Drawing Parallels between Statistics and Nature

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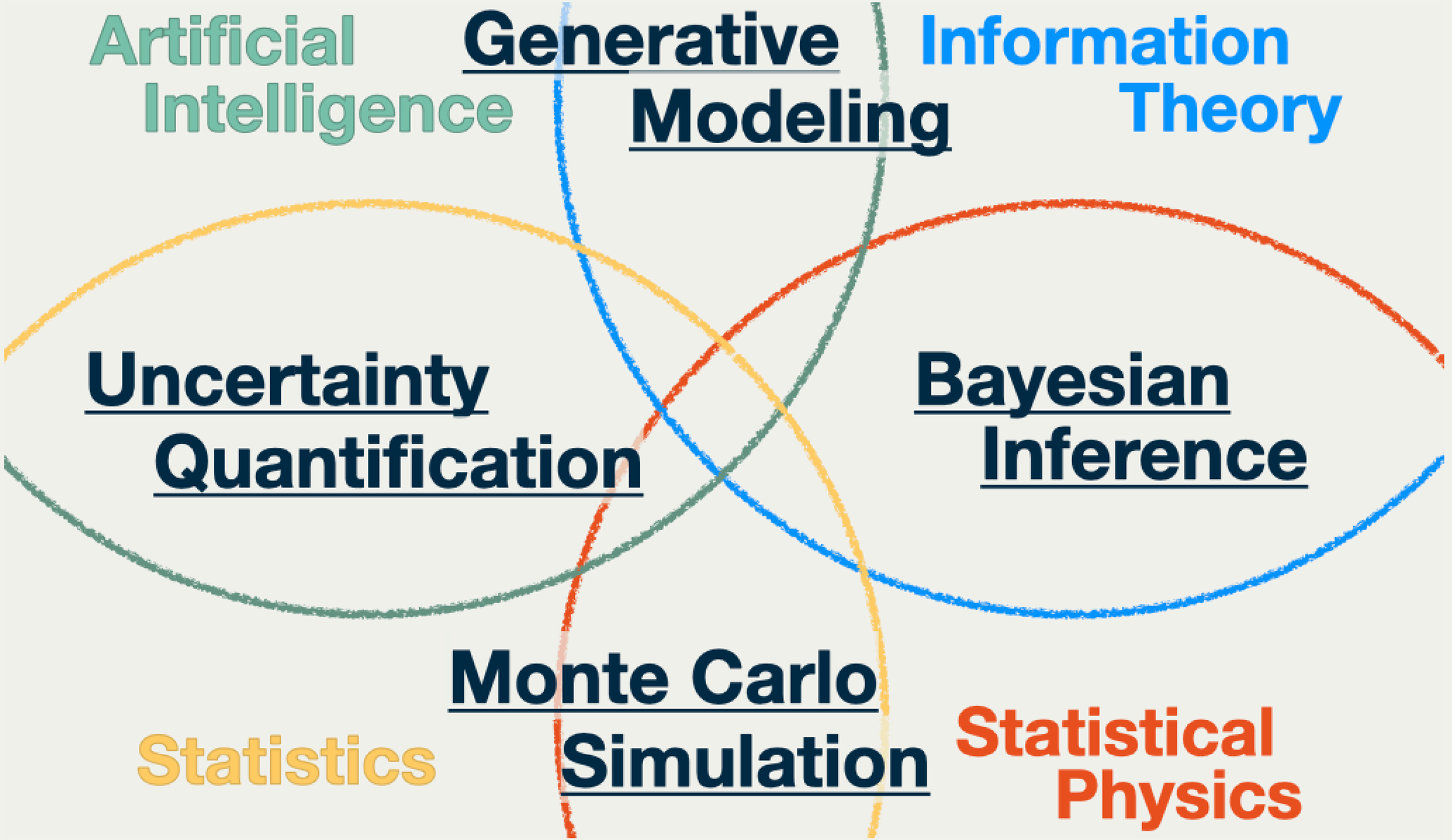
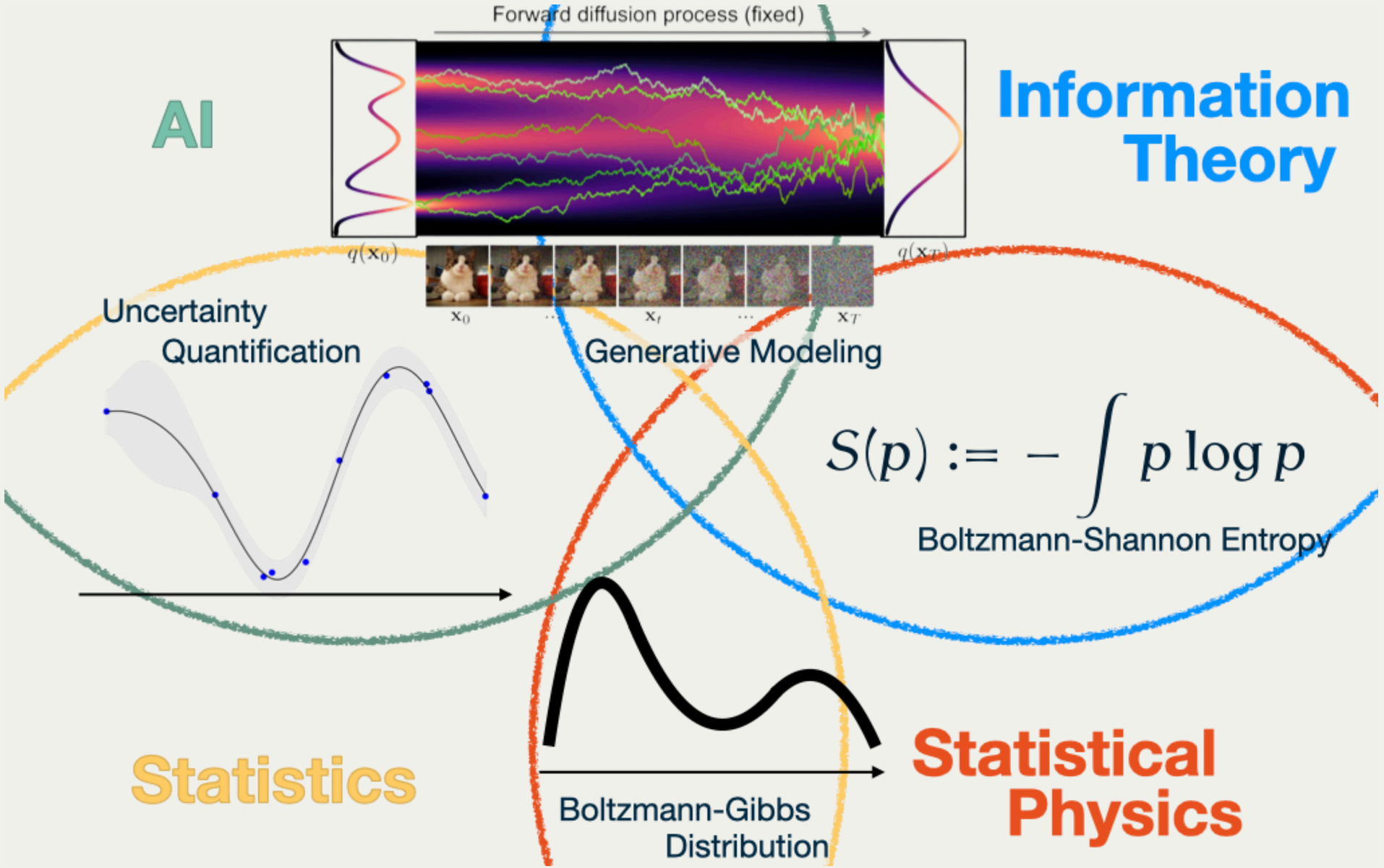
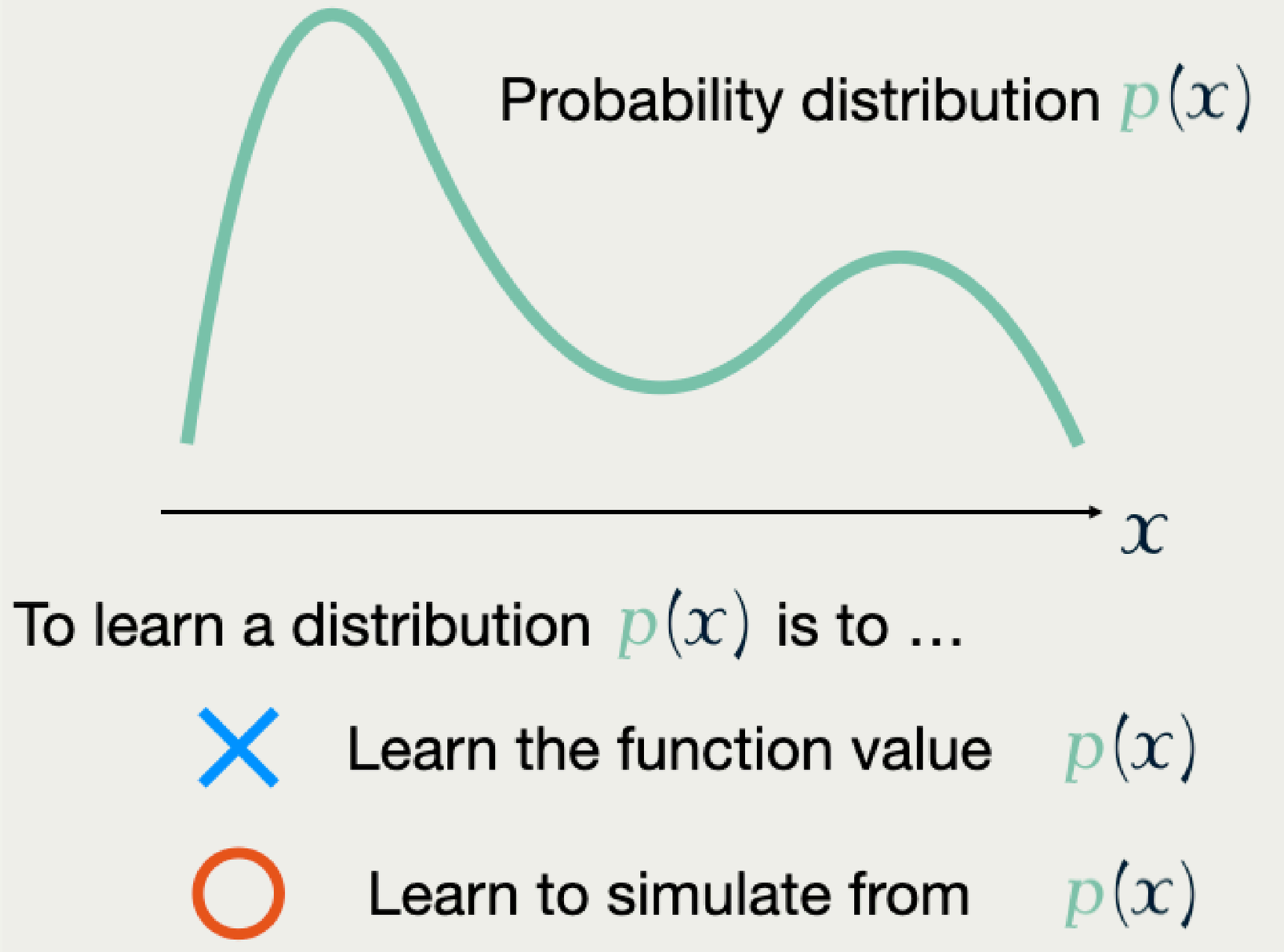
Keywords in My Research



Distribution: Key of New Science



A Computational Reinterpretation



Development in Monte Carlo Methods

Random Walk Metropolis

Langevin Diffusion

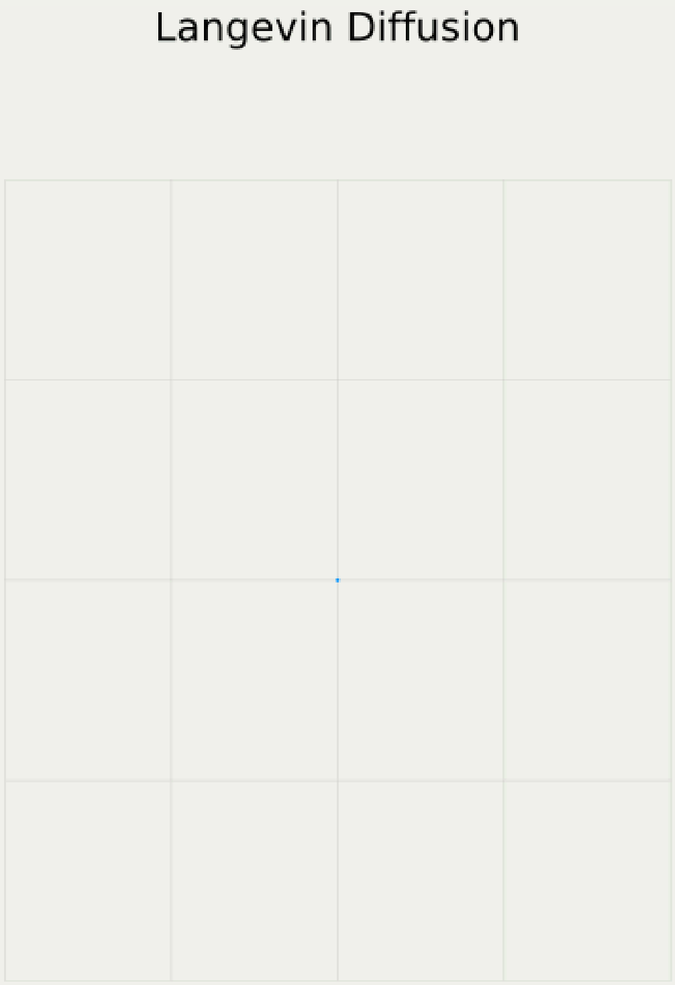
Zig-Zag Sampler

Markov Chain

Diffusion

Jump Process

What's Wrong with Diffusion?



Equilibrium ≒ Reversibility

Langevin Diffusion represents a particle in a medium.

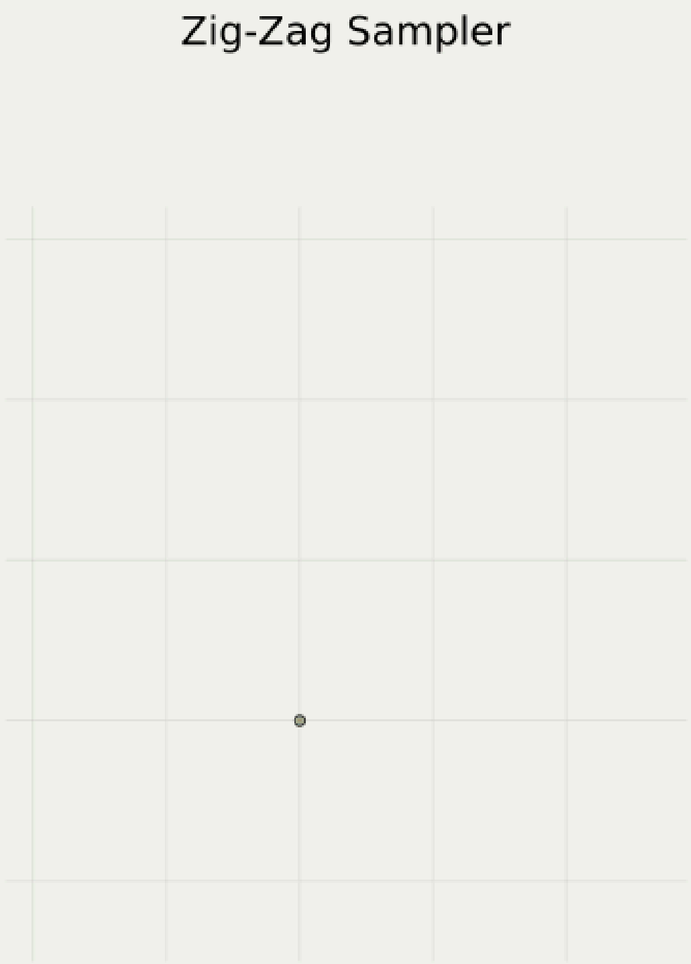
E.g. *A sugar particle in a coffee*

- Nature is not necessarily efficient.

  E.g. *Would you wait until the sugar dissolves? To have a cup of coffee?*

- It's difficult to simulate.

What's New in PDMP?



Irreversibility & Acceleration

- **Ballistic motion**, up until a turn

  E.g. *Stirring coffee with a spoon*

- No artificial symmetry (e.g. detailed balance)

  → Fast convergence & reduced computational cost

All with a new strategy of simulation, which seems to be very efficient (ongoing research)

PDMP Package

Piecewise Deterministic Markov Process

Python

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pdmp_jax

This repository contains a JAX implementation of the PDMP sampler describe in the article "Automated Techniques for Efficient Sampling of Piecewise-Deterministic Markov Processes". The following PDMP samplers are implemented:

- Zig-Zag sampler (Joris Bierkens, Paul Fearnhead, Gareth Roberts. "The Zig-Zag process and super-efficient sampling for Bayesian analysis of big data." The Annals of Statistics, 47(3) 1288-1320 June 2019.)
- Bouncy Particle Sampler (Bouchard-Côté, A., Vollmer, S. J., & Doucet, A. (2018). The Bouncy Particle Sampler: A Nonreversible Rejection-Free Markov Chain Monte Carlo Method. Journal of the American Statistical Association, 113(522), 855–867.)
- Forward Event Chain (Forward Ref with random time for the orthogonal switch) (Michel, M., Durmus, A., & Sénécal, S. (2020). Forward Event-Chain Monte Carlo: Fast Sampling by Randomness

```
pip install pdmp-jax
```

Julia

README MIT license

PDMPFlux

Documentation	Workflows	Code Coverage	Quality Assurance
docs stable docs dev	CI passing	codecov 32%	tested with Aqua.jl

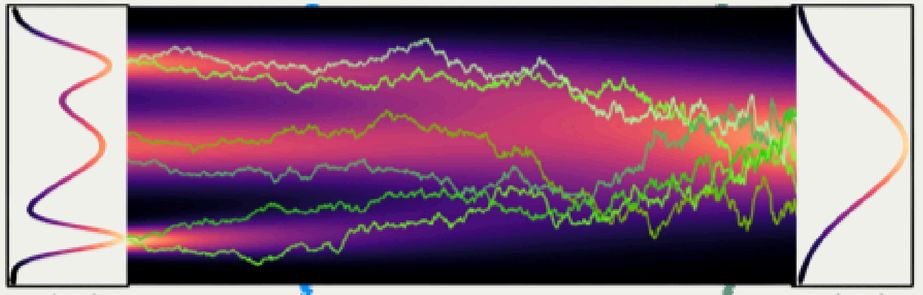
Overview

`PDMPFlux.jl` provides a fast and efficient implementation of **Piecewise Deterministic Markov Process (PDMP)** samplers, using a grid-based Poisson thinning approach proposed in Andral and Kamatani (2024).

By the means of the automatic differentiation engines, `PDMPFlux.jl` only requires `dim` and `U`, which is the negative log density of the target distribution (e.g., posterior). $$ U(x) = -\log p(x) + \text{const}. $$

```
] add PDMPFlux
```

Bringing Science Back



AI

Information Theory

Uncertainty Quantification

Generative Modeling

Irreversibility

$$S(p) := -\int p \log p$$

Boltzmann-Shannon Entropy

Bayesian Inference

Monte Carlo Simulation

Statistics

Boltzmann-Gibbs Distribution

Statistical Physics