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FINANCIAL MARKET DATA ANALYSIS

Open Source Technologies for Real-Time Data Analytics

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2020
Budapest, Hungary

Introduction

- Financial market types
- Technical analysis and indicators
- Market deep(er) dive
  - #1: FOREX
  - #2: Digital currencies

Financial markets

- **DEF:** (Financial) **securities** (instruments/assets) is a generic term to describe stocks, bonds and other instruments representing the right to receive future benefits under a set of stated conditions
- **DEF: Financial markets** are the places where (financial) securities are exchanged at efficient market prices
  - Financial markets exist to bring buyers and sellers together
  - Financial markets are domestic (national) or international
  - **Efficient market price** = unbiased price based on the collective speculation of all investors about (future) value, i.e. a price which reflects supply and demand
  - Securities can be exchanged directly between seller and buyer (**over the counter** – OTC), or via different intermediaries (**exchange traded** – ET)
- Real-time market data source examples: Thomson Reuters, Bloomberg, Binance

Types of actors

Lenders-savers

- Companies
- Financial institutions
- Government
- Households / individuals
- Foreigners

Borrower-spenders

- Companies
- Financial institutions
- Government
- Households / individuals
- Foreigners

Types of markets

Traditional markets

- Money market
- Capital market
- Foreign exchange markets, i.e. FOREX
- Commodity market
- Derivatives market
- Insurance markets

Others

- Labor market
- Digital currencies, e.g. Bitcoin, Ethereum

Money market

- **Function:** center for short term borrowing with maturity of 1 year or less
- **Core activity:** interbank lending
- **Instruments:** certificate of deposit, treasury bill, short-term government securities transactions, commercial papers
- **Amounts:** large
- **Players:** financial institutions, e.g. central-, commercial, and savings banks
- **Motivation:** players with surplus funds borrow to others in need of cash, allows governments to raise funds
- **Impact:** determine short-term interest rates
- **Data:** Money Markets Statistical Reporting (MMSR)

Capital markets

- **Function:** market for long- and short-term funds
  - Primary market = first issue, sold to initial buyers
  - Secondary markets = re-sale of instruments issued earlier
- **Core activity:** financing via bond/share issue & trade
- **Instruments:** bonds, stocks
- **Amounts:** all
- **Players:** individuals and institutions in demand and supply of long-term capital, e.g. stock markets, commercial banks, insurance companies, investment funds, companies
- **Motivation:** raise money via issuing bonds/shares, speculate on future prices, dividends
- **Impact:** set market prices of shares (companies) and bonds (governments, companies), secondary markets provide liquidity
- **Data:** Center for Research in Security Prices (CRSP), Thomson Reuters, Bloomberg, S&P

Foreign exchange markets

- **Function:** a **global** decentralized or over-the-counter (OTC) market for the trading of **currencies** (Wikipedia)
  - Note: no central exchange → buyer & seller negotiate directly
- **Core activity:** 24/7 trading in currency pairs in Tokyo, Hong Kong, London, New York
- **Instruments:** currency pairs, e.g. USD/EUR
- **Amounts:** all
- **Players:** large international banks, central banks, currency traders/speculators, governments (e.g. large international contracts)
- **Motivation:** provide liquidity in and between currency pairs, low margins on numerous trades → use of leverage ("multiplier")
- **Impact:** impacts international trade via setting exchange rates, most liquid financial market of all
- **Data:** Thomson Reuters, Bloomberg, MetaTrader 4 & 5, myFXbook

Commodity market

- **Function:** commodity markets trade in primary resources, i.e. not manufactured products
- **Core activity:** global exchange of primary resources = commodities, e.g. iron/steel, precious stones/metals, minerals, oil
- **Instruments:** physical/derivatives trading, forwards, futures, options, swaps and Exchange-traded commodities (ETC)
- **Amounts:** usually large
- **Players:** producers of primary resources (e.g. large mining corporations)
- **Motivation:** set the efficient market prices for commodities
- **Impact:** sets the prices of raw resources → impacts prices of manufactured goods
- **Data:** International Monetary Fund (IMF) Primary Commodity Prices, Aspect Decision Support Center (DSC)

Derivatives market

- **Function:** market for exchanging derivatives, which are financial instruments derived from other (usually financial) assets/instruments
- **Core activity:** package other financial instruments into derivatives and trade
- **Instruments:** exchange-traded and over-the-counter derivatives, futures contracts, options
- **Amounts:** large
- **Players:** producers (e.g. primary resources), investment funds, insurance companies, individuals (2020 note!)
- **Motivation:** earn by speculating on the future prices or by buying primary resources in advance (e.g. 1-year ahead) and at a discount
- **Impact:** provides liquidity to producers well in advance of their produce becoming available
- **Data:** Optionmetrics, Thomson Reuters, Bloomberg

Insurance markets

- **Function:** measurable risk of loss transferred from one entity to another for a fee, e.g. Casco insurance for a car
- **Core activity:** buy and sell insurance
- **Instruments:** insurance, social insurance (e.g. healthcare)
- **Amounts:** all
- **Players:** insurance companies, private companies, banks (e.g. against credit card fraud), governments (in health)
- **Motivation:** transfer risk to another entity and stay in business even when suffering large losses
- **Impact:** operational (periodic) cost factored into service and product prices, e.g. car insurance in paid as part of a monthly instalment
- **Data:** ?

Digital currency market

- **Function:** avoid expensive intermediaries (i.e. banks) in a truly democratic electronic market
- **Core activity:** anonymous online payments (at least mostly)
- **Instruments:** different cryptocurrencies, e.g. Bitcoin (BTC), Ethereum (ETH), Litecoin (LTC), Peercoin
- **Amounts:** all
- **Players:** all
- **Motivation:** create a democratic, de-centralized, low-cost (?!), short-term digital financial market
- **Impact:** transparent fees, banks lower fees, use in criminal activities (anonymous), more open
- **Data:** Binance, Coin Metrics, Morningstar

Financial intermediaries

Type of intermediary	Sources of funds (Primary liabilities)	Uses of funds (Primary assets)
Depository institutions, i.e. Banks		
Commercial banks	Deposits	Loans, mortgages, government securities, bonds
Credit unions	Deposits	Consumer loans
Contractual savings institutions		
Life insurance companies	Premium from (insurance) policies	Corporate bonds and mortgages
Fire and casualty insurance	Premium from (insurance) policies	Bonds, stock, government securities
Pension funds	Employer and employee transfers	Corporate bonds and stock
Investment intermediaries		
Finance companies	Stock, bonds	Consumer and business loans
Mutual funds	Shares	Stocks, bonds
Money market mutual funds	Shares	Money market instruments

TECHNICAL ANALYSIS

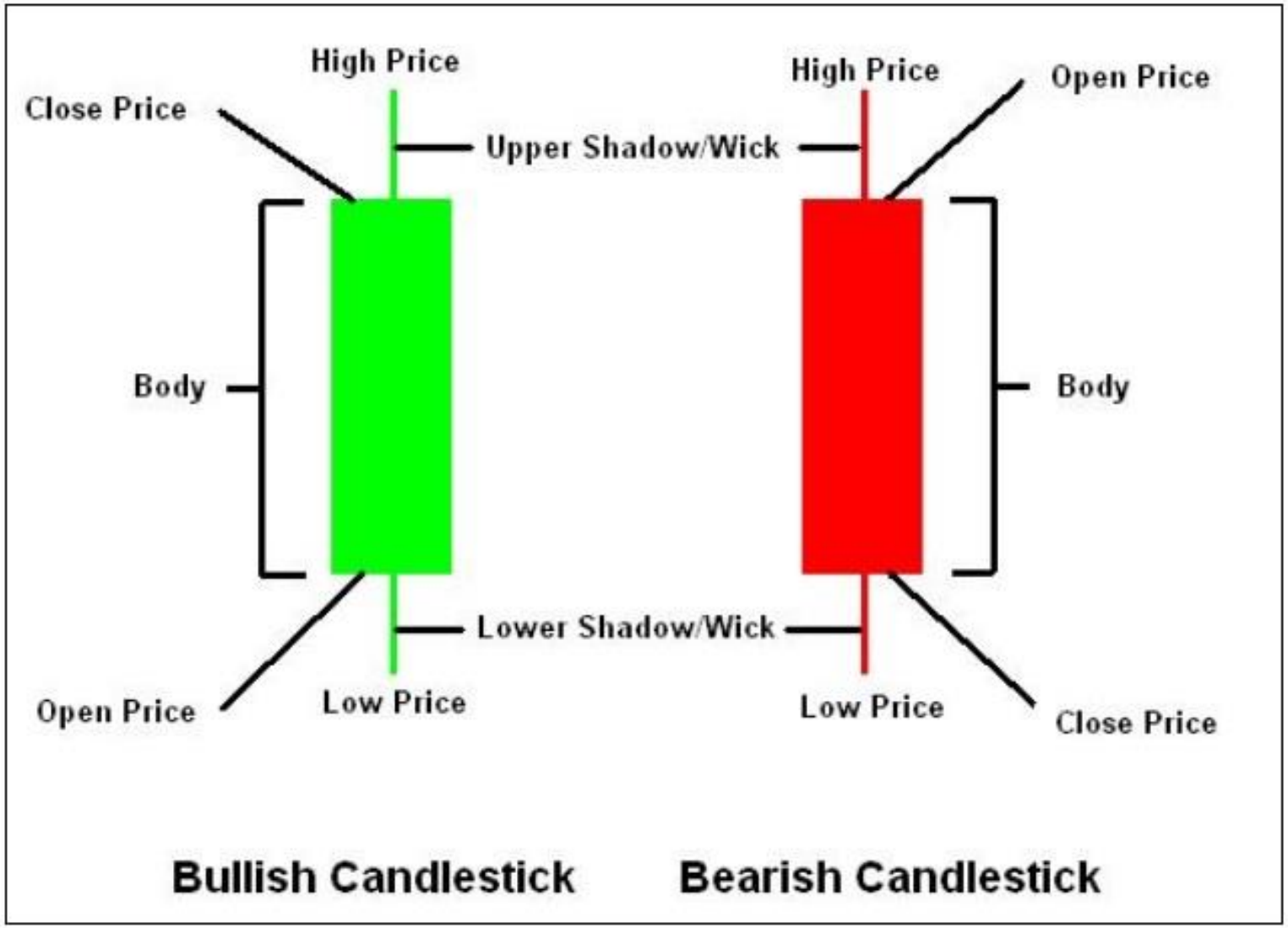
Additional definitions

- **DEF: Technical analysis** is methodology for forecasting the direction of financial instrument prices based on the study of historical market data, e.g. price, (trading) volume.
  - Traces of technical analysis in Amsterdam-based merchant's account of the Dutch financial markets in the ~17th century.
  - Candlestick techniques appeared in the ~18th century Asia.
- **DEF:** An **automated trading system (ATS)** is a software-based solution which creates and automatically submits orders to an exchange (or market center).
- **DEF:** A **trading strategy** is a predefined plan (e.g. set of rules) whose goal is to achieve a profitable return by going long or short in financial markets.

Candlestick charts – 1

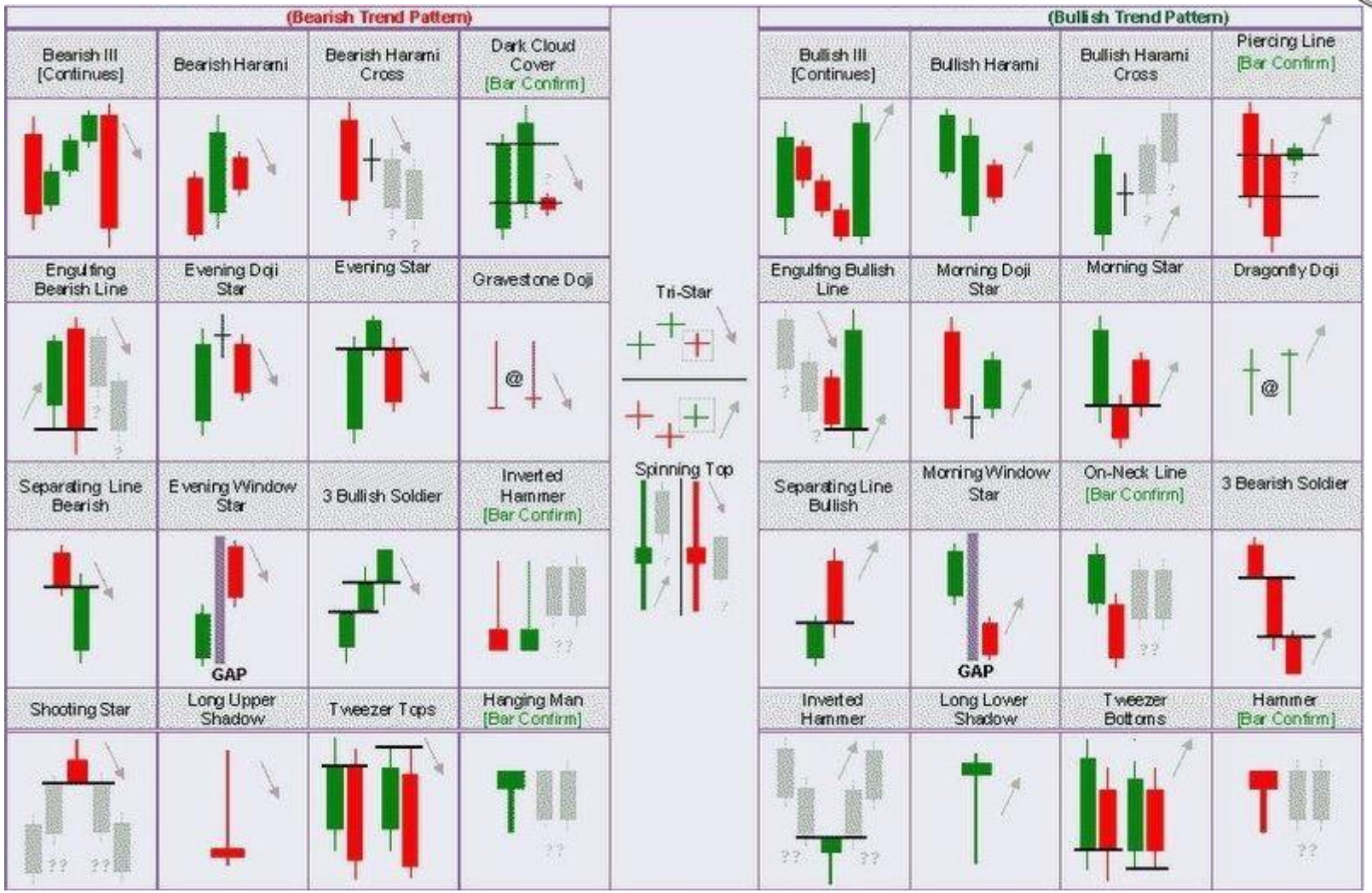
http://www.learntotradethemarket.com/forex-japanese-candlestick-charts

Candlestick charts – 2



http://www.forexposed.com/2017/09/how-to-read-candlestick-chart-in-forex.html

Candlestick patterns



http://forexpops.com/candlestick-patterns/

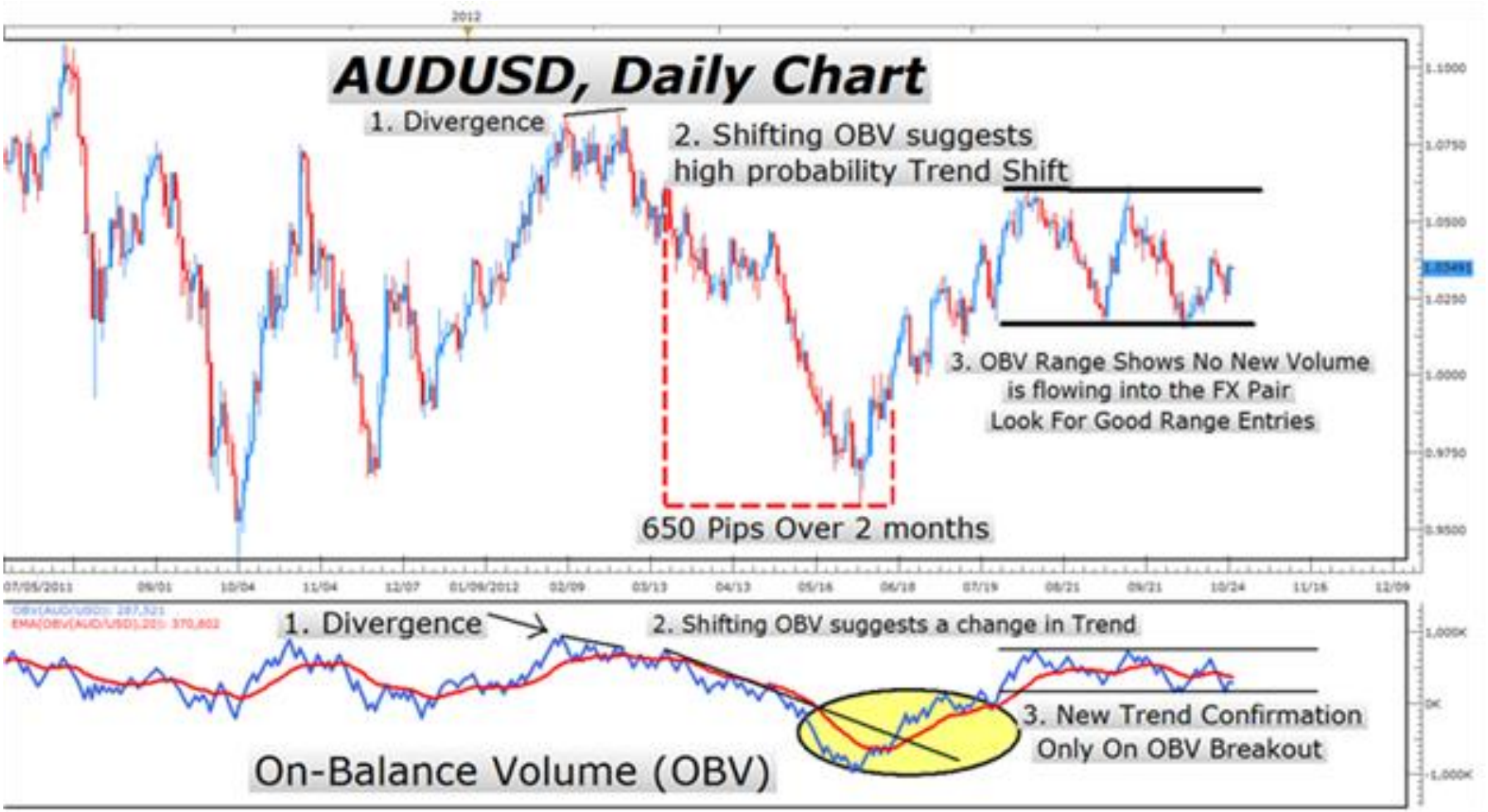
Indicators

- Due to the large number and volume of transactions, derived indicators are used alongside raw data
  - Indicators are a secondary measure to actual price movements
- Indicator types by timeline:
  - **Lagging indicators** follow price movements and act as a confirmation tool.
  - **Leading indicators** precede price movements and try to predict the future.
- Indicator type by intent:
  - Trend
  - Volume
  - Momentum
  - Volatility

Trend: Simple Moving Average (SMA)

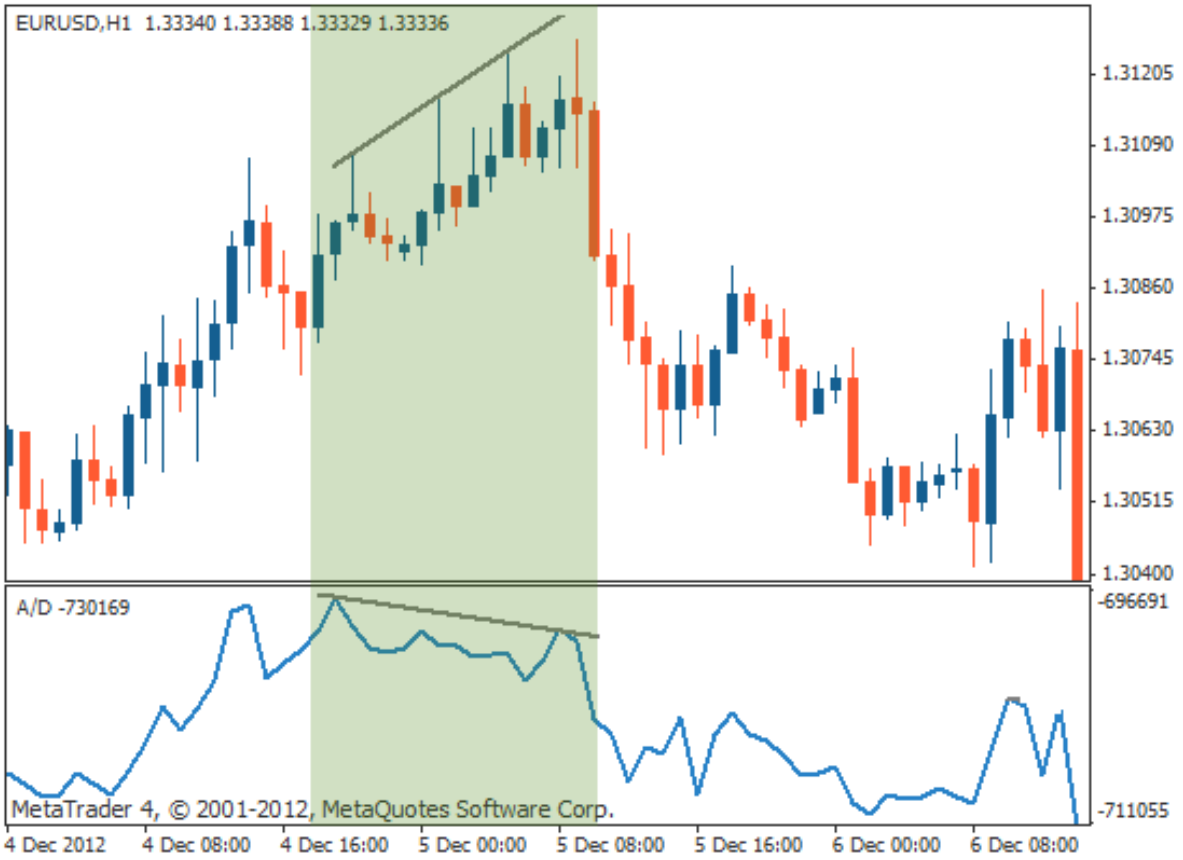
https://www.babypips.com/learn/forex/using-moving-averages

Volume: On Balance Volume (OBV)



https://www.babypips.com/learn/forex/using-moving-averages

Volume: Accumulation/Distribution (Acc/Dist)



$$CLV = \frac{(C - L) - (H - C)}{H - L}$$

$$ACCDIST_i = ACCDIST_{i-1} + CLV \times Volume$$

Momentum: Rate of Change (ROC)

$$ROC = \frac{Closing_i - Closing_{i-N}}{Closing_{i-N}} \times 100$$

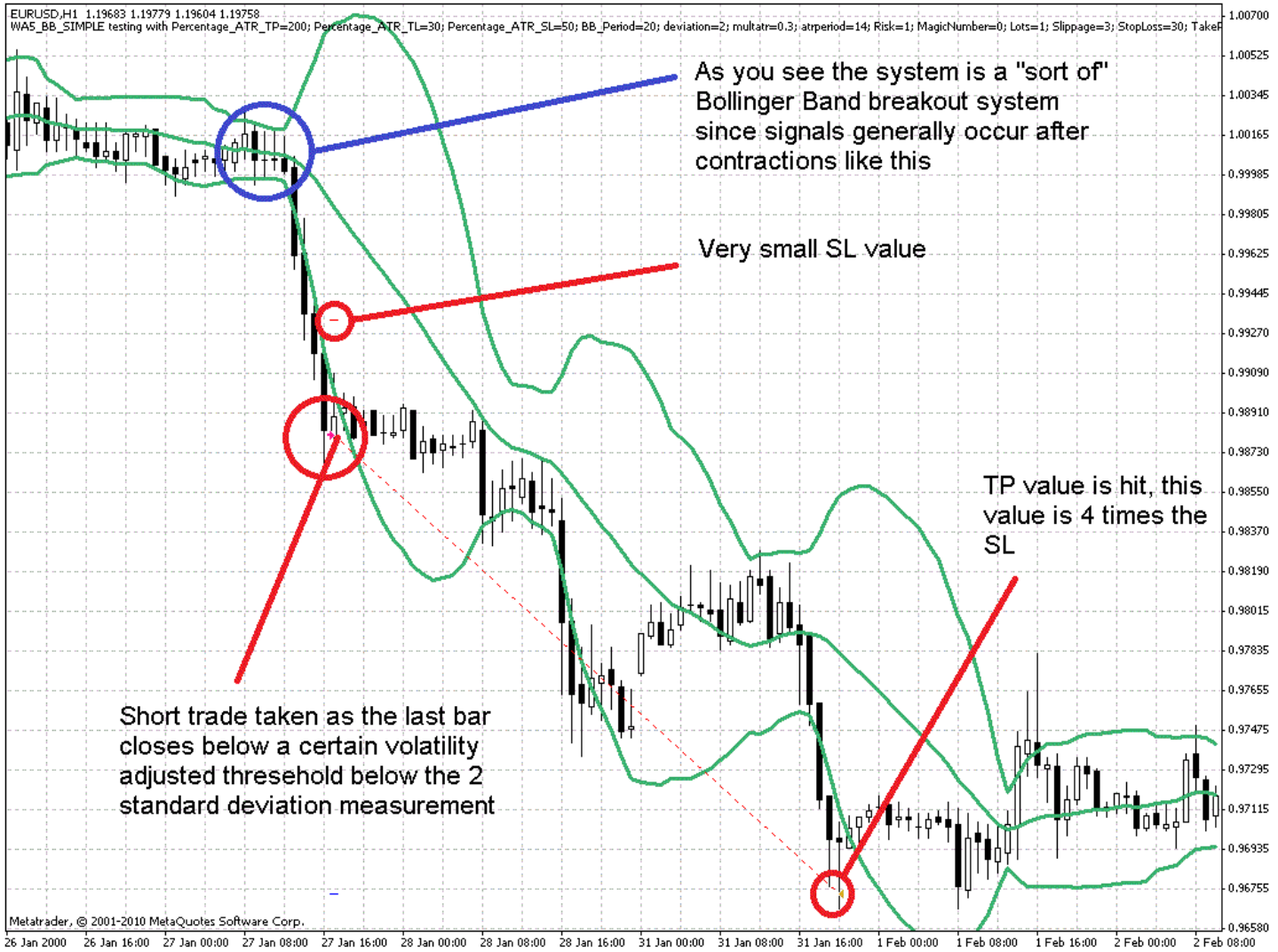
https://www.dolphintrader.com/volume-rate-change-vroc-forex-indicator-mt4/

Momentum: Relative Strength Index (RSI)

$$RSI = 100 - \frac{100}{1 + RS}, where\ RS_{period} = \frac{AvgGain}{AvgLoss}$$

https://www.investoo.com/indicators-relative-strength-index-rsi/

Volatility: Bollinger band



https://mechanicalforex.com/2010/06/playing-with-bollinger-bands-likely.html

FOREX

FOREX intro

- The foreign exchange market (Forex, FX, or currency market) is a **global** decentralized or over-the-counter (OTC) market for the trading of **currencies** (Wikipedia)
  - Currencies are traded in pairs, e.g. EURUSD (or EUR/USD)
  - The **largest** trading market in **trading volume**
  - The largest participants in the FX markets are big banks, e.g. Citi, JP Morgan, UBS, Deutsche Bank, etc.
- Top 5 trading locations by popularity (data from 2017)
  - London, United Kingdom (41%),
  - New York, United States (19%),
  - Singapore (6%),
  - Tokyo, Japan (6%) and
  - Hong Kong, China (4%).

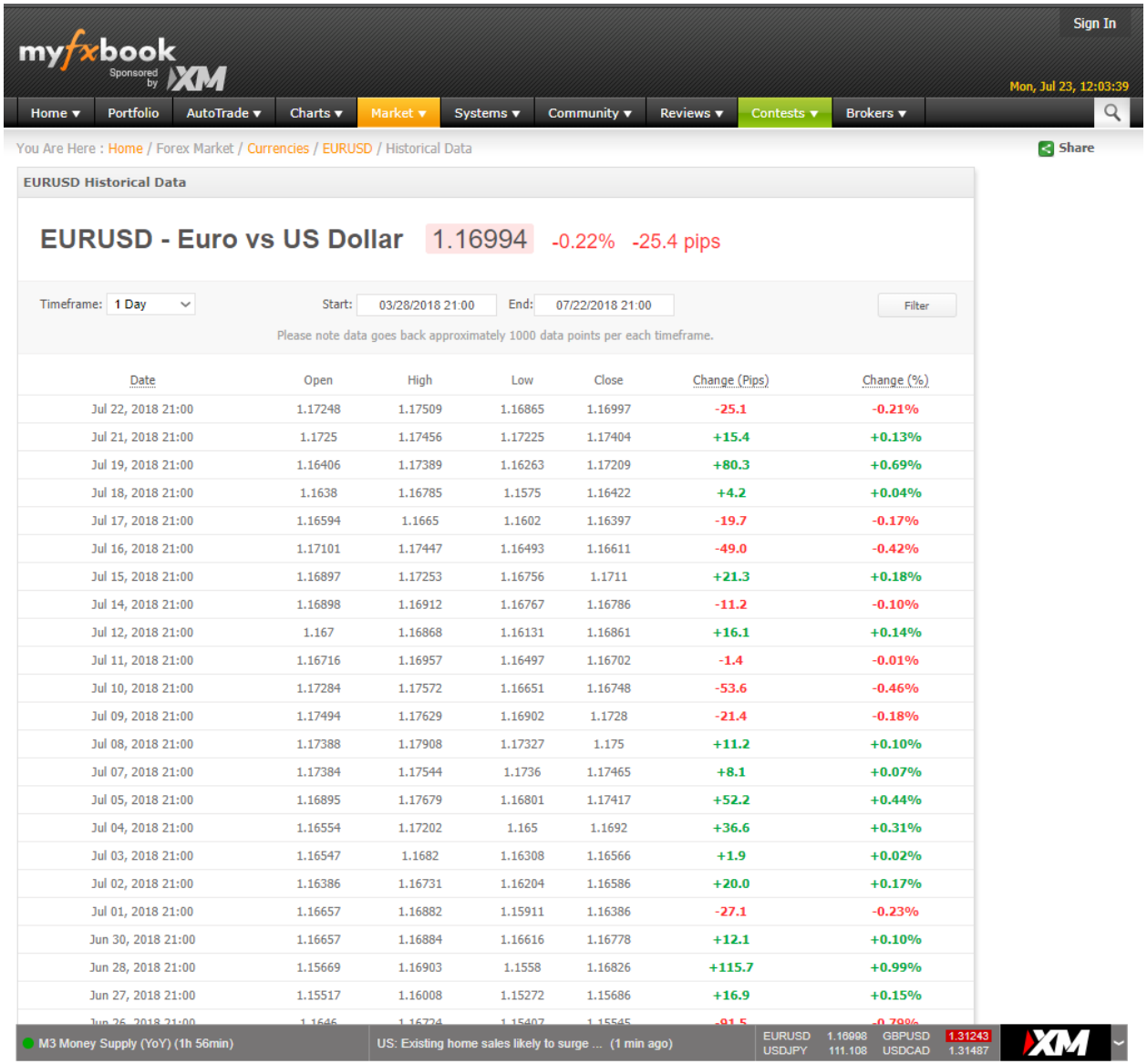
Round-the-clock trading

EDT	GMT	Trading Sessions, Summer time
8:00	12:00	LONDON
9:00	13:00	LONDON
10:00	14:00	LONDON
11:00	15:00	LONDON
12:00	16:00	NEW YORK
13:00	17:00	NEW YORK
14:00	18:00	NEW YORK
15:00	19:00	NEW YORK
16:00	20:00	NEW YORK
17:00	21:00	NEW YORK
18:00	22:00	SIDNEY
19:00	23:00	SIDNEY
20:00	0:00	SIDNEY
21:00	1:00	SIDNEY
22:00	2:00	SIDNEY
23:00	3:00	SIDNEY
0:00	4:00	TOKYO
1:00	5:00	TOKYO
2:00	6:00	TOKYO
3:00	7:00	TOKYO
4:00	8:00	TOKYO
5:00	9:00	TOKYO
6:00	10:00	TOKYO
7:00	11:00	TOKYO

EST	GMT	Trading sessions, Winter time
7:00	12:00	LONDON
8:00	13:00	LONDON
9:00	14:00	LONDON
10:00	15:00	LONDON
11:00	16:00	LONDON
12:00	17:00	NEW YORK
13:00	18:00	NEW YORK
14:00	19:00	NEW YORK
15:00	20:00	NEW YORK
16:00	21:00	NEW YORK
17:00	22:00	SIDNEY
18:00	23:00	SIDNEY
19:00	0:00	SIDNEY
20:00	1:00	SIDNEY
21:00	2:00	SIDNEY
22:00	3:00	SIDNEY
23:00	4:00	SIDNEY
0:00	5:00	SIDNEY
1:00	6:00	TOKYO
2:00	7:00	TOKYO
3:00	8:00	TOKYO
4:00	9:00	TOKYO
5:00	10:00	TOKYO
6:00	11:00	TOKYO

http://www.learnfxtrade.com/trading-sessions/

Raw data example



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EURUSD Historical Data

EURUSD - Euro vs US Dollar 1.16994 -0.22% -25.4 pips

Timeframe: 1 Day | Start: 03/28/2018 21:00 | End: 07/22/2018 21:00 | Filter

Please note data goes back approximately 1000 data points per each timeframe.

Date	Open	High	Low	Close	Change (Pips)	Change (%)
Jul 22, 2018 21:00	1.17248	1.17509	1.16865	1.16997	-25.1	-0.21%
Jul 21, 2018 21:00	1.1725	1.17456	1.17225	1.17404	+15.4	+0.13%
Jul 19, 2018 21:00	1.16406	1.17389	1.16263	1.17209	+80.3	+0.69%
Jul 18, 2018 21:00	1.1638	1.16785	1.1575	1.16422	+4.2	+0.04%
Jul 17, 2018 21:00	1.16594	1.1665	1.1602	1.16397	-19.7	-0.17%
Jul 16, 2018 21:00	1.17101	1.17447	1.16493	1.16611	-49.0	-0.42%
Jul 15, 2018 21:00	1.16897	1.17253	1.16756	1.1711	+21.3	+0.18%
Jul 14, 2018 21:00	1.16898	1.16912	1.16767	1.16786	-11.2	-0.10%
Jul 12, 2018 21:00	1.167	1.16868	1.16131	1.16861	+16.1	+0.14%
Jul 11, 2018 21:00	1.16716	1.16957	1.16497	1.16702	-1.4	-0.01%
Jul 10, 2018 21:00	1.17284	1.17572	1.16651	1.16748	-53.6	-0.46%
Jul 09, 2018 21:00	1.17494	1.17629	1.16902	1.1728	-21.4	-0.18%
Jul 08, 2018 21:00	1.17388	1.17908	1.17327	1.175	+11.2	+0.10%
Jul 07, 2018 21:00	1.17384	1.17544	1.1736	1.17465	+8.1	+0.07%
Jul 05, 2018 21:00	1.16895	1.17679	1.16801	1.17417	+52.2	+0.44%
Jul 04, 2018 21:00	1.16554	1.17202	1.165	1.1692	+36.6	+0.31%
Jul 03, 2018 21:00	1.16547	1.1682	1.16308	1.16566	+1.9	+0.02%
Jul 02, 2018 21:00	1.16386	1.16731	1.16204	1.16586	+20.0	+0.17%
Jul 01, 2018 21:00	1.16657	1.16882	1.15911	1.16386	-27.1	-0.23%
Jun 30, 2018 21:00	1.16657	1.16884	1.16616	1.16778	+12.1	+0.10%
Jun 28, 2018 21:00	1.15669	1.16903	1.1558	1.16826	+115.7	+0.99%
Jun 27, 2018 21:00	1.15517	1.16008	1.15272	1.15686	+16.9	+0.15%

M3 Money Supply (YoY) (1h 56min) | US: Existing home sales likely to surge ... (1 min ago) | EURUSD 1.16998 GBPUSD 1.31243 USDJPY 111.108 USDCAD 1.31487 | XM

Input data

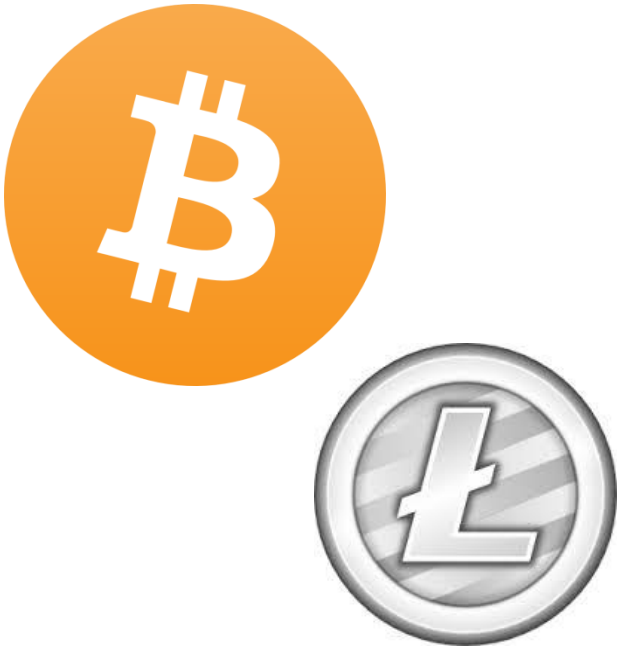
- Select lookback (time) period (e.g. 1 year's data for building a model) and currency pair(s) (e.g. EURUSD)
- Raw data:
  - Historical price data for the chosen currency pair(s), e.g. https://www.myfxbook.com/en/forex-market/currencies/EURUSD-historical-data
- Calculated data
  - One or more trend indicators, e.g. 20 SMA
  - One or more volume indicators, e.g. ACC/DIST
  - One or more momentum indicators, e.g. Relative Strength Index (RSI)
  - One or more volatility indicators, e.g. Bollinger bands
- Turn it into a series of historical data for training purposes:
  - (currency pair, data & time, 20_sma, roc, rsi, bb_lo, bb_hi)

Problems in ‘fortune-telling’

- Forecasts are noisy and with relatively low confidence
- Confidence is always a challenge
  - How to calculate confidence level for a 1-minute ahead forecast on a 1-5 scale?
- Holding period
  - How long to keep open a long or short position to obtain the optimal yield (i.e. highest gain with lowest risk)?
- Volume to invest
  - Which % of investment funds to invest into a certain position?
  - Note: volume is very important because of the leverage mechanism (!)
- Hedging strategy?

References

- Yves Hilpisch, “Python for Finance”, O'Reilly Media, 2014.
- Philip J. Romero, Tucker Balch, “What hedge funds really do – An introduction to portfolio management”, Business Expert Press, 2014.
- “Machine learning for Trading”, (free) Udacity course https://www.udacity.com/course/machine-learning-for-trading--ud501.
- Investopedia, https://www.investopedia.com
- MyFXBook, https://www.myfxbook.com
  - They organize contests (!)
- Mechanical FOREX, https://mechanicalforex.com



DIGITAL CURRENCIES

Digital currency

- **DEF:** A digital currency is available (only) in digital form
  - Also known as: digital money, electronic money/currency
  - Stored in an electronic wallet associated with a physical person or legal entity
- **Examples:** cryptocurrencies (e.g. Bitcoin), in-game currencies in online gaming
- Advantages:
  - Instantaneous transactions
  - Borderless transfer of ownership
  - Anonymity
  - Potential for lower transaction fees
- Disadvantages:
  - Hard to regulate, i.e. governments might struggle to monitor and/or control digital currencies
  - Might be used by criminals

Bitcoin definitions

- **DEF:** Bitcoin is cryptographic software-based online payment system, i.e. cryptocurrency
  - Described by Satoshi Nakamoto in 2008.
  - Introduced as open-source software in 2009.
  - Abbreviation: BTC.
- Payments are recorded in a public ledger using its own unit of account (Bitcoin).
- It is a form of digital currency (physical form is absent), created and held electronically.
- It can be used to buy things electronically.
- Bitcoin can be divided into smaller unit called Satoshi.
  - 1 Satoshi = one hundred milionth of 1 BTC.

Bitcoin history

- 2009: Bitcoin announced by Satoshi Nakamoto
  - Pseudonym for person or group of person
- 2009-2011: slow start…
- 2011-2013: Silk Road and Dread Pirate Roberts
- End 2013: Bitcoin price skyrockets
- and the world notices!

Bitcoin characteristics

- It is decentralized
- It is easy to set up and it is fast
- It is anonymous
- It is completely transparent
- Transaction fees are miniscule, i.e. rather small
- Transactions are irreversible

Decentralized

- Base for the Bitcoin protocol is a peer-to-peer system which means that there is no need for a third party.
- Therefore, in theory, bitcoin network is not controled by central authority (fully decentralized monetary system).
- Bitcoins are being created by a community of people that anyone can join.
- In theory, there is no authority (financial institution) which can tinker with monetary policy and in that sense devalue or revalue Bitcoin currency.

Anonymous & Transparent

- Bitcoins are stored in wallet with digital credentials for your bitcoin holdings and allows you to access them.
- Wallet uses public-key cryptography, in which two keys, one public and one private are generated. Public key can be thought of as an account number or name and the private key, ownership credentials.
- Bitcoin is transferred to the next owner when the next owner gives a public key and previous owner uses his private key to publish a record into system announcing that the ownership has changed to the new public key.
- Bitcoin protocol stores details of every single transaction that occurred in the network in huge version of general ledger (Block chain).

Small fees & Irreversible

- Bitcoin doesn’t charge fees for either national or international transfers.
- Bitcoin is not the first private money, not the first digital currency, and not the first currency based on cryptography, but it has been the first to rely on a peer to peer network decentralization to avoid double spending.
- Bitcoin protects against double spending by verifying each transaction added to the blockchain to ensure that the inputs for the transaction had not previously already been spent.

Mining = BTC creation

- Miners use special software to solve math problems (Bitcoin algorithm), and upon completing the task they receive certain amount of coins.
- They are created each time a user discovers a new block i.e. finds hash value with required characteristics.
- Software is creating new units until it reaches amount of 21 million units → Bitcoin is a currency with finite supply.
- The rate of block creation is approximately constant over time (6 per hour) with 50 % reduction every four years.
- Halving (in theory) continues until 2110-2140 when 21 million BTC will have been issued.

Earn BTCs

- Mining
- Accept BTC as payment
- Earn BTC via trading
- Earn Bitcoins as regular income
- Earn Bitcoin from interest payments
- Other: donations, gambling, getting tipped, completing tasks on websites...

https://blog.internshala.com/2018/10/how-to-earn-money-online-top-10-ways-for-making-money-online-in-india/

Summary

- Financial market types
- Technical analysis and indicators in real-time financial data analsysi
- Market focus #1: FOREX
- Market focus #2: Digital currencies

Thank you for your attention!