The Fast Calorimeter Challenge 2022: Results & The Road Ahead

— Villa Mondragone, Frascati, Italy —

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The Fast Calorimeter Challenge 2022: Results & The Road Ahead

- We now have seen 12 talks with different approaches

- All of them better than midjourney $\Rightarrow$

$\Rightarrow$ The big Question: How do they compare to each other?

"Calorimeter Simulation"

A total of 40 samples have been submitted

- Until Monday afternoon, 40 samples have been submitted.
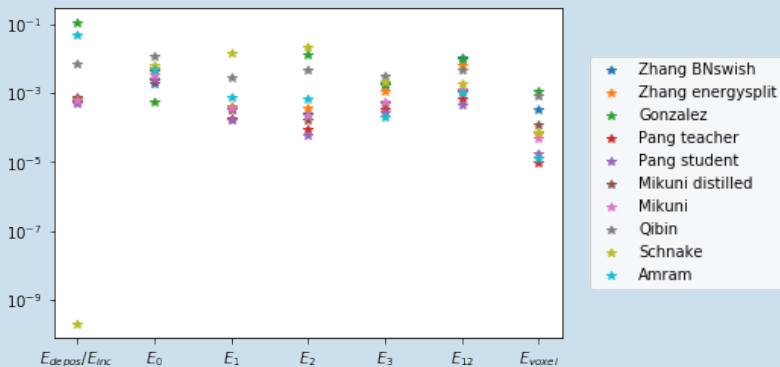
- Not enough time to run all comparisons.

$\Rightarrow$ A few histogram χ^2

$\Rightarrow$ Focus on Multi-class classifier for now:
Train on submission 1 vs. submission 2 vs. ... vs. submission n
Which submission is GEANT4 the closest to?
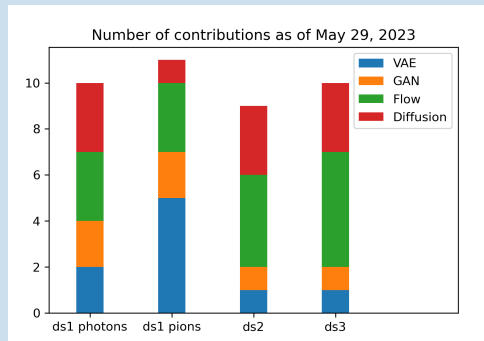
Number of contributions as of May 29, 2023

Histograms ds1 photons

- Looking at histogram χ^2 of
  $E_{tot}/E_{inc}, E_{layer0}, E_{layer1}, E_{layer2}, E_{layer3}, E_{layer12}, E_{voxel}$

$\Rightarrow$ Keep in mind: I didn't check E_{inc}-dist, normalizations, doubles, some sets are imbalanced, ...

Histograms ds1 photons

- Looking at histogram χ^2 of
  $E_{tot}/E_{inc}, E_{layer0}, E_{layer1}, E_{layer2}, E_{layer3}, E_{layer12}, E_{voxel}$
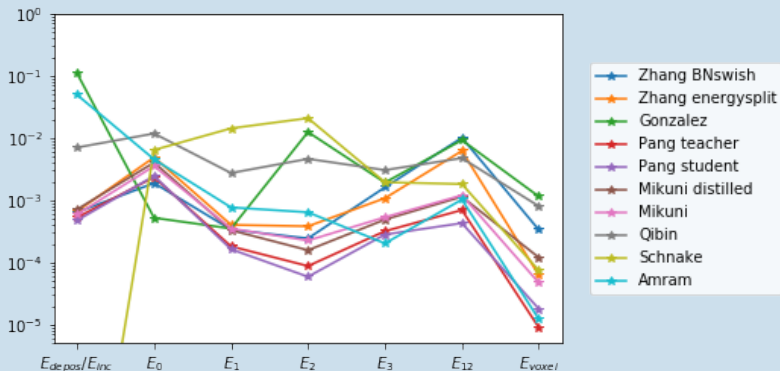

$\Rightarrow$ Keep in mind: I didn't check E_{inc}-dist, normalizations, doubles, some sets are imbalanced, …

Architecture and Training

- Simple DNN with 2 hidden layer of 2048 neurons.

- features: $log_{10}E_{inc}, \mathcal{I}_a / E_{inc}$

- Cross Entropy loss, ADAM optimizer, 50 epochs (val loss min around 15)

$\Rightarrow$ Keep in mind: I didn't check E_{inc}-dist, normalizations, doubles, thresholds, ...
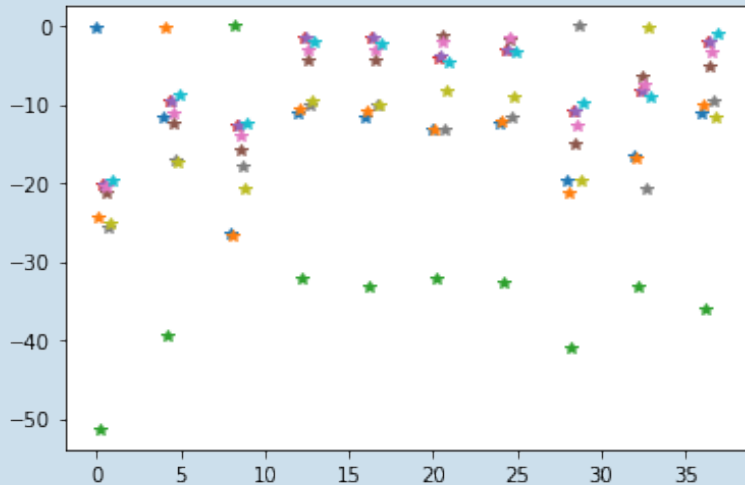pion data has doubles, some sets are imbalanced, only 1 training
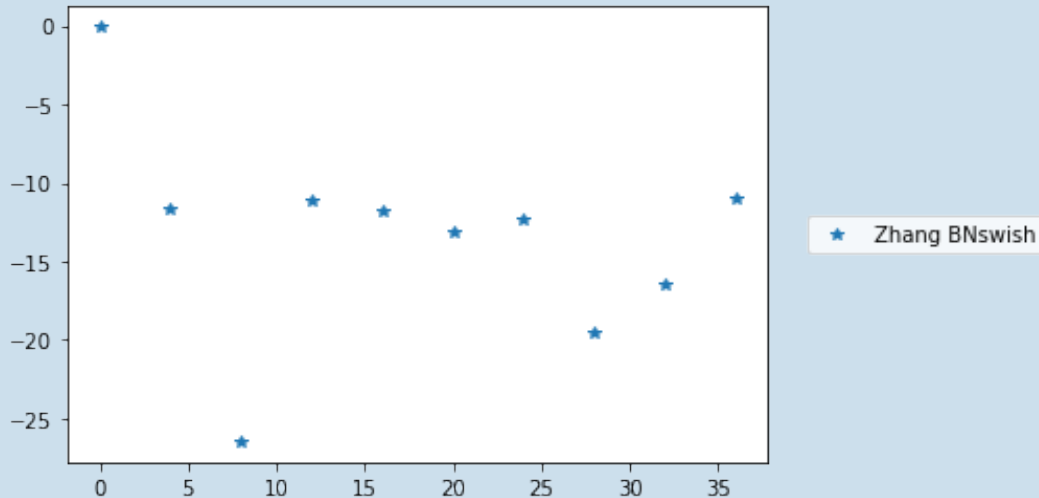
Log-posterior ds1 photons

Log-posterior ds1 photons

submission vs submission:

Log-posterior ds1 photons

submission vs geant:

Geant Truth

Zhang BNswish: -19.78
Zhang energysplit: -8.57
Gonzalez: -12.70
Pang teacher: -1.76
Pang student: -1.90
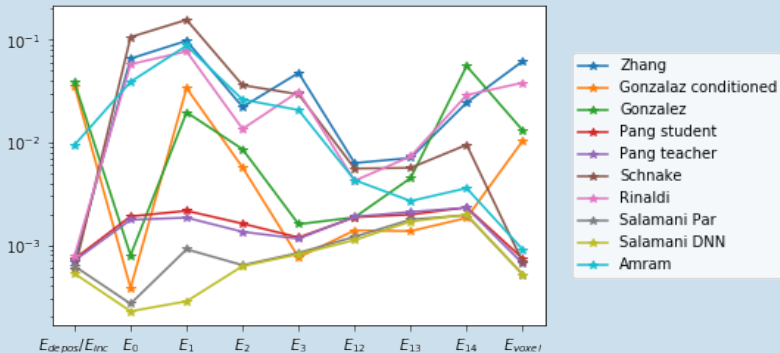Mikuni distilled: -4.57
Mikuni: -3.18
Qibin: -9.84
Schnake: -9.29
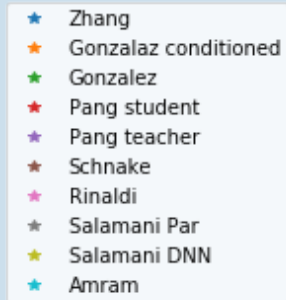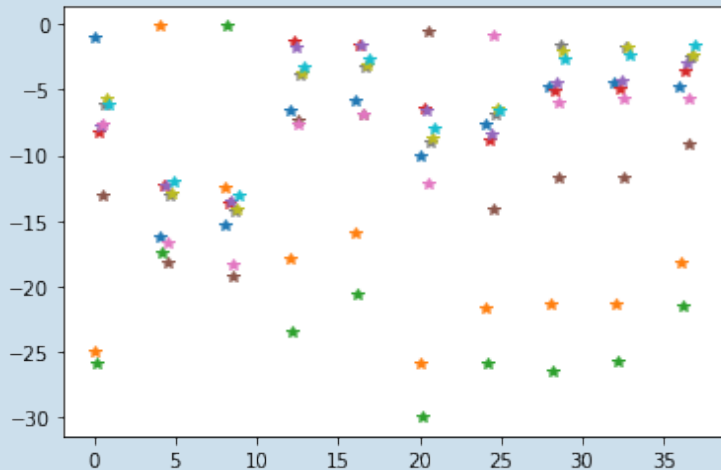Amram: -1.39

Histograms ds1 pions

- Looking at histogram χ^2 of
  E_{tot}/E_{inc}, E_{layer0}, E_{layer1}, E_{layer2}, E_{layer3}, $E_{layer12}$, $E_{layer13}$, $E_{layer14}$, E_{voxel}

$\Rightarrow$ Keep in mind: I didn't check E_{inc}-dist, normalizations, doubles, some sets are imbalanced, (only 1 training), …
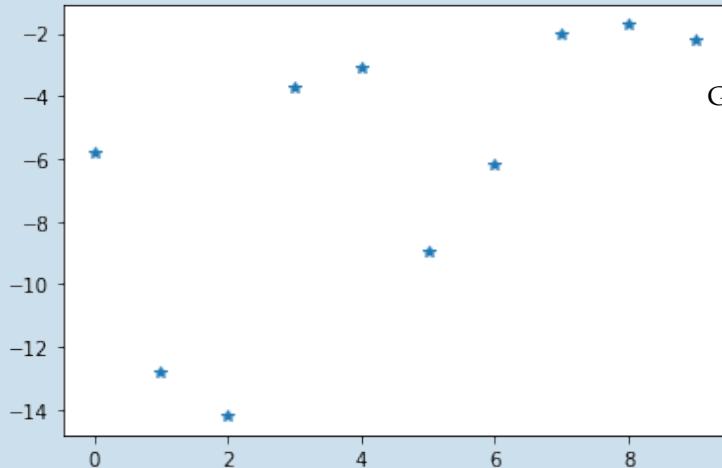
Log-posterior ds1 pions

submission vs submission:
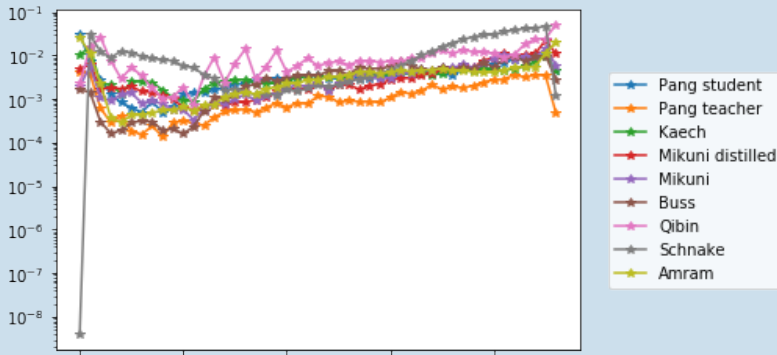
Log-posterior ds1 pions

submission vs geant:

Geant Truth

Zhang: -5.81
Gonzalaz conditioned: -12.83
Gonzalez: -14.19
Pang student: -3.74
Pang teacher: -3.09
Schnake: -8.94
Rinaldi: -6.19
Salamani Par: -2.00
Salamani DNN: -1.72
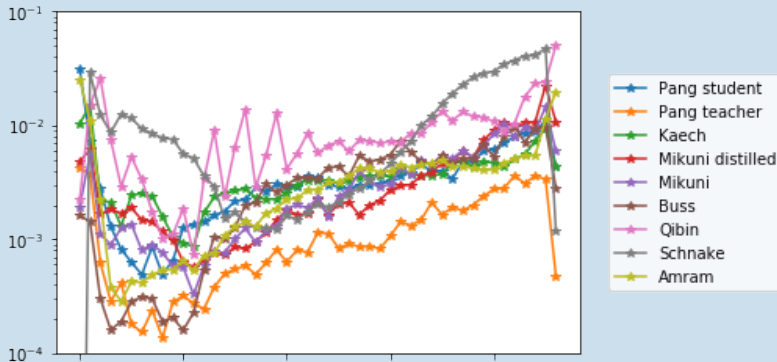Amram: -2.20

Histograms ds2

- Looking at histogram χ^2 of
  $E_{tot}/E_{inc}, E_{layer0}, E_{layer1}, \dots E_{layer44}, E_{voxel}$

$\Rightarrow$ Keep in mind: I didn't check E_{inc}-dist, normalizations, doubles, some sets are imbalanced, (only 1 training), ...

Histograms ds2

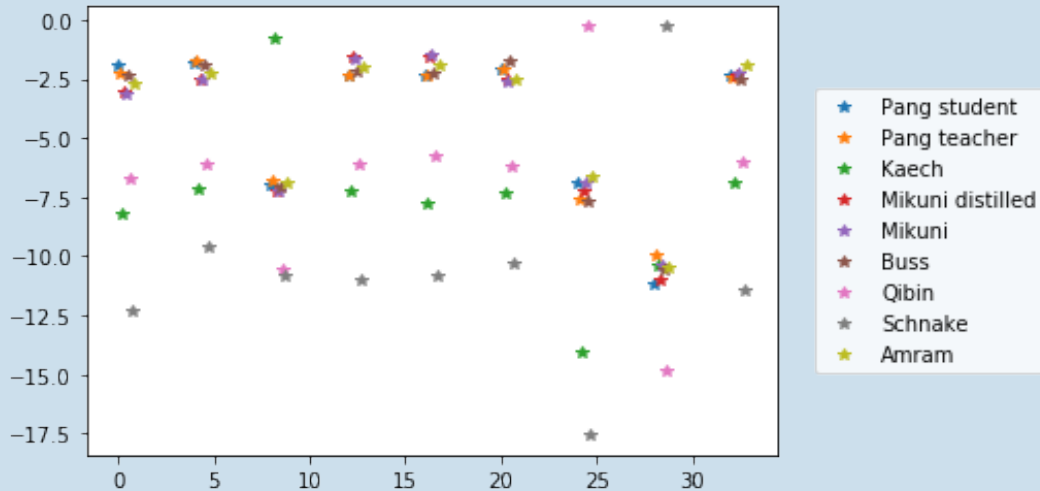- Looking at histogram χ^2 of
  $E_{tot}/E_{inc}, E_{layer0}, E_{layer1}, \ldots E_{layer44}, E_{voxel}$

$\Rightarrow$ Keep in mind: I didn't check E_{inc}-dist, normalizations, doubles, some sets are imbalanced, (only 1 training), …
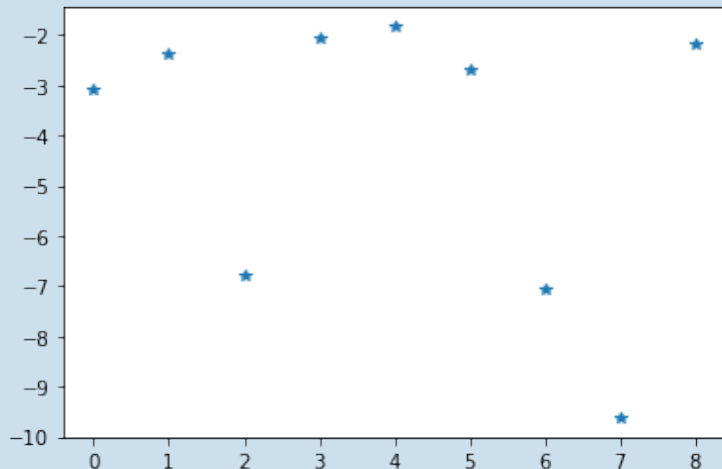
Log-posterior ds2

submission vs submission:
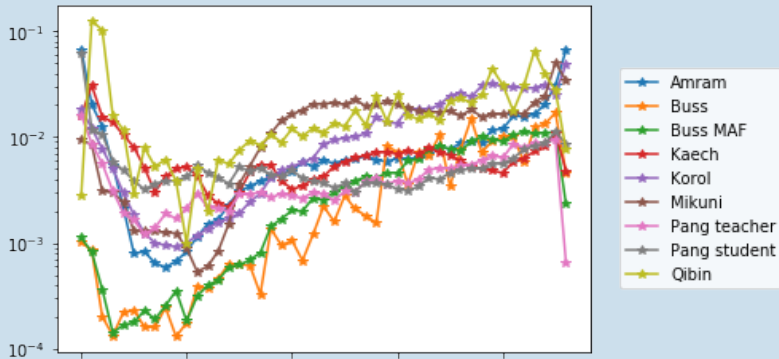
Log-posterior ds2

submission vs geant:

GEANT Truth

Pang student: -3.07
Pang teacher: -2.37
Kaech: -6.79
Mikuni distilled: -2.07
Mikuni: -1.84
Buss: -2.69
Qibin: -7.06
Schnake: -9.62
Amram: -2.17

Histograms ds3

- Looking at histogram χ^2 of
  $E_{tot}/E_{inc}, E_{layer0}, E_{layer1}, \ldots E_{layer44}, E_{voxel}$

$\Rightarrow$ Keep in mind: I didn't check E_{inc}-dist, normalizations, doubles, some sets are imbalanced, ...

Log-posterior ds3

submission vs submission
submission vs geant

Not enough time / RAM ;-)

Next steps:

- We will publish a new dataset for ds1 pions: train + eval
- We will run the detailed comparison of more metrics.
- ⇒ I will contact you more often with questions, maybe we should have a common channel in the ML4Jets SLACK?
- We will summarize our results in a joint paper, to be submitted to EPJC or Rept.Prog.Phys.
- ⇒ We need your (final!) samples by end of July!
- ⇒ We need your (final!) models by end of July!
- ⇒ We need your write-up by end of July!

- ⇒ Have it on arXiv for ML4Jets in November.

The Summary Paper

- Each contribution should write 1-3 pages about Architecture, Preprocessing and Training

- Each group of contributions (GANs, Flows, . . .) should coordinate the general model introduction

- We will draft the results based on everyones feedback/contributions

The Summary Paper — Results section

- Histograms of `evaluate.py`, sparsity, ...

- timings / number of trainable parameters / memory usage on same hardware

- multiclass and sample vs. Geant classifiers, sliced by E_{inc}, model type, large/small weights, ...

- correlation plots of the above

The Fast Calorimeter Challenge 2022:
Results & The Road Ahead

- Thank you to everyone who contributed to the challenge — via samples, ideas, discussions, …!!!

- Some fun is behind us, but there is a lot more ahead:
⇒ Re-training / fine-tuning of models
⇒ in-depth comparisons
⇒ the write-up

- A Big Thank You to
  Michele Faucci Giannelli, Marco Vanadia, Umberto De Sanctis,
  and all local organizers!