

# Learning human motion intention for pHRI assistive control



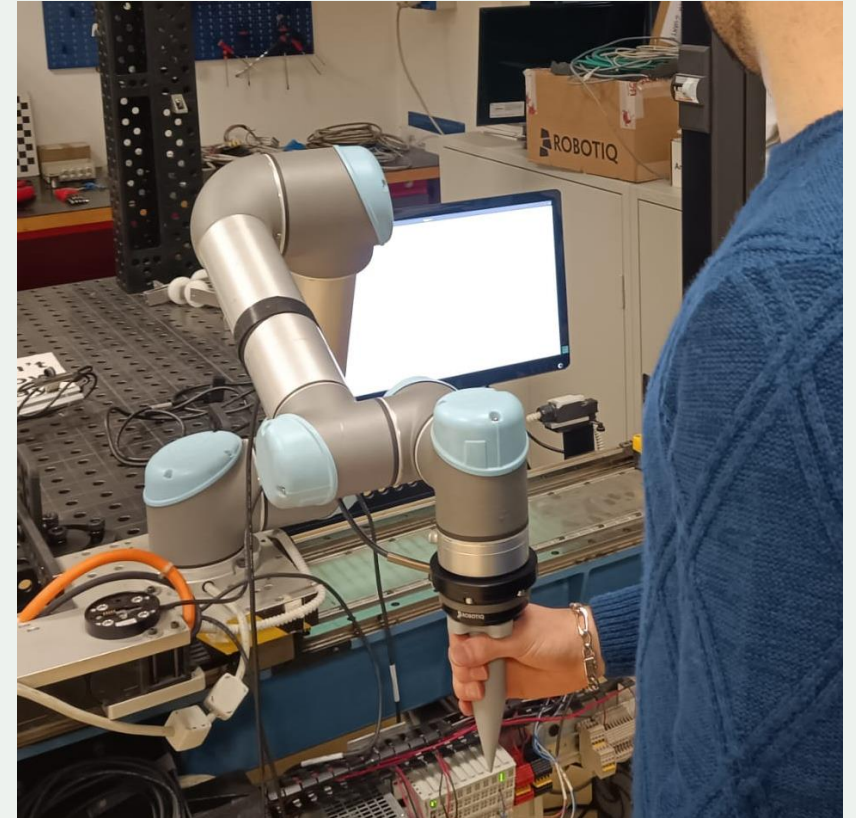
Paolo Franceschi<sup>1,2</sup>, Fabio Bertini<sup>3</sup>, Francesco Braghin<sup>3</sup>, Loris Roveda<sup>4</sup>, Nicola Pedrocchi<sup>1</sup>, and Manuel Beschi<sup>2</sup>

<sup>1</sup>CNR-STIIMA, <sup>2</sup>UniBs, <sup>3</sup>Polimi, <sup>4</sup>IDSIA-SUPSI



# Motivation

- Let the robot understand human desired motion intention
- human intention: the desired trajectory that the human wants to follow over a finite rolling prediction horizon

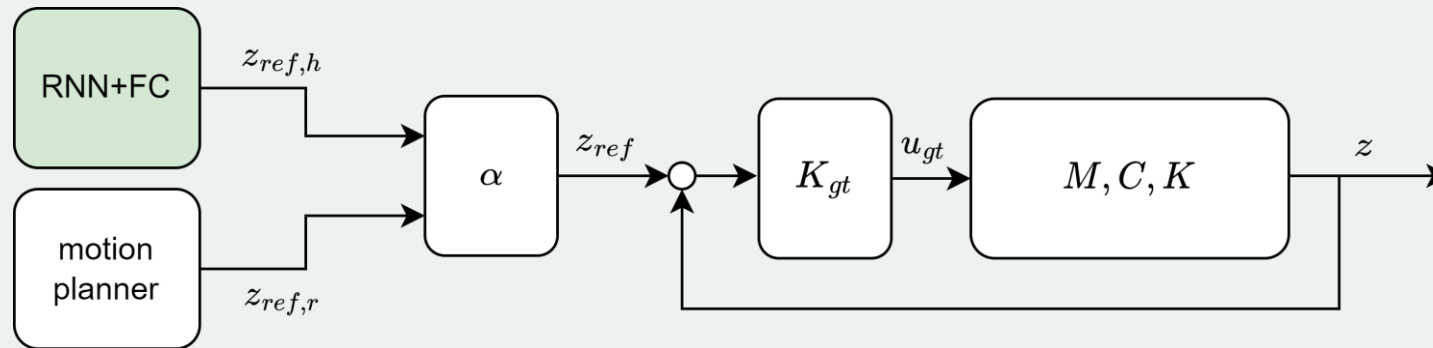


# Method

- Cooperative GT control
- Human intention predictive model
  - Iterative training
  - Transfer learning

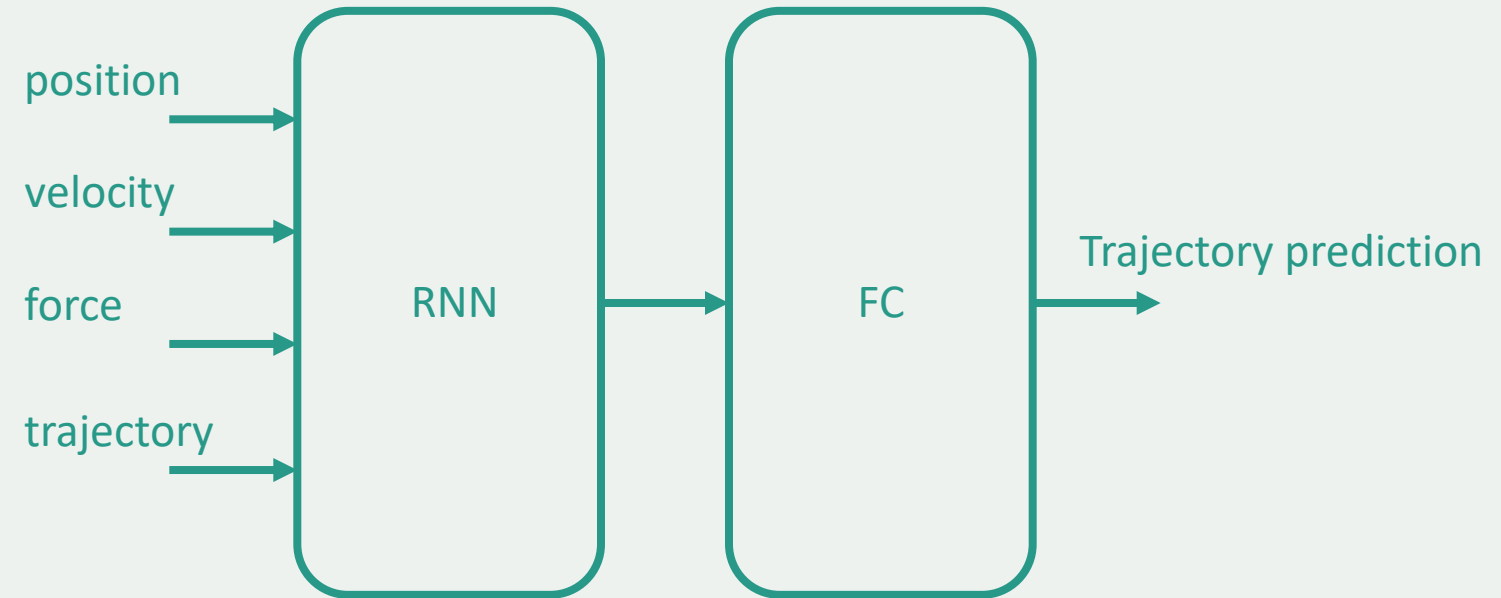


# Cooperative GT controller

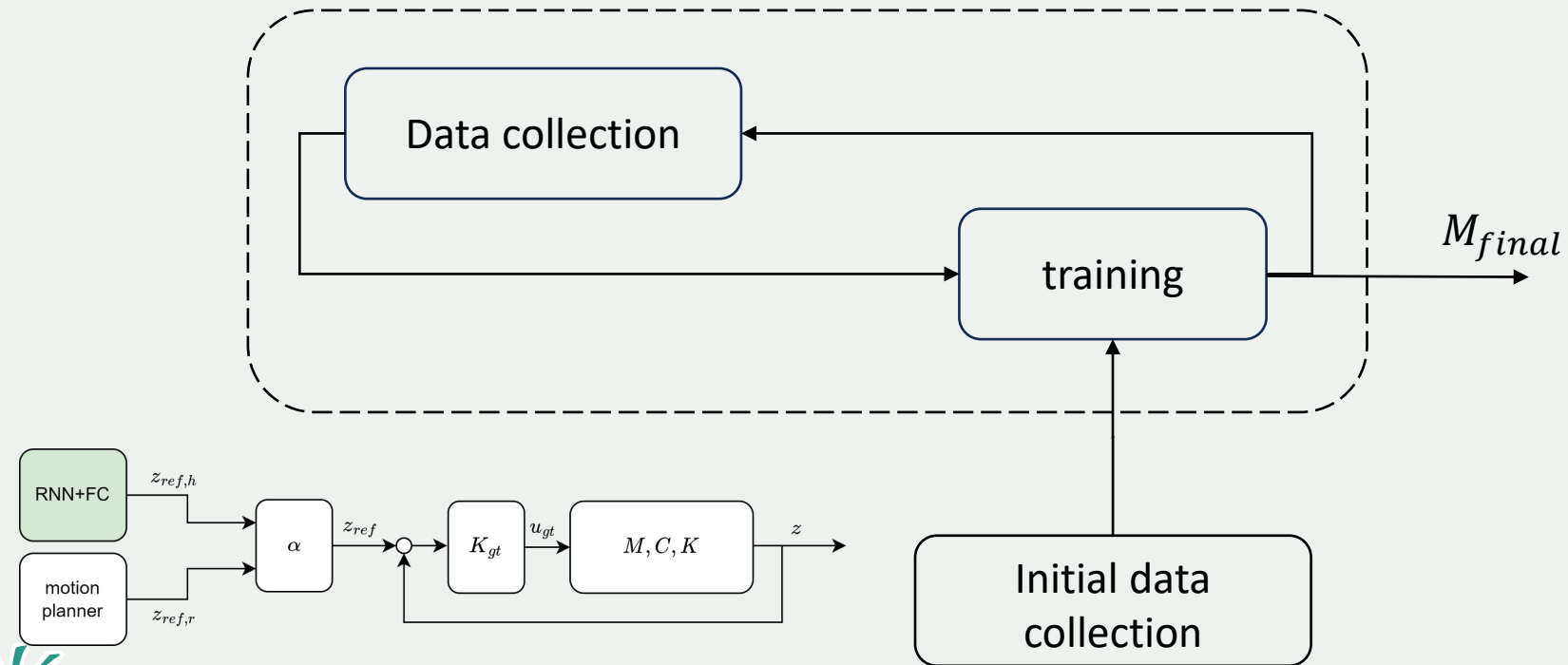


# Learning model

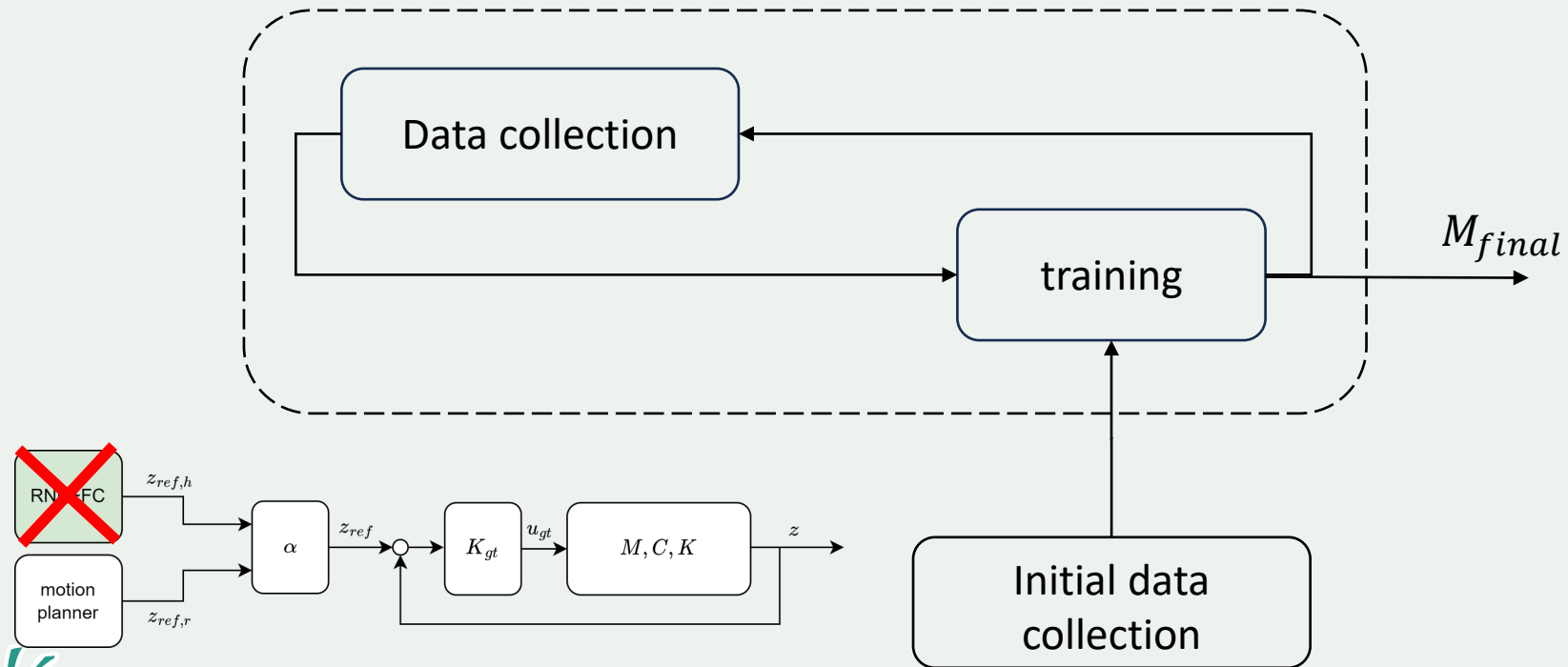
RNN+FC



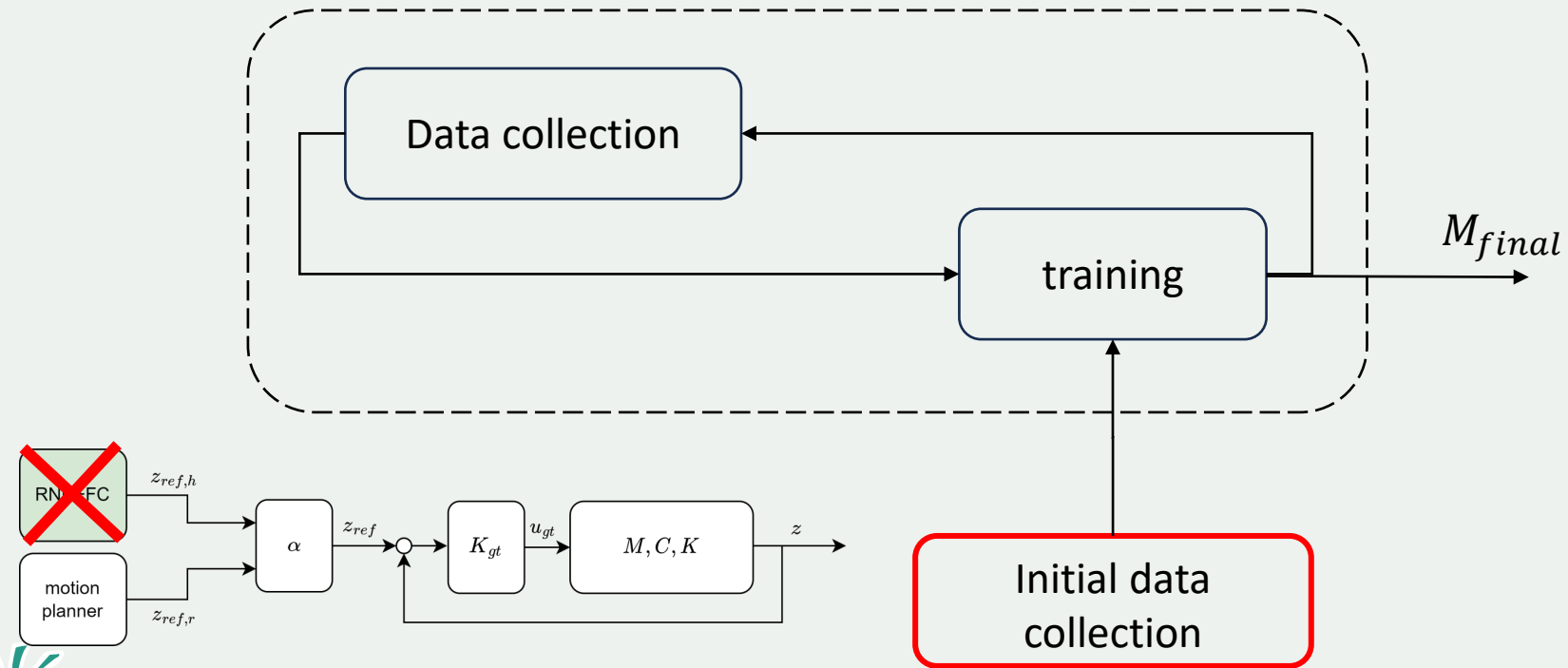
# Iterative Training



# Iterative Training

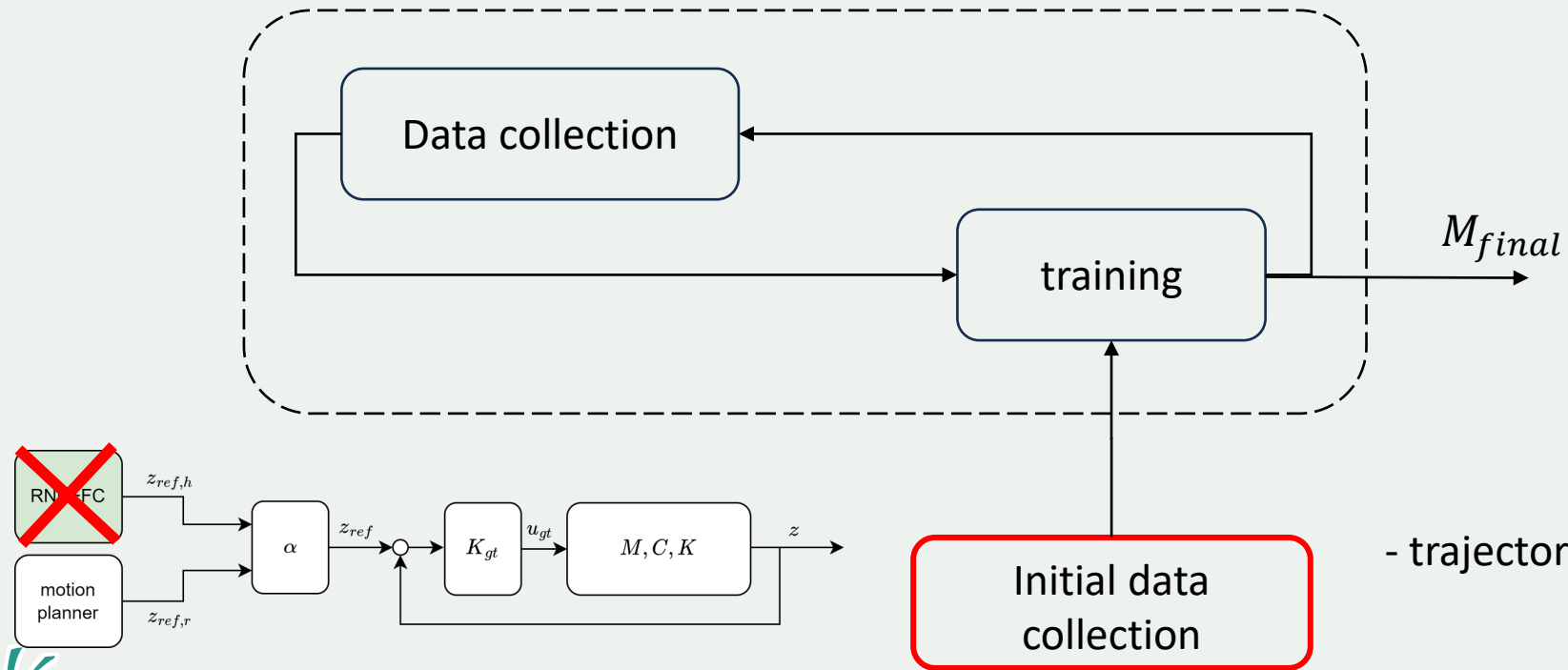


# Iterative Training

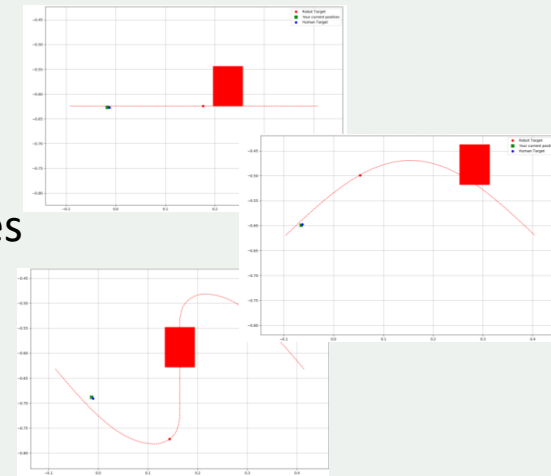




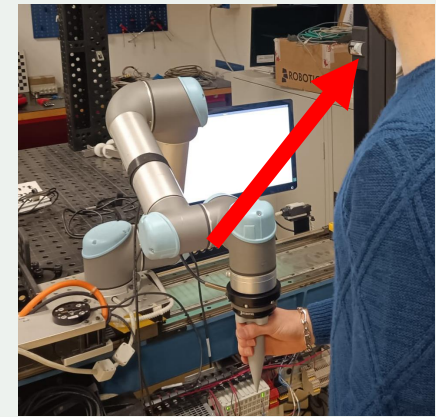
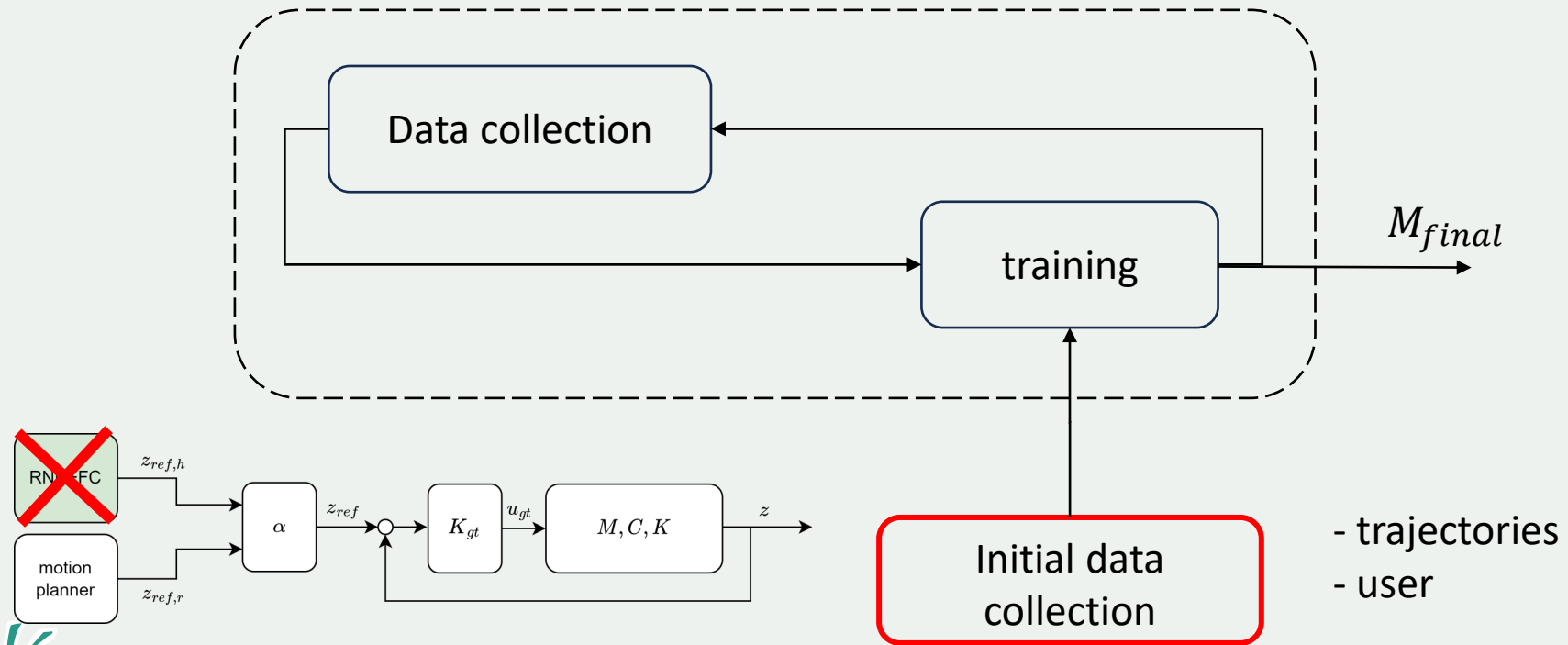
# Iterative Training



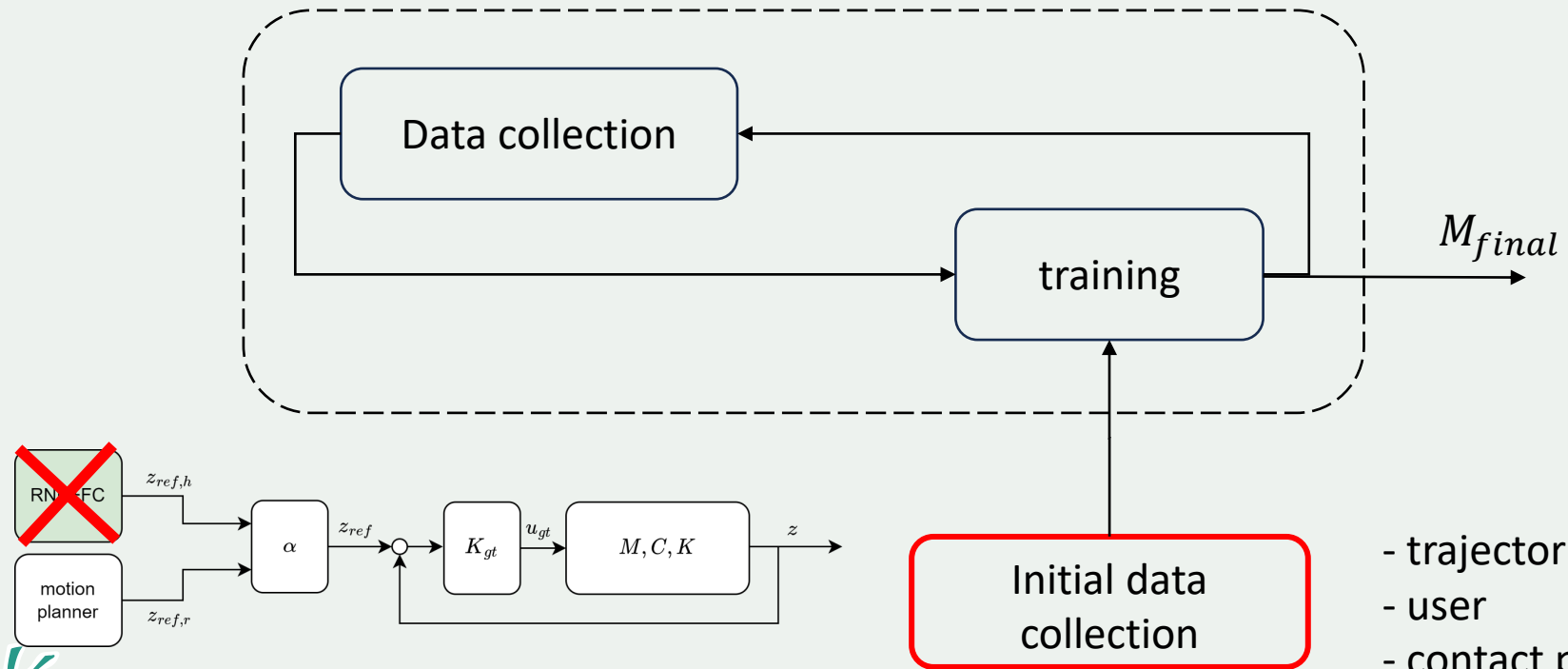
- trajectories



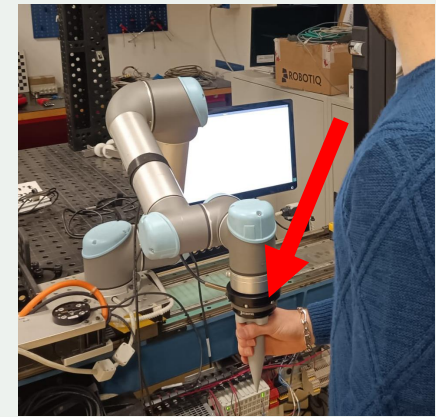
# Iterative Training



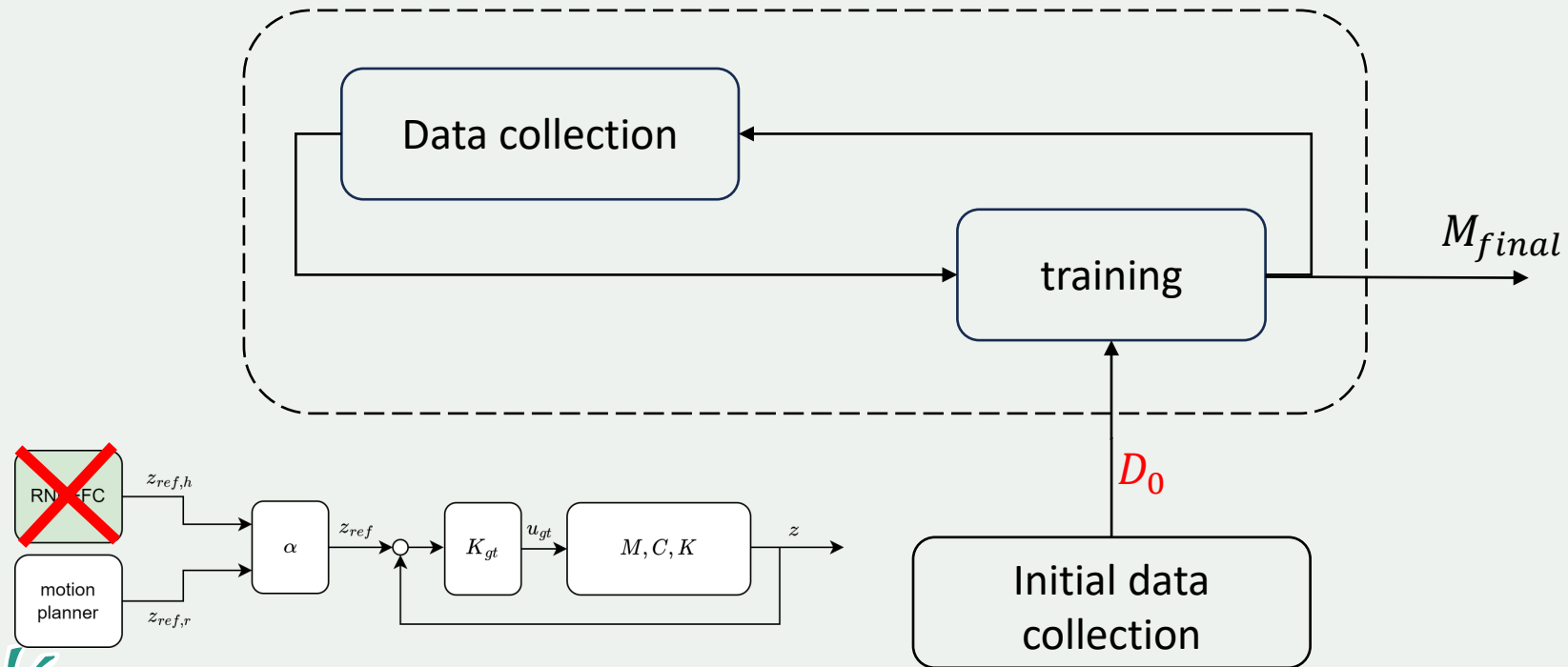
# Iterative Training



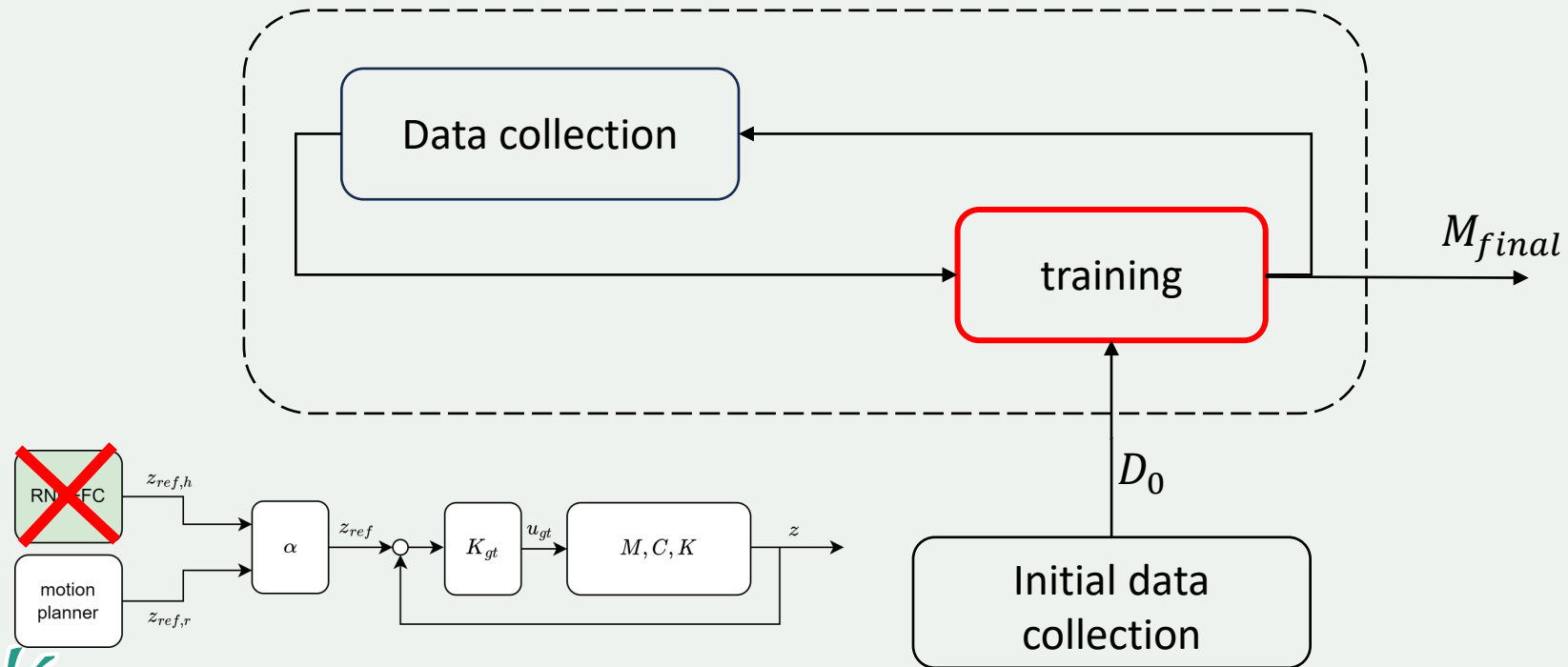
- trajectories
- user
- contact point



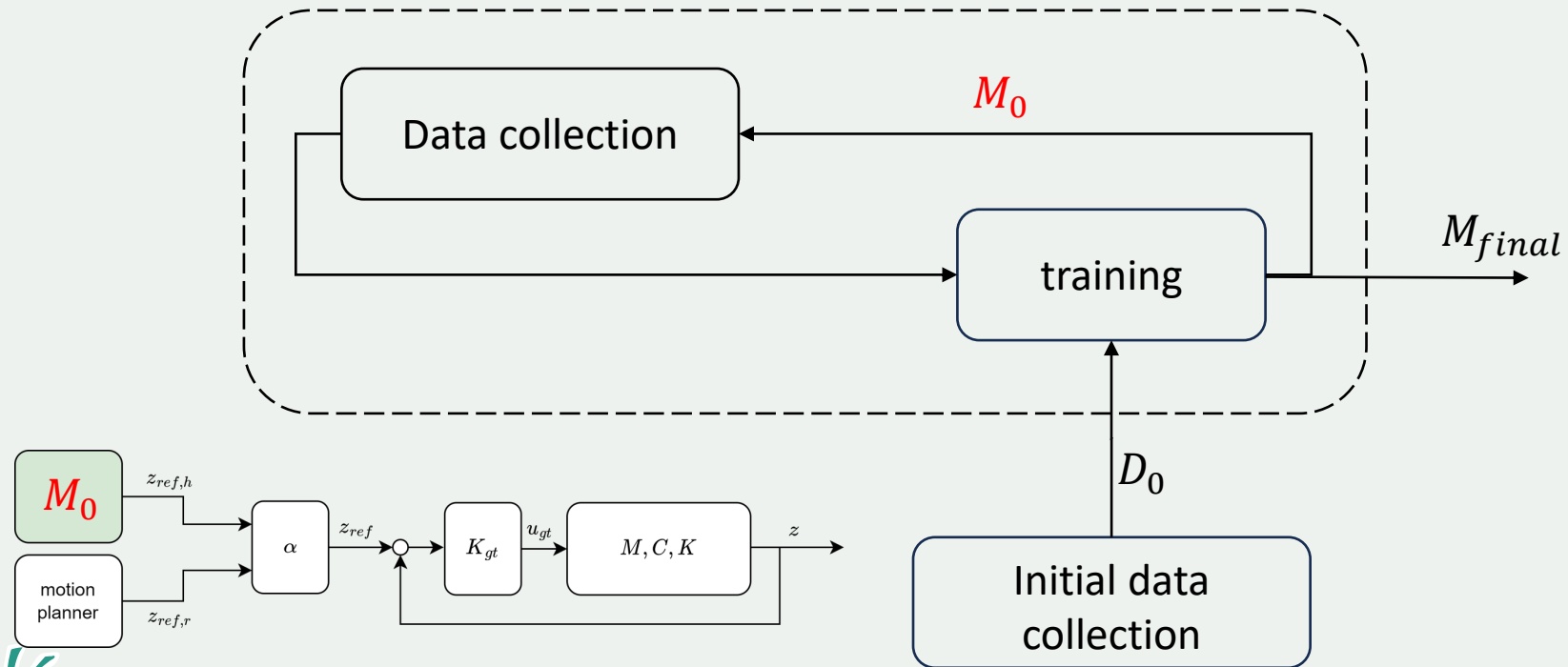
# Iterative Training



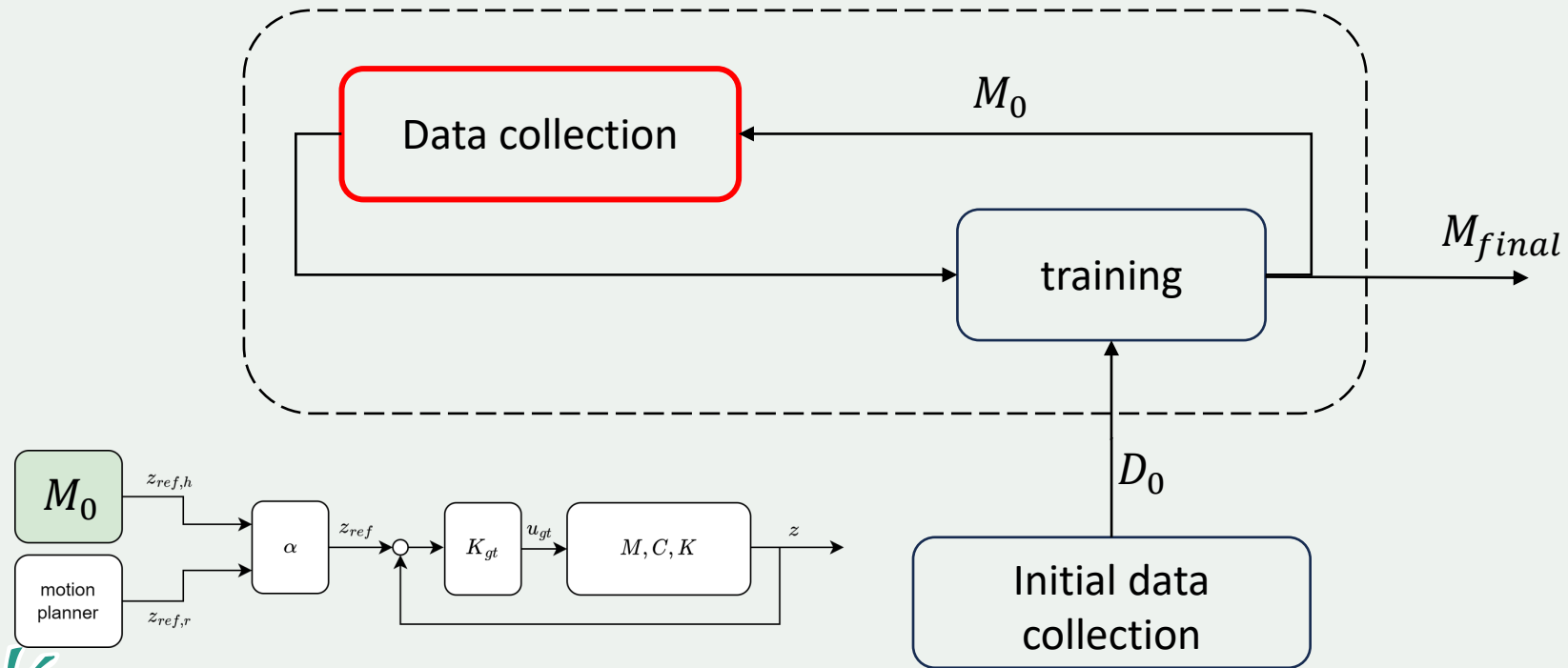
# Iterative Training



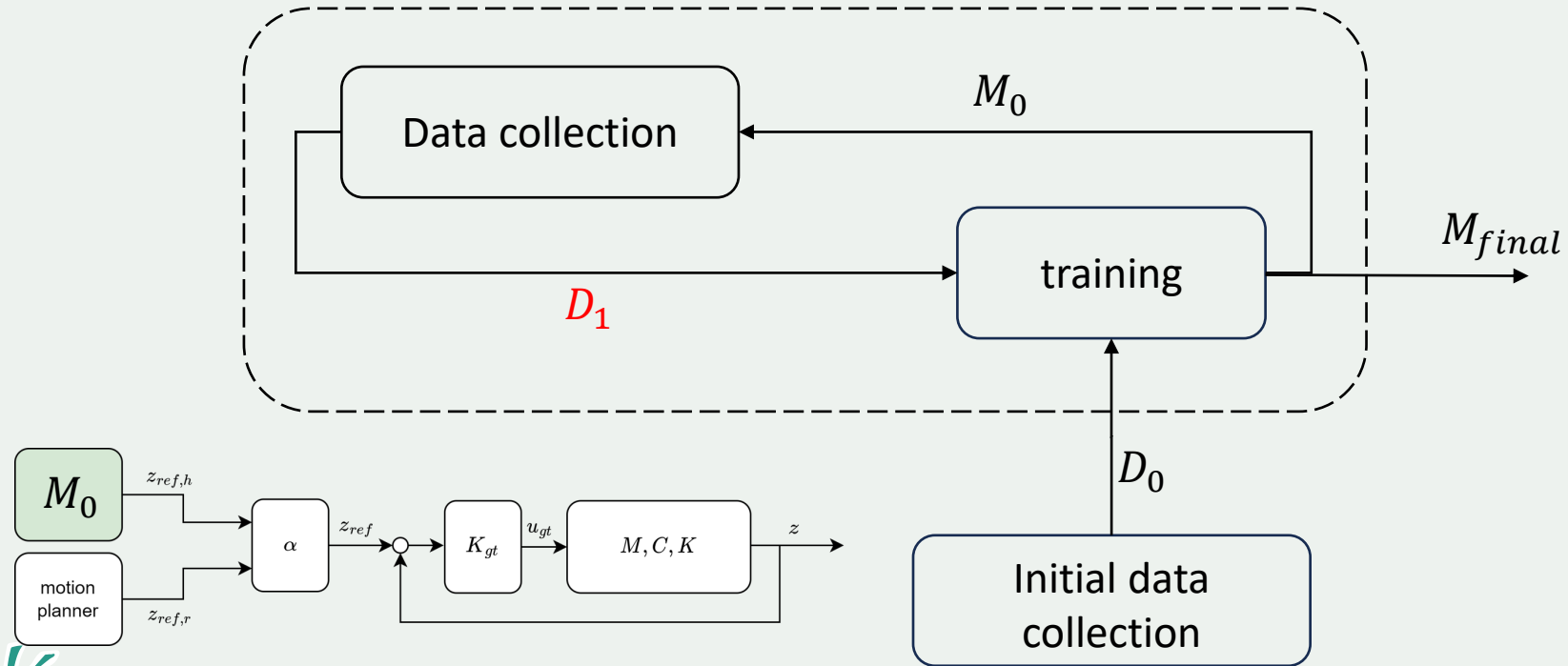
# Iterative Training



# Iterative Training

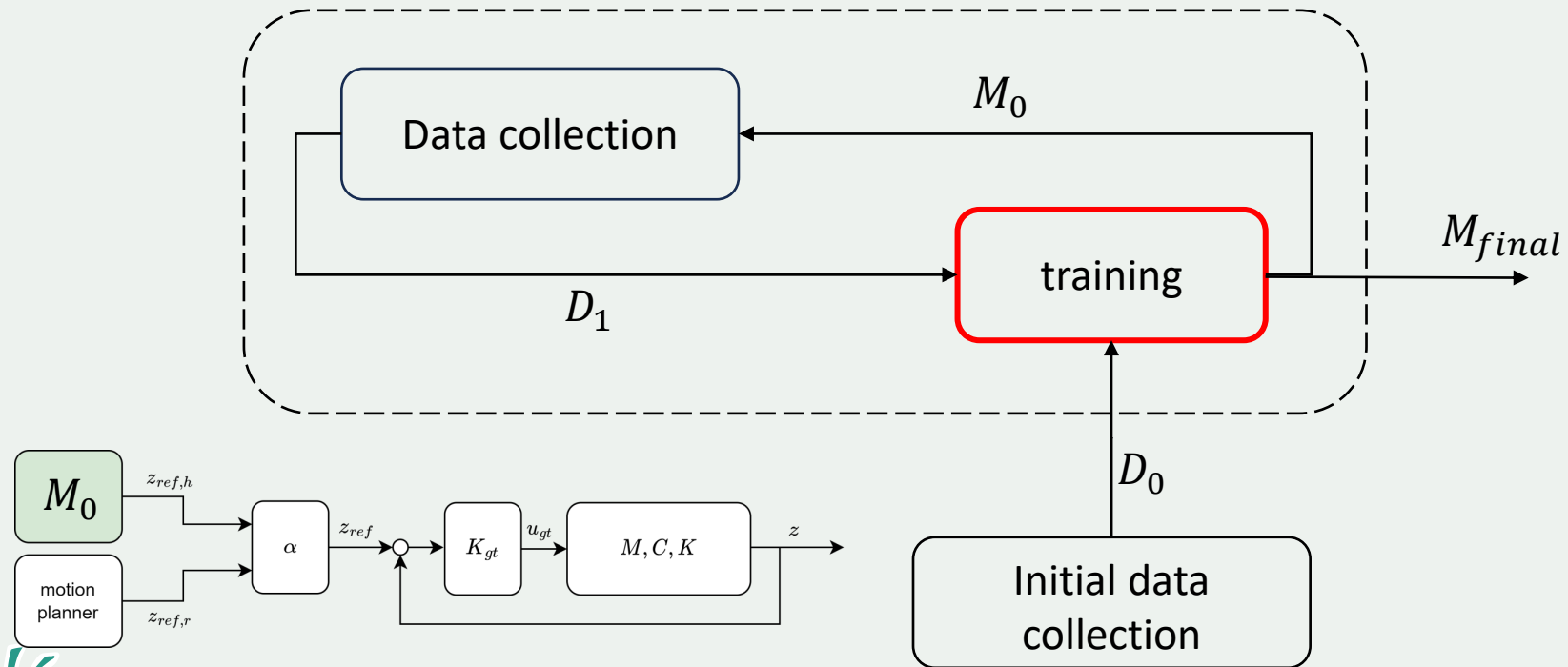


# Iterative Training

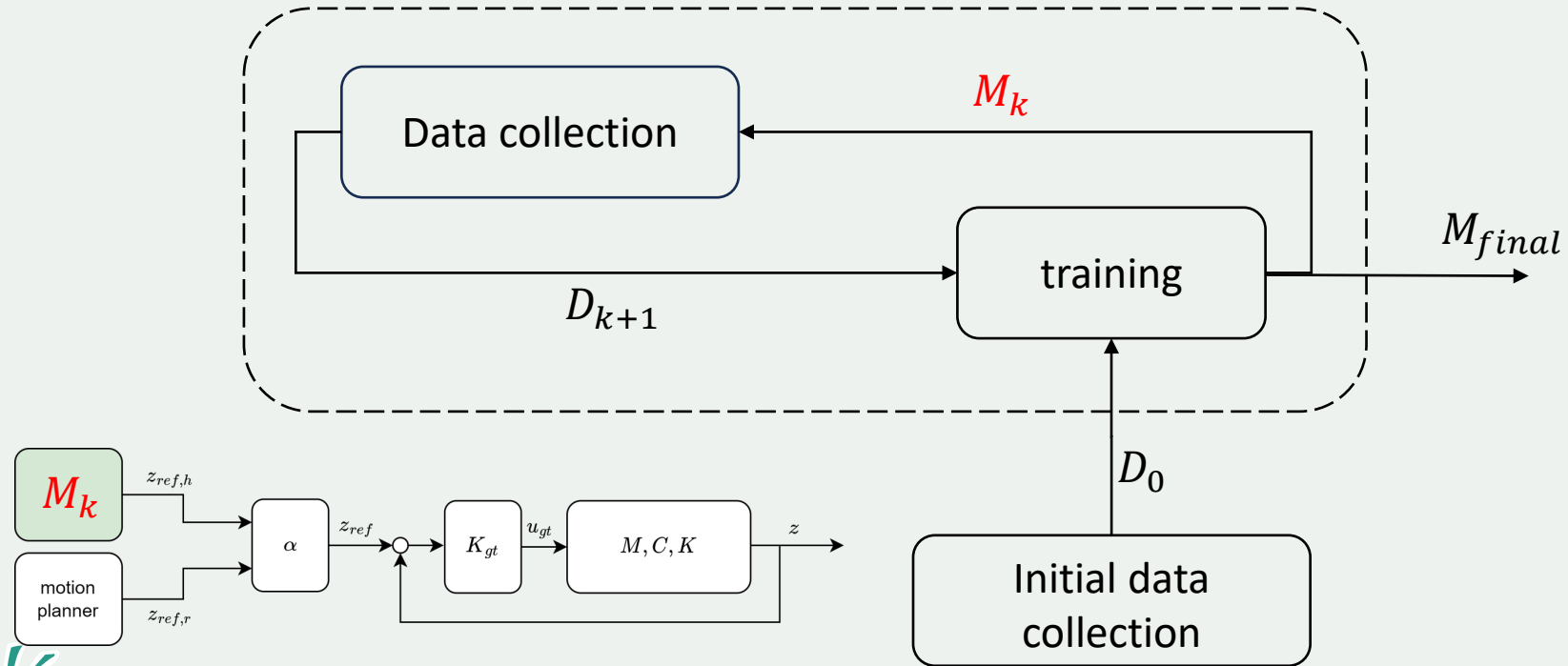




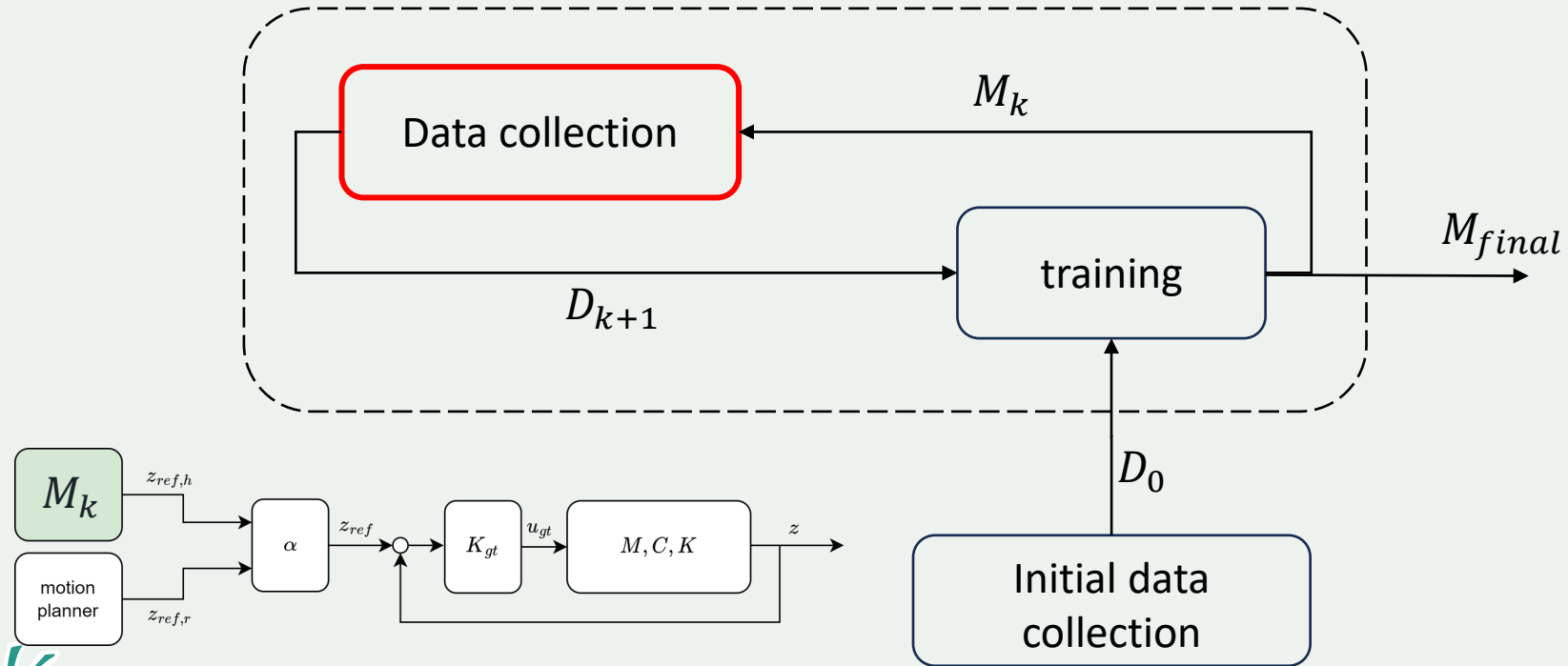
# Iterative Training



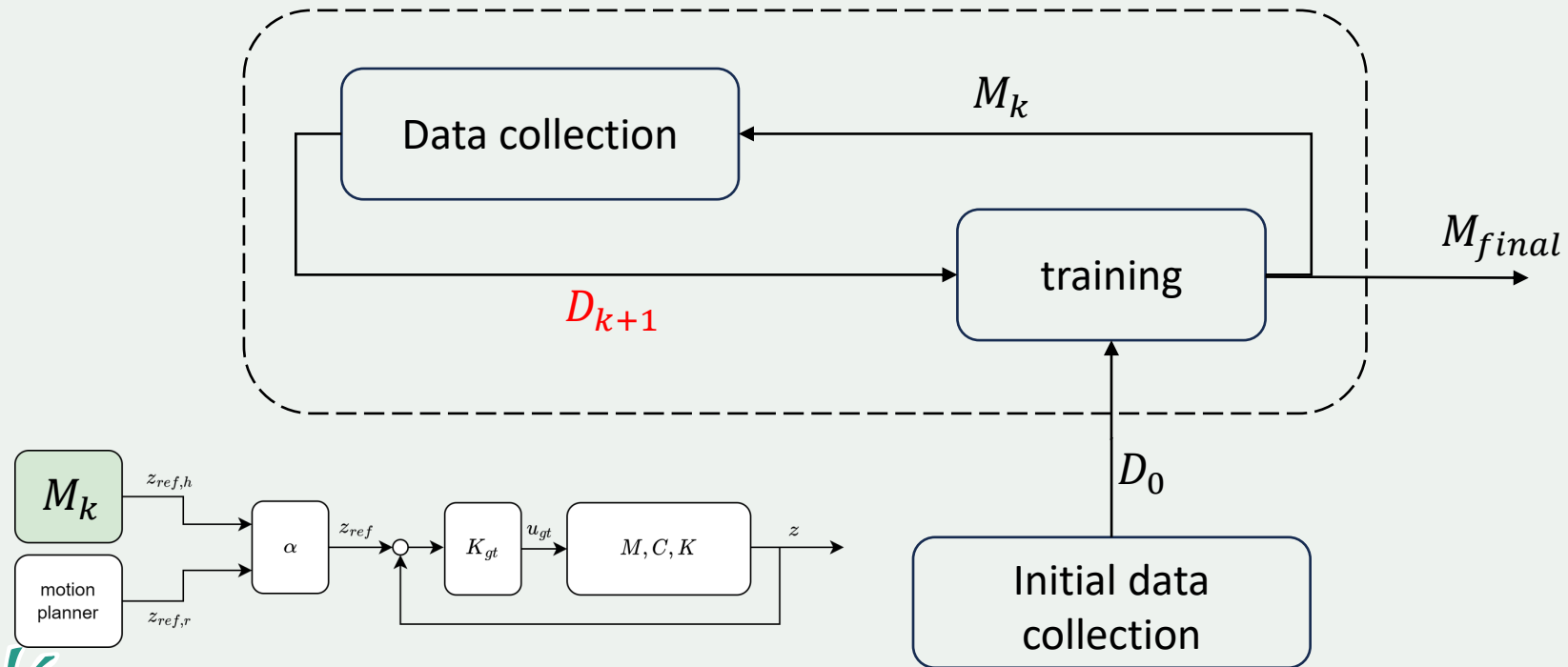
# Iterative Training



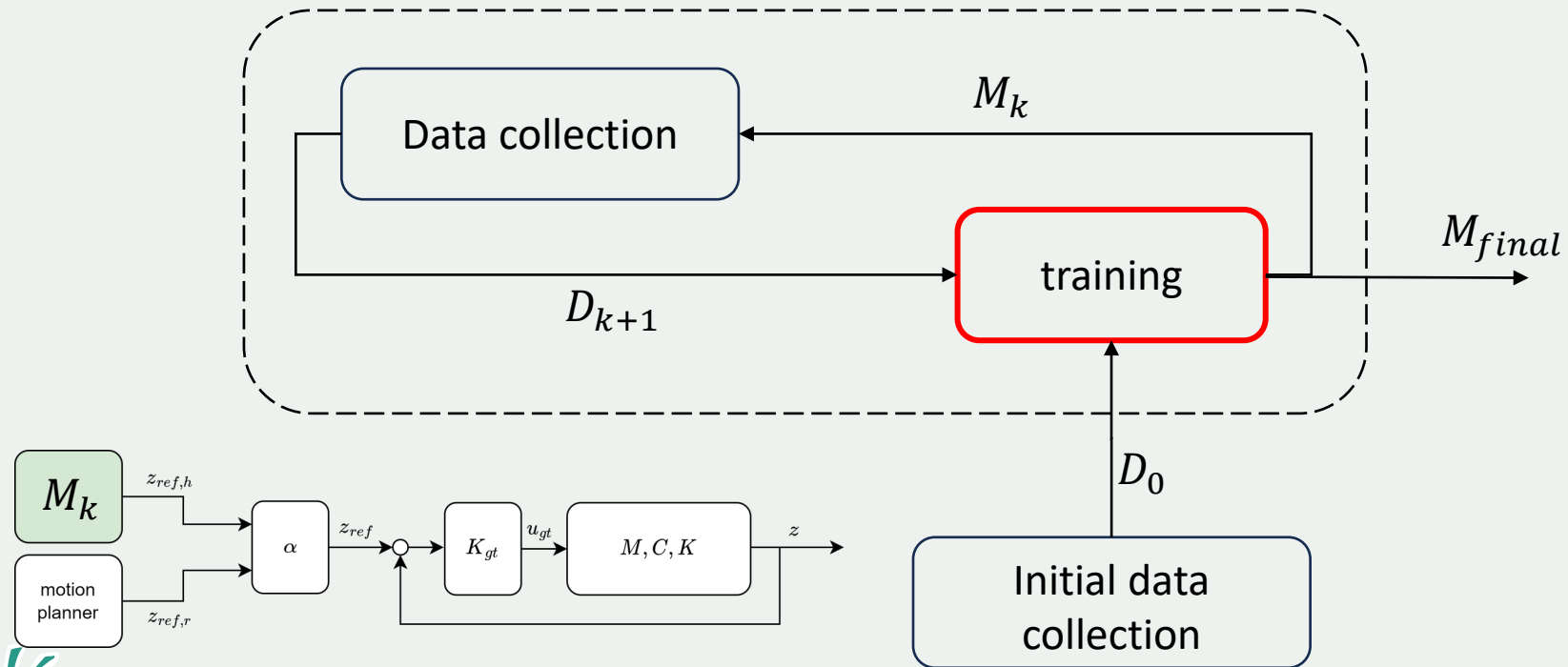
# Iterative Training



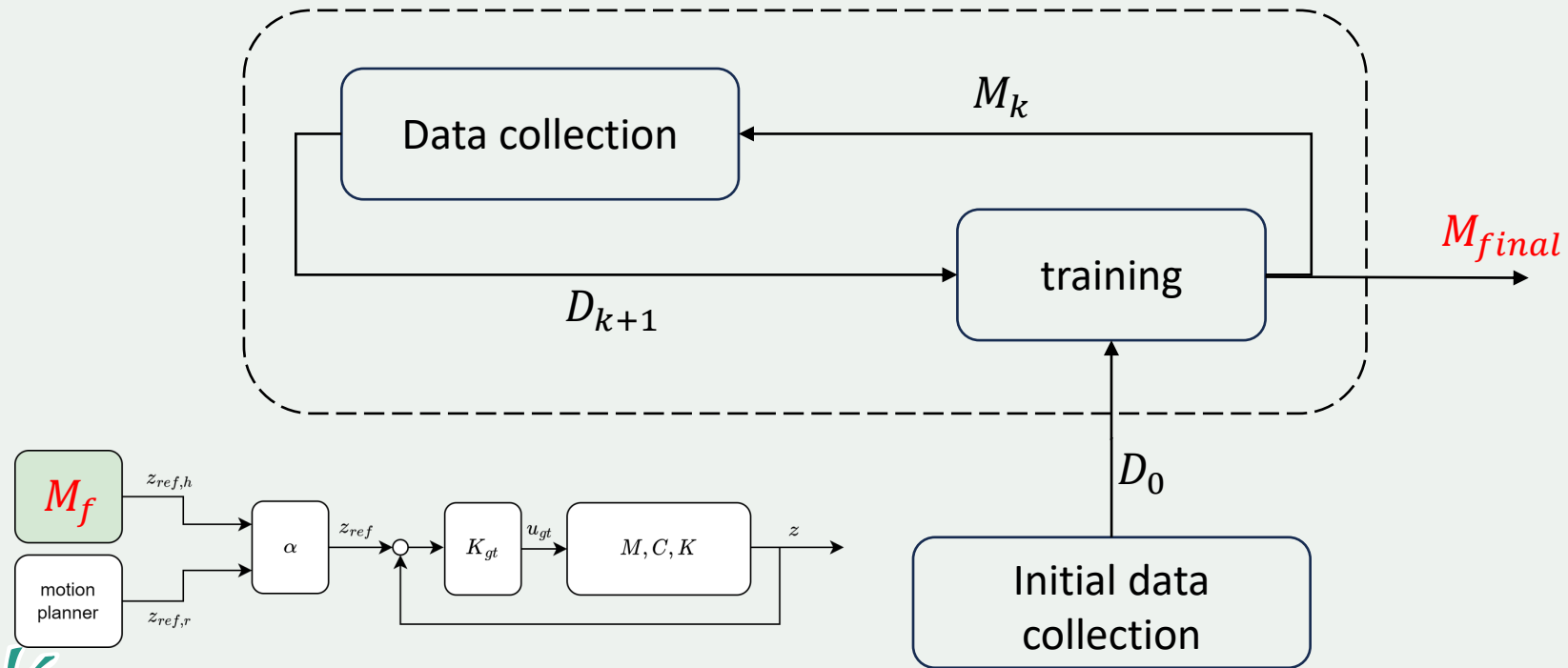
# Iterative Training



# Iterative Training



# Iterative Training



# Iterative Training

Pros:

+ Improves predicting capabilities of the model at each iteration



# Iterative Training

Pros:

+ Improves predicting capabilities of the model at each iteration

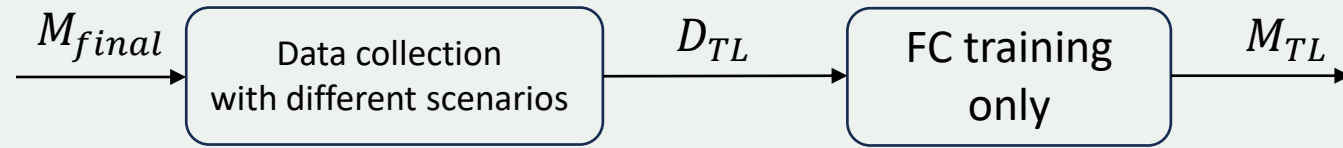
Cons:

- time consuming
- fitted under precise conditions (task, user, trajectory, etc)

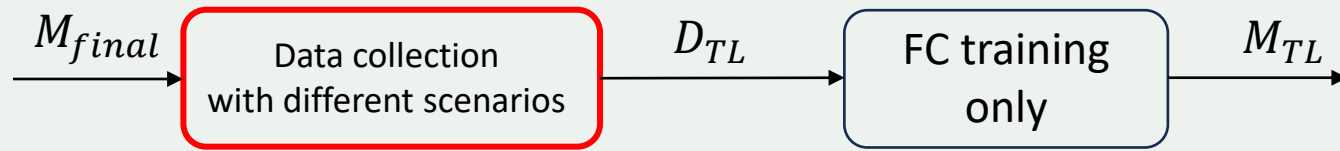




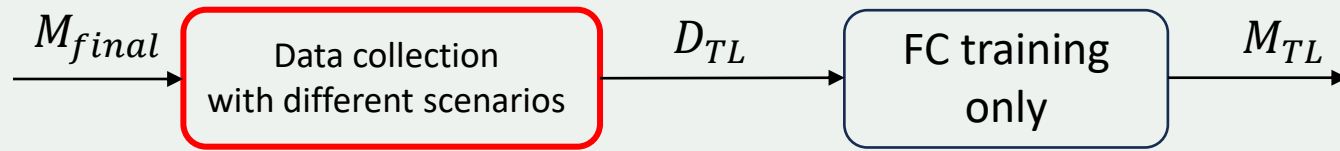
# Transfer Learning



# Transfer Learning



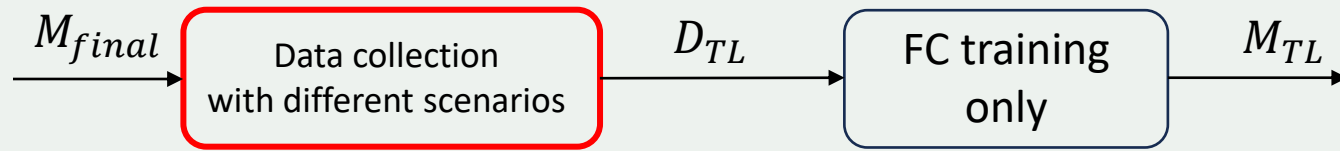
# Transfer Learning



- different trajectories



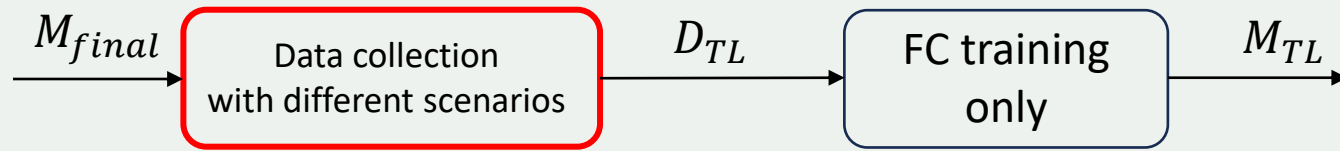
# Transfer Learning



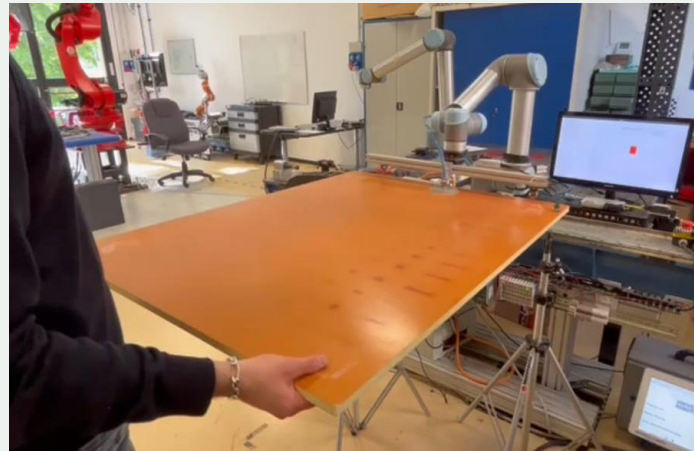
- different trajectories
- different users



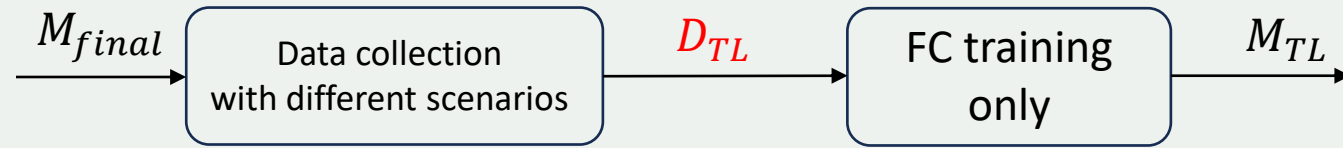
# Transfer Learning



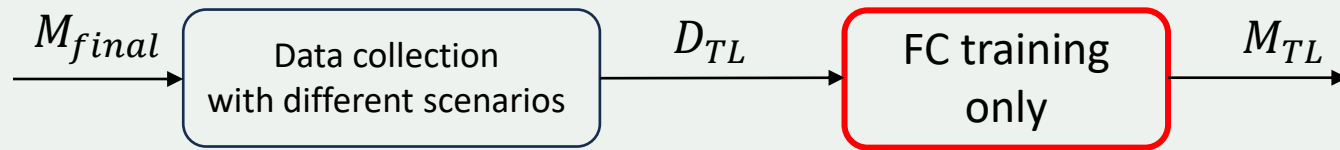
- different trajectories
- different users
- different objects



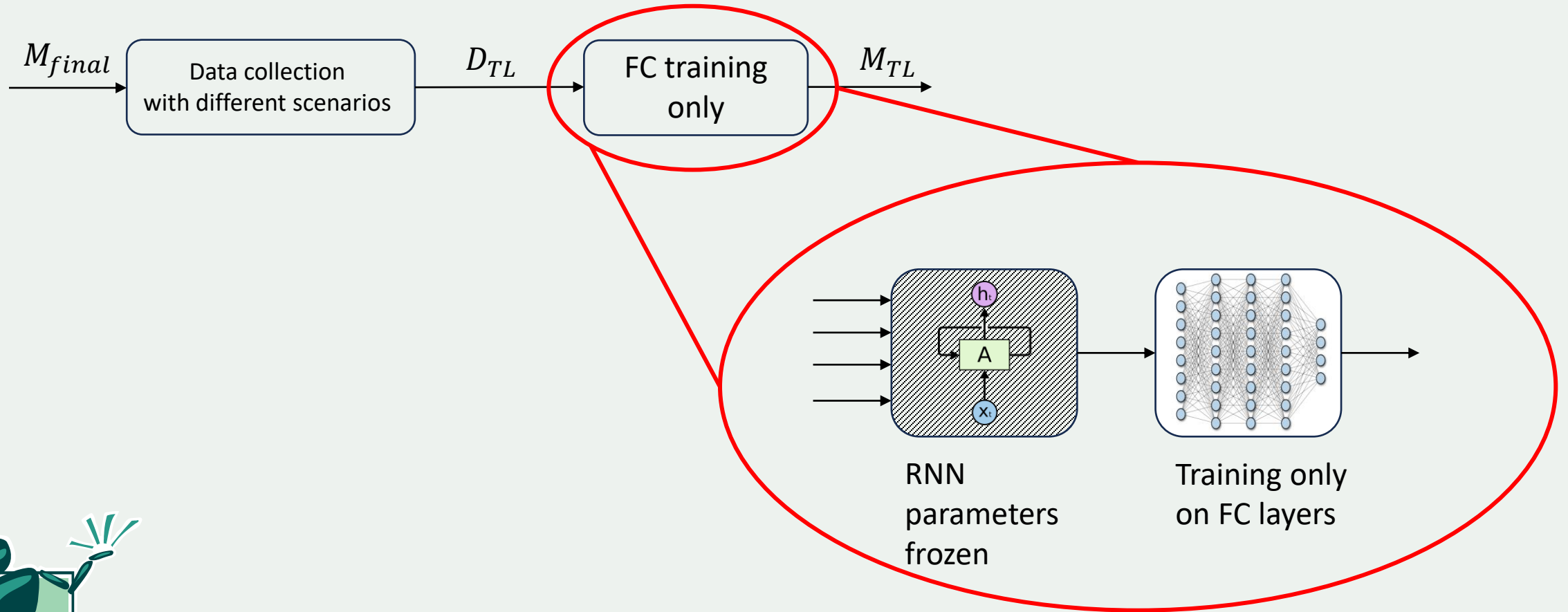
# Transfer Learning



# Transfer Learning

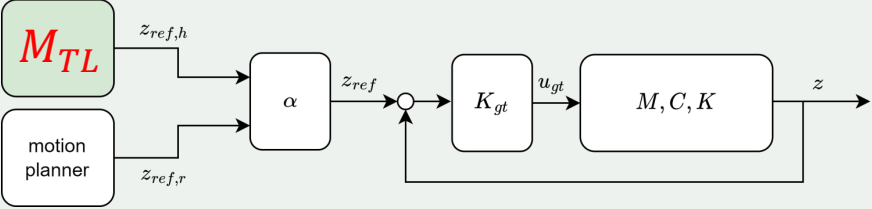
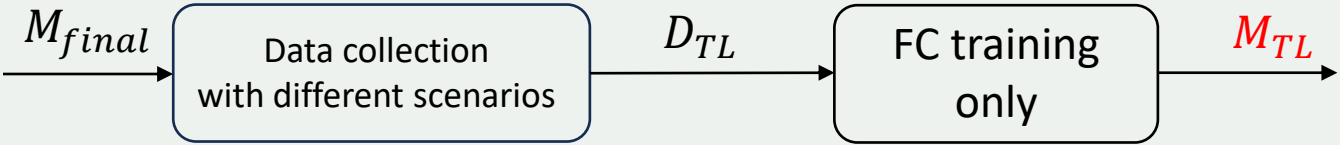


# Transfer Learning

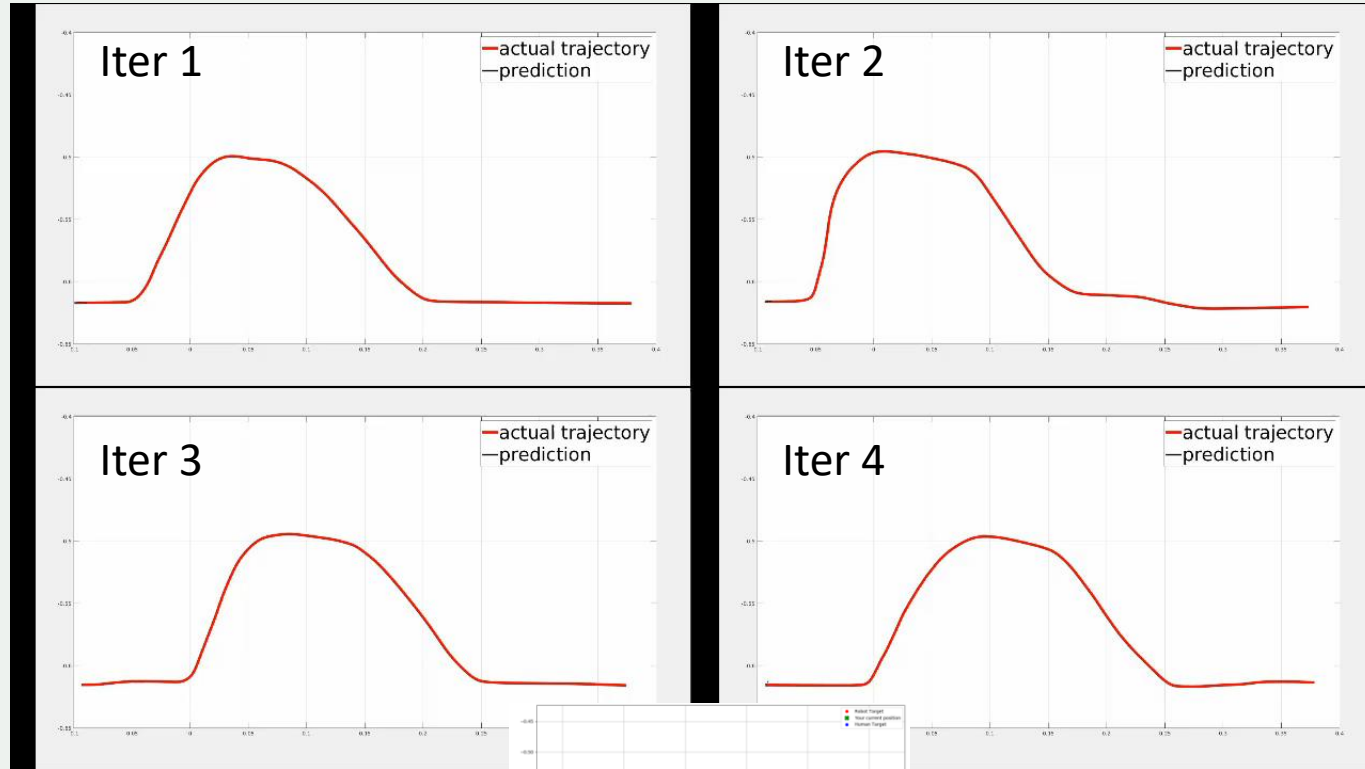
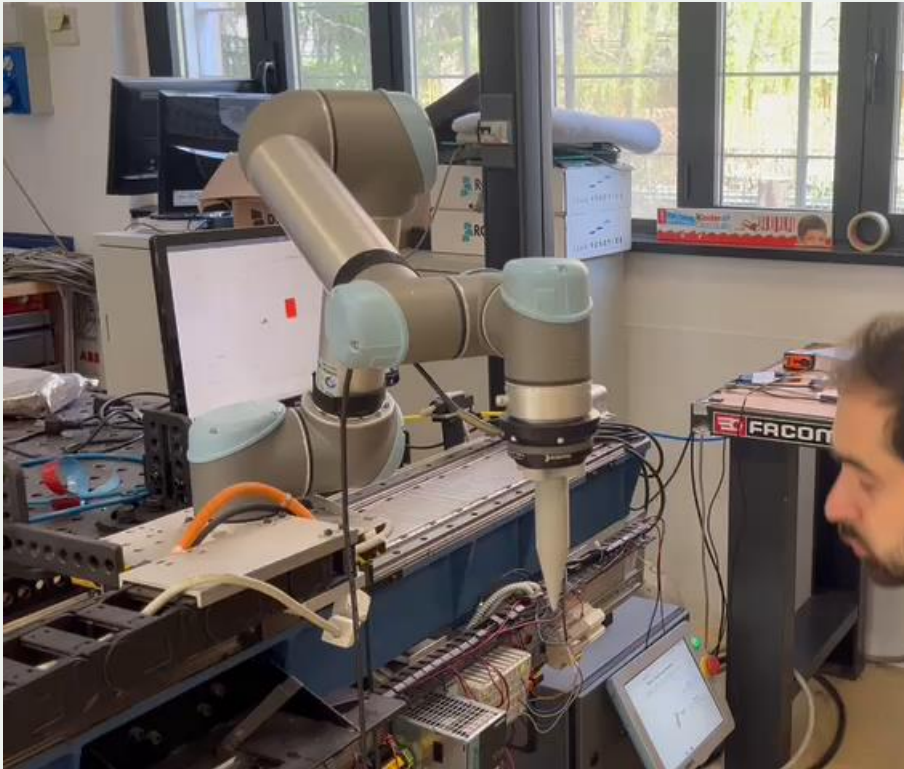




# Transfer Learning



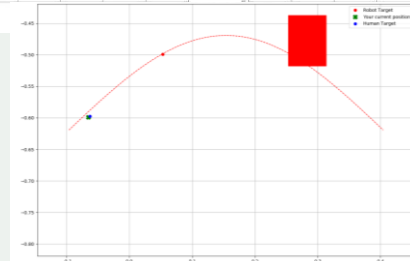
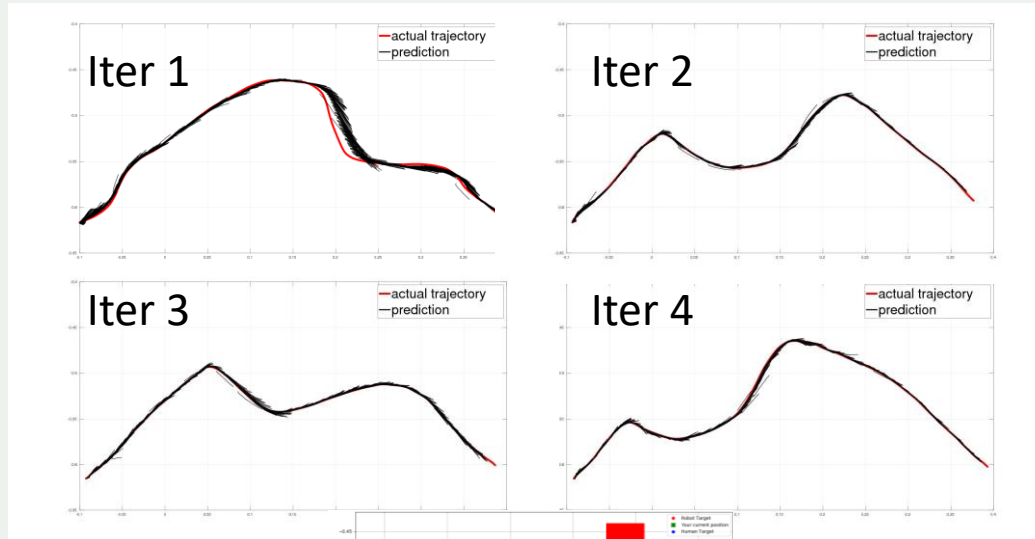
# Iterative training results



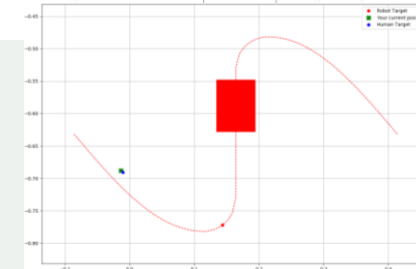
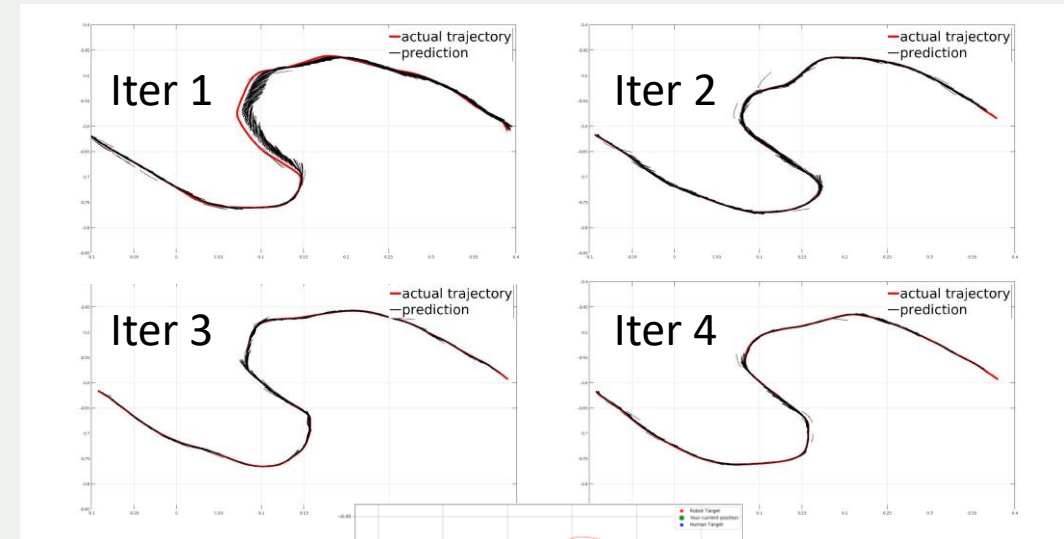
Linear nominal trajectory



# Iterative training results



Cos nominal trajectory

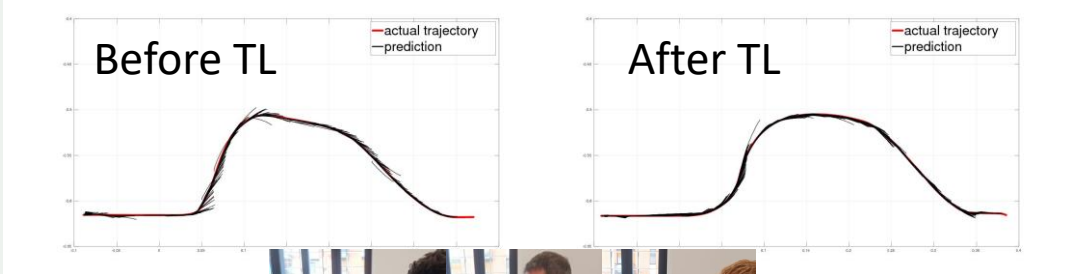


S nominal trajectory



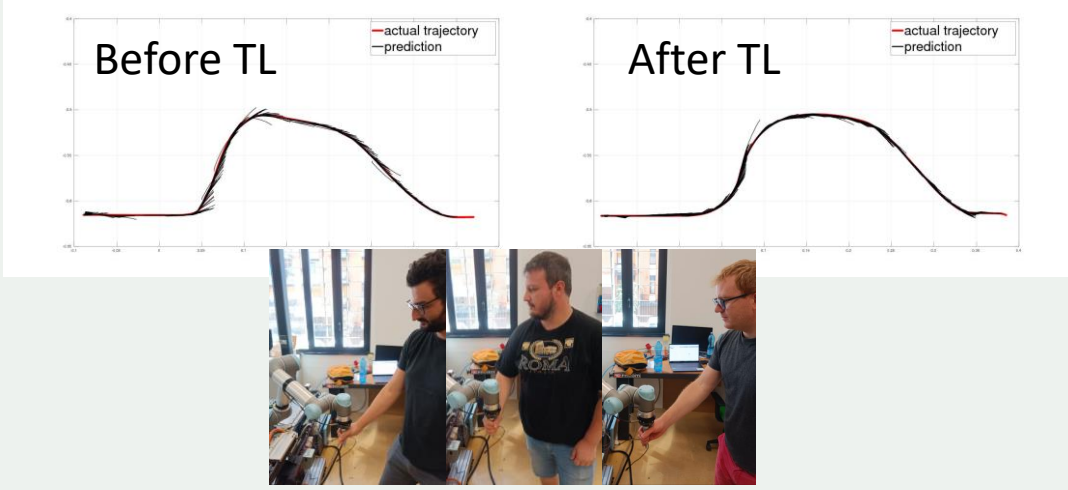
# Transfer learning results

TL on new users

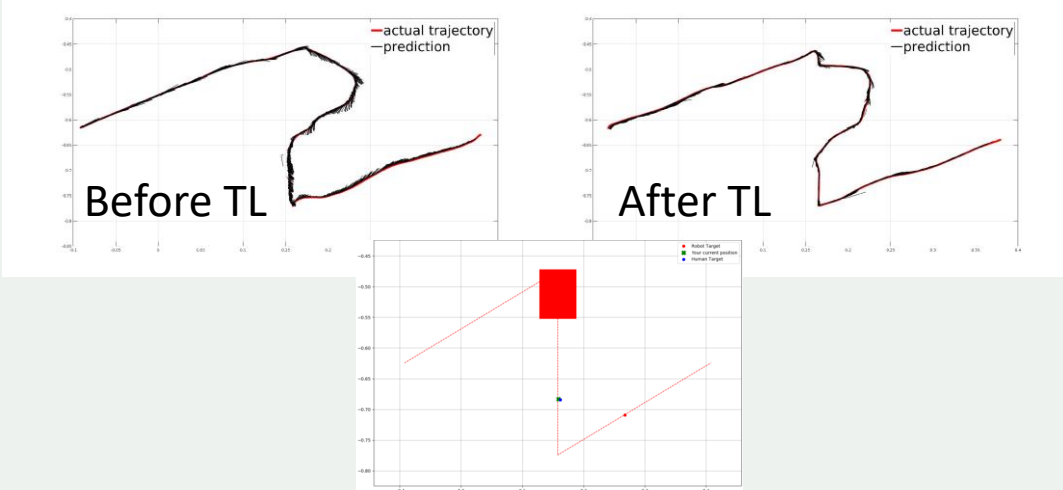


# Transfer learning results

TL on new users

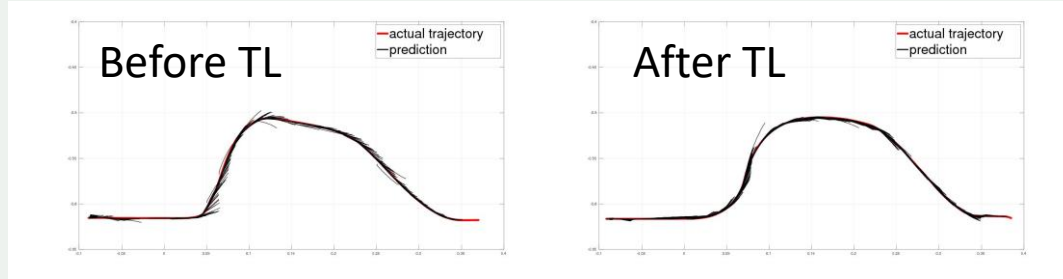


TL on new trajectory

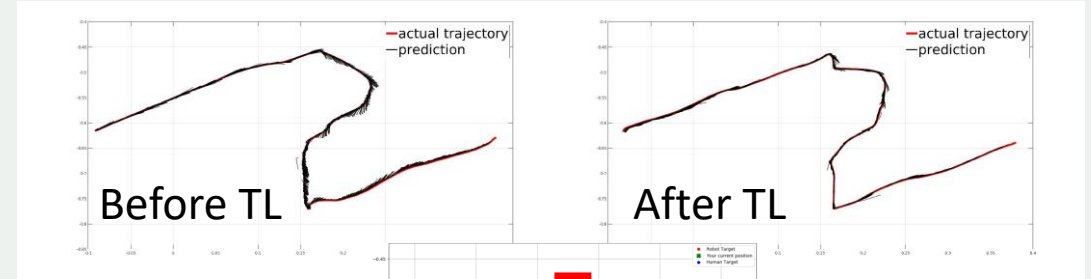


# Transfer learning results

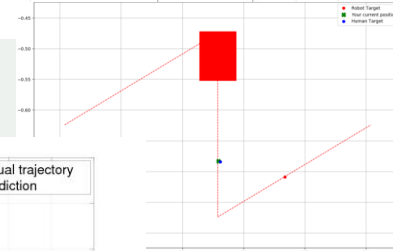
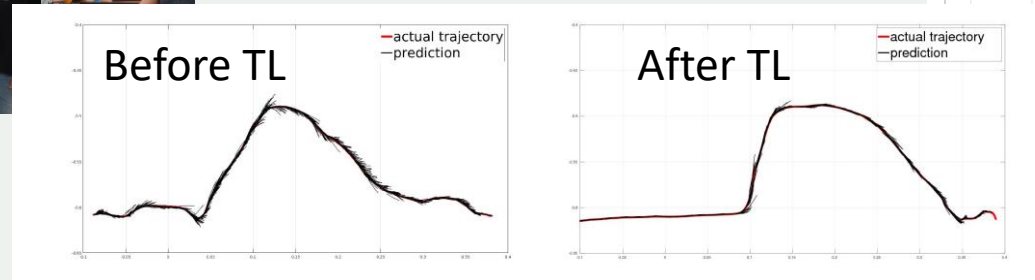
## TL on new users

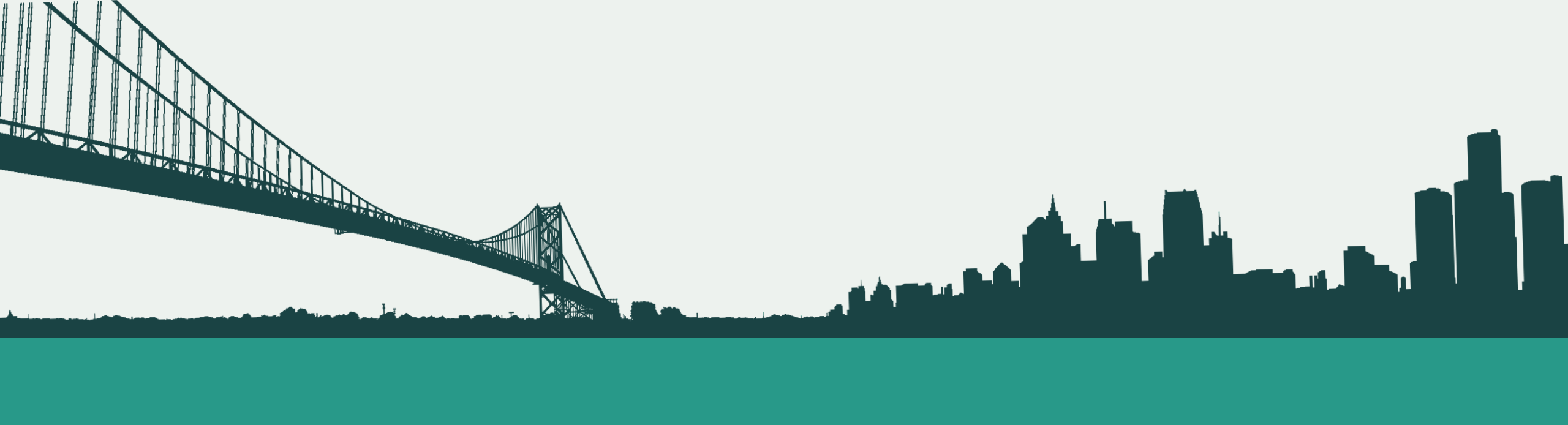


## TL on new trajectory



## TL on new object





# Thank you !

For any question, feel free to contact me at  
[franceschi.pl@gmail.com](mailto:franceschi.pl@gmail.com)