NATIONAL INSTITUTE OF TECHNOLOGY, DURGAPUR

SOFTWARE ENGINEERING LABORATORY

ASSIGNMENT 1

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Question

Write a program to store and display the CFG for given program segment.
i) Find maximal set of independent paths of the above generated CFG.
ii) Find the region and cyclomatic complexity of the CFG.
Write a program to detect loops from the generated CFG

Code

```
from pycfg.pycfg import PyCFG,CFGNode, slurp
import argparse
import tkinter as tk
from PIL import ImageTk, Image

def detectLoopInGraph(adj:dict, hasVisited:dict, currentVisited:dict, x:str):
    flag=False
    for node in adj[x]:
        if hasVisited[node]==0:
            hasVisited[node]=1
            currentVisited[node]=1
            flag=detectLoopInGraph(adj,hasVisited,currentVisited,node)
            if flag:
                return True
            currentVisited[node]=0
        elif currentVisited[node]==1:
            return True
    return False

def DFS(adj:dict, n:str, hasVisited:dict, pathList:list):
    flag=False
    for edge in adj[n]:
        if hasVisited[edge] == 0:
            flag=True
            hasVisited[edge]=1
            pathList.append(n)
            DFS(adj,edge[1],hasVisited,pathList)
            pathList.pop()
            hasVisited[edge]=0
    if not flag:
        pathList.append(n)
        st.append(pathList.copy())
        pathList.pop()

if __name__ == '__main__':
    parser = argparse.ArgumentParser()
```

```
parser.add_argument('pythonfile', help ='The python file to be analyzed')
args = parser.parse_args()
arcs = []

cfg = PyCFG()
cfg.gen_cfg(slurp(args.pythonfile).strip())
g = CFGNode.to_graph(arcs)
g.draw(args.pythonfile + '.png', prog ='dot')
print("Nodes are as follows:")
print(g.nodes())
adje = dict()
hasVisited = dict()
for x in g.nodes():
    adje[str(x)] = g.out_edges(x)
    for y in adje[str(x)]:
        hasVisited[y]=0
pathList = list()
st = list()
DFS(adje,'0',hasVisited,pathList)
numberOfIndPaths=len(st)
if(numberOfIndPaths>=1):
    print("Number of independent paths:",numberOfIndPaths)
    print("The independent paths are as follows: ")
    for s in st:
        k=1
        for i in s:
            if(k<len(s)):
                print(f'{i}->',end="")
            else:
                print(i)
            k=k+1
adj=dict()
currentVisited = dict()
for x in g.nodes():
    adj[str(x)]=g.out_neighbors(x)
    for y in adj[str(x)]:
        hasVisited[y]=0
        currentVisited[y]=0
if detectLoopInGraph(adj,hasVisited,currentVisited,'0'):
    print("Loop was detected in CFG")
else:
    print("No loop was detected in CFG")
nodes = g.number_of_nodes()  # no. of nodes.
edges = g.number_of_edges()  # no. of Edges.
complexity = edges - nodes + 2       # Cyclomatic complexity
```

```
    print("Nodes\t\t\t",str(nodes))
    print("Edges\t\t\t",str(edges))
    print("Cyclomatic Complexity\t",str(complexity))
    print("Bounded regions\t\t",str(complexity-1))

    # Draw using tkinter.
    root = tk.Tk()
    root.title("Control Flow Graph")
    img1 = Image.open(str(args.pythonfile) + ".png") # PIL solution
    img1 = img1.resize((800, 600), Image.ANTIALIAS)
    img = ImageTk.PhotoImage(img1)

    background ="gray"

    panel = tk.Label(root, height = 600, image = img)
    panel.pack(side = "top", fill ="both", expand = "yes")

    frame = tk.Frame(root, bg = background)
    frame.pack(side ="bottom", fill ="both", expand = "yes")

    tk.Label(frame, text ="Nodes\t\t"+str(nodes), bg = background).pack()
    tk.Label(frame, text ="Edges\t\t"+str(edges), bg = background).pack()
    tk.Label(frame, text ="Cyclo Complexity\t"+str(complexity), bg =
background).pack()
    tk.Label(frame, text ="Bounded regions\t"+str(complexity-1), bg =
background).pack()

    root.mainloop()
```

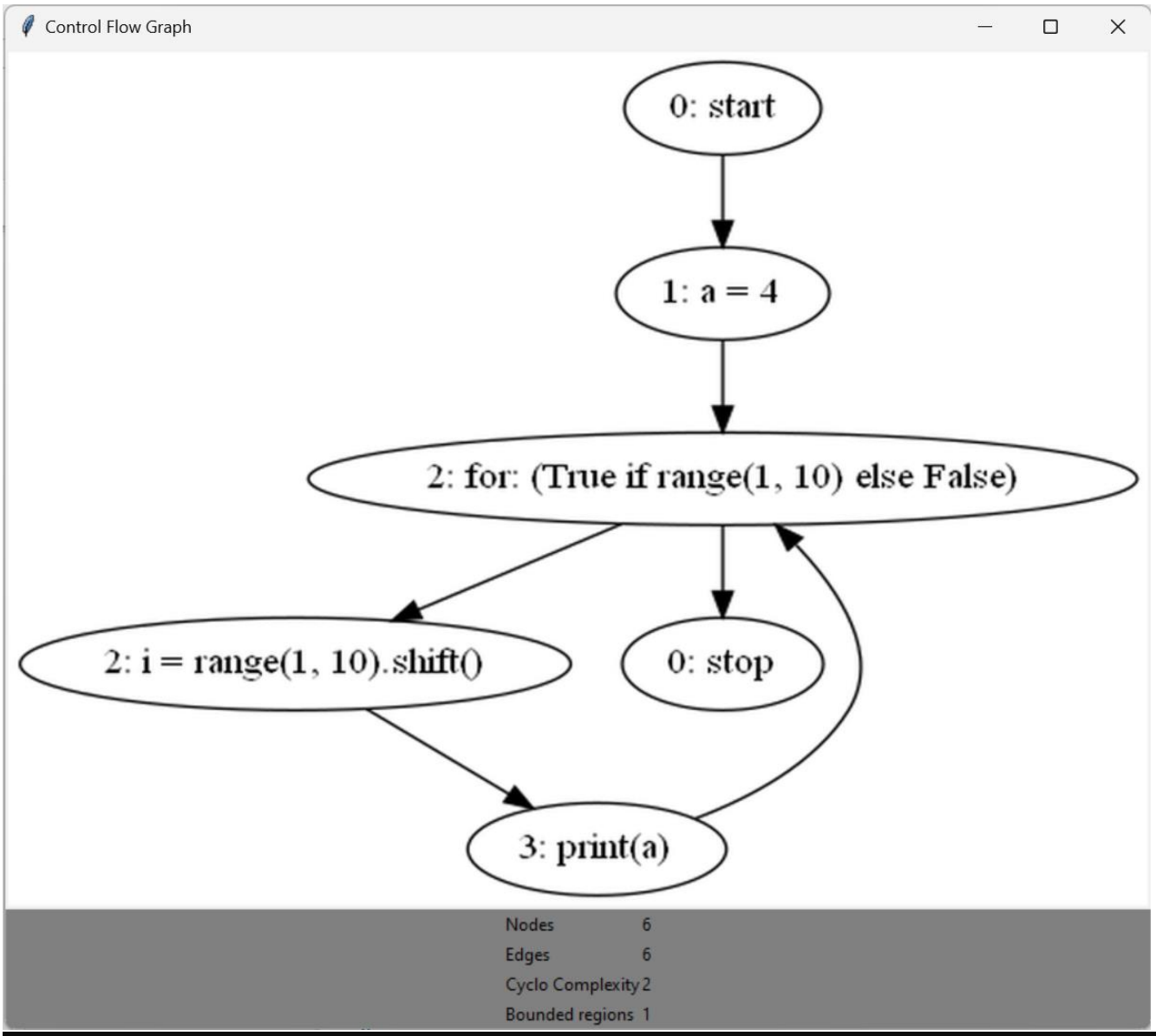
Output:

For loop

Code:

```
a=4
for i in range(1,10):
    print(a)
```

Output:



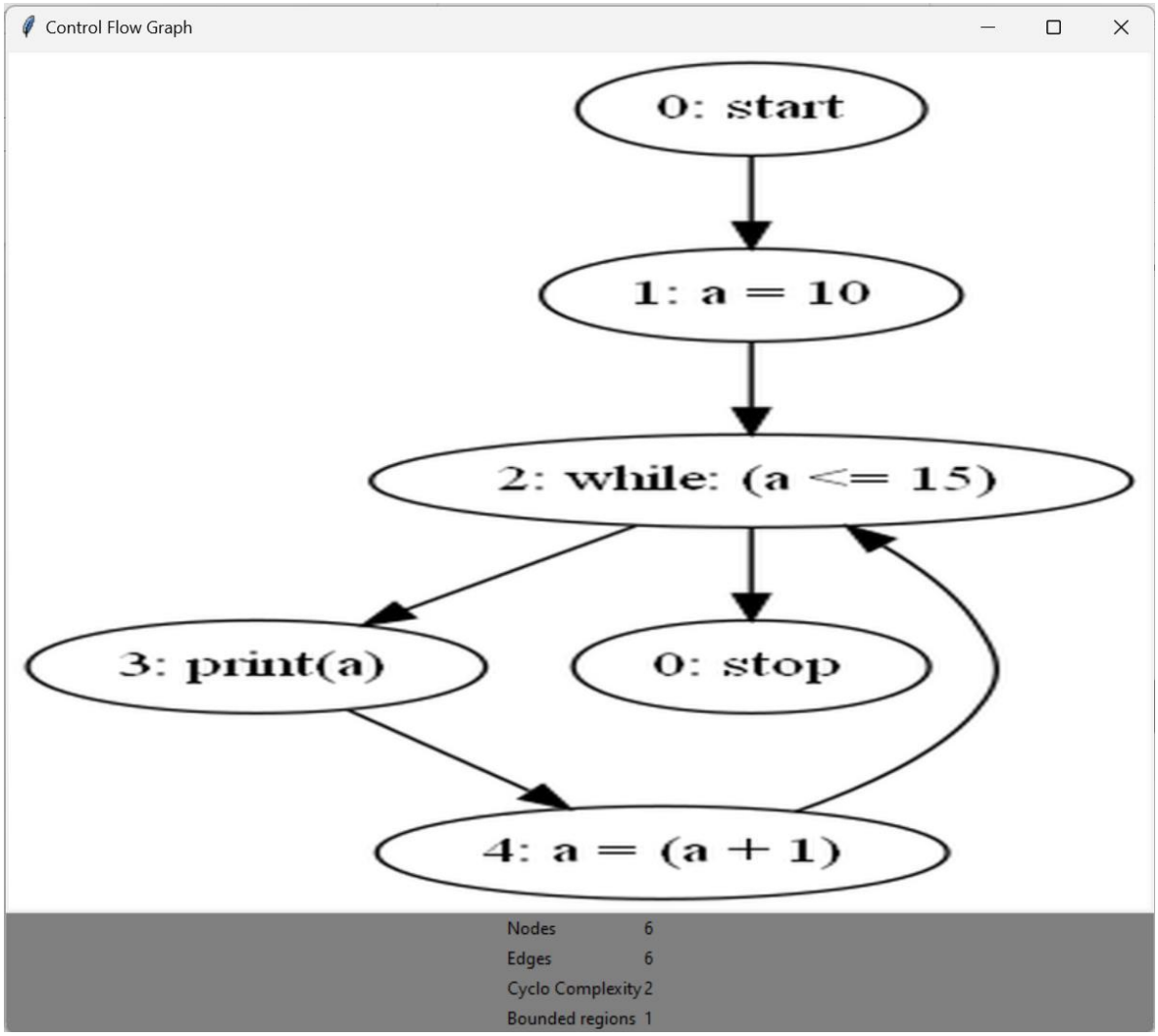

```
PS D:\Software Engineering Laboratory\Assignment 1> python .\CFG.py .\test.py
Nodes are as follows:
['0', '1', '2', '4', '3', '5']
Number of independent paths: 2
The independent paths are as follows:
0->1->2->3->4->2->5
0->1->2->5
Loop was detected in CFG
Nodes                   6
Edges                   6
Cyclomatic Complexity   2
Bounded regions         1
```

While Loop:

Code:

```
a=10
while(a<=15):
    print(a)
    a=a+1
```

Output:



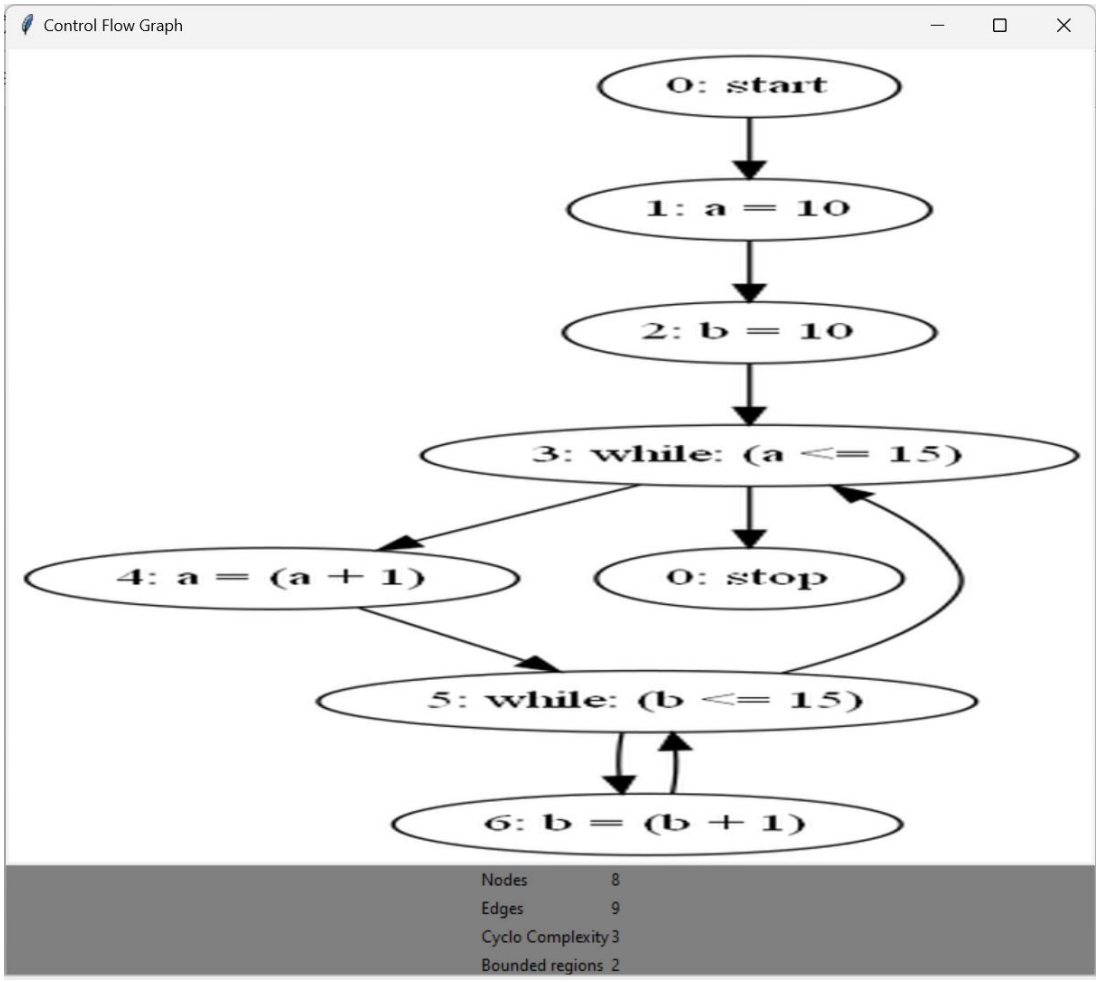

```
PS D:\Software Engineering Laboratory\Assignment 1> python .\CFG.py .\while.py
Nodes are as follows:
['0', '1', '2', '4', '3', '5']
Number of independent paths: 2
The independent paths are as follows:
0->1->2->3->4->2->5
0->1->2->5
Loop was detected in CFG
Nodes                   6
Edges                   6
Cyclomatic Complexity   2
Bounded regions         1
```

Nested While Loop:

Code:

```
a=10
b=10
while(a<=15):
    a=a+1
    while(b<=15):
        b=b+1
```

Output:



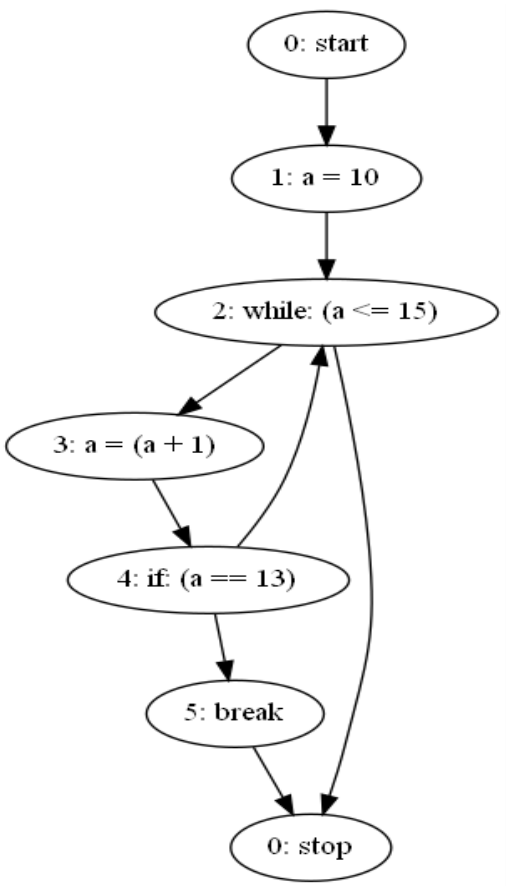

```
PS D:\Software Engineering Laboratory\Assignment 1> python .\CFG.py .\nestedWhile.py
Nodes are as follows:
['0', '1', '2', '3', '5', '4', '6', '7']
Number of independent paths: 3
The independent paths are as follows:
0->1->2->3->4->5->3->7
0->1->2->3->4->5->6->5->3->7
0->1->2->3->7
Loop was detected in CFG
Nodes                   8
Edges                   9
Cyclomatic Complexity   3
Bounded regions         2
```

Break statement:

Code:

```
a=10
while(a<=15):
    a=a+1
    if(a==13):
        break
```

Output:



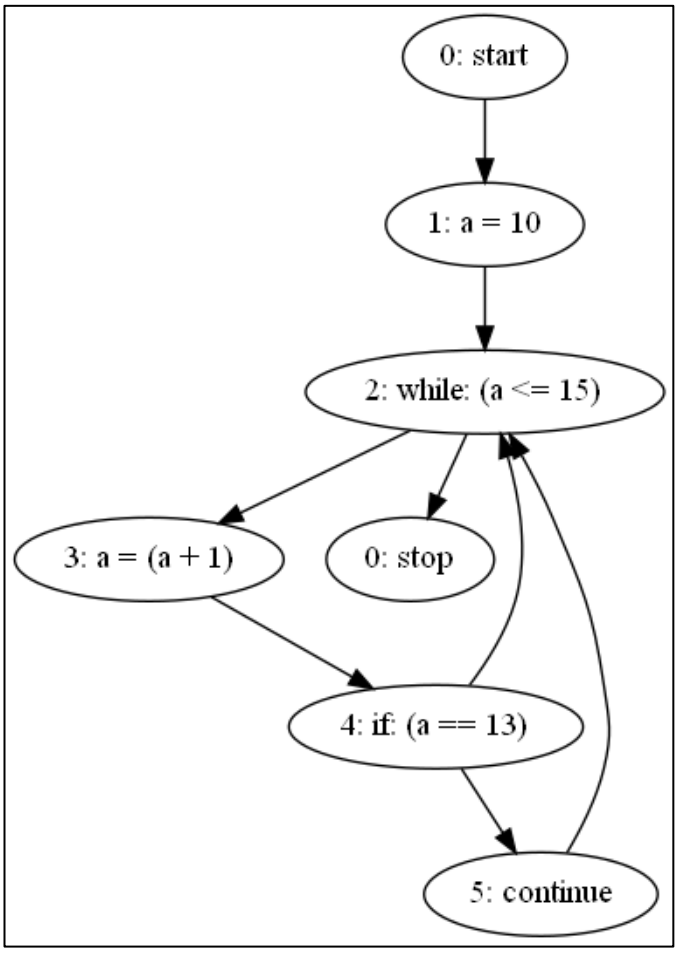

```
PS D:\Software Engineering Laboratory\Assignment 1> python .\CFG.py .\break.py
Nodes are as follows:
['0', '1', '2', '4', '3', '5', '6']
Number of independent paths: 3
The independent paths are as follows:
0->1->2->3->4->2->6
0->1->2->3->4->5->6
0->1->2->6
Loop was detected in CFG
Nodes                   7
Edges                   8
Cyclomatic Complexity   3
Bounded regions         2
```

Continue statement

Code:

```
a=10
while(a<=15):
    a=a+1
    if(a==13):
        continue
```

Output:



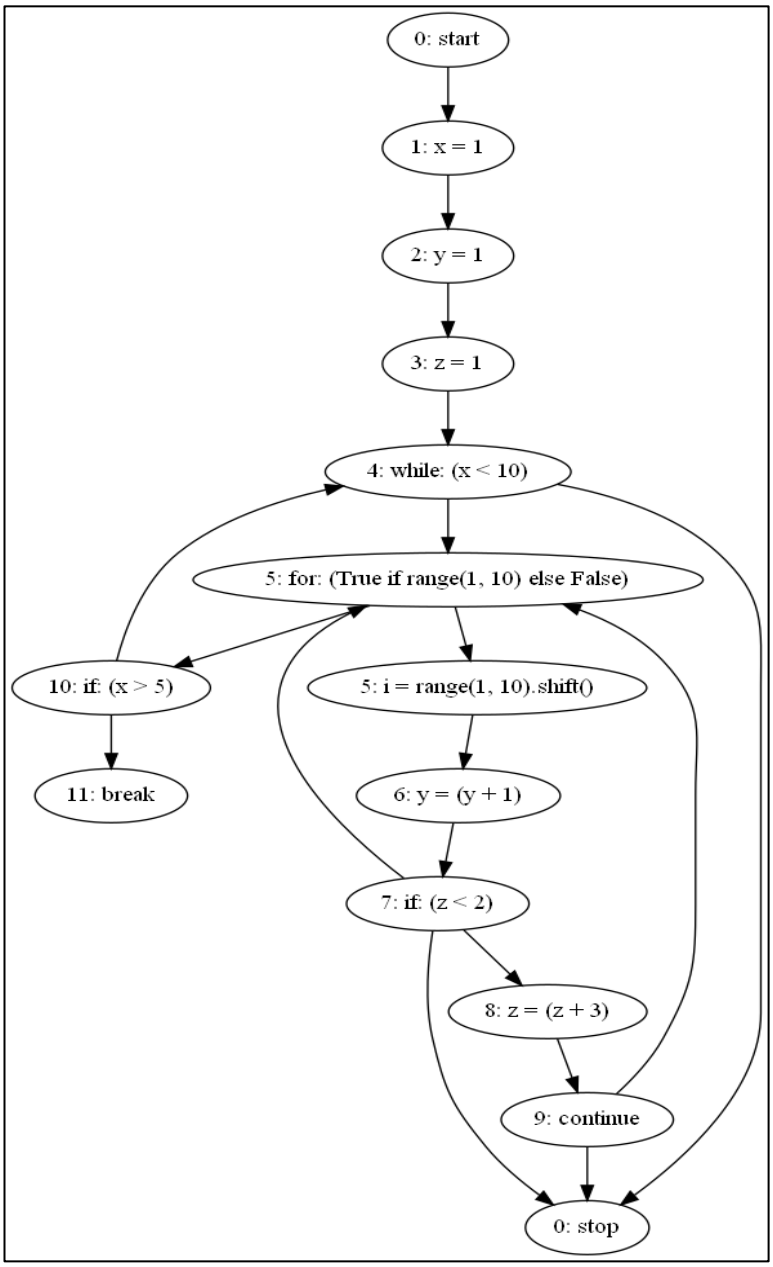

```
PS D:\Software Engineering Laboratory\Assignment 1> python .\CFG.py .\continue.py
Nodes are as follows:
['0', '1', '2', '5', '4', '3', '6']
Number of independent paths: 3
The independent paths are as follows:
0->1->2->3->4->2->6
0->1->2->3->4->5->2->6
0->1->2->6
Loop was detected in CFG
Nodes                   7
Edges                   8
Cyclomatic Complexity   3
Bounded regions         2
```

All of the above:

Code:

```
x=1
y=1
z=1
while x<10:
    for i in range(1,10):
        y=y+1
        if z<2:
            z=z+3
            continue
    if x>5:
        break
```

Output:



```
PS D:\Software Engineering Laboratory\Assignment 1> python .\CFG.py .\all.py
Nodes are as follows:
['0', '1', '2', '3', '4', '11', '5', '10', '8', '6', '7', '9', '12', '13']
Number of independent paths: 9
The independent paths are as follows:
0->1->2->3->4->5->11->4->13
0->1->2->3->4->5->11->12
0->1->2->3->4->5->6->7->8->5->11->4->13
0->1->2->3->4->5->6->7->8->5->11->12
0->1->2->3->4->5->6->7->8->9->10->5->11->4->13
0->1->2->3->4->5->6->7->8->9->10->5->11->12
0->1->2->3->4->5->6->7->8->9->10->13
0->1->2->3->4->5->6->7->8->13
0->1->2->3->4->13
Loop was detected in CFG
Nodes                   14
Edges                   18
Cyclomatic Complexity   6
Bounded regions         5
```