# Shah Rukh Qasim

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## Projects and Experiences

Oct 2019–Current **Ph.D. (Computer Science) – CERN Doctoral Student, enrolled in Manchester Metropolitan University**, *Geneva, Switzerland*, Advisors: Dr. Maurizio Pierini, Dr. Jan Kieseler, Dr. Raheel Nawaz .

**Defense:** February 17, 2023 **Graduation:** June 2023 (expected)

**Multi-Particle Reconstruction with Dynamic Graph Neural Networks**

Thousands of particles are created in high-energy collisions at the Large Hadron Collider (LHC). These particles leave signatures in the LHC detectors in the form of 3D point clouds. The task of finding the incident particles given these point clouds is called particle reconstruction. It is often a very complex task as the point clouds can be composed of up to $\mathcal{O}(10^5)$ detector hits produced by up to $\mathcal{O}(10^3)$ incident particles. I worked on dedicated graph neural networks to perform multi-particle calorimetric reconstruction as my main Ph.D. project. My work produced the first-ever machine-learning-based end-to-end reconstruction algorithm that works in high occupancy environments [1,2,3]. While my work is focused on the High Granularity Calorimeter (HGCAL) at the Compact Muon Solenoid (CMS) Experiment, the techniques studied are general and are applicable not only to other calorimeters but also to other problems such as track reconstruction, and set the stage for the next era of particle reconstruction that is expected to be end-to-end.

Jan 2018–Jan 2019 **Technical Student – Research Intern at CERN**, *Geneva, Switzerland*, Supervisors: Dr. Maurizio Pierini, Dr. Jan Kieseler.

I explored the applicability of graph neural networks in particle physics and proposed a high-performance dynamic graph neural network called GravNet [5]. I showed that it offers better performance than convolutional neural networks and is faster than the Dynamic Graph Convolutional Neural Network (DGCNN) – the state-of-the-art – while achieving better performance. It is one of the first works exploring graph neural networks in particle physics and remains highly cited.

June–Sept 2017 **Summer Intern at Computer Vision and Mixed Reality Group**, *Hochschule RheinMain*, Wiesbaden, Germany, Supervisors: Prof. Dr. Adrian Ulges, Prof. Dr. Ulrich Schwanecke | Feedback.

I worked on computer vision during this internship. More specifically, I explored underwater video processing for fish counting. I implemented two state-of-the-art approaches from CVPR 2016 and CVPR 2017 and evaluated them for both fish and people counting. I also worked on generating synthetic underwater fish data to benchmark the performance of these counting methods.

2016–2019 **TUKL R&D Lab, SEECS**, *Islamabad*, Pakistan, Supervisor: Dr. Faisal Shafait.

I spent most of my free time in a research lab during the last two years of my undergrad, working on various research and development projects. I was focused on document structure analysis, working on problems such as invoice parsing, data extraction from forms, table detection [7], and parsing [6]. Besides this, I was also honored to guide more junior students through their research projects.

2015–2016 **Freelancing**.

I worked on developing applications (mostly Android apps) for clients during my free time at the university.

## Selected Publications | References

1. S.R. Qasim, N Chernyavskaya, J Kieseler, K Long, O Viazlo, M Pierini, R Nawaz. End-to-end multi-particle reconstruction in high occupancy imaging calorimeters with graph neural networks. European Physical Journal C. 2022. Link

2. S Bhattacharya et al. GNN-based end-to-end reconstruction in the CMS Phase 2 High-Granularity Calorimeter. 20th International Workshop on Advanced Computing and Analysis Techniques in Physics Research. 2021. Link
3. S.R. Qasim, K Long, J Kieseler, M Pierini, R Nawaz. Multi-particle reconstruction in the High Granularity Calorimeter using object condensation and graph neural networks. 25th International Conference on Computing in High Energy and Nuclear Physics 2021. Link
4. Distance-Weighted Graph Neural Networks on FPGAs for Real-Time Particle Reconstruction in High Energy Physics. Front. Big Data 3. 2020. Link
5. S.R. Qasim, J Kieseler, Y Iiyamaa, M. Pierini. Learning representations of irregular particle-detector geometry with distance-weighted graph networks. European Physical Journal C. 2019. Link, Code
6. S.R. Qasim. H Mahmood. F Shafait. Rethinking table parsing using deep learning. The 15th International Conference on Document Analysis and Recognition. 2019. Link, Code
7. A Gilani, S.R. Qasim. I Malik. F Shafait. Table Detection using Deep Learning. The 14th International Conference on Document Analysis and Recognition. 2017. Link

## Other Education

2014–2019 **Bachelor of Engineering at School of Electrical Engineering and Computer Science**, *NUST (National University of Sciences and Technology)*, Islamabad.

- Took a gap year after 7th semester (2018) to join CERN as a technical student. Rejoined in February 2019.

## Teaching/Supervision

Fall 2017 **Teaching Assistant**, *Course of data structures and algorithms*.
Helped with evaluation, designing problems, semester project and resolving queries.

Spring 2019 **Teaching Assistant**, *Course of research methodology*.
Helped with grading of assignments.

## Skills

Languages C++, Python, Java

Others TensorFlow (including the backend), CUDA, PyTorch, Geant4, Numpy, NetworkX, OpenCV, Linux, MATLAB, Databases (SQL), Android, Boost, HPC, Adobe Illustrator and more

## Non-professional interests

Bouldering and reading pop science