LO 1. Define and understand the role of **training data** and **testing data** in statistical learning.

LO 2. Utilize common **loss functions**, including mean squared error, absolute error, and misclassification error. You should be able to evaluate these by hand on small datasets and in R code from larger ones.

LO 3. Apply the one-dimensional **best split** estimator by hand on small datasets.

LO 4. Understand the R code in the function `casl_utils_best_split`.

LO 5. Visualize simple linear regression from a scatter plot and understand the interpretation of the coefficients.

LO 6. Derive the simple linear regression ordinary least squares (OLS) coefficients using calculus.

LO 7. Apply the matrix format of the least squares estimator and understand the notation for y, X, β, and $\widehat{\beta}$.

LO 8. View a matrix as a linear transformation between $\mathbb{R}^n$ and $\mathbb{R}^m$ and matrix multiplication as function composition.

LO 9. Understand the matrix transpose and inverse, its notation, and rules for applying these to matrix equations.

LO 10. Derive the equations for the gradient of an inner product:

$$\nabla_\beta \left(a^t \beta\right) = a$$

And the gradient of a quadratic form:

$$\nabla_\beta \left(\beta^t A \beta\right) = \frac{1}{2} A^t \beta.$$

LO 11. Derive the normal equations for the ordinary least squares estimator for multivariate linear regression.

LO 12. Understand the geometric interpretation of the singular value decomposition (SVD) and role of the singular values.

LO 13. Apply the SVD to the normal equations to find a computationally stable solution to the ordinary least squares problem for linear regression.

LO 14. Compute the SVD in R and use matrix methods to directly compute the ordinary least squares estimator.

LO 15. Apply the `lm.fit` function to have R compute the ordinary least squares solution directly.