

▼ BPL_TEST2_Chemostat 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_Chemostat 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
cryptography	pkgs/main/linux-64::cryptography-36.0.0-py37h9ce1e76_0

```

1ana pkgs/main/noarch::1ana-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

.....

```
!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-handling 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-pyhd3eb~ --> pkgs/main/linu
urllib3 pkgs/main/noarch::urllib3-1.26.8-pyhd3eb1b0_0 --> pkgs/main/linu

```

```

urllib3          pkgs/main/noarch::urllib3-1.26.8-py39~ --> pkgs/main/linux
xz               5.2.5-h7b6447c_0 --> 5.2.6-h5eee18k
zlib             1.2.12-h7f8727e_1 --> 1.2.12-h5eee18k

```

Downloading and Extracting Packages

```

cffi-1.15.1      | 227 KB      | : 100% 1.0/1 [00:00<00:00, 6.34it/s]
ca-certificates-2022 | 124 KB      | : 100% 1.0/1 [00:00<00:00, 17.30it/s]
ncurses-6.3      | 781 KB      | : 100% 1.0/1 [00:00<00:00, 2.87it/s]
openssl-1.1.1q   | 2.5 MB      | : 100% 1.0/1 [00:00<00:00, 6.12it/s]
setuptools-63.4.1 | 1.1 MB      | : 100% 1.0/1 [00:00<00:00, 6.24it/s]
conda-package-handl | 887 KB      | : 100% 1.0/1 [00:00<00:00, 6.86it/s]

cryptography-37.0.1 | 1.3 MB      | : 100% 1.0/1 [00:00<00:00, 6.37it/s]
libgomp-11.2.0     | 474 KB      | : 100% 1.0/1 [00:00<00:00, 12.03it/s]
_openmp_mutex-5.1  | 21 KB       | : 100% 1.0/1 [00:00<00:00, 16.08it/s]
toolz-0.11.2      | 49 KB       | : 100% 1.0/1 [00:00<00:00, 16.51it/s]
pip-22.2.2        | 2.3 MB      | : 100% 1.0/1 [00:00<00:00, 3.42it/s]
tk-8.6.12         | 3.0 MB      | : 100% 1.0/1 [00:00<00:00, 5.54it/s]
xz-5.2.6          | 394 KB      | : 100% 1.0/1 [00:00<00:00, 10.50it/s]
sqlite-3.39.3     | 1.1 MB      | : 100% 1.0/1 [00:00<00:00, 11.27it/s]
conda-22.9.0      | 878 KB      | : 100% 1.0/1 [00:00<00:00, 7.51it/s]
libgcc-ng-11.2.0  | 5.3 MB      | : 100% 1.0/1 [00:00<00:00, 2.91it/s]
ld_impl_linux-64-2.3 | 654 KB      | : 100% 1.0/1 [00:00<00:00, 11.40it/s]
zlib-1.2.12       | 103 KB      | : 100% 1.0/1 [00:00<00:00, 17.38it/s]
urllib3-1.26.11   | 181 KB      | : 100% 1.0/1 [00:00<00:00, 13.95it/s]
tqdm-4.64.1       | 126 KB      | : 100% 1.0/1 [00:00<00:00, 14.29it/s]
requests-2.28.1   | 92 KB       | : 100% 1.0/1 [00:00<00:00, 16.22it/s]
certifi-2022.9.24 | 154 KB      | : 100% 1.0/1 [00:00<00:00, 15.27it/s]
libstdcxx-ng-11.2.0 | 4.7 MB      | : 100% 1.0/1 [00:00<00:00, 4.45it/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
```

```

liblapack          conda-forge/linux-64::liblapack-0.3.0-15_linux64_openblas
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-py37hf2a6cf1_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

```

conda

pkgs/main::conda-22.9.0-py3/n06a4308_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, 8.10it/s]
icu-68.2	13.1 MB	: 100% 1.0/1 [00:02<00:00, 2.20s/it]
ca-certificates-2022	150 KB	: 100% 1.0/1 [00:00<00:00, 16.46it/s]
metis-5.1.0	4.1 MB	: 100% 1.0/1 [00:00<00:00, 1.12it/s]
numpy-1.21.6	6.1 MB	: 100% 1.0/1 [00:01<00:00, 1.59s/it]
gmp-6.2.1	806 KB	: 100% 1.0/1 [00:00<00:00, 4.34it/s]
sundials-5.8.0	1.0 MB	: 100% 1.0/1 [00:00<00:00, 2.41it/s]
assimulo-3.2.9	2.6 MB	: 100% 1.0/1 [00:00<00:00, 1.81it/s]
libopenblas-0.3.20	10.1 MB	: 100% 1.0/1 [00:01<00:00, 1.94s/it]
conda-22.9.0	960 KB	: 100% 1.0/1 [00:00<00:00, 3.39it/s]
lxml-4.8.0	1.4 MB	: 100% 1.0/1 [00:00<00:00, 3.08it/s]
scipy-1.7.3	21.8 MB	: 100% 1.0/1 [00:04<00:00, 4.05s/it]
libxslt-1.1.33	522 KB	: 100% 1.0/1 [00:00<00:00, 5.44it/s]
libiconv-1.17	1.4 MB	: 100% 1.0/1 [00:00<00:00, 4.43it/s]
mpfr-4.1.0	2.6 MB	: 100% 1.0/1 [00:00<00:00, 2.00it/s]
libcbblas-3.9.0	12 KB	: 100% 1.0/1 [00:00<00:00, 26.45it/s]
certifi-2022.9.24	155 KB	: 100% 1.0/1 [00:00<00:00, 16.96it/s]
libgfortran5-12.1.0	1.8 MB	: 100% 1.0/1 [00:00<00:00, 2.61it/s]
suitesparse-5.10.1	2.4 MB	: 100% 1.0/1 [00:00<00:00, 2.14it/s]
pyfmi-2.7.4	12.4 MB	: 100% 1.0/1 [00:01<00:00, 1.57s/it]
libgfortran-ng-12.1.	23 KB	: 100% 1.0/1 [00:00<00:00, 22.22it/s]
tbb-2021.5.0	1.9 MB	: 100% 1.0/1 [00:00<00:00, 3.02it/s]
fmllib-2.2.3	532 KB	: 100% 1.0/1 [00:00<00:00, 6.02it/s]
python_abi-3.7	4 KB	: 100% 1.0/1 [00:00<00:00, 28.87it/s]
openssl-1.1.1o	2.1 MB	: 100% 1.0/1 [00:00<00:00, 2.47it/s]
liblapack-3.9.0	12 KB	: 100% 1.0/1 [00:00<00:00, 26.54it/s]
libxml2-2.9.12	772 KB	: 100% 1.0/1 [00:00<00:00, 3.85it/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/linu
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, 2.44it/s]
blas-1.0	46 KB	: 100% 1.0/1 [00:00<00:00, 14.57it/s]
numpy-1.19.1	21 KB	: 100% 1.0/1 [00:00<00:00, 10.39it/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_Chemostat_linux_jm_cs.fmu
- Setup-file - BPL_TEST2_Chemostat_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_Chemostat
```

```
Cloning into 'BPL_TEST2_Chemostat'...
```

```
%cd BPL_TEST2_Chemostat
```

```
/content/BPL_TEST2_Chemostat
```

```
run -i BPL_TEST2_Chemostat_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]
```

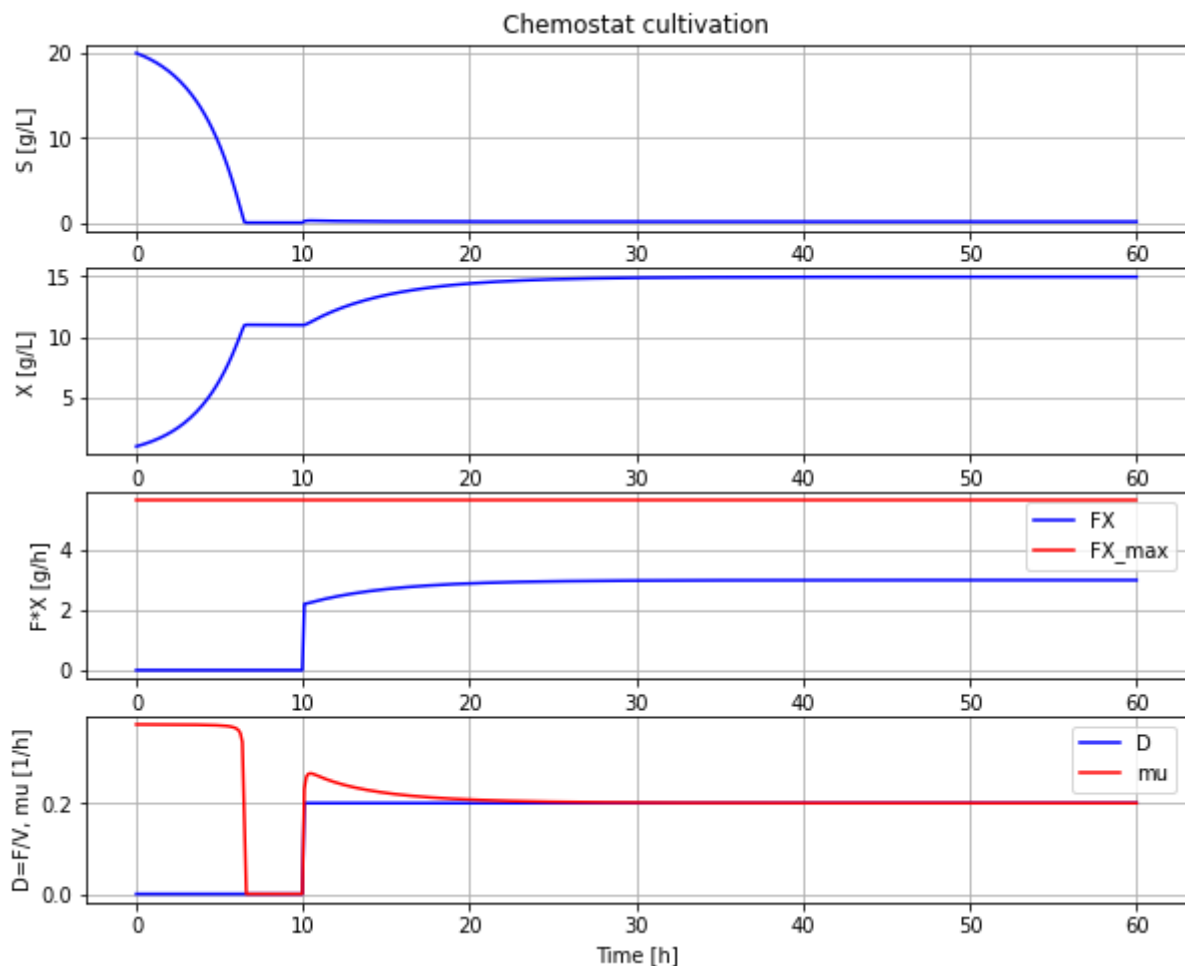
```
newplot()
```

```
par(Y=0.50, qSmax=0.75, Ks=0.1) # Culture parameters
```

```
init(V_0=1.0, VX_0=1.0, VS_0=20) # Bioreactor startup
```

```
par(S_in=30, t0=0, F0=0, t1=10, F1=0.2) # Substrate feeding
```

```
simu(60)
```



The maximal biomass productivity $F \cdot X_{\max}$ [g/h] marked red in the diagram above

```
# The maximal biomass productivity  $FX_{max}$  [g/h] marked red in the diagram above  
# can be calculated for CSTR from the FMU and is  
cstrProdMax(model)
```



5.625

```
describe('cstrProdMax')
```

Calculate from the model maximal chemostat productivity FX_{max} : 5.625 [g/h]

```
describe('parts')
```

['bioreactor', 'bioreactor.culture', 'D', 'dosagescheme', 'feedtank', 'harvest

```
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.Chemostat  
-Generated: 2022-05-29T14:37:34  
-Description: Bioprocess Library version 2.0.9  
-Interaction: FMU-explore ver 0.9.1
```

✓ 0s completed at 08:51

