

Logistic regressionSolved

1. Consider a binary classification problem where we want to predict whether a student will pass or fail based on their study hours. The logistic regression model has been trained, and the learned parameters are $a_0 = -5$ (intercept) and $a_1 = 0.8$ (coefficient for study hours).
- Write the logistic regression equation for this problem.
 - Calculate the probability that a student who studied for 7 hours will pass.
 - Determine the predicted class (pass or fail) for this student based on threshold of 0.5.
2. Consider $z = [2, 1, 0]$ for three classes. Apply softmax function to find the probability values of three classes.

Ans 1 Given, logistic regression equation:-

$$P(\text{pass}) = \frac{1}{1 + e^{-(a_0 + a_1 x)}}$$

where,

$$a_0 = -5 \text{ (Intercept)}$$

$$a_1 = 0.8 \text{ (coefficient for study hours)}$$

 x represents study hours.

Q1 logistic regression equation

$$P(\text{pass}) = \frac{1}{1 + e^{-(a_0 + a_1 x)}}$$

Q2 Probability of passing for 7 hours of study.
We substitute, $x = 7$:

$$P(\text{pass}) = \frac{1}{1 + e^{-(a_0 + a_1 x)}}$$

$$P(\text{pass}) = \frac{1}{1 + e^{-51.5}}$$

$$P(\text{pass}) = \frac{1}{1 + e^{-0.6}}$$

$$P(\text{pass}) = \frac{1}{1 + 0.518} = 0.645$$

Conclusion:

- * If $P(\text{pass}) > 0.5$, the student is predicted to pass.
 - * If $P(\text{pass}) < 0.5$, the student is predicted to fail.
- So based on this $P(\text{pass}) = 0.645$ approximately,
Therefore, the student is pass.

2. Sol 1

The softmax function for vector z is:

$$P_i = \frac{e^{z_i}}{\sum_{j=1}^K e^{z_j}}$$

$$\text{Let } z = [z_1, z_2, z_3]$$

$$\begin{aligned} P_1 &= \frac{e^2}{e^2 + e^1 + e^0} = \frac{7.389}{11.107} = 0.665 \\ P_2 &= \frac{e^1}{e^2 + e^1 + e^0} = \frac{2.718}{11.107} = 0.245 \\ P_3 &= \frac{e^0}{e^2 + e^1 + e^0} = \frac{1}{11.107} = 0.090 \end{aligned}$$

Reviewed

After building the logistic regression model, write the answers for the following questions in your observation book.

1. For dataset file "HR-Comm-Sp.csv".

(1) Which variables did you identify as having direct and clear impact on employee retention? Why?

Sol (1) Salary

* Employees with low salary had a higher chance of leaving compared to those with medium or higher salary.

* The bar chart showed a negative correlation between salary and attrition rate.

(2) Department + Urban department (e.g. sales, technical) had higher attrition.

(3) Satisfaction + workload + low satisfaction, long hours, and fewer promotions increased attrition.

(1) What was the accuracy of your logistic regression model? Do you think that is a good accuracy? Why or why not?

* Accuracy: 78.13%

* Good or not? of above 80%, it's good, if below 70% improvements are needed. It is performing moderately.

* Factors like feature selection, using a different model (Decision trees, random forest etc) or handling imbalanced data could help improve performance.

2. for Zoo dataset.

- (i) Did you perform any data preprocessing steps? If yes, what were they, and why were they necessary?
As merged dataset removed irrelevant attributes and applied hot encoding.
- (ii) were there any missing or inconsistent values in the dataset? how did you handle them?

No missing values found. They can be handled with filling with mean, median or mode methods.

- (iii) What does the Confusion matrix tell you about the performance of your model?

More correct predictions along the diagonal mean better model performance.

- (iv) which class types were most frequently misclassified? why do you think this happened?

Reason Similar features, imbalanced data, and model frustration in handling complex patterns.

Lab-5KNN Classification modelSolved

Consider the following dataset, for $K=3$ and test data $(X, 35, 100)$ at $(\text{Person}, \text{Age}, \text{Salary})$. Solve using KNN classifier model and predict the target.

Person	Age	Salary	Target
A	18	50	N
B	23	55	N
C	24	70	N
D	41	60	Y
E	43	70	Y
F	38	40	Y
X	35	100	Y

Step 1: Compute Euclidean distance

$$d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$$

$$A: \sqrt{(35-18)^2 + (100-50)^2} = 59.97$$

$$B: \sqrt{(35-23)^2 + (100-55)^2} = 46.57$$

$$C: \sqrt{(35-24)^2 + (100-70)^2} = 32.02$$

$$D: \sqrt{(35-41)^2 + (100-60)^2} = 40.45$$

$$E: \sqrt{(35-43)^2 + (100-70)^2} = 31.05$$

$$F: \sqrt{(35-38)^2 + (100-40)^2} = 60.07$$

Step 2: Select $K=3$ Nearest Neighbours.

Sorting the distances, the 3 nearest neighbours are

1. E (31.05, Y)
2. C (32.02, N)
3. D (40.45, Y)

Step 3: Majority voting.

Among the 3 nearest neighbors

2 are $y(E, D)$

1 is $N(C)$.

Since y is the majority (2 out of 3), the predicted target for x is y .

Final Prediction

For person $(35, 100)$. The predicted target is y (yes).

To write 2

1. For KNN

How to choose the K value? Demonstrate using accuracy rate and error rate.

2. For Distance Scaling

What is the purpose of Distance Scaling? How to perform it?

① Test Different K values (e.g., 1, 3, 5, 7, 9, 11, 13, 15, 17, 19, 21, 23, 25, 27, 29, 31, 33, 35, 37, 39, 41, 43, 45, 47, 49, 51, 53, 55, 57, 59, 61, 63, 65, 67, 69, 71, 73, 75, 77, 79, 81, 83, 85, 87, 89, 91, 93, 95, 97, 99, 101, 103, 105, 107, 109, 111, 113, 115, 117, 119, 121, 123, 125, 127, 129, 131, 133, 135, 137, 139, 141, 143, 145, 147, 149, 151, 153, 155, 157, 159, 161, 163, 165, 167, 169, 171, 173, 175, 177, 179, 181, 183, 185, 187, 189, 191, 193, 195, 197, 199, 201, 203, 205, 207, 209, 211, 213, 215, 217, 219, 221, 223, 225, 227, 229, 231, 233, 235, 237, 239, 241, 243, 245, 247, 249, 251, 253, 255, 257, 259, 261, 263, 265, 267, 269, 271, 273, 275, 277, 279, 281, 283, 285, 287, 289, 291, 293, 295, 297, 299, 301, 303, 305, 307, 309, 311, 313, 315, 317, 319, 321, 323, 325, 327, 329, 331, 333, 335, 337, 339, 341, 343, 345, 347, 349, 351, 353, 355, 357, 359, 361, 363, 365, 367, 369, 371, 373, 375, 377, 379, 381, 383, 385, 387, 389, 391, 393, 395, 397, 399, 401, 403, 405, 407, 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for already data: z-score Standardization is preferred.