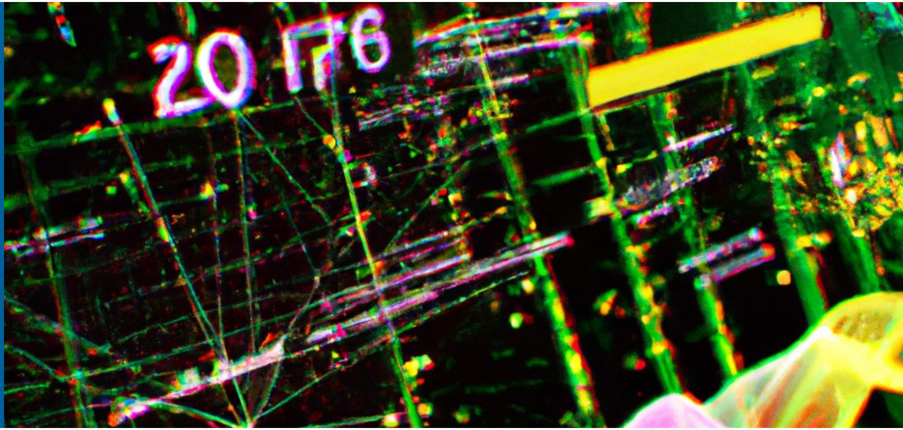
ATPESC 2023 – TRACK : MACHINE LEARNING

Argonne NATIONAL LABORATORY

INTRODUCTION TO AI TESTBEDS AT ALCF AND HANDS-ON



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U.S. DEPARTMENT OF ENERGY
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ALCF AI Testbed

https://www.alcf.anl.gov/alcf-ai-testbed

Cerebras CS-2

SambaNova DataScale SN30

Graphcore
Bow Pod64

Habana
Gaudi1

GroqRack

- Cerebras: 2 CS-2 nodes, each with 850,000 Cores, compute-intensive models
- SambaNova: DataScale SN30 8 nodes (8 SN30 RDUs per node) - 1TB mem per device, models with large memory footprint
- Graphcore: BowPod64 4 nodes (16 IPUs per node) - MIMD, irregular workloads such as graph neural networks
- GroqRack: 8 nodes, 8 GroqNodes per node - inference at batch 1
- Habana Gaudi1: 2 nodes, 8 cards per node - On-chip integration of RDMA over Converged Ethernet (RoCE2), scale-out efficiency

ALCF AI Testbed

https://www.alcf.anl.gov/alcf-ai-testbed

Cerebras CS-2

SambaNova DataScale SN30

Graphcore Bow Pod64

Learn about Architectures

Track 1 – Hardware Architectures
Advancing Scientific Machine Learning with AI Accelerators in ALCF AI Testbed
Murali Emani

Learn about Dataflow

Track 1 – Hardware Architectures
Introduction on DataFlow Architectures and Trends
Jose Monsalve Diaz, Sid Raskar

Director's Discretionary (DD) awards support various project objectives from scaling code to preparing for future computing competition to production scientific computing in support of strategic partnerships.

Getting Started on ALCF AI Testbed:

Apply for a Director's Discretionary (DD) Allocation Award

Cerebras CS-2, SambaNova Datascale SN30 and Graphcore Bow Pod64 are available for allocations

[Allocation Request Form]

[AI Testbed User Guide]

cerebras

CEREBRAS WAFER-SCALE ENGINE (WSE-2)

Still the Largest Chip Ever Made

850,000 cores optimized for sparse linear algebra

46,225 mm² silicon

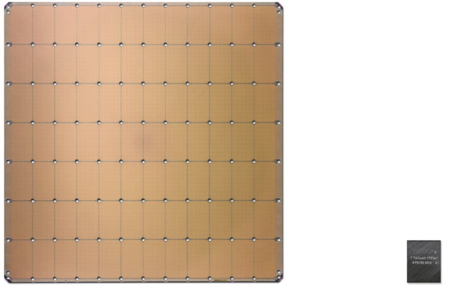
2.6 trillion transistors

40 gigabytes of on-chip memory

20 PByte/s memory bandwidth

220 Pbit/s fabric bandwidth

7nm process technology



Cerebras WSE-2
2.6 Trillion Transistors
46,225 mm² Silicon

Largest GPU
54.2 Billion Transistors
826 mm² Silicon

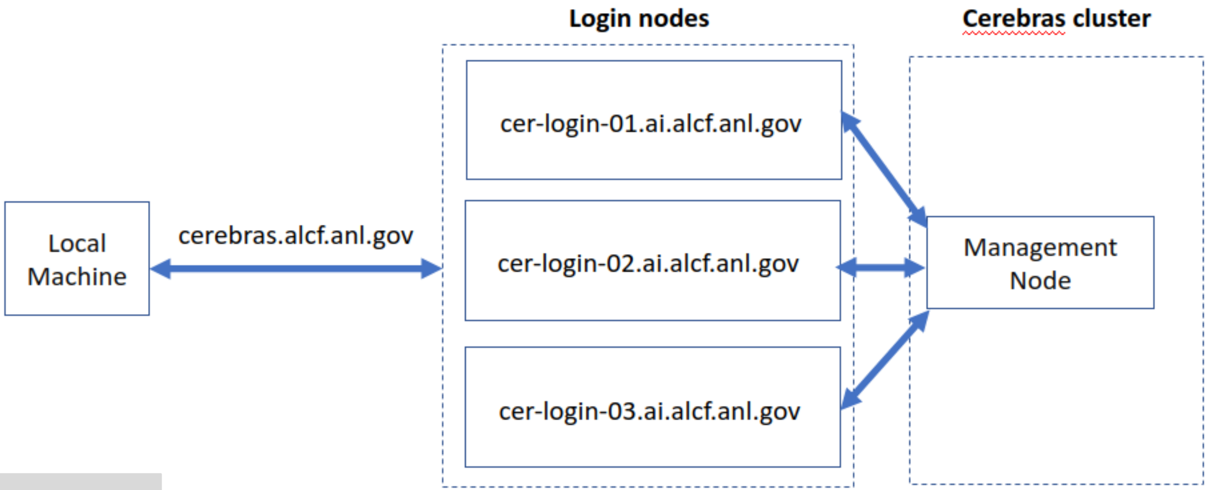
Cluster-scale performance in a single chip

CEREBRAS SYSTEMS AT ALCF

- 2-node Wafer-Scale Cluster
  - Supporting up to 30BN parameter models
  - Computer Vision and NLP optimized
  - 2x CS-2s, with:
    - 850k cores each
    - 40GB on chip memory each
  - Can distribute jobs across one or both CS-2s, with data parallel scaling when using both machines

CONNECTION TO A CS-2 NODE

https://docs.alcf.anl.gov/ai-testbed/cerebras/getting-started/



Log in to Login Node

```
$ ssh ALCFUserID@cerebras.ai.alcf.anl.gov
$ Password: <MobilePass+ Code>
```

ENVIRONMENT SETUP

Cerebras virtual environments

```
$ /software/cerebras/python3.8/bin/python3.8 -m venv venv_pt
$ source ~/venv_pt/bin/activate
$ pip3 install --disable-pip-version-check /opt/cerebras/wheels/cerebras_pytorch-
1.9.1+1cf4d0632b-cp38-cp38-linux_x86_64.whl --find-links=/opt/cerebras/wheels/
$ pip install numpy==1.23.4
$ pip install datasets transformers
```

On subsequent logins

```
$ source venv_pt/bin/activate
```

WORKFLOW

- **Compile**
  - Compiles are done automatically when no usable cached compile is found for the model.
  - Maps the resources required to run an application to a CS-2 wafer.
  - Significant compile times for large models.

- **Run**
  - Execution of a compiled model using
    - One or more CS-2s.
    - Support nodes in the CS-2 cluster.

EXAMPLE PROGRAMS - MODELZOO

Clone Cerebras Modelzoo

```
$ mkdir ~/R_1.9.1
$ cd ~/R_1.9.1
$ git clone https://github.com/Cerebras/modelzoo.git
$ cd modelzoo
$ git tag
$ git checkout Release_1.9.1
```

https://github.com/Cerebras/modelzoo.git

TYPICAL ANATOMY OF A MODEL IN MODEL ZOO

run.py	Main script to execute train, eval, prediction in CS-2 or GPU
configs/	Folder with different parametrizations of the model in .yaml files
model.py	Creation of the NN model function
utils.py	Helper functions to set up run.py
data.py	Helper functions to prepare data

EXAMPLE PROGRAM – MNIST / PIPELINED

Goto Example Directory

```
$ cd ~/R_1.9.1/modelzoo/modelzoo/fc_mnist/pytorch/
```

Activate the environment.

```
$ source venv_pt/bin/activate
```

Compile and Run

```
$ export MODEL_DIR=model_dir
$ if [ -d "$MODEL_DIR" ]; then rm -Rf $MODEL_DIR; fi

$ cp /software/cerebras/dataset/fc_mnist/pytorch/configs/params.yaml.modified configs/

$ python run.py CSX pipeline --job_labels name=pt_fc_mnist --params
configs/params.yaml.modified --mode train --model_dir $MODEL_DIR --mount_dirs /home/
/software --python_paths /home/$(whoami)/R_1.9.1/modelzoo --compile_dir /$(whoami) |& tee
mytest.log
```

IMPORTANT DIRECTORY PATHS AND LINKS

Cerebras Modelzoo Repository
https://github.com/Cerebras/modelzoo.git

Important datasets Path
/software/cerebras/dataset

AI Testbeds User Guide

Cerebras Documentation

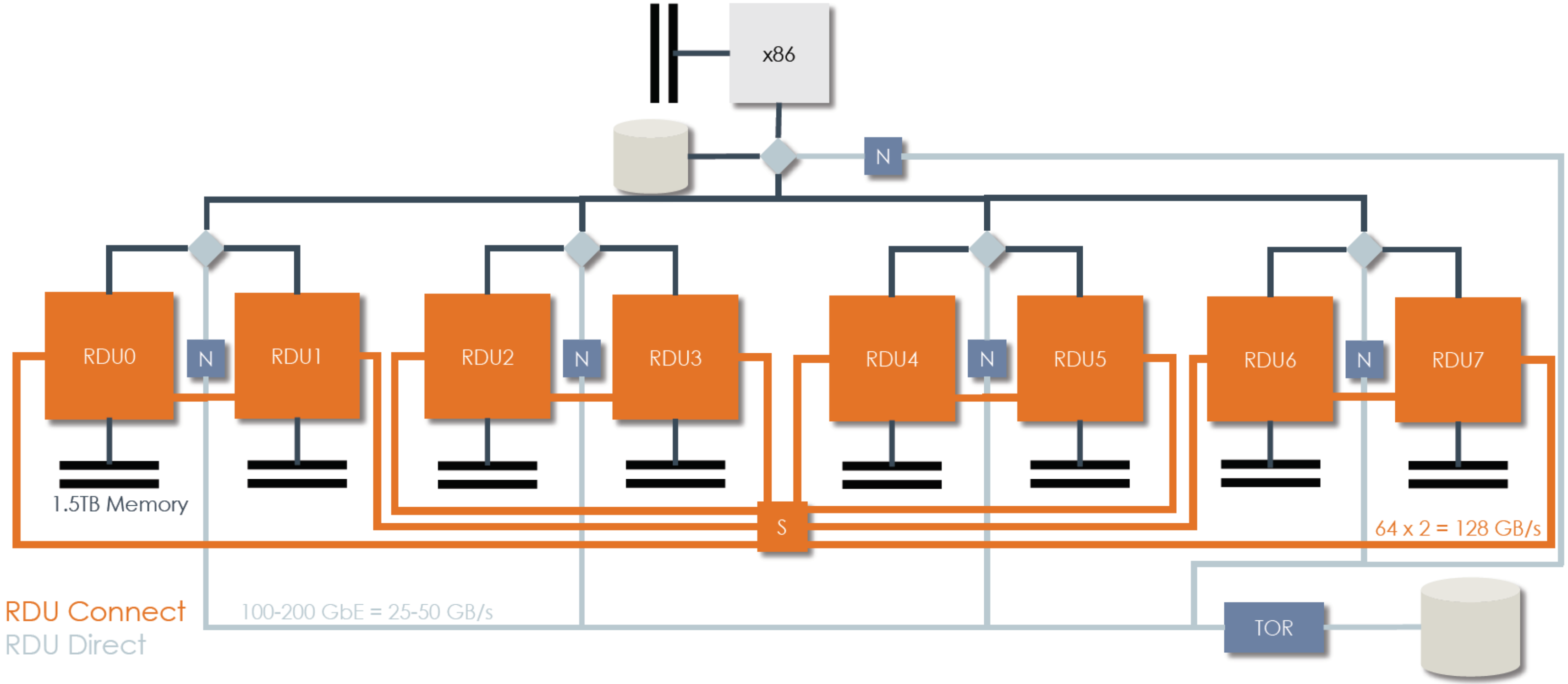
SambaNova™
SYSTEMS

SAMBANOVA CARDINAL SN30 RDU

Cardinal SN30™
Reconfigurable Dataflow Unit™

- 7nm TSMC, 86B transistors
- 102 km of wire
- 640 MB on-chip, 1,024 GB external
- 688 TFLOPS (bf16)
- RDU-Connect™

HARDWARE DESIGN



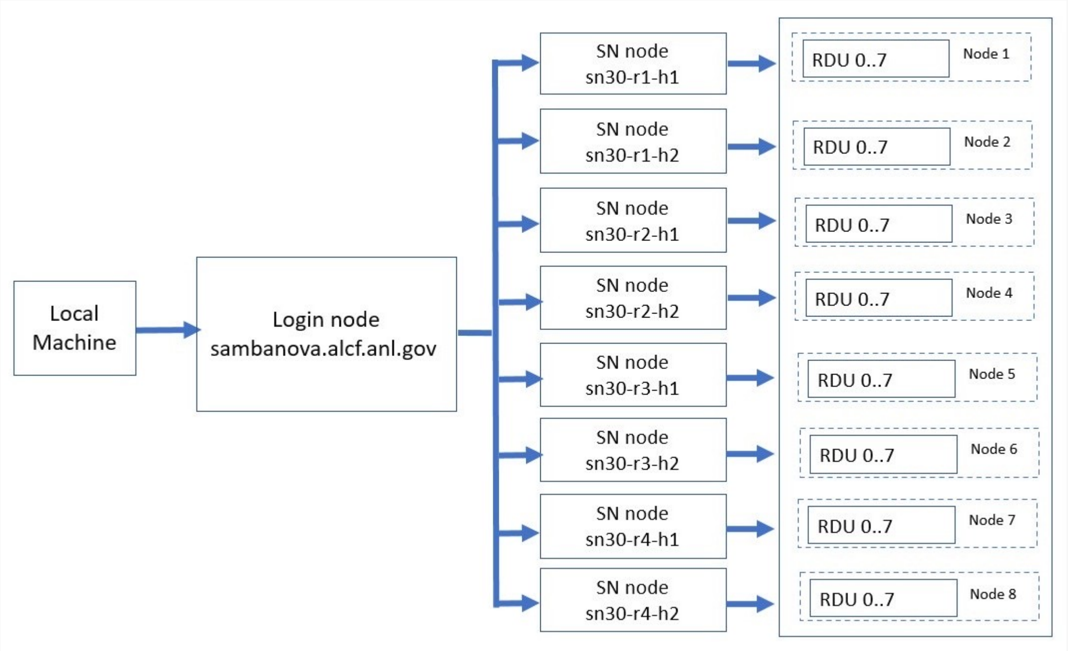
CONNECTING TO SAMBANOVA SN-30

Log in to Login Node

```
$ ssh ALCFUserID@sambanova.alcf.anl.gov
Password: <MobilePass+ Code>
```

From login node to a SN30 node

```
$ ssh sn30-r1-h1
```



ENVIRONMENT SETUP

SambaFlow software stack and the associated environmental variables are setup at login

Create Virtual Environment and Install Packages

```
$ python -m venv --system-site-packages my_env
$ source my_env/bin/activate

$ python3 -m pip install <package>
```

Pre-Built Environments

```
/opt/sambaflow/apps/
```

WORKFLOW

Compile

- Model compilation and ' **.pef** ' generation.
- Maps the compute and memory resources required to run an application on RDUs
- Re-compile only when model parameters change.
- Significant compile times for large models.

```
srun python lenet.py compile -b=1 --pef-name="lenet" --output-folder="pef"
```

Run

- Model trained on RDU using the ".pef" generated as part of compile process and the training dataset.

```
srun python lenet.py run --pef="pef/lenet/lenet.pef"
```

EXAMPLE PROGRAM: MNIST

Make a copy of the apps directory into the home directory

```
$ cp –r /opt/sambaflow/apps/ ~
```

Activate Virtual Environment

```
$ source ~/apps/starters/ffn_mnist/vene/bin/activate
```

Compile and Run

```
$ srun python ffn_mnist.py compile -b=1 --pef-name="ffn_mnist" --mac-v2
$ srun python ffn_mnist.py run -b 1 -p out/ffn_mnist/ffn_mnist.pef
```

IMPORTANT DIRECTORY PATHS AND LINKS

Sambanova Applications Path
`/opt/sambaflow/apps/`

Sambanova Model scripts
`/data/ANL/scripts/`

Important Datasets
`/software/sambanova/dataset/`

AI Testbeds User Guide

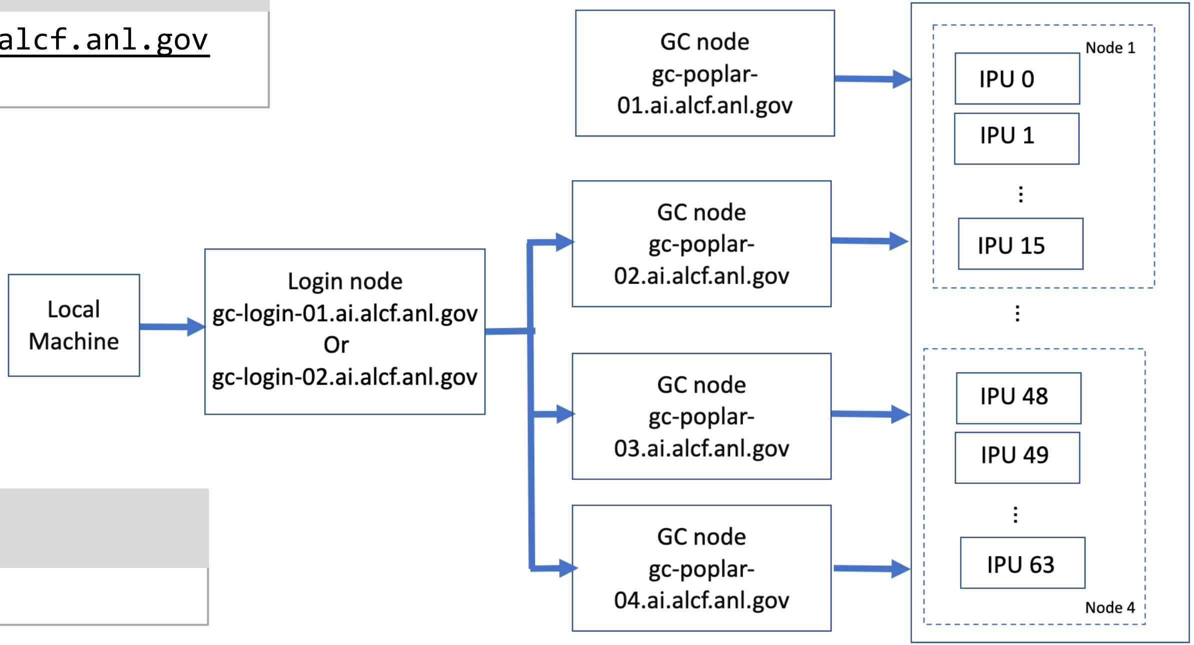
Sambanova Documentation

GRAPHCORE

CONNECTION AND LOGIN

Log in to Login Node

```
$ ssh ALCFUserID@gc-login-01.ai.alcf.anl.gov
$ Password: <MobilePass+ Code>
```



Log in to a Graphcore Node

```
ssh gc-poplar-02.ai.alcf.anl.gov
```

ENVIRONMENT SETUP

The Poplar SDK on Graphcore

```
/software/graphcore/poplar_sdk/
```

The default poplar version (3.1.0) is enabled automatically upon logging into a graphcore node.

PopTorch Environment Setup

```
$ mkdir -p ~/venvs/graphcore
$ virtualenv ~/venvs/graphcore/poptorch31_env
$ source ~/venvs/graphcore/poptorch31_env/bin/activate
$ export POPLAR_SDK_ROOT=/software/graphcore/poplar_sdk/3.1.0
$ export POPLAR_SDK_ROOT=$POPLAR_SDK_ROOT
$ pip install $POPLAR_SDK_ROOT/poptorch-3.1.0+98660_0a383de63f_ubuntu_20_04-cp38-cp38-
linux_x86_64.whl
```

EXAMPLE PROGRAMS

Clone Graphcore Examples Repository

```
$ git clone https://github.com/graphcore/examples.git
$ cd examples
```

Activate PopTroch Environment for MNIST and install dependancies

```
$ cd examples/tutorials/simple_applications/pytorch/mnist
$ python -m pip install torchvision==0.14.0
```

Run MNIST Example

```
$ /opt/slurm/bin/srun --ipus=1 python mnist_poptorch.py
```

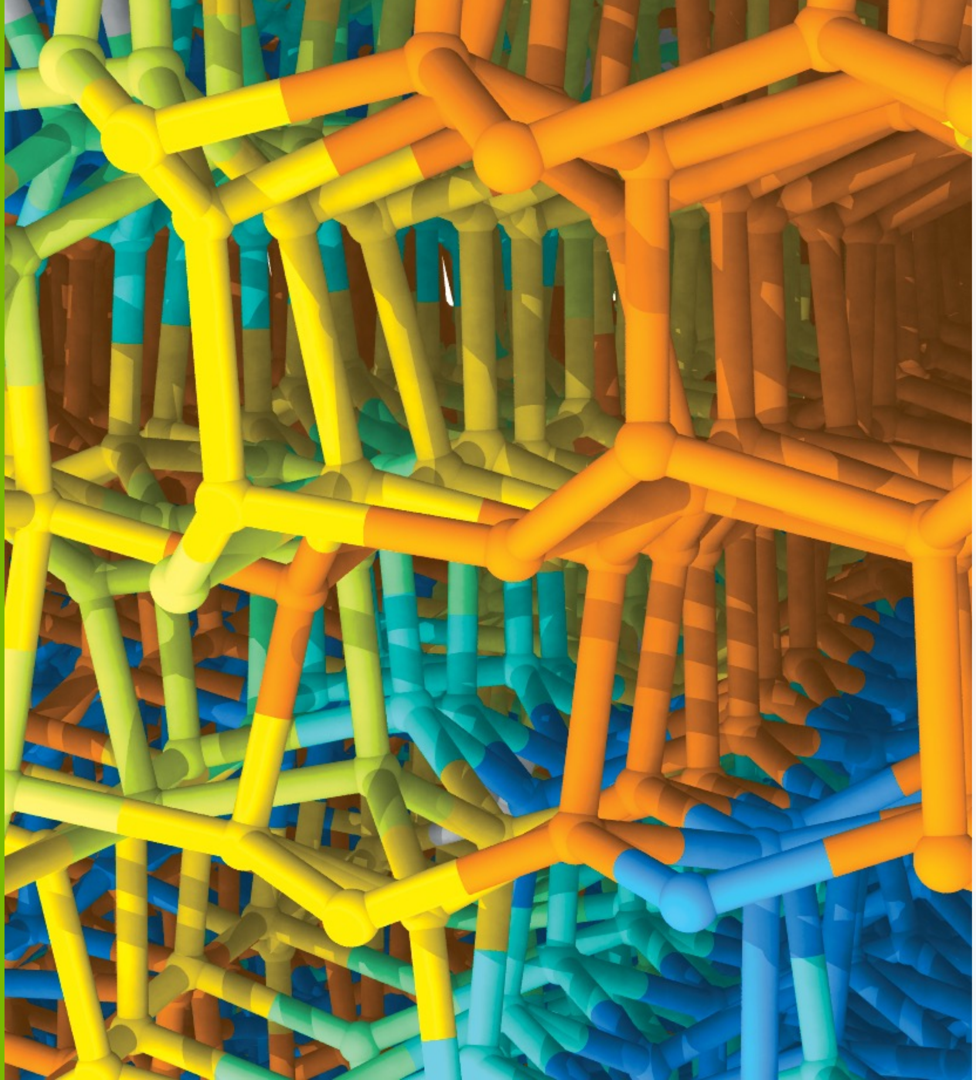
IMPORTANT DIRECTORY PATHS AND LINKS

Graphcore Exaples Repository
/opt/sambaflow/apps/

Graphcore SDK Path
/software/graphcore/poplar_sdk

AI Testbeds User Guide

Graphcore Documentation



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