

Math 1B03/1ZC3 - Tutorial 6



Feb. 11th/ 14th, 2014

Tutorial Info:

- **Website:** <http://ms.mcmaster.ca/~dedieula>.
- **Review Session:** I'll be TAing a review session for the midterm on Mon. Feb. 24th, 4:30-6:30pm, in JHE 264. There will also be 4 other reviews happening this day at different times. See Avenue for the times/ rooms.
- **Math Help Centre:** Wednesdays 2:30-5:30pm.
- **Email:** dedieula@math.mcmaster.ca .



Examples:

- 1. Consider

$$A = \begin{pmatrix} 3 & 10 \\ 1 & 0 \end{pmatrix}.$$

- a) Find a matrix P that diagonalizes A .
- Recall:** A is said to be **diagonalizable** if there exists an invertible matrix P such that $P^{-1}AP$ is a diagonal matrix. (i.e. $P^{-1}AP = D$, where D is a diagonal matrix).
- Procedure for Diagonalizing a Matrix:**
 1. Find the eigenvalues $\lambda_1, \dots, \lambda_k$ and eigenvectors v_1, \dots, v_l of your matrix A .
 2. Create a matrix P by putting your eigenvectors as the columns of P .
 3. Create a matrix D by putting your eigenvalues along the diagonal such that the eigenvalue in column i corresponds to the eigenvector in column i of P .
 4. Find P^{-1} .
 5. Check to make sure $A = PDP^{-1}$.
- b) Find A^{100} .
- Recall)** If $A = PDP^{-1}$, then $A^k = PD^kP^{-1}$.



Examples:

- 2. Consider

$$A = \begin{pmatrix} -2 & -27 & 9 \\ 0 & -2 & 0 \\ 0 & -18 & 4 \end{pmatrix}.$$

Find A^k .

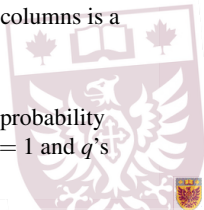


Examples:

- **3.** Suppose the population of raccoons in the city in 2010 is 100 and the population of raccoons in the nearby forest is 300. Suppose we also know that 10% of the racoons in the forest move to the city, and 5% of the raccoons in the city move to the forest each year.
- **a)** Set up a transition matrix to describe this phenomenon.
- **Recall:** Our transition matrix takes us from time k to time $k + 1$:

$$\begin{pmatrix} w_{k+1} \\ c_{k+1} \end{pmatrix} = \begin{pmatrix} P_{11} & P_{12} \\ P_{21} & P_{22} \end{pmatrix} \begin{pmatrix} w_k \\ c_k \end{pmatrix}.$$

- **b)** Is T a regular stochastic matrix?
- **Recall:** A square matrix A is called a **stochastic matrix** if each of its columns is a probability vector (i.e. the entries of each column sum to 1).
- **c)** Does T have a steady-state vector? If so, what is it?
- **Recall:** If P is a regular transition matrix for a Markov chain, then $\exists!$ probability vector q such that $Pq = q$ (i.e. q is an eigenvector corresponding to $\lambda = 1$ and q 's entries sum to 1). This vector is called the **steady-state vector**.



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- **d)** In the long term, how will the population of raccoons in the city and woods be distributed?
 - **Recall:** If q is a steady-state vector for a regular Markov chain, then for any initial probability vector x_0 , $\lim_{k \rightarrow \infty} P^k x_0 = q$, where P is the transition matrix for this chain.
 - **e)** How many raccoons will be in the city after 20 years?
 - **Recall:** We know $x_n = P^n x_0$, where x_0 is the initial state vector, x_n is the state vector at time n , and P is the transition matrix.

