CS368 MATLAB Programming

Lecture 10

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

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Multiple Choice

Quiz

Q1

- Which answer(s) is correct?
- *A* : All of the below. ✗
- *B* : None of the below. ✗
- *C* : All of the above. ✗
- *D* : One of the above. ✗
- [✓ *E*] : None of the above. ✓

Indicator Variables

Math

- If the same task is performed for different values of a variable, use an indicator variable and vectorize.
- If different tasks are performed for different values of a variable, use a *switch* conditional.
- If different tasks are performed under different conditions, use an *if* conditional.

Switch

Code

- Different tasks are performed for $x = v_1$, for $x = v_2$ or v_3, and for every other value of x.

```
switch x
   case v1
      ...
   case {v2, v3}
      ...
   otherwise
      ...
end
```

If Else

Code

- Different tasks are performed if $x \neq 0$, if $x = 0$ but $y \neq 0$, and if $x = 0$ and $y = 0$.

```
if x ≠ 0
    ...
elseif y ≠ 0
    ...
else
    ...
end
```

Condition for If

Code

- *if x* and *if x ~= 0* represent the same condition. The expression *x ~= 0* should be treated as a variable whose value is $\begin{cases} 1 & \text{if } x \neq 0 \\ 0 & \text{if } x = 0 \end{cases}$.
- *while x* and *while x ~= 0* represent the same loop for the same reason.

Conditionals, Switch

Quiz

```
x = 10; switch mod(x, 4)
    case 0
        x + 1
    case {1, 2}
        x * 2
    otherwise
        x ^ 3
end
```

→ 2

Q2

0, 1, 2, 3

$x = 8$

case 0 ⇒ 9

$x = 7$

case otherwise ⇒ 7^3

- A : 11
- [✓ B : 20]
- C : 1000

Conditionals, If

Quiz

Q3

```
x = 10;
if x < 10 && ~mod(x, 2)
  x + 1
elseif ~mod(x , 3)
  x * 2
else
  x ^ 3
end
```

not

and

1 ⇒ 0

else if 0

false

mod(x, 3) == 0

- A : 11
- B : 20
- [✓ C : 1000]

Conditionals, Variable as Condition

Quiz

Q4

```
x = 0; y = 1; z = 2;
if x && ~y && z
  x
elseif x || ~y || z
  y
else
  z
end
```

false

false false = 2 not 0

true

$x \sim= 0 \;||\; y \sim= 0 \;||\; z \sim= 0$

- A : 0
- [✓ B : 1]
- C : 2

Number of Input Arguments

Code

- When the function *function* $z = f(x,\ y)$ is called, $0, 1$ or 2 arguments can be provided.
- *switch* can be used here to perform different tasks when different number of arguments are given.
- *nargin* is the number of input arguments provided when the function is called.

Log with Optional Input Arguments

Code

- For example, a new log function can be defined by *log()* returns 1, *log(x)* returns natural log (x), and *log(n, x)* returns $\log_n(x)$.

```
function z = log(x, y)
  switch nargin
    case 1
      z = log(x);
    case 2
      z = log(y) / log(x);
    otherwise
      z = 1;
  end; end
```

$\log_x y$

→ nargin = 0 or 3, 4 ...

Variable Length Input Argument

Code

varargin

- *varargin* represents an arbitrary number of input variables.
- It can only be used as the last argument of a function, for example, *function y = f(x1, x2, x3, ~~varagin~~)*.

at the end

- The *i*-th argument can be accessed by *varargin{i}*.

cell array

Log with Variable Length Argument

Code

- For example, a new log function can be defined so that it returns a vector if more than one input is provided.

```
function z = log(x, varagin)
if nargin == 1
  z = log(x);
else
  z = [log(x) zeros(1, nargin - 1)];
  for t = 2:nargin
    z(t) = log(varagin{t - 1});
  end; end; end
```

r

end

ends

log(1) → 0

log(1, 2, 3) →

[log, log2, log3]

[log(x) 0, 0, 0, ...]

log(2) log(3)

Output Arguments

Code

function [y, $\underline{\text{varargout}}$] = f(x, y..)

- $\underline{\textit{varargout}}$ represents an arbitrary number of output variables.
- $\underline{\textit{nargout}}$ represents the number of output variables assigned when the function is called.
- For example, $\underline{x} = \underline{size}([1\ \ 2;\ \ 3\ \ 4])$ assigns x the value **2 2** and $\underline{[x,\ y]} = size([1\ \ 2;\ \ 3\ \ 4])$ assigns x the value **2** .

Recursion

Math

- A function that uses itself in the body is called a recursive function.

```
function z = f(x)
if x ... % base case
  z = ...
else % recursion
  z = ... f(x') ...
end
```

Recursion Example, Factorial

Code

$n! = n(n-1)(n-2)\cdots 1$

- To compute the factorial of $n \geqslant 0$:

```
function z = f(x)
  if ~x   x == 0
    z = 1;
  else
    z = x * f(x - 1);
  end
end
```

$f(0) = 0! = 1$

$f(n) = n! = n \cdot \underline{(n-1)!}$

$= n \cdot f(n-1)$

$\underline{f(3)} = 3 \cdot f(2) = 3 \cdot 2 \cdot \underline{f(1)}$

$x=3$

$x=2$

$= 3 \cdot 2 \cdot \underline{1} \cdot \cancel{f(0)}$

$x = 0$

Recursion Example, Vector Sum

Code

- To compute the sum of the values in a vector *v*:

```
function z = f(x, t)
    if nargin == 1
        z = f(x, 0);
    elseif t > length(x)
        z = 0;
    else
        z = x(t) + f(x, t + 1);
    end
end
```

0 3

f([1, 2, 3]) = 6

f([1,2,3], 1)

1+ f([1,2,3], 2)

2+ f([1,2,3], 3)

3+ f([1,2,3], 4)

0

current value

sum of remaining values

Recursion, Fibonacci

Quiz

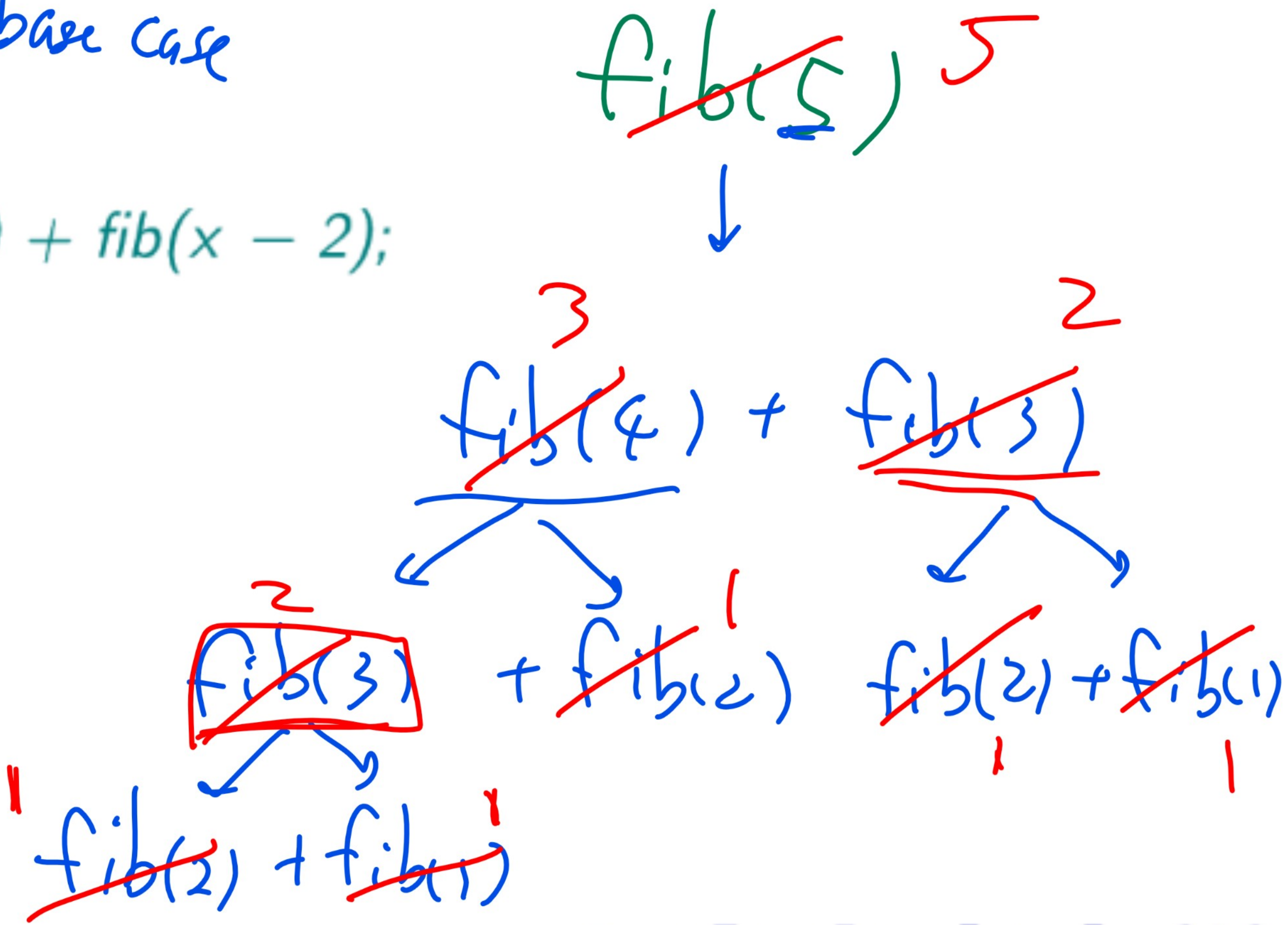
1, 1, 2, 3, 5, 8, 13..

Q5

```
function z = fib(x)
    if x < 3
      z = 1;
    else
      z = fib(x − 1) + fib(x − 2);
    end
end
fib (5)
```

base case

- [✓ A : 5]
- B : 7



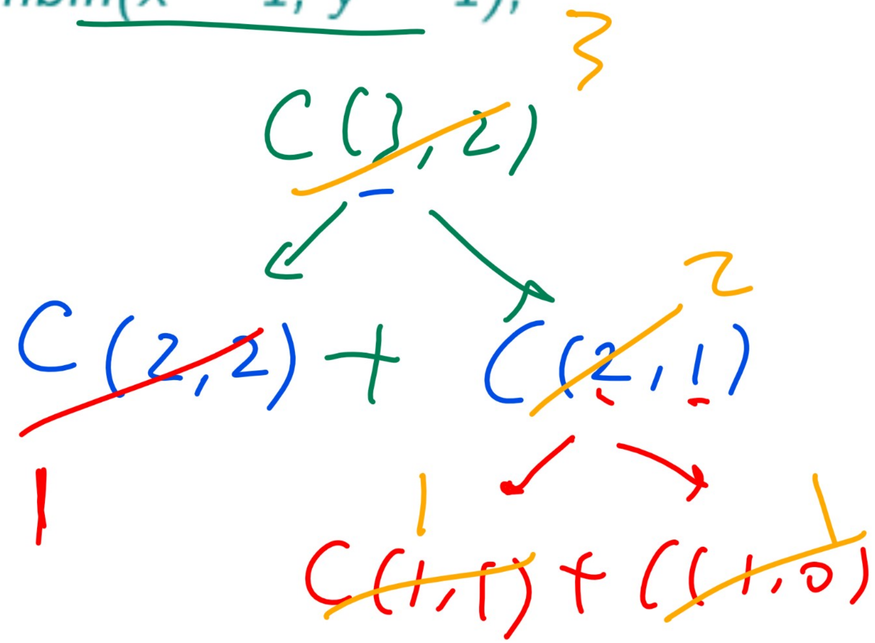
Recursion, Binomial

Quiz

Q6

```
function z = combin(x, y)
      2           3
   if y == 0 || y == x
      z = 1;
   else
      z = combin(x − 1, y) + combin(x − 1, y − 1);
   end
end
combin(3, 2)
```

- [✓ A : 3]
- B : 6



Recursion, Greatest Common Divisor

Quiz

Q7

```
function z = gcd(x, y)
    if y == 0
        z = x;
    else
        z = gcd(y, mod(x, y));
    end
end
gcd(10, 6)
```

- [✓ A : 2]
- B : 6

gcd(10, 6)

↓

gcd(6, 4)

↓

gcd(4, 2)

↓

gcd(2, 0)

y=0

Recursion, Greatest Common Divisor Again

Quiz

```
function z = gcd(x, y)
  if y == 0
    z = x;
  else
    z = gcd(y, mod(x, y));
  end
end
```

~~g~~gcd(9, 16)

- [✓ A : 1]
- C : 9

Q8

gcd(9, 16)

d

gcd(16, 7)

gcd(7, ~~9~~ 2)

c

gcd(2, 1)

c

gcd(1, 0)

~~gcd(1, 0)~~

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