pysyncrosim Documentation

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ApexRMS

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CONTENTS:

`pysyncrosim` is the Python interface to SyncroSim

CHAPTER

ONE

INSTALLATION

`pysyncrosim` can be installed using either the `conda` or `pip` package managers. `conda` is a general package manager capable of installing packages from many sources, but `pip` is strictly a Python package manager. While the installation instructions below are based on a Windows 10 operating system, similar steps can be used to install pysyncrosim for Linux.

Before beginning the installation of `pysyncrosim`, make sure you have the latest release of SyncroSim installed.

1.1 Dependencies

`pysyncrosim` was tested and developed using **Python 3.8** and **SyncroSim 2.3.10**. Because `pysyncrosim` uses `rasterio` for integrating spatial data, it also requires a C library dependency: `GDAL >=2.3`.

- python>=3.8
- pandas=1.3.2
- numpy=1.21.2
- rasterio>=1.2.6

1.2 Using conda

Follow these steps to get started with `conda` and use `conda` to install `pysyncrosim`.

1. Install `conda` using the Miniconda or Anaconda installer (in this tutorial we use Miniconda). To install Miniconda, follow this link and under the **Latest Miniconda Installer Links**, download Miniconda for your operating system. Open the Miniconda installer and follow the default steps to install `conda`. For more information, see the conda documentation.

2. To use `conda`, open the command prompt that was installed with the Miniconda installer. To find this prompt, type "anaconda prompt" in the **Windows Search Bar**. You should see an option appear called **Anaconda Prompt (miniconda3)**. Select this option to open a command line window. All code in the next steps will be typed in this window.

3. You can either install `pysyncrosim` and its dependencies into your base environment, or set up a new `conda` environment (recommended). Run the code below to set up and activate a new `conda` environment called "myenv" that uses Python 3.8.

```
# Create new conda environment
conda create -n myenv python=3.8

# Activate environment
conda activate myenv
```

You should now see that "(base)" has been replaced with "(myenv)" at the beginning of each prompt.

4. Set the package channel for `conda`. To be able to install `pysyncrosim`, you need to access the `conda-forge` package channel. To configure this channel, run the following code in the Anaconda Prompt.

```
# Set conda-forge package channel
conda config --add channels conda-forge
```

5. Install `pysyncrosim` using `conda install`. Installing `pysyncrosim` will also install its dependencies: `pandas`, `numpy`, and `rasterio`.

```
# Install pysyncrosim
conda install pysyncrosim
```

`pysyncrosim` should now be installed and ready to use!

1.3 Using pip

Use `pip` to install `pysyncrosim` to your default python installation. You can install Python from www.python.org. You can also find information on how to install `pip` from the pip documentation.

Install `pysyncrosim` using `pip install`. Installing `pysyncrosim` will also install its dependencies: `pandas`, `numpy`, and `rasterio`.

```
# Make sure you are using the latest version of pip
pip install --upgrade pip

# Install pysyncrosim
pip install pysyncrosim
```

CHAPTER

TWO

QUICKSTART

`pysyncrosim` is the Python interface to the SyncroSim software framework, a program that structures and models your data. This tutorial will cover the basics of using the `pysyncrosim` package within the SyncroSim software framework.

To complete this tutorial, you must install SyncroSim and install pysyncrosim. You will also need to install the helloworldTime SyncroSim Package.

2.1 Overview of SyncroSim

SyncroSim is a software platform that helps you turn your data into forecasts. At the core of SyncroSim is an engine that automatically structures your existing data, regardless of its original format. SyncroSim transforms this structured data into forecasts by running it through a Pipeline of calculations (i.e. a suite of models). Finally, SyncroSim provides a rich interface to interact with your data and models, allowing you to explore and track the consequences of alternative "what-if" forecasting Scenarios. Within this software framework is the ability to use and create SyncroSim packages.

For more details consult the SyncroSim online documentation.

2.2 Overview of `pysyncrosim`

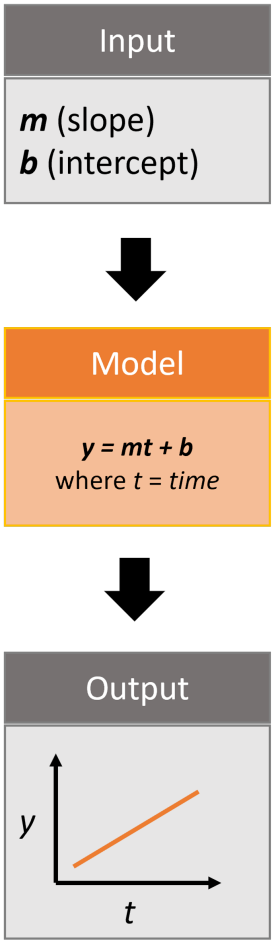
`pysyncrosim` is a Python package designed to facilitate the development of modeling workflows for the SyncroSim software framework. Using the `pysyncrosim` interface, simulation models can be added and run through SyncroSim to transform Scenario-based datasets into model forecasts. This Python package takes advantage of general features of SyncroSim, such as defining Scenarios with spatial or non-spatial inputs, running Monte Carlo simulations, and summarizing model outputs.

`pysyncrosim` requires SyncroSim 2.3.10 or higher.

2.3 SyncroSim Package: *helloworldTime*

helloworldTime was designed to be a simple package to show off some key functionalities of SyncroSim, including the ability to add timesteps to SyncroSim modeling workflows.

The package takes from the user two inputs, *m* and *b*, representing a slope and an intercept value. It then runs these input values through a linear model, $y=mt+b$, where *t* is *time*, and returns the *y* value as output.



2.4 Set Up

2.4.1 Install SyncroSim

Before using `pysyncrosim`, you will first need to download and install the SyncroSim software. Versions of SyncroSim exist for both Windows and Linux.

2.4.2 Installing and Loading Python Packages

Install `pysyncrosim` using either `conda install` or `pip install`. See the Installation page for more detailed installation instructions.

Then, in a new Python script, import `pysyncrosim`.

```
>>> import pysyncrosim as ps
```

2.4.3 Connecting Python to SyncroSim

The next step in setting up the Python environment for the `pysyncrosim` workflow is to create a SyncroSim Session instance in Python that provides the connection to your installed copy of the SyncroSim software. A new Session is created using the `Session()` class. The Session can be initialized with a path to the folder on your computer where SyncroSim has been installed. If no arguments are specified when the Session class is initialized, then the default install folder is used (Windows only).

```
# Load Session
>>> mySession = ps.Session()

# Load Session using path to SyncroSim Installation
>>> mySession = ps.Session(location = "path/to/install_folder")
```

You can check to see which version of SyncroSim your Python script is connected to by running the `version()` method.

```
# Check SyncroSim version
>>> mySession.version()
'Version is: 2.3.10'
```

2.4.4 Installing SyncroSim Packages

Finally, check if the `helloworldTime` package is already installed. Use the `packages()` method to first get a list of all currently installed SyncroSim Packages.

```
# Check which SyncroSim Packages are installed
>>> mySession.packages()
Empty DataFrame
Columns: [index, Name, Description, Version, Extends]
Index: []
```

Currently we do not have any packages installed! To see which packages are available from the SyncroSim package server, you can use the `installed = False` argument in the `packages()` method.

```
# Check out available SyncroSim Packages
>>> available_packages = mySession.packages(installed=False)
>>> available_packages.head()
            demosales  \
0               dgsim
1          helloworld
2  helloworldPipeline
```

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```
3   helloworldSpatial
4      helloworldTime

  Example SyncroSim Base Package of a very simple sales forecasting model  \
0     Simulates demographics of wildlife populations
1      Example demonstrating how to create a package
2                           Example using pipelines
3                        Example using spatial data
4                           Example using timesteps

   1.1.0
0  2.3.0
1  1.0.1
2  1.0.0
3  1.0.2
4  1.0.0
```

Install `helloworldTime` using the `add_packages()` method from the Session class. This method takes a Package name as input and then queries the SyncroSim Package server for the specified Package.

```
# Install helloworldTime Package
>>> mySession.add_packages("helloworldTime")
['helloworldTime'] installed successfully
```

To install a package from a *.ssimpkg* file on your local computer rather than installing directly from the server, you can use the Session `add_packages()` method with the `packages` argument set to the filepath to the local Package.

```
# Install helloworldTime Package locally
>>> mySession.add_packages("path/to/helloworldTime.ssimpkg")
```

Now `helloworldTime` should be included in the Package list.

```
>>> mySession.packages()
        index                Name                                      Description Version␣
↪Extends
     0      0      helloworldTime    Example demonstrating how to use timesteps   1.0.0 ␣
↪    NaN
```

You can also update or remove a SyncroSim Package from your Session using the `update_packages()` method and the `remove_packages()` method.

```
# Update installed packages
>>> mySession.update_packages("myPackage")

# Remove installed packages
>>> mySession.remove_packages("myPackage")
```

2.5 Create a Modeling Workflow

When creating a new modeling workflow from scratch, we need to create class instances of the following scopes:

- Library
- Project
- Scenario

These classes are hierarchical, such that a Library can contain many Projects, and each Project can contain many Scenarios. All parameters or configurations set in a Library are inherited by all Projects within the Library, and all parameters or configurations set in a Project are inherited by all Scenarios within that Project.

2.5.1 Create a New Library

A SyncroSim Library is a file (with *.ssim* extension) that stores all of your model inputs and outputs. The format of each SyncroSim Library is unique to the SyncroSim Package with which it is associated. We create a new Library class instance using `library()` that is connected (through your Session) to a SyncroSim Library file.

```
# Create a new Library
>>> myLibrary = ps.library(name = "helloworldLibrary",
>>>                        session = mySession,
>>>                        package = "helloworldTime")

# Check Library information
>>> myLibrary.info
                    Property                                        Value
0                       Name:                           helloworldLibrary
1                      Owner:                                         NaN
2              Last Modified:                       2021-09-10 at 3:13 PM
3                       Size:                         196 KB  (200,704 B)
4                  Read Only:                                          No
5               Package Name:                                helloworldTime
6        Package Description:  Example demonstrating how to use timesteps
7    Current Package Version:                                       1.0.0
8    Minimum Package Version:                                       1.0.0
9       External input files:              helloworldLibrary.ssim.input
10     External output files:             helloworldLibrary.ssim.output
11           Temporary files:               helloworldLibrary.ssim.temp
12              Backup files:             helloworldLibrary.ssim.backup
```

We can also use the `library()` function to open an existing Library. For instance, now that we have created a Library called "helloworldLibrary.ssim", we would simply specify that we want to open this Library using the `name` argument.

```
# Open existing Library
>>> myLibrary = ps.library(name = "helloworldLibrary")
```

Note that if you want to create a new Library file with an existing Library name rather than opening the existing Library, you can use `overwrite=True` when initializing the Library class instance.

2.5.2 Create a New Project

Each SyncroSim Library contains one or more SyncroSim Projects, each represented by an instance of class Project in `pysyncrosim`. Projects typically store model inputs that are common to all your Scenarios. In most situations you will need only a single Project for your Library; by default each new Library starts with a single Project named "Definitions" (with a unique `project_id` = 1). The `projects()` method of the Libarry class is used to both create and retrieve Projects for a specific Library.

```
# Create (or open) a Project in this Library
>>> myProject = myLibrary.projects(name = "Definitions")

# Check Project information
>>> myProject.info
           Property                   Value
0         ProjectID                       1
1              Name             Definitions
2             Owner                     NaN
3  DateLastModified  2021-12-21 at 10:48 PM
4        IsReadOnly                      No
```

2.5.3 Create a New Scenario

Finally, each SyncroSim Project contains one or more Scenarios, each represented by an instance of class Scenario in `pysyncrosim`.

Scenarios store the specific inputs and outputs associated with each Transformer in SyncroSim. SyncroSim models can be broken down into one or more of these Transformers. Each Transformer essentially runs a series of calculations on the input data to transform it into the output data. Scenarios can contain multiple Transformers connected by a series of Pipelines, such that the output of one Transformer becomes the input of the next.

Each Scenario can be identified by its unique `scenario_id`. The `scenarios()` method of class Library or class Project is used to both create and retrieve Scenarios. Note that if using the Library class to generate a new Scenario, you must specify the Project to which the new Scenario belongs if there is more than one Project in the Library.

```
# Create a new Scenario using the Library class instance
>>> myScenario = myLibrary.scenarios(name = "My First Scenario")

# Open the newly-created Scenario using the Project class instance
>>> myScenario = myProject.scenarios(name = "My First Scenario")

# Check Scenario information
>>> myScenario.info
              Property                   Value
0           ScenarioID                       1
1            ProjectID                       1
2                 Name      My First Scenario
3            IsResult                      No
4            ParentID                     NaN
5               Owner                     NaN
6    DateLastModified  2021-09-10 at 3:13 PM
```

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```
7           IsReadOnly                    No
8    MergeDependencies                    No
9   IgnoreDependencies                   NaN
10         AutoGenTags                   NaN
```

2.5.4 View Model Inputs

Each SyncroSim Library contains multiple SyncroSim Datasheets. A SyncroSim Datasheet is simply a table of data stored in the Library, and they represent the input and output data for Transformers. Datasheets each have a *scope*: either Library, Project, or Scenario. Datasheets with a Library scope represent data that is specified only once for the entire Library, such as the location of the backup folder. Datasheets with a Project scope represent data that are shared over all Scenarios within a Project. Datasheets with a Scenario scope represent data that must be specified for each generated Scenario. We can view Datasheets of varying scopes using the `datasheets()` method from the Library, Project, and Scenario classes.

```
# View a summary of all Datasheets associated with the Scenario
>>> myScenario.datasheets()
          Package                              Name     Display Name
0  helloworldTime   helloworldTime_InputDatasheet   InputDatasheet
1  helloworldTime  helloworldTime_OutputDatasheet  OutputDatasheet
2  helloworldTime       helloworldTime_RunControl      Run Control
```

If we want to see more information about each Datasheet, such as the scope of the Datasheet or if it only accepts a single row of data, we can set the `optional` argument to `True`.

```
# View detailed summary of all Datasheets associated with a Scenario
>>> myScenario.datasheets(optional=True)
      Scope         Package                              Name     Display Name  \
0  Scenario  helloworldTime   helloworldTime_InputDatasheet   InputDatasheet
1  Scenario  helloworldTime  helloworldTime_OutputDatasheet  OutputDatasheet
2  Scenario  helloworldTime       helloworldTime_RunControl      Run Control

  Is Single Is Output
0       Yes        No
1        No        No
2       Yes        No
```

From this output we can see the the `RunControl` Datasheet and `InputDatasheet` only accept a single row of data (i.e. `Is Single = Yes`). This is something to consider when we configure our model inputs.

To view a specific Datasheet rather than just a DataFrame of available Datasheets, set the `name` parameter in the `datasheets()` method to the name of the Datasheet you want to view. The general syntax of the name is: "<name of package>_<name of Datasheet>". From the list of Datasheets above, we can see that there are three Datasheets specific to the `helloworldTime` package.

```
# View the input Datasheet for the Scenario
>>> myScenario.datasheets(name = "helloworldTime_InputDatasheet")
Empty DataFrame
Columns: [m, b]
Index: []
```

Here, we are viewing the contents of a SyncroSim Datasheet as a Python `pandas` DataFrame. Although both SyncroSim Datasheets and `pandas` DataFrames are both represented as tables of data with predefined columns and an unlimited number of rows, the underlying structure of these tables differ.

2.5.5 Configure Model Inputs

Currently our input Scenario Datasheets are empty! We need to add some values to our input Datasheet (`InputDatasheet`) and run control Datasheet (`RunControl`) so we can run our model.

First, assign the contents of the input Datasheet to a new `pandas` DataFrame using the Scenario `datasheets()` method, then check the columns that need input values.

```
# Load input Datasheet to a new pandas DataFrame
>>> myInputDataframe = myScenario.datasheets(
>>>     name = "helloworldTime_InputDatasheet")

# Check the columns of the input DataFrame
>>> myInputDataframe.info()
<class 'pandas.core.frame.DataFrame'>
Index: 0 entries
Data columns (total 2 columns):
 #   Column  Non-Null Count  Dtype
---  ------  --------------  -----
 0   m       0 non-null      object
 1   b       0 non-null      object
dtypes: object(2)
memory usage: 0.0+ bytes
```

The input Datasheet requires two values:

- m : the slope of the linear equation.
- b : the intercept of the linear equation.

Now we will update the input DataFrame. This can be done in many ways, such as creating a new `pandas` DataFrame with matching column names, or appending values as a dictionary to `myInputDataframe`.

For this example, we will append values to `myInputDataframe` using a Python dictionary and the `pandas append()` function. Note that in the previous section we discovered that the input Datasheets only accept a single row of values, so we can only have one value each for our slope (m) and intercept (b).

```
# Create input data dictionary
>>> myInputDict = {"m": 3, "b": 10}

# Append input data dictionary to myInputDataframe
>>> myInputDataframe = myInputDataframe.append(myInputDict,
>>>                                            ignore_index=True)

# Check values
>>> myInputDataframe
   m  b
0  3  10
```

2.5.6 Saving Modifications to Datasheets

Now that we have a complete DataFrame of input values, we will save this DataFrame to a SyncroSim Datasheet using the Scenario `save_datasheet()` method. The `save_datasheet()` method exists for the Library, Project, and Scenario classes, so the class method chosen depends on the scope of the Datasheet.

```
>>> myScenario.save_datasheet(name = "helloworldTime_InputDatasheet",
>>>                           data = myInputDataframe)
```

2.5.7 Configuring the RunControl Datasheet

There is one other Datasheet that we need to configure for our model to run. The `RunControl` Datasheet provides information about how many time steps to use in the model. Here, we set the minimum and maximum time steps for our model. Similar to above, we'll add this information to a Python dictionary and then add it to the `RunControl` Datasheet using the `pandas append()` function. We need to specify data for the following two columns:

- *MinimumTimestep* : the starting time point of the simulation.
- *MaximumTimestep* : the end time point of the simulation.

```
# Load RunControl Datasheet to a ``pandas`` DataFrame
>>> runSettings = myScenario.datasheets(
>>>     name = "helloworldTime_RunControl")

# Check the columns of the RunControl DataFrame
>>> runSettings.info()
<class 'pandas.core.frame.DataFrame'>
Index: 0 entries
Data columns (total 2 columns):
 #   Column           Non-Null Count  Dtype
---  ------           --------------  -----
 0   MinimumTimestep  0 non-null      object
 1   MaximumTimestep  0 non-null      object
dtypes: object(2)
memory usage: 0.0+ bytes

# Create RunControl data dictionary
>>> runControlDict = {"MinimumTimestep": 1, "MaximumTimestep": 10}

# Append RunControl data dictionary to RunControl DataFrame
>>> runSettings = runSettings.append(runControlDict, ignore_index=True)

# Check values
>>> runSettings
  MinimumTimestep MaximumTimestep
0               1              10

# Save RunControl pandas DataFrame to a SyncroSim Datasheet
>>> myScenario.save_datasheet(name = "helloworldTime_RunControl",
>>>                           data = runSettings)
```

2.6 Run Scenarios

2.6.1 Setting Run Parameters

We will now run our Scenario using the Scenario `run()` method.

```
# Run the Scenario
>>> myResultsScenario = myScenario.run()
```

2.6.2 Checking the Run Log

For more information use the Scenario `run_log()` method. Note that this method can only be called when a Scenario is a *Results Scenario*.

```
# Get run details for My First Scenario
>>> myResultsScenario.run_log()
                                          Run Log
0       STARTING SIMULATION: 2022-01-13 : 8:34:46 AM
1          Parent Scenario is: [1] My First Scenario
2  Result scenario is: [2] My First Scenario ([1]...
3                              CONFIGURING: Primary
4                                 RUNNING: Primary
5       SIMULATION COMPLETE: 2022-01-13 : 8:34:54 AM
6                    Total simulation time: 00:00:08
```

2.7 View Results

2.7.1 Results Scenarios

A Results Scenario is generated when a Scenario is run, and is an exact copy of the original Scenario (i.e. it contains the original Scenario's values for all input Datasheets). The Results Scenario is passed to the Transformer in order to generate model output, with the results of the Transformer's calculations then being added to the Results Scenario as output Datsheets. In this way the Results Scenario contains both the output of the run and a snapshot record of all the model inputs.

Check out the current Scenarios in your Library using the Library `scenarios()` method.

```
# Check Scenarios that currently exist in your Library
>>> myLibrary.scenarios()
   ScenarioID  ProjectID                                          Name  \
0           1          1                              My First Scenario
1           2          1  My First Scenario ([1] @ 13-Jan-2022 8:34 AM)

  IsResult
0       No
1      Yes
```

The first Scenario is our original Scenario, and the second is the Results Scenario with a time and date stamp of when it was run. We can also see some other information about these Scenarios, such as whether or not the Scenario is a result or not (i.e. `isResult` column).

2.7.2 Viewing Results

The next step is to view the output Datasheets added to the Result Scenario when it was run. We can load the result tables using the Scenario `datasheets()` method, and setting the name parameter to the Datasheet with new data added.

```
# Results of Scenario
>>> myOutputDataframe = myResultsScenario.datasheets(
>>>     name = "helloworldTime_OutputDatasheet")

# View results table
>>> myOutputDataframe.head()
   Iteration  Timestep     y
0        NaN         1  13.0
1        NaN         2  16.0
2        NaN         3  19.0
3        NaN         4  22.0
4        NaN         5  25.0
```

2.8 Working with Multiple Scenarios

You may want to test multiple alternative Scenarios that have slightly different inputs. To save time, you can copy a Scenario that you've already made, give it a different name, and modify the inputs. To copy a completed Scenario, use the Scenario `copy()` method.

```
# Check which Scenarios you currently have in your Library
>>> myLibrary.scenarios().Name
0                                My First Scenario
1    My First Scenario ([1] @ 13-Jan-2022 8:34 AM)
Name: Name, dtype: object

# Create a new Scenario as a copy of an existing Scenario
>>> myNewScenario = myScenario.copy("My Second Scenario")

# Make sure this new Scenario has been added to the Library
>>> myLibrary.scenarios().Name
0                                My First Scenario
1    My First Scenario ([1] @ 13-Jan-2022 8:34 AM)
2                               My Second Scenario
Name: Name, dtype: object
```

To edit the new Scenario, let's first load the contents of the input Datasheet and assign it to a new `pandas` DataFrame using the Scenario `datasheets()` method. We will set the `empty` argument to `True` so that instead of getting the values from the existing Scenario, we can start with an empty DataFrame again.

```
# Load empty input Datasheets as a Pandas DataFrame
>>> myNewInputDataframe = myNewScenario.datasheets(
>>>     name = "helloworldTime_InputDatasheet", empty = True)

# Check that we have an empty DataFrame
>>> myNewInputDataframe.info()
<class 'pandas.core.frame.DataFrame'>
```

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```
Index: 0 entries
Data columns (total 2 columns):
 #   Column  Non-Null Count  Dtype
---  ------  --------------  -----
 0   m       0 non-null      object
 1   b       0 non-null      object
dtypes: object(2)
memory usage: 0.0+ bytes
```

Now, all we need to do is add some new values the same way we did before, using the `pandas append()` function.

```
# Create an input data dictionary
>>> newInputDict = {"m": 4, "b": 10}

# Append new input data dictionary to new input DataFrame
>>> myNewInputDataframe = myNewInputDataframe.append(newInputDict,
>>>                                                  ignore_index=True)

# View the new inputs
>>> myNewInputDataframe
   m   b
0  4  10
```

Finally, we will save the updated DataFrame to a SyncroSim Datasheet using the Scenario `save_datasheet()` method.

```
# Save pandas DataFrame to a SyncroSim Datasheet
>>> myNewScenario.save_datasheet(name = "helloworldTime_InputDatasheet",
>>>                              data = myNewInputDataframe)
```

We will keep the `RunControl` Datasheet the same as the first Scenario.

2.8.1 Run Scenarios

We now have two SyncroSim Scenarios. We can run all the Scenarios using Python list comprehension.

```
# Create a List of Scenarios
>>> myScenarioList = [myScenario, myNewScenario]

# Run all Scenarios
>>> myResultsScenarioAll = [scn.run() for scn in myScenarioList]
```

2.8.2 View Results

From running many Scenario at once we get a list of Result Scenarios. To view the results, we can use the Scenario `datasheets()` method on the indexed list.

```
# View results of second Scenario
>>> myResultsScenarioAll[1].datasheets(
>>>       name = "helloworldTime_OutputDatasheet")
   Iteration  Timestep     y
```

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```
0         NaN          1  14.0
1         NaN          2  18.0
2         NaN          3  22.0
3         NaN          4  26.0
4         NaN          5  30.0
5         NaN          6  34.0
6         NaN          7  38.0
7         NaN          8  42.0
8         NaN          9  46.0
9         NaN         10  50.0
```

2.8.3 Identifying the Parent Scenario of a Results Scenario

If you have many alternative Scenarios and many Results Scenarios, you can always find the parent Scenario that was run in order to generate the Results Scenario using the Scenario `parent_id` attribute.

```
# Find parent ID of first Results Scenario
>>> myResultsScenarioAll[0].parent_id
1.0

# Find parent ID of second Results Scenario
>>> myResultsScenarioAll[1].parent_id
3.0
```

2.9 Access Model Metadata

2.9.1 Getting SyncroSim Class Information

Retrieve information about your Library, Project, or Scenario using the `info` attribute.

```
# Retrieve Library information
>>> myLibrary.info
                     Property                                      Value
0                        Name:                        helloworldLibrary
1                       Owner:                                      NaN
2               Last Modified:                    2021-09-10 at 3:13 PM
3                        Size:                      196 KB  (200,704 B)
4                   Read Only:                                       No
5                Package Name:                             helloworldTime
6         Package Description:  Example demonstrating how to use timesteps
7    Current Package Version:                                     1.0.0
8    Minimum Package Version:                                     1.0.0
9       External input files:           helloworldLibrary.ssim.input
10     External output files:          helloworldLibrary.ssim.output
11           Temporary files:            helloworldLibrary.ssim.temp
12              Backup files:          helloworldLibrary.ssim.backup

# Retrieve Project information
```

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```
>>> myProject.info
           Property                    Value
0         ProjectID                        1
1              Name              Definitions
2             Owner                      NaN
3  DateLastModified  2021-12-21 at 10:48 PM
4        IsReadOnly                       No

# Retrieve Scenario information
>>> myScenario.info
              Property                   Value
0           ScenarioID                       1
1            ProjectID                       1
2                 Name      My First Scenario
3             IsResult                      No
4             ParentID                     NaN
5                Owner                     NaN
6     DateLastModified  2021-09-10 at 3:13 PM
7           IsReadOnly                      No
8    MergeDependencies                      No
9   IgnoreDependencies                     NaN
10         AutoGenTags                     NaN
```

The following attributes can also be used to get useful information about a Library, Project, or Scenario instance:

- `name`: used to retrieve or assign a name.
- `owner`: used to retrieve or assign an owner.
- `date_modified`: used to retrieve the timestamp when the last changes were made.
- `readonly`: used to retrieve or assign the read-only status.
- `description`: used to retrieve or add a description.

You can also find identification numbers of Projects or Scenarios using the following attributes:

- `project_id`: used to retrieve the Project Identification number.
- `scenario_id`: used to retrieve the Scenario Identification number.

2.10 Backup your Library

Once you have finished running your models, you may want to backup the inputs and results into a zipped *.backup* subfolder. First, we want to modify the Library Backup Datasheet to allow the backup of model outputs. Since this Datasheet is part of the built-in SyncroSim core, the name of the Datasheet has the prefix "core". We can get a list of all the core Datasheets with a Library scope using the Library `datasheets()` method with `summary` set to `"CORE"`.

```
# Find all Library-scoped Datasheets
>>> myLibrary.datasheets(summary = "CORE")
      Package                      Name              Display Name
0        core               core_Backup                    Backup
1        core          core_CondaConfig       Conda Configuration
2        core           core_LNGPackage  Last Known Good Packages
```

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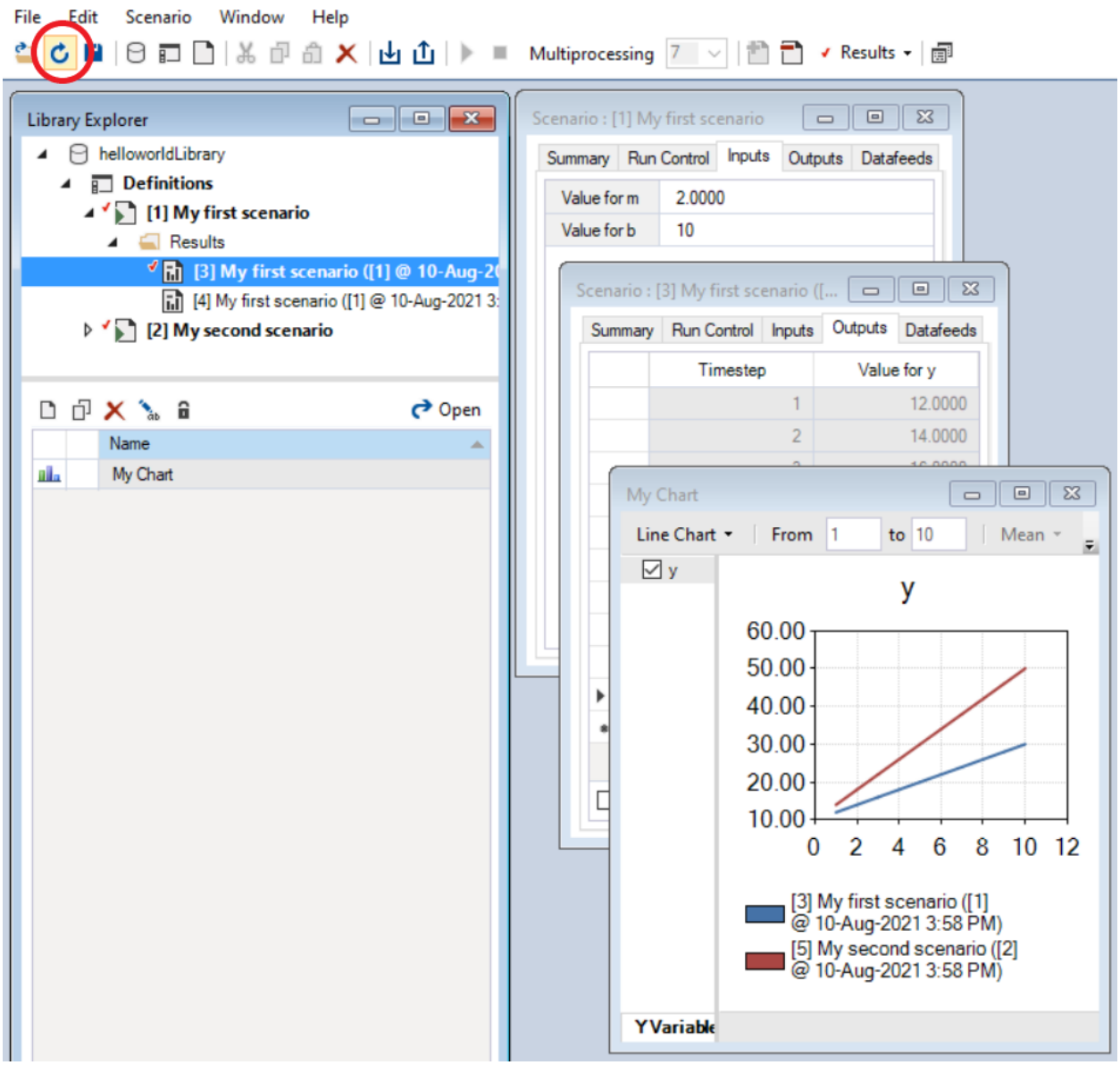
```
3         core       core_Multiprocessing           Multiprocessing
4         core               core_Options                   Options
5         core  core_ProcessorGroupOption   Processor Group Options
6         core   core_ProcessorGroupValue    Processor Group Values
7         core              core_PyConfig      Python Configuration
8         core               core_RConfig           R Configuration
9         core              core_Settings                  Settings
10        core             core_SysFolder                   Folders
11  corestime          corestime_Options           Spatial Options

# Get the current values for the Library's Backup Datasheet
>>> myDataframe = myLibrary.datasheets(name = "core_Backup")

# View current values for the Library's Backup Datasheet
>>> myDataframe
  IncludeInput  IncludeOutput BeforeUpdate
0          Yes            NaN          Yes

# Add IncludeOutput to the Library's Backup Datasheet
>>> myDataframe["IncludeOutput"] = "Yes"

# Save the pandas DataFrame to a SyncroSim Datasheet
>>> myLibrary.save_datasheet(name = "core_Backup", data = myDataframe)

# Check to make sure IncludeOutput is now set to "Yes"
>>> myLibrary.datasheets(name = "core_Backup")
```

Now, you can use the Library `backup()` method to backup your Library.

```
>>> myLibrary.backup()
```

2.11 pysyncrosim and the SyncroSim Windows User Interface

It can be useful to work in both `pysyncrosim` and the SyncroSim Windows User Interface at the same time. You can easily modify Datasheets and run Scenarios in `pysyncrosim`, while simultaneously refreshing the Library and plotting outputs in the User Interface as you go. To sync the Library in the User Interface with the latest changes from the `pysyncrosim` code, click the refresh icon (circled in red below) in the upper tool bar of the User Interface.



2.12 SyncroSim Package Development

If you wish to design SyncroSim packages using python and pysyncrosim, you can follow the Creating a Package and Enhancing a Package tutorials on the SyncroSim documentation website.

Note: SyncroSim v2.3.10 is required to develop python-based SyncroSim packages.

CHAPTER

THREE

RUNNING PYSYNCROSIM IN SPYDER

If using conda, the spyder IDE is easy to install and straightforward to use.

1. First, install spyder either in your base environment or in your conda environment using the following code.

```
# Install spyder
conda install spyder
```

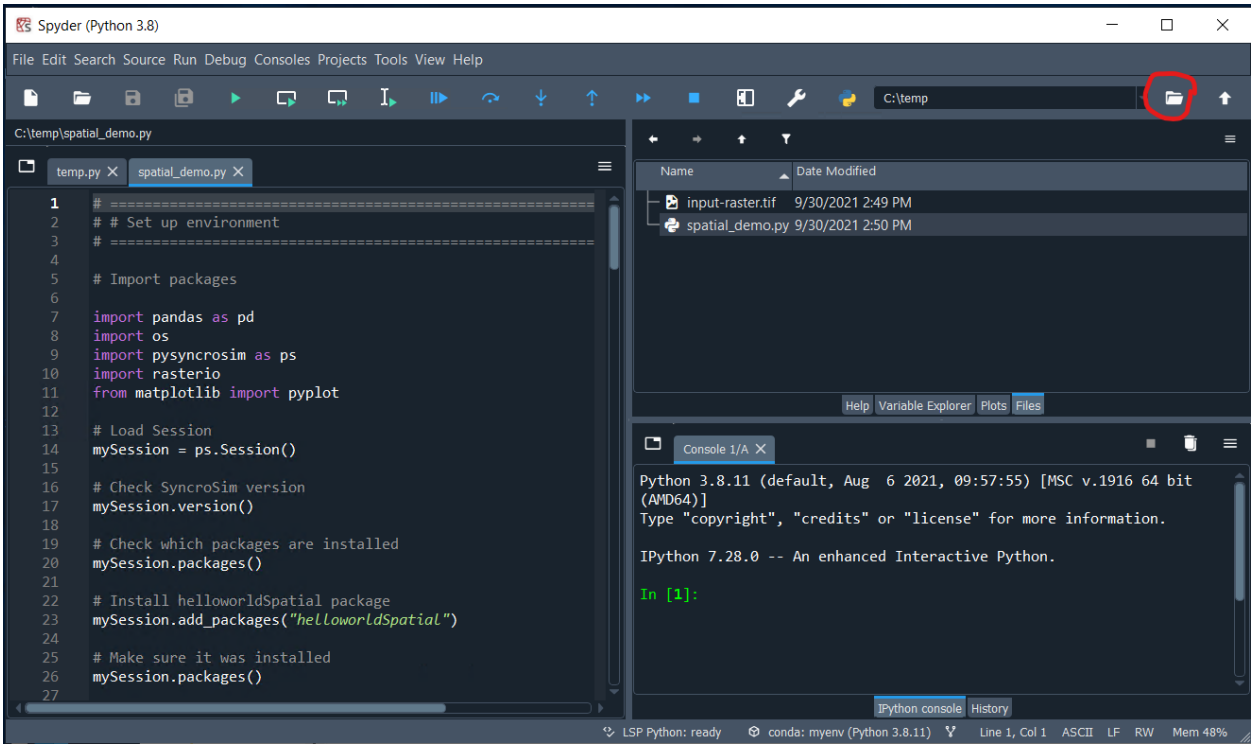
2. Open the IDE by typing spyder in the command prompt.

```
# Open spyder
spyder
```

Note: you may get a pop-up saying you have a missing dependency, rtree. You can safely ignore this warning.

3. Within the IDE, change the working directory to the directory containing your pysyncrosim scripts (e.g. spatial_demo.py and input-raster.tif)

4. Open and run your pysyncrosim scripts from the left-hand window. You can run scripts line-by-line in spyder by selecting the line(s) you want to run and pressing F9.


Spyder (Python 3.8)
File Edit Search Source Run Debug Consoles Projects Tools View Help
C:\temp
C:\temp\spatial_demo.py
temp.py
spatial_demo.py
# ==========
# # Set up environment
# ==========
# Import packages
import pandas as pd
import os
import pysyncrosim as ps
import rasterio
from matplotlib import pyplot
# Load Session
mySession = ps.Session()
# Check SyncroSim version
mySession.version()
# Check which packages are installed
mySession.packages()
# Install helloworldSpatial package
mySession.add_packages("helloworldSpatial")
# Make sure it was installed
mySession.packages()
Name
Date Modified
input-raster.tif 9/30/2021 2:49 PM
spatial_demo.py 9/30/2021 2:50 PM
Help
Variable Explorer
Plots
Files
Console 1/A
Python 3.8.11 (default, Aug 6 2021, 09:57:55) [MSC v.1916 64 bit (AMD64)]
Type "copyright", "credits" or "license" for more information.
IPython 7.28.0 -- An enhanced Interactive Python.
In [1]:
IPython console
History
LSP Python: ready
conda: myenv (Python 3.8.11)
Line 1, Col 1
ASCII
LF
RW
Mem 48%

CHAPTER

FOUR

API REFERENCE

environment	
helper	
library.Library	A class to represent a SyncroSim Library.
project.Project	A class to represent a SyncroSim Project.
raster.Raster	A class to represent a raster object.
scenario.Scenario	A class representing a SyncroSim Scenario.
session.Session	A class to represent a SyncroSim Session.

4.1 pysyncrosim.environment

Functions

progress_bar([report_type, iteration, ...])	Begins, steps, ends, and reports progress for a SyncroSim simulation.
runtime_input_folder(scenario, datasheet_name)	Creates a SyncroSim Datasheet input folder.
runtime_output_folder(scenario, datasheet_name)	Creates a SyncroSim Datasheet output folder.
runtime_temp_folder(folder_name)	Creates a SyncroSim Datasheet temporary folder.

4.2 pysyncrosim.helper

Functions

library(name[, session, package, addons, ...])	Creates a new SyncroSim Library and opens it as a Library class instance.

4.3 pysyncrosim.library.Library

class pysyncrosim.library.**Library**(*location*, *session*)

A class to represent a SyncroSim Library.

__init__(*location*, *session*)

Initializes a pysyncrosim Library instance.

Parameters

- **location** (*String*) – Filepath to Library location on disk.
- **session** (*Session*) – pysyncrosim Session instance.

Return type None.

Methods

__init__(location, session)	Initializes a pysyncrosim Library instance.
backup()	Creates a backup of a SyncroSim Library.
datasheets([name, summary, optional, empty, ...])	Retrieves a DataFrame of Library Datasheets.
delete([project, scenario, force])	Deletes a SyncroSim class instance.
disable_addons(name)	Disable addon package(s) of a SyncroSim Library.
enable_addons(name)	Enable addon package(s) of a SyncroSim Library.
projects([name, pid, summary, overwrite])	Creates or opens one or more SyncroSim Projects in the Library.
run([scenarios, project, jobs, ...])	Runs a list of Scenario objects.
save_datasheet(name, data[, scope])	Saves a pandas DataFrane as a SyncroSim Datasheet.
scenarios([name, project, sid, pid, ...])	Retrieves a Scenario or DataFrame of Scenarios in this Library.
update()	Updates a SyncroSim Library.

Attributes

addons	Retrieves the addon(s) this Library is using.
date_modified	Retrieves the last date this Library was modified.
description	Gets or sets the description for this Library.
info	Retrieves information about this Library.
location	Retrieves the file path to this Library.
name	Retrieves or sets the name of this Library.
owner	Gets or sets the owner of this Library.
package	Retrieves the package this Library is using.
readonly	Gets or sets the read-only status of this Library.
session	Retrieves the Session associated with this Library.

4.4 pysyncrosim.project.Project

class pysyncrosim.project.**Project**(*pid*, *name*, *library*)

A class to represent a SyncroSim Project.

__init__(*pid*, *name*, *library*)

Initializes a pysyncrosim Project instance.

Parameters

- **pid** (*Int*) – Project ID.
- **name** (*String*) – Project name.
- **library** (*Library*) – pysyncrosim Library instance.

Return type None.

Methods

__init__(pid, name, library)	Initializes a pysyncrosim Project instance.
copy([name])	Creates a copy of an existing Project.
datasheets([name, summary, optional, empty, ...])	Retrieves a DataFrame of Project Datasheets.
delete([scenario, force])	Deletes a Project or Scenario.
run([scenarios, jobs, copy_external_inputs])	Runs a list of Scenario objects.
save_datasheet(name, data)	Saves a Project-scoped Datasheet.
scenarios([name, sid, optional, summary, ...])	Retrieve a DataFrame of Scenarios in this Project.

Attributes

date_modified	Gets the last date this Project was modified.
description	Gets or sets the Project description.
info	Retrieves Project information.
library	Retrieves the Library the Project belongs to.
name	Retrieves or sets Project name.
owner	Gets or sets the owner of this Project.
pid	Retrieves Project ID.
readonly	Gets or sets the read-only status for this Project.

4.5 pysyncrosim.raster.Raster

class pysyncrosim.raster.**Raster**(*source*, *iteration=None*, *timestep=None*)

A class to represent a raster object.

__init__(*source*, *iteration=None*, *timestep=None*)

Methods

__init__(source[, iteration, timestep])	

values([band])	Gets the values in each cell of the raster

Attributes

crs	Gets the coordinate system of the raster
dimensions	Gets the dimensions of the raster
extent	Gets the extent of the raster
name	Gets the name of the raster
resolution	Gets the resolution of the raster
source	Gets the filepath of the raster

4.6 pysyncrosim.scenario.Scenario

class pysyncrosim.scenario.**Scenario**(*sid=None*, *name=None*, *project=None*, *library=None*)

A class representing a SyncroSim Scenario.

__init__(*sid=None*, *name=None*, *project=None*, *library=None*)

Methods

__init__([sid, name, project, library])	

copy([name])	Creates a copy of an existing Scenario class instance.
datasheet_rasters(datasheet[, column, ...])	Retrieves spatial data columns from one or more SyncroSim Datasheets.
datasheets([name, summary, optional, empty, ...])	Retrieves a DataFrame of Scenario Datasheets.
delete([force])	Deletes a Scenario.
dependencies([dependency, remove, force])	Gets, sets, or removes dependencies from a Scenario.
ignore_dependencies([value])	Retrieves or sets the Datafeeds to ignore for a Scenario.
merge_dependencies([value])	Retrieves or sets whether or not a Scenario is configured to merge dependencies at run time.
results([sid])	Retrieves DataFrame of Results Scenarios or retrieves a Results Scenario instance for this Scenario.
run([jobs, copy_external_inputs])	Runs a Scenario.
run_log()	Returns a run log for a Results Scenario.
save_datasheet(name, data)	Saves a pandas DataFrame as a SyncroSim Datasheet.

Attributes

date_modified	Gets the last date this Scenario was modified.
description	Gets or sets the Scenario description.
info	Retrieves Scenario information.
is_result	Retrieves information about whether this Scenario is a Results Scenario or not.
library	Retrieves Library class instance associated with this Library.
name	Retrieves or sets a Scenario name.
owner	Gets or sets the owner of this Scenario.
parent_id	Retrieves the ID of the parent Scenario of a Results Scenario.
project	Retrieves Project class instance associated with this Scenario.
project_id	Gets the Project ID associated with this Scenario.
readonly	Gets or sets the read-only status for this Scenario.
sid	Retrieves Scenario ID.

4.7 pysyncrosim.session.Session

class pysyncrosim.session.**Session**(*location=None*, *silent=True*, *print_cmd=False*)

A class to represent a SyncroSim Session.

__init__(*location=None*, *silent=True*, *print_cmd=False*)

Initializes a pysyncrosim Session instance.

Parameters

- **location** (*Str, optional*) – Filepath to SyncroSim executable. If None, then uses default location on windows. The default is None.
- **silent** (*Logical, optional*) – If True, will not print warnings from the console. The default is True.
- **print_cmd** (*Logical, optional*) – If True, arguments from the console command will be printed. The default is False.

Raises

- **ValueError** – Raises error if the location given does not exist.
- **RuntimeError** – Raises error if the version of the SyncroSim installation is incompatible with the current version of pysyncrosim.

Return type None.

Methods

__init__([location, silent, print_cmd])	Initializes a pysyncrosim Session instance.
add_packages(packages)	Installs a package.
packages([installed])	Retrieves DataFrame of installed packages.
remove_packages(packages)	Uninstalls a package.
update_packages([packages])	Updates a package to the newest version.
version()	Retrieves SyncroSim version.

Attributes

location	Retrieves the location for this Session.
print_cmd	Gets or sets the print_cmd status of the SyncroSim Session.
silent	Gets or sets the silent status for this Session.

CHAPTER

FIVE

SUPPORT

To report a bug, ask a question, or request an enhancement for the pysyncrosim software, fill out an issue on the pysyncrosim GitHub or send an email to info@apexrms.com.

CHAPTER

SIX

INDICES AND TABLES

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