

Real_data_example_Binomial-MGWR

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Notebook Outline:

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0.0.1 Set up Cells

```
In [1]: import sys
        sys.path.append("C:/Users/msachde1/Downloads/Research/Development/mgwr")

In [2]: import warnings
        warnings.filterwarnings("ignore")
        import pandas as pd
        import numpy as np

        from mgwr.gwr import GWR
        from spglm.family import Gaussian, Binomial, Poisson
        from mgwr.gwr import MGWR
        from mgwr.sel_bw import Sel_BW
        import multiprocessing as mp
        pool = mp.Pool()
        from scipy import linalg
        import numpy.linalg as la
        from scipy import sparse as sp
        from scipy.sparse import linalg as spla
        from spreg.utils import spdot, spmultiply
        from scipy import special
        import libpysal as ps
```

```

import seaborn as sns
import matplotlib.pyplot as plt
from copy import deepcopy
import copy
from collections import namedtuple
import spglm

```

0.0.2 Clearwater Landslides Dataset

Clearwater data - downloaded from link: <https://sgsup.asu.edu/sparc/multiscale-gwr>

```
In [3]: data_p = pd.read_csv("C:/Users/msachde1/Downloads/logistic_mgwr_data/landslides.csv")
```

```
In [4]: data_p.head()
```

```

Out[4]:   UserID      X      Y      Elev      Slope  SinAspct  CosAspct  \
0        1  616168.5625  5201076.5  1450.475  27.44172  0.409126 -0.912478
1        2  624923.8125  5201008.5  1567.476  21.88343 -0.919245 -0.393685
2        3  615672.0000  5199187.5  1515.065  38.81030 -0.535024 -0.844837
3        4  615209.3125  5199112.0  1459.827  26.71631 -0.828548 -0.559918
4        5  616354.6875  5198945.5  1379.442  27.55271 -0.872281 -0.489005

      AbsSouth  Landslid  DistStrm
0    24.1499         1      8.506
1    66.8160         1     15.561
2    32.3455         1     41.238
3    55.9499         1     17.539
4    60.7248         1     35.023

```

0.0.3 Univariate example

GWR Binomial model with independent variable, $x = \text{slope}$

```

In [5]: coords = list(zip(data_p['X'],data_p['Y']))
        y = np.array(data_p['Landslid']).reshape((-1,1))
        elev = np.array(data_p['Elev']).reshape((-1,1))
        slope = np.array(data_p['Slope']).reshape((-1,1))
        SinAspct = np.array(data_p['SinAspct']).reshape(-1,1)
        CosAspct = np.array(data_p['CosAspct']).reshape(-1,1)
        X = np.hstack([elev,slope,SinAspct,CosAspct])
        x = CosAspct

        X_std = (X-X.mean(axis=0))/X.std(axis=0)
        x_std = (x-x.mean(axis=0))/x.std(axis=0)
        y_std = (y-y.mean(axis=0))/y.std(axis=0)

In [6]: bw=Sel_BW(coords,y,x_std,family=Binomial(),constant=False).search()
        gwr_mod=GWR(coords,y,x_std,bw=bw,family=Binomial(),constant=False).fit()
        bw

```

```
Out[6]: 108.0
```

Running the function with family = Binomial()

Bandwidths check

```
In [7]: selector = Sel_BW(coords,y,x_std,family=Binomial(),multi=True,constant=False)
        selector.search(verbose=True)
```

```
Current iteration: 1 ,SOC: 0.0752521
```

```
Bandwidths: 108.0
```

```
Current iteration: 2 ,SOC: 0.0213201
```

```
Bandwidths: 184.0
```

```
Current iteration: 3 ,SOC: 5.8e-05
```

```
Bandwidths: 184.0
```

```
Current iteration: 4 ,SOC: 1e-06
```

```
Bandwidths: 184.0
```

```
Out[7]: array([184.])
```

```
In [8]: mgwr_mod = MGWR(coords, y,x_std,selector,family=Binomial(),constant=False).fit()
```

```
HBox(children=(IntProgress(value=0, description='Inference', max=1), HTML(value='')))
```

Parameter check

```
In [9]: mgwr_mod.bic
```

```
Out[9]: 325.23949237389036
```

```
In [10]: gwr_mod.bic
```

```
Out[10]: 338.19722049287054
```

0.0.4 Multivariate example

```
In [12]: bw=Sel_BW(coords,y,X_std,family=Binomial(),constant=True).search()
        gwr_mod=GWR(coords,y,X_std,bw=bw,family=Binomial(),constant=True).fit()
        bw
```

```
Out[12]: 121.0
```

Bandwidth check

```
In [13]: selector = Sel_BW(coords,y,X_std,family=Binomial(),multi=True,constant=True)
         selector.search(verbose=True)

Current iteration: 1 ,SOC: 0.116124
Bandwidths: 43.0, 62.0, 191.0, 100.0, 108.0
Current iteration: 2 ,SOC: 0.0266811
Bandwidths: 43.0, 106.0, 210.0, 100.0, 184.0
Current iteration: 3 ,SOC: 0.0008147
Bandwidths: 43.0, 106.0, 210.0, 100.0, 184.0
Current iteration: 4 ,SOC: 5.28e-05
Bandwidths: 43.0, 106.0, 210.0, 100.0, 184.0
Current iteration: 5 ,SOC: 5.3e-06
Bandwidths: 43.0, 106.0, 210.0, 100.0, 184.0

Out[13]: array([ 43., 106., 210., 100., 184.])

In [14]: mgwr_mod = MGWR(coords, y,X_std,selector,family=Binomial(),constant=True).fit()
HBox(children=(IntProgress(value=0, description='Inference', max=1), HTML(value='')))
```

AIC, AICc, BIC check

```
In [15]: gwr_mod.aicc, mgwr_mod.aicc

Out[15]: (264.9819711678866, 251.85376815296377)
```

0.0.5 Global model check

```
In [16]: selector=Sel_BW(coords,y,X_std,multi=True,family=Binomial(),constant=True)
         selector.search(verbose=True,multi_bw_min=[239,239,239,239,239], multi_bw_max=[239,239,239,239,239])

Current iteration: 1 ,SOC: 0.6120513
Bandwidths: 239.0, 239.0, 239.0, 239.0, 239.0
Current iteration: 2 ,SOC: 0.0594775
Bandwidths: 239.0, 239.0, 239.0, 239.0, 239.0
Current iteration: 3 ,SOC: 0.0025897
Bandwidths: 239.0, 239.0, 239.0, 239.0, 239.0
Current iteration: 4 ,SOC: 0.0001289
Bandwidths: 239.0, 239.0, 239.0, 239.0, 239.0
Current iteration: 5 ,SOC: 1.17e-05
Bandwidths: 239.0, 239.0, 239.0, 239.0, 239.0
Current iteration: 6 ,SOC: 1.2e-06
Bandwidths: 239.0, 239.0, 239.0, 239.0, 239.0
```

```
Out[16]: array([239., 239., 239., 239., 239.])
```

```
In [17]: mgwr_mod = MGWR(coords, y,X_std,selector,family=Binomial(),constant=True).fit()  
HBox(children=(IntProgress(value=0, description='Inference', max=1), HTML(value='')))
```

```
In [18]: gwr_mod.summary()
```

```
=====
Model type                                Binomial
Number of observations:                    239
Number of covariates:                     5
```

Global Regression Results

```
-----
Deviance:                                266.246
Log-likelihood:                           -133.123
AIC:                                       276.246
AICc:                                     276.504
BIC:                                      -1015.246
Percent deviance explained:                0.182
Adj. percent deviance explained:           0.168
```

Variable	Est.	SE	t(Est/SE)	p-value
X0	0.389	0.150	2.591	0.010
X1	-0.784	0.166	-4.715	0.000
X2	0.654	0.168	3.881	0.000
X3	0.039	0.149	0.264	0.792
X4	-0.371	0.156	-2.381	0.017

Geographically Weighted Regression (GWR) Results

```
-----
Spatial kernel:                           Adaptive bisquare
Bandwidth used:                            121.000
```

Diagnostic information

```
-----
Effective number of parameters (trace(S)): 23.263
Degree of freedom (n - trace(S)):         215.737
Log-likelihood:                           -106.599
AIC:                                       259.725
AICc:                                     264.982
BIC:                                      340.598
Percent deviance explained:               0.345
```

Adjusted percent deviance explained: 0.274
 Adj. alpha (95%): 0.011
 Adj. critical t value (95%): 2.571

Summary Statistics For GWR Parameter Estimates

Variable	Mean	STD	Min	Median	Max
X0	0.459	0.360	-0.360	0.436	1.232
X1	-0.824	0.479	-2.128	-0.729	-0.095
X2	0.567	0.390	-0.030	0.600	1.328
X3	0.103	0.270	-0.473	0.183	0.565
X4	-0.331	0.247	-1.118	-0.287	0.096

In [19]: np.mean(mgwr_mod.params,axis=0)

Out[19]: array([0.19936242, -0.3251776 , 0.32069312, 0.04295657, -0.20408904])

In [20]: mgwr_mod.bic, gwr_mod.bic

Out[20]: (303.9521120546862, 340.5982180538755)