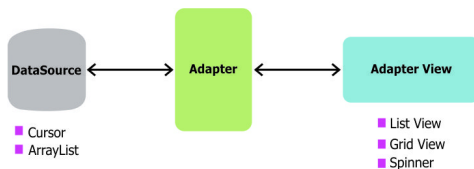


# Using an ArrayAdapter with ListView

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In Android development, any time we want to show a vertical list of scrollable items we will use a `ListView` which has data populated using an `Adapter`. The simplest adapter to use is called an `ArrayAdapter` because the adapter converts an `ArrayList` of objects into `View` items loaded into the `ListView` container.



The `ArrayAdapter` fits in between an `ArrayList` (data source) and the `ListView` (visual representation) and configures two aspects:

- Which array to use as the data source for the list
- How to convert any given item in the array into a corresponding `View` object

Note as shown above that there are other data sources besides an `ArrayAdapter` such as the `CursorAdapter` which instead binds directly to a result set from a [Local SQLite Database](#).

## Row View Recycling

When using an adapter and a `ListView`, we need to make sure to understand how view recycling works.

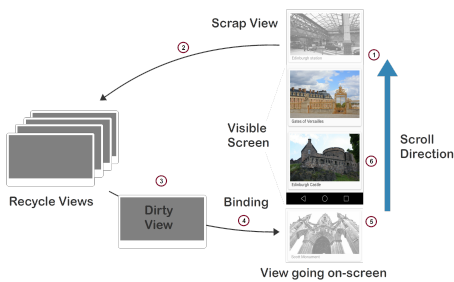
When your `ListView` is connected to an adapter, the adapter will instantiate rows until the `ListView` has been fully populated with enough items to fill the full height of the list. At that point, no additional row items are created in memory.

Instead, as the user scrolls through the list, **items that leave the screen are kept in memory for later use** and then every new row that enters the screen **reuses an older row**

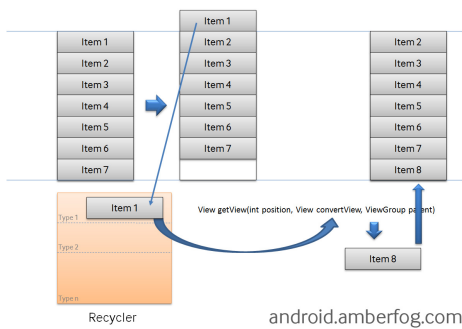
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**kept around in memory.** In this way, even for a list of 1000 items, only ~7 item view rows are ever instantiated or held in memory. Here is a visual overview of recycling:



Here is another related diagram on view recycling:



Refer to [this ListView guide](#) for another look at how this works to optimize the performance of your lists. Be sure to check out [this Udacity video on view recycling](#) as well. If you wish to evaluate how fast your ListView is rendering, check out the [Profiling GPU](#) tool, which provides a graphical way of visualizing the layout performance.

## Using a Basic ArrayAdapter

To use a basic `ArrayAdapter`, you just need to initialize the adapter and attach the adapter to the `ListView`. First, we initialize the adapter:

```
ArrayAdapter<String> itemsAdapter =
    new ArrayAdapter<String>(this, and
```

The `ArrayAdapter` requires a declaration of the type of the item to be converted to a `View` (a `String` in this case) and then accepts three arguments: `context` (activity instance), XML item layout, and the array of data. Note that we've chosen `simple_list_item_1.xml` which is a simple `TextView` as the layout for each of the items.

Now, we just need to connect this adapter to a `ListView` to be populated:

```
ListView listView = (ListView) findView  
listView.setAdapter(itemsAdapter);
```

By default, this will now convert each item in the data array into a view by calling `toString` on the item and then assigning the result as the value of a `TextView` (`simple_list_item_1.xml`) that is displayed as the row for that data item. If the app requires a more complex translation between item and `View` then we need to create a custom `ArrayAdapter` instead.

## Using a Custom ArrayAdapter

When we want to display a series of items into a list using a custom representation of the items, we need to use our own custom XML layout for each item. To do this, we need to create our own custom `ArrayAdapter` class. See [this repo for the source code](#). First, we often need to define a model to represent the data within each list item.

### Defining the Model

Given a Java object that has certain fields defined such as a `User` class:

```
public class User {  
    public String name;  
    public String hometown;  
  
    public User(String name, String ho  
        this.name = name;  
        this.hometown = hometown;  
    }  
}
```

We can create a custom `ListView` of `User` objects by subclassing `ArrayAdapter` to describe how to translate the object into a view within that class and then using it like any other adapter.

### Creating the View Template

Next, we need to create an XML layout that represents the view template for each item in `res/layout/item_user.xml` :

```
<LinearLayout xmlns:android="http://sc  
    android:layout_width="match_parent"  
    android:layout_height="match_parent"  
    <TextView  
        android:id="@+id/tvName"  
        android:layout_width="wrap_conte  
        android:layout_height="wrap_cont  
        android:text="Name" />
```

```

<TextView
    android:id="@+id/tvHome"
    android:layout_width="wrap_conte
    android:layout_height="wrap_cont
    android:text="HomeTown" />
</LinearLayout>

```

## Defining the Adapter

Next, we need to define the adapter to describe the process of converting the Java object to a View (in the `getView` method). The naive approach to this (without any view caching) looks like the following:

```

public class UsersAdapter extends Arra
    public UsersAdapter(Context contex
        super(context, 0, users);
    }

    @Override
    public View getView(int position,
        // Get the data item for this po
        User user = getItem(position);
        // Check if an existing view is
        if (convertView == null) {
            convertView = LayoutInflater
        }
        // Lookup view for data populati
        TextView tvName = (TextView) co
        TextView tvHome = (TextView) co
        // Populate the data into the te
        tvName.setText(user.name);
        tvHome.setText(user.hometown);
        // Return the completed view to
        return convertView;
    }
}

```

That adapter has a constructor and a `getView()` method to describe the **translation between the data item and the View** to display.

`getView()` is the method that returns the actual view used as a row within the `ListView` at a particular position. Another method used is `getItem()` which is already present in the `ArrayAdapter` class and its task is to simply get the data item associated with the specified `position` in the data set which is associated with that `ArrayAdapter`.

## Attaching the Adapter to a ListView

Now, we can use that adapter in the Activity to display an array of items into the `ListView`:

```

// Construct the data source
ArrayList<User> arrayOfUsers = new Arr
// Create the adapter to convert the ar
UsersAdapter adapter = new UsersAdapte
// Attach the adapter to a ListView

```

```

ListView listView = (ListView) findView
listView.setAdapter(adapter);

```

At this point, the ListView is now successfully bound to the users array data.

## Populating Data into ListView

Once the adapter is attached, items will automatically be populated into the ListView based on the contents of the array. You can add new items to the adapter at any time with:

```

// Add item to adapter
User newUser = new User("Nathan", "San
adapter.add(newUser);
// Or even append an entire new collect
// Fetching some data, data has now ret
// If data was JSON, convert to ArrayLi
JSONArray jsonArray = ...;
ArrayList<User> newUsers = User.fromJson
adapter.addAll(newUsers);

```

which will append the new items to the list. You can also clear the entire list at any time with:

```

adapter.clear();

```

Using the adapter now, you can add, remove and modify users and the items within the ListView will automatically reflect any changes.

## Constructing Models from External Source

In order to create model instances, you will likely be loading the data from an external source (i.e database or REST JSON API), so you should create two additional methods in each model to allow for construction of a list or a singular item **if the data is coming from a JSON API**:

```

public class User {
    // Constructor to convert JSON obje
    public User(JSONObject object){
        try {
            this.name = object.getStri
            this.hometown = object.get
        } catch (JSONException e) {
            e.printStackTrace();
        }
    }

    // Factory method to convert an arr
    // User.fromJson(jsonArray);
    public static ArrayList<User> from
        ArrayList<User> users = new
        for (int i = 0; i < jsonObj
            try {
                users.add(new User(j

```

```

        } catch (JSONException e) {
            e.printStackTrace();
        }
    }
    return users;
}
}

```

For more details, check out our guide on [converting JSON into a model](#). If you are not using a JSON source for your data, you can safely skip this step.

## Attaching Event Handlers Within Adapter

Within a `ListView`, we can easily [attach event listeners](#) onto any of the views that are item position aware with:

```

public class UsersAdapter extends ArrayAdapter<User> {
    // ...
    @Override
    public View getView(int position, View convertView, ViewGroup parent) {
        // ...
        // Lookup view for data population
        Button btButton = (Button) convertView;
        // Cache row position inside the button
        btButton.setTag(position);
        // Attach the click event handler
        btButton.setOnClickListener(new View.OnClickListener() {
            @Override
            public void onClick(View v) {
                int position = (Integer) v.getTag();
                // Access the row position
                User user = getItem(position);
                // Do what you want here...
            }
        });
        // ... other view population as needed
        // Return the completed view
        return convertView;
    }
}

```

You can also similarly pass an entire object through a tag as well as shown here:

```

// Inside adapter `getView` method
User user = getItem(position);
// Cache user object inside the button
btButton.setTag(user);
// Attach the click event handler
btButton.setOnClickListener(new View.OnClickListener() {
    @Override
    public void onClick(View view) {
        // Access user from within the button
        User user = (User) view.getTag();
        // Do what you want here...
    }
});

```

With this approach you can easily access data as needed from within any event handlers.

## Improving Performance with the ViewHolder Pattern

To improve performance, we should modify the custom adapter by applying the **ViewHolder** pattern which speeds up the population of the ListView considerably by caching view lookups for smoother, faster item loading:

```
public class UsersAdapter extends ArrayAdapter<User> {
    // View lookup cache
    private static class ViewHolder {
        TextView name;
        TextView home;
    }

    public UsersAdapter(Context context,
        super(context, R.layout.item_user));

    @Override
    public View getView(int position, View convertView, ViewGroup parent) {
        // Get the data item for this position
        User user = getItem(position);
        // Check if an existing view is available for recycling
        ViewHolder viewHolder; // viewHolder is null if a new view is created
        if (convertView == null) {
            // If there's no view to re-use, create one
            viewHolder = new ViewHolder();
            LayoutInflater inflater = LayoutInflater.from(context);
            convertView = inflater.inflate(R.layout.item_user, parent, false);
            viewHolder.name = (TextView) convertView.findViewById(R.id.name);
            viewHolder.home = (TextView) convertView.findViewById(R.id.home);
            // Cache the viewHolder object for reuse
            convertView.setTag(viewHolder);
        } else {
            // View is being recycled, re-use it
            viewHolder = (ViewHolder) convertView.getTag();
        }
        // Populate the data from the data item
        // into the template view.
        viewHolder.name.setText(user.name);
        viewHolder.home.setText(user.home);
        // Return the completed view to the caller
        return convertView;
    }
}
```

In this example we also have a private static class called `ViewHolder`. Making calls to `findViewById()` can be slow in practice, and if your adapter has to call it for each view in your row for every single row then you can often run into performance issues. What the `ViewHolder` class does is cache the call to `findViewById()`. Once your `ListView` has reached the max amount of rows it can display on a screen, Android is smart enough to begin recycling those row Views. We check if a View is recycled with `if (convertView == null)`. If it is not null then we have a recycled View and can just change its values, otherwise we need to create a new row View. The magic behind this is the `setTag()` method which lets us attach an arbitrary object onto a View

object, which is how we save the already inflated `view` for future reuse.

## Beyond ViewHolders

Customizing Android ListView Rows by Subclassing describes a strategy for obtaining instances of child views using a similar approach as a ViewHolder but without the explicit ViewHolder subclass.

## References

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- <http://lucasr.org/2012/04/05/performance-tips-for-androids-listview/>
- <http://www.doubleencore.com/2013/05/layout-inflation-as-intended/>
- <http://www.bignerdranch.com/blog/customizing-android-listview-rows-subclassing/>