NAHEED ANJUM ARAFAT

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RESEARCH INTERESTS & EXPERTISE

My interest and expertise lie in the algorithmic, applied and topological aspects of non-relational data such as graphs and their higher-order counterpart: hypergraphs. However, in recent years, I have branched into various aspects of graph representation learning, such as designing adversarially robust GNN, applications to physics-based simulations, and knowledge graph-augmented LLMs.

- **Graph representation learning:** (1) Designed physics-driven Graph Neural Networks to exploit low-resolution simulation data to efficiently and effectively predict flow field on high-resolution mesh originating from complex aerodynamical systems. (2) Improved robustness of Graph Neural Networks under adversarial attack. (3) Proposed algorithms to measure and reduce uncertainty associated with real-valued properties on uncertain graphs.
- **Higher-order data representations and Topological Data Analysis:** Designed algorithms for (1) finding core nodes in hypergraphs, (2) generating and estimating properties of random hypergraphs with a prescribed constraint, (3) visualising hypergraphs, (4) subsampling nodes to approximate and accelerate the computation of topological features.

I have published in reputable data mining and ML venues such as ICML, VLDB, ECML-PKDD, DEXA and journals such as SEC (IF=10). I also have 1 patent filed at the UK IP office.

EDUCATION

National University of Singapore (NUS) — Singapore
PhD in Computer Science — *Aug 2015 - Nov 2020*

- **Thesis**: Analysis and generation of data with topology from combinatorial representations

Bangladesh University of Engineering and Technology (BUET) — Dhaka, Bangladesh
Bachelors in Computer Science & Engineering — *May 2014*

- **Thesis**: A Fuzzy Dominance Based Evolutionary Algorithm for solving many-objective optimisation problems.

EMPLOYMENT HISTORY

Research Fellow — Singapore
Rolls-Royce@NTU Corporate Lab, NTU — *July 2021 - 2024*

Research Fellow — Singapore
Department of Information Systems & Analytics, NUS — *July 2020 - July 2021*

Research Assistant — Singapore
Department of Computer Science, NUS — *Nov 2019 - June 2020*

Full-time Lecturer — Dhaka, Bangladesh
Department of Computer Science, United International University — *Jun 2014 - Jul 2015*

Part-time Developer — Dhaka, Bangladesh
Software Global Consultancy — *Jan 2014 - Mar 2014*

RESEARCH EXPERIENCE

Research Fellow Rolls-Royce@NTU Corporate Lab, NTU
PI: Associate Professor Adams Wai Kin Kong *July 2021 - Present*

- **Projects:** (1) Super-resolution/-fidelity of CFD simulations. (2) Accelerating unsteady flow simulation with physics-based AI.

Research Fellow Department of Information Systems & Analytics, NUS
PI: Assistant Professor UM Sungyong *July 2020 - July 2021*

- **Project:** Co-evolution of software ecosystem networks.

Research Assistant Department of Computer Science, NUS
PI: Professor Tan Kian Lee *Nov 2019 - June 2020*

- **Project:** Random generation of hypergraphs with prescribed constraints.

RESEARCH MANAGEMENT EXPERIENCE

- **Research Equipment Purchasing**
  1. I led the acquisition of a high-performance GPU server for experimenting with deep neural networks.
     - I managed the entire procurement process, from preparing requirement specifications for Invitation-To-Quote (ITQ) and setting clear evaluation criteria to evaluating potential vendors and overseeing the installation, testing & commissioning of the server.
     - I collaborated with the IT department to ensure seamless integration of the new equipment into ongoing research projects, significantly enhancing the computational capabilities of RR@NTU Corp Lab.

- **Grant Writing**
  1. AI Singapore Research Grant. Status (Dec 2023): under review
     - I collaborated with my PI (Adams) on developing the grant proposal by proposing ideas for potential work packages and drafted sections of the grant application, such as discussing state-of-the-art and their limitations.

TEACHING EXPERIENCE

As Graduate Assistant NUS
Jan 2016 - 2019

As a graduate teaching assistant, I conducted weekly tutorials and held student consultation sessions.

- **Courses-**
  - **Big Data Techniques and Technologies (BT4221)**: Department Of Information Systems and Analytics, School of Computing - Semester 1, 2019.
  - **Data Management and Warehousing (BT5110)**: Master Of Science Business Analytics Programme - Semester 1 of 2019, 2018 and 2017.
  - **Information Visualisation (CS5346)**: Department of Computer Science, School of Computing - Semester 2, 2018.
  - **Discrete Structures (CS1231)**: Department of Computer Science, School of Computing - Semester 1, 2016.
  - **Programming Methodology (CS1010E)**: Department of Computer Science, School of Computing - Semester 2 of 2017 and 2016.

As Full-time Lecturer United International University

As a full-time lecturer, I designed module curriculum, prepared lecture notes, assignments and exam questions, delivered lectures, conducted lab-sessions, and evaluated assignment submissions and exam-scripts. I was also involved in various administrative duties.

- **Courses-**
  - **Advanced Programming Languages**: Summer 2014, Fall 2014, Spring 2015, Summer 2015 trimesters.
  - **Data Structures**: Fall 2014, Summer 2015 trimesters.
  - **Discrete Mathematics**: Summer 2014 trimester.
  - **Structured Programming Language**: Spring 2015 trimester.
  - **Electric Circuits**: Fall 2014, Spring 2015, Summer 2015 trimesters.

As Mentor NUS, NTU

I held consultation, discussion, brainstorming and coding sessions to train the students in academic research. I also read their write-ups and gave feedback to improve them.

- **Loh Sher En Jessica**: PhD student at NTU. (2021-2023)
- **Arpit Kumar Rai**: Undergraduate student, IIT (2021-2022)
- **Debabrata Mahapatra**: PhD lab-rotation under Stéphane Bressan (2019)

RESEARCH PUBLICATIONS

- **Conference Proceedings**
  1. **Naheed Anjum Arafat**, Ehsan Bonabi Mobaraki, Arijit Khan, Yllka Vela, and Francesco Bonchi. Estimate and reduce uncertainty in uncertain graphs. In *2024 IEEE 11th International Conference on Data Science and Advanced Analytics (DSAA)*, 2024
  2. *Loh Sher En Jessica, ***Naheed Anjum Arafat**, Wei Xian Lim, Wai Lee Chan, and Adams Wai Kin Kong. Finite volume features, global geometry representations, and residual training for deep learning-based cfd simulation. ICML, 2024. * = equal contribution
  3. Wei Xian Lim, **Naheed Anjum Arafat**, Wai Lee Chan, and Adams Wai Kin Kong. Multi-order loss functions for accelerating unsteady flow simulations with physics-based ai. In *2024 IEEE Conference on Artificial Intelligence (CAI)*, 2024
  4. **Naheed Anjum Arafat**, Arijit Khan, Arpit Kumar Rai, and Bishwamittra Ghosh. Neighborhood-based hypergraph core decomposition. volume 16. VLDB Endowment, May 2023
  5. **Naheed Anjum Arafat**, Debabrota Basu, Laurent Decreusefond, and Stéphane Bressan. Construction and random generation of hypergraphs with prescribed degree and dimension sequences. In *Database and Expert Systems Applications*, pages 130–145, Cham, 2020. Springer International Publishing
  6. **Naheed Anjum Arafat**, Debabrota Basu, and Stéphane Bressan. Topological data analysis with ϵ-net induced lazy witness complex. In *Database and Expert Systems Applications*, pages 376–392, Cham, 2019. Springer International Publishing
  7. **Naheed Anjum Arafat** and Stéphane Bressan. Hypergraph drawing by force-directed placement. In *International Conference on Database and Expert Systems Applications*, pages 387–394, Cham, 2017. Springer International Publishing
- **Journals**
  1. Siddhartha Shankar Das, Md Monirul Islam, and **Naheed Anjum Arafat**. Evolutionary algorithm using adaptive fuzzy dominance and reference point for many-objective optimization. *Swarm and evolutionary computation*, 44:1092–1107, 2019
- **Patents**
  1. Fluid flow simulation. Inventors: Loh Sher En Jessica, **Naheed Anjum Arafat**, Adams Wai Kin Kong, Wai Lee Chan, Bryce D Conduit. Status (Dec 2023): Filed with Rolls-Royce at UK Intellectual Property Office (https://www.ipo.gov.uk/p-ipsum/Case/ApplicationNumber/GB2312389.6)
- **Preprints**
  1. Bishwamittra Ghosh, Sarah Hasan, **Naheed Anjum Arafat**, and Arijit Khan. Consistency of language models for logic facts checking on knowledge graphs. 2024. under review (NeurIPS 2024)
  2. **Naheed Anjum Arafat**, Debabrota Basu, Yulia Gel, and Yuzhou Chen. When witnesses defend: A witness graph topological layer for adversarial graph learning. 2024. under review (NeurIPS 2024)
  3. **Naheed Anjum Arafat**, Arijit Khan, Arpit Kumar Rai, and Bishwamittra Ghosh. (extended version) neighborhood-based hypergraph core decomposition. 2023
  4. **Naheed Anjum Arafat**, Debabrota Basu, Laurent Decreusefond, and Stéphane Bressan. (extended version) construction and random generation of hypergraphs with prescribed degree and dimension sequences (extended version). 2020
- **Workshops/Posters**
  1. **Naheed Anjum Arafat**, Debabrota Basu, and Stéphane Bressan. ϵ-net induced lazy witness complexes on graphs. *Workshop on Applications of Topological Data Analysis (ATDA), held in conjunction with ECML-PKDD*, 2019

TALKS

- **Guest Lectures:**
  - **Big Data Techniques and Technologies module (NUS):** I delivered two guest lectures on 'Practical data analysis using Amazon EMR and Sagemaker services' during Semester 1, 2020 offering of undergraduate module BT4221.
  - **Data Management and Warehousing module (NUS):** I delivered a hands-on lecture on 'developing retail-sales data mart using Pentaho' during Semester 1, 2018 offering of masters module BT5111.
  - **Information visualisation module (NUS):** I delivered a guest lecture on 'Graph and hypergraph data visualisation tools' during Semester 2, 2018 offering of masters module CS5346.
- **Seminar Talks:**
  - **Moscow-Beijing Topology seminer 2022:** I presented my work on Topological data analysis.
  - **DEXA 2020:** I presented my paper: *Construction and random generation of hypergraphs with prescribed degree and dimension sequences*
  - **DEXA 2019:** I presented my paper: *Topological data analysis with ϵ-net induced lazy witness complex.*
  - **E2S2-CREATE seminar:** I gave a talk on *Topological Data Analysis* at E2S2-CREATE Seminar, Feb 2018 attended by 20+ researchers from E2S2 project funded by NRF.

ACADEMIC SERVICES

- **PC Member:** CODS-COMAD 2023, TKDE 2023, TKDE 2021, SKIMA 2014.
- **Reviewer:** Journal of Applied and Computational Topology, DASFAA 2020, DAWAK 2020, ICDE 2018, VLDB 2017, DEXA 2017.
- **Co-organiser:** Co-organised *8th International Conference on Software, Knowledge, Information Management and Applications (SKIMA), 2014* held at United International University, Bangladesh.
- **Session Chair:** pVLDB 2023 (Learning, Recommendations, Social Networks)
- **Session Chair:** Chaired two sessions at *NUS SoC-Telecom ParisTech joint workshop on Data Sciences and Artificial Intelligence, April 2018* attended by 20+ researchers from Telecom ParisTech and NUS.
- **Session Chair:** Chaired two sessions at *NUS School of Computing Research Workshop, March 2018* attended by professors and researchers from various countries in Asia.

AWARDS & ACHIEVEMENTS

- **Distinguished PC member award: CODS-COMAD 2023**
- **NUS Research Scholarship** for PhD students (2015-2019).
- **Teaching Assistant Training Certificate** issued by the Centre for Development of Teaching & Learning (CDTL), NUS for completing training on applying 'Collaborative Learning' approaches.
- **Distinguished Poster Award** at Undergraduate Research Poster Presentation Workshop 2014, Department of Computer Science and Engineering, BUET for presenting a poster titled 'Many-Objective Evolutionary Approach using Fuzzy Dominance with Bidirectional Bias'.
- **Inter-University Hardware Project Show Champion** award for showcasing the project titled 'Cell phone operated mini-car with surveillance' at CSE festival 2013, BUET.
- **Imdad-Sitara Khan Scholarship** for higher-secondary studies (2006-2008) and undergraduate studies (2009-2013).
- **Talent pool Board scholarship** for excellence in Secondary and Higher Secondary exams, Jessore Board, Bangladesh.

TECHNICAL SKILLS

- **ML Libraries**: Scikit-Learn, PyTorch, PyTorch Geometric, DeepRobust
- **Data science Tools**: Pandas, Numpy, Scipy, d3, networkX.
- **Programming Languages**: Python, C, C++, Java, Matlab, R, Processing
- **Build Tools** : CMake
- **Big Data Frameworks**: Hadoop, Spark
- **Data warehousing & Viz. Tools:** Pentaho Data Integration, Tableau
- **Databases:** MySQL, PostgreSQL, Oracle
- **Web Dev:** HTML/HTML5, CSS/CSS3, JavaScript, JQuery, JQuery Mobile
- Excellent presentation skill and proficiency in technical writing (Latex).
- Ability to work independently as well as in a team.
- Ability to communicate effectively and methodically.

REFERENCES

Available upon request