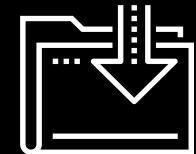


# Introduction to Time Series

Fintech  
Lesson 11.1



# Class Objectives

---

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



Recognize the importance of time data in the financial industry.



Manipulate time series data by using Pandas.



Use exploratory data analysis techniques on time series data.



Identify time series patterns in stock market data by using advanced slicing techniques and time pattern identification methods.



Use heatmaps to identify relationships within time series data.

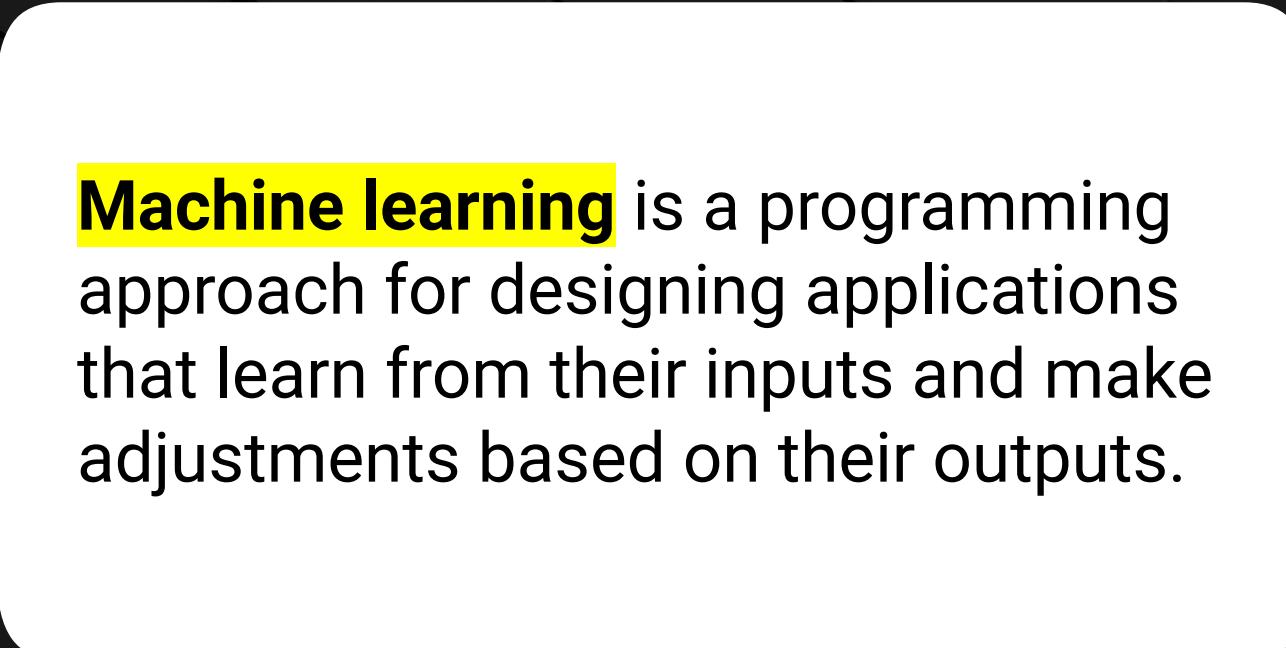


**WELCOME**





What do you know about  
machine learning?



**Machine learning** is a programming approach for designing applications that learn from their inputs and make adjustments based on their outputs.

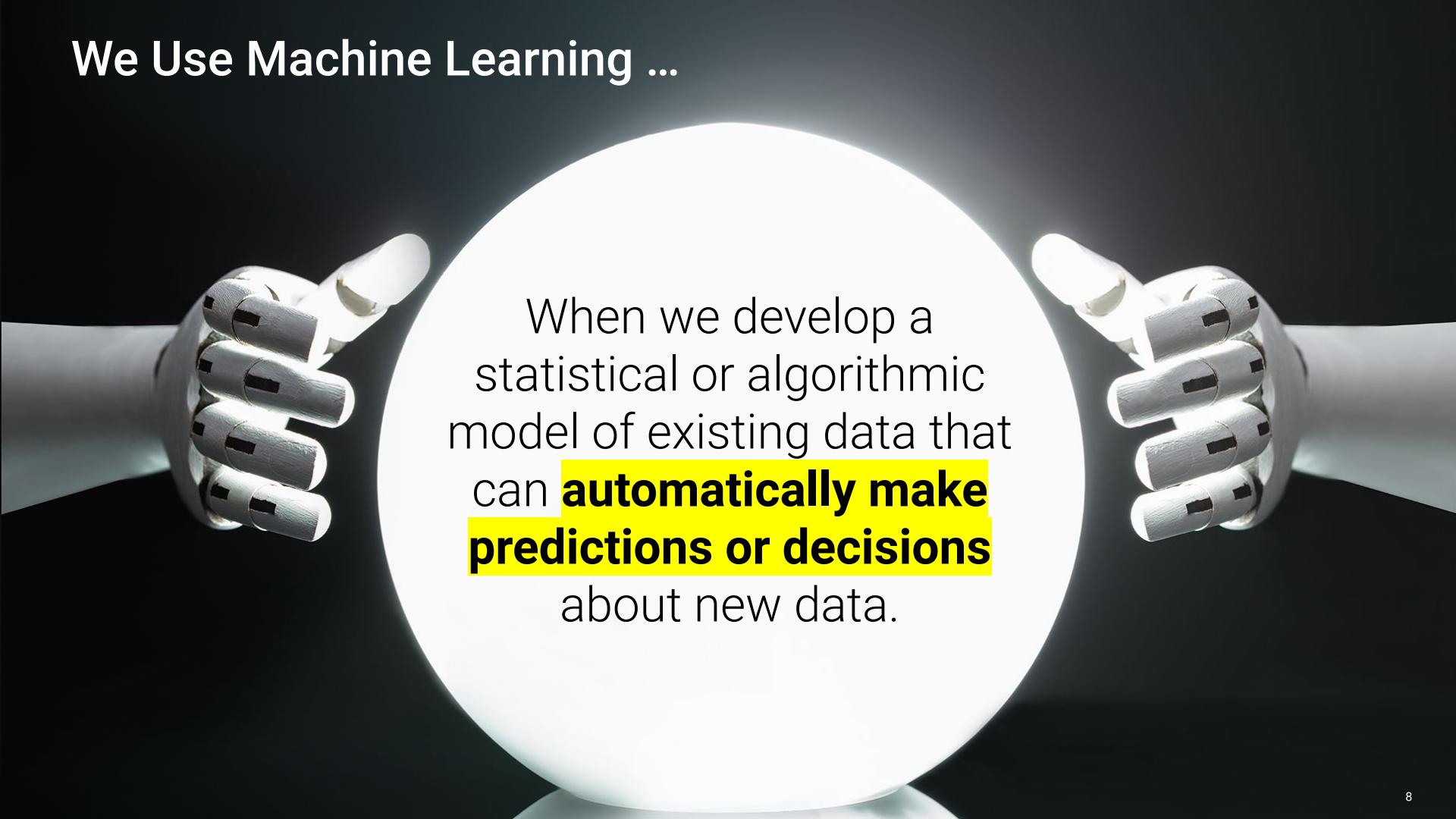
# Recap: Machine Learning

A machine learning algorithm automatically adapts (automatic configuration) to improve the accuracy and precision of outcomes and predictions, so we do not need to configure inputs and manually change to the algorithm.

Because machine learning algorithms can learn on their own, developers do not need to worry about coding for every scenario.



# We Use Machine Learning ...



When we develop a statistical or algorithmic model of existing data that can **automatically make predictions or decisions** about new data.

# Recap: Machine Learning

---

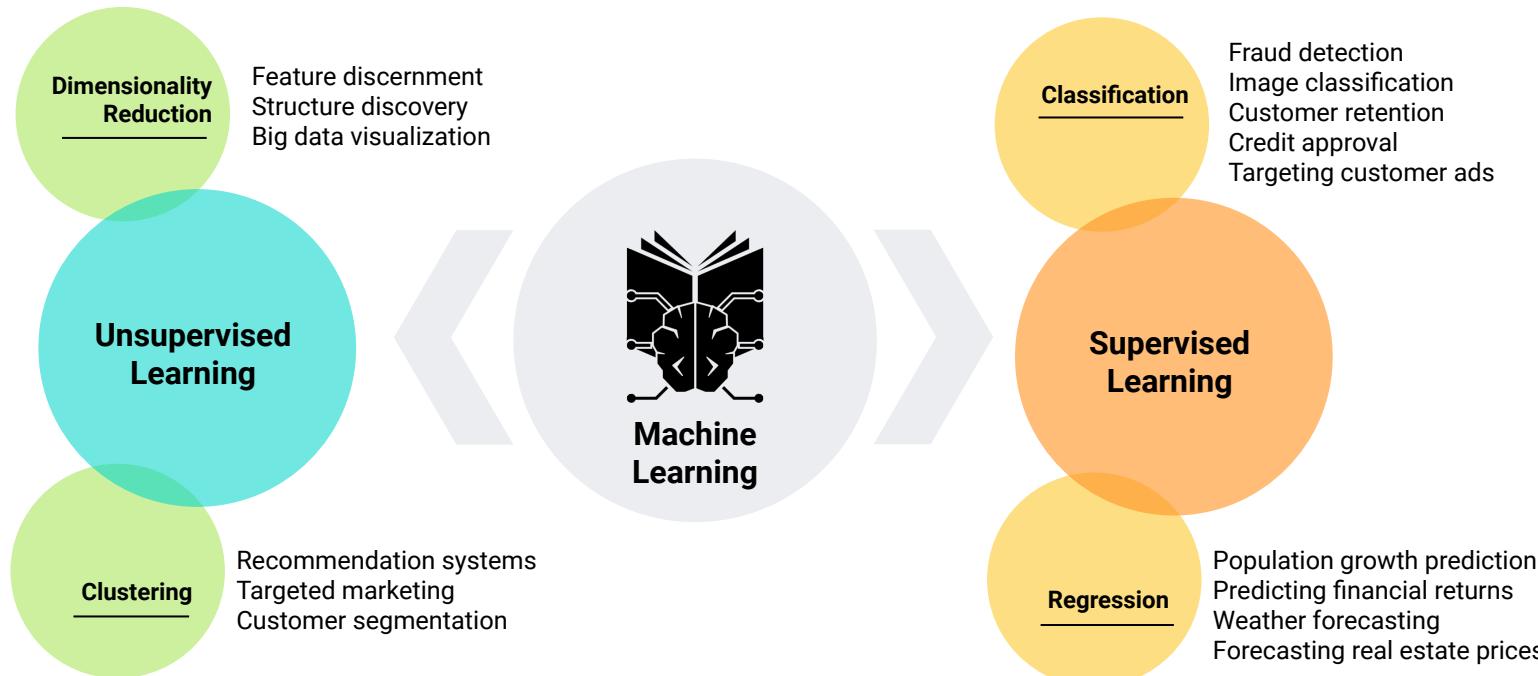
All machine learning pipelines follow a **Model-Fit-Predict** paradigm where we use a dataset or data model to fit, or train, the algorithm.



Once the algorithm has been trained, we can use the model and the algorithm to make actual predictions.

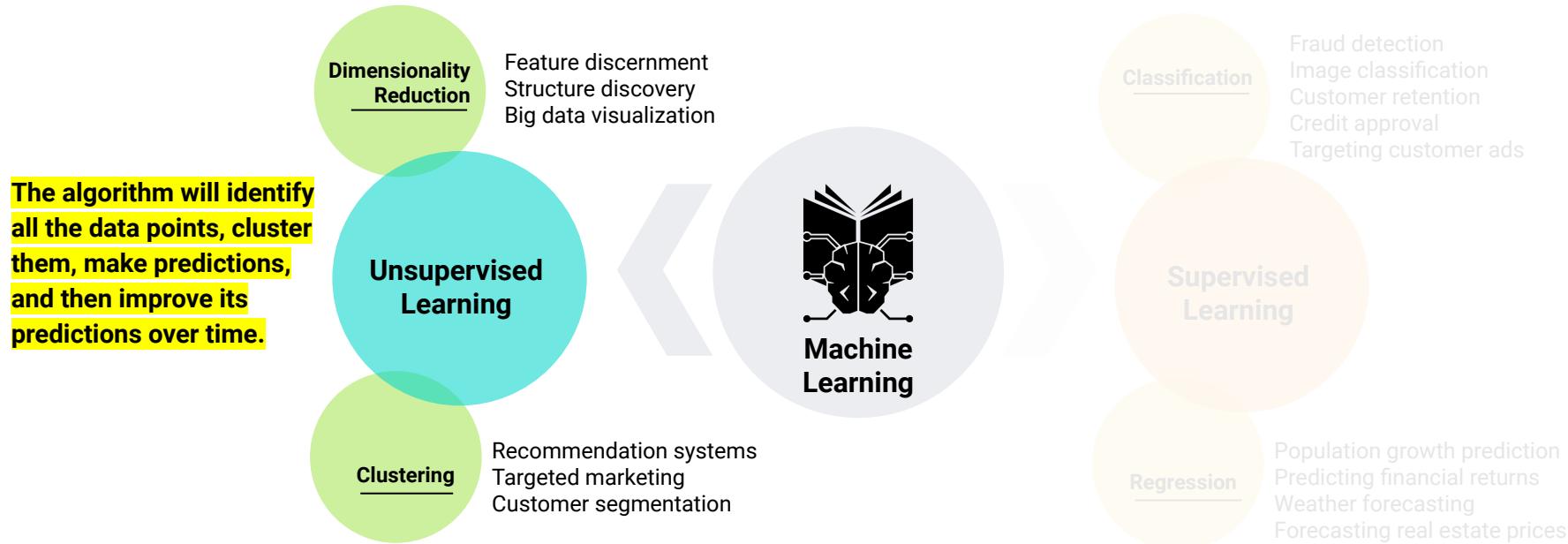
# Recap: Machine Learning

We've learned that machine learning has **two main approaches:**



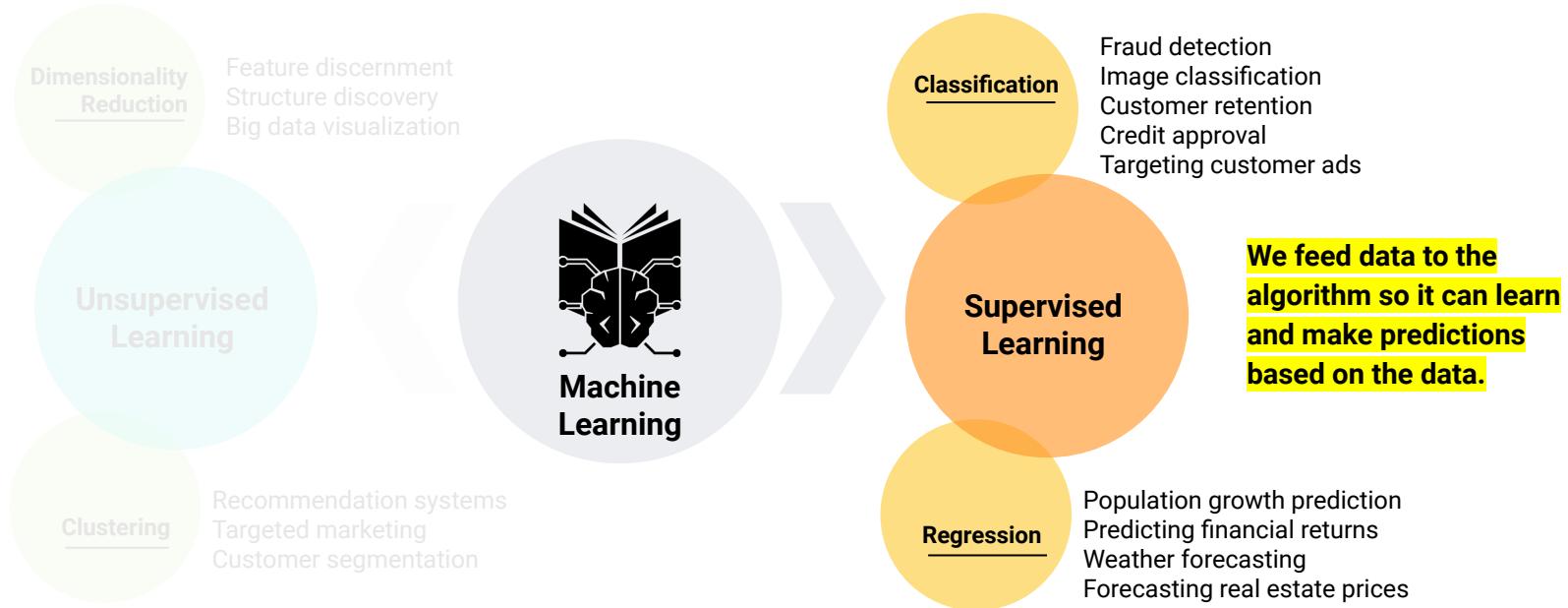
# Recap: Machine Learning

We've already covered **unsupervised learning**, which is when an intelligent algorithm learns as it goes, without having observed any type of data before.



# Recap: Machine Learning

This week, we'll cover **supervised learning**.

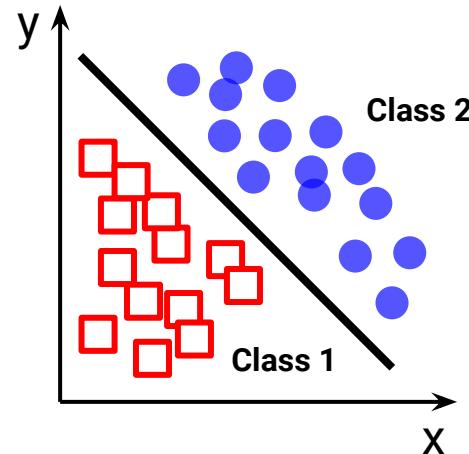


# Recap: Machine Learning

**Classification** and **regression** are types of supervised learning. Both are used for making predictions. With supervised learning, we need to know the potential outcomes from the start.

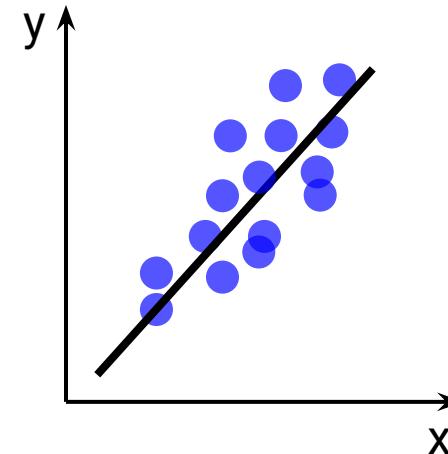
## Classification

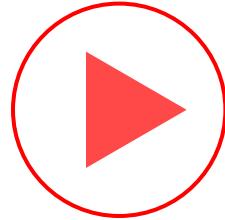
(classifying outcomes as classes/groups)



## Regression

(fitting data to predict where a new data point lies)





Time For a Quick Video

---

How Machines Learn

# How Machines Learn

---

The following machine learning examples were mentioned in the video:

01

An algorithm decides what price you are willing to pay at a particular moment.

02

An algorithm predicts which financial transactions are fraudulent.

03

Algorithms continuously trade against other algorithms in the stock market.



The concept of time is an important element in decision-making.

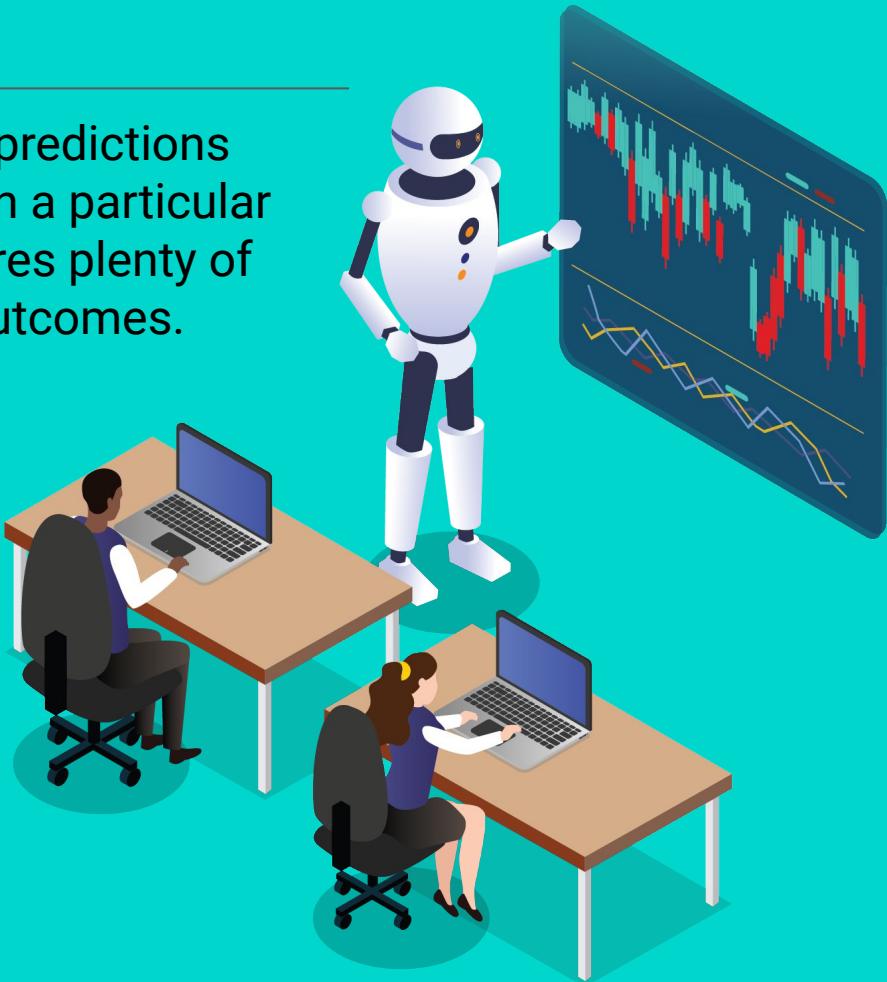
- Your willingness to pay for something might depend on the time of day (late-night shopping, anyone?) or year (holiday season).
- Financial transactions that occur very late at night or very early in the morning have a greater chance of being fraudulent.
- Profitable strategies might appear and disappear depending on market conditions that change constantly over time.

# Recap: Machine Learning

For a machine learning model to make predictions about all these outcomes, such as when a particular stock trade would be profitable, it requires plenty of historical data on both good *and* bad outcomes.



To make good decisions, a model needs many examples to learn from.





Many practical applications for machine learning models in finance involve **supervised learning** of time series data.

# Introduction to Time Series Data

# Introduction to Time Series Data

---

Our lives are based on the results of decisions that we make at specific times.  
**For example:** Time might drive us to buy warm clothes in the winter or search for the perfect vacation spot in the summer.



# Introduction to Time Series Data

---

Time also impacts how the financial world works and behaves.

**For example:**

When you make an investment or deposit money in your savings account, the value of the money can increase over time.

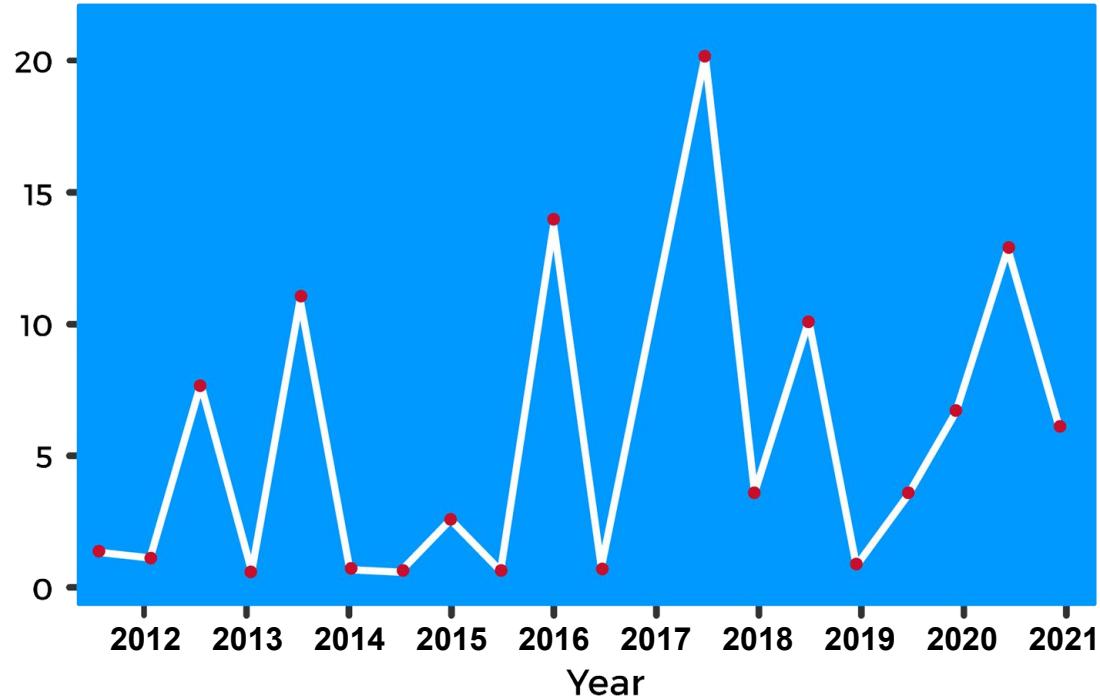


# The Importance of Time in Finance

---

Time is essential in financial decision-making, so we need to learn how to manipulate, analyze, and understand data that is measured over time.

This type of data is called  
**time series data**.



# Introduction to Time Series Data

In this class, you will learn how to manipulate time series data with **Python** and **Pandas**.

- You will learn to use these tools' advanced capabilities for analyzing and working with data in multiple formats from different sources.
- With these skills, you can build more sophisticated time series models, including ones that can make predictions across different time scales (such as days, weeks, years, and time zones).





# Challenge

---

## Forecasting Net Prophet

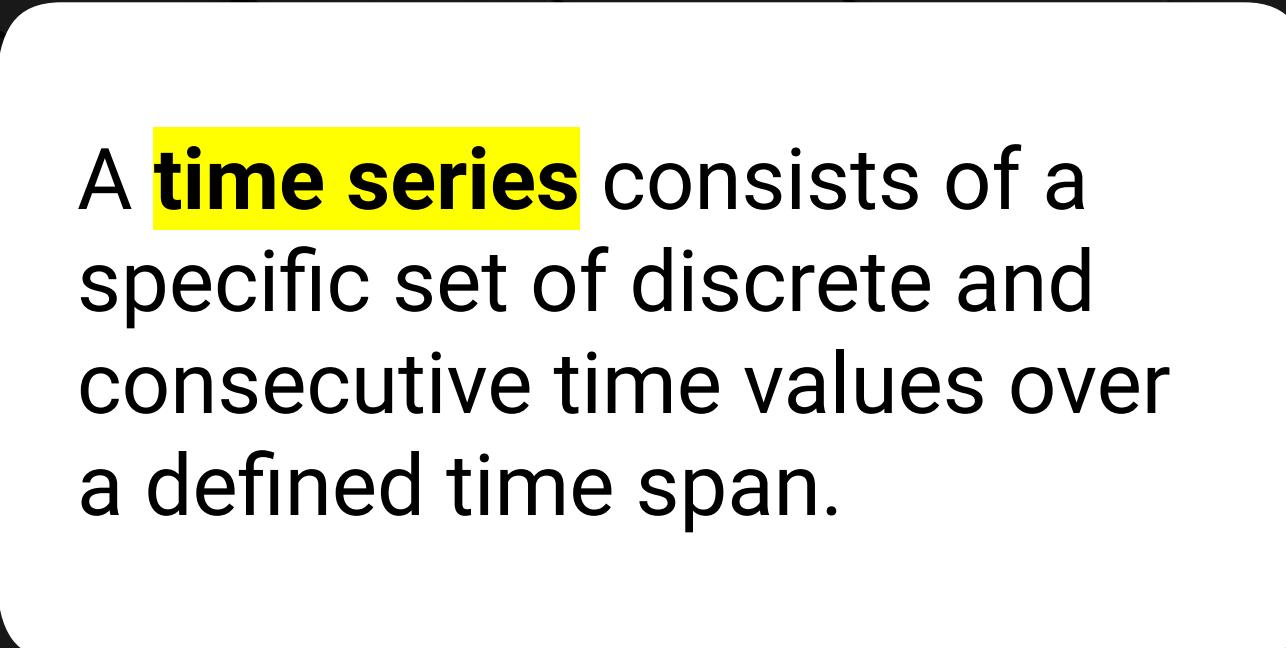


**Advanced analytics** is becoming  
very popular in the fintech industry.



Advanced analytics offers developers and companies a way to analyze thousands of large datasets and to use computer predictions that drive investments and decision-making.

These large datasets typically contain data that involves a **time series**.



A **time series** consists of a specific set of discrete and consecutive time values over a defined time span.

# In This Module's Challenge Assignment, You Will:

---

- Assume the role of a growth analyst for Mercado Libre, the most popular e-commerce site in Latin America.
- Create a model for a time series analysis of the site's user traffic, and analyze financial and user data to help the company grow.



**mercado  
libre**

# Challenge Demo

---

The assignment requires you to:



Identify unusual patterns in time series data by using Pandas and other tools.



Mine the data for seasonal patterns by using the hvPlot visualization tool.



Build sales-forecast and user-interest predictive models for the firm by using Facebook Prophet.



You will learn about Prophet during Day 2 of Module 11.

# Questions?



# The Importance of Time in Finance

# Aspects of Time Data

Time plays a role in almost every financial analysis task, including:

## Discovering

Discovering the closing prices on various stock exchanges around the globe.



## Aggregating

Aggregating the daily revenue for a firm that has sales in different countries or regions.



## Forecasting

Forecasting cryptocurrency prices.



# Aspects of Time Data

---

To model and predict future events in time ...



We need the ability to handle everything that relates to time data.

Because financial markets stay active all around the world and thus at all hours of the day ...



We need the ability to convert time zones.

To recognize patterns in time data ...



We need the ability to resample our data, converting hourly data to daily data or daily data to weekly data.

# Using Pandas to Work with Time Data

# Python and Pandas

In today's class, you'll learn about the intricacies of manipulating time series data with **Python** and **Pandas**.

- The concepts of dates and times in a programming language can be complicated.

*This is especially true when we consider the globe with its various time zones and levels of granularity.*

- These levels range from daily data to data measured at the microsecond.

*Also, there are many ways to format and store dates and times on computers.*

- As you learned in earlier units, Python and Pandas supply functions that help us work with dates and times in a DataFrame.

*These functions use `datetime` objects, which will also make it easier to work with time series models.*



**A common example of time series data in the fintech space involves the stock market.**

We can measure the price of each stock at specific intervals throughout the trading day, such as every minute, every hour, or every day (which will give us the closing price).





In this demo, we'll analyze the  
S&P 500, the index of the top-500  
public stocks in the United States.



## Instructor Demonstration

---

# Using Pandas to Work with Time Data



# What Is Coordinated Universal Time?

**Coordinated Universal Time** (UTC—the initialism places “Coordinated” last) is a time standard that anyone in the world can use to specify an exact moment in time regardless of the location.



UTC doesn't adjust  
for daylight savings  
time, which is what  
differentiates it from

Greenwich Mean  
Time (GMT).

THE ROYAL OBSERVATORY

# Coordinated Universal Time (UTC)

Whenever a timestamp includes a plus sign (+) or a minus sign (-), the number after the sign indicates the number of hours that we need to add or subtract from UTC to get the correct time zone.

**Common time zones for stock data include:**

- 05:00

New York  
standard time

- 04:00

New York  
daylight savings time



The UTC time standard also matches London's time zone at +00:00.

# Coordinated Universal Time (UTC)

---

The [Time Zone Database](#) contains the time zone codes used by Python and other programming languages.



This database is an international collaboration project that the Internet Assigned Numbers Authority (IANA) supports.



The database is updated to reflect changes that governments make to time zone boundaries, UTC offsets, and daylight savings rules.



You are encouraged to learn more about the Time Zone Database and how it's managed.

# Questions?





## Instructor Demonstration

---

Using Pandas for datetime Objects

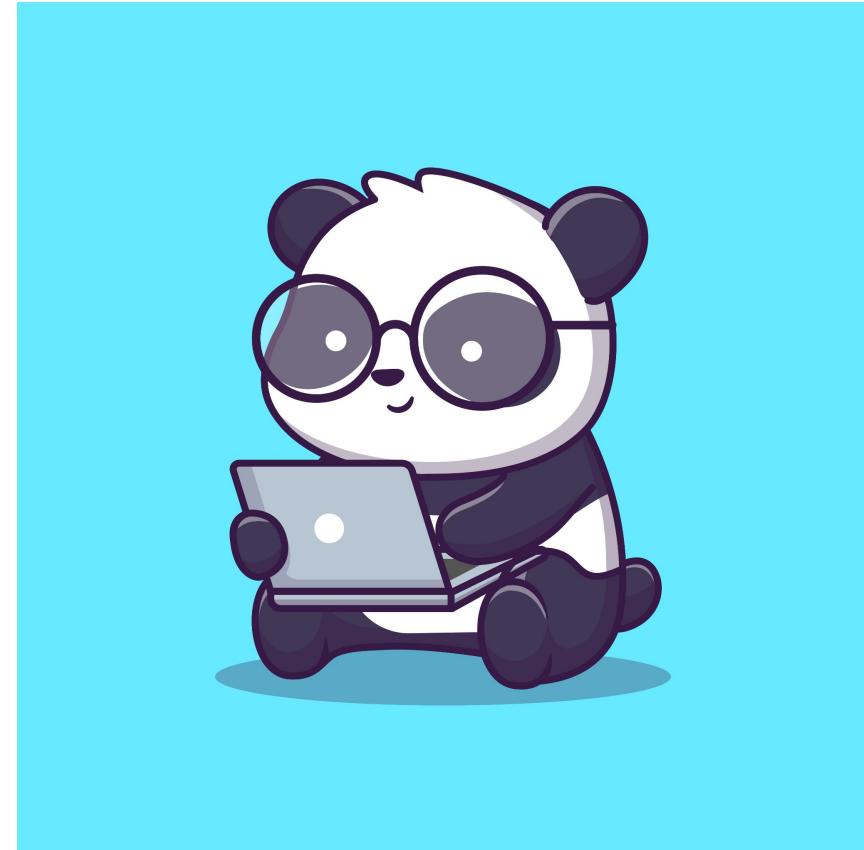
# Using Pandas for datetime Objects

---

With Pandas, we can use `datetime` objects to perform mathematical and other programming operations on dates and times.

Calling the Pandas `to_datetime` function and passing it a parameter of “today” returns an object called Timestamp, which contains the following parts:

- The `date` and `time` information of the user’s current date in the format of year-month-day
- The time in the format of hours-minutes-seconds-milliseconds



# Using Pandas for datetime Objects

Timestamp is the Pandas equivalent of the Python `datetime` object.



Timestamp



datetime

- Used for entries that make up the Pandas `DatetimeIndex` and other time-oriented data structures.
- Convenient when we want to use an API to pull financial market data that ranges from a particular time in the past to today.



## Instructor Demonstration

---

### Using the Time-Related Functions



You will gain practical experience with these Python tools throughout the module.

# Questions?





## Instructor Demonstration

---

Converting UTC Data to a Specific Time Zone

# Financial markets commonly trade across time zones.

To compare assets across  
these markets, we need to  
convert from one time zone  
to another.



# Questions?





# Activity: Inspecting Time Zones in Stock Data

In this activity, you will load historical stock data about Tesla Motors (TSLA) to practice your `datetime` data transformation skills.

Suggested Time:

---

20 Minutes



Time's Up! Let's Review.

# Questions?





## Instructor Demonstration

---

### Analyzing Market Data Across Time

# Stock Market Patterns

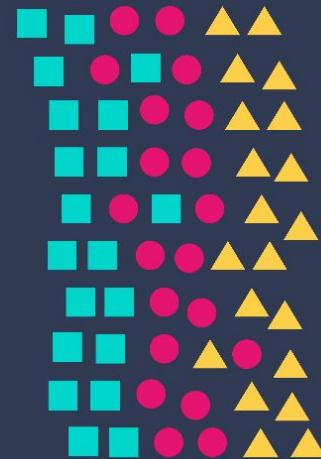
# Stock Market Patterns

---

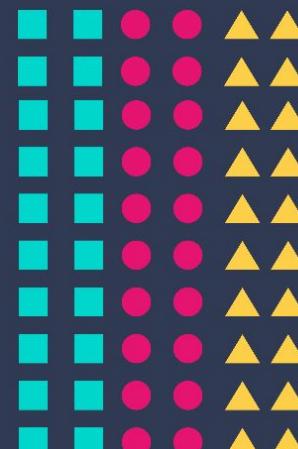
The more we understand the patterns in our data, the better we become at training and building models that involve this data.



Big data



Analytics



Decisions



In the stock market, patterns of behavior often result from everyday human activities and behaviors.

Examples include going to lunch or feeling excited about the market opening or closing.

These identifiable patterns in our data are known as

**common intra-day stock market patterns**

and

**time-of-day stock market patterns.**



# Stock Market Patterns

---

Some of the more common patterns include:



A surge in trading volume at the opening of the market at 9:30 a.m. Eastern Time



A spike in trading volume when the market closes its positions at lunchtime



A daily high or low price that's tested around lunchtime



Increases in trading volume and the potential for price movement between 2:00 and 3:00 p.m. Eastern Time



A final push before the market closes, just before 4:00 p.m. Eastern Time



Let's try to find some patterns in  
our S&P 500 data by visualizing  
them with plots!



## Instructor Demonstration

---

### Checking the Closing Prices

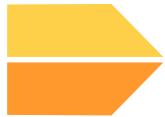
# Slicing Time Data

---

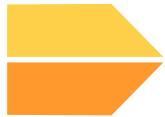
Slicing time data shows the advantage of occasionally zooming in on our data to identify trends.



If we examined the entire dataset, we would have difficulty observing a lunchtime trend.



But by zooming in to a specific time, smaller trends like this become more apparent.



When we identify trends, we can incorporate them—big or small—into our time series models for better accuracy.



## Instructor Demonstration

---

### Further Time Slicing with Pandas



Countdown timer

15:00

(with alarm)

Break





# Activity: Visualizing Stock Data

In this activity, you will convert a date column to `datetime` and perform slicing functions on various dates.

Suggested Time:

---

20 Minutes



Time's Up! Let's Review.

# Questions?



# Exploring Time Series Data

# Exploring Time Series Data

In this section, we'll learn how to use Pandas to explore time series data for seasonal patterns.





One of the goals of time series analysis is to support better decision-making by understanding how the series events behave.

# Exploring Time Series Data

---

For example, using home sales data, we can identify the best time to sell a property based on increasing demand or higher sale prices.



To make such decisions, we need to identify any pattern that exists in a visualization depicting financial data over time.



# Exploring Time Series Data

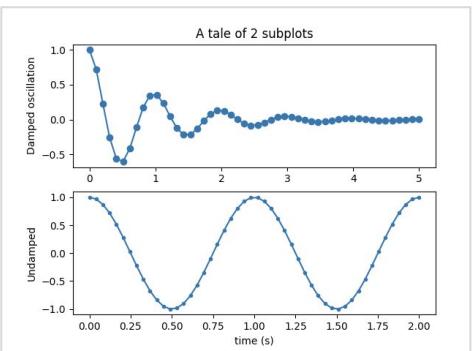
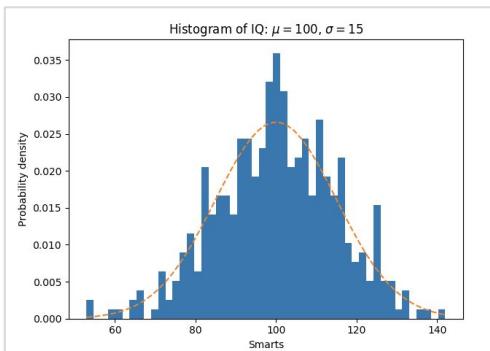
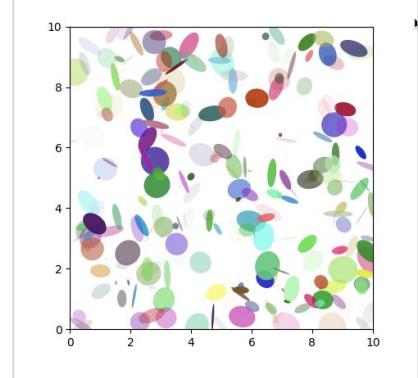
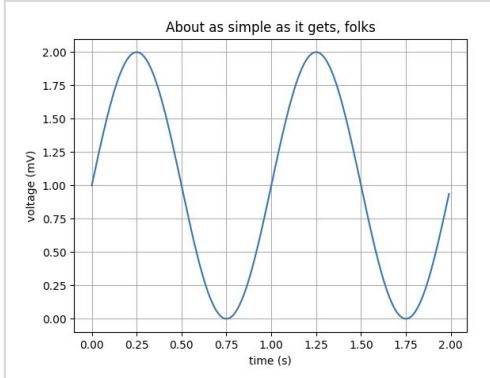
In this demonstration, you will:



Create and interpret visualizations, such as line plots, to analyze time series data for decision-making.



Analyze time series data by using heatmaps to recognize relationships.





## Instructor Demonstration

---

### Exploring Time Series Data



## Instructor Demonstration

---

Analyzing Time Data  
from a Quarterly Perspective

# Analyzing Time Data from a Quarterly Perspective

---

Now, we'll analyze the homes-sold series from a quarterly perspective. We'll use the DatetimeIndex attributes and the groupby function to compute the total home sales per quarter, as the following code shows:

```
# Compute the total home sales per quarter
quarterly_sales =
df_home_sales["homes_sold"].groupby(by=[df_home_sales.index.quarter]).sum()

# Display total home sales per quarter
quarterly_sales
```



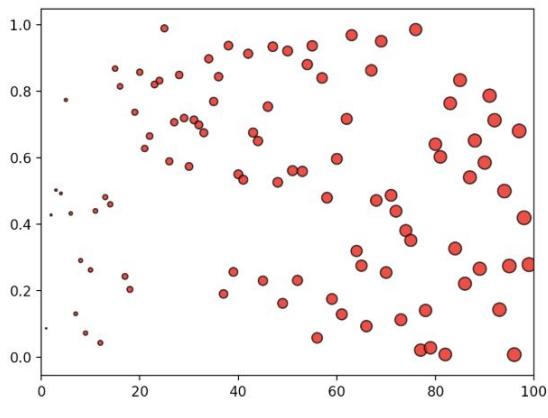
## Instructor Demonstration

---

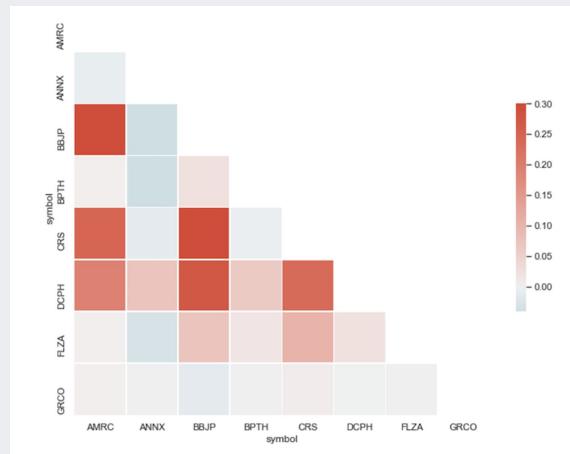
# Visualizing Time Data by Using hvPlot

# Visualizing Time Data by Using hvPlot

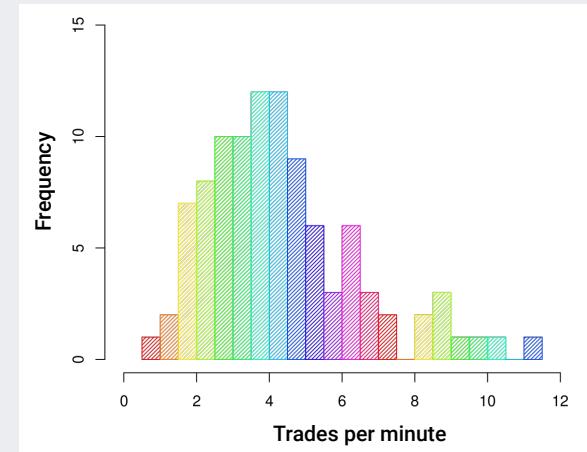
Grouping time series data and creating line plots offers a visual method for analyzing time series and identifying trends. But, depending on the patterns that we want to explore, we might want to use other types of visualizations, such as scatter plots, heatmaps, or histograms.



Scatter plot



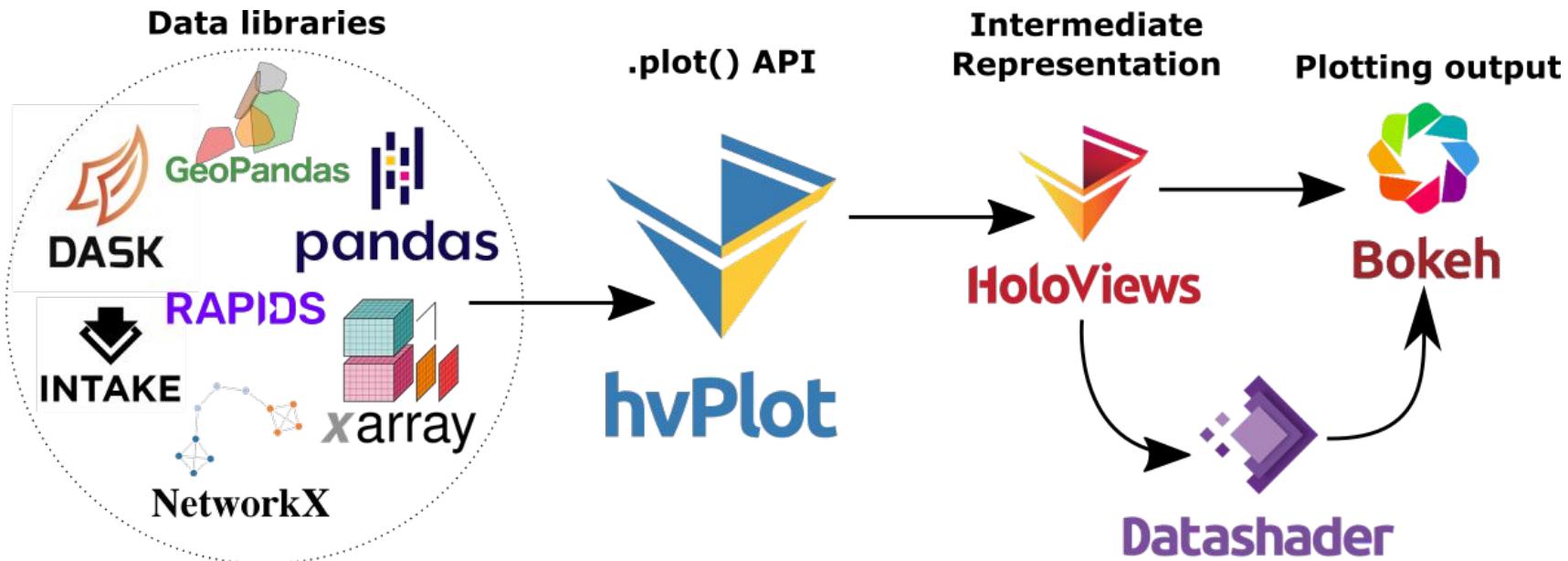
Heatmap



Histogram

# Visualizing Time Data by Using hvPlot

Now, we'll learn how to use the hvPlot library to provide more information about the time series in the plot.



# Questions?





# Activity: Analyzing Time Series Patterns in the S&P 500 Index

In this activity, you will use your newly developed skills to visualize and analyze time series patterns in the S&P 500 volume data.

Suggested Time:

---

20 Minutes



Time's Up! Let's Review.

# Questions?





## In the next class, you'll learn how to:

- Use correlations to identify whether two time series with seasonal patterns have a relationship—and whether that relationship is predictable.
- Forecast time series and interpret the forecasting results.

# Questions?



*The  
End*