This document serves as your complete strategic blueprint for winning **Arbitrage Arena 2026**. To win, you must satisfy the technical requirements while demonstrating an "Institutional Mindset"—prioritizing risk management over raw profits.

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1. The Strategy: "Hybrid Regime-Switching Model"

For a competition focused on **Crash Survivability**, a pure "Buy and Hold" or a simple AI prediction model will likely fail. You should use a **Hybrid Model** that combines **Rule-Based Risk Logic** with **Statistical Indicators**.

Why Hybrid?

- **Reliability:** Pure AI models (like LSTMs) often hallucinate during unprecedented market crashes (Black Swans).
- **Explainability:** Judges reward models where you can clearly explain the "Why" behind a trade.
- **The "Switch":** The model identifies the market "regime" (Calm vs. Volatile) and changes its behavior entirely when danger is detected.

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2. Core Technical Requirements Check

Ensure your notebook includes these exact sections to hit the **100-point Prelims Matrix**:

Component	Weight	How to Win It
Model Logic	25 pts	Use a "Canary Signal" (e.g., if NASDAQ drops, exit BTC).
Data Handling	10 pts	Use forward-fill for missing data; align timestamps perfectly.
Risk Management	15 pts	Mandatory: Stop-losses, Volatility-based position sizing.
Backtesting	20 pts	Include transaction costs (0.1% slippage) to show realism.

Evaluation Metrics	20 pts	Must calculate **CSI, Max Drawdown, and Sharpe Ratio**.
Clarity	10 pts	Use LaTeX for formulas and professional charts (Seaborn/Plotly).

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3. The "Winning" Model Architecture: The 3-Layer Defense

If choosing **Problem 1 (Crypto Flash Crash)**, implement this architecture:

Layer 1: The Crash Detector (Feature Engineering)

Don't just look at price. Calculate these three "Loophole" indicators:

1. **DUVOL (Down-to-Up Volatility):** Calculate the ratio of standard deviation on "down" days vs "up" days. A rising DUVOL is a precursor to a crash.
2. **NCSKEW (Negative Skewness):** Measures if the returns are becoming asymmetric (more heavy-tail risk).
3. **Cross-Asset Canary:** Monitor the **NASDAQ Index** dataset. High-tech equity sell-offs almost always lead to crypto liquidations within 24 hours.

Layer 2: The Logic Engine (Regime Switching)

- **Normal Regime:** Use a simple trend-following signal (e.g., RSI or Moving Average Crossover).
- **Crash Regime:** Triggered if DUVOL > Threshold OR NASDAQ Return < -3%.
    - *Action:* Liquidate 100% of holdings to Cash.

Layer 3: The Recovery logic

- Wait for **"Volatility Mean Reversion"**. Do not buy back until the 10-day rolling volatility drops below its 30-day average.

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4. Best Libraries to Use (The "Pro" Stack)

Use these specific libraries to make your notebook look professional and save time:

- **pandas & numpy:** Non-negotiable for data cleaning.

- **vectorbt: (The Secret Weapon)** A high-performance library that allows you to backtest thousands of strategy parameters in seconds. It generates professional equity curves and drawdown charts automatically.
- **PyPortfolioOpt:** Use this if you switch to Problem 2. It implements the "Markowitz Mean-Variance Optimization" and "Black-Litterman" models used by major banks.
- **statsmodels:** For calculating the statistical metrics like Skewness and Kurtosis required for "Logic & Innovation" points.
- **Seaborn:** For the "Correlation Heatmap" requested in the problem statement.

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5. Winning Presentation (The Technical Report)

The PPT is where you sell your "logic." Use these slide titles:

1. **Executive Summary:** Our model achieved a **CSI of X** while maintaining a **Max Drawdown of only Y%**.
2. **The "Canary" Alpha:** How we used Equity data to predict Crypto crashes.
3. **Mathematical Framework:** (Insert LaTeX equations for CSI and DUVOL).
4. **Stress Test Results:** A side-by-side comparison of "Market Performance" vs "Our Model" during the 2022 FTX crash.
5. **Failure Analysis:** Be honest about when the model fails (e.g., "V-shaped" recoveries where it exits too early).

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6. Calculation Formulas (Use these in your Notebook)

To impress the judges, render these using LaTeX:

Crash Survivability Index (CSI):

$$CSI = \frac{R_{strategy} - R_{f}}{\max(Drawdown)}$$

Where $R_{strategy}$ is the return during the crash window.
Risk-Adjusted Return (Sharpe Ratio):

$$Sharpe = \frac{\mu - r_f}{\sigma}$$
