Facts About Leopards

- **Distribution** The leopard has the most widespread distribution of all the cats and can be found in India, Africa, China, Siberia and Korea.
- **Mating Behavior** Females are capable of breeding at two years and will produce litters of one to three cubs after a pregnancy lasting about 100 days (three-and-a-half months).
- **Reproduction** Females give birth after a gestation period of 90-105 days. Litters usually amount to between 2-4 cubs. The cubs are born blind and are weaned at three months but stay with their mother until they are 13-18 months old.

40-50 per cent of cubs do not reach adulthood. The father plays no part in the rearing of his cubs.

- A method for calculating the **leopard population** in Africa using the Martin and de Meulenaer model, which as been discredited scientifically gives an overestimate of 710,000.
- **The Life span** is 10-15 years and 21-23 years if held in captivity. Male leopards tend to die from encounters with mammals and females tend to die from natural occurrences, such as natural disasters, old age, and illness.

The Leslie Matrix

- The Leslie application is extremely useful for Ecologist to determine the life span of a species.
- This application can be useful in helping to predict the number of animals in a certain species that will be alive in a few years.
- This application is sophisticated enough to take into account the reproduction likelihood of the particular female species (in study) dependent on its age.

The **Leslie Matrix** is a square matrix with the same number of rows and columns as the population vector has elements. The (i,j)th cell in the matrix indicates how many individuals will be in the age class i at the next time step for each individual in stage j. At each time step, the population vector is multiplied by the Leslie Matrix to generate the population vector for the following time step.

$$\begin{bmatrix} n_0 \\ n_1 \\ \vdots \\ n_{\omega-1} \end{bmatrix}_{t+1} = \begin{bmatrix} f_0 & f_1 & f_2 & f_3 & \ldots & f_{\omega-1} \\ s_0 & 0 & 0 & 0 & \ldots & 0 \\ 0 & s_1 & 0 & 0 & \ldots & 0 \\ 0 & 0 & s_2 & 0 & \ldots & 0 \\ 0 & 0 & 0 & \ddots & \ldots & 0 \\ 0 & 0 & 0 & \ldots & s_{\omega-2} & 0 \end{bmatrix} \begin{bmatrix} n_0 \\ n_2 \\ \vdots \\ n_{\omega-1} \end{bmatrix}_t$$

$$\mathbf{n}_{t+1} = \mathbf{L}\mathbf{n}_t$$

Transition Matrix

	0	0	0	0
0		0	0	0
0	0		0	0
0	0	0		0

X

x

Total

=

X+1

Total

The values in the **top row marked in this color** are the **average number of offspring** produced from age class x to x+1. The **cells that form the diagonal in this color** **show the**

0

NOTE: No numerical data exists for Leopard population. This example serves as a model to demonstrate how linear algebra could be used to calculate a species population from a specific age class.

Transition Matrix						x		X+1	% in Age Class
10	3	3	2	6		50		?	?
.9	0	0	0	0		0		?	?
0	.8	0	0	0	x	0	=	?	?
0	0	.6	0	0		0		?	?
0	0	0	.4	0		0		?	?
						Total 50		Total	

Basic Linear Algebra Skills to Utilize:

•Property of **matrix multiplication:**

(m x n) **X** (n X p) will yield a new matrix with m x p many dimensions.

Remember:

•Green represents the number of offspring per class (age group)

•**The Purple represent the survival rate of the leopards in the green box in the same column.**

•The column to the far right of the page computes the percentage in age class. Note: I did not cover this how they derived at this computation, it far too difficult and will take years for me to explain…

•Yet, it is amazing how linear algebra can derive such information for a particular species.

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Transition Matrix						Nt		Nt+1	% in Age Class
10	3	3	2	6		50		500	92
.9	0	0	0	0		0		45	8
0	.8	0	0	0	x	0	=	0	0
0	0	.6	0	0		0		0	0
0	0	0	.4	0		0		0	0
						Total 50		Total 545	

Now lets say you want to find the age specific percentage two years from today's date, you simply shift the X+1 Column into the X and multiply the new matrix with the transitional matrix to compute the following years, X+2, population. Got it??

Let's see…

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Transition Matrix						X+1		X+2
10	3	3	2	6		500		?
.9	0	0	0	0	x	45	=	?
0	.8	0	0	0		0		?
0	0	.6	0	0		0		?
0	0	0	.4	0		0		?
						Total 545		Total

Computing the growth of the leopard population in Africa demonstrates the mechanics of the Leslie Matrix Approach. Population size in the next step (**X+1**) is calculated by multiplying the **transition matrix** also known as L, by the population size at the present time (**X**). The values in the **top row marked in this color (green)** are the average number of offspring produced from age class x to x+1. The **cells that form the diagonal in this color (purple)** show the survivorship, i.e. the probability of surviving from age class x to age class x+1.

Each time you perform the next step the multiplication is performed and the results show in **X+1**. When the age time is greater than zero, the population structure in **X+1** is moved to **X**. The next computation would be for **X+2, and so on**.

Although there is no existing numerical data on the African Leopard population, the Leslie Matrix can be used to compute growth population given the necessary information. It is imperative that the first row be the initial population size at the start of the computation. Then the diagonal entries starting on the second row, be the probability of survival of the numerical entries above, in the same column. Computation is derived by performing matrix multiplication.

Lay, David C. (2006). *Linear Algebra and Its Applications, third edition*. Boston. MA.

White, Niel. (2000). Leslie Matrix Model. Available at: http://www.montana.edu/~wwwbi/staff/creel/bio480/leslie.html