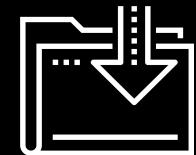


# Deep Neural Networks

Fintech  
Lesson 13.2



# Class Objectives

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By the end of the class, you will be able to:



Explain the difference between neural networks and deep neural networks.



Build deep learning models by using Keras.



**WELCOME**

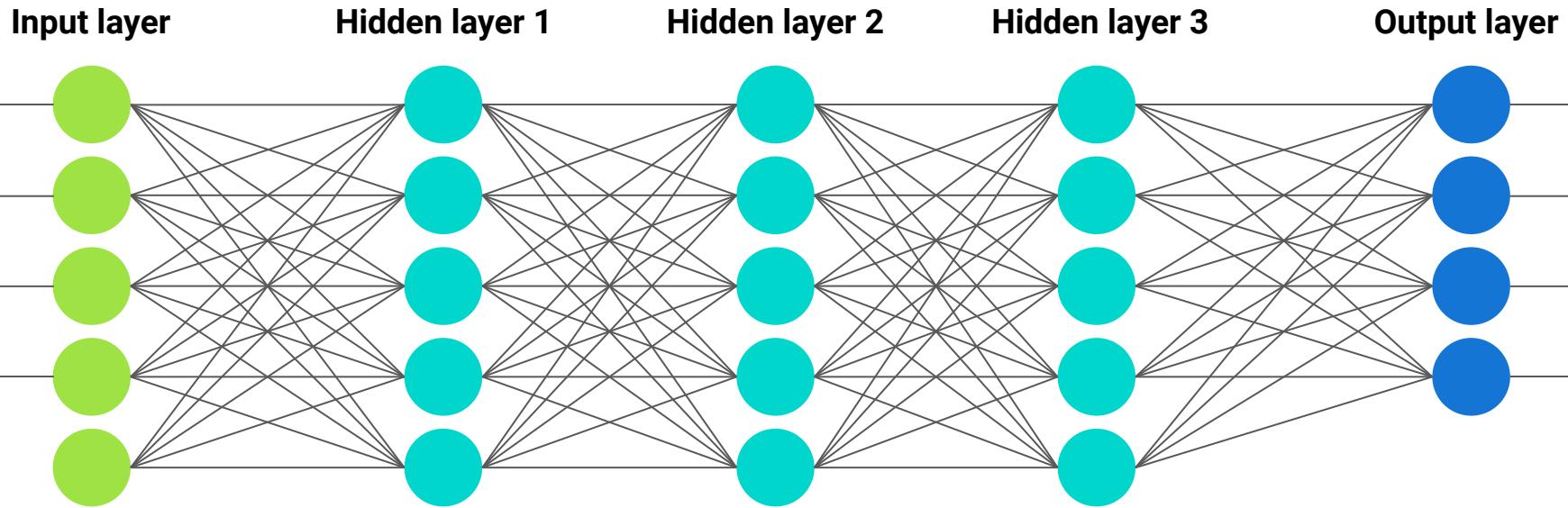


Today, we will dive into  
constructing **deep learning models**  
with real-world data.

# Deep Neural Networks

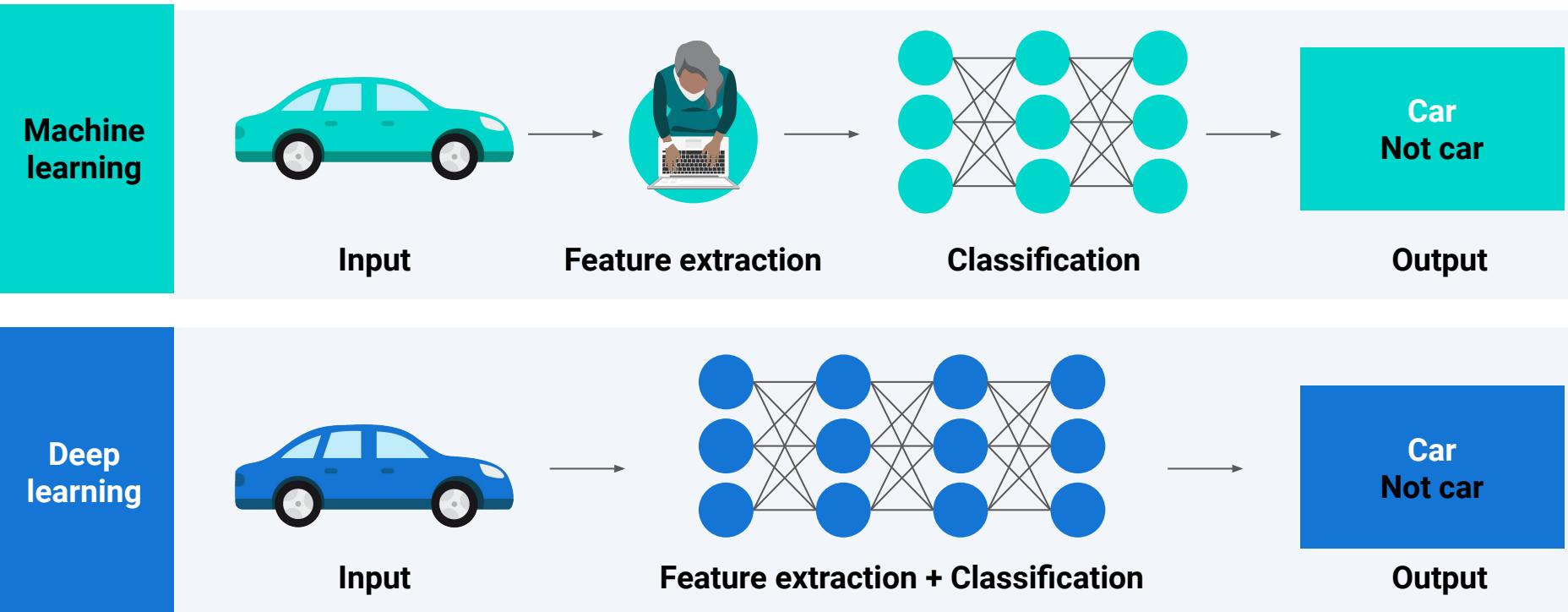
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Generally speaking, deep learning models are neural networks with more than one hidden layer.



# Machine Learning vs. Deep Learning

Deep neural networks are much more effective than traditional machine-learning approaches at discovering nonlinear relationships among data.

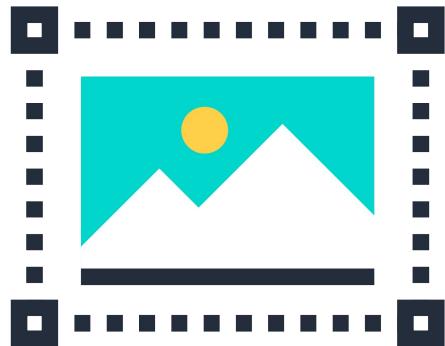


# Deep Neural Networks

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Deep neural networks are often the best choice for complex or unstructured data like:

Image



Text

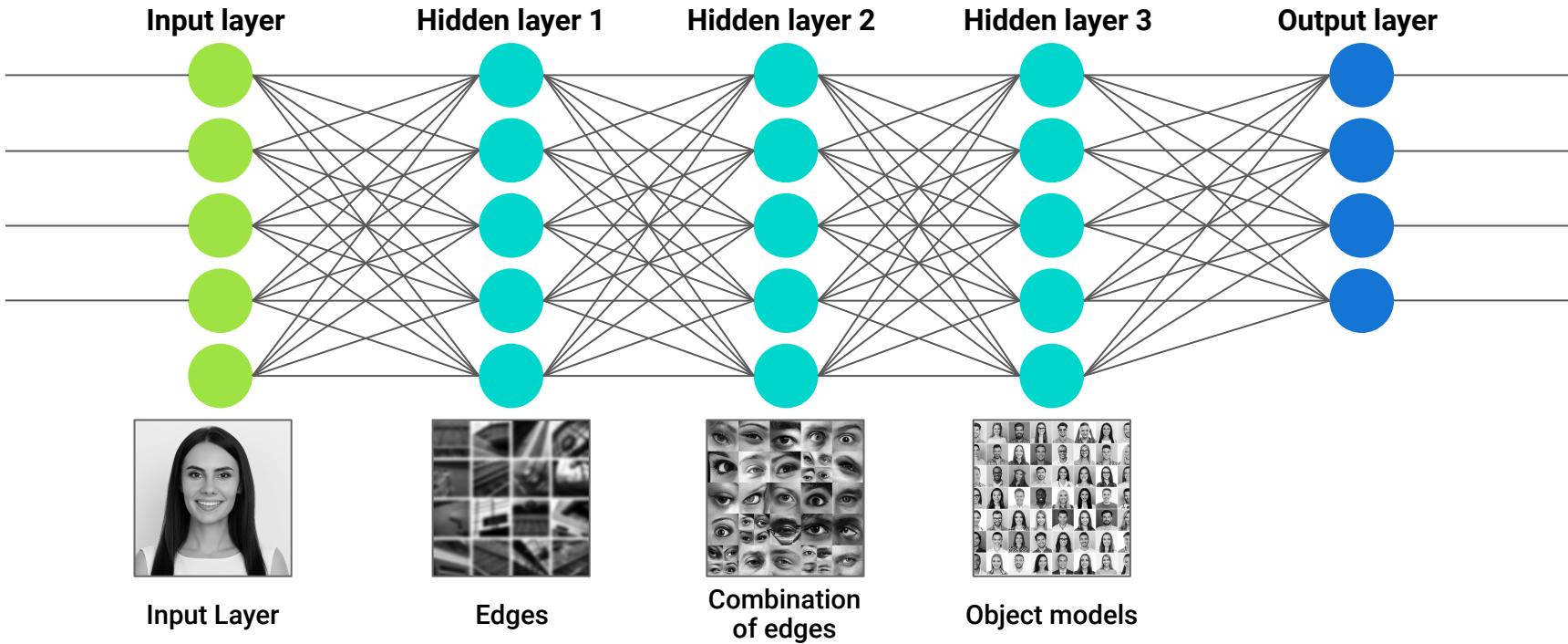


Voice



# Deep Neural Networks

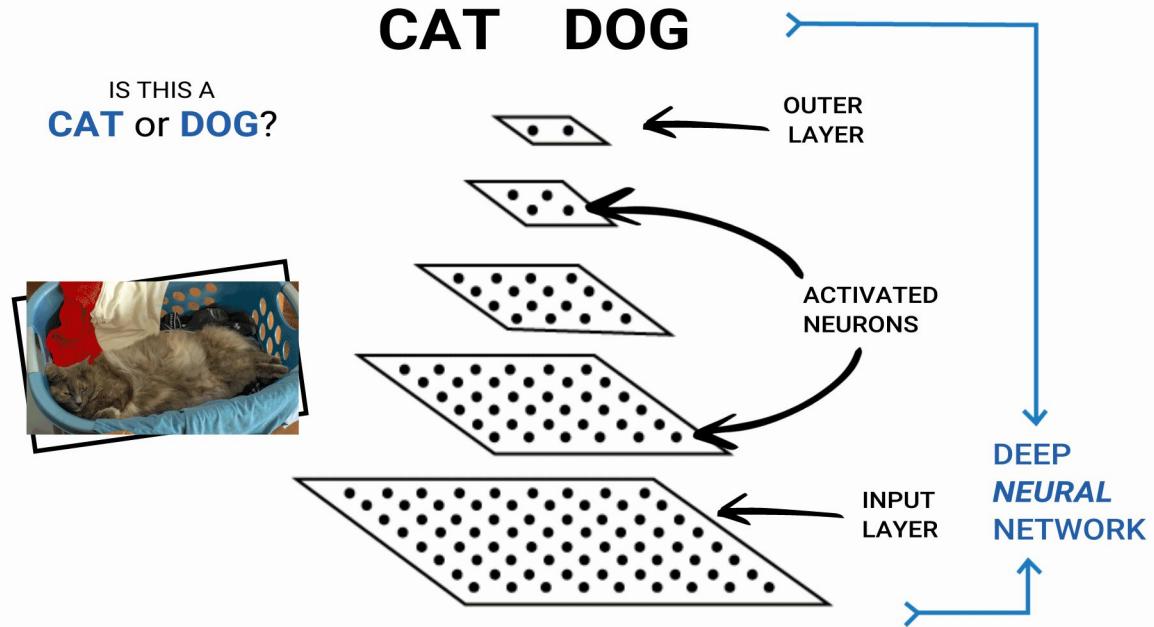
In image recognition, each layer can identify different image features in the process of defining or identifying the image.



# Introduction to Deep Learning

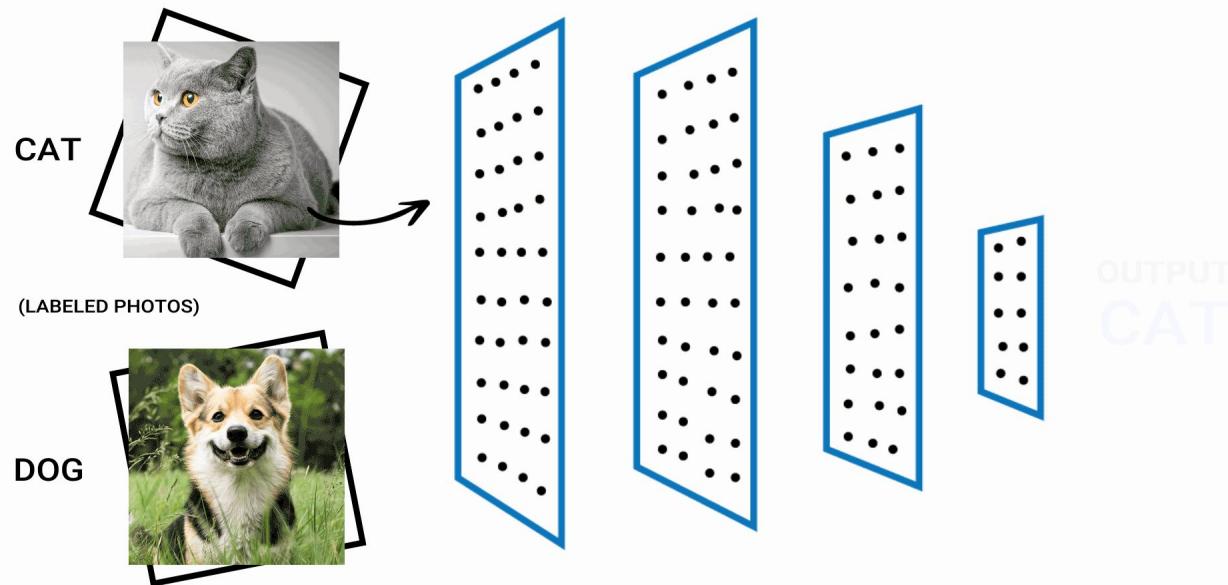
# Introduction to Deep Learning

Neural networks calculate the weights of various input data and pass them to the next layer of neurons. This process continues until the data reaches the output layer, which makes the final decision on the predicted category or numerical value of an instance.



# Introduction to Deep Learning

While definitions vary, we can consider neural networks with more than one hidden layer to be deep learning models. The decreasing cost and greater availability of computing power has increased our ability to create and use these models.

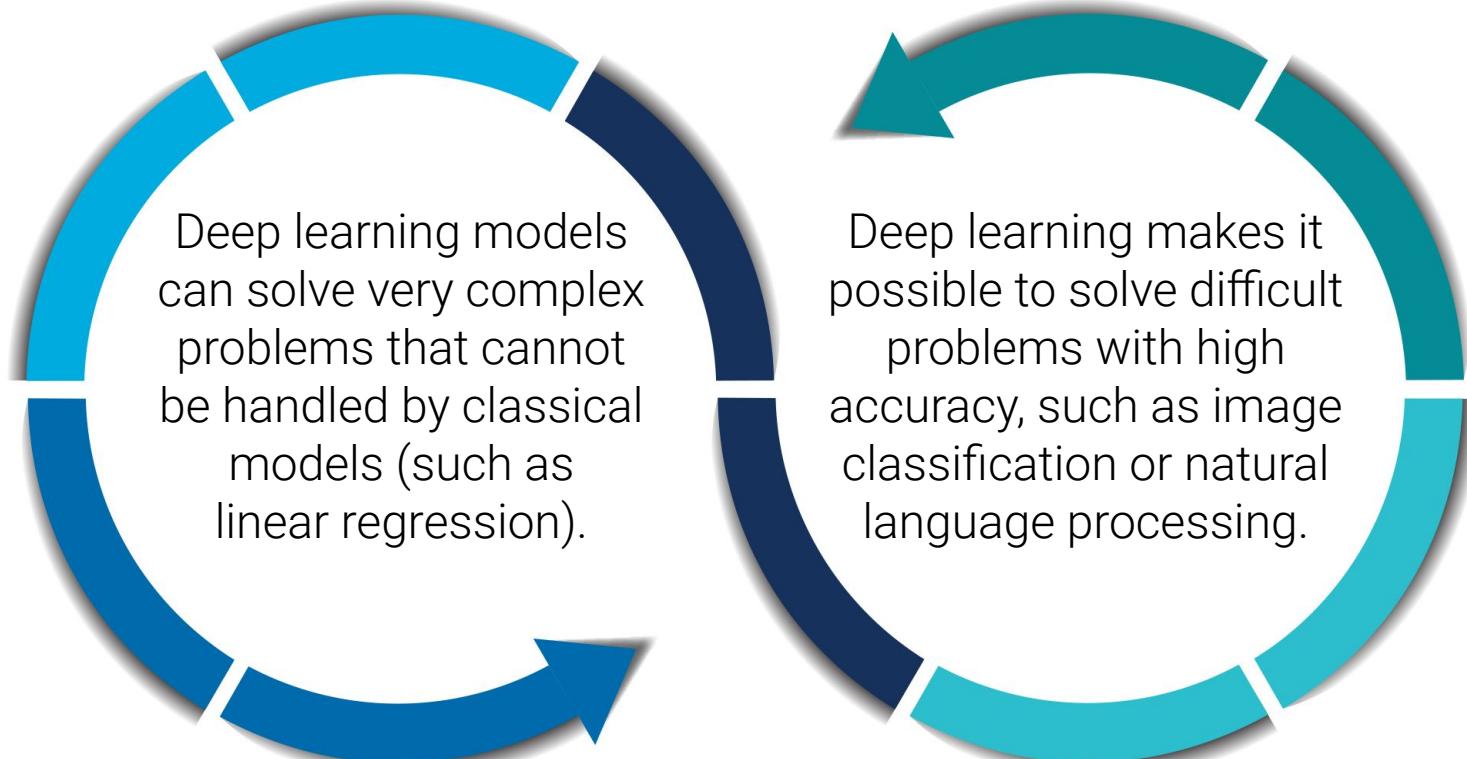




Each additional layer of neurons  
makes it possible to model more  
complex relationships and concepts.

# Introduction to Deep Learning

---





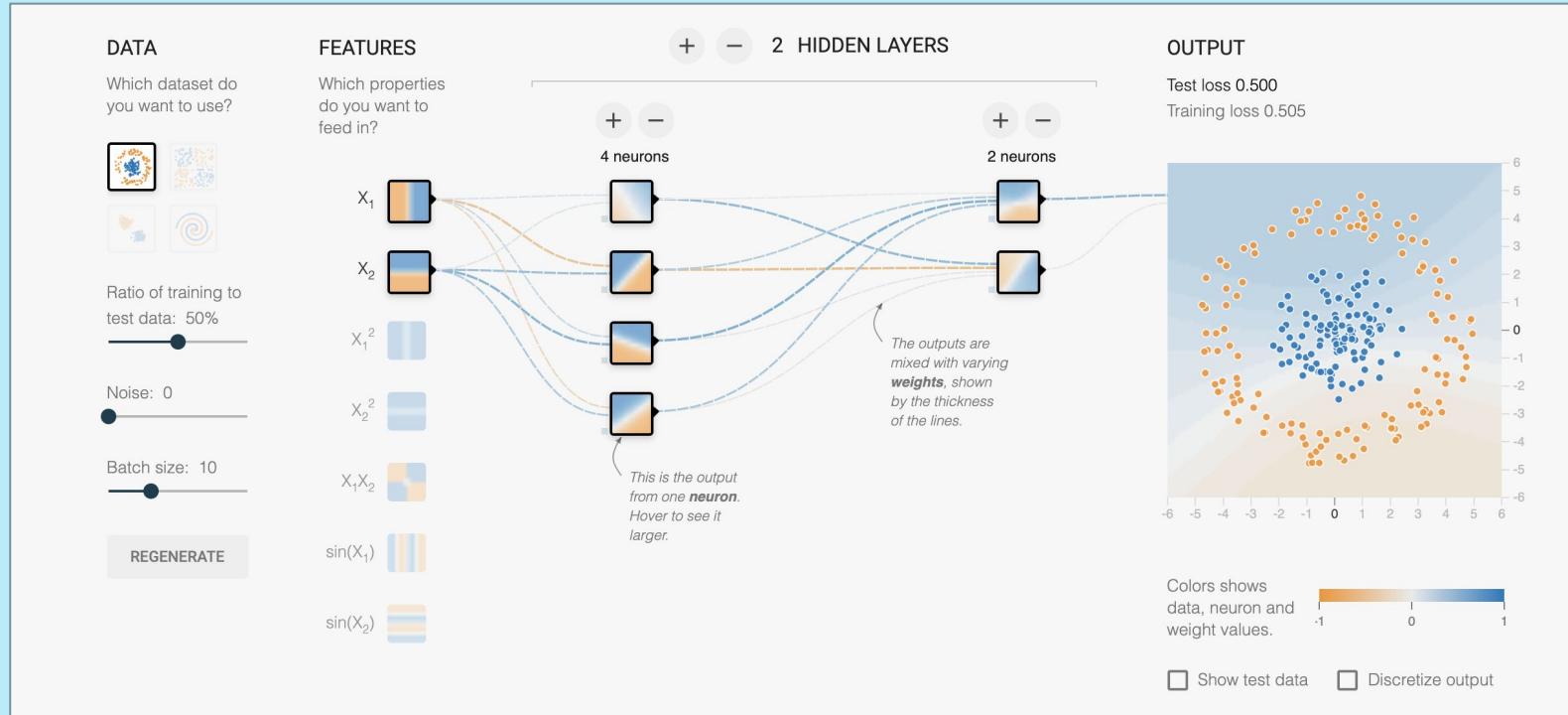
We are going to use the **TensorFlow**  
**Playground** to build our neural networks.

**TensorFlow Playground** is an application developed by TensorFlow as a teaching tool to “demystify the black box” of neural networks.



# TensorFlow Playground

The [application](#) provides a working simulation of a neural network as it trains on a variety of different datasets and conditions.



# TensorFlow Playground

---

Regardless of what machine learning model or technology is used, the same general modeling workflow exists across all data science:

01

Decide on a model and create a model instance.

02

Split into training and testing sets and preprocess the data.

03

Train/fit the training data to the model.

04

Evaluate the model for predictions and transformations.



# Instructor Demonstration

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## TensorFlow Playground



What are some examples of classification or regression problems that might benefit from a deep learning model?

# Sample Answer

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Facial recognition



# Sample Answer

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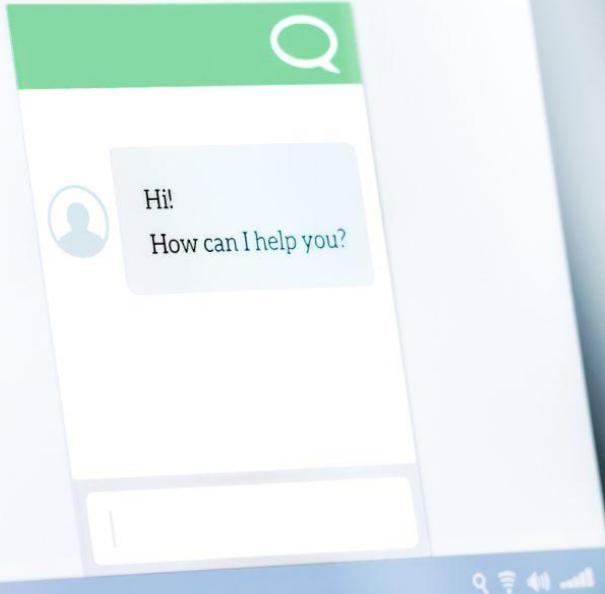
Medical diagnoses



# Sample Answer

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Natural language generation for chatbots

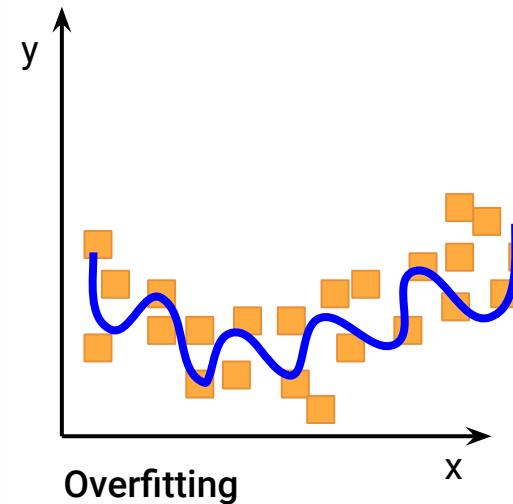
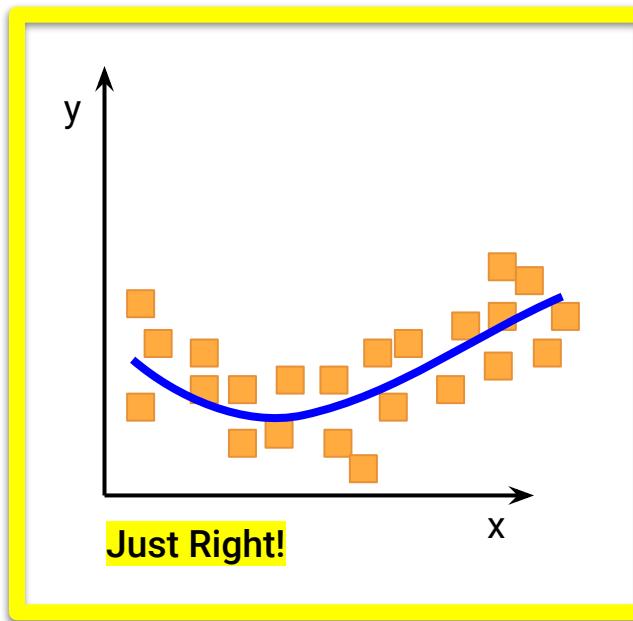
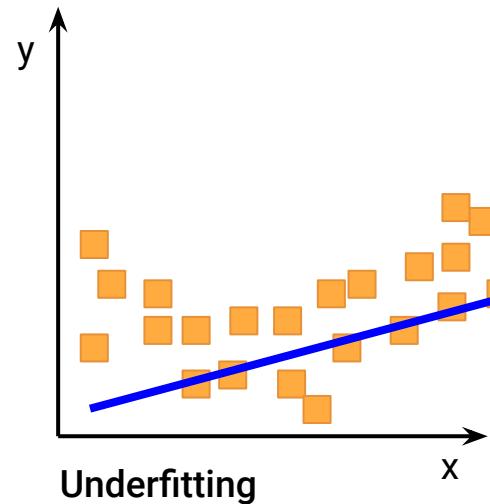




How can we determine if a neural network has too many layers of neurons?

# Sample Answer:

We can watch for signs of overfitting. For example, test accuracy is far lower than training accuracy.



# Questions?





## Instructor Demonstration

---

### Deep Learning with Keras

# Questions?





# Activity: Predicting Fraudulent Transactions

In this activity, you will build a deep learning model that can predict financial fraud.

Suggested Time:

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20 minutes



Time's Up! Let's Review.

# Questions?





Countdown timer

15:00

(with alarm)

Break





# Deep Learning with Nonlinear Data

Suggested Time:

---

20 minutes



How can we improve the  
model accuracy?

# Sample Answers

---

01

We can add more neurons to the hidden layer.

02

We can add a second hidden layer.

03

We can test with different activation functions.

# How Can We Improve the Model Accuracy?

---

Sample Answers:



Adding more neurons to the model is a possible solution, but we might overfit the model.



We could add a second layer to the model. This is a good solution that is part of deep learning. The next class will cover this topic.



We can test with different activation functions. This is typically the first thing to try, especially when dealing with nonlinear data.



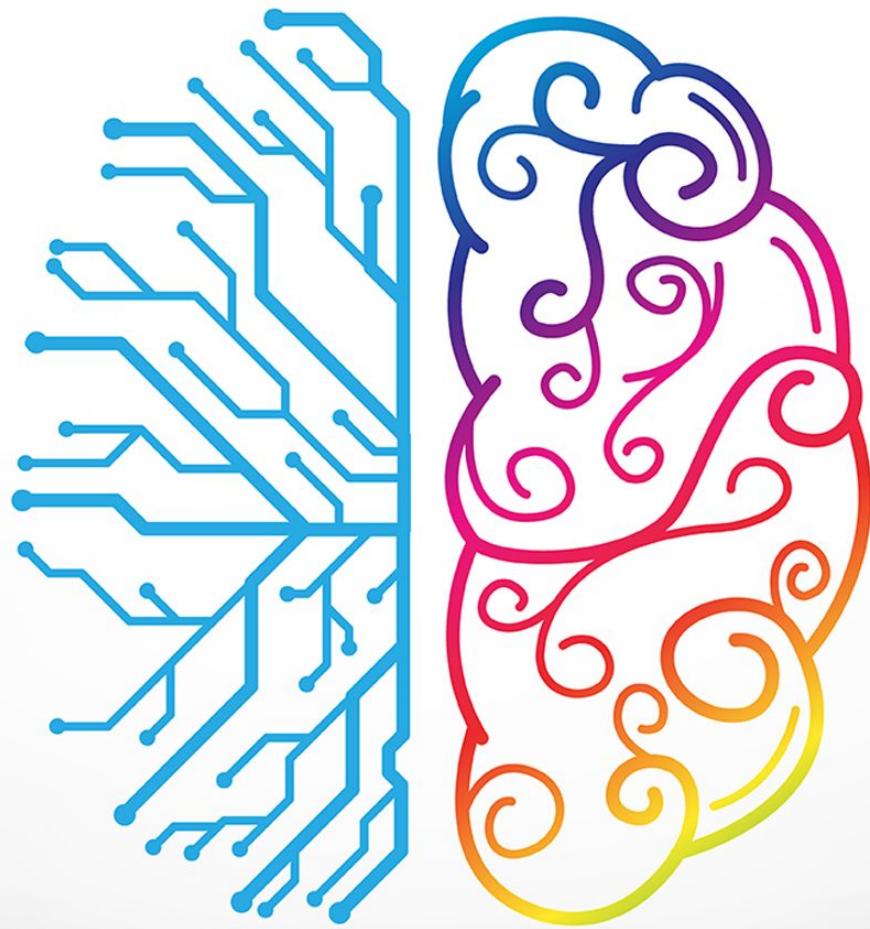
Using more epochs for training is another strategy to improve the model's accuracy.

A photograph of a person's hands and arms as they work on a laptop. The person is wearing a blue and white horizontally striped shirt. The laptop screen displays several lines of code in a light-colored font against a dark background. The person's hands are positioned on the keyboard, and a small red beaded bracelet is visible on their left wrist.

Spend some time  
modifying the code to  
use a different number of  
hidden layer nodes, and  
observe how the model  
accuracy changes.

Modeling neural networks is a mix of science and art.

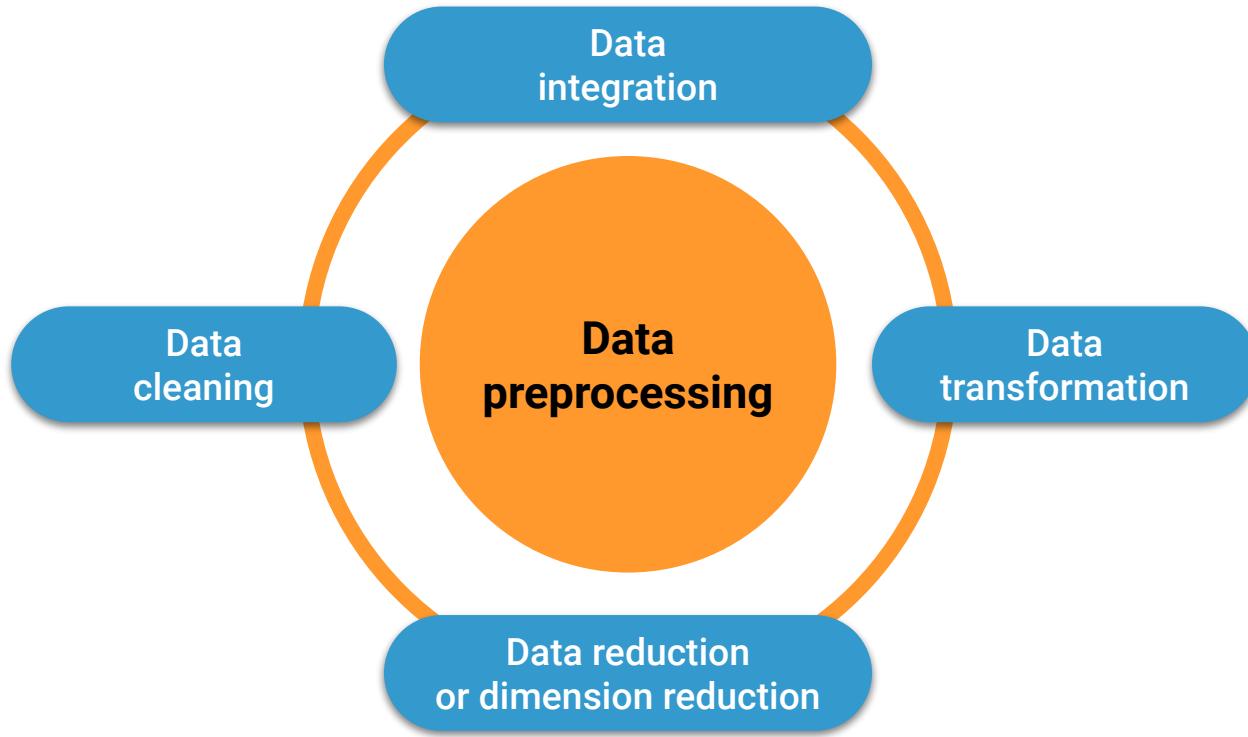
You'll find the best model through playing around with the number of neurons and testing different activation functions.



# Encoding Categorical Variables

# Encoding Categorical Variables

For all machine learning models (including neural networks), our first step is to preprocess the data.



# Encoding Categorical Variables

---

Neural networks often have difficulty training on numerical variables that are represented in different units or that have different scales of magnitude.

We previously used the `StandardScaler` module from scikit-learn to mitigate this problem for numerical variables.

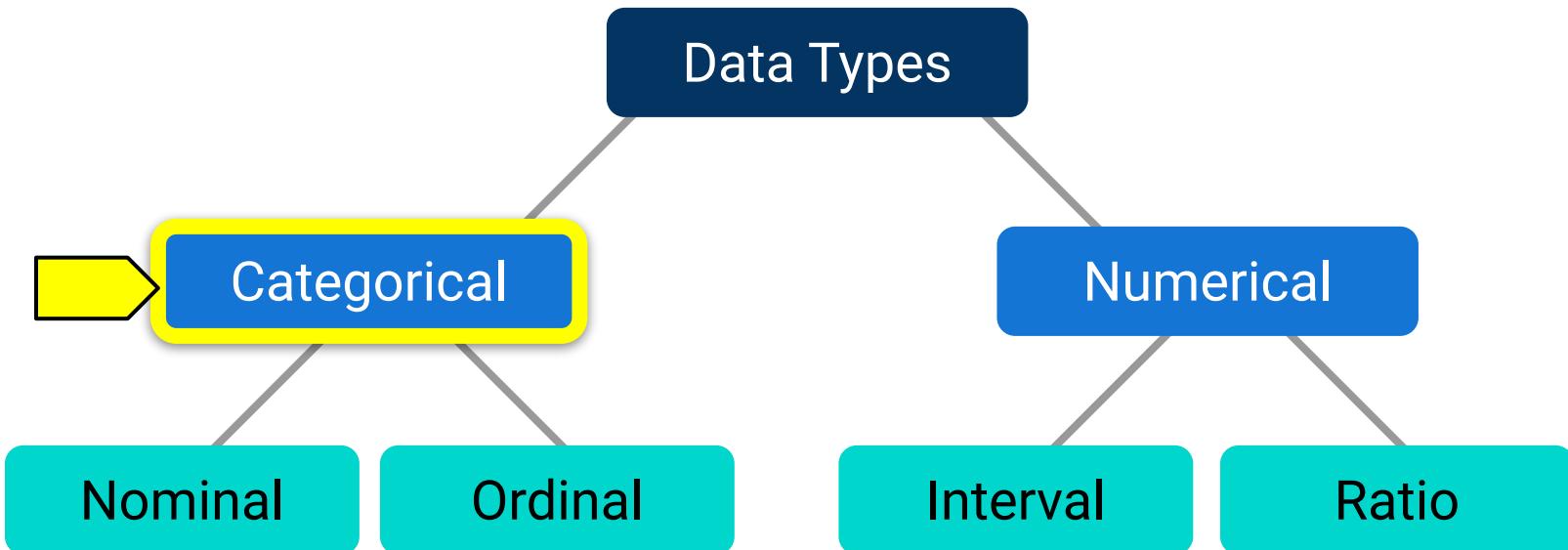
This module scales the values of different variables by normalizing data to center around the mean.



# Encoding Categorical Variables

---

Neural networks cannot process categorical variables in their raw forms. As the name implies, categorical variables represent categories, like a person's city of residence, or different industries of companies in a stock portfolio, in their raw forms.



# Encoding Categorical Variables

---

Remember...



We previously used the Pandas `get_dummies()` function to solve this problem for categorical variables.



However, `get_dummies` can run into trouble if the testing dataset contains categories that are not present in the training dataset.



To account for this potential `get_dummies` issue, we will use `OneHotEncoder`, a scikit-learn module that allows us to specify what happens when a new category appears in testing data.

# One-Hot Encoding

One-hot encoding involves taking a categorical variable, such as color, and creating three new variables of the colors. Each instance of the data now shows a **1** if it corresponds to that color, and **0** if it does not.

	A	B	C	D	E	F	G	H	I
1	Original data:		One-hot encoding Format						
2	id	Color		id	White	Red	Black	Purple	Gold
3	1	White		1	1	0	0	0	0
4	2	Red		2	0	1	0	0	0
5	3	Black		3	0	0	1	0	0
6	4	Purple		4	0	0	0	1	0
7	5	Gold		5	0	0	0	0	1



## Instructor Demonstration

---

Encoding Categorical Variables: OneHotEncoder

# Questions?





# Activity: Encoding Categorical Variables

In this activity, you will build a deep learning model that can predict employee attrition. In doing so, you'll use `onehotencoder` to help construct your input data.

Suggested Time:

---

20 minutes



Time's Up! Let's Review.

# Encoding Categorical Variables

---

Before going through the code, our work will be broken into three sections:

01

Preprocess the data.

02

Create a neural network model to predict employee attrition.

03

Train and evaluate the neural network model.

# Questions?



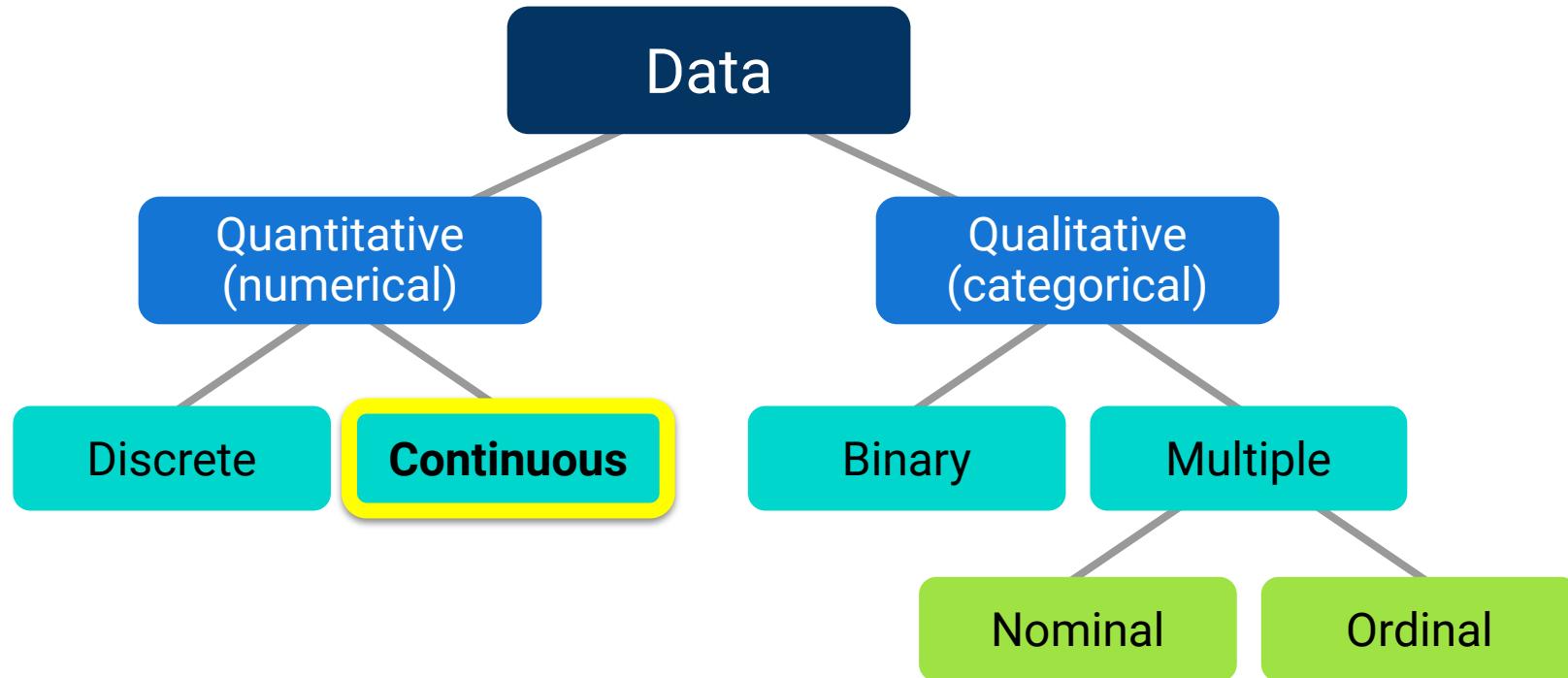
# Multiclass Prediction in Deep Learning

The first step of building deep neural networks—or any machine learning model—is understanding what you’re trying to predict.



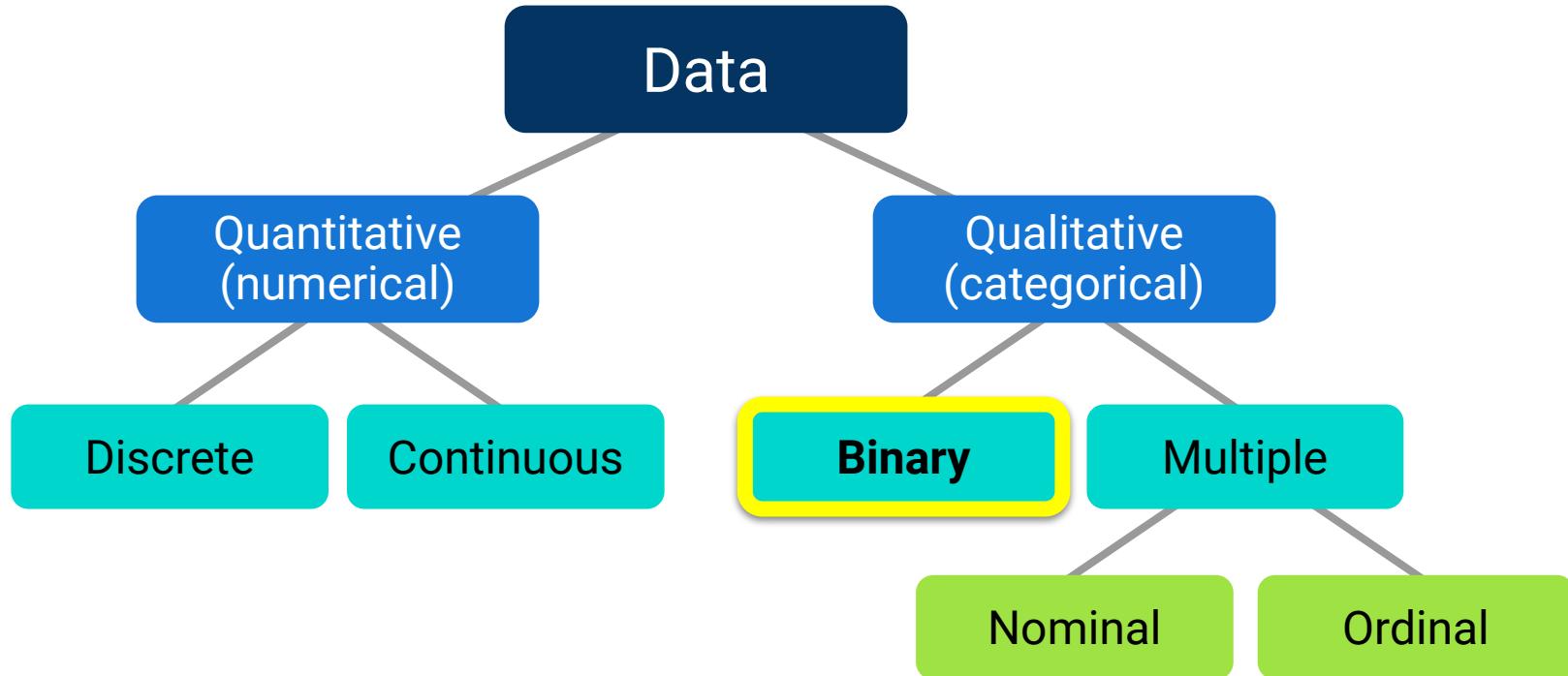
# Continuous Variable

When  $y$  is something like a stock return, the growth rate of a company, or other wide-ranging continuous number, our target variable is continuous.



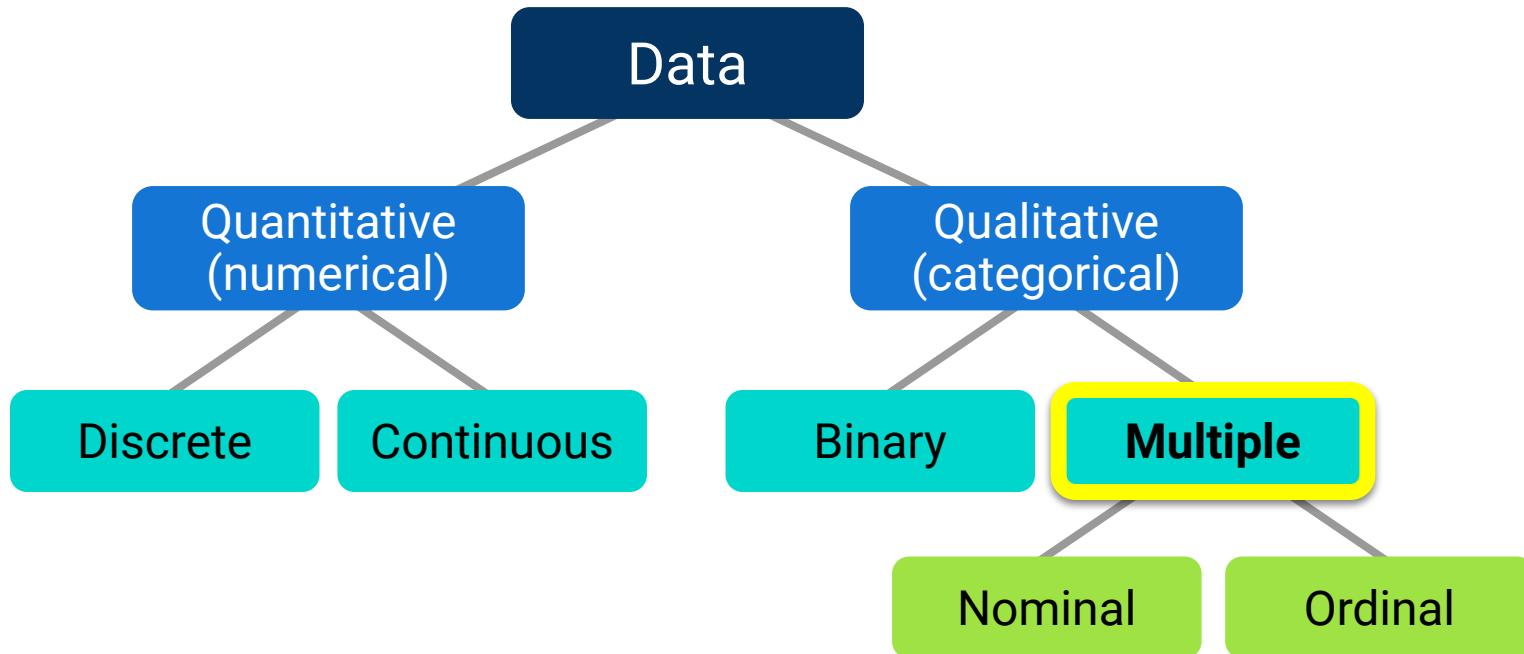
# Categorical Variables: Binary

In finance, there are many “Yes or No” type events that we want to predict: they either will or won’t happen.



# Categorical Variables: Multiclass

When  $y$  is a **multi-class categorical** variable, we're trying to predict among many outcomes. For example, we might try to predict the credit score ranking ("Bad," "Okay," "Good," "Great") to which a consumer belongs.





# Multiclass Prediction in Deep Learning Models

Suggested Time:

---

20 minutes

# Questions?







## Next Class

You will learn how to save your models for practical deployment as well as for future iterative improvements.

*The  
End*