COMP 3511
Operating Systems

Lab #8 review

Outline

- Thrashing
- Working Set Model
- File System

Q. 1

- Provide a short definition for each of the following terms:
    - Page fault
    - Resident Set
    - Working Set

Q. 1

- ## Page fault
  A page fault occurs when the CPU tries to use a logical address for which a corresponding physical address does not exist, that is, the process page that contains the logical address had not been loaded into physical memory. The OS must load the logical page into physical memory to allow the process to continue its execution.

- ## Resident Set
  the set of logical pages of a process loaded into physical memory.

- ## Working Set
  The set of pages required by a process to execute, that is, according to locality of reference, the set of pages required by the process in memory to keep the number of page faults to a minimum.

Q. 2a

- Describe how thrashing can occur in using the terms defined in Q. 1.

Q. 2a

- If a process resident set is smaller than its working set, it will generate many page faults. This means that the process can spend considerable time waiting for I/O due to these page faults.

- A process is thrashing if it is spending more time paging than executing.

- The OS when it sees that the system is under utilized, can add more processes to the system. This causes a cascading effect that leads to thrashing.

Q. 2b

- Consider a demand-paged computer system where the degree of multiprogramming is currently fixed at four processes. The system was recently measured to determine utilization of CPU and the **paging** disk (which means that the regular I/O to the disk is not included in the statistics). The results are one of the following alternatives. For each case, what is happening? Can the degree of multiprogramming be increased to increase the CPU utilization?

  a) CPU utilization 13 percent; disk utilization 97 percent
  b) CPU utilization 87 percent; disk utilization 3 percent
  c) CPU utilization 13 percent; disk utilization 3 percent

Q. 2b

a) Thrashing is occurring, since the disk utilization is very high while the CPU is underutilized. Processes are spending most of their time paging. The degree of multiprogramming cannot be increased. On the contrary, one or more processes should be suspended to allow increase in the utilization of the CPU.

b) CPU utilization is sufficiently high to leave things alone. Any increase in the degree of multiprogramming could lead to thrashing.

c) Increase the degree of multiprogramming. The CPU is available for executing additional processes.

Working-Set Model

- The locality model states that, as a process executes, it moves from locality to locality. A locality is defined as a set of pages that are actively used together.

- Working-Set model is based on the locality
  - $\Delta \equiv$ working-set window $\equiv$ a fixed number of page references
  - WSS_i (working set of Process P_i) = total number of pages referenced in the most recent Δ (varies in time)
  - $D = \Sigma\, WSSi \equiv$ total demand for frames (by all processes)

Working-Set Model

- Consider the parameter Δ used to define the working-set window in the working-set model.

  - What is the effect of setting Δ to a small value on the page fault frequency and the number of active (non-suspended) processes currently executing in the system?

  - What is the effect when Δ is set to a very high value?
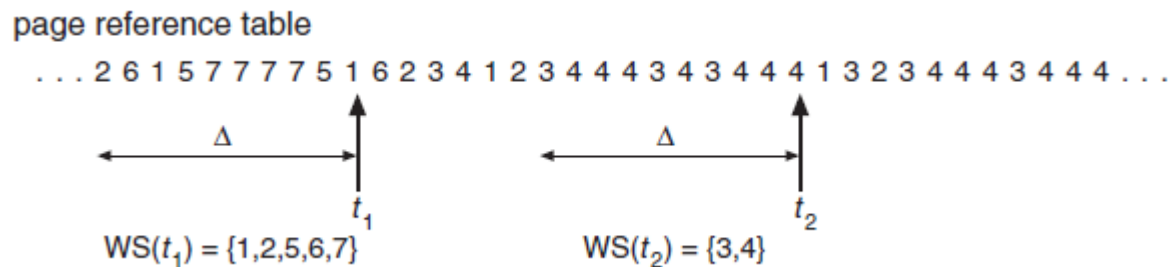
Working-Set Model

- When Δ is set to a small value
  - the set of resident pages for a process might be underestimated

  - allowing a process to be scheduled even though all of its required pages are not resident

  - This could result in a large number of page faults

Working-Set Model

- When Δ is set to a large value
  - a process's resident set is overestimated

  - this might prevent many processes from being scheduled even though their required pages are resident

  - However, once a process is scheduled, it is unlikely to generate page faults since its resident set has been overestimated

Working-Set Window

- A working set is the set of pages in the most recent working-set window Δ.

- The working-set window is a moving window. At each memory reference, a new reference appears at one end, and the oldest reference drops off the other end.

- A page is in the working set if it is referenced anywhere in the working-set window.

- *For example, in the following working-set model:*

page reference table

. . . 2 6 1 5 7 7 7 7 5 1 6 2 3 4 1 2 3 4 4 4 3 4 3 4 4 4 1 3 2 3 4 4 4 3 4 4 4 . . .

$WS(t_1) = \{1,2,5,6,7\}$ $WS(t_2) = \{3,4\}$

- If Δ = *10 memory references, then the working set at time t1 is {1,2,5,6,7}. By time t2, the working set has changed to {3,4}*

Q. 3

- Given a process that references virtual pages during its execution as indicated in the table below and an observation window size Δ of 5; complete the table below to show the process working set changes during its execution.

Page Reference	Working set
3	3
2	3,2
4	3,2,4
3	3,2,4
4	3,2,4
2	3,2,4
2	3,2,4
3	3,2,4
4	
5	
6	
7	
6	
7	5,6,7

Q. 3

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3	3,2,4
4	3,2,4
2	3,2,4
2	3,2,4
3	3,2,4
4	3,2,4
5	3,2,4,5
6	3,2,4,5,6
7	3,4,5,6,7
6	4,5,6,7
7	5,6,7

Q. 4

- Can a page be in two working sets at the same time? Explain.

Q. 4

- If pages can be shared, it is possible that a page is in two working sets at the same time.

- For example, if two users of a timesharing system are running the same editor at the same time, and the program text is shared rather than copied, some of those pages may be in each user's working set at the same time.

FILE SYSTEM

Q. 5

- What is the difference between a mandatory lock and an advisory file lock

Q. 5

- Answer:
- Mandatory locking requires that the operating system does not allow access to any file that is locked, until it is released, even if the program does not explicitly ask for a lock on the file. An advisory file locking scheme will not prevent access to a locked file, and it is up to the programmer to ensure that locks are appropriately acquired and released.

Q. 6

a) Specify the primary advantages the acyclic graph directory has compared with the tree directory.

b) Several aspects need to be considered when using acyclic-graph directory, please state two of them.

Q. 6

a) Specify the primary advantages the acyclic graph directory has compared with the tree directory.

- Acyclic graph directory permits the sharing of files or directories. It is more flexible than the simple tree structure.

b) Several aspects need to be considered carefully when using acyclic-graph directory, please state two of them.

1. A file may have multiple absolute path names hence can be accessed by different file names.

2. When can the space allocated to a shared file be deallocated and reallocated to other files.

Q. 7

- Consider the listing of command "ls –liaR" that provides the contents of a Linux file system on the next page. The arguments of ls are described as below:

    -l: long listing format

    -i: provide the inode number

    -a: list all entries in directories including the hidden ones

    -R: recurs into subdirectories

Q. 7

```
[root@sitedev mnt1]# ls -liaR .
total 7
    1 drwxr-xr-x   4 root    root       128 Mar 27 09:24 .
 96770 drwxr-x---   8 root    root      4096 Mar 27 09:47 ..
    2 drwxr-xr-x   5 test1   244       160 Mar 27 09:24 dir1
    3 drwxr-xr-x   4 test1   244       160 Mar 27 09:30 dir2

./dir1:
total 5
    2 drwxr-xr-x   5 test1   244       160 Mar 27 09:24 .
    1 drwxr-xr-x   4 root    root      128 Mar 27 09:24 ..
    4 drwxr-xr-x   2 test1   244        96 Mar 27 09:36 ad
    5 drwxr-xr-x   2 test1   244        96 Mar 27 09:29 bd
    6 drwxr-xr-x   2 test1   244        96 Mar 27 09:30 cd
```

Q. 7

- What are access permissions for 'dir2', what's its user id, group id, link count, size in bytes, and time modified?

Q. 7

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3 drwxr-xr-x   4 test1   244   160 Mar 27 09:30 dir2

  - rwxr-xr-x: owner has permissions of read, write, execute

    group has permissions of read and execute

    others have permissions of read and execute

  - Its user id is test1; group id is 244; number of link count is 4 which means the number of times it is referenced by the directory or in this case the number of subdirectories (including . and ..); size is 160 bytes; the time modified is Mar 27 09:24.

Q. 8

- What are three common methods for remote file -sharing?

Q. 8

- manually transferring files between machines via programs like ftp.

- distributed file system (DFS), in which remote directories are visible from a local machine. The DFS method involves a much tighter integration between the machine that is accessing the remote files and the machine providing the files.

- In the third method, a browser is needed to access remote files on the World Wide Web, and separate operations (essentially a wrapper for ftp) are used to transfer files.