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Data Archive Book

Welcome to the Data Archive Book.

Statsmodel has this summary table unlike Sklearn

Explanation of summary

The dependent variable is 'duration'. The model used is a Logit regression (logistic in common lingo), while the method

- Maximum Likelihood Estimation (MLE). It has clearly converged after classifying 518 observations.
- The Pseudo R-squared is 0.21 which is within the 'acceptable region'.
- The duration variable is significant and its coefficient is 0.0051.
- The constant is also significant and equals: -1.70 (p value close to 0)
- High p value, suggests to remove from model, drop one by one, ie Feature Selection.

Specifically a graph such as,

```
Optimization terminated successfully.
         Current function value: 0.546118
         Iterations 7
```

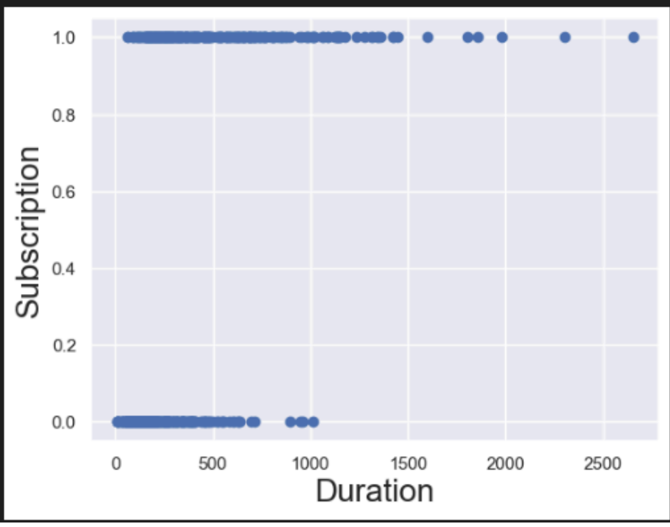
Logit Regression Results

Dep. Variable:	y	No. Observations:	518
Model:	Logit	Df Residuals:	516
Method:	MLE	Df Model:	1
Date:	Wed, 24 Jan 2024	Pseudo R-squ.:	0.2121
Time:	09:55:29	Log-Likelihood:	-282.89
converged:	True	LL-Null:	-359.05
Covariance Type:	nonrobust	LLR p-value:	5.387e-35

	coef	std err	z	P>|z|	[0.025	0.975]
const	-1.7001	0.192	-8.863	0.000	-2.076	-1.324
duration	0.0051	0.001	9.159	0.000	0.004	0.006

```python
# Create a scatter plot of x1 (Duration, no constant) and y (Subscribed)
plt.scatter(x1,y,color = 'C0')
# Don't forget to label your axes!
plt.xlabel('Duration', fontsize = 20)
plt.ylabel('Subscription', fontsize = 20)
plt.show()
```

[7] ✓ 0.2s



ℕ

==Logistic regression models the log-odds of the probability as a linear function of the input features.==

It models the probability of an input belonging to a particular class using a logistic (sigmoid) function.

The model establishes a decision boundary (threshold) in the feature space.

Logistic regression is best suited for cases where the decision boundary is approximately linear in the feature space.

Logistic Regression can be used for Binary Classificationtasks.

Related Notes:

- Logistic Regression Statsmodel Summary table
- Logistic Regression does not predict probabilities
- Interpreting logistic regression model parameters
- Model Evaluation
- To get Model Parameters use Maximum Likelihood Estimation

In ML_Tools, see:

- Regression_Logistic_Metrics.ipynb

Key Concepts of Logistic Regression

Logistic Function (Sigmoid Function)

Logistic regression models the probability that an input belongs to a particular class using the logistic (sigmoid) function. This function maps any real-valued input into the range (0,1), representing the probability of belonging to the positive class (usually class 1).

The sigmoid function is defined as:

$$\sigma(z) = \frac{1}{1+e^{-z}}$$

where

$$z = \mathbf{w} \cdot \mathbf{x} + b$$

Thus, the logistic regression model is given by:

$$P(y = 1 \mid \mathbf{x}) = \sigma(z)$$

Log odds: Transforming from continuous to 0-1

Logistic regression is based on the ==log-odds== (logit) transformation, which expresses probability in terms of odds:

$$\text{Odds} = \frac{P(y=1|\mathbf{x})}{1-P(y=1|\mathbf{x})}$$

Taking the natural logarithm of both sides gives the logit function:

$$\log\left(\frac{P(y=1|\mathbf{x})}{1-P(y=1|\mathbf{x})}\right) = \mathbf{w}\cdot\mathbf{x}+b$$

This equation shows that ==logistic regression models the log-odds of the probability as a linear function of the input features.==

Decision Boundary

- Similar to Support Vector Machines, logistic regression defines a decision boundary that separates the two classes.
- The logistic function determines the probability of a data point belonging to a specific class. If this probability exceeds a given ==threshold== (typically 0.5), the model assigns the point to the positive class; otherwise, it is classified as negative.

Binary Classification

- Logistic regression is primarily used for binary classification tasks, where the target variable has only two possible values (e.g., "0" and "1").
- It can handle multiple independent variables (features) and assigns probabilities to the target classes based on the feature values.
- Examples include:

No Residuals

- Unlike Linear Regression, logistic regression does not compute standard residuals.
- Instead, Model Evaluation is performed by comparing predicted probabilities with actual class labels using metrics such as accuracy, precision, recall, and the Confusion Matrix.

Also see:

Related terms:

- Cost function for logistic regression
- Gradient computation in logistic regression
- Regularized logistic regression
- Cost function for regularized logistic regression

Logistic regression can be extended to handle non-linear decision boundaries through:

- Polynomial features to capture more complex relationships.
- Regularization techniques to improve generalization.

Explaining logistic regression