

PROGRAMMING HANDHELD SYSTEMS

ADAM PORTER

THREADS, ASYNCTASKS & HANDLERS

TODAY'S TOPICS

THREADING OVERVIEW
ANDROID'S UI THREAD
THE ASYNCTASK CLASS
THE HANDLER CLASS

WHAT IS A THREAD?

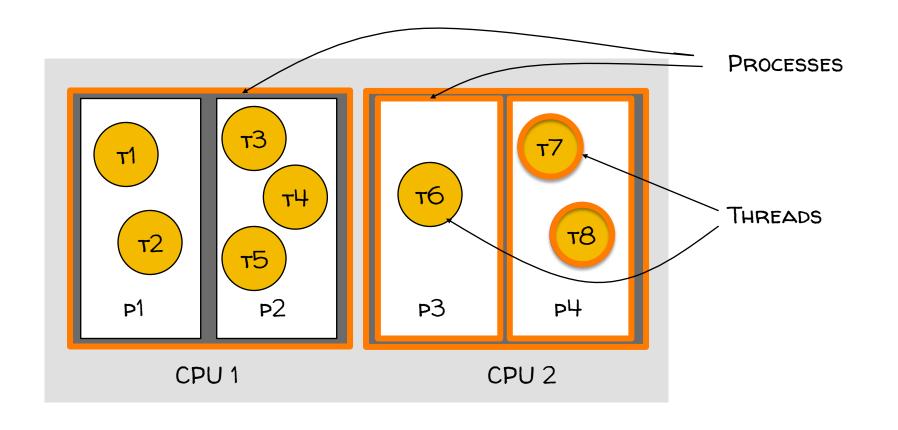
CONCEPTUAL VIEW

PARALLEL COMPUTATION RUNNING IN A PROCESS

IMPLEMENTATION VIEW

A PROGRAM COUNTER AND A STACK

WITH HEAP AND STATIC AREAS THAT ARE SHARED WITH OTHER THREADS



COMPUTING DEVICE

JAVA THREADS

REPRESENTED BY AN OBJECT OF TYPE JAVA.LANG.THREAD

THREADS IMPLEMENT THE RUNNABLE INTERFACE

void run()

SEE:

http://docs.oracle.com/javase/tutorial/essential/concurrency/threads.html

SOME THREAD METHODS

void start()
Starts the Thread
void sleep(long time)
SLEEPS FOR THE GIVEN PERIOD

SOME OBJECT METHODS

void wait()

CURRENT THREAD WAITS UNTIL ANOTHER THREAD INVOKES NOTIFY() ON THIS OBJECT

void notify()

WAKES UP A SINGLE THREAD THAT IS WAITING ON THIS OBJECT

BASIC THREAD USE CASE

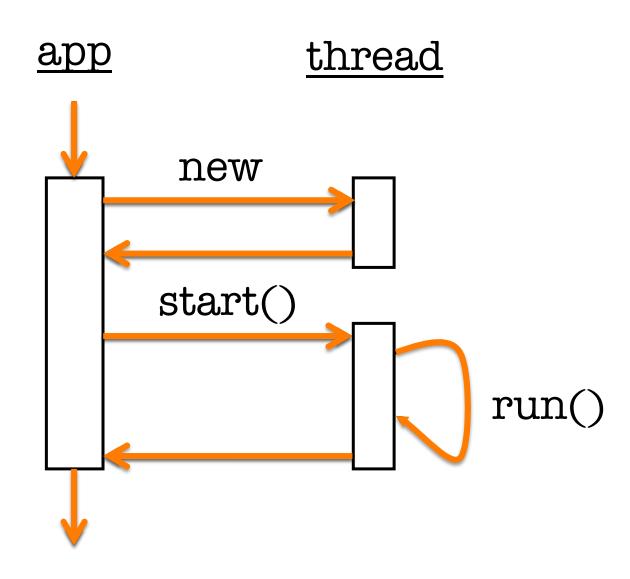
INSTANTIATE A THREAD OBJECT

INVOKE THE THREAD'S start() METHOD

THREAD'S run() METHOD GET CALLED

THREAD TERMINATES WHEN run() RETURNS

BASIC THREAD USE CASE



THREADINGNOTHREADING

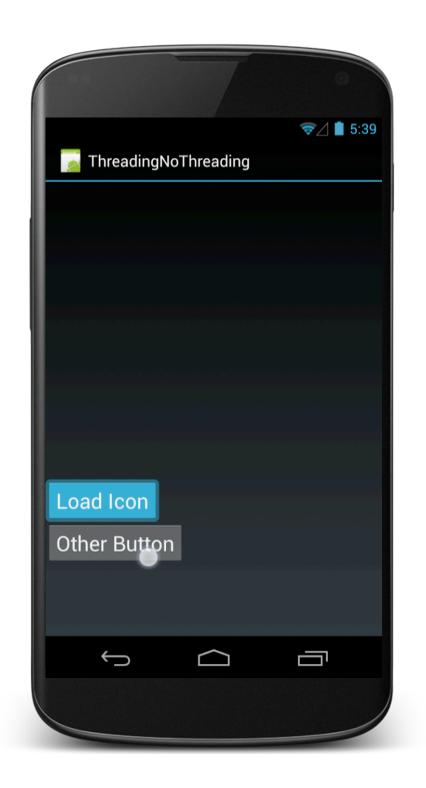
APPLICATION DISPLAYS TWO BUTTONS LOADICON

LOAD A BITMAP FROM A RESOURCE FILE & DISPLAY

SHOW LOADED BITMAP

OTHER BUTTON

DISPLAY SOME TEXT



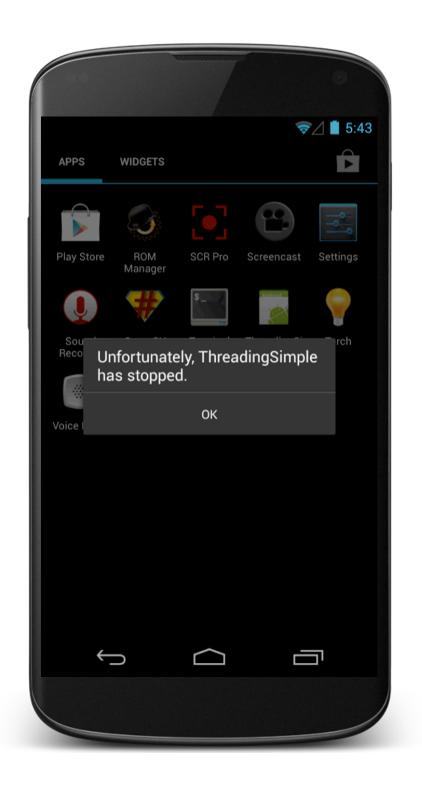
THREADINGSIMPLE

SEEMINGLY OBVIOUS, BUT INCORRECT, SOLUTION:
BUTTON LISTENER SPAWNS A SEPARATE
THREAD TO LOAD BITMAP & DISPLAY IT

THREADINGSIMPLE

```
public class SimpleThreadingExample extends Activity {
   private static final String TAG = "SimpleThreadingExample";
   private Bitmap mBitmap;
   private ImageView mIView;
    private int mDelay = 5000;
   @Override
    public void onCreate(Bundle savedInstanceState) {
        super.onCreate(savedInstanceState);
        setContentView(R.layout.main);
        mIView = (ImageView) findViewById(R.id.imageView);
        final Button loadButton = (Button) findViewById(R.id.loadButton);
        loadButton.setOnClickListener(new OnClickListener() {
            @Override
            public void onClick(View v) {
                loadIcon();
        });
        final Button otherButton = (Button) findViewById(R.id.otherButton);
        otherButton.setOnClickListener(new OnClickListener() {
            @Override
            public void onClick(View v) {
                Toast.makeText(SimpleThreadingExample.this, "I'm Working",
                        Toast.LENGTH SHORT).show();
       });
```

THREADINGSIMPLE



THE UI THREAD

APPLICATIONS HAVE A MAIN THREAD (THE UI THREAD)

APPLICATION COMPONENTS IN THE SAME PROCESS USE THE SAME UI THREAD

USER INTERACTION, SYSTEM CALLBACKS & LIFECYCLE METHODS HANDLED IN THE UI THREAD

IN ADDITION, UI TOOLKIT IS NOT THREAD-SAFE

IMPLICATIONS

BLOCKING THE UI THREAD HURTS APPLICATION RESPONSIVENESS

LONG-RUNNING OPERATIONS SHOULD RUN IN BACKGROUND THREADS

DON'T ACCESS THE UI TOOLKIT FROM A NON-UI THREAD

IMPROVED SOLUTION

NEED TO DO WORK IN A BACKGROUND THREAD, BUT UPDATE THE UI IN THE UI THREAD

ANDROID PROVIDES SEVERAL METHODS THAT ARE GUARANTEED TO RUN IN THE UI THREAD

boolean View.post (Runnable action)
void Activity.
runOnUiThread (Runnable action)



THREADINGVIEWPOST

```
@Override
public void onCreate(Bundle savedInstanceState) {
    super.onCreate(savedInstanceState);
    setContentView(R.layout.main);
    mImageView = (ImageView) findViewById(R.id.imageView);
    final Button button = (Button) findViewById(R.id.loadButton);
    button.setOnClickListener(new OnClickListener() {
        @Override
        public void onClick(View v) {
            loadIcon();
    });
    final Button otherButton = (Button) findViewById(R.id.otherButton);
    otherButton.setOnClickListener(new OnClickListener() {
        @Override
        public void onClick(View v) {
            Toast.makeText(SimpleThreadingViewPostActivity.this, "I'm Working",
                    Toast.LENGTH SHORT).show();
   });
```

THREADINGVIEWPOST

```
private void loadIcon() {
    new Thread(new Runnable() {
        @Override
        public void run() {
            try {
                Thread.sleep(mDelay);
            } catch (InterruptedException e) {
                e.printStackTrace();
            mBitmap = BitmapFactory.decodeResource(getResources(),
                    R.drawable.painter);
            mImageView.post(new Runnable() {
                @Override
                public void run() {
                    mImageView.setImageBitmap(mBitmap);
            });
   }).start();
```

PROVIDES A STRUCTURED WAY TO MANAGE WORK INVOLVING BACKGROUND & UI THREADS

BACKGROUND THREAD

PERFORMS WORK

INDICATES PROGRESS

UI THREAD

DOES SETUP

PUBLISHES INTERMEDIATE PROGRESS

USES RESULTS

```
GENERIC CLASS
 class AsyncTask<Params, Progress, Result> {
GENERIC TYPE PARAMETERS
  PARAMS - TYPE USED IN BACKGROUND
 WORK
  PROGRESS - TYPE USED WHEN INDICATING
 PROGRESS
  RESULT - TYPE OF RESULT
```

```
Void onPreExecute()

Runs in UI Thread before doInBackground()

Result

doInBackground (Params...params)

Performs work in background Thread

May call

void publishProgress(Progress... values)
```

```
void
onProgressUpdate (Progress... values)
Invoked in response to publishProgress()
void onPostExecute (Result result)
Runs after doInBackground()
```



THREADINGASYNCTASK

```
@Override
public void onCreate(Bundle savedInstanceState) {
    super.onCreate(savedInstanceState);
    setContentView(R.layout.main);
    mImageView = (ImageView) findViewById(R.id.imageView);;
    mProgressBar = (ProgressBar) findViewById(R.id.progressBar);
    final Button button = (Button) findViewById(R.id.loadButton);
    button.setOnClickListener(new OnClickListener() {
        public void onClick(View v) {
            new LoadIconTask().execute(R.drawable.painter);
    });
    final Button otherButton = (Button) findViewById(R.id.otherButton);
    otherButton.setOnClickListener(new OnClickListener() {
        @Override
        public void onClick(View v) {
            Toast.makeText(AsyncTaskActivity.this, "I'm Working",
                    Toast.LENGTH_SHORT).show();
    });
}
```

THREADINGASYNCTASK

```
class LoadIconTask extends AsyncTask<Integer, Integer, Bitmap> {
    @Override
    protected void onPreExecute() {
        mProgressBar.setVisibility(ProgressBar.VISIBLE);
    }
    @Override
    protected Bitmap doInBackground(Integer... resId) {
        Bitmap tmp = BitmapFactory.decodeResource(getResources(), resId[0]);
        // simulating long-running operation
        for (int i = 1; i < 11; i++) {
            sleep();
            publishProgress(i * 10);
        }
        return tmp;
    }
}</pre>
```

THREADINGASYNCTASK

```
@Override
protected void onProgressUpdate(Integer... values) {
    mProgressBar.setProgress(values[0]);
@Override
protected void onPostExecute(Bitmap result) {
    mProgressBar.setVisibility(ProgressBar.INVISIBLE);
    mImageView.setImageBitmap(result);
private void sleep() {
   try {
        Thread.sleep(mDelay);
    } catch (InterruptedException e) {
        Log.e(TAG, e.toString());
```

HANDLER

EACH HANDLER IS ASSOCIATED WITH A THREAD

ONE THREAD CAN HAND OFF WORK TO ANOTHER THREAD BY SENDING MESSAGES & POSTING RUNNABLES TO A HANDLER ASSOCIATED WITH THE OTHER THREAD

HANDLER^D

RUNNABLE

CONTAINS AN INSTANCE OF THE RUNNABLE INTERFACE

SENDER IMPLEMENTS RESPONSE

MESSAGE

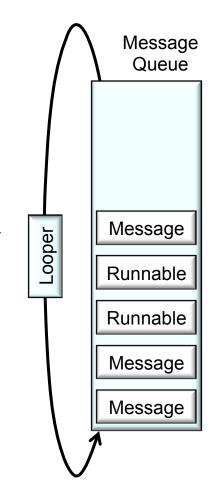
CAN CONTAIN A MESSAGE CODE, AN OBJECT & INTEGER ARGUMENTS

HANDLER IMPLEMENTS RESPONSE

HANDLER ARCHITECTURE

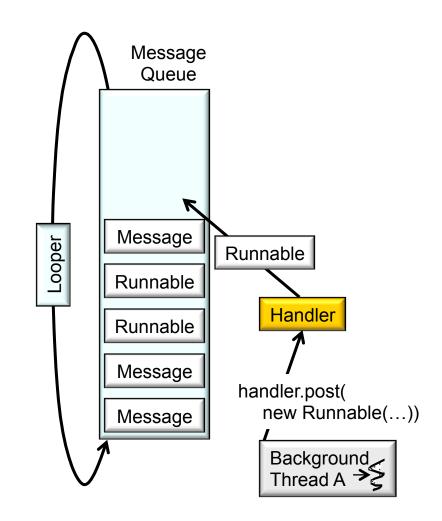
EACH ANDROID
THREAD IS
ASSOCIATED WITH A
MESSAGEQUEUE & A
LOOPER

A MESSAGEQUEUE
HOLDS MESSAGES
AND RUNNABLES TO
BE DISPATCHED BY
THE LOOPER



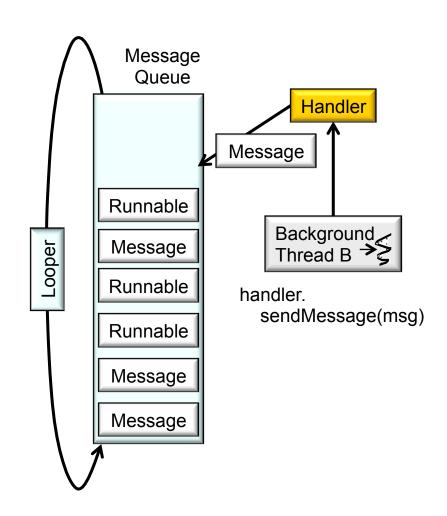
HANDLER ARCHITECTURE

ADD RUNNABLES TO MESSAGEQUEUE BY CALLING HANDLER'S post() METHOD



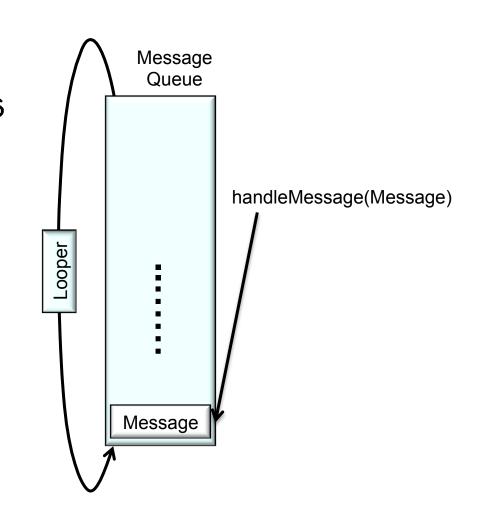
HANDLER ARCHITECTURE

ADD MESSAGES TO MESSAGEQUEUE BY CALLING HANDLER'S sendMessage() METHOD



HANDLER ARCHITECTURE

LOOPER DISPATCHES
MESSAGES BY
CALLING THE
HANDLER'S
handleMessage()
METHOD IN THE
MESSAGEQUEUE'S
THREAD



HANDLER ARCHITECTURE

Message Queue LOOPER DISPATCHES RUNNABLES BY CALLING THEIR run() METHOD IN THE Looper run() MESSAGEQUEUE'S THREAD Runnable

RUNNABLES & HANDLERS

```
boolean post(Runnable r)
  ADD RUNNABLE TO THE MESSAGEQUEUE
boolean
  postAtTime(Runnable r, long uptimeMillis)
  ADD RUNNABLE TO THE MESSAGEQUEUE. RUN AT A SPECIFIC
  TIME (BASED ON SystemClock.upTimeMillis())
boolean
  postDelayed(Runnable r, long delayMillis)
  ADD RUNNABLE TO THE MESSAGE QUEUE. RUN AFTER THE
  SPECIFIED AMOUNT OF TIME ELAPSES
```

MESSAGES & HANDLERS

CREATE MESSAGE & SET MESSAGE CONTENT

HANDLER.OBTAINMESSAGE()

MESSAGE.OBTAIN()

MESSAGE PARAMETERS INCLUDE

INT ARG1, ARG2, WHAT

OBJECT OBJ

BUNDLE DATA

MANY VARIANTS. SEE DOCUMENTATION

MESSAGES & HANDLERS

```
sendMessage()
 QUEUE MESSAGE NOW
sendMessageAtFrontOfQueue()
 INSERT MESSAGE NOW AT FRONT OF QUEUE
sendMessageAtTime()
 QUEUE MESSAGE AT THE STATED TIME
sendMessageDelayed()
 QUEUE MESSAGE AFTER DELAY
```

THREADINGHANDLERMESSAGES

```
static class UIHandler extends Handler {
    WeakReference<HandlerMessagesActivity> mParent;
    public UIHandler(WeakReference<HandlerMessagesActivity> parent) {
        mParent = parent;
    @Override
    public void handleMessage(Message msg) {
        HandlerMessagesActivity parent = mParent.get();
        if (null != parent) {
            switch (msg.what) {
            case SET PROGRESS BAR VISIBILITY: {
                parent.getProgressBar().setVisibility((Integer) msg.obj);
                break;
            case PROGRESS UPDATE: {
                parent.getProgressBar().setProgress((Integer) msg.obj);
                break;
            case SET BITMAP: {
                parent.getImageView().setImageBitmap((Bitmap) msg.obj);
                break;
Handler handler = new UIHandler(new WeakReference<HandlerMessagesActivity>(
        this));
```

THREADINGHANDLERMESSAGES

```
@Override
public void onCreate(Bundle savedInstanceState) {
    super.onCreate(savedInstanceState);
    setContentView(R.layout.main);
    mImageView = (ImageView) findViewById(R.id.imageView);
    mProgressBar = (ProgressBar) findViewById(R.id.progressBar);
    final Button button = (Button) findViewById(R.id.loadButton);
    button.setOnClickListener(new OnClickListener() {
        public void onClick(View v) {
            new Thread(new LoadIconTask(R.drawable.painter, handler))
                    .start();
    });
    final Button otherButton = (Button) findViewById(R.id.otherButton);
    otherButton.setOnClickListener(new OnClickListener() {
        @Override
        public void onClick(View v) {
            Toast.makeText(HandlerMessagesActivity.this, "I'm Working",
                    Toast.LENGTH SHORT).show();
    });
```

THREADINGHANDLERMESSAGES

```
private class LoadIconTask implements Runnable {
    private final int resId;
    private final Handler handler;
    LoadIconTask(int resId, Handler handler) {
        this.resId = resId;
        this.handler = handler;
    public void run() {
        Message msg = handler.obtainMessage(SET_PROGRESS_BAR_VISIBILITY,
                ProgressBar. VISIBLE);
        handler.sendMessage(msg);
        final Bitmap tmp = BitmapFactory.decodeResource(getResources(),
                resId);
        for (int i = 1; i < 11; i++) {
            sleep();
            msg = handler.obtainMessage(PROGRESS_UPDATE, i * 10);
            handler.sendMessage(msg);
        msg = handler.obtainMessage(SET_BITMAP, tmp);
        handler.sendMessage(msg);
        msg = handler.obtainMessage(SET PROGRESS BAR VISIBILITY,
                ProgressBar.INVISIBLE);
        handler.sendMessage(msg);
    private void sleep() {
        try {
            Thread.sleep(mDelay);
        } catch (InterruptedException e) {
            e.printStackTrace();
```

THREADINGHANDLERRUNNABLE

```
@Override
public void onCreate(Bundle savedInstanceState) {
    super.onCreate(savedInstanceState);
    setContentView(R.layout.main);
    mImageView = (ImageView) findViewById(R.id.imageView);
   mProgressBar = (ProgressBar) findViewById(R.id.progressBar);
    final Button button = (Button) findViewById(R.id.loadButton);
    button.setOnClickListener(new OnClickListener() {
        public void onClick(View v) {
            new Thread(new LoadIconTask(R.drawable.painter)).start();
    });
    final Button otherButton = (Button) findViewById(R.id.otherButton);
    otherButton.setOnClickListener(new OnClickListener() {
       @Override
        public void onClick(View v) {
            Toast.makeText(HandlerRunnableActivity.this, "I'm Working",
                    Toast.LENGTH SHORT).show();
   });
```

THREADINGHANDLERRUNNABLE

```
private class LoadIconTask implements Runnable {
    int resId;
    LoadIconTask(int resId) {
        this.resId = resId;
    public void run() {
        handler.post(new Runnable() {
            @Override
            public void run() {
                mProgressBar.setVisibility(ProgressBar.VISIBLE);
        });
        mBitmap = BitmapFactory.decodeResource(getResources(), resId);
        // Simulating long-running operation
        for (int i = 1; i < 11; i++) {
            sleep();
            final int step = i;
            handler.post(new Runnable() {
                @Override
                public void run() {
                    mProgressBar.setProgress(step * 10);
            });
        }
        handler.post(new Runnable() {
            @Override
            public void run() {
                mImageView.setImageBitmap(mBitmap);
        });
        handler.post(new Runnable() {
            @Override
            public void run() {
                mProgressBar.setVisibility(ProgressBar.INVISIBLE);
       });
```

NEXT TIME

ALARMS