ML4FE Discussion Session

Julia Gonski

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ML4FE Workshop

Emergent Topics: Technology (Day 1)

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- 📌 Keeping up with the latest in **commercial technology**; eg. Groq tests
- 📌 Tools for synthesizing advanced ML strategies; ex. **streaming, structured pruning, high-granularity quantization**
- 📌 Lack of **cross-system design**, particularly in HEP: avoid boxing into front-end vs. trigger vs. offline
  - 📌 **Full differentiable DAQ design/optimization** with data rates, costs, etc.
    - Proof-of-concept: optimize FPGAs for algorithm distribution?
  - 📌 **Classical vs. ML comparisons** (performance, resources…)
- 📌 **eFPGAs**: "radiation damage *requires* retraining"
  - Concrete metrics; ex. FPGA vs. eFPGA comparison + largest possible size recticle
  - 📌 **Analog compute?**

Emergent Topics: Physics Applications (Day 2)

- Physics: enabling advanced future detectors (4D tracking, 5D high granularity calorimetry, streaming EIC)
  - 📌 **3D integration** of advanced sensors (ex. AC-LGADs for precision timing) + intelligence
- Physics: Higgs + flavor physics, b-tagging
  - 📌 **Smart pixels**: training in ASIC? Differentiable optimization (inc. power management?) Smart MAPS? (L Grey)
  - Super high data rate handling = 📌 **rad-hard silicon photonics**
- Physics: quantum sensors/networks
  - Intelligence in cold electronics; ex. real-time control/stability for **smart quantum devices**
- Physics: accelerator design, optimization, tuning
  - 📌 **Digital twins/surrogates?**
- 📌 **AI-enhanced chip design:** timing closure, verification, etc.

Towards a White Paper

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- A white paper on the arXiv discussing workshop outcomes and R&D thrusts for ML4FE could help us 1) organize internally & 2) underline the importance for funding agencies
  - Ex. HEP community ML white paper [1807.02876] (<20 pages), Fast ML white paper [2110.13041]

- "Edge and Heterogenous Machine Learning Hardware Systems for HEP"
- Proto-outline:
  - Introduction
  - Technologies & Tools → Day 1
  - Physics & Applications → Day 2
  - Key R&D Areas

➡ ***If interested in helping with writing/editing, please reach out!***

Proposal Concepts

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- Want to be well-prepared and nimble in the event that AI funding opportunities are released later this year
  - Pre-fabbed “proposal concepts” with PI collabs and rough ideas/deliverables/resources would be useful here

- **Discussion:**
  - Any emergent themes you agree/disagree with or that I missed?
  - Any that were discussed, but fit better in other scopes?
  - What are critical other groups to engage with?
  - Any other thoughts/comments/questions/ideas?

Backup