

▼ BPL_TEST2_Fedbatch script with PyFMI ver 2.7.4

The key library PyFMI v2.7.4 is installed and downgrading is done Numpy v1.19.1. To simplify this we first install conda.

After the installation a small application BPL_TEST2_Fedbatch is loaded and run. You can continue with this example if you like.

```
!lsb_release -a # Actual VM Ubuntu version used by Google
```

```
No LSB modules are available.
Distributor ID: Ubuntu
Description:    Ubuntu 18.04.6 LTS
Release:        18.04
Codename:       bionic
```

```
%env PYTHONPATH=
```

```
env: PYTHONPATH=
```

```
!wget https://repo.anaconda.com/miniconda/Miniconda3-py37_4.12.0-Linux-x86_64.sh
!chmod +x Miniconda3-py37_4.12.0-Linux-x86_64.sh
!bash ./Miniconda3-py37_4.12.0-Linux-x86_64.sh -b -f -p /usr/local
import sys
sys.path.append('/usr/local/lib/python3.7/site-packages/')
```

```
- ruamel_yaml==0.15.100=py37h27cfd23_0
- setuptools==61.2.0=py37h06a4308_0
- six==1.16.0=pyhd3eb1b0_1
- sqlite==3.38.2=hc218d9a_0
- tk==8.6.11=h1ccaba5_0
- tqdm==4.63.0=pyhd3eb1b0_0
- urllib3==1.26.8=pyhd3eb1b0_0
- wheel==0.37.1=pyhd3eb1b0_0
- xz==5.2.5=h7b6447c_0
- yaml==0.2.5=h7b6447c_0
- zlib==1.2.12=h7f8727e_1
```

The following NEW packages will be INSTALLED:

_libgcc_mutex	pkgs/main/linux-64::_libgcc_mutex-0.1-main
_openmp_mutex	pkgs/main/linux-64::_openmp_mutex-4.5-1_gnu
brotlipy	pkgs/main/linux-64::brotlipy-0.7.0-py37h27cfd23_1003
ca-certificates	pkgs/main/linux-64::ca-certificates-2022.3.29-h06a4308_1
certifi	pkgs/main/linux-64::certifi-2021.10.8-py37h06a4308_2
cffi	pkgs/main/linux-64::cffi-1.15.0-py37hd667e15_1
charset-normalizer	pkgs/main/noarch::charset-normalizer-2.0.4-pyhd3eb1b0_0
colorama	pkgs/main/noarch::colorama-0.4.4-pyhd3eb1b0_0
conda	pkgs/main/linux-64::conda-4.12.0-py37h06a4308_0
conda-content-tru~	pkgs/main/noarch::conda-content-trust-0.1.1-pyhd3eb1b0_0
conda-package-han~	pkgs/main/linux-64::conda-package-handling-1.8.1-py37h7f8
cymath	pkgs/main/linux-64::cymath-0.2.9-py37h06a4308_0

```

cryptograpny      pkgs/main/linux-64::cryptograpny-36.0.0-py37h9ce1e76_0
idna              pkgs/main/noarch::idna-3.3-pyhd3eb1b0_0
ld_impl_linux-64 pkgs/main/linux-64::ld_impl_linux-64-2.35.1-h7274673_9
libffi           pkgs/main/linux-64::libffi-3.3-he6710b0_2
libgcc-ng        pkgs/main/linux-64::libgcc-ng-9.3.0-h5101ec6_17
libgomp          pkgs/main/linux-64::libgomp-9.3.0-h5101ec6_17
libstdcxx-ng     pkgs/main/linux-64::libstdcxx-ng-9.3.0-hd4cf53a_17
ncurses          pkgs/main/linux-64::ncurses-6.3-h7f8727e_2
openssl          pkgs/main/linux-64::openssl-1.1.1n-h7f8727e_0
pip              pkgs/main/linux-64::pip-21.2.2-py37h06a4308_0

pycosat          pkgs/main/linux-64::pycosat-0.6.3-py37h27cfd23_0
pycparser        pkgs/main/noarch::pycparser-2.21-pyhd3eb1b0_0
pyopenssl        pkgs/main/noarch::pyopenssl-22.0.0-pyhd3eb1b0_0
pysocks          pkgs/main/linux-64::pysocks-1.7.1-py37_1
python           pkgs/main/linux-64::python-3.7.13-h12debd9_0
readline         pkgs/main/linux-64::readline-8.1.2-h7f8727e_1
requests         pkgs/main/noarch::requests-2.27.1-pyhd3eb1b0_0
ruamel_yaml      pkgs/main/linux-64::ruamel_yaml-0.15.100-py37h27cfd23_0
setuptools       pkgs/main/linux-64::setuptools-61.2.0-py37h06a4308_0
six              pkgs/main/noarch::six-1.16.0-pyhd3eb1b0_1
sqlite           pkgs/main/linux-64::sqlite-3.38.2-hc218d9a_0
tk               pkgs/main/linux-64::tk-8.6.11-h1ccaba5_0
tqdm             pkgs/main/noarch::tqdm-4.63.0-pyhd3eb1b0_0
urllib3          pkgs/main/noarch::urllib3-1.26.8-pyhd3eb1b0_0
wheel            pkgs/main/noarch::wheel-0.37.1-pyhd3eb1b0_0
xz               pkgs/main/linux-64::xz-5.2.5-h7b6447c_0
yaml             pkgs/main/linux-64::yaml-0.2.5-h7b6447c_0
zlib             pkgs/main/linux-64::zlib-1.2.12-h7f8727e_1

```

Preparing transaction: done

Executing transaction: done

installation finished

```
!conda update -n base -c defaults conda --yes
```

```

colorama-0.4.4-pyhd3eb1b0_0
conda-content-trust-0.1.1-pyhd3eb1b0_0
six-1.16.0-pyhd3eb1b0_1

```

The following packages will be UPDATED:

```

_openmp_mutex      4.5-1_gnu --> 5.1-1_gnu
ca-certificates    2022.3.29-h06a4308_1 --> 2022.07.19-h06
certifi            2021.10.8-py37h06a4308_2 --> 2022.9.24-py37
cffi               1.15.0-py37hd667e15_1 --> 1.15.1-py37h74
conda              4.12.0-py37h06a4308_0 --> 22.9.0-py37h06
conda-package-hand 1.8.1-py37h7f8727e_0 --> 1.9.0-py37h5ee
cryptography       36.0.0-py37h9ce1e76_0 --> 37.0.1-py37h9c
ld_impl_linux-64   2.35.1-h7274673_9 --> 2.38-h1181459_
libgcc-ng          9.3.0-h5101ec6_17 --> 11.2.0-h123456
libgomp            9.3.0-h5101ec6_17 --> 11.2.0-h123456
libstdcxx-ng       9.3.0-hd4cf53a_17 --> 11.2.0-h123456
ncurses            6.3-h7f8727e_2 --> 6.3-h5eee18b_3
openssl            1.1.1n-h7f8727e_0 --> 1.1.1q-h7f8727
pip                21.2.2-py37h06a4308_0 --> 22.2.2-py37h06
requests           pkgs/main/noarch::requests-2.27.1-pyh~ --> pkgs/main/linu
setuptools         61.2.0-py37h06a4308_0 --> 63.4.1-py37h06
sqlite             3.38.2-hc218d9a_0 --> 3.39.3-h508229
tk                 8.6.11-h1ccaba5_0 --> 8.6.12-h1ccaba

```

```

tqdm          pkgs/main/noarch::tqdm-4.63.0-py39_0 --> pkgs/main/linux
urllib3       pkgs/main/noarch::urllib3-1.26.8-pyhd~ --> pkgs/main/linux
xz            5.2.5-h7b6447c_0 --> 5.2.6-h5eee18h
zlib          1.2.12-h7f8727e_1 --> 1.2.12-h5eee18h

```

Downloading and Extracting Packages

```

xz-5.2.6           | 394 KB      | : 100% 1.0/1 [00:00<00:00, 6.34it/s]
conda-package-handl | 887 KB      | : 100% 1.0/1 [00:00<00:00, 10.02it/s]
libgomp-11.2.0     | 474 KB      | : 100% 1.0/1 [00:00<00:00, 11.22it/s]
ca-certificates-2022 | 124 KB      | : 100% 1.0/1 [00:00<00:00, 15.86it/s]
sqlite-3.39.3      | 1.1 MB      | : 100% 1.0/1 [00:00<00:00, 11.11it/s]

conda-22.9.0       | 878 KB      | : 100% 1.0/1 [00:00<00:00, 7.33it/s]
certifi-2022.9.24  | 154 KB      | : 100% 1.0/1 [00:00<00:00, 14.13it/s]
toolz-0.11.2       | 49 KB       | : 100% 1.0/1 [00:00<00:00, 15.12it/s]
cffi-1.15.1        | 227 KB      | : 100% 1.0/1 [00:00<00:00, 13.55it/s]
zlib-1.2.12        | 103 KB      | : 100% 1.0/1 [00:00<00:00, 15.48it/s]
urllib3-1.26.11    | 181 KB      | : 100% 1.0/1 [00:00<00:00, 12.00it/s]
tqdm-4.64.1        | 126 KB      | : 100% 1.0/1 [00:00<00:00, 13.27it/s]
libgcc-ng-11.2.0   | 5.3 MB      | : 100% 1.0/1 [00:00<00:00, 3.96it/s]
ncurses-6.3        | 781 KB      | : 100% 1.0/1 [00:00<00:00, 3.30it/s]
_openmp_mutex-5.1  | 21 KB       | : 100% 1.0/1 [00:00<00:00, 14.06it/s]
libstdcxx-ng-11.2.0 | 4.7 MB      | : 100% 1.0/1 [00:00<00:00, 4.69it/s]
setuptools-63.4.1  | 1.1 MB      | : 100% 1.0/1 [00:00<00:00, 6.13it/s]
ld_impl_linux-64-2.3 | 654 KB      | : 100% 1.0/1 [00:00<00:00, 11.33it/s]
cryptography-37.0.1 | 1.3 MB      | : 100% 1.0/1 [00:00<00:00, 6.87it/s]
requests-2.28.1    | 92 KB       | : 100% 1.0/1 [00:00<00:00, 13.81it/s]
openssl-1.1.1q     | 2.5 MB      | : 100% 1.0/1 [00:00<00:00, 4.12it/s]
tk-8.6.12          | 3.0 MB      | : 100% 1.0/1 [00:00<00:00, 4.30it/s]
pip-22.2.2         | 2.3 MB      | : 100% 1.0/1 [00:00<00:00, 3.57it/s]

```

Preparing transaction: done

Verifying transaction: done

Executing transaction: done

!conda --version

!python --version

conda 22.9.0

Python 3.7.13

!conda install -c conda-forge pyfmi==2.7.4 --yes # Install the key package

```

-----
libopenblas      conda-forge/linux-64::libopenblas-0.3.20-pthreads_h78a641
libxml2          conda-forge/linux-64::libxml2-2.9.12-h72842e0_0 None
libxslt          conda-forge/linux-64::libxslt-1.1.33-h15afd5d_2 None
lxml             conda-forge/linux-64::lxml-4.8.0-py37h540881e_2 None
metis           conda-forge/linux-64::metis-5.1.0-h58526e2_1006 None
mpfr            conda-forge/linux-64::mpfr-4.1.0-h9202a9a_1 None
numpy           conda-forge/linux-64::numpy-1.21.6-py37h976b520_0 None
pyfmi           conda-forge/linux-64::pyfmi-2.7.4-py37h161383b_0 None
python_abi      conda-forge/linux-64::python_abi-3.7-2_cp37m None
scipy           conda-forge/linux-64::scipy-1.7.3-py37hf2a6cfl_0 None
suitesparse     conda-forge/linux-64::suitesparse-5.10.1-h9e50725_1 None
sundials        conda-forge/linux-64::sundials-5.8.0-h558c624_0 None
tbb             conda-forge/linux-64::tbb-2021.5.0-h924138e_1 None

```

The following packages will be UPDATED:

```
ca-certificates pkgs/main::ca-certificates-2022.07.19~ --> conda-forge::c
conda pkgs/main::conda-22.9.0-py37h06a4308_0 --> conda-forge::c
```

The following packages will be SUPERSEDED by a higher-priority channel:

```
certifi pkgs/main/linux-64::certifi-2022.9.24~ --> conda-forge/nc
openssl pkgs/main::openssl-1.1.1q-h7f8727e_0 --> conda-forge::c
```

Downloading and Extracting Packages

libblas-3.9.0	12 KB	: 100% 1.0/1 [00:00<00:00, 8.64it/s]
certifi-2022.9.24	155 KB	: 100% 1.0/1 [00:00<00:00, 11.51it/s]
libopenblas-0.3.20	10.1 MB	: 100% 1.0/1 [00:02<00:00, 2.82s/it]
python_abi-3.7	4 KB	: 100% 1.0/1 [00:00<00:00, 21.08it/s]
libxslt-1.1.33	522 KB	: 100% 1.0/1 [00:00<00:00, 3.15it/s]
libgfortran5-12.1.0	1.8 MB	: 100% 1.0/1 [00:00<00:00, 1.92it/s]
tbb-2021.5.0	1.9 MB	: 100% 1.0/1 [00:00<00:00, 1.07it/s]
liblapack-3.9.0	12 KB	: 100% 1.0/1 [00:00<00:00, 20.46it/s]
libiconv-1.17	1.4 MB	: 100% 1.0/1 [00:00<00:00, 3.30it/s]
gmp-6.2.1	806 KB	: 100% 1.0/1 [00:00<00:00, 3.00it/s]
pyfmi-2.7.4	12.4 MB	: 100% 1.0/1 [00:03<00:00, 3.04s/it]
libgfortran-ng-12.1.	23 KB	: 100% 1.0/1 [00:00<00:00, 21.44it/s]
numpy-1.21.6	6.1 MB	: 100% 1.0/1 [00:02<00:00, 2.20s/it]
conda-22.9.0	960 KB	: 100% 1.0/1 [00:00<00:00, 2.22it/s]
libxml2-2.9.12	772 KB	: 100% 1.0/1 [00:00<00:00, 4.26it/s]
scipy-1.7.3	21.8 MB	: 100% 1.0/1 [00:06<00:00, 6.21s/it]
openssl-1.1.1o	2.1 MB	: 100% 1.0/1 [00:00<00:00, 1.90it/s]
fmilib-2.2.3	532 KB	: 100% 1.0/1 [00:00<00:00, 2.06it/s]
metis-5.1.0	4.1 MB	: 100% 1.0/1 [00:01<00:00, 1.25s/it]
assimulo-3.2.9	2.6 MB	: 100% 1.0/1 [00:01<00:00, 1.22s/it]
libcblas-3.9.0	12 KB	: 100% 1.0/1 [00:00<00:00, 21.79it/s]
ca-certificates-2022	150 KB	: 100% 1.0/1 [00:00<00:00, 15.91it/s]
lxml-4.8.0	1.4 MB	: 100% 1.0/1 [00:00<00:00, 1.22it/s]
sundials-5.8.0	1.0 MB	: 100% 1.0/1 [00:00<00:00, 2.04it/s]
icu-68.2	13.1 MB	: 100% 1.0/1 [00:03<00:00, 3.15s/it]
mpfr-4.1.0	2.6 MB	: 100% 1.0/1 [00:00<00:00, 1.48it/s]
suitesparse-5.10.1	2.4 MB	: 100% 1.0/1 [00:00<00:00, 1.21it/s]

Preparing transaction: done

Verifying transaction: done

Executing transaction: done

Retrieving notices: ...working... done

```
!conda install numpy=1.19.1 --yes # Need to downgrade numpy
```

Collecting package metadata (current_repodata.json): done

Solving environment: failed with initial frozen solve. Retrying with flexible

Collecting package metadata (repodata.json): done

Solving environment: done

Package Plan

```
environment location: /usr/local
```

```
added / updated specs:
```

```
- numpy=1.19.1
```

The following packages will be downloaded:

package	build	
-----	-----	
blas-1.0	openblas	46 KB
numpy-1.19.1	py37h30dfecb_0	21 KB
numpy-base-1.19.1	py37h75fe3a5_0	4.1 MB
-----	-----	
Total:		4.2 MB

The following NEW packages will be INSTALLED:

```
blas          pkgs/main/linux-64::blas-1.0-openblas None
numpy-base   pkgs/main/linux-64::numpy-base-1.19.1-py37h75fe3a5_0 None
```

The following packages will be UPDATED:

```
openssl      conda-forge::openssl-1.1.1o-h166bdaf_0 --> pkgs/main::ope
```

The following packages will be SUPERSEDED by a higher-priority channel:

```
ca-certificates  conda-forge::ca-certificates-2022.9.2~ --> pkgs/main::ca-
certifi          conda-forge/noarch::certifi-2022.9.24~ --> pkgs/main/linv
conda            conda-forge::conda-22.9.0-py37h89c186~ --> pkgs/main::cor
numpy            conda-forge::numpy-1.21.6-py37h976b52~ --> pkgs/main::num
```

Downloading and Extracting Packages

```
numpy-base-1.19.1 | 4.1 MB | : 100% 1.0/1 [00:00<00:00, 1.26it/s]
numpy-1.19.1      | 21 KB | : 100% 1.0/1 [00:00<00:00, 3.71it/s]
blas-1.0          | 46 KB | : 100% 1.0/1 [00:00<00:00, 10.65it/s]
Preparing transaction: done
Verifying transaction: done
Executing transaction: done
Retrieving notices: ...working... done
```

▼ Now specific installation run a simulation and notebook for that

Start with connecting to Github. Then upload the two files:

- FMU - BPL_TEST2_Fedbatch_linux_jm_cs.fmu
- Setup-file - BPL_TEST2_Fedbatch_explore.py

```
# Filter out DeprecationWarnings for 'np.float as alias' is needed - wish I could m
import warnings
warnings.filterwarnings("ignore")
```

```
%%bash
git clone https://github.com/janpeter19/BPL_TEST2_Fedbatch
```

```
Cloning into 'BPL_TEST2_Fedbatch'...
```

```
%cd BPL_TEST2_Fedbatch
```

```
/content/BPL_TEST2_Fedbatch
```

```
run -i BPL_TEST2_Fedbatch_explore.py
```

Linux - run FMU pre-compiled JModelica 2.4

Model for bioreactor has been setup. Key commands:

- par() - change of parameters and initial values
- init() - change initial values only
- simu() - simulate and plot
- newplot() - make a new plot
- show() - show plot from previous simulation
- disp() - display parameters and initial values from the last simulation
- describe() - describe culture, broth, parameters, variables with values /

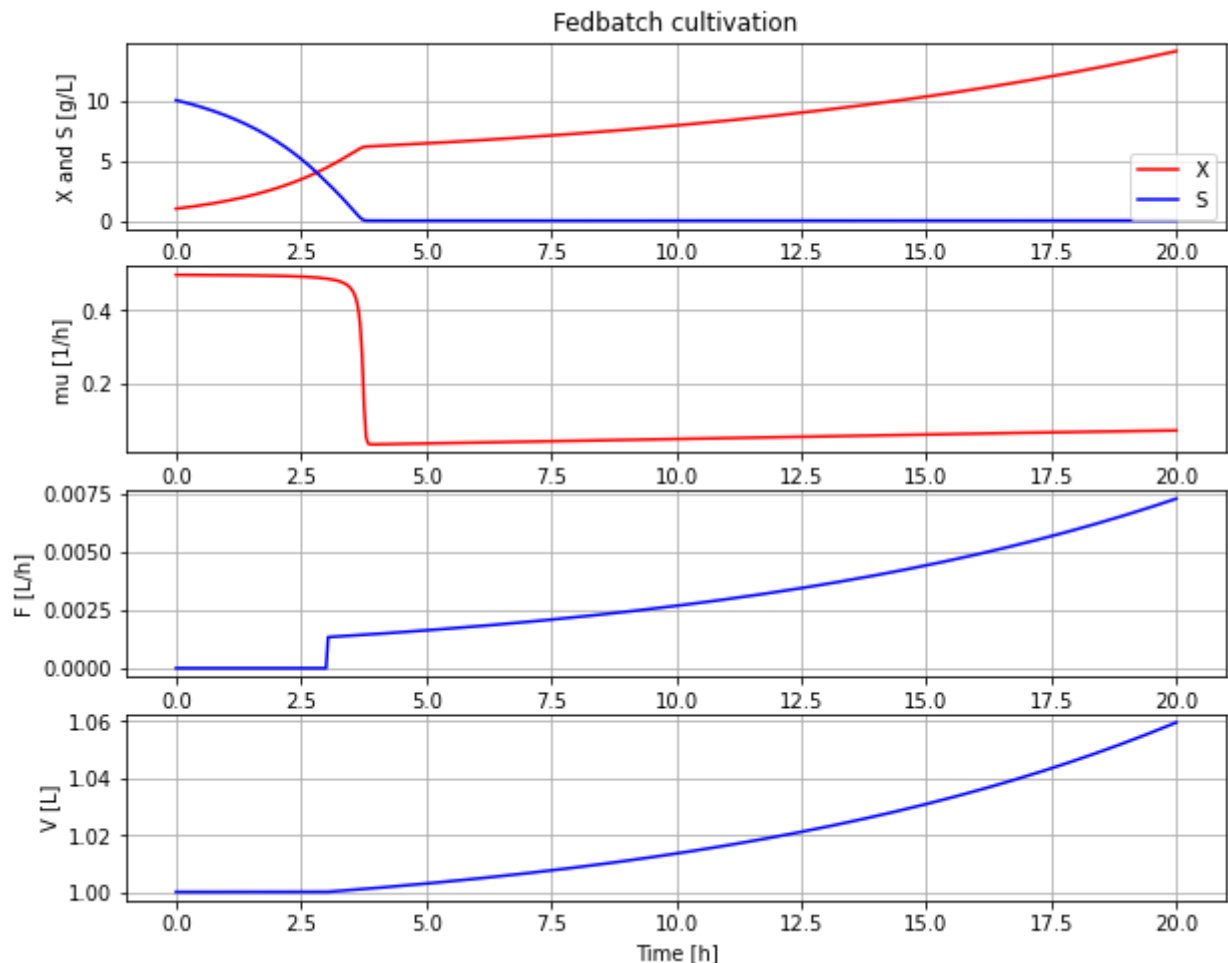
Note that both disp() and describe() takes values from the last simulation

Brief information about a command by help(), eg help(simu)

Key system information is listed with the command system_info()

```
%matplotlib inline
plt.rcParams['figure.figsize'] = [25/2.54, 20/2.54]

# Simulation with default values of the process
newplot(plotType='TimeSeries')
simu(20)
```



```
disp(mode='long')
```

```

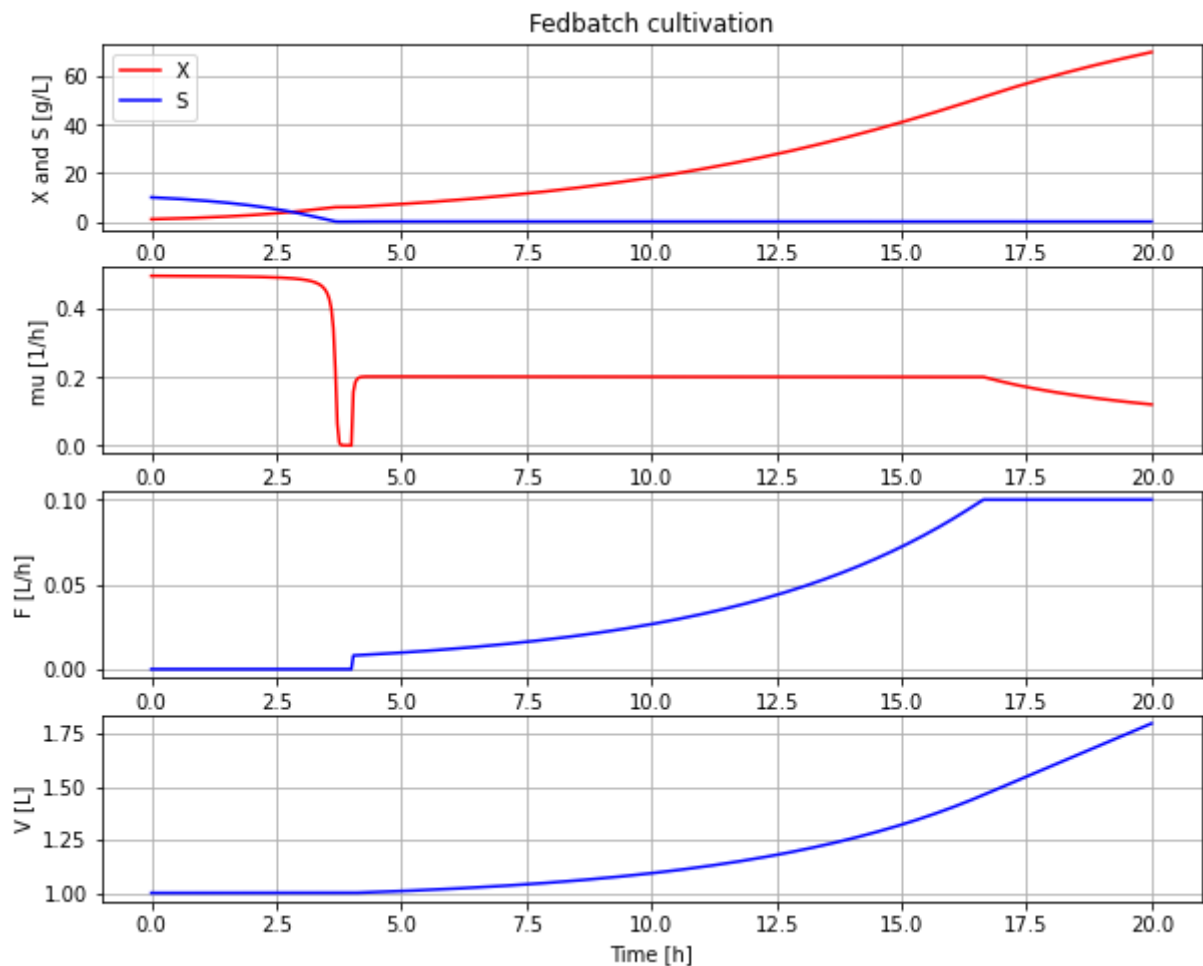
bioreactor.V_0 : V_0 : 1.0
bioreactor.m_0[1] : VX_0 : 1.0
bioreactor.m_0[2] : VS_0 : 10.0
bioreactor.culture.Y : Y : 0.5
bioreactor.culture.qSmax : qSmax : 1.0
bioreactor.culture.Ks : Ks : 0.1
feedtank.c_in[2] : feedtank.S_in : 300.0
feedtank.V_0 : feedtank.V_0 : 10.0
dosagescheme.mu_feed : mu_feed : 0.1
dosagescheme.t_start : t_start : 3.0
dosagescheme.F_start : F_start : 0.001
dosagescheme.F_max : F_max : 0.3
bioreactor.culture.mu : mu : 0.073

```

```

# A more typical feed scheme for the culture at hand
newplot(plotType='TimeSeries')
par(t_start=4, F_start=0.008, mu_feed=0.2, F_max=0.1)
simu(20)

```



```
system_info()
```

```

System information
-OS: Linux
-Python: 3.7.14
-PyFMI: 2.7.4
-FMU by: JModelica.org
-FMI: 2.0

```

-Type: FMUModelCS2
-Name: BPL_TEST2.Fedbatch
-Generated: 2022-05-29T13:42:58
-Description: Bioprocess Library version 2.0.9
-Interaction: FMU-explore ver 0.9.1

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✓ 0s completed at 08:51

