

# My Research and I

*...and maybe you as well*

Syed Waqar Nabi

[syed.nabi@glasgow.ac.uk](mailto:syed.nabi@glasgow.ac.uk)

<https://waqarnabi.github.io/>

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Me, me, me

- 2009 - Engineering Doctorate in System Level Integration
- 2009 – 2014: Mostly teaching and academic admin in Pakistan
- 2014 – 2020: Post-doc at Glasgow
- 2020 onwards: Lecturer at Glasgow
  - 2023-24: Secondment in the industry
- Member of:
  - Systems Research Section (GLASS)
    - Low-Carbon and Sustainable Computing Theme
  - Education & Practice Research Section (EAP)
    - Skills and Competencies Research Group

# Two Broad Areas of Research

## 1. Computing **Systems** (Systems Research Section)

- **Heterogeneous** Computing
  - Scientific Computing, High-performance Computing
- **Optimization** of Computing Systems
  - Focus on: Low-carbon and Sustainable Computing
  - Also: Performance, Energy, Resources

## 2. Computing **Education** (Education & Practice Research Section)

- Competency-based Education, Work-based Learning
- Computing Education in Low- and Middle-Income Countries (LMICs)

Cross-cutting theme: **Sustainability, Responsibility and Equity** in Computing **Education** and **Practice**

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# UN Sustainable Development Goals (UNSDGs)



**4** QUALITY  
EDUCATION



**10** REDUCED  
INEQUALITIES



**13** CLIMATE  
ACTION



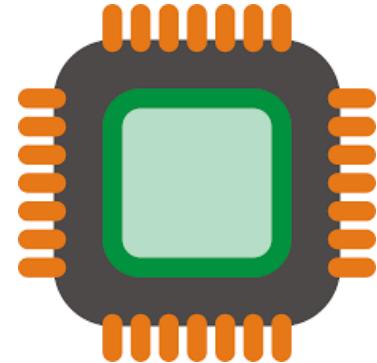
**17** PARTNERSHIPS  
FOR THE GOALS

# Computing Systems

# Computer Systems – Heterogeneous Computing

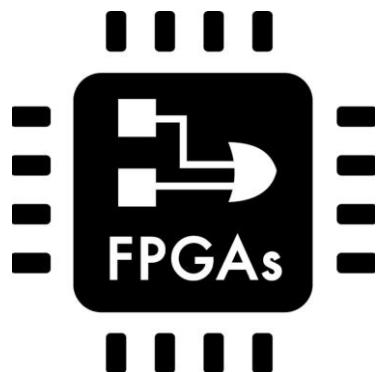
## What?

- Use heterogeneous devices for **various workloads** (e.g. scientific workloads, AI workloads)
- Make it **easier** to program and more **efficient**

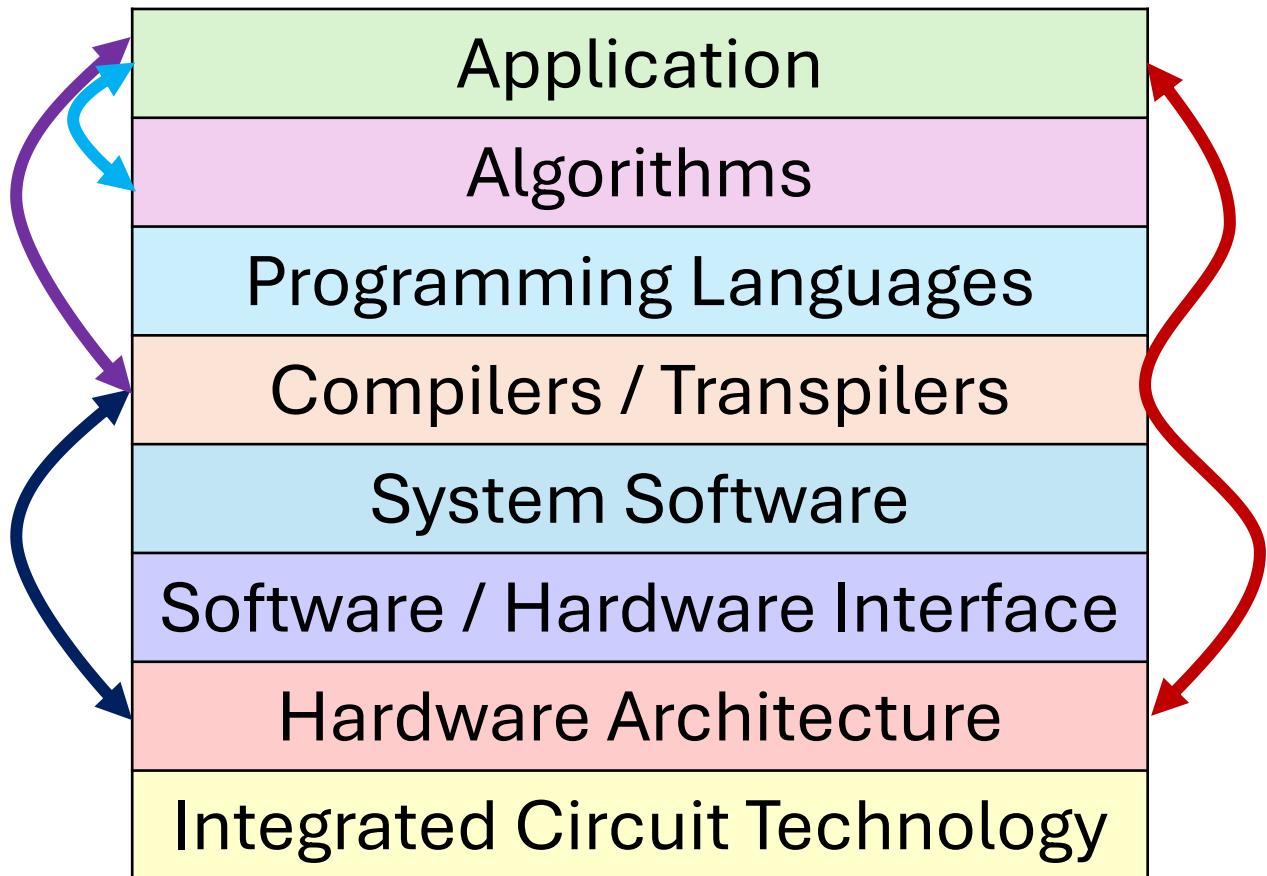


## How?

- Making smarter tools and compilers for **Heterogeneous Computing**
  - Finding patterns in code
  - Predicting performance
  - Source-source translations
  - Back-end code generation
  - Front-end APIs and DSLs (standard, custom)
  - In-house, on the cloud
  - Embedded/edge devices
- Static **and** dynamic tuning



# Computer Systems – Cross-Layer Optimization



- Integrating optimization across layers presents opportunities (and challenges!)
- Optimization can be for:
  - Performance (Latency, Throughput)
  - Resources (compute, memory)
  - Energy
  - Carbon footprint
  - Functionality
  - Programmability / Portability

# Some PhD Projects

## Completed or On-going

- Compiler / Hardware Co-design for Irregular Code Patterns
- 3D Medical Imaging for Resource-Constrained Environments
- RISC-V<sup>1</sup> extensions for energy-efficient DNN Models
- Efficient Deep Learning on the Edge

## Proposed

- Dynamic, Heterogeneity-Aware Energy Optimization of Scientific / AI workloads
- Optimizing High Throughput Computing for Physics Experiments using Accelerators
- Energy-Efficient Database Management Systems
- Accessible Computing for Modelling Climate Change and Mitigation for LMICs

<sup>1</sup>an open-source, extensible CPU architecture

# Computing Education



# Computing Education

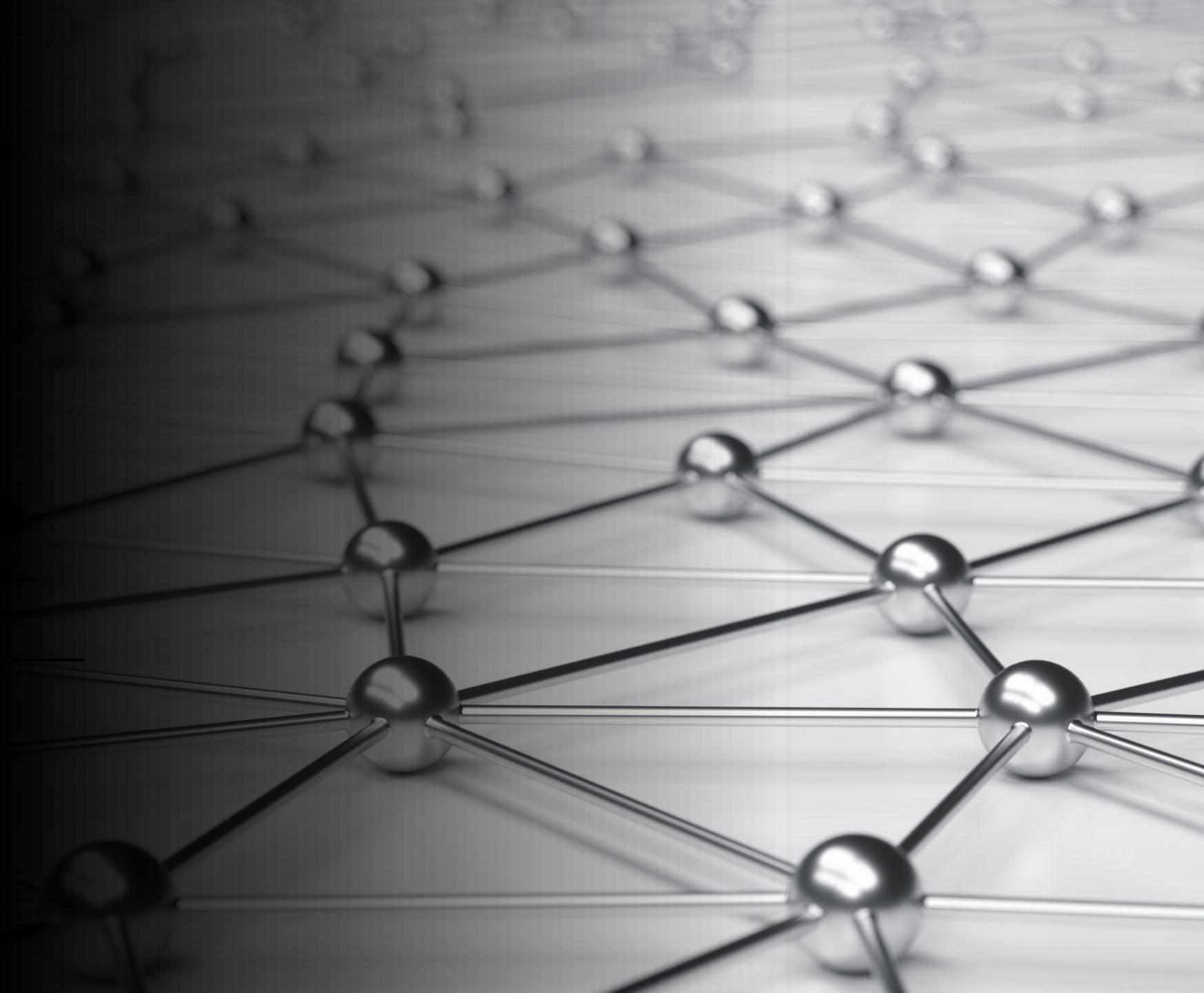
## Focus Areas

- Competency-Based Education, Mastery Learning
  - Responsible use of AI
- Addressing Disparities in Computing Educational Attainment
  - Focus on Low- and Middle-Income Countries

## Phd Projects

- On-going
  - Test-driven Approaches for Comprehending Code in Novice Learners
  - LLMs as Virtual Lab Assistants
- Proposed
  - Evaluating Responsible AI Use for Enabling Mastery Learning
  - AI for addressing disparities in Computing Education

# Network



# Colleagues I co-supervise PhD Students with

- Prof Wim Vanderbauwhede
- Dr Nikela Papadopoulou
- Dr Lauritz Thamsen
- Dr Jose Cano Reyes
- Dr Maria Kallia
- Dr Mireilla Bikanga Ada
- Dr Fani Deligianni
- Dr Hasan Abbas (Engineering)

# Thank you!

[syed.nabi@glasgow.ac.uk](mailto:syed.nabi@glasgow.ac.uk)

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