# OMEGA: ON-LINE MEMORY-BASED GENERAL PURPOSE SYSTEM CLASSIFIER

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# ABSTRACT

A *time series* is a sequence of data points in which the order of the data points is important. In many cases, each data point consists of both inputs and outputs. The reason that the time order of such a time series is important may be that at a certain time instant, the outputs are determined not only by the current inputs, but also by some of the more recent inputs and outputs. If we extend the input vector to include those previous inputs and outputs in addition to the current inputs, then the outputs are fully determined by the expanded input vector. Thus, we can transform a time series into a set of data points where the time order is no longer important.

Given a time series, a system classifier's purpose is to determine to which category the underlying system belongs, among a set of pre-defined candidate categories. To do so, our system classification algorithm transforms the time series into a set of expanded data points. It then employs a memory-based classifier to calculate a sequence of probabilities that measure how likely these expanded data points are to belong to each of the categories. Finally, it uses likelihood analysis and hypothesis testing to summarize these classification results. Our method can also handle the classification of non-time series.

Our contributions include: (1) the methodology that decomposes time series classification into the likelihood analysis of a sequence of classifications; (2) a new memory-based classifier that has many desirable properties; (3) re-organization of the memory in the form of a cached kd-tree that greatly improves the computational efficiency of information retrieval and memory-based learning algorithms; and (4) fast feature selection based on intensive cross-validation and greedy searching.

Compared with other methods, our new system classifier is simple to understand, easy to implement, robust for various types of systems, and adaptive to datasets with different densities and/or noise levels. It is capable of distinguishing the various categories of the underlying system without requiring any predefined thresholds. It is efficient not only because it can perform classification quickly, but also because it can focus on the promising categories while ignoring the others after only a few iterations. Based on our empirical evaluations, our method tends to be more accurate than other methods.

# DEDICATION

*To my family.*

*To my advisor.*

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