Pseudo-Codes

Bi-Objective Reliability Based Design Optimization: Applications in Portfolio Investment Analysis

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Note: Details of plan of codes, pseudo-codes and other set of detailed runs results (not discussed in this paper) are all give in the open access link, <**https://github.com/RNSengupta/Bi-Objective_RBDO_Paper**> which any interested reader can refer

```
----------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 (β'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 (β'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]
  END: Function [Bootstrap]

          ----------FUNCTION: OPTIMIZATION----------
  DEFINE: Function [Optimization Method used for Models I, II, III]
  START: Function [Optimization Method used for Models I, II, III]
```

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```
19:      FUNCTIONALITY: Performs Optimization for Models I, II, II to find
         the deterministic objective value and decision variables 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 U
24:   END: Function [Rosenblatt Transformation]

     ----------FUNCTION: RBDO: PERFORMANCE MEASURE APPROACH----------
25:   DEFINE: Function [RBDO: Performance Measure Approach]
26:   START: Function [RBDO: Performance Measure Approach]
27:      FUNCTIONALITY: Performs RBDO: Performance Measure Approach]
         optimization to find the MPP points U*
28:   END: Function [RBDO: Performance Measure Approach]

      ----------FUNCTION: INVERSE ROSENBLAT TRANSFORMATION----------
29:   DEFINE: Function [Inverse Rosenblatt Transformation]
30:   START: Function [Inverse Rosenblatt Transformation]
31:      FUNCTIONALITY: Performs inverse Rosenblatt Transformation to find
         w
32:   END: Function [Inverse Rosenblatt Transformation]

33:   REPEAT: Steps 17 to 32 till optimality condition is satisfied

34:   CALCULATE: [optimal values of w, Objective function]
35:   REPORT: [optimal values of w, Objective function, return-risk,
      optimal weights for different values of reliability index values,
      β's]
36: END
```