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LAB ASSIGNMENT-04

Experiment Title: System Calls, VM Detection, and File System Operations using Python

Task 1: Batch Processing Simulation (Python)

Write a Python script to execute multiple .py files sequentially, mimicking batch processing.

Implementation:

```
import subprocess

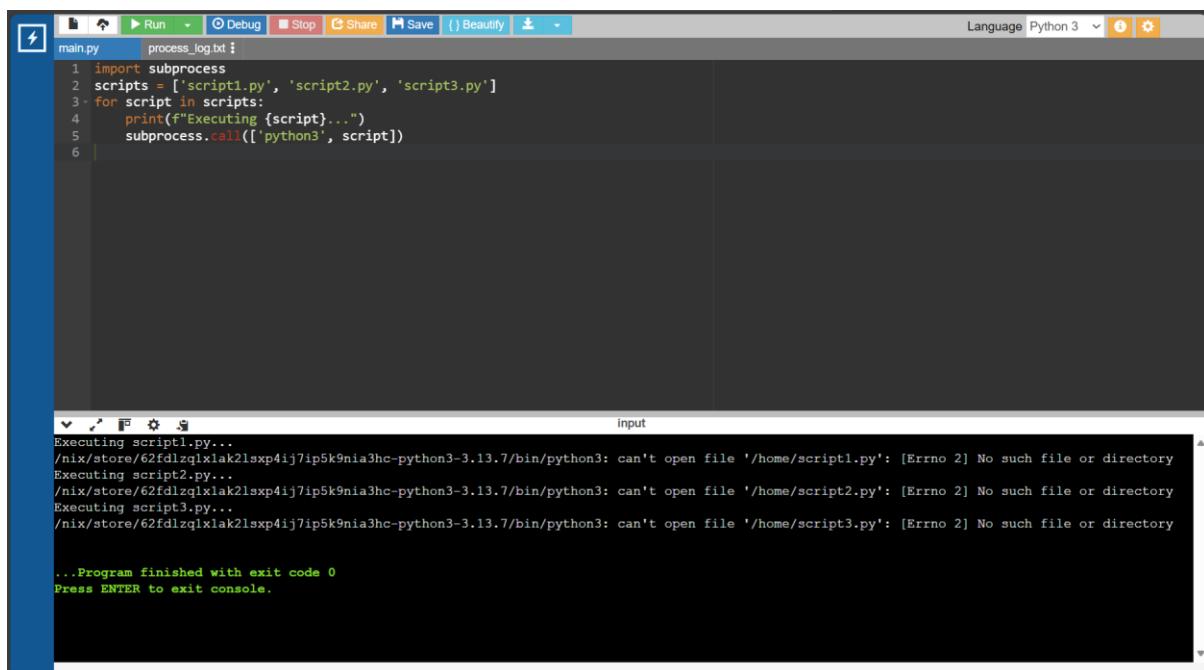
scripts = ['script1.py', 'script2.py', 'script3.py']

for script in scripts:

    print(f"Executing {script}...")

    subprocess.call(['python3', script])
```

Output:



```
main.py
```

```
1 import subprocess
2 scripts = ['script1.py', 'script2.py', 'script3.py']
3 for script in scripts:
4     print(f"Executing {script}...")
5     subprocess.call(['python3', script])
6 
```

```
Executing script1.py...
/nix/store/62fdlzdqlx1ak2lsxp4ij7ip5k9nia3hc-python3-3.13.7/bin/python3: can't open file '/home/script1.py': [Errno 2] No such file or directory
Executing script2.py...
/nix/store/62fdlzdqlx1ak2lsxp4ij7ip5k9nia3hc-python3-3.13.7/bin/python3: can't open file '/home/script2.py': [Errno 2] No such file or directory
Executing script3.py...
/nix/store/62fdlzdqlx1ak2lsxp4ij7ip5k9nia3hc-python3-3.13.7/bin/python3: can't open file '/home/script3.py': [Errno 2] No such file or directory

...Program finished with exit code 0
Press ENTER to exit console.
```

Task 2: System Startup and Logging

Simulate system startup using Python by creating multiple processes and logging their start and end into a log file.

Implementation:

```
import multiprocessing
import logging
import time

logging.basicConfig(filename='system_log.txt', level=logging.INFO,
                    format='%(asctime)s - %(processName)s - %(message)s')

def process_task(name):
    logging.info(f"{name} started")
    time.sleep(2)
    logging.info(f"{name} terminated")

if __name__ == '__main__':
    print("System Booting...")
    p1 = multiprocessing.Process(target=process_task, args=("Process-1",))
    p2 = multiprocessing.Process(target=process_task, args=("Process-2",))
    p1.start()
    p2.start()
    p1.join()
    p2.join()
    print("System Shutdown.")
```

Output:

The screenshot shows a Python development environment. In the top pane, there are three tabs: 'main.py', 'process.log.txt', and 'system.log.txt'. The 'main.py' tab contains the following code:

```
1 2025-11-30 11:45:59,559 - Process-1 - Process-1 started
2 2025-11-30 11:45:59,561 - Process-2 - Process-2 started
3 2025-11-30 11:46:01,560 - Process-1 - Process-1 terminated
4 2025-11-30 11:46:01,561 - Process-2 - Process-2 terminated
5
```

In the bottom pane, there is a terminal window titled 'Input' with the following text:

```
System Booting...
System Shutdown.

...Program finished with exit code 0
Press ENTER to exit console.
```

Task 3: System Calls and IPC (Python - fork, exec, pipe)

Use system calls (fork(), exec(), wait()) and implement basic Inter-Process Communication using pipes in C or Python.

Implementation:

```
import os

r, w = os.pipe()

pid = os.fork()

if pid > 0:

    os.close(r)

    os.write(w, b"Hello from parent")

    os.close(w)

    os.wait()

else:

    os.close(w)

    message = os.read(r, 1024)

    print("Child received:", message.decode())
```

```
os.close(r)
```

Output:

The screenshot shows a Python development environment with a code editor and a terminal window. The code in the editor is a Python script named 'main.py' that creates a pipe, forges a child process, and either writes a message to the child or reads it from the child. The terminal window below shows the output of the script execution.

```
1 import os
2 r, w = os.pipe()
3 pid = os.fork()
4 if pid > 0:
5     os.close(r)
6     os.write(w, b"Hello from parent")
7     os.close(w)
8     os.wait()
9 else:
10    os.close(w)
11    message = os.read(r, 1024)
12    print("Child received:", message.decode())
13    os.close(r)
14
```

Child received: Hello from parent

...Program finished with exit code 0
Press ENTER to exit console.

Task 4: VM Detection and Shell Interaction

Create a shell script to print system details and a Python script to detect if the system is running inside a virtual machine.

Implementation:

```
#!/bin/bash
echo "Kernel Version:"
uname -r
echo "User:"
whoami
echo "Hardware Info:"
lscpu | grep 'Virtualization'
```

Python Script:

```
import os
```

```
import subprocess

def check_dmi():
    """Check system DMI data for known VM identifiers."""
    vm_signatures = ["virtual", "vmware", "kvm", "qemu", "hyper-v", "xen"]
    try:
        output = subprocess.check_output(["sudo", "dmidecode"],
                                        stderr=subprocess.DEVNULL).decode().lower()
        return any(sig in output for sig in vm_signatures)
    except:
        return False

def check_cpu_flags():
    """Check CPU flags for hypervisor bit."""
    try:
        with open("/proc/cpuinfo") as f:
            data = f.read().lower()
        return "hypervisor" in data
    except:
        return False

def check_mac_address():
    """Check if the MAC address belongs to a VM vendor."""
    vm_mac_prefixes = [
        "00:05:69", "00:0C:29", "00:1C:14", # VMware
        "08:00:27", # VirtualBox
        "52:54:00", # QEMU / KVM
        "00:15:5D", # Hyper-V
    ]
    try:
        output = subprocess.check_output(["ip", "link"]).decode().lower()
```

```

for prefix in vm_mac_prefixes:
    if prefix.lower() in output:
        return True
except:
    pass
return False

def detect_vm():
    print("\n--- Virtual Machine Detection ---")
    dmi = check_dmi()
    hypervisor_flag = check_cpu_flags()
    mac_vm = check_mac_address()
    if dmi or hypervisor_flag or mac_vm:
        print("This system appears to be running inside a VIRTUAL MACHINE.")
    else:
        print("This system appears to be running on BARE METAL hardware.")
    print("\nDetails:")
    print(f"DMI-based detection: {dmi}")
    print(f"CPU hypervisor flag: {hypervisor_flag}")
    print(f"MAC address virtual: {mac_vm}")

if __name__ == "__main__":
    detect_vm()

```

Output:

Task 5: CPU Scheduling Algorithms

Implement FCFS, SJF, Round Robin, and Priority Scheduling algorithms in Python to calculate WT and TAT.

Implementation:

"""\nFCFS Scheduling\n"""\n

```
def fcfs(processes):\n    processes.sort(key=lambda x: x['arrival'])\n    time = 0\n    for p in processes:\n        if time < p['arrival']:\n            time = p['arrival']\n        p['wt'] = time - p['arrival']\n        time += p['burst']\n        p['tat'] = p['wt'] + p['burst']\n    return processes
```

"""\nSJF Scheduling\n"""\n

```
def sjf(processes):\n    processes = sorted(processes, key=lambda x: x['arrival'])\n    completed, time = 0, 0\n    n = len(processes)\n    while completed < n:\n        available = [p for p in processes if p['arrival'] <= time and 'done' not in p]\n        if not available:\n            time += 1\n            continue\n        p = min(available, key=lambda x: x['burst'])\n        p['wt'] = time - p['arrival']\n        time += p['burst']\n        p['tat'] = p['wt'] + p['burst']\n    return processes
```

```

p['done'] = True
completed += 1
return processes

"""Round Robin"""
def round_robin(processes, quantum):
    from collections import deque
    q = deque()
    time = 0
    remaining = {p['pid']: p['burst'] for p in processes}
    processes.sort(key=lambda x: x['arrival'])
    i = 0
    completed = 0
    n = len(processes)
    while completed < n:
        while i < n and processes[i]['arrival'] <= time:
            q.append(processes[i])
            i += 1
        if not q:
            time = processes[i]['arrival']
            continue
        p = q.popleft()
        exec_time = min(quantum, remaining[p['pid']])
        remaining[p['pid']] -= exec_time
        time += exec_time
        while i < n and processes[i]['arrival'] <= time:
            q.append(processes[i])
            i += 1
        if remaining[p['pid']] == 0:
            p['tat'] = time - p['arrival']
            p['wt'] = p['tat'] - p['burst']

```

```

    completed += 1
else:
    q.append(p)
return processes

```

"""\Priority Scheduling"""

```

def priority_scheduling(processes):
    time = 0
    completed = 0
    n = len(processes)
    processes.sort(key=lambda x: x['arrival'])
    while completed < n:
        available = [p for p in processes if p['arrival'] <= time and 'done' not in p]
        if not available:
            time += 1
            continue
        p = min(available, key=lambda x: x['priority'])
        p['wt'] = time - p['arrival']
        time += p['burst']
        p['tat'] = p['wt'] + p['burst']
        p['done'] = True
        completed += 1
    return processes

```

```

processes = [
    {'pid': 1, 'arrival': 0, 'burst': 5, 'priority': 2},
    {'pid': 2, 'arrival': 1, 'burst': 3, 'priority': 1},
    {'pid': 3, 'arrival': 2, 'burst': 8, 'priority': 4},
    {'pid': 4, 'arrival': 3, 'burst': 6, 'priority': 3},
]

```

```

import copy

print("\n--- FCFS ---")

for p in fcfs(copy.deepcopy(processes)):

    print(p)

print("\n--- SJF ---")

for p in sjf(copy.deepcopy(processes)):

    print(p)

print("\n--- Round Robin (Q=2) ---")

for p in round_robin(copy.deepcopy(processes), quantum=2):

    print(p)

print("\n--- Priority Scheduling ---")

for p in priority_scheduling(copy.deepcopy(processes)):

    print(p)

```

Output:

```

main.py      process_log.txt  system_log.txt
86     {'pid': 4, 'arrival': 3, 'burst': 6, 'priority': 3},
87 ]
88
89 import copy
90 print("\n--- FCFS ---")
91 for p in fcfs(copy.deepcopy(processes)):
92     print(p)
93
94 print("\n--- SJF ---")
95 for p in sjf(copy.deepcopy(processes)):
96     print(p)
97
98 print("\n--- Round Robin (Q=2) ---")
99 for p in round_robin(copy.deepcopy(processes), quantum=2):
100    print(p)
101
102 print("\n--- Priority Scheduling ---")
103 for p in priority_scheduling(copy.deepcopy(processes)):
104     print(p)
105
106

```

--- FCFS ---

```

('pid': 1, 'arrival': 0, 'burst': 5, 'priority': 2, 'wt': 0, 'tat': 5)
('pid': 2, 'arrival': 1, 'burst': 3, 'priority': 1, 'wt': 4, 'tat': 7)
('pid': 3, 'arrival': 2, 'burst': 8, 'priority': 4, 'wt': 6, 'tat': 14)
('pid': 4, 'arrival': 3, 'burst': 6, 'priority': 3, 'wt': 13, 'tat': 19)

```

--- SJF ---

```

('pid': 1, 'arrival': 0, 'burst': 5, 'priority': 2, 'wt': 0, 'tat': 5, 'done': True)
('pid': 2, 'arrival': 1, 'burst': 3, 'priority': 1, 'wt': 4, 'tat': 7, 'done': True)
('pid': 3, 'arrival': 2, 'burst': 8, 'priority': 4, 'wt': 12, 'tat': 20, 'done': True)
('pid': 4, 'arrival': 3, 'burst': 6, 'priority': 3, 'wt': 5, 'tat': 11, 'done': True)

```

--- Round Robin (Q=2) ---