**Case Study: Portfolio Credit-Risk Optimization Modeled by Scenarios and Mixtures of Normal Distributions**

[Back to main page](http://www.ise.ufl.edu/uryasev/research/testproblems/)

[**Case study background and problem formulations**](http://www.ise.ufl.edu/uryasev/files/2011/12/CS_Portfolio_Credit-Risk_Optimization.pdf)

**PROBLEM 1: problem\_var\_LLN**  
Minimize Var\_risk (minimizing Value-at-Risk)  
subject to   
Linear = 1 (budget constraint)  
Linear ≥ Const (portfolio return constraint)  
Box constraints (bounds on decision variables)  
——————————————————————–  
Var = VaR Risk for Loss  
Box constraints = constraints on individual decision variables  
——————————————————————–

Download Problem Data (LARGE DATA FILES; SEVERAL MINUTES MAY BE NEEDED FOR DOWNLOADING)

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| **Problem Datasets** | | | | **# of Variables** | **# of Scenarios** | **Objective Value** | **Solving Time, PC 2.66GHz (sec)** |
| Dataset1 | [Problem Statement](http://www.ise.ufl.edu/uryasev/files/2014/02/problem_var_lln_short_.txt) | [Data](http://www.ise.ufl.edu/uryasev/files/2014/02/data_problems_1_4_short.zip) | [Solution](http://www.ise.ufl.edu/uryasev/files/2014/02/solution_problem_var_lln_short.zip) | 3,000 | 10,000 | 2.808627866 | 18.57 |

**PROBLEM 2: problem\_cvar\_LLN**   
Minimize Cvar\_risk (minimizing Conditional Value-at-Risk)   
subject to   
Linear = 1 (budget constraint)   
Linear ≥ Const (portfolio return constraint)   
Box constraints (bounds on decision variables)   
——————————————————————–  
Cvar\_risk = CVaR Risk for Loss  
Box constraints = constraints on individual decision variables  
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| **Problem Datasets** | | | | **# of Variables** | **# of Scenarios** | **Objective Value** | **Solving Time, PC 2.66GHz (sec)** |
| Dataset1 | [Problem Statement](http://www.ise.ufl.edu/uryasev/files/2014/02/problem_cvar_lln_short_.txt) | [Data](http://www.ise.ufl.edu/uryasev/files/2014/02/data_problems_1_4_short.zip) | [Solution](http://www.ise.ufl.edu/uryasev/files/2014/02/solution_problem_cvar_lln_short.zip) | 3,000 | 10,000 | 3.41392772129 | 1.16 |

**PROBLEM 3: problem\_avg\_var\_CLT**  
Minimize Avg\_var\_risk\_ni (minimizing Average Value-at-Risk for Normal Independent Distribution)   
subject to   
Linear = 1 (budget constraint)   
Linear ≥ Const (portfolio return constraint)   
Box constraints (bounds on decision variables)   
——————————————————————–  
Avg\_var\_risk\_ni = Average Value-at-Risk for Multivariate Normal Independent Distribution  
Box constraints = constraints on individual decision variables  
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| **Problem Datasets** | | | | **# of Variables** | **# of Scenarios** | **Objective Value** | **Solving Time, PC 2.66GHz (sec)** |
| Dataset1 | [Problem Statement](http://www.ise.ufl.edu/uryasev/files/2014/02/problem_avg_var_clt_short_.txt) | [Data](http://www.ise.ufl.edu/uryasev/files/2014/02/data_problems_1_4_short.zip) | [Solution](http://www.ise.ufl.edu/uryasev/files/2014/02/solution_problem_avg_var_clt_short.zip) | 3,000 | 10,000 | 3.13761873657 | 371.68 |

**PROBLEM 4: problem\_avg\_cvar\_CLT**   
Minimize Avg\_cvar (minimizing Average Conditional Value-at-Risk for Normal Independent Distribution)   
subject to   
Linear = 1 (budget constraint)   
Linear ≥ Const (portfolio return constraint)   
Box constraints (bounds on decision variables)   
——————————————————————–  
Avg\_cvar\_risk\_ni = Average Conditional Value-at-Risk for Multivariate Normal Independent Distribution  
Box constraints = constraints on individual decision variables  
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Download Problem Data (LARGE DATA FILES; SEVERAL MINUTES MAY BE NEEDED FOR DOWNLOADING)

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| **Problem Datasets** | | | | **# of Variables** | **# of Scenarios** | **Objective Value** | **Solving Time, PC 2.66GHz (sec)** |
| Dataset1 | [Problem Statement](http://www.ise.ufl.edu/uryasev/files/2014/02/problem_avg_cvar_clt_short_.txt) | [Data](http://www.ise.ufl.edu/uryasev/files/2014/02/data_problems_1_4_short.zip) | [Solution](http://www.ise.ufl.edu/uryasev/files/2014/02/solution_problem_avg_cvar_clt_short.zip) | 3,000 | 10,000 | 3.648889845209 | 241.56 |

**PROBLEM 5: problem\_avg\_var\_CLT (alternative formulation)**   
Minimize Xvar (minimizing Average Value-at-Risk for Normal Independent Distribution using alternative formulation of Problem 3)   
subject to   
Linear = 1 (budget constraint)   
Avg\_pr\_pen\_ni ≤ 1-α (probability constraint)   
Linear ≥ Const (portfolio return constraint)   
Box constraints (bounds on decision variables)   
——————————————————————–  
Xvar = additional variable which is equal to VaR at optimality  
Avg\_pr\_pen\_ni = Average Probability Exceeding Penalty for Loss Normal Independent  
Box constraints = constraints on individual decision variables  
Box constraints = constraints on individual decision variables  
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Download Problem Data (LARGE DATA FILES; SEVERAL MINUTES MAY BE NEEDED FOR DOWNLOADING)

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| **Problem Datasets** | | | | **# of Variables** | **# of Scenarios** | **Objective Value** | **Solving Time, PC 2.66GHz (sec)** |
| Dataset1 | [Problem Statement](http://www.ise.ufl.edu/uryasev/files/2014/02/problem_avg_var_clt_alt_short_.txt) | [Data](http://www.ise.ufl.edu/uryasev/files/2014/02/data_problem_5-6_short.zip) | [Solution](http://www.ise.ufl.edu/uryasev/files/2014/02/solution_problem_avg_var_clt_short.zip) | 3,001 | 10,000 | 3.13761873657 | 371.68 |

**PROBLEM 6: problem\_avg\_cvar\_CLT (alternative formulation)**  
Minimize Xvar + 1/(1-α )\*Avg\_pm\_pen\_ni (minimizing Average Conditional Value-at-Risk for Normal Independent Distribution using alternative formulation of Problem 4)   
subject to   
Linear = 1 (budget constraint)   
Linear ≥ Const (portfolio return constraint)   
Box constraints (bounds on decision variables)   
——————————————————————–  
Xvar = additional variable which is equal to VaR at optimality  
Avg\_pm\_pen\_ni = Average Partial Moment Penalty for Loss Normal Independent  
Box constraints = constraints on individual decision variables  
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| **Problem Datasets** | | | | **# of Variables** | **# of Scenarios** | **Objective Value** | **Solving Time, PC 2.66GHz (sec)** |
| Dataset1 | [Problem Statement](http://www.ise.ufl.edu/uryasev/files/2014/02/problem_avg_cvar_clt_alt_short_.txt) | [Data](http://www.ise.ufl.edu/uryasev/files/2014/02/data_problem_5-6_short.zip) | [Solution](http://www.ise.ufl.edu/uryasev/files/2014/02/solution_problem_avg_cvar_clt_alt_short.zip) | 3,001 | 10,000 | 3.648903768121 | 192.91 |

**CASE STUDY SUMMARY**  
This case study evaluates several alternative formulations of optimization problems for minimizing credit risk of a portfolio of financial contracts with different counterparties. The formulations and numerical runs (both models and data) are motivated by paper Iscoe et al. (2009). This paper considers various approximations to the conditional portfolio loss distribution and formulate VaR and CVaR minimization problems for each case. Formulations exploit the conditional independence of counterparties under a structural credit risk model. The case studies consider the “conventional” scenarios and the mixture of normal distribution approaches for modeling the conditional loss distribution.  
Similar to Iscoe et al. (2009) we find four optimal portfolios for minimization problems with different but closely risk measures. Problems 1,2 consider quantile-based risk measures, var\_risk, cvar\_risk with “conventional” scenarios and Problems 3,4 consider avg\_var\_risk\_ni, avg\_cvar\_risk\_ni calculating mixtures of normal independent distributions.  
Additionally, Problems 3,4 involving avg\_var\_risk\_ni and avg\_cvar\_risk\_ni were equivalently reformulated with functions avg\_pr\_pen\_ni, avg\_pm\_pen\_ni. These formulations help to understand relation between “avg\_…” functions.  
Case study demonstrates that PSG optimization provides results comparable to Iscoe, I., et al. (2009).