Spatial Summarization of Image Collections

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Outline

1. Augmented features
2. Sampling the distribution
3. Extending the location set

Leftover question

- Does using a feature matrix $\mathbf{X}' = \mathbf{X} \mid \mathbb{I}$ improve the results?

		K			
		0	2	5	10
L	0	17.38 ± 1.81	18.75 ± 2.95	18.82 ± 2.58	18.91 ± 2.40
	2	22.66 ± 4.58	28.53 ± 4.36		
	5	25.40 ± 4.77		31.59 ± 2.38	
	10	31.13 ± 2.92			30.49 ± 3.51

- Not really, the best score so far is 34.35 ± 2.15 with $\mathbf{X} = \mathbb{I}$.
- Running time is significantly slower, because of the increased number of features $M = N + 4$.

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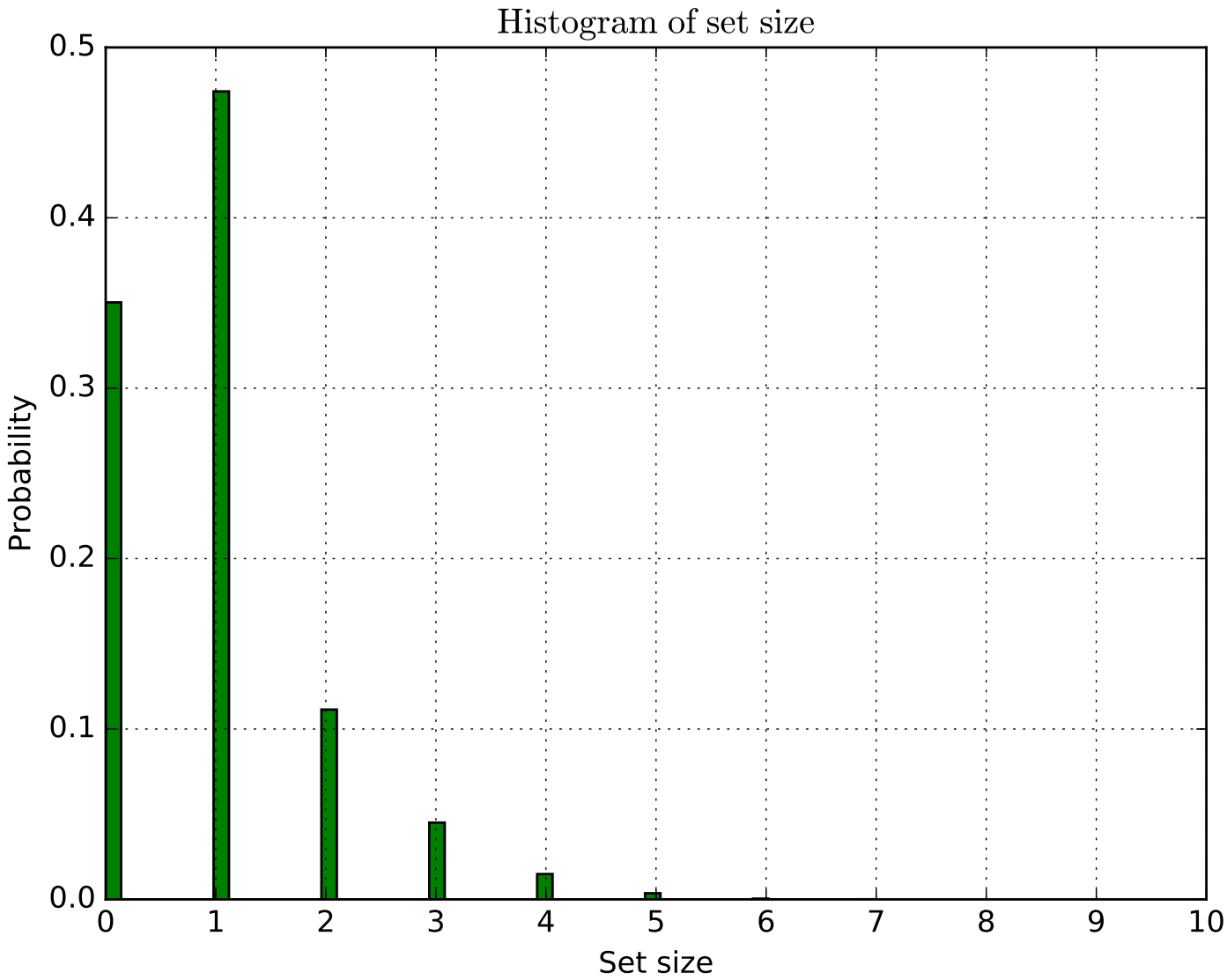
Sampling from the model

- Using the best model, i.e. without features and with $L = 5, K = 5$.
- How does the resulting distribution look?
- How to use the distribution to recommend sets?

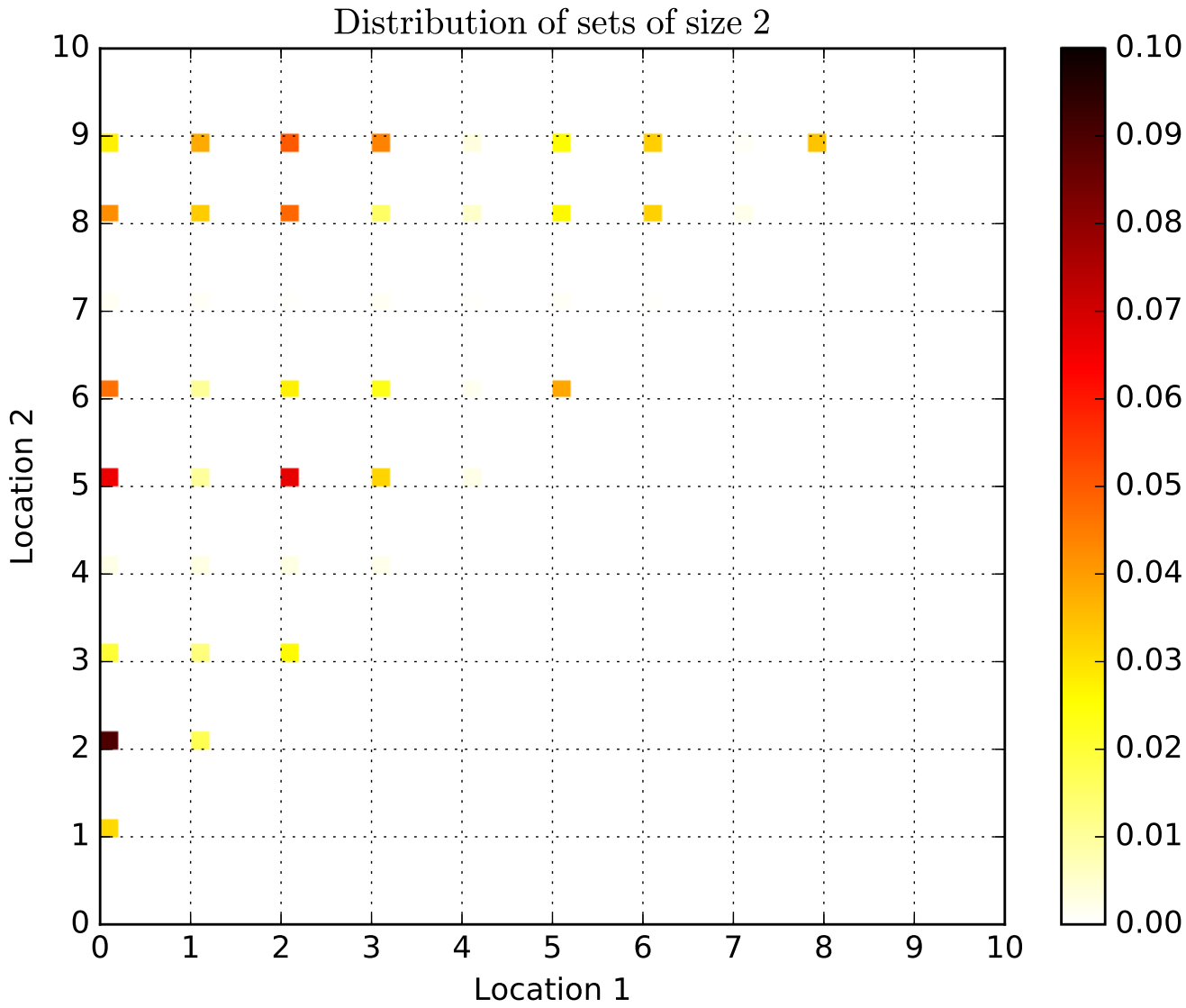
Exact sampling

- With $N = 10$, it is possible to calculate the probabilities from the model for all $2^{10} = 1024$ possible sets.
- Evaluating the model on all sets $S \subseteq V$ and then normalizing the probability distribution.
- Takes only seconds to evaluate.

Distribution of set size ($100k$ samples)



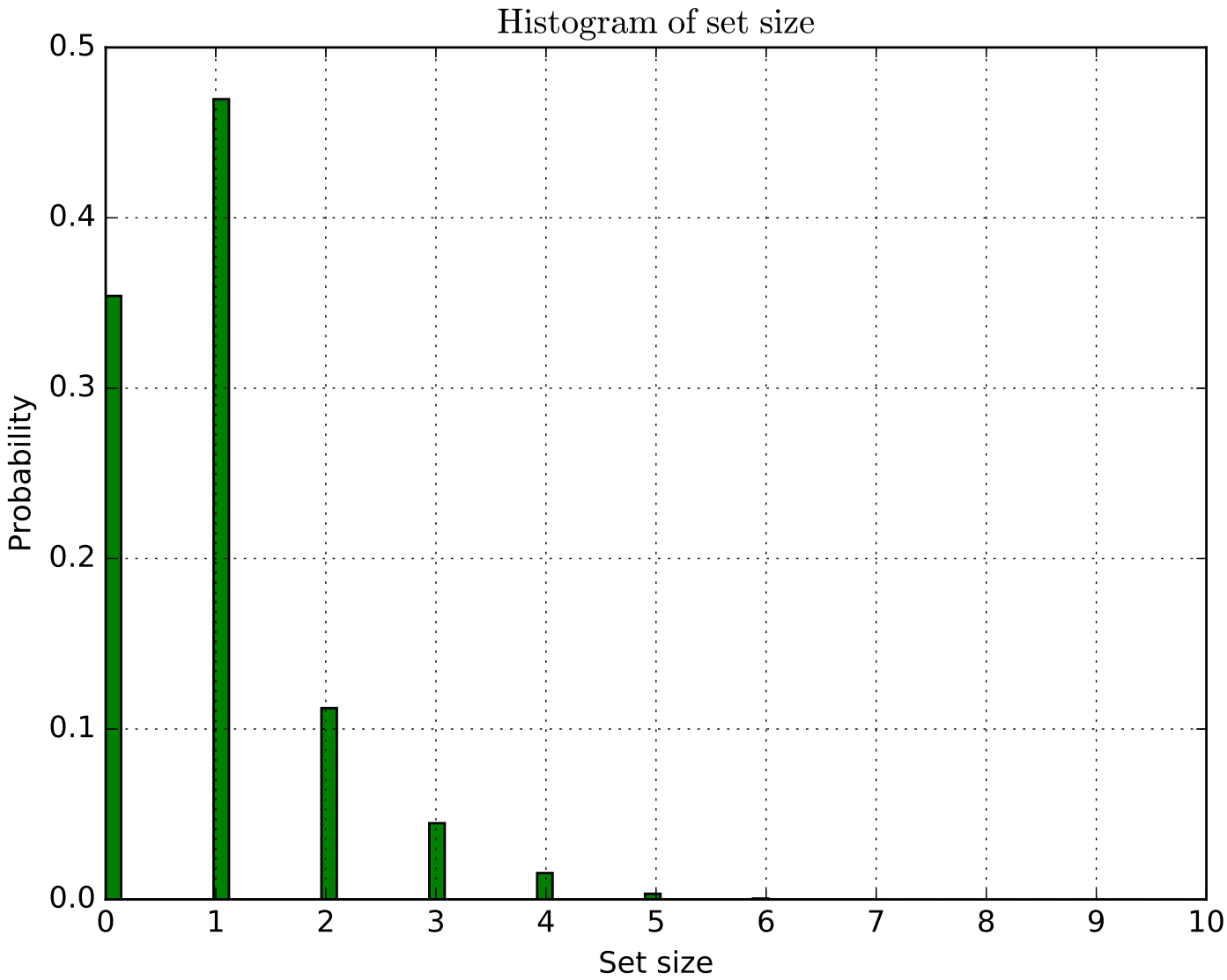
Distribution of sets with $|S| = 2$ ($100k$ samples)



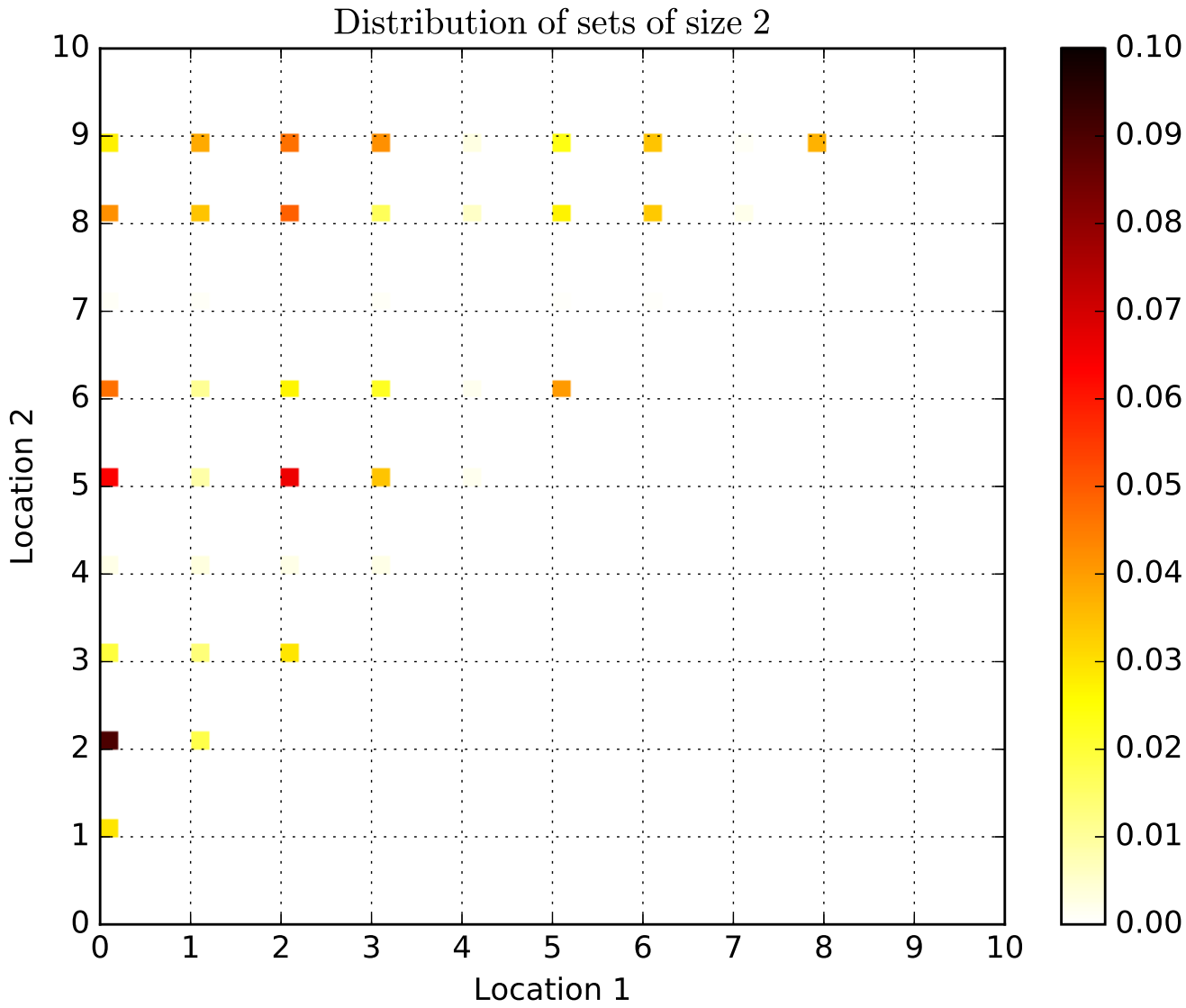
Gibbs sampling

- What about a method that scales? For example if $N = 30$, then there are $2^{30} = 1073741824$ sets.
- Gibbs sampling as presented in [1].
- Run for $1M$ iterations, remove the first half of iterations are burn-in.
- Running time is a couple of minutes.

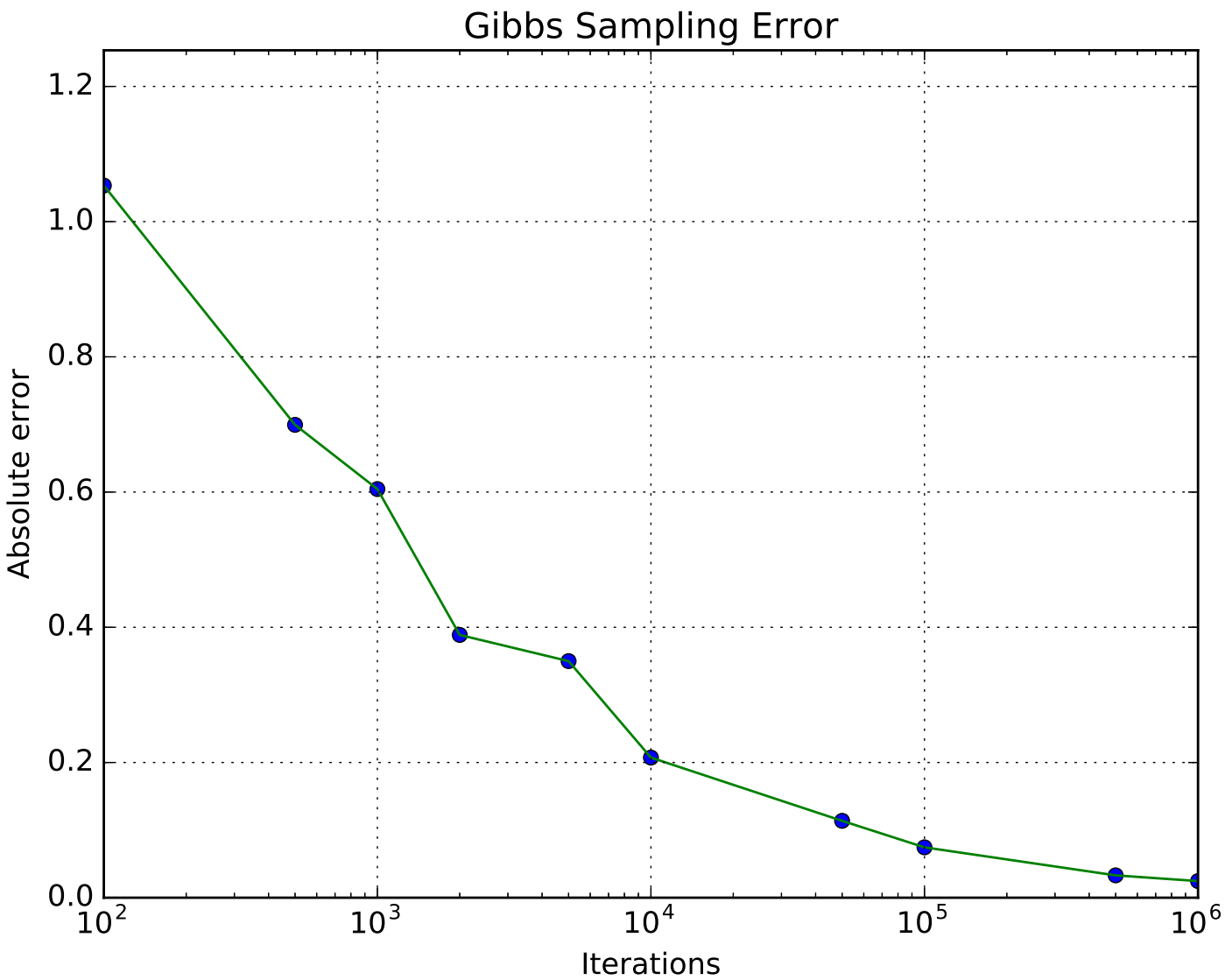
Distribution of set size ($100k$ samples)



Distribution of sets with $|S| = 2$ ($100k$ samples)



Gibbs Sampling Performance



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More mean-shift clusters

- Original dataset has over 160k photos.
- When clustered using mean-shift with a bandwidth of approximately 100m, there are over 2k clusters.
- Previous tests were done using the 10 top clusters according number of photos per cluster. This covered only over 30k photos.
- Does the approach scale if the number of clusters is increased?
- 50 clusters cover over 100k photos.
- 12k paths are present, in comparison there were 8k paths with 10 clusters.

Baselines

Model	Accuracy	MRR
Modular	9.21 ± 1.02	27.00 ± 1.01
Markov	19.72 ± 1.23	34.50 ± 1.00
Markov with rejection	$\mathbf{22.36 \pm 1.41}$	$\mathbf{38.65 \pm 1.09}$
Proximity	12.76 ± 0.70	27.71 ± 0.88
Proximity with rejection	14.74 ± 0.64	31.34 ± 1.14

- Similar trend as with $N = 10$, Markov with rejection is the best model and it's significantly better than the modular model.

FLDC - Facility Location Diversity and Coherence

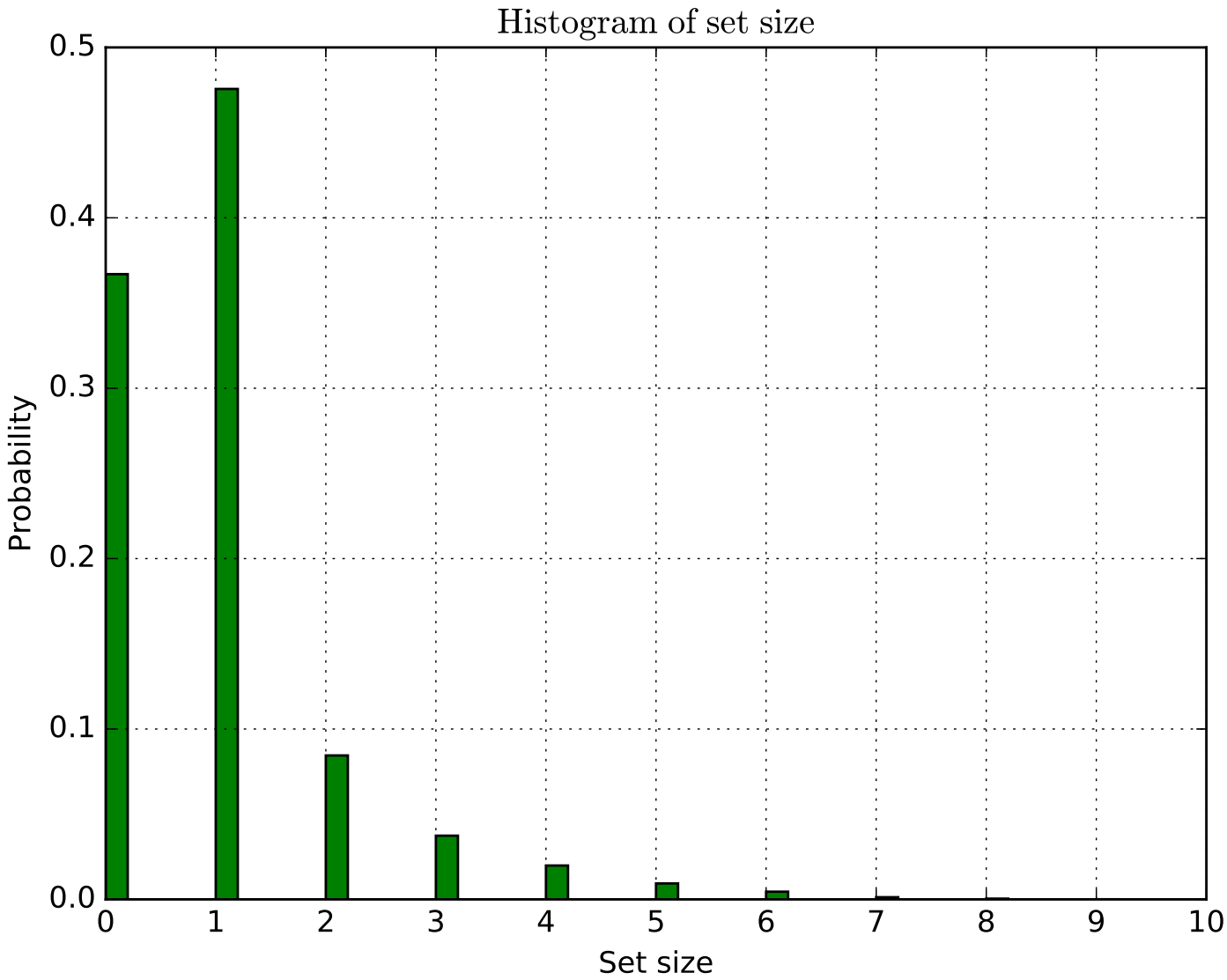
- Use the best model from the case for $N = 10$.
- The model with a diversity term, i.e. submodular, and a coherence term, i.e. supermodular. Without features, i.e. $\mathbf{X} = \mathbb{I}$.
- Running on $k = 10$ folds, with a noise factor of 50.
- Latent dimensions are: $0 \leq L \leq 20, 0 \leq M \leq 20$.

Evaluation

		K			
		0	2	10	20
	0	9.21 ± 1.02	16.24 ± 1.43	16.12 ± 1.29	16.44 ± 1.77
L	2	12.09 ± 1.36	17.05 ± 0.91		
	10	12.94 ± 1.39		19.28 ± 0.73	
	20	9.17 ± 2.27			$\mathbf{21.53 \pm 1.24}$

- Model with diversity and coherence term has performance close to the markov model with rejection.

Distribution of set size ($100k$ samples)



Frequency of data

Table: Frequency of Item Sets

Set	Frequency
$[0, 7]$	61
$[27, 28]$	39
$[13, 7]$	36
$[11, 14]$	27
$[0, 13]$	25
$[2, 7]$	23
$[10, 2]$	22
$[25, 34]$	22
$[2, 15]$	21
$[10, 15]$	21

Table: Locations

Index	Location
0	Grossmünster
2	Bürkliterrasse
7	Fraumünster
10	Quaibrücke
11	Hauptbahnhof
13	Rathaus
14	Urania-Sternwarte
15	Bellevue
25	Frau Gerolds Garten
27	Zoo
28	Restaurant Masoala (Zoo)
34	Stadion Letzigrund

References


Gotovos, A., Hassani, S. H., and Krause, A.
Sampling from probabilistic submodular models.
In *Neural Information Processing Systems (NIPS)* (December 2015).