Fast and Robust Convergence of Chained Classifiers by Generating Operons through Niche Formation

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To handle complex tasks, classifier systems need to form internal structure such as long chains and default hierarchies. However, some studies have reported that such structures are quite instable within normal classifier systems (CSs) (Wilson & Goldberg, 1989). On the other hand, in genetics, there are some interesting mechanisms that can be applied to classifier systems. An operon is a genetic unit that is a conjunction of genes activated together, and an ideal form to maintain long chains stably under genetic operation.

Two CS implementations of operons have been proposed elsewhere; *corporations* and *chunks*. A corporation is coupled successive classifiers and encapsulates internal message passing to avoid long chain instability, which is proposed by Wilson & Goldberg (1989), and implemented partially by Smith (1995) and fully by Tomlinson & Bull (1998). However, their implementation is based on a mutation type operator to form corporations so that it is less plausible to accomplish high performance efficiently. A chunk is a meta-classifier that has an arbitrary number of conditions and actions (Weiss, 1994). Since strength-based criteria are used to form and dissolve chunks when two classifiers are activated sequentially, it is more plausible to perform well than mutation type operators.

We propose a new type of operon classifier system (OCS) that employs a locking mechanism to generate operons. OCS is based on a niche CS that employs fitness sharing, covering, and restricted mating to maintain diversity of classifiers. An action set is *locked* when $avg_{as} \geq \sigma * avg_{whole}$, and *unlocked* vice versa, where σ is a control parameter. No new classifier is added to a locked action set so that the action set performs stably under genetic reproduction (a match set is also locked in the same way). An operon is a set of action sets and formed when two consecutively activated action sets (or operons) are both locked. If an operon performs badly, a *cut-tail* operator is invoked to cut the last-added action set off.

We conducted some boolean function experiments whose appropriate chain length is 3, and results are shown in Figure 1 (results are consistent under some parameter settings). As it shows, OCS outperforms normal CS, and lock-based OCS displays better performance than strength-based OCS. Furthermore, we found that locking has an effect to hold down the number of match sets (approx.1/100 of non-locking). Thus, lock-based OCS enhances computational efficiency while it ingeniously maintains long chains.

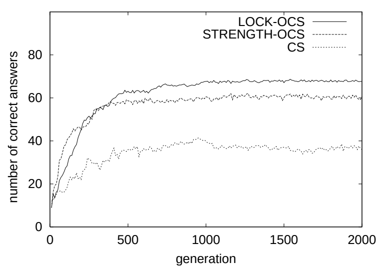

Figure 1: Results

References

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