Rogues Gallery: A Community Research Infrastructure for Post-Moore Computing

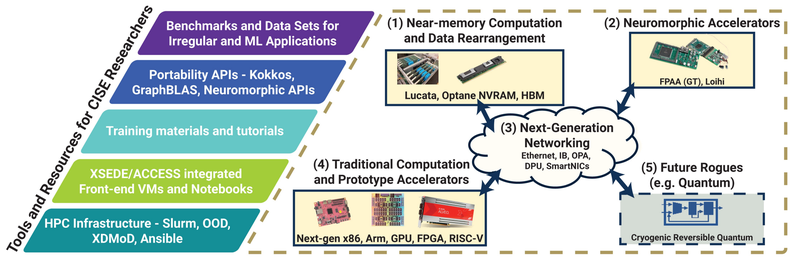
PIs: Jeffrey Young, Tom Conte, Ada Gavrilovska, Jennifer Hasler, Richard Vuduc
SP: Alex Daglis Contributors: Sterling Peet, Will Powell, Aaron Jezghani

Georgia Tech

OAC #2016701

Project Motivation

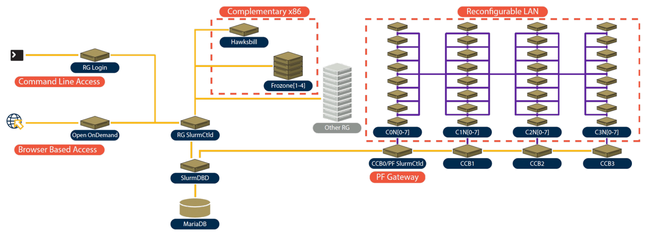
The Rogues Gallery (CRNCH RG) is a community testbed effort focused on developing our understanding of next-generation hardware with a focus on unorthodox and uncommon technologies. These ***"rogues"*** are often highly heterogeneous yet poorly supported for today's scientific researchers. The Rogues Gallery enables researchers to make better use of next-generation technologies by combining tools, training, library development, and infrastructure.



The Rogues Gallery Incorporates Hardware, Software, and Training to Enable New Scientific Use Cases

Infrastructure Development

- The Rogues Gallery contains **40 servers and 40+ development** boards – Intel CLX, SKL, ICX; AMD/NVIDIA GPUs; Arm; RISC-V; Xilinx
  - Extreme heterogeneity with GPU, FPGAs, FPAAs, Optane Memory, InfiniBand, OmniPath, and Ethernet networking
  - Libraries, tools, and benchmarks accelerate new research projects
- Running latest Slurm and Open OnDemand (OOD)
  - Nine different Slurm clients run across x86, Arm, GPU, and RISC-V platforms!
- Collaboration with Partnership for Advanced Computing Environments (PACE) enables containers, novel architecture workflows, and migration to larger ACCESS systems.



Rogues Gallery workflows incorporate emulation and execution capabilities with support for web-based Jupyter notebooks and visualization.

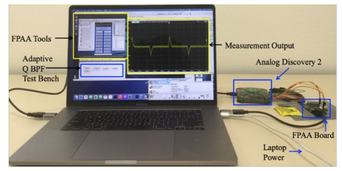
Program Highlights

- First deployment of A64FX with OOD, later adopted by RIKEN for Fugaku
- Largest public instance of Lucata Pathfinder - #211 on 2021 Graph500 and #46 on GreenGraph500 rankings
- Support for over 150 researchers and 50-60 external users across multiple areas

- 100+ tutorial attendees
- 100s of supported students

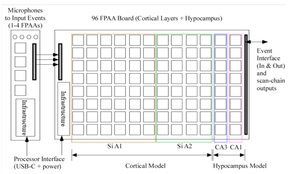
Research Contributions

- The testbed has supported over 20 research papers since its inception [1] and 4 papers on novel architecture workflows
- Research work spans applications for near-memory computing (CXL, Lucata, Optane) to graph-based accelerators (FlowGNN, etc.) and neuromorphic accelerators
- The Field Programmable Analog Array (FPAA) from Co-PI Hasler's group has continued to evolve with support for analog and neuromorphic applications
  - New hardware supports easier programming and larger designs
  - Python and Xcos support a fully open-source CLI and graphical workflow for the FPAA
  - Utilized in multiple classes like Analog VLSI (2020,2022,2024)

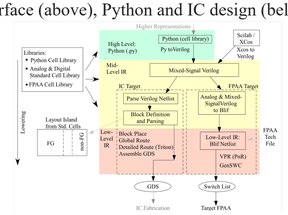


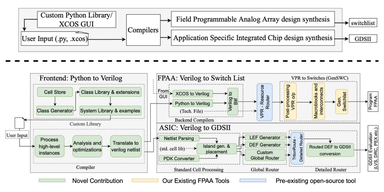
FPAA Tools and Experiment on Single Laptop

Next generation tools: graphical with Xcos interface (above), Python and IC design (below)



Large-scale FPAA on a single board



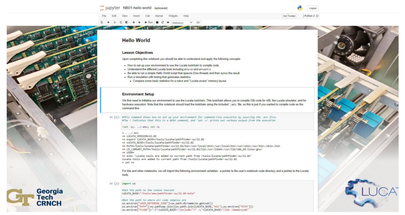


Open-source Python-Based FPAA Workflow

External Outreach and Training

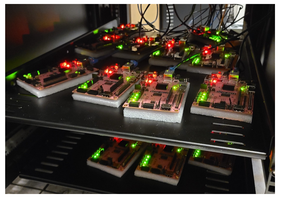
- The testbed has supported 10 tutorials across venues including SC, HPEC, ASPLOS, Telluride, MICRO, PEARC
  - Tutorials supported by custom Jupyter notebooks and Open OnDemand interface
  - Collaborative tutorials developed with Lucata, NVIDIA, UCF and other companies
- Multiple Birds of a Feather, Arm HPC workshops, and other sessions on novel architectures at SC and ISC

2023 Vortex GPGPU Tutorial

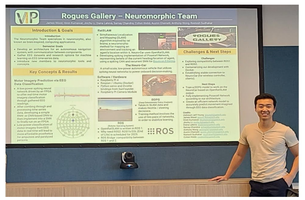


Custom notebook for HPEC Lucata Pathfinder tutorial

Educational Impacts



PYNQ Cluster Supports Large Classes



Rogues Gallery VIP Poster Presentations

- First of its kind PYNQ FPGA cluster supports 80-130 students per semester for undergraduate and graduate coursework
- Vertically Integrated Project (VIP) Class supports 30 students per semester, growing from an initial cohort of 9 students
- Student efforts are key to improve Rogues Gallery infrastructure including documentation and training notebooks

Learn More about Rogues Gallery

Main CRNCH Rogues Gallery Website: crnch-rg.cc.gatech.edu
CRNCH Rogues Gallery Publications: crnch-rg.cc.gatech.edu/crnch-rg-publications [1]