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The WILLIAM STATES LEE COLLEGE *of* ENGINEERING

Introduction to ML

Lecture 1: Supervised Learning

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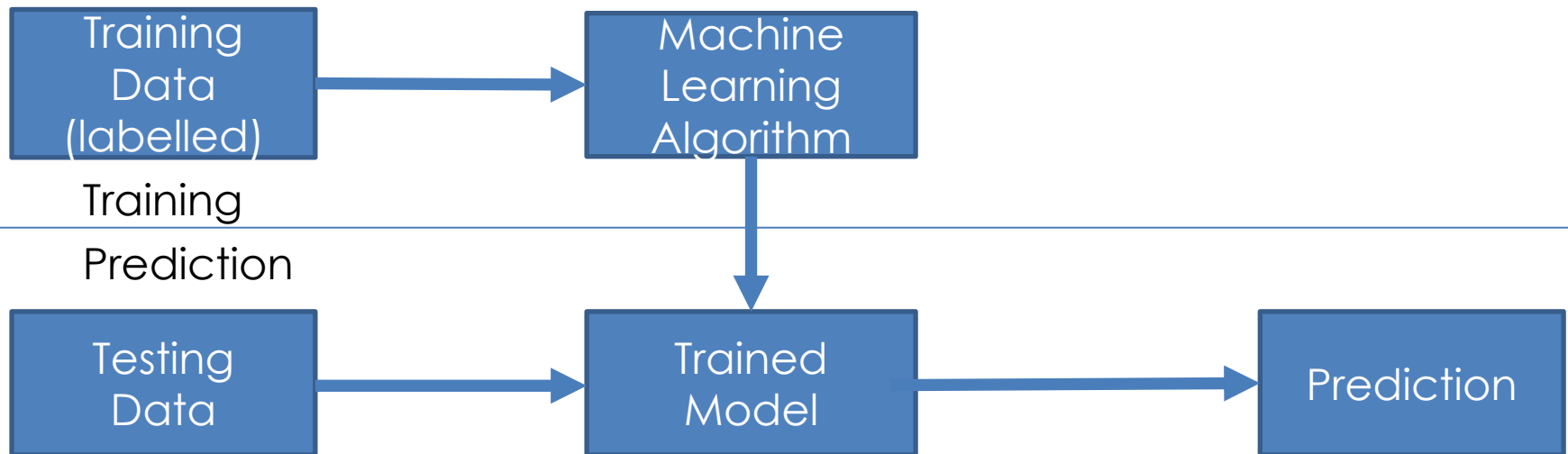
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ML – types of training/learning

- **Supervised** learning: uses a series of labelled examples with direct feedback
 - **Unsupervised/clustering** learning: no feedback
 - **Reinforcement** learning: indirect feedback, after many examples
 - **Semi-supervised learning:** partial labelled samples and possibly (a lot of) unlabeled samples
- Self-supervised learning
 - Weakly-supervised learning
- Popular in the deep learning era

Supervised Learning

- **Supervised** learning: uses a series of labelled examples with direct feedback
- The most common learning approach



Supervised learning

- The basic supervised learning framework



- Learning:** given a *training set* of labeled examples $\{(\mathbf{x}_1, y_1), \dots, (\mathbf{x}_N, y_N)\}$, estimate the parameters of the prediction function f
- Inference:** apply f to a never before seen *test example* \mathbf{x} and output the predicted value $y = f(\mathbf{x})$

Supervised learning

- Learning goal

$$y = f(x)$$

A diagram illustrating the supervised learning equation $y = f(x)$. The equation is written in blue. Below the equation, three red arrows point upwards to the components: the first arrow points to y and is labeled "output"; the second arrow points to f and is labeled "mapping function"; the third arrow points to x and is labeled "input".

- The goal is to approximate the mapping function so well that when you have new input data (x) that you can predict the output variables (Y) for that data accurately.

Supervised learning

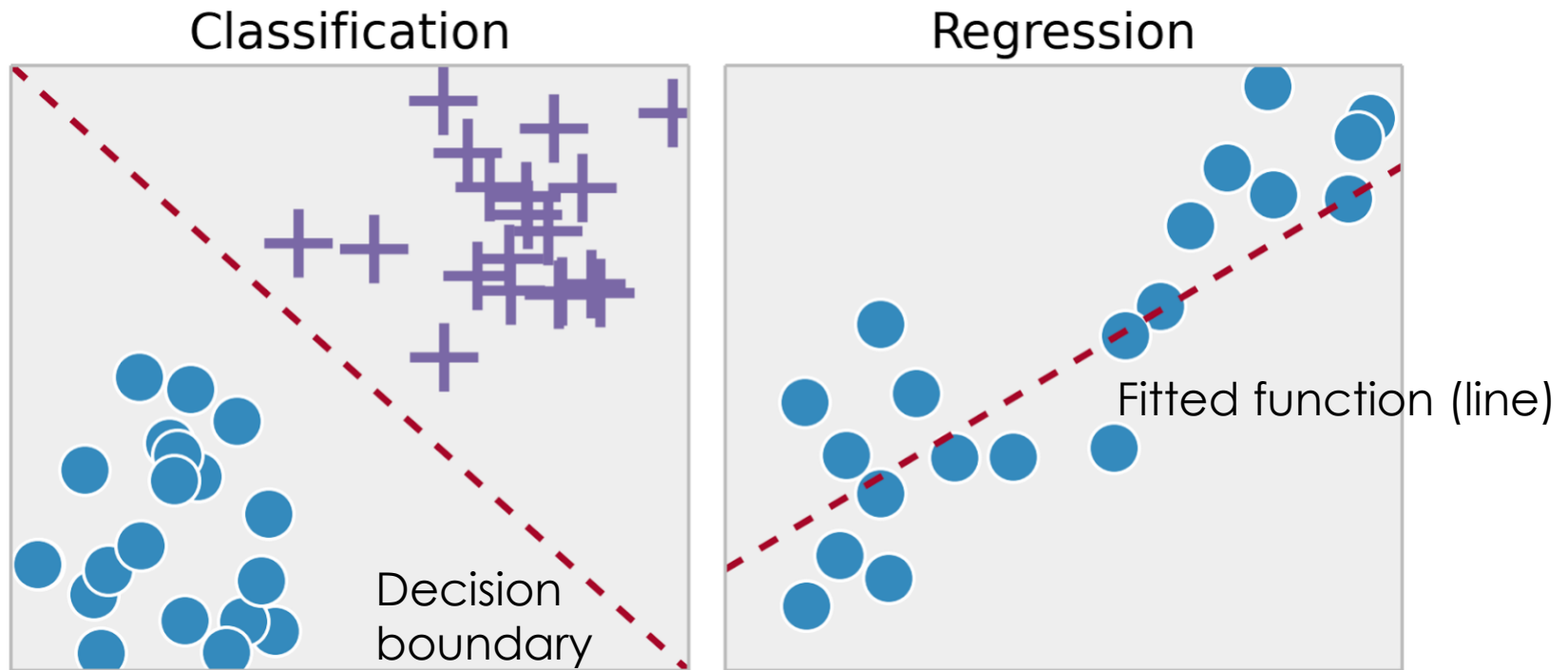
- Supervised learning problems can be further grouped into **Regression** and **Classification** problems
- What is the difference?
 - Output or predictive value:
 - numerical for regression (real or continuous value)
 - categorical for classification

Supervised learning

- A classification problem is when the output variable is a category (discrete class label), such as “red” or “blue” or “disease” and “no disease”.
- A classification algorithm may predict a continuous value, but the continuous value is in the form of a probability for a class label.
- A regression algorithm may predict a discrete value, but the discrete value in the form of an integer quantity.

Classification vs. regression



- A visual example of comparison



Quiz

- Supervised learning

Classification (C) or Regression (R) ?

	Input	Output	C or R
1.	Credit history	Lend money?	
2.		High school, college, Graduate	
3.		Age	

Types of classification

- **Binary classification**—when there is only two classes to predict, usually 1 or 0 values.
- **Multi-Class classification**—When there are more than two class labels to predict
 - E.g. image classification problems where there are more than thousands classes(cat, dog, fish, car,...)

Algorithms for classification

- Decision Trees
- Logistic Regression
- Naive Bayes
- K Nearest Neighbors
- SVM
- Neural Network
-

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Algorithm of regression

- Linear Regression
- Regression Trees (e.g. Random Forest)
- Support Vector Regression (SVR)
- Etc.

Regression Model

Regression model

- Explanatory variables are termed the **independent** variables and the variables to be explained are termed the **dependent** variables.
- Regression model estimates the nature of the relationship between the independent and dependent variables.

Examples

- Stock Market Forecast

$f($



$) =$ Dow Jones Industrial Average at tomorrow

- Self-driving Car

$f($

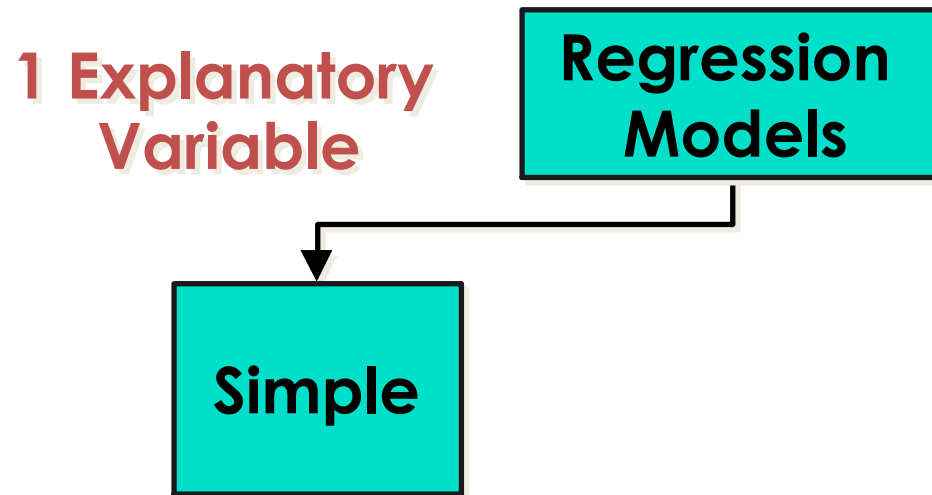


$) =$ Steering angle

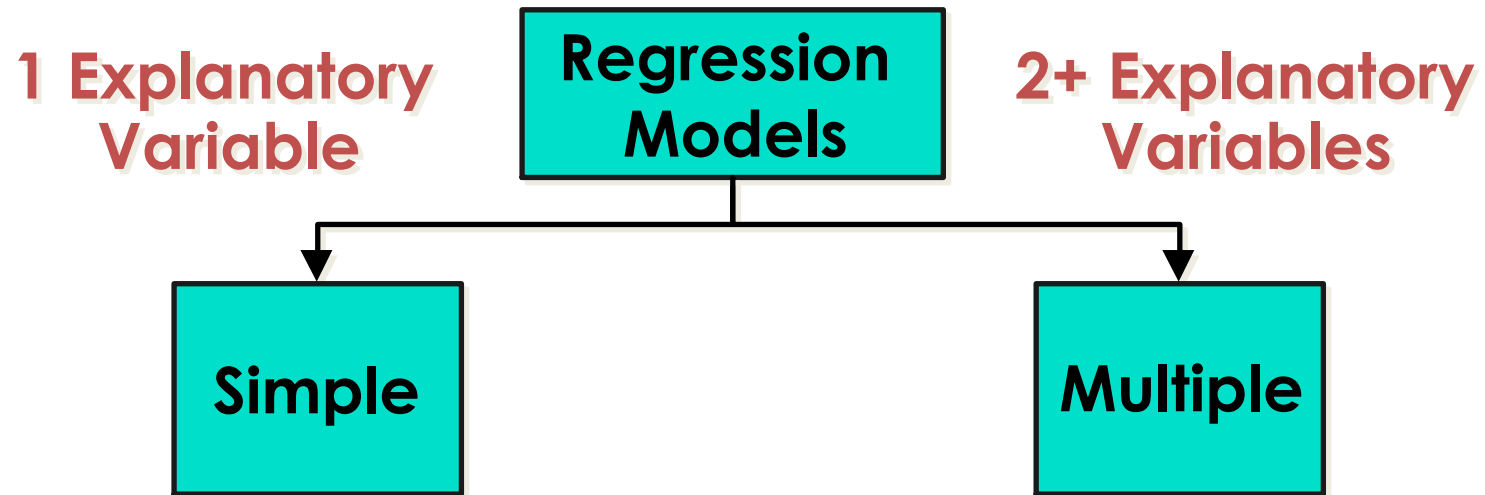
Types of Regression Models

**Regression
Models**

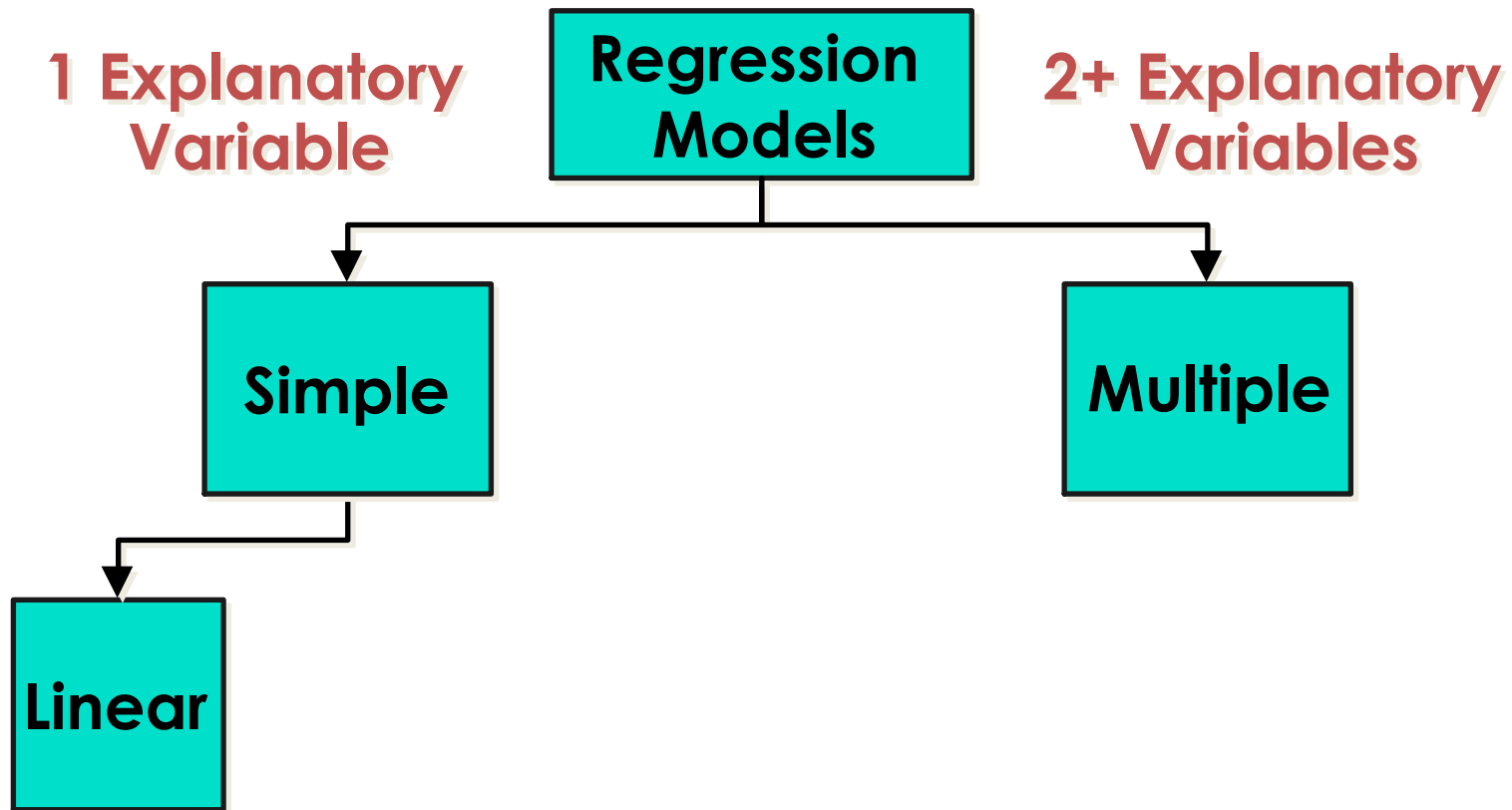
Types of Regression Models



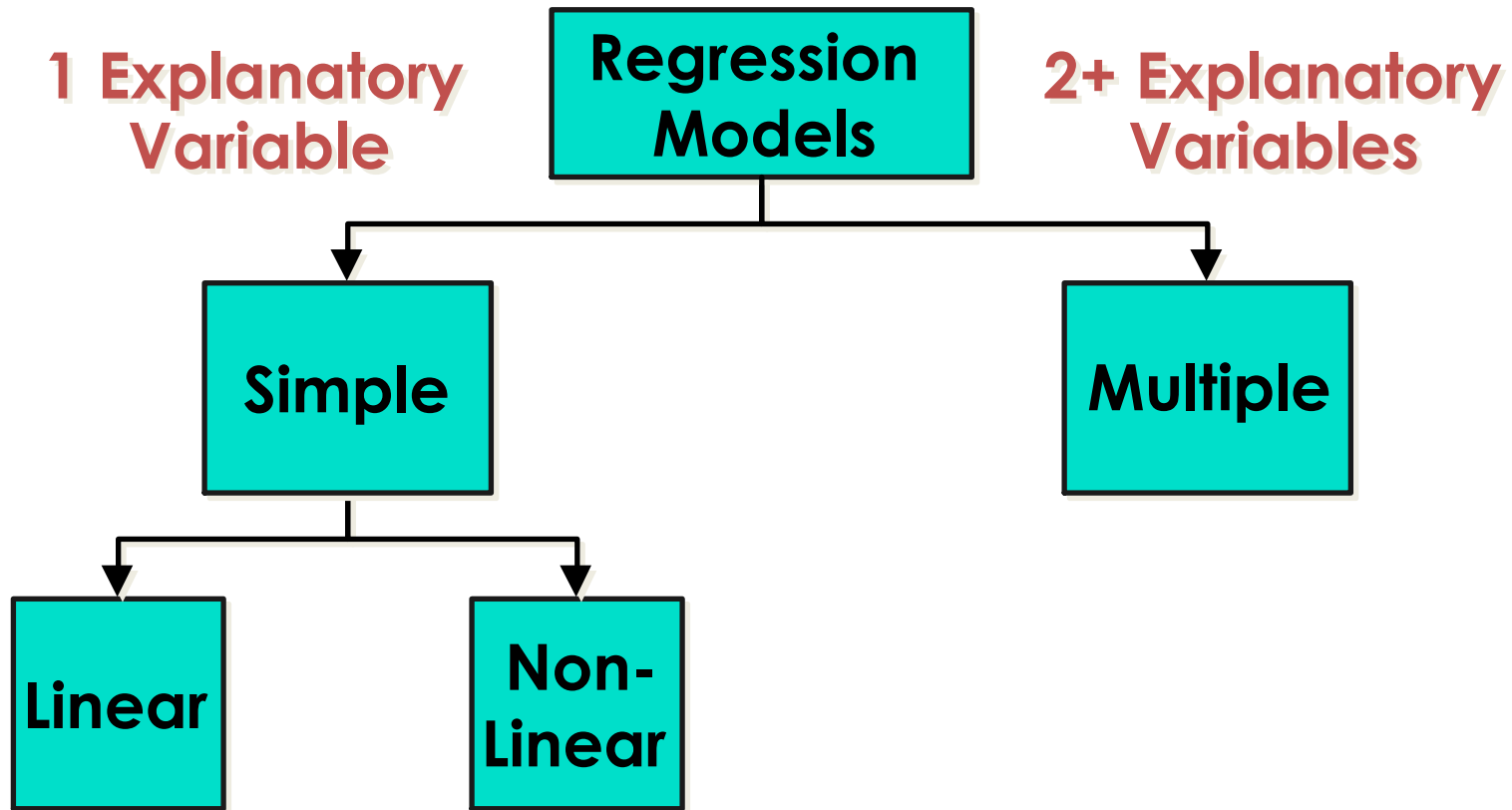
Types of Regression Models



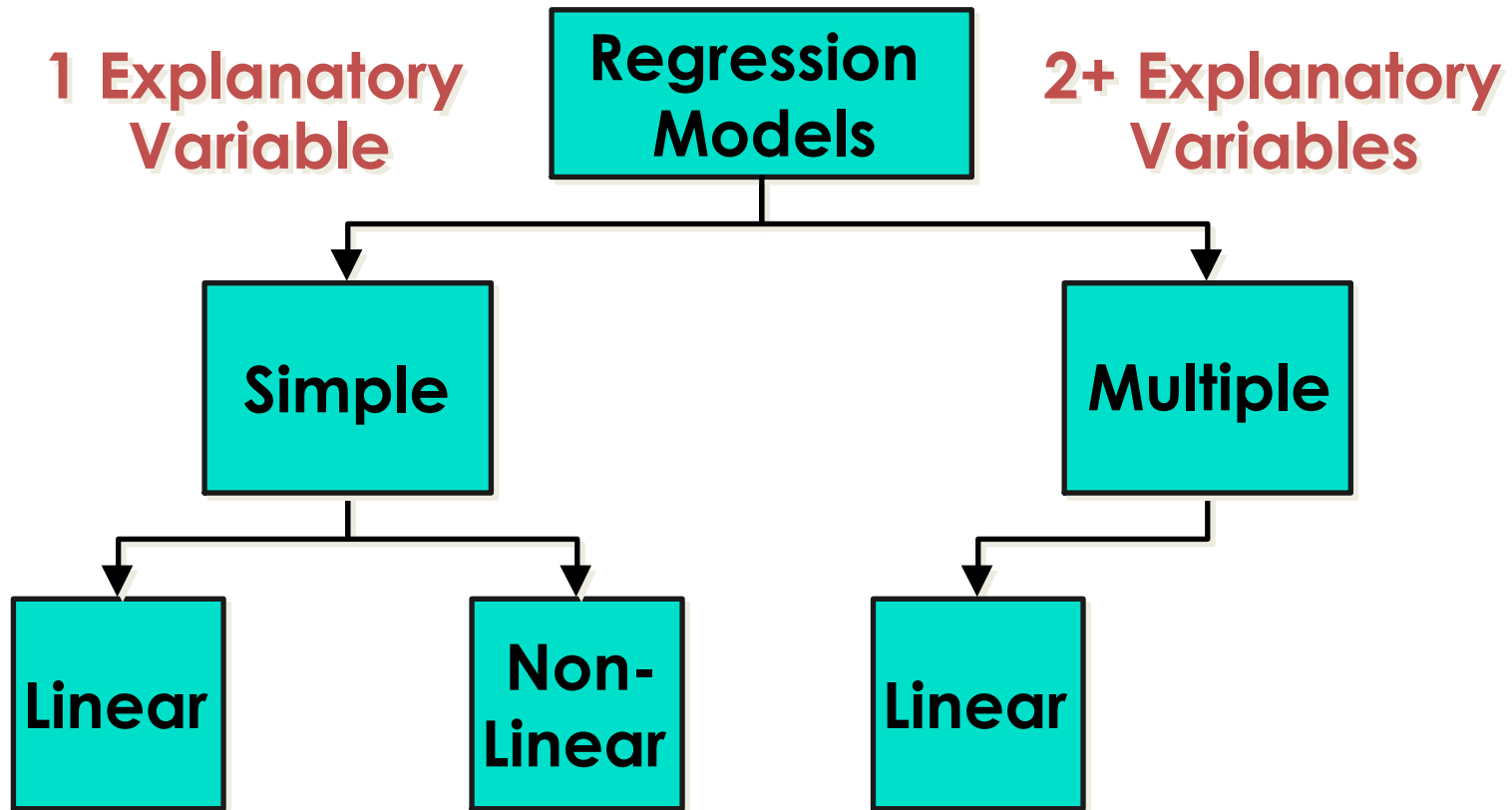
Types of Regression Models



Types of Regression Models



Types of Regression Models



Types of Regression Models

