Binary Bouncy Particle Sampler

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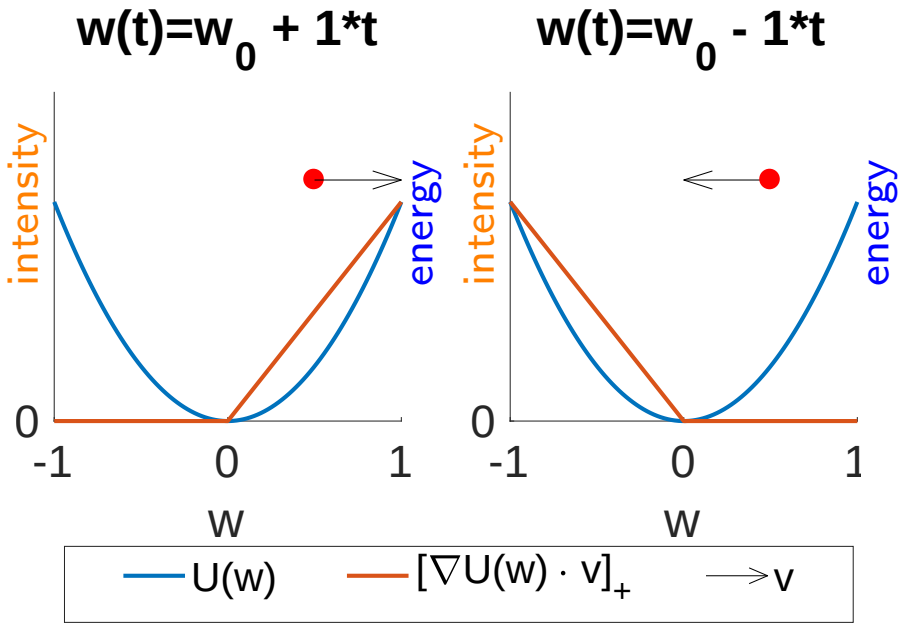
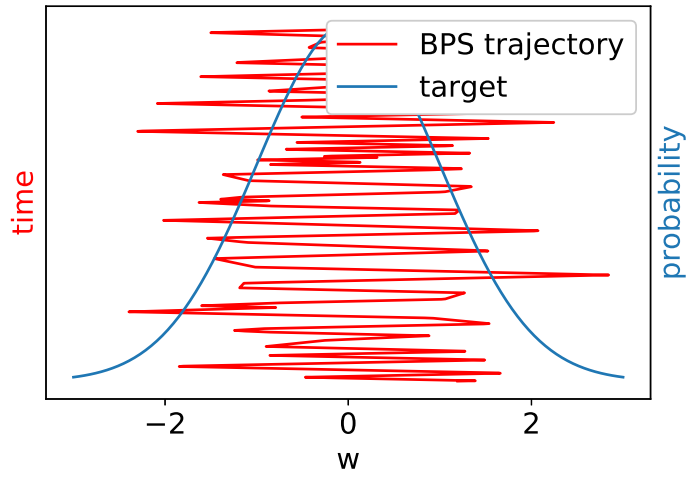
Bouncy Particle Sampler [Bouchard-Côté et.al., 2015]

- The space is augmented with a velocity variable $\mathbf{v} \in S^{d-1}$.
- Velocity reflection events given by Poisson process with rate $\lambda(t) = [\mathbf{v} \cdot \nabla U(\mathbf{w}_0 + \mathbf{v}t)]_+$.
- Output is a piecewise linear trajectory
- The kernel is non-reversible.



- Velocity reflection:
$$\mathbf{v} \leftarrow \mathbf{v} - 2\frac{(\mathbf{v}\cdot\nabla U(\mathbf{w}))\nabla U(\mathbf{w})}{||\nabla U(\mathbf{w})||^2}$$



Binary Bouncy Particle Sampling

- Map $\mathbf{y} \in \mathbb{R}^d$ into binary vector $s_{\mathbf{y}} = sign(\mathbf{y})$, componentwise.
- Define piecewise continuous potentials:
  $U_E(\mathbf{y}) = |\mathbf{y}| - \log p(\mathbf{s_y})$
  $U_G(\mathbf{y}) = \frac{1}{2}\mathbf{y}^2 - \log p(\mathbf{s_y})$
- When a particle hits a discontinuity, cross with probability $\min(1, e^{-U(0^-)+U(0^+)})$
- Poisson process sampling is exact using inverse CDF method.