Preface

This monograph is aimed at presenting a smooth and unified transition from the general fractional programming (or program) to the semi-infinite fractional programming (or program), especially in terms of framework for theoretical foundation and real-world applications, some new classes of generalized second-order invex functions and second-order univex functions, new sets of second-order necessary optimality conditions, numerous sets of second-order sufficient optimality conditions, and several sets of second-order duality models for establishing numerous duality theorems for a discrete minmax (or maxmin) semi-infinite fractional programming problem. Under the current interdisciplinary computer-oriented research environment, semi-infinite fractional programming is among the most rapidly expanding research areas in terms of its multifacet applications empowerment for real-world problems that can be handled by transforming them into semi-infinite fractional programming problems.

A mathematical fractional programming problem with a finite number of variables and infinitely many constraints is called a semi-infinite fractional programming problem in the literature. On the other hand, mathematical fractional programming problems with a finite number of constraints are referred to as generalized fractional programming problems, and they have been the focus of more research endeavors in terms of providing realistic models for some significant real-world problems, including the problems encountered in multiobjective programming, approximation theory, goal programming, facility location planning, and economics, and their mathematical tractability (they can be transformed into equivalent parametric nonlinear programming problems with nonfractional objective functions).

As a matter of fact, in mathematical optimization programs, a fractional programming (or program) is a generalization to linear fractional programming. These problems lay the theoretical foundation that will enable us to fully investigate the second-order optimality and duality aspects of our principal fractional programming problem as well as the semi-infinite counterpart, which is the main focus of this monograph to empower graduate students, faculty, and other research enthusiasts for more accelerated research advances with significant applications in the

interdisciplinary sense without borders. The main ingredients of this presentation are as follows:

Parametric Optimality
Parametric Duality
Parameter-free Optimality
Parameter-free Duality
Nonfractional Optimality
Nonfractional Duality

There are some quality books and surveys on generalized fractional programming problems, while it seems there are no such references exclusively in semi-infinite fractional programming other than some surveys in the literature since semi-infinite fractional programming is a new fast-developing research field transitioning from the generalized fractional programming. Furthermore, the methodology (the use of alternative concepts, partitioning schemes, and duality models) adopted in this book, as well as for the main results, will prove useful for other classes of nonlinear semi-infinite fractional programming and beyond. The generalized fractional programming problems have a wide range of real-world problems, which can be transformed into some sort of a generalized fractional programming problem.

Let us consider fractional programs that arise from management decision science. If we consider a system efficiency in an economical sense, it is equivalent to maximizing system efficiency leading to fractional programs with occurring objectives:

Maximizing productivity
Maximizing return on investment
Maximizing return/risk
Minimizing cost/time
Minimizing output/input

We envision that this monograph is a unique presentation of interdisciplinary research for the world scientific community (including graduate students, faculty, and general readers). Furthermore, some of the new concepts can be applied to duality theorems based on using a new class of multitime multiobjective variational problems as well.

I am extremely grateful to Prof. G.J. Zalmai, Northern Michigan University, for giving me tremendous opportunities for collaborative research, especially relating to semi-infinite fractional programming problems in a series of research publications, while most of the new concepts are already referred to as Zalmai-type sonvexities and Zalmai-type sounivexities in the literature. Furthermore, I express my deepest appreciation to Prof. R.N. Mohapatra, University of Central Florida, for his guiding star roles during my academic adventures and beyond.

San Marcos, USA Ram U. Verma
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Verma, R.U.

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