Efficient Modeling of Analogy

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Abstract. Analogical modeling (AM) is a memory based model with a documented performance comparable to other types of memory based learning. Known algorithms implementing AM have a computationally complexity of $O(2^n)$. We formulate a representation theorem on analogical modeling which is used for implementing a range of approximations to AM with a complexity starting as low as $O(n)$.

1 Introduction

The algorithm for Analogical Modeling (AM) was first published in 1989 [1], and has since remained unchanged with the exception for some minor corrections [1, 2]. Known implementations of AM [2] suffer from having an exponential time complexity $O(n)$ where n is the number of features used to describe a particular example.

AM is a memory based model and constructs a classifier on the basis of a set of examples $\mathcal{D}$. The key computation for the analogical classifier is the construction of the analogical set $\mathcal{A}$ (defined below) associated with an exemplar τ in conjunction with $\mathcal{D}$. We will show that the effect of the analogical classifier is obtained by constructing a generally smaller set $\mathcal{M}$, which, together with a set of parameters C, has the same effect as the original. The aim of this article is to prove that there exists a simpler, yet (roughly) equivalent function to build an analogical classifier, which avoids building the full lattice $\mathcal{L}$ of the original model. The new function uses the set $\mathcal{M}$ and a set of parameters to compute a close approximation. Different parameter sets correspond to different approximations.

2 Background on AM

AM has been used as a simulation model of cognitive psycholinguistics, and it compares well with connectionist models [3, 4]. AM does not suffer from the problems associated with the delta-rule of connectionist learning [3, pp.62 ff], and at the same time it accounts for significant phenomena such as 'perceptual learning, latent inhibition, and extinction [...] within a single mechanism' (ibid. p.62). In fact, there are very few assumptions in AM; there are, for example, no assumption on the distribution of exemplars, nor are global weights calculated.