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Java

JavaOne℠

The Ghost in the Virtual Machine
A Reference to References

Bob Lee

Google Inc.

Google

Goals

- Perform manual cleanup the right way.
- Take the mystery out of garbage collection.
- Become honorary VM sanitation engineers.

An external resource

```
public class NativeResource {
  public NativeResource() { init(); }

  /** Allocates native memory. */
  private native void init();

  /** Writes to native memory. */
  public native void write(byte[] data);

  /** Frees native memory. */
  @Override protected native void finalize();
}
```

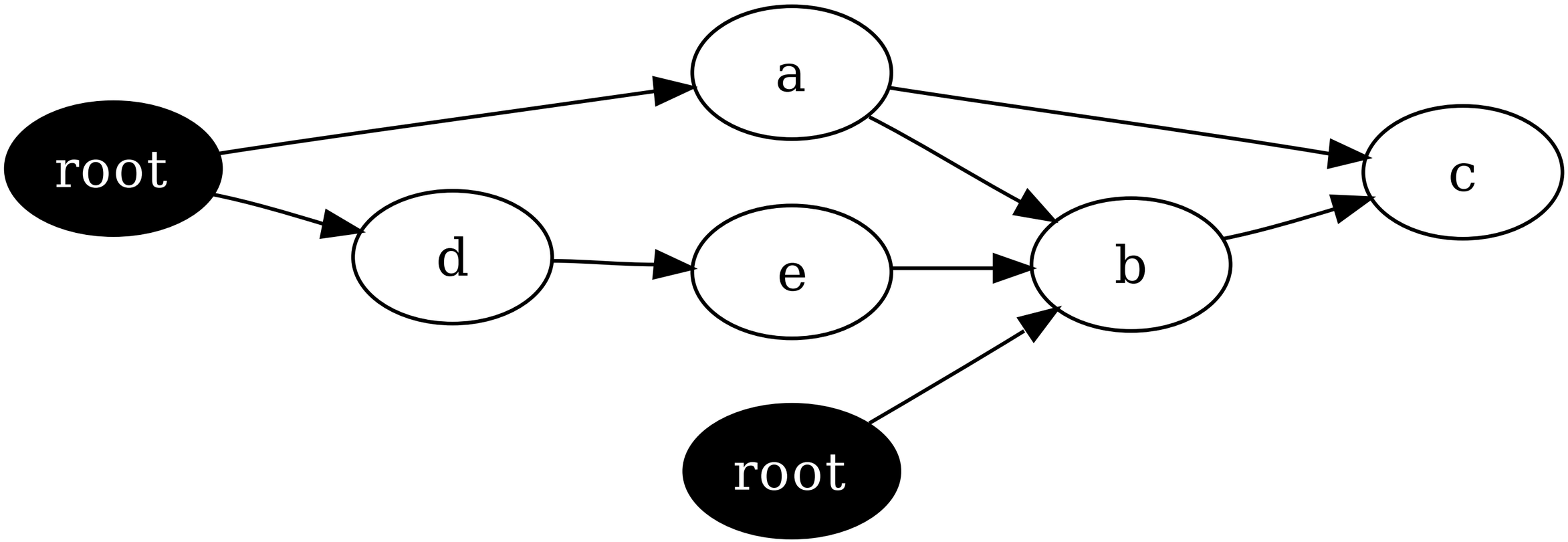
Let's play War!

```
public class SegfaultFactory {
  private final NativeResource nr;
  public SegfaultFactory(NativeResource nr) {
    this.nr = nr;
  }

  @Override protected void finalize() {
    // 50/50 chance of failure
    nr.write("I'm taking the VM with me!".getBytes());
  }
}
```

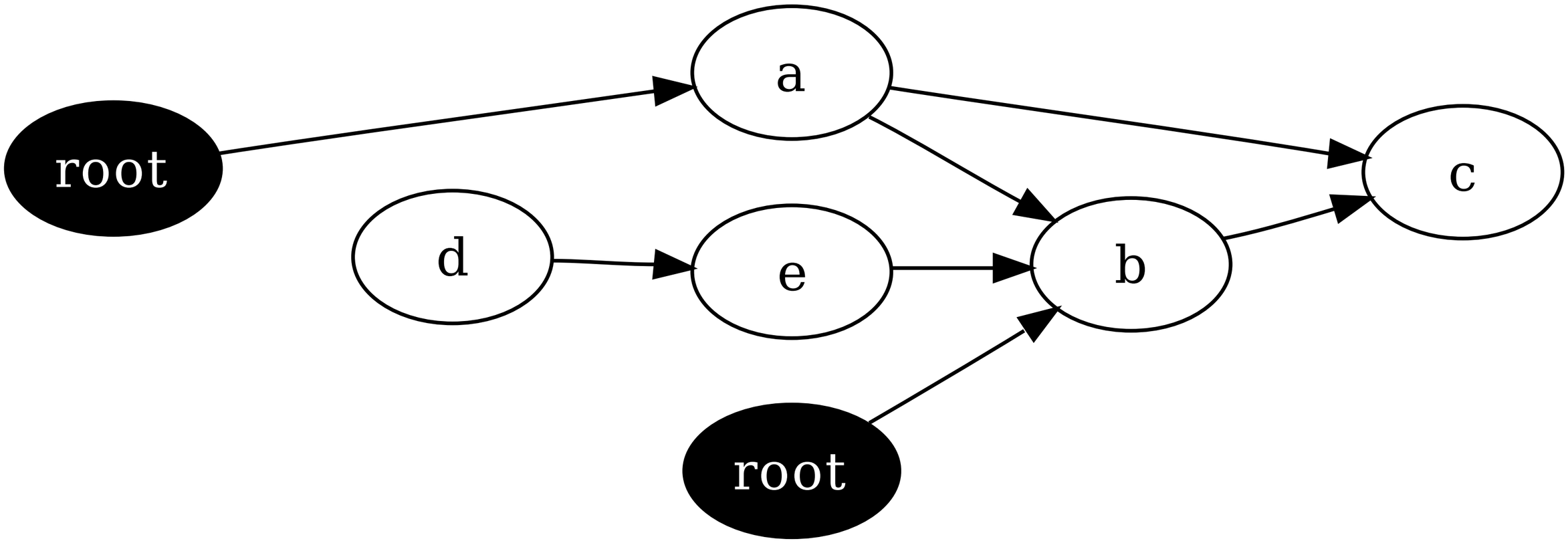
Use protection.

```
public class SafeNativeResource extends NativeResource {
  private boolean finalized;

  @Override public synchronized void write(byte[] data) {
    if (!finalized)
      super.write(data);
    else /* do nothing? */;
  }

  @Override protected synchronized void finalize() {
    finalized = true;
    super.finalize();
  }
}
```

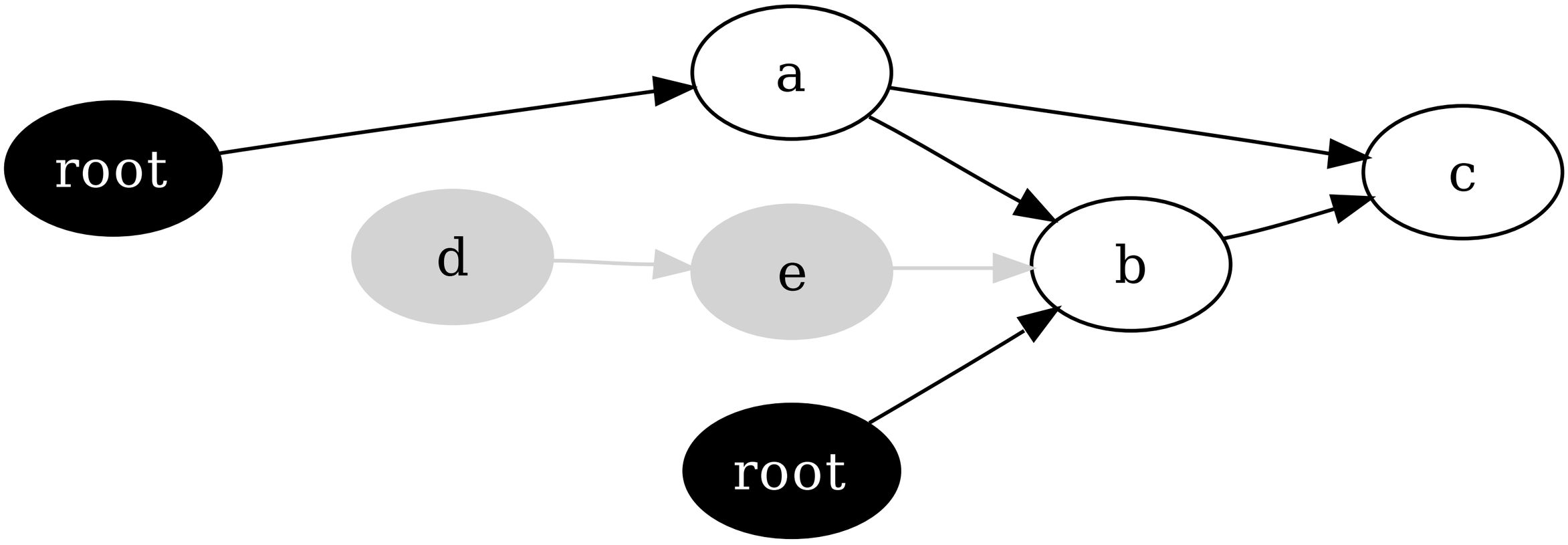
How does garbage collection work?



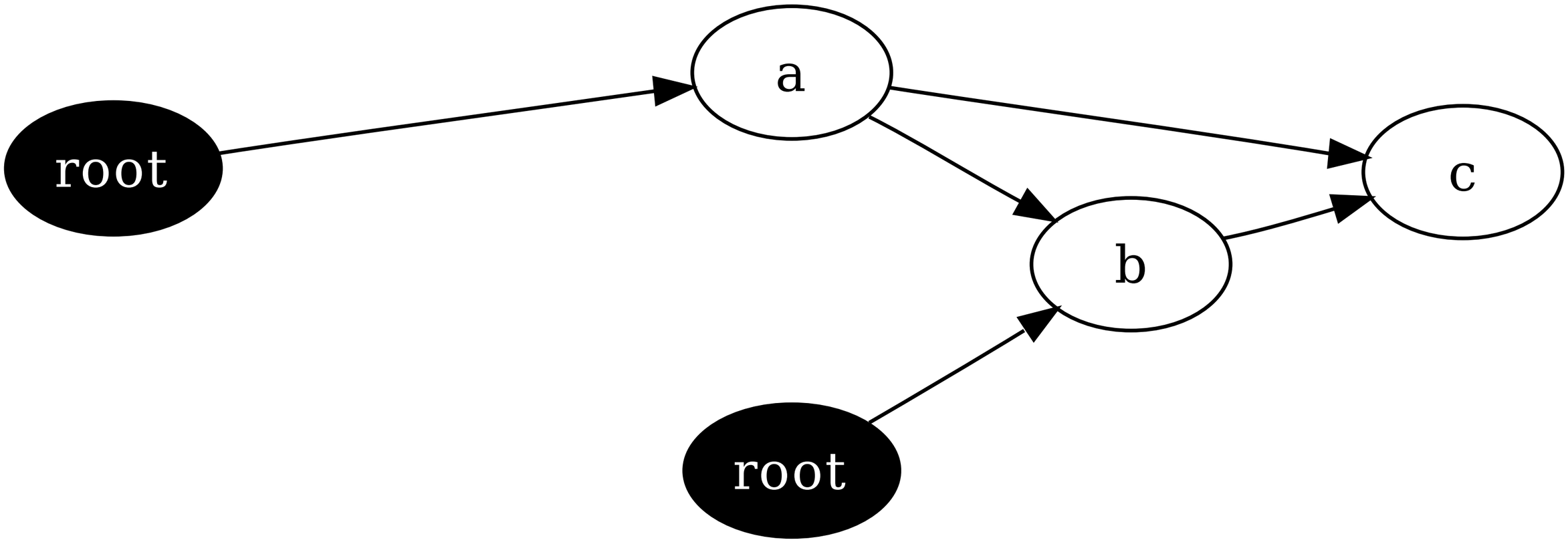
If the reference to D goes away...



We can no longer reach D or E.



So the collector reclaims them.



Reachability

- An object is *reachable* if a live thread can access it.
- Examples of heap roots:
  - System classes (which have static fields)
  - Thread stacks
  - In-flight exceptions
  - JNI global references
  - The finalizer queue
  - The interned String pool
  - etc. (VM-dependent)

Dante's Heap - The Levels of Reachability

- Strong
- Soft
- Weak
- Finalizer
- Phantom, JNI weak
- Unreachable

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Two options for freeing native resources

> Use a finalizer.
  - You must defend against subsequent use!
> Or use a phantom reference.

Weak references aren't for caching!

- Many collectors will reclaim weak refs immediately.
- Use soft reference for caching, as intended:

“Virtual machine implementations are encouraged to bias against clearing recently-created or recently-used soft references.”

- The `SoftReference` documentation