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**CSC205 section 1 Spring 2015 Homework 10**

**How to Submit:**

**Please submit your solutions (parts A and B separately) through Blackboard. Remember to put your name and homework number on all the documents that you submit as attachments.**

**Total possible points in this homework: 10 for part B (+8 extra regular points if you get at least 5 points out of Q2)**

**(You receive 1 bonus point towards Part A if you get all Part A questions correct.)**

# Part B

2. [10 pts] Read the article “The working set model for program behavior” by Denning 1968. (link: http://cs.gmu.edu/cne/pjd/PUBS/WSModel\_1968.pdf) and answer the following questions.

1. [0.5 pt] What is new in this work? (from *abstract*)

The working set model is developed which is the working set of pages associated with a process.

1. [0.5 pt] What are the two constituents of the system demand of a *computation*?

## (from 1.Introduction)

Processor demand and memory demand

1. [0.5 pt] What are the two reasons that a computer (operating system) cannot seek external help from the compiler when managing the system resources?
2. Because of data dependence there may be no way to decide until run time just which modules will be included in a computation.
3. Compiler is used often in the operating system and if it is slow and bulky, it can be a serious drain on system resources.
4. [0.5 pt] Name four existing memory allocation strategies other than the one proposed by the author. (from *2.Background*)

Random Selection, FIFO, Least Recently Used, and ATLAS Loop Detection Method.

1. [0.5 pt] What is the meaning of the working set of a program? (from *3.Working*

## Set Model)

For the programmer the working set of a program is the smallest collection of information that must be present in the main memory to assure that the execution of the program is most efficient. For the system it is the set of the most recently used pages.

f. [0.5 pt] When using the working set for memory allocation, what memory requirement must be met before a program can be run? (from the end of

## 3.Working Set Model)

Before running a program there must be enough pages of memory free to contain its working set.

g. [3 pts] Explain the definitions of the following symbols, either using the author’s words, or using your own terminologies. Be as precise as possible.

1. *W(t, r)* andω*(t, r)*W(t, r) is the working set of information of a process at time t to be the collection of information referenced by the process during the process time interval. ω*(t, r)* is the number of pages in the working set; the working set size.
2. {*tn*}n>=0and {*xn*}*n>=1*{*tn*}n>=0 is a sequence of instants in process time at which successive references to a given page occur. {*xn*}*n>=1* is the interreference intervals which are independent, identically distributed random variables.
3. Fx(α)

Fx(α) = Pr[x <= α] is the distribution function where the derivative of this function is the density function.

1. A, T and M

A is an interval of process time that gives the expected number of time a single page reenters the working set as A multiplied by the average process-time rate at which on page is reentering the working set. T is the traverse time is the time spent by the process in “page-wait” every time there is a reentry. M is the available pages of memory.

1. λ(r), ϕ(r) and Φ(r)

λ(r) is the average process-time rate at which one page is reentering the working set. ϕ(r) estimates the average real-time rate at which one page is reentering the working set. Φ(r) estimates the average number of pages per unit real-time returning to main memory from auxiliary memory.

1. σ(r)  
   σ(r) is a sensitivity function that measures how sensitive is the reentry rate λ(r) to changes in r.

Here are some examples: *t* denotes an instant of time

*r* denotes the length of a time interval preceding *t*, over which the working set of a program is studied, and it is called the working set parameter

*x* denotes the process-time interval between successive references to the same page.

1. [1 pt] At time *t*, suppose a process *p* has referenced pages 1, 2, 8, 12, 16 and 21 in the time interval *r* that just passed. Over the next time interval α*,* where α*<r*, pages 1 and 8 are evicted and page 9 is loaded into the memory. Find *W(t,* *r),* and *W(t+*α*, r)*.

*W(t,* *r) = {1, 2, 8, 12, 16, 21}*

*W(t+*α*, r)* = {2, 9, 12, 16, 21}

1. [2 pts] What are the four properties of a working set *W(t, r)*?

Size, Prediction, Reentry Rate, and r-Sensitivity

1. [1 pt] What choice of *r* does the author recommend? Why?

The choice of r will have to represent a compromise between too much page traffic and too much wasted memory space. Because the return traffic functions play roles in determining if r is too small and the number of working sets simultaneously to occupy a core memory of given size plays a role in determining when r is too large. Therefore there must be a balance between both and is what the author recommends.