



**#ASLI ENGINEERING**

# Mark and Sweep Garbage Collection



**BY**

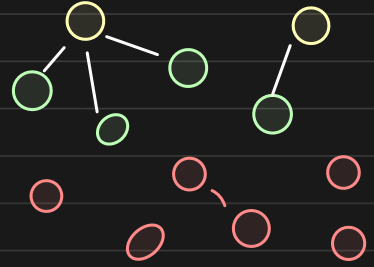
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# Mark and Sweep Garbage Collection

The core idea:

## PHASE 1: MARKING

Collector traverses through the graph of objects and **marking** each one it finds



## PHASE 2: SWEEPING

Collector traverses all the objects in the heap and deletes that are **unmarked** **unreachable from the root**

**Root:** registers, thread stack, global variables

Mark Sweep is an **indirect** collection algorithm

↳ it identifies what's live

↳ everything else becomes the **garbage**

## Mutator and Collector Threads

Usual development stuff

Garbage Collector

NEW → Creating obj  
READ → Reading obj  
WRITE → Writing obs

→ COLLECTOR

To simplify, we assume

↳ stop-the-world GC

all mutator threads stop,

↳ while the collector thread is cleaning up

↳ multiple mutator threads, but one collector thread

\* We would gradually increase the complexity

Any automatic memory management system has 3 tasks:

- allocate space for new objects
- identify LIVE objects
- reclaim space occupied by dead objects

When is collector thread invoked?

When the NEW command is fired  
but the mutator thread is unable  
to allocate the object.

def new():

obj = allocate()

if obj = NULL:

collect()

obj = allocate()

if obj = NULL:

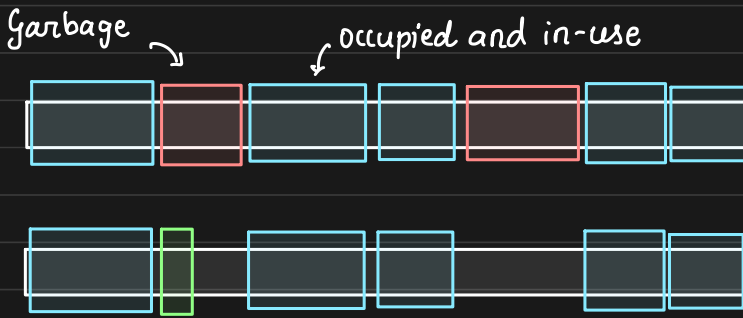
raise "Out of Memory"

return obj

Invoke the  
Garbage Collector

If still unable to  
allocate, throw error

FATAL ERROR [often]



Runtime tries to allocate a chunk of memory but it fails, it triggers a cleanup and retries

## Phase 1: Prepare the root list

The garbage collector prepares the root list traversing which it will identify the **LIVE** objects

The root objects are thread stack, global vars

```
def get_roots():
    return ROOTS
    ↑
    detailed implementation
    in the future
```

## Phase 2: Mark roots and proceed

Each root is **marked** and added to the list.

```
def mark_roots():
    for root in ROOTS:
        root.is_marked = True
        list.add(root)
        mark()
```

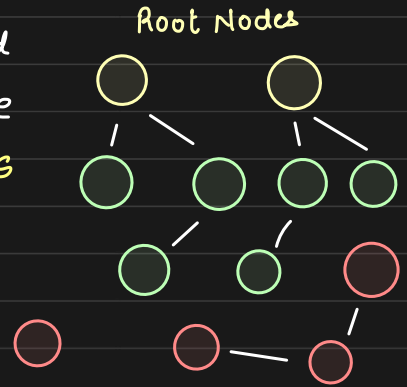
Add the marked root to the list for further processing

Start the mark phase

\* By invoking the 'mark()' after each root we keep the list smaller → lesser load on memory

But can keep out as well.

The 'list' we used to put all the marked roots and other referenced objects can be a **Stack** and our **marking** becomes a **DFS**



### Phase 3: mark

For each root we initiate **marking** in which we traverse all the objects reachable from it and **mark** them, and continue to do this till we have visited and marked all reachable obj

```
def mark():
```

```
    while not list.empty():
```

```
        obj = list.pop()
```

```
        for c_obj in CHLD(obj):
```

```
            if c_obj.is_marked:
```

```
                continue
```

```
                c_obj.is_marked = 1
```

```
                list.add(c_obj)
```

continue, if already marked

mark the child obj

Add the unvisited

child in the list

\* Any unmarked object is **garbage**

## Phase 4: Sweep

The sweep phase iterates through all the objects allocated on the heap and

- frees the unmarked objects
- unmarks the marked object

↑  
prepare them for the next cycle

```
def sweep():
```

```
    for obj in OBJECTS:
```

```
        if NOT obj.is_marked:
```

```
            free(obj)
```

```
        else
```

```
            obj.is_marked = False
```

## Super Optimization: ★

We can save effort to reset marked bit

if we can flip the meaning every GC cycle

eg: CYCLE 1: Bit 1 → marked

Bit 0 → unmarked

CYCLE 2: Bit 0 → marked

Bit 1 → unmarked