CS 3250: Software Testing (Fall 2025)

POTD 5: Graph for source code (Data flow) – fizzBuzz – solution

Due 16-Oct-2025, 11:00am EST

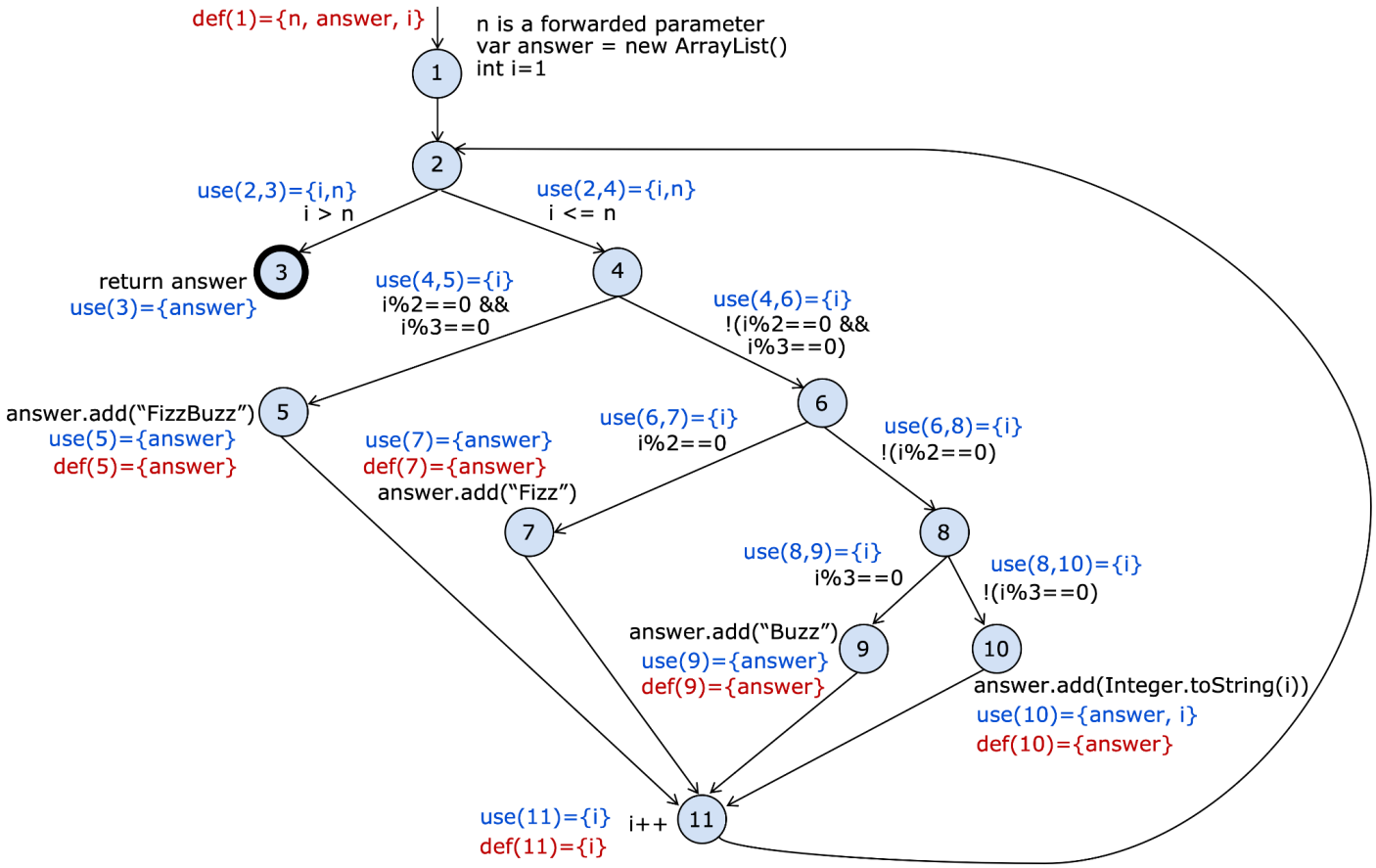
Purpose: Create graph representation for source code; apply data flow graph coverage to source code; get ready for assignment 4; prepare for quiz 3 and the final exam

You may make a copy of a worksheet and complete this activity, or type your answers in any text editor. You may work alone or with another student in this course (max team size=2).

Consider the following Java method

```
public static List<String> fizzBuzz(int n)
{
   var answer = new ArrayList();
   for (int i = 1; i <= n; i++)
   {
      if (i % 2 == 0 && i % 3 == 0)
         answer.add("FizzBuzz");
      else if (i % 2 == 0)
         answer.add("Fizz");
      else if (i % 3 == 0)
         answer.add("Buzz");
      else
         answer.add(Integer.toString(i));
   }
   return answer;
}
```

1. Draw a **Control Flow Graph** for the fizzBuzz method. Annotate **all** information (i.e., source code, defs and uses).



2. List all **du-pairs**, then derive **du-paths** (the du-paths then can be used as test requirements)

DU-pairs	DU-paths
Variable **n**	
[1, (2,3)] [1, (2,4)]	[1, 2, 3] [1, 2, 4]
Variable **answer**	
[1, 3] *empty answer*	[1, 2, 3]
[1, 5]	~~[1, 2, 4, 5]~~ *semantically unreachable – i is initialized to 1. The first iteration results in [1,2,4,6,8,10] because i=1.* *Do not include [1,2,4,5,11,2,4,5] – no def-clear path.*
[1, 7]	~~[1, 2, 4, 6, 7]~~ *semantically unreachable – i is initialized to 1. The first iteration results in [1,2,4,6,8,10] because i=1.*
[1, 9]	~~[1, 2, 4, 6, 8, 9]~~ *semantically unreachable – i is initialized to 1. The first iteration results in [1,2,4,6,8,10] because i=1.*
[1, 10]	[1, 2, 4, 6, 8, 10]
[5, 3]	[5, 11, 2, 3]
[5, 5] *use before def*	~~[5, 11, 2, 4, 5]~~ *semantically unreachable – due to i++*
[5, 7]	~~[5, 11, 2, 4, 6, 7]~~ *semantically unreachable – due to i++*
[5, 9]	~~[5, 11, 2, 4, 6, 8, 9]~~ *semantically unreachable – due to i++*
[5, 10]	[5, 11, 2, 4, 6, 8, 10]
[7, 3]	[7, 11, 2, 3]
[7, 5]	~~[7, 11, 2, 4, 5]~~ *semantically unreachable – due to i++*
[7, 7] *use before def*	~~[7, 11, 2, 4, 6, 7]~~ *semantically unreachable – due to i++*
[7, 9]	[7, 11, 2, 4, 6, 8, 9]
[7, 10]	[7, 11, 2, 4, 6, 8, 10]
[9, 3]	[9, 11, 2, 3]
[9, 5]	~~[9, 11, 2, 4, 5]~~ *semantically unreachable – due to i++*
[9, 7]	[9, 11, 2, 4, 6, 7]
[9, 9] *use before def*	~~[9, 11, 2, 4, 6, 8, 9]~~ *semantically unreachable – due to i++*
[9, 10]	~~[9, 11, 2, 4, 6, 8, 10]~~ *semantically unreachable – due to i++*
[10, 3]	[10, 11, 2, 3]

[10, 5]	[10, 11, 2, 4, 5]
[10, 7]	[10, 11, 2, 4, 6, 7]
[10, 9]	~~[10, 11, 2, 4, 6, 8, 9]~~ *semantically unreachable – due to i++*
[10, 10] *use before def*	~~[10, 11, 2, 4, 6, 8, 10]~~ *semantically unreachable – due to i++*
Variable **i**	
[1, (2,3)]	[1, 2, 3]
[1, (2,4)]	[1, 2, 4]
[1, (4,5)]	~~[1, 2, 4, 5]~~ *semantically unreachable – i is initialized to 1. The first iteration results in [1,2,4,6,8,10] because i=1.* *Do not include [1,2,3,5,11,2,4,5] – no def-clear path.*
[1, (4,6)]	[1, 2, 4, 6]
[1, (6,7)]	~~[1, 2, 4, 6, 7]~~ *semantically unreachable – i is initialized to 1. The first iteration results in [1,2,4,6,8,10] because i=1.*
[1, (6,8)]	[1, 2, 4, 6, 8]
[1, (8,9)]	~~[1, 2, 4, 6, 8, 9]~~ *semantically unreachable – i is initialized to 1. The first iteration results in [1,2,4,6,8,10] because i=1.*
[1, (8,10)]	[1, 2, 4, 6, 8, 10]
[1, 10]	[1, 2, 4, 6, 8, 10]
[1, 11]	~~[1, 2, 4, 5, 11]~~ *semantically unreachable – i is initialized to 1.* ~~[1, 2, 4, 6, 7, 11]~~ *semantically unreachable – i is initialized to 1.* ~~[1, 2, 4, 6, 8, 9, 11]~~ *semantically unreachable – i is initialized to 1.* [1, 2, 4, 6, 8, 10, 11]
[11, (2,3)]	[11, 2, 3]
[11, (2,4)]	[11, 2, 4]
[11, (4,5)]	[11, 2, 4, 5]
[11, (4,6)]	[11, 2, 4, 6]
[11, (6,7)]	[11, 2, 4, 6, 7]
[11, (6,8)]	[11, 2, 4, 6, 8]
[11, (8,9)]	[11, 2, 4, 6, 8, 9]
[11, (8,10)]	[11, 2, 4, 6, 8, 10]
[11, 10]	[11, 2, 4, 6, 8, 10]
[11, 11] *use before def*	[11, 2, 4, 5, 11] [11, 2, 4, 6, 7, 11] [11, 2, 4, 6, 8, 9, 11] [11, 2, 4, 6, 8, 10, 11]

3. Apply **All-Defs** to design tests — some test paths tour multiple test requirements

variable	Test requirements	Test paths	Test cases (input values and expected output)
n	[1,2,3]	[1,2,3]	input: n=0, expected: answer=[]
answer	[1,2,3]	[1,2,3]	input: n=0, expected: answer=[]
	[5,11,2,3]	[1,2, 4,6,8,10,11, 2,4,6,7,11, 2,4,6,8,9,11, 2,4,6,7,11, 2,4,6,8,10,11, 2,4,5,11, 2,3]	input: n=6, expected: answer=[1,Fizz,Buzz,Fizz,5,FizzBuzz]
	[7,11,2,3]	[1,2, 4,6,8,10,11, 2,4,6,7,11, 2,3]	input: n=2, expected: answer=[1,Fizz]
	[9,11,2,3]	[1,2, 4,6,8,10,11, 2,4,6,7,11, 2,4,6,8,9,11, 2,3]	input: n=3, expected: answer=[1,Fizz,Buzz]
	[10,11,2,3]	[1,2, 4,6,8,10,11, 2,3]	input: n=1; expected: answer=[1]
i	[1,2,3]	[1,2,3]	input: n=0, expected: answer=[]
	[11, (2,3)]	[1,2, 4,6,8,10,11, 2,3]	input: n=1, expected: answer=[1]

4. Apply **All-Uses** to design tests

variable	Test requirements	Test paths	Test cases (input values and expected output)
n	[1,2,3] *For du [1, (2,3)]*	[1,2,3]	input: n=0, expected: answer=[]
	[1,2,4] *For du [1, (2,4)]*	[1,2, 4,6,8,10,11, 2,3]	input: n=1; expected: answer=[1]
answer	[1,2,3] *For du [1,3]*	[1,2,3]	input: n=0, expected: answer=[]
	[1,2,4,6,8,10] *For du [1,10]*	[1,2, 4,6,8,10,11, 2,3]	input: n=1; expected: answer=[1]
	[5,11,2,3] *For du [5,3]*	[1,2, 4,6,8,10,11, 2,4,6,7,11, 2,4,6,8,9,11, 2,4,6,7,11, 2,4,6,8,10,11, 2,4,5,11, 2,3]	input: n=6, expected: answer=[1,Fizz,Buzz,Fizz,5,FizzBuzz]
	[5,11,2,4,6,8,10] *For du [5,10]*	[1,2, 4,6,8,10,11, 2,4,6,7,11, 2,4,6,8,9,11, 2,4,6,7,11, 2,4,6,8,10,11, 2,4,5,11, 2,4,6,8,10,11, 2,3]	input: n=7, expected: answer=[1,Fizz,Buzz,Fizz,5,FizzBuzz,7]

	[7,11,2,3] *For du [7,3]* [7,11,2,4,6,8,9] *For du [7,9]* [7,11,2,4,6,8,10] *For du [7,10]* [9,11,2,3] *For du [9,3]* [9,11,2,4,6,7] *For du [9,7]* [10,11,2,3] *For du [10,3]* [10,11,2,4,5] *For du [10,5]* [10,11,2,4,6,7] *For du [10,7]*	[1,2, 4,6,8,10,11, 2,4,6,7,11, 2,3] [1,2, 4,6,8,10,11, 2,4,6,7,11, 2,4,6,8,9,11, 2,3] [1,2, 4,6,8,10,11, 2,4,6,7,11, 2,4,6,8,9,11, 2,4,6,7,11, 2,4,6,8,10,11, 2,3] [1,2, 4,6,8,10,11, 2,4,6,7,11, 2,4,6,8,9,11, 2,3] [1,2, 4,6,8,10,11, 2,4,6,7,11, 2,4,6,8,9,11, 2,4,6,7,11, 2,4,6,8,10,11, 2,3] [1,2, 4,6,8,10,11, 2,3] [1,2, 4,6,8,10,11, 2,4,6,7,11, 2,4,6,8,9,11, 2,4,6,7,11, 2,4,6,8,10,11, 2,4,5,11, 2,3] [1,2, 4,6,8,10,11, 2,4,6,7,11, 2,4,6,8,9,11, 2,4,6,7,11, 2,4,6,8,10,11, 2,4,5,11, 2,3]	input: n=2; expected: answer=[1,Fizz] input: n=3, expected: answer=[1,Fizz,Buzz] input: n=5, expected: answer=[1,Fizz,Buzz,Fizz,5] input: n=3, expected: answer=[1,Fizz,Buzz] input: n=5, *(or n=4, we reuse test n=5)* expected: answer=[1,Fizz,Buzz,Fizz,5] input: n=1; expected: answer=[1] input: n=6, expected: answer=[1,Fizz,Buzz,Fizz,5,FizzBuzz] input: n=6, *(or n=2, we reuse test n=6)* expected: answer=[1,Fizz,Buzz,Fizz,5,FizzBuzz]
i	[1,2,3] *For du [1,(2,3)]* [1,2,4] *For du [1,(2,4)]* [1,2,4,6] *For du [1,(4,6)]* [1,2,4,6,8] *For du [1,(6,8)]* [1,2,4,6,8,10] *For du [1, (8,10)]* *and [1,10]* [1,2,4,6,8,10,11] *For du [1,11]* [11,2,3] *For du [11,(2,3)]* [11,2,4] *For du [11,(2,4)]*	[1,2,3] [1,2, 4,6,8,10,11, 2,3] [1,2, 4,6,8,10,11, 2,3] [1,2, 4,6,8,10,11, 2,3] [1,2, 4,6,8,10,11, 2,3] [1,2, 4,6,8,10,11, 2,3] [1,2, 4,6,8,10,11, 2,3] [1,2, 4,6,8,10,11, 2,4,6,7,11, 2,4,6,8,9,11, 2,4,6,7,11, 2,4,6,8,10,11, 2,4,5,11, 2,3]	input: n=0, expected: answer=[] input: n=1, expected: answer=[1] input: n=1, expected: answer=[1] input: n=1, expected: answer=[1] input: n=1, expected: answer=[1] input: n=1, expected: answer=[1] input: n=1, expected: answer=[1] input: n=6, expected: answer=[1,Fizz,Buzz,Fizz,5,FizzBuzz]

	[11,2,4,5] *For du [11,(4,5)]* [11,2,4,6] *For du [11,(4,6)]* [11,2,4,6,7] *For du [11,(6,7)]* [11,2,4,6,8] *For du [11,(6,8)]* [11,2,4,6,8,9] *For du [11,(8,9)]* [11,2,4,6,8,10] *For du [11,(8,10)] and [11,10]* [11,2,4,6,8,10,11] *For du [11,11]*	[1,2, 4,6,8,10,11, 2,4,6,7,11, 2,4,6,8,9,11, 2,4,6,7,11, 2,4,6,8,10,11, 2,4,5,11, 2,3] [1,2, 4,6,8,10,11, 2,4,6,7,11, 2,4,6,8,9,11, 2,4,6,7,11, 2,4,6,8,10,11, 2,4,5,11, 2,3] [1,2, 4,6,8,10,11, 2,4,6,7,11, 2,4,6,8,9,11, 2,4,6,7,11, 2,4,6,8,10,11, 2,4,5,11, 2,3] [1,2, 4,6,8,10,11, 2,4,6,7,11, 2,4,6,8,9,11, 2,4,6,7,11, 2,4,6,8,10,11, 2,4,5,11, 2,3] [1,2, 4,6,8,10,11, 2,4,6,7,11, 2,4,6,8,9,11, 2,4,6,7,11, 2,4,6,8,10,11, 2,4,5,11, 2,3] [1,2, 4,6,8,10,11, 2,4,6,7,11, 2,4,6,8,9,11, 2,4,6,7,11, 2,4,6,8,10,11, 2,4,5,11, 2,3] [1,2, 4,6,8,10,11, 2,4,6,7,11, 2,4,6,8,9,11, 2,4,6,7,11, 2,4,6,8,10,11, 2,4,5,11, 2,3]	input: n=6, expected: answer=[1,Fizz,Buzz,Fizz,5,FizzBuzz] input: n=6, expected: answer=[1,Fizz,Buzz,Fizz,5,FizzBuzz] input: n=6, expected: answer=[1,Fizz,Buzz,Fizz,5,FizzBuzz] input: n=6, expected: answer=[1,Fizz,Buzz,Fizz,5,FizzBuzz] input: n=6, expected: answer=[1,Fizz,Buzz,Fizz,5,FizzBuzz] input: n=6, expected: answer=[1,Fizz,Buzz,Fizz,5,FizzBuzz] input: n=6, expected: answer=[1,Fizz,Buzz,Fizz,5,FizzBuzz]

5. Apply **All-DU-Paths** to design tests

variable	Test requirements	Test paths	Test cases (input values and expected output)
n	1,2,3] *For du [1, (2,3)]* [1,2,4] *For du [1, (2,4)]*	[1,2,3] [1,2, 4,6,8,10,11, 2,3]	input: n=0, expected: answer=[] input: n=1; expected: answer=[1]
answer	[1,2,3] *For du [1,3]* [1,2,4,6,8,10] *For du [1,10]* [5,11,2,3] *For du [5,3]* [5,11,2,4,6,8,10] *For du [5,10]*	[1,2,3] [1,2, 4,6,8,10,11, 2,3] [1,2, 4,6,8,10,11, 2,4,6,7,11, 2,4,6,8,9,11, 2,4,6,7,11, 2,4,6,8,10,11, 2,4,5,11, 2,3] [1,2, 4,6,8,10,11, 2,4,6,7,11, 2,4,6,8,9,11, 2,4,6,7,11, 2,4,6,8,10,11, 2,4,5,11, 2,4,6,8,10,11, 2,3]	input: n=0, expected: answer=[] input: n=1; expected: answer=[1] input: n=6, expected: answer=[1,Fizz,Buzz,Fizz,5,FizzBuzz] input: n=7, expected: answer=[1,Fizz,Buzz,Fizz,5,FizzBuzz,7]

	[7,11,2,3] *For du [7,3]* [7,11,2,4,6,8,9] *For du [7,9]* [7,11,2,4,6,8,10] *For du [7,10]* [9,11,2,3] *For du [9,3]* [9,11,2,4,6,7] *For du [9,7]* [10,11,2,3] *For du [10,3]* [10,11,2,4,5] *For du [10,5]* [10,11,2,4,6,7] *For du [10,7]*	[1,2, 4,6,8,10,11, 2,4,6,7,11, 2,3] [1,2, 4,6,8,10,11, 2,4,6,7,11, 2,4,6,8,9,11, 2,3] [1,2, 4,6,8,10,11, 2,4,6,7,11, 2,4,6,8,9,11, 2,4,6,7,11, 2,4,6,8,10,11, 2,3] [1,2, 4,6,8,10,11, 2,4,6,7,11, 2,4,6,8,9,11, 2,3] [1,2, 4,6,8,10,11, 2,4,6,7,11, 2,4,6,8,9,11, 2,4,6,7,11, 2,4,6,8,10,11, 2,3] [1,2, 4,6,8,10,11, 2,3] [1,2, 4,6,8,10,11, 2,4,6,7,11, 2,4,6,8,9,11, 2,4,6,7,11, 2,4,6,8,10,11, 2,4,5,11, 2,3] [1,2, 4,6,8,10,11, 2,4,6,7,11, 2,4,6,8,9,11, 2,4,6,7,11, 2,4,6,8,10,11, 2,4,5,11, 2,3]	input: n=2; expected: answer=[1,Fizz] input: n=3, expected: answer=[1,Fizz,Buzz] input: n=5, expected: answer=[1,Fizz,Buzz,Fizz,5] input: n=3, expected: answer=[1,Fizz,Buzz] input: n=5, expected: answer=[1,Fizz,Buzz,Fizz,5] input: n=1; expected: answer=[1] input: n=6, expected: answer=[1,Fizz,Buzz,Fizz,5,FizzBuzz] input: n=6, expected: answer=[1,Fizz,Buzz,Fizz,5,FizzBuzz]
i	[1,2,3] *For du [1,(2,3)]* [1,2,4] *For du [1,(2,4)]* [1,2,4,6] *For du [1,(4,6)]* [1,2,4,6,8] *For du [1,(6,8)]* [1,2,4,6,8,10] *For du [1, (8,10)]* *and [1,10]* [1,2,4,6,8,10,11] *For du [1,11]* [11,2,3] *For du [11,(2,3)]* [11,2,4] *For du [11,(2,4)]*	[1,2,3] [1,2, 4,6,8,10,11, 2,3] [1,2, 4,6,8,10,11, 2,3] [1,2, 4,6,8,10,11, 2,3] [1,2, 4,6,8,10,11, 2,3] [1,2, 4,6,8,10,11, 2,3] [1,2, 4,6,8,10,11, 2,3] [1,2, 4,6,8,10,11, 2,4,6,7,11, 2,4,6,8,9,11, 2,4,6,7,11, 2,4,6,8,10,11, 2,4,5,11, 2,3]	input: n=0, expected: answer=[] input: n=1, expected: answer=[1] input: n=1, expected: answer=[1] input: n=1, expected: answer=[1] input: n=1, expected: answer=[1] input: n=1, expected: answer=[1] input: n=1, expected: answer=[1] input: n=6, expected: answer=[1,Fizz,Buzz,Fizz,5,FizzBuzz]

	[11,2,4,5] *For du [11,(4,5)]*	[1,2, 4.6.8.10.11, 2.4.6.7.11, 2.4.6.8.9.11, 2.4.6.7.11, 2.4.6.8.10.11, 2.4.5.11, 2,3]	input: n=6, expected: answer=[1,Fizz,Buzz,Fizz,5,FizzBuzz]
	[11,2,4,6] *For du [11,(4,6)]*	[1,2, 4.6.8.10.11, 2.4.6.7.11, 2.4.6.8.9.11, 2.4.6.7.11, 2.4.6.8.10.11, 2.4.5.11, 2,3]	input: n=6, expected: answer=[1,Fizz,Buzz,Fizz,5,FizzBuzz]
	[11,2,4,6,7] *For du [11,(6,7)]*	[1,2, 4.6.8.10.11, 2.4.6.7.11, 2.4.6.8.9.11, 2.4.6.7.11, 2.4.6.8.10.11, 2.4.5.11, 2,3]	input: n=6, expected: answer=[1,Fizz,Buzz,Fizz,5,FizzBuzz]
	[11,2,4,6,8] *For du [11,(6,8)]*	[1,2, 4.6.8.10.11, 2.4.6.7.11, 2.4.6.8.9.11, 2.4.6.7.11, 2.4.6.8.10.11, 2.4.5.11, 2,3]	input: n=6, expected: answer=[1,Fizz,Buzz,Fizz,5,FizzBuzz]
	[11,2,4,6,8,9] *For du [11,(8,9)]*	[1,2, 4.6.8.10.11, 2.4.6.7.11, 2.4.6.8.9.11, 2.4.6.7.11, 2.4.6.8.10.11, 2.4.5.11, 2,3]	input: n=6, expected: answer=[1,Fizz,Buzz,Fizz,5,FizzBuzz]
	[11,2,4,6,8,10] *For du [11,(8,10)]* *and [11,10]*	[1,2, 4.6.8.10.11, 2.4.6.7.11, 2.4.6.8.9.11, 2.4.6.7.11, 2.4.6.8.10.11, 2.4.5.11, 2,3]	input: n=6, expected: answer=[1,Fizz,Buzz,Fizz,5,FizzBuzz]
	[11,2,4,5,11] *For du [11,11]*	[1,2, 4.6.8.10.11, 2.4.6.7.11, 2.4.6.8.9.11, 2.4.6.7.11, 2.4.6.8.10.11, 2.4.5.11, 2,3]	input: n=6, expected: answer=[1,Fizz,Buzz,Fizz,5,FizzBuzz]
	[11,2,4,6,7,11] *For du [11,11]*	[1,2, 4.6.8.10.11, 2.4.6.7.11, 2.4.6.8.9.11, 2.4.6.7.11, 2.4.6.8.10.11, 2.4.5.11, 2,3]	input: n=6, expected: answer=[1,Fizz,Buzz,Fizz,5,FizzBuzz]
	[11,2,4,6,8,9,11] *For du [11,11]*	[1,2, 4.6.8.10.11, 2.4.6.7.11, 2.4.6.8.9.11, 2.4.6.7.11, 2.4.6.8.10.11, 2.4.5.11, 2,3]	input: n=6, expected: answer=[1,Fizz,Buzz,Fizz,5,FizzBuzz]
	[11,2,4,6,8,10,11] *For du [11,11]*	[1,2, 4.6.8.10.11, 2.4.6.7.11, 2.4.6.8.9.11, 2.4.6.7.11, 2.4.6.8.10.11, 2.4.5.11, 2,3]	input: n=6, expected: answer=[1,Fizz,Buzz,Fizz,5,FizzBuzz]

Grading rubric

[Total: 10 points]: Done (or provide evidence of your attempt, full or reasonable effort)

- (5 points) — Providing evidence of your attempt, minimal effort

(-2.5 points) for 24 hours late (submitted after 16-Oct-2025 11am EST, by 17-Oct-2025 11am EST)
(-5 points) for 48 hours late (submitted after 17-Oct-2025 11am EST, by 18-Oct-2025 11am EST)

Submission

- Save your report as a .pdf file
- Upload your report (.pdf) to ***POTD 5 on Gradescope***.
- Connect your partner to your group on Gradescope so that everyone receives credit
- Each team submits only ***one*** copy

Making your submission available to instructor and course staff is ***your*** responsibility; if we cannot access or open your file, you will not get credit. Be sure to test access to your file before the due date.

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