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Nonparametric Sparse Tensor Factorization with Hierarchical Gamma Processes

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Tensors Represent Multiway Data

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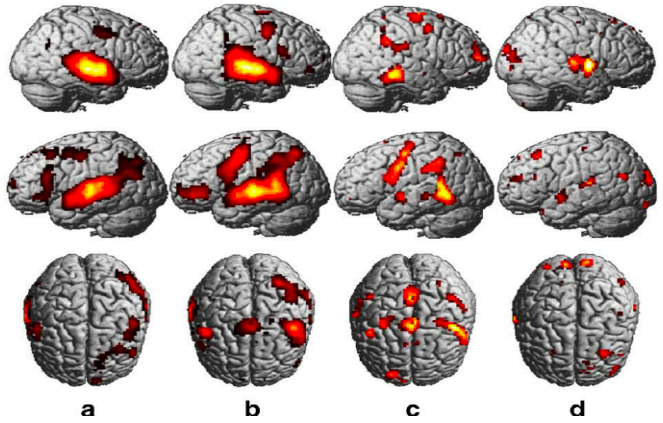

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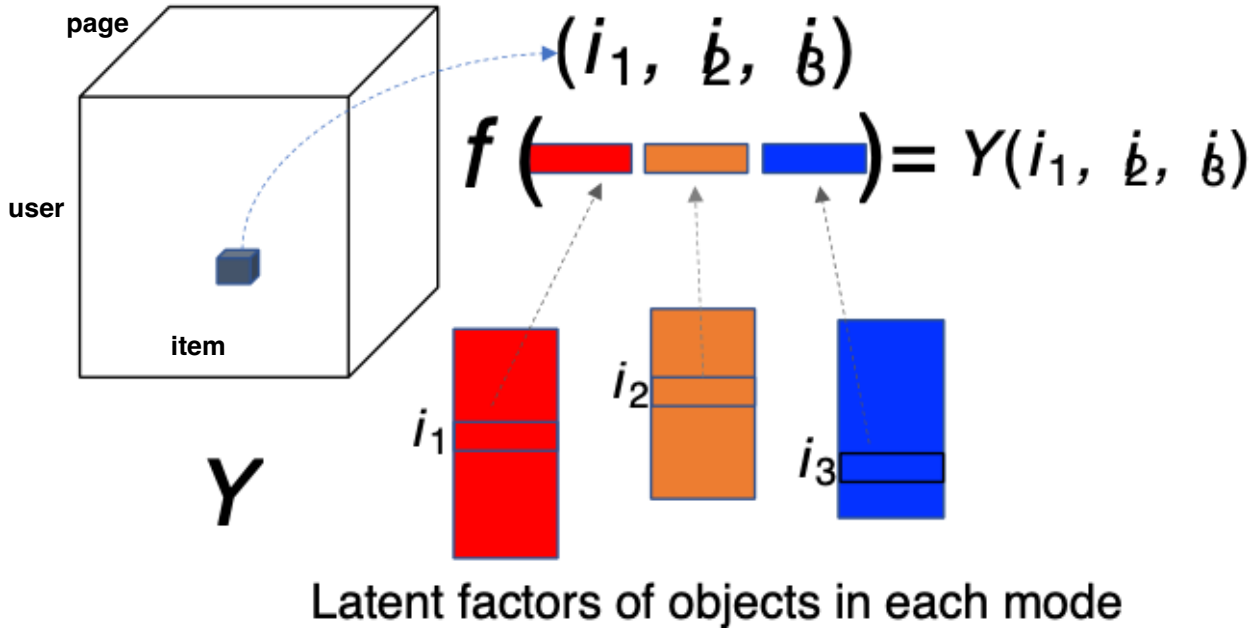
Tensor Decomposition

- Tensor decomposition estimates a set of latent factors for each node in each mode of the tensor
- Most current methods use priors that assume the proportion of observed entries is constant
- Often only a small proportion of entries are observed
- A recent work (Tillinghast, Zhe 2021) introduced a Sparse model, NEST, but it is inflexible
- The goal of this work is to create a more flexible sparse tensor model for tensor decomposition



Sparse Tensor Models

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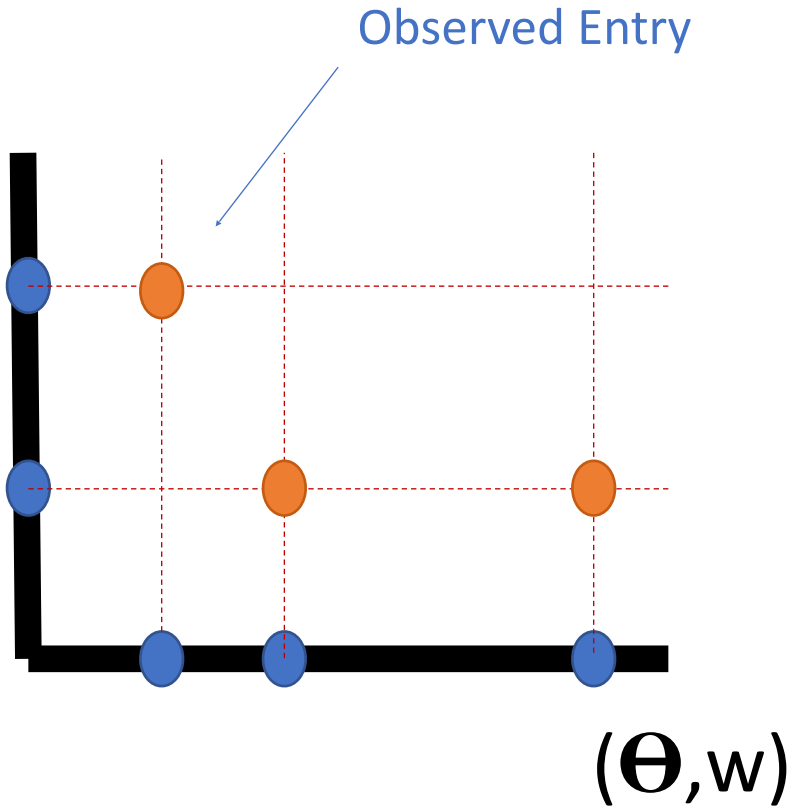
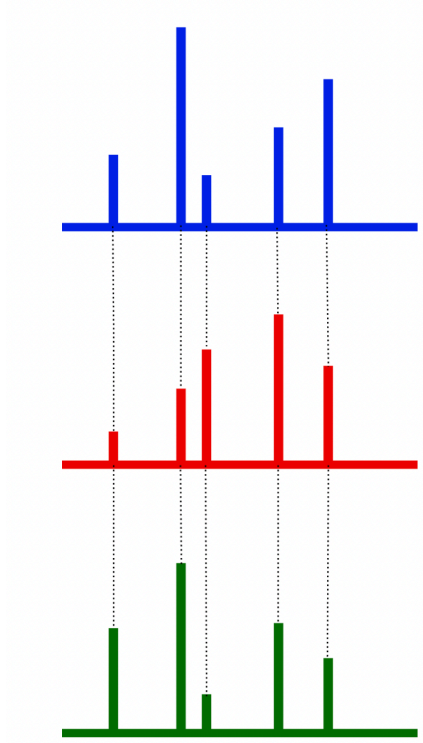
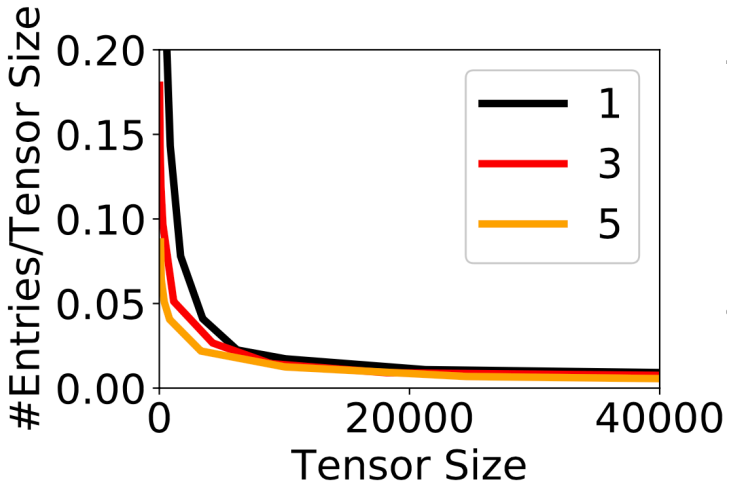
- Represent observed entry locations as points in $\mathbf{R}^d$
- Location, $\boldsymbol{\Theta}$, encodes intrinsic properties
- **w** encodes how nodes interact (sociabilities)
- For sparsity, specify non-parametric priors over ($\boldsymbol{\Theta}$,**w**)
- NEST only allows for **w**, to be 1 dimensional using a Dirichlet Process
- Our goal is to have a flexible model where the dimension the locations and sociabilities can be chosen as desired



HΓP Sparse Tensor Model

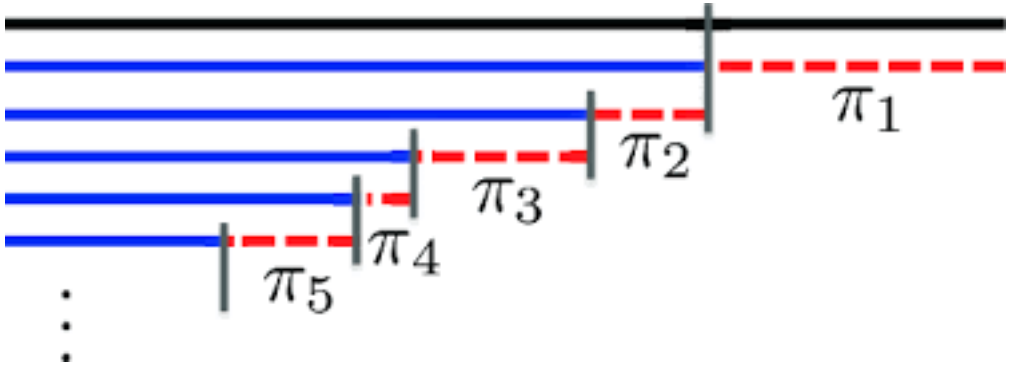
- Use use coupling to sample multiple sociabilities that share underlying locations
- For each mode of the tensor sample, a gamma process as the base measure for the mode, then sample *k* gamma process
- This leads to a flexible, provably sparse tensor model





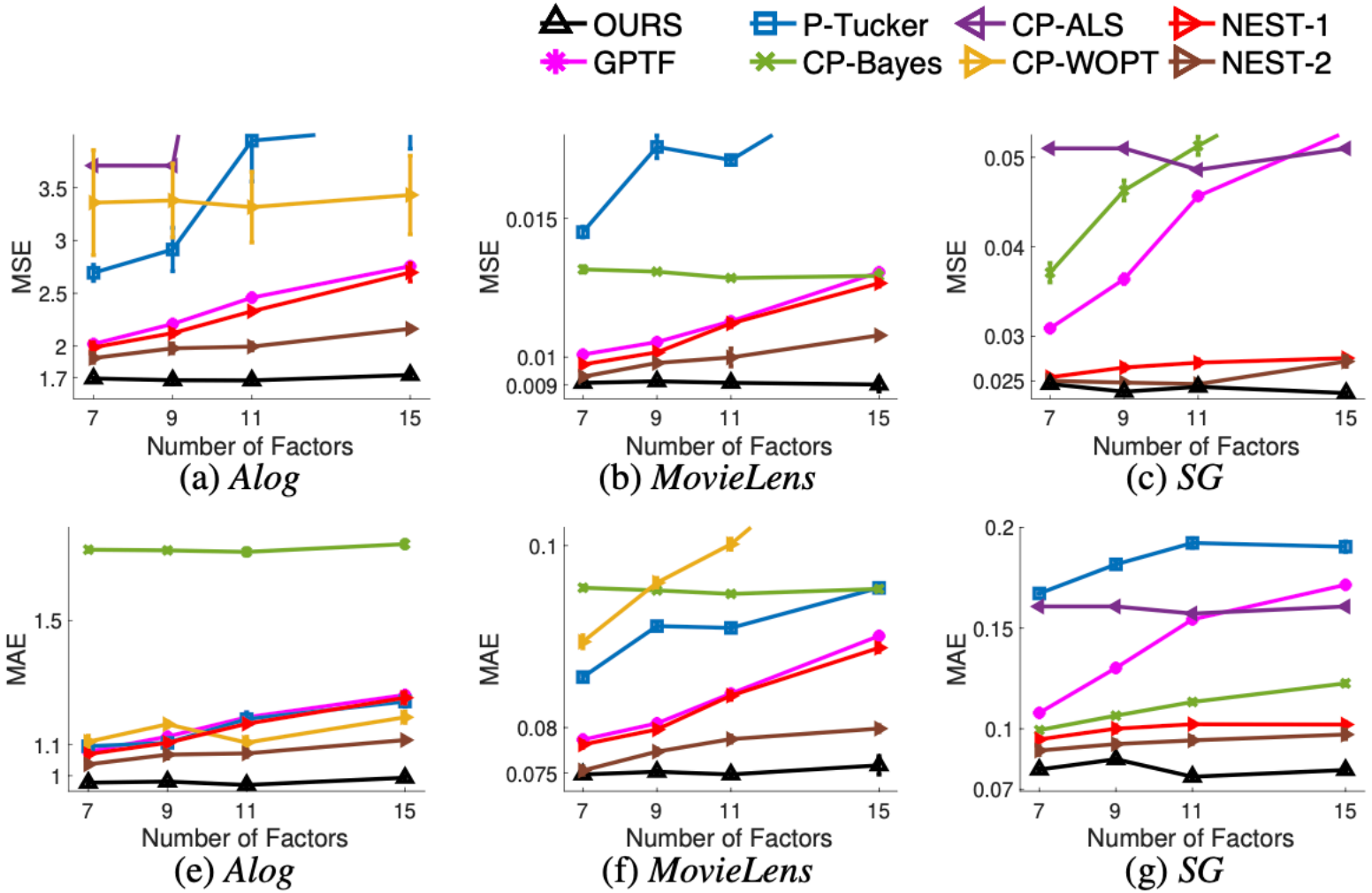
Algorithm

- With finite data, the tensor model can be normalized to a Poisson point process where the rate measure is the product of hierarchical Dirichlet processes
- For inference we use sample partitions, density transformations, and random Fourier features to develop a stochastic variational estimation algorithm



Results

- The additional flexibility given by our HΓP prior results in improved performance in link prediction and entry value prediction over NEST



Thank You!