A New Model to Realize Variable Size Genetic Network Programming

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Genetic Network Programming (GNP) [1] is an extension of Genetic Programming motivated by the strong expression ability of graph. A program in GNP is an arbitrary directed graph, composed of nodes connected to each other by directed arcs. Figure 1 shows the basic scheme of GNP system. Previously, the program size of GNP was fixed. In the paper, a new method is proposed, where the program size is adaptively changed depending on the frequency of use of nodes. Generally, large programs have high expression ability, while their evolutions are disturbed by their enormous search spaces, also they occupy many memory resources and consume much calculation time. To control and to decide a proper program size are important and difficult problems in Evolutionary Computation. We introduce two additional operators, *add operator* and *delete operator*, that can change the number of each kind of node functions in a GNP program based on the degree of contribution of a node function to the fitness value.

A GNP program is composed of *judgement nodes* (Js), *processing nodes* (Ps), and a specific *start node*. A judgement node performs a kind of judgement function, then it transfers control to one of nodes connected by its arcs according to the judgement result. That is, the judgement nodes are conditional branch decision functional nodes. A processing node performs a kind of action function, then it transfers control to a node connected by its arc. A program run starts from the start node. The continuous control flow through a GNP program can express an intelligent and complicated program, because a graph can include the temporal information and sequential information implicitly.

The basic concepts of the proposed two operators are the following simple and valid rules. A frequently used node function through a program run would be an important node function, then the node function should be added; on the contrary, a scarcely used node could be unimportant node, then the node should be deleted. That is, the proposed method varies program sizes not by applying genetic operators randomly, but by taking account of the interaction between the current program and the environment properly.

Simulation results show that the proposed method is clearly of great advantage to evolve GNP programs. It seems that the proposed method saves the time to seek the proper initial program size and reduces the anxiety of the program bloat. Moreover, these additional operators can automatically distinguish important node functions from unimportant node functions for the target environment.

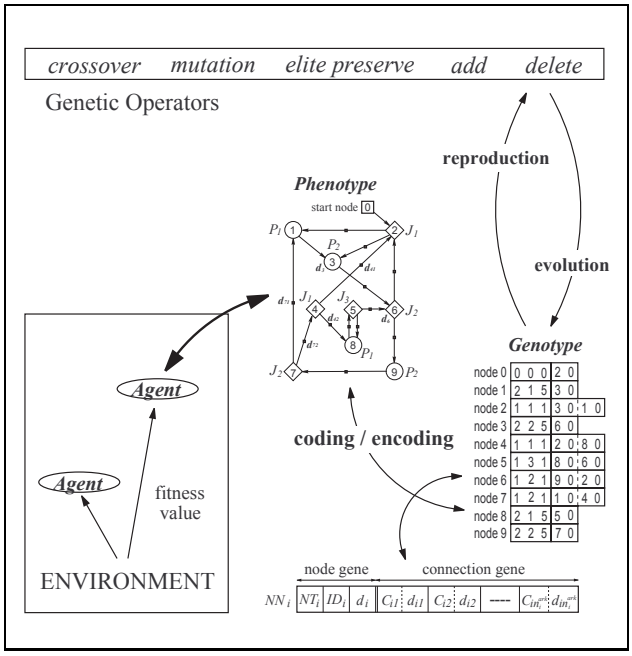

Figure 1: The Basic Scheme of GNP System

References

[1] Katagiri, H., Hirasawa, K., Hu, J., and Murata, J. (2001). Network structure oriented evolutionary model-genetic network programming-and its comparison with genetic programming. In Goodman, E. D., editor, *2001 Genetic and Evolutionary Computation Conference Late Breaking Papers*, pages 219–226, San Francisco, California, USA.