# Metric Adaptation and Representation Upgrade in an Emotion-based Agent Model*

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The research presented here follows a biologically inspired approach, based on the hypothesis that emotions contribute decisively for humans to cope with complex and dynamic environments. This hypothesis is founded on neurophysiological findings showing that damage in the emotion circuitry of the brain cause inability to handle simple, common life tasks [1]. Inspired by these findings, an emotion-based agent model was previously presented [2], proposing a double-processing of stimuli: a simple representation termed *perceptual image,* designed for fast processing and immediate response to urgent situations, and a complex representation termed *cognitive image,* thus slow to process, are extracted from each stimulus reaching the agent. These two representations are extracted and processed, simultaneously, by the two levels of the architecture: the perceptual and the cognitive levels. The parallelism of the processing is essential, so that quick response to urgent situations is not compromised by the slow processing of the cognitive level. These two representations are then associated and stored in memory. Once the agent faces a new situation, it matches the incoming stimulus with the agent memory, thus retrieving the associated images.

The agent model hypothesizes that the representations matching mechanism proceeds according to two steps. In the first step, a perceptual image is obtained from the stimulus and matched against the perceptual images in memory. For the ones yielding a closer match, the agent, in the second step, matches the cognitive image extracted from the stimulus with those indexed by the closest perceptual images. This mechanism is termed *indexing.* Considering that the cognitive matching mechanism is an operation more complex than the perceptual one, this mechanism allows for a narrowing of the candidate cognitive images, thus providing an efficient algorithm to find cognitive matches. This indexing mechanism was previously formulated and theoretically analyzed, under the assumption that the matching of the cognitive and perceptual images are performed in metric spaces [3]. The goal of the indexing mechanism is then to find the memory pair which cognitive image minimizes its distance to the one extracted from the stimulus, employing the perceptual representation to do so in an efficient manner.

With the issue of indexing efficiency in mind, the research presented here concerns the following problem: how to construct a perceptual representation

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(and metric) with the goal of optimizing the indexing efficiency. In other words, the ideal perceptual representation and metric are the ones that yield small perceptual distances iff the corresponding cognitive distances are also small. To do so, two strategies are explored. One corresponds to adapting a perceptual metric, via a set of parameters, such that cognitive proximity implies perceptual nearness, in a given environment. The second strategy addresses the improvement of the perceptual representation, in the following sense. Assuming that the perceptual representation is a vector of features extracted from stimuli, when these features are not sufficiently representative, the goal is to upgrade the perceptual representation with new, more representative, features. Both of these strategies are approached using Multidimensional Scaling (MDS) techniques [4].

We propose to perform a gradient descent, within the framework of the nonmetric MDS w.r.t. a parameterization of the perceptual metric, instead of w.r.t. the point coordinates. These parameters can, for instance, assign a degree of relevance to each feature of the perceptual representation. Regarding the construction of additional perceptual features, we propose to append each perceptual image with a pre-specified amount of additional components. These components represent the values that the new features ought to take, for each one of the perceptual images in the training set. Their values are randomly initialized, and subject to gradient descent as in the nonmetric MDS. Concerning the obtainment of those added components for new stimuli, the idea we advance is to utilize the obtained values to construct a regression model. That regression model can then be used to obtain the new features values for new stimuli. Details concerning the methodology and the adaptation algorithm can be found in the companion paper [5].

Experimentation have shown interesting results [5], illustrating the proposed methodology. Both metric adaptation and the inclusion of new features were experimented with, using a synthetic world as testbed. Performance evaluations showed a clear benefit in terms of improved indexing efficiency.

## References


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