Amirkabir University of Technology
(Tehran Polytechnic)

Operating Systems

Processes-Part3

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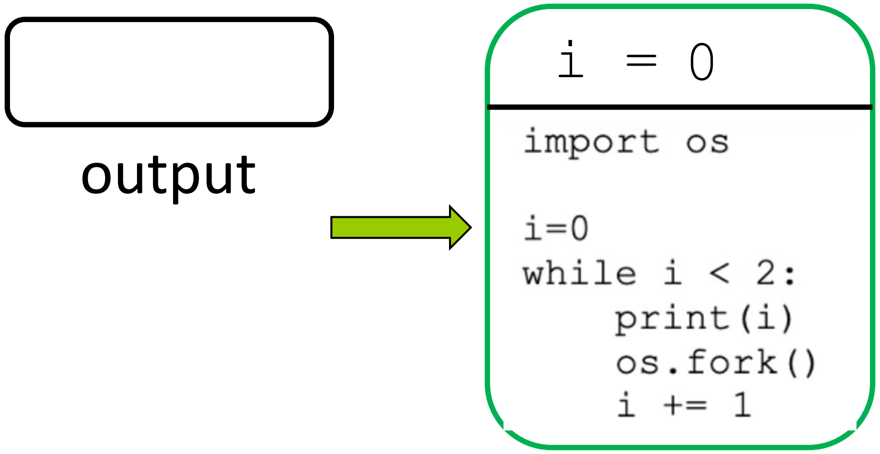
Fork Example



```
import os

i=0
while i < 2:
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    os.fork()
    i += 1
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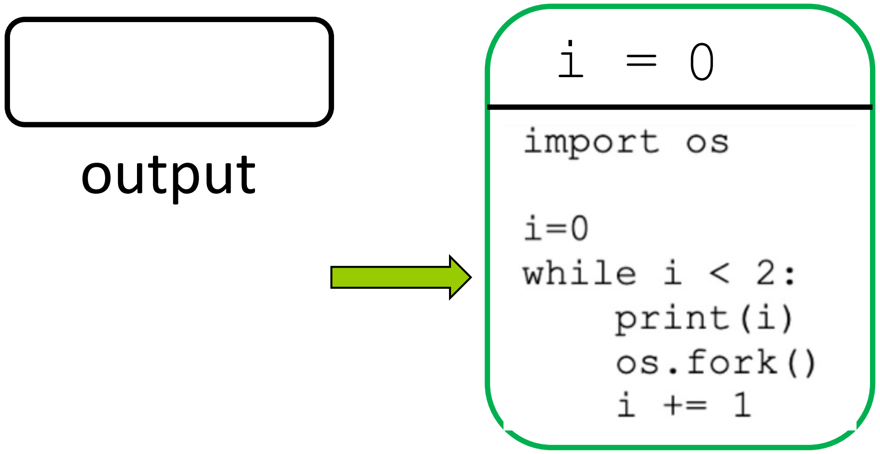

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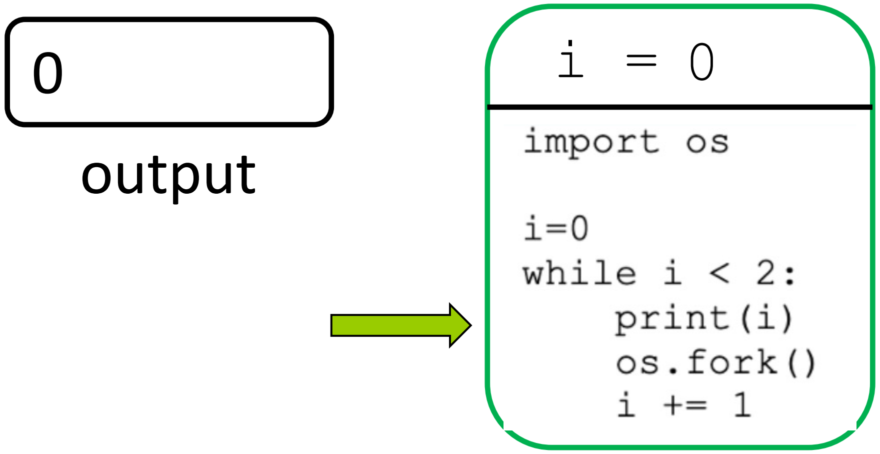

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    i += 1
```
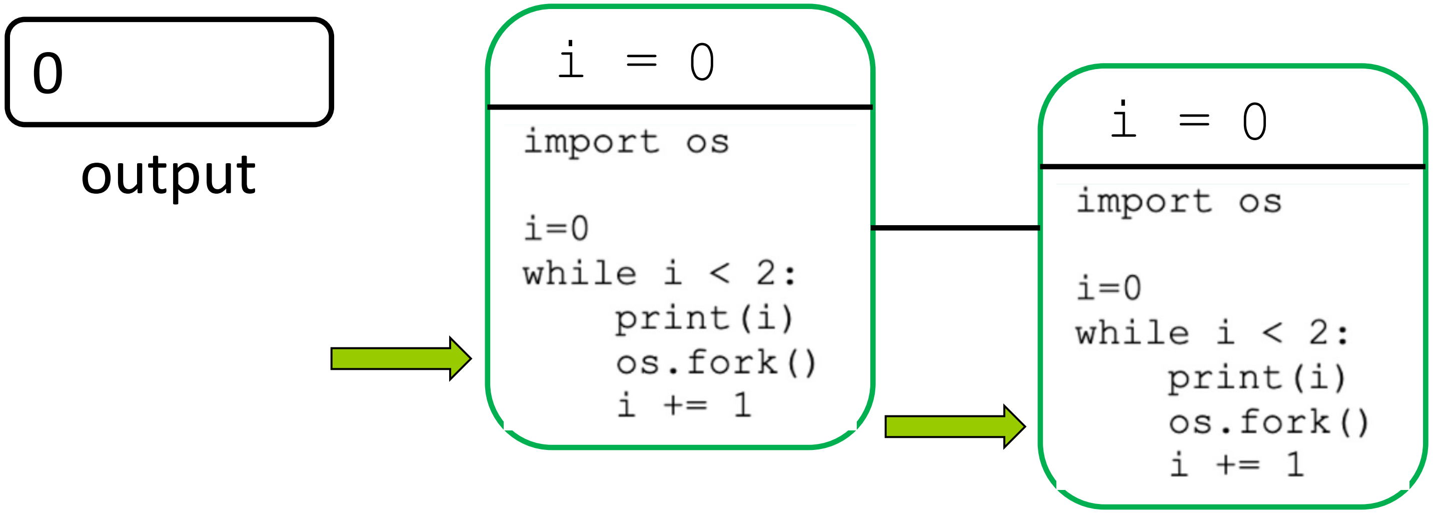

Fork Example



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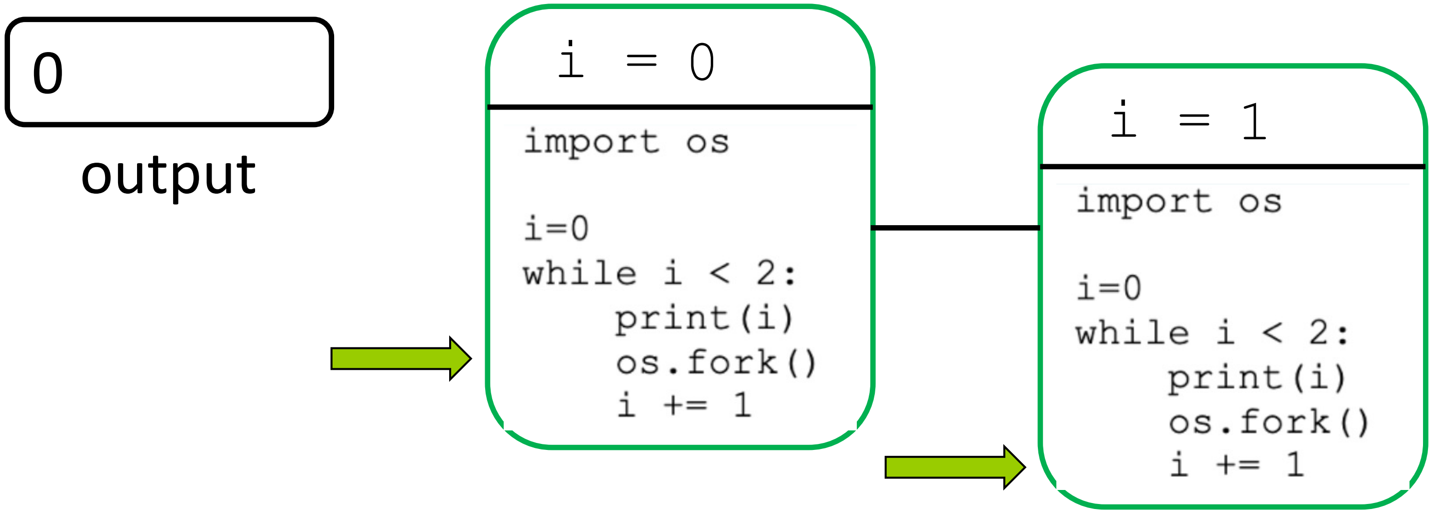
Fork Example



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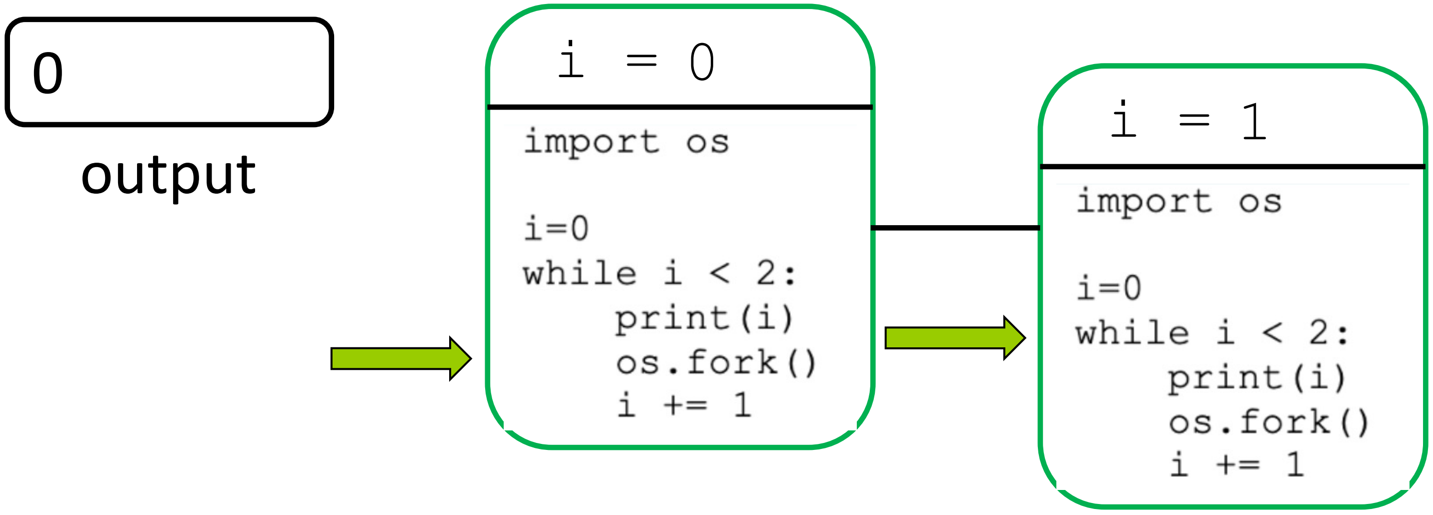

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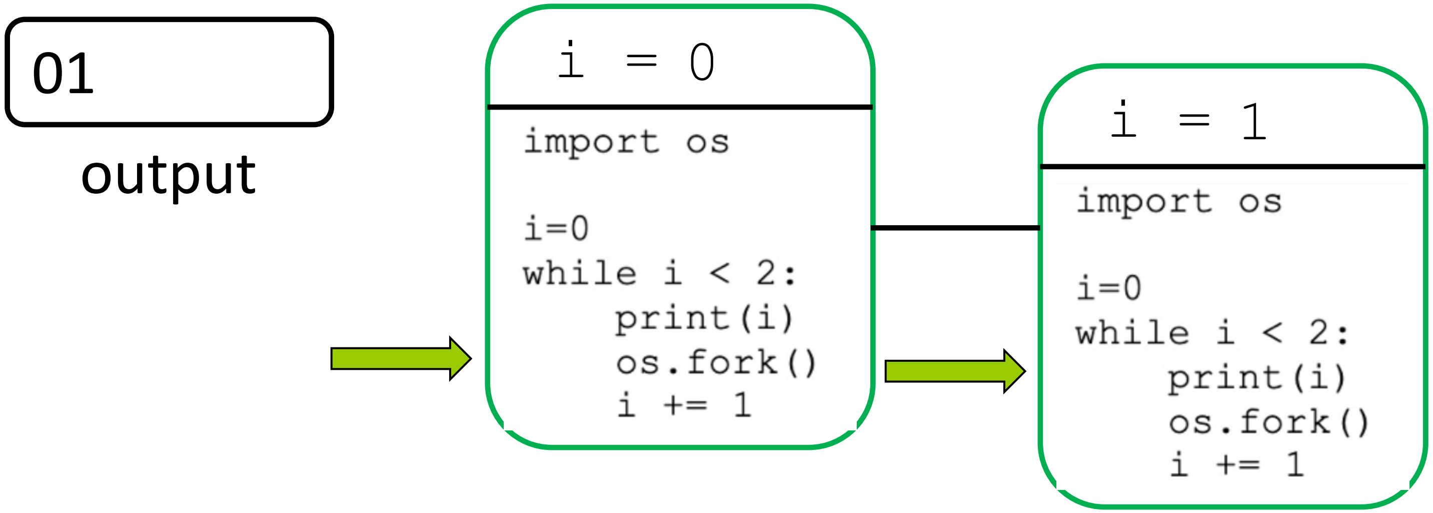


```
01
```

output

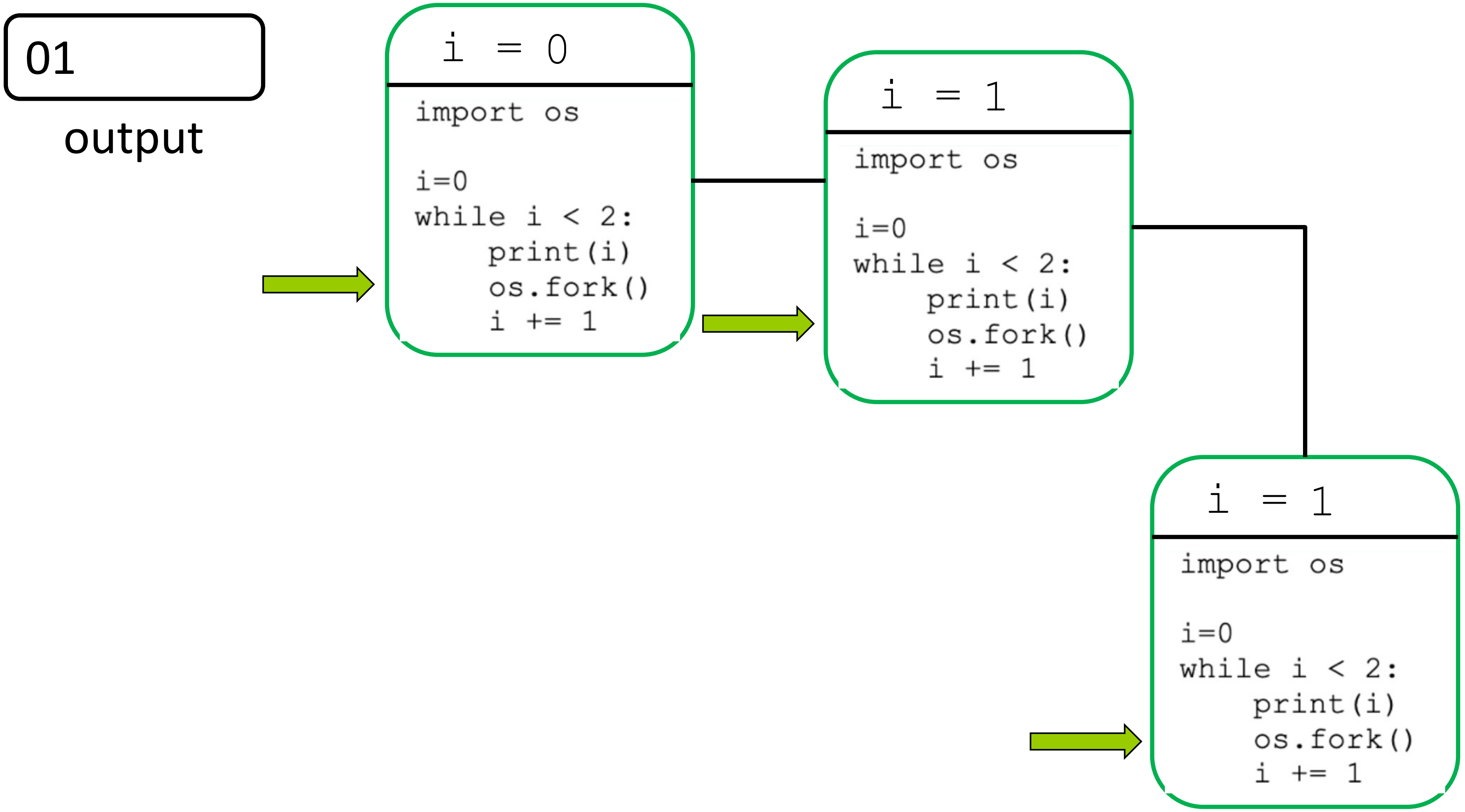
i = 0

```python
import os

i=0
while i < 2:
     print(i)
     os.fork()
     i += 1
```

i = 1

```python
import os

i=0
while i < 2:
     print(i)
     os.fork()
     i += 1
```

Fork Example



```
import os

i=0
while i < 2:
    print(i)
    os.fork()
    i += 1
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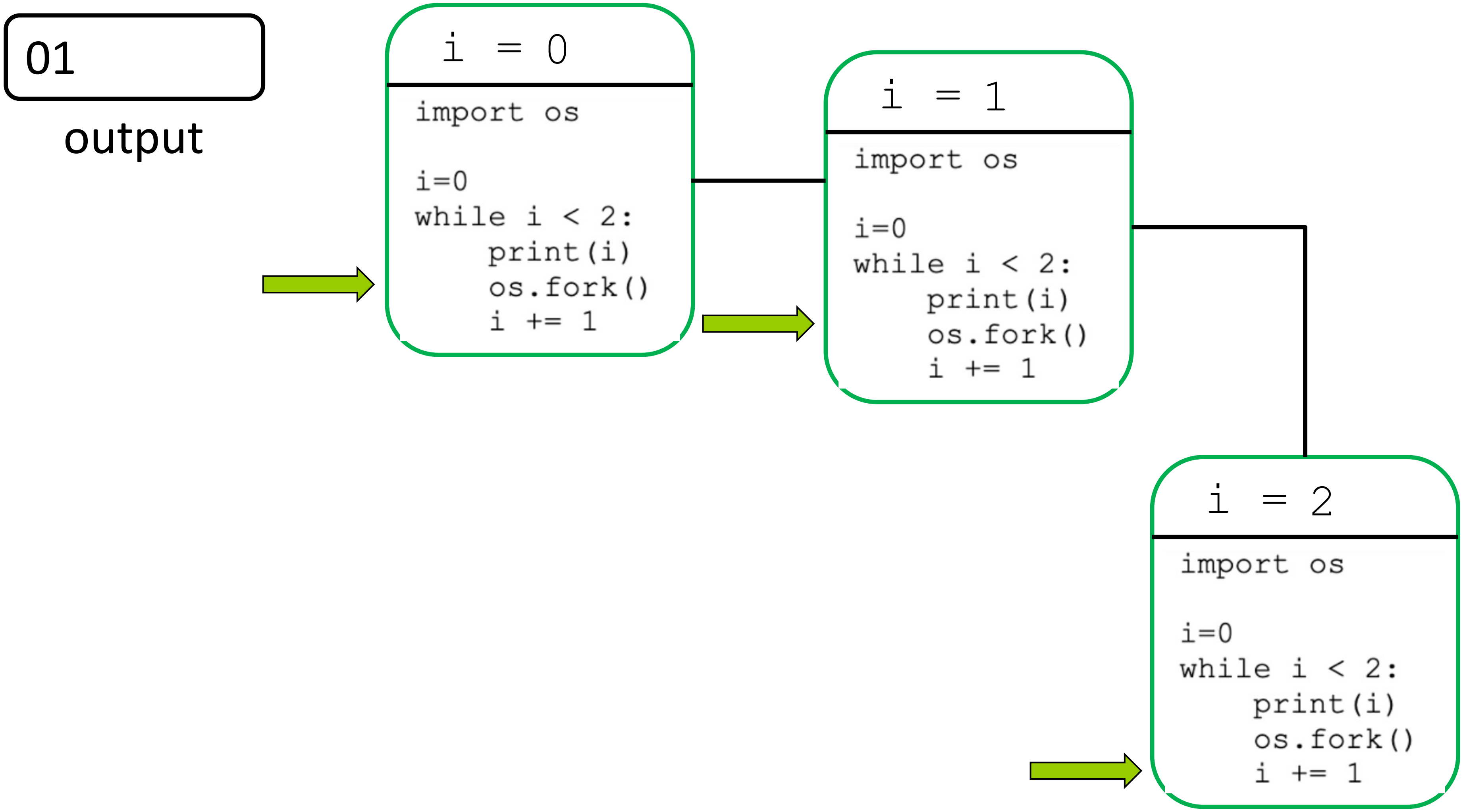

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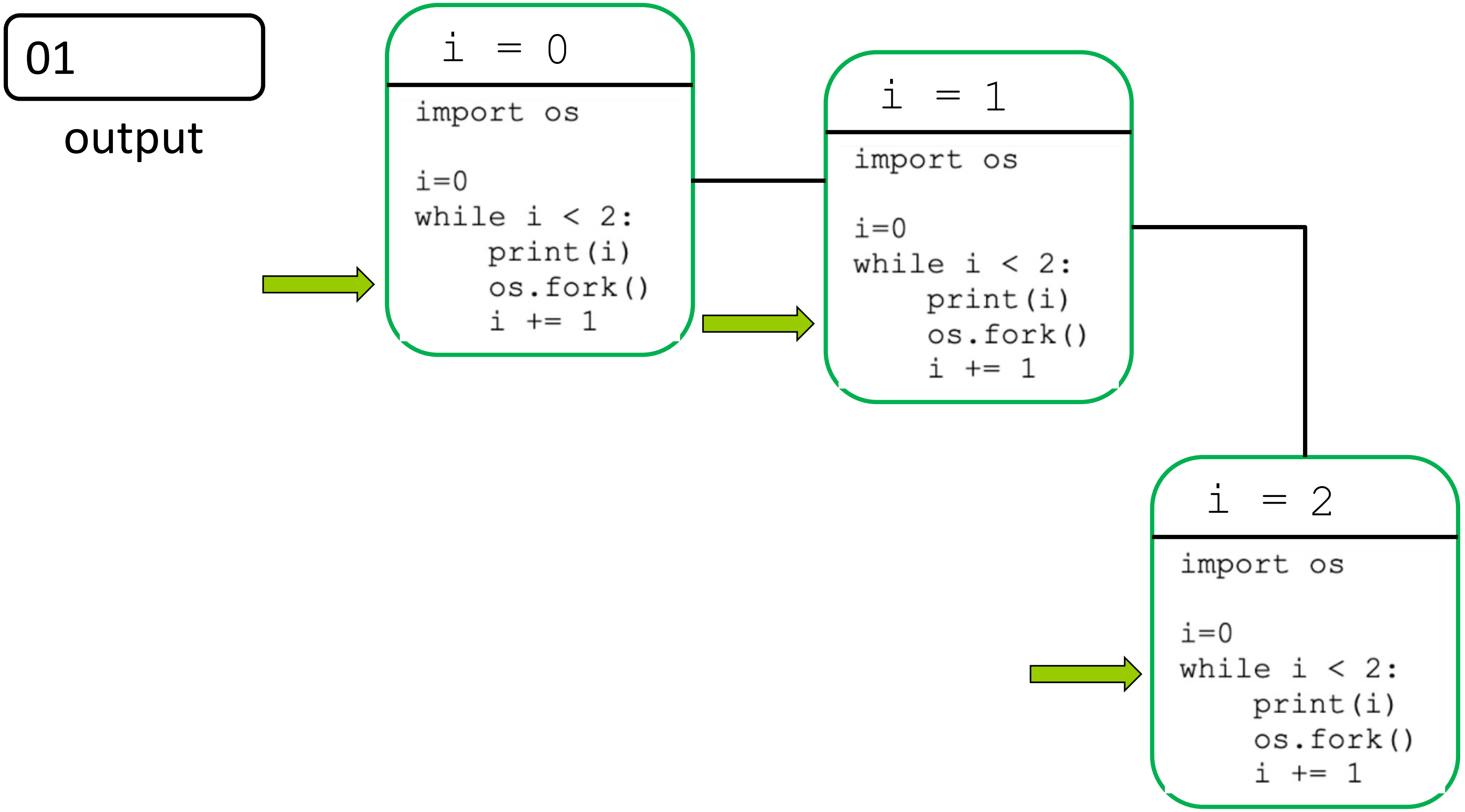


```
01
```

output

i = 0

```
import os

i=0
while i < 2:
    print(i)
    os.fork()
    i += 1
```

i = 1

```
import os

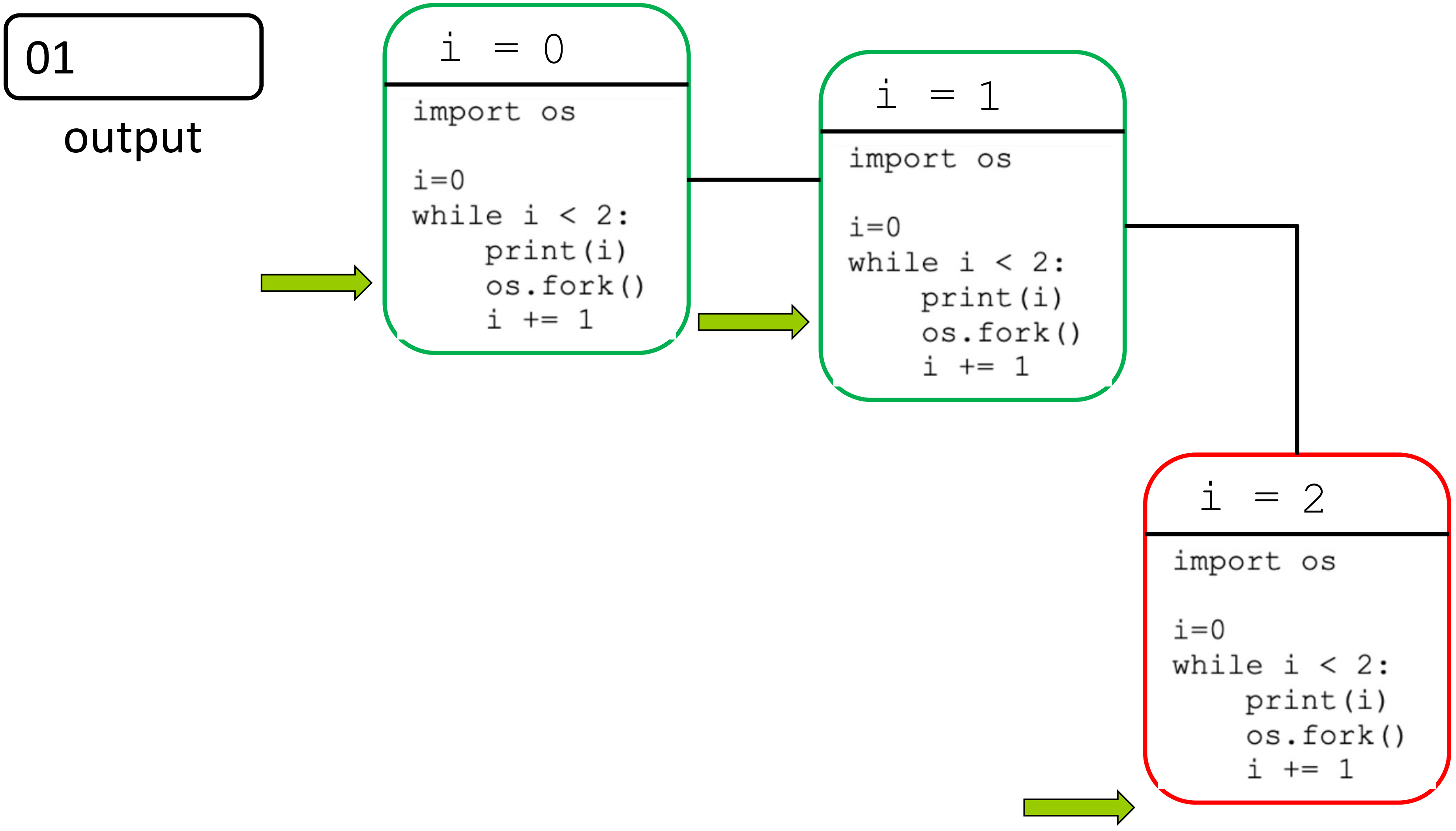
i=0
while i < 2:
    print(i)
    os.fork()
    i += 1
```

i = 2

```
import os

i=0
while i < 2:
    print(i)
    os.fork()
    i += 1
```

Fork Example



```
import os

i=0
while i < 2:
     print(i)
     os.fork()
     i += 1
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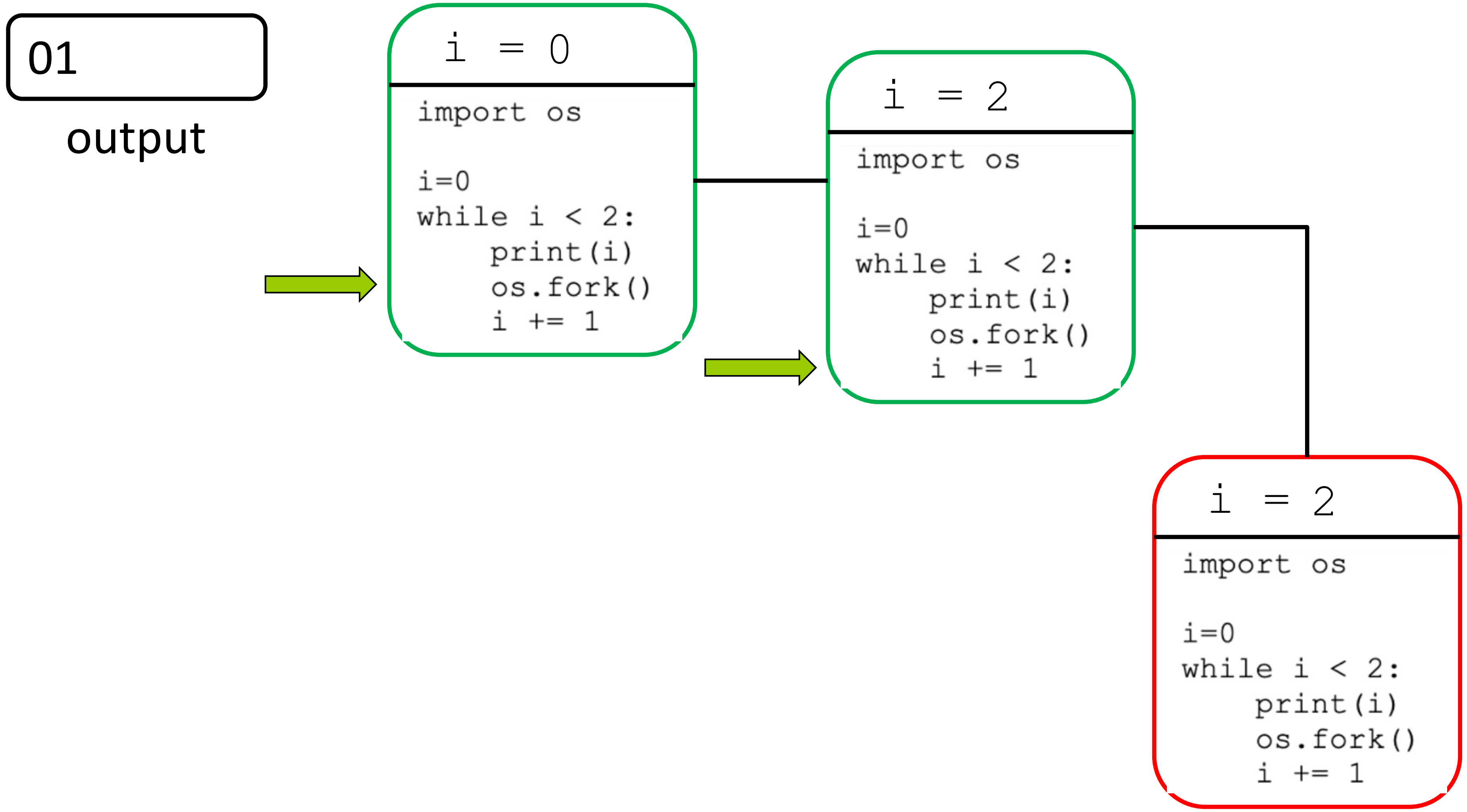
Fork Example



```
01
```

```
i = 0
import os

i=0
while i < 2:
     print(i)
     os.fork()
     i += 1
```

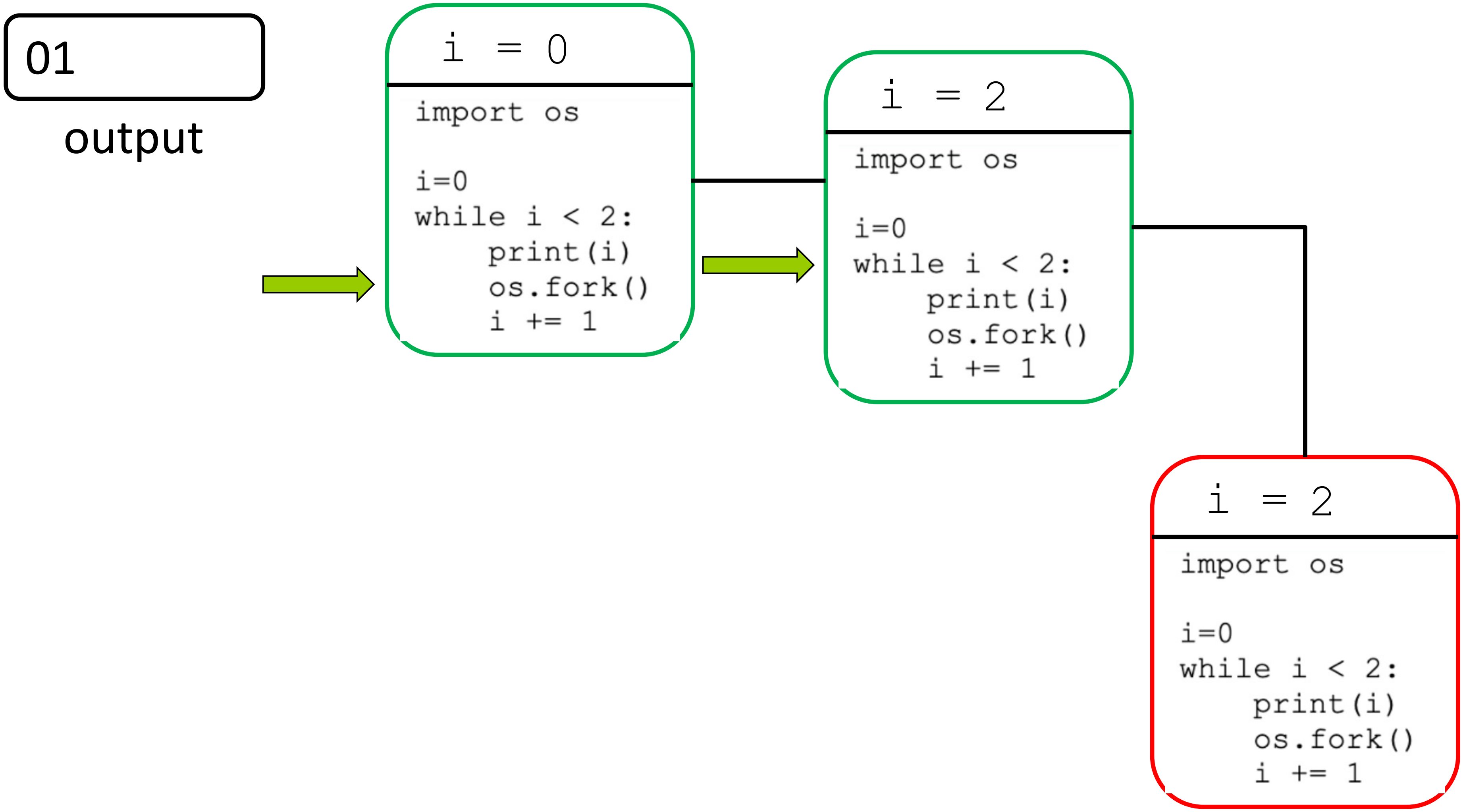
```
i = 2
import os

i=0
while i < 2:
     print(i)
     os.fork()
     i += 1
```

```
i = 2
import os

i=0
while i < 2:
     print(i)
     os.fork()
     i += 1
```

Fork Example



```
import os

i=0
while i < 2:
     print(i)
     os.fork()
     i += 1
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```
import os

i=0
while i < 2:
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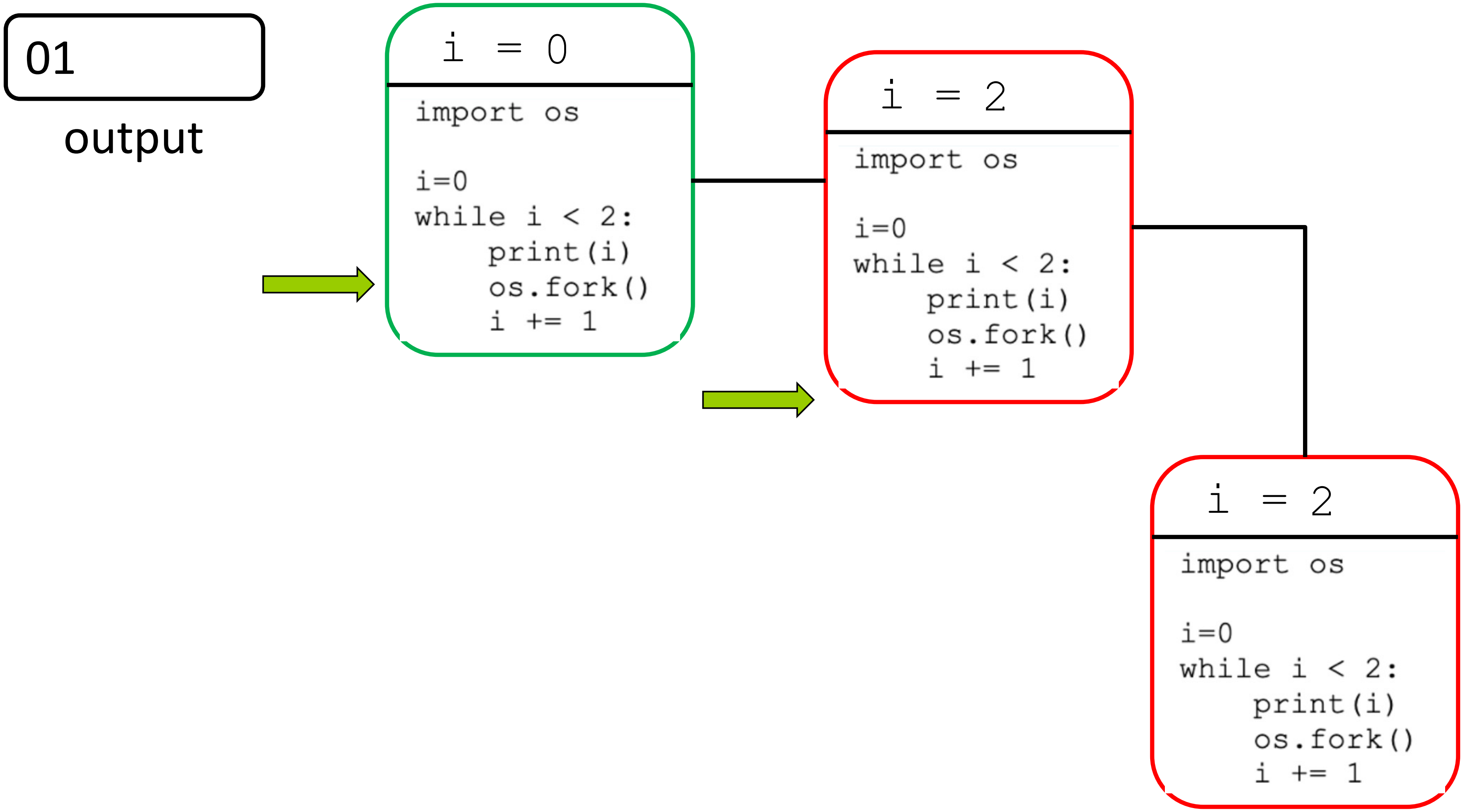

```
import os

i=0
while i < 2:
      print(i)
      os.fork()
      i += 1
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i=0
while i < 2:
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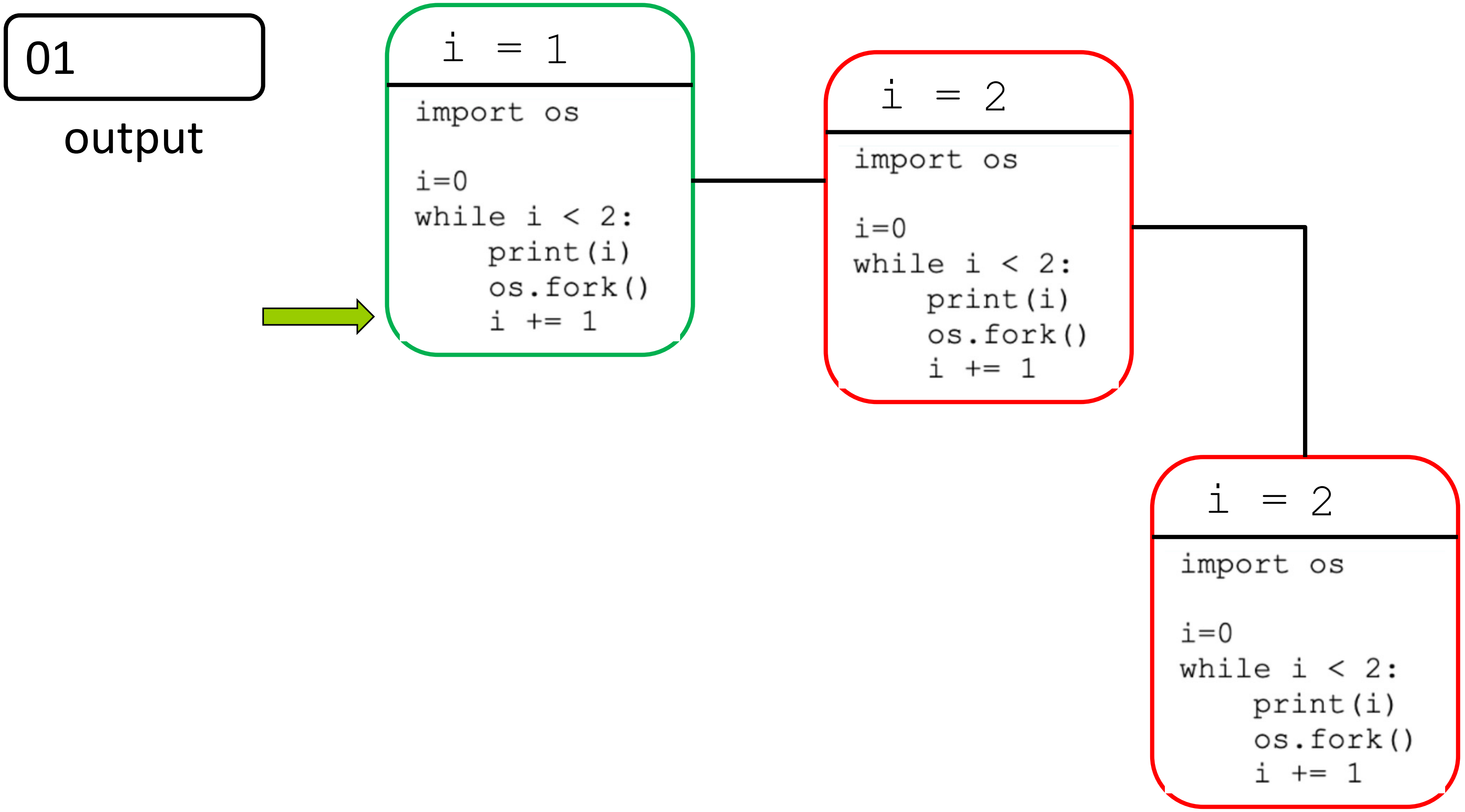
Fork Example



```
01
```

output

```
i = 1
import os

i=0
while i < 2:
    print(i)
    os.fork()
    i += 1
```

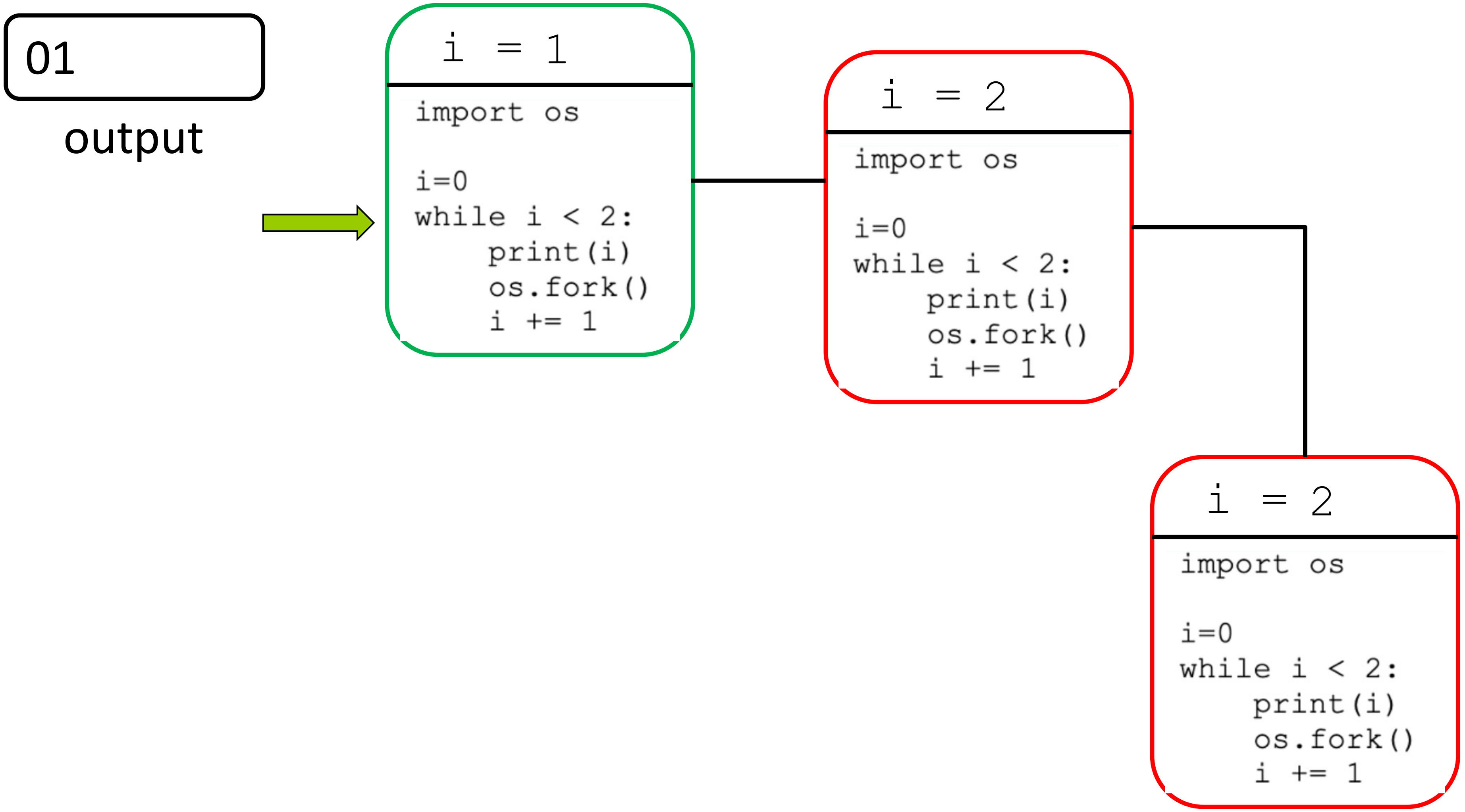
```
i = 2
import os

i=0
while i < 2:
    print(i)
    os.fork()
    i += 1
```

```
i = 2
import os

i=0
while i < 2:
    print(i)
    os.fork()
    i += 1
```

Fork Example



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i=0
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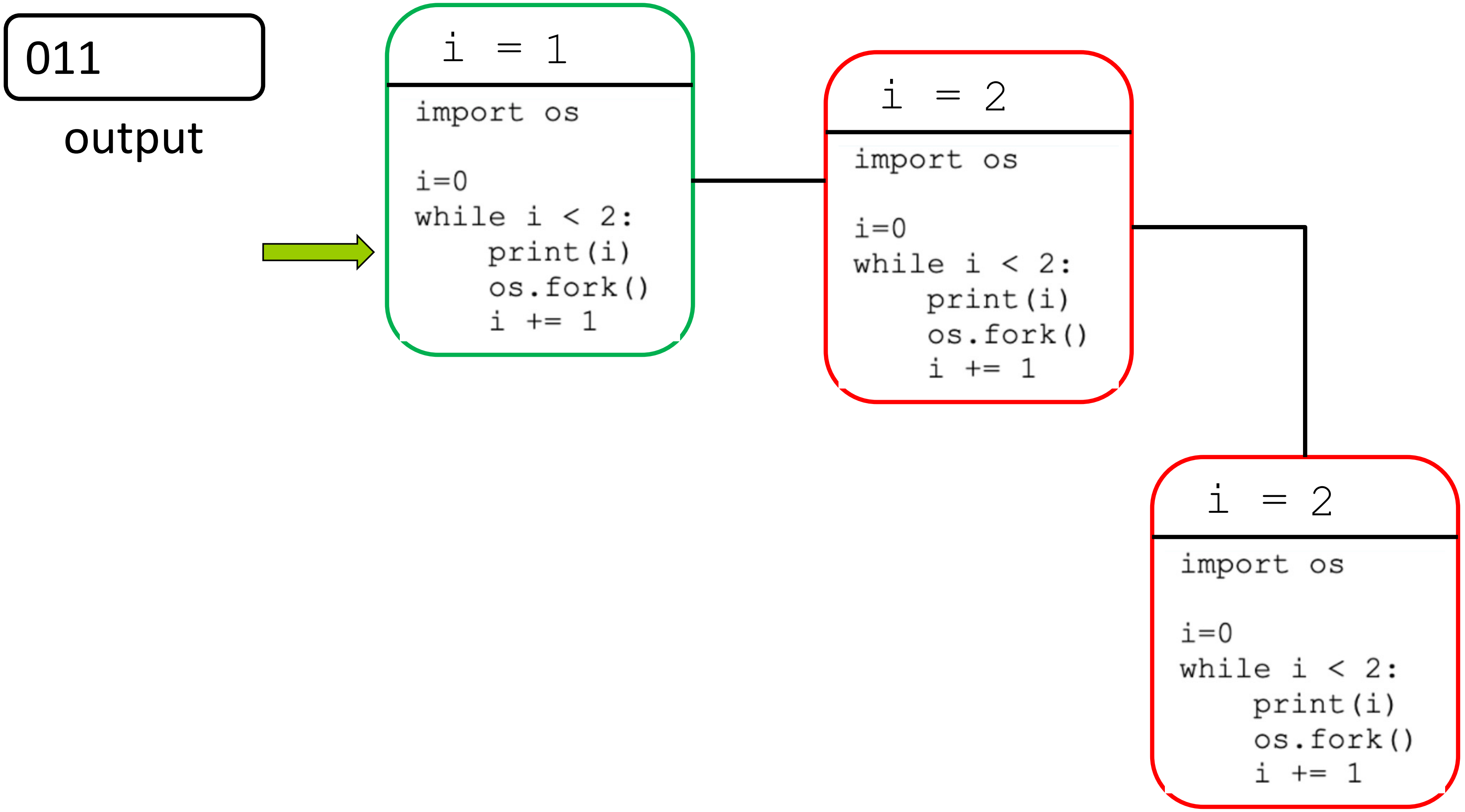
Fork Example



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import os

i=0
while i < 2:
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     os.fork()
     i += 1
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```
import os

i=0
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import os

i=0
while i < 2:
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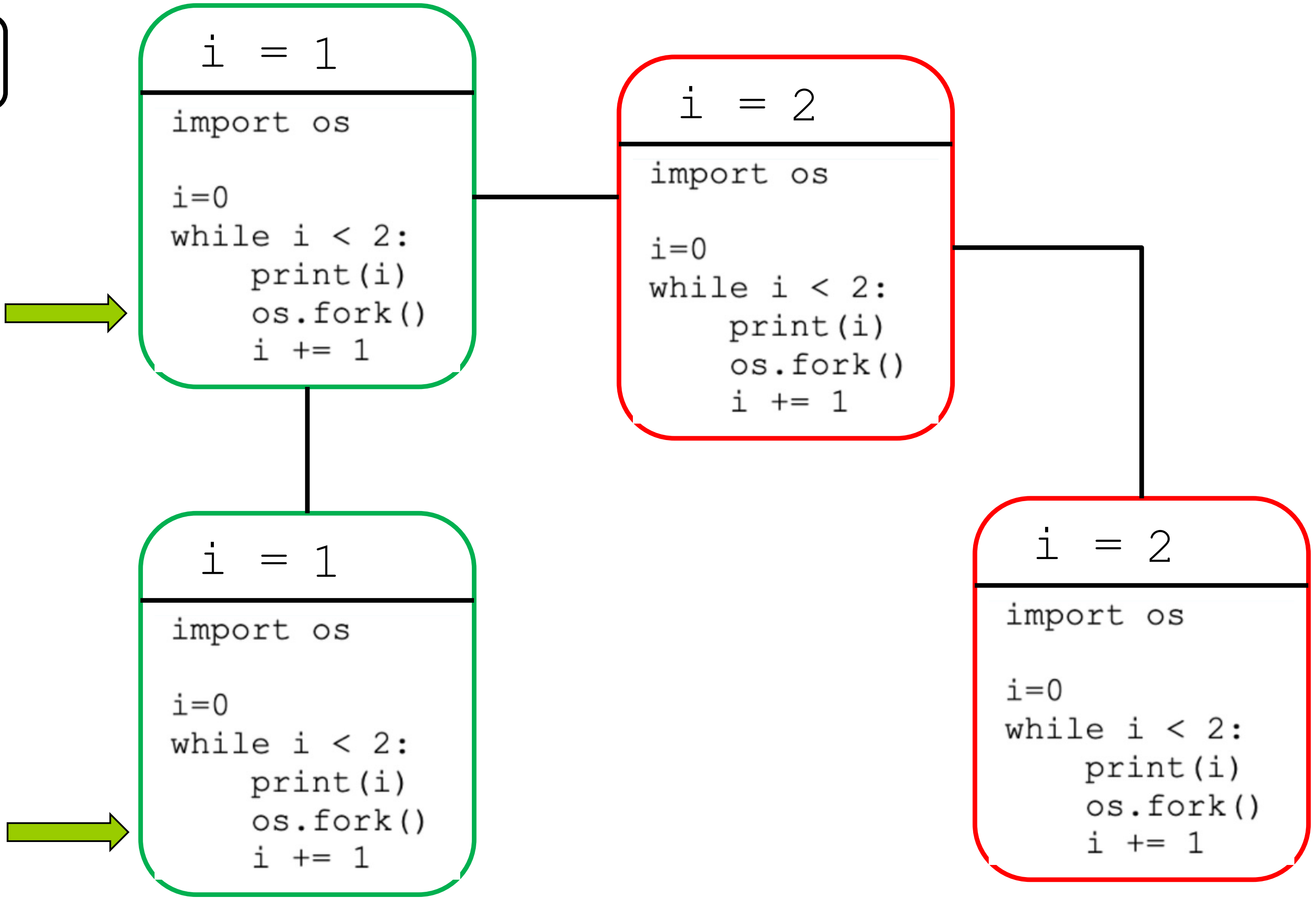
     os.fork()
     i += 1
```

Fork Example

```
011
```

output



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i=0
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    os.fork()
    i += 1
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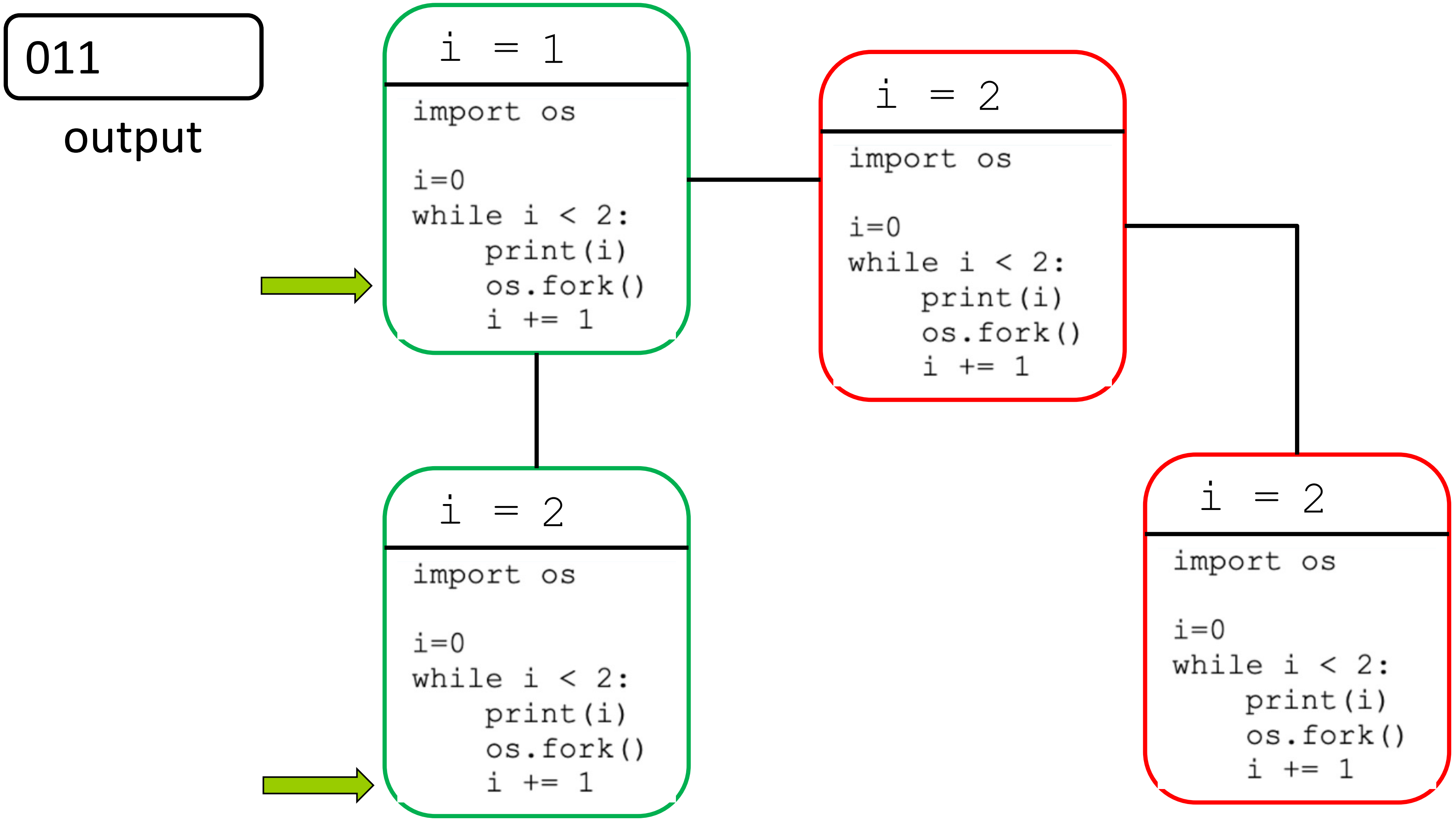
Fork Example



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i=0
while i < 2:
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     i += 1
```
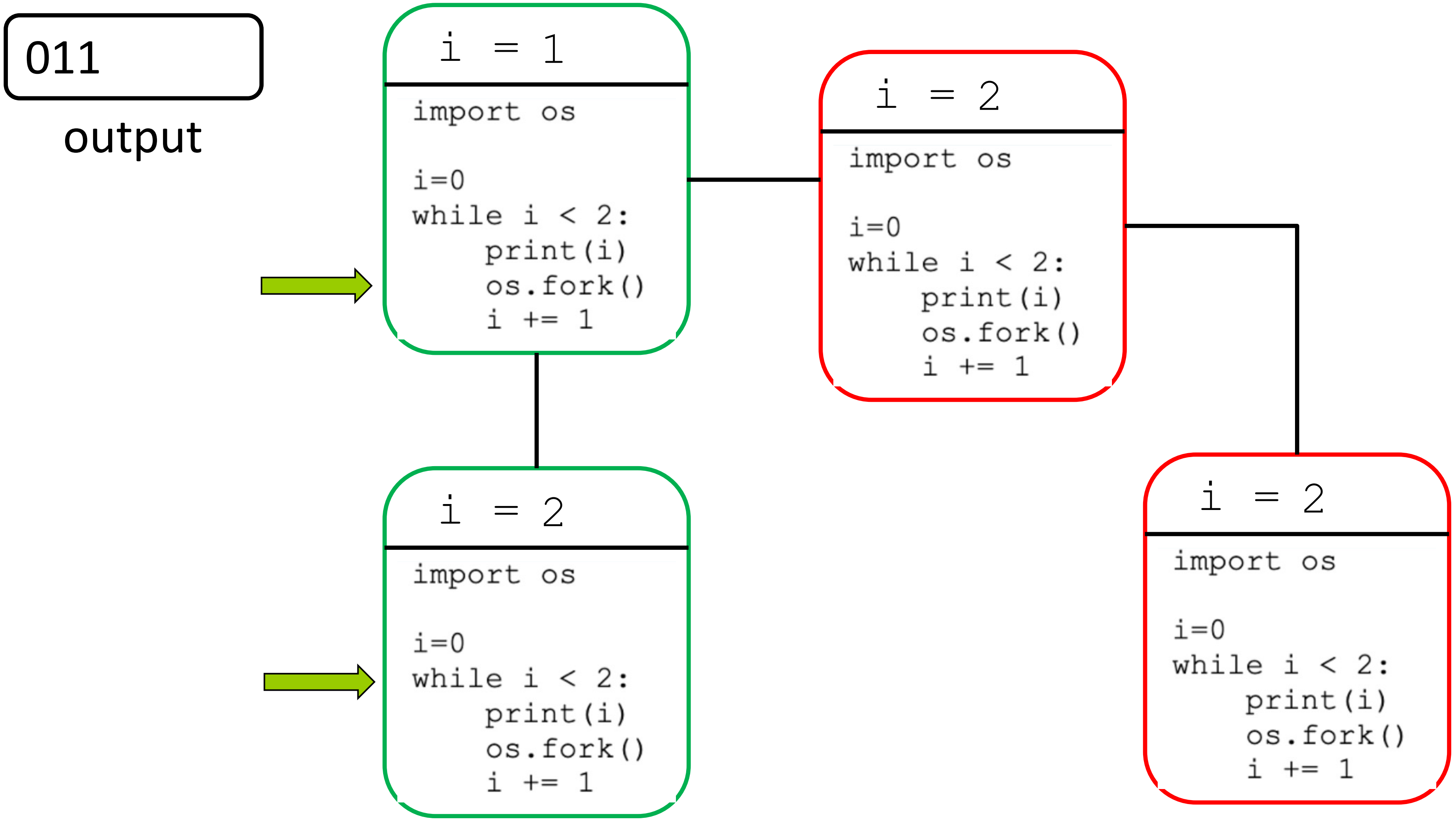

Fork Example



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    i += 1
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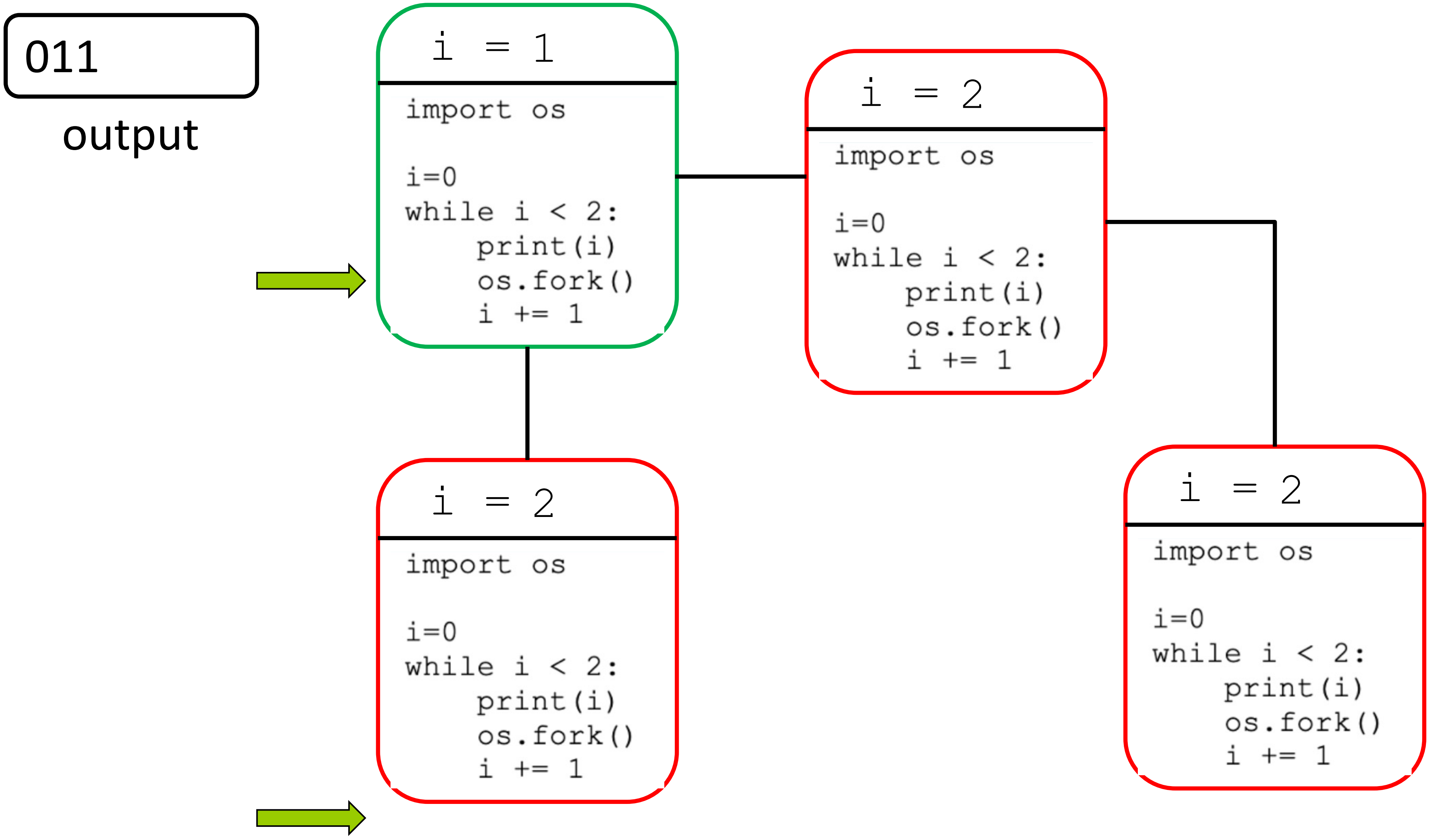
Fork Example



```
011
```

```
import os

i=0
while i < 2:
    print(i)
    os.fork()
    i += 1
```

```
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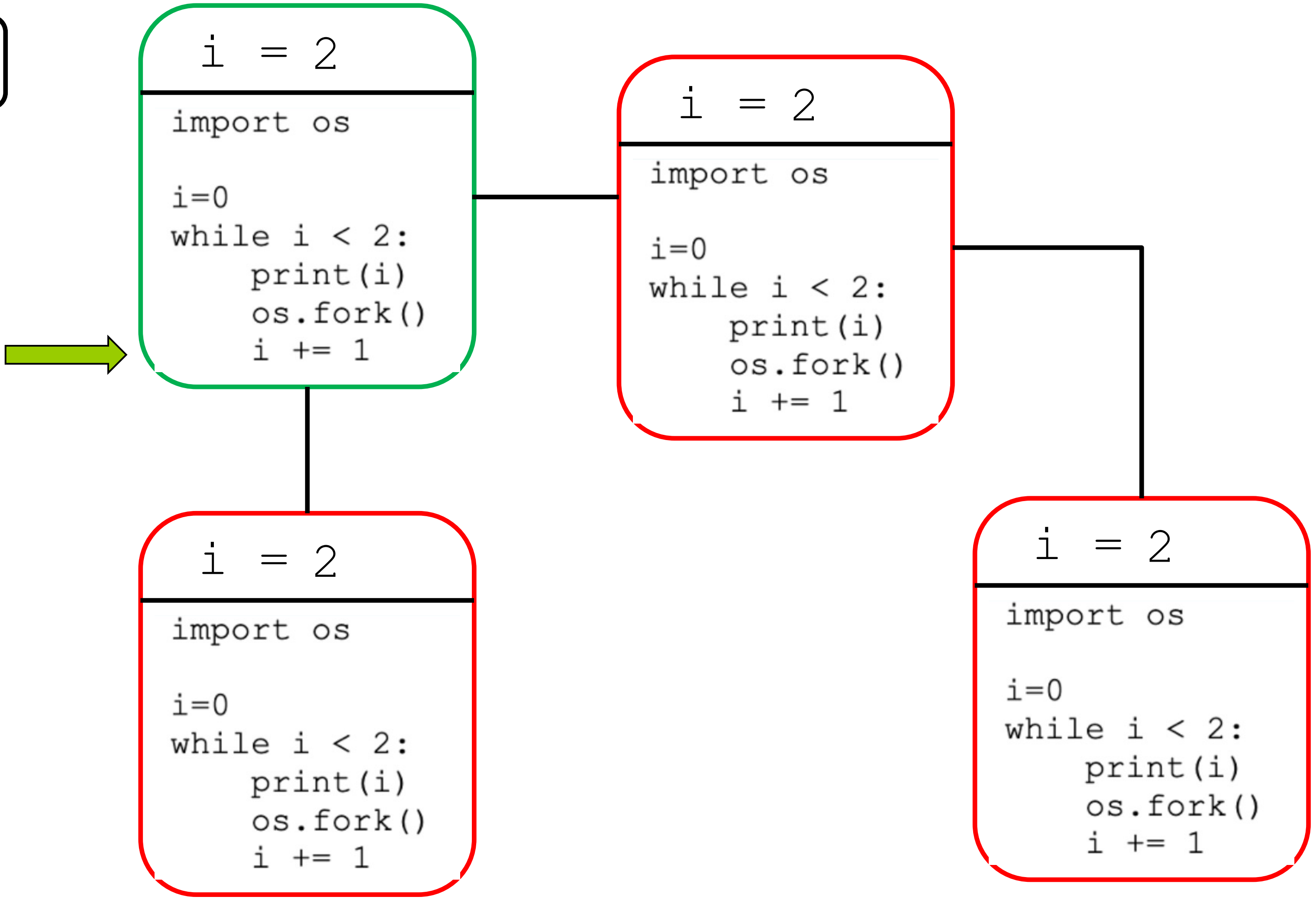
Fork Example

```
011
```

output



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i = 2
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i=0
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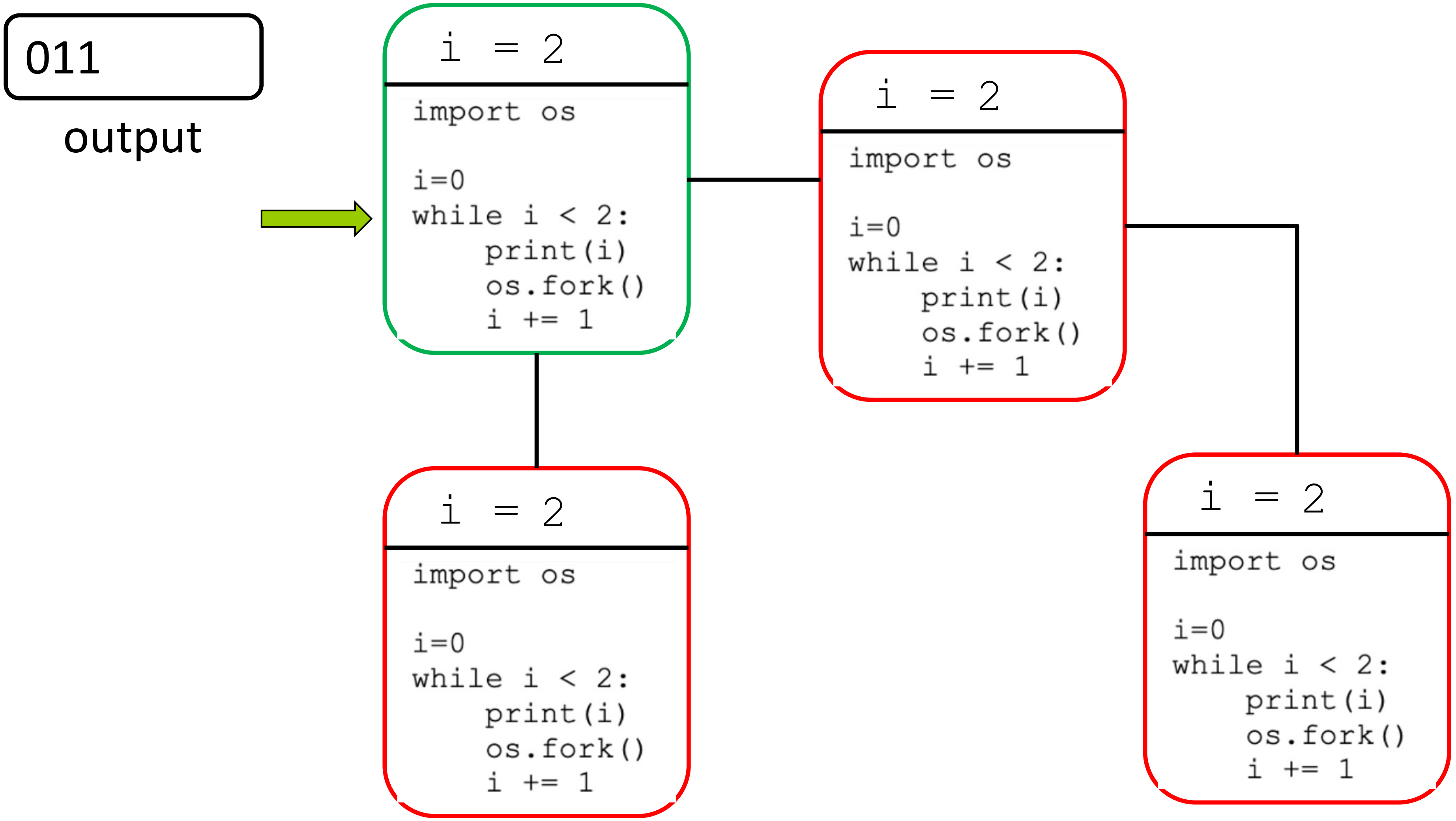

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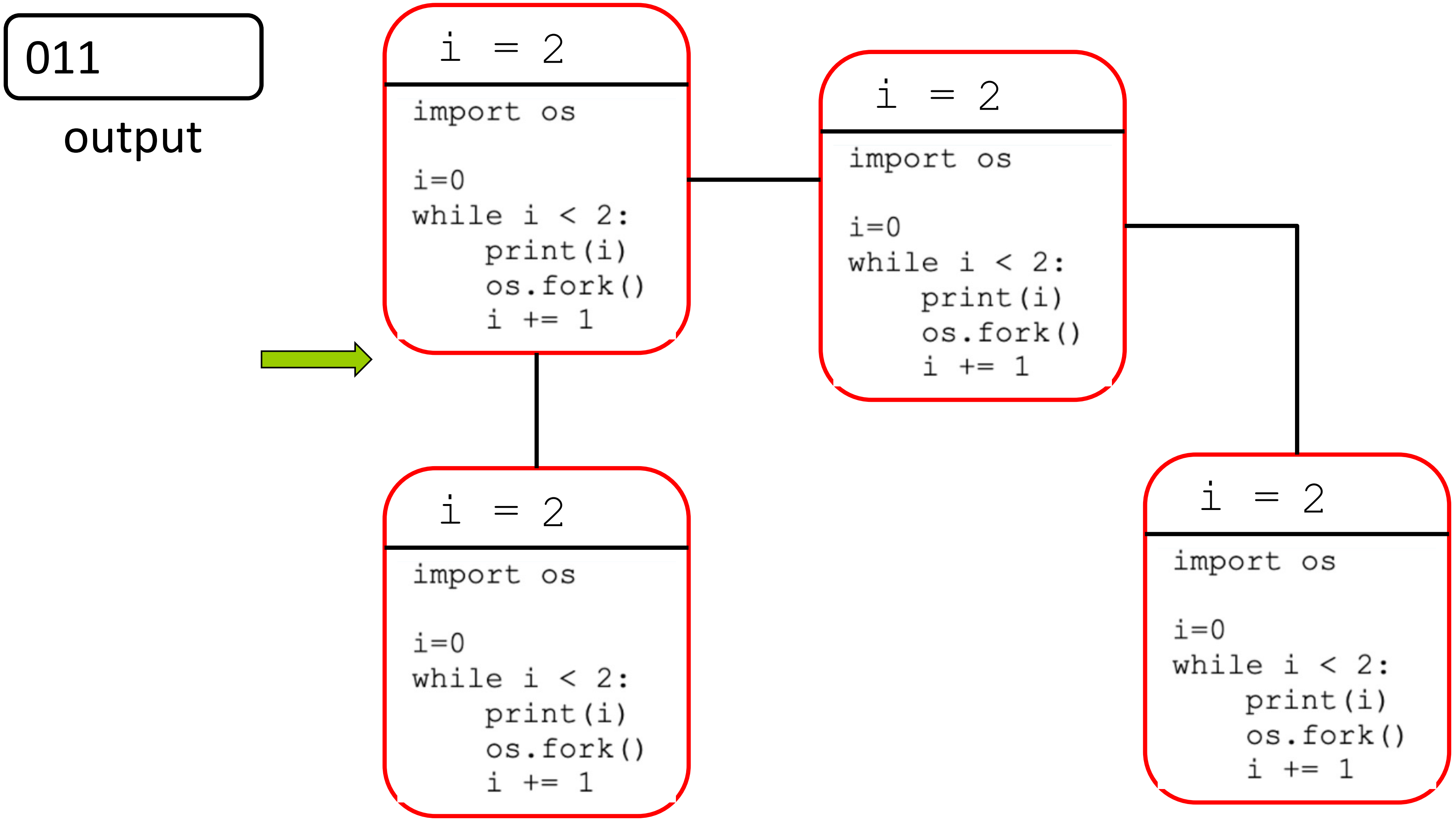

```
011
```

output

i = 2

```
import os

i=0
while i < 2:
    print(i)
    os.fork()
    i += 1
```

i = 2

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i=0
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```

Sample exam question

۱. در اثر اجرای برنامه زیر چند پردازه ایجاد می‌شوند. روش محاسبه شما بایستی مشخص باشد و تنها یک عدد برای پاسخ کفایت نمی‌کند.

```
main(){
    forkthem(5);
}
void forkthem(int n){
    if( n >0 ) {
            fork();
            forkthem(n-1);
    }
}
```

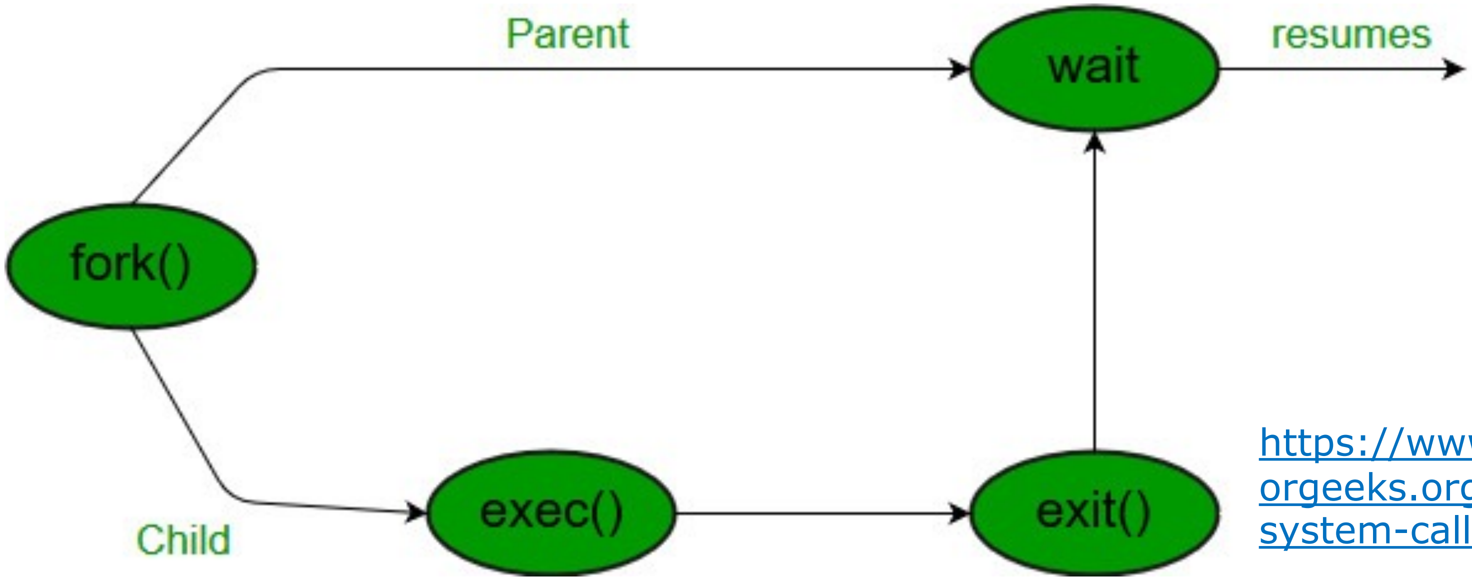
Sample exam question (cont.)

۲. خروجی برنامه‌های زیر چیست؟ به شکل خلاصه توضیح دهید.

```
// Program 1
main(){
    int val = 5;
    int pid;
    if (pid = fork())
            wait(pid);
    val++;
    printf ("%d\n", val);
    return val;
}
// Program 2
main(){
    int val = 5;
    int pid;
    if (pid = fork())
            wait(pid);
    else
            exit(val);
    val++;
    printf ("%d\n", val);
    return val;
}
```

Process Termination

- Process executes last statement and then asks the operating system to ***delete it*** using the **`exit()`** system call.
  - Returns status data from child to parent (via **`wait()`**)
  - Process' resources are deallocated by operating system.



https://www.geeksforgeeks.org/wait-system-call-c/

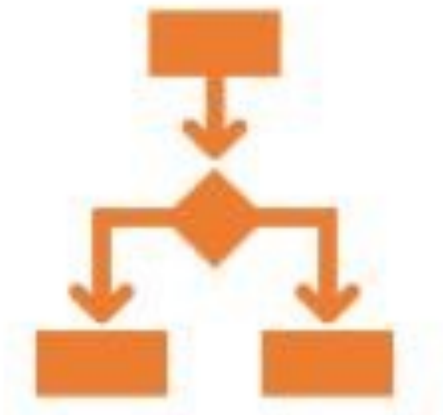
Process Termination (cont.)

- Parent may terminate the execution of children processes using the **`abort()`** system call.

- Some reasons for doing so:
  - Child has exceeded allocated resources.
  - Task assigned to child is no longer required.
  - The parent is exiting, and the operating systems does not allow a child to continue if its parent terminates.

Process Termination (cont.)

- Some OSs do not allow child to ***exists*** if its parent has terminated.
  - If a process terminates, then all its children must also be terminated.
  - **Cascading termination:** All children, grandchildren, etc., are terminated.
  - The termination is initiated by the operating system.



Process Termination (cont.)

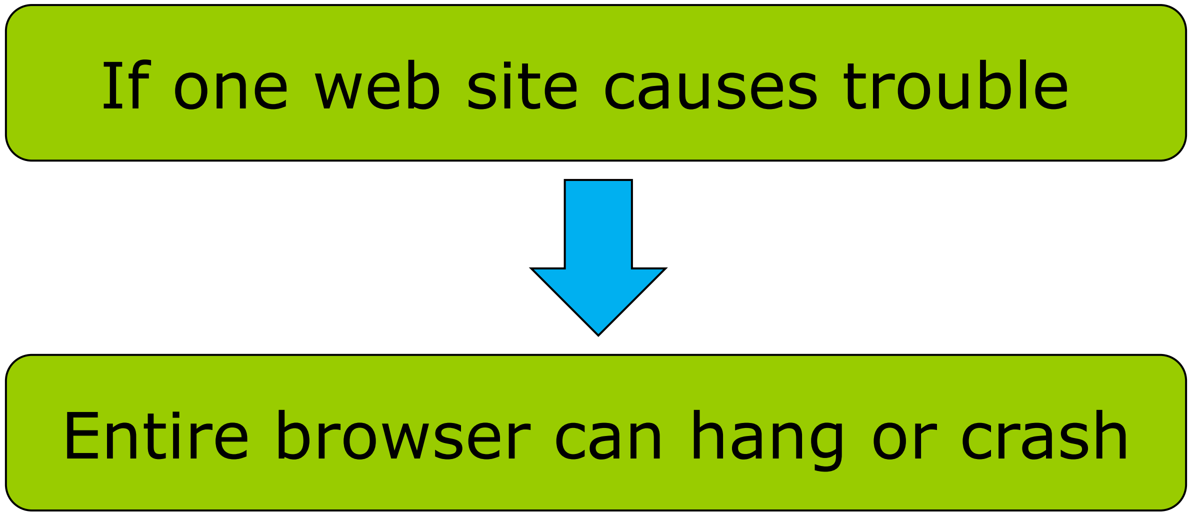
- The parent process may wait for termination of a child process by using the ***wait()*** system call.
  - The call returns status information and the pid of the terminated process.

pid = wait(&status);

- If no parent waiting (did not invoke wait()), process is a zombie.
- If parent terminated without invoking wait(), process is an orphan.

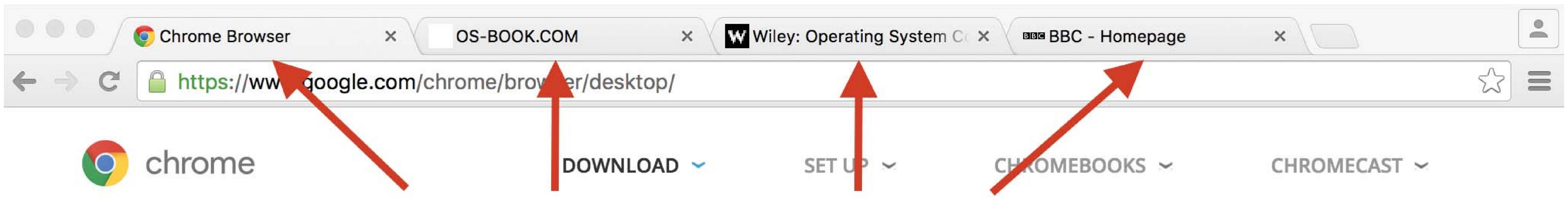
Multiprocess Architecture – Browser

- Many web browsers ran as single process (some still do)


If one web site causes trouble
Entire browser can hang or crash

Multiprocess Architecture – Chrome Browser (cont.)

- Google Chrome is multiprocess with 3 different types of processes:
  - Browser process manages user interface, disk and network I/O.
  - Renderer process renders web pages, deals with HTML, Javascript.
    - A new renderer created for each website opened
    - Runs in sandbox restricting disk and network I/O (why?)
  - Plug-in process for each type of plug-in.



Each tab represents a separate process.

Inter-Process Communication

- Processes within a system may be ***independent*** or ***cooperating***
- Cooperating process can affect or be affected by other processes, including ***sharing data***.
- Reasons for cooperating processes:
  - Information sharing
  - Computation speedup
  - Modularity
  - Convenience

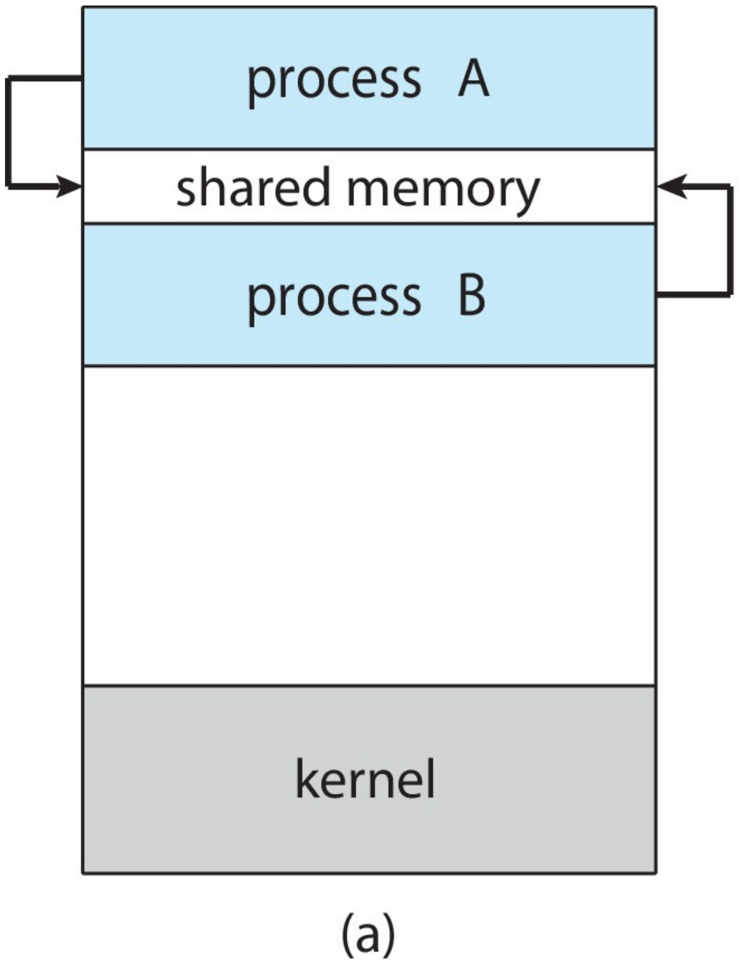
Inter-Process Communication (Cont.)

- Cooperating processes need interprocess communication (IPC)
- Two models of IPC
  - **Shared memory**
  - **Message passing**
    - **We do not cover this.**

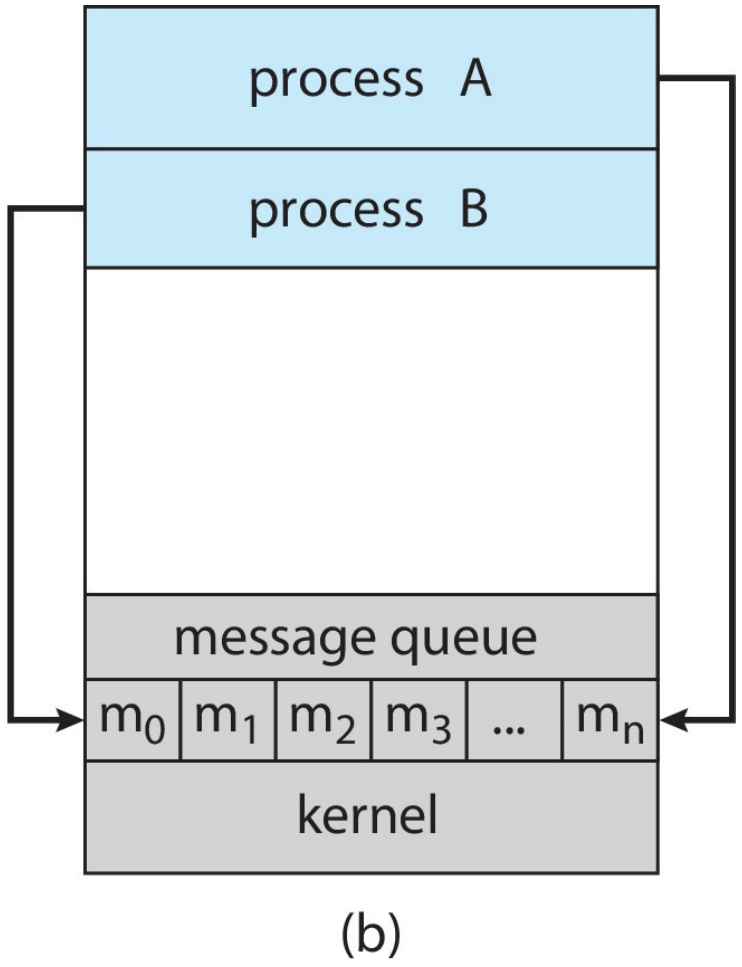
Communications Models

(a) Shared memory.

(b) Message passing.



process A
shared memory
process B
kernel
(a)



process A
process B
message queue
m_0 m_1 m_2 m_3 ... m_n
kernel
(b)