Modeling Population Growth Using Life History Data

Leslie Matrix-

Point = to use age structure data to make more accurate predictions of population change over time.

$$\mathbf{A} \times \vec{N}_t = \vec{N}_{t+1}$$

$\mathbf{A}$ x N_t = N_{t+1}

$$\begin{bmatrix} & & \\ & & \\ & & \end{bmatrix} \times \begin{bmatrix} \\ \\ \\ \end{bmatrix} = \begin{bmatrix} \\ \\ \\ \end{bmatrix}$$

$$\lambda \times N_t = N_{t+1}$$

$$\mathbf{A} \times \vec{N}_t = \vec{N}_{t+1}$$

Probability of surviving to next time step

x (age)	l_x	b_x	P_x
0	1.0	0	
1	0.8	2	0.8/1.0
2	0.4	3	
3	0.1	1	
4	0	0	

$$P_x = l_{x+1}/l_x$$

$$\mathbf{A} \times \vec{N}_t = \vec{N}_{t+1}$$

x (age)	l_x	b_x	P_x (Probability of surviving to next time step)	F_x (Age-specific fecundity)
0	1.0	0		
1	0.8	2	0.8	1.6
2	0.4	3	0.5	1.5
3	0.1	1	0.25	0.25
4	0	0	0	0

$P_x = l_{x+1}/l_x$ $\qquad$ $F_x = b_x * P_x$

Next Year's Population:

$$\mathbf{A} \times N_t = N_{t+1}$$

$$\begin{bmatrix} 1.6 & 1.5 & 0.25 & 0 \\ 0.8 & & & \\ & 0.5 & & \\ & & 0.25 & \end{bmatrix} \times \begin{bmatrix} N_0 \\ N_1 \\ N_2 \\ N_3 \end{bmatrix} = \begin{bmatrix} \\ \\ \\ \\ \end{bmatrix}$$

Multiplying a matrix by a vector

Next Year's Population:

A x N_t = N_{t+1}

$$\begin{bmatrix} 1.6 & 1.5 & 0.25 & 0 \\ 0.8 & & & \\ & 0.5 & & \\ & & 0.25 & \end{bmatrix} \times \begin{bmatrix} 50 \\ 50 \\ 50 \\ 50 \end{bmatrix} = \begin{bmatrix} 167 \\ \\ \\ \\ \end{bmatrix}$$

Next year's babies =

$$N_{o\ t+1} = F_oN_{o\ t} + F_1N_{1\ t} + F_2N_{2\ t} + F_3N_{3\ t}$$

$$= 80 \quad + \ 75 \quad + \ 12.5 \quad + \ 0$$

Next Year's Population:

A x N_t = N_{t+1}

$$\begin{bmatrix} 1.6 & 1.5 & 0.25 & 0 \\ 0.8 & & & \\ & 0.5 & & \\ & & 0.25 & \end{bmatrix} \times \begin{bmatrix} 50 \\ 50 \\ 50 \\ 50 \end{bmatrix} = \begin{bmatrix} 167 \\ 40 \\ \\ \\ \end{bmatrix}$$

Next Year's Population:

A	x	N_t	=	N_{t+1}

$$\begin{bmatrix} 1.6 & 1.5 & 0.25 & 0 \\ 0.8 & & & \\ & 0.5 & & \\ & & 0.25 & \end{bmatrix} \times \begin{bmatrix} 50 \\ 50 \\ 50 \\ 50 \end{bmatrix} = \begin{bmatrix} 167 \\ 40 \\ 25 \\ \ \end{bmatrix}$$

Next Year's Population:

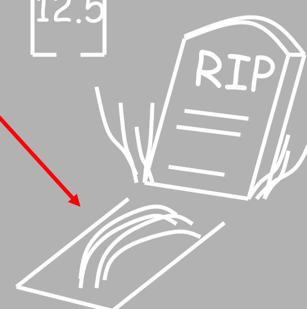
A	x	N_t	=	N_{t+1}

$$\begin{bmatrix} 1.6 & 1.5 & 0.25 & 0 \\ 0.8 & & & \\ & 0.5 & & \\ & & 0.25 & \end{bmatrix} \times \begin{bmatrix} 50 \\ 50 \\ 50 \\ 50 \end{bmatrix} = \begin{bmatrix} 167 \\ 40 \\ 25 \\ 12.5 \end{bmatrix}$$

Next Year's Population:

A	x	N_t	=	N_{t+1}

$$\begin{bmatrix} 1.6 & 1.5 & 0.25 & 0 \\ 0.8 & & & \\ & 0.5 & & \\ & & 0.25 & \end{bmatrix} \times \begin{bmatrix} 50 \\ 50 \\ 50 \\ 50 \end{bmatrix} = \begin{bmatrix} 167 \\ 40 \\ 25 \\ 12.5 \end{bmatrix}$$



Next Year's Population:

A	x	N_t	=	N_{t+1}

$$\begin{bmatrix} 1.6 & 1.5 & 0.25 & 0 \\ 0.8 & & & \\ & 0.5 & & \\ & & 0.25 & \end{bmatrix} \times \begin{bmatrix} 50 \\ 50 \\ 50 \\ 50 \end{bmatrix} = \begin{bmatrix} 167 \\ 40 \\ 25 \\ 12.5 \end{bmatrix}$$

All other values in **A** are 0

Next Year's Population:

$$\mathbf{A} \times N_t = N_{t+1}$$

$$\begin{bmatrix} 1.6 & 1.5 & 0.25 & 0 \\ 0.8 & & & \\ & 0.5 & & \\ & & 0.25 & \end{bmatrix} \times \begin{bmatrix} 50 \\ 50 \\ 50 \\ 50 \end{bmatrix} = \begin{bmatrix} 167 \\ 40 \\ 25 \\ 12.5 \end{bmatrix}$$

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A=			
1.6	1.5	0.25	0
0.8	0	0	0
0	0.5	0	0
0	0	0.25	0
Nt			
50			
50			
50			
50			
200			