# Stock Technical Analysis with Python

## Section 2: Stock Technical Indicators

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# Stock Technical Indicators

- **Stock Technical Indicators** are calculated by applying a certain formula to stock prices and volume data.
- They are used to alert on the need to study price action with greater detail, confirm other technical indicators' signals or predict future stock prices direction.
- They are either plotted on top of price bars as overlays or below as oscillators and there are two main types: **lagging** and **leading stock technical indicators**.

# Lagging Stock Technical Indicators

- **Lagging stock technical indicators** are used to follow price movements by identifying uptrends or downtrends. They consist of **simple moving averages SMA**, **exponential moving averages EMA**, **Bollinger bands® BB** and **parabolic stop and reverse SAR** among many others.

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# Moving Averages

- **Moving Averages MA** are overlays that smooth stock price data to identify trends. **Simple Moving Averages SMA** and **Exponential Moving Averages EMA** are the most popular.

$$SMA_n = \frac{Sum_n(Close)}{n}$$

$$current\ EMA_n = \frac{2}{n+1} * (current\ Close - previous\ EMA_n) + previous\ EMA_n$$

$$initial\ EMA_n = SMA_n(n\ periods\ Close)$$

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# Bollinger Bands®

- **Bollinger bands® BB** are overlays that identify statistically normal stock price movements. Twenty days and two standard deviations are commonly used for its calculation (John Bollinger. "Using Bollinger Bands". *Technical Analysis of Stocks & Commodities*. 1992).

$$Middle\ Band = SMA_{20}(Close)$$

$$Upper\ Band = SMA_{20}(Close) + 2 * STDEV_{20}(Close)$$

$$Lower\ Band = SMA_{20}(Close) - 2 * STDEV_{20}(Close)$$

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# Parabolic Stop and Reverse

- **Parabolic stop and reverse SAR** is an overlay that identifies reversal points between stock prices' uptrends and downtrends (J. Welles Wilder Jr. "New Concepts in Technical Trading Systems". *Commodities Magazine (now Futures Magazine).* 1978).

- a. **Extreme Point** calculation.

$$EP(Uptrend) = Highest\ High\ Current\ Uptrend$$

$$EP(Downtrend) = Lowest\ Low\ Current\ Downtrend$$

# Parabolic Stop and Reverse

- • b. **Acceleration Factor** calculation.

$$AF(\boldsymbol{Uptrend}) = if\big(New\ High\ in\ EP(Uptrend)\big):$$

$$Current\ AF(Uptrend) = Previous\ AF(Uptrend) + 0.02$$

$$Else\ Current\ AF(Uptrend) = Previous\ AF(Uptrend)$$

$$AF(\boldsymbol{Downtrend}) = if\big(New\ Low\ in\ EP(Downtrend)\big):$$

$$Current\ AF(Downtrend) = Previous\ AF(Downtrend) + 0.02$$

$$Else\ Current\ AF(Downtrend) = Previous\ AF(Downtrend)$$

# Parabolic Stop and Reverse

- c. **Parabolic Stop and Reverse** calculation.

$$Current\ SAR(Up)$$
$$= Previous\ SAR(Up) + Prev.AF * (Prev.EP(Up)$$
$$- Prev.SAR(Up))$$

$$Current\ SAR(Down)$$
$$= Previous\ SAR(Dn) - Prev.AF * (Prev.SAR(Dn)$$
$$- Prev.EP(Dn))$$

# Leading Stock Technical Indicators

- **Leading stock technical indicators** are used to lead price movements by identifying their momentum as either the tendency of rising prices to rise further or falling prices to fall further. Most of them are either centered or bounded oscillators and consist of **average directional movement index ADX**, **commodity channel index CCI**, **moving averages convergence/divergence MACD**, **rate of change ROC**, **relative strength index RSI**, **stochastic oscillator Full STO** and **Williams %R** among many others.

# Average Directional Movement Index

- **Average directional movement index ADX** is a bounded oscillator that measures a stock price trend's strength and momentum. Fourteen days are commonly used for its calculation (J. Welles Wilder Jr. "New Concepts in Technical Trading Systems". *Commodities Magazine (now Futures Magazine)*. 1978)

- a. Daily **true range**, **positive/negative directional movement** calculation.

$$TR(1) = Max\ Between(High - Low, |High - previous\ Close|, |Low - previous\ Close|)$$

$$DM(1)p = If(current\ High - previous\ High > previous\ Low - current\ Low):$$
$$DM(1)p = Max\ Between(current\ High - previous\ High, 0)$$
$$Else\ DM(1)p = 0$$

$$DM(1)n = If(previous\ Low - current\ Low > current\ High - previous\ High):$$
$$DM(1)n = Max\ Between(previous\ Low - current\ Low, 0)$$
$$Else\ DM(1)n = 0$$

# Average Directional Movement Index

- b. Fourteen days **smoothing with Wilder's techniques**.

$$\boldsymbol{TR(14)} = prev\ TR(14) * \left( \frac{prev\ TR(14)}{14} \right) + TR(1)$$

$$initial\ TR(14) = SMA_{14}(TR(1))$$

$$\boldsymbol{DM(14)p} = prev\ DM(14)p * \left( \frac{prev\ DM(14)p}{14} \right) + DM(1)p$$

$$initial\ DM(14)p = SMA_{14}(DM(1)p)$$

$$\boldsymbol{DM(14)n} = prev\ DM(14)n * \left( \frac{prev\ DM(14)n}{14} \right) + DM(1)n$$

$$initial\ DM(14)n = SMA_{14}(DM(1)n)$$

# Average Directional Movement Index

- c. Fourteen days **positive/negative directional index** calculation.

$$DI(14)p = \left| 100 * \left( \frac{DM(14)p}{TR(14)} \right) \right|$$

$$DI(14)n = \left| 100 * \left( \frac{DM(14)n}{TR(14)} \right) \right|$$

- d. Fourteen days **directional movement index** calculation.

$$DX(14) = \left[ 100 * \left( \frac{Difference\ DI(14)}{Sum\ DI(14)} \right) \right]$$

$$Difference\ DI(14) = |DI(14)p - DI(14)n|$$
$$Sum\ DI(14) = DI(14)p + DI(14)n$$

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# Average Directional Movement Index

- e. Fourteen days **average directional movement index** calculation.

$$current\ ADX(14)$$
$$= \frac{[(previous\ ADX(14) * 13) + current\ DX(14)]}{14}$$

$$initial\ ADX(14) = SMA_{14}(DX(14))$$

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# Commodity Channel Index

- **Commodity channel index CCI** is a bounded oscillator that measures a stock's price variation from its statistical mean. Twenty days and constant factor are commonly used to make sure most values fall within bands (Donald R. Lambert. "Commodity Channel Index: Tool for Trading Cyclic Trends". *Commodities Magazine (now Futures Magazine)*. 1980)

- a. **Typical price** calculation.

$$TP = \frac{High + Low + Close}{3}$$

- b. **Typical price smoothing** calculation.

$$SMA_{20}(TP) = \frac{Sum_{20}(TP)}{20}$$

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# Commodity Channel Index

- c. **Mean absolute deviation** calculation.

$$MAD = \frac{Sum_{20}|SMA_{20}(TP) - TP|}{20}$$

- d. **Commodity channel index** calculation.

$$CCI(20, 0.015) = \frac{Typical\ Price - SMA(20)\ of\ Typical\ Price}{0.015 * Mean\ Absolute\ Deviation}$$

# Moving Averages Convergence/Divergence

- **Moving averages convergence/divergence MACD** is a centered oscillator that measures a stock's price momentum and identifies trends. Twelve days are commonly used for short term smoothing, twenty six days for long term smoothing and nine days for signal (Gerald Appel. *"Technical Analysis: Powerful Tools for Active Investors"*. FT Press. 2005).

- a. **Short term** (twelve days) and **long term** (twenty six days) **smoothing** calculation.

$$current\ EMA_{12} = \frac{2}{12 + 1} * (current\ Close - previous\ EMA_{12}) + previous\ EMA_{12}$$
$$initial\ EMA_{12} = SMA_{12}(12\ periods\ Close)$$

$$current\ EMA_{26} = \frac{2}{26+1} * (current\ Close - previous\ EMA_{26}) + previous\ EMA_{26}$$
$$initial\ EMA_{26} = SMA_{26}(26\ periods\ Close)$$

# Moving Averages Convergence/Divergence

- b. **Moving average convergence/divergence indicator** calculation.

$$MACD(12,26) = EMA_{12}(Close) - EMA_{26}(Close)$$

- c. Nine days **moving average convergence/divergence indicator smoothing** calculation.

$$Signal(9) = EMA_9[MACD(12,26)]$$

- d. **Moving average convergence/divergence indicator histogram** calculation.

$$MACD\ Histogram(12,26,9) = MACD(12,26) - Signal(9)$$

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# Rate of Change

- **Rate of change ROC** is a bounded oscillator that measures a stock's price change speed or momentum. Two hundred and fifty days are commonly used for one business year calculation, one hundred and twenty five for one semester, sixty three for one quarter and twenty one for one month.

$$ROC(21) = \frac{Current\ Close - Close\ 21\ Days\ Ago}{Close\ 21\ Days\ Ago} * 100$$

# Relative Strength Index

- **Relative strength index RSI** is a bounded oscillator that measures a stock price trend's strength or weakness. Fourteen days are commonly used for its calculation (J. Welles Wilder Jr. "New Concepts in Technical Trading Systems". *Commodities Magazine (now Futures Magazine). 1978* ).

- a. Fourteen days **average gain** and **loss**.

$$AG(14) = \frac{Sum\ Gains\ Last\ 14\ Days}{14}$$

$$AL(14) = \frac{Sum\ Losses\ Last\ 14\ Days}{14}$$

# Relative Strength Index

- b. Fourteen days **relative strength** calculation.

$$RS(14) = \frac{Average\ Gain}{Average\ Loss}$$

- c. Fourteen days **relative strength index** calculation.

$$RSI(14) = \frac{100}{1 + Relative\ Strength(14)}$$

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# Stochastic Oscillator

- **Stochastic Oscillator Full STO** is a bounded oscillator that compares a stock price to its smoothed maximum high. Fourteen days and three days double data smoothing are commonly used in its calculation (George C. Lane. "Lane's Stochastics". *Technical Analysis of Stocks & Commodities*. 1984).

- a. Fourteen days **maximum high** and **minimum low** calculation.

$$High\ High_{14} = Max(High_{14})$$

$$Low\ Low_{14} = Min(Low_{14})$$

- b. Fourteen days **fast stochastic** calculation.

$$Fast\ \%K(14) = \frac{Close - LowLow_{14}}{HighHigh_{14} - LowLow_{14}} * 100$$

# Stochastic Oscillator

- c. Three day **fast stochastic smoothing** calculation.

$$Slow\ \%K(14,3) = Fast\ \%D(14,3) = SMA_3\ (\%K) = \frac{Sum_3[Fast\ \%K(14)]}{3}$$

- d. Three day **slow stochastic smoothing** calculation.

$$Slow\ \%D(14,3,3) = SMA_3\ (\%D) = \frac{Sum_3[Fast\ \%D(14)]}{3}$$

# Williams %R

- **Williams %R** is a bounded oscillator that compares a stock price to its past range's maximum high. Fourteen days are commonly used in its calculation (Larry Williams Website <http://williamspercentr.com/>)

- a. Fourteen days **maximum high** and **minimum low** calculation.

$$High\,High_{14} = Max(High_{14})$$

$$Low\,Low_{14} = Min(Low_{14})$$

- b. Fourteen days **Williams %R** calculation.

$$Williams\,\%R(14) = \frac{HighHigh_{14} - Close}{HighHigh_{14} - LowLow_{14}} * (-100)$$