

## ▼ 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.

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

No LSB modules are available.
Distributor ID: Ubuntu
Description:   Ubuntu 22.04.2 LTS
Release:      22.04
Codename:     jammy

%env PYTHONPATH=

env: PYTHONPATH=

!wget https://repo.anaconda.com/miniconda/Miniconda3-py310_23.1.0-1-Linux-x86_64.sh
!chmod +x Miniconda3-py310_23.1.0-1-Linux-x86_64.sh
!bash ./Miniconda3-py310_23.1.0-1-Linux-x86_64.sh -b -f -p /usr/local
import sys
sys.path.append('/usr/local/lib/python3.10/site-packages/')

--2023-09-26 06:11:44--  https://repo.anaconda.com/miniconda/Miniconda3-py310_23.1.0-1-Linux-x86_64.sh
Resolving repo.anaconda.com (repo.anaconda.com)... 104.16.131.3, 104.16.130.3, 2606:4700::6810:8303, ...
Connecting to repo.anaconda.com (repo.anaconda.com)|104.16.131.3|:443... connected.
HTTP request sent, awaiting response... 200 OK
Length: 74403966 (71M) [application/x-sh]
Saving to: 'Miniconda3-py310_23.1.0-1-Linux-x86_64.sh'

Miniconda3-py310_23 100%[=====] 70.96M 174MB/s in 0.4s

2023-09-26 06:11:45 (174 MB/s) - 'Miniconda3-py310_23.1.0-1-Linux-x86_64.sh' saved [74403966/74403966]

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
```

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

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

```
conda 23.7.4  
Python 3.10.13
```

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

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

## ▼ Notes: BPL\_TEST2\_PID\_Fedbatch\_reg

This notebook just produce the Figure 6 in the paper "Design ideas behind Bioprocess Library for Modelica", by J P Axelsson, to be presented in the 15th International Modelica Conference in Aachen, Germany, October 9-11, 2023.

Test run for in BPL\_TEST2\_PID test-case fedbatch\_reg that demonstrate substrate control of the feed flow around fixed exponential dosage scheme. Note, that here is a small drift from  $\mu_{ref}$  at the end.

**Note** For the JModelica compilation the derivative part and thus Td, and N cannot be used. Likely due to usage of MSL 3.2.2

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

- FMU - BPL\_TEST2\_PID\_Fedbatch\_reg6\_linux\_om\_me.fmu
- Setup-file - BPL\_TEST2\_PID\_Fedbatch\_reg6\_explore.me.py

```
%%bash
git clone https://github.com/janpeter19/CONF_2023_10_MODELICA15

Cloning into 'CONF_2023_10_MODELICA15'...

%cd CONF_2023_10_MODELICA15

/content/CONF_2023_10_MODELICA15

run -i BPL_TEST2_PID_Fedbatch_reg6_explore.py

Linux - run FMU pre-compiled OpenModelica 1.21.0

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

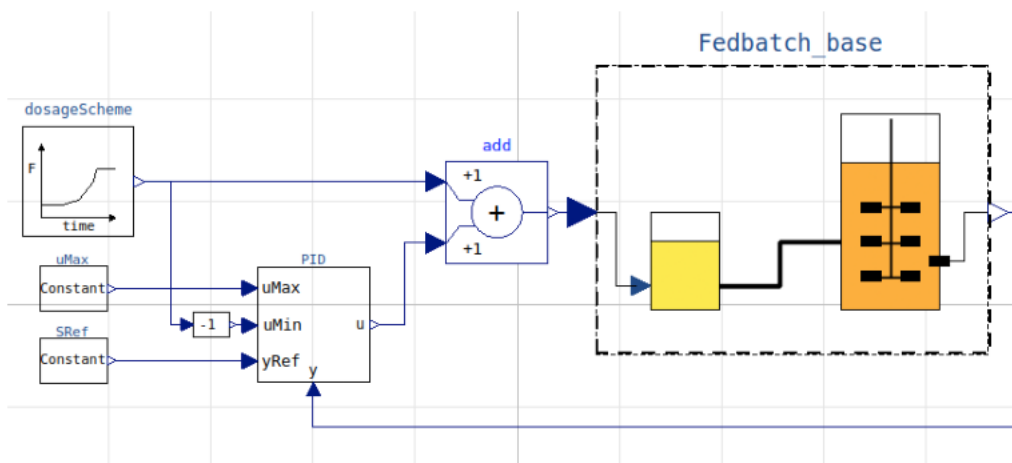
Note that both disp() and describe() takes values from the last simulation
and the command process_diagram() brings up the main configuration

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")

process_diagram()
```

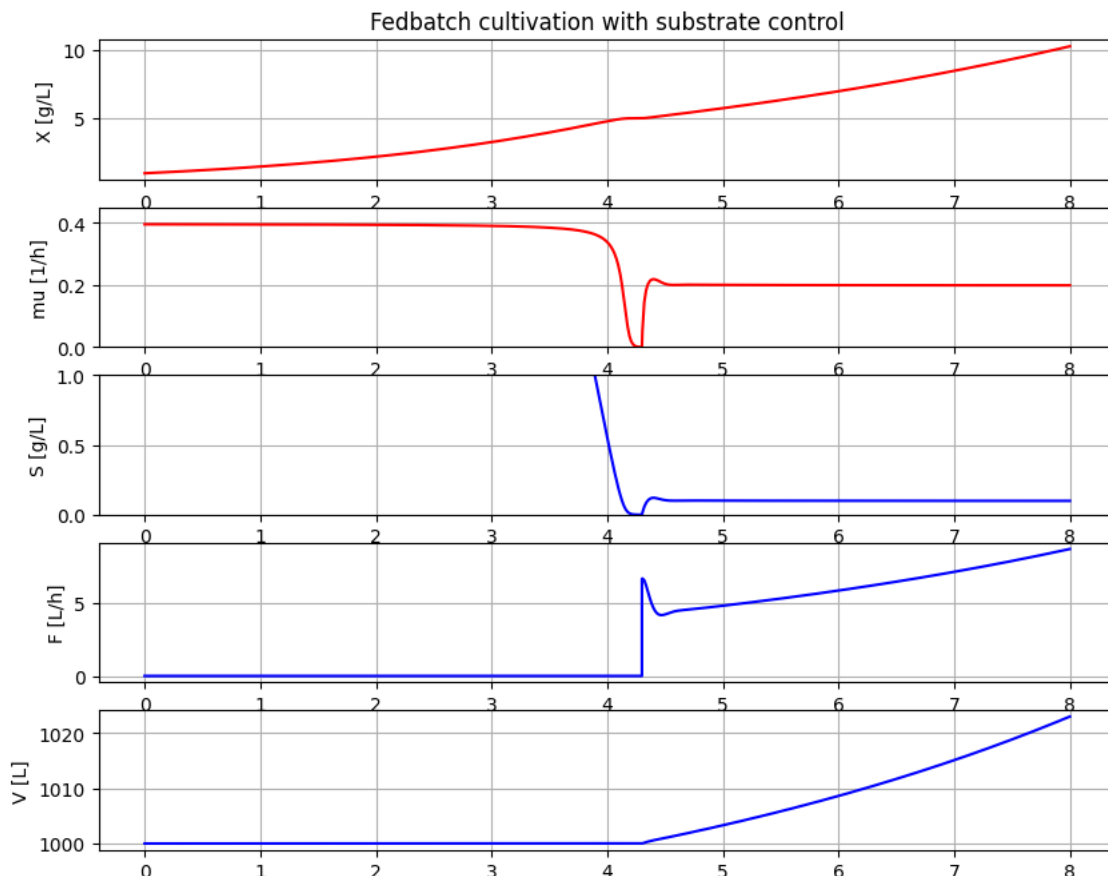


```
# Simulation of the process with controller
par(Y=0.40, qSmax=1.0, Ks=0.1)          # Culture parameters
init(V_0=1e3, VX_0=1e3, VS_0=10*1e3)   # Process initialization

par(S_in=600)                           # Feed profile
par(t_start=4.3, F_start=4, mu_feed=0.2, F_max=35)

par(S_ref=0.1)                          # Substrate controller
par(t_regStart=4.3)
par(uMax=50)

newplot()
ax2.set_ylim([0, 0.45]); ax3.set_ylim([0, 1])
setLines(['-']);
par(K=30, Ti=0.5)
simu(8)
```



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

```
MSL: 3.2.3 - used components: RealInput, RealOutput, LimPID-components
```

```
system_info()
```



#### System information

```
-OS: Linux
-Python: 3.10.12
-Scipy: not installed in the notebook
-PyFMI: 2.11.0
-FMU by: OpenModelica Compiler OpenModelica 1.21.0
-FMI: 2.0
-Type: FMUModelME2
-Name: BPL_TEST2_PID.Fedbatch_reg6
-Generated: 2023-08-22T10:54:51Z
-MSL: 3.2.3
-Description: Bioprocess Library version 2.1.1-beta
-Interaction: FMU-explore version 0.9.8
```

