18-642 Recitation #3

September 13, 2019

Updates

- Homework:
  - Homeworks through #6 graded on canvas
  - Homeworks #9/10/11 due Wednesday night
- Homework grading
  - Points are mostly for good faith effort (no single “correct” answer)
  - Points taken off if:
    - You didn’t answer all parts of a question
    - You didn’t follow directions for a question
    - You didn’t cite/explain your work
    - You’re obviously phoning it in or being a jerk
  - Read comments on canvas, even if you got full points
  - Full points does not mean you got the right answer
    - We’ll try to cover some common issues in recitation
    - If you’re not sure – ask!

Updates

- Projects:
  - Project 2 graded on canvas
  - Project 3 due tonight
  - Project 4 released, due in a week

Updates

- Reminder to use staff email and office hours for questions
  - Email only for administrative questions – it's hard to answer conceptual questions
  - If you can't make office hours, send us a note ahead of time with your availability and we'll try to work something out

Today

- Project #4
- Homework discussion

Project #3 Questions?

- Reminder: you can omit conformance with any three checklist items
  - You have to tell us which three in writeup
  - For Project #4 you'll have to fix them
  - Intended to give slack to students who are still coming up to speed on programming skills

Project 4

- Peer reviews
  - Your groups are assigned on canvas
  - There is a live lecture + video lecture on this
- For each review:
  - One person is the scribe
    - Person who has code under review
  - One person is the leader
    - Rotate this; by the end of all reviews, everyone has had a turn being scribe and being leader
- **Fix** any issues that come up **AFTER** the review

Peer Review Checklist

- Fill one out for **each** review

	A	B	C
1	**Peer Review Checklist 18-642**		
2	(Substitute forms may be used as long as they are comparable)		
3			
4	**Group#**		
5	**Date:**		
6	**Artifact:**		
7	**Scribe:**		
8	**Leader:**		
9	**Time spent:**		
10			
11	**Issue#**	**Issue Description**	**Status**
12	1		
13	2		
14	3		
15	4		
16	5		
17	6		

Peer Review Reminders

- Inspect the item, not the author
- Don't get defensive
- Find but don't fix problems
- Limit meetings to two hours
- Keep a reasonable pace
- Avoid "religious" debates on style *(While enforcing what the Project 3 checklist says)*

What to review

- Go through code line by line
- Leader is in charge of
  - Saying when to move on to the next line
  - Reading through Project 3 style checklist out loud
- Prof Koopman's review checklist is a good starting point for more general reviews:
  - https://betterembsw.blogspot.com/2018/01/
  - Note that some items won't apply to your code
  - OK to use this too, but **Proj #3 style is mandatory**

Project #4 Questions?

- Group hand-in
  - All spreadsheets at end of review session
    - Status column will be blank
- Individual hand-in
  - Your code
  - Your spreadsheet with “status” filled in
  - A writeup

McCabe's Cyclomatic Complexity

- Measures complexity by counting branching logic
- Generally used as a guideline to how readable/testable/maintanable source is
- High complexity of a module indicates:
  - Deeply nested loops
  - Lots of branch statements
  - Functionality that is not factored out into modules
- For detailed example, see posted recitation 3 slides online

Applications to testing

- Code coverage testing:
  - "White box" testing (can see the code)
  - Want to test all logic
  - Branch coverage testing
  - Path coverage testing

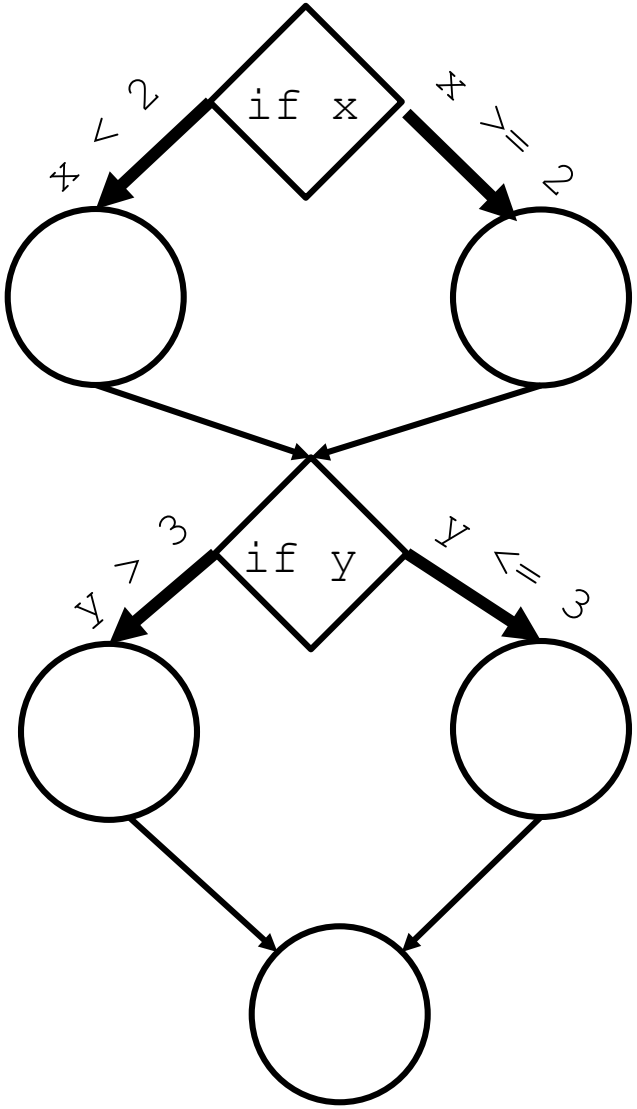
Branch coverage

Test cases

{x=1, y=2}

{x = 3, y=4}

All branches covered



Path coverage

Test cases:

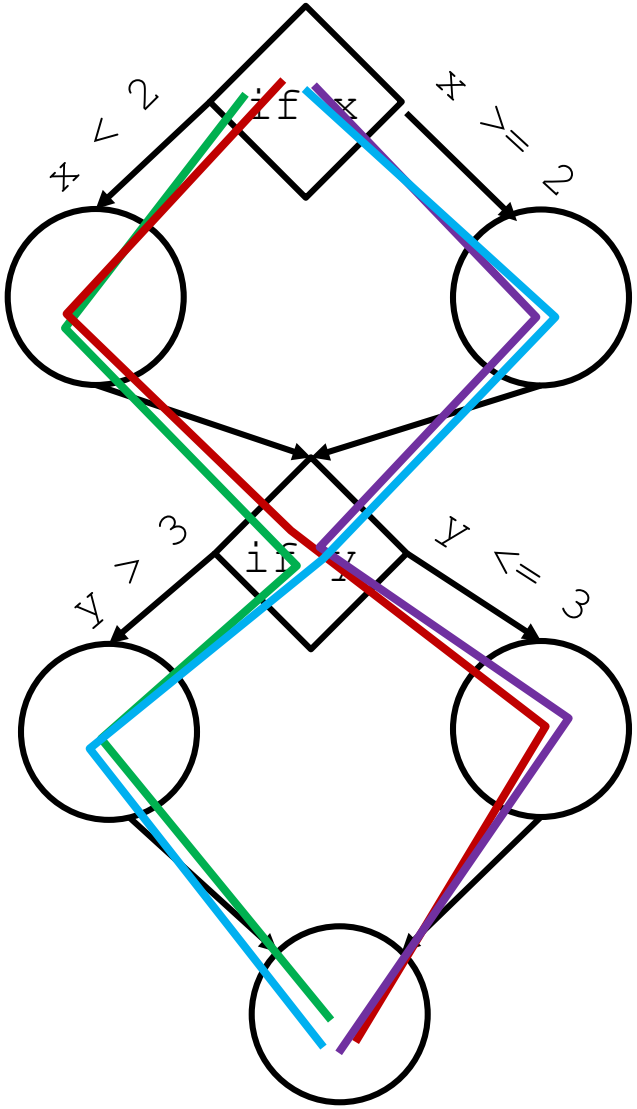
{x=1, y=2}

{x=1,y=4}

{x=3,y=2}

{x=3,y=4}

All paths tested



Cyclomatic Complexity and Testing

# of tests to achieve full branch coverage

<= MCC # <=

*# of tests to achieve full path coverage**

*Unless some paths are impossible

- Gives a lower bound to achieving path coverage (so a high MCC means a lot of testing)
- Also gives notion of how many test cases are needed to obtain “sufficient coverage”
- See McCabe paper, Section VII for more discussion

https://en.wikipedia.org/wiki/Cyclomatic_complexity

T. J. McCabe, "A Complexity Measure," in *IEEE Transactions on Software Engineering*, vol. SE-2, no. 4, pp. 308-320, Dec. 1976.

Subprocesses

```
for (i = 0; i < N; i++) {
      sub_process(i);
}
```

- Still has MCC of 2.
- Testing complexity in this module requires testing that the inside of the loop is reached, and testing the outside of the loop
- Complexity of sub_process() is computed separately because it can be unit-tested separately
- Takeaway: refactor code to reduce MCC
- **Do this for project 3!!**

MCC and SCC

- McCabe's cyclomatic complexity
  - Counts # of if/while/for conditionals in the code
- Strict cyclomatic complexity
  - Includes +1 for every condition within a branch
- `if (a < 0 && b > 0)` adds +1 to MCC, +2 to SCC
- You'll encounter this in the homework

These have same MCC, but which is more readable?

```
if (isInBounds(x)){
 if (y > 0) {
   if (prime factor(x,y)){
    if (COMPUTE_FLAG){
     do_function(x,y)
    }
   }
  }
}
```

```
if (!isInBounds(x)
 return false;
if (y <= 0)
 return false;
if (!COMPUTE_FLAG)
 return false;
do_function(x,y)
```

Spaghetti Code

- High MCC is just one indicator of spaghetti code
- Others:
  - Global variables
  - Copy-pasted code
  - Obfuscated variable names

background image: https://imgflip.com/memegenerator/Eminem

Questions?

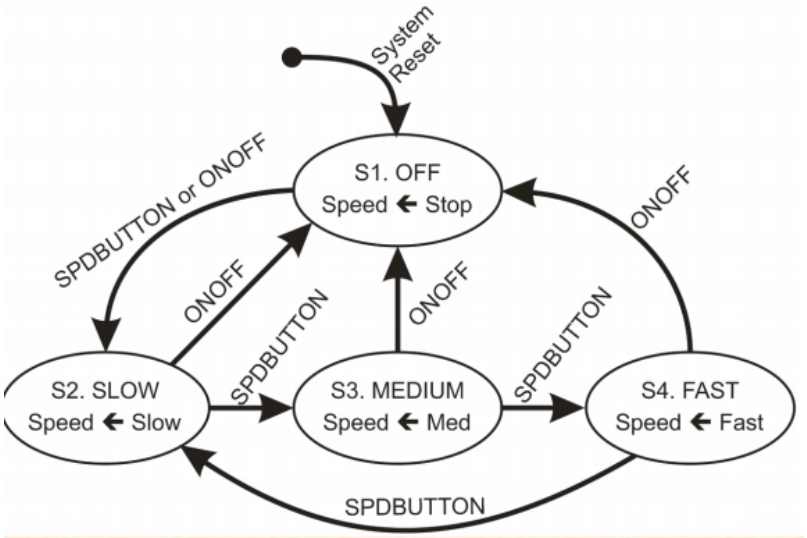
Lightning Round

➔ Which rule do you like & why?
➔ Which rule do you hate and why?

- 1. Sections 1.2-1.5 (General Rules)
- 2. Sections 1.6-1.8 (General Rules)
- 3. Sections 2.1-2.2 (Comments)
- 4. Sections 3.1-3.3 (Whitespace Rules)
- 5. Sections 3.4-3.6 (Whitespace Rules)
- 6. Sections 4.1-4.4 (Module Rules)
- 7. Sections 5.1-5.5 (Data Type Rules)
- 8. Sections 6.1-6.3 (Procedure Rules)
- 9. Sections 7.1-7.2 (Variable Rules)
- 0. Sections 8.1-8.5 (Statement Rules)

Lightning Round Roster

HW Review: State Charts



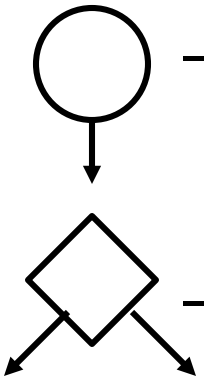
http://www.ece.cmu.edu/~ece642/lectures/08_modalstatechart.pdf

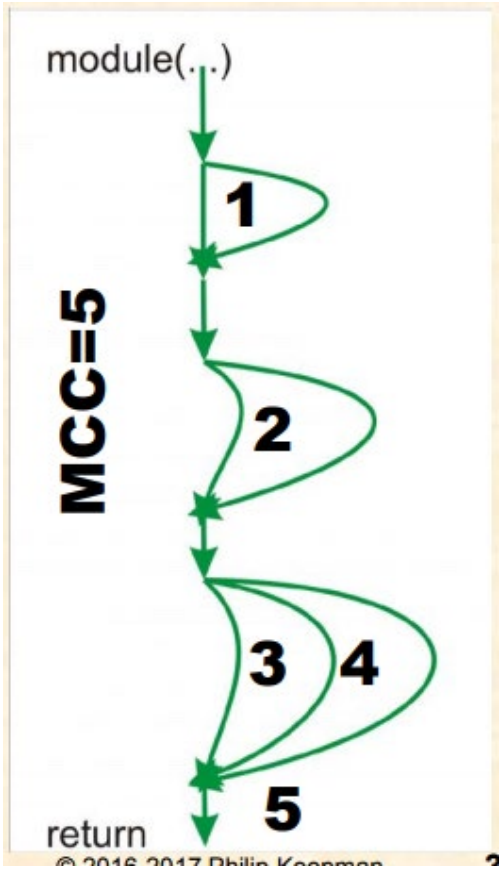
- Used to express stateful behavior
- Number the states
- Name the states
- Input to system causes state transition
- Each state sets all output variables
- Avoid complex behaviors within state subroutine
- Avoid actions on transition

Bonus MCC/SCC Slides

Determining MCC

- Turn code into graph and count # of loops + 1
- Notation to turn code into graph:
  - Circle for statement(s) with no branching logic
  - Diamond for branching logic

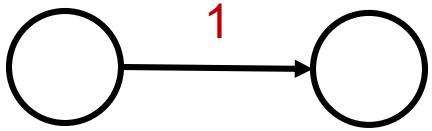




http://www.ece.cmu.edu/~ece642/lectures/06_spaghettiocode.pdf

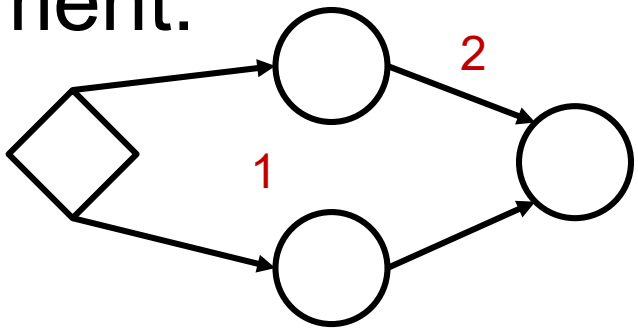
Common constructions

- Sequential, no branching:



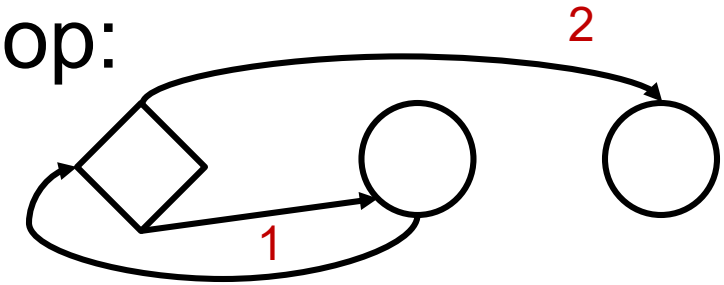
MCC = 1

- IF statement:



MCC = 2

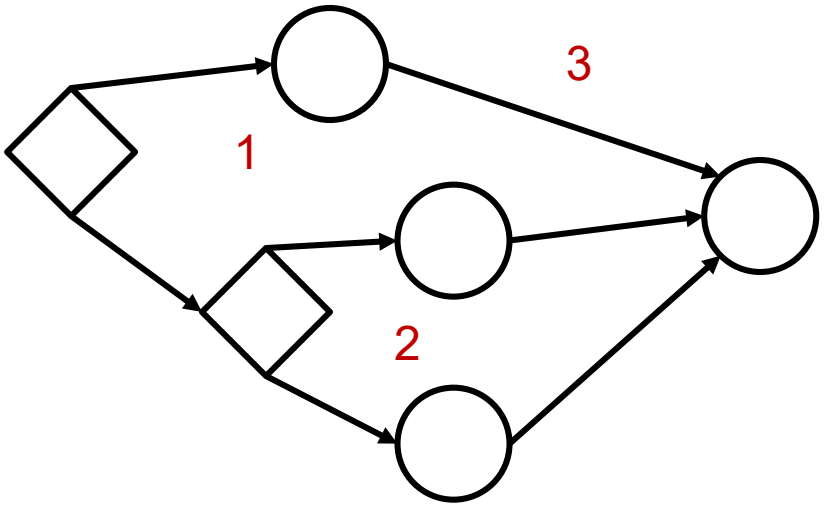
- For loop:



MCC = 2

Switch/multi-case IF:

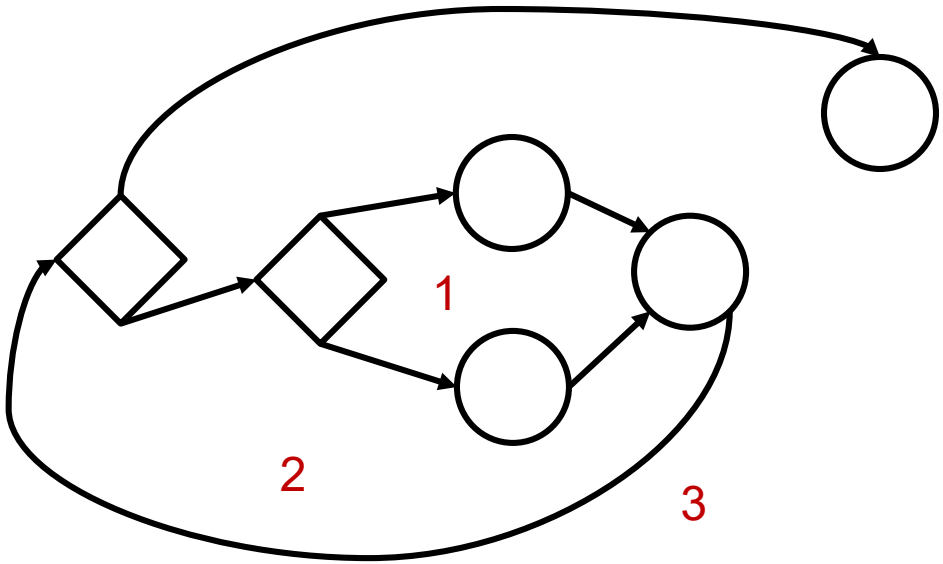
```
if (x == 1) {
  …
} else if (x == 2) {
  …
} else {
  …
}
```



MCC = 3

IF within FOR:

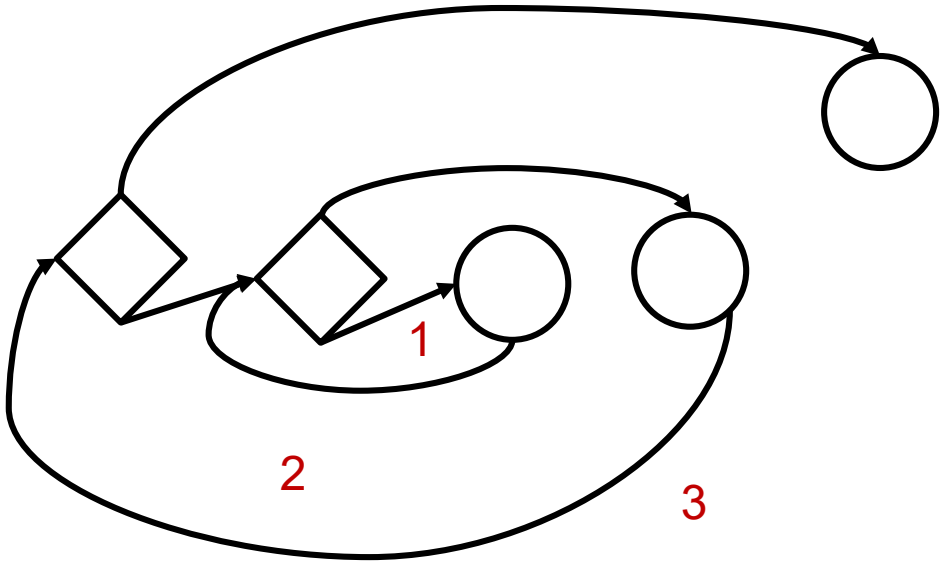
```
for (i = 0; i < 10; i++) {
  if (i % 2 == 0) {
      …
  } else {
      …
  }
}
```



MCC = 3

Nested Loop:

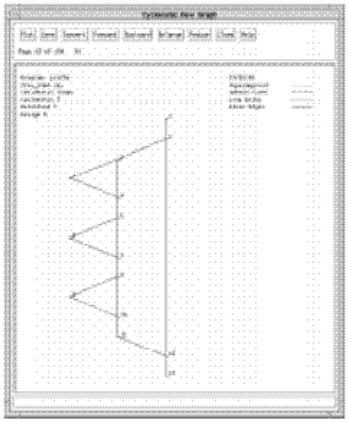
```
for (i = 0; i < N; i++) {
  for (j = 0; j < N; j++) {
      …
  }
}
```



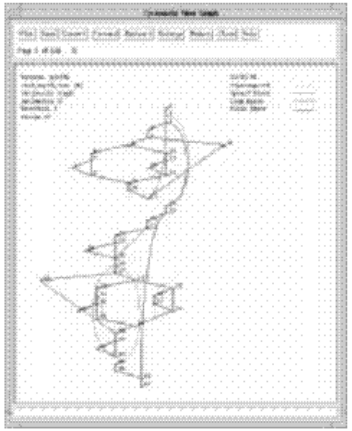
MCC = 3

More complex code

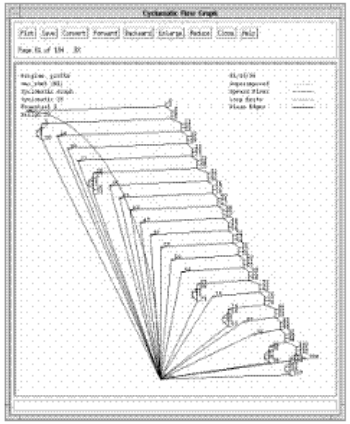
- Count total number of if/for/while statements and add 1
- Tools available to compute for you



Complexity=5



Complexity=17



Complexity=28

https://betterembsw.blogspot.com/2014/06/avoid-high-cyclomatic-complexity.html

Pitfalls of MCC

- Not an exact # of test cases to run (testing generally strives for path coverage)
- Switch statements increase MCC a lot but are sometimes necessary for things like message translation
  - Prof Koopman's blog post: *https://betterembsw.blogspot.com/2014/06/avoid-high-cyclomatic-complexity.html*
- Decent measure of code comprehension, but not the only one