Computing and Software Engineering

GET211

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Line Plot

Create a line plot for the function $y = \sin(x)$ where x ranges from 0 to 2π.

```
x = 0:0.1:2*pi; % Create a vector of x values
y = sin(x);     % Compute the sine of each x value
plot(x, y);     % Create a line plot
title('Sine Wave'); % Add a title
xlabel('x'); % Label the x-axis
ylabel('sin(x)'); % Label the y-axis
grid on; % Turn on the grid
```

Generate 200 random points with x and y values drawn from a normal distribution. Create a scatter plot of these points.

```
x = randn(200, 1); % Generate 200 random x values
y = randn(200, 1); % Generate 200 random y values
scatter(x, y); % Create a scatter plot
title('Scatter Plot of Random Points');
xlabel('x');
ylabel('y');
grid on;
```

Bar Plot

Create a bar plot to show the sales data of four products: A, B, C, and D with sales of 50, 75, 60, and 90 units, respectively.

```
products = categorical({'A', 'B', 'C', 'D'});
sales = [50, 75, 60, 90];
bar(products, sales);
title('Product Sales');
xlabel('Products');
ylabel('Sales (units)');
```

Histogram

Generate a histogram of 1000 data points drawn from a uniform distribution between 0 and 1.

```
data = rand(1000, 1);
histogram(data);
title('Histogram of Uniformly Distributed Data');
xlabel('Data Values');
ylabel('Frequency');
```

Adding Legends

Create a plot for the functions $y1 = \sin(x)$ and $y2 = \cos(x)$ on the same graph with different line styles and colors. Add a legend to distinguish between the two lines.

```
x = 0:0.1:2*pi;
y1 = sin(x);
y2 = cos(x);
plot(x, y1, '-r', 'DisplayName', 'sin(x)');  % Red line for sine
hold on;
plot(x, y2, '--b', 'DisplayName', 'cos(x)');  % Blue dashed line for cosine
hold off;
legend show;
title('Sine and Cosine Waves');
xlabel('x');
ylabel('Value');
grid on;
```

Subplots

Create a 2x1 grid of subplots. In the first subplot, plot $y = \sin(x)$. In the second subplot, plot $y = \cos(x)$.

```
x = 0:0.1:2*pi;
y1 = sin(x);
y2 = cos(x);

subplot(2, 1, 1); % Create a 2x1 grid of plots, and activate the first plot
plot(x, y1);
title('Sine Wave');
xlabel('x');
ylabel('sin(x)');

subplot(2, 1, 2); % Activate the second plot
plot(x, y2);
title('Cosine Wave');
xlabel('x');
ylabel('cos(x)');
```

Plot the function $y = \sin(x)$ where x ranges from 0 to 2π. Add a text annotation at $x = \pi/2$, $y = 1$ and draw an arrow pointing to this point.

```
x = 0:0.1:2*pi;
y = sin(x);
plot(x, y);
title('Sine Wave with Annotation');
xlabel('x');
ylabel('sin(x)');
grid on;

% Add text annotation
text(pi/2, 1, 'Maximum Point', 'HorizontalAlignment',
    'right');

% Add arrow annotation
annotation('textarrow', [0.3 0.4], [0.8 0.9],
    'String', 'Peak');
```

Custom Axis Limits and Ticks

Plot the function $y = \sin(2x)$ where x ranges from 0 to 2π. Set the x-axis limits from 0 to 2π and the y-axis limits from -2 to 2. Customize the x-axis ticks to show every $\frac{\pi}{2}$ and the y-axis ticks to show every unit.

```
% Define the data
x = 0:0.01:2*pi;
y = sin(2*x);

% Create the plot
figure;
plot(x, y, 'b', 'LineWidth', 2);
title('Plot of y = sin(2x) with Custom Axis Limits and Ticks');
xlabel('x');
ylabel('y');
grid on;

% Set custom axis limits
xlim([0 2*pi]);
ylim([-2 2]);

% Set custom ticks
xticks(0:pi/2:2*pi);
yticks(-2:1:2);

% Set custom tick labels for x-axis
xticklabels({'0', 'pi/2', 'pi', '3pi/2', '2pi'});
```

Changing Line Styles and Colors

```
x = 0:0.1:10;
y1 = sin(x);
y2 = cos(x);
plot(x, y1, '-.k', 'LineWidth', 2);  % Black dash-dot line with width 2
hold on;
plot(x, y2, ':m', 'LineWidth', 1);  % Magenta dotted line with width 1
hold off;
title('Customized Lines');
xlabel('x');
ylabel('Value');
legend('sin(x)', 'cos(x)');
grid on;
```

Exporting Plots

```
x = 0:0.1:10;
y = sin(x);
plot(x, y);
title('Sine Wave');
xlabel('x');
ylabel('sin(x)');
grid on;

% Save the plot as a PNG file
saveas(gcf, 'sine_wave.png');

% Save the plot as a PDF file
saveas(gcf, 'sine_wave.pdf');
```

Figure Properties

Create a figure with a white background and name it 'My Figure'. Plot the function $y = \exp(-x)$ for x ranging from 0 to 5.

```
figure('Name', 'My Figure', 'NumberTitle', 'off',
    'Color', 'w');
x = 0:0.1:5;
y = exp(-x);
plot(x, y);
title('Exponential Decay');
xlabel('x');
ylabel('exp(-x)');
grid on;
```

Create a contour plot for the function $z = \sin(x) \cdot \cos(y)$ over the range $-2\pi \leq x, y \leq 2\pi$.

```
[X, Y] = meshgrid(-2*pi:0.1:2*pi, -2*pi:0.1:2*pi);
Z = sin(X) .* cos(Y);
contour(X, Y, Z);  % Create a contour plot
title('Contour Plot');
xlabel('X');
ylabel('Y');
```

Using Built-in Apps for Data Visualization

MATLAB includes several built-in apps for specific types of data visualization, such as the Curve Fitting app, the Signal Analyzer app, and the Image Viewer app. These apps provide graphical interfaces for performing complex visualization tasks.

```
curveFittingApp;  % Opens the Curve Fitting app
signalAnalyzer;   % Opens the Signal Analyzer app
imageTool;        % Opens the Image Viewer app
```

Exercise

Create a plot for the function $y = x^2$ where x ranges from -10 to 10.
- Customize the plot by:
- Adding a grid
- Changing the line color to green
- Setting the line width to 3
- Adding a title, labels, and a legend

Symbolic Calculations

MATLAB provides powerful tools for symbolic calculations using the `Symbolic Math Toolbox`. Symbolic calculations allow for exact arithmetic, algebraic manipulation, and calculus operations.

Defining Symbolic Variables

To perform symbolic calculations, you first need to define symbolic variables. This can be done using the `syms` function.

```
% Define symbolic variables
syms x y z
```

Symbolic Differentiation

Differentiate the cubic function $f(x) = x^3 + 2x^2 + x + 1$ with respect to x.

```
% Define a symbolic variable and function
syms x
f = x^3 + 2*x^2 + x + 1;

% Differentiate the function with respect to x
df = diff(f, x);
disp('The derivative of the function is:');
disp(df);
```

Symbolic Integration

Determine the indefinite integral of the Gaussian function $f(x) = e^{-x^2}$.

```
% Define a symbolic variable and function
syms x
f = exp(-x^2);

% Integrate the function with respect to x
F = int(f, x);
disp('The indefinite integral of the function is:');
disp(F);
```

Simplifying a Symbolic Expression

Simplify the rational expression $\frac{x^3-x^2+x-1}{x-1}$.

```
% Define a symbolic variable and expression
syms x
expr = (x^3 - x^2 + x - 1) / (x - 1);

% Simplify the expression
simplified_expr = simplify(expr);
disp('The simplified expression is:');
disp(simplified_expr);
```

Solving a Quadratic Equation

Symbolic math also enables solving equations algebraically. You can solve both single-variable and multi-variable equations.
Solve the quadratic equation $x^2 - 5x + 6 = 0$ for x.

```
% Define a symbolic variable and quadratic equation
syms x
eqn = x^2 - 5*x + 6 == 0;

% Solve the equation
solutions = solve(eqn, x);
disp('The solutions of the quadratic equation are:');
disp(solutions);
```

Solving a System of Linear Equations

Solve the system of linear equations $2x + 3y = 6$ and $x - 4y = -5$ for x and y.

```
% Define symbolic variables and equations
syms x y
eqn1 = 2*x + 3*y == 6;
eqn2 = x - 4*y == -5;

% Solve the system of equations
solutions = solve([eqn1, eqn2], [x, y]);
disp('The solutions for x and y are:');
disp(solutions);

% Extract the solutions
sol_x = solutions.x;
sol_y = solutions.y;
```

Solving a Nonlinear Equation

Solve the cubic nonlinear equation $x^3 - 3x + 1 = 0$.

```
% Define a symbolic variable and equation
syms x
eqn = x^3 - 3*x + 1 == 0;

% Solve the equation
solutions = solve(eqn, x);
disp('The solutions of the nonlinear equation are:');
disp(solutions);
```

Symbolic Operations Exercise

Given the expression below, determine the differentiation, integration and simplification of the expression

```
% Define an expression
expr = x^2 + 3*x + 2;

% Differentiate the expression with respect to x


% Integrate the expression with respect to x


% Simplify the expression
```

Symbolic Taylor Series Expansion

Find the Taylor series expansion of $\sin(x)$ around $x = 0$ up to the fifth degree.

```
% Define a symbolic variable and function
syms x
f = sin(x);

% Compute the Taylor series expansion around x = 0 up
    to the 5th degree
taylor_f = taylor(f, x, 'Order', 6);
disp('The Taylor series expansion of sin(x) around x
    = 0 is:');
disp(taylor_f);
```

Symbolic Matrix Operations

Compute the determinant and inverse of a symbolic 2x2 matrix.

```
% Define symbolic variables and a symbolic matrix
syms a b c d
A = [a b; c d];

% Compute the determinant and inverse of the matrix
det_A = det(A);
inv_A = inv(A);
disp('The determinant of matrix A is:');
disp(det_A);
disp('The inverse of matrix A is:');
disp(inv_A);
```

Solving a Differential Equation

Solve the second-order linear differential equation $y'' + 5y' + 6y = 0$.

```
% Define a symbolic function and its derivative
syms y(t)
Dy = diff(y, t);

% Define the differential equation
ode = diff(y, t, 2) + 5*Dy + 6*y == 0;

% Solve the differential equation
solution = dsolve(ode);
disp('The general solution of the differential
    equation is:');
disp(solution);
```

Laplace Transform

Compute the Laplace transform of $f(t) = e^{-2t}\sin(3t)$.

```
% Define a symbolic function of time
syms t s
f = exp(-2*t) * sin(3*t);

% Compute the Laplace transform
F = laplace(f, t, s);
disp('The Laplace transform of the function is:');
disp(F);
```

Exercise

Using symbolic method

1. Define a symbolic expression $f(x) = x^3 + 3x^2 - x - 3$.
2. Factorize and simplify the expression.
3. Evaluate $f(x)$ at $x = 2$.

Exercise

Using symbolic method

1. Solve $x^3 + 3x^2 - x - 3 = 0$ for x.
2. Solve $x^2 + y^2 = 25$ and $x + y = 7$ for x and y.

Exercise

Using symbolic method

1. Compute the derivative and integral of $g(x) = e^x \sin(x)$.
2. Evaluate the integral of $g(x)$ from $x = 0$ to $x = \pi$.