TECHNISCHE UNIVERSITÄT DARMSTADT

TASK 4: VISCOELASTICITY

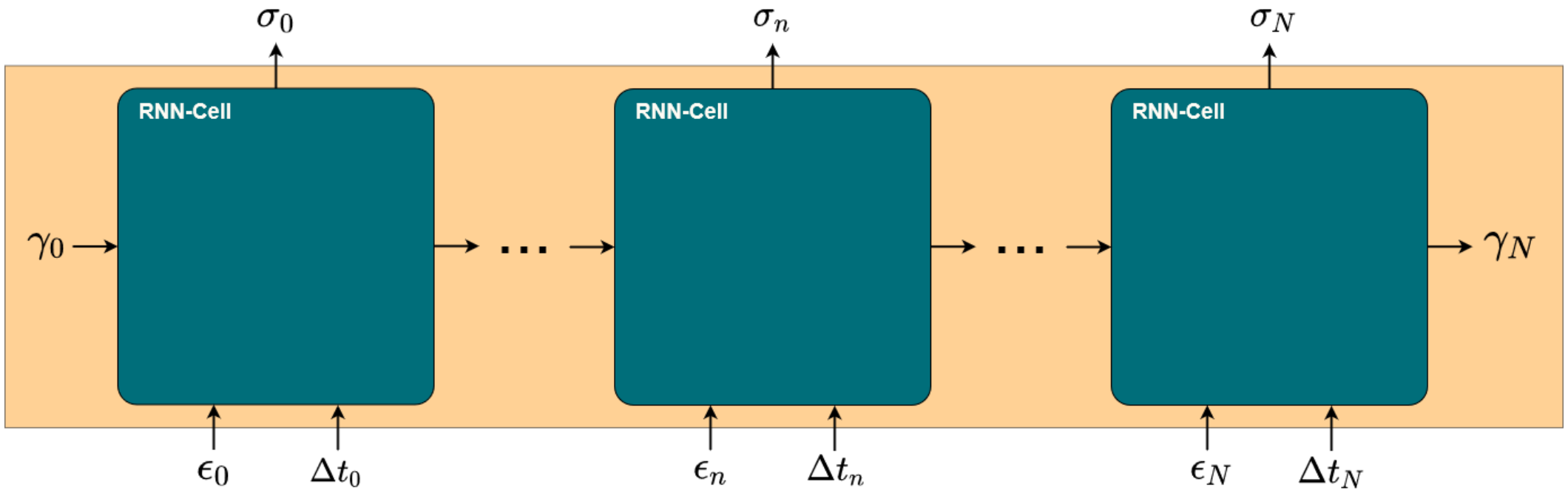
Fabian Roth

SECTIONS

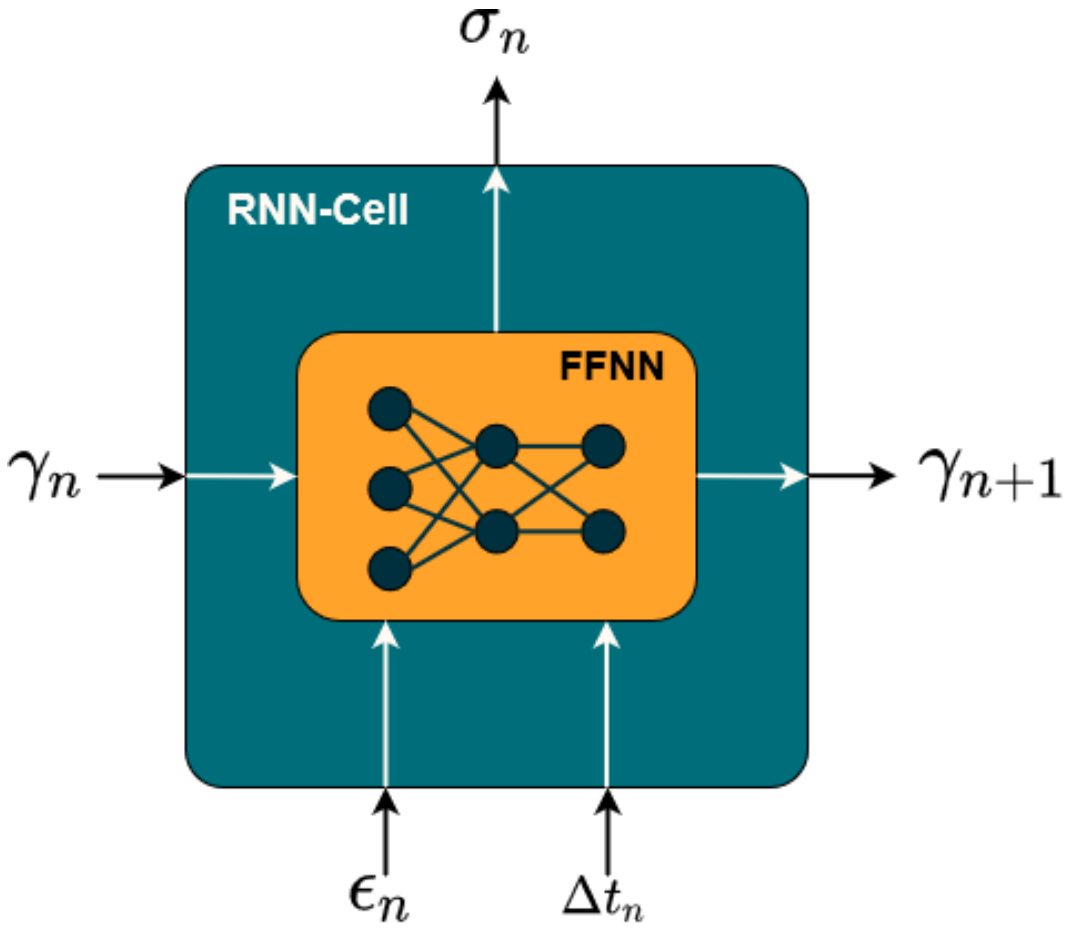
TECHNISCHE UNIVERSITÄT DARMSTADT

RNN ARCHITECTURE

TECHNISCHE UNIVERSITÄT DARMSTADT



SIMPLE RNN



Physical Knowledge:

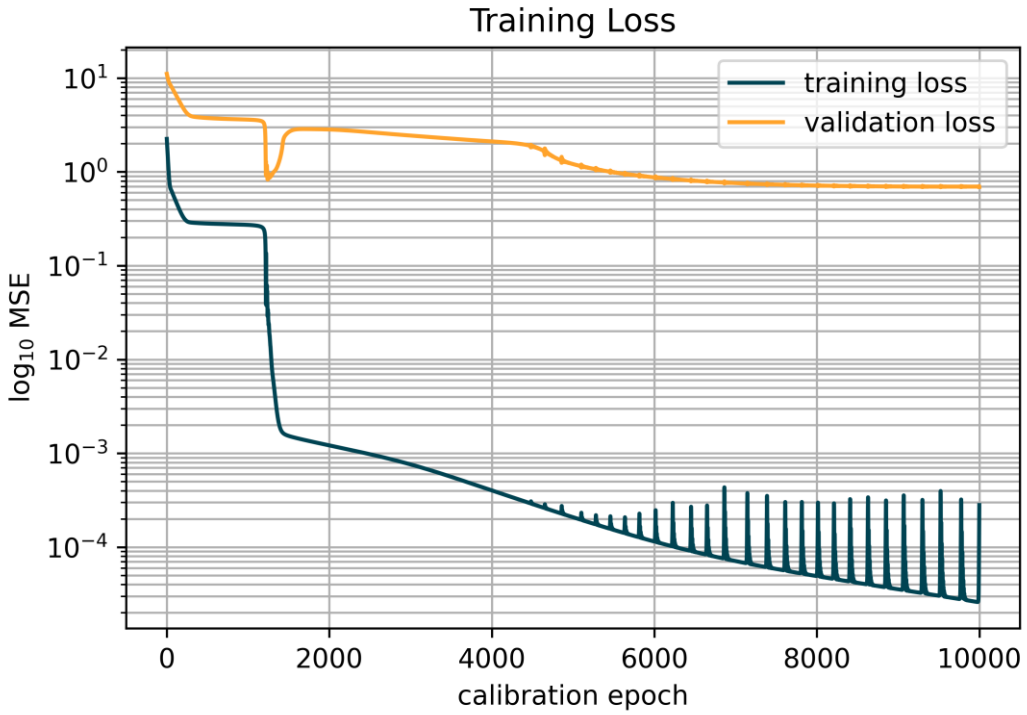
- ✗ Thermodynamics
- ✗ Equilibrium stiffness
- ✗ Non equilibrium stiffness
- ✗ Relaxation behavior

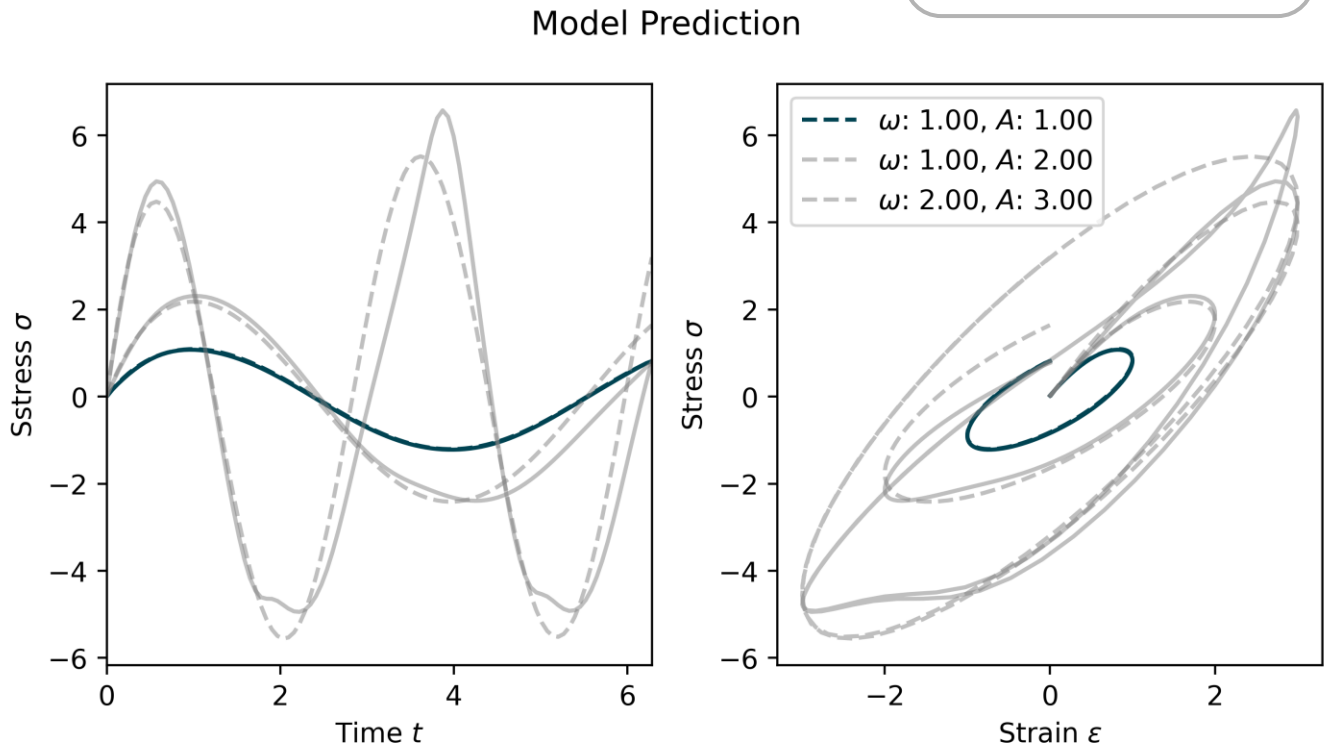
SIMPLE RNN

TECHNISCHE UNIVERSITÄT DARMSTADT

Trained on $\omega = 1, A = 1$

Epochs: 10,000
L. Rate: 0.001
Layers: 32, 2





SIMPLE RNN

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Epochs: 10,000
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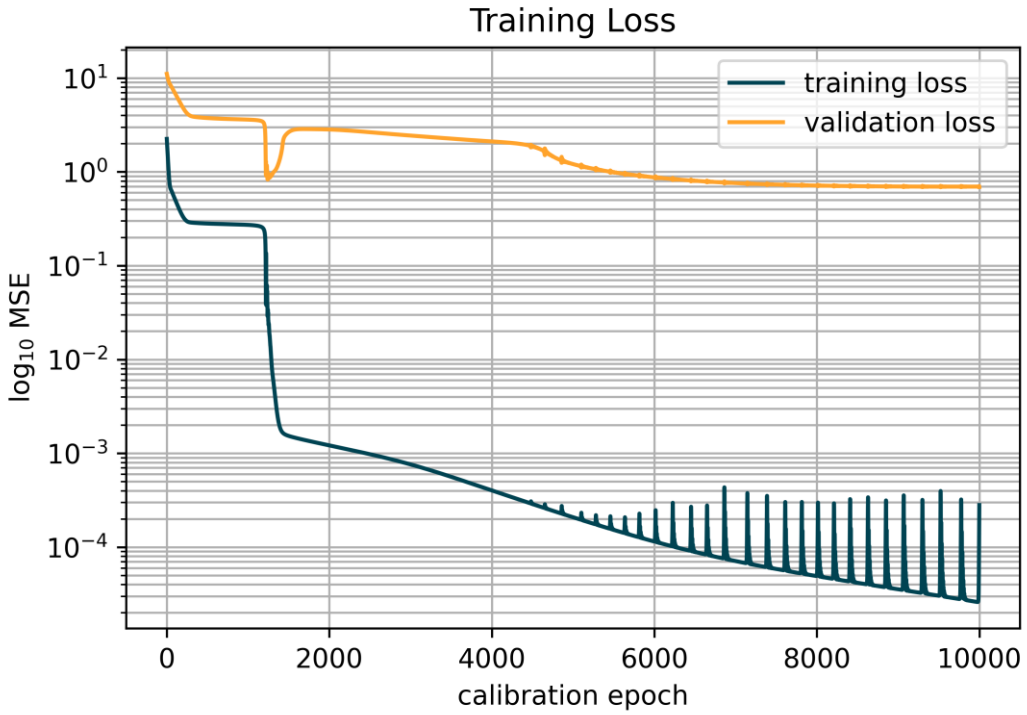
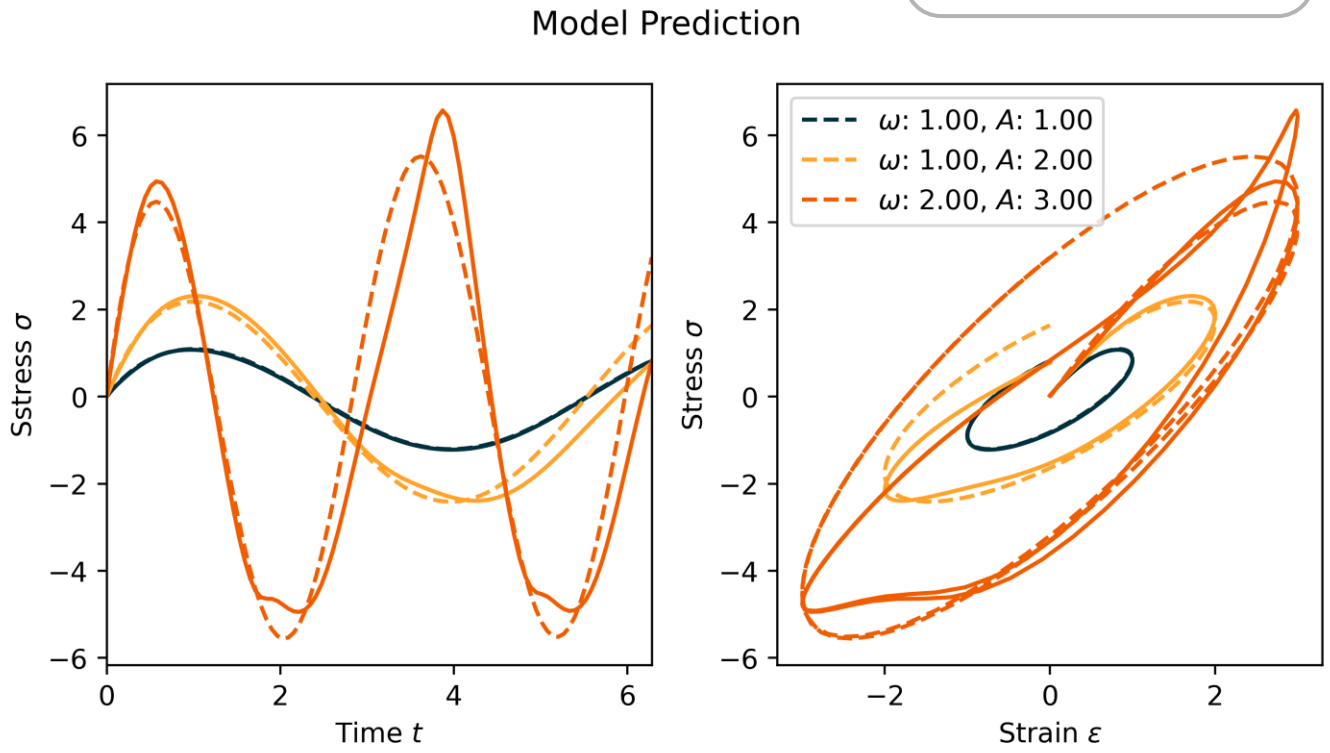
Layers: 32, 2





SIMPLE RNN

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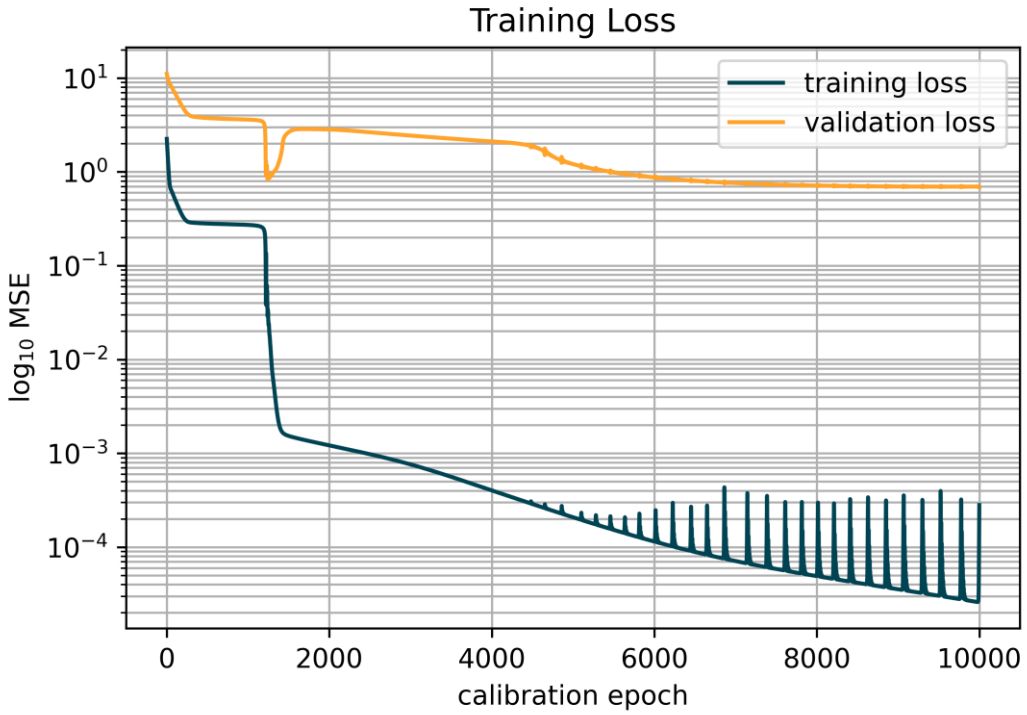
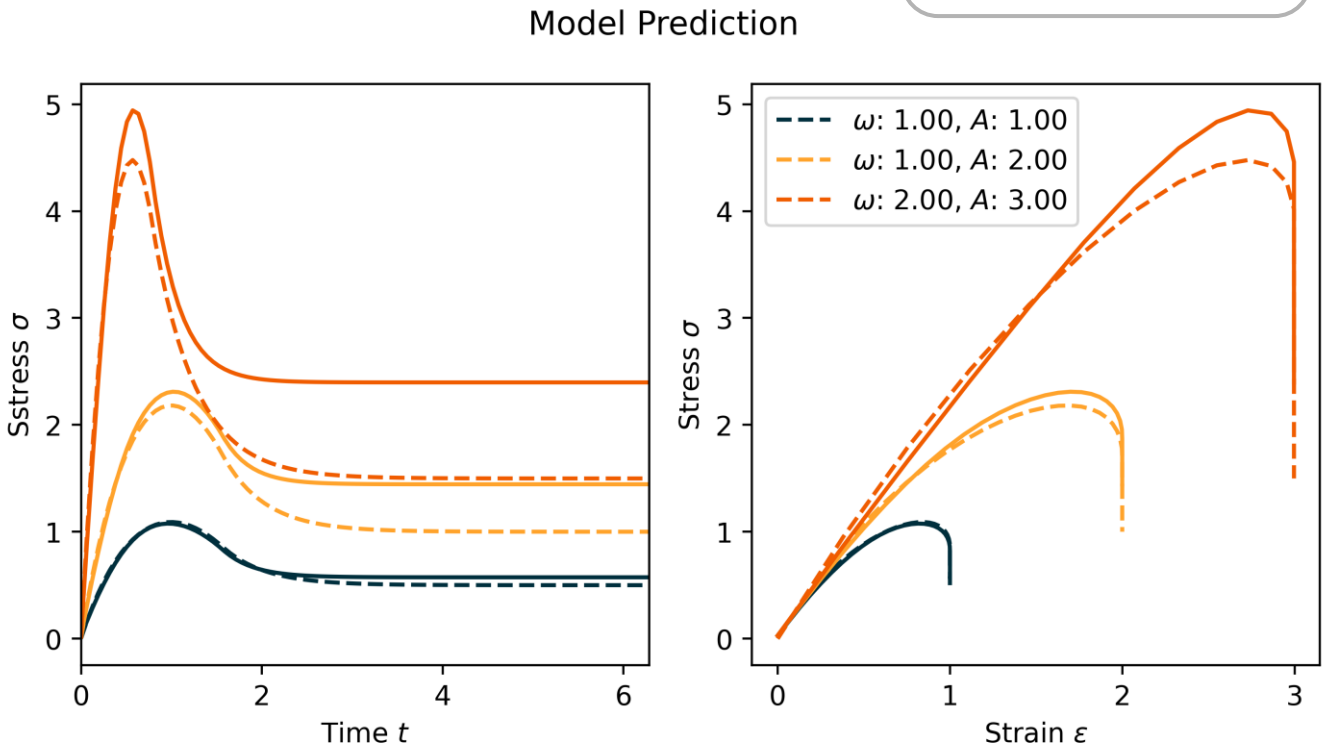
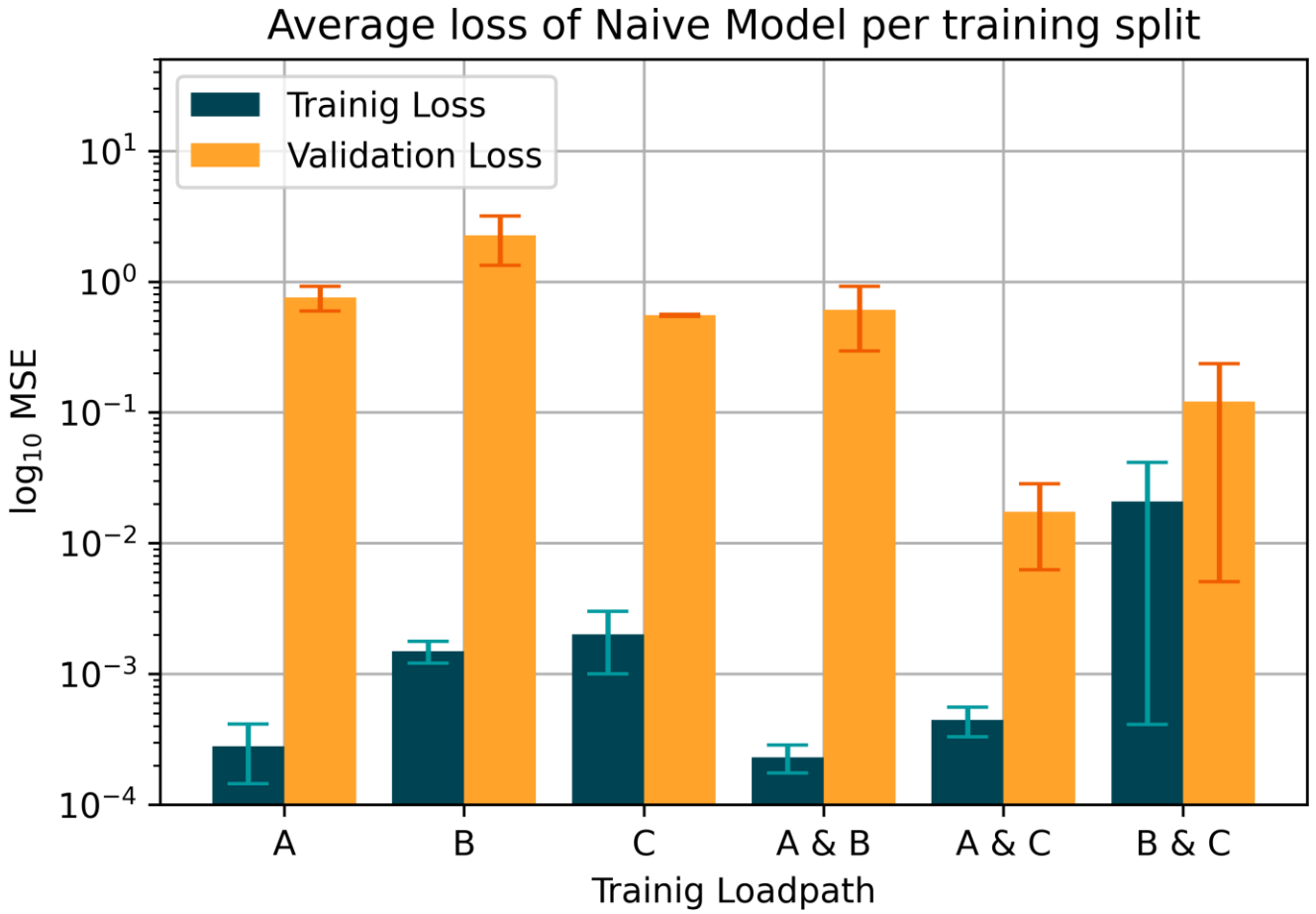
Layers: 32, 2





SIMPLE RNN



A: $\omega = 1, A = 1$
B: $\omega = 1, A = 2$
C: $\omega = 2, A = 3$

Epochs: 4000
L. Rate: 0.001
Layers: $32, 2$
Instances: 2

4 - 2.1

SIMPLE RNN

TECHNISCHE UNIVERSITÄT DARMSTADT

Epochs: 4000
L. Rate: 0.001
Layers: 32, 2
Instances: 2

A: $\omega = 1, A = 1$
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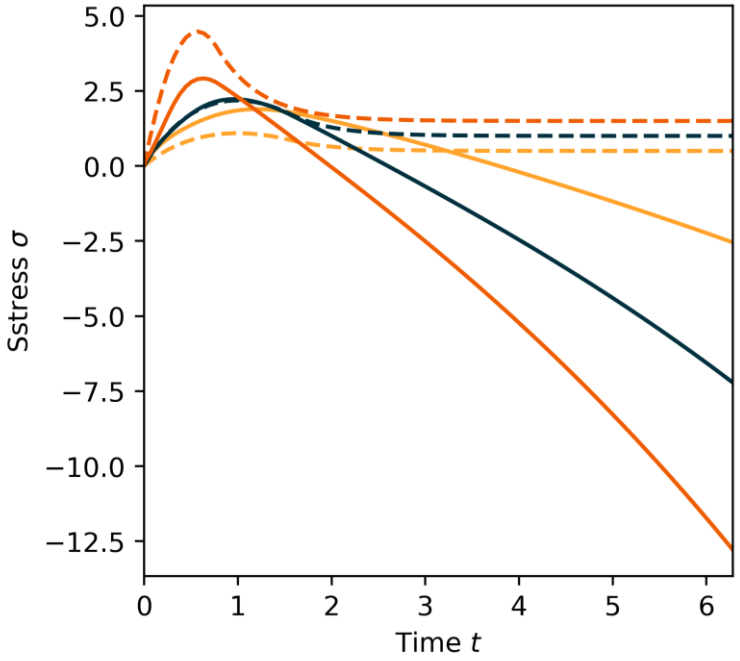
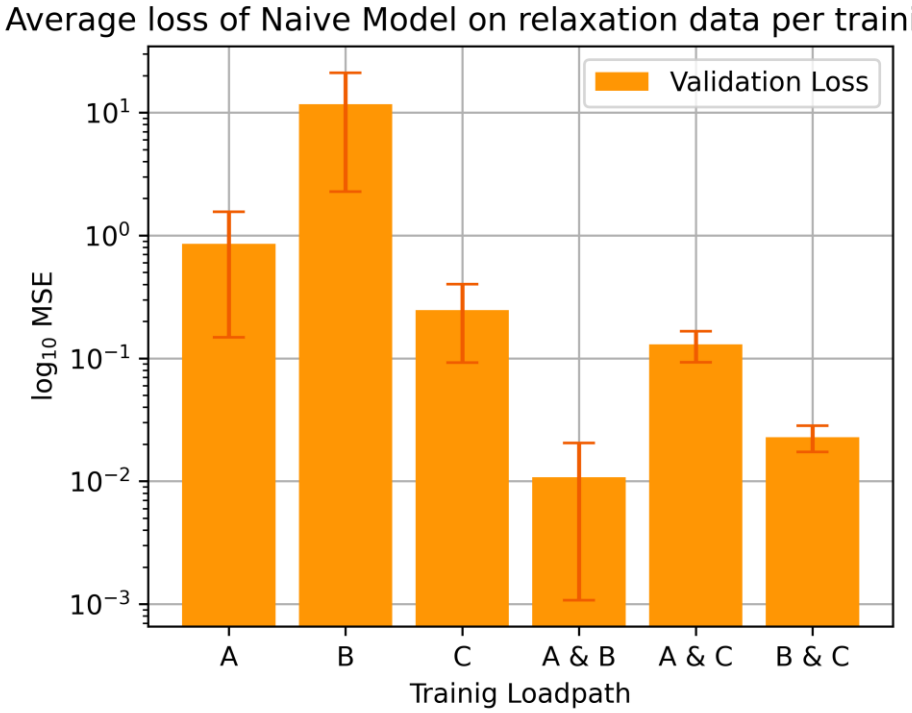
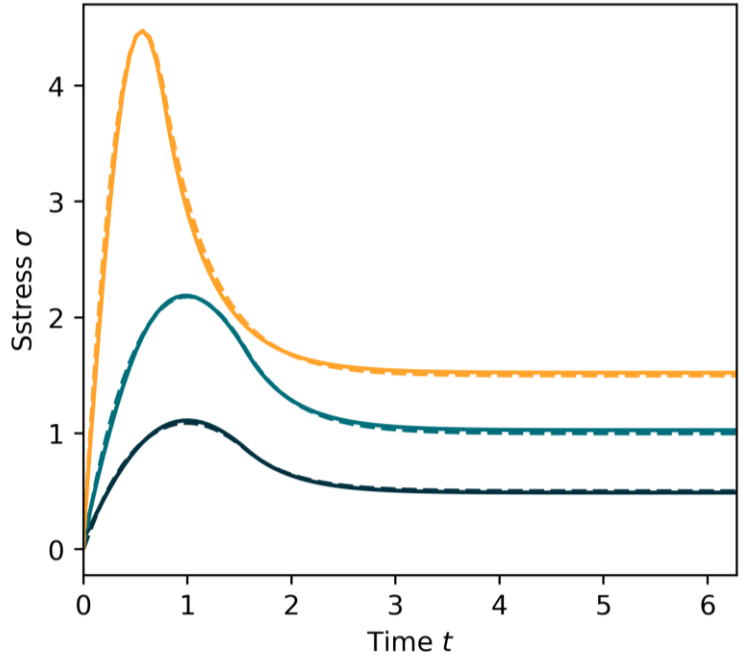
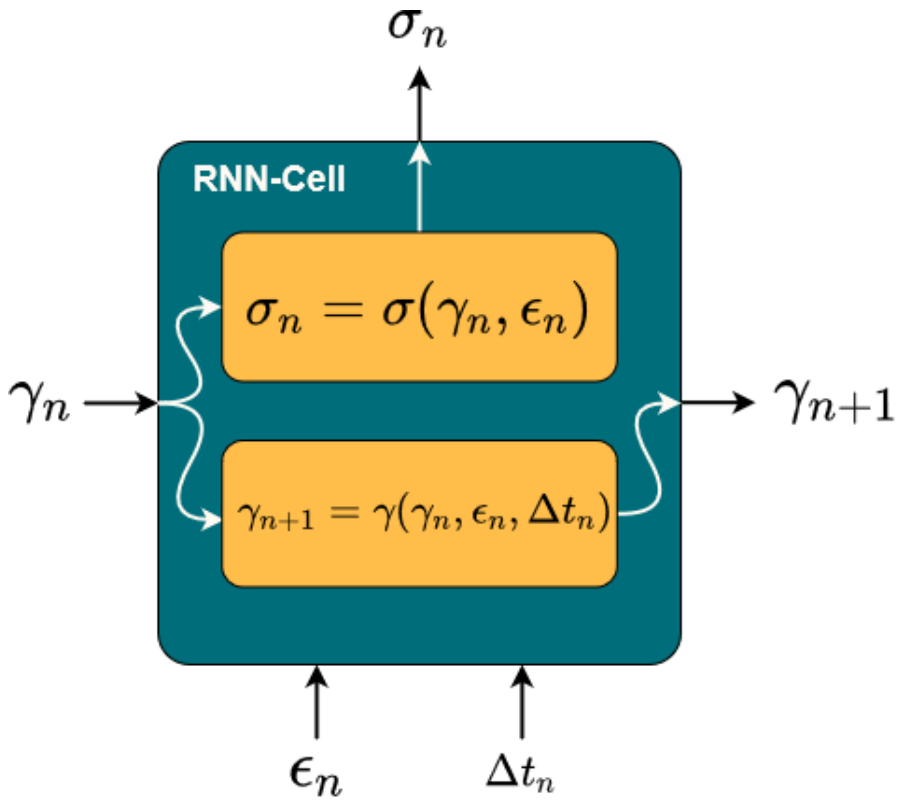


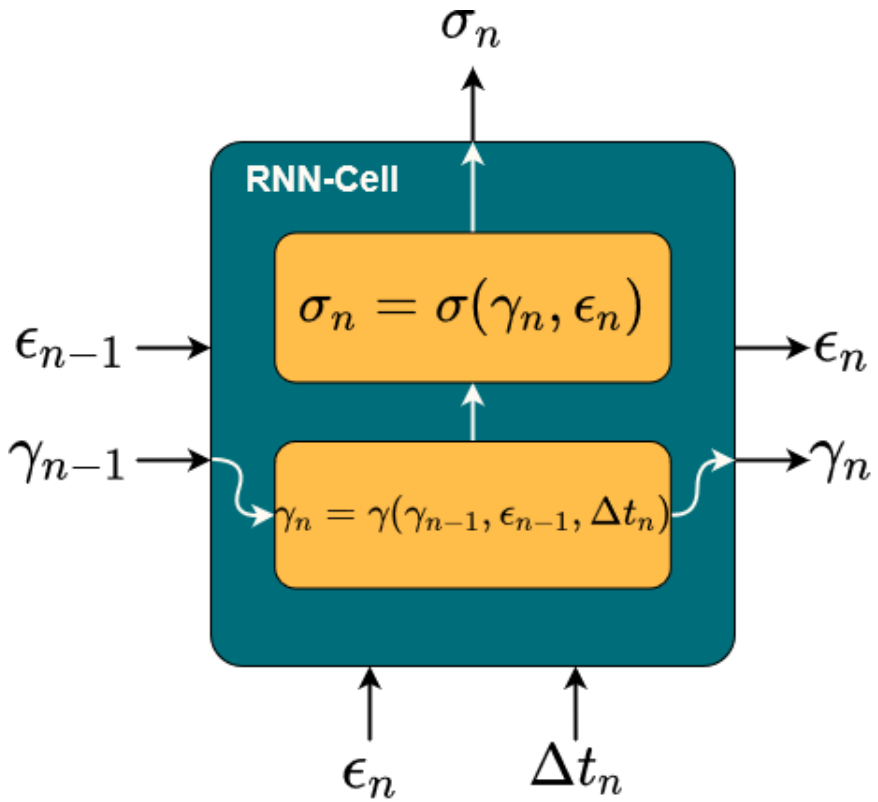




ANALYTIC MAXWELL MODEL

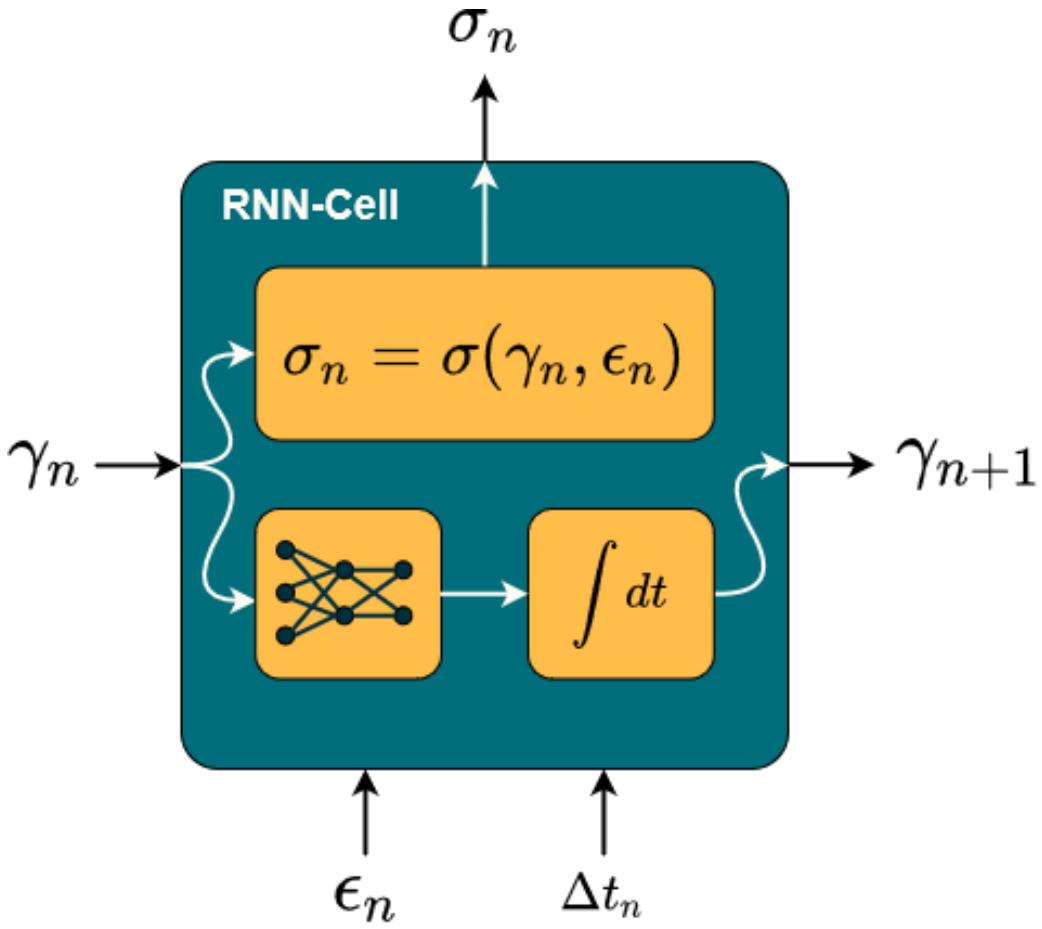


$$\Delta t_n = t_{n+1} - t_n$$



$$\Delta t_n = t_n - t_{n-1}$$

FFNN MAXWELL MODEL



Physical Knowledge:

- ✅ Thermodynamics*
- ✅ Equilibrium stiffness
- ✅ Non equilibrium stiffness
- ❌ Relaxation behavior

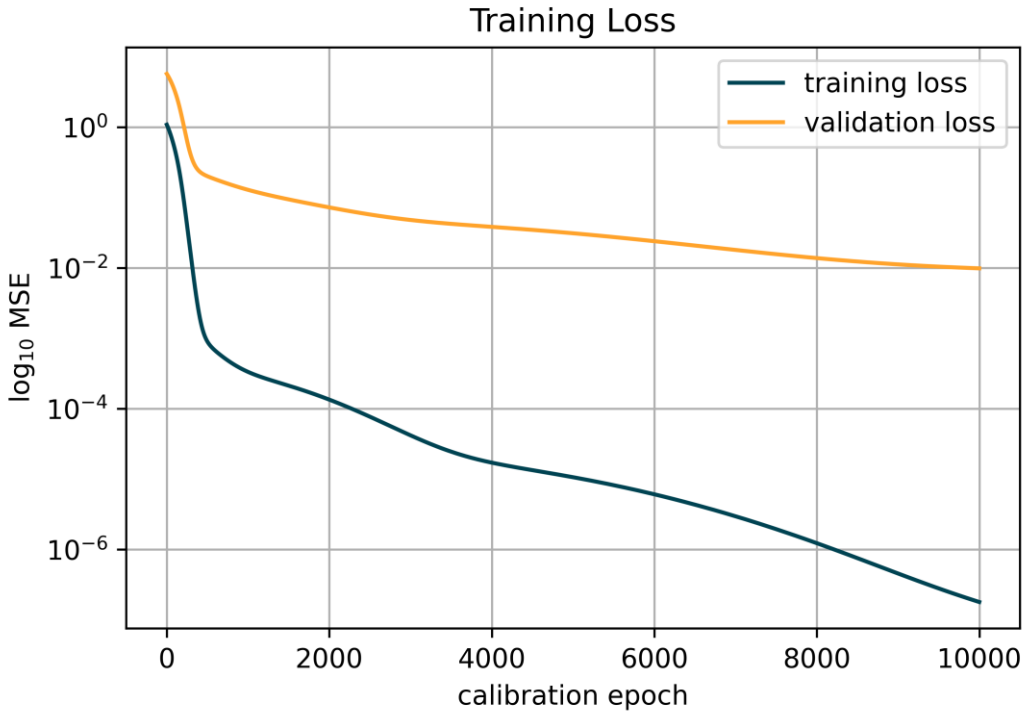
*For exact integration

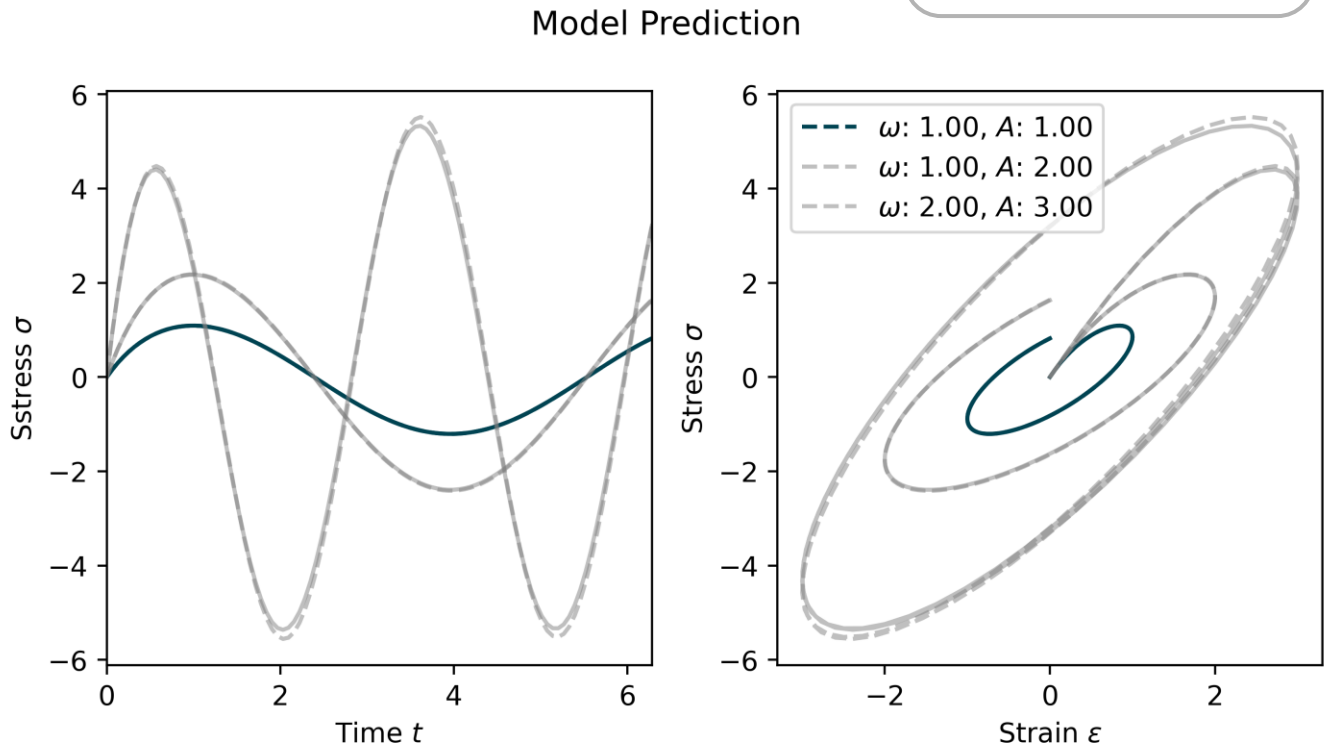
FFNN MAXWELL MODEL

TECHNISCHE UNIVERSITÄT DARMSTADT

Trained on $\omega = 1, A = 1$

Epochs: 10,000
L. Rate: 0.001
Layers: 8, 8, 1





FFNN MAXWELL MODEL

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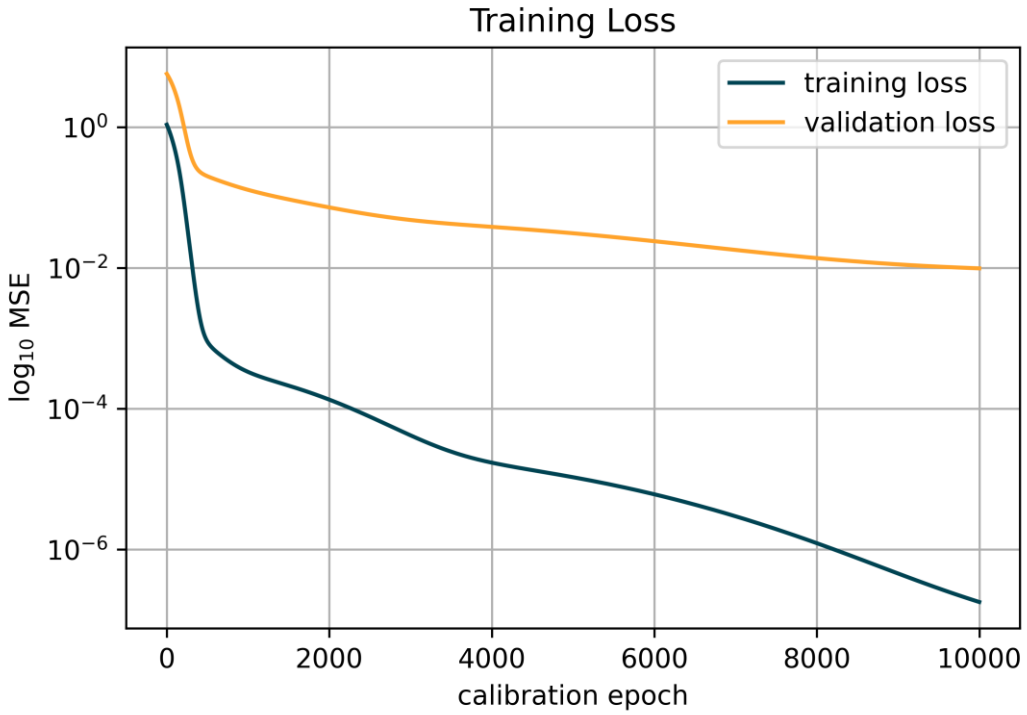

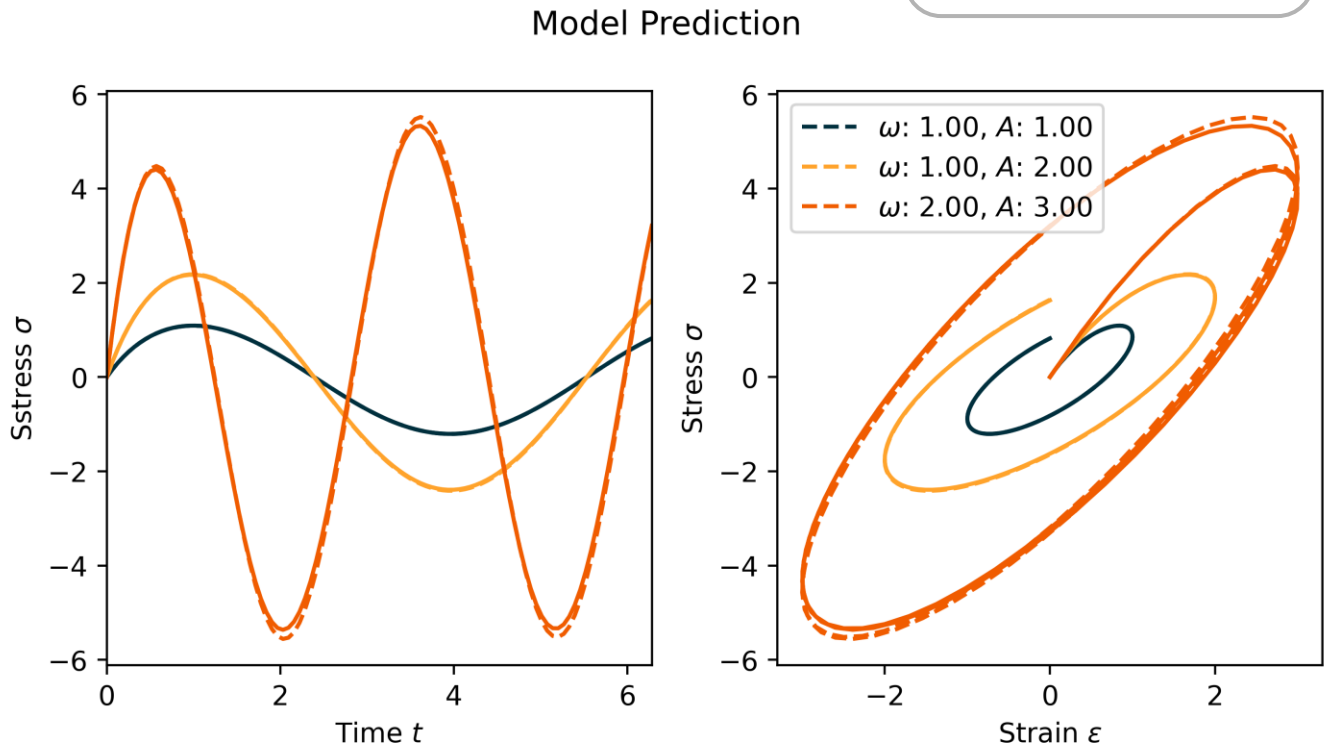

FFNN MAXWELL MODEL

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Epochs: 10,000
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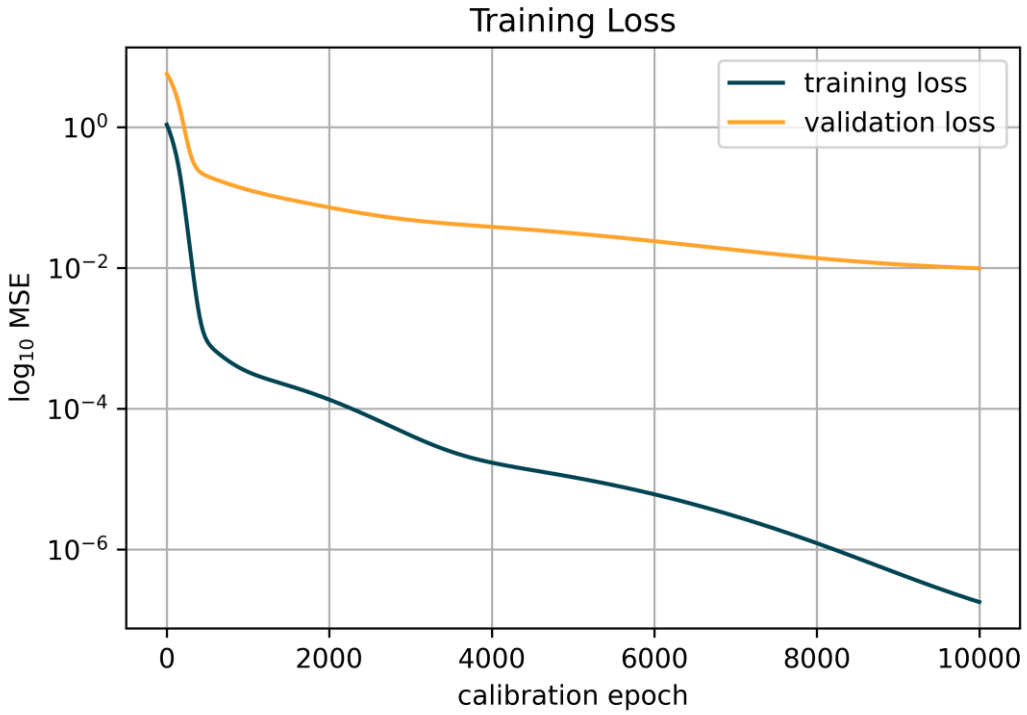
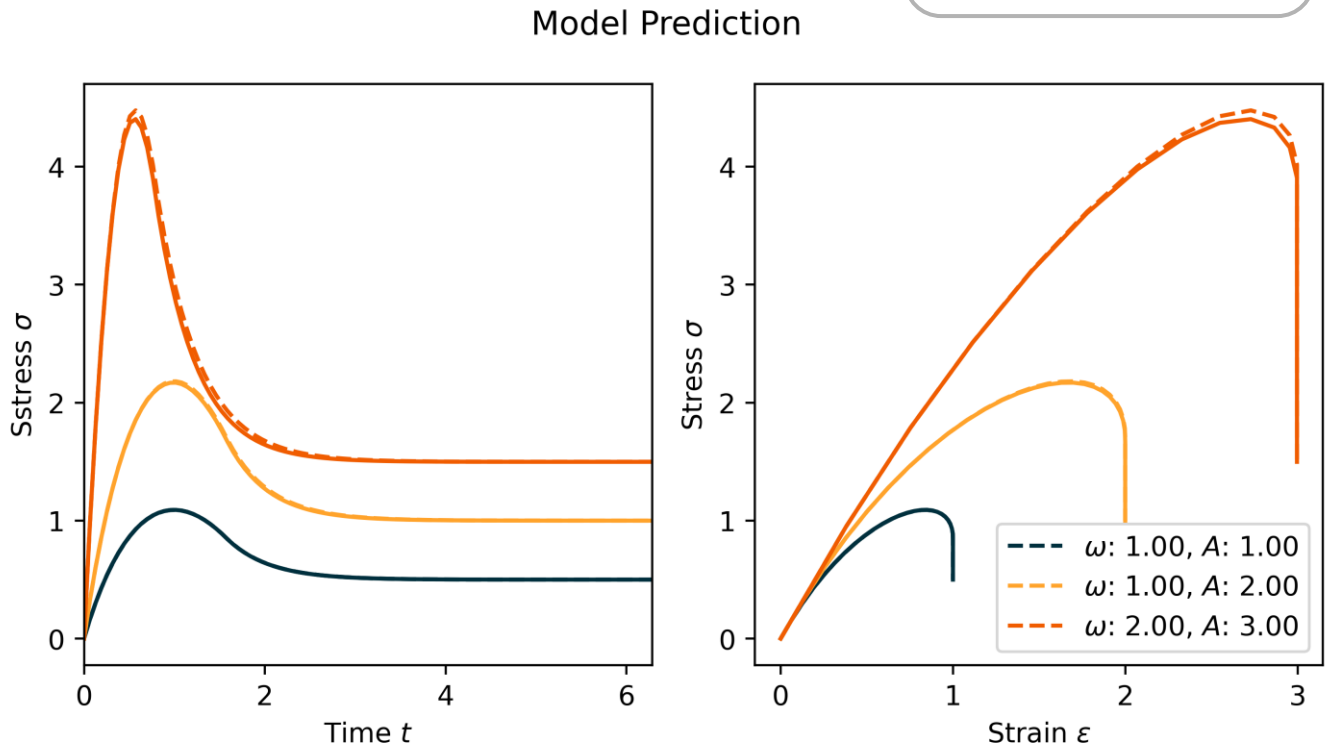
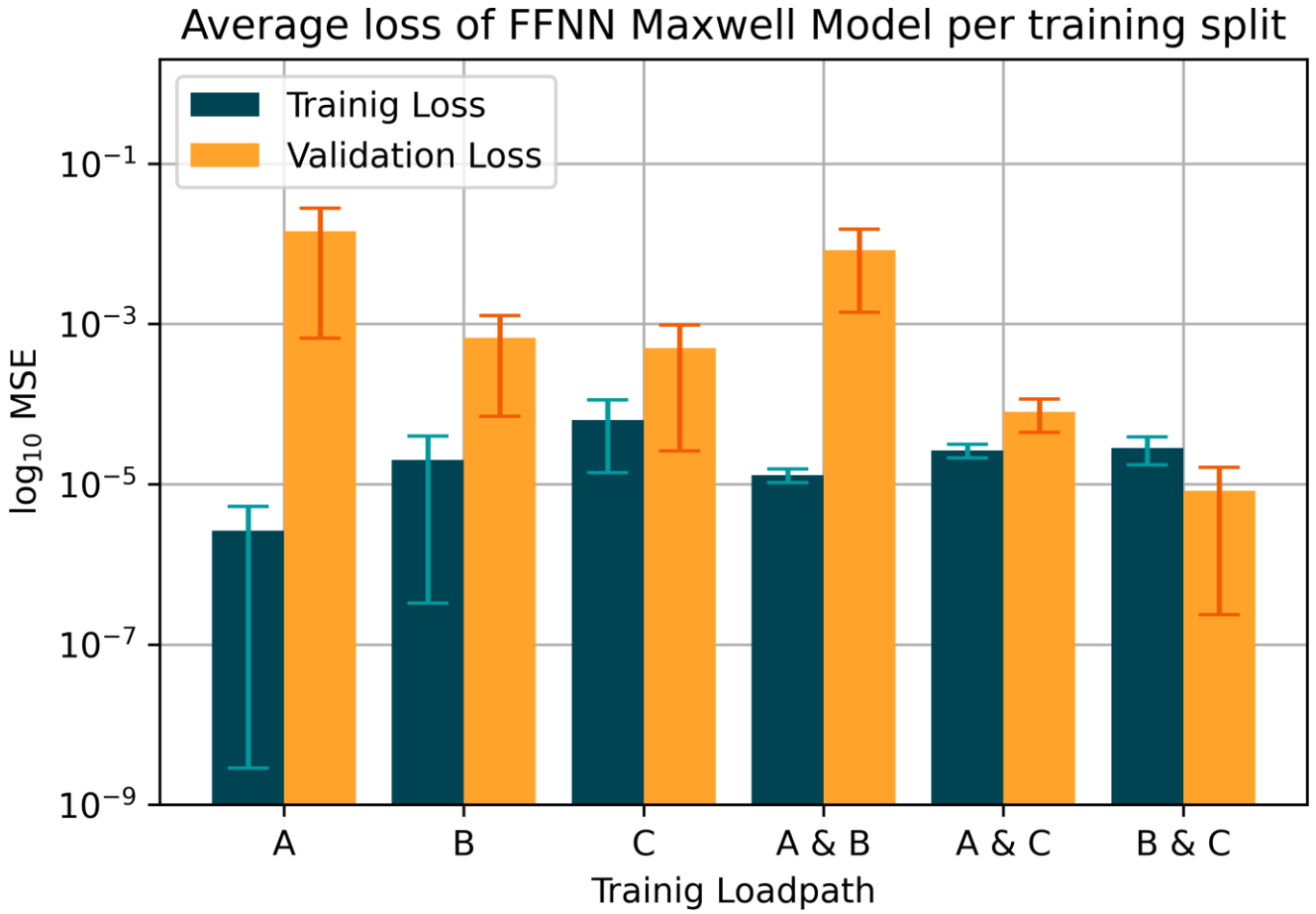




FFNN MAXWELL MODEL



A: $\omega = 1, A = 1$
B: $\omega = 1, A = 2$
C: $\omega = 2, A = 3$

Epochs: 4000
L. Rate: 0.001
Layers: $8, 8, 1$
Instances: 2

FFNN MAXWELL MODEL

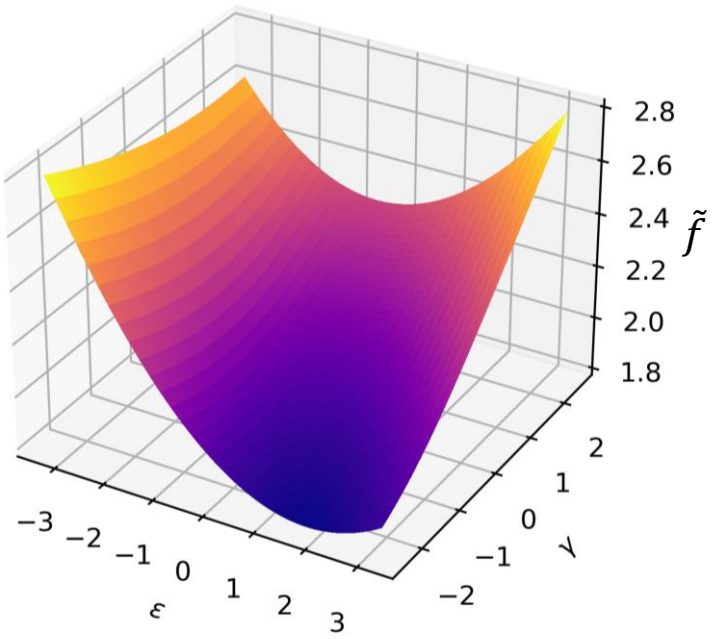
TECHNISCHE UNIVERSITÄT DARMSTADT

Evolution Equation: $\dot{\gamma} = \tilde{f}(\varepsilon, \gamma)(\varepsilon - \gamma)$

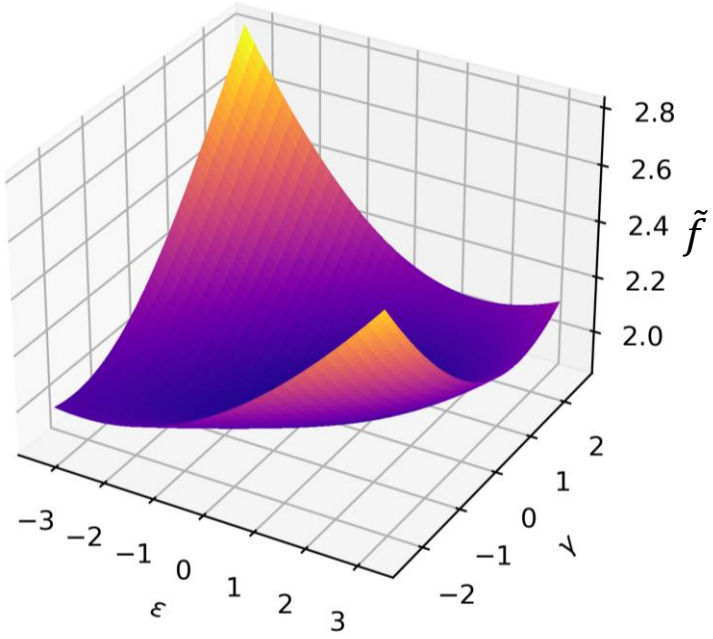
Model: $\tilde{f} = FFNN(\varepsilon, \gamma)$, Data: $\tilde{f} = \frac{E}{\eta} = 2$

Epochs: 3,000
L. Rate: 0.001
Layers: 8, 8, 1

Trained on A



Trained on C

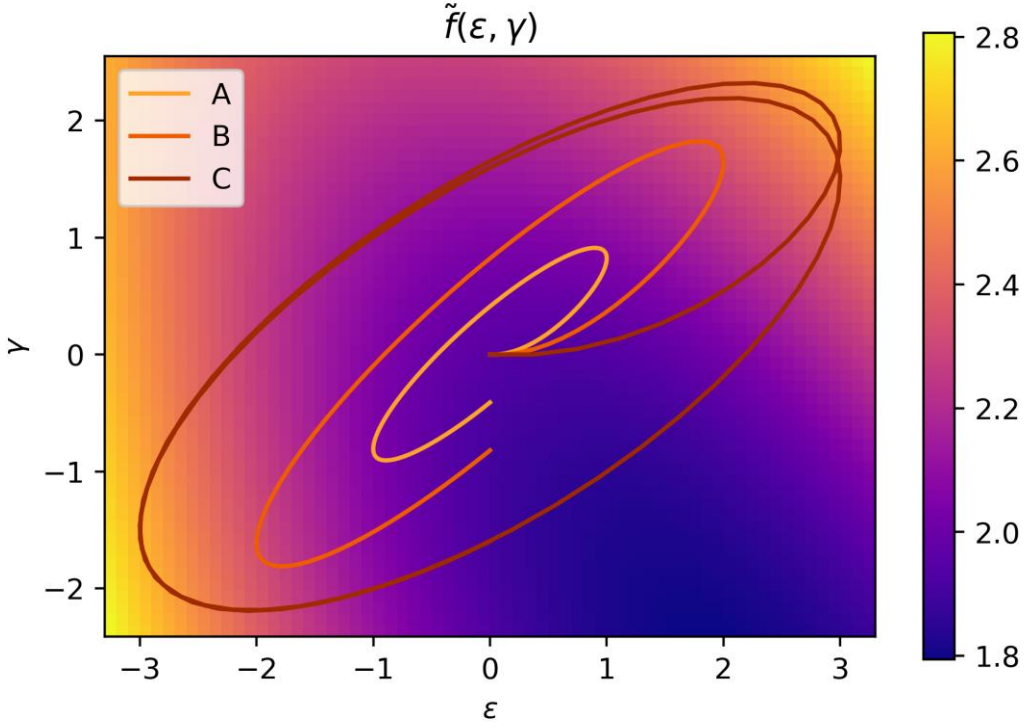


FFNN MAXWELL MODEL

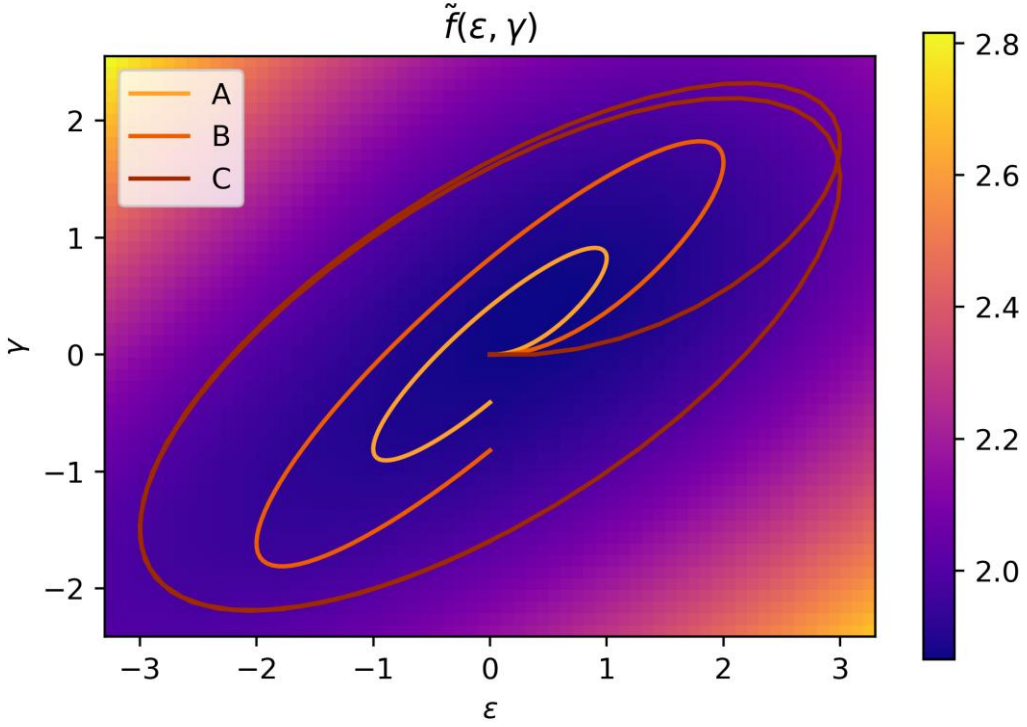
TECHNISCHE UNIVERSITÄT DARMSTADT

Epochs: 3,000
L. Rate: 0.001
Layers: 8, 8, 1

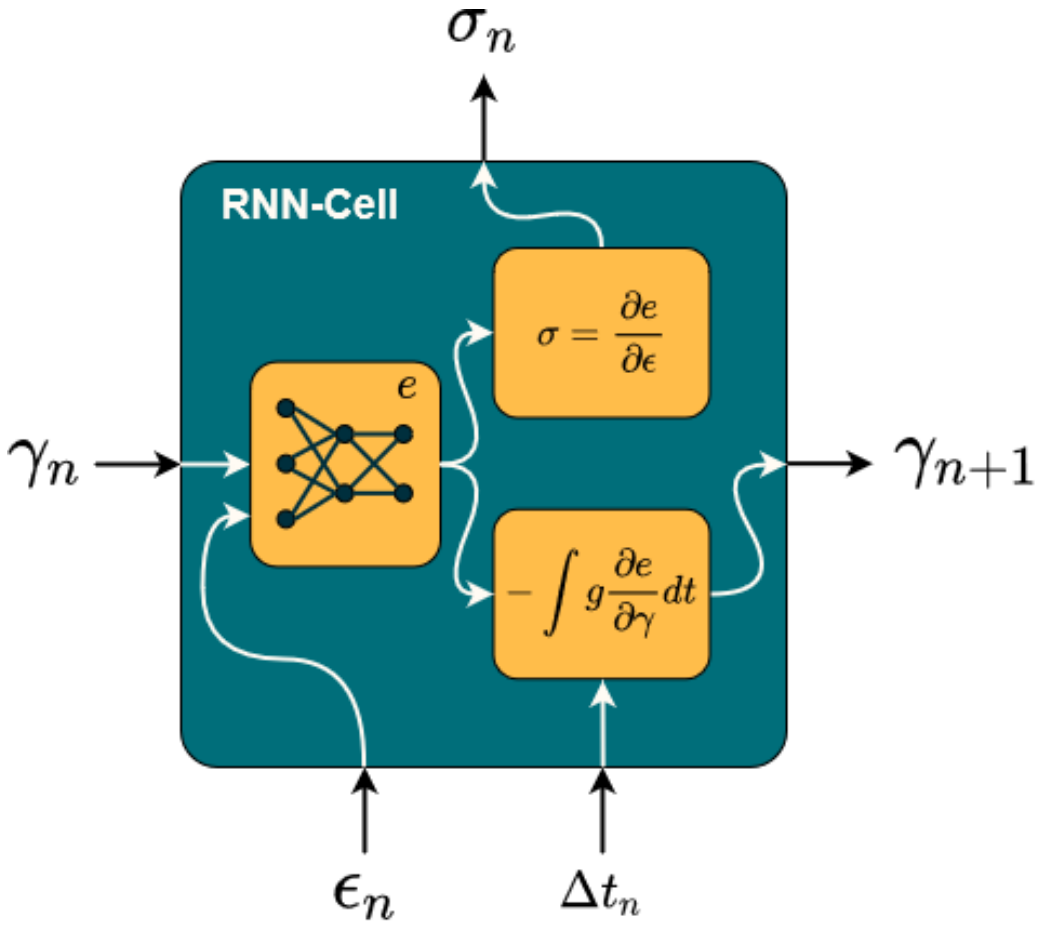
Trained on A



Trained on C



GSM MODEL



Physical Knowledge:

- ✅ Thermodynamics*
- ❌ Equilibrium stiffness
- ❌ Non equilibrium stiffness
- ❌ Relaxation behavior

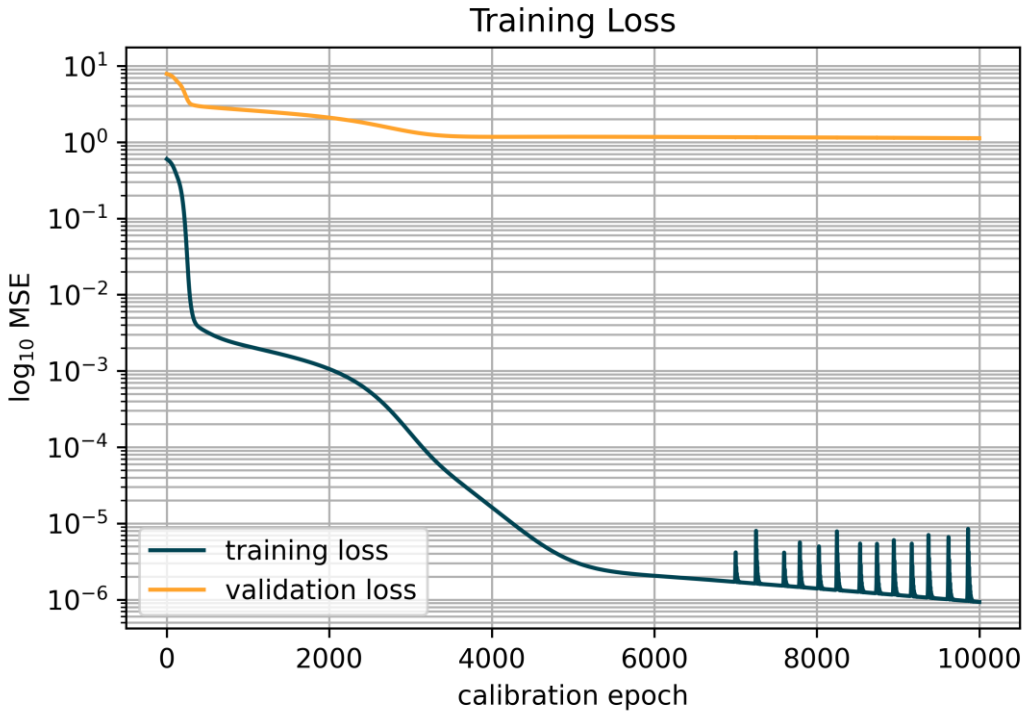
*For exact integration

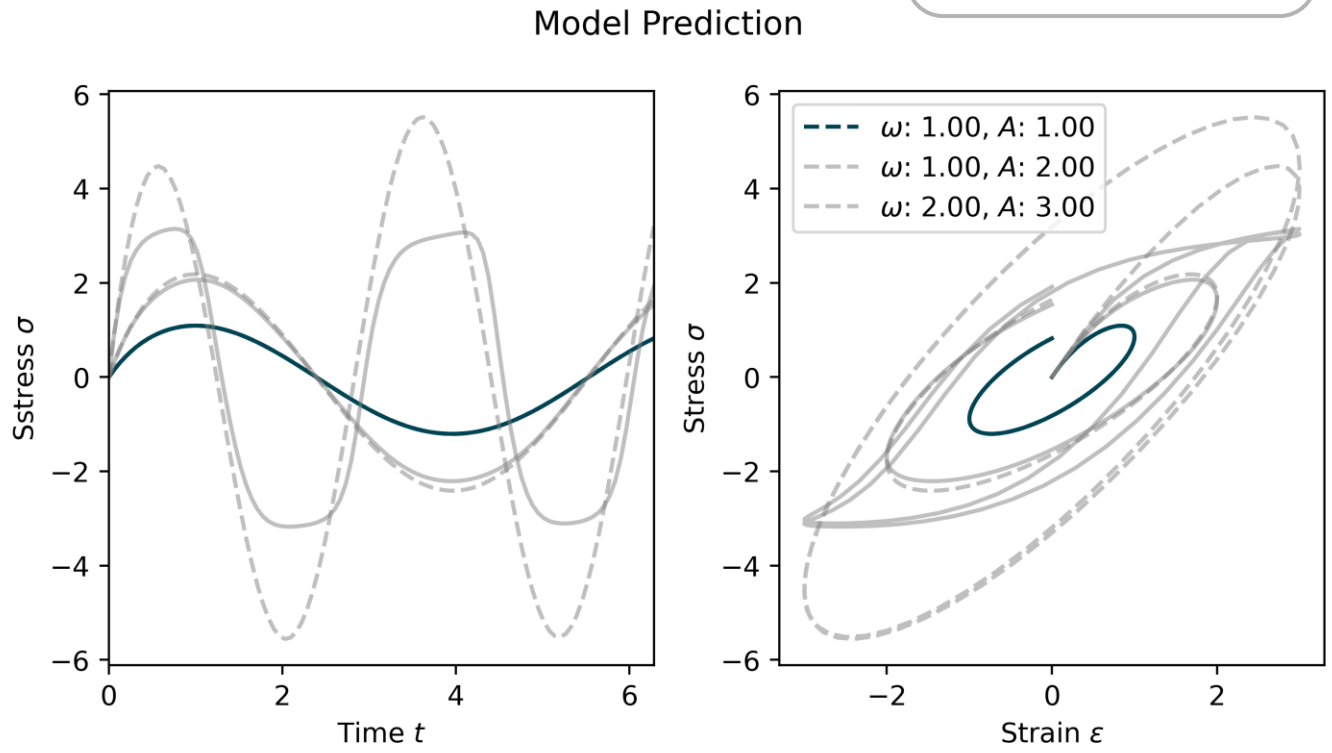
GSM MODEL

TECHNISCHE UNIVERSITÄT DARMSTADT

Trained on $\omega = 1, A = 1$

Epochs: 10,000
L. Rate: 0.001
Layers: 8, 8, 1





GSM MODEL

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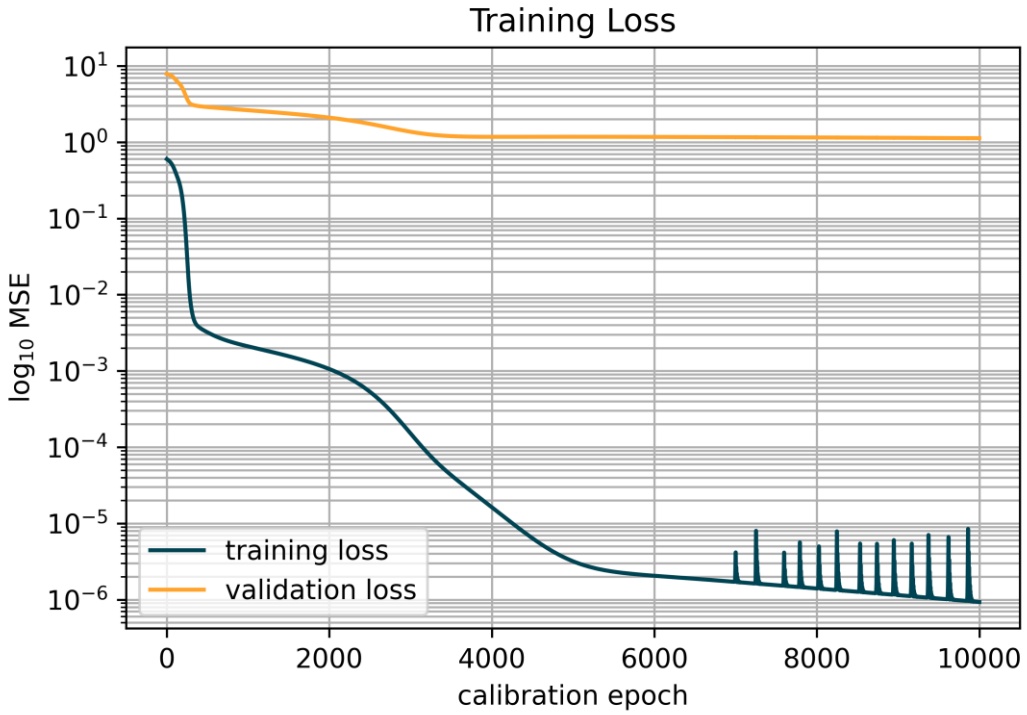

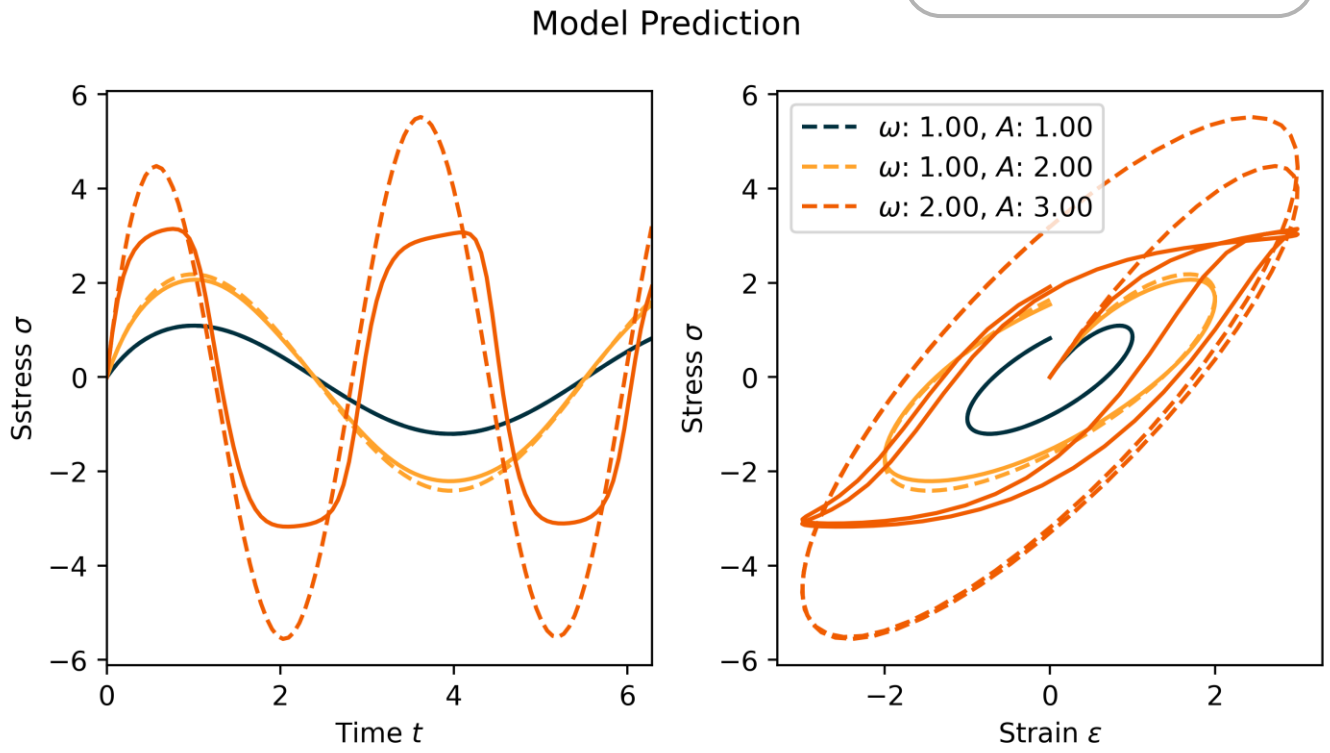

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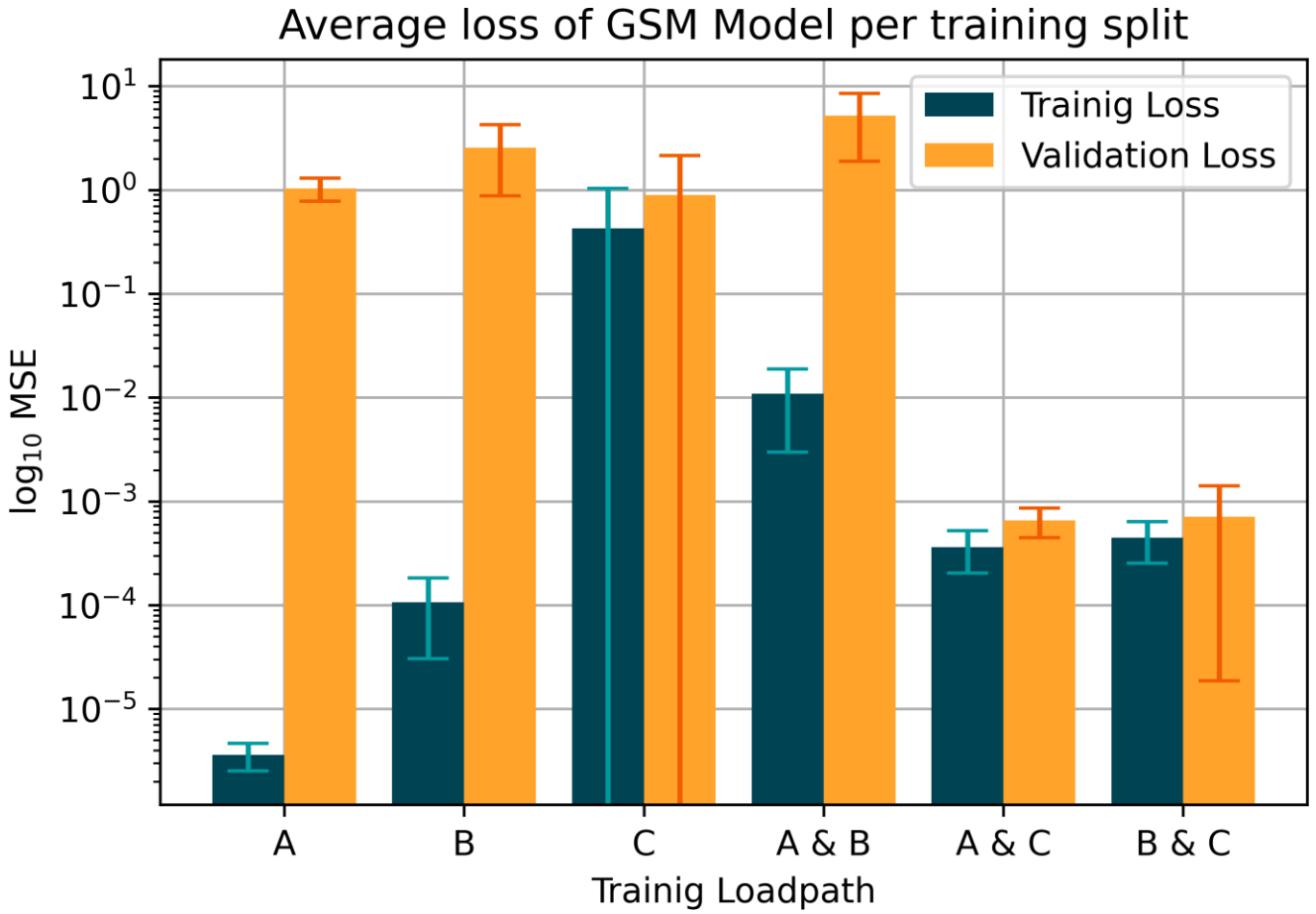


A: $\omega = 1, A = 1$
B: $\omega = 1, A = 2$
C: $\omega = 2, A = 3$

Epochs: 6000
L. Rate: 0.001
Layers: $8, 8, 1$
Instances: 3

DISCUSSION

4 - 2.1

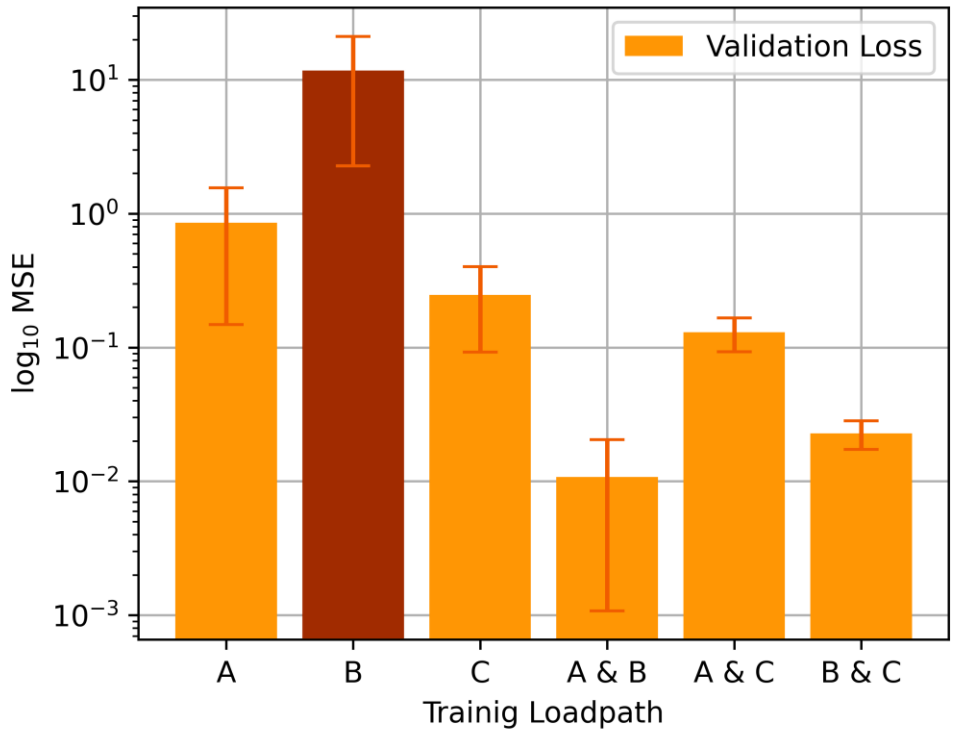
SIMPLE RNN

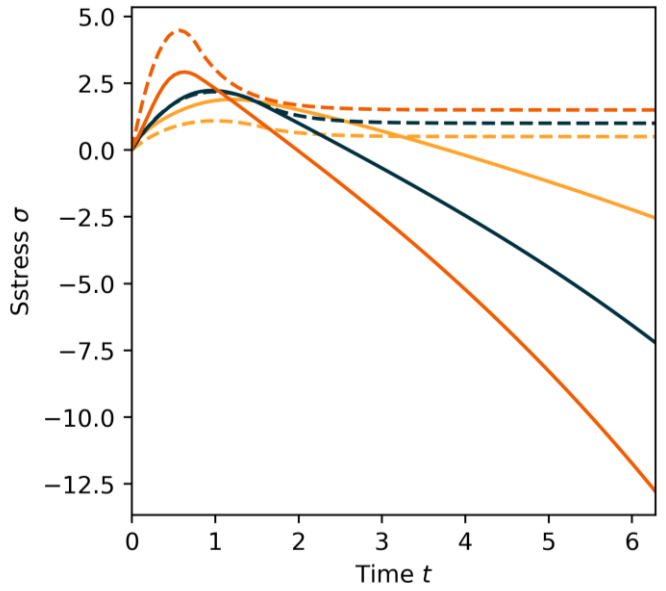
TECHNISCHE UNIVERSITÄT DARMSTADT

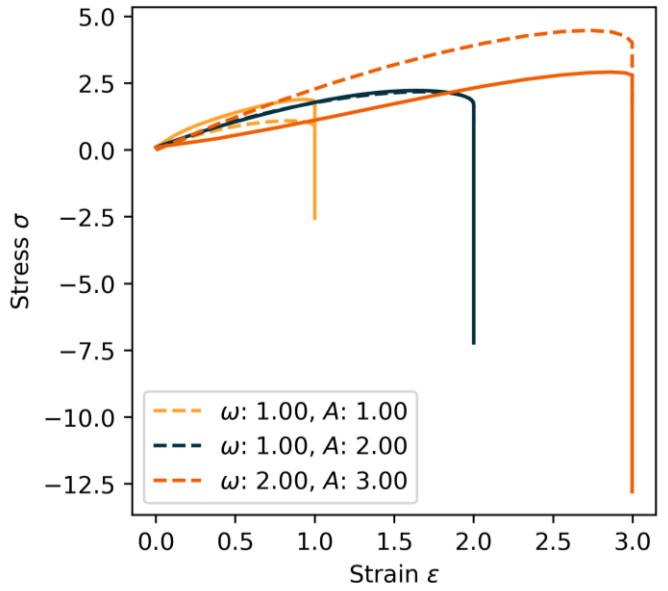
Epochs: 4000
L. Rate: 0.001
Layers: 32, 2
Instances: 2

A: $\omega = 1, A = 1$
B: $\omega = 1, A = 2$
C: $\omega = 2, A = 3$

Average loss of Naive Model on relaxation data per training split







4 - 2.1

SIMPLE RNN

TECHNISCHE UNIVERSITÄT DARMSTADT

Epochs: 4000
L. Rate: 0.001
Layers: 32, 2
Instances: 2

A: $\omega = 1, A = 1$
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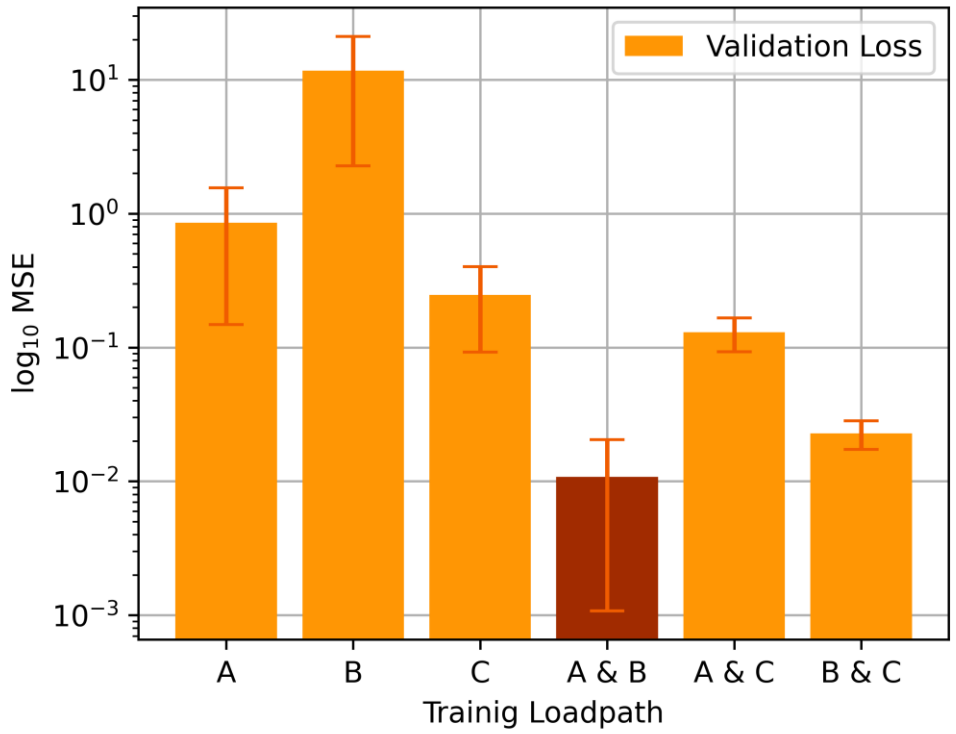
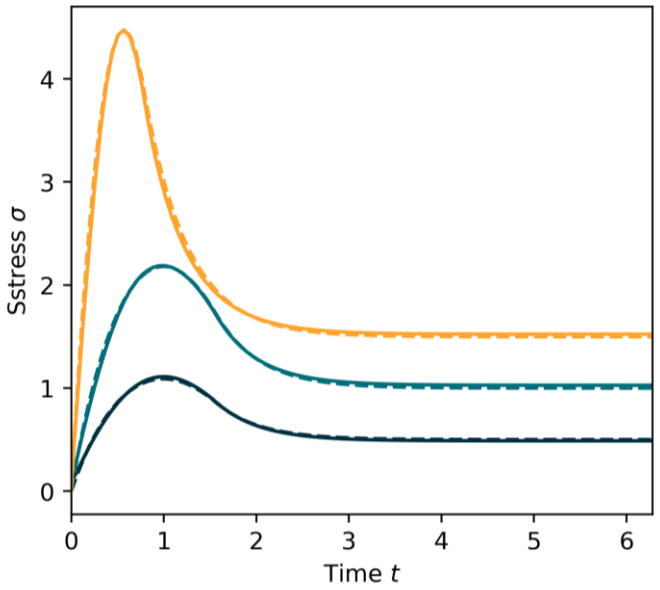
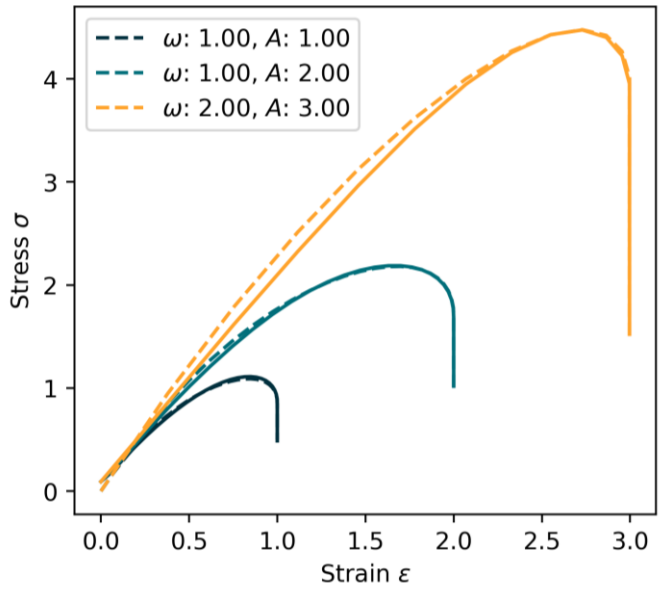
Average loss of Naive Model on relaxation data per training split

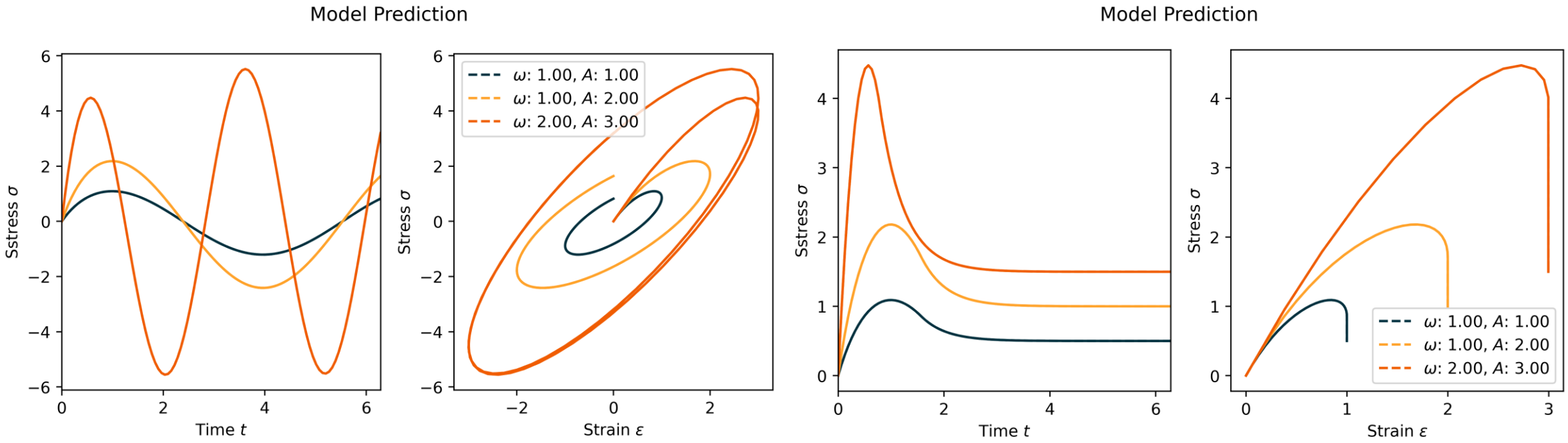






ANALYTIC MAXWELL MODEL

TECHNISCHE UNIVERSITÄT DARMSTADT

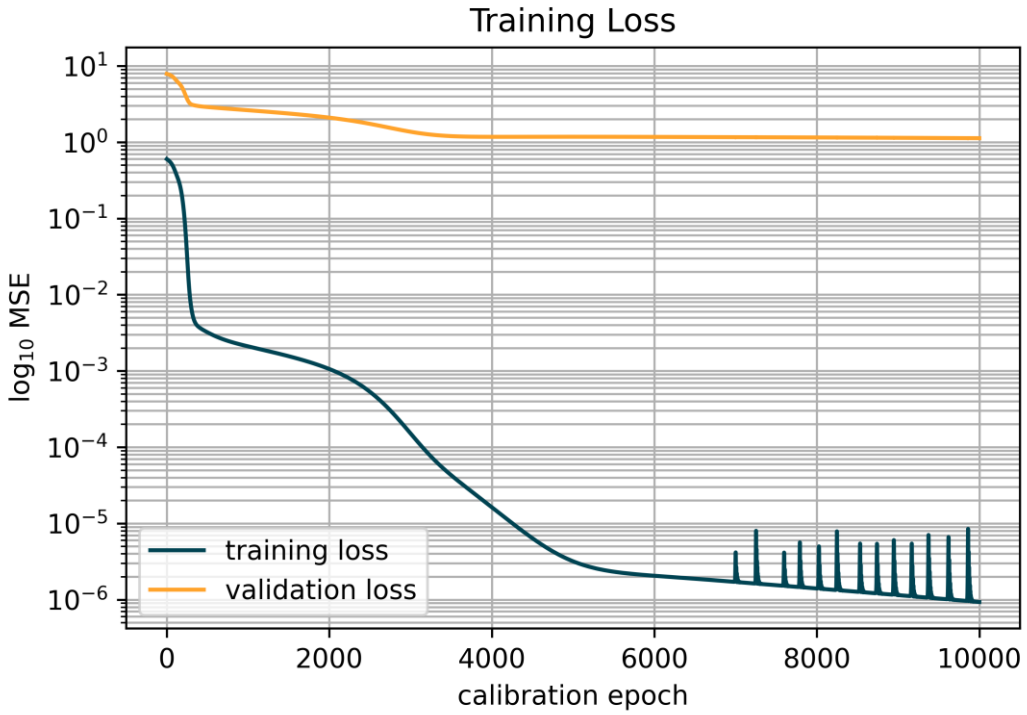


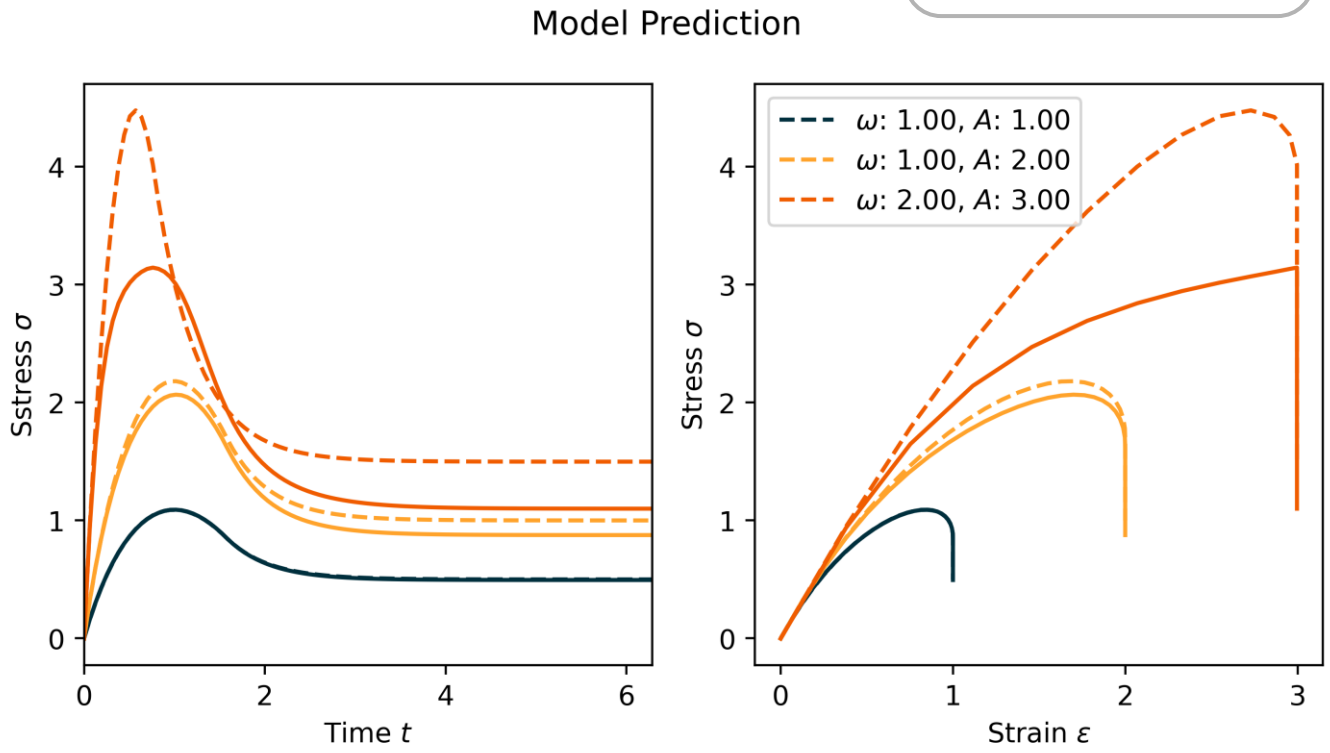
GSM MODEL

TECHNISCHE UNIVERSITÄT DARMSTADT

Trained on $\omega = 1, A = 1$

Epochs: 10,000
L. Rate: 0.001
Layers: 8, 8, 1



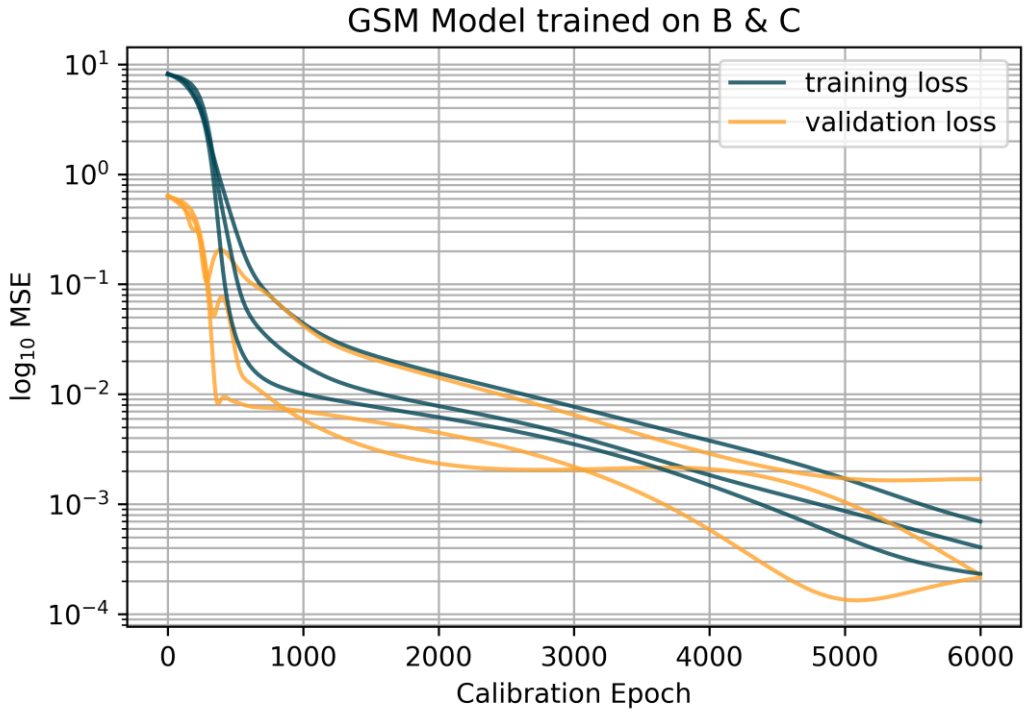


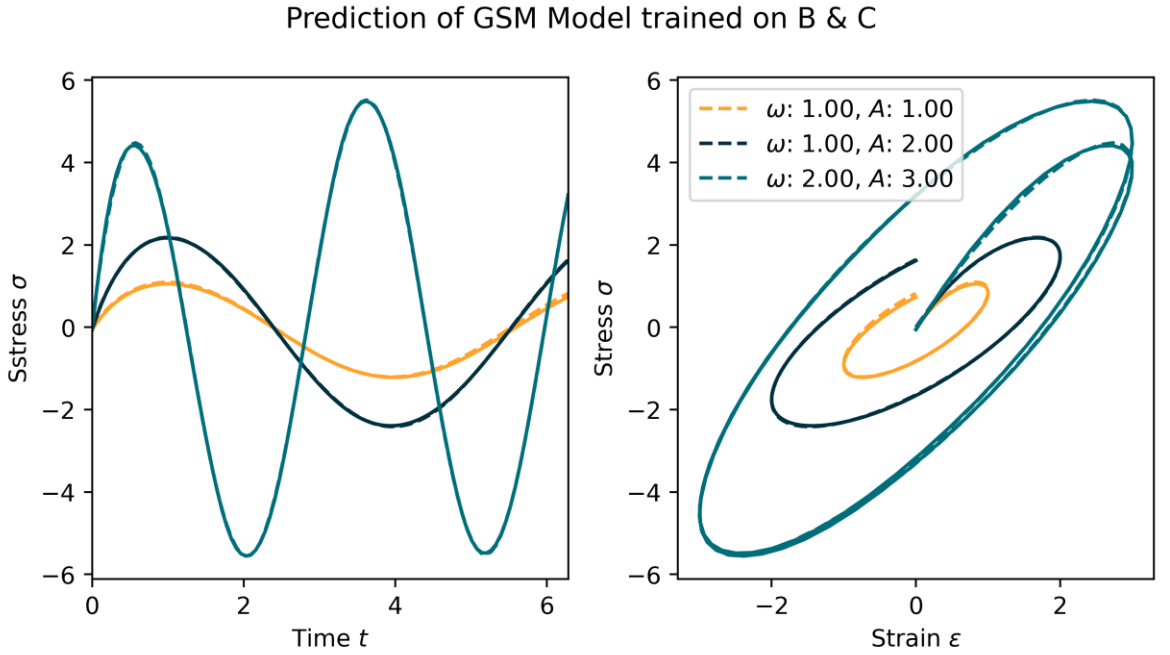
GSM MODEL

TECHNISCHE UNIVERSITÄT DARMSTADT

Trained on B & C

Epochs: 6,000
L. Rate: 0.001
Layers: 8, 8, 1





4 - 2.4

GSM MODEL

TECHNISCHE UNIVERSITÄT DARMSTADT

Epochs: 6,000
L. Rate: 0.001
Layers: 8, 8, 1

Trained on C