Self-adaptive networks with history extrapolation, evolutionary selection and real-time response

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Abstract

The paper proposes an alternative routing mechanism for dynamic and reconfigurable communication networks. Distance-based routing algorithms are the most widely deployed but they do not take into account multi-link possibilities, dynamic response and other technical factors that could improve the overall network performance.

The Self Adaptive Evolutionary Network (SAEN) architecture proposes a modern approach on resource utilization by combining load-balancing technologies, history behavior analysis and genetic algorithms for enforcing the optimal routing solution. Unlike traditional routing in which the next-hop decision is done at the transited node, SAEN proposes a holistic routing system with the help of classifiers. In this context, a classifier is a set of properties that define the inbound traffic and impose minimum requirements for that traffic and a tolerated deviation. Thus, it is possible to use this approach for any type of communication network. Edge nodes to not make routing decisions but rather enforce the system-wide ones.

Each possible route, from entry to exit, in the Autonomous System is a chromosome. Each chromosome has its history stored for evaluation purposes.

\[
Cf = \{\text{InputFilter}((\text{sourceAS, proto, QoS, others})) \}
\]

\[
\text{Param}_1 \{\text{Name} (\text{Latency, Bandwidth}) \text{ Min/Max tolerated value}\}
\]

\[
\text{Fitness weight}
\]

\[
\ldots
\]

\[
\text{Param}_N
\]

Classifier. Configurable filters and parameters. Fitness function. \(C=\) chromosome. \(Cf=\) Classifier.

The fitness function is the core element that governs how the route for a specific classifier, the chromosome, is chosen. In a genetic algorithm, the current population of chromosomes is evaluated by the fitness function and, as a result of this operation, a new generation of chromosomes could emerge or the algorithm could stop. In each generation, relatively good solutions are reproduced. These solutions (chromosomes) are selected for propagation and bad solutions disappear.

Genetic algorithms represents one of the techniques for solving multi-criteria optimization problems, based on genetic and natural selection who can offer solutions for high complexity problems, such as searching for a solution in SAEN. Optimal solutions are being evaluated according to their history. The search is done with a genetic algorithms that uses standard operators (crossover, mutation). Each chromosome is scored by the fitness function. Based on its history, it is possible to predict how a certain link will behave, ahead of time.

Although there are other approaches of using artificial intelligence in computer networks (for example [1],[2],[3]), the unique factor in the presented method is combining such an approach with behaviour prediction, based on data sampled in time.

References


