Surrogate-assisted evolutionary computation: Recent advances and future challenges - SUMMARY

Yaochu Jin

Surrogate assisted evolutionary computation can be used in solving multi and single objective problems, but it's also a method for addressing dynamic optimization problems, constrained optimization problems and multi-modal optimization problems. Surrogate assisted evolutionary computation is, inter alia, a way to reduce computational time in evolutionary optimization of expensive problems, which has been the main motivation behind its development.

Surrogates are in principle used with the real fitness function. Population initialization, crossover, mutation and preselection to pre-screen candidate solutions are tasks where surrogates are used for. When used for the former three tasks, surrogates can reduce randomness in genetic operators, rendering them informed operators. Individual-based, generation-based and population-based are the general divisions for managing surrogates.

In surrogate-assisted evolutionary computation the essential question is "which individuals should be chosen to be evaluated or re-evaluated using the real fitness function". When evaluating individuals, an uncomplicated way to do it is evaluating the individuals that have a good fitness value. The higher is the approximation accuracy the more often a surrogate should be used. Another way to choose individuals for re-evualation is clustering the population into a number of crisp or fuzzy clusters. The high-dimensionality in the design space is one of the main difficulties in improving approximation accuracy. A surrogate can be built in a new space of a lower dimension to overcome this difficulty. That can be done with dimension reduction techniques.

In real-world optimization problems it is not only the performance of the obtained optimal to be concerned about, but also the sensitivity of the performance to small changes in the environment or design variables. We talk about robust optimization solutions when an optimal solution is not sensitive to such changes. For robust solutions with evolutionary algorithms, both implicit averaging and explicit averaging can be used. Sometimes in real-world applications an explicit constraint does not exist, which may result in unstable computational fluid dynamic simulations. Surrogates can be used to avoid time-consuming unstable computational fluid dynamic simulations to judge whether a solution is feasible or not.

The effectiveness of surrogate-assisted evolutionary computation has to be demonstrated in real-world applications because it is a more application-driven way of optimization.

Eero Lantto