Towards sustainable power systems: improving battery degradation forecasts with enhanced multi-task learning

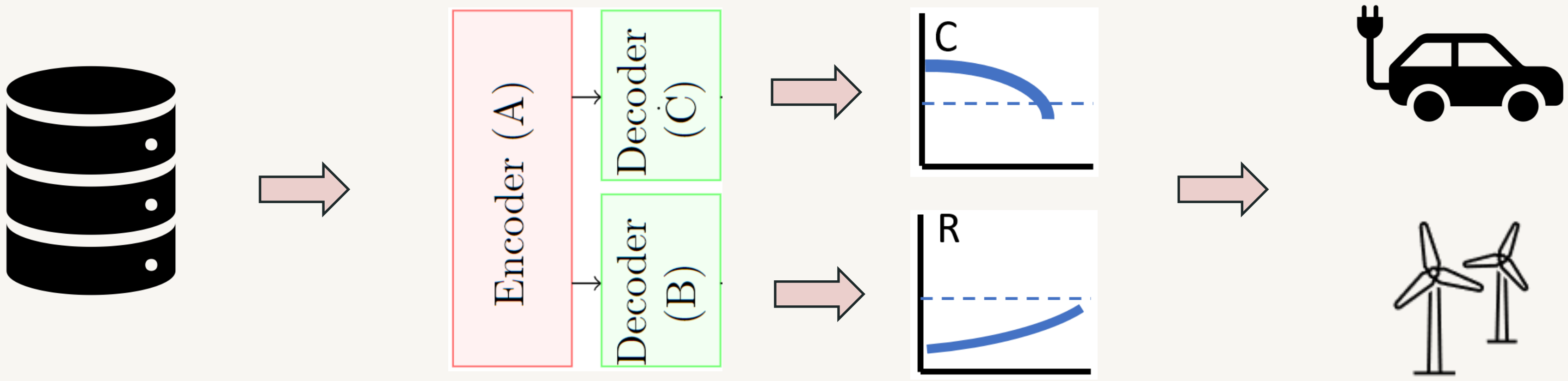
Emilie Grégoire, Xia Zeng, Sam Verboven, Maitane Berecibar

VRIJE UNIVERSITEIT BRUSSEL

DATA ANALYTICS LABORATORY RESEARCH GROUP

ELECTROMOBILITY RESEARCH CENTRE

Towards sustainable power systems: improving battery degradation forecasts with enhanced multi-task learning



Emilie Grégoire, Xia Zeng, Sam Verboven, Maitane Berecibar

Towards sustainable power systems

Further enhancing the use of electric vehicles and renewable energy sources is key to assuring a fossil-free future.

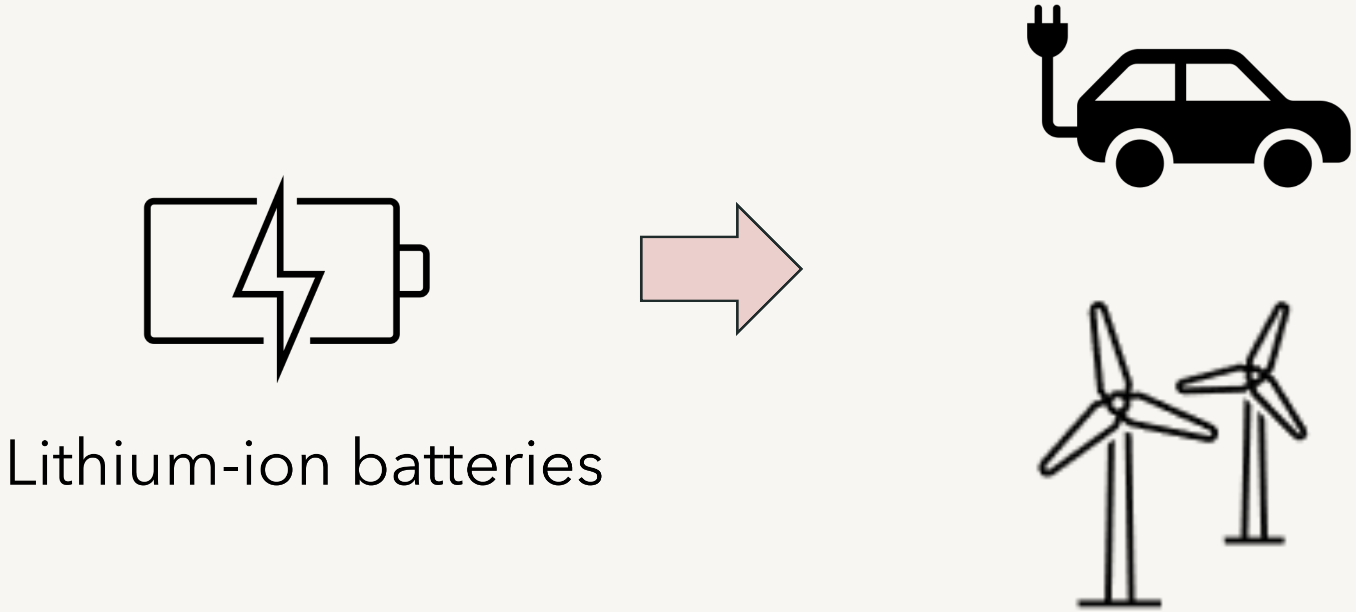
Emilie Grégoire, Xia Zeng, Sam Verboven, Maitane Berecibar

Towards sustainable power systems

To do so, one needs highly efficient energy systems: long-living batteries with high energy density

Emilie Grégoire, Xia Zeng, Sam Verboven, Maitane Berecibar

Towards sustainable power systems

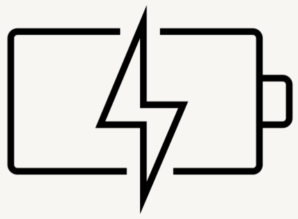


Emilie Grégoire, Xia Zeng, Sam Verboven, Maitane Berecibar

Problem Formulation

However, to use the full potential of Lithium-ion batteries one should still:

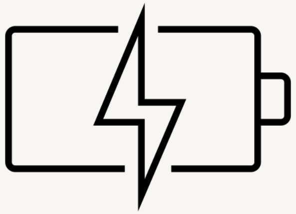
- Extend the lifetime
- Reduce safety risks
- Reduce the maintenance costs
- Further improve overall efficiency



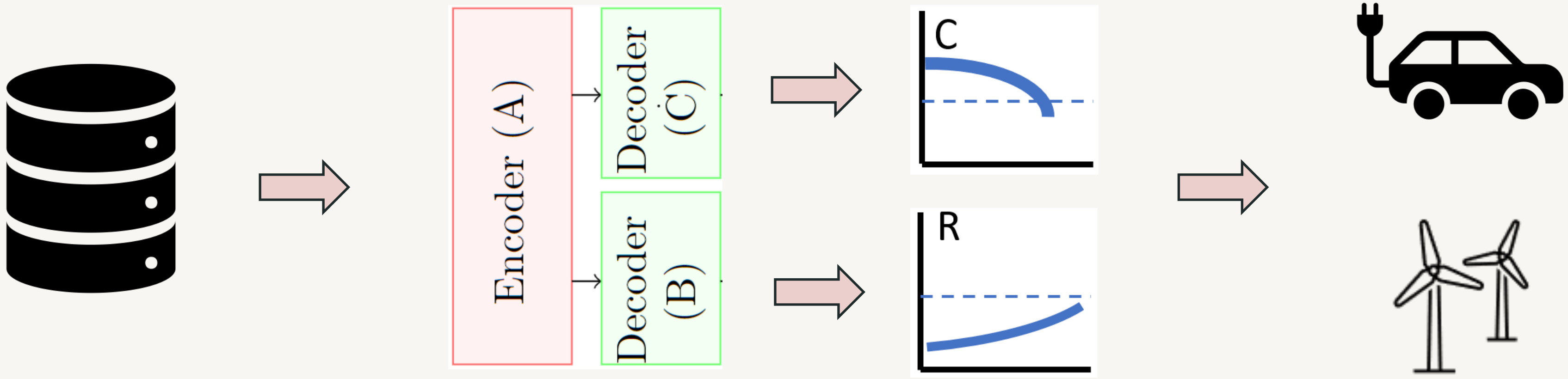
Problem Formulation

A key challenge to addressing the points is the accurate forecasting of battery degradation:

When will the battery become unusable/unsafe?

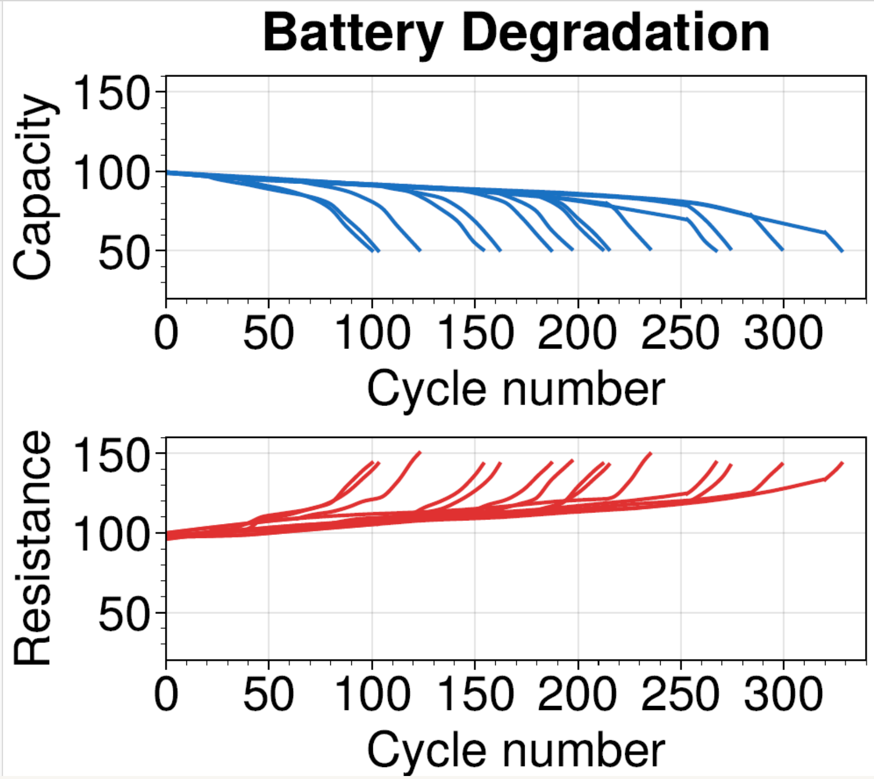


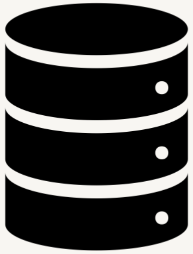
Proposed solution



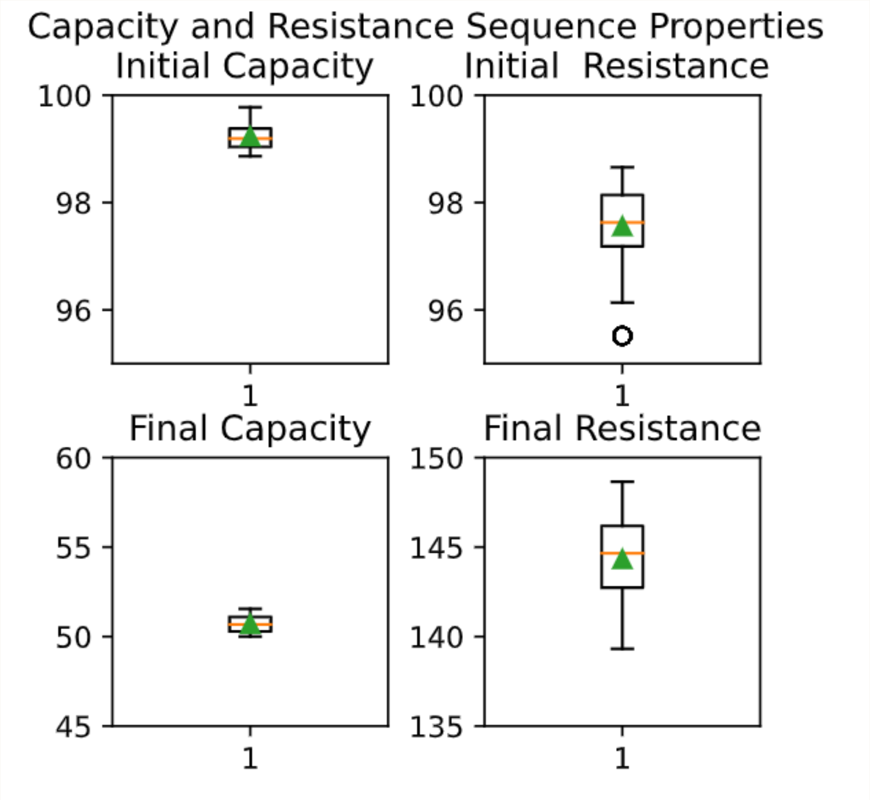
Proposed solution: data

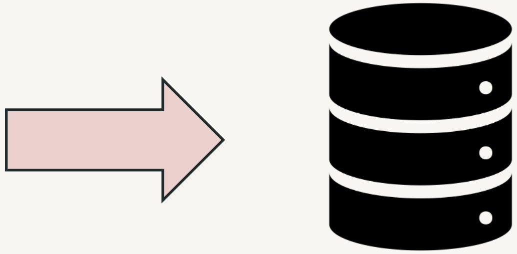
Proposed solution: data





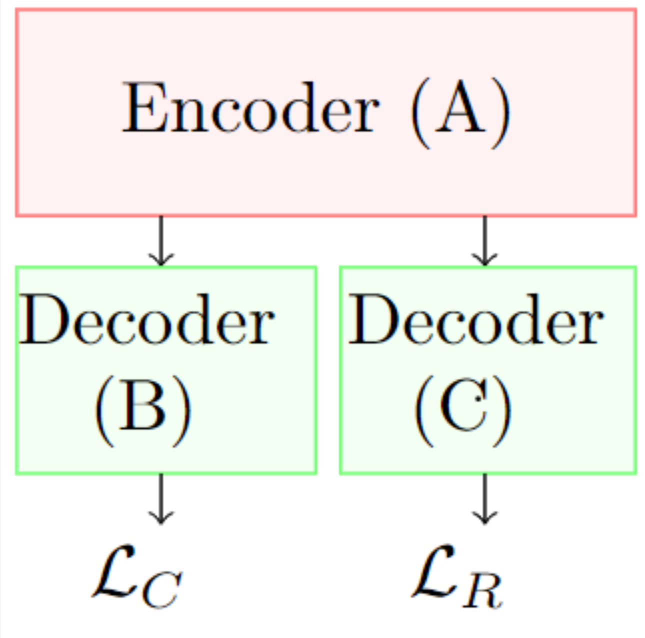
Proposed solution: data





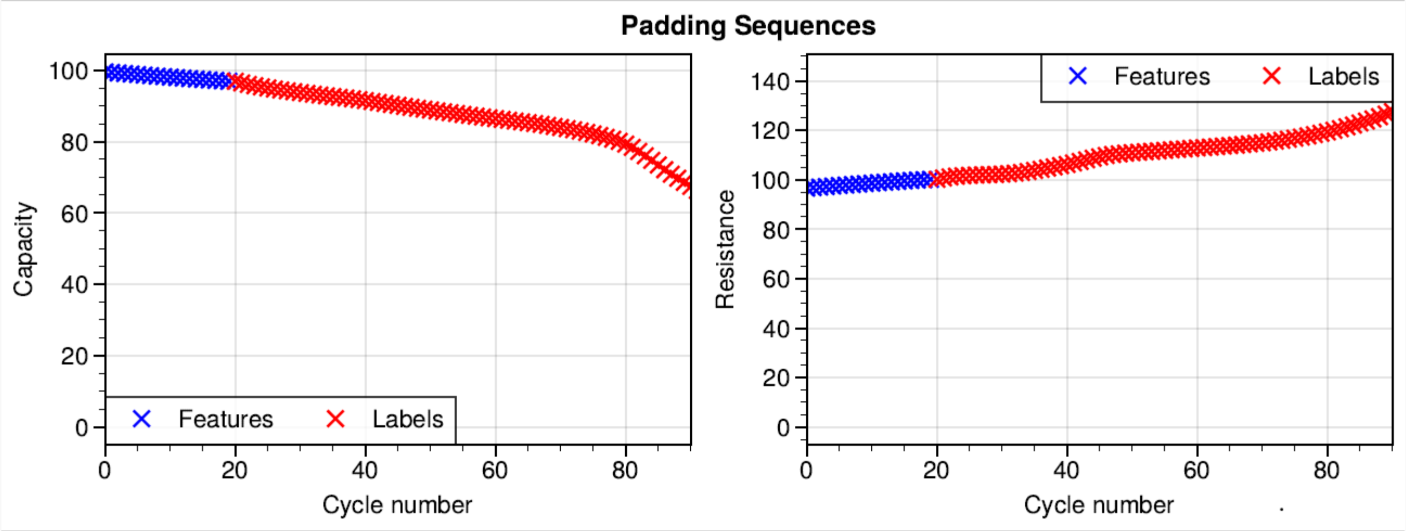
Proposed solution: multi-task model

Sequence-to-sequence model that forecasts capacity and resistance trajectories simultaneously

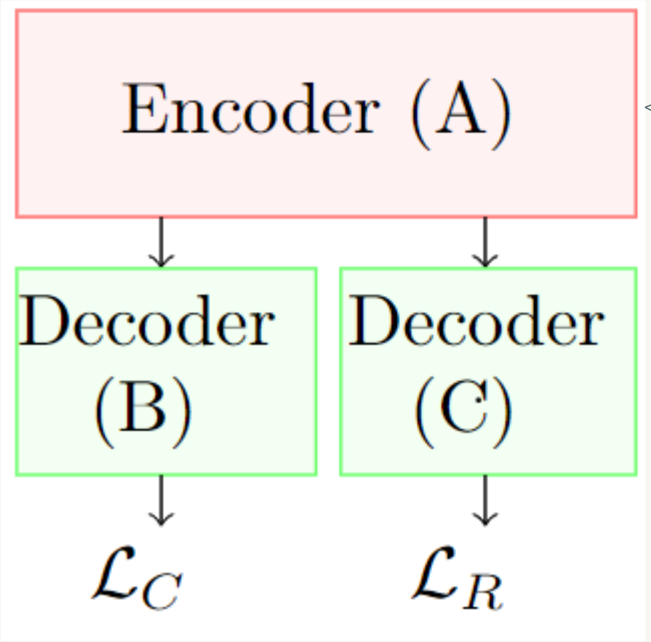


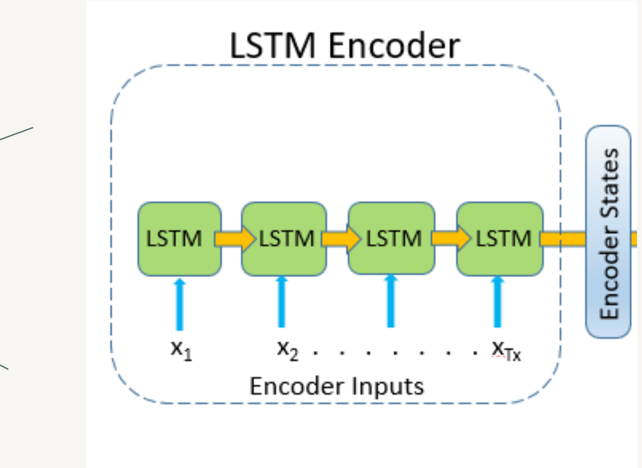
Proposed solution: multi-task model

Sequence-to-sequence model that forecasts capacity and resistance trajectories simultaneously

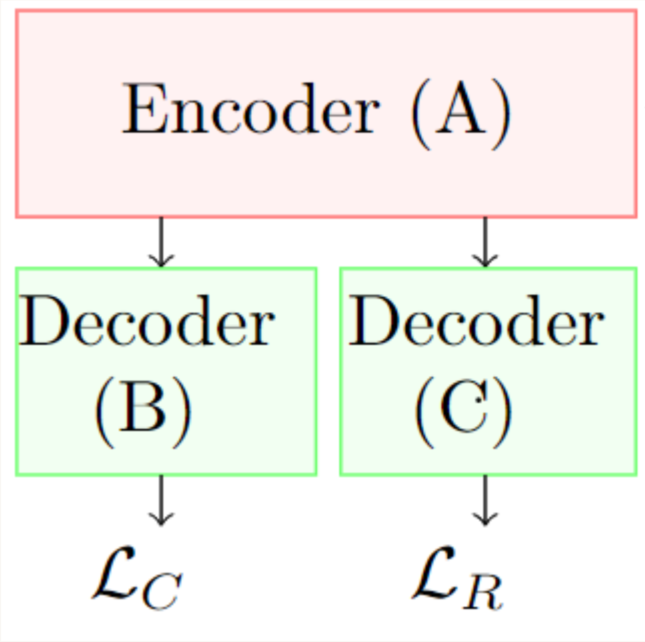


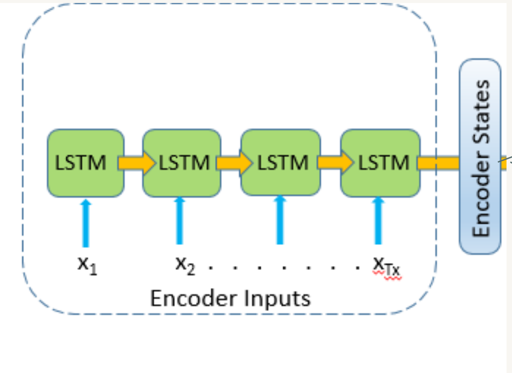
Proposed solution: multi-task model

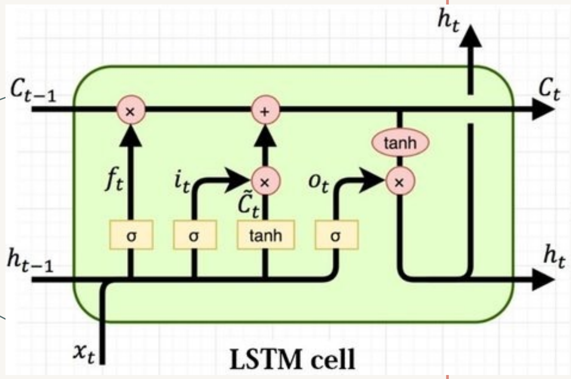




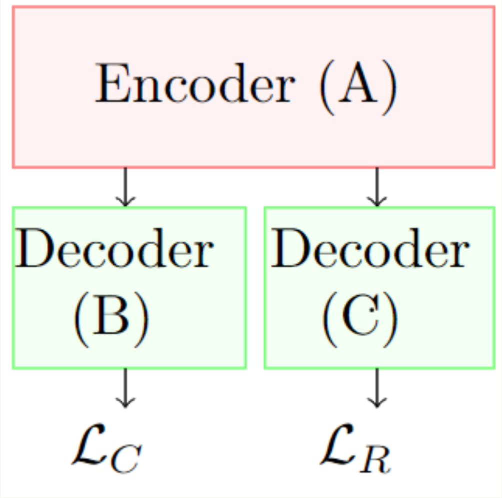
Proposed solution: multi-task model







Our contribution: optimizing task weighting techniques



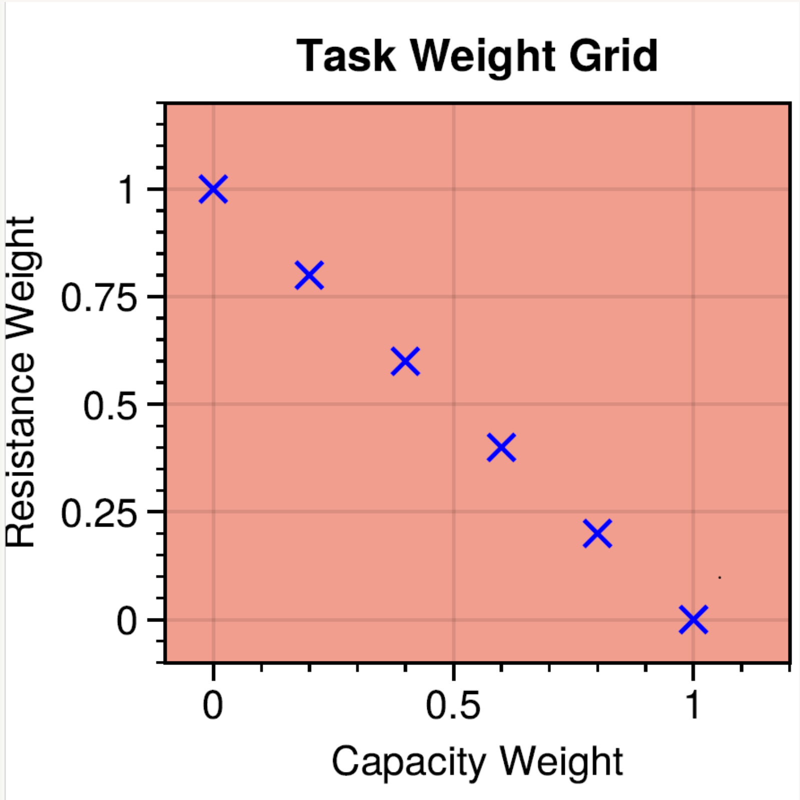
$$\mathcal{L}_{Tot} = w_C \mathcal{L}_C + w_R \mathcal{L}_R$$

Our contribution: optimizing task weighting techniques

1) Static weighting:

Analyze the impact of different weights between 0 and 1:

Performance? Task relationship?

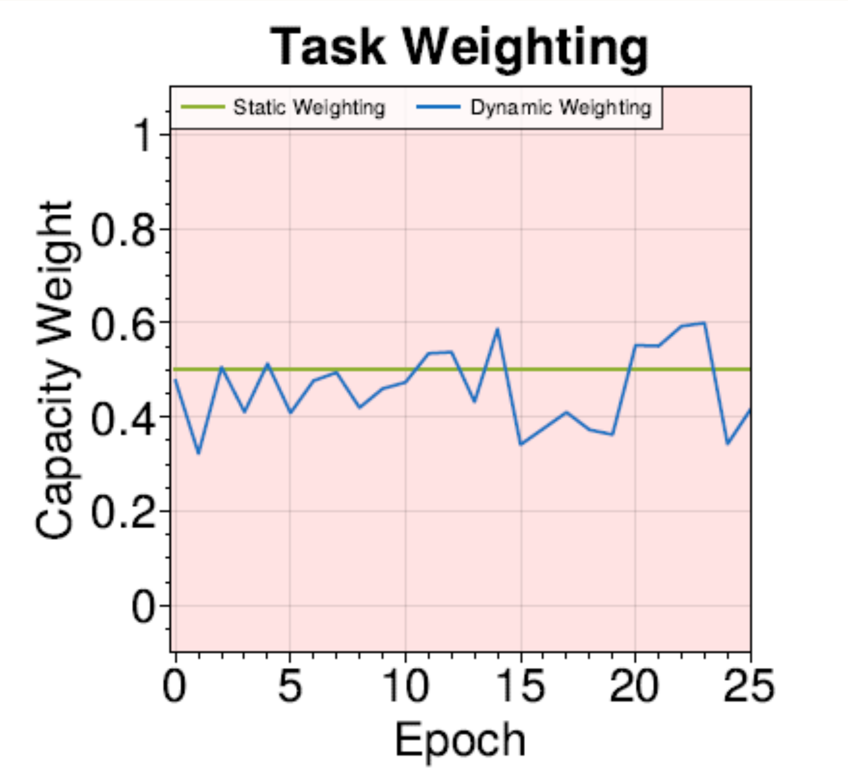


$$\mathcal{L}_{Tot} = w_C \mathcal{L}_C + w_R \mathcal{L}_R$$

Our contribution: optimizing task weighting techniques

2) Dynamic weighting:

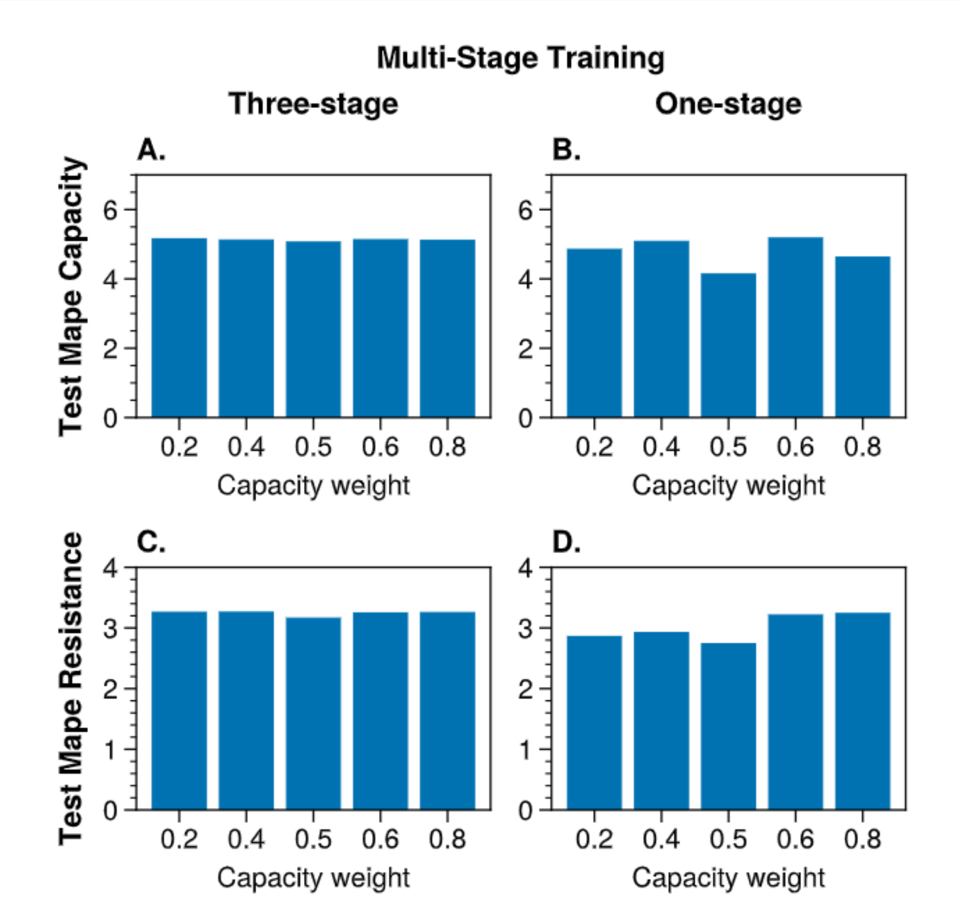
- From Multi-Task learning it is known that task relationships are dynamic
- Therefore, dynamic task weighting is needed



$$\mathcal{L}_{Tot} = w_C \mathcal{L}_C + w_R \mathcal{L}_R$$

First results: static weighting

Uniform weighting works surprisingly well!



First results: dynamic weighting

- Dynamic weighting can improve static weighting

- Variance is still very big: searching for dynamic weighting algorithms which reduce the variance