LOGISTIC REGRESSION

LOGISTIC REGRESSION

- Logistic regression predicts the probability of occurrence of an event

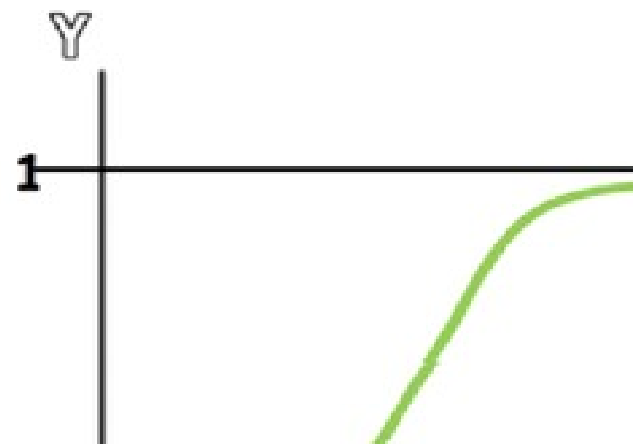
- Logistic regression analyzes the relationship between a dichotomous dependent variable And the independent variables

- Logistic regression can be used to answer the questions like

  - what is the probability that the debtor will pay back the loan?
  - what is the probability that the customer will churn?
  - what is the probability that the student will pass the test?
  - what is the probability that the claim is fraud?

- Application across domain like finance, healthcare, retail, telecom and insurance so on

LOGISTIC REGRESSION EQUATION



The equation for Logistic regression is:

$$\boxed{Ln[p/(1-p)] = \alpha + \beta X + e}$$

- p is the probability that the Y Occurs
- p/(1-p) is the “odd ratio”
- In [p/(1-p)] is the log odd ratio, or “logit”

The logistic distribution constraints the estimated probabilities to lie between o and 1

The estimated probability is: $p = 1/[1+\exp(-\alpha-\beta X)]$

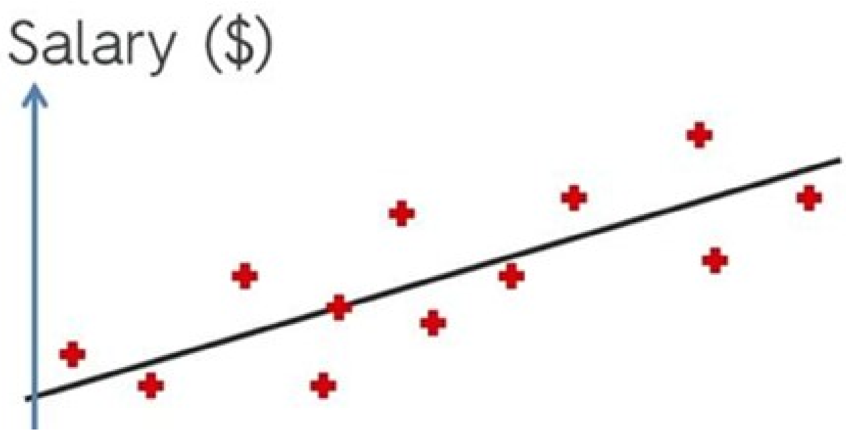
Simple Linear Regression

$$y = b_0 + b_1{}^*x_1$$

Dependent variable (DV)

Inde

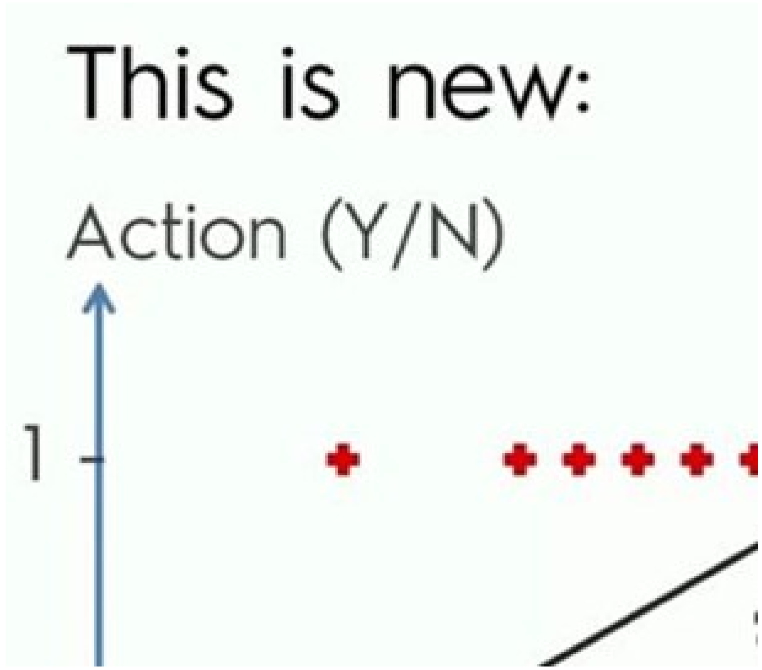
Multiple



y =

Sal

LOGISTIC REGRESSION



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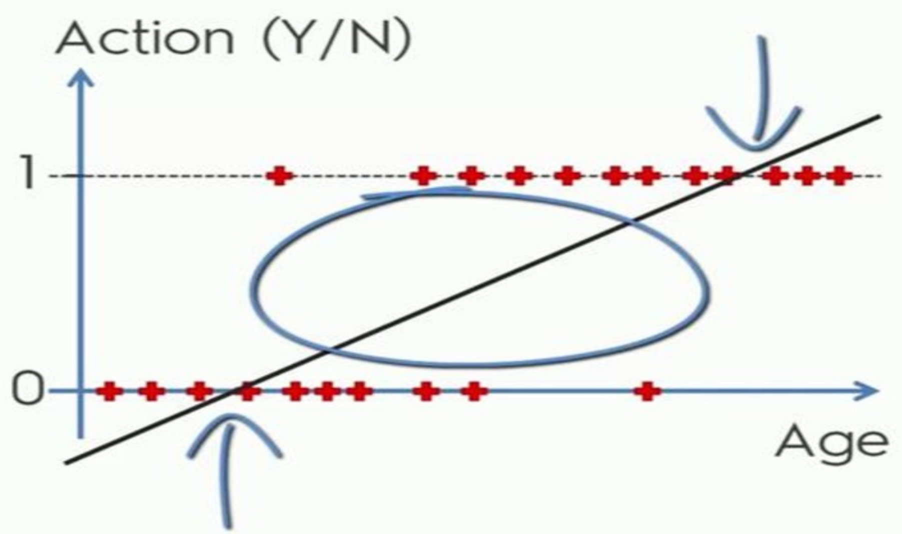

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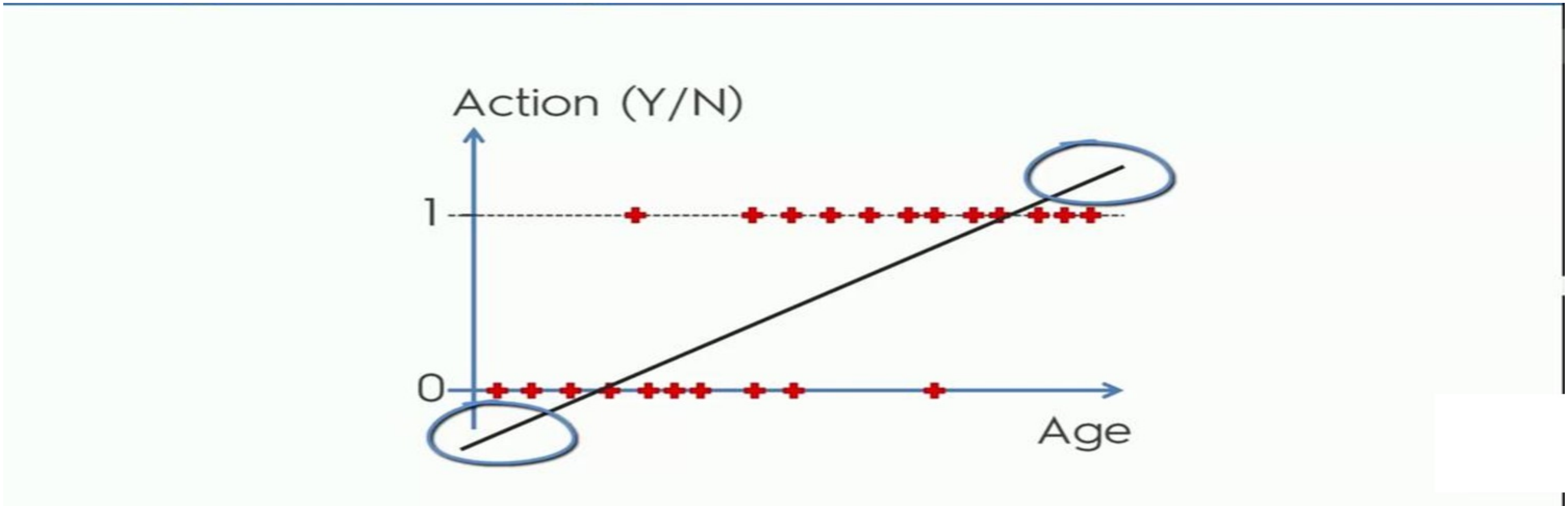

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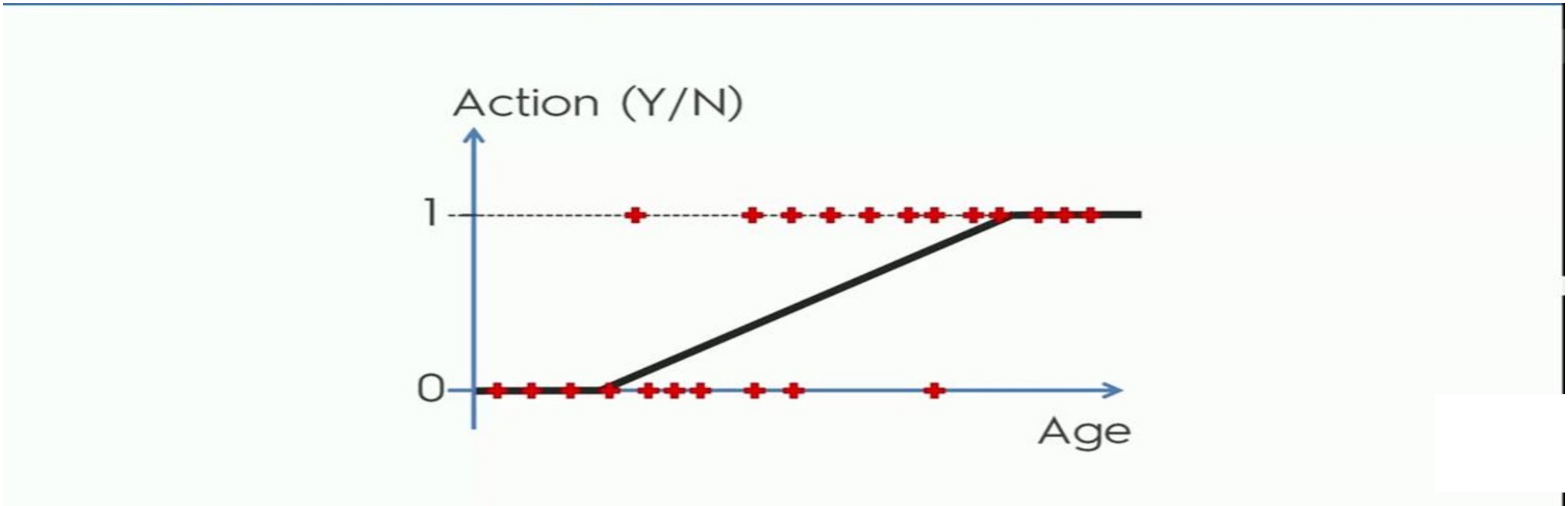

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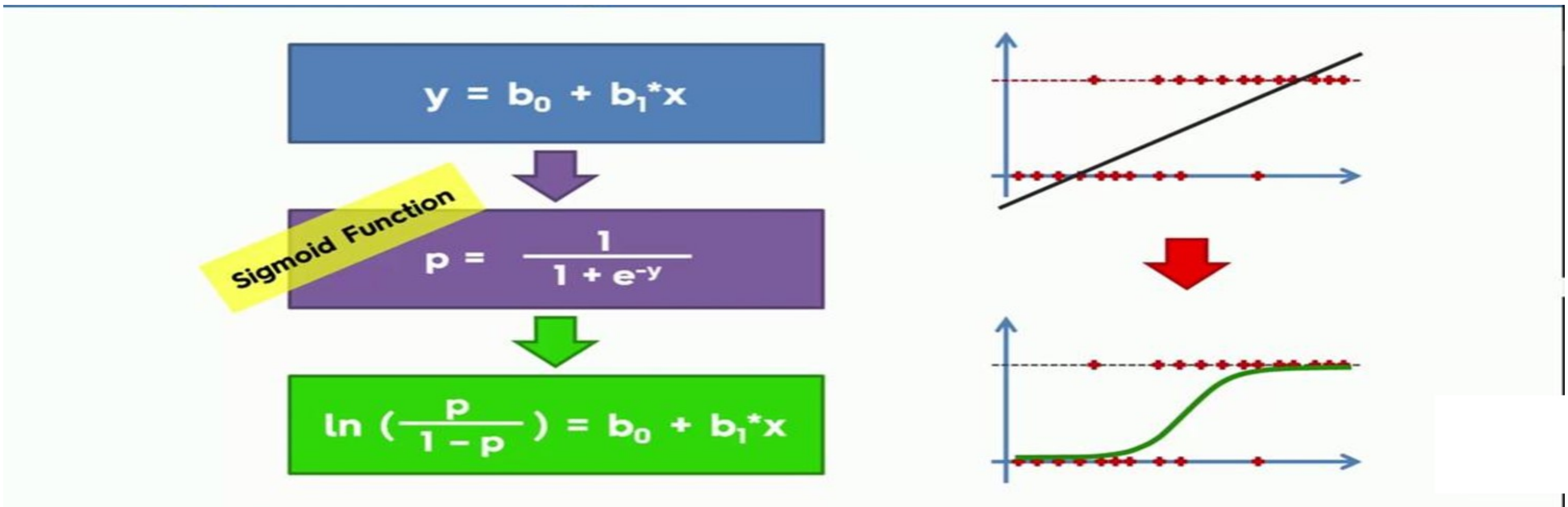

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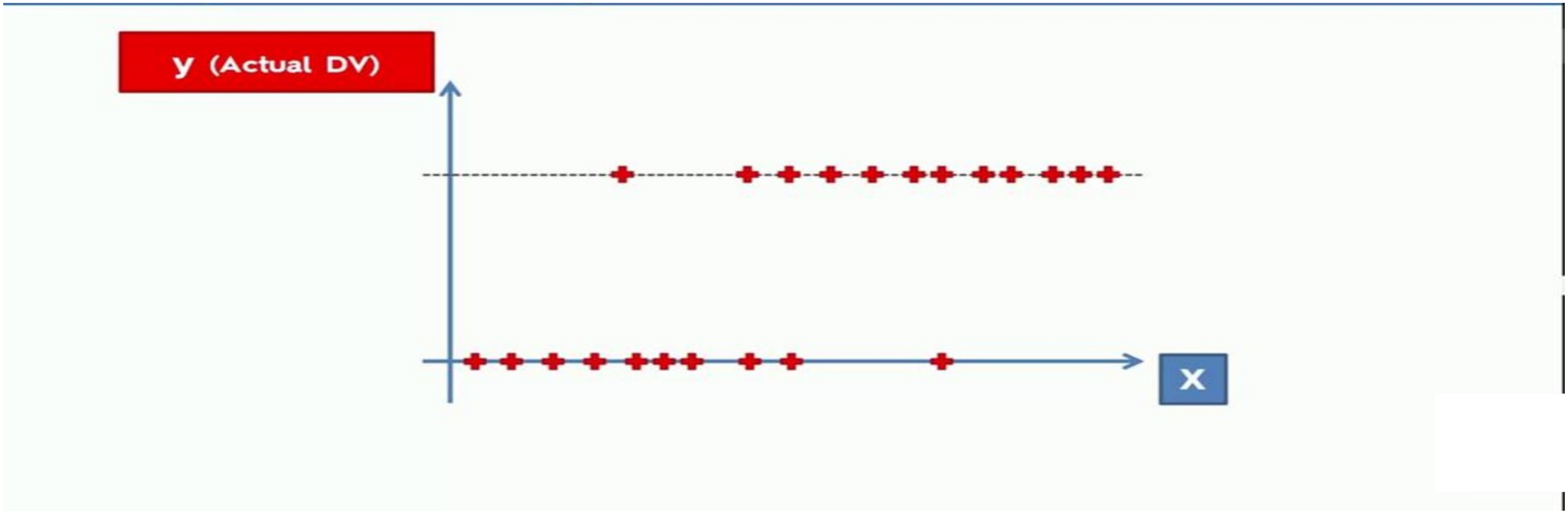

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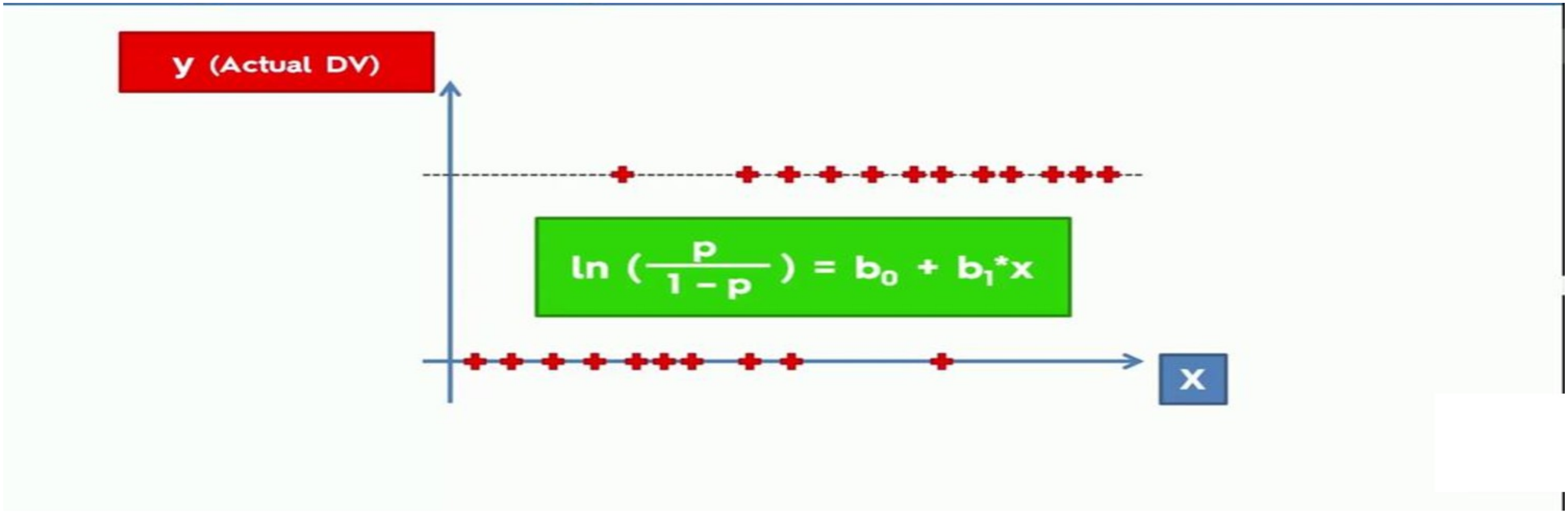

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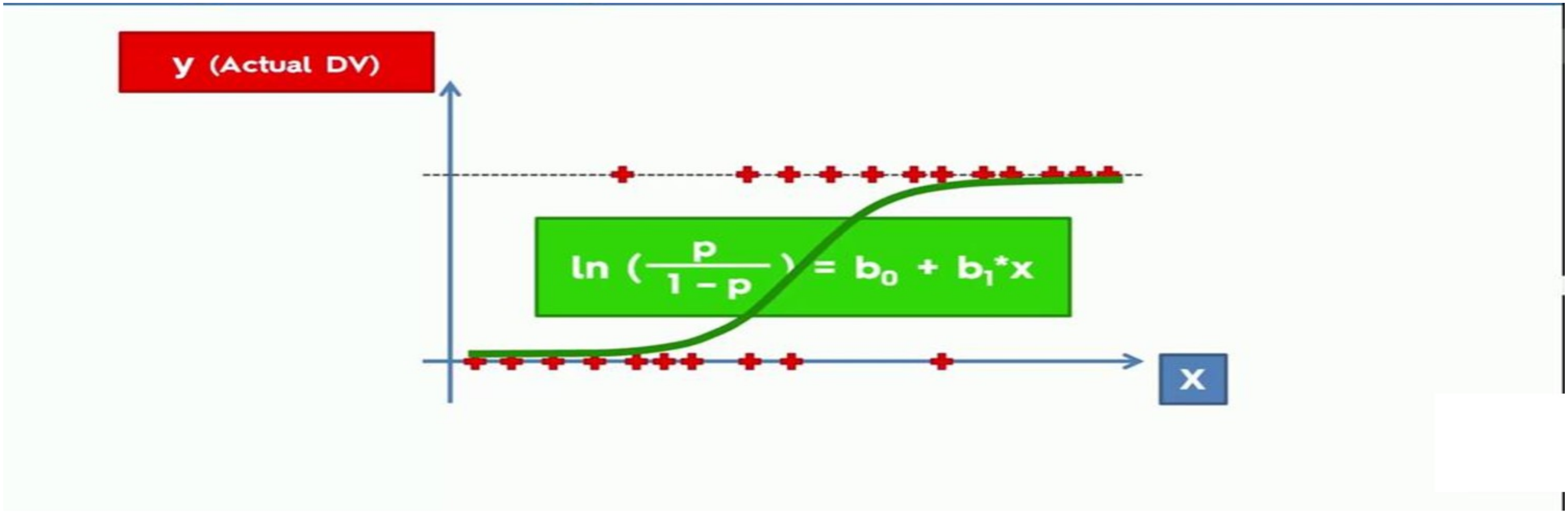

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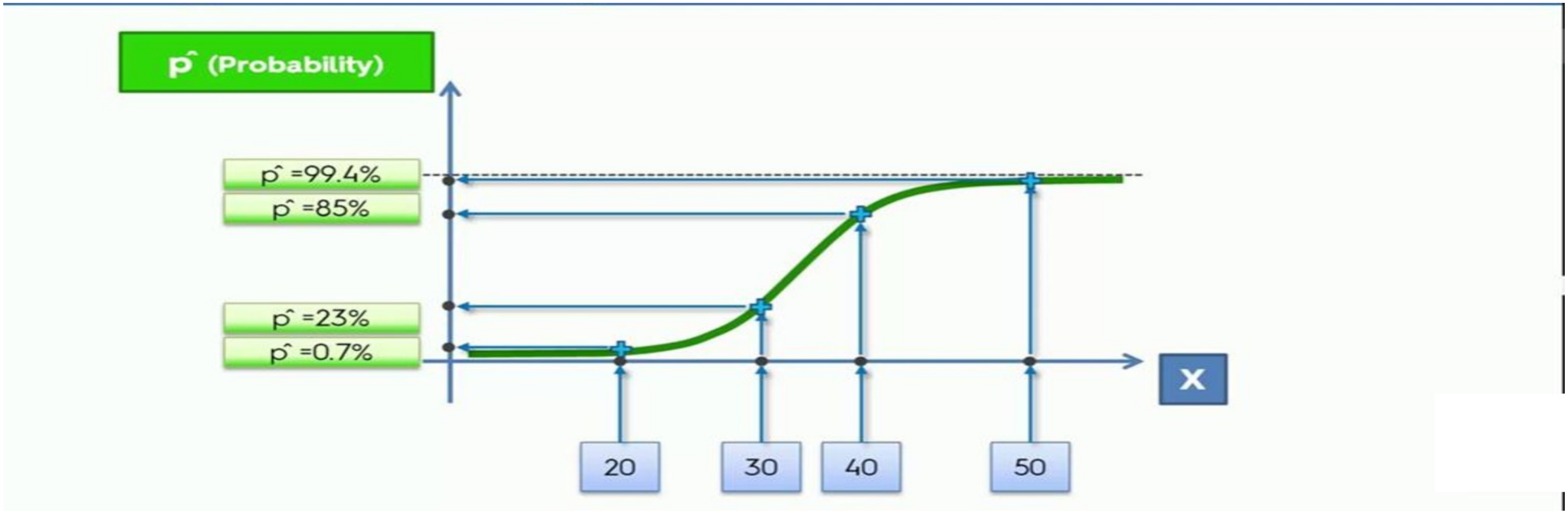

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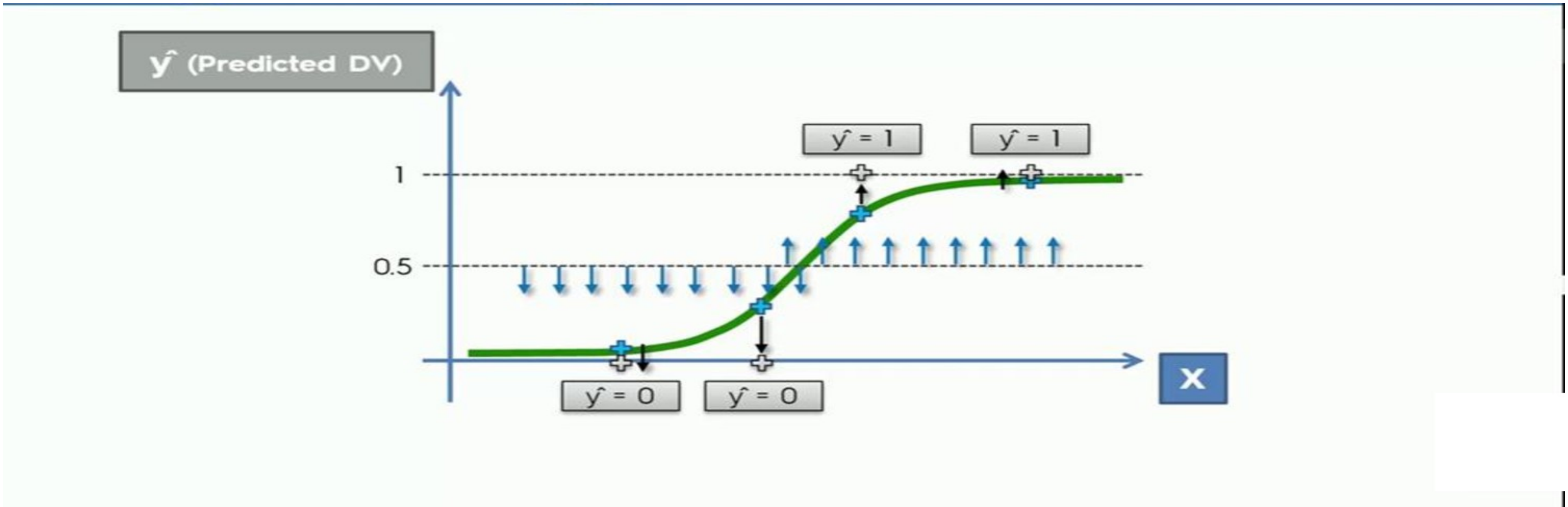

LOGISTIC REGRESSION

- Logistic regression is another technique borrowed by machine learning from the field of statistics.

- It is the go-to method for binary classification problems (problems with two class values).

- Logistic regression is named for the function used at the core of the method, the logistic function.

- The Logistic function, also called the sigmoid function,It’s an S-shaped curve that can take any real-valued number and map it into a value between 0 and 1, but never exactly at those limits.   1 / (1 + e^-value)

- Where ‘e’ is the base of the natural logarithms (Euler’s number or the EXP() function in your spreadsheet) and value is the actual numerical value that you want to transform

REPRESENTATION

- Logistic regression uses an equation as the representation, very much like linear regression.

- Input values (x) are combined linearly using weights or coefficient values (referred to as the Greek capital letter Beta) to predict an output value (y).

- A key difference from linear regression is that the output value being modeled is a binary values (0 or 1) rather than a numeric value.

- logistic regression equation: y = e^(b0 + b1*x) / (1 + e^(b0 + b1*x))

- Where y is the predicted output, b0 is the bias or intercept term and b1 is the coefficient for the single input value (x).

- Each column in your input data has an associated b coefficient (a constant real value) that must be learned from your training data.

LOGISTIC REGRESSION

- Logistic regression models the probability of the default class (e.g. the first class).

- For example, if we are modeling people's sex as male or female from their height, then the first class could be male and the logistic regression model could be written as the probability of male given a person's height, or more formally:
P(sex=male|height)

- Written another way, we are modeling the probability that an input (X) belongs to the default class (Y=1), we can write this formally as: P(X) = P(Y=1|X)

- We're predicting probabilities? I thought logistic regression was a classification algorithm?

- Note that the probability prediction must be transformed into a binary values (0 or 1) in order to actually make a probability prediction.

LEARNING THE LOGISTIC REGRESSION MODEL

- The coefficients (Beta values b) of the logistic regression algorithm must be estimated from your training data. This is done using maximum-likelihood estimation.

- **Maximum-likelihood estimation** is a common learning algorithm used by a variety of machine learning algorithms, although it does make assumptions about the distribution of your data (more on this when we talk about preparing your data).

- The best coefficients would result in a model that would predict a value very close to 1 (e.g. male) for the default class and a value very close to 0 (e.g. female) for the other class. The intuition for maximum-likelihood for logistic regression is that a search procedure seeks values for the coefficients (Beta values) that minimize the error in the probabilities predicted by the model to those in the data (e.g. probability of 1 if the data is the primary class).

- Minimization algorithm is used to optimize the best values for the coefficients for your training data.

- This is often implemented in practice using efficient numerical optimization algorithm (like the Quasi-newton method).

- When you are learning logistic, you can implement it yourself from scratch using the much simpler gradient descent algorithm.

MAKING PREDICTIONS WITH LOGISTIC REGRESSION EXAMPLE :

- Making predictions with a logistic regression model is as simple as plugging in numbers into the logistic regression equation and calculating a result.

- Let's say we have a model that can predict whether a person is male or female based on their height (completely fictitious).
  Given a height of 150cm is the person male or female.

- We have learned the coefficients of b0 = -100 and b1 = 0.6.

- Using the equation above we can calculate the probability of male given a height of 150cm or more formally P(male|height=150).

  y = e^(b0 + b1*X) / (1 + e^(b0 + b1*X))
  y = exp(-100 + 0.6*150) / (1 + EXP(-100 + 0.6*X))
  y = 0.0000453978687 **(Or a probability of near zero that the person is a male.)**

- In practice we can use the probabilities directly. Because this is classification and we want a crisp answer, we can snap the probabilities to a binary class value, for example:

0 if p(male) < 0.5
1 if p(male) >= 0.5

SUMMARY

- Logistic regression algorithm for machine learning and predictive modeling.
- What the logistic function is and how it is used in logistic regression.
- That the key representation in logistic regression are the coefficients, just like linear regression.
- That the coefficients in logistic regression are estimated using a process called maximum-likelihood estimation.
- That making predictions using logistic regression is so easy that you can do it in excel.
- That the data preparation for logistic regression is much like linear regression.