IN4MATX 133: User Interface Software

Lecture 11:
Separation in Angular & Modeling human performance

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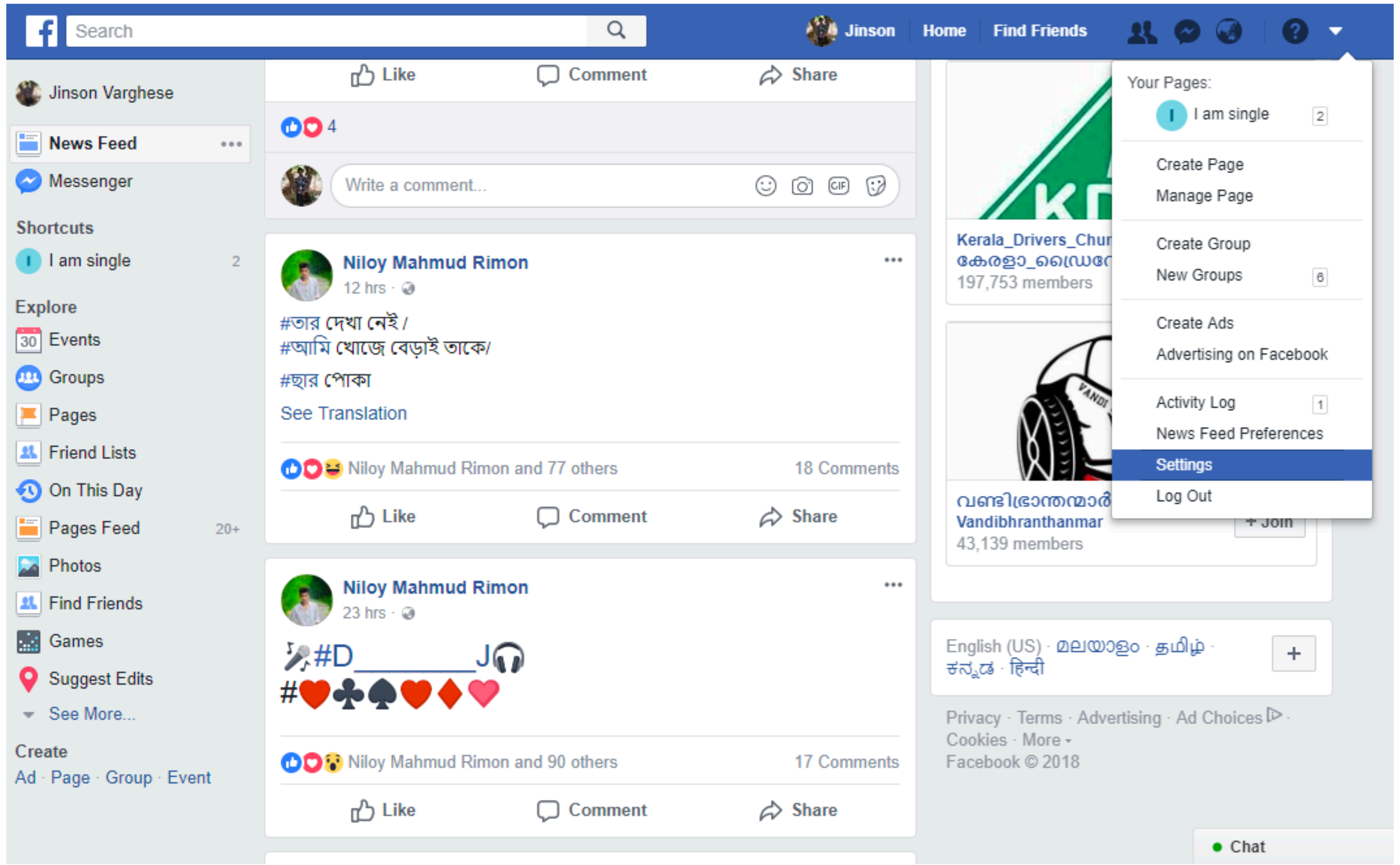
Today’s goals

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},
  { path: 'track/:id', component: TrackPageComponent},
  { path: 'album/:id', component: AlbumPageComponent},
  { path: '', component: HomePageComponent}
];

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

Listens for any endpoint `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) { }

  ngOnInit() {
   var albumId = this.route.snapshot.paramMap.get('id');
  }

}
```

“Injecting a service”

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';
import { HttpClient, HttpHeaders } from '@angular/common/http';

@Injectable({
  providedIn: 'root'
})
export class SpotifyService {
 baseUrl:string = 'http://localhost:8888';

  constructor(private http:HttpClient) { }

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

Defined as injectable

Services can inject other services!

What module(s) can use this service

HttpClient injected

Import a custom service

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

Import service via file structure

```
@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

Question

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

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

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

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
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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';
```

Import class via file structure

```
@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();
  }
```

Instantiate it like any other class

```
  ngOnInit() {
  }
}
```

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

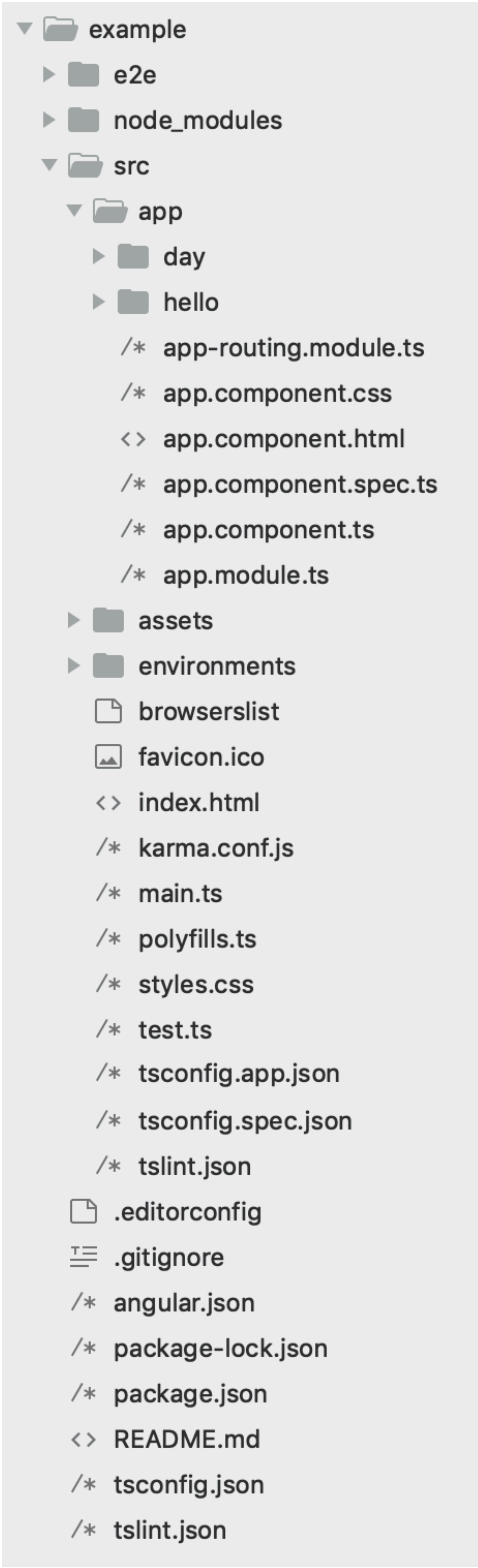
```
import * as chroma from 'chroma-js';
```
Note: different syntax

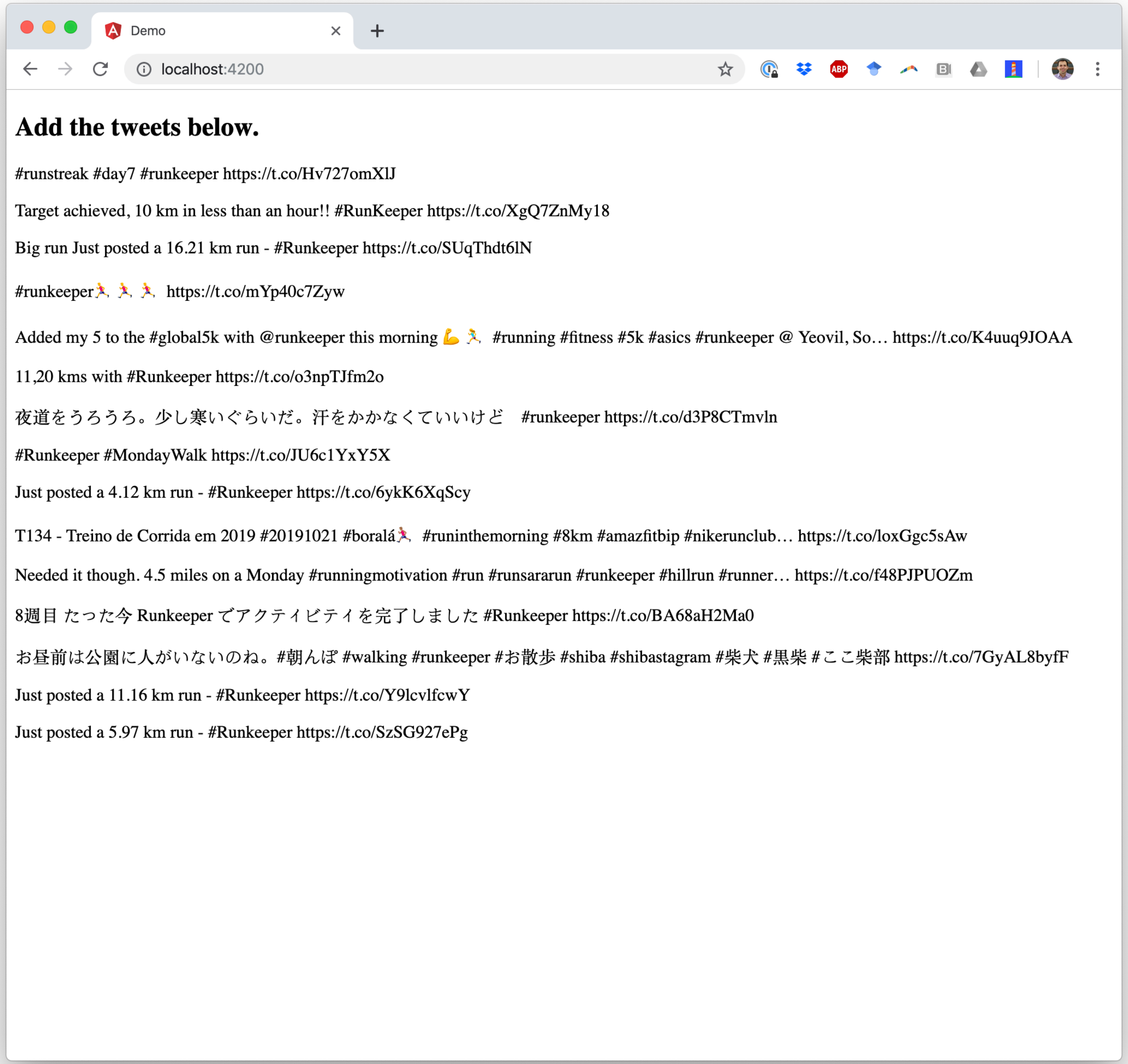
```
export class Dataparser {

  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




Demo
localhost:4200
Add the tweets below.
#runstreak #day7 #runkeeper https://t.co/Hv727omXlJ
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 #amazfitbip #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。#朝んぽ #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 A
- B B
- C Roughly equal
- D
- E

Question

Which button would be faster to click on?

- (A) A
- (B) 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

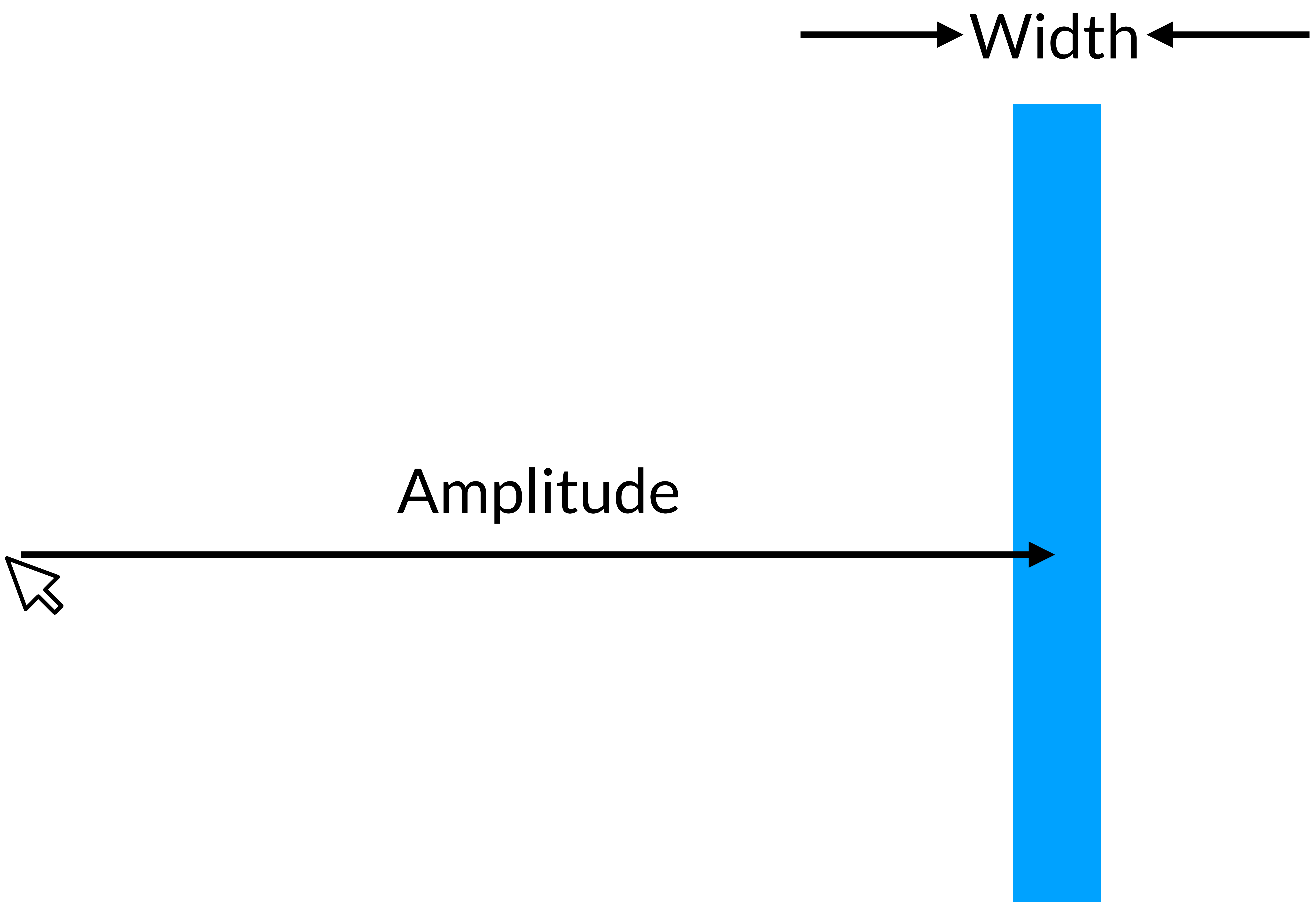
https://en.wikipedia.org/wiki/Fitts%27s_law

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 log2(A / W + 1)
  - What kind of equation does this look like?
- y = mx + b
- MT = a + bx, where x = log2(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 log2(A / W + 1)
- Time, in seconds, to acquire the target (e.g., click on the button)

Index of Difficulty (ID)

- log2(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)

- log2(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)

- log2(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 log2(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

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

- A) 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?
  - $MT = a + b \log2(A/W + 1)$
- So how can we reduce movement time?
  - Reduce amplitude (A)
  - Increase width (W)

“Beating” Fitts’s law

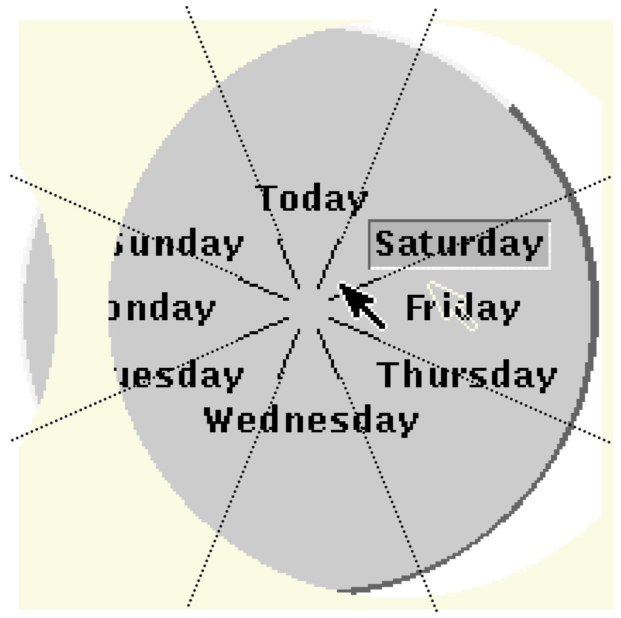
- Put targets closer together
- Make targets bigger
- Make cursor bigger
- Make impenetrable edges

Question

Which menu will be faster on average?

(A) Pop-up Linear Menu

(B) Pop-up Pie Menu



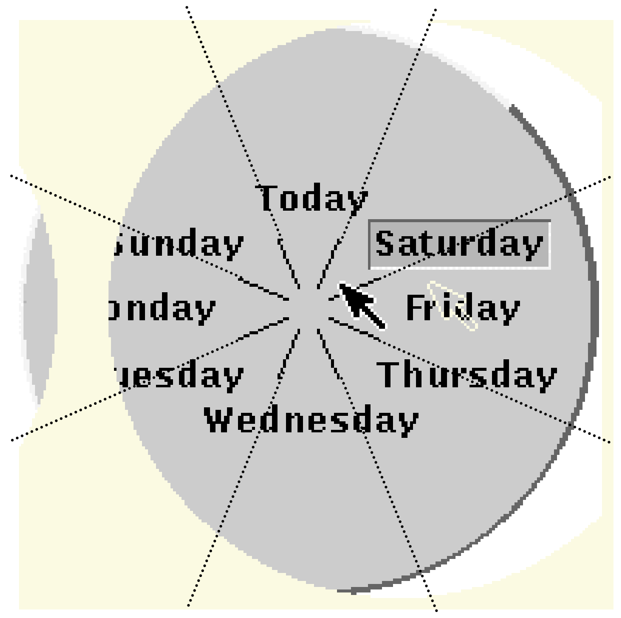
- (A) A
- (B) B
- (C) Roughly equal
- (D)
- (E)

Question

Which menu will be faster on average?

(A) Pop-up Linear Menu

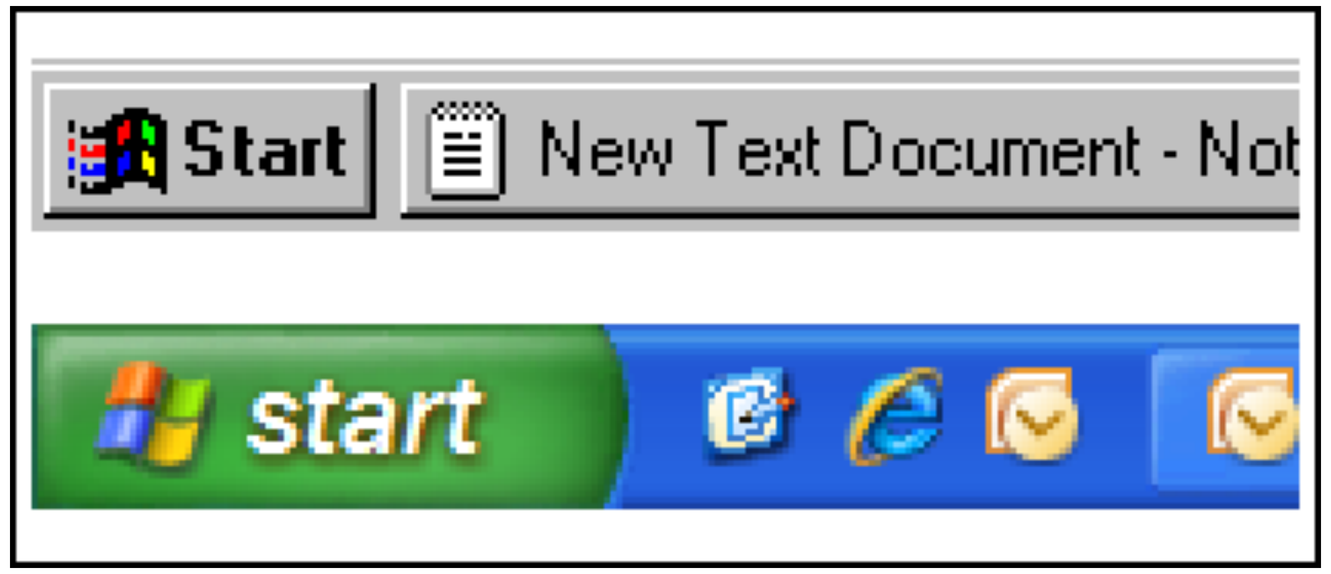
(B) Pop-up Pie Menu



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

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

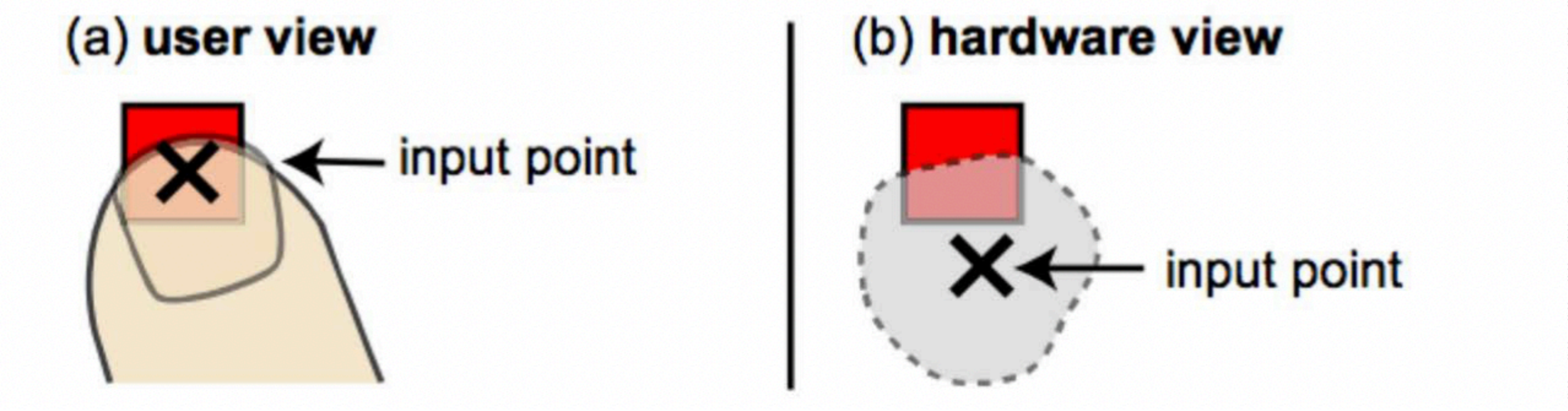
- But in practice, touchscreens on mobile tend not to be much faster
  - Buttons are smaller
  - People tend to be slower near the edges of touchscreens

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



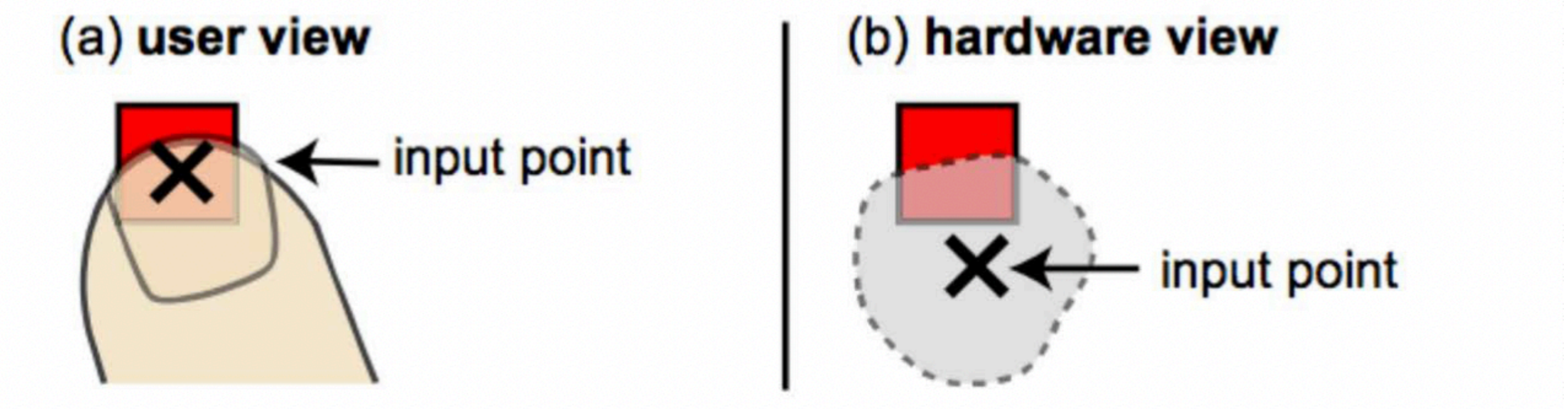
Daniel Vogel and Patrick Baudisch. 2007. Shift: a technique for operating pen-based interfaces using touch. CHI 2007. https://doi.org/10.1145/1240624.1240727

Modeling touch position

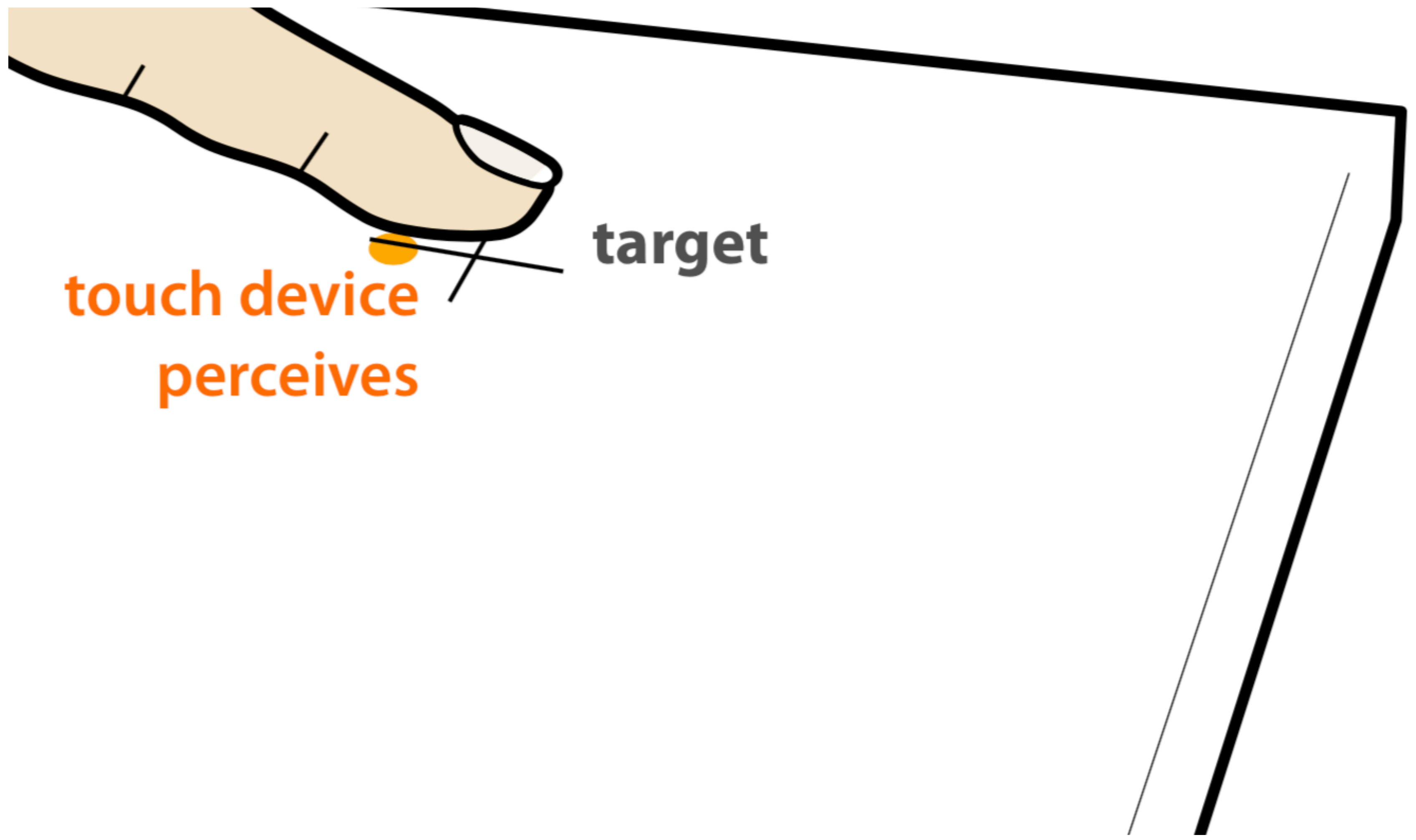
- One interpretation of the problem:
  our fingers are fat
  - We should use tiny styluses to make our our selection more accurate
- Another interpretation:
  our model of touch position is inaccurate
  - We should make our model better

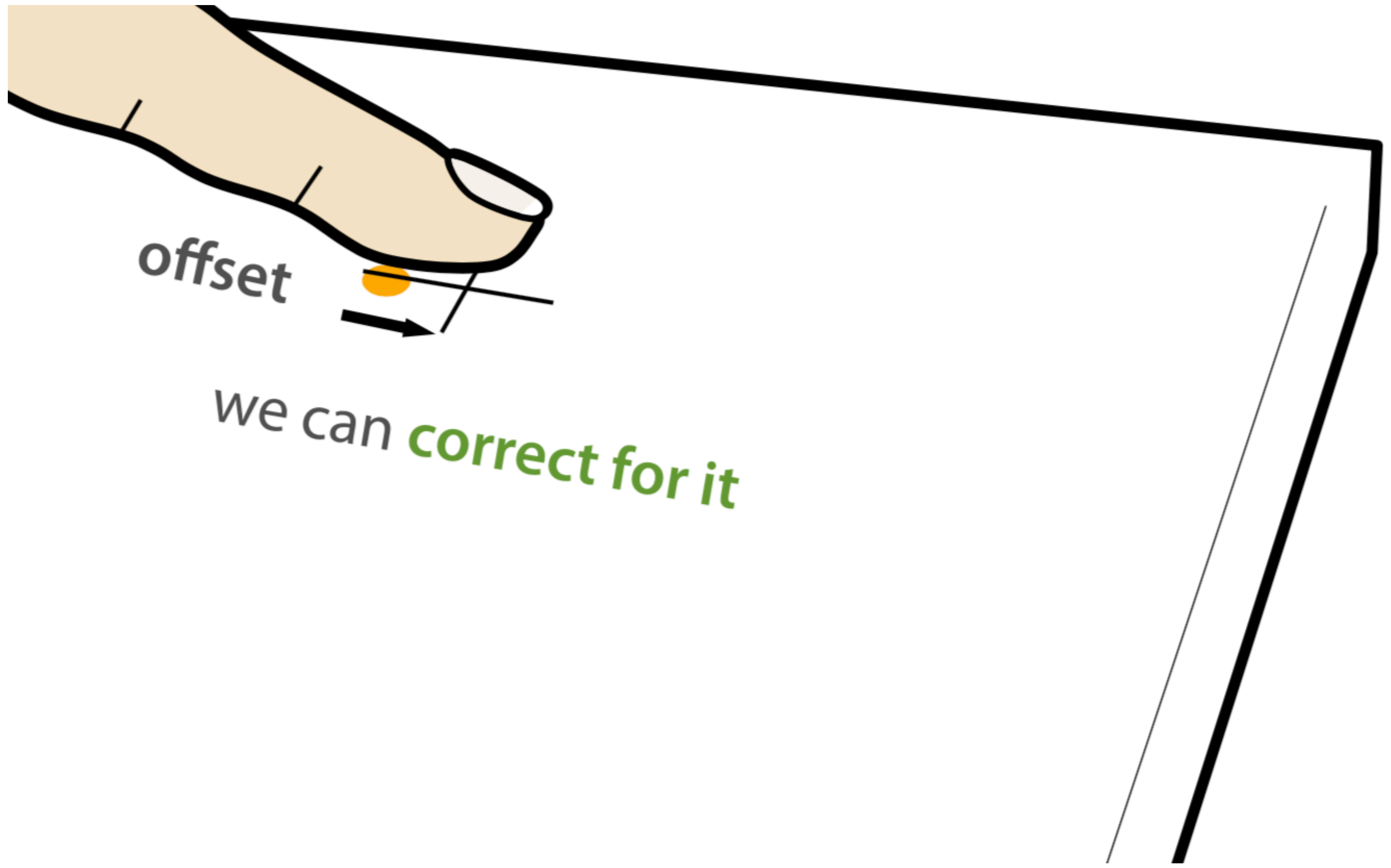
Modeling touch position

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



Modeling touch position

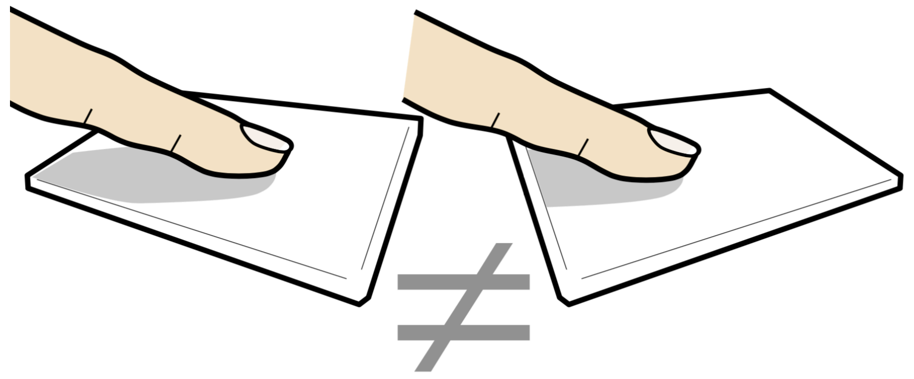




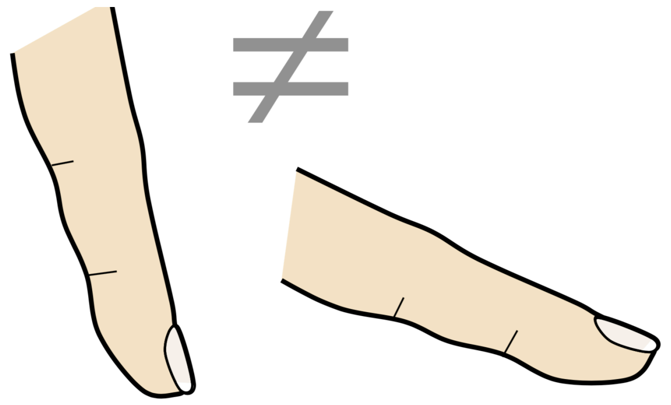
Christian Holz and Patrick Baudisch. 2011. Understanding touch. CHI 2011. https://doi.org/10.1145/1978942.1979308

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



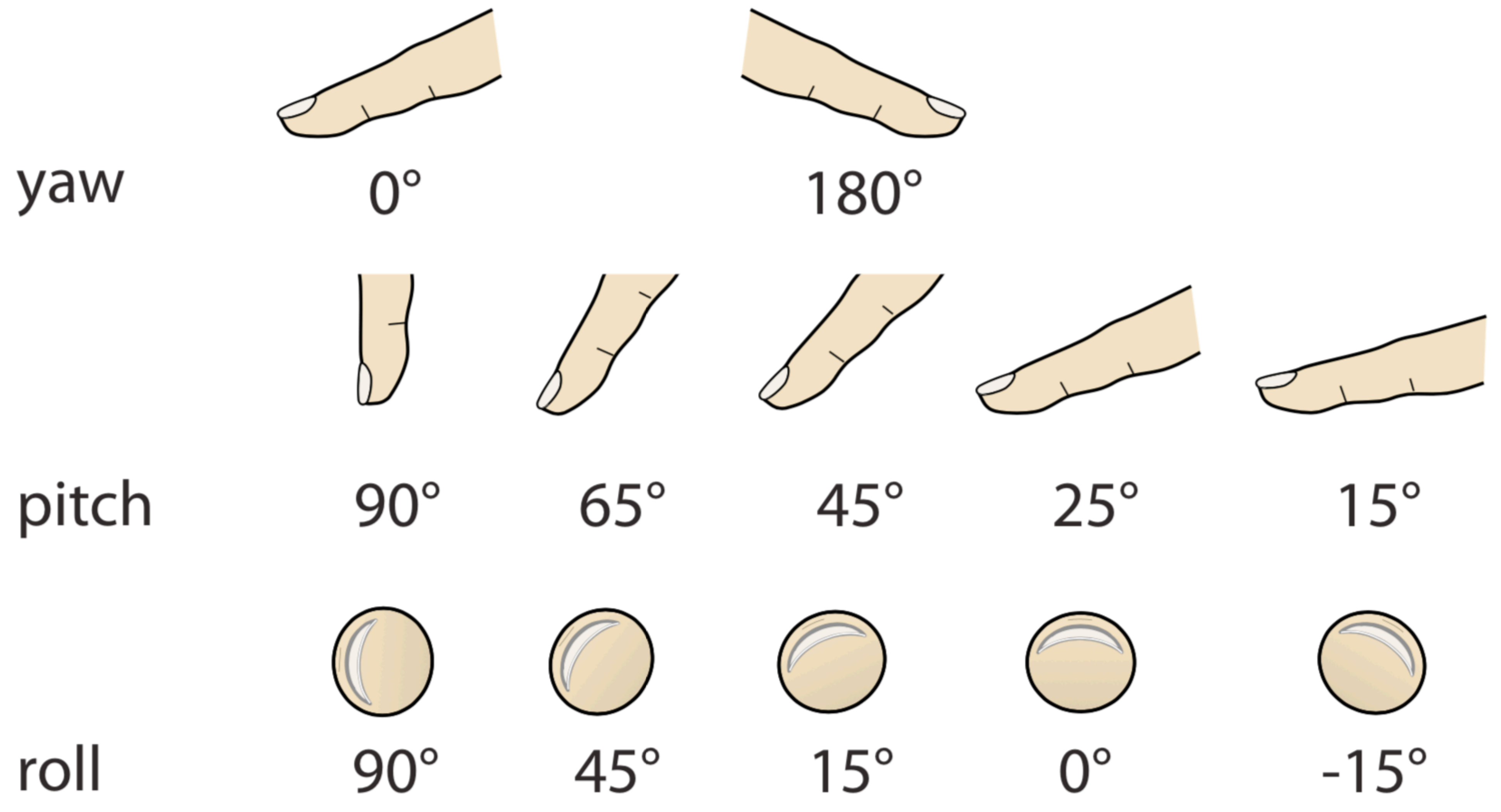
Pitch: angle of finger

Roll: rotation of finger

Christian Holz and Patrick Baudisch. 2011. Understanding touch. CHI 2011. https://doi.org/10.1145/1978942.1979308

Modeling touch position

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



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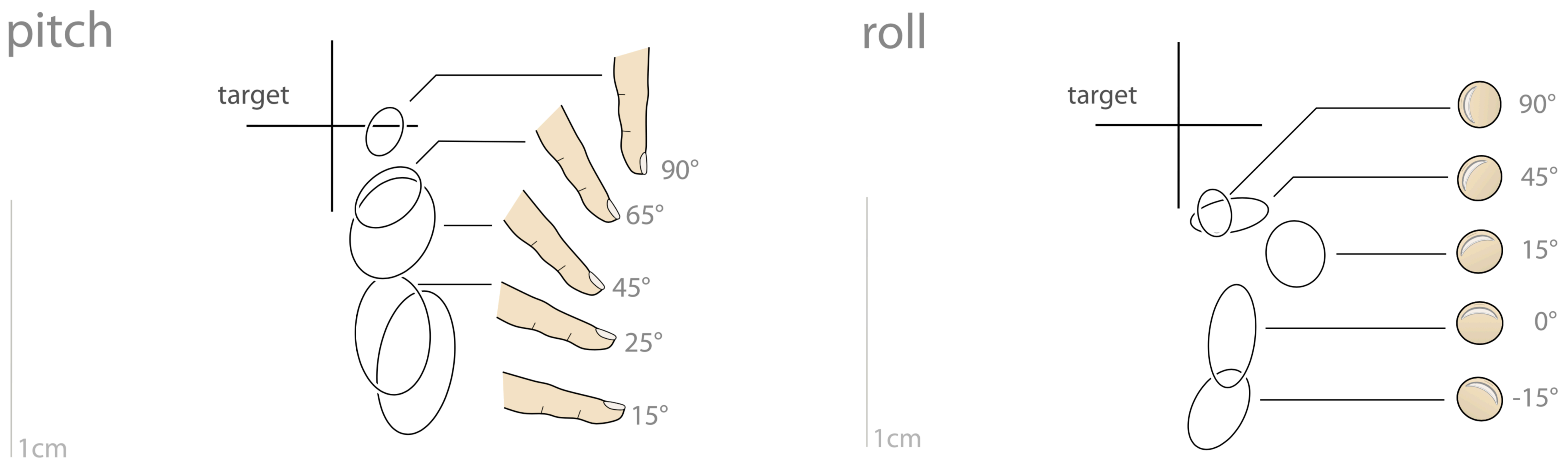
Modeling touch position



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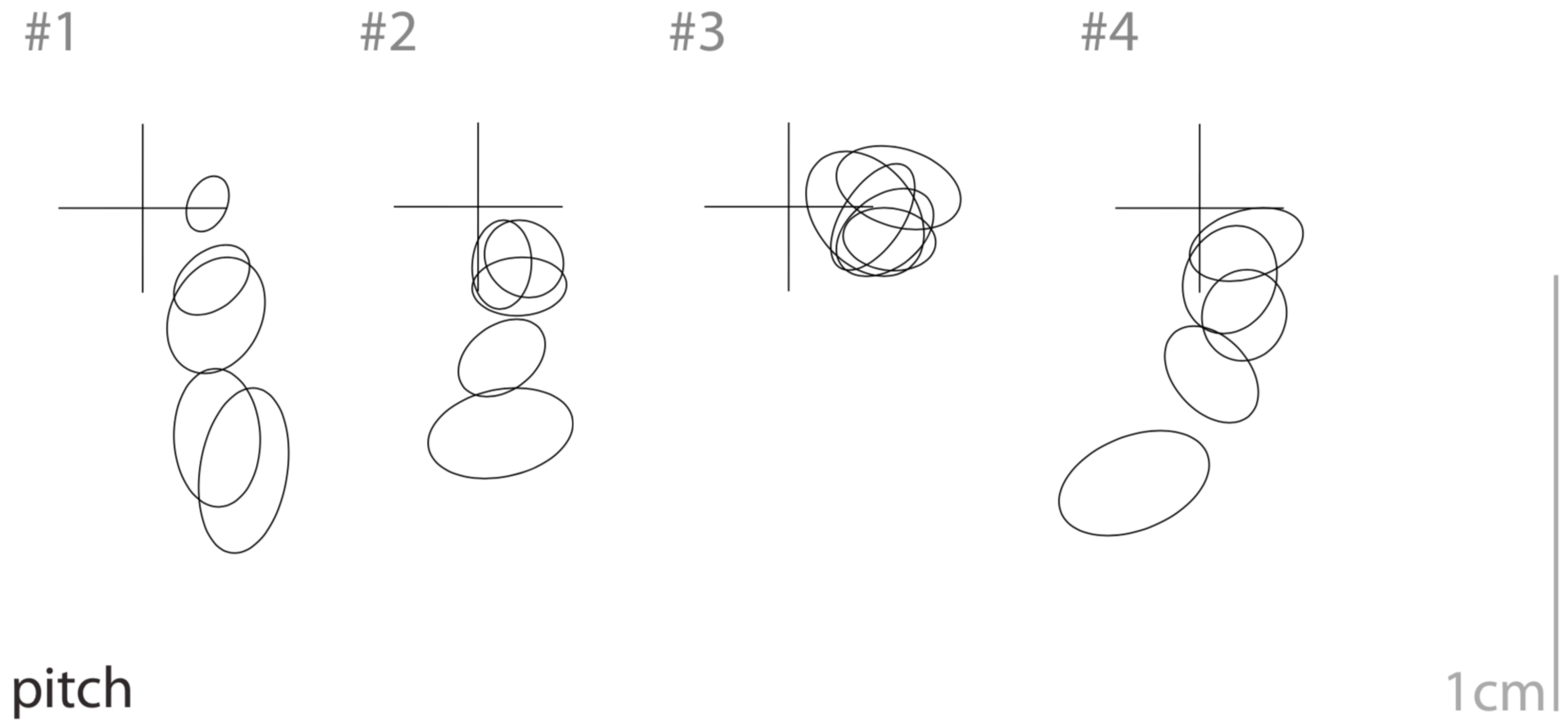
Modeling touch position

user



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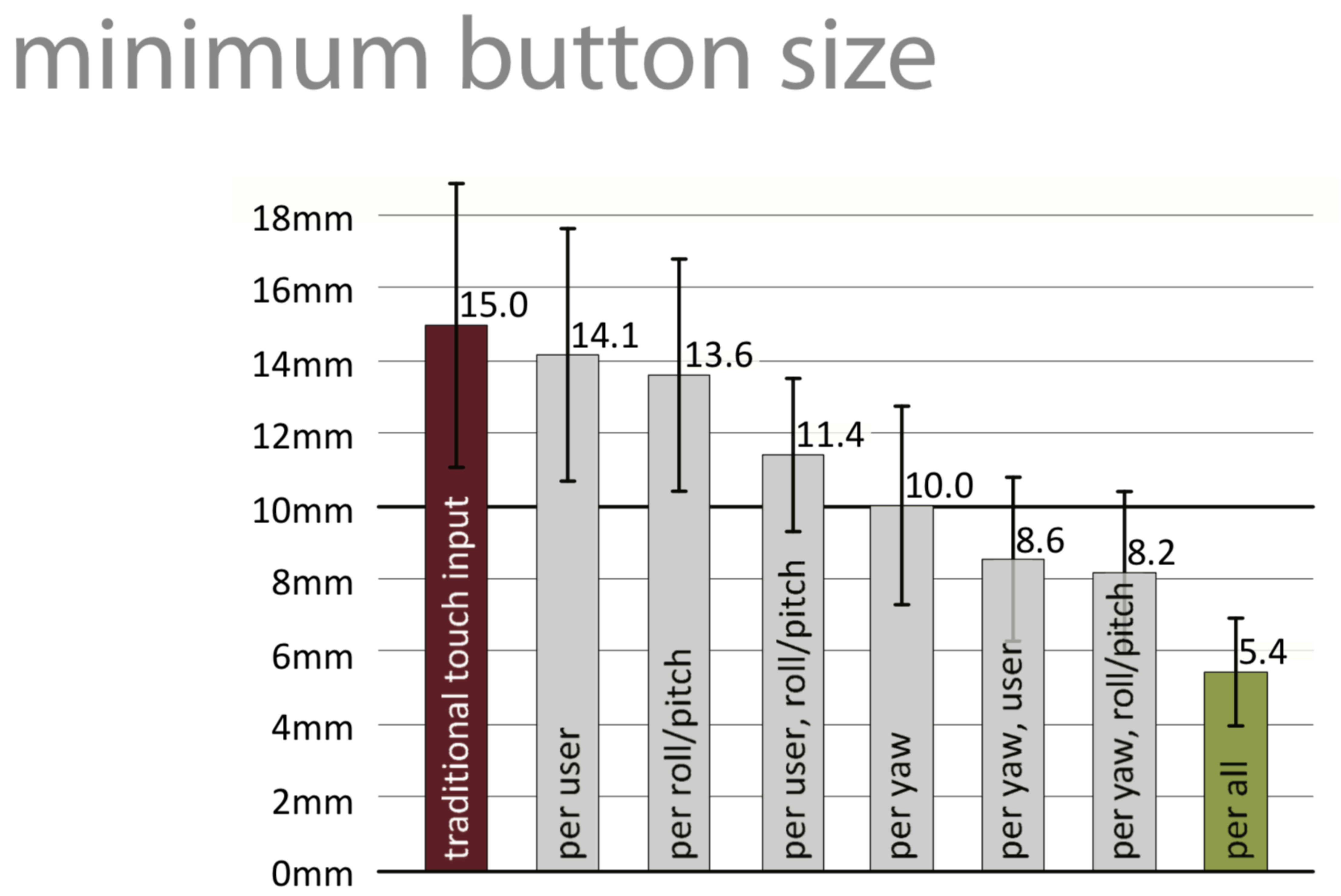
Modeling touch position



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

Christian Holz and Patrick Baudisch. 2011. Understanding touch. CHI 2011. https://doi.org/10.1145/1978942.1979308

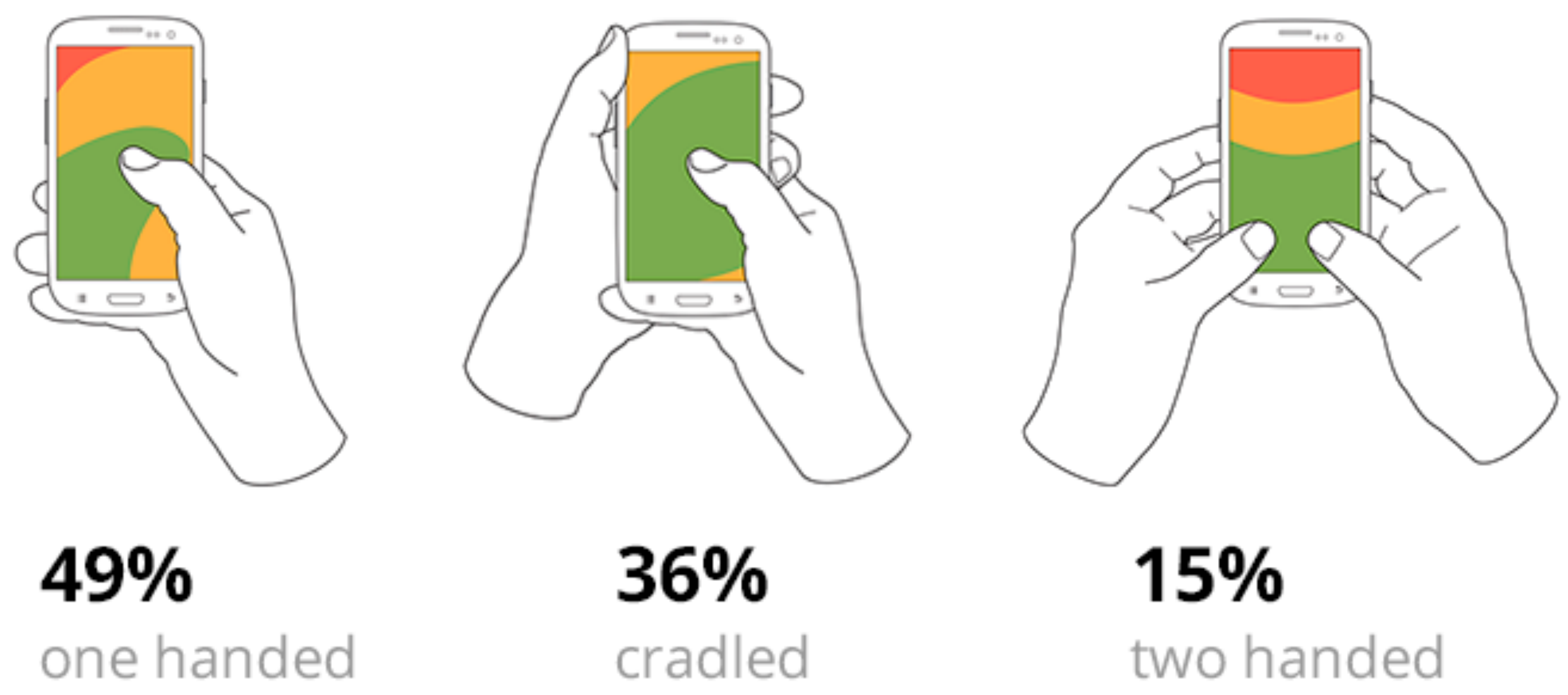
Modeling touch input

- 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?

Christian Holz and Patrick Baudisch. 2011. Understanding touch. CHI 2011. https://doi.org/10.1145/1978942.1979308

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?



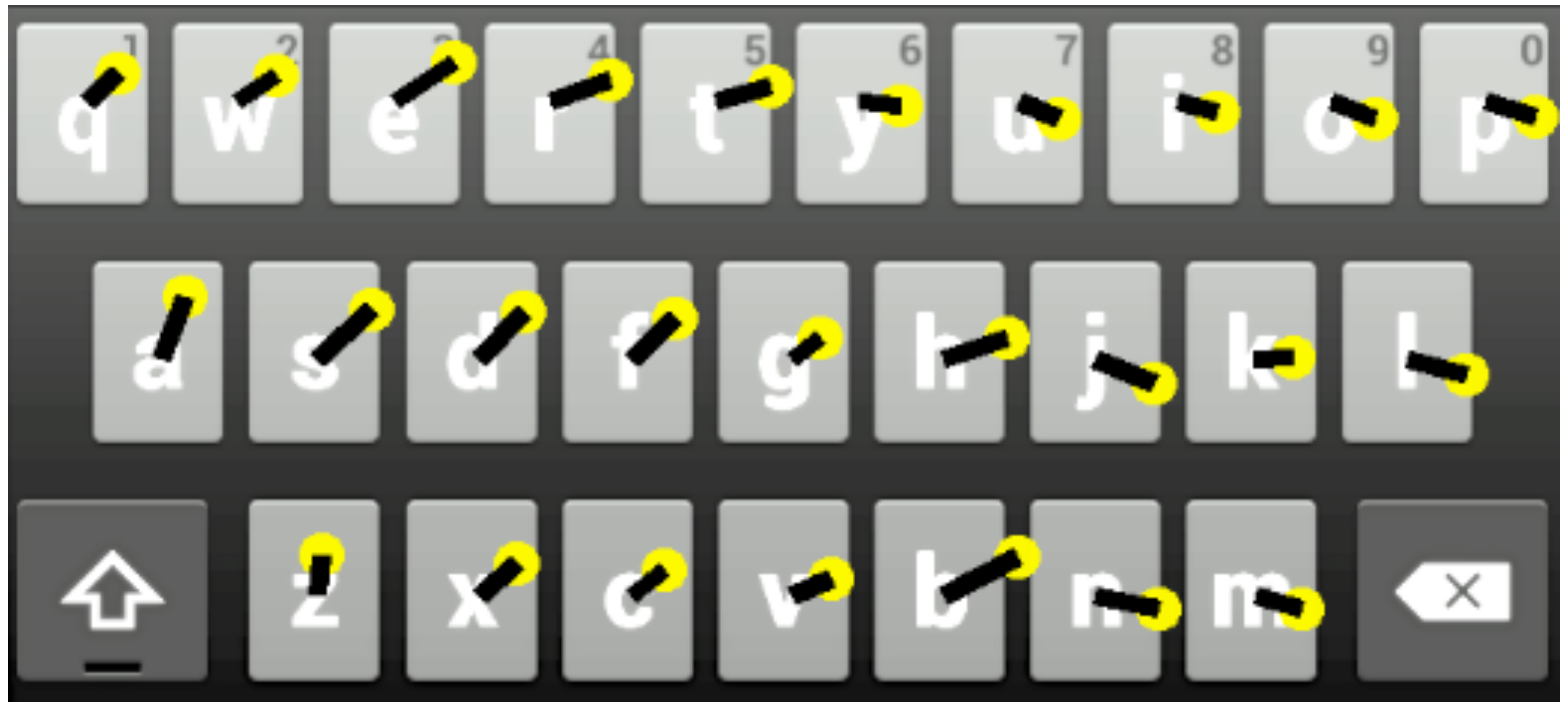
http://static.googleusercontent.com/media/www.google.com/en//intl/ALL_ALL/think/multiscreen/pdf/multi-screen-moblie-whitepaper_research-studies.pdf

Modeling phone grip


Left Thumb

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



Right Thumb

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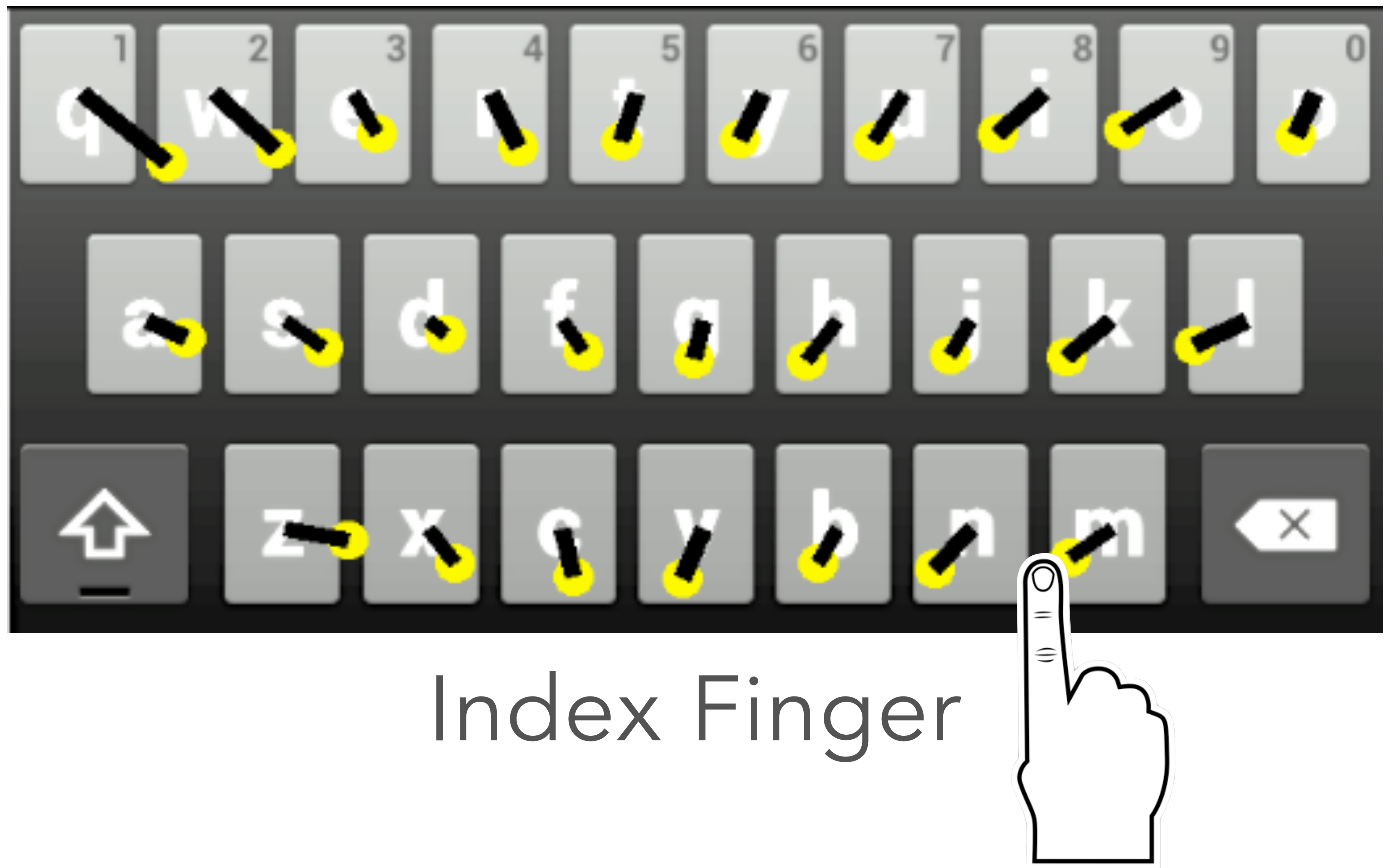
Modeling phone grip



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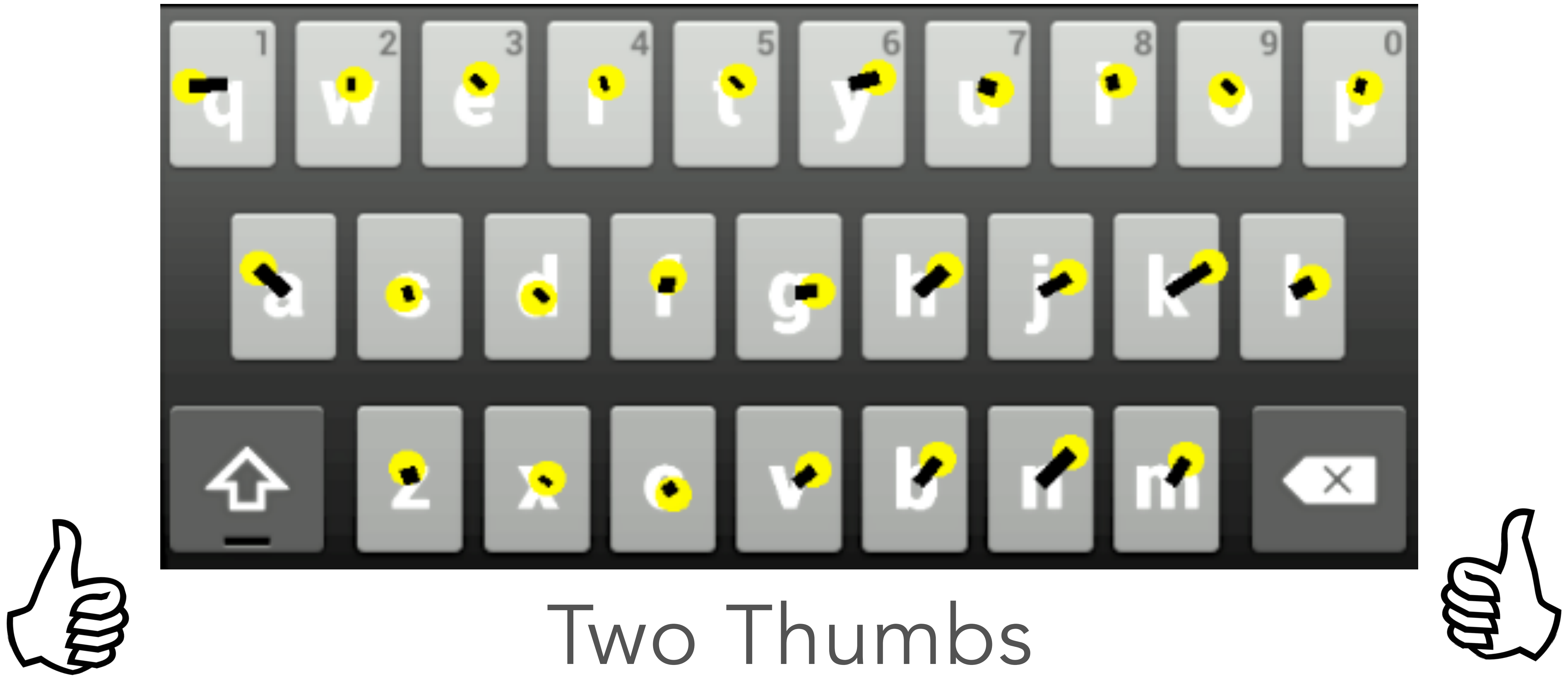
Modeling phone grip



Two Thumbs

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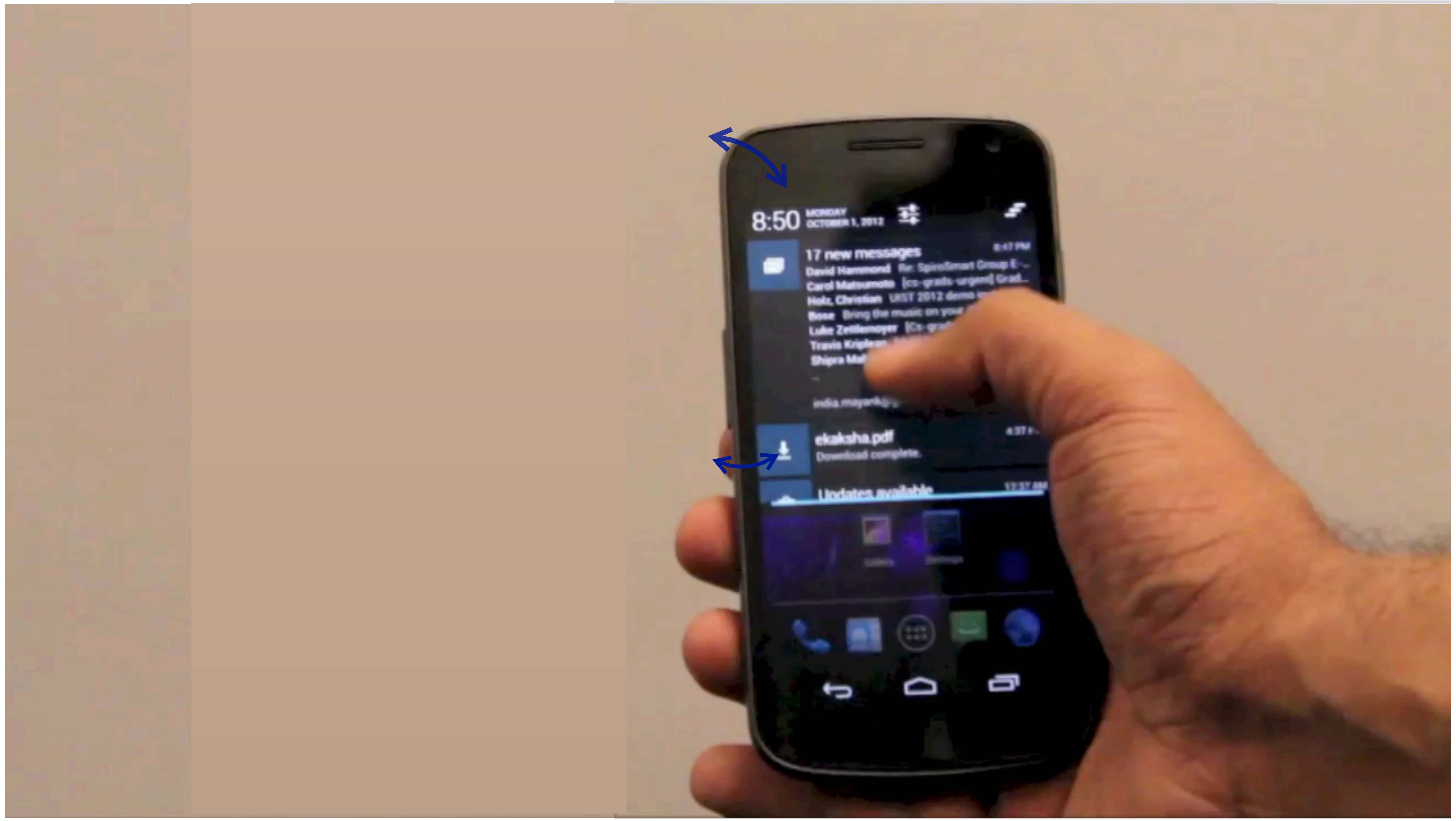
Detecting phone grip with sensors



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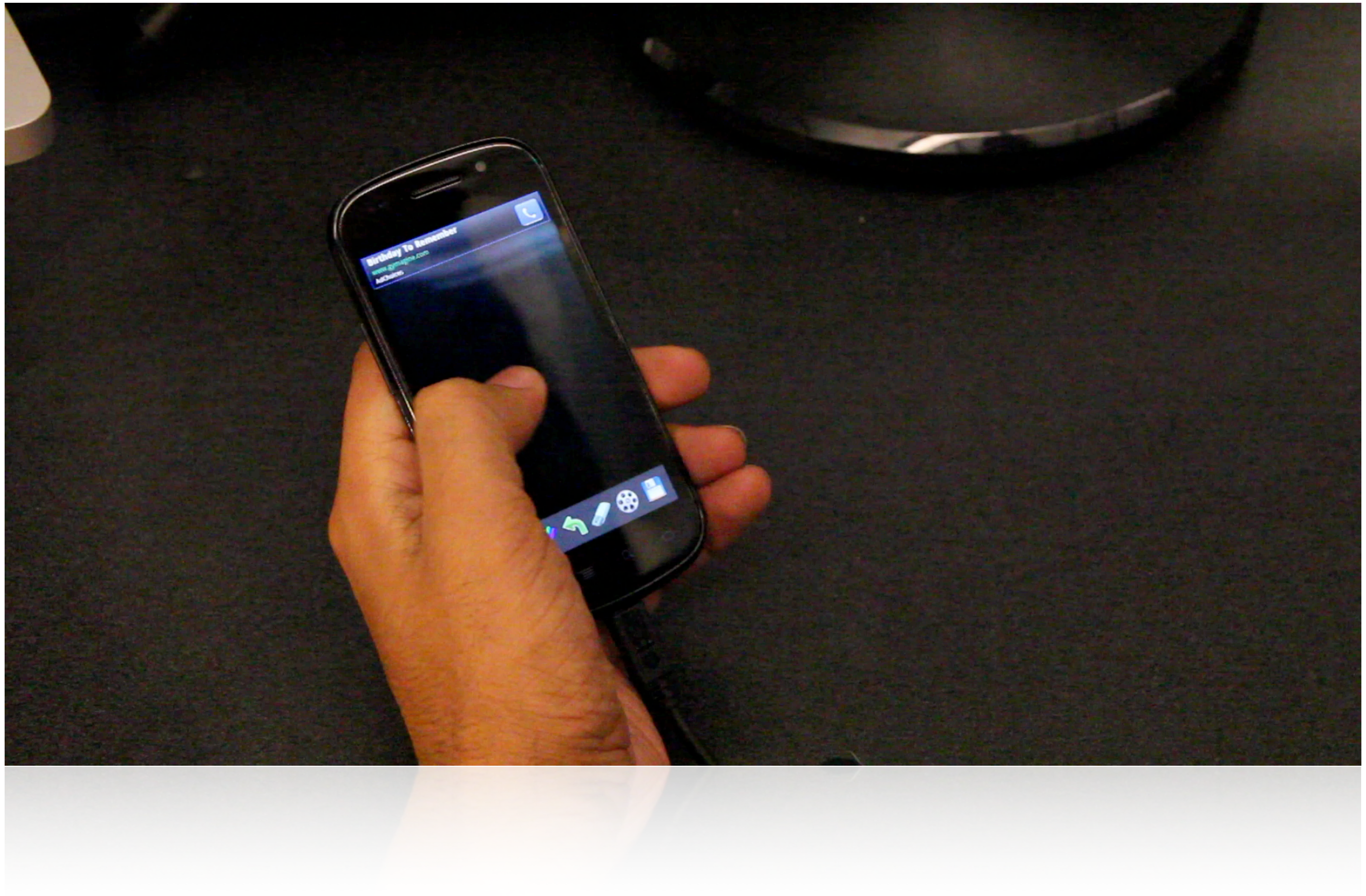
Detecting phone grip with sensors



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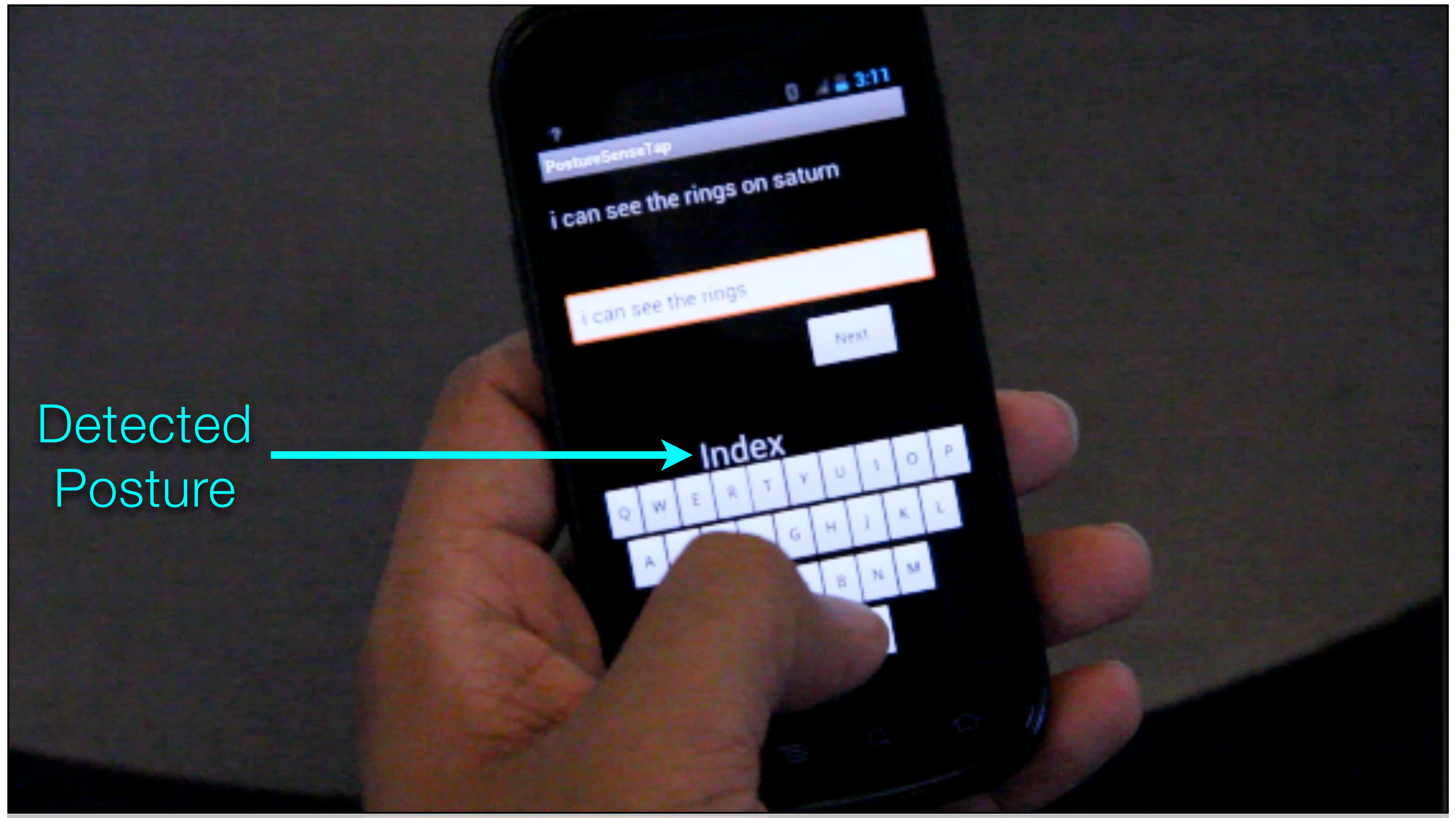

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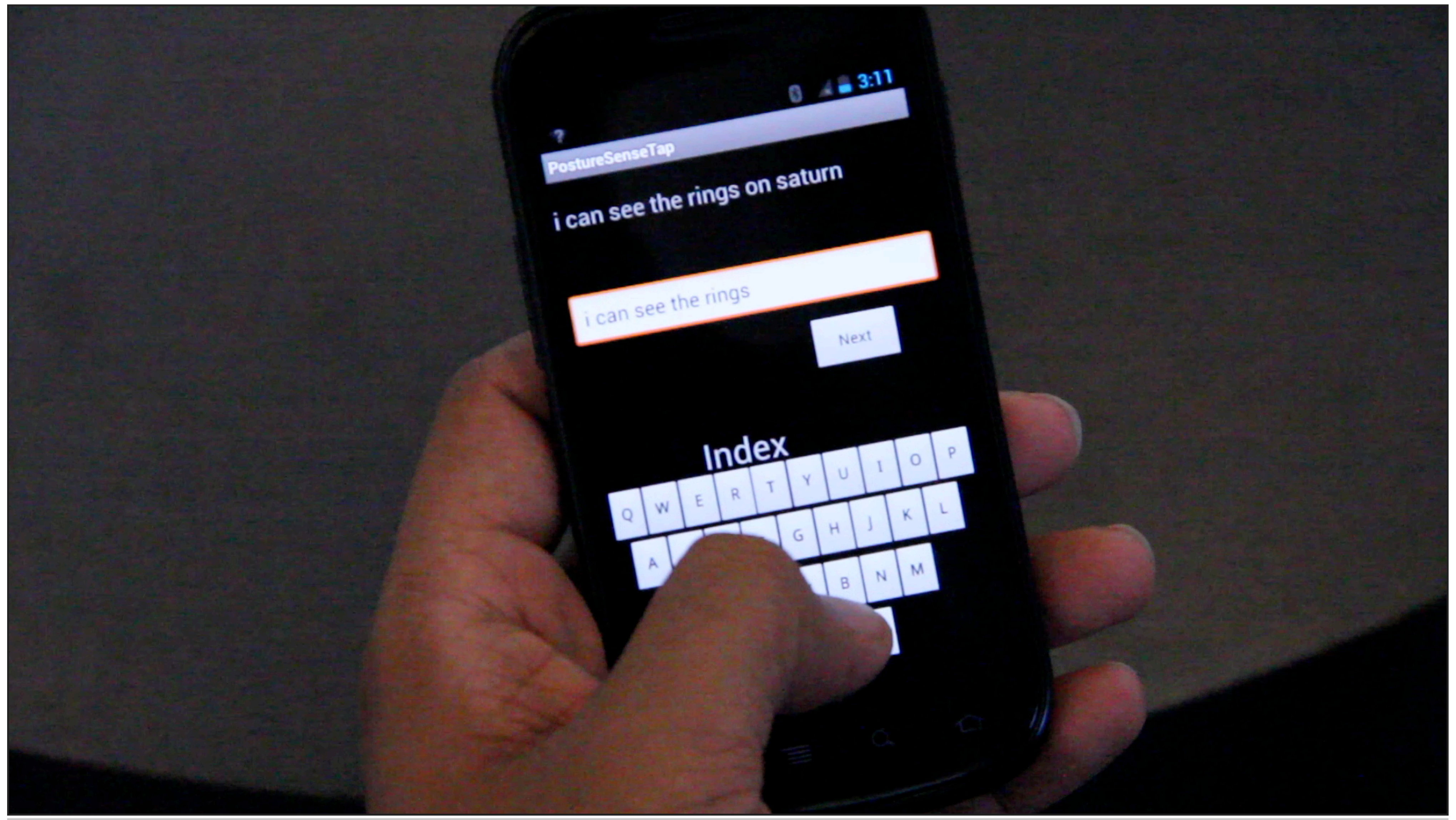

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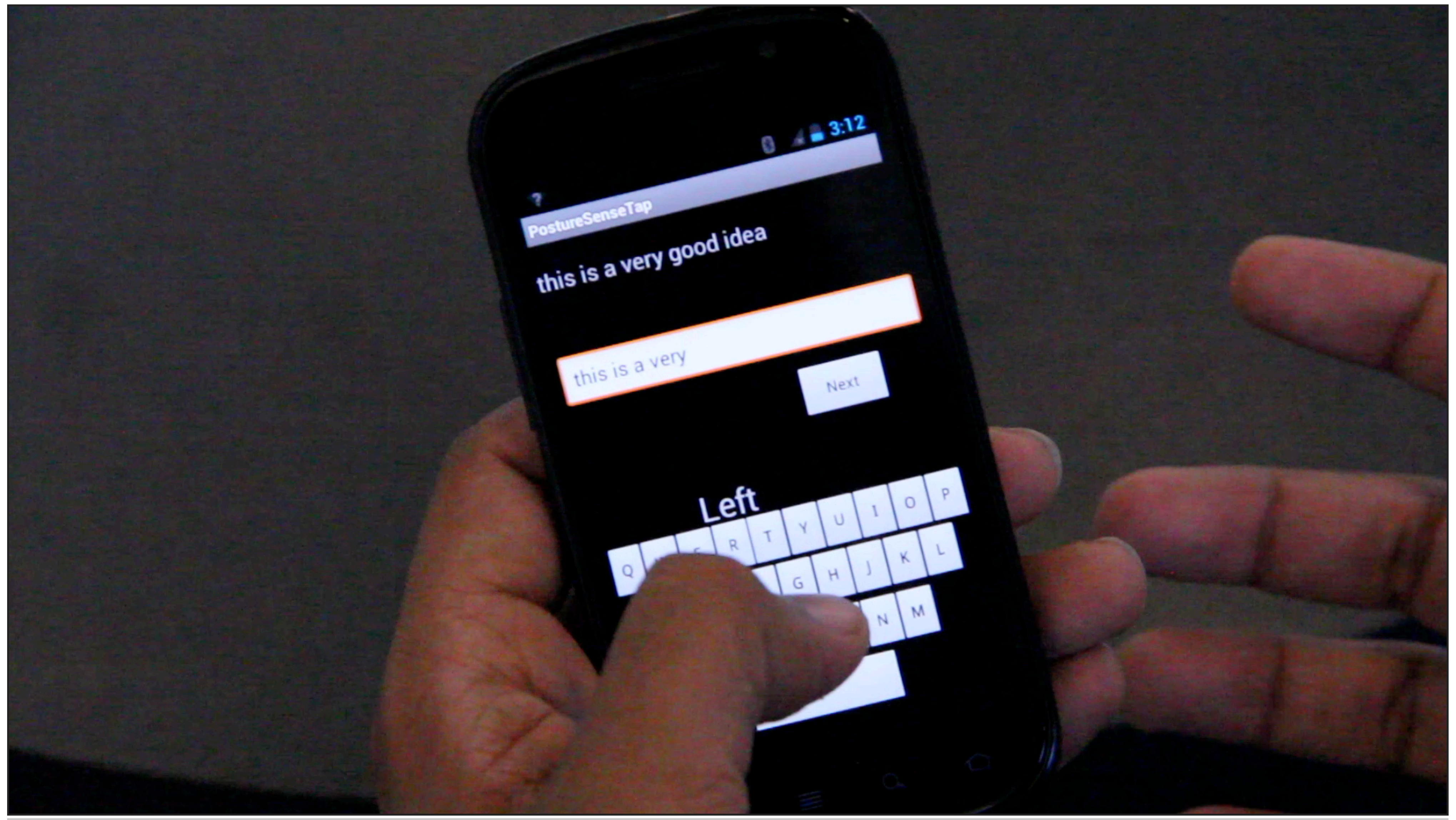

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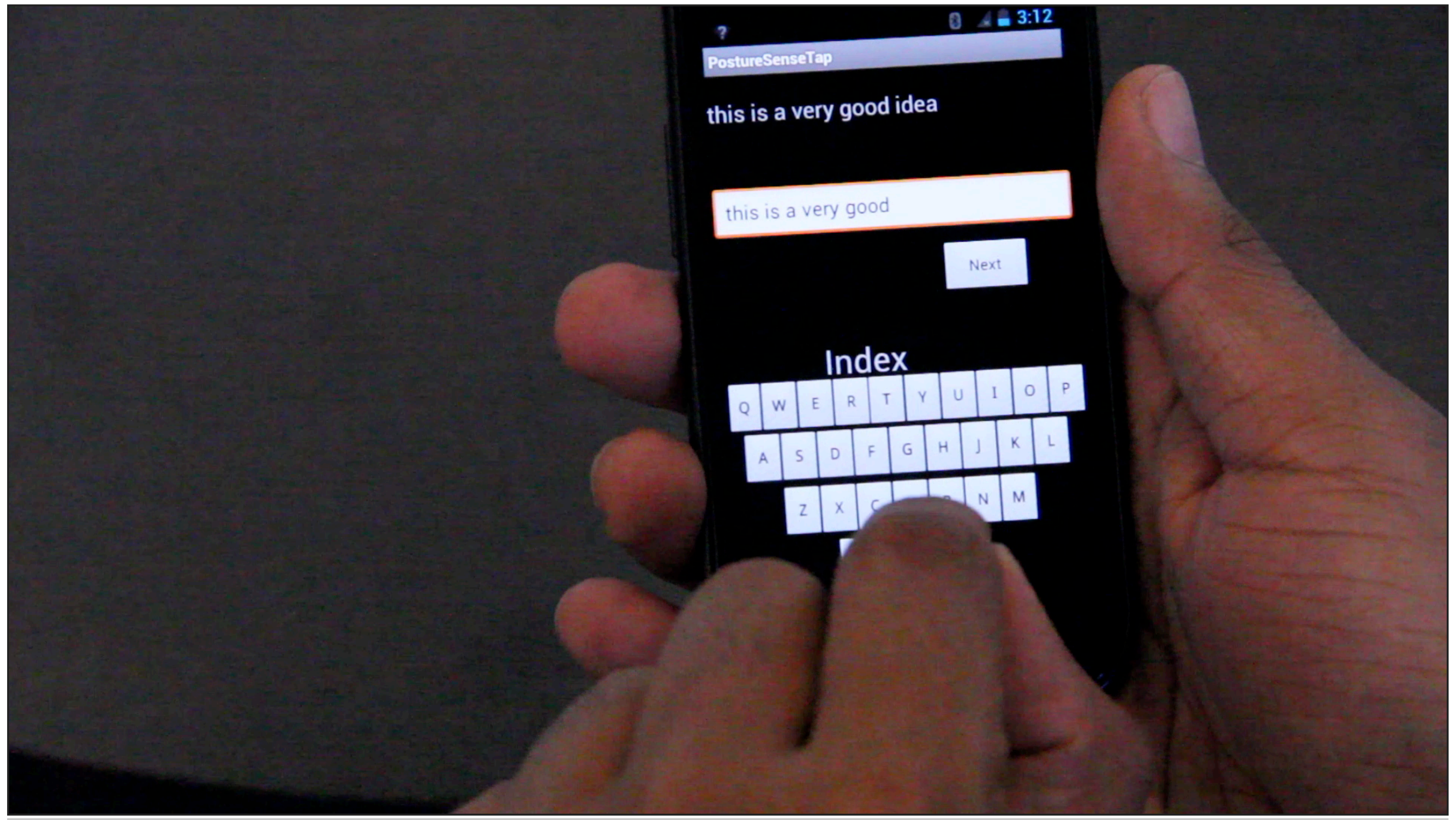

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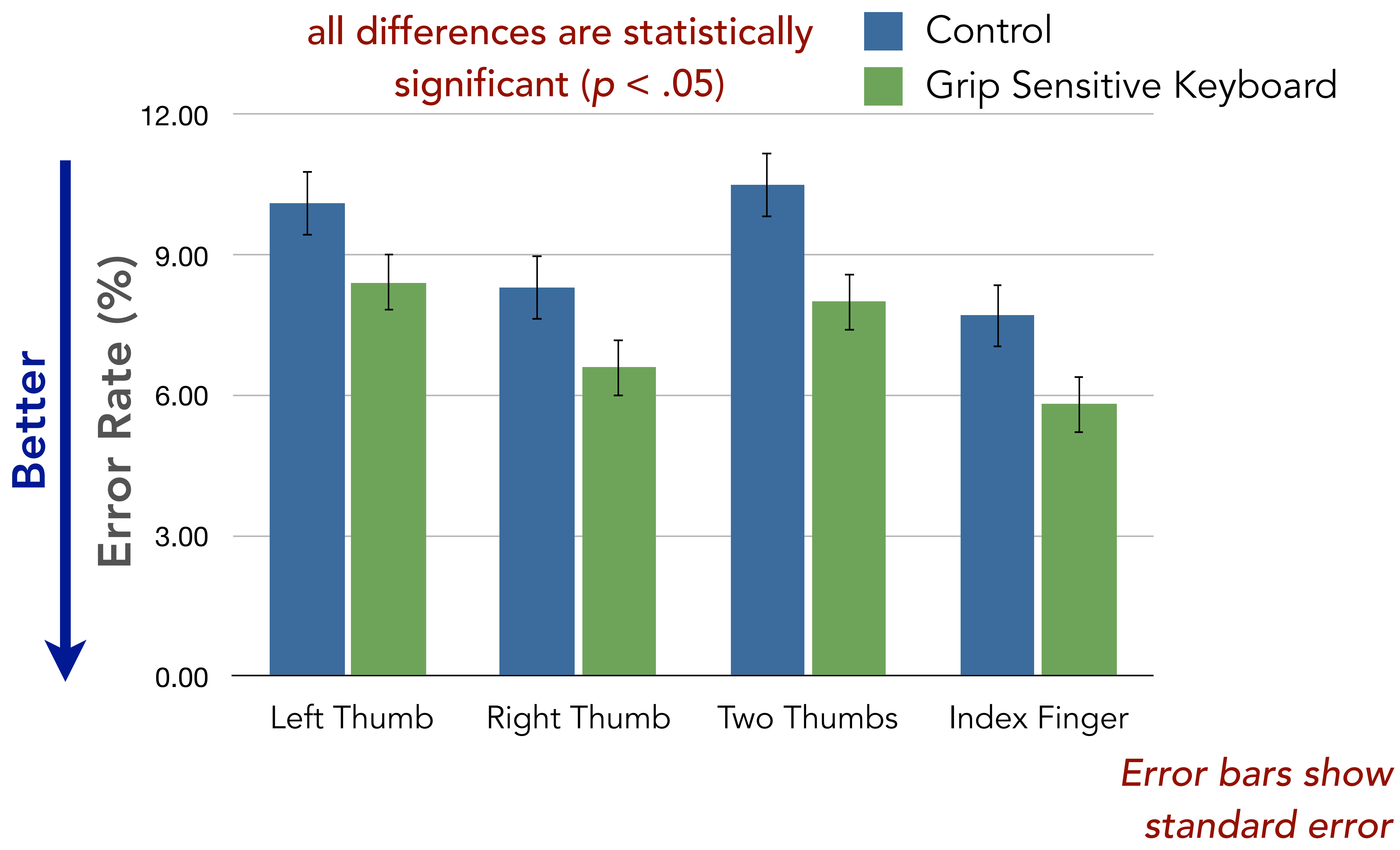

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Summary

- 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 Lucas de Melo Silva
TA Jong Ho Lee