MATLAB

Symbolic

2020-09-25

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MATLAB command : syms & symfun

- Declare symbols(variables) & declare the formula

MATLAB command "syms" is used to declare symbols.
If one want to make a function and evaluate the function value at some points, then it can be used to take a task.

For example, I want to compute $f(x, y) = \cos(x)\log(y)$ at $x = e, y = \pi$.

1. Declare the symbols. (variables)

```
syms x y
```

2. Declare the formula. (function)

```
f = symfun(cos(x)*log(y), [x, y])        % [x ,y] is input variables.
```

3. Compute the function value

```
f(exp(1), pi)
```

One can see the answer as 'cos(3060513257434037/1125899906842624)*log(pi)'.
If want to see answer as a decimal point, use "eval" command.
i.e. Use the code like "eval(f(exp(1), pi))"

Check the value eval(pi) and eval(exp(1)).

MATLAB command : syms & symfun

- Declare symbols(variables) & declare the formula

If want compute 2 functions like $f_1(x, y) = x^3 - y$ and $f_2(x, y) = \frac{\sqrt{x}}{y}$ at $(1, 1), (0.2, 4), (3, -1)$.

1. Declare the symbols. (variables)

```
syms x y
```

2. Declare the formula. (function)

```
f = symfun([x^3-y, sqrt(x)/y], [x, y])        % f will give the 1*2 vector values
```

3. Compute the function value

```
f(1, 1), f(0.2, 4), f(3, -1)
```

Here x, y are not a vector, they are the symbols(variables).
So you do not need to use elementwise operations(.+ .- .* ./ .^).
Just use (+ - * / ^) operations.

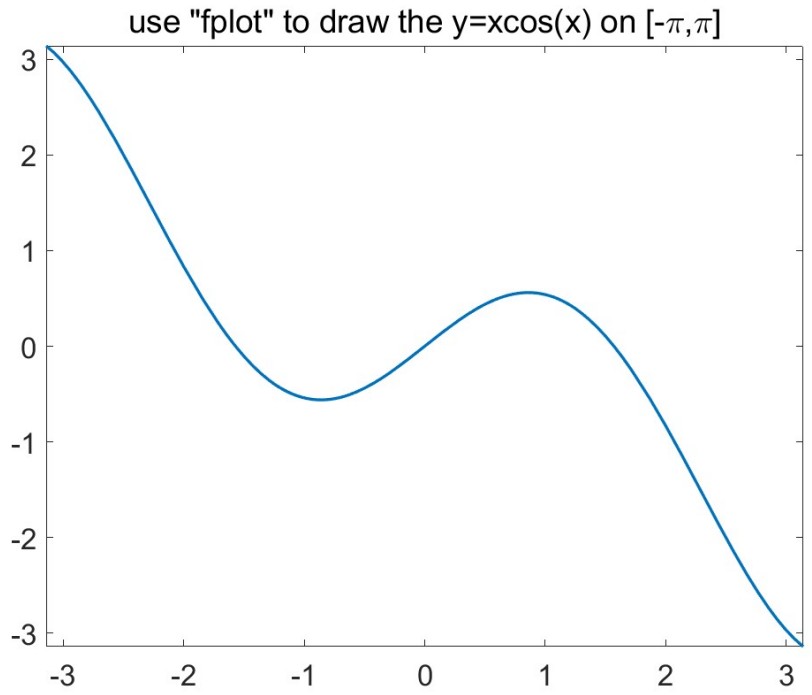
MATLAB command : fplot

- Draw the function defined by symbol.

MATLAB command "fplot" draw the function defined by symbol.

For example, draw the function $y = x * \cos(x)$ on $-\pi \leq x \leq \pi$.

1. Declare the symbol. (variable)
   syms x
2. Declare the formula. (function)
   y = x*cos(x)
3. Draw the function
   figure(1), fplot(y, [-pi, pi])



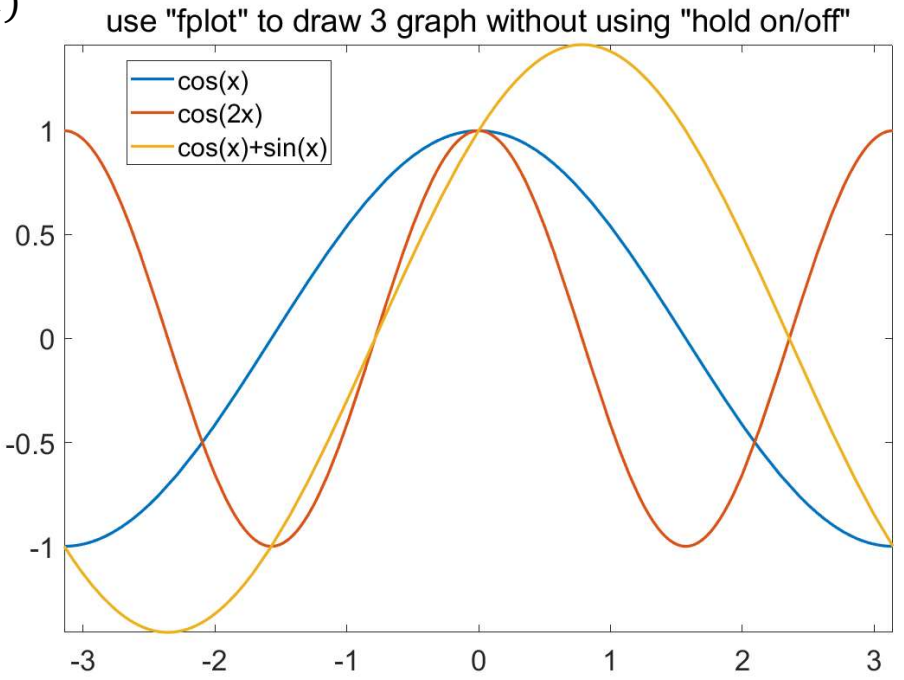
MATLAB command : fplot

- Draw the function defined by symbol.

Using "fplot", you can draw the graph at once without using "hold on" and "hold off".

For example, draw the functions $\begin{cases} y = \cos(x) \\ y = \cos(2x) \\ y = \cos(x) + \sin(x) \end{cases}$ on $-\pi \leq x \leq \pi$.

1. Declare the symbol. (variable)
   syms x
2. Declare the formula. (function)
   y = [cos(x), cos(2*x), cos(x)+sin(x)]
3. Draw the function
   figure(1), fplot(y, [-pi, pi])



MATLAB command : expand & factor

- Declare symbols(variables) & declare the formula

MATLAB command "expand" gives the expanded and simplified equation of input.
MATLAB command "factor" gives the factorization form of input equation or input number.

Examples

MATLAB codes	**output**
syms x y	
p=(x-2)*(x+4) expand(p)	x^2+2*x-8
expand(cos(x+y))	cos(x)*cos(y)-sin(x)*sin(y)
factor(x^2-4)	[x-2, x+2]
factor(x^2-y^2)	[x+y, x+y]

Type "help expand" to see more details of command "expand".
Type "help factor" to see more details of command "factor".
In general "help ###" gives more details about MATLAB command "###".

MATLAB command : solve & subs

- Find the roots of the equation & substitute the variables

MATLAB command "solve" gives the roots of the equation.
MATLAB command "subs" can verify the roots.

For example, find the roots of $x^4 - 2x^3 - 13x^2 + 14x + 24 = 0$ and verify the roots.

1. Declare the symbol. (variable)

```
syms x
```

2. Declare the equation.

```
y = x^4-2*x^3-13*x^2+14*x+24
```

3. Find the roots of the equation.

```
roots = solve(y == 0, x)      % solve the equation y=0 for variable x.
```

4. Verify the roots.

```
subs(y, x, roots)             % calculate y value by substituting roots for variable x.
```

MATLAB command : limit

- Find the limits expression

MATLAB command "limit" finds the limits expression.

For example, find the value of $\lim_{h \to 0} \frac{e^{x+h} - e^{x}}{h}$.

1. Declare the symbol. (variable)

   syms x h
2. Declare the expression.

   f = (exp(x+h) - exp(c)) / h
3. Find the limits.

   limit(f, h, 0) % give the result of limit of f when h goes to 0

```
syms x h
f = (exp(x+h)-exp(x))/h;
limit(f ,h ,0)
```

```
ans =

exp(x)
```

MATLAB command : diff

- Find the derivative of function

MATLAB command "limit" finds the derivative of function.

For example, find the second derivative of $f(x) = xlog(x)$.

1. Declare the symbol. (variable)
   syms x
2. Declare the expression.
   f = x * log(x)
3. Find the second derivative of $f(x)$.
   diff(f, x, 2) % give the second derivative of f with respect to x

```
syms x
f = x*log(x);
fx = diff(f, x, 1);  % first derivative
fxx = diff(f, x, 2); % second derivative
```

```
fx =

log(x) + 1


fxx =

1/x
```

MATLAB command : taylor

- Give the Taylor series expansion of the function.

MATLAB command "taylor" gives the Taylor series expansion of the function.

For example, find the Taylor expansion of $f(x) = \cos(x)$ centered at $x = 1$ up to the 4th order terms.

1. Declare the symbol. (variable)
   syms x
2. Declare the expression.
   f = cos(x)
3. Find the Taylor series of $f(x)$.
   taylor(f, x, 1, 'order', 5)

% give the Taylor expansion of f centered at 1 with 5 terms
% constant term is 0th order, so need 5 terms to represent 4th order

```
syms x
f = log(x);
T4 = taylor(f, x, 1, 'order', 5);
```

```
T4 =

x - (x - 1)^2/2 + (x - 1)^3/3 - (x - 1)^4/4 - 1
```

MATLAB command : int
- Give the indefinite/definite integral of the function.

MATLAB command "int" gives the indefinite/definite integral of the function.

For example, find the indefinite integral $\int x^2 sin(x) dx$.

1. Declare the symbol. (variable)
   syms x
2. Declare the expression.
   f = x^2 * sin(x)
3. Find the Taylor series of $f(x)$.
   Int(f, x) % give indefinite integral of f with respect to x

```
syms x
f = x^2 * sin(x);
F = int(f, x);
```

```
F =

2*x*sin(x) - cos(x)*(x^2 - 2)
```

MATLAB command : int

- Give the indefinite/definite integral of the function.

MATLAB command "int" gives the indefinite/definite integral of the function.

For example, find the definite integral $\int_0^{\pi} x^2 \sin(x)\, dx$.

1. Declare the symbol. (variable)
   syms x
2. Declare the expression.
   f = x^2 * sin(x)
3. Find the Taylor series of $f(x)$.
   Int(f, x, [0, pi])

% give definite integral of f with respect to x in interval [0, π]

```
syms x
f = x^2 * sin(x);
Fab = int(f, x, [0, pi]);
```

```
Fab =

pi^2 - 4
```

Please study and practice yourself by using "help ###"