

# Writing a training loop from scratch

[https://www.tensorflow.org/guide/keras/writing\\_a\\_training\\_loop\\_from\\_scratch](https://www.tensorflow.org/guide/keras/writing_a_training_loop_from_scratch)  
([https://www.tensorflow.org/guide/keras/writing\\_a\\_training\\_loop\\_from\\_scratch](https://www.tensorflow.org/guide/keras/writing_a_training_loop_from_scratch))

## Import libraries

```
In [1]: # Python libraries
import os
import pandas as pd # for data manipulation
import numpy as np # for data manipulation
import tensorflow as tf
import matplotlib.pyplot as plt
from sklearn.model_selection import train_test_split

# To enable LaTeX and select a font
plt.rcParams.update({
    "text.usetex": True,
    "font.family": "sans-serif",
    "font.sans-serif": "Helvetica",
})

# Using ipynb import functions defined in other nb
from ipynb.fs.defs.myfun_load_dataset import *
from ipynb.fs.full.myfun_models import *
from ipynb.fs.full.myfun_nn import *
from ipynb.fs.full.myfun_opt import *
from ipynb.fs.defs.myfun_plot import *
```

2023-08-28 13:04:25.250075: I tensorflow/core/platform/cpu\_feature\_guard.cc:193] This TensorFlow binary is optimized with oneAPI Deep Neural Network Library (oneDNN) to use the following CPU instructions in performance-critical operations: SSE4.1 SSE4.2 AVX AVX2 FMA To enable them in other operations, rebuild TensorFlow with the appropriate compiler flags.

Tensorflow/Keras: 2.11.0  
sklearn: 1.3.0

## Data Acquisition

```
In [2]: # Load the dataset
par_dir = os.path.dirname(os.getcwd()) # parent dir
dir_name = par_dir + "/NN-interaction"
merged_df, dflist = load_dataset(dir_name, 'post')
```

## Create the model NN

```
In [3]: # Create the model  
DOE = [[1,2,1]] #Design of experiment  
model = create_model(DOE[0])
```

## Get $v_0$ mean over each df looping on dflist

```
In [4]: # params  
NUM_EPOCHS = 200  
LEARNING_RATE_NN = 0.1  
LEARNING_RATE_v0 = 0.5  
flag_print = True  
flag_save = True  
  
dataset = dflist
```

```
In [5]: import time

#v0_mean_list = []
v0_dflist = []

start_time2 = time.time()

for df in dataset:

    v0 = 30
    start_time1 = time.time()

    print("=="*30)
    print(f"In df n.{df['N. file'][0]}/{len(dflist)} we have {len(df)}")
    print("-"*30)
    info_df = solve_nn_df(df, model, v0, NUM_EPOCHS, LEARNING_RATE_NN)

    v0_list = [l[1] for l in info_df]
    v0_mean = np.array(v0_list).mean()
    #v0_mean_list.append(v0_mean)

    v0_df = pd.DataFrame({'v0_list': v0_list,\n                          'n_scn': len(df),\n                          'N. file': df['N. file'][0]})

    v0_dflist.append(v0_df)

    print(f"\nv0_mean in this df is: {v0_mean}")
    print("Time taken: %.2fs" % (time.time() - start_time1))

    print("=="*30)
    time_taken=time.time() - start_time2
    print("Time taken: %.2fs" % (time_taken))
```

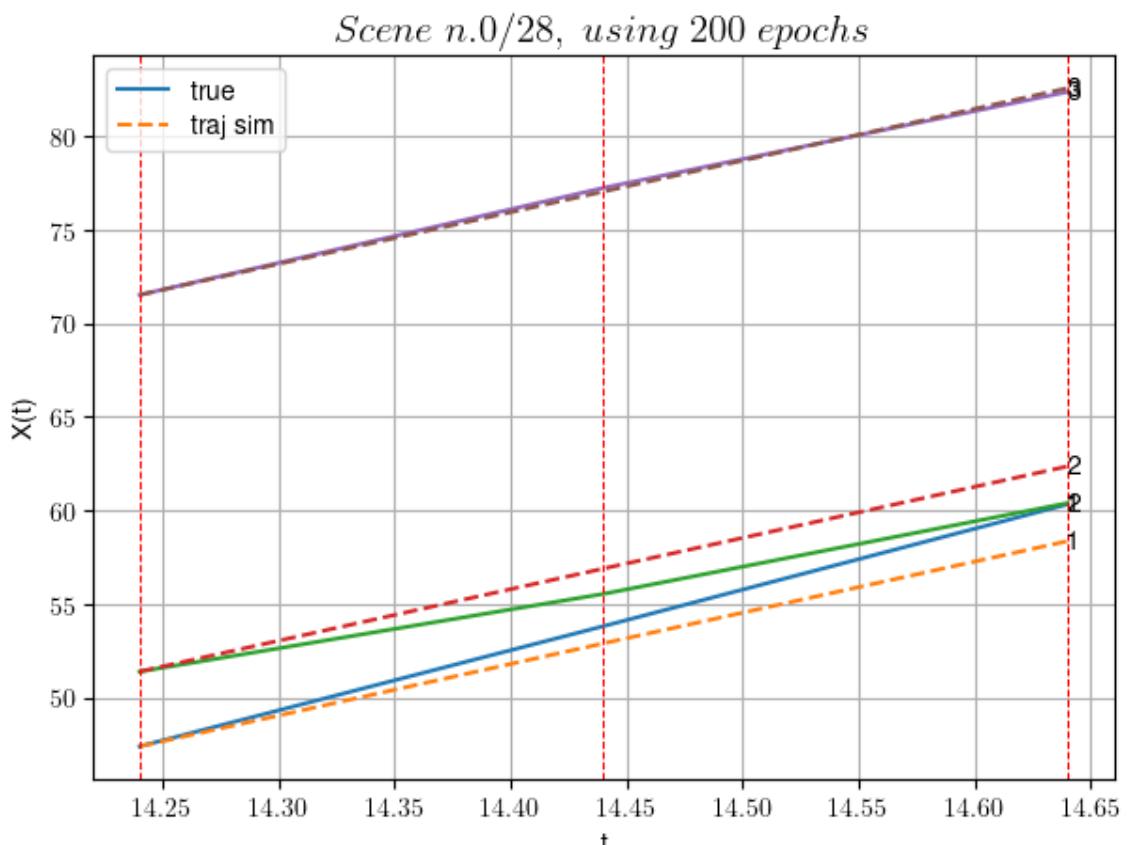
=====

In df n.1/10 we have 28 scenes

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Scene n.0/28, time interval:[14.24,14.64]

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Loss: 1.1669155248630056  
v0 updated: 27.638873683178705

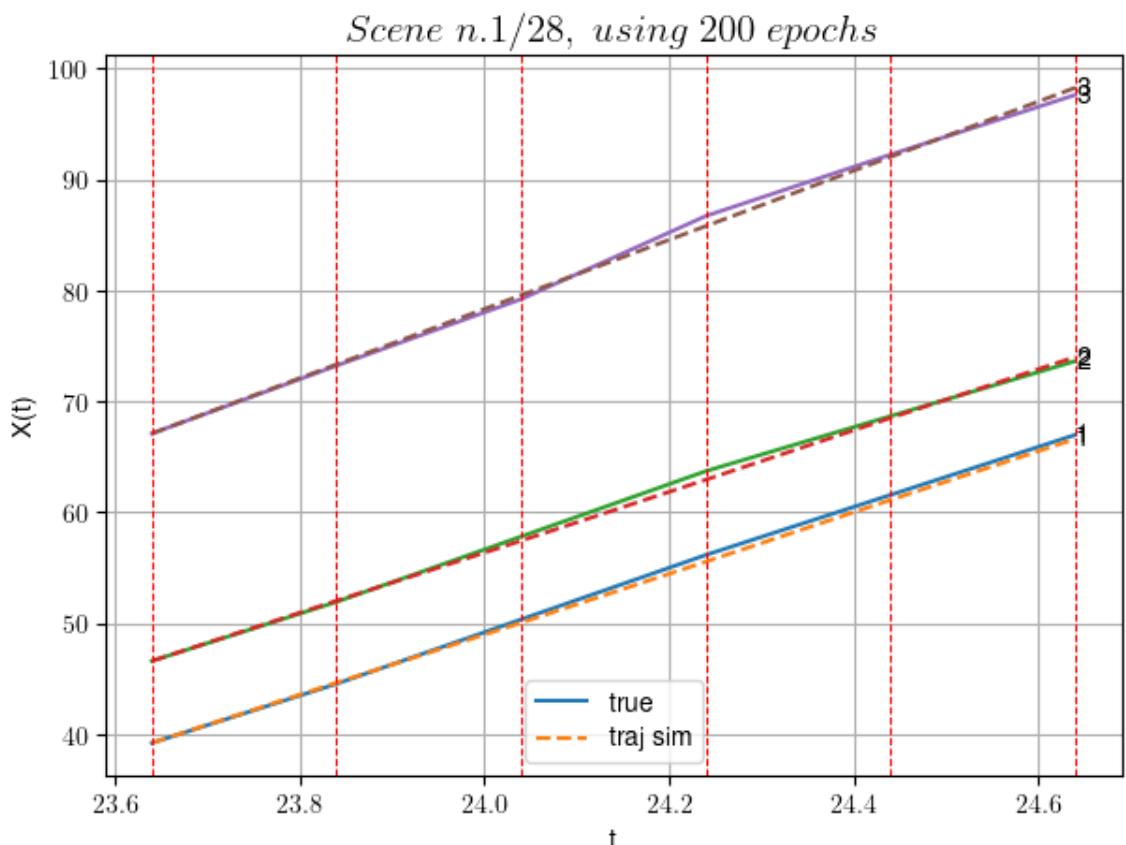
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Scene n.1/28, time interval:[23.64,24.64]

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Loss: 0.17461963417344883  
v0 updated: 31.183120056293088

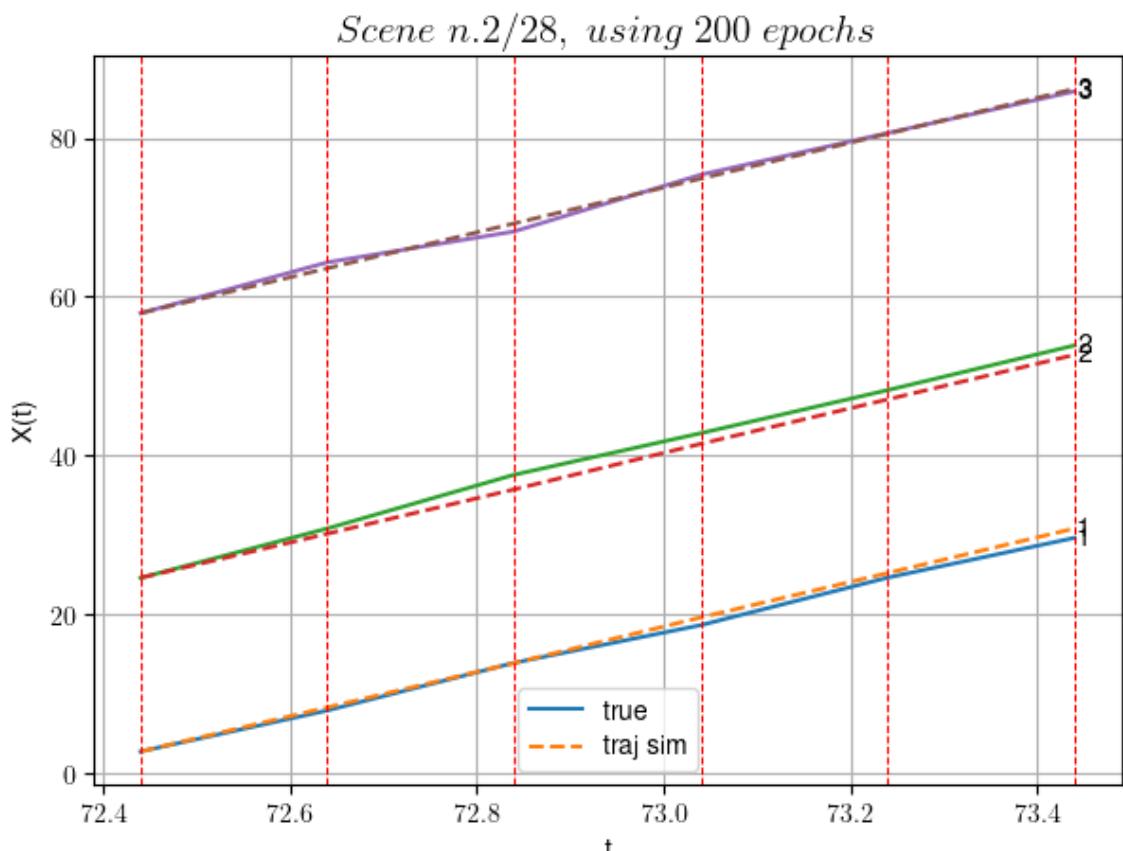
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Scene n.2/28, time interval:[72.44,73.44]

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Loss: 0.7298870677744008  
v0 updated: 28.25284108639968

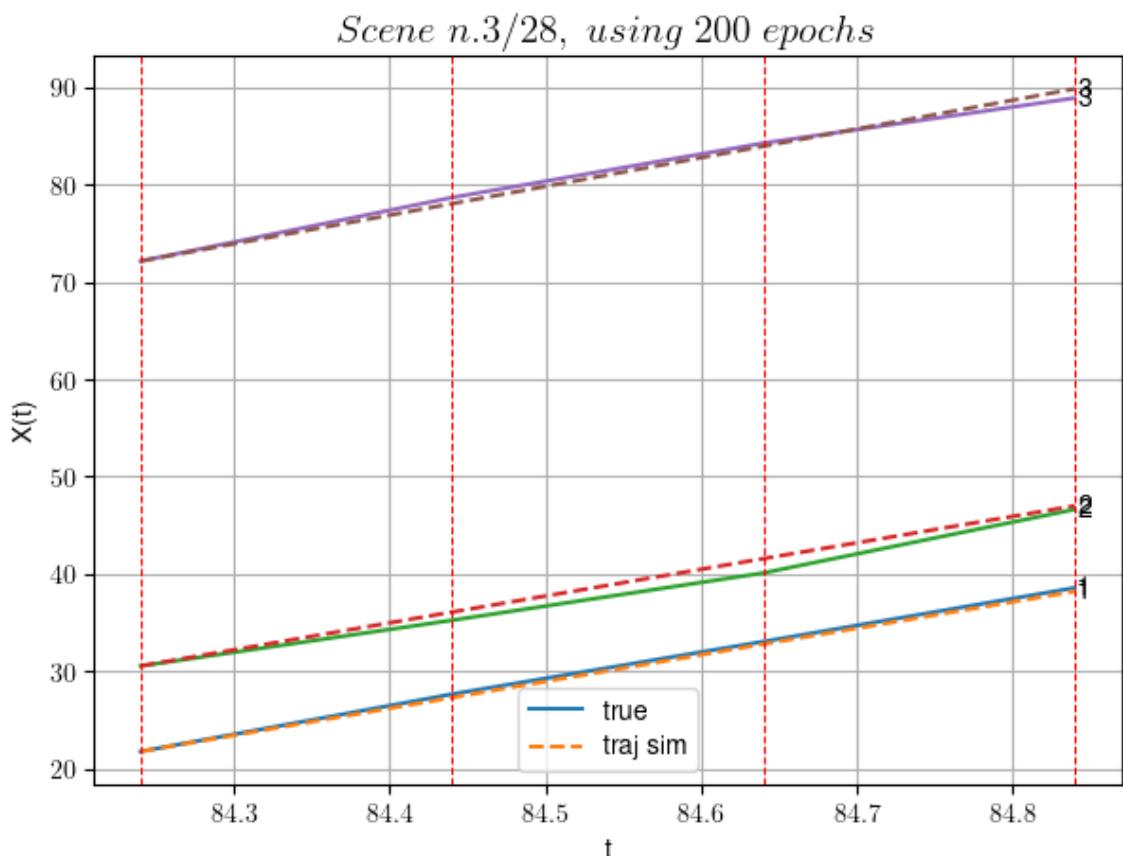
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Scene n.3/28, time interval:[84.24,84.84]

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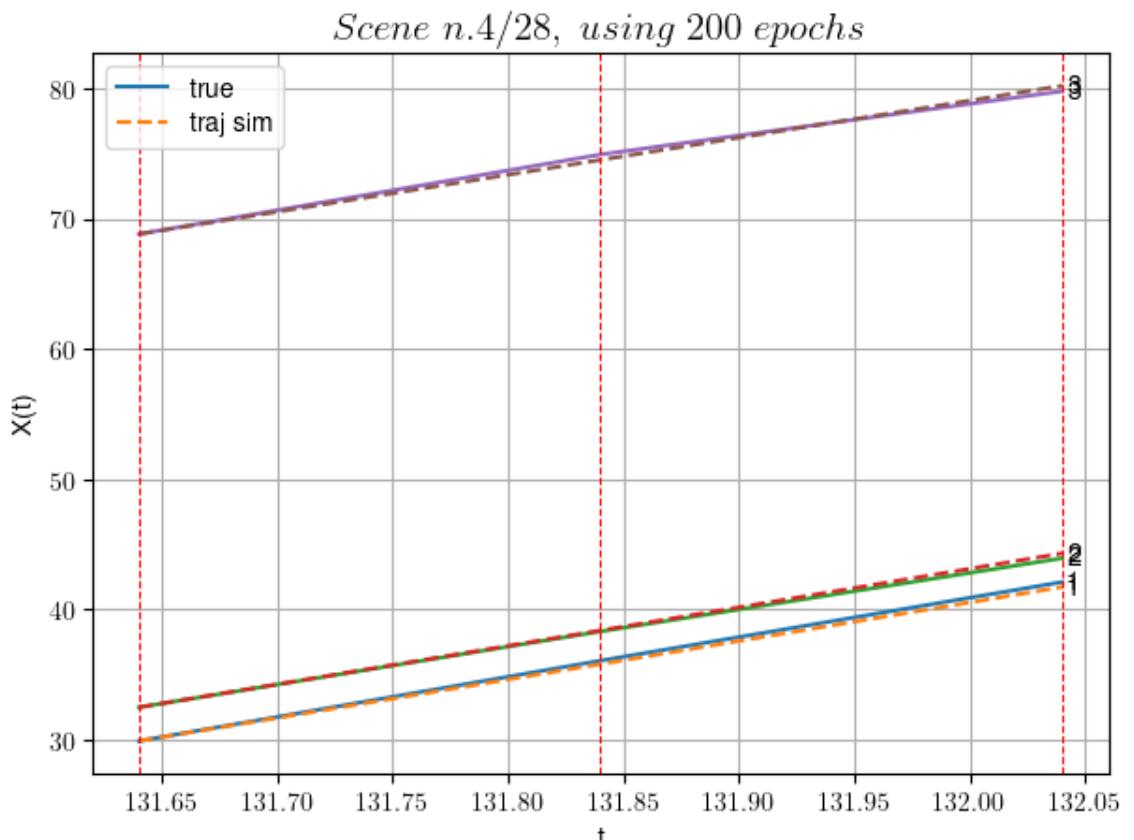


Loss: 0.3949290128852662  
v0 updated: 29.49492078688976

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Scene n.4/28, time interval:[131.64,132.04]

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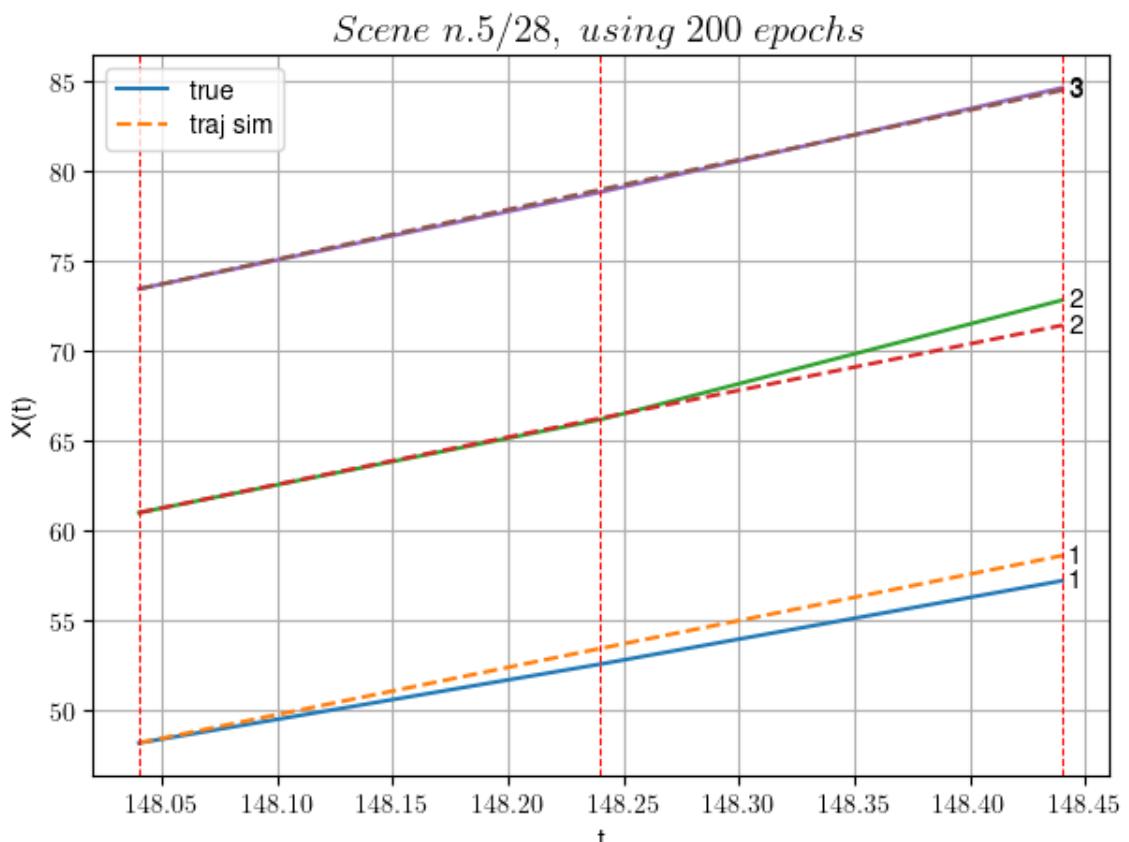


Loss: 0.07871141595235909  
v0 updated: 28.44460242678685

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Scene n.5/28, time interval:[148.04,148.44]

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Loss: 0.5249261951740155  
v0 updated: 27.624268173797052

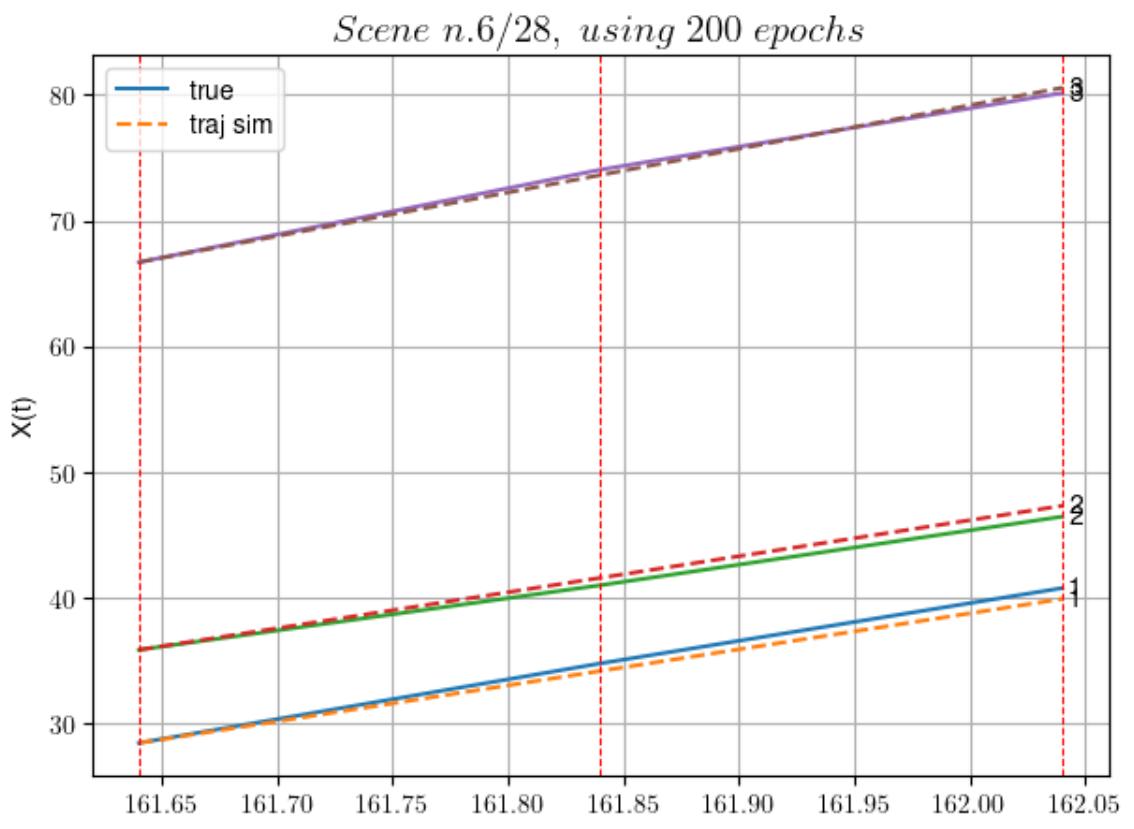
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Scene n.6/28, time interval:[161.64,162.04]

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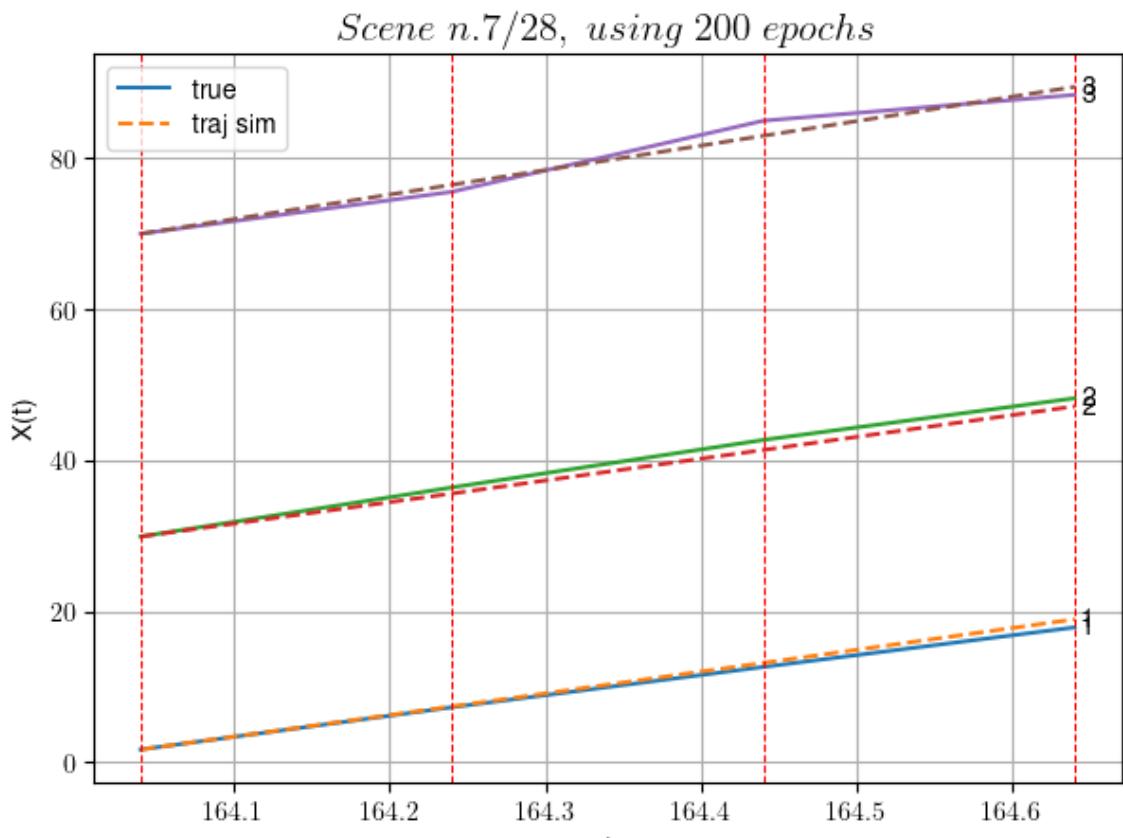


Loss: 0.2837752361202915  
v0 updated: 34.70664156222626

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Scene n.7/28, time interval:[164.04,164.64]

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Loss: 0.9151555496824949  
v0 updated: 32.430179643519104

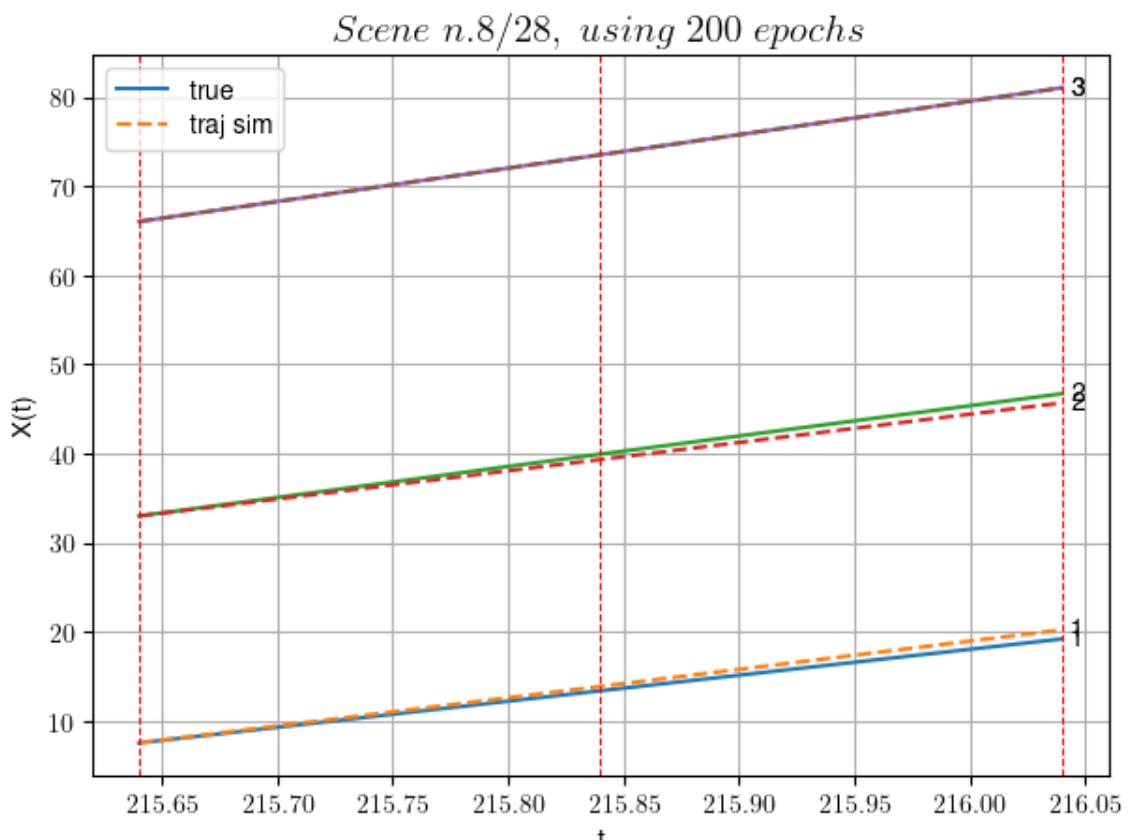
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Scene n.8/28, time interval:[215.64,216.04]

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Loss: 0.302065580810477  
v0 updated: 37.47556118388204

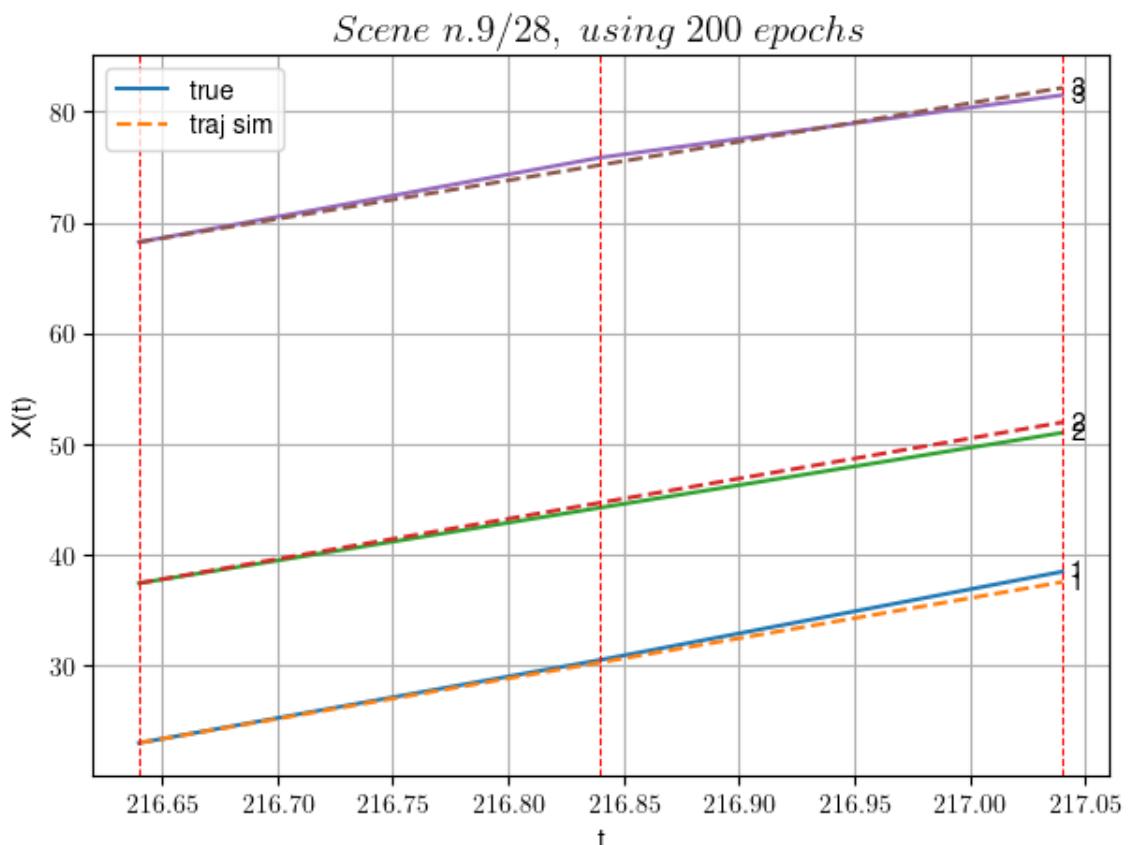
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Scene n.9/28, time interval:[216.64,217.04]

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Loss: 0.3231894646886742  
v0 updated: 34.84649774220546

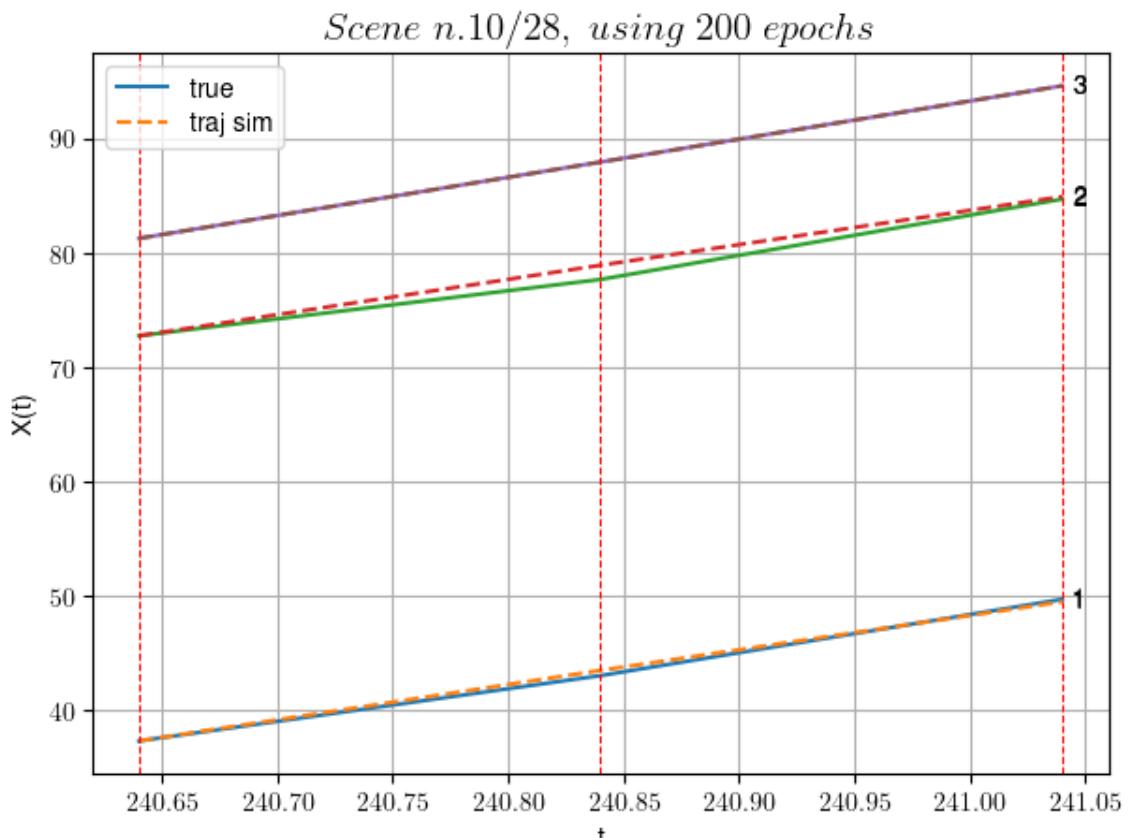
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Scene n.10/28, time interval:[240.64,241.04]

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Loss: 0.20491069866610293  
v0 updated: 33.34109723927839

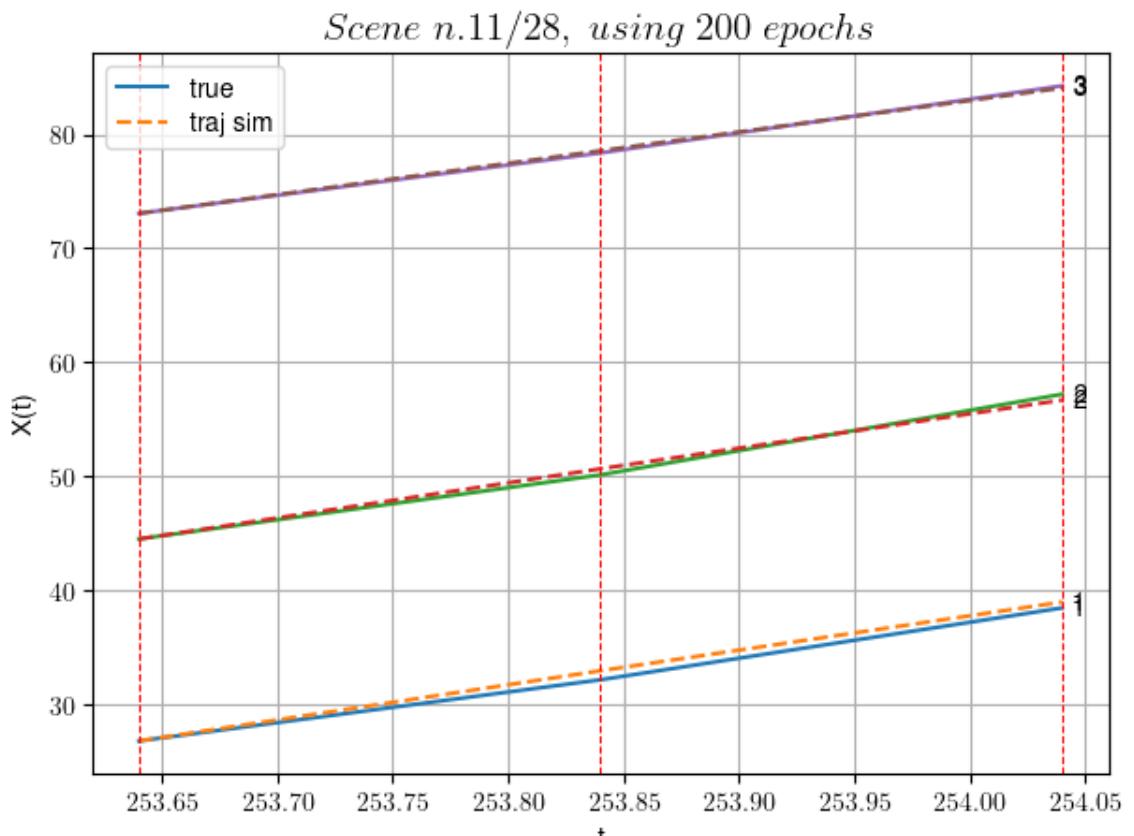
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Scene n.11/28, time interval:[253.64,254.04]

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Loss: 0.16907673672324064  
v0 updated: 27.47765219817996

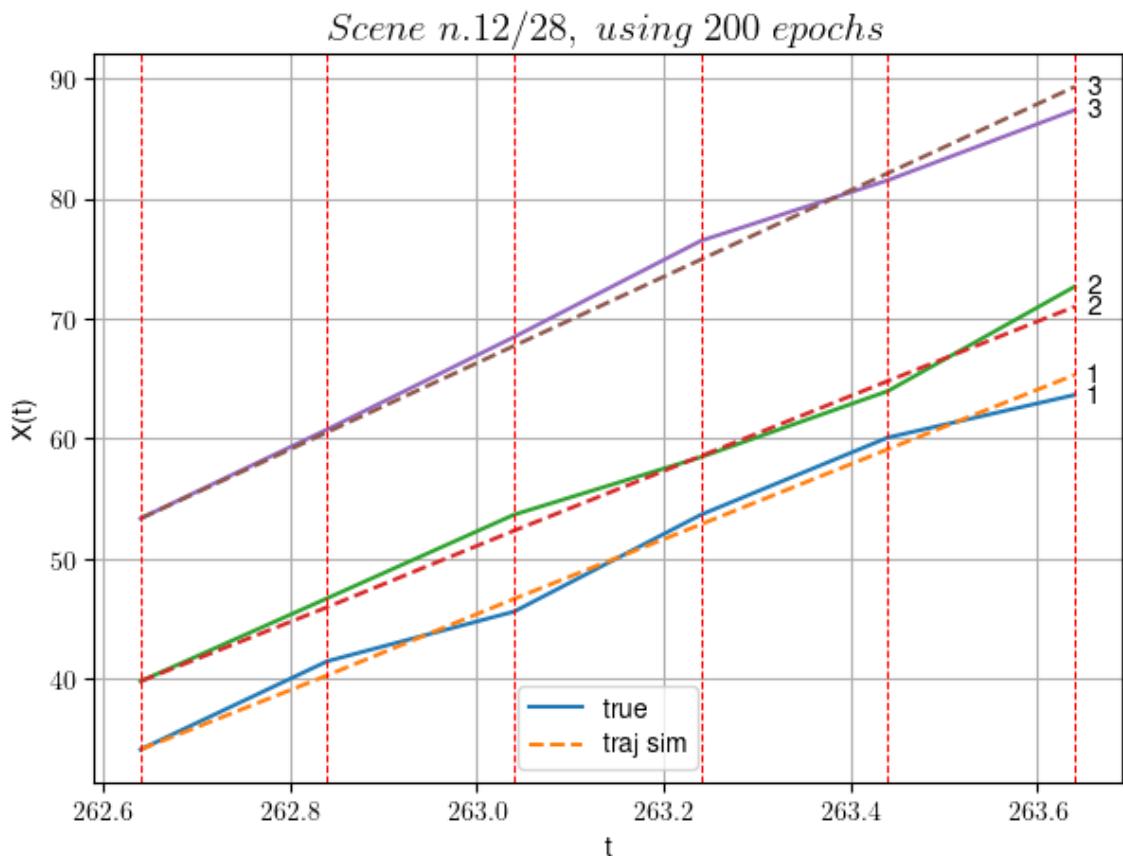
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Scene n.12/28, time interval:[262.64,263.64]

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Loss: 1.0973169648481684  
v0 updated: 35.92458500353821

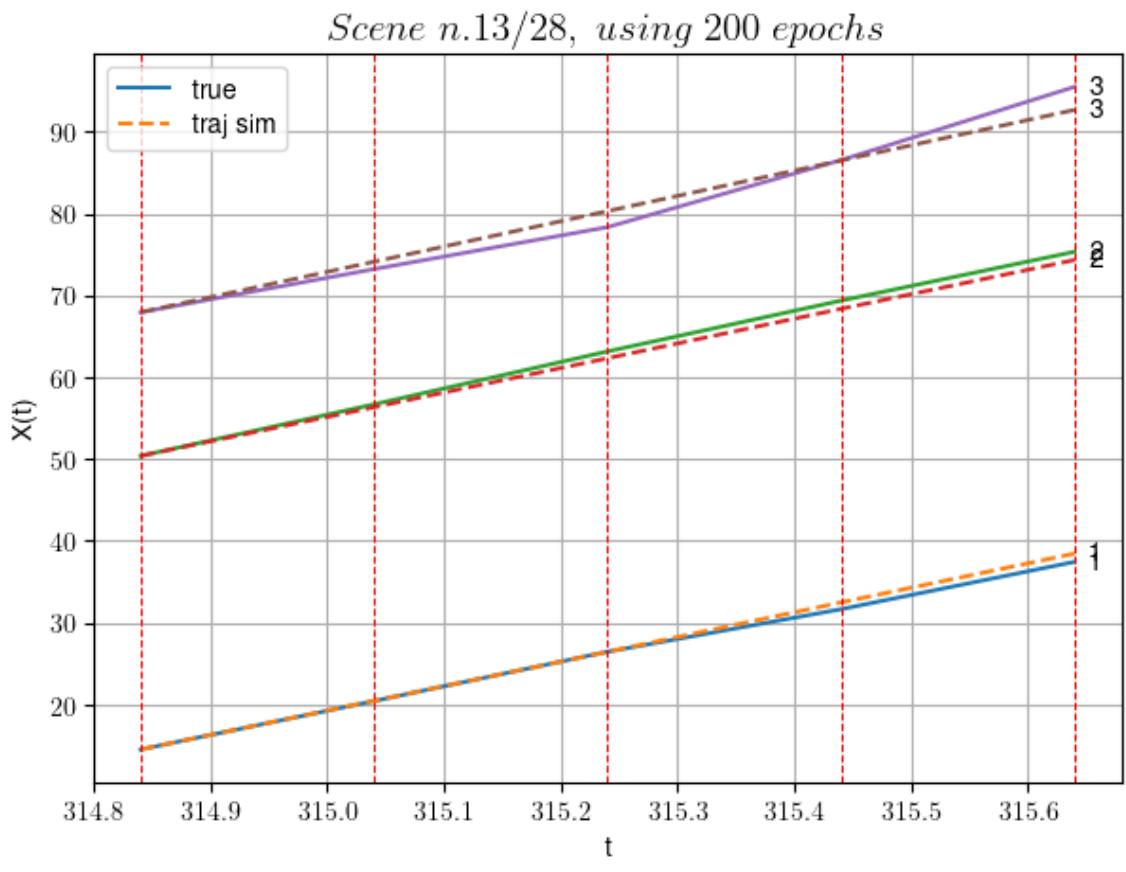
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Scene n.13/28, time interval:[314.84,315.64]

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Loss: 1.144361511143767  
v0 updated: 30.925230826449667

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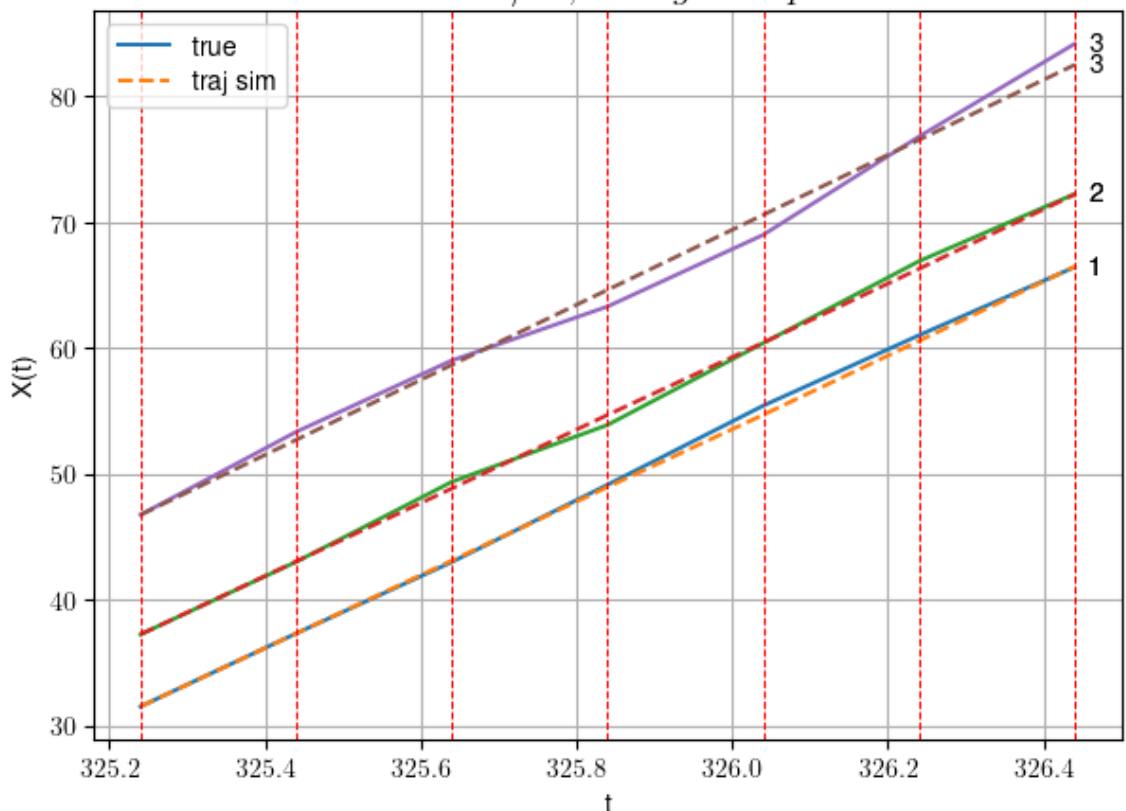
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Scene n.14/28, time interval:[325.24,326.44]

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Scene n.14/28, using 200 epochs

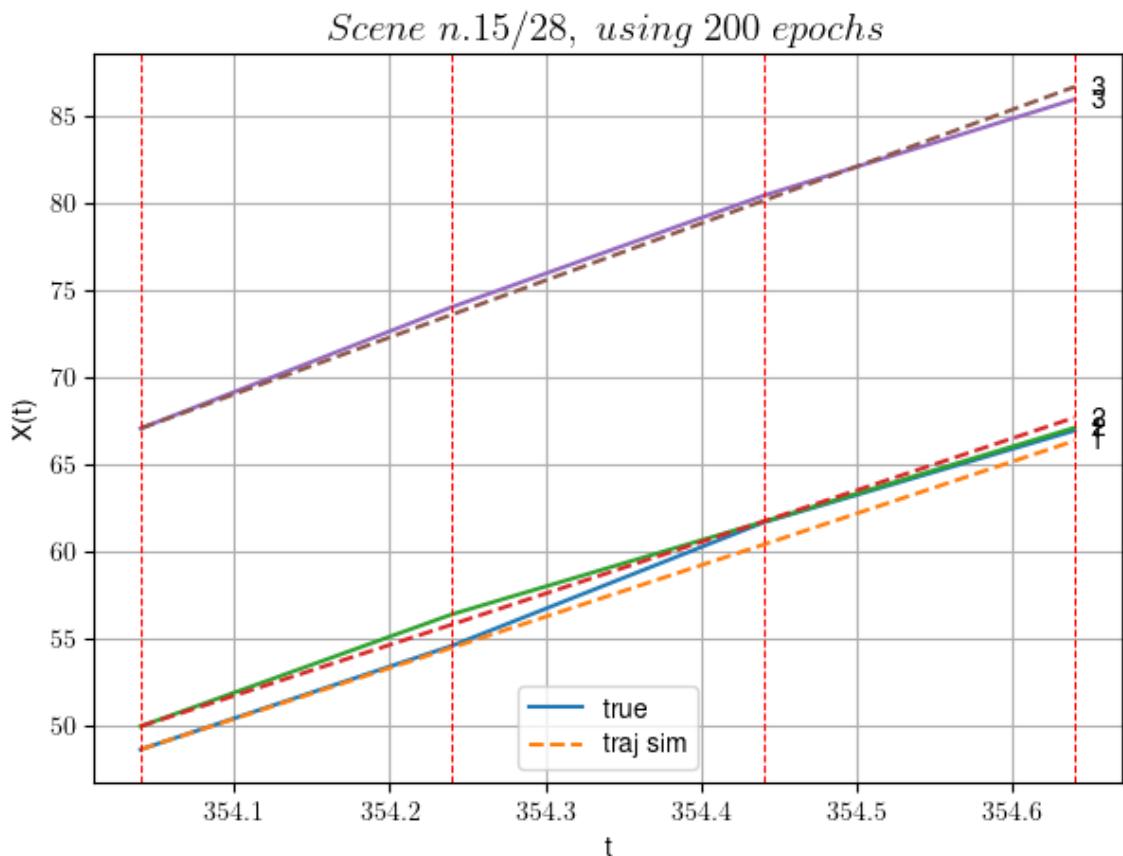


Loss: 0.46231104335713535  
v0 updated: 29.804248983551886

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Scene n.15/28, time interval:[354.04,354.64]

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Loss: 0.2872588004147127  
v0 updated: 32.690564649736196

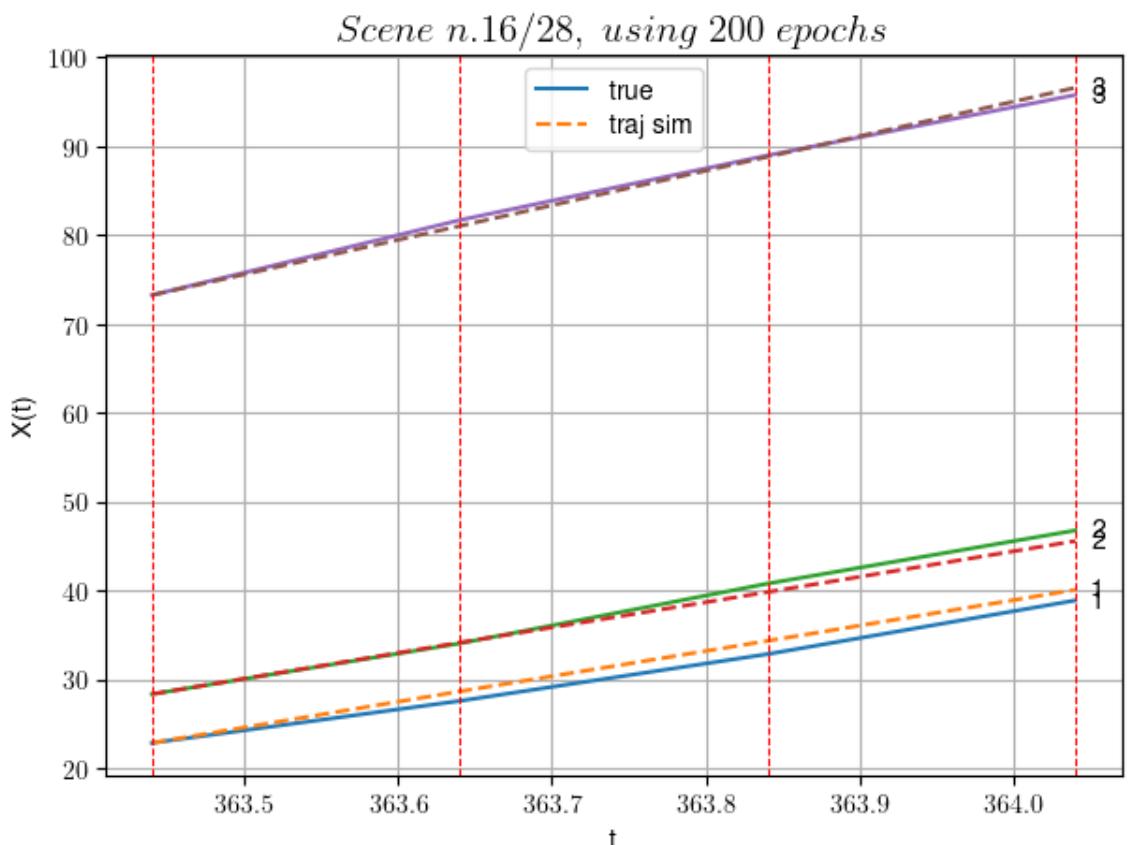
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Scene n.16/28, time interval:[363.44,364.04]

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Loss: 0.6882973244249807  
v0 updated: 38.91369632733983

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Scene n.17/28, time interval:[386.64,387.44]

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Loss: 1.0328694510985723  
v0 updated: 39.33583802523491

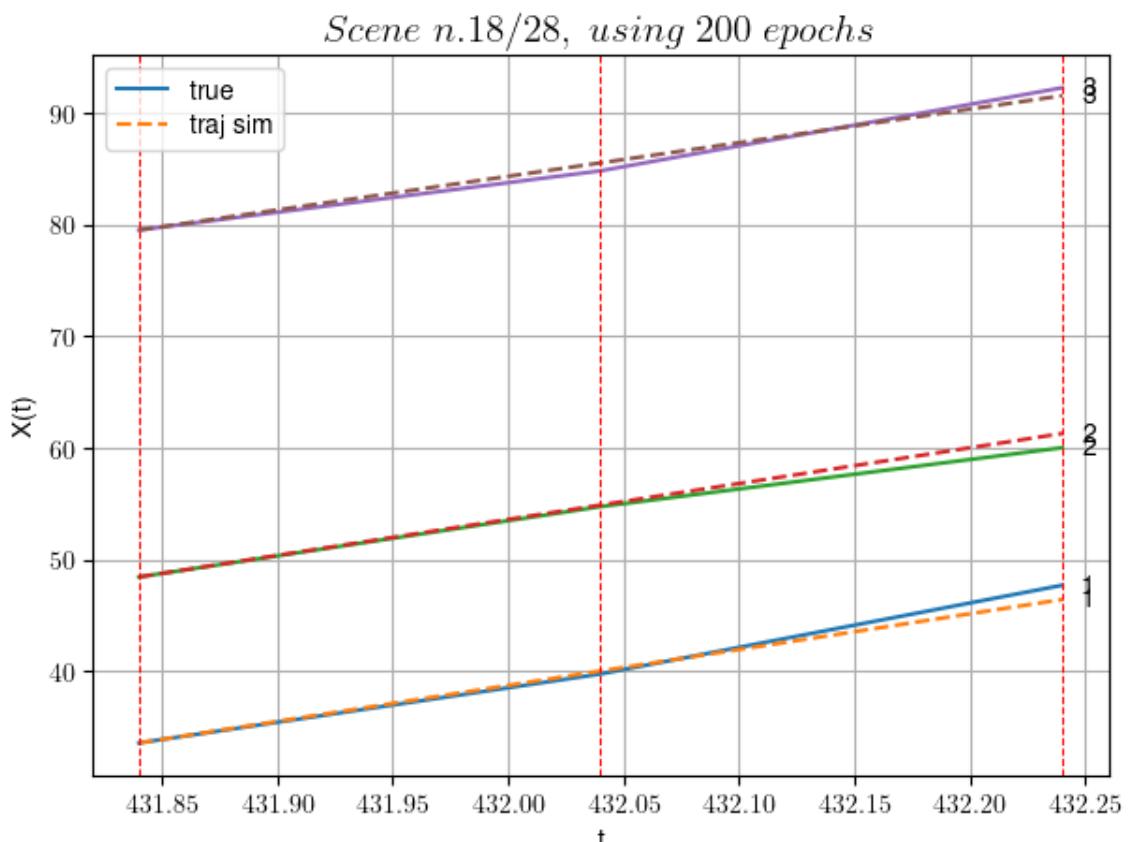
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Scene n.18/28, time interval:[431.84,432.24]

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Loss: 0.48418411872152783  
v0 updated: 30.08406922558775

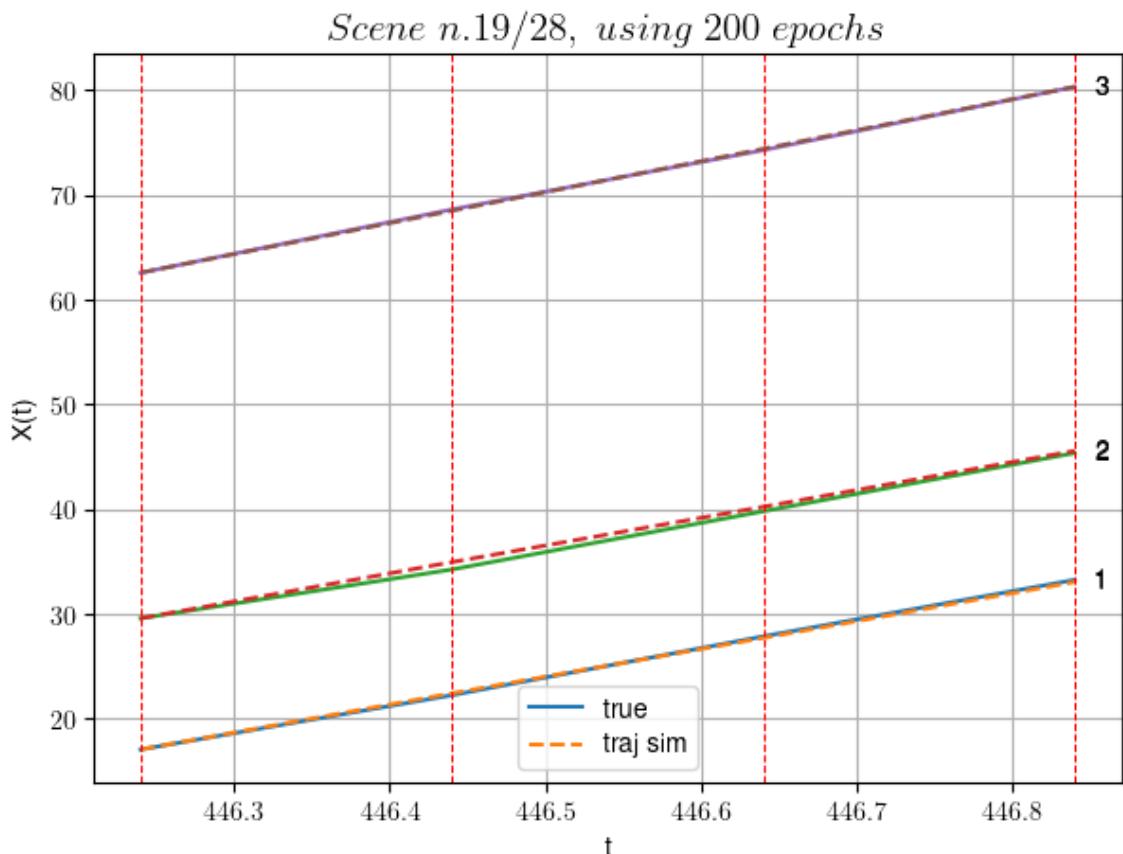
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Scene n.19/28, time interval:[446.24,446.84]

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Loss: 0.07127288365760241  
v0 updated: 29.554918451780917

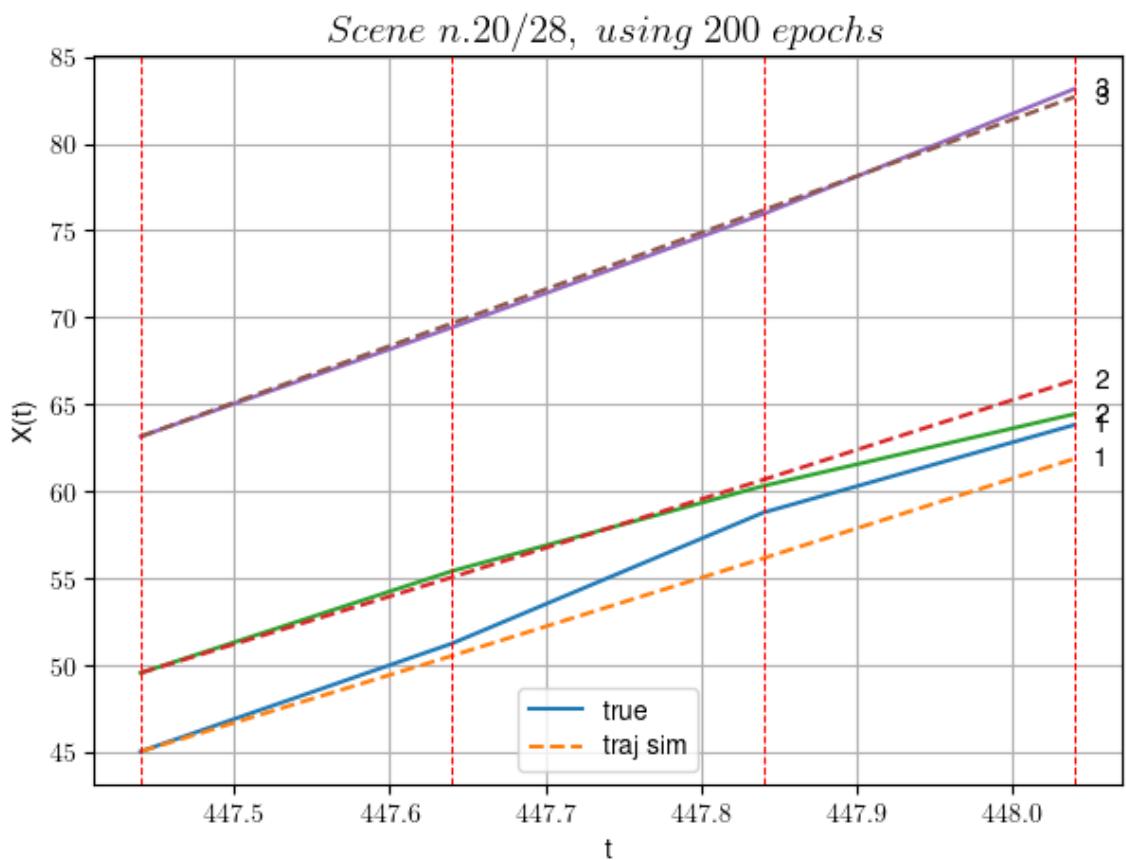
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Scene n.20/28, time interval:[447.44,448.04]

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Loss: 1.299719510871809  
v0 updated: 32.5820218344366

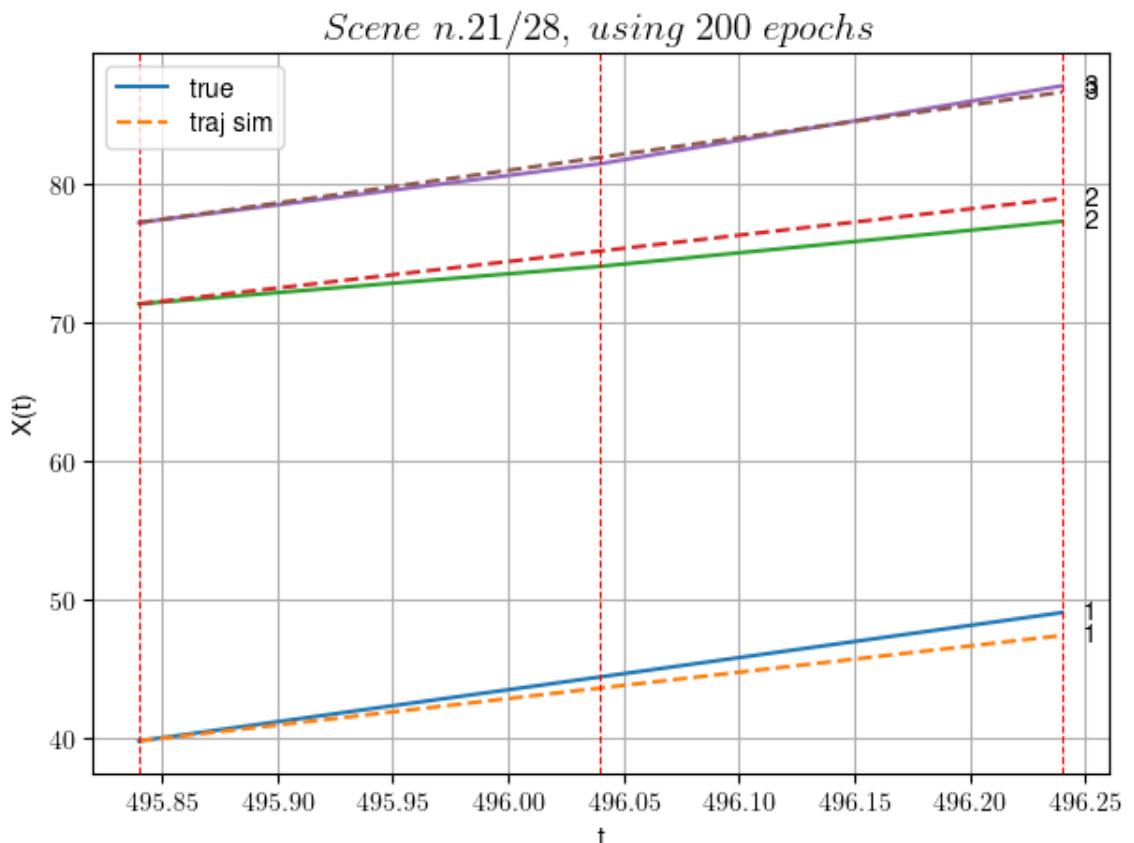
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Scene n.21/28, time interval:[495.84,496.24]

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Loss: 0.8615967009990994  
v0 updated: 23.570161299904782

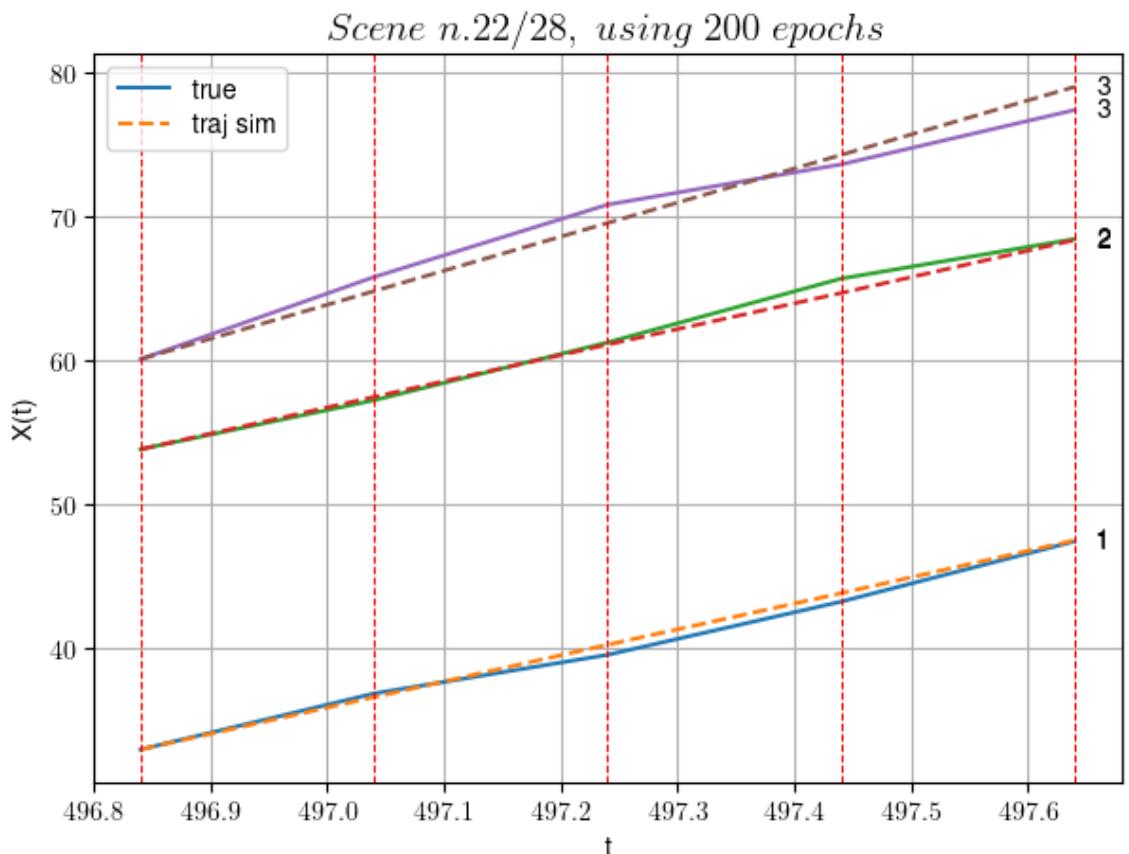
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Scene n.22/28, time interval:[496.84,497.64]

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Loss: 0.5072481926100189  
v0 updated: 23.67797143206563

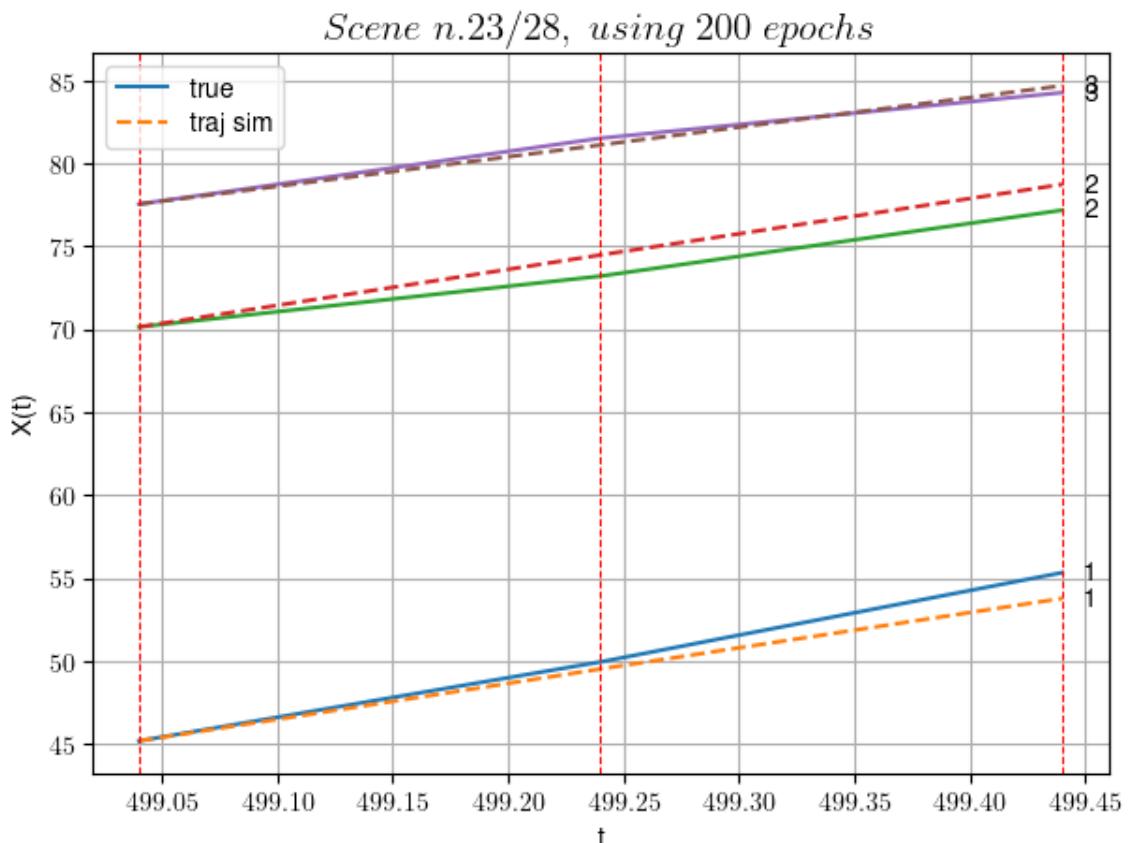
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Scene n.23/28, time interval:[499.04,499.44]

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Loss: 0.7756527367514844  
v0 updated: 17.845523963555102

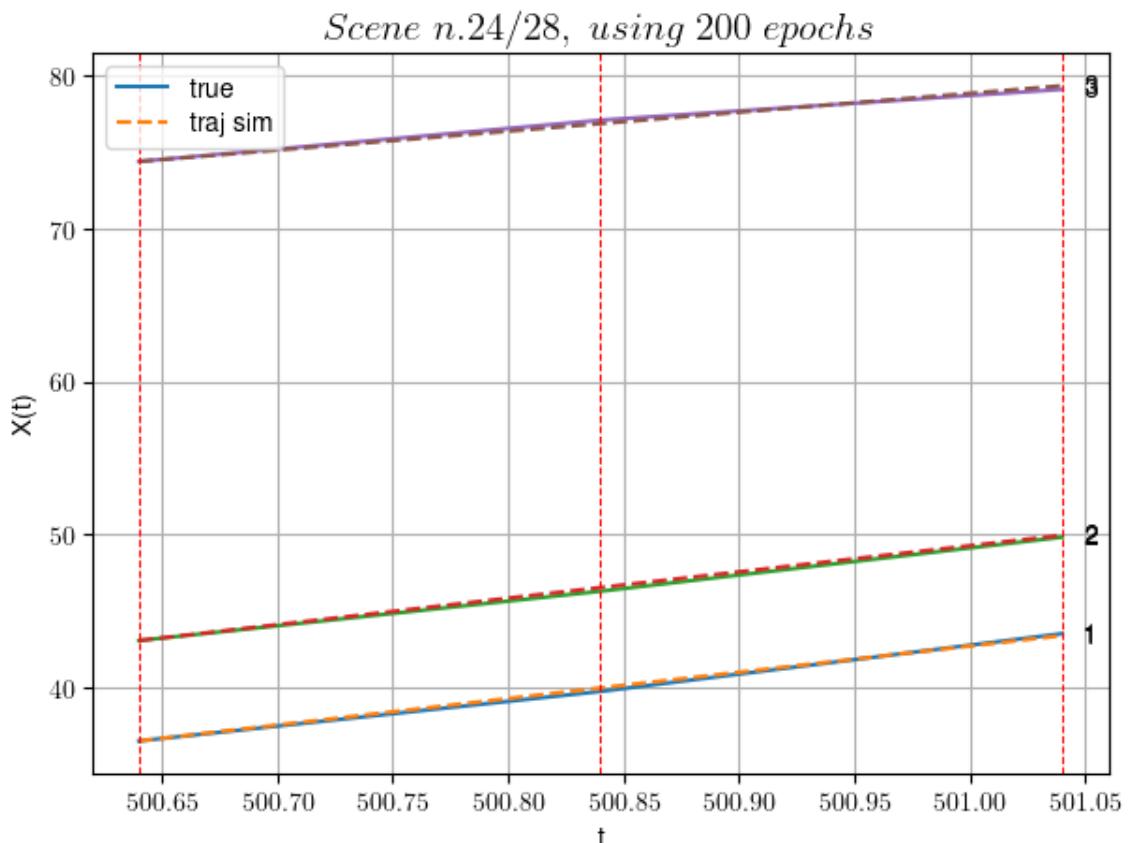
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Scene n.24/28, time interval:[500.64,501.04]

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Loss: 0.028112743979043106  
v0 updated: 12.38073766898182

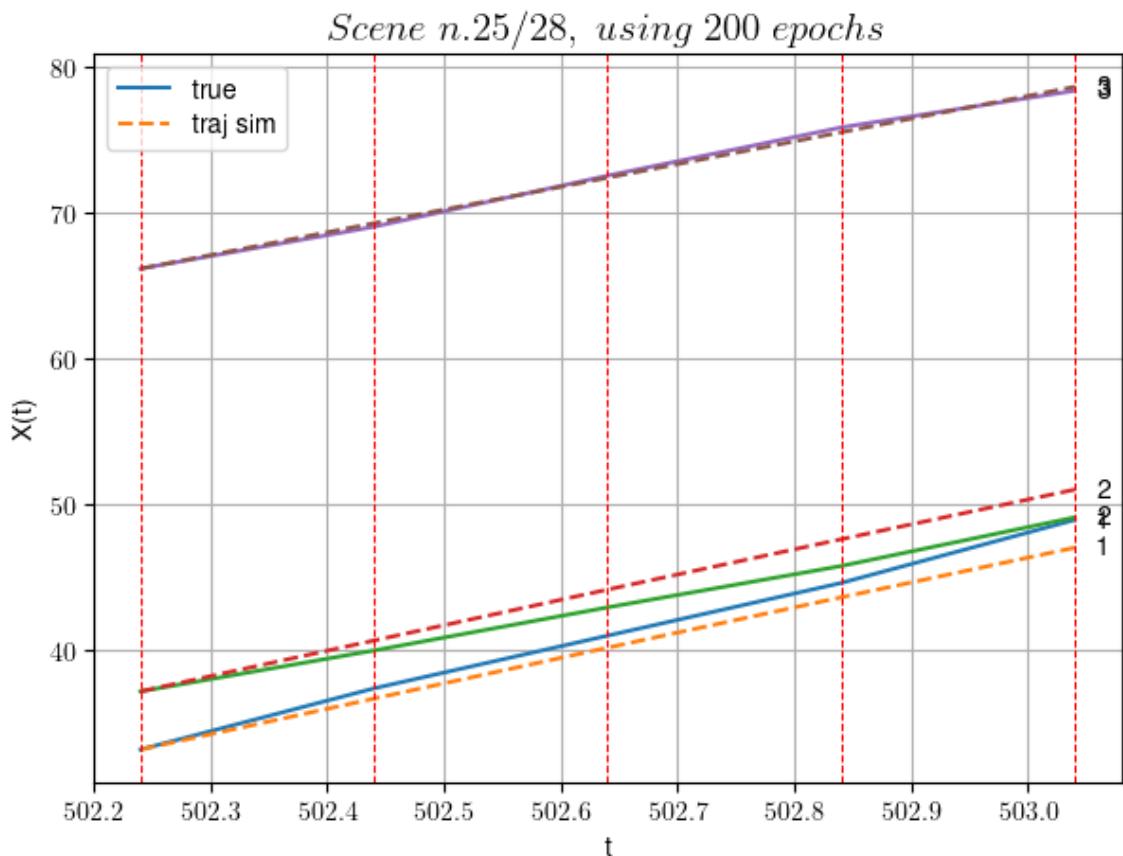
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Scene n.25/28, time interval:[502.24,503.04]

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Loss: 1.000827657226351  
v0 updated: 15.596848958505237

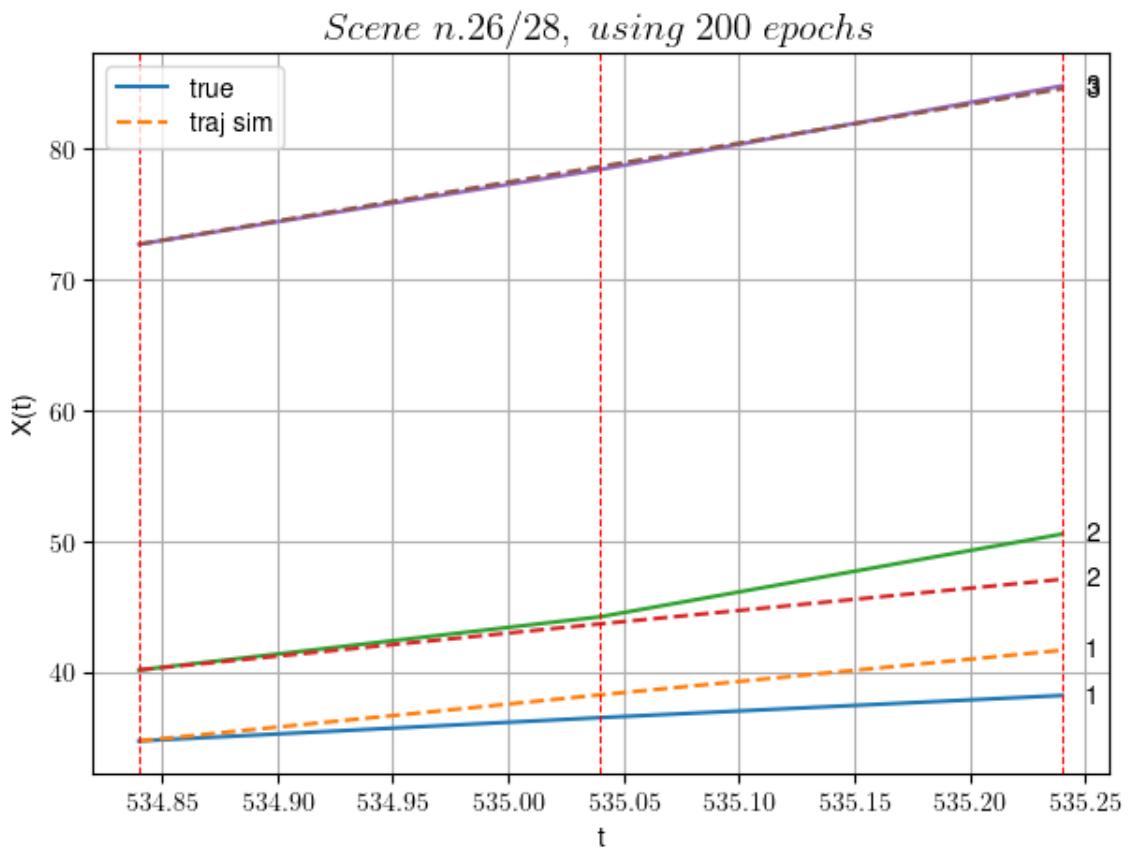
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Scene n.26/28, time interval:[534.84,535.24]

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Loss: 3.0435613296624466  
v0 updated: 29.753753037486266

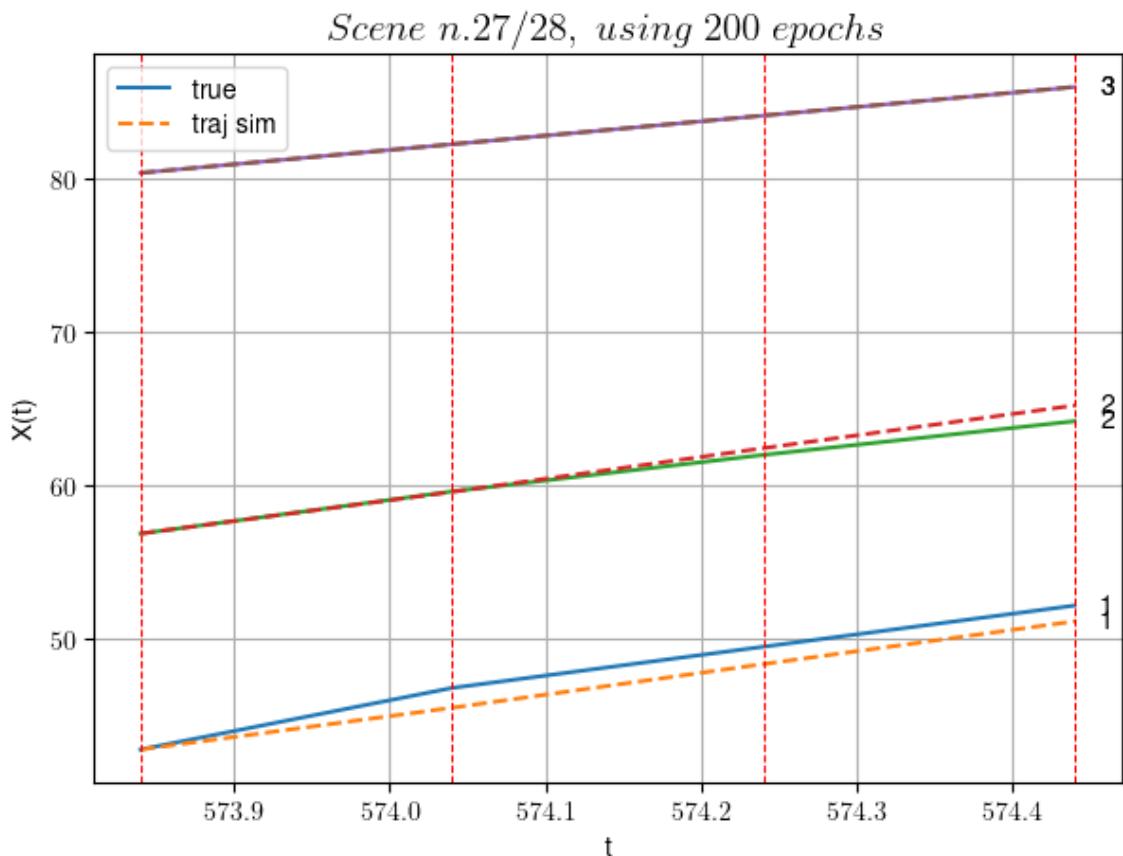
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Scene n.27/28, time interval:[573.84,574.44]

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Loss: 0.43925300230819975  
v0 updated: 9.361406021746825

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v0\_mean in this df is: 28.932693265541598  
Time taken: 144.63s

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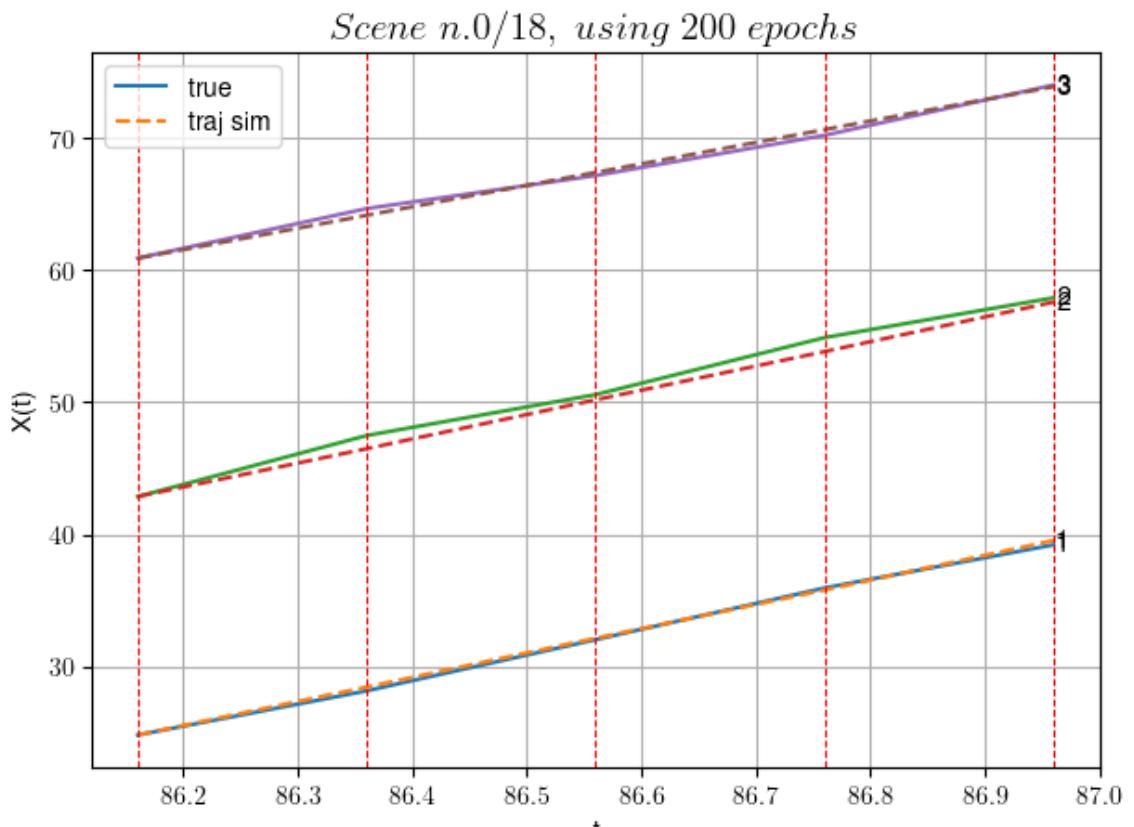
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In df n.2/10 we have 18 scenes

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Scene n.0/18, time interval:[86.16,86.96]

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Loss: 0.20828001171308383  
v0 updated: 16.25044385096199

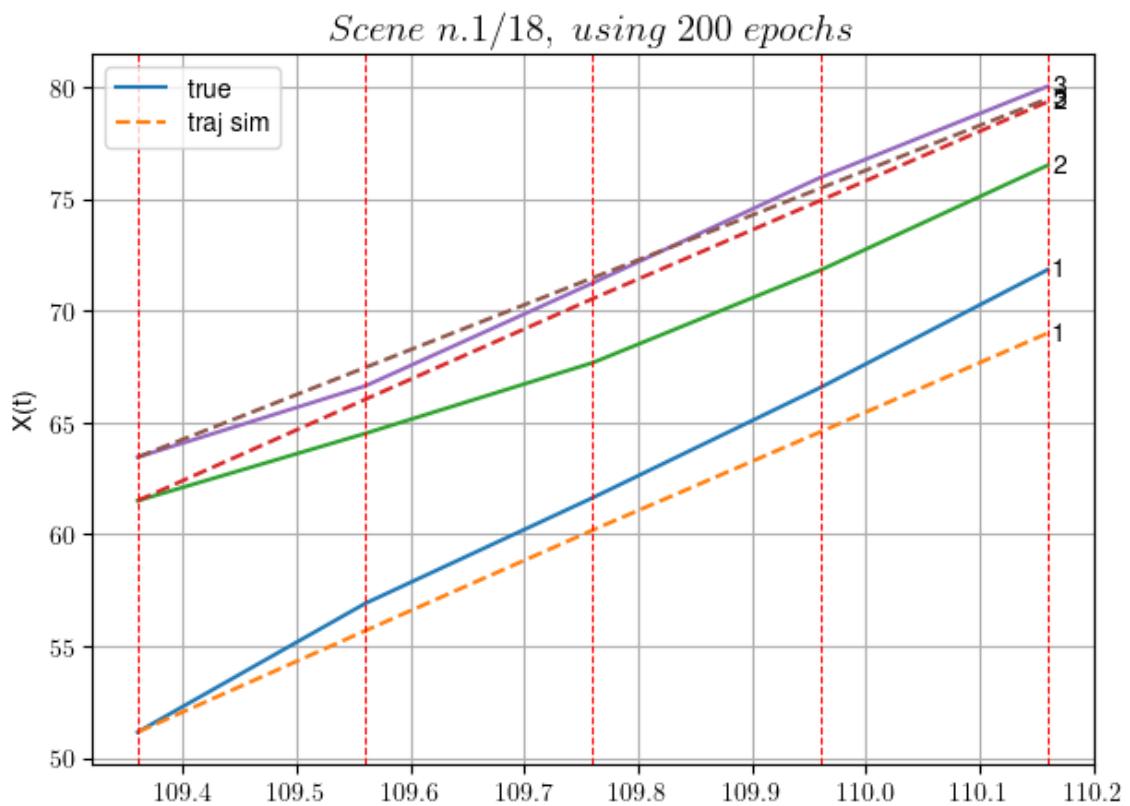
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Scene n.1/18, time interval:[109.36,110.16]

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Loss: 3.0105596170105646  
v0 updated: 20.044801660133817

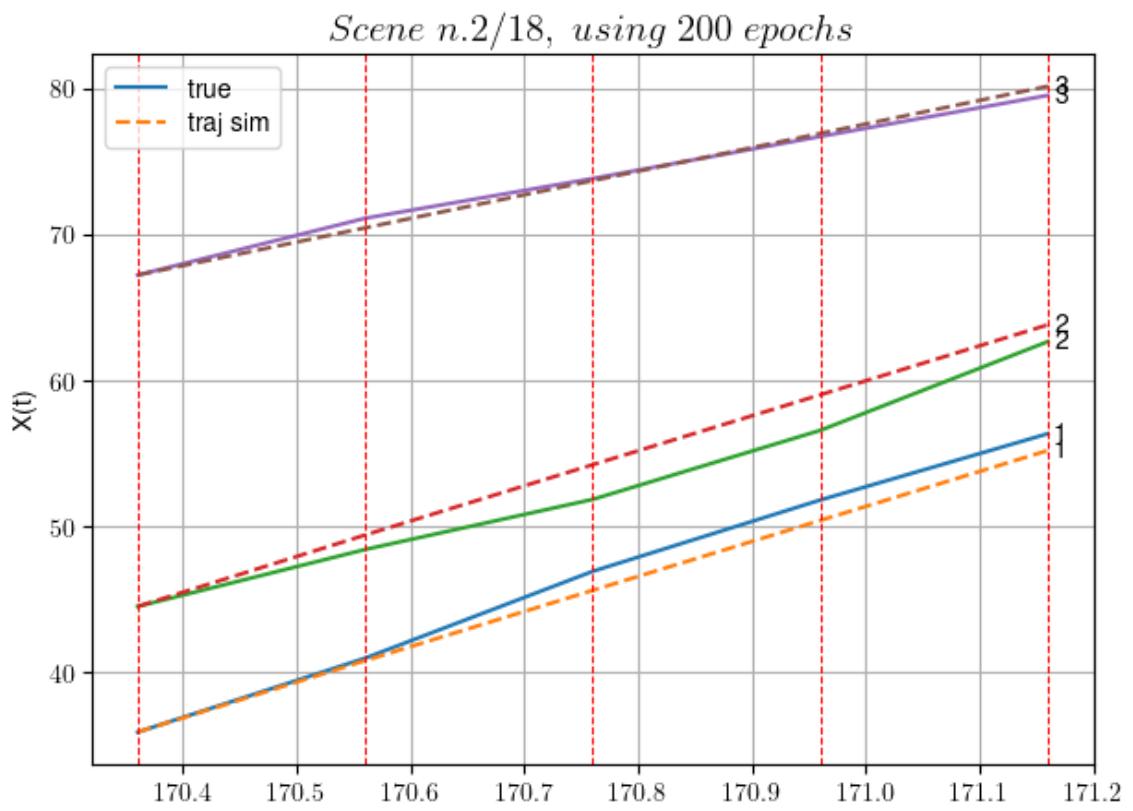
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Scene n.2/18, time interval:[170.36,171.16]

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Loss: 1.3181672877937032  
v0 updated: 16.166815108702973

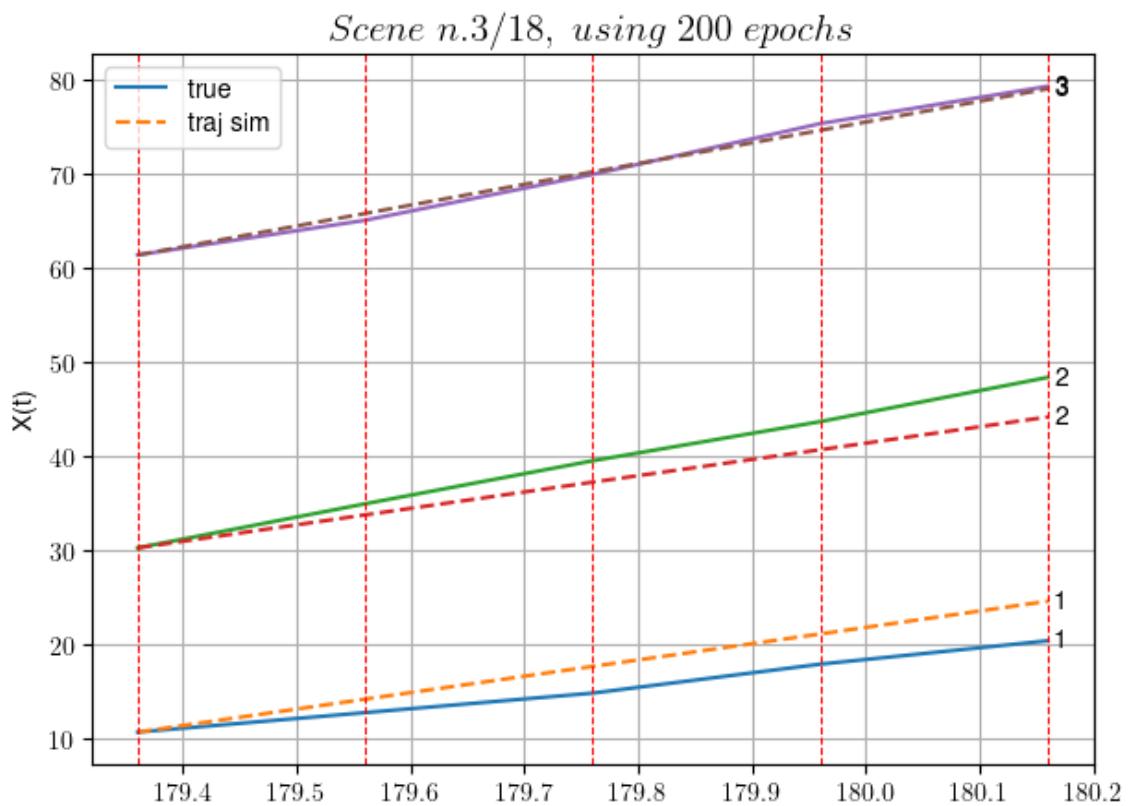
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Scene n.3/18, time interval:[179.36,180.16]

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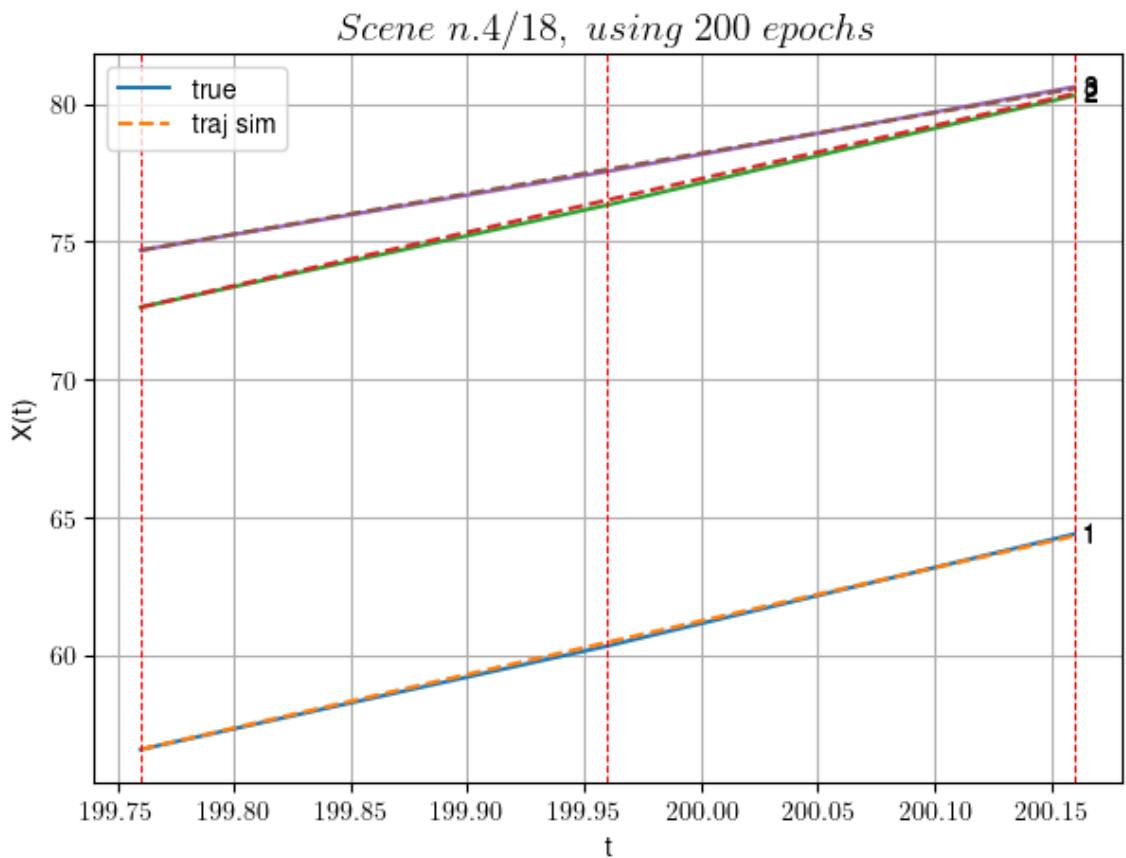
Loss: 4.83559825068946

v0 updated: 22.09069359979243

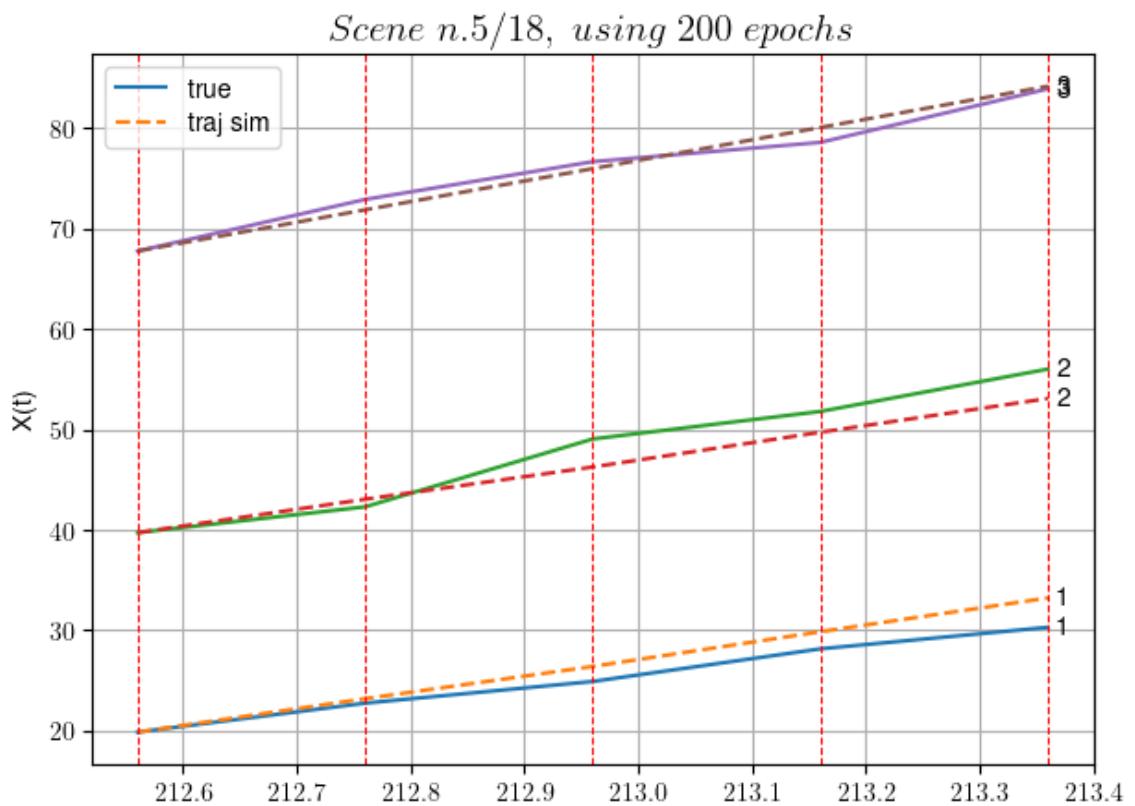
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Scene n.4/18, time interval:[199.76,200.16]

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Scene n.5/18, time interval:[212.56,213.36]



Loss: 2.5984316938181666  
v0 updated: 20.517558612694323

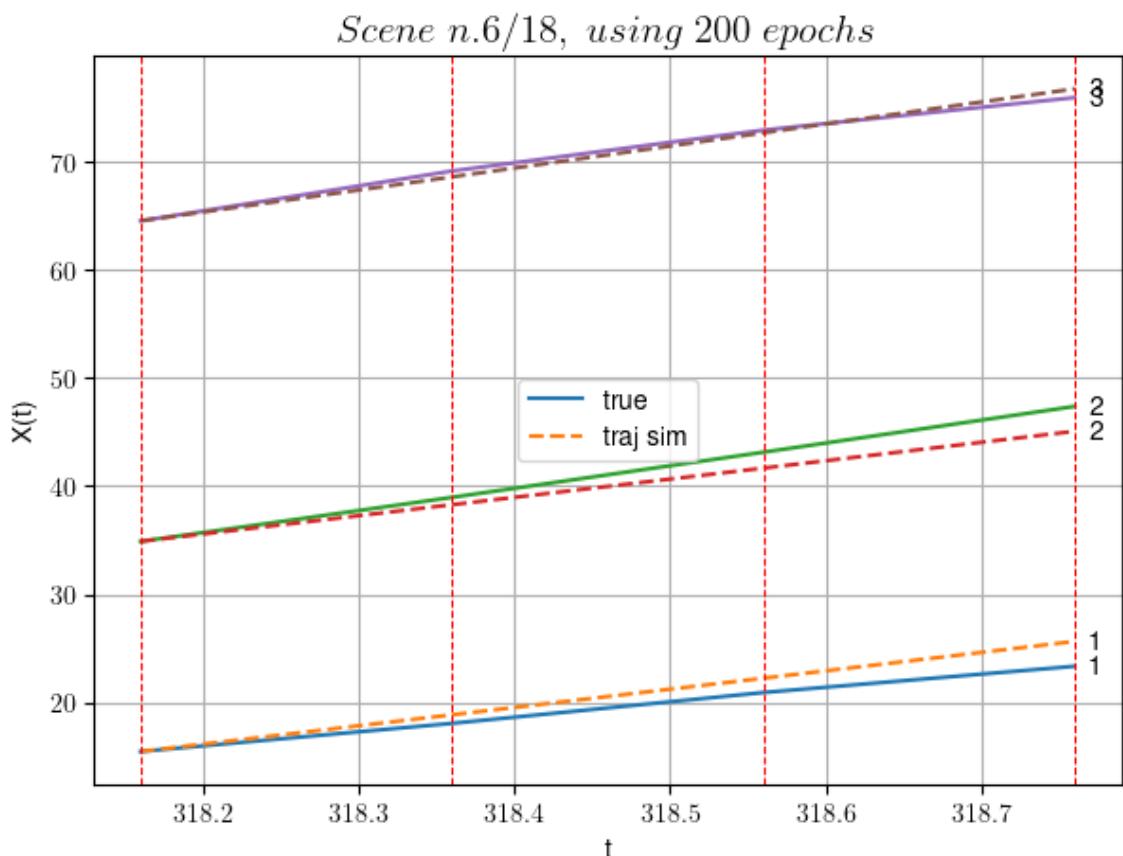
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Scene n.6/18, time interval:[318.16, 318.76]

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Loss: 1.3841498736367717  
v0 updated: 20.365787750550588

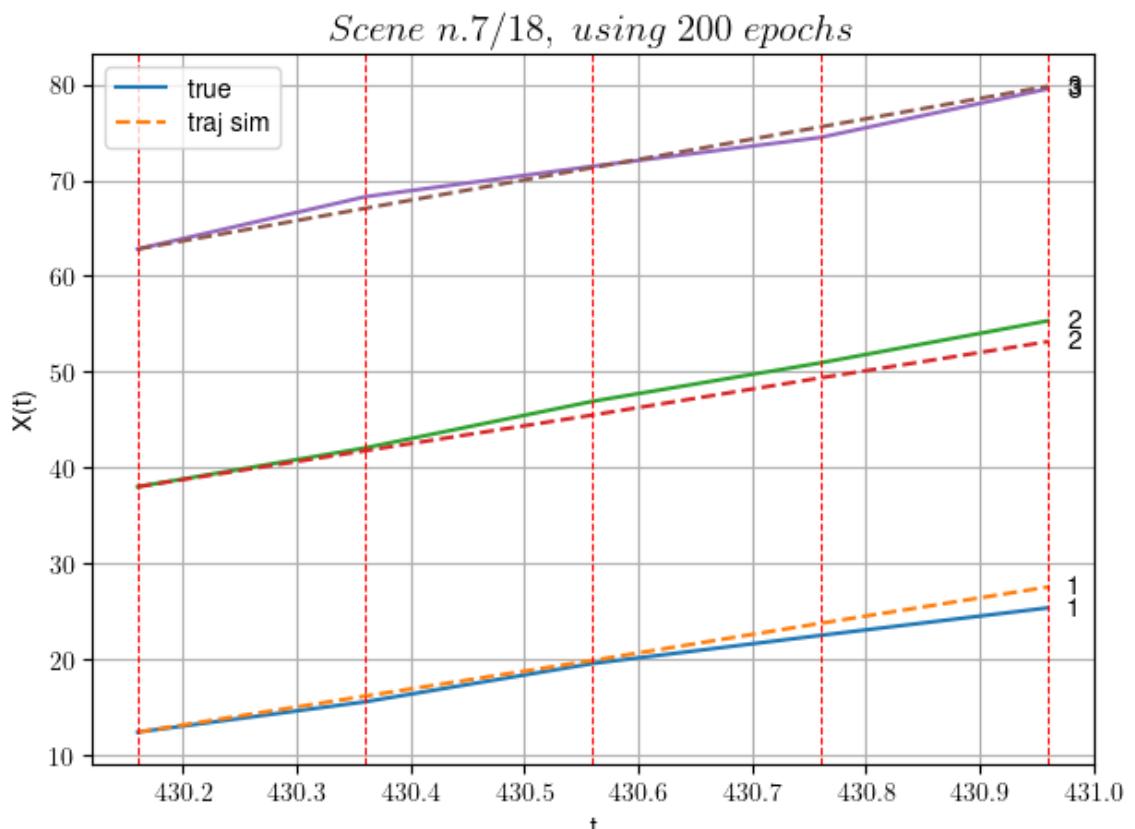
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Scene n.7/18, time interval:[430.16,430.96]

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Loss: 1.2595752219635155  
v0 updated: 21.24652473815916

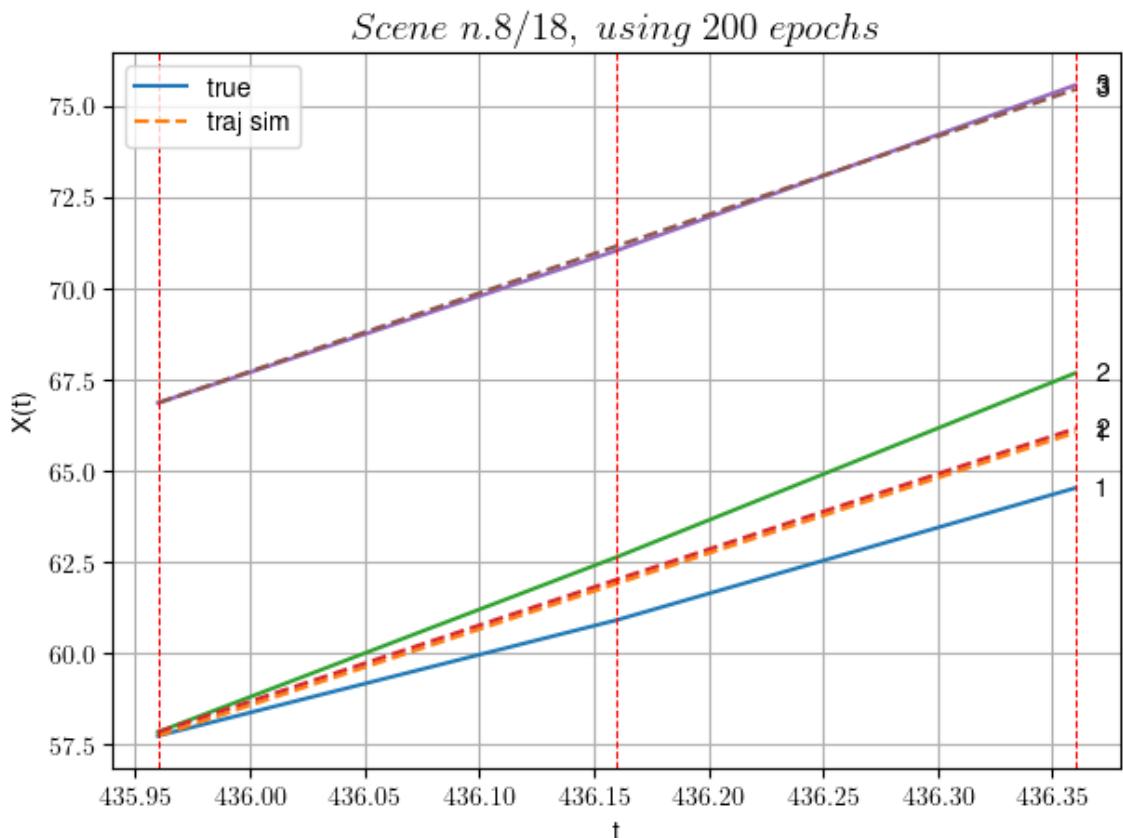
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Scene n.8/18, time interval:[435.96, 436.36]

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Loss: 0.6697702198439889  
v0 updated: 21.468093936591146

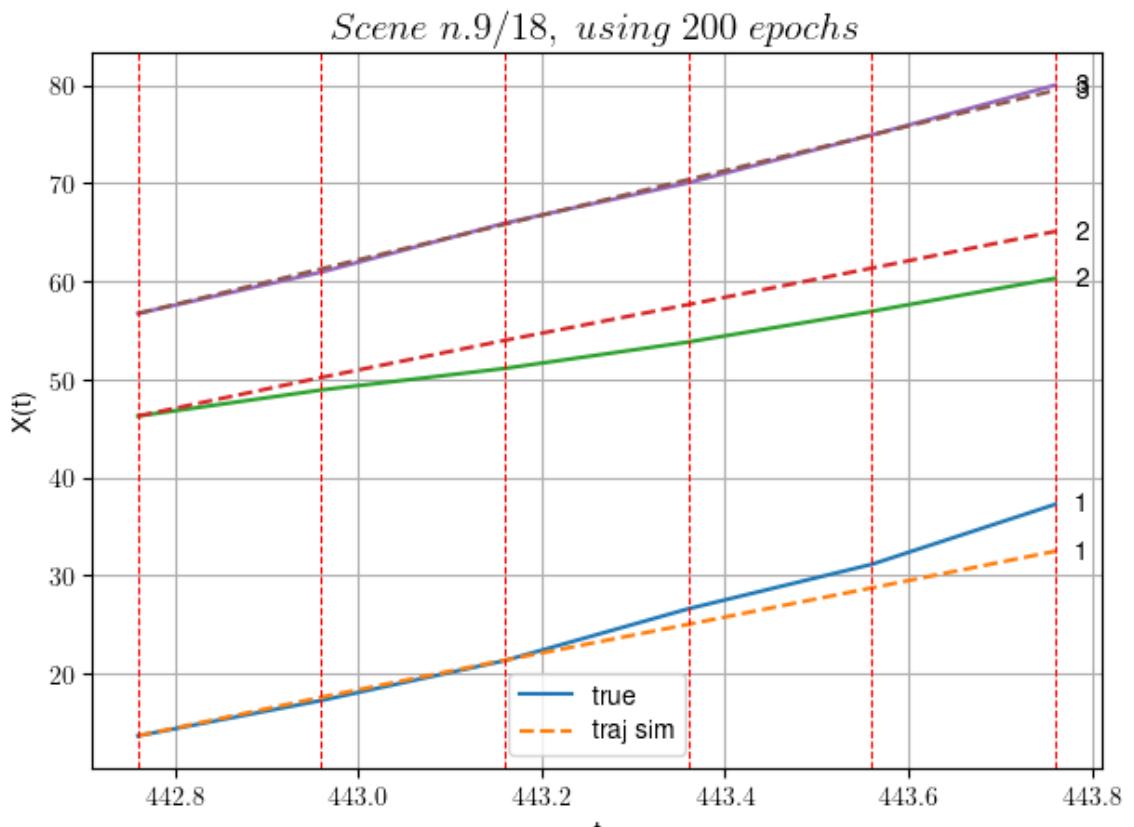
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Scene n.9/18, time interval:[442.76,443.76]

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Loss: 5.474290616104508  
v0 updated: 22.78382896397465

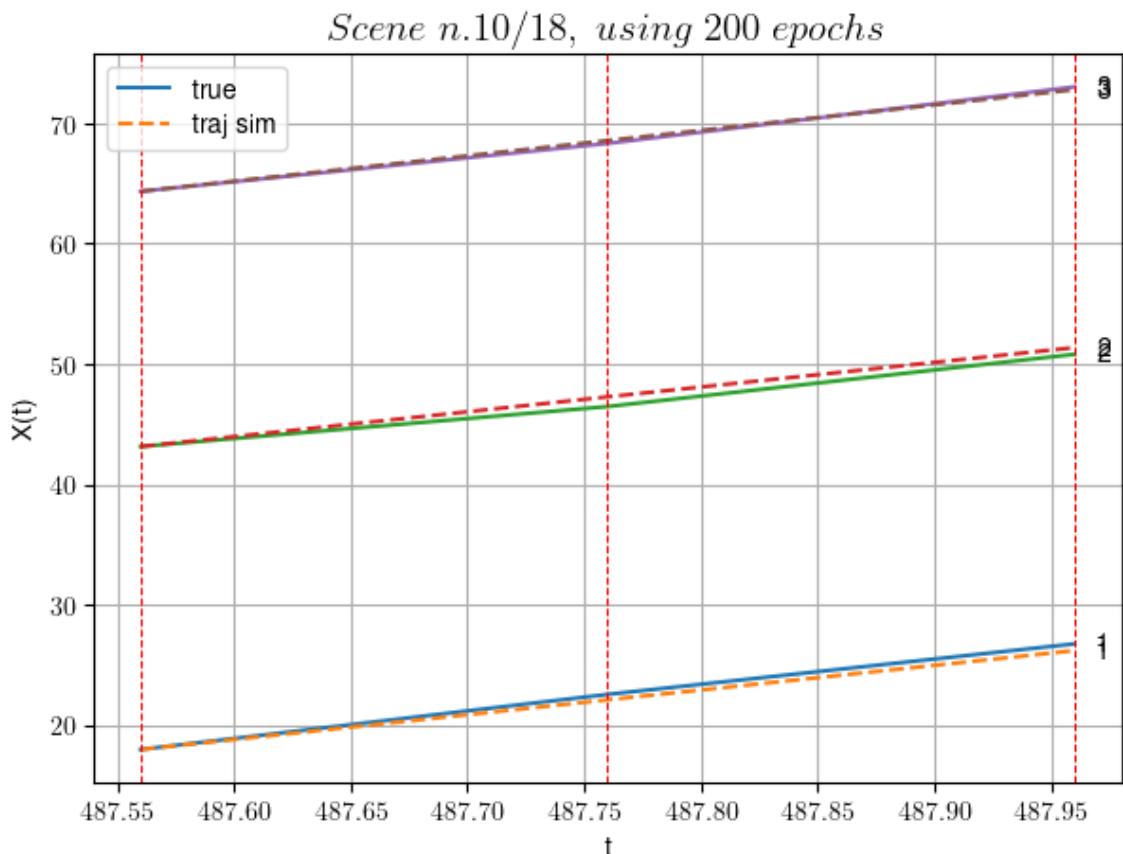
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Scene n.10/18, time interval:[487.56,487.96]

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Loss: 0.177005984282255  
v0 updated: 21.121659499827274

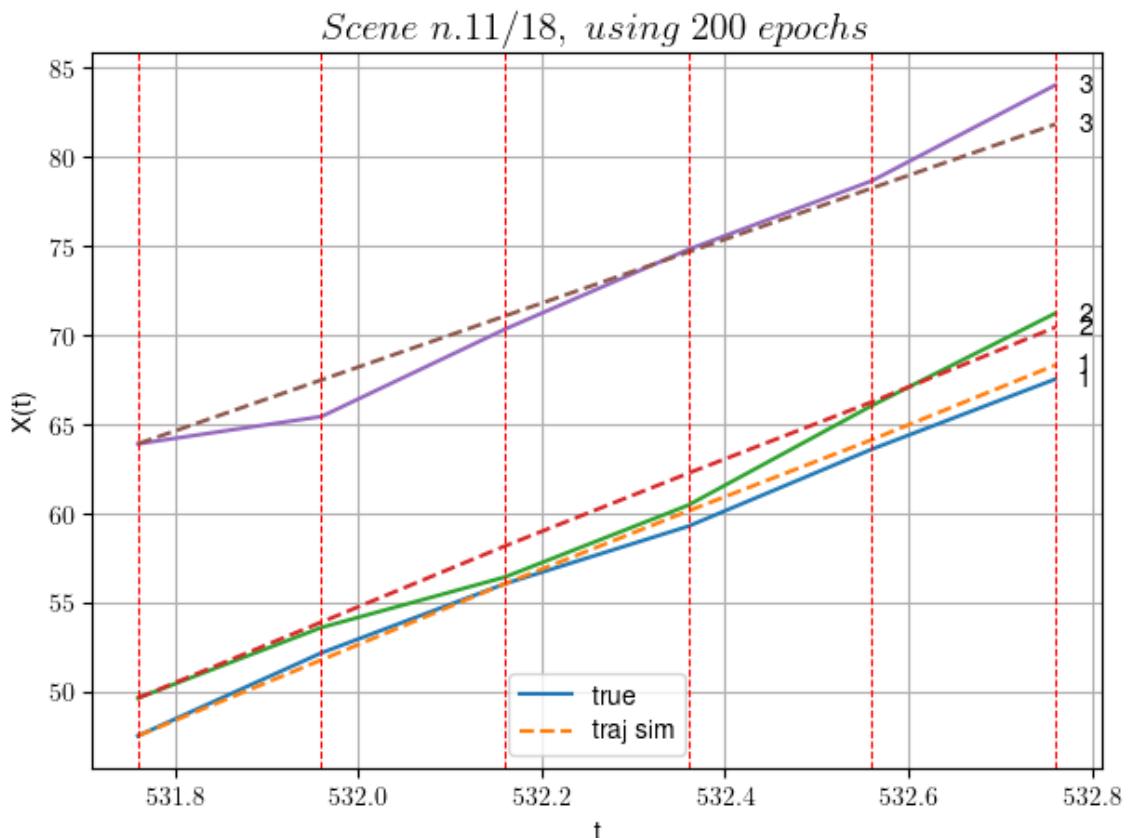
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Scene n.11/18, time interval:[531.76,532.76]

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Loss: 1.0324202917620846  
v0 updated: 17.92500440798753

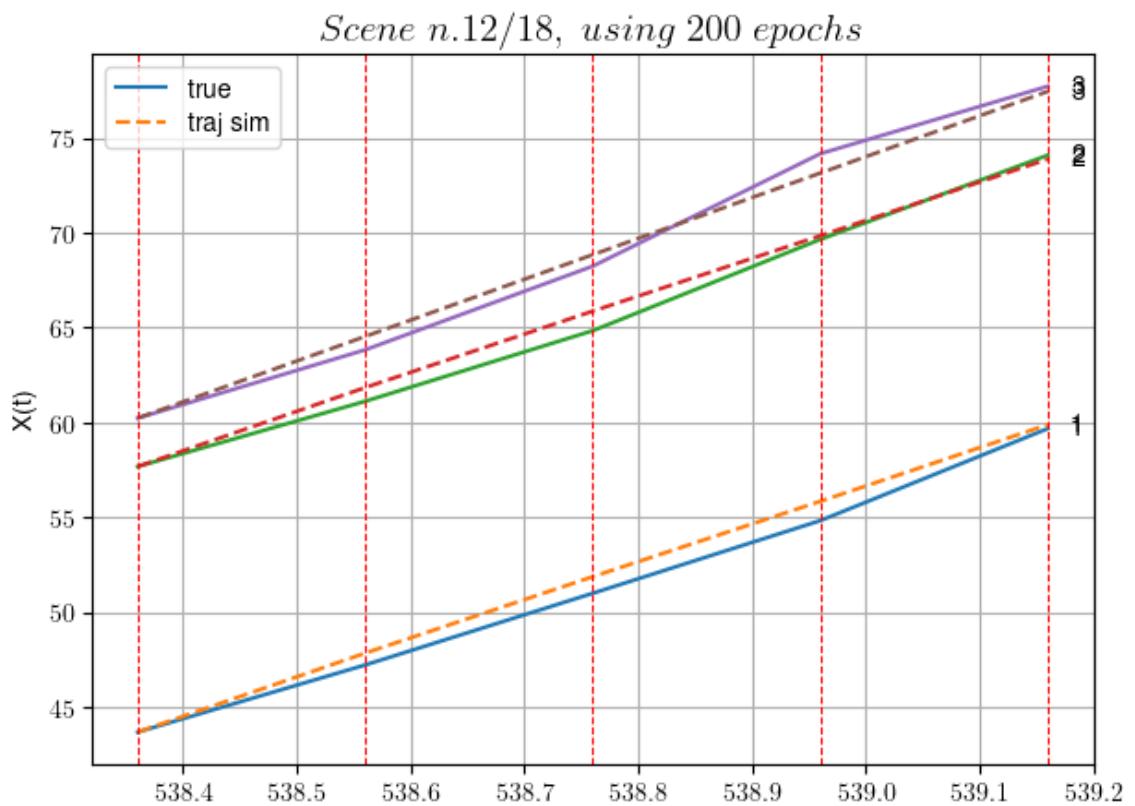
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Scene n.12/18, time interval:[538.36,539.16]

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Loss: 0.39122765425387085  
v0 updated: 21.528181738872128

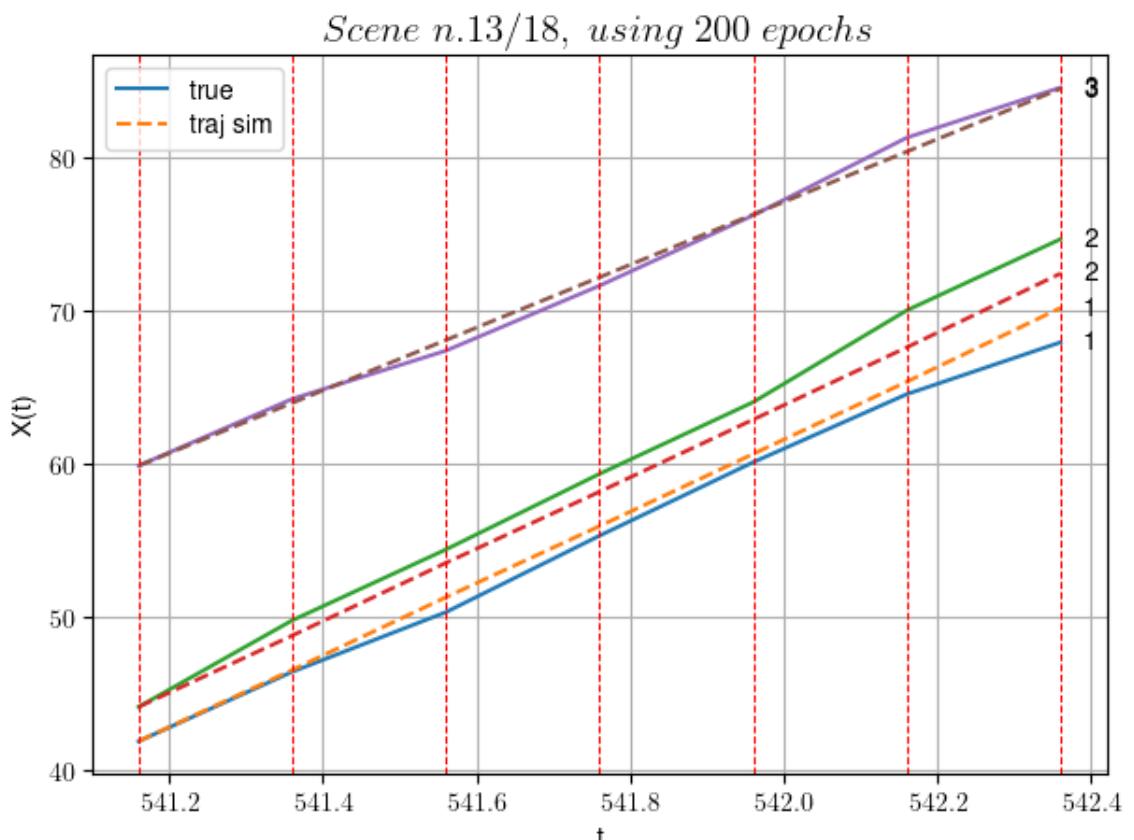
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Scene n.13/18, time interval:[541.16,542.36]

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Loss: 1.1571416020930503  
v0 updated: 20.50043309196578

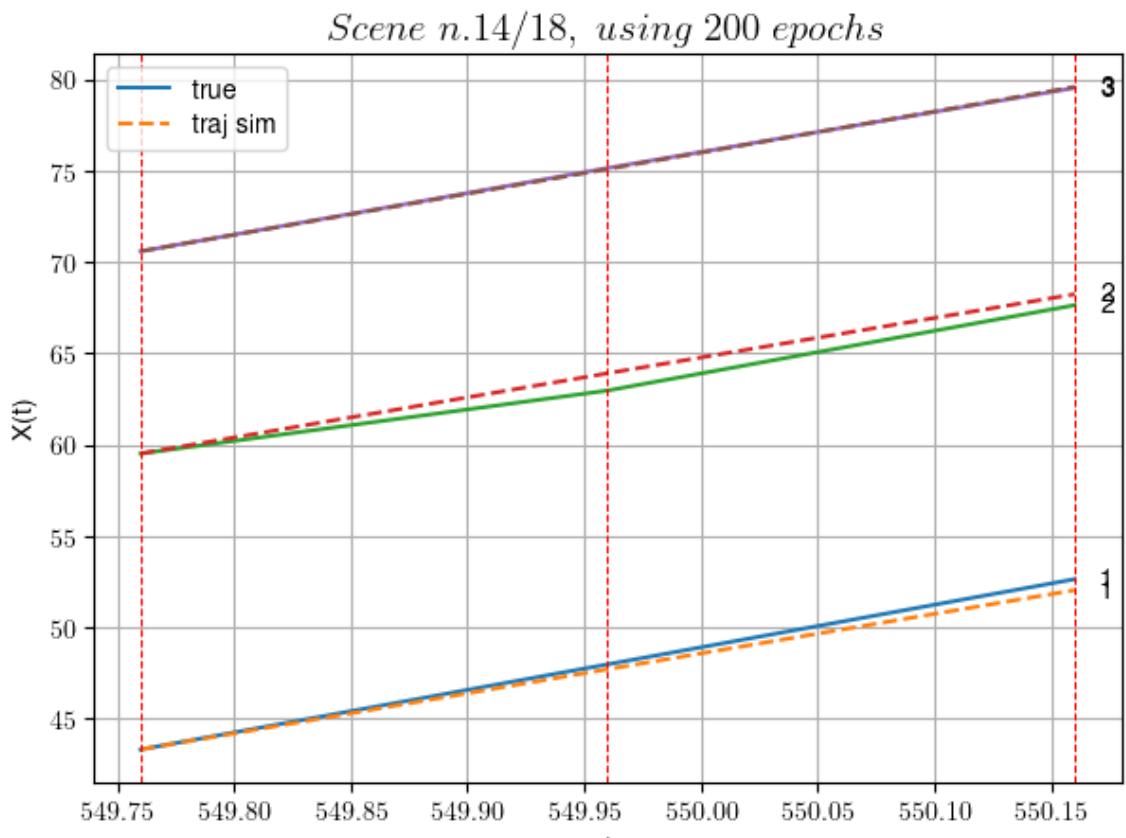
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Scene n.14/18, time interval:[549.76,550.16]

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Loss: 0.1875802248880658  
v0 updated: 22.503959325258233

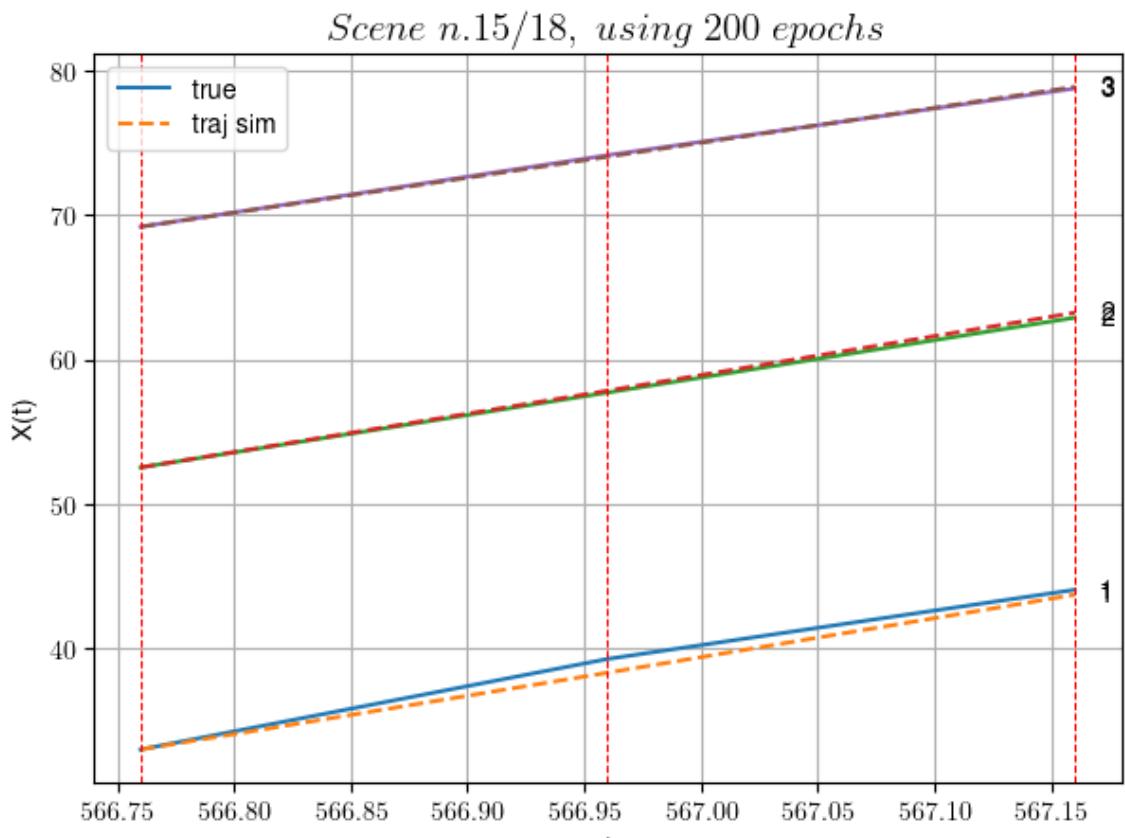
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Scene n.15/18, time interval:[566.76,567.16]

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Loss: 0.13229562802013756  
v0 updated: 24.228864140655777

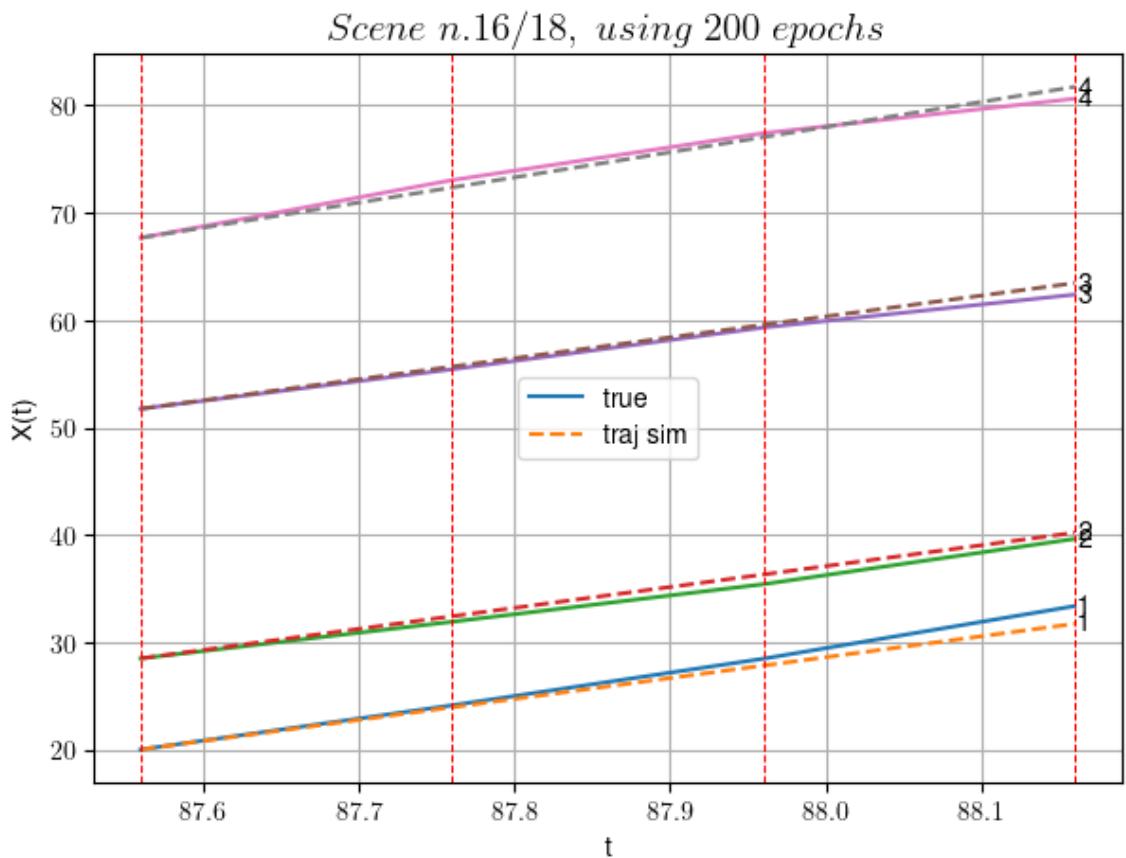
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Scene n.16/18, time interval:[87.56,88.16]

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Loss: 0.4802973314578022  
v0 updated: 23.439775970163954

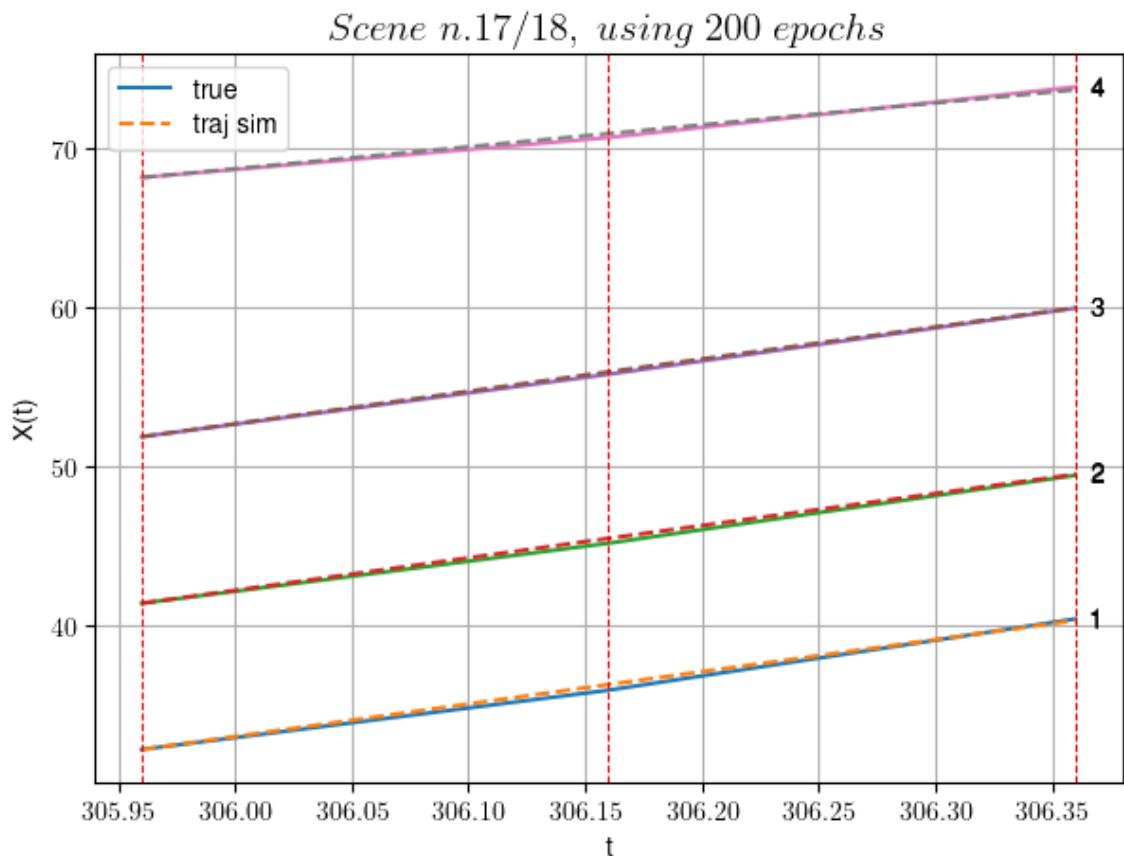
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Scene n.17/18, time interval:[305.96,306.36]

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Loss: 0.0298213442435897  
v0 updated: 13.781892213856752

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v0\_mean in this df is: 21.567993269996126  
Time taken: 103.40s

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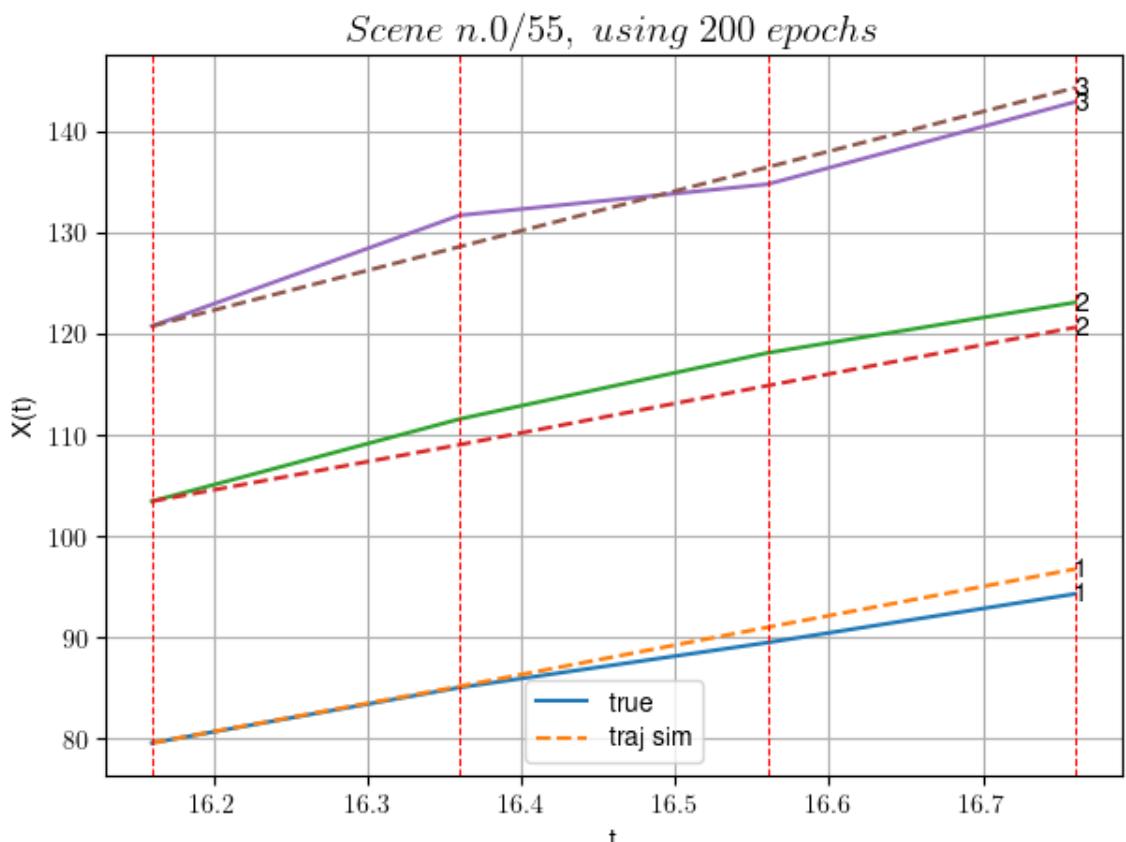
In df n.3/10 we have 55 scenes

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Scene n.0/55, time interval:[16.16,16.76]

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Loss: 3.7991360945348824  
v0 updated: 39.21715010860685

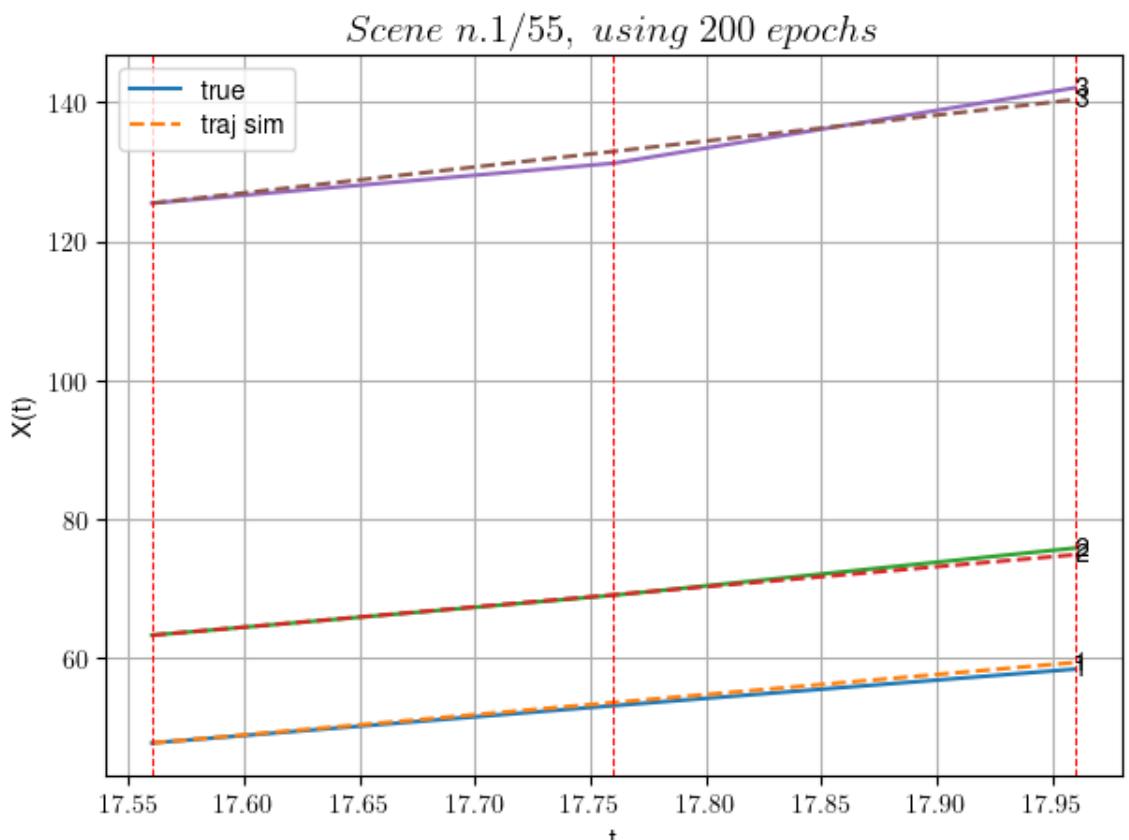
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Scene n.1/55, time interval:[17.56,17.96]

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Loss: 0.8741189295498938  
v0 updated: 37.33354775754679

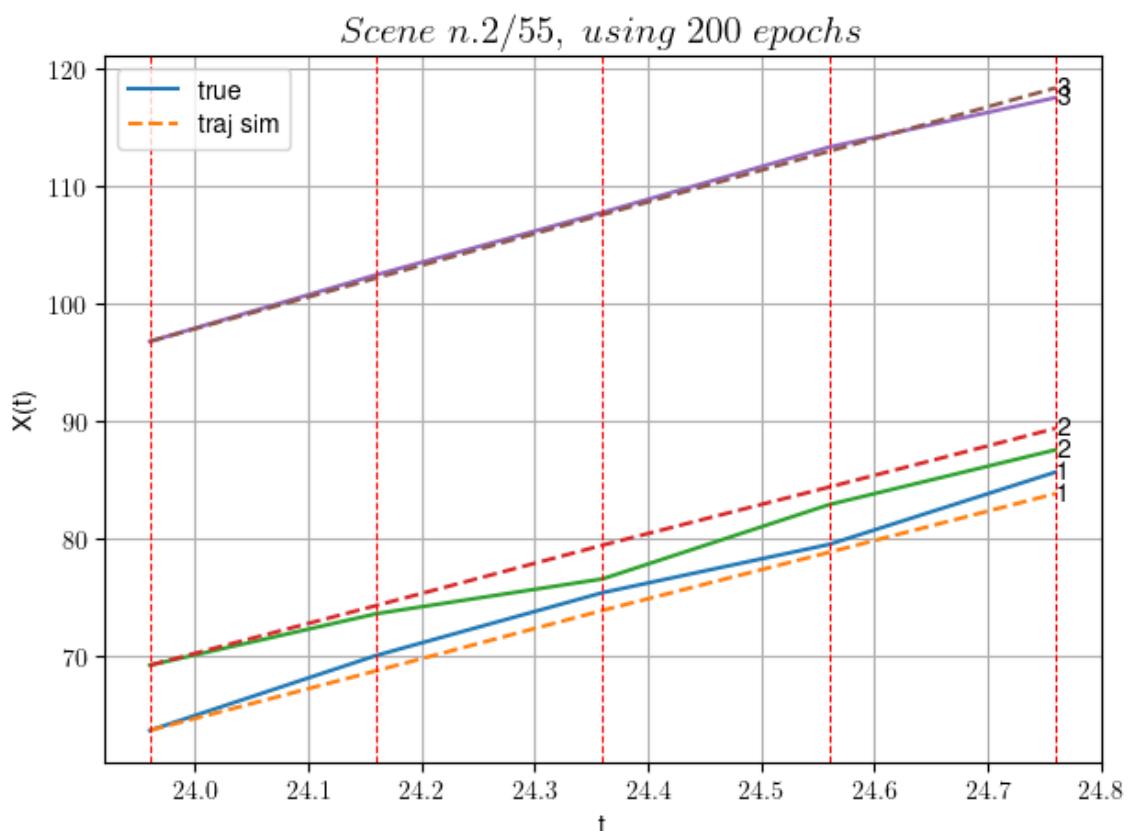
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Scene n.2/55, time interval:[23.96,24.76]

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Loss: 1.5372380915338943  
v0 updated: 27.019940095947995

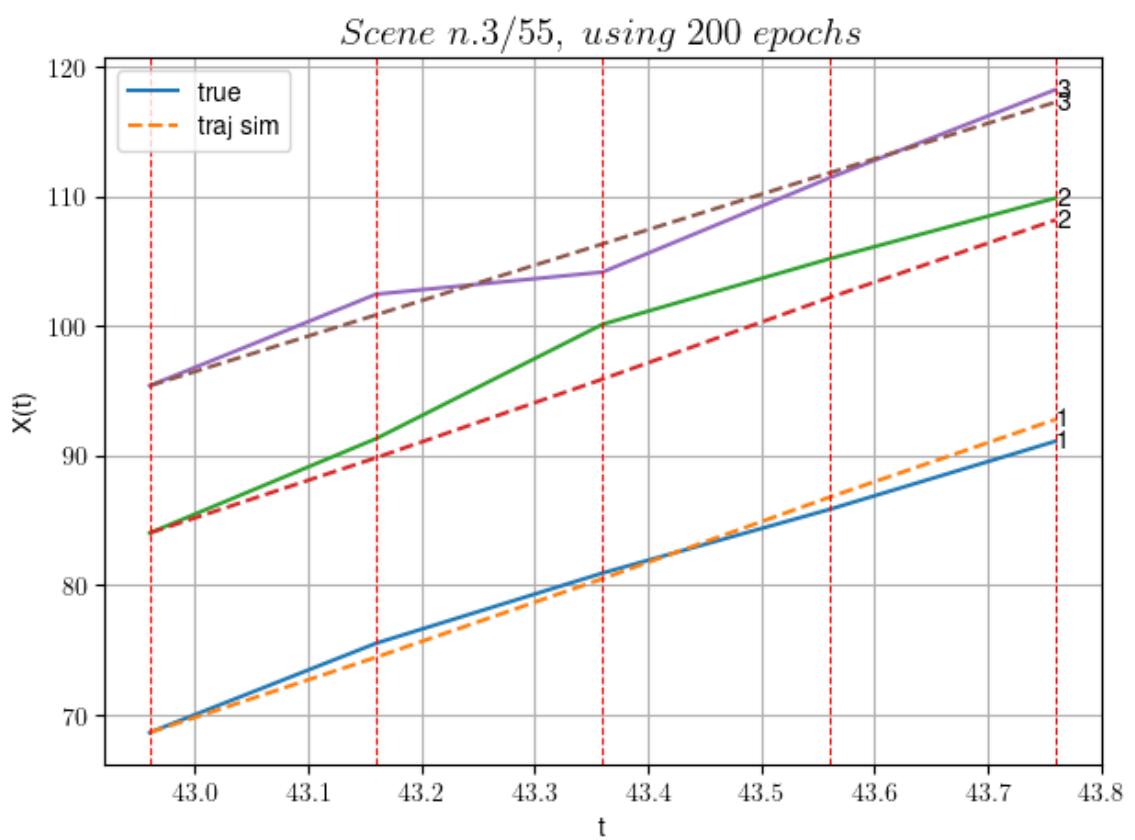
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Scene n.3/55, time interval:[42.96,43.76]

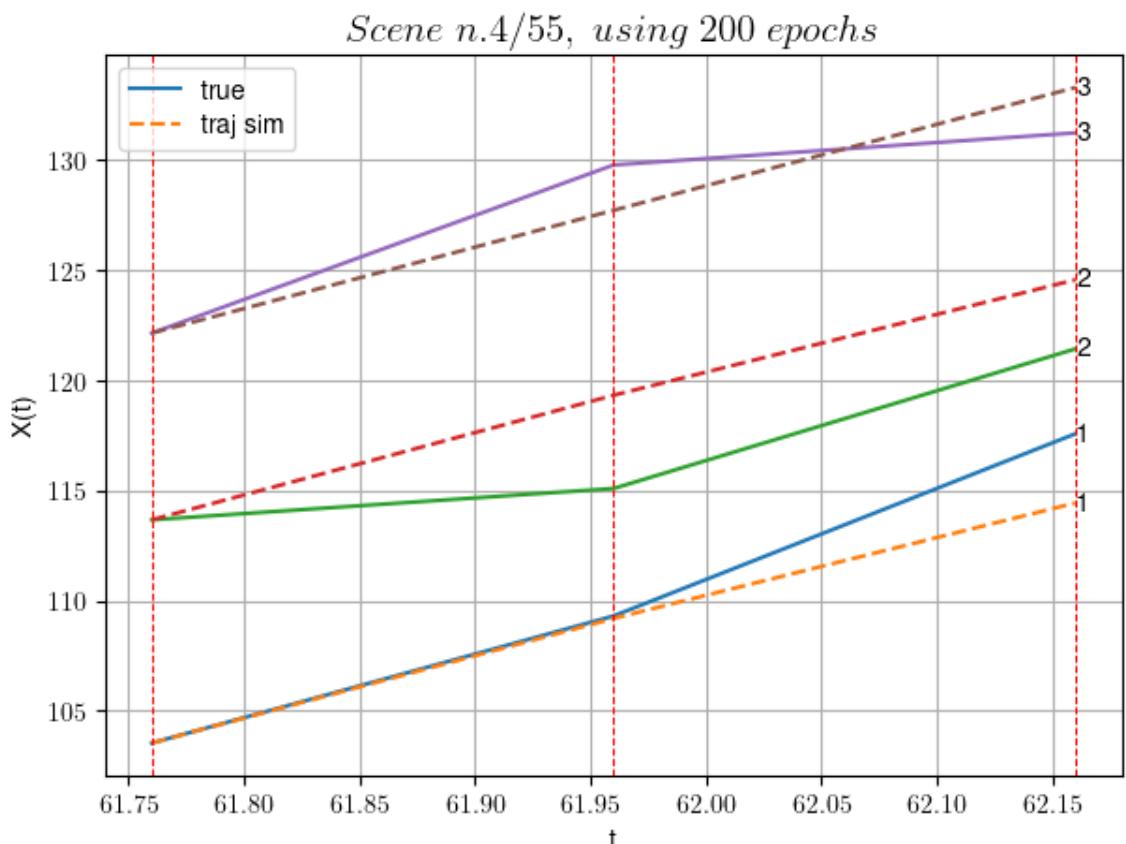
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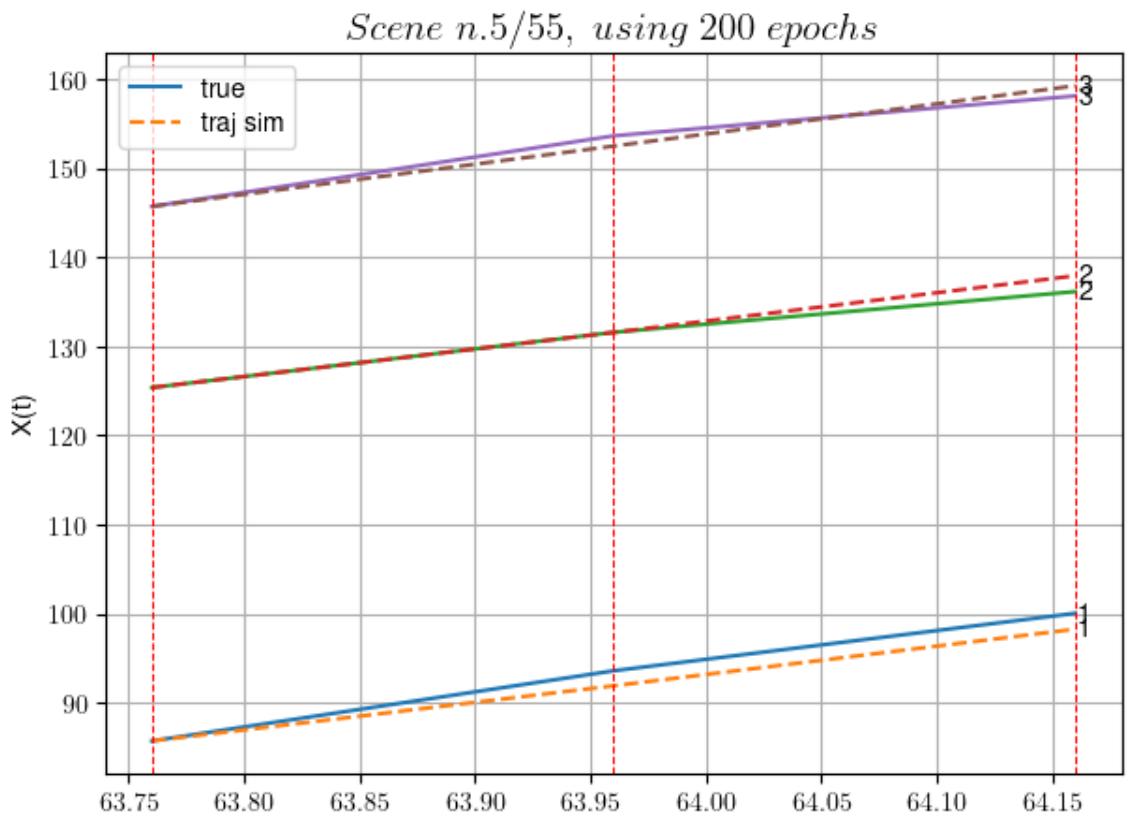
Loss: 3.020812925927542  
v0 updated: 27.353582436749843

Scene n.4/55, time interval:[61.76,62.16]



Loss: 5.1091522333777695  
v0 updated: 27.832473006374567

Scene n.5/55, time interval:[63.76,64.16]



Loss: 1.3038301450132919  
v0 updated: 33.83566643209178

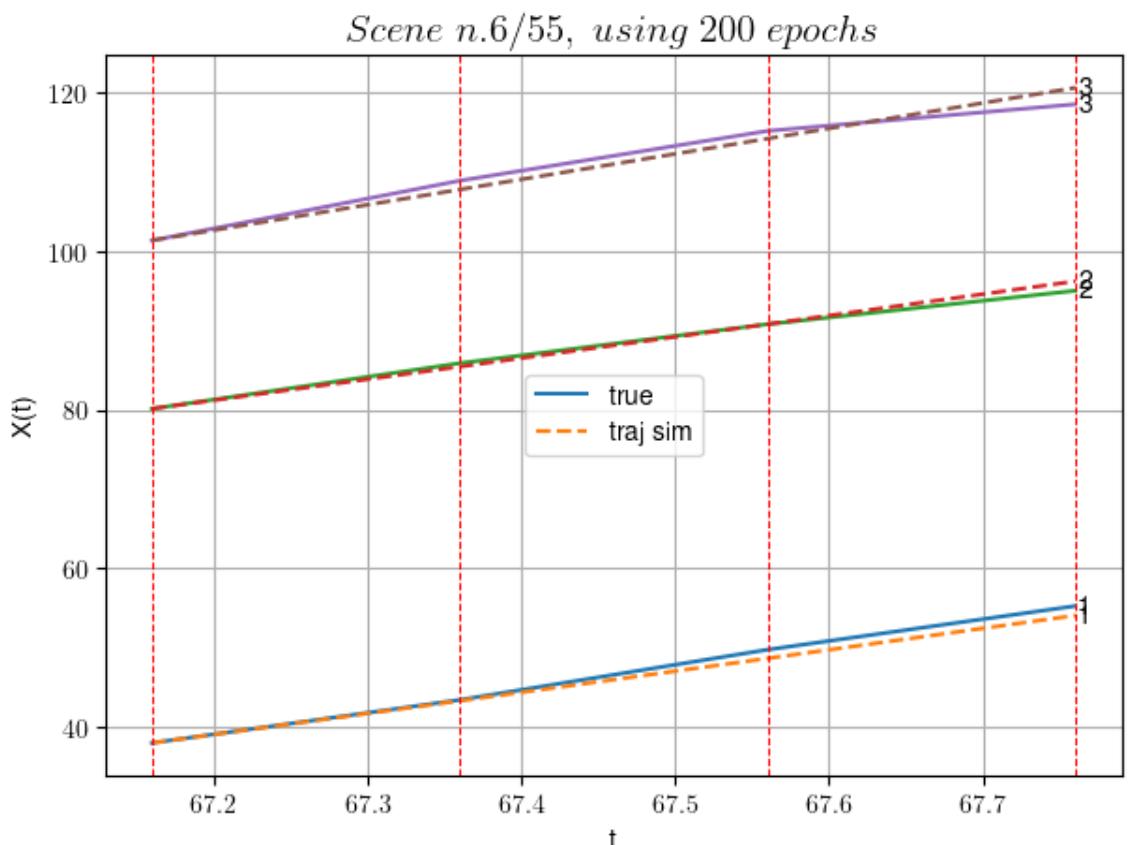
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Scene n.6/55, time interval:[67.16,67.76]

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Loss: 0.9009057483640293  
v0 updated: 32.13697253892425

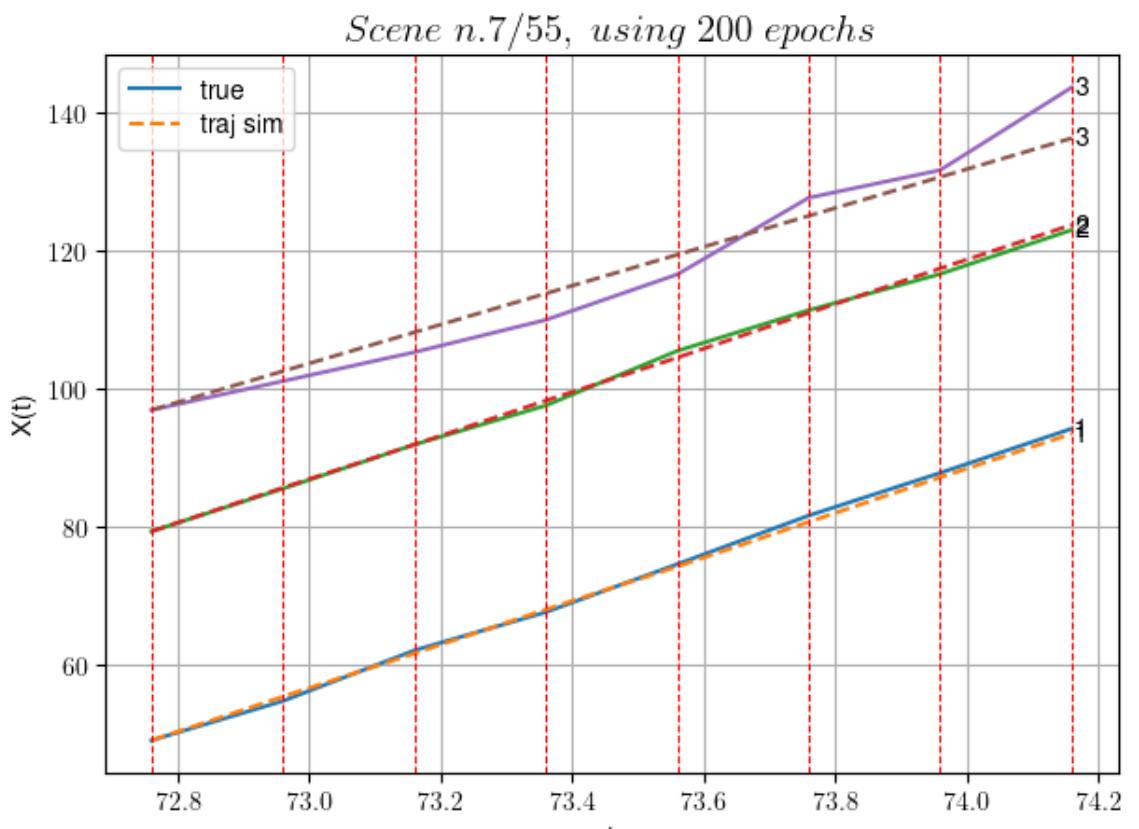
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Scene n.7/55, time interval:[72.76,74.16]

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Loss: 4.192558058096769  
v0 updated: 28.12330316633905

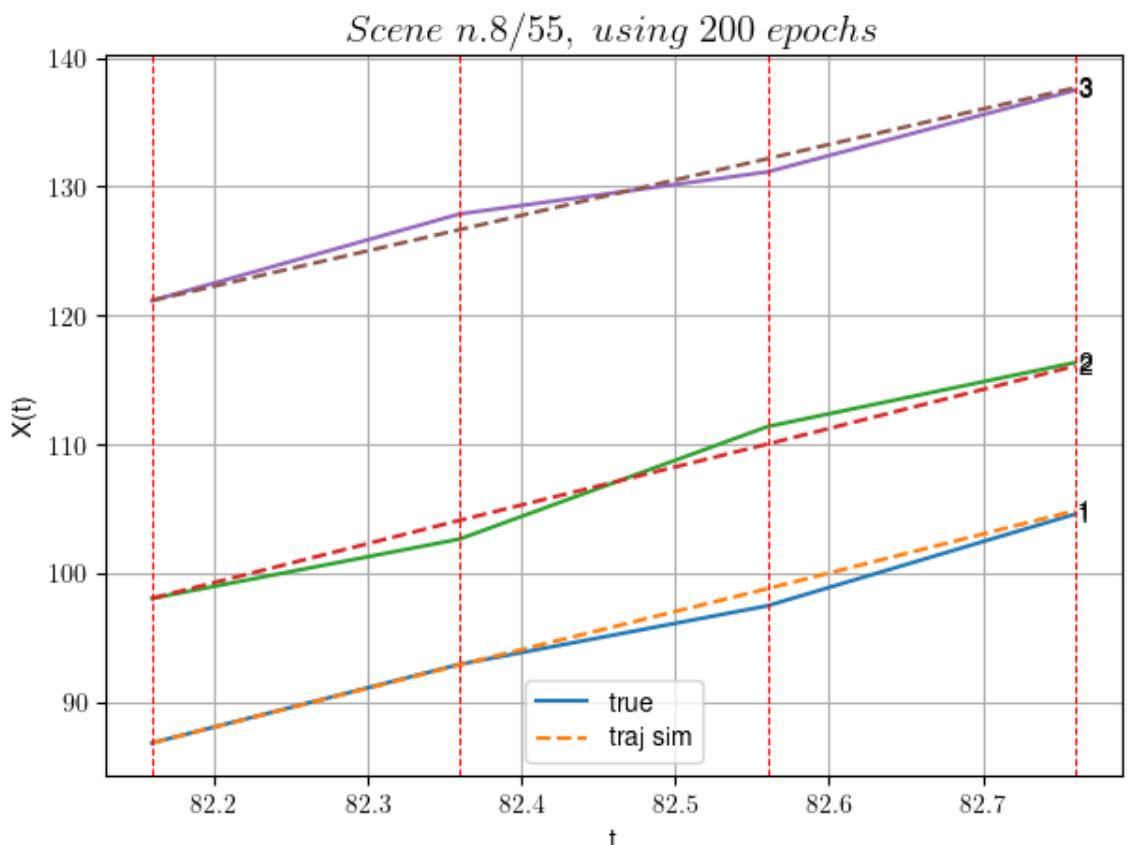
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Scene n.8/55, time interval:[82.16,82.76]

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Loss: 0.7045020146873151  
v0 updated: 27.552927285636404

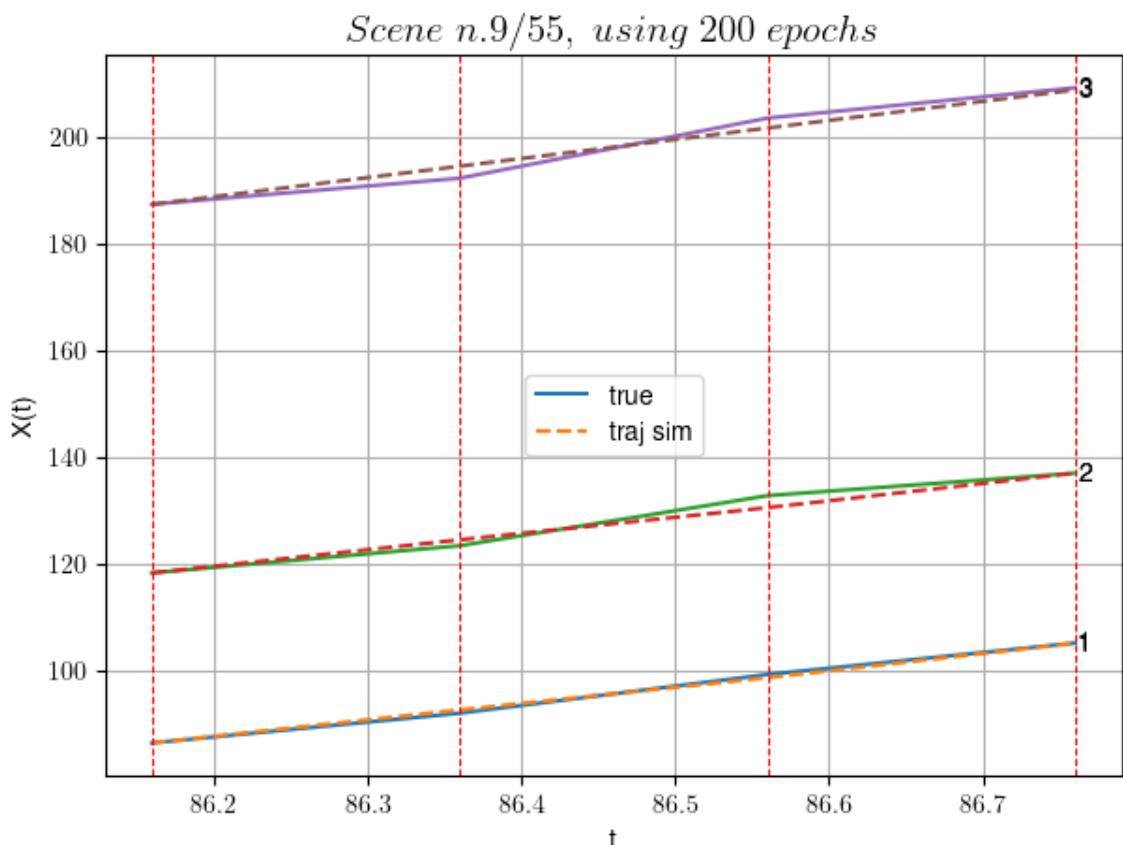
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Scene n.9/55, time interval:[86.16,86.76]

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Loss: 1.3144505416562786  
v0 updated: 35.758406855917755

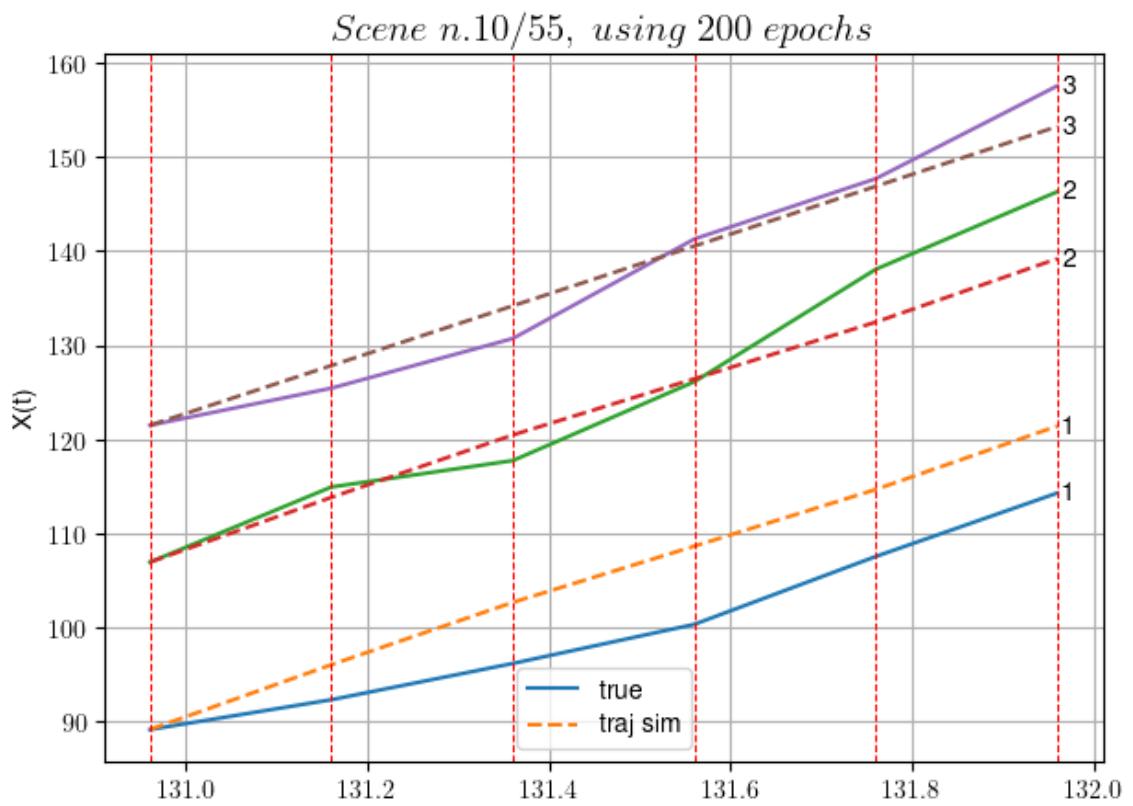
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Scene n.10/55, time interval:[130.96,131.96]

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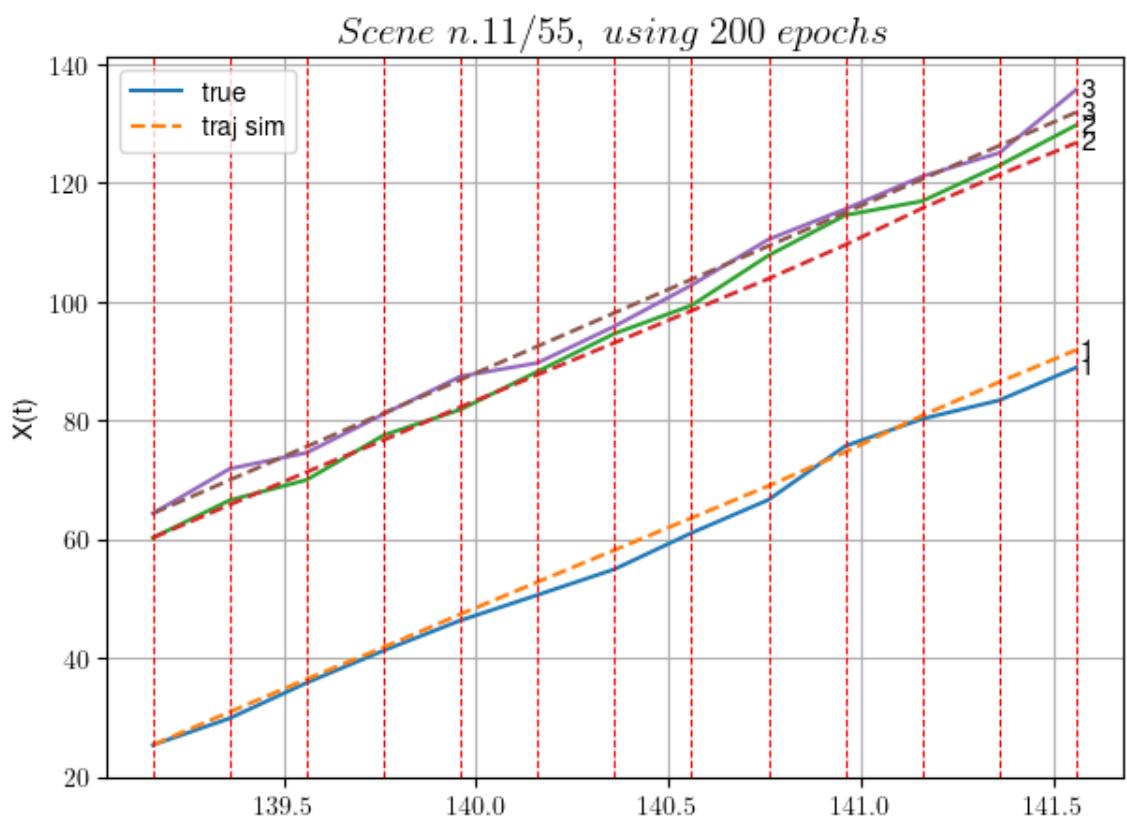


Loss: 19.730305379289813  
v0 updated: 31.750413794800306

---

Scene n.11/55, time interval:[139.16,141.56]

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Loss: 3.7352273629349746  
v0 updated: 28.146667787591962

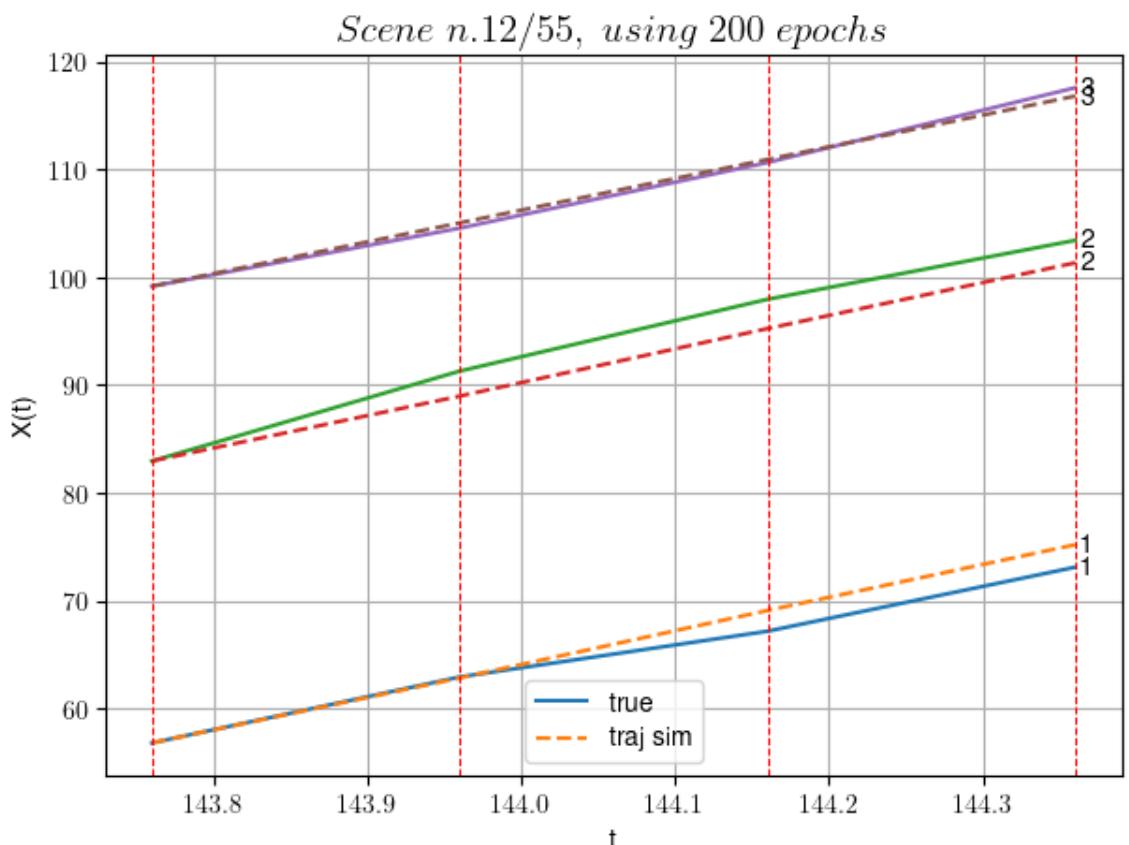
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Scene n.12/55, time interval:[143.76,144.36]

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Loss: 2.174639747026396  
v0 updated: 29.41538708161572

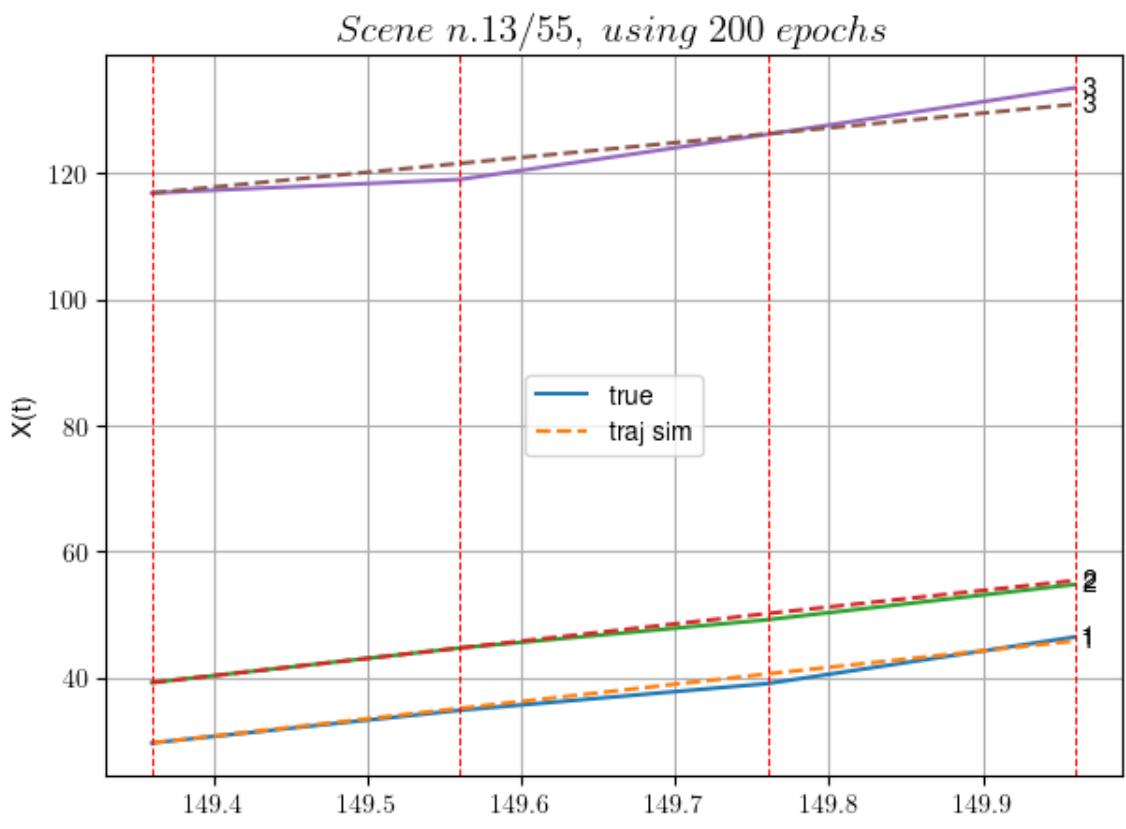
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Scene n.13/55, time interval:[149.36,149.96]

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Loss: 1.4649157223513163  
v0 updated: 23.450754392043912

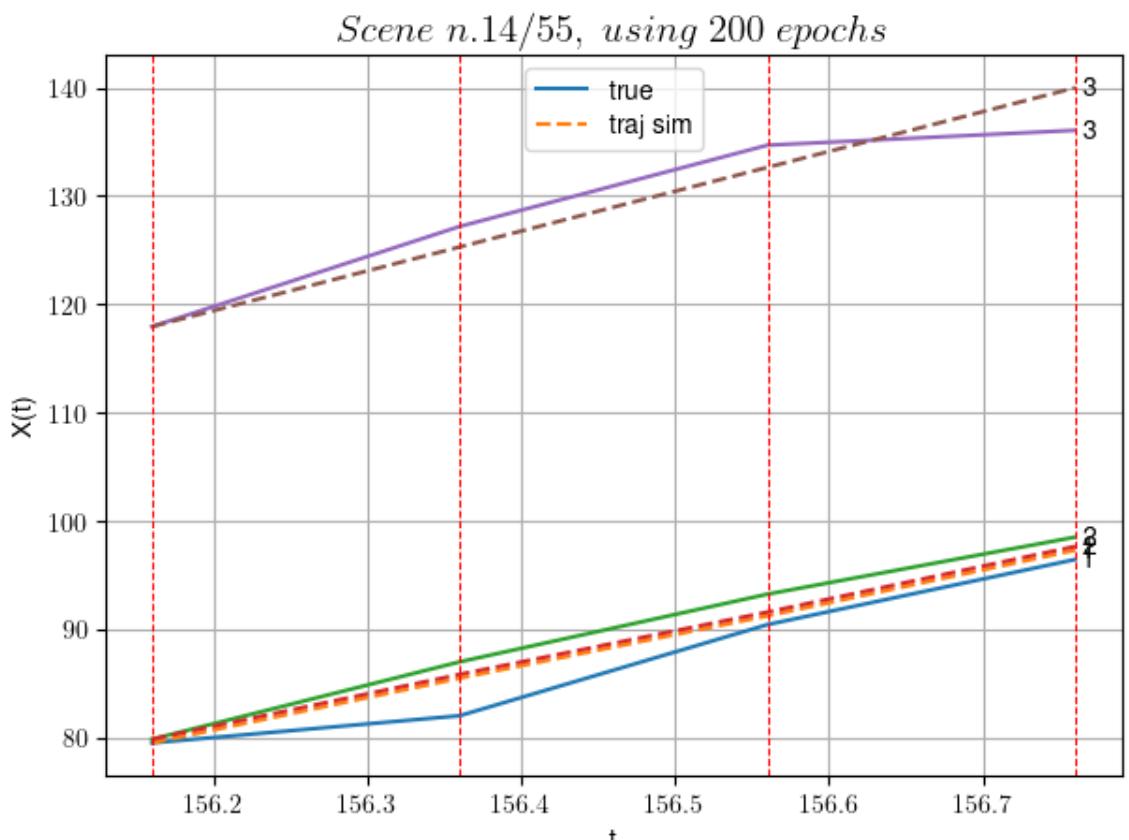
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Scene n.14/55, time interval:[156.16,156.76]

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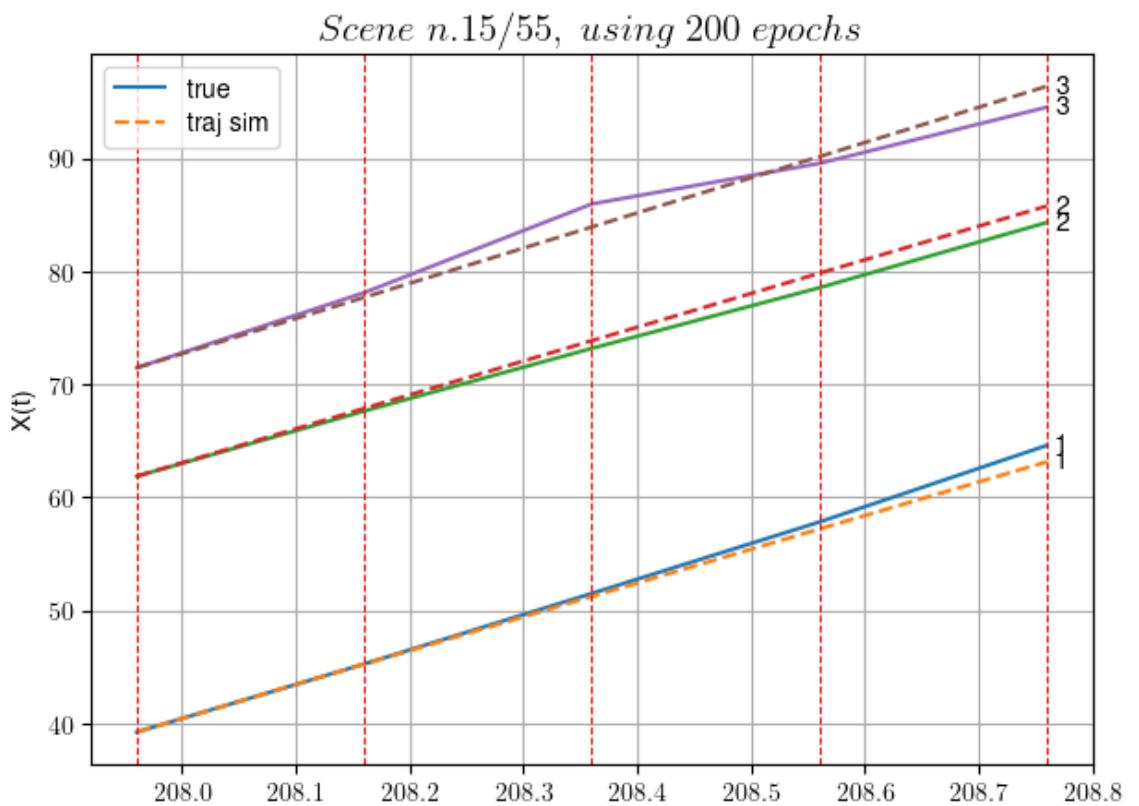


Loss: 3.4594761888398646  
v0 updated: 36.77217279713519

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Scene n.15/55, time interval:[207.96,208.76]

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Loss: 0.9968770072551134  
v0 updated: 31.123674479426654

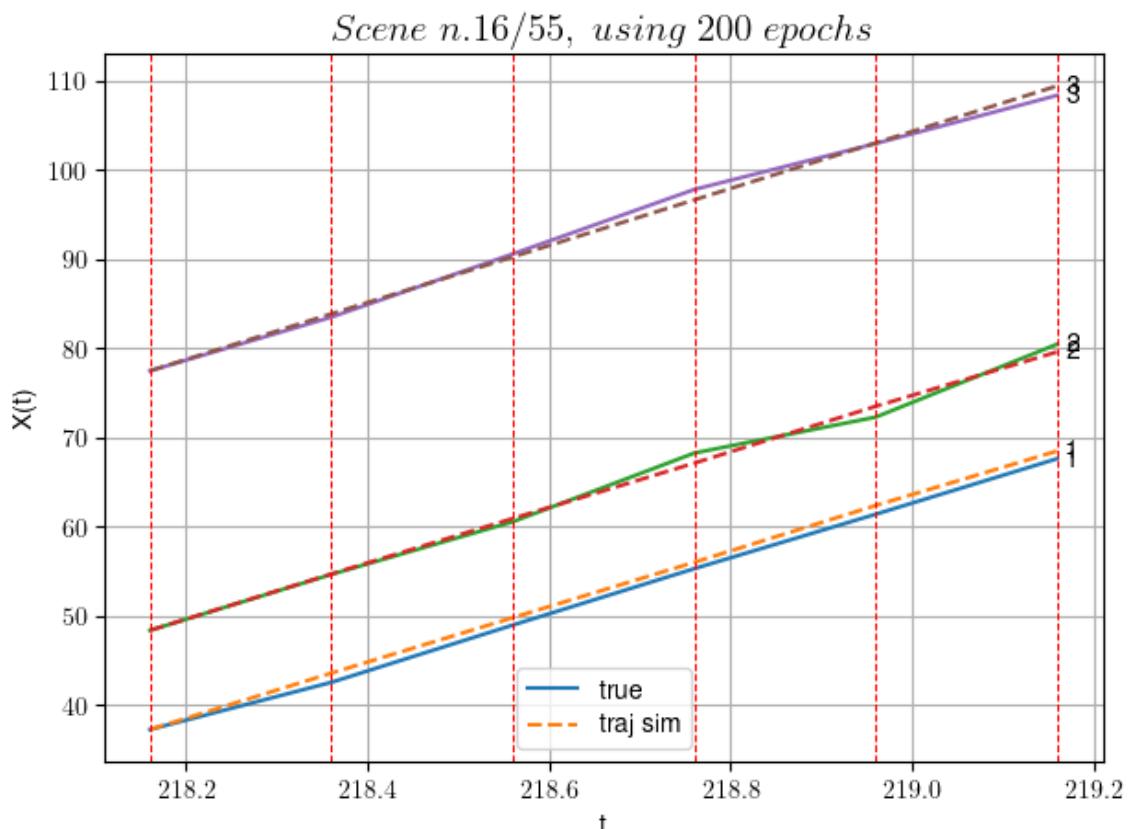
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Scene n.16/55, time interval:[218.16,219.16]

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Loss: 0.5731601246156511  
v0 updated: 31.94478783305763

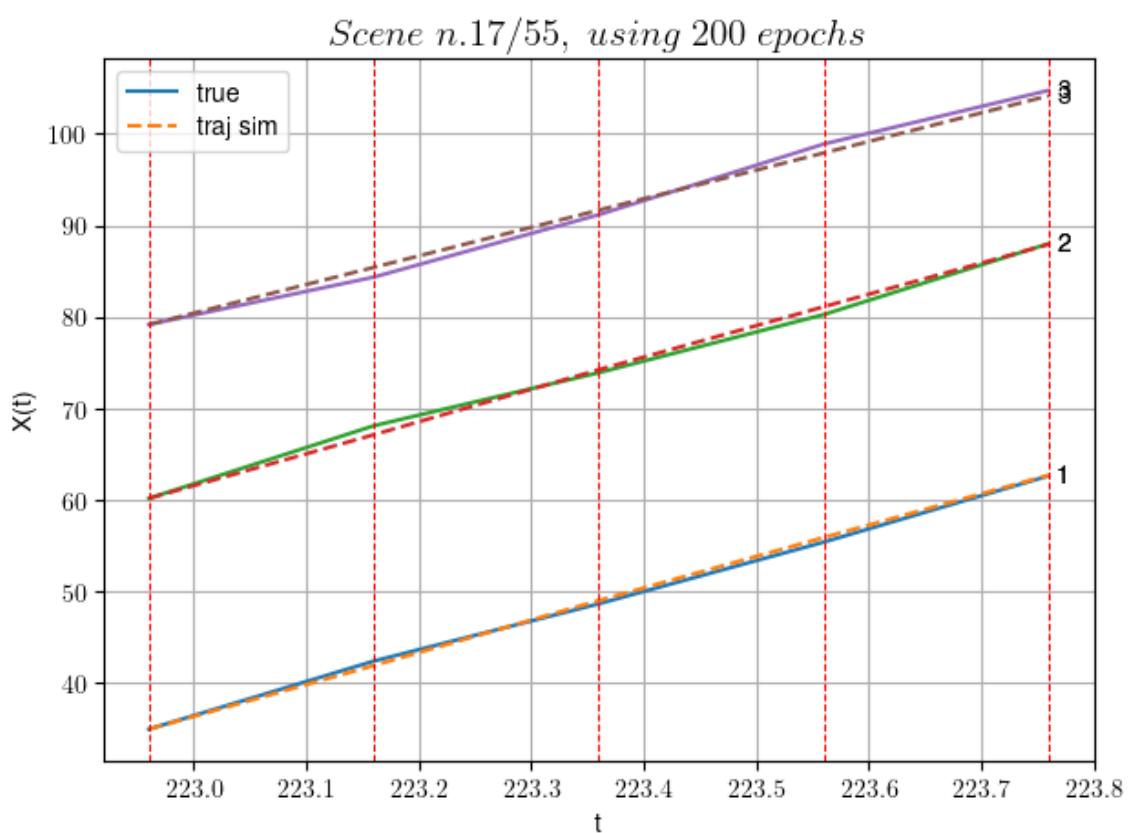
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Scene n.17/55, time interval:[222.96,223.76]

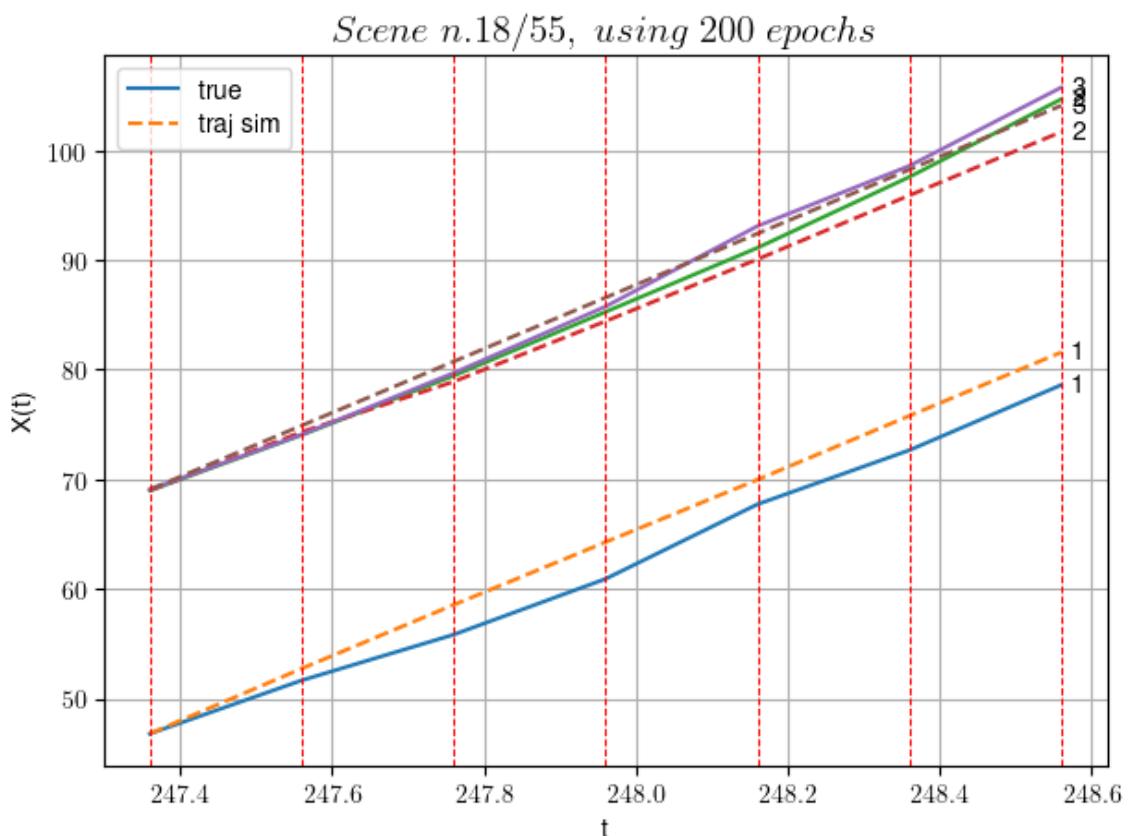
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Loss: 0.34102353018517834  
v0 updated: 31.27834550412877

Scene n.18/55, time interval:[247.36,248.56]



Loss: 3.013349978742512  
v0 updated: 29.20042400293088

Scene n.19/55, time interval:[269.56,270.96]



Loss: 0.6733795875888634  
v0 updated: 30.538583647650018

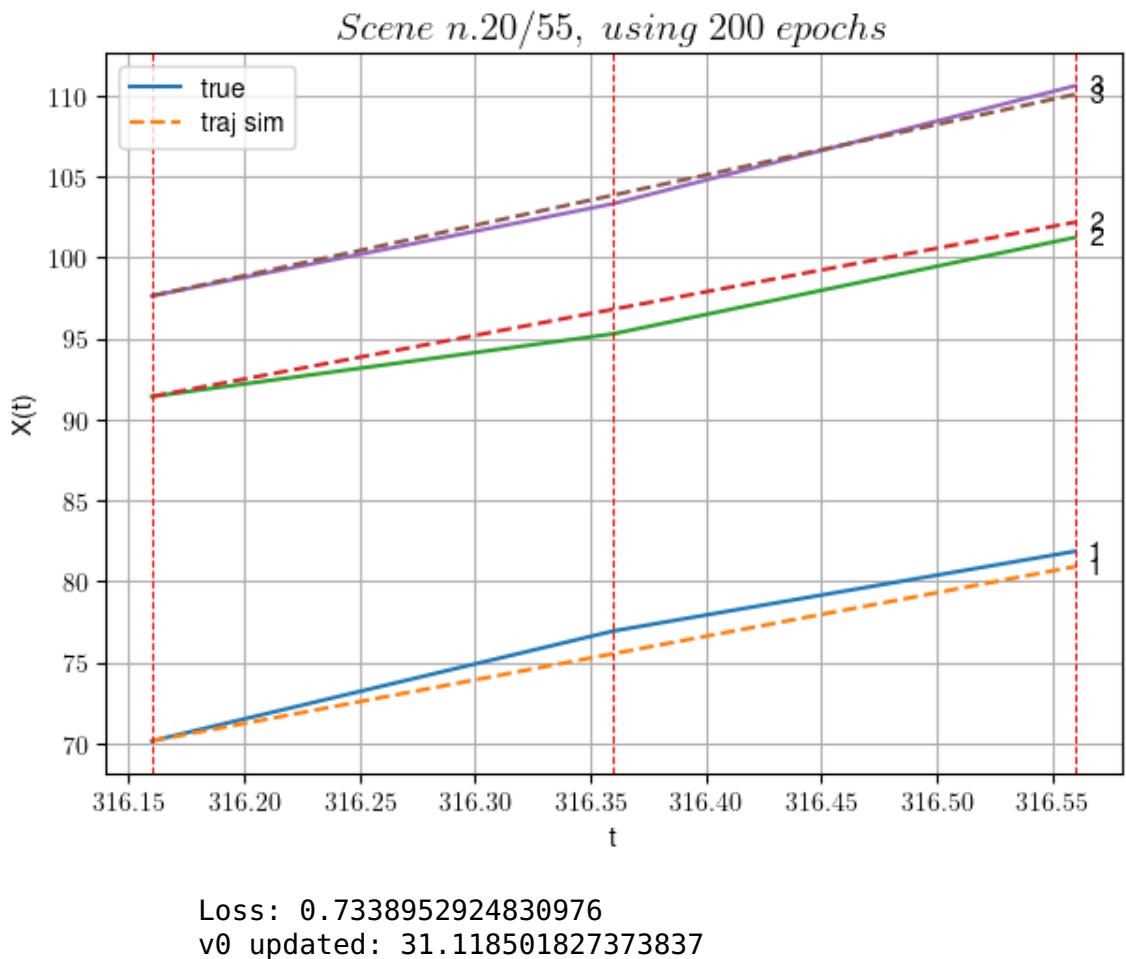
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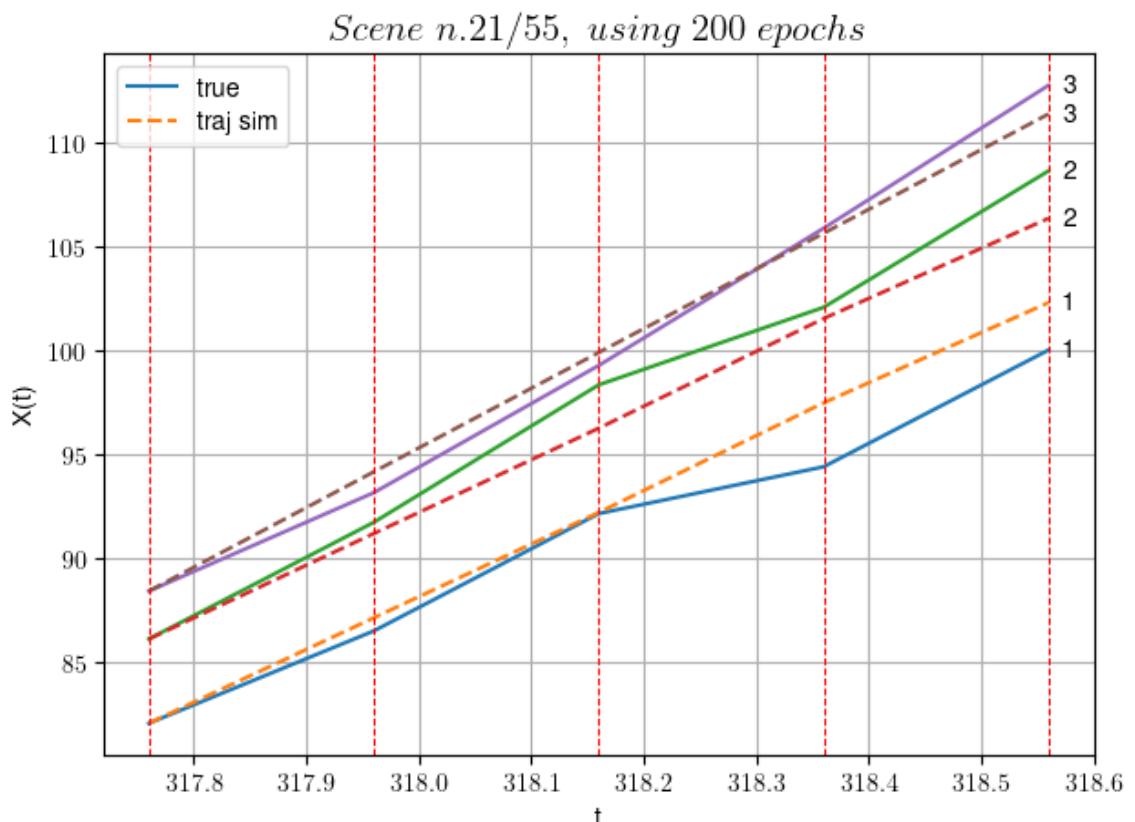
Scene n.20/55, time interval:[316.16,316.56]

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Scene n.21/55, time interval:[317.76,318.56]

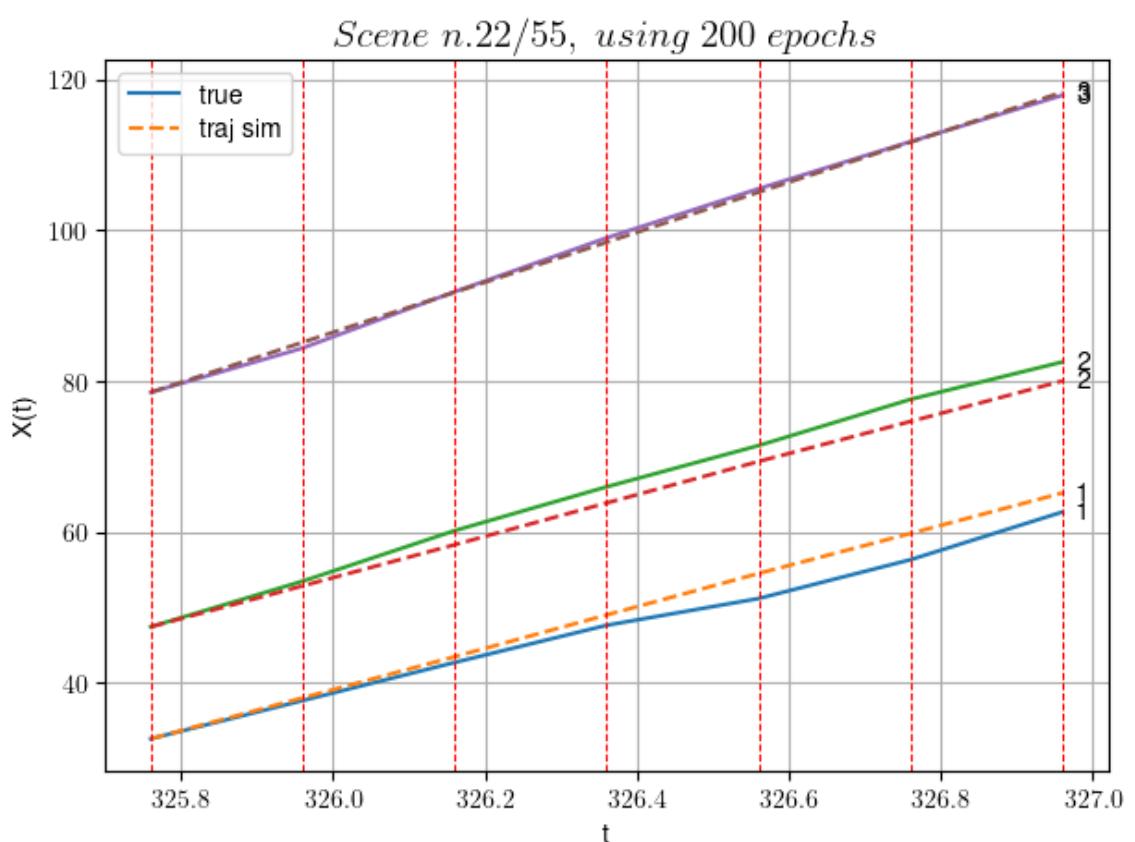


Loss: 1.9090487634921418  
v0 updated: 28.731001411505158

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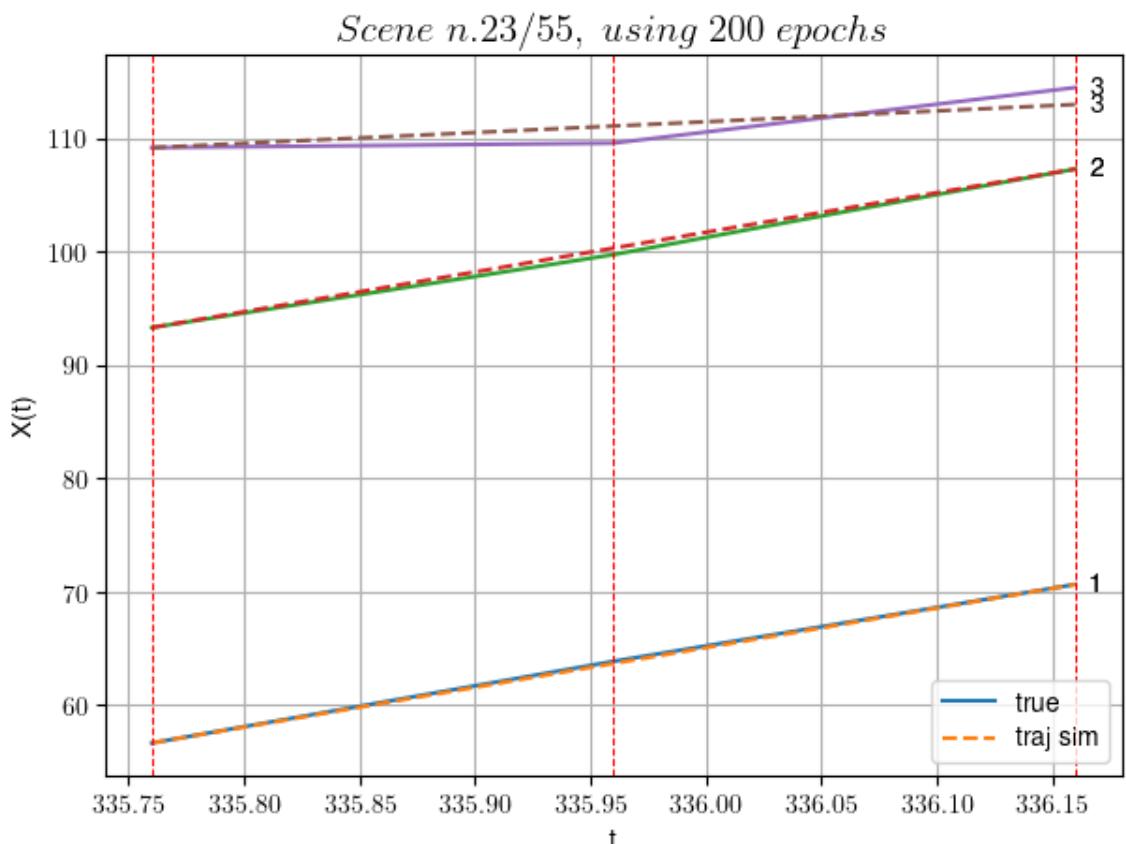
Scene n.22/55, time interval:[325.76,326.96]

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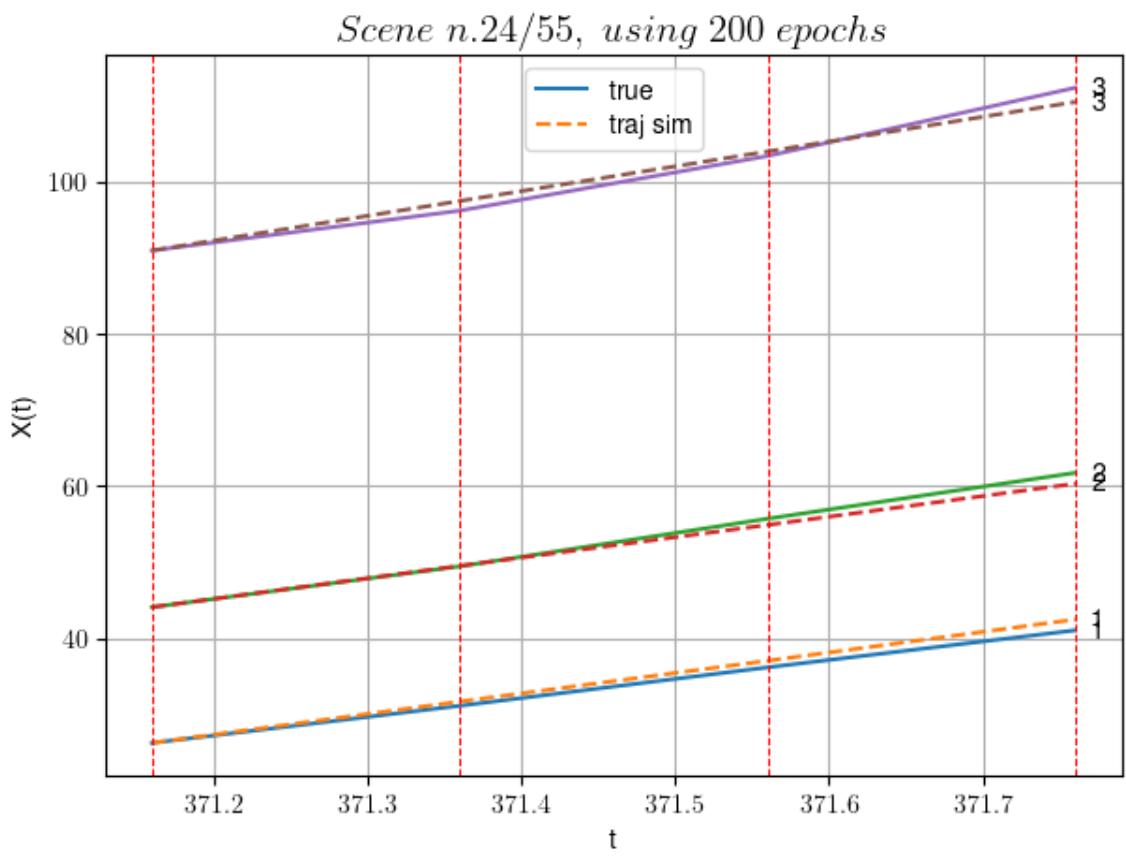
Loss: 2.9129313295933734  
v0 updated: 33.13210942893414

Scene n.23/55, time interval:[335.76,336.16]



Loss: 0.5398193119908694  
v0 updated: 9.51819454011644

Scene n.24/55, time interval:[371.16,371.76]



Loss: 0.93868427497265  
v0 updated: 32.53671918608213

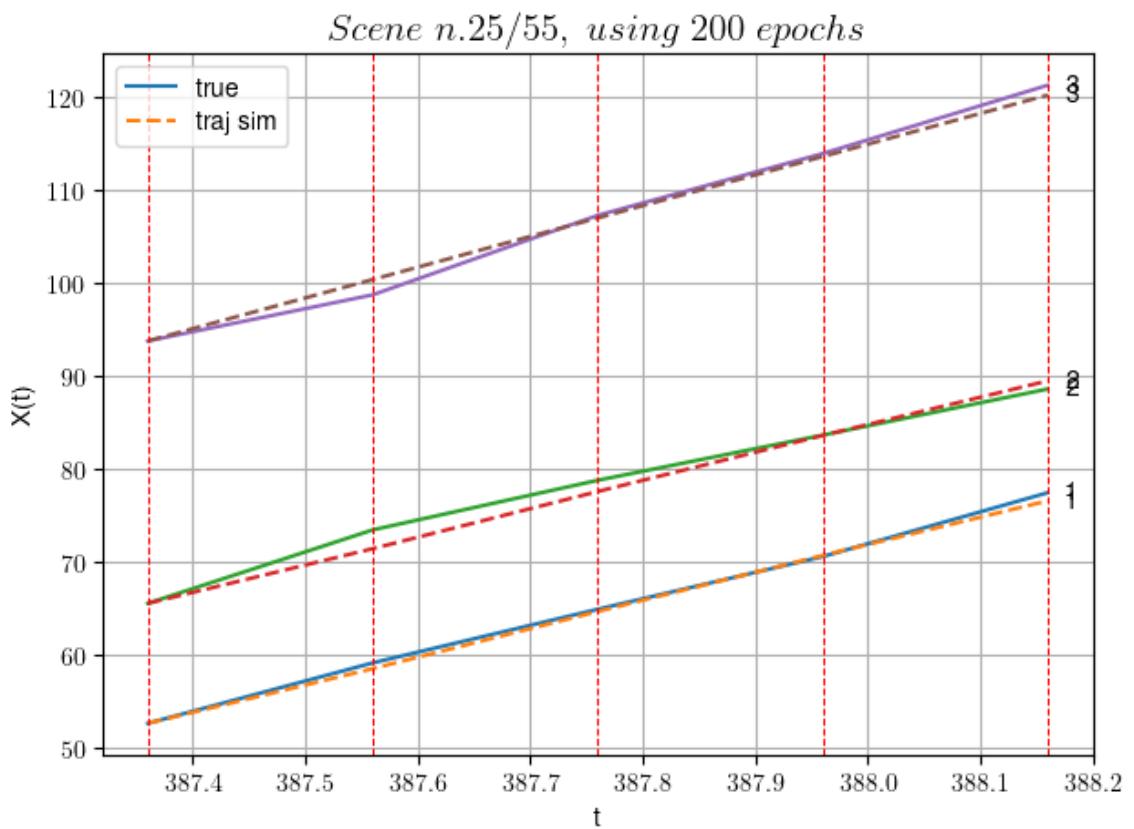
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Scene n.25/55, time interval:[387.36,388.16]

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Loss: 0.7667661385413199  
v0 updated: 33.02856902380123

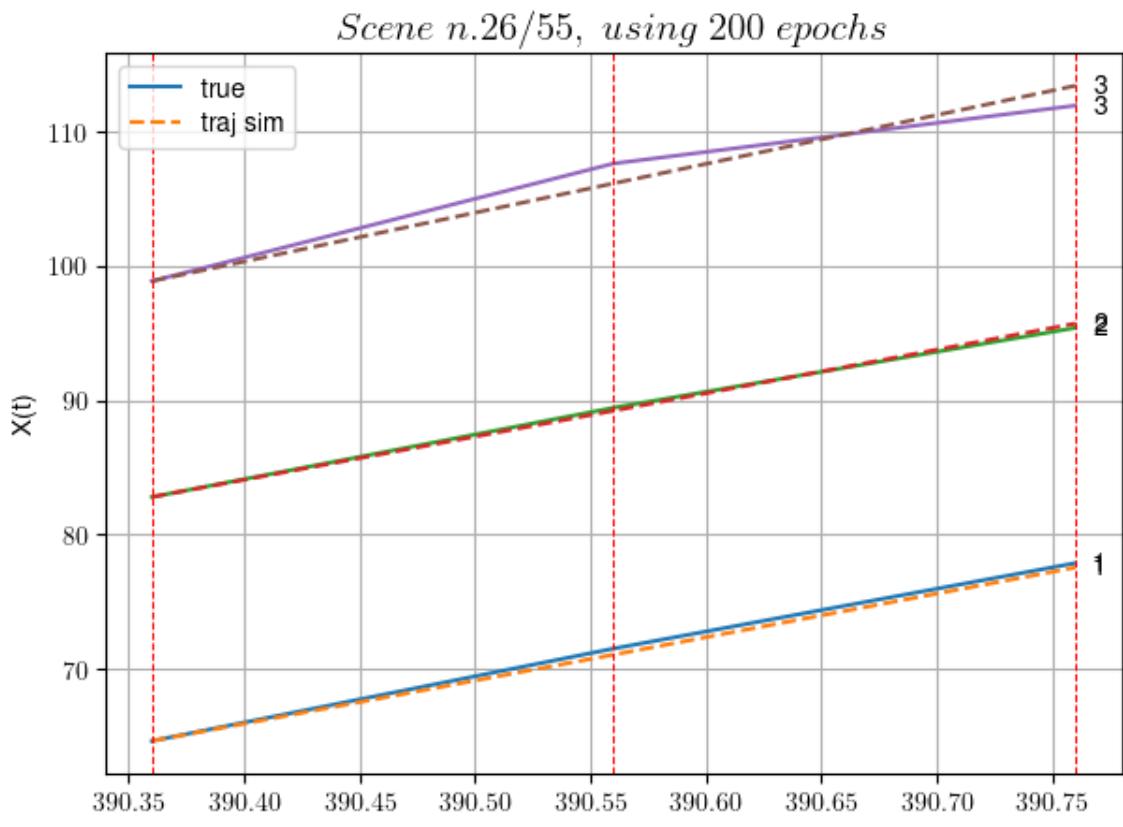
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Scene n.26/55, time interval:[390.36,390.76]

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Loss: 0.5367480781255706  
v0 updated: 36.3472833737466

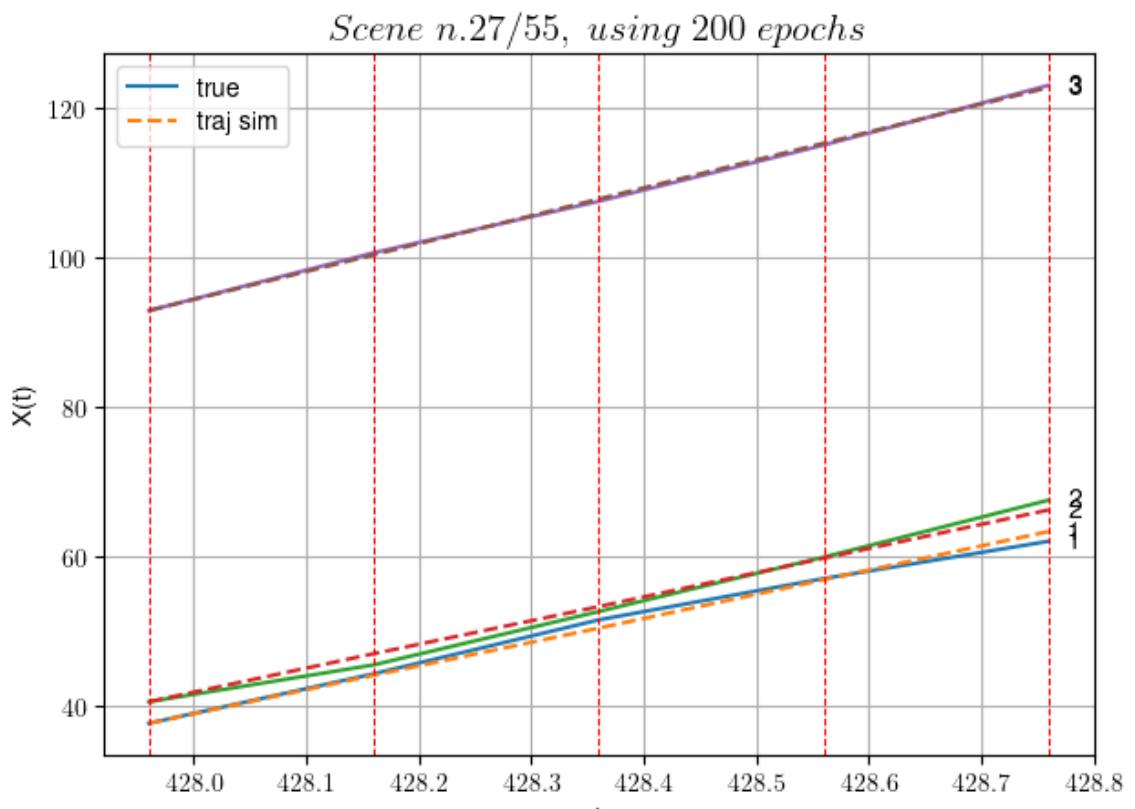
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Scene n.27/55, time interval:[427.96,428.76]

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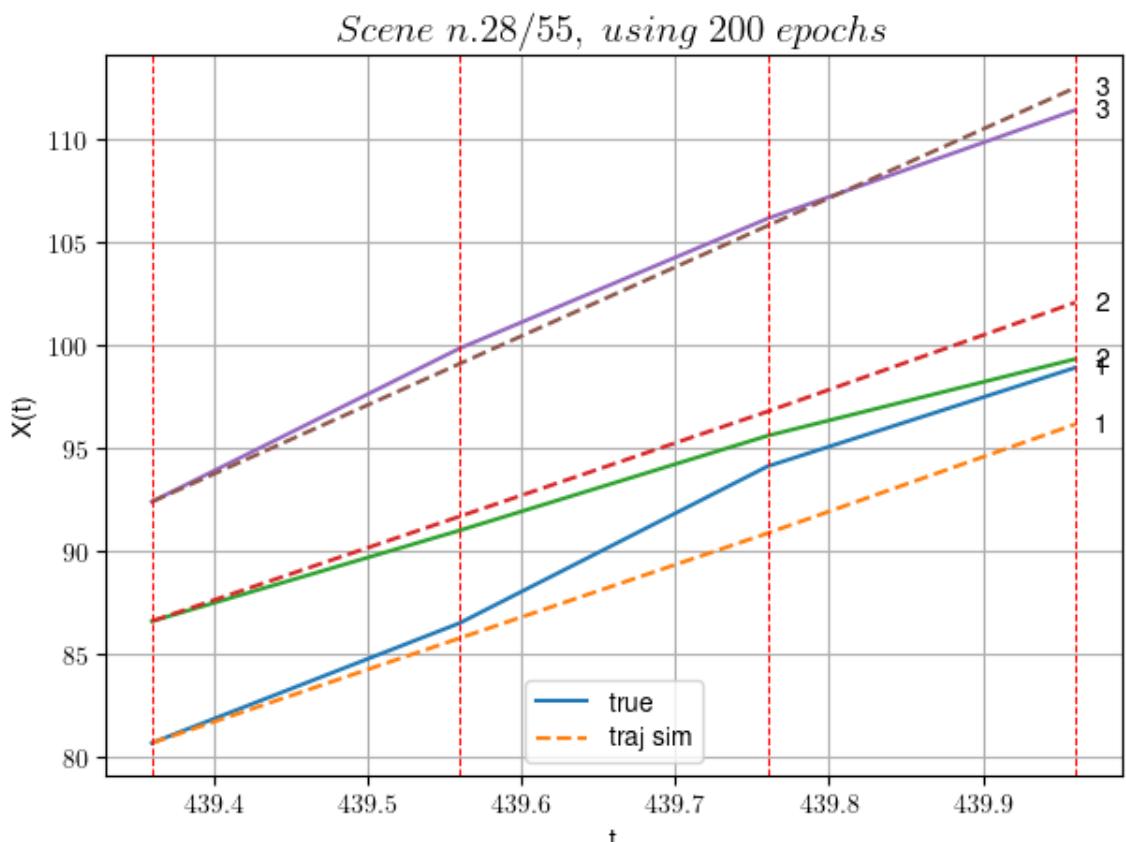
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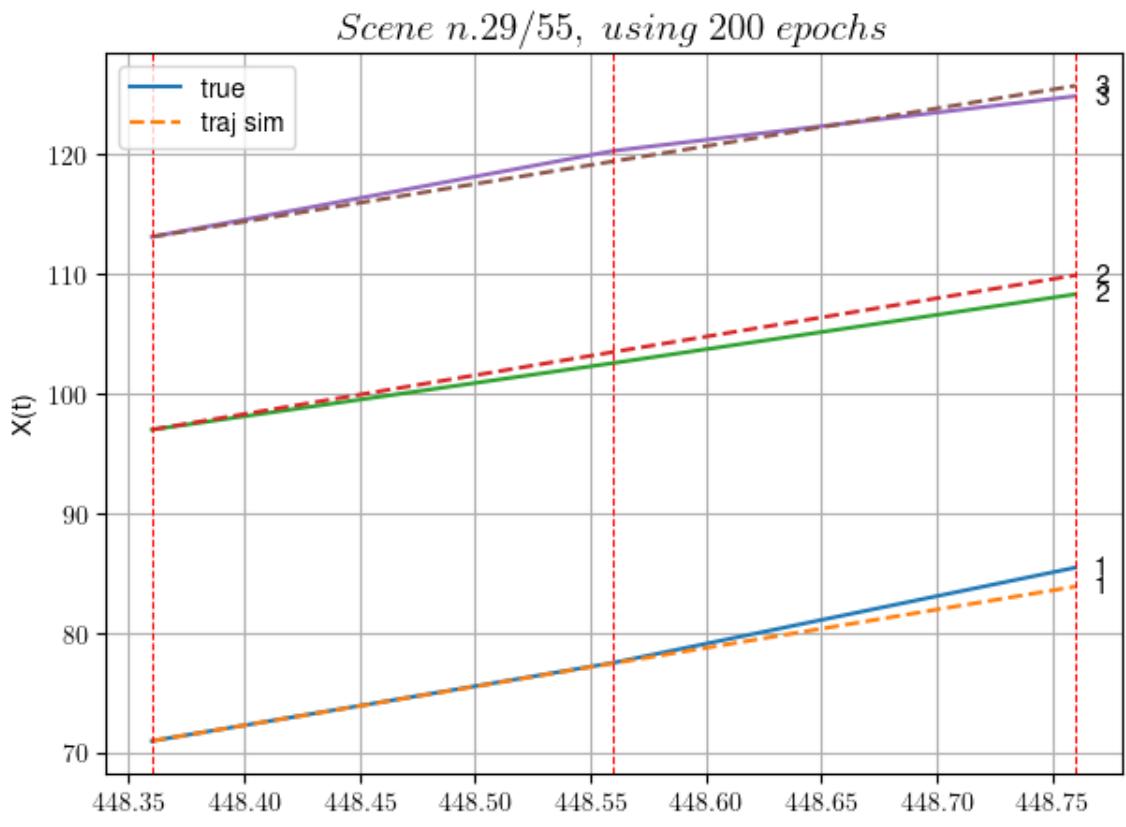
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Scene n.28/55, time interval:[439.36,439.96]

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Scene n.29/55, time interval:[448.36,448.76]



Loss: 0.8245165678146941  
v0 updated: 31.583307782368443

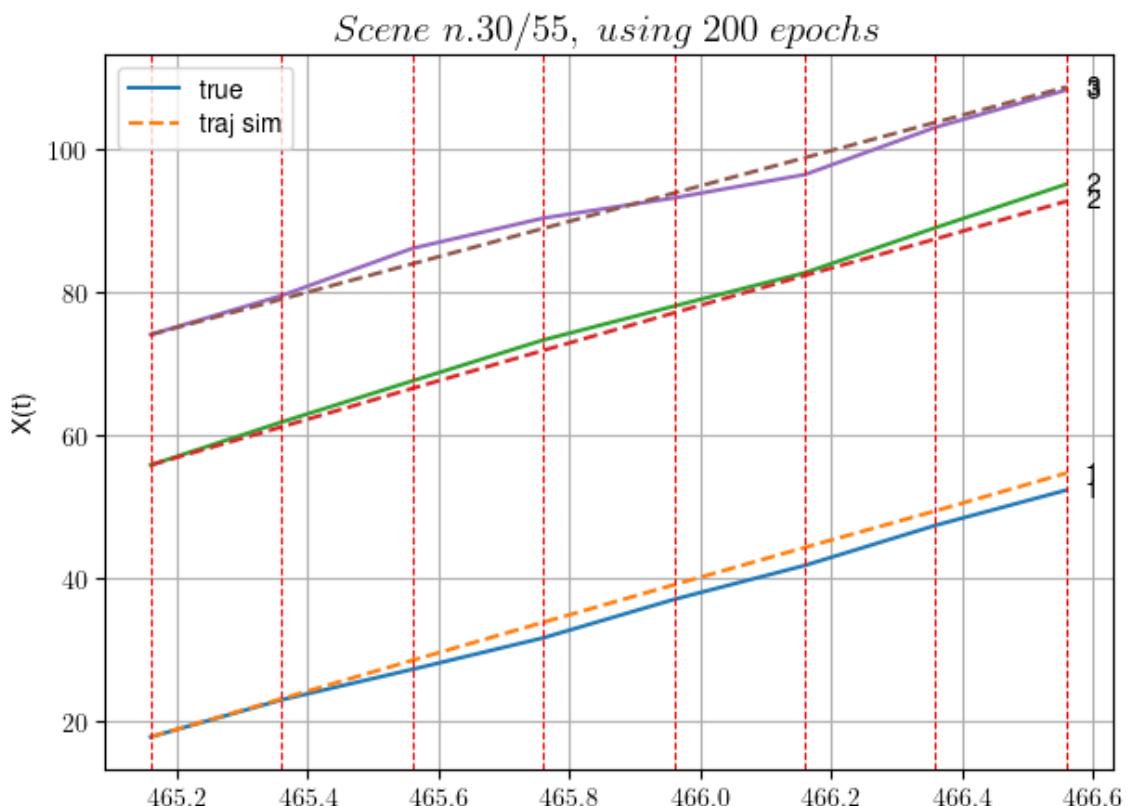
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Scene n.30/55, time interval:[465.16,466.56]

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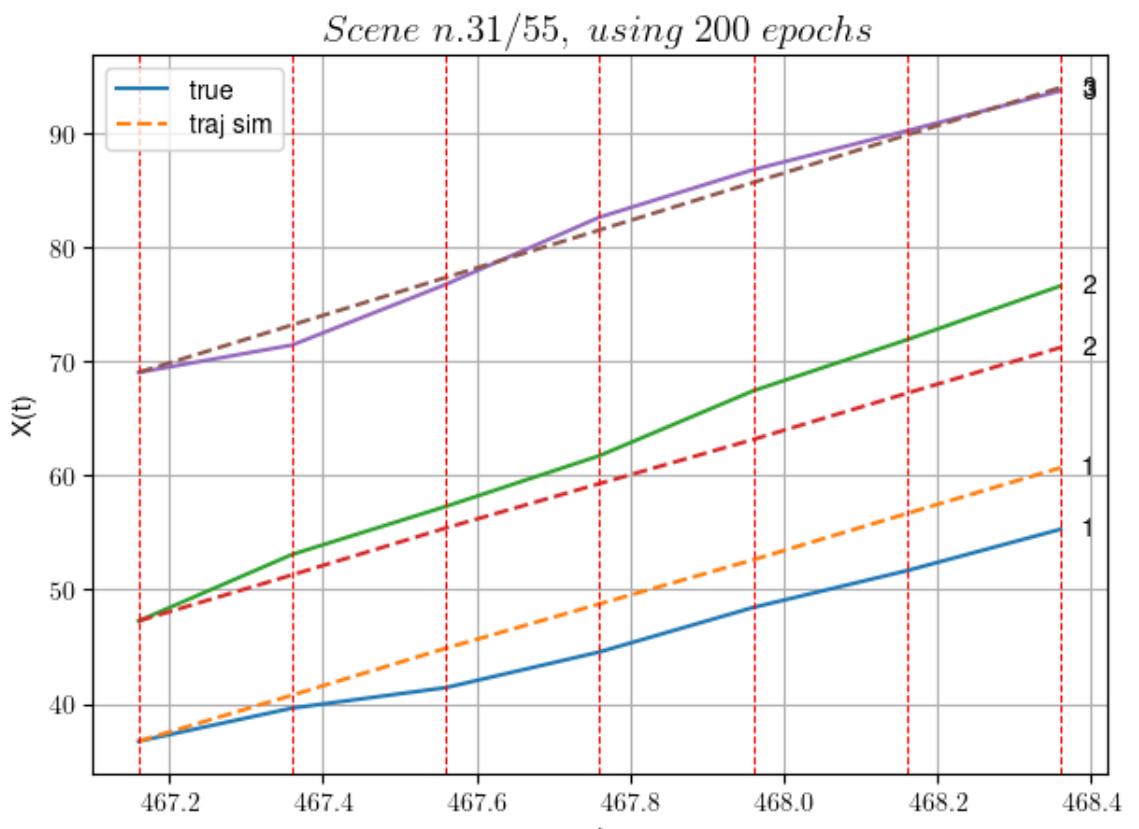
Loss: 2.213056104503791

v0 updated: 24.727874292569464

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Scene n.31/55, time interval:[467.16,468.36]

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Loss: 9.069239792360658  
v0 updated: 20.786390638769962

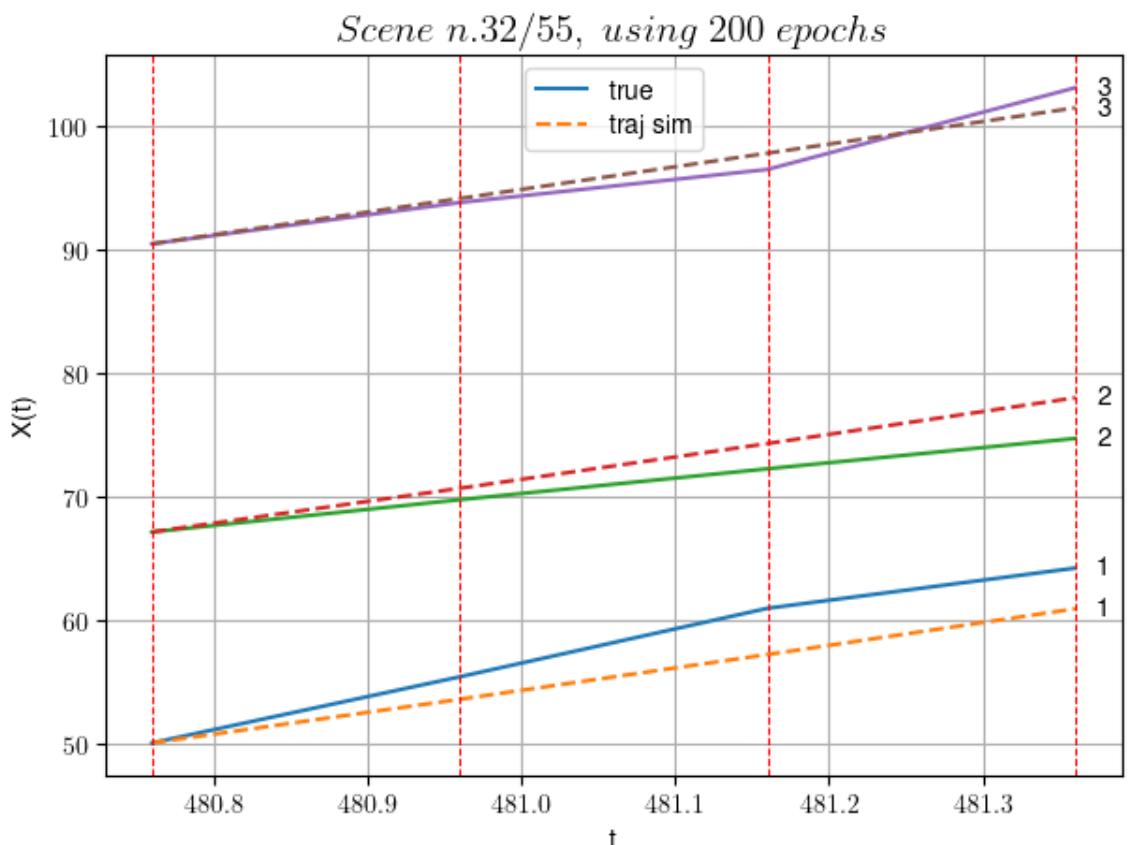
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Scene n.32/55, time interval:[480.76,481.36]

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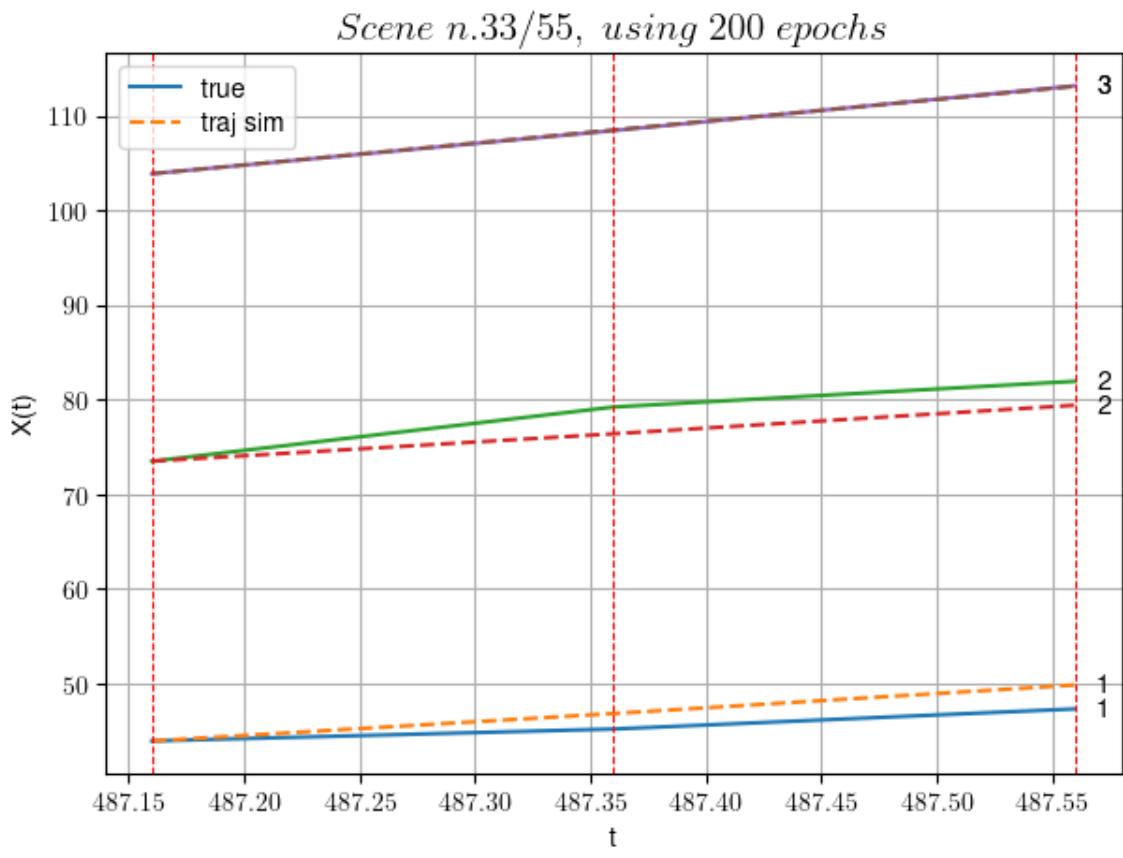


Loss: 4.030519898725794  
v0 updated: 18.31768317689234

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Scene n.33/55, time interval:[487.16,487.56]

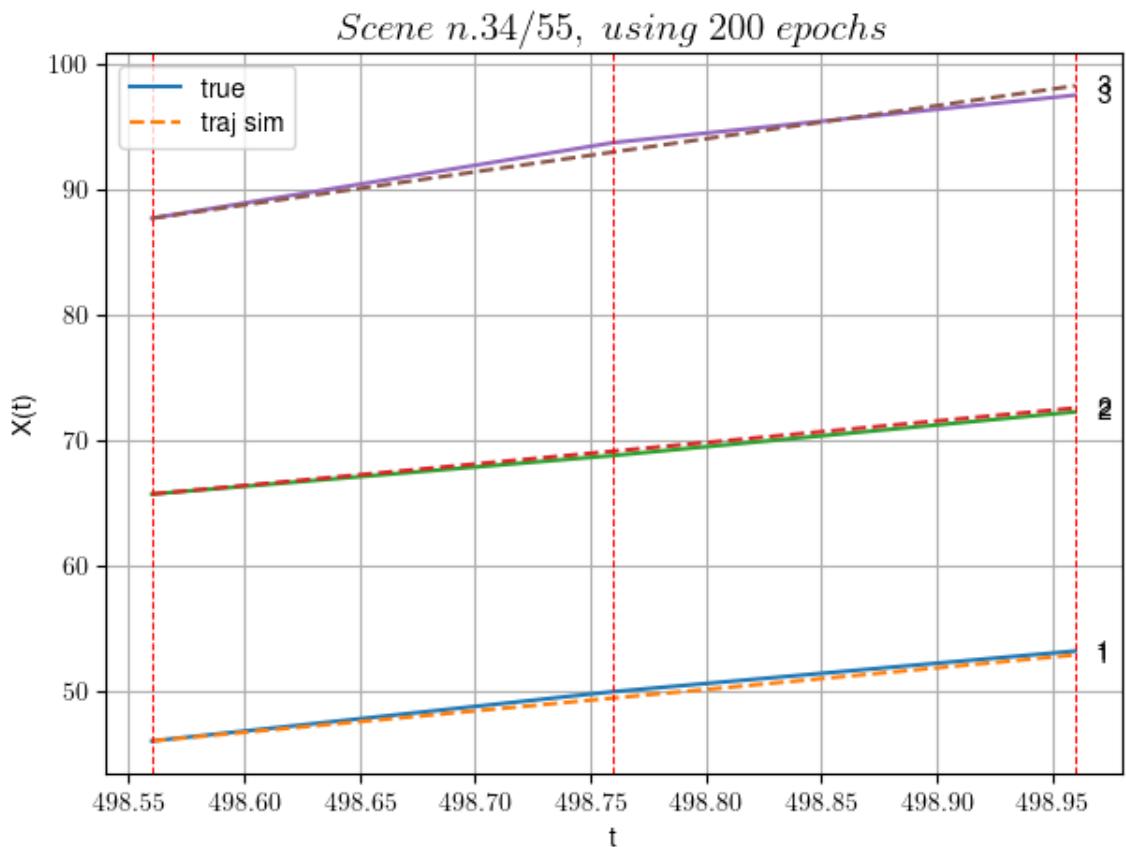
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Scene n.34/55, time interval:[498.56,498.96]

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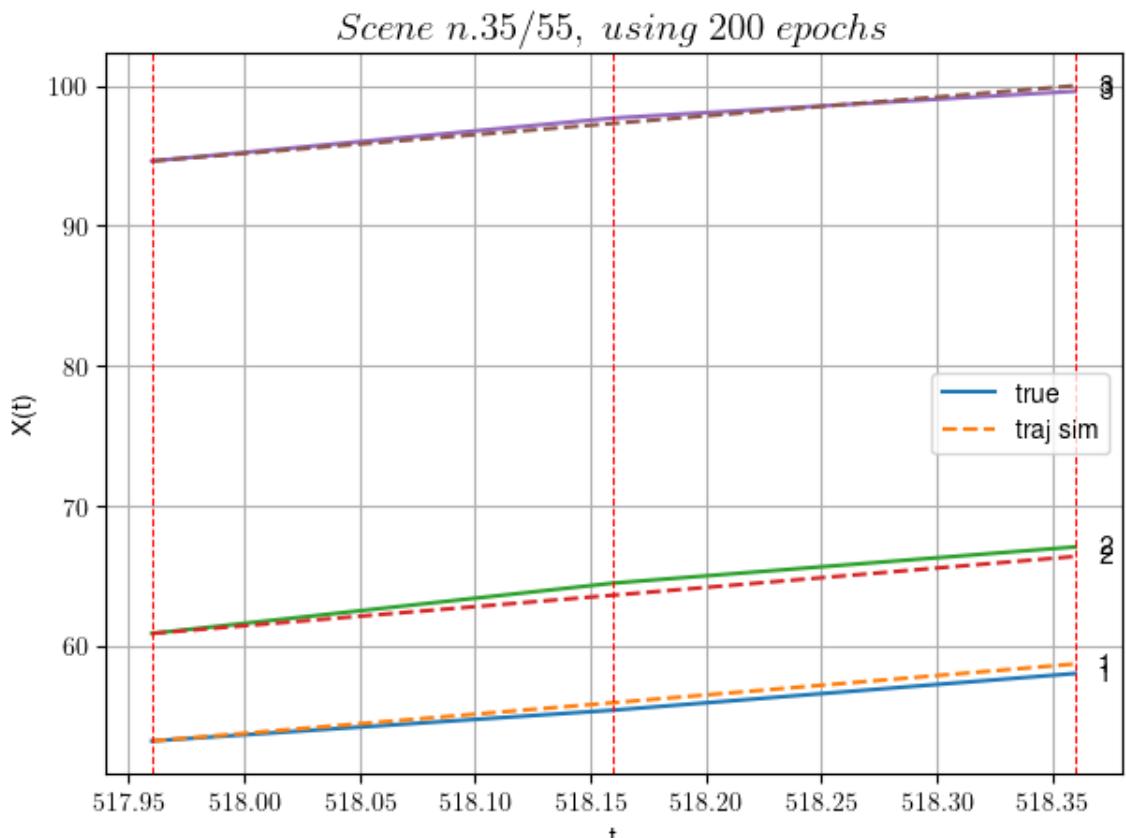


Loss: 0.18831510634036222  
v0 updated: 26.40821113207029

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Scene n.35/55, time interval:[517.96,518.36]

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Loss: 0.2510300759056301  
v0 updated: 13.453926468383587

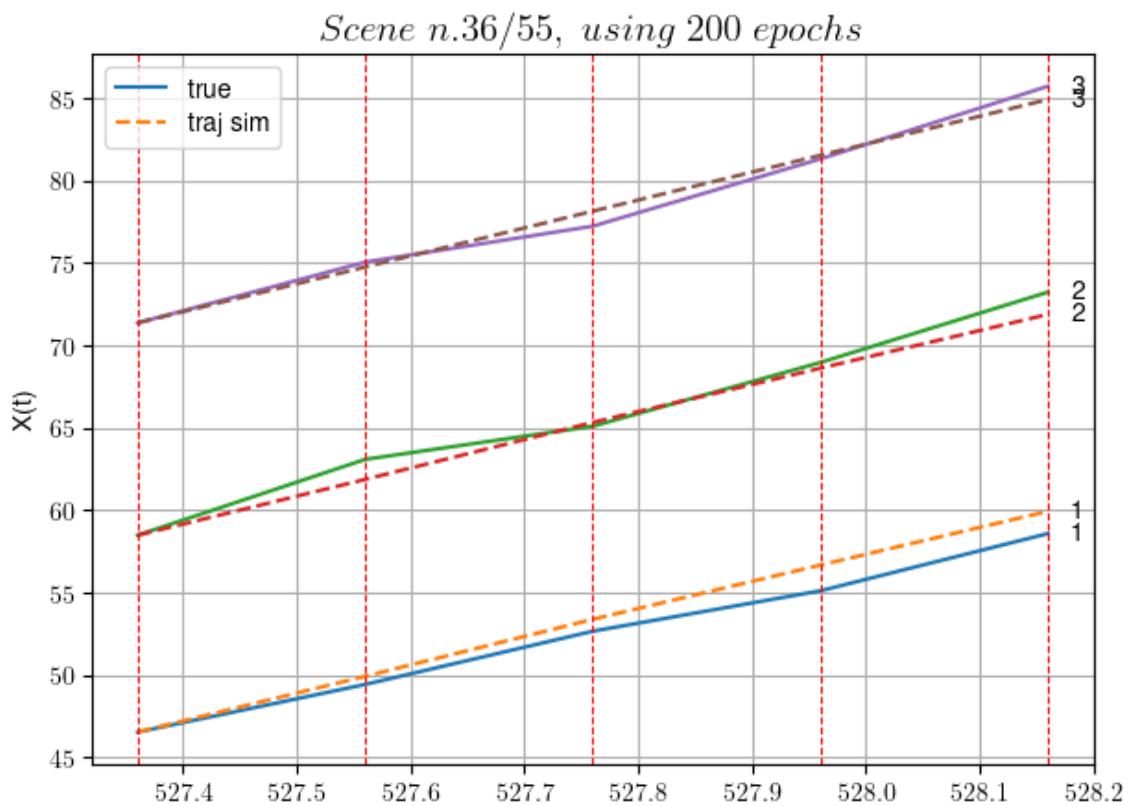
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Scene n.36/55, time interval:[527.36,528.16]

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Loss: 0.6743855766574655  
v0 updated: 16.935267042056086

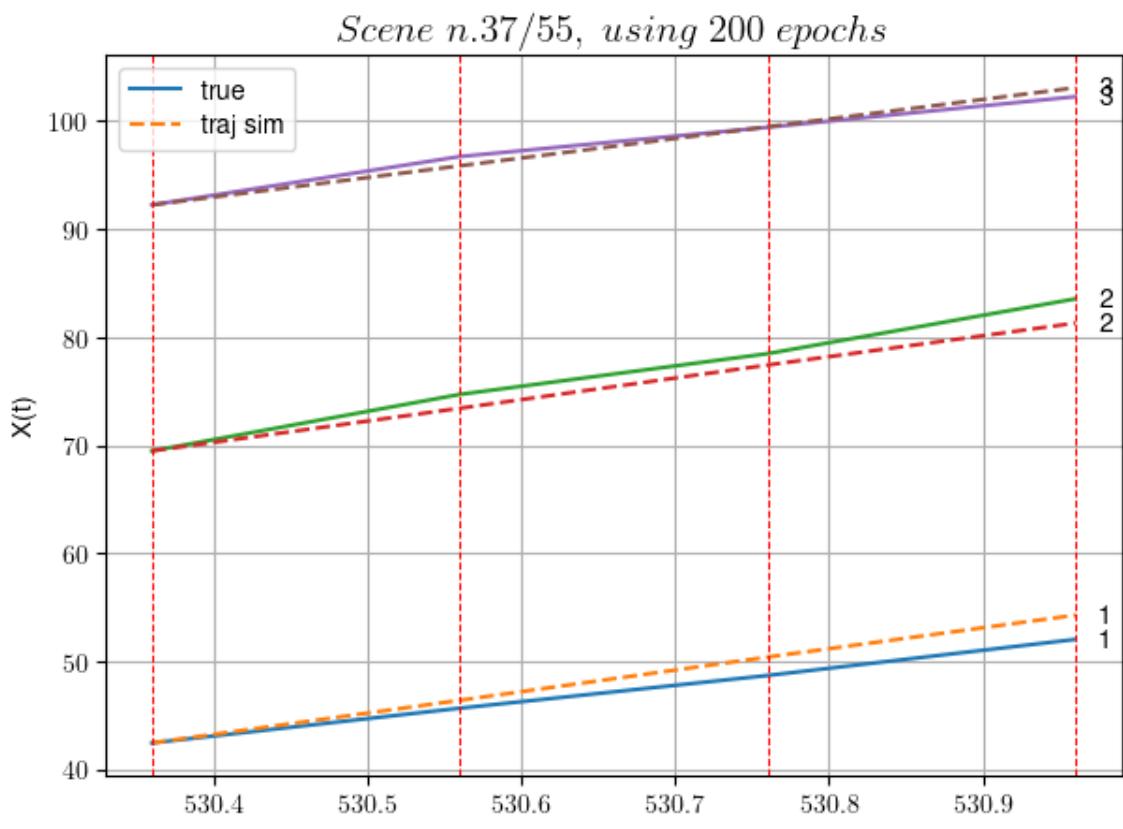
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Scene n.37/55, time interval:[530.36,530.96]

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Loss: 1.4736346805062757  
v0 updated: 18.067971080825455

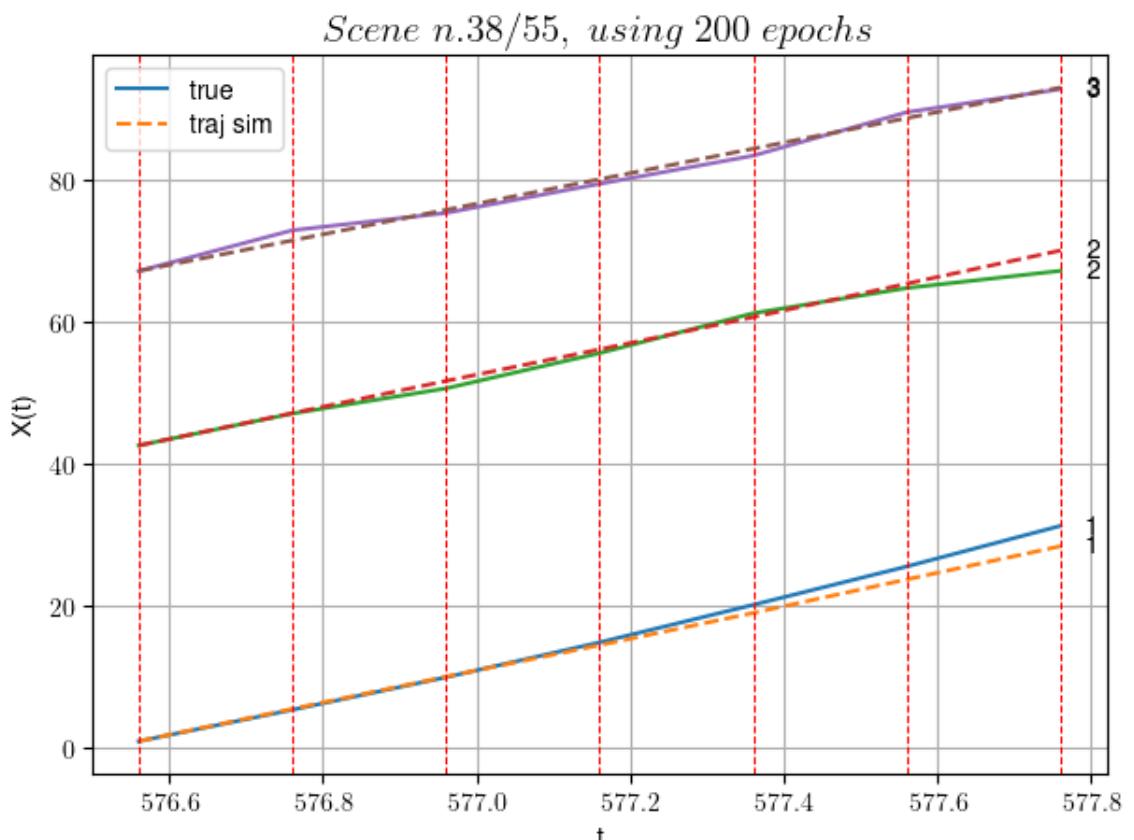
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Scene n.38/55, time interval:[576.56,577.76]

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Loss: 1.31705743883455  
v0 updated: 21.52600293608991

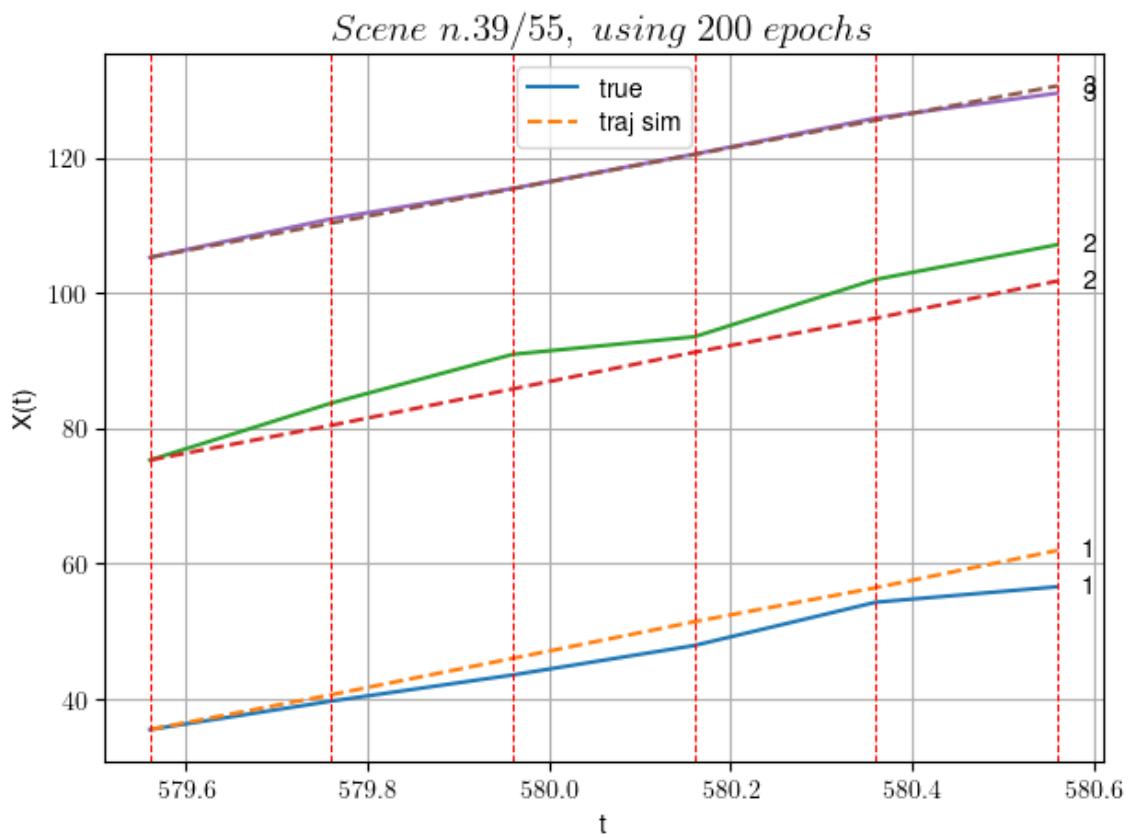
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Scene n.39/55, time interval:[579.56,580.56]

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Loss: 8.804431783625555  
v0 updated: 25.36350099714996

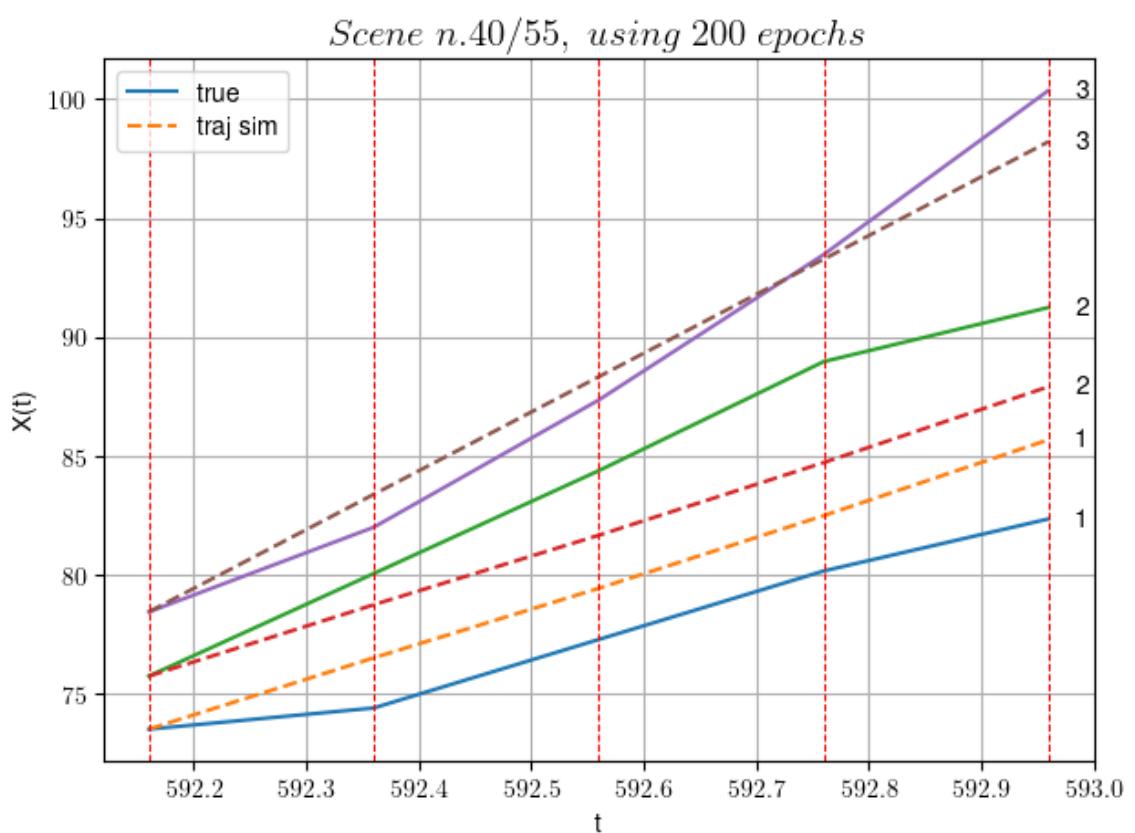
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Scene n.40/55, time interval:[592.16,592.96]

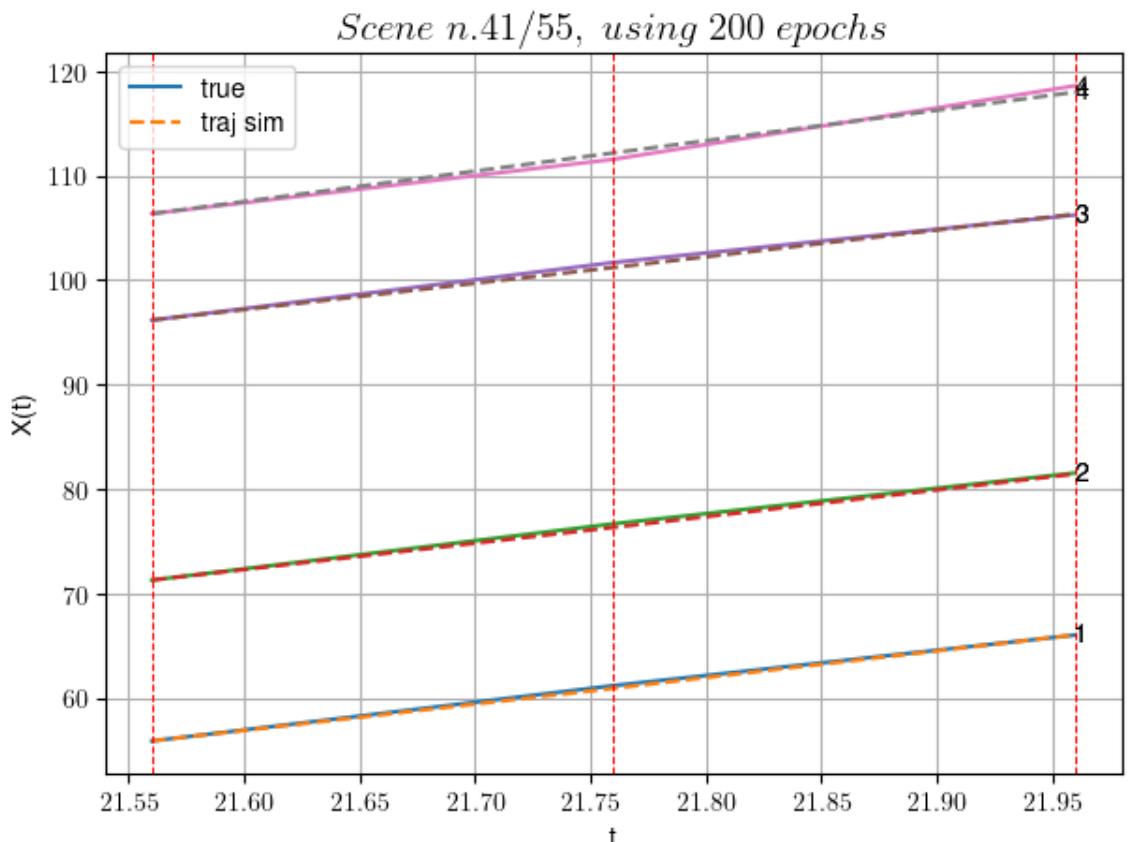
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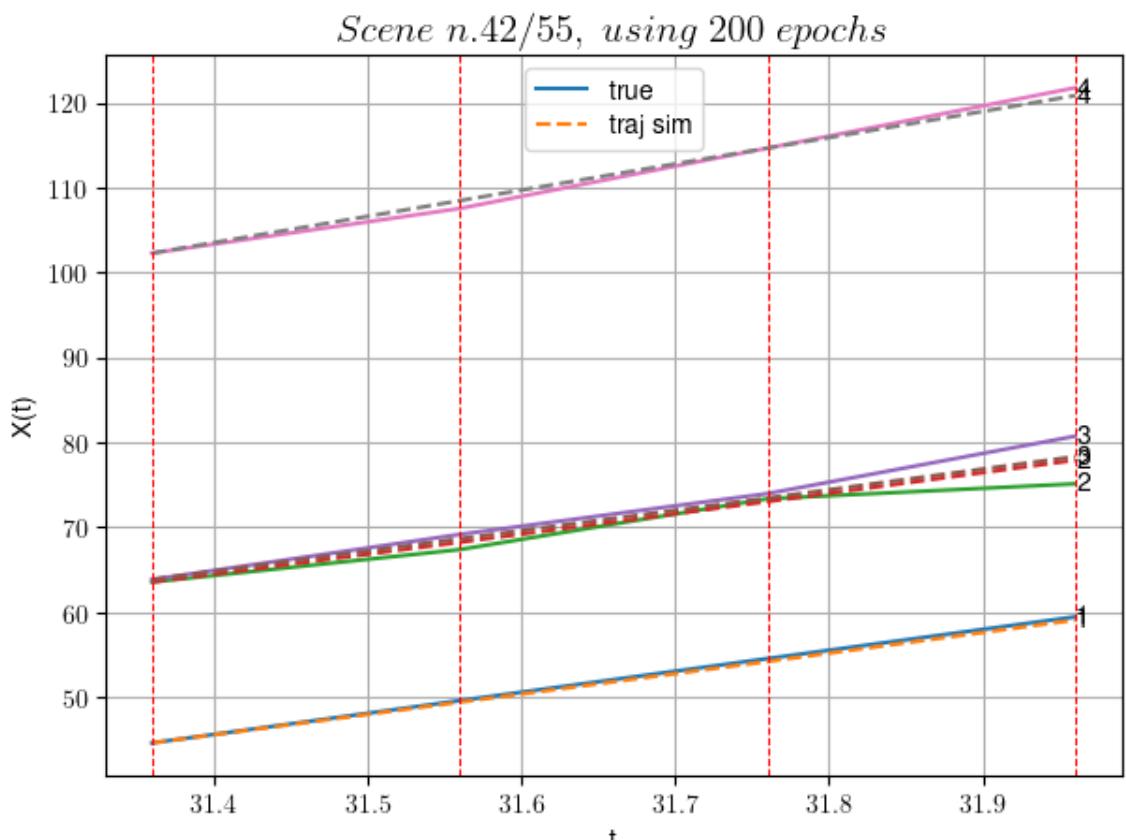
Loss: 4.7550046660533445  
v0 updated: 24.715789260210165

Scene n.41/55, time interval:[21.56,21.96]



Loss: 0.09877804499328294  
v0 updated: 29.08930460717769

Scene n.42/55, time interval:[31.36,31.96]

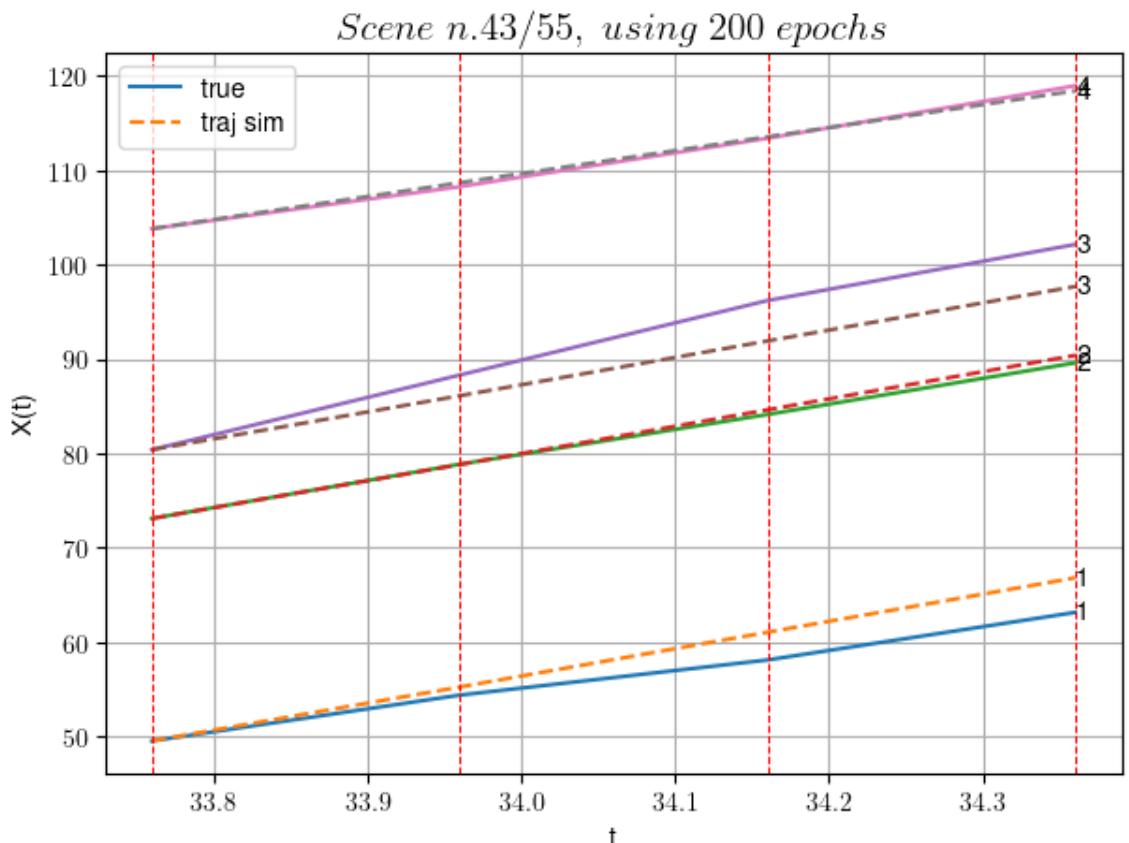


Loss: 1.0576774699796916  
v0 updated: 30.91152272256765

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Scene n.43/55, time interval:[33.76,34.36]

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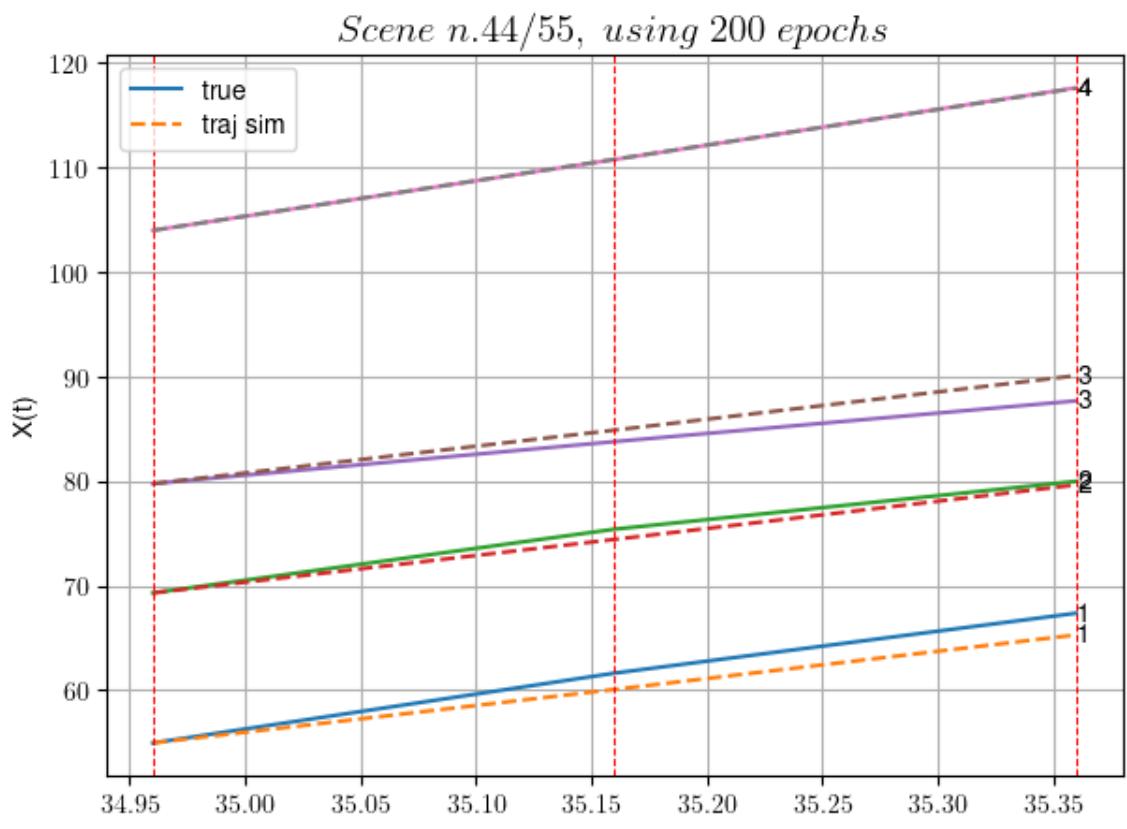


Loss: 4.203071994227673  
v0 updated: 24.350672666072207

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Scene n.44/55, time interval:[34.96,35.36]

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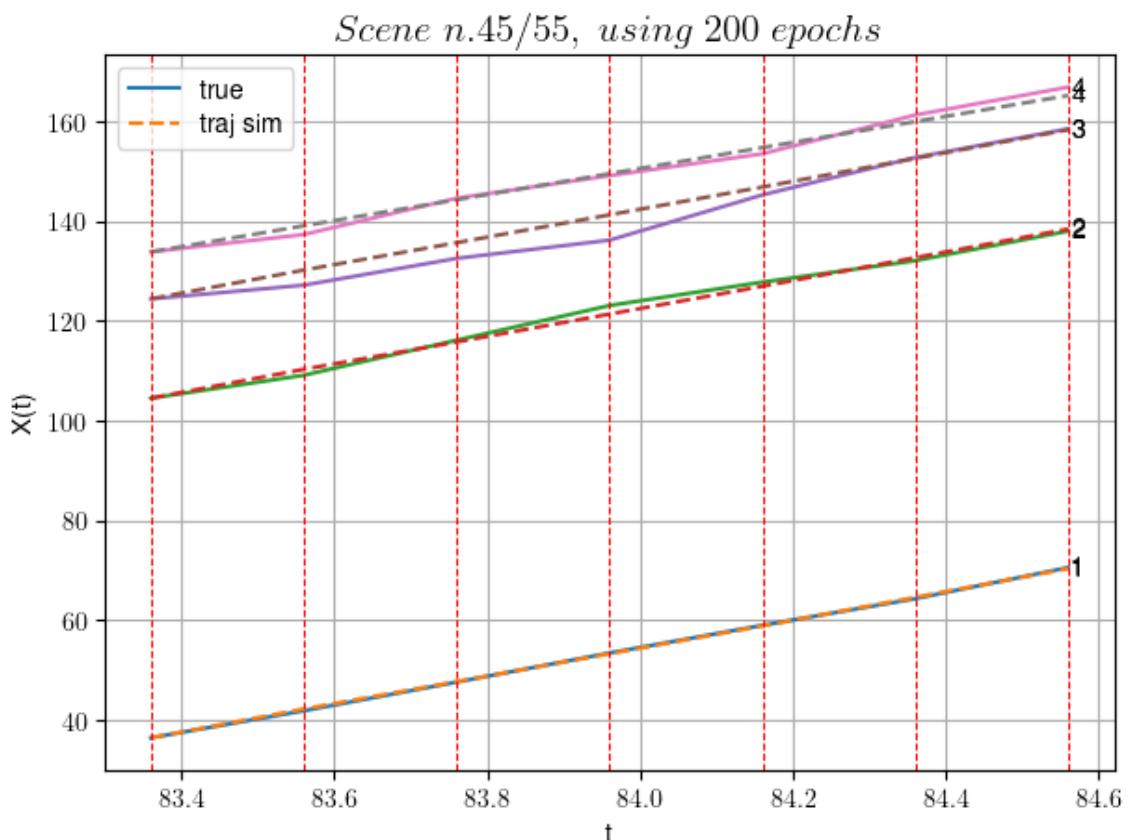


Loss: 1.2378703185576205  
v0 updated: 34.01960344941417

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Scene n.45/55, time interval:[83.36,84.56]

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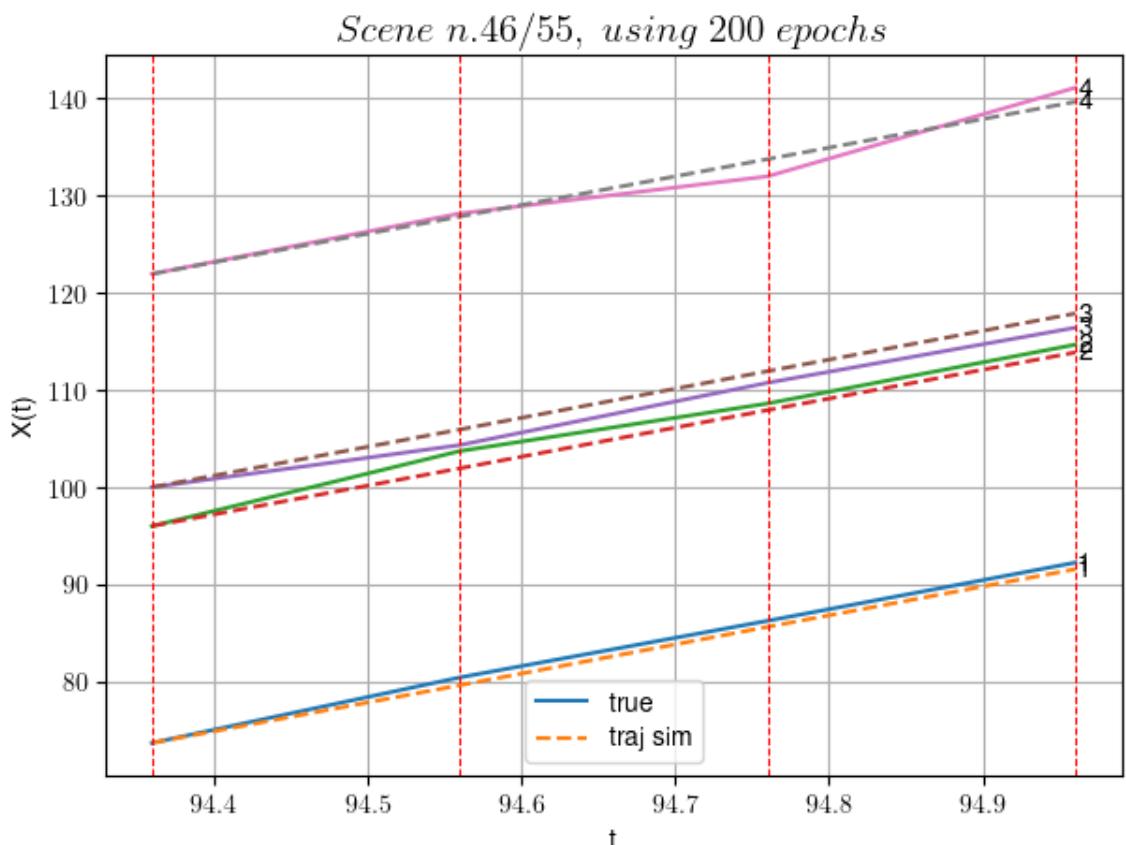


Loss: 2.249874666033817  
v0 updated: 26.131707170269824

---

Scene n.46/55, time interval:[94.36,94.96]

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Loss: 1.0751482658698022  
v0 updated: 29.52907574185515

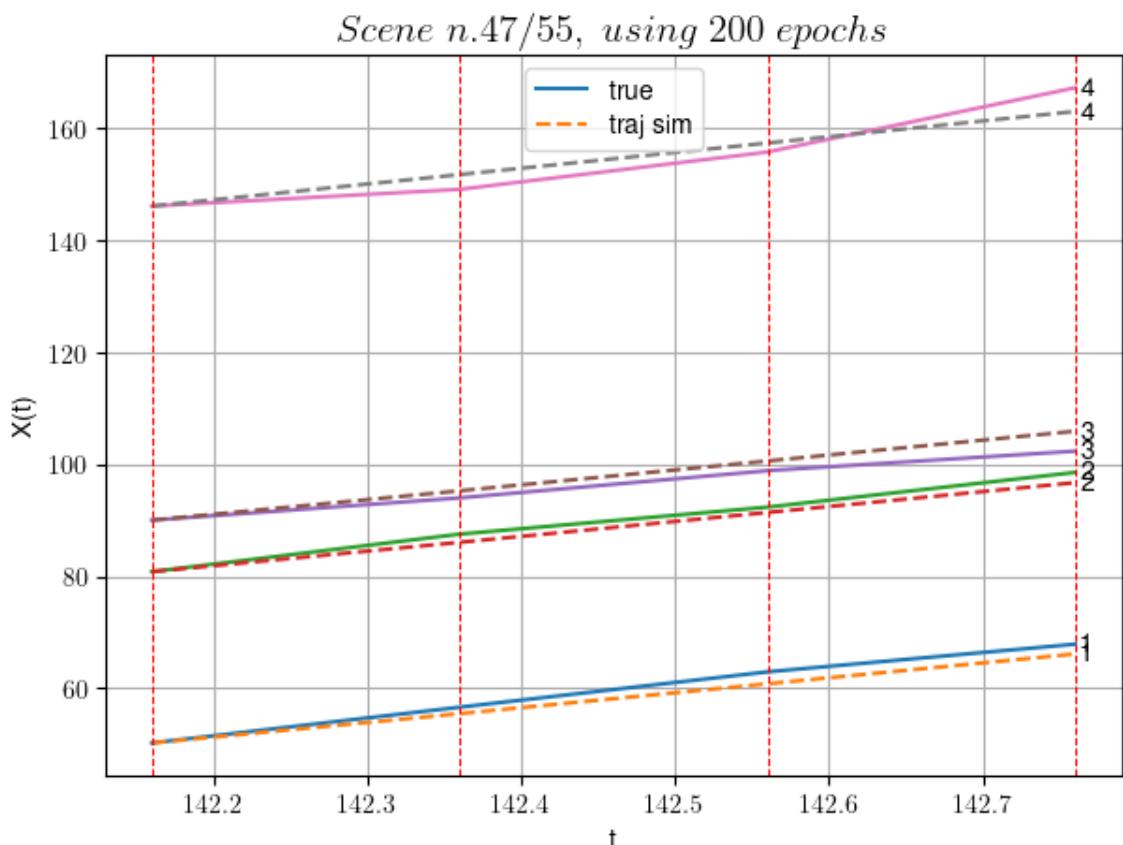
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Scene n.47/55, time interval:[142.16,142.76]

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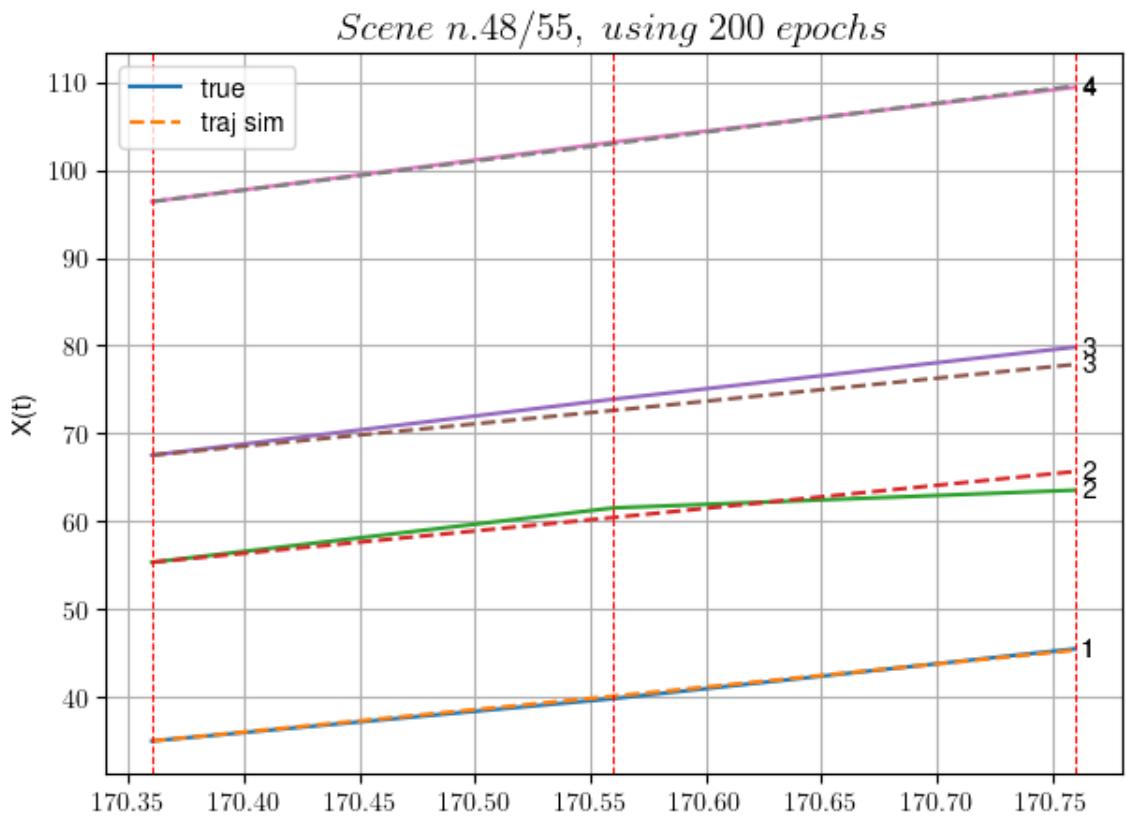


Loss: 3.753000128471376  
v0 updated: 28.13281408756362

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Scene n.48/55, time interval:[170.36,170.76]

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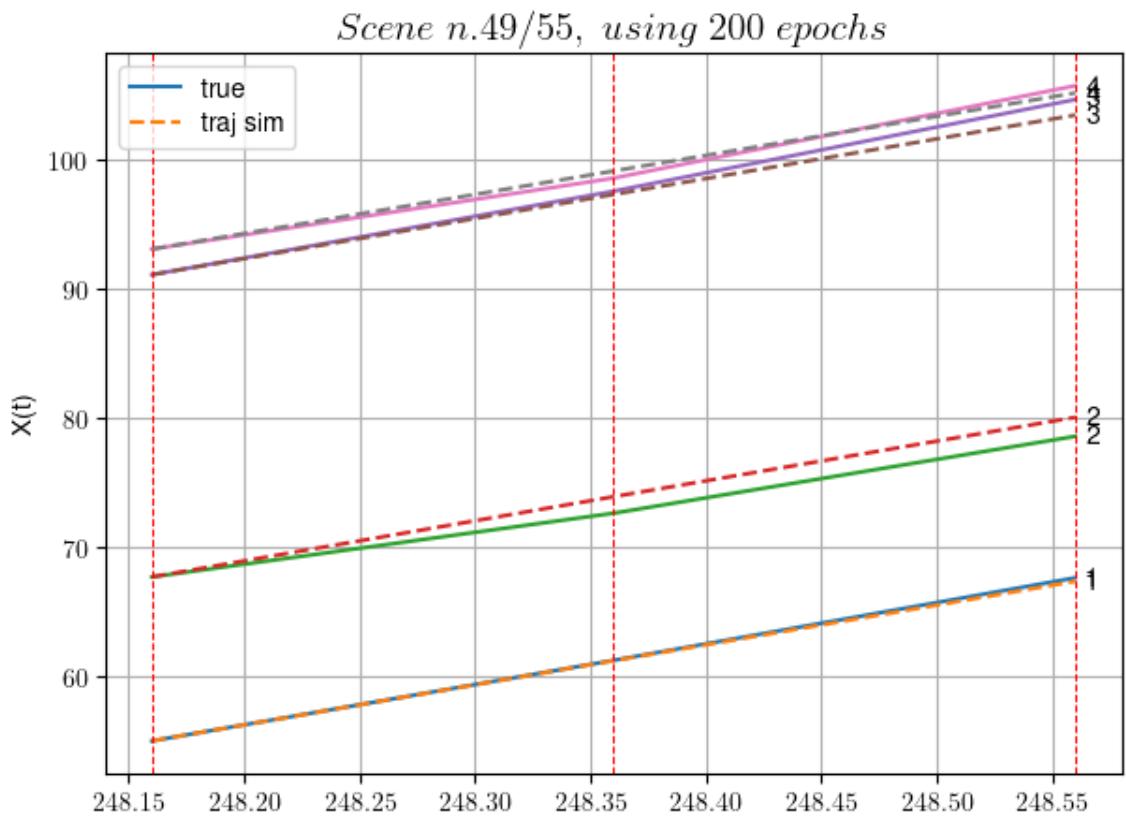


Loss: 0.946580330466954  
v0 updated: 32.978076203930534

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Scene n.49/55, time interval:[248.16,248.56]

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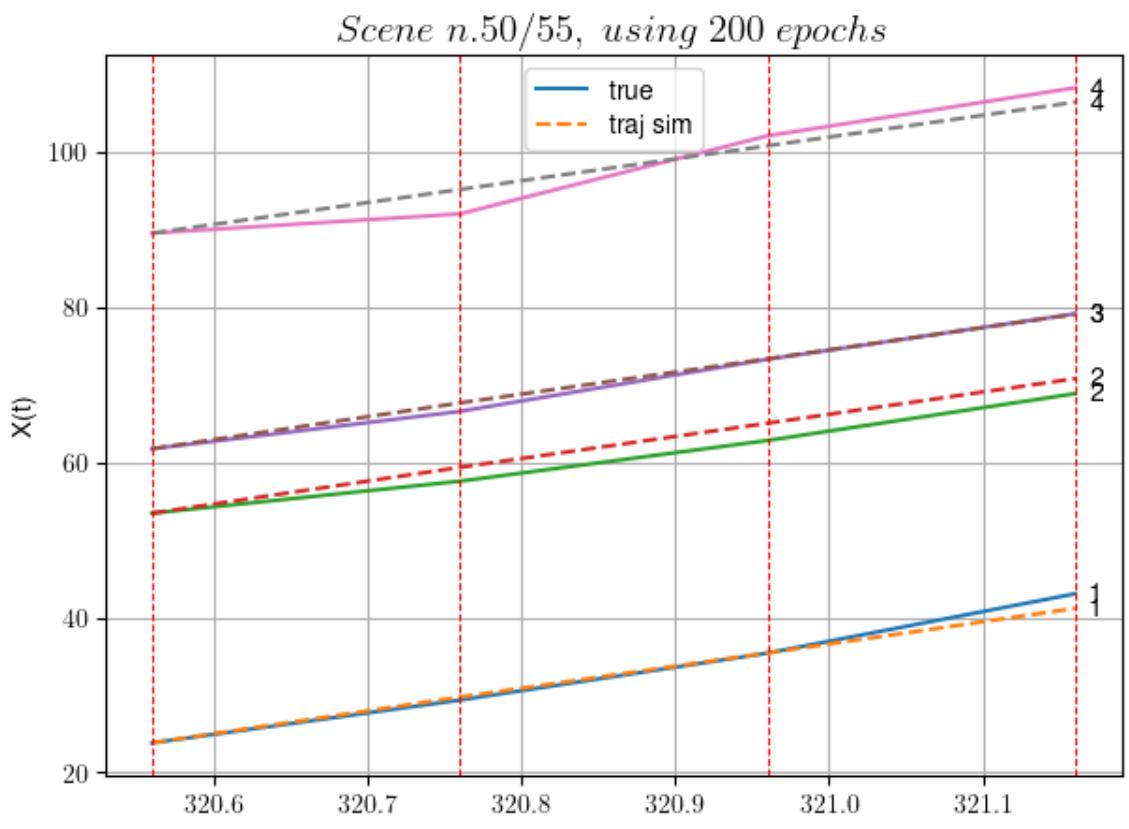


Loss: 0.5005418958944632  
v0 updated: 30.247436531641956

---

Scene n.50/55, time interval:[320.56,321.16]

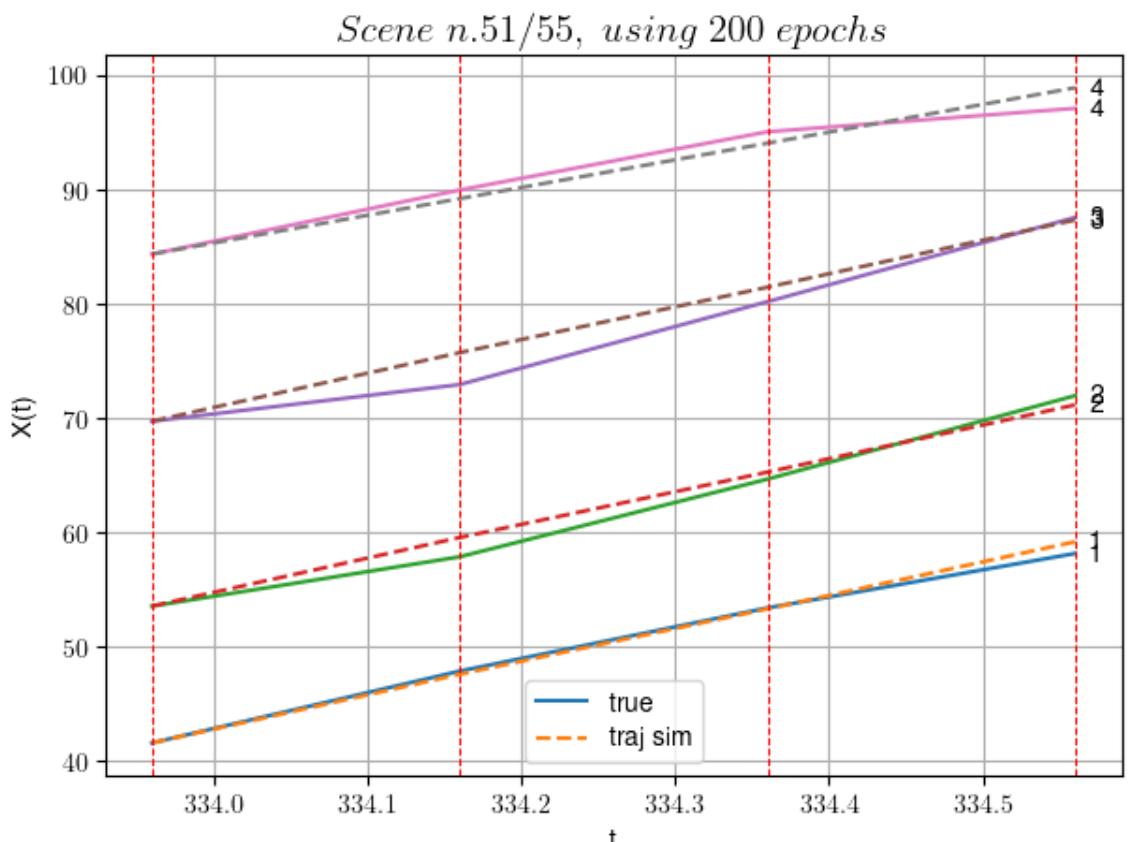
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Scene n.51/55, time interval:[333.96,334.56]

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Loss: 1.2044664304797075  
v0 updated: 24.25439744624117

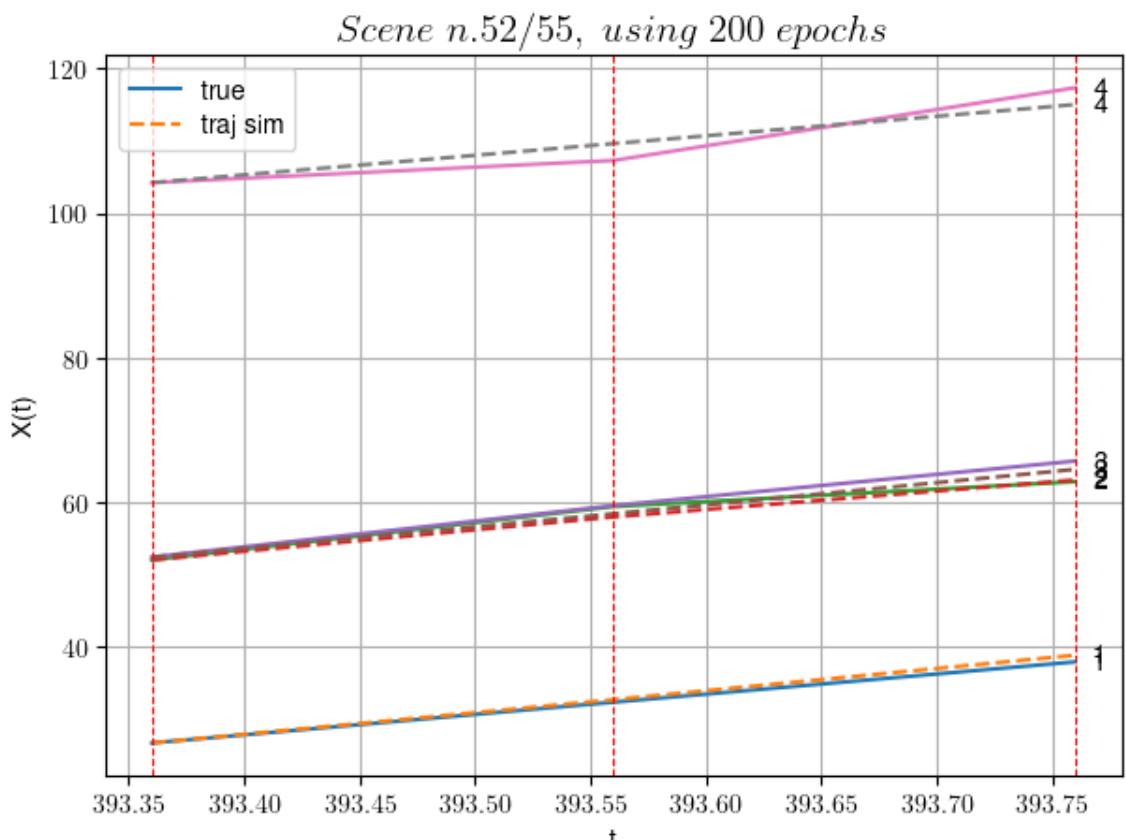
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Scene n.52/55, time interval:[393.36,393.76]

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Loss: 1.3778214075842672  
v0 updated: 27.024739809175404

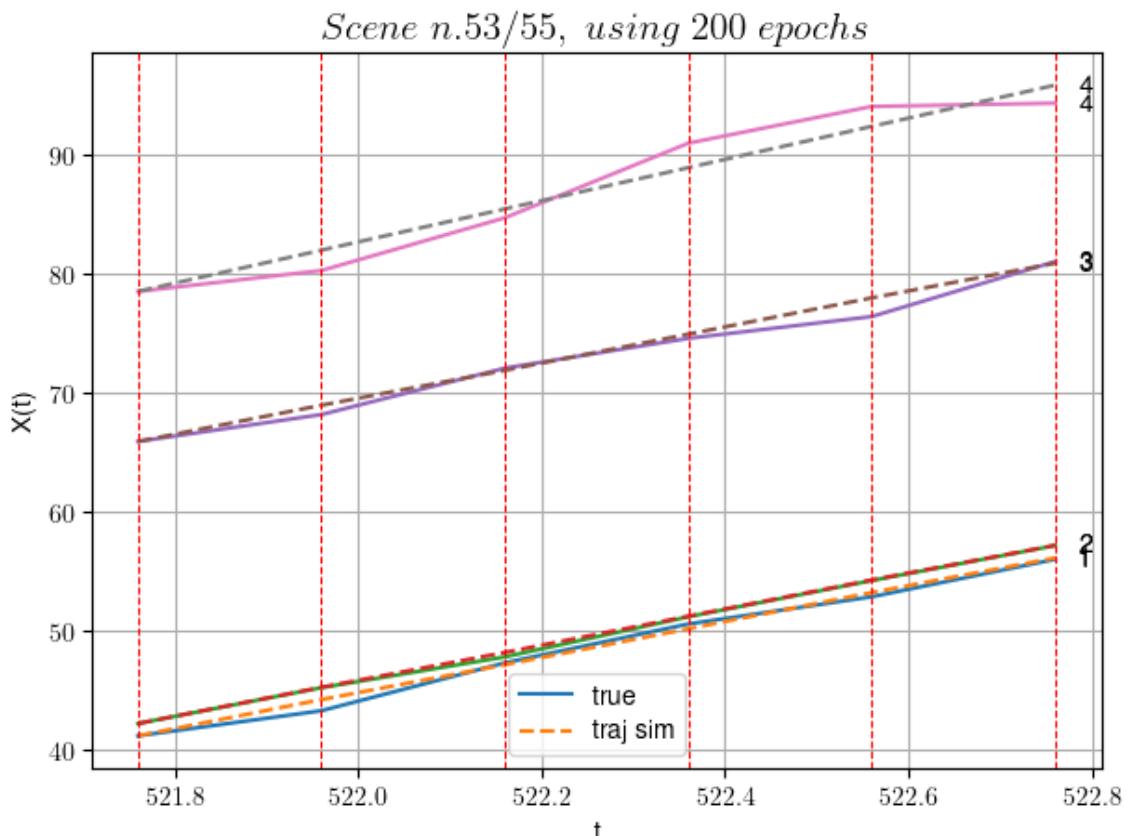
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Scene n.53/55, time interval:[521.76,522.76]

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Loss: 0.7246924201135431  
v0 updated: 17.32636276783626

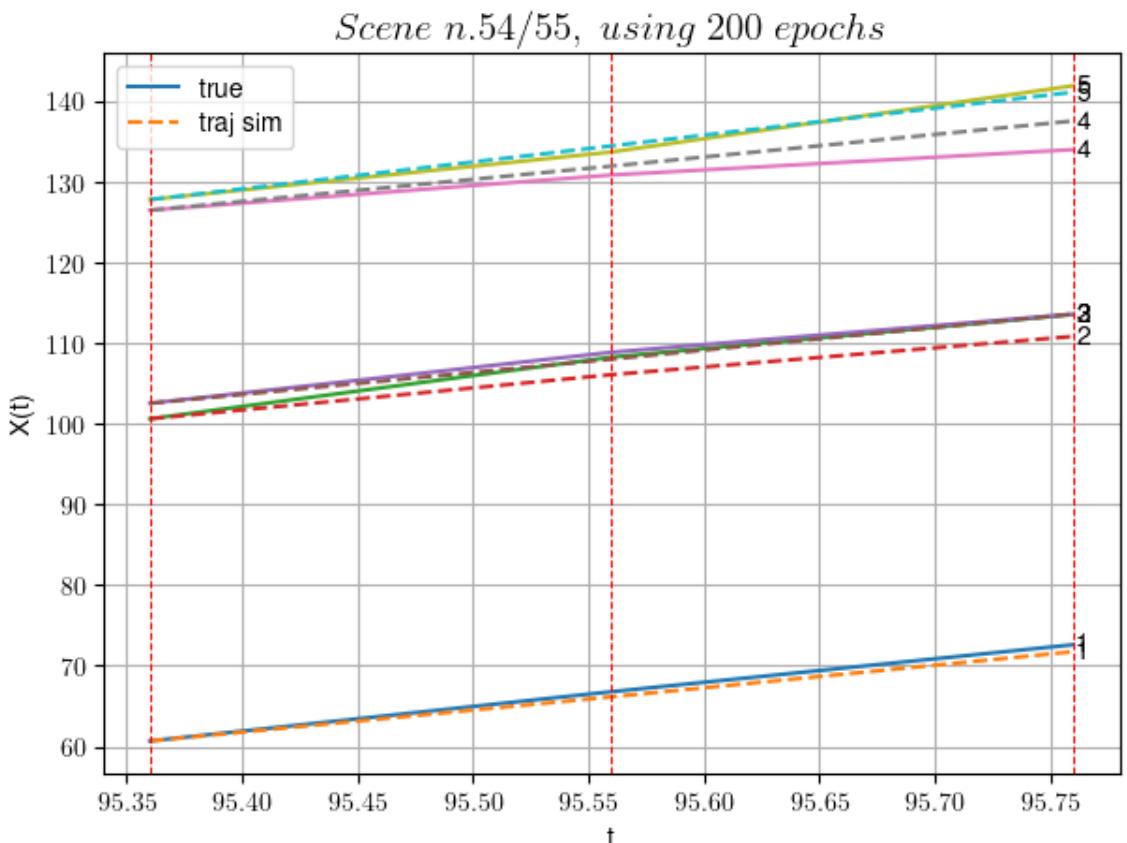
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Scene n.54/55, time interval:[95.36,95.76]

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Loss: 1.9373329861633362  
v0 updated: 33.293747251049474

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v0\_mean in this df is: 28.553527636062665  
Time taken: 327.93s

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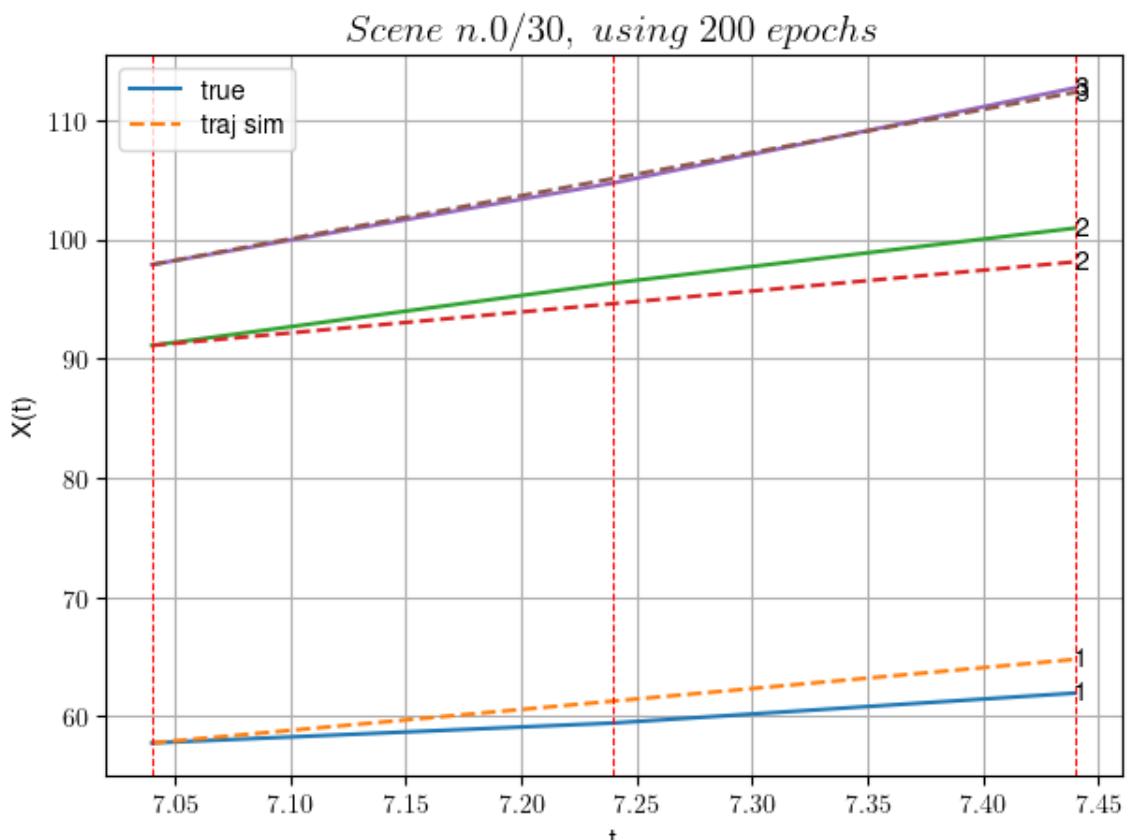
In df n.4/10 we have 30 scenes

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Scene n.0/30, time interval:[7.04, 7.44]

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Loss: 2.51731066638844  
v0 updated: 36.147472929252125

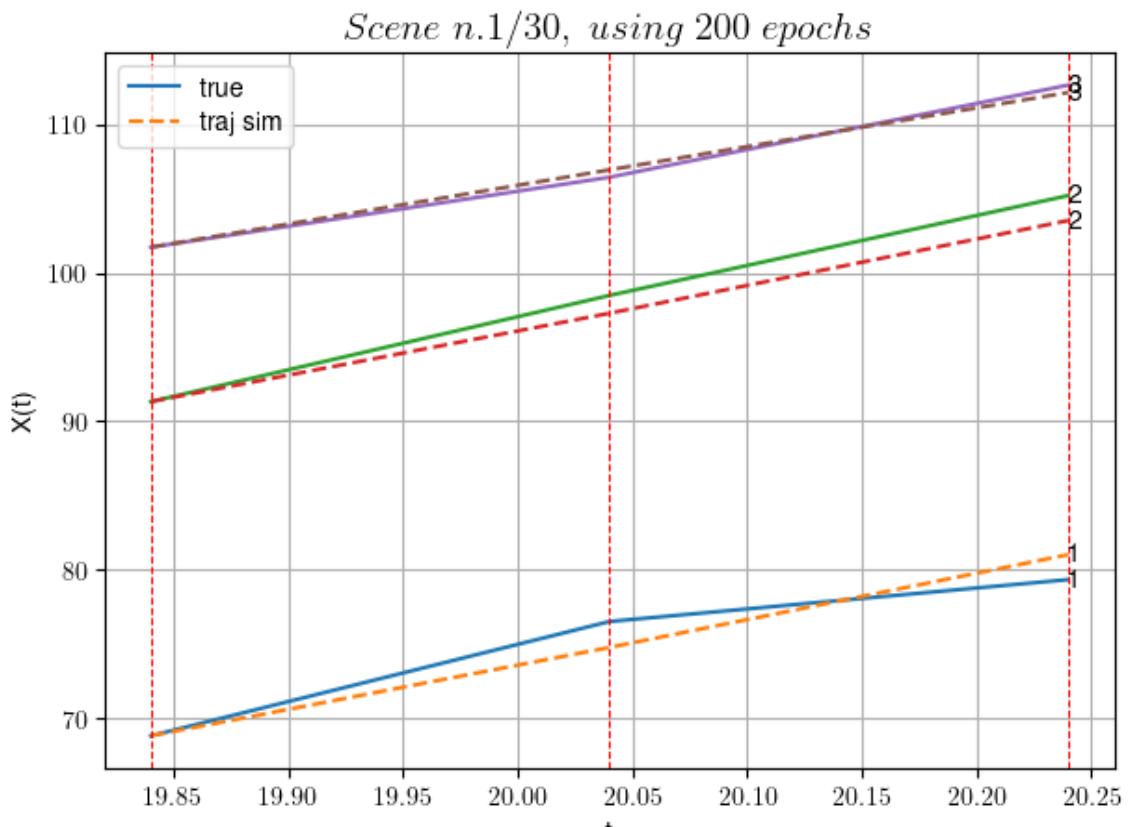
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Scene n.1/30, time interval:[19.84,20.24]

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Loss: 1.1812223205455992  
v0 updated: 26.06329397762493

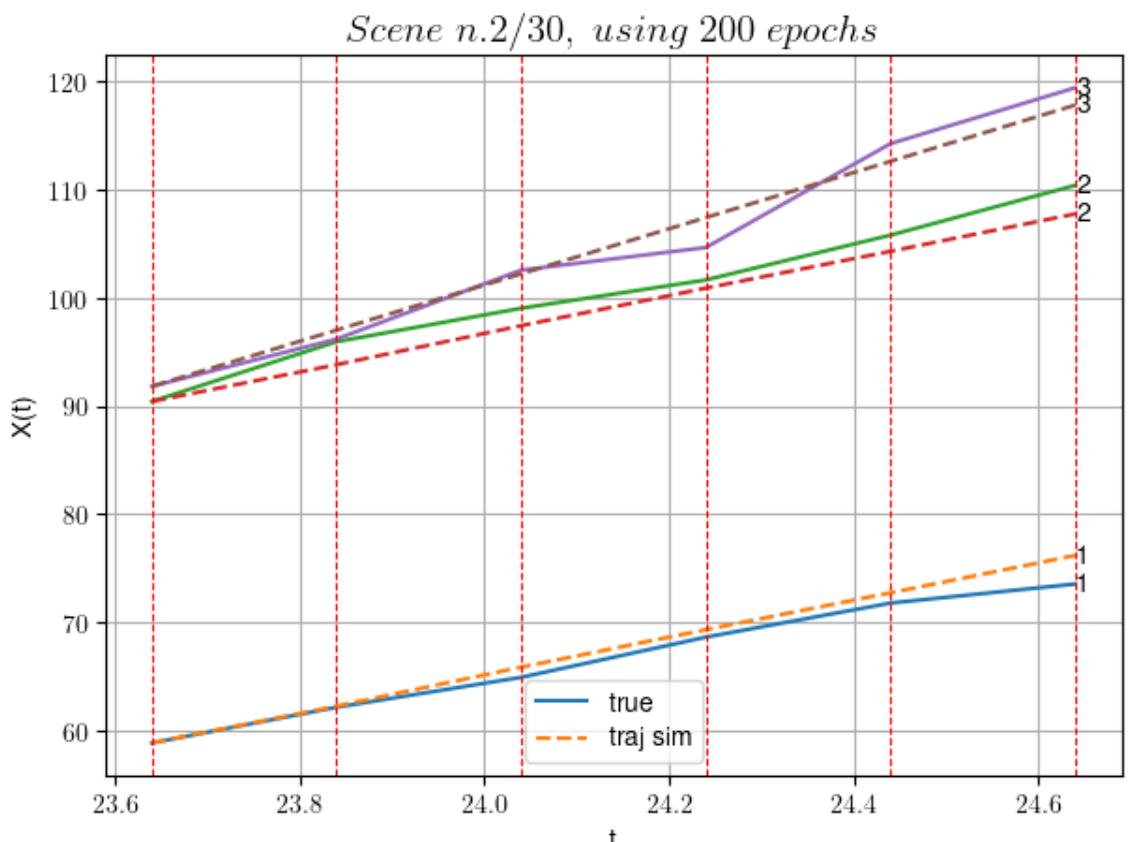
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Scene n.2/30, time interval:[23.64,24.64]

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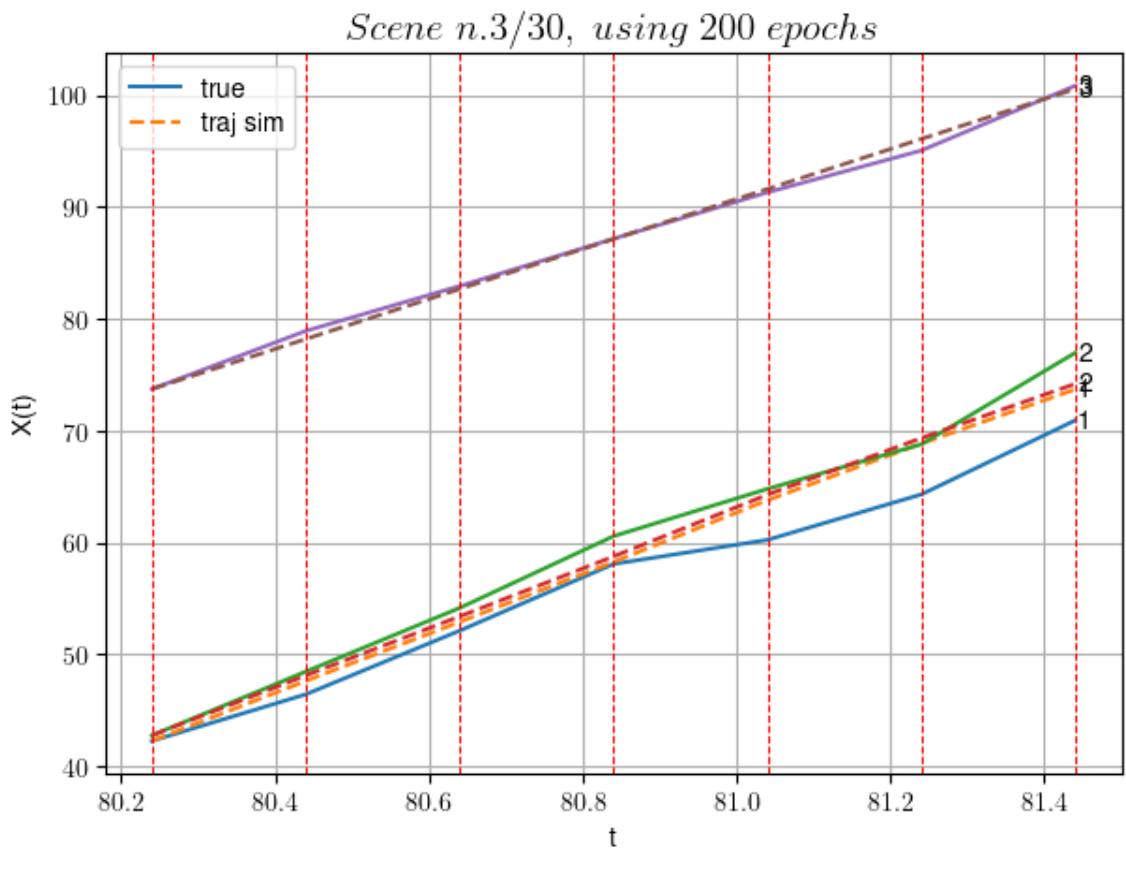
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Scene n.3/30, time interval:[80.24,81.44]

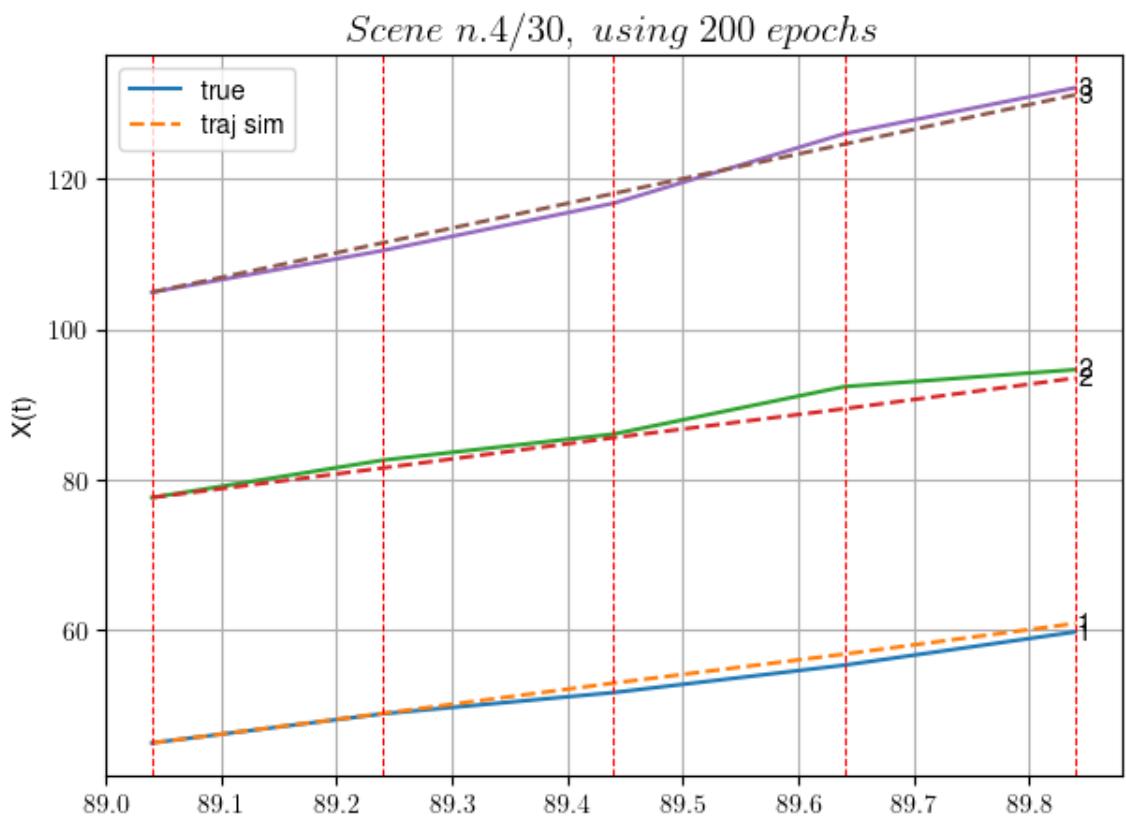
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Scene n.4/30, time interval:[89.04,89.84]

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Loss: 1.4451992409952048  
v0 updated: 32.77238417172515

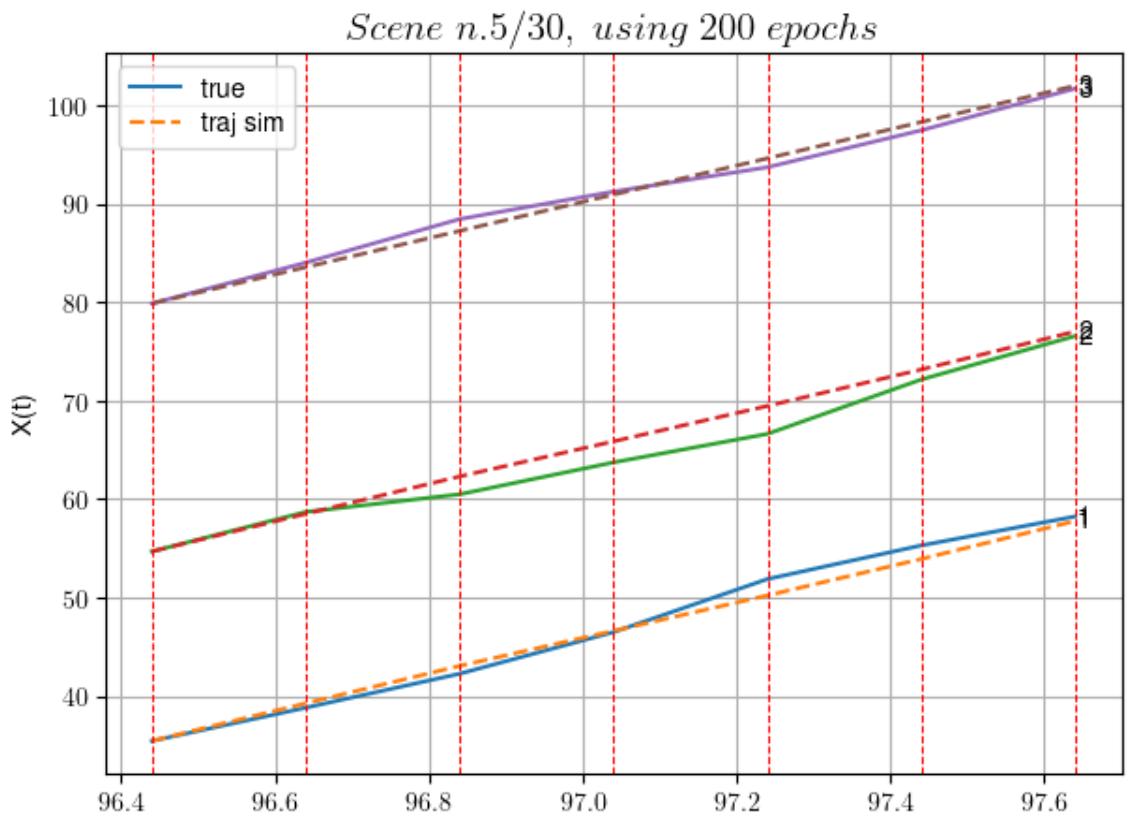
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Scene n.5/30, time interval:[96.44,97.64]

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Loss: 1.2476979579362057  
v0 updated: 18.41401615430983

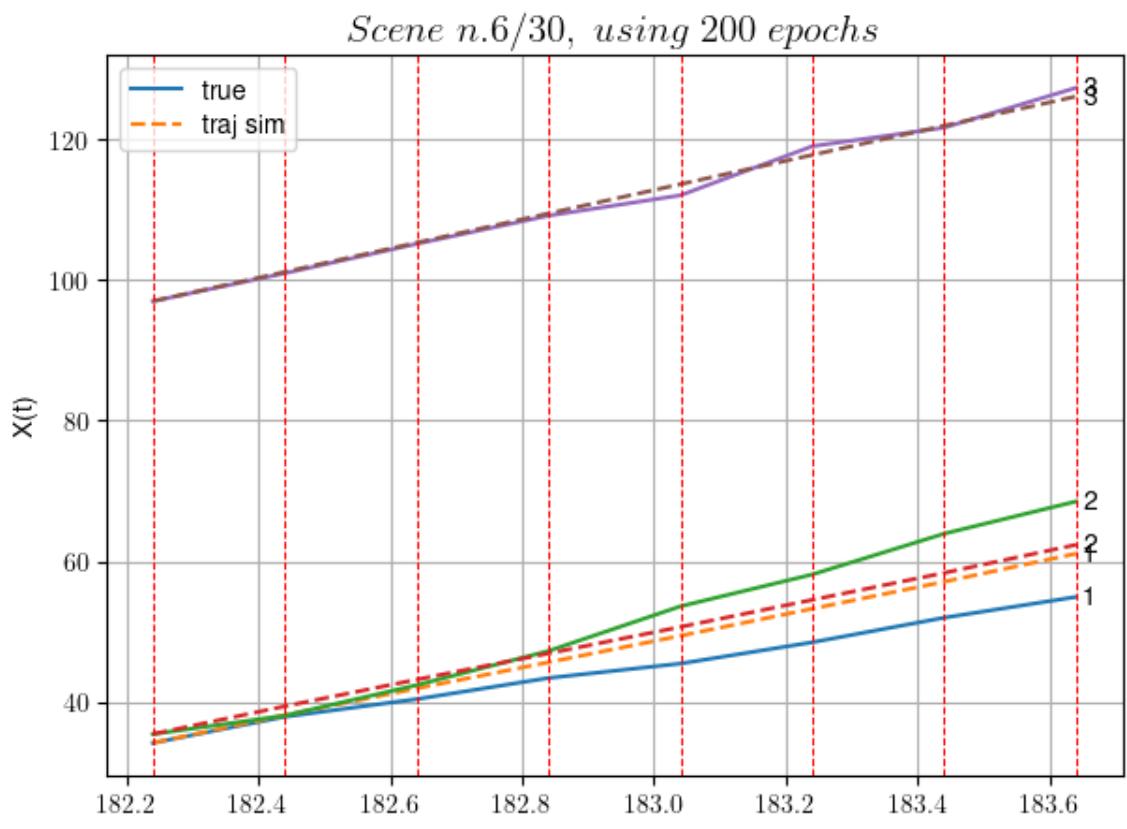
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Scene n.6/30, time interval:[182.24,183.64]

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Loss: 8.686834293644607  
v0 updated: 20.78333071696649

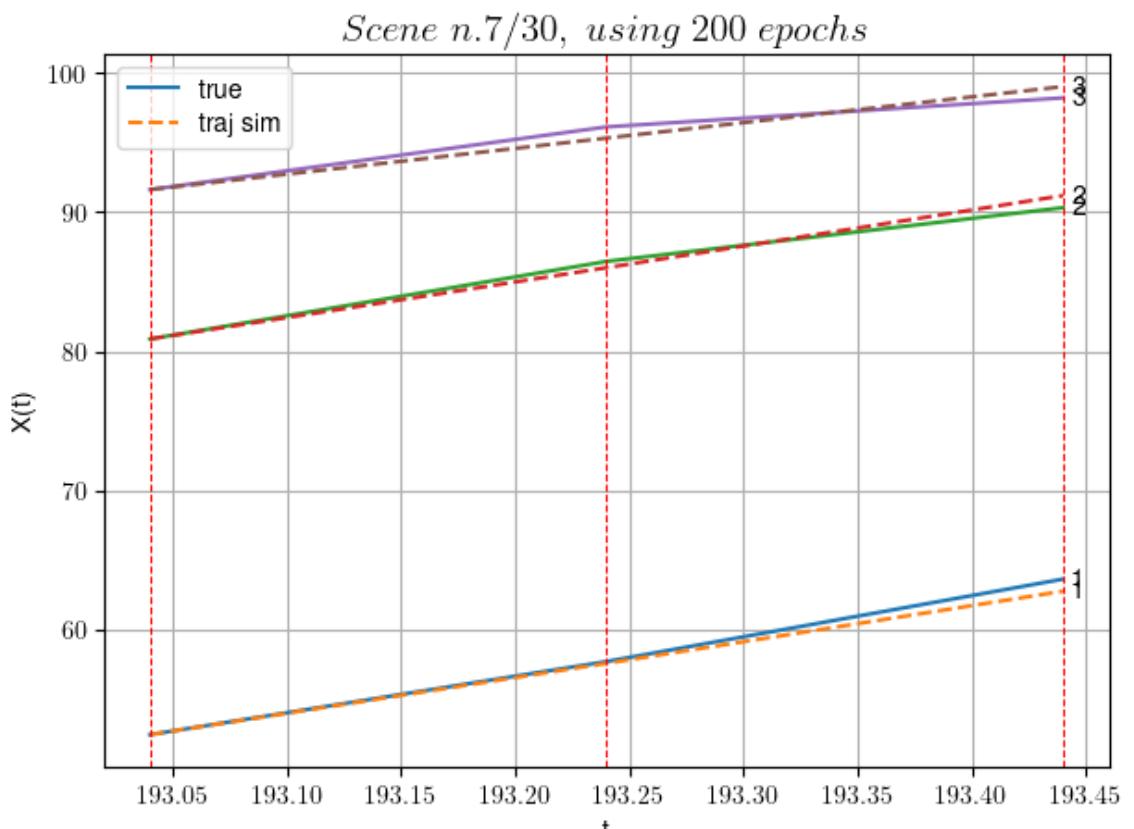
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Scene n.7/30, time interval:[193.04,193.44]

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Loss: 0.3385878927494493  
v0 updated: 18.519148732885238

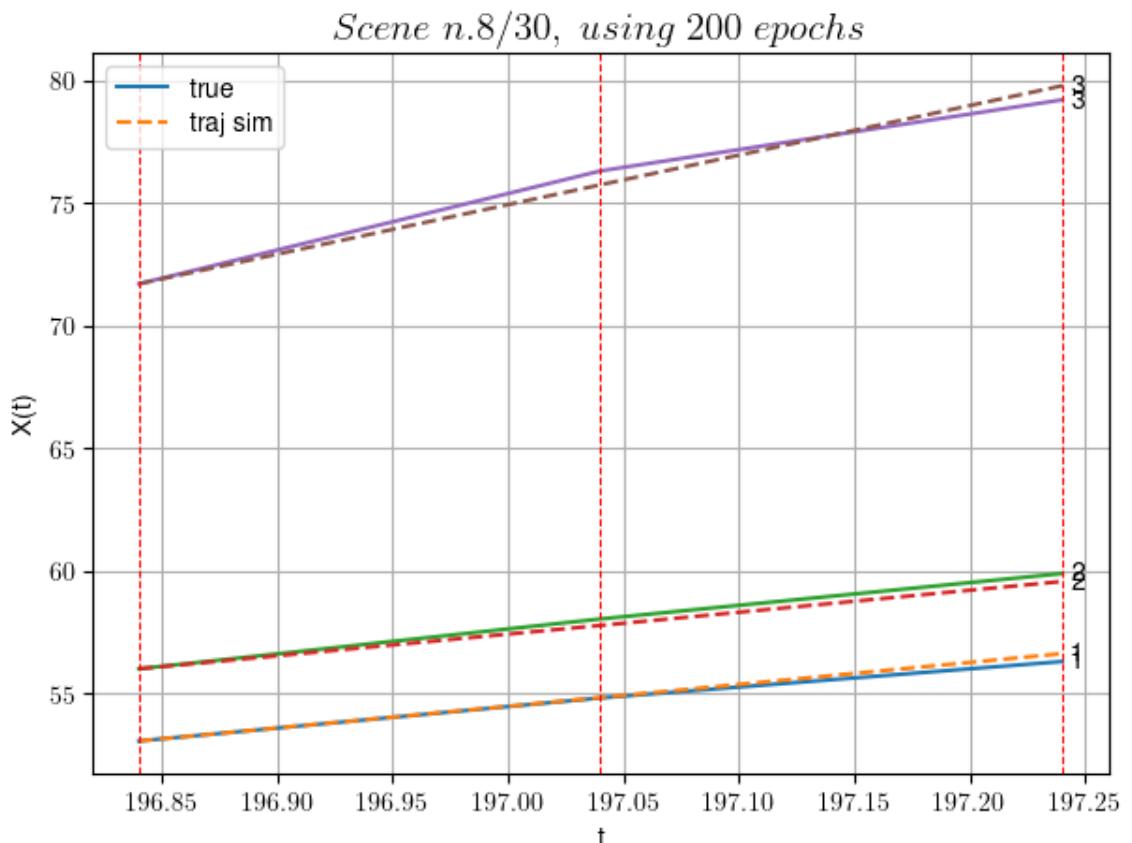
---

---

Scene n.8/30, time interval:[196.84,197.24]

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---



Loss: 0.10307610701439758  
v0 updated: 20.19954608763423

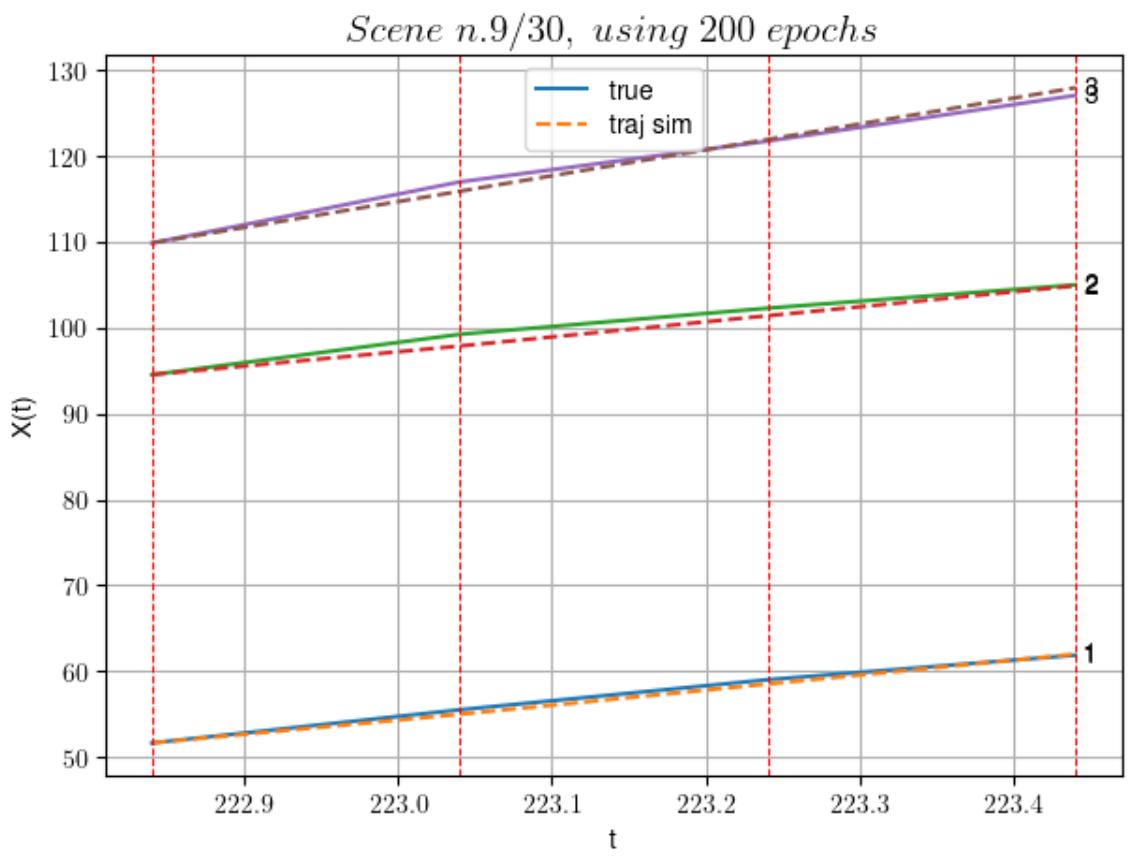
---

---

Scene n.9/30, time interval:[222.84,223.44]

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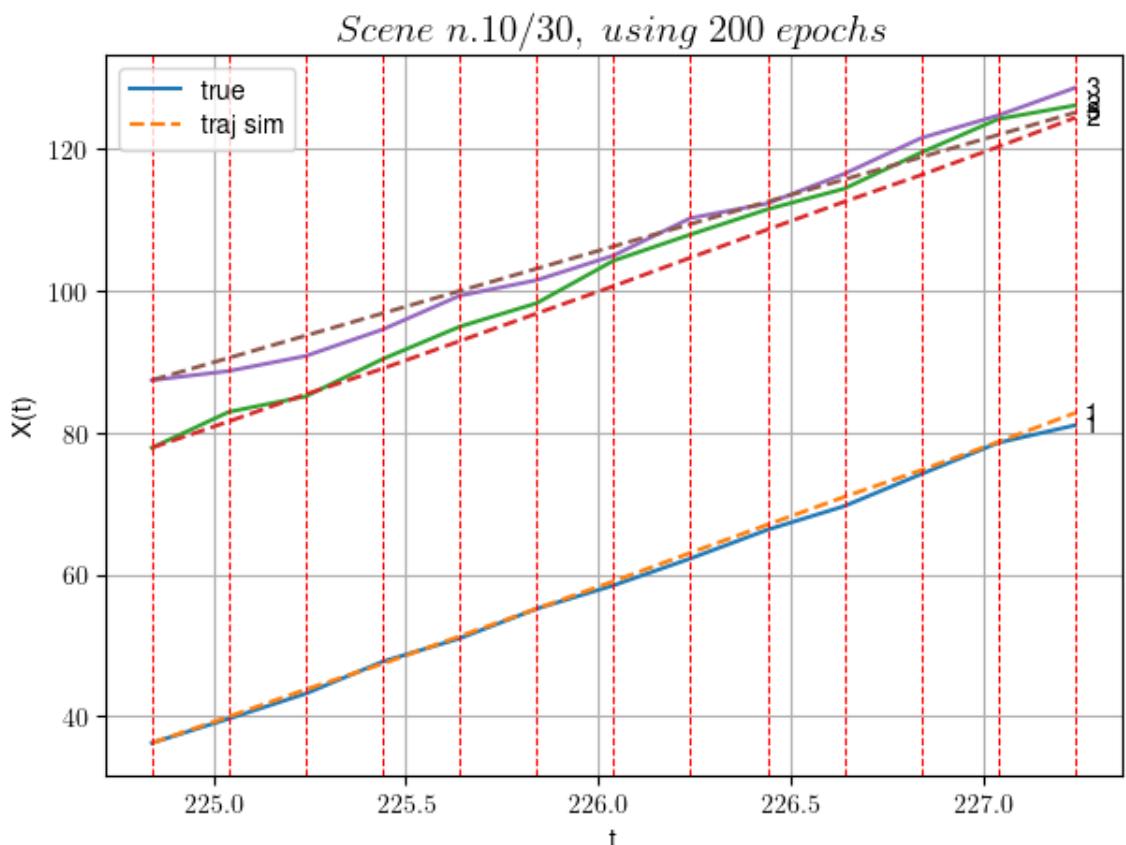
---



---

Scene n.10/30, time interval:[224.84,227.24]

---



Loss: 3.347386653960799  
v0 updated: 15.729363702731368

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---

Scene n.11/30, time interval:[230.84,232.24]

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---

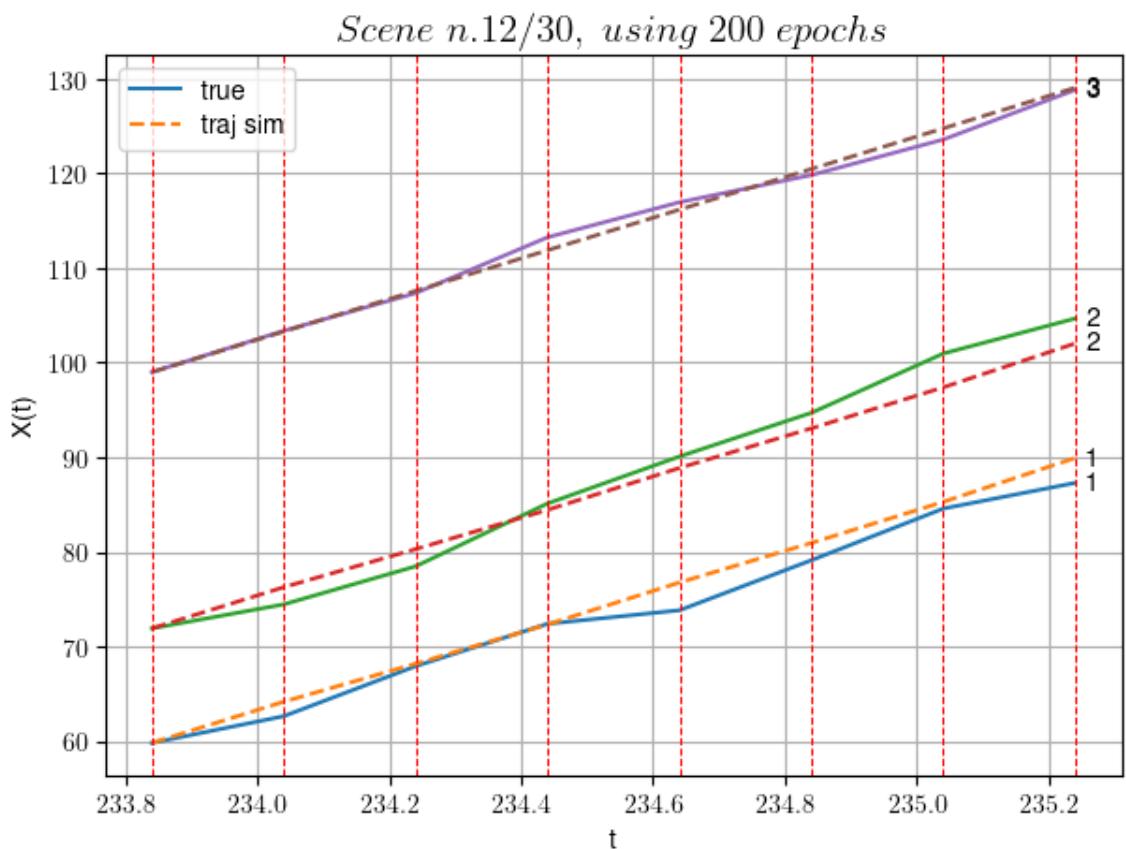


Loss: 26.298319432761442  
v0 updated: 23.330054741611075

---

Scene n.12/30, time interval:[233.84,235.24]

---



Loss: 2.381703925285695  
v0 updated: 21.472180424121877

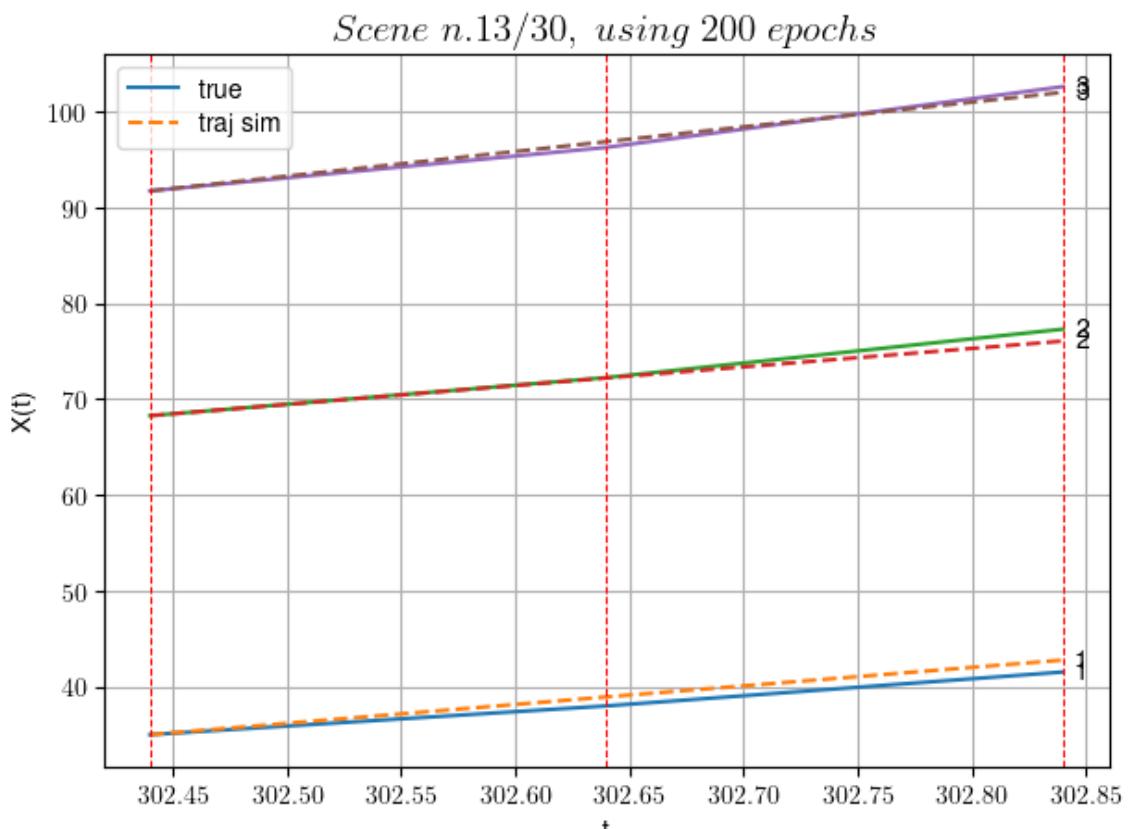
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---

Scene n.13/30, time interval:[302.44,302.84]

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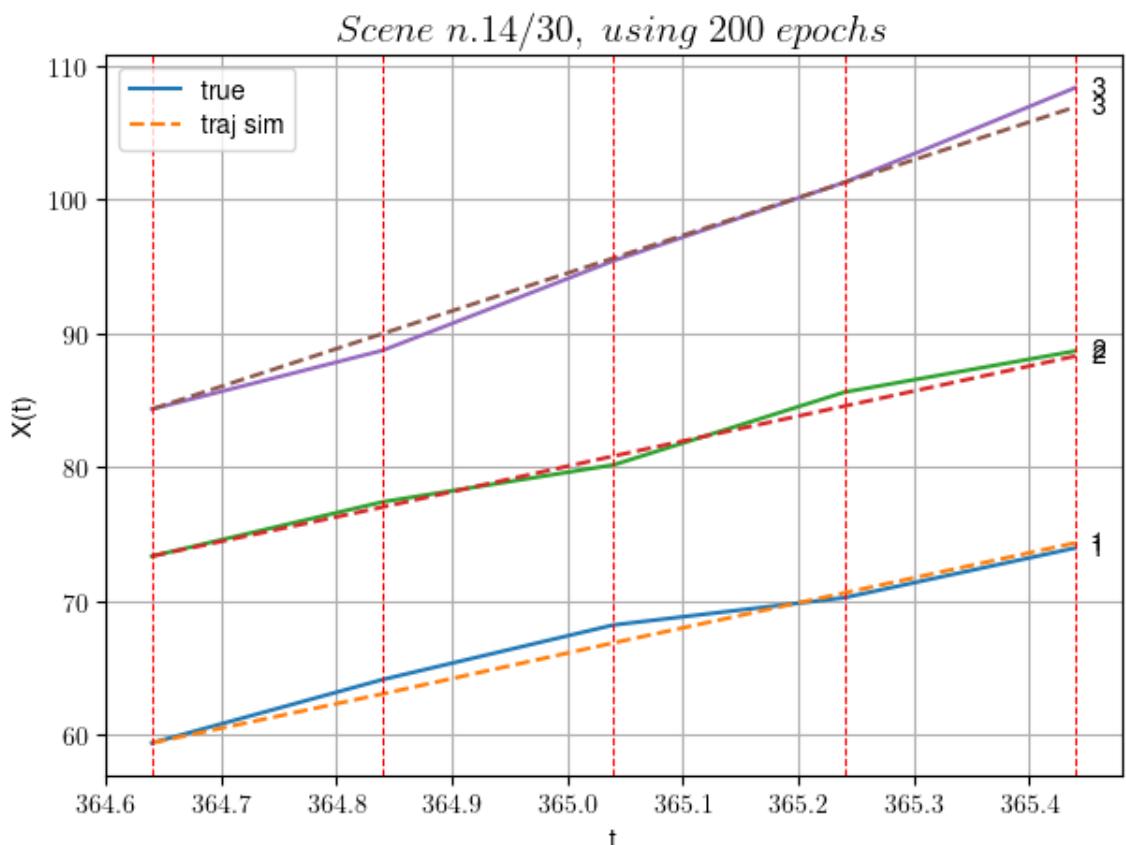
Loss: 0.5251942368077404

v0 updated: 25.749210786691933

---

Scene n.14/30, time interval:[364.64,365.44]

---

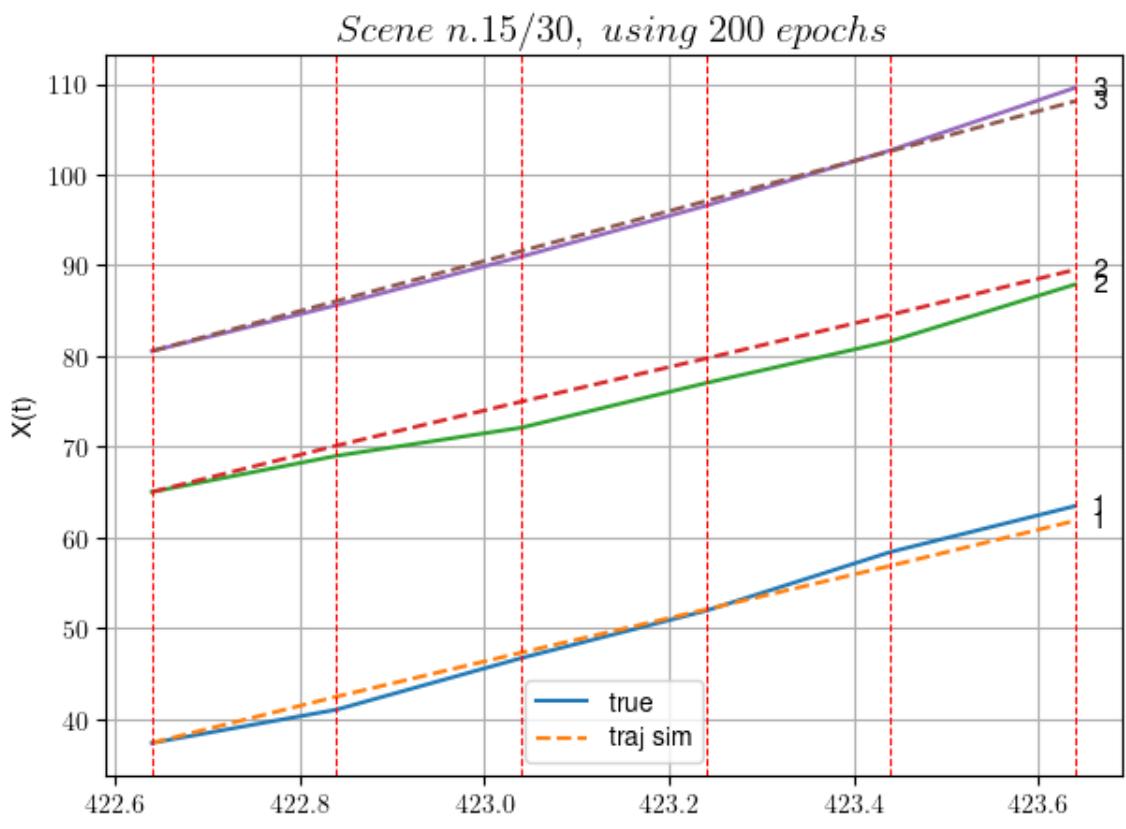


Loss: 0.5800360383648852  
v0 updated: 28.20769503184908

---

Scene n.15/30, time interval:[422.64,423.64]

---



Loss: 2.1312441956594683  
v0 updated: 27.54778513206394

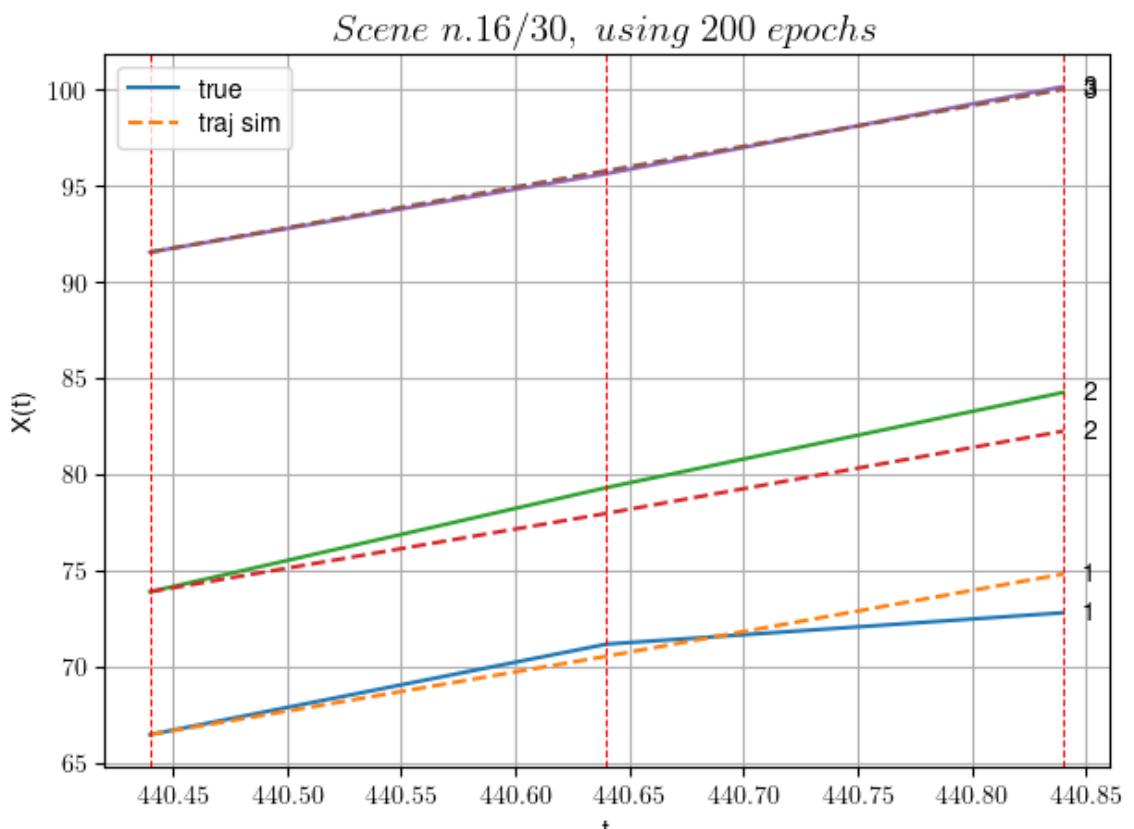
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Scene n.16/30, time interval:[440.44,440.84]

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Loss: 1.146009294757162

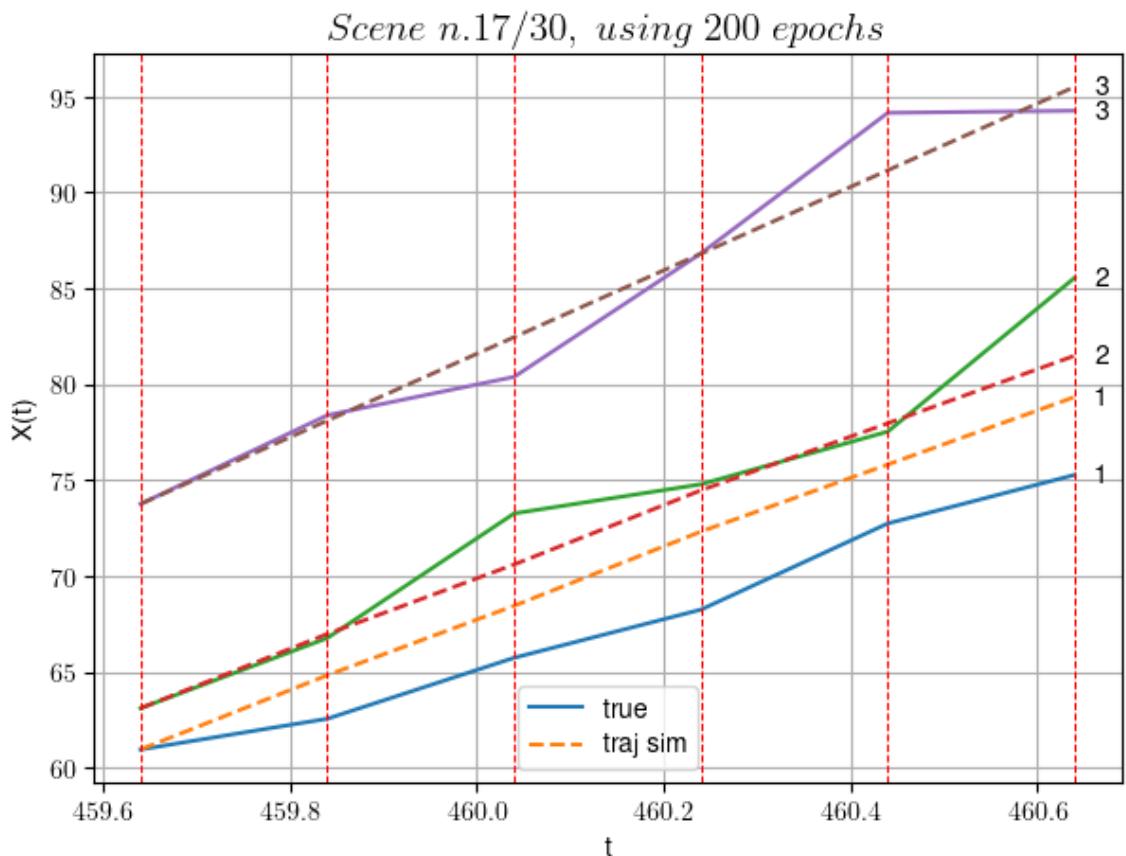
v0 updated: 21.13673717572745

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---

Scene n.17/30, time interval:[459.64,460.64]

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Loss: 5.216621353856582  
v0 updated: 21.758536788642303

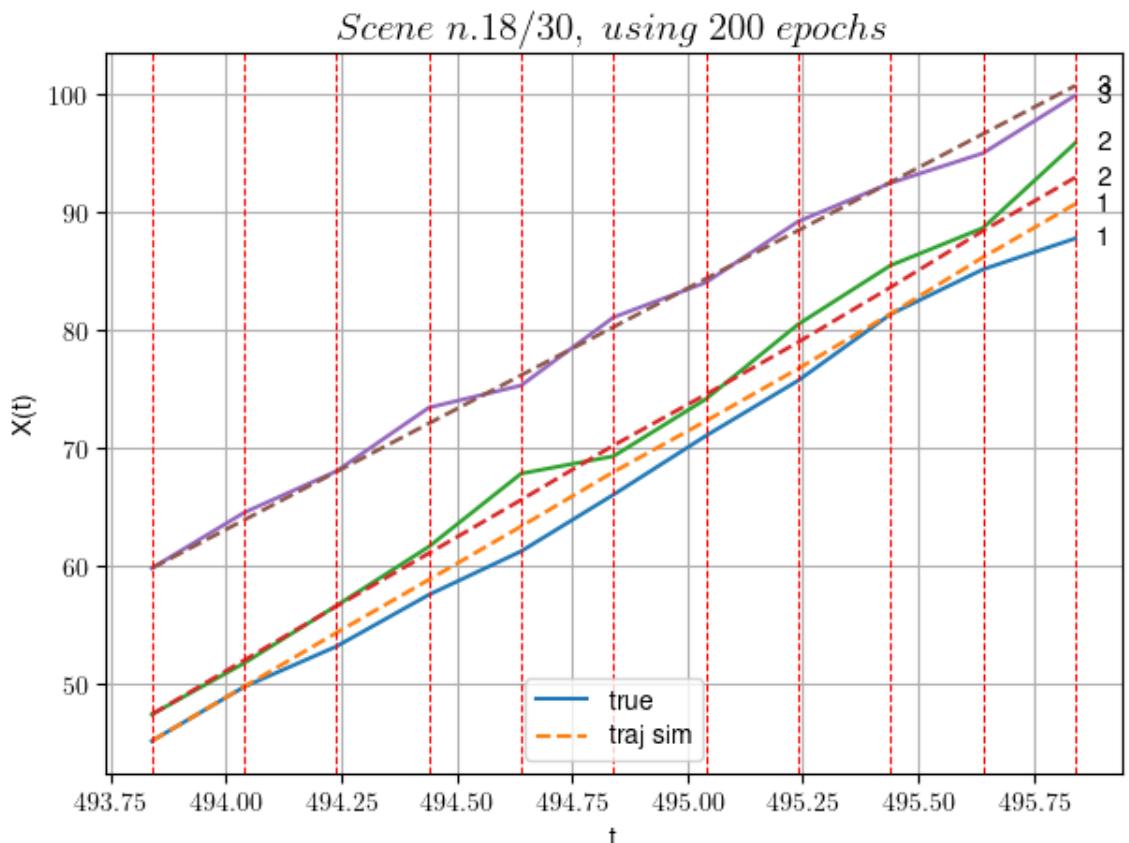
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Scene n.18/30, time interval:[493.84,495.84]

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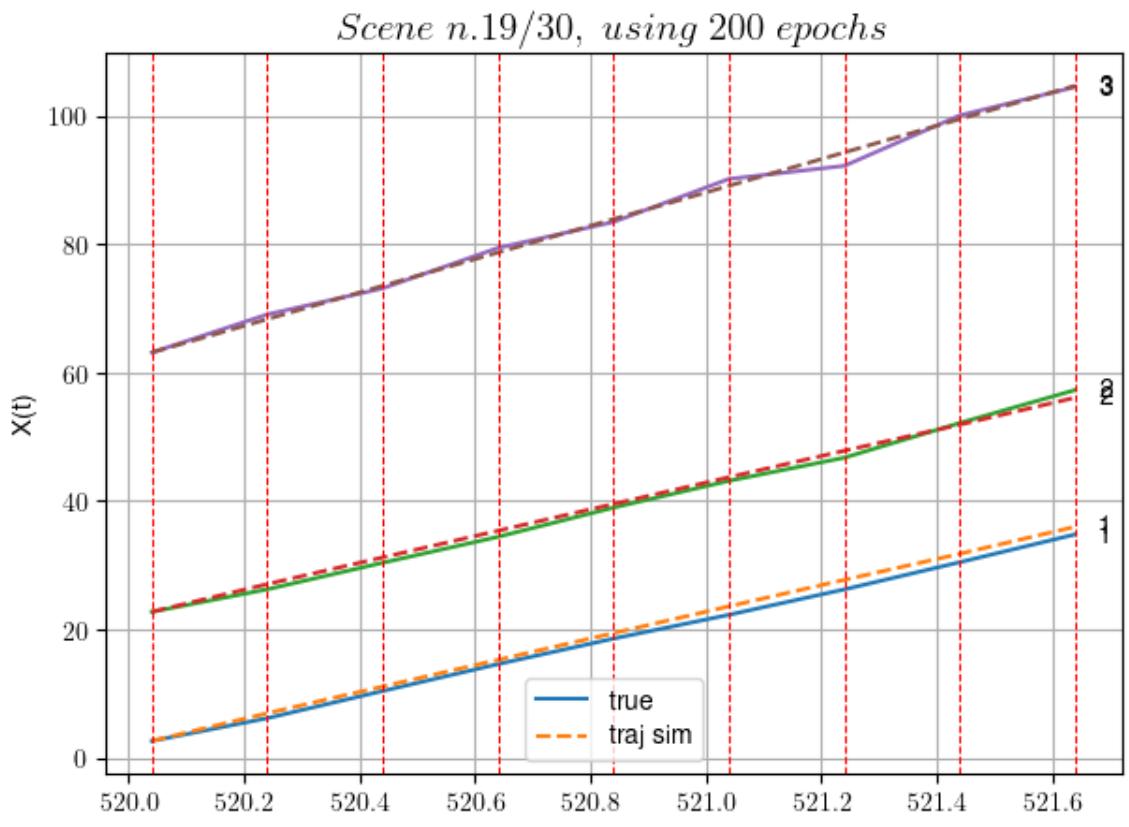
Loss: 1.5616017930101886  
v0 updated: 20.44744200453107

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---

Scene n.19/30, time interval:[520.04,521.64]

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Loss: 0.819243485095873  
v0 updated: 25.967240218471442

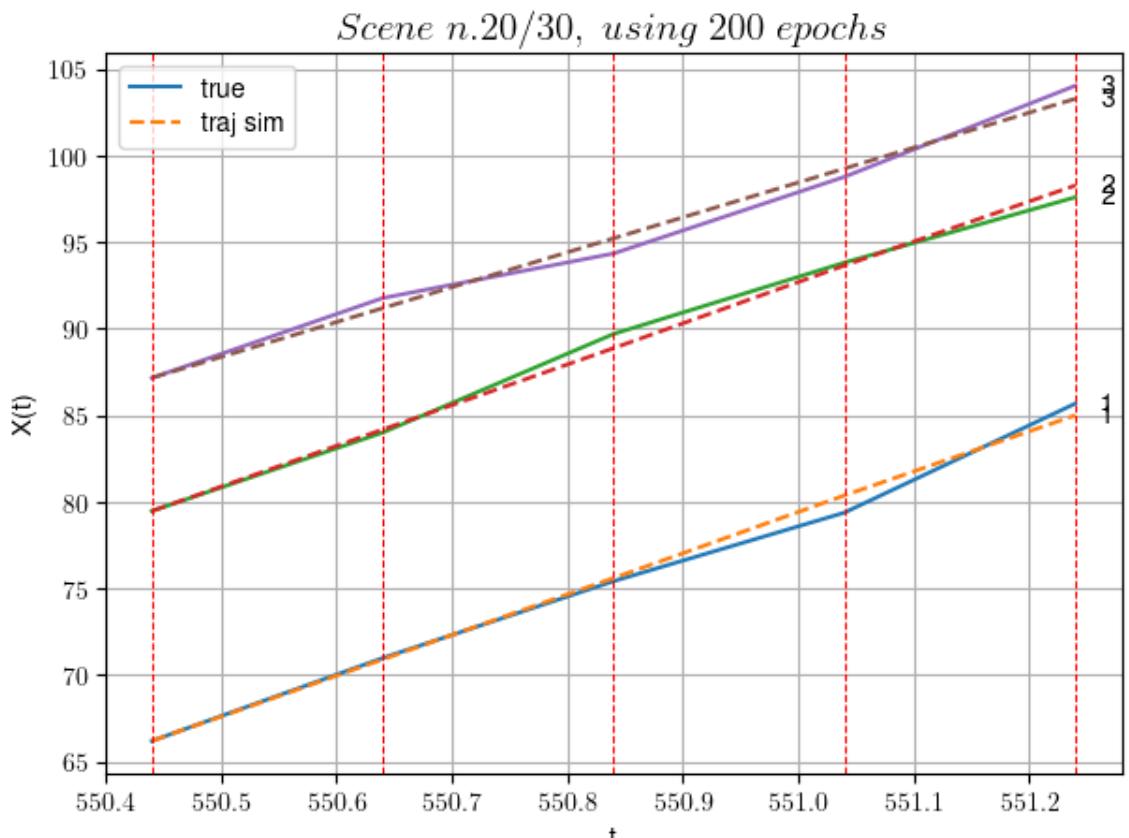
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---

Scene n.20/30, time interval:[550.44,551.24]

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Loss: 0.3059578033379852  
v0 updated: 20.15921482706291

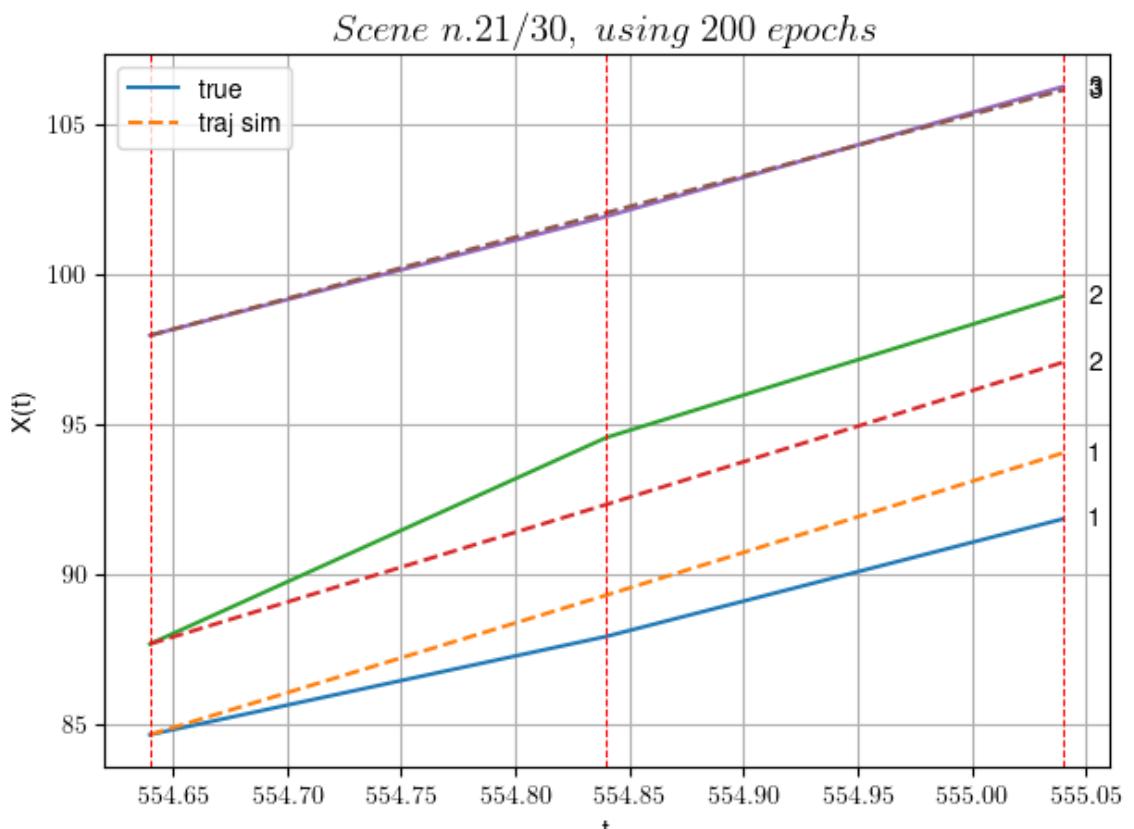
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Scene n.21/30, time interval:[554.64,555.04]

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Loss: 1.8427679422850811  
v0 updated: 20.45122402685835

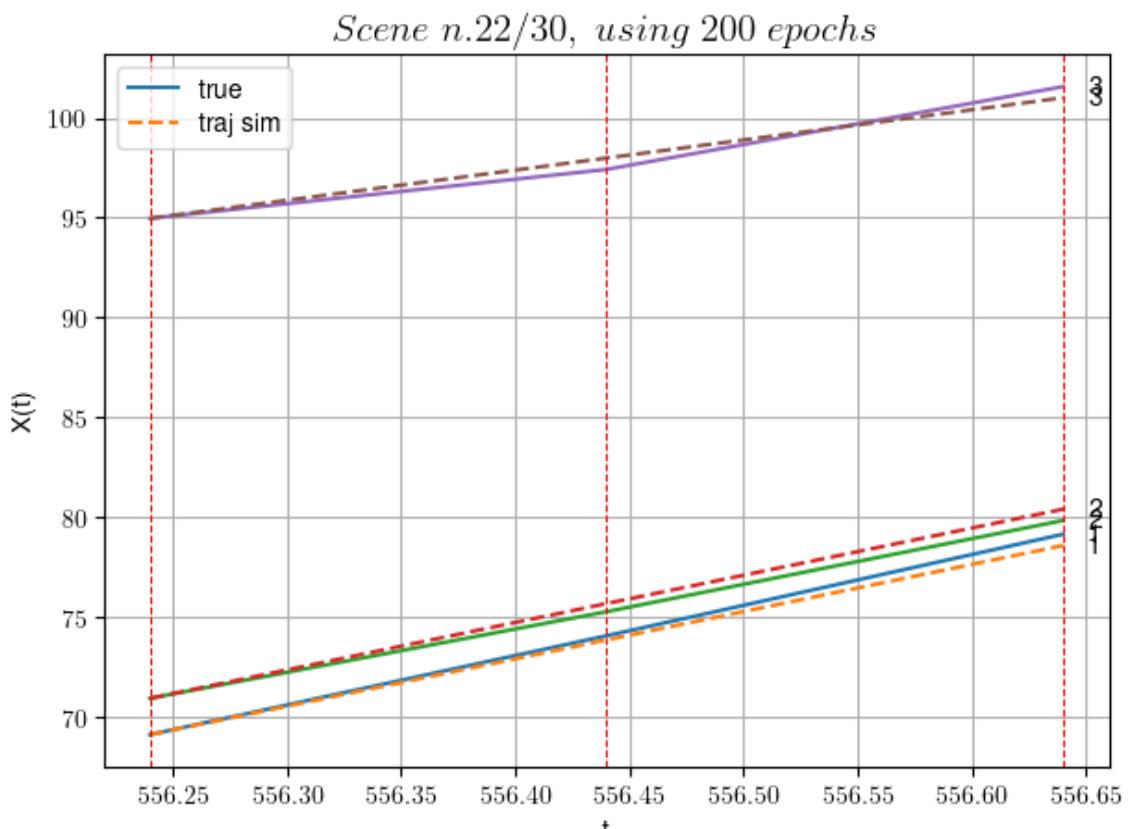
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Scene n.22/30, time interval:[556.24,556.64]

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Loss: 0.16466453193991418  
v0 updated: 15.10246810565707

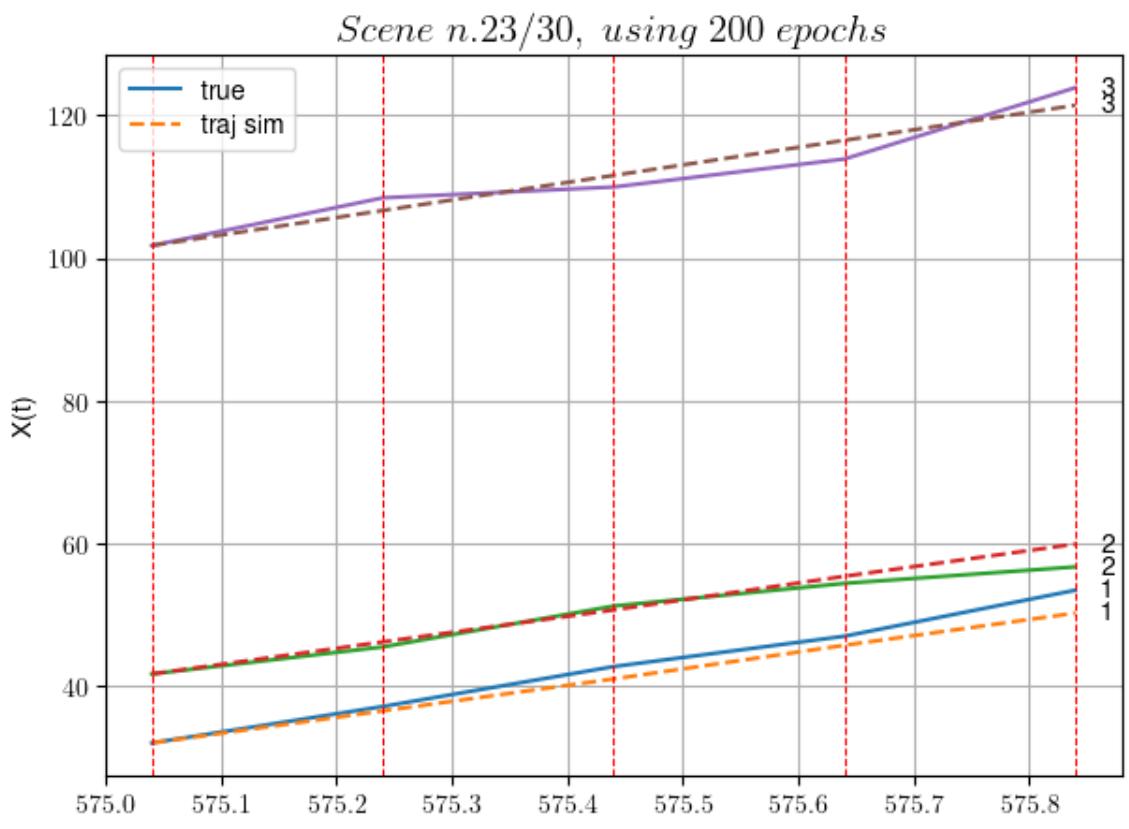
---

---

Scene n.23/30, time interval:[575.04,575.84]

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---



Loss: 3.053602406779133  
v0 updated: 24.55161048759143

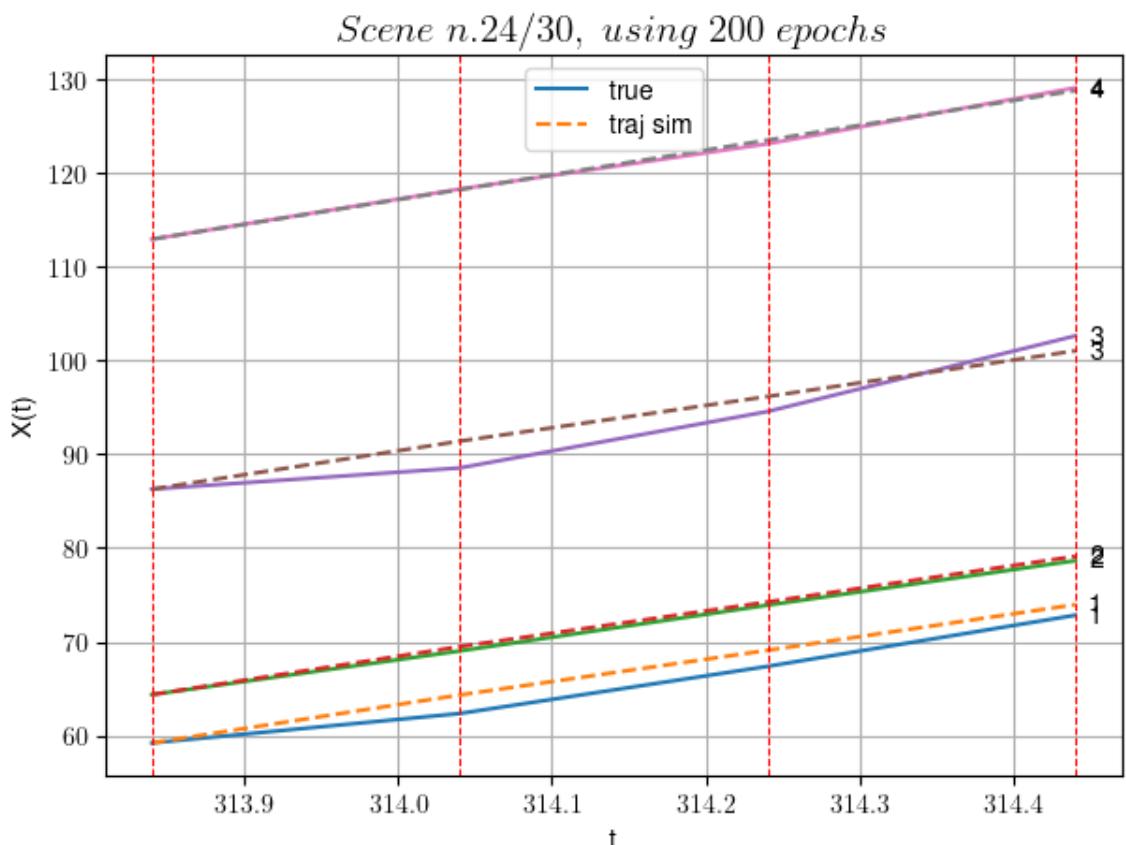
---

---

Scene n.24/30, time interval:[313.84,314.44]

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---



Loss: 1.3878732062538388  
v0 updated: 26.437615898639695

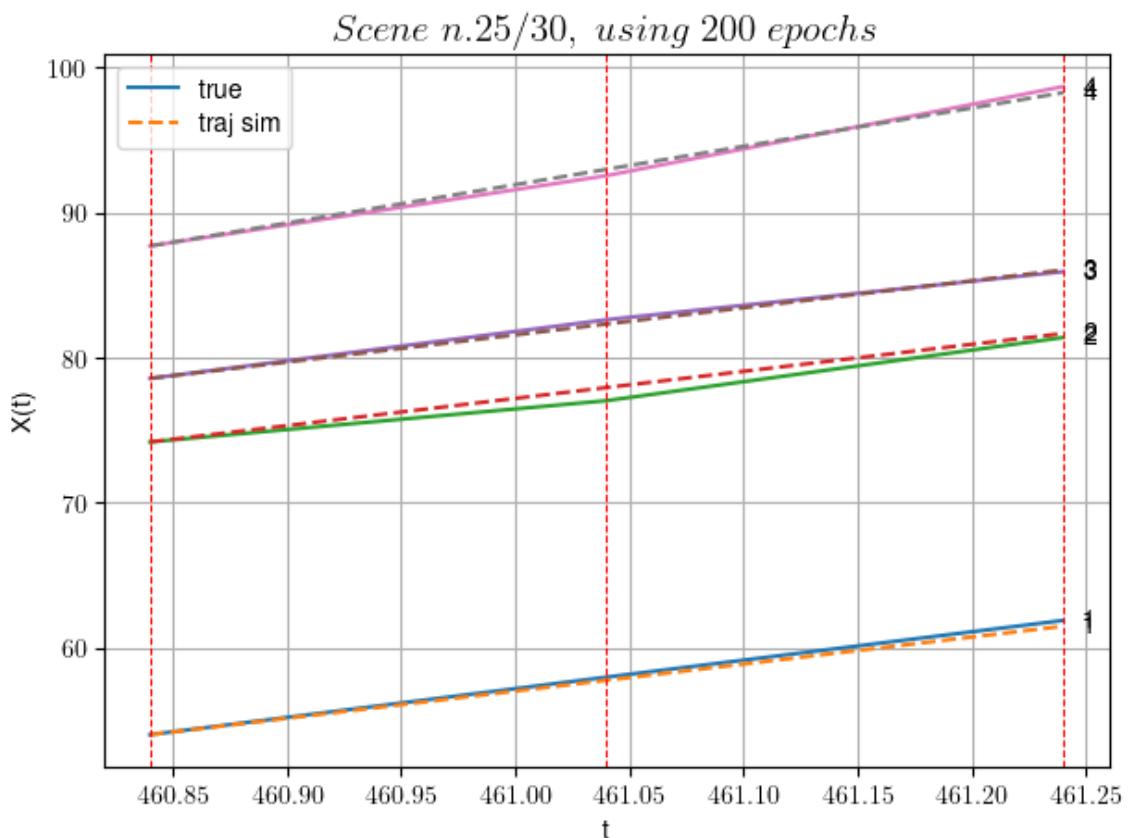
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Scene n.25/30, time interval:[460.84,461.24]

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Loss: 0.13042152016940237  
v0 updated: 26.426470006325165

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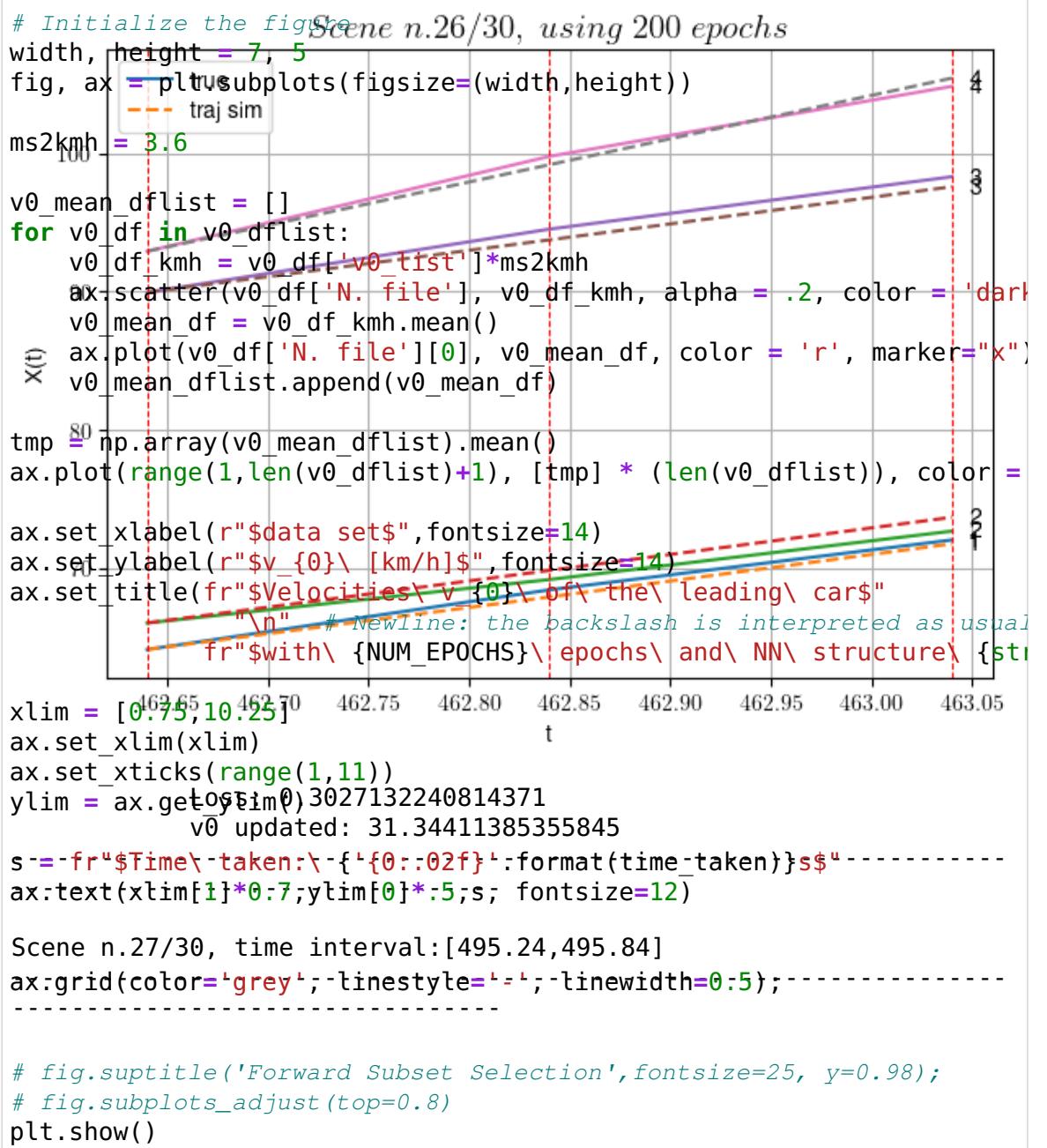
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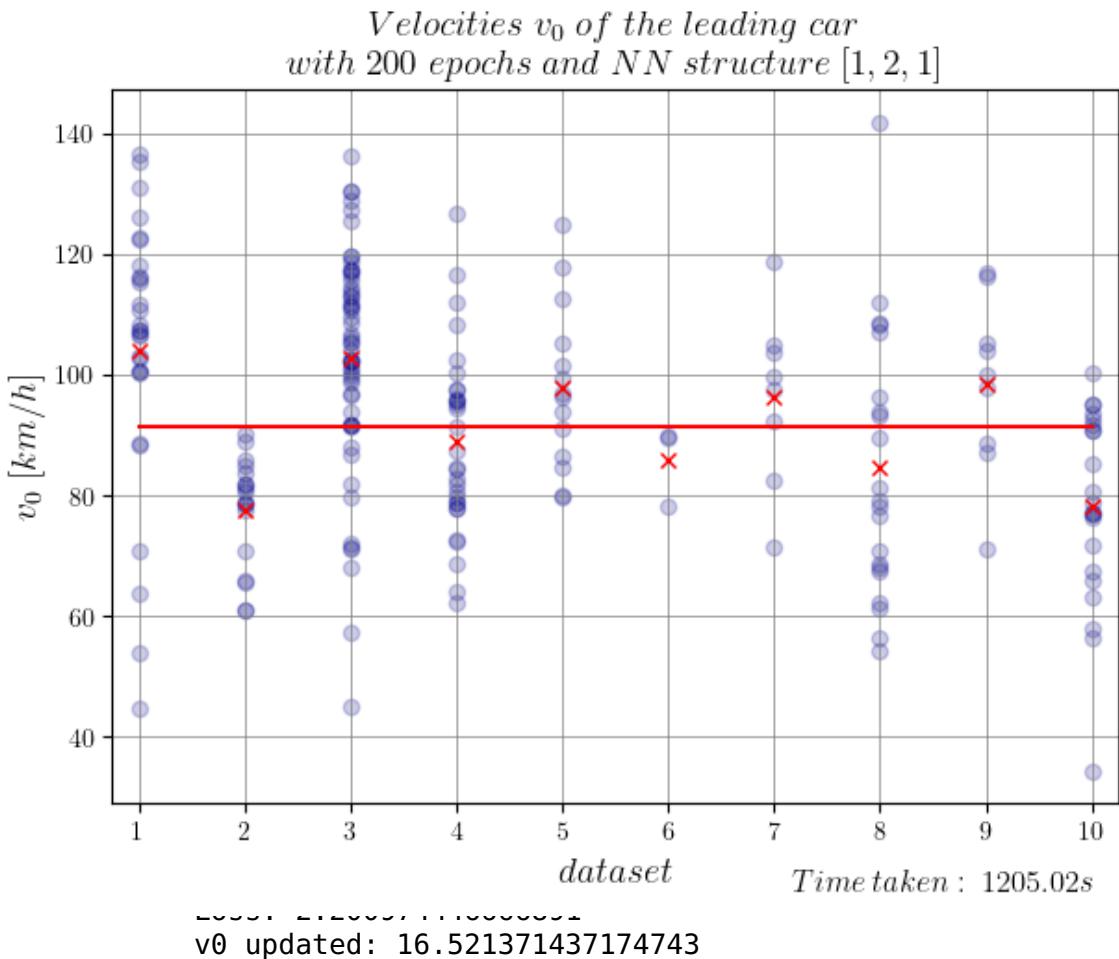
Scene n.26/30, time interval:[462.64,463.04]

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In [14]:





### Save the figure

```
In [15]: Scene n.28/30, time interval:[541.84,542.84]
# Save figure
if flag_save:
    ext = ".svg"
    xs = DOE[0]
    s = ''.join(str(x) for x in xs)
    df_seen = [df['N_file'][0] for df in dataset]
    df_seen_str = '-'.join(str(x) for x in df_seen)
    title = f"v0_df{df_seen_str}_{NUM_EPOCHS}epochs_NN{s}"
    fig.savefig("img/" + title + ext, bbox_inches='tight')
```





























































































































































