

OPERATING SYSTEMS

Memory Management

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Virtual Memory

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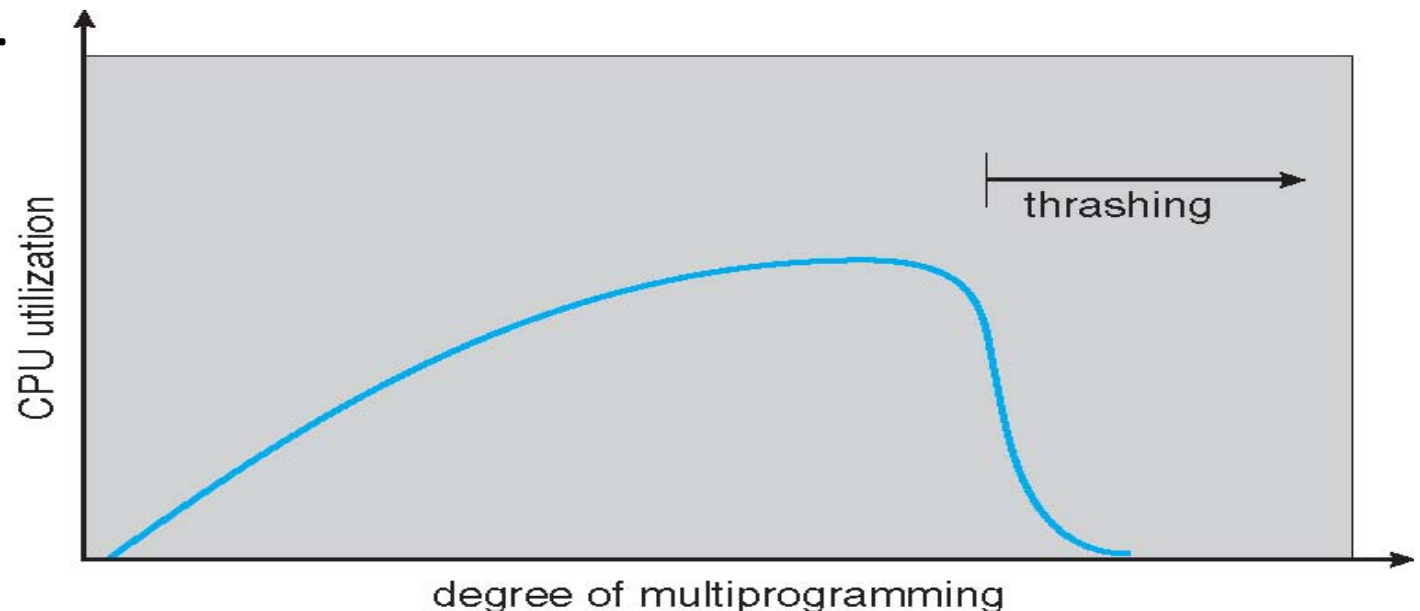
Slides Credits for all the PPTs of this course



- The slides/diagrams in this course are an **adaptation**, **combination**, and **enhancement** of material from the following resources and persons:
 1. Slides of Operating System Concepts, Abraham Silberschatz, Peter Baer Galvin, Greg Gagne - 9th edition 2013 and some slides from 10th edition 2018
 2. Some conceptual text and diagram from Operating Systems - Internals and Design Principles, William Stallings, 9th edition 2018
 3. Some presentation transcripts from A. Frank – P. Weisberg
 4. Some conceptual text from Operating Systems: Three Easy Pieces, Remzi Arpaci-Dusseau, Andrea Arpaci Dusseau

- ❑ If a process does not have “enough” pages, the page-fault rate is very high
 - ❑ Page fault to get page
 - ❑ Replace existing frame
 - ❑ But quickly need replaced frame back
 - ❑ This leads to:
 - ▶ Low CPU utilization
 - ▶ Operating system thinking that it needs to increase the degree of multiprogramming
 - ▶ Another process added to the system
- ❑ **Thrashing** ≡ a process is busy swapping pages in and out

- Thrashing results in severe performance problems.
- Consider the scenario of the paging systems performance.
- As the degree of multiprogramming increases, CPU utilization also increases.
- Why there is a decrease in the CPU Utilization when the degree of multiprogramming is increased?.
- How this will be handled?



[?] We can Limit the effects of thrashing by using a **local replacement algorithm** (or priority replacement algorithm)

[?] If process starts thrashing, it cannot steal frames from another processes

[?] how does demand paging work?

Locality model

[?] Process migrates from one locality to another

[?] Localities may overlap

[?] Why does thrashing occur?

Σ size of locality > total memory size

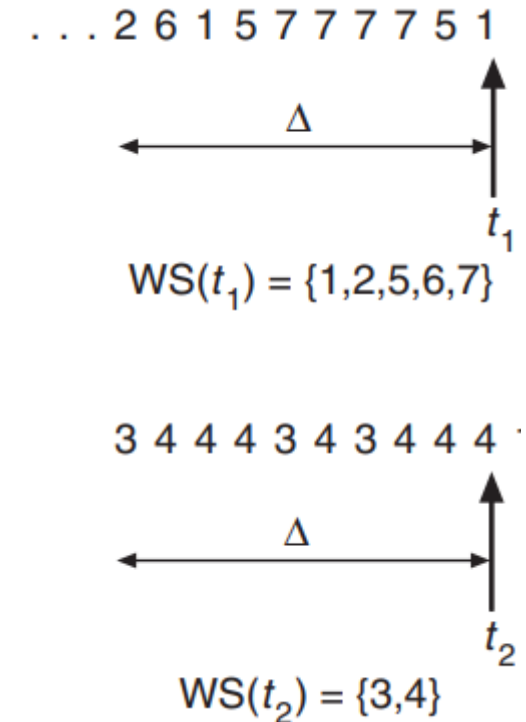
[?] Limit effects by using local or priority page replacement

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Keeping Track of the Working Set



- ❑ The working-set model is based on the assumption of locality.
- ❑ The parameter, Δ , defines the working-set window.
- ❑ It is examine the most recent Δ page references.
- ❑ The set of pages in the most recent Δ page references is the working set.
- ❑ If a page is in active use, it will be in the working set.
- ❑ If it is no longer being used, it will drop from the working set time units after its last reference.
- ❑ Thus, the working set is an approximation of the program's locality
- ❑ Approximate the **W-S** model with interval timer + a reference bit



- ❑ Example: $\Delta = 10,000$ references
 - ❑ Timer interrupts after every 5000 time units
 - ❑ Keep in memory 2 bits for each page
 - ❑ Whenever a timer interrupts copy and sets the values of all reference bits to 0
 - ❑ If one of the bits in memory = 1 \Rightarrow page in working set
- ❑ Why is this not completely accurate?
 - ❑ We cannot tell where, within an interval of 5000, a reference occurred.
- ❑ Improvement = 10 bits and interrupt every 1000 time units but overhead to service more frequent interrupts

? Parameter $\Delta \equiv$ working-set window \equiv a fixed number of page references

Example: 10,000 instructions

? WSS_i (working set of Process P_i) =

total number of pages referenced in the most recent Δ (parameter that varies in time)

? if Δ too small will not encompass entire locality

? if Δ too large will encompass several localities

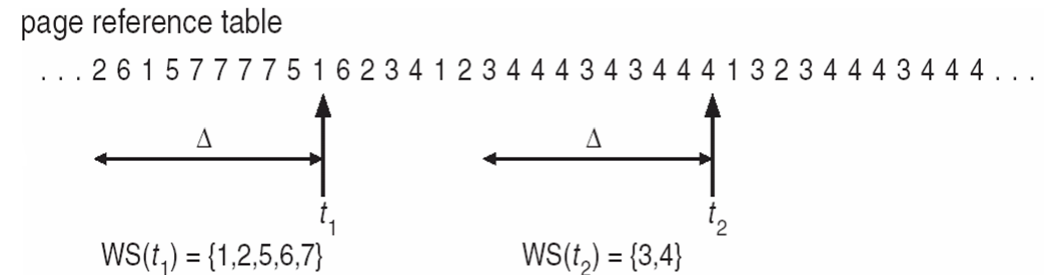
? if $\Delta = \infty \Rightarrow$ will encompass entire program

? $D = \sum WSS_i \equiv$ total demand frames

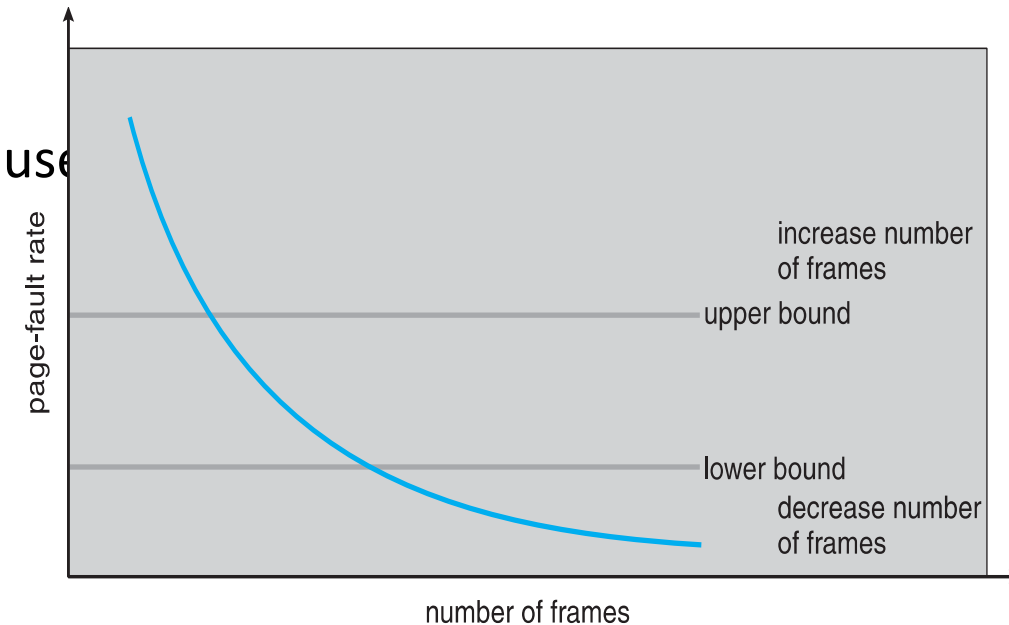
? Approximation of locality

? if $D > m$ (*available frames*) \Rightarrow Thrashing will occur

? Policy if $D > m$, then suspend or swap out one of the processes



- ❑ More direct approach than W-S model
 - ❑ Control the page-fault rate
 - ❑ Looks clumsy to control thrashing
- ❑ Establish “acceptable” **page-fault frequency (PFF)** rate and use local replacement policy
 - ❑ If actual rate too low, process loses frame
 - ❑ If actual rate too high, process gains frame.
 - ❑ processes can be suspended if the free frames is zero
- ❑ With the working-set strategy, we may have to swap out a process.
 - ❑ If page fault Increases and no free frames available





THANK YOU

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