

BPL_TEST2_Fedbatch script with PyFMI

The key library PyFMI is installed.

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

```
In [1]: !lsb_release -a # Actual VM Ubuntu version used by Google
```

```
No LSB modules are available.  
Distributor ID: Ubuntu  
Description:   Ubuntu 22.04.4 LTS  
Release:      22.04  
Codename:     jammy
```

```
In [2]: %env PYTHONPATH=
```

```
env: PYTHONPATH=
```

```
In [3]: !python --version
```

```
Python 3.11.11
```

```
In [4]: !wget https://repo.anaconda.com/miniconda/Miniconda3-py311_24.11.1-0-Linux-x86_64.s  
!chmod +x Miniconda3-py311_24.11.1-0-Linux-x86_64.sh  
!bash ./Miniconda3-py311_24.11.1-0-Linux-x86_64.sh -b -f -p /usr/local  
import sys  
sys.path.append('/usr/local/lib/python3.11/site-packages/')
```

```
--2025-03-27 08:34:16-- https://repo.anaconda.com/miniconda/Miniconda3-py311_24.11.1-0-Linux-x86_64.sh
Resolving repo.anaconda.com (repo.anaconda.com)... 104.16.191.158, 104.16.32.241, 2606:4700::6810:20f1, ...
Connecting to repo.anaconda.com (repo.anaconda.com)|104.16.191.158|:443... connected.
HTTP request sent, awaiting response... 200 OK
Length: 145900576 (139M) [application/octet-stream]
Saving to: 'Miniconda3-py311_24.11.1-0-Linux-x86_64.sh'

Miniconda3-py311_24 100%[=====>] 139.14M  117MB/s   in 1.2s

2025-03-27 08:34:17 (117 MB/s) - 'Miniconda3-py311_24.11.1-0-Linux-x86_64.sh' saved
[145900576/145900576]

PREFIX=/usr/local
Unpacking payload ...

Installing base environment...

Preparing transaction: ...working... done
Executing transaction: ...working... done
installation finished.
```

```
In [5]: !conda update -n base -c defaults conda --yes
```

Channels:
- defaults
Platform: linux-64
Collecting package metadata (repodata.json): - 00\ 00| 00/ 00- 00\ 00| 00/ 00- 00\
00| 00/ 00- 00\ 00| 00/ 00- 00done
Solving environment: | 00/ 00done

Package Plan

environment location: /usr/local

added / updated specs:
- conda

The following packages will be downloaded:

package	build	
-----	-----	
ca-certificates-2025.2.25	h06a4308_0	129 KB
certifi-2025.1.31	py311h06a4308_0	163 KB
openssl-3.0.16	h5eee18b_0	5.2 MB
-----	-----	
Total:		5.5 MB

The following packages will be UPDATED:

ca-certificates	2024.11.26-h06a4308_0 --> 2025.2.25-h06a4308_0
certifi	2024.8.30-py311h06a4308_0 --> 2025.1.31-py311h06a4308_0
openssl	3.0.15-h5eee18b_0 --> 3.0.16-h5eee18b_0

Downloading and Extracting Packages:

openssl-3.0.16	5.2 MB	: 0% 0/1 [00:00<?, ?it/s]
certifi-2025.1.31	163 KB	: 0% 0/1 [00:00<?, ?it/s]
ca-certificates-2025	129 KB	: 0% 0/1 [00:00<?, ?it/s]
openssl-3.0.16	5.2 MB	: 2% 0.023860751601296512/1 [00:00<00:04, 4.37s/it]
certifi-2025.1.31	163 KB	: 79% 0.7872097632460872/1 [00:00<00:00, 7.55it/s]
certifi-2025.1.31	163 KB	: 100% 1.0/1 [00:00<00:00, 7.55it/s]
ca-certificates-2025	129 KB	: 100% 1.0/1 [00:00<00:00, 8.10it/s]
ca-certificates-2025	129 KB	: 100% 1.0/1 [00:00<00:00, 8.10it/s]

Preparing transaction: - 00done
Verifying transaction: | 00/ 00- 00done
Executing transaction: | 00done

```
In [6]: !conda --version  
!python --version
```

```
conda 24.11.1  
Python 3.11.11
```

```
In [7]: !conda config --set channel_priority strict
```

```
In [8]: !conda install -c conda-forge pyfmi --yes # Install the key package
```

```
Channels:
- conda-forge
- defaults
Platform: linux-64
Collecting package metadata (repodata.json): - 22\ 22| 22/ 22- 22\ 22| 22/ 22- 22\
22| 22/ 22- 22\ 22| 22/ 22- 22\ 22| 22/ 22- 22\ 22| 22/ 22- 22\ 22| 22/ 22- 22\ 22|
22/ 22- 22\ 22| 22/ 22- 22\ 22| 22/ 22- 22\ 22| 22/ 22- 22\ 22| 22/ 22- 22\ 22| 22/
22- 22\ 22| 22/ 22- 22\ 22| 22/ 22- 22\ 22| 22/ 22- 22\ 22| 22/ 22- 22\ 22| 22/ 22do
ne
Solving environment: \ 22| 22/ 22- 22done
```

Package Plan

environment location: /usr/local

added / updated specs:

- pyfmi

The following packages will be downloaded:

package	build		
-----	-----		
_x86_64-microarch-level-3	2_broadwell	8 KB	conda-forge
assimulo-3.6.0	py311h083bc19_0	1.1 MB	conda-forge
certifi-2025.1.31	pyhd8ed1ab_0	159 KB	conda-forge
conda-25.3.0	py311h38be061_0	1.1 MB	conda-forge
fmilib-2.4.1	hac33072_1	383 KB	conda-forge
gmp-6.3.0	hac33072_2	449 KB	conda-forge
libamd-3.3.3	haaf9dc3_7100102	49 KB	conda-forge
libblas-3.9.0	31_h59b9bed_openblas	16 KB	conda-forge
libbtf-2.3.2	h32481e8_7100102	27 KB	conda-forge
libcamd-3.3.3	h32481e8_7100102	46 KB	conda-forge
libcbblas-3.9.0	31_he106b2a_openblas	16 KB	conda-forge
libccolamd-3.3.4	h32481e8_7100102	42 KB	conda-forge
libcholmod-5.3.1	h59ddab4_7100102	1.1 MB	conda-forge
libcolamd-3.3.4	h32481e8_7100102	33 KB	conda-forge
libcxsparse-4.4.1	h32481e8_7100102	118 KB	conda-forge
libgcc-14.2.0	h767d61c_2	828 KB	conda-forge
libgcc-ng-14.2.0	h69a702a_2	52 KB	conda-forge
libgfortran-14.2.0	h69a702a_2	52 KB	conda-forge
libgfortran-ng-14.2.0	h69a702a_2	53 KB	conda-forge
libgfortran5-14.2.0	hf1ad2bd_2	1.4 MB	conda-forge
libgomp-14.2.0	h767d61c_2	449 KB	conda-forge
libklu-2.3.5	hf24d653_7100102	142 KB	conda-forge
liblapack-3.9.0	31_h7ac8fdf_openblas	16 KB	conda-forge
libldl-3.3.2	h32481e8_7100102	24 KB	conda-forge
libopenblas-0.3.29	pthreads_h94d23a6_0	5.6 MB	conda-forge
libparu-1.0.0	h17147ab_7100102	91 KB	conda-forge
librbio-4.3.4	h32481e8_7100102	47 KB	conda-forge
libspex-3.2.3	had10066_7100102	79 KB	conda-forge
libspqr-4.3.4	h852d39f_7100102	213 KB	conda-forge
libstdcxx-14.2.0	h8f9b012_2	3.7 MB	conda-forge
libstdcxx-ng-14.2.0	h4852527_2	53 KB	conda-forge
libsuitesparseconfig-7.10.1	h92d6892_7100102	42 KB	conda-forge
libumfpack-6.3.5	heb53515_7100102	424 KB	conda-forge

metis-5.1.0		hd0bc9f9_1007	3.7 MB	conda-forge
mpfr-4.2.1		h90cbb55_3	620 KB	conda-forge
numpy-2.2.4		py311h5d046bc_0	8.6 MB	conda-forge
openssl-3.4.1		h7b32b05_0	2.8 MB	conda-forge
pyfmi-2.16.3		py311h9f3472d_0	5.2 MB	conda-forge
python_abi-3.11		2_cp311	5 KB	conda-forge
scipy-1.15.2		py311h8f841c2_0	16.4 MB	conda-forge
suitesparse-7.10.1		ha0f6916_7100102	12 KB	conda-forge
sundials-7.1.1		ha52427a_0	907 KB	conda-forge

Total:			56.1 MB	

The following NEW packages will be INSTALLED:

_x86_64-microarch~	conda-forge/noarch::_x86_64-microarch-level-3-2_broadwell
assimulo	conda-forge/linux-64::assimulo-3.6.0-py311h083bc19_0
fmilib	conda-forge/linux-64::fmilib-2.4.1-hac33072_1
gmp	conda-forge/linux-64::gmp-6.3.0-hac33072_2
libamd	conda-forge/linux-64::libamd-3.3.3-haaf9dc3_7100102
libblas	conda-forge/linux-64::libblas-3.9.0-31_h59b9bed_openblas
libbtf	conda-forge/linux-64::libbtf-2.3.2-h32481e8_7100102
libcamd	conda-forge/linux-64::libcamd-3.3.3-h32481e8_7100102
libcbblas	conda-forge/linux-64::libcbblas-3.9.0-31_he106b2a_openblas
libccolamd	conda-forge/linux-64::libccolamd-3.3.4-h32481e8_7100102
libcholmod	conda-forge/linux-64::libcholmod-5.3.1-h59ddb4_7100102
libcolamd	conda-forge/linux-64::libcolamd-3.3.4-h32481e8_7100102
libcxsparse	conda-forge/linux-64::libcxsparse-4.4.1-h32481e8_7100102
libgcc	conda-forge/linux-64::libgcc-14.2.0-h767d61c_2
libgfortran	conda-forge/linux-64::libgfortran-14.2.0-h69a702a_2
libgfortran-ng	conda-forge/linux-64::libgfortran-ng-14.2.0-h69a702a_2
libgfortran5	conda-forge/linux-64::libgfortran5-14.2.0-hf1ad2bd_2
libklu	conda-forge/linux-64::libklu-2.3.5-hf24d653_7100102
liblapack	conda-forge/linux-64::liblapack-3.9.0-31_h7ac8fdf_openblas
libldl	conda-forge/linux-64::libldl-3.3.2-h32481e8_7100102
libopenblas	conda-forge/linux-64::libopenblas-0.3.29-pthreads_h94d23a6_0
libparu	conda-forge/linux-64::libparu-1.0.0-h17147ab_7100102
librbio	conda-forge/linux-64::librbio-4.3.4-h32481e8_7100102
libspex	conda-forge/linux-64::libspex-3.2.3-had10066_7100102
libspqr	conda-forge/linux-64::libspqr-4.3.4-h852d39f_7100102
libstdcxx	conda-forge/linux-64::libstdcxx-14.2.0-h8f9b012_2
libsuitesparsecon~	conda-forge/linux-64::libsuitesparseconfig-7.10.1-h92d6892_7100102
libumfpack	conda-forge/linux-64::libumfpack-6.3.5-heb53515_7100102
metis	conda-forge/linux-64::metis-5.1.0-hd0bc9f9_1007
mpfr	conda-forge/linux-64::mpfr-4.2.1-h90cbb55_3
numpy	conda-forge/linux-64::numpy-2.2.4-py311h5d046bc_0
pyfmi	conda-forge/linux-64::pyfmi-2.16.3-py311h9f3472d_0
python_abi	conda-forge/linux-64::python_abi-3.11-2_cp311
scipy	conda-forge/linux-64::scipy-1.15.2-py311h8f841c2_0
suitesparse	conda-forge/linux-64::suitesparse-7.10.1-ha0f6916_7100102
sundials	conda-forge/linux-64::sundials-7.1.1-ha52427a_0

The following packages will be UPDATED:

conda	pkgs/main::conda-24.11.1-py311h06a430~ --> conda-forge::conda-25.3.0-py311h38be061_0
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```

libgcc-ng          pkgs/main::libgcc-ng-11.2.0-h1234567_1 --> conda-forge::libgcc-
ng-14.2.0-h69a702a_2
libgomp            pkgs/main::libgomp-11.2.0-h1234567_1 --> conda-forge::libgomp
-14.2.0-h767d61c_2
libstdcxx-ng       pkgs/main::libstdcxx-ng-11.2.0-h12345~ --> conda-forge::libstdc
xx-ng-14.2.0-h4852527_2
openssl            pkgs/main::openssl-3.0.16-h5eee18b_0 --> conda-forge::openssl
-3.4.1-h7b32b05_0

```

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

```

certifi            pkgs/main/linux-64::certifi-2025.1.31~ --> conda-forge/noarch::
certifi-2025.1.31-pyhd8ed1ab_0

```

Downloading and Extracting Packages:

```

scipy-1.15.2      | 16.4 MB | : 0% 0/1 [00:00<?, ?it/s]
numpy-2.2.4       | 8.6 MB  | : 0% 0/1 [00:00<?, ?it/s]

```

```

libopenblas-0.3.29 | 5.6 MB  | : 0% 0/1 [00:00<?, ?it/s]

```

```

pyfmi-2.16.3      | 5.2 MB  | : 0% 0/1 [00:00<?, ?it/s]

```

```

metis-5.1.0       | 3.7 MB  | : 0% 0/1 [00:00<?, ?it/s]

```

```

libstdcxx-14.2.0  | 3.7 MB  | : 0% 0/1 [00:00<?, ?it/s]

```

```

openssl-3.4.1     | 2.8 MB  | : 0% 0/1 [00:00<?, ?it/s]

```

```

libgfortran5-14.2.0 | 1.4 MB  | : 0% 0/1 [00:00<?, ?it/s]

```

```

conda-25.3.0      | 1.1 MB  | : 0% 0/1 [00:00<?, ?it/s]

```

assimulo-3.6.0 | 1.1 MB | : 0% 0/1 [00:00<?, ?it/s]

libcholmod-5.3.1 | 1.1 MB | : 0% 0/1 [00:00<?, ?it/s]

sundials-7.1.1 | 907 KB | : 0% 0/1 [00:00<?, ?it/s]

libgcc-14.2.0 | 828 KB | : 0% 0/1 [00:00<?, ?it/s]

mpfr-4.2.1 | 620 KB | : 0% 0/1 [00:00<?, ?it/s]

gmp-6.3.0 | 449 KB | : 0% 0/1 [00:00<?, ?it/s]

libgomp-14.2.0 | 449 KB | : 0% 0/1 [00:00<?, ?it/s]

libumfpack-6.3.5 | 424 KB | : 0% 0/1 [00:00<?, ?it/s]

fmilib-2.4.1	383 KB	:	0% 0/1 [00:00<?, ?it/s]
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libspqr-4.3.4	213 KB	:	0% 0/1 [00:00<?, ?it/s]
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... (more hidden) ...

pyfmi-2.16.3	5.2 MB	:	1% 0.005967906113297332/1 [00:00<00:17, 17.17 s/it]
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libopenblas-0.3.29	5.6 MB	:	1% 0.005535800927408837/1 [00:00<00:19, 19.16 s/it]
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metis-5.1.0	3.7 MB	:	1% 0.008351599057998349/1 [00:00<00:12, 12.21 s/it]
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scipy-1.15.2	16.4 MB	:	0% 0.0009529389827073913/1 [00:00<02:03, 123.34s/it]
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pyfmi-2.16.3	5.2 MB	: 44% 0.44460900544065124/1 [00:00<00:00, 2.58it/s]
libopenblas-0.3.29	5.6 MB	: 36% 0.3598270602815744/1 [00:00<00:00, 2.05it/s]
metis-5.1.0	3.7 MB	: 45% 0.4509863491319108/1 [00:00<00:00, 2.60it/s]
scipy-1.15.2	16.4 MB	: 14% 0.13531733554444958/1 [00:00<00:01, 1.35s/it]
scipy-1.15.2	16.4 MB	: 30% 0.30303459650095044/1 [00:00<00:00, 1.15it/s]
metis-5.1.0	3.7 MB	: 100% 1.0/1 [00:00<00:00, 3.47it/s]
metis-5.1.0	3.7 MB	: 100% 1.0/1 [00:00<00:00, 3.47it/s]
libstdcxx-14.2.0	3.7 MB	: 0% 0.0042177278432850495/1 [00:00<01:31, 92.35s/it]
libopenblas-0.3.29	5.6 MB	: 100% 1.0/1 [00:00<00:00, 2.68it/s]
libopenblas-0.3.29	5.6 MB	: 100% 1.0/1 [00:00<00:00, 2.68it/s]
pyfmi-2.16.3	5.2 MB	: 100% 1.0/1 [00:00<00:00, 2.52it/s]
scipy-1.15.2	16.4 MB	: 52% 0.5241164404890652/1 [00:00<00:00, 1.48it/s]
openssl-3.4.1	2.8 MB	: 1% 0.0055741049077571376/1 [00:00<01:23, 84.16s/it]
libgfortran5-14.2.0	1.4 MB	: 1% 0.011206734985068174/1 [00:00<00:41, 42.37s/it]

scipy-1.15.2	16.4 MB	: 67% 0.6727749217914183/1 [00:00<00:00, 1.47it/s]
numpy-2.2.4	8.6 MB	: 100% 1.0/1 [00:00<00:00, 3.09it/s]

libgfortran5-14.2.0	1.4 MB	: 100% 1.0/1 [00:00<00:00, 42.37s/it]
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openssl-3.4.1	2.8 MB	: 90% 0.9030049950566562/1 [00:00<00:00, 2.09it/s]
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libstdcxx-14.2.0	3.7 MB	: 100% 1.0/1 [00:00<00:00, 2.59it/s]
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conda-25.3.0	1.1 MB	: 1% 0.01395284272989957/1 [00:00<00:42, 42.70s/it]
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scipy-1.15.2	16.4 MB	: 88% 0.881468559004337/1 [00:00<00:00, 1.67it/s]
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conda-25.3.0	1.1 MB	: 100% 1.0/1 [00:00<00:00, 42.70s/it]
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libcholmod-5.3.1 | 1.1 MB | : 1% 0.014870549794649543/1 [00:00<00:42, 43.04
s/it]

openssl-3.4.1 | 2.8 MB | : 100% 1.0/1 [00:00<00:00, 2.09it/s]

sundials-7.1.1 | 907 KB | : 2% 0.01763373830085844/1 [00:00<00:37, 38.52
s/it]

libgcc-14.2.0 | 828 KB | : 2% 0.01932337522187561/1 [00:00<00:34, 35.48
s/it]

libcholmod-5.3.1 | 1.1 MB | : 100% 1.0/1 [00:00<00:00, 43.04s/it]

assimulo-3.6.0 | 1.1 MB | : 100% 1.0/1 [00:00<00:00, 41.50s/it]

sundials-7.1.1 | 907 KB | : 100% 1.0/1 [00:00<00:00, 38.52s/it]

libgcc-14.2.0 | 828 KB | : 100% 1.0/1 [00:00<00:00, 35.48s/it]

mpfr-4.2.1 | 620 KB | : 3% 0.025811696239942908/1 [00:00<00:28, 28.77
s/it]

gmp-6.3.0 | 449 KB | : 4% 0.03561313321233331/1 [00:00<00:20, 20.97
s/it]

gmp-6.3.0 | 449 KB | : 100% 1.0/1 [00:00<00:00, 20.97s/it]

libgomp-14.2.0 | 449 KB | : 4% 0.03562807972826631/1 [00:00<00:20, 21.63
s/it]

mpfr-4.2.1 | 620 KB | : 100% 1.0/1 [00:00<00:00, 28.77s/it]

libgomp-14.2.0 | 449 KB | : 100% 1.0/1 [00:00<00:00, 21.63s/it]

libumfpack-6.3.5 | 424 KB | : 4% 0.037731330084655984/1 [00:00<00:20, 20.84
s/it]

libumfpack-6.3.5 | 424 KB | : 100% 1.0/1 [00:00<00:00, 20.84s/it]

libspqr-4.3.4 | 213 KB | : 8% 0.07503068271326775/1 [00:00<00:10, 10.95
s/it]

fmilib-2.4.1 | 383 KB | : 4% 0.04180391656566945/1 [00:00<00:18, 19.70
s/it]

libspqr-4.3.4 | 213 KB | : 100% 1.0/1 [00:00<00:00, 10.95s/it]

fmilib-2.4.1 | 383 KB | : 100% 1.0/1 [00:00<00:00, 19.70s/it]

... (more hidden) ...

... (more hidden) ...

scipy-1.15.2	16.4 MB	: 100% 1.0/1 [00:01<00:00, 1.67it/s]
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libopenblas-0.3.29	5.6 MB	: 100% 1.0/1 [00:01<00:00, 2.68it/s]
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pyfmi-2.16.3	5.2 MB	: 100% 1.0/1 [00:01<00:00, 2.52it/s]
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libgfortran5-14.2.0	1.4 MB	: 100% 1.0/1 [00:01<00:00, 1.34s/it]
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libgfortran5-14.2.0	1.4 MB	: 100% 1.0/1 [00:01<00:00, 1.34s/it]
---------------------	--------	--------------------------------------

libstdc++-14.2.0 | 3.7 MB | : 100% 1.0/1 [00:01<00:00, 2.59it/s]

conda-25.3.0 | 1.1 MB | : 100% 1.0/1 [00:02<00:00, 2.27s/it]

conda-25.3.0 | 1.1 MB | : 100% 1.0/1 [00:02<00:00, 2.27s/it]

openssl-3.4.1 | 2.8 MB | : 100% 1.0/1 [00:02<00:00, 2.09it/s]

libcholmod-5.3.1 | 1.1 MB | : 100% 1.0/1 [00:02<00:00, 2.72s/it]

libcholmod-5.3.1 | 1.1 MB | : 100% 1.0/1 [00:02<00:00, 2.72s/it]

assimulo-3.6.0 | 1.1 MB | : 100% 1.0/1 [00:03<00:00, 3.00s/it]

assimulo-3.6.0 | 1.1 MB | : 100% 1.0/1 [00:03<00:00, 3.00s/it]

sundials-7.1.1 | 907 KB | : 100% 1.0/1 [00:03<00:00, 3.23s/it]

sundials-7.1.1 | 907 KB | : 100% 1.0/1 [00:03<00:00, 3.23s/it]

libgcc-14.2.0 | 828 KB | : 100% 1.0/1 [00:03<00:00, 3.39s/it]

libgcc-14.2.0 | 828 KB | : 100% 1.0/1 [00:03<00:00, 3.39s/it]

gmp-6.3.0 | 449 KB | : 100% 1.0/1 [00:03<00:00, 3.45s/it]

gmp-6.3.0 | 449 KB | : 100% 1.0/1 [00:03<00:00, 3.45s/it]
numpy-2.2.4 | 8.6 MB | : 100% 1.0/1 [00:03<00:00, 3.09it/s]

libgomp-14.2.0 | 449 KB | : 100% 1.0/1 [00:03<00:00, 3.56s/it]

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mpfr-4.2.1 | 620 KB | : 100% 1.0/1 [00:03<00:00, 3.56s/it]

mpfr-4.2.1 | 620 KB | : 100% 1.0/1 [00:03<00:00, 3.56s/it]

libumfpack-6.3.5 | 424 KB | : 100% 1.0/1 [00:03<00:00, 3.60s/it]

libumfpack-6.3.5 | 424 KB | : 100% 1.0/1 [00:03<00:00, 3.60s/it]

libspqr-4.3.4 | 213 KB | : 100% 1.0/1 [00:03<00:00, 3.63s/it]

libspqr-4.3.4 | 213 KB | : 100% 1.0/1 [00:03<00:00, 3.63s/it]

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fmilib-2.4.1	383 KB	: 100% 1.0/1 [00:03<00:00, 3.69s/it]
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scipy-1.15.2	16.4 MB	: 100% 1.0/1 [00:05<00:00, 1.67it/s]
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```
Preparing transaction: - \ done
Verifying transaction: / - \ | / done
Executing transaction: \ | / - \ | / - \ | / - \ | / - \ | / - \ | / - \ | / - \ | / done
```

BPL_TEST2_Fedbatch setup

This notebook just produce the Figure 2 in the paper "Design ideas behind Bioprocess Library for Modelica", by J P Axelsson, to be presented at the 15th International Modelica Conference in Aachen, Germany, October 9-11, 2023.

Now specific installation and the run simulations. Start with connecting to Github. Then upload the two files:

- FMU - BPL_TEST2_Fedbatch_linux_om_me.fmu
- Setup-file - BPL_TEST2_Fedbatch_explore.me.py

```
In [9]: %%bash
git clone https://github.com/janpeter19/CONF_2023_10_MODELICA15
```

Cloning into 'CONF_2023_10_MODELICA15'...

```
In [10]: %cd CONF_2023_10_MODELICA15
/content/CONF_2023_10_MODELICA15
```

```
In [11]: run -i BPL_TEST2_Fedbatch_explore.py
```

Linux - run FMU pre-compiled OpenModelica

Model for the process 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/units

Note that both disp() and describe() takes values from the last simulation and the command process_diagram() brings up the main configuration

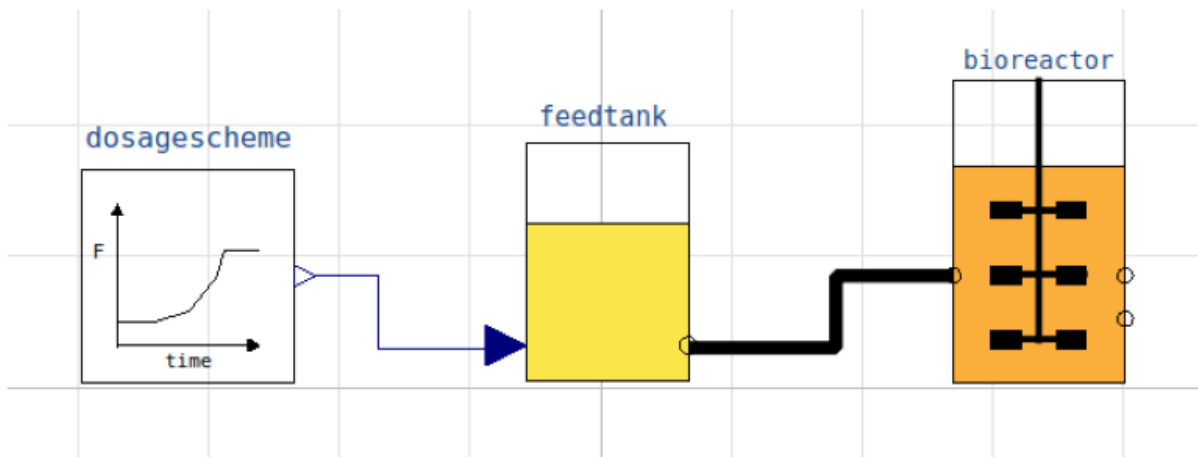
Brief information about a command by help(), eg help(simu)

Key system information is listed with the command system_info()

```
In [12]: %matplotlib inline
plt.rcParams['figure.figsize'] = [25/2.54, 20/2.54]
```

```
In [13]: import warnings
warnings.filterwarnings("ignore")
```

```
In [14]: process_diagram()
```

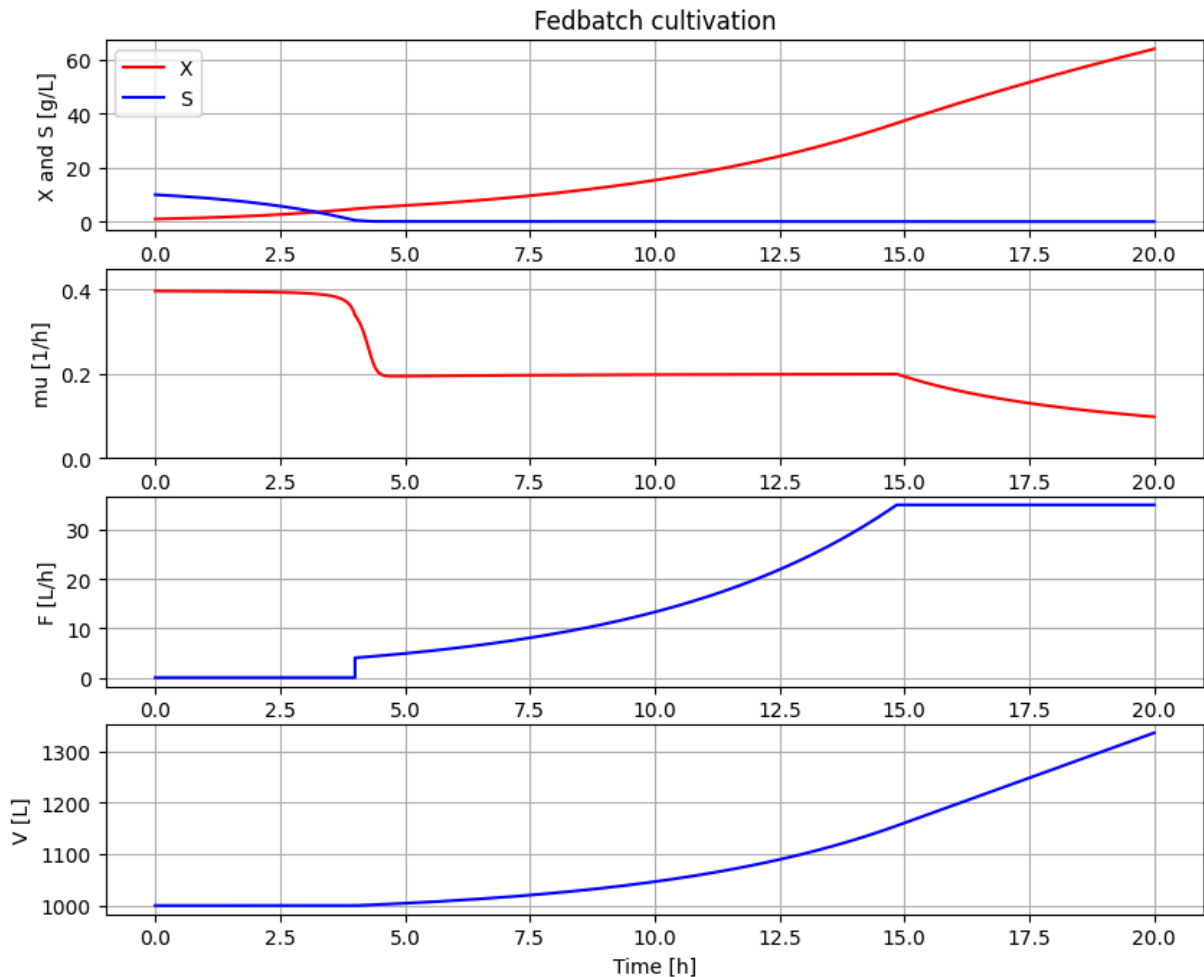


```
In [15]: describe('culture'); print(); #describe('liquidphase')
```

Simplified text book model - only substrate S and cell concentration X

```
In [16]: # Simulation of the process
newplot(plotType='TimeSeries')
ax2.set_ylim([0, 0.45])
init(V_0=1000, VX_0=1*1e3, VS_0=10*1e3)
par(feedtank_S_in=600, Ks=0.1, Y=0.40)
par(t_start=4, F_start=4.0, mu_feed=0.2, F_max=35)
simu(20)
```


Could not find cannot import name 'dopri5' from 'assimulo.lib' (/usr/local/lib/python3.11/site-packages/assimulo/lib/__init__.py)
 Could not find cannot import name 'rodas' from 'assimulo.lib' (/usr/local/lib/python3.11/site-packages/assimulo/lib/__init__.py)
 Could not find cannot import name 'odassl' from 'assimulo.lib' (/usr/local/lib/python3.11/site-packages/assimulo/lib/__init__.py)
 Could not find ODEPACK functions.
 Could not find RADAR5
 Could not find GLIMDA.



In [17]: `disp('culture')`

Y : 0.4
 qSmax : 1.0
 Ks : 0.1

In [17]:

In [18]: `describe('mu')`

Cell specific growth rate variable : 0.098 [1/h]

In [19]: `describe('parts')`

['bioreactor', 'bioreactor.culture', 'dosagescheme', 'feedtank']

In [20]: `describe('MSL')`

MSL: 3.2.3 - used components: RealInput, RealOutput

In [21]: `system_info()`

System information

-OS: Linux

-Python: 3.11.11

-Scipy: not installed in the notebook

-PyFMI: 2.16.3

-FMU by: OpenModelica Compiler OpenModelica 1.21.0

-FMI: 2.0

-Type: FMUModelME2

-Name: BPL_TEST2.Fedbatch

-Generated: 2023-04-20T12:24:29Z

-MSL: 3.2.3

-Description: Bioprocess Library version 2.1.1

-Interaction: FMU-explore version 0.9.8

In [21]: