Discussion:

C \rightarrow \text{array = scalar} \rightarrow [\underline{\text{value}}]

main() {
    char line[80];
    getline(line, sizeof(line));
}

Alternative:

char * line = malloc(80)

free(line);

Page Table Entry (PTE): -

20

PPN

\[ \begin{array}{c}
20 \\
\hline
PPN
\end{array} \]

Present 0: generated page fault
0/1/W - o: Read only
P/U/* - mapping for user processes/OS system calls.

User mode -> supervision mode

Provided so that
us can measure
usage of memory
(cused by the TKB)
Accessed and dirty bits are used when swapping a process to the disk.

* enables to create a hierarchy of memory:
- CPU
- Cache
- RAM
- Disk.

* we have to exist another page home Page replacement algorithm.

Page Replacement:
- Applicable to replacements in TLB
- Disk buffers
- Whichever locality of reference comes into picture.

what is the page replacement problem:
- Given an access pattern \( a_1, a_2, \ldots, a_N \) an \( E \) virtual pages.
and physical pages \( P_1 \ldots P_m \) to \( N \) which \( P_i \) due of go in?

1. LRU - Least recently used
2. FIFO - First in first out
3. OPT - optimal algorithm
   (not realizable in a real system)

| access patterns | 1 2 3 4 | 2 1 2 4 | 5 4 2 3 | 6 5 3 2 1 3 |
|                | 1 2 3 4 | 4 1 2 2 | 5 4 3 3 | 6 5 2 1 3 |
|                | 1 2 3 4 | 3 4 1 1 | 2 5 5 4 | 3 6 6 5 2 3 |
| * 2            | 2 3 4 5 | 1 2 2 5 | 4 3 3 6 | 5 5 4 5 3 2 |

<table>
<thead>
<tr>
<th>FIFO</th>
<th>5 hits/15 misses</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 2 3 4</td>
<td>2 1 2 4</td>
</tr>
<tr>
<td>1 2 3 4</td>
<td>4 2 1 2</td>
</tr>
<tr>
<td></td>
<td>1 2 3 4</td>
</tr>
<tr>
<td></td>
<td>1 2 3 4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>LRU</th>
<th>8 hits/12 misses</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 1 1 1</td>
<td>1 1 1 1</td>
</tr>
<tr>
<td>2 2 2 2</td>
<td>2 2 2 2</td>
</tr>
<tr>
<td>3 4</td>
<td>4 4 4 4</td>
</tr>
</tbody>
</table>

| OPT            | 10 hits/10 misses |
* In practice LRU is efficient.
* All the misses represent a page fault.

**Clock Algorithm:**

- If not hit, evict it and bring a new page.
- Called a clock cause it (writing resembles that of a clock!!)

**Summarize:**

**FIFO:**

- Evict
- Fault

**LRU:**

- Access
- Fault
clock:

\[ y \xrightarrow{f_0} \text{evict} \]

\[ \text{fault} \]

Reading Assignment:

book 8.4, 8.7 — Paging
9.1, 9.4 — VM.