Backtesting Algorithmic Trading

FinTech

Lesson 14.2

Class Objectives

By the end of this lesson, you will be able to:

Describe what implies to backtest an algorithmic trading strategy.

Construct a dual moving average crossover trading signal strategy for both a long and short-position strategy.

Evaluate the performance of a trading algorithm by using backtesting and risk/reward characteristics.

Use the `FinTA` Python library to incorporate different technical indicators as trading signals in an algorithm.


WELCOME

Legal Disclaimer

The content contained in the FinTech Boot Camp (the “Course”) is for informational purposes only.

You should not construe any such information or other material provided pursuant to the Course (the “Materials”) as investment, financial, tax, legal or other advice. The Materials are not investment advice and any observations concerning any security, trading algorithm or investment strategy provided in the Course is not a recommendation to buy, sell or hold such investment or security or to make any other investment decisions. edX Boot Camps LLC, its parent, subsidiaries, and affiliates (“edX”) do not provide any advice regarding the nature, potential value, risk or suitability of any particular investment strategy, trading algorithm, transaction, security or investment. Any use of the Materials, and any decisions made in reliance thereon, including any trading or investment decisions or strategies, are made at your own risk.

You should seek the advice of a competent, licensed professional if you require investment, trading or other advice. No employee, agent or representative of edX is authorized to provide any professional advice in connection with the Course and any such advice, if given, is in violation of edX’s policies, is unauthorized and may not be relied upon. Nothing contained in the Materials constitutes a solicitation, recommendation, endorsement, or offer by edX or any third party service provider to buy or sell any securities or other financial instruments in this or in in any other jurisdiction whether or not such solicitation or offer would be unlawful under the securities laws of such jurisdiction.

Introduction to Backtesting

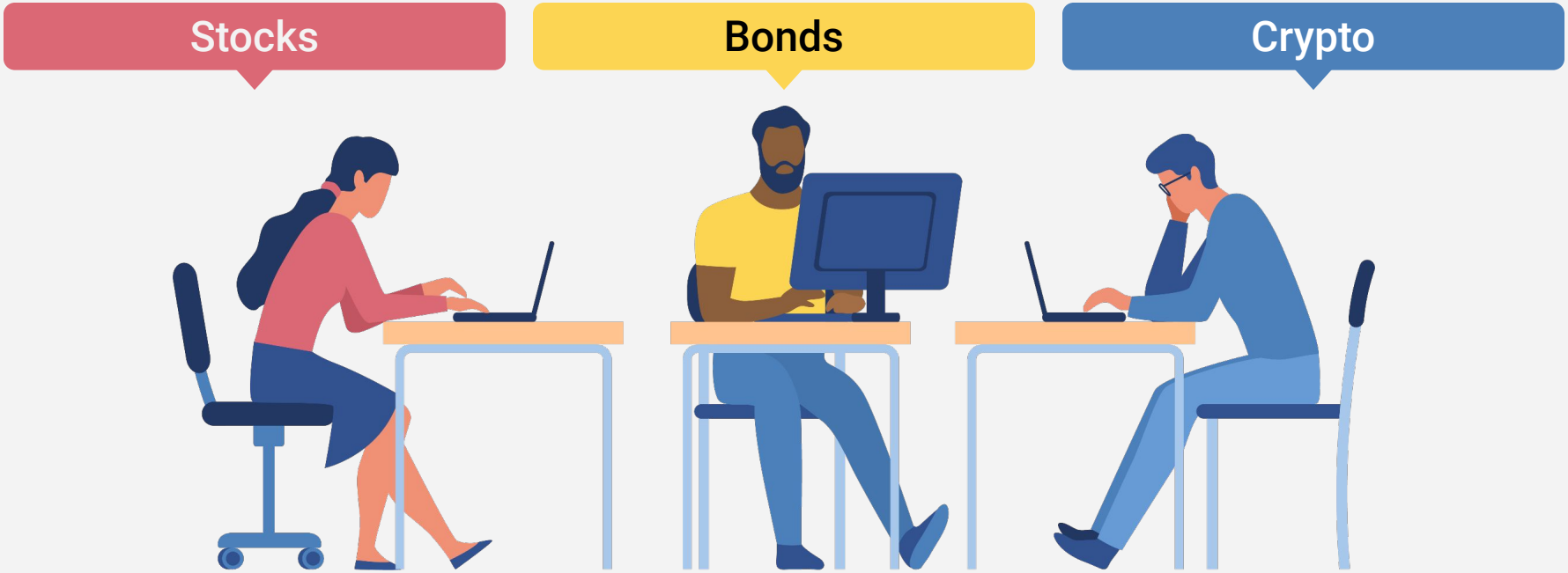
Introduction to Backtesting

Algorithmic trading has become common and widely available across the financial world. But deciding what strategy to use may be a challenging task for financial analyst due to the enormous number of trading algorithms that can be used.

Backtesting is a method that allows us to assess how well a strategy works retrospectively, using historical data to validate how accurately the strategy would have predicted the actual results.

Introduction to Backtesting

Although we can backtest and apply a trading algorithm to essentially anything that's tradeable—whether it's stocks, bonds, or crypto—, no single trading strategy works for every individual or situation.



What's an optimal trading algorithm?

The **optimal trading algorithm** is the one that fits the investor's risk tolerance; as its name suggests, it is the level of risk that an investor is willing to tolerate.

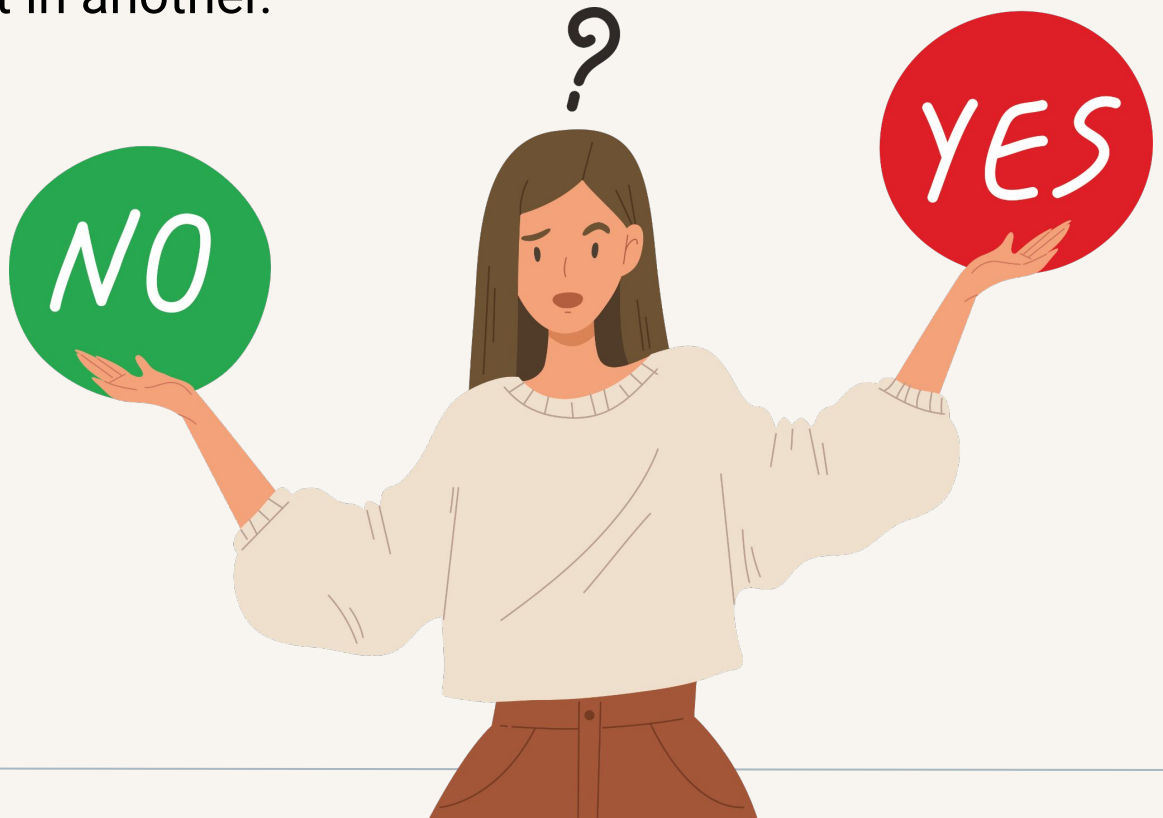
Risk Tolerance

Risk averse individuals want more-conservative trading strategies, or those with less potential profit but also less risk of loss.

Risk tolerant individuals are willing to take on more-speculative trading strategies, or those with the potential for great profit but also for great loss.

Risk Tolerance

An individual might also feel more risk averse in one situation and more risk tolerant in another.



Risk Tolerance Examples

You might treat your retirement account differently than the short-term account that you use to fund your day-to-day living expenses.

You may want to take more risk with your retirement account if a long time will elapse until you'll need the funds.

If you need the funds from your short-term account to pay the mortgage or rent next month, you won't have time to make up for potential investment losses.

Risk Tolerance Scale

Moderately Conservative
Willing to accept a small measure of risk in exchange for potentially higher returns, but still primarily focused on protecting the current principal balance.

Moderately Aggressive
Primarily focused on long-term returns for the portfolio, and willing to accept significant levels of risk to achieve them.

Conservative
Primarily focused on capital preservation. Willing to forgo potentially higher returns in exchange for protecting current assets.

Moderate
Demonstrates an equal interest in reducing risk and providing higher returns.

Aggressive
Primarily focused on maximizing portfolio returns and performance. The risk level is extremely high, and the loss of capital is likely.

Risk Tolerance

A financial advisor usually discovers a customer's risk tolerance and then determines a trading strategy appropriate for the customer's needs. We can take similar steps for algorithmic trading.

01 We evaluate a trading algorithm to determine its risk/reward characteristics.

02 We determine whether the algorithm meets our needs.

Questions?

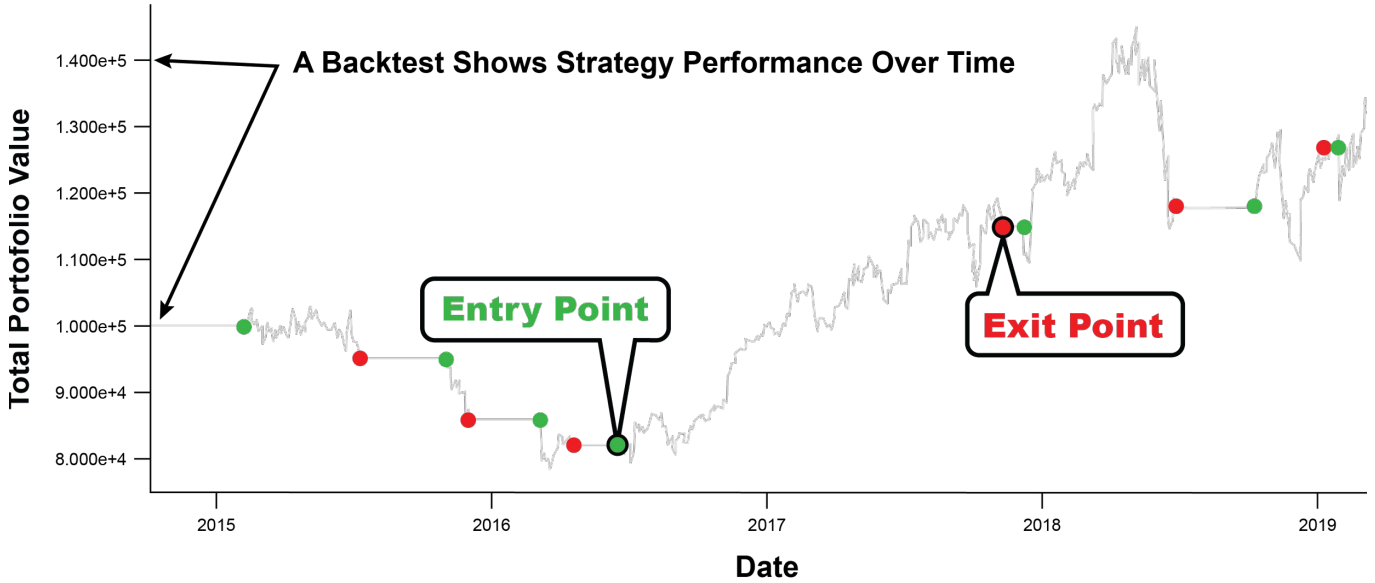
Instructor Demonstration

Backtesting a Trading Algorithm

Risk Vs. Reward

Risk Vs. Reward

Backtesting helps gauge an algo strategy's risk/reward characteristics.
It also supplies a standardized baseline for assessing the relative performance of different trading algorithms.



Risk Vs. Reward

In order to backtest a trading algorithm, we feed it historical stock data to analyze its trading performance and its risk/reward characteristics for a hypothetical portfolio.

Traders	Use backtesting to compare the viability of trading strategies that they might employ, as well as to tweak successful strategies.
Analysts	Use backtesting as a way to test and compare various trading techniques that might be used in a large investment portfolio.

Activity:
Backtest Your Short-Position Algorithm

In this activity, you'll backtest an algorithm to determine both the changes to the overall portfolio values and the daily return and cumulative return metrics.

Suggested Time:

20 Minutes

Time's Up! Let's Review.

Questions?

Assessing the Risk/Reward Characteristics of a Trading Algorithm

Risk/Reward Characteristics of a Trading Algorithm

There are two considerations that should be done when we backtest a trading algorithm:

Past vs. Future Performance

- When we backtest a trading algorithm, the results are based on historical data.
- This means that backtesting might demonstrate that the algorithm would have been profitable in the past.
- However, it doesn't guarantee how the algorithm will perform in the future.
- An algorithmic trading strategy that's designed to succeed with past data might not work with future data.

Risk/Reward Management

Due to the inherent uncertainty about future profitability, the golden rule of trading is to use risk/reward management.

Since future market conditions are unknowable, traders should make investments only when they feel comfortable with the level of risk that’s required for achieving a certain level of profit.

Before deploying a trading algorithm, we need to analyze the algorithm's overall risk/reward characteristics at both the portfolio and per-trade level.

The risk/reward characteristics of a trading strategy can be understood as the amount of risk, or the potential loss, that a person assumes for an investment with the expectation of returning a gain, or an expected amount of profit.

Instructor Demonstration

Generating the Risk/Reward Evaluation Metrics

Risk/Reward Metrics

These metrics can be calculated historically with backtesting, or they can be used to measure future trades and opportunities for portfolio growth.

	Definition	Implementation
Annualized Return	We calculate it by first averaging the daily return values over the time period of the dataset.	We then multiply that average daily return value by 252, or the number of trading days in a year.
Cumulative Returns	The aggregate percentage return (that is, the percentage gain or percentage loss) for an investment.	We usually measure the cumulative return across the entire investment rather than for a particular time period.
Annual Volatility	The amount that each daily return value differs from the asset's average daily return value (that is, the standard deviation of the asset's daily return values), measured on an annualized basis.	The annual volatility helps determine the amount that the stock will potentially gain or lose vs. the expected amount, over a single year.

Risk/Reward Metrics, continued

	Definition	Implementation
Sharpe Ratio	A measurement of an asset's outperformance as compared to the asset's volatility. The outperformance is measured by the difference between the asset's ROI and the return expected from an asset assumed to have no risk, like a three-month US Treasury bill. (Because three-month Treasury bill returns are, these days, zero, we usually just exclude this last term from the formula.)	The asset's volatility is characterized by the standard deviation of its daily return values.
Sortino Ratio	A variation of the Sharpe ratio that differentiates an asset's harmful volatility from its overall volatility. The Sharpe ratio measures an investment's ROI vs. its volatility, treating positive or negative results the same way. By contrast, the Sortino ratio focuses on the **downside standard deviation**, which measures the downside volatility of the asset.	The distinction has relevance, because investors tend to have more concern about negative surprises than positive ones.

Columns of the `trade_evaluation` DataFrame.

Stock	The name of the asset that we're trading
Entry Date	The date that we entered (bought) the trade.
Exit Date	The date that we exited (sold) the trade.
Shares	The number of shares that we executed for the trade.
Entry Share Price	The price of the asset when we entered the trade.
Exit Share Price	The price of the asset when we exited the trade.
Entry Portfolio Holding	The cost of the trade on entry (which is the number of shares multiplied by the entry share price).
Exit Portfolio Holding	The proceeds that we made from the trade on exit (which is the number of shares multiplied by the exit share price).
Profit/Loss	The profit or loss from the trade (which is the proceeds from the trade minus the cost of the trade).

Questions?

Activity:
Evaluating Your Short-Position Algorithm

In this activity, you'll evaluate the risk/reward characteristics of the short-position strategy that you created before.

Suggested Time:

25 Minutes

Time's Up! Let's Review.

Questions?


Break

Instructor Demonstration

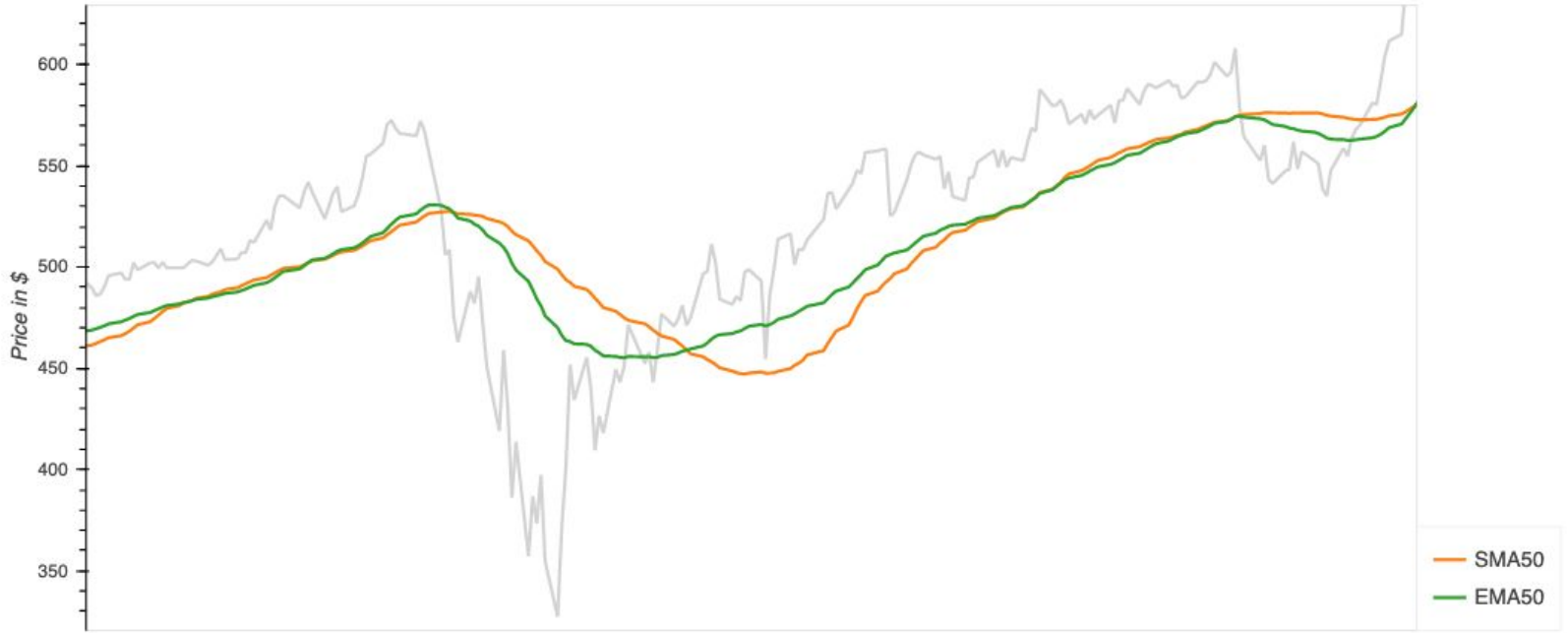
Alternative Technical Indicators

A close relative to the simple moving average (SMA) technical indicators that were just utilized is the Exponential Moving Average (EMA).

The **Exponential Moving Average (EMA)** technical indicator weights the recent prices more heavily than prices further in the past.

SMA versus EMA

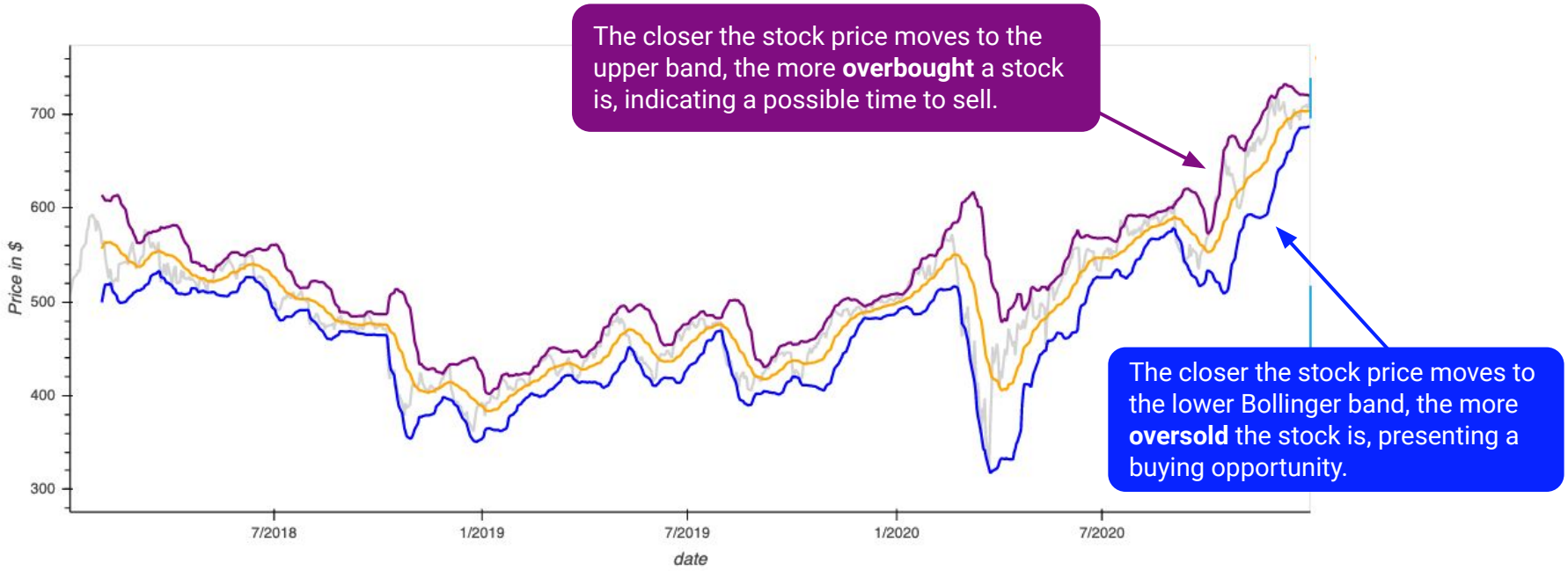
A long-position dual moving average crossing over trading algorithm can be built by simply replacing the SMA technical indicators with EMA technical indicators.



A **Bollinger Band** is a technical indicator defined by a set of trend lines plotting two standard deviations, both positive and negative, away from the running simple moving average of a security's price.

Bollinger Bands

Bollinger Bands help to identify when an asset is either overbought (i.e., at an unusually high price) or oversold (unusually low).



Activity:
Using FinTA for Trading Signals

In this activity, you'll utilize the `FinTA` Python library to generate the technical indicator values used in several trading algorithms.

Suggested Time:

25 Minutes

Time's Up! Let's Review.

Questions?

Now that we are able to create a variety of trading algorithms using different technical indicators, how do we go about evaluating them?

The next step in the process is to backtest the various trading algorithms using evaluation metrics such as per-trade profit and loss as well as risk metrics like annualized volatility and the Sharpe/Sortino ratio.


The End