Spatial Summarization of Image Collections

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Outline

Featurized model

- $|V| = 7$
- $$\mathbf{X} = \begin{pmatrix} 5 & 0 & 1 \\ 5 & 1 & 0 \\ 5 & 1 & 1 \\ 3 & 0 & 1 \\ 3 & 0 & 0 \\ 1 & 1 & 1 \\ 1 & 1 & 0 \end{pmatrix}$$
- $\mathbf{a} = \overrightarrow{0}$
- $\mathbf{B} = \begin{pmatrix} 0 & 20 & 20 \end{pmatrix}^\intercal$
- $\mathbf{C} = \begin{pmatrix} 2 & 0 & 0 \end{pmatrix}^\intercal$

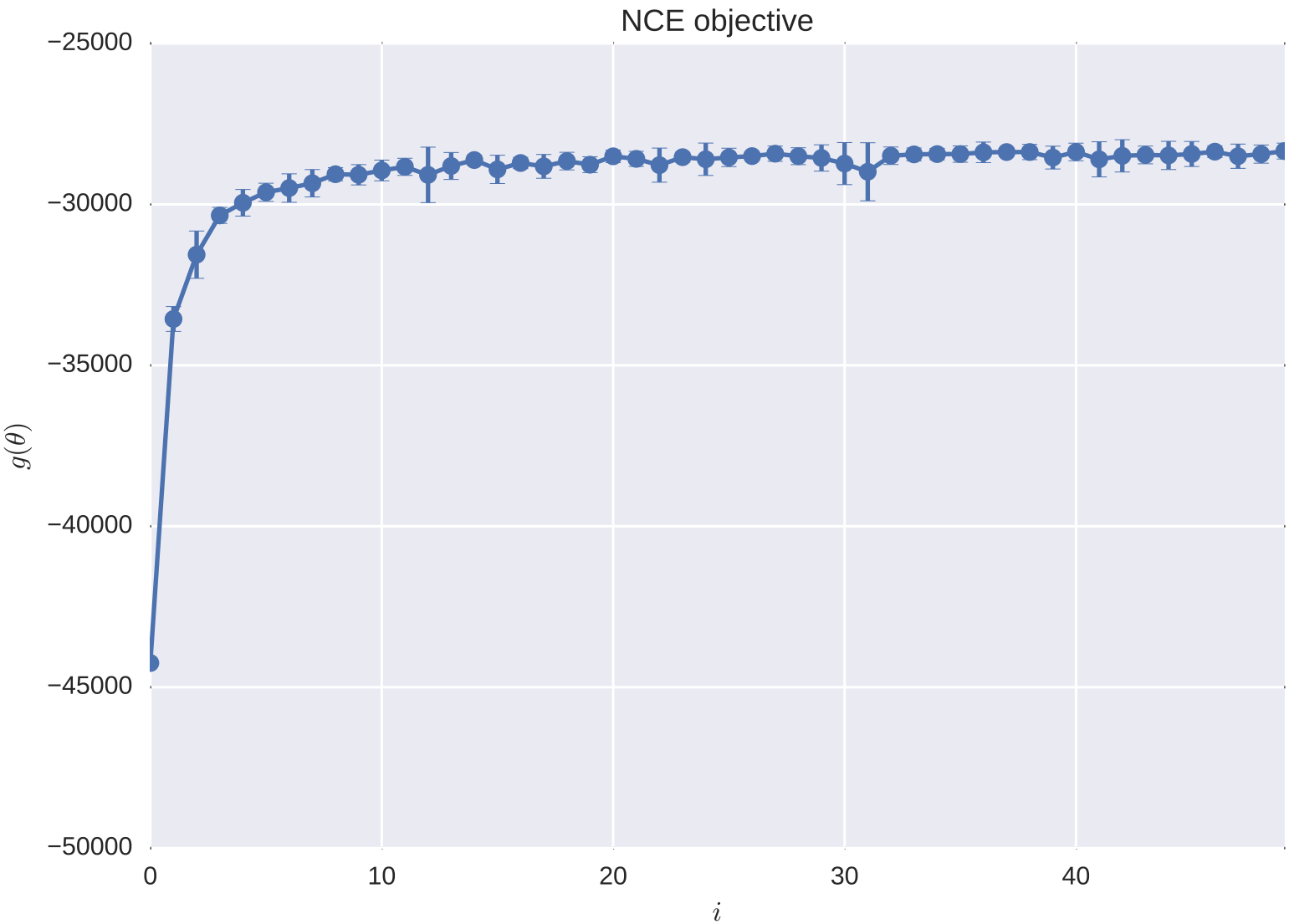
FLDC equivalent model

- $\mathbf{u} = \overrightarrow{0}$
- $\mathbf{W}_D = \begin{pmatrix} 20 & 20 & 40 & 20 & 0 & 40 & 20 \end{pmatrix}^\intercal$
- $\mathbf{W}_C = \begin{pmatrix} 10 & 10 & 10 & 6 & 6 & 2 & 2 \end{pmatrix}^\intercal$
- $P(S) \approx 0.25 \mid S \in \{\{0,4\},\{1,4\},\{2,4\},\{3,4\}\}$

Learning results

- 10,000 samples from the distribution.
- The maximum prediction accuracy is 62.5%.
- After 10 passes:
  - $\mathbf{a} = \begin{pmatrix} 0.05 \pm 0.03 & -0.37 \pm 0.03 & -0.31 \pm 0.03 \end{pmatrix}$
  - $\mathbf{B} = \begin{pmatrix} 0.81 \pm 0.03 & 8.33 \pm 0.02 & 8.33 \pm 0.02 \end{pmatrix}^{\mathsf{T}}$
  - $\mathbf{C} = \begin{pmatrix} 1.82 \pm 0.01 & 0.00 \pm 0.00 & 0.00 \pm 0.00 \end{pmatrix}^{\mathsf{T}}$
- After 50 passes:
  - $\mathbf{a} = \begin{pmatrix} 0.01 \pm 0.03 & -0.05 \pm 0.04 & -0.03 \pm 0.03 \end{pmatrix}$
  - $\mathbf{B} = \begin{pmatrix} 0.60 \pm 0.03 & 12.5 \pm 0.03 & 12.5 \pm 0.03 \end{pmatrix}^{\mathsf{T}}$
  - $\mathbf{C} = \begin{pmatrix} 2.11 \pm 0.03 & 0.00 \pm 0.00 & 0.00 \pm 0.00 \end{pmatrix}^{\mathsf{T}}$

NCE objective



Featurized model II

- $$\mathbf{X} = \begin{pmatrix} 5 & 0 & 1 \\ 4 & 1 & 0 \\ 4 & 1 & 1 \\ 3 & 0 & 1 \\ 3 & 1 & 0 \\ 2 & 1 & 1 \\ 2 & 1 & 0 \end{pmatrix}$$
- $$\mathbf{B} = \begin{pmatrix} 0 & 0 \\ 10 & 0 \\ 0 & 10 \end{pmatrix}$$
- $\mathbf{C} = \begin{pmatrix} 1 & 0 & 0 \end{pmatrix}^{\intercal}$

FLDC equivalent model

- $$\mathbf{W}_D = \begin{pmatrix} 0 & 10 \\ 10 & 0 \\ 10 & 10 \\ 0 & 10 \\ 10 & 0 \\ 10 & 10 \\ 10 & 0 \end{pmatrix}$$
- $\mathbf{W}_C = \begin{pmatrix} 5 & 4 & 4 & 3 & 3 & 2 & 2 \end{pmatrix}^\intercal$
- $P(\{0,1\}) \approx 0.4$
- $P(S) \approx 0.15 \mid S \in \{\{1,3\},\{0,4\},\{3,4\}\}$
- $P(S) \approx 0.05 \mid S \in \{\{0,6\},\{3,6\}\}$

Learning results

- 100 pass over data and noise.
- $\mathbf{u} = \begin{pmatrix} 0.19 & 0.22 & 0.14 \end{pmatrix}^{\mathsf{T}}$
- $$\mathbf{B} = \begin{pmatrix} 0.27 & 0.25 \\ 0.07 & 9.66 \\ 9.46 & 0.08 \end{pmatrix}$$
- $\mathbf{C} = \begin{pmatrix} 1.11 & 0.84 & 0.80 \end{pmatrix}^{\mathsf{T}}$

Learning results - FLDC

- $\mathbf{u} = \begin{pmatrix} 0.69 & 0.48 & -4.58 & 0.12 & -0.22 & -4.30 & -1.09 \end{pmatrix}^{\mathsf{T}}$
- $$\mathbf{W}_D = \begin{pmatrix} 0.81 & 3.66 \\ 3.93 & 0.81 \\ 0.95 & 0.98 \\ 0.80 & 3.66 \\ 3.40 & 0.74 \\ 1.04 & 0.94 \\ 3.41 & 0.67 \end{pmatrix}$$
- $\mathbf{W}_C = \begin{pmatrix} 1.71 & 1.71 & 0.38 & 1.73 & 1.72 & 0.24 & 1.44 \end{pmatrix}^{\mathsf{T}}$

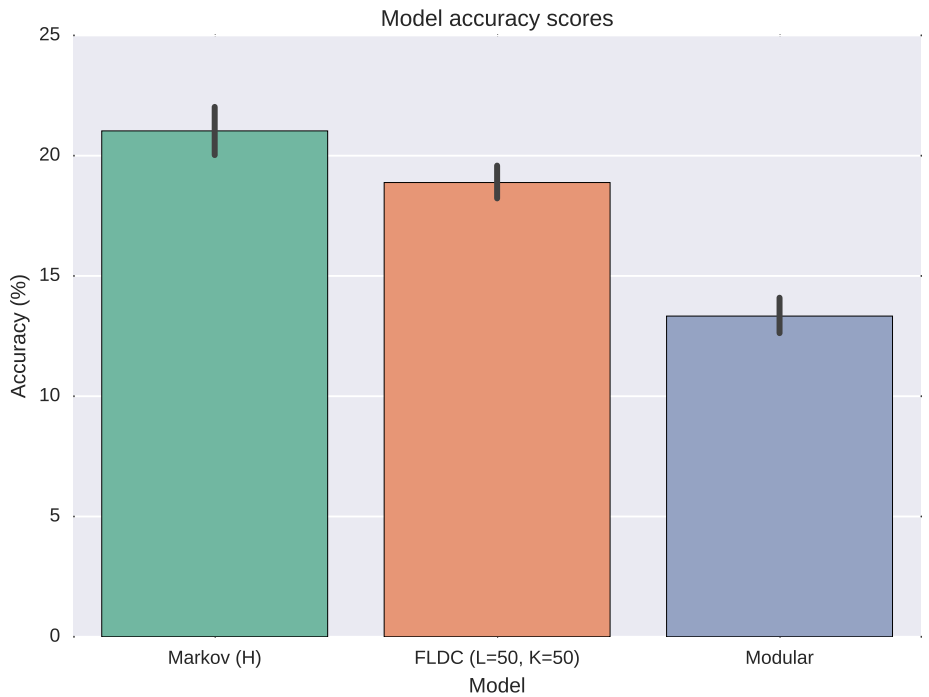
Learned models

Subset	Model	Modular	FLDC	FFLDC
$\{0, 1\}$	0.40	0.14 ± 0.00	0.29 ± 0.05	0.36 ± 0.05
$\{0, 4\}$	0.15	0.04 ± 0.00	0.10 ± 0.03	0.11 ± 0.03
$\{1, 3\}$	0.15	0.05 ± 0.00	0.12 ± 0.04	0.12 ± 0.03
$\{3, 4\}$	0.15	0.02 ± 0.00	0.09 ± 0.03	0.13 ± 0.04
$\{0, 6\}$	0.05	0.02 ± 0.00	0.04 ± 0.01	0.03 ± 0.01
$\{3, 6\}$	0.05	0.00 ± 0.00	0.03 ± 0.01	0.05 ± 0.02

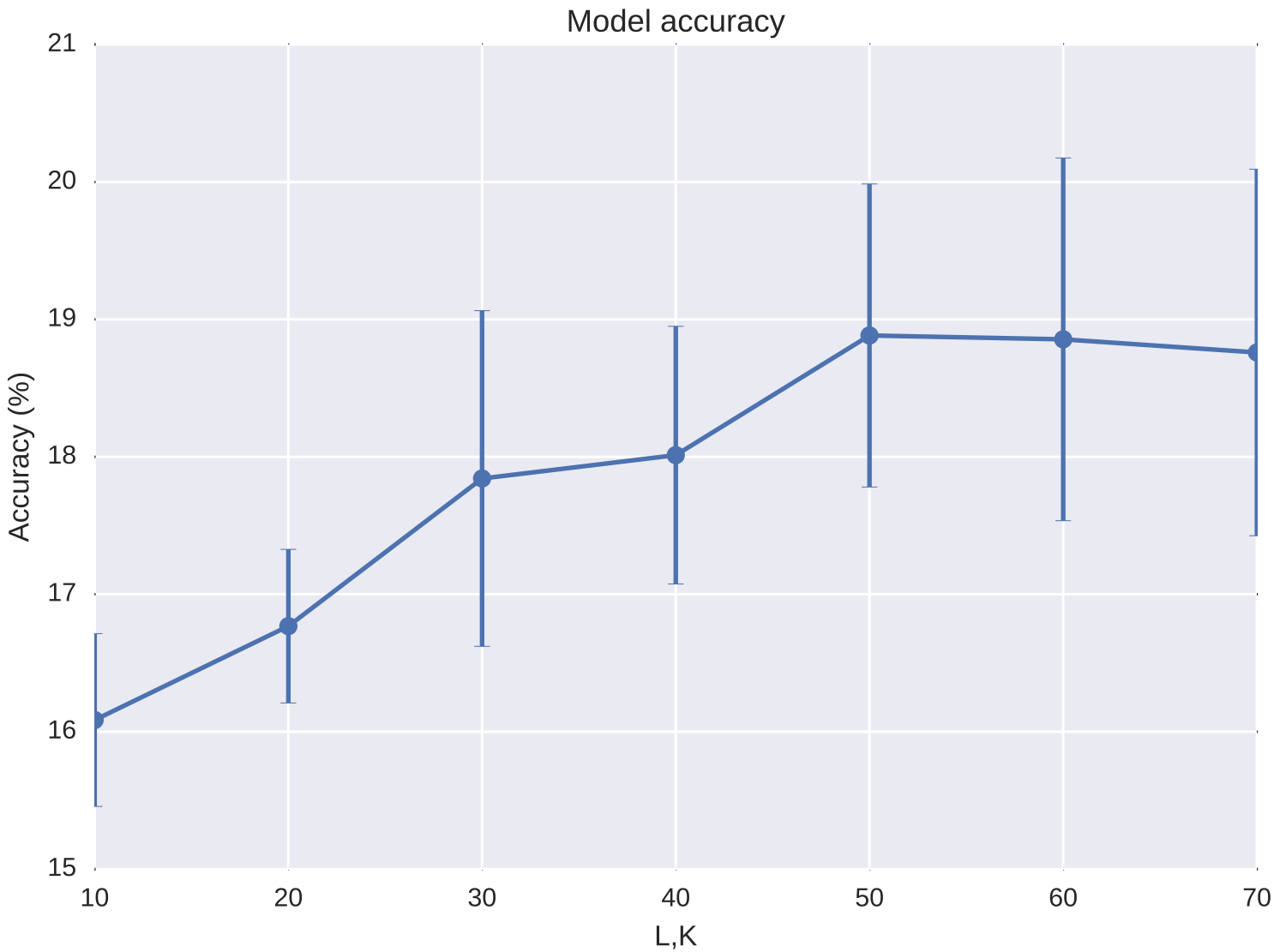
Outline

Larger dataset

- Increase the number of selected clusters to 100.
- The best results without features are:

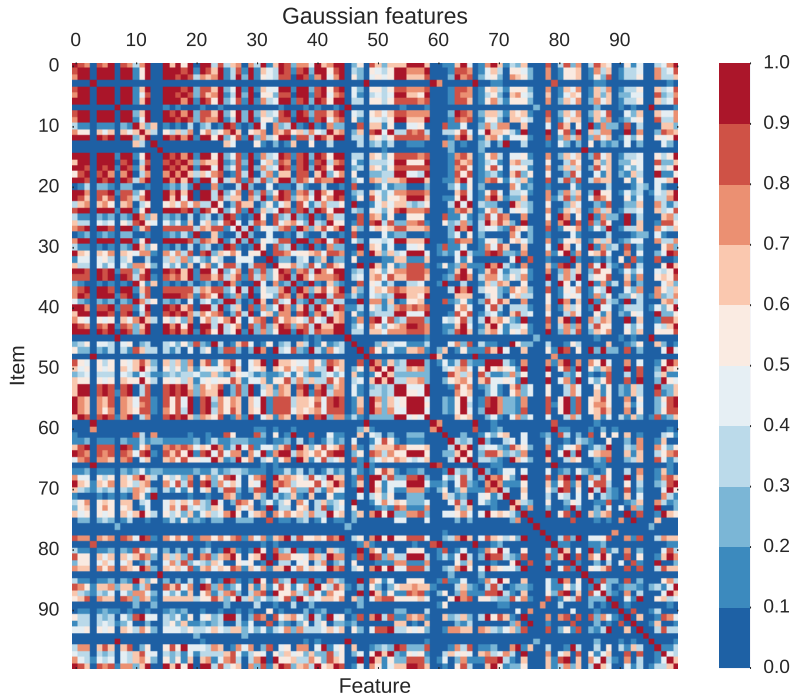


FLDC model

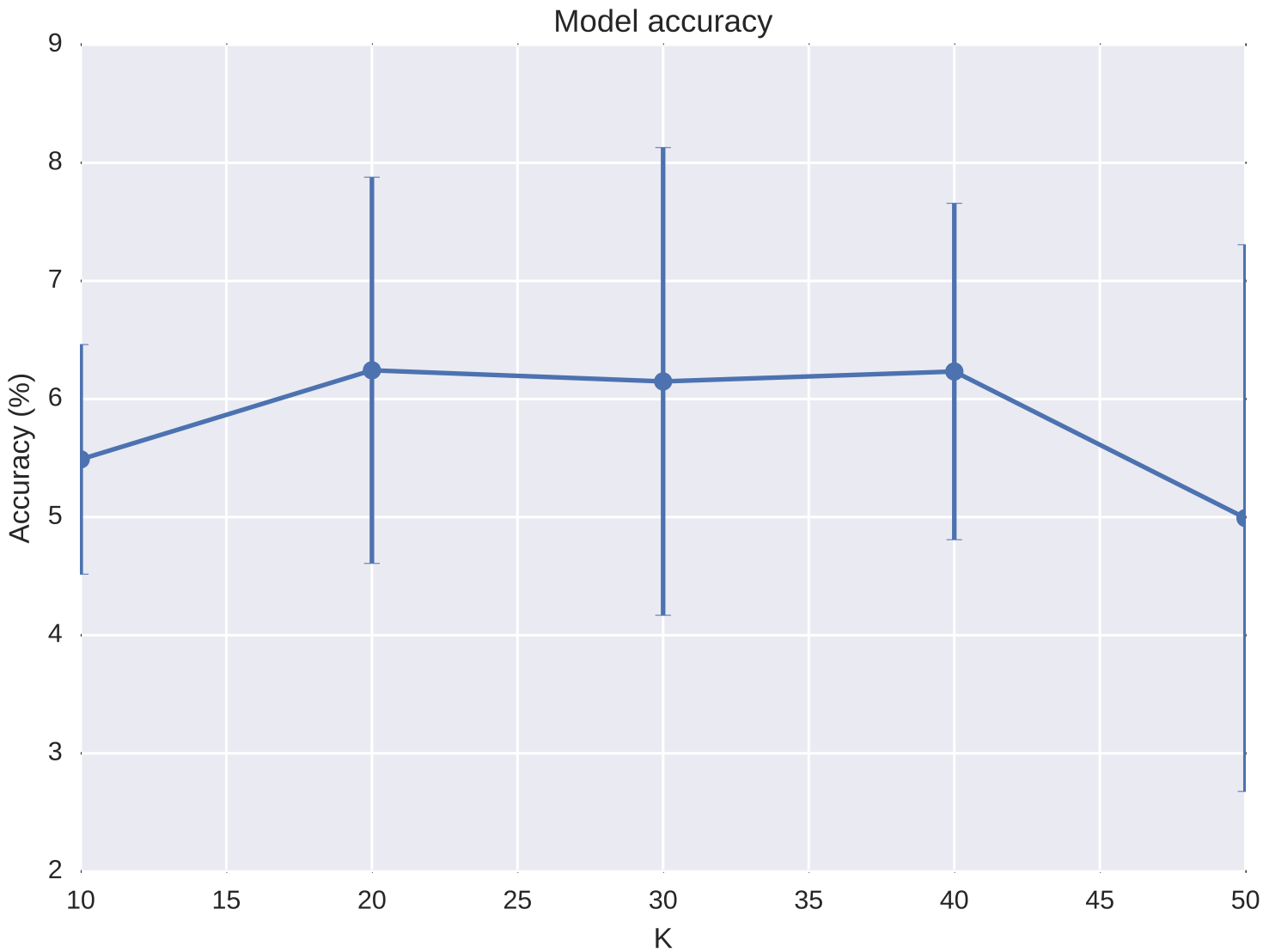

Model accuracy
Accuracy (%)
21
20
19
18
17
16
15
10
20
30
40
50
60
70
L,K

Selecting the features

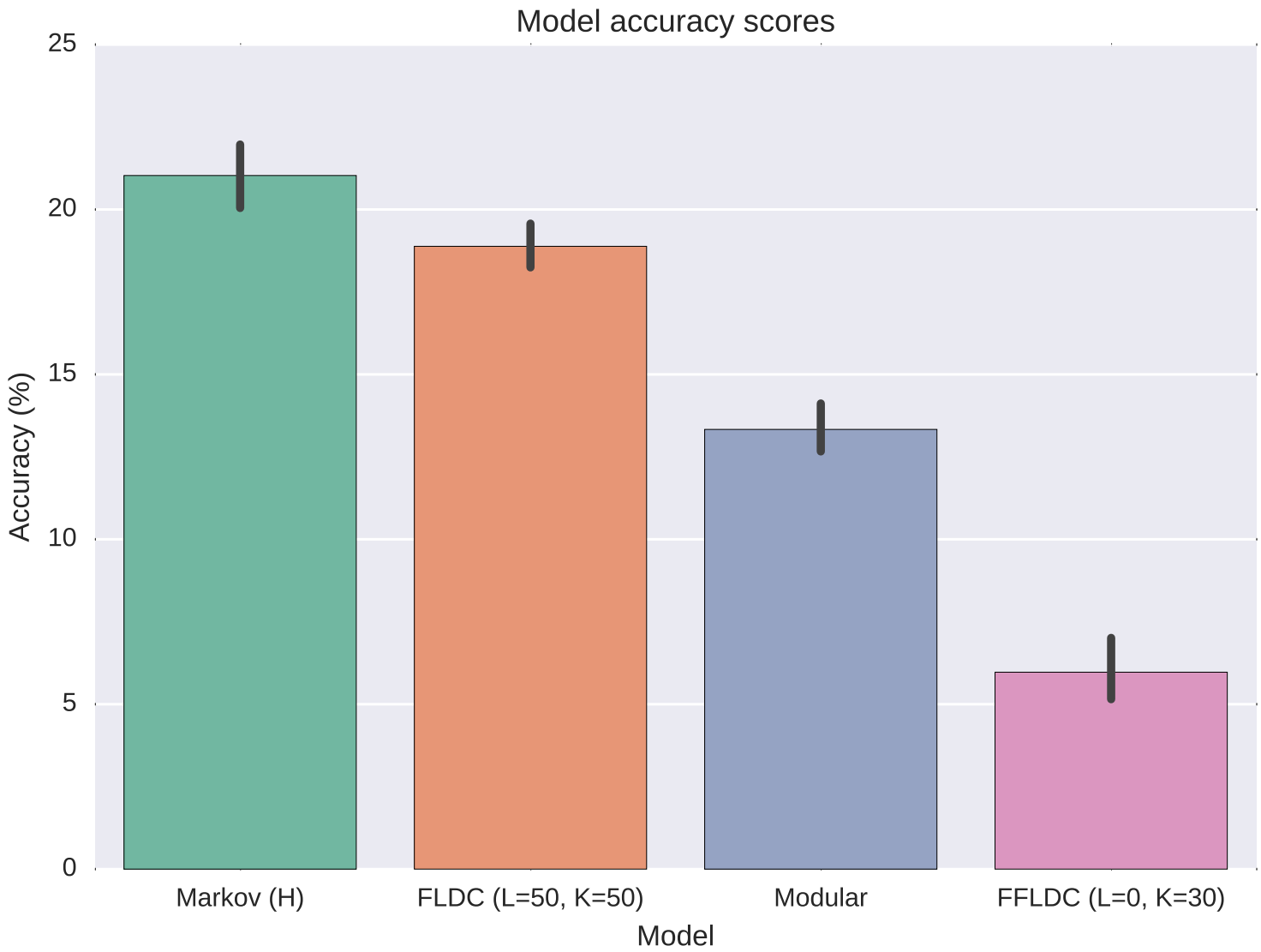
- If σ is too big then the feature matrix is full of 1s.
- If σ is too small then the feature matrix is too similar to the identity.



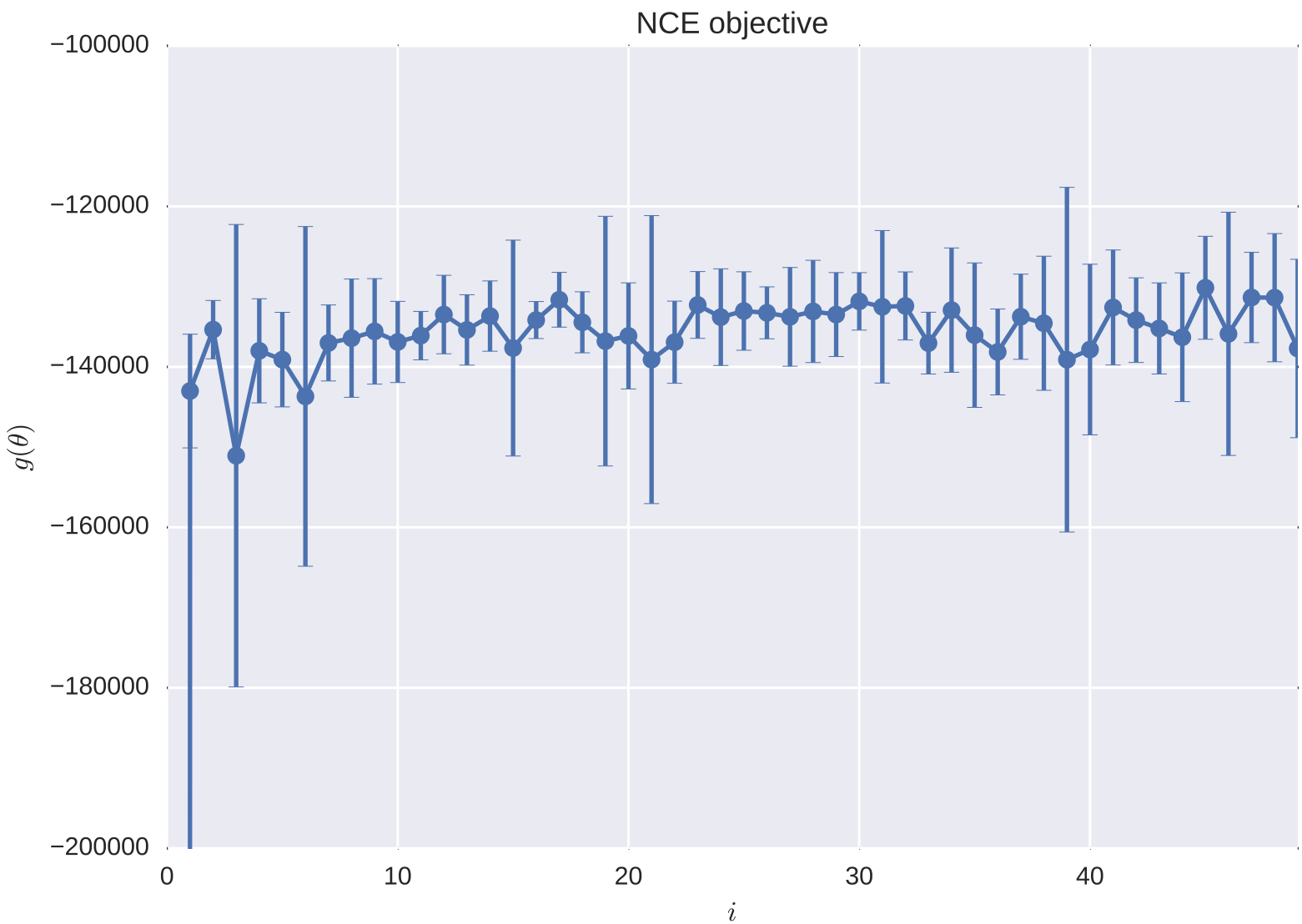
Using 10 features



Best results



NCE Learning



Outline

Outline I

Outline II