HW 3

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AMATH 422 Au 22

In [ ]:
```
import matplotlib.pyplot as plt
import numpy as np
import scipy as sp

plt.rcParams['axes.facecolor'] = 'white'
plt.rcParams['savefig.facecolor'] = 'white'
```

In [ ]:
```
## setting up owl population dynamic matrix ##
A = np.zeros((51,51))
A[1,0] = 0.361
A[2,1] = 0.4
A[3,2] = 0.5

for i in range(51):
    if (i<50) and (A[i+1,i] == 0):
        A[i+1,i] = 0.942
    if i>=3:
        A[0,i] = 0.24
```

In [ ]:
```
## calculating eig vals, eig vecs, and left eig vecs ##
l, v = np.linalg.eig(A)

idx = np.argsort(np.abs(l))
l_max = np.abs(l).max()
v_max = v[:,idx[-1]]

l, w = np.linalg.eig(A.T)
idx = np.argsort(np.abs(l))
w_max = w[:,idx[-1]]
```

In [ ]:
```
## calculating matrix of elasticity ##
s = (w_max.reshape(-1,1)@v_max.reshape(1,-1))/(v_max@w_max)
e = s*A/l_max

p = np.zeros((50))
for i in range(50):
    p[i] = np.real(e)[i+1,i]
```

In [ ]:
```
np.set_printoptions(precision = 4, threshold = False)
print(f'The matrix of elasticies is as follows:\n {np.real(e)}\n')
np.set_printoptions(precision = 5, threshold = np.inf)
print(f'The elasticies of the fecundities are as follows: \n {np.real(e[0,:])}\n')
print(f'The elasticies of the death probabilites are as follows: \n {p}')
```

```
The matrix of elasticies is as follows:
 [[0.     0.     0.     ... 0.0007 0.0007 0.0007]
 [0.0369 0.     0.     ... 0.     0.     0.    ]
 [0.     0.0369 0.     ... 0.     0.     0.    ]
 ...
 [0.     0.     0.     ... 0.     0.     0.    ]
 [0.     0.     0.     ... 0.0015 0.     0.    ]
 [0.     0.     0.     ... 0.     0.0007 0.    ]]

The elasticies of the fecundities are as follows:
 [0.      0.      0.      0.00081 0.0008  0.0008  0.0008  0.0008  0.0008
 0.0008  0.00079 0.00079 0.00079 0.00079 0.00079 0.00079 0.00078 0.00078
 0.00078 0.00078 0.00078 0.00078 0.00077 0.00077 0.00077 0.00077 0.00077
 0.00077 0.00077 0.00076 0.00076 0.00076 0.00076 0.00076 0.00076 0.00076
 0.00075 0.00075 0.00075 0.00075 0.00075 0.00075 0.00074 0.00074 0.00074
 0.00074 0.00074 0.00074 0.00074 0.00073 0.00073]

The elasticies of the death probabilites are as follows:
 [0.03688 0.03688 0.03688 0.03607 0.03527 0.03447 0.03367 0.03287 0.03207
 0.03128 0.03048 0.02969 0.0289  0.02811 0.02732 0.02654 0.02575 0.02497
 0.02419 0.02341 0.02263 0.02186 0.02108 0.02031 0.01954 0.01876 0.018
 0.01723 0.01646 0.0157  0.01494 0.01418 0.01342 0.01266 0.0119  0.01115
 0.01039 0.00964 0.00889 0.00814 0.00739 0.00665 0.0059  0.00516 0.00442
 0.00368 0.00294 0.0022  0.00147 0.00073]
```

Looking at all of the values of the fecundities at age 3 and above, there is a slight but noticeable decrease in the elasticity of values from about $e_{0,j} = 8.1 \times 10^{-4}$, due to them being able to have offspring at age $a = 3$, to $e_{0j} = 7.3 \times 10^{-4}$, as less and less owls make it into their advanced years of maturity to produce offspring. Likewise, the elasticies for annual survival probabilites are the highest betweeen ages 0 to 3 due to that time period having the highest mortality rate among the female owls while lowest at age 50 since few owls make it to that age.

By increasing the survivability of young, immature offspring (specifically ages 0 to 3), the greatest good can be done for female northern spotted owls. Likewise, ensuring the survivability of early maturity owls (which I define to about the first 10 years of maturity) can contribute similarly positive results to the species survival.

Thanks for reading!

-Avi