

# An Approach to Trading Strategy Optimization by Perfect Timing

Adam Wojciechowski

Poznan University of Technology  
ul. Piotrowo 2, 60-965 Poznań, Poland  
Adam.Wojciechowski@put.poznan.pl

## Abstract

Many stock and currency traders like technical analysis of price charts and prediction of future price movement based on indicators, assessment of dynamic and price candlestick formations appearing on charts. In this paper there is a proposal of an algorithmic trading system based on relatively simple price action formation, identified in mixed time intervals for the same asset. However, what made the system effective and profitable was proper timing which limited open and buy signals rose by the strategy only to time slots selected individually for each day of a week. Optimization process and selection of the best time slots for particular asset confirmed that nature of price movement vary depending on investors activity which may be stimulated by important message announcement calendar. The aim of the paper is to show a systematic approach for defining an algorithmic trading system and optimizing procedure. Although it is intended to be a didactic material it describes an up-to-date system which may be used for real trading and may be adapted for various assets.

**Keywords:** algorithmic trading, trading strategy, strategy timing, optimization, genetic algorithms

## 1. Introduction

Forex trading is a process of opening and closing CFD (contract for difference) contracts on currency rates. There are numerous handbooks, manuals and tutorials available over the Internet on how to trade. However, every trader should find his way of trading plan that corresponds to individual risk acceptance, greed, patience and ability to track price changes during working days (King et al., 2011).

The idea for building the trading system presented in this paper appeared in the beginning of the year 2015 when I tried to encourage Computer Science students at Poznan University of Technology, Poland to pay attention to automated trading instead of manual transactions. All of participants were novice traders fascinated by simplicity of trading and speed of account value changes. After some time of exercise in manual trading students were asked to define their trading plan and use it consequently to observe the benefits of keeping losses under acceptable level and joy of systematic growth of demo account. It did not come easily and only a few students built and used their trading plans. Soon it came to daylight that it is impossible to operate manually a trading plan which uses signals that may appear on the screen during day or night. Young traders had two ways to follow – either focus on signals and trades performed once a day (e.g. at midnight) or write a trading strategy (expert advisor, EA) – a piece of software that analyses current situation on price chart after each tick (each minimal change of price) and may place new or close CFD contracts. Beginnings were not easy – it required to learn a new programming language (MQL) – but students knew that this new skill may bring them a chance not only to build an automatic trading strategy but also to validate their concepts and rules when to open a new contract and when to close it. I proposed my students a

competition who beats my trading system which I started to build in parallel to students' systems and results of the process are collected in the article.

All the examples and strategy presented in this article were first implemented in MQL programming language then optimized and validated in MetaTrader 4.0 system for trading and analysis. Initial experiments with the strategy did not show its strength, unless it was used only in selected hours chosen for each day of a week. The process of selecting hours when the program is allowed to open new contracts became an important part of strategy optimisation. Timing selection performed periodically (monthly) uncovered dynamics of traders activity on the market but made the strategy particularly effective in the period of experiment: March to August 2015.

Structure of the paper is the following: after a short introduction a basic price chart notation – Japanese candlestick – is presented. Then, in chapter 3, there is discussion why it is better to use an automated trading strategy rather than open and close contracts manually. In section 4 there is a proposal of a trading strategy validated on EURUSD within 6 months period in 2015 and some practical observations are collected from real life trading using the strategy. The paper ends with conclusions and literature references.

**Warning.** The trading strategy and results presented in this article are illustration of market behaviour in particular period of 2015 and they do not constitute an investment advice. Good transactions and profits in reported periods do not guarantee similar behaviour of the trading system in the future. The author is not liable for any loss or damage, including without limitation, any loss of profit, which may arise directly or indirectly from use of or reliance on information provided in this paper.

## 2. Japanese Candlestick Chart

### 2.1. Anatomy of a candlestick

Japanese candlestick charts came to daylight in 18<sup>th</sup> century. A Japanese rice trader, Munehisa Homma, used candlestick charting schema to observe price changes and forecast possible reversals in trends. Candlestick chart allows to analyze price changes by drawing volatility of price in selected intervals. Characteristic price values: *open* – opening price, price of the first transaction, *close* – price of the last transaction, *high* – highest transactional price and *low* – lowest price in analyzed period determine shape of a candle on the chart. The area between *open* and *close* price level is known as candle body and is coloured white (bullish) if  $open < close$  or is black (bearish) when  $open > close$ . Lines above and below candle body reaching high and low correspondingly are known as upper and bottom wicks. Since that first use of candlestick price charts several formations have been identified and attributed *reversals* or *trend continuation* signals. This popular charting schema is also known as Japanese candlestick and currently it is built in all major tools for price action and technical analysis. The history of candlestick charts and many candlestick formations are collected and described by Nison (2001) in traders' handbook.

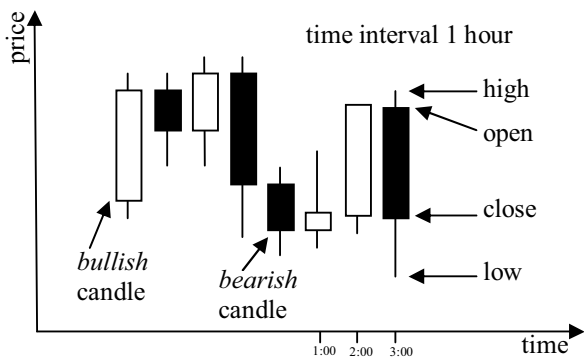


Fig. 1: Candlestick chart. Each candle represents range of price change within one time interval.

According to Taylor and Allen (1992) report more than 90% of London traders and analytics use candlestick price charts for analysis and prediction of future possible price action. Regardless whether the technique itself may give signals on possible price reversals or trend continuation the number of users of candlesticks among traders and popularity of the tools able to draw candlestick price charts may form critical mass able to predict self-fulfilling signals.

### 2.2. Candlestick formations

Graphical form of candlestick chart is close to bar chart. However candle shapes plus candle body colour form various compositions known among analytics as *formations*. Investors' handbooks enumerate very many various candlestick formations. They can be classified by signals they announce (trend continuation or reversal) length of candle sequence that can be interpreted as full formation that carries a signal for an investor. Just to name a few formations let's see them on fig. 2. It is obvious that the shorter the sequence of candles

constitutes a formation the easier it is to find them on price chart. The shortest formations are built out of one candle which appears on the chart assisted by specific neighbourhood of preceding candles.

Price formations may be identified on charts in every time interval. *Buy* or *sell* signals read from candles on smaller intervals appear more frequently than on higher intervals but signals derived from candlestick formations on charts with higher time interval ( $\geq 1$  hour) are considered as more accurate, more stable and with higher information value.

The art of trading based on candlestick patterns assumes that a trader may decide about the time to enter the market (to open a new contract) but also one can estimate where to place defensive order, so called *stop-loss* (close an order with accepted loss) and what level the price may reach on the chart in next intervals – to place a *take-profit* order (to close the contract with income). Candlestick formations help traders to decide about potential reversal on the market and show an entry point as well as they are also used to determine stop levels. In order to foresee and speculate potential price action on higher time intervals investors may observe and analyse candles on smaller time intervals since they react more dynamic to price changes. This practice requires experience however, because the classic candlestick patterns are typically interpreted and give the best prediction on a single time interval.

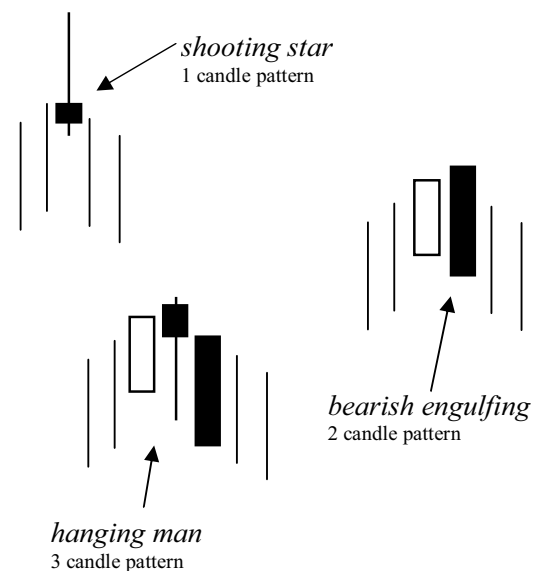


Fig. 2. Examples of candlestick formations. All three patterns announce trend reversal from bullish to bearish.

Apart of candlestick charts traders like to assess current state of the market on indicators. These are functions which typically take price or traded volume values from previous intervals as an argument and they are calculated and plotted on or below price chart. Investors like to predict possible future price action based on signals coming from indicators, their superposition or relation of indicators and current price.

## 3. Automated Trading

Trading on FOREX market is attractive for at least a couple of reasons:

- dynamic price movements;
- financial leverage;
- market open 24h on working days.

All mentioned above arguments allow for speedy change of value of trader's open contracts. Gains and losses are faster than on comparable stock market investments mainly because one can open contracts of high volume while deposited cash capital reach only 1% (1/100) of open contract value, and sometimes financial leverage is even higher than 1:100, e.g. 1:200. In a typical situation, a trader having EUR 1 000 on cash account may open a contract of the value 100 times higher: EUR 100 000. This strong magnetic power of money leverage available on FOREX is also a trap for not experienced traders because even a small price change multiplied by huge contract volume may easily liquidate deposit accounts.

According to many investors' handbooks emotions are the strongest trader's enemy (Steenbarger 2015, Fernandez et al. 2010). Greed, fear, euphoria and panic may take control over trader's behaviour. Uncurbed appetite for being reach and lack of patience lost many investors accounts. Investors' weakness lies also in difficulty to accept relatively small loss to avoid and escape from risk. Thus investors build trading plans. These are rule systems based on individual's wisdom, experience and knowledge about candlestick patterns or other predictive techniques. Trading plan if it exists needs to be verified. Now, in era of computer applications assisting traders in opening and closing contracts, back-test validation of a trading plan requires coding the trading plan into a program and running it on historical data. Such an approach is the fastest and relatively good verification technique to observe how effective in money making rule system hidden in the trading plan is (Wang et al., 2009).

#### 4. Proposed Trading Strategy: Break H1 opposite H4 colour

##### 4.1 Multiple time interval perspective

Many trading rules derived from Japanese candlestick formations which are described in traders' handbooks are based on single time interval perspective. It means that a trader chooses time interval appropriate for his investment perspective and plots a price chart. Also it is a general rule that candles are interpreted when they are closed (embrace entire time period).

Building a new strategy let's assume that we have insight into candles plotted on two time intervals H1 and H4 (one and four hour candles respectively). A general condition for opening a new *buy* contract is that: current price breaks previous hour *high*. Additionally current reversal (price is below previous hour *high*) occurs within a H4 bull candle. The *pending buy* order is send to broker's system when all conditions below are met:

1. There are no other working *buy* contracts;
2. Current Relative Strength Indicator RSI(5) indicator is above oversold level (price is not dynamically falling);
3. Current H4 candlestick is *white*; price is going up in a longer timeframe perspective;
4. Current *price* is a *threshold* below previous hour high level  $High[1]$  (a condition to send a pending order is

that execution price is at *stops level* distance from current price  $\rightarrow threshold \geq stops level$ );

5. Current *price* is a *threshold* above previous hour low level:  $Low[1]$  (together with condition 4. it allows to send a pending order if previous hour candle was at least 2x *threshold* tall; in practice it means that there was no stagnation of price in previous hour);
6. Current hour *high* is below previous hour *high*,  $High[1] > High[0]$ . This condition protects from opening next *buy* order if price waves above and below previous hour high.
7. The *Pending Buy* order expires on the beginning of new H1 candle.

Defensive *Stop Loss* and closing *Take Profit* price levels are calculated according to formulas:

$$TP = OrderOpenPrice + atrTP * ATR(10, H1);$$

$$SL = OrderOpenPrice - atrSL * ATR(10, H1);$$

where  $ATR(10, H1)$  is the value of Average True Range indicator calculated for last 10 periods on 1-hour interval. *Take Profit* and *Stop Loss* are set up dynamically depending on current volatility  $\rightarrow$  the higher ATR value the more dynamic price change is expected in next periods (although ATR shows information on previous periods, not predictions).

An attention is paid to risk avoidance. All contracts are open with stop loss defensive level. Also it was practiced to close all contracts on Friday evening, at 21:45, to avoid exposure to big change of price when market re-open on Sunday 23:00, CET.

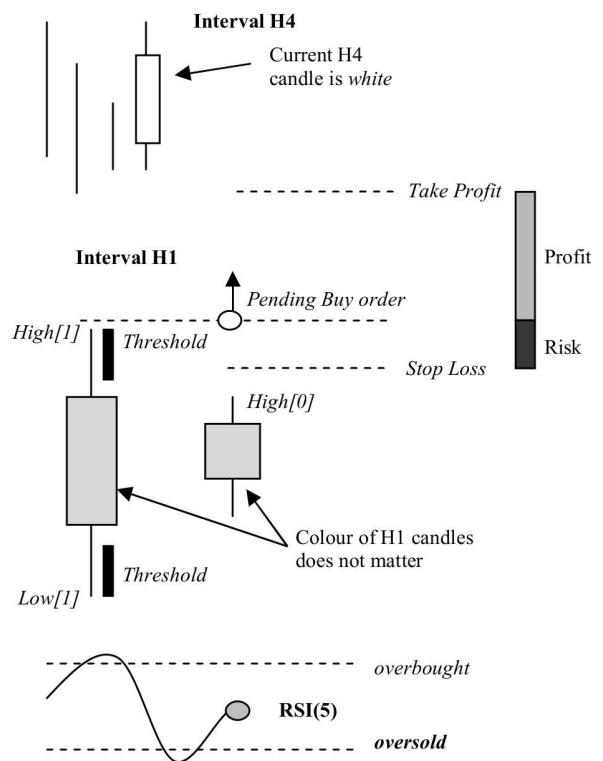


Fig. 3. Conditions for sending a pending buy order.

Conditions for placing a *pending sell* order are symmetric to *pending buy* order. They assume that current H4 candle is *black* and the order is placed below previous H1 candle low level:  $Low[1]$ , while RSI(5)

remains below *overbought* level. Sell order activation takes place if price breaks *Low[1]* from *North* to *South*.

#### 4.2 Initial variables tuning

Meta Trader 4.0, which was the platform for experiments, allows for systematic tuning of variables used in a strategy. The procedure is based on repetitive simulation of execution of transactions with different values of selected variables. Each variable may have defined upper and lower bound and step of change. Optimization test is performed on selected timeframe using stored historical price data for selected asset on smallest available interval. In our case 1M (one minute) candles we used in all experiments. One should notice that number of required passes in optimization process grows very fast with number of optimizes variables. If one wants to find the best setting of  $k$  variables and for each variable  $s_k$  values are considered, the total number of passes is:

$$\text{Passes} = \prod_{i=1}^k s_i$$

To speed up optimization process which takes hours when a couple of variables are optimized, Meta Trader may use its genetic algorithm for selecting generations of variable sets in optimization. Finally, after running several tests with various variability ranges and various granularity of variables, using historical data from October 2014 till March 2015 for EURUSD the optimal set of variable values was selected. In particular some values remained unchanged during further experiments: number of periods to calculate ATR in H1 = 10; number of periods to calculate RSI in H1 = 5; RSI signal levels: *oversold* = 21, *overbought* = 79; Threshold = 60 pips

Variables *atrSL* and *atrTP* were crucial in calculation of *StopLoss* and *TakeProfit* levels as described in section 4.1. In order to keep trading rules close to market volatility *atrSL* and *atrTP* were adjusted monthly and were optimized for data taken from 3-month time window directly preceding trading month. However one could not say that they visibly fluctuated. Finally, in experiment described in this paper we assume *atrSL*=0.8 and *atrTP*=2.0 for the whole trading period April to September 2015. In experiment we also used trailing stop procedure with size 420 pips (in price measurement to five decimal places, pip=price interest point). For strategy optimization each trade was opened with identical volume: 0.1 LOT. Initial value of deposit was US\$ 1 000.

#### 4.3 Validation of the *Break H1 opposite H4 colour*

In order to verify how much one could earn by automated trading with *Break H1 opposite H4 colour* strategy a monthly experiment was performed in April 2015. Although the expert advisor (EA, Meta Trader's name for programs dedicated for automated trading) was optimized in conditions of equal volume in each transaction, this condition was changed in validation. Instead of equal volume per transaction we used a rule of equal aggressive risk. It was set to 7% per transaction, which meant that in the worst case in the experiment 7% of deposit could be lost in a transaction. Transaction volume is individually calculated for each transaction to guarantee 7% risk. The more money are on deposit the bigger volume may be traded. Gains should grow or shrink proportionally to

deposited capital. Such a rule is also a fuse for a trader because if his deposit is smaller he risks less money per transaction.

The strategy traded very well. In the end of first validation month profit was close to 70%, Initial deposit of US\$ 1 000 grew to US\$ 1 698 within April 2015, see fig. 4.

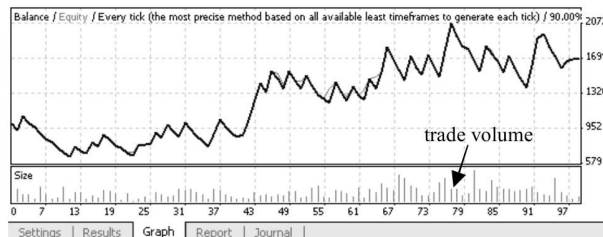


Fig. 4. *Break H1 opposite H4 colour EA* performance in April 2015 without timing, EURUSD.

At a glance performance of EA might seem positive. Especially in the end of April deposit is 70% bigger than in the beginning of test period. But one should notice that on April 6, the budget shrank to US\$ 650 which means that within 4 days the strategy lost 1/3 of initial capital. Partly it is consequence of high acceptance of risk: 7% per transaction. Within the month there were 98 transactions: 35 profit trades and 63 loos trades. In such circumstances profit was only a result of good risk/reward ratio which was 2/5. Deeper analysis of graph (Fig. 4) and list of all transactions led to the conclusion that profit trades appeared mainly in some particular hours within a week. Thus another test was performed to select weekly hours when profitable transactions were opened. It strongly improved profit.

To play fair, the best timing for EA validated on transactions in April was selected upon optimization run on data from January to March 2015. Optimisation was performed with time granularity of 1 hour. After optimization the EA was rebuilt to send new orders only within 'good' hours. Only 31 hours were selected based on the rule that in the reference period (Jan to Mar 2015) the strategy needed to earn at least US\$ 25 on transactions opened within particular hour, trading constant volume of 0.1 LOT in each transaction. Performance of timed strategy is shown on fig. 5.

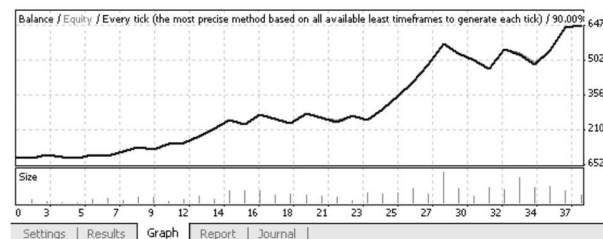


Fig. 5. *Break H1 opposite H4 colour EA* performance in April 2015 after timing, EURUSD.

After timing procedure the strategy performed much better. Initial deposit of US\$ 1 000 grew to US\$ 6 509 within April 2015, which is c.a. 550% monthly growth of the capital. But what is also important for traders the saw shape of the deposit chart on fig. 4 was smoothed on chart on fig. 5 (after timing) when loss transactions did happen but much less frequently than before timing. Total

number of transactions was 37: 21 profit trades and 16 loss trades.

Intriguing question is whether positive performance of the timed strategy in April 2015 was an exceptional incident or the strategy may generate gain in next periods. To verify it the experiment was performed in the period of April to August 2015. Results are collected in table 1. Initial deposit in every month is equal to US\$ 1000, maximum risk in a single transaction is 7%. All conditions and variables were optimized for the best performance of the strategy for the data from January to March, 2015.

Table 1. Profit generated in April to Sept. 2015 by the strategy optimized and timed for period Jan.-Mar.2015.

Month	Number of transactions		Max. profit sequence	Max. loss sequence	Net profit [%]
	profit	loss			
IV.2015	21	16	5	3	<b>550,9</b>
V.2015	20	9	3	2	<b>806,6</b>
VI.2015	20	18	5	3	<b>416,0</b>
VII.2015	15	15	6	5	<b>163,8</b>
VIII2015	15	15	5	3	<b>260,4</b>
IX.2015	8	27	4	11	<b>-45,4</b>

For comparison purpose let's analyze effectiveness of trading process performed by the same strategy, with identical variable settings but timing changed monthly. It means that after collecting history of price change in a next month, the strategy is re-timed, new trading hours are selected, to guarantee highest return in 3-month period directly preceding trading month, e.g. strategy optimized in the sense of timing on data from Feb. to Apr. is used to trade in May and so on.

Table 2. Profit generated in April to Sept. 2015 by the strategy optimized for period Jan.-Mar.,2015 and timed for 3-month period preceding trading month.

Month	Number of transactions		Max. profit sequence	Max. loss sequence	Net profit [%]
	profit	loss			
IV.2015	21	16	5	3	<b>550,9</b>
V.2015	12	22	2	4	<b>25,0</b>
VI.2015	17	29	4	7	<b>24,8</b>
VII.2015	15	18	6	2	<b>113,3</b>
VIII2015	16	17	2	2	<b>188,4</b>
IX.2015	11	35	2	8	<b>-49,2</b>

Information on maximum length of consecutive profit and loss sequence is provided because it may help a trader to reduce risk in single transaction (play smaller volume) when a winning sequence is unexpectedly long and vice versa. Relatively weak profit observed in table 2. in May and June, when compared to results from table 1. may be result of Summer time adjustment which takes place in the end of March and happened in the middle of strategy optimizing data set. Time change is not practiced world-wide and it is a potential hint to explain serious differences in effectiveness of strategy timed for period Jan.-Mar. and for periods having March time adjustment in the middle.

Good improvement of the strategy performance was achieved when list of monthly optimized parameters was extended by *atrSL* and *atrTP*. It allowed to adjust

expected stop loss and take profit range to values closer to current market conditions.

## 5. Conclusions

The strategy *Break H1 opposite H4 colour* appeared to be an effective proposal for algorithmic trading but it showed its strength after timing procedure. However, what came to daylight in experiments, when the strategy was used in parallel on demo and real account, some of real trades were not open on the real account. They were rejected by broker's server. After a closer observation it appeared that those orders could not be accepted because the broker widened the fork of stop levels from 50 to 500 pips for a couple of minutes during dynamic trading periods, when important traders news were published. This problem could later be overcome but for some time it was very frustrating.

One more conclusion with strongly didactical meaning is observation that comes from the last rows of table 1. and table 2. No matter how much was won in previous months, almost half of the money was lost in September. In order to protect profits from previous periods it is necessary to locate them in lower risk investment. Reported experiment was run with very high risk acceptance: first to show possible high profits but secondly - to warn about potential losses.

Strategy optimization costs hours of computations. However, this work is done by computer and trader's task is to plan such routine because it converts into profit.

Further experiments are planned to validate effectiveness of the strategy *Break H1 opposite H4 colour* on other financial instruments.

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