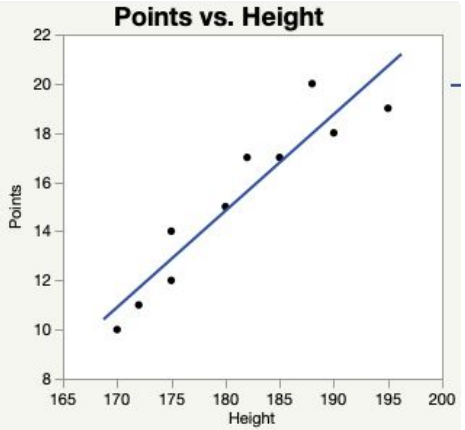
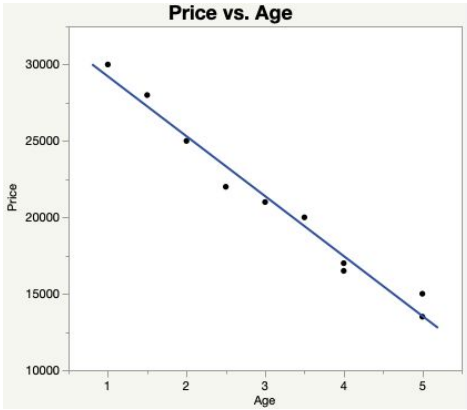
Linear regression is commonly used to find relationships between variables

For example, consider a **basketball** coach selecting players.
Here, ***height*** (input variable) is commonly considered to *linearly* influence ***number of points*** (output variable) scored during games.





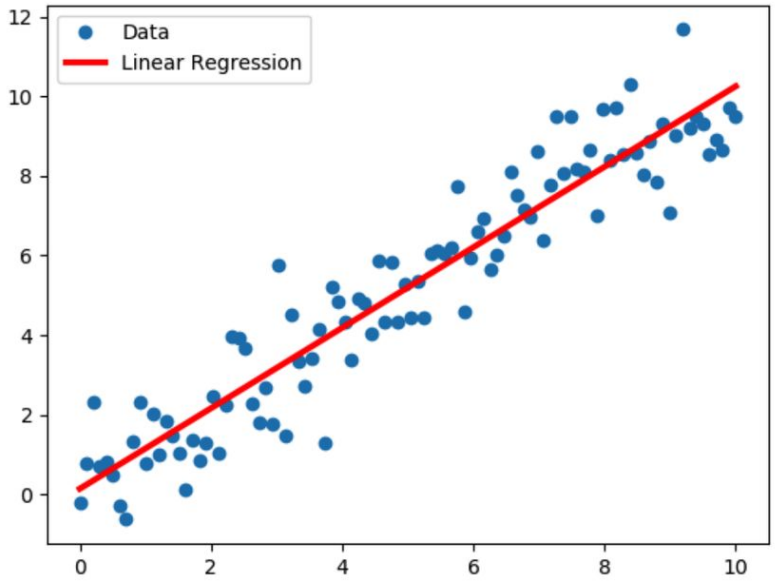
As a second example, consider a **second-hand car dealership.**
Here, the ***age*** (input) of the car typically has a *negative linear* effect on the **selling price** (output)**.**

Input Variables in Linear Regression

Quite often, there can be **multiple input variables** (X1, X2,...,Xn) that have an influence on an output variable (Y).
For example, both ***age*** and ***engine capacity*** can determine the ***selling price*** of a car.

In **linear regression**, this relationship is a linear combination:

$$Y = a1\ X1 + a2\ X2 + \ldots + an\ Xn$$



Here: Y = a X + b

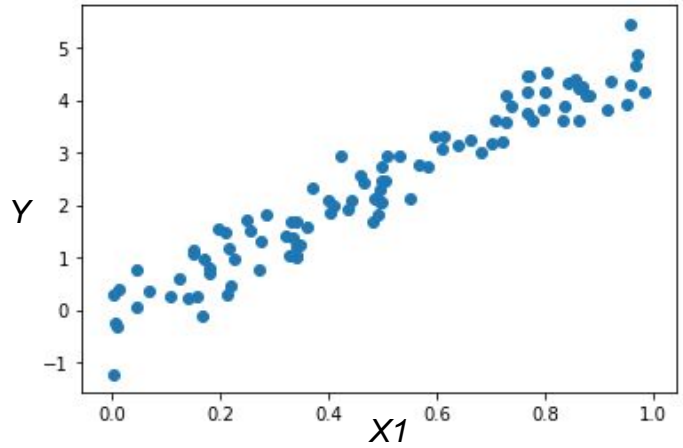
Including and Excluding Variables

Given several **input variables** (X1, X2,...,Xn), quite often **not all** input variables are related to the output variable (Y).
For example, the **colour** of a car might not determine the **selling price.**

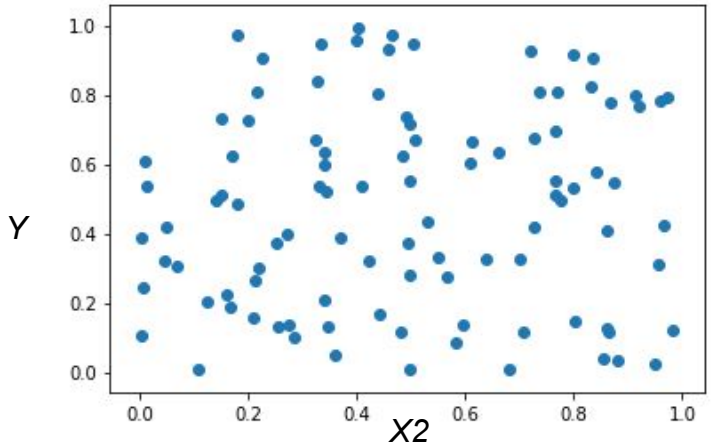
Here, there is **no correlation** between colour and selling price. In a linear regression model, input variables that are not correlated to the output variable should **not be included** in the model.

Example: Including and Excluding Variables

For instance in this example:



X1: correlated to Y



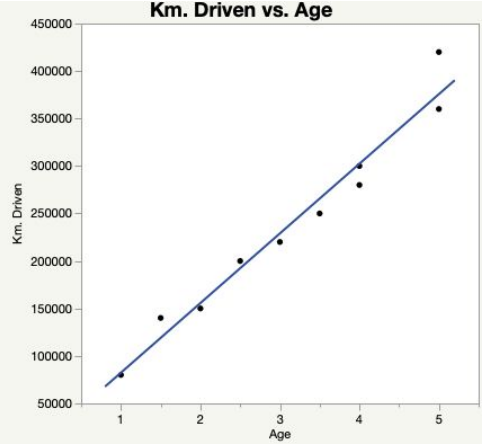
X2: not correlated to Y

It is clear that **X2 is not correlated** to Y and **should not be included** into the regression model. However, **X1 is correlated and should be included**.

Collinearity in Input Variables

Quite often, **two input variables** (Xi, Xj) can be **correlated** to each other.

For example, the ***age*** of a car may be directly correlated to the ***number of kilometres driven***.



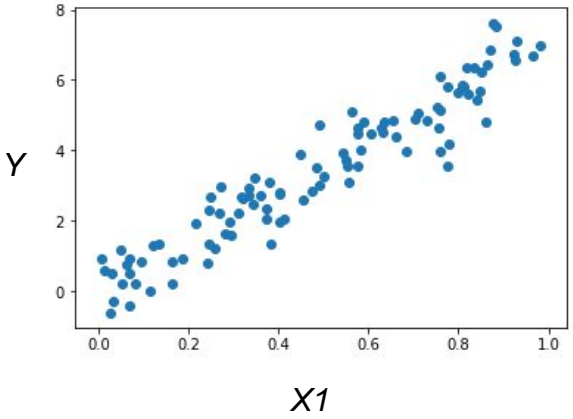
Models with Correlated Input Variables

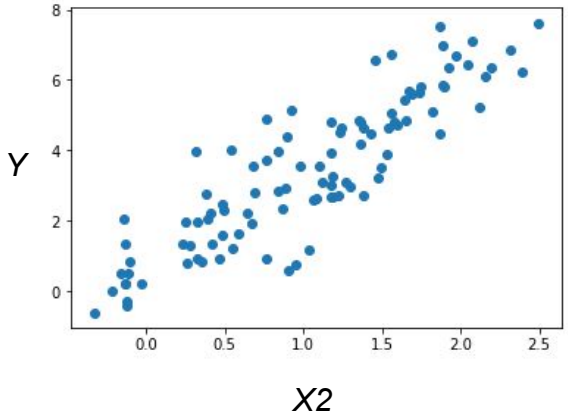
If all input variables are independent (uncorrelated) of each other, then the task is simple: all input variables correlated to the output Y have to be included in the regression model.

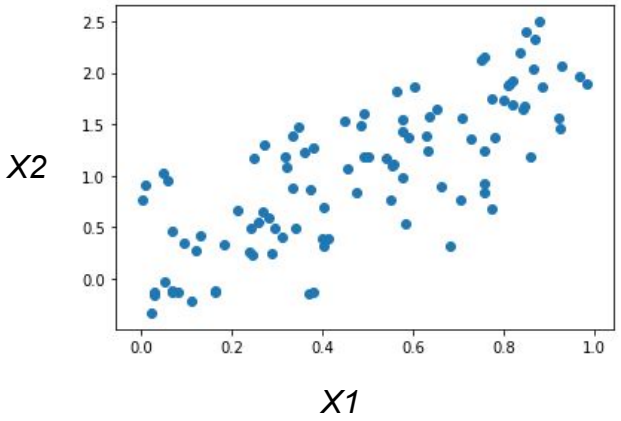
However, **if two input variables Xi and Xj are correlated** to each other, but also to the output Y, it is **better to include only one of the two** into the linear regression model. *(Indeed, the necessary information is already included, and having both might weaken the system.)*

An Example Case

For instance, in this example:







X1 and X2 are correlated to the output Y, so both should be included?

In fact **no**: X1 and X2 are also correlated, so it is better to include only one!