Lecture 14: Function handles

Announcements

- Last lecture!
- A3 due tonight (Mon, Oct 18)
- Textbook challenge activities due tomorrow
- Office hours through this week; consulting remains available

Agenda

- Referring to functions in variables
- Passing functions to other functions
- Anonymous functions
- Parameterized functions

Variables

- Conceptually, a box that stores a *value*
  - Array variables: a big box broken up into smaller ones
- "Variable" – something that can change
  - Can assign different values
  - Can pass different arguments to functions (input parameters)

- What if we want to change a *computation*?

Example: accumulation pattern

Sum

```
function acc = sumof(v)

acc = v(1);
for k = 2:length(v)
    acc = sum([acc v(k)]);
end
```

Maximum

```
function acc = maxof(v)

acc = v(1);
for k = 2:length(v)
    acc = max([acc v(k)]);
end
```

Examples: mathematics

- Where does *a function* cross zero? (rootfinding)
- What is the area under *a function*'s curve? (integration)
- Where is *a function* the smallest? (optimization)

Examples: event handling

- Graphical user interface
  - When the user clicks this button, execute *this function*

Function handles

- Allows a variable to refer to a function
- Syntax: `@function_name`
- Examples:
  - `h = @sum;`
  - `s = h([1 1]);  % s = 2`
  - `h = @max;`
  - `m = h([3 1]);  % m = 3`

- *`function_name`* can be a:
  - built-in function
  - user-defined function
  - local function (in the same file)

Function functions

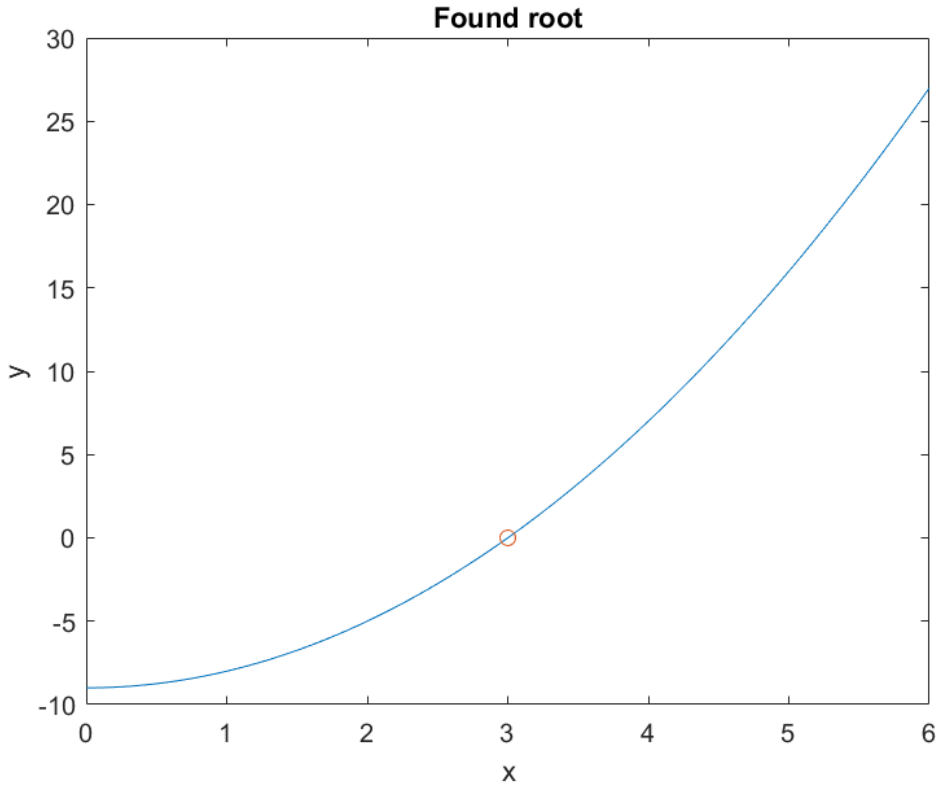
- Can write functions that take other functions as arguments
  - Input parameter will be a function handle

```
function acc = accof(v,f)


acc = v(1);
for k = 2:length(v)
    acc = f([acc v(k)]);
end
```

Demo: mathematics

- `fzero(func,xguess)`
  - Find root near xguess
- `integral(func,xmin,xmax)`
  - Definite integral from xmin to xmax
- `fminbnd(func,xmin,xmax)`
  - Minimize between xmin and xmax



Anonymous functions

- Creating a new .m file just to use as an argument to function-functions feels excessive
- Using local functions is more convenient, but still need to pick a name
- For simple functions, can define anonymously in the expression in which they're used

- Syntax: `@(params) expr`
  - Function body must be a 1-line expression evaluating to the output value
- Example: `@(x) sin(x) - x`
  - Declares a handle to a function of one argument, *x*, that returns the value of sin(*x*)-*x*

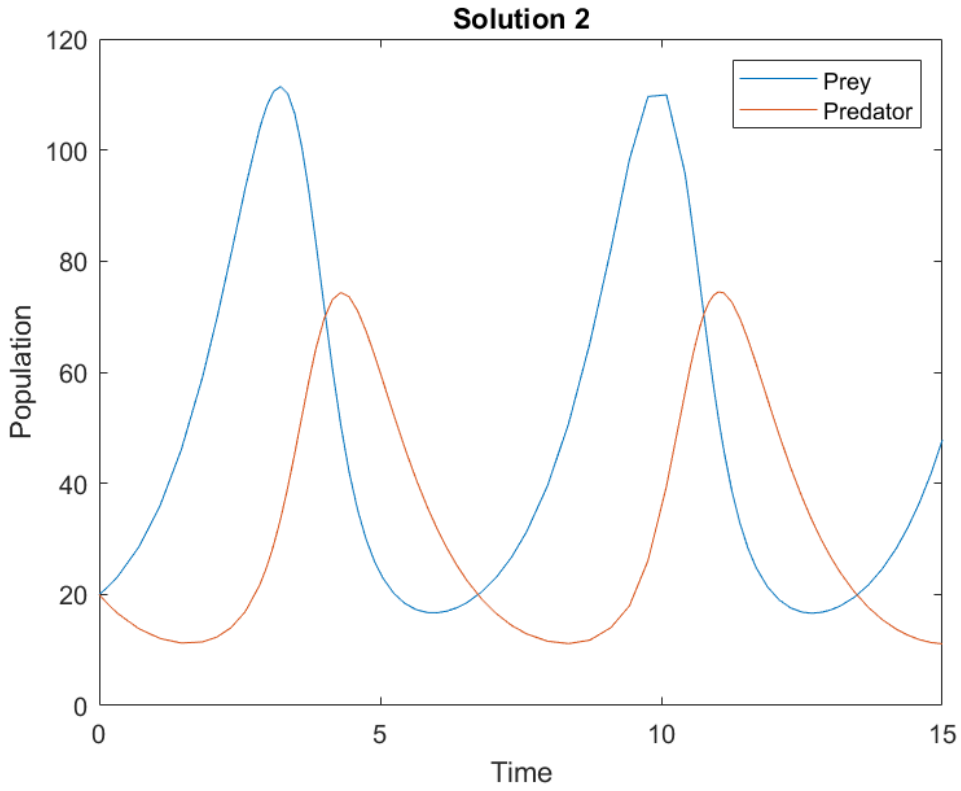
Parameterized functions

- Function handles must take *exactly* the number of arguments that a function-function expects to provide
  - But user-defined functions often take additional arguments for flexibility
  - For a given operation, want to hold some arguments constant

- Use anonymous functions to "bind" values for other input parameters
- Example:
  `@(x) quadratic(x,2,0,-18)`
  - Binds parameter values 2, 0, -18 to the 2nd-4th arguments of a named function `quadratic()`

Example: solving differential equations

- `[ts,ys]=ode45(rhs,tspan,y0)`
  - `dydt = rhs(t, y)`
  - `tspan = [t0 tf]`
  - `y, y0, dydt`: column vectors
  - `[length(ts), length(y)] = size(ys)`



Where to go from here?

- mathworks.com – Many free tutorials on specific topics
- *Getting Started with MATLAB* by Rudra Pratap – Good for independent learning with science/engineering applications
- Read function documentation – lots of informative examples
- Just play! (take advantage while it's free) Check out MATLAB Community forums, "File Exchange"