uniswap_v3_1h_arbitrum

July 6, 2023

1 An example breakout strategy on ETH-USDC pairs

This is an example algorithmic trading strategy backtest for ETH-USDC pair on Uniswap v3 on Arbitrum blockchain.

- Trading DEX spot market, long only
- Bollinger bands technical indicator based breakout strategy
- Run the trailing stop loss strategy on
- Use hourly candles instead
- Open positions with 80% of trading capital
- Use 15 minute candles for stop loss trigger
- Demostrates how to generate 40% yearly returns and $7M yearly volume with $10,000 initial capital
- Maximum drawdown is a bit risky 15%
- Backtested 2022-06 - 2023-06

1.1 Set up

Set up the parameters used in in this strategy backtest study.

- Backtested blockchain, exchange and trading pair
- Backtesting period
- Strategy parameters for technical indicators

[20]:

```python
import datetime
import pandas as pd

from tradingstrategy.chain import ChainId
from tradingstrategy.timebucket import TimeBucket
from tradeexecutor.strategy.cycle import CycleDuration
from tradeexecutor.strategy.strategy_module import TradeRouting, ReserveCurrency

# How our trades are routed.
TRADE_ROUTING = TradeRouting.uniswap_v3_usdc

# How often the strategy performs the decide_trades cycle.
# We do it for every 4h.
TRADING_STRATEGY_CYCLE = CycleDuration.cycle_1h
```

```
# Strategy keeps its cash in USDC
RESERVE_CURRENCY = ReserveCurrency.usdc

# Time bucket for our candles
CANDLE_TIME_BUCKET = TimeBucket.h1

# Which trading pair we are backtesting on
TRADING_PAIR = (ChainId.arbitrum, "uniswap-v3", "WETH", "USDC", 0.0005)

# How much % of the cash to put on a single trade
POSITION_SIZE = 0.80

# Start with this amount of USD
INITIAL_DEPOSIT = 10_000

# Candle time granularity we use to trigger stop loss checks
STOP_LOSS_TIME_BUCKET = TimeBucket.m15

#
# Strategy thinking specific parameter
#

# How many candles we load in the decide_trades() function for calculating indicators
LOOKBACK_WINDOW = 90

# Moving average
#
# How many candles to smooth out for Bollinger band's middle line
EMA_CANDLE_COUNT = 20

# How many candles we use to calculate the Relative Strength Indicator
RSI_LENGTH = 14

# RSI must be above this value to open a new position
RSI_THRESHOLD = 20

# Backtest range
START_AT = datetime.datetime(2022, 6, 1)
END_AT = datetime.datetime(2023, 6, 1)

# Stop loss relative to the mid price during the time when the position is opened
#
# If the price drops below this level, trigger a stop loss
STOP_LOSS_PCT = 0.98
```

```python
# What is the trailing stop loss level
TRAILING_STOP_LOSS_PCT = 0.9975

# Activate trailing stop loss when this level is reached
TRAILING_STOP_LOSS_ACTIVATION_LEVEL=1.03
```

1.2 Strategy logic and trade decisions

- `decide_trades` function decide what trades to take.
- See README for explanations on technical indicators used

[21]:

```python
from typing import List, Dict

from pandas_ta import bbands
from pandas_ta.overlap import ema
from pandas_ta.momentum import rsi

from tradingstrategy.universe import Universe

from tradeexecutor.state.visualisation import PlotKind
from tradeexecutor.state.trade import TradeExecution
from tradeexecutor.strategy.pricing_model import PricingModel
from tradeexecutor.strategy.pandas_trader.position_manager import␣
  ↪PositionManager
from tradeexecutor.state.state import State
from tradeexecutor.strategy.pandas_trader.position_manager import␣
  ↪PositionManager


def decide_trades(
        timestamp: pd.Timestamp,
        universe: Universe,
        state: State,
        pricing_model: PricingModel,
        cycle_debug_data: Dict) -> List[TradeExecution]:
    """The brain function to decide the trades on each trading strategy cycle.

    - Reads incoming execution state (positions, past trades)

    - Reads the current universe (candles)

    - Decides what trades to do next, if any, at current timestamp.

    - Outputs strategy thinking for visualisation and debug messages

    :param timestamp:
        The Pandas timestamp object for this cycle. Matches
        TRADING_STRATEGY_CYCLE division.
        Always truncated to the zero seconds and minutes, never a real-time␣
↪clock.

    :param universe:
        Trading universe that was constructed earlier.

    :param state:
        The current trade execution state.
        Contains current open positions and all previously executed trades,␣
↪plus output
        for statistics, visualisation and diangnostics of the strategy.

    :param pricing_model:
        Pricing model can tell the buy/sell price of the particular asset at a␣
↪particular moment.

    :param cycle_debug_data:
        Python dictionary for various debug variables you can read or set,␣
↪specific to this trade cycle.
        This data is discarded at the end of the trade cycle.

    :return:
        List of trade instructions in the form of :py:class:`TradeExecution`␣
↪instances.
        The trades can be generated using `position_manager` but strategy could␣
↪also hand craft its trades.
    """

    # We have only a single trading pair for this strategy.
    pair = universe.pairs.get_single()

    # How much cash we have in a hand
    cash = state.portfolio.get_current_cash()

    # Get OHLCV candles for our trading pair as Pandas Dataframe.
    # We could have candles for multiple trading pairs in a different strategy,
    # but this strategy only operates on single pair candle.
    # We also limit our sample size to N latest candles to speed up␣
↪calculations.
    candles: pd.DataFrame = universe.candles.get_single_pair_data(timestamp,␣
↪sample_count=LOOKBACK_WINDOW)

    # We have data for open, high, close, etc.
    # We only operate using candle close values in this strategy.
    close_prices = candles["close"]
```

```python
    # Calculate exponential moving for candle close
    # https://tradingstrategy.ai/docs/programming/api/technical-analysis/overlap/help/pandas_ta.overlap.ema.html#ema
    moving_average = ema(close_prices, length=EMA_CANDLE_COUNT)

    # Calculate RSI for candle close
    # https://tradingstrategy.ai/docs/programming/api/technical-analysis/momentum/help/pandas_ta.momentum.rsi.html#rsi
    current_rsi = rsi(close_prices, length=RSI_LENGTH)[-1]

    trades = []

    if moving_average is None:
        # Cannot calculate EMA, because
        # not enough samples in backtesting buffer yet.
        return trades

    price_latest = close_prices.iloc[-1]

    # Create a position manager helper class that allows us easily to create
    # opening/closing trades for different positions
    position_manager = PositionManager(timestamp, universe, state, pricing_model)

    # Calculate Bollinger Bands with a 20-day SMA and 2 standard deviations using pandas_ta
    # See documentation here https://tradingstrategy.ai/docs/programming/api/technical-analysis/volatility/help/pandas_ta.volatility.bbands.html#bbands
    bollinger_bands = bbands(close_prices, length=20, std=1)
    bb_upper = bollinger_bands["BBU_20_1.0"]
    bb_lower = bollinger_bands["BBL_20_1.0"]

    if not position_manager.is_any_open():
        # No open positions, decide if BUY in this cycle.
        # We buy if the price on the daily chart closes above the upper Bollinger Band.
        if price_latest > bb_upper.iloc[-1] and current_rsi >= RSI_THRESHOLD:
            buy_amount = cash * POSITION_SIZE
            new_trades = position_manager.open_1x_long(pair, buy_amount, stop_loss_pct=STOP_LOSS_PCT)
            trades.extend(new_trades)

    else:
        # We have an open position, decide if SELL in this cycle.
        # We close the position when the price closes below the 20-day moving␣
 ↪average.
        if price_latest < moving_average.iloc[-1]:
            new_trades = position_manager.close_all()
            trades.extend(new_trades)

        # Check if we have reached out level where we activate trailing stop␣
 ↪loss
        position = position_manager.get_current_position()
        if price_latest >= position.get_opening_price() *␣
 ↪TRAILING_STOP_LOSS_ACTIVATION_LEVEL:
            position.trailing_stop_loss_pct = TRAILING_STOP_LOSS_PCT
            position.stop_loss = float(price_latest * TRAILING_STOP_LOSS_PCT)

    # Visualise our technical indicators
    visualisation = state.visualisation
    visualisation.plot_indicator(timestamp, "BB upper", PlotKind.
 ↪technical_indicator_on_price, bb_upper.iloc[-1], colour="darkblue")
    visualisation.plot_indicator(timestamp, "BB lower", PlotKind.
 ↪technical_indicator_on_price, bb_lower.iloc[-1], colour="darkblue")
    visualisation.plot_indicator(timestamp, "EMA", PlotKind.
 ↪technical_indicator_on_price, moving_average.iloc[-1], colour="darkgreen")
    visualisation.plot_indicator(timestamp, "RSI", PlotKind.
 ↪technical_indicator_detached, current_rsi)

    return trades
```

1.3 Defining the trading universe

We create a trading universe with a single blockchain, single exchange and a single trading pair.

Trading Strategy framework supports complex strategies, spanning thousands of pairs and lending pools, but we are not interested in this example.

[22]:

```
import datetime
from tradingstrategy.client import Client
from tradeexecutor.strategy.trading_strategy_universe import␣
 ↪load_pair_data_for_single_exchange, TradingStrategyUniverse
from tradeexecutor.strategy.execution_context import ExecutionContext
from tradeexecutor.strategy.universe_model import UniverseOptions


def create_single_pair_trading_universe(
        ts: datetime.datetime,
        client: Client,
        execution_context: ExecutionContext,
        universe_options: UniverseOptions,
) -> TradingStrategyUniverse:

    # Fetch backtesting datasets from the server
    dataset = load_pair_data_for_single_exchange(
        client,
        time_bucket=CANDLE_TIME_BUCKET,
        pair_tickers=[TRADING_PAIR],
        execution_context=execution_context,
        universe_options=universe_options,
        stop_loss_time_bucket=STOP_LOSS_TIME_BUCKET,
    )

    # Convert loaded data to a trading pair universe
    universe = TradingStrategyUniverse.create_single_pair_universe(
        dataset,
        pair=TRADING_PAIR,
    )

    return universe
```

1.4 Set up the market data client

The Trading Strategy market data client is the Python library responsible for managing the data feeds needed to run the backtest.None

We set up the market data client with an API key.

If you do not have an API key yet, you can register one.

[23]:

```
from tradingstrategy.client import Client

client = Client.create_jupyter_client()
```

```
Started Trading Strategy in Jupyter notebook environment, configuration is
stored in /Users/moo/.tradingstrategy
```

1.5 Load data

This will pull JSONL data feed for the trading pair from Trading Strategy oracle node.

[24]:

```
from tradeexecutor.strategy.execution_context import ExecutionMode
from tradeexecutor.strategy.universe_model import UniverseOptions

universe = create_single_pair_trading_universe(
    END_AT,
    client,
    ExecutionContext(mode=ExecutionMode.data_preload),
    UniverseOptions()
)
```

```python
print(f"We loaded {universe.universe.candles.get_candle_count():,} candles.")
```

```
Loading OHLCV data for 42161-uniswap-v3:   0%|          | 0/58229356 [00:00<?, ?
 ↪it/s]
```

```
Loading granular price data for stop loss/take profit for None:   0%|          |␣
 ↪0/58228459 [00:00<?, ?it/s]
```

```
We loaded 16,144 candles.
```

1.6 Run backtest

Run backtest using giving trading universe and strategy function.

- Running the backtest outputs `state` object that contains all the information on the backtesting position and trades.

[25]:

```python
from tradeexecutor.backtest.backtest_runner import run_backtest_inline

state, universe, debug_dump = run_backtest_inline(
    name="Bollinger bands example",
    start_at=START_AT,
    end_at=END_AT,
    client=client,
    cycle_duration=TRADING_STRATEGY_CYCLE,
    decide_trades=decide_trades,
    universe=universe,
    initial_deposit=INITIAL_DEPOSIT,
    reserve_currency=RESERVE_CURRENCY,
    trade_routing=TRADE_ROUTING,
)

trade_count = len(list(state.portfolio.get_all_trades()))
print(f"Backtesting completed, backtested strategy made {trade_count} trades")
```

```
  0%|          | 0/31536000 [00:00<?, ?it/s]
```

```
Backtesting completed, backtested strategy made 734 trades
```

1.7 Analysing the backtest results

Examine `state` that contains all actions the trade executor took.

[26]:

```python
print(f"Positions taken: {len(list(state.portfolio.get_all_positions()))}")
print(f"Trades made: {len(list(state.portfolio.get_all_trades()))}")
```

```
Positions taken: 367
Trades made: 734
```

1.7.1 Equity curve and drawdown

Visualise equity curve and related performnace over time.

- Returns
- Drawdown
- Daily returns

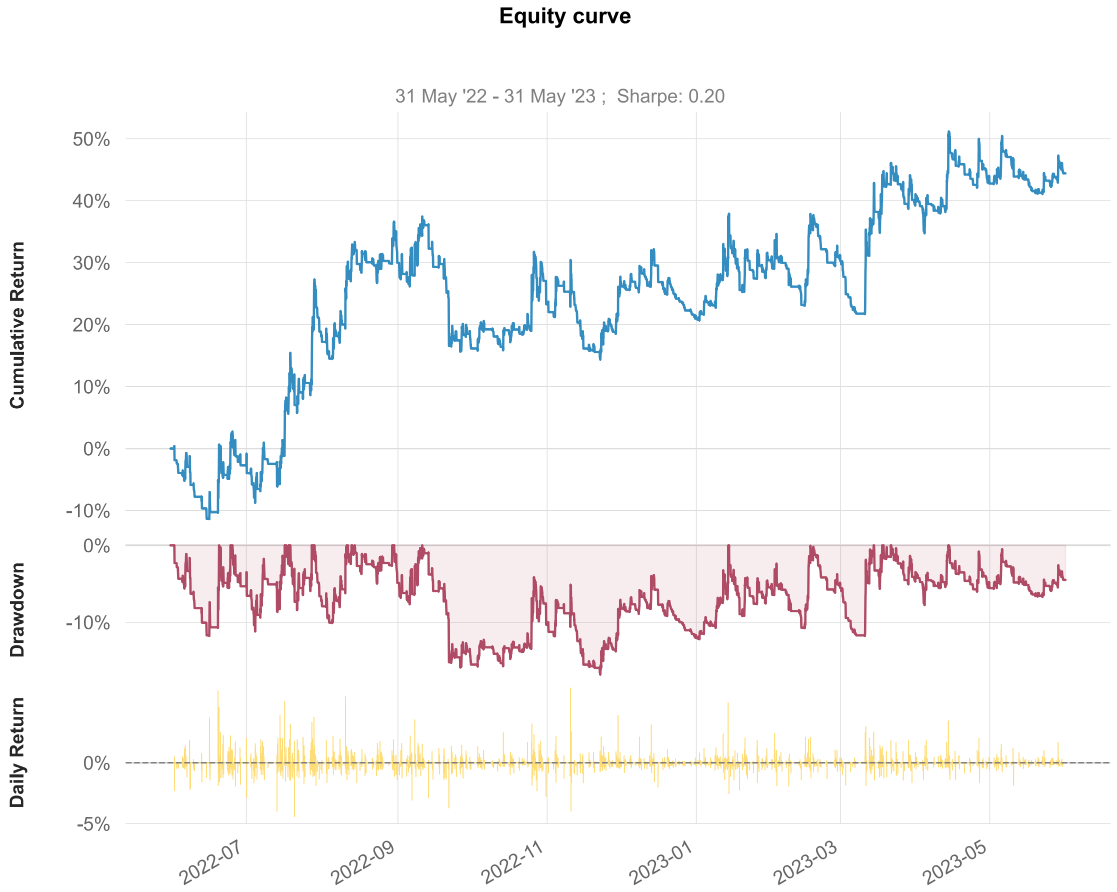
[27]:

```
from tradeexecutor.backtest.notebook import setup_charting_and_output
from tradeexecutor.visual.equity_curve import calculate_equity_curve,␣
 ↪calculate_returns
from tradeexecutor.visual.equity_curve import visualise_equity_curve

# Set Jupyter Notebook output mode parameters
setup_charting_and_output()

curve = calculate_equity_curve(state)
returns = calculate_returns(curve)
visualise_equity_curve(returns)
```

[27]:



1.7.2 Returns monthly breakdown

- Monthly returns

- Best day/week/month/year

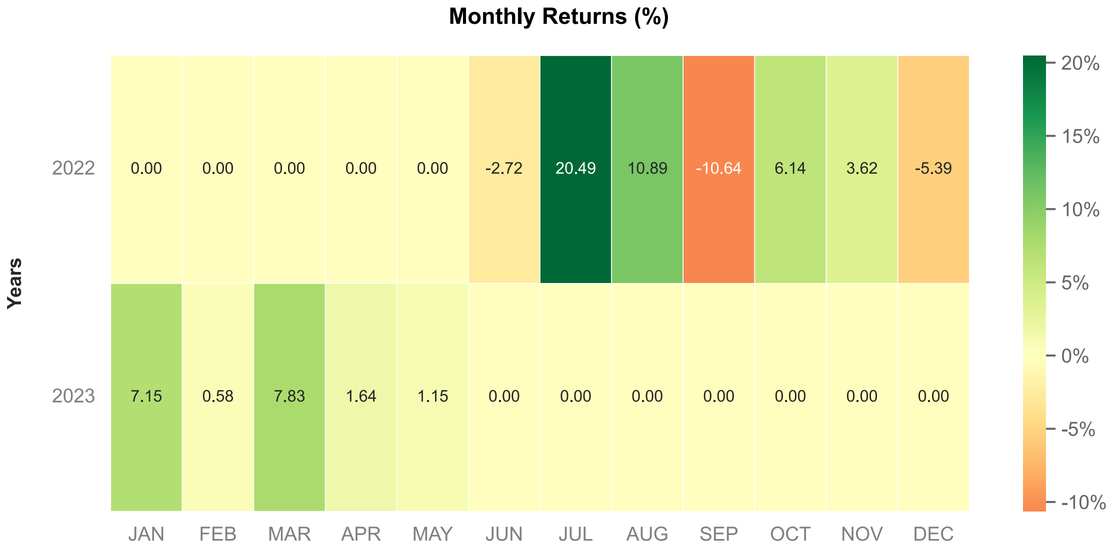
[28]:

```
from tradeexecutor.visual.equity_curve import visualise_returns_over_time

visualise_returns_over_time(returns)
```

```
/Users/moo/Library/Caches/pypoetry/virtualenvs/tradingview-defi-strategy-
XB2Vkmi1-py3.10/lib/python3.10/site-packages/quantstats/stats.py:968:
FutureWarning: In a future version of pandas all arguments of DataFrame.pivot
will be keyword-only.
  returns = returns.pivot('Year', 'Month', 'Returns').fillna(0)
```

[28]:



1.7.3 Returns distribution

Show the difference between good and bad trading periods.

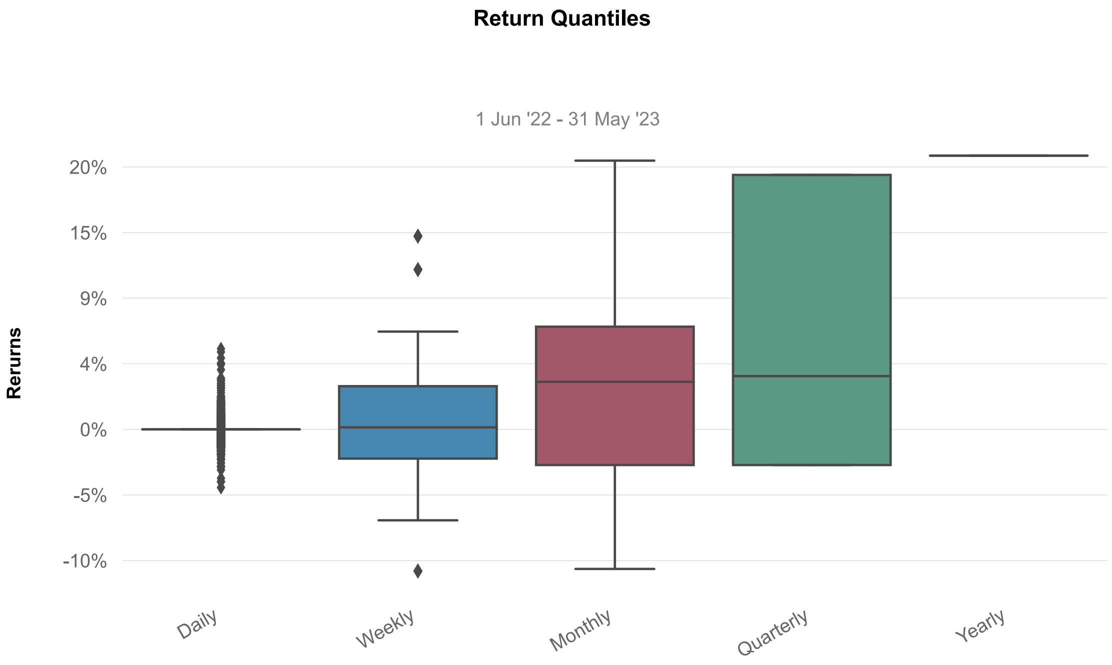
- Daily/montly/yearly
- Best/worst/avg.

[29]:

```
from tradeexecutor.visual.equity_curve import visualise_returns_distribution

visualise_returns_distribution(returns)
```

[29]:



1.7.4 Price action and technical indicators

- Plot the prica action for the trading pair we backtested.
- Overlay trades on the top of technical indicators

[30]:

```python
from tradeexecutor.visual.single_pair import visualise_single_pair, visualise_single_pair_positions_with_duration_and_slippage
from tradingstrategy.charting.candle_chart import VolumeBarMode

# figure = visualise_single_pair(
#     state,
#     universe.universe.candles,
#     start_at=START_AT,
#     end_at=END_AT,
#     volume_bar_mode=VolumeBarMode.separate,
#     volume_axis_name="Volume (USD)",
#     height = 1000,
# )

# figure.show()
```

1.7.5 Position visualisation

- Visualise individual positions over the price timeline
- Hover your mouse on the position marker circle to get its underlying details

- Positions closed for profit are marked green while losing ones are red

[31]:

```
candles = universe.universe.candles.get_candles_by_pair(universe.
  ↪get_single_pair().internal_id)

#figure2 = visualise_single_pair_positions_with_duration_and_slippage(
#     state,
#     candles,
#     start_at=START_AT,
#     end_at=END_AT,
#)

#figure2.show()
print("Not shown as the chart is too cluttered and slow")
```

```
Not shown as the chart is too cluttered and slow
```

1.7.6 Benchmarks

Here we benchmark the strategy performance against some baseline scenarios.

- Buy and hold US dollar
- Buy and hold ETH

[32]:

```
from tradeexecutor.visual.benchmark import visualise_benchmark

traded_pair = universe.universe.pairs.get_single()

fig = visualise_benchmark(
    "Bollinger bands example strategy",
    portfolio_statistics=state.stats.portfolio,
    all_cash=state.portfolio.get_initial_deposit(),
    buy_and_hold_asset_name=traded_pair.base_token_symbol,
    buy_and_hold_price_series=universe.universe.candles.
  ↪get_single_pair_data()["close"],
    start_at=START_AT,
    end_at=END_AT,
    height=800
)

fig.show()
```

1.7.7 Analyse trade statistics

Here we calculate statistics on how well the strategy performed.

- Won/lost trades
- Timeline of taken positions with color coding of trade performance

[33]:

```
from tradeexecutor.analysis.trade_analyser import build_trade_analysis

analysis = build_trade_analysis(state.portfolio)
```

1.7.8 Trade summary

Overview of strategy performance

[34]:

```
from IPython.core.display_functions import display

summary = analysis.calculate_summary_statistics()

with pd.option_context("display.max_row", None):
    display(summary.to_dataframe())
```

```
                                                    0
Trading period length                        363 days
Return %                                       44.42%
Annualised return %                            44.61%
Cash at start                              $10,000.00
Value at end                               $14,441.67
Trade volume                            $7,309,085.24
Position win percent                           31.61%
Total positions                                   367
Won positions                                     116
Lost positions                                    251
Stop losses triggered                             143
Stop loss % of all                             38.96%
Stop loss % of lost                            56.97%
Winning stop losses                                83
Winning stop losses percent                    58.04%
Losing stop losses                                 60
Losing stop losses percent                     41.96%
Take profits triggered                              0
Take profit % of all                            0.00%
Take profit % of won                            0.00%
Zero profit positions                               0
Positions open at the end                           0
Realised profit and loss                    $4,441.67
Portfolio unrealised value                      $0.00
Extra returns on lending pool interest          $0.00
Cash left at the end                       $14,441.67
Average winning position profit %               3.12%
Average losing position loss %                 -1.22%
Biggest winning position %                      9.20%
Biggest losing position %                      -4.88%
Average duration of winning positions          0 days
Average duration of losing positions           0 days
```

```
LP fees paid                                 $3,655.46
LP fees paid % of volume                         0.05%
Average position:                                0.15%
Median position:                                -0.51%
Most consecutive wins                                4
Most consecutive losses                             13
Biggest realized risk                           -3.90%
Avg realised risk                               -0.98%
Max pullback of total capital                  -11.59%
Max loss risk at opening of position             1.64%
```

1.7.9 Position and trade timeline

Display all positions and how much profit they made.

[35]:

```python
from tradeexecutor.analysis.trade_analyser import expand_timeline

timeline = analysis.create_timeline()

expanded_timeline, apply_styles = expand_timeline(
        universe.universe.exchanges,
        universe.universe.pairs,
        timeline)

# Do not truncate the row output
with pd.option_context("display.max_row", None):
    display(apply_styles(expanded_timeline))
```

```
<pandas.io.formats.style.Styler at 0x2a8995db0>
```

1.8 Finishing notes

Print out a line to signal the notebook finished the execution successfully.

[36]:

```python
print("All ok")
```

```
All ok
```