GUIDE TO DX

event loop

IN ECMASCRIPT

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event loop

The event loop is the runtime model in ECMAScript

To understand the event loop
is to understand how ECMAScript
code is executed.

- code execution
- event handling
- memory management

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The event loop is an infinite loop
that runs for as long as there is
is an active execution context

Everything happens automatically ,
the developer needs to do nothing other
than understand the mechanism.

fundamental concept

low-level

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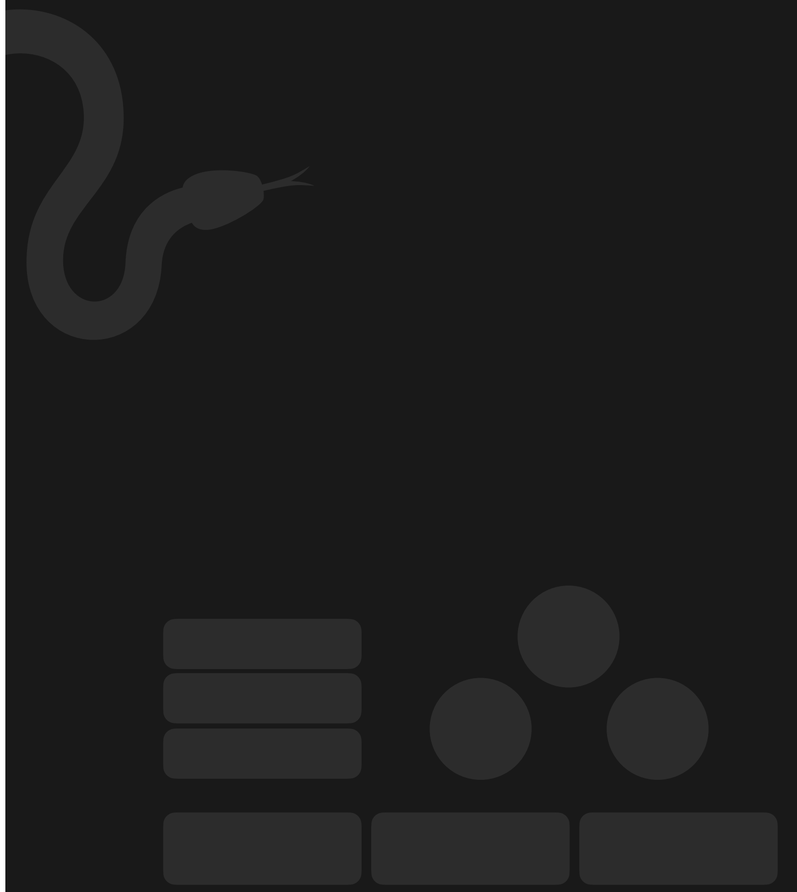
Three parts make up the event loop:

- Stack: contains all function calls
- Heap: contains all variables
- Queue: contains all messages



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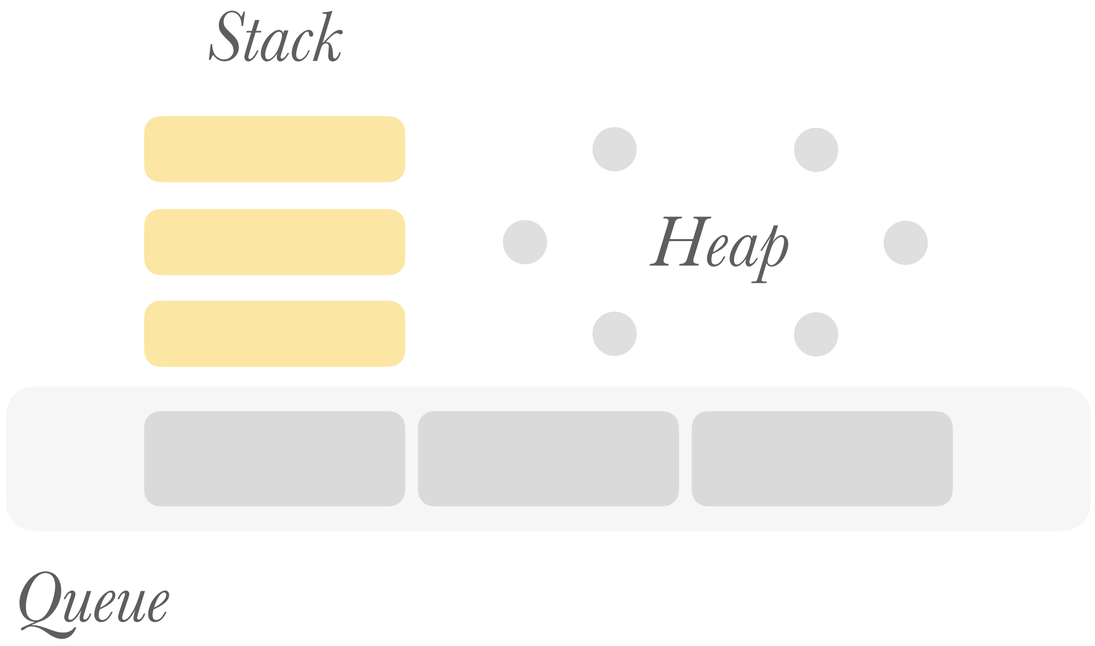

visualized

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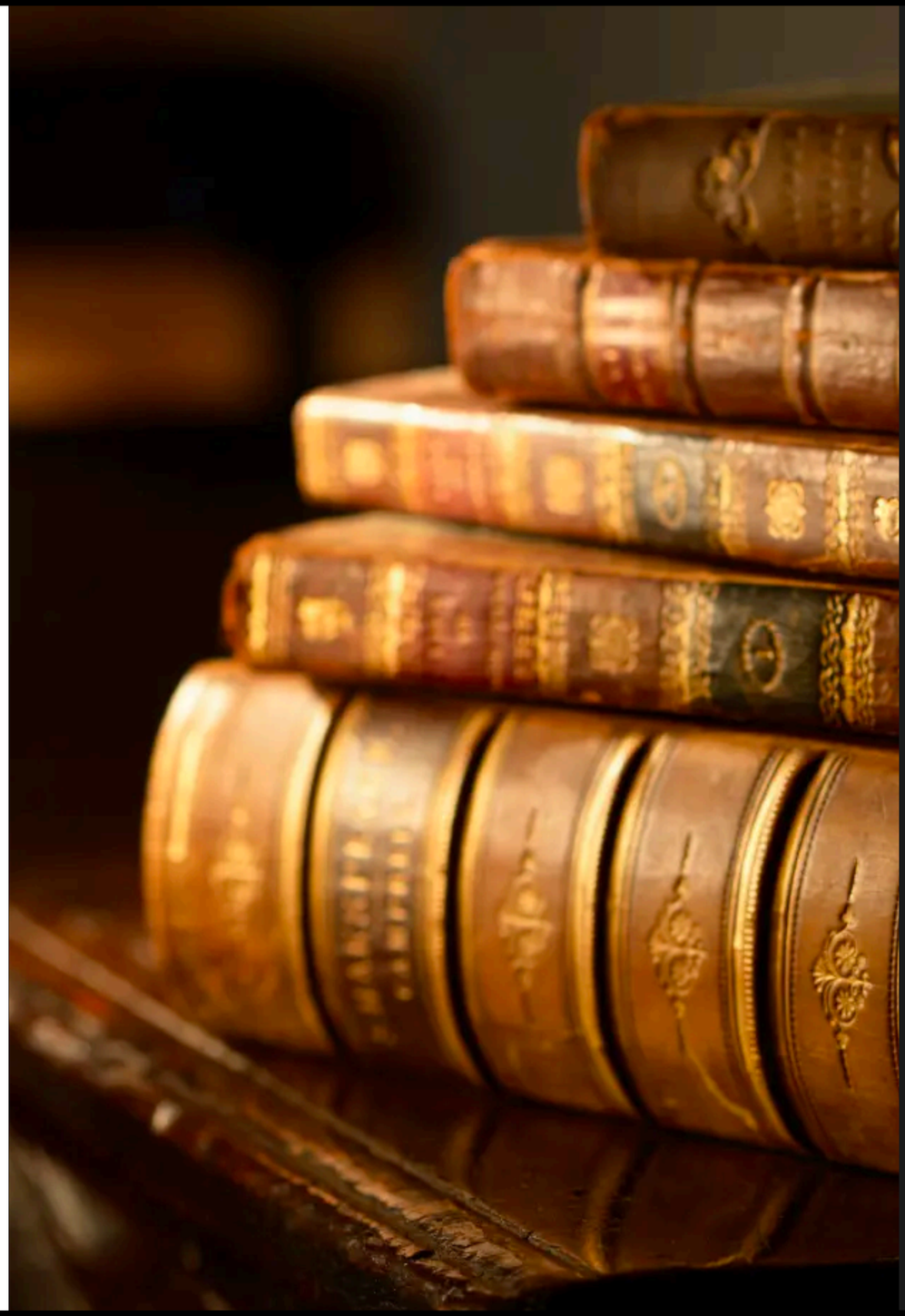
> The *stack* contains all the commands in the order of execution and is what we see in a stack trace



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We begin with the stack because it is what decides where to place what, and what order to execute code

It is managed by the Operating System that runs the ECMAScript engine.

FILO

very fast

call stack

—stack_size

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There is only one stack per process,
since it is single-threaded

To achieve multi-threaded-like setup
we need to run multiple processes,
each with its own stack.

blocking

messaging

nodemon

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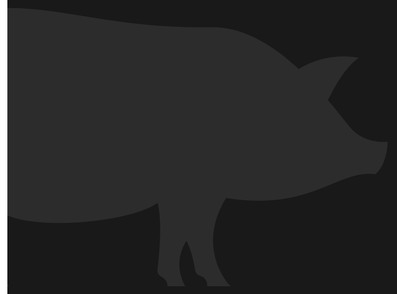

The stack records function call sequence, thus call stack

It also serves as the memory store for primitive values such as booleans, strings, and numbers.

call sequence

memory lookup

heap references

simple storage

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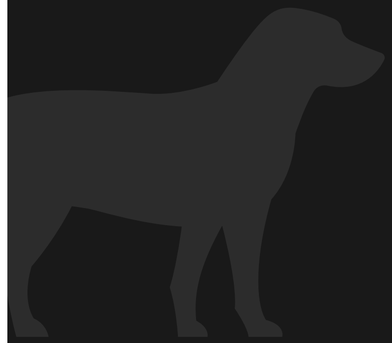

Pointers are recorded onto the stack
to non-primitive values

All pointers are by reference.

references

fast lookup

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Since a pointer lives on the stack, we can conclude that the declaration keyword *const* protects the identifier's value that is registered on the stack

This also helps explain why a primitive value declared a *const* cannot be modified but an object's (referenced) value can.

immutability

copy by reference

copy by value

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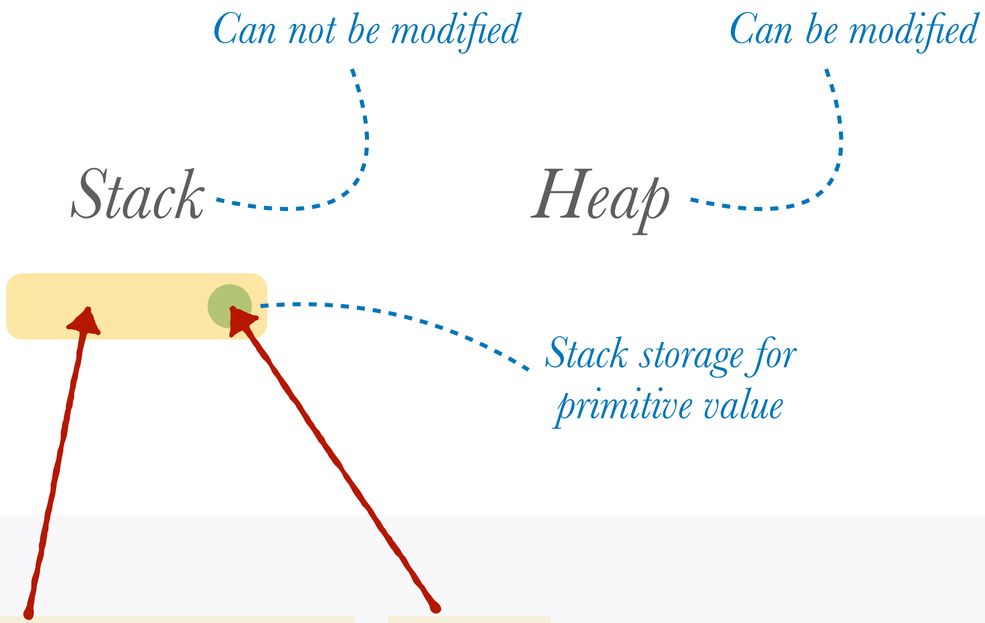

visualized

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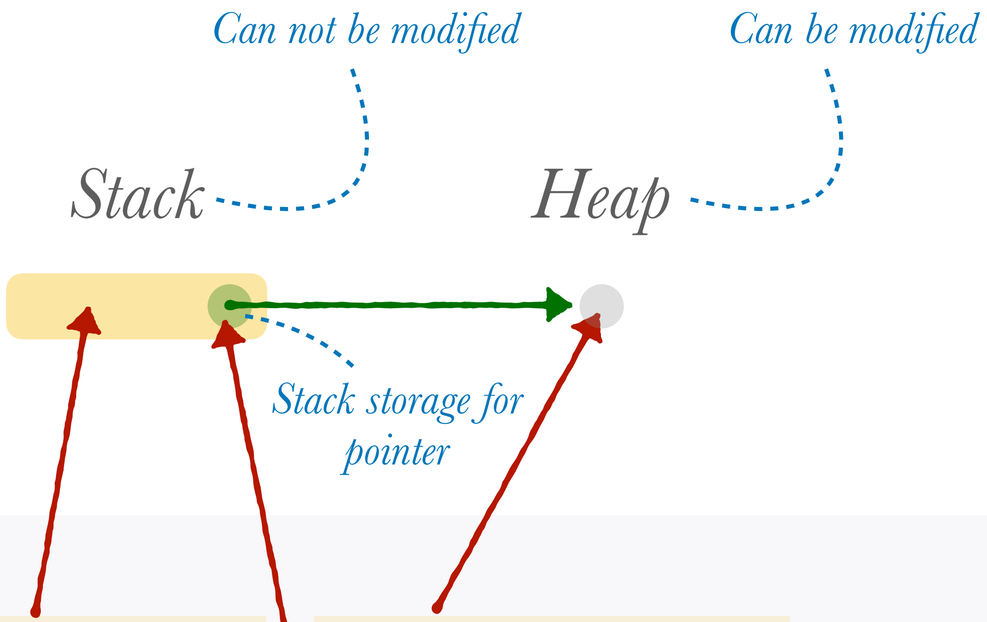

visualized

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Noteworthy is that anything stored in the global scope is kept in a global frame on the stack.

This explains why keeping things in the global scope is bad, since it is referenced for the code's lifetime.

memory footprint

system requirements

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In summary, a function call gets added to the stack as a frame, and once it is done executing it gets popped off from the stack, moving on to the next frame in the stack.

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> The *heap* is the unstructured storage space where the event loop stores *most* of its data

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The heap is unordered memory space where all the dynamic data such as variables and complex data structures live

It is managed by the engine that runs the ECMAScript code, such as V8.

unstructured

slower

garbage collection

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Garbage collection occurs in the heap

Each engine can implement its own garbage collection strategy, however they all implement a mark-and-sweep algorithm.

speed up

clean up

free up

optimizing

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There are two memory regions in the heap memory space:

- Young generation
- Old generation

moving

performance

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Think of the young generation memory space as the RAM space, therefore it is faster

Think of the old generation memory space as the ROM space, therefore it is slower.

lookup

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A minor garbage collection using a Scavenge algorithm occur in young generation memory region

A major garbage collection uses the better-known Mark-Sweep-Compact algorithm which replaces the more naïve reference-counting algorithm.

optimization

circular reference

memory leak

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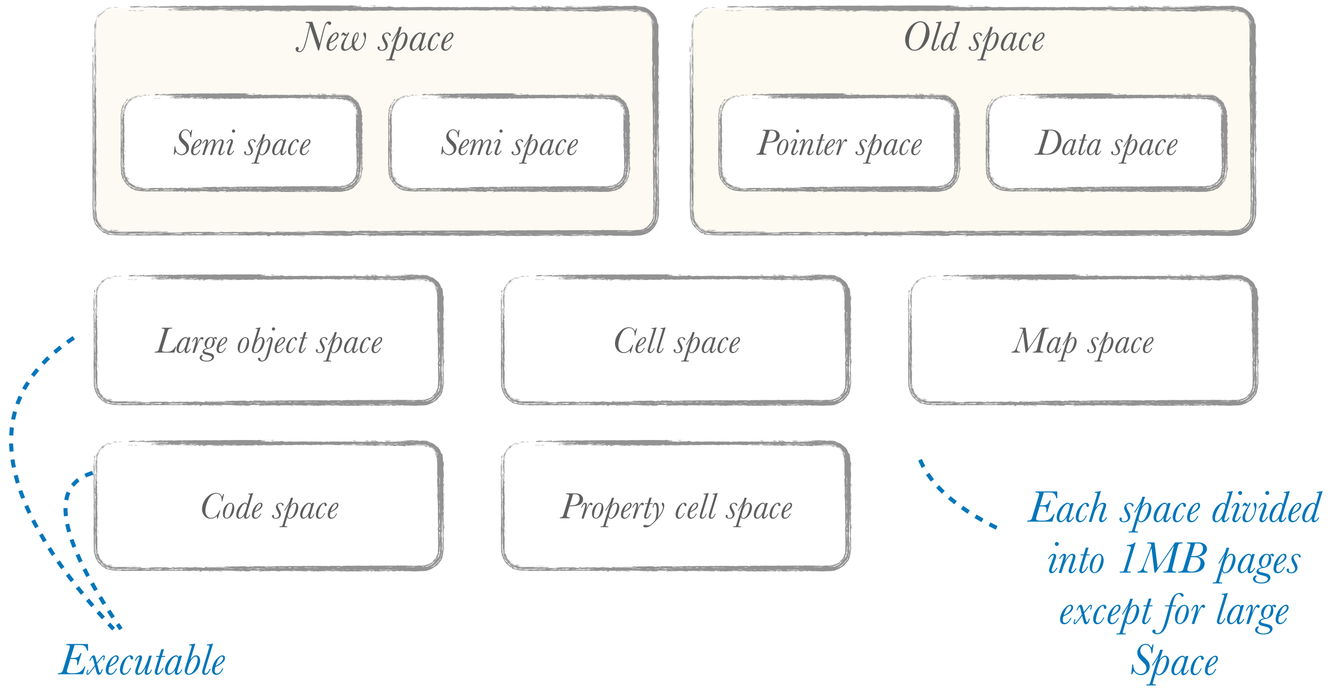
The heap divides its data into spaces



JIT

—min_semi_space_size

—max_semi_space_size

—initial_old_space_size

—max_old_space_size

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Most objects enter the new space of the heap, and anything that survives two garbage collection cycles gets moved to the old space.

marking

sweeping

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> The *queue* is actually not a queue
> but a set since it grabs the first
> runnable task instead of
> *de-queuing* the first task

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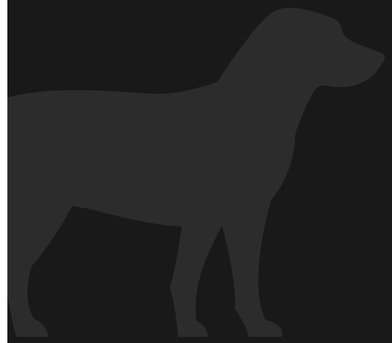

The queue is what tracks all asynchronously called functions such as callbacks and *events*

It gets called into action once the current stack is empty.

sequence

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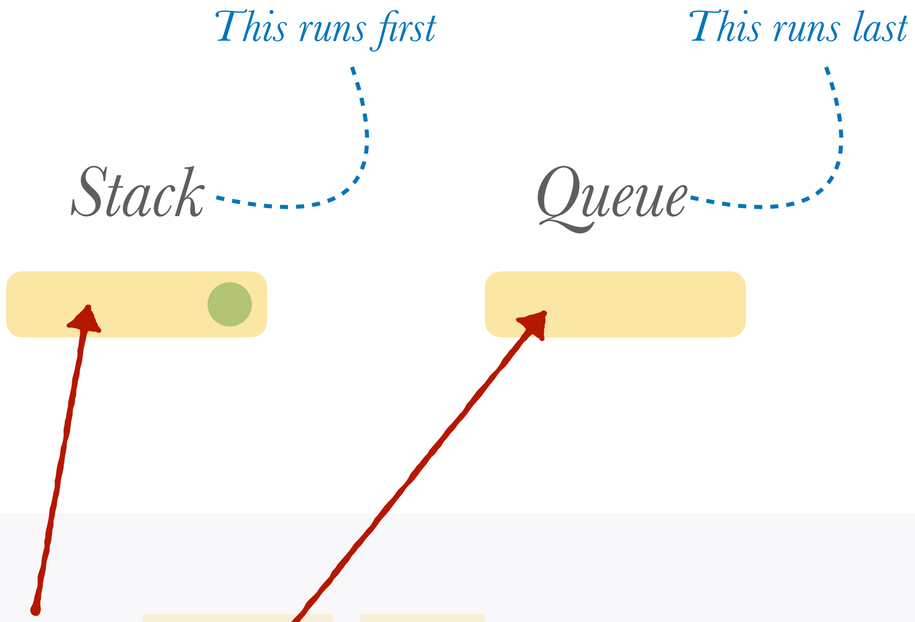


```
setTimeout(callback, 1000);
```

visualized

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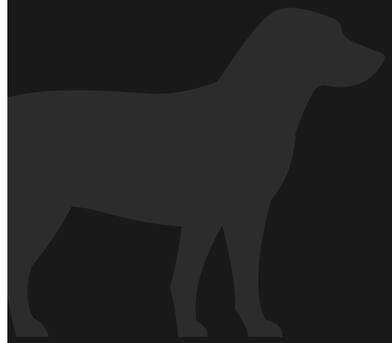

A function call with a callback gets added to the stack

The callback gets added to the queue

The callback only gets called after the stack is empty and any queue messages that are queued ahead.

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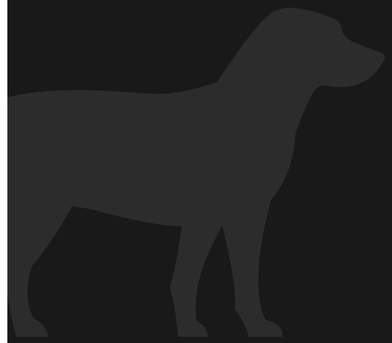

Since anything on the queue relies on any preceding calls to complete, we are not guaranteed when our queue message will be processed

This is why the delay specified in functions like setTimeout is not a guaranteed but a minimum timing.

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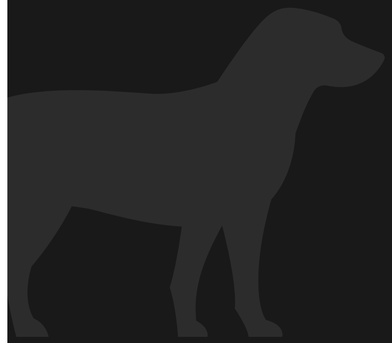

The queue as a whole is known as the message queue

The message queue in turn is split up into multiple queues that bear different names and have different purposes depending on runtime context.

sequence

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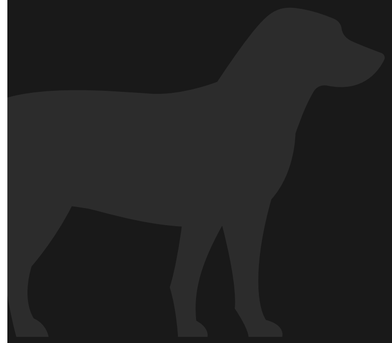

We have two purpose-specific queues:

- Macrotasks: used for *callbacks*
  aka *Callback queue*

- Microtasks: used for *thenables*
  aka *Job queue*

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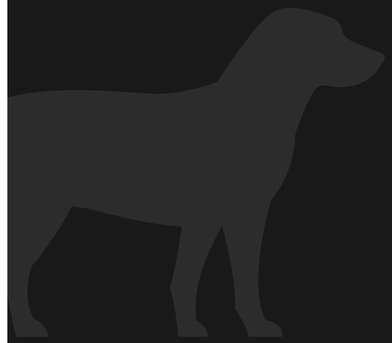

Immediately after a macrotask is complete, the engine executes all microtasks before moving on to the next macro task

Event handling and rendering are suspended until all microtasks have completed.

prioritization

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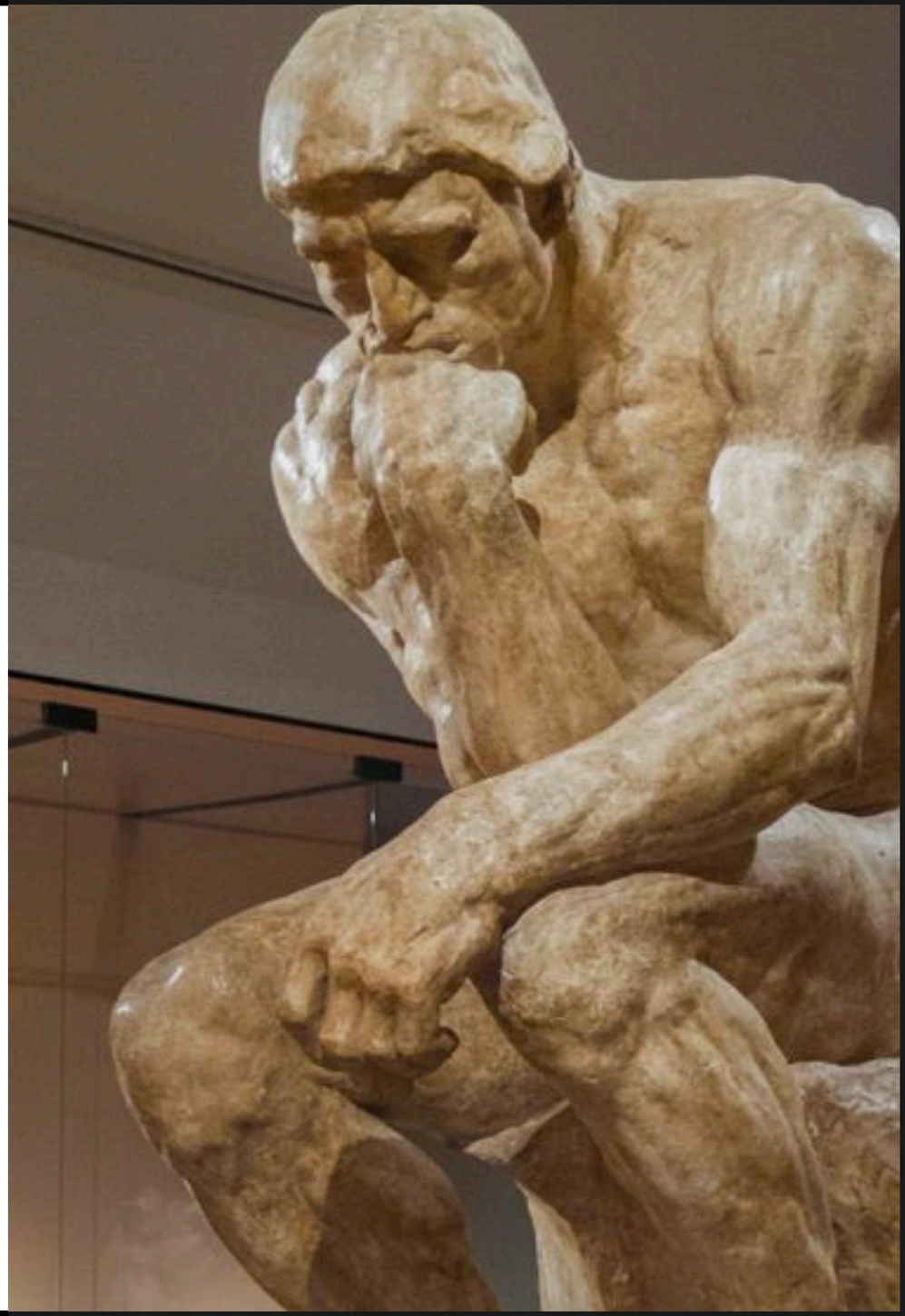
> While we do not need to actively think about the event loop, we can write better code with a basic understanding.



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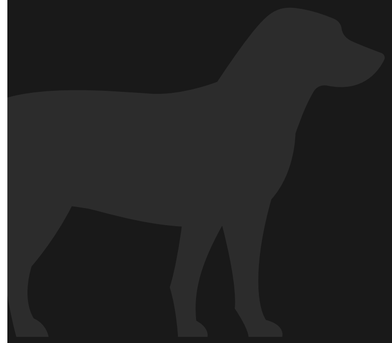

The event loop is non-blocking except for few exceptions like alert() and synchronous XHR

However, keep in mind that the garbage collector, when running, *is* blocking.

continuous

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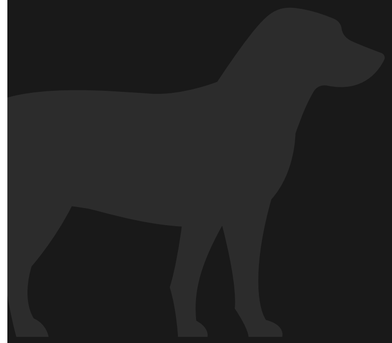

The non-blocking aspect relates only to the execution of the code

Rendering *is* blocked however while the queue is processed for example.

continuous

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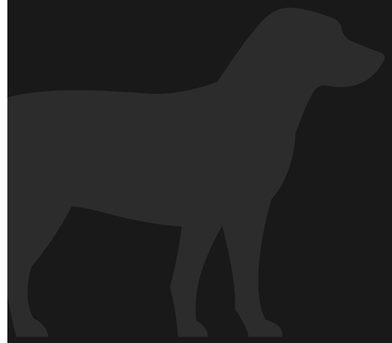

A web-worker and cross-origin iframe have their own event stacks, heaps, and message queues

These separate runtimes can use the postMessage API to communicate with each other

isolation

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Milan has over 28 years of professional experience

Presently he focuses on front-end technologies, especially React and W3C Web Components

Contact him with any questions.

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Website coming soon…

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