Risk valuation using ProActive workflows

Activeeon

SCALE BEYOND LIMITS

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

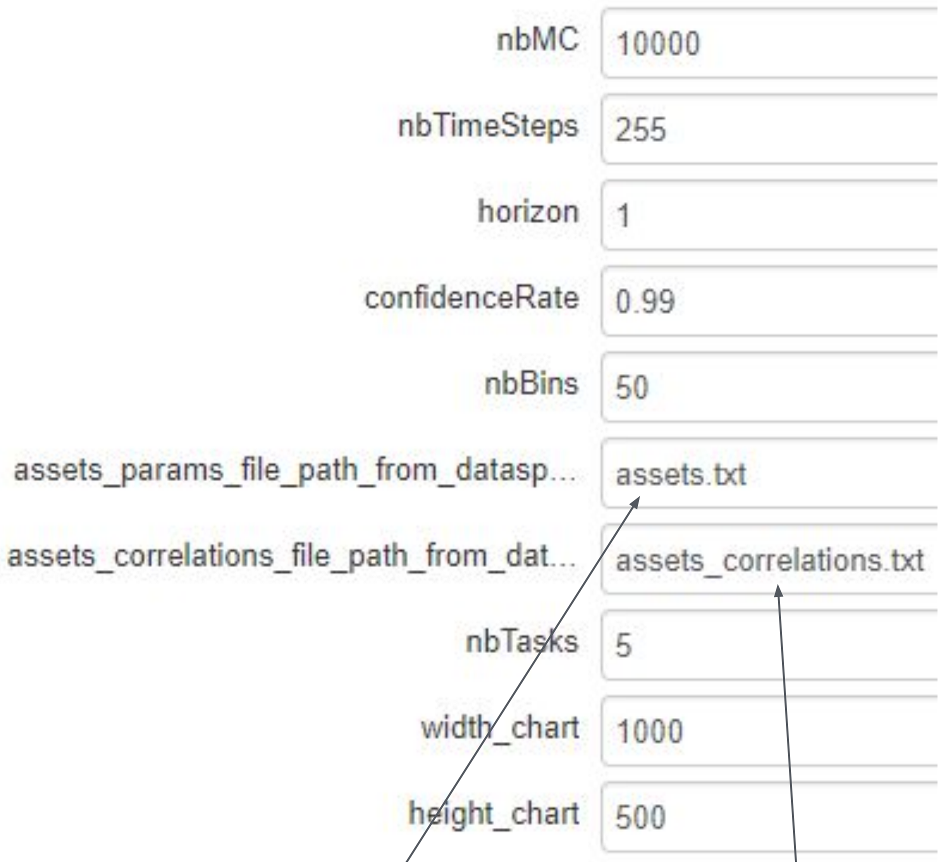
L_t the porfolio loss at *t*

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.



nbMC	10000	number of portfolio simulations. The number of tasks does not necessary divide the total number of simulations
nbTimeSteps	255	number of time steps of the portfolio simulations paths, up to the horizon
horizon	1	horizon. Here time steps are set to 1/255
confidenceRate	0.99	VaR confidence rate. Here 99%
nbBins	50	number of bins to plot the frequencies bar chart
assets_params_file_path_from_datasp...	assets.txt	file to describe assets params, a line per asset: start price, drift rate (yearly return), volatility rate (yearly return), weight
assets_correlations_file_path_from_dat...	assets_correlations.txt	correlations matrix of the assets
nbTasks	5	number of replicated tasks to parallelize the MC simulations
width_chart	1000	width of the generated chart
height_chart	500	height of the generated chart

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

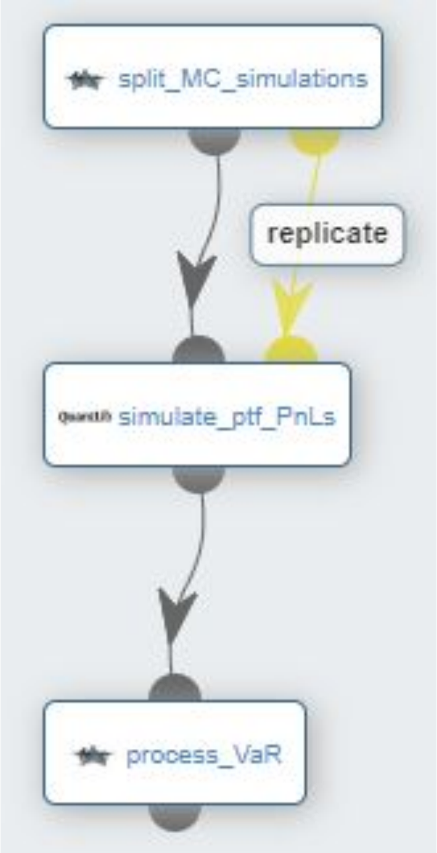
```
1 0 0
0 1 0
0 0 1
```

Monte_Carlo_VaR_portfolio.xml

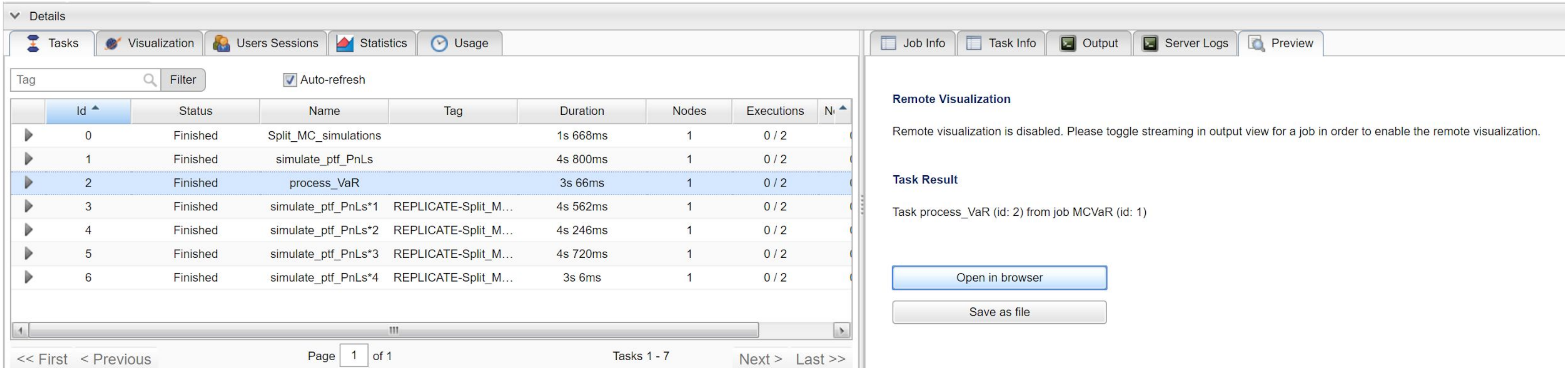
Estimate the number of MC simulations per replicated task. The tasks number does not necessary divide the total number of simulations

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



Details

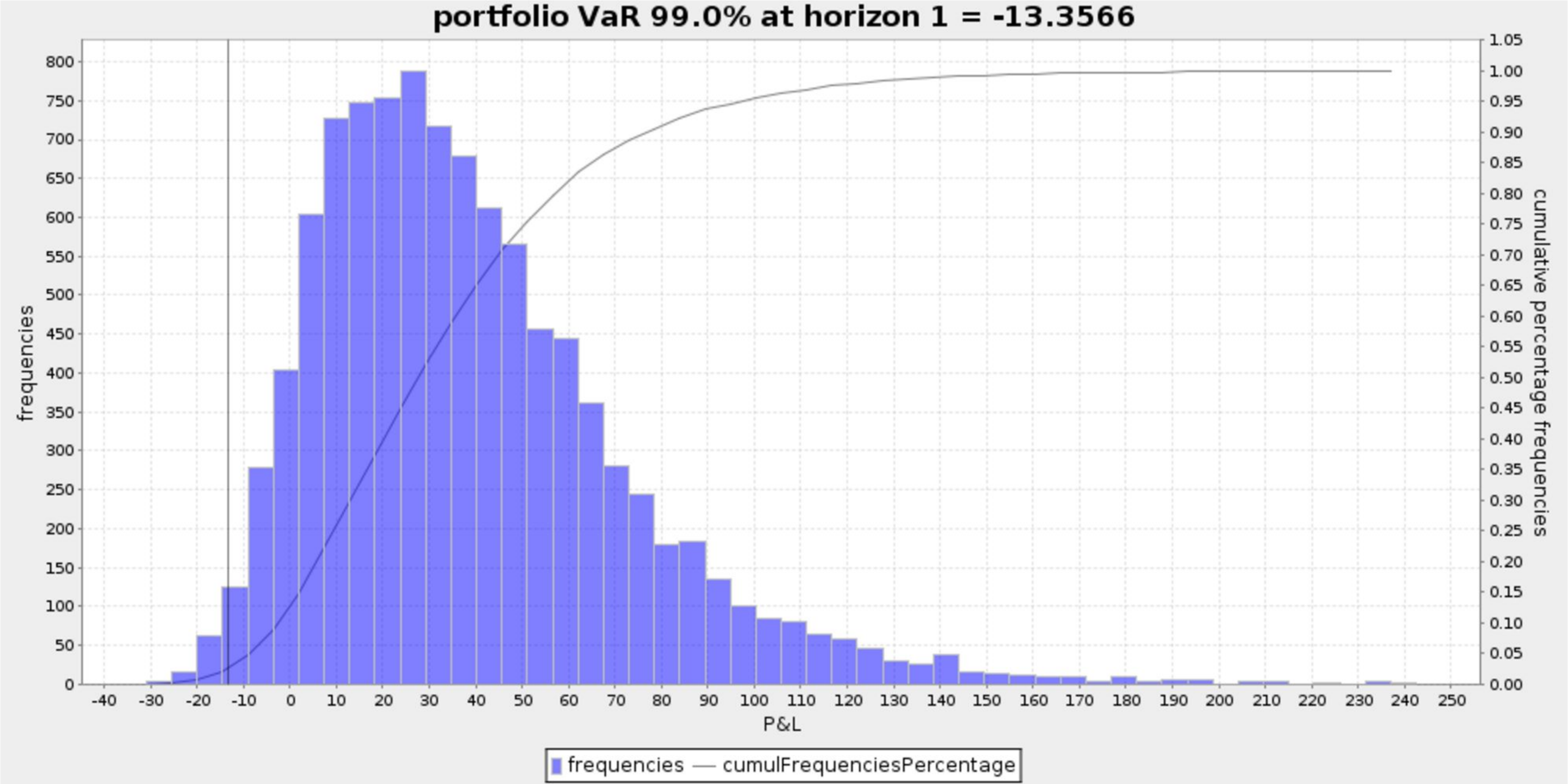
Id	Status	Name	Tag	Duration	Nodes	Executions	N
0	Finished	Split_MC_simulations		1s 668ms	1	0 / 2	
1	Finished	simulate_ptf_PnLs		4s 800ms	1	0 / 2	
2	Finished	process_VaR		3s 66ms	1	0 / 2	
3	Finished	simulate_ptf_PnLs*1	REPLICATE-Split_M...	4s 562ms	1	0 / 2	
4	Finished	simulate_ptf_PnLs*2	REPLICATE-Split_M...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

Remote Visualization

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

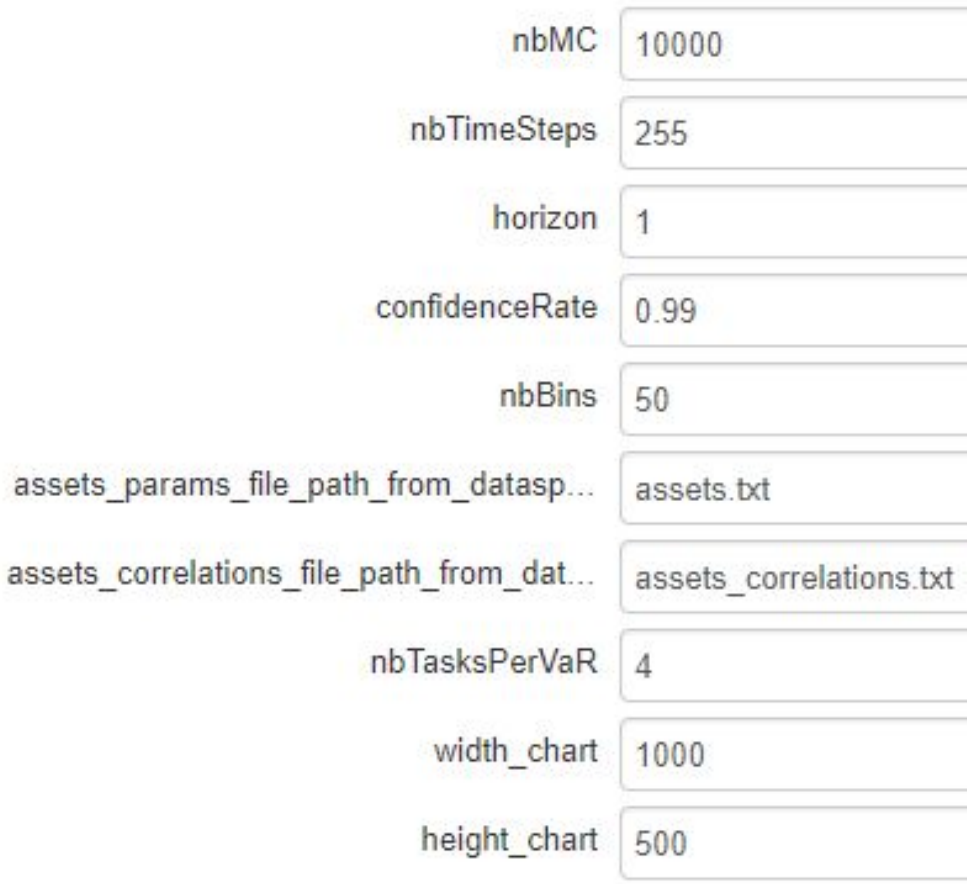
Task Result

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



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.



nbMC	10000	number of portfolio simulations. The number of tasks does not necessary divide the total number of simulations
nbTimeSteps	255	number of time steps of the portfolio simulations paths, up to the horizon
horizon	1	horizon. Here time steps are set to 1/255
confidenceRate	0.99	VaR confidence rate. Here 99%
nbBins	50	number of bins to plot the frequencies bar chart
assets_params_file_path_from_datasp...	assets.txt	file to describe assets params, a line per asset: start price, drift rate (yearly return), volatility rate (yearly return), weight
assets_correlations_file_path_from_dat...	assets_correlations.txt	correlations matrix of the assets
nbTasksPerVaR	4	number of replicated tasks per VaR to parallelize the MC simulations
width_chart	1000	width of the generated chart
height_chart	500	height of the generated chart

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

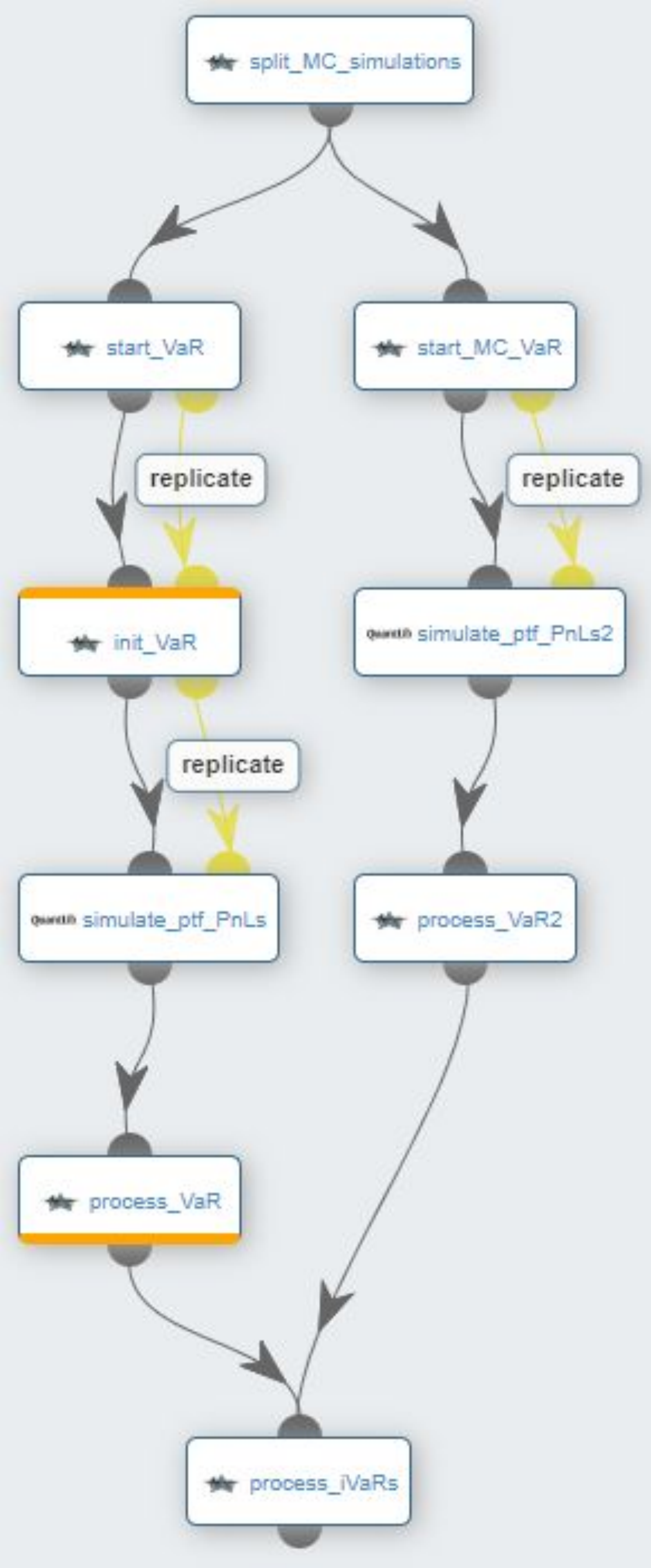
1st level of replicated tasks: a replicated task per asset (Y)

Each replicated task instanciates an assets params files, by setting to 0 its corresponding asset. By this way, the estimated VaR will not consider the asset

2nd level of replicated tasks: a replicated task per subset of MC simulations. Each replicated task processes a subset of the MC simulations according to its instanciated assets params file (i.e. instanciated by its father replicated task)

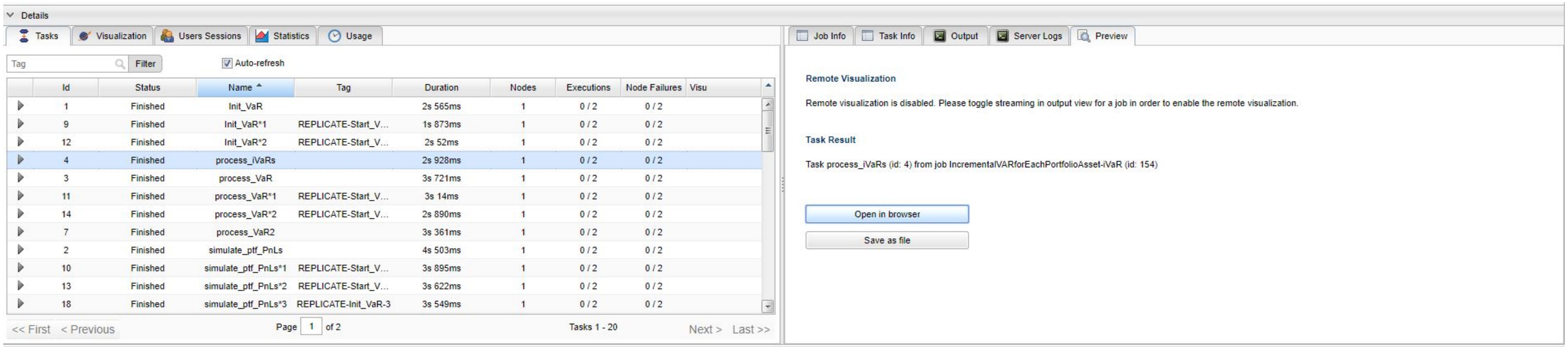
1st level of replicated tasks: a replicated task to merge the MC simulations processed by its sons task. Each task estimates the VaR related to Y, stores it, and generates the corresponding frequencies bar chart

Compute and println the iVaR related to each asset (portfolio VaR estimated by the right branch - portfolio VaR without the asset Y estimated by the left branch), merge all the frequencies bar charts into a single png file and exposes it



Perform the MC VaR like **Monte_Carlo_VaR_portfolio.xml**

incremental_Monte_Carlo_VaR_each_portfolio_asset.xml



Id	Status	Name ▲	Tag	Duration	Nodes	Executions	Node Failures	Visu
1	Finished	Init_VaR		2s 565ms	1	0 / 2	0 / 2	
9	Finished	Init_VaR*1	REPLICATE-Start_V...	1s 873ms	1	0 / 2	0 / 2	
12	Finished	Init_VaR*2	REPLICATE-Start_V...	2s 52ms	1	0 / 2	0 / 2	
4	Finished	process_iVaRs		2s 928ms	1	0 / 2	0 / 2	
3	Finished	process_VaR		3s 721ms	1	0 / 2	0 / 2	
11	Finished	process_VaR*1	REPLICATE-Start_V...	3s 14ms	1	0 / 2	0 / 2	
14	Finished	process_VaR*2	REPLICATE-Start_V...	2s 890ms	1	0 / 2	0 / 2	
7	Finished	process_VaR2		3s 361ms	1	0 / 2	0 / 2	
2	Finished	simulate_ptf_PnLs		4s 503ms	1	0 / 2	0 / 2	
10	Finished	simulate_ptf_PnLs*1	REPLICATE-Start_V...	3s 895ms	1	0 / 2	0 / 2	
13	Finished	simulate_ptf_PnLs*2	REPLICATE-Start_V...	3s 622ms	1	0 / 2	0 / 2	
18	Finished	simulate_ptf_PnLs*3	REPLICATE-Init_VaR-3	3s 549ms	1	0 / 2	0 / 2	

<< First < Previous Page 1 of 2 Tasks 1 - 20 Next > Last >>

Remote Visualization

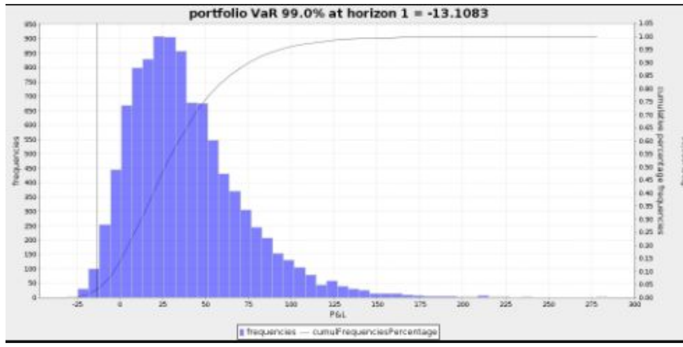
Remote visualization is disabled. Please toggle streaming in output view for a job in order to enable the remote visualization.

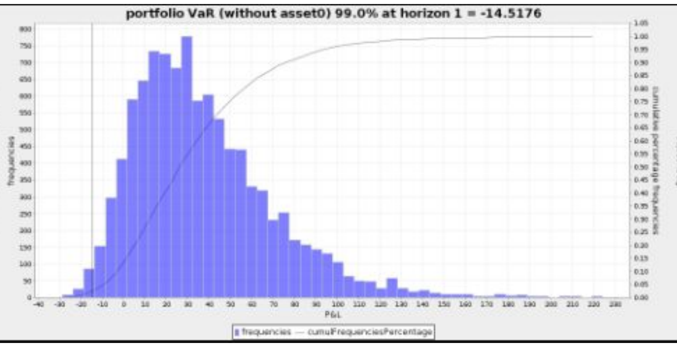
Task Result

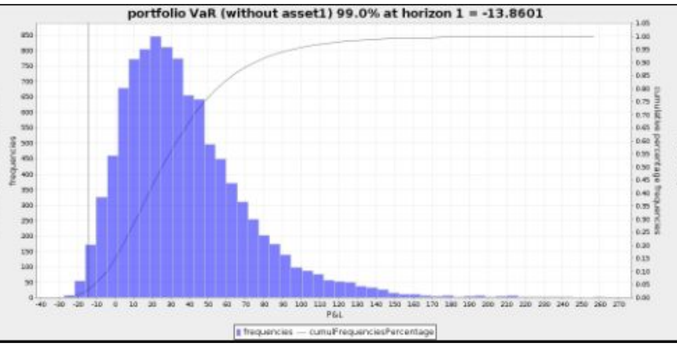
Task process_iVaRs (id: 4) from job IncrementalVARforEachPortfolioAsset-iVaR (id: 154)

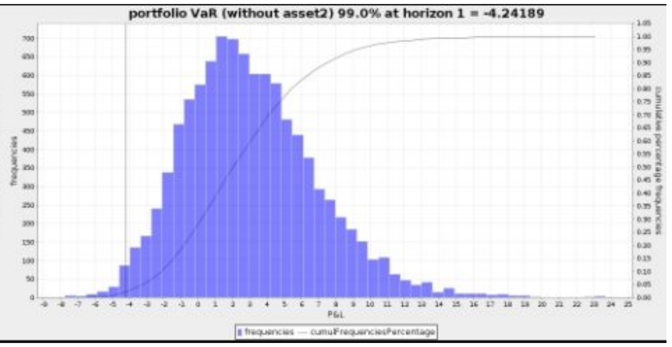
Open in browser

Save as file


portfolio VaR 99.0% at horizon 1 = -13.1083

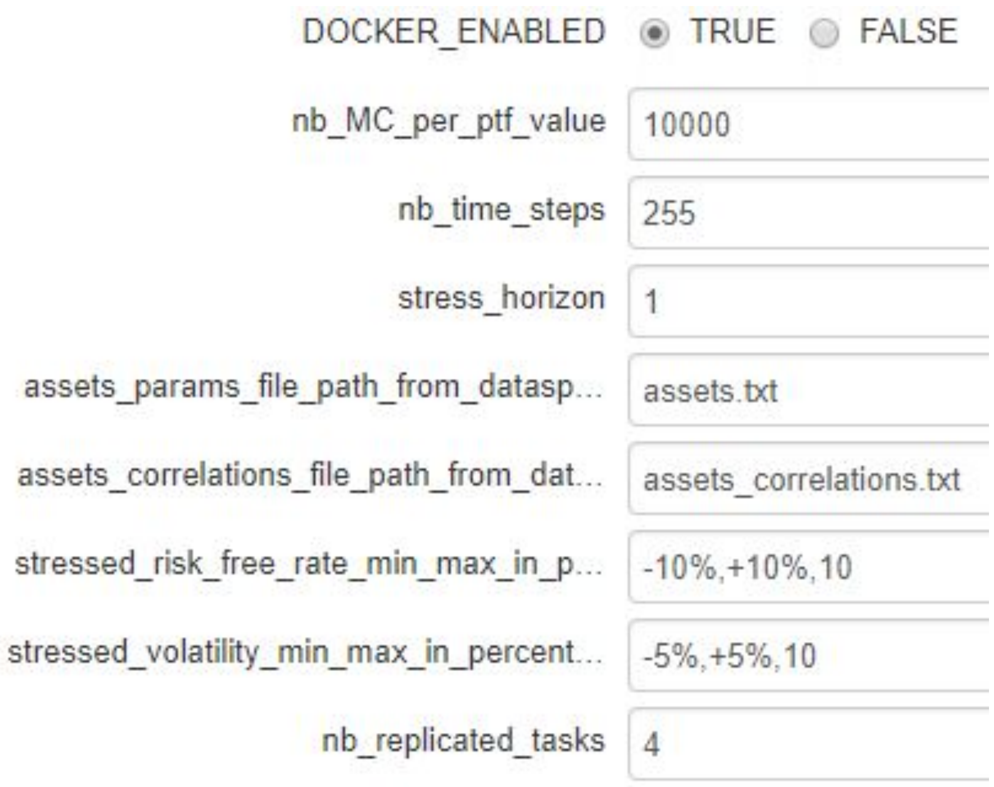

portfolio VaR (without asset0) 99.0% at horizon 1 = -14.5176


portfolio VaR (without asset1) 99.0% at horizon 1 = -13.8601


portfolio VaR (without asset2) 99.0% at horizon 1 = -4.24189

stress_testing_Monte_Carlo_value_portfolio.xml

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



DOCKER_ENABLED	● TRUE ○ FALSE	run the plotting task into a docker container for matplotlib support
nb_MC_per_ptf_value	10000	number of portfolio simulations per PnL estimation
nb_time_steps	255	number of time steps of the portfolio simulations paths, up to the horizon
stress_horizon	1	horizon until which portfolio is stressed (here time steps are set to 1/255)
assets_params_file_path_from_datasp...	assets.txt	file to describe assets params, a line per asset: start price, drift rate (yearly return), volatility rate (yearly return), weight
assets_correlations_file_path_from_dat...	assets_correlations.txt	correlations matrix of the assets
stressed_risk_free_rate_min_max_in_p...	-10%,+10%,10	range of the percentages of variation to apply to the risk free rate and number of steps to consider in this range
stressed_volatility_min_max_in_percent...	-5%,+5%,10	range of the percentages of variation to apply to the portolio asset volatilities and number of steps to consider in this range
nb_replicated_tasks	4	number of replicated tasks which have in charge the stressed PnL simulations

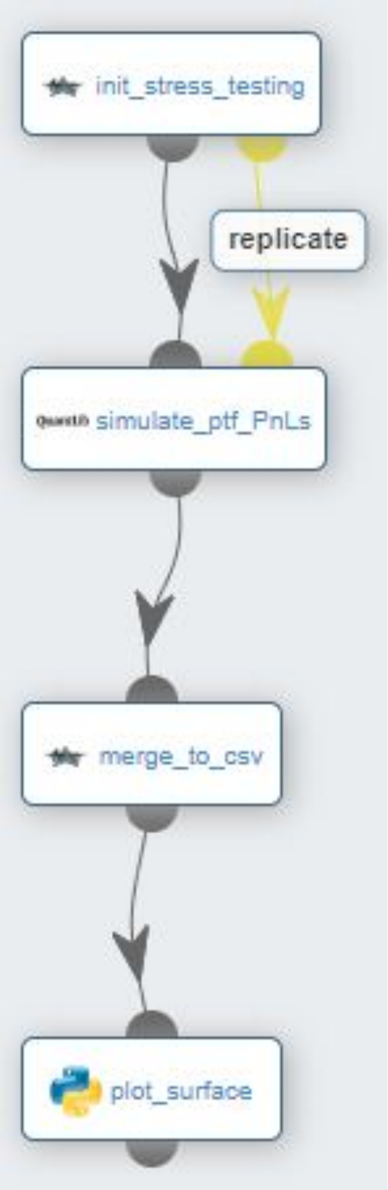
stress_testing_Monte_Carlo_value_portfolio.xml

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

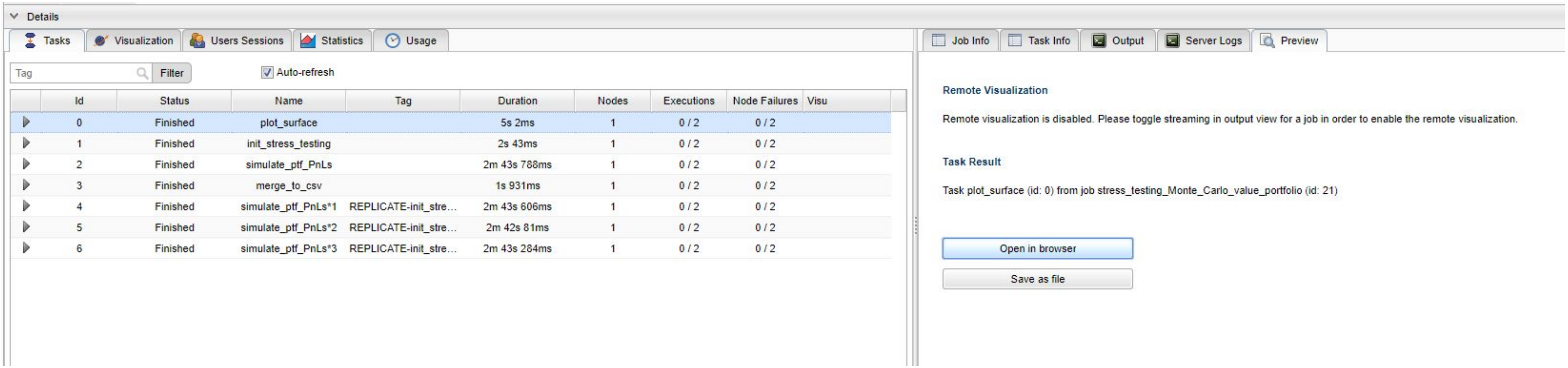
Using Quanlib, each replicated task processes a subset of the MC simulations and deduces the PnL (profit and loss) of each simulated path. An expected PnL is estimated per risk free rate and volatility stressed percentage. On the task side, PnLs are saved into a dedicated file

Merge all stressed PnLs into a single csv file

Plot a 3D representation of the stressed PnLs



stress_testing_Monte_Carlo_value_portfolio.xml



☑ Auto-refresh

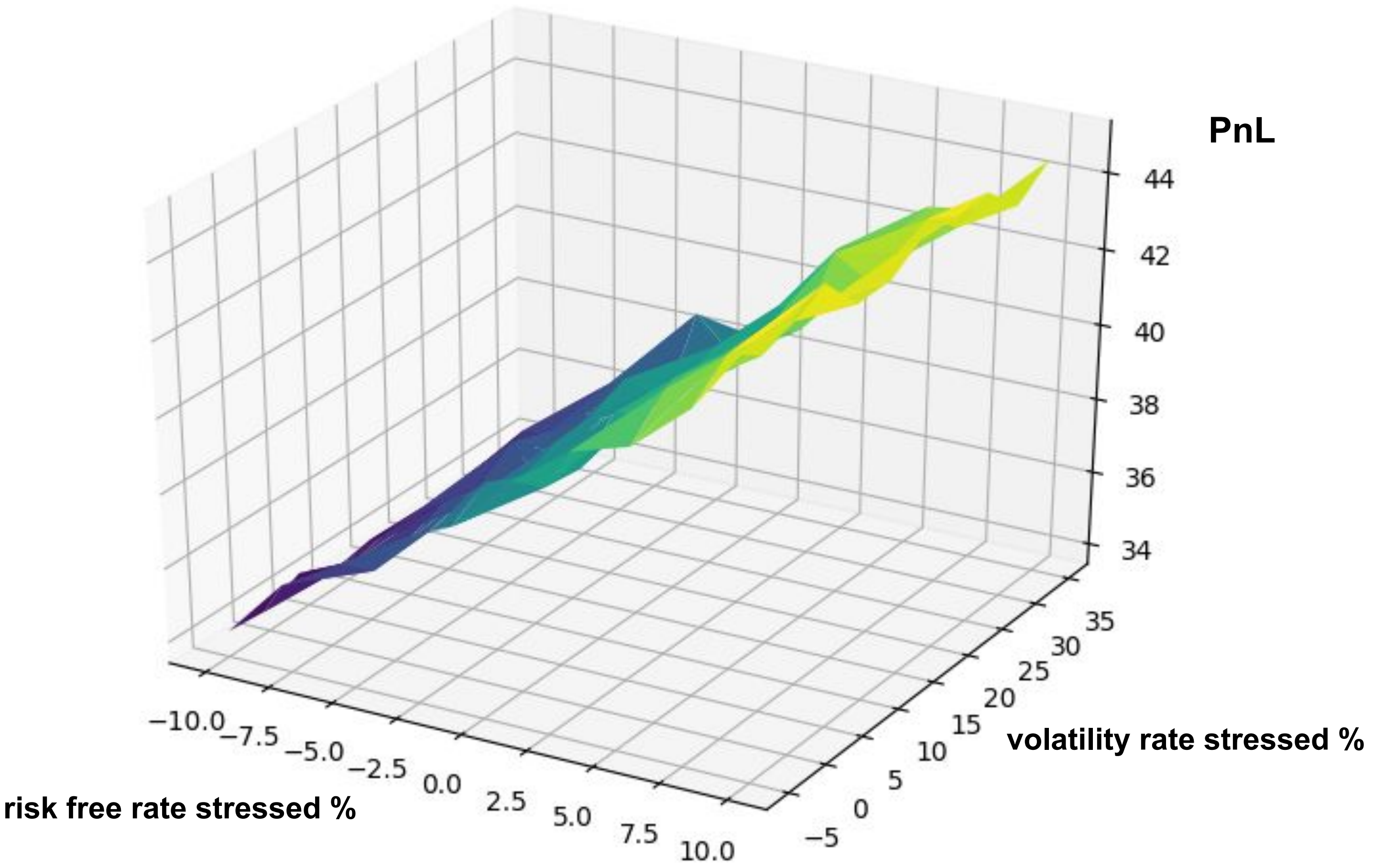
	Id	Status	Name	Tag	Duration	Nodes	Executions	Node Failures	Visu
	0	Finished	plot_surface		5s 2ms	1	0 / 2	0 / 2	
	1	Finished	init_stress_testing		2s 43ms	1	0 / 2	0 / 2	
	2	Finished	simulate_ptf_PnLs		2m 43s 788ms	1	0 / 2	0 / 2	
	3	Finished	merge_to_csv		1s 931ms	1	0 / 2	0 / 2	
	4	Finished	simulate_ptf_PnLs*1	REPLICATE-init_stre...	2m 43s 606ms	1	0 / 2	0 / 2	
	5	Finished	simulate_ptf_PnLs*2	REPLICATE-init_stre...	2m 42s 81ms	1	0 / 2	0 / 2	
	6	Finished	simulate_ptf_PnLs*3	REPLICATE-init_stre...	2m 43s 284ms	1	0 / 2	0 / 2	

Remote Visualization

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

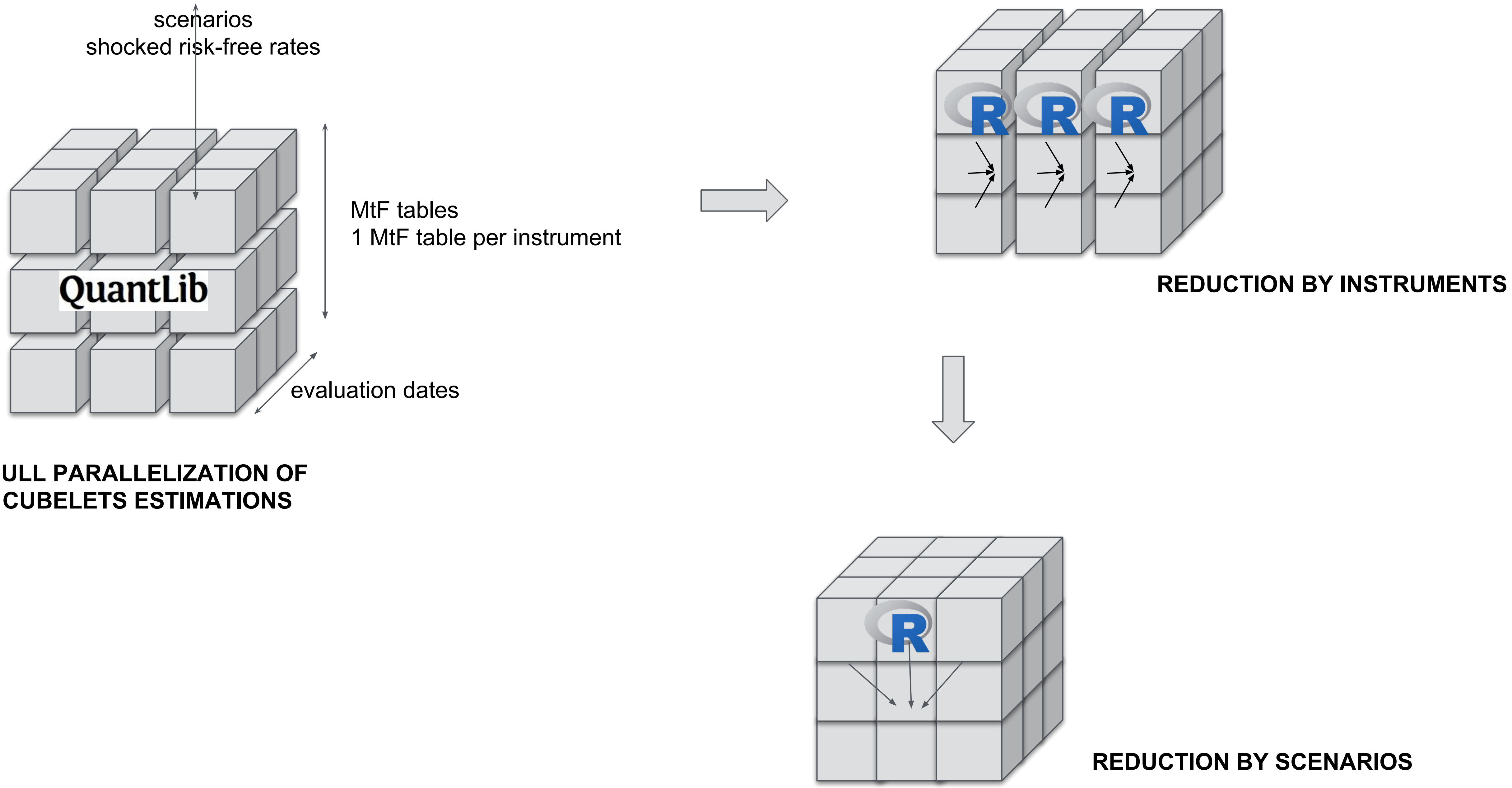
Task Result

Task plot_surface (id: 0) from job stress_testing_Monte_Carlo_value_portfolio (id: 21)



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,..).



scenarios
shocked risk-free rates

MtF tables
1 MtF table per instrument

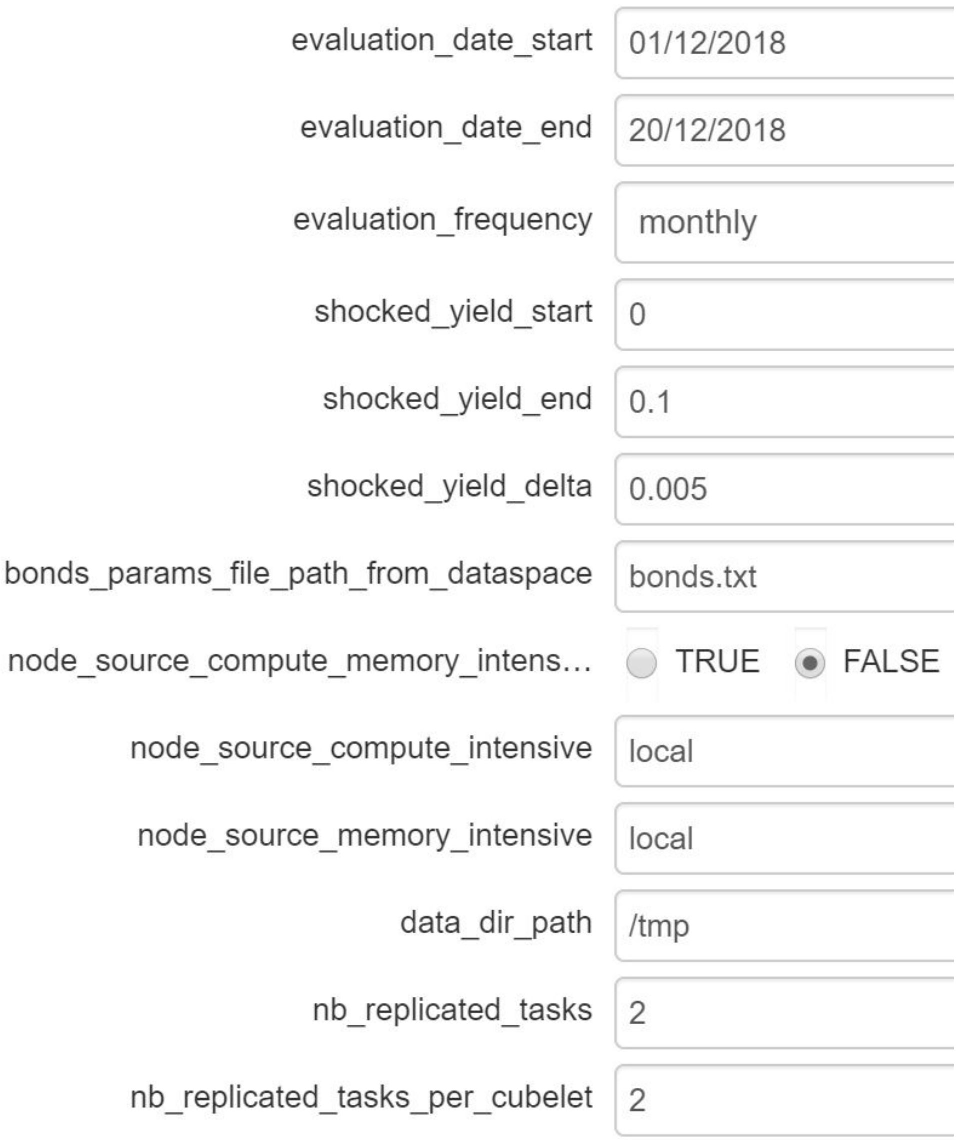
evaluation dates

FULL PARALLELIZATION OF
CUBELETS ESTIMATIONS

REDUCTION BY INSTRUMENTS

REDUCTION BY SCENARIOS

Mark_to_Future_cube_stats.xml



evaluation_date_start	01/12/2018	start date of the evaluations
evaluation_date_end	20/12/2018	end date of the evaluations
evaluation_frequency	monthly	evaluation frequency (monthly, biweekly)
shocked_yield_start	0	shocked yield start
shocked_yield_end	0.1	shocked yield end
shocked_yield_delta	0.005	shocked yield delta
bonds_params_file_path_from_dataspace	bonds.txt	file to describe bonds params, a line per bond: bond id, settlement days, face amount, coupon rate, redemption, issue date, maturity date, payment frequency
node_source_compute_memory_intens...	○ TRUE ● FALSE	boolean to either reserve compute and memory intensive nodes sources for compute and memory intensive tasks or not
node_source_compute_intensive	local	compute intensive node source name
node_source_memory_intensive	local	memory intensive node source name
data_dir_path	/tmp	data dir path to store generated data before reductions (for large data)
nb_replicated_tasks	2	number of replicated tasks to split scenarios
nb_replicated_tasks_per_cubelet	2	number of replicated tasks to split bonds

Mark_to_Future_cube_stats.xml

Split the scenarios and bonds over the replicated tasks

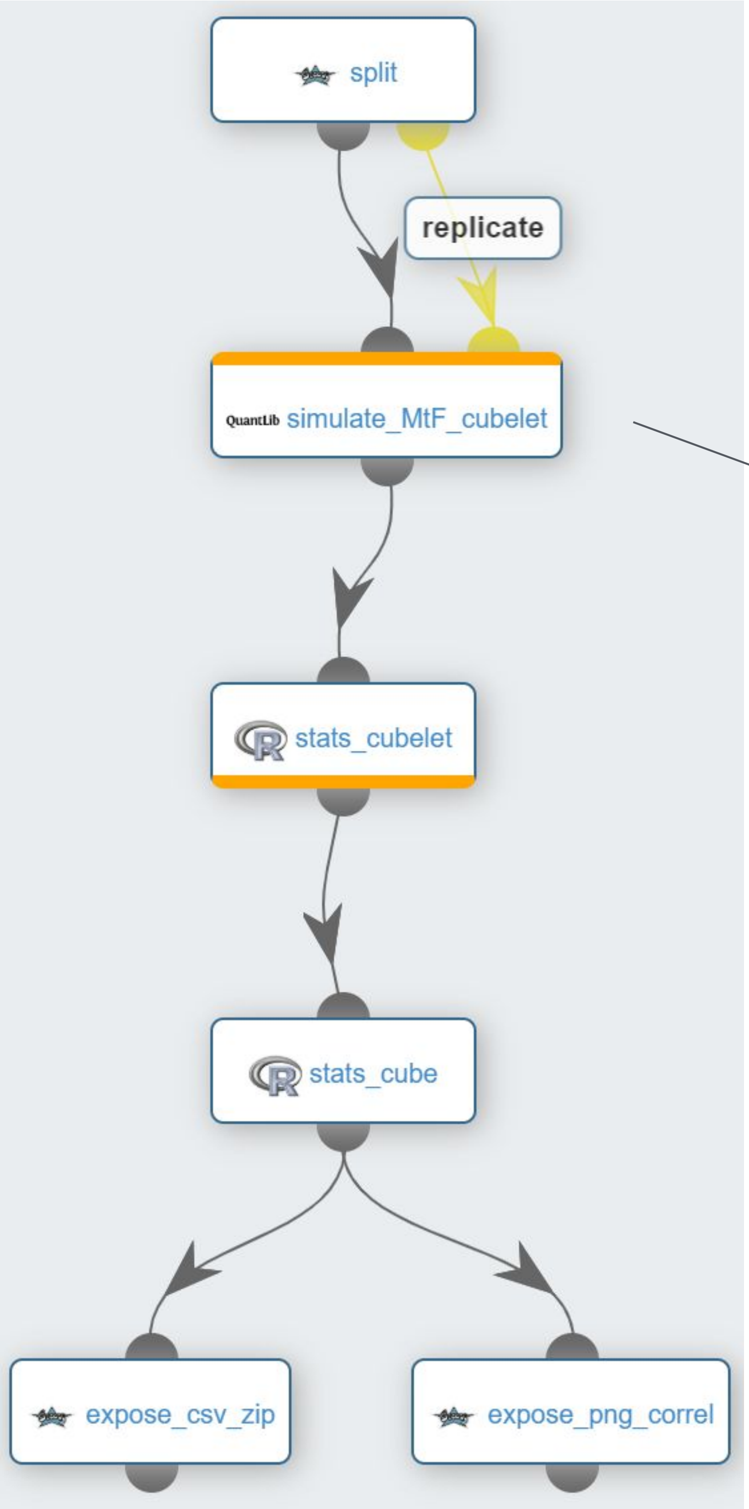
1st level of replicated tasks: a replicated task per subset of scenarios

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

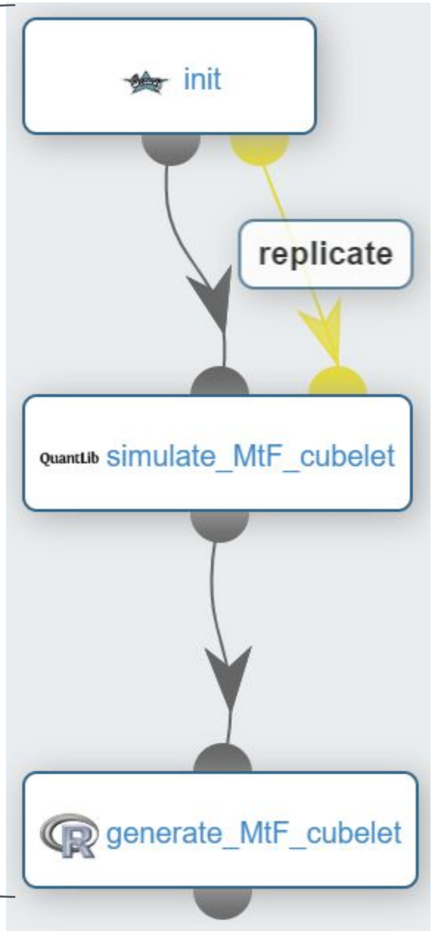


Init parameters

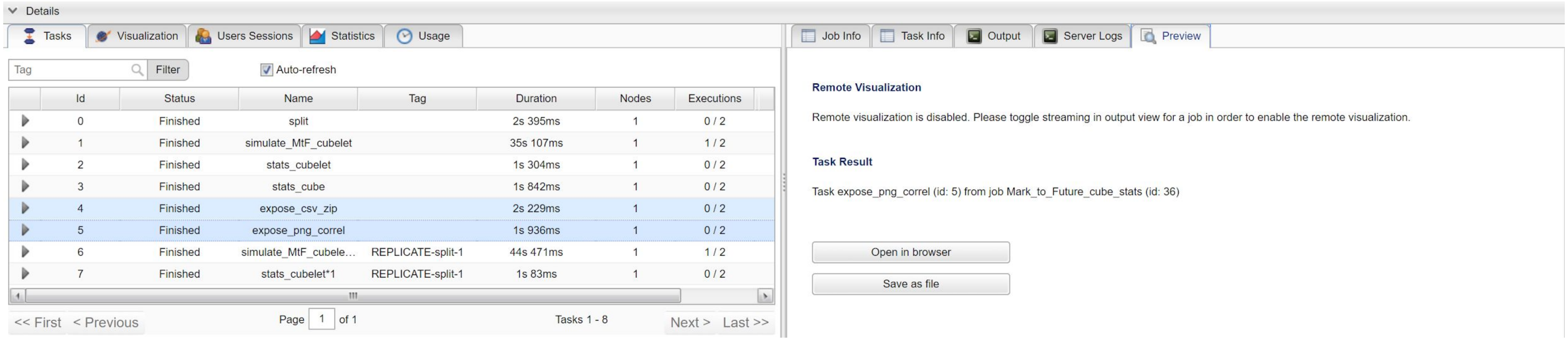
2nd level of replicated tasks: a replicated task per subset of bonds

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



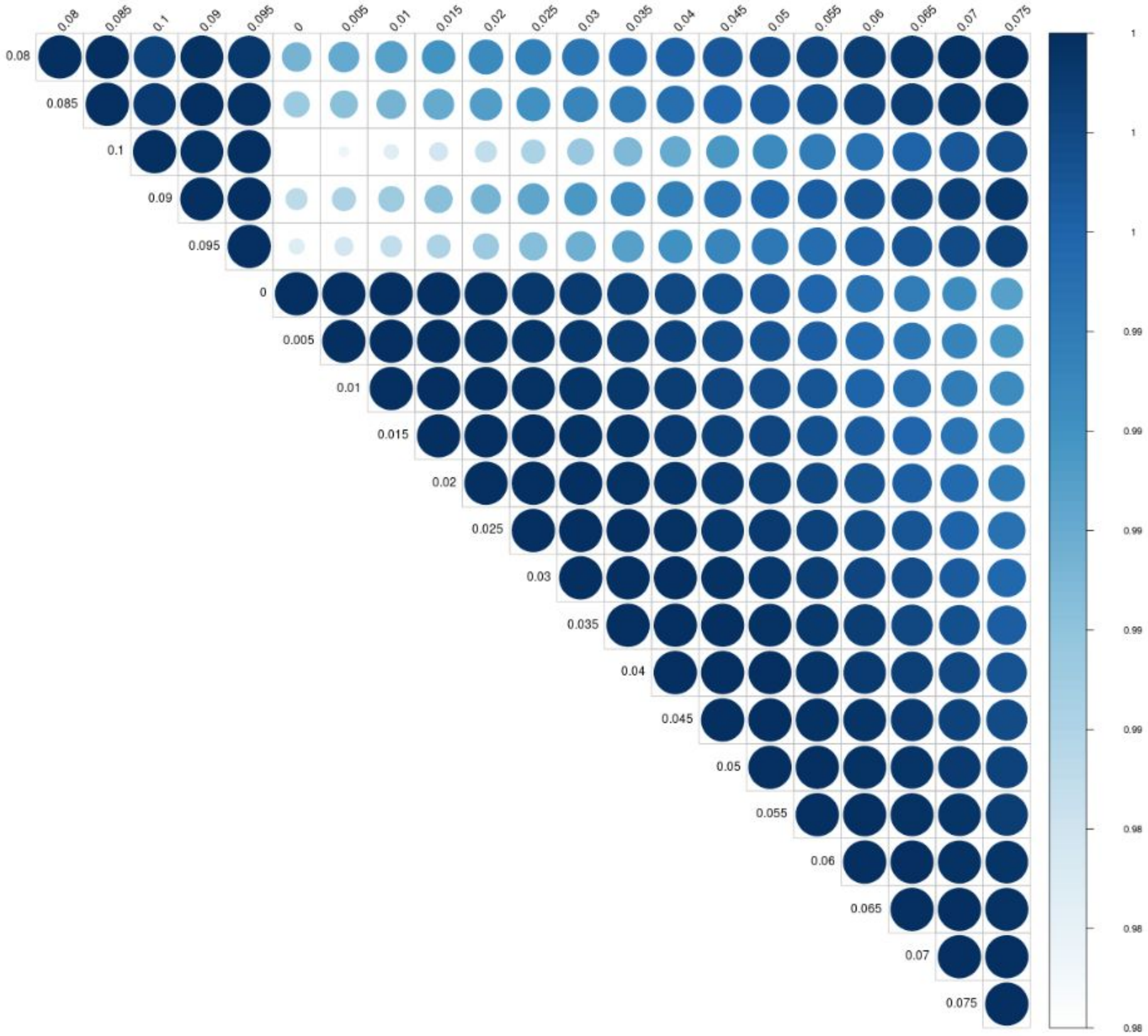
Id	Status	Name	Tag	Duration	Nodes	Executions
0	Finished	split		2s 395ms	1	0 / 2
1	Finished	simulate_MtF_cubelet		35s 107ms	1	1 / 2
2	Finished	stats_cubelet		1s 304ms	1	0 / 2
3	Finished	stats_cube		1s 842ms	1	0 / 2
4	Finished	expose_csv_zip		2s 229ms	1	0 / 2
5	Finished	expose_png_correl		1s 936ms	1	0 / 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

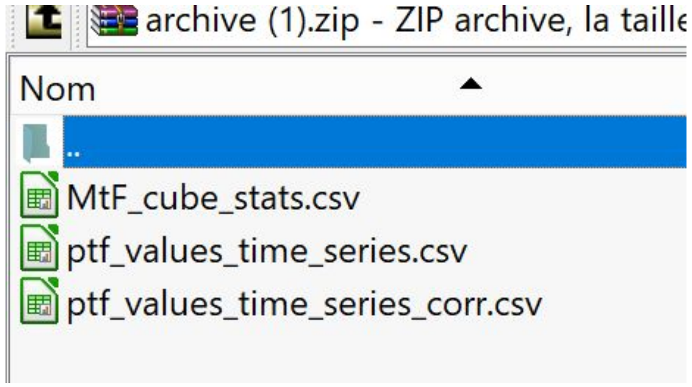
Remote Visualization

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)





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

MtF_cube_stats.csv
ptf_values_time_series.csv
ptf_values_time_series_corr.csv