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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

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 7/8/10 (32- or 64-bit)
- Mac OS X 10.10 (Yosemite) up to 10.14 (Mojave)
- GNOME or KDE desktop (tested on gLinux)
- Chrome OS

General Prerequisites

4 GB RAM min, 8 GB RAM rec

2-4 GB+ 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

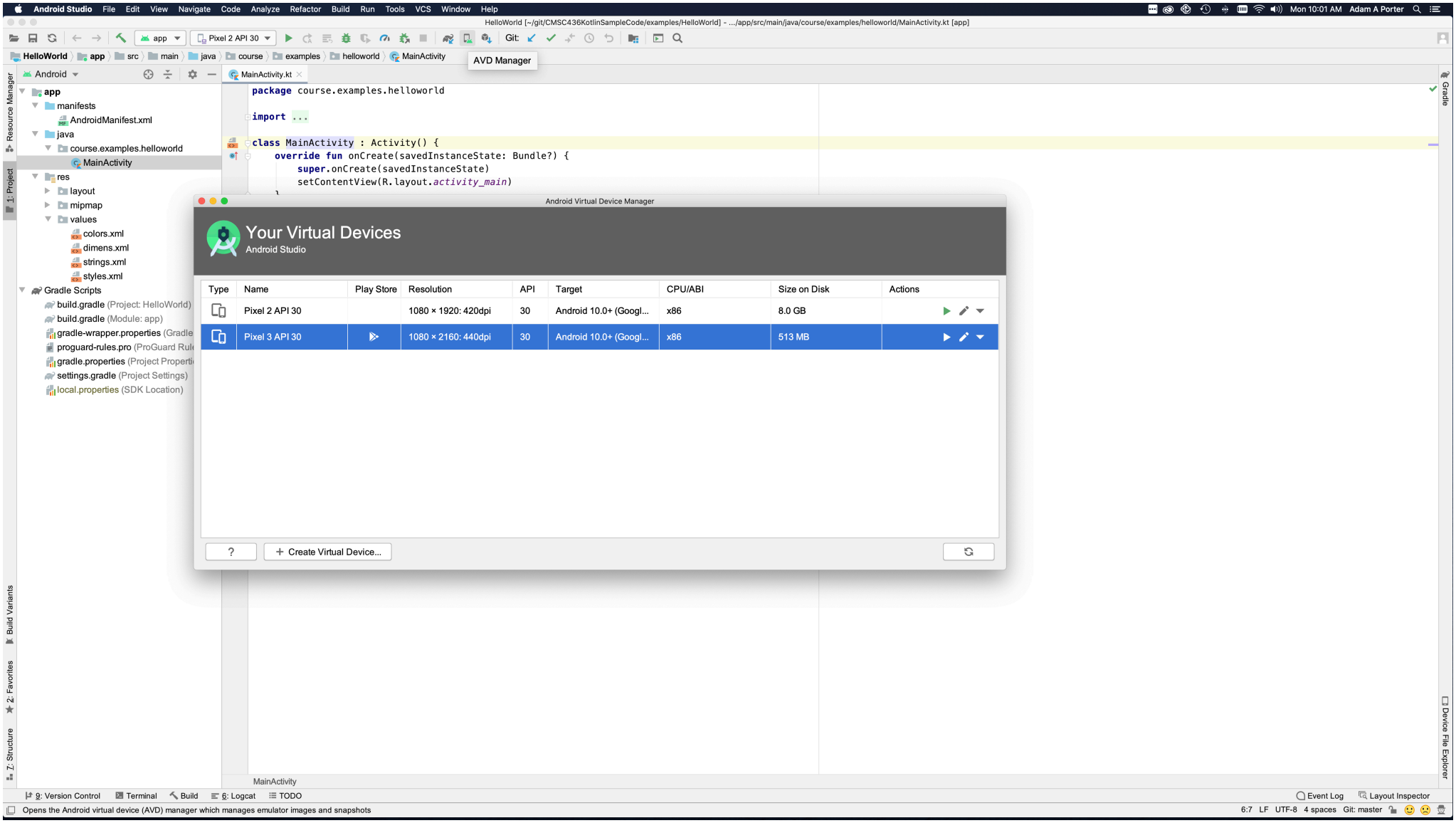
System image for emulator

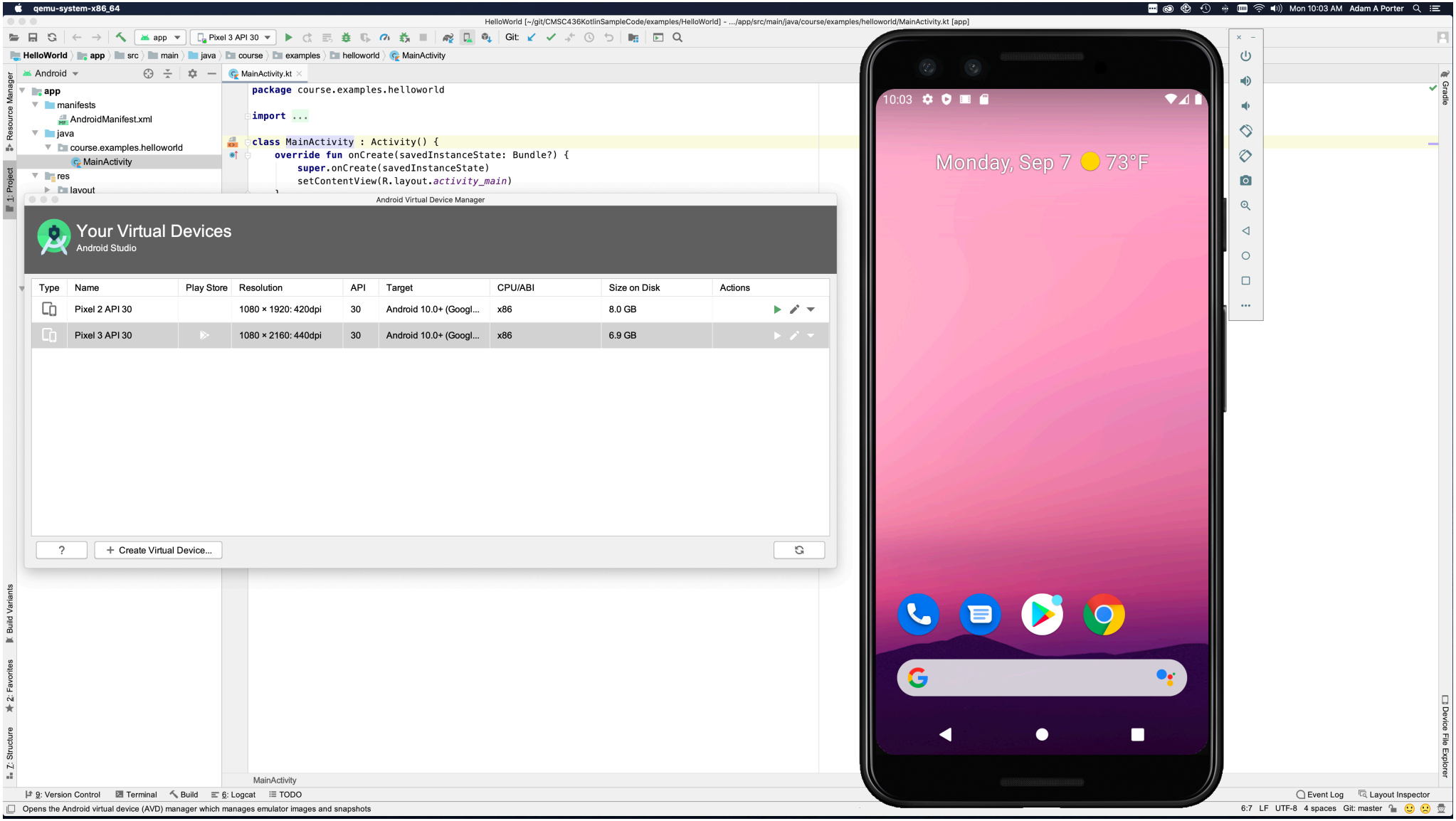
HelloWorld

```
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:
AVD Manager
HelloWorld app src main java course examples helloworld MainActivity
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)
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
513 MB
?
+ Create Virtual Device...
MainActivity
9: Version Control
Terminal
Build
6: Logcat
TODO
Event Log
Layout Inspector
Opens the Android virtual device (AVD) manager which manages emulator images and snapshots
6:7 LF UTF-8 4 spaces Git: master
Resource Manager
1: Project
Build Variants
2: Favorites
7: Structure
Gradle
Device File Explorer


qemu-system-x86_64
Mon 10:03 AM Adam A Porter
HelloWorld [~/git/CMSC436KotlinSampleCode/examples/HelloWorld] - .../app/src/main/java/course/examples/helloworld/MainActivity.kt [app]
app
Pixel 3 API 30
Git:
HelloWorld
app
src
main
java
course
examples
helloworld
MainActivity
Android
MainActivity.kt
app
manifests
AndroidManifest.xml
java
course.examples.helloworld
MainActivity
res
layout
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
?
Create Virtual Device...
10:03
Monday, Sep 7
73°F
MainActivity
9: Version Control
Terminal
Build
6: Logcat
TODO
Event Log
Layout Inspector
Opens the Android virtual device (AVD) manager which manages emulator images and snapshots
6:7
LF
UTF-8
4 spaces
Git: master
Resource Manager
1: Project
Build Variants
2: Favorites
7: Structure
Gradle
Device File Explorer

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

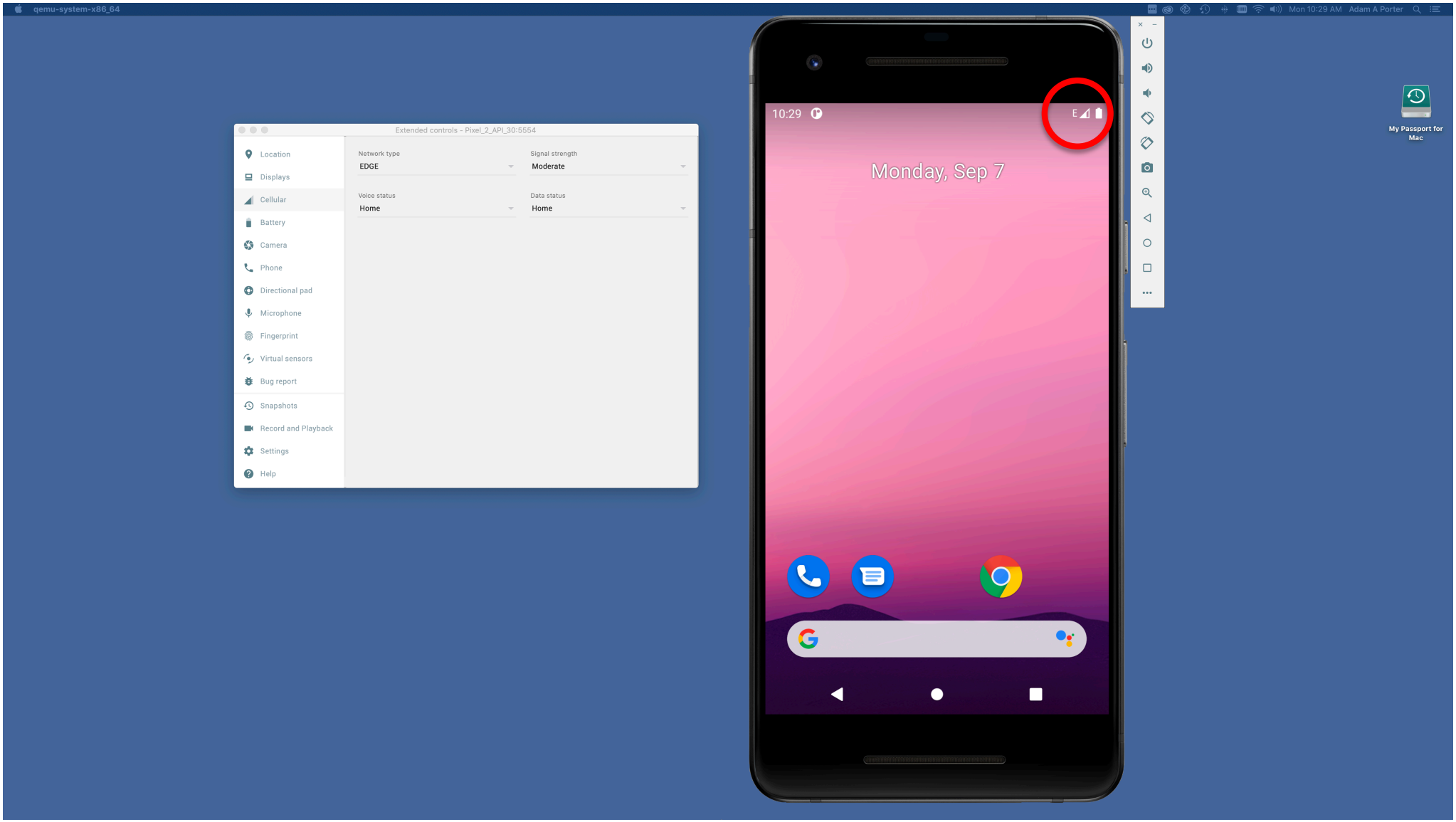
Advanced Features

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

- Network speed/latencies
- Battery power
- Location coordinates

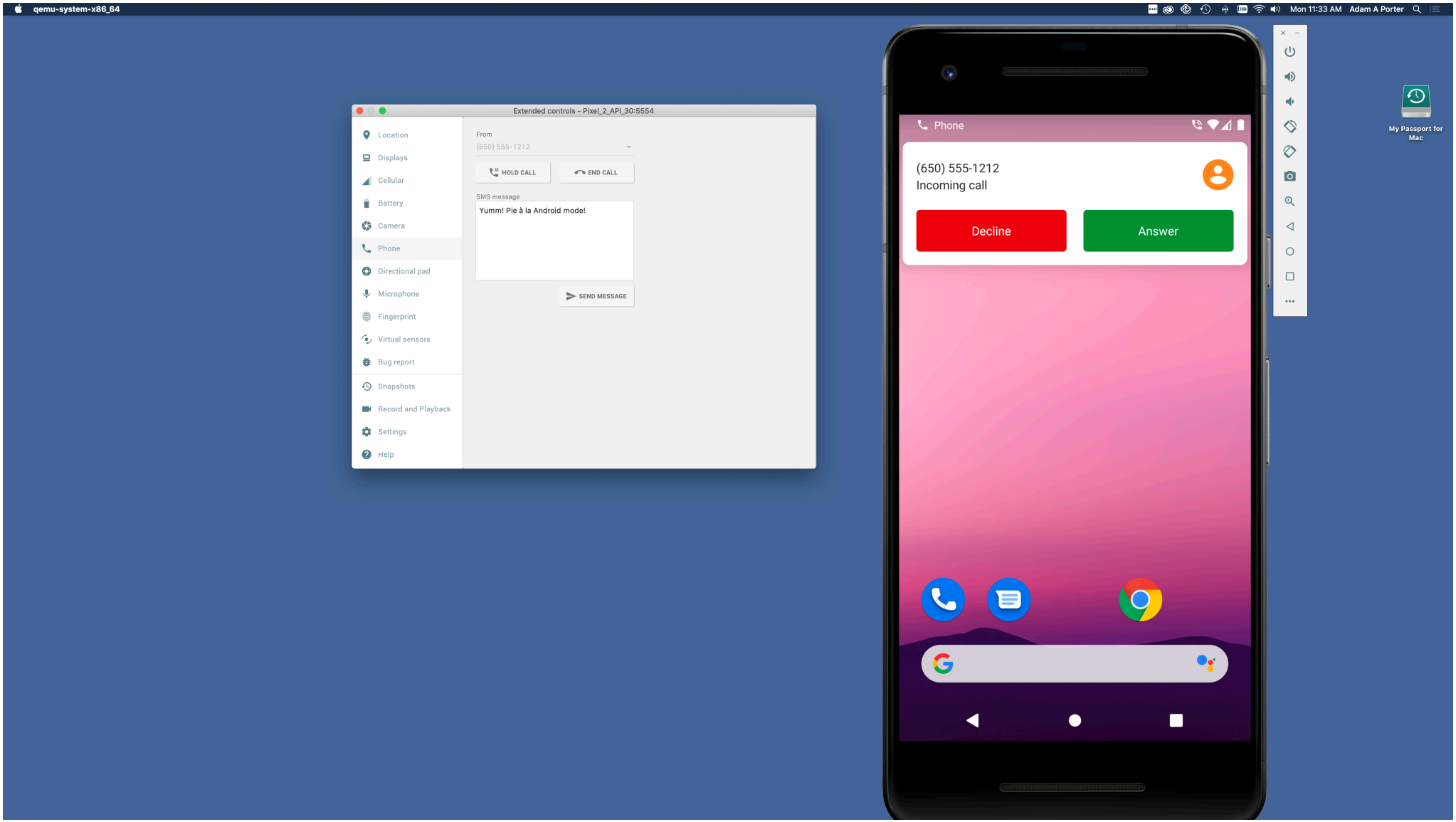
Advanced Features

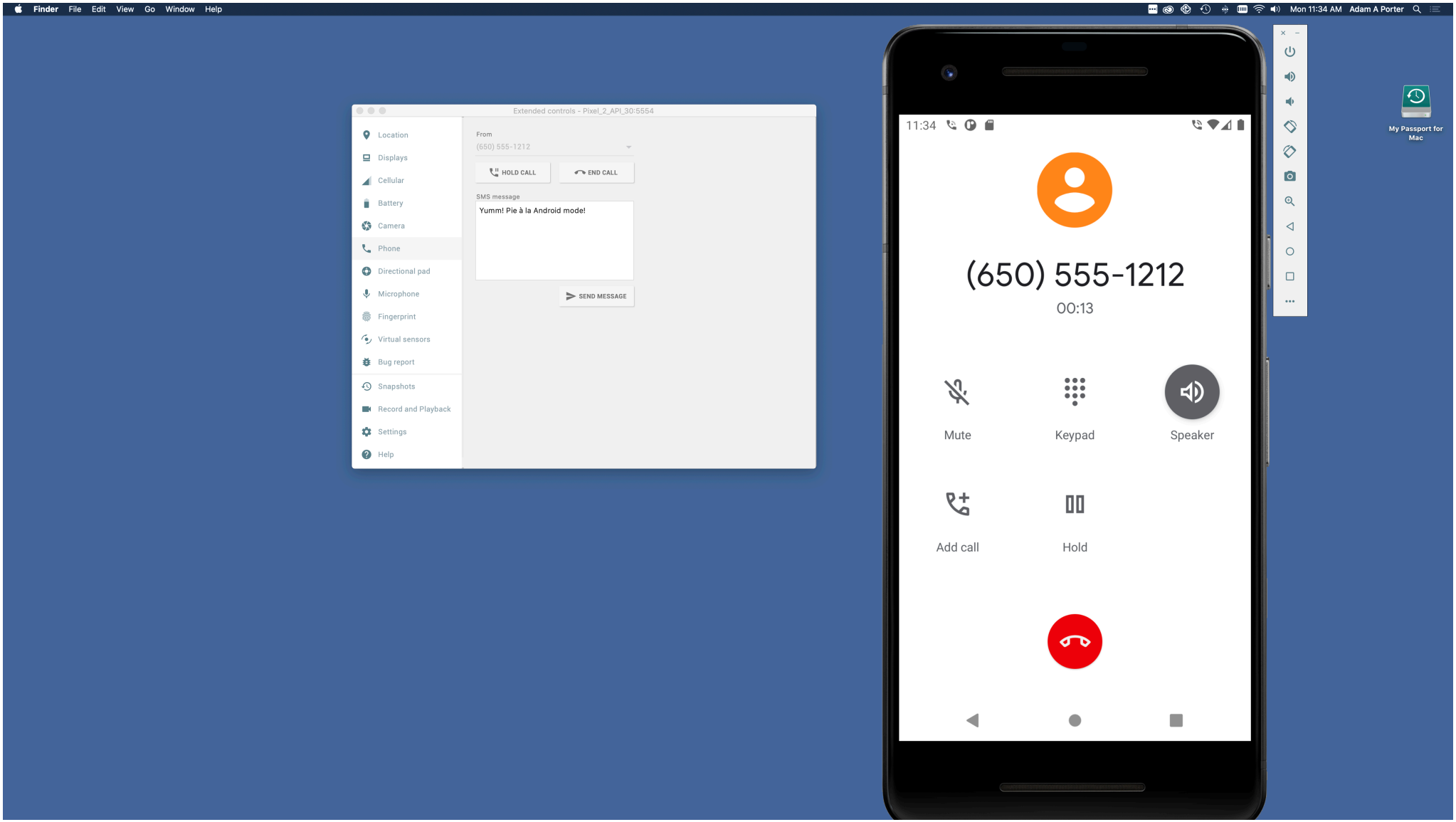
Change network speeds


qemu-system-x86_64
Mon 10:29 AM Adam A Porter
Extended controls - Pixel_2_API_30:5554
Location
Displays
Cellular
Battery
Camera
Phone
Directional pad
Microphone
Fingerprint
Virtual sensors
Bug report
Snapshots
Record and Playback
Settings
Help
Network type
EDGE
Signal strength
Moderate
Voice status
Home
Data status
Home
10:29
E
Monday, Sep 7
My Passport for Mac

Advanced Features

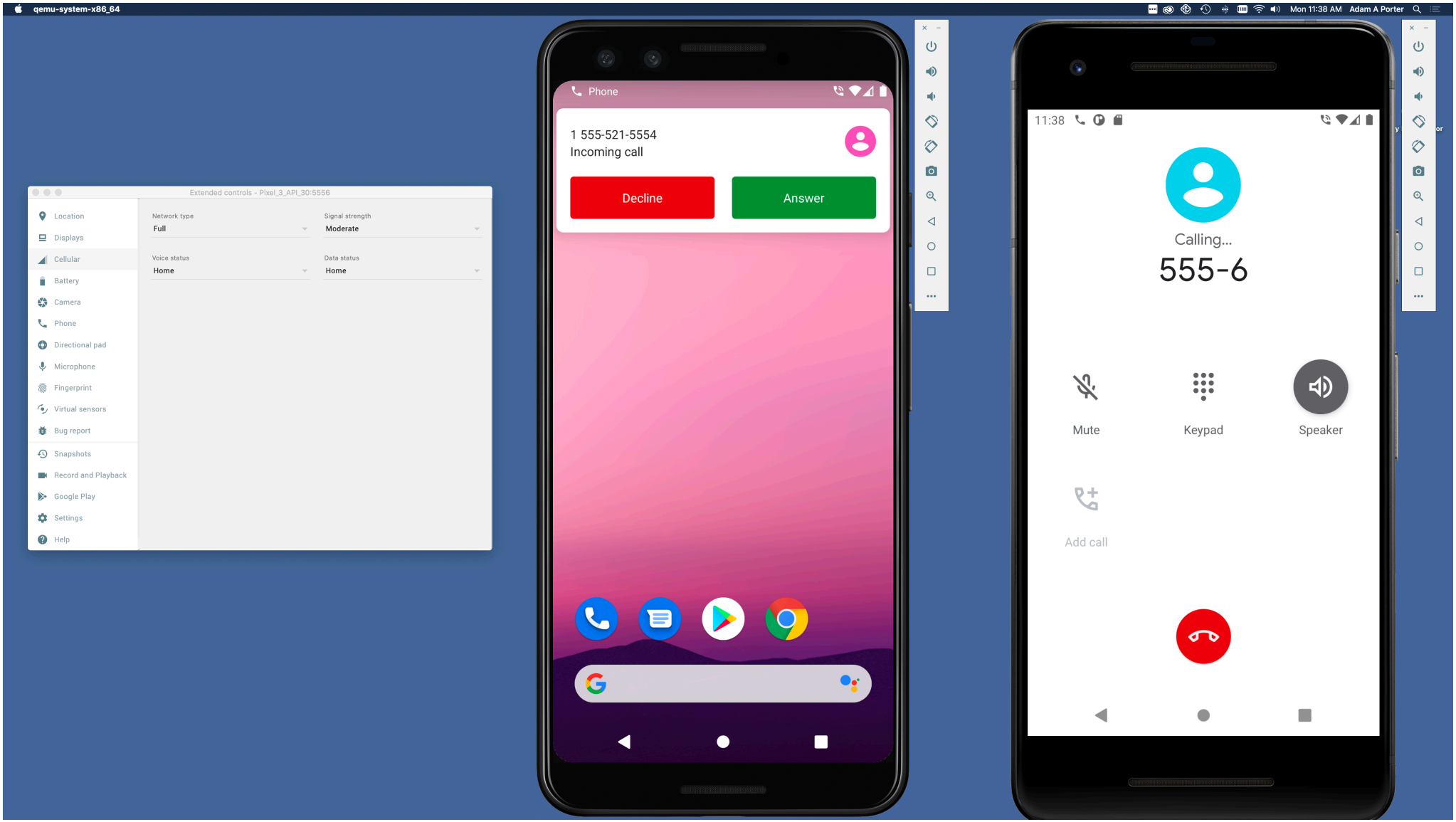
Emulate incoming phone calls & SMS messages

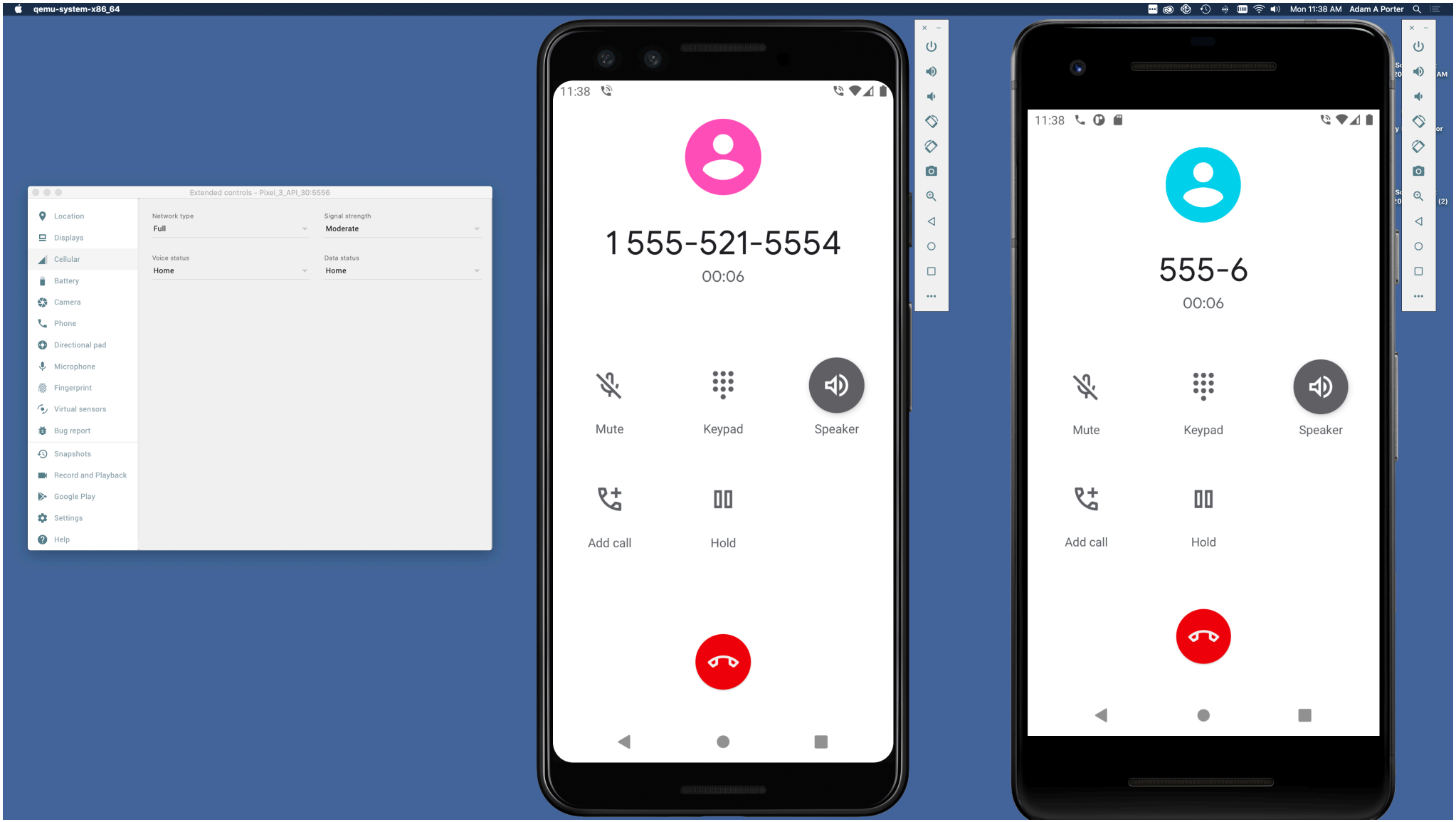

qemu-system-x86_64
Mon 11:33 AM
Adam A Porter
Extended controls - Pixel_2_API_30:5554
Location
Displays
Cellular
Battery
Camera
Phone
Directional pad
Microphone
Fingerprint
Virtual sensors
Bug report
Snapshots
Record and Playback
Settings
Help
From
(650) 555-1212
HOLD CALL
END CALL
SMS message
Yumm! Pie à la Android mode!
SEND MESSAGE
Phone
(650) 555-1212
Incoming call
Decline
Answer
My Passport for Mac


Finder File Edit View Go Window Help
Mon 11:34 AM Adam A Porter
Extended controls - Pixel_2_API_30:5554
Location
Displays
Cellular
Battery
Camera
Phone
Directional pad
Microphone
Fingerprint
Virtual sensors
Bug report
Snapshots
Record and Playback
Settings
Help
From
(650) 555-1212
HOLD CALL
END CALL
SMS message
Yumm! Pie à la Android mode!
SEND MESSAGE
11:34
(650) 555-1212
00:13
Mute
Keypad
Speaker
Add call
Hold
My Passport for Mac

The Android Emulator

Can interconnect multiple emulators


qemu-system-x86_64
Mon 11:38 AM Adam A Porter
Extended controls - Pixel_3_API_30:5556
Location
Displays
Cellular
Battery
Camera
Phone
Directional pad
Microphone
Fingerprint
Virtual sensors
Bug report
Snapshots
Record and Playback
Google Play
Settings
Help
Network type
Full
Signal strength
Moderate
Voice status
Home
Data status
Home
Phone
1 555-521-5554
Incoming call
Decline
Answer
11:38
Calling...
555-6
Mute
Keypad
Speaker
Add call


qemu-system-x86_64
Mon 11:38 AM Adam A Porter
Extended controls - Pixel_3_API_30:5556
Location
Displays
Cellular
Battery
Camera
Phone
Directional pad
Microphone
Fingerprint
Virtual sensors
Bug report
Snapshots
Record and Playback
Google Play
Settings
Help
Network type
Full
Signal strength
Moderate
Voice status
Home
Data status
Home
11:38
1 555-521-5554
00:06
Mute
Keypad
Speaker
Add call
Hold
11:38
555-6
00:06
Mute
Keypad
Speaker
Add call
Hold

Advanced Features

Many more options

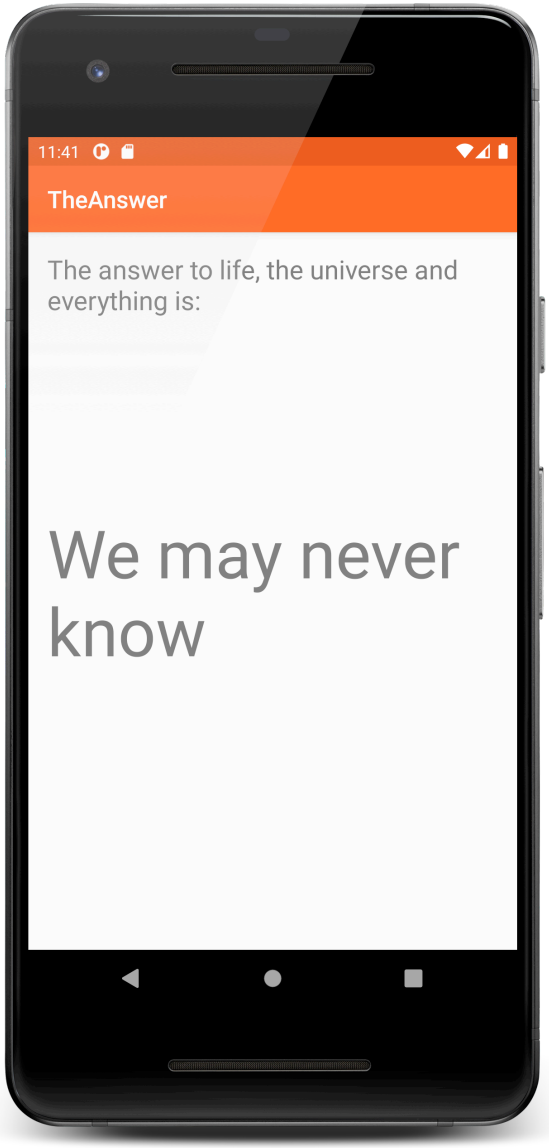
See:

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

Debugger

Tool for examining the internal state of a running application

TheAnswer


11:41
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 }
    }
}
```

11:49
TheAnswer
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

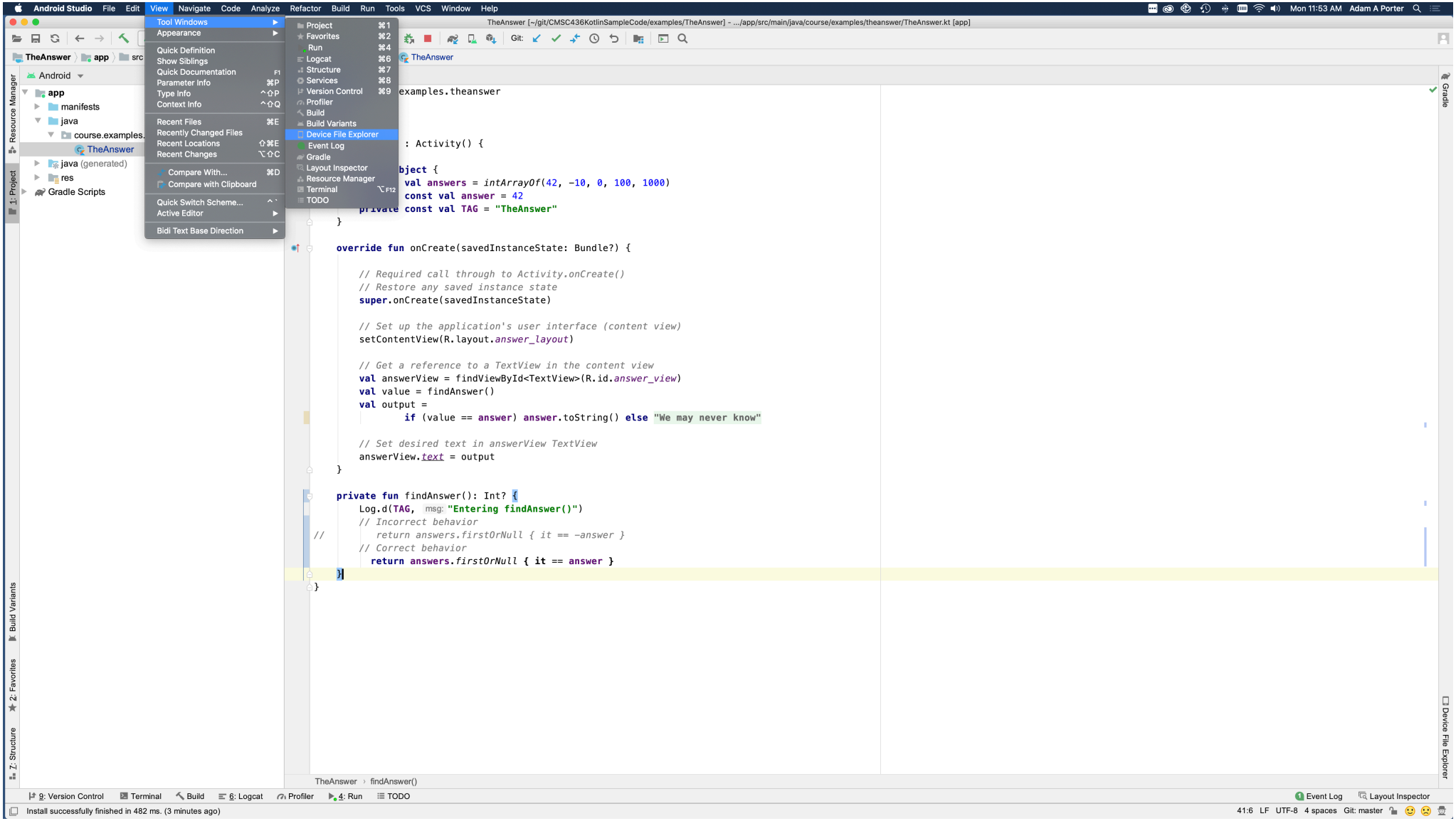
CPU Profiler

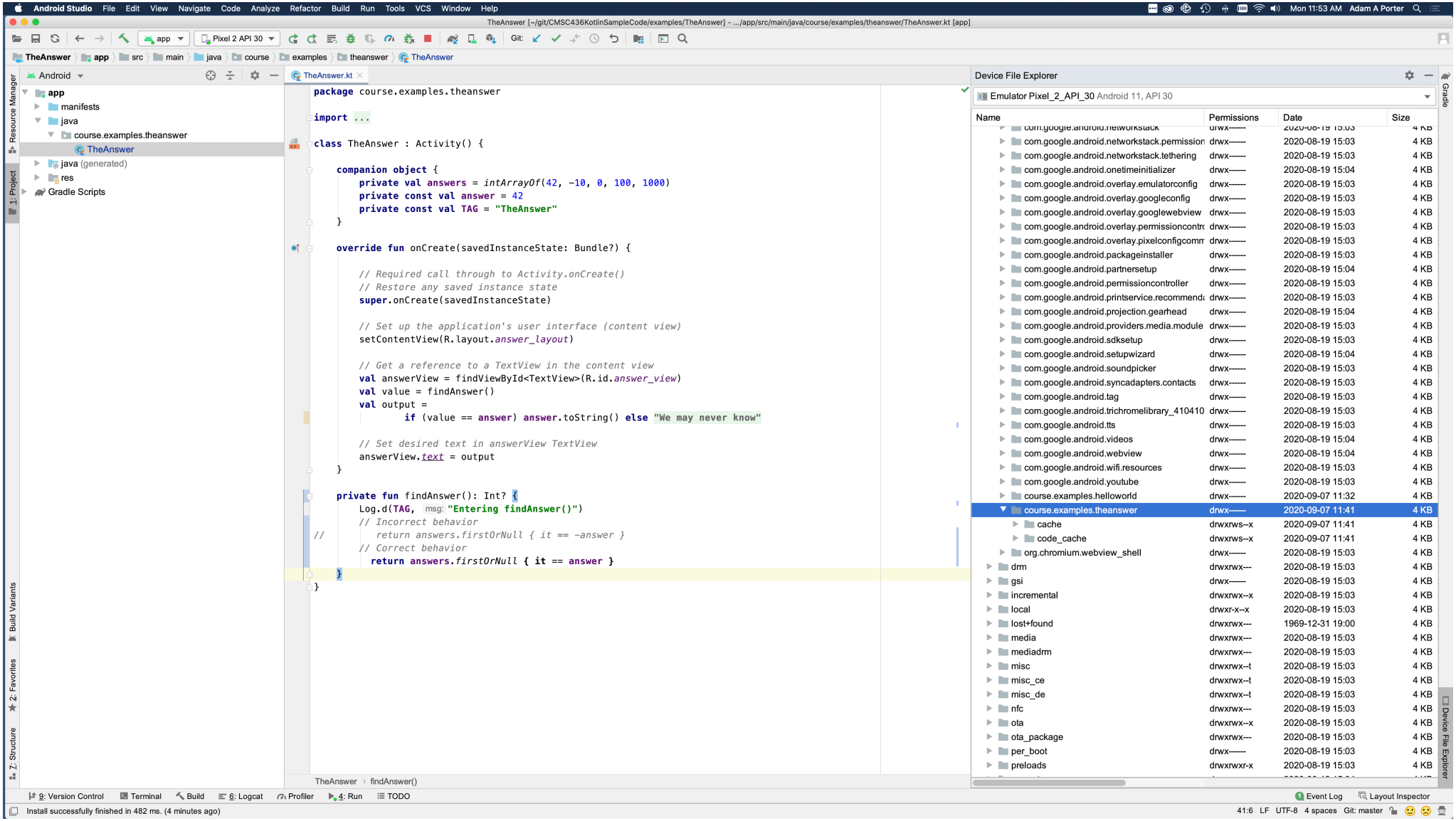
Layout Inspector

Device File Explorer

View, copy, and delete files on your device

Often used to examine and verify file creation and transfer


Android Studio File Edit View Navigate Code Analyze Refactor Build Run Tools VCS Window Help
Mon 11:53 AM Adam A Porter
TheAnswer [~/git/CMSC436KotlinSampleCode/examples/TheAnswer] - .../app/src/main/java/course/examples/theanswer/TheAnswer.kt [app]
Tool Windows
Appearance
Quick Definition
Show Siblings
Quick Documentation F1
Parameter Info ⌘P
Type Info ^⇧P
Context Info ^⇧Q
Recent Files ⌘E
Recently Changed Files
Recent Locations ⇧⌘E
Recent Changes ⌥⇧C
Compare With... ⌘D
Compare with Clipboard
Quick Switch Scheme... ^`
Active Editor
Bidi Text Base Direction
Project ⌘1
Favorites ⌘2
Run ⌘4
Logcat ⌘6
Structure ⌘7
Services ⌘8
Version Control ⌘9
Profiler
Build
Build Variants
Device File Explorer
Event Log
Gradle
Layout Inspector
Resource Manager
Terminal ⌥F12
TODO
Android
app
manifests
java
course.examples.
TheAnswer
java (generated)
res
Gradle Scripts
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 }
TheAnswer › findAnswer()
9: Version Control
Terminal
Build
6: Logcat
Profiler
4: Run
TODO
Event Log
Layout Inspector
Install successfully finished in 482 ms. (3 minutes ago)
41:6 LF UTF-8 4 spaces Git: master

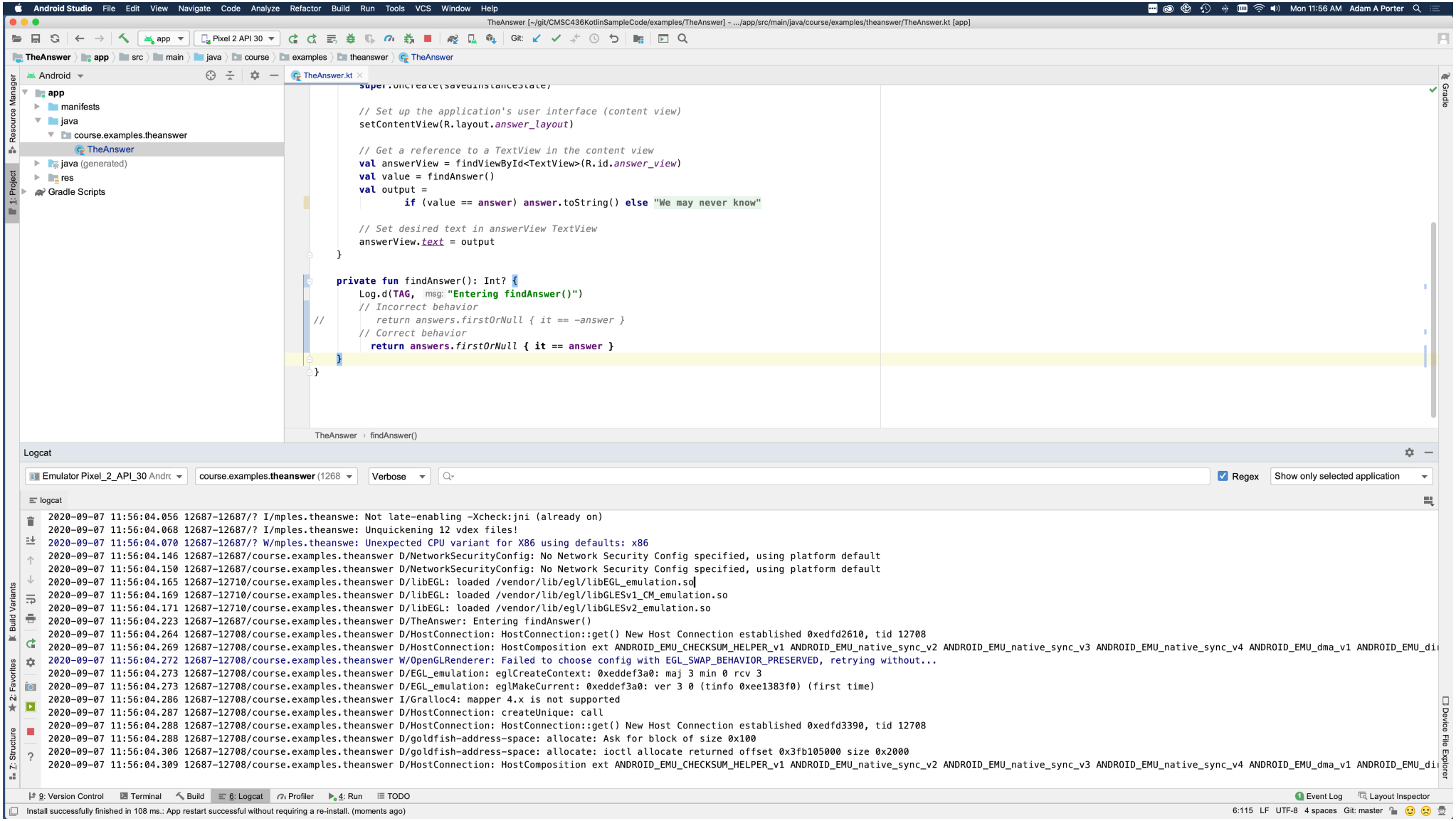

Android Studio File Edit View Navigate Code Analyze Refactor Build Run Tools VCS Window Help
Mon 11:53 AM Adam A Porter
TheAnswer [~/git/CMSC436KotlinSampleCode/examples/TheAnswer] - .../app/src/main/java/course/examples/theanswer/TheAnswer.kt [app]
app
Pixel 2 API 30
Git:
TheAnswer app src main java course examples theanswer TheAnswer
Android
app
manifests
java
course.examples.theanswer
TheAnswer
java (generated)
res
Gradle Scripts
TheAnswer.kt
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 }
}
}
TheAnswer › findAnswer()
Device File Explorer
Emulator Pixel_2_API_30 Android 11, API 30
Name
Permissions
Date
Size
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.permissionconfig drwx------ 2020-08-19 15:03 4 KB
com.google.android.overlay.pixelconfigcommon 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.recommendation 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
9: Version Control
Terminal
Build
6: Logcat
Profiler
4: Run
TODO
Event Log
Layout Inspector
Install successfully finished in 482 ms. (4 minutes ago)
41:6 LF UTF-8 4 spaces Git: master
Resource Manager
1: Project
Build Variants
2: Favorites
7: Structure
Gradle
Device File Explorer

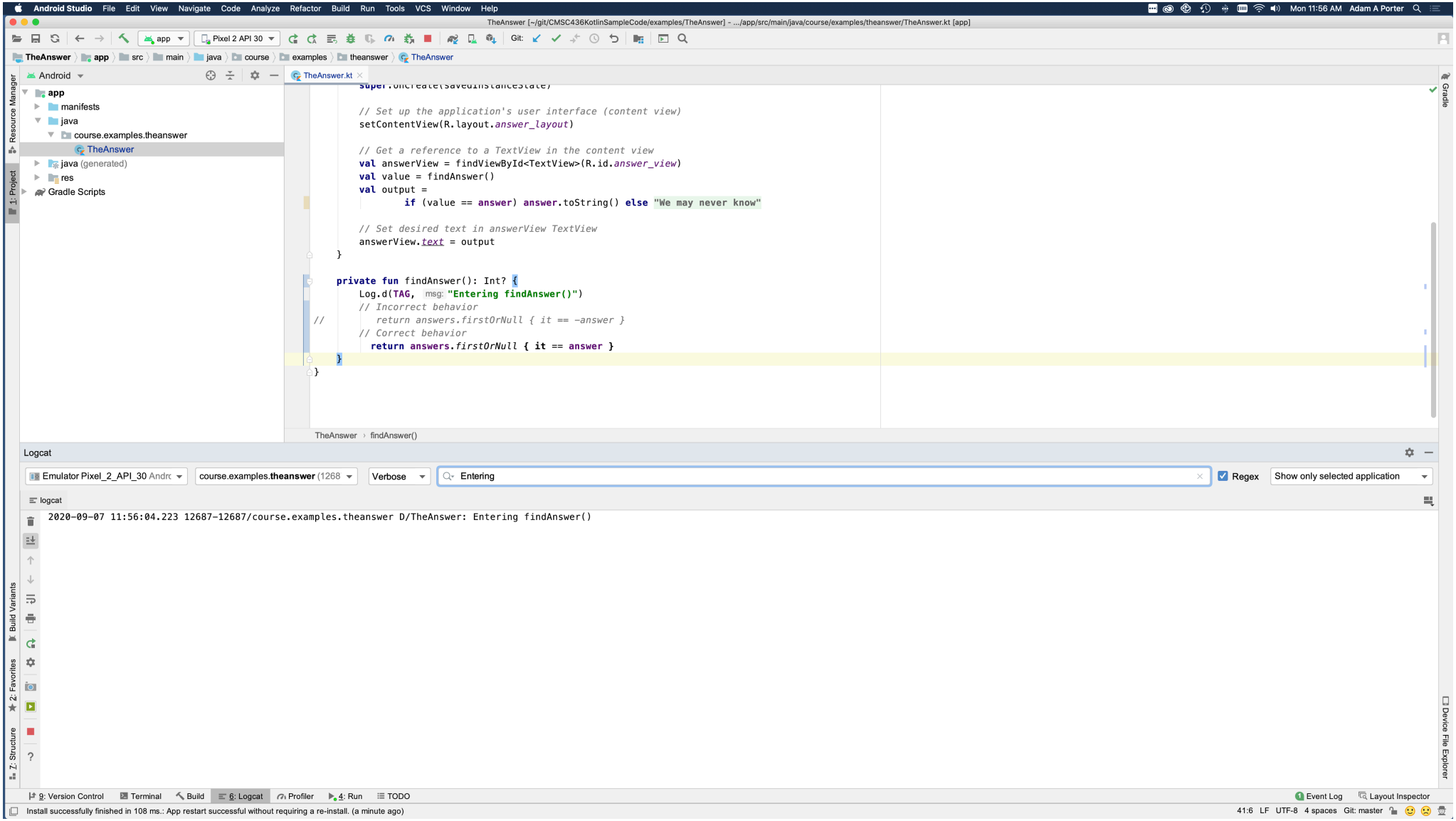
Logcat

Write and review log messages

Apps use Log class to write messages to log

Developer can search and filter log messages

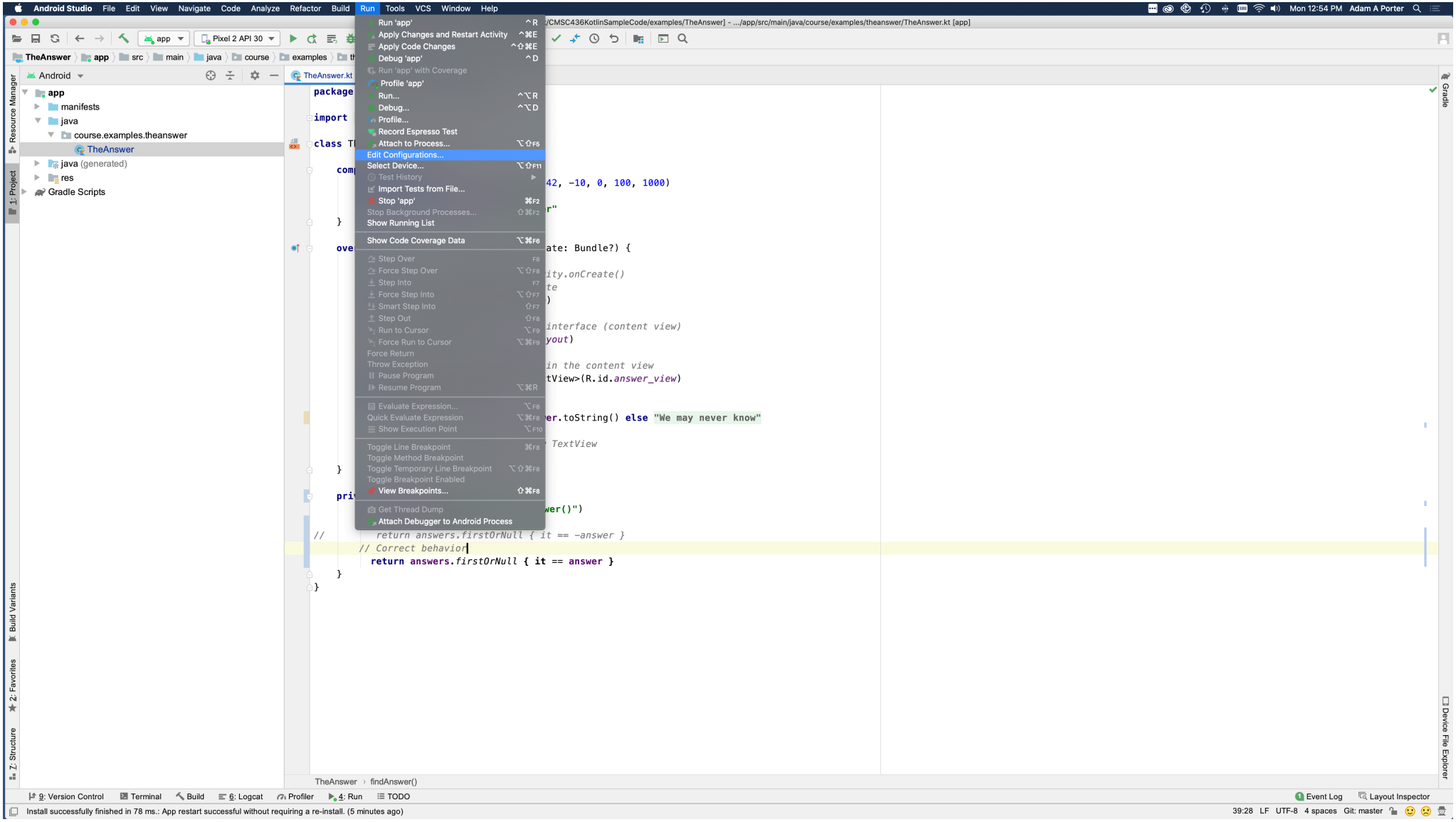

Android Studio File Edit View Navigate Code Analyze Refactor Build Run Tools VCS Window Help
Mon 11:56 AM Adam A Porter
TheAnswer [~/git/CMSC436KotlinSampleCode/examples/TheAnswer] - .../app/src/main/java/course/examples/theanswer/TheAnswer.kt [app]
app
Pixel 2 API 30
Git:
TheAnswer app src main java course examples theanswer TheAnswer
Android
app
manifests
java
course.examples.theanswer
TheAnswer
java (generated)
res
Gradle Scripts
TheAnswer.kt
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 }
}
}
TheAnswer › findAnswer()
Logcat
Emulator Pixel_2_API_30 Andro
course.examples.theanswer (1268
Verbose
Regex
Show only selected application
logcat
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
9: Version Control
Terminal
Build
6: Logcat
Profiler
4: Run
TODO
Event Log
Layout Inspector
Install successfully finished in 108 ms.: App restart successful without requiring a re-install. (moments ago)
6:115 LF UTF-8 4 spaces Git: master

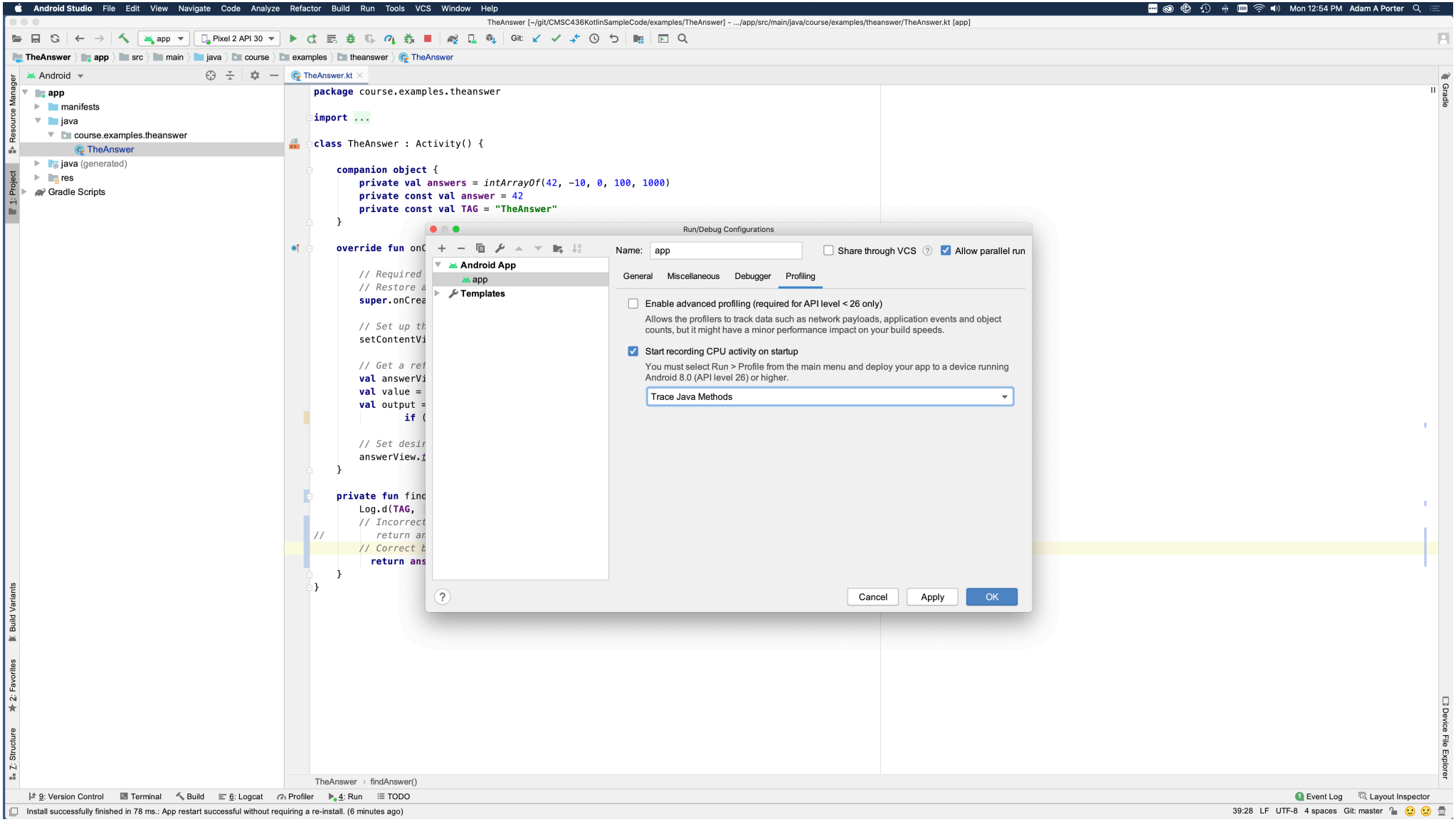

Android Studio File Edit View Navigate Code Analyze Refactor Build Run Tools VCS Window Help
Mon 11:56 AM Adam A Porter
TheAnswer [~/git/CMSC436KotlinSampleCode/examples/TheAnswer] - .../app/src/main/java/course/examples/theanswer/TheAnswer.kt [app]
app
Pixel 2 API 30
Git:
TheAnswer app src main java course examples theanswer TheAnswer
Android
app
manifests
java
course.examples.theanswer
TheAnswer
java (generated)
res
Gradle Scripts
TheAnswer.kt
// 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 }
}
}
TheAnswer › findAnswer()
Logcat
Emulator Pixel_2_API_30 Andro
course.examples.theanswer (1268
Verbose
Entering
Regex
Show only selected application
logcat
2020-09-07 11:56:04.223 12687-12687/course.examples.theanswer D/TheAnswer: Entering findAnswer()
9: Version Control
Terminal
Build
6: Logcat
Profiler
4: Run
TODO
Event Log
Layout Inspector
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
Resource Manager
1: Project
Build Variants
2: Favorites
7: Structure
Device File Explorer

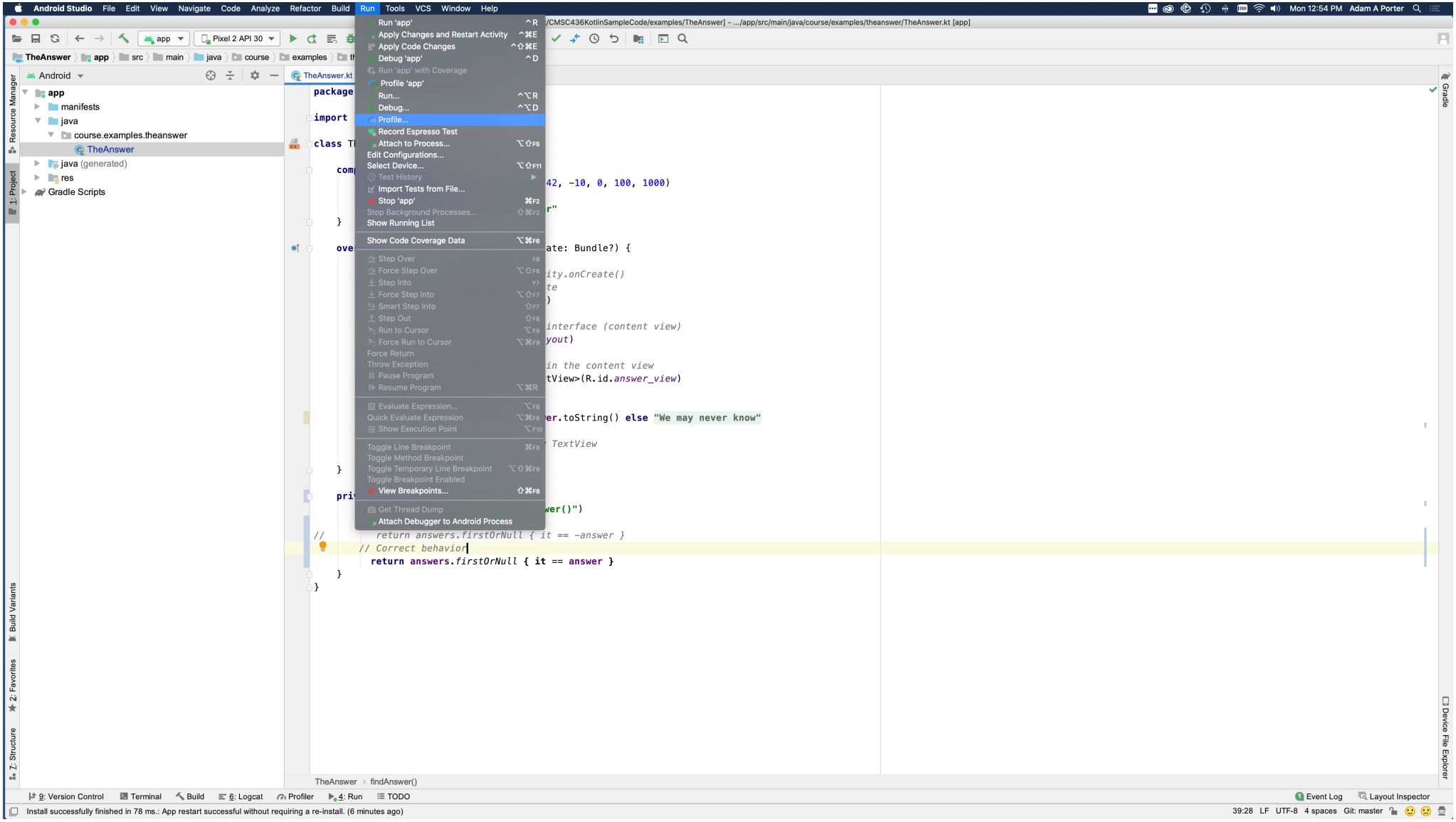
CPU Profiler

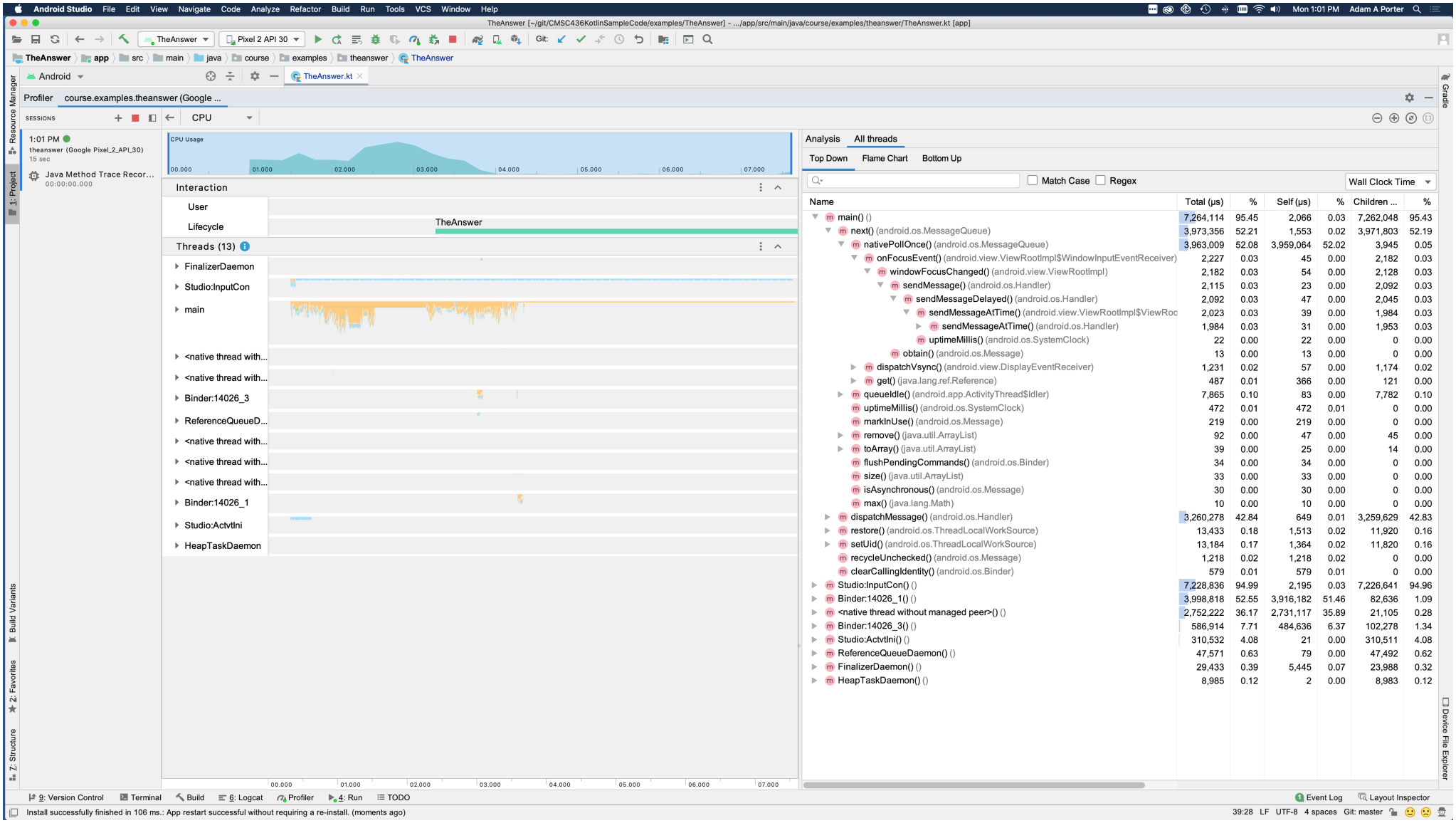
Logs execution sequences and timing taken from a running application

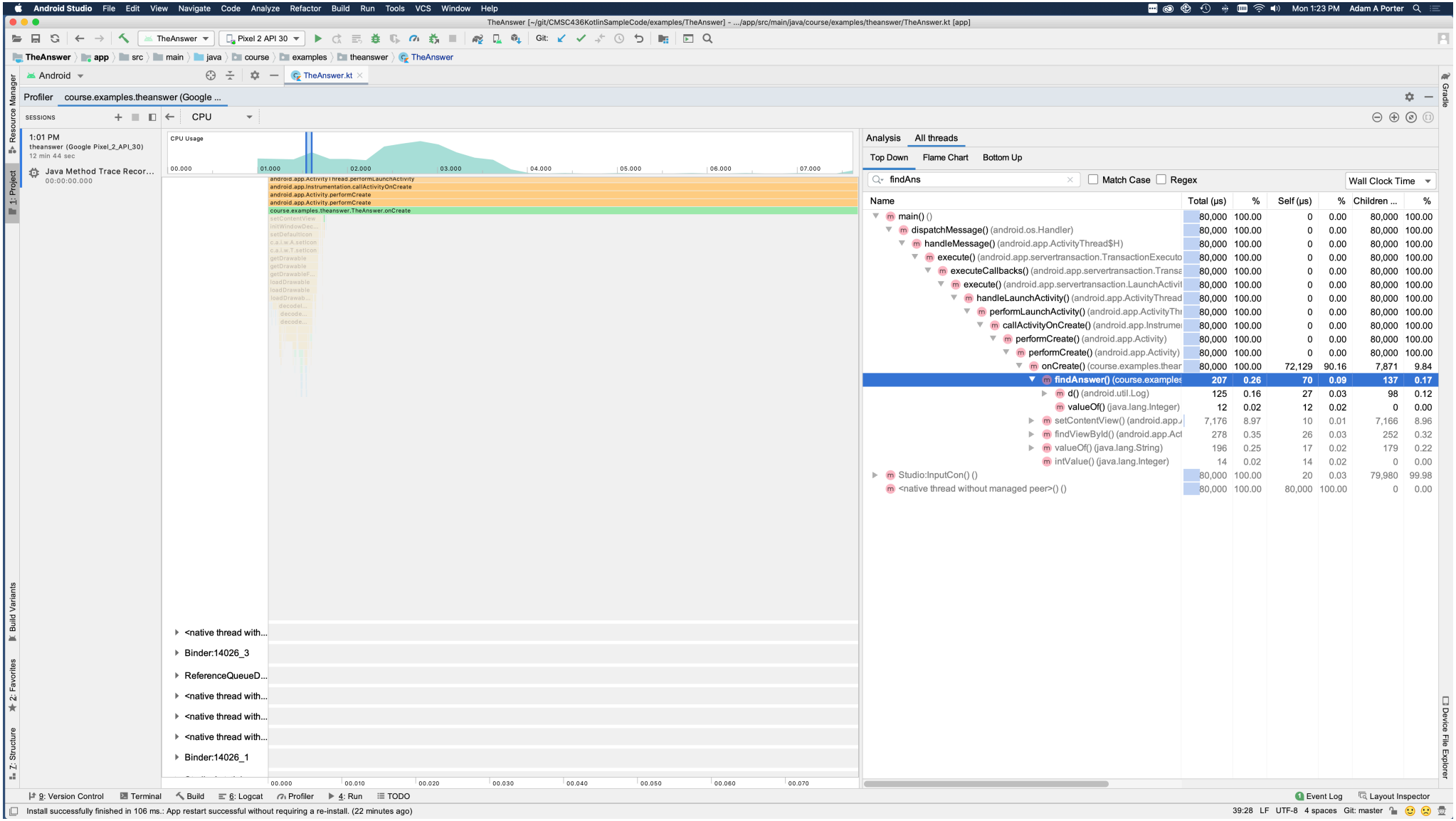
Graphically displays method traces and metrics


Android Studio File Edit View Navigate Code Analyze Refactor Build Run Tools VCS Window Help
Mon 12:54 PM Adam A Porter
Run 'app' ^R
Apply Changes and Restart Activity ^⌘E
Apply Code Changes ^⇧⌘E
Debug 'app' ^D
Run 'app' with Coverage
Profile 'app'
Run... ^⌥R
Debug... ^⌥D
Profile...
Record Espresso Test
Attach to Process... ⌥⇧F5
Edit Configurations...
Select Device... ⌥⇧F11
Test History
Import Tests from File...
Stop 'app' ⌘F2
Stop Background Processes... ⇧⌘F2
Show Running List
Show Code Coverage Data ⌥⌘F6
Step Over F8
Force Step Over ⌥⇧F8
Step Into F7
Force Step Into ⌥⇧F7
Smart Step Into ⇧F7
Step Out ⇧F8
Run to Cursor ⌥F9
Force Run to Cursor ⌥⌘F9
Force Return
Throw Exception
Pause Program
Resume Program ⌥⌘R
Evaluate Expression... ⌥F8
Quick Evaluate Expression ⌥⌘F8
Show Execution Point ⌥F10
Toggle Line Breakpoint ⌘F8
Toggle Method Breakpoint
Toggle Temporary Line Breakpoint ⌥⇧⌘F8
Toggle Breakpoint Enabled
View Breakpoints... ⇧⌘F8
Get Thread Dump
Attach Debugger to Android Process
TheAnswer.kt
// return answers.firstOrNull { it == -answer }
// Correct behavior
return answers.firstOrNull { it == answer }
TheAnswer › findAnswer()
9: Version Control
Terminal
Build
6: Logcat
Profiler
4: Run
TODO
Event Log
Layout Inspector
Install successfully finished in 78 ms.: App restart successful without requiring a re-install. (5 minutes 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 12:54 PM Adam A Porter
TheAnswer [~/git/CMSC436KotlinSampleCode/examples/TheAnswer] - .../app/src/main/java/course/examples/theanswer/TheAnswer.kt [app]
app
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
TheAnswer.kt
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 an
// 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
Cancel
Apply
OK
TheAnswer › findAnswer()
9: Version Control
Terminal
Build
6: Logcat
Profiler
4: Run
TODO
Event Log
Layout Inspector
Install successfully finished in 78 ms.: App restart successful without requiring a re-install. (6 minutes ago)
39:28 LF UTF-8 4 spaces Git: master
Resource Manager
1: Project
Build Variants
2: Favorites
7: Structure
Gradle
Device File Explorer

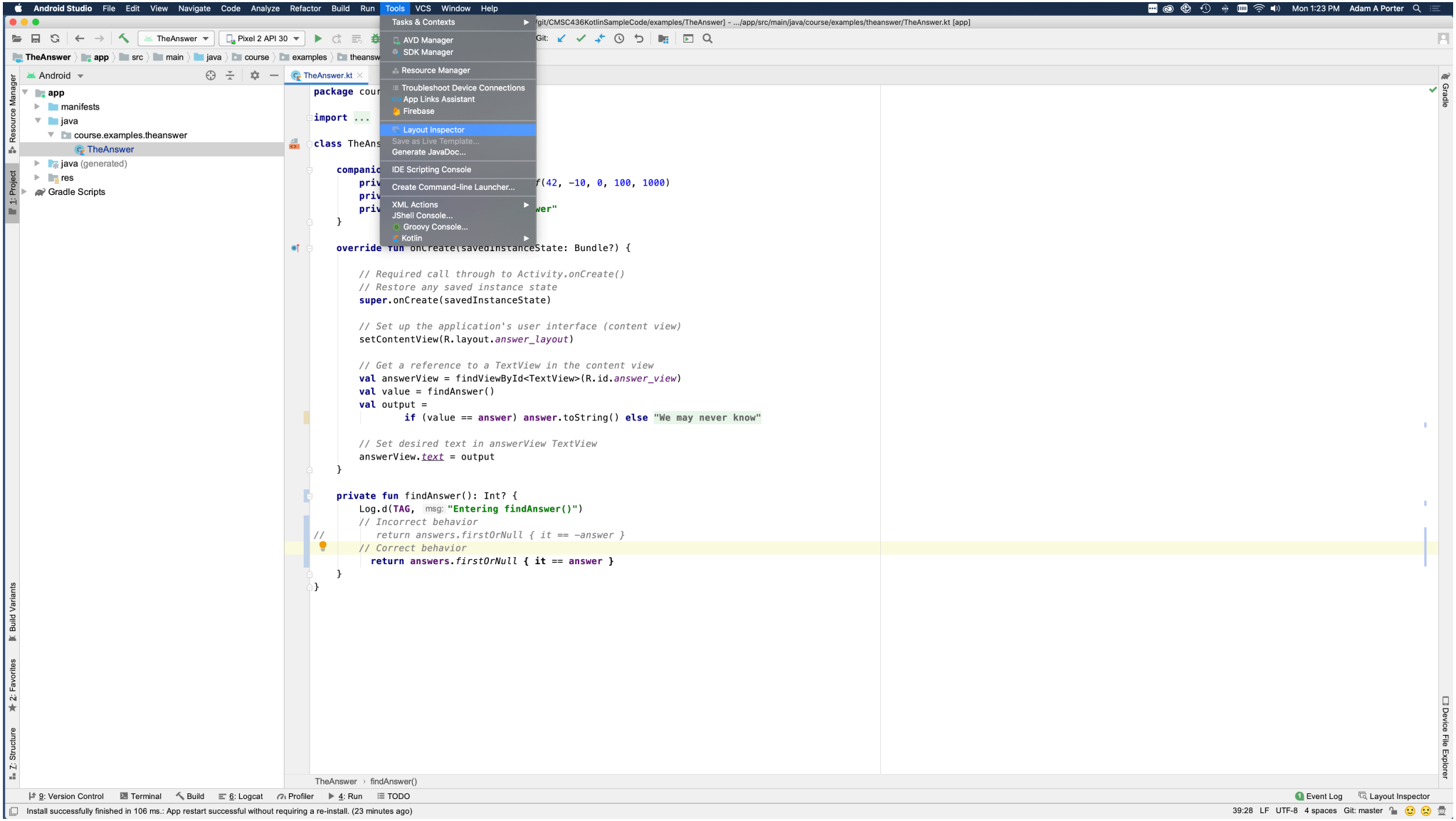

Android Studio File Edit View Navigate Code Analyze Refactor Build Run Tools VCS Window Help
Mon 12:54 PM Adam A Porter
Run 'app' ^R
Apply Changes and Restart Activity ^⌘E
Apply Code Changes ^⇧⌘E
Debug 'app' ^D
Run 'app' with Coverage
Profile 'app'
Run... ^⌥R
Debug... ^⌥D
Profile...
Record Espresso Test
Attach to Process... ⌥⇧F5
Edit Configurations...
Select Device... ⌥⇧F11
Test History
Import Tests from File...
Stop 'app' ⌘F2
Stop Background Processes... ⇧⌘F2
Show Running List
Show Code Coverage Data ⌥⌘F6
Step Over F8
Force Step Over ⌥⇧F8
Step Into F7
Force Step Into ⌥⇧F7
Smart Step Into ⇧F7
Step Out ⇧F8
Run to Cursor ⌥F9
Force Run to Cursor ⌥⌘F9
Force Return
Throw Exception
Pause Program
Resume Program ⌥⌘R
Evaluate Expression... ⌥F8
Quick Evaluate Expression ⌥⌘F8
Show Execution Point ⌥F10
Toggle Line Breakpoint ⌘F8
Toggle Method Breakpoint
Toggle Temporary Line Breakpoint ⌥⇧⌘F8
Toggle Breakpoint Enabled
View Breakpoints... ⇧⌘F8
Get Thread Dump
Attach Debugger to Android Process
TheAnswer.kt
// return answers.firstOrNull { it == -answer }
// Correct behavior
return answers.firstOrNull { it == answer }
TheAnswer › findAnswer()
9: Version Control
Terminal
Build
6: Logcat
Profiler
4: Run
TODO
Event Log
Layout Inspector
Install successfully finished in 78 ms.: App restart successful without requiring a re-install. (6 minutes ago)
39:28 LF UTF-8 4 spaces Git: master

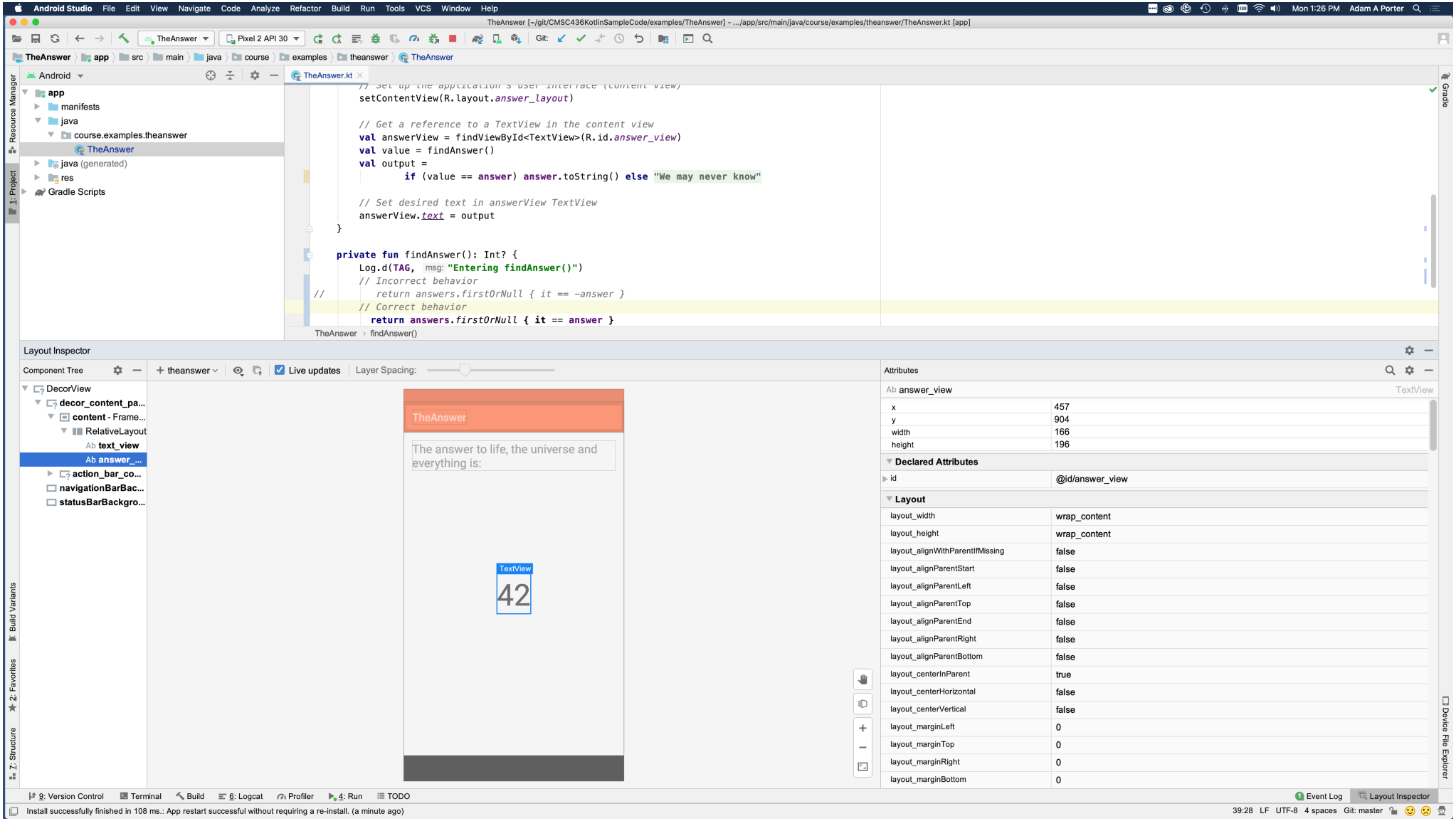

Android Studio File Edit View Navigate Code Analyze Refactor Build Run Tools VCS Window Help
Mon 1:01 PM Adam A Porter
TheAnswer [~/git/CMSC436KotlinSampleCode/examples/TheAnswer] - .../app/src/main/java/course/examples/theanswer/TheAnswer.kt [app]
TheAnswer app src main java course examples theanswer TheAnswer
Profiler course.examples.theanswer (Google ...
SESSIONS
CPU
1:01 PM
theanswer (Google Pixel_2_API_30)
15 sec
Java Method Trace Recor...
00:00:00.000
CPU Usage
Interaction
User
Lifecycle
TheAnswer
Threads (13)
FinalizerDaemon
Studio:InputCon
main
<native thread with...
<native thread with...
Binder:14026_3
ReferenceQueueD...
<native thread with...
<native thread with...
<native thread with...
Binder:14026_1
Studio:ActvtIni
HeapTaskDaemon
Analysis
All threads
Top Down
Flame Chart
Bottom Up
Match Case
Regex
Wall Clock Time
Name
Total (µs)
Self (µs)
Children ...
main() ()
next() (android.os.MessageQueue)
nativePollOnce() (android.os.MessageQueue)
onFocusEvent() (android.view.ViewRootImpl$WindowInputEventReceiver)
windowFocusChanged() (android.view.ViewRootImpl)
sendMessage() (android.os.Handler)
sendMessageDelayed() (android.os.Handler)
sendMessageAtTime() (android.view.ViewRootImpl$ViewRoc
sendMessageAtTime() (android.os.Handler)
uptimeMillis() (android.os.SystemClock)
obtain() (android.os.Message)
dispatchVsync() (android.view.DisplayEventReceiver)
get() (java.lang.ref.Reference)
queueIdle() (android.app.ActivityThread$Idler)
uptimeMillis() (android.os.SystemClock)
markInUse() (android.os.Message)
remove() (java.util.ArrayList)
toArray() (java.util.ArrayList)
flushPendingCommands() (android.os.Binder)
size() (java.util.ArrayList)
isAsynchronous() (android.os.Message)
max() (java.lang.Math)
dispatchMessage() (android.os.Handler)
restore() (android.os.ThreadLocalWorkSource)
setUid() (android.os.ThreadLocalWorkSource)
recycleUnchecked() (android.os.Message)
clearCallingIdentity() (android.os.Binder)
Studio:InputCon() ()
Binder:14026_1() ()
<native thread without managed peer>() ()
Binder:14026_3() ()
Studio:ActvtIni() ()
ReferenceQueueDaemon() ()
FinalizerDaemon() ()
HeapTaskDaemon() ()
9: Version Control
Terminal
Build
6: Logcat
Profiler
4: Run
TODO
Event Log
Layout Inspector
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
CPU
1:01 PM
theanswer (Google Pixel_2_API_30)
12 min 44 sec
Java Method Trace Recor...
00:00:00.000
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
<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
Name
Total (µs)
%
Self (µs)
%
Children ...
%
main() ()
dispatchMessage() (android.os.Handler)
handleMessage() (android.app.ActivityThread$H)
execute() (android.app.servertransaction.TransactionExecuto
executeCallbacks() (android.app.servertransaction.Transa
execute() (android.app.servertransaction.LaunchActivit
handleLaunchActivity() (android.app.ActivityThread
performLaunchActivity() (android.app.ActivityThr
callActivityOnCreate() (android.app.Instrume
performCreate() (android.app.Activity)
performCreate() (android.app.Activity)
onCreate() (course.examples.thear
findAnswer() (course.examples
d() (android.util.Log)
valueOf() (java.lang.Integer)
setContentView() (android.app.
findViewById() (android.app.Act
valueOf() (java.lang.String)
intValue() (java.lang.Integer)
Studio:InputCon() ()
<native thread without managed peer>() ()
80,000 100.00 0 0.00 80,000 100.00
80,000 100.00 0 0.00 80,000 100.00
80,000 100.00 0 0.00 80,000 100.00
80,000 100.00 0 0.00 80,000 100.00
80,000 100.00 0 0.00 80,000 100.00
80,000 100.00 0 0.00 80,000 100.00
80,000 100.00 0 0.00 80,000 100.00
80,000 100.00 0 0.00 80,000 100.00
80,000 100.00 0 0.00 80,000 100.00
80,000 100.00 0 0.00 80,000 100.00
80,000 100.00 72,129 90.16 7,871 9.84
207 0.26 70 0.09 137 0.17
125 0.16 27 0.03 98 0.12
12 0.02 12 0.02 0 0.00
7,176 8.97 10 0.01 7,166 8.96
278 0.35 26 0.03 252 0.32
196 0.25 17 0.02 179 0.22
14 0.02 14 0.02 0 0.00
80,000 100.00 20 0.03 79,980 99.98
80,000 100.00 80,000 100.00 0 0.00
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
Install successfully finished in 106 ms.: App restart successful without requiring a re-install. (22 minutes ago)
39:28 LF UTF-8 4 spaces Git: master

Layout Inspector

Shows the runtime organization of the user interface


Android Studio File Edit View Navigate Code Analyze Refactor Build Run Tools VCS Window Help
Mon 1:23 PM Adam A Porter
Tasks & Contexts
AVD Manager
SDK Manager
Resource Manager
Troubleshoot Device Connections
App Links Assistant
Firebase
Layout Inspector
Save as Live Template...
Generate JavaDoc...
IDE Scripting Console
Create Command-line Launcher...
XML Actions
JShell Console...
Groovy Console...
Kotlin
TheAnswer
Pixel 2 API 30
Git:
Android
app
manifests
java
course.examples.theanswer
TheAnswer
java (generated)
res
Gradle Scripts
TheAnswer.kt
package cour
import ...
class TheAns
companio
priv
priv
priv
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 }
TheAnswer › findAnswer()
9: Version Control
Terminal
Build
6: Logcat
Profiler
4: Run
TODO
Event Log
Layout Inspector
Install successfully finished in 106 ms.: App restart successful without requiring a re-install. (23 minutes 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 1:26 PM Adam A Porter
TheAnswer [~/git/CMSC436KotlinSampleCode/examples/TheAnswer] - .../app/src/main/java/course/examples/theanswer/TheAnswer.kt [app]
TheAnswer › app › src › main › java › course › examples › theanswer › TheAnswer
Android
app
manifests
java
course.examples.theanswer
TheAnswer
java (generated)
res
Gradle Scripts
TheAnswer.kt
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 }
TheAnswer › findAnswer()
Layout Inspector
Component Tree
theanswer
Live updates
Layer Spacing:
DecorView
decor_content_pa...
content - Frame...
RelativeLayout
text_view
answer_...
action_bar_co...
navigationBarBac...
statusBarBackgro...
TheAnswer
The answer to life, the universe and everything is:
TextView
42
Attributes
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
9: Version Control
Terminal
Build
6: Logcat
Profiler
4: Run
TODO
Event Log
Layout Inspector
Install successfully finished in 108 ms.: App restart successful without requiring a re-install. (a minute ago)
39:28 LF UTF-8 4 spaces Git: master

Next

Application Fundamentals

Example Applications

HelloWorld

TheAnswer