

This is the repeatability evaluation package for the tool paper "Verse: A Python library for reasoning about multi-agent hybrid system scenarios".

The artifact is a virtual machine that contains instruction and software to reproduce all experiment results in the paper.

The admin password of the artifact is `cav2023-re`

The `artifact_evaluation.txt` file contains instruction to reproduce all experiments in the paper. A PDF version of the file can be found in `artifact_evaluation.pdf`.

Artifact Link

The link to the artifact on Figshare is:

The link to the artifact on Google drive is:

A detailed interactive tutorial for verse can be found at:

<https://github.com/AutoVerse-ai/Verse-library/blob/main/tutorial/tutorial.ipynb>

and a PDF version of the tutorial is included in the artifact as "tutorial.pdf".

The tool is publicly available at

<https://github.com/AutoVerse-ai/Verse-library>

Estimated Runtime

The run-time for regenerating data in Table 1 in the paper is approximately 1187.6s (~20min).

The run-time for regenerating data in Simulation section of Table 2 in the paper is approximately 174s (~3min).

The run-time for regenerating data in Reach section of Table 2 in the paper is approximately 4682s (~78min).

Experiment Replication Instructions

To replicate the experiments in the paper, fist move to the root directory of the tool using command

```
cd /home/cav23/Desktop/Verse-library
```

To replicate our experiments from the paper, please run following commands from the root directory of the artifact.

1. For results in Table 1 Run command

```
python3 artifact_evaluation/exprs.py
```

The results for all experiments in Table 1 will be generated as below at the end of execution.

```
2 & Q & M6 & DryVR & No & 8 & 34.54\\
2 & Q & M5 & DryVR & No & 5 & 31.67\\
2 & Q & M5 & NeuReach & No & 4 & 261.41\\
3 & Q & M5 & DryVR & No & 7 & 42.67\\
7 & C & M2 & DryVR & No & 37 & 59.95\\
3 & C & M1 & DryVR & No & 5 & 26.36\\
3 & C & M3 & DryVR & No & 4 & 34.23\\
3 & C & M4 & DryVR & No & 7 & 74.02\\
3 & C & M1 & DryVR & Yes & 5 & 26.85\\
2 & C & M1 & DryVR & No & 5 & 23.0\\
2 & C & M1 & NeuReach & No & 5 & 319.34\\
1 & V & N/A & DryVR & N/A & 1 & 13.85\\
1 & S & N/A & DryVR & N/A & 3 & 14.7\\
1 & G & N/A & DryVR & N/A & 3 & 22.99\\
```

Where each row corresponds to entry in the table from left to right, top to bottom.

2. For results in Table 2,

Simulation: Run command

```
python3 artifact_evaluation/inc-expr.py s
```

The results for the experiments in Table 2 section Simulation will be generated as below at the end of execution

```
& repeat & 45 & 16.92 & 430 & 1.05 & 438 & 3.83 & 83.33 \\
& change init & 24 & 14.93 & 431 & 12.98 & 436 & 4.07 & 75.91 \\
& change ctrl & 45 & 16.1 & 431 & 8.49 & 438 & 4.38 & 78.19 \\
```

Reach: Run command

```
python3 artifact_evaluation/inc-expr.py v
```

The results for the experiments in Table 2 section Verification will be generated as below at the end of execution

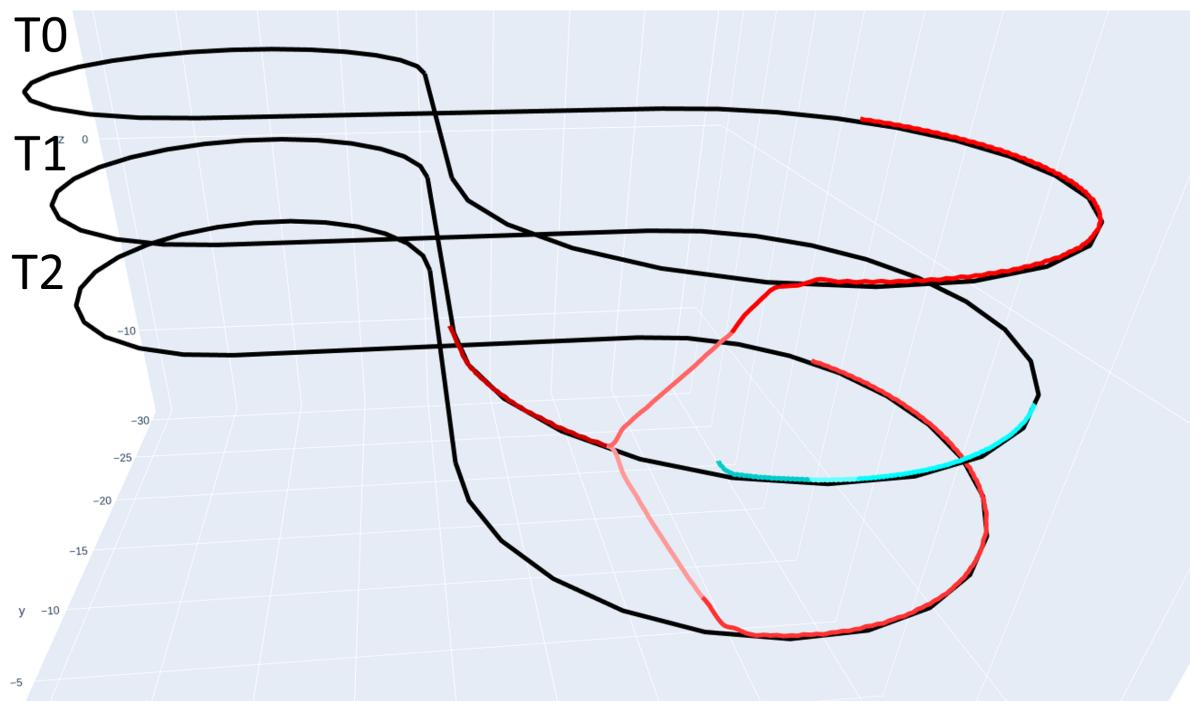
```
& repeat & 105 & 464.77 & 498 & 58.99 & 482 & 3.23 & 76.79 \\
& change init & 49 & 384.84 & 486 & 362.25 & 500 & 3.7 & 73.21 \\
& change ctrr & 93 & 428.83 & 498 & 227.49 & 491 & 4.0 & 73.44 \\
```

3. To reproduce Fig. 1,

Center: Run command

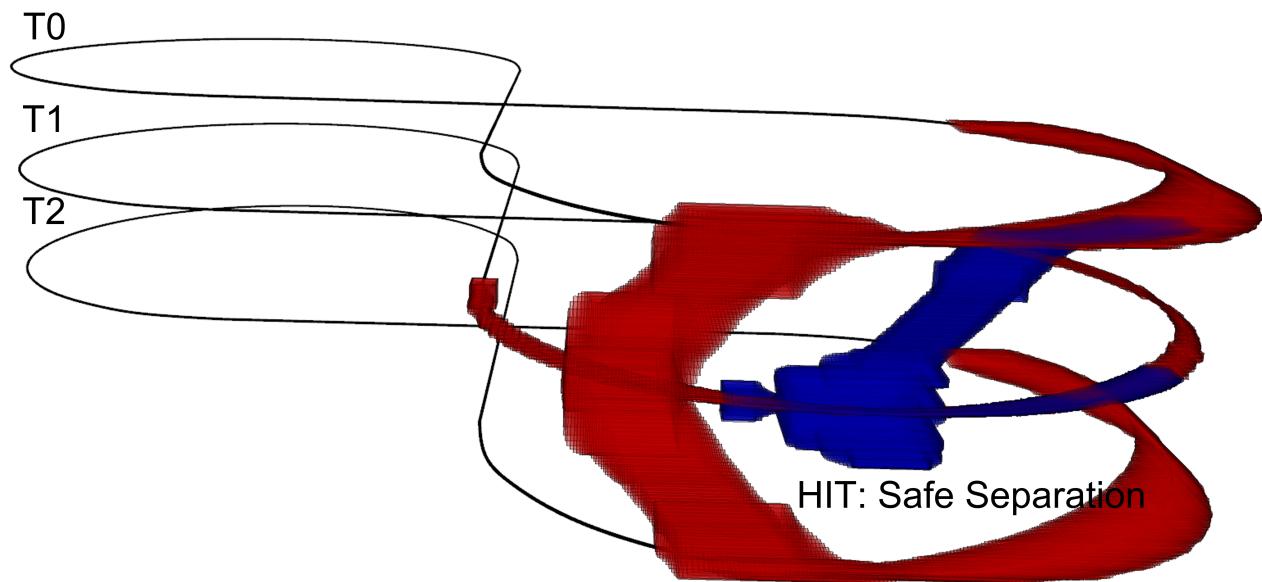
```
python3 demo/cav2023/exp1/exp1_sim.py p
```

Verse will automatically open a browser window to show the resulting plot as below.



Right: Run command

```
python3 demo/cav2023/exp1/exp1.py p
```

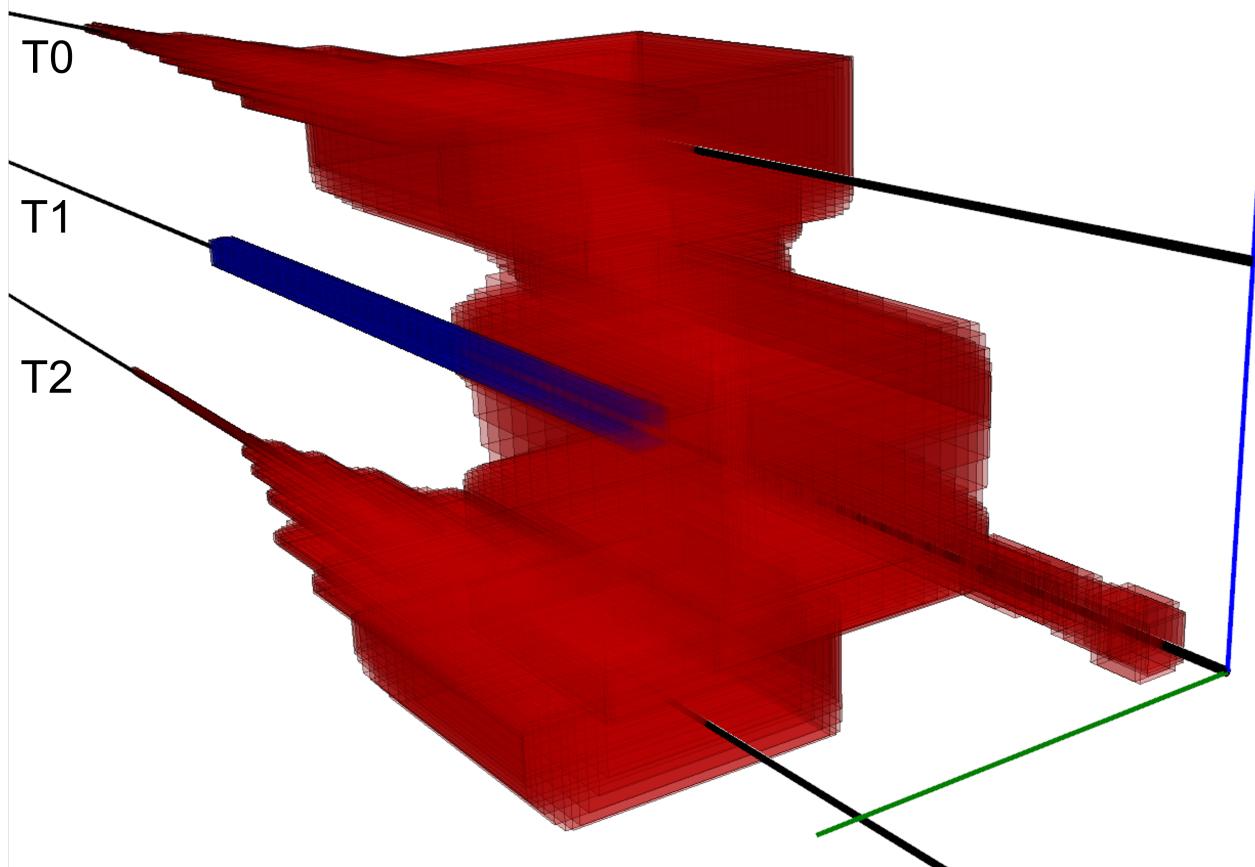


4. To reproduce Fig. 4, from left to right

(1) Run command

```
python3 demo/cav2023/exp9/exp9_dryvr.py p1
```

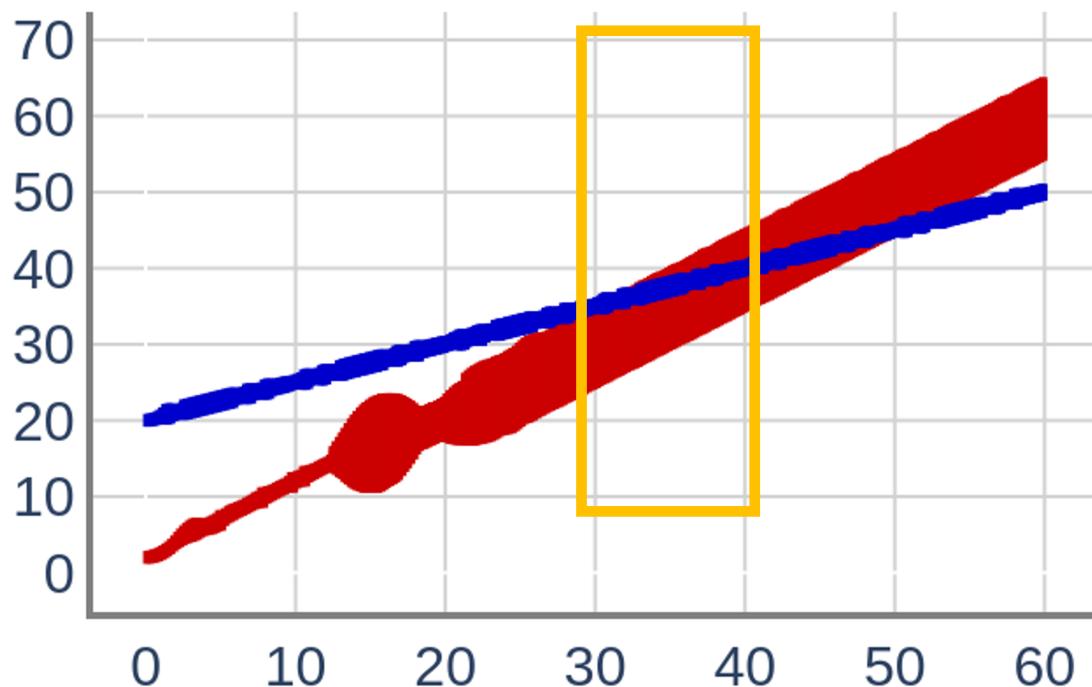
The result will looks like below.

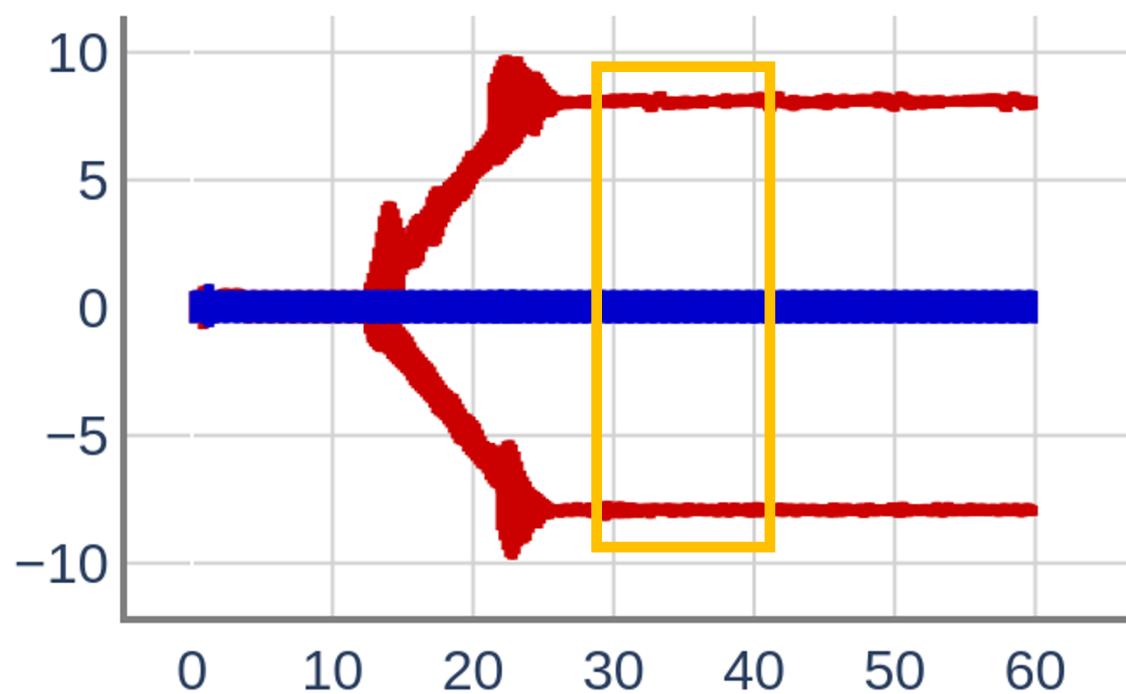


(2)-(3) Run command

```
python3 demo/cav2023/exp9/exp9_dryvr.py pc
```

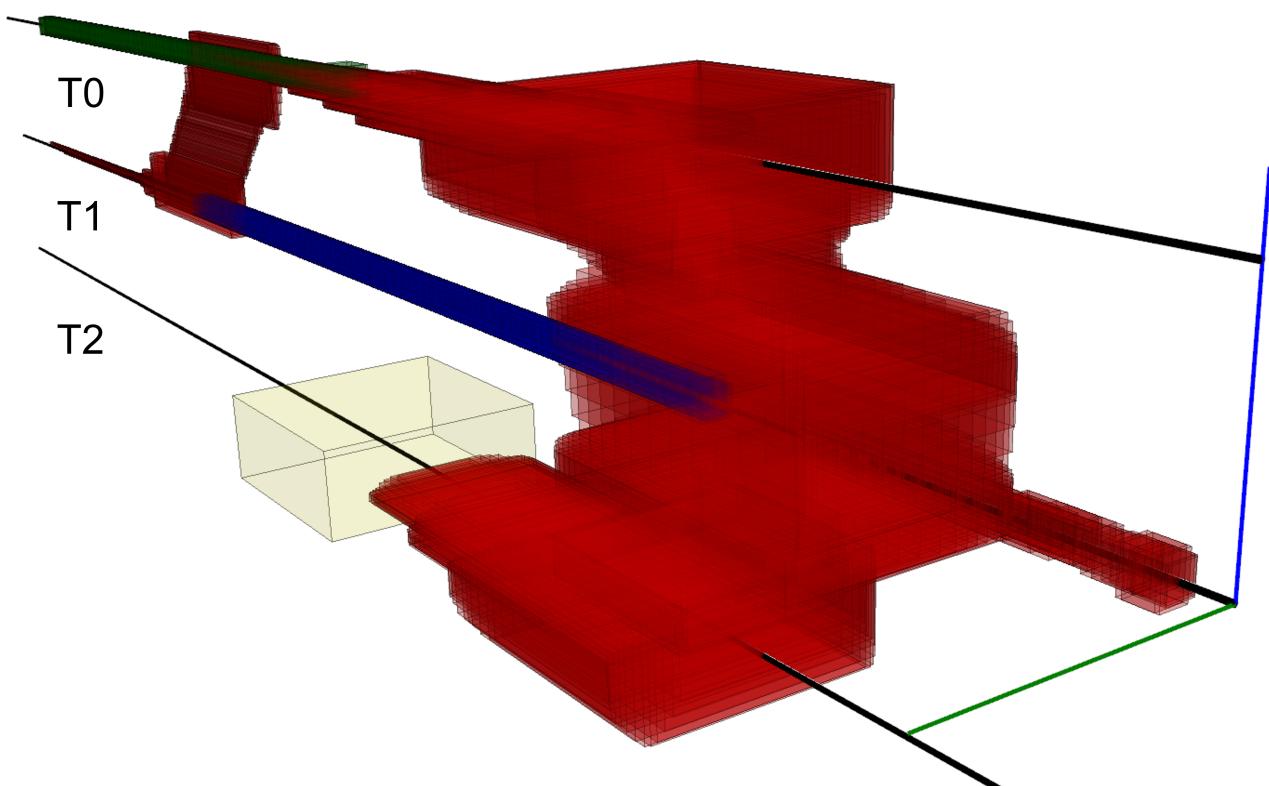
Verse will automatically open two browser windows to show the two resulting plots as below. Note that the yellow boxes in the figures are drawn separately.



**(4) Run command**

```
python3 demo/cav2023/exp10/exp10_dryvr.py p
```

The result will looks like below.

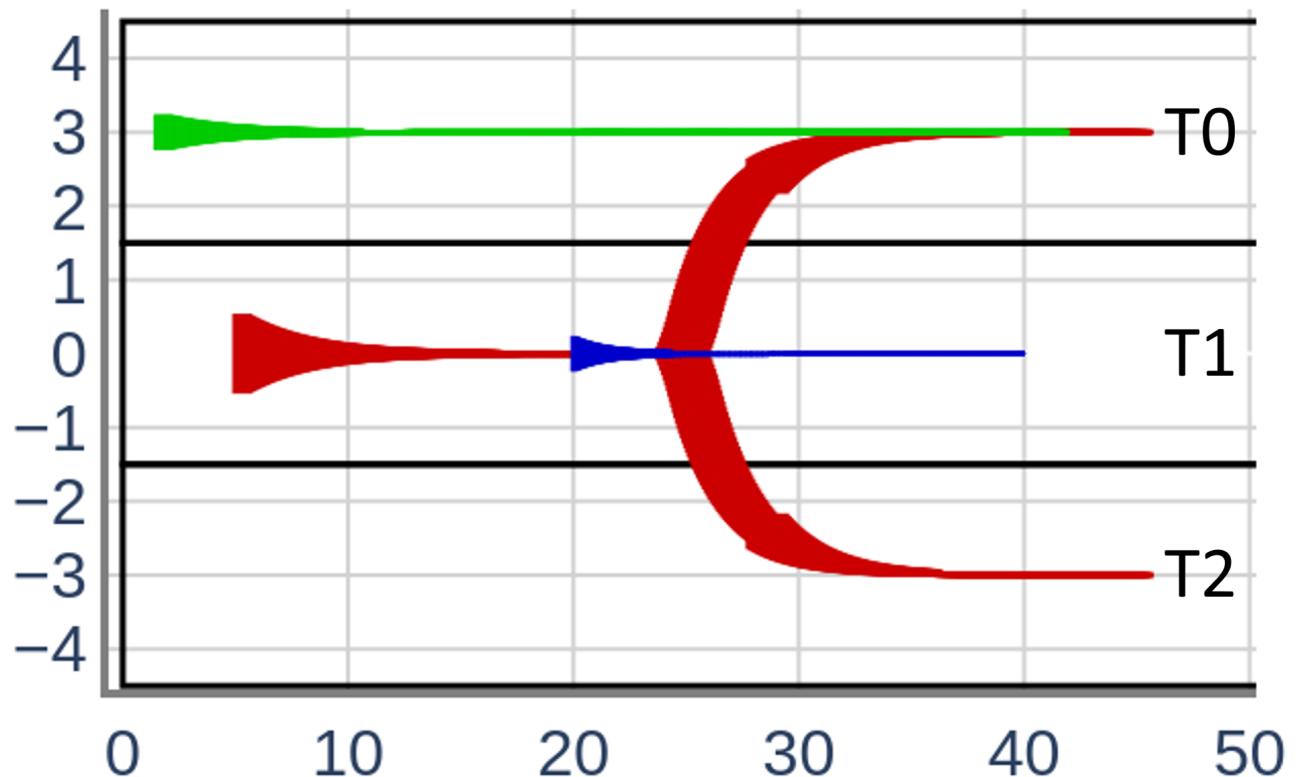


5. To reproduce Fig. 6,

Left: Run command

```
python3 demo/cav2023/exp2/exp2_straight.py p
```

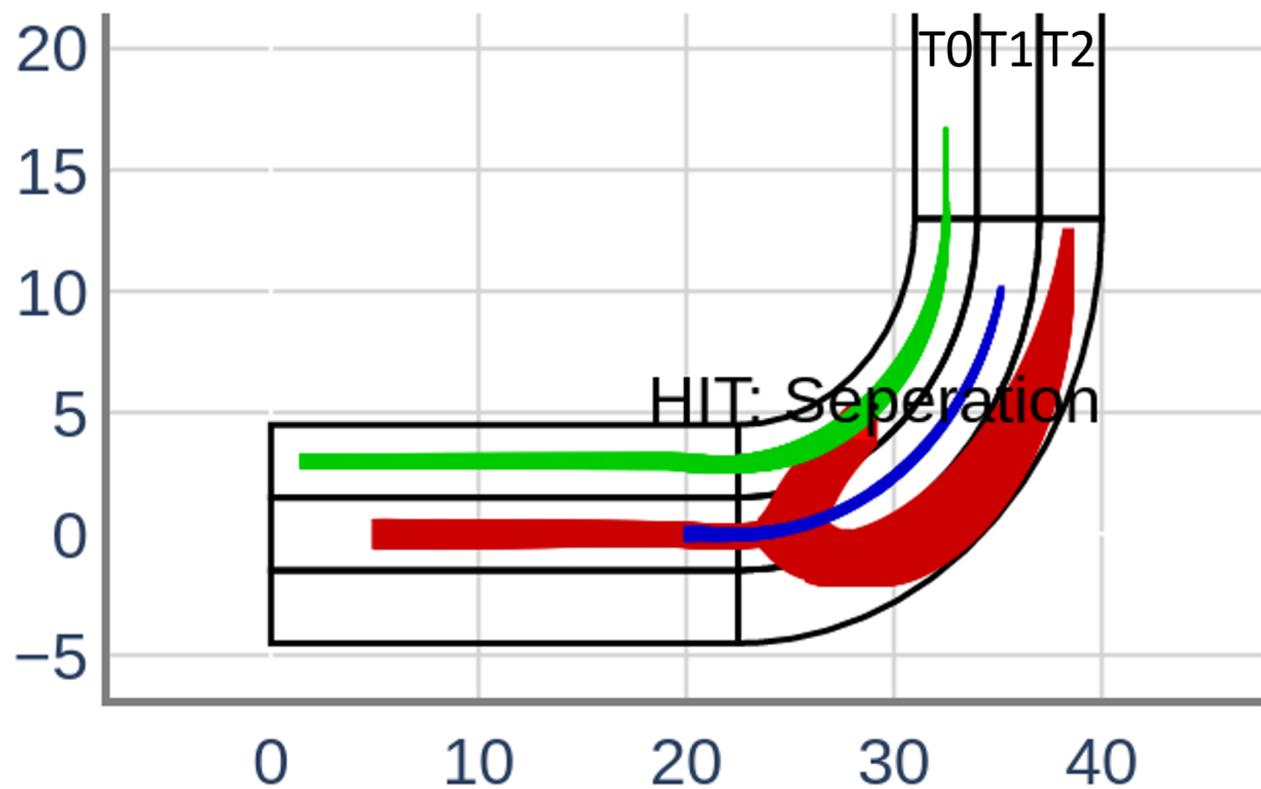
Verse will automatically open a browser window to show the resulting plot as below.



Center: Run command

```
python3 demo/cav2023/exp2/exp2_curve.py p
```

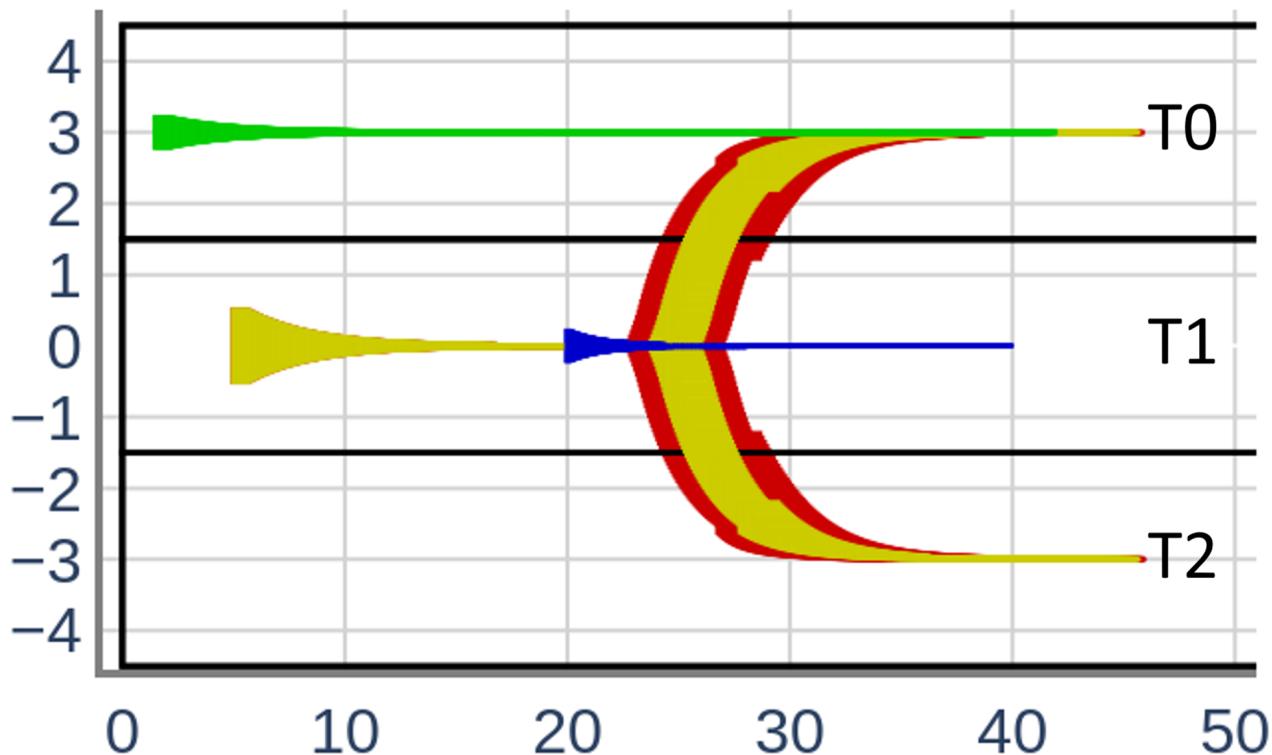
Verse will automatically open a browser window to show the resulting plot as below.



Right: Run command

```
python3 demo/cav2023/exp4/exp4.py p
```

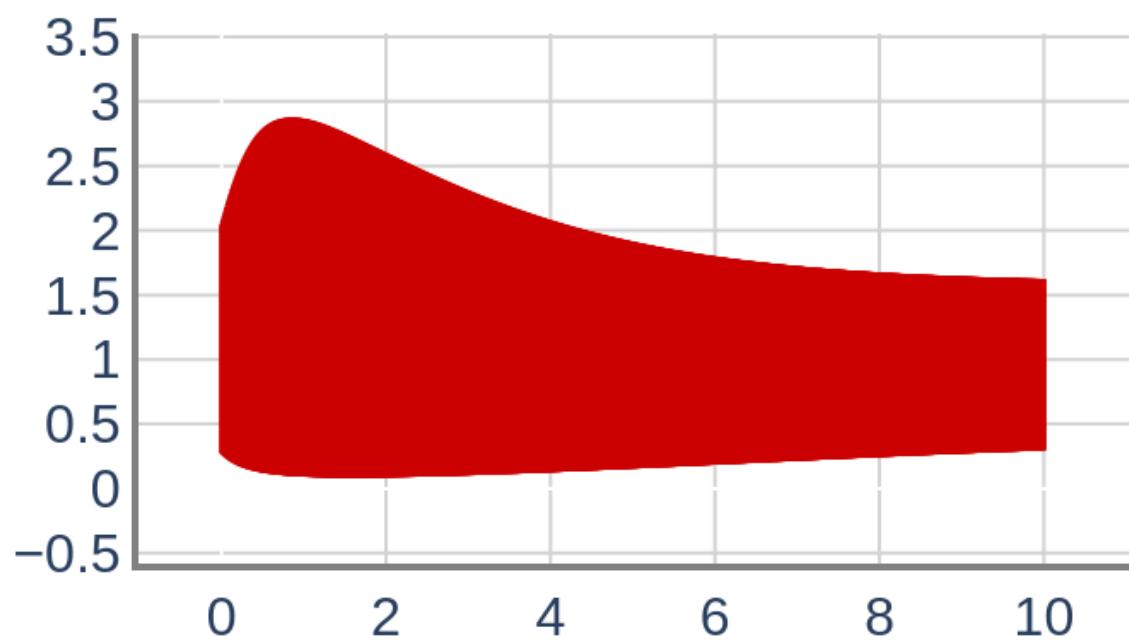
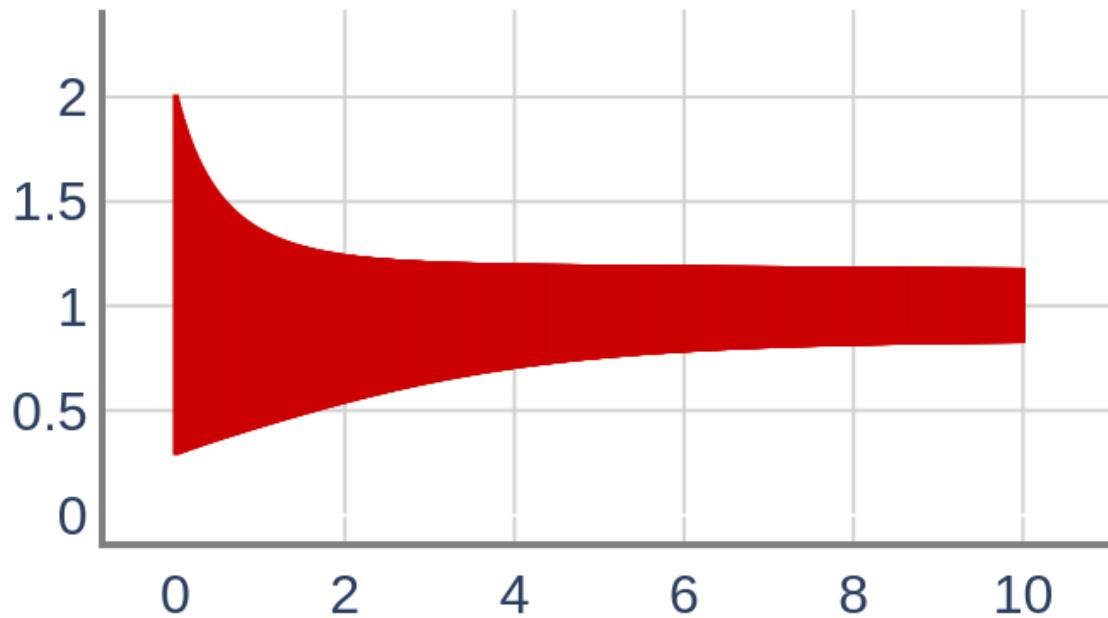
Verse will automatically open a browser window to show the resulting plot as below.



6. To reproduce Fig. 8 in Appendix, run command

```
python3 demo/cav2023/exp7/exp7.py p
```

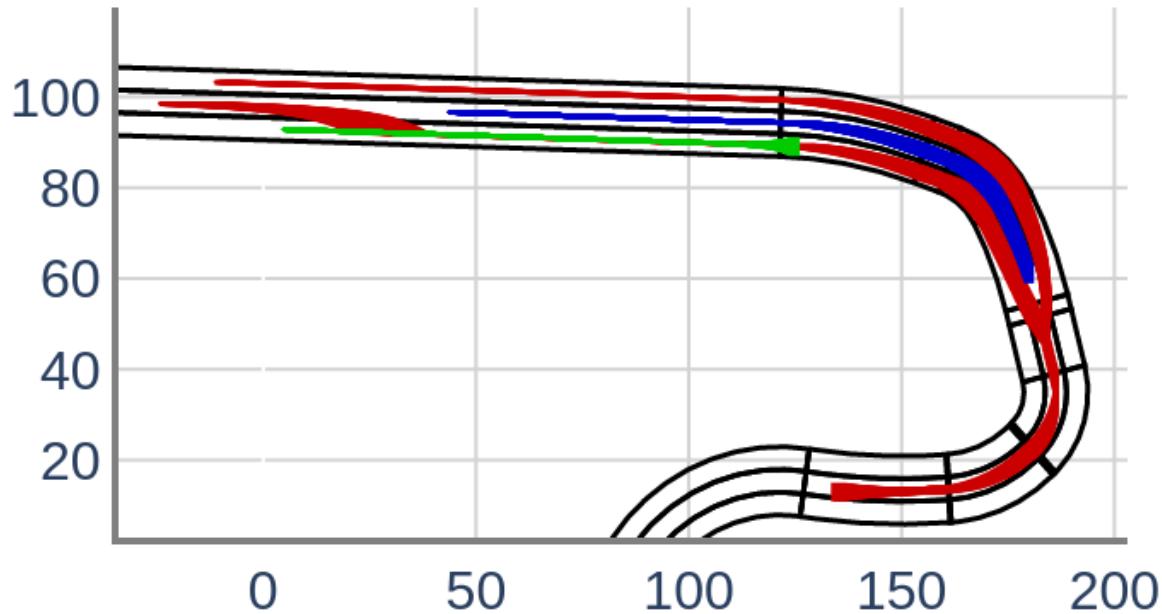
Verse will automatically open two browser windows to show the plots as shown below.



7. To reproduce Fig. 7 in Appendix, run command

```
python3 demo/cav2023/exp5/exp5.py p
```

Verse will automatically open a browser window to show the resulting plot. The right figure is a zoom in of the left figure as shown below.



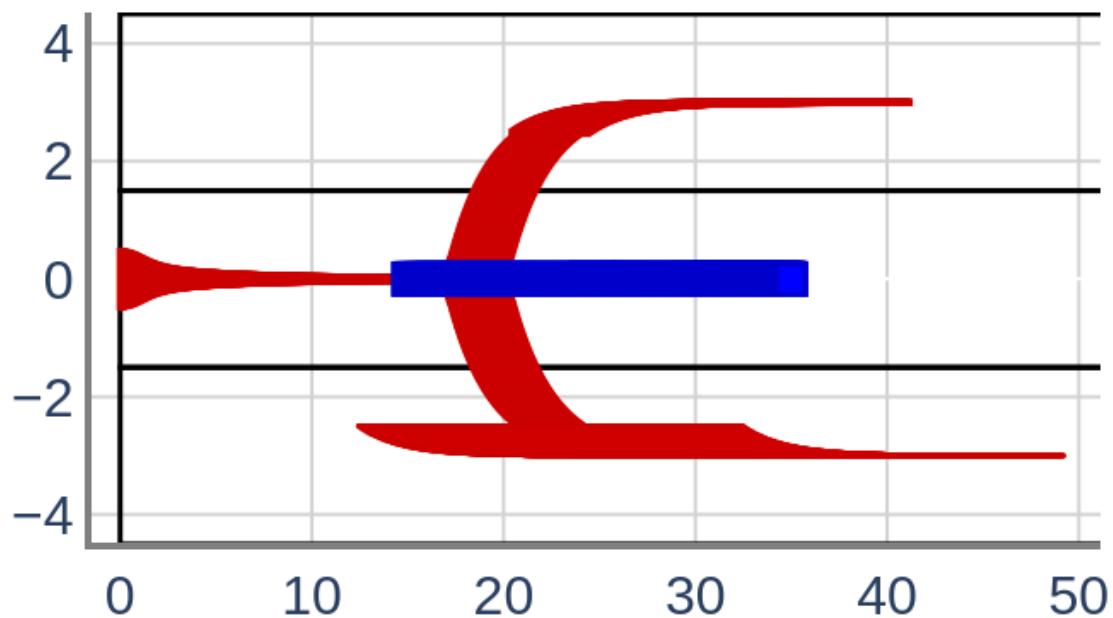
8. To reproduce Fig. 10 in Appendix,

Left: Run command

```
python3 demo/cav2023/exp6/exp6_neureach.py p
```

Verse will automatically open a browser window to show the resulting plot as shown below. Note that due to the randomization in NeuReach's algorithm, the generated figure can be slightly different from

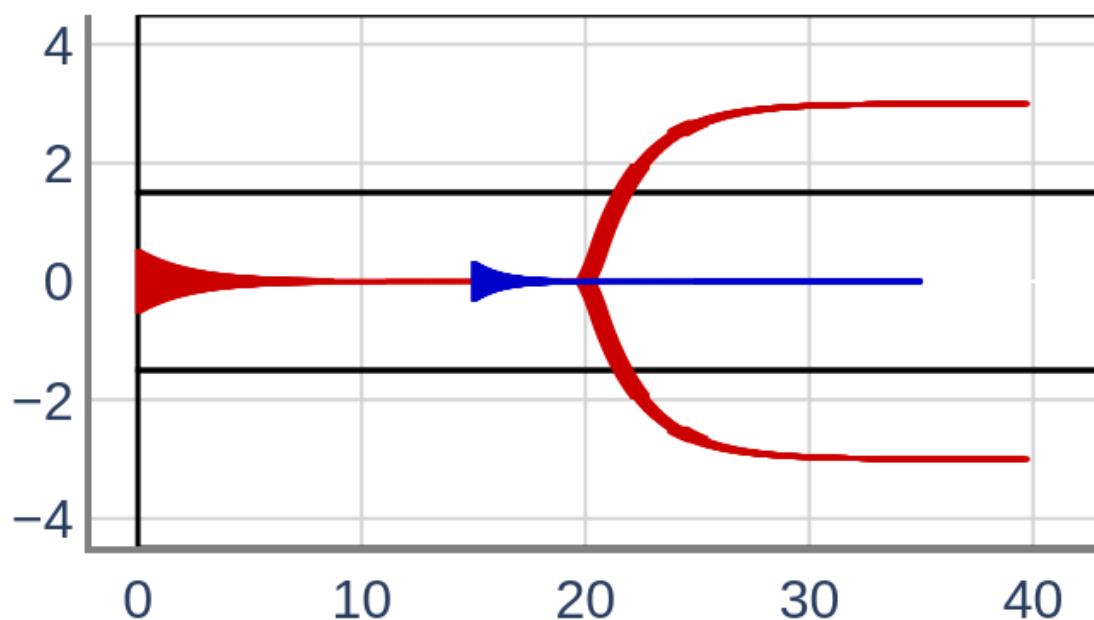
the one included in the paper.



Right: Run command

```
python3 demo/cav2023/exp6/exp6_dryvr.py p
```

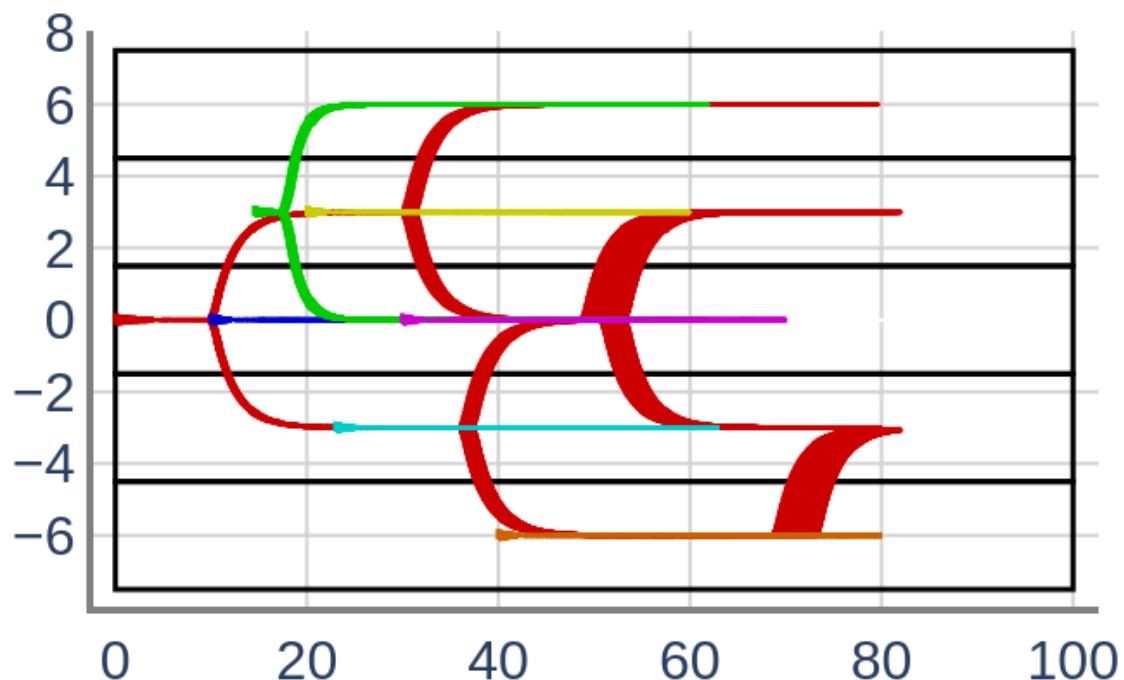
Verse will automatically open a browser window to show the resulting plot as shown below.



9. To reproduce Fig. 11 in Appendix, run command

```
python3 demo/cav2023/exp3/exp3.py p
```

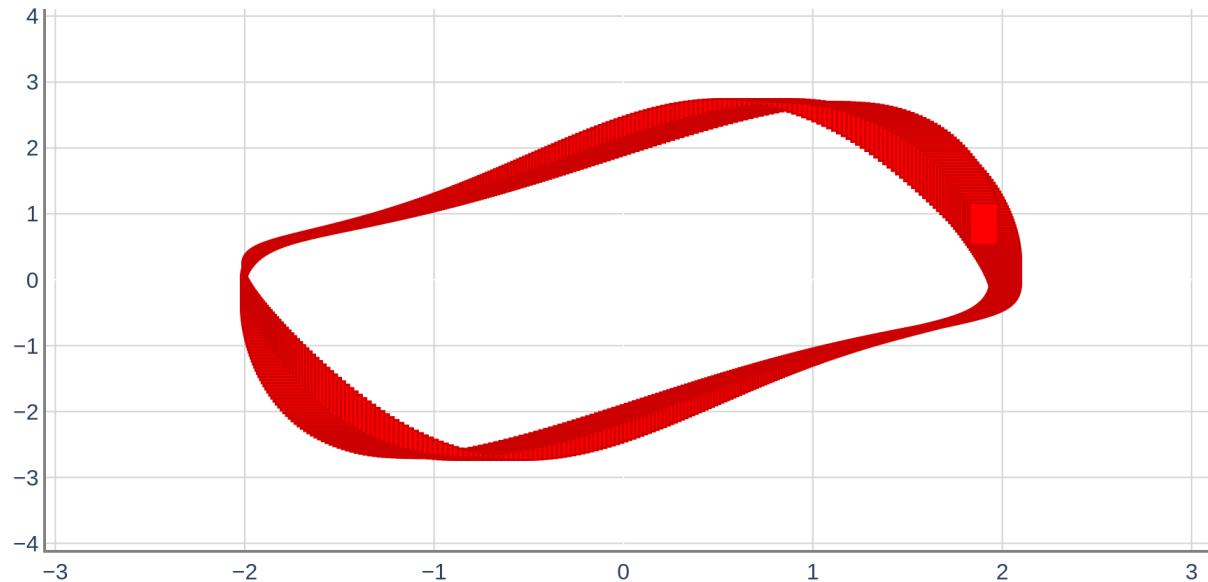
Verse will automatically open a browser window to show the resulting plot as shown below.



10. To reproduce Fig. 12 in Appendix, run command **Left**: Run command

```
pyhton3 demo/cav2023/exp12/vanderpol_demo2.py p
```

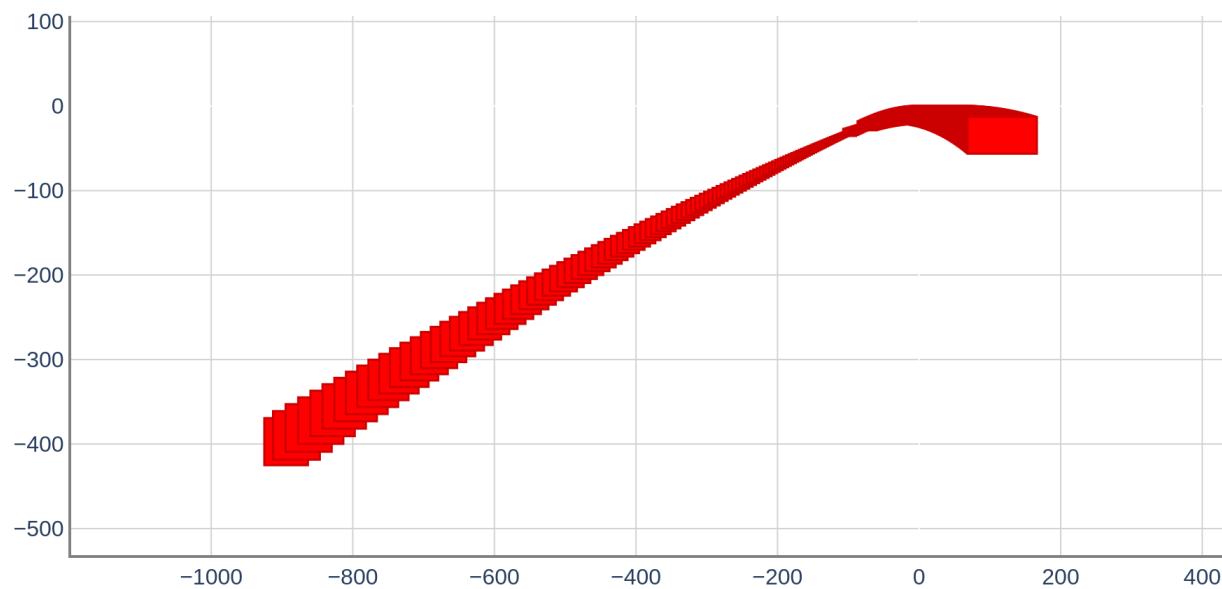
Verse will automatically open a browser window to show the resulting plot as shown below



Center: Run command

```
python3 demo/cav2023/exp12/vanderpol_demo2.py p
```

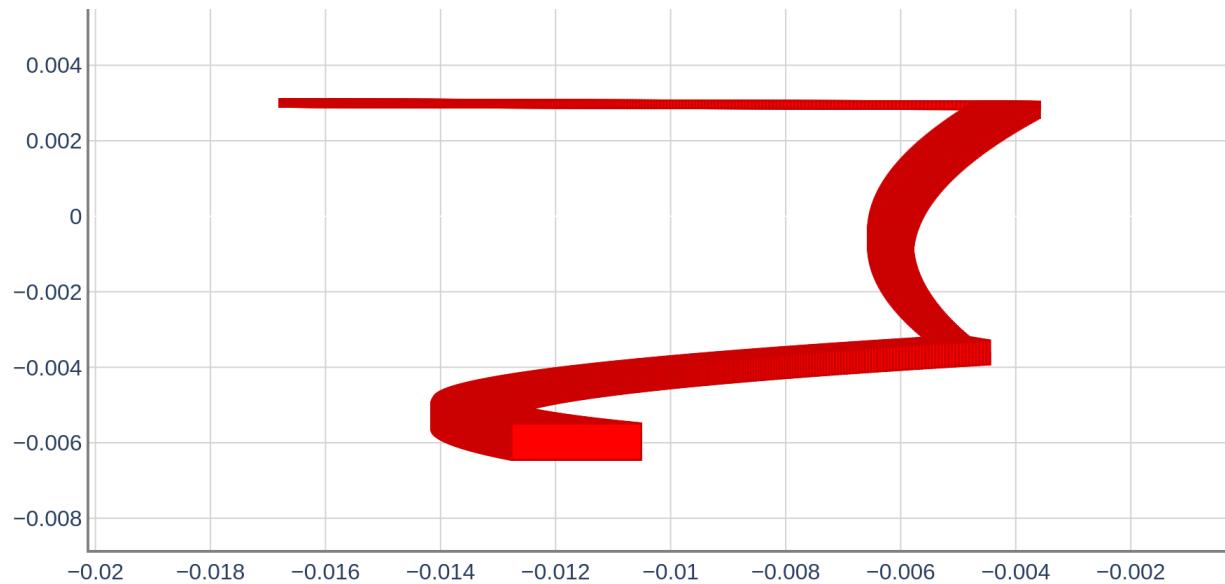
Verse will automatically open a browser window to show the resulting plot as shown below



Right: Run command

```
python3 demo/cav2023/exp12/vanderpol_demo2.py p
```

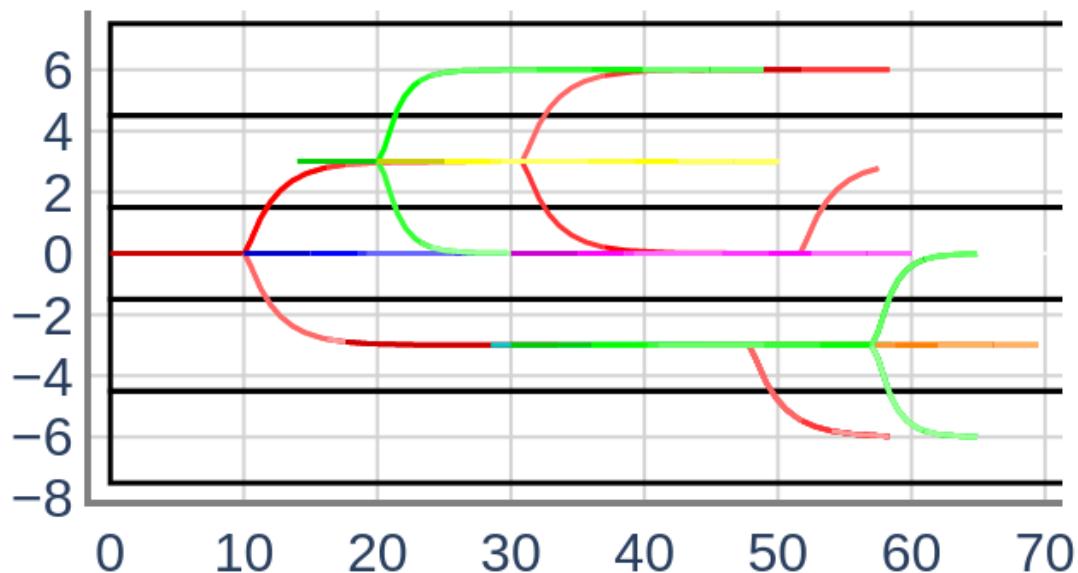
Verse will automatically open a browser window to show the resulting plot as shown below



11. To reproduce Fig. 13 in Appendix **Left:** Run command

```
python3 demo/cav2023/exp11/inc-expr.py sbp
```

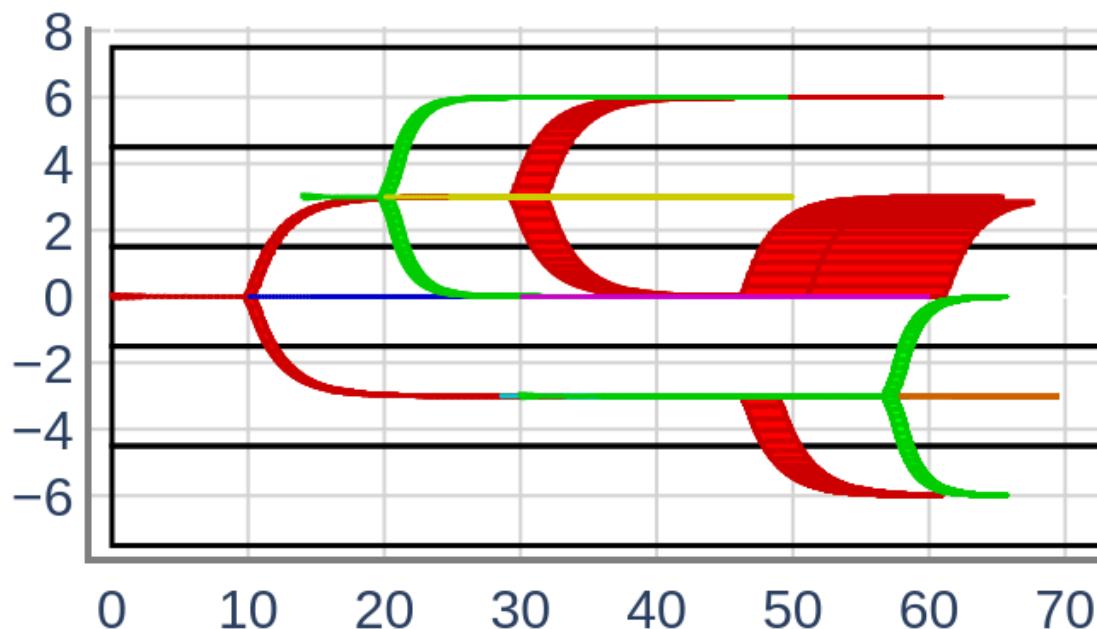
Verse will automatically open a browser window to show the resulting plot as shown below



Right: Run command

```
python3 demo/cav2023/exp11/inc-expr.py vbp
```

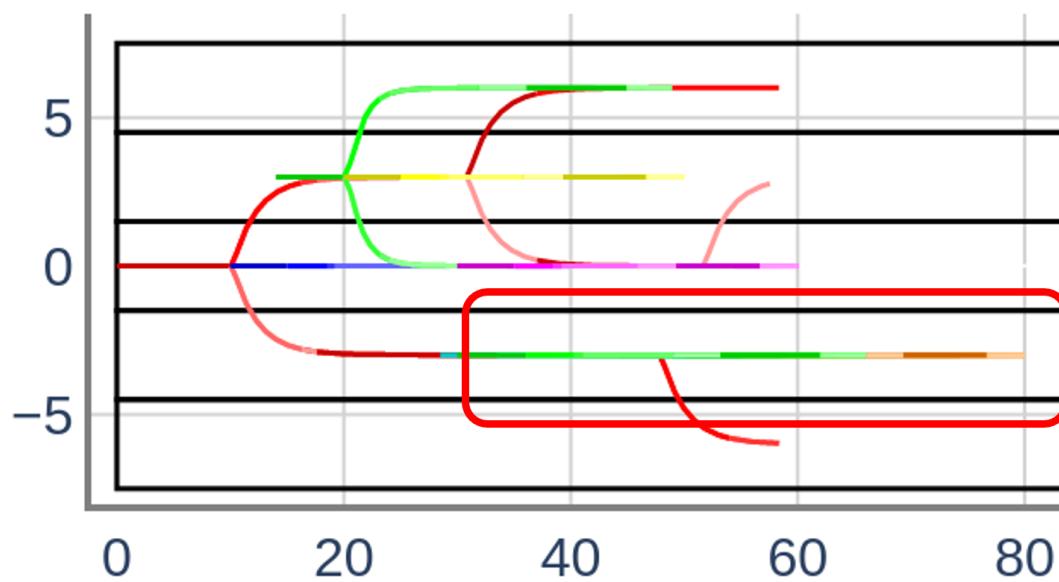
Verse will automatically open a browser window to show the resulting plot as below.



12. To reproduce Fig. 16 in Appendix **Left**: Run command

```
python3 demo/cav2023/exp11/inc-expr.py snp
```

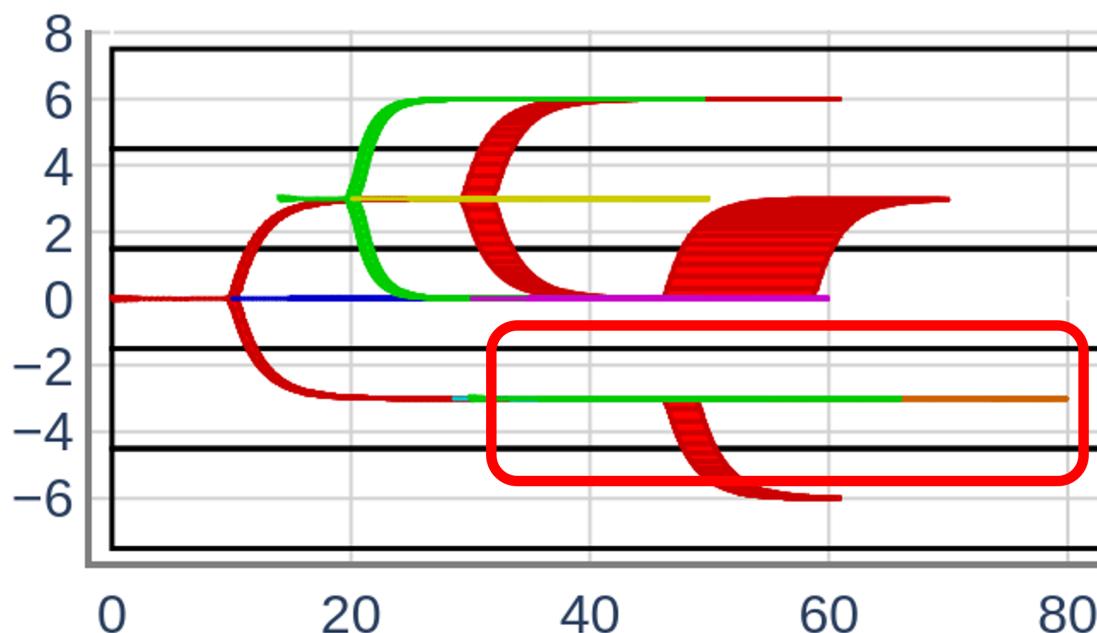
Verse will automatically open a browser window to show the resulting plot as below. Note that the red box in the figure is added separately.



Right: Run command

```
python3 demo/cav2023/exp11/inc-expr.py vnp
```

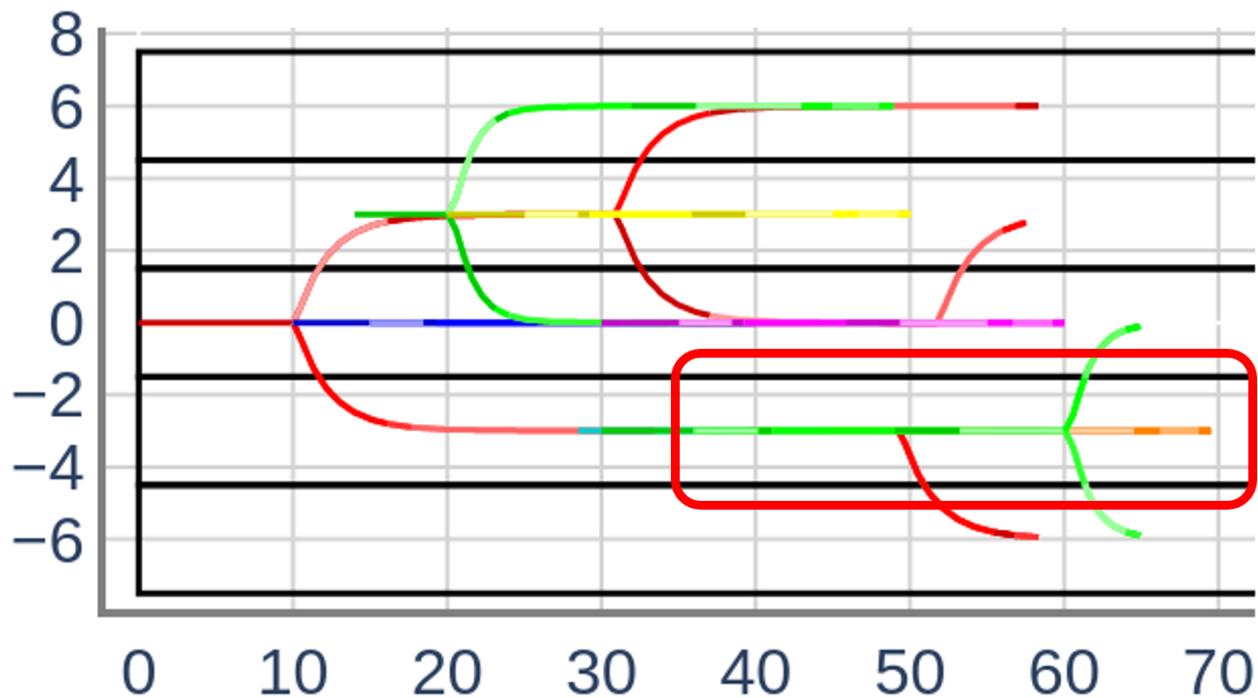
Verse will automatically open a browser window to show the resulting plot as below. Note that the red box in the figure is added separately.



13. To reproduce Fig. 17 in Appendix **Left**: Run command

```
python3 demo/cav2023/exp11/inc-expr.py s8p
```

Verse will automatically open a browser window to show the resulting plot as below. Note that the red box in the figure is added separately.



Right: Run command

```
python3 demo/cav2023/exp11/inc-expr.py v8p
```

Verse will automatically open a browser window to show the resulting plot as below. Note that the red box in the figure is added separately.

