
Scenario Logic and Probabilistic Management of Risk in Business and Engineering

Applied Optimization

Volume 93

Series Editors:

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Scenario Logic and Probabilistic Management of Risk in Business and Engineering

by

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Springer

Library of Congress Cataloging-in-Publication Data

A C.I.P. Catalogue record for this book is available from the Library of Congress.

ISBN 1-4020-2977-2 e-ISBN 1-4020-2978-0 Printed on acid-free paper.

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Printed in the United States of America.

9 8 7 6 5 4 3 2 1 SPIN 11161448

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E. D. Solojentsev. *Scenario logic and probabilistic management of risk in business and engineering*. Pages — 391 p., Figures — 70; Tables — 40; Refers — 118.

The methodological aspects of the scenario logic and probabilistic (LP) non-success risk management are considered, following from analysis of connections between management and risk, personals and risk, and from study of risk management at stages of design, test and operation of complex systems.

The theoretical bases of the scenario non-success risk LP-management in business and engineering are stated, including LP-calculus, LP-methods, and LP-theory with groups of incompatible events (GIE). Examples of risk LP-models with logical connections *OR*, *AND*, *NOT*, cycles and GIE are given. Methods and algorithms for the scenario risk LP-management in problems of classification, investment and effectiveness are described.

Risk LP-models and results of numerical investigations for credit risks, risk of frauds, security portfolio risk, risk in quality, accuracy, and risk in multi-state system reliability are given. A rather large number of new problems of estimation, analysis and management of risk are considered. In some problems the risk LP-models prove to be showed almost two times more accurate and seven times more robustness than other well-known models of risks. Software for risk problems based on LP-methods, LP-theory with GIE and cortege algebra, is described too.

The book is intended for experts and scientists in the area of the risk in business and engineering, in problems of classification, investment and effectiveness, and students and post-graduates.

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FOREWORD

In the forewords to the books “Logic and probabilistic valuation of banking risks and frauds in business” (St. Petersburg, Politechnika, 1996) and “Logic and probabilistic models of risk in banks, business and quality” (St. Petersburg, Nauka, 1999) by the author of the presented book E. D. Solojntsev, and V. V. Karasev, V. E. Solojntsev I already wrote that they open new fields for application of rigorous analytical methods of estimation, analysis and investigation of the risk in economics and engineering. In those forewords I expressed the hope, which I am glad to express again, that the new logic and probabilistic methods of risk estimation will have happy fortune.

In many respects the occurrence of this new book is stimulated by E. D. Solojntsev’s activity for organization of International Scientific Schools “Modelling and Analysis of Safety and Risk in Complex Systems” (St. Petersburg: June 18–22, 2001; July 2–5, 2002; August 20–23, 2003). Russian and foreign scientists and experts presented more than 300 papers on the Schools devoted to the problems of safety and risk in economics and engineering.

For many years the author worked in industry in the field of designing and testing of complex engineering systems. Now he works in an academic institute, where he is engaged in risk problems in engineering, banking and business. His achievement in the risk field were noticed by Universities of Germany, Japan and Switzerland, where he was invited for scientific collaboration.

The experience and the knowledge allows the author to propose the uniform logic and probabilistic (LP) approach to the risk estimation and analysis both in engineering and economics, and to lay foundation for systematization and formation of the risk LP-theory and, as well as to create the scientific principles of the scenario LP-management by risk.

The titles of author’s papers such as “the logic and probabilistic **estimation**”, “the logic and probabilistic **models**”, “the logic and probabilistic **approach** to the risk analysis”, despite the clearness of the

terms separably (they are well known for many people, who are far from the risk analysis in engineering, economics, politics) require some explanation for their combination “logic and probabilistic”).

Unfortunately, most of books in the field published in Russian, including “Mathematical encyclopedia dictionary” [M., “Soviet encyclopedia”, 1988, 846 p.], avoid definition of the probabilistic logic, as a logic of statements, accepting a set of degrees of plausibility, that is the values are contained in the interval between “truth” and “false”.

As the revolutionary break in the development of **the inductive logic** George Boole’s paper “Mathematical analysis of the logic being experience of calculus of the deductive reasoning”, published in 1847, should be mentioned. The **calculus** of statements is the essence of mathematical logic and the new step in development of the formal logic.

One of the fathers of the mathematical theory of the information Clod Elwud Shannon succeeded to close the gap between the logic algebraic theory and its practical application. In the D.Sc. dissertation (1938) he developed principles of the logic model of the computer, *by connecting Boolean algebra with the functioning of electrical circuits*. The success of his ideas concerning connections between the binary calculus, the Boolean algebra and electrical circuits, Shannon explained as follows: “Simply it is happened so, that nobody else was acquainted with both areas simultaneously”.

The necessity of quantitative estimation of non-failure operation of complex technical structures at the beginning of the 60s XX century stimulated **the so-called logic and probabilistic calculus (LPC)** which is a part of the mathematics treating rules of calculus and operating with statements of two-value logic. LPC is based on the logic algebra and rules of replacement of logic arguments in functions of the logic algebra (FAL) by probabilities of their being true and rules of replacement of the logic operations by the arithmetic ones.

In other words, with the of help of LPC it became possible to connect the Boolean algebra with the probability theory not only for the elementary structures, but also for the structures, whose formalization results in FAL of iterated type (bridge, network, monotonous). This original “bridge of knowledge” includes some proven theorems, properties and algorithms, which constitute the mathematical basis of LPC.

Investigation of the safety problem has resulted in development of **the original logic and probabilistic theory of safety (LPTS)**, which allows to estimate quantitatively **the risk** of system (as a measure of its danger) and to **rank** the contribution of separate arguments to the system danger (in the case of an absence of truth probabilities of

initiating events). The ranking of arguments under their contribution to the system reliability was proposed by me in 1976 in the monograph [Reliability of Engineering Systems. Principles and Analysis. Mir Publishers, Moscow, 1976, 532 p.] with the help of introduction of concepts: “Boolean difference”, “weight” and “importance” of an argument.

The aim of the author, from my point of view, is the connection of the logic and probabilistic calculus used in the field of technical systems, with questions of risk in economics and organizational systems.

Studying the works by the author, I realized that these economical and organizational systems essentially differ from technical ones, and the direct carrying the knowledge and results of LPC from area of engineering into area of economics is not effective, and sometimes and it is not even possible. It is likely that much time and many efforts will be needed so that the new approaches in the logic and probabilistic calculus could make the same revolutionary break in the financial market, what was made by George Boole in development of the inductive logic in the middle of XIX century, and by G. Markowitz in the choice of the optimal security portfolio with the help of the analytical theory of probabilities in the middle of XX century.

The author presumably not wishing to simplify solutions of real problems of risk has selected the algorithmic method as the basic method. In this connection it is useful to quote the Academician Ya. Tsipkin: “Algorithmic approach to resolving extreme problems enables to use modern computers and not to squeeze the problem conditions into Procrustean bed of the analytical approach, that usually move us far beyond from those real problems, which we really wanted to consider”.

The existing publications on the management LP-theory by risk are not complete, have small circulation and are not known for a wide community of experts. The typical difficulty in mastering by the scenario LP-management by the risk in economics and engineering, can be explained the fact that the risk LP-theory and such scientific disciplines as the LP-calculus, the methods of discrete mathematics and combinatorics are not usually included into the educational programs of high schools. Therefore publication of the given monograph devoted to the LP-management by risk, seems to be actual.

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of Natural Sciences,
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