Generative Models for Fast Calorimeter Simulation

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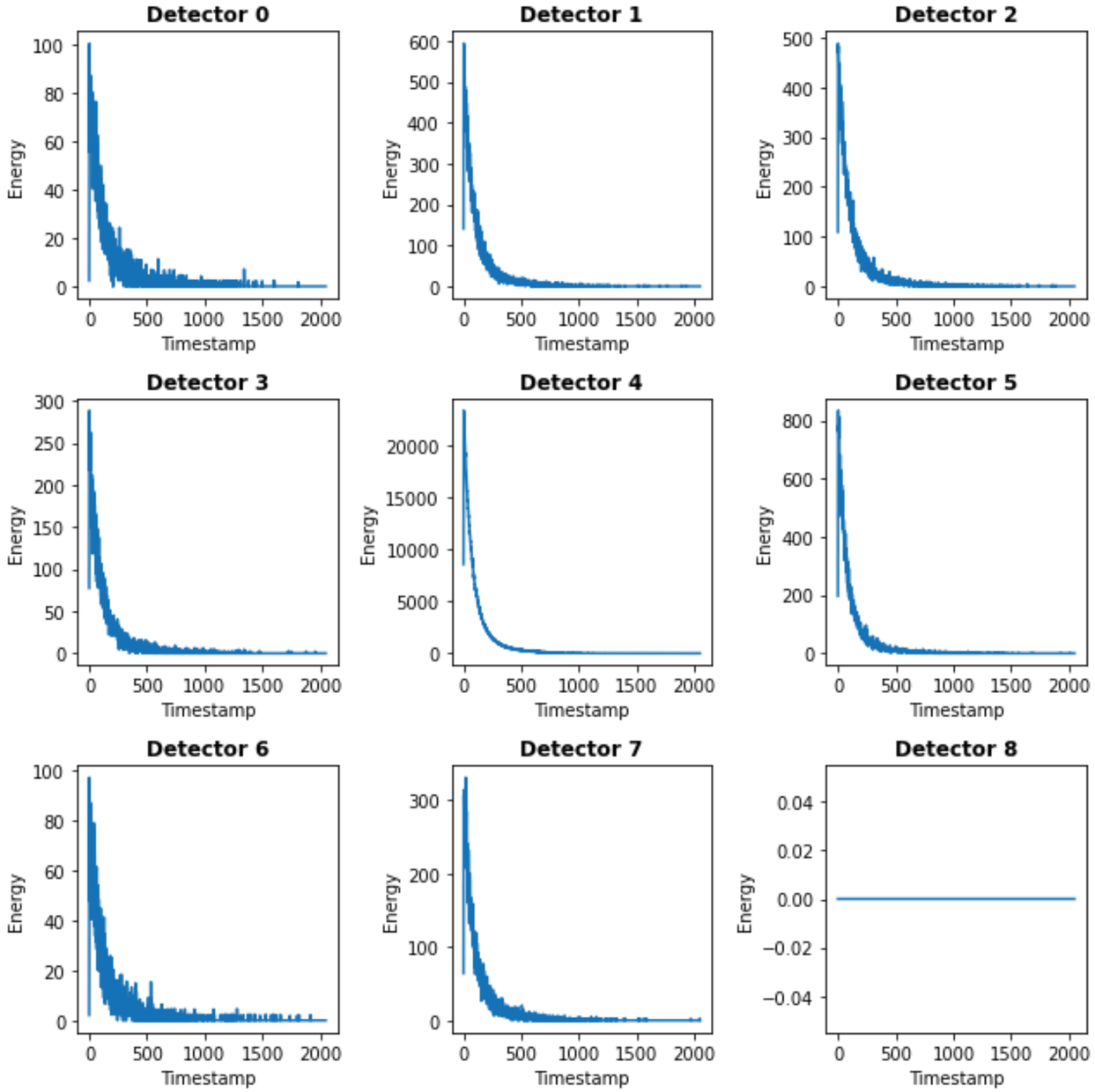
Raw data

x	y	z	PhotonEnergy	detector	timestamp	event
-3.004690	1.328449	-70.5	2.141223	4	24.760641	49
-0.468398	-0.370210	70.5	2.468826	13	53.060432	98
1.529158	-9.985240	70.5	2.316181	12	101.482025	7
0.151825	3.020663	70.5	2.225431	13	67.399384	121
-0.244425	1.808865	-70.5	2.275145	4	161.846832	8
2.049987	0.156744	-70.5	2.010571	4	281.849182	30
-0.078669	-0.058568	-70.5	2.255597	4	714.835999	123
0.197061	0.208369	-70.5	2.004221	4	107.345573	81
-0.190887	-0.358387	-70.5	2.041891	4	100.982964	91
1.380018	-0.500000	-70.5	1.877096	4	78.418350	70

Data example



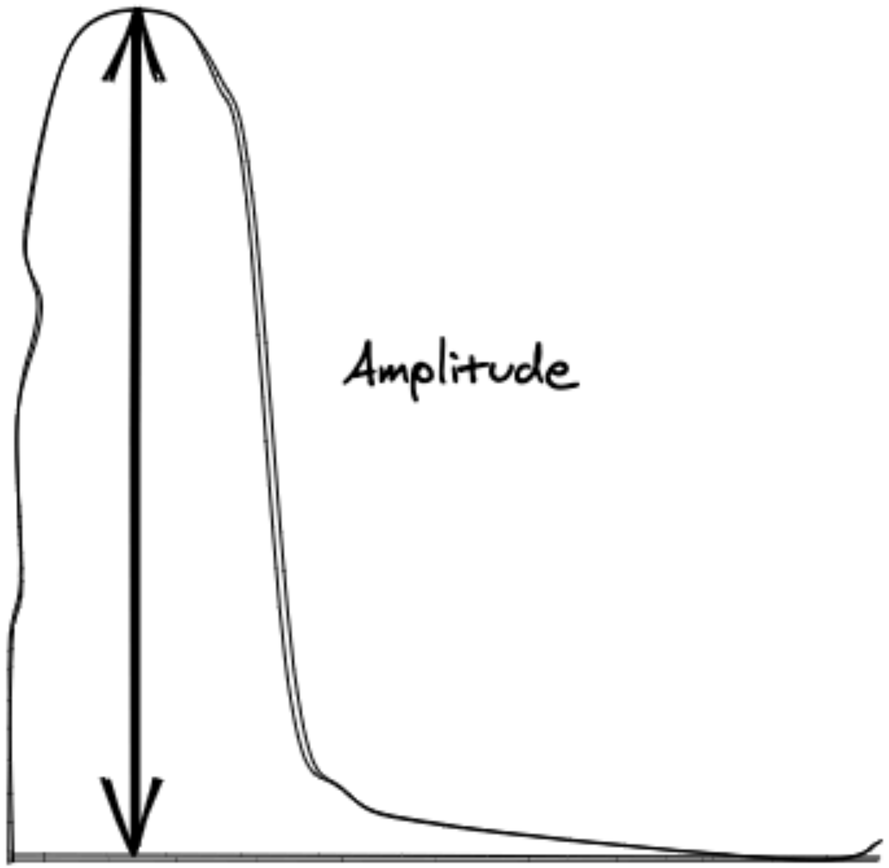
Problem

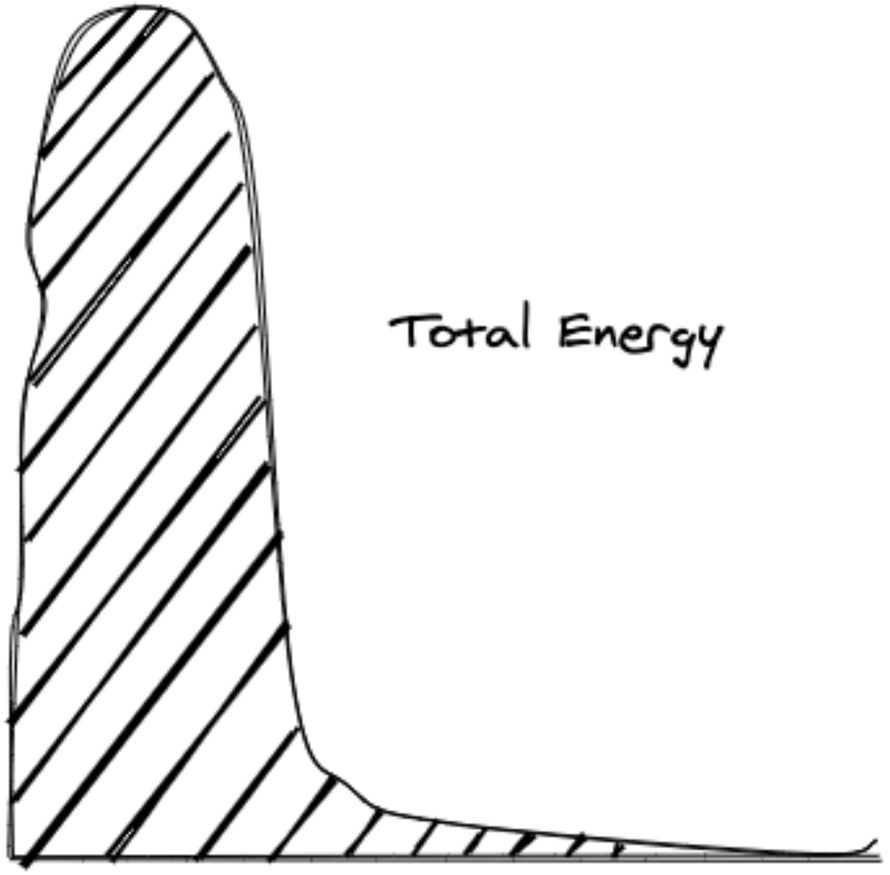
```
18:46:44 Job submitted
21:07:53 Job terminated
```

0.5 Mev - 1TeV

Requirements

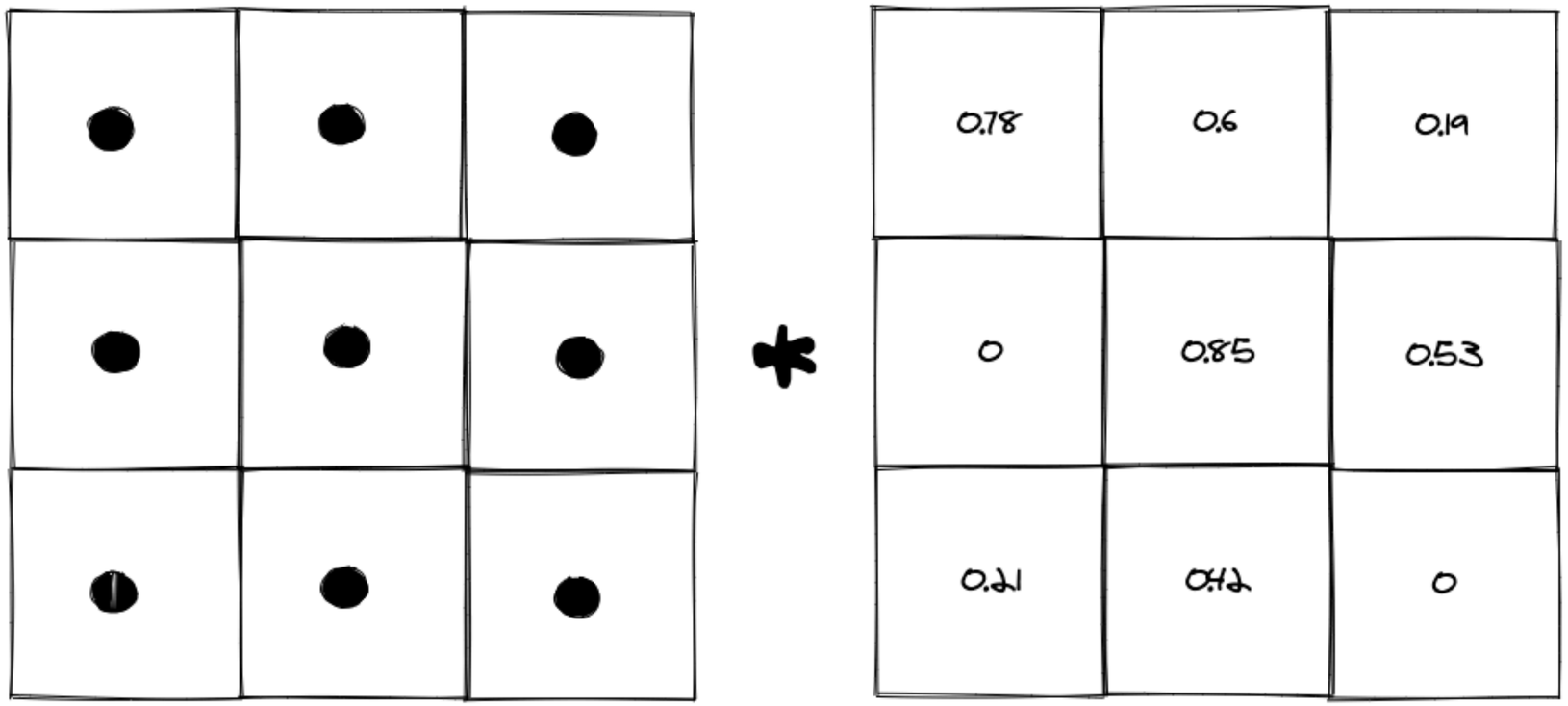
Energy characteristic



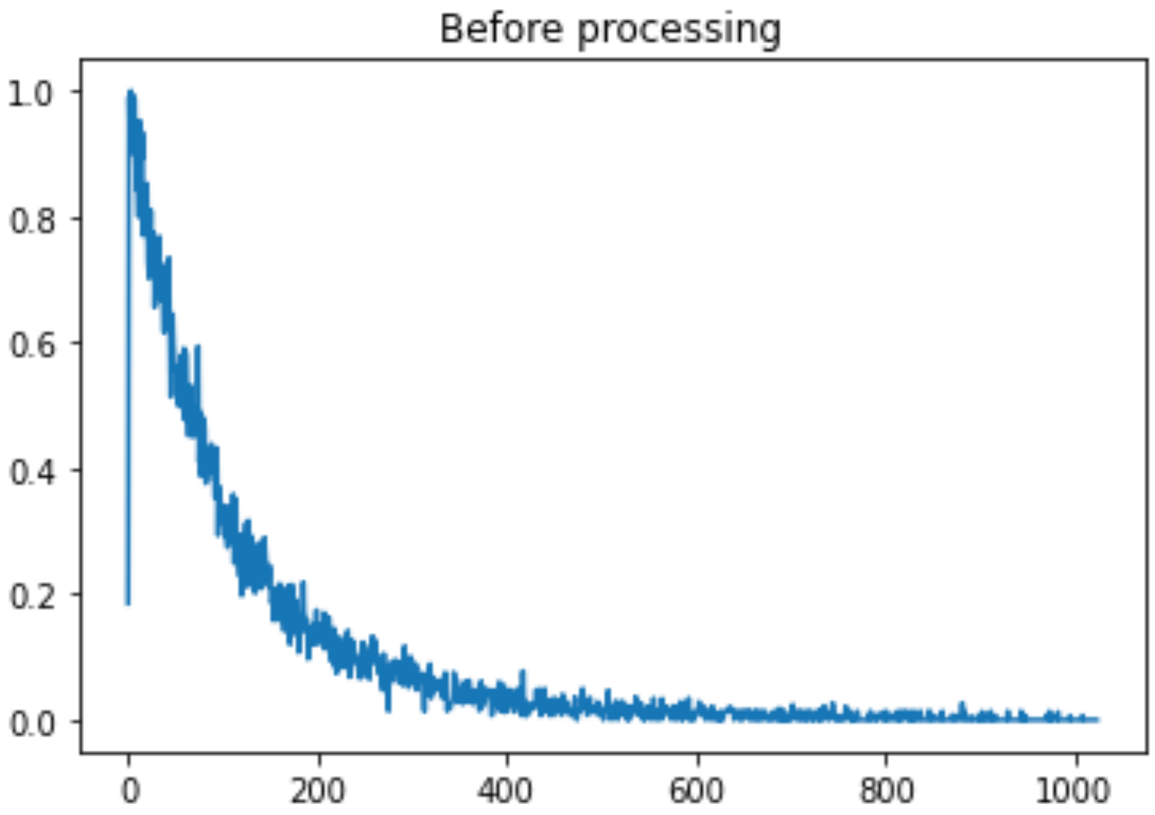


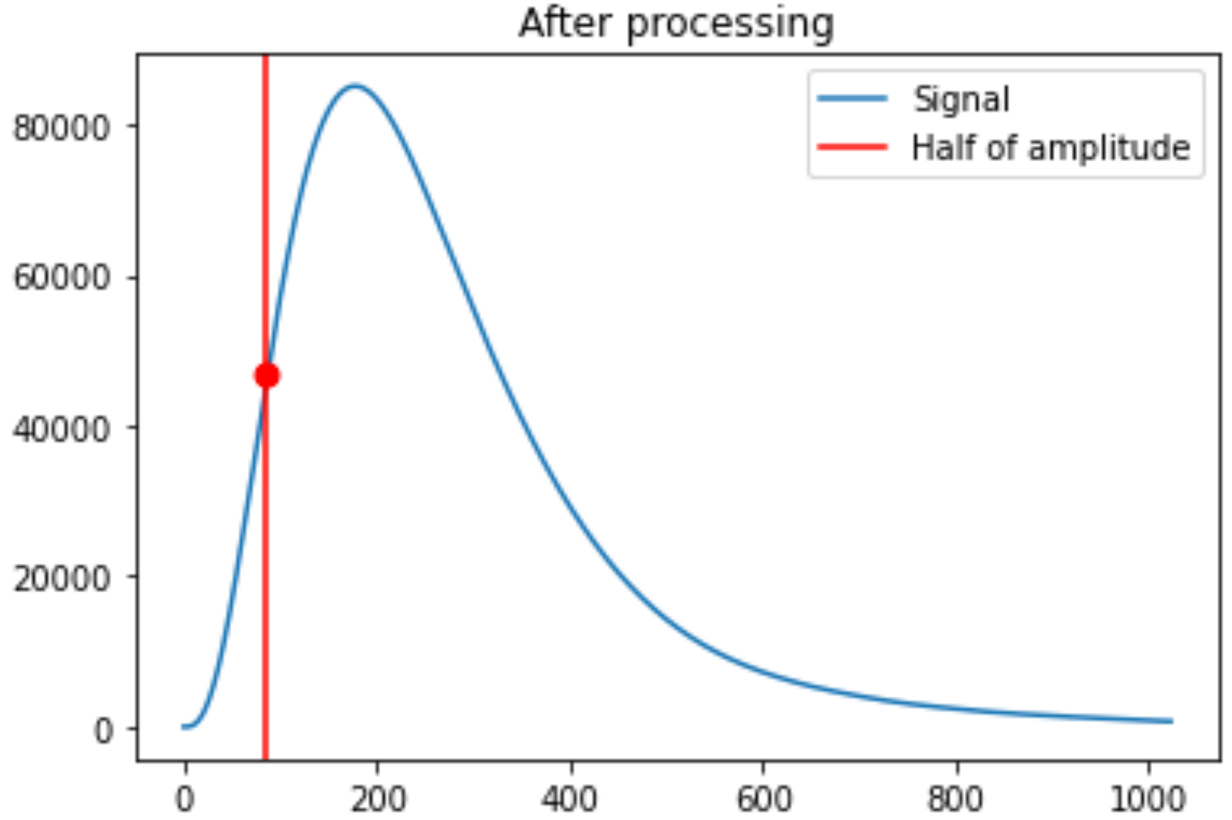
$$\text{Energy characteristic} = \frac{\text{Total Energy}}{\text{Amplitude}}$$

Space characteristic



Time characteristic

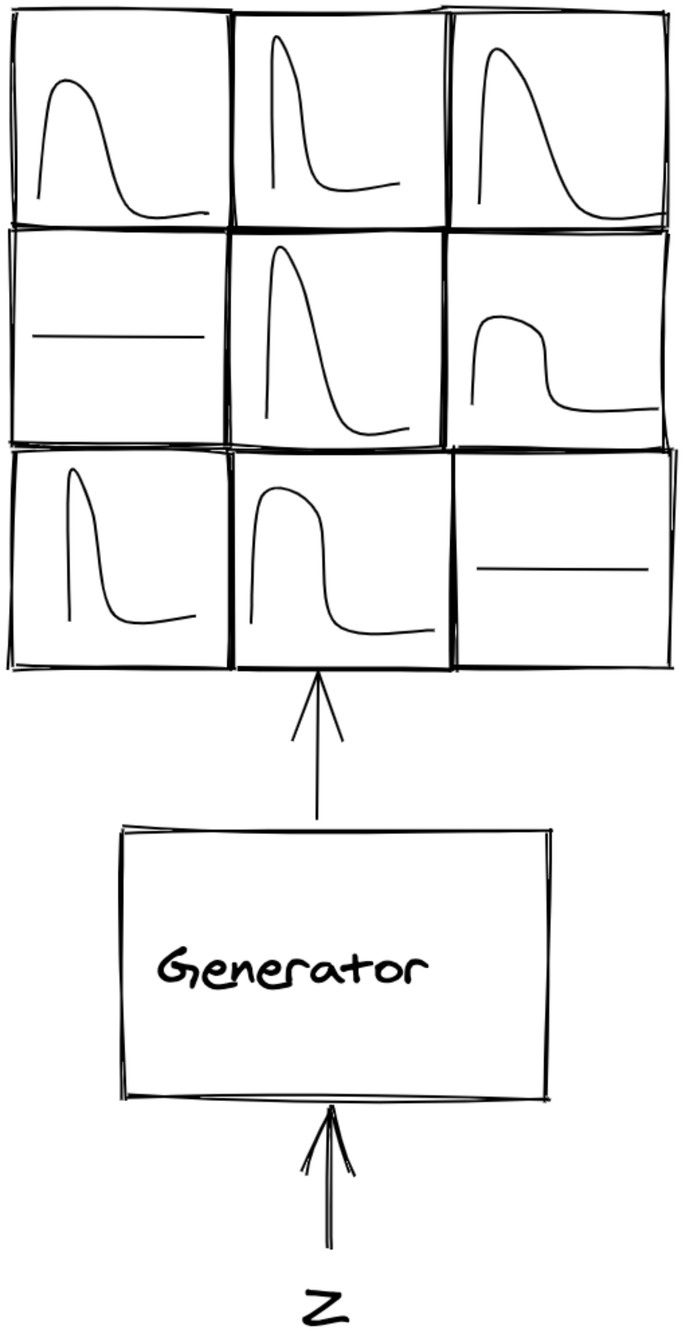




Processing kernel = $\frac{(x-y)^2}{e^{x-y}}$

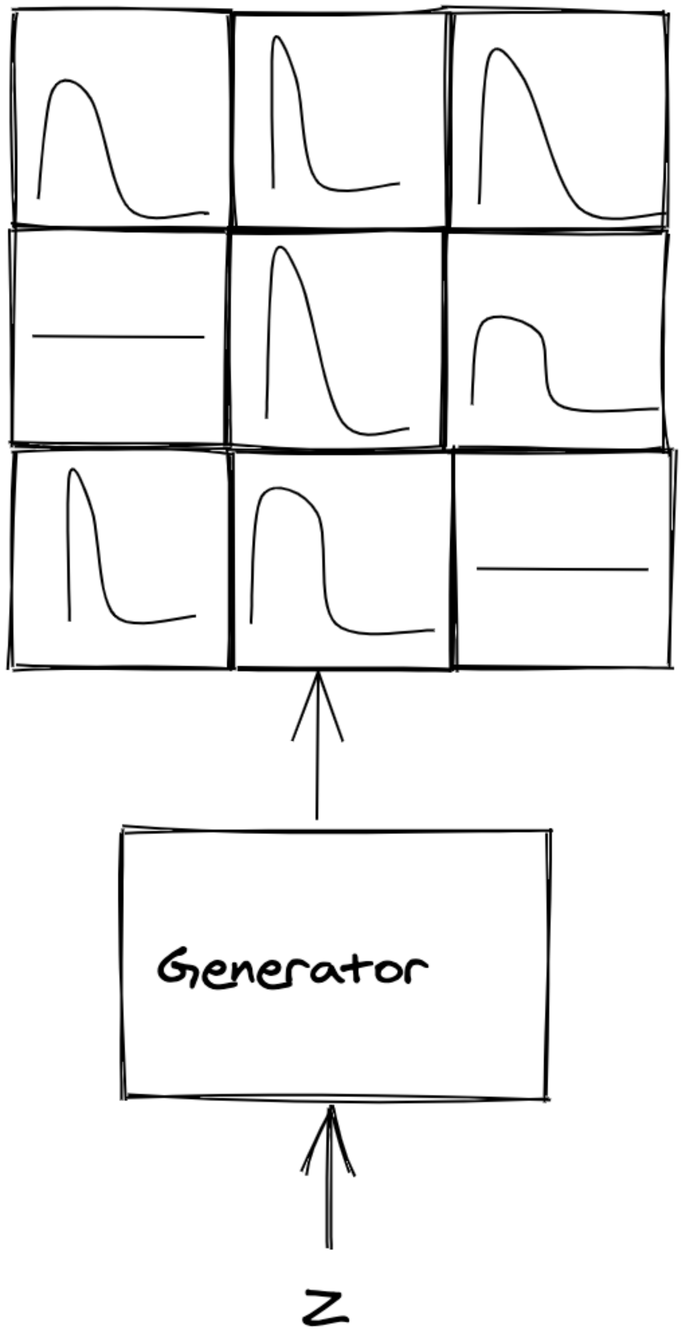
Model

Ideal model

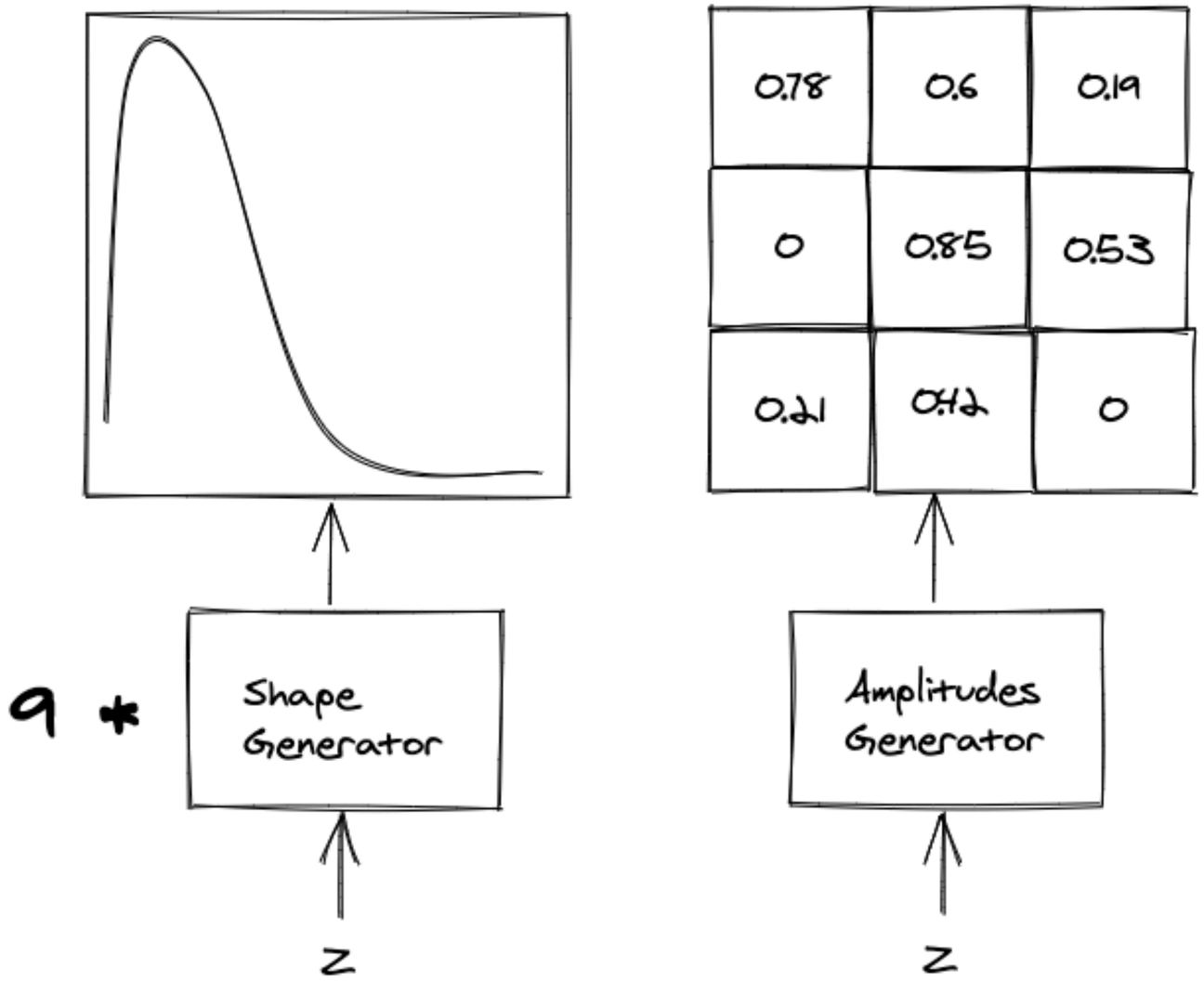


Ideal model

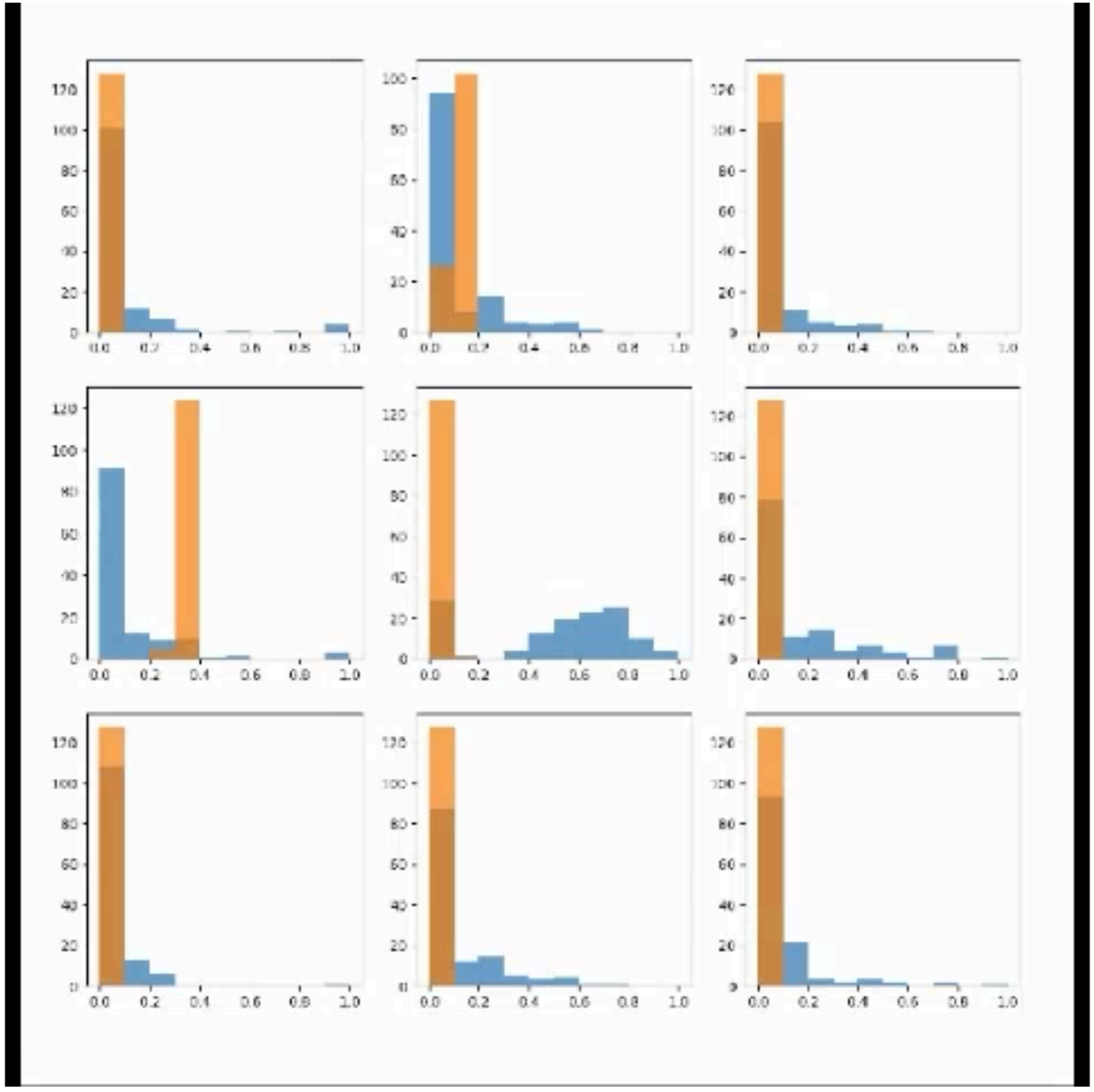
1024 * 9 = 9216 output size



Current approach



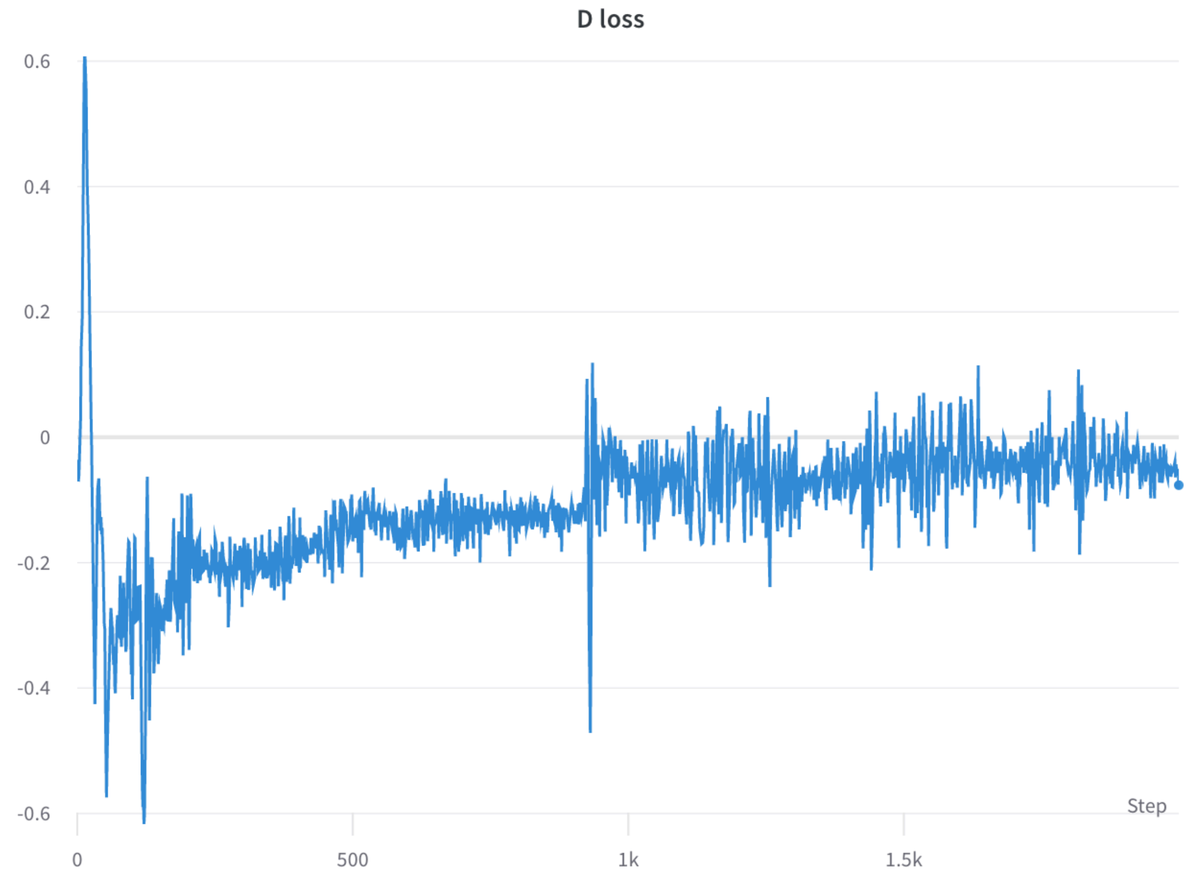
Amplitudes Generative Model

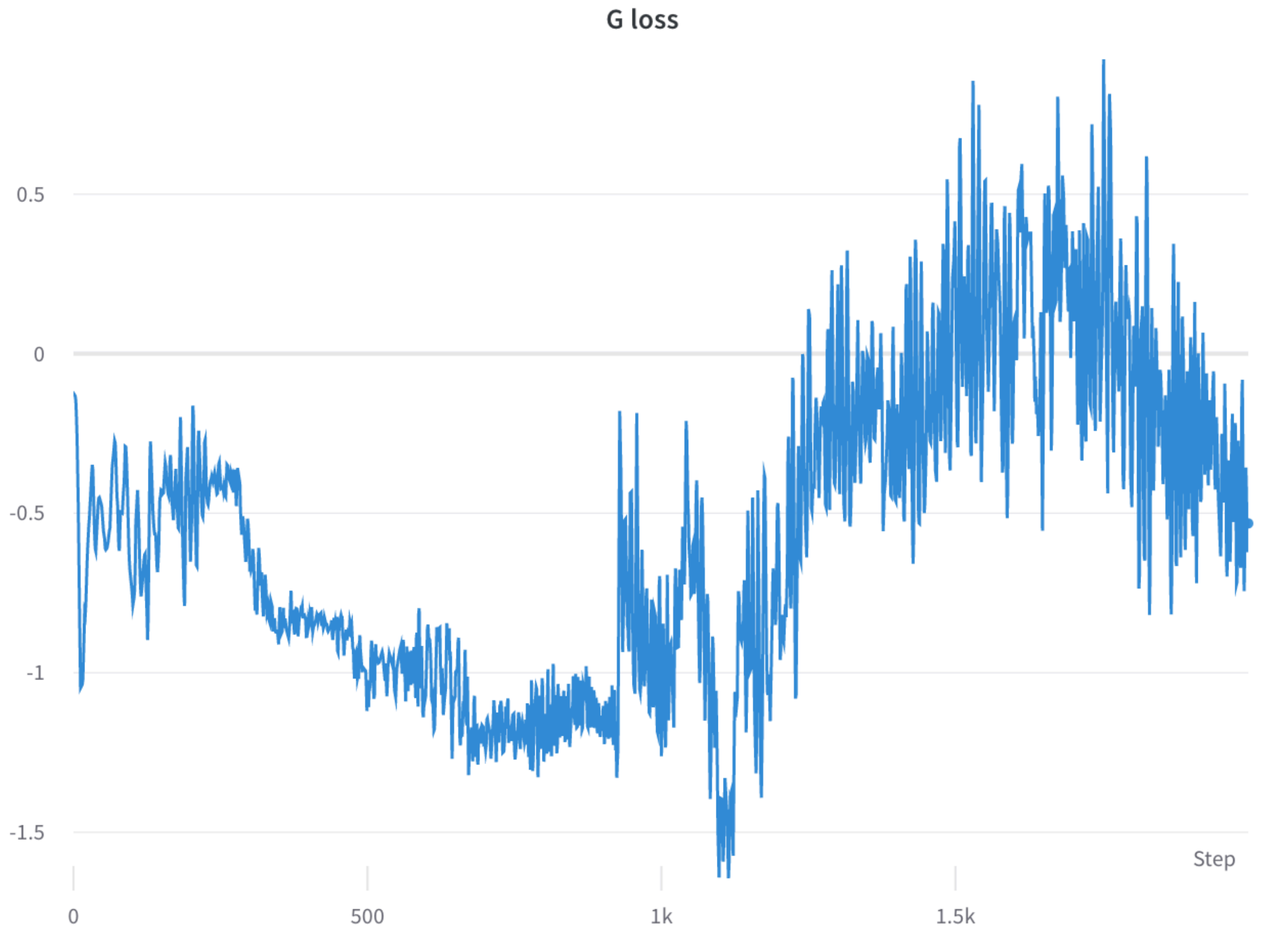


Generator

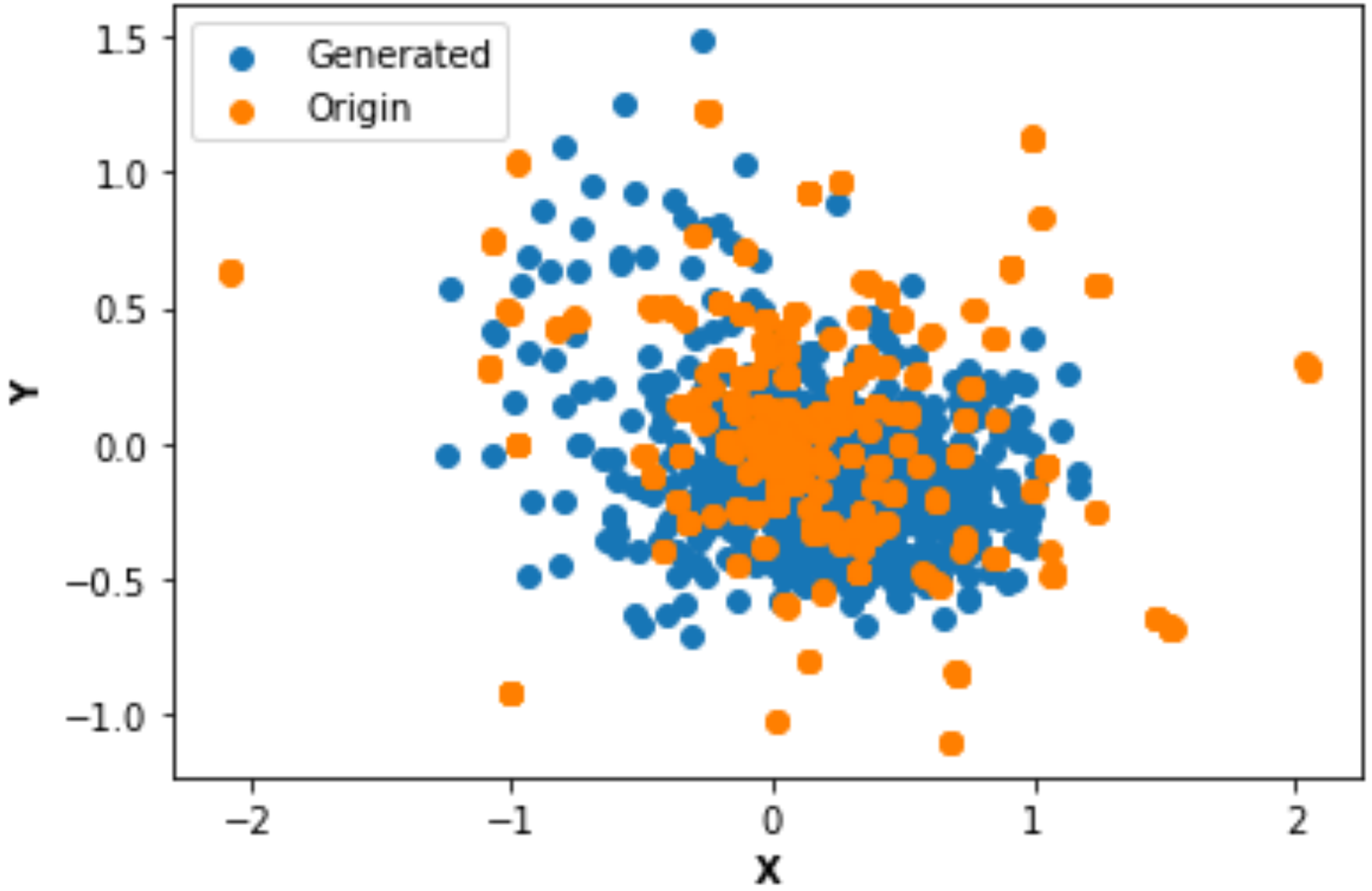
Discriminator

Loss curves


D loss
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
Step
0
500
1k
1.5k

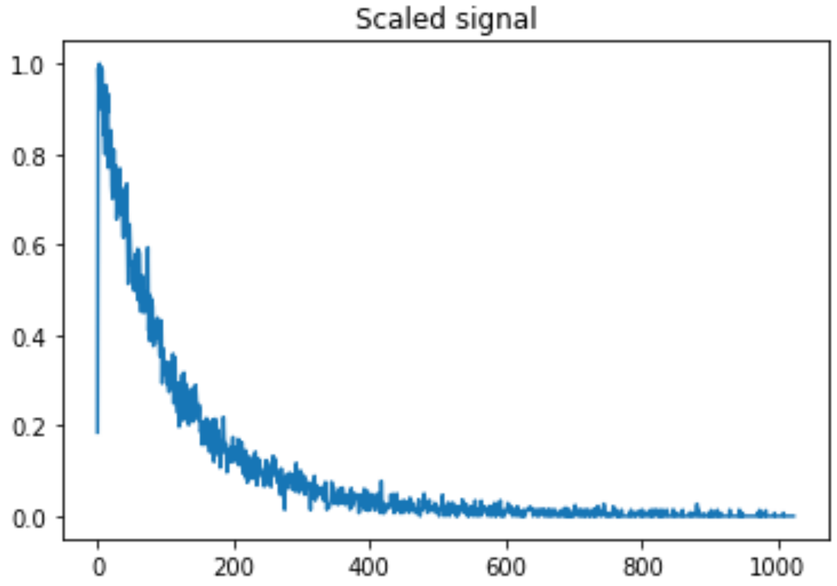

G loss
0.5
0
-0.5
-1
-1.5
Step
0
500
1k
1.5k

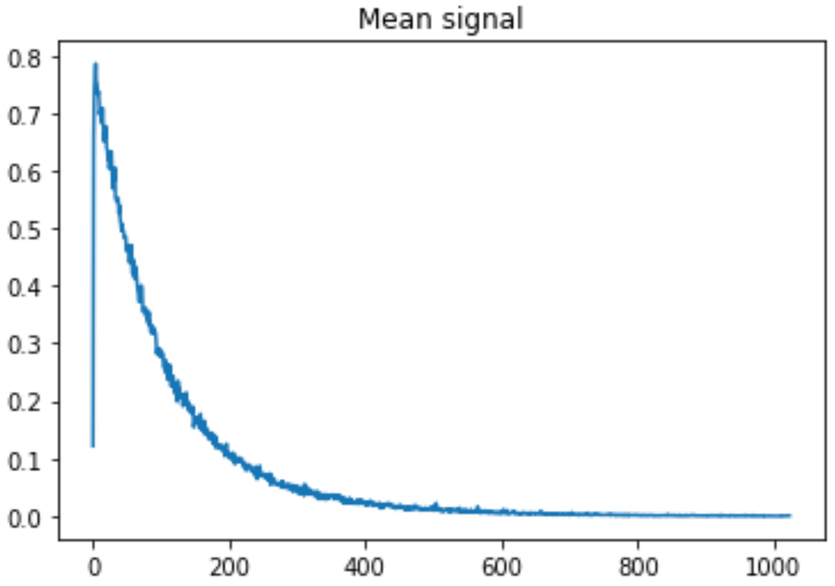
Space characteristic

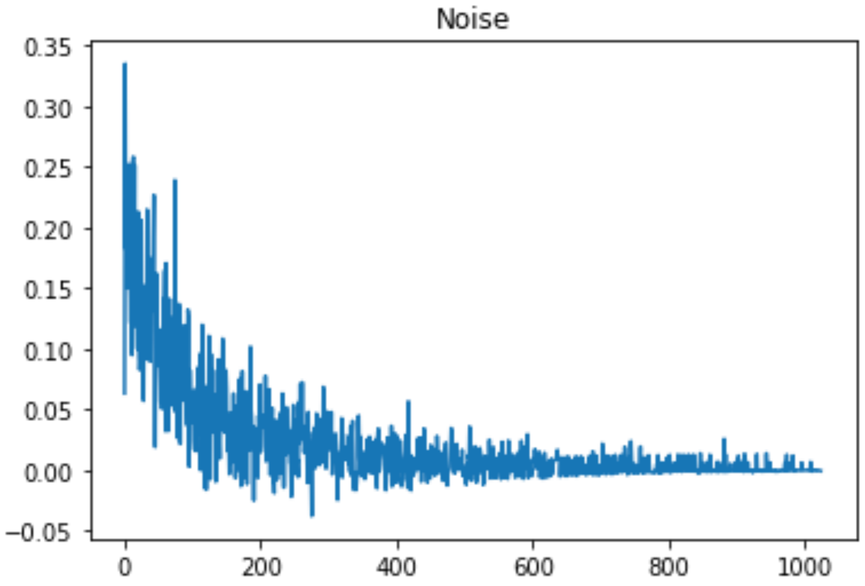


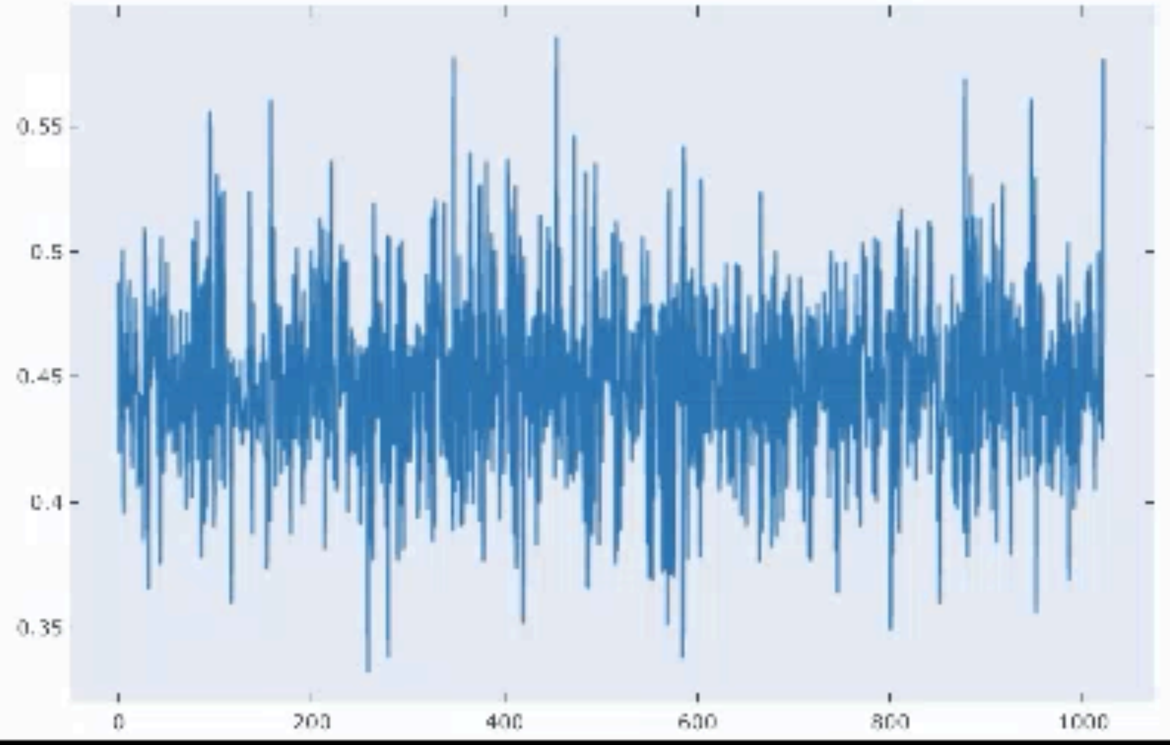
Shapes Generative Model

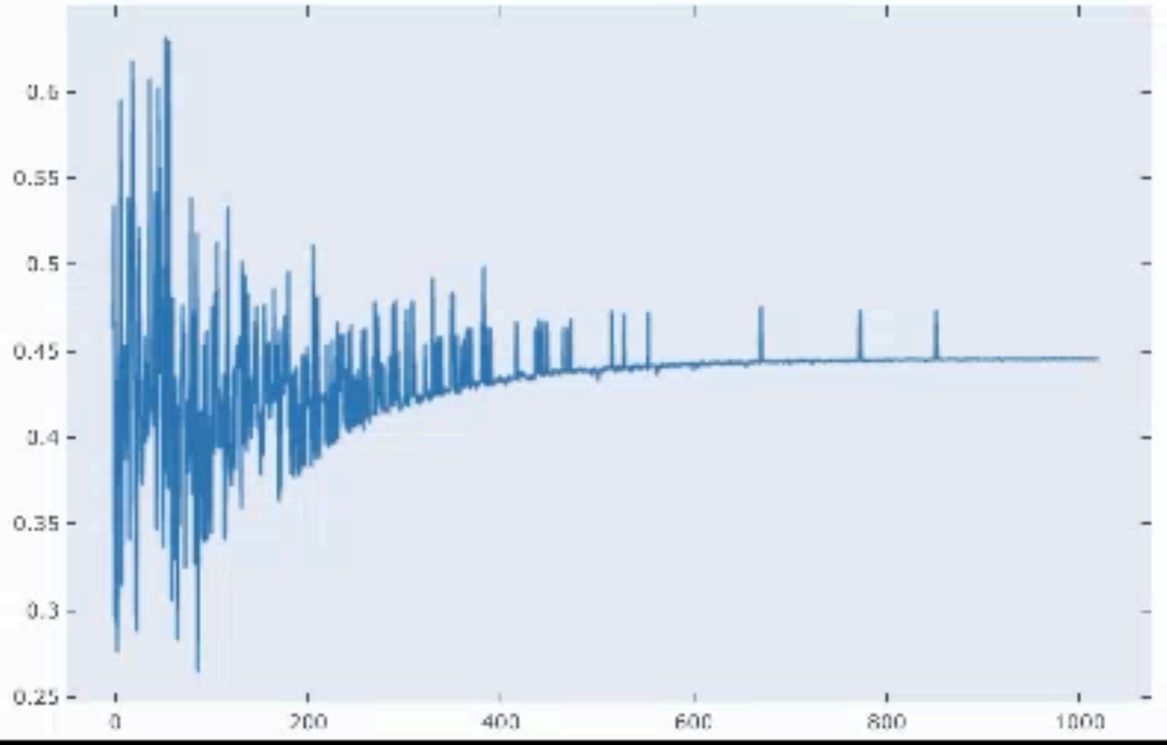
Data preparation



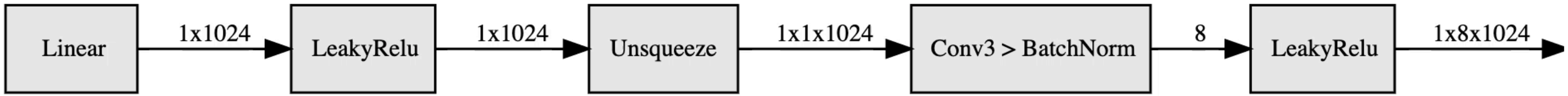





0.55
0.5
0.45
0.4
0.35
0
200
400
600
800
1000

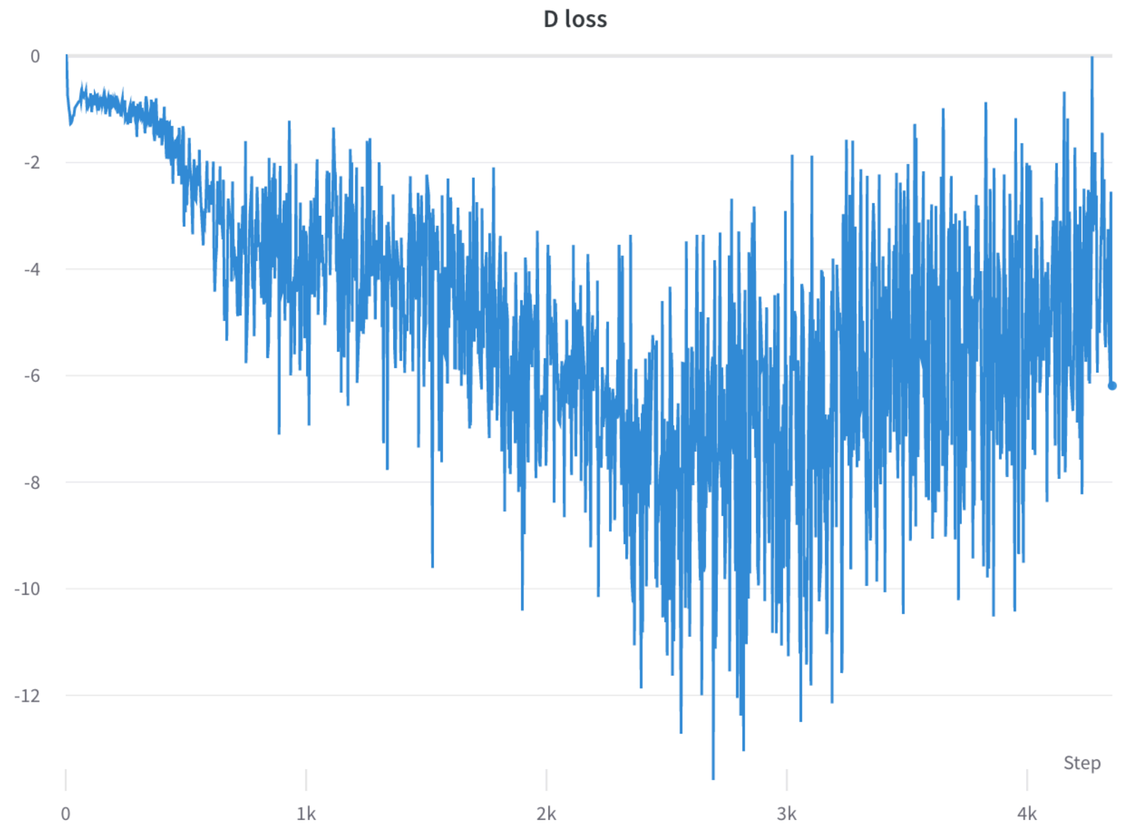

0.6
0.55
0.5
0.45
0.4
0.35
0.3
0.25
0
200
400
600
800
1000

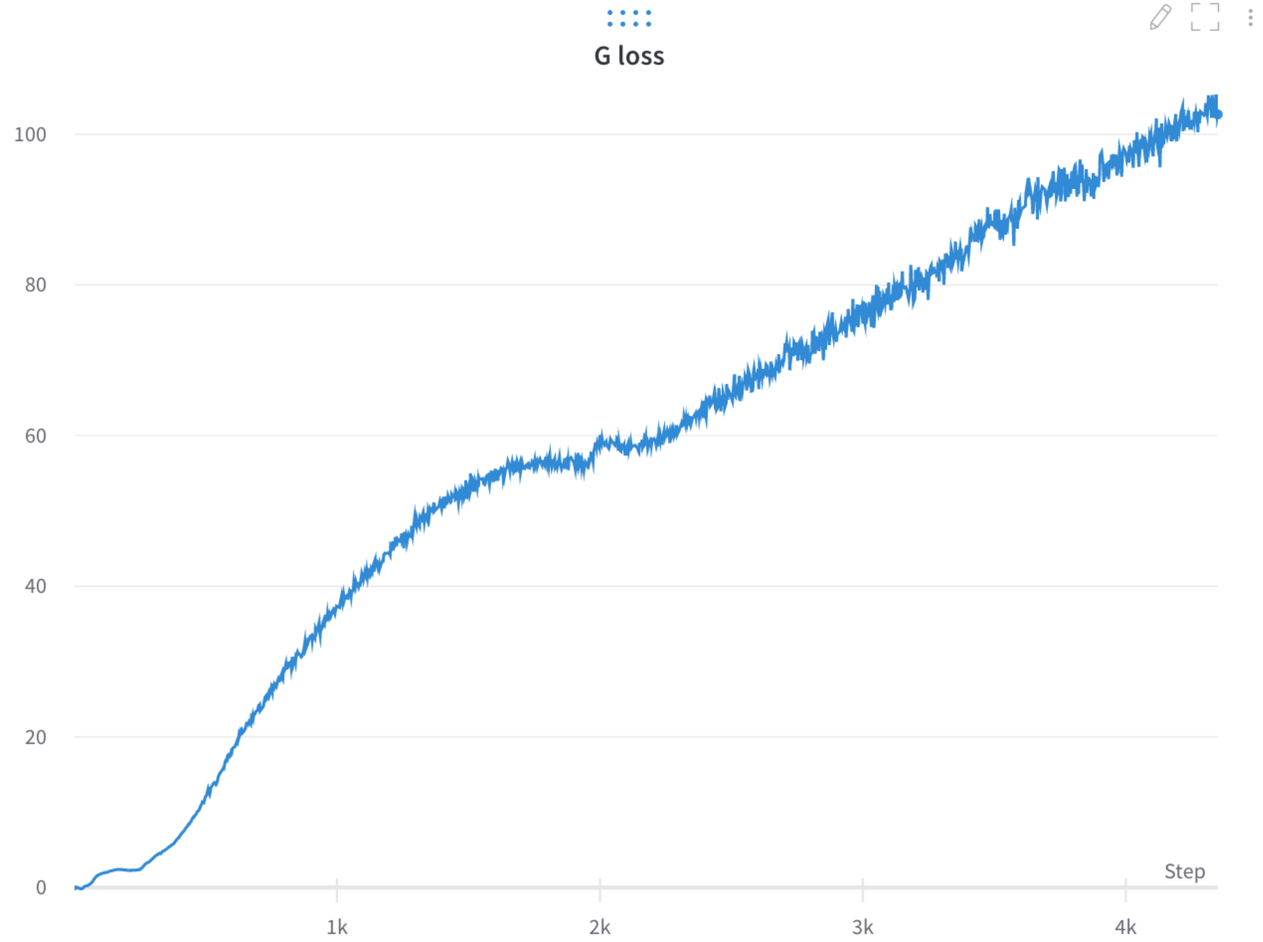
Generator



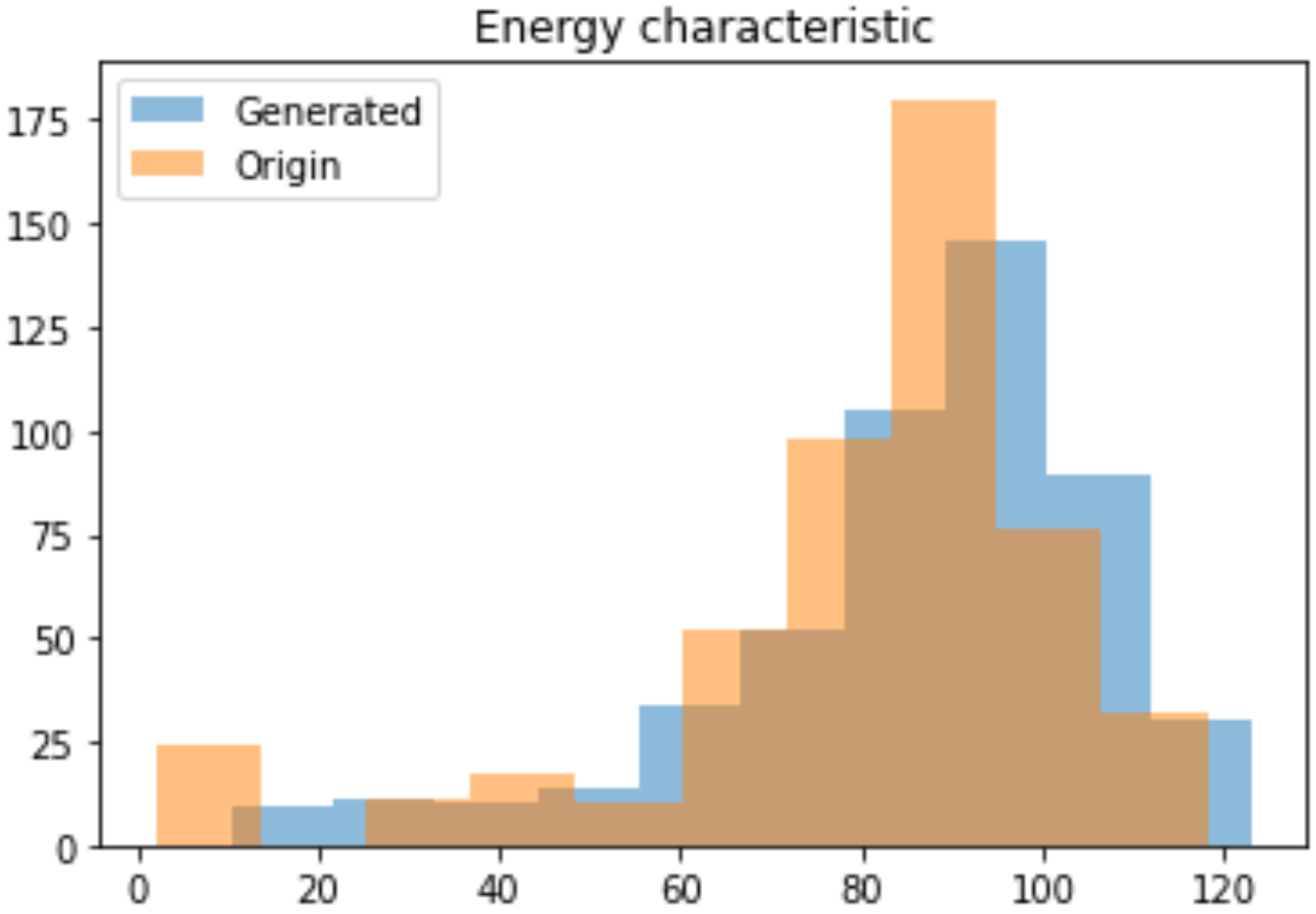
Discriminator

Loss curves

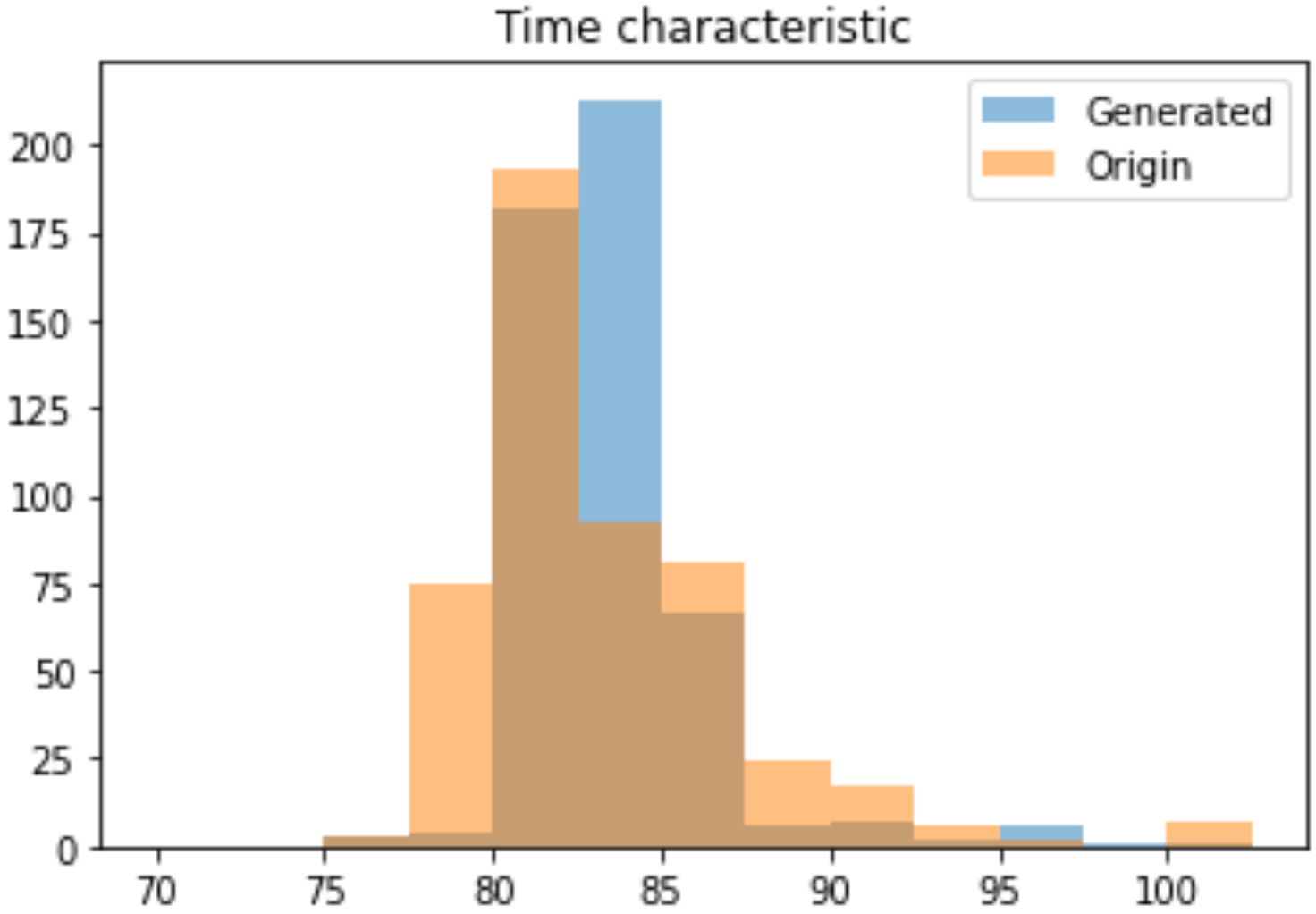

D loss
0
-2
-4
-6
-8
-10
-12
Step
0
1k
2k
3k
4k


G loss
100
80
60
40
20
0
Step
1k
2k
3k
4k

Energy characteristic



Time characteristic



Further Experiments

- One model for all detectors
- Conditional GAN on energy
- Conditional GAN on coordinates
- Conditional GAN on angle

Any Questions?

https://github.com/whiteRa2bit/hep_generative_models

master · 2 branches · 21 tags · Go to file · Add file · Code

whiteRa2bit Improved training (#36) ... 95d7aa1 13 hours ago 102 commits

generation	Improved training (#36)	13 hours ago
notebooks	Improved training (#36)	13 hours ago
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.gitignore	Checkpoints saver (#35)	2 days ago
.style.yapf	Refactoring (#26)	10 days ago
LICENSE	Add autoencoder model on nakagami data	6 months ago
README.md	Update README.md	6 months ago
setup.py	Improved training (#36)	13 hours ago

README.md

Generative models applied to High Energy Physics problems

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Releases 21

generation 0.6.2 Latest
13 hours ago

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Languages

- Jupyter Notebook 99.9%
- Python 0.1%