associate Dean of Academic Affairs, 352-392-0943, nishida@eng.ufl.edu

Software Use
All faculty, staff, and students of the University are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against University policies and rules, disciplinary action will be taken as appropriate. We, the members of the University of Florida community, pledge to uphold ourselves and our peers to the highest standards of honesty and integrity.

Student Privacy
There are federal laws protecting your privacy with regards to grades earned in courses and on individual assignments. For more information, please see: https://registrar.ufl.edu/ferpa.html

Campus Resources:

Health and Wellness

U Matter, We Care:
Your well-being is important to the University of Florida. The U Matter, We Care initiative is committed to creating a culture of care on our campus by encouraging members of our community to look out for one another and to reach out for help if a member of our community is in need. If you or a friend is in distress, please contact umatter@ufl.edu so that the U Matter, We Care Team can reach out to the student in distress. A nighttime and weekend crisis counselor is available by phone at 352-392-1575. The U Matter, We Care Team can help connect students to the many other helping resources available including, but not limited to, Victim Advocates, Housing staff, and the Counseling and Wellness Center. Please remember that asking for help is a sign of strength. In case of emergency, call 9-1-1.

Counseling and Wellness Center: http://www.counseling.ufl.edu/cwc, and 392-1575; and the University Police Department: 392-1111 or 9-1-1 for emergencies.

Sexual Discrimination, Harassment, Assault, or Violence

If you or a friend has been subjected to sexual discrimination, sexual harassment, sexual assault, or violence contact the **Office of Title IX Compliance**, located at Yon Hall Room 427, 1908 Stadium Road, (352) 273-1094, title-ix@ufl.edu

Sexual Assault Recovery Services (SARS)
Student Health Care Center, 392-1161.

University Police Department at 392-1111 (or 9-1-1 for emergencies), or http://www.police.ufl.edu/.

Academic Resources

E-learning technical support, 352-392-4357 (select option 2) or e-mail to Learning-support@ufl.edu. https://lss.at.ufl.edu/help.shtml.

Career Resource Center, Reitz Union, 392-1601. Career assistance and counseling. https://www.crc.ufl.edu/.

Library Support, http://cms.uflib.ufl.edu/ask. Various ways to receive assistance with respect to using the libraries or finding resources.

Teaching Center, Broward Hall, 392-2010 or 392-6420. General study skills and tutoring. https://teachingcenter.ufl.edu/.

Writing Studio, 302 Tigert Hall, 846-1138. Help brainstorming, formatting, and writing papers. https://writing.ufl.edu/writing-studio/.

Student Complaints Campus*:
https://www.dso.ufl.edu/documents/UF_Complaints_policy.pdf.

On-Line Students Complaints*: http://www.distance.ufl.edu/student-complaint-process.