(Year of 2004-2005)

Possible Topics of Diploma Thesis for Undergraduates

Akira Imada

The topic of this year.

The topics of this year are exploration of a simulated desert. Two of them are by a jeep and the other is by ants. *"A Jeep in a Desert Problem"* is an extention of the classical *"Jeep Problem"*, that is, how far a jeep can penetrate into the desert with a constraint about gasoine.

Three candidate topics

(1) A Jeep in a Desert Problem — An approach by messy-Genetic Algorithm (m-GA)

- We design a jeep which can explore a desert with a maximum distance given an amount of petrol. We employ here a so-called m-GA which evolves a populatin of the flexible length of chromosomes. It would be interesting to observe the evolution from a simple structure to complex ones.

(2) A Jeep in a Desert Problem — An approach by growing Finite State Machine (FSM)

- The action of the jeep is determined by a FSM. The structure of the FSM is also evolved here from a simplest to a very complex one.

(3) Ants in a Desert Problem — An application of Ant Colony Optimization

- Instead of the Jeep, here we observe a group of ants whose intelligence is evolved.

To Know more in detail

"A Jeep in a Desert" is a 2-dimensional extention of the classical *"Jeep Problem"* of 1-dimensional world. Bellow, find a brief explanation on what is Jeep Problem, how we extend it and how Ant's behavior instead of Jeep look.

Jeep Problem

Assume we have a Jeep at the base which locates at the edge of a desert. The Jeep has a tank which can be filled with a maximum of one-unit of gasoline. With one unit of gasoline, the jeep can move one unit of distance. The Jeep can only fill gasoline at the base. The jeep can carry empty container(s) to put its gasoline on the desert for a future use. Assume the tour should be on the streight line in the desert.

The question is "How far the jeep can penetrate into the desert on the straight road when n unit of gasoline is available at the base.

For example when $n = 2$, the best strategy is to start the base with one unit of gasoline in its tank and go 1/3 unit distance (it has spent 1/3 unit of gasoline to reach the point), then put 1/3 unit of gasoline in the container there (now jeep has 1/3 unit of gasoline in the tank) and go back to the base. Exactly when the jeep arrive to base all gasoline filled at the start was spent. Then jeep fill the 2nd unit of gasoline given, go 1/3 unit fill the gasoline that was previously put and the tank is again full, then go forward until all the gasoline in the tank will be spent. Therefore the maximum distance the jeep can go is 4/3 unit of distance.

Guess the maximum distance when $n = 3$. We already know the maximum distance with n unit ofgasoline is D_n is expressed as the recursive relation $D_n = D_{n-1} + 1/(2n - 1)$.

Our interest is on whether an evolutionary computation can find an almost optimum strategy, say, when $n = 5$ in which maximum distance is 1323/945=1.4. (If my calcuration is correct. Try it by yourself).

Jeep in a Desert Problem

"A Jeep in a Desert Problem" is a new original problem extended from the above mentioned classical *"Jeep Problem"*, which I now think of proposing in some International conference.

Instead of penetrating into the desert on the 1-dimensional streight line, we assume a 2-dimensional desert which is divided into $n \times n$ grids. A possible objective of the jeep is to find exit in an opposite end of the desert, or visit as many grids as possible. Like the original vergion, the jeep can put gas at some of the grids for a future use. Some grids might contain obstacle which avoid the jeep to enter into the grid.

Ants in a Desert

Instead of jeep, ants explore the desert. After exploring the desert, at least one of the ants should reach the exit. The desert is too large for an ant to reach the exit without eating food during his/her journey. Hence ant should carry some foods, but ant has a limit of amount of food to carry at a time. Interesting, isn"t it?

Have fun and Best of luck.