Google™ 09 I/O

How Do I Code Thee?
Let Me Count The Ways.

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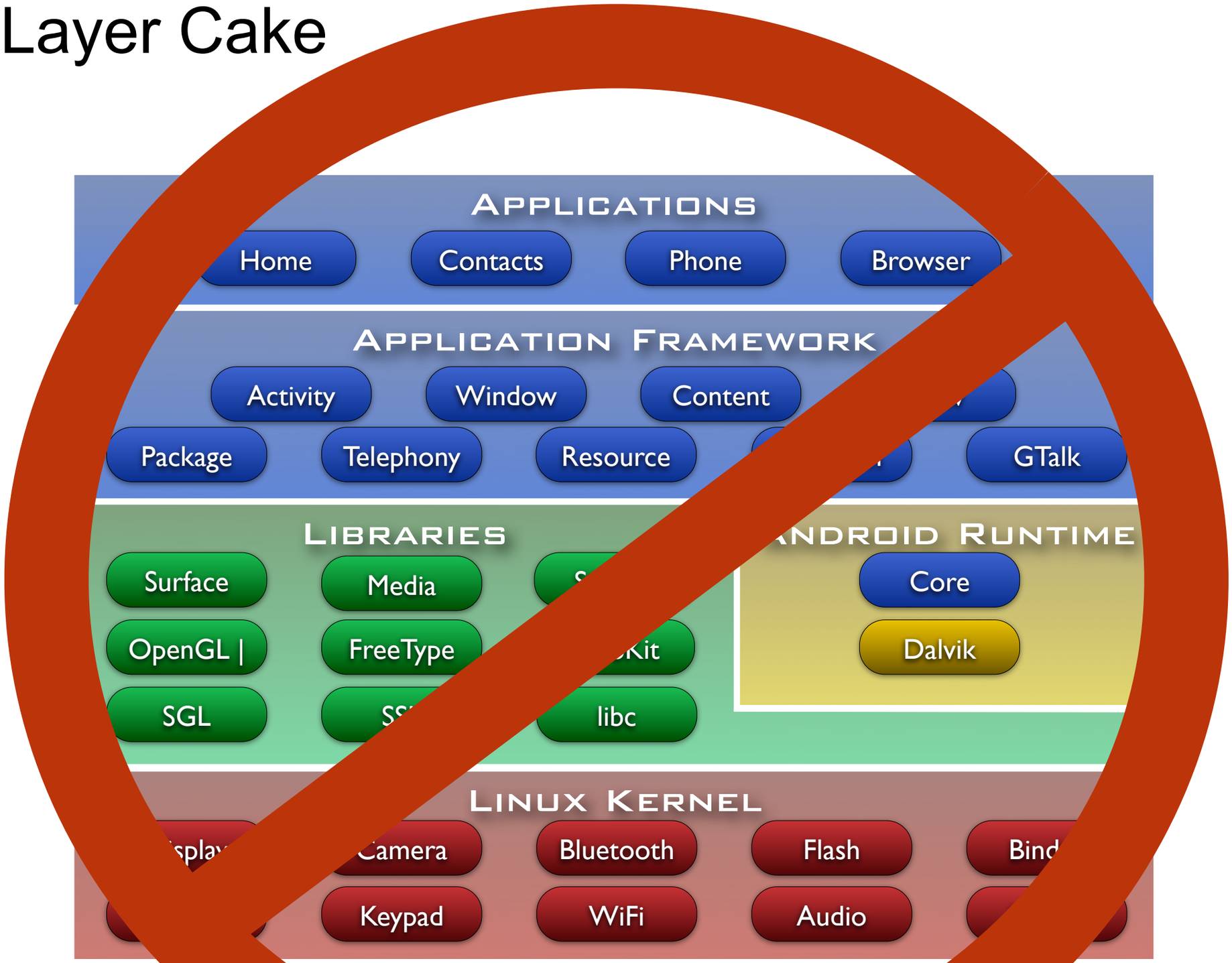
What is Android?

The Layer Cake

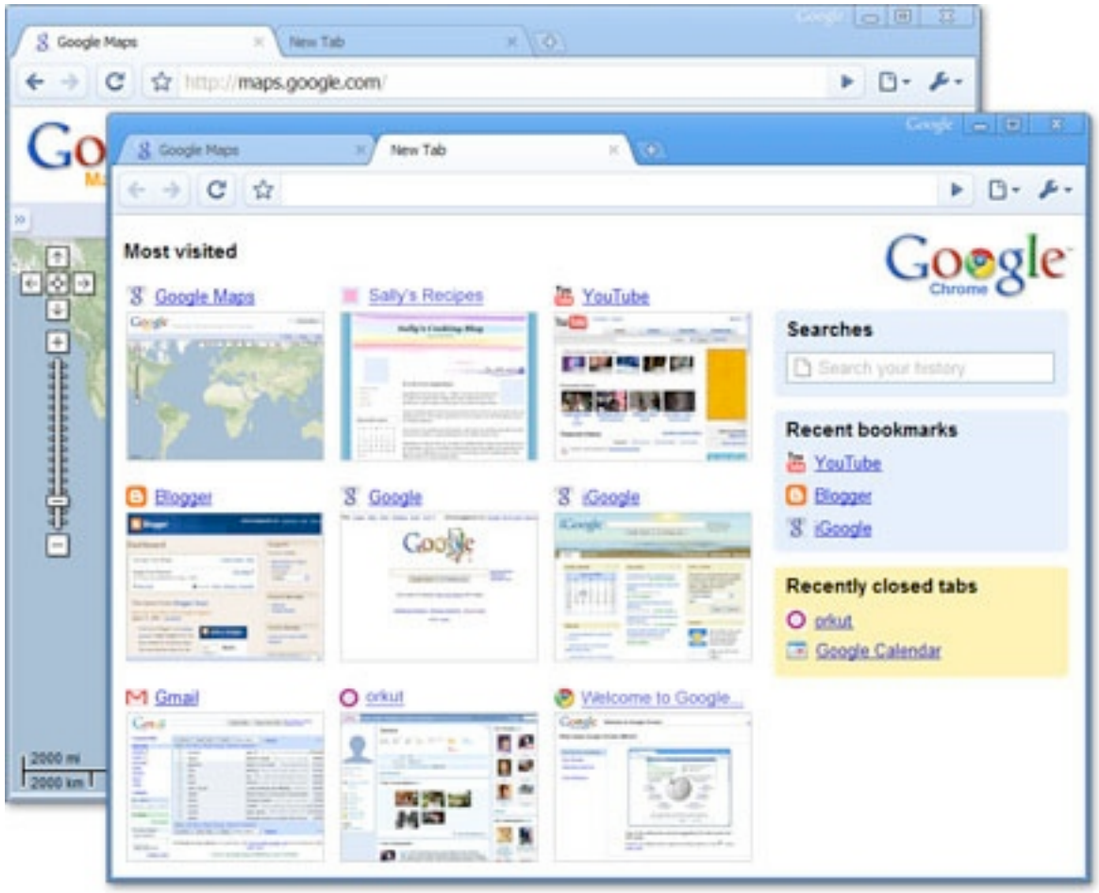


What is Android?

A chunk of code for making phone calls

Image by Evi Christodoulou; http://www.flickr.com/search/?q=startac&l=comm&ct=0

A robust network stack and Internet client



A Platform for Running Code

Image by sludgegulper; http://www.flickr.com/photos/sludgeulper/3441498831/

A Platform for Running Code

- Android has an application platform, true
- But we didn't create Android in an attempt to "own mobile"
- Android is a framework for interacting components
  - Apps can pull in pieces of other apps, the web, or even native

Image by genvessel; http://www.flickr.com/photos/genvessel/177133869/
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"Give me your compiled, your ARM, your huddled bytecodes yearning to run free, the wretched refuse of your teeming store. Send these, the threadless, scripted stuff to me, I lift my lamp beside the coder’s door."

Agenda

- Introduce the Three Kinds
- Demonstrate how to use them
- Useful comparisons & statistics
- Future directions

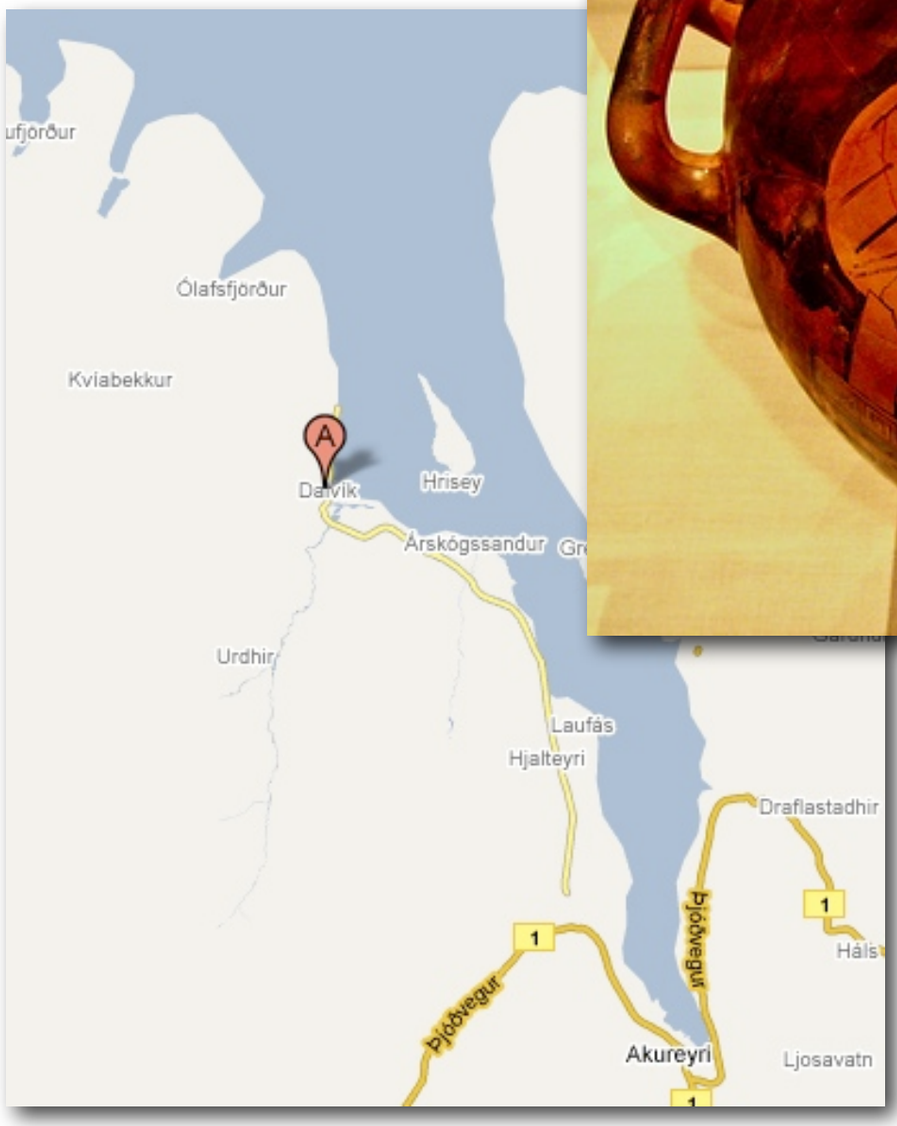
Anti-Agenda

- I will not...
  - Teach you how to write apps
  - Rehash stuff that's covered elsewhere
  - Pass judgment

Three Delicious Flavors

The (current) Three Kinds of Android Code

- Managed Code
- Ajax
- Native Code



Dalvik Code

Wait Wait, Hold Up

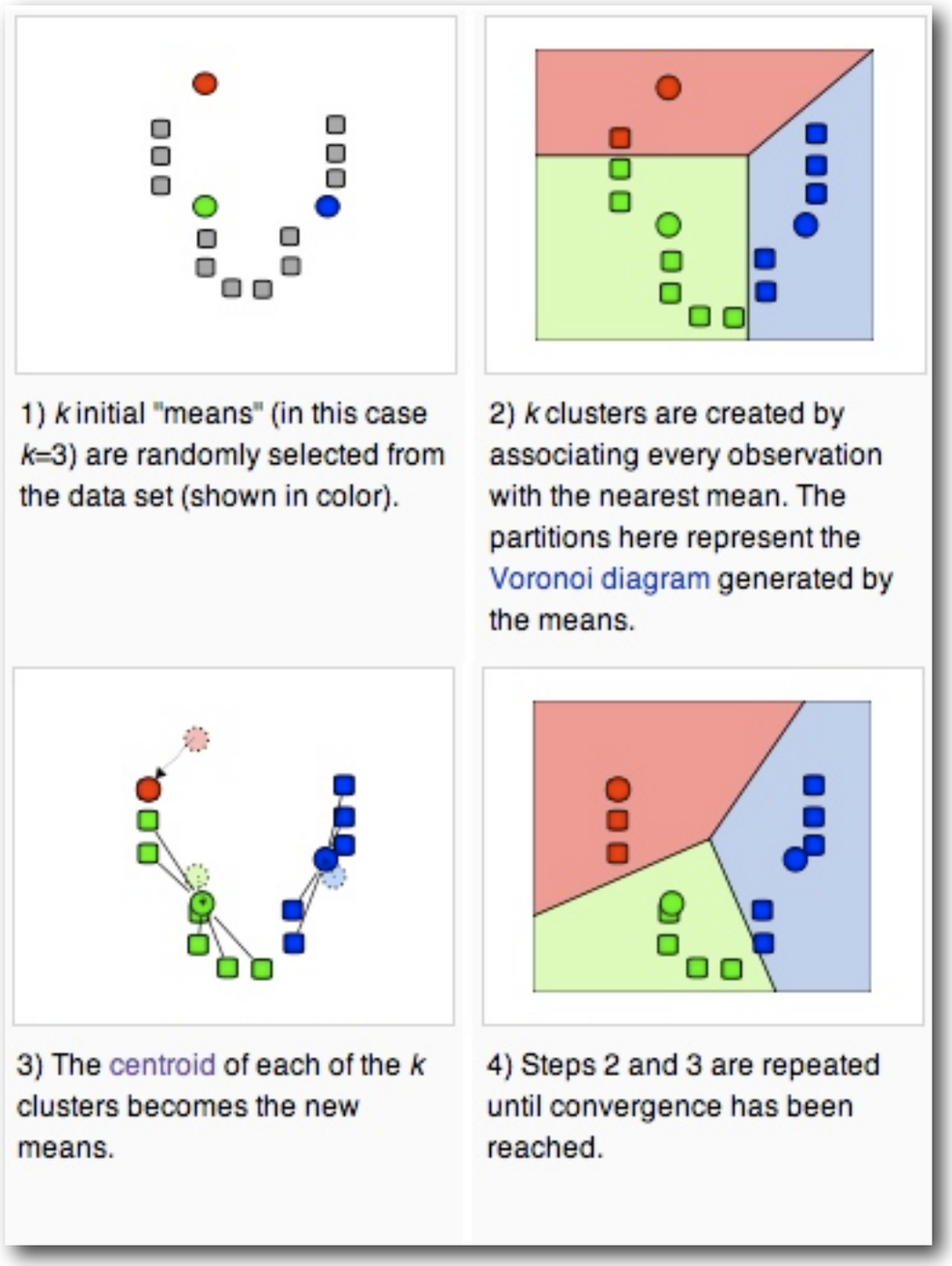
I Need a Victim

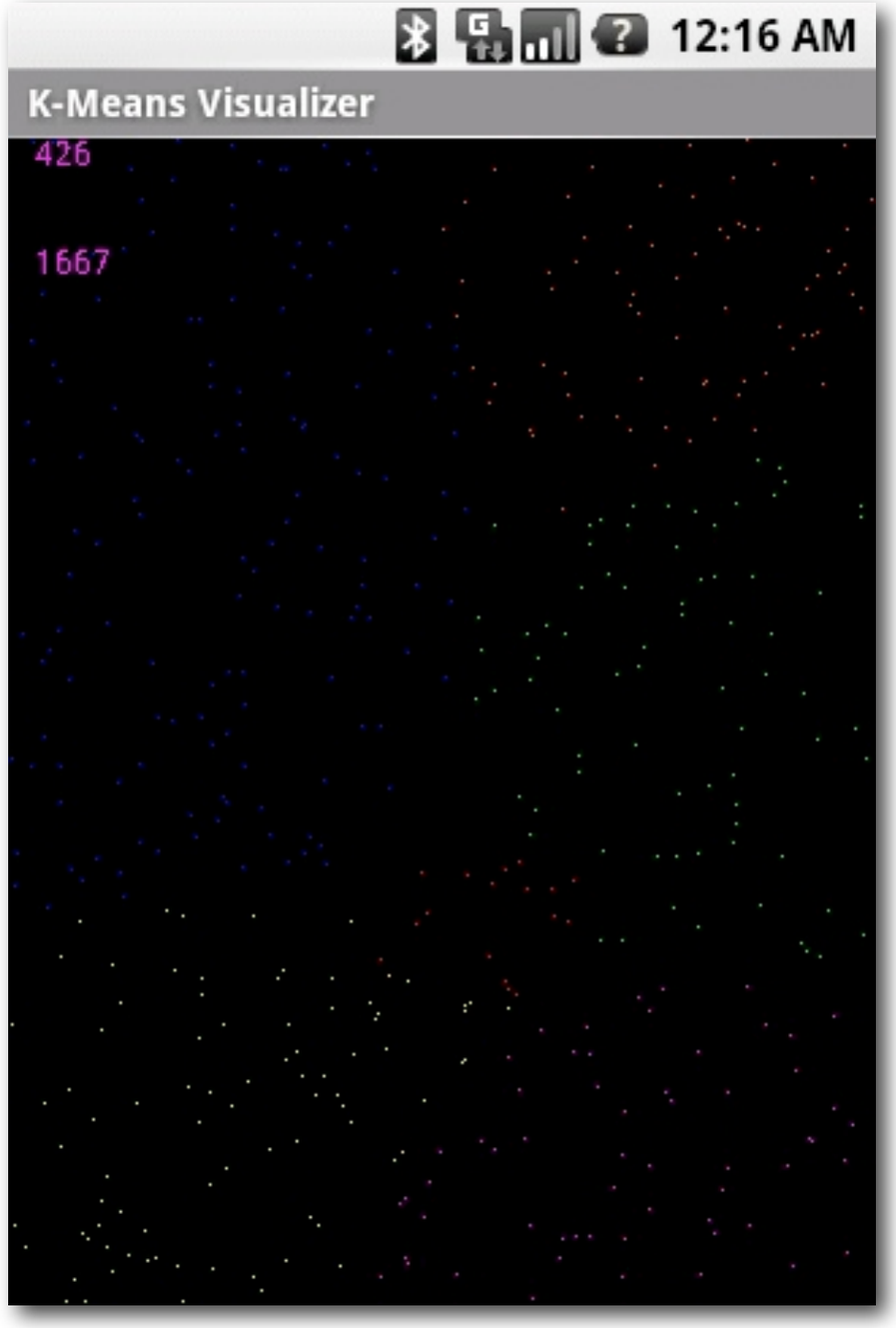
- Interesting but computationally significant
- Efficiently externalizable
- Must make for an interesting visualization

How about.... k-means clustering?

- Used to identify clusters in sets of points
- We'll use a simple 2D version
  - 500 randomly-generated points
  - 6 clusters (ROYGBV)
- Easy to visualize on screen
- 3 implementations
  - "Pure" Dalvik app (i.e. 100% Java source code)
  - Same visualization code with C algorithm implementation
  - JavaScript

K-Means Clustering in 2,000 Words



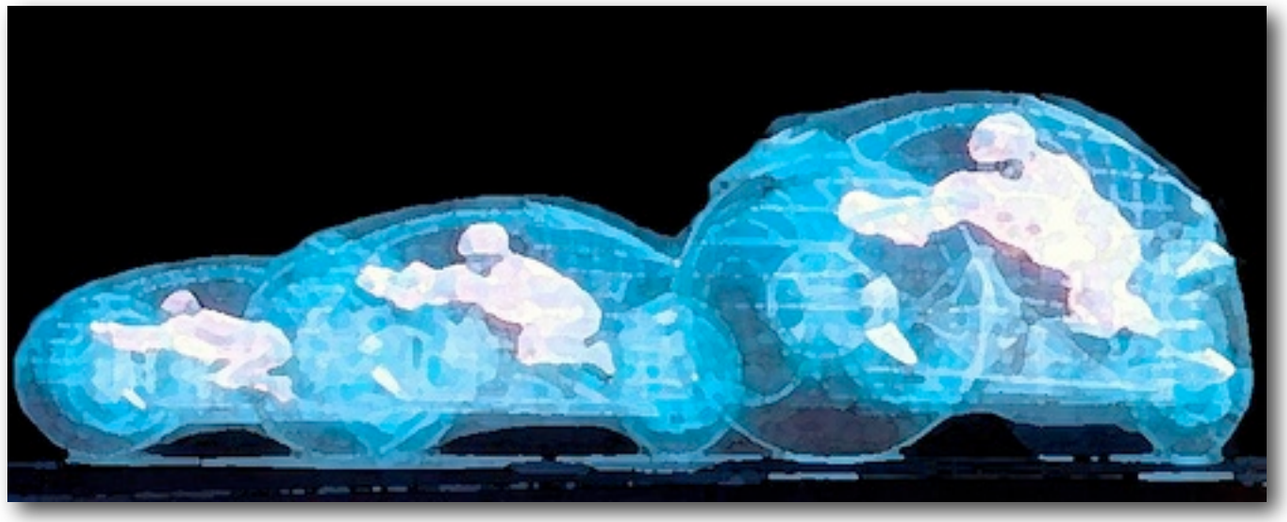


Source: http://en.wikipedia.org/wiki/K-means_clustering

Dalvik Code

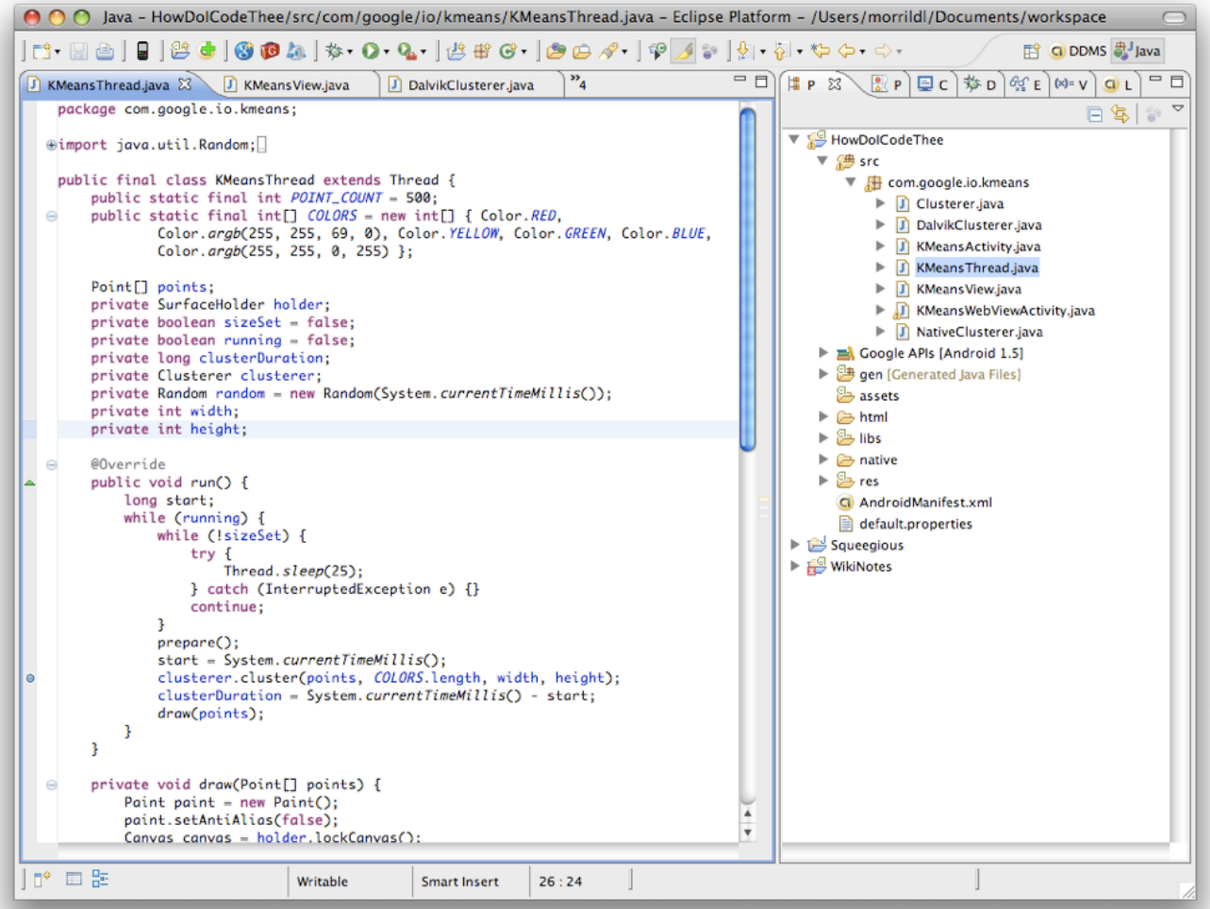
Dalvik - Overview

- Dalvik is a virtual machine, similar to the JVM or .Net CLR
- Memory-protected, garbage-collected, & lifecycle-managed
- Optimized for embedded machines
  - Built to reduce much of the need for a JITC
- Custom bytecode format; included translator from Java bytecode



Dalvik - Writing Apps

- Apps run on Dalvik, which provides core framework APIs
- APIs are backed by system infrastructure in native code
  - e.g. OpenGL, Binder IPC, media, etc.
- Popular tools are supported, and an Eclipse plugin is available



Dalvik - What Can You Do?

- Rich UIs
- Background services
- Shared components
- Tight integration with system events and UI
- ...but there are other sessions covering standard app dev in detail

Dalvik - What Can't You Do?

- Not much!
- Dalvik is the primary app platform -- the crossroads
- That does not necessarily mean it's right for your app, though
  - Some apps need raw speed
  - Some apps don't need tight integration

Dalvik - Demo

```
package com.google.io.kmeans;

import java.util.Random;

public final class KMeansThread extends Thread {
    public static final int POINT_COUNT = 500;
    public static final int[] COLORS = new int[] { Color.RED,
            Color.argb(255, 255, 69, 0), Color.YELLOW, Color.GREEN, Color.
            Color.argb(255, 255, 0, 255) };

    Point[] points;
    private SurfaceHolder holder;
    private boolean sizeSet = false;
    private boolean running = false;
    private long clusterDuration;
    private Clusterer clusterer;
    private Random random = new Random(System.currentTimeMillis());
    private int width;
    private int height;

    @Override
    public void run() {
        long start;
        while (running) {
            while (!sizeSet) {
                try {
                    Thread.sleep(25);
                } catch (InterruptedException e) {}
                continue;
            }
            prepare();
            start = System.currentTimeMillis();
            clusterer.cluster(points, COLORS.length, width, height);
            clusterDuration = System.currentTimeMillis() - start;
            draw(points);
        }
    }

    private void draw(Point[] points) {
        Paint paint = new Paint();
        paint.setAntiAlias(false);
        Canvas canvas = holder.lockCanvas();
        try {
            long start = System.currentTimeMillis();
            canvas.drawARGB(255, 0, 0, 0); // black the screen
            for (Point point : points) {
                paint.setColor(COLORS[point.cluster]);
                canvas.drawPoint((int)point.x, (int)point.y, paint);
            }
```

Dalvik - Examples

- Core system apps
- Currently (nearly) all apps on the Android Market

Dalvik - Future

- Improved (faster, better) garbage collection
- Just-In-Time compilation
- Optimizations in core libraries
- Additional APIs -- Bluetooth, P2P, and more

Ajax (Web) Apps

Ajax - Overview

- Apps are broken up into convenient declarative layouts & code
- JavaScript code mutates the DOM to create UI effects
- Network access is available via XMLHttpRequest
- Recently, <canvas> allows JavaScript to do direct painting

Ajax on Android - Overview

- Android's Browser is based on WebKit + SquirrelFish
- WebKit v528.5, equivalent to Safari 4 beta
  - Reports as 3.1.2 in the user-agent string -- oops!
- Includes Gears 0.5.17.0 (including location)
- Includes support for the <canvas> tag

Ajax - What Can You Do?

- Old sk00l
  - You can, of course, just build static web page apps

Ajax - What Can You Do?

- But you can also build dynamic UIs, via DOM or <canvas>
- You can fetch & store data on your origin server
- With HTML5, you can also:
  - Access location
  - Run code outside the main thread
  - Store data & pages locally

Ajax on Android - What Can't You Do?

- Android doesn't currently support HTML5, but does have Gears
- Background processing
  - Code only runs when Browser is open and your page is loaded
- Access system & framework APIs [1]

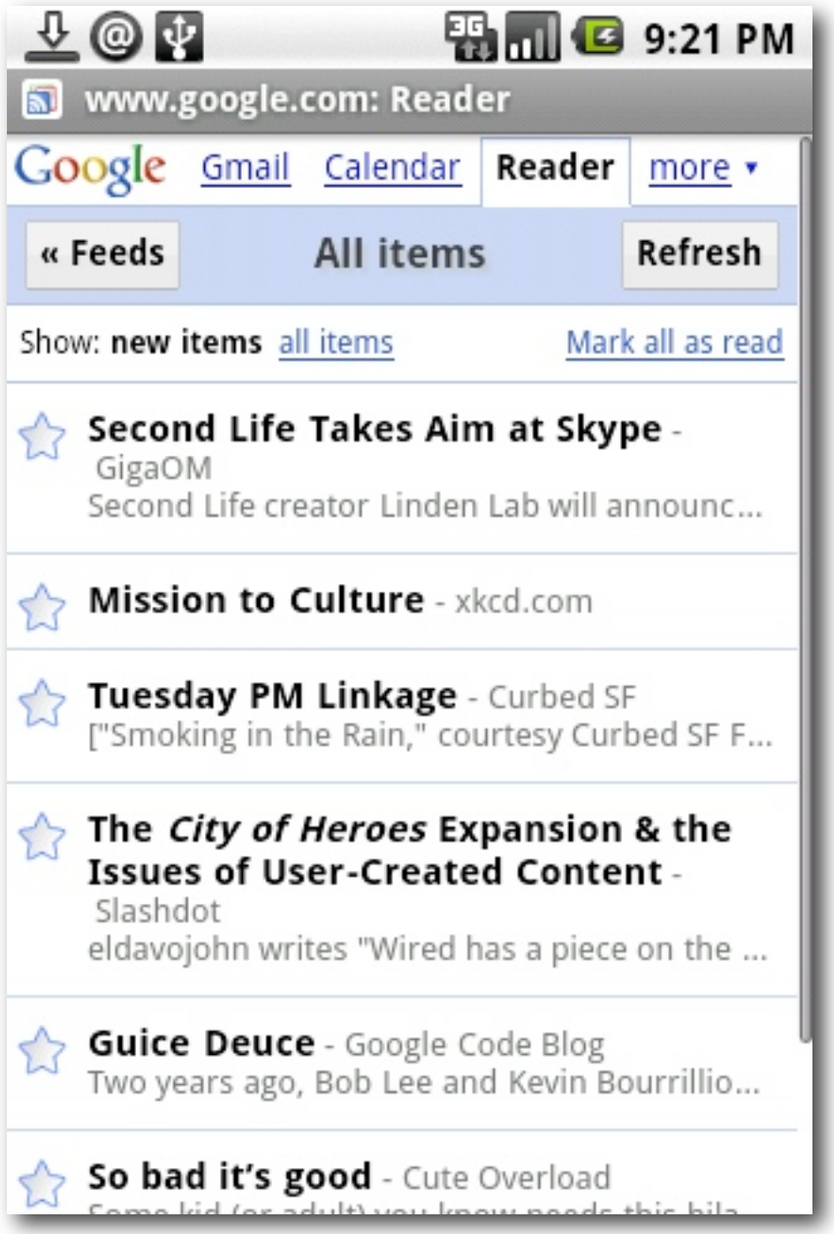
[1] - Hold that thought, though.

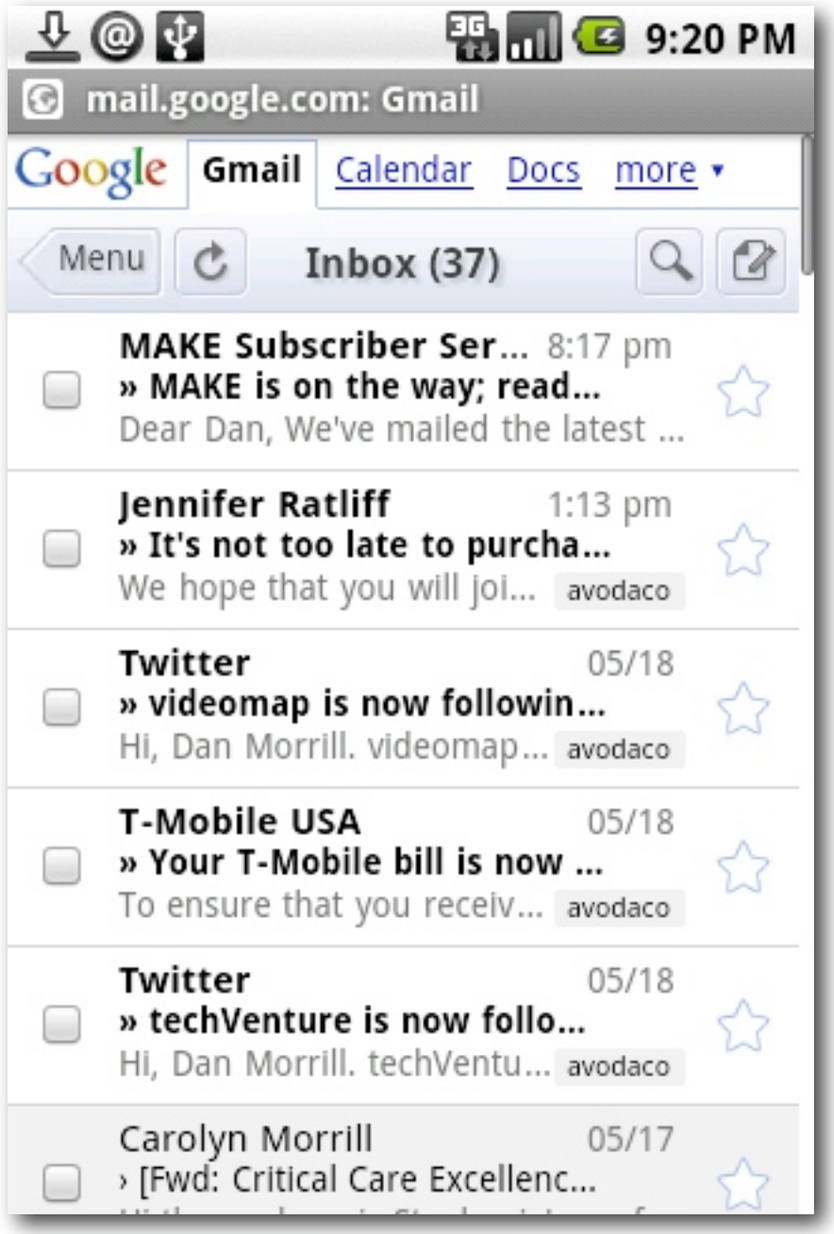
Ajax - Demo

```
var means = new Array();
var distances = {};

function computeDistance(a, b) {
    return Math.sqrt(Math.pow(a.x - b.x, 2) + Math.pow(a.y - b.y, 2));
}

function cluster() {
    var converged = false;
    var dirty = false;
    var distance = 0.0;
    var curMinDistance = 0.0;
    var sumX = new Array();
    var sumY = new Array();
    var clusterSizes = new Array();
    var cluster = new Array();
    var loopCount = 0;

    while (!converged) {
        dirty = false;
        for (var i = 0; i < points.length; i = i + 1) {
            point = points[i];
            curMinDistance = distances[hash(point)];
            for (var j = 0; j < means.length; j = j + 1) {
                mean = means[j];
                distance = computeDistance(point, mean);
                if (distance < curMinDistance) {
                    dirty = true;
                    curMinDistance = distance;
                    point.cluster = j;
                }
            }
        }
        if (!dirty) {
            converged = true;
            break;
        }
        for (var i = 0; i < means.length; i = i + 1) {
            sumX[i] = 0;
            sumY[i] = 0;
            clusterSizes[i] = 0;
        }
        for (var i = 0; i < points.length; i = i + 1) {
            sumX[points.cluster] = sumX[points.cluster] + points.x;
            sumY[points.cluster] = sumY[points.cluster] + points.y;
            clusterSizes[points.cluster] = clusterSizes[points.cluster] + 1;
        }
        for (var i = 0; i < means.length; i = i + 1) {
            means[i].x = sumX[i] / clusterSizes[i];
            means[i].y = sumY[i] / clusterSizes[i];
        }
        loopCount = loopCount + 1;
        if (loopCount > MAX_LOOP_COUNT) {
            converged = true;
        }
    }
}

function hash(booga) {
```

Ajax - Examples

- Google Reader for mobile
- Gmail (web version)
- Many mobile web apps (of various fruit flavors)



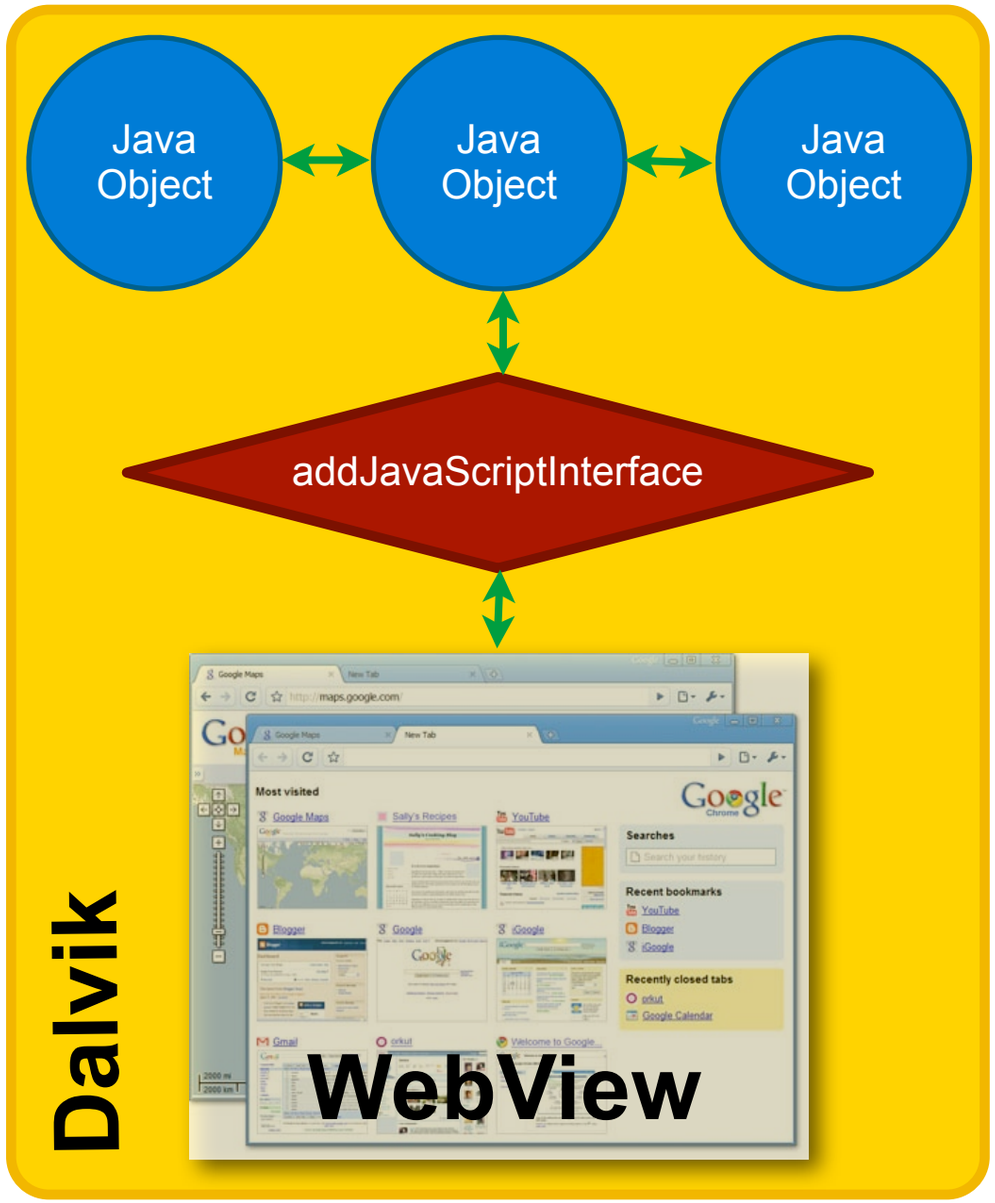


Ajax - Future

- HTML5 will keep getting better
- Android will continue to include a world-class browser
  - Gears today, HTML5 in the future
  - Plans to upgrade to an even faster JSVM
- Who knows what else? I hear the future is a crazy place

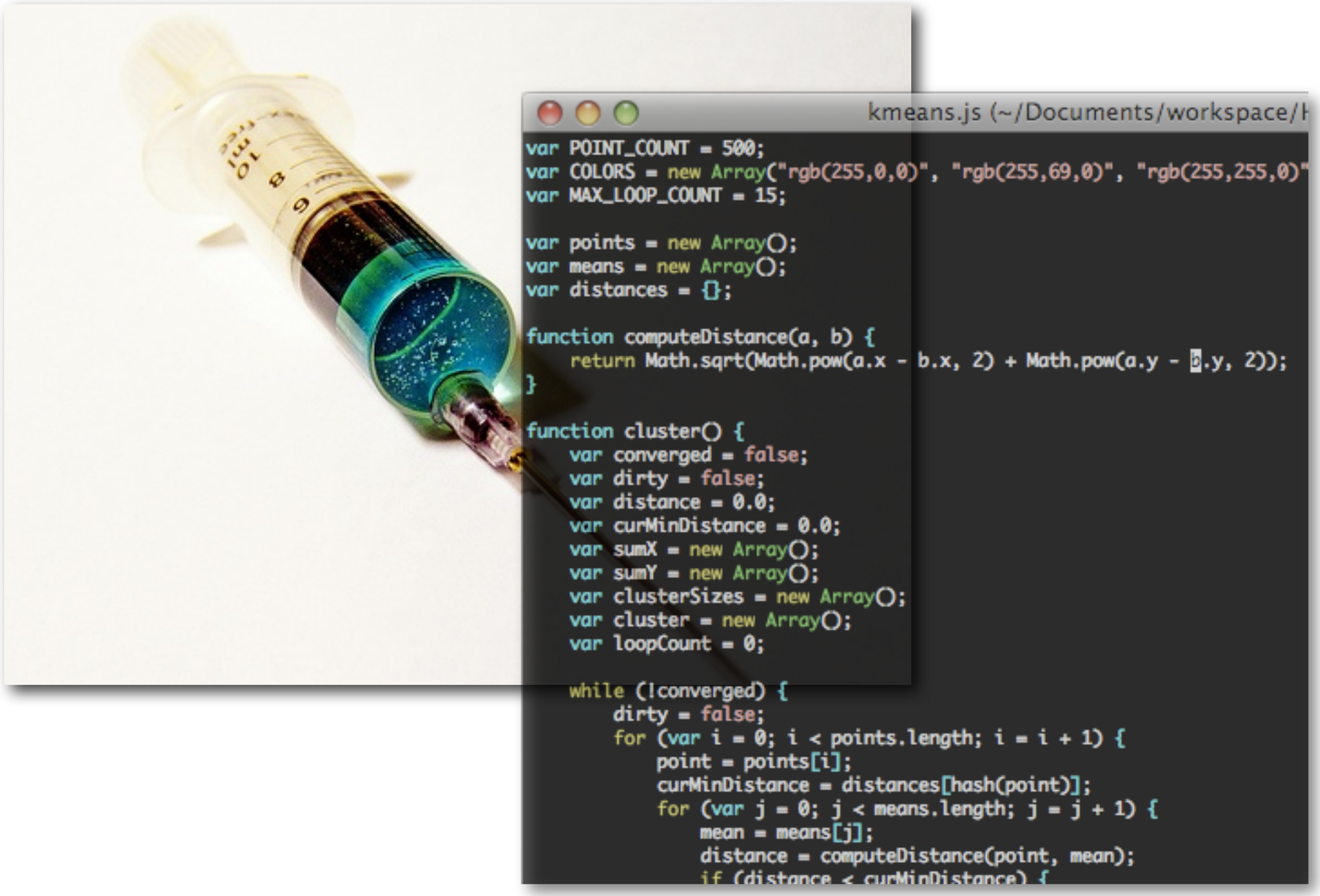
Ajax - What Else Can You Do?

- Augmented Ajax



Augmented Ajax

- Inject functionality into JavaScript



Native Code

Native - Overview

- Launched as a Dalvik application
- Loads a dynamic library (.so, ARM ELF, linked against Bionic)
- Makes calls into native code via JNI for heavy lifting
- .so files are created using the NDK complement to the SDK
- Work-in-progress NDK added to donut branch in git

Native - What Can You Do?

- Physics simulations
- Efficient/fast loading of large-ish data files
- Speed-intensive lookups, such as for IMEs
- Custom VMs (long live obsolete games!)
- Unsupported things...
  - Technically, other libraries are present, but have no guarantees
  - Use them, and you deserve the Market user ratings you will get when your app breaks

Native - What Can’t You Do?

- Current set of APIs is limited to libm and libc
- More will be added over time
- h@x0r the system -- sandboxing still applies

Native - Demo

```c
#include <stdlib.h>

double computeDistance(double aX, double aY, double bX, double bY) {
    return sqrt((aX - bX) * (aX - bX) + (aY - bY) * (aY - bY));
}

typedef struct {
    double x;
    double y;
    int cluster;
} point;

#define MAX_LOOP_COUNT 15;

JNIEXPORT void JNICALL
Java_com_google_io_kmeans_NativeClusterer_cluster(JNIEnv* env, jobject jobj,
jobjectArray points, jint numClusters, jint width, jint height) {
    int converged = 0;
    int dirty = 0;
    double curMinDistance = 0;
    int loopCount = 0;
    jsize numPoints = (*env)->GetArrayLength(env, points);
    double distances[numPoints];
    point means[numClusters];
    double sumX[numClusters];
    double sumY[numClusters];
    int clusterSizes[numClusters];
    double distance = 0;
    int cluster = 0;
    jobject point;
    jclass pointClass;
    jfieldID xFID, yFID, clusterFID;
    jdouble ptX = 0, ptY = 0;
    int i, j;

    // cache some JNI objects so we don't keep requerying them
    pointClass = (*env)->FindClass(env, "com/google/io/kmeans/Clusterer$Point");
    xFID = (*env)->GetFieldID(env, pointClass, "x", "D");
    yFID = (*env)->GetFieldID(env, pointClass, "y", "D");
    clusterFID = (*env)->GetFieldID(env, pointClass, "cluster", "I");

    // initialize the means
    for (i = 0; i < numClusters; ++i) {
        means[i].x = rand() % width;
        means[i].y = rand() % height;
        means[i].cluster = i;
    }

    // initializes the distances record
    for (i = 0; i < numPoints; ++i) {
        distances[i] = 100000000.0; // might break for larger resolutions
    }

    // the main loop
    while (!converged) {
        dirty = 0;
        for (i = 0; i < numPoints; ++i) {
            point = (*env)->GetObjectArrayElement(env, points, i);
            for (j = 0; j < numClusters; ++j) {
```

Native - Examples

- SCUMMVM
- Spotify
- Much of the system, actually...

Native - Future

- Add additional libraries, but which? TBD.
  - Let us know!
- No plans to make native code a fully-independent app model
  - ...but there's no reason to prevent developers from doing stuff

Bonus Demo

How Do You Choose?

Some Data

Modality	Total	Rendering Time	Percent Rendering
Dalvik	614	16	2.6%
JavaScript	936	303	32.4%
Native	127	15	11.2%

Some Data

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Some Data

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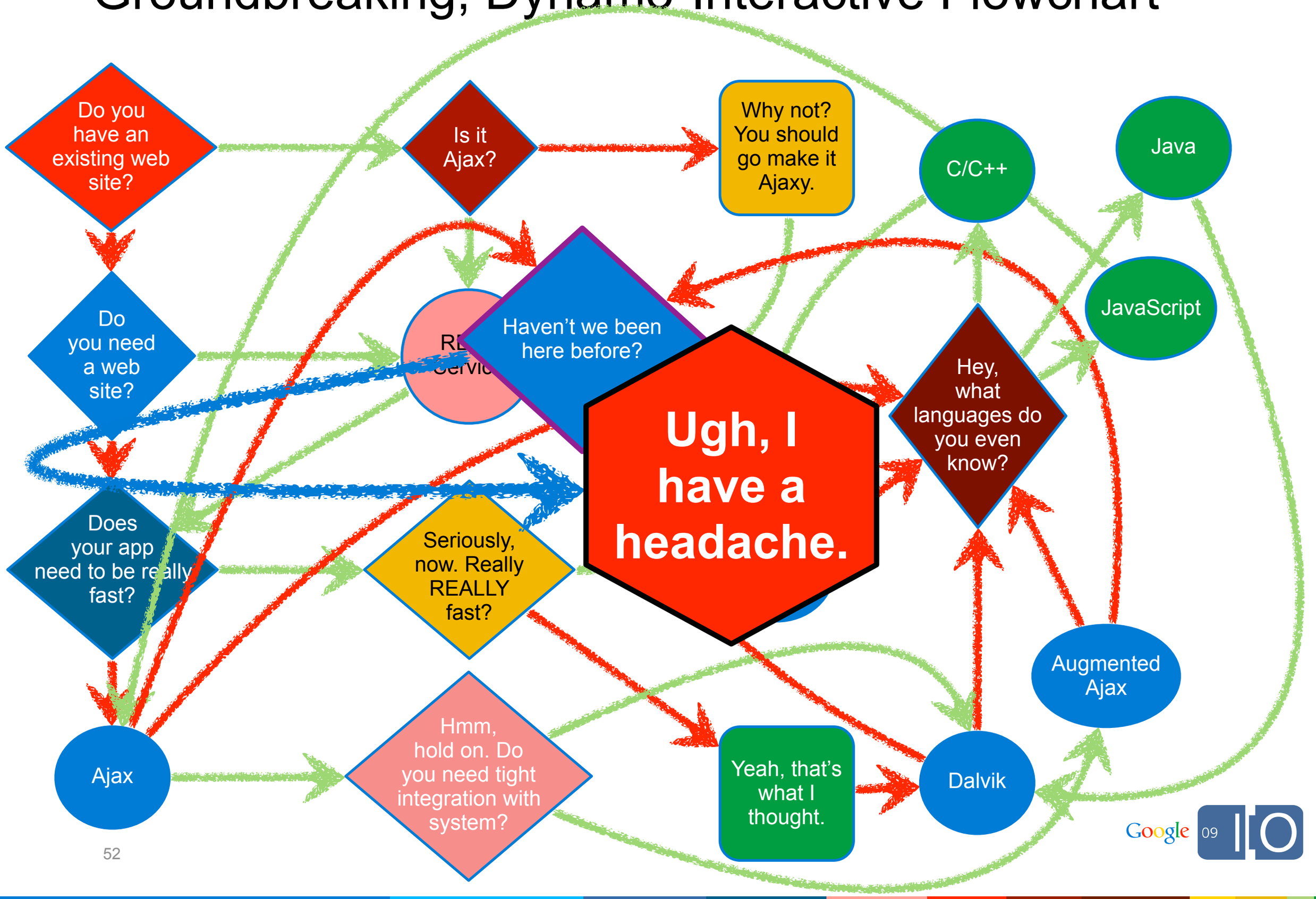
What's that mean?

- Dalvik is very competitive with other pure-interpreted VMs
- Dalvik, as a front-end for native code, usually beats JavaScript
  - But clearly, there are use cases where that doesn't matter
- And of course, custom native code will always win the speed test

Groundbreaking, Dynamo-Interactive Flowchart



The Bottom Line

- There’s more than one way to do it
- We aren’t out to shove a paradigm down your throat (ouch?)

The Bottom Line

- The “centroid” of your app can be anywhere
  - Dalvik apps can embed the web; web apps can call to Dalvik
  - Apps can include native code pieces for better performance
- Understand your app, & decide based on your app’s needs
  - If you’re doing lots of drawing, use Dalvik
  - If you have a web presence already, use (Dalvik-enhanced?) Ajax
  - If you have large, slow algorithms, use Dalvik + native code
  - Your skills do mean something: go with what you know!

And That's Pretty Much The Long and Short of It

Source available at: http://code.google.com/p/hdict

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