Computational Methods in Physics (PHY 365)

FA23

Dr. Muhammad Kamran

Department of Physics

COMSATS University Islamabad

Lab 11

MATLAB's trapz function

- Q = trapz(Y) returns the approximate integral of Y via the trapezoidal method with unit spacing.
  - If Y is a vector, then trapz(Y) is the approximate integral of Y.
  - If Y is a matrix, then trapz(Y) integrates over each column and returns a row vector of integration values.

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- Q = trapz(X, Y) integrates Y with spacing increment X.
  - If X is a scalar, then trapz(X, Y) is equivalent to X * trapz(Y).

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- Q = trapz(X, Y) integrates Y with spacing increment X.
  - If X is a scalar, then trapz(X, Y) is equivalent to X * trapz(Y).
- Q = trapz(____ , dim) integrates along the dimension "dim" using any of the previous syntax.
  - If Y is a matrix, then trapz(X , Y , 2) integrates each row of Y.

MATLAB's trapz function

- trapz integrates numeric data rather than functional expressions.
- To perform double or triple integrations on an array of numeric data, nest function calls to trapz.

MATLAB's trapz function

- Problem: Use trapz function to calculate the integral

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- The interval

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y = x_interval .^2;
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y = x_interval .^2;
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- Calling the trapz function

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trapz_int = trapz(y);
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MATLAB's trapz function

- Displaying the result

fprintf('The approximate value of the integral is %3.4f \n',trapz_int)

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  x_interval = linspace(1,5);

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- We now calculate the integral using non-unit spacing.
- The interval

  x_interval = linspace(1,5);

- Calling the trapz function

  trapz_int = trapz(x_interval , y);

MATLAB's trapz function

```
% The interval

x_interval = 1 : 5;

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% The integrand

y = x_interval .^ 2;

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% Calling the function

trapz_int = trapz(y);

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fprintf('The approximate value of the integral is %3.4f \n',trapz_int)
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MATLAB's trapz function

- Problem: Use trapz function to calculate the double integral

$$I = \int_{-5}^{5} \int_{-3}^{3} \left(x^2 + y^2\right) dx\, dy.$$

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- The intervals

```
x_interval = linspace(-3 , 3);
y_interval = linspace(-5 , 5);
[X , Y] = meshgrid(x_interval , y_interval);
```

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- Problem: Use trapz function to calculate the double integral

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x_interval = linspace(-3 , 3);
y_interval = linspace(-5 , 5);
[X , Y] = meshgrid(x_interval , y_interval);
```

- The integrand

```
F = X .^2 + Y .^2;
```

MATLAB's trapz function

- Calling the function

```
trapz_int = trapz(y_interval , trapz(x_interval , F , 2));
```

  → Here the integration over x first is performed first, producing a column vector.

  → Then, the integration over y reduces the column vector to a single scalar.

MATLAB's trapz function

- Calling the function

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  → Here the integration over x first is performed first, producing a column vector.

  → Then, the integration over y reduces the column vector to a single scalar.

- Displaying the result

  fprintf('The approximate value of the integral is %3.4f \n', trapz_int)

MATLAB's trapz function

- Problem: Use trapz function to calculate the triple integral

$$I = \int_{-1}^{1} \int_{-5}^{5} \int_{-3}^{3} \left(x^2 + y^2 + z^2\right) dx\, dy\, dz.$$

MATLAB's trapz function

- Problem: Use trapz function to calculate the triple integral

$$I = \int_{-1}^{1} \int_{-5}^{5} \int_{-3}^{3} \left(x^2 + y^2 + z^2\right) dx\, dy\, dz.$$

- The intervals

```
x_interval = linspace(-3 , 3);
y_interval = linspace(-5 , 5);
z_interval = linspace(-1 , 1);
[X , Y , Z] = meshgrid(x_interval , y_interval ,
z_interval);
```

MATLAB's trapz function

- The integrand

```
F = X .^2 + Y .^2 + Z .^2;
```

MATLAB's trapz function

- The integrand

```
F = X .^2 + Y .^2 + Z .^2;
```

- Calling function

```
trapz_int = trapz(z_interval , trapz(y_interval ,
trapz(x_interval , F)));
```

MATLAB's trapz function

- The integrand

  F = X .^2 + Y .^2 + Z .^2;

- Calling function

  trapz_int = trapz(z_interval , trapz(y_interval , trapz(x_interval , F)));

- Displaying the result

  fprintf('The approximate value of the integral is %3.4f \n', trapz_int)

References

- https://www.mathworks.com/help/matlab/ref/trapz.html
- http://www.ece.northwestern.edu/local-apps/matlabhelp/techdoc/ref/trapz.html
- https://www.educba.com/matlab-trapz/