⌄ BPL_TEST2_Batch script with FMPy

The key library FMPy 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 22.04.3 LTS
    Release:        22.04
    Codename:       jammy
```

```
%env PYTHONPATH=
```

⤓ env: PYTHONPATH=

```
!wget https://repo.anaconda.com/miniconda/Miniconda3-py312_24.3.0-0-Linux-x86_64.sh
!chmod +x Miniconda3-py312_24.3.0-0-Linux-x86_64.sh
!bash ./Miniconda3-py312_24.3.0-0-Linux-x86_64.sh -b -f -p /usr/local
import sys
sys.path.append('/usr/local/lib/python3.12/site-packages/')
```

⤓ --2024-05-21 06:21:12-- https://repo.anaconda.com/miniconda/Miniconda3-py312_24.3.0-0-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: 143351488 (137M) [application/octet-stream]
    Saving to: 'Miniconda3-py312_24.3.0-0-Linux-x86_64.sh'

    Miniconda3-py312_24 100%[===================>] 136.71M   158MB/s    in 0.9s

    2024-05-21 06:21:13 (158 MB/s) - 'Miniconda3-py312_24.3.0-0-Linux-x86_64.sh' saved [143351488/143351488]

    PREFIX=/usr/local
    Unpacking payload ...

    Installing base environment...

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

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

⤓ Channels:
```
     - defaults
    Platform: linux-64
    Collecting package metadata (repodata.json): done
    Solving environment: done

    ## Package Plan ##

      environment location: /usr/local

      added / updated specs:
        - conda


    The following packages will be downloaded:

        package                    |            build
        ---------------------------|-----------------
        conda-24.5.0               | py312h06a4308_0       1.2 MB
        frozendict-2.4.2           | py312h06a4308_0        36 KB
        openssl-3.0.13             |       h7f8727e_1       5.2 MB
        ------------------------------------------------------------
                                               Total:       6.5 MB

    The following NEW packages will be INSTALLED:

        frozendict         pkgs/main/linux-64::frozendict-2.4.2-py312h06a4308_0

    The following packages will be UPDATED:

        conda                             24.3.0-py312h06a4308_0 --> 24.5.0-py312h06a4308_0
```

```
         openssl                                        3.0.13-h7f8727e_0 --> 3.0.13-h7f8727e_1


      Downloading and Extracting Packages:
      openssl-3.0.13        | 5.2 MB    | :    0% 0/1 [00:00<?, ?it/s]
      conda-24.5.0          | 1.2 MB    | :    0% 0/1 [00:00<?, ?it/s]

      openssl-3.0.13        | 5.2 MB    | :    0% 0.0029973471355570501/1 [00:00<00:53, 53.55s/it]

      frozendict-2.4.2      | 36 KB     | :   44% 0.43853215920344746/1 [00:00<00:00,  2.48it/s]
      conda-24.5.0          | 1.2 MB    | :    1% 0.01293349794914382/1 [00:00<00:13, 13.92s/it]

      frozendict-2.4.2      | 36 KB     | : 100% 1.0/1 [00:00<00:00,  2.48it/s]
      conda-24.5.0          | 1.2 MB    | : 100% 1.0/1 [00:00<00:00,  1.78it/s]




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

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

⇥ conda 24.5.0
    Python 3.12.2

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

⇥

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

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

```
#!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

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

> ⤓ Linux - run FMU pre-compiled OpenModelica 1.23.0-dev
>
>   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/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()

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

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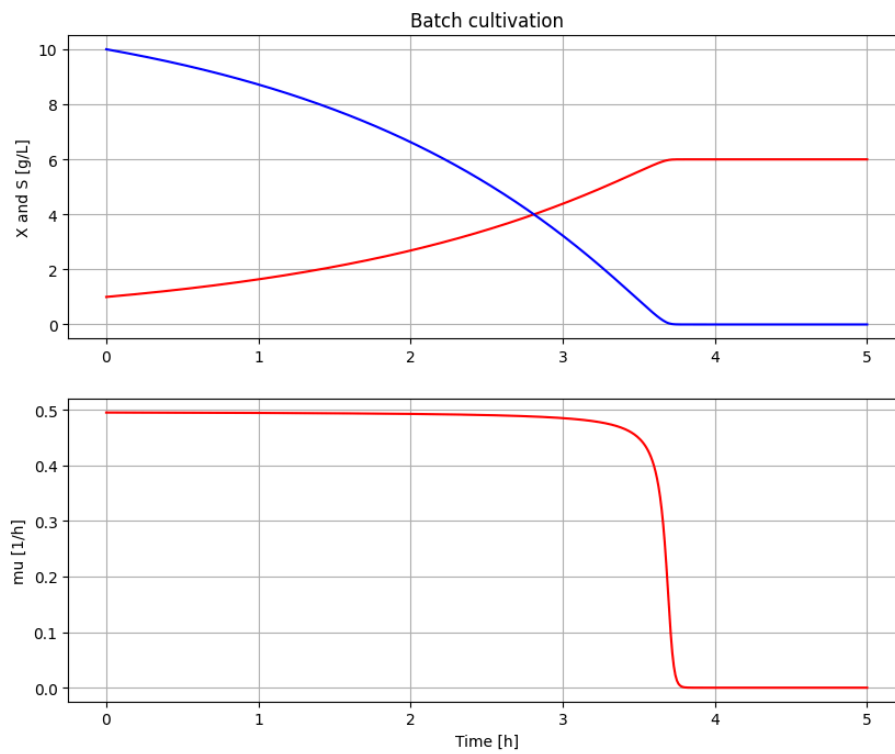
⌄ BPL_TEST2_Batch - demo

```
describe('culture'); print(); #describe('liquidphase')                          # Pump schedule parameter
```

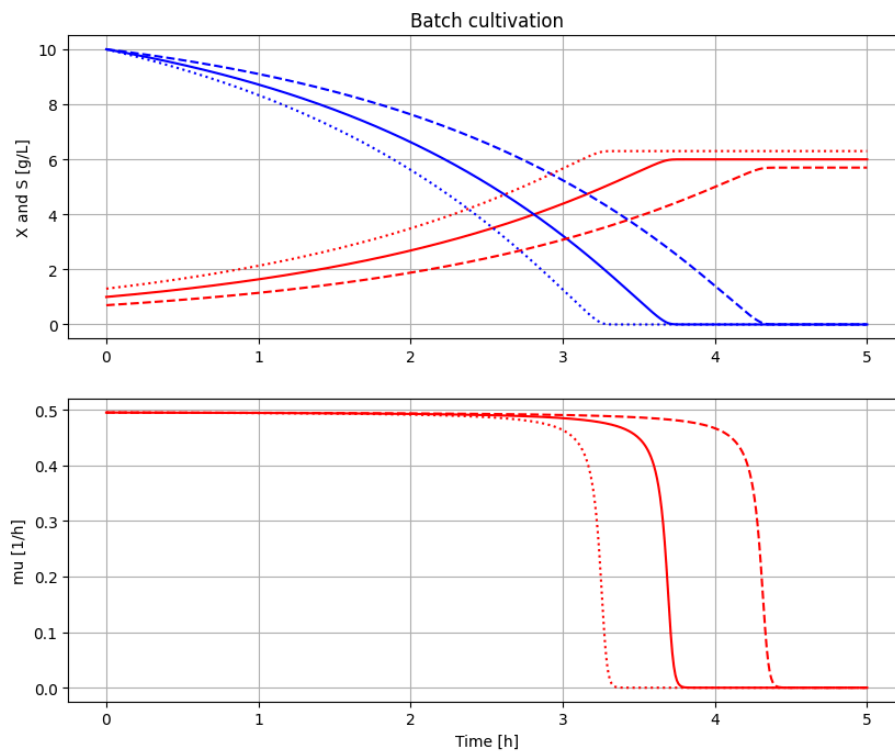> ⤓ Simplified text book model - only substrate S and cell concentration X

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

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

# Restore default value of VX_start
init(VX_start=1.0)
```
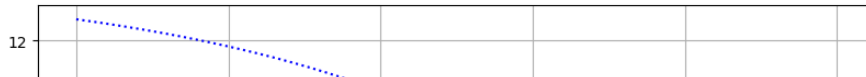
```
# Simulation were initial value of substrate VS_start is varied
newplot(plotType='TimeSeries')
for value in [10, 7, 13]: init(VS_start=value); simu(5)

# Restore default value of VS_start
init(VS_start=10)
```
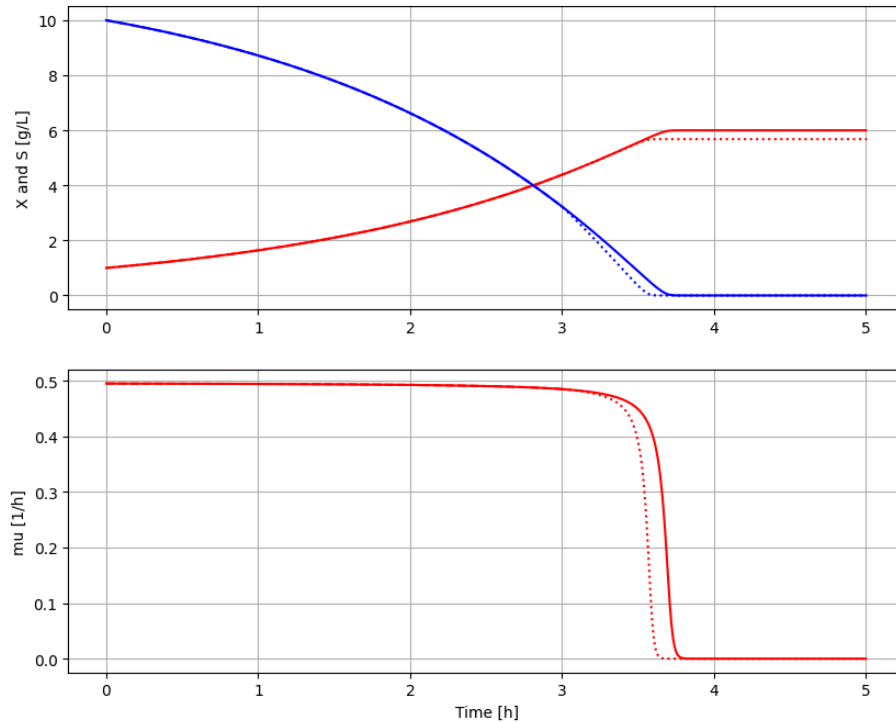
Batch cultivation

```
# 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