CS 145: Scientific Programming

Review problems for Exam 1

1. The distance from a point (x_0, y_0) to a line $ax + by + c = 0$ is given by:

$$d = \frac{|ax_0 + by_0 + c|}{\sqrt{a^2 + b^2}}$$

   Write Matlab code to compute the distance of the point $(3, -4)$ from the line $2x - 7y - 10 = 0$. (Hint: First define the variables you know, and then use the abs and sqrt commands to calculate d.)

2. Sound level L_p in units of decibels is determine by:

$$L_p = 20 \log_{10}(\frac{p}{p_0})$$

   where p is the sound pressure of the sound, and $p_0 = 20 \times 10^{-6}$ is a reference sound pressure.

   (a) Determine the sound pressure of 90 decibels of noise (the amount generated by a passing truck).

   (b) How many times larger (louder) is the sound pressure of the truck versus the sound pressure during a normal conversation, where the loudness is 65 decibels?

3. Give the output of the following Matlab commands:

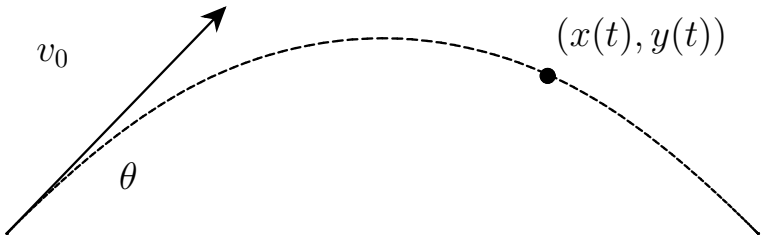
   (a) [3 : 3 : 15]

   (b) [7 : −2 : −3]

   (c) zeros(3)

4. The position as a function of time $(x(t), y(t))$ of a projectile fired with a speed of v_0 at an angle θ is given by: $x(t) = tv_0 \cos(\theta)$ and $y(t) = tv_0 \sin(\theta) - \frac{gt^2}{2}$, where $g = 9.81 m/s^2$. The distance r to a projectile at time t is then given by $r(t) = \sqrt{x(t)^2 + y(t)^2}$.

   Consider an example where $v_0 = 100 m/s^2$ and $\theta = 90°$. Give Matlab code to generate a array that holds the distance to the projectile every second from 0 seconds up to 10 seconds and graphs the result.



5. Fisheries commonly estimate the growth of a fish using the von Bertalanffy growth law:

$$L = L_{\max}(1 - e^{-K(t+\tau)})$$

   where $L_{\max}$ is the maximum length, K is a rate constant, and τ is a time constant. These constants vary greatly depending on the species of fish. Assume $L_{\max} = 50$cm, and $\tau = 0.5$ years, calculate the length of a fish at 2 years of age for $K = 0.25, 0.5$, and 0.75 years.

6. Give Matlab code to solve the following system of linear equations:

$$\begin{aligned} 1.5a - 2b + c + 3d &= 7.5 \\ 3a + b - c + 4d &= 16 \\ 2a + 6b - 3c - d &= 78 \\ 5a + 2b + 4c - 2d &= 71 \end{aligned}$$

7. Suppose you have two arrays `x` and `y` of length `n`. Use array operations to calculate

$$\sum_{i=1}^{n} \sqrt{\frac{|x_i - y_i|}{x_i^2 + y_i^2}}$$

8. The factorial $n!$ of a positive integer is defined by $n! = n \cdot (n-1) \cdot (n-2) \cdots 3 \cdot 2 \cdot 1$. Write a script that (assuming n has been predefined as a positive integer) will compute the value of $n!$ and save it as a variable named nfac.

9. Write a Matlab program that (assuming m and n have already been predefined) creates a matrix of size $n \times m$, where the entry in row i and column j contains the value $\sin(i + j)$ (where $i + j$ is in radians).

10. Write a program the creates a array `sums` of length 100 where the entry at index `n` is equal to

$$\sum_{i=1}^{n} \frac{sin(i)}{2^i}$$

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