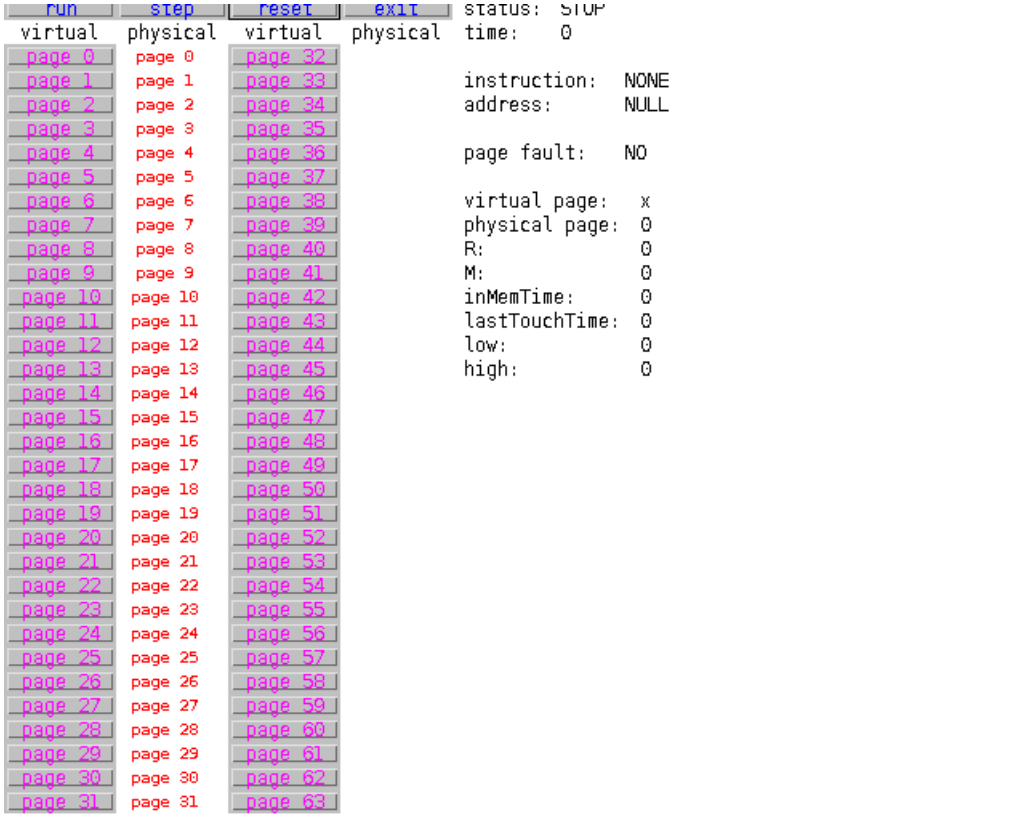
EOPSY Lab Task 4 – Filip Wasilewski

Setting

We have a simulator of memory management simulator. We can configure it using two files: commands, and memory.conf. The results of our simulation are displayed in the graphical UI provided, as well as the result log file „traceline”.



UI example

Clicking on virtual page number gives us in the parameters some information, the same as will be described in input files. For now i want to draw our attention to parameter physical page. It will give us number of page mapped to the selected virtual one.

The input files

This is how example file commands looks like:

READ bin 100

READ 19
WRITE hex CC32
READ bin 100000000000000
READ bin 100000000000000
WRITE bin 110000000000001
WRITE random

The commands pattern, which are READ/WRITE commands from specific address have a pattern:

READ <OPTIONAL number type: bin/hex/oct> <virtual memory address or 'random'>

WRITE <OPTIONAL number type: bin/hex/oct> <virtual memory address or 'random'>

The file memory.conf is a bit more complex. It looks like (without comments):

---

memset 0 0 0 0 0 0
memset 1 1 0 0 0 0
(there is 32 of these memset lines)

enable_logging true
log_file tracefile
pagesize 16384
addressradix 16
numpages 64

---

memset sets the virtual and physical page, the numbers next to it are:

- virt page #
- physical page #
- R (read from)
- M (modified)
- inMemTime (ns)
- lastTouchTime (ns)

enable_logging – ['true'/'false'] when true specify a log_file or leave blank for stdout. You specify name below in logfile property for the results to be printed there.

page size - defaults 2^14, can't be greater than 2^26

addressradix - sets the base in which numerical values are displayed

numpages – sets the number of pages (physical and virtual), defaults to 64, has to be at least 2 (because then we have one physical one virtual), and not more than 64

Result file

„Tracefile" has logs of operations, which were conducted. There is not a lot to look at here. The example logs look like this:

READ 4 ... okay
READ 13 ... okay
WRITE cc32 ... okay
READ 4000 ... okay
READ 4000 ... okay
WRITE 6001 ... okay
WRITE 78a4e ... okay

So we get update how the specific operation performed.

Task objective

The task is as follows:

1. Create a command file that maps any 8 pages of physical memory to the first 8 pages of virtual memory
2. Then the program reads from one virtual memory address on each of the 64 virtual pages.
3. We should step through the simulator one operation at a time and see if you can predict which virtual memory addresses cause page faults.
4. Last task is to determine page replacement algorithm is being used?

1, 2, 3 - Memory mapping and reading

Those tasks combined proved to be impossible to conduct! Why? Because numpages sets the number of pages always to be equal to each other. So when we want to map 8 physical pages, we need to have 8 virtual ones.

But the task is to read from all 64 of virtual pages, which is not possible even for 64 physical pages. Because numpages is a sum of those two types, we can have at most 32 pages virtually mapped to 32

pages physically (we can determine that because for max value of numpages, 64, only 32 physical pages are created and mapped to 32 virtual pages).

It does not mean we can't read from virtual page 32. It is that we immediately know when the program will return page fault – when we reach the page incorrectly mapped, when page 32 (i remind, because numeration starts from 0) will be operated on, due to the fact, that in it's physical page mapping parameter, in the program we have -1.

I will show in the next point, that the first page to fault will be the first one not mapped properly, so page 33, 32 in program

4 – Page replacement algorithm

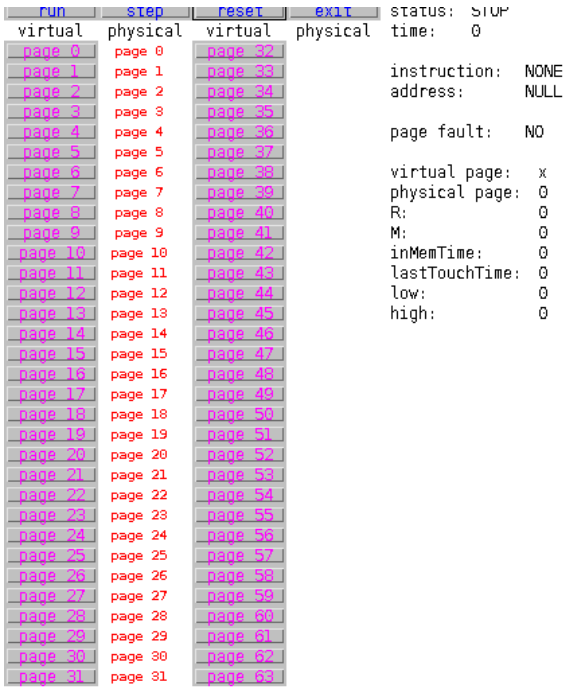
As an example, i will have two instructions in commands, one reads from the address, which would be page number 33 (numeration starts from 0), having mapped max of 32 pages. The other one will read from page 0. It will allow us to determine how pages are replaced.

This is how our commands file looks like:

WRITE hex 80000
WRITE hex 1

Where 0x80000 is the address in virtual page 32

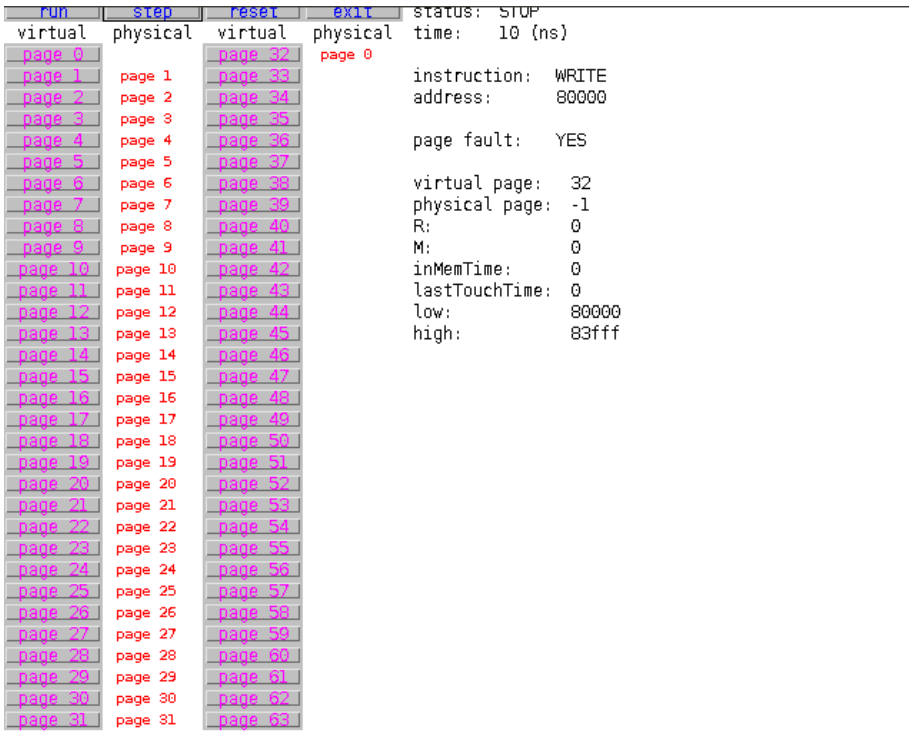
Let's look once more at the starting situation:



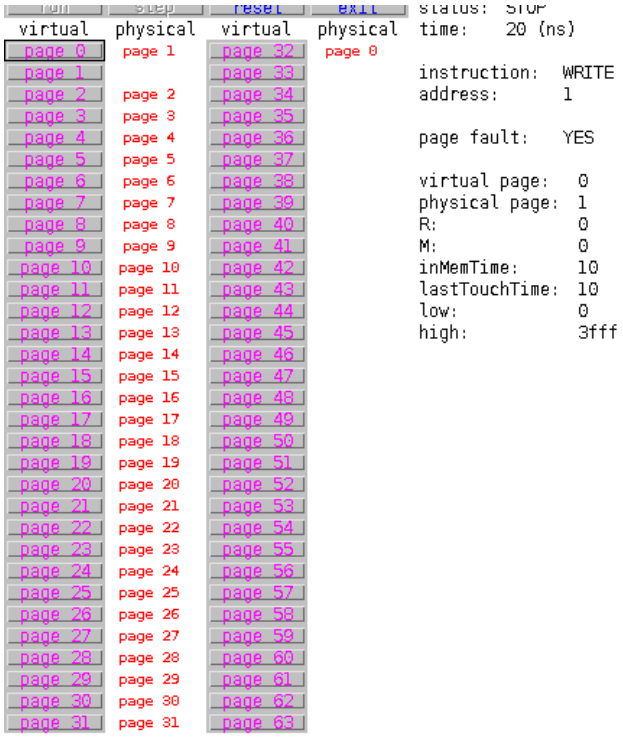
Then, when we execute the first instruction, surprise! Because there could be mapped max of 32 pages, 33rd (denoted here as 32) was not mapped, when we wrote to the address beyond mapped ones, the page faulted and we needed to use the algorithm to replace the page. Virtual page 33 is now mapped to physical page 0, whereas virtual 0 has no mapping.

There appears log in tracefile:

WRITE 80000 ... page fault



Going further, we see that with writing to page 0 now gives another page fault, another replacement happens:



As the file PageFault.java confirms, the algorithm used to replace pages is FIFO – First In First Out.

It keeps pages in a queue, from oldest to newest. When a replacement is called, front of queue is the one chosen to be removed, to assign somewhere where needed.

This explains, why the first page to be remapped was page 0, and consequently page 1 became next.