

# Logistic Regression: Multiclass Classification

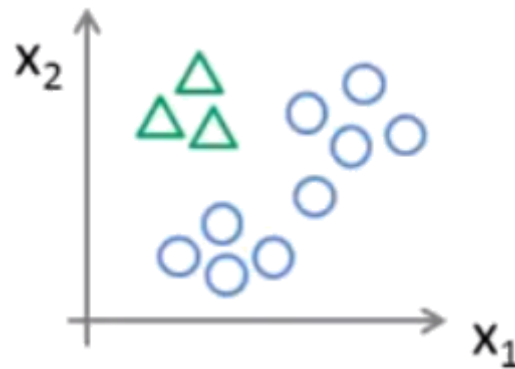
*Multiclass Classification* is *Logistic Regression* with more than two classes or outcomes. For example, classifying a type of car: van, truck, sports car, etc. For example, possible  $y$  values could be:

$y = 1$  for a van

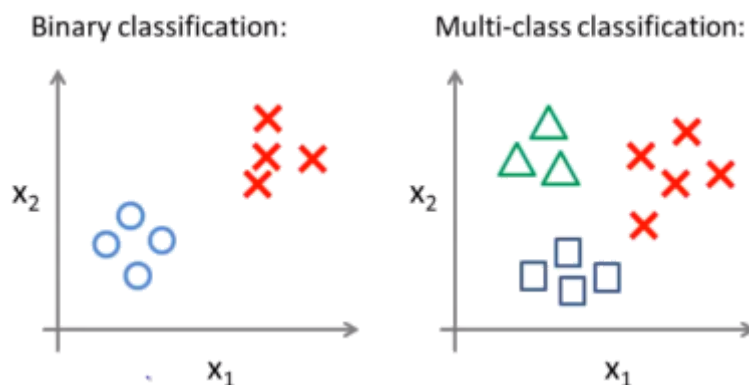
$y = 2$  for a truck

$y = 3$  for a sports car

Multiclass Classification can be achieved using what is called *One-vs-All (One-vs-Rest)* where we basically make each class a different *Binary Classification* problem. For example, in the illustration below we would produce three different *Binary Classification* problems to get three different predictions.



The below illustration depicts this concept. We pick one class and treat the other two classes as a single class and perform a single *Binary Classification* problem. This is what is meant by the term *One-vs-all*.



In the illustration above, the green triangles would be a value of 1 and the blue circles would be a value of 0. This is formally written as:

$h_{\theta}^i(x) = y_1$  where the superscript,  $i$  in this case, identifies the number of the class, 1, 2, or 3 for example.

We repeat this for the remainder of the classes producing three different predictions. This is expressed as, Given  $i$  is 1, 2 or 3 then what is the probability of  $y = i$  given the values of  $x$  and  $\theta$ :

Given  $i \in \{1, 2, 3\}$  then  $h_{\theta}^i(x) = P(y = i|x; \theta)$

What we will end up with are different predictions for each classifier where we want select the prediction,  $i$ , that *maximizes*  $h_{\theta}^i(x)$  (yields the highest probability).