MATLAB Brush Up Course
Practice Set 2

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Problem 1: Logical and Relational Operators

1. Given the matrix $M = \begin{bmatrix} 3 & 7 & 2 \\ 8 & 5 & 6 \\ 1 & 4 & 9 \end{bmatrix}$:
   - Replace all elements less than 4 with 0.
   - Display all elements that are greater than or equal to 6.
2. Given two vectors $A = [2, 4, 6, 8, 10]$ and $B = [1, 3, 5, 7, 9]$, find the elements in A that are greater than the corresponding elements in B.
3. Using the matrix $N = \begin{bmatrix} -3 & 5 & -1 \\ 2 & -8 & 7 \\ -4 & 6 & -2 \end{bmatrix}$, find the sum of all positive elements in N.

Problem 2: Conditional Statements and Joint Conditions

1. Create a script that determines whether a number is considered 'low', 'medium', or 'high' based on two thresholds. The script should:
   - Take a number as input.
   - Define two thresholds, lowThreshold and highThreshold.
   - Output 'low' if the number is less than the lowThreshold.
   - Output 'medium' if the number is between the two thresholds.
   - Output 'high' if the number is greater than the highThreshold.
2. Write a script to calculate and categorize the body mass index (BMI) of an individual. The script should:
   - Take a person's weight (in kilograms) and height (in meters) as input.
   - Calculate the BMI (BMI = weight / height^2).
   - Categorize the BMI as follows:
     - Underweight: BMI < 18.5

  - Normal weight: $18.5 \leq \text{BMI} < 25$
  - Overweight: $25 \leq \text{BMI} < 30$
  - Obese: $\text{BMI} \geq 30$
- Output the category.

Problem 3: Loops

1. Create the Hilbert matrix of order 4 using a for loop. A Hilbert matrix is a square matrix with entries being the unit fractions $H(i, j) = \frac{1}{i+j-1}$.

2. Write a script to simulate a simple game of dice. Roll a six-sided dice (using random numbers) until you get a six, counting the number of rolls it takes.

3. Simulate an economic process involving investment growth.

   Given initial investments and a random annual return rate (following a normal distribution with a mean of 5% and a standard deviation of 2%), calculate the average investment value over 10 years. Perform this simulation 100 times and calculate the average final investment value.

   - Initial investments: 1000
   - Number of years: 10
   - Number of simulations: 100
   - Annual return rate: Normally distributed with mean = 5%, std dev = 2%

   Output the average final investment value for each entity after 100 simulations.

4. Create a script that simulates the temperature variation of a substance over time and determines the state of the substance (solid, liquid, or gas) at each time step.

   - Start with an initial temperature and simulate its change over 24 hours.
   - The temperature changes by a random value between -30 and 30 degrees each hour.
   - Define thresholds for solid (below 0°C), liquid (0°C to 100°C), and gas (above 100°C).
   - Use a 'for' loop for the 24-hour simulation, and 'if' statements to determine the state.

   Output the state of the substance at each hour.

Problem 4: Simulation of AR(2) Process

Given the AR(2) process defined by $x_t = \alpha_1 \cdot x_{t-1} + \alpha_2 \cdot x_{t-2} + \epsilon_t$, where ϵ_t is a normally distributed random variable with mean 0 and standard deviation σ, perform the following tasks:

- Set α_1 and α_2 to specific values (e.g., 0.5 and -0.2).

- Assume 100 steps for the process and a standard deviation of 1 for ϵ_t.
- Initialize the first two values of the process to 0.
- Generate the subsequent values using the AR(2) formula.
- Calculate the mean.