UCI-MDS-F25 Bitcoin Dashboard

Dynamic Bitcoin Accumulation Strategy - Fact Sheet

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Project Overview

The UCI-MDS-F25 Bitcoin Dashboard is an advanced web application designed to help users accumulate Bitcoin intelligently using data-driven dynamic strategies. The platform combines sophisticated machine learning models with intuitive visualization tools to optimize Bitcoin purchases over time.

Unlike traditional Dollar Cost Averaging (DCA), this dashboard employs dynamic allocation strategies that adjust investment amounts based on market conditions, aiming to maximize "Sats-per-Dollar" (SPD) - the amount of Bitcoin accumulated per dollar invested.

Model Performance Metrics

Final Score	Win Rate

94.5%

Overall Model Performance

99.4%

vs. Uniform DCA Strategy

Test Windows

4,750

Rolling Windows Analyzed

Reward Percentile

89.55%

Weighted Performance

Out-of-Sample Performance (2021-2025)

Test Period Win Rate

100.0%

Out-of-Sample Performance

Test Period Score

91.45%

Validation Score

Key Achievement: The GT-MSA-S25-Trilemma Model achieved a 99.4% win rate against uniform DCA across 4,750+ rolling windows since 2011, demonstrating consistent outperformance across multiple market cycles.

Strategy Architecture

Two-Layer System

Strategic Layer (α parameters)

Sets annual investment planning based on 5 momentum signals:

- **z30:** 30-day momentum: Short-term price momentum
- **z90:** 90-day momentum: Quarterly trend analysis
- **z180:** 180-day momentum: 6-month trend strength
- **z365:** 365-day momentum: Annual cycle position
- **z1461:** 1461-day momentum: 4-year halving cycle awareness

Tactical Layer (β parameters)

Makes daily adjustments based on real-time market conditions, dynamically reallocating investment weights to optimize entry timing.

Model Parameters

- **23-Parameter System:** Optimized through extensive backtesting

- **Beta Distribution Mixture:** Three prototypes for baseline allocation curves

- **Sequential Allocation:** Ensures minimum weight constraints and budget compliance

- **Feature Engineering:** Z-scores calculated with proper lagging to avoid look-ahead bias

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Key Features

- **Advanced Analytics Dashboard:** Real-time portfolio performance tracking with comprehensive metrics

- **Strategy Comparison:** Side-by-side comparison of dynamic vs. uniform DCA strategies

- **Risk Metrics:** Sharpe ratio, Sortino ratio, maximum drawdown, volatility, and Calmar ratio

- **Daily Schedule:** Personalized investment calendar showing exact daily purchase amounts

- **Price Signals:** Visual indicators for buy signals with weight distribution charts

- **Bayesian Learning:** Adaptive model that updates beliefs based on observed market behavior

- **News & Social Integration:** Market sentiment analysis from news and social media

- **Email Updates:** Automated daily email notifications with investment recommendations

- **Purchase Indicators:** Technical indicators to guide optimal entry points

- **Historical Backtesting:** Performance analysis from 2011 to present

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Portfolio Analytics Capabilities

Metric	Description
Sharpe Ratio	Risk-adjusted return metric (annualized, risk-free rate adjusted)
Sortino Ratio	Downside risk-adjusted return (focuses on negative volatility)
Maximum Drawdown	Largest peak-to-trough decline with date tracking

Win Rate	Percentage of profitable days in the portfolio
Annual Volatility	Standard deviation of returns (annualized)
Calmar Ratio	Annualized return divided by maximum drawdown
Sats-per-Dollar (SPD)	Core metric: Bitcoin accumulated per dollar invested
Portfolio Value Tracking	Real-time portfolio valuation with P&L tracking

Methodology & Key Definitions

Investment Framework

- **Dollar-Cost Averaging (DCA):** Invest the same amount on a regular schedule regardless of price. Simple, removes emotion, but ignores market conditions.

- **Dynamic DCA (This Project):** Invests more when Bitcoin is statistically "cheap" and less when it's "expensive," while respecting the total budget.

- **Investment Window:** A user-selected horizon (e.g., 180 days) across which the total budget is fully deployed.

Sats-per-Dollar (SPD)

SPD measures how many satoshis you receive per dollar invested. If the price is lower, SPD is higher. It is the core accumulation efficiency metric used for evaluation.

> **SPD Intuition**
>
> For a day with price P (in USD), 1 USD buys 1/P BTC. Since 1 BTC = 100,000,000 sats, SPD ≈ (100,000,000 / P). Dynamic DCA aims to allocate more weight to days with higher SPD.

Performance and Risk Metrics

- **Sharpe Ratio:** Annualized average excess return divided by volatility. Higher is better; measures risk-adjusted performance.
- **Sortino Ratio:** Like Sharpe but penalizes only downside volatility (negative returns).
- **Maximum Drawdown:** The largest peak-to-trough portfolio decline observed over the period.
- **Volatility:** Standard deviation of returns; reported annually for comparability.
- **Calmar Ratio:** Annualized return divided by the absolute value of maximum drawdown.
- **Win Rate:** Percentage of days with positive PnL.

Backtesting Protocol

- **Rolling Windows:** The strategy is evaluated across thousands of overlapping windows from 2011 to present.
- **No Look-Ahead:** Features use lagging and forward-fill rules to avoid future leakage.
- **Budget Discipline:** Daily weights always sum to 100% of the total budget over the window and respect a minimum daily allocation.
- **Out-of-Sample Checks:** Performance is also validated over more recent years to assess generalization.

Assumptions

- **Liquidity:** Orders fill at daily close price without slippage for the scale considered.
- **Fees:** Transaction costs are not modeled by default; real results may differ.
- **Data Quality:** Historical pricing is assumed accurate and continuous after preprocessing.

Limitations

- **Regime Shifts:** Past patterns may not persist; crypto markets evolve rapidly.

- **Model Risk:** Parameter choices, feature engineering, and priors affect outcomes.

- **Operational Frictions:** Taxes, spreads, and execution timing can reduce realized performance.

How the Dynamic Strategy Works

Strategic vs. Tactical Layers

Strategic Layer: Uses 5 momentum features (z30, z90, z180, z365, z1461) to shape a baseline allocation curve across the window via Beta mixtures.
Tactical Layer: Adjusts the baseline daily based on current feature conditions, emphasizing days that appear statistically favorable.

- **Minimum Daily Weight:** Ensures continuous participation and avoids "all-in/all-out" behavior.

- **Sequential Allocation:** Preserves prior-day decisions and distributes remaining budget safely across future days.

- **Budget Closure:** The sum of daily allocations equals 100% of the user's budget by the end of the window.

Frequently Asked Questions

- **Is this timing the market?** It's structured allocation, not prediction. The model tilts spending to statistically favorable days while maintaining full budget deployment.

- **Why SPD instead of returns?** For accumulators, the priority is maximizing BTC per dollar over time, not mark-to-market gains at each step.

- **Can I add fees?** Yes. The simulation layer can be extended to subtract a per-trade or percentage fee before computing PnL and SPD.

- **What if prices only rise?** The model still invests daily (via minimum weights) and completes the budget schedule.

- **How do I export this fact sheet?** Run the fact sheet generator to produce an HTML file you can share or print.

Technical Architecture

Technology Stack

Python 3 Streamlit Pandas NumPy SciPy Plotly

CoinMetrics API NewsAPI Google Sheets API

Data Sources

- **Historical Price Data:** CoinMetrics (2011-present)
- **Market News:** NewsAPI integration for sentiment analysis
- **Social Media:** Social sentiment tracking
- **User Preferences:** Google Sheets integration for personalized settings

Core Modules

- **Model Layer:** Strategy implementation (GT-MSA-S25-Trilemma, Smart Shopper)
- **Analytics Layer:** Portfolio metrics and risk analysis
- **UI Layer:** Interactive charts, controls, and visualizations
- **Data Layer:** Data loading, validation, and preprocessing
- **Email Layer:** Automated notifications and recommendations

Development Team

Sam Townsend

From: Virginia Beach, VA, USA

Undergrad: University of Virginia

Interest: Surfing enthusiast

Caleb Traxler

From: Ventura County, CA, USA

Undergrad: University of California, Los Angeles

Interest: Investing in stocks, securities, and real estate

Abigail Mori

From: Honolulu, HI, USA

Undergrad: University of Connecticut

Interest: Training for a half marathon

Albert Wu

From: Taipei, Taiwan

Undergrad: Soochow University

Interest: Hiking and camping

Qunli Liu

From: Taizhou, Jiangsu, China

Undergrad: University of California, Berkeley

Interest: Singing and street dance

Yicheng Wen

From: China

Undergrad: The Chinese University of Hong Kong, Shenzhen

Interest: Cooking and learning different styles

Model Attribution

GT-MSA-S25-Trilemma Model developed by Youssef Ahmed, Georgia Institute of Technology.

This sophisticated two-layer Bitcoin accumulation strategy achieved a 94.5% final score with a 99.4% win rate against uniform DCA across 4,750+ rolling windows since 2011.

Important Disclaimer

This tool is for educational and informational purposes only.

It is designed to demonstrate a quantitative investment strategy. It is **not financial advice**. The cryptocurrency market is highly volatile, and investing in Bitcoin involves significant risk. Please do your own research and consider consulting with a qualified financial advisor before making any investment decisions. Past performance is not indicative of future results.

UCI Master of Data Science - Fall 2025 Capstone Project

University of California, Irvine

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