Estimating portfolio Monte Carlo Value at Risk using ProActive

How does it work

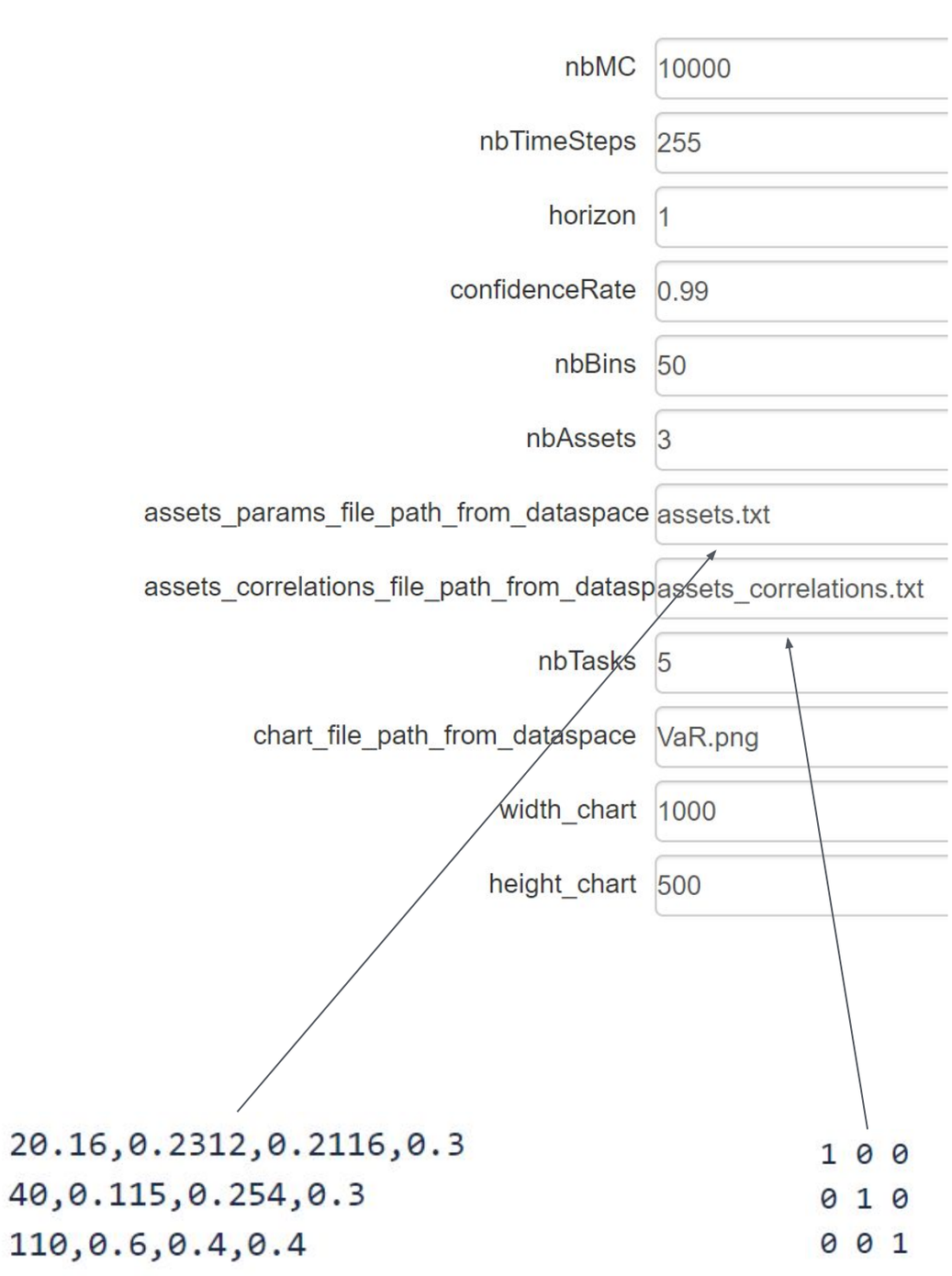
One-day 95% VaR of $1 million ⇔ 5% probability that the portfolio will fall in value by more than $1 million over a one-day period

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.

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.

stress_testing_Monte_Carlo_value_portfolio.xml estimates the portfolio PnL (Profit and Loss) over stressed volatilities and risk free rates.

Monte_Carlo_VaR_portfolio.xml



number of portfolio simulations. The number of tasks does not necessary divide the total number of simulations

number of time steps of the portfolio simulations paths, up to the horizon

horizon. Here time steps are set to 1/255

VaR confidence rate. Here 99%

number of bins to plot the frequencies bar chart

number of assets composing the portfolio

file to describe assets params, a line per asset: start price, drift rate (yearly return), volatility rate (yearly return), weight

correlations matrix of the assets

number of replicated tasks to parallelize the MC simulations

name of the png output file (frequencies bar chart with VaR)

width of the generated chart

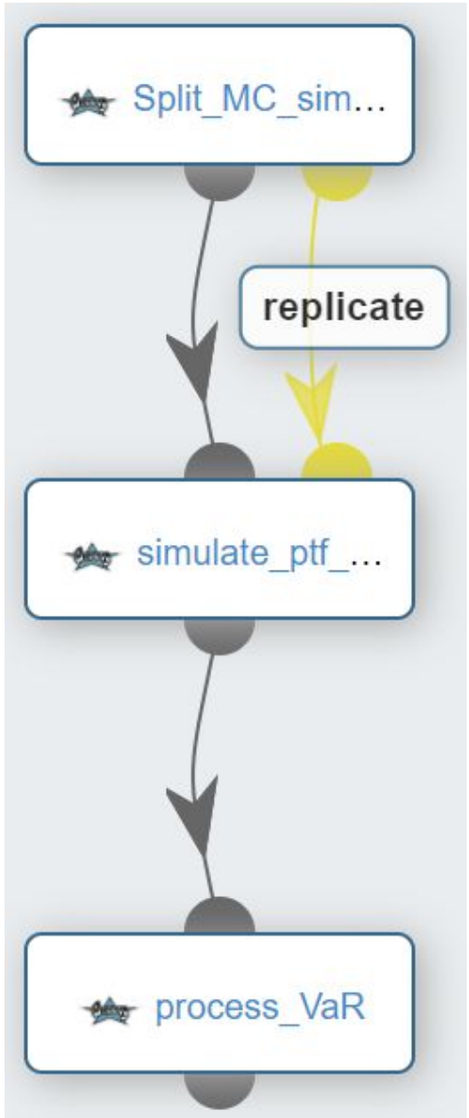
height of the generated chart

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 horizonof 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

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

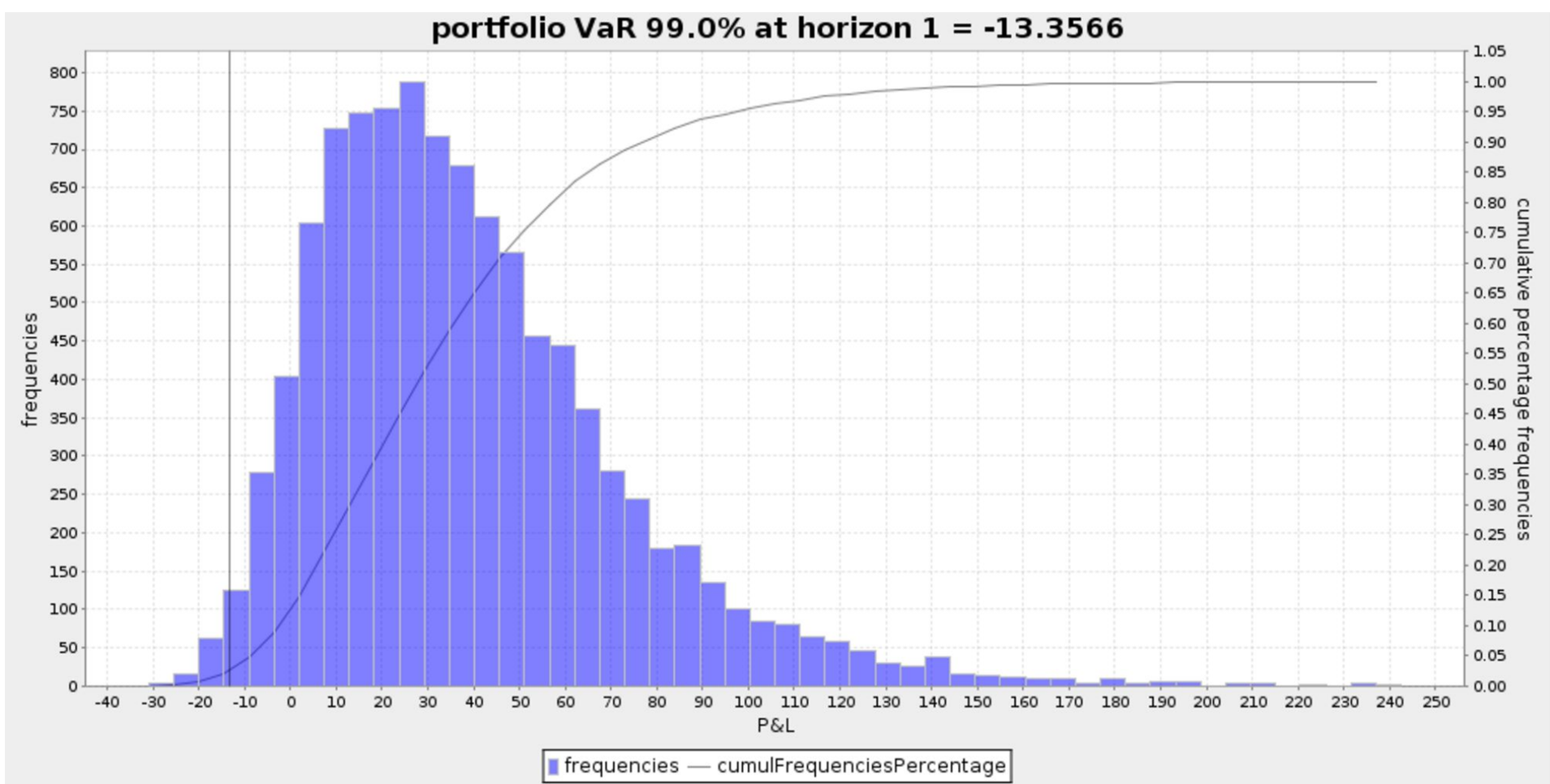
Remote visualization is disabled. Please toggle streaming in output view for a job in order to enable the remote visualization.

Task Result

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

Open in browser

Save as file



incremental_Monte_Carlo_VaR_each_portfolio_asset.xml.xml

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
nbAssets	3	number of assets composing the portfolio
assets_params_file_path_from_dataspace	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_dataspace	assets_correlations.txt	correlations matrix of the assets
nbTasksPerVaR	4	number of replicated tasks per VaR to parallelize the MC simulations
chart_file_path_from_dataspace	VaR.png	name of the png output file (frequencies bar chart with VaR)
width_chart	1000	width of the generated chart
height_chart	500	height of the generated chart

incremental_Monte_Carlo_VaR_each_portfolio_asset.xml.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

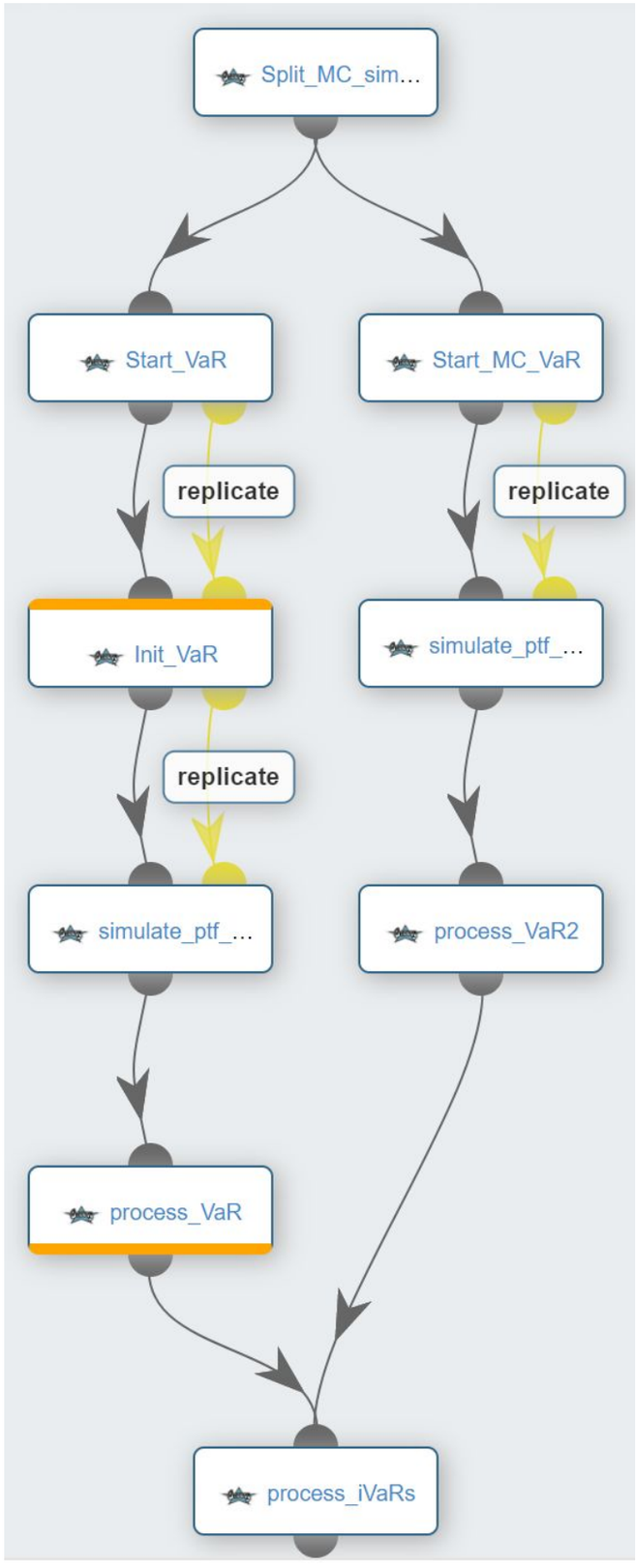
1st level of replicated tasks: a replicated task per asset (Y)

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 **MCVaR.xml**

incremental_Monte_Carlo_VaR_each_portfolio_asset.xml.xml

Details

Tasks | Visualization | Users Sessions | Statistics | Usage

Tag | Filter | Auto-refresh

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	

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

Remote Visualization

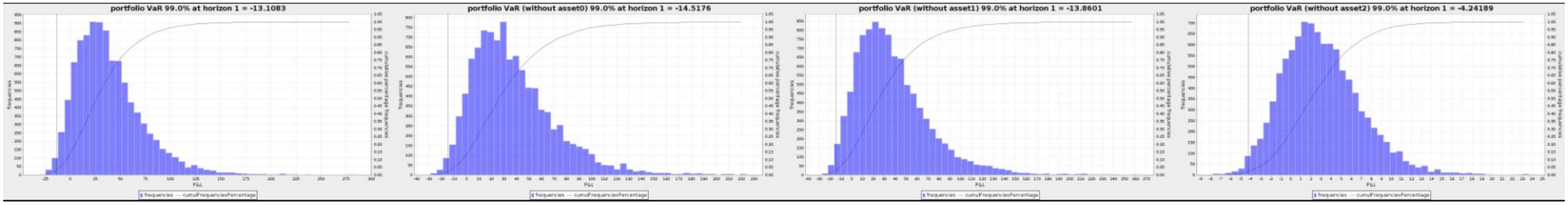
Remote visualization is disabled. Please toggle streaming in output view for a job in order to enable the remote visualization.

Task Result

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

Open in browser

Save as file



stress_testing_Monte_Carlo_value_portfolio.xml

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%,+35%,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

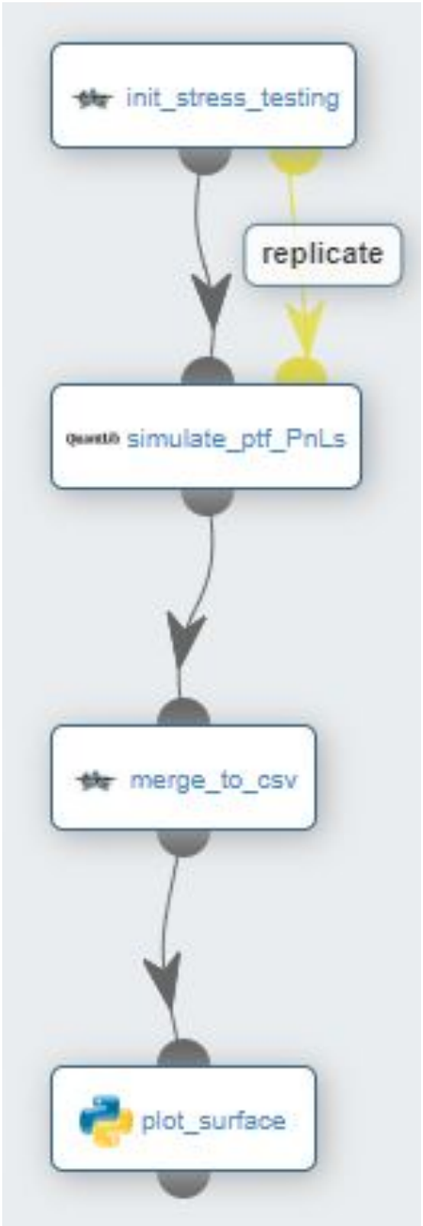
stress_testing_Monte_Carlo_value_portfolio.xml

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

Using Quanlib, each replicated task proceses 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

Details

Tasks | Visualization | Users Sessions | Statistics | Usage

Tag | Filter | 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	

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

Open in browser

Save as file