Finding Wavelet Packet Bases with an Estimation Distribution Algorithm

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Abstract

EBBA - a new Estimation Distribution Algorithm is introduced. The aim of the paper is to show that an adequate knowledge of the structure of the problem can allow the construction of efficient evolutionary algorithms.

1 Evolutionary Best-Basis Search

EBBA is an Estimation Distribution Algorithm that uses the same dependency graph in all generations (Muehlenbein and Ochoa 1998). Given a signal, it computes the best basis of a wavelet packet tree. The graph is constructed based on the tree-like structure of the wavelet packet. A non evolutionary method for this task, the Best-Basis Algorithm (**BBA**), was introduced in (Coifman and Wickerhauser 1992).

The **BBA**, searches an L-level decomposition of an $N = 2^L$-sample periodic signal requiring O(N) comparisons. However, very often the cost of computing the best-basis is very high. Some work have been done to reduce the cost of the **BBA**. In (Marpe et all 96) a Complexity Constraint Best-Basis (**CCBBA**) algorithm was introduced for image and video coding.

The key part of any EDA algorithm is the estimation of the distribution of the selected gene pool. In **EBBA** we use the tree like structure of the wavelet packet. Having the nodes of the tree labeled, top-down and left to right with the integers from 0 to $2^L - 2$. A candidate best-basis solution is represented by a random vector: $< b_0, b_1, \ldots, b_{2^L-2} >$ where the b_i take values in $\{0, 1, 2\}$, and $b_j = 0$ when the j-node belong to the basis; $b_j = 1$ when the j-node is expanded to get the basis and $b_j = 2$ when the j-node is below a node belonging to the basis.

We model the joint distribution of the selected set with the product of all conditional probability p(child | father). They will be different from 0 or 1 only in two cases: (father=1, child=1) or (father=1, child=0). For these cases the conditional probability are **q** and **q-1**. The value **q** is estimated by $q = \frac{c(child=1, father=1)}{c(father=1)+3}$ where the function **c** just computes the number of bases in the selected set that complain with the condition. The simplest **EBBA**:

- **STEP 0:** Generate $N \gg 0$ legal bases randomly.
- **STEP 1:** Select $M \leq N$ bases. Estimate the distribution $p^s(B,t)$ of the selected set, computing the q-values of each node.
- **STEP 2:** Generate N new bases according to the distribution $p^s(B,t)$. Set $t \Leftarrow t+1$.
- **STEP 3:** If not finished, go to STEP 1.

Conclusiones

The algorithm is extended with some techniques that allow the computation of the selected set without fully evaluating the population. As a result, **EBBA** is able to find the best basis before the whole tree is computed. Unlike the **CCBBA** method the part of the space that is searched is determined automatically. Moreover, unlike the BBA method non-additive functions can be used as well.

References

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