EAR ISC2024 tutorial: Advanced use cases and optimization

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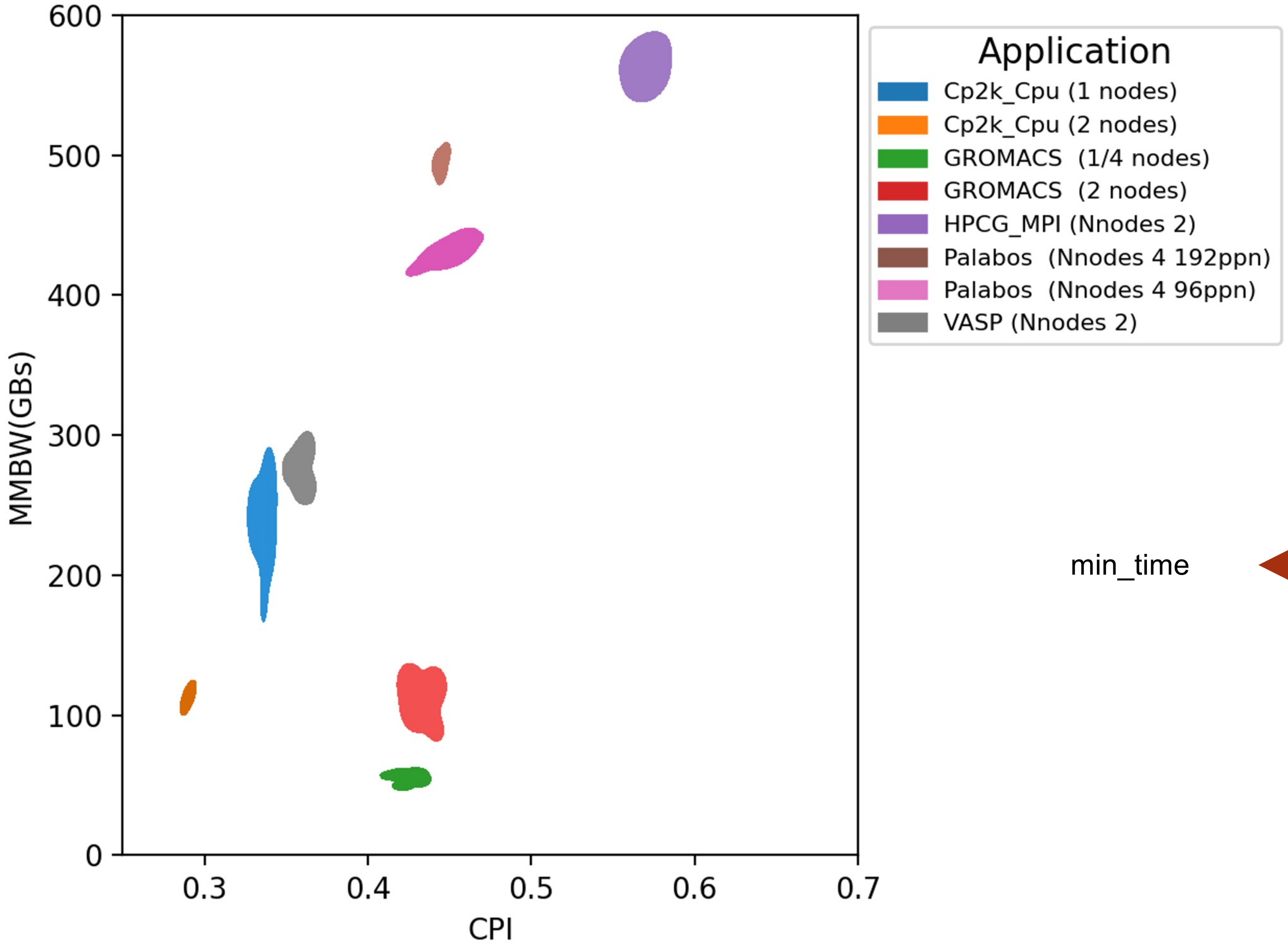
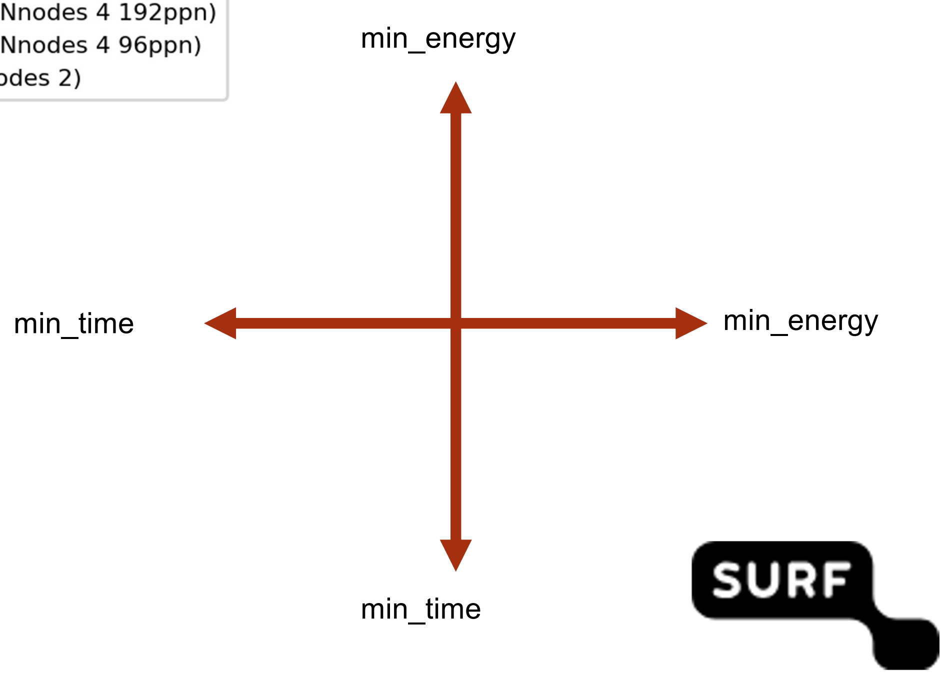
Advance use cases and optimization

- Codes in /projects/0/energy-course and GIT
- GIT: https://github.com/sara-nl/ISC-2024-EAR-tutorial/tree/main
- Get the examples and test them
  - https://github.com/sara-nl/ISC-2024-EAR-tutorial/tree/main/tutorials/monitoring_ear
  - GROMACS singularity
  - PyTorch
  - Palabos
- Data visualization
  - https://github.com/sara-nl/ISC-2024-EAR-tutorial/tree/main/tutorials/visualization
  - Grafana (using local installation)
  - ear-job-analytics tool

Application characterization/optimization





min_energy

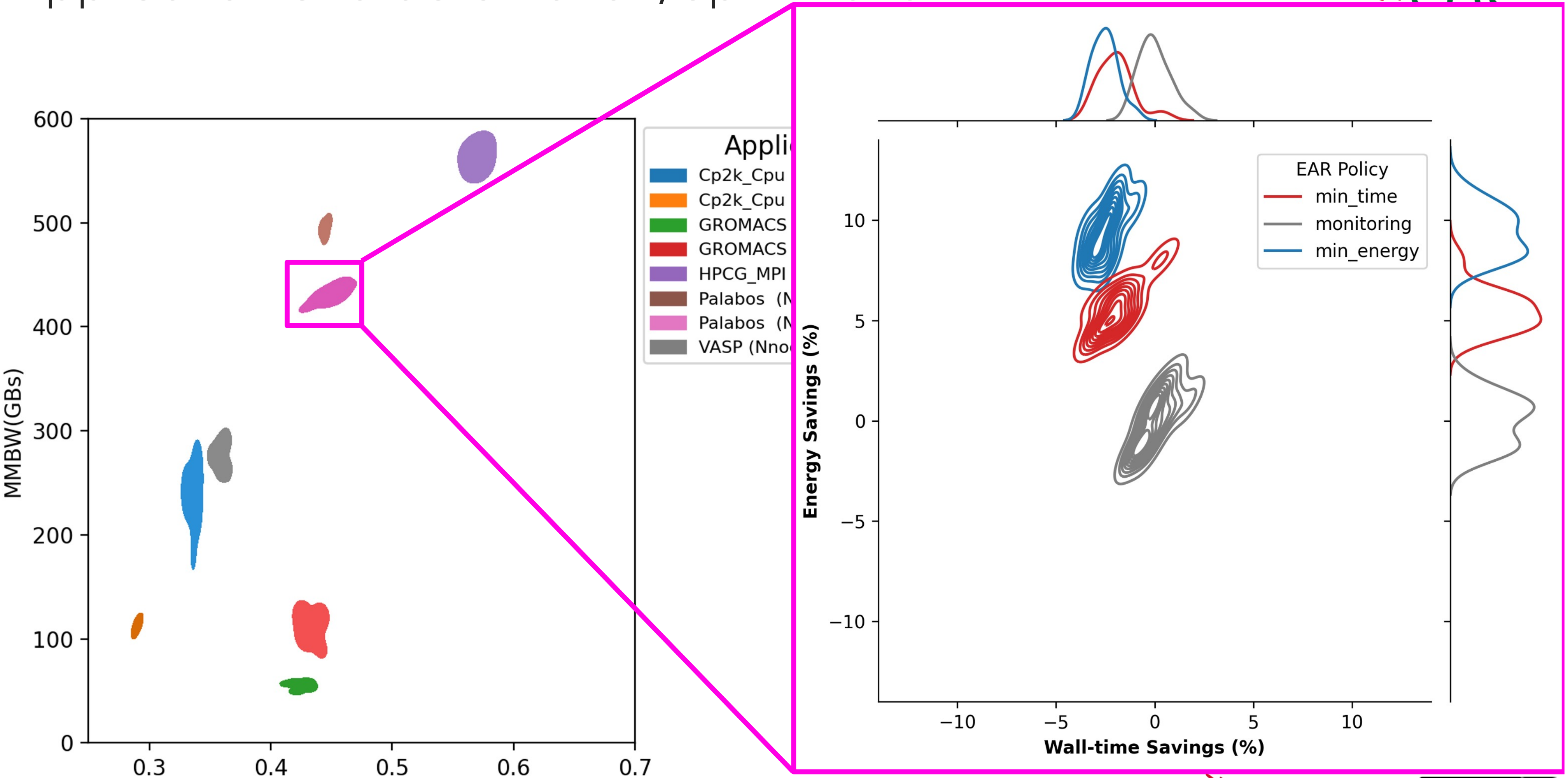
min_time

min_energy

min_time

https://www.eas4dc.com

Application characterization/optimization



https://www.eas4dc.com

Use cases

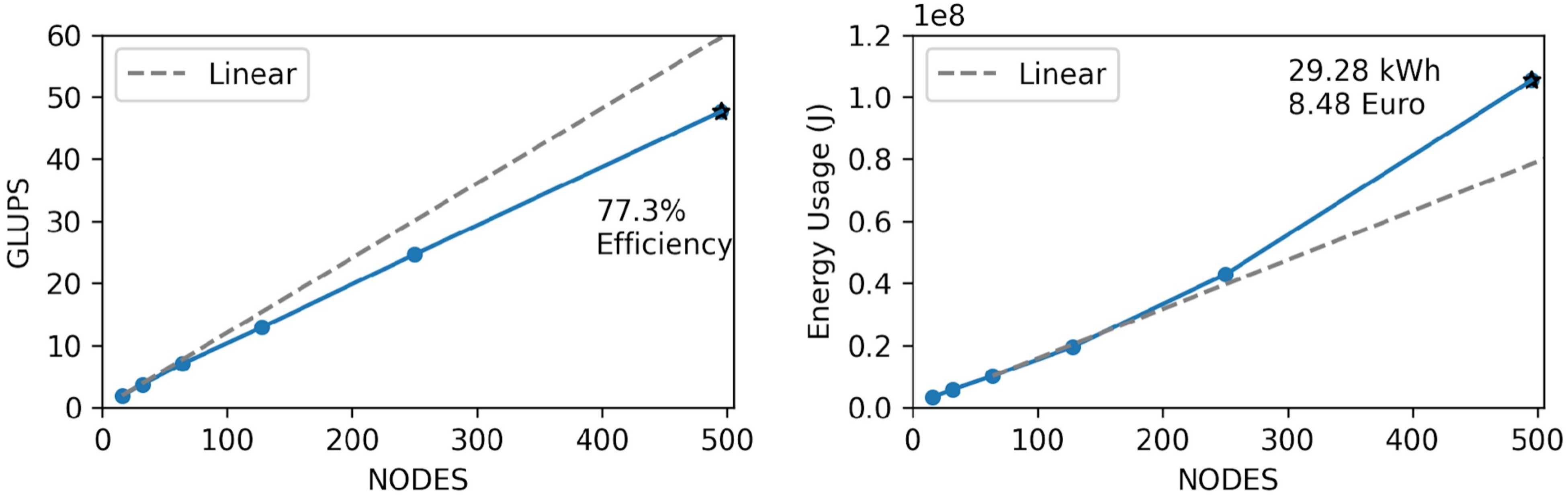
- Singularity
  - GROMACS (monitoring)
- CPU apps
  - Palabos: monitoring and dynamic optimization
  - NPB: dynamic optimization
- GPU apps
  - GROMACS singularity (monitoring)
  - PyTorch (min_energy)
- All of them, understand, visualize and compare energy efficiency when doing dynamic optimization

GROMACS-GPU: Singularity + EAR

- Singularity/Apptainer
  - https://apptainer.org/
  - https://docs.sylabs.io/guides/3.5/user-guide/introduction.html
  - https://catalog.ngc.nvidia.com/orgs/hpc/collections/nvidia_hpc/entities
- Singularity containers allow applications to use host services (such as ear)
  - Paths must be binded
  - Environment variables must be defined
  - https://github.com/sara-nl/ISC-2024-EAR-tutorial/blob/main/tutorials/monitoring_ear/GROMACS_SINGULARITY_GPU.sh

Palabos: Lattice-Boltzmann Solver

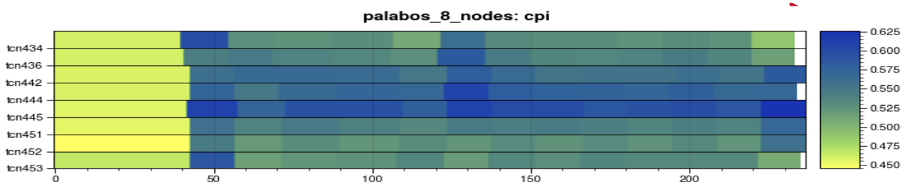
Strong Scaling Benchmark

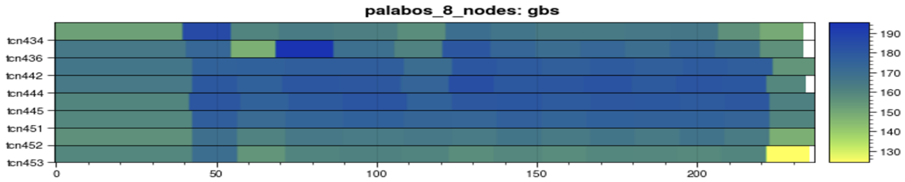


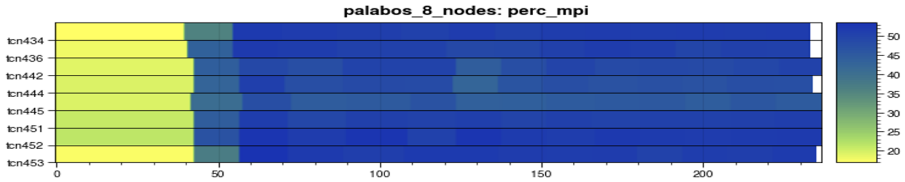
- An average electric car consumes about 0.2 kwh/km
- 495 node case (which ran for 9 minutes) just drove a car 150 km!

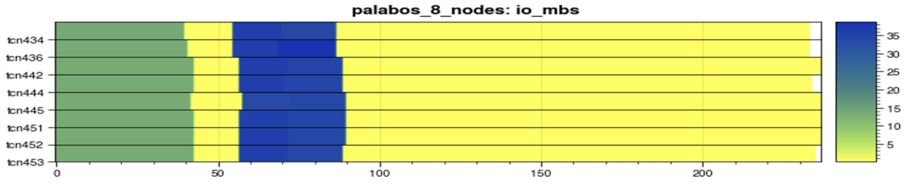
Palabos:
Strong Scaling Benchmark

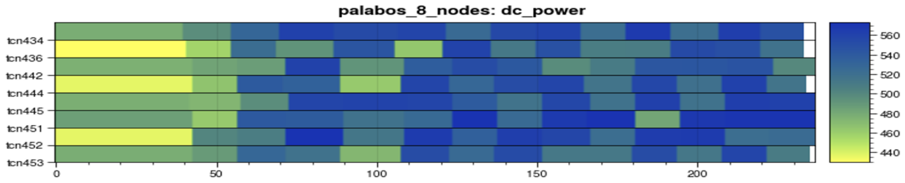
- Per-node, Per-iteration ”traces”
- Node Power
- Avg CPU Freq (node)
- Main memory BW (GB/s)
- CPI (Cycles per instruction)
- MPI% (percentage spent in MPI calls)
- I/O (network communication)


palabos_8_nodes: cpi


palabos_8_nodes: gbs


palabos_8_nodes: perc_mpi


palabos_8_nodes: io_mbs

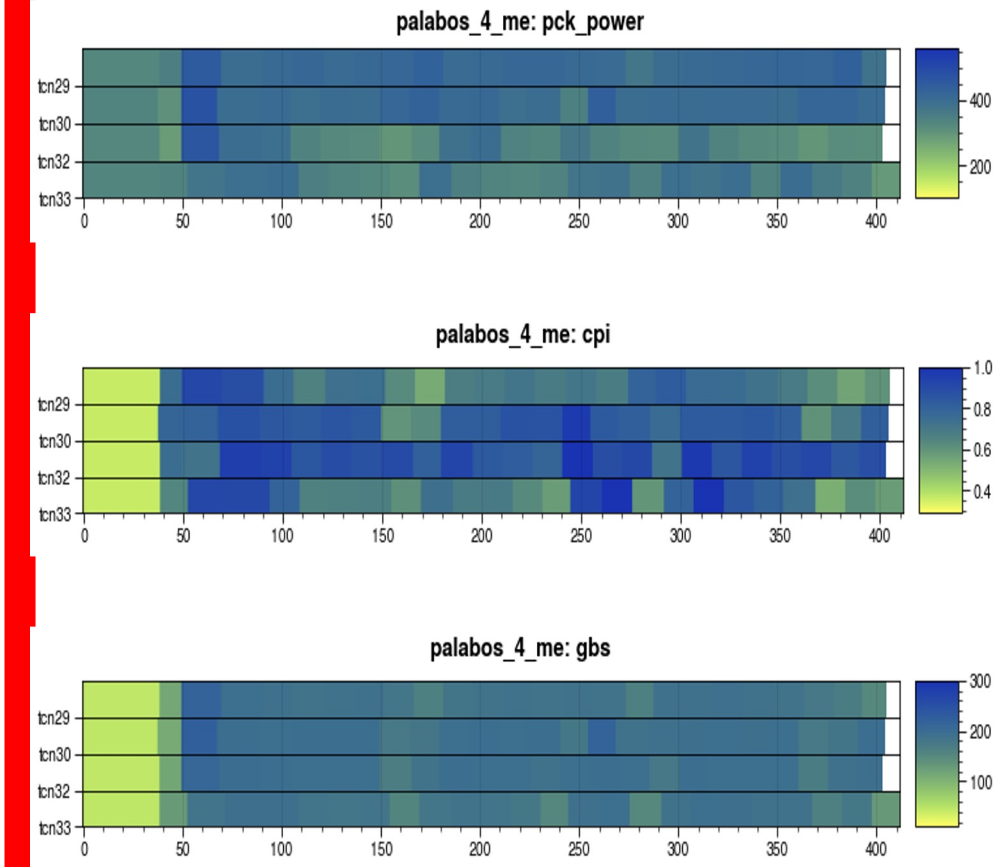

palabos_8_nodes: dc_power

optimization

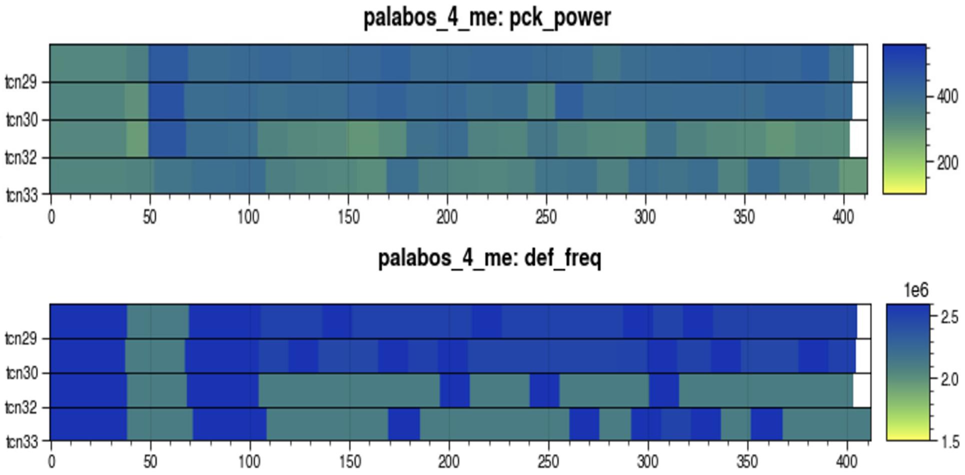
- Codes in /projects/0/energy-course
- GIT: https://github.com/sara-nl/ISC-2024-EAR-tutorial/tree/main
- Get the examples, add EAR **monitoring and min_energy** policy and compare
  - –ear=on → monitoring
  - –ear-policy=min_energy → selects min_energy policy
  - Run 2 steps in the same job to guarantee both runs are executed in the same node (s)
  - https://github.com/sara-nl/ISC-2024-EAR-tutorial/tree/main/tutorials/monitoring_ear
  - NPB : Rome vs Genoa
  - Palabos (use 1 and 4 nodes, node input_1_node_XL.xml input file)
    - Rome vs Genoa
  - PyTorch
    - Get some extra savings when running in exclusive mode
    - export EAR_JOB_EXCLUSIVE_MODE=1

Data visualization

- https://github.com/sara-nl/ISC-2024-EAR-tutorial/blob/main/tutorials/visualization/README.md
- ear-job-analytics
  - Requires loops in DB: export EARL_REPORT_LOOPS=1
  - Use ear-job-anaytics directly or use create_traces.sh script
- Grafana
  - Running al DC and executing SQL queries (more powerful, but depends on DC)
  - Local installation:
    - Grafana server installed and running locally
    - Data gathered in CSV format with eacct and using CSV plugin
    - Not mandatory but more information if loops are in DB
    - Can be use also without EAR DB: –ear-user-db=filename



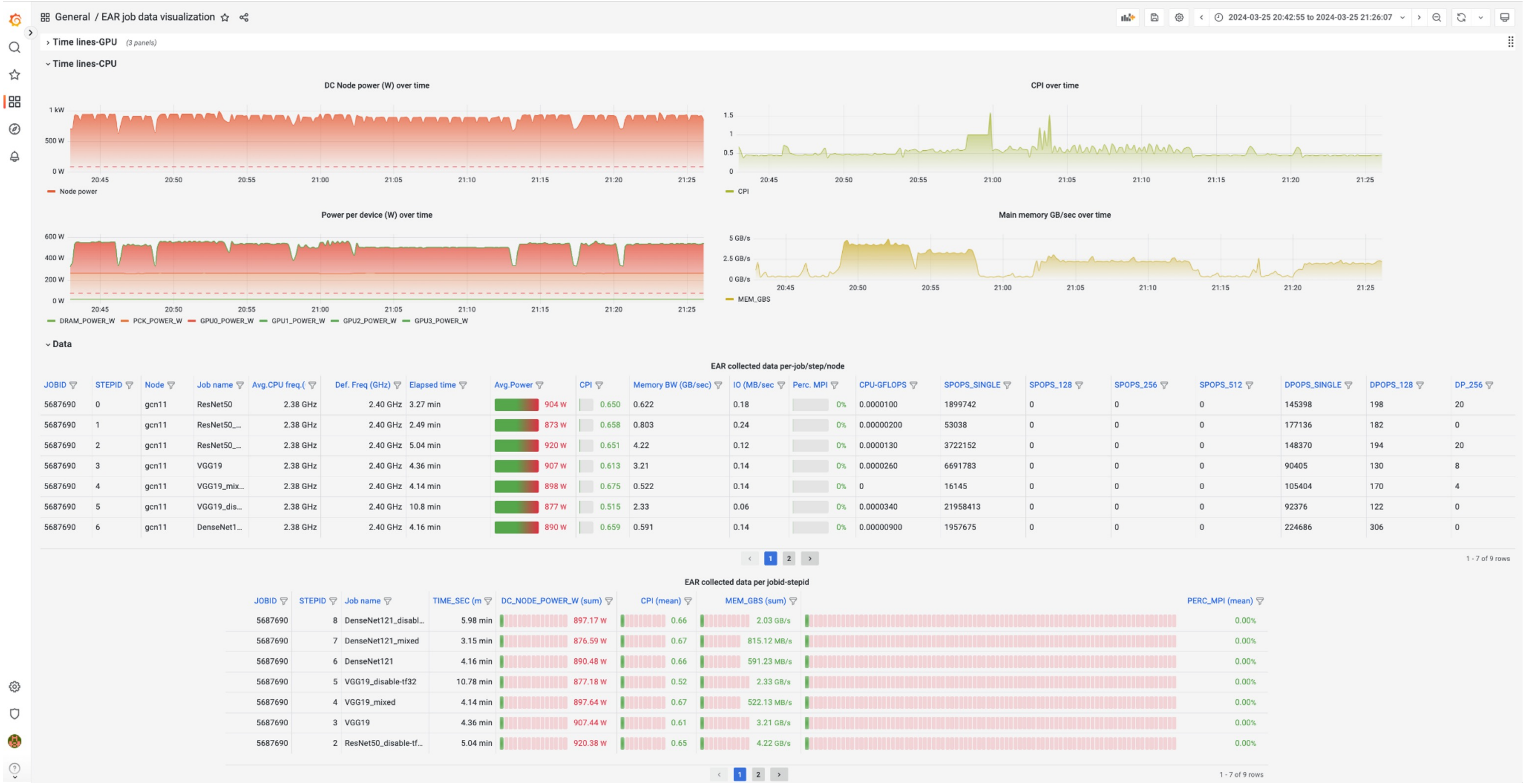
Application metrics



Runtime optimization

Visualization with Grafana

- Steps to use EAR data are in grafana with CSV are
  - Have a local grafana installation with CSV plugins supported
  - Export EAR application data in csv format using eacct (-l -c option) or –ear-user-db flag
  - Export EAR application runtime data in csv format using eacct (-r -c option) or –ear-user-db flag
  - Add a source data based on a local file (Public folder)
    - julita.corbalan$ cp tensorflow.csv ear_data_apps.csv
    - julita.corbalan$ cp tensorflow_loops.csv ear_data_loops.csv
  - Import the EAR json file with the dashboards for data visualization
    - "EAR job data visualization.json"
  - Reload the dashboards



General / EAR job data visualization

2024-03-25 20:42:55 to 2024-03-25 21:26:07

› Time lines-GPU (3 panels)

⌄ Time lines-CPU

⌄ Data

EAR collected data per-job/step/node

JOBID	STEPID	Node	Job name	Avg.CPU freq.(	Def. Freq (GHz)	Elapsed time	Avg.Power	CPI	Memory BW (GB/sec)	IO (MB/sec	Perc. MPI	CPU-GFLOPS	SPOPS_SINGLE	SPOPS_128	SPOPS_256	SPOPS_512	DPOPS_SINGLE	DPOPS_128	DP_256
5687690	0	gcn11	ResNet50	2.38 GHz	2.40 GHz	3.27 min	904 W	0.650	0.622	0.18	0%	0.0000100	1899742	0	0	0	145398	198	20
5687690	1	gcn11	ResNet50_...	2.38 GHz	2.40 GHz	2.49 min	873 W	0.658	0.803	0.24	0%	0.00000200	53038	0	0	0	177136	182	0
5687690	2	gcn11	ResNet50_...	2.38 GHz	2.40 GHz	5.04 min	920 W	0.651	4.22	0.12	0%	0.0000130	3722152	0	0	0	148370	194	20
5687690	3	gcn11	VGG19	2.38 GHz	2.40 GHz	4.36 min	907 W	0.613	3.21	0.14	0%	0.0000260	6691783	0	0	0	90405	130	8
5687690	4	gcn11	VGG19_mix...	2.38 GHz	2.40 GHz	4.14 min	898 W	0.675	0.522	0.14	0%	0	16145	0	0	0	105404	170	4
5687690	5	gcn11	VGG19_dis...	2.38 GHz	2.40 GHz	10.8 min	877 W	0.515	2.33	0.06	0%	0.0000340	21958413	0	0	0	92376	122	0
5687690	6	gcn11	DenseNet1...	2.38 GHz	2.40 GHz	4.16 min	890 W	0.659	0.591	0.14	0%	0.00000900	1957675	0	0	0	224686	306	0

‹ 1 2 ›

1 - 7 of 9 rows

EAR collected data per jobid-stepid

JOBID	STEPID	Job name	TIME_SEC (m	DC_NODE_POWER_W (sum)	CPI (mean)	MEM_GBS (sum)	PERC_MPI (mean)
5687690	8	DenseNet121_disabl...	5.98 min	897.17 W	0.66	2.03 GB/s	0.00%
5687690	7	DenseNet121_mixed	3.15 min	876.59 W	0.67	815.12 MB/s	0.00%
5687690	6	DenseNet121	4.16 min	890.48 W	0.66	591.23 MB/s	0.00%
5687690	5	VGG19_disable-tf32	10.78 min	877.18 W	0.52	2.33 GB/s	0.00%
5687690	4	VGG19_mixed	4.14 min	897.64 W	0.67	522.13 MB/s	0.00%
5687690	3	VGG19	4.36 min	907.44 W	0.61	3.21 GB/s	0.00%
5687690	2	ResNet50_disable-tf...	5.04 min	920.38 W	0.65	4.22 GB/s	0.00%

‹ 1 2 ›

1 - 7 of 9 rows

Go to ISC tutorial github and do the exercises

https://github.com/sara-nl/ISC-2024-EAR-tutorial/tree/main/tutorials/policies