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2  # Name:      Markov Transition Matrix Probability
3  # Purpose:   Example of land cover change model using Markov chains
4  #
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6  #
7  # Created:   10/10/2016
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9  # Licence:   <your licence>
10 # Modifications:
11 #
12 #-----
13 # Import system modules
14 import sys, string, os
15 import numpy as np
16 import matplotlib.pyplot as plt
17 import csv
18
19 path = sys.path[0]
20 inCSV = path + '/crosstab_lc.csv'
21 crosstab = [] #store rows in list
22 with open(inCSV, 'rb') as csvfile:
23     lcreader = csv.reader(csvfile, delimiter=',')
24     for row in lcreader:
25         crosstab.append(row)
26 lcmat = np.array(crosstab) #convert list to matrix array
27 lcmat = lcmat[1:15, 1:15] # discard first row and first column (labels)
28 lcmat.shape # check dimensions of matrix
29 transm = lcmat.astype(np.float) # convert string to float
30 transm = transm*(1/900.) #convert to number of cells instead of area
31                                     # This does not change the probability since it's a
32                                     # constant that multiplies all values
33 totCol = np.sum(transm,axis =1) #get sum of each row
34 totCol.shape
35 tp = transm/totCol[:,None] #element in row divided by corresponding vector
36 tp.shape
37 # initial state
38 thisLC = np.array([0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0,]).reshape(1,14)
39 Xt = thisLC #(1x14)
40 ndec = 10
41 for t in range(1,ndec+1): #includes 10
42     thisD = np.dot(Xt[t-1:,:],tp) #multiply row (1x14) by tp matrix (14x14).
43                                     # result is (1x14)
44     Xt = np.concatenate((Xt,thisD), axis=0) #store results as row to Xt matrix,
45                                     #Xt dimension is (2x14),(3x14)...
46                                     # In the next loop t-1 is the
47                                     #previous land cover probability
48                                     #This is a Markov chain.
49 yval1 = Xt[:,2] #developed low intensity
50 yval2 = Xt[:,3] #developed medium intensity
51 yval3 = Xt[:,4] #developed high intensity
52 yval4 = Xt[:,8] # shrub, scrub
53
54 xval = range(0,ndec+1) #x-axis, start with present (zero) up to 10 (inclusive)

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55 plt.plot(xval, yval1, 'b--', marker = 'x')
56 plt.plot(xval, yval2, 'k-.' , marker = 'o')
57 plt.plot(xval, yval3, 'r:', marker = '^')
58 plt.plot(xval, yval4, 'g-', marker = '*')
59 plt.xlabel('Decades')
60 plt.ylabel('Probability')
61 plt.legend(('Dev. Low Int.', 'Dev. Medium Int.', 'Dev. High Int.',
62            'Shrub/Scrub'))
63 plt.show()
64
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