

Instance Based Manifesto?*

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Abstract

Page's definition of localism is inspired by the instance based paradigm. However, the locality of *representations* is not necessary for a model to be instance based and, on the other hand, explicit featural representations are generally considered local. The important distinction is between instance based and non-instance-based paradigms and not between distributed and local representations as Page claims.

Page's discussion of localist models in Section 2.6 and his list of references makes it clear that when giving his definition he had the instance based paradigm in mind. His localist model supports this interpretation, because its knowledge representation scheme is instance based (weights of output units), its learning method is a version of vector quantization and its decision method is in fact the simple 1-nearest neighbor algorithm with some noise added (Mitchell 1997).

Though Page concentrates on psychological modeling where delicate details are important, I would like to comment on his paper from the more general grounds of artificial intelligence and mathematics. The problem that connects these two fields is catastrophic inference. From a mathematical point of view all learning methods are function approximators. Given the exemplars of some concept (i.e. a subset of a general category), they form a function which can classify all possible inputs. There are differences between the methods but practically every method can be applied to every problem or every modeling task in psychology; there is nothing in principle that could prevent this free applicability and, indeed, this is what we see happening in practice. (For instance Page demonstrates that his instance based model can indeed explain different phenomena.) However, there

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is a major borderline between instance based methods and others: the amount of knowledge stored by the instance based models can be increased anytime while the latter forget everything when taught new examples; this is the price to pay to have fast and effective algorithms. Instance based methods typically run slower and need much more memory but they are flexible and extendable.

Based on the above observations my (simplified) interpretation of Page's suggestion is that – since in psychological modeling computational efficiency is not very important – we should choose instance based models. If this interpretation is correct (which I shall assume henceforth) I agree with the suggestion. My problem is that Page handles the concept of local representation and instance based modeling equivalent which is unfortunately not true. The dimension of the distributed/non-distributed nature of representation and the dimension of the instance-based/non-instance-based nature of the paradigm are independent.

To show this independence in a brief technical paragraph, I will sketch the basic idea of a truly distributed implementation of an instance based memory model. Let us represent our learning samples as vectors of features. Let the values of features be real numbers. Now, let the representation of our knowledge be the sum of these vectors. The recognition operation can simply be taken as the following: if the dot product of the test sample (presented as a vector) and our memory (i.e. the sum of all exemplars) is small then we say the sample is not in the memory; if it is large, then we say it is in the memory (i.e. it is recognized). A mathematical assumption is necessary in order to make the model function properly: the vectors involved must be pairwise (approximately) orthogonal. The number of vectors stored is limited as a function of their length (i.e. the number of features). This model has most of the properties of usual instance based models e.g. it does not suffer from the catastrophic inference problem, since one can always add new vectors to the memory (until its capacity is exceeded). In this framework, generalization and other phenomena can be modeled too. The model is for illustration only. More sophisticated models based on linear algebraic properties of vectors and matrices exist, see for instance (Murdock 1982; Pike 1984; Kohonen et al. 1981).

To summarize: the two dimensions of modeling (the distributed/non-distributed nature of representation and the chosen paradigm) are independent. The instance based paradigm does not exclude distributed implementations, whereas – unlike Page – many of us would consider e.g. explicit featural representations (in models which are not necessarily instance based) localist. Finally, the debate is certainly not confined to the field of connectionism, though instance based models can have connectionist implementations (or visualizations) as in Page's model. Psychological models and learning algorithms should be classified at a more abstract level. The properties of the actual units do not necessarily reflect the behavior of a model in certain situations. I think – clarifying the terminology – “Modelling in psychol-

ogy: An instance based manifesto” would have been a better title for what Page may have wanted to say.

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