Digital terrain modeling is an important task in several geospatial information applications. Digital Terrain Models (DTMs) are used, for instance, for orthophotos generation, 3-D city modeling, Flight simulation, and virtual battlefield training. Recently, Digital Earth (DE) (e.g., Microsoft Virtual Earth and Google’s Earth) is being explored and implemented as an organizational framework for information about the Earth by allowing the users to interact, to search, and even to simulate over a virtual rendering of the planet. Hence, DTMs will become a critical enabler for several anticipated applications of DE, for example, visualization, and walk-through in mountainous areas that cover large regions or even continents.

This book aims to fill a critical ground in the methods of digital terrain modeling. According to the authors, this book is suitable as an MSc-level GIS textbook, or for researchers and practitioners in geosciences. Based on our experience, this book is also suitable as a textbook for senior undergraduate students in photogrammetry or geomatics in general, civil engineering, and even computer science students who are majoring in computer graphics, computer vision, and/or 3-D game development. This book requires a medium working knowledge in several subject areas, such as statistics, spatial analysis, numerical analysis, linear algebra, and computational geometry. This book synthesized the knowledge of these subjects into a well coherent structure. Consequently, this book can be viewed as digital signal processing for the 3-D geometrical point patterns data, or more specifically, “geometrical signal processing”. For example, the reader will come upon sampling, modeling methods, interpolation, quality control, accuracy, and multi-scale representations, which are classical topics in the signal processing community.

This book contains fifteen chapters. It starts with a very nice introduction chapter that covers the digital terrain modeling from several integrated perspectives. The result of this integration is well reflected by presenting the digital terrain modeling as a central activity surrounded by data acquisition, data manipulation and management, computation and modeling, and applications. In addition, the introduction offers a workflow diagram for the process of DTMs generation, which is very helpful for students as well as practitioners.

The second chapter covers qualitative and quantitative terrain descriptors and sampling strategies. The quantitative descriptors are confined to the frequency spectrum, fractal dimension, curvature, covariance and auto-correlation, and semivariogram. The sampling
strategies are classified to statistical-based sampling, geometrical-based sampling, and feature-based sampling.

Chapter three provides a general overview for the data collection techniques for DTMs. These techniques are: photogrammetry, radar, LIDAR, cartographic digitization, and GPS direct data collection.

Chapter four provides a general overview of several modeling methods for the digital terrain. These techniques are point-based, triangular-based, grid-based, and hybrid-based surface modeling. The triangular irregular networks (TIN) method was touched very briefly in this chapter. Chapter five is completely dedicated to the generation of TIN. Then, chapter six offers several interpolation schemes for terrain data.

Chapter seven addresses the quality control in terrain data acquisition with strong emphasis on gross-error detection. As a minor shortcoming, there is no use or adaptation of robust estimation, such as M-estimator, in gross-error detection. Beside robust estimation, gross-error detection would also benefit from statistical bootstrapping and model selection. Chapter eight addresses the accuracy aspects of the obtained DTMs using empirical and theoretical models. Then, chapter nine switches to the multi-scale representations of DTMs. Although there are well-known mathematical techniques for multi-scale representations, such as Gaussian smoothing, the authors argue for an empirical technique called “the natural principle”.

Chapter ten addresses the pragmatic aspects of DTMs data management using databases and files. In addition, it also addresses the compression of DTMs data along the classical lines of digital image compression. This is a very nice chapter, particularly, for the practitioners and programmers who are directly involving in the generation of DTMs.

Chapter eleven and twelve deal with the mathematical aspects of contouring and visualization respectively. The mathematical modeling of visualization, presented in this chapter, can benefit greatly from the continuous development in computer graphics and computational geometry.

Chapter thirteen is concerned with the interpretation of the DTMs using a simple set of parameters. It is structured around three major themes of parameters. The first one is concerned with geometric terrain parameters, such as volume, slope, and aspect. The second one is the hydrological terrain parameters, such as flow directions, flow accumulation matrix, and flow lines. These parameters are used collectively to infer the drainage networks and catchments. The third theme is concerned with the visibility terrain parameters such as line of sight analysis. This chapter does not address the issue of break-lines extraction, which is very fundamental in several applications such as orthophotos generation. As a side remark, but not as a shortcoming, it worth mentioning in this chapter the complexity brought by new applications of DTMs such as man-made objects extraction (e.g., roads and buildings) and the difficulty associated with their parametric or non-parametric modeling. Although these issues were touched very briefly at the beginning of chapter fifteen under digital terrain modeling with complex construction, it may be better to group them with this chapter because they have natural fit with the advocated parameter themes.

Chapter fourteen highlights very briefly five application domains for the DTMs. These domains are civil engineering, remote sensing, military engineering, resources and environmental
management, and marine navigation. Indeed, several other domains will benefit from this book such as 3-D medical imaging and 3-D CAD modeling because they share some of the intrinsic aspects of digital terrain modeling. Chapter fifteen concludes the book with the notion of what is beyond. Three areas were touched very briefly in this chapter, namely, manual and semi-automated building modeling, digital Earth representation (DE), and three dimensional modeling.

On the whole, regardless of the minor shortcomings discussed previously, this book will be welcomed by its target audience with pleasure and great appreciation. Its content is well-explained, very readable, and there are reasonable details to implement its algorithms. It summarizes the important development in digital terrain modeling and it sets the stage to move on to address new challenges ahead.