Operating System

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**OS 2021 Problem Sheet #7**

**Problem 7.1:** positioning algorithms

1. Best-fit

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | 17 KiB | 8 KiB | 10 KiB | 21 KiB | 12 KiB | 13 KiB | Unallocated |
| 11 KiB: |  |  |  |  | ////// |  |  |
|  |  |  |  |  | 12 KiB – 11 KiB  1 leftover |  |  |
| 9 KiB: |  |  | ////// |  |  |  |  |
|  |  |  | 10 KiB – 9 KiB  1 leftover |  |  |  |  |
| 7 KiB: |  | ////// |  |  |  |  |  |
|  |  | 8 KiB – 7 KiB  1 leftover |  |  |  |  |  |
| 16 KiB: | ////// |  |  |  |  |  |  |
|  | 17 KiB – 16 KiB  1 leftover |  |  |  |  |  |  |

Fragmentation = 1 KiB + 1 KiB + 1 KiB + 21 KiB + 1 KiB + 13 KiB = 38 KiB

1. Worst-fit

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | 17 KiB | 8 KiB | 10 KiB | 21 KiB | 12 KiB | 13 KiB | Unallocated |
| 11 KiB: |  |  |  | ////// |  |  |  |
|  |  |  |  | 21 KiB – 11 KiB  10 leftover |  |  |  |
| 9 KiB: | ////// |  |  |  |  |  |  |
|  | 17 KiB – 9 KiB  8 leftover |  |  |  |  |  |  |
| 7 KiB: |  |  |  |  |  | ////// |  |
|  |  |  |  |  |  | 13 KiB – 7 KiB  6 leftover |  |
| 16 KiB: |  |  |  |  |  |  | ////// |
|  |  |  |  |  |  |  | 16 KiB |

Fragmentation = 17 KiB + 8 KiB + 10 KiB + 10 KiB + 12 KiB + 6 KiB = 63 KiB

1. First-fit

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | 17 KiB | 8 KiB | 10 KiB | 21 KiB | 12 KiB | 13 KiB | Unallocated |
| 11 KiB: | ////// |  |  |  |  |  |  |
|  | 17 KiB – 11 KiB  6 leftover |  |  |  |  |  |  |
| 9 KiB: |  |  | ////// |  |  |  |  |
|  |  |  | 10 KiB – 9 KiB  1 leftover |  |  |  |  |
| 7 KiB: |  | ////// |  |  |  |  |  |
|  |  | 8 KiB – 7 KiB  1 leftover |  |  |  |  |  |
| 16 KiB: |  |  |  | ////// |  |  |  |
|  |  |  |  | 21 KiB – 16 KiB  5 leftover |  |  |  |

Fragmentation = 6 KiB + 1 KiB + 1 KiB + 5 KiB + 12 KiB + 13 KiB = 38 KiB

1. Next-fit

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | 17 KiB | 8 KiB | 10 KiB | 21 KiB | 12 KiB | 13 KiB | Unallocated |
| 11 KiB: | ////// |  |  |  |  |  |  |
|  | 17 KiB – 11 KiB  6 leftover |  |  |  |  |  |  |
| 9 KiB: |  |  | ////// |  |  |  |  |
|  |  |  | 10 KiB – 9 KiB  1 leftover |  |  |  |  |
| 7 KiB: |  |  |  | ////// |  |  |  |
|  |  |  |  | 21 KiB – 7 KiB  14 leftover |  |  |  |
| 16 KiB: |  |  |  |  |  |  | ////// |
|  |  |  |  |  |  |  | 16 KiB |

Fragmentation = 6 KiB + 8 KiB + 1 KiB + 14 KiB + 12 KiB + 13 KiB = 54 KiB

**Problem 7.2:** buddy system

1. A: +113 KiB, B: +56 KiB, C: +82 KiB, D: +30 KiB, E: +42 KiB, F: +48 KiB

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| 512 KiB | | | | | | |
| A | 128 KiB | | | 256 KiB | | |
| A | B | 64 KiB | | 256 KiB | | |
| A | B | 64 KiB | | C | 128 KiB | |
| A | B | D | 32 KiB | C | 128 KiB | |
| A | B | D | 32 KiB | C | E | 64 KiB |
| A | B | D | 32 KiB | C | E | F |

ii.

Fragmentations:

A: 128 – 113 = 15 KiB

B: 64 – 56 = 8 KiB

C: 128 – 82 = 46 KiB

D: 32 – 30 = 2 KiB

E: 64 – 42 = 22 KiB

F: 64 – 48 = 16 KiB

Overall internal fragmentation = 15 + 8 + 46 + 2 + 22 + 16 = 142 KiB

The largest chunk of memory that can be **allocated** is 32 KiB.

1. G: 132 KiB

No, it will not be allocated even if C return its allocation. When C return its allocation, the next available largest chunk of memory to be allocated will be 128 KiB. Since G will not be able to fit in that, it will not be allocated space.

**Problem 7.3:** buddy system

1. First-In-First-Out (FIFO)
   1. For two frames

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Reference string | 1 | 4 | 2 | 3 | 4 | 4 | 1 | 3 | 2 | 1 |
| Frame 0 | 1 | 1 | 2 | 2 | 4 | 4 | 4 | 3 | 3 | 1 |
| Frame 1 |  | 4 | 4 | 3 | 3 | 3 | 1 | 1 | 2 | 2 |
| Faults | x | x | x | x | x |  | x | x | x | x |

Hits = 1

Total page fault = 9

* 1. For three frames

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Reference string | 1 | 4 | 2 | 3 | 4 | 4 | 1 | 3 | 2 | 1 |
| Frame 0 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| Frame 1 |  | 4 | 4 | 4 | 4 | 4 | 1 | 1 | 1 | 1 |
| Frame 2 |  |  | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| Faults | x | x | x | x |  |  | x |  |  |  |

Hits = 5

Total page fault = 5

1. Belady’s Optimal (BO)
   1. For two frames

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Reference string | 1 | 4 | 2 | 3 | 4 | 4 | 1 | 3 | 2 | 1 |
| Frame 0 | 1 | 1 | 2 | 3 | 3 | 3 | 3 | 3 | 2 | 2 |
| Frame 1 |  | 4 | 4 | 4 | 4 | 4 | 1 | 1 | 1 | 1 |
| Faults | x | x | x | x |  |  | x |  | x |  |

Hits = 4

Total page fault = 6

* 1. For three frames

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Reference string | 1 | 4 | 2 | 3 | 4 | 4 | 1 | 3 | 2 | 1 |
| Frame 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Frame 1 |  | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| Frame 2 |  |  | 2 | 3 | 3 | 3 | 3 | 3 | 2 | 2 |
| Faults | x | x | x | x |  |  |  |  | x |  |

Hits = 5

Total page fault = 5

1. Least Recently Used (LRU)
   1. For two frames

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Reference string | 1 | 4 | 2 | 3 | 4 | 4 | 1 | 3 | 2 | 1 |
| Frame 0 | 1 | 1 | 2 | 2 | 4 | 4 | 4 | 4 | 2 | 3 |
| Frame 1 |  | 4 | 4 | 3 | 3 | 3 | 1 | 3 | 3 | 1 |
| Faults | x | x | x | x | x |  | x | x | x | x |

Hits = 1

Total page fault = 9

* 1. For three frames

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Reference string | 1 | 4 | 2 | 3 | 4 | 4 | 1 | 3 | 2 | 1 |
| Frame 0 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| Frame 1 |  | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 2 | 2 |
| Frame 2 |  |  | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 |
| Faults | x | x | x | x |  |  | x |  | x |  |

Hits = 4

Total page fault = 6