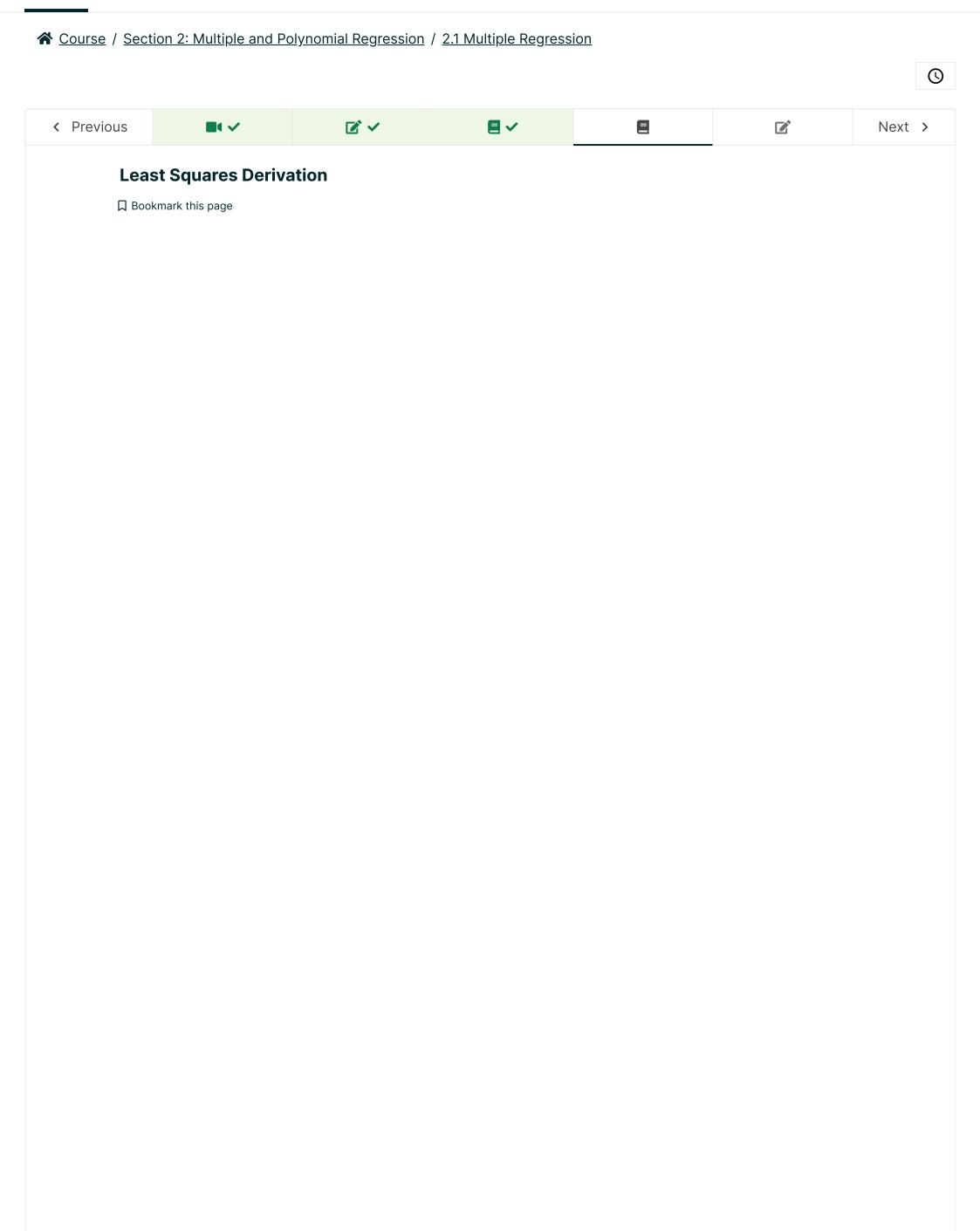


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DEFINITION: TRANSPOSE OF A MATRIX

Given the following 3×2 matrix

$$X = egin{pmatrix} x_{11} & x_{12} \ x_{21} & x_{22} \ \dots & \dots \end{pmatrix}$$

The transpose of the above matrix is of the form:

$$X^T \; = \; egin{pmatrix} x_{11} & x_{21} & \dots \ x_{12} & x_{22} & \dots \end{pmatrix}$$

In transpose, rows become columns and columns become rows.

You can perform transpose over numpy objects by calling

or

DEFINITION: INVERSE OF A MATRIX

When we multiply a number by its reciprocal, we get 1.

For a number n,

$$n \cdot \frac{1}{n} = 1$$

Similarly, when we multiply a matrix by its inverse, we get the Identity matrix.

For a matrix A,

$$A A^{-1} = I$$

is used to calculate the inverse of a matrix, if it exists.

Multiple Linear Regression

In Multiple Linear Regression, the model takes a simple algebraic form:

$$Y = X \beta$$

We will again choose the MSE as our loss function, which can be expressed in vector notation as:

$$MSE\left(eta
ight) \; = \; rac{1}{n} ||Y \, - \, X \, eta||^2$$

$$MSE\left(eta
ight) \; = \; rac{1}{n} \sum_{i=1}^{n} \left(y_{i} \; - \; x_{i1}eta_{1} \; - \; x_{i2}eta_{2}
ight)^{2}$$

■ Calculator

Taking the derivative of the loss i.e. MSE with respect to the model parameter β gives:

$$rac{\partial L}{\partial eta} \ = \ - \, 2 X^T \, (Y \, - X eta)$$

For optimization, we set the values of the partial derivative to zero, i.e.

$$egin{array}{lll} rac{\partial L}{\partial eta} &= 0 \; \Rightarrow \; -2 X^T \left(Y \, - \, X eta
ight) \; = \; 0 \ \ & \Rightarrow \; & X^T \left(Y \, - \, X eta
ight) \; = \; 0 \end{array}$$

Optimization of the previous equation gives:

$$X^T X \beta = X^T Y$$

Multiplying both sides with $(X^TX)^-1$, we get:

$$\left(X^TX\right)^{-1}X^TX\beta = \left(X^TX\right)^{-1}X^TY$$

Thus, we get

$$\beta = (X^T X)^{-1} X^T Y$$

Backtracking this equation to fit the model optimization problem, we have

$$\hat{eta} \; = \; ig(X^T Xig)^{-1} X^T Y \; = rgmin_{eta} MSE\left(eta
ight)$$

Discussion Board (External resource)

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