yuimaGUI: A graphical user interface for the yuima package. User Guide yuimaGUI v1.0

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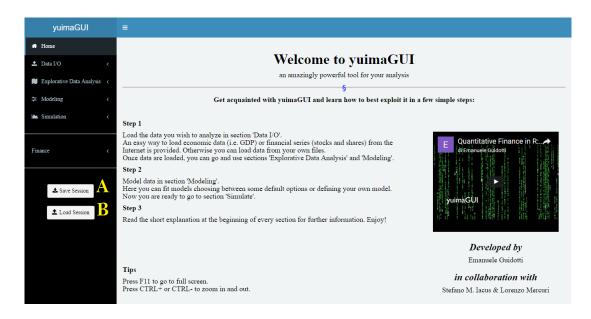
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1 yuimaGUI: Home



In this section it is explained how to use the interface in very few simple steps:

Step 1 Load the data you wish to analyze in section 'Data I/O'. An easy way to load economic data (i.e. GDP) or financial series (stocks and shares) from the Internet is provided. Otherwise you can load data from your own files. Once data are loaded, you can go and use sections 'Explorative Data Analysis' and 'Modeling'.

Step 2 Model data in section 'Modeling'. Here you can fit models choosing between some default options or defining your own model. Now you are ready to go to section 'Simulate'.

Step 3 Read the short explanation at the beginning of every section for further information. Enjoy!

On the right you can find a short video showing the usage of yuimaGUI. On the left it is the sidebar to change section. Buttons A and B allow to save everything you did using yuimaGUI (button A: *Save Session*) and to resume or share your work (button B: *Load Session*) loading a file previously saved by clicking on button A.

2 yuimaGUI: Data I/O

In this section you can load data from the Internet (section *Financial and Economic Data*) or from your local files (section *Your Data*).

2.1 Financial & Economic Data

yuimaGUI	≡
A Home	Load Financial and Economic data
🛓 Data I/O 🛛 🗸 🗸	Load Financial and Economic data For Stocks and Shares select Yahoo source using symbols you can find here.
» Financial & Economic Data	For currencies and metals select Oanda source and type the two symbols divided by '/ (e.g. EUR/USD or XAU/USD). Symbols are available here . Economic series are available on Federal Reserve Bank of St. Louis . Follow this example to find symbols.
» Your Data	Multiple symbols are allowed if divided by empty space and/or commas (e.g. AAPL FB CSCO or AAPL,FB,CSCO).
Explorative Data Analysis <	
⊊ Modeling <	Insert Symbol
📥 Simulation <	Download data from
	1900-01-01 to 2017-02-07
Finance <	Source
	Yahoo (OHLC data)
▲ Save Session	Lood data
▲ Load Session	

In this section you can load financial and economic data from the Internet. Type the symbols of the series you want to load, select the source of the data, choose the time horizon and click on *Load data*.

Loaded data will be displayed in the table of this section. Select a row of this table to plot the corresponding series. You can filter, save or delete the series. This table contains all the data you loaded, included those loaded in section *Your data* (see section 2.2).

Insert Symbol Type here the symbol(s) of the asset(s) you want to load. Stocks and shares, currencies and metals, economic indicators are available. All the useful links and information to find the symbols are given in the description of this section (see figure).

Download data from Select the time horizon in which you want to load the data. If data are available only after the starting date you chose, they will be loaded from when they are available.

Source Select the source for the data. If you are loading stocks and shares select Yahoo (OHLC data), in this case it will be loaded a series for the opening price, the closing price, high, low, adjusted closing price and volume. If you are loading currencies and metals select Oanda (Currencies & Metals). If you are loading economic indicators select Federal Reserve Bank of St. Louis.

2.2 Your Data

Upload your file and specify its structure. A preview will be shown below. Declare if the file contains raw and/or column headers and specify what kind of field separator has to be used to read the data. Each column will be uploaded as a different series. So you might want to switch columns with rows if your file is organized differently.									
Search:									
FB.Adjusted									
38.23									
34.029999									
31									
32									
33.029999									
31.91									
•									

In this section you can load data from your local files. Select the file you want to upload and specify its structure. A preview will be shown on the right. Each column will be loaded as a different series. Click on *Load data* to upload the file.

Once data are loaded, it will be shown the same table you find in section *Financial and Economic Data* (see section 2.1). You can filter, save or delete the series contained in this table.

Choose file to upload Choose the file to upload.

Headers Does the file contain headers? *Auto* option tries to detect headers automatically but you should specify explicitly if the file contains headers only for rows, only for columns, both or none of them.

Field Separator Select the field separator for your file. Available options are: space, comma, semicolon, tab.

Index The index (usually time) for the series. You can use row headers as index, numeric index (1,2,3,...) or any column of your file.

Index Format If you are using a numeric index select option *numeric*, otherwise you have to specify the date format you are using.

More Settings Here you can choose the decimal and thousands separator, the string that has to be interpreted as a missing value and the line from which to start reading the file. You can eventually switch rows with columns in reading the file.

3 yuimaGUI: Explorative Data Analysis

After loading the data, you can use this section and perform various kind of analysis: change poiint estimation, clustering analysis, lead-lag and correlation analysis.

3.1 Change Point Estimation

Here you can estimate change points using different methods, both parametric and nonparametric. You can detect change points in the distribution of the increments of the process, in the distribution of the percentage increments of the process (returns for stocks and shares) and change points in the volatility of the process.

3.1.1 Nonparametric

yuimaGUI						
Home Data I/O <	Change Point Estimation Select the data you wish to estimate change points for.					
Explorative Data Analysis Choose the algorithm you want to use for estimation. Results will be shown below by plotting the series and the detected change points. Section 2.2.2.2.2.2.2.2.2.2.2.2.2.2.2.2.2.2.2.						
 » Clustering » Lead-Lag & Correlation 	Nonparametric Parametric					
⊊ Modeling <	Available data Selected data					
🖾 Simulation <	Symb From To Symb Symb Symb Subtraction Select from table beside Method					
	FB.Open 2012-05-18 2016-03-22 No data available in table Percentage Increments Distribution ▼					
Finance <	FB.High 2012-05-18 2016-03-22 p-value					
	FB.Low 2012-05-18 2016-03-22 0,01					
▲ Save Session	FB.Close 2012-05-18 2016-03-22					
≜ Load Session	Select Select All Delete Delete All Start Estimation					

Table Available data contains all the series you loaded previously in section Data I/O. Select from this table the series you want to estimate change points for; they will be moved to table Selected data. Choose the method and the p-value to use for estimation and click on button Start Estimation. Change points will be estimated for every series in table Selected data.

Results will be shown below and include: plots of the series and its (percentage) increments with the detected change points; instants of change points with their p-value.

Method and p-value Available methods are *Percentage Increments Distribution* and *Increments Distribution*. They detect change points in the (percentage) increments distribution of the process, up to a confidence level given by the p-value used. The algorithm is as follows:

- 1. Compute the (percentage) increments of the process
- 2. For any t in the observation grid of the process, run a two-sample Kolmogorov-Smirnov test comparing the empirical (percentage) increments distribution between:
 - t_0 (initial time) and t
 - t and T (final time)
- 3. Find the minimum p-value, and the corresponding t_{min} , obtained by the KS tests. If it is greater than the **p-value** used, then the algorithm stops. Otherwise, a change point is detected at time $t_{CP} = t_{min}$.
- 4. Repeat point 2 and 3 but, instead of using the whole grid of observation, use only observations between t_0 and t_{CP} . Repeat again point 2 and 3 using observations between t_{CP} and T.

3.1.2 Parametric

yuimaGUI	≡					
₩ Home ★ Data I/O <	Data LO Change Point Estimation Select the data you wish to estimate change points for. Change Point Estimation S					
	Available data Selected data Search: Model Symb From To Symb Select from table beside Geometric Brownian Motion					
Finance <	FB.Open 2012-05-18 2016-03-22 No data available in table Training set (%) FB.High 2012-05-18 2016-03-22 Image: Control of the set					
▲ Save Session▲ Load Session	FB.Close 2012-05-18 2016-03-22 Select Select All Delete Delete All					

Table Available data contains all the series you loaded previously in section Data I/O. Select from this table the series you want to estimate change points for; they will be moved to table Selected data. Choose the diffusive model (also user-defined diffusive models can be selected, see section 4.1.2) and the training set. You can choose the window to use for change point estimation clicking on button Set Range. More settings are provided through button Advanced Settings (see section 4.1.1 for further information). Click on button Start Estimation and change points will be estimated for every series in table Selected data.

Results will be shown below and include: plot of the series with the detected change point; instant of the change point; estimates for the parameters of the chosen diffusive model before and after the change point. Change Points are estimated using the following algorithm:

- 1. Estimate parameters (see section 4.1.1) for the selected **model** using the left-hand side of the **training set** (by default the first 20% of observations are used)
- 2. Estimate parameters (see section 4.1.1) for the selected **model** using the right-hand side of the **training set** (by default the last 20% of observations are used)
- 3. Estimate the change point by quasi-maximum likelihood approach using estimates obtained in point 1 and 2
- 4. Estimate parameters for the selected model before and after the detected change point
- 5. Estimate again the change point by quasi-maximum likelihood approach using estimates obtained in point 4
- 6. Iterate point 4 and 5 until the algorithm converges. If it does not, then an error is returned.

3.2 Clustering

yuimaGUI		
🖶 Home		
🛓 Data I/O <	Clustering Select data you want to cluster.	
📜 Explorative Data Analysis 🗸	Choose the distance you want to use and the kind of linkage for the hierarchical cluster analysis. Results will be shown below by plotting dendrogram and multidimensional scaling output.	
» Change Point Estimation		
 Clustering Lead-Lag & Correlation 	Available data Selected data	
≆ Modeling <	Search: Search:	Linkage
≠ Modeling <	Symb 🔶 From 🔶 To 🔶 Symb 🔶 Select from table beside 🚽	Complete 👻
📥 Simulation <	FB.Open 2012-05-18 2016-03-22 No data available in table	Distance
	FB.High 2012-05-18 2016-03-22	Percentage Increments Distribution 🔹
Finance <	FB.Low 2012-05-18 2016-03-22	
	FB.Close 2012-05-18 2016-03-22	
▲ Save Session ▲ Load Session	Select All Delete All	Start Clustering

Table Available data contains all the series you loaded previously in section Data I/O. Select from this table the series you want to cluster together; they will be moved to table Selected data. Choose the kind of linkage and distance you want to use. Then click on button Start Clustering. Results will be shown below and include both dendrogram and multidimensional scaling in order to help to identify clusters.

Linkage The kind of linkage to use for hierarchical clustering.

Distance The kind of distance to use for hierarchical clustering. Many well-known distances are provided, together with two new distances: *Percentage Increments Distribution* and *Increments Distribution*. In this case, the distance between two series is computed by:

$$d(f,g) \equiv \frac{1}{2} \int |f-g|$$

where f and g are the empirical (percentage) increments distribution of the two series. The *Percentage Increments Distribution* is very suitable for stocks and shares because it compares the distribution of returns, thus grouping together assets with similar volatility and drift.

3.3 Lead-Lag & Correlation

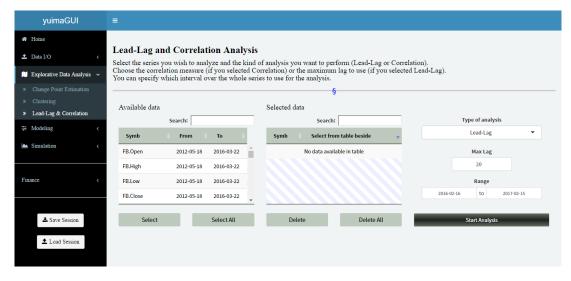


Table Available data contains all the series you loaded previously in section Data I/O. Select from this table the series you want to compute correlation or lead-lag for; they will be moved to table Selected data. Choose the kind of analysis to run (correlation or lead-lag) and click on button Start Analysis.

Results will be shown below in matrix form. If you selected *correlation* analysis then the correlation matrix will be shown. If you selected *lead-lag* analysis then the lead-lag matrix will be shown, with all the useful information on how to read the results. In this case only lead-lag effects statistically significant for the confidence level you choose are displayed.

Type of Analysis Correlation or Lead-Lag.

Max Lag This input is shown if you selected *Lead-Lag* analysis. It is the maximum lag that can be detected by the algorithm. It is expressed in days if you are using series indexed by date. It is expressed in the same unit of measure of the index if you are using numerical indexes.

Method This input is shown if you selected *Correlation* analysis. It is the method to use to compute the correlation matrix.

Range Select the window of observation to use to carry out the analysis.

4 yuimaGUI: Modeling

At the moment, only univariate models are available.

4.1 Univariate

In this section you can estimate univariate models on data previously uploaded (*Run estimation*, see section 4.1.1) and define your own model to estimate or simulate (*Set Model*, see section 4.1.2). Finally, diagnostic tools for goodness of fit are provided (*Estimates*, see section 4.1.3).

4.1.1 Run estimation

yuimaGUI	≡
# Home	Univariate Model Estimation
🛓 Data I/O 🛛 🗸	Select the data and the model you wish to estimate. Every model will be fitted to every selected series.
🕅 Explorative Data Analysis ≺	Click on buttons 'Set Range' and 'Advanced Settings' to customize the estimation process. Some default models are available but you can set your own model (tab 'Set model') and use it for estimation and/or simulation purposes.
≢ Modeling ~	§
» Univariate	Run estimation Set model Estimates
Simulation <	Model Class
	Diffusion process
Finance <	Model Name $dX_t = \mu X_t \; dt + \sigma X_t \; dW_t$
	Geometric Brownian Motion $dX_t = (heta_1 + heta_2 X_t) \ dt + heta_3 X_t^{ heta_1} \ dW_t$
♣ Save Session	Chan-Karoly-Longstaff-Sanders (CKLS)
	Available data Selected data
1 Load Session	Available data Selected data Selected data
	Symb From To Symb Select from table beside
	FB.Open 2012-05-18 2016-03-22 No data available in table Set Range
	FB.High 2012-05-18 2016-03-22
	FB.Low 2012-05-18 2016-03-22 Advanced Settings
	FB.Close 2012-05-18 2016-03-22
	Select All Delete Delete All Start Models Estimation

Select the class of the model you want to estimate. Then, select the model(s) to estimate. For every class, you can choose the model among a list of default models and the ones you set in section Set Model (see section 4.1.2). Table Available data contains all the series you loaded previously in section Data I/O. Select from this table the series you want to estimate the models on; they will be moved to table Selected data. You can choose the window of observation to use for estimation clicking on button Set Range. More settings are provided through button Advanced Settings. Click on *Start Models Estimation* and every selected model will be fitted on every selected series. Results will be shown in section *Estimates* (see section 4.1.3).

Model Class The class of the model to estimate. At the moment, available options are: *Diffusion Process, Fractional Process, Compound Poisson, CARMA* (Continuous Time ARMA model), *COGARCH* (Continuous Time GARCH model).

Model Name The model to estimate. You can choose among default models and those set in section *Set Model* (see section 4.1.2).

Set Range Here you can set, for every series you selected, the observation window to use for model estimation.

Advanced Settings Here you have full control over the estimation settings. Estimation is carried out via quasi-maximum likelihood approach. First, a random starting value is generated for every parameter and we try to maximize the likelihood starting from these random values. We do this for a number of times given by the input **trials**. Finally, we select the maximum likelihood estimates choosing among the optimization problems we ran. Of course, the higher the number of **trials** the more reliable the estimates (but also more time consuming the algorithm).

# Home			Advan	ced Settings	×	
🔔 Data I/O 🛛 🗸	Univariate Mo Select the data and th					
	Click on buttons 'Set Some default models	Series Se	-		Settings	
筆 Modeling ~		Serie FB.Adjus			Model Brownian Motion	
	Run estimation					
Simulation <		delta FB.Adjusted	Convert to log		rameter	
		0,01	FALSE •		mu 💌	
Finance <		Apply	Apply to All series		start	
· mance ·						
	Chan-I	General S	ottings	start: Min	start: Max	
📥 Save Session	Chan-	metho		0,147463820608017	0,147463820608017	
± Load Session	Available data	L-BFGS		lower	upper	
_ Load Session	Available data	trials	seed			
	Symb	1		Apply	Apply to All series	
	FB.Low	Apply	Apply to All series			Set Range
	FB.Close	Apply to All serie				occumpe.
	FB.Volume					Advanced Settings
	FB.Adjusted					
					Close	
	Select	Select All		Delete	Delete All	Start Models Estimation

Series Settings: Series. Select a series for which to modify the estimation settings.

Series Settings: delta. Distance between observations. If there are 252 observation per year (as in financial series) and you want to measure time in years, then you should choose $delta = 1/252 \simeq 0.004$. If the selected series has numerical indexes then it is recommended to use the true distance between observations (done by default) in order to have the estimates for the parameters using the same units of measure of the series. For many default models it will be possible to convert the estimates in various unit of measure (see section 4.1.3).

Series Settings: Convert to Log. Convert series to logarithm? This option is available only for positive series. If you select *True* then the model(s) will be estimated on the logarithm of the series. If you simulate a model estimated this way (see section 5.1.1) then the logarithm of the trajectory will be simulated and finally it will be converted back to the original trajectory computing its exponential.

Series Settings: Apply. Apply the Series Settings changes to the selected series.

Series Settings: Apply to All Series. Apply the Series Settings changes to all series.

Model Settings: Model. Select a model for which to modify the estimation settings

Model Settings: Parameter. Select a parameter of the selected model

Model Settings: start. Starting value of the selected parameter in the optimization problem. If not specified, it is generated randomly between start Min and Start Max.

Model Settings: start Min. The lower bound to randomly generate the starting value for the selected parameter in the optimization problem.

Model Settings: start Max. The upper bound to randomly generate the starting value for the selected parameter in the optimization problem.

Model Settings: lower. Lower bound for the estimate of the selected parameter.

Model Settings: upper. Upper bound for the estimate of the selected parameter.

Model Settings: Apply. Apply the *Model Settings* changes in the estimation of the selected model only on the selected series.

Model Settings: Apply to All Series. Apply the *Model Settings* changes in the estimation of the selected model on all the selected series.

General Settings: method. The method to use in maximizing the likelihood.

General Settings: trials. The number of times to try optimizing the likelihood.

General Settings: seed. The random number generator seed. It can be unspecified.

General Settings: Apply. Apply the *General Settings* changes in the estimation of the selected model only on the selected series.

General Settings: Apply to All Series. Apply the *General Settings* changes in the estimation of the selected model on all the series.

General Settings: Apply to All Series & Models. Apply the *General Settings* changes in the estimation of all the models on all the series.

4.1.2 Set Model

yuimaGUI	≡					
# Home						
▲ Data I/O <	Univariate Me Select the data and		ation wish to estimate. Every model will be fitted to every selected series.			
📜 Explorative Data Analysis ≺	Click on buttons 'Se	t Range' and 'A	Advanced Settings' to customize the estimation process. but you can set your own model (tab 'Set model') and use it for estimation and/or simulation purposes.			
≢ Modeling ~			§			
» Univariate	Run estimation	Set model	Estimates			
🕍 Simulation <			Model Class			
			Diffusion process			
Finance <			Model Name			
🛓 Save Session		dX = a(t,	(X, heta)dt+b(t,X, heta)dW			
▲ Load Session	a(t,	$X, \theta)$	b(t,X, heta)			
		_	Save Model			
			Save Model			

In this section you can define your own models to use for estimation and simulation purposes. Diffusion process you set here will be available also for change point analysis (see section 3.1.2). Select the class of the model to define and give a name to your model. Then define the model and click on *Save Model*.

Model Class Select the class of the model to define. Available options are: *Diffusion process*, *Fractional process* and *Compound Poisson*.

Model Name Type a name for your model.

Definition of Model For diffusion and fractional process you can specify the drift and diffusion terms. For compound poisson process you can specify the intensity. Type into the specific boxes the expression for the required terms. You can use standard functions (like *cos, sin, log, exp, ...*). Text strings are interpreted as parameters but x denotes the value of the process and t denotes the value of the index (usually time, but not necessarily).

4.1.3 Estimates

yuimaGUI	≡
★ Home ▲ Data I/O < ● Explorative Data Analysis <	Univariate Model Estimation Select the data and the model you wish to estimate. Every model will be fitted to every selected series. Click on buttoms 'Ser Range' and 'Advanced Settings' to customize the estimation process. Some default models are available but you can set your own model (tab 'Set model') and use it for estimation and/or simulation purposes.
≆ Modeling ~ » Univariate	Run estimation Set model Estimates
Simulation <	FB.Adjusted More Info
Finance <	$dX_t = \mu X_t \; dt + \sigma X_t \; dW_t$ sigma mu
▲ Save Session	Estimate 0.396 0.3 Std. Error 0.008 0.2
▲ Load Session	Base Yearly 🔻
	Search:
	Symb Class Addel Jumps From To AIC BIC
	FB.Adjusted 1 FB.Adjusted Diffusion process Geometric Brownian Motion 2012-05-18 2017-02-15 4432.71642485169 4442.88487769588
	FB.Adjusted 2 FB.Adjusted Diffusion process Chan-Karolyi-Longstaff-Sanders (CKLS) 2012-05-18 2017-02-15 4146.86247160351 4167.1993772919
	Show Fitting Delete All

Here you can find all the information about the estimation you ran (see section 4.1.1). Estimated models are stored in the table you can see in the picture above, which includes also some information criteria (AIC and BIC). Click on a row of the table and the estimates will be shown. Click on the little link *More Info* on the upper-left corner of the tab to show the advanced settings used for estimation. The orange button on the bottom-left corner of the tab provides a very useful tool to visualize the goodness of fit of the model.

Base This input is available only if you are using series indexed by date. It controls the unit of measure of the estimates shown in the table above (yearly, semestral, ..., daily). If you are using numerical indexes then estimates are given in the same unit of measure used by the series the model was estimated on. The conversion is not always possible: user defined models (see section 4.1.2) are not supported while the majority of default models are supported. If the conversion is not possible, then estimates obtained with the chosen **delta** (see section 4.1.1 \rightarrow Advanced Settings \rightarrow Series Settings: delta) will be shown.

More Info It shows the advanced settings used for estimation and displays the estimates without applying any conversion, thus related to the **delta** used for estimation (see section 4.1.1 \rightarrow Advanced Settings \rightarrow Series Settings: delta). Show Fitting This tool is available for: Diffusive, Compound Poisson and COGARCH models.

Diffusive Process. It is shown the plot of the empirical versus the theoretical distribution (standard gaussian) of standardized increments:

$$\Delta W_t = \frac{\Delta X_t - \hat{\mu}(t, X_t) \Delta t}{\hat{\sigma}(t, X_t)}$$

where the notation is the same of the following general diffusive process:

$$dX_t = \mu(t, X_t)dt + \sigma(t, X_t)dW_t$$

It is also given the p-value for the Kolmogorov-Smirnov test that checks if the empirical and theoretical distribution are the same.

Compound Poisson. It is shown the plot of the empirical versus the estimated cumulative intensity of the process. It is also shown the plot of the empirical versus the estimated distribution of jumps (increments of the process) and the p-value for the Kolmogorov-Smirnov test that checks if the two distribution are the same.

COGARCH. It is shown the plot of the empirical versus the estimated volatility process.

5 yuimaGUI: Simulation

At the moment, only univariate simulation is available.

5.1 Univariate

In this section you can simulate univariate models, both previously estimated (*Estimated models*, see section 5.1.1) and non-estimated (*Non-estimated models*, see section 4.1.2). Trajectories, distributions and quantiles will be computed and readily available (*Simulations*, see section 4.1.3).

5.1.1 Estimated models

yuimaGUI	≡
 ✤ Home ▲ Data I/O < ▶ Explorative Data Analysis < 	Univariate Simulation Select the estimated models you wish to simulate. If you want to simulate a model that has not been estimated you can use the 'Non-estimated models'. Citck on buttoms 'Set Simulation' and Advanced Settings' to customize the simulation process.
₩ Modeling <	• • • • • • • • • • • • • • • • • • •
🕍 Simulation 🗸 🗸	Estimated models Non-estimated models Simulations
» Univariate	Available models
	Search:
Finance <	Symb Class Model Jumps From To AIC BIC
	FB.Adjusted 1 FB.Adjusted Diffusion process Geometric Brownian Motion 2012-05-18 2016-03-22 3434.47981451057 3444.22407071324
▲ Save Session ▲ Load Session	FB.Adjusted 2 FB.Adjusted Diffusion process Chan-KarolyI-Longstalf-Sanders (CKLS) 2012-05-18 2016-03-22 3287.8407985841 3307.32931098946
	Select Select All
	Selected Models Search: Symb Please select models from the table above No data available in table Set Simulation Advanced Settings
	Delete All Start Simulation

Table Available Models contains all the models you estimated previously in section Modeling \rightarrow Univariate (see section 4.1.3). Select from this table the model(s) you want to simulate. They will be moved to table Selected Models. You can set the simulation clicking on button Set Simulation. More settings are provided through button Advanced Settings. Click on Start Simulation and every selected model will be simulated.

Results will be shown in section *Simulations* (see section 5.1.3).

Set Simulation Here you can set the:

Simulation Interval Range for the simulation.

Initial Value Initial value for the process to simulate. By default, it is the last value of the series the model was estimated on.

Number of Simulations Number of trajectories to simulate.

Number of Steps Number of steps per trajectory. By default, it is computed using the same observation frequency of the series the model was estimated on.

Advanced Settings Here some advanced options are provided:

RNG seed The Random Number Generator seed. By default, it is not specified.

Save trajectory Save the whole trajectory or only its final value? Default to TRUE: save the whole trajectory. It is recommended to set it to FALSE when running a high **number of simulations** and/or when using a high **number of steps** per trajectory; otherwise the computation may be extremely slow.

5.1.2 Non-estimated models

yuimaGUI	=						
 ♣ Home ▲ Data I/O < ♠ Explorative Data Analysis < ₩ Modeling < 	Univariate Simulation Select the estimated models you wish to simulate. If you want to simulat a model that has not been estimated you can use tab 'Non-estimated models'. Click on buttons 'Set Simulation' and 'Advanced Settings' to customize the simulation process.						
Simulation	Estimated models	Non-estimated models	Simulations	Ş			
» Univariate		Hon estimated models		V I. V III			
			$dX_t =$	$\mu X_t \ dt + \sigma X_t \ dW_t$			
Finance <		Class	Model Name Geometric Brownian Motion 👻	Class	- Model	arch: mu sigma	
Lord Sension		Simulation II MY_Id rameter iggma • Save	D Parameter value 1	WY_Id Diffusion process	Geometric Brownian Motion	0 1 Delete All	
	Selected Models						
				Search:			
	Symb	 Please select mode 	els from the table above	¢			
			No data available in table		Set Simul		
		Delete		Delete All	Start Simu	lation	

Here you can simulate model(s) specifying the values for its parameters. Select the class of the model to simulate (*Diffusion process, Fractional process, Compound Poisson*), the name of the model and give an ID to your simulation. Then select a parameter of the chosen model and set a value for it. Click on the *Save* button and the model will appear in the table beside. Select and set a value for all the parameters of the model. Then you can select the model and it will appear in table *Selected Models*. You can set the simulation clicking on button *Set Simulation*. More settings are provided through button *Advanced Settings*. Click on *Start Simulation* and every selected model will be simulated.

Results will be shown in section *Simulations* (see section 5.1.3).

Set Simulation Here you can set the:

Simulation Interval Range for the simulation.

Initial Value Initial value for the process to simulate.

Number of Simulations Number of trajectories to simulate.

Number of Steps Number of steps per trajectory.

Advanced Settings Here some advanced options are provided:

RNG seed The Random Number Generator seed. By default, it is not specified.

Save trajectory Save the whole trajectory or only its final value? Default to TRUE: save the whole trajectory. It is recommended to set it to FALSE when running a high **number of simulations** and/or when using a high **number of steps** per trajectory; otherwise the computation may be extremely slow.

5.1.3 Simulations

yuimaGUI							
Home							
Data I/O <	Univariate Simulation						
Explorative Data Analysis <	Select the estimated models you wish to simulate. If you want to simulate a model that has not been estimated you can use tab 'Non-estimated models'. Click on buttons 'Set Simulation' and 'Advanced Settings' to customize the simulation process.						
E Modeling <	§						
Simulation ~	Estimated models Non-estimated models Simulations						
 Univariate 	Search:						
inance <	Symb Class Model Jumps N N Simulated Estimated Estimated Estimated to from to						
	MY_id 1 MY_id Diffusion process Geometric Brownian Motion 1000 1000 0 1						
	FB.Adjusted 1 FB.Adjusted 2 Diffusion process Geometric Brownian Motion 1000 250 2016-03-22 2017-03-22 2012-05-18 2016-03-22						
📩 Save Session	FB.Adjusted 2 FB.Adjusted Diffusion process Chan-Karolyi-Longstaff-Sanders (CKLS) 1000 250 2016-03-22 2017-03-22 2012-05-18 2016-03-22						
▲ Load Session							

Here you can find all the information about the simulations you ran (see section 5.1.1 and 5.1.2). Simulations are stored in the table you can see in the picture above. Click on the orange button on the bottom-left corner to show simulations.

Show Simulations Here trajectories, distribution and quantiles are shown in an very userfriendly way. The first plot (see picture below) shows the simulated trajectories while the second one shows the distribution of the final value of the trajectories. You can click on any point in the first plot and the second one will show the distribution of the trajectories at that point. You can adjust the number of bins of the histogram and compute quantiles with the sliders beside. You can also save and download in a text file both the trajectories and the distributions shown.

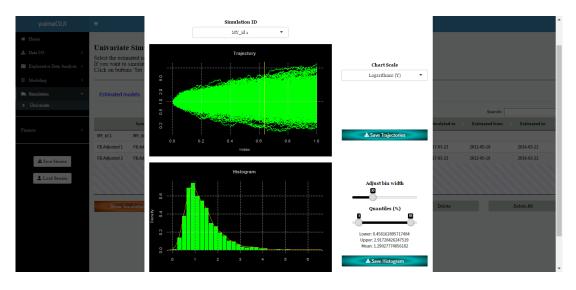


Chart Scale Scale for plotting trajectories: *Linear*, Logarithmic(Y), Logarithmic(X), Logarithmic(XY)

Save Trajectories Download a text file with all the simulated trajectories

Adjust bin width Change the number of bins used by the histogram

Quantiles (%) Select the lower and the upper percentage quantile. Below it is shown the values of the quantiles and the mean of the distribution between the two quantiles. This tool is very useful to easily compute risk measures such as Value at Risk and Expected Shortfall.

Save Histogram Download a text file with all the information about the histogram

6 yuimaGUI: Finance

Here you can find useful tools specifically designated for Finance.

6.1 P&L distribution

In this section you can simulate the Profit and Loss distribution of a portfolio composed by european call/put options and the underlying asset; trading costs are included and customizable. The evolution of asset prices is simulated by models you estimated in section $Modeling \rightarrow Univariate$ (see section 4.1). After running the simulation (*Start simulations*, see section 6.1.1), results will be shown in section Profit@Loss (see section 6.1.2). Here you can choose the number of options and assets to include in your portfolio and the Profit@Loss distribution will be plotted. Quantiles and risk measure are provided in a very user-friendly way.

6.1.1 Start simulations

yuimaGUI	=							
♣ Home ▲ Data I/O ✓ Explorative Data Analysis ✓ Modeling	Here you can manage risk of a portfolio composed by options and the underlying asset. The evolution of the underlying asset is simulated by models you estimated in section Modeling. After performing the simulation click on button "Show P&L" in the Profit&Loss" and customize your portfolio. The Profit&Loss distribution of your portfolio will be displayed (it includes transaction costs that you can customize).							
Simulation <	Start simulations Profit&Loss							
Finance ~	Click on the model by which to simulate the evolution of the underlying asset Search:							
» P&L distribution	Symb Class Model Jumps From To AIC BIC							
	FB.Adjusted 1 FB.Adjusted Diffusion process Chan-Karolyi-Longstaff-Sanders (CKLS) 2012-05-18 2016-03-22 3287.84079610167 3307.32930850702							
🛓 Save Session	FB.Adjusted 2 FB.Adjusted Diffusion process Geometric Brownian Motion 2012-05-18 2016-03-22 3434.47981451057 3444.22407071324							
▲ Load Session								
	Option Type: Strike Price: Maturity: Option Market Price:							
	Call • 112,25 2017.03.23 50							
	Asset Market Price: Number of Options per Lot:							
	112,25 1							
	Number of Simulations 1000 Start Computation							

The table contains models you estimated previously in section $Modeling \rightarrow Univariate$ (see section 4.1.3). Select the model to simulate the evolution of the asset. Trajectories are simulated from the end of the series the model was estimated on to the maturity of the option. Then, specify the parameters of the option, the last price of the asset, the number of trajectories to simulate and click on *Start Computation*.

Results will be shown in section Profit & Loss (see section 6.1.2).

Option Type, Strike Price, Maturity Type (*Call* or *Put*), strike price and maturity of the European option

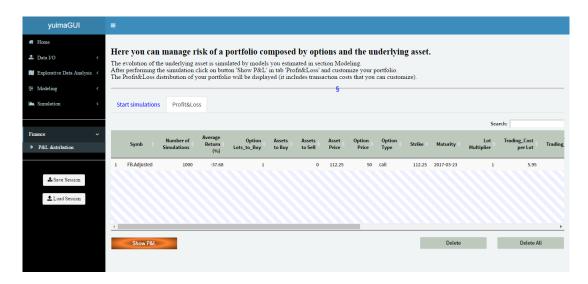
Option Market Price The market price of the option. You should type here the Ask price because you are simulating to buy the option (no short selling on options are allowed).

Asset Market Price The market price of the asset. By default it is the last price of the series the model was estimated on.

Number of Options per Lot Options are not usually traded individually but in Lots. Type here how many options a Lot includes.

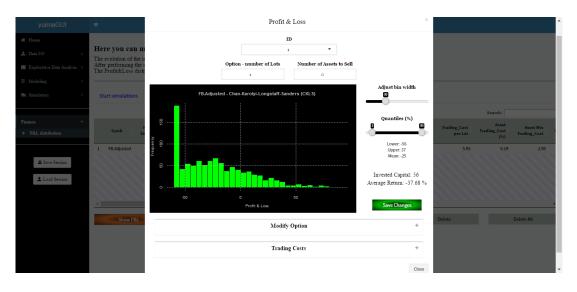
Number of Simulations The number of trajectories to simulate.

6.1.2 Profit&Loss



Here you can find all the information about your simulated portfolios (see section 6.1.1). Portfolios are stored in the table you can see in the picture above. Click on the orange button on the bottom-left corner to show Profit&Loss distributions, adjust the portfolios, manage risk and customize trading costs.

Show P&L The histogram (see picture below) shows the Profit&Loss distribution of the portfolio composed by the number of options and assets you type into inputs **Option: number of Lots** and **Number of Assets to Buy/Sell**. You can adjust the bin width and compute quantiles and risk measures using the slides beside. You can also modify on the fly the parameters of the option and trading costs expanding boxes **Modify Option** and **Trading Costs**. The Profit&Loss distribution will be readily updated. You can save the portfolio clicking on button *Save Changes*.



Option: Number of Lots. Number of option Lots to buy.

Number of Assets to Buy/Sell. If you are buying a Call option, this input represents the number of assets to sell to hedge the portfolio. If you are buying a Put option, this input represents the number of assets to buy to hedge the portfolio.

Adjust bin width Change the number of bins used by the histogram

Quantiles (%) Select the lower and the upper percentage quantile. Below it is shown the values of the quantiles and the mean of the distribution between the two quantiles. This tool is very useful to easily compute risk measures such as Value at Risk and Expected Shortfall.

Save Changes Save the portfolio into the table of this section (*Profit@Loss*, section 6.1.2)

Modify Option Expand this box to modify the type, strike price and market price of the option. The Profit&Loss distribution will be readily updated.

Trading Costs Expand this box to modify the trading costs: percentage commission on buying/selling assets, minimum commission on buying/selling assets, yearly interest rate on short selling (asset), fix commission on buying one Lot of options. The Profit&Loss distribution will be readily updated.