5. GUI: Layout

Recall: Android widgets

9:26:00 pm Analog/DigitalClock	Button 1 Button 2 Button 3 Button	Plain Serif Bold Italic Checkbox	S M T W T F S 30 31 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 1 2 3 4 5 6 7 8 9 12:15 PM Date/TimePicker
EditText 1 (206)555-1212 •••••••••••• EditText	Gallery	ImageView/Button	ProgressBar
Plain Serif Bold Bold & Italic RadioButton	Spinner Spinner	Plain Serif Bold Italic TextView	1600 Pennsylvania Ave NW Washington DC http://www.go... Web Images Places News Google Instant (beta) is off: Turn on Location unavailable - update MapView, WebView

Button

A clickable widget with a text label

- key attributes:

`android:clickable="`***`bool`***`"`	set to false to disable the button
`android:id="@+id/`***`theID`***`"`	unique ID for use in Java code
`android:onClick="`***`function`***`"`	function to call in activity when clicked (must be public, void, and take a View arg)
`android:text="`***`text`***`"`	text to put in the button

- represented by `Button` class in Java code

```
Button b = (Button) findViewById(R.id.theID);
...
```

Sizing and Positioning

How does the programmer specify where each component appears, how big each component should be, etc.?

- **Absolute positioning** (C++, C#, others):
  - Programmer specifies exact pixel coordinates of every component.
  - "Put this button at (x=15, y=75) and make it 70x31 px in size."

- **Layout managers** (Java, Android):
  - Objects that decide where to position each component based on some general rules or criteria.
    - "Put these four buttons into a 2x2 grid and put these text boxes in a horizontal flow in the south part of the app."
  - More flexible and general; works better with a variety of devices.

ViewGroup as layout

- ViewGroup superclass represents containers of widgets/views
  - layouts are described in **XML** and mirrored in Java code
  - Android provides several pre-existing layout managers; you can define your own **custom layouts** if needed
  - layouts can be **nested** to achieve combinations of features

- in the Java code and XML:
  - an **Activity** is a ViewGroup
  - various Layout classes are also ViewGroups
  - widgets can be added to a ViewGroup, which will then manage that widget's position/size behavior

XML, in brief

- **XML** : a language for describing hierarchical text data. *
  - Uses **tags** that consist of **elements** and **attributes**. Tags can be **nested**.
  - Some tags are opened and closed; others self-close.

```
<element attr="value" attr="value">  ...  </element>
<element attr="value" attr="value" />     (self-closing)
```

- Example: ** XML is <u>case-sensitive</u>!*

```
<!-- this is a comment -->
<course name="Android" semester="sp">
    <instructor>Google</instructor>
    <ta>none</ta>
</course>
```

Changing layouts

- go to the Text view for your layout XML file
- modify the opening/closing tags to the new layout type, e.g. `LinearLayout`
- now go back to Design view and add widgets

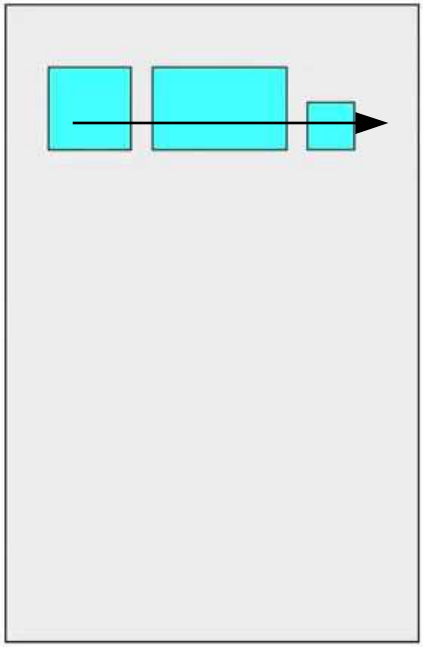
MainActivity.java × activity_main.xml ×

```
1  <LinearLayout xmlns:android="http://schemas.android.com/apk/res/android"
2      xmlns:tools="http://schemas.android.com/tools" android:layout_width="match_parent"
3      android:layout_height="match_parent" android:paddingLeft="16dp"
4      android:paddingRight="16dp"
5      android:paddingTop="16dp"
6      android:paddingBottom="16dp" tools:context=".MainActivity">
7
8  </LinearLayout>
9
```

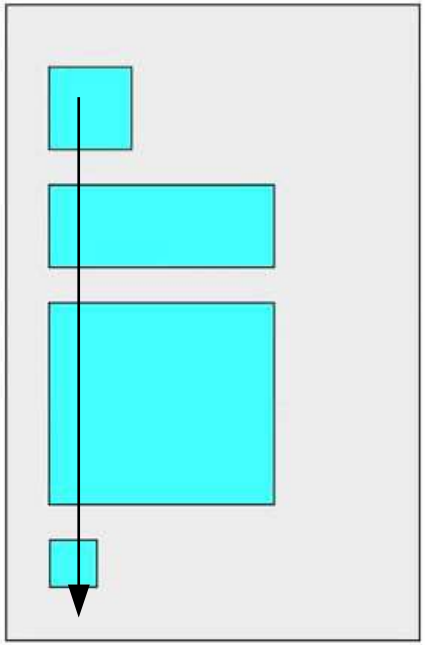
LinearLayout

- lays out widgets/views in a single line
- **orientation** of horizontal (default) or vertical
- items do *not* wrap if they reach edge of screen!

horizontal



vertical



LinearLayout example

```
<LinearLayout ...
        android:orientation="horizontal"
        tools:context=".MainActivity">
    <Button ... android:text="Button 1" />
    <Button ... android:text="Button 2 Hooray" />
    <Button ... android:text="Button 3" />
    <Button ... android:text="Button 4
                        Very Long Text" />
</LinearLayout>
```

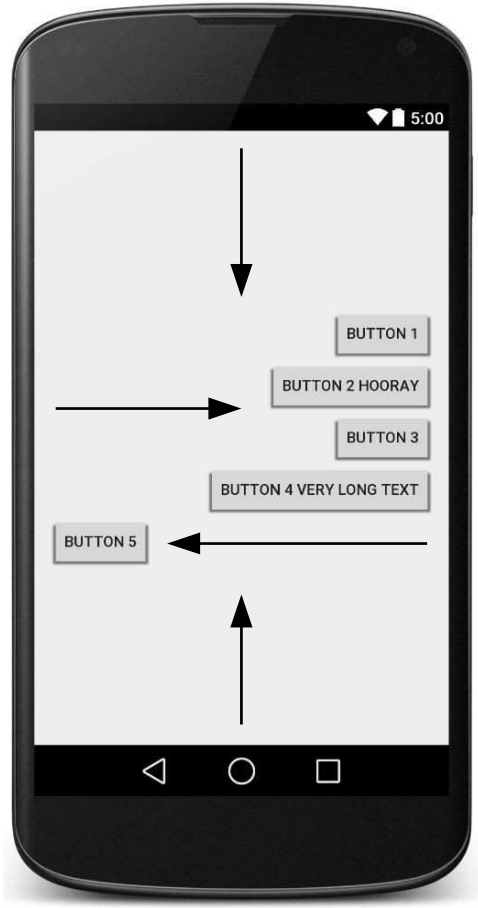
- In our examples, we'll use `...` when omitting boilerplate code that is auto-generated by Android Studio and not relevant to the specific example at hand.

LinearLayout example

```
<LinearLayout ...
        android:orientation="vertical"
        tools:context=".MainActivity">
    <Button ... android:text="Button 1" />
    <Button ... android:text="Button 2
                                Hooray" />
    <Button ... android:text="Button 3" />
    <Button ... android:text="Button 4
                        Very Long Text" />
</LinearLayout>
```

Gravity

- **gravity**: alignment direction that widgets are pulled
  - top, bottom, left, right, center
  - combine multiple with |
  - set `gravity` on the layout to adjust all widgets; set `layout_gravity` on an individual widget

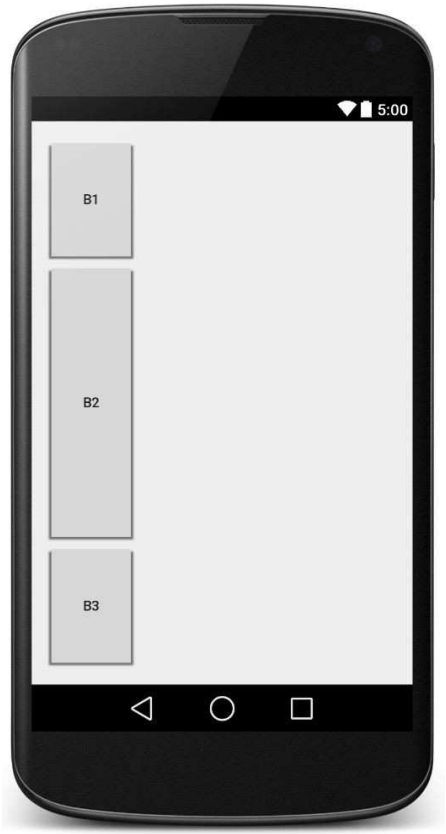



```
<LinearLayout ...
        android:orientation="vertical"
        android:gravity="center|right">
    <Button ... android:text="Button 1" />
    <Button ... android:text="Button 2 Hooray" />
    <Button ... android:text="Button 3" />
    <Button ... android:text="Button 4 Very Long Text" />
    <Button ... android:text="Button 5"
               android:layout_gravity="left" />
</LinearLayout>
```

Weight

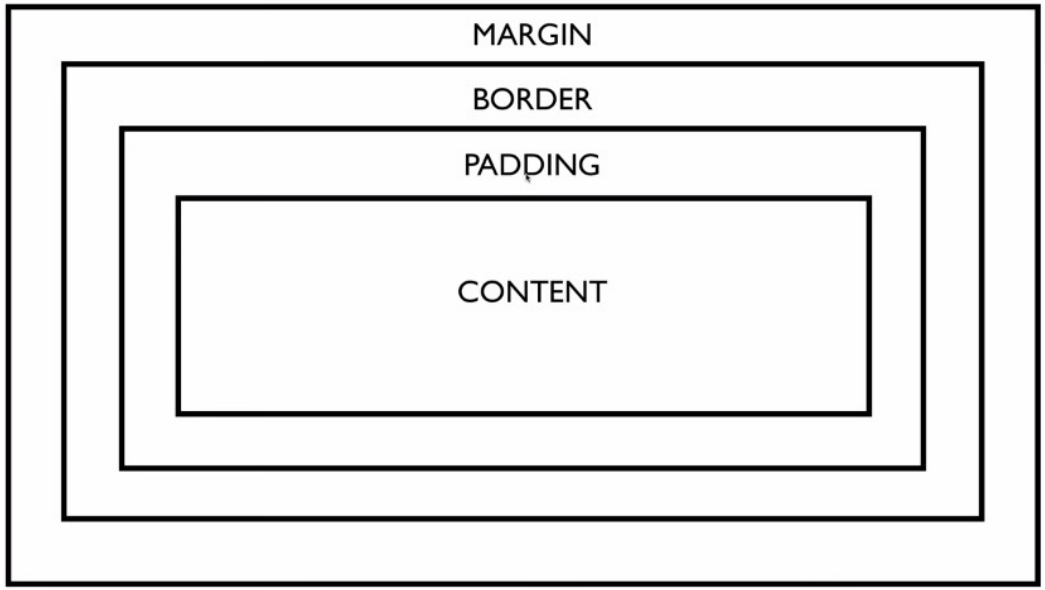
- **weight**: gives elements relative sizes by integers
  - widget with weight ***K*** gets ***K***/total fraction of total size
  - cooking analogy: "2 parts flour, 1 part water, ..."

```
<LinearLayout ...
        android:orientation="vertical">
    <Button ... android:text="B1"
               android:layout_weight="1" />
    <Button ... android:text="B2"
               android:layout_weight="3" />
    <Button ... android:text="B3"
               android:layout_weight="1" />
</LinearLayout>
```



Widget box model

- content: every widget or view has a certain size (width x height) for its content, the widget itself
- padding: you can artificially increase the widget's size by applying padding in the widget just outside its content
- border: outside the padding, a line around edge of widget
- margin: separation from neighboring widgets on screen



Sizing an individual

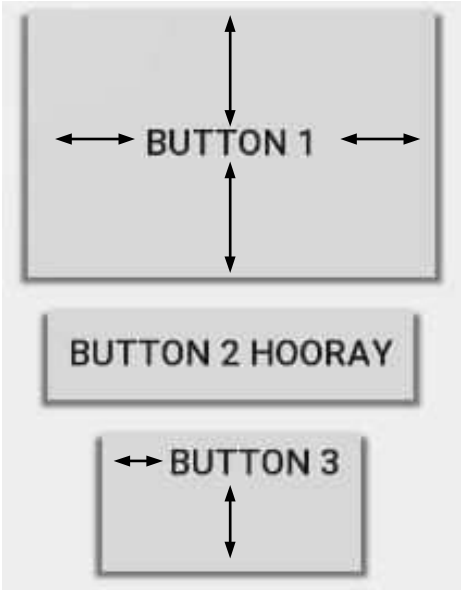
- **width** and **height** of a widget can be:
  - `wrap_content` : exactly large enough to fit the widget's content
  - `match_parent` : as wide or tall as 100% of the screen or layout
  - a specific fixed width such as 64dp *(not usually recommended)*
    - *dp = device pixels; dip = device-independent pixels; sp = scaling pixels*

```
<Button ...
        android:layout_width="match_parent"
        android:layout_height="wrap_content"  />
```

Padding

- **padding**: extra space *inside* widget
  - set `padding` to adjust all sides; paddingTop, Bottom, Left, Right for one side
  - usually set to specific values like 10dp

    (some widgets have a default value ~16dp)

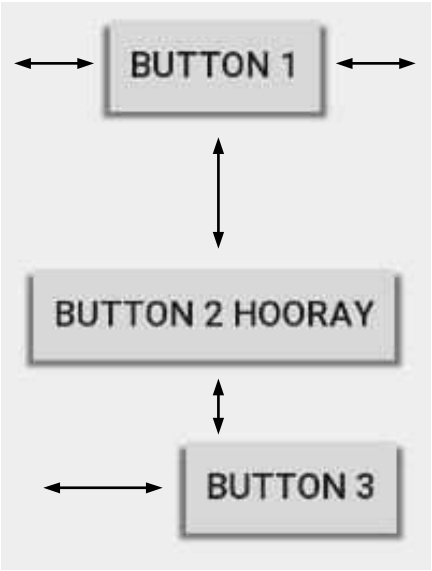



```
<LinearLayout ...
        android:orientation="vertical">
    <Button ... android:text="Button 1"
               android:padding="50dp" />
    <Button ... android:text="Button 2 Hooray" />
    <Button ... android:text="Button 3"
               android:paddingLeft="30dp"
               android:paddingBottom="40dp" />
</LinearLayout>
```

Margin

- **margin**: extra space *outside* widget to separate it from others
  - set `layout_margin` to adjust all sides; layout_marginTop, Bottom, Left, Right
  - usually set to specific values like 10dp

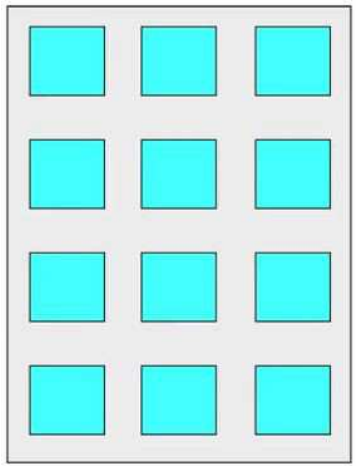
    *(set defaults in res/values/**dimens.xml**)*




```
<LinearLayout ...
        android:orientation="vertical">
    <Button ... android:text="Button 1"
               android:layout_margin="50dp" />
    <Button ... android:text="Button 2 Hooray" />
    <Button ... android:text="Button 3"
               android:layout_marginLeft="30dp"
               android:layout_marginTop="40dp" />
</LinearLayout>
```

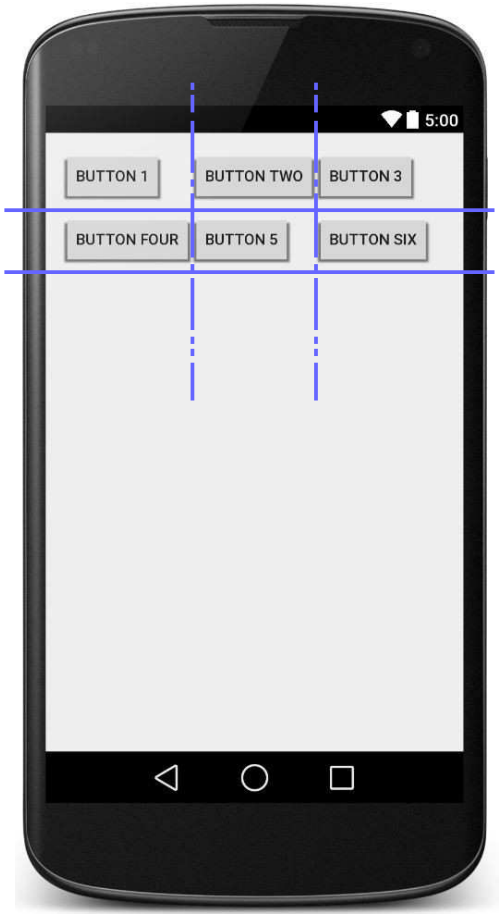
GridLayout

- lays out widgets/views in lines of **rows** and **columns**
  - orientation attribute defines row-major or column-major order
  - introduced in Android 4; replaces older TableLayout
- by default, rows and columns are equal in size
  - each widget is placed into "next" available row/column index unless it is given an explicit `layout_row` and `layout_column` attribute
  - grid of 4 rows, 3 columns:



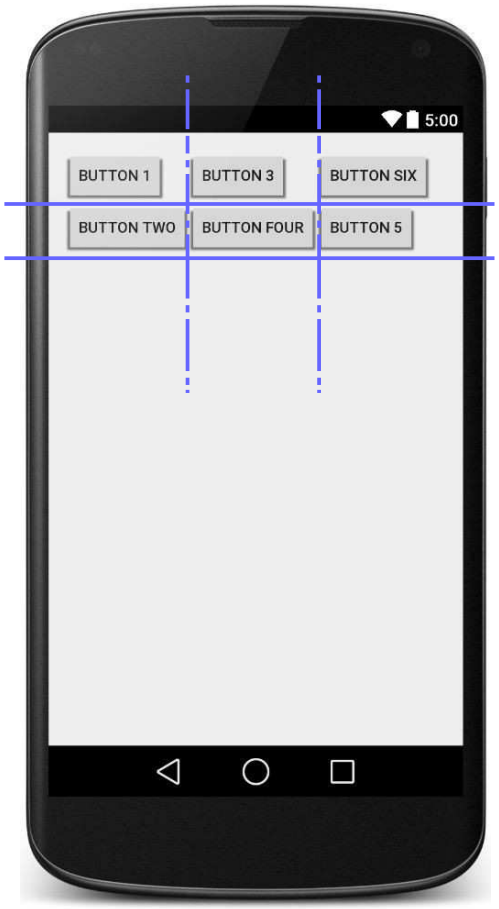
GridLayout example

```
<GridLayout ...
        android:rowCount="2"
        android:columnCount="3"
        tools:context=".MainActivity">
    <Button ... android:text="Button 1" />
    <Button ... android:text="Button Two" />
    <Button ... android:text="Button 3" />
    <Button ... android:text="Button Four" />
    <Button ... android:text="Button 5" />
    <Button ... android:text="Button Six" />
</GridLayout>
```



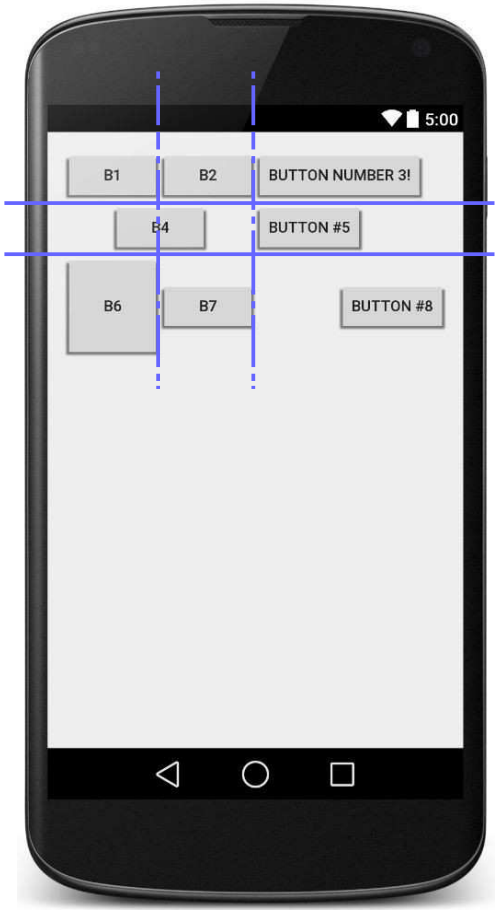
GridLayout example

```
<GridLayout ...
        android:rowCount="2"
        android:columnCount="3"
        android:orientation="vertical">
    <Button ... android:text="Button 1" />
    <Button ... android:text="Button Two" />
    <Button ... android:text="Button 3" />
    <Button ... android:text="Button Four" />
    <Button ... android:text="Button 5"
               android:layout_row="1"
               android:layout_column="2" />
    <Button ... android:text="Button Six"
               android:layout_row="0"
               android:layout_column="2" />
</RelativeLayout>
```



GridLayout example

```
<GridLayout ...
        android:rowCount="2"
        android:columnCount="3">
    <Button ... android:text="B1" />
    <Button ... android:text="B2" />
    <Button ... android:text="Button Number 3!" />
    <Button ... android:text="B4"
       android:layout_columnSpan="2"
       android:layout_gravity="center" />
    <Button ... android:text="B5" />
    <Button ... android:text="B6"
       android:layout_paddingTop="40dp"
       android:layout_paddingBottom="40dp" />
    <Button ... android:text="B7" />
    <Button ... android:text="Button #8"
       android:layout_gravity="right" />
</RelativeLayout>
```



Nested layout

- to produce more complicated appearance, use a **nested** layout
  - (layouts inside layouts)

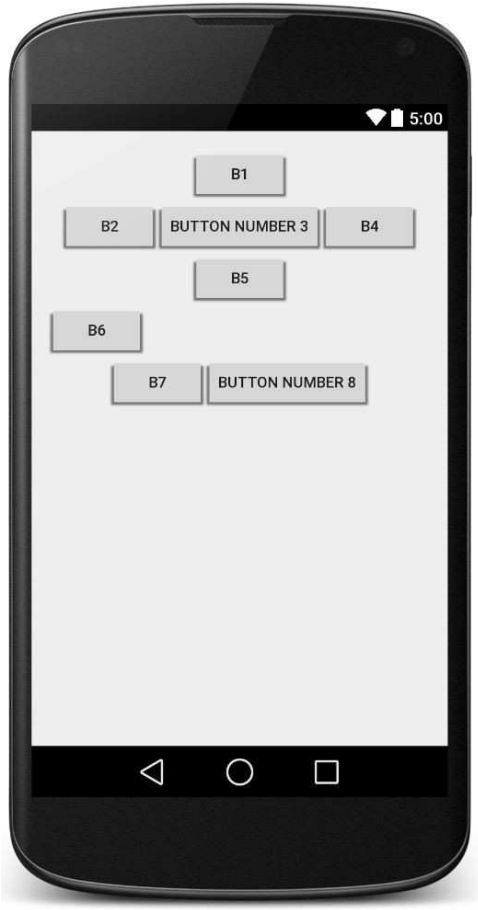
- what layout(s) are used to create the appearance at right?
  - overall activity:
  - internal layouts:

Nested layout template

```
<OuterLayoutType ...>

    <InnerLayoutType ...>
        <Widget ... />
        <Widget ... />
    </InnerLayoutType>

    <InnerLayoutType ...>
        <Widget ... />
        <Widget ... />
    </InnerLayoutType>

    <Widget ... />
    <Widget ... />
</OuterLayoutType>
```

Nested layout exercise

- Write the layout XML necessary to create the following app UI.
  - How many overall layouts are needed?
  - Which widgets go into which layouts?
  - ...



Nested layout solution

```
<LinearLayout ...
        android:orientation="vertical" android:gravity="center|top">
    <Button ... android:text="B1" />
    <LinearLayout ...
            android:layout_width="match_parent"
            android:layout_height="wrap_content"
            android:orientation="horizontal"
            android:gravity="center|top">
      <Button ... android:text="B2" />
      <Button ... android:text="Button Number 3" />
      <Button ... android:text="B4" />
    </LinearLayout>
    <Button ... android:text="B5" />
    <Button ... android:text="B6" android:layout_gravity="left" />
    <LinearLayout ...
            android:layout_width="match_parent"
            android:layout_height="wrap_content"
            android:orientation="horizontal"
            android:gravity="center|top">
      <Button ... android:text="B7" />
      <Button ... android:text="Button Number 8" />
    </LinearLayout>
</LinearLayout>
```