

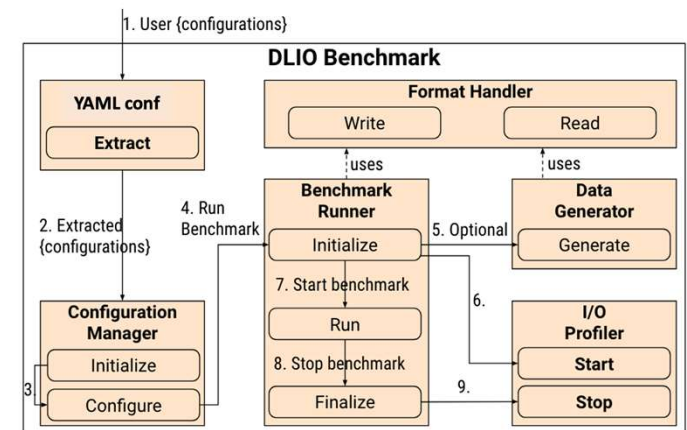
# ML WORKLOADS

# SIMULATION I/O VS AI I/O

- Simulation:
  - Collective reads/writes
  - Could be irregular, small, but never random
  - Standardization: MPI and libraries
- AI
  - Repeated reads of training model
  - No coordination among processes
  - No “middleware for AI” (yet)
  - Sometimes part of a workflow, not a single application

# DLIO: A DEEP LEARNING BENCHMARK

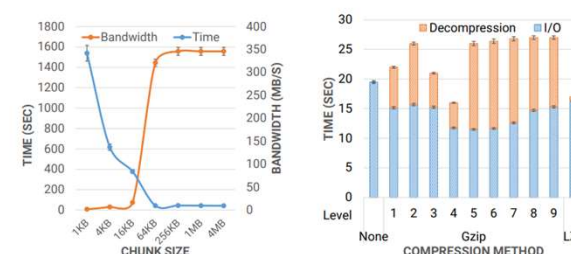
- Framework for evaluating deep learning I/O performance
- Replaces computationally intensive phases with sleep
- But performs I/O the way deep learning framework would
  - Calls “torch DataLoader” or “tensorflow.data” loaders with synthetic data
- More information:
  - [https://argonne-lcf.github.io/dlio\\_benchmark](https://argonne-lcf.github.io/dlio_benchmark)
  - [https://github.com/argonne-lcf/dlio\\_benchmark](https://github.com/argonne-lcf/dlio_benchmark)



*DLIO: A Data-Centric Benchmark for Scientific Deep Learning Applications*, Harihan Devarajan et al, CCGrid21

# DLIO TRAINING: RAPID EXPERIMENTATION

- Able to sweep across a wide range of parameters quickly
- Lessons learned in DLIO simulations apply directly to actual ML framework/workflow
- Helps improve Darshan
- Future work: integrating DLIO instrumentation with Darshan's py-darshan interface for improved reporting



Experimenting with access (“chunk”) size and compression; from *DLIO: A Data-Centric Benchmark for Scientific Deep Learning Applications*, Harihan Devarajan et al, CCGrid21



DLIO tracing of workflow

# ADDITIONAL TOPICS

- Helpful tools:
  - Ltrace and strace
    - Confirming behavior of I/O libraries
  - Gdb
    - “why is everyone stalled in this collective?”
- Technologies
  - GPU programming?
    - NVIDIA’s ‘gpu direct storage’: <https://developer.nvidia.com/gpudirect-storage>
  - DAOS:
    - Novel storage architecture, showing up on Aurora

# BIG PICTURE SUMMARY

- I/O subsystems complex with lots of layers
- Initial experiences not likely to be ideal
- Use libraries and frameworks (where available)
  - Portability across file systems, machines, storage technologies
- Darshan helps Scientists and I/O folks meet on common ground
- Consultants at your site (e.g. ALCF, OLCF, NERSC) love solving problems

# ACKNOWLEDGEMENTS

- Some material drawn from *Parallel I/O In Practice*, our full day SC tutorial. Thanks to Brent Welch, Rob Ross, Glenn Lockwood, Katie Antypas, Marc Unangst, Rajeev Thakur, and Bill Loewe.
- Some material drawn from ATPESC “Data and I/O Day”. Thanks to Phil Carns and Shane Snyder
- This research used resources of the Argonne Leadership Computing Facility, which is a DOE Office of Science User Facility supported under Contract DE-AC02-06CH11357.
- I carried out this work under a 2022 Better Scientific Software (BSSW) fellowship. Thanks to BSSW and ECP IDEAS for their support.