2 Make-up exams allowed

All on Friday. Preferences form will be released today

New questions - same format / similar content

If you have 5 exam points — do not sign up for retake

Lecture Thu

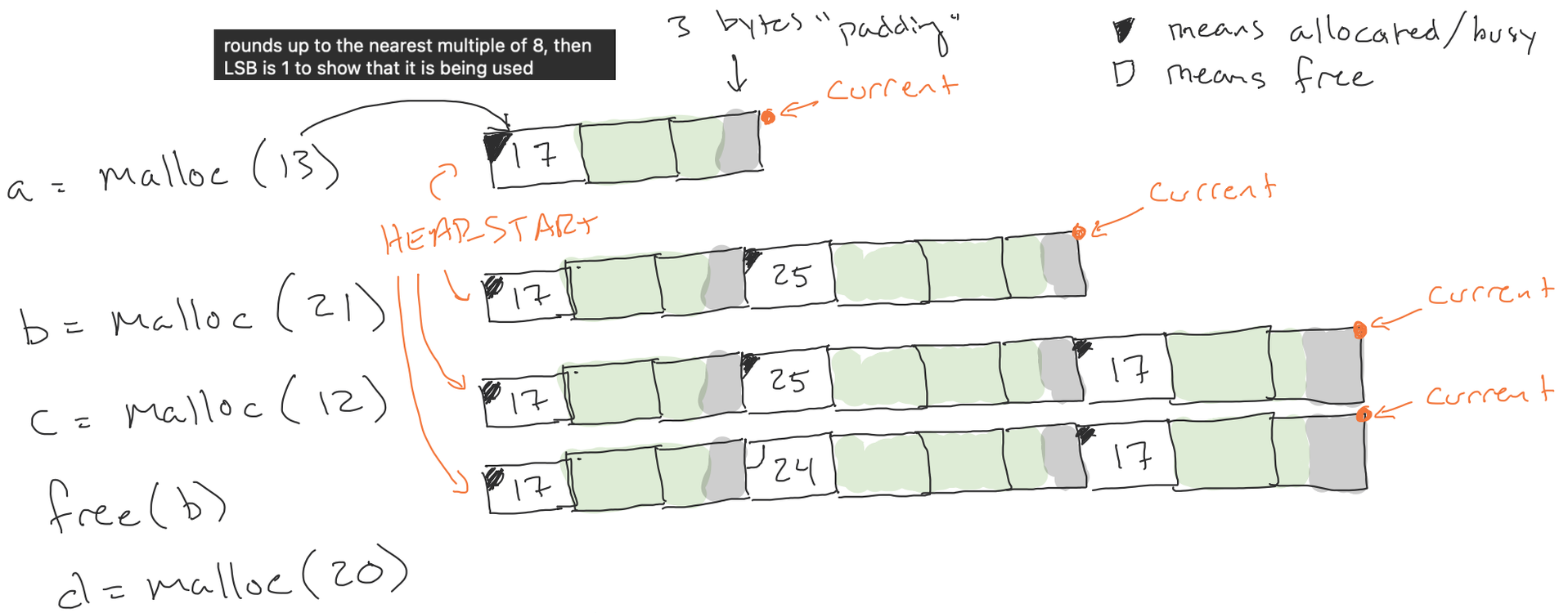
- exam review
- AMAA (Joe)
- fun topic — memory laid out in OS
  - Rust
  - other fun thing you want
  - rant about why malloc is bad and we shouldn't teach it

unrelated, but what does coalesce mean in the last question of the problem set

rounds up to the nearest multiple of 8, then LSB is 1 to show that it is being used

3 bytes "padding"

■ means allocated/busy
□ means free



GOAL: re-use space for b

Problem: our implementation used a variable "current" to use as the start of new mallocs

What to do? Need a better strategy for selecting space to use.

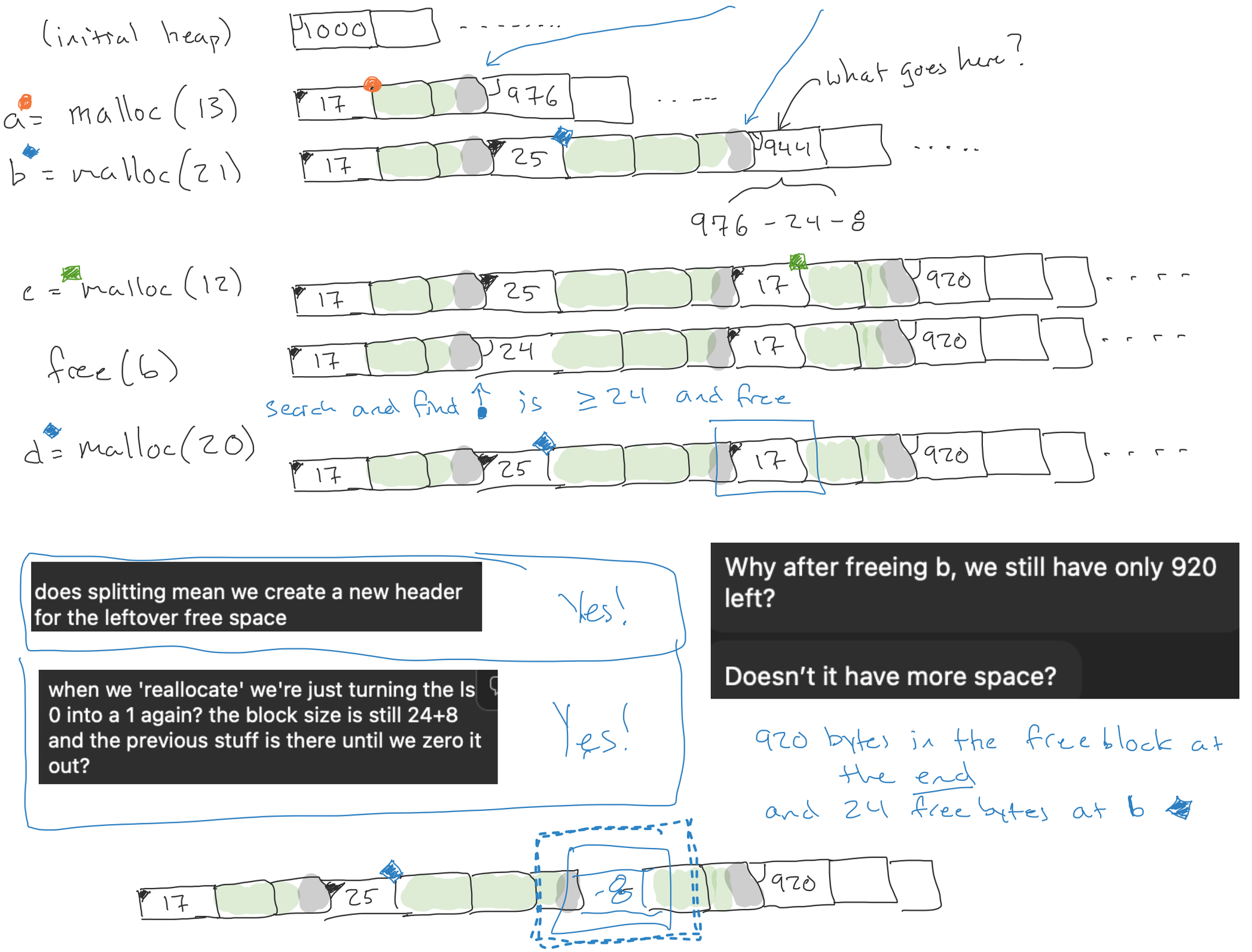
How to find the free space from "b"?

scan the start of the heap and use the first free block that is large enough??

Scan through existing memory blocks in the heap and use the first free block that fits

You need to scan the memory starting from the beginning or maintain a free list of available memory blocks.

split large block?



does splitting mean we create a new header for the leftover free space

Yes!

when we 'reallocate' we're just turning the ls 0 into a 1 again? the block size is still 24+8 and the previous stuff is there until we zero it out?

Yes!

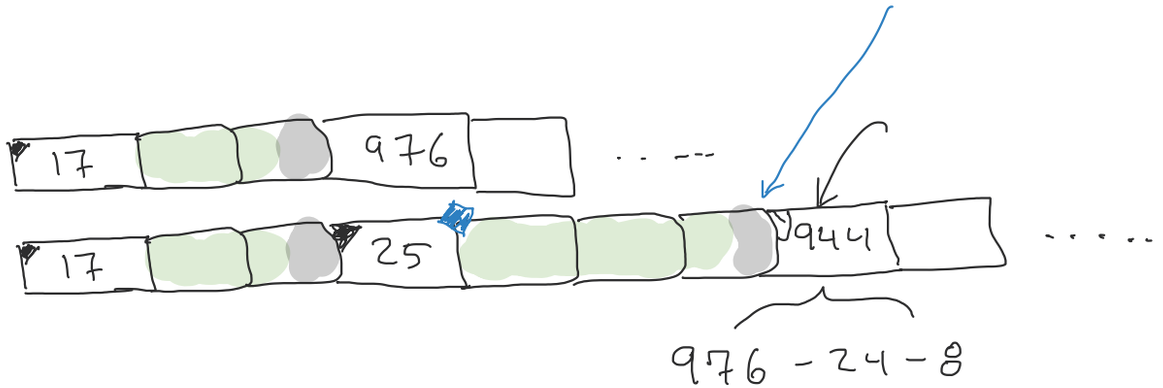
Why after freeing b, we still have only 920 left?

Doesn't it have more space?

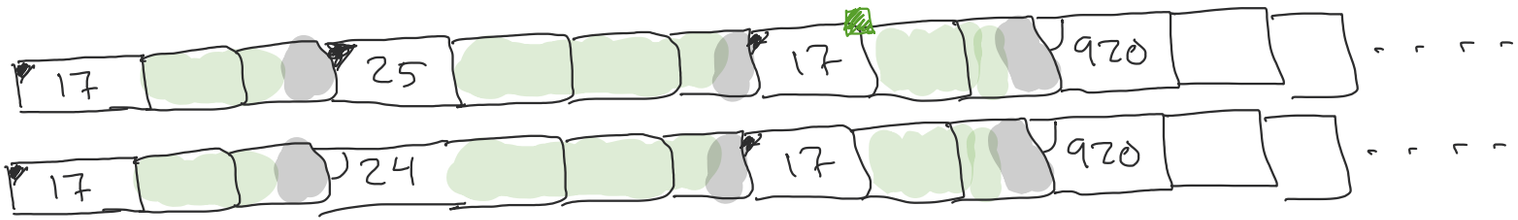
920 bytes in the free block at the end and 24 free bytes at b

a = malloc(13)

b = malloc(21)



e = malloc(12)



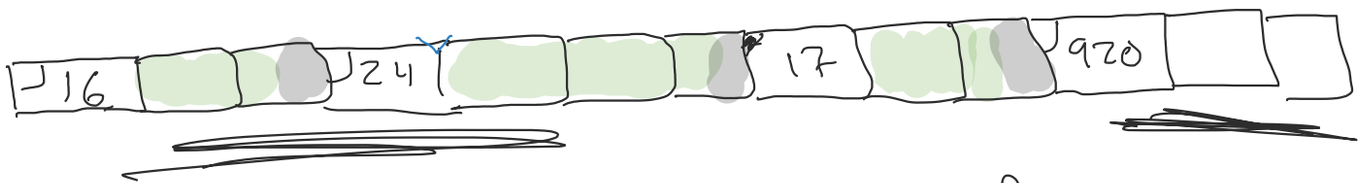
free(b)

search and find ↑ is ≥ 24 and free

d = malloc(20)

free(a)

free(d)



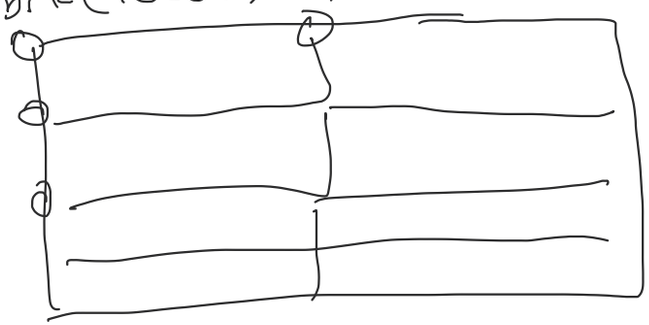
"coalescing" is the merging of adjacent free blocks

e = malloc(40)

Malloc design points:

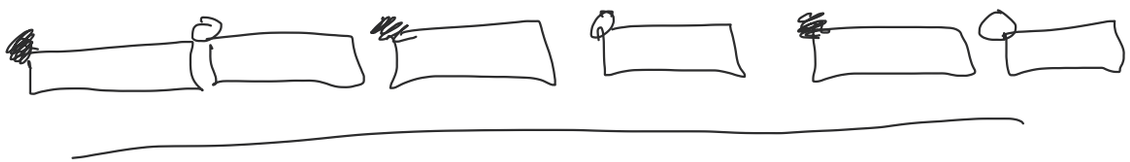
- throughput: how many ops/sec / how fast is malloc/free?
- utilization: how much overhead/wasted space?

sbrk(10000) // this is for 32 byte allocation



bitfield

- fragmentation
- coalescing



Allocators

Virtual Memory is the OS-level of these strategies

Variable/Role	*Address*	*Data* 0/8 1/9 2/A 3/B 4/C 5/D 6/E 7/F
	0x...00	
	0x...08	
	0x...10	
	0x...18	
	0x...20	
	0x...28	
	0x...30	
	0x...38	
	0x...40	
	0x...48	
	0x...50	
	0x...58	
	0x...60	
	0x...68	
	0x...70	
	0x...78	
	0x...80	
	0x...88	
	0x...90	
	0x...98	
	0x...A0	
	0x...A8	
	0x...B0	
	0x...B8	
	0x...C0	
	0x...C8	
	0x...D0	
	0x...D8	
	0x...E0	
	0x...E8	
	0x...F0	
	0x...F8	

Variable/Role	*Address*	*Data* 0/8 1/9 2/A 3/B 4/C 5/D 6/E 7/F
	0x...00	
	0x...08	
	0x...10	
	0x...18	
	0x...20	
	0x...28	
	0x...30	
	0x...38	
	0x...40	
	0x...48	
	0x...50	
	0x...58	
	0x...60	
	0x...68	
	0x...70	
	0x...78	
	0x...80	
	0x...88	
	0x...90	
	0x...98	
	0x...A0	
	0x...A8	
	0x...B0	
	0x...B8	
	0x...C0	
	0x...C8	
	0x...D0	
	0x...D8	
	0x...E0	
	0x...E8	
	0x...F0	
	0x...F8	

Variable/Role	*Address*	*Data* 0/8 1/9 2/A 3/B 4/C 5/D 6/E 7/F
	0x...00	
	0x...08	
	0x...10	
	0x...18	
	0x...20	
	0x...28	
	0x...30	
	0x...38	
	0x...40	
	0x...48	
	0x...50	
	0x...58	
	0x...60	
	0x...68	
	0x...70	
	0x...78	
	0x...80	
	0x...88	
	0x...90	
	0x...98	
	0x...A0	
	0x...A8	
	0x...B0	
	0x...B8	
	0x...C0	
	0x...C8	
	0x...D0	
	0x...D8	
	0x...E0	
	0x...E8	
	0x...F0	
	0x...F8	

Variable/Role	*Address*	*Data* 0/8 1/9 2/A 3/B 4/C 5/D 6/E 7/F
	0x...00	
	0x...08	
	0x...10	
	0x...18	
	0x...20	
	0x...28	
	0x...30	
	0x...38	
	0x...40	
	0x...48	
	0x...50	
	0x...58	
	0x...60	
	0x...68	
	0x...70	
	0x...78	
	0x...80	
	0x...88	
	0x...90	
	0x...98	
	0x...A0	
	0x...A8	
	0x...B0	
	0x...B8	
	0x...C0	
	0x...C8	
	0x...D0	
	0x...D8	
	0x...E0	
	0x...E8	
	0x...F0	
	0x...F8	

Variable/Role	*Address*	*Data* 0/8	1/9	2/A	3/B	4/C	5/D	6/E	7/F
	0x...88								
	0x...90								
	0x...98								
	0x...A0								
	0x...A8								
	0x...B0								
	0x...B8								
	0x...C0								
	0x...C8								
	0x...D0								
	0x...D8								
	0x...E0								
	0x...E8								
	0x...F0								
	0x...F8								
	0x...00								
	0x...08								
	0x...10								
	0x...18								
	0x...20								
	0x...28								
	0x...30								
	0x...38								
	0x...40								
	0x...48								
	0x...50								
	0x...58								
	0x...60								
	0x...68								
	0x...70								
	0x...78								
	0x...80								

Variable/Role	*Address*	*Data* 0/8	1/9	2/A	3/B	4/C	5/D	6/E	7/F
	0x...88								
	0x...90								
	0x...98								
	0x...A0								
	0x...A8								
	0x...B0								
	0x...B8								
	0x...C0								
	0x...C8								
	0x...D0								
	0x...D8								
	0x...E0								
	0x...E8								
	0x...F0								
	0x...F8								
	0x...00								
	0x...08								
	0x...10								
	0x...18								
	0x...20								
	0x...28								
	0x...30								
	0x...38								
	0x...40								
	0x...48								
	0x...50								
	0x...58								
	0x...60								
	0x...68								
	0x...70								
	0x...78								
	0x...80								