▾ BPL_TEST2_Batch script with FMPy ver 0.3.15

The key library FMPy ver 0.3.15 is installed.

After the installation a small application BPL_TEST2_Batch 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 20.04.5 LTS
    Release:        20.04
    Codename:       focal
```

```
%env PYTHONPATH=
```

```
    env: PYTHONPATH=
```

```
!wget https://repo.anaconda.com/miniconda/Miniconda3-py38_22.11.1-1-Linux-x86_64.sh
!chmod +x Miniconda3-py38_22.11.1-1-Linux-x86_64.sh
!bash ./Miniconda3-py38_22.11.1-1-Linux-x86_64.sh -b -f -p /usr/local
import sys
sys.path.append('/usr/local/lib/python3.8/site-packages/')
```

```
    --2023-03-27 11:03:00--  https://repo.anaconda.com/miniconda/Miniconda3-py38_22.11.1-1-Linux-x86_64.sh
    Resolving repo.anaconda.com (repo.anaconda.com)... 104.16.130.3, 104.16.131.3, 2606:4700::6810:8303, ...
    Connecting to repo.anaconda.com (repo.anaconda.com)|104.16.130.3|:443... connected.
    HTTP request sent, awaiting response... 200 OK
    Length: 64630241 (62M) [application/x-sh]
    Saving to: 'Miniconda3-py38_22.11.1-1-Linux-x86_64.sh'

    Miniconda3-py38_22. 100%[===================>]  61.64M   118MB/s    in 0.5s

    2023-03-27 11:03:01 (118 MB/s) - 'Miniconda3-py38_22.11.1-1-Linux-x86_64.sh' saved [64630241/64630241]

    PREFIX=/usr/local
    Unpacking payload ...

    Installing base environment...


    Downloading and Extracting Packages


    Downloading and Extracting Packages

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

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

```
    Collecting package metadata (current_repodata.json): done
    Solving environment: \
    The environment is inconsistent, please check the package plan carefully
    The following packages are causing the inconsistency:

      - conda-forge/noarch::bokeh==2.4.3=pyhd8ed1ab_3
      - defaults/linux-64::matplotlib-base==3.7.1=py38h417a72b_1
      - defaults/linux-64::pillow==9.4.0=py38h6a678d5_0
      - defaults/linux-64::libwebp==1.2.4=h11a3e52_1
      - conda-forge/noarch::dask==2023.1.1=pyhd8ed1ab_0
      - defaults/linux-64::libtiff==4.5.0=h6a678d5_2
      - defaults/linux-64::matplotlib==3.7.1=py38h06a4308_1
      - defaults/linux-64::pyqtwebengine==5.15.7=py38h6a678d5_1
      - defaults/linux-64::pyqt==5.15.7=py38h6a678d5_1
      - defaults/linux-64::qtwebkit==5.212=h4eab89a_4
      - defaults/linux-64::lcms2==2.12=h3be6417_0
      - conda-forge/noarch::fmpy==0.3.15=h13ae965_done

    ## Package Plan ##

      environment location: /usr/local

      added / updated specs:
        - conda


    The following packages will be UPDATED:

      ca-certificates                  2022.10.11-h06a4308_0 --> 2023.01.10-h06a4308_0
      conda                            22.11.1-py38h06a4308_4 --> 23.1.0-py38h06a4308_0
```

```
        conda-package-han~                        1.9.0-py38h5eee18b_1 --> 2.0.2-py38h06a4308_0
        cryptography                             38.0.1-py38h9ce1e76_0 --> 39.0.1-py38h9ce1e76_0
        ncurses                                       6.3-h5eee18b_3 --> 6.4-h6a678d5_0
        openssl                                    1.1.1s-h7f8727e_0 --> 1.1.1t-h7f8727e_0
        pyopenssl        pkgs/main/noarch::pyopenssl-22.0.0-py~ --> pkgs/main/linux-64::pyopenssl-23.0.0-py38h06a4308_0
        requests                                2.28.1-py38h06a4308_0 --> 2.28.1-py38h06a4308_1
        sqlite                                    3.40.0-h5082296_0 --> 3.41.1-h5eee18b_0
        tqdm                                    4.64.1-py38h06a4308_0 --> 4.65.0-py38hb070fc8_0
        urllib3                                 1.26.13-py38h06a4308_0 --> 1.26.14-py38h06a4308_0
        xz                                        5.2.8-h5eee18b_0 --> 5.2.10-h5eee18b_1


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

        typing_extensions  conda-forge/noarch::typing_extensions~ --> pkgs/main/linux-64::typing_extensions-4.4.0-py38h06a4308_



    Downloading and Extracting Packages

    Preparing transaction: done
    Verifying transaction: done
    Executing transaction: done
```

```
!conda --version
!python --version
```

```
    conda 23.1.0
    Python 3.8.15
```

```
!conda install -c conda-forge fmpy --yes # Install the key package
```

```
    Collecting package metadata (current_repodata.json): done
    Solving environment: -
    The environment is inconsistent, please check the package plan carefully
    The following packages are causing the inconsistency:

      - conda-forge/noarch::typing-extensions==4.5.0=hd8ed1ab_done

    ## Package Plan ##

      environment location: /usr/local

      added / updated specs:
        - fmpy


    The following packages will be UPDATED:

      typing_extensions  pkgs/main/linux-64::typing_extensions~ --> conda-forge/noarch::typing_extensions-4.5.0-pyha770c72_0

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

      ca-certificates    pkgs/main::ca-certificates-2023.01.10~ --> conda-forge::ca-certificates-2022.12.7-ha878542_0
      certifi            pkgs/main/linux-64::certifi-2022.12.7~ --> conda-forge/noarch::certifi-2022.12.7-pyhd8ed1ab_0
      conda              pkgs/main::conda-23.1.0-py38h06a4308_0 --> conda-forge::conda-23.1.0-py38h578d9bd_0



    Downloading and Extracting Packages

    Preparing transaction: done
    Verifying transaction: done
    Executing transaction: done
```

```
!conda install matplotlib --yes
```

```
    Collecting package metadata (current_repodata.json): done
    Solving environment: done

    ## Package Plan ##

      environment location: /usr/local

      added / updated specs:
        - matplotlib


    The following packages will be UPDATED:

      ca-certificates    conda-forge::ca-certificates-2022.12.~ --> pkgs/main::ca-certificates-2023.01.10-h06a4308_0

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

      certifi            conda-forge/noarch::certifi-2022.12.7~ --> pkgs/main/linux-64::certifi-2022.12.7-py38h06a4308_0
      conda              conda-forge::conda-23.1.0-py38h578d9b~ --> pkgs/main::conda-23.1.0-py38h06a4308_0
```

```
    Downloading and Extracting Packages

    Preparing transaction: done
    Verifying transaction: done
    Executing transaction: done
```

```
#!conda install scipy --yes
```

```
#!conda install xlrd --yes
```

```
#!conda install openpyxl --yes
```

▾ BPL_TEST2_Batch setup

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

- FMU - BPL_TEST2_Batch_linux_om_me.fmu
- Setup-file - BPL_TEST2_Batch_fmpy_explore.py

```
%%bash
git clone https://github.com/janpeter19/BPL_TEST2_Batch
```

```
    Cloning into 'BPL_TEST2_Batch'...
```

```
%cd BPL_TEST2_Batch
```

```
    /content/BPL_TEST2_Batch/BPL_TEST2_Batch/BPL_TEST2_Batch/BPL_TEST2_Batch
```

```
run -i BPL_TEST2_Batch_fmpy_explore.py
```

```
    Linux - run FMU pre-compiled OpenModelica 1.21.x

    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 simula
     - 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()
    <Figure size 708.661x566.929 with 0 Axes>
```

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

```
import warnings
warnings.filterwarnings("ignore")
```
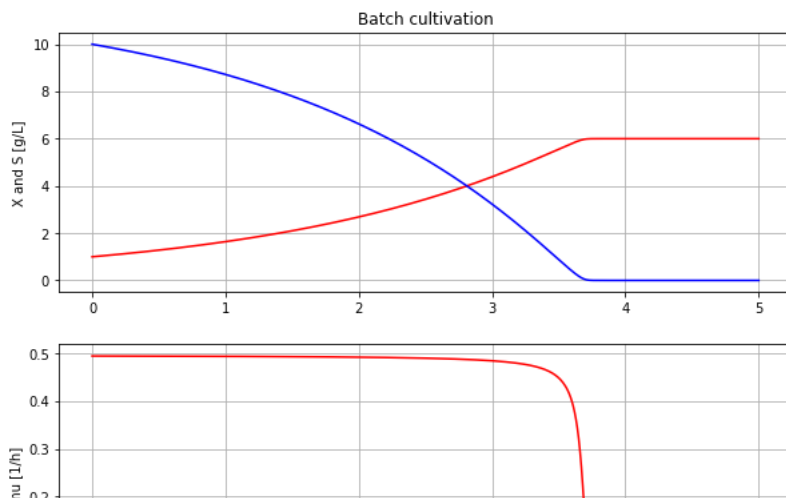
▾ BPL_TEST2_Batch - demo

```
describe('culture'); print(); #describe('liquidphase')                                    # Pump schedule parameter
```
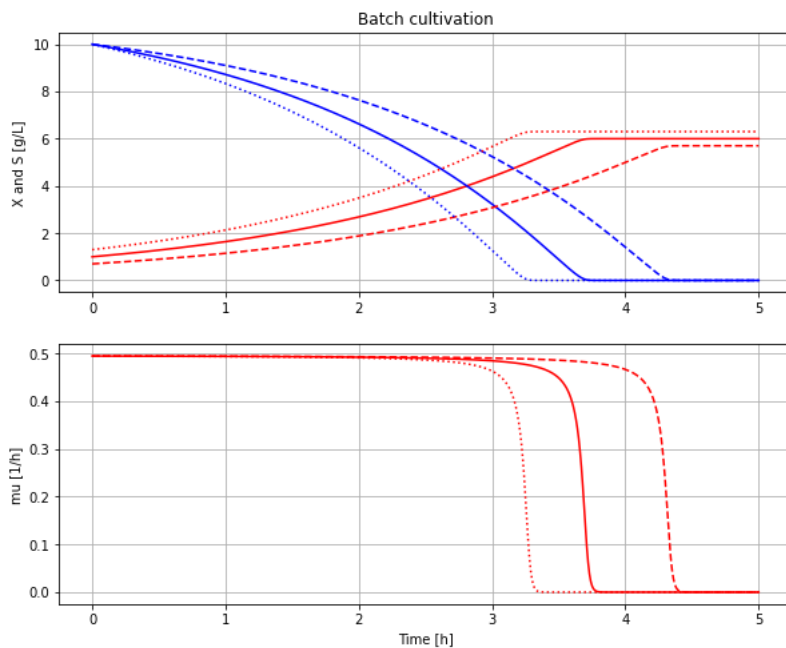
```
    Simplified text book model - only substrate S and cell concentration X
```

```
# Simulation with default values of the process
newplot(plotType='TimeSeries')
simu()
```
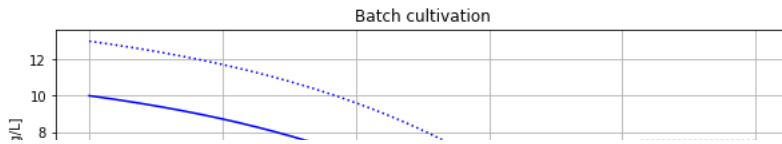
```
# Simulation were initial value of biomass VX_0 is varied
newplot(plotType='TimeSeries')
for value in [1.0, 0.7, 1.3]: init(VX_0=value); simu(5)

# Restore default value of VX_0
init(VX_0=1.0)
```



```
# Simulation were initial value of substrate VS_0 is varied
newplot(plotType='TimeSeries')
for value in [10, 7, 13]: init(VS_0=value); simu(5)

# Restore default value of VS_0
init(VS_0=10)
```
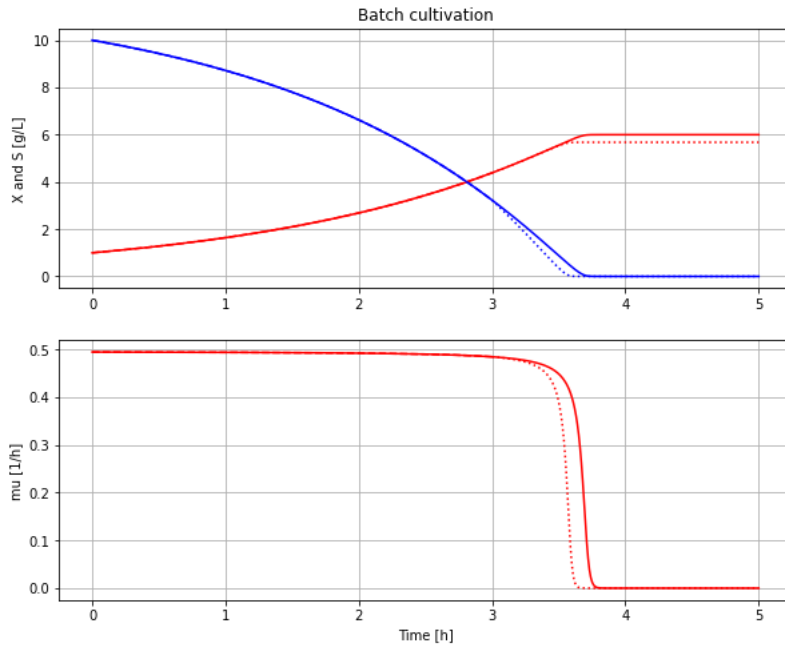
```
# Simulation where metabolism is changed after 3 hours
newplot(plotType='TimeSeries')
simu(5)

simu(3)
par(Y=0.4, qSmax=1.0/(0.4/0.5)); simu(2, 'cont')

# Restore default value of Y and qSmax
par(Y=0.5, qSmax=1.0)
```



```
disp('culture')
```

```
    Y : 0.4
    qSmax : 1.25
    Ks : 0.1
```

```
# Growth rate variable at the end of the cultivation
describe('mu')
```

```
    Cell specific growth rate variable : 0.0 [ 1/h ]
```

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

```
    ['bioreactor', 'bioreactor.culture']
```

```
describe('MSL')
```

```
    MSL: 3.2.3 - used components: none
```

```
system_info()
```

```
    System information
     -OS: Linux
     -Python: 3.9.16
     -Scipy: not installed in the notebook
     -FMPy: 0.3.15
     -FMU by: OpenModelica Compiler OpenModelica 1.21.0~dev-185-g9d983b8
     -FMI: 2.0
     -Type: ME
     -Name: BPL_TEST2.Batch
     -Generated: 2023-01-19T09:34:26Z
     -MSL: 3.2.3
     -Description: Bioprocess Library version 2.1.1-beta
     -Interaction: FMU-explore for FMPy version 0.9.7
```

✓ 0s   completed at 13:07   ● ✕