

Suppose a new species of pig *Sus-Gigantis* in a small region had the following population

Age Groups	Birth Rate	Survival Rate
0-2	0.00	0.60
2-4	0.00	0.85
4-6	1.20	0.90
6-8	0.70	0.80
8-10	0.60	0.50
10-12	0.05	0.00

	Age Groups (in years)					
Year: 2008	0-2	2-4	4-6	6-8	8-10	10-12
# of Pigs in initial population	30	25	26	28	22	15

a. Calculate how many 0-2 year olds there will be in the next 5 year cycle.

$$30(0) + 25(0) + 26(1.2) + 28(.7) + 22(.6) + 15(.05) = 64.75 \approx 65$$

b. Complete the Table for the next cycle and show your steps.

	Age Groups (in years)					
	0-2	2-4	4-6	6-8	8-10	10-12
in initial pop (Year:2008)	30	25	26	28	22	15
		$30(.6)$	$25(.85)$	$26(.9)$	$28(.8)$	$22(.5)$
Population (Year: 2010)	64.75	18	21.25	23.4	22.4	11

c. Complete the Table for the next cycle and show your steps.

$$\text{BABIES: } 64.8(0) + 18(0) + 21.3(1.2) + 23.4(.7) + 22.4(.6) + 11(.05) = 55.9$$

	Age Groups (in years)					
	0-2	2-4	4-6	6-8	8-10	10-12
in initial pop (Year:2010)	64.75	18	21.3	23.4	22.4	11
		$64.8(.6)$	$18(.85)$	$21.25(.9)$	$23.4(.8)$	$22.4(.5)$
Population (Year: 2012)	55.9	38.9	15.3	19.125	18.7	11.2

DO THIS PROBLEM AGAIN BUT USING MATRICES.....

Suppose a species of pig, *Sus-Gigantis*, has characteristics as described below:

Age Groups	Birth Rate	Survival Rate
0-2	0.00	0.60
2-4	0.00	0.85
4-6	1.20	0.90
6-8	0.70	0.80
8-10	0.60	0.50
10-12	0.05	0.00

	Age Groups (in years)					
Year: 2008	0-2	2-4	4-6	6-8	8-10	10-12
# of Pigs in initial population	30	25	26	28	22	15

- a. Create the initial population matrix and the corresponding LESLIE matrix.

POPULATION MATRIX	LESLIE MATRIX
$[P] = \begin{bmatrix} 30 & 25 & 26 & 28 & 22 & 15 \end{bmatrix}$	$[L] = \begin{bmatrix} 0 & 0.6 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0.85 & 0 & 0 & 0 \\ 1.2 & 0 & 0 & 0.9 & 0 & 0 \\ 0.7 & 0 & 0 & 0 & 0.8 & 0 \\ 0.6 & 0 & 0 & 0 & 0 & 0.5 \\ 0.05 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}$

- b. How many Leslie Cycles would have been completed by the year 2010?

$$\frac{2010 - 2008}{2} = \frac{2}{2}$$

1 CYCLE

- c. Using your calculator and the Matrices created in "part a" of this question determine the population of monkeys for each age group in the year 2010.

$$[P] \cdot [L] = \begin{bmatrix} 164.75 & 18 & 21.25 & 23.4 & 22.4 & 11 \end{bmatrix}$$

	Age Groups (in years)					
	0-2	2-4	4-6	6-8	8-10	10-12
Population (Year: 2010)	64.75	18	21.25	23.4	22.4	11

- d. How would you suggest estimating how many pigs were in each age group in the year 2011?

WE COULD FIND THE POPULATION IN 2010 $P_1 = [P] \cdot [L]$ AND FIND THE POPULATION IN 2012 $P_2 = [P] \cdot [L]^2$						
	0-2	2-4	4-6	6-8	8-10	10-12
2010 POPULATION $[P] \cdot [L]$	64.75	18	21.25	23.4	22.4	11
2012 POPULATION $[P] \cdot [L]^2$	55.87	38.85	15.3	19.125	18.72	11.2

- e. What would be your estimate for the year 2011 using your suggestion from part d?

	Age Groups (in years)					
	0-2	2-4	4-6	6-8	8-10	10-12
Population (Year: 2011)	$\frac{64.8 + 55.9}{2}$	$\frac{18 + 38.85}{2}$	$\frac{21.25 + 15.3}{2}$	$\frac{23.4 + 19.125}{2}$	$\frac{22.4 + 18.72}{2}$	$\frac{11 + 11.2}{2}$
	60.3	28.425	18.275	21.2625	20.56	11.1

- f. Why is it necessary for the survival rate of the last group to be 0 for this model to work?

THERE ARE A COUPLE OF REASONS. IF IT WAS NOT ZERO THE POPULATION MATRIX WOULD HAVE TO CONTINUE TO ADD ANOTHER COLUMN AND THE LESLIE MATRIX COULDN'T BE A SQUARE MATRIX WHICH WOULD PREVENT US FROM RAISING IT TO AN EXPONENT.

2. Suppose a certain species of Elephants has characteristics as described:

Age Groups	Birth Rate	Survival Rate
0-5	0.00	0.50
5-10	0.10	0.70
10-15	0.40	0.80
15-20	0.90	0.70
20-25	1.10	0.60
25-30	0.30	0.40
30-35	0.00	0

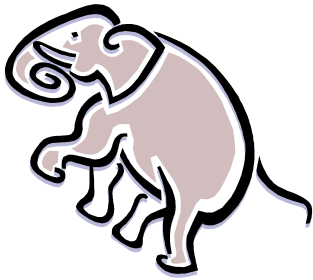
	Age Groups (in years)						
Year: 2000	0-5	5-10	10-15	15-20	20-25	25-30	30-35
# of elephants in initial population	20	30	10	30	12	10	6

a. Calculate how many 0-5 year olds there will be in the next 5 year cycle.

$$20(0) + 30(.1) + 10(.4) + 30(.9) + 12(1.1) + 10(.3) + 6(0) = 50.2$$

b. Complete the Table for the next cycle and show your steps.

	Age Groups (in years)						
	0-5	5-10	10-15	15-20	20-25	25-30	30-35
in initial pop (Year:2000)	20	30	10	30	12	10	6
		$30(.1)$	$10(.4)$	$30(.9)$	$12(1.1)$	$10(.3)$	$6(0)$
Population (Year: 2005)	50.2	10	21	8	21	7.2	4



c. Create the initial population matrix and the corresponding LESLIE matrix.

$$P_0 = [20 \ 30 \ 10 \ 30 \ 12 \ 10 \ 6] \quad L = \begin{bmatrix} 0 & .5 & 0 & 0 & 0 & 0 & 0 \\ 0.1 & 0 & .7 & 0 & 0 & 0 & 0 \\ 0.4 & 0 & 0 & .8 & 0 & 0 & 0 \\ 0.9 & 0 & 0 & 0 & .7 & 0 & 0 \\ 1.1 & 0 & 0 & 0 & 0 & .6 & 0 \\ 0.3 & 0 & 0 & 0 & 0 & 0 & .4 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

d. How many Leslie Cycles would have been completed by the year 2025?

$$\frac{2025 - 2000}{5} = \frac{25}{5} = 5$$

5 cycles

e. Using your calculator and the Matrices created in "part a" of this question determine the population of elephants for each age group in the year 2025.

$$[P_0] \cdot [L]^5 =$$

	Age Groups (in years)						
	0-5	5-10	10-15	15-20	20-25	25-30	30-35
Population (Year: 2025)	26.46	14.05	10.63	11.72	9.84	2.35	2.82

f. It appears that the overall population is declining. If this trend continues how long (or in what year) would you estimate until the population of all of the subgroup categories finally fall below 1 elephant.

Approximately 43 cycles
OR 215 years

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- g. BONUS: How would you suggest estimating elephant populations in each age group in 2026?

	0-5	5-10	10-15	15-20	20-25	25-30	30-35
2025	26.5	14.1	10.6	11.7	9.8	2.4	2.8
2030	27.7	13.2	9.8	8.5	8.2	5.9	0.9

FIND ONE FIFTH THE DISTANCE FROM 2025 TO 2030 USING LINEAR APPROXIMATION.

- h. What would be your estimate for the year 2026 using your suggestion from part e?

	Age Groups (in years)						
	0-5	5-10	10-15	15-20	20-25	25-30	30-35
Population (Year: 2026)	26.7	13.9	10.5	11.1	9.5	3.1	2.4