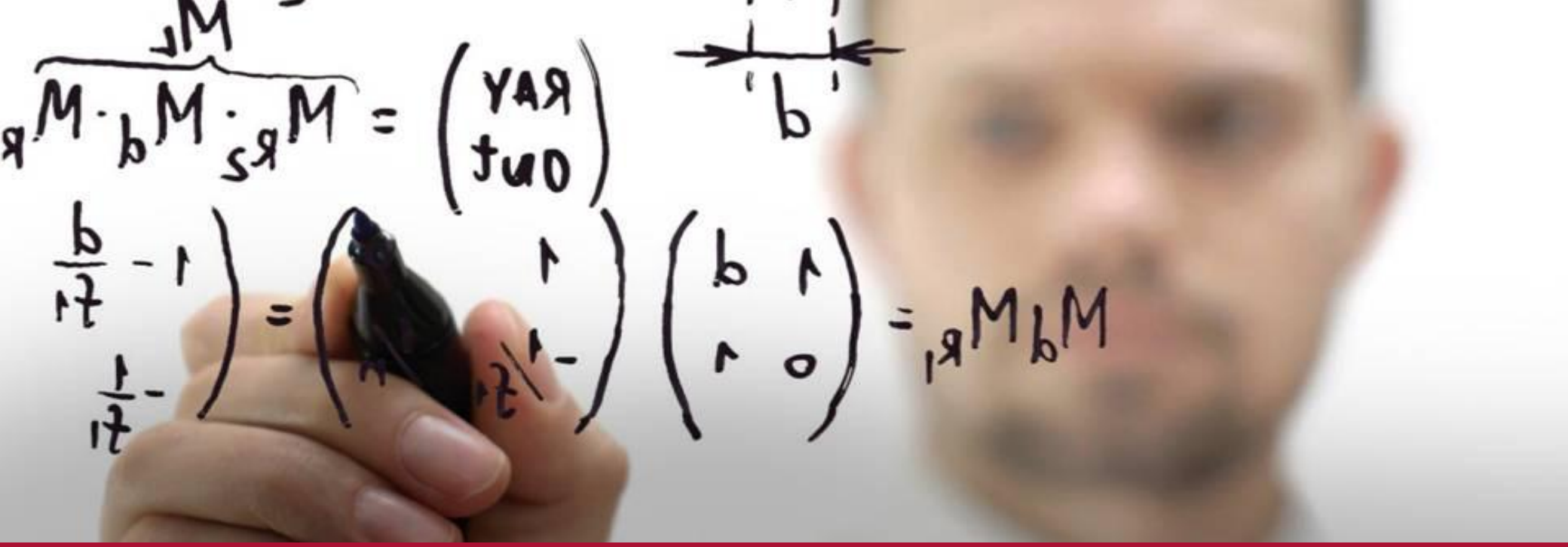


Lesson X : Regression Algorithms

Model Essentials: Regressions

- **Predict new cases.**
- **Select useful inputs.**
- **Optimize complexity.**

Prediction formula

Sequential selection

Best model from sequence

Linear Regression Prediction Formula

$$\hat{y} = \hat{w}_0 + \hat{w}_1 x_1 + \hat{w}_2 x_2$$

- $\hat{y}$: prediction estimate
- $\hat{w}_0$: intercept estimate
- $\hat{w}_1$: parameter estimate
- x_1: input measurement
- $\hat{w}_2$: parameter estimate
- x_2: input measurement

Choose intercept and parameter estimates to *minimize*:

$$\sum_{\text{training data}} (y_i - \hat{y}_i)^2$$

- $\sum$: squared error function
- y_i: training data
- $\hat{y}_i$: prediction estimate

Linear Regression Prediction Formula

$$\hat{y} = \hat{w}_0 + \hat{w}_1 x_1 + \hat{w}_2 x_2$$

- $\hat{y}$: prediction estimate
- $\hat{w}_0$: intercept estimate
- $\hat{w}_1$, $\hat{w}_2$: parameter estimates
- x_1, x_2: input measurement

Choose intercept and parameter estimates to *minimize*.

squared error function

$$\sum_{\text{training data}} (y_i - \hat{y}_i)^2$$

Logistic Regression Prediction Formula

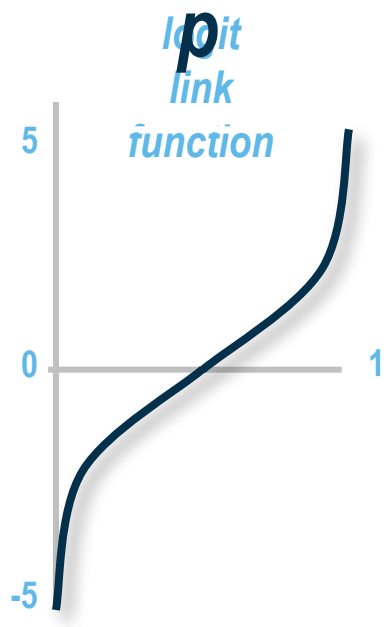
$$\log\left(\frac{\hat{p}}{1-\hat{p}}\right) = \hat{w}_0 + \hat{w}_1 x_1 + \hat{w}_2 x_2$$

logit scores

Logit Link Function

$$\log\left(\frac{\hat{p}}{1-\hat{p}}\right) = \hat{w}_0 + \hat{w}_1 x_1 + \hat{w}_2 x_2$$

logit scores

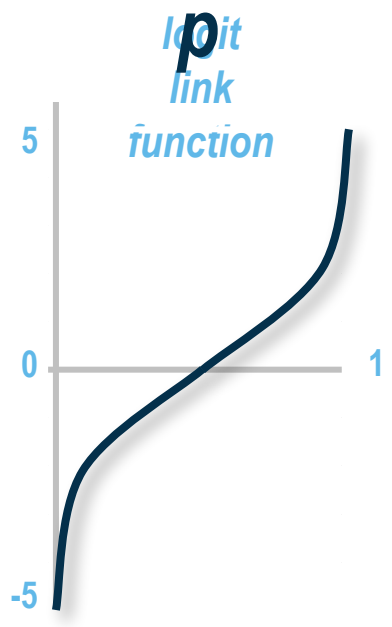


The logit link function transforms probabilities (between 0 and 1) to logit scores (between −∞ and +∞).

Logit Link Function

$$\log\left(\frac{\hat{p}}{1-\hat{p}}\right) = \hat{w}_0 + \hat{w}_1 x_1 + \hat{w}_2 x_2$$

logit scores



The logit link function transforms probabilities (between 0 and 1) to logit scores (between −∞ and +∞).

Logit Link Function

$$\log\left(\frac{\hat{p}}{1-\hat{p}}\right) = \hat{w}_0 + \hat{w}_1 x_1 + \hat{w}_2 x_2 = \text{logit}(\hat{p})$$

$$\hat{p} = \frac{1}{1 + e^{-\text{logit}(\hat{p})}}$$

To obtain prediction estimates, the logit equation is solved for p.

Logit Link Function

$$\log\left(\frac{\hat{p}}{1-\hat{p}}\right) = \hat{w}_0 + \hat{w}_1 x_1 + \hat{w}_2 x_2 = \text{logit}(\hat{p})$$

$$\hat{p} = \frac{1}{1 + e^{-\text{logit}(\hat{p})}}$$

To obtain prediction estimates, the logit equation is solved for p.

Logit Link Function

$$\text{logit}(\hat{p}) = \hat{w}_0 + \hat{w}_1 \cdot x_1 + \hat{w}_2 \cdot x_2$$

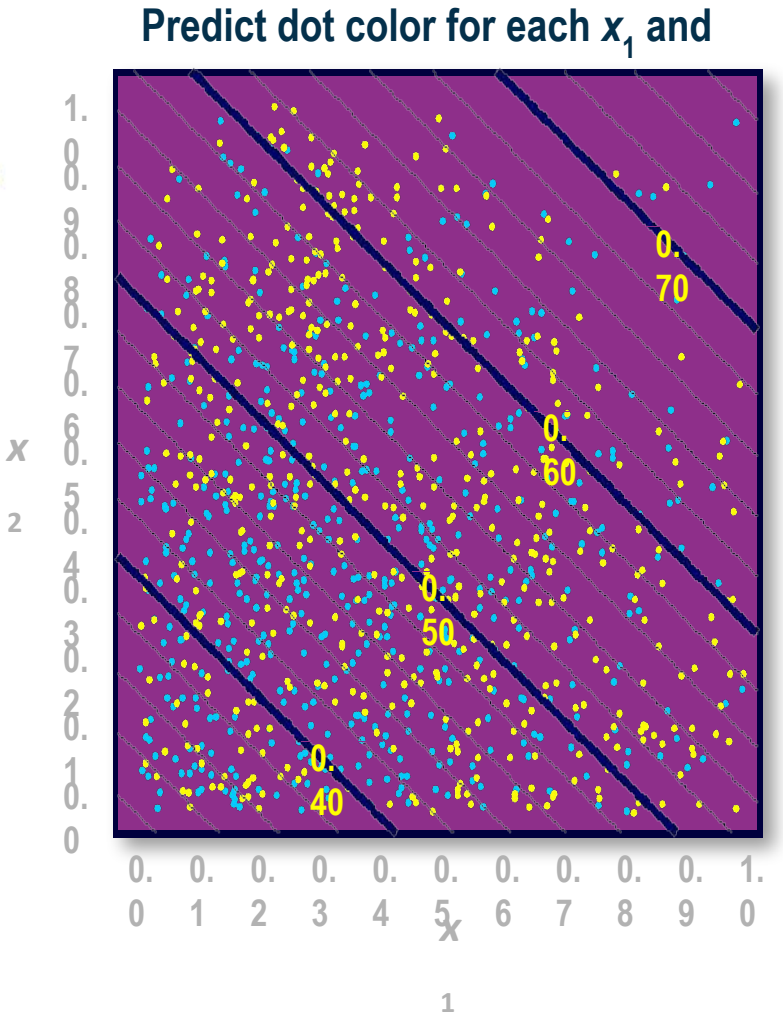
$$\hat{p} = \frac{1}{1 + e^{-\text{logit}(\hat{p})}}$$

Simple Prediction Illustration: Regressions

$$\text{logit}(\hat{p}) = \hat{w}_0 + \hat{w}_1 x_1 + \hat{w}_2 x_2$$

$$\hat{p} = \frac{1}{1 + e^{-\text{logit}(\hat{p})}}$$

You need intercept and parameter estimates.



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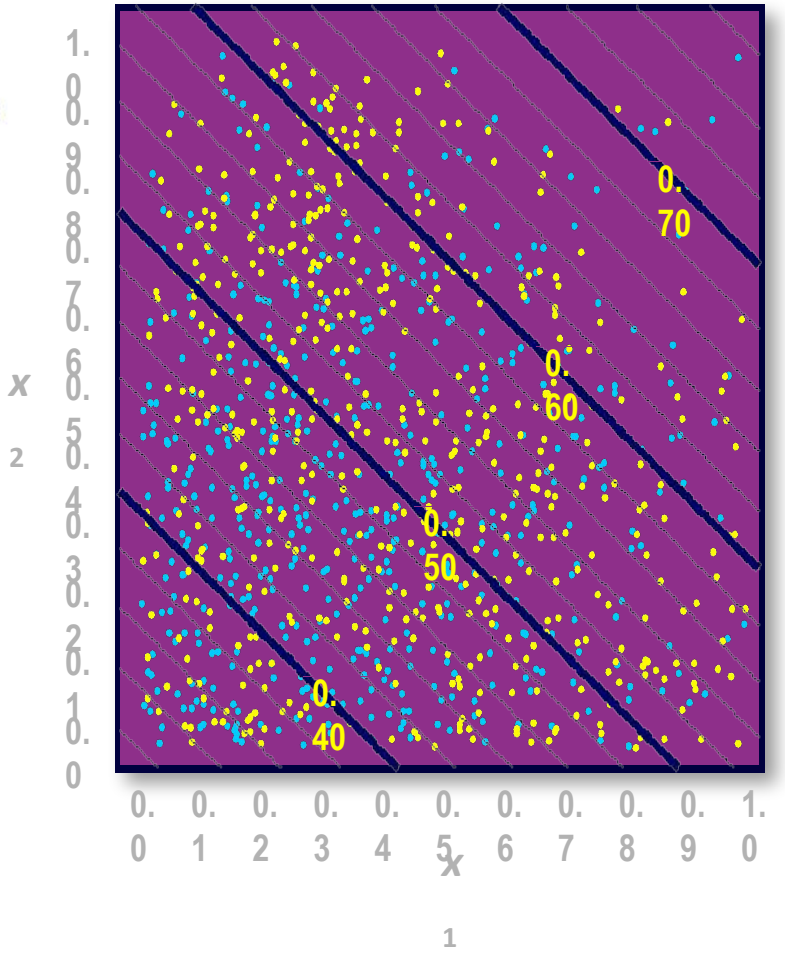


Simple Prediction Illustration: Regressions

$$\text{logit}(\hat{p}) = \hat{w}_0 + \hat{w}_1 x_1 + \hat{w}_2 x_2$$

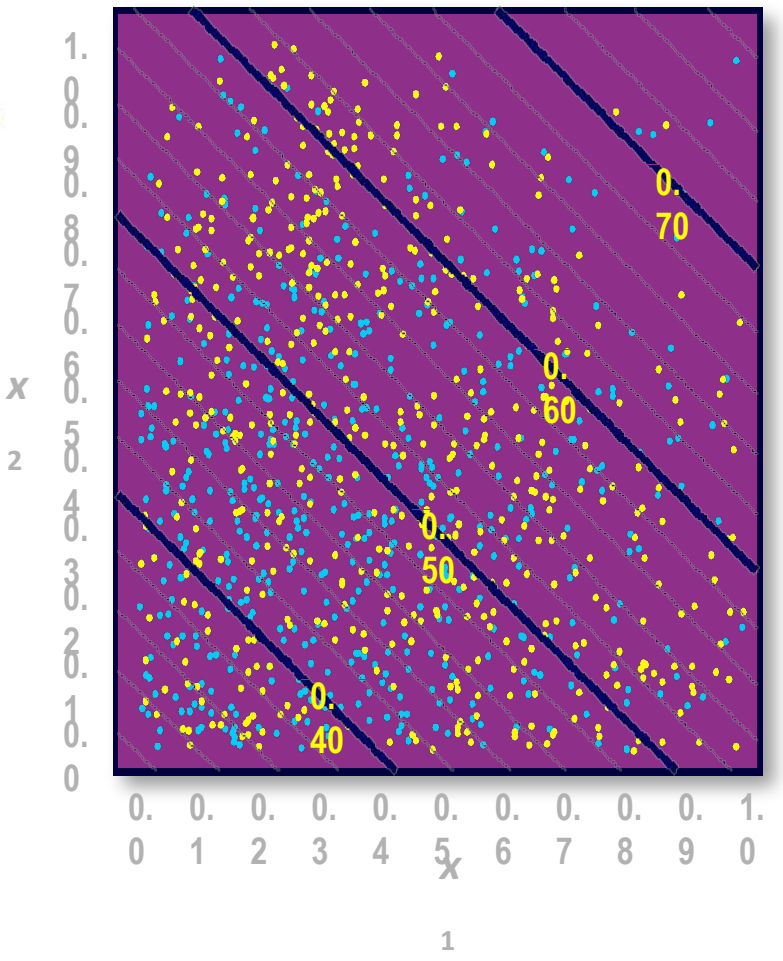
$$\hat{p} = \frac{1}{1 + e^{-\text{logit}(\hat{p})}}$$

Find parameter estimates by *maximizing*

$$\sum \log(\hat{p}_i) + \sum \log(1 - \hat{p}_i)$$

primary outcome training cases — *secondary outcome training cases*

log-likelihood function



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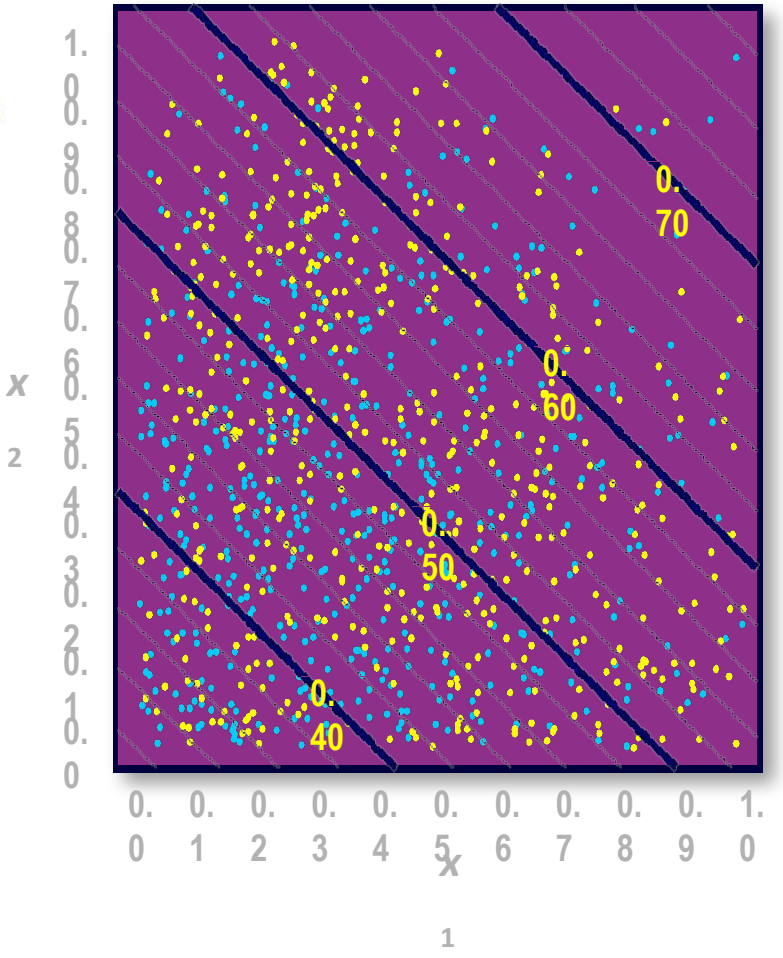
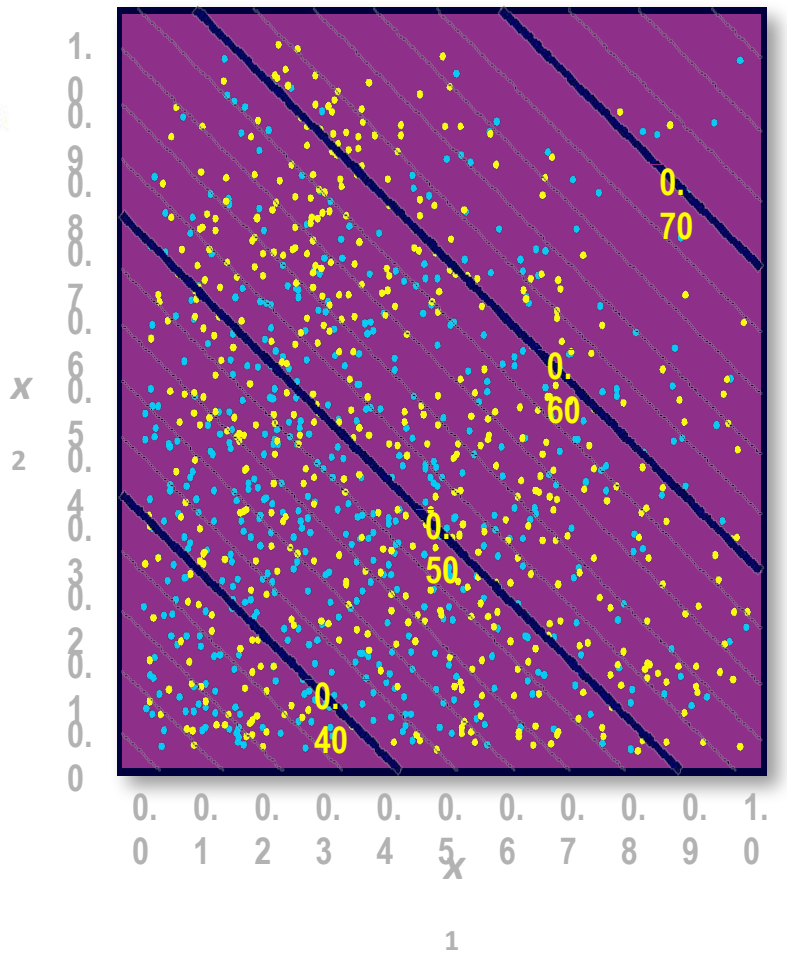


Simple Prediction Illustration: Regressions

$$\text{logit}(\hat{p}) = -0.81 + 0.92\,x_1 + 1.11\,x_2$$

$$\hat{p} = \frac{1}{1 + e^{-\text{logit}(\hat{p})}}$$

Using the maximum likelihood estimates, the prediction formula assigns a logit score to each x_1 and x_2.



4.01 Multiple Choice Question

What is the logistic regression prediction for the indicated point?

a. 0.243

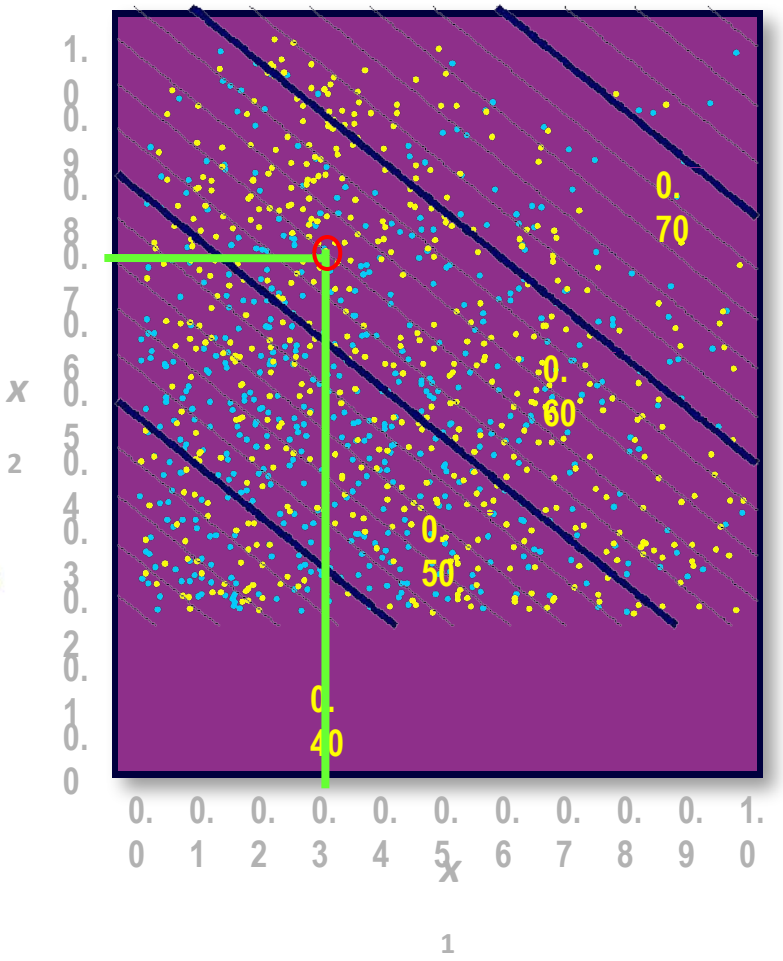
b. 0.56

c. yellow

d. It depends.

$$\text{logit}(\hat{p}) = -0.81 + 0.92\,x_1 + 1.11\,x_2$$

$$\hat{p} = \frac{1}{1 + e^{-\text{logit}(\hat{p})}}$$



4.01 Multiple Choice Question – Correct Answer

What is the logistic regression prediction for the indicated point?

a. 0.243

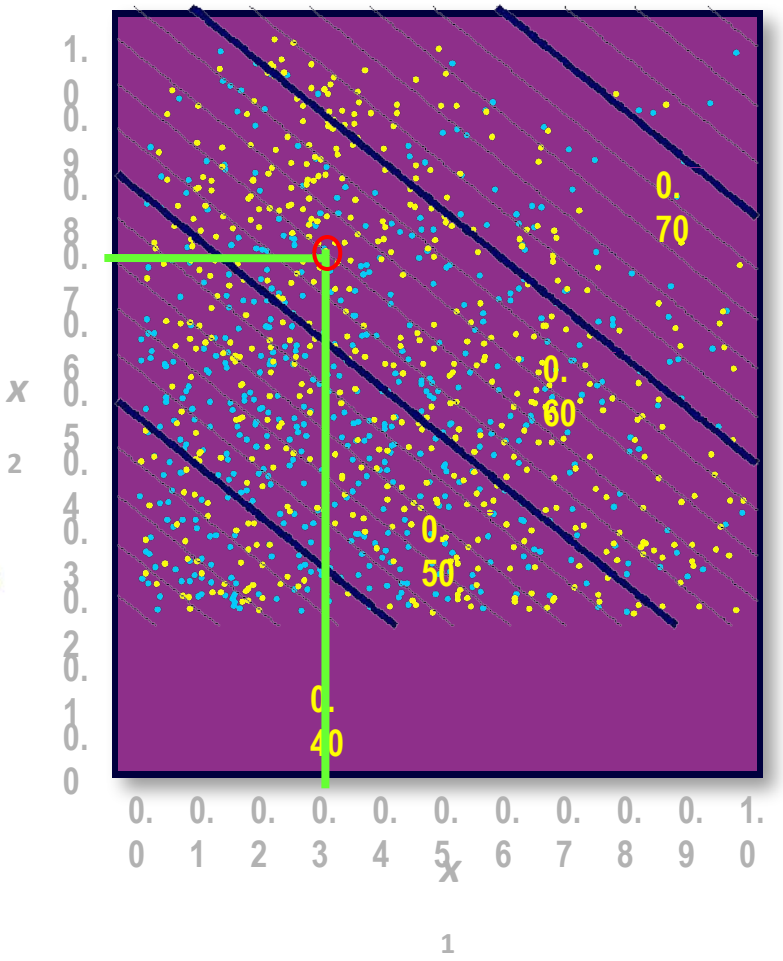
b. 0.56

c. yellow

d. It depends.

$$\text{logit}(\hat{p}) = -0.81 + 0.92\,x_1 + 1.11\,x_2$$

$$\hat{p} = \frac{1}{1 + e^{-\text{logit}(\hat{p})}}$$



Regressions: Beyond the Prediction Formula

- **Manage missing values.**
- **Interpret the model.**
- **Handle extreme or unusual values.**
- **Use nonnumeric inputs.**
- **Account for nonlinearities.**

Construct a Regression using SKlearn

ADSUP Lesson VIII Ra

1- Construct a Regression model for Fitness Dataset

Practice

This practice reinforces the concepts discussed previously.

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