

Available commands

```
Available Commands:  
init memory <size> - Initialize physical memory  
init virtual <vmem> <pmem> <page> - Initialize virtual memory  
init cache <1|2> - Initialize L1 or L2 cache  
set allocator <first|best|worst> - Set memory allocation strategy  
malloc <size> - Allocate memory  
free <id> - Free memory by ID  
read <address> - Read from memory (cache simulation)  
translate <virtual_addr> - Translate virtual to physical address  
dump - Show memory layout  
stats - Show memory statistics  
cache stats - Show cache statistics  
help - Show this help message  
exit - Exit simulator
```

Running sequential allocation txt file

```
> memory of size 1024 created  
> Allocator set  
> Memory allocated with ID: 1 using first-fit  
> Memory allocated with ID: 2 using first-fit  
> Memory allocated with ID: 3 using first-fit  
> Memory allocated with ID: 4 using first-fit  
> Memory allocated with ID: 5 using first-fit  
> Memory allotted from: 0 to: 49 to user with ID: 1  
Memory allotted from: 50 to: 124 to user with ID: 2  
Memory allotted from: 125 to: 224 to user with ID: 3  
Memory allotted from: 225 to: 349 to user with ID: 4  
Memory allotted from: 350 to: 499 to user with ID: 5  
Free memory from: 500 to: 1023  
> Total memory 1024  
Free memory 524  
Allocated memory 500  
Memory Utilization 48.8281%  
External Fragmentation 0%  
Internal Fragmentation 0%  
Total Allocation Attempts: 5  
Successful Allocations: 5  
Failed Allocations: 0  
Allocation Success Rate 100%
```

Fragmentation Test - Deallocation Behavior

```
==> Test 2: Fragmentation Test ==>
Memory Management Simulator
Type 'help' for available commands
> memory of size 800 created
> Allocator set
> Memory allocated with ID: 1 using first-fit
> Memory allocated with ID: 2 using first-fit
> Memory allocated with ID: 3 using first-fit
> Memory allocated with ID: 4 using first-fit
> Memory allotted from: 0 to: 99 to user with ID: 1
Memory allotted from: 100 to: 179 to user with ID: 2
Memory allotted from: 180 to: 299 to user with ID: 3
Memory allotted from: 300 to: 359 to user with ID: 4
Free memory from: 360 to: 799
> Total memory 800
Free memory 440
Allocated memory 360
Memory Utilization 45%
External Fragmentation 0%
Internal Fragmentation 0%
Total Allocation Attempts: 4
Successful Allocations: 4
Failed Allocations: 0
Allocation Success Rate 100%
> Memory with ID 2 freed successfully
> Memory with ID 4 freed successfully
> Memory allotted from: 0 to: 99 to user with ID: 1
Free memory from: 100 to: 179
Memory allotted from: 180 to: 299 to user with ID: 3
Free memory from: 300 to: 799
> Total memory 800
Free memory 580
```

```
Allocated memory 220
Memory Utilization 27.5%
External Fragmentation 13.7931%
Internal Fragmentation 0%
Total Allocation Attempts: 4
Successful Allocations: 4
Failed Allocations: 0
Allocation Success Rate 100%
> Memory allocated with ID: 5 using first-fit
> Memory allocated with ID: 6 using first-fit
> Memory allotted from: 0 to: 99 to user with ID: 1
Memory allotted from: 100 to: 149 to user with ID: 5
Free memory from: 150 to: 179
Memory allotted from: 180 to: 299 to user with ID: 3
Memory allotted from: 300 to: 339 to user with ID: 6
Free memory from: 340 to: 799
> Total memory 800
Free memory 490
Allocated memory 310
Memory Utilization 38.75%
External Fragmentation 6.12245%
Internal Fragmentation 0%
Total Allocation Attempts: 6
Successful Allocations: 6
Failed Allocations: 0
Allocation Success Rate 100%
```

Cache Hit Test

```
==== Test 3: Cache Hit Test ====
Memory Management Simulator
Type 'help' for available commands
> memory of size 2048 created
> Enter Cache size
Enter Block Size
Enter associativity
> Found in main memory
> Found in L1 cache
> Found in main memory
> Found in L1 cache
> Found in L1 cache
> Found in main memory
> Found in L1 cache
> L1 Cache - Hits: 4, Misses: 3, Hit Ratio: 0.571429
L1 Cache - Hits: 4, Misses: 3, Hit Ratio: 0.571429
> End
```

Running multilevel cache test.txt file

```
ForegroundColor Cyan ; Get-Content tests\multilevel_cache_test.txt | .  
==== Test: Multi-level Cache Test ===  
Memory Management Simulator  
Type 'help' for available commands  
> memory of size 4096 created  
> Enter Cache size  
Enter Block Size  
Enter associativity  
> Enter Cache size  
Enter Block Size  
Enter associativity  
> Found in main memory  
> Found in main memory  
> Found in L1 cache  
> Found in main memory  
> Found in L1 cache  
> Found in main memory  
> Found in L1 cache  
> L1 Cache - Hits: 3, Misses: 4, Hit Ratio: 0.428571  
L2 Cache - Hits: 0, Misses: 4, Hit Ratio: 0  
L1 Cache - Hits: 3, Misses: 4, Hit Ratio: 0.428571  
L2 Cache - Hits: 0, Misses: 4, Hit Ratio: 0  
.
```

LRU Replacement Test

```
==> LRU Replacement Test ==>
Memory Management Simulator
Type 'help' for available commands
> memory of size 2048 created
> Enter Cache size
> Enter Block Size
> Enter associativity
> > Found in main memory
> Found in L1 cache
> > > Found in main memory
> Found in L1 cache
> Found in L1 cache
> > > Found in main memory
> Found in L1 cache
> > L1 Cache - Hits: 4, Misses: 3, Hit Ratio: 0.571429
L1 Cache - Hits: 4, Misses: 3, Hit Ratio: 0.571429
```

Basic Translation Test – Page Faults

```
==> Basic Translation Test ==>
Memory Management Simulator
Type 'help' for available commands
> memory of size 1024 created
> Virtual memory initialized: 2048 virtual, 1024 physical, page size 256
Virtual memory initialized: 2048 virtual, 1024 physical, page size 256
> Virtual address 0 -> Physical address 768
Virtual address 0 -> Physical address 768
> Virtual address 100 -> Physical address 868
Virtual address 100 -> Physical address 868
> Virtual address 256 -> Physical address 512
Virtual address 256 -> Physical address 512
> Virtual address 500 -> Physical address 756
Virtual address 500 -> Physical address 756
> Virtual address 1000 -> Physical address 488
Virtual address 1000 -> Physical address 488
> Virtual address 1500 -> Physical address 220
Virtual address 1500 -> Physical address 220
```

Page Fault Test -LRU

```
==> Test: Page Fault Test ==>
Memory Management Simulator
Type 'help' for available commands
> Virtual memory initialized: 2048 virtual, 512 physical, page size 256
Virtual memory initialized: 2048 virtual, 512 physical, page size 256
> Virtual address 0 -> Physical address 256
Virtual address 0 -> Physical address 256
> Virtual address 256 -> Physical address 0
Virtual address 256 -> Physical address 0
> Virtual address 512 -> Physical address 256
Virtual address 512 -> Physical address 256
> Virtual address 0 -> Physical address 0
Virtual address 0 -> Physical address 0
> Virtual address 768 -> Physical address 256
Virtual address 768 -> Physical address 256
> Virtual address 256 -> Physical address 0
Virtual address 256 -> Physical address 0
```

Allocators Comparison

```
==> Test: Allocator Comparison Test ==>
Memory Management Simulator
Type 'help' for available commands
> memory of size 1000 created
> Allocator set
> Memory allocated with ID: 1 using first-fit
> Memory allocated with ID: 2 using first-fit
> Memory allocated with ID: 3 using first-fit
> Memory allocated with ID: 4 using first-fit
> Memory allocated with ID: 5 using first-fit
> Memory allotted from: 0 to: 99 to user with ID: 1
Memory allotted from: 100 to: 299 to user with ID: 2
Memory allotted from: 300 to: 399 to user with ID: 3
Memory allotted from: 400 to: 549 to user with ID: 4
Memory allotted from: 550 to: 649 to user with ID: 5
Free memory from: 650 to: 999
> Total memory 1000
Free memory 350
Allocated memory 650
Memory Utilization 65%
External Fragmentation 0%
Internal Fragmentation 0%
Total Allocation Attempts: 5
Successful Allocations: 5
Failed Allocations: 0
Allocation Success Rate 100%
> Memory with ID 2 freed successfully
> Memory with ID 4 freed successfully
> Memory allotted from: 0 to: 99 to user with ID: 1
Free memory from: 100 to: 299
Memory allotted from: 300 to: 399 to user with ID: 3
Free memory from: 400 to: 549
```

```
Memory allotted from: 550 to: 649 to user with ID: 5
Free memory from: 650 to: 999
> Total memory 1000
Free memory 700
Allocated memory 300
Memory Utilization 30%
External Fragmentation 50%
Internal Fragmentation 0%
Total Allocation Attempts: 5
Successful Allocations: 5
Failed Allocations: 0
Allocation Success Rate 100%
> Memory allocated with ID: 6 using first-fit
> Memory allocated with ID: 7 using first-fit
> Memory allotted from: 0 to: 99 to user with ID: 1
Memory allotted from: 100 to: 179 to user with ID: 6
Memory allotted from: 180 to: 239 to user with ID: 7
Free memory from: 240 to: 299
Memory allotted from: 300 to: 399 to user with ID: 3
Free memory from: 400 to: 549
Memory allotted from: 550 to: 649 to user with ID: 5
Free memory from: 650 to: 999
> Total memory 1000
Free memory 560
Allocated memory 440
Memory Utilization 44%
External Fragmentation 37.5%
Internal Fragmentation 0%
Total Allocation Attempts: 7
Successful Allocations: 7
Failed Allocations: 0
```

```
Allocation Success Rate 100%
> memory of size 1000 created
> Allocator set
> Memory allocated with ID: 1 using best-fit
> Memory allocated with ID: 2 using best-fit
> Memory allocated with ID: 3 using best-fit
> Memory allocated with ID: 4 using best-fit
> Memory allocated with ID: 5 using best-fit
> Memory allotted from: 0 to: 99 to user with ID: 1
Memory allotted from: 100 to: 299 to user with ID: 2
Memory allotted from: 300 to: 399 to user with ID: 3
Memory allotted from: 400 to: 549 to user with ID: 4
Memory allotted from: 550 to: 649 to user with ID: 5
Free memory from: 650 to: 999
> Total memory 1000
Free memory 350
Allocated memory 650
Memory Utilization 65%
External Fragmentation 0%
Internal Fragmentation 0%
Total Allocation Attempts: 5
Successful Allocations: 5
Failed Allocations: 0
Allocation Success Rate 100%
> Memory with ID 2 freed successfully
> Memory with ID 4 freed successfully
> Memory allotted from: 0 to: 99 to user with ID: 1
Free memory from: 100 to: 299
Memory allotted from: 300 to: 399 to user with ID: 3
Free memory from: 400 to: 549
Memory allotted from: 550 to: 649 to user with ID: 5
Free memory from: 650 to: 999
```

```
> Total memory 1000
Free memory 700
Allocated memory 300
Memory Utilization 30%
External Fragmentation 50%
Internal Fragmentation 0%
Total Allocation Attempts: 5
Successful Allocations: 5
Failed Allocations: 0
Allocation Success Rate 100%
> Memory allocated with ID: 6 using best-fit
> Memory allocated with ID: 7 using best-fit
> Memory allotted from: 0 to: 99 to user with ID: 1
Free memory from: 100 to: 299
Memory allotted from: 300 to: 399 to user with ID: 3
Memory allotted from: 400 to: 479 to user with ID: 6
Memory allotted from: 480 to: 539 to user with ID: 7
Free memory from: 540 to: 549
Memory allotted from: 550 to: 649 to user with ID: 5
Free memory from: 650 to: 999
> Total memory 1000
Free memory 560
Allocated memory 440
Memory Utilization 44%
External Fragmentation 37.5%
Internal Fragmentation 0%
Total Allocation Attempts: 7
Successful Allocations: 7
Failed Allocations: 0
Allocation Success Rate 100%
> memory of size 1000 created
> Allocator set
```

```
> Allocator set
> Memory allocated with ID: 1 using worst-fit
> Memory allocated with ID: 2 using worst-fit
> Memory allocated with ID: 3 using worst-fit
> Memory allocated with ID: 4 using worst-fit
> Memory allocated with ID: 5 using worst-fit
> Memory allotted from: 0 to: 99 to user with ID: 1
Memory allotted from: 100 to: 299 to user with ID: 2
Memory allotted from: 300 to: 399 to user with ID: 3
Memory allotted from: 400 to: 549 to user with ID: 4
Memory allotted from: 550 to: 649 to user with ID: 5
Free memory from: 650 to: 999
> Total memory 1000
Free memory 350
Allocated memory 650
Memory Utilization 65%
External Fragmentation 0%
Internal Fragmentation 0%
Total Allocation Attempts: 5
Successful Allocations: 5
Failed Allocations: 0
Allocation Success Rate 100%
> Memory with ID 2 freed successfully
> Memory with ID 4 freed successfully
> Memory allotted from: 0 to: 99 to user with ID: 1
Free memory from: 100 to: 299
Memory allotted from: 300 to: 399 to user with ID: 3
Free memory from: 400 to: 549
Memory allotted from: 550 to: 649 to user with ID: 5
Free memory from: 650 to: 999
> Total memory 1000
Free memory 700
```

Allocation Failure Test

```
==> Test: Allocation Failure Test ==
Memory Management Simulator
Type 'help' for available commands
> memory of size 500 created
> Allocator set
> Memory allocated with ID: 1 using first-fit
> Memory allocated with ID: 2 using first-fit
> Memory allocated with ID: 3 using first-fit
> Memory allotted from: 0 to: 99 to user with ID: 1
Memory allotted from: 100 to: 249 to user with ID: 2
Memory allotted from: 250 to: 369 to user with ID: 3
Free memory from: 370 to: 499
> Total memory 500
Free memory 130
Allocated memory 370
Memory Utilization 74%
External Fragmentation 0%
Internal Fragmentation 0%
Total Allocation Attempts: 3
Successful Allocations: 3
Failed Allocations: 0
Allocation Success Rate 100%
> memory not available
> Memory allocated with ID: 4 using first-fit
> Memory allocated with ID: 5 using first-fit
> Memory allotted from: 0 to: 99 to user with ID: 1
Memory allotted from: 100 to: 249 to user with ID: 2
Memory allotted from: 250 to: 369 to user with ID: 3
Memory allotted from: 370 to: 449 to user with ID: 4
Memory allotted from: 450 to: 499 to user with ID: 5
> Total memory 500
```

```
Free memory 0
Allocated memory 500
Memory Utilization 100%
External Fragmentation 0%
Internal Fragmentation 0%
Total Allocation Attempts: 6
Successful Allocations: 5
Failed Allocations: 1
Allocation Success Rate 83.3333%
> Memory with ID 2 freed successfully
> Memory allotted from: 0 to: 99 to user with ID: 1
Free memory from: 100 to: 249
Memory allotted from: 250 to: 369 to user with ID: 3
Memory allotted from: 370 to: 449 to user with ID: 4
Memory allotted from: 450 to: 499 to user with ID: 5
> Total memory 500
Free memory 150
Allocated memory 350
Memory Utilization 70%
External Fragmentation 0%
Internal Fragmentation 0%
Total Allocation Attempts: 6
Successful Allocations: 5
Failed Allocations: 1
Allocation Success Rate 83.3333%
> memory not available
> memory not available
> Memory allocated with ID: 6 using first-fit
> Memory allotted from: 0 to: 99 to user with ID: 1
Memory allotted from: 100 to: 199 to user with ID: 6
Free memory from: 200 to: 249
```

```
Memory allotted from: 250 to: 369 to user with ID: 3
Memory allotted from: 370 to: 449 to user with ID: 4
Memory allotted from: 450 to: 499 to user with ID: 5
> Total memory 500
Free memory 50
Allocated memory 450
Memory Utilization 90%
External Fragmentation 0%
Internal Fragmentation 0%
Total Allocation Attempts: 9
Successful Allocations: 6
Failed Allocations: 3
Allocation Success Rate 66.6667%
```

Full System Integration Test

```
Memory Management Simulator
Type 'help' for available commands
> memory of size 2048 created
> Allocator set
> Enter Cache size
Enter Block Size
Enter associativity
> Enter Cache size
Enter Block Size
Enter associativity
> Virtual memory initialized: 4096 virtual, 2048 physical, page size 256
Virtual memory initialized: 4096 virtual, 2048 physical, page size 256
> Memory allocated with ID: 1 using best-fit
> Found in main memory
> Virtual address 500 -> Physical address 2036
Virtual address 500 -> Physical address 2036
> Memory allocated with ID: 2 using best-fit
> Found in main memory
> Virtual address 1000 -> Physical address 1768
Virtual address 1000 -> Physical address 1768
> Memory with ID 1 freed successfully
> Found in L1 cache
> Virtual address 1500 -> Physical address 1500
Virtual address 1500 -> Physical address 1500
> Free memory from: 0 to: 199
Memory allotted from: 200 to: 349 to user with ID: 2
Free memory from: 350 to: 2047
> Total memory 2048
Free memory 1898
Allocated memory 150
```

```
Memory Utilization 7.32422%
External Fragmentation 10.5374%
Internal Fragmentation 0%
Total Allocation Attempts: 2
Successful Allocations: 2
Failed Allocations: 0
Allocation Success Rate 100%
> L1 Cache - Hits: 1, Misses: 2, Hit Ratio: 0.333333
L2 Cache - Hits: 0, Misses: 2, Hit Ratio: 0
L1 Cache - Hits: 1, Misses: 2, Hit Ratio: 0.333333
L2 Cache - Hits: 0, Misses: 2, Hit Ratio: 0
> End
```