Homa Esfahanizadeh

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Research Domain

I am a postdoctoral research scientist specialized in information theory, distributed computation, data privacy, and machine learning. My work has focused on addressing practical challenges in data communication and computation across distributed systems. These challenges include privacy concerns, delays, and failures, and they arise in cutting-edge domains such as ML training and inference, cloud infrastructure, and emerging communication networks (6G and beyond). I propose practical solutions that have theoretical motivations and guarantees in terms of complexity, latency, and precision.

Professional Experience

Post-Doctoral Research Associate — Mar 2020 – Present
Massachusetts Institute of Technology (MIT) — *Cambridge, MA, USA*

- Enabled **privacy-preserving learning** through neural estimation of mutual information – 27% lower chance of revealing sensitive information in ML data sharing [GitHub], papers: InfoShape ’23, PEOPL ’23, Syfer ’22, NeuraCrypt ’21.
- Designed **fast and multi-resolution computing** for federated learning – 23% higher chance of meeting deadlines with 40% lower cost [GitHub], papers: CloudNet ’22 **[best paper runner-up]**, Infocom ’22, JSAIT ’21.
- Developed **ultra-reliable low-latency communication (URLLC)** solutions using network slicing and coding – less than 10 msec delay for obstructed mmWave communication, papers: Net. Letters ’23, Comm. Magazine ’21.
- Wrote and submitted grant proposals that are awarded by Fintech, Jameel Clinic, JMA Wireless, and US Air force.
- Technical leader in several cross-institutional collaborations with University of Aveiro (Portugal), University of Coimbra (Portugal), Technion (Israel), UT Austin (USA), Ubiwhere Inc. (Portugal), and IBM Inc. (USA).
- Co-advised and mentored students at all levels: For example, Andrea Jaba [thesis], William Wu [thesis, **MIT’s best thesis award**], and Alexander Mariona (current Ph.D student).
- Instructor for **Oral communication** (Spring ’22) and guest lecturer for **Principles of digital communication** (Fall ’21).

Industry Internship — Jul 2018 – Oct 2018
Samsung Semiconductor Inc. — *San Diego, CA, USA*

- Designed decoder of LDPC codes for 5G cellular networks using Reinforcement Learning

Ph.D Student Researcher — Sep 2015 – Dec 2019
University of California, Los Angeles (UCLA) — *Los Angeles, CA, USA*

- Built frameworks for efficient design of **low-latency error-correcting codes (SC-LDPC)** – 10x better error correction by enabling previously infeasible optimizations [GitHub], selected papers: TMAG ’22 , TCOM ’19.
- Introduced novel **multi-dimensional error correction codes** – 100x lower BER in the error floor region compared to the 1D counterpart, papers: TCOM ’20, NVMW ’21 [**best paper award**].
- Customized error correction design for specific storage applications: **magnetic recording** and **flash memories**, selected papers: TMAG ’18, NVMW ’18 [**best paper award**], ITW ’17, TMAG ’16.
- Mentored students at all levels: Lev Tauz (Ph.D), Jose Suarez (Ph.D), Ruiyi Wu (M.Sc), and Andrew Tan (B.Sc).
- Collaborated with several partners from storage industry, e.g., Western Digital, Seagate Technology, and IDEMA.
- Teacher Assistant for **Mathematical Foundations of Data Storage Systems** (Summer ’19) and **Probability and statistics** (Fall ’17), and **Communication systems** (Spring ’17).

M.Sc Student Researcher — Sep 2015 – Dec 2019
University of Tehran (UT) — *Tehran, Iran*

- Identified the optimum mapping among **Network Coding**, **Index Coding**, and **Matrix Completion**, paper: ITW ’14.
- Teacher Assistant for **Wireless multimedia communication theory** (Spring ’13 and ’14), **Multimedia Communication Laboratory** (Spring ’14), and **Microprocessor Laboratory** (Fall and Spring ’12 and ’13).

Technical Skills

Programming Languages : C++, Python, Matlab

Collaboration Platforms : Overleaf, GitHub

Machine Learning : PyTorch, TensorFlow, Scikit-learn, Data pre-processing, Model training and evaluation

Education

University of California, Los Angeles (UCLA) Los Angeles, CA, USA
Ph.D in Electrical Engineering, Signals and Systems, GPA: 3.74/4 *Sep 2015 – Dec 2019*
Thesis: Spatially-coupled codes for modern data storage systems
Advisor: Lara Dolecek

University of Tehran (UT) Tehran, Iran
M.Sc in Electrical Engineering, Communication Systems, GPA: 17.41/20 *Sep 2012 – Jul 2015*
Thesis: Topological interference management in multiple unicast networks through index coding
Advisor: Farshad Lahouti and Babak Hassibi

University of Tehran (UT) Tehran, Iran
B.Sc in Electrical Engineering, Telecommunications, GPA: 17.43/20 *Sep 2008 – Jul 2012*
Thesis: Fixed-point implementation of turbo decoder on DSP
Advisor: Farshad Lahouti

Honors and Awards

- Best paper runner-up at the IEEE International Conference on Cloud Networking (CloudNet) for “Distributed computations with layered resolution", Nov 2022.
- Memorable paper award at the Non-Volatile Memories Workshop (NVMW) for the paper “Non-uniform windowed decoding for multi-dimensional spatially coupled LDPC codes" (news on UCSD website), Mar 2021.
- Dissertation Year Fellowship (DYF), University of California, Los Angeles, ECE Department, 2018.
- Memorable paper award at the Non-Volatile Memories Workshop (NVMW) for the paper “A three-stage approach for designing non-binary spatially-coupled codes for Flash memories" (news on UCSD website), Mar 2018.
- University fellowship, University of California, Los Angeles (UCLA), ECE Department, 2015.
- Ranked as top 10 percent among the B.Sc. students of Electrical Engineering in the year 2012, University of Tehran.
- Ranked as third in national robocup soccer simulation competition, Iran, 2006.
- Selected among Iranian high school students to participate in the rescue league of robocub international champion, Bremen, Germany, 2006.

Services

- Supervisor of Several International High-School Interns, MIT, Summer ’22 and Summer ’23.
- Technical Program Committee: IEEE International Conference on Communications (ICC), 2023.
- Organizer of weekly group series for paper reading at MIT, focused on“Private data release", 2022.
- Technical Program Committee: Non-Volatile Memories Workshop (NVMW), 2021.
- Journal reviewer: Elsevier Physical Communication, IEEE Communications Letters, IEEE Transactions on Communications (TCOM), IEEE Transactions on Information Theory (T-IT), IEEE Transactions on Magnetics (TMAG), IEEE Journal on Selected Areas in Information Theory (JSAIT), and IEEE Transactions on Very Large Scale Integration (VLSI) Systems, IEEE BITS.
- Conference reviewer: IEEE ICASSP, IEEE ICC, IEEE ISIT, IEEE ITW, NVMW, and IEEE Intermag.

Selected Publications

- **H. Esfahanizadeh**, W. Wu, M. Ghobadi, R. Barzilay, M. Medard, “InfoShape: Task-based neural data shaping via mutual information," *IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP)*, 2023.
- **H. Esfahanizadeh**, A. Cohen, M. Médard, and S. Shamai, “Distributed computations with layered resolution," *IEEE International Conference on Cloud Networking (CloudNet)*, 2022, **CloudNet best paper runner-up**.
- **H. Esfahanizadeh**, A. Cohen, M. Médard, “Stream iterative distributed coded computing for learning applications in heterogeneous systems,” *IEEE International Conference on Computer Communications (INFOCOM)*, 2022.
- A. Cohen, **H. Esfahanizadeh**, B. Sousa, J. P. Vilela, M. Luís, D. Raposo, F. Michel, S. Sargento, and M. Médard, “Bringing network coding into SDN: A case-study for highly meshed heterogeneous communications,” *IEEE Communications Magazine (COMMAG)*, 2021.
- **H. Esfahanizadeh**, A. Hareedy, and L. Dolecek, “Finite-length construction of high performance spatially-coupled codes via optimized partitioning and lifting,” *IEEE Transactions on Communications (TCOM)*, 2019.
- L. Tauz, **H. Esfahanizadeh**, and L. Dolecek, “Non-Uniform windowed decoding for multi-dimensional spatially-coupled LDPC codes," *Non-Volatile Memories Workshop (NVMW)*, 2021, **Winner of memorable paper award**.
- A. Hareedy, **H. Esfahanizadeh**, and L. Dolecek, “A three-stage approach for designing non-binary spatially-coupled codes for Flash memories," *Non-Volatile Memories Workshop (NVMW)*, 2018, **Winner of memorable paper award**.
- **H. Esfahanizadeh**, F. Lahouti, and B. Hassibi, “A matrix completion approach to linear index coding problem,” *IEEE Information Theory Workshop (ITW)*, 2014.

Seminars

- University of California, San Diego (UCSD), “Robust information sharing and processing: reliability, speed, and adaptability", Mar 2023.
- University of California, Santa Barbara (UCSB), “Robust information sharing and processing: reliability, speed, and adaptability", Mar 2023.
- University of California, Santa Cruz (UCSC), “Coding for utilizing distributed resources: from communication reliability to ML privacy", May 2022.
- Rensselaer Polytechnic Institute (RSI), “Private collaborative learning using random codes", May 2021.

References

- Prof. Muriel Médard (MIT): medard@mit.edu and https://www.rle.mit.edu/ncrcg/
- Prof. Manya Ghobadi (MIT): ghobadi@csail.mit.edu and https://people.csail.mit.edu/ghobadi/
- Prof. Lara Dolecek (UCLA): dolecek@ee.ucla.edu and https://loris.seas.ucla.edu/
- Prof. Alejandro Cohen (Technion): alecohen@technion.ac.il and https://sites.google.com/view/alejandrocohen/