LSB: Local Self-Balancing MCMC in Discrete Spaces

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Problem

Sampling in high dimensions

\[ p_X(x) = \frac{p_X(x')}{Z} \]

MCMC

\[ T(x' | x) = A(x', x)Q(x' | x) \]

Locally Balanced Proposal [1]

\[ Q(x' | x) = \frac{g(Q(x'))}{g(x)} \quad (x' \in N(x)) \]

\[ g(t) = t g(1/t) \]

Question: How to adapt the proposal to target to improve sampling efficiency?

Solution

Parametrizations

- Linear (LSB 1)
  \[ g(t) = t g(1/t) \]
  \[ g_0(t) = \sum_{i=1}^{I} \theta_i g_i(t) \]

- Nonlinear (LSB 2)
  \[ g_0(t) = \min \left\{ \mathcal{E}_\theta(t), t \mathcal{E} \left( \frac{1}{t} \right) \right\} \]

Objective

Any non-negative real function \( \mathcal{E}_\theta(t) \)

\[ I_\theta = KL \{ p_X(x) T(x' | x) \| p_X(x)p_X(x') \} \]

Learning procedure

Use historical samples to estimate the objective and update theta at each sampling iteration (during burn-in phase)

Experiments

2D Ising

Bayesian Networks

References

[1] Zanella. Informed Proposals for Local MCMC in Discrete Spaces. Journal of the American Statistical Association 2020

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