Ignify Consulting

Garbage Collection

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Using Resources

Allocate memory for resource.
Set the initial state of the resource.
Use the resource.
Clean up the resource.
Free the memory.

What is Garbage Collection?

Automatic reclamation of unused objects.
Recycling of memory.
Decreases development time.
Prevents memory leaks.
Prevents dangling pointers.

Types of Garbage Collection

Reference Counting
Tracing

Reference Counting

Each object has a count of references to it.
Count increased when an additional reference is added. (B = A)
Count decreased when a reference is removed. (B = null or B = C)
Object is unused when count reaches 0.

Reference Counting

Advantages

- Simple to implement.
- Overhead is small and constant.
- Can be interleaved with normal program operation.

Reference Counting

Disadvantages

Cannot deal with cyclic structures:

$B \rightarrow A$, $A \rightarrow B$

$A \rightarrow B \rightarrow C \rightarrow D \rightarrow A$

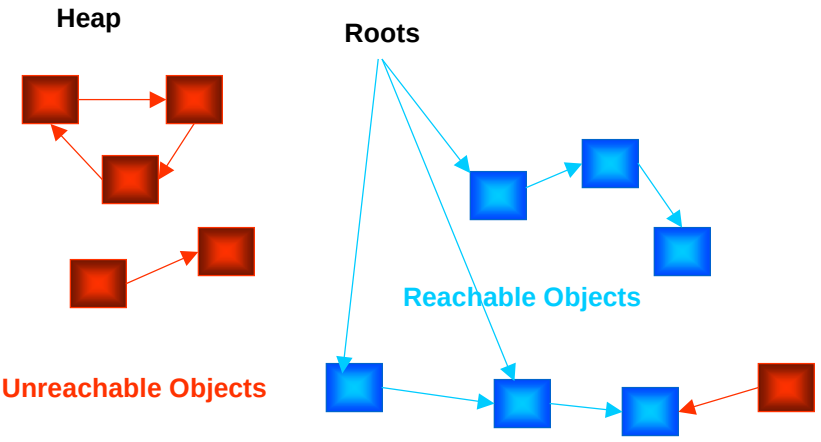
Parents & children with references to each other

Tracing

Roots: Global variables, local variables, instance members, class members, running threads.

Object is unused when unreachable from roots.

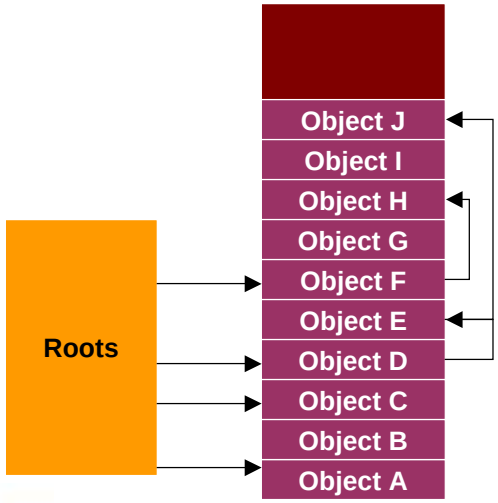
Tracing



Types of Tracing Collector

Mark-and-Sweep Collector
Copying Collector

Mark-and-Sweep Collector



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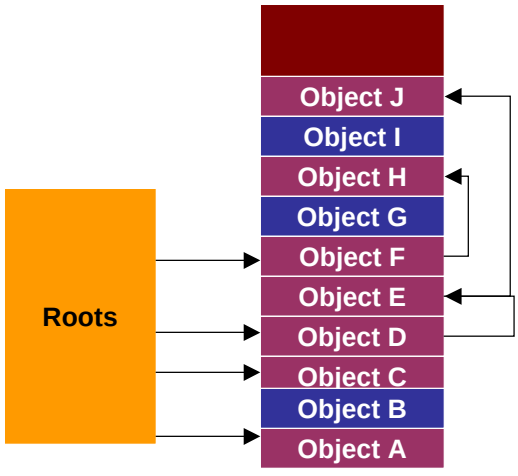
Mark-and-Sweep Collector



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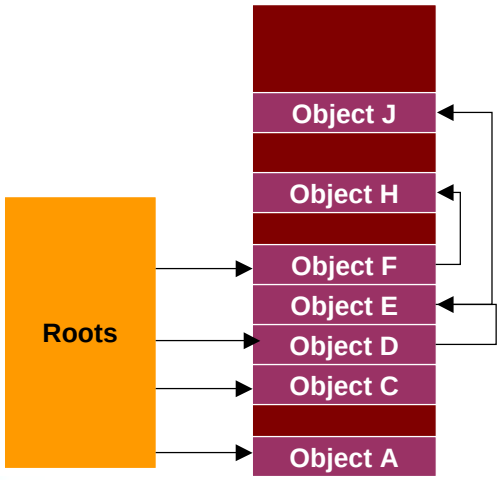
Mark-and-Sweep Collector



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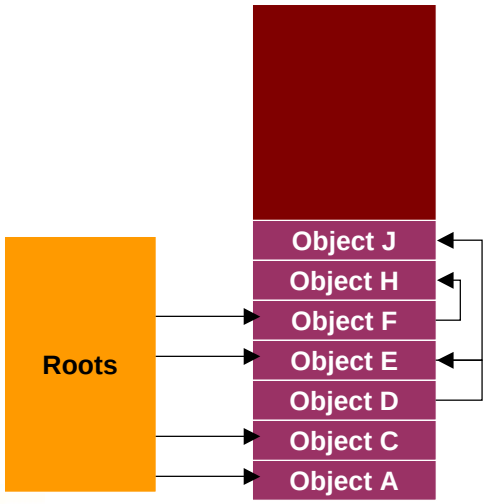
Mark-and-Sweep Collector



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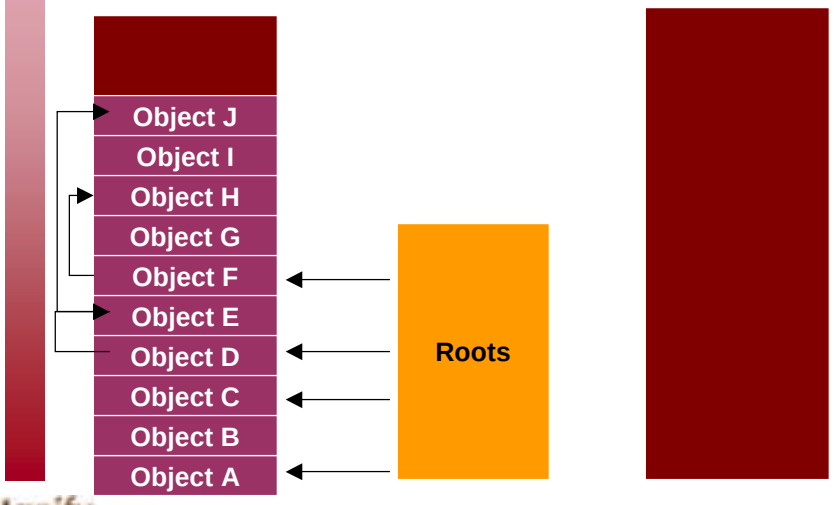
Copying Collector



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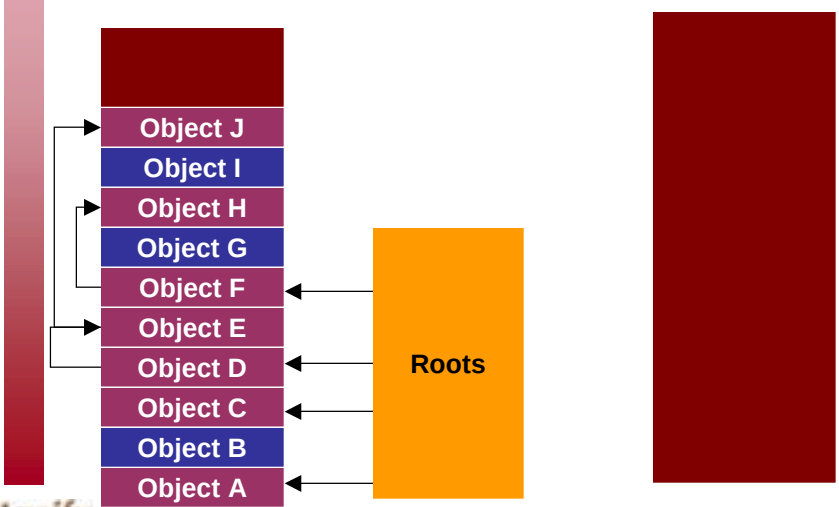
Copying Collector



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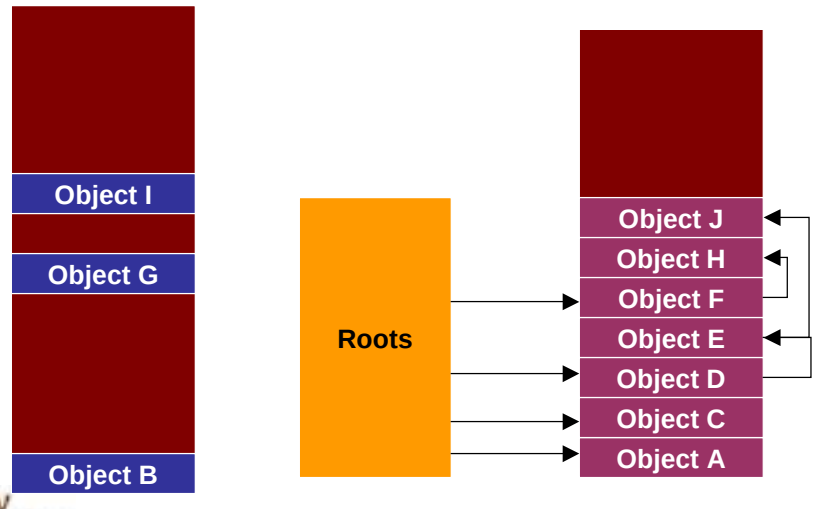

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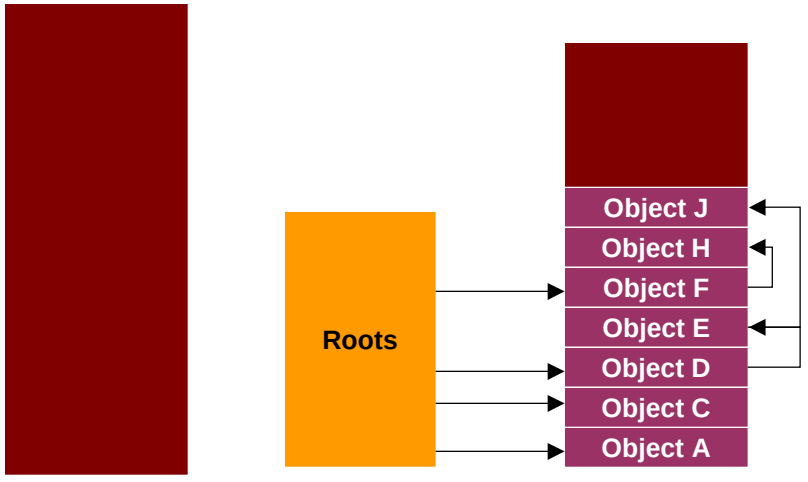

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Generational Collector

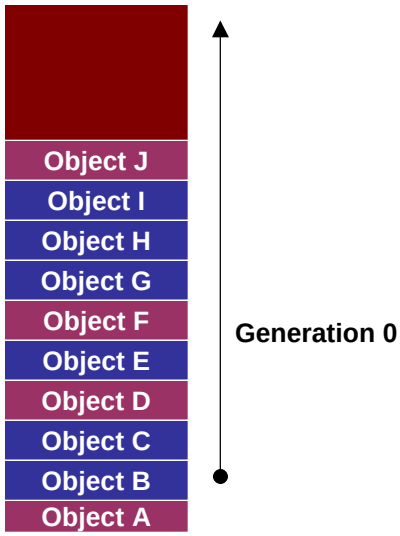
Most objects have very short lives.

Some objects have very long lives.

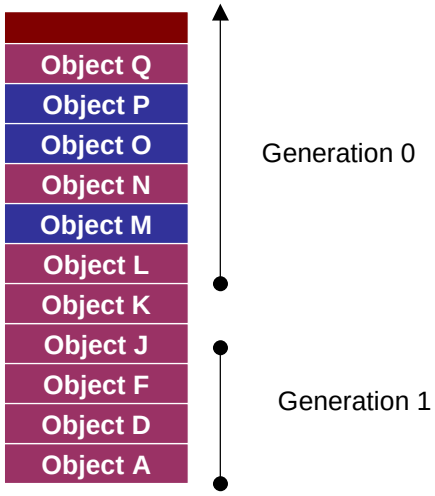
Younger objects frequently reference older objects; the reverse is rare.

Compacting a portion of the heap is faster than compacting the whole heap.

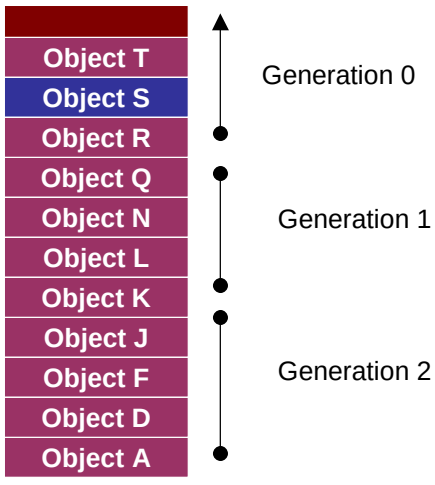
Generational Collector



Generational Collector



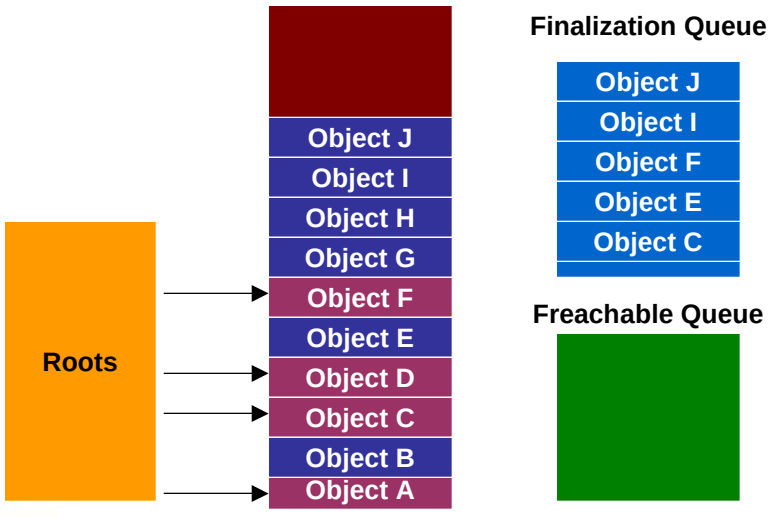
Generational Collector



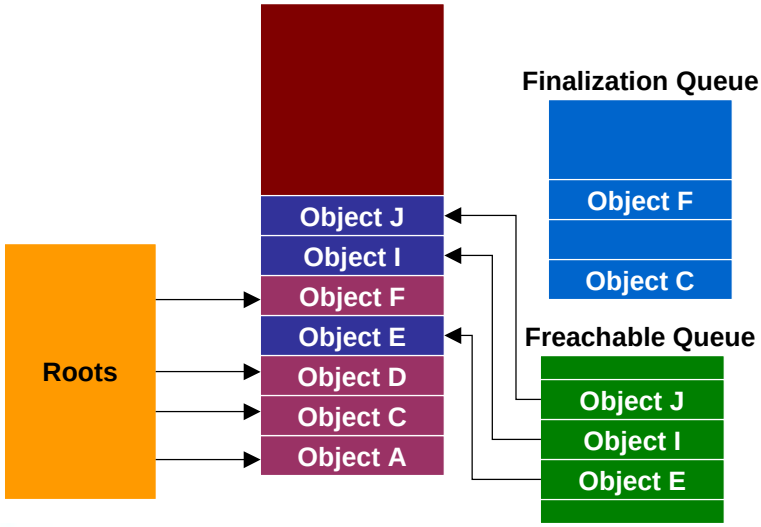
Finalization

Allows a resource to clean up when collected.
Class must implement finalize().
Not like a destructor.

Finalization



Finalization



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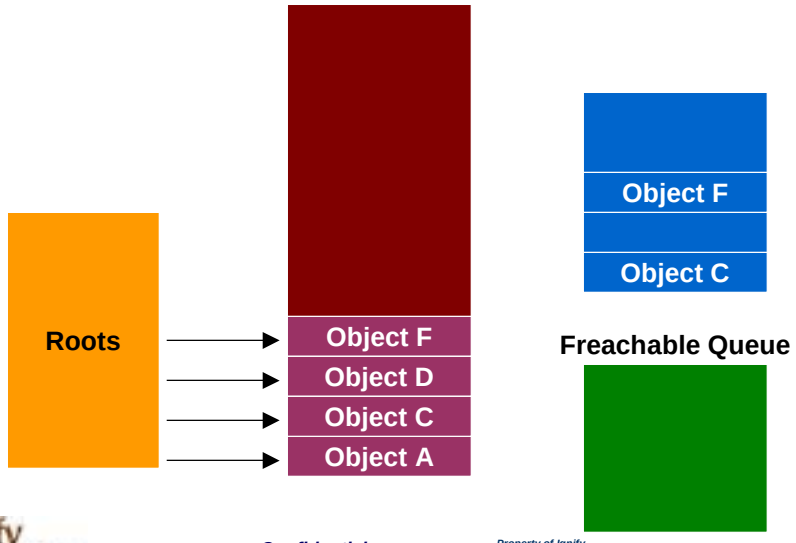
Finalization



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Finalization

Finalizable objects take longer to allocate.
Lifetime of object, and all dependant objects may be prolonged.
Increases memory pressure.
Errors during finalization are ignored.

Finalization

No control over when finalization happens.
Finalization may not happen.
Objects may be resurrected.

Weak References

Allow app to reference the object.
Allow garbage collector to collect the object.
Allow objects to be cached.
Destroys cached objects if memory is required.

Drawbacks of Garbage Collection

Significant performance hit.
Program execution halts during collection.
Little control over scheduling of collection.
No control over finalization.

Online Resources

The Garbage Collection List

http://www.iecc.com/gclist/

Memory Management in the .NET Framework

http://msdn.microsoft.com/msdnmag/issues/1100/GCI/GCI.asp

Online Resources

Reference Objects and Garbage Collection

http://developer.java.sun.com/developer/technicalArticles/ALT/RefObj/

Inside the Java 2 Virtual Machine - Garbage Collection

http://www.artima.com/insidejvm/ed2/ch09GarbageCollection01.html

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