Lahore University of Management Sciences

CS678 – Topics in Internet Research

Spring 2022

Instructors	Dr. Zafar Ayyub Qazi
Room No.	SBASSE 9-G24A (Zafar)
Office Hours	TBA
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Class Timings	TuThr 12:30pm-1:45pm
Class Venue	Zoom
Course URL	http://lms.lums.edu.pk

Course Teaching Methodology

- **Teaching Methodology:** Synchronous (Live Lectures)
- **Lecture details:** Lectures will be conducted live over Zoom

Note:
(1) Please create a zoom account with your LUMS email address if you don't have one already. You would NOT be able to attend lectures otherwise
(2) Make sure to familiarize yourself with features of zoom (https://zoom.us/) such as chat, raising a hand, and breakout rooms if you haven't already done so

Course Basics				
Credit Hours	3 credit hours			
Lecture(s)	2 per week		Duration	75 minutes per lecture

Course Distribution	
Core	None
Elective	All
Open for Student Category	All

COURSE DESCRIPTION

CS678 is a graduate-level course on networking and systems research that aims to introduce students to several hot topics in this broad domain including cloud and edge computing, privacy-preserving machine learning, cellular networks, and ICTD

CS678 involves lectures, paper readings, discussions, and a semester-long research project. We will read classical research works as well as explore the state-of-the-art. Students will be required to write paper summaries and participate in class discussions. In addition, students will be expected to participate in a semester-long research project.

Course Prerequisite(s)

- CS382 (Net-Centric Computing) or CS471 (Computer Networks) or CS4713 (Introduction to the Internet: Architecture and Protocols)

Course Objectives

- To become familiar with state-of-the-art in computer networking research
- To understand how to analyze and critique research works
- To engage in networking research through a semester-long research project

Learning Outcomes

- To develop an understanding of principles behind state-of-the-art network protocols and architectures
- To gain experience in critically analyzing research works
- To conduct networking research by carrying out an independent research project

Grading Breakup and Policy

- Class Participation & Attendance: 20%
- Paper Reviews: 15%
- Quizzes: 15%
- Project: 50%

- Proposal: 5%
- Midterm Report/Review: 15%
- Final Report/Presentation: 30%

Research Project

The semester-long research project is one of the most important components of the course. The goal is to carry out novel research that by the end of the semester would be publishable in a good quality workshop or a conference. Past research projects in this course have been quite successful. Here are some papers that started out as course projects:

- Mukhtiar Ahmad, Syed Usman Jafri, Azam Ikram, Wasiq Noor Ahmad Qasmi, Muhammad Ali Nawazish, Zartash Afzal Uzmi, Zafar Ayyub Qazi. "Low Latency and Consistent Cellular Control Plane" in ACM SIGCOMM 2020
- Ammar Tahir, M. Tahir Munir, Shaiq Munir Malik, Zafar Qazi and Ihsan Qazi. "Deconstructing Google's Web Light Service" in WWW 2020, Taiwan
- Ihsan Qazi, Fahad Dogar, Ali Raza Tariq, Ghulam Murtaza, Abeer Ahmad, Nathan Stocking. "MissIt: Using Missed Calls for Free, Extremely Low Bit-Rate Communication in Developing Regions" in ACM CHI 2020, USA
- Arsalan Jumani, Fizza Zafar, Zafar Qazi, Ihsan Qazi. "Device-Aware Adaptive Video Streaming" in ACM SIGCOMM 2019, China (poster)
- Arsalan Jumani, Fizza Zafar, Zafar Qazi, Ihsan Qazi. "Unraveling Poor Video Streaming Experiences in the Developing World" in ACM IMC 2018 (poster), USA
- Aqib Nisar, Aqsa Kashaf, Ihsan Qazi, Zartash Uzmi. "Incentivizing Censorship Measurements via Circumvention" in ACM SIGCOMM 2018, Hungary
- Hira Javaid, H. Kamran Khalil, Zartash Afzal Uzmi, Ihsan Ayyub Qazi. "Online Advertising under Internet Censorship" in ACM HotNets 2017, USA
- Tooba Ahsen, Fatima Tariq, M. Tirmazi, Ifrah Idrees, Zafar Qazi, Ihsan Qazi, Zartash Uzmi. "DRIBS: Flow Scheduling over Asymmetric Datacenter Topologies" in NSDI 2017, USA (poster paper)
- Kamran Nishat, Farrukh Javed, Saim Salman, Nofel Yaseen, Ans Fida, Ihsan Qazi, "SlickFi: A Service Differentiation Scheme for High-Speed WLANs using Dual Radio APs" in ACM CoNEXT 2016, Irvine, USA
- Aqib Nisar, Aqsa Kashaf, Zartash Uzmi, Ihsan Qazi, "A Case for Marrying Censorship Measurements with Circumvention" in ACM HotNets 2015, USA
- H. Pirzada, M. R. Mahboob, Ihsan Qazi, "eSDN: Rethinking Datacenter Transports Using End-Host SDN Controllers" in ACM SIGCOMM 2015, UK (poster)
- Ruwaifa Anwar, Kamran Nishat, Mohsin Ali, Zahaib Akhtar, Haseeb Niaz, and Ihsan Qazi, "Loss Differentiation: Moving onto High- Speed Wireless LANs" in IEEE INFOCOM 2014, Canada
- Aisha Mushtaq, Asad Khalid Ismail, Abdul Wasay, Bilal Mahmood, Ihsan Qazi, and Zartash Uzmi, "Rethinking Buffer Management in Data Center Networks" in ACM SIGCOMM 2014, USA (poster paper)
- Ali Munir, Ihsan Qazi, Zartash Uzmi, Aisha Mushtaq, Saad Ismail, M. Safdar Iqbal, and Basma Khan "Minimizing Flow Completion Times in Data Centers" in IEEE INFOCOM 2013, Italy

Paper Reviews

Each class will have one or two assigned readings that we will all read prior to class. All students are expected to have thoroughly read the papers, and come to class ready to discuss them in detail. This is essential to get the most out of the class! Before each class, students must submit a short review (max 1/2-page) of the required readings on LMS. Reviews will be due midnight before the day of the lecture. The review is expected to cover the following points:

1. What problem is the paper solving and why is it important?
2. What is the main idea of the paper?
3. Identify any limitations of the paper.
4. How would you improve the paper or build on it in future work?

Project Proposal

The project proposal is due **11:59pm on Friday, February 4th** in the form of a written document (**max 2 pages**). The proposal should at least have the following sections:

- Introduction
  - What is the problem you plan to address? Why is it important to solve?
- Related Work
  - What are the most related works? (analyze prior works and cite related papers)
- Proposed Approach
  - What is your proposal and how does it differ from prior work?
- Timeline and Division of Work
  - Mention a timeline and a division (if there are 2 or more members in the project) of the project tasks

Midterm Review/Report

Students are expected to make substantial progress before the midterm review and are expected to submit a report **(max 3 pages)** on the milestones achieved (e.g., experiments conducted, initial results and hypothesis, and any preliminary design) and a list of future tasks to be carried out. The report will be submitted on LMS.

Final Report

The final report should be structured as a conference/workshop paper and should include (i) description of the problem, (ii) problem motivation, (iii) your solution/idea, (iv) discussion of related works, (v) evaluation of your solution, and (vi) a conclusion. We strongly suggest that you write your final report using LaTeX. It is the de-facto tool in which most CS/EE research papers are written. While it has a small start-up cost, it is much easier to collaboratively write research papers using LaTeX than using Word. We highly suggest using an online LaTeX editor such as OverLeaf (https://www.overleaf.com). You may alternatively install a local version of LaTeX on your computer and use the following a sample LaTeX template (http://www.cs.cmu.edu/~dga/15-744/S07/sample.tar.gz) or a MS Word template (sample file: http://conferences.sigcomm.org/sigcomm/2016/doc/word-acm- 10pt-on-12pt-7.0x9.25.doc) for ACM SIG proceedings).

Source Code Control

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You are required to use GitHub, version control platform for performing source code control for your project. Please share a link of your public repository by the project proposal deadline.

Class Participation (CP)
Students will be expected to actively participate in the class in the form of questions, critique of the paper, new ideas, etc. CP may include a short (oral) summary of the paper at the start of each class, for which students will be chosen randomly. Grading of CP will also include attendance as a component.

Policies
- All deadlines are hard
- All assigned work must be done individually (unless specified otherwise)
- Re-grading can be requested within 2 days after grade reporting

Examination Detail	
Midterm Exam	Yes/No: No (Instead there is a midterm project report)
Final Exam	Yes/No: No

Academic Honesty

The principles of truth and honesty are recognized as fundamental to the community of learners. This means that all academic work shall be done by the student (or group of students) to whom it is assigned without unauthorized aid of any kind. All forms of academic dishonesty (e.g., plagiarism, cheating) are prohibited. Any instance of academic dishonesty in this course will be dealt with swiftly and severely. For further information about this, please make yourself familiar with the relevant sections of the LUMS student handbook.

Cheating besides being unethical also has many profound negative consequences:
- It takes away your opportunity for learning and lowers your confidence
- You'd never get this time back!
- Negatively impacts your colleagues

The entire course staff is here to help you succeed. If you invest the time to learn the material and complete the assignments, you won't need to copy any answers.

We want you to succeed!

If you are feeling overwhelmed, come to our office hours and talk with us. We know university life can be stressful – and especially so during the COVID-19 pandemic – and we want to help you succeed.

Harassment Policy

SBASSE, LUMS and particularly this class, is a harassment free zone. There is absolutely zero tolerance for any behaviour that is intended or has the expected result of making anyone uncomfortable and negatively impacts the class environment, or any individual's ability to work to the best of their potential. In case a differently-abled student requires accommodations for fully participating in the course, students are advised to contact the instructor so that they can be facilitated accordingly.

If you think that you may be a victim of harassment, or if you have observed any harassment occurring in the purview of this class, please reach out and speak to me. If you are a victim, I strongly encourage you to reach out to the Office of Accessibility and Inclusion at oai@lums.edu.pk or the sexual harassment inquiry committee at harassment@lums.edu.pk for any queries, clarifications, or advice. You may choose to file an informal or a formal complaint to put an end of offending behavior. You can find more details regarding the LUMS sexual harassment policy here. To file a complaint, please write to harassment@lums.edu.pk.

SSE Council on Equity and Belonging

In addition to LUMS resources, SBASSE's Council on Belonging and Equity is committed to devising ways to provide a safe, inclusive and respectful learning environment for students, faculty and staff. To seek counsel related to any issues, please feel free to approach either a member of the council or email at cbe.sse@lums.edu.pk

Rights and Code of Conduct for Online Teaching

A misuse of online modes of communication is unacceptable. TAs and Faculty will seek consent before the recording of live online lectures or tutorials. Please ensure if you do not wish to be recorded during a session to inform the faculty member. Please also ensure that you prioritize formal means of communication (email, LMS) over informal means to communicate with course staff.

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Schedule

No	Date	Session	Author(s)
1	18/1/22	[Introduction] Course overview	
2	20/1/22	[Reading Research Papers] "How to Read a Paper" in ACM SIGCOMM CCR 2007 "How to build research network systems in your spare time" in SIGCOMM CCR 2010	S. Keshav R. Mahajan
		Internet Architecture and Networking Paradigms	
3	25/1/22	[Internet Architecture] "The Design Philosophy of the DARPA Internet Protocols" in ACM SIGCOMM 1988	D. Clark et al.
4	27/1/22	[Future of Internet] "Rethinking the design of the Internet: The end-end arguments vs. the brave new world" ACM Transactions on Internet Technology 2001	D. Clark et al.
5	1/2/22	[Internet Resilience] "Solar superstorms: planning for an internet apocalypse" ACM SIGCOMM 2021 "Facebook Outage: what went wrong and why did it take so long to fix after social network went down?" Guardian 2021	S. Abu Jyothi et al. Guardian
6	3/2/22	[Datacenter networking and Cloud computing] "A View of the Cloud Computing" in Communications of the ACM, 2010 "A Guided Tour through Data-center Networking" in Communications of ACM, 2012	M. Armbrust et al. D. Abts et al.
7	8/2/22	[Datacenter networking and Cloud computing trends] "Attack of the Killer Microseconds" in Communications of the ACM, 2017 "Cloud Programming Simplified: A Berkeley View on Serverless Computing" (Section 1-3 only) Berkeley tech report 2019.	
8	10/2/22	[Edge Computing] "The Emergence of Edge Computing" in Computer, vol. 50, no. 1, pp. 30-39, Jan. 2017. [Optional] "Augmenting Cognition Through Edge Computing" in IEEE Computer, July 2019	M. Satyanarayanan M. Satyanarayanan
9	15/2/22	[Network programmability: SDN and programmable control planes] [Video] "The future of networking and the past of protocols", talk by Scott Shenker at the Open Networking Summit, 2011 "The Road to SDN: An intellectual history of programmable networks" in ACM SIGCOMM CCR 2014	Scott Shenker N. Feamster et al.
10	16/2/22	[RDMA based datacenters] **Guest Lecture by Prof. Radhika Mittal (University of Illinois at Urbana-Champaign, US)**	
11	18/2/22	[Network programmability: programmable data planes] **Guest Lecture by Prof. Muhammad Shahbaz (Purdue University, US)**	
		Next Generation Mobile Networks	
12	24/2/22	[Past, Present, and Future of Cellular Networks] (1) A brief background of cellular networks (2) Introduction to 5G	Slides
13	1/3/22	[Problem with the Cellular Control Plane] "A Control Plane Perspective on Reducing Data Access Latency in LTE Networks" in MobiCom 2017	Y. Li et al.
14	3/3/22	[Redesigning the Cellular Control Plane] "Low Latency and Consistent Cellular Control Plane" in ACM SIGCOMM 2020	M. Ahmad et al.
15	8/3/22	[The need for new abstractions] "A High Performance Packet Core for Next-Generation Cellular Networks", in ACM SIGCOMM 2017	Zafar Qazi et al.
16	10/3/22	[Democratizing Cellular Access] "Democratizing cellular access with CellBricks" in ACM SIGCOMM 2021	
		Web Affordability and Performance	
17	15/3/22	[Affordable and Inclusive Web] **Guest Lecture by Prof. Ihsan Ayyub Qazi (LUMS)** Reading: "Rethinking Web for Affordability and Inclusion" in ACM HotNets 2021	Ihsan Qazi et al.
18	17/3/22	[QoE issues with Mobile Web Browsing] "Mobile Web Browsing Under Memory Pressure" in ACM SIGCOMM CCR 2020	Ihsan Qazi et al.

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19	22/3/22	[Accelerating Mobile Pages] "AMP up your Mobile Web Experience: Characterizing the Impact of Google's Accelerated Mobile Project" in MobiCom 2019 [Optional] "Horcrux: Automatic JavaScript Parallelism For Resource-Efficient Web Computation" in USENIX OSDI 2021	B. Jun et al. S. Mardani et al.
20	24/3/22	[The search for a Web transcoding service] "Deconstructing Google's Web Light Service" in WWW 2020 [Optional] "Flywheel: Google's Data Compression Proxy for the Mobile Web" in NSDI 2015	M. Tahir Munir et al.
21	29/3/22	[Adaptive video streaming] "A Buffer-Based Approach to Rate Adaptation: Evidence from a large video streaming service" in ACM SIGCOMM 2014	T. Huang et al.
22	04/04/22	[Optimizing video streaming] **Guest Lecture by Dr. Zahaib Akthar (Amazon Prime Video)** Reading "Neural Adaptive Video Streaming with Pensieve" in ACM SIGCOMM 2017 [Optional] "Oboe: Auto-tuning Video ABR algorithms to Network Conditions" in ACM SIGCOMM 2018	 H. Mao et al. Zahaib Akthar et al.
		Federated Learning: Privacy Preserving Decentralized ML	
23	5/04/22	[Privacy Preserving Machine Learning] "Collaborative machine learning without centralized training data" Google Blog "Federated Learning of Deep Networks using Model Averaging" 2016 [Optional] "Learning Differentially Private Recurrent Language Models" ICLR 2018	 H. B. McMahan et al. H. B. McMahan et al. H. B. McMahan et al.
24	7/04/22	[Scaling Federated Learning] "Towards Federated Learning at Scale: System Design" in SysML 2019 [Optional] "LEAF: A Benchmark for Federated Settings" NeurIPS Workshop 2019	 K. Bonawitz et al. S. Caldas et al
25	12/04/22	[Adapting Federated Learning to Heterogenous Clients] "Towards Inclusive Federated Learning" in arXiv:2110.14205 2021 [Optional] "Expanding the Reach of Federated Learning by Reducing Client Resource Requirements" in arXiv:1812.07210 2019	 M. Tahir Munir et al. S. Caldas et al.
26	14/04/22	[Fairness in Federated Learning] "Fair Resource Allocation in Federated Learning" ICLR 2020 [Optional] "Advances and Open Problems in Federated Learning" in arXiv:1912.04977 2019	 T. Li et al. P. Kairouz et al.
27	19/04/22	[Final Project Presentations]	
28	21/04/22	[Final Project Presentations]	

Please note the schedule above is tentative and can be subject to some changes.