Risk valuation using ProActive workflows

Basics

Value At Risk (VaR)

One-day 95% VaR of $1 million ⇔ 5% probability that the portfolio worst-case loss will exceed $1 million over a one-day period

Monte Carlo (MC) simulations

$$\widetilde{X_n} = \frac{1}{n}\sum_{i=1}^{n} X_i \xrightarrow{n\to+\infty} \mathbb{E}\,X$$

The Law of Large Numbers states for large *n*, the empirical average is very close to the expected value

Estimating the VaR using MC simulations

$$\mathbb{P}(L_t > x) = \frac{1}{nb\_VaR}\sum_{i=1}^{nb\_VaR} \mathbb{1}_{L_t^i > x} = 1 - \alpha$$

x the portfolio VaR

L_t the porfolio loss at *t*

α the VaR probability

nb_VaR the number of MC simulations

Monte_Carlo_VaR_portfolio.xml

Estimates the Monte Carlo Value at Risk (MC VaR) of a portfolio. We use the geometric Brownian motion (GBM) method to simulate stock price paths, but more advanced assets can be integrated thanks to the Quantlib C++ lib.

Simulation

nbMC	10000	The number of Monte Carlo simulations.
nbTimeSteps	255	The number of time steps to the horizon.
horizon	1	The horizon in year fraction.
assets_params_file_path_from_dataspace	assets.txt	The relative path from the dataspace of the asset params file following the csv format.
assets_correlations_file_path_from_dataspace	assets_correlations.txt	The relative path from the dataspace of the asset correlations file.

VaR

confidenceRate	0.99	The confidence level rate.
nbBins	50	The number of bins for the portfolio estimation distributions.

Parallelization

nbTasks	5	The number of ProActive replicated tasks.

Display

width_chart	1000	The width of the chart in pixels.
height_chart	500	The height of the chart in pixels.
chart_message_to_append		A message to append to the generated chart title.

```
20.16,0.2312,0.2116,0.3
40,0.115,0.254,0.3
110,0.6,0.4,0.4
```

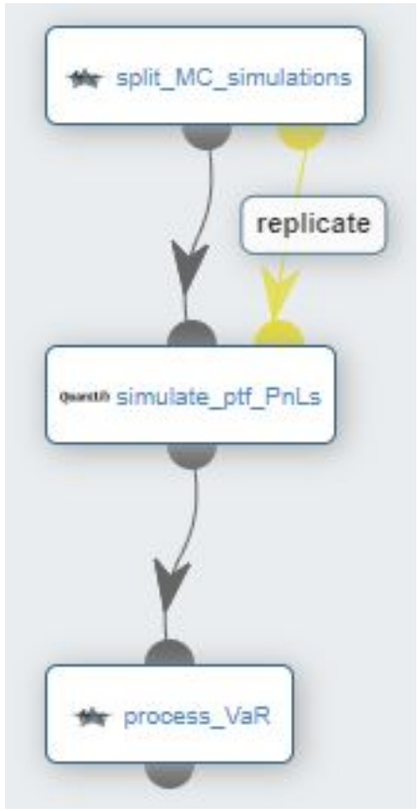
```
1 0 0
0 1 0
0 0 1
```

Monte_Carlo_VaR_portfolio.xml

Estimate the number of MC simulations per replicated task. The tasks number does not necessary divide the total number of simulations

Using Quanlib, each replicated task proceses a subset of the MC simulations and deduces the PnL (profit and loss) of each simulated path (value at horizon of a simulation - value at start). On the task side, PnLs are saved into a dedicated file

This task gathers all the PnLs into a single array, sorts them, and retrieves the VaR at the VaR_index corresponding to (1 - confidenceRate) * nbMC. Finally, it generates the corresponding frequencies bar chart and exposes it (view/download)



Monte_Carlo_VaR_portfolio.xml

ACTIVEEON
SCALE BEYOND LIMITS

Details

Tasks | Visualization | Users Sessions | Statistics | Usage

Tag | Filter | Auto-refresh

Id	Status	Name	Tag	Duration	Nodes	Executions	N
0	Finished	Split_MC_simulations		1s 668ms	1	0 / 2	
1	Finished	simulate_ptf_PnLs		4s 800ms	1	0 / 2	
2	Finished	process_VaR		3s 66ms	1	0 / 2	
3	Finished	simulate_ptf_PnLs*1	REPLICATE-Split_M…	4s 562ms	1	0 / 2	
4	Finished	simulate_ptf_PnLs*2	REPLICATE-Split_M…	4s 246ms	1	0 / 2	
5	Finished	simulate_ptf_PnLs*3	REPLICATE-Split_M…	4s 720ms	1	0 / 2	
6	Finished	simulate_ptf_PnLs*4	REPLICATE-Split_M…	3s 6ms	1	0 / 2	

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Job Info | Task Info | Output | Server Logs | Preview

Remote Visualization

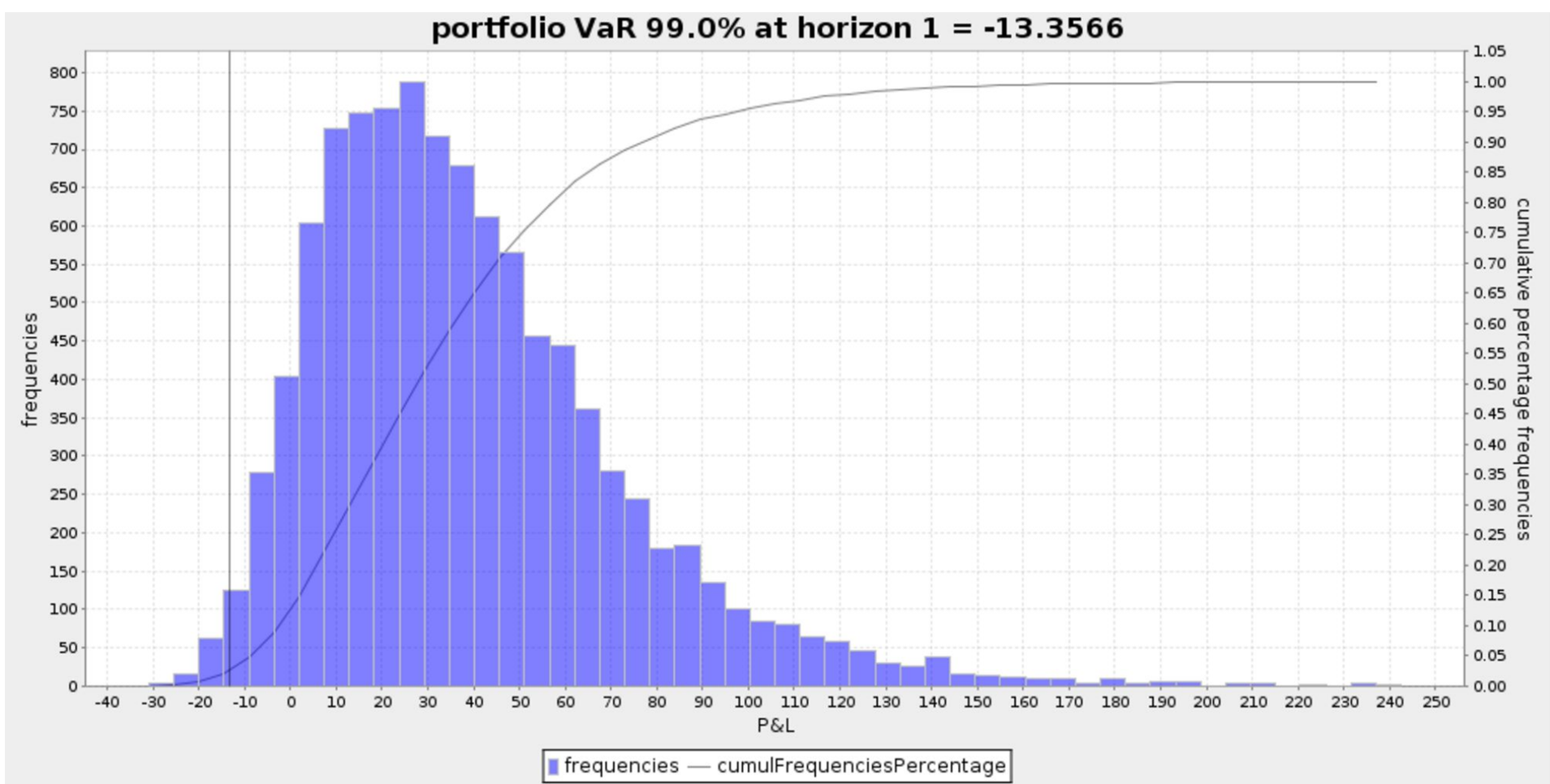
Remote visualization is disabled. Please toggle streaming in output view for a job in order to enable the remote visualization.

Task Result

Task process_VaR (id: 2) from job MCVaR (id: 1)

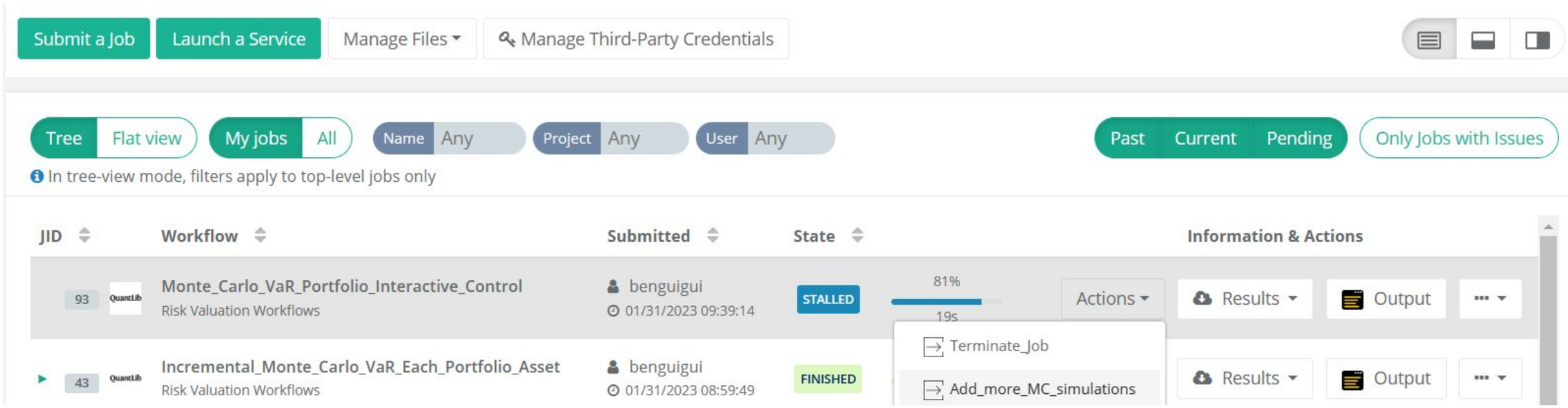
Open in browser

Save as file



Monte_Carlo_VaR_portfolio_Interactive_Control.xml

The interactive version of the Monte_Carlo_VaR_portfolio workflow allows the user to relaunch it to add more MC simulations for a more accurate VaR. The estimated VaR can be “refined incrementally.”



The user will be asked to specify the new MC simulation number to be aggregated to the VaR estimation.

incremental_Monte_Carlo_VaR_each_portfolio_asset.xml

Estimates the incremental VaR (iVaR) for each asset of the portfolio. iVaR quantifies the risk a position (or sub-portfolio) is adding to a portfolio. For instance, the iVaR related to an asset Y, is the difference between the portfolio VaR with and without Y.

incremental_Monte_Carlo_VaR_each_portfolio_asset.xml

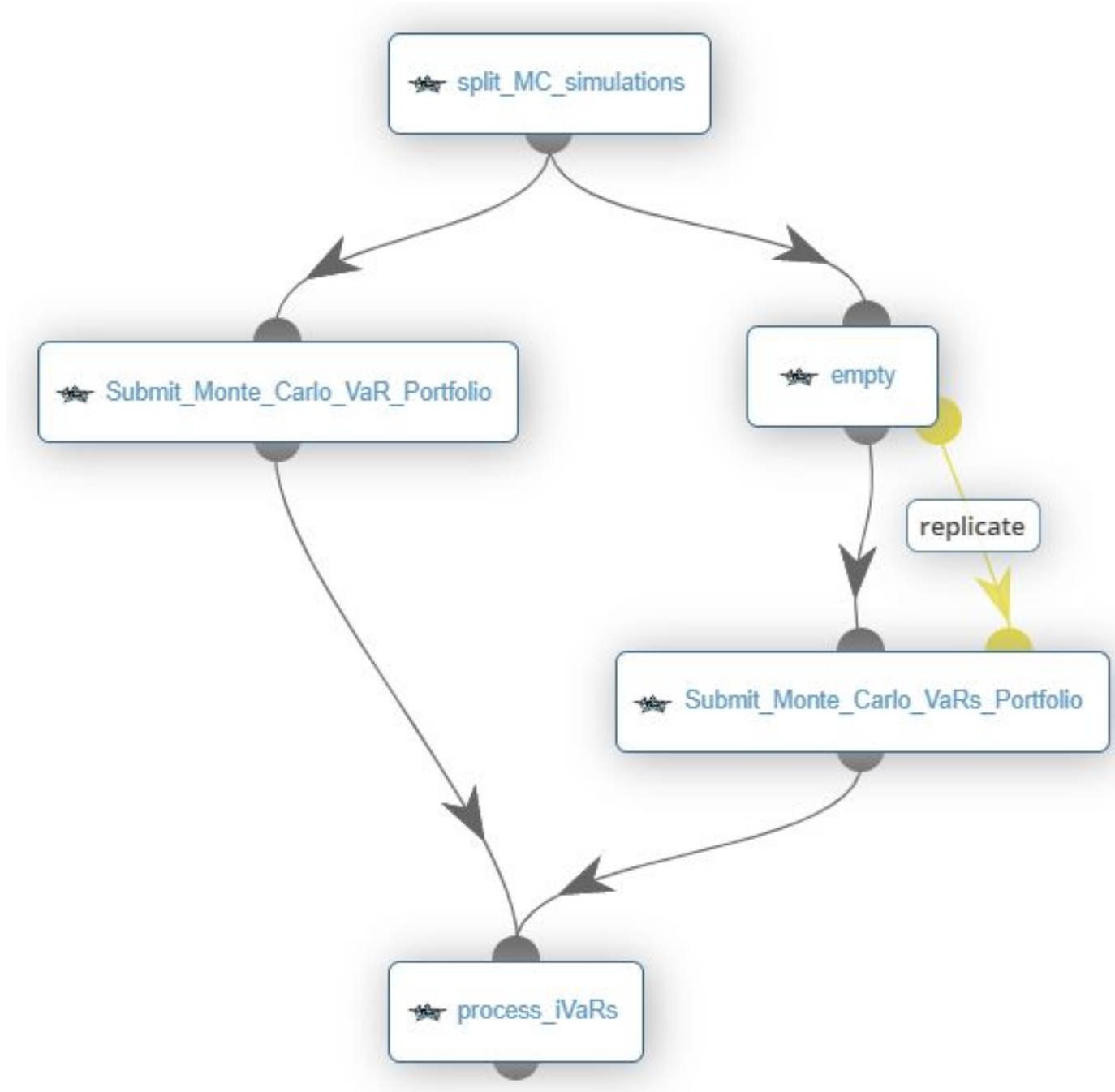
Estimate the number of MC simulations per replicated task for each VaR (right branch and left branch). The tasks number must divide the total number of simulations

(left branch) A task submitting the Monte_Carlo_VaR_portfolio wkw by considering all assets specified by the user

(right branch) **1st level of replicated tasks:** a replicated task per asset (Y)

(right branch) Each replicated task instanciates an asset params files, by excluding an asset from the portfolio, ie setting to 0 the asset weight. Then each task submit the Monte_Carlo_VaR_portfolio wkw (**2nd inner level of replicated tasks**) with this instanciated asset params file as input.

Gather the portfolio VaR over all assets (left branch) and all partial VaRs (right branch). Compute and println the iVaR related to each asset (portfolio VaR estimated by the left branch - one portfolio VaR without the asset Y estimated by the right branch)



incremental_Monte_Carlo_VaR_each_portfolio_asset.xml

ACTIVEEON
SCALE BEYOND LIMITS

Details

Tasks | Visualization | Users Sessions | Statistics | Usage

Tag | Filter | Auto-refresh | Filters: Submitted | Pending | Current | Past | Error

Id	Status	Name	Tag	Duration
0	Finished	split_MC_simulations		900ms
1	Finished	Submit_Monte_Carlo_VaR_Portfolio		17s 923ms
2	Finished	emtpy		860ms
3	Finished	Submit_Monte_Carlo_VaRs_Portfolio		23s 575ms
4	Finished	process_iVaRs		1s 404ms
5	Finished	Submit_Monte_Carlo_VaRs_Portfolio*1	REPLICATE-emtpy-1	20s 101ms
6	Finished	Submit_Monte_Carlo_VaRs_Portfolio*2	REPLICATE-emtpy-2	24s 704ms

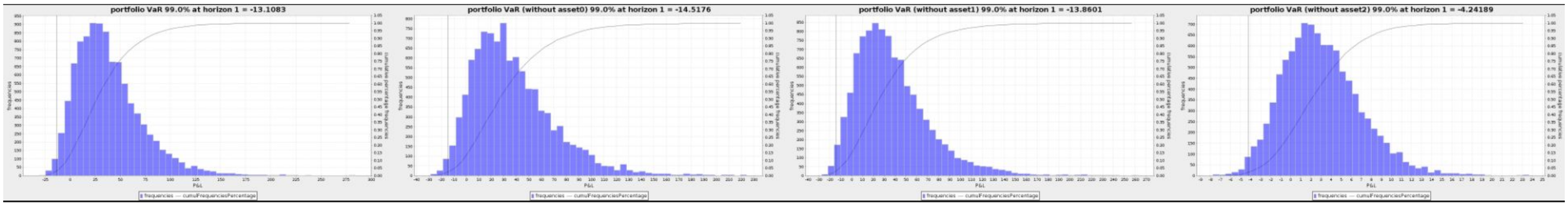
Job Info | Job Variables | Job Results | Task Info | Task Preview | Output | Server Logs

Result List:

process_iVaRs | Open in browser | Save as file

Result Map

No items to show.



stress_testing_Monte_Carlo_value_portfolio.xml

Estimates the portfolio PnL (Profit and Loss) over stressed volatilities and risk free rates.

Simulation

nb_MC_per_ptf_value	1000	The number of Monte Carlo simulations per portfolio estimation.
nb_time_steps	255	The number of time steps to the horizon.
stress_horizon	1	The stress horizon in year fraction.
assets_params_file_path_from_dataspace	assets.txt	The relative path from the dataspace of the asset params file following the csv format.
assets_correlations_file_path_from_dataspace	assets_correlations.txt	The relative path from the dataspace of the asset correlations file.
stressed_risk_free_rate_min_max_in_percent_and_steps	-10%,+10%,8	The min, max, step of the stressed risk free rate range.
stressed_volatility_min_max_in_percent_and_steps	-5%,+5%,8	The min, max, step of the stressed volatility rate range.

Parallelization

nb_replicated_tasks	4	The number of ProActive replicated tasks which must divide the risk free rate step number x the volatility step number. These latter are deduced from stressed_risk_free_rate_min_max_in_percent_and_steps and stressed_volatility_min_max_in_percent_and_steps respectively.

Others

DOCKER_ENABLED	(•) TRUE ( ) FALSE	If true, the workflow tasks will be executed inside a docker container

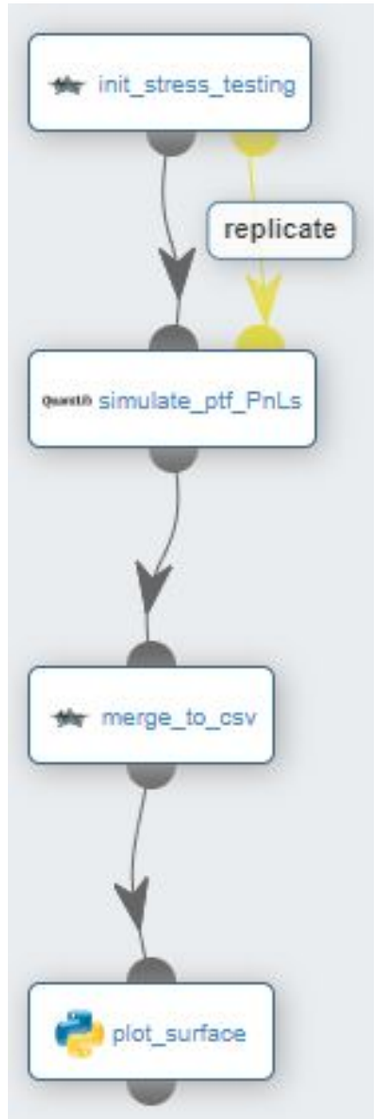
stress_testing_Monte_Carlo_value_portfolio.xml

Estimate the number of MC simulations per replicated task. The tasks number must divide the total number of simulations

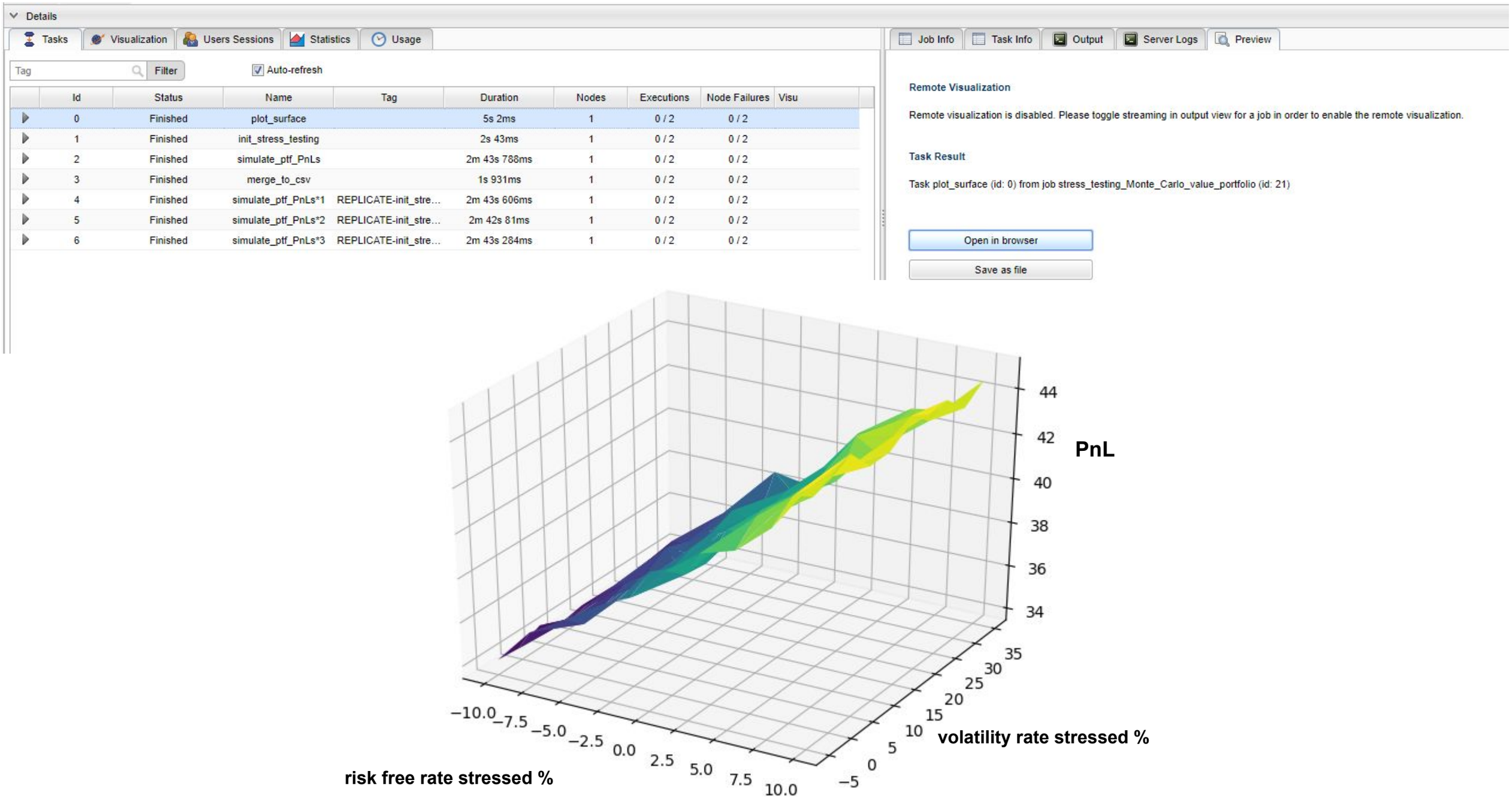
Using Quanlib, each replicated task processes a subset of the MC simulations and deduces the PnL (profit and loss) of each simulated path. An expected PnL is estimated per risk free rate and volatility stressed percentage. On the task side, PnLs are saved into a dedicated file

Merge all stressed PnLs into a single csv file

Plot a 3D representation of the stressed PnLs



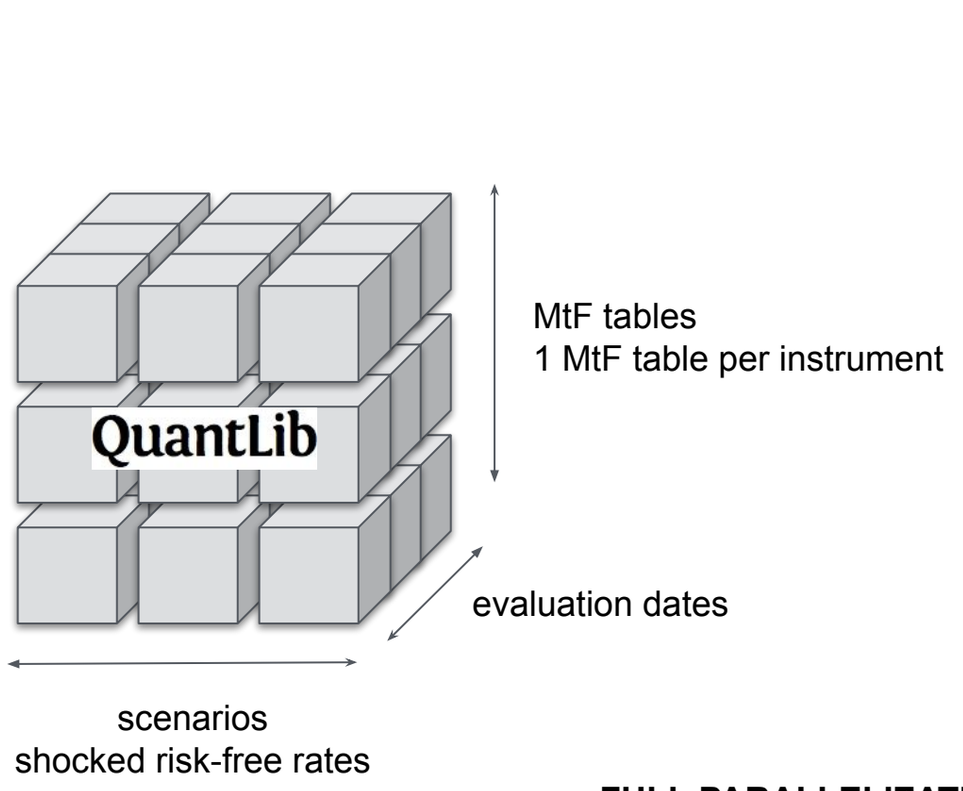
stress_testing_Monte_Carlo_value_portfolio.xml

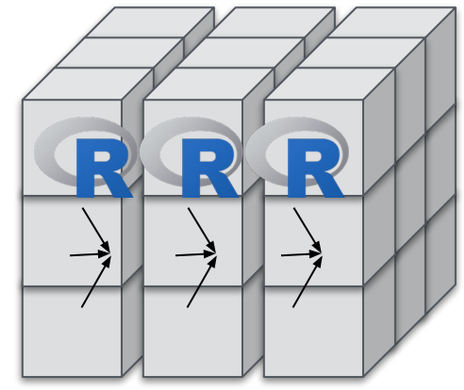


Identically as the Monte_Carlo_VaR_portfolio workflow, an interactive version is available to add more MC simulations to each stressed portfolio estimation (see stress_testing_Monte_Carlo_value_portfolio_Interactive_Control).

Mark_to_Future_cube_stats.xml

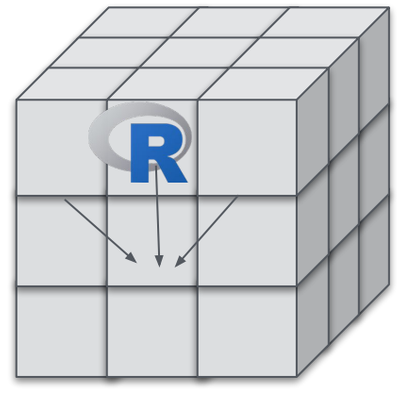
Estimates a Mark-to-Future (MtF) cube of a bond portfolio. Each cell of the cube integrates the valuation of a bond at a specific time given a specific scenario. This can be easily extended thanks to the high maintenability of the implementation (C++ Quantlib for the pricing engine, inputs split in Java/Groovy, R for the cube/cubelet stats,..).





REDUCTION BY INSTRUMENTS

FULL PARALLELIZATION OF CUBELETS ESTIMATIONS



REDUCTION BY SCENARIOS

Mark_to_Future_cube_stats.xml

Simulation

evaluation_date_start	01/12/2018	The start date of the evalution.
evaluation_date_end	20/12/2021	The end date of the evalution.
evaluation_frequency	biweekly	The time discretization.
shocked_yield_start	0	The start of the shocked yield range.
shocked_yield_end	0.1	The end of the shocked yield range.
shocked_yield_delta	0.005	The yield step of the shocked yield range.
bonds_params_file_path_from_dataspace	bonds.txt	The relative path from the dataspace of the bond params file following the tsv format.

Parallelization

nb_replicated_tasks	2	The number of ProActive replicated tasks, each having in charge a cubelet, i.e. a subset of the senarios.
nb_replicated_tasks_per_cubelet	2	The number of ProActive replicated tasks, each having in charge a cubelet, i.e. a subset of the instruments.

Hardware Resources

node_source_compute_memory_intensive_exclusive	○ TRUE ◉ FALSE	Exclusive usage or not of the targeted node sources.
node_source_compute_intensive		Name of the targeted node source dedicated to compute intensive tasks.
node_source_memory_intensive		Name of the targeted node source dedicated to memory intensive tasks.

Others

data_dir_path	/tmp	The path of the output files.

Mark_to_Future_cube_stats.xml

Split the scenarios and bonds over the replicated tasks

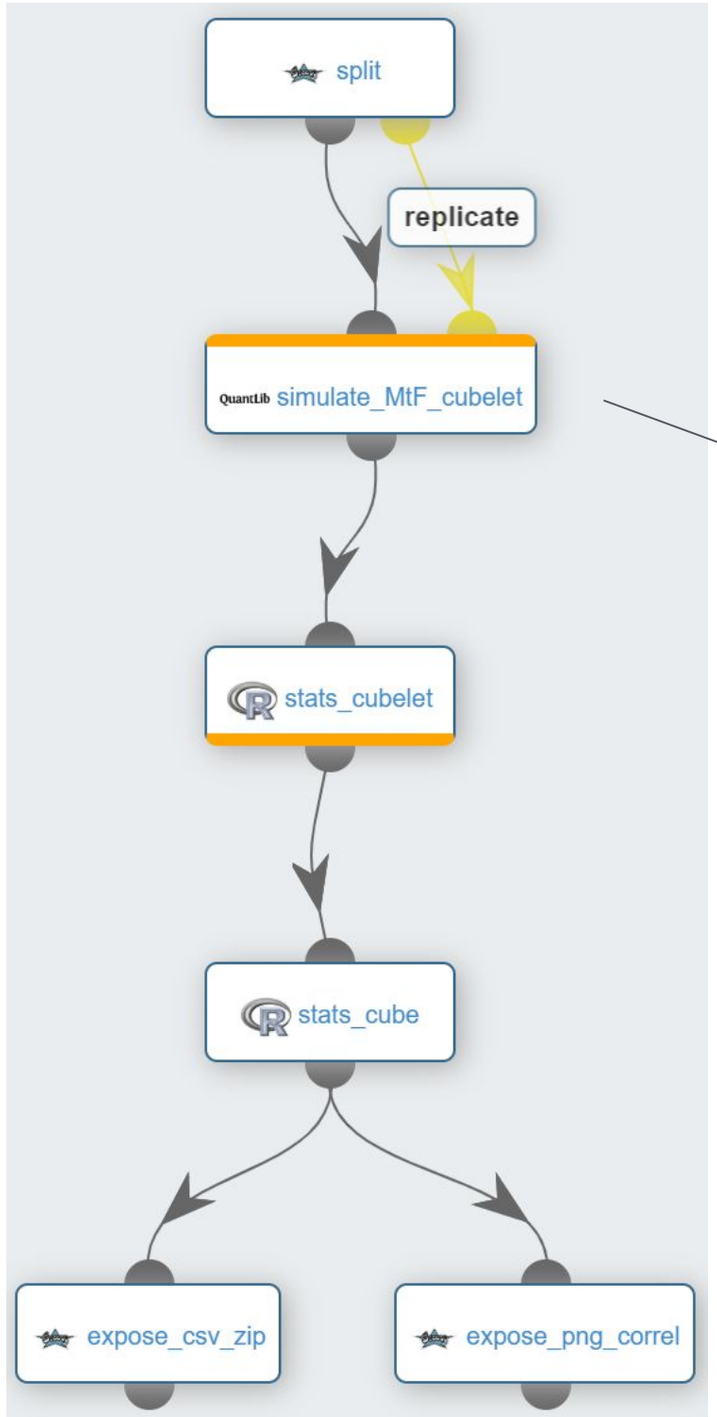
1st level of replicated tasks: a replicated task per subset of scenarios

Each replicated task pull from the catalog and submit the cubelet simulation workflow

Compute the portfolio clean prices per scenario and evaluation date (cubelets)

Merge the portfolio clean prices into a single csv file (cube). Compute portfolio prices time series for each scenario and create a csv file. Compute correlations over scenarios and create a csv file + heat map png file

Allow user to visualize/download the png/csv zip files

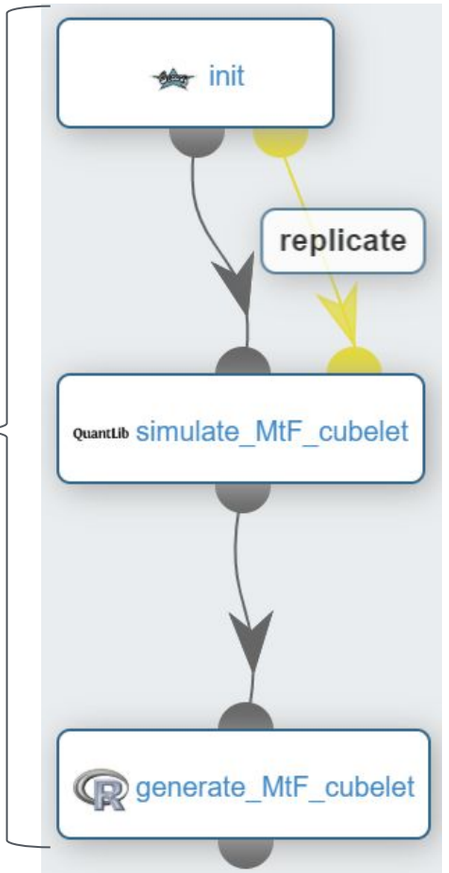


Init parameters

2nd level of replicated tasks: a replicated task per subset of bonds

Using Quanlib, each replicated task estimates a subset of the portfolio clean prices (cubelet)

Merge cubelets (bonds -> portfolio) and create a csv file



Mark_to_Future_cube_stats.xml

Details

Tasks | Visualization | Users Sessions | Statistics | Usage

Tag | Filter | Auto-refresh

Id	Status	Name	Tag	Duration	Nodes	Executions
0	Finished	split		2s 395ms	1	0 / 2
1	Finished	simulate_MtF_cubelet		35s 107ms	1	1 / 2
2	Finished	stats_cubelet		1s 304ms	1	0 / 2
3	Finished	stats_cube		1s 842ms	1	0 / 2
4	Finished	expose_csv_zip		2s 229ms	1	0 / 2
5	Finished	expose_png_correl		1s 936ms	1	0 / 2
6	Finished	simulate_MtF_cubele…	REPLICATE-split-1	44s 471ms	1	1 / 2
7	Finished	stats_cubelet*1	REPLICATE-split-1	1s 83ms	1	0 / 2

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Job Info | Task Info | Output | Server Logs | Preview

Remote Visualization

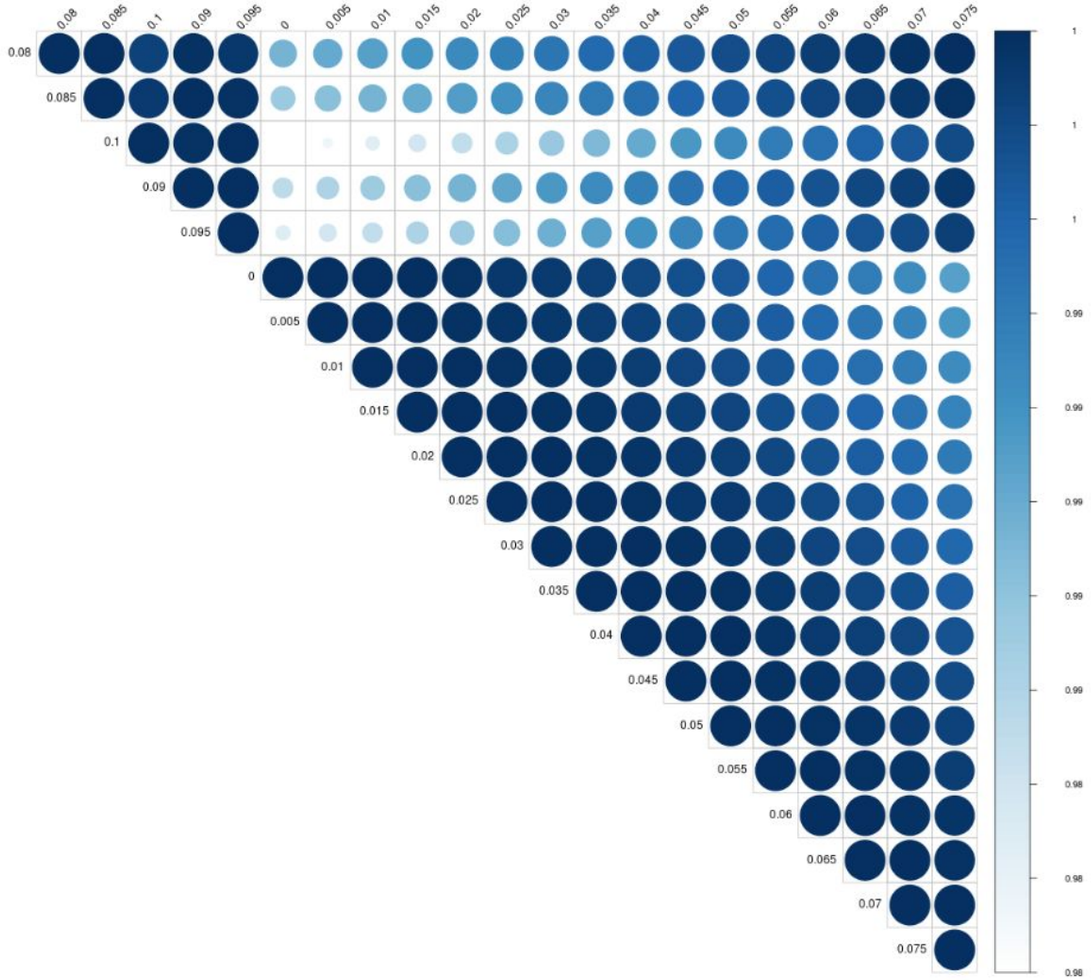
Remote visualization is disabled. Please toggle streaming in output view for a job in order to enable the remote visualization.

Task Result

Task expose_png_correl (id: 5) from job Mark_to_Future_cube_stats (id: 36)

Open in browser

Save as file



archive (1).zip - ZIP archive, la taille

Nom

..

MtF_cube_stats.csv

ptf_values_time_series.csv

ptf_values_time_series_corr.csv