

# Multi-visit inference of mobility data

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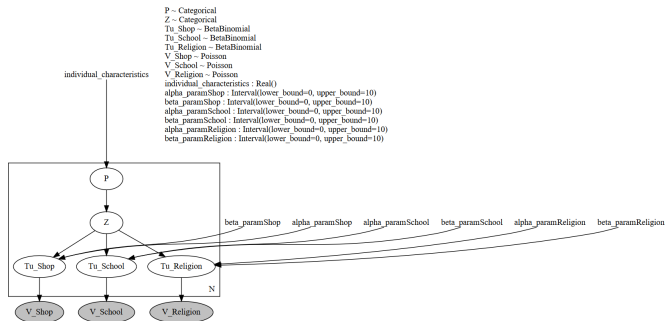
December 5, 2022

## Problem quick summary

The problem I try to solve is to infer individual mobility patterns from aggregated mobility data. The mobility data is SafeGraph, Census related data is from US Census data, and individual needs is based on FACS library.

The prepared case studies are SantaFe (New Mexico  $\sim 84\text{K}$ ), Seattle Washington ( $\sim 730\text{K}$ ), New York city (New York  $\sim 8,460\text{K}$ ), Appleton (Wisconsin  $\sim 75\text{K}$ ), and GreenBay (Wisconsin  $\sim 107\text{K}$ ).

# The simple model



Base model with aggregated visits to retailing services (44-45), education services (61), and religious locations (8131)

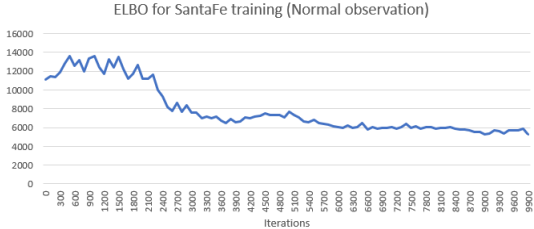
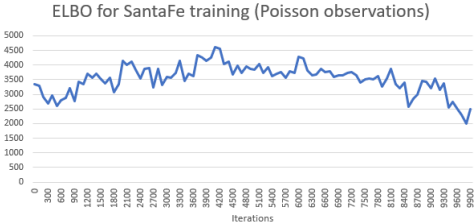
# Learning parameters

The algorithm used for inference is ADAM (Adaptive Moment Estimation) which is a more flexible variant of Stochastic Gradient Descent. It has three parameters:

- Learning rate
- Decay rate for the first moment
- Decay rate for the second moment

The model is implemented by Pyro library. The proposed based model is also tested under Normal distribution of observations. From the base model, it is assumed that each individual based on age and occupation has specific chance of visiting multiple places during a month based on the  $\alpha$  and  $\beta$  obtained from training the model. It is assumed that the support of Beta-Binomial is large enough to make sure the model can fit well.

# Results - ELBO



# Results - Hold out data

Sum absolute error for different cities. Model trained on SantaFe with Poisson observation

<u>SantaFe</u>	Seattle	New York city	Appleton	<u>GreenBay</u>
104	2287	9120	607	509

Sum absolute error for different cities. Model trained on SantaFe with Normal observation

<u>SantaFe</u>	Seattle	New York city	Appleton	<u>GreenBay</u>
612	5613	62202	507	767

# Extension

