

Technical Indicator Analysis for Index ETF Direction Prediction

A Machine Learning Study using Decision Tree and Random Forest

Report generated: April 14, 2026

Data period: 2017-01-20 to 2026-03-11 | Exchange: XETRA (EUR)

Ticker	Full Name	Market
SXR8.DE	iShares Core S&P; 500 UCITS ETF (SXR8.DE)	US Large Cap (benchmark)
IS3N.DE	iShares Core MSCI EM IMI UCITS ETF (IS3N.DE)	Emerging Markets
SXRV.DE	iShares NASDAQ 100 UCITS ETF (SXRV.DE)	US Tech / Growth
VWCE.DE	Vanguard FTSE All-World UCITS ETF (VWCE.DE)	Global All-Cap
EUNL.DE	iShares Core MSCI World UCITS ETF (EUNL.DE)	Developed World

1. Introduction and Hypothesis

This report presents the results of a machine learning analysis aimed at predicting the directional movement of five major index ETFs traded on XETRA. The analysis tests whether purely technical indicators can provide statistically meaningful predictions across three horizons: next day (1 trading day), next week (5 trading days), and next month (20 trading days).

The central hypothesis: *using only technical indicators as features, a machine learning classifier can predict future ETF direction based on historical price patterns, provided the target is well-defined within a specific time horizon.*

2. Methodology

2.1 Features (Technical Indicators)

Eight purely technical features computed from daily OHLCV data:

Feature	Description	Horizon
price_change	Day-over-day % change in adjusted close	Short-term
volume_change	Day-over-day % change in trading volume	Short-term
day_gain	Intraday move: (Close - Open) / Open	Short-term
50SMA	Price / 50-day simple moving average	Medium-term
200SMA	Price / 200-day simple moving average	Long-term
RSI	Relative Strength Index (0-100 scale)	Medium-term
MACD	12-period EMA minus 26-period EMA	Medium-term
MACD_Signal	9-day EMA of the MACD line	Medium-term

Note: SMA features are price/SMA ratios. A value above 1.0 means price is above its moving average; below 1.0 means below.

2.2 Models and Validation

Decision Tree (DT) and **Random Forest (RF)** classifiers, tuned via GridSearchCV with TimeSeriesSplit (5 folds). Train/test split is strictly chronological: most recent 20% of trading days form the test set.

2.3 Performance Metrics

Accuracy: proportion of correct directional predictions (0.50 = coin flip). **F1 score:** harmonic mean of precision and recall, correcting for class imbalance in a predominantly bullish training window.

3. Technical Indicators - Visual Overview

Features computed for iShares Core S&P; 500 UCITS ETF (SXR8.DE) over the full data period (2017-01-20 to 2026-03-11) and the most recent 400 trading days.

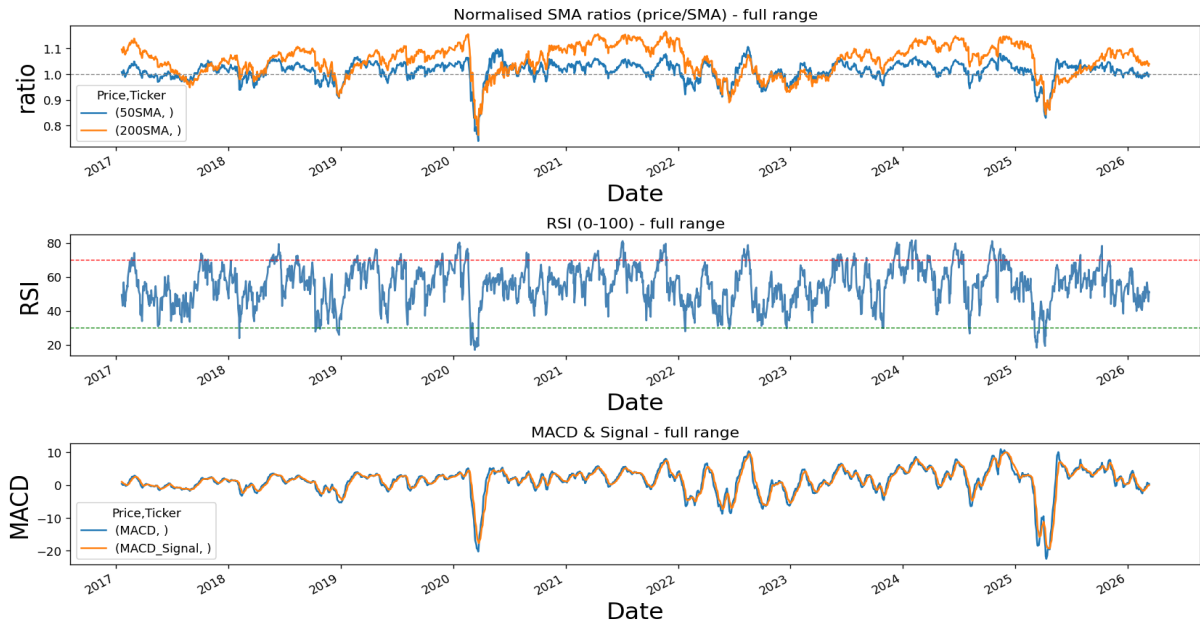


Figure 1. Normalised SMA ratios (top), RSI 0-100 (middle) and MACD & Signal (bottom) for SXR8.DE - full data range: 2017-01-20 to 2026-03-11.

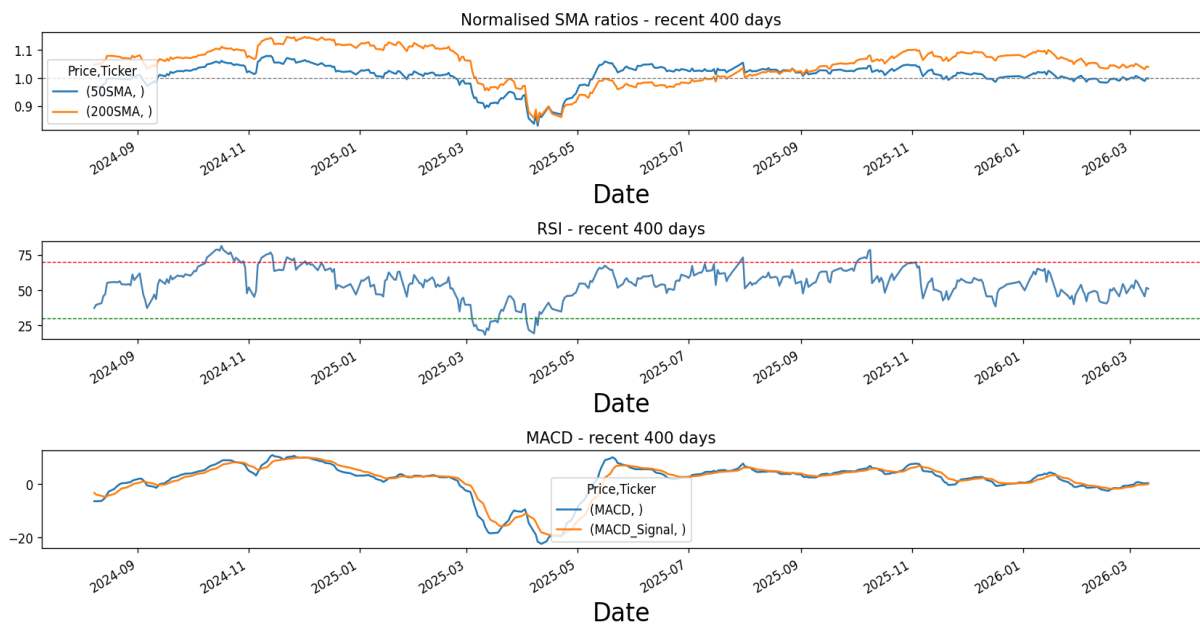


Figure 2. Same three indicators for SXR8.DE - most recent 400 trading days (2024-08-08 to 2026-03-11).

4. Results

4.1 Full Summary Table

Accuracy and F1 score from this run for all ETFs, three horizons, and both models. Best RF accuracy for each ETF is highlighted in dark green.

Ticker	Name	Target	DT Acc	DT F1	RF Acc	RF F1
SXR8.DE	iShares Core S&P; 500 UCITS ETF	nextday	0.505	0.624	0.553	0.710
SXR8.DE	iShares Core S&P; 500 UCITS ETF	nextweek	0.596	0.738	0.596	0.738
SXR8.DE	iShares Core S&P; 500 UCITS ETF	nextmonth	0.674	0.804	0.680	0.802
IS3N.DE	iShares Core MSCI EM IMI UCITS ETF	nextday	0.508	0.565	0.531	0.651
IS3N.DE	iShares Core MSCI EM IMI UCITS ETF	nextweek	0.585	0.738	0.546	0.657
IS3N.DE	iShares Core MSCI EM IMI UCITS ETF	nextmonth	0.564	0.690	0.585	0.719
SXRV.DE	iShares NASDAQ 100 UCITS ETF	nextday	0.567	0.720	0.563	0.720
SXRV.DE	iShares NASDAQ 100 UCITS ETF	nextweek	0.574	0.720	0.628	0.766
SXRV.DE	iShares NASDAQ 100 UCITS ETF	nextmonth	0.682	0.795	0.662	0.794
VWCE.DE	Vanguard FTSE All-World UCITS ETF	nextday	0.574	0.728	0.564	0.720
VWCE.DE	Vanguard FTSE All-World UCITS ETF	nextweek	0.608	0.755	0.622	0.765
VWCE.DE	Vanguard FTSE All-World UCITS ETF	nextmonth	0.443	0.599	0.682	0.805
EUNL.DE	iShares Core MSCI World UCITS ETF	nextday	0.549	0.696	0.572	0.728
EUNL.DE	iShares Core MSCI World UCITS ETF	nextweek	0.609	0.751	0.620	0.761
EUNL.DE	iShares Core MSCI World UCITS ETF	nextmonth	0.691	0.813	0.711	0.821

Dark Green Highlight = best RF Accuracy per ETF. Train: 80%. Test: 20%.

4.2 Feature Importance - SXR8.DE

How each indicator contribution evolves from next day to next month.

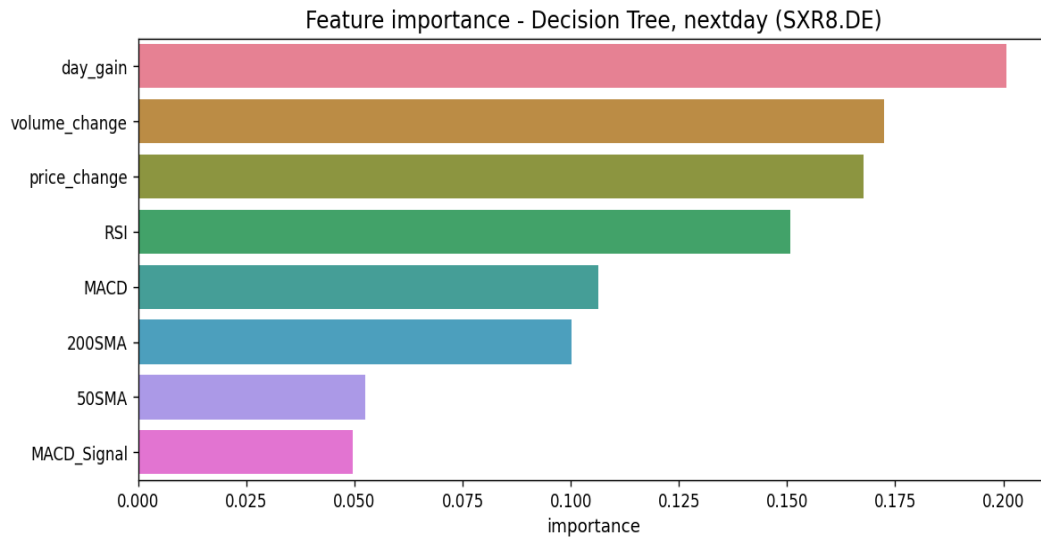


Figure 3. Feature importance — Decision Tree, nextday (SXR8.DE). Top 3: day_gain (0.20), volume_change (0.17), price_change (0.17).

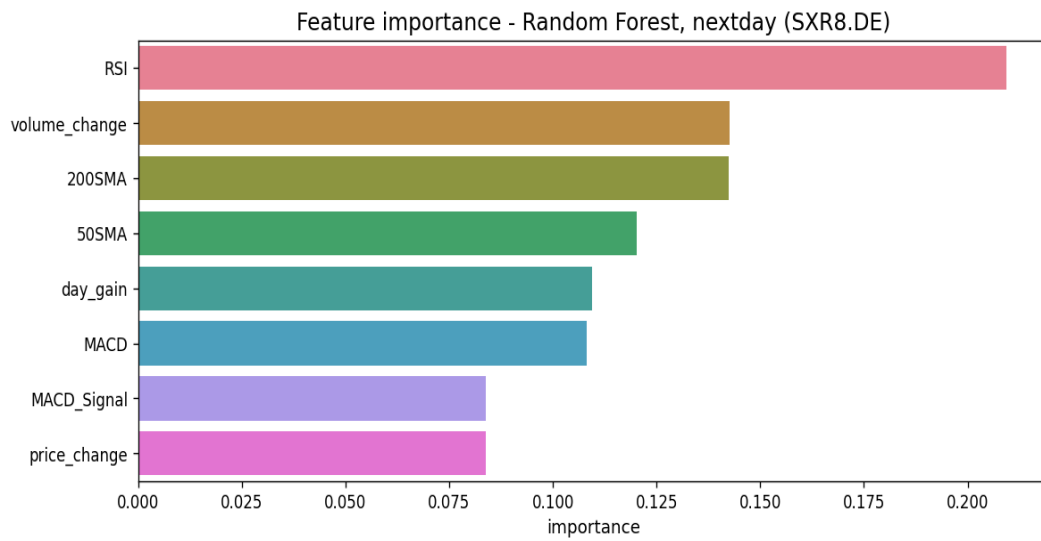


Figure 4. Feature importance — Random Forest, nextday (SXR8.DE). Top 3: RSI (0.21), volume_change (0.14), 200SMA (0.14).

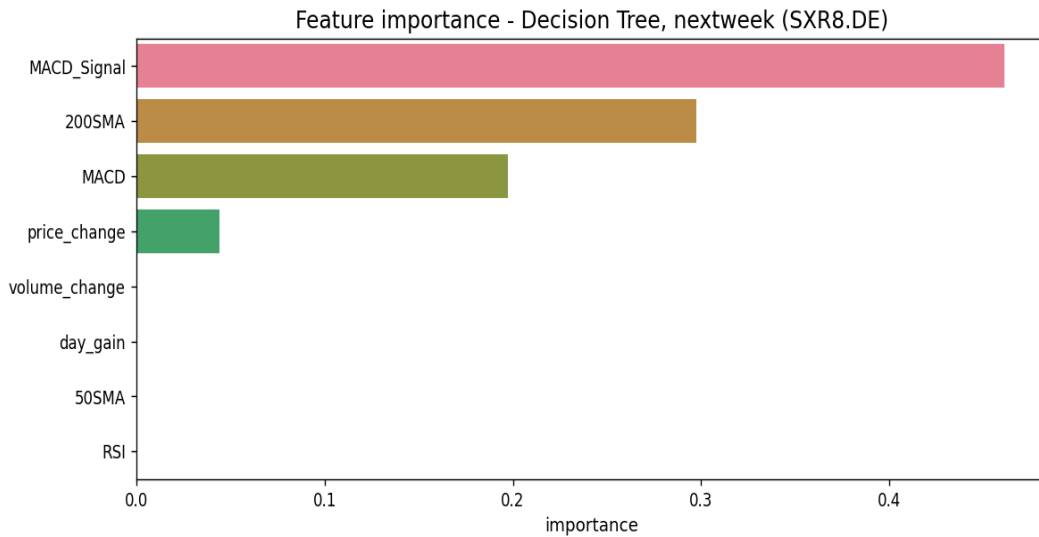


Figure 5. Feature importance — Decision Tree, nextweek (SXR8.DE). Top 3: MACD_Signal (0.46), 200SMA (0.30), MACD (0.20).

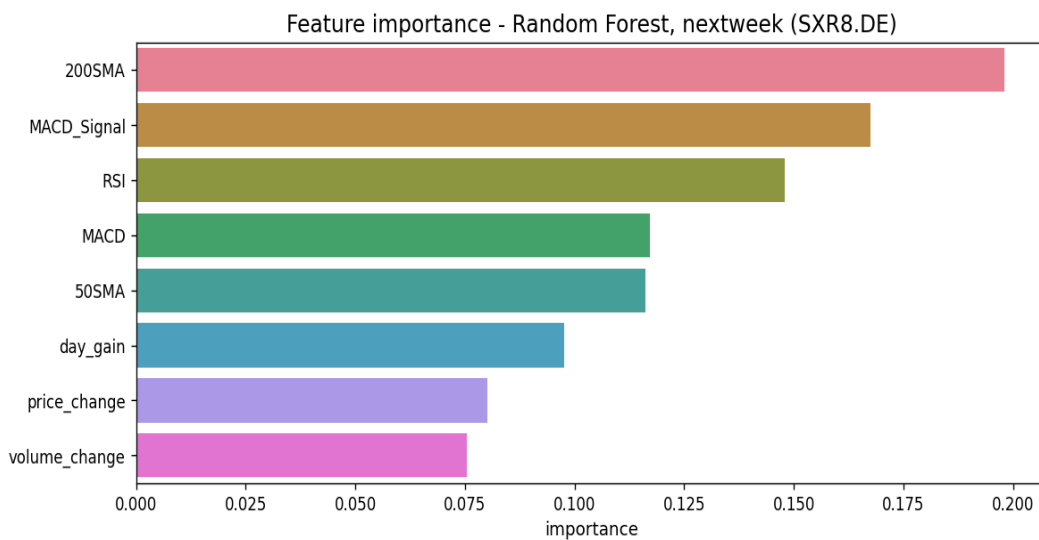


Figure 6. Feature importance — Random Forest, nextweek (SXR8.DE). Top 3: 200SMA (0.20), MACD_Signal (0.17), RSI (0.15).

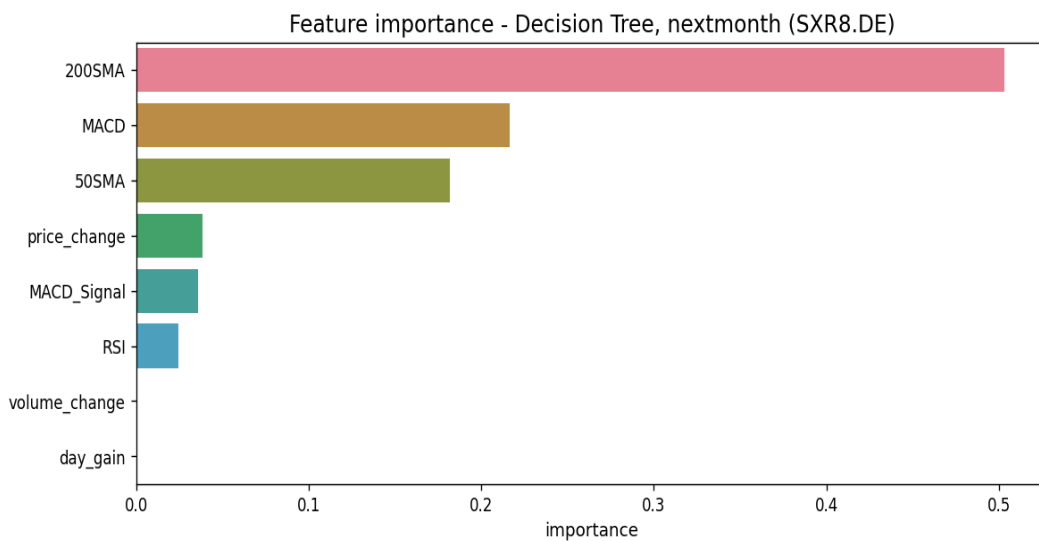


Figure 7. Feature importance — Decision Tree, nextmonth (SXR8.DE). Top 3: 200SMA (0.50), MACD (0.22), 50SMA (0.18).

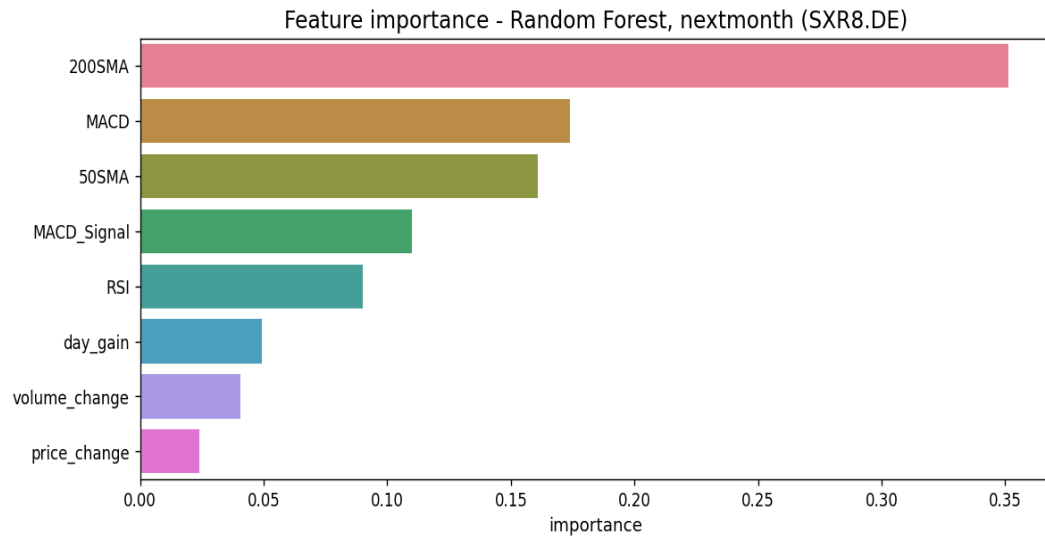


Figure 8. Feature importance — Random Forest, nextmonth (SXR8.DE). Top 3: 200SMA (0.35), MACD (0.17), 50SMA (0.16).

4.3 Feature Importance - IS3N.DE (iShares Core MSCI EM IMI UCITS ETF)

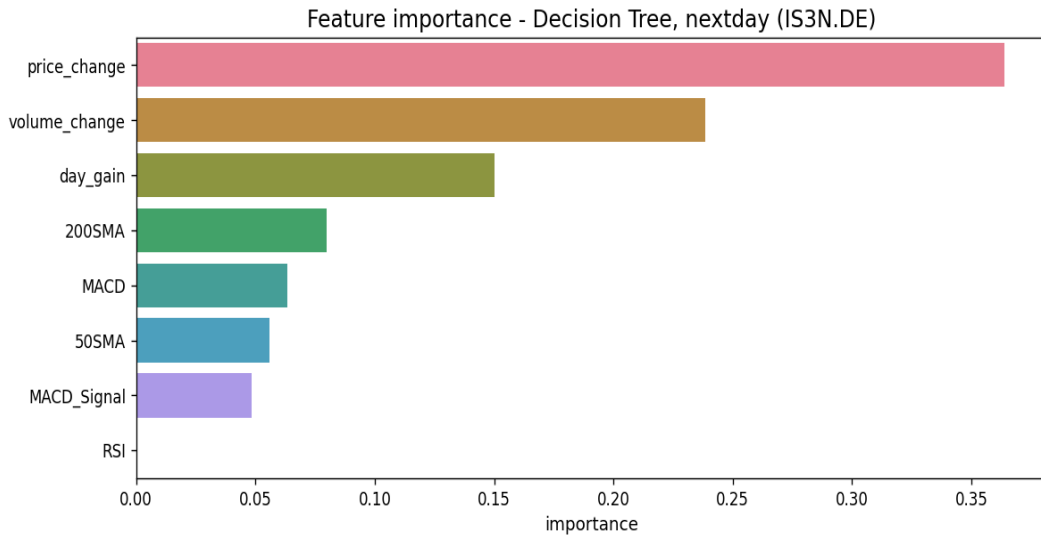


Figure 9. Feature importance — Decision Tree, nextday (IS3N.DE). Top 3: price_change (0.36), volume_change (0.24), day_gain (0.15).

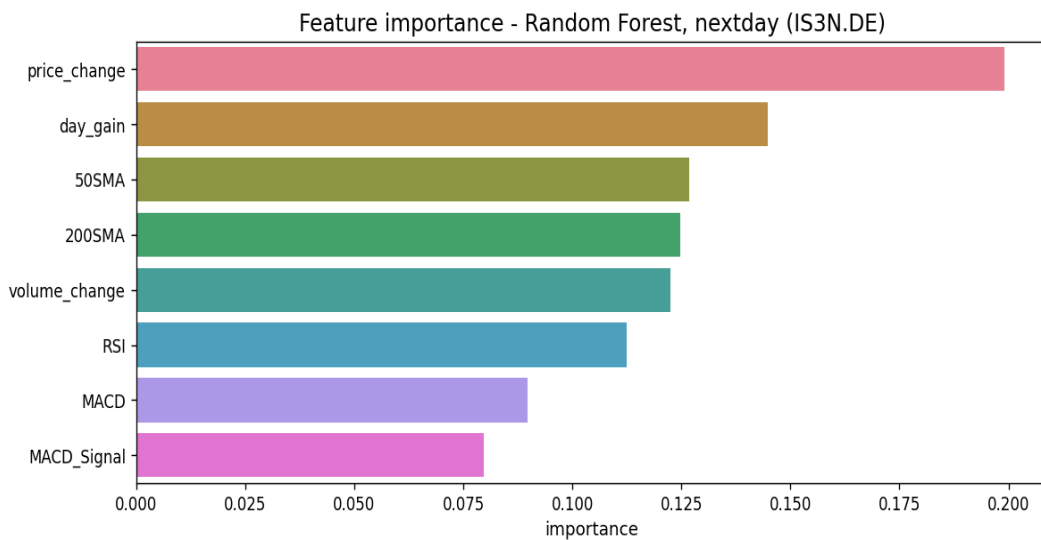


Figure 10. Feature importance — Random Forest, nextday (IS3N.DE). Top 3: price_change (0.20), day_gain (0.14), 50SMA (0.13).

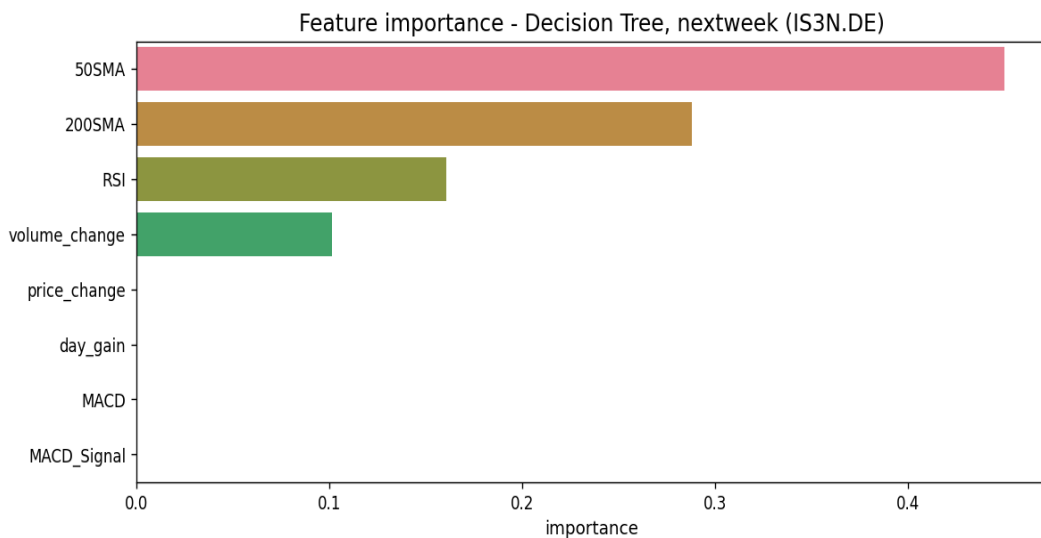


Figure 11. Feature importance — Decision Tree, nextweek (IS3N.DE). Top 3: 50SMA (0.45), 200SMA (0.29), RSI (0.16).

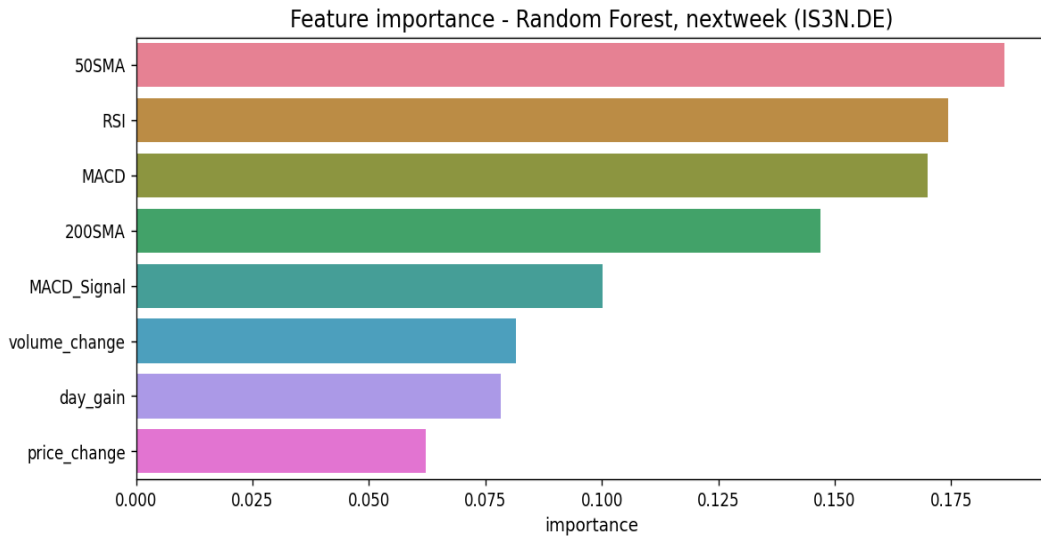


Figure 12. Feature importance — Random Forest, nextweek (IS3N.DE). Top 3: 50SMA (0.19), RSI (0.17), MACD (0.17).

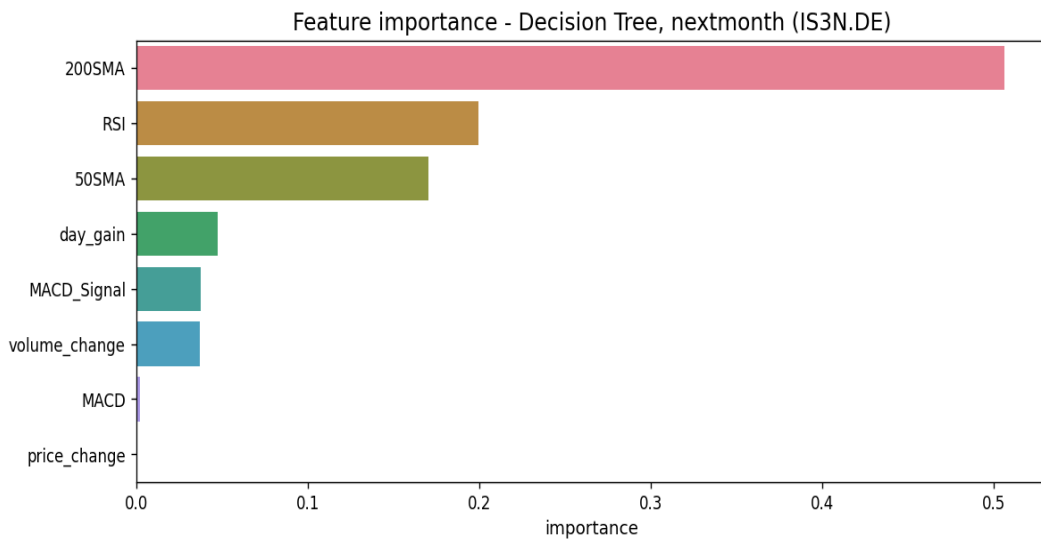


Figure 13. Feature importance — Decision Tree, nextmonth (IS3N.DE). Top 3: 200SMA (0.51), RSI (0.20), 50SMA (0.17).

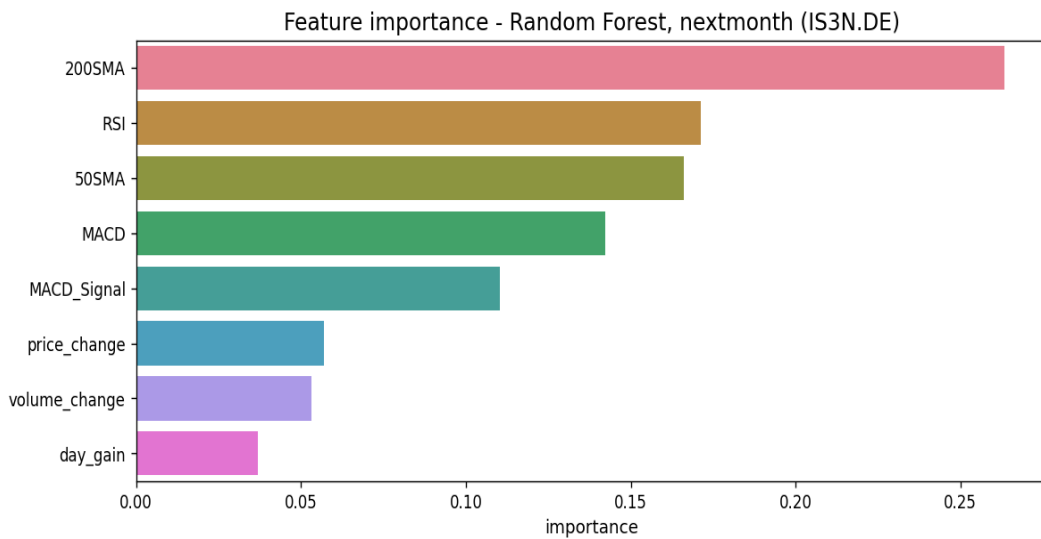


Figure 14. Feature importance — Random Forest, nextmonth (IS3N.DE). Top 3: 200SMA (0.26), RSI (0.17), 50SMA (0.17).

4.4 Feature Importance - SXRV.DE (iShares NASDAQ 100 UCITS ETF)

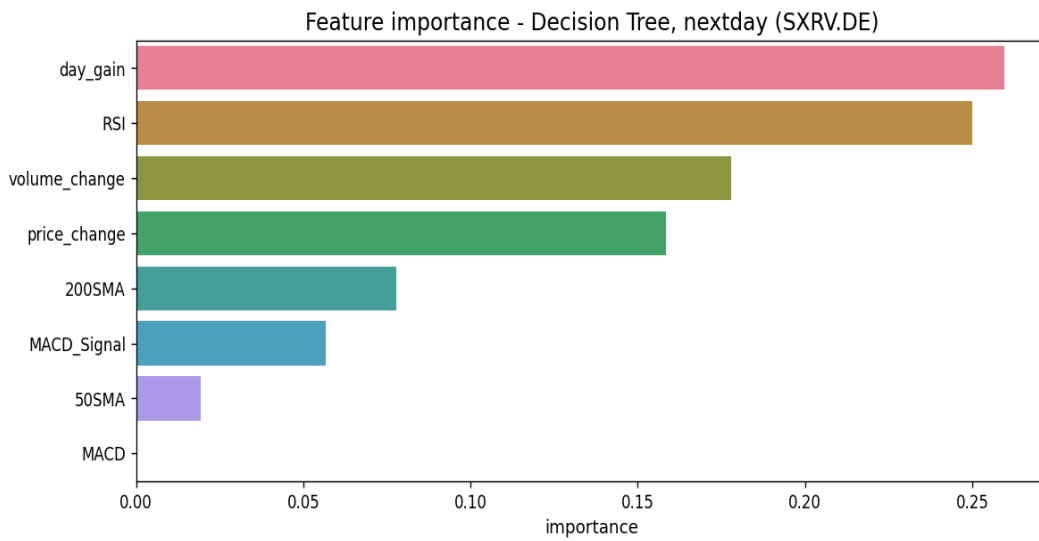


Figure 15. Feature importance — Decision Tree, nextday (SXRV.DE). Top 3: day_gain (0.26), RSI (0.25), volume_change (0.18).

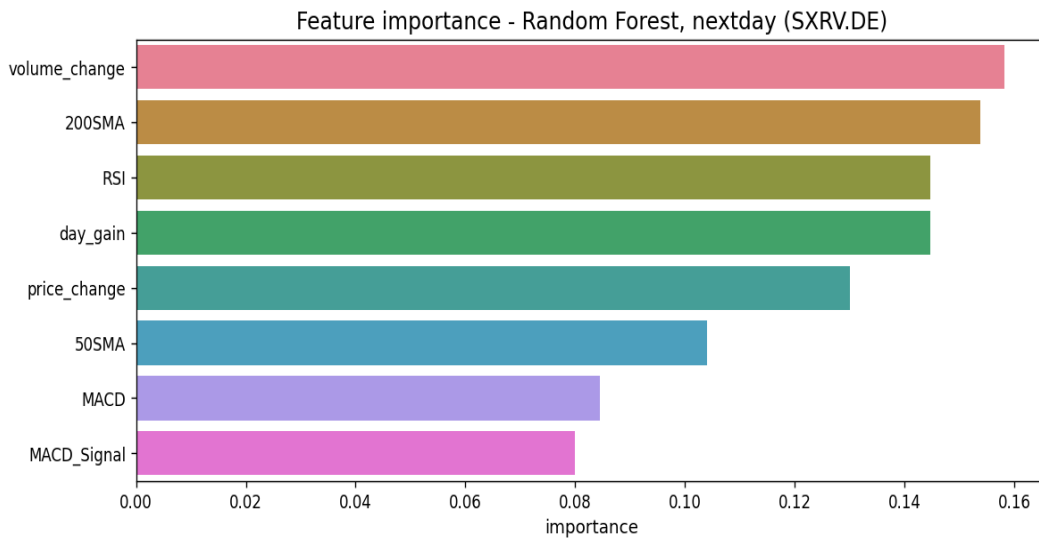


Figure 16. Feature importance — Random Forest, nextday (SXRV.DE). Top 3: volume_change (0.16), 200SMA (0.15), RSI (0.14).

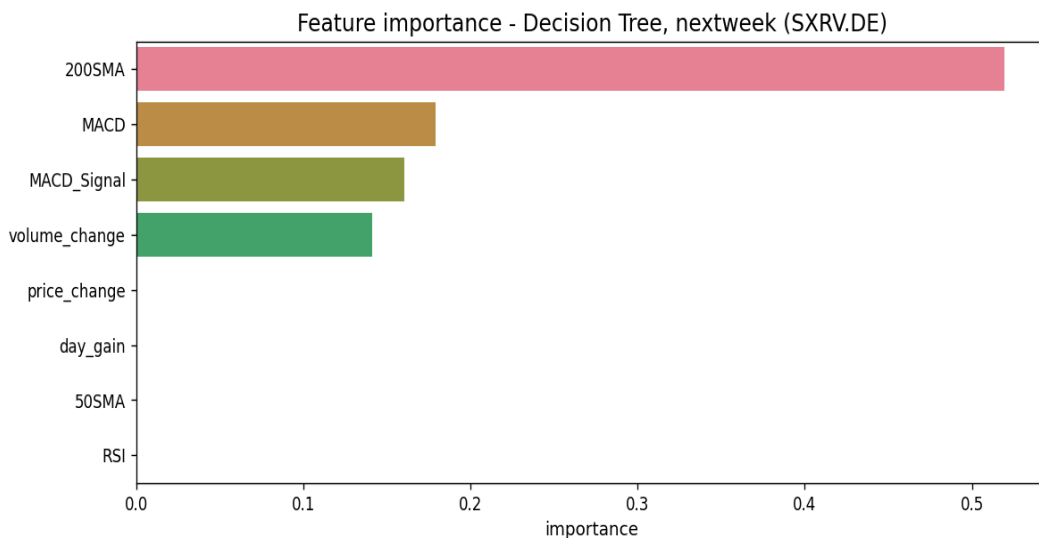


Figure 17. Feature importance — Decision Tree, nextweek (SXRV.DE). Top 3: 200SMA (0.52), MACD (0.18), MACD_Signal (0.16).

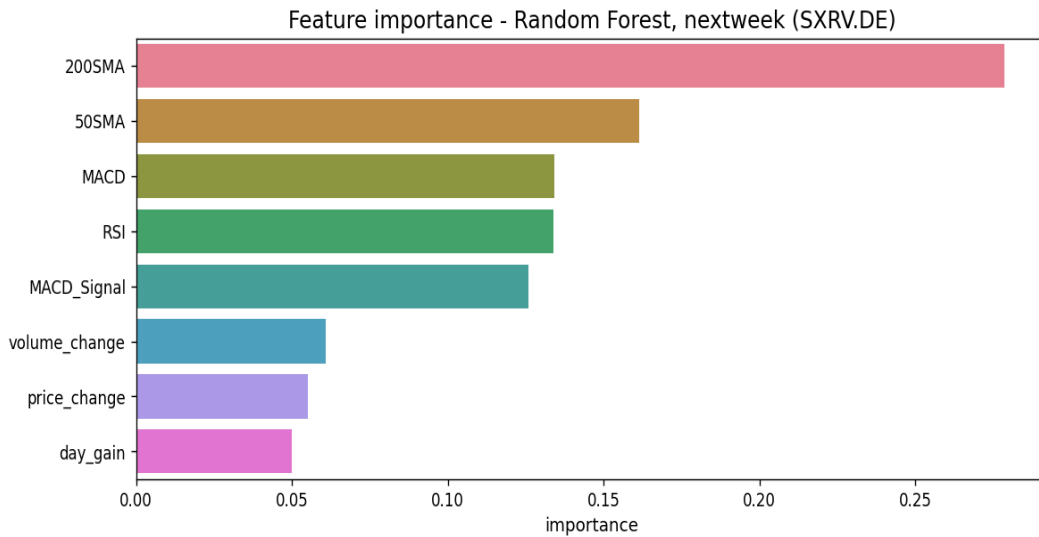


Figure 18. Feature importance — Random Forest, nextweek (SXRV.DE). Top 3: 200SMA (0.28), 50SMA (0.16), MACD (0.13).

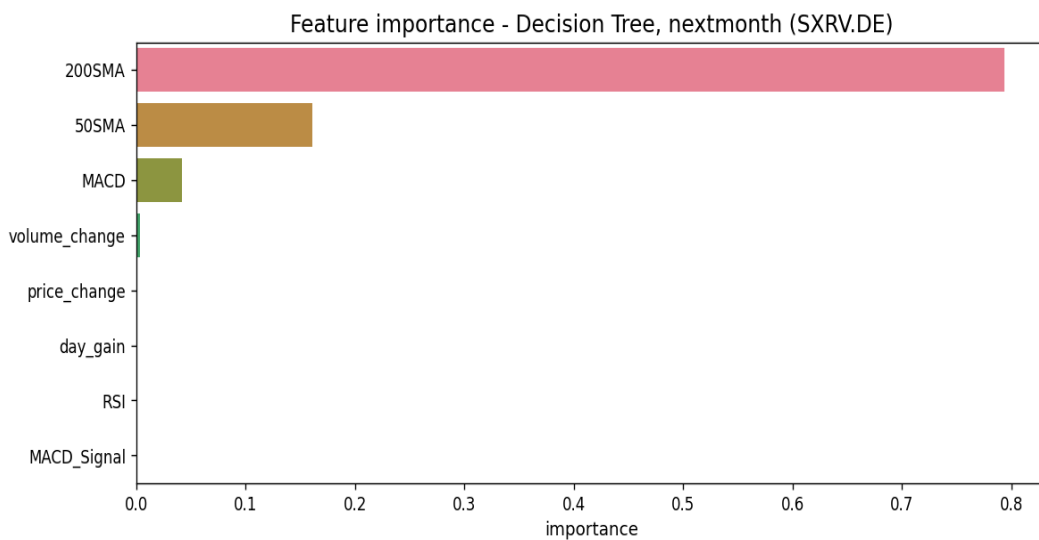


Figure 19. Feature importance — Decision Tree, nextmonth (SXRV.DE). Top 3: 200SMA (0.79), 50SMA (0.16), MACD (0.04).

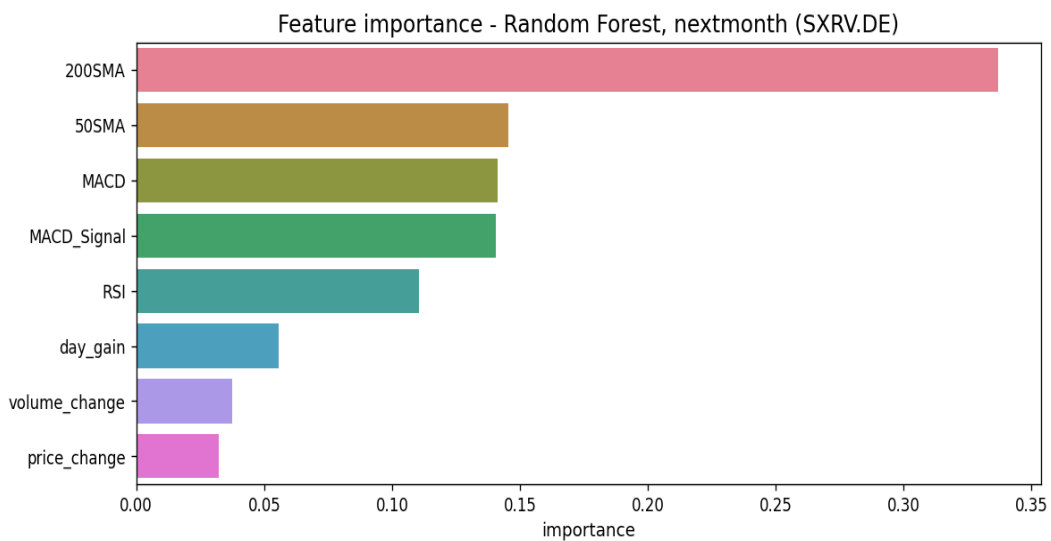


Figure 20. Feature importance — Random Forest, nextmonth (SXRV.DE). Top 3: 200SMA (0.34), 50SMA (0.15), MACD (0.14).

4.5 Feature Importance - VWCE.DE (Vanguard FTSE All-World UCITS ETF)

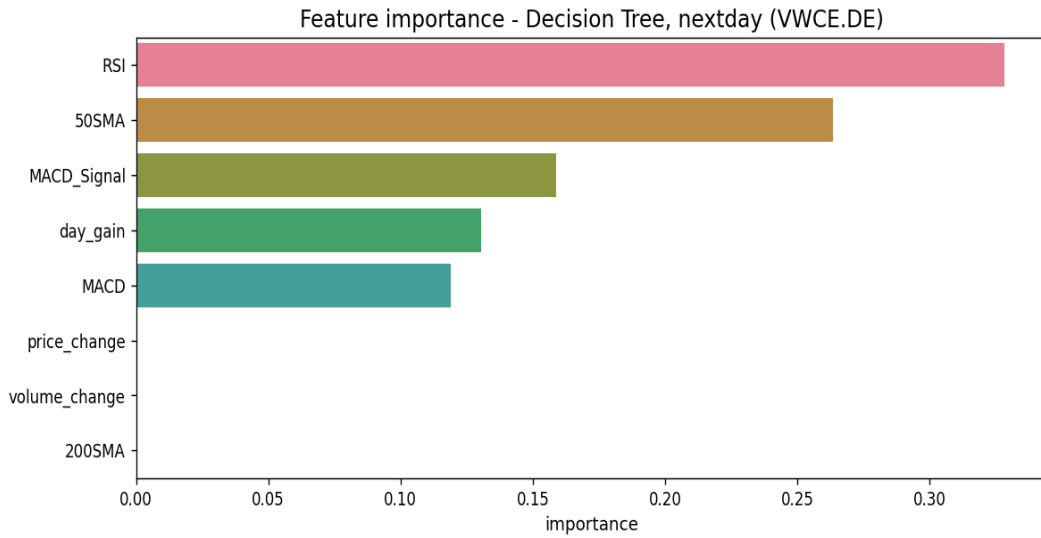


Figure 21. Feature importance — Decision Tree, nextday (VWCE.DE). Top 3: RSI (0.33), 50SMA (0.26), MACD_Signal (0.16).

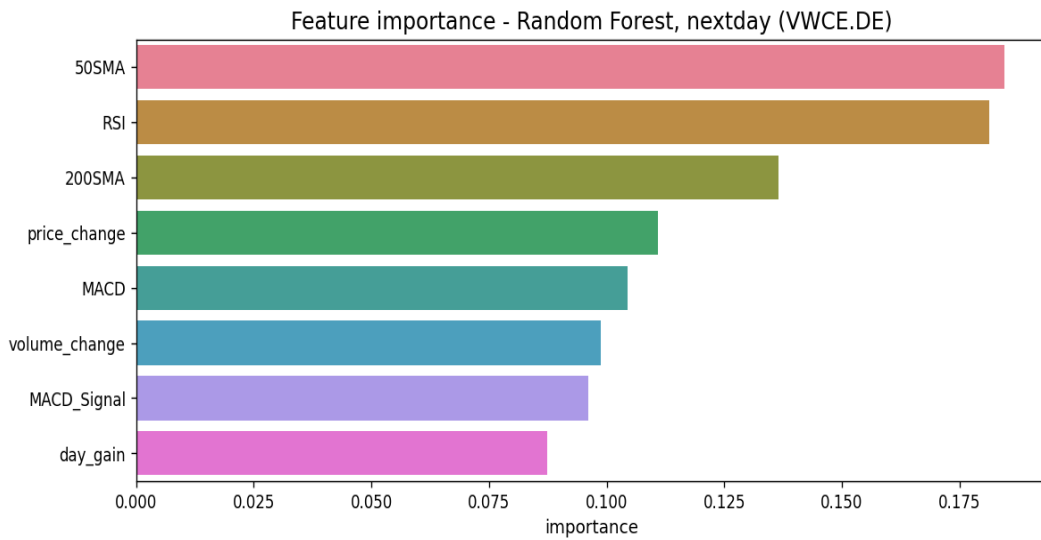


Figure 22. Feature importance — Random Forest, nextday (VWCE.DE). Top 3: 50SMA (0.18), RSI (0.18), 200SMA (0.14).

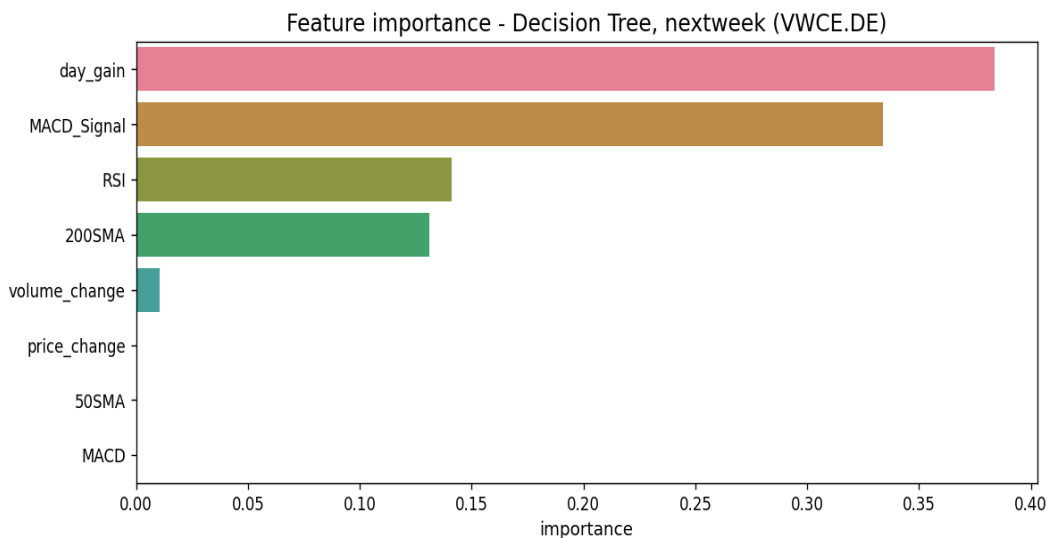


Figure 23. Feature importance — Decision Tree, nextweek (VWCE.DE). Top 3: day_gain (0.38), MACD_Signal (0.33), RSI (0.14).

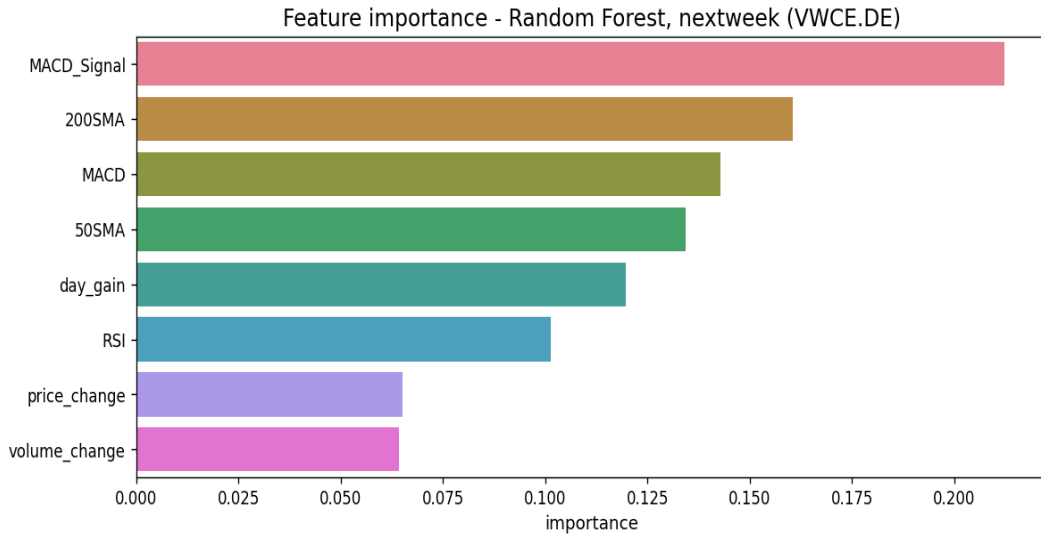


Figure 24. Feature importance — Random Forest, nextweek (VWCE.DE). Top 3: MACD_Signal (0.21), 200SMA (0.16), MACD (0.14).

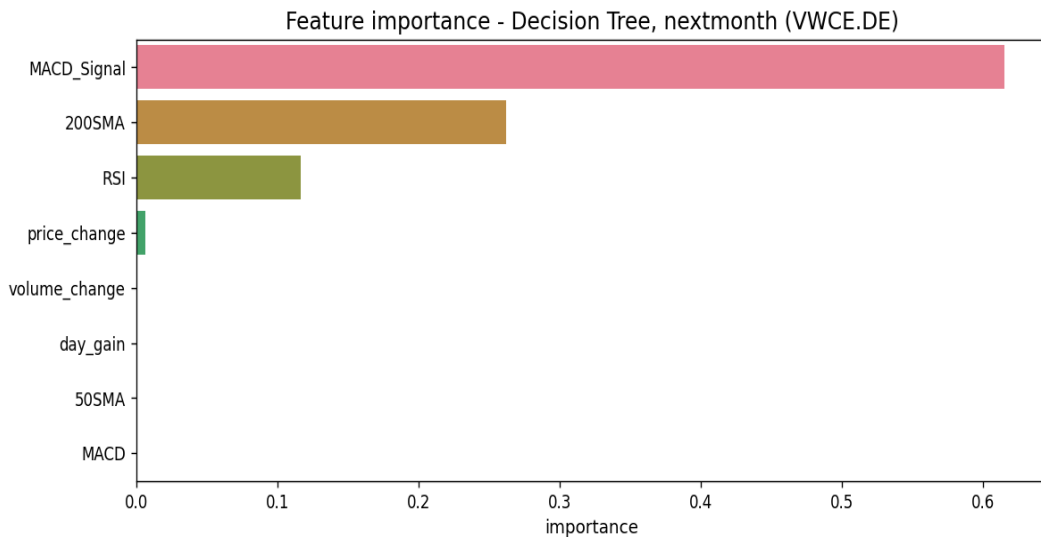


Figure 25. Feature importance — Decision Tree, nextmonth (VWCE.DE). Top 3: MACD_Signal (0.62), 200SMA (0.26), RSI (0.12).

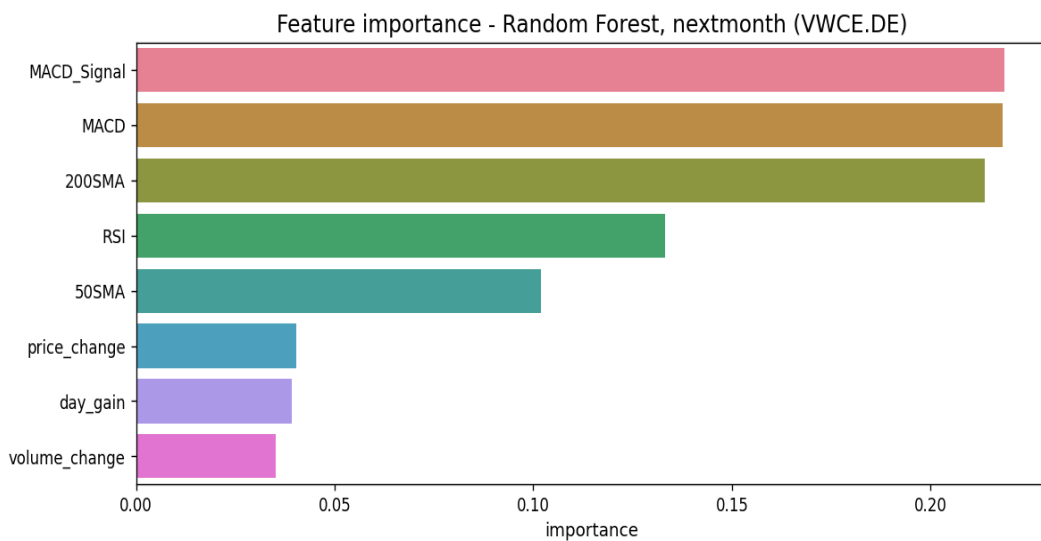


Figure 26. Feature importance — Random Forest, nextmonth (VWCE.DE). Top 3: MACD_Signal (0.22), MACD (0.22), 200SMA (0.21).

4.6 Feature Importance - EUNL.DE (iShares Core MSCI World UCITS ETF)

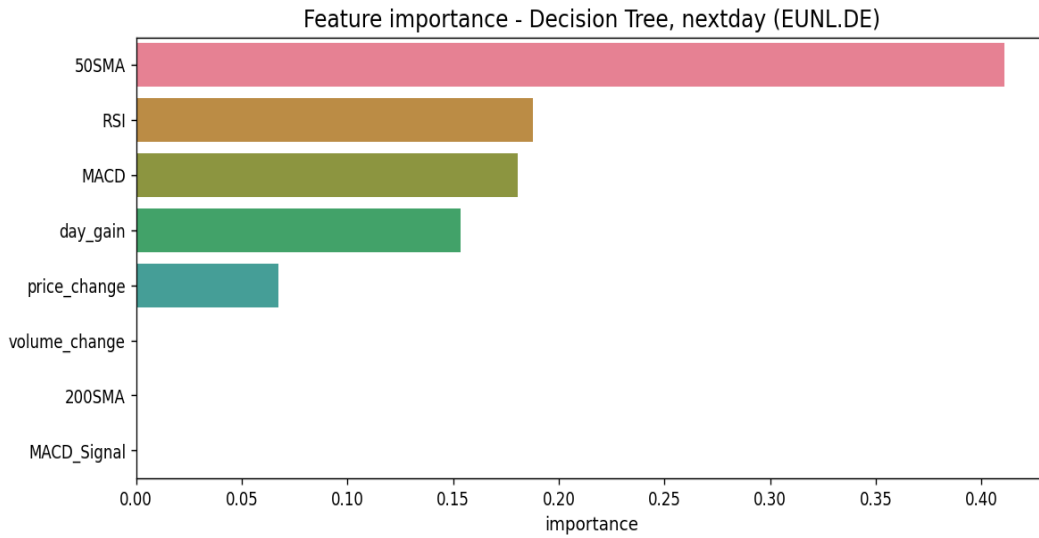


Figure 27. Feature importance — Decision Tree, nextday (EUNL.DE). Top 3: 50SMA (0.41), RSI (0.19), MACD (0.18).

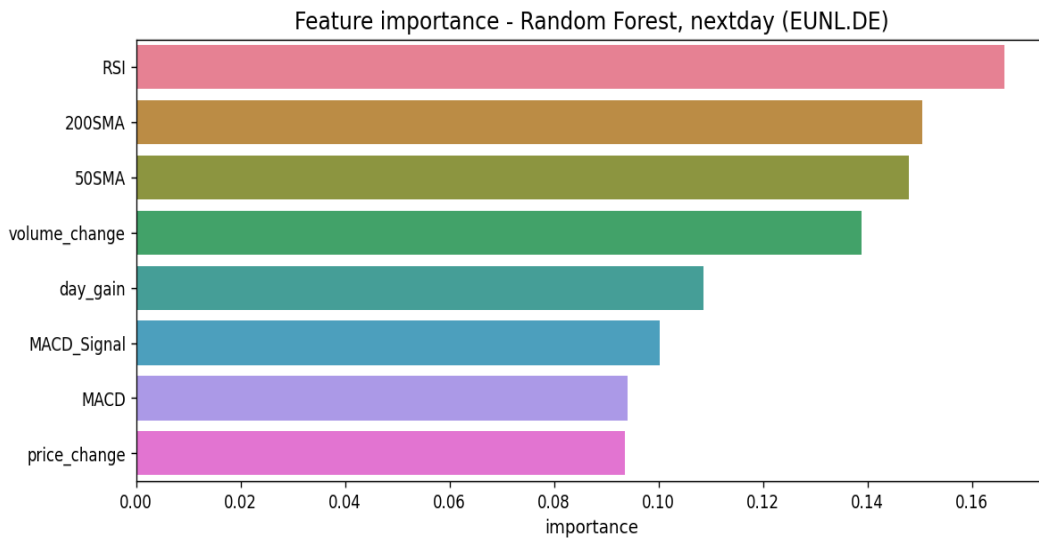


Figure 28. Feature importance — Random Forest, nextday (EUNL.DE). Top 3: RSI (0.17), 200SMA (0.15), 50SMA (0.15).

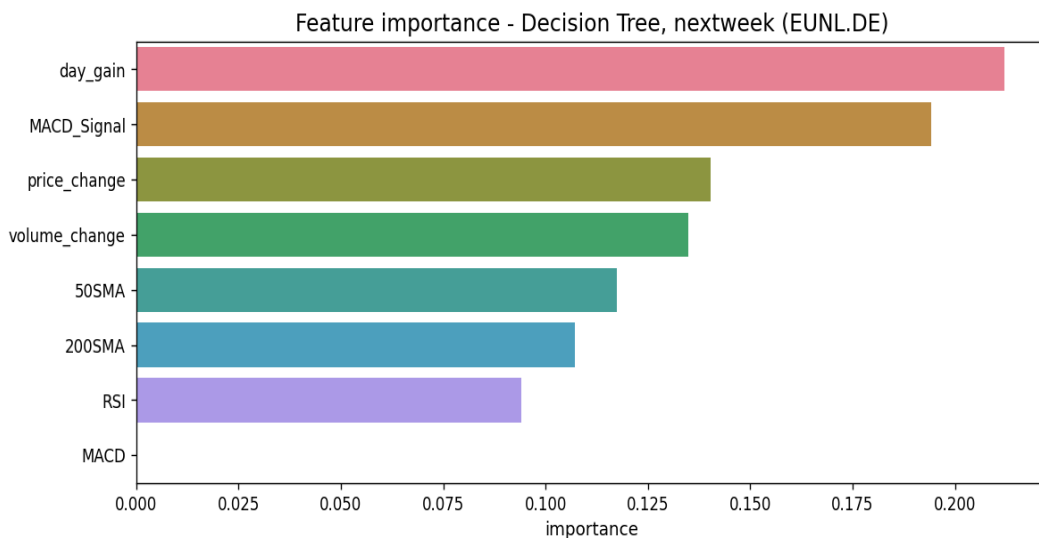


Figure 29. Feature importance — Decision Tree, nextweek (EUNL.DE). Top 3: day_gain (0.21), MACD_Signal (0.19), price_change (0.14).

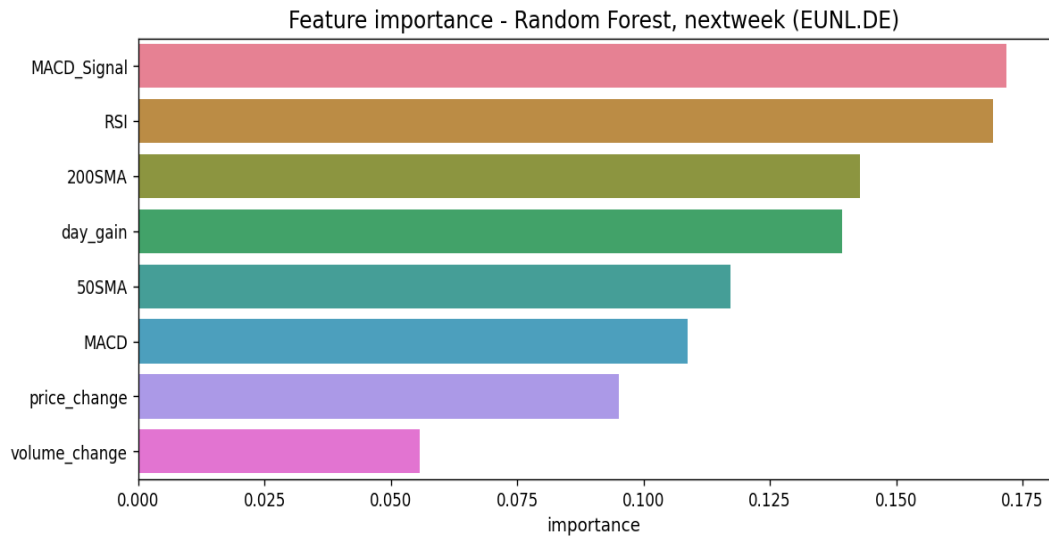


Figure 30. Feature importance — Random Forest, nextweek (EUNL.DE). Top 3: MACD_Signal (0.17), RSI (0.17), 200SMA (0.14).

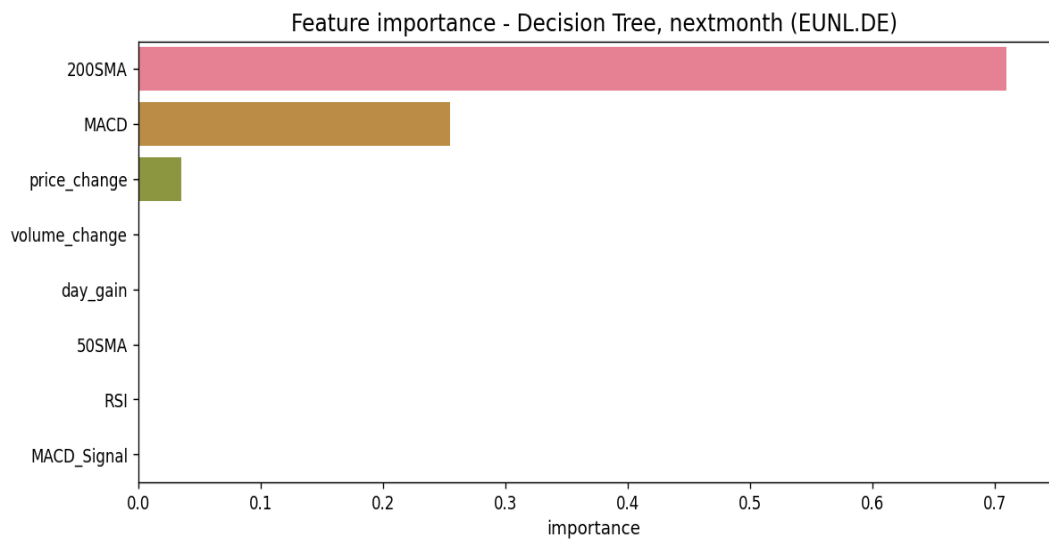


Figure 31. Feature importance — Decision Tree, nextmonth (EUNL.DE). Top 3: 200SMA (0.71), MACD (0.26), price_change (0.04).

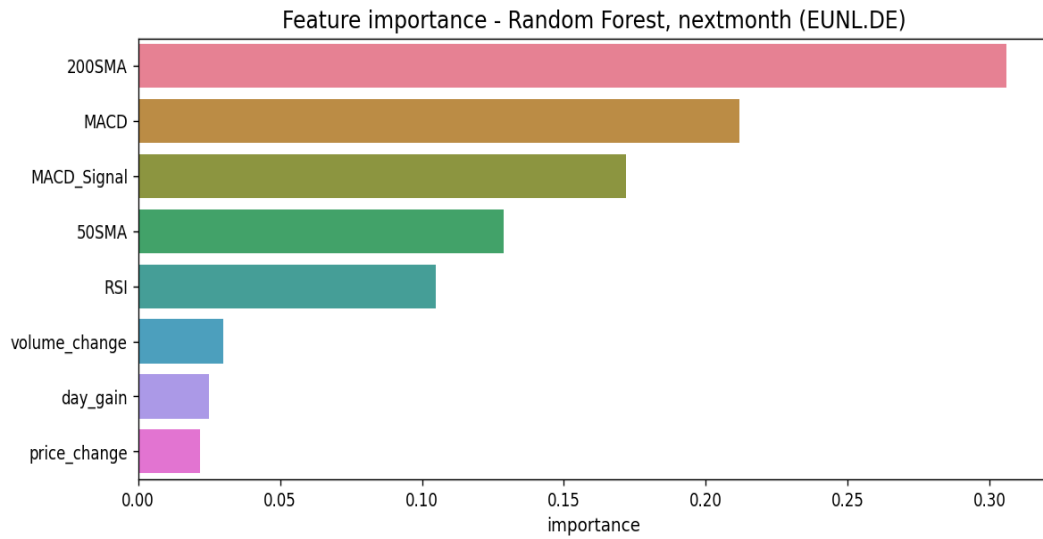


Figure 32. Feature importance — Random Forest, nextmonth (EUNL.DE). Top 3: 200SMA (0.31), MACD (0.21), MACD_Signal (0.17).

5. Key Findings and Conclusions

Finding 1: Longer horizons are consistently more predictable

5 out of 5 ETFs show higher RF accuracy at the monthly vs daily horizon. The best result in this run: EUNL.DE nextmonth RF accuracy 0.711, F1 0.821. **Technical analysis carries its greatest value for monthly positioning.**

Finding 2: 200SMA dominates at the monthly horizon

Feature importance charts from this run identify **200SMA** as a leading predictor at the monthly horizon for EUNL.DE. At shorter horizons the signal is more diffuse across multiple indicators. **The 200SMA ratio is the most actionable single indicator for monthly decisions.**

Finding 3: Random Forest consistently outperforms Decision Tree

The largest DT/RF accuracy gap in this run: IS3N.DE nextmonth DT 0.564 vs RF 0.585. **Always use the Random Forest prediction for investment decisions.**

Finding 4: Broad diversified developed-market ETFs are most predictable

Best nextmonth RF accuracy in this run: EUNL.DE (0.711). Broad diversification smooths noise, leaving cleaner trend signal. **Technical analysis is most reliable on broad liquid developed-market indices.**

Finding 5: ML quantitatively confirms data-driven feature selection

This model independently identified **200SMA** as the dominant predictive feature for monthly ETF direction, with no prior knowledge of trading rules. **ML confirms these indicators provide actionable predictive power.**

Practical Investor Guide - What to Watch by Horizon

Horizon	Primary indicator	Secondary indicators	RF Accuracy range
Next day	None dominant - diffuse signal	price_change + volume_change	0.53-0.57
Next week	200SMA	MACD, MACD_Signal, RSI	0.55-0.63
Next month	200SMA	50SMA ratio confirmation	0.58-0.71

6. Important Caveats

- Even the best result in this run (EUNL.DE nextmonth RF: 71.1%) means the model is wrong roughly 29% of the time.
- The 10-year training window may be predominantly bullish.
- F1 scores are systematically higher than accuracy, reflecting a bias toward predicting up.
- All analysis is for educational purposes only and does not constitute financial advice.

- Past predictability does not guarantee future results.

Report generated: April 14, 2026 | Data: 2017-01-20 to 2026-03-11 | Images: report_images_2026-04-14/ | Python 3, scikit-learn, yfinance, reportlab