

# NAHEED ANJUM ARAFAT

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Last position: Research Fellow, Rolls-Royce@NTU Corporate lab, Nanyang Technological University, Singapore

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## RESEARCH INTERESTS & EXPERTISE

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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

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### National University of Singapore (NUS)

PhD in Computer Science

Singapore

Aug 2015 - Nov 2020

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

### Bangladesh University of Engineering and Technology (BUET)

Bachelors in Computer Science & Engineering

Dhaka, Bangladesh

May 2014

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

## EMPLOYMENT HISTORY

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### Research Fellow

Rolls-Royce@NTU Corporate Lab, NTU

Singapore

July 2021 - 2024

### Research Fellow

Department of Information Systems & Analytics, NUS

Singapore

July 2020 - July 2021

### Research Assistant

Department of Computer Science, NUS

Singapore

Nov 2019 - June 2020

### Full-time Lecturer

Department of Computer Science, United International University

Dhaka, Bangladesh

Jun 2014 - Jul 2015

### Part-time Developer

Software Global Consultancy

Dhaka, Bangladesh

Jan 2014 - Mar 2014

## RESEARCH EXPERIENCE

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### Research Fellow

PI: Associate Professor Adams Wai Kin Kong

Rolls-Royce@NTU Corporate Lab, NTU

July 2021 - Present

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

### Research Fellow

PI: Assistant Professor UM Sungyong

Department of Information Systems & Analytics, NUS

July 2020 - July 2021

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

### Research Assistant

PI: Professor Tan Kian Lee

Department of Computer Science, NUS

Nov 2019 - June 2020

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

## RESEARCH MANAGEMENT EXPERIENCE

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### • 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

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### 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

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### ◦ Conference Proceedings

1. \*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
2. **Naheed Anjum Arafat**, Arijit Khan, Arpit Kumar Rai, and Bishwamitra Ghosh. Neighborhood-based hypergraph core decomposition. volume 16. VLDB Endowment, May 2023
3. **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
4. **Naheed Anjum Arafat**, Debabrota Basu, and Stéphane Bressan. Topological data analysis with  $\epsilon$ -net induced lazy witness complex. In *Database and Expert Systems Applications*, pages 376–392, Cham, 2019. Springer International Publishing
5. **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. Bishwamitra 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**, Ehsan Bonabi Mobaraki, Arijit Khan, Yllka Vela, and Francesco Bonchi. Estimate and reduce uncertainty in uncertain graphs. 2024. under review (DSAA 2024)
3. **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)
4. **Naheed Anjum Arafat**, Arijit Khan, Arpit Kumar Rai, and Bishwamitra Ghosh. (extended version) neighborhood-based hypergraph core decomposition. 2023
5. **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.  $\epsilon$ -net induced lazy witness complexes on graphs. *Workshop on Applications of Topological Data Analysis (ATDA), held in conjunction with ECML-PKDD*, 2019

## TALKS

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### ◦ 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 seminar 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  $\epsilon$ -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 NRE

## ACADEMIC SERVICES

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- **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

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- **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

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- **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

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Available upon request