Learning Inhomogeneous FRAME Models for Object Patterns

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Abstract
We investigate an inhomogeneous version of the FRAME (Filters, Random field, and Maximum Entropy) model and apply it to modeling object patterns. The inhomogeneous FRAME is a non-stationary Markov random field model that reproduces the observed marginal distributions or statistics of filter responses at all the different locations, scales and orientations. Our experiments show that the inhomogeneous FRAME model is capable of generating a wide variety of object patterns in natural images. We then propose a sparsified version of the inhomogeneous FRAME model where the model reproduces observed statistical properties of filter responses at a small number of selected locations, scales and orientations. We propose to select these locations, scales, and orientations by a shared sparse coding scheme, and we explore the connection between the sparse FRAME model and the linear additive sparse coding model. Our experiments show that it is possible to learn sparse FRAME models in unsupervised fashion and the learned models are useful for object classification.

Sparse FRAME Model
> Model
- p(Δα, t) = \( \exp \left( \frac{\sum_{i} \log |t_i|}{\lambda} \right) \)
where \( \Delta \) is the perturbations (varying within limited ranges) of the location and orientation of the i-th basis function.
> Learning

Step 1: Selecting \( \beta = (\beta_{i_0}, t_i) \) by deformable shared space matching algorithm to minimize
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\sum \left| \left| \mathbf{t}_i - \mathbf{t}_{i_0} \right| \right|^2
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subject to \( \beta' \) is deformable.

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