RELIABILITY BASED MULTI-OBJECTIVE PORTFOLIO OPTIMIZATION

ADITYA GUPTA (18114002)
MTech thesis under the supervision of Dr. RAGHU NANDAN SENGUPTA and Dr. SUBHANKAR MUKHERJEE
Industrial and Management Engineering, Indian Institute of Technology Kanpur, INDIA

Pseudo-Codes for the paper *Bi-Objective Reliability Based Design Optimization: Applications in Portfolio Investment Analysis*

Raghu Nandan SENGUPTA, IME Dept., IIT Kanpur, INDIA, Email: raghus@iitk.ac.in
Aditya GUPTA, ICICI Lombard, Mumbai, INDIA, Email: aditya.gupta@icicilombard.com
Subhankar MUKHERJEE, IME Dept., IIT Kanpur, INDIA, Email: subhankar@iitk.ac.in
Gregor WEISS, Faculty of Economics and Management, Leipzig University, GERMANY
Email: weiss@wifa.uni-leipzig.de

----------**INITIALIZATION**----------

START
IMPORT: *Library Functions,*
DEFINE: *Variables* [Number of Pareto runs (B_1), Number of Pareto runs (B_2), n, S, r, r_f, w, Alpha (α), Gamma (γ), Time (t), Expected Value/Mean, Variance, Covariance, Skewness, CVaR, EVaR, Threshold values for returns (r_P^*), Threshold values for variance (σ_P^{2*}), Threshold values for CVaR ($CVaR^*$), Threshold values for EVaR ($EVaR^*$), Reliability values ($\beta's$)]
INPUT: *Initial Values* [Number of Pareto runs (B_1), Number of Pareto runs (B_2), n, S, r, r_f, w, Alpha (α), Gamma (γ), Time (t), Expected Value/Mean, Variance, Covariance, Skewness, CVaR, EVaR, Threshold values for returns (r_P^*), Threshold values for variance (σ_P^{2*}), Threshold values for CVaR ($CVaR^*$), Threshold values for EVaR ($EVaR^*$), Reliability values ($\beta's$)]

----------**DEFINITIONS OF DIFFERENT FUNCTIONS**----------

----------**FUNCTION: ARCH/GARCH FOR EVD**----------

DEFINE: *Function* [ARCH/GARCH FOR EVD]
START: *Function* [ARCH/GARCH FOR EVD]
FUNCTIONALITY: Performs ARCH/GARCH to find the volatility of returns based on EVD
CALCULATE: [*Find the left tail, central and upper tail distributions, calculate the estimates of shape, scale and location parameter of EVD. Then find the one step returns used to used for optimization*]
REPORT: [*Find the left tail, central and upper tail distributions, calculate the estimates of shape, scale and location parameter of EVD. Then find the one step returns used to used for optimization*]
END: *Function* [Bootstrap]

----------**FUNCTION: BOOTSTRAP**----------

DEFINE: *Function* [Bootstrap]
START: *Function* [Bootstrap]
FUNCTIONALITY: *Performs bootstrap to find the kernel densities for both Mean and Variance of all N assets*
CALCULATE: [All statistical values and statistical test values as required to check for distribution properties]
REPORT: [All statistical values and statistical test values as required to check for distribution properties]

Pseudo-Codes for the paper *Bi-Objective Reliability Based Design Optimization: Applications in Portfolio Investment Analysis*

Raghu Nandan SENGUPTA, IME Dept., IIT Kanpur, INDIA, Email: raghus@iitk.ac.in
Aditya GUPTA, ICICI Lombard, Mumbai, INDIA, Email: aditya.gupta@icicilombard.com
Subhankar MUKHERJEE, IME Dept., IIT Kanpur, INDIA, Email: subhankar@iitk.ac.in
Gregor WEISS, Faculty of Economics and Management, Leipzig University, GERMANY
Email: weiss@wifa.uni-leipzig.de

16: **END**: *Function* [Bootstrap]

----------**FUNCTION: OPTIMIZATION**----------
17: **DEFINE**: *Function* [Optimization Method used for Models I, II, III]
18: **START**: *Function* [Optimization Method used for Models I, II, III]
19: **FUNCTIONALITY**: *Performs Optimization for Models I, II, II to find the deterministic objective value and decision variables* $\boldsymbol{w}$*. Also check whether optimality condition is satisfied if* ***YES*** *then terminate else proceed*
20: **END**: *Function* [Optimization Method used for Models I, II, III]

----------**FUNCTION: ROSENBLAT TRANSFORMATION**----------
21: **DEFINE**: *Function* [Rosenblatt Transformation]
22: **START**: *Function* [Rosenblatt Transformation]
23: **FUNCTIONALITY**: *Performs* Rosenblatt Transformation *to find* $\boldsymbol{U}$
23: **END**: *Function* [Rosenblatt Transformation]

----------**FUNCTION: RBDO: PERFORMANCE MEASURE APPROACH**----------
24: **DEFINE**: *Function* [RBDO: Performance Measure Approach]
25: **START**: *Function* [RBDO: Performance Measure Approach]
26: **FUNCTIONALITY**: *Performs* RBDO: Performance Measure Approach] *optimization to find the MPP points* $\boldsymbol{U}^*$
27: **END**: *Function* [RBDO: Performance Measure Approach]

----------**FUNCTION: INVERSE ROSENBLAT TRANSFORMATION**----------
28: **DEFINE**: *Function* [Inverse Rosenblatt Transformation]
29: **START**: *Function* [Inverse Rosenblatt Transformation]
30: **FUNCTIONALITY**: *Performs inverse* Rosenblatt Transformation *to find* $\boldsymbol{w}$
31: **END**: *Function* [Inverse Rosenblatt Transformation]

32: **REPEAT**: *Steps 17 to 31 till optimality condition is satisfied*

33: **CALCULATE**: [optimal values of $\boldsymbol{w}$, Objective function]
34: **REPORT**: [optimal values of $\boldsymbol{w}$, Objective function, return-risk, optimal weights for different values of reliability index values, $\beta's$]
35: **END**