statistical models, hypothesis tests, and data exploration

statsmodels [_images/statsmodels-logo-v2-horizontal.svg]

statsmodels [about.html#about-statsmodels] is a Python module that provides classes and functions for the estimation of many different statistical models, as well as for conducting statistical tests, and statistical data exploration. An extensive list of result statistics are available for each estimator. The results are tested against existing statistical packages to ensure that they are correct. The package is released under the open source Modified BSD (3-clause) license. The online documentation is hosted at statsmodels.org [https://www.statsmodels.org/].

Introduction

`statsmodels` supports specifying models using R-style formulas and `pandas` DataFrames. Here is a simple example using ordinary least squares:

```
In [1]: import numpy as np

In [2]: import statsmodels.api as sm

In [3]: import statsmodels.formula.api as smf

# Load data
In [4]: dat = sm.datasets.get_rdataset("Guerry", "HistData").data

# Fit regression model (using the natural log of one of the regressors)
In [5]: results = smf.ols('Lottery ~ Literacy + np.log(Pop1831)', data=dat).fit()

# Inspect the results
In [6]: print(results.summary())
                            OLS Regression Results
==============================================================================
Dep. Variable:                Lottery   R-squared:                       0.348
Model:                            OLS   Adj. R-squared:                  0.333
Method:                 Least Squares   F-statistic:                     22.20
Date:                Sat, 27 Aug 2022   Prob (F-statistic):           1.90e-08
Time:                        04:32:58   Log-Likelihood:                -379.82
No. Observations:                  86   AIC:                             765.6
Df Residuals:                      83   BIC:                             773.0
Df Model:                           2
Covariance Type:            nonrobust
================================================================================
                   coef    std err          t      P>|t|      [0.025      0.975]
--------------------------------------------------------------------------------
Intercept      246.4341     35.233      6.995      0.000     176.358     316.510
Literacy        -0.4889      0.128     -3.832      0.000      -0.743      -0.235
np.log(Pop1831) -31.3114      5.977     -5.239      0.000     -43.199     -19.424
==============================================================================
Omnibus:                        3.713   Durbin-Watson:                   2.019
Prob(Omnibus):                  0.156   Jarque-Bera (JB):                3.394
Skew:                          -0.487   Prob(JB):                        0.183
Kurtosis:                       3.003   Cond. No.                         702.
==============================================================================

Notes:
[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.
```

You can also use `numpy` arrays instead of formulas:

```
In [7]: import numpy as np

In [8]: import statsmodels.api as sm

# Generate artificial data (2 regressors + constant)
In [9]: nobs = 100

In [10]: X = np.random.random((nobs, 2))

In [11]: X = sm.add_constant(X)

In [12]: beta = [1, .1, .5]

In [13]: e = np.random.random(nobs)

In [14]: y = np.dot(X, beta) + e

# Fit regression model
In [15]: results = sm.OLS(y, X).fit()

# Inspect the results
In [16]: print(results.summary())
                            OLS Regression Results
==============================================================================
Dep. Variable:                      y   R-squared:                       0.247
Model:                            OLS   Adj. R-squared:                  0.231
Method:                 Least Squares   F-statistic:                     15.90
Date:                Sat, 27 Aug 2022   Prob (F-statistic):           1.07e-06
Time:                        04:32:58   Log-Likelihood:                -18.185
No. Observations:                 100   AIC:                             42.37
Df Residuals:                      97   BIC:                             50.18
Df Model:                           2
Covariance Type:            nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
const          1.5135      0.073     20.685      0.000       1.368       1.659
x1             0.1958      0.102      1.925      0.057      -0.006       0.398
x2             0.4922      0.104      4.740      0.000       0.286       0.698
==============================================================================
Omnibus:                       23.831   Durbin-Watson:                   1.951
Prob(Omnibus):                  0.000   Jarque-Bera (JB):                6.295
Skew:                          -0.262   Prob(JB):                       0.0430
Kurtosis:                       1.888   Cond. No.                         4.95
==============================================================================

Notes:
[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.
```

Have a look at *dir(results)* to see available results. Attributes are described in *results.__doc__* and results methods have their own docstrings.

Citation

Please use following citation to cite statsmodels in scientific publications:

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