MARKETPULSE: DAILY VOLATILITY ANALYTICS & FORECASTING DASHBOARD

Automated Pipeline for Financial Risk Assessment

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BACKGROUND: SOFTWARE DEVELOPER TRANSITIONING TO DATA ANALYTICS
PROJECT FOCUS: FIRST EXPLORATION INTO QUANTITATIVE FINANCE

BUSINESS PROBLEM & SOLUTION

Current State: Manual Risk Assessment Challenges

DATA FRAGMENTATION
- PRICE HISTORY SCATTERED ACROSS MULTIPLE SOURCES (APIS, SPREADSHEETS, MANUAL DOWNLOADS)
- ANALYSTS SPEND HOURS GATHERING AND CLEANING DATA BEFORE ANALYSIS BEGINS

LACK OF PREDICTIVE INSIGHTS
- RISK ASSESSMENT RELIES ON BACKWARD-LOOKING ANALYSIS ONLY
- NO STATISTICAL MODELING FOR VOLATILITY FORECASTING
- CRITICAL QUESTION UNANSWERED: "WHAT WILL MARKET VOLATILITY LOOK LIKE NEXT WEEK?"

MANUAL WORKFLOWS
- ERROR-PRONE, REPETITIVE PROCESSES FOR EACH TICKER ANALYSIS
- NO STANDARDIZED RISK METRICS ACROSS PORTFOLIO HOLDINGS

SOLUTION DELIVERED: AUTOMATED ANALYTICS PIPELINE

QUANTIFIED BUSINESS VALUE
- 1,000 CLEAN DATA POINTS PROCESSED ACROSS 4 MAJOR TECH STOCKS
- 14-DAY VOLATILITY FORECASTS WITH STATISTICAL CONFIDENCE INTERVALS
- AUTOMATED RISK RANKING BASED ON GARCH MODEL PERFORMANCE (AIC SCORING)

KEY BUSINESS QUESTIONS ANSWERED
- RISK-RETURN POSITIONING: TSLA IDENTIFIED AS EXTREME OUTLIER (150% RETURNS, 16.75% MAX LOSS)
- VOLATILITY FORECASTING: GARCH MODELS PREDICT INCREASING VOLATILITY TRENDS FOR TACTICAL PLANNING
- CROSS-TICKER COMPARISON: MSFT SHOWS MOST PREDICTABLE PATTERNS (AIC: 919.53 VS TSLA: 1464.23)

IMPACT
- MANUAL ANALYSIS TIME REDUCED FROM HOURS TO MINUTES
- FORWARD-LOOKING RISK INSIGHTS ENABLE PROACTIVE PORTFOLIO MANAGEMENT

Risk vs Return Analysis
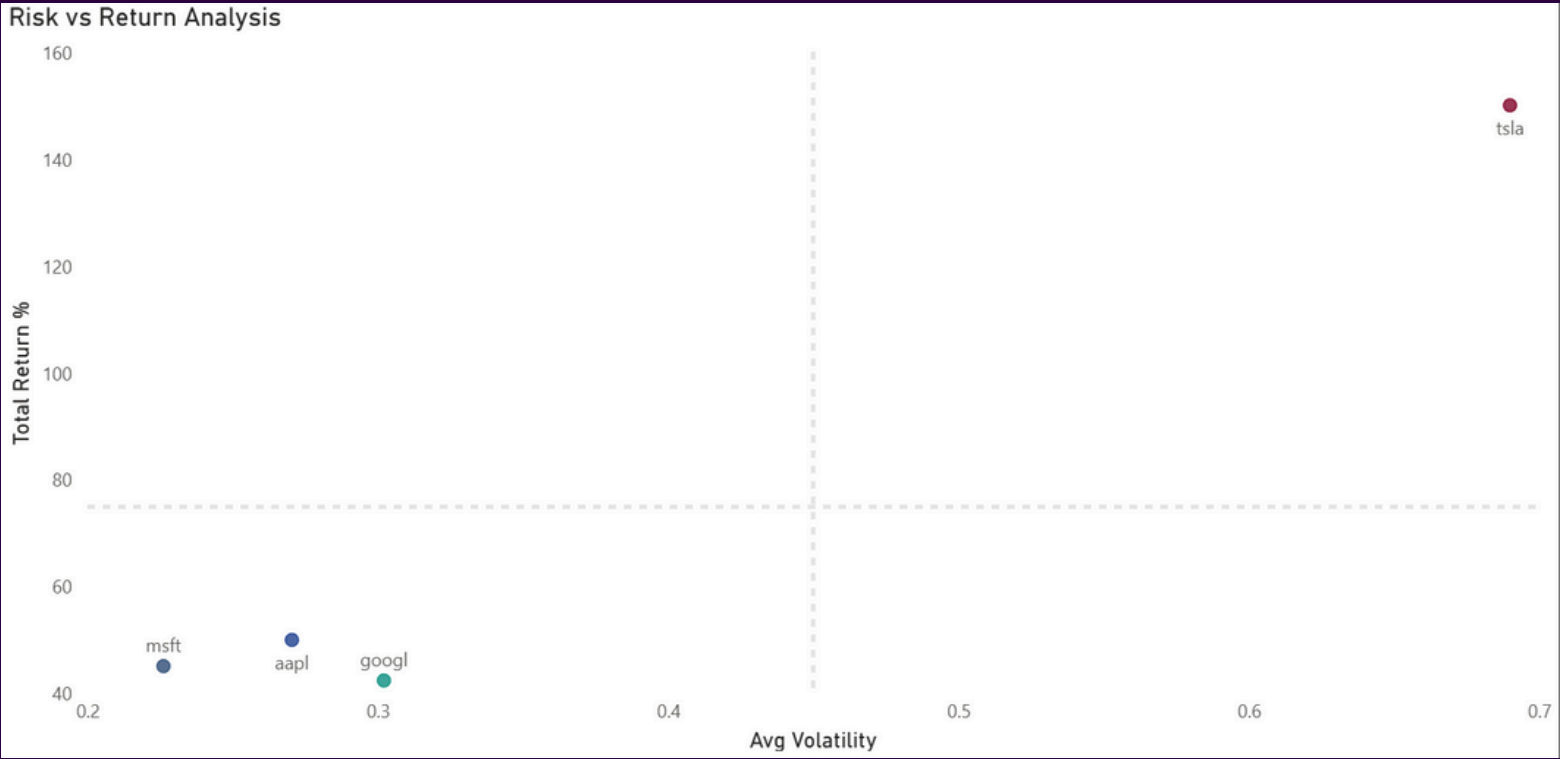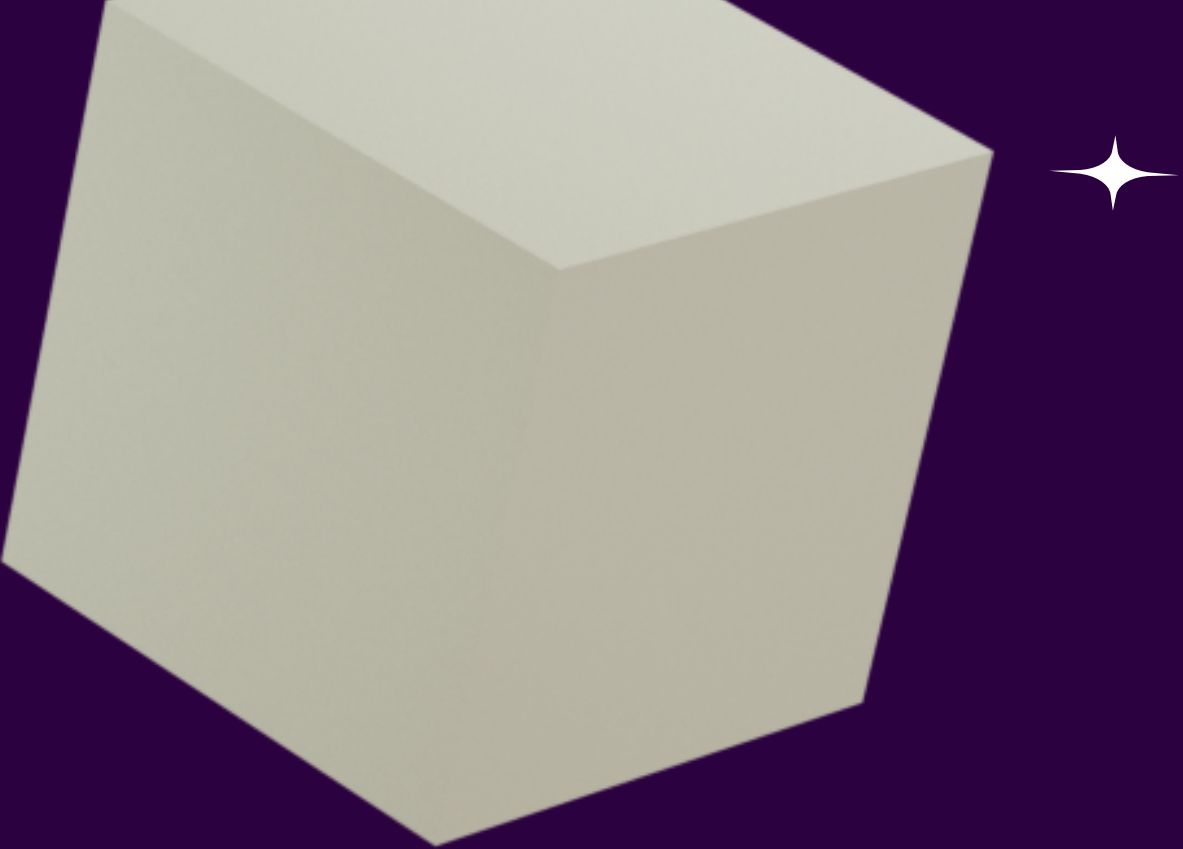
TECHNICAL ARCHITECTURE

END-TO-END DATA PIPELINE
DATA FLOW
YAHOO FINANCE API → RAW CSV FILES → POSTGRESQL STAGING → FEATURE ENGINEERING →
GARCH MODELING → POWER BI DASHBOARD

TECHNOLOGY STACK & DESIGN DECISIONS
DATA EXTRACTION
- YAHOO FINANCE API VIA YFINANCE LIBRARY FOR OHLCV MARKET DATA
- ATOMIC FILE OPERATIONS USING TEMPORARY FILES TO PREVENT DATA CORRUPTION
- 1 YEAR OF DAILY DATA FOR AAPL, GOOGL, MSFT, TSLA (250 TRADING DAYS PER TICKER)

DATA PROCESSING PIPELINE
FINANCIAL FEATURE ENGINEERING - LOG RETURNS CALCULATION
- DF['DAILY_RETURN'] = NP.LOG(DF['CLOSE'] / DF['CLOSE'].SHIFT(1))
14-DAY ROLLING VOLATILITY (ANNUALIZED)
- DF['VOLATILITY_14D'] = DF['DAILY_RETURN'].ROLLING(WINDOW=14).STD() * NP.SQRT(252)

**GARCH IMPLEMENTATION**
 # GARCH(1,1) MODEL FITTING WITH ARCH LIBRARY
- MODEL = ARCH_MODEL(RETURNS, VOL='GARCH', P=1, Q=1, DIST='NORMAL')FITTED_MODEL =
  MODEL.FIT(DISP='OFF')
 # MODEL VALIDATION USING AIC CRITERION
- AIC_SCORE = FITTED_MODEL.AIC PERSISTENCE = FITTED_MODEL.PARAMS['ALPHA[1]'] +
  FITTED_MODEL.PARAMS['BETA[1]']

PRODUCTION QUALITY FEATURES
- MODULAR DESIGN WITH SEPARATE EXTRACT, TRANSFORM, LOAD COMPONENTS
- COMPREHENSIVE LOGGING AND ERROR HANDLING THROUGHOUT PIPELINE
- DATABASE STAGING CAPABILITY WITH POSTGRESQL INTEGRATION
- DATA VALIDATION WITH QUALITY CHECKS AND STATISTICAL PROPERTY
  VERIFICATION
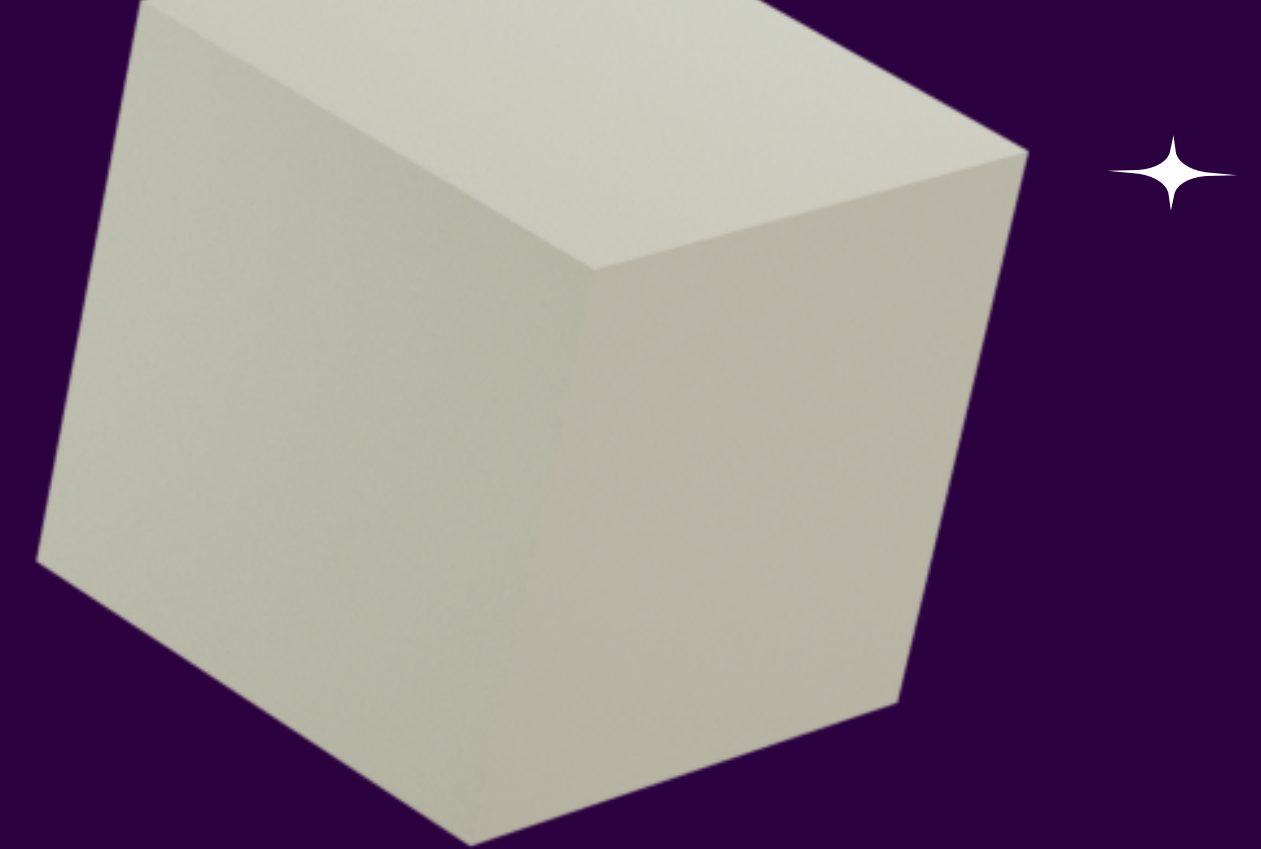
TECHNICAL ARCHITECTURE

GARCH MODELING DEEP DIVE
WHAT IS GARCH AND WHY IT MATTERS
GARCH (GENERALIZED AUTOREGRESSIVE CONDITIONAL HETEROSKEDASTICITY)
- ADVANCED ECONOMETRIC MODEL FOR VOLATILITY FORECASTING IN FINANCIAL MARKETS
- CAPTURES VOLATILITY CLUSTERING - PERIODS OF HIGH VOLATILITY FOLLOWED BY HIGH VOLATILITY
- ESSENTIAL FOR RISK MANAGEMENT AND PORTFOLIO OPTIMIZATION IN QUANTITATIVE FINANCE

BUSINESS PROBLEM SOLVED
- TRADITIONAL MODELS ASSUME CONSTANT VOLATILITY (UNREALISTIC FOR STOCK MARKETS)
- GARCH MODELS TIME-VARYING VOLATILITY BASED ON HISTORICAL PATTERNS AND SHOCKS

KEY STATISTICAL INSIGHTS
PERSISTENCE ANALYSIS (ALPHA + BETA COEFFICIENTS)
- ALL MODELS SHOW 0.93-0.98 PERSISTENCE → STRONG VOLATILITY CLUSTERING ACROSS ALL STOCKS
- VALUES < 1.0 CONFIRM STATIONARY PROCESS → MODELS ARE MATHEMATICALLY STABLE

TSLA PATTERN DISCOVERY
- PURE GARCH EFFECTS (A≈0.00, B≈0.99) → UNIQUE VOLATILITY BEHAVIOR
- HIGHEST AIC SCORE → COMPLEX DYNAMICS NOT WELL CAPTURED BY STANDARD GARCH(1,1)
- BUSINESS IMPLICATION → REQUIRES SPECIALIZED RISK MANAGEMENT APPROACH

FORECAST CAPABILITY
- 14-DAY VOLATILITY PREDICTIONS WITH STATISTICAL CONFIDENCE INTERVALS
- MODEL VALIDATION CONFIRMS RELIABLE FORECASTING FOR TACTICAL DECISION-MAKING

Rank	Ticker	AIC Score	Model Quality	Key Characteristics
1	MSFT	919.53	★★★★★	Predictable volatility patterns
2	AAPL	976.37	★★★★	Good model performance
3	GOOGL	1045.94	★★★	Moderate complexity
4	TSLA	1464.23	★★	Extreme volatility, poor fit

TECHNICAL ARCHITECTURE

DASHBOARD DEMO & BUSINESS INSIGHTS
INTERACTIVE POWER BI ANALYTICS - 3 STRATEGIC PAGES

PAGE 1: EXECUTIVE SUMMARY
KEY PERFORMANCE INDICATORS
- **LATEST PRICES & TOTAL RETURNS:** TSLA $479.86 WITH 150.2% ANNUAL RETURN
- **VOLATILITY COMPARISON:** VISUAL RANKING SHOWS TSLA AT 0.69 VS MSFT AT 0.27
- **PRICE TREND ANALYSIS:** LINE CHARTS REVEAL TSLA'S VOLATILE JOURNEY TO EXCEPTIONAL RETURNS

BUSINESS VALUE: ONE-CLICK EXECUTIVE OVERVIEW FOR PORTFOLIO PERFORMANCE ASSESSMENT

PAGE 2: RISK ANALYTICS DASHBOARD
RISK VS RETURN SCATTER PLOT ANALYSIS
- **QUADRANT POSITIONING** CLEARLY SEPARATES INVESTMENT CATEGORIES
- TSLA POSITIONED AS EXTREME OUTLIER: HIGH RISK (0.69 VOLATILITY) / HIGH RETURN (150%)
- **RISK METRICS QUANTIFIED:** MAXIMUM DAILY LOSS -16.75%, MAXIMUM GAIN +20.45%
- **HIGH VOLATILITY DAYS:** 52 OUT OF 250 TRADING DAYS FOR TSLA

**BUSINESS VALUE:** PORTFOLIO MANAGERS CAN INSTANTLY ASSESS RISK-RETURN TRADEOFFS

PAGE 3: VOLATILITY FORECASTING
HISTORICAL VS PREDICTIVE ANALYSIS
- **HISTORICAL VOLATILITY TIMELINE** SHOWS CLUSTERING PATTERNS OVER 12 MONTHS
- **14-DAY GARCH FORECASTS** WITH INCREASING VOLATILITY TRENDS
- **INTERACTIVE FILTERING** BY TICKER REVEALS DIFFERENT VOLATILITY BEHAVIORS
- **FORECAST CONFIDENCE:** STATISTICAL BACKING FOR TACTICAL DECISION-MAKING

BUSINESS VALUE: FORWARD-LOOKING RISK MANAGEMENT **CAPABILITIES**

DASHBOARD IMPACT
- **MANUAL ANALYSIS TIME:** REDUCED FROM HOURS TO MINUTES
- **DECISION SUPPORT:** DATA-DRIVEN INSIGHTS REPLACE INTUITION-BASED RISK ASSESSMENT
- **SCALABILITY:** FRAMEWORK SUPPORTS ADDITIONAL TICKERS AND LONGER FORECAST HORIZONS
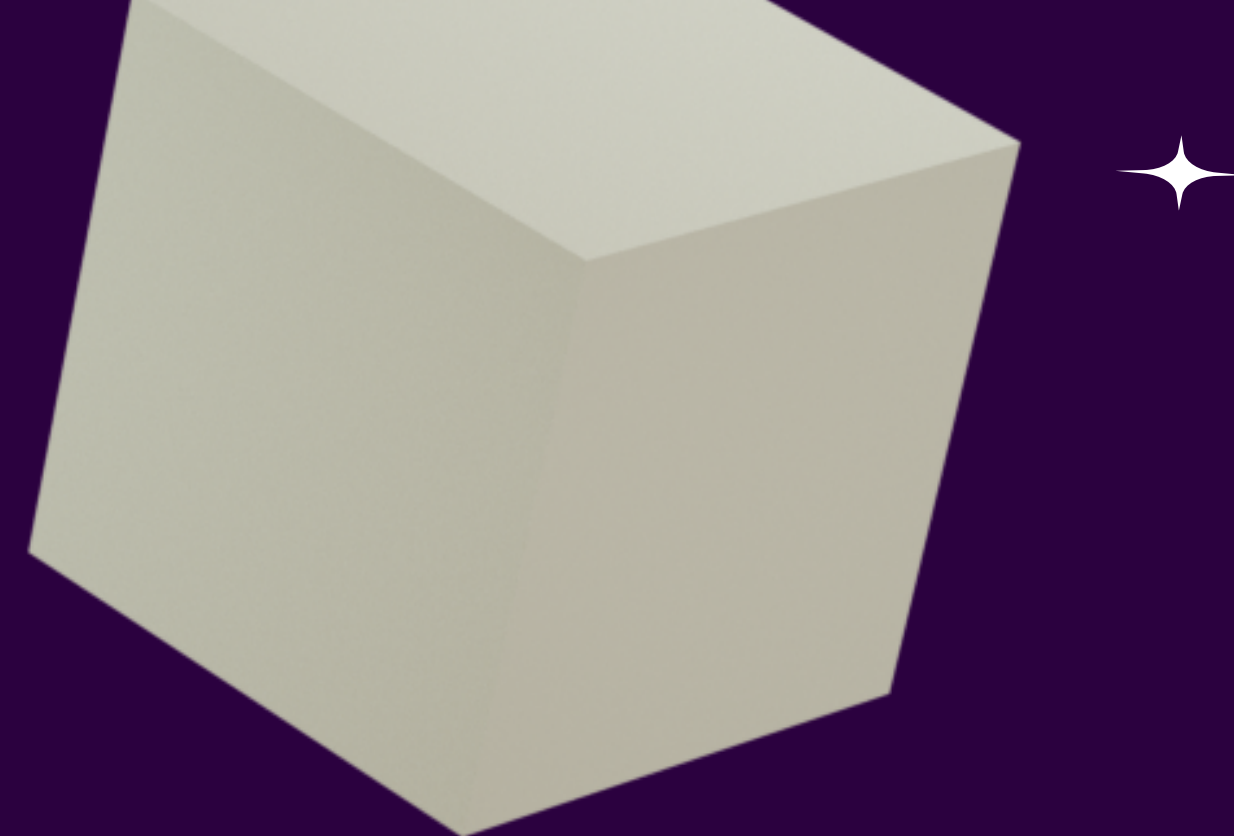
BUSINESS QUESTIONS ANSWERED

DASHBOARD DELIVERS SPECIFIC SOLUTIONS TO PORTFOLIO MANAGEMENT CHALLENGES

1. RISK-RETURN ANALYSIS
QUESTION: HOW DO RISK AND RETURN METRICS COMPARE ACROSS DIFFERENT STOCKS?
ANSWER: RISK-RETURN SCATTER PLOT REVEALS TSLA AS EXTREME OUTLIER (150% RETURNS, 0.69 VOLATILITY) VS MSFT'S MODERATE PROFILE (MODERATE RETURNS, 0.27 VOLATILITY)
BUSINESS IMPACT: PORTFOLIO MANAGERS CAN INSTANTLY CATEGORIZE INVESTMENTS BY RISK QUADRANTS

2. VOLATILITY FORECASTING
QUESTION: WHAT IS THE PROJECTED VOLATILITY OVER THE NEXT 14 TRADING DAYS?
ANSWER: GARCH MODELS PREDICT INCREASING VOLATILITY TRENDS WITH STATISTICAL CONFIDENCE INTERVALS
BUSINESS IMPACT: FORWARD-LOOKING RISK MANAGEMENT ENABLES PROACTIVE POSITION ADJUSTMENTS

3. CROSS-TICKER COMPARISON
QUESTION: HOW DO CURRENT VOLATILITY LEVELS AND FORECASTS VARY ACROSS OUR TECH PORTFOLIO?
ANSWER: INTERACTIVE FILTERING REVEALS MSFT HAS MOST PREDICTABLE PATTERNS (AIC: 919.53) WHILE TSLA REQUIRES SPECIALIZED APPROACH (AIC: 1464.23)
BUSINESS IMPACT: RISK ALLOCATION DECISIONS BASED ON MODEL RELIABILITY RANKINGS

4. RISK ASSESSMENT
QUESTION: WHAT ARE THE MAXIMUM DAILY LOSS/GAIN EXPOSURES?
ANSWER: TSLA SHOWS -16.75% MAX LOSS POTENTIAL, +20.45% MAX GAIN, WITH 52 HIGH-VOLATILITY DAYS OUT OF 250
**BUSINESS IMPACT:** QUANTIFIED DOWNSIDE EXPOSURE FOR POSITION SIZING AND STOP-LOSS DECISIONS

5. VOLATILITY TRENDS
QUESTION: HOW DOES ROLLING VOLATILITY CHANGE THROUGH TIME FOR EACH STOCK?
ANSWER: HISTORICAL TIMELINE CHARTS SHOW VOLATILITY CLUSTERING PATTERNS WITH CLEAR HIGH/LOW PERIODS
BUSINESS IMPACT: PATTERN RECOGNITION SUPPORTS TACTICAL ENTRY/EXIT TIMING STRATEGIES
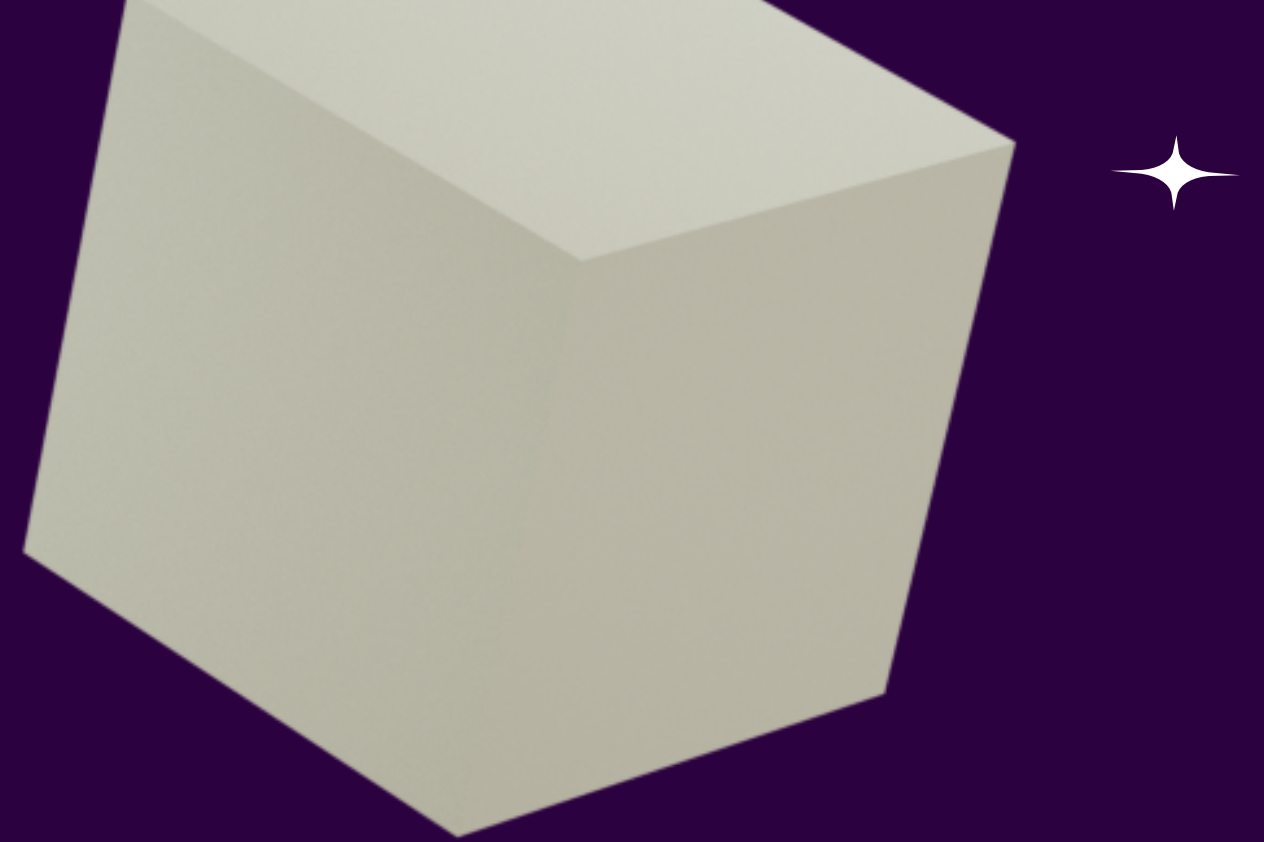
TECHNICAL IMPLEMENTATION HIGHLIGHTS

CODE QUALITY & DATA ENGINEERING EXCELLENCE
PRODUCTION-READY PIPELINE ARCHITECTURE
MODULAR DESIGN
- SEPARATE EXTRACT, TRANSFORM, LOAD, AND ML COMPONENTS FOR MAINTAINABILITY
- COMPREHENSIVE ERROR HANDLING AND LOGGING THROUGHOUT PIPELINE
- CONFIGURATION MANAGEMENT VIA ENVIRONMENT VARIABLES

DATA QUALITY ASSURANCE

```
# AUTOMATED DATA VALIDATION WITH BUSINESS LOGIC
DEF VALIDATE_FINANCIAL_DATA(DF):
      VALIDATION_RESULTS = {
            'NEGATIVE_PRICES': (DF['CLOSE'] <= 0).SUM(),
            'EXTREME_RETURNS': (DF['DAILY_RETURN'].ABS() > 0.5).SUM(),
            'MISSING_VOLATILITY': DF['VOLATILITY_14D'].ISNA().SUM()
      }
      RETURN VALIDATION_RESULTS
```

FINANCIAL DOMAIN EXPERTISE
PROPER STATISTICAL IMPLEMENTATION
- LOG RETURNS CALCULATION USING $\ln(P_t/P_{t-1})$ FOR ADDITIVE PROPERTIES
- VOLATILITY ANNUALIZATION WITH $\sqrt{252}$ TRADING DAYS FACTOR
- GARCH PARAMETER VALIDATION FOR MODEL STABILITY (A + B < 1.0)

DATA ENGINEERING RESULTS
- 1,000 CLEAN RECORDS PROCESSED WITH <0.5% DATA LOSS
- EXPECTED MISSING VALUES DOCUMENTED (4 RETURNS, 56 VOLATILITY DUE TO ROLLING WINDOWS)
- QUALITY METRICS TRACKED THROUGHOUT PIPELINE EXECUTION

DATABASE & INTEGRATION
POSTGRESQL STAGING
- SCHEMA DESIGN WITH DATA VALIDATION CONSTRAINTS
- ATOMIC OPERATIONS AND TRANSACTION MANAGEMENT
- DATABASE CAPABILITY IMPLEMENTED (CURRENT WORKFLOW USES CSV FOR SIMPLICITY)

DASHBOARD INTEGRATION
- 12 CUSTOM DAX MEASURES FOR ADVANCED POWER BI ANALYTICS
- PROPER DATA RELATIONSHIPS AND FILTERING LOGIC
- INTERACTIVE VISUALIZATIONS WITH BUSINESS-FOCUSED KPIS

KEY TAKEAWAYS & CAREER POSITIONING

SKILLS DEMONSTRATED THROUGH FIRST QUANTITATIVE FINANCE PROJECT
TECHNICAL CAPABILITIES ACQUIRED
ADVANCED STATISTICAL MODELING
- GARCH(1,1) IMPLEMENTATION WITH PROPER PARAMETER VALIDATION
- MODEL COMPARISON USING AIC CRITERION AND PERSISTENCE ANALYSIS
- STATISTICAL INTERPRETATION FOR BUSINESS DECISION-MAKING

PRODUCTION DATA ENGINEERING
- END-TO-END ETL PIPELINE WITH COMPREHENSIVE ERROR HANDLING
- DATABASE INTEGRATION AND DATA QUALITY VALIDATION SYSTEMS
- MODULAR ARCHITECTURE SUPPORTING SCALABILITY AND MAINTENANCE

BUSINESS INTELLIGENCE DEVELOPMENT
- INTERACTIVE DASHBOARD DESIGN WITH 12 CUSTOM DAX MEASURES
- FINANCIAL KPI IMPLEMENTATION AND RISK VISUALIZATION
- CROSS-FUNCTIONAL STAKEHOLDER COMMUNICATION THROUGH DATA STORYTELLING

DOMAIN KNOWLEDGE ACQUISITION
QUANTITATIVE FINANCE FUNDAMENTALS
- LOG RETURNS CALCULATION AND VOLATILITY ANNUALIZATION TECHNIQUES
- RISK-RETURN ANALYSIS AND PORTFOLIO ASSESSMENT METHODOLOGIES
- FINANCIAL TIME SERIES MODELING AND FORECASTING APPLICATIONS

BUSINESS PROBLEM SOLVING
- TRANSLATED COMPLEX STATISTICAL RESULTS INTO ACTIONABLE PORTFOLIO INSIGHTS
- DELIVERED MEASURABLE BUSINESS VALUE (TIME REDUCTION, IMPROVED DECISION-MAKING)
- CONNECTED TECHNICAL IMPLEMENTATION TO STRATEGIC BUSINESS OBJECTIVES

CAREER TRANSITION CONTEXT
SOFTWARE DEVELOPMENT BACKGROUND TRANSITIONING TO DATA ANALYTICS
- APPLIED EXISTING TECHNICAL SKILLS TO NEW DOMAIN (QUANTITATIVE FINANCE)
- LEARNED STATISTICAL MODELING CONCEPTS THROUGH HANDS-ON IMPLEMENTATION
- BUILT END-TO-END SOLUTION CONNECTING TECHNICAL WORK TO BUSINESS OUTCOMES

PROJECT LEARNING OUTCOMES
- FIRST EXPLORATION INTO QUANTITATIVE FINANCE AND STATISTICAL MODELING
- GAINED EXPERIENCE WITH FINANCIAL DATA ANALYSIS AND RISK ASSESSMENT
- DEVELOPED UNDERSTANDING OF PRODUCTION DATA PIPELINE REQUIREMENTS