Google™ 11 I O

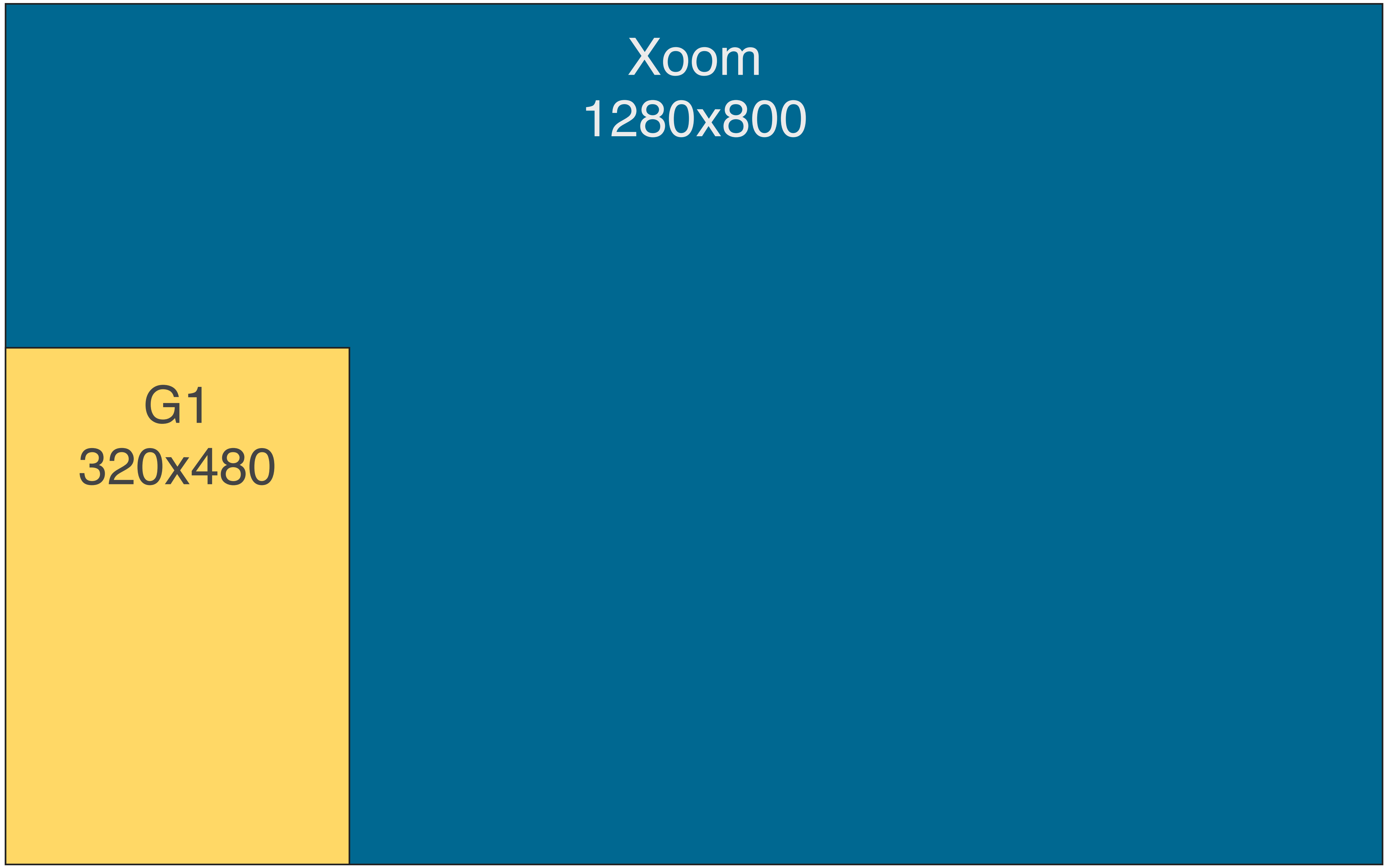
Memory Management for Android Apps

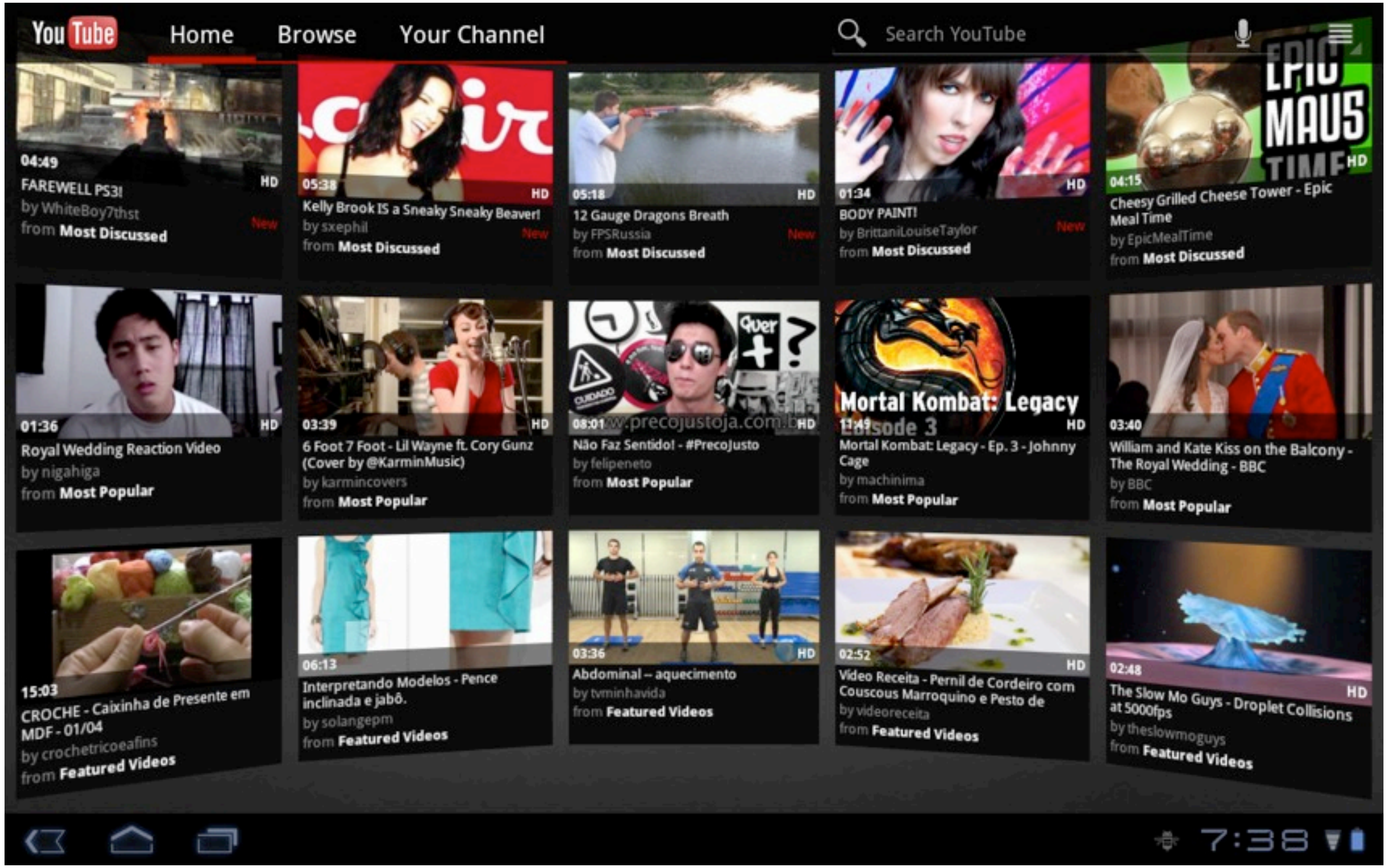
Patrick Dubroy (dubroy.com · @dubroy)

May 11, 2011

192MB RAM

1GB RAM


Xoom
1280x800
G1
320x480



04:49 HD
FAREWELL PS3!
by WhiteBoy7thst
New
from Most Discussed

05:38 HD
Kelly Brook IS a Sneaky Sneaky Beaver!
by sxephil
New
from Most Discussed

05:18 HD
12 Gauge Dragons Breath
by FPSRussia
New
from Most Discussed

01:34 HD
BODY PAINT!
by BrittaniLouiseTaylor
New
from Most Discussed

04:15 HD
Cheesy Grilled Cheese Tower - Epic Meal Time
by EpicMealTime
from Most Discussed

01:36 HD
Royal Wedding Reaction Video
by nigahiga
from Most Popular

03:39 HD
6 Foot 7 Foot - Lil Wayne ft. Cory Gunz (Cover by @KarminMusic)
by karmincovers
from Most Popular

08:01 HD
Não Faz Sentido! - #PrecoJusto
by felipeneto
from Most Popular

13:49 HD
Mortal Kombat: Legacy - Ep. 3 - Johnny Cage
by machinima
from Most Popular

03:40
William and Kate Kiss on the Balcony - The Royal Wedding - BBC
by BBC
from Most Popular

15:03
CROCHE - Caixinha de Presente em MDF - 01/04
by crochetricoeafins
from Featured Videos

06:13
Interpretando Modelos - Pence inclinada e jabô.
by solangepm
from Featured Videos

03:36 HD
Abdominal -- aquecimento
by tvminhavida
from Featured Videos

02:52 HD
Video Receita - Pernil de Cordeiro com Couscous Marroquino e Pesto de
by videoreceita
from Featured Videos

02:48 HD
The Slow Mo Guys - Droplet Collisions at 5000fps
by theslowmoguys
from Featured Videos

Software ~~Work~~ expands to fill the ~~time~~ memory available.

Overview

- Changes in Gingerbread and Honeycomb
  - heap size
  - GC
  - bitmaps
- Understanding heap usage
  - logs
  - memory leaks
  - Eclipse Memory Analyzer (MAT)

Expectations

- Android
- Dalvik heap
- Garbage collection
- OutOfMemoryError

Heap Size

- Heap size limits
  - G1: 16MB
  - Droid: 24MB
  - Nexus One: 32MB
  - Xoom: 48MB

- ActivityManager.getMemoryClass()

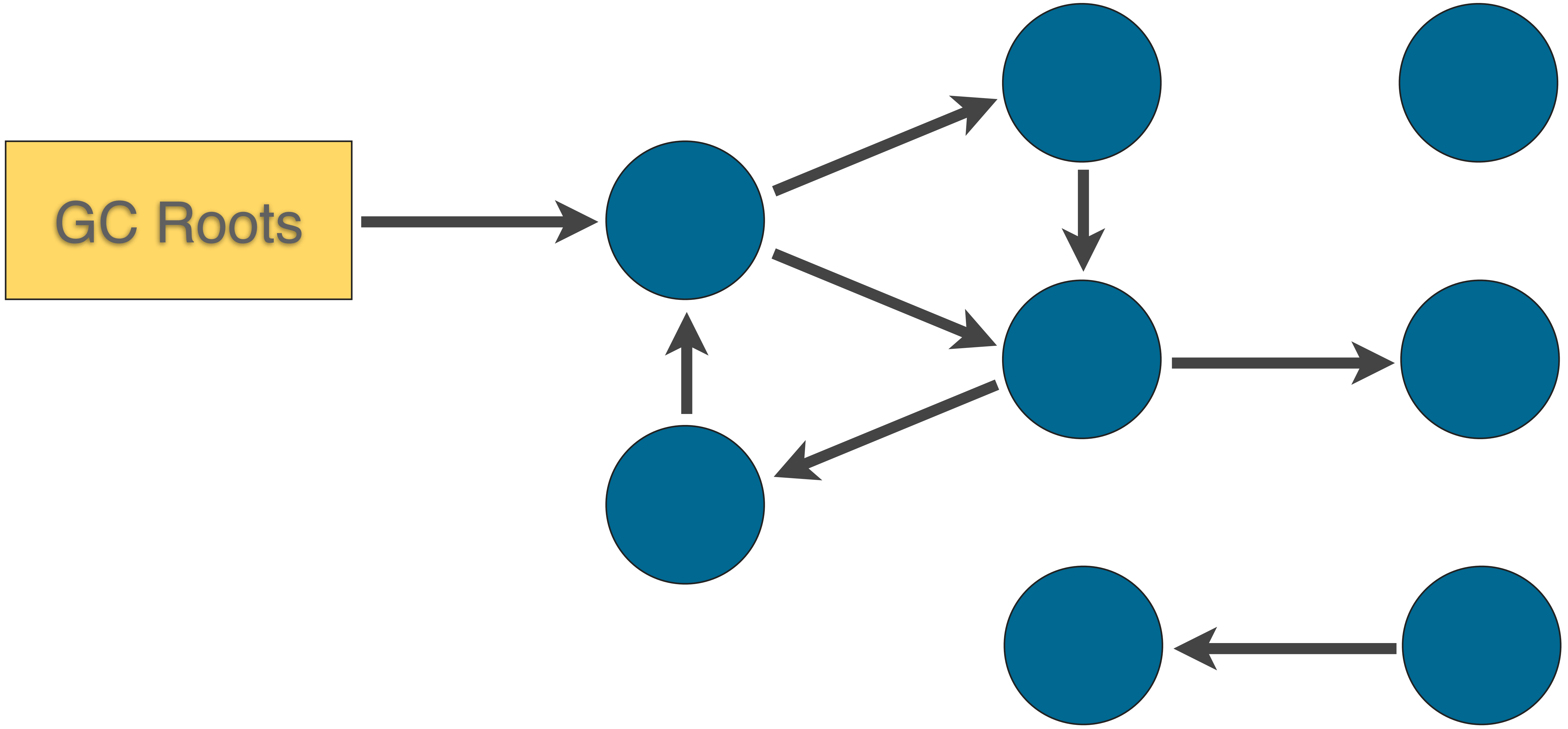
Large Heaps

- Honeycomb adds “largeHeap” option in AndroidManifest.xml:
  - Degrades performance! Use only if you understand why you need it.

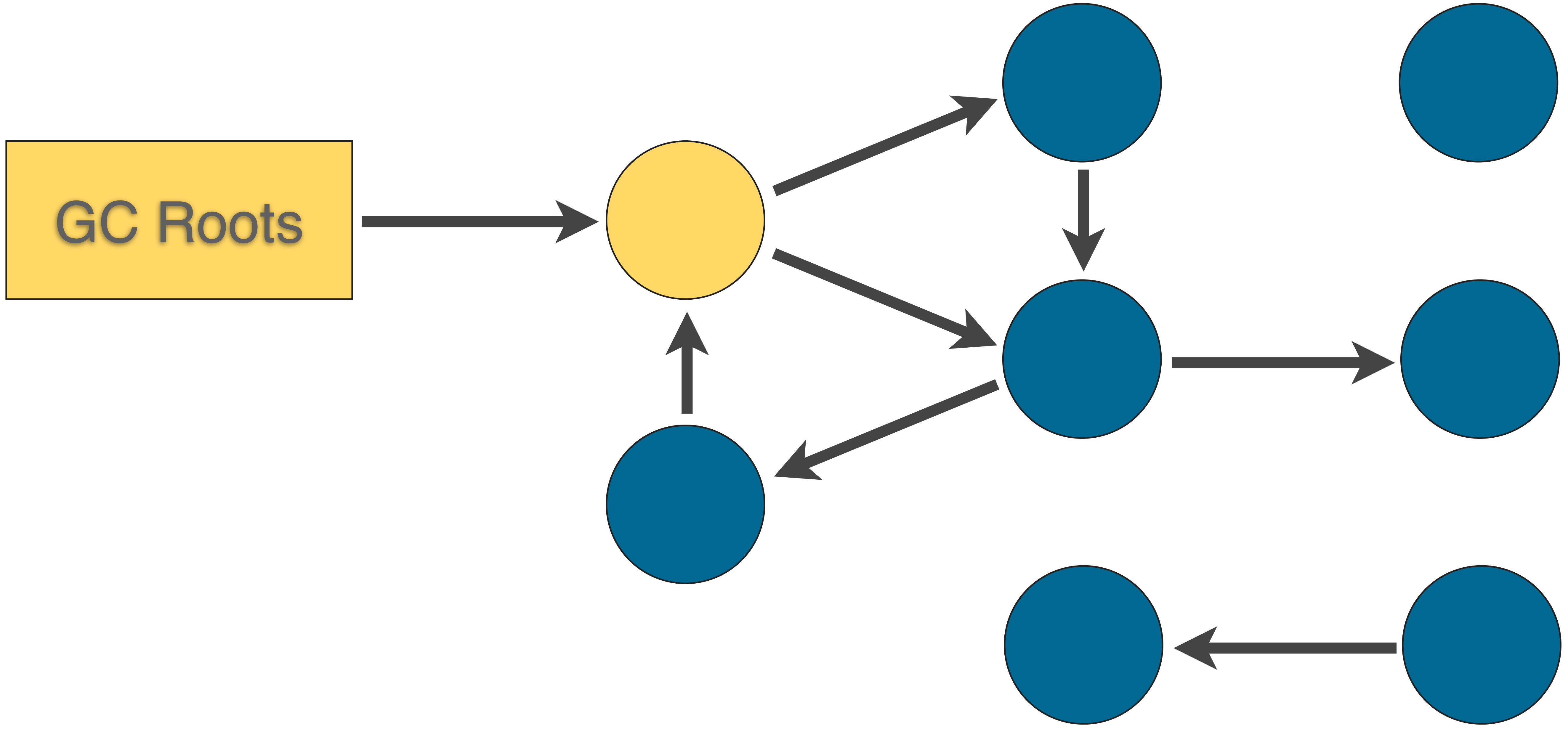
```
<application
    android:name="com.example.foobar"
    android:largeHeap="true"
    ...
    </application>
```

ActivityManager.getLargeMemoryClass()

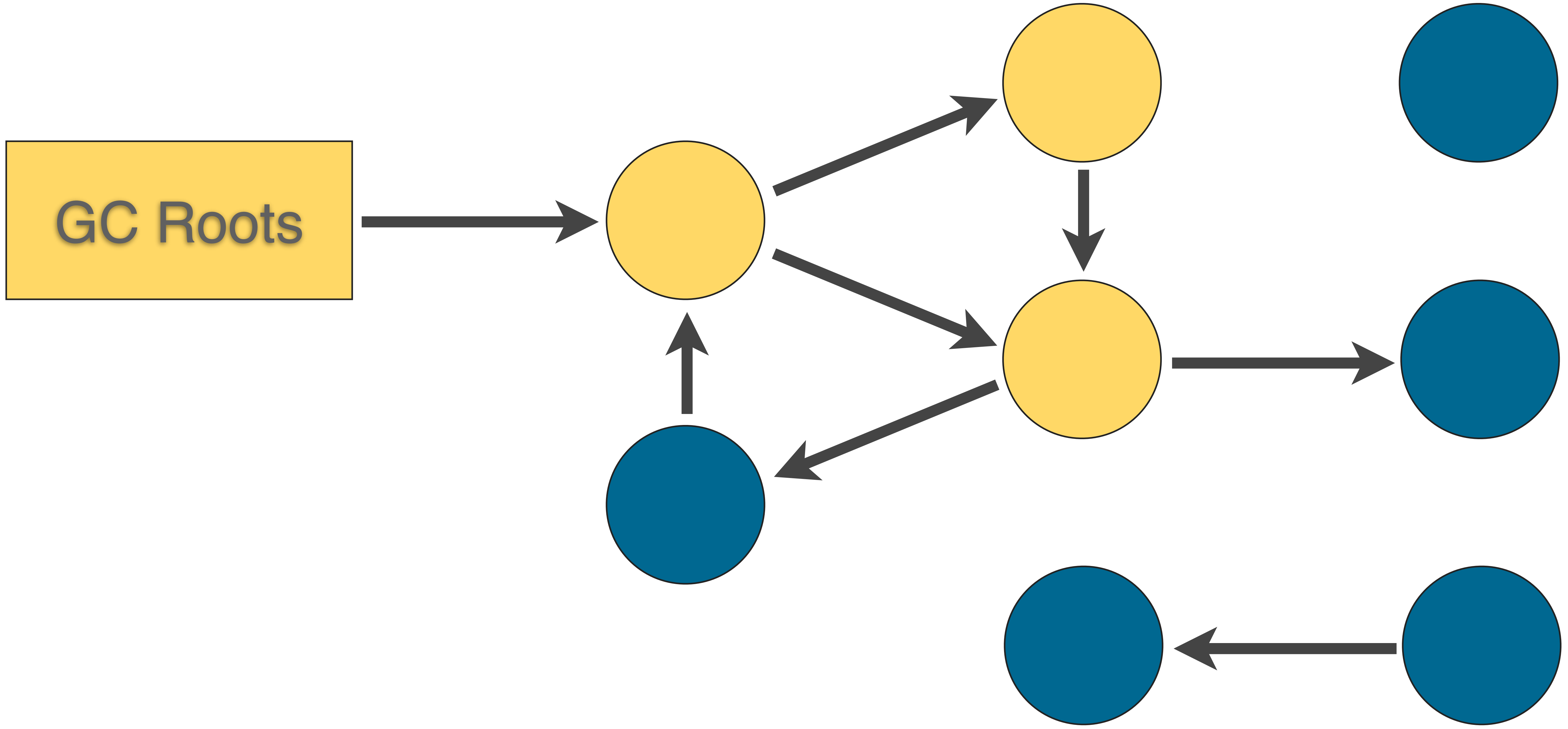
Garbage Collection



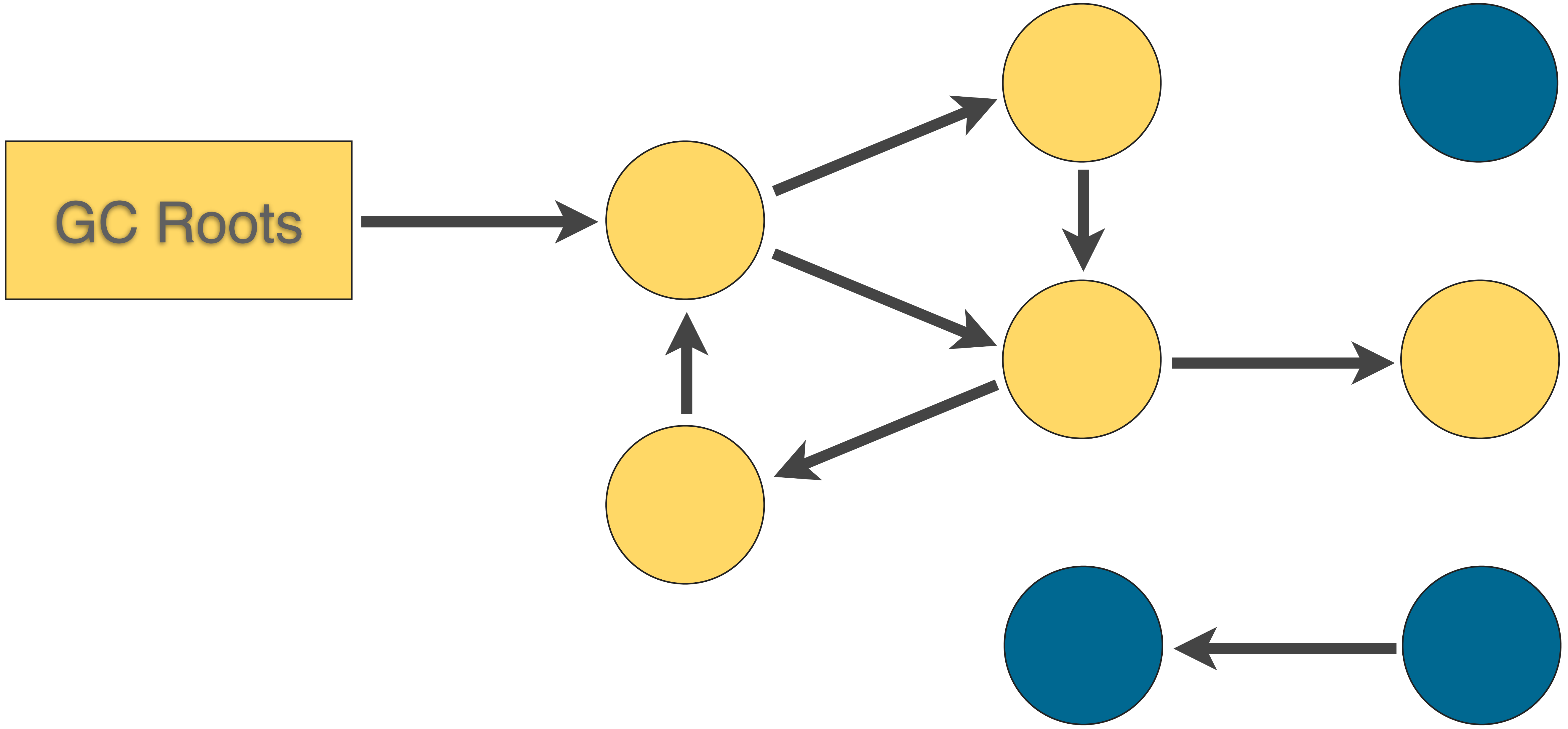
Garbage Collection



Garbage Collection



Garbage Collection



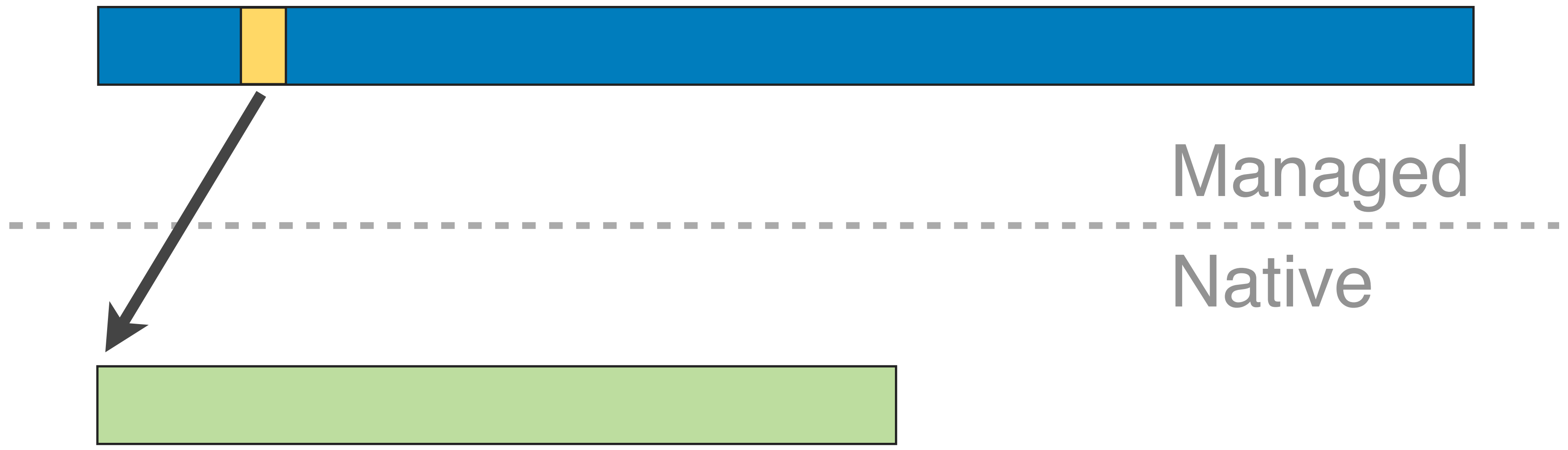
Garbage Collection

- Bigger heaps = longer pauses?
- Pre-Gingerbread GC:
  - Stop-the-world
  - Full heap collection
  - Pause times often > 100ms
- Gingerbread and beyond:
  - Concurrent (mostly)
  - Partial collections
  - Pause times usually < 5ms

Bitmaps

Old way (pre-Honeycomb):

- freed via recycle() or finalizer
- hard to debug
- full, stop-the-world GCs



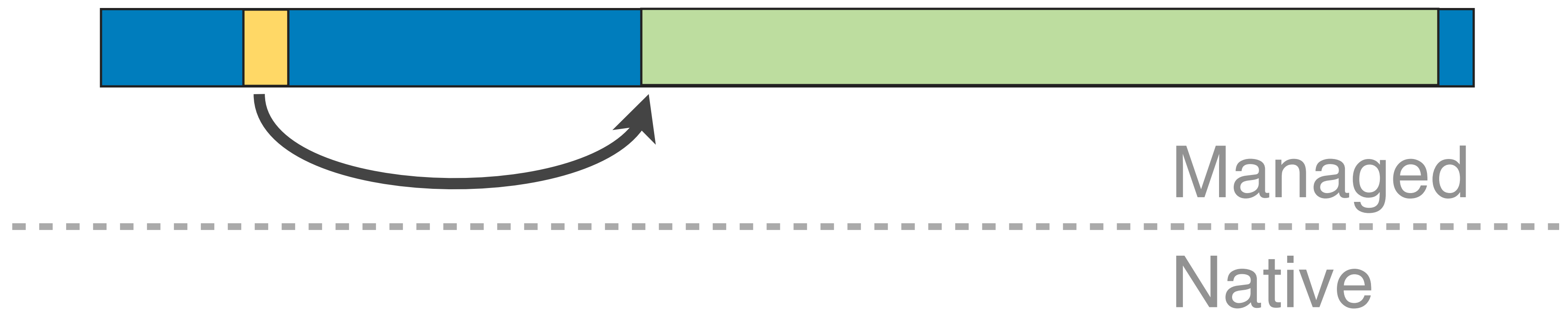
Bitmaps

Old way (pre-Honeycomb):

- freed via recycle() or finalizer
- hard to debug
- full, stop-the-world GCs

New way:

- freed synchronously by GC
- easier to debug
- concurrent & partial GCs



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Interpreting Log Messages

```
D/dalvikvm( 9050): GC_CONCURRENT freed 2049K, 65% free 3571K/
9991K, external 4703K/5261K, paused 2ms+2ms
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- Reason for GC
  - GC_CONCURRENT
  - GC_FOR_MALLOC
  - GC_EXTERNAL_ALLOC
  - GC_HPROF_DUMP_HEAP
  - GC_EXPLICIT

Interpreting Log Messages

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- Reason for GC
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- Reason for GC
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- Heap statistics

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- Reason for GC
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- Heap statistics
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Interpreting Log Messages

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- Reason for GC
- Amount freed
- Heap statistics
- External memory statistics
- Pause time

Heap Dumps

- Binary dump of all objects
- Create with:
  - DDMS
  - `android.os.Debug.dumpHprofData()`
- Convert to standard HPROF format:

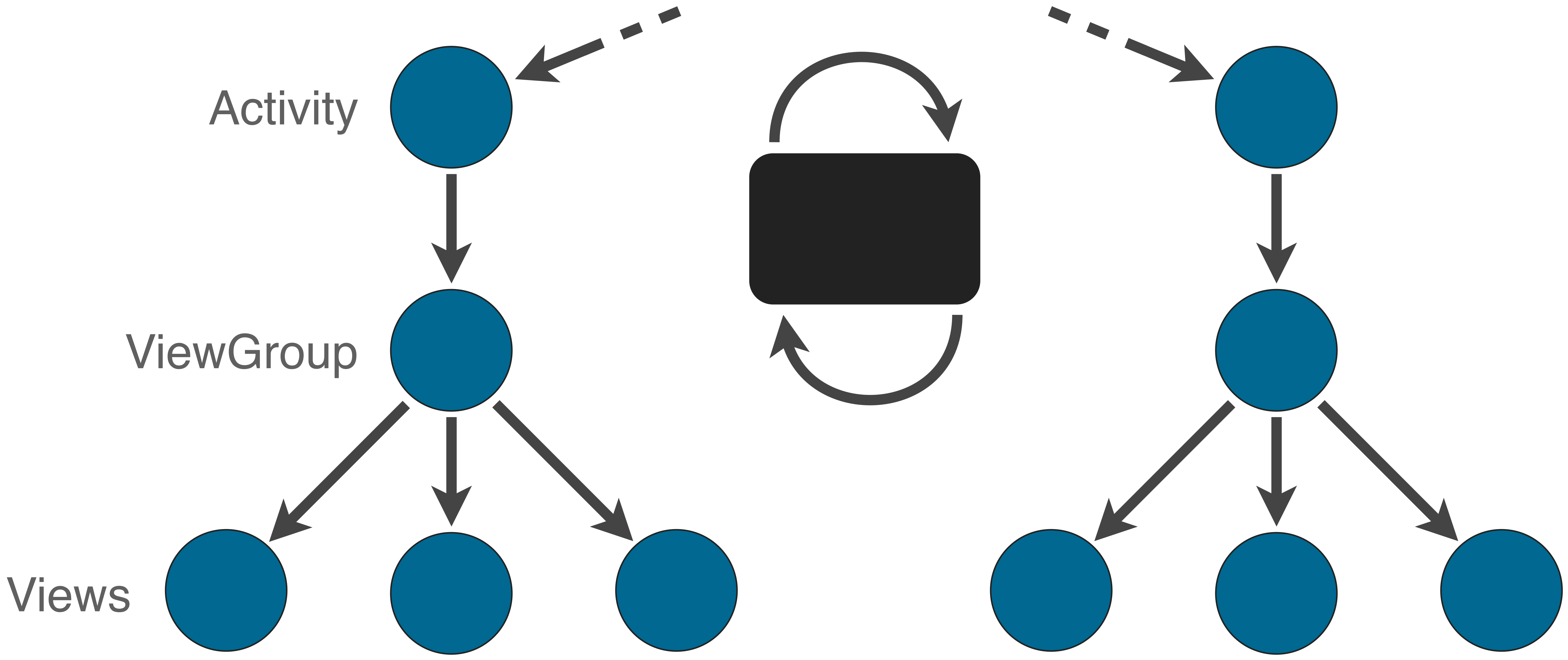
```
hprof-conv orig.hprof converted.hprof
```

- Analyze with MAT, jhat, etc.

Memory Leaks

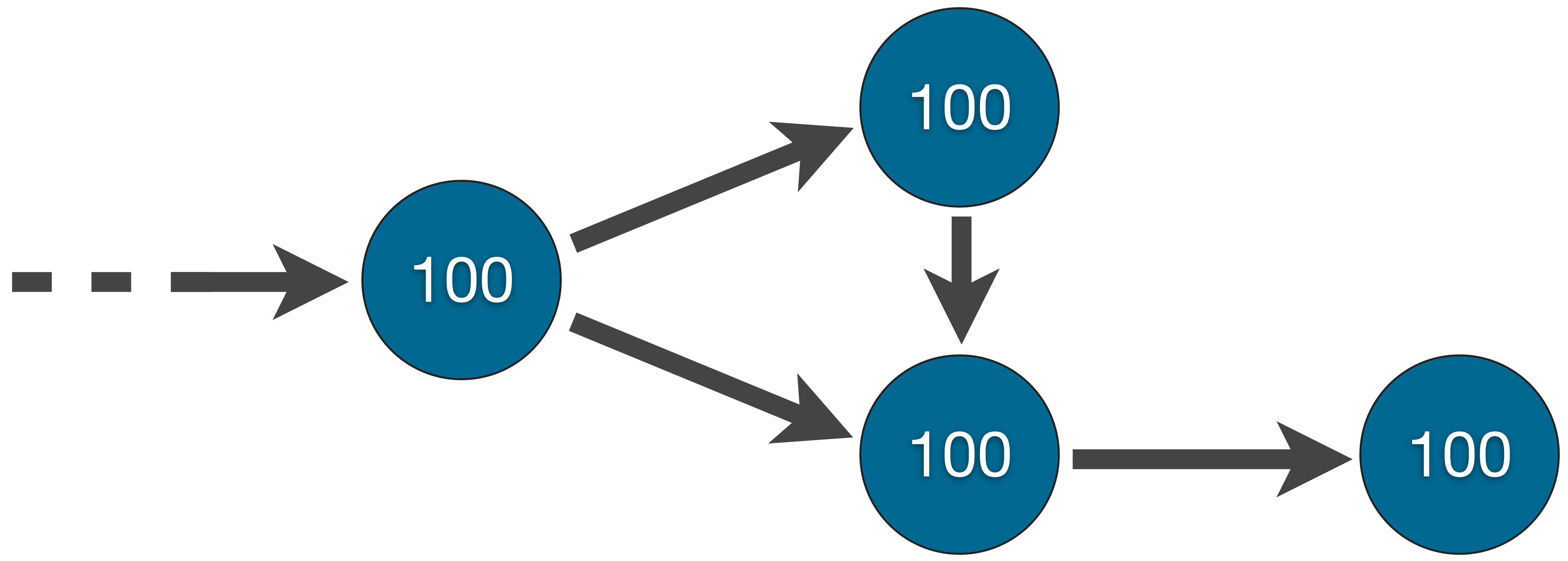
- GC does not prevent leaks!
- Leak: ref to an unused object preventing GC
- References to Activity (Context)
  - View, Drawable, ...

Memory Leaks



Eclipse Memory Analyzer (MAT)

- Download from http://eclipse.org/mat/
- “Shallow heap” and “retained heap”



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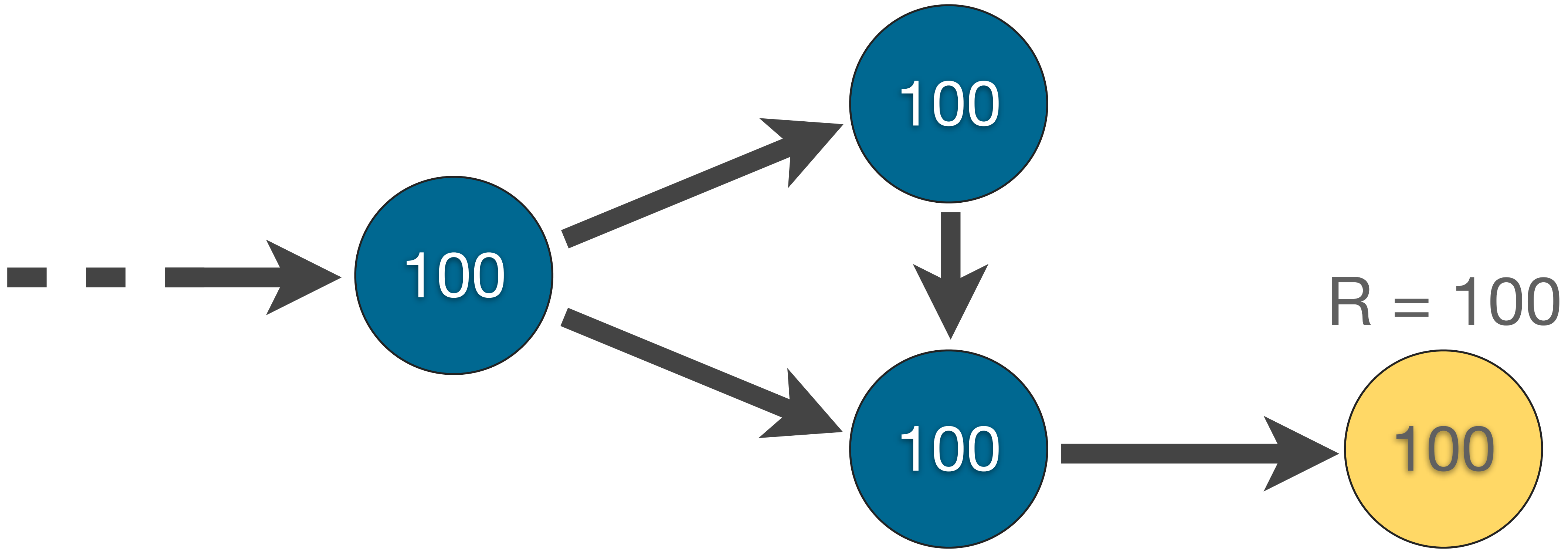

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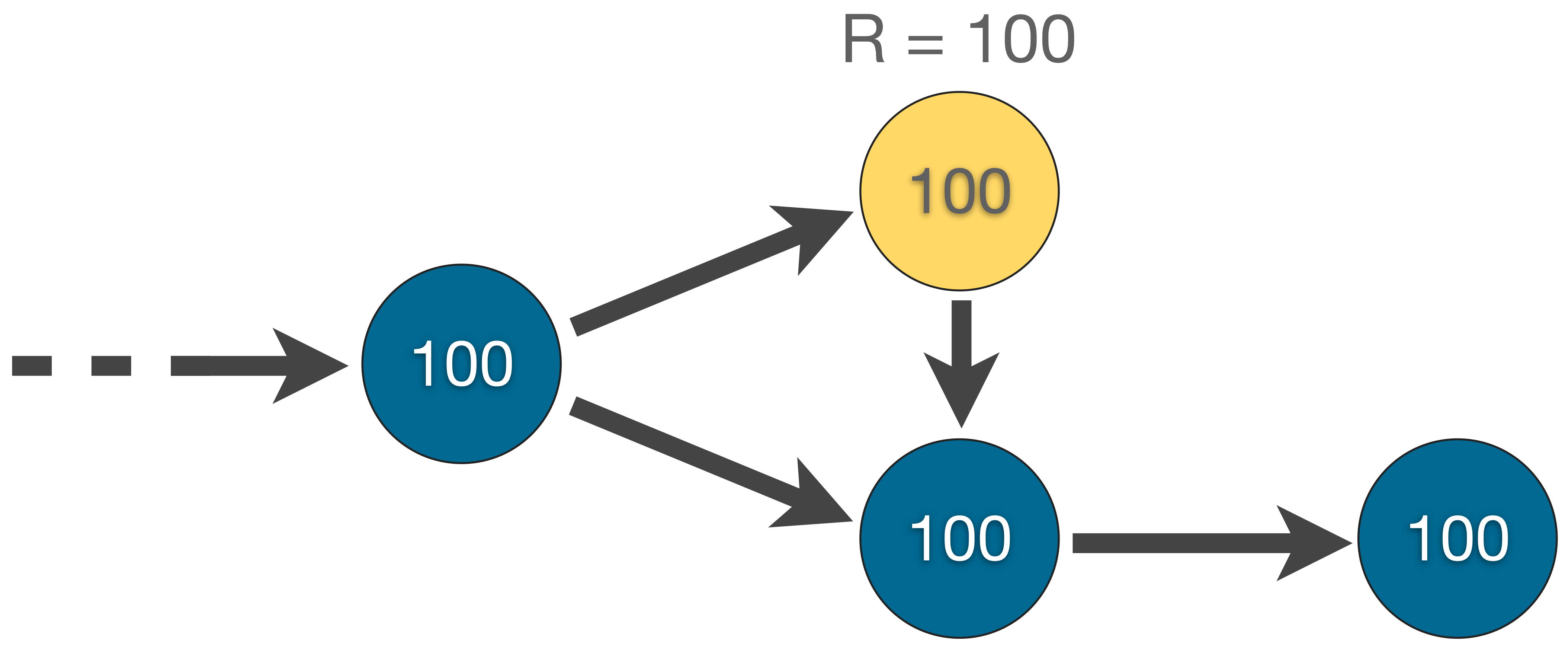

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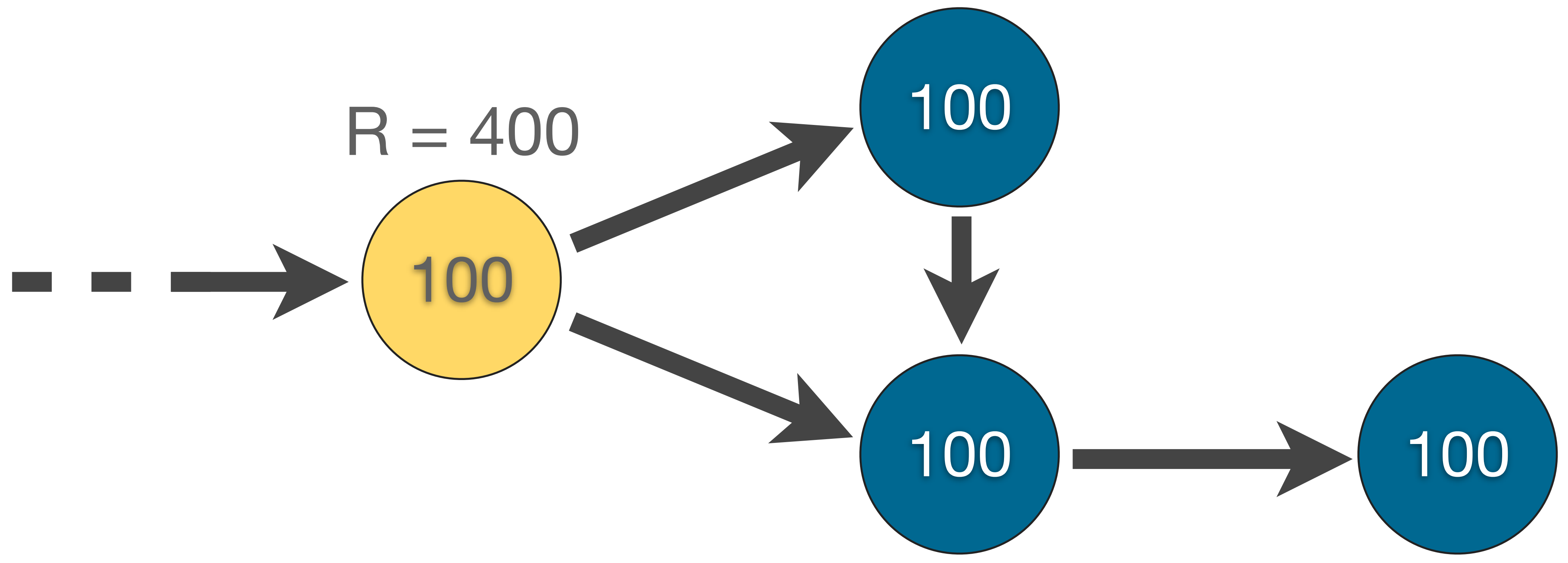

Dominator Tree

- Dominator: closest object on every path to node

$$\begin{tikzcd}
 & B \arrow[r] & D \\
A \arrow[ur] \arrow[dr] & & \\
 & C \arrow[uur] \arrow[r] & E
\end{tikzcd}$$

$$\begin{tikzcd}
 & A \arrow[dl] \arrow[d] \arrow[dr] & \\
B & C \arrow[d] & D \\
 & E &
\end{tikzcd}$$

Demo: Debugging a memory leak with MAT

```
public class MainActivity extends Activity implements ActionBar.TabListener {

    static Leaky leak = null;

    class Leaky {
        void doSomething() {
            System.out.println("Wheee!!!");
        }
    }

    @Override
    public void onCreate(Bundle savedInstanceState) {
        super.onCreate(savedInstanceState);

        if (leak == null) {
            leak = new Leaky();
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    ...
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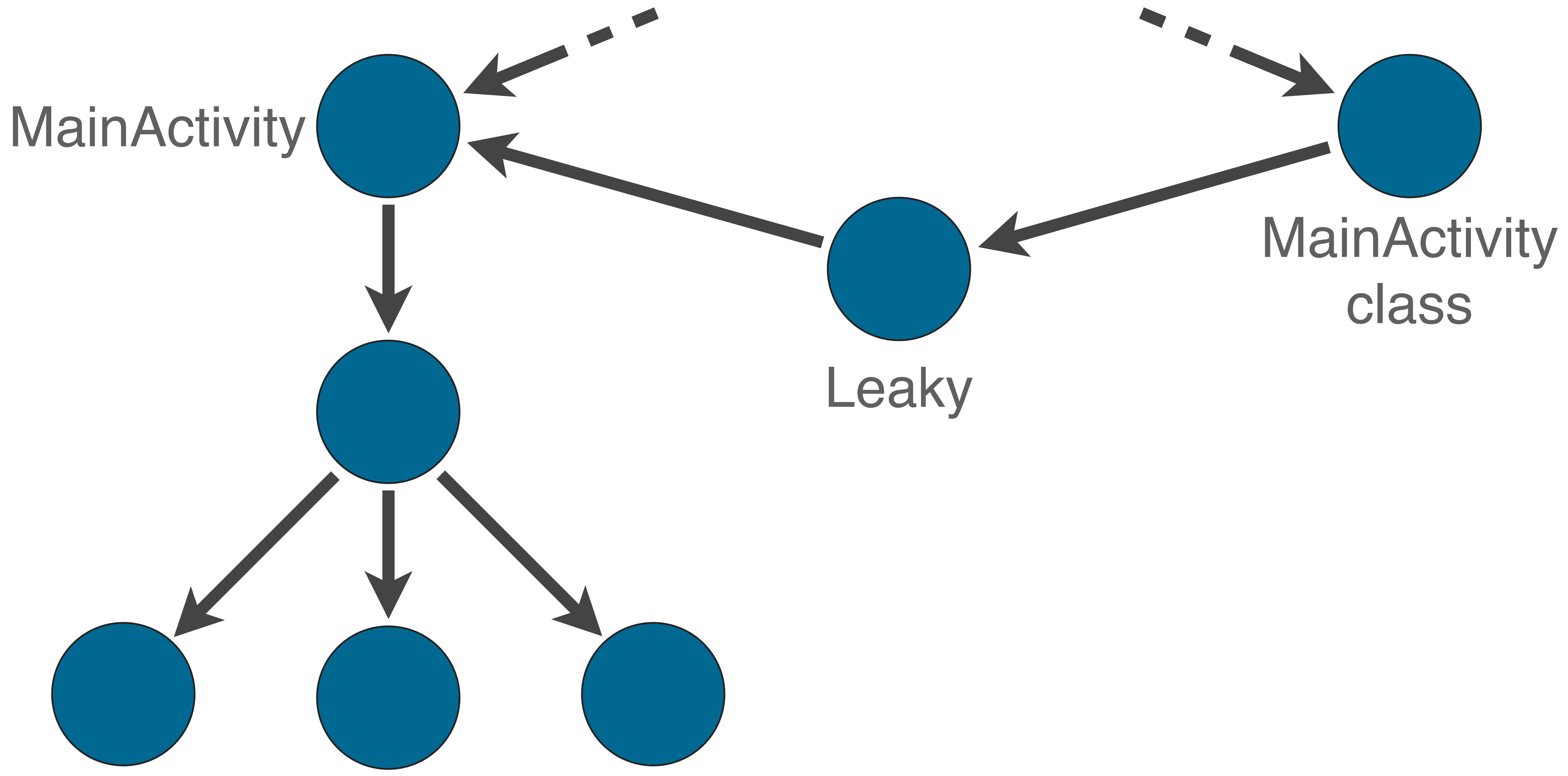
MainActivity
Leaky
MainActivity class

Demo: Debugging a memory leak with MAT

Memory Leaks

- References to Activity, Context, View, Drawable, ...
- Non-static inner classes (e.g. Runnable)
- Caches

Links

- Articles on Android Developers Blog
  - Memory Analysis for Android Applications
  - Avoiding Memory Leaks by Romain Guy
- Eclipse Memory Analyzer: http://www.eclipse.org/mat/
- Markus Kohler's Java Performance Blog: http://kohlerm.blogspot.com/

- Feedback on this talk:
  http://speakermeter.com/talks/memory-management-android