

MATA35 - Module 2 (weeks 3-4) practice problems

**This is NOT the practice quiz. Just a selection of practice problems covering the material.**

**Problem 1.** Solve each of the following problems. If the answer is undefined, state so explicitly.

(a)  $\begin{bmatrix} 3 & -1 & 0 \\ 1 & 0 & 2 \\ -2 & 0 & 1 \end{bmatrix} - \begin{bmatrix} 1 & 3 \\ 2 & 2 \\ 3 & 1 \end{bmatrix}$

(b)  $\begin{bmatrix} 3 & -1 & 0 \\ 1 & 0 & 2 \\ -2 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 3 \\ 2 & 2 \\ 3 & 1 \end{bmatrix}$

(c)  $\begin{bmatrix} 3 & -1 & 0 \\ 1 & 0 & 2 \\ -2 & 0 & 1 \end{bmatrix}^2 \begin{bmatrix} 1 & 3 \\ 2 & 2 \\ 3 & 1 \end{bmatrix}$

(d)  $\begin{bmatrix} 3 & -1 & 0 \\ 1 & 0 & 2 \\ -2 & 0 & 1 \end{bmatrix}^2 \begin{bmatrix} 1 & 3 \\ 2 & 2 \\ 3 & 1 \end{bmatrix}^2$

(e)  $\left( \begin{bmatrix} 3 & -1 \\ 1 & 0 \end{bmatrix} - \begin{bmatrix} 2 & 2 \\ 3 & 1 \end{bmatrix} \right)^2$

**Problem 2.** Solve the following systems of equations. If there are multiple solutions, give both the most general form of the solution and at least one specific solution (without free variables). If there are no solutions, state as much.

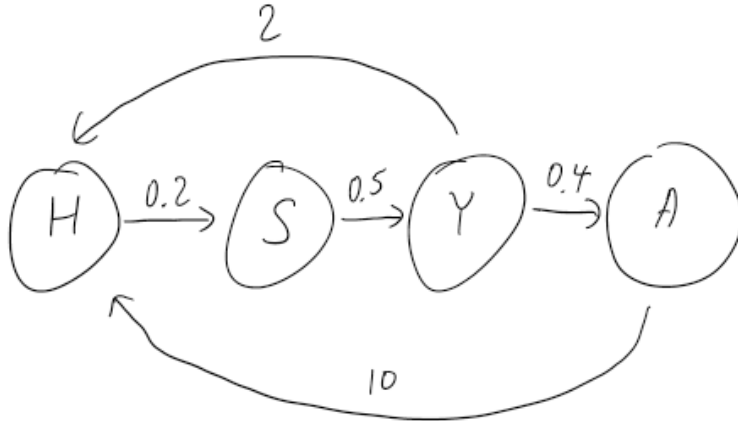
(a)

$$\begin{aligned} w + x + 2y - z &= 1 \\ w + 2x - 2y - 3z &= 6 \\ 3w - x - y - z &= 6 \\ w + x + y - 2z &= 2 \end{aligned}$$

(b)

$$\begin{aligned} x + y - z &= 1 \\ x + 2y - 3z &= 3 \\ x + z &= -1 \\ y - 2z &= 2 \end{aligned}$$

**Problem 3.** A population of sea turtles can be divided up into 4 stages, hatchlings (H), second-years (S), young adults (Y), and adults (A), with the Leslie diagram given below.



The population in year 1 is composed of 0 hatchlings, 10 second years, 5 young adults, and 2 adults.

- Write the Leslie Matrix.
- Estimate the population in each group in year 2.
- Estimate the population in each group in year 3.

**Problem 4.** Find the determinant and multiplicative inverse for each of the following matrices. If an inverse does not exist or is undefined, say why.

1.  $\begin{bmatrix} 3 & -1 \\ 1 & 0 \end{bmatrix}$

2.  $\begin{bmatrix} 3 & -1 & 0 \\ 1 & 0 & 2 \\ -1 & 1 & 2 \end{bmatrix}$

3.  $\begin{bmatrix} 3 & -1 \\ 1 & 0 \\ 2 & -1 \end{bmatrix}$

4.  $\begin{bmatrix} 3 & -1 & 0 \\ 1 & 0 & 2 \\ -1 & 1 & 4 \end{bmatrix}$

**Problem 5.** Find all eigenvalues and eigenvectors for the following matrix. Show your work.

(a)  $\begin{bmatrix} 2 & -2 \\ -2 & 5 \end{bmatrix}$

(b)  $\begin{bmatrix} 1 & 2 \\ 2 & 1 \end{bmatrix}$

**Problem 6.** A new invasive species of feral cats has just been accidentally released in Australia. As an ecologist, you have built a 2-stage Leslie population model for the cats, and have measured the following rates:

- Each year, an adult cat has on average 10 kittens.
  - Each year, kittens survive to adulthood with probability 0.15 (if the kittens survive, they become adults the next year).
  - Kittens don't have any children their first year of life.
  - Each year, an adult has a 0.5 chance of dying.
- (a) Draw a Leslie diagram and Leslie matrix for this population.
- (b) If you have measured the first year population to be 20 feral cats and no kittens, what is your estimate for the population after 5 years. You do not need to simplify, and can leave the answer in terms of fractions and powers.
- (c) What is the long-term ratio of adult cats to kittens?