VLSI testing - Assignment 1

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Overwiew

This homework assignment is to find all the possible paths between a designated start node and a designated end node. Since there is no loops or D-type flip-flops in this probelm, the whole circuit can be treated as a directed graph.

Algorithm

DFS search

An straightforward approach would be simply using DFS search.
The algorithm is described as follows.

```
func dfs (g, path):
    if g is not end_gate
        for every h in g's fanout
            dfs(h, path + g)
    if g is end_gate
        print (path + g)

dfs(start_gate, "")
```

However, the whole process can be very long. Thus, some modification is inevitable, which will be discussed later.

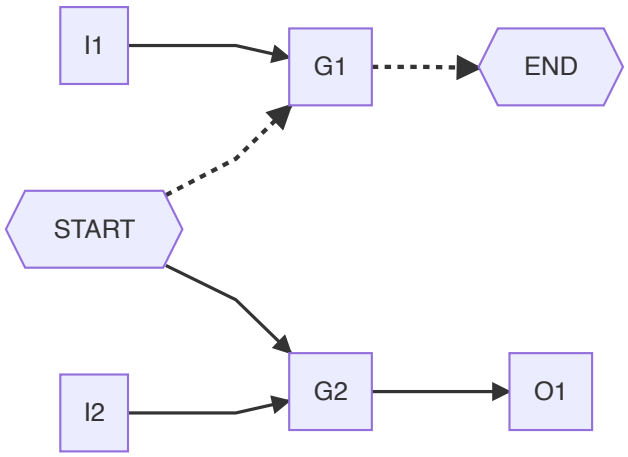
BFS search

I also tried BFS search. However, the same situation goes to BFS search. The program doesn't terminate with simple BFS search.

Remove gates that don't contribute to the path

Consider the case below. The only path from START to END is the dotted arrow. However, when doing search, the path START --> G2 --> O1 is also considered. It will not know it's an unvalid path until they reach O1, a gate without fanout but not the designated end node. Similar thing goes to BFS search, G2 and O1 will maintain extra useless information and leads to a long execution time.

When the circuit size become bigger, the differcnes will affect the execution time and memory usage significantly.



So I do a modification here. Before doing any kinds of search, starts from the designated output, marks its fanins as active, and do the same thing treated the fanins as the designated output.

```
func mark_active_gates():
  initialize a queue Q
  push the designated output into Q
  while Q is not empty
  do
    g = pop an element from Q
    mark g as active
    push g's every fanins into Q
```

After the whole process, we can be certain that every non-active gates will not contribute to the paths to the designated output. When doing search, we can ignore every non-active gates to speed up the process !

After adding the process, the original DFS search becomes:

```
func dfs' (g, path):
    if g is not end_gate
        for every h in g's fanout
          if h is active // only process active gates !!
          do
            dfs'(h, path + g)
    if g is end_gate
        print (path + g)

func main():
  mark_active_gates()  // mark active gates first
  dfs'(start_gate, "")  // then do the search
```

Test Cases Result

For a use case, the upper result uses **BFS search**; the bottom uses **DFS search**. I use DFS seach in the assignment, BFS search is for comparison.

Test Case 1

```
./atpg -path -start G3 -end PO_G16 c17.bench
```

```
Start parsing input file
Finish reading circuit file
G3 net17 G16 PO_G16
G3 net14 net18 G16 PO_G16
The paths from G3 to PO_G16: 2
total CPU time = 0.000239
```

```
Start parsing input file
Finish reading circuit file
G3 net14 net18 G16  PO_G16
G3 net17 G16  PO_G16
The paths from G3 to PO_G16: 2
total CPU time = 0.000293
```

Test Case 2

```
./atpg -path -start 126GAT_30 -end PO_863GAT_424 c880.bench
```

```
( ... ignores above ...)
The paths from 126GAT_30 to PO_863GAT_424: 4
total CPU time = 0.002918
```

```
( ... ignores above ...)
The paths from 126GAT_30 to PO_863GAT_424: 4
total CPU time = 0.001906
```

Test Case 3

```
./atpg -path -start 126GAT_30 -end PO_863GAT_424 c880.bench
```

```
( ... ignores above ...)
The paths from 307GAT_18 to PO_2548GAT_840: 468
total CPU time = 0.023831
```

```
( ... ignores above ...)
The paths from 307GAT_18 to PO_2548GAT_840: 468
total CPU time = 0.018417
```

Build

```
make
./atpg -path -start <PI> -end <PO> <circuit_name>
```