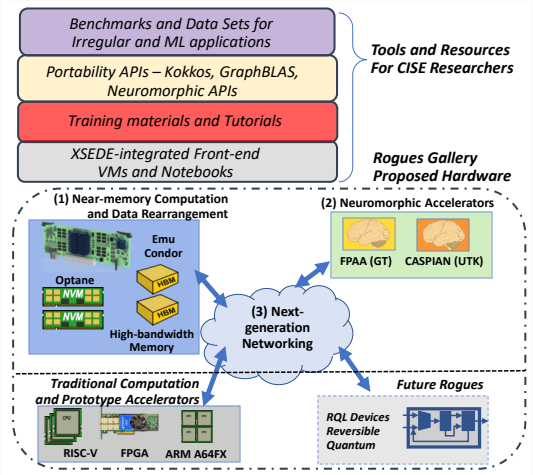
Rogues Gallery Updates and Enabled Research

Rogues Gallery Directors: Jason Riedy (CSE), Jeffrey Young (CS)

Center for Research into Novel Computing Hierarchies at Georgia Tech

31 January 2020

Rogues Gallery



- Rogues Gallery: Community testbed for new, unique architectures
- Available for students, industry, and government partners
- Hardware *plus* GT tools and APIs
  - Habanero runtime, Kokkos API for the Emu, Spatter and STINGER benchmarks
- Training and education: Key pillars! External tutorials, VIP class at GT

Enabled Research

CISE Enabled Research Pillars

Sparse/Irregular HPC
- Graph analytics
- Scientific Computing
- Database and Big Data Acceleration

HW/SW Codesign
- Polyhedral compilation,
- Design of libraries, runtimes, APIs for novel devices
- Benchmarking and characterization

Machine Learning
- Low-power edge AI
- Autonomous vehicles
- SLAM for robotics
- Dynamic and life-long learning

Next-generation Networking
- 5G software stacks
- Edge computing services
- In-situ and encrypted data analysis
- Data reduction and line-speed DSP

Rogues Gallery Hardware and Software Support

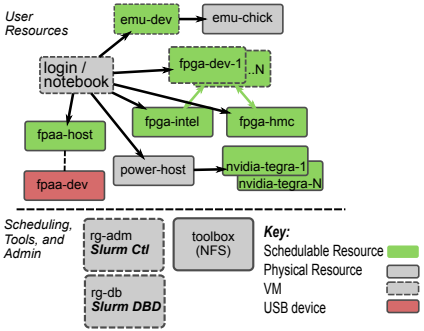
- Emu Pathfinder
- FPGA+HBM
- CASPIAN
- Tensor, Streaming Graph APIs
- ARM A64FX

- Emu Pathfinder
- FPGAs + RISC-V
- Optane
- Kokkos, Habanero-C runtimes

- FPAA and CASPIAN
- EMU Pathfinder
- FPGAs
- RASP/TENNLab SW
- Emu Scikit-learn

- Ettus USRP-2947 and Ettus E-320
- Mellanox Bluefield NICs
- FPGAs
- FPAA and CASPIAN

Current Infrastructure



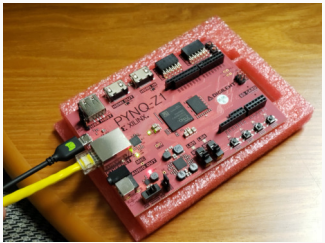
Will Powell, Jason Riedy, Jeffrey S. Young, and Thomas M. Conte. 2019. Wrangling Rogues: A Case Study on Managing Experimental Post-Moore Architectures. PEARC 2019.

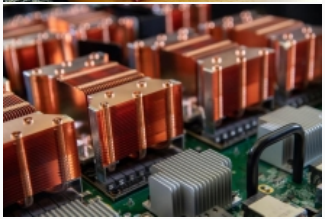
- Limit the use of physical resources to novel hardware
- Use CoC VM pool wherever possible for tools, debugging, support
- Schedulable queues and reservations! *(In progress)*

Recent Acquisitions

Rogues Gallery has brought online new rogues and next-generation hardware

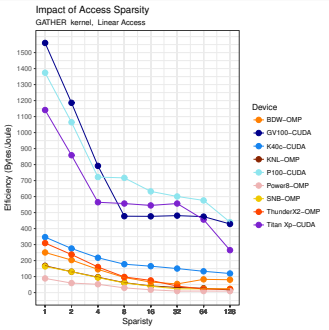
- Available for students (technology fee)
  - Intel and Xilinx FPGAs in many form factors
  - PYNQ for neuromorphic work via Nengo
  - POWER9 + 4×V100
  - DGX-1, DGX station
- Coming soon, IDEaS's HIVE collaboration: Arm A64FX mini-cluster

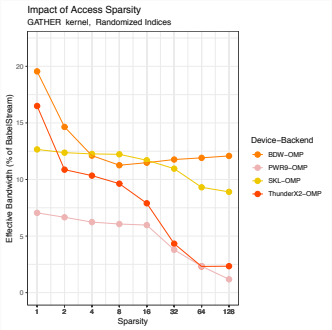


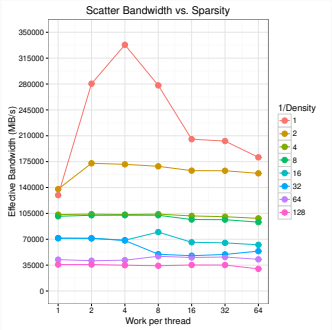


Benchmarking: spatter.io

Parameterized gather/scatter benchmark, already used in industry.







OpenMP, CUDA Backends; SyCL, HIP, and Kokkos backends coming soon!

Student Education

Vertically Integrated Project: Undergraduate research opportunity for *a grade*; teams are self-directed with guidance from faculty.

`http://vip.gatech.edu/`

Current projects (15 students, 8 continuing):

- NeuroCar: Drive a rally care neuromorphically rather than w/GPU
- Quantum optimizations: Extend ORNL's XACC for better HW mapping
- Secure branch prediction: No-history, based on register file
- Emu: Parallel primitives and ML

And the student **Quantum Computing Association**!

Tutorials and More

- Tutorials in 2019: ASPLOS and PEARC
  - Materials available at `https://crnch-rg.gitlab.io/`
  - Slides, Jupyter notebook and setup
- CRNCH supports and helps host the “Advanced Architecture Testbeds BoF” each year at SuperComputing

Upcoming three-session MS at SIAM PP along with ExxonMobil

Acknowledgments

Fantastic students and colleagues:

- Srinivas Eswar (GT CSE)
- Dr. Eric Hein (GT ECE ⇒ Emu)
- Patrick Lavin (GT CSE)
- Dr. Jiajia Li (GT CSE ⇒ PNNL)
- Abdurrahman Yaşar (GT CSE)
- Dr. Ümit Çatalürek (GT CSE)
- Dr. Tom Conte (GT CS/ECE)
- Dr. Bora Uçar (ENS Lyon CNRS)
- Dr. Rich Vuduc (GT CSE)
- **Undergraduates → interns!**

Code, tutorials: `https://gitlab.com/crnch-rg`

Related “advanced architecture” testbeds:

- ORNL: ExCL
- PNNL: CENATE
- Argonne
- Sandia: HAAPS
- Berkeley: AQCT

Rogues Gallery: Active and Growing

- Added FPGA resources and more
- Continued integration of existing resources (Emu, FPAA, *etc.*)
- Tight collaboration with industry, labs, and standards
  - IEEE 754-2019 recommends primitives for multi-precision
- Ongoing community outreach and education
- **Students going to industry, labs, internships…**

CRNCH Rogues Gallery connects researchers *and students* with novel architectures and architects with upcoming applications.

Let us host / manage your neat stuff!

`http://crnch.gatech.edu/rogues-gallery`