Basics of Information Systems

Winter Semester 2022–23

For discussion on Wednesday, December 21, 2022

1. Show that if a process occupies m bytes of memory, virtual memory is divided into page frames of s bytes each, and the page table entry for each page requires t bytes of memory, then the optimal size of the page frame is

$$s = \sqrt{2\,m\,t}\,.$$

Hint: Assume that, on average, half of a page frame is wasted. Also assume that each page needs exactly one page table entry of t bytes.[1]

2. Continuing Problem 1: On 32-bit Intel architectures, the standard size of a page frame is $4\,\mathrm{KB} = 2^{12}\,\mathrm{B}$. A single entry in the page table requires $32\,\mathrm{bit} = 4\,\mathrm{B}$. What is the implicit assumption on the typical size of a process?

3. Continuing Problems 1 and 2: On 64-bit architectures, the size of a page table entry goes up to $64\,\mathrm{bit} = 8\,\mathrm{B}$. How does the result change? Comment!

4. (Forouzan, P7-9.) Three processes (A, B, and C) are running concurrently. Process A has acquired `File1`, but needs `File2`. Process B has acquired `File3`, but needs `File1`. Process C has acquired `File2`, but needs `File3`. Draw a diagram for these processes. Is this a deadlock situation?

5. (Forouzan, P7-10.) Three processes (A, B, and C) are running concurrently. Process A has acquired `File1`. Process B has acquired `File2`, but needs `File1`. Process C has acquired `File3`, but needs `File2`. Draw a diagram for these processes. Is this a deadlock situation? If your answer is "no", show how the processes can eventually finish their tasks.

6. One solution to the *dining philosophers problem* demands that only four of the five philosopher sit at the table at any one time. When a philosopher finishes eating, she gets up and lets the standing philosopher take a seat. Is this solution free of deadlock? Is starvation possible?

[1] In practice, things are more complicated as page tables are organized as multilevel trees to be able to efficiently address non-contiguous blocks of virtual memory. So the formula given is just a back-of-the-envelope estimate.