

## ① Tool - "Free"

Read "man free"

Few fns for memory allocations

- free
- malloc
- valloc
- aligned-alloc
- realloc

vm\_stat on mac shows stats  
for virtual memory .

## ②

Mach Virtual Memory Statistics: (page size of 16384 bytes)	
Pages free:	98168.
Pages active:	691320.
Pages inactive:	684476.
Pages speculative:	13938.
Pages throttled:	0.
Pages wired down:	201560.
Pages purgeable:	6604.
"Translation faults":	1653935639.
Pages copy-on-write:	92421749.
Pages zero filled:	752771768.
Pages reactivated:	173676792.
Pages purged:	17613184.
File-backed pages:	367871.
Anonymous pages:	1021863.
Pages stored in compressor:	1261568.
Pages occupied by compressor:	352611.
Decompressions:	86557747.
Compressions:	100539180.
Pageins:	24316419.
Pageouts:	793901.
Swapins:	1976000.
Swapouts:	2447101.

```
sysctl hw.memsize | awk '{print $2 / 1024 / 1024 " MB"}'  
32768 MB
```

$$= \frac{32768}{1024}$$

$$= 32\text{GB}$$

```
Memory Statistics (MB):  
Free Memory: 868.25 MB  
Active Memory: 11278.41 MB  
Inactive Memory: 10832.20 MB  
Wired Memory: 3120.88 MB  
Compressed Memory: 5374.77 MB
```

From intuition I expected free memory to be more.

Turns out "inactive memory" keeps recently used memory pages, kind of like a cache for disk to avoid slower load times.

It will be reclaimed if needed by the OS.

③ Memory-user.c  $\Rightarrow$  use malloc to allocate memory, for let's say a integer array.

Optional time param to make program exit post that.

4

## 100 MB program allocation

Memory Statistics (MB):	
Free Memory:	78.94 MB
Active Memory:	11594.23 MB
Inactive Memory:	11550.91 MB
Wired Memory:	3144.53 MB
Compressed Memory:	5509.86 MB

Program stopped

Memory Statistics (MB):	
Free Memory:	176.47 MB
Active Memory:	11527.70 MB
Inactive Memory:	11503.62 MB
Wired Memory:	3192.45 MB
Compressed Memory:	5501.64 MB

400 MB allocation program stopped

Memory Statistics (MB):	
Free Memory:	475.73 MB
Active Memory:	11402.22 MB
Inactive Memory:	11382.14 MB
Wired Memory:	3121.14 MB
Compressed Memory:	5518.55 MB

On free the  
free memory is  
more, until it  
becomes inactive  
memory possibly

At higher memory like 1000 MB, the  
inactive memory is reclaimed to be  
part of free so allocation can  
happen successfully.

*Allocated*

Memory Statistics (MB):	
Free Memory:	88.34 MB
Active Memory:	11173.06 MB
Inactive Memory:	11158.67 MB
Wired Memory:	3217.47 MB
Compressed Memory:	6267.45 MB

*1000 MB*

*Free allocation*

Memory Statistics (MB):	
Free Memory:	1074.94 MB
Active Memory:	10664.80 MB
Inactive Memory:	10629.47 MB
Wired Memory:	3239.48 MB
Compressed Memory:	6287.81 MB

(5) pmap  $\Rightarrow$  equivalent kind on Mac is  
vmmap

Read that one's man page.

(6)

vmmap pid  
Discord

MALLOC ZONE	VIRTUAL SIZE	RESIDENT SIZE	DIRTY SIZE	SWAPPED SIZE	ALLOCATION COUNT	BYTES ALLOCATED	DIRTY+SWAP FRAG SIZE	% FRAG	REGION COUNT
DefaultMallocZone_0x102e10000	512.0M	80K	80K	656K	1673	135K	601K	82%	1
MallocHelperZone_0x102dc8000	196.0M	64K	64K	496K	130	194K	366K	66%	13
DefaultPurgeableMallocZone_0x102e9c000	0K	0K	0K	0K	0	0K	0K	0%	0
_SBindingEvaluator_0x10a660000	0K	0K	0K	0K	0	0K	0K	0%	0
TOTAL	708.0M	144K	144K	1152K	1803	329K	967K	75%	14

==== Summary for process 19698

ReadOnly portion of Libraries: Total=1.7G resident=625.0M(36%) swapped\_out\_or\_unallocated=1.1G(64%)

Writable regions: Total=3.4G written=780.0M(22%) resident=722.0M(21%) swapped\_out=89.2M(3%) unallocated=2.6G(77%)

Memory Tag 253	1001dc04000-1001dc08000	[	16K	16K	16K	0K]	rw-/rwx	SM=PRV
Memory Tag 253	1001dc10000-1001dc24000	[	80K	0K	0K	80K]	rw-/rwx	SM=COW
Memory Tag 253	1001dc24000-1001dc38000	[	80K	0K	0K	0K]	rw-/rwx	SM=PRV

REGION TYPE	VIRTUAL SIZE	RESIDENT SIZE	DIRTY SIZE	SWAPPED SIZE	VOLATILE SIZE	NONVOL SIZE	EMPTY SIZE	REGION COUNT (non-coalesced)
Activity Tracing	256K	32K	0K	32K	0K	32K	0K	1
ColorSync	112K	0K	0K	112K	0K	0K	0K	4
IOKit	64K	16K	16K	0K	0K	0K	0K	4
IOSurface	320K	0K	0K	0K	0K	0K	0K	20
Image IO	304K	0K	0K	0K	0K	0K	304K	19
Kernel Alloc Once	32K	16K	16K	0K	0K	0K	0K	1
MALLOC guard page	192K	0K	0K	0K	0K	0K	0K	12
MALLOC metadata	432K	16K	16K	336K	0K	0K	0K	15
MALLOC_MEDIUM	128.0M	0K	80K	0K	0K	0K	0K	1
MALLOC_NANO	512.0M	80K	80K	656K	0K	0K	0K	1
MALLOC_SMALL	64.0M	16K	16K	320K	0K	0K	0K	8
MALLOC_TINY	4096K	48K	48K	96K	0K	0K	0K	4
Mach message	192K	160K	160K	32K	0K	0K	0K	6
Memory Tag 241	320K	0K	0K	80K	0K	0K	0K	4
Memory Tag 253	32.1G	148.2M	113.2M	71.8M	0K	0K	0K	6271
Memory Tag 253 (reserved)	2560K	0K	0K	0K	0K	0K	0K	8
Memory Tag 254	315.5M	121.1M	113.8M	0K	0K	0K	0K	2352
Memory Tag 255	1.1T	445.3M	422.6M	9472K	0K	0K	0K	7001
Memory Tag 255 (reserved)	256K	0K	0K	0K	0K	0K	0K	4
PROTECTED_MEMORY	16K	0K	0K	16K	0K	0K	0K	1
STACK GUARD	57.8M	0K	0K	0K	0K	0K	0K	113
Stack	898.3M	2288K	2288K	288K	0K	0K	0K	114
VM_ALLOCATE	3040K	1104K	1104K	32K	0K	0K	0K	30
_AUTH	4897K	2422K	14K	229K	0K	0K	0K	642
_AUTH_CONST	68.6M	36.1M	0K	0K	0K	0K	0K	884
_CTF	824	0K	0K	0K	0K	0K	0K	1
_DATA	25.3M	18.1M	1457K	1204K	0K	0K	0K	867
_DATA_CONST	33.4M	21.9M	3616K	6080K	0K	0K	0K	893
_DATA_DIRTY	2750K	1872K	278K	161K	0K	0K	0K	335
_FONT_DATA	2352	720	0K	0K	0K	0K	0K	1
_INFO_FILTER	8	8	0K	0K	0K	0K	0K	1
_LINKEDIT	587.3M	56.5M	0K	0K	0K	0K	0K	3
_OBJC_RW	2354K	2178K	2112	32K	0K	0K	0K	1

## ⑦ with -submap

==== Non-writable regions for process 71969									
REGION TYPE	START - END	[ VSIZE	RSDNT	DIRTY	SWAP]	PRT/MAX	SHRMOD	PURGE	REGION DETAIL
--TEXT	1046c8000-1046cc000	[ 16K	16K	0K	0K]	r--/r-x	SM=COW		/Users/USER/*/memory-user
--DATA_CONST	1046c9000-1046d0000	[ 16K	16K	0K	0K]	r--/rw-	SM=COW		/Users/USER/*/memory-user
--LINKEDIT	1046d0000-1046d4000	[ 16K	16K	0K	0K]	r--/---	SM=COW		/Users/USER/*/memory-user
shared memory	1046dc000-1046e4000	[ 32K	32K	32K	0K]	r--/---	SM=SHM		
MALLOC metadata	1046e4000-1046e8000	[ 16K	16K	16K	0K]	r--/rwx	SM=SHM		MallocHelperZone_0x1046e4000 zone structure
MALLOC guard page	1046fc000-1046f0000	[ 16K	0K	0K	0K]	---	SM=SHM		
MALLOC guard page	1046fc000-104700000	[ 16K	0K	0K	0K]	---	SM=SHM		
MALLOC guard page	104700000-104704000	[ 16K	0K	0K	0K]	---	SM=SHM		
MALLOC guard page	104710000-104714000	[ 16K	0K	0K	0K]	---	SM=SHM		
MALLOC guard page	104714000-104718000	[ 16K	0K	0K	0K]	---	SM=SHM		
MALLOC guard page	104724000-104728000	[ 16K	0K	0K	0K]	---	SM=SHM		
MALLOC metadata	104728000-10472c000	[ 16K	16K	16K	0K]	r--/rwx	SM=PRV		
MALLOC metadata	10472c000-104730000	[ 16K	16K	16K	0K]	r--/rwx	SM=SHM		DefaultMallocZone_0x10472c000 zone structure
STACK GUARD	167738000-16af3c000	[ 56.0M	0K	0K	0K]	---	SM=NUL		stack guard for thread 0
Submap	180000000-1f4000000	[ 1.8G	0K	0K	0K]	r--/---	SM=SHM		machine-wide VM submap

_DATA_CONST	1f14420f8-1f1442108	[ 16	16	0K	0K]	r--/rw-	SM=COW		/usr/lib/libSystem.B.dylib
Submap	1f400000-1f49b4000	[ 9936K	0K	0K	0K]	r--/---	SM=PRV		process-only VM submap
Submap	1f49d4000-1f6000000	[ 22.2M	0K	0K	0K]	r--/---	SM=PRV		process-only VM submap
Submap	1f6000000-1f6850000	[ 8512K	0K	0K	0K]	r--/---	SM=PRV		process-only VM submap
--TPRO_CONST	1f6850000-1f6850050	[ 80	80	0K	0K]	r--/rw-	SM=COW		/usr/lib/system/libdyld.dylib
--TPRO_CONST	1f6850050-1f6894058	[ 272K	48K	32K	0K]	r--/rw-	SM=COW		/usr/lib/dyld

⑧ running vmmap on my memory-user program that allocates memory for given size

# For 100MB

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==== Non-writable regions for process 71969									
REGION TYPE	START - END	VSIZE	RSDNT	DIRTY	SWAP]	PRT/MAX	SHRMOD	PURGE	REGION DETAIL
--TEXT	1046c8000-1046cc000	[ 16K	16K	0K	0K]	r-x/r-x	SM=COW		/Users/USER/*/memory-user
--DATA_CONST	1046cc000-1046d0000	[ 16K	16K	0K	0K]	r--/rw-	SM=COW		/Users/USER/*/memory-user
--LINKEDIT	1046d0000-1046d4000	[ 16K	16K	0K	0K]	r--/r--	SM=COW		/Users/USER/*/memory-user
shared memory	1046dc000-1046e4000	[ 32K	32K	32K	0K]	r--/r--	SM=SHM		
MALLOC metadata	1046e4000-1046e8000	[ 16K	16K	16K	0K]	r--/rwx	SM=SHM		MallocHelperZone_0x1046e4000 zone structure
MALLOC guard page	1046ec000-1046f0000	[ 16K	0K	0K	0K]	---/rwx	SM=SHM		
MALLOC guard page	1046fc000-104700000	[ 16K	0K	0K	0K]	---/rwx	SM=SHM		

==== Writable regions for process 71969									
REGION TYPE	START - END	VSIZE	RSDNT	DIRTY	SWAP]	PRT/MAX	SHRMOD	PURGE	REGION DETAIL
Kernel Alloc Once	1046d4000-1046dc000	[ 32K	16K	16K	0K]	rw-/rwx	SM=PRV		
MALLOC metadata	1046e8000-1046ec000	[ 16K	16K	16K	0K]	rw-/rwx	SM=SHM		
MALLOC metadata	1046f0000-1046f0000	[ 48K	32K	32K	0K]	rw-/rwx	SM=SHM		
MALLOC metadata	104784000-104710000	[ 48K	32K	32K	0K]	rw-/rwx	SM=SHM		
MALLOC metadata	104718000-104724000	[ 48K	32K	32K	0K]	rw-/rwx	SM=SHM		
MALLOC metadata	104730000-104734000	[ 16K	16K	16K	0K]	rw-/rwx	SM=SHM		
MALLOC_TINY	125e00000-125f00000	[ 1024K	32K	32K	0K]	rw-/rwx	SM=PRV		MallocHelperZone_0x1046e4000
MALLOC_LARGE metadata	125f00000-125f04000	[ 16K	16K	16K	0K]	rw-/rwx	SM=PRV		MallocHelperZone_0x1046e4000
MALLOC_SMALL	126000000-126800000	[ 8192K	32K	32K	0K]	rw-/rwx	SM=PRV		MallocHelperZone_0x1046e4000
MALLOC_LARGE	126800000-12cc00000	[100.0M	100.0M	100.0M	0K]	rw-/rwx	SM=PRV		MallocHelperZone_0x1046e4000

==== Summary for process 71969									
ReadOnly portion of Libraries: Total=589.9M resident=59.5M(10%) swapped_out_or_unallocated=530.4M(90%)									
Writable regions: Total=629.5M written=100.6M(16%) resident=100.7M(16%) swapped_out=0K(0%) unallocated=528.8M(84%)									
REGION TYPE	VIRTUAL SIZE	RESIDENT SIZE	DIRTY SIZE	SWAPPED SIZE	VOLATILE SIZE	NONVOL SIZE	EMPTY SIZE	REGION COUNT	(non-coalesced)
=====	=====	=====	=====	=====	=====	=====	=====	=====	=====
Kernel Alloc Once	32K	16K	16K	0K	0K	0K	0K	1	
MALLOC guard page	96K	0K	0K	0K	0K	0K	0K	6	
MALLOC metadata	224K	176K	176K	0K	0K	0K	0K	8	
MALLOC_LARGE	100.0M	100.0M	100.0M	0K	0K	0K	0K	1	see MALLOC ZONE table below
MALLOC_LARGE metadata	16K	16K	16K	0K	0K	0K	0K	1	see MALLOC ZONE table below
MALLOC_NANO	512.0M	128K	128K	0K	0K	0K	0K	1	see MALLOC ZONE table below
MALLOC_SMALL	8192K	32K	32K	0K	0K	0K	0K	1	see MALLOC ZONE table below
MALLOC_TINY	1024K	32K	32K	0K	0K	0K	0K	1	see MALLOC ZONE table below
STACK GUARD	56.0M	0K	0K	0K	0K	0K	0K	1	see MALLOC ZONE table below
Stack	8176K	96K	96K	0K	0K	0K	0K	1	
__AUTH	35K	35K	520	0K	0K	0K	0K	14	
__AUTH_CONST	198K	149K	0K	0K	0K	0K	0K	43	
__DATA	178K	176K	91K	0K	0K	0K	0K	39	
__DATA_CONST	109K	109K	0K	0K	0K	0K	0K	43	
__DATA_DIRTY	78K	78K	78K	0K	0K	0K	0K	22	
__LINKEDIT	584.3M	54.2M	0K	0K	0K	0K	0K	2	
__OBJC_RW	2354K	2210K	18K	0K	0K	0K	0K	1	
__TEXT	5676K	5388K	0K	0K	0K	0K	0K	45	
__TPRO_CONST	272K	48K	32K	0K	0K	0K	0K	2	
page table in kernel	273K	273K	273K	0K	0K	0K	0K	1	
shared memory	32K	32K	32K	0K	0K	0K	0K	1	
unused but dirty shlib __DATA	68K	68K	68K	0K	0K	0K	0K	25	
=====	=====	=====	=====	=====	=====	=====	=====	=====	=====
TOTAL	1.2G	163.1M	101.1M	0K	0K	0K	0K	260	
=====	=====	=====	=====	=====	=====	=====	=====	=====	=====
MALLOC ZONE	VIRTUAL SIZE	RESIDENT SIZE	DIRTY SIZE	SWAPPED SIZE	ALLOCATION COUNT	BYTES ALLOCATED	DIRTY+SWAP FRAG SIZE	% FRAG	REGION COUNT
=====	=====	=====	=====	=====	=====	=====	=====	=====	=====
DefaultMallocZone_0x10472c000	512.0M	128K	128K	0K	170	6K	122K	96%	1
MallocHelperZone_0x1046e4000	109.0M	100.1M	100.1M	0K	9	100.0M	73K	1%	4
=====	=====	=====	=====	=====	=====	=====	=====	=====	=====
TOTAL	621.0M	100.2M	100.2M	0K	179	100.0M	195K	1%	5

