Designing an optimal deep learning solution at Dell EMC

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Agenda

HPC Innovation Lab Update
Deep Learning at Dell
Dell EMC HPC Innovation Lab charter

**Design, develop and integrate HPC systems**
- Flexible reference architectures
- Systems tuned for research computing, manufacturing, life sciences, oil and gas, etc.

**New Investment:**
- More SMEs, huge innovation ecosystem

**Act as the focal point for joint R&D activities**
- Technology collaboration with partners for joint innovation
- Research coordination with DSC, COEs and customers

**HPC Innovation Lab**

**Prototype and evaluate advanced technologies**
- HPC+Cloud, HPC+Big Data
- Processors, Accelerators, File systems, software, etc.

**Conduct application performance studies and develop best practices**
- White papers, blogs, presentations
- [www.hpcatdell.com](http://www.hpcatdell.com)

**Technical briefings, tours, remote access**
HPC Innovation Lab

13K sqft facility with 1300+ servers and ~10PB storage dedicated to HPC research, development and innovation in collaboration with Dell HPC community

Zenith

- Top500 system based on Intel Scalable Systems Framework (OPA, KNL, Xeon, OpenHPC)
- 544-nodes total system size
- 384-nodes with dual 6148 processors, 160-nodes C6320p with Intel Xeon Phi (KNL) processors and non-blocking OPA fabric
- 538 TFlops sustained performance (#373 on Top 500)

Rattler

- Research/development system in collaboration with Bright Computing, Mellanox, nVidia
- 84 nodes with IB EDR and 6148 processors
- 13 nodes with Accelerators (P100, PSXM2, P40, P4, V100, V SXM2)
Deep Learning @ Dell
DL Landscape and Current Challenges and Responsibilities

• Too many parameters to tune, easy to get wrong answers:
  – Frameworks: Caffe2, TensorFlow, MXNet etc.
  – Networks: AlexNet, GoogleNet, Inception, ResNet
  – Parameters: batch size, epoch, learning rate, prefetch rate, shuffle, Compressed vs un etc.
  – Two phases: Training & Inference
  – Software ecosystem: Application updates and OS support

• Meaning of Deep Learning, Machine Learning and AI
  – Justifying results

• Learning Curve
  – Hardware and software ecosystems and Expertise
    › Xeon, Xeon Phi, GPU, KNM
  – Challenges vary as hardware and software vary
  – Porting existing models is hard

• Scalability questions and distributed Training
  – Intel Labs 9600 Xeon Phis
  – 768 node Xeon Phi scalability by Intel Labs and SurfSara
1. SKL improves performance of different models by ~50% and more compared to BDW for several NNs
2. Processor used is 6142(16c 2.6) and 2697 v4(18c, 2.3)
Intel Caffe Deep Learning Performance on SKL – Aug 17

- KNL and top bin SKL perform similarly for deep learning Frameworks
- 6148 good medium for performance as well as performance/W
• Performance has been improving with subsequent versions of Intel Caffe
Intel Caffe SKL scalability:

• Results shown are best performance numbers after hyper parameter sweep for each node count.
  • Thread count, batch size, prefetch size, learning-rate etc
• Intel Caffe 1.0.4, Imagenet compressed lmdb dataset, /dev/shm, Resnet_50_8k_batch model, MKL DNN, MLSL, SKL 6148, OPA, 192 GB memory
Intel Optimized Caffe KNL Scalability

- Results shown are best performance numbers after hyper parameter sweep for each node count.
  - Thread count, batch size, prefetch size, learning-rate etc
- Intel Caffe 1.0.4, Imagenet compressed lmdb dataset, /dev/shm, Resnet_50_64_nodes_8k_batch model, MKL DNN, MLSL,KNL-F 7230, OPA, 192 GB memory, 60 threads, Cache mode
Storage Subsystems: NFS Scaling

![Diagram showing CAFFE scalability - KNL (resnet_50) with images/sec on the y-axis and No. of nodes on the x-axis. The diagram illustrates the performance improvement with increasing number of nodes.](image)
Storage Subsystem evaluation

- Results shown are best performance numbers after hyper parameter sweep for each configuration.
- Intel Caffe 1.0.4, Imagenet compressed lmdb dataset, /dev/shm, Resnet_50_64_nodes_8k_batch model, MKL DNN, MLSL, SKL 6142/6148, OPA, 192 GB memory, HDD 1Tb Sata, SSD, 2x 400GB Raid0
Resnet_50: Impact of thread count on BDW at 4 nodes

- Optimize for the platform. 30 threads out performs fully subscribed nodes.
- MLSL library needs some dedicated cores for optimal performance
Containerization

- Results within run to run variation as well as node to node variation
- Gold 6148, 192 GB, Compressed Imagenet, /dev/shm, Resnet_50_8k_batch model. Singularity 2.3.1