Chapter 06 - Symbolic Functions

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What is a Function?

There are two different ways of thinking of functions in calculus and hence in Matlab. One is symbolically (as a string of symbols) and the other is as a function handle, which is a little more confusing but necessary and will be left for later. These two ways are interchangeable in some contexts and not in others. The difference between symbolic functions and function handles is one of the things that confuses students the most.

Symbolic Functions

To define a symbolic function we first do the following:

```
syms f(x);
```

This does two things - it makes `x` symbolic and it makes `f(x)` symbolic. We can then actually define the function:

```
f(x) = x^4+7*x^2+x+exp(2*x)
```

```
f(x) =
```

```
x + exp(2*x) + 7*x^2 + x^4
```

Now we can do some basic things with this function.

Plugging into Symbolic Functions

We can substitute a constant for the symbol `x`:

```
f(3)
```

```
ans =
```

```
exp(6) + 147
```

or alternately we could plug in a different symbolic variable provided it's defined as such first:

```
syms t;
f(t)
```

```
ans =

t + exp(2*t) + 7*t^2 + t^4
```

or even more complicated expressions, and simplify!

```
syms s t;
simplify(f(2*t+s))
```

```
ans =

s + 2*t + exp(2*s + 4*t) + 7*(s + 2*t)^2 + (s + 2*t)^4
```

Solving with Symbolic Functions

The `solve` command works with symbolic functions. If we simply plug in the function then `solve` sets it equal to `0`:

```
syms f(x);
f(x) = x^2-x-6;
solve(f(x))
```

```
ans =

 -2
  3
```

This does the same as if we did

```
solve(f(x)==0)
```

```
ans =

 -2
  3
```

Or we can set it equal to something else:

```
solve(f(x)==5)
```

```
ans =
```

```
 1/2 - (3*5^(1/2))/2
 (3*5^(1/2))/2 + 1/2
```

Or another expression:

```
solve(f(x)==2*x+1)
```

```
ans =

 3/2 - 37^(1/2)/2
 37^(1/2)/2 + 3/2
```

Even involving `f(x)` itself:

```
solve(f(x)==2*f(x+1))
```

```
ans =

 - 33^(1/2)/2 - 3/2
   33^(1/2)/2 - 3/2
```

Factoring Symbolic Functions

We can also factor symbolic functions, which don't need to be polynomials:

```
syms f(x);
f(x) = x^2+x*sin(x);
factor(f(x))
```

```
ans =

[ x, x + sin(x)]
```

Functions of Several Variables

Even though this is beyond the scope of the prerequisites of this course it's worth noting that we can also assign and work with functions of more than one variable, for example:

```
syms f(x,y);
f(x,y) = x^2+x*y;
```

and then

```
f(2,3)
```

```
ans =
```

```
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```

Published with MATLAB® R2016b