

BUILDING AUTOMATED TRADING STRATEGIES

INTRODUCTION TO AUTOMATED STRATEGY
BUILDING & OPTIMIZATION



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& OPTIMIZATION »

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INTRODUCTION:

THE QUEST FOR THE HOLY GRAIL OF TRADING

As technology advances, so does the trading industry. Since the new millennium, automated trading is witnessing a significant growth. The implementation of automated trading strategies has become a common practice for both professional and retail traders. Nowadays, retail traders have access to hundreds of financial markets worldwide using a simple personal computer and an internet connection. Furthermore, building an automated trading system is easier and cheaper than ever.

Automated trading systems can automate the whole trading process, from the trading decision to market execution. The enormous multi-tasking power of these systems allows the simultaneous analysis of hundreds of financial markets. Moreover, an automated system has no emotions and can trade 24/7 without feeling stress or fatigue. All these advantages make the creation of a successful automated trading system the '**holy grail**' for any ambitious trader.



Institutional traders use a wide variety of sophisticated automated systems. According to the Bank of England (2017), there are two mega-trends. On the one side, there are large advances in data-driven modeling techniques that

combine computational statistics, mathematical optimization, pattern recognition, predictive analytics and artificial intelligence. On the other side, there is a rapidly increasing amount of granular data, often referred to as Big Data.

Retail traders apply automated strategies based on Expert Advisors (EAs) running on four trading platforms: MetaTrader-4, MetaTrader-5, TradeStation, and NinjaTrader. These EAs can analyze the market 24/7 and create trading signals based mainly on technical analysis. Their algorithms can spot trading opportunities based on price movements and their products (volatility, strong trends, reversals, etc.). For risk management and position sizing, these EAs incorporate basic money management techniques.

This eBook includes general information and educational resources for explaining the modern use of automated trading, plus some practical information and advice on how to create a proprietary automated trading system. The optimization of a trading strategy through sophisticated backtesting and walk-through steps is maybe the most difficult part of strategy building. The danger of over-optimization always exists and requires the implementation of methods based on randomness (Monte Carlo, etc.). This eBook contains information on how to successfully backtest and optimize automated strategies using advanced commercial software.

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CHAPTER-1: THE BASICS OF AUTOMATED TRADING

Automated trading is a method of trading the global financial markets based on a combination of computer software and hardware. Automated trading is a sophisticated branch of systematic trading and all automated trading systems are systematic.


Major Assumptions of Systematic Trading

Systematic trading assumes the following:

1. The existence of a rules-driven trading strategy that is based on objectively reproducible (computable) inputs
2. The application of that strategy with discipline and outside of the human emotional context¹



When we refer to automated trading, we refer to the way that trading orders are actually executed. An automated trading system must be able to execute trades without human intervention by placing also limit orders (usually a take-profit and a stop-loss).

¹  Professional Automated Trading Theory and Practice (Eugene A. Durenard)

Advantages & Disadvantages of Automated Trading

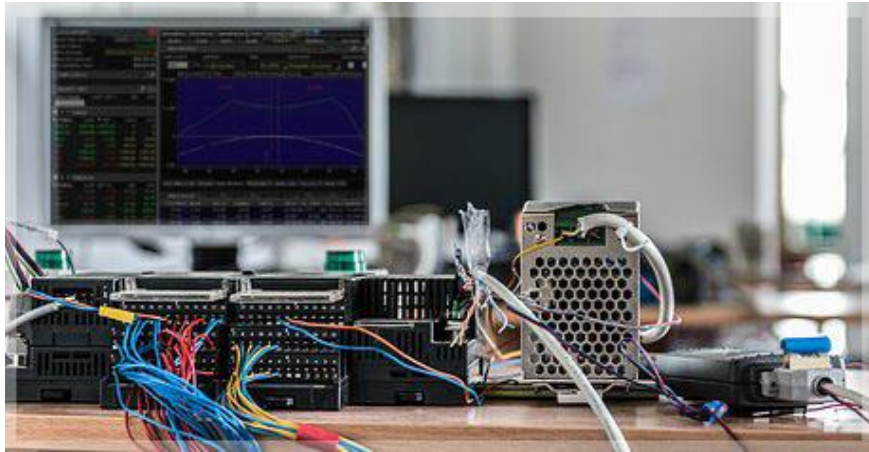
Major Advantages of Automated Trading

- ✓ The greatest advantage of automated trading is that it is able to minimize emotions throughout the trading process. The emotional character of our human nature is highly disturbing our decision-making process when we trade in any financial market. Fear, hyper-optimism and other similar feelings deriving from the emotional part of our brain are working against logic and finally against the odds of winning. This emotional part is the worst trader there is.
- ✓ Manual trading has limitations regarding the stamina of our human nature. An automated trading system never gets tired. Using a VPS hosting service you can turn-off your PC and continue trading 24hours per day.
- ✓ Automated trading offers the ability to easily and quickly backtest any trading idea. It is very difficult to backtest manual trading strategies.
- ✓ Automated trading systems are also able to analyze simultaneously multiple financial markets, and take advantage of trading opportunities in a much shorter reaction time.

Major Disadvantages of Automated Trading

- ☒ The greater disadvantage of an automated trading system is that it can deal only the market conditions that it is programmed to deal with. That means that new market conditions deriving from major fundamental changes cannot be interpreted and incorporated.
- ☒ A major event, such is a country's default to meet its payments, usually leads to extreme volatility in the market, and extreme volatility can change everything. Semi-automatic systems may adapt better to new market conditions, as they can be re-adjusted anytime.

- ☒ In addition, some experts argue that auto-trading systems are inefficient because they create trading signals based on backward-looking indicators.



General Categories of Automated Trading

According to Mitra, di Bartolomeo, and Banerjee (2011), automated trading can be divided into five (5) main categories:

(i) Algorithmic Executions

Opening and closing speculative positions based on mathematical algorithms.

(ii) Statistical Arbitrage

Statistical arbitrage trading, which is based on the automation of the investment decision process.

(iii) Crossing Transactions

A financial market participant seeks a counterparty to be the other side of the trade, without exposing the existence of the order to the general population of market participants.

(iv) Electronic Liquidity Provision

Willing to buy or sell any asset upon counterparty request, electronic liquidity providers differ from traditional market makers in that they often do not openly identify the set of assets in which they will trade.

(v) Predatory Trading

Typically placing thousands of simultaneous orders into a market while expecting to execute only a tiny fraction of all orders. This “place and cancel” process has two purposes. The first is an information gathering process. By observing which orders execute, the predatory trader expects to gain knowledge of the trading intentions of larger market participants such as institutional asset managers. Such asymmetric information can then be used to advantage in the placement of subsequent trades. A second and even more ambitious form of predatory trading is to place orders so as to artificially create abnormal trading volume or price trends in a particular security so as to purposefully mislead other traders and thereby gain advantage.²

In this eBook, we will focus on (i) algorithmic executions.

Combining Software/Hardware

As mentioned before, institutional traders use complex and sophisticated automated trading systems. Retail traders on the other hand use a simple combination of software/hardware including a personal computer and a trading platform.

² «Automated Analysis of News to Compute Market Sentiment: Its Impact on Liquidity and Trading» - G. Mitra, D. di Bartolomeo and A. Banerjee (2011)

Minimum Configuration for Retail Traders

These are the minimum requirements for building an automated trading system:

1. Dedicated ECN trading account (offering competitive pricing)
2. Personal Computer (minimum 5 cores, 8 GB Ram, 300GB HD)
3. Fast and reliable internet connection
4. An Automated Trading platform (usually it's free)
5. Installing an Expert Advisor (commercial or custom-made)
6. VPS Service (generally offers better and more reliable results)



Using a VPS Service

VPS means Virtual Private Server and it is an internet hosting service. A VPS service allows traders to run automated strategies on a Virtual Machine without using their own computers. The aim is to minimize the risk of connectivity failures and simplify the whole process of trading 24/5.

There are a few Forex brokers offering a free VPS hosting (under a policy):

- ✚ IC Markets (includes only deposit requirements)
- ✚ XM Group (deposit and volume requirements)
- ✚ FBS (deposit and volume requirements)

Table-1: Brokers offering free Forex VPS

BROKER	REQUIREMENTS	FUNDING	ACCOUNTS
<p>» IC MARKETS</p> <ul style="list-style-type: none"> ■ MT4/MT5 ■ FIX/API Trading ■ Auto-Trading ■ cTrader Account ■ PAMM accounts ■ Multilingual Support 	<ul style="list-style-type: none"> ■ Free VPS for all traders holding more than \$5,000 	<p>□ \$200 minimum deposit</p> <p>METHODS:</p> <ul style="list-style-type: none"> • Credit Cards • Skrill • Neteller, Skrill • More methods 	<p>► Visit IC Markets</p> <p>Review Broker:</p> <p>► Review Broker</p>
<p>» FBS VPS</p> <ul style="list-style-type: none"> ■ MT4/MT5 ■ Multilingual Eastern-European and Asian Customer Support ■ \$50 (Free) No-Deposit Bonus 	<ul style="list-style-type: none"> ■ Traders must deposit at least \$450 to get the free VPS ■ Required at least 3 round turn lots per month 	<p>□ \$5 minimum deposit</p> <p>METHODS:</p> <ul style="list-style-type: none"> • Credit Cards • Skrill • WebMoney • PerfectMoney • More methods 	<p>► Visit FBS</p> <p>Review Broker:</p> <p>► Review FBS</p>
<p>» XM GROUP VPS</p> <ul style="list-style-type: none"> ■ FIX/API Trading ■ MT4/MT5 ■ Multilingual Support 	<ul style="list-style-type: none"> ■ Clients must maintain a minimum of (Equity - Credit) USD 5,000 to get the free VPS ■ Required at least 5 round turn lots per month 	<p>□ \$5 minimum deposit</p> <p>METHODS:</p> <ul style="list-style-type: none"> • Credit Cards • Skrill • Liberty Reserve • Neteller • More Methods 	<p>► Visit XM</p> <p>Review Broker:</p> <p>► XM Review</p>

CHAPTER-2: THE ALGORITHMIC APPROACH

Automated trading refers to the process of automating manual trades. This process usually focuses on the prediction of asset price movement based on a recognizable price trend and its historical time. Other methodologies may include macroeconomic indicators, news releases, and many other events.



On the other hand, Algorithmic Trading refers mainly to the research and analysis of market conditions and trading data in order to develop efficient instructions and rules. It includes a wide variety of parameters such as price, time, and quantity. Actually, algorithmic trading uses common techniques of classic financial mathematics (asset pricing theory, etc.).

The different approaches, at a glance:

- Algorithmic trading → automating research and analysis
- Automated trading → automating trade execution

Algorithmic Trading

Algorithmic trading or Algo trading or Black box trading means trading the global financial markets using computer algorithms following a defined set of

rules and instructions. These algorithms continuously analyze the dynamics of demand/supply and then place market orders. The whole process excludes human intervention.

Basic assumptions of Algorithmic Trading

These are some fundamental assumptions of quantitative finance³:

- I. Historic results have at least some predictive ability {Sharpe 1994}
- II. Financial Markets are not perfectly efficient (at least in the short-term)
- III. Financial Markets have a finite depth
- IV. Regularities in financial data do exist, but only for short periods of time, a window of opportunity may open, and then at some future time it will close
- V. The financial data (price and quantity) are driven by human psychology and societal decisions, and therefore are random and unstable

Components of an Algorithmic Signaling Machine

An algorithmic system incorporates two basic components:

1. The Forecasting Module

The forecasting module analyzes the dynamics of the market, and especially what concerns potential changes in the dynamics of demand/supply

2. The Action Module

The action module suggests and/or executes a specific trading action at a specific price and time (opens, modifies, and closes a series of trading orders)

³ “Automated Finance: The Assumptions and Behavioral Aspects of Algorithmic Trading” -Kumiega, Andrew and Van Vliet, Ben

Common Modules for Creating Forecasting Indicators:

These are some common forecasting modules:

1. Intermarket Correlations (correlations between different markets)
2. Volume Clustering (important changes in trading volumes can predict upcoming price movements)
3. Imbalances of Demand/Supply (changes in the volume of orders on one side may forecast upcoming price movements)
4. Asset Pricing Inefficiencies (comparing asset pricing to linked variables -such is the sectoral indexes for shares)
5. News Effect (the market's reaction to news may create a predictable pattern)

Tools for Creating and Optimizing Algorithmic Trading Systems

These are some tools for building an algorithmic signaling machine:

- Pattern Recognition (machine learning)
- Order/Volume Breakout Analysis
- Time Series Analysis
- Intermarket Correlations Analysis
- Market Sentiment Measures (data mining metrics of positivity/negativity of the language used in particular entities or events)
- Historical Backtesting
- Monte-Carlo Simulation (using random sampling to solve deterministic problems)
- Hamilton–Jacobi–Bellman (HJB) Equation (central to optimal control theory)

- Queuing Theory (mathematical study based on predicting the time and length of waiting lines or queues)
- Sharpe/Sortino Ratios (differentiate harmful volatility from overall volatility by using the downside deviation or else the asset's standard deviation of negative asset returns)
- Walk-Through Optimization



Quantitative Analysis

Quantitative analysis uses a wide variety of data in order to build trading models and trading strategies capable of generating trading signals. The forecasting models include several fundamental and statistical data (mean reversion, etc.). Note, that before these models can be transformed into complete trading strategies, they must be highly back-tested with historical data. More about backtesting and optimization in Chapter-7.

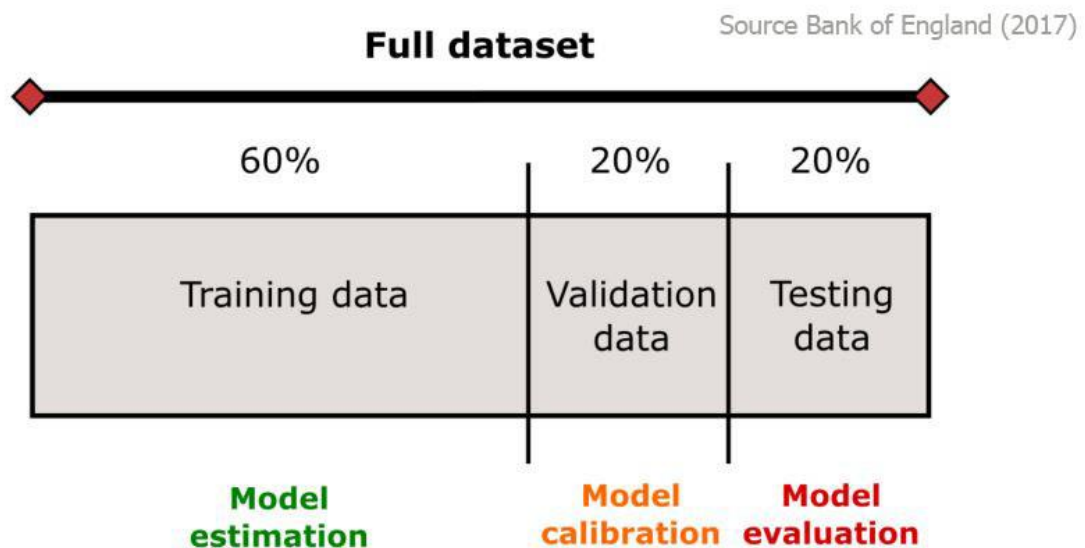
Machine Learning

Machine learning refers to the process of using statistical tools and techniques in order to offer computer systems the ability to 'Learn'. Learning means

improving the performance of the computer system without direct human intervention (without specifically programmed). A machine learning system includes the following components⁴:

- A. a problem
- B. a data source
- C. a model
- D. an optimization algorithm
- E. validation & testing

Graph-1: Model generation stages in machine learning {source: The Bank of England)



Programming Language for Building Algorithmic Systems

These are the most commonly used programming languages for building algorithmic strategies:

1. Microsoft Visual C++/C# (Ideal for Maximum Trading Speed)

⁴ "Machine learning at central banks" -Chiranjit Chakraborty and Andreas Joseph (BoE 2017)

C++ is commonly used in High-Frequency Trading (HFT). It includes advantages such as speed, advanced code debugging, high volumes of data management, code completion (IntelliSense), and easy project overview.

2. Python (Open Source -Ideal for Back-testing and Researching)

Python is a high-level language commonly used in Algorithmic trading. It includes advantages such as high-performing libraries, advanced back-testing capabilities, and a very easy to use interface. Link: <https://www.python.org/>

3. MatLab (Mathematical Language)

Matlab is designed to deal with extensive algebra operations, but it is also used for researching historical financial data.

4. R Language (Free Statistical Language)

R is a statistical programming language, which can build trade systems. Link: <https://www.r-project.org/>

5. Java (Free Programming Language)

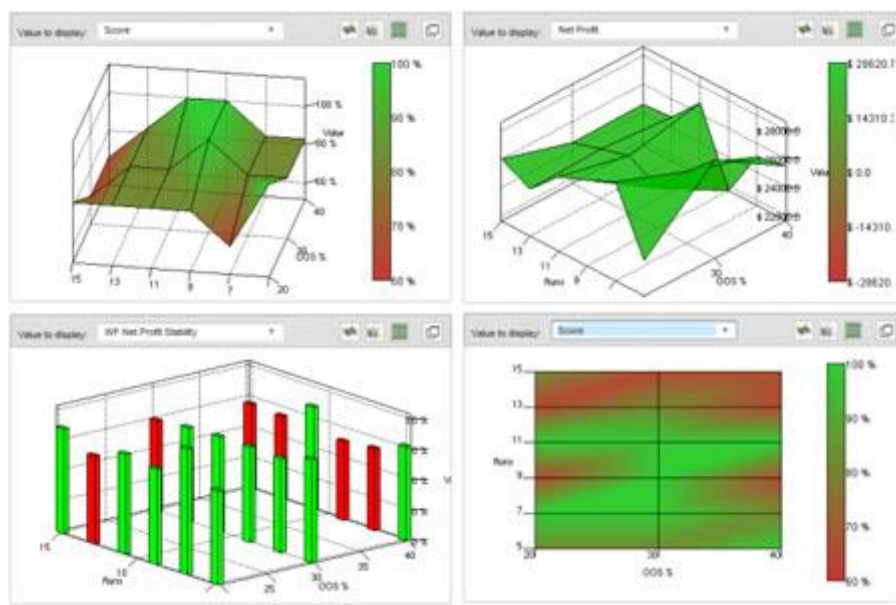
Java is a programming language used for low latency data operations, modeling, and trade simulations.

6. MQL (Free Coding Language for MetaTrader Platforms)

MQL is a free coding language, built-in on every MetaTrader platform. It is extremely easy to use and offers a user-friendly editor/compiler. On the other hand, it has some limitations.

STRATEGYQUANT –AN AUTOMATED STRATEGY BUILDING AND OPTIMIZATION PLATFORM

Strategy Quant is an advanced platform for finding or building from scratch algorithmic strategies without any programming skills. The application can also perform very advanced backtesting and sophisticated (walk-through) optimization. Saving files in multiple formats allows automated strategies to be fully compatible with all major trading platforms {MetaTrader-4, MetaTrader-5, TradeStation, and NinjaTrader}.



More information about StrategyQuant in Chapter-7.

The Strategy Quant Website: ► [the Strategy Quant Web Site](#)

CHAPTER-3: AUTOMATED TRADING STRATEGIES

An automated trading strategy refers to a software code that includes a set of rules and conditions capable of automatically creating and submitting trading orders to an OTC market or an organized exchange. This means that the code includes an analysis framework and a decision-making module that is able to select trades and position sizes. A fully automated strategy works without any human intervention. Almost every manual trading strategy can get partially or fully automated.

The Two Approaches of Automated Strategy Building

There are many different approaches for building automated-trading strategies. The two key approaches include:

- a. Model-based strategies
- b. Data-driven strategies

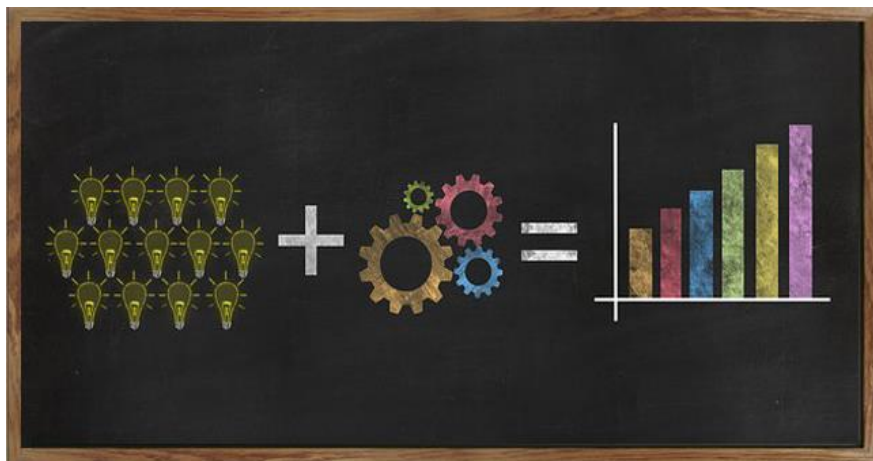
Data-driven strategies are complex and require significant resources. Therefore, this eBook emphasizes model-based strategies, which are easier to implement.

The Seven (7) Questions

Every efficient automated trading strategy should incorporate a decision-making module capable of answering the following questions:

1. What assets/markets to trade?
2. What direction to trade (bulls/bears)?
3. When to trade (best price or time)?

4. What is the trading cost (fees, spread, overnight cost)?
5. Are there any hidden risks involved (liquidity risks, correlations with other assets, etc.)?
6. How much to trade (position sizing)?
7. What trading orders should be used (market orders, pending orders, stops)?
8. When or where to sell (target-price, price intervals, etc.)?



The Basic Automated Trading Strategies

Designing a successful trading strategy involves beating the market's future price expectations either by more knowledgeable or faster processing of the available information⁵. There are tens of different automated trading strategies. You can even combine two or more strategies to build a multi-trading system.

(1) Trend-Following Strategies

This is the most popular automated trading strategy. A trend-following strategy uses historical data to evaluate and follow strong price trends using:

- i. Historical Support & Resistance

⁵ "Automated Trading with Machine Learning on Big Data" Dymitr Ruta (2014)

- ii. Price channel breakouts
- iii. Technical analysis indicators
- iv. Moving Averages (for example combining a 50-day and a 200-day moving average)

(2) Volatility-Expansion Strategies

There are several automated trading strategies based on volatility (volatility expansion, volatility breakouts, etc.). The volatility expansion is a short-term strategy that focuses on sudden changes of volatility in the price of financial assets. Price gaps may also play an important role for the volatility expansion strategy. Gaps on a price chart are areas where the price move up or down, with no trading in between.

At a Glance:

- i. Combining market volatility with price metrics (price gaps may also play an important role)
- ii. The strategy offers a high winning percentage but low profits per trade

(3) Mean-Reversion Strategies

The Mean-Reversion strategy assumes that the price of a financial asset will revert to its mean price 80% of all times. In other words, 80% of all times the markets are ranging. That means extreme highs and lows create good opportunities to sell or buy the market and wait for the price to return to its mean.

The Mean-Reversion Strategy:

- i. Using historical data to generate an average asset price
- ii. Calculating the current price range
- iii. Breaking the range triggers the execution of a trade

(4) News-Event Based Algorithmic Strategies

Automated-trading can prove very useful when trading the news. A simple news-event based strategy may open trade positions based on the difference between actual data and market consensus. Other more sophisticated news-event strategies attempt to quantify more complex news items.

At a Glance:

- i. Quantifying scheduled/unscheduled news releases
- ii. Determining the impact of news on particular markets/assets
- iii. Avoiding stop-hunting techniques on major news releases

(5) Market Sentiment Algorithmic Strategies

Market sentiment strategies attempt to quantify the investor's sentiment based on a wide variety of data sources such as:

- i. COT report (CBOE)
- ii. Put/Call Ratio
- iii. Social Media Measures (data-mining)
- iv. Online Trading Sentiment Measures

(6) Other Automated-Trading Strategies

There are many more automated trading strategies such as:

- Arbitrage strategies
- Statistical arbitrage strategies
- Volume Weighted Average Price (VWAP) strategies
- Time Weighted Average Price (TWAP) strategies
- Mathematical Model Based Strategies, and many more

CHAPTER-4: TRADING COST, RISK, AND MONEY MANAGEMENT WHEN APPLYING AUTOMATED STRATEGIES

Risk management refers to the process of protecting a trading account against all systematic risks. Risk refers to the likeliness a partial or total loss will occur. Risk management is certainly a very important issue towards the long-term success of every automated strategy and must reflect your appetite for risk.



These are the main categories of systematic risks that can be assessed and managed:

- (1) **Market Risk** (the general risk from unfavorable price movements)
 - Management: Allocating no more than 1-2% of your available capital on any individual market position
- (2) **Correlation Risks** (price correlations between assets or asset classes)
 - Management: Adding correlation parameters to the decision-making process of your system (i.e. avoiding simultaneous positions on EURUSD and GBPUSD which are 84% positively correlated pairs)

(3) **Extreme-Volatility Risk**

- Management: Adding time parameters (i.e. not trading 30 minutes before and after, scheduled news releases)

(4) **Extreme Slippage**

- Management: Trading exclusively with ECN/STP brokers (avoiding dealing-desk firms which create markets within markets)

(5) **Systematic Liquidity Risk** (we refer to systematic liquidity risk and not to non-systematic liquidity risk)

- Management: Using tight leverage and applying your automated strategies on dedicated accounts (never confuse automated trading with manual trading)

(6) **Counter-party defaults**

- Management: Trading only with high-regulated brokers having a long presence in the market and maintaining headquarters in respectful countries

(7) **Software/Hardware Failures**

- Management: A VPS can reduce the occurrence of such failures

There are other risks that it is even more difficult to manage. For example, black swan events. Black swan events refer to news/events that deviate significantly beyond the market expectations.

Latency

Latency refers to time delays between a request and a response. There are internal and external sources of latency (Eugene A. Durenard 2013)⁶:

⁶ Professional Automated Trading Theory and Practice (Eugene A. Durenard)

➤ External:

Once the message has been sent by the adaptor, it leaves the trading infrastructure and potentially goes over a wire to a pipe (T1 line), gets processed by the ECN, comes back from the ECN on the T1, and then on the wire.

➤ Internal:

Once the message is received by the adaptor, it is translated by the translation layer, then processed by the aggregator/disaggregator layer, by the OMS, and then by the control layer. A decision is potentially made that goes back to the OMS, aggregator/disaggregator layer, and back to the translation layer, then finally the adaptor.



In simple words, latency can occur in many different parts of a data stream process:

- ❖ Trader's hardware configuration
- ❖ Software configuration
- ❖ Internet Provider's connectivity module
- ❖ Broker's servers
- ❖ Liquidity Provider's servers
- ❖ General market-based servers

The Cost of Trading

Trading cost matters, especially if you plan to implement an intraday trading strategy, which involves opening/closing several positions on a daily basis.

These are the most important sources of trading cost:

(1) Trading Spread and Trading Commissions

The trading spread and commissions are very important for intraday strategies, which involve the execution of a great number of daily trades. In general, ECN brokers offer tighter spreads and lower commissions than Dealing-Desk Firms.

(2) Slippage

Slippage refers to the deviation in pips between the actual execution price and the expected execution price. Again, ECN brokers offer lower slippage on order execution than Dealing-Desk Firms.

(3) Overnight Cost

Refers to the cost when carrying positions overnight (SWAP charges). This type of cost involves only swing or position strategies and it is irrelevant for intraday strategies.

(4) Deposit Fees

Depending on the fund method, some brokers may charge some small fees on deposits or withdrawals. Usually they charge about \$20 on withdrawals.

(5) Inactive Fees

Some brokers may charge fees on trading accounts that remain inactive more than 6 months.

Money Management

Money management refers to the process of managing the available capital of a trading account. The key components of money management include position sizing and trading orders (stop-loss, take-profit, trailing stop, OCO, etc.). Nevertheless, money management is a broader concept that also incorporates tens of other important parameters.



Position Sizing

Position sizing means the size of a position within a portfolio. Position sizing may refer to a percentage or a dollar value. The money management component of an automated system applies position sizing in order to determine how many units of an asset it will buy/sell.

There are many methods for calculating position sizing.

Trading -The 1% and 2% Rules

If you trade one single large account, you need some basic rules. Many professional traders follow the 2% rule and that means no trading position should be worth more than 2% of a portfolio. Other larger asset managers

follow the 1% rule and that means no trading position should be worth more than 1% of a portfolio.

The Kelly Formula

The Kelly formula can help traders to calculate how much to risk on a single trade position. The formula was introduced by John L. Kelly, and became popular later by the Ed Thorp:

$$\text{Optimum Size (\%)} = W - (1 - W) / R$$

Where:

- Optimum Size (%) = percentage of capital to be put into a single trade.
- W = The historical winning percentage of a trading system
- R = The Historical Average Profit/Loss ratio

There is also an expanded version of the formula that appeared in Thorp's interview in the book Hedge Fund Market Wizards⁷:

$$F = PW - (PL / (\$W / \$L))$$

Where:

- F = Fraction of capital to bet
- PW = Probability of winning the bet
- PL = Probability of losing the bet
- \$W = Dollars won if bet is won
- \$L = Dollars lost if bet is lost

⁷ "Generalizing the Kelly Criterion" -Boyles Asset Management, LLC (2014)

Adding Extra Parameters

Money management should not be limited to position sizes and stops. There are many other parameters, filters, and actions capable of reducing the risk exposure of an automated trading strategy:

- Measuring the maximum drawdown (%)
- Inserting time parameters (i.e. trading from Tuesday to Friday)
- Stop trading when there are consecutive losers in a row
- Stop trading before and after scheduled news-releases
- Setting a max amount of accepted loss for a particular period (day/week)
- Identifying a significant break in the equity moving average
- Many more parameters



Growing Small Accounts

One of the smartest tactics of money management is to trade many small accounts for every automated strategy you want to implement, instead of using a single large account. This will provide you with an enormous advantage.

- “Don’t put all your eggs in the same basket” or else “Don’t put all your capital in the same trading account”

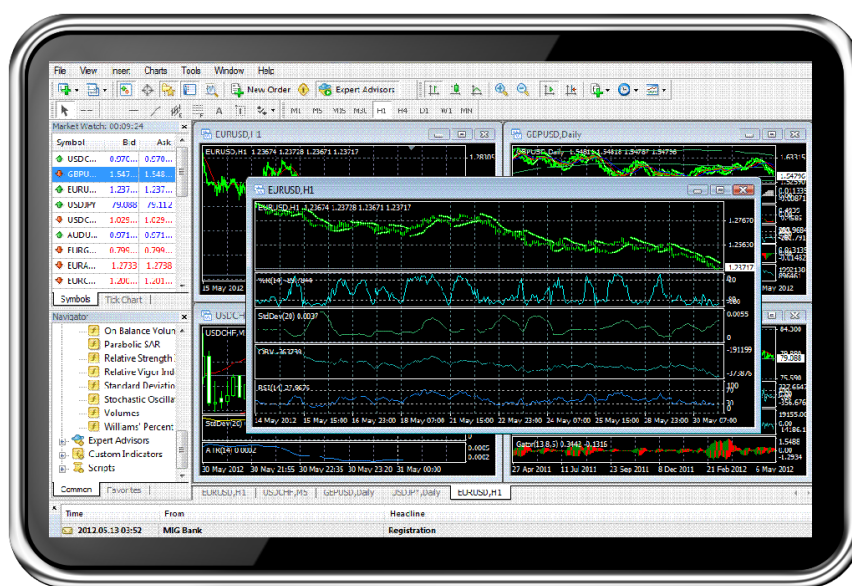
The Right Approach

Enjoy growing a small account, and if this account makes good money then withdraw $\frac{2}{3}$ of your profits into your bank account and leave your initial capital plus $\frac{1}{3}$ of the profits.

Another advantage of growing small accounts is that you can eliminate fear. Fear that your positions may generate huge losses, fear that your initial stops can remain unfilled, fear that your broker may face bankruptcy, etc.

CHAPTER-5: AUTOMATED STRATEGY BUILDING ON METATRADER

MetaTrader 4 (MT4) is the Forex industry's standard electronic trading platform. The platform is free, and depending on your Forex broker, offers a wide variety of financial classes including currencies, bonds, equities, commodities, and cryptocurrencies.



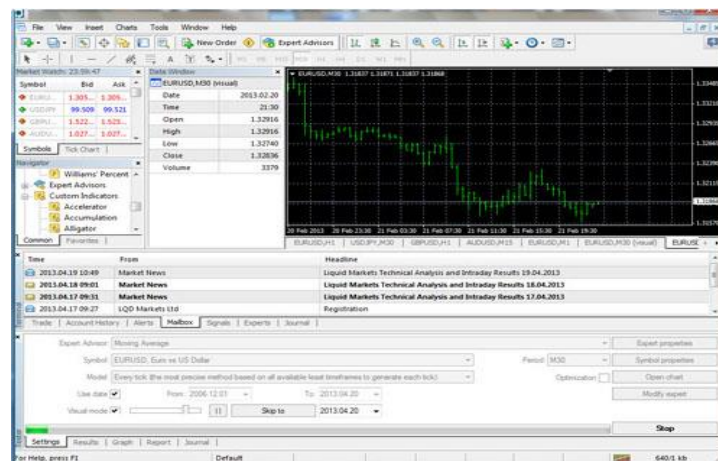
Basic MetaTrader-4 Features

- Compatibility with Ms Windows, Apple MacOS, and Linux
- Supporting automated trading and Expert Advisors
- All types of trading orders
- 30 indicators and 24 graphical objects built-in
- Built-in coding language MQL4
- Including editor and compiler for building EAs
- 9 time-frames, from one minute to one month

- Back-testing module for evaluating the performance of any Expert Advisor
- History of trading operations

The Metaquotes Language-4

MT4 offers also a great variety of applications using its own coding language Metaquotes Language-4. MQL4 is a high-level object-oriented programming language based on C++ and can create indicators and Expert Advisors (EAs). A great advantage of MetaTrader4 is that it allows editing, compiling, and running any indicator or Expert Advisor inside the platform itself. The language allows developing complex EAs with large amount of calculations and accurately manage almost all parameters.



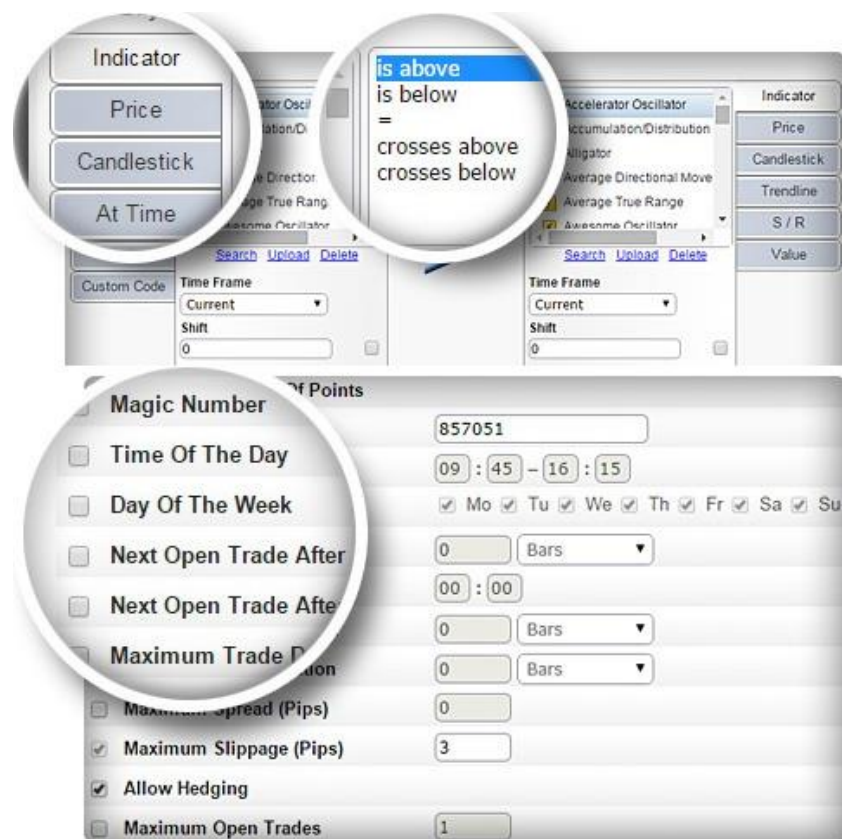
The MQL4 language for automated trading:

- ❖ Custom Function Libraries
- ❖ Structure and syntax of the language is similar to C++
- ❖ Requiring low hardware resources
- ❖ Full functions for managing and controlling trading orders
- ❖ Built-in MT4 editor and compiler allowing easy modification and testing of any MQL4 code

CREATING AUTOMATED TRADING SYSTEMS WITHOUT ANY PROGRAMMING SKILLS (EA BUILDER)

For those who are lacking programming skills, there is an advanced online application (EA Builder) that can provide a user-friendly interface for transforming ideas into fully automated trading strategies.

» [the EA Builder App](#)



EA Builder Basic Features (for MT4, MT5, or TradeStation)

- Completely free for creating indicators
- 100% Web-based App
- Requires \$97 (one-off) only if you need to create EAs
- Full set of built-in functions (including even trendlines and time parameters)
- Full Money-Management system modules

- The outcome is a single compiled MQL4/MQL5 file, ready to trade
- 15 video tutorials
- Can be used on any PC, MAC, or Linux-based computer

The EA Builder is an application that can transform trading ideas into indicators or Expert Advisors (EAs). The system is 100% web-based and it is compatible with MT4, MT5, and TradeStation platforms. It is important to mention that in order to use EA-Builder you do not need to have any programming skills. Even beginners can use the application. EA Builder is a free service for creating indicators but in order to create EAs (Forex Robots), you have to pay 97USD (one-time).

» [the EA Builder's Official Webpage](#)

The Advantages of this Method

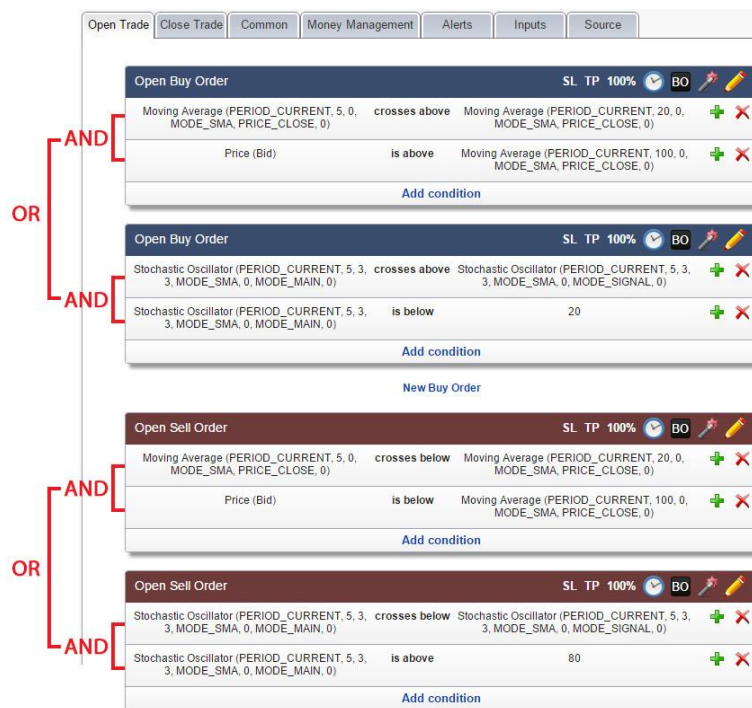
1. Free for creating indicators (which can be later transformed into EAs)
2. No need for Programming Skills (graphical environment)
3. Can build automated strategies for trading all asset classes in any timeframe
4. Includes tens of functions and a wide variety of technical analysis indicators
5. Action alert methods (e-mail, audio alerts, on-screen)
6. Spread and slippage control (important for scalping strategies)
7. EAs for trading Binary Options
8. Supports MT4, MT5, and Tradestation
9. The final code can be used in unlimited accounts (no limits)

Automated-Trading Functions

- Full functionality (time, support & resistance, trendlines, etc.)

- Use arrows via the EA Builder's graphical interface
- Use unlimited variables for creating EAs
- Insert multiple money management systems
- EA Builder can develop EAs for trading Binary Options
- EA Builder Output is human-readable and it is included in a single file
- Adjust Lot Size / Number of Contracts
- Martingale / Anti-Martingale techniques
- Customize Time Preferences and select even specific Days / Hours to trade

Graph-2: Inserting multiple conditons (order execution)



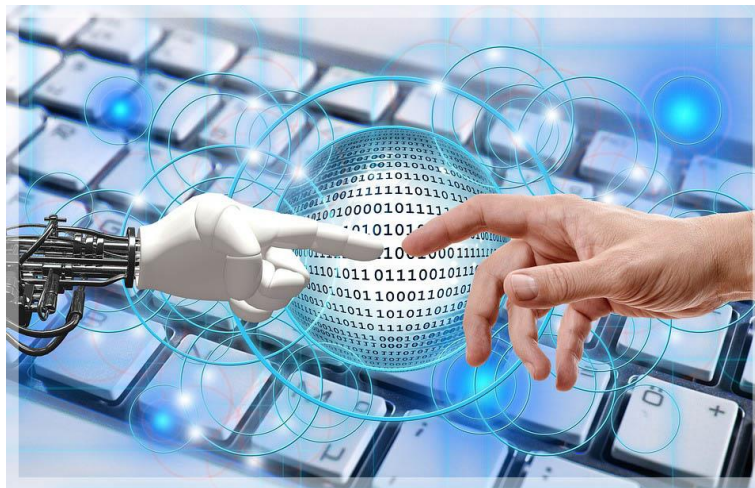
Start Building Indicators for Free

The EA Builder for creating Indicators is completely free and without any time limits. Later you can transform these indicators into fully automated trading strategies. The full version that enables creating Expert Advisors costs 97 USD (one-time).

» [EA Builder Free for Creating MT4/MT5 Indicators](#)

CHAPTER-6: TRADING WITH EXPERT ADVISORS (EAs)

An Expert Advisor or else an E.A. or else a Forex Robot is a set of programmed analysis and techniques including indicators, special filters and rules. Whenever all these tools agree upon forecasting the direction of a trend, a trading order is automatically executed. The trades may be either bullish or bearish aiming to trade any market conditions.



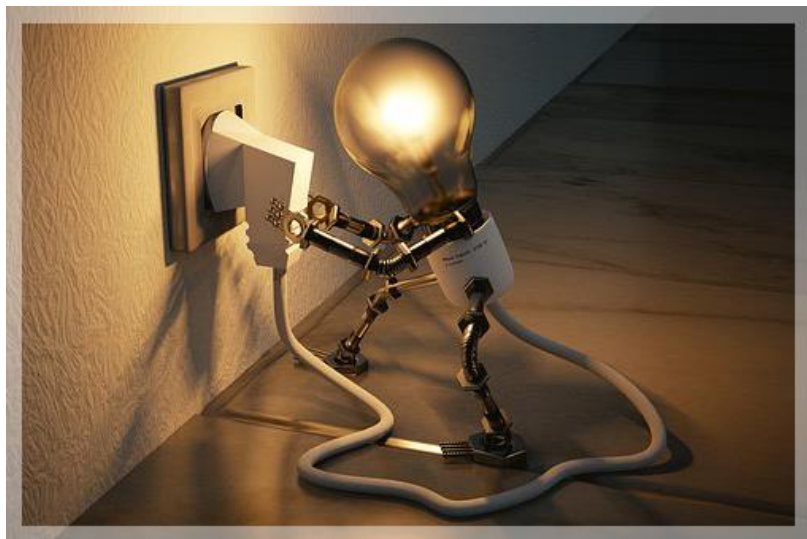
In general, we can distinguish automated trading into semi-automated trading and fully automated trading systems:

- A semi-automatic system is able to execute automated orders while it is continuously re-adjusted by a human programmer/analyst. This is happening in order the system to fit the special conditions of any given market. For example, in a day when the market is ranging with low volatility and limited liquidity, the controller reduces the risk ratio and the system becomes more risk-averse selecting only high-probable trades.

- From the other hand, fully automated systems exclude any human intervention. This category includes Expert Advisors or else Forex Robots.

Using Expert Advisors

EAs are able to manage any trading operation by sending and executing trades directly to your broker's server. All trades include two additional orders (a stop-loss and a target-profit price). These additional orders can be automatically re-adjusted anytime.



How to Program an Expert Advisor from Scratch?

Expert Advisors are coded in specific languages, according to the trading platform that they will be used. For example, if the platform is the popular MT4 then the language is MQL4 (Metaquotes) and if the platform is MetaTrader5 then the language is MQL5. If you do not have programming skills, you can use the EA Builder app presented below (table).

Scalping, Technology, and Brokers

Forex EAs usually apply scalping techniques based on technical analysis. Scalping is a trading strategy targeting profits of 4-10 pips. If you trade from your own PC, keep in mind that the speed of execution is very crucial when you use a scalping system. A fast VPS service can generate much better results.

Furthermore, prefer to open trading accounts with ECN/STP brokers (NDD) offering good conditions for scalping (tight spreads, and low slippage on order execution). Avoid dealing-desk (DD) firms. Note that many dealing-desks even forbid scalping.

Recommendations when Using Commercial EAs:

Here are some key points and general recommendations:

1. Check always who is behind the project

Check the programmer or the team behind the development of any Expert Advisor.

2. Focus on Winning Pips and not on Winning Ratio

Some Expert Advisors are designed to trade using wide stop-loss and narrow target-profit orders. That means that they win most of the time but when they lose, they lose hard. Avoid these systems; the desired Risk/Reward ratio must be above 1:1.

3. Don't to take anything for granted

Double-check any information regarding the past performance of any Expert Advisor. Never trust EAs that will not provide reliable data regarding their past performance.

4. EAs perform better on ECN/STP accounts

As explained before, ECN/STP accounts provide the best environment for automated trading.

5. Start with a Demo Account

You can test any EA on a demo account and then a micro-lot account before using it with a standard-lot account. That may save you a lot of money.

6. Don't Confuse Manual and Automated Trading

Use a dedicated account to trade with an Expert Advisor. Do not trade manually on the same account, because altering the available balance may confuse the money management algorithms of your EA. Moreover, do not use more than one EA in the same account.

The Importance of the Right Settings

Given that you have chosen the right system, another important issue is to enter the right settings into the system. An automated system must adapt to current market conditions (APPENDIX-2). That is especially important in the case of a fully automated system such as a Forex Robot. Read the manual very carefully and then make the necessary adjustments.

Comparing Commercial MetaTrader-4 Expert Advisors

Table-2: Popular Expert Advisors for MT4 and MT5

FOREX ROBOT	STYLE	COST	INFO
□ WALLSTREET ROBOT	■ Scalping: EUR/USD, GBP/USD, USD/JPY, USD/CHF, AUD/USD	■ 299 USD for one time ■ 3 Licenses ■ Free the Omega Indicator	» Visit Web Site ► Review System

FOREX ROBOT	STYLE	COST	INFO
<ul style="list-style-type: none"> □ EA BUILDER 	<ul style="list-style-type: none"> ■ Expert Advisor Builder (CREATING CUSTOM EAs) 	<ul style="list-style-type: none"> ■ 97 USD for one time ■ Unlimited Licenses 	<ul style="list-style-type: none"> » Visit Web Site ► Review System
<ul style="list-style-type: none"> □ GPS FOREX v.3 	<ul style="list-style-type: none"> ■ Scalping several pairs during the Asian Session 	<ul style="list-style-type: none"> ■ 149 USD for one time ■ 1 License 	<ul style="list-style-type: none"> » Visit Web Site ► Review System
<ul style="list-style-type: none"> □ FX MEGADROID 	<ul style="list-style-type: none"> ■ Scalping only EURUSD 	<ul style="list-style-type: none"> ■ 67 USD for one time 	<ul style="list-style-type: none"> » Visit Web Site ► Review System

- Expert Advisors reviews and resources: ForexRobots.net

CHAPTER-7: BACKTESTING & OPTIMIZING AUTOMATED TRADING STRATEGIES

Backtesting is a computerized process that tests how a trading strategy has performed during a past period. This process involves reconstructing trades that would have occurred during a past period using historical data.



Backtesting Your Automated Strategy

The Backtesting Process

Backtesting is a key process during the development of any efficient trading-strategy. There are several benefits occurring during the process of backtesting trading strategies:

- ✓ **Fast evaluation of multiple strategies**

Backtesting allows testing a great variety of trading strategies against normal and abnormal market conditions including factors such as variable spreads, slippage, latency, etc.

- ✓ **Choosing among different strategies**

Backtesting may help traders to select the most efficient strategy for trading a particular asset class

✓ Allows Strategy optimization

Optimization helps to increase the performance of the selected strategy by modifying secondary parameters or simply some values associated with that strategy's implementation process

✓ Final verification

The final backtesting of a strategy ensures the quality and efficiency of all our re-calculations and adjustments during the optimization process.

Key Performance Statistics

These are the key performance statistics when backtesting automated trading strategies:

- Net profit or loss (in pips) / Average gain or average loss (in pips)
- Win-to-loss Ratio
- Losing and Winning streak
- Max Drawdown % (the percentage of the maximum peak-to-trough decline during a specific period)
- Maximum Exposure % (maximum percentage of capital allocation in the market)
- Annualized return % (return over a year)
- Sharpe Ratio (comparing the trading strategy's returns with the standard deviation of those returns)

Monte Carlo Analysis⁸

Monte Carlo methods can analyze investment portfolios and algorithmic trading strategies. This is happening by simulating the various sources of

⁸ https://en.wikipedia.org/wiki/Monte_Carlo_methods_in_finance

uncertainty affecting their value, and then determining the distribution of their value over the range of resultant outcomes. This is usually done with the help of stochastic asset models. The advantage of Monte Carlo methods over other techniques increases as the dimensions (sources of uncertainty) of the problem increase.

The Monte Carlo Walk-Forward Analysis

Monte Carlo Walk-Forward is a combination of walk-forward analysis and Monte Carlo analysis.

Graph-3: Rolling Walk Forward Analysis



Image: Tradestation.com

Platforms for Backtesting Trading Strategies

Different algorithmic strategies may require the use of different software packages; these are some popular software solutions:

- [MATLAB](#)
- [Python](#)
- [C++](#)

- [R](#)
- [MetaTrader Backtesting](#)
- [Strategy Quant](#)

General Rules for Successful Backtesting

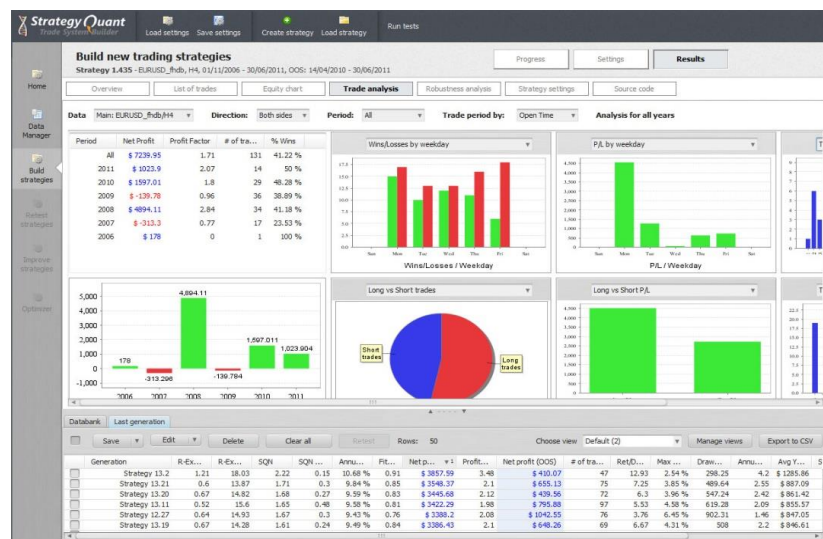
These are some basic rules for successful backtesting:

- ✓ Perform various backtesting experiments (test your strategy during all different types of market –bullish, bearish, and ranging)
- ✓ Backtest your strategy over a long time frame that includes normal and abnormal market conditions
- ✓ Volatility statistics are very important for leveraged accounts (for example if your strategy performed a 60% winning ratio but it had 20 losing streaks in a row, most probably your account will be out of money in real market conditions)
- ✓ Use backtesting as a component of a general trading experiment (a trading experiment that also includes optimization and customization)
- ✓ Avoid over-optimization. (Over-optimization means that after many calculations and re-calculations, the results of backtesting are optimized for past market conditions)
- ✓ Customization is very important (traders must tune all backtesting parameters with accuracy and mimic real market conditions)
- ✓ Successful backtesting cannot guarantee future results. The market conditions are fully dynamic and strategies that performed well in the past may fail tomorrow.

Backtesting is an essential process for building successful automated trading strategies. The key point to remember is that backtesting is not an autonomous project. Backtesting should be a dynamic component of a general trading experiment, which also includes customization and optimization.

ADVANCED STRATEGY BUILDING & OPTIMIZATION USING THE STRATEGYQUANT

Strategy Quant is an advanced strategy building application that is able to backtest and optimize automated strategies using a very sophisticated framework.



There is no need for programming skills and any strategy can be saved in MetaTrader, TradeStation, or NinjaTrader formats.

The Strategy Quant Website: ► [the Strategy Quant Web](#)

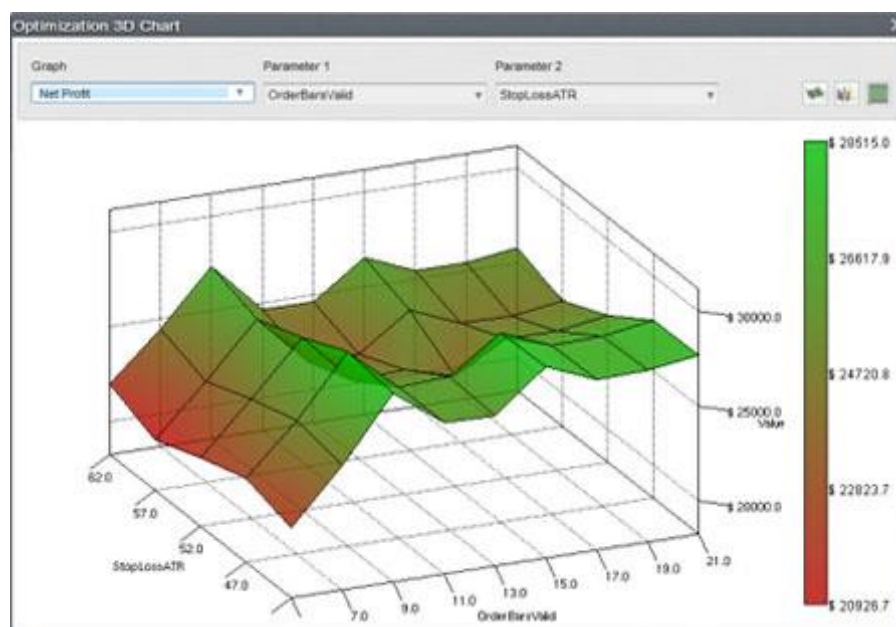
Basic Features

- ❖ Fast automated-strategy building
- ❖ Find hundreds of different existing strategies
- ❖ No need for programming skills
- ❖ 4 modes (building, re-testing, improvement, optimization)
- ❖ Automated backtesting based on a wide variety of parameters
- ❖ Includes more than 40 indicators, patterns, candlesticks, etc.

- ❖ Using randomness to test a strategy in any market conditions
- ❖ Ideal re-optimizations process (includes two separate modules for the job)
- ❖ Robustness testing (evaluate the best strategies on any timeframe)
- ❖ Supports MetaTrader, TradeStation, and NinjaTrader platforms

Additional Features

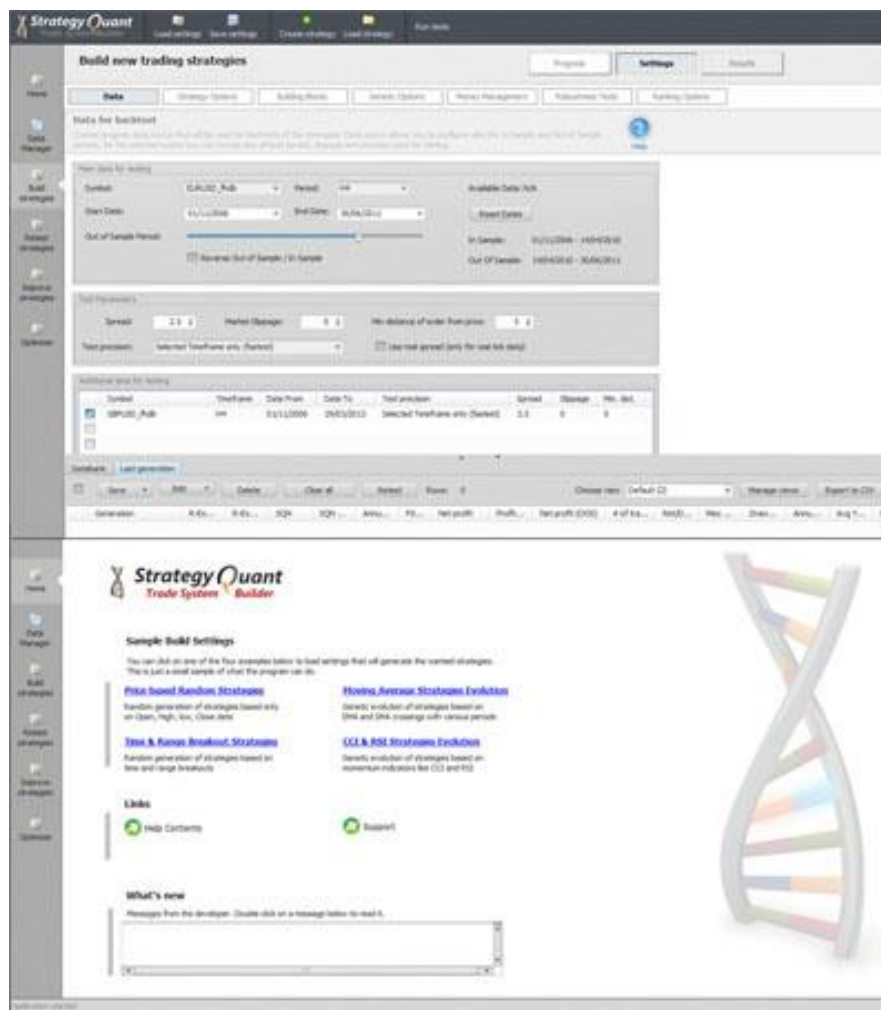
- ❖ Use of Monte Carlo testing to test quality of the strategies (Monte Carlo testing allows you to find out if a trading strategy has potential for a stable profit when trading real money)
- ❖ Build a strategy and re-test it for a different market or timeframe (add other conditions and optimize it)
- ❖ Wide options for filtering strategies (determine what you expect from the strategy. How much it should earn, what the maximum risk is, profit factor and other indicators)



- ❖ Built-in walk-forward optimizer and cluster analysis tools (This tool allows you to find out what results the strategy has when optimized)

regularly and finds the ideal time period for which to optimize the parameters)

- ❖ 4 entry orders, 7 output orders and intelligent stop loss
- ❖ Enter at Market, Stop, Limit, Reverse, Adaptive SL and PT, Trailing stops



Free Trial

Use the following link to get a 14-day free fully functional trial for Strategy Quant:

► <http://strategyquant.sjv.io/c/1281640/495137/8548>

CHAPTER-8: CONCLUSIONS

These are some general conclusions regarding automated trading:

- Automated trading is a sophisticated branch of systematic trading. All automated trading systems are systematic but NOT all systematic systems are automated systems
- When we refer to an automated trading strategy, we refer to the way that trading orders are executed. An automated trading strategy must be able to execute trades without human intervention by also placing limit orders (a take-profit and a stop-loss)
- Nowadays, due to the technological advancement of the financial industry, any retail trader can afford the cost of buying or creating an automated trading strategy
- The great advantage of automated trading is that it is able to exclude human psychology out of the trading game. Furthermore, an automated trading system never gets tired. Using a VPS hosting service you can turn-off your PC and continue trading 24hours per day
- Automated trading requires a good (but not very expensive) combination of computer software and hardware
- Retail traders mainly use strategies running on platforms such as MetaTrader-4 and MetaTrader-5. On the other hand, institutional traders use data-driven modelling techniques or trading systems based on granular data, often referred to as Big Data
- There are two key approaches for building automated-trading strategies: Model-based and Data-driven approaches
- An algorithmic trading strategy incorporates two basic components: the forecasting and the trading modules
- Machine learning refers to the process of using statistical tools and techniques in order to offer computer systems the ability to 'Learn'

- Risk management is a very important issue for the long-term success of every automated-trading system
- Many professional traders follow the 2% rule and that means no trading position should be worth more than 2% of a portfolio
- Enjoy growing a small account, and if this account makes good money then withdraw 2/3 of your profits into your bank account and leave your initial capital plus 1/3 of the profits



When Buying Commercial Expert Advisors (EAs) or other Automated Trading Systems

- Make sure your Forex/CFD broker fully accepts automated trading and scalping (avoid stealth mode techniques)
- ECN/STP accounts provide the best conditions for automated trading (avoid Dealing-Desks)
- Make sure that the automated system you plan to use is compatible with your trading style, and especially with your risk profile
- Focus on Winning Pips and not on Winning Ratio
- The desired Risk/Reward ratio of your Expert Advisor must be above 1:1
- Focus on the maximum drawdown in order to assess the downside risk

- If you plan to buy a commercial EA, find out who is behind the system (developer, team of developers).
- Review the historic performance of the system in detail (1-2 years minimum)
- Don't trust EAs that will not provide reliable data regarding their past performance
- Make sure the trading history of the system is linked with what is being traded today by the system
- If you have the chance, evaluate the performance of any system in real time before you buy it
- If you can manage it, insert all past available trades in a Monte Carlo Simulation (this method is helpful in randomizing any future trading results)



- Test your EA on a demo account and then a micro-lot account before using it with a standard-lot account
- Trade small account sizes (micro-lot) before trading standard-lot accounts
- Expert Advisors require dedicated accounts (do not confuse multiple EAs or manual trading with automated trading)
- Use a VPS hosting service to minimize failures

When Backtesting

- Use backtesting as a component of a general trading experiment which also includes optimization and customization
- Perform various backtesting experiments in order to test your strategy in all market conditions (bullish, bearish, and ranging)
- Backtest your automated strategy over a long time frame
- Over-optimization means after many calculations and re-calculations, the backtesting results are optimized for past market conditions
- To avoid over-optimization, use randomness in your backtesting experiments
- Successful backtesting can never guarantee future results, therefore, don't risk too much on any automated trading strategy, no matter how promising it seems

APPENDIX

(1) SELECTING BROKERS FOR AUTOMATED TRADING

The Importance of Choosing the Right Forex Broker

If you decide to implement an intraday automated trading strategy (i.e. scalping) you should choose a very competitive Forex broker. Some Forex brokers even forbid scalping, so be extra careful with that.



These are some basic factors determining the ideal Forex Broker for intraday trading:

1. Tight Spreads

Tight spreads are very important to trade Forex in the short-term. When your target profit is just 3-5 pips the difference between 0.5 and 2.0 spread is huge.



2. Fast Execution




High execution delay can catastrophically disturb short-term trading. That is why you should be after only No-Dealing Desk Brokers. A NDD broker is either an ECN or a STP broker.

3. Latency of Servers

When the servers of a Forex broker are located in the same data center as its liquidity provider, execution delays are minimized, and traders get the best fills. Professional algorithmic traders give extra weight in their broker's server location.

Table-3: Forex Brokers (Allowing Auto-Trading & Scalping)

ECN/STP BROKER	FEATURES	FUNDING	ACCOUNTS
 <p>» IC MARKETS ACCOUNTS</p> <p>REGULATION: <input type="checkbox"/> ASIC Australia (No. 335692)</p> <p>CORPORATE INFO:</p> <ul style="list-style-type: none"> IC Markets foundation in 2009 (domiciled in Australia) Segregation via two Tier-1 Australian Banks 	<ul style="list-style-type: none"> ■ MT4/MT5 & cTrader ■ A wide Forex asset index, and Crypto assets ■ Spread as low as 0.1 pip plus \$7.0 round commissions ■ PAMM Accounts ■ FIX/API Trading ■ Free VPS ■ Low deposit requirements for true ECN trading <p>COMPENSATION: -NO</p>	<p><input type="checkbox"/> \$200 minimum account</p> <p>FUND METHODS:</p> <ul style="list-style-type: none"> • Credit Cards • Bank Wire • Skrill • WebMoney • Paypal • Neteller • Qiwi • FasaPay • Bitcoin 	<p>Very tight spreads and trade commissions. Fund your account via Skrill, Paypal, and Bitcoin. Free VPS for auto-traders</p> <p>► Visit IC Markets</p> <p>Review Broker: ► Review IC Markets</p>
 <p>» XM ACCOUNTS</p> <p>REGULATION: <input type="checkbox"/> CySEC, ASIC, FCA UK</p> <p>CORPORATE INFO:</p> <ul style="list-style-type: none"> XM foundation 	<ul style="list-style-type: none"> ■ MT4/MT5 ■ Wide Asset Index ■ CFDs on Futures ■ Multilingual support ■ Low deposit requirements for true ECN 	<p><input type="checkbox"/> \$5 minimum account</p> <p>Bonuses: only for non-Europeans</p> <p>FUND METHODS:</p> <ul style="list-style-type: none"> • Credit Cards • Bank Wire 	<p>A wide asset index and a great variety of platforms and other trade options.</p> <p>► Visit XM</p> <p>Review Broker: ► Review XM</p>

<p>in 2009 (domiciled in Cyprus)</p> <ul style="list-style-type: none"> Segregation via Top-tier Banks 	<p>COMPENSATION:</p> <p>-Yes, via ICF Cyprus</p>	<ul style="list-style-type: none"> Skrill Neteller 	
 <p>» FXCC ACCOUNTS</p> <p>REGULATION:</p> <p>□ FCA UK (549790) CySEC (121/10)</p> <p>CORPORATE INFO:</p> <ul style="list-style-type: none"> FXCC foundation in 2010 (domiciled in Cyprus) Audited by Deloitte 	<ul style="list-style-type: none"> MT4 Wide Forex Asset Index FIX/API Trading NY4 Equinix server for automated trading <p>COMPENSATION:</p> <p>-Yes, via ICF Cyprus</p>	<p>□ \$100 minimum account</p> <p>FUND METHODS:</p> <ul style="list-style-type: none"> Credit Cards Bank Wire Skrill WebMoney Neteller 	<p>Specialized in Forex Trading (30+ pairs):</p> <p>► Visit FXCC</p> <p>Review Broker:</p> <p>► Review FXCC</p>
 <p>» FXTM ACCOUNTS</p> <p>REGULATION:</p> <p>□ CySEC (No 185/12) FCA UK (License 777911)</p> <p>CORPORATE INFO:</p> <ul style="list-style-type: none"> FXTM foundation in 2011 (domiciled in Cyprus) 	<ul style="list-style-type: none"> MT4/MT5 Wide Asset Index 50 Forex pairs plus many CFD assets FXTM Loyalty Program <p>COMPENSATION:</p> <p>-Yes, via ICF Cyprus</p>	<p>□ \$10 minimum account</p> <p>FUND METHODS:</p> <ul style="list-style-type: none"> Credit Cards Bank Wire Skrill Western Union Neteller Bitcoin (via Skrill) DotPay Yandex 	<p>A wide range of trading accounts, including ECN and ECN Pro Trading account</p> <p>► Visit FXTM</p> <p>Review Broker:</p> <p>► Review FXTM</p>
 <p>» JUSTFOREX ACCOUNTS</p>	<ul style="list-style-type: none"> MT4/MT5 90+ Forex pairs 39 Cryptocurrency pairs 	<p>□ \$5 minimum account</p> <p>FUND METHODS:</p> <ul style="list-style-type: none"> Credit Cards 	<p>Offering 90 Forex Pairs plus tens of Crypto pairs and a 100% welcome bonus.</p>

<p>REGULATION:</p> <p>□ IFSC (60/241/TS/17)</p> <p>CORPORATE INFO:</p> <ul style="list-style-type: none"> • JustForex foundation in 2012 (domiciled in Belize) 	<ul style="list-style-type: none"> ■ Trading Contests ■ 100% welcome bonus <p>COMPENSATION:</p> <p>-NO</p>	<ul style="list-style-type: none"> • Bank Wire • Neteller • WebMoney • PerfectMoney • FasaPay • QIWI • Bitcoin and Bitcoin Cash 	<p>► Visit JustForex</p> <p>Review Broker:</p> <p>► Review JustForex</p>
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(2) **ADAPTING TO NEW MARKET CONDITIONS** -ADAPTIVE AUTONOMOUS AGENTS (AAA)

According to Eugene A. Durenard (2013), an AAA is a physical or software decision-making process that is composed of the following three elements:

1. **Sensors:**

Any device that receives information from the external world.

Trading strategy: various indicators as well as performance measures of a range of simulated strategies.

2. **Actuators:**

Any device by which the agent outputs information and acts on the external world.

Trading strategy: order management system that ensures current desired market position and emits current desired passive or aggressive orders

3. **Adaptive Control System:**

A goal-oriented decision-making system that reads sensors and activates actuators.

Trading strategy: feedback and subsumption architecture that achieves optimal profit under constraints of capital utilization and minimal drawdown⁹. (Note that subsumption architecture is a robotic architecture associated with behavior-based robotics)

⁹ Professional Automated Trading Theory and Practice” -Eugene A. Durenard (2013)

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BUILDING AUTOMATED TRADING STRATEGIES

«INTRODUCTION TO AUTOMATED STRATEGY BUILDING
& OPTIMIZATION»

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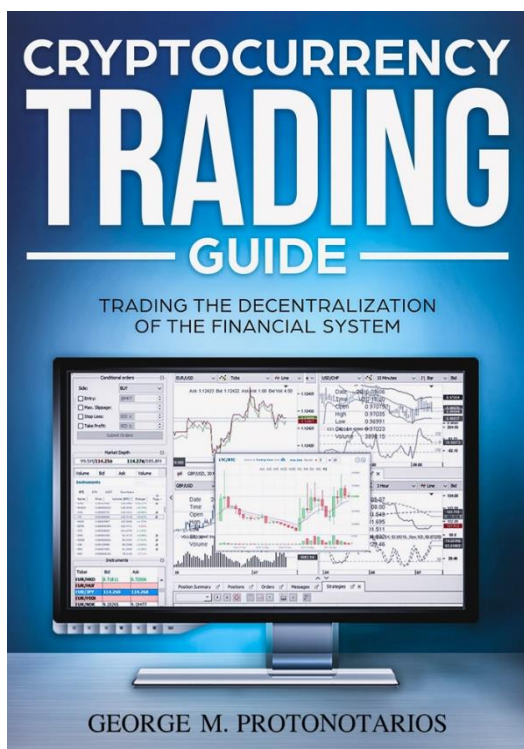
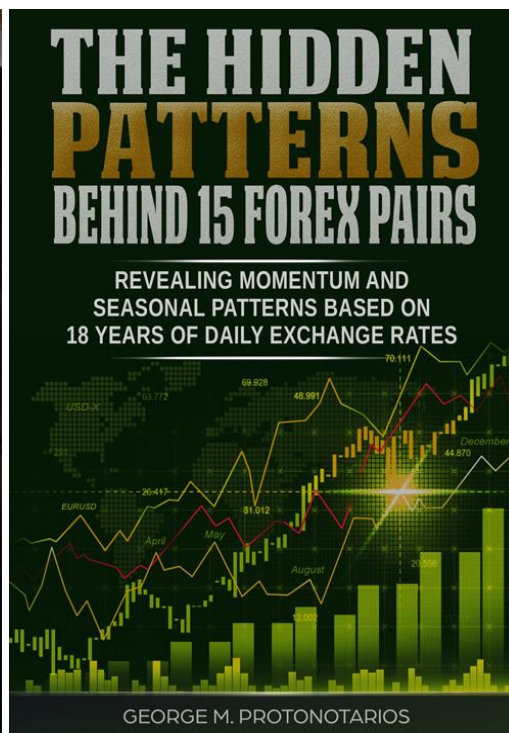
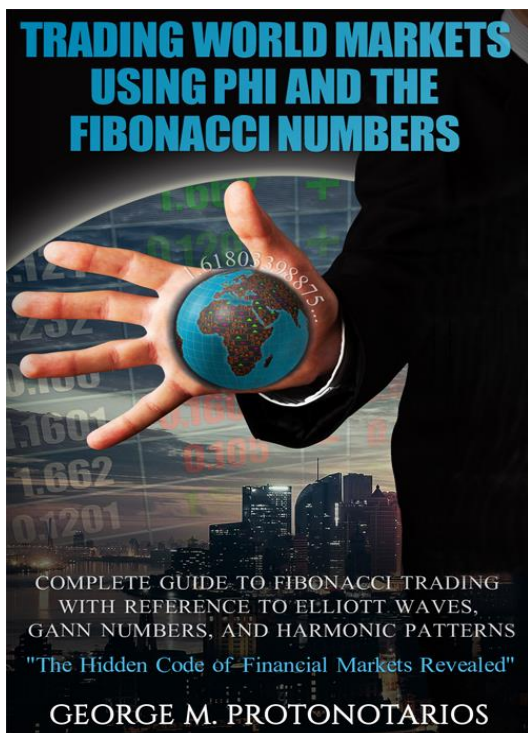
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