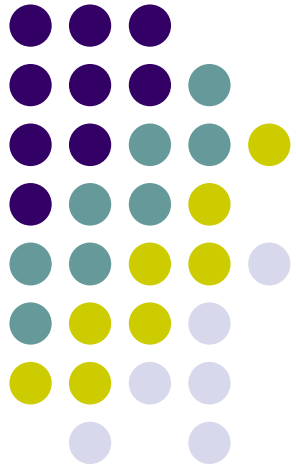
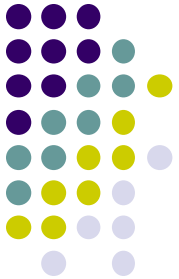
CS 528 Mobile and Ubiquitous Computing

Lecture 4b: Face Detection, recognition, interpretation + SQLite Databases

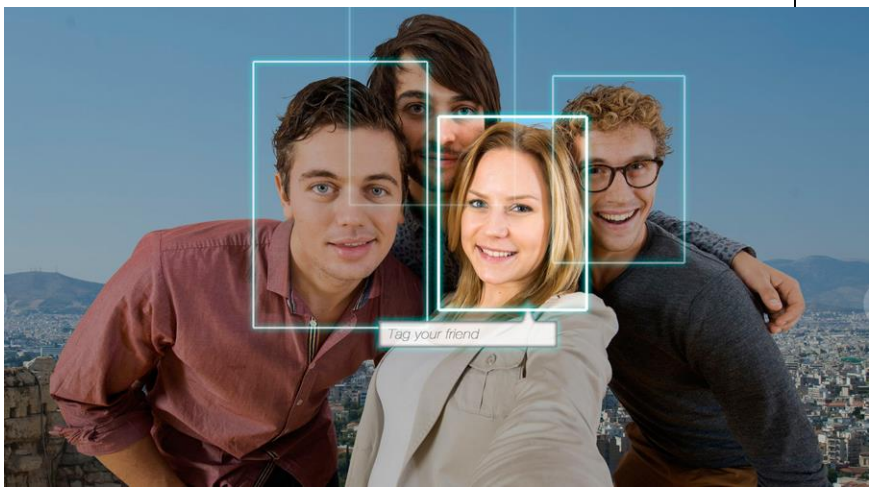
Emmanuel Agu





Face Recognition

Face Recognition



- Answers the question:

Who is this person in this picture?

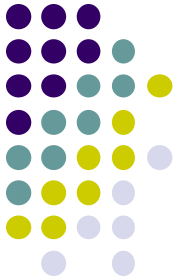
Example answer: John Smith

- Compares unknown face to database of faces with known identity
- Neural networks/deep learning now makes comparison faster

FindFace App: Stalking on Steroids?

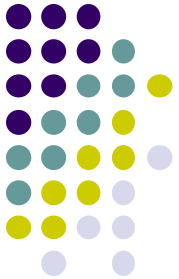
- See stranger you like? Take a picture
- App searches 1 billion pictures using neural networks < 1 second
- Finds person's picture, identity, link on VK (Russian Facebook)
  - You can send friend Request
- ~ 70% accurate!
- Can also upload picture of celebrity you like
- Finds 10 strangers on Facebook who look similar, can send friend request

FindFace App



- Also used in law enforcement
  - Police identify criminals on watchlist

Ref: http://www.computerworld.com/article/3071920/data-privacy/face-recognition-app-findface-may-make-you-want-to-take-down-all-your-online-photos.html

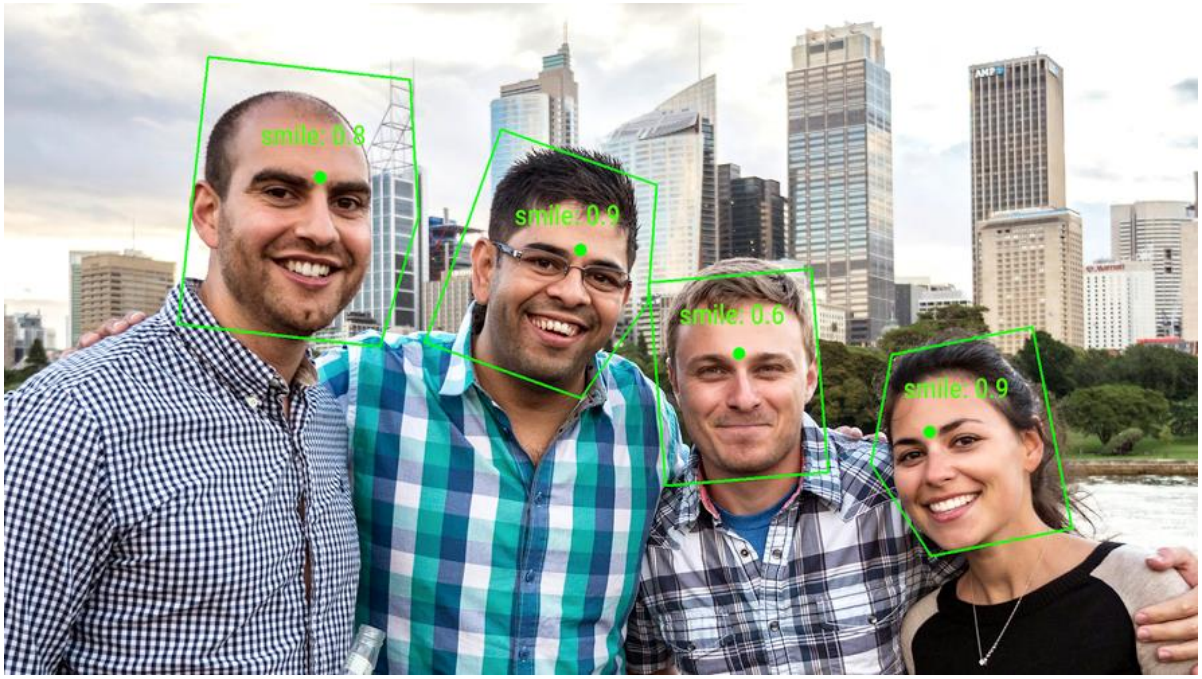


Face Detection

Mobile Vision API

https://developers.google.com/vision/

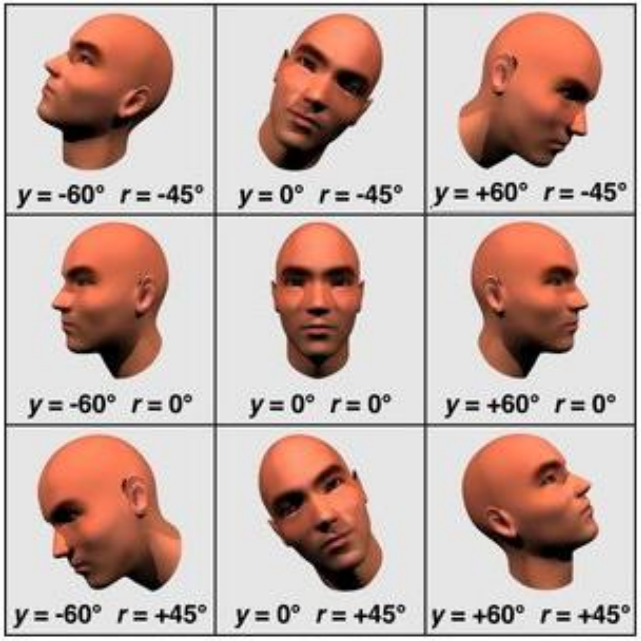
- **Face Detection:** Are there [any] faces in this picture?
- **How?** Locate face in photos and video and
  - **Facial landmarks:** Eyes, nose and mouth
  - **State of facial features:** Eyes open? Smiling?



Face Detection: Google Mobile Vision API

Ref: https://developers.google.com/vision/face-detection-concepts

- Detects faces:
  - reported at a position, with size and orientation
  - Can be searched for landmarks (e.g. eyes and nose)

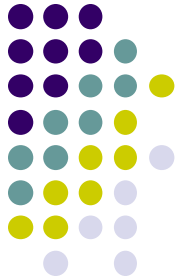


Orientation

Landmarks

Euler Y angle	detectable landmarks
< -36 degrees	left eye, left mouth, left ear, nose base, left cheek
-36 degrees to -12 degrees	left mouth, nose base, bottom mouth, right eye, left eye, left cheek, left ear tip
-12 degrees to 12 degrees	right eye, left eye, nose base, left cheek, right cheek, left mouth, right mouth, bottom mouth
12 degrees to 36 degrees	right mouth, nose base, bottom mouth, left eye, right eye, right cheek, right ear tip
> 36 degrees	right eye, right mouth, right ear, nose base, right cheek

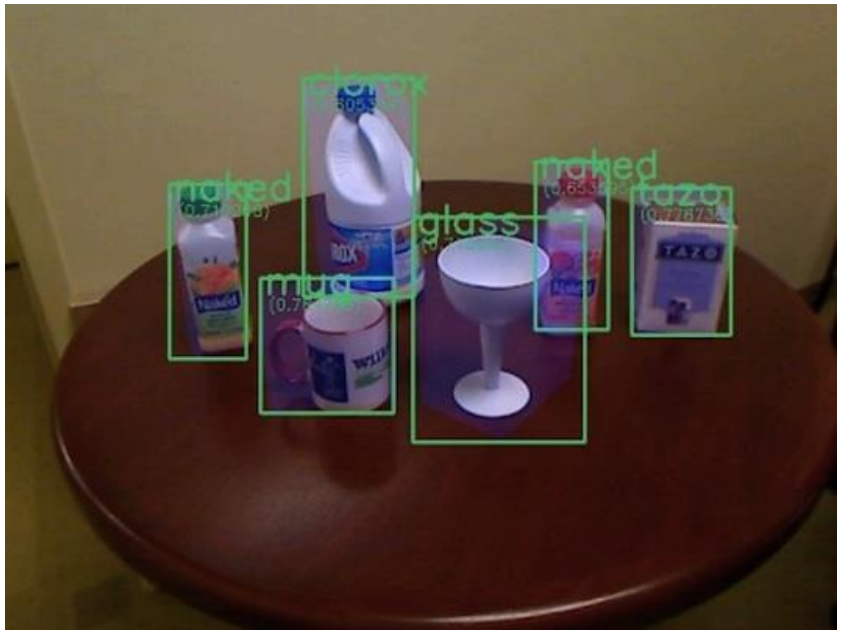
Google Mobile Vision API



- Mobile Vision API also does:
  - **Face tracking:** detects faces in consecutive video frames
  - **Classification:** Eyes open? Face smiling?
- Classification:
  - Determines whether a certain facial characteristic is present
  - API currently supports 2 classifications: eye open, smiling
  - Results expressed as a confidence that a facial characteristic is present
    - Confidence > 0.7 means facial characteristic is present
    - E.g. > 0.7 confidence means likely person is smiling
- Mobile vision API does face **detection** but NOT **recognition**

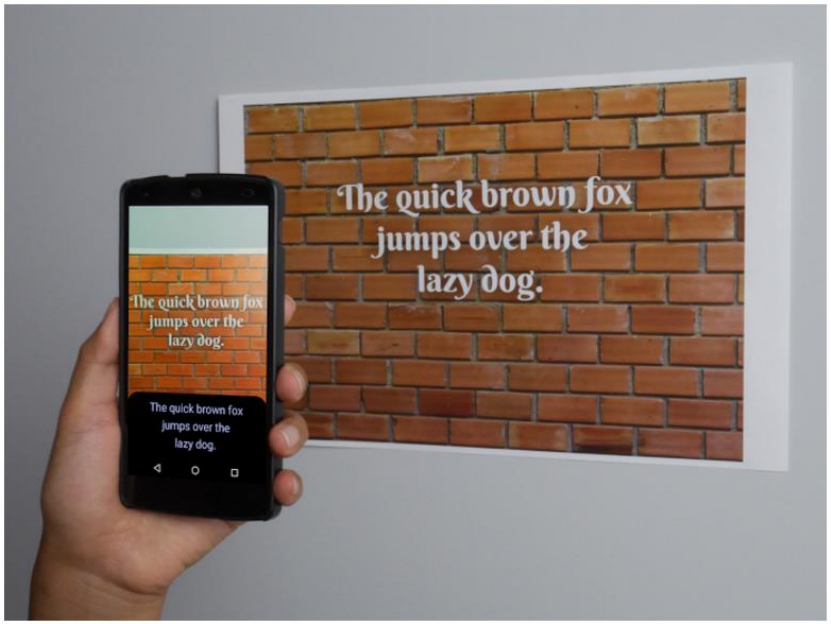
Face Detection

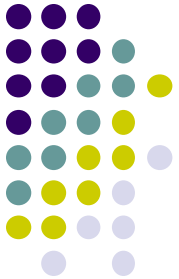
- **Face detection:** Special case of object-class detection
- **Object-class detection task:** find locations and sizes of all objects in an image that belong to a given class.
  - E.g: bottles, cups, pedestrians, and cars
- **Object matching:** Objects in picture compared to objects in database of labelled pictures



Mobile Vision API: Other Functionality

- Barcode scanner
- Recognize text

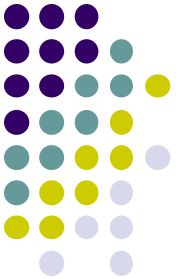




Face Detection Using Google's Mobile Vision API

Getting Started with Mobile Vision Samples

https://developers.google.com/vision/android/getting-started



- Get **Android Play Services SDK** level 26 or greater
- Download mobile vision samples from github

Sample code for the Android Mobile Vision API. https://developers.google.com/vision/

47 commits | 1 branch | 0 rel

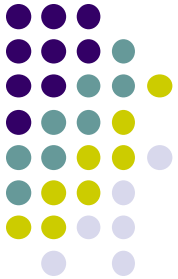
Branch: master | New pull request | New file | Find file | HTTPS

claywilkinson Merge branch 'master' into github_live ...

.google	Adding initial facetracker sample.
visionSamples	merging github changes to internal repo.
.gitignore	Adding barcode-reader sample.
LICENSE	Adding initial facetracker sample.
README.md	Manual merge of github pull requests.

Creating the Face Detector

Ref: https://developers.google.com/vision/android/detect-faces-tutorial



- In app's **onCreate** method, create face detector

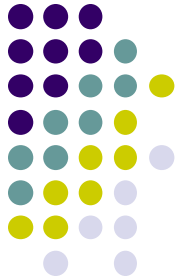
```
FaceDetector detector = new FaceDetector.Builder(context)
    .setTrackingEnabled(false)
    .setLandmarkType(FaceDetector.ALL_LANDMARKS)
    .build();
```

Don't track points

Detect all landmarks

- **detector** is base class for implementing specific detectors. E.g. face detector, bar code detector
- Tracking finds same points in multiple frames (continuous)
- Detection works best in single images when **trackingEnabled** is false

Detecting Faces and Facial Landmarks



- Create Frame (image data, dimensions) instance from bitmap supplied

```
Frame frame = new Frame.Builder().setBitmap(bitmap).build();
```

- Call detector synchronously with frame to detect faces

```
SparseArray<Face> faces = detector.detect(frame);
```

- Detector takes **Frame** as input, outputs array of **Faces** detected
- **Face** is a single detected human face in image or video
- Iterate over array of faces, landmarks for each face, and draw the result based on each landmark position

```
for (int i = 0; i < faces.size(); ++i) {
    Face face = faces.valueAt(i);
    for (Landmark landmark : face.getLandmarks()) {
        int cx = (int) (landmark.getPosition().x * scale);
        int cy = (int) (landmark.getPosition().y * scale);
        canvas.drawCircle(cx, cy, 10, paint);
    }
}
```

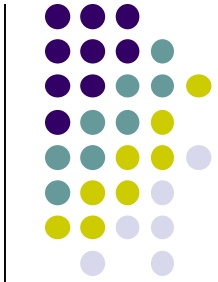
Iterate through face array

Get face at position i in Face array

Return list of face landmarks (e.g. eyes, nose)

Returns landmark's (x, y) position where (0, 0) is image's upper-left corner

Other Stuff



- To count faces detected, call **faces.size( )**. E.g.

```
TextView faceCountView = (TextView) findViewById(R.id.face_count);
faceCountView.setText(faces.size() + " faces detected");
```

- Querying Face detector's status

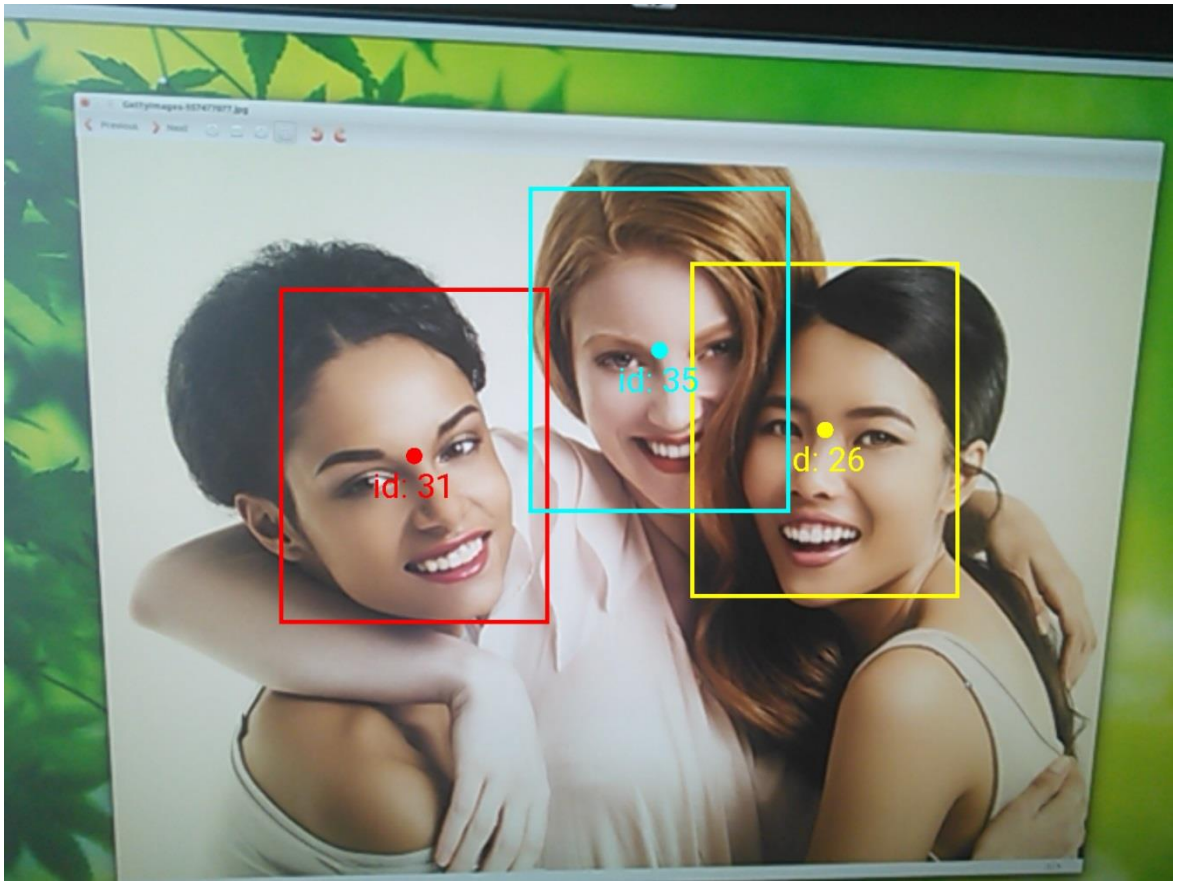
```
if (!detector.isOperational()) {
    // ...
}
```

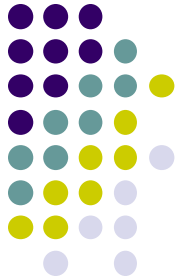
- Releasing Face detector (frees up resources)

```
detector.release();
```

Detect & Track Multiple Faces in Video

- Can also track multiple faces in image sequences/video, draw rectangle round each one

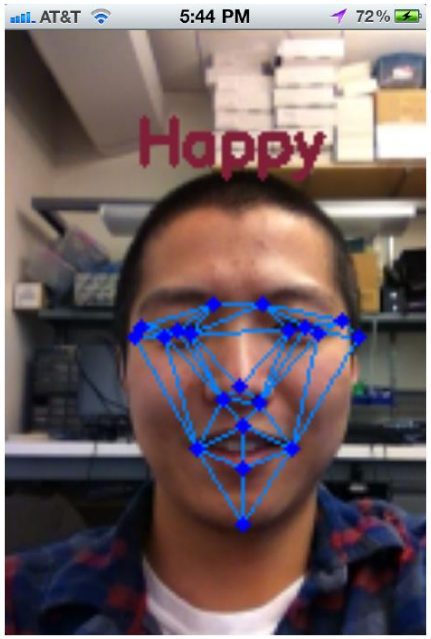




Face Interpretation

Visage Face Interpretation Engine

- Real-time face interpretation engine for smart phones
  - Tracking user's 3D head orientation + facial expression

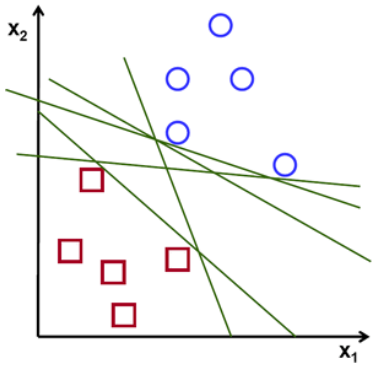


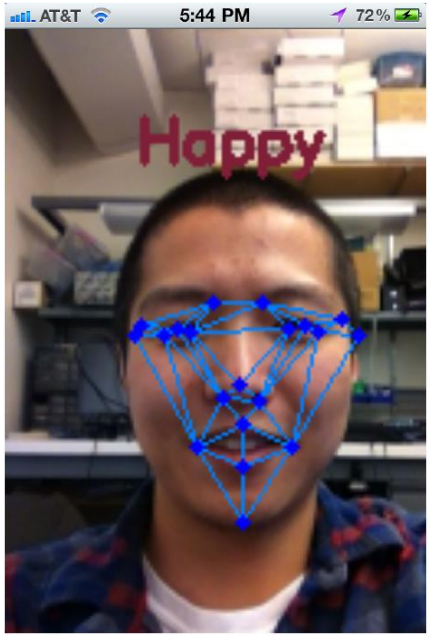
- Facial expression?
  - angry, disgust, fear, happy, neutral, sad, surprise
  - Use? Can be used in Mood Profiler app

Yang, Xiaochao, et al. "Visage: A face interpretation engine for smartphone applications." *Mobile Computing, Applications, and Services Conference*. Springer Berlin Heidelberg, 2012. 149-168.

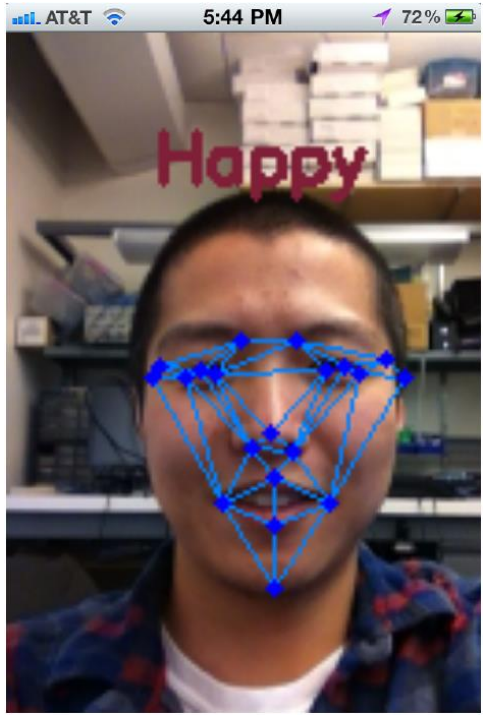
Facial Expression Inference

- Active appearance model
  - Describes 2D image as triangular mesh of landmark points
- 7 expression classes: angry, disgust, fear, happy, neutral, sad, surprise
- Extract triangle shape, texture features
- Classify features using Machine learning

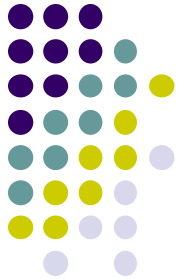




Classification Accuracy



Expressions	Anger	Disgust	Fear	Happy	Neutral	Sadness	Surprise
Accuracy(%)	82.16	79.68	83.57	90.30	89.93	73.24	87.52

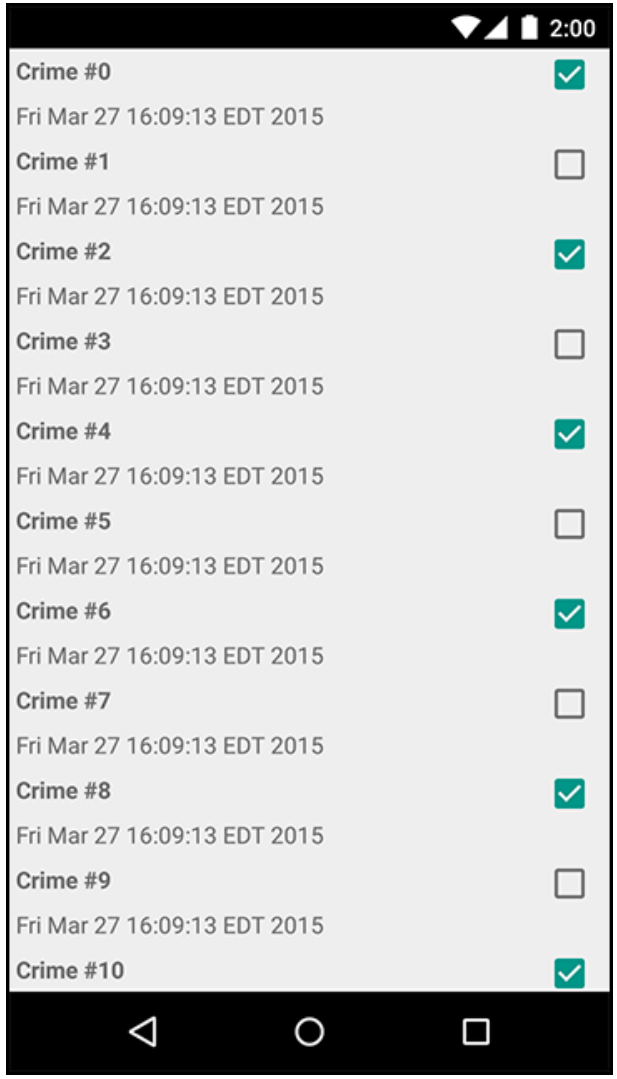


Skipped Android Nerd Ranch CriminalIntent Chapters

Chapter 9: Displaying Lists with RecyclerView

- RecyclerView facilitates view of large dataset

- E.g Allows crimes in **CriminalIntent** to be listed

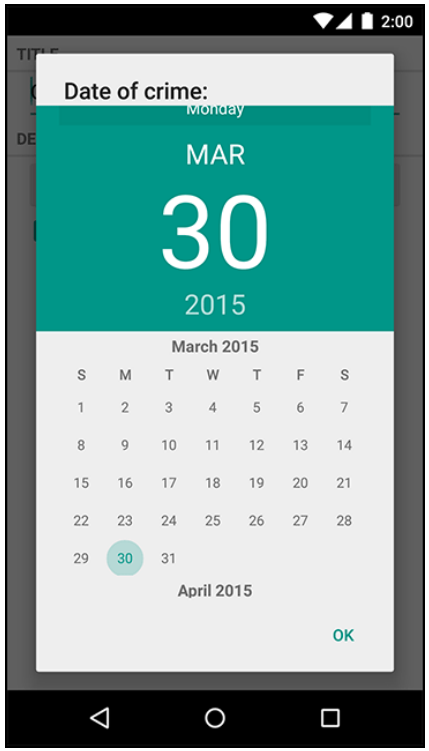


Chapter 11: Using ViewPager

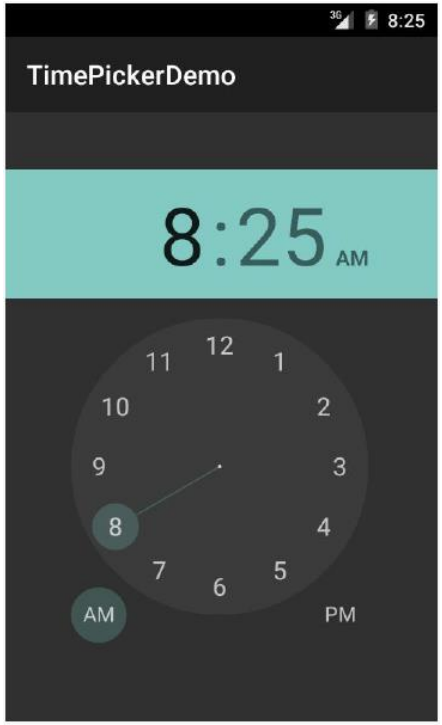
- ViewPager allows users swipe between screens (e.g. Tinder?)
- E.g. Users swipe between Crimes in CriminalIntent

Chapter 12: Dialogs

- Dialogs present users with a choice or important information
- DatePicker allows users pick date
- Users can pick a date on which a crime occurred in **CriminalIntent**



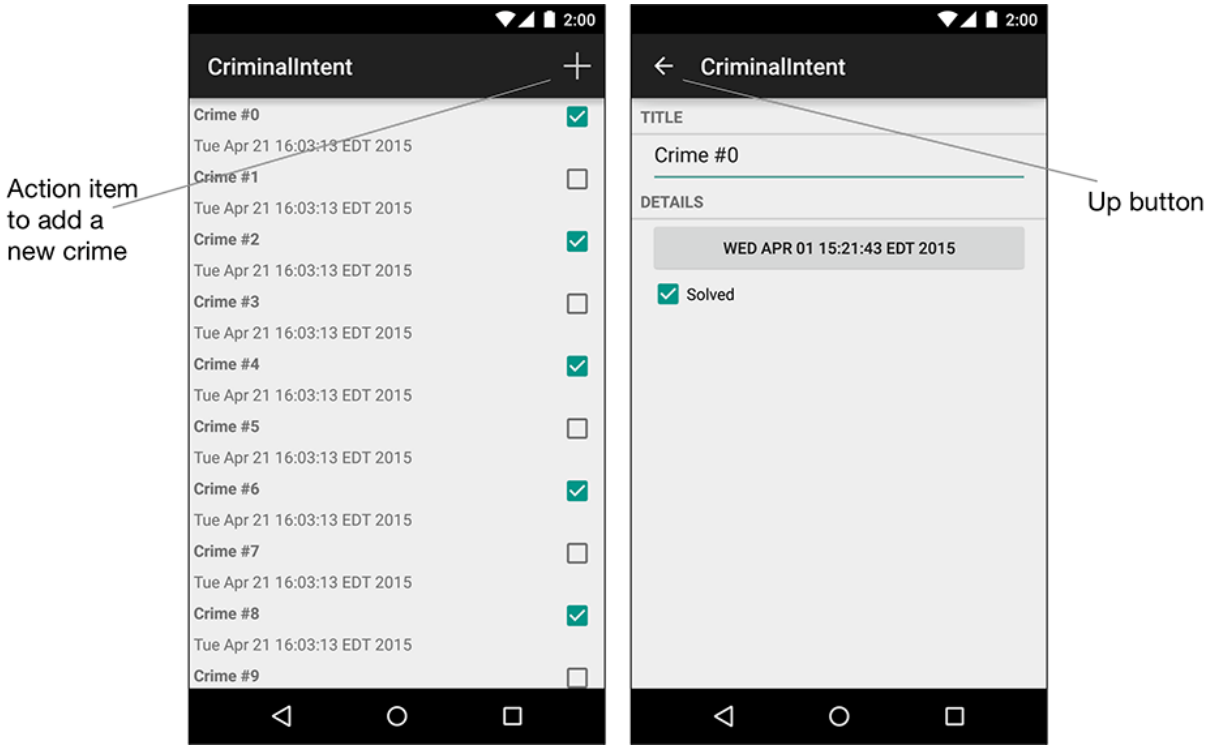
DatePicker

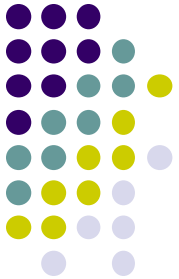


TimePicker

Chapter 13: The Toolbar

- Toolbar includes actions user can take
- In CriminalIntent, menu items for adding crime, navigate up the screen hierarchy

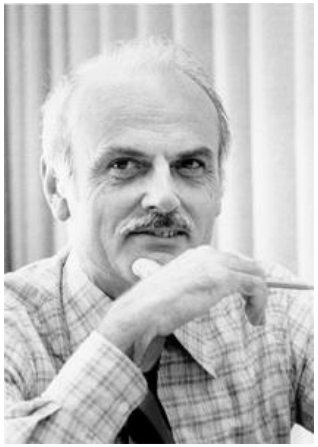




Android Nerd Ranch Ch 14
SQLite Databases

Background on Databases

- Relational DataBase Management System (RDBMS)
  - Introduced by E. F. Codd (Turing Award Winner)



- Relational Database
  - data stored in tables
  - relationships among data stored in tables
  - data can be accessed and viewed in different ways

Example Wines Database

- **Relational Data:** Data in different tables can be related

Winery Table

Winery ID	Winery name	Address	Region ID
1	Moss Brothers	Smith Rd.	3
2	Hardy Brothers	Jones St.	1
3	Penfolds	Arthurton Rd.	1
4	Lindemans	Smith Ave.	2
5	Orlando	Jones St.	1

Region Table

Region ID	Region name	State
1	Barossa Valley	South Australia
2	Yarra Valley	Victoria
3	Margaret River	Western Australia

Ref: Web Database Applications with PHP and MySQL, 2nd Edition , by Hugh E. Williams, David Lane

Keys

- Each table has a key
- **Key:** column used to uniquely identify each row

KEYS

Winery Table

Winery ID	Winery name	Address	Region ID
1	Moss Brothers	Smith Rd.	3
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Region Table

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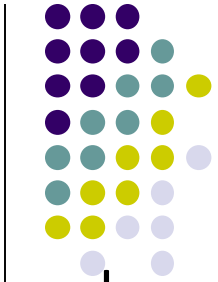
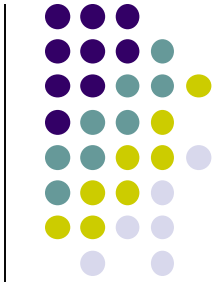
SQL and Databases



- **SQL:** language used to manipulate information in a Relational Database Management System (RDBMS)
- SQL Commands:
  - **CREATE TABLE** - creates new database table
  - **ALTER TABLE** - alters a database table
  - **DROP TABLE** - deletes a database table
  - **SELECT** - get data from a database table
  - **UPDATE** - change data in a database table
  - **DELETE** - remove data from a database table
  - **INSERT INTO** - insert new data in a database table

CriminalIntent Database



- **SQLite:** open source relational database
- SQLite implements subset (most but not all) of SQL
  - http://www.sqlite.org/
- Android includes SQLite database
- **Goal:** Store crimes in CriminalIntent in SQLite database
- First step, define database table of **crimes**

_id	uuid	title	date	solved
1	13090636733242	Stolen yogurt	13090636733242	0
2	13090732131909	Dirty sink	13090732131909	1

CriminalIntent Database

- Create **CrimeDbSchema** class to store **crime** database
- Define columns of the Crimes database table

```
public class CrimeDbSchema {
    public static final class CrimeTable {
        public static final String NAME = "crimes";

        public static final class Cols {
            public static final String UUID = "uuid";
            public static final String TITLE = "title";
            public static final String DATE = "date";
            public static final String SOLVED = "solved";
        }
    }
}
```

Name of Table

_id	uuid	title	date	solved
1	13090636733242	Stolen yogurt	13090636733242	0
2	13090732131909	Dirty sink	13090732131909	1

SQLiteOpenHelper

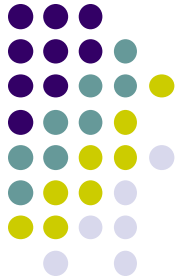
- **SQLiteOpenHelper** class used for database creation, opening and updating
- In **CriminalIntent**, create subclass of **SQLiteOpenHelper** called **CrimeBaseHelper**

```
public class CrimeBaseHelper extends SQLiteOpenHelper {
    private static final int VERSION = 1;
    private static final String DATABASE_NAME = "crimeBase.db";

    public CrimeBaseHelper(Context context) {
        super(context, DATABASE_NAME, null, VERSION);
    }


    @Override
    public void onCreate(SQLiteDatabase db) {

    }

    @Override
    public void onUpgrade(SQLiteDatabase db, int oldVersion, int newVersion) {

    }
}
```

Used to create the database (to store Crimes)

Called the first time database is created

Use CrimeBaseHelper to open SQLite Database

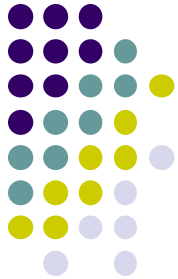


```
public class CrimeLab {
    private static CrimeLab sCrimeLab;

    private List<Crime> mCrimes;
    private Context mContext;
    private SQLiteDatabase mDatabase;

    ...

    private CrimeLab(Context context) {
      mContext = context.getApplicationContext();
      mDatabase = new CrimeBaseHelper(mContext)
              .getWritableDatabase();
      mCrimes = new ArrayList<>();
    }

    ...
```

Store instance of context in variable. Will need it later

Opens new writeable Database

Create CrimeTable in onCreate( )



onCreate called first time database is created

```
@Override
public void onCreate(SQLiteDatabase db) {
    db.execSQL("create table " + CrimeTable.NAME + "(" +
            " _id integer primary key autoincrement, " +
            CrimeTable.Cols.UUID + ", " +
            CrimeTable.Cols.TITLE + ", " +
            CrimeTable.Cols.DATE + ", " +
            CrimeTable.Cols.SOLVED +
            ")"
    );
}
```

Create CrimeTable in our new Crimes Database

Writing Crimes to Database using ContentValues

- In Android, writing to databases is done using class **ContentValues**
- **ContentValues** is key-value pair
- Create method to create **ContentValues** instance from a **Crime**

```
    public getCrime(UUID id) {
        return null;
    }

    private static ContentValues getContentValues(Crime crime) {
        ContentValues values = new ContentValues();
        values.put(CrimeTable.Cols.UUID, crime.getId().toString());
        values.put(CrimeTable.Cols.TITLE, crime.getTitle());
        values.put(CrimeTable.Cols.DATE, crime.getDate().getTime());
        values.put(CrimeTable.Cols.SOLVED, crime.isSolved() ? 1 : 0);

        return values;
    }
}
```

Takes Crime as input

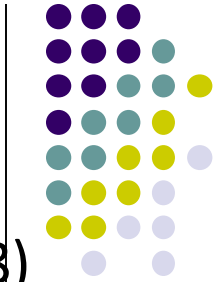
key

value

Converts Crime to ContentValues

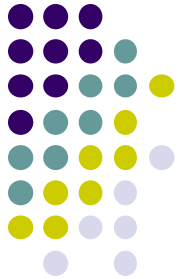
Returns values as output

Quiz 2



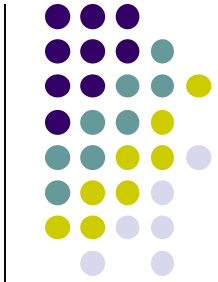
- Quiz in class next Thursday (First 20 mins of class Thur, 9/28)
- Short answer questions
- Try to focus on understanding, not memorization
- Covers:
  - Lecture slides for lectures 3a,3b,4a,4b
  - Project 1
  - 2 code examples from **Android Nerd Ranch (2nd edition)**
    - geoQuiz Second Activity Example (Ch 5)
    - CriminalIntent Example (Ch 16)

Project 2



- Project 1 is now due 6pm on Monday, September 25
- Project 2 will be emailed out (URL) on Monday, September 25

References



- Google Mobile Vision API, https://developers.google.com/vision/
- Camera “Taking Photos Simply” Tutorials, http://developer.android.com/training/camera/photobasics.html
- Busy Coder’s guide to Android version 6.3
- CS 65/165 slides, Dartmouth College, Spring 2014
- CS 371M slides, U of Texas Austin, Spring 2014