AND240

Touch in Android

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Objectives

1. Handle single-touch events
2. Capture multi-touch interactions

Handle single-touch events

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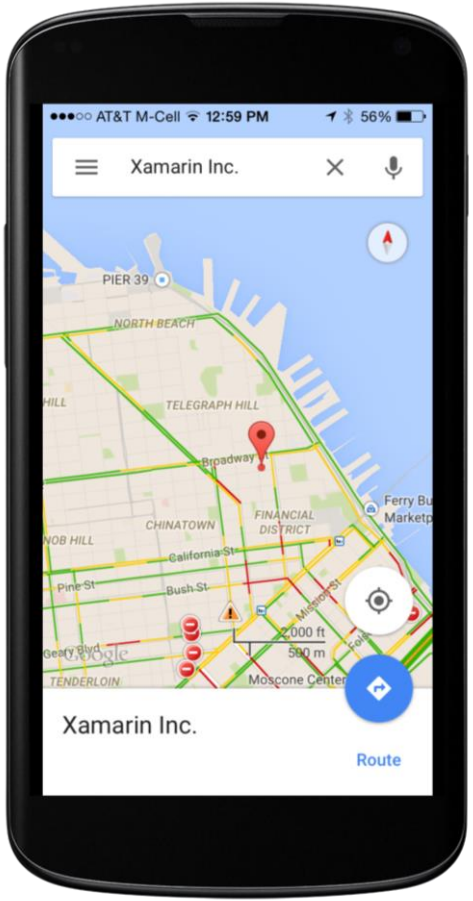
Tasks

1. Motivate touch UI
2. Determine event type
3. Subscribe to touch events
4. Utilize event data

Touch UI benefits

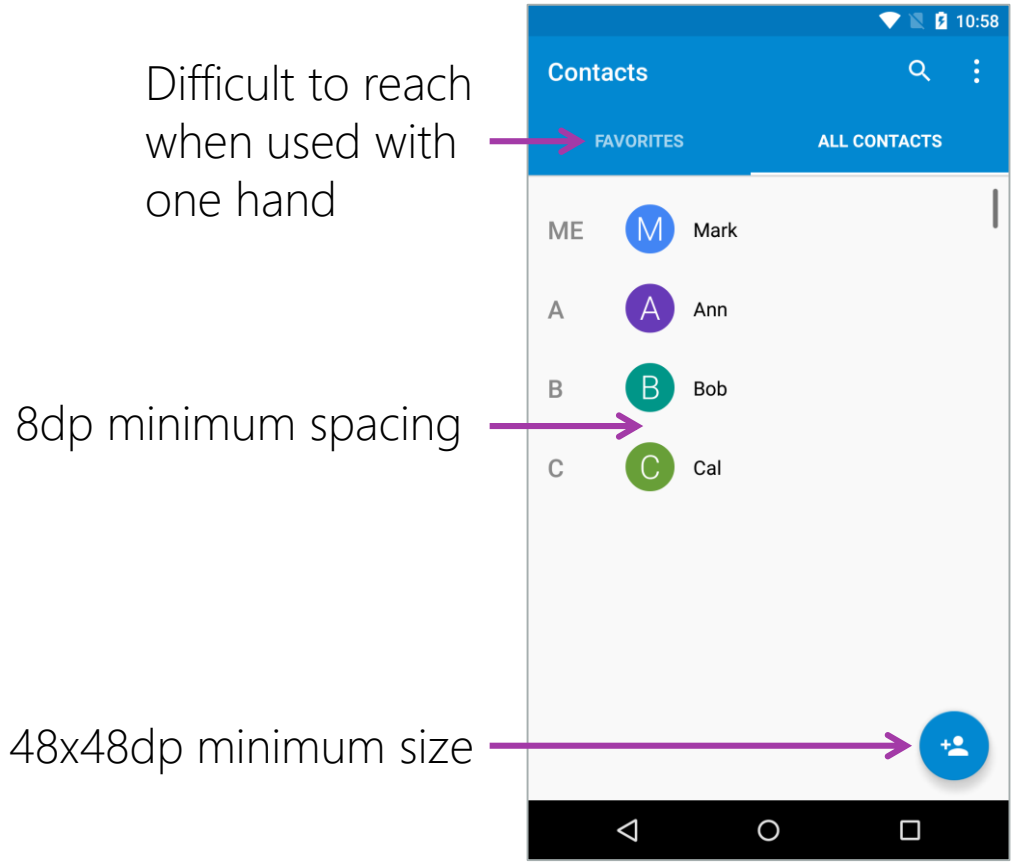
- Touch allows *direct* interaction with content

Touch is intuitive, it mimics how users work with physical objects



Challenges

- Designing for touch can be challenging; it requires careful attention to the placement and size of touchable items



Google layout guidelines: google.com/design/spec/layout/metrics-keylines.html

Touch vs. mouse design

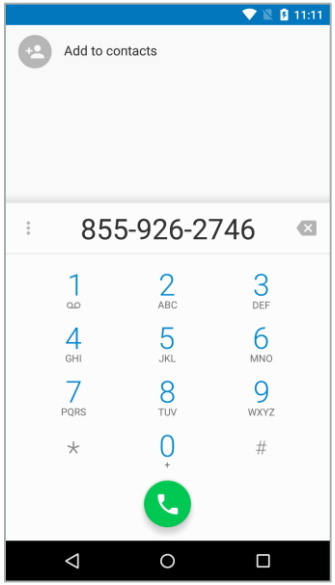
- Design considerations differ between Touch and Mouse; the patterns that work for desktop UI will not succeed in a touch-based UI

Touch	Mouse
Low precision for targets	High precision for targets
No right-click	Right-click available
No cursor	Cursor visible
Fingers will obscure the screen	Mouse will not obscure the screen
Portrait and landscape views	Only one view
Multiple fingers	One pointer

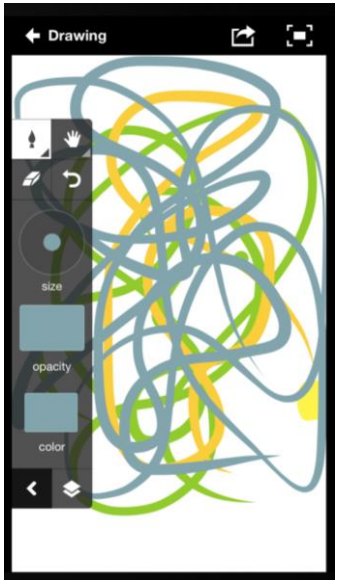
User events

- Android sends you both high-level events (e.g. button-click) and low-level events (e.g. touch)

Button and text-changed events are sufficient to build this UI



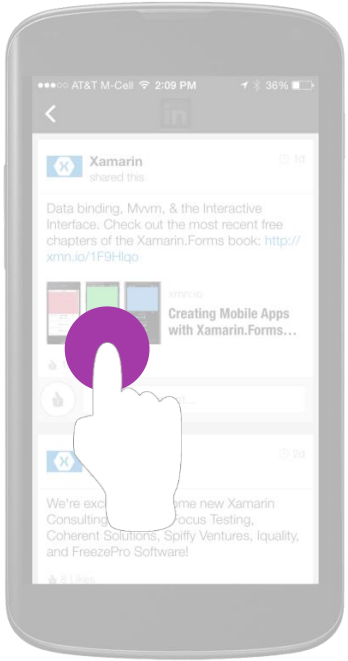
Drawing, Photo, and Games need low-level touch events



The remainder of this course discusses the physical touch events

What is a touch action?

- An *action* is a physical manipulation of the screen e.g. down/move/up



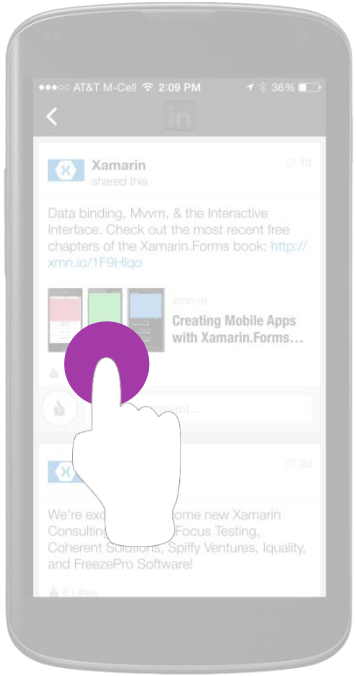
Make initial contact

Move an existing touch point

Lift a finger from the screen

Action sequence

- A screen interaction is made up of a sequence of low-level touch actions



Reported action: `Down`

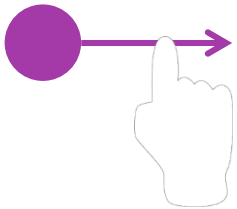
Reported action: `Move Move Move ...`

Reported action: `Up`

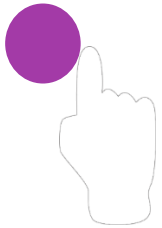
Actions

- `MotionEventActions` is an **`enum`** that reports the type of touch action

`MotionEventActions.Down`
Finger contacts the screen



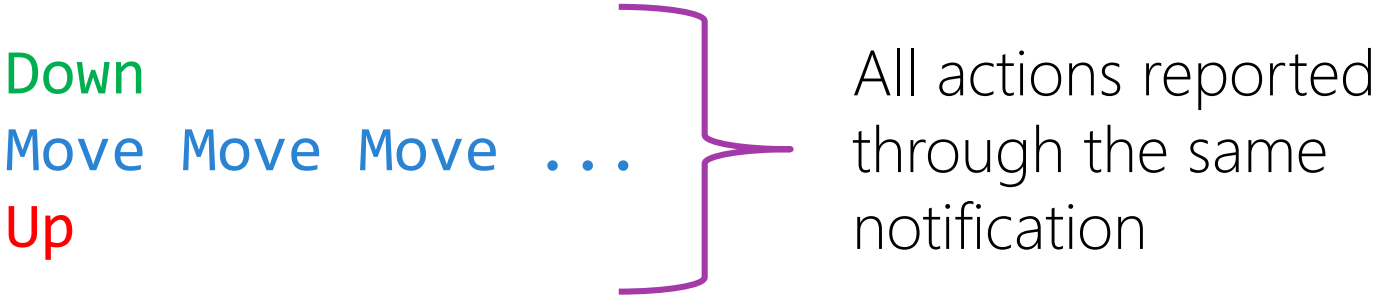
`MotionEventActions.Move`
Finger moves on the screen



`MotionEventActions.Up`
Finger is lifted from the screen

Action reporting

- There is a single notification for all actions rather than separate down, move, and up notifications



Touch reporting

- The **View** class offers three ways to receive notifications of touch actions

C#-style event →
Java-style listener →
Override in a derived class →

```
public class View : ...
{ ...
  event EventHandler<View.TouchEventArgs> Touch;

  void SetOnTouchListener(View.IOnTouchListener l);

  virtual bool OnTouchEvent(MotionEvent e);
}
```


The choice between the event and listener is personal preference.
The **OnTouchEvent** method is used when you code a derived class of **View**

Touch data

- Touch notifications provide a **`MotionEvent`** containing the event details

All three reporting styles include a **`MotionEvent`** object

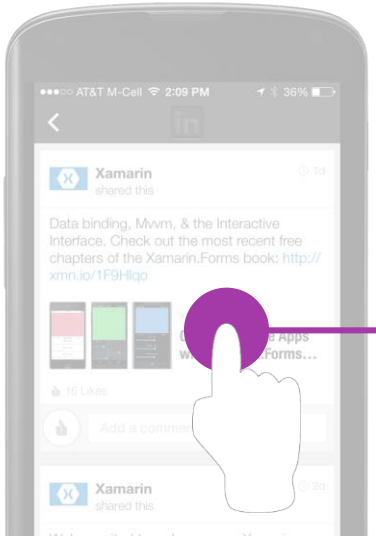
```
public class View : ...
{ ...
  event EventHandler<View.TouchEventArgs> Touch;

  void SetOnTouchListener(View.IOnTouchListener l);

  virtual bool OnTouchEvent(MotionEvent e);
}
```

MotionEvent object

- **`MotionEvent`** includes information about the touch interaction

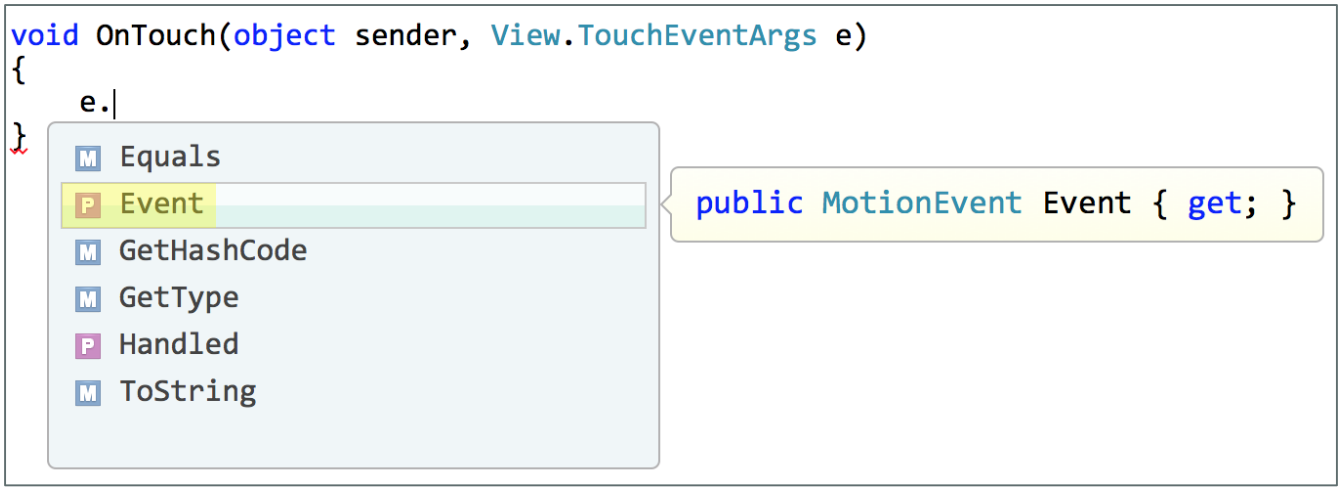


`MotionEvent`

- Action: down, move, up
- Coordinates: X and Y
- Device type: finger, stylus, etc.
- Device stats: pressure, size
- . . .

Event property

- **`TouchEventArgs.Event`** provides the **`MotionEvent`** object for the event-style notification



How to determine the action

- The action is available in the **MotionEvent.ActionMasked** property

Determine the user action

```
void OnTouch(object sender, View.TouchEventArgs e)
{
  switch (e.Event.ActionMasked)
  {
    case MotionEventActions.Down: ... break;
    case MotionEventActions.Move: ... break;
    case MotionEventActions.Up  : ... break;
  }
}
```


You can also use the **Action** property to determine the user action; however, it contains multiple values so you must apply a bitmask: **(e.Event.Action & MotionEventActions.Mask)**

How to get the position

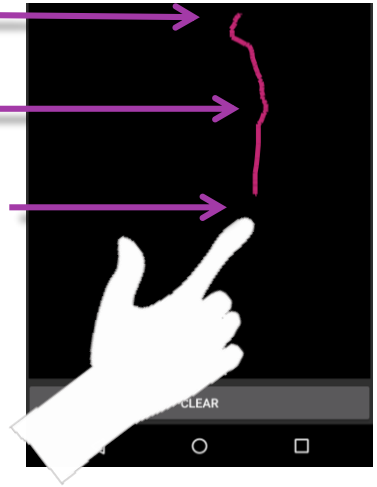
- The touch-event position is reported as X and Y coordinates relative to the view they are reported from, where **(0,0)** is the top-left

```
void OnTouch(object sender, View.TouchEventArgs e)
{
  ...
  float x = e.Event.GetX();
  float y = e.Event.GetY();
  ...
}
```

Example: Draw a line [concept]

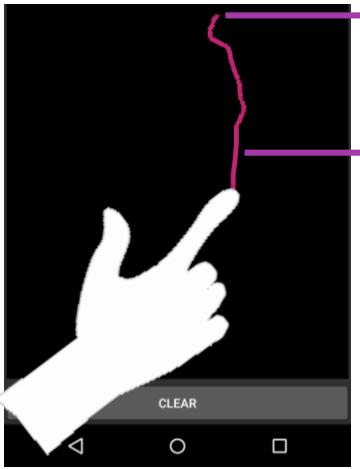
- Touch events can be used to build a drawing app; for example, you could let the user draw a line with their finger

1. Begin the line on the **Down** action
2. Add a segment on the **Move** action
3. Reset on **Up** (not used in single-touch)



Example: Draw a line [Path]

- The **Path** class represents a collection of geometric lines and curves




```
public class Path : Java.Lang.Object
{
  // begin a new segment (does not do any drawing)
  public virtual void MoveTo(float x, float y);

  // draw a line from previous point to this point
  public virtual void LineTo(float x, float y);
  ...
}
```

Example: Draw a line [implementation]

- You add points to the line as the user moves their finger

Only need one **Path**, it holds multiple lines

```
Path p = new Path();
```

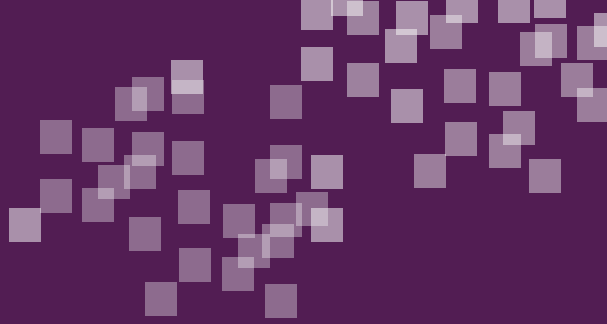
```
void OnTouch(object sender, View.TouchEventArgs e)
{
  var x = e.Event.GetX();
  var y = e.Event.GetY();

  switch (e.Event.ActionMasked)
  {
    case MotionEventActions.Down: p.MoveTo(x, y); break;
    case MotionEventActions.Move: p.LineTo(x, y); break;
  }
}
```

Get the coordinates

Start a new line

Add point to current line



Individual Exercise

Create a drawing app using single-touch

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Summary

1. Motivate touch UI
2. Determine event type
3. Subscribe to touch events
4. Utilize event data

Capture multi-touch interactions

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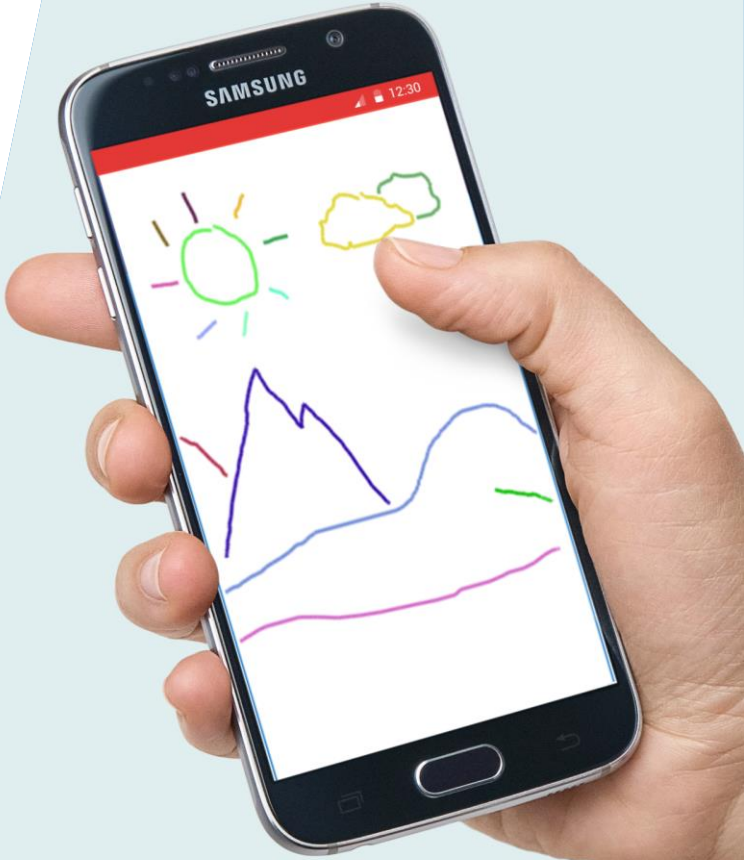
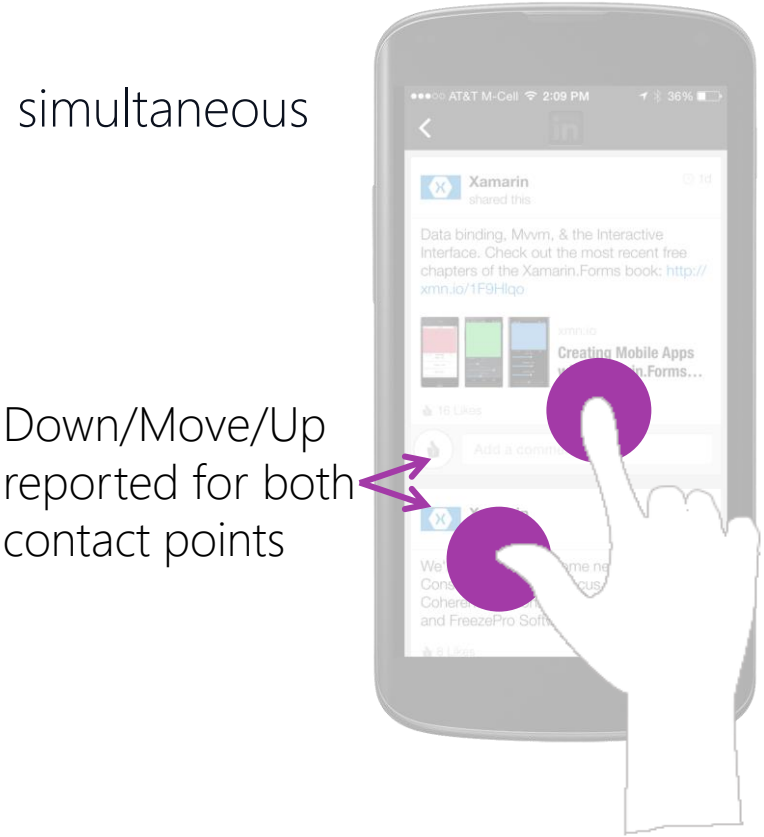
Tasks

1. Discuss multi-touch in Android
2. Describe pointer motion event actions
3. Respond to multi-touch events
4. Create a multi-touch application



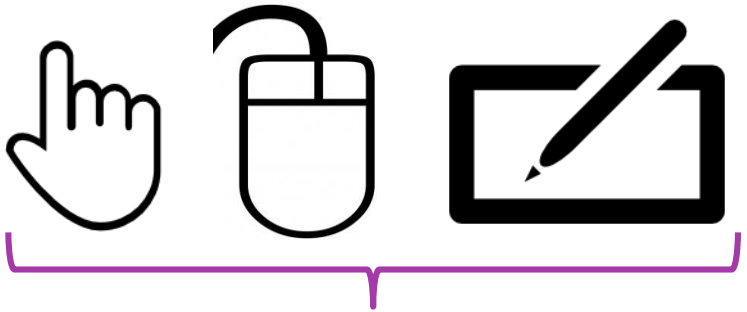
Multi-touch

- Most Android devices support multiple simultaneous touch points



What is a pointer?

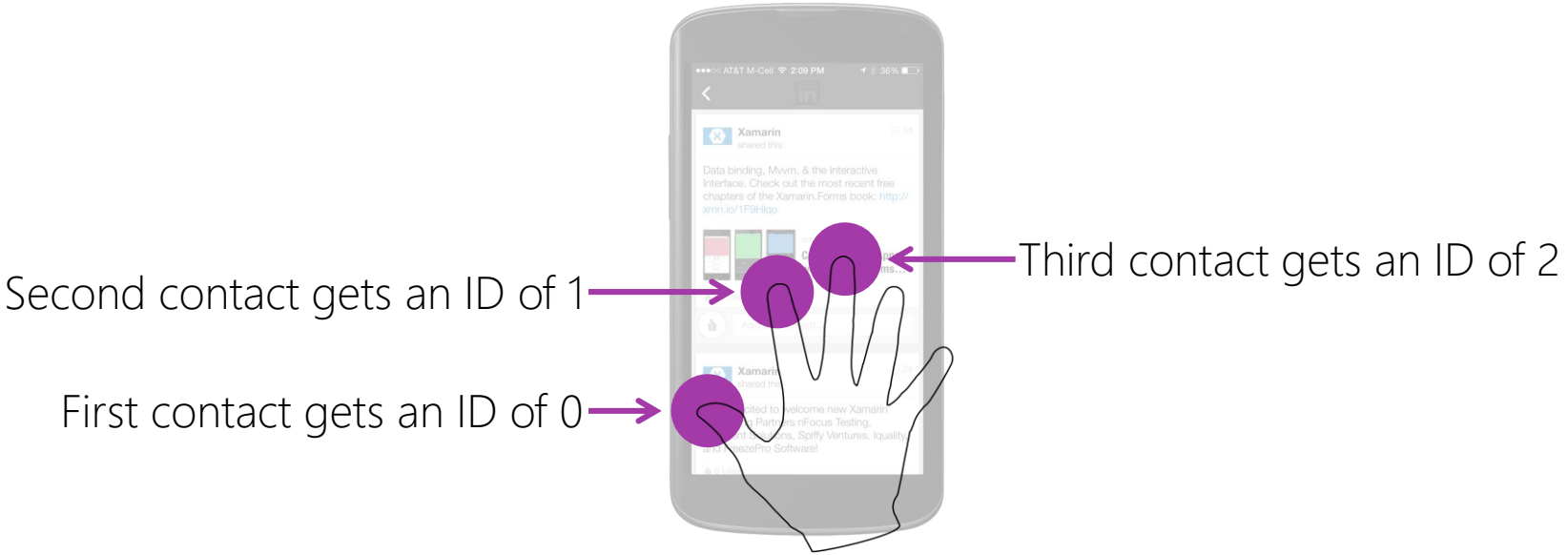
- *Pointer* is the generic term for any instrument that can interact with screen elements



Finger, mouse, and stylus are pointers

What is a pointer ID?

- A *pointer ID* is an integer that is assigned to a pointer when it first makes contact and remains the same until that pointer leaves the screen

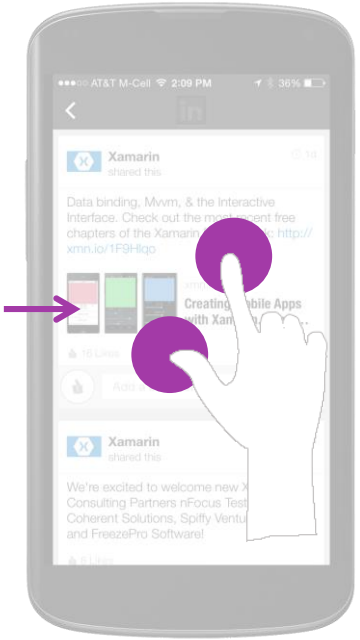


IDs are typically consecutive values starting at 0 but this is not guaranteed

Primary vs. non-primary touch events

- Android differentiates between primary (first/only touch) and non-primary (subsequent) contacts

First-down and last-up are reported differently than other contacts



Android originally supported only single-touch; the multi-touch APIs were added later

Motion event actions for multi-touch

- Non-primary contacts are reported using specific values in the **`MotionEventActions`** enum

`MotionEventActions.PointerDown`

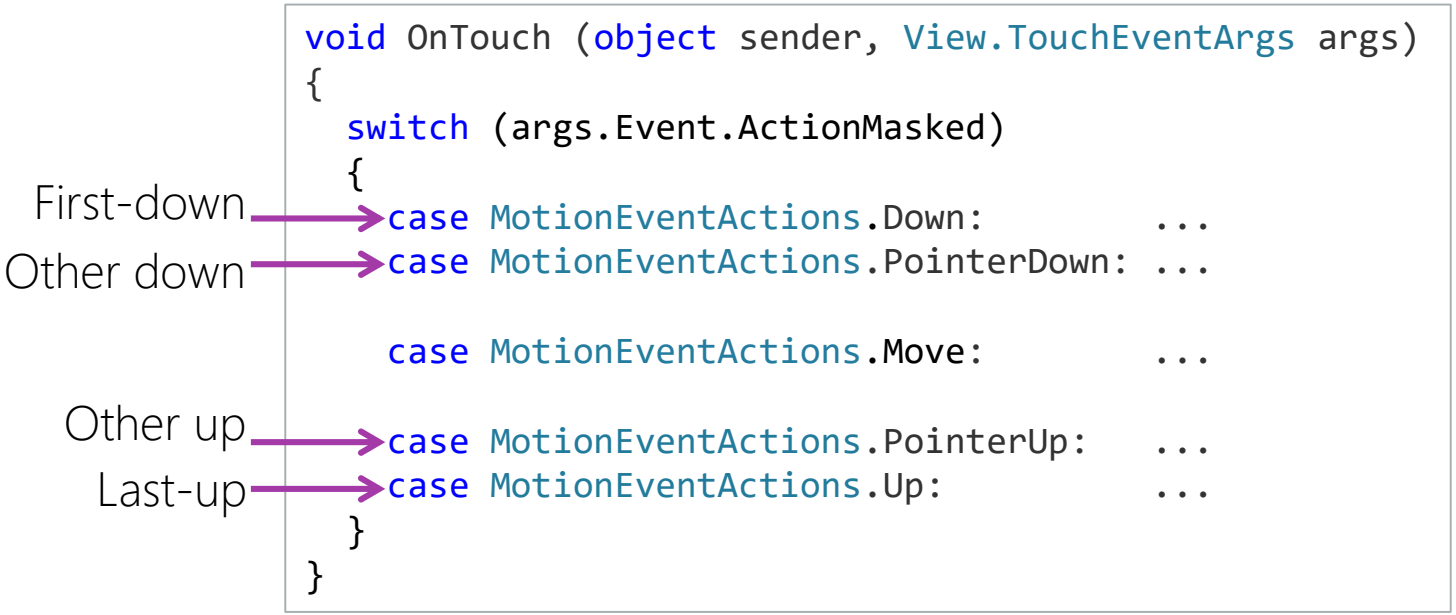
A new finger contacts the screen while there is already at least one other contact

`MotionEventActions.PointerUp`

A finger is lifted from the screen while there is still at least one other contact remaining

Multi-touch MotionEventActions

- There are 5 cases to handle for multi-touch down/move/up actions



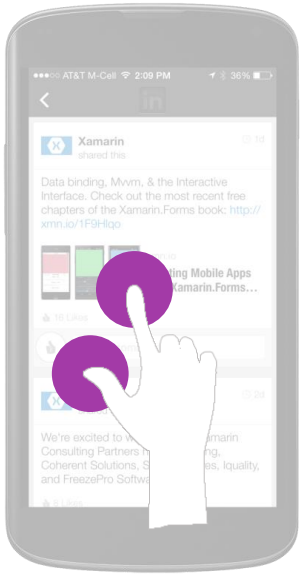

```
void OnTouch (object sender, View.TouchEventArgs args)
{
  switch (args.Event.ActionMasked)
  {
    case MotionEventActions.Down:          ...
    case MotionEventActions.PointerDown:   ...

      case MotionEventActions.Move:        ...

    case MotionEventActions.PointerUp:     ...
    case MotionEventActions.Up:            ...
  }
}
```

Multi-touch batched moves

- Down and up are reported as each pointer contacts or leaves the screen; however, move events report all current pointers at once



Sequence of reported actions:
Down
PointerDown
Move (includes new coords for both pointers)
Move (includes new coords for both pointers)
…
PointerUp
Up

Note that the position of some pointers may not change between move events

Getting the number of active touches

- Android reports the number of active contacts in the **`MotionEvent`**'s **`PointerCount`** property

```
void OnTouch (object sender, View.TouchEventArgs args)
{
    int currentTouches = args.Event.PointerCount;
    ...
}
```

Number of current contacts

Group Exercise

MotionEventActions for multi-touch

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Multi-touch data

- Android tracks data such as coordinates, stylus pressure, stylus size, etc. for all current touch points

Pointer ID: 0	Pointer ID: 1	Pointer ID: 2
X	X	X
Y	Y	Y
Pressure	Pressure	Pressure
...	...	...

There is one record for each active contact

Data storage

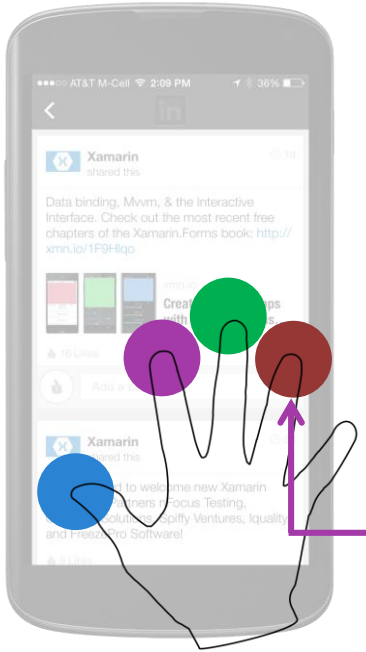
- Android does not say how data for the current contacts is stored; it can help to visualize it as an array with indices from **`0`** to **`PointerCount-1`**

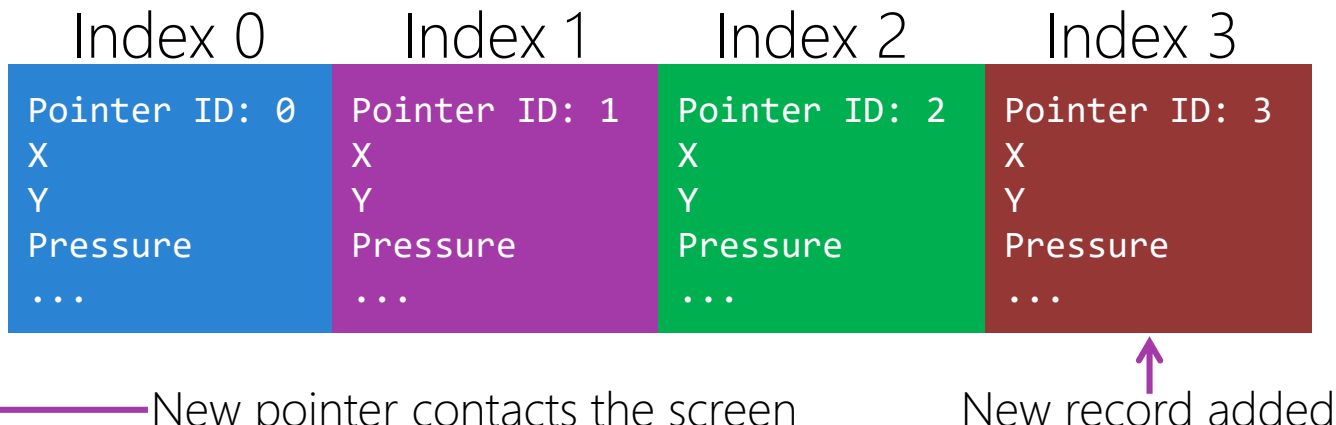
Index 0	Index 1	Index 2
Pointer ID: 0 X Y Pressure ...	Pointer ID: 1 X Y Pressure ...	Pointer ID: 2 X Y Pressure ...

`PointerCount` is 3 so indices are **`0`**,**`1`**,**`2`**

Adding records

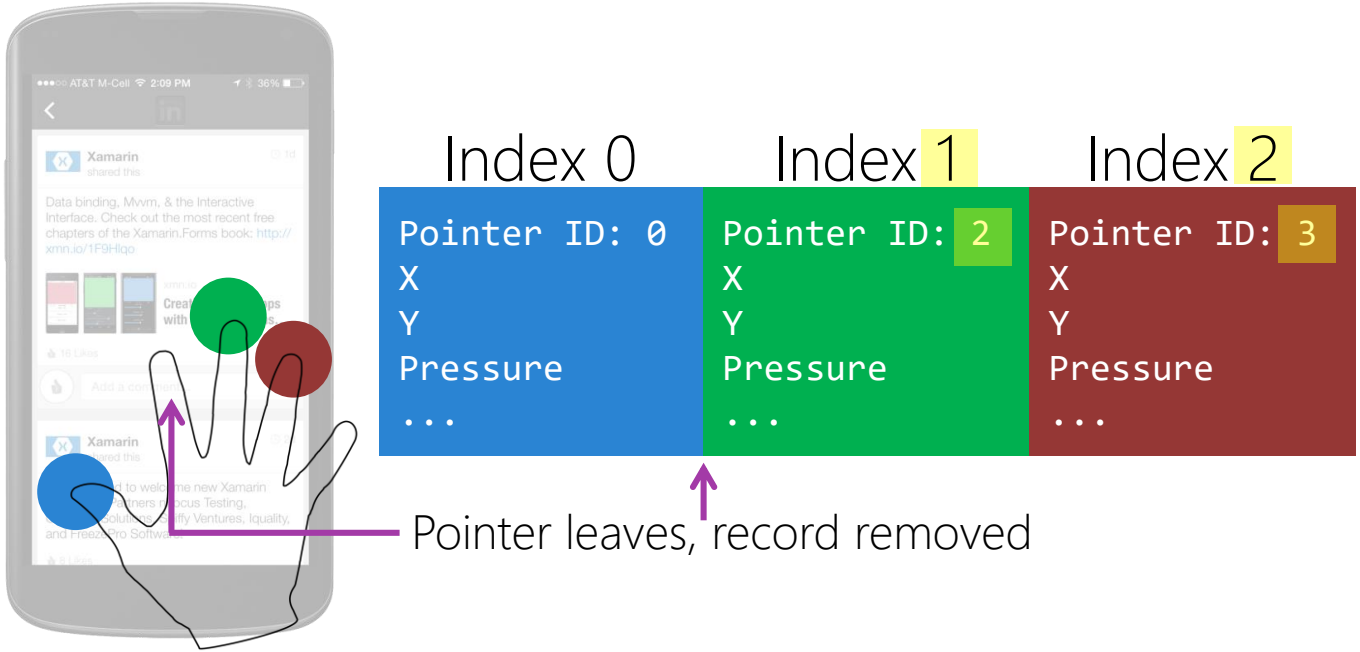
- Typically, records for new contacts are added at the end (Note: Android says the exact ordering is not guaranteed)





Removing records

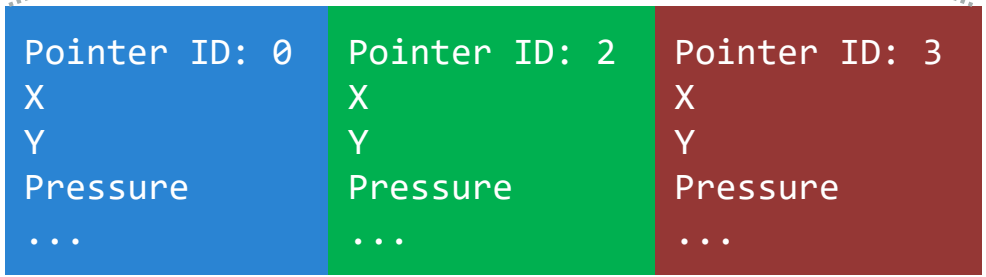
- As contacts leave the screen, their records are removed and the other records are compacted (this means Index and ID can get out of sync)



MotionEvent data

- **`MotionEvent`** contains data for all current contacts

```
void OnTouch (object sender, View.TouchEventArgs args)
{
  MotionEvent e = args.Event;
  ...
}
```

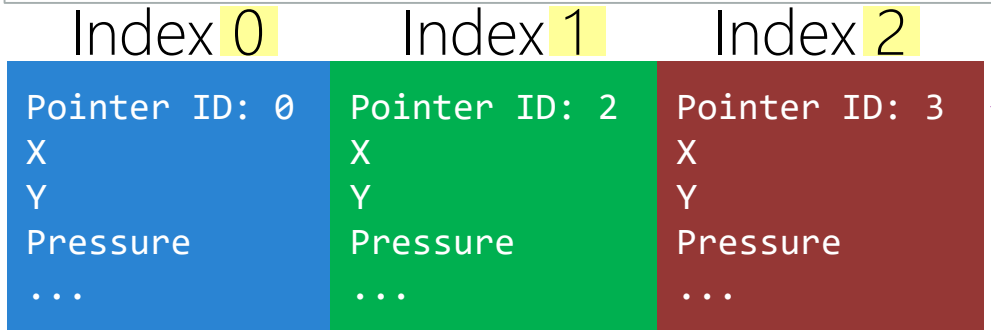


Your event handler has access to data for all contacts

Accessing data

- **`MotionEvent`** has **`Get`** methods that take an index

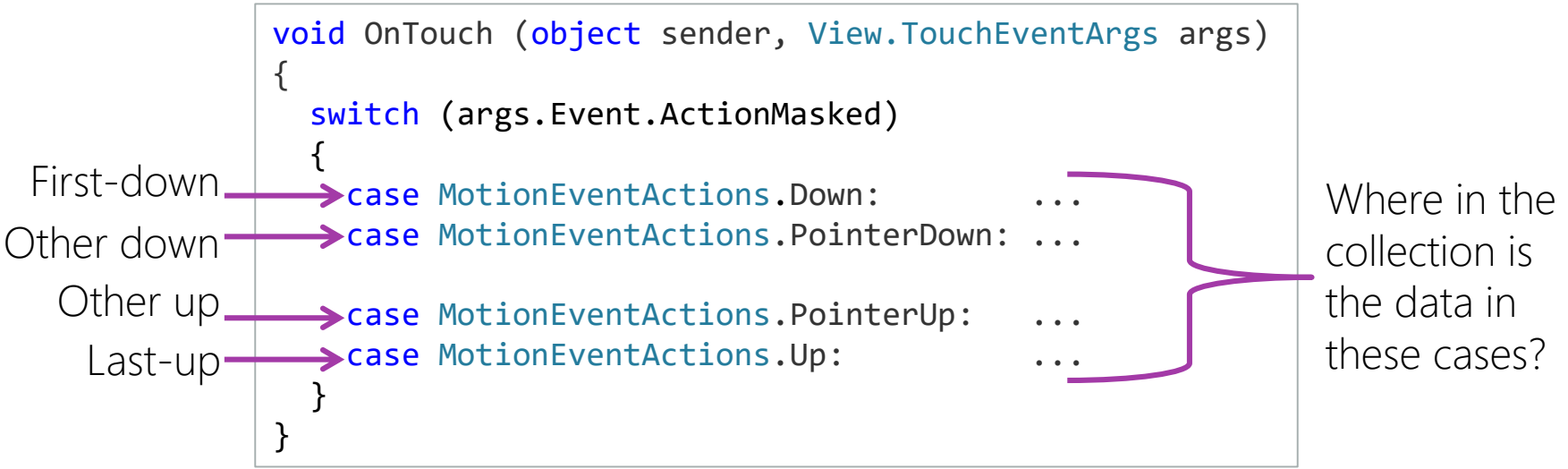
```
void OnTouch (object sender, View.TouchEventArgs args)
{
  for (int index = 0; index < args.Event.PointerCount; index++)
  {
    int   id = args.Event.GetPointerId(index);
    float x  = args.Event.GetX(index);
    float y  = args.Event.GetY(index);
  }
}
```



Do not use the Pointer ID for access, it might not be a valid index

ActionIndex [motivation]

- For the down and up events, how do you know which element to look at to get the pointer ID, X, Y, etc.?



ActionIndex [Down and Up]

- **Down** and **Up** do not need any additional info; they report first-finger-down and last-finger-up so there is a single element in the collection

```
void OnTouch (object sender, View.TouchEventArgs args)
{
  switch (args.Event.ActionMasked)
  {
    case MotionEventActions.Down: int id = args.Event.GetPointerId(0); ...
    case MotionEventActions.Up:   int id = args.Event.GetPointerId(0); ...
      ...
  }
}
```

First-down

Last-up

Pass **0** to the **Get** methods

ActionIndex [definition]

- **ActionIndex** indicates the index of the non-primary pointer that contacted or left the screen during **PointerDown** and **PointerUp**

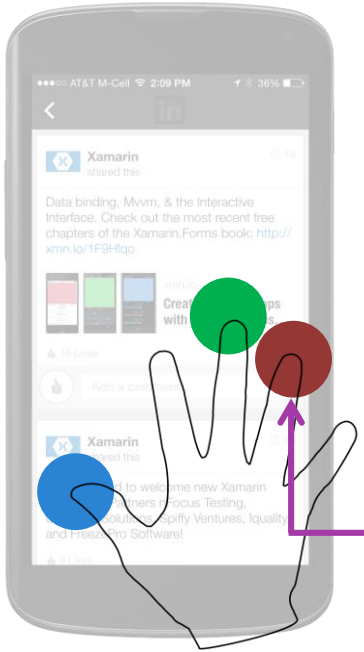
```
void OnTouch (object sender, View.TouchEventArgs args)
{
  switch (args.Event.ActionMasked)
  {
    case MotionEventActions.PointerDown: int id = args.Event.GetPointerId(args.Event.ActionIndex); ...
    case MotionEventActions.PointerUp:   int id = args.Event.GetPointerId(args.Event.ActionIndex); ...
    ...
  }
}
```

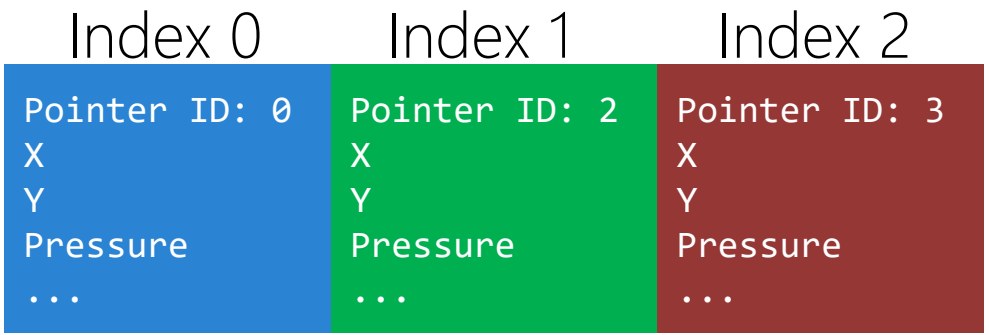
ActionIndex is only valid for these two actions

Access the element corresponding to the finger that caused this action

ActionIndex [PointerDown]

- **`PointerDown`** reports that a non-primary finger touched the screen; **`ActionIndex`** tells where the new record was added



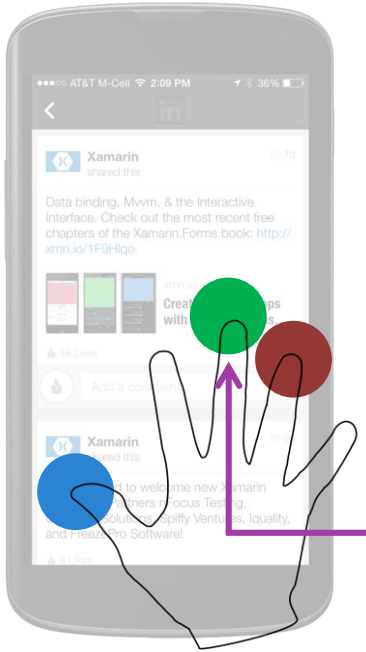


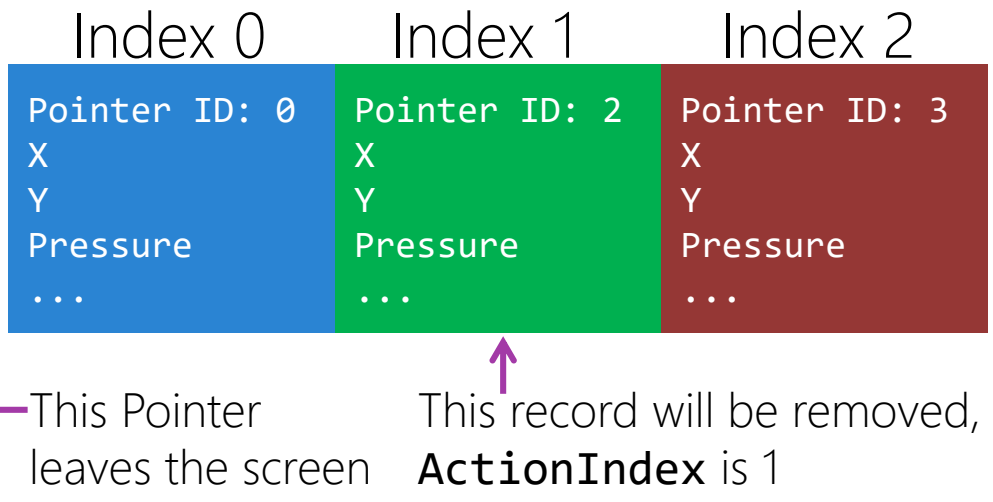
New pointer contacts the screen

New record added here, **`ActionIndex`** will be 2

ActionIndex [PointerUp]

- **`PointerUp`** reports that a non-primary finger left the screen; **`ActionIndex`** tells which record is about to be deleted





Flash Quiz

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Flash Quiz

① The **`ActionIndex`** is best described as:

a) The pointer's position on the screen

b) The pointer's ID

c) The pointer's position in the collection

Flash Quiz

① The **`ActionIndex`** is best described as

a) The pointer's position on the screen

b) The pointer's ID

c) The pointer's position in the collection

Flash Quiz

② The `ActionIndex` is valid for which `MotionEventActions`?

a) `Down`

b) `PointerDown`

c) `Move`

d) `PointerUp`

e) `Up`

Flash Quiz

② The **`ActionIndex`** is valid for which **`MotionEventActions`**?

a) Down

b) PointerDown

c) Move

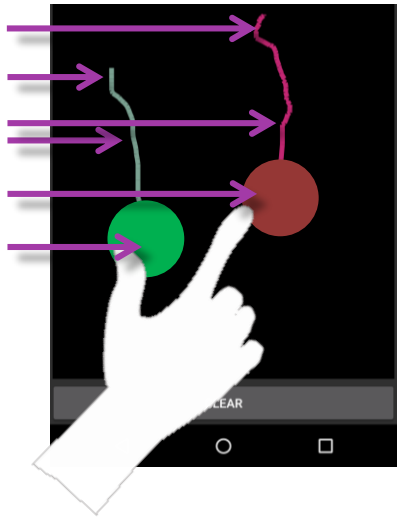
d) PointerUp

e) Up

Example: Draw multiple lines [concept]

- Multi-touch events can be used to let the user drawer multiple lines at the same time

1. Begin a line on the **`Down`** action
2. Begin a line on the **`PointerDown`** action
3. Add points to all lines on the **`Move`** action
4. Stop adding points on **`PointerUp`** action
5. Stop adding points on the **`Up`** action



Example: Draw multiple lines [begin]

- Create a new **Path** as each finger contacts the screen; store them in a dictionary keyed by pointer ID

All active lines →

```
Dictionary<int, Path> paths = new Dictionary<int, Path>();
```

Use **0** with **Get** methods on **Down** →

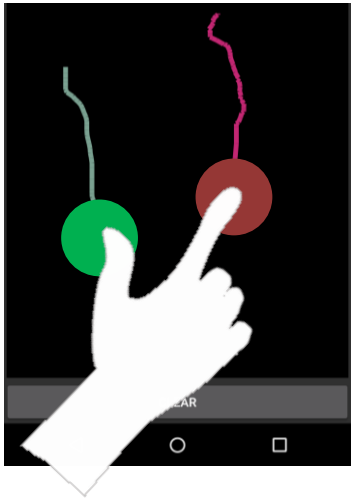
Use **ActionIndex** with **Get** methods on **PointerDown** →

```
case MotionEventActions.Down
  var path = new Path();
  paths.Add(e.Event.GetPointerId(0), path);
  path.MoveTo(e.Event.GetX(0), e.Event.GetY(0));
  break;

case MotionEventActions.PointerDown:
  var path = new Path();
  paths.Add(e.Event.GetPointerId(e.Event.ActionIndex), path);
  path.MoveTo(e.Event.GetX(e.Event.ActionIndex),
              e.Event.GetY(e.Event.ActionIndex));
  break;
```

Example: Draw multiple lines [move]

- On **Move**, use pointer ID to find the right **Path** object in the dictionary



Index 0	Index 1
Pointer ID: 0 X 200 Y 175 Pressure ...	Pointer ID: 2 X 50 Y 225 Pressure ...

You loop through this list

```
for (int i = 0; i < e.PointerCount; i++)
{
  int   id = e.Event.GetPointerId(i);
  float x  = e.Event.GetX(i);
  float y  = e.Event.GetY(i);

  var path = paths[id];

  path.LineTo(x, y);
}
```

Use the pointer ID to locate the correct line for this X/Y pair

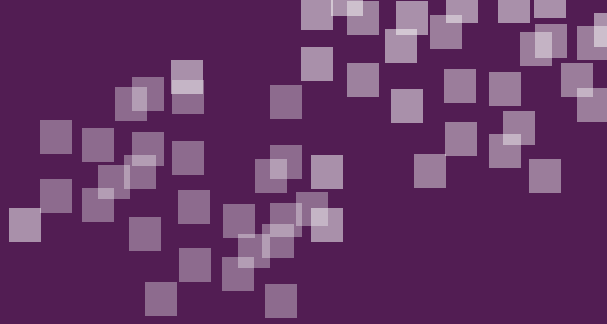
Example: Draw multiple lines [end]

- Remove a **Path** from the dictionary when its pointer leaves the screen

Use **ActionIndex** with **Get** method on **PointerUp**

Use **0** with **Get** method on **Up**

```
case MotionEventActions.PointerUp:
{
  int id = e.Event.GetPointerId(e.ActionIndex);
  paths.Remove(id);
  break;
}
case MotionEventActions.Up:
{
  int id = e.Event.GetPointerId(0);
  paths.Remove(id);
  break;
}
```



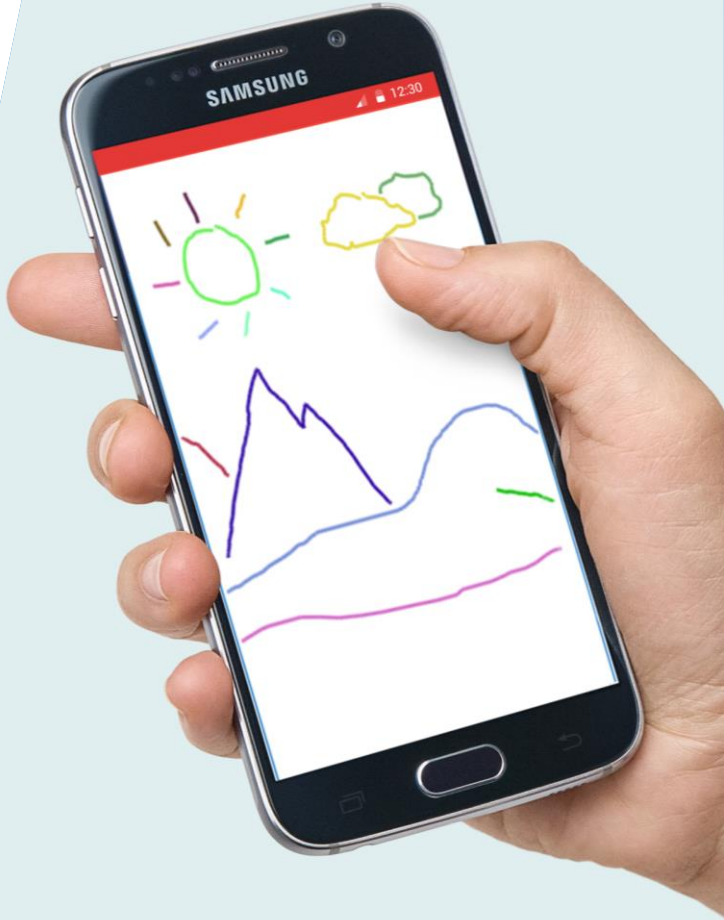
Individual Exercise

Create a multi-touch drawing app

Xamarin University

Summary

1. Discuss multi-touch in Android
2. Describe pointer motion event actions
3. Respond to multi-touch events
4. Create a multi-touch application



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