CS368 MATLAB Programming

Lecture 11

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Based on lecture slides by Michael O'Neill and Beck Hasti

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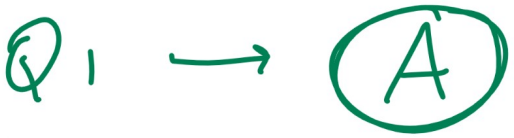
Errors

Math



- Syntax error is an error in spelling or grammar.
- MATLAB displays red messages for syntax errors, so they are easy to find and fix.
- Semantic error is an error in meaning or logic.
- For small programs, compare the program outputs with expected outputs computed by hand to find and fix the semantic error.
- For large programs, break into smaller programs and debug each one.

Debugger

Code

- A debugger can set break points.
- A break point stops the program so that the current variable values can be viewed in Workspace.
- It is useful to check if loops and conditionals are written correctly.

User Input Validation

Code

- Use a while loop to keep asking for user input until the input is valid.

```
1 valid = 0;
2 while ~valid
3   x = input(...)
4   if ... % check valid
5     valid = 1;
6   end
7 end
```

Input Validation Membership Functions

Code

- *isletter (x)* or *isstrprop (x, 'alpha')* checks if the string *x* contains characters that are letters *'a'* to *'z'* or *'A'* to *'Z'*.
- *isstrprop (x, 'digit')* checks if the string *x* contains characters that are numbers *'0'* to *'9'*.
- *ismember(x, y)* checks if the string *x* contains characters that are characters in the other string *y*.
- These functions treat *x* as a vector and returns a Boolean vector specifying whether each character in *x* belongs to some set of characters.

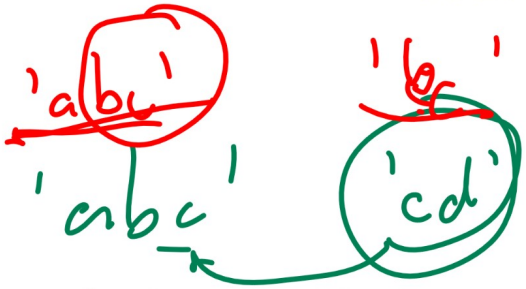
P6

'abc', 'cd'

0, 0, 1

Input Validation Substring Functions

Code



- *contains*(x, y) checks if the string x contains a substring y.
- *count*(x, y) counts the number of occurrences of y in the string x.
- *startsWith*(x, y) and *endsWith*(x, y) checks if the string x starts with or ends with the substring y.
- These functions treat x as a single string and checks if it contains certain substrings.

Input Validation, Check Contain

Quiz

- (Check if the string s contains a letter from t.)
- 1
1. s = 'abc'; t = 'cde';
- A : contains(s, t)
- B : ismember(s, t)
- C : max(ismember(s, t)
- D : min(ismember(s, t)

Q2

abcde → yes

1, 1, 1

0 0 !

one of s is member of t

all of s is member of t

all of them 1

Input Validation, Check Combination

Quiz

- (Check if the string s contains at least two letters and a number.)
- 0 — false
1. `s = 'abc';`
   - A: `sum( isletter (s) + isstrprop (s, 'digit')) >= 3`
   - B: `(sum( isletter (s)) >= 2) | (sum(isstrprop(s, 'digit')) >= 1)`
   - C: `(sum( isletter (s)) >= 2) & (sum(isstrprop(s, 'digit')) >= 1)`

Q3

at least 2 letters OR at least 1 number

1, 1, 1 → true

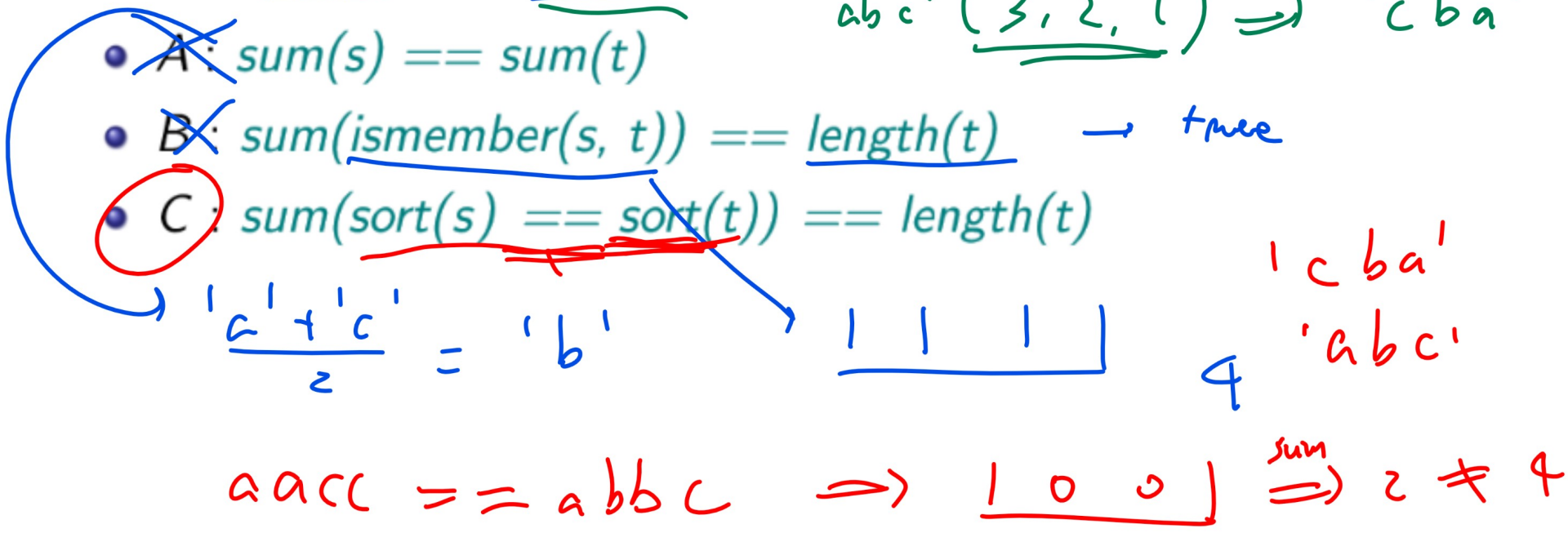
0, 0, 0 → false

[| | or scalar
& & and

Input Validation, Check Permutation

Quiz

- (Check if s is a permutation of t.)
- 0 → false
1. `s = 'aacc'; t = 'abbc';`
   - ~~A~~: `sum(s) == sum(t)`
   - ~~B~~: `sum(ismember(s, t)) == length(t)` → true
   - C: `sum(sort(s) == sort(t)) == length(t)`



Input Argument Validation

Code

- The inputs to a function can be validated so that an input that does not satisfy the conditions will cause an error instead of incorrect outputs.

```
1 function f(x)
2   arguments
3     x (size) class {functions} = default value
4   end
5   ... % actual function
6 end
```

log(-1)

Input Argument Size

Code

- In *x (size) class {functions}*, the size is specified by a comma-separated list.
- *x (n, m)* ... requires *x* to be an $n \times m$ matrix.
- *x (n, :)* ... requires *x* to be a matrix with *n* rows or a vector with *n* elements.
- *x (:, m)* ... requires *x* to be a matrix with *m* columns.

Input Argument Class

Code

- In *x (size) class {functions}*, the class is specified by its class name.
- *x char ...* and *x string ...* require *x* to be a string.
- *x single ...* and *x double ...* require *x* to be a number.
- *x logical ...* requires *x* to be a Boolean variable.

Input Argument Validation Function

Code

- In *x (size) class {functions}*, the functions are special functions that raise an error when some conditions are not satisfied.
- For example, *x {mustBeGreaterThanOrEqual(x, l), mustBeLessThanOrEqual(x, u)}* ... requires *x* to be between *l* and *u*, and raises an error when $x < l$ or $x > u$.
- For example, *x {mustBeMember(x, [u v w])}* requires *x* to be one of *u* or *v* or *w*.

Function of Functions

Math

- A functional (noun.) is a function can take another function as an input, or returns another function as an output. Functionals are also called higher-order functions.
- The differential and integral operators are functionals: they take a function as input and outputs another function (or a scalar).

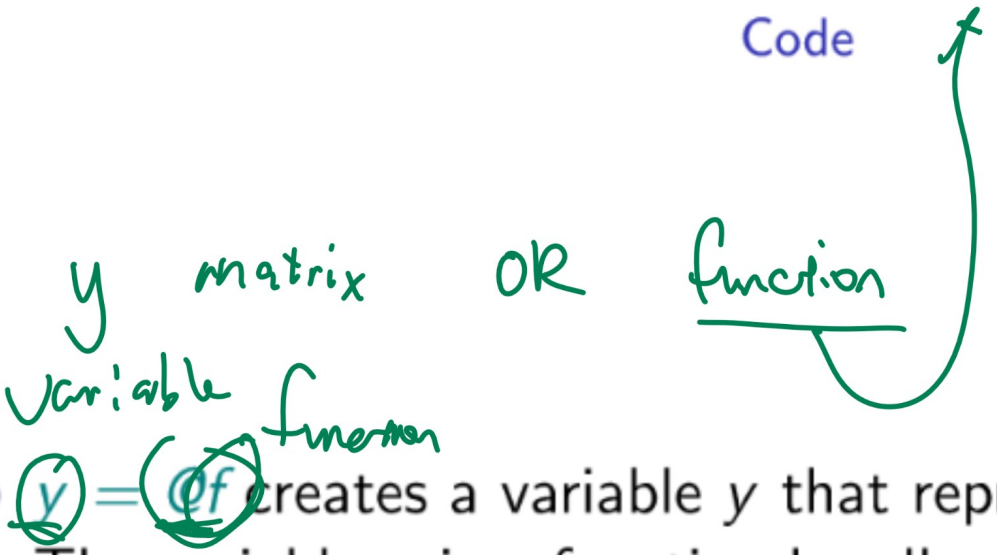
functional

$\frac{d}{dx}(f, x) \rightarrow$ number

$\frac{d}{dx}(f) \rightarrow f'$ another function

$\int (f, a, b) \rightarrow$ number

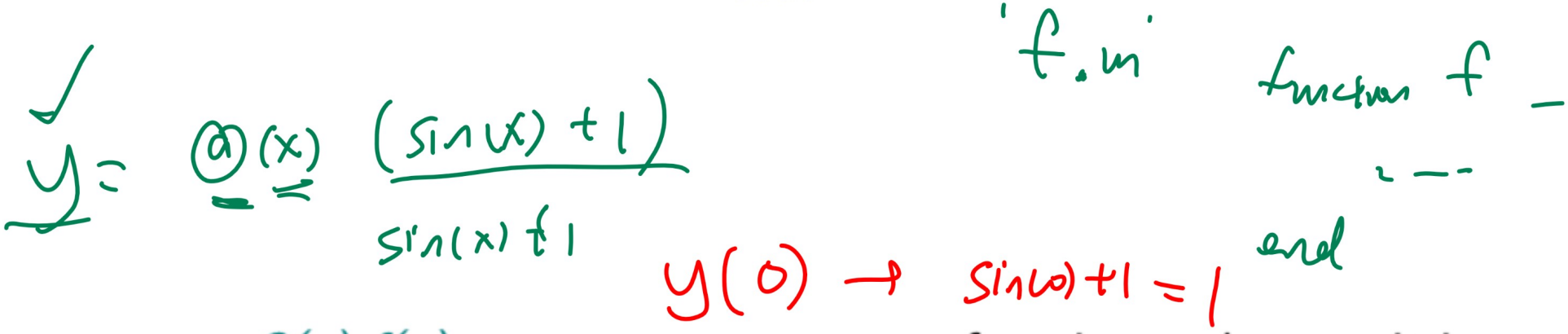
Function Handle



- $y = @f$ creates a variable y that represents the function f. The variable y is a function handle.
- Function handles provide a way to pass a function as an input argument to another function.

Anonymous Functions

Code



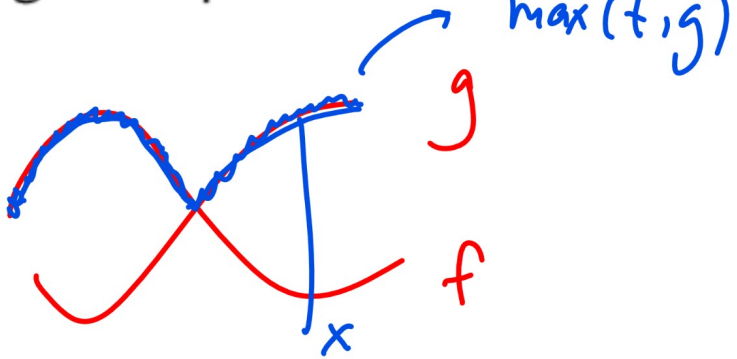
- $y = @(x)\ f(x)$ creates an anonymous function and stores it in the variable named y.
- Anonymous functions provide a way to write a function handle without defining a separate file for the function.

Function Max at Value Example

Code

- Another version of the max function can be defined to find the maximum of two functions f and g at a point x.

```
1 function mfg = maxFun(f, g, x)
2     mfg = max(f(x), g(x));
3 end
```



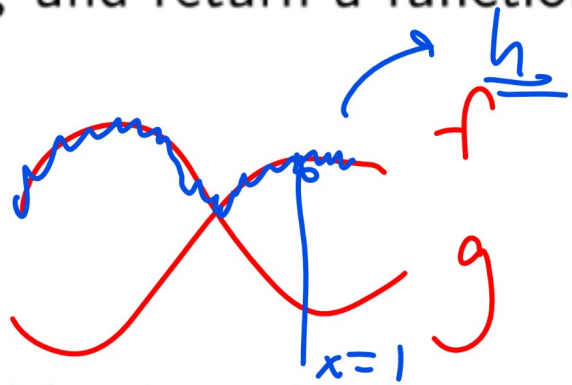
- For example, `maxFun(@sin, @(x)(sin(2 * x)), 1)` finds the maximum between $\sin(1)$ and $\sin(2 \cdot 1)$.

Function Max Example

Code

- Another version of the max function can be defined to find the maximum of two functions f and g and return a function.

```
1 function mfg = maxFun(f, g)
2     mfg = @(x)(max(f(x), g(x)));
3 end
```



- For example, if $h = maxFun(@sin, @(x)(sin(2 * x)))$, then $h(1)$ finds the maximum between $\sin(1)$ and $\sin(2 \cdot 1)$.

$h =$ 

$h(1) = \max(f(1), g(1))$
$\sin(1) \quad \sin(2)$

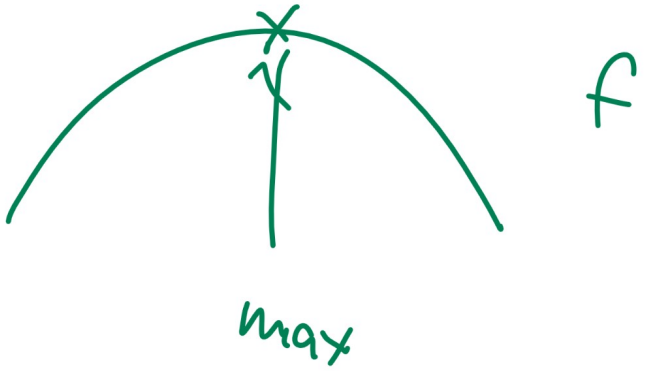
Function Handle, Max

Quiz

1. *function h = maxFun(f, x)*
2. *h = max(f(x));*
3. *end*

- *maxFun(@(x)(−x.^2), −2:2)*
- *B* : −4
- *C* : 0
- *D* : 4
- *E* : Error

Q5



$-x^2$

0

$-x.^2$ at $[-2,-1,0,1,2]$

max $[-4,-1,0,-1,-4] = 0$

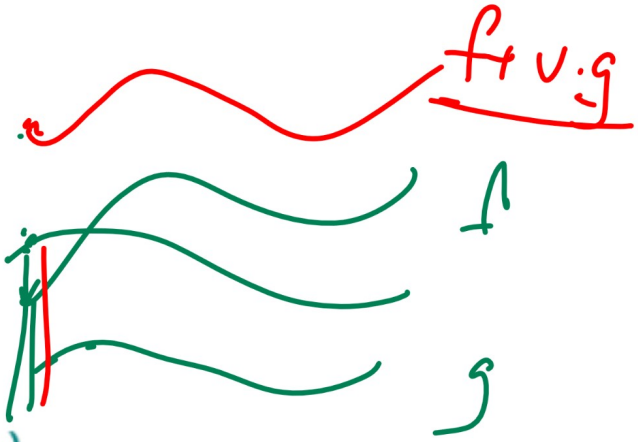
Function Handle, Noise

Quiz

Q6

1. *function h = noise(f, g, v)*
2. *h = @(x)(f(x) + v * g(x));*
3. *end*

- *h = noise(@sqrt, @(x)(x.^2), 0.5); h(4)*
- *B* : 18
- *C* : 10
- *D* : 6
- *E* : Error



$\sqrt{x} + 0.5\, x^2$

h

$\sqrt{4} + 0.5 \cdot 16$

$2 + 8 = 10$

Piazza post list of input validation functions

→ p1 - p3, p4 - p6 code next week.

→ debugger example next week.

Function Handle, Random Noise

Quiz

1. *function h = noise(f, g)*
2. *h = @(x)(f(x) + rand() * g(x));*
3. *end*

- *h = noise(@sqrt, @(x)(x.^2)); h(4) == h(4)*
- B : 0
- C : 1
- E : Error

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