# Foreword

*The world is continuous the mind is discrete.*

*David Mumford (born 1937)*

Recently, I was confronted with the problem of planning my travel from Israel to New Zealand, home of the two authors of this book. When taking two antipodal points on the globe, like Haifa and Queenstown, there is an infinite number of shortest paths connecting these points. Still, due to constraints like reachable airports and airlines, finding the optimal solution was almost immediate.

Throughout the long history of geometry sciences, the problem of finding the shortest path in various scenarios occupied the minds of researchers in many fields. Even in Euclidean spaces, which are considered simple, the introduction of obstacles leads to challenging problems for which efficient computational solvers are hard to find. The optimal path in 3D space with polyhedral obstacles was among the first geometric problems proven to be, at least formally, computationally hard to solve. It took almost 20 years for a team of 5 programming experts to eventually implement a method approximating the continuous Dijkstra algorithm that is reviewed in this book. Exact problems are hard to solve, and approximations are obviously required.

My personal line of work when dealing with geometric problems somewhat differs from the school of thought promoted by this book. A numerical approximation in my vocabulary involves the notion of accuracy that depends on an underlying grid resolution. This grid is defined by sampling the domain of the problem and leads to the field of numerical geometry in which efficient solvers are simple to design.

The alternative computational geometry school of thought describes obstacles as polyhedral structures that allegedly define the "exact" problem. The resulting challenges under this setting are extremely difficult to overcome. Still, the unifying bridge between these two philosophical branches is defined by the geometric problems. Without being familiar with the difficulty involved in designing a path between points in a weighted domain, one could not appreciate the conceptual simplicity of numerical Eikonal solvers.

This book addresses the type of hard problems in the computational geometry flavor while inventing constraints that allow for efficient solvers to be designed. For example, the creative rubberband methods explored in this book restrict the optimal paths to bands of bounded width, thereby redefining problems and simplifying the challenges, proving yet again Aleksandr Pushkin's observation that "*inspiration is needed in geometry, just as much as in poetry.*" I hope that, like me, the reader would find the geometrical challenges introduced in this book fascinating and also appreciate the elegance of the proposed solutions.

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*Ron Kimmel*