CS798

Modern Network Protocols and Applications

Instructor

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About Instructor:

Professor Ammar is visiting the School of Computer Science as a Dean's Distinguished Visiting Professor for the Fall 2022 Term. His academic home is the School of Computer Science at Georgia Tech. He is a Waterloo Ph.D. Alum. You can find more about him here http://www.cc.gatech.edu/~ammar

Prerequisite

- A previous introductory networking course (could have been taken anywhere and does not have to be recent)

Course Information

This is a "second" advanced course in networking. We will cover a broad spectrum of advanced topics in networking, building on basic knowledge you acquired in a basic introductory course. The goal is to provide exposure to modern network architectures, protocols and applications.

The course is based on a popular course taught by Professor Ammar at Georgia Tech which typically enrolls over 100 students every time it is offered. The material in the course has helped students in furthering their career prospects at top tech companies. The material can also serve as a springboard for further research in networks and systems. You can find one review of Professor Ammar's teaching here https://www.reddit.com/r/gatech/comments/rsfvtj/appreciation_post_for_the_profs/

We plan to cover the following units (2-3 weeks each) (see Detailed Outline and Schedule at the end of this document)

1. Interdomain Routing,
2. Modern Congestion Control
3. Advances in Transport Protocols
4. Video Over the Internet

This term we will be using Piazza for class discussion. The system is highly catered to getting you help fast and efficiently from classmates, the TA, and myself. Rather than emailing questions to the teaching staff, I encourage you to post your questions on Piazza. If you have any problems or feedback for the developers, email team@piazza.com.

Find our class signup link at: https://piazza.com/uwaterloo.ca/fall2022/cs798

Readings

The class does not have prescribed textbook. Most of the material that we will cover is not covered in depth in any textbook. ***Reading material will be provided online as the course progresses.***

The following textbooks are very useful as a reference for background material.

- J. Kurose and K. Ross, Computer Networking, A top down approach featuring the Internet

  Tip: You can find very inexpensive older editions of this book online. A 3rd, 4th or 5th edition is perfectly fine as a reference.
- Computer Networking : Principles, Protocols and Practice, 2nd edition by Olivier Bonaventure https://www.computer-networking.info/2nd/html/ (open source and free)

HWs, Projects, Tests and Grading

There will be

- 2 HW assignments
- 2 Projects (May involve some programming)
- 2 Tests (one around mid-term and the other during last day of classes) No Final.

Grading

- HW 1, 2: 15% each
- Projects 1, 2: 20% each
- Tests 1, 2: 15% each

Regrading and Late Policy

HWs, and projects will be due online at 11:59pm on the date specified. There is a 1-hour grace period after that where late submissions will not incur a late penalty. Submissions that are 1 to 24 hours late will incur a 20% penalty and submissions that are 24 to 48 hours late will incur a 50% penalty. No submissions will be accepted more than 48 hours late.

Regrade requests should be submitted no later than one week from the time the grade is announced. Please

Detailed Outline

- Introduction
    - What is the Internet and what holds it together?
- Advanced Internet Routing
    - Routing Architecture
    - The structure and evolution of Inter-domain Routing
    - The Border Gateway Protocol (BGP)
- Modern Internet Congestion Control
    - History and Evolution of Congestion Control
    - Congestion Control for Fast Networks
    - Modern Schemes: BBR, GCC
- Advances in the Transport Layer
    - Transport Innovation Challenges
    - Multipath TCP (MPTCP)
    - QUIC
- Video over the Internet
    - Adaptive Video Streaming
    - Video Conferencing

Detailed Schedule (subject to changes as the course progresses):

Date	Unit	Topic	HW/Project/Test	Comment
Sept 8	Intro	Course Logistics/ Internet refresher		First day of class
Sept 13	Inter-Domain Routing (IDR)	Internet Routing Architecture		
Sept 15	IDR	Internet Autonomous System Graph		
Sept 20	IDR	Policy Routing		
Sept 22	IDR	BGP		
Sept 27	IDR	IDR Management	HW 1 Given	
Sept 29	Congestion Control (CC)	Congestion Control Functions		
Oct 4	CC	Classic TCP Congestion Control	HW 1 Due Project 1 Given	IDR Project
Oct 6	CC	Congestion Control for Fast Transport (CUBIC)		
Oct 11				Reading Week
Oct 13				Reading Week
Oct 18	CC	Google's BBR		
Oct 20	CC	Congestion Control for UDP Transport	Project 1 Due	
Oct 25			Test 1	Coverage Sept 8 - Oct 20
Oct 27	Modern Transport (MT)	Transport innovation challenges		
Nov 1	MT	Multipath TCP		
Nov 3	MT	Multipath TCP		
Nov 8	MT	QUIC		
Nov 10	MT	QUIC		
Nov 15	Video on the Internet (VoI)	Video Enablers/ Video Compression	HW 2 Given	
Nov 17	VoI	Video Compression		
Nov 22	VoI	Adaptive Video Streaming	HW 2 Due Project 2 Given	Video Project
Nov 27	VoI	Adaptive Video Streaming		
Nov 29	VoI	Video Conferencing		
Dec 1	VoI	Video Conferencing	Project 2 Due	
Dec 6			Test 2	Coverage Oct 27- Dec 1

GENERAL UW Guidelines

Intellectual Property:

Students should be aware that this course contains the intellectual property of their instructor, TA, and/or the University of Waterloo. Intellectual property includes items such as:

- Lecture content, spoken and written (and any audio/video recording thereof);
- Lecture handouts, presentations, and other materials prepared for the course (e.g., PowerPoint slides);
- Questions or solution sets from various types of assessments (e.g., assignments, quizzes, tests, final exams); and
- Work protected by copyright (e.g., any work authored by the instructor or TA or used by the instructor or TA with permission of the copyright owner).

Course materials and the intellectual property contained therein, are used to enhance a student's educational experience. However, sharing this intellectual property without the intellectual property owner's permission is a violation of intellectual property rights. For this reason, it is necessary to ask the instructor, TA and/or the University of Waterloo for permission before uploading and sharing the intellectual property of others online (e.g., to an online repository).

Permission from an instructor, TA or the University is also necessary before sharing the intellectual property of others from completed courses with students taking the same/similar courses in subsequent terms/years. In many cases, instructors might be happy to allow distribution of certain materials. However, doing so without expressed permission is considered a violation of intellectual property rights.

Academic Integrity:

In order to maintain a culture of academic integrity, members of the University of Waterloo community are expected to promote honesty, trust, fairness, respect and responsibility. [Check http://uwaterloo.ca/academic-integrity for more information.]

Grievance:

A student who believes that a decision affecting some aspect of his/her university life has been unfair or unreasonable may have grounds for initiating a grievance. Read Policy 70, Student Petitions and Grievances, Section 4, https://uwaterloo.ca/secretariat/policies-procedures-guidelines/policy-70. When in doubt, please be certain to contact the department's administrative assistant who will provide further assistance.

Discipline:

A student is expected to know what constitutes academic integrity [check https://uwaterloo.ca/academic-integrity/integrity-waterloostudents/what-misconduct] to avoid committing an academic offence, and to take responsibility for his/her actions. A student who is unsure whether an action constitutes an offence, or who needs help in learning how to avoid offences (e.g., plagiarism, cheating) or about "rules" for group work/collaboration, should seek guidance from the course instructor, TA, academic advisor, or the Undergraduate Associate Dean. For information on categories of offences and types of penalties, students should refer to

Policy 71, Student Last Modified: Oct. 2013 Discipline, www.uwaterloo.ca/secretariat/policies-procedures-guidelines/policy- 71. For typical penalties, check Guidelines for the Assessment of Penalties, http://uwaterloo.ca/secretariat/policies-proceduresguidelines/guidelines/guidelines-assessment-penalties.

Appeals:

A decision made or penalty imposed under Policy 70 (Student Petitions and Grievances) (other than a petition) or Policy 71 (Student Discipline) may be appealed if there are grounds. A student who believes he/she has grounds for an appeal should refer to Policy 72 (Student Appeals).

Note for Students with Disabilities:

AccessAbility Services (formerly the Office for Persons with Disabilities), located in Needles Hall, Room 1132, collaborates with all academic departments to arrange appropriate accommodations for students with disabilities, without compromising the academic integrity of the curriculum. If you require academic accommodations to lessen the impact of your disability, please register with AccessAbility Services at the beginning of each academic term.

Mental Health

If you or anyone you know experiences any academic stress, difficult life events, or feelings like anxiety or depression, we strongly encourage you to seek support.

On-campus Resources

- Campus Wellness https://uwaterloo.ca/campus-wellness/
- Counselling Services: counselling.services@uwaterloo.ca / 519-888-4567 ext 32655 / Needles Hall North 2nd floor, (NH 2401)
- MATES: one-to-one peer support program offered by Federation of Students (FEDS) and Counselling Services: mates@uwaterloo.ca
- Health Services service: located across the creek from Student Life Centre, 519-888-4096.

Off-campus Resources

- Good2Talk (24/7): Free confidential help line for post-secondary students. Phone: 1-866-925-5454
- Here 24/7: Mental Health and Crisis Service Team. Phone: 1-844-437-3247
- OK2BME: set of support services for lesbian, gay, bisexual, transgender or questioning teens in Waterloo. Phone: 519-884-0000 extension 213

Diversity

It is our intent that students from all diverse backgrounds and perspectives be well served by this course, and that students' learning needs be addressed both in and out of class. We recognize the immense value of the diversity in identities, perspectives, and contributions that students bring, and the benefit it has on our educational environment. Your suggestions are encouraged and appreciated. Please let us know ways to improve the effectiveness of the course for you personally or for other students or student groups. In particular:

We will gladly honor your request to address you by an alternate/preferred name or gender pronoun. Please advise us of this preference early in the semester so we may make appropriate changes to our records.

We will honor your religious holidays and celebrations. Please inform of us these at the start of the course.

We will follow AccessAbility Services guidelines and protocols on how to best support students with different learning needs.