# Biking Route Planning Based on Target Calorie Comsumption

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Cycling becomes more popular recently, because it is not only environmentally friendly, but also a more pleasant way to lose weight. Conventional researches in route planning usually focus on selecting a route of minimum time, distance, or risks. This thesis, on the other hand, aims at methodologies to generate a least risky biking route that satisfies the calorie consumption requirement specified by the cyclist. We first introduce methods to estimate risks associated with nodes or arcs and propose a calorie consumption formula that takes the 3-dimensional geographical data over each route segment, the biking velocity and weight of the cyclist, and the speed and direction of the wind into consideration. Three categories of biking routes: simple paths, eulerian subgraphs, and general circuits are investigated. These are NP-hard integer programming problems. Their IP formulations have to include plenty of subtour elimination constraints due to the lower bound in the calorie consumption.

The problem of seeking an optimal biking route of the first category (i.e. an optimal simple path) can be viewed as a specialized constrained shortest path (CSP). We have exploit variants of conventional CSP methodologies such as K-shortest path (KSP) algorithms and Lagrangian Relaxation (LR), but found they both consume too much time. We then develop variants of Genetic Algorithms (GA) and Particle Swarm Optimization (PSO) heuristics to efficiently calculate an optimal biking route. Moreover, we also derive valid inequalities that generate new cuts in the branch-and- cut scheme and conduct preprocessing to simplify the network, so that the IP solution time is further reduced.

To effciently seek optimal biking routes that are circuits, we also propose a few GA and PSO heuristics that involve different encoding mechanisms. Computational experiments indicate our proposed PSO heuristics are more effcient and effective than the state-of-the-art IP solver and GA, for solving these three categories of biking routes, and thus are suitable for real-world implementation.

***Keywords*:** biking route, calorie, integer programming, Genetic Algorithm, Particle Swarm Optimization

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