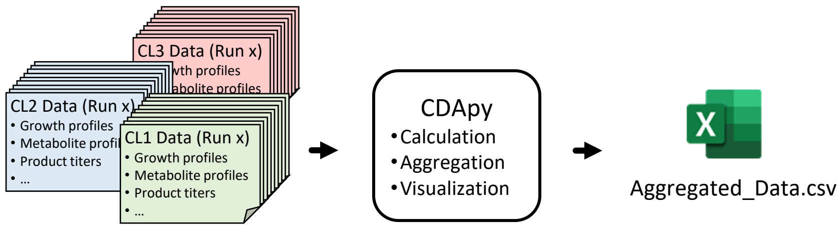
Cell Culture Data Pipeline Python Package (CDApy)



Process Data Entry (Excel)

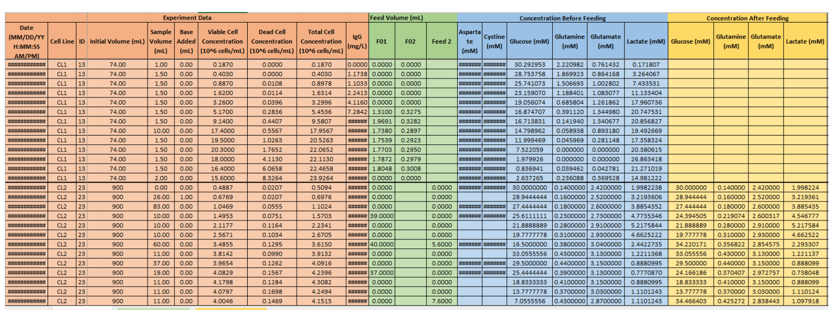
Multiple batches and cell lines

New features compared to Excel worksheet:

- Process multiple batches and cell lines at the same time
- Provide rolling window regression for specific-rate calculation
- Provide interactive plotting to analyze and compare process profiles

Credit to Yudai Fukae

Excel data input (1): process data entry



			Experiment Data							Feed Volume (mL)			Concentration Before Feeding						Concentration After Feeding			
Date (MM/DD/YY H:MM:SS AM/PM)	Cell Line	ID	Initial Volume (mL)	Sample Volume (mL)	Base Added (mL)	Viable Cell Concentration (10^6 cells/mL)	Dead Cell Concentration (10^6 cells/mL)	Total Cell Concentration (10^6 cells/mL)	IgG (mg/L)	F01	F02	Feed 2	Aspartate (mM)	Cystine (mM)	Glucose (mM)	Glutamine (mM)	Glutamate (mM)	Lactate (mM)	Glucose (mM)	Glutamine (mM)	Glutamate (mM)	Lactate (mM)
#############	CL1	13	74.00	1.00	0.00	0.1870	0.0000	0.1870	0.0000	0.0000	0.0000		#######	#######	30.292953	2.220982	0.761432	0.171807				
#############	CL1	13	74.00	1.50	0.00	0.4030	0.0000	0.4030	1.1738	0.0000	0.0000		#######	#######	28.753758	1.869923	0.864168	3.264067				
#############	CL1	13	74.00	1.50	0.00	0.8870	0.0108	0.8978	1.1033	0.0000	0.0000		#######	#######	25.741073	1.506693	1.002802	7.433531				
#############	CL1	13	74.00	1.50	0.00	1.6200	0.0114	1.6314	2.2413	0.0000	0.0000		#######	#######	23.159070	1.188401	1.083077	11.133404				
#############	CL1	13	74.00	1.50	0.00	3.2600	0.0396	3.2996	4.1160	0.0000	0.0000		#######	#######	19.056074	0.685804	1.261862	17.960736				
#############	CL1	13	74.00	1.50	0.00	5.1700	0.2836	5.4536	7.2842	1.3100	0.3275		#######	#######	16.874707	0.391120	1.344980	20.747531				
#############	CL1	13	74.00	1.50	0.00	9.1400	0.4407	9.5807	######	1.9691	0.3282		#######	#######	16.713831	0.141940	1.340677	20.856827				
#############	CL1	13	74.00	10.00	0.00	17.4000	0.5567	17.9567	######	1.7380	0.2897		#######	#######	14.798962	0.058938	0.893180	19.492669				
#############	CL1	13	74.00	1.50	0.00	19.5000	1.0263	20.5263	######	1.7539	0.2923		#######	#######	11.999469	0.045969	0.281148	17.358324				
#############	CL1	13	74.00	1.50	0.00	20.3000	1.7652	22.0652	######	1.7703	0.2950		#######	#######	7.522059	0.000000	0.000000	20.380615				
#############	CL1	13	74.00	1.50	0.00	18.0000	4.1130	22.1130	######	1.7872	0.2979		#######	#######	1.979926	0.000000	0.000000	26.863418				
#############	CL1	13	74.00	1.50	0.00	16.4000	6.0658	22.4658	######	1.8048	0.3008		#######	#######	0.836941	0.039462	0.042781	21.271019				
#############	CL1	13	74.00	2.00	0.00	15.6000	8.3264	23.9264	######	0.0000	0.0000		#######	#######	2.637265	0.236088	0.369528	14.981222				
#############	CL2	23	900	0.00	0.00	0.4887	0.0207	0.5094	######	0.0000		0.0000	#######	#######	30.0000000	0.1400000	2.4200000	1.9982238	30.000000	0.140000	2.420000	1.998224
#############	CL2	23	900	26.00	1.00	0.6769	0.0207	0.6976	######	0.0000		0.0000			28.9444444	0.1600000	2.5200000	3.2193606	28.944444	0.160000	2.520000	3.219361
#############	CL2	23	900	83.00	0.00	1.0469	0.0555	1.1024	######	0.0000		0.0000	#######	#######	27.4444444	0.1800000	2.6000000	3.8854352	27.444444	0.180000	2.600000	3.885435
#############	CL2	23	900	10.00	0.00	1.4953	0.0751	1.5703	######	39.0000		0.0000	#######	#######	25.6111111	0.2300000	2.7300000	4.7735346	24.394505	0.219074	2.600317	4.546777
#############	CL2	23	900	10.00	0.00	2.1177	0.1164	2.2341	######	0.0000		0.0000			21.8888889	0.2800000	2.9100000	5.2175844	21.888889	0.280000	2.910000	5.217584
#############	CL2	23	900	10.00	0.00	2.5671	0.1034	2.6705	######	0.0000		0.0000			19.7777778	0.3100000	2.9300000	4.6625222	19.777778	0.310000	2.930000	4.662522
#############	CL2	23	900	60.00	0.00	3.4855	0.1295	3.6150	######	40.0000		5.6000	#######	#######	16.5000000	0.3800000	3.0400000	2.4422735	34.220171	0.356822	2.854575	2.293307
#############	CL2	23	900	11.00	0.00	3.8142	0.0990	3.9132	######	0.0000		0.0000			33.0555556	0.4300000	3.1300000	1.2211368	33.055556	0.430000	3.130000	1.221137
#############	CL2	23	900	37.00	0.00	3.9654	0.1262	4.0916	######	0.0000		0.0000	#######	#######	29.5000000	0.4400000	3.1500000	0.8880995	29.500000	0.440000	3.150000	0.888099
#############	CL2	23	900	19.00	0.00	4.0829	0.1567	4.2396	######	37.0000		0.0000	#######	#######	25.4444444	0.3900000	3.1300000	0.7770870	24.166186	0.370407	2.972757	0.738048
#############	CL2	23	900	11.00	0.00	4.1798	0.1284	4.3082	######	0.0000		0.0000			18.8333333	0.4100000	3.1500000	0.8880995	18.833333	0.410000	3.150000	0.888099
#############	CL2	23	900	11.00	0.00	4.0797	0.1698	4.2494	######	0.0000		0.0000			13.7777778	0.3700000	3.0300000	1.1101243	13.777778	0.370000	3.030000	1.110124
#############	CL2	23	900	11.00	0.00	4.0046	0.1469	4.1515	######	0.0000		7.6000			7.0555556	0.4300000	2.8700000	1.1101243	34.466403	0.425272	2.838443	1.097918

- Enter basic process data (orange, excluding concentrations), feed volume (green), concentration before feeding (blue), and concentration after feeding (yellow, optional)
- Accept datasets from cell lines/processes that have different settings (e.g., different feeds or measurements)
- Can add columns to include more online/offline measurements (orange), feeds (green), or chemical species (blue and orange)

* This Excel template is different from the previous Excel batch sheet.

Excel data input (2): feed concentration and polynomial degree sheets

	A	F	G	I
1	Cell Line	CL1	CL1	CL2
2	ID	13	13	21
3	Feed Name	F01	F02	Feed 2
9	Glucose (mM)	400.0		400.0
10	Glutamine (mM)		200.0	
11	Glutamate (mM)	11.6		
15	Lactate (mM)	0.0		
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Measured Data | Feed Concentration | Polynomial Degree

- Enter the composition of feeds in the “Feed Concentration” sheet
- Feed name should be consistent with the ones in the “Measured Data” sheet

	A	D	E
1	Cell Line	CL1	CL2
2	ID	13	21
3	Cell	3	3
9	Glucose	4	4
10	Glutamine	3	3
11	Glutamate	4	4
15	Lactate	5	6

Measured Data | Feed Concentration | Polynomial Degree

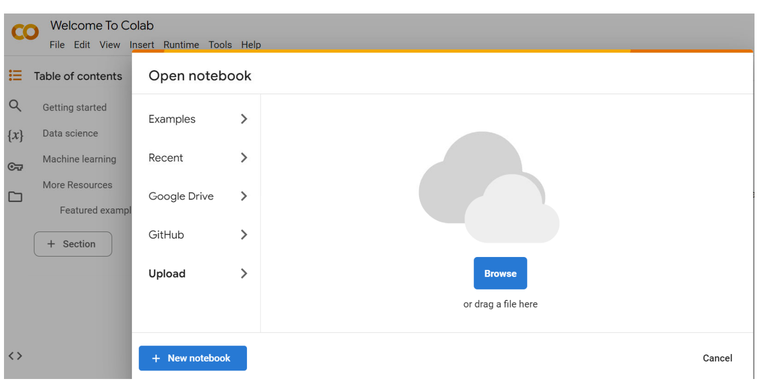
- Define the polynomial degree used for the polynomial regression of specific rate calculations
- Can use varying degrees for different species and cell lines/experiments (IDs)

Step-by-step to run tutorial notebooks on Google Colab (1)

Step 1: Open Google Colab (https://colab.research.google.com/)

* Google Colab is a hosted Jupyter Notebook service that requires no setup to use and provides free-of-charge access to computing resources

Step 2: Upload the “Part2_Python_oackage_tutorial.ipynb” to Google Colab



Step-by-step to run tutorial notebooks on Google Colab (2)

Step 3: Run the first cell (grey area shown below) with the “play” bottom to setup the package

1. Package setup

Can ignore the printout when exectuting the code unless error message raises.

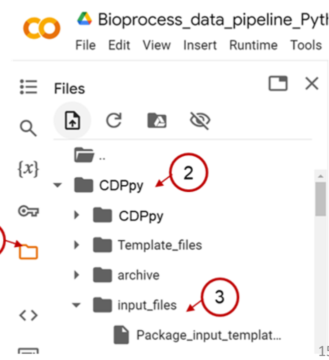
Play

```
# clone package from GitHub
!git clone https://github.com/ddolab/CDPpy.git

# install/update necessary package for plotting
!pip install dash
!pip install pandas==1.4.3

# go into the pacakge folder
import os
os.chdir('/content/CDPpy')
```

Step 4: Follow the steps in the screenshot and upload the input Excel file into the “input_files” folder



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Step-by-step to run tutorial notebooks on Google Colab (3)

Step 5: type the file name of the input Excel file in section 2.1

```
# setup the input filenase
input_fname = 'Part2_Package_input_Example.xlsx'
```

Step 6: Performing the data processing by running the rest of the notebook with “play” bottoms

- Section 2: example of processing one cell line data
- Section 3: example of processing multiple cell line data (slide 17)

Step 7: Go to section 4 to plot and analyze process profiles. (Slide 18)

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Full codes for processing multi-cell-line datasets in CDApy

```python
# Specify parameters that store data infomrmation for cell line 1 (CL1)
param_1 = FedBatchParameters(
          # input the cell line name, be consistent with the input excel file
          cell_line_name='CL1',
          # input "True" if there are measurements on concentrations after feeding, otherwise, "False"
          use_concentration_after_feed=False,
          # input "True" if feeding composition is known, otherwise, "False"
          use_feed_concentration=True)

# Specify parameters that store data infomrmation for cell line 2 (CL2)
param_2 = FedBatchParameters(
          # input the cell line name, be consistent with the input excel file
          cell_line_name='CL2',
          # input "True" if there are measurements on concentrations after feeding, otherwise, "False"
          use_concentration_after_feed=False,
          # input "True" if feeding composition is known, otherwise, "False"
          use_feed_concentration=True)
```

Specify data information for each cell line

```python
### Repeat section 2.2
# create a Python object to preform the data processing of CL1/2
cell_line_1_2= FedBatchCellCulture()

# define path to the input data file. Change the filename if needed.
path = input_path(input_fname)

# load the data set to the data-processing object
cell_line_1_2.load_data(file=path)

# peform data processsing with specified parameters that store data infomrmation.
# pass different data information with separate input params
cell_line_1_2.perform_data_process(parameters=[param_1, param_2])
```

**Change input filename if needed

Input and process data

```python
# export the processed dataset
cell_line_1_2.save_excel(file_name='output_CL1_2.xlsx')
```

Save results to Excel

* More details can be found in sections 2 & 3 in tutorial Jupyter notebook

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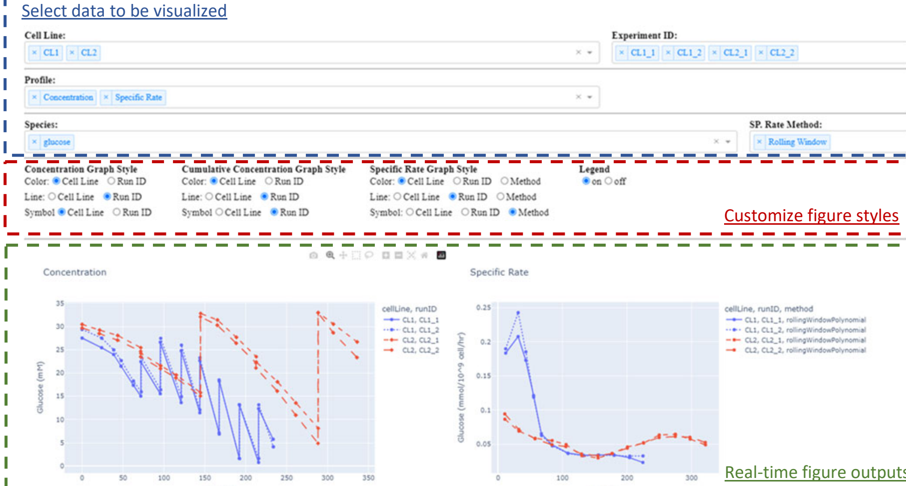
Interactive Plotting Widget – Customized Data Visualization

Select data to be visualized



Customize figure styles

Real-time figure outputs

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