

# A Trial of Evacuation Route Planning Based on Genetic Algorithm for Dealing with Real-World Problem

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## ABSTRACT

From the viewpoint of ICT-based disaster prevention design, evacuation route planning is one of the hot topics to be solved. Since we have quite a lot of natural disasters these days, its role has become important more and more than before. In order to deal with this tough problem, a genetic algorithm (GA) is adopted, and a revised selection procedure for preserving variety of individuals in each generation is introduced. As a result of some computer simulations applied to Hizen-Hamashuku, one of the model areas in this research project, it is found that the proposed method is effective.

Keywords : evacuation route planning, genetic algorithm (GA), variety, Hizen-Hamashuku, ICT-based disaster prevention design (ICTDPD).

## 1. Introduction

Recently, we have quite a lot of natural disasters, and such situation will not be changed near future. Coincidentally, there was a big earthquake in the center of Kyushu Island last April. Then, evacuation route planning is one of the crucial topics in case of emergency. In the preceding study, a genetic algorithm (GA) is employed to solve this kind of task [1]. Its basic idea is working well, but an adopted model city is too simple to evaluate its effectiveness. As a next step, a complex model city is adopted here for dealing with an upcoming real-world problem.

## 2. Overview of previous study

A route planning task with multiple goals is tried based on the evolutionary manner in the previous study [1]. From the viewpoint of an analogy with the evolutionary theory, a GA-based method is carried out by repetition of i) selection, ii) crossover, and iii) mutation from generation to generation for aiming at reduction of a pre-defined cost function. Its primal objective is to find out the shortest pathway to the nearest goal, but to find out alternative shortest pathways to the other goals is also considered. Because it is a preliminary study, a simple model city consisting of only ten nodes, each of which corresponds to an intersection, is adopted. As a result of some computer simulations, it showed good performance which we have intended in advance.

By the way, we have been studying an ICT-based disaster prevention design for these several years, and Hizen-Hamashuku in Kashima City, Saga Prefecture,

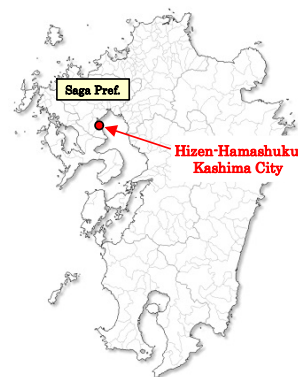


Figure 1. Location of Kashima City in Kyushu Island

Japan is one of its model areas [2]. It is a preservation district of historic buildings, and its location is shown in Figure 1. Then, as a next step, the above-mentioned framework is introduced into a real-world problem as a case study. Not shown here for brevity, a direct extension of the conventional method is not sufficient, and most trials are ended in failure. This is why the task size affects its performance. Moreover, losing variety of surviving individuals must be a serious problem, because their offsprings never invent any new characteristics.

## 3. Computer simulations

### 3.1 Methods

First of all, 36 intersections are selected from the map of Hizen-Hamashuku, and its graph-based

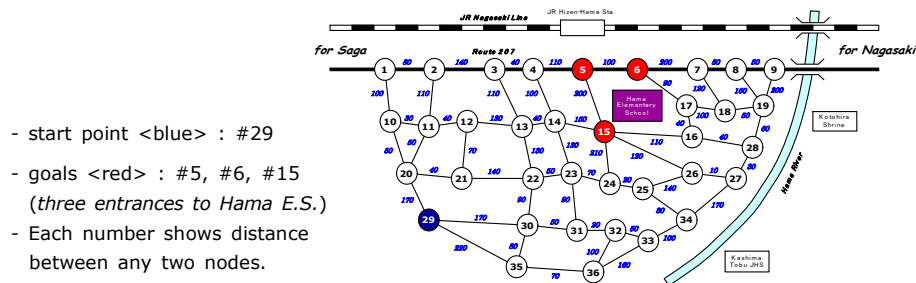


Figure 1. Graph-based representation of Hizen-Hamashuku in Kashima City, Saga Prefecture, Japan

Table 1. Results of computer simulations --- the total refuge length for each trial

trial #	1	2	3	4	5	6	7	8	9	10	total score
conventional method	-	-	580	580	580	590	580	590	710	-	7/10
optimal solution type			ii	ii	i		ii				4/10
proposed method	580	580	580	580	670	580	580	820	580	580	10/10
optimal solution type	ii	i	i	i		ii	ii		ii	ii	8/10

representation is summarized in Figure 2. In this map, three nodes such as #5, #6, and #15 are identified as entrances to Hama Elementary School, and all refugees will move toward one of them in case of emergency. Under the above-mentioned condition, 6000 individuals (parents) are determined by random numbers distributed uniformly. Each individual has 36 genes, and their arrangement corresponds to the intersections one-by-one serially from an arbitrary start point to the refuge place. Once its heading part of each gene sequence reaches the goal successfully, the remaining part is ignored. The evolutionary procedure is repeated for 6000 times to reduce the total refuge length. In the selection phase, the worst 600 individuals are eliminated at first, and then the best 600 individuals are duplicated instead. But for the sake of preserving variety of individuals in each generation, the identical individuals are deleted prior to the other ones even though they show good performance. And, a cyclic crossover is employed not to generate any individuals (offsprings) containing the same genes simultaneously. Any mutations are not considered here for simplicity.

### 3.2 Results

In this study, ten different kinds of initial states are prepared, and a task to find out any pathways starting from the node #29 is tried. According to Table 1, all trials can reach the goal (10/10), and eight trials can find out the shortest pathway successfully (8/10). In this case, there are two optimal solutions, whose total length is 580, as follows:

- i) #29 - #20 - #11 - #12 - #13 - #14 - #15,
- ii) #29 - #30 - #22 - #13 - #14 - #15.

An overview of the previous study is also summarized in Table 1. It clearly says that the proposed method shows a better score than the conventional method.

One of urgent problems that we want to point out here is a computational load. Generally speaking, the GA-based method costs a lot, so how to save it is essential from the viewpoint of practical application.

## 4. Conclusions

In this article, evacuation route planning is tried from the viewpoint of ICT-based disaster prevention design, and the GA-based framework is introduced into a real-world problem as a case study. The key aspect proposed here is how to preserve variety of individuals in each generation during the selection phase. As a result of computer simulations, it is found that the proposed method shows a better score than the conventional method, and it is concluded that the proposed method is effective.

## 5. Acknowledgements

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