

IN4MATX 133: User Interface Software

Lecture 11:
Separation in Angular &
Modeling human performance

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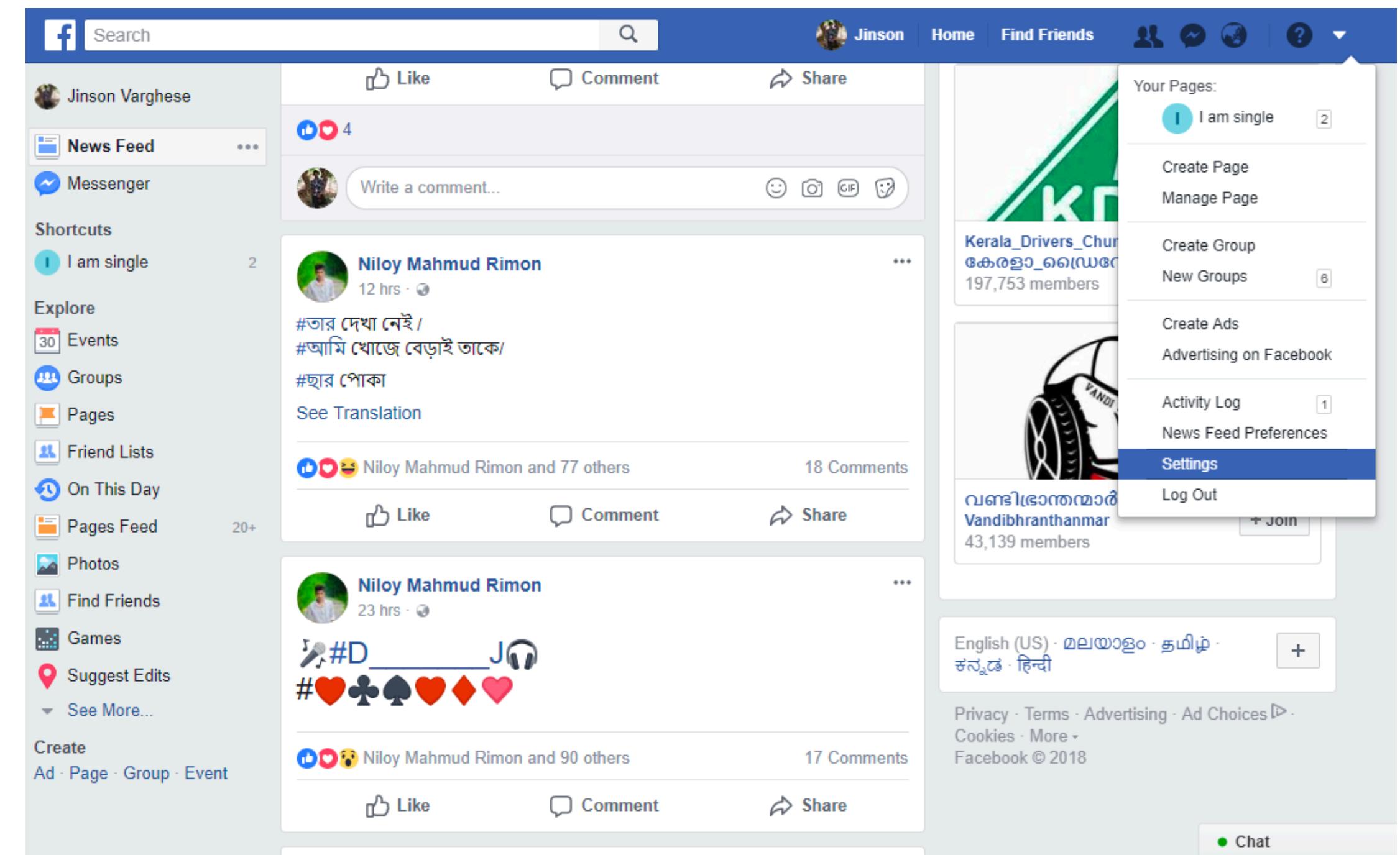
Today's goals

By the end of today, you should be able to...

- Differentiate and explain the roles of Angular components, modules, and services
- Implement a service in Angular
- Navigate Angular's file structure
- Describe the major components of Fitts's Law
- Explain how Fitts's Law impacts how interfaces should be designed
- Describe approaches for correcting systematic errors in touch performance

A “large” client interface

- Hundreds of pages and ways to navigate between pages
- Repeated UI elements (status updates)
 - Angular implements these as *components*
- Different content, links, etc. displayed for each person



A “large” client interface

- Loading lots of libraries can be slow and expensive
- So Angular supports sectioning parts of projects into distinct modules

Angular modules

- Segment code into a library, similar to a JavaScript library
- A component only imports the modules it needs

Angular modules

- By default, each Angular app has one module, `app.module.ts`
- But an app can create multiple modules to section off code
 - `ng generate module [name]`
- Modules can *import* other modules
- Modules also *declare* which components they use
 - When you create a new component (`ng generate component [name]`), it automatically gets added to the declarations for the root module

Angular modules

```
import { BrowserModule } from '@angular/platform-browser';
import { NgModule } from '@angular/core';

import { AppRoutingModule } from './app-routing.module';
import { AppComponent } from './app.component';
import { HelloComponent } from './hello/hello.component';
import { DayComponent } from './day/day.component';

@NgModule({
  declarations: [ ←Components used
    AppComponent,
    HelloComponent,
    DayComponent
  ],
  imports: [ ←Modules to import
    BrowserModule,
    AppRoutingModule
  ],
  providers: [ ],
  bootstrap: [AppComponent] ←The “root” component of the module
})
export class AppModule { }
```

Angular modules

- `BrowserModule` is included by default
 - Required to run any app in the browser
- When creating an Angular project, can specify whether a *Routing* module should be created
 - Routing: defines what URIs to send to what endpoints
 - For Angular, defines what URIs to send to what components

Angular routing

app-routing.module.ts

```
import { NgModule } from '@angular/core';
import { Routes, RouterModule } from '@angular/router';
import { ArtistPageComponent } from './pages/artist-page/artist-page.component';
import { TrackPageComponent } from './pages/track-page/track-page.component';
import { AlbumPageComponent } from './pages/album-page/album-page.component';
import { HomePageComponent } from './pages/home-page/home-page.component';

const routes: Routes = [
  { path: 'artist/:id', component: ArtistPageComponent}, ←Listens for any endpoint
  { path: 'track/:id', component: TrackPageComponent},
  { path: 'album/:id', component: AlbumPageComponent},
  { path: '', component: HomePageComponent}
];

@NgModule({
  imports: [RouterModule.forRoot(routes)],
  exports: [RouterModule]
})
export class AppRoutingModule { }
```

artist/:id
id can be retrieved in
album-page.component.ts

Retrieving route in a component

```
import { Component, OnInit } from '@angular/core';
import { ActivatedRoute } from '@angular/router';

@Component({
  selector: 'app-album-page',
  templateUrl: './album-page.component.html',
  styleUrls: ['./album-page.component.css']
})
export class AlbumPageComponent implements OnInit {

  constructor(private route: ActivatedRoute) {} ←“Injecting a service”

  ngOnInit() {
    var albumId = this.route.snapshot.paramMap.get('id'); ← Retrieve the id
    }                                     from the URI
}

}
```

Angular services

- Anything not associated with a specific view should be turned into a *service*
 - e.g., getting data from an API, parsing URIs for routing information
- Helps keep components lightweight
- Services can then be *injected* into a component (*importing*)
- To inject, import the service and retrieve it as a parameter in the constructor
 - `ng generate service [name]`

Angular services

```
import { Component, OnInit } from '@angular/core';
import { ActivatedRoute } from '@angular/router'; ← Importing a service

@Component({
  selector: 'app-album-page',
  templateUrl: './album-page.component.html',
  styleUrls: ['./album-page.component.css']
})
export class AlbumPageComponent implements OnInit {

  constructor(private route: ActivatedRoute) {} ← Injecting it

  ngOnInit() {
    var albumId = this.route.snapshot.paramMap.get('id'); ← Service can be
    }                                                 referenced later
  }
}
```

Angular services

```
import { Injectable } from '@angular/core'; ←Defined as injectable
import { HttpClient, HttpHeaders } from '@angular/common/http';
↑
@Injectable({
  providedIn: 'root' ←What module(s) can use this service
})
export class SpotifyService {
  baseUrl:string = 'http://localhost:8888';

  constructor(private http:HttpClient) { } ←HttpClient injected

  private sendRequestToExpress(endpoint:string) {
  }
}
```

Import a custom service

```
import { Component, OnInit } from '@angular/core';
import { ActivatedRoute } from '@angular/router';
import { SpotifyService } from '../services/spotify.service';

@Component({
  selector: 'app-album-page',
  templateUrl: './album-page.component.html',
  styleUrls: ['./album-page.component.css']
})
export class AlbumPageComponent implements OnInit {
```

```
  constructor(private route: ActivatedRoute,
  private spotifyService: SpotifyService) { }
```

Inject it like any other service



Import service via file structure

Question



Which of these is best implemented as a *module*, *service*, and *component*?

- (A) (1) Service, (2) Component, (3) Component
- (B) (1) Service, (2) Module, (3) Component
- (C) (1) Service, (2) Module, (3) Module
- (D) (1) Module, (2) Service, (3) Component
- (E) (1) Module, (2) Module, (3) Module



1. A library which communicates with Snapchat's database
2. The interface and packages needed to create and send a Snap
3. The interface and interaction for putting text on a Snapped photo

Question



Which of these is best implemented as a *module*, *service*, and *component*?

- A (1) Service, (2) Component, (3) Component
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- E (1) Module, (2) Module, (3) Module



- 1. A library which communicates with Snapchat's database
- 2. The interface and packages needed to create and send a Snap
- 3. The interface and interaction for putting text on a Snapped photo

Angular classes

- Plain-old classes can also be made in Angular
 - Any processing or munging you need to do, for example

- ng generate class [name]

```
export class Dataparser {  
  public constructor() {  
    console.log('Hello, world!');  
  }  
}
```

Import a class

```
import { Component, OnInit, Input } from '@angular/core';
import { Dataparser } from '../dataparser';

@Component({
  selector: 'app-day',
  templateUrl: './day.component.html',
  styleUrls: ['./day.component.css']
})
export class DayComponent implements OnInit {
  @Input() today:string;

  days = ["Sunday", "Monday", "Tuesday", "Wednesday", "Thursday", "Friday", "Saturday"];

  constructor() {
    var data = new Dataparser();
  }

  ngOnInit() {
  }
}
```

 Import class via file structure

 Instantiate it like any other class

Import a library

- Since Angular is in TypeScript, it can use any JavaScript or TypeScript library
- Install as normal with npm: `npm install [packagename]`
 - If you want TypeScript typings, don't forget to install `@types/[packagename]`

Import a library

```
import * as chroma from 'chroma-js'; ←Note: different syntax
```

```
export class Dataparser {  
  
  constructor() {  
    console.log(chroma('royalblue')); // '#4169e1'  
  }  
}
```

↑
Can now be referenced

Angular's file structure

- Angular projects generate a *lot* of files
 - There are about 75 in the starter code for A3
- Most are boilerplate

```
▼ example
  ► e2e
  ► node_modules
  ▼ src
    ▼ app
      ► day
      ► hello
      /* app-routing.module.ts
      /* app.component.css
      <> app.component.html
      /* app.component.spec.ts
      /* app.component.ts
      /* app.module.ts
    ► assets
    ► environments
    □ browserslist
    □ favicon.ico
    <> index.html
    /* karma.conf.js
    /* main.ts
    /* polyfills.ts
    /* styles.css
    /* test.ts
    /* tsconfig.app.json
    /* tsconfig.spec.json
    /* tslint.json
    □ .editorconfig
    ≡ .gitignore
    /* angular.json
    /* package-lock.json
    /* package.json
    <> README.md
    /* tsconfig.json
    /* tslint.json
```

Add the tweets below.

#runstreak #day7 #runkeeper <https://t.co/Hv727omXIJ>

Target achieved, 10 km in less than an hour!! #RunKeeper <https://t.co/XgQ7ZnMy18>

Big run Just posted a 16.21 km run - #Runkeeper <https://t.co/SUqThdt6lN>

#runkeeper🏃‍♂️🏃‍♂️🏃‍♂️ <https://t.co/mYp40c7Zyw>

Added my 5 to the #global5k with @runkeeper this morning 🏃‍♂️🏃‍♂️ #running #fitness #5k #asics #runkeeper @ Yeovil, So... <https://t.co/K4uuq9JOAA>

11,20 kms with #Runkeeper <https://t.co/o3npTJfm2o>

夜道をうろうろ。少し寒いぐらいだ。汗をかかなくていいけど #runkeeper <https://t.co/d3P8CTmvln>

#Runkeeper #MondayWalk <https://t.co/JU6c1YxY5X>

Just posted a 4.12 km run - #Runkeeper <https://t.co/6ykK6XqScy>

T134 - Treino de Corrida em 2019 #20191021 #boralá🏃‍♂️ #runinthemorning #8km #amazfitip #nikerunclub... <https://t.co/loxGgc5sAw>

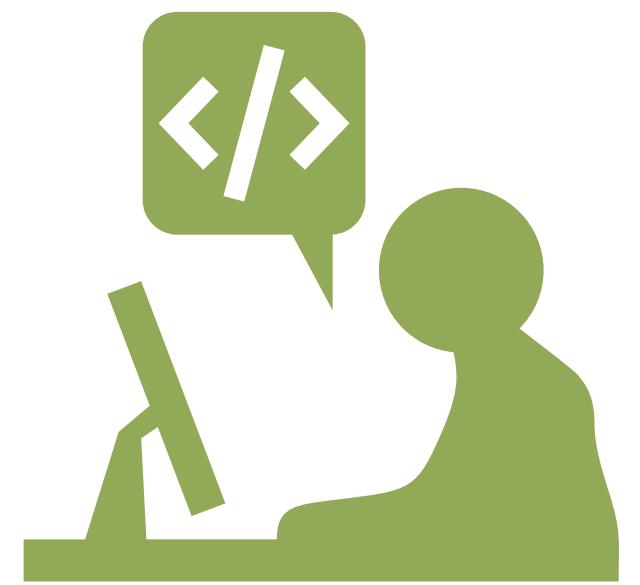
Needed it though. 4.5 miles on a Monday #runningmotivation #run #runsararun #runkeeper #hillrun #runner... <https://t.co/f48PJPUOZm>

8週目 たった今 Runkeeper でアクティビティを完了しました #Runkeeper <https://t.co/BA68aH2Ma0>

お昼前は公園に人がいないのね。#朝んば #walking #runkeeper #お散歩 #shiba #shibastagram #柴犬 #黒柴 #ここ柴部 <https://t.co/7GyAL8byfF>

Just posted a 11.16 km run - #Runkeeper <https://t.co/Y9lcvlfcwY>

Just posted a 5.97 km run - #Runkeeper <https://t.co/SzSG927ePg>



A3 assignment partners

- We're not going to create pairs because there's a long list of properties which go into creating a good match; most of which we don't know
 - Programming background/interest (frontend, backend, user experience, etc.)
 - Schedule and other commitments
 - Preferred working style (in-person, remote, etc.)

Good questions to ask an assignment partner

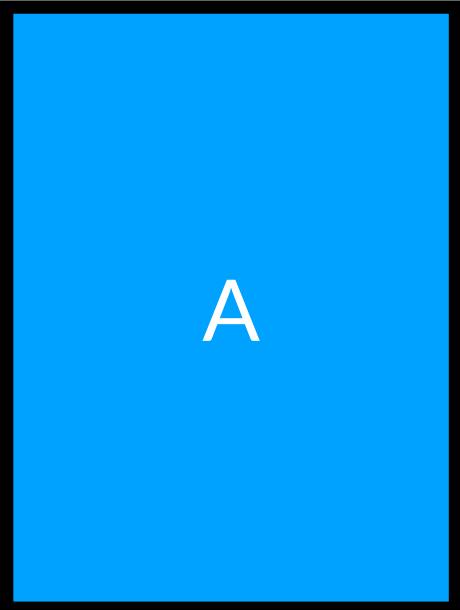
- When do you normally work (morning, afternoon, evening, late evening)?
- Do you live on campus? Near campus?
- Would you prefer meeting up in-person or online?
- Are you interested in frontend development, backend development, user experience, etc.?
- What's the minimum grade you would be comfortable receiving on this assignment?

Switching topics: Modeling performance

Question



Which button would be faster to click on?

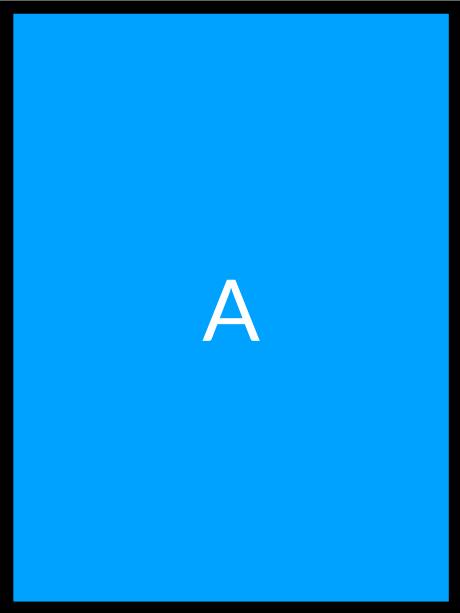


- A
- B
- C Roughly equal
- D
- E

Question



Which button would be faster to click on?



- A
- B
- C Roughly equal
- D
- E

Fitts's Law (1954)

- Models time to acquire targets in aimed movement
 - Reaching for control in a cockpit
 - Moving across a dashboard
 - Pulling defective items from a conveyor belt
 - Clicking on icons using a mouse

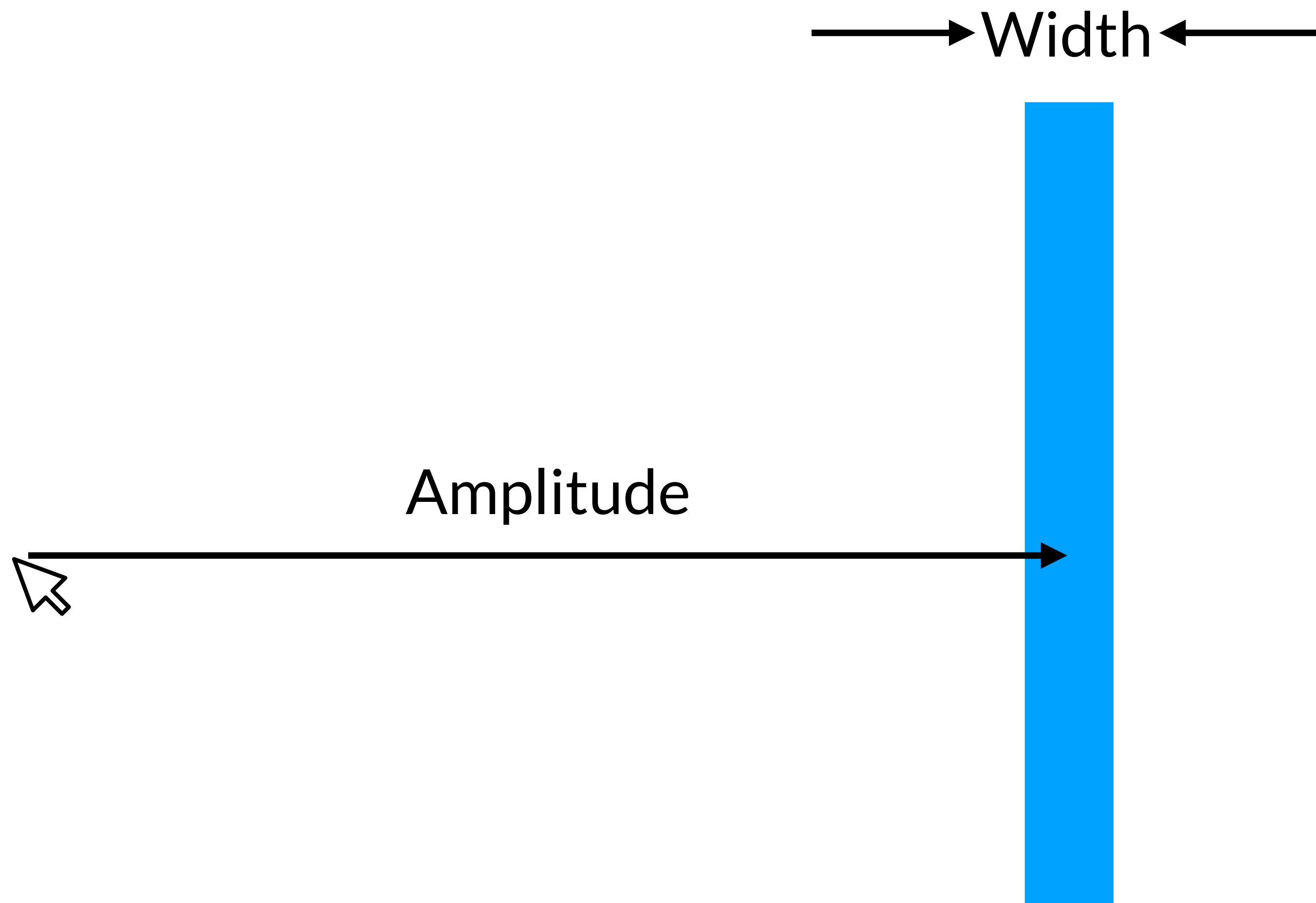
https://en.wikipedia.org/wiki/Fitts%27s_law

Fitts's Law (1954)

- Very powerful, widely used
 - Holds for many circumstances (e.g., under water)
 - Allows for comparison among different experiments
 - Used both to measure and predict

https://en.wikipedia.org/wiki/Fitts%27s_law

Point-select task



Fitts's Law

- $MT = a + b \log_2(A / W + 1)$
 - What kind of equation does this look like?

Fitts's Law

- $MT = a + b \log_2(A / W + 1)$
 - What kind of equation does this look like?
- $y = mx + b$
- $MT = a + bx$, where $x = \log_2(A / W + 1)$
 - x is called the Index of Difficulty (ID)
 - As “A” goes up, ID goes up
 - As “W” goes up, ID goes down

Movement Time (MT)

- $MT = a + b \log_2(A / W + 1)$
- Time, in seconds, to acquire the target (e.g., click on the button)

Index of Difficulty (ID)

- $\log_2(A / W + 1)$
 - Fitts's Law claims that the time to acquire a target increases linearly with the log of the ratio of the movement distance or amplitude (A) to target width (W)

Index of Difficulty (ID)

- $\log_2(A / W + 1)$
 - Fitts's Law claims that the time to acquire a target increases linearly with the log of the ratio of the movement distance or amplitude (A) to target width (W)
- Why is it significant that it is a ratio?
 - Units of A and W don't matter
 - Allows comparison across experiments

Index of Difficulty (ID)

- $\log_2(A / W + 1)$
 - Fitts's Law claims that the time to acquire a target increases linearly with the log of the ratio of the movement distance or amplitude (A) to target width (W)
- ID units typically in “bits”
 - Because of association with information capacity and somewhat arbitrary use of base-2 logarithm

Index of Performance (IP)

- $MT = a + b \log_2(A / W + 1)$
 - b is slope
- $1/b$ is called Index of Performance (IP)
 - If MT is in seconds, IP is in bits/second
- Also called “throughput” or “bandwidth”
- a and b depend on the input device

Question



</> touch

Will a mouse or a touchpad have lower movement time (MT)?

- A mouse
- B A touchpad
- C Roughly equal
- D
- E



[Fitts's law demo]

<http://www.yorku.ca/mack/FittsLawSoftware/>

“Beating” Fitts’s law

- It is the law, right?
 - $MT = a + b \log_2(A/W + 1)$
- So how can we reduce movement time?
 - Reduce amplitude (A)
 - Increase width (W)

“Beating” Fitts’s law

- Put targets closer together
- Make targets bigger
- Make cursor bigger
- Make impenetrable edges

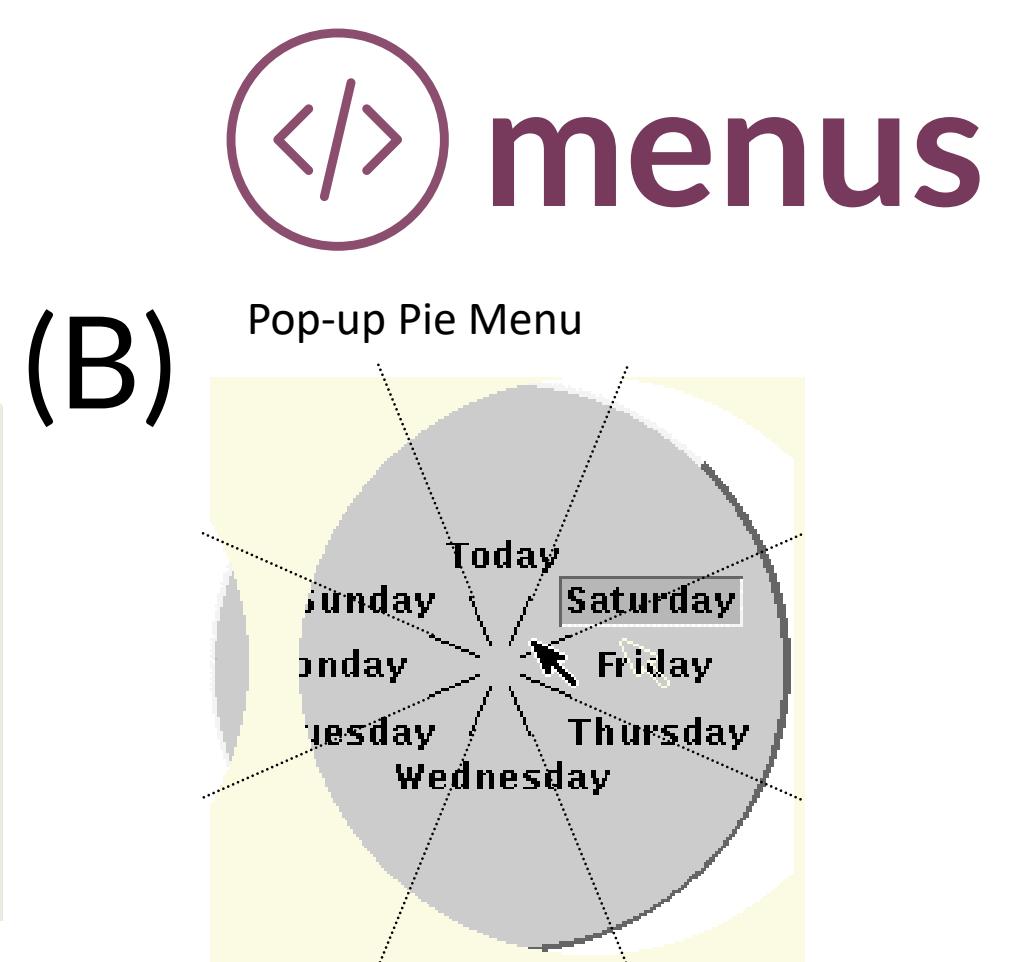
Question



Which menu will be faster on average?

(A) Pop-up Linear Menu

Today
Sunday
Monday
Tuesday
Wednesday
Thursday
Friday
Saturday



- A
- B
- C Roughly equal
- D
- E

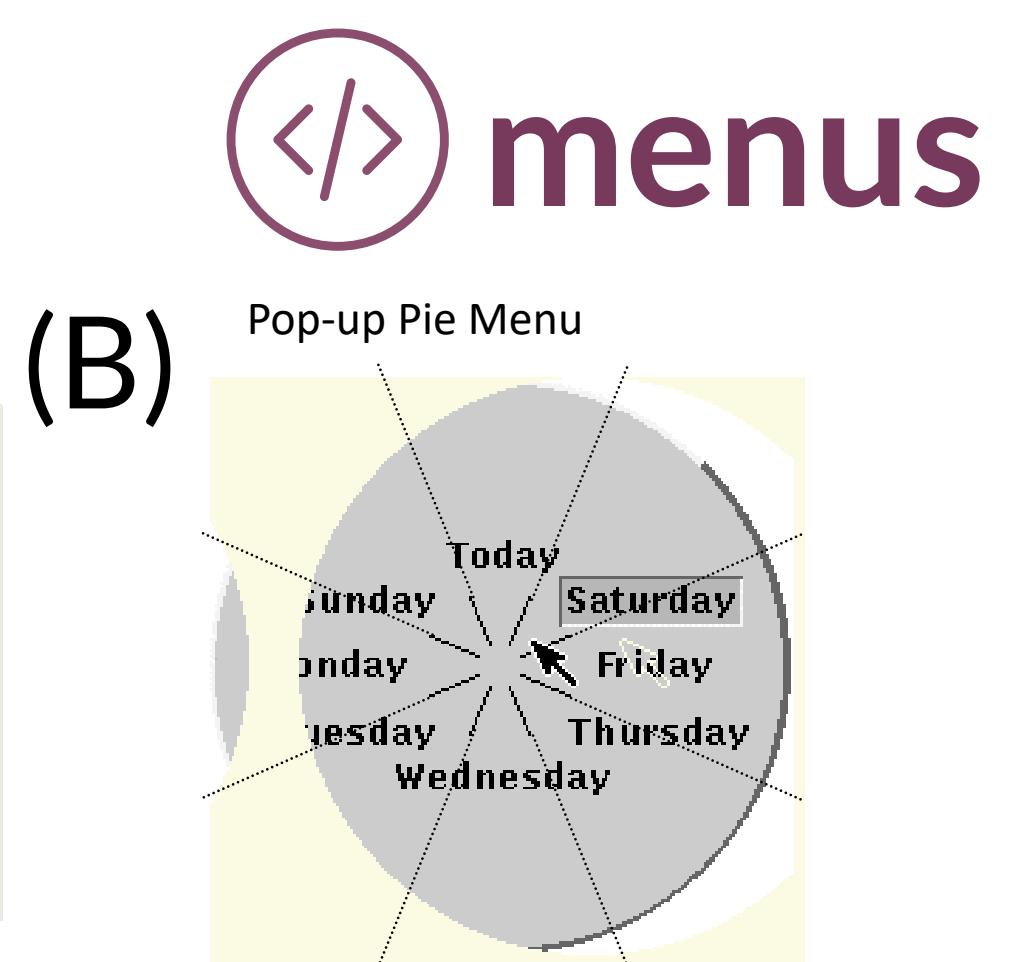
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Which menu will be faster on average?

(A) Pop-up Linear Menu

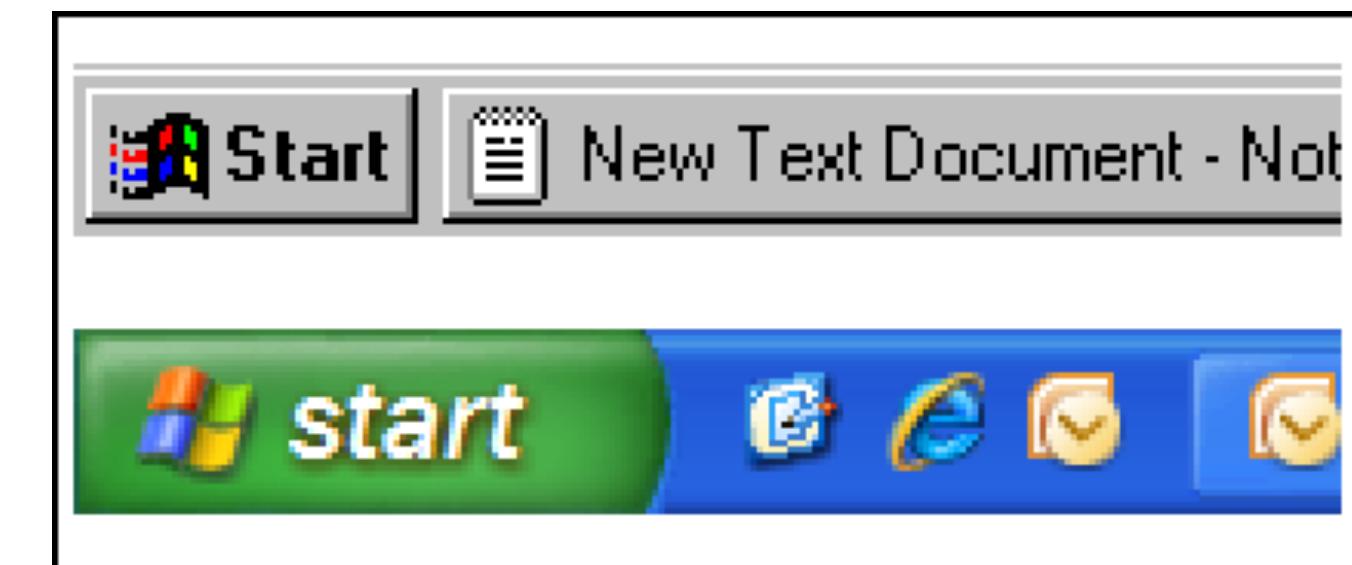
Today
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- A
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Fitts's Law in windowing

- Windows 95: missed by a pixel
- Windows XP: good to the end
- Corners and edges make great targets
 - Do not have to move precisely to trigger them
 - They have “infinite” width



Fitts's Law in other domains

- How would Fitts's Law apply to using touch input on a phone?
 - Shorter distances (smaller screen)
- All things being equal, movement times *should* be lower
 - Shorter distances, faster to move your finger than a mouse

Fitts's Law in other domains

- But in practice, touchscreens on mobile tend not to be much faster
 - Buttons are smaller
 - People tend to be slower near the edges of touchscreens

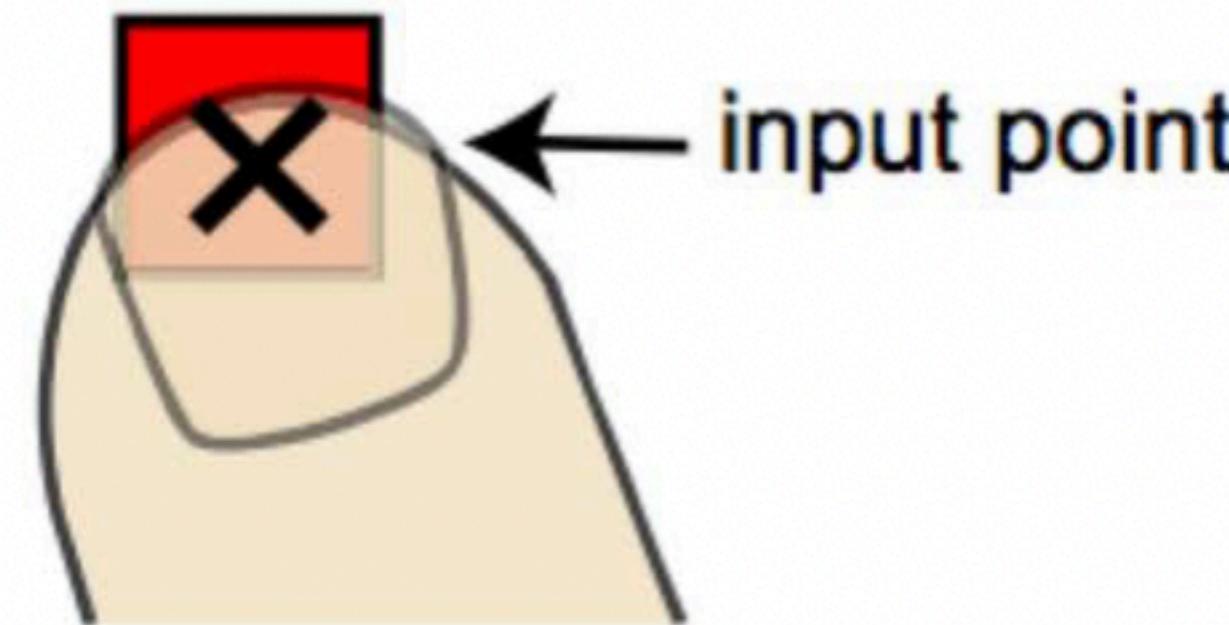
Modeling input

Modeling mouse position

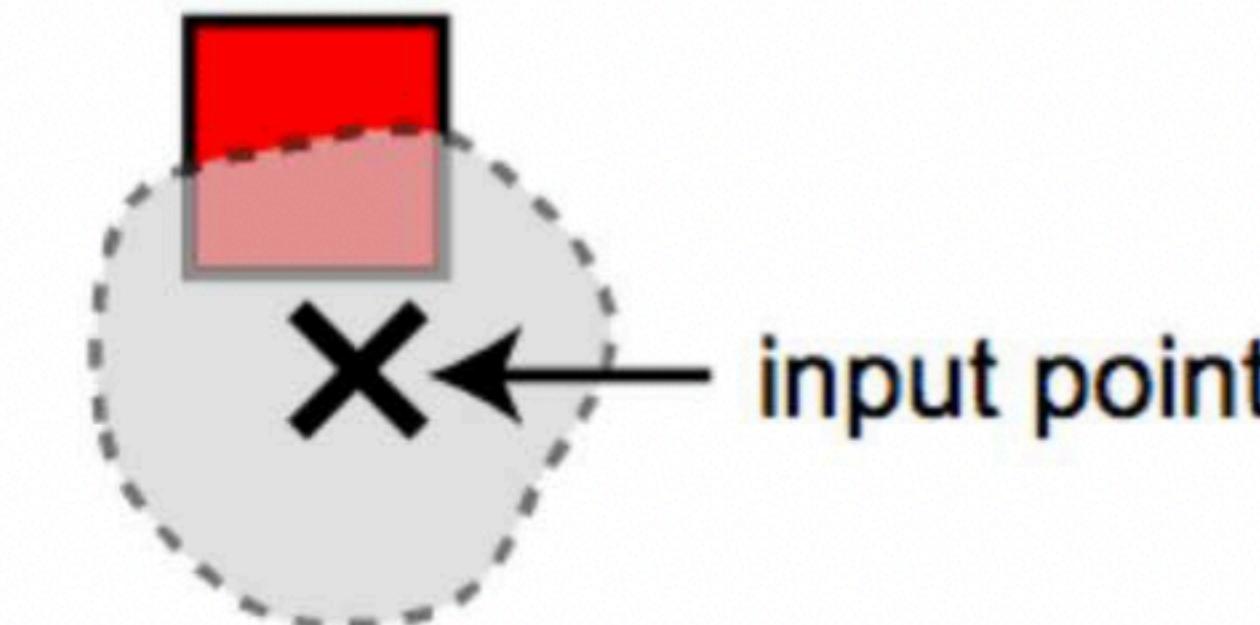
- Mouse pointer is relatively small
- We model it via X, Y position on the screen
- See whether that X, Y overlaps with a button, for example
 - Targets are usually large enough that “exact” position does not matter

Modeling touch position

(a) user view



(b) hardware view



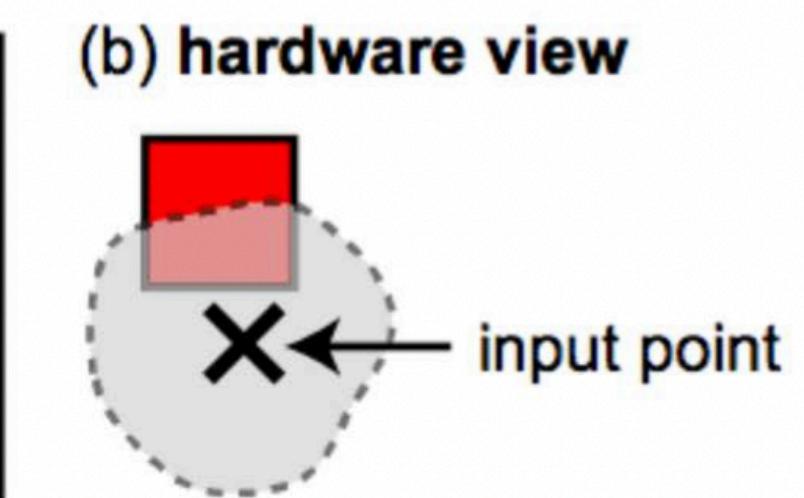
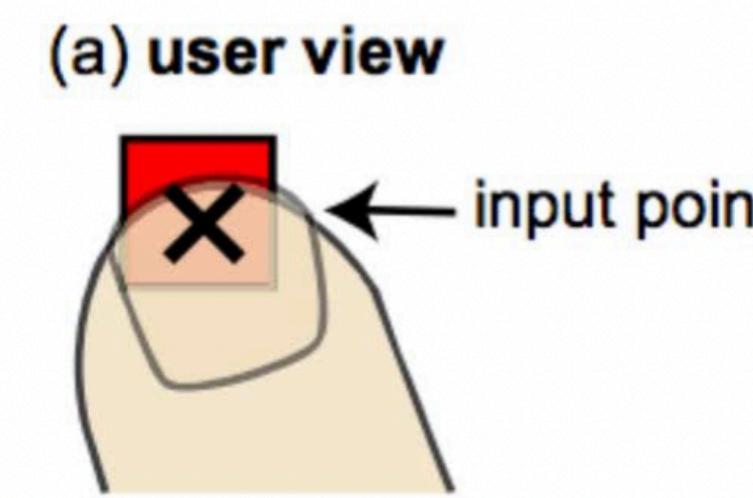
Modeling touch position

- One interpretation of the problem:
our fingers are fat
 - We should use tiny styluses to make our selection more accurate
- Another interpretation:
our model of touch position is inaccurate
 - We should make our model better

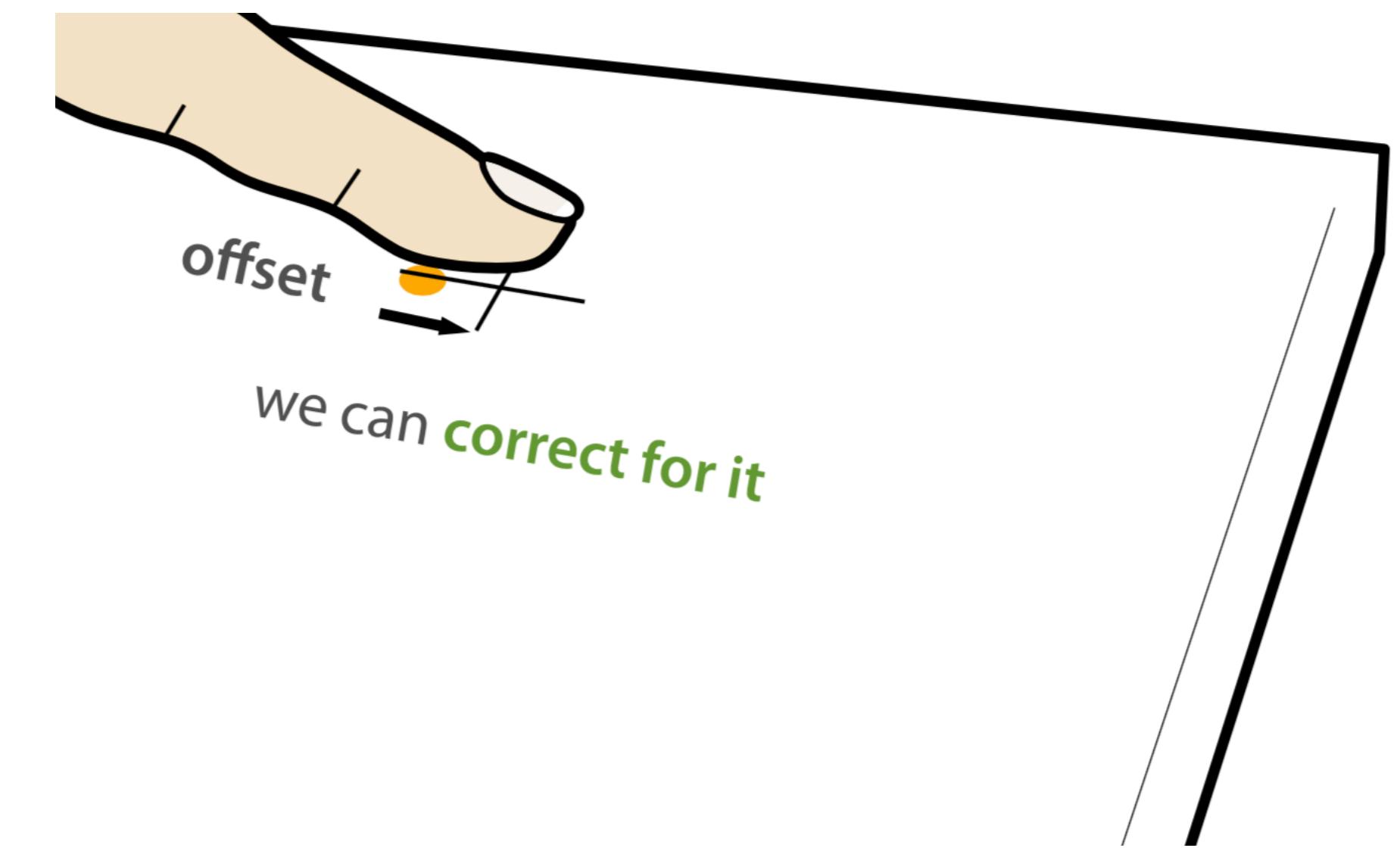
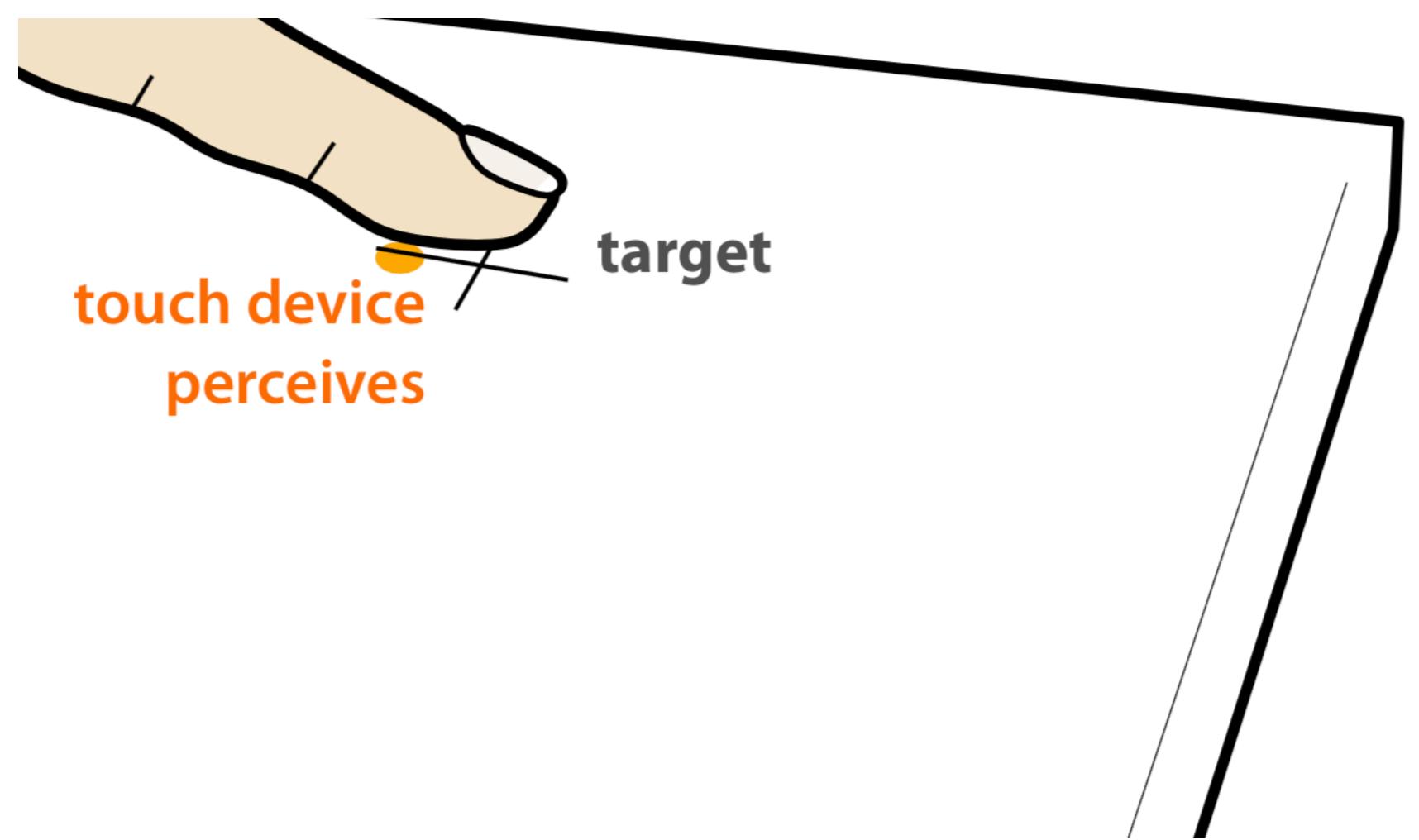


Modeling touch position

- How can we improve our model?
- Make the hardware view more closely match the user view

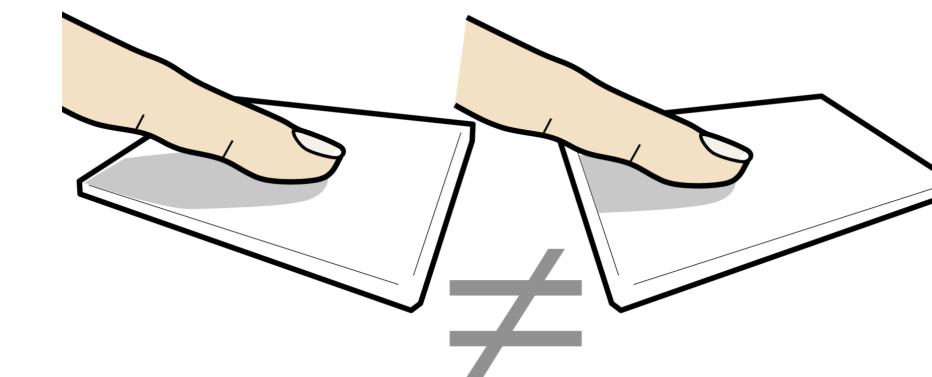


Modeling touch position

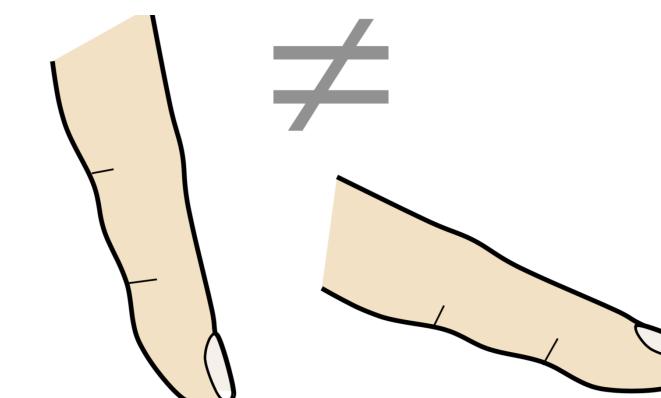


Modeling touch position

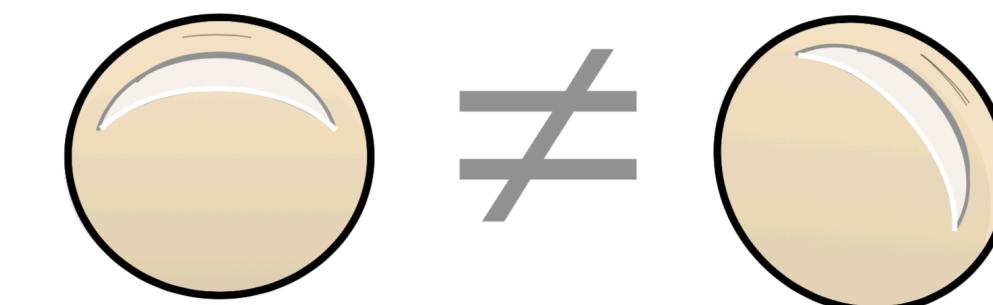
- Hypothesis: yaw, pitch, and roll all impact touch position
 - Additionally, for each person, finger size/shape and mental model impact touch position



Yaw: angle of touch device



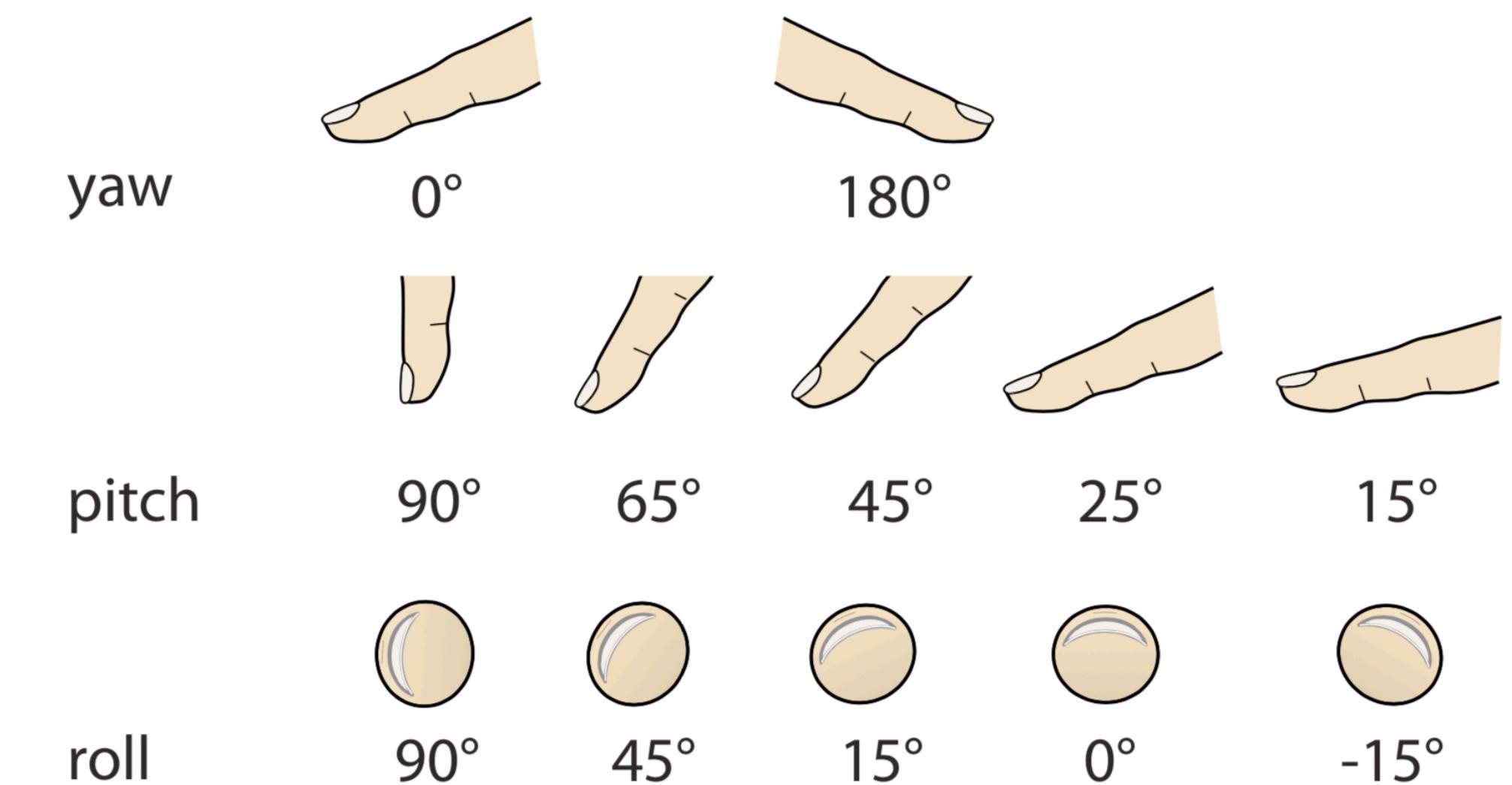
Pitch: angle of finger



Roll: rotation of finger

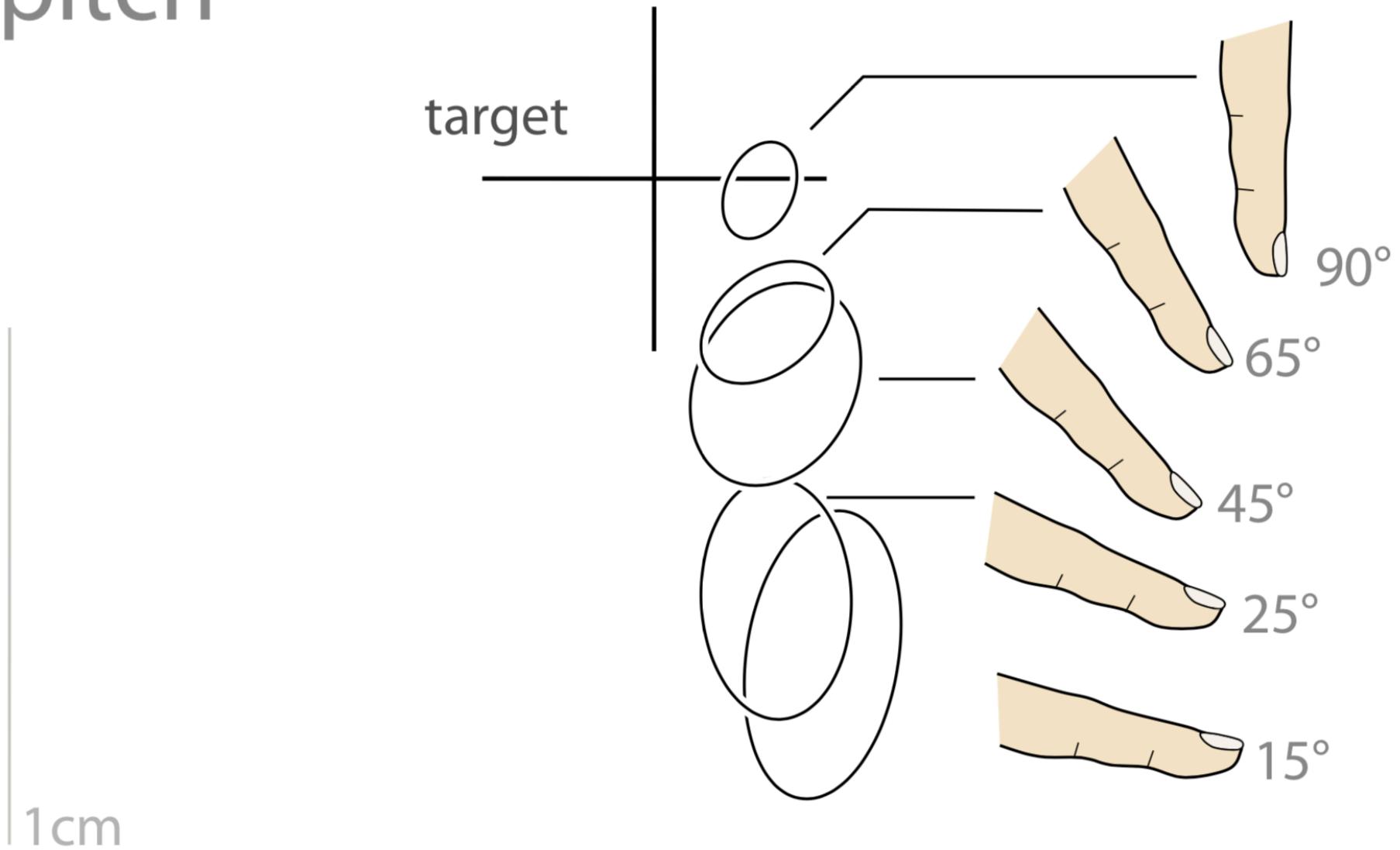
Modeling touch position

- Ran a study
 - 12 participants touched 600 points each
 - Varied yaw, pitch, and roll

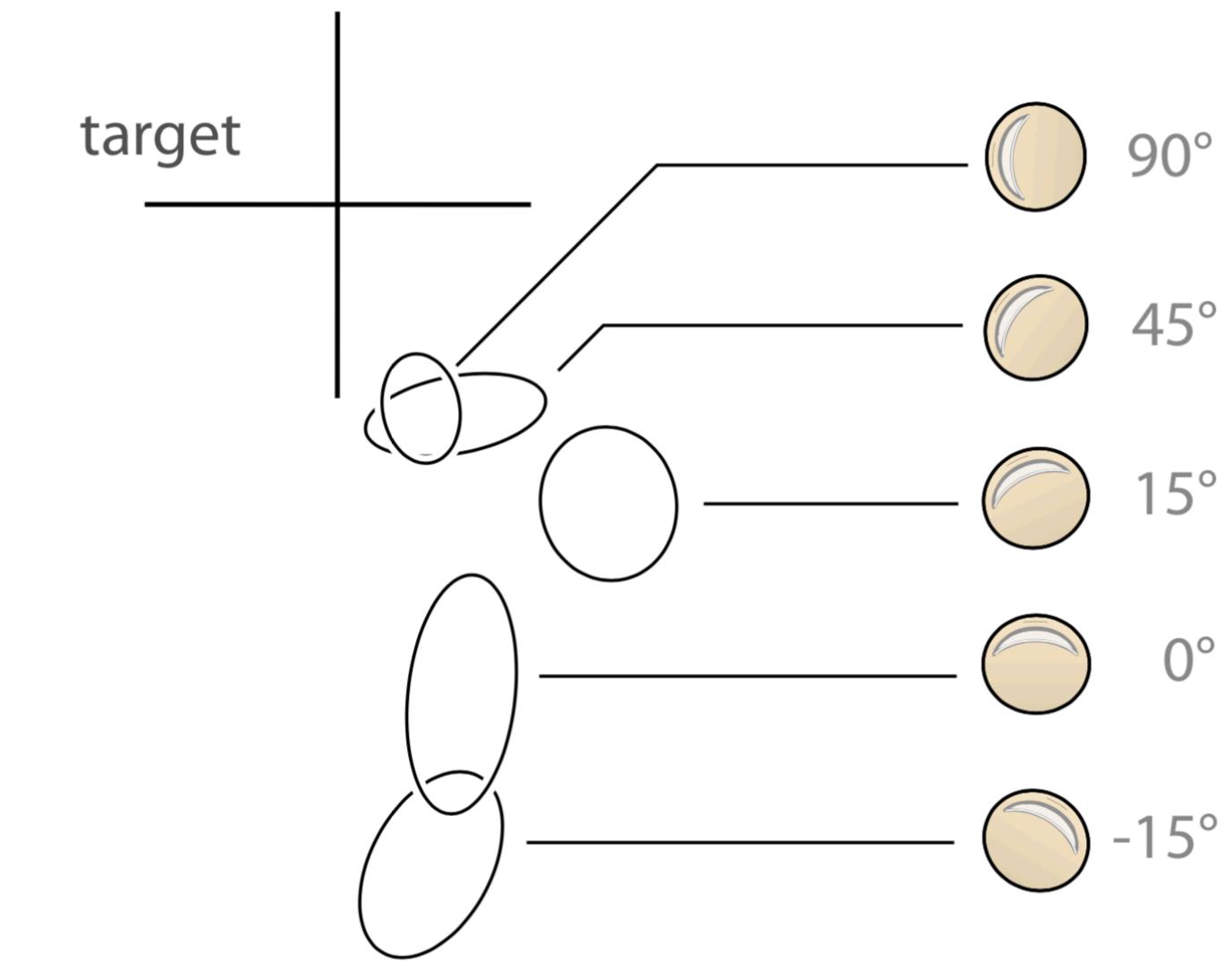


Modeling touch position

pitch

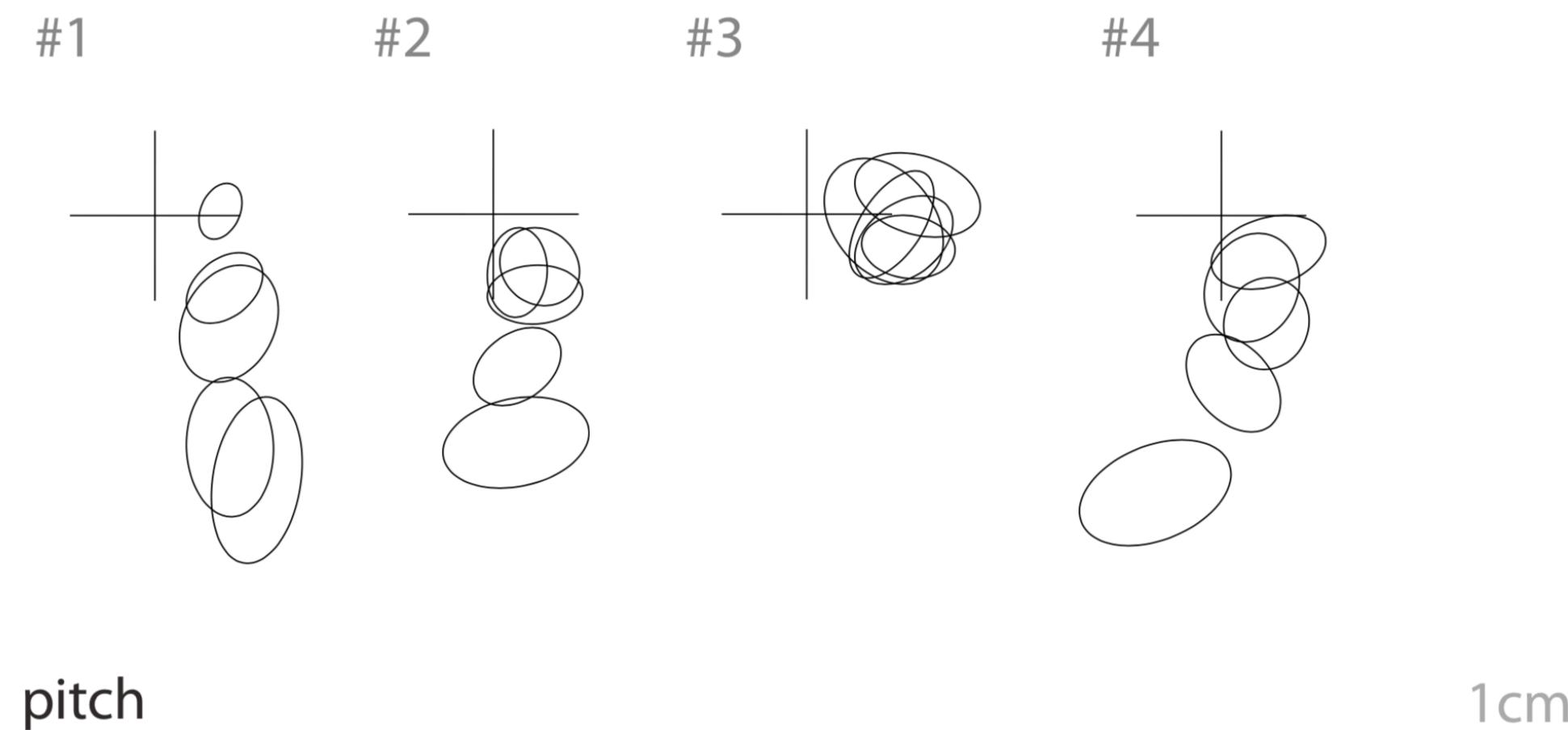


roll



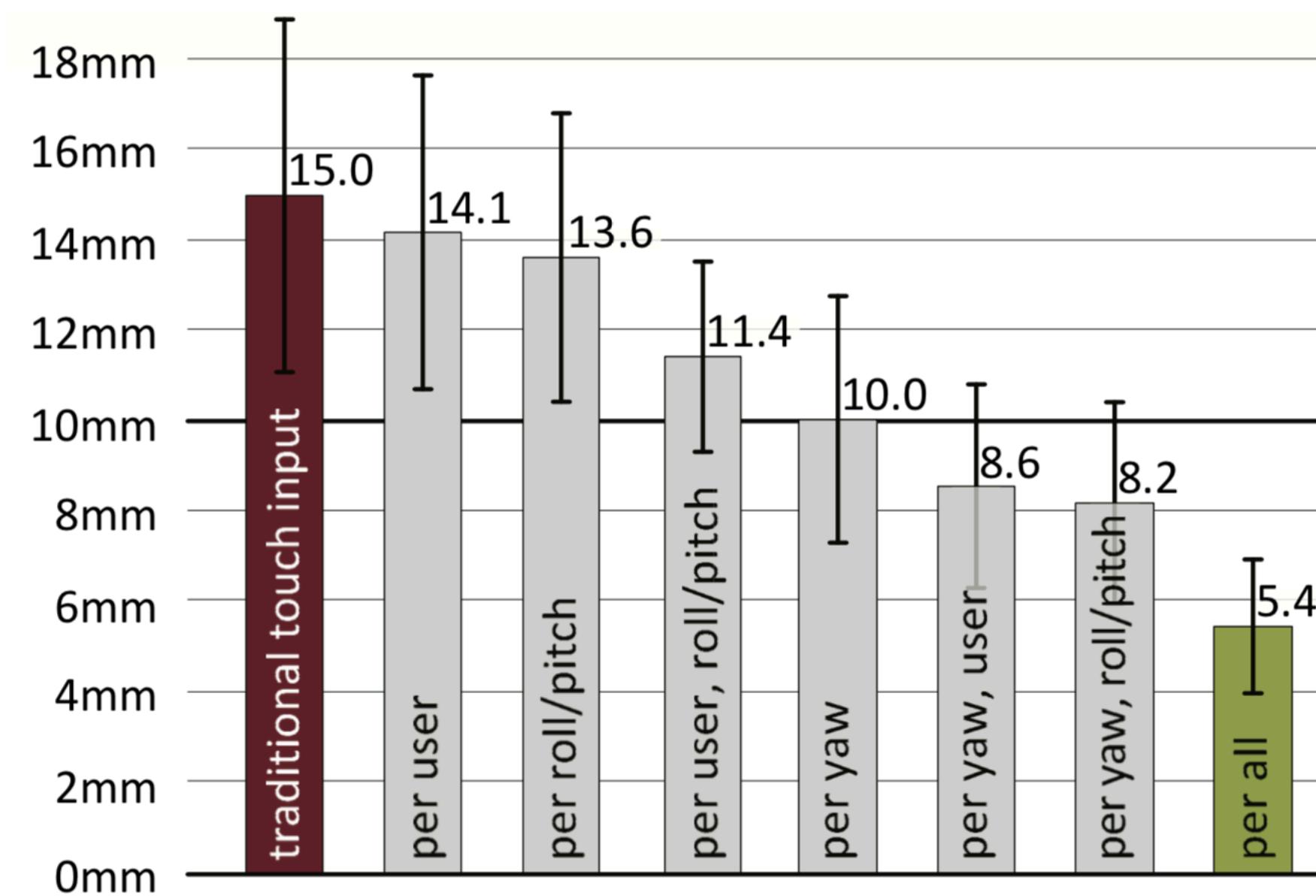
Modeling touch position

user



Modeling touch position

minimum button size



Improving the model means that buttons can be **3x** smaller and not be any harder to click

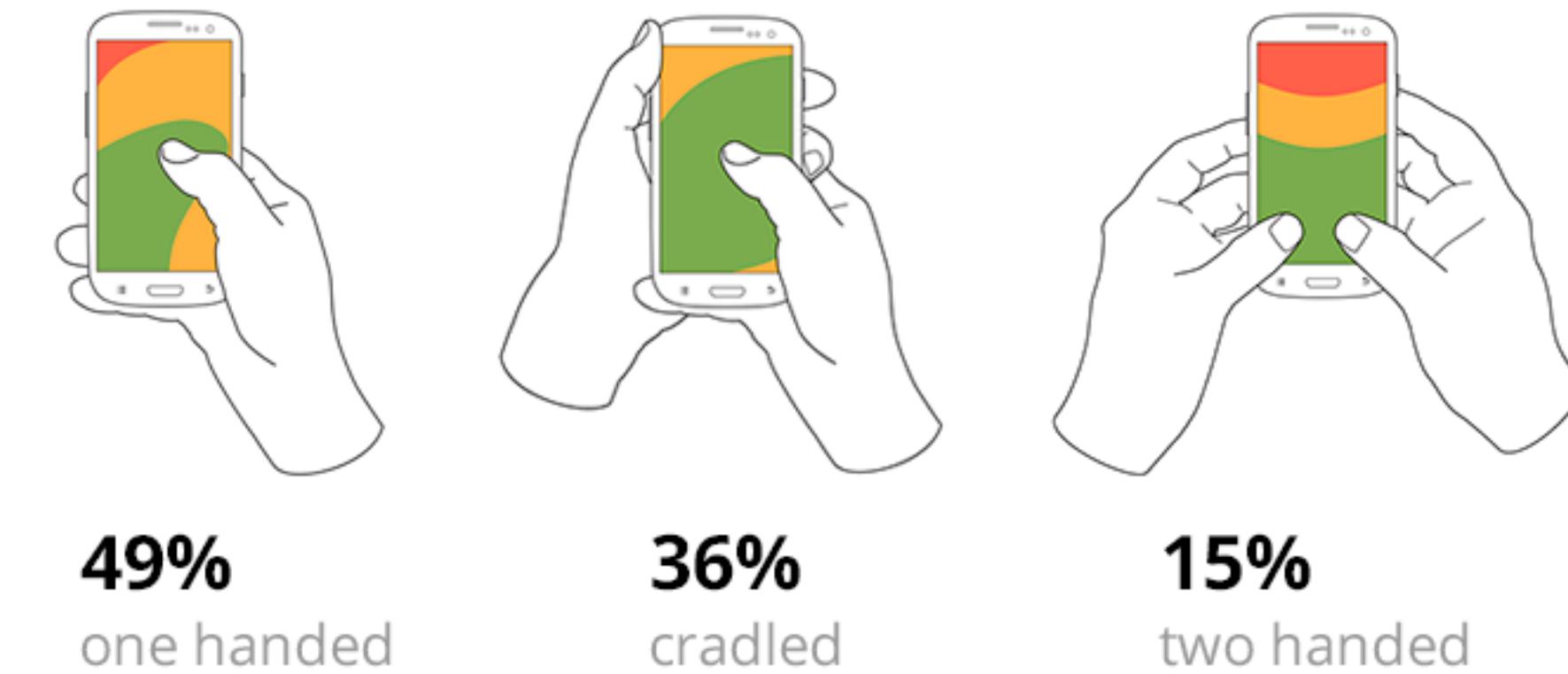
Modeling touch input

- Study was *very controlled*
 - Participant sat in a chair, the screen was on a desk
 - How about the other ways that people use their phones?

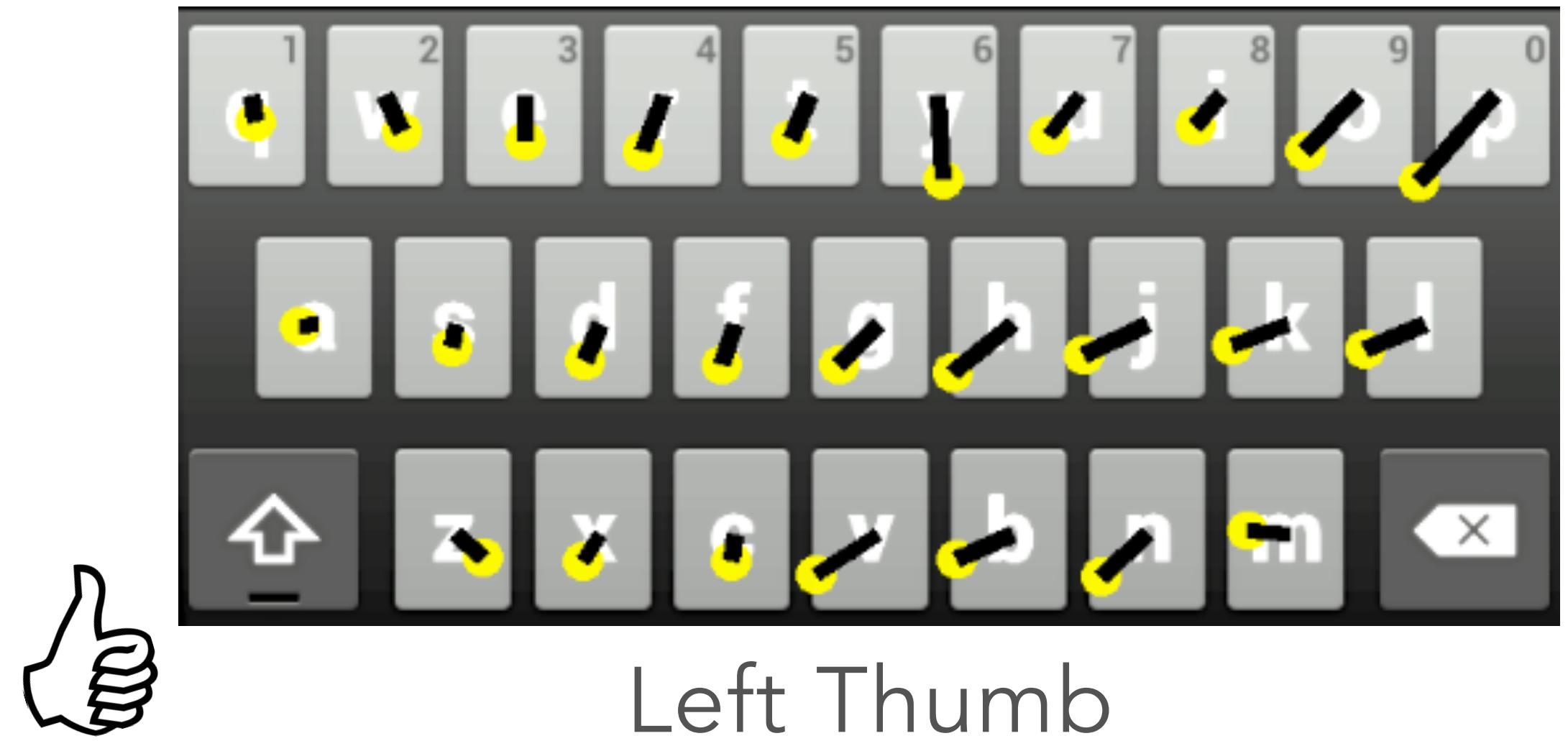


Modeling phone grip

- People grip their phones in different ways
- Grip changes with phone size, hand size
 - Situational changes (e.g., walking, holding something)
- Can we detect phone grip and update our model?



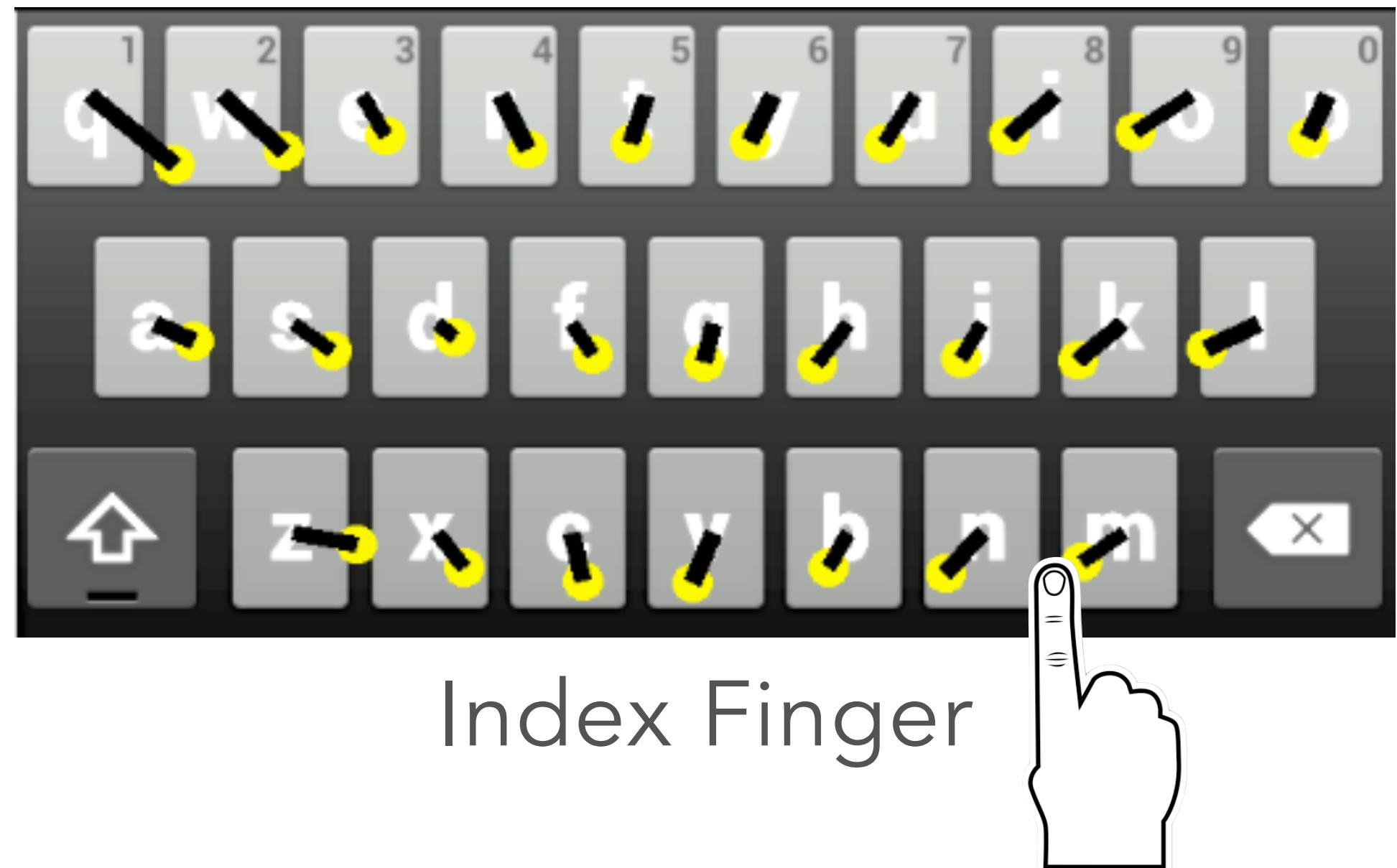
Modeling phone grip



Modeling phone grip

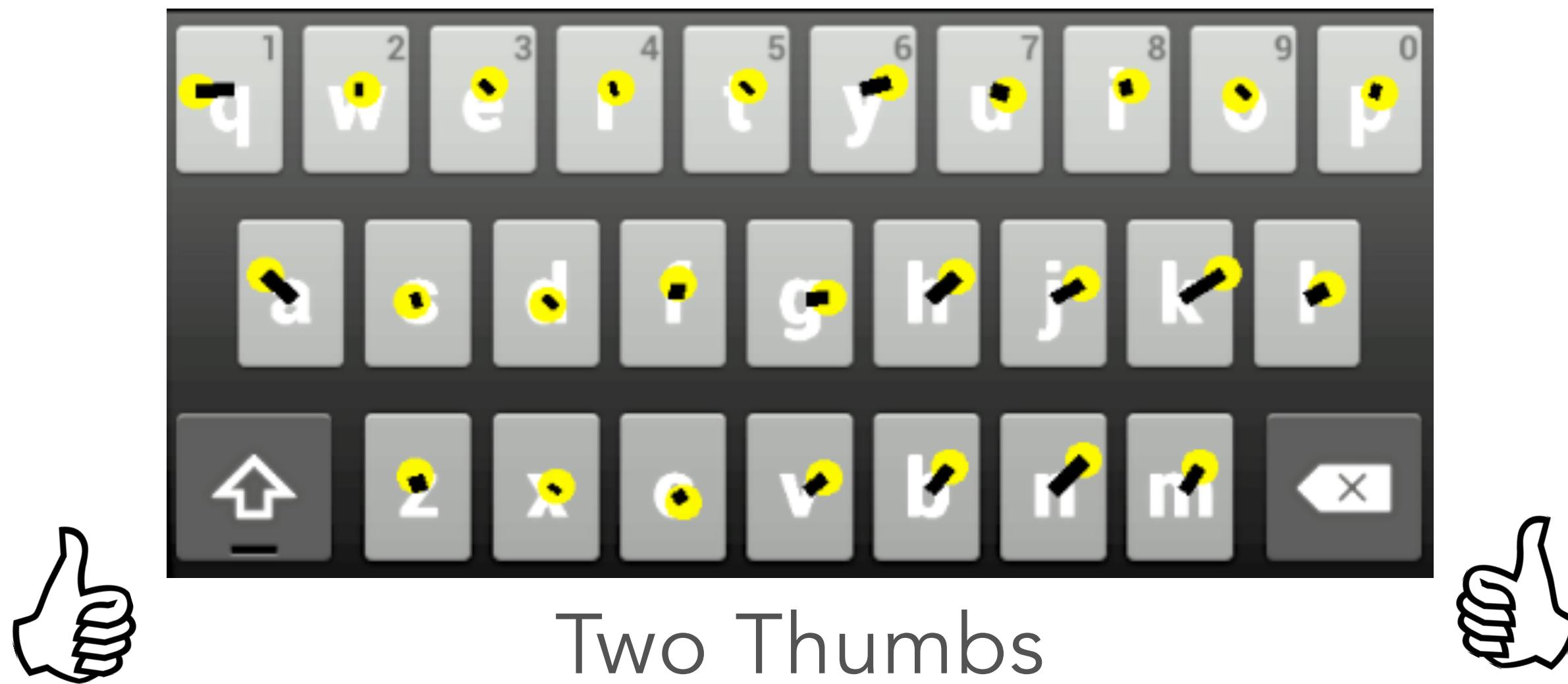


Modeling phone grip



Mayank Goel, Alex Jansen, Travis Mandel, Shwetak N. Patel, and Jacob O. Wobbrock. 2013. ContextType: using hand posture information to improve mobile touch screen text entry. CHI 2013. <https://doi.org/10.1145/2470654.2481386>

Modeling phone grip

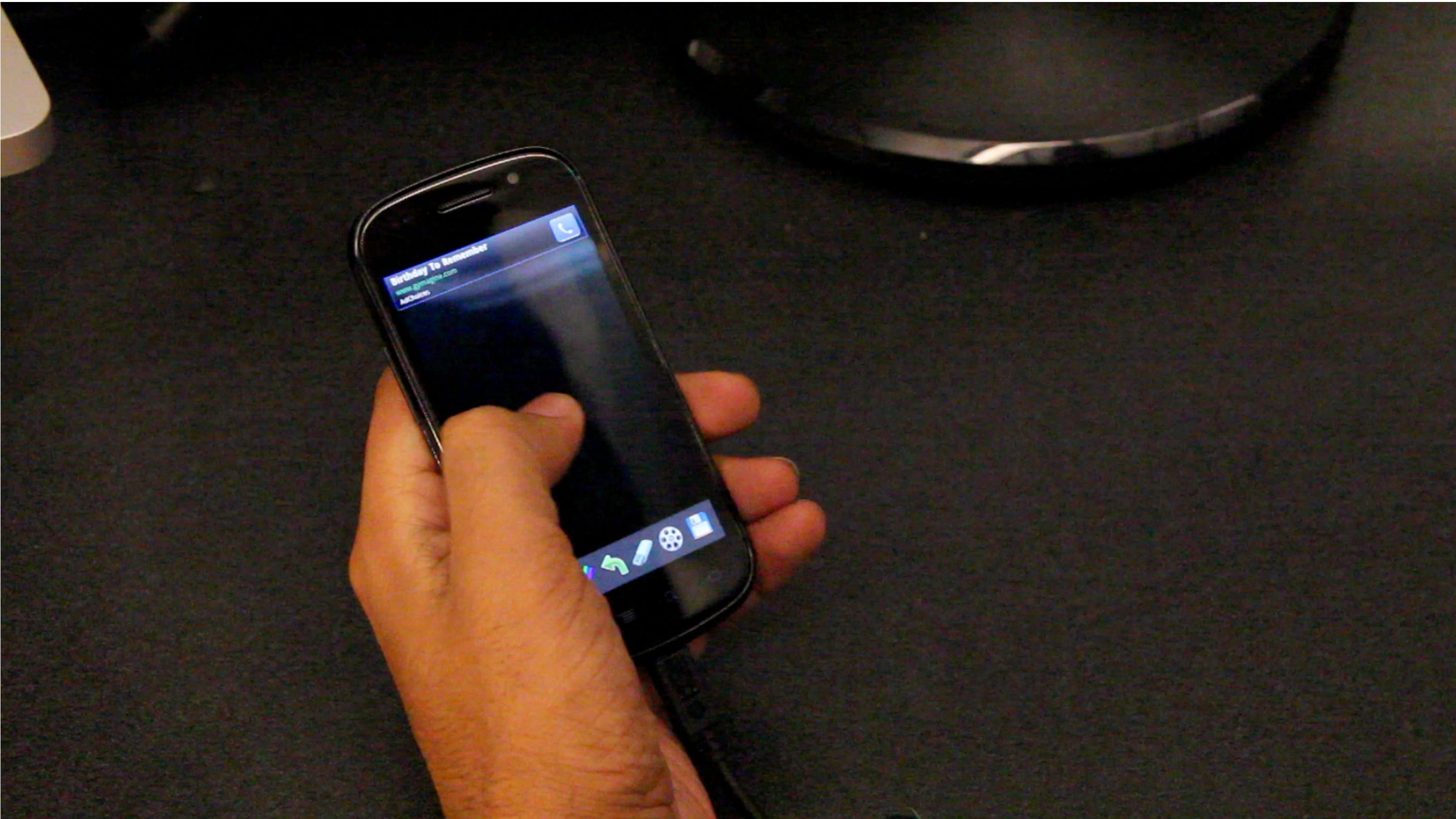


Detecting phone grip with sensors



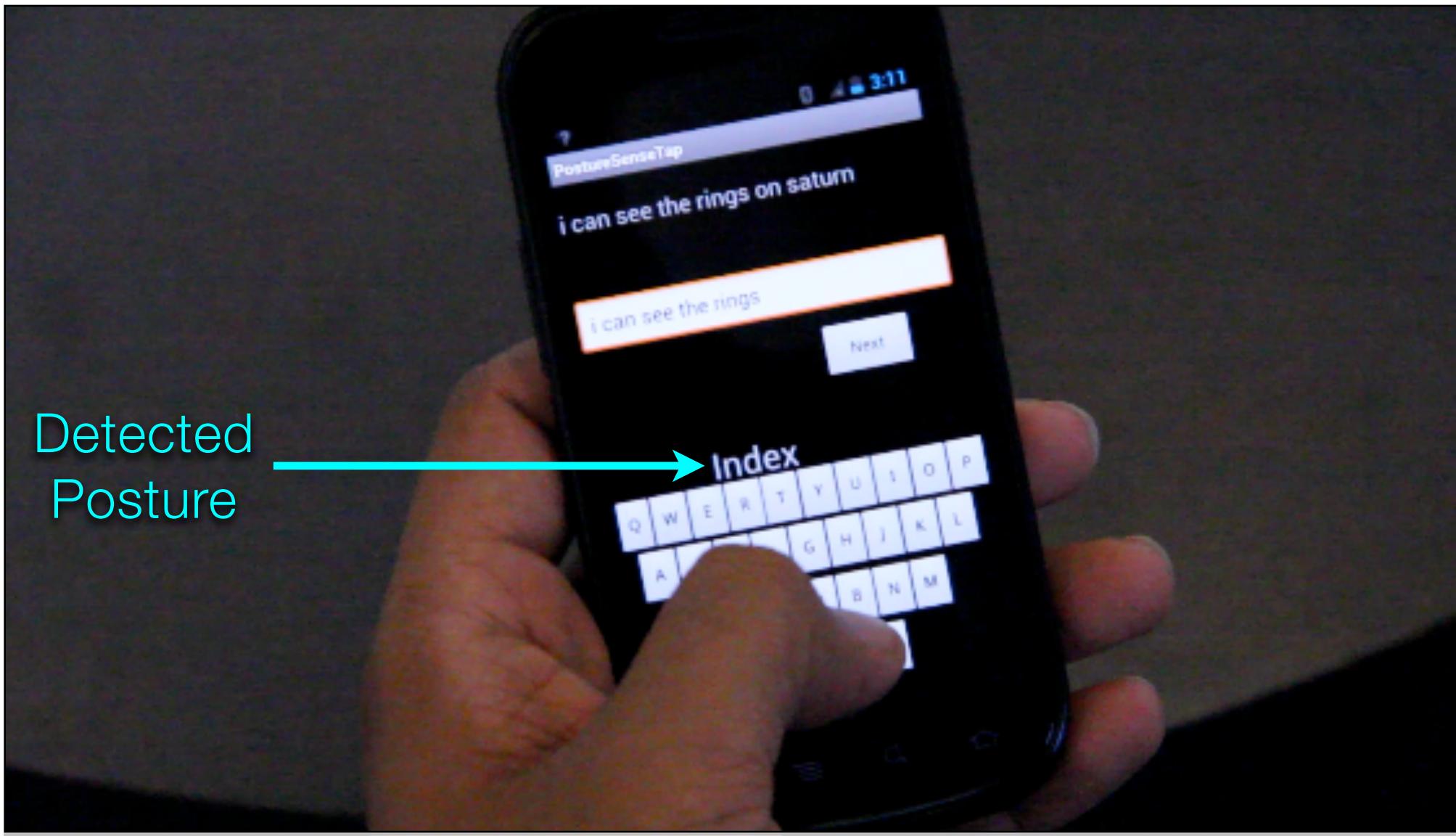
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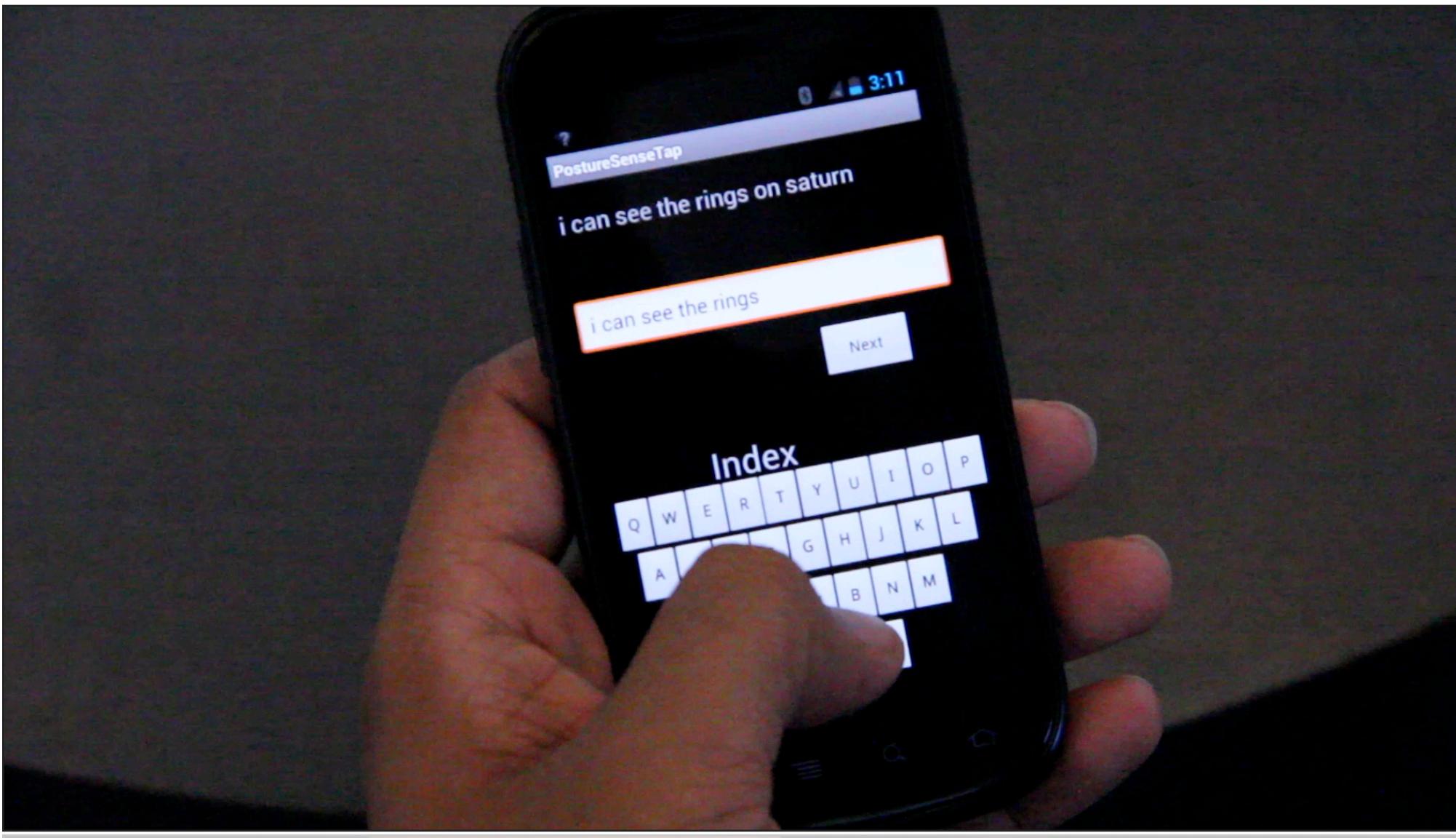
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Detecting phone grip with sensors



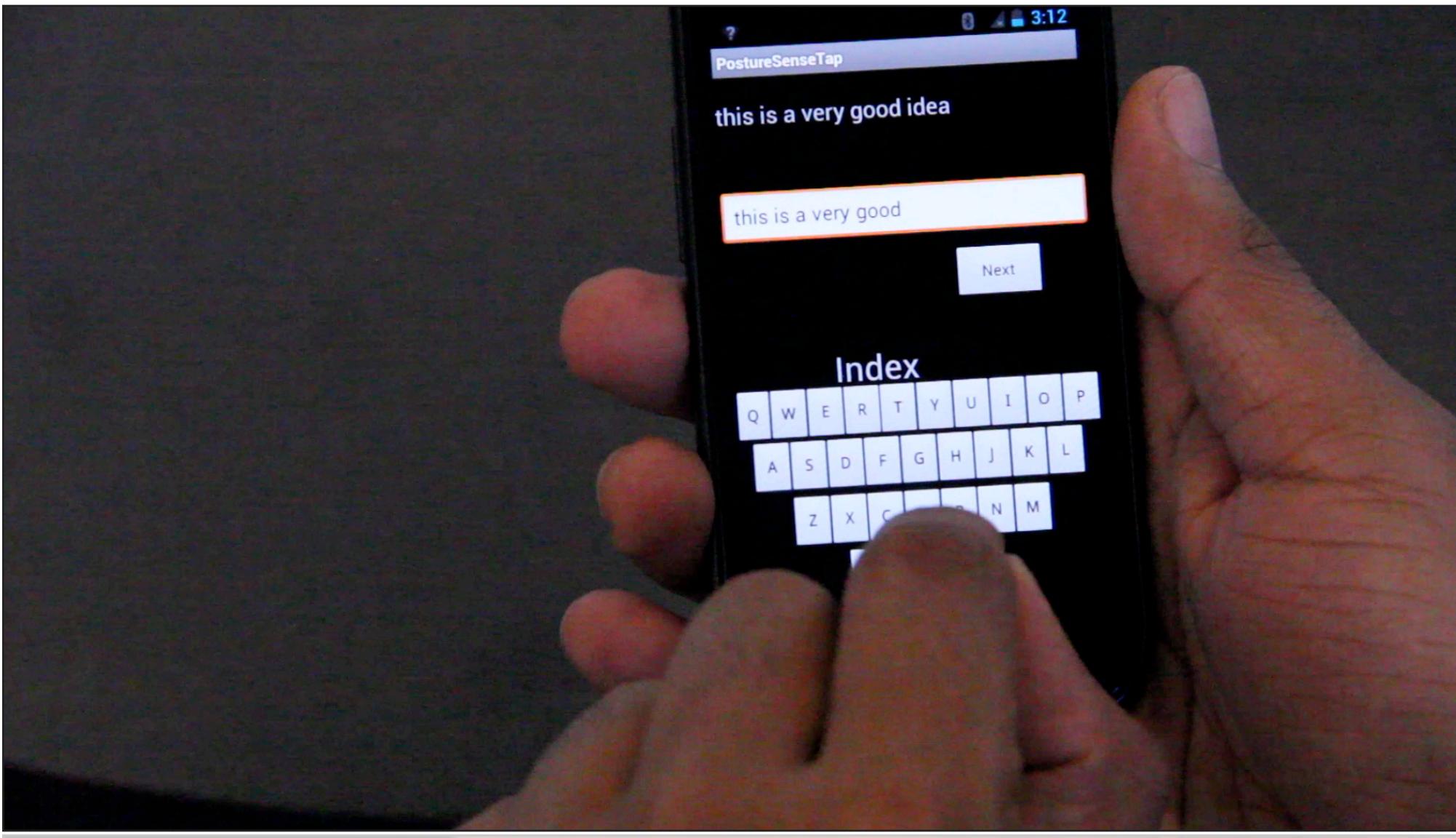
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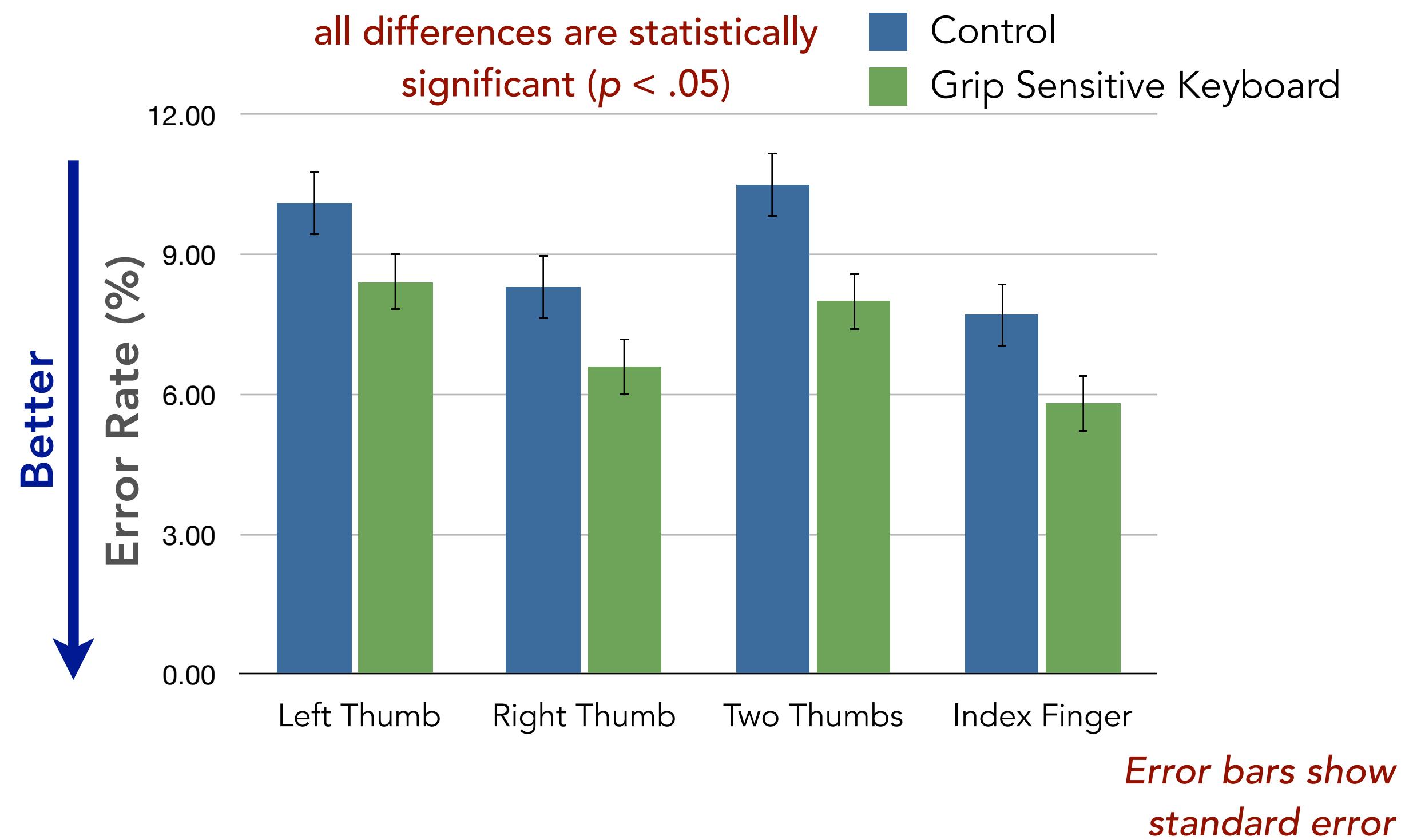
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Summary

- Modeling helps us measure and predict whether a tool or approach is beneficial for a task
- Fitts's law models time taken to click on a target
 - Demonstrates that larger, nearer buttons reduce time taken
- Improved models lead to higher accuracy
 - Adjust for finger angle and rotation rather than assuming that a user intends to touch with the center of their finger
 - Infer grip using phone sensors to improve typing accuracy

Today's goals

By the end of today, you should be able to...

- Differentiate and explain the roles of Angular components, modules, and services
- Implement a service in Angular
- Navigate Angular's file structure
- Describe the major components of Fitts's Law
- Explain how Fitts's Law impacts how interfaces should be designed
- Describe approaches for correcting systematic errors in touch performance

IN4MATX 133: User Interface Software

Lecture 11:
Separation in Angular &
Modeling human performance

Professor Daniel A. Epstein
TA Eunkyung Jo
TA Lucas de Melo Silva