iML-WKW Use Case TurboSWAN

AIWAM meets iML-WKW

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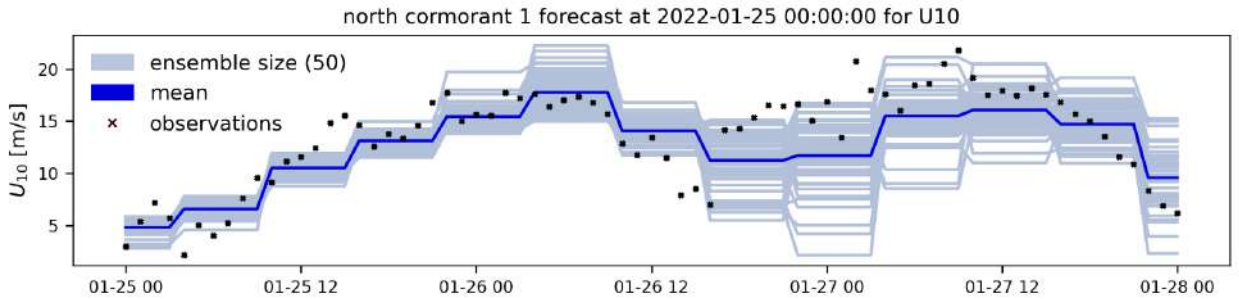
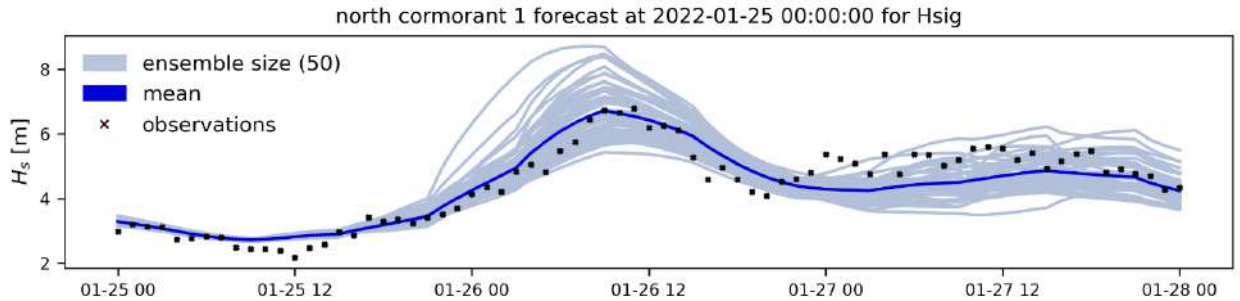
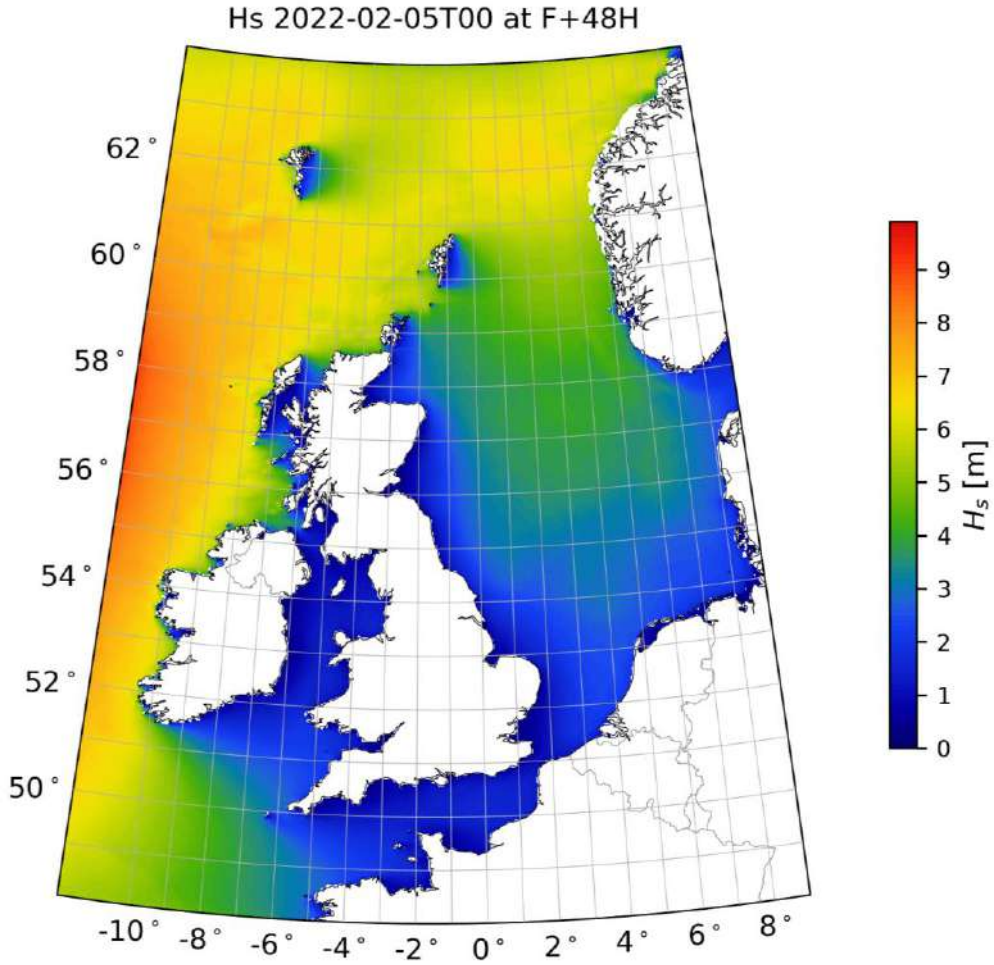
Use case: speed up training TurboSWAN

- SWAN-North Sea for operational wave forecasts







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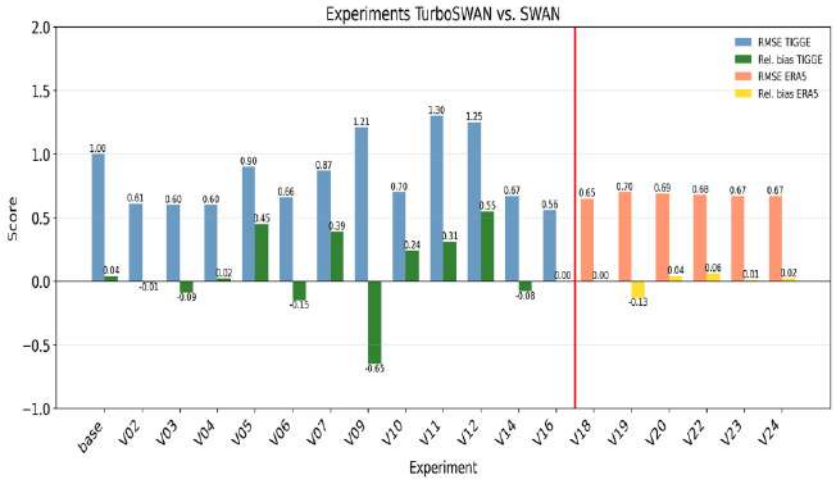
Use case: speed up training TurboSWAN

Trainingsdata: SWAN-DCSM 1979-2022 model results

incl ERA5 wind fields, water levels, boundary conditions.

Set up the fast surrogate model: TurboSWAN

- Time lag in wind?
- Waterdepth or water level?
- Loss function relative or absolute, …
- …



runid			input								
	dataset	Lag [hr]	Wave B.C.	Wind	Lev	Flow	Augm	Architecture	Loss	Mask	Output
2024	TIGGE*	0, -6	yes	U,V	WL	yes	-	0	sMSE	-	5 pars
Base	TIGGE	0, -6	yes	U,V	WL	yes	-	0	sMSE	-	5 pars
V02	TIGGE	0, -6	yes	U,V	dep	yes	-	1	sMSE	-	5 pars
V03	TIGGE	0, -6	yes	U,V	dep	yes	-	2	sMSE	-	5 pars
V04	TIGGE	0, -6	yes	U,V	dep	yes	-	3	sMSE	-	5 pars
V05	TIGGE	0, -6	yes	U,V	dep	yes	-	4	sMSE	-	5 pars
V06	TIGGE	0	yes	U,V	dep	yes	-	4	sMSE	-	5 pars
V07	TIGGE	0, -12	yes	U,V	dep	yes	-	4	sMSE	-	5 pars
V09	TIGGE	0, -6	yes	U,V	dep	yes	-	3	sMSE	yes	5 pars
V10	TIGGE	0	yes	U,V	dep	yes	-	3	sMSE	-	5 pars
V11	TIGGE	0, -6	-	τ_x, τ_y	dep	-	-	3	sMSE	-	Hs
V12	TIGGE	0, -6	-	τ_x, τ_y	dep	-	-	3	sMSE	yes	Hs
V14	TIGGE	0, -6	-	τ_x, τ_y	dep	-	yes	3	sMSE	yes	Hs
V16	TIGGE	0	-	U,V	dep	-	-	3	sMSE	-	Hs
V18	18yrERA5	0	yes	U,V	dep	-	-	3	sMSE	-	Hs
V19	18yrERA5	0	yes	U,V	dep	-	-	3	rMAE	-	Hs
V20	18yrERA5	0	yes	U,V	dep	-	-	3	uMSE	-	Hs
V22	18yrERA5	0, -3	yes	U,V	dep	-	-	3	uMSE	-	Hs
V23	18yrERA5	0, -6	yes	U,V	dep	-	-	3	uMSE	-	Hs
V24	18yrERA5	0, -3 -6 -9	yes	U,V	dep	-	-	3	uMSE	-	Hs

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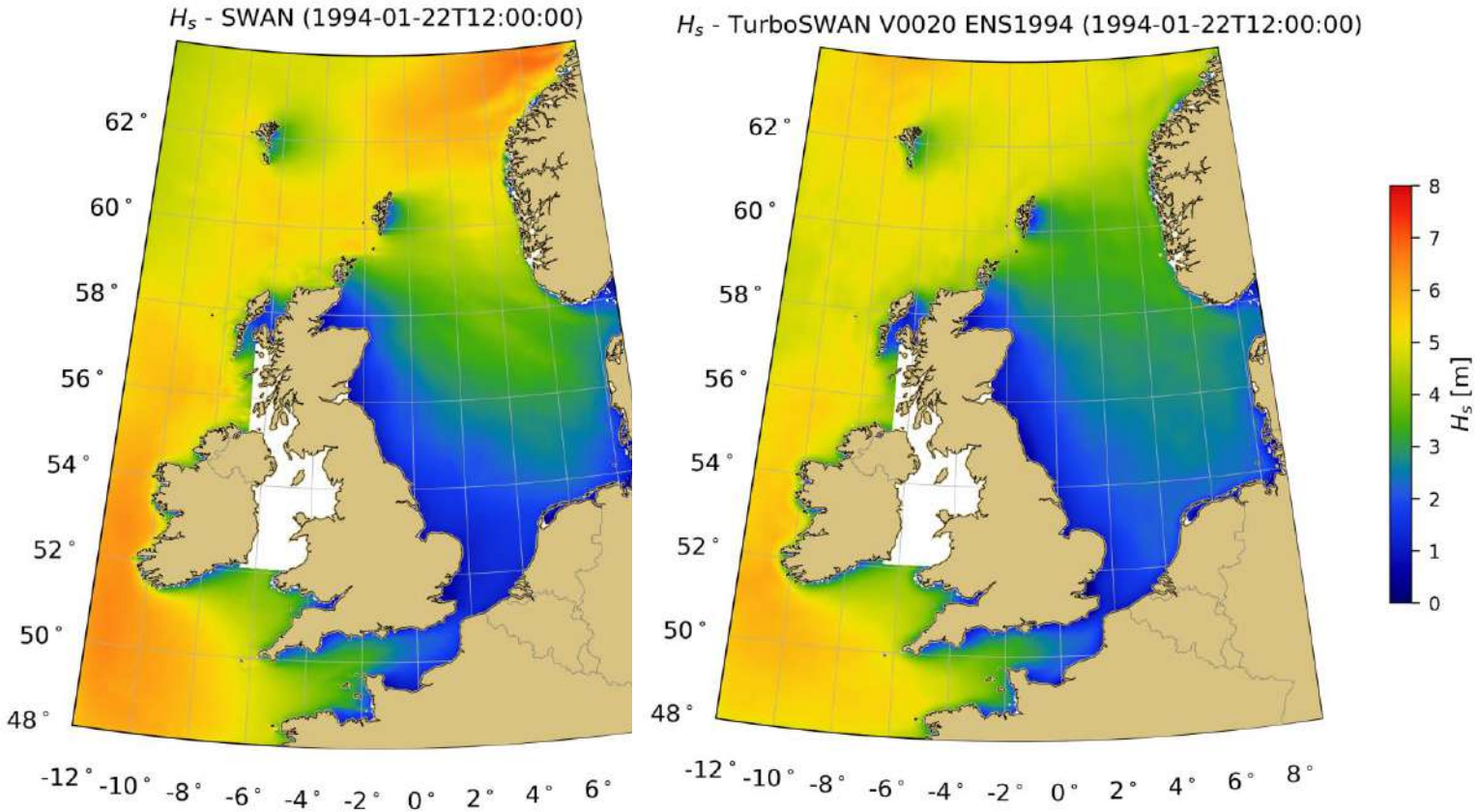
Use case: speed up training TurboSWAN

How can we optimise this process?

- Faster
- Better structured
- Automated

100 iterations…??

-> Let ‘s ask iML-WKW!



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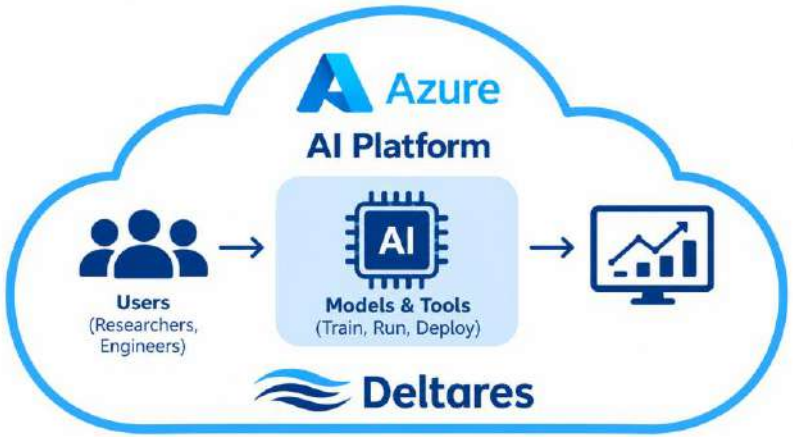
Perfect timing

- The MLX team had just expanded
- MLX needed a new use case at Deltares, to help onboard the new team-members
- Deltares was quite far with building an Proof of Concept AI platform, which we could use

MLX
MACHINE LEARNING EXCHANGE
MAKING ML WORK IN PRACTICE

USE case



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How can we help?

To help the Turboswan use case we needed:

- Orchestration
- More compute
- Parallelisation
- Some more compute



The AI platform already had orchestration

Compute on Azure would be expensive (€ 100k+ for the estimated 70.000 GPUhours), so we had to use Surf (Snellius)

New features:

- Facilitate parallelisation
- Optimize runs
- Optimize GPU usage

- (Integrate the AI Platform with Snellius)

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Overview

AIWaM and iML-WKW

- Make experiments faster: run many trials at once instead of one at a time.
- Make results accessible: record data, settings and scores in one place.
- Make training cheaper: on Snellius, the optimised run process 78% more samples per second.



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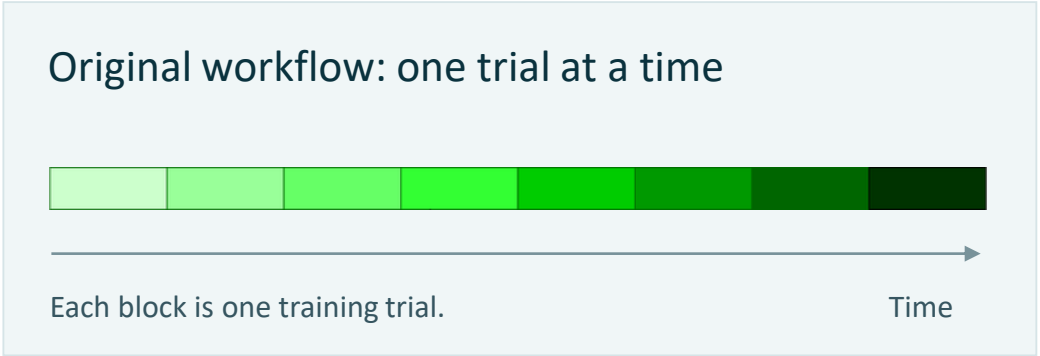
Make research faster

- Original: Test one set of training settings at a time.



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Make research faster

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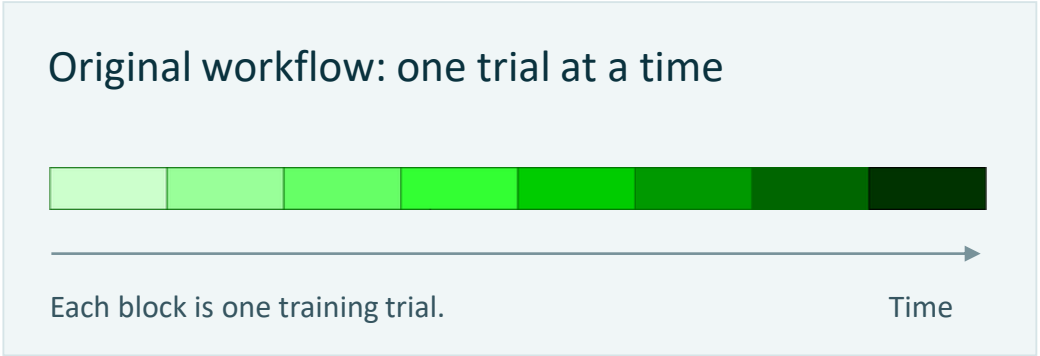
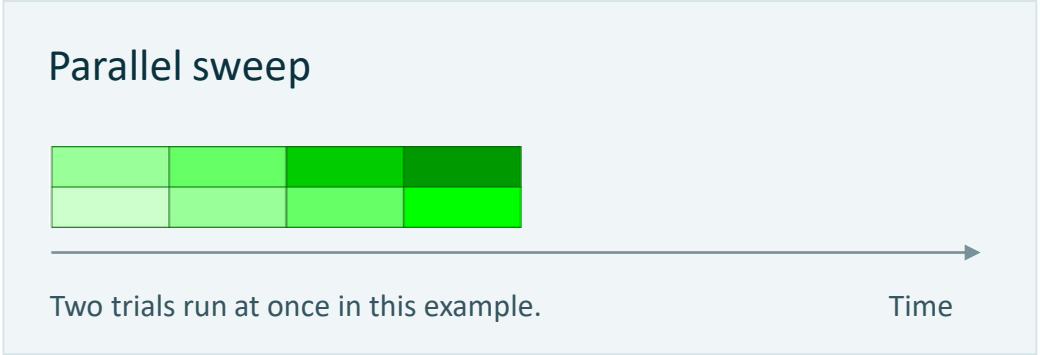
- With a sweep, several trials can run at the same time.





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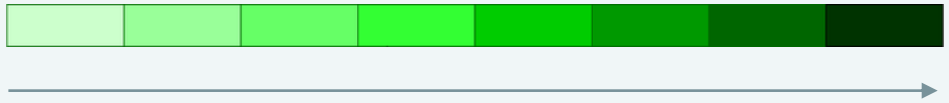
Make research faster

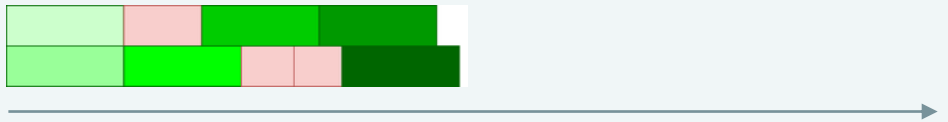
- Original: Test one set of training settings at a time.
- With a sweep, several trials can run at the same time.
- The results can guide the next trials, and trials that make little progress can stop early.

Original workflow: one trial at a time



Each block is one training trial. Time

Parallel sweep with early stopping



The pink blocks show trials that stopped early. Time

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Make research accessible

The entire team can:

- See which data and settings each run used.

Inputs and settings in MLflow



Example training recipe

```
[training]
learning_rate = 1e-4
lr_decay_steps = 10000
lr_decay_rate = 0.9
n_epochs = 3
batch_size = 2
```

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Make research accessible

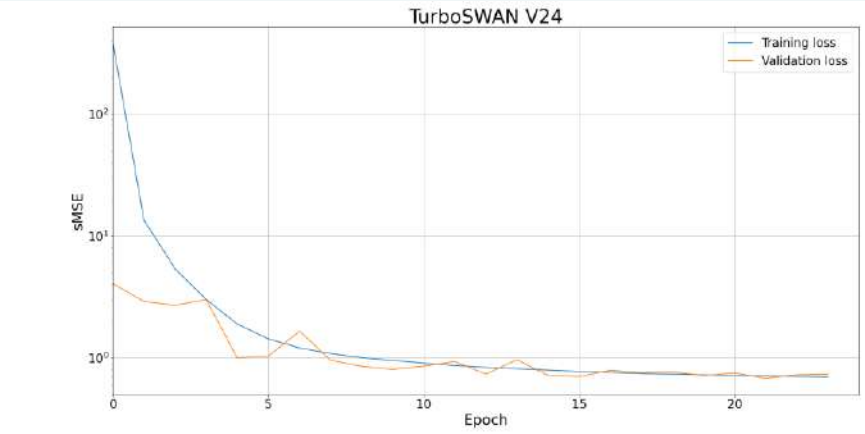
The entire team can:

- See which data and settings each run used.
- Compare training progress and scores.

Inputs and settings in MLflow



Training progress



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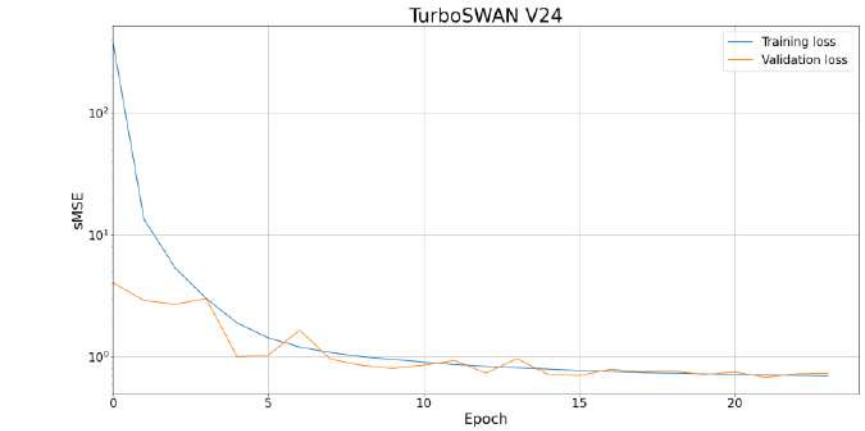
Make research accessible

The entire team can:

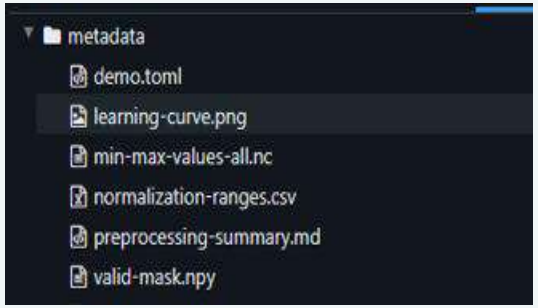
- See which data and settings each run used.
- Compare training progress and scores.

- Share a link to the trained model and its plots.

Training progress



Saved plots and files



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Make research cheaper

- Parallel trials finish sooner but can use just as much GPU time.

Example: two one-hour trials

One after the other	Together
2 hours waiting	1 hour waiting

Both use two GPU-hours in total.

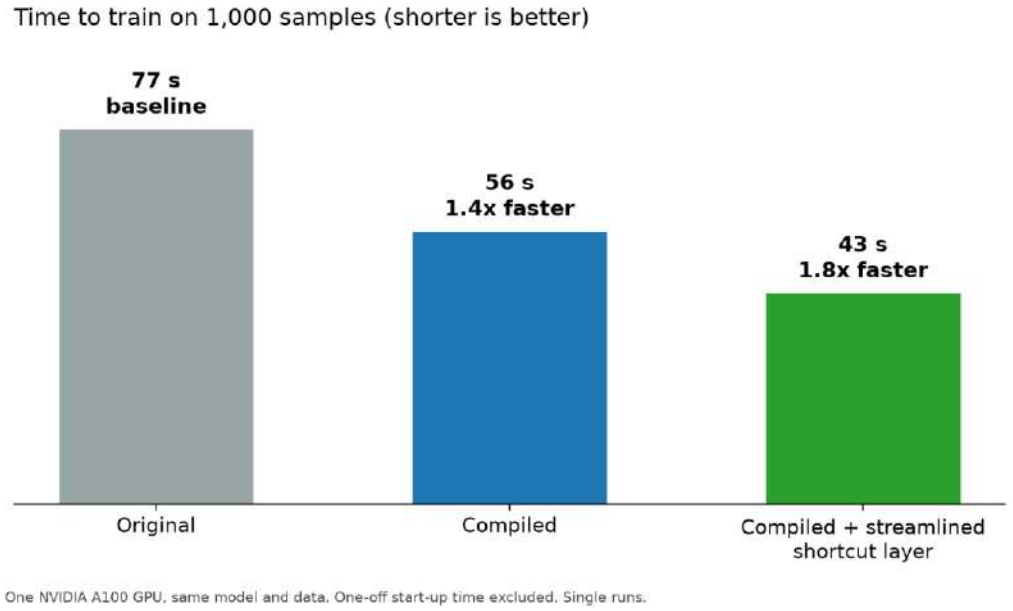
Make research cheaper

- Parallel trials finish sooner but can use just as much GPU time.
- We benchmarked TurboSWAN on Snellius GPUs.
- Grouped small GPU operations with compilation and streamlining.
- Now process 78% more training samples per second.

Example: two one-hour trials

One after the other	Together
2 hours waiting	1 hour waiting

Both use two GPU-hours in total.



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What iML enables

- Allow you to run more experiments at the same time.
- Each optimised run takes less time and uses fewer computing resources.
- In short: enable easier, faster experimentation for researchers☺



Bring us a use case you would like help with!

iML weather climate water