Recording in Progress

This class is being recorded

Please turn off your video and/or video if you do not wish to be recorded

CMSC436: Programming Handheld Systems

Android Development Environment

The Android Platform

A multi-layered software stack for building and running mobile applications

The Android Development Environment

Starts with knowledge of the Android platform

Your workbench for writing Android applications

See:

https://developer.android.com/studio/intro/

Today’s Topics

Downloading Android SDK

Using the Android Studio IDE

Using the Android emulator

Debugging Android applications

Other tools

Prerequisites

Supported Operating Systems:

- Microsoft Windows 8/10 (64-bit)
- Mac OS X 10.14 (Mojave) or higher
- Any 64-bit Linux that supports Gnome, KDE, Unity DE

General Prerequisites

8GB RAM min

8GB memory for Android SDK, emulator system images, and caches

1280 x 800 min screen resolution

Getting Started

Download & install Android Studio

See: https://developer.android.com/studio/

Android Studio

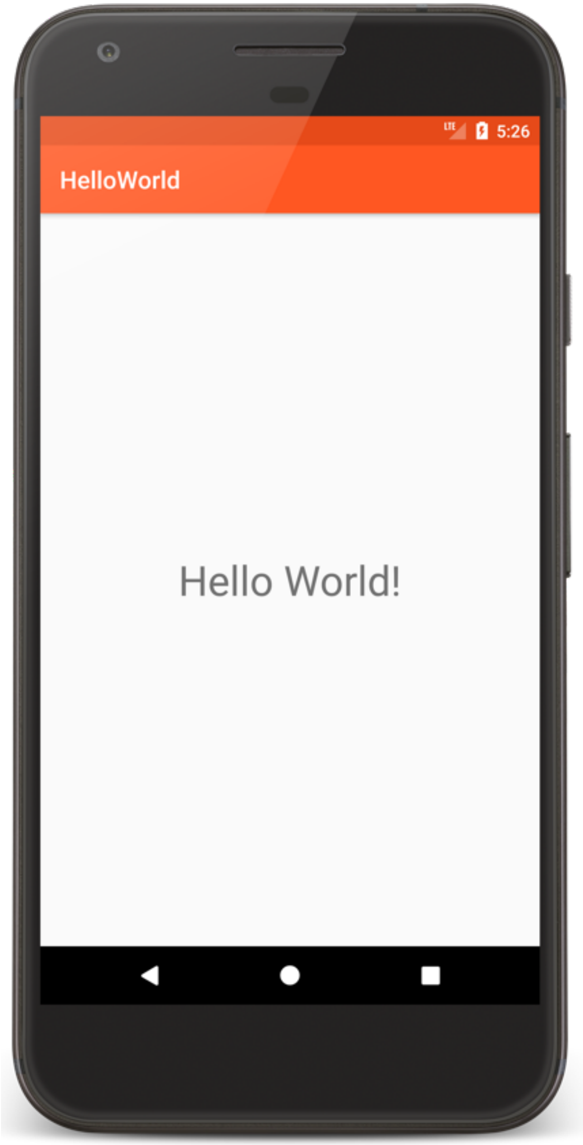
Android platform

Android Studio IDE

Key development tools

System image for emulator

HelloWorld

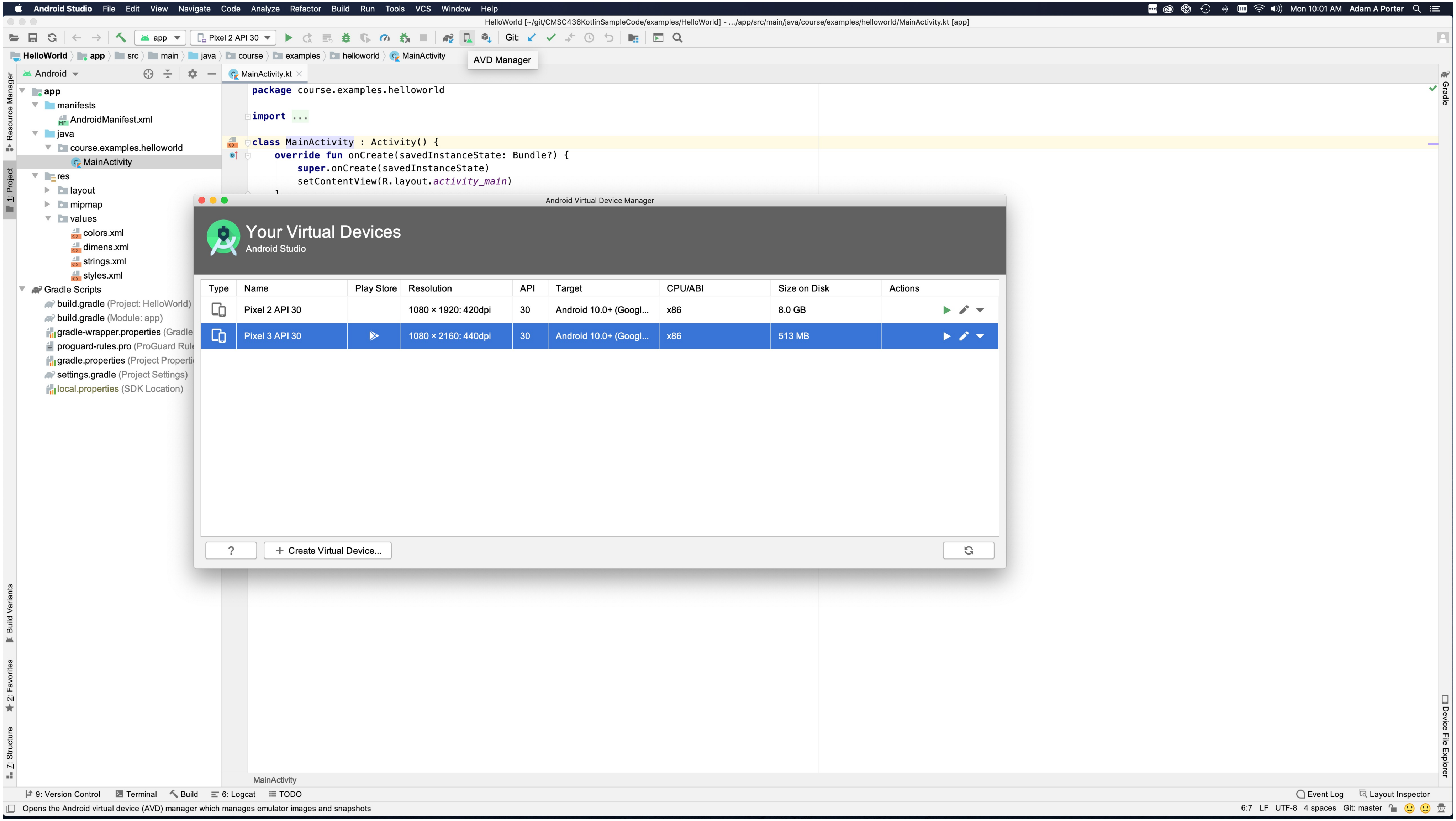


Hello World!

```
package course.examples.helloworld

import android.app.Activity
import android.os.Bundle

class MainActivity : Activity() {

   override fun onCreate(savedInstanceState: Bundle?) {
      super.onCreate(savedInstanceState)
      setContentView(R.layout.activity_main)
   }
}
```

The Android Emulator

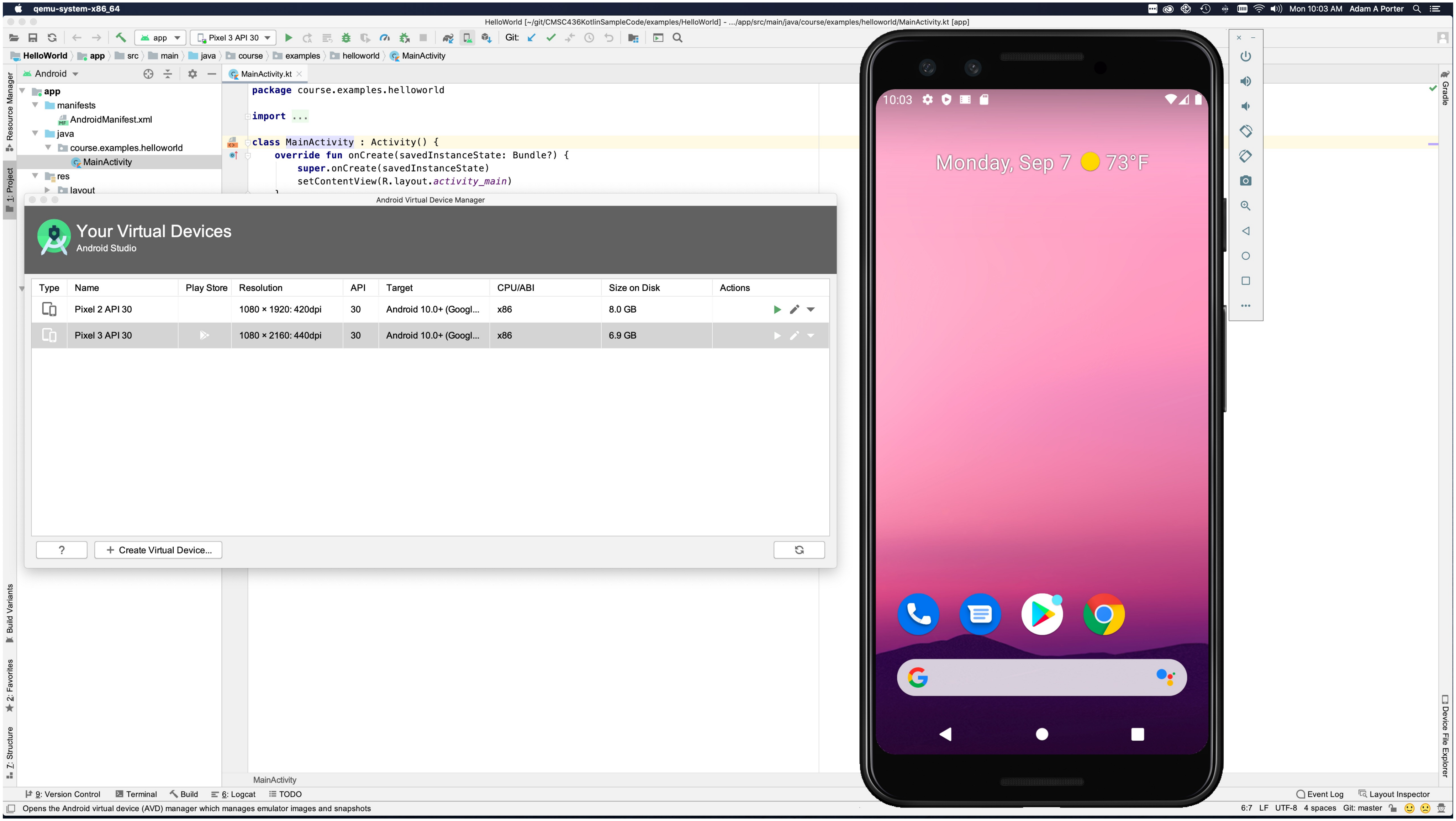
Runs virtual devices


Android Studio File Edit View Navigate Code Analyze Refactor Build Run Tools VCS Window Help
Mon 10:01 AM Adam A Porter
HelloWorld [~/git/CMSC436KotlinSampleCode/examples/HelloWorld] - .../app/src/main/java/course/examples/helloworld/MainActivity.kt [app]
app
Pixel 2 API 30
Git:
HelloWorld app src main java course examples helloworld MainActivity
AVD Manager
Android
MainActivity.kt
app
manifests
AndroidManifest.xml
java
course.examples.helloworld
MainActivity
res
layout
mipmap
values
colors.xml
dimens.xml
strings.xml
styles.xml
Gradle Scripts
build.gradle (Project: HelloWorld)
build.gradle (Module: app)
gradle-wrapper.properties (Gradle
proguard-rules.pro (ProGuard Rul
gradle.properties (Project Properti
settings.gradle (Project Settings)
local.properties (SDK Location)
Resource Manager
1: Project
Build Variants
2: Favorites
Z: Structure
Gradle
Device File Explorer
Android Virtual Device Manager
Your Virtual Devices
Android Studio
?
+ Create Virtual Device...
MainActivity
9: Version Control
Terminal
Build
6: Logcat
TODO
Event Log
Layout Inspector
6:7 LF UTF-8 4 spaces Git: master

```
package course.examples.helloworld

import ...

class MainActivity : Activity() {
    override fun onCreate(savedInstanceState: Bundle?) {
        super.onCreate(savedInstanceState)
        setContentView(R.layout.activity_main)
    }
```

Type	Name	Play Store	Resolution	API	Target	CPU/ABI	Size on Disk	Actions
	Pixel 2 API 30		1080 × 1920: 420dpi	30	Android 10.0+ (Googl...	x86	8.0 GB	
	Pixel 3 API 30		1080 × 2160: 440dpi	30	Android 10.0+ (Googl...	x86	513 MB	

Opens the Android virtual device (AVD) manager which manages emulator images and snapshots



```
package course.examples.helloworld

import ...

class MainActivity : Activity() {
    override fun onCreate(savedInstanceState: Bundle?) {
        super.onCreate(savedInstanceState)
        setContentView(R.layout.activity_main)
    }
```

Android Virtual Device Manager

Your Virtual Devices
Android Studio

Type	Name	Play Store	Resolution	API	Target	CPU/ABI	Size on Disk	Actions
	Pixel 2 API 30		1080 × 1920: 420dpi	30	Android 10.0+ (Googl...	x86	8.0 GB	
	Pixel 3 API 30		1080 × 2160: 440dpi	30	Android 10.0+ (Googl...	x86	6.9 GB	

Opens the Android virtual device (AVD) manager which manages emulator images and snapshots

The Android Emulator

Pros

- Doesn’t require an actual phone
- Hardware is reconfigurable
- Changes are non-destructive

The Android Emulator

Cons

- Slower than an actual device
- Some features unavailable
  - e.g., no support for Bluetooth, USB connections, NFC, etc.
- Performance / user experience can be misleading

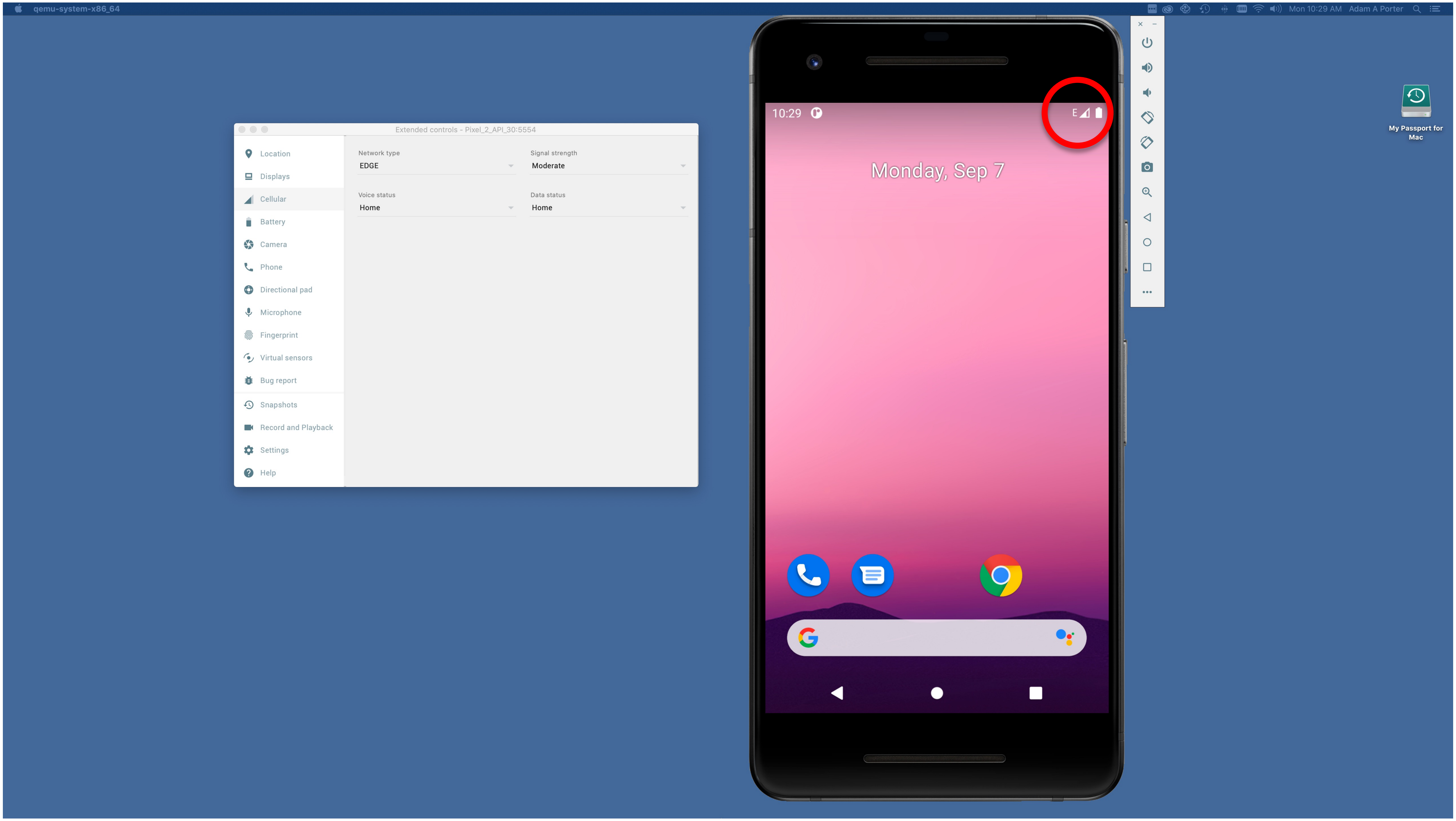
Advanced Features

Can emulate many different device/user characteristics, such as:

- Network speed/latencies
- Battery power
- Location coordinates

Advanced Features

Change network speeds



Network type
EDGE

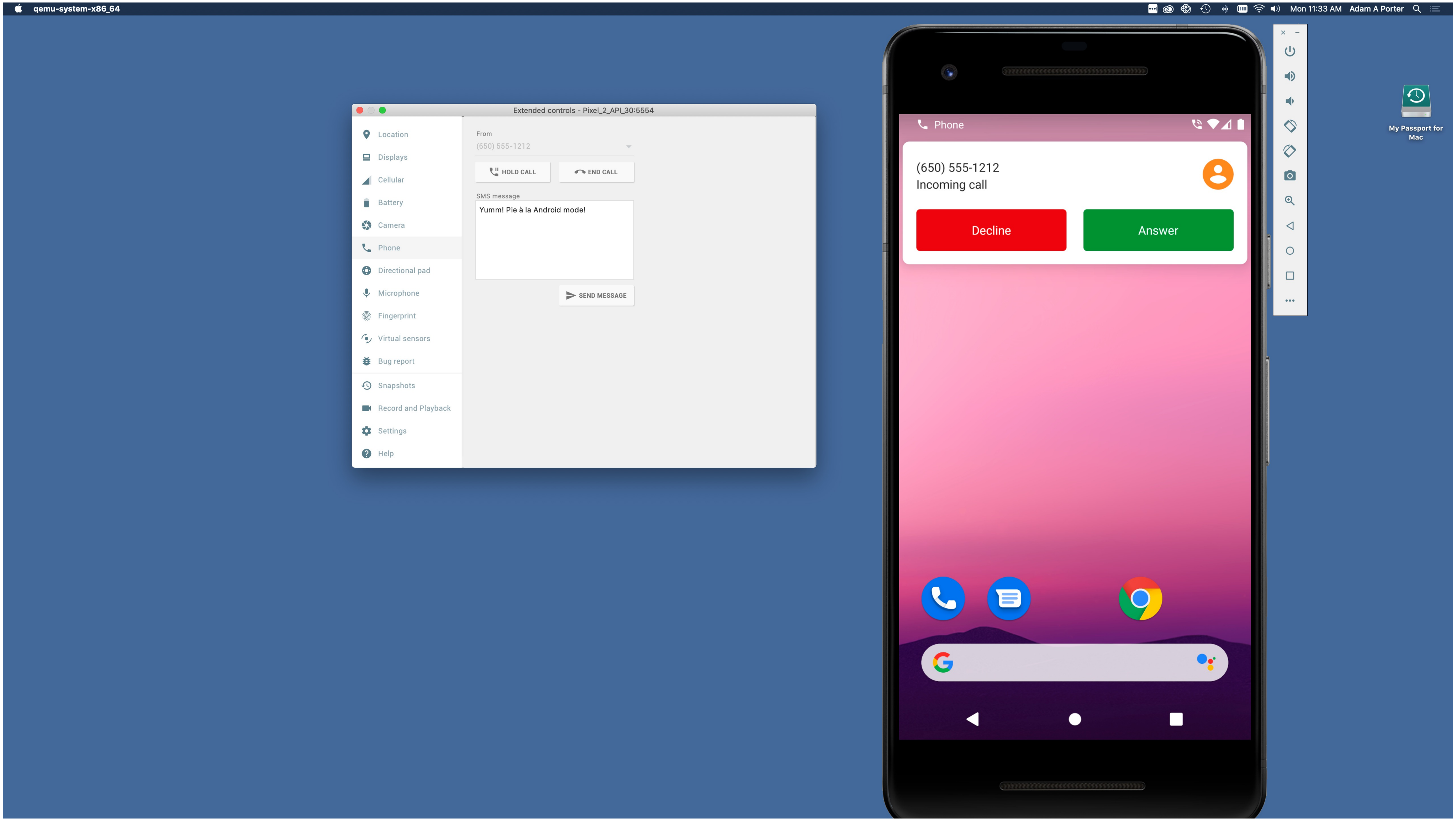
Signal strength
Moderate

Voice status
Home

Data status
Home

Advanced Features

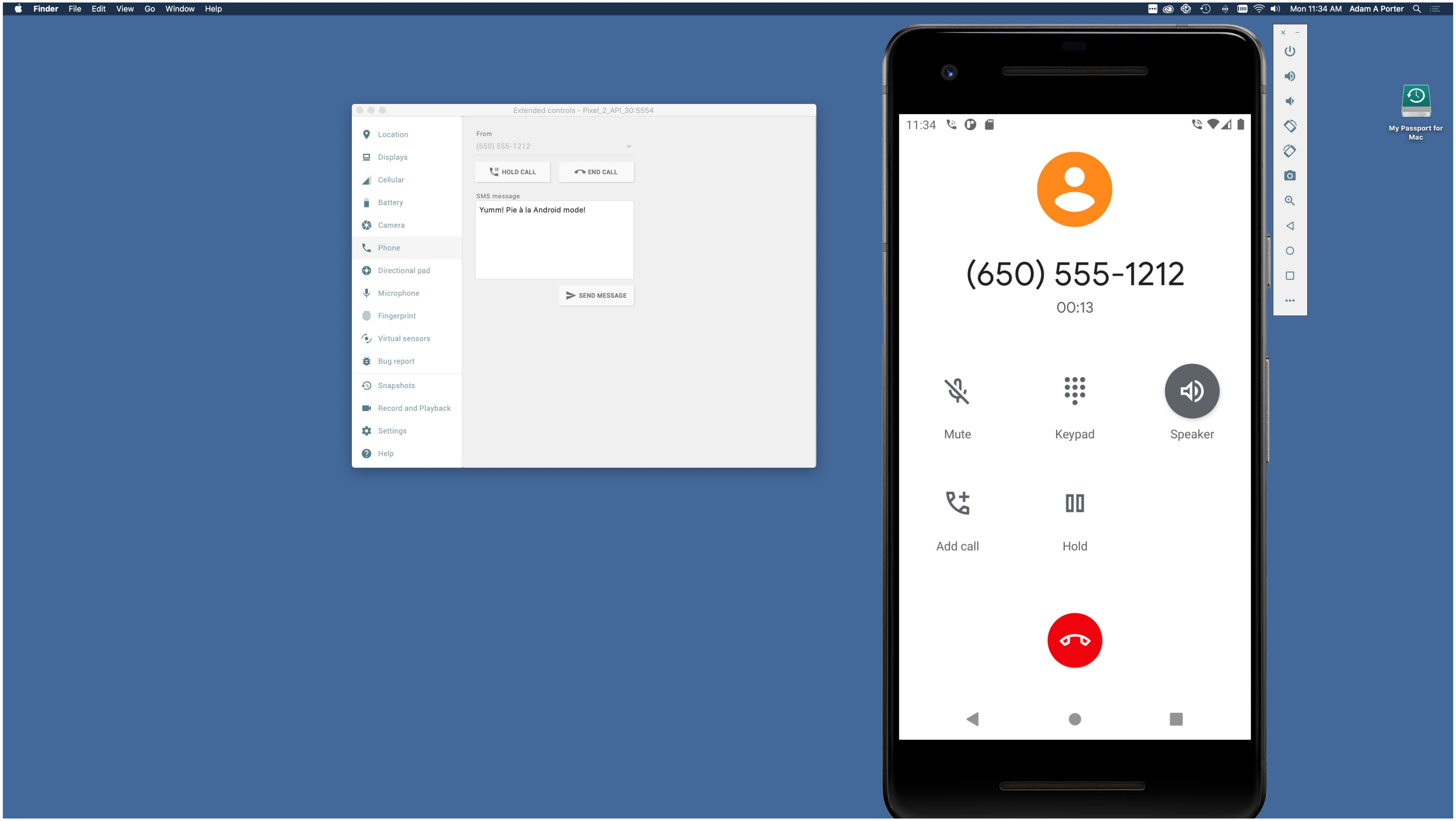
Emulate incoming phone calls & SMS messages



From: (650) 555-1212

SMS message: Yumm! Pie à la Android mode!

(650) 555-1212
Incoming call



Extended controls - Pixel_2_API_30:5554

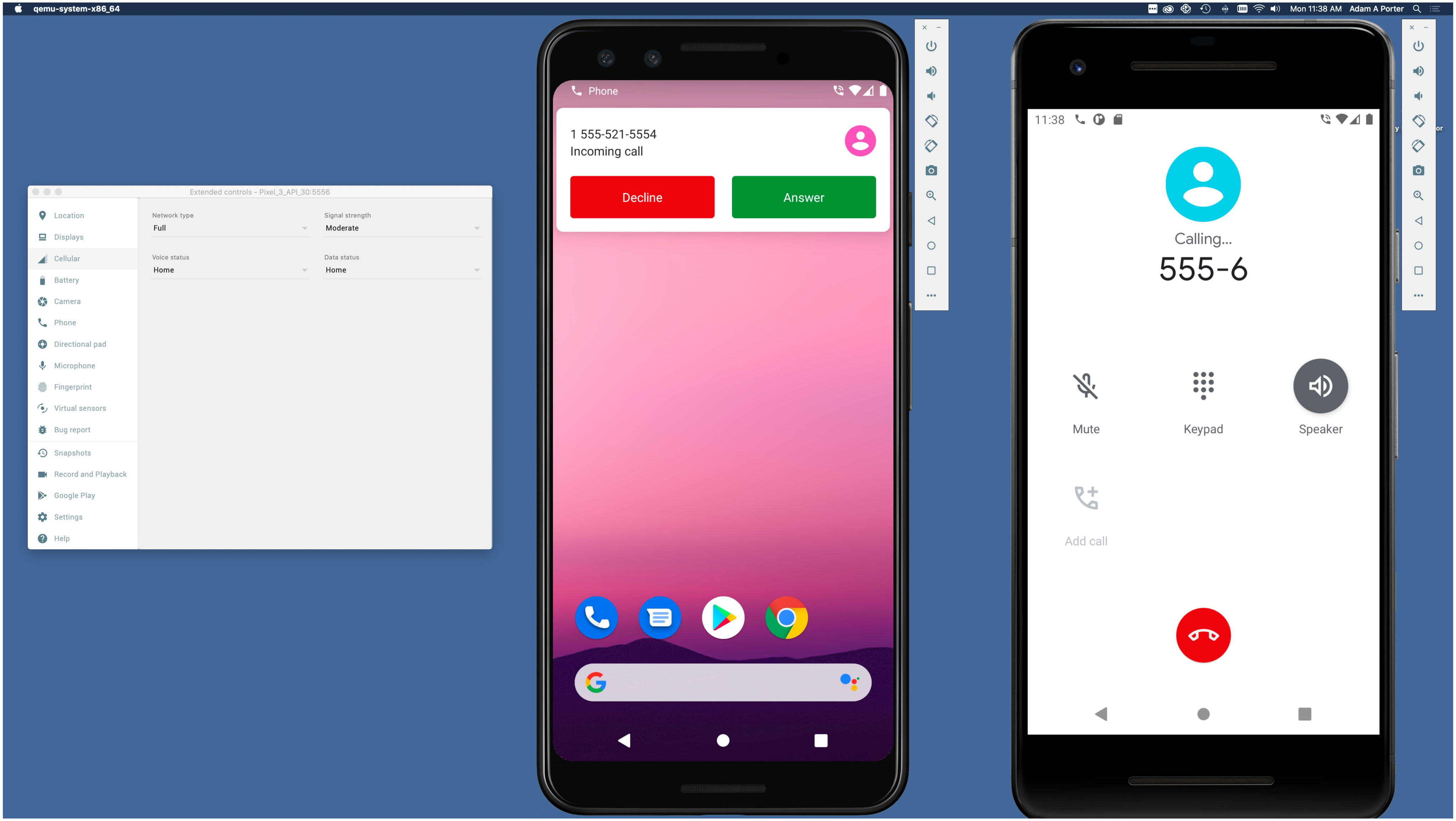
From
(650) 555-1212

SMS message
Yumm! Pie à la Android mode!

(650) 555-1212
00:13

The Android Emulator

Can interconnect multiple emulators

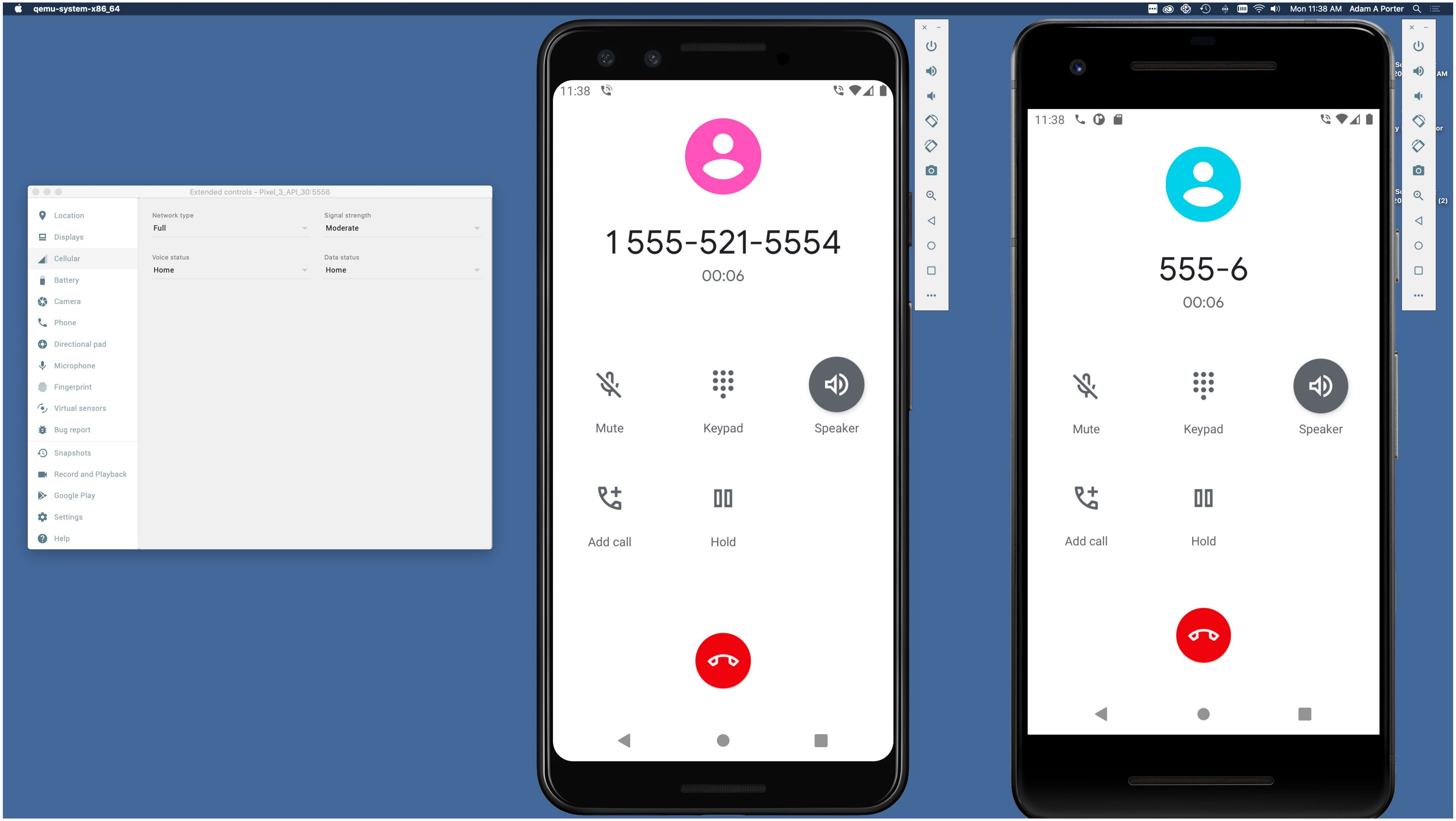


Network type: Full

Signal strength: Moderate

Voice status: Home

Data status: Home



Network type: Full

Signal strength: Moderate

Voice status: Home

Data status: Home

11:38

1 555-521-5554

00:06

11:38

555-6

00:06

Advanced Features

Many more options

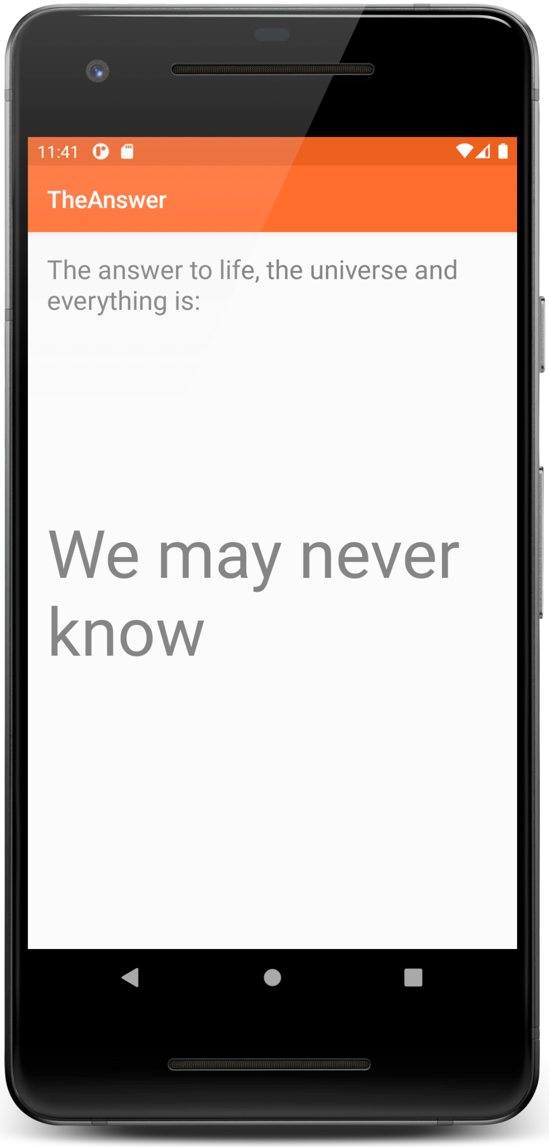
See:

https://developer.android.com/studio/run/emulator.html

Debugger

Tool for examining the internal state of a running application

TheAnswer

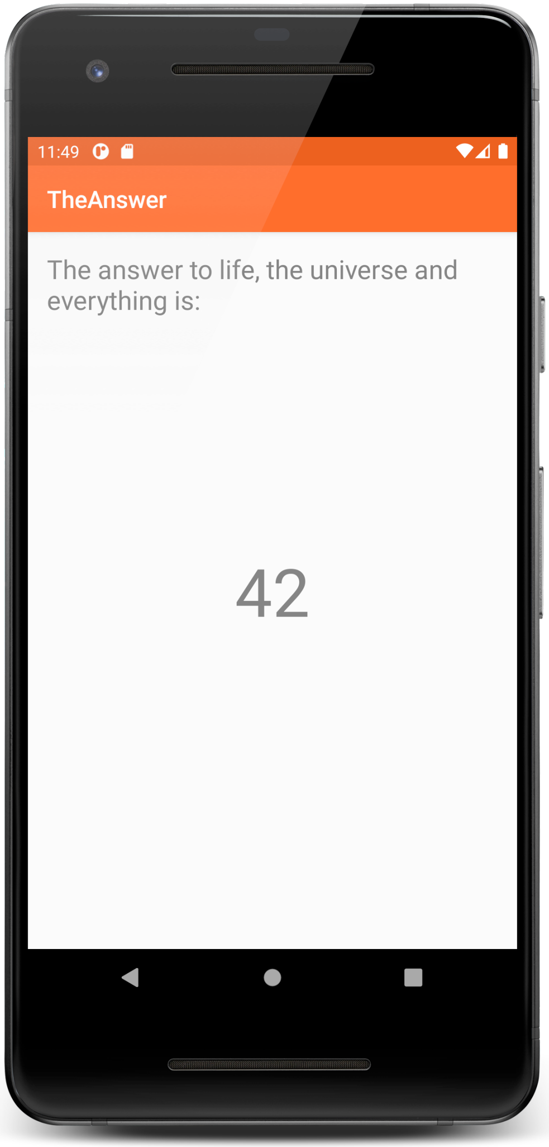


TheAnswer

The answer to life, the universe and everything is:

We may never know

```
class TheAnswer : Activity() {
    companion object {
        private val answers = intArrayOf(42, -10, 0, 100, 1000)
        private const val answer = 42
        private const val TAG = "TheAnswer"
    }


    override fun onCreate(savedInstanceState: Bundle?) {
        // Required call through to Activity.onCreate()
        // Restore any saved instance state
        super.onCreate(savedInstanceState)

        // Set up the application's user interface (content view)
        setContentView(R.layout.answer_layout)
        val value = findAnswer()
        val output = if (value != null) answer.toString()
                          else getString(R.string.never_know_string)

        // Get a reference to a TextView in the content view
        val answerView = findViewById<TextView>(R.id.answer_view)
        // Set desired text in answerView TextView
        answerView.text = output
    }
    private fun findAnswer(): Int? {
        Log.d(TAG, "Entering findAnswer()")
        // Incorrect behavior
         return answers.firstOrNull { it == -answer }
         // Correct behavior
        //  return answers.firstOrNull { it == answer }
    }
}
```



The answer to life, the universe and everything is:

42

Development Tools

Android Studio provides numerous tools for monitoring application behaviors

Example Tools

Device File Explorer

Logcat

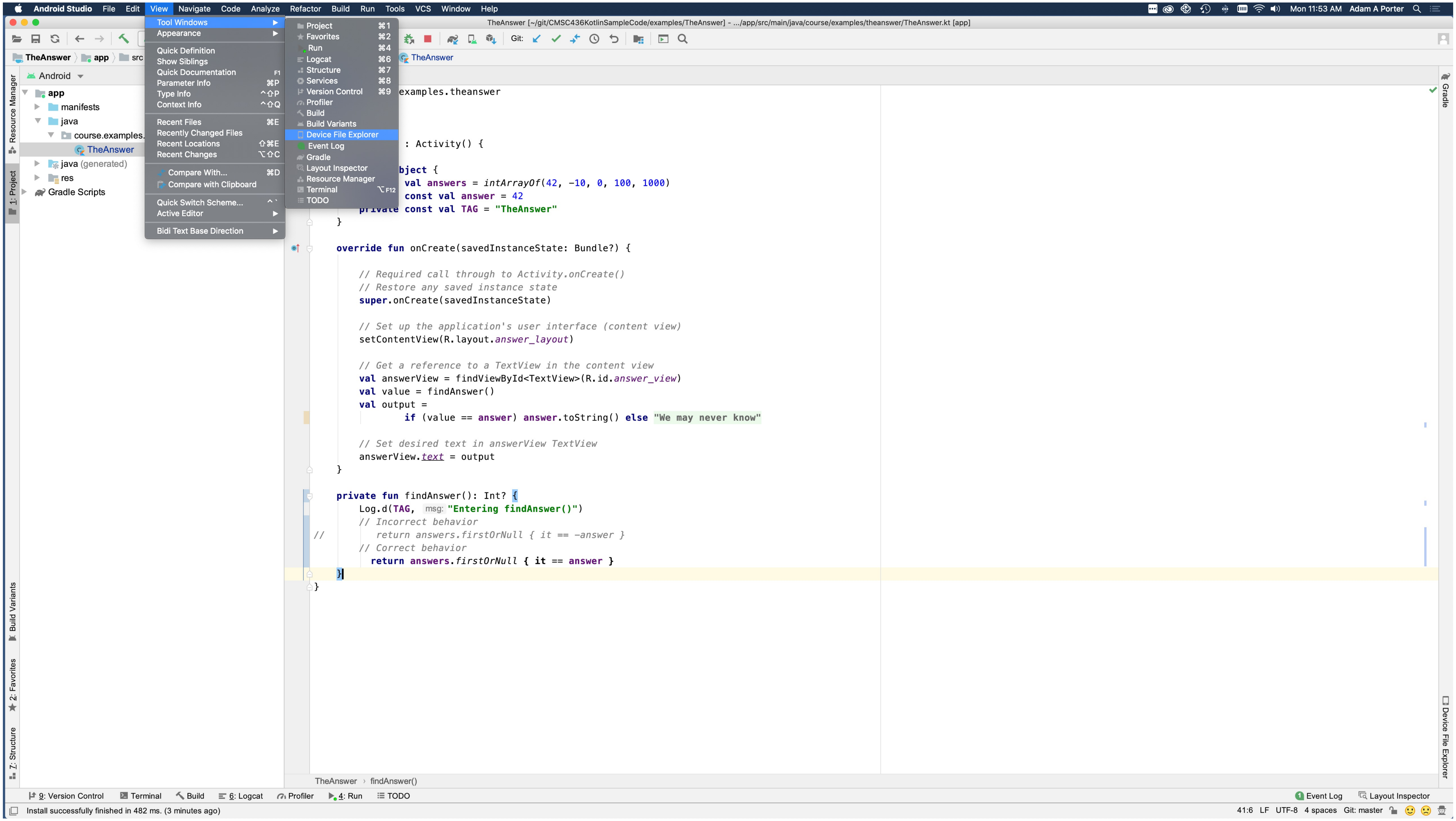
CPU Profiler

Layout Inspector

Device File Explorer

View, copy, and delete files on your device

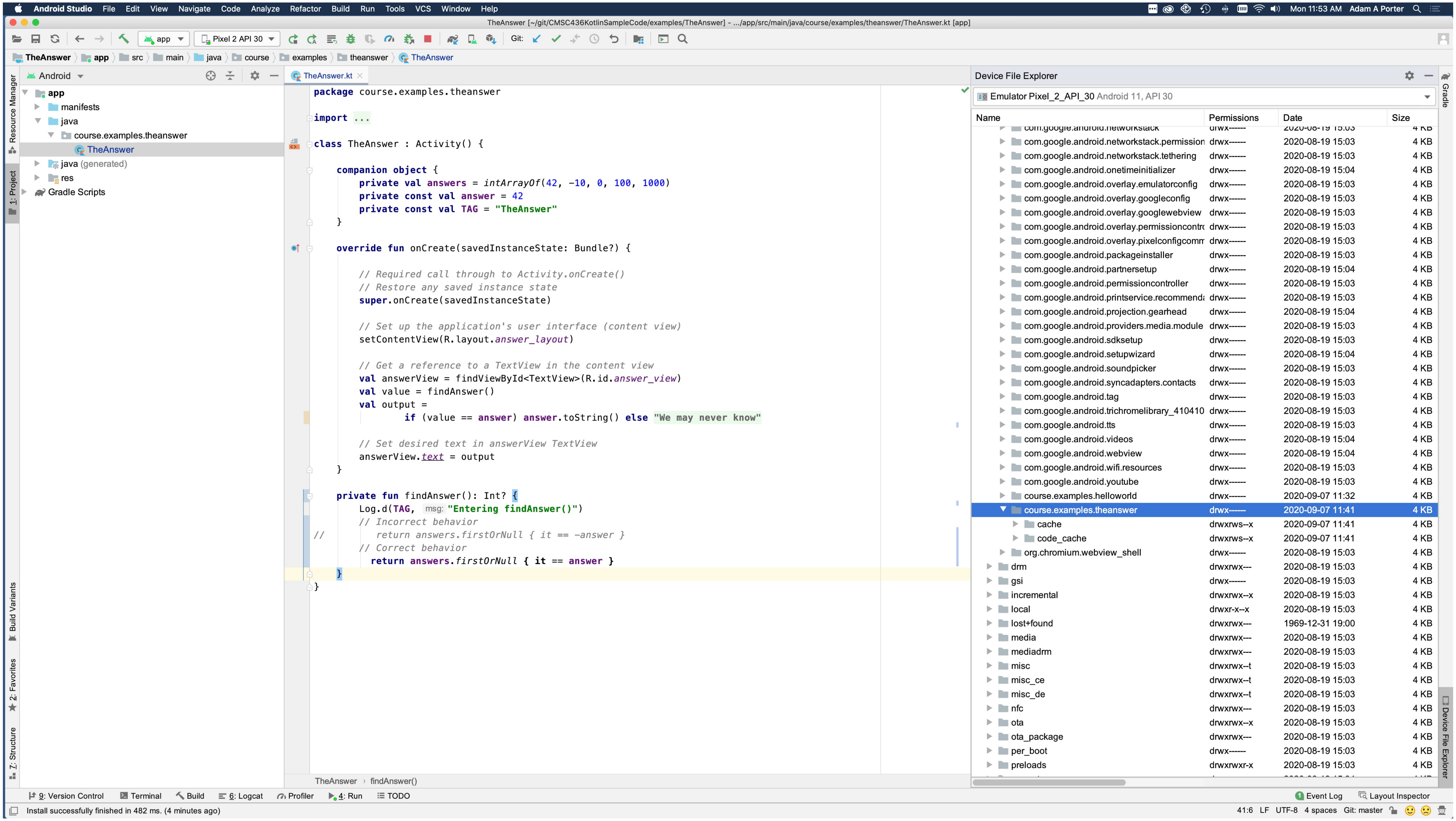
Often used to examine and verify file creation and transfer



TheAnswer [~/git/CMSC436KotlinSampleCode/examples/TheAnswer] - .../app/src/main/java/course/examples/theanswer/TheAnswer.kt [app]

```
examples.theanswer


: Activity() {

bject {
    val answers = intArrayOf(42, -10, 0, 100, 1000)
    const val answer = 42
private const val TAG = "TheAnswer"
    }

    override fun onCreate(savedInstanceState: Bundle?) {

        // Required call through to Activity.onCreate()
        // Restore any saved instance state
        super.onCreate(savedInstanceState)

        // Set up the application's user interface (content view)
        setContentView(R.layout.answer_layout)

        // Get a reference to a TextView in the content view
        val answerView = findViewById<TextView>(R.id.answer_view)
        val value = findAnswer()
        val output =
                if (value == answer) answer.toString() else "We may never know"

        // Set desired text in answerView TextView
        answerView.text = output
    }

    private fun findAnswer(): Int? {
        Log.d(TAG, msg: "Entering findAnswer()")
        // Incorrect behavior
//         return answers.firstOrNull { it == -answer }
        // Correct behavior
          return answers.firstOrNull { it == answer }
    }
}
```

Install successfully finished in 482 ms. (3 minutes ago)



TheAnswer [~/git/CMSC436KotlinSampleCode/examples/TheAnswer] - .../app/src/main/java/course/examples/theanswer/TheAnswer.kt [app]

```
app
  manifests
  java
    course.examples.theanswer
      TheAnswer
  java (generated)
  res
Gradle Scripts
```

```kotlin
package course.examples.theanswer

import ...

class TheAnswer : Activity() {

    companion object {
        private val answers = intArrayOf(42, -10, 0, 100, 1000)
        private const val answer = 42
        private const val TAG = "TheAnswer"
    }

    override fun onCreate(savedInstanceState: Bundle?) {

        // Required call through to Activity.onCreate()
        // Restore any saved instance state
        super.onCreate(savedInstanceState)

        // Set up the application's user interface (content view)
        setContentView(R.layout.answer_layout)

        // Get a reference to a TextView in the content view
        val answerView = findViewById<TextView>(R.id.answer_view)
        val value = findAnswer()
        val output =
                if (value == answer) answer.toString() else "We may never know"

        // Set desired text in answerView TextView
        answerView.text = output
    }

    private fun findAnswer(): Int? {
        Log.d(TAG, msg: "Entering findAnswer()")
        // Incorrect behavior
//          return answers.firstOrNull { it == -answer }
        // Correct behavior
          return answers.firstOrNull { it == answer }
    }
}
```

Device File Explorer

Emulator Pixel_2_API_30 Android 11, API 30

Name	Permissions	Date	Size
com.google.android.networkstack	drwx------	2020-08-19 15:03	4 KB
com.google.android.networkstack.permission	drwx------	2020-08-19 15:03	4 KB
com.google.android.networkstack.tethering	drwx------	2020-08-19 15:03	4 KB
com.google.android.onetimeinitializer	drwx------	2020-08-19 15:04	4 KB
com.google.android.overlay.emulatorconfig	drwx------	2020-08-19 15:03	4 KB
com.google.android.overlay.googleconfig	drwx------	2020-08-19 15:03	4 KB
com.google.android.overlay.googlewebview	drwx------	2020-08-19 15:03	4 KB
com.google.android.overlay.permissioncontr	drwx------	2020-08-19 15:03	4 KB
com.google.android.overlay.pixelconfigcomm	drwx------	2020-08-19 15:03	4 KB
com.google.android.packageinstaller	drwx------	2020-08-19 15:03	4 KB
com.google.android.partnersetup	drwx------	2020-08-19 15:04	4 KB
com.google.android.permissioncontroller	drwx------	2020-08-19 15:03	4 KB
com.google.android.printservice.recommenda	drwx------	2020-08-19 15:03	4 KB
com.google.android.projection.gearhead	drwx------	2020-08-19 15:04	4 KB
com.google.android.providers.media.module	drwx------	2020-08-19 15:03	4 KB
com.google.android.sdksetup	drwx------	2020-08-19 15:03	4 KB
com.google.android.setupwizard	drwx------	2020-08-19 15:04	4 KB
com.google.android.soundpicker	drwx------	2020-08-19 15:03	4 KB
com.google.android.syncadapters.contacts	drwx------	2020-08-19 15:03	4 KB
com.google.android.tag	drwx------	2020-08-19 15:03	4 KB
com.google.android.trichromelibrary_410410	drwx------	2020-08-19 15:03	4 KB
com.google.android.tts	drwx------	2020-08-19 15:03	4 KB
com.google.android.videos	drwx------	2020-08-19 15:04	4 KB
com.google.android.webview	drwx------	2020-08-19 15:04	4 KB
com.google.android.wifi.resources	drwx------	2020-08-19 15:03	4 KB
com.google.android.youtube	drwx------	2020-08-19 15:03	4 KB
course.examples.helloworld	drwx------	2020-09-07 11:32	4 KB
course.examples.theanswer	drwx------	2020-09-07 11:41	4 KB
cache	drwxrws--x	2020-09-07 11:41	4 KB
code_cache	drwxrws--x	2020-09-07 11:41	4 KB
org.chromium.webview_shell	drwx------	2020-08-19 15:03	4 KB
drm	drwxrwx---	2020-08-19 15:03	4 KB
gsi	drwx------	2020-08-19 15:03	4 KB
incremental	drwxrwx--x	2020-08-19 15:03	4 KB
local	drwxr-x--x	2020-08-19 15:03	4 KB
lost+found	drwxrwx---	1969-12-31 19:00	4 KB
media	drwxrwx---	2020-08-19 15:03	4 KB
mediadrm	drwxrwx---	2020-08-19 15:03	4 KB
misc	drwxrwx--t	2020-08-19 15:03	4 KB
misc_ce	drwxrwx--t	2020-08-19 15:03	4 KB
misc_de	drwxrwx--t	2020-08-19 15:03	4 KB
nfc	drwxrwx---	2020-08-19 15:03	4 KB
ota	drwxrwx--x	2020-08-19 15:03	4 KB
ota_package	drwxrwx---	2020-08-19 15:03	4 KB
per_boot	drwx------	2020-08-19 15:03	4 KB
preloads	drwxrwxr-x	2020-08-19 15:03	4 KB

Install successfully finished in 482 ms. (4 minutes ago)

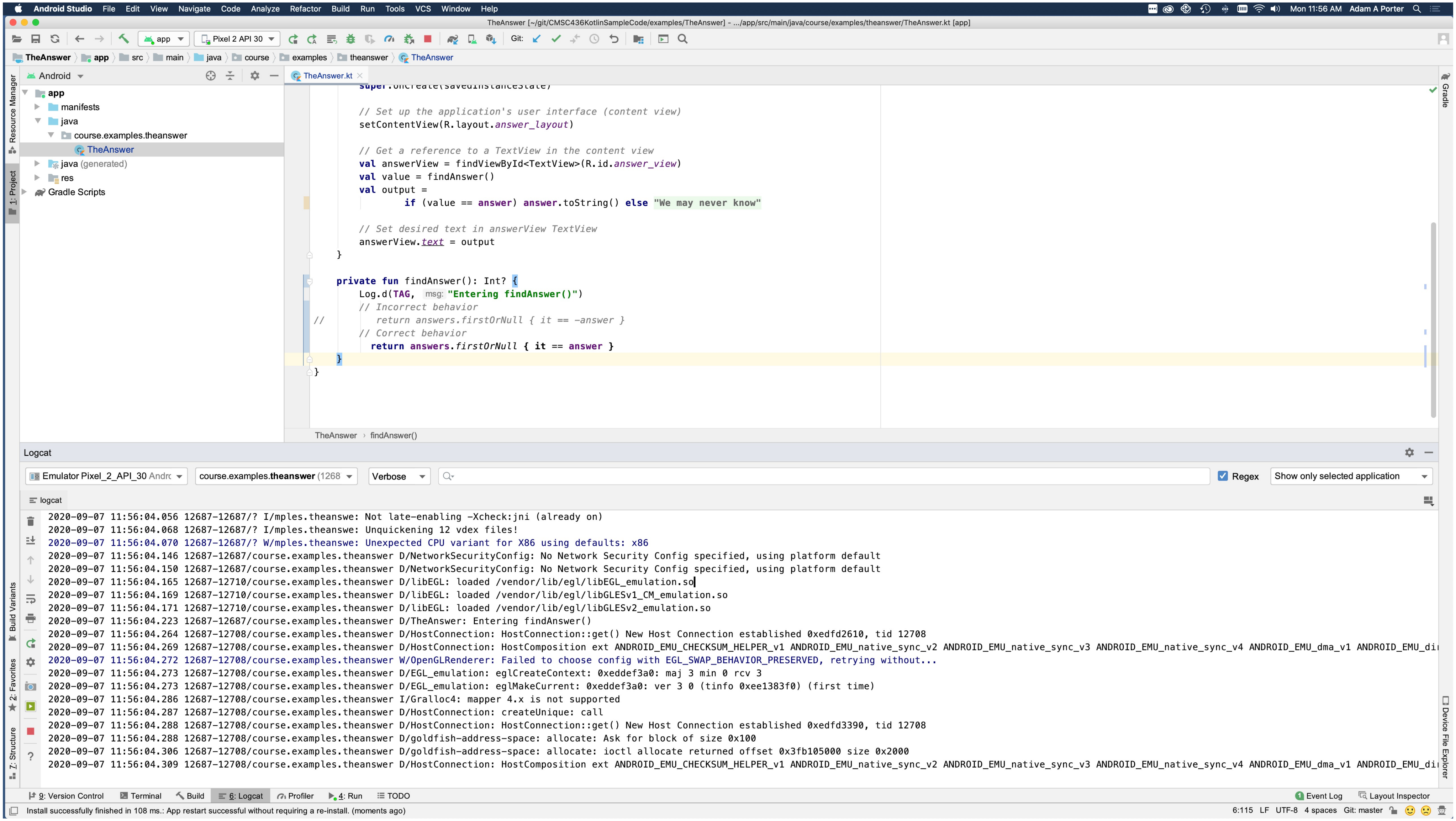
41:6 LF UTF-8 4 spaces Git: master

Logcat

Write and review log messages

Apps use Log class to write messages to log

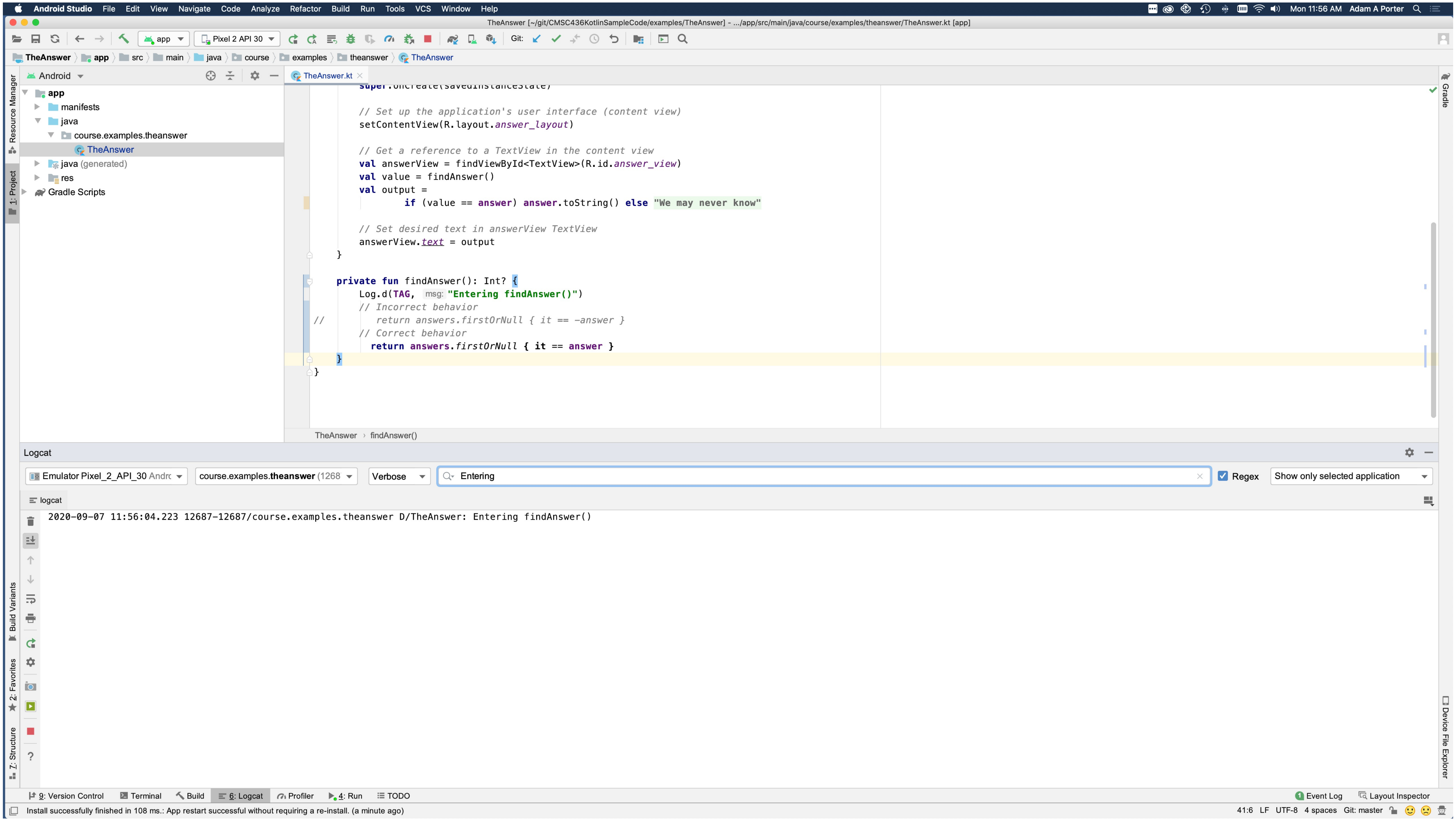
Developer can search and filter log messages



```
        super.onCreate(savedInstanceState)

        // Set up the application's user interface (content view)
        setContentView(R.layout.answer_layout)

        // Get a reference to a TextView in the content view
        val answerView = findViewById<TextView>(R.id.answer_view)
        val value = findAnswer()
        val output =
                if (value == answer) answer.toString() else "We may never know"

        // Set desired text in answerView TextView
        answerView.text = output
    }

    private fun findAnswer(): Int? {
        Log.d(TAG, msg: "Entering findAnswer()")
        // Incorrect behavior
//          return answers.firstOrNull { it == -answer }
        // Correct behavior
          return answers.firstOrNull { it == answer }
    }
}
```

```
2020-09-07 11:56:04.056 12687-12687/? I/mples.theanswe: Not late-enabling -Xcheck:jni (already on)
2020-09-07 11:56:04.068 12687-12687/? I/mples.theanswe: Unquickening 12 vdex files!
2020-09-07 11:56:04.070 12687-12687/? W/mples.theanswe: Unexpected CPU variant for X86 using defaults: x86
2020-09-07 11:56:04.146 12687-12687/course.examples.theanswer D/NetworkSecurityConfig: No Network Security Config specified, using platform default
2020-09-07 11:56:04.150 12687-12687/course.examples.theanswer D/NetworkSecurityConfig: No Network Security Config specified, using platform default
2020-09-07 11:56:04.165 12687-12710/course.examples.theanswer D/libEGL: loaded /vendor/lib/egl/libEGL_emulation.so
2020-09-07 11:56:04.169 12687-12710/course.examples.theanswer D/libEGL: loaded /vendor/lib/egl/libGLESv1_CM_emulation.so
2020-09-07 11:56:04.171 12687-12710/course.examples.theanswer D/libEGL: loaded /vendor/lib/egl/libGLESv2_emulation.so
2020-09-07 11:56:04.223 12687-12687/course.examples.theanswer D/TheAnswer: Entering findAnswer()
2020-09-07 11:56:04.264 12687-12708/course.examples.theanswer D/HostConnection: HostConnection::get() New Host Connection established 0xedfd2610, tid 12708
2020-09-07 11:56:04.269 12687-12708/course.examples.theanswer D/HostConnection: HostComposition ext ANDROID_EMU_CHECKSUM_HELPER_v1 ANDROID_EMU_native_sync_v2 ANDROID_EMU_native_sync_v3 ANDROID_EMU_native_sync_v4 ANDROID_EMU_dma_v1 ANDROID_EMU_di
2020-09-07 11:56:04.272 12687-12708/course.examples.theanswer W/OpenGLRenderer: Failed to choose config with EGL_SWAP_BEHAVIOR_PRESERVED, retrying without...
2020-09-07 11:56:04.273 12687-12708/course.examples.theanswer D/EGL_emulation: eglCreateContext: 0xeddef3a0: maj 3 min 0 rcv 3
2020-09-07 11:56:04.273 12687-12708/course.examples.theanswer D/EGL_emulation: eglMakeCurrent: 0xeddef3a0: ver 3 0 (tinfo 0xee1383f0) (first time)
2020-09-07 11:56:04.286 12687-12708/course.examples.theanswer I/Gralloc4: mapper 4.x is not supported
2020-09-07 11:56:04.287 12687-12708/course.examples.theanswer D/HostConnection: createUnique: call
2020-09-07 11:56:04.288 12687-12708/course.examples.theanswer D/HostConnection: HostConnection::get() New Host Connection established 0xedfd3390, tid 12708
2020-09-07 11:56:04.288 12687-12708/course.examples.theanswer D/goldfish-address-space: allocate: Ask for block of size 0x100
2020-09-07 11:56:04.306 12687-12708/course.examples.theanswer D/goldfish-address-space: allocate: ioctl allocate returned offset 0x3fb105000 size 0x2000
2020-09-07 11:56:04.309 12687-12708/course.examples.theanswer D/HostConnection: HostComposition ext ANDROID_EMU_CHECKSUM_HELPER_v1 ANDROID_EMU_native_sync_v2 ANDROID_EMU_native_sync_v3 ANDROID_EMU_native_sync_v4 ANDROID_EMU_dma_v1 ANDROID_EMU_di
```

Install successfully finished in 108 ms.: App restart successful without requiring a re-install. (moments ago)



```
        super.onCreate(savedInstanceState)

        // Set up the application's user interface (content view)
        setContentView(R.layout.answer_layout)

        // Get a reference to a TextView in the content view
        val answerView = findViewById<TextView>(R.id.answer_view)
        val value = findAnswer()
        val output =
                if (value == answer) answer.toString() else "We may never know"

        // Set desired text in answerView TextView
        answerView.text = output
    }

    private fun findAnswer(): Int? {
        Log.d(TAG,  msg: "Entering findAnswer()")
        // Incorrect behavior
//          return answers.firstOrNull { it == -answer }
        // Correct behavior
          return answers.firstOrNull { it == answer }
    }
}
```

Entering

```
2020-09-07 11:56:04.223 12687-12687/course.examples.theanswer D/TheAnswer: Entering findAnswer()
```

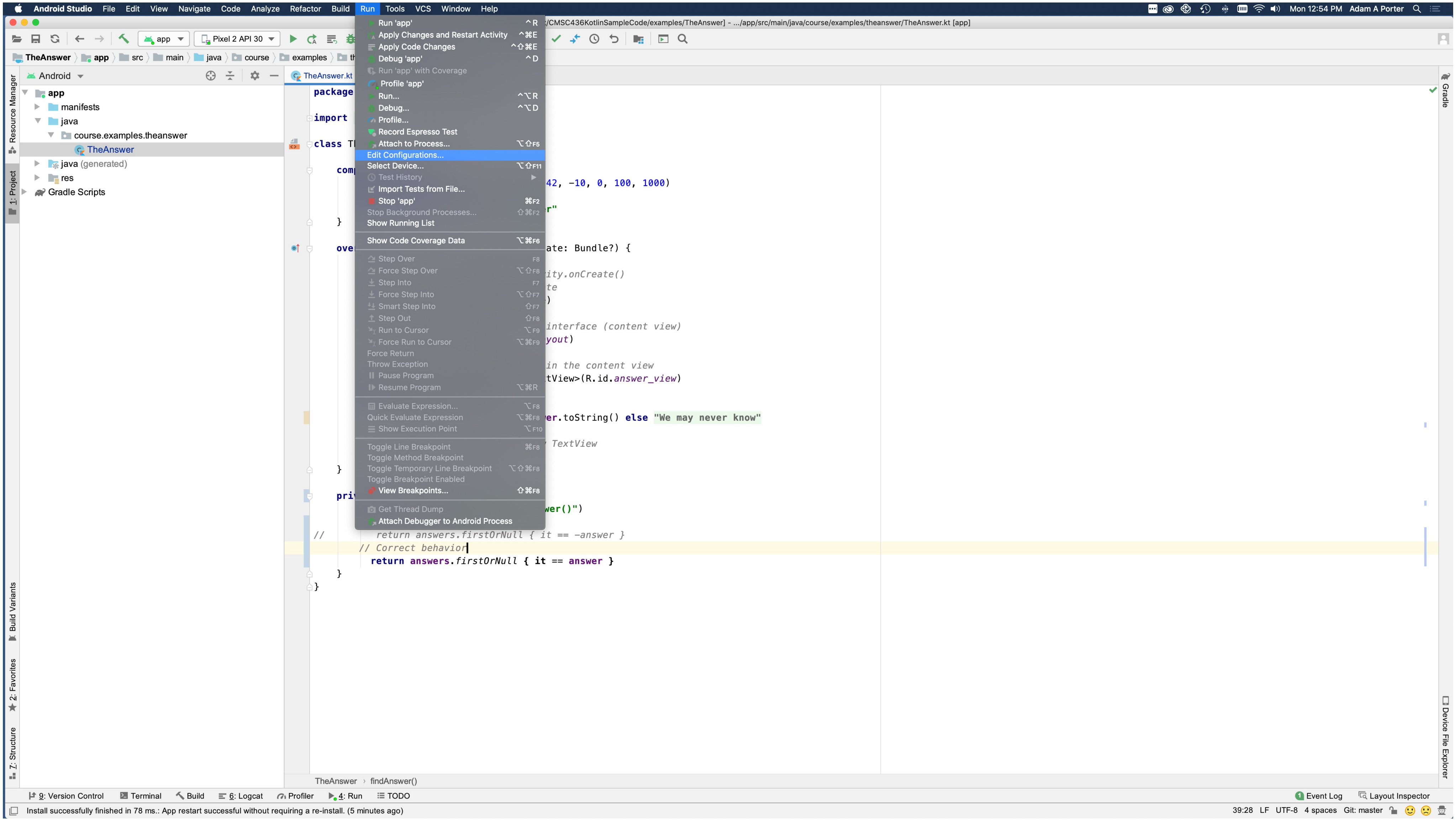
Install successfully finished in 108 ms.: App restart successful without requiring a re-install. (a minute ago)

41:6 LF UTF-8 4 spaces Git: master

CPU Profiler

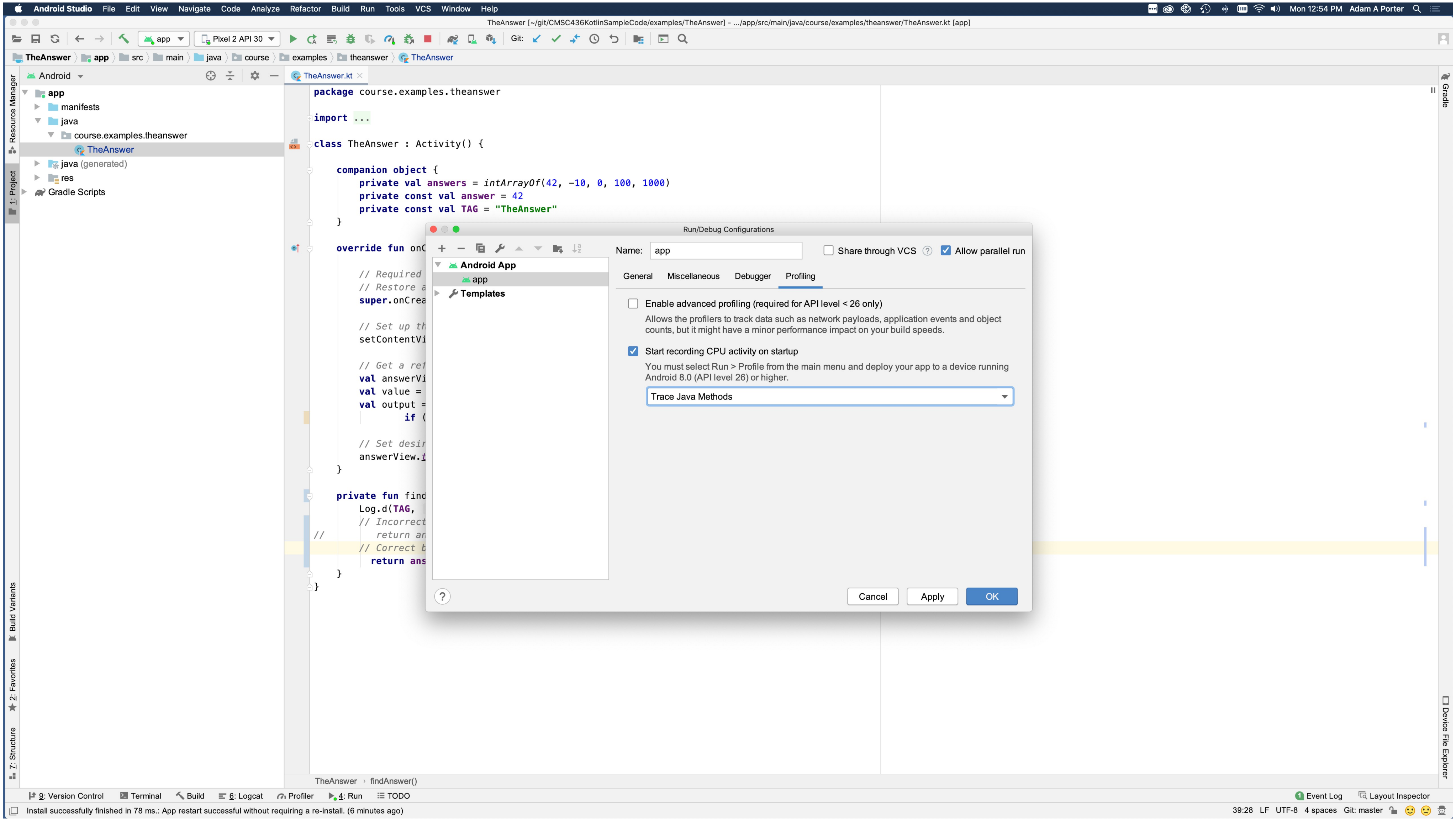
Logs execution sequences and timing taken from a running application

Graphically displays method traces and metrics



```
package
import
class T
    comp
                                    42, -10, 0, 100, 1000)
                                    r"
    }
    ove                             ate: Bundle?) {
                                    ity.onCreate()
                                    te
                                    )
                                    interface (content view)
                                    yout)
                                    in the content view
                                    tView>(R.id.answer_view)
                                    er.toString() else "We may never know"
                                    TextView
    }
    pri
                                    wer()")
//          return answers.firstOrNull { it == -answer }
        // Correct behavior
          return answers.firstOrNull { it == answer }
    }
}
```

Install successfully finished in 78 ms.: App restart successful without requiring a re-install. (5 minutes ago)



TheAnswer [~/git/CMSC436KotlinSampleCode/examples/TheAnswer] - .../app/src/main/java/course/examples/theanswer/TheAnswer.kt [app]

- app
  - manifests
  - java
    - course.examples.theanswer
      - TheAnswer
  - java (generated)
  - res
- Gradle Scripts

```
package course.examples.theanswer

import ...

class TheAnswer : Activity() {

    companion object {
        private val answers = intArrayOf(42, -10, 0, 100, 1000)
        private const val answer = 42
        private const val TAG = "TheAnswer"
    }

    override fun onC

        // Required
        // Restore a
        super.onCrea

        // Set up th
        setContentVi

        // Get a ref
        val answerVi
        val value =
        val output =
                if (

        // Set desir
        answerView.t
    }

    private fun find
        Log.d(TAG,
        // Incorrect
//          return ar
        // Correct b
          return ans
    }
}
```

Run/Debug Configurations

- Android App
  - app
- Templates

Name: app

□ Share through VCS ☑ Allow parallel run

General Miscellaneous Debugger Profiling

□ Enable advanced profiling (required for API level < 26 only)

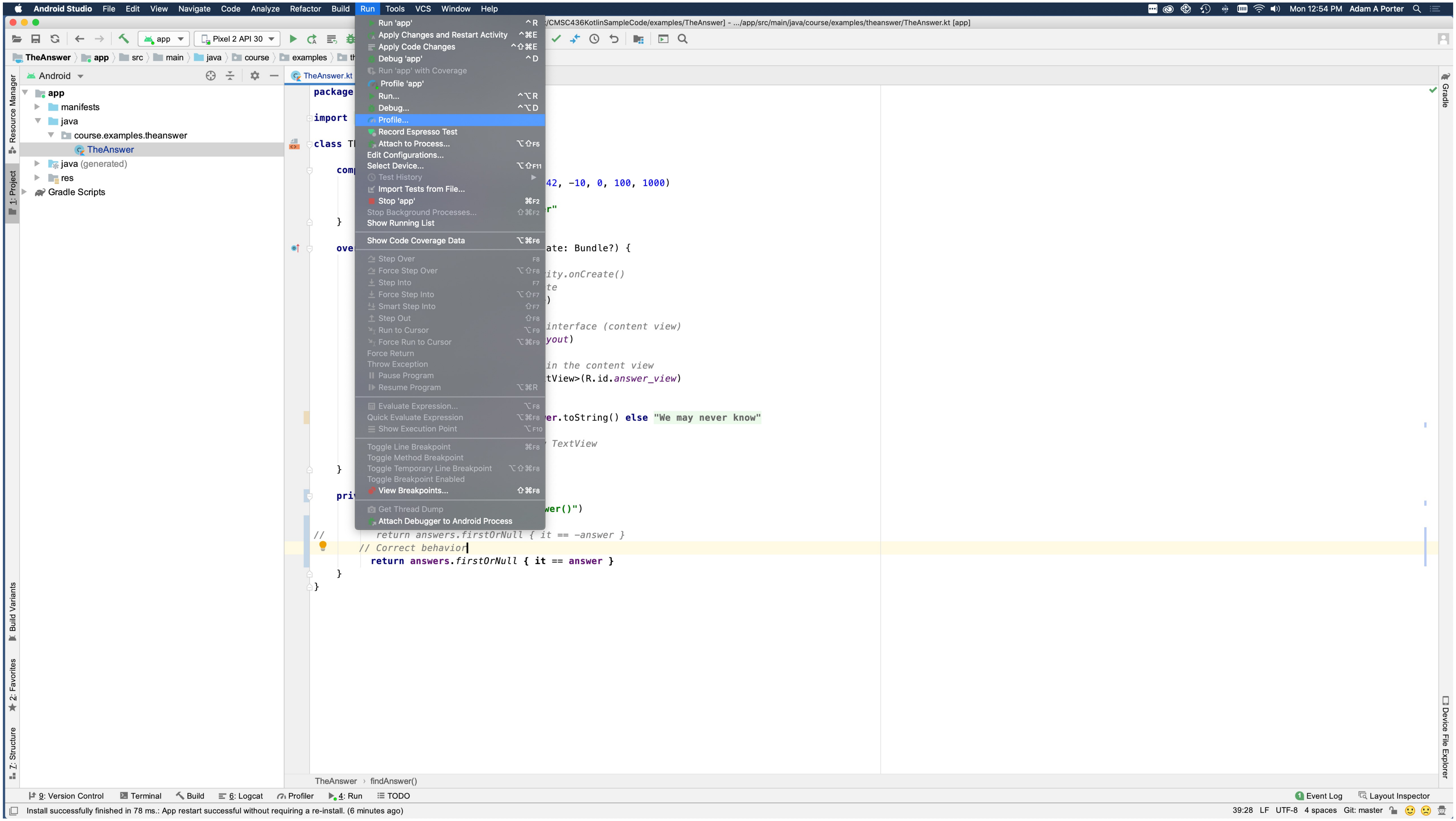
Allows the profilers to track data such as network payloads, application events and object counts, but it might have a minor performance impact on your build speeds.

☑ Start recording CPU activity on startup

You must select Run > Profile from the main menu and deploy your app to a device running Android 8.0 (API level 26) or higher.

Trace Java Methods

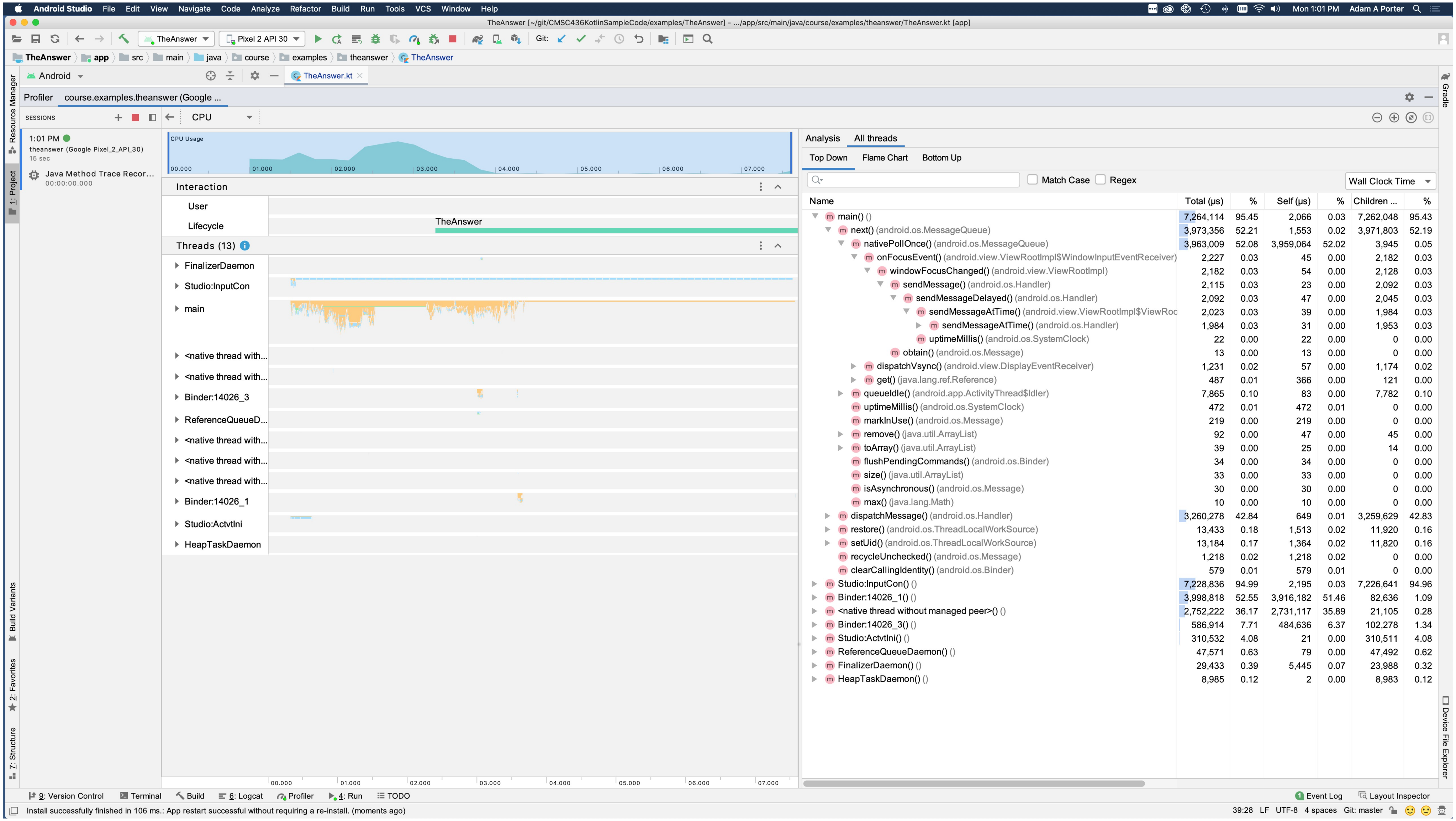
Install successfully finished in 78 ms.: App restart successful without requiring a re-install. (6 minutes ago)



/CMSC436KotlinSampleCode/examples/TheAnswer] - .../app/src/main/java/course/examples/theanswer/TheAnswer.kt [app]

```
package

import

class Tl

    comp
                         42, -10, 0, 100, 1000)

                         r"
    }

    ove                  ate: Bundle?) {

                         ity.onCreate()
                         te
                         )

                         interface (content view)
                         yout)

                         in the content view
                         tView>(R.id.answer_view)

                         er.toString() else "We may never know"

                         TextView

    }

    pri
                         wer()")
//      return answers.firstOrNull { it == -answer }
        // Correct behavior
        return answers.firstOrNull { it == answer }
    }
}
```

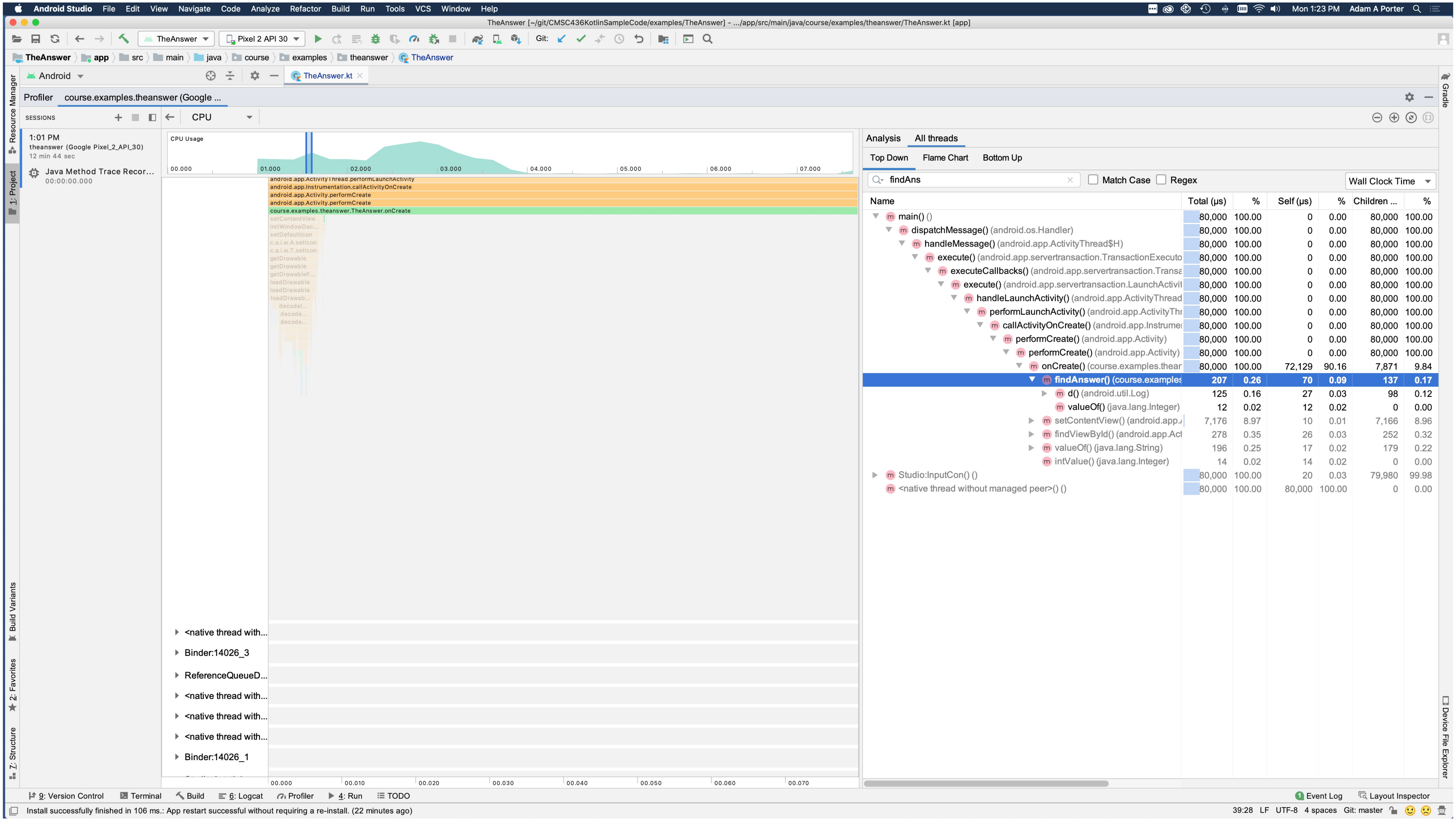
Install successfully finished in 78 ms.: App restart successful without requiring a re-install. (6 minutes ago)



Name	Total (μs)	%	Self (μs)	%	Children ...	%
main() ()	7,264,114	95.45	2,066	0.03	7,262,048	95.43
next() (android.os.MessageQueue)	3,973,356	52.21	1,553	0.02	3,971,803	52.19
nativePollOnce() (android.os.MessageQueue)	3,963,009	52.08	3,959,064	52.02	3,945	0.05
onFocusEvent() (android.view.ViewRootImpl$WindowInputEventReceiver)	2,227	0.03	45	0.00	2,182	0.03
windowFocusChanged() (android.view.ViewRootImpl)	2,182	0.03	54	0.00	2,128	0.03
sendMessage() (android.os.Handler)	2,115	0.03	23	0.00	2,092	0.03
sendMessageDelayed() (android.os.Handler)	2,092	0.03	47	0.00	2,045	0.03
sendMessageAtTime() (android.view.ViewRootImpl$ViewRoc	2,023	0.03	39	0.00	1,984	0.03
sendMessageAtTime() (android.os.Handler)	1,984	0.03	31	0.00	1,953	0.03
uptimeMillis() (android.os.SystemClock)	22	0.00	22	0.00	0	0.00
obtain() (android.os.Message)	13	0.00	13	0.00	0	0.00
dispatchVsync() (android.view.DisplayEventReceiver)	1,231	0.02	57	0.00	1,174	0.02
get() (java.lang.ref.Reference)	487	0.01	366	0.00	121	0.00
queueIdle() (android.app.ActivityThread$Idler)	7,865	0.10	83	0.00	7,782	0.10
uptimeMillis() (android.os.SystemClock)	472	0.01	472	0.01	0	0.00
markInUse() (android.os.Message)	219	0.00	219	0.00	0	0.00
remove() (java.util.ArrayList)	92	0.00	47	0.00	45	0.00
toArray() (java.util.ArrayList)	39	0.00	25	0.00	14	0.00
flushPendingCommands() (android.os.Binder)	34	0.00	34	0.00	0	0.00
size() (java.util.ArrayList)	33	0.00	33	0.00	0	0.00
isAsynchronous() (android.os.Message)	30	0.00	30	0.00	0	0.00
max() (java.lang.Math)	10	0.00	10	0.00	0	0.00
dispatchMessage() (android.os.Handler)	3,260,278	42.84	649	0.01	3,259,629	42.83
restore() (android.os.ThreadLocalWorkSource)	13,433	0.18	1,513	0.02	11,920	0.16
setUid() (android.os.ThreadLocalWorkSource)	13,184	0.17	1,364	0.02	11,820	0.16
recycleUnchecked() (android.os.Message)	1,218	0.02	1,218	0.02	0	0.00
clearCallingIdentity() (android.os.Binder)	579	0.01	579	0.01	0	0.00
Studio:InputCon() ()	7,228,836	94.99	2,195	0.03	7,226,641	94.96
Binder:14026_1() ()	3,998,818	52.55	3,916,182	51.46	82,636	1.09
<native thread without managed peer>() ()	2,752,222	36.17	2,731,117	35.89	21,105	0.28
Binder:14026_3() ()	586,914	7.71	484,636	6.37	102,278	1.34
Studio:ActvtIni() ()	310,532	4.08	21	0.00	310,511	4.08
ReferenceQueueDaemon() ()	47,571	0.63	79	0.00	47,492	0.62
FinalizerDaemon() ()	29,433	0.39	5,445	0.07	23,988	0.32
HeapTaskDaemon() ()	8,985	0.12	2	0.00	8,983	0.12

Install successfully finished in 106 ms.: App restart successful without requiring a re-install. (moments ago)

39:28 LF UTF-8 4 spaces Git: master


Android Studio File Edit View Navigate Code Analyze Refactor Build Run Tools VCS Window Help
Mon 1:23 PM Adam A Porter
TheAnswer [~/git/CMSC436KotlinSampleCode/examples/TheAnswer] - .../app/src/main/java/course/examples/theanswer/TheAnswer.kt [app]
TheAnswer
Pixel 2 API 30
Git:
TheAnswer app src main java course examples theanswer TheAnswer
Android
TheAnswer.kt
Profiler course.examples.theanswer (Google ...
SESSIONS
1:01 PM
theanswer (Google Pixel_2_API_30)
12 min 44 sec
Java Method Trace Recor...
00:00:00.000
CPU
CPU Usage
00.000 01.000 02.000 03.000 04.000 05.000 06.000 07.000
android.app.ActivityThread.performLaunchActivity
android.app.Instrumentation.callActivityOnCreate
android.app.Activity.performCreate
android.app.Activity.performCreate
course.examples.theanswer.TheAnswer.onCreate
setContentView
initWindowDec...
setDefaultIcon
c.a.i.w.A.setIcon
c.a.i.w.T.setIcon
getDrawable
getDrawable
getDrawableF...
loadDrawable
loadDrawable
loadDrawab...
decodel...
decode...
decode...
<native thread with...
Binder:14026_3
ReferenceQueueD...
<native thread with...
<native thread with...
<native thread with...
Binder:14026_1
00.000 00.010 00.020 00.030 00.040 00.050 00.060 00.070
Analysis All threads
Top Down Flame Chart Bottom Up
findAns
Match Case
Regex
Wall Clock Time
Resource Manager
1: Project
Build Variants
2: Favorites
7: Structure
Gradle
Device File Explorer
9: Version Control Terminal Build 6: Logcat Profiler 4: Run TODO
Event Log Layout Inspector
39:28 LF UTF-8 4 spaces Git: master

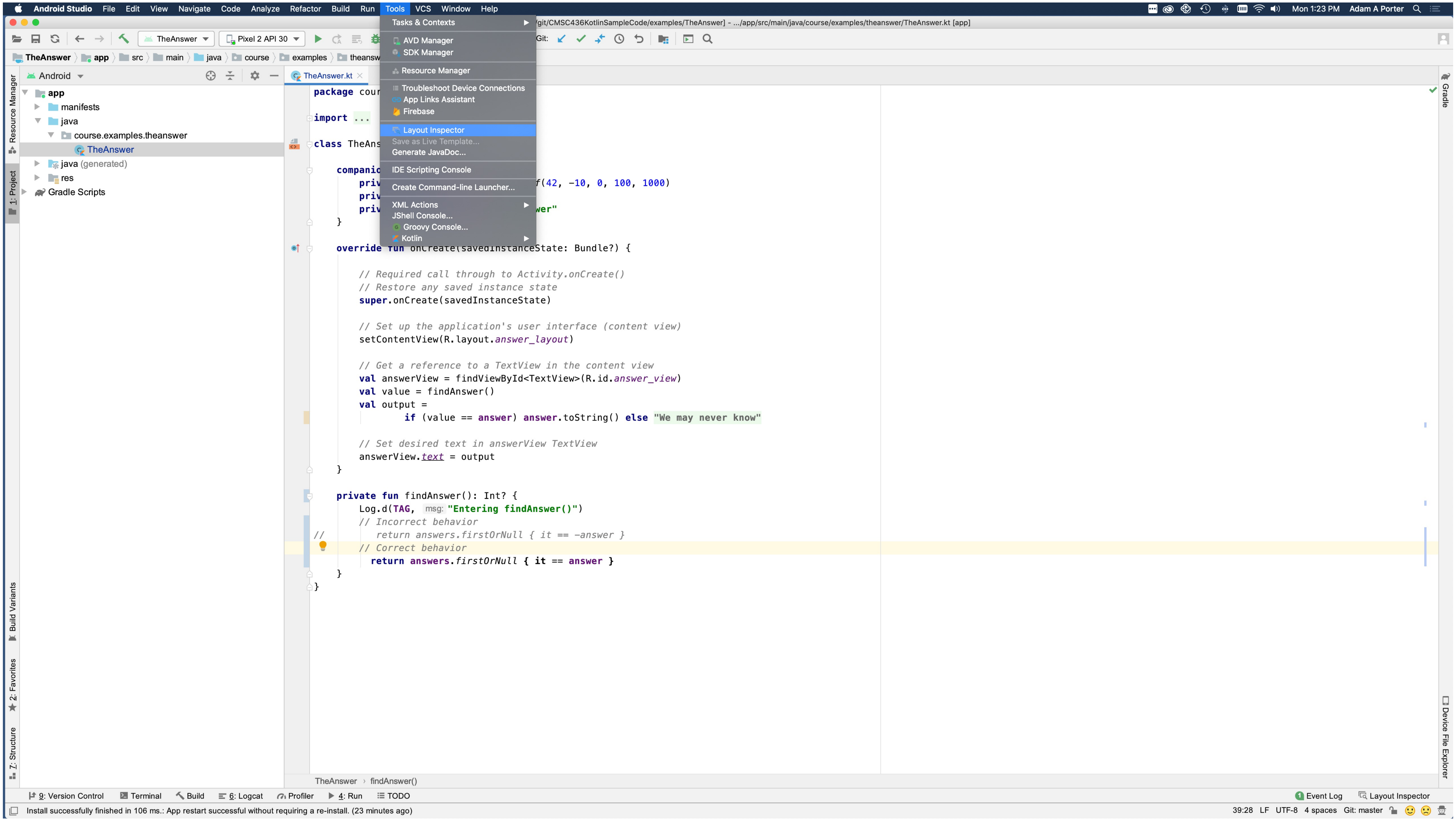
🔍 findAns ✕ □ Match Case □ Regex Wall Clock Time

Name	Total (μs)	%	Self (μs)	%	Children ...	%
▼ main() ()	80,000	100.00	0	0.00	80,000	100.00
▼ dispatchMessage() (android.os.Handler)	80,000	100.00	0	0.00	80,000	100.00
▼ handleMessage() (android.app.ActivityThread$H)	80,000	100.00	0	0.00	80,000	100.00
▼ execute() (android.app.servertransaction.TransactionExecuto	80,000	100.00	0	0.00	80,000	100.00
▼ executeCallbacks() (android.app.servertransaction.Transa	80,000	100.00	0	0.00	80,000	100.00
▼ execute() (android.app.servertransaction.LaunchActivit	80,000	100.00	0	0.00	80,000	100.00
▼ handleLaunchActivity() (android.app.ActivityThread	80,000	100.00	0	0.00	80,000	100.00
▼ performLaunchActivity() (android.app.ActivityThı	80,000	100.00	0	0.00	80,000	100.00
▼ callActivityOnCreate() (android.app.Instrumeı	80,000	100.00	0	0.00	80,000	100.00
▼ performCreate() (android.app.Activity)	80,000	100.00	0	0.00	80,000	100.00
▼ performCreate() (android.app.Activity)	80,000	100.00	0	0.00	80,000	100.00
▼ onCreate() (course.examples.thear	80,000	100.00	72,129	90.16	7,871	9.84
▼ findAnswer() (course.examples	207	0.26	70	0.09	137	0.17
▶ d() (android.util.Log)	125	0.16	27	0.03	98	0.12
valueOf() (java.lang.Integer)	12	0.02	12	0.02	0	0.00
▶ setContentView() (android.app./	7,176	8.97	10	0.01	7,166	8.96
▶ findViewById() (android.app.Act	278	0.35	26	0.03	252	0.32
▶ valueOf() (java.lang.String)	196	0.25	17	0.02	179	0.22
intValue() (java.lang.Integer)	14	0.02	14	0.02	0	0.00
▶ Studio:InputCon() ()	80,000	100.00	20	0.03	79,980	99.98
<native thread without managed peer>() ()	80,000	100.00	80,000	100.00	0	0.00

Install successfully finished in 106 ms.: App restart successful without requiring a re-install. (22 minutes ago)

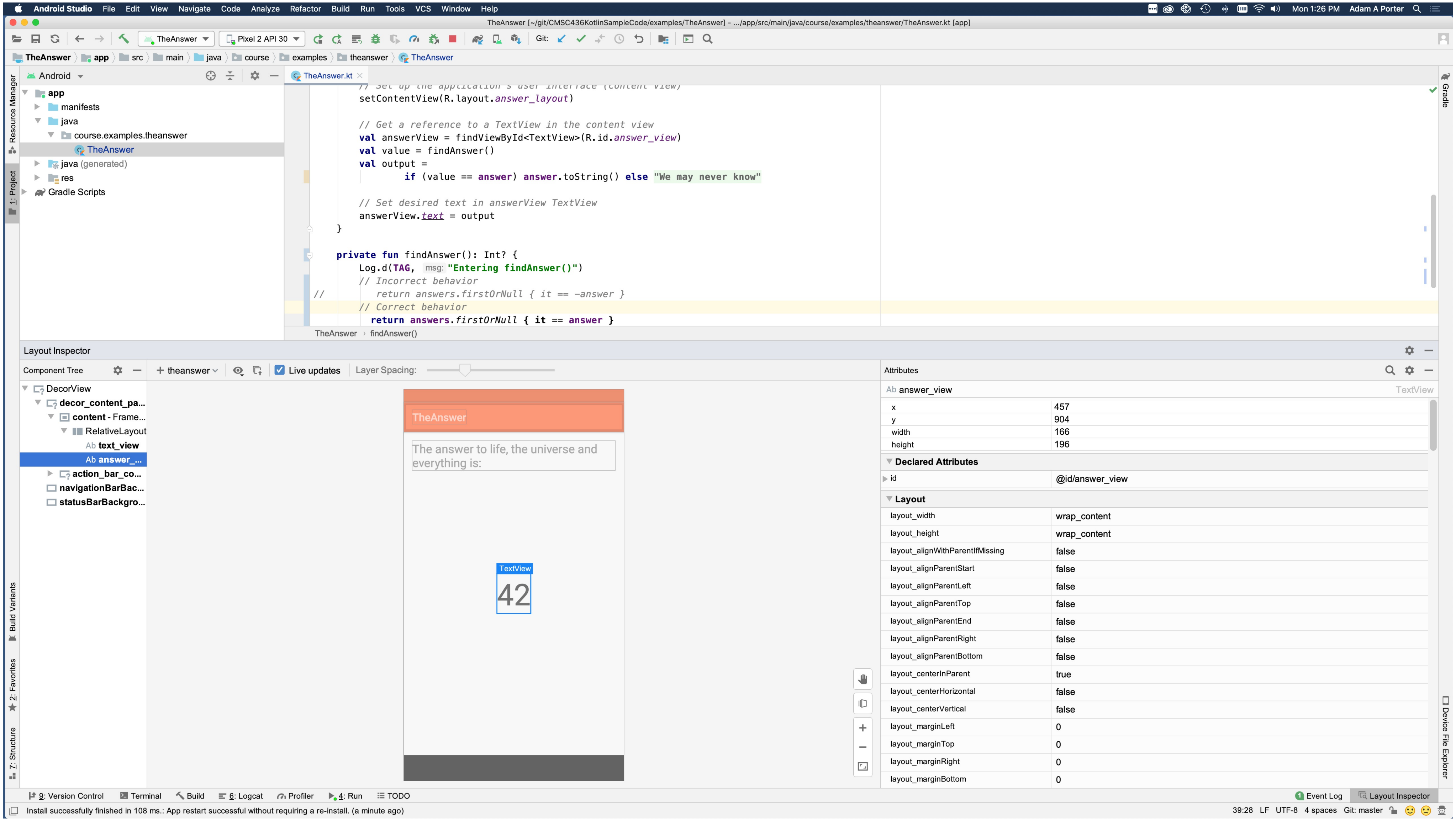
Layout Inspector

Shows the runtime organization of the user interface



```
package cour

import ...

class TheAns

    companic                                    f(42, -10, 0, 100, 1000)
        priv
        priv
        priv                                    wer"
    }

    override fun onCreate(savedInstanceState: Bundle?) {

        // Required call through to Activity.onCreate()
        // Restore any saved instance state
        super.onCreate(savedInstanceState)

        // Set up the application's user interface (content view)
        setContentView(R.layout.answer_layout)

        // Get a reference to a TextView in the content view
        val answerView = findViewById<TextView>(R.id.answer_view)
        val value = findAnswer()
        val output =
                if (value == answer) answer.toString() else "We may never know"

        // Set desired text in answerView TextView
        answerView.text = output
    }

    private fun findAnswer(): Int? {
        Log.d(TAG,  msg: "Entering findAnswer()")
        // Incorrect behavior
//          return answers.firstOrNull { it == -answer }
        // Correct behavior
          return answers.firstOrNull { it == answer }
    }
}
```

Install successfully finished in 106 ms.: App restart successful without requiring a re-install. (23 minutes ago)



Android Studio File Edit View Navigate Code Analyze Refactor Build Run Tools VCS Window Help
Mon 1:26 PM Adam A Porter
TheAnswer [~/git/CMSC436KotlinSampleCode/examples/TheAnswer] - .../app/src/main/java/course/examples/theanswer/TheAnswer.kt [app]
TheAnswer
Pixel 2 API 30
Git:
TheAnswer app src main java course examples theanswer TheAnswer
Android
app
manifests
java
course.examples.theanswer
TheAnswer
java (generated)
res
Gradle Scripts
Resource Manager
1: Project
Build Variants
2: Favorites
7: Structure
Gradle
Device File Explorer
TheAnswer.kt

```kotlin
        // Set up the application's user interface (content view)
        setContentView(R.layout.answer_layout)

        // Get a reference to a TextView in the content view
        val answerView = findViewById<TextView>(R.id.answer_view)
        val value = findAnswer()
        val output =
                if (value == answer) answer.toString() else "We may never know"

        // Set desired text in answerView TextView
        answerView.text = output
    }

    private fun findAnswer(): Int? {
        Log.d(TAG, msg: "Entering findAnswer()")
        // Incorrect behavior
//          return answers.firstOrNull { it == -answer }
        // Correct behavior
          return answers.firstOrNull { it == answer }
```

Ab answer_view TextView

x	457
y	904
width	166
height	196
Declared Attributes	
id	@id/answer_view
Layout	
layout_width	wrap_content
layout_height	wrap_content
layout_alignWithParentIfMissing	false
layout_alignParentStart	false
layout_alignParentLeft	false
layout_alignParentTop	false
layout_alignParentEnd	false
layout_alignParentRight	false
layout_alignParentBottom	false
layout_centerInParent	true
layout_centerHorizontal	false
layout_centerVertical	false
layout_marginLeft	0
layout_marginTop	0
layout_marginRight	0
layout_marginBottom	0

Install successfully finished in 108 ms.: App restart successful without requiring a re-install. (a minute ago)

Next

Application Fundamentals

Example Applications

HelloWorld

TheAnswer