

Tunneling-based energy models

One-Page Summary

Key Questions Addressed

Theme	Question
Pattern Discovery	Given the inherent instability and volatility in Bitcoin, can machine learning help identify recurring patterns or structures?
Physics Integration	Can physics-inspired ideas refine machine learning models and support the development of practical trading strategies?

Conceptual Ideas Proposed

- **Energy-based models (EBMs)** are trained on Bitcoin price data to identify **low-energy** (stable) and **high-energy** (disruptive) market states.
- Inspired by **quantum tunneling**, a **tunneling probability** is defined—higher in stable periods, lower during major spikes or crashes—serving as a regime indicator.
- **Trading strategies** use tunneling probability thresholds, as well as price trends, to define entry and exit points aligned with market regime shifts.

Key Results

- In 5-year in-sample testing, **high tunneling scores** coincide with major inflection points (e.g., 2022), while **low scores** correspond with major price spikes (e.g., 2023).
- The developed trading strategy achieves **49%+ CAGR** with a **Sharpe Ratio around 1**, outperforming a **Buy-and-Hold benchmark of 33%+ CAGR**.

Illustrative Figures and Tables

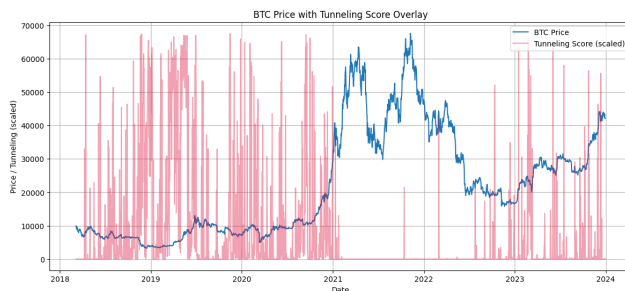


Figure 1: BTC Price with Tunneling Score Overlay (2018–2023). High scores, indicated in pink, indicates periods of higher stability or inflection points

Metric	Value
Strategy CAGR	49.44%
Sharpe Ratio	0.96
Max Drawdown	64.95%
Total Trades	170
Avg. Holding Period	5.59 days
BTC Buy-and-Hold CAGR	33.46%

Table 1: Backtested Trading Performance Using Tunneling Probabilities (BTC).