# Nonparametric Hamiltonian Monte Carlo

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## How it works

threshold = normal; sum = 0 while sum < threshold: sum += normal</pre> observe(sum, normal(threshold, 1))

Question: Say current sample is -3.1. how to propose the next sample?

HMC travels along the surface starting at -3.1 but reaches 1.15 which is NOT a sample of the program!



#### Gaussian mixture $\mu_k \sim \text{Uniform}([0, 100]^3)$ random number of mixture components · 200 training data points: from prior with $x_n \sim \frac{1}{K} \sum_{k=1}^{K} \mathcal{N}_3(\mu_k, 10^2 I_3)$ $K^* = 9$ Particle Gibbs (PGibbs) & Random-Walk 8 0.3 -MH (RMH) $(w_k, h_k)_{k \in \mathbb{N}} \sim \mathrm{DP}(\alpha, H)$ mixture means and weights drawn $x_n \sim \sum_{k=1}^{\infty} w_k \cdot \mathcal{N}(h_k, \Sigma) \quad \text{for } n = 1, \dots, N$ from Dirichlet process (via stick-breaking) • no fixed number K of components 0.01 ours $K^* = 9$ 600

**NP-HMC** extends **HMC** to **nonparametric models** (models with a varying and possibly unbounded number of parameters).

## **Evaluation**

- Compared with Lightweight MH (LMH),
- NP-HMC is closest to  $K^* = 9$



### **Dirichlet Process mixture**

- Instead all components with weight >
- 200 training data points: from prior with
- compute LPPD on 50 training data points (from prior with with  $K^* = 9$ )