CS 240 Computer Systems

Week 5: File Formats and Memory

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Virtual Memory - Limited Resources

In our memory hierarchy, we know memory pages are loaded into the processor cache -- nearly always a page at a time -- but what if we want more storage than our RAM?

RAM:	P1 Page Table:	Disk Pages:	
[0]:	[0]:	...	1: Load Program 2: Run PC1 - malloc(4000) 3. Run PC2: - malloc(10000) - Open hiddenImage.png - Read all of image 4: Run PC3 - Access OG 4 KB - Finish program
[1]:	[1]:	./programCode (1/5)	
[2]:	[2]:	./programCode (2/5)	
[3]:	[3]:	./programCode (3/5)	
	[4]:	./programCode (4/5)	
	[5]:	./programCode (5/5)	
	[6]:		
	[7]:		
	[8]:		
	[9]:		
	[10]:		
	[11]:	hiddenImage.png	
	[12]:	hiddenImage.png	
	[13]:	hiddenImage.png	
	[14]:		
	[15]:	...	

...assume that this system has 4 KB pages.

Q1: What is the range of possible file sizes for **`hiddenImage.png`**?

Q2: What is the range of possible file sizes for **`./programCode`**?

Q3: What is the size of the heap immediately before the program finished?

Page Eviction/Replacement Strategies:

When we need to remove a page from RAM and store it on disk, how do we decide which page to remove?

[1]:

Page Accesses:	17	33	40	17	43	8	99	33	99	17
RAM										

[2]:

Page Accesses:	17	33	40	17	43	8	99	33	99	17
RAM										

[3]:

Page Accesses:	17	33	40	17	43	8	99	33	99	17
RAM										

[4]:

Page Accesses:	17	33	40	17	43	8	99	33	99	17
RAM										

[5]:

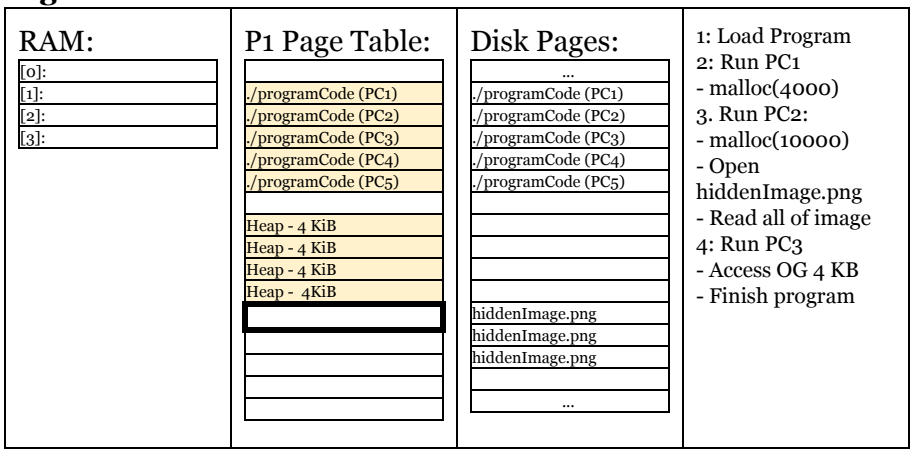
Page Accesses:	17	33	40	17	43	8	99	33	99	17
RAM										

<u>Remember:</u> We count the number of **page faults**, or the number of times we needed to replace the contents of a page of RAM, as a metric to determine the performance of an eviction scheme.

To accomplish page eviction, every page table entry has many status bits:

1.
2.
3.
4.
5.

Segmentation Faults



Q: What happens if we access the address of the **bold** entry inside of our page table above?

We know the following:

- Every page table entry takes 4B of space
- Every address between 0 - 2^{64} is addressable.
- Each 4 KB page needs its own page table entry.

Q: How big is our page table?

Q: How many entries can our page table have if we need to fit a page table into a single page?

Q: What can be to make this happen?