

Hypermedia In Action

7. Building a Contacts App With Hyperview

This chapter covers:

- Transforming the existing Contacts web app into a native mobile app using Hyperview
- Using Hyperview behaviors to navigate between screens using stacks and modals
- Communicating between screens using the Events system
- Using the same backend to power both the web app and mobile app

Earlier chapters in this book explained the benefits of building apps using the hypermedia architecture. These benefits were demonstrated by building a robust Contacts web application. Then, Chapter 6 argued that hypermedia concepts can and should be applied to platforms other than the Web. We introduced Hyperview as an example of a hypermedia format and client specifically designed for building mobile apps. But you may still be wondering: what is it like to create a fully-featured, production-ready mobile app using Hyperview? Do I have to learn a whole new language and framework? In this chapter, we will show Hyperview in action by porting the Contacts web app to a native mobile app. You will see that almost many web development techniques (and indeed, much of the code) are completely identical when developing with Hyperview. How is that possible?

1. Our Contacts web app was built with the principle of HATEOAS (Hypermedia as the Engine of Application State). All of the app's features (retrieving, searching, editing, and creating contacts) are implemented in the backend (the `Contacts` Python class). Our mobile app, built with Hyperview, also leverages HATEOAS and relies on the backend for all of the app's logic. That means the `Contacts` Python class can power our mobile app the same way it powers the web app, without any changes required.
2. The client-server communication in the web app happens using HTTP. The HTTP server for our web app is written using the Flask framework. Hyperview also uses HTTP for client-server communication. So we can re-use the Flask routes and views from the web app for the mobile app as well.
3. The web app uses HTML for its hypermedia format, and Hyperview uses HXML. HTML and HXML are different formats, but the base syntax is similar (nested tags with

attributes). This means we can use the same templating library (Jinja) for HTML and HXML. Additionally, many of the concepts of htmx are built into HXML. We can directly port web app features implemented with htmx (search, infinite loading) to HXML.

Essentially, we can re-use almost everything from the web app backend, but we will need to replace the HTML templates with HXML templates. Most of the sections in this chapter will assume we have the web contacts app running locally and listening on port 5000. The focus will be on creating new HXML templates for our mobile app's UI.

7.1. Creating a mobile app

But before we dive into HXML, there's one pesky requirement: the Hyperview client. When developing web applications, you only need to worry about the server because the client (web browser) is universally available. There's no equivalent Hyperview client installed on every mobile device. Instead, we will create our own Hyperview client, customized to only talk to our server. This client can be packaged up into an Android or iOS mobile app, and distributed through the respective app stores.

Luckily, we don't need to start from scratch to implement a Hyperview client. The Hyperview code repository comes with a demo backend and a demo client built using Expo. We will use this demo client but point it to our contacts app backend as a starting point.

```
> git clone git@github.com:Instawork/hyperview.git
> cd hyperview/demo
> yarn ❶
> yarn start ❷
```

❶ Install dependencies for the demo app

❷ Start the Expo server to run the mobile app in the iOS simulator.

After running `yarn start`, you will be presented with a prompt asking you to open the mobile app using an Android emulator or iOS simulator. Select an option based on which developer SDK you have installed. (The screenshots in this chapter will be taken from the iOS simulator.) With any luck, you will see the Expo mobile app installed in the simulator. The mobile app will automatically launch and show a screen saying "Network request failed." That's because by default, this app is configured to make a request to

<http://0.0.0.0:8085/index.xml>, but our backend is listening on port 5000. To fix this, we can make a simple configuration change in the `demo/src/constants.js` file:

```
//export const ENTRY_POINT_URL = 'http://0.0.0.0:8085/index.xml'; ❶  
export const ENTRY_POINT_URL = 'http://0.0.0.0:5000/'; ❷
```

- ❶ The default entriypoint URL in the demo app
- ❷ Setting the URL to point to our contacts app

We're not up and running yet. With our Hyperview client now pointing to the right endpoint, we see a different error, a "ParseError". That's because the backend is responding to requests with HTML content, but the Hyperview client expects an XML response (specifically, HXML). So it's time to turn out attention to our Flask backend. We will go through the Flask views, and replace the HTML templates with HXML templates. Specifically, let's support the following features to our mobile app:

- A searchable list of contacts
- Viewing the details of a contact
- Editing a contact
- Deleting a contact
- Adding a new contact

Listing 7. 1. Zero Client-Configuration in Hypermedia Applications

For many mobile apps that use the Hyperview client, configuring this endpoint URL is the only on-device code you need to write to deliver a full-featured app. Think of the endpoint URL as the address you type into a web browser to open a web app.

Except in Hyperview, there is no address bar, and the browser is hard-coded to only open one URL.

This URL will load the first screen when a user launches the app.

Every other action the user can take will be declared in the HXML of that first screen.

This minimal configuration is one elegant aspect of the Hypermedia-driven architecture!

Of course, you may want to write more on-device code to support more features in your mobile app.

We will demonstrate how to do that later in this chapter, in the section called "Extending the Client".

7.2. A Searchable List of Contacts

We will start building our Hyperview app with the endpoint screen, the list of contacts. For the initial version of this screen, let's support the following features from the web app:

- display a scrollable list of contacts
- "search-as-you-type" field above the list
- "infinite-scroll" to load more contacts as the user scrolls through

Additionally, we will add a "pull-to-refresh" interaction on the list, since users expect this from list UIs in mobile apps.

If you recall, all of the pages in the Contacts web app extended a common base template, `layout.html`. We need a similar base template for the screens of the mobile app. This base template will contain the style rules for our UI, and a basic structure common to all screens. Let's call it `layout.xml`.

Listing 7. 2. Base template hv/layout.xml

```
<doc xmlns="https://hyperview.org/hyperview">
  <screen>
    <styles><!-- omitted for brevity --></styles>
    <body style="body" safe-area="true">
      <header style="header">
        {% block header %} ❶
          <text style="header-title">Contacts.app</text>
        {% endblock %}
      </header>

      <view style="main">
        {% block content %}{% endblock %} ❷
      </view>
    </body>
  </screen>
</doc>
```

- ❶ The header section of the template, with a default title
- ❷ The content section of the template, to be provided out by other templates.

We covered the HXML tags and attributes in the previous chapter. This template sets up a basic screen layout using `<doc>`, `<screen>`, `<body>`, `<header>`, and `<view>` tags. Note that the HXML syntax plays well with the Jinja templating library. Here, we're using Jinja's blocks to define two sections (header and content) that will hold the unique content of a screen. With our base template completed, we can create a template specifically for the contacts list screen.

Listing 7. 3. Start of hv/index.xml

```
{% extends 'hv/layout.xml' %} ❶

{% block content %} ❷
  <form> ❸
    <text-field name="q" value="" placeholder="Search..." style="search-field" />
    <list id="contacts-list"> ❹
      {% include 'hv/rows.xml' %}
    </list>
  </form>
{% endblock %}
```

- ❶ Extend the base layout template
- ❷ Override the `content` block of the layout template
- ❸ Create a search form that will issue an HTTP GET to `/contacts`
- ❹ The list of contacts, using a Jinja `include` tag.

This template extends the base `layout.xml`, and overrides the `content` block with a `<form>`. At first, it might seem strange that the form wraps both the `<text-field>` and the `<list>` elements. But remember: in Hyperview, the form data gets included in any request originating from a child element. We will soon add interactions to the list (pull to refresh) that will require the form data. Note the use of a Jinja `include` tag to render the HXML for the rows of contacts in the list (`hv/rows.xml`). Just like in the HTML templates, we can use the `include` to break up our HXML into smaller pieces. It also allows the server to respond with just the `rows.xml` template for interactions like searching, infinite scroll, and pull-to-refresh.

Listing 7. 4. `hv/rows.xml`

```
<items xmlns="https://hyperview.org/hyperview"> ❶
  {% for contact in contacts %} ❷
    <item key="{{ contact.id }}" style="contact-item"> ❸
      <text style="contact-item-label">
        {% if contact.first %}
          {{ contact.first }} {{ contact.last }}
        {% elif contact.phone %}
          {{ contact.phone }}
        {% elif contact.email %}
          {{ contact.email }}
        {% endif %}
      </text>
    </item>
  {% endfor %}
</items>
```

- ❶ An HXML element that groups a set of `<item>` elements in a common parent
- ❷ Iterate over the contacts that were passed in to the template
- ❸ Render an `<item>` for each contact, showing the name, phone number, or email.

In the web app, each row in the list showed the contact's name, phone number, and email

address. But in a mobile app, we have less real-estate. It would be hard to cram all this information into one line. Instead, the row just shows the contact's first and last name, and falls back to email or phone if the name is not set. To render the row, we again make use of Jinja template syntax to render dynamic text with data passed to the template.

We now have templates for the base layout, the contacts screen, and the contact rows. But we still have to update the Flask views to use these templates. Let's take a look at the `contacts()` view in its current form, written for the web app:

Listing 7. 5. `app.py`

```
@app.route("/contacts")
def contacts():
    search = request.args.get("q")
    page = int(request.args.get("page", 1))
    if search:
        contacts_set = Contact.search(search)
        if request.headers.get('HX-Trigger') == 'search':
            return render_template("rows.html", contacts=contacts_set, page=page)
    else:
        contacts_set = Contact.all(page)
    return render_template("index.html", contacts=contacts_set, page=page)
```

This view supports fetching a set of contacts based on two query params, `q` and `page`. It also decides whether to render the full page (`index.html`) or just the contact rows (`rows.html`) based on the `HX-Trigger` header. This presents a minor problem. The `HX-Trigger` header is set by the `htmx` library; there's no equivalent feature in `Hyperview`. Moreover, there are multiple scenarios in `Hyperview` that require us to respond with just the contact rows:

- searching
- pull-to-refresh
- loading the next page of contacts

Since we can't depend on a header like `HX-Trigger`, we need a different way to detect if the client needs the full screen or just the rows in the response. We can do this by introducing a new query param, `rows_only`. When this param has the value `true`, the view will respond to the request by rendering the `rows.xml` template. Otherwise, it will

respond with the `index.xml` template:

Listing 7. 6. `app.py`

```
@app.route("/contacts")
def contacts():
    search = request.args.get("q")
    page = int(request.args.get("page", 1))
    rows_only = request.args.get("rows_only") == "true" ❶
    if search:
        contacts_set = Contact.search(search)
    else:
        contacts_set = Contact.all(page)

    template_name = "hv/rows.xml" if rows_only else "hv/index.xml" ❷
    return render_template(template_name, contacts=contacts_set, page=page)
```

❶ Check for a new `rows_only` query param

❷ Render the appropriate HXML template based on `rows_only`

There's one more change we have to make. Flask assumes that most views will respond with HTML. So Flask defaults the `Content-Type` response header to a value of `text/html`. But the Hyperview client expects to receive HXML content, indicated by a `Content-Type` response header with value `application/vnd.hyperview+xml`. The client will reject responses with a different content type. To fix this, we need to explicitly set the `Content-Type` response header in our Flask views. We will do this by introducing a new helper function, `render_to_response()`:

Listing 7. 7. `app.py`

```
def render_to_response(template_name, *args, **kwargs):
    content = render_template(template_name, *args, **kwargs) ❶
    response = make_response(content) ❷
    response.headers['Content-Type'] = 'application/vnd.hyperview+xml' ❸
    return response
```

❶ Renders the given template with the supplied arguments and keyword arguments.

❷ Create an explicit response object with the rendered template

❸ Sets the response `Content-Type` header to XML.

As you can see, this helper function uses `render_template()` under the hood. `render_template()` returns a string. This helper function uses that string to create an explicit `Response` object. The response object has a `headers` attribute, allowing us to set and change the response headers. Specifically, `render_to_response()` sets `Content-Type` to `application/xml` so that the Hyperview client recognizes the content. This helper is a drop-in replacement for `render_template` in our views. So all we need to do is update the last line of the `contacts()` function.

Listing 7. 8. `contacts()` function

```
return render_to_response(template_name, contacts=contacts_set, page=page) ❶
```

❶ Render the HXML template to an XML response.

With these changes to the `contacts()` view, we can finally see the fruits of our labor. After restarting the backend and refreshing the screen in our mobile app, we can see the contacts screen!

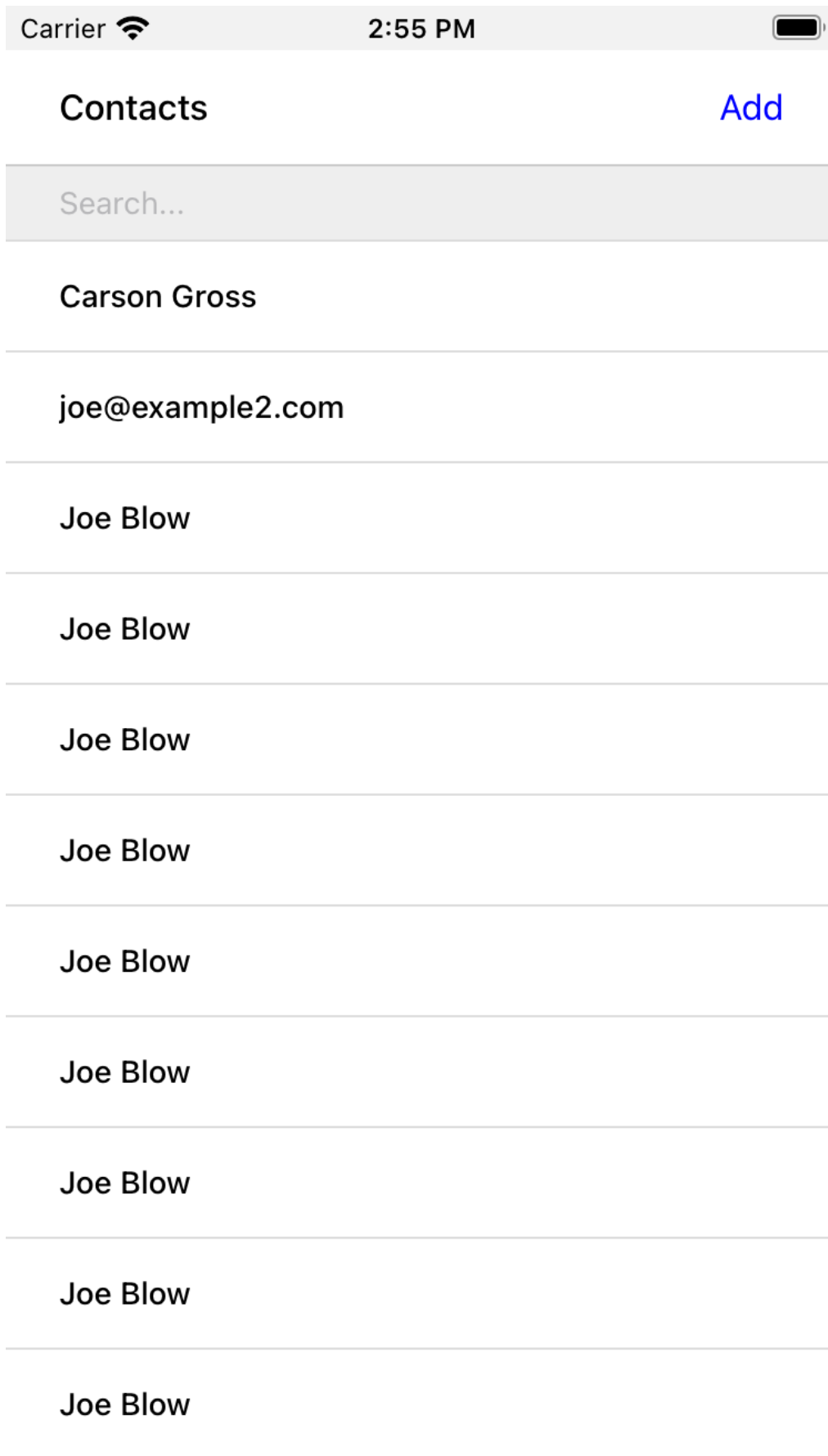


Figure 7. 1. Contacts Screen

7.2.1. Searching Contacts

So far, we have a mobile app that displays a screen with a list of contacts. But our UI doesn't support any interactions. Typing a query in the search field doesn't filter the list of contacts. Let's add a behavior to the search field to implement a search-as-you-type interaction. This requires expanding `<text-field>` to add a `<behavior>` element.

Listing 7. 9. Snippet of `hv/index.xml`

```
<text-field name="q" value="" placeholder="Search..." style="search-field">
  <behavior
    trigger="change" ❶
    action="replace-inner" ❷
    target="contacts-list" ❸
    href="/contacts?rows_only=true" ❹
    verb="get" ❺
  />
</text-field>
```

- ❶ This behavior will trigger when the value of the text field changes
- ❷ When the behavior triggers, the action will replace the content inside the target element.
- ❸ The target of the action is the element with ID `contacts-list`.
- ❹ The replacement content will be fetched from this URL path.
- ❺ The replacement content will be fetched with the `GET` HTTP method.

The first thing you'll notice is that we changed the text field from using a self-closing tag (`<text-field />`) to using opening and closing tags (`<text-field>...</text-field>`). This allows us to add a child `<behavior>` element to define an interaction. The `trigger="change"` attribute tells Hyperview that a change to the value of the text field will trigger an action. Any time the user edits the content of the text field by adding or deleting characters, an action will trigger. The remaining attributes on the `<behavior>` element define the action. `action="replace-inner"` means the action will update content on the screen, by replacing the HXML content of an element with new content. For `replace-inner` to do its thing, we need to know 2 things: the current element on the screen that will be targeted by the action, and the content that will be used for the replacement. `target="contacts-list"` tells us the ID of the current element. Note that we set `id="contacts-list"` on the `<list>` element in `index.xml`. So when the user enters a

search query into the text field, Hyperview will replace the content of `<list>` (a bunch of `<item>` elements) with new content (`<item>` elements that match the search query). relative href. (The domain is inferred from the domain used to fetch the screen). Note that href includes our `rows_only` query param; we want the response to only include the rows and not the entire screen.

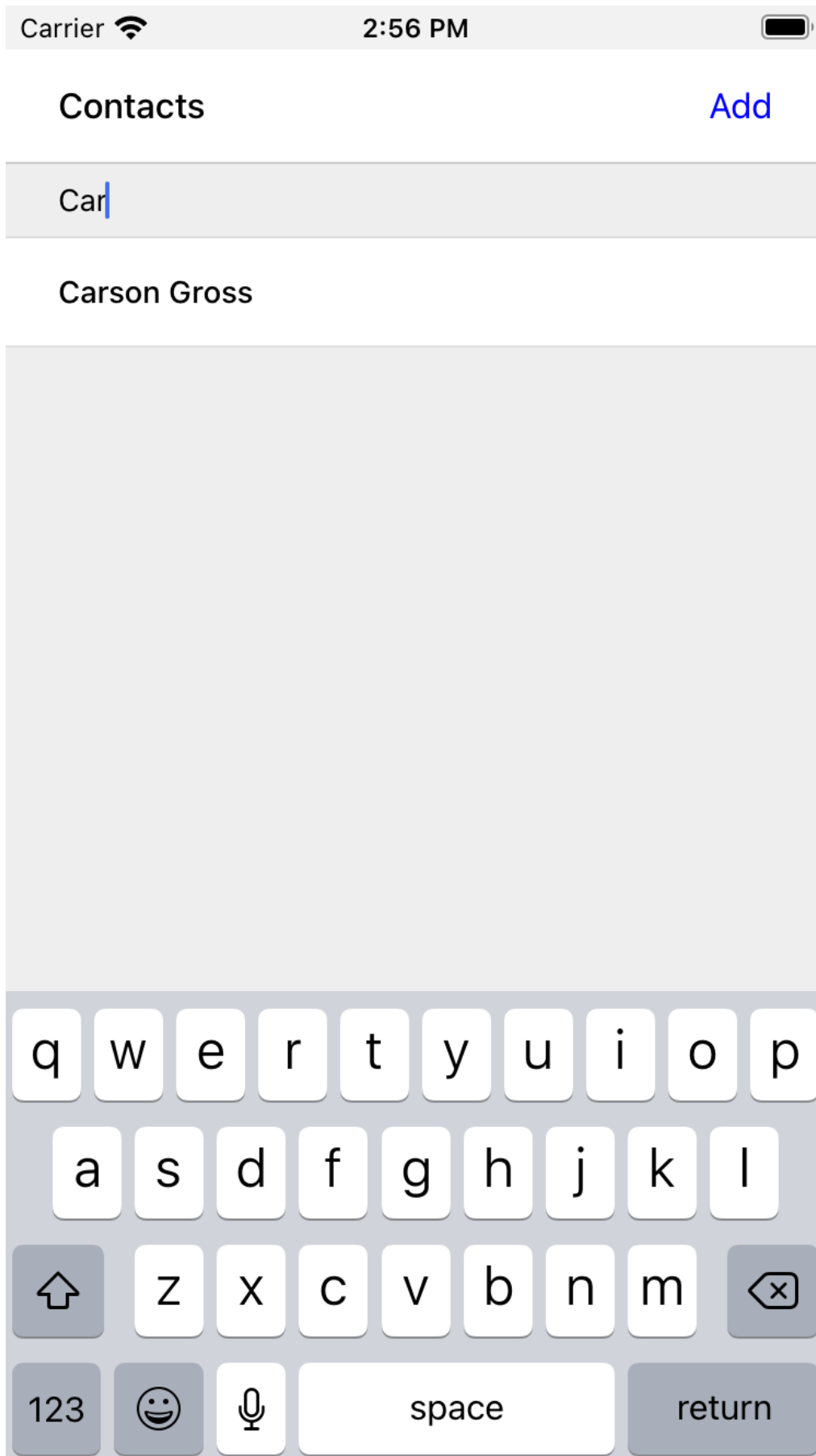


Figure 7. 2. Searchings for Contacts

That's all it takes to add search-as-you-type functionality to our mobile app! As the user types a search query, the client will make requests to the backend and replace the list with the search results. You may be wondering, how does the backend know the query to use? The `href` attribute in the behavior does not include the `q` param expected by our backend. But remember, in `index.xml`, we wrapped the `<text-field>` and `<list>` elements with a parent `<form>` element. The `<form>` element defines a group of inputs that will be serialized and included in any HTTP requests triggered by its child elements. In this case, the `<form>` element surrounds the search behavior and the text field. So the value of the `<text-field>` will be included in our HTTP request for the search results. Since we are making a GET request, the name and value of the text field will be serialized as a query param. Any existing query params on the `href` will be preserved. This means the actual HTTP request to our backend looks like `GET /contacts?rows_only=true&q=Car`. Our backend already supports the `q` param for searching, so the response will include rows that match the string "Car".

7.2.2. Infinite scroll

If the user has hundreds or thousands of contacts, loading them all at once may result in poor app performance. That's why most mobile apps with long lists implement an interaction known as "infinite scroll". The app loads a fixed number of initial items in the list, let's say 100 items. If the user scrolls to the bottom of the list, they see a spinner indicating more content is loading. Once the content is available, the spinner is replaced with the next page of 100 items. These items are appended to the list, they don't replace the first set of items. So the list now contains 200 items. If the user scrolls to the bottom of the list again, they will see another spinner, and the app will load the next set of content. Infinite scroll improves app performance in two ways:

- The initial request for 100 items will be processed quickly, with predictable latency.
- Subsequent requests can also be fast and predictable.
- If the user doesn't scroll to the bottom of the list, the app won't have to make subsequent requests.

Our Flask backend already supports pagination on the `/contacts` endpoint via the `page` query param. We just need to modify our HXML templates to make use of this parameter. To do this, let's edit `rows.xml` to add a new `<item>` below the Jinja for-loop:

Listing 7. 10. Snippet of hv/rows.xml

```
<items xmlns="https://hyperview.org/hyperview">
  {% for contact in contacts %}
    <item key="{{ contact.id }}" style="contact-item">
      <!-- omitted for brevity -->
    </item>
  {% endfor %}
  {% if contacts|length > 0 %}
    <item key="load-more" id="load-more" style="load-more-item"> ❶
      <behavior
        trigger="visible" ❷
        action="replace" ❸
        target="load-more" ❹
        href="/contacts?rows_only=true&page={{ page + 1 }}" ❺
        verb="get"
      />
      <spinner /> ❻
    </item>
  {% endif %}
</items>
```

- ❶ Include an extra `<item>` in the list to show the spinner
- ❷ The item behavior triggers when visible in the viewport
- ❸ When triggered, the behavior will replace an element on the screen
- ❹ The element to be replaced is the item itself (ID `load-more`)
- ❺ Replace the item with the next page of content
- ❻ The spinner element

If the current list of contacts passed to the template is empty, we can assume there's no more contacts to fetch from the backend. So we use a Jinja conditional to only include this new `<item>` if the list of contacts is non-empty. This new `<item>` element gets an ID and a behavior. The behavior defines the infinite scroll interaction. Up until now, we've seen **trigger** values of **change** and **refresh**. But to implement infinite scroll, we need a way to trigger the action when the user scrolls to the bottom of the list. The **visible** trigger can be used for this exact purpose. It will trigger the action when the element with the behavior is visible in the device viewport. In this case, the new `<item>` element is the last item in the list, so the action will trigger when the user scrolls down far enough for the item

to enter the viewport. As soon as the item is visible, the action will make an HTTP GET request, and replace the loading `<item>` element with the response content. Note that our href includes the `rows_only=true` query param, or our response will only include HXML for the contact items, and not the entire screen. Also, we're passing the `page` query param, incrementing the current page number to ensure we load the next page.

What happens when there's more than one page of items? The initial screen will include the first 100 items, plus the "load-more" item at the bottom. When the user scrolls to the bottom of the screen, Hyperview will request the second page of items (`&page=2`), and replace the "load-more" item with the new items. But this second page of items will include a new "load-more" item. So once the user scrolls through all of the items from the second page, Hyperview will again request more items (`&page=3`). And once again, the "load-more" item will be replaced with the new items. This will continue until all of the items will be loaded on the screen. At that point, there will be no more contacts to return, the response will not include another "load-more" item, and our pagination is over.

7.2.3. Pull-to-refresh

Pull-to-refresh is a common interaction in mobile apps, especially on screens featuring dynamic content. It works like this: At the top of a scrolling view, the user pulls the scrolling content downwards with a swipe-down gesture. This reveals a spinner "below" the content. Pulling the content down sufficiently far will trigger a refresh. While the content refreshes, the spinner remains visible on screen, indicating to the user that the action is still taking place. Once the content is refreshed, the content retracts back up to its default position, hiding the spinner and letting the user know that the interaction is done.

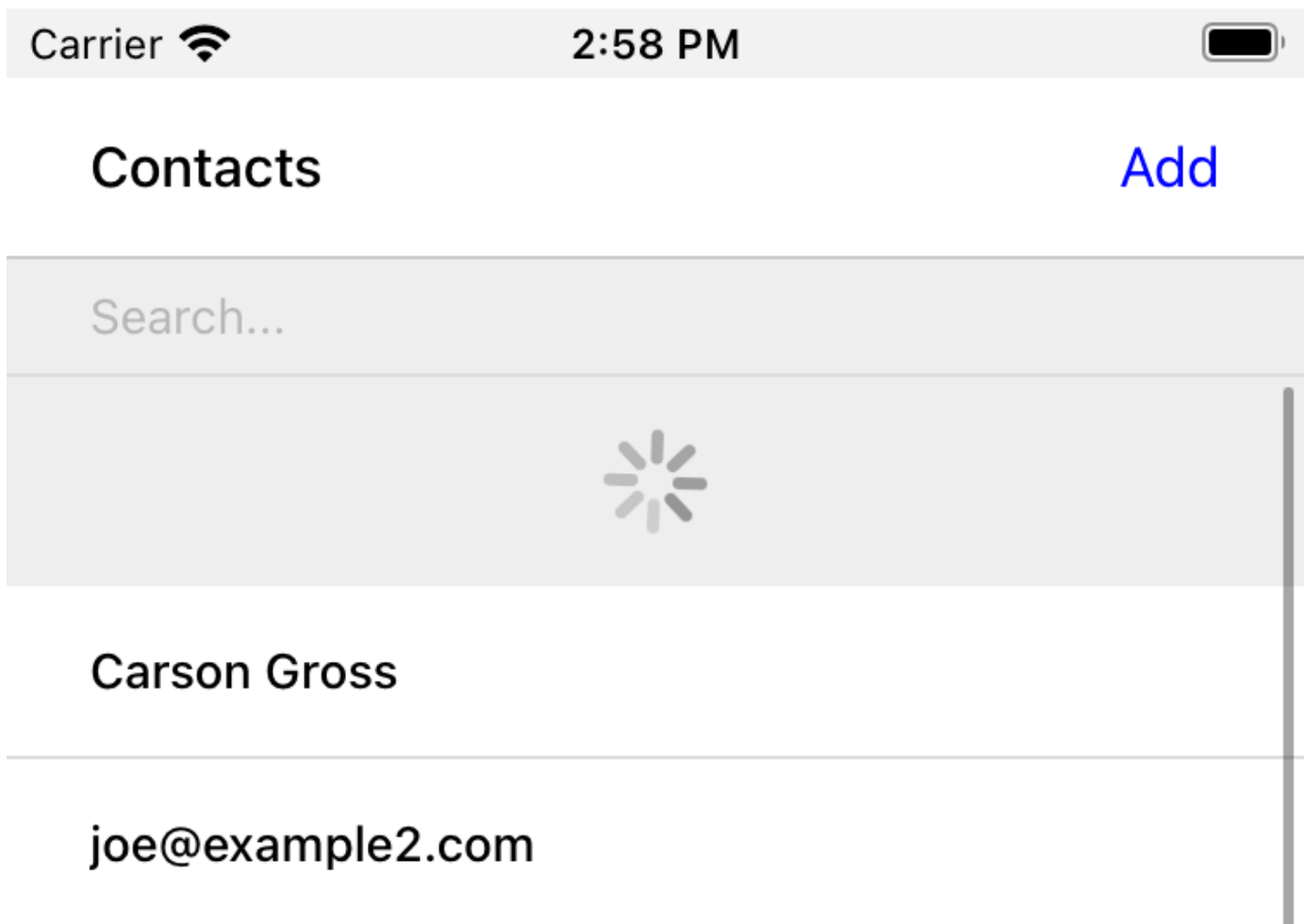


Figure 7. 3. Pull-to-refresh

This pattern is so common and useful that it's built in to Hyperview via the `refresh` action. Let's add pull-to-refresh to our list of contacts to see it in action.

Listing 7. 11. Snippet of `hv/index.xml`

```
<list id="contacts-list"
  trigger="refresh" ❶
  action="replace-inner" ❷
  target="contacts-list" ❸
  href="/contacts?rows_only=true" ❹
  verb="get" ❺
>
  {% include 'hv/rows.xml' %}
</list>
```

- ❶ This behavior will trigger when the user does a "pull-to-refresh" gesture.
- ❷ When the behavior triggers, this action will replace the content inside the target element.

- ③ The target of the action is the `<list>` element itself.
- ④ The replacement content will be fetched from this URL path.
- ⑤ The replacement content will be fetched with the GET HTTP method.

You'll notice something unusual in the snippet above: rather than adding a `<behavior>` element to the `<list>`, we added the behavior attributes directly to the `<list>` element. This is a shorthand notation that's sometimes useful for specifying single behaviors on an element. It is equivalent to adding a `<behavior>` element to the `<list>` with the same attributes. So why did I use the shorthand syntax here? It has to do with the action, `replace-inner`. Remember, this action replaces all child elements of the target with the new content. This includes `<behavior>` elements too! Let's say our `<list>` did contain a `<behavior>`. If the user did a search or pull-to-refresh, we would replace the content of `<list>` with the content from `rows.xml`. The `<behavior>` would no longer be defined on the `<list>`, and subsequent attempts to pull-to-refresh would not work. By defining the behavior as attributes of `<list>`, the behavior will persist even when replacing the items in the list. Generally, I prefer to use explicit `<behavior>` elements in my HXML. It makes it easier to define multiple behaviors, and to move the behavior around while refactoring. But the shorthand syntax is good to apply in situations like this.

7.2.4. Viewing The Details Of A Contact

Now that our contacts list screen is in good shape, we can start adding other screens to our app. The natural next step is to create a details screen, which appears when the user taps an item in the contacts list. Let's update the template that renders the contact `<item>` elements, and add a behavior to show the details screen.

Listing 7. 12. hv/rows.xml

```
<items xmlns="https://hyperview.org/hyperview">
  {% for contact in contacts %}
    <item key="{{ contact.id }}" style="contact-item">
      <behavior trigger="press" action="push" href="/contacts/{{ contact.id }}" /> ❶
      <text style="contact-item-label">
        <!-- omitted for brevity -->
      </text>
    </item>
  {% endfor %}
</items>
```

❶ Behavior to push the contact details screen onto the stack when pressed.

Our Flask backend already has a route for serving the contact details at `/contacts/<contact_id>`. In our template, we use a Jinja variable to dynamically generate the URL path for the current contact in the for-loop. We also used the "push" action to show the details by pushing a new screen onto the stack. If you reload the app, you can now tap any contact in the list, and Hyperview will open the new screen. However, the new screen will show an error message. That's because our backend is still returning HTML in the response, and the Hyperview client expects HXML. Let's update the backend to respond with HXML and the proper headers.

Listing 7. 13. app.py

```
@app.route("/contacts/<contact_id>")
def contacts_view(contact_id=0):
    contact = Contact.find(contact_id)
    return render_to_response("hv/show.xml", contact=contact) ❶
```

❶ Generate an XML response from a new template file.

Just like with the `contacts()` view, `contacts_view()` uses `render_to_response()` to set the `Content-Type` header on the response. We're also generating the response from a new HXML template, which we can create now:

Listing 7. 14. hv/show.xml

```
{% extends 'hv/layout.xml' %} ❶

{% block header %} ❷
  <text style="header-button">
    <behavior trigger="press" action="back" /> ❸
    Back
  </text>
{% endblock %}

{% block content %} ❹
<view style="details">
  <text style="contact-name">{{ contact.first }} {{ contact.last }}</text>

  <view style="contact-section">
    <text style="contact-section-label">Phone</text>
    <text style="contact-section-info">{{contact.phone}}</text>
  </view>

  <view style="contact-section">
    <text style="contact-section-label">Email</text>
    <text style="contact-section-info">{{contact.email}}</text>
  </view>
</view>
{% endblock %}
```

- ❶ Extend the base layout template
- ❷ Override the **header** block of the layout template to include a "Back" button
- ❸ Behavior to navigate to the previous screen when pressed
- ❹ Override the **content** block to show the full details of the selected contact.

The contacts detail screen extends the base `layout.xml` template, just like we did in `index.xml`. This time, we're overriding content in both the **header** block and **content** block. Overriding the header block lets us add a "Back" button with a behavior. When pressed, the Hyperview client will unwind the navigation stack and return the user to the contacts list. Note that triggering this behavior is not the only way to navigate back. The Hyperview client respects navigation conventions on different platforms. On iOS, users can also navigate to the previous screen by swiping right from the left edge of the device. On Android, users can also navigate to the previous screen by pressing the hardware back

button. We don't need to specify anything extra in the HXML to get these interactions!

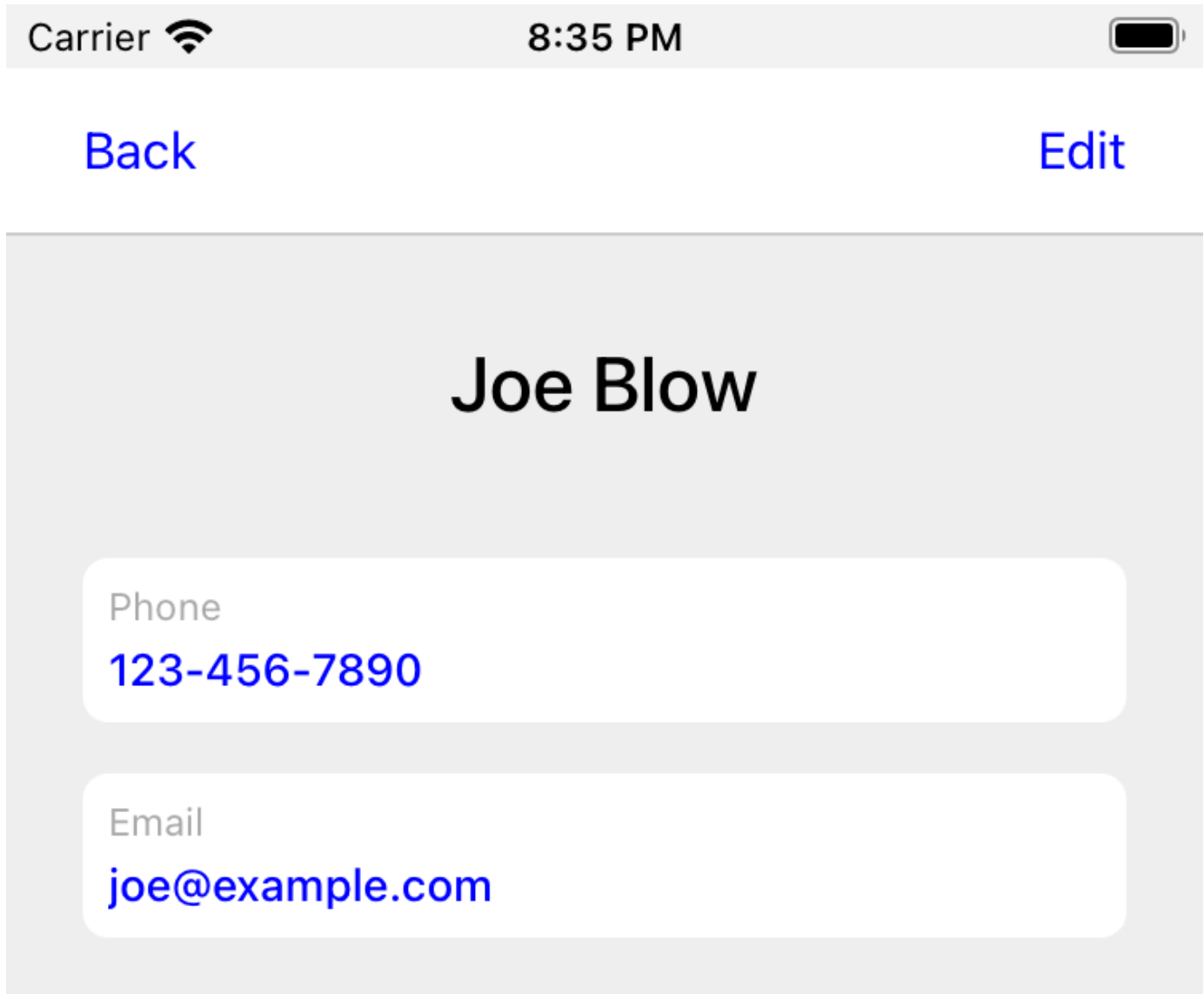


Figure 7. 4. Contact Details Screen

With just a few simple changes, we've gone from a single-screen app to a multi-screen app. Note that we didn't need to change anything in the actual mobile app code to support our new screen. This is a big deal. In traditional mobile app development, adding screens can be a significant task. Developers need to create the new screen, insert it into the appropriate place of the navigation hierarchy, and write code to open the new screen from existing screens. In Hyperview, we just added a behavior with `action="push"`.

7.3. Editing a Contact

So far, our app lets us browse a list of contacts, and view details of a specific contact. Wouldn't it be nice to update the name, phone number, or email of a contact? Let's add UI

to edit contacts as our next enhancement.

First we have to figure out how we want to display the editing UI. We could push a new editing screen onto the stack, the same way we pushed the contact details screen. But that's not the best design from a user-experience perspective. Pushing new screens makes sense when drilling down into data, like going from a list to a single item. But editing is not a "drill-down" interaction, it's a mode switch between viewing and editing. So instead of pushing a new screen, let's replace the current screen with the editing UI. That means we need to add a button and behavior that use the `reload` action. This button can be added to the header of the contact details screen.

Listing 7. 15. Snippet of `hv/show.xml`

```
{% block header %}
  <text style="header-button">
    <behavior trigger="press" action="back" />
    Back
  </text>

  <text style="header-button"> ❶
    <behavior trigger="press" action="reload" href="/contacts/{{contact.id}}/edit" />
  ❷
    Edit
  </text>
{% endblock %}
```

❶ The new "Edit" button

❷ Behavior to reload the current screen with the edit screen when pressed

Once again, we're reusing an existing Flask route (`/contacts/<contact_id>/edit`) for the edit UI, and filling in the contact ID using data passed to the Jinja template. We also need to update the `contacts_edit_get()` view to return an XML response based on an HXML template (`hv/edit.xml`). I'll skip the code sample because the needed changes are identical to what we applied to `contacts_view()` in the previous section. Instead, let's focus on the template for the edit screen.

Listing 7. 16. hv/edit.xml

```
{% extends 'hv/layout.xml' %}

{% block header %}
  <text style="header-button">
    <behavior trigger="press" action="back" href="#" />
    Back
  </text>
{% endblock %}

{% block content %}
<form> ❶
  <view id="form-fields"> ❷
    {% include 'hv/form_fields.xml' %} ❸
  </view>

  <view style="button"> ❹
    <behavior
      trigger="press"
      action="replace-inner"
      target="form-fields"
      href="/contacts/{{contact.id}}/edit"
      verb="post"
    />
    <text style="button-label">Save</text>
  </view>
</form>
{% endblock %}
```

- ❶ Form wrapping the input fields and buttons
- ❷ Container with ID, containing the input fields
- ❸ Template include to render the input fields
- ❹ Button to submit the form data and update the input fields container

Since the edit screen needs to send data to the backend, we wrap the entire content section in a `<form>` element. This ensures the form field data will be included in the HTTP requests to our backend. Within the `<form>` element, our UI is divided into two sections: the form fields, and the Save button. The actual form fields are defined in a separate template (`form_fields.xml`) and added to the edit screen using a Jinja include tag.

Listing 7. 17. hv/form_fields.xml

```
<view style="edit-group">
  <view style="edit-field">
    <text-field name="first_name" placeholder="First name" value="{{ contact.first
  }}" /> ❶
    <text style="edit-field-error">{{ contact.errors.first }}</text> ❷
  </view>

  <view style="edit-field"> ❸
    <text-field name="last_name" placeholder="Last name" value="{{ contact.last }}"
  />
    <text style="edit-field-error">{{ contact.errors.last }}</text>
  </view>

  <!-- same markup for contact.email and contact.phone -->
</view>
```

- ❶ Text input holding the current value for the contact's first name
- ❷ Text element that could display errors from the contact model
- ❸ Another text field, this time for the contact's last name

I omitted the code for the contact's phone number and email address, because they follow the same pattern as the first and last name. Each contact field has its own `<text-field>`, and a `<text>` element below it to display possible errors. The `<text-field>` has two important attributes:

- **name** defines the name to use when serializing the text-field's value into form data for HTTP requests. We are using the same names as the web app from previous chapters (**first_name**, **last_name**, **phone**, **email**). That way, we don't need to make changes in our backend to parse the form data.
- **value** defines the pre-filled data in the text field. Since we are editing an existing contact, it makes sense to pre-fill the text field with the current name, phone, or email.

You might be wondering, why did I choose to define the form fields in a separate template (**form_fields.xml**)? To understand that decision, we need to first discuss the "Save" button. When pressed, the Hyperview client will make an HTTP POST request to **contacts/<contact_id>/edit**, with form data serialized from the `<text-field>`

inputs. The HXML response will replace the contents of form field container (ID `form-fields`). But what should that response be? That depends on the validity of the form data:

1. If the data is invalid (eg duplicate email address), our UI will remain in the editing mode and show error messages on the invalid fields. This allows the user to correct the errors and try saving again.
2. If the data is valid, our backend will persist the edits, and our UI will switch back to a display mode (the contact details UI).

So our backend needs to distinguish between a valid and invalid edits. To support these two scenarios, let's make some changes to the existing `contacts_edit_post()` view in the Flask app.

Listing 7. 18. `app.py`

```
@app.route("/contacts/<contact_id>/edit", methods=["POST"])
def contacts_edit_post(contact_id=0):
    c = Contact.find(contact_id)
    c.update(request.form['first_name'], request.form['last_name'],
request.form['phone'], request.form['email']) ❶
    if c.save(): ❷
        flash("Updated Contact!")
        return render_to_response("hv/form_fields.xml", contact=c, saved=True) ❸
    else:
        return render_to_response("hv/form_fields.xml", contact=c) ❹
```

- ❶ Update the contact object from the request's form data.
- ❷ Attempt to persist the updates. This returns `False` for invalid data.
- ❸ On success, render the form fields template, and pass a `saved` flag to the template
- ❹ On failure, render the form fields template. Error messages are present on the contact object.

This view already contains conditional logic based on whether the contact model `save()` succeeds. If `save()` fails, we render the `form_fields.xml` template. `contact.errors` will contain error messages for the invalid fields, which will be rendered into the `<text style="edit-field-error">` elements. If `save()` succeeds, we will also render the `form_fields.xml` template. But this time, the template will get a `saved` flag, indicating success. We will update the template to use this flag to implement our desired UI: switching

the UI back to display mode.

Listing 7. 19. hv/form_fields.xml

```
<view style="edit-group">
  {% if saved %} ❶
    <behavior
      trigger="load" ❷
      action="reload" ❸
      href="/contacts/{{contact.id}}" ❹
    />
  {% endif %}

  <view style="edit-field">
    <text-field name="first_name" placeholder="First name" value="{{ contact.first
  }}" />
    <text style="edit-field-error">{{ contact.errors.first }}</text>
  </view>

  <!-- same markup for the other fields -->
</view>
```

- ❶ Only include this behavior after successfully saving a contact.
- ❷ Trigger the behavior immediately
- ❸ The behavior will reload the entire screen
- ❹ The screen will be reloaded with the contact details screen.

The Jinja template conditional ensures that our behavior only renders on successful saves, and not when the screen first opens (or the user submits invalid data). On success, the template includes a behavior that triggers immediately thanks to `trigger="load"`. The action reloads the current screen with the Contact Details screen (from the `/contacts/<contact_id>` route). The result? When the user hits "Save", our backend persists the new contact data, and the screen switches back to the Details screen. Since the app will make a new HTTP request to get the contact details, it's guaranteed to show the freshly saved edits.

Listing 7. 20. Why not use a redirect?

You may remember the web app version of this code behaved a little differently. On a successful save, the view returned ``redirect("/contacts/" + str(contact_id))``. This HTTP redirect would tell the web browser to navigate to the contact details page.

This approach is not supported in Hyperview.

Why?

A web app's navigation stack is simple: a linear sequence of pages, with only one active page at a time.

Navigation in a mobile app is considerably more complex.

Mobile apps use a nested hierarchy of navigation stacks, modals, and tabs.

All screens in this hierarchy are active, and may be displayed instantly in response to user actions.

In this world, how would the Hyperview client interpret an HTTP redirect?

Should it reload the current screen, push a new one, or navigate to a screen in the stack with the same URL?

Instead of making a choice that would be suboptimal for many scenarios, Hyperview takes a different approach.

Server-controlled redirects are not possible, but the backend can render navigation behaviors into the HXML.

This is what we do switch from the Edit UI to the Details UI in the code above.

Think of these as client-side redirects, or better yet client-side navigations.

We now have a working Edit UI in our contacts app. Users can enter the Edit mode by pressing a button on the contact details screen. In the Edit mode, they can update the contact's data and save it to the backend. If the backend rejects the edits as invalid, the app stays in Edit mode and shows the validation errors. If the backend accepts and persists the edits, the app will switch back to the details mode, showing the updated contact data.



Let's add one more enhancement to the Edit UI. It would be nice to let the user switch away from the Edit mode without needing to save the contact. This is typically done by providing a "Cancel" action. We can add this as a new button below the "Save" button.

Listing 7. 21. Snippet of hv/edit.xml

```
<view style="button">
  <behavior trigger="press" action="replace-inner" target="form-fields"
href="/contacts/{{contact.id}}/edit" verb="post" />
  <text style="button-label">Save</text>
</view>
<view style="button"> ❶
  <behavior
    trigger="press"
    action="reload" ❷
    href="/contacts/{{contact.id}}" ❸
  />
  <text style="button-label">Cancel</text>
</view>
```

- ❶ New Cancel button on the edit screen
- ❷ When pressed, reload the entire screen
- ❸ The screen will be reloaded with the contact details screen.

This is the same technique we used to switch from the edit UI to the details UI upon successfully editing the contact. But pressing "Cancel" will update the UI faster than pressing "Save". On save, the app will first make a POST request to save the data, and then a GET request for the details screen. Cancelling skips the POST, and immediately make the GET request.

Carrier  2:23 PM 

[Back](#)

Joe

Blow

joe@example.com
Email Must Be Unique



123-456-7890

[Save](#)

[Cancel](#)

q w e r t y u i o p

a s d f g h j k l

 z x c v b n m 



123   space return

Figure 7. 5. Contact Edit Screen

7.3.1. Updating the Contacts List

At this point, we can claim to have fully implemented the Edit UI. But there's a problem. In fact, if we stopped here, users may even consider the app to be buggy! Why? It has to do with syncing the app state across multiple screens. Let's walk through this series of interactions:

1. Launch the app to the Contacts List.
2. Press on the contact "Joe Blow" to load his Contact Details.
3. Press Edit to switch to the edit mode, and change the contact's first name to "Joseph".
4. Press Save to switch back to viewing mode. The contact's name is now "Joseph Blow".
5. Hit the back button to return to the Contacts List.

Did you catch the issue? Our Contacts list is still showing the same list of names as when we launched the app. The contact we just renamed to "Joseph" is still showing up in the list as "Joe". This is a general problem in Hypermedia applications. The client does not have a notion of shared data across different parts of the UI. Updates in one part of the app will not automatically update other parts of the app. Luckily, there's a solution to this problem in Hyperview: events. Events are built into the behavior system, and allow lightweight communication between different parts of the UI.

Listing 7. 22. Event Behaviors

Events are a client-side feature of Hyperview.

You are probably familiar with events from working with HTML and the DOM.

DOM Elements will dispatch events as a result of user interactions.

Scripts can listen for these events, and respond to them by running arbitrary JavaScript code.

Events in Hyperview are a good deal simpler, but they don't require any scripting and can be defined declaratively in the HXML.

This is done through the behavior system.

Events require adding a new behavior attribute, action type, and trigger type:

- `'event-name'`: This attribute of `'<behavior>'` defines the name of the event that will either be dispatched or listened for.

- `'action="dispatch-event"'`: When triggered, this behavior will dispatch an event with the name defined by the `'event-name'` attribute.

This event is dispatched globally across the entire Hyperview app.

- `'trigger="on-event"'`: This behavior will trigger if another behavior in the app dispatches an event matching the `'event-name'` attribute.

If a `<behavior>` element uses `action="dispatch-event"` or `trigger="on-event"`, it must also define an `event-name`.

Note that multiple behaviors can dispatch an event with the same name.

Likewise, multiple behaviors can trigger on the same event name.

Let's look at this simple behavior:

```
<behavior trigger="press" action="toggle" target="container" />
```

Pressing an element containing this behavior will toggle the visibility of an element with the ID "container".

But what if the element we want to toggle is on a different screen?

The "toggle" action and target ID lookup only work on the current screen, so this solution wouldn't work.

The solution is to create two behaviors, one on each screen, communicating via events:

- Screen A:

```
<behavior trigger="press" action="dispatch-event" event-name="button-pressed" />
```
- Screen B:

```
<behavior trigger="on-event" event-name="button-pressed" action="toggle" target="container" />
```

Pressing an element containing the first behavior (on Screen A) will dispatch an event with the name "button-pressed".

The second behavior (on Screen B) will trigger on an event with this name, and toggle the visibility of an element with ID "container".

Events have plenty of uses, but the most common is to inform different screens about backend state changes that require the UI to be re-fetched.

We know enough about Hyperview's event system to solve the bug in our app. When the user saves a change to a contact, we need to dispatch an event from the Details screen. And the Contacts screen needs to listen to that event, and reload itself to reflect the edits. Since the `form_fields.xml` template already gets the `saved` flag when the backend successfully saves a contact, it's a good place to dispatch the event:

Listing 7. 23. Snippet from hv/form_fields.xml

```
{% if saved %}
  <behavior
    trigger="load" ❶
    action="dispatch-event" ❷
    event-name="contact-updated" ❸
  />
  <behavior ❹
    trigger="load"
    action="reload"
    href="/contacts/{{contact.id}}"
  />
{% endif %}
```

- ❶ Trigger the behavior immediately
- ❷ The behavior will dispatch an event
- ❸ The event name is "contact-updated"
- ❹ The existing behavior to show the Details UI.

Now, we just need the contacts list to listen for the `contact-updated` event, and reload itself:

Listing 7. 24. Snippet from hv/index.xml

```
<form>
  <behavior
    trigger="on-event" ❶
    event-name="contact-updated" ❷
    action="replace-inner" ❸
    target="contacts-list"
    href="/contacts?rows_only=true"
    verb="get"
  />
  <!-- text-field omitted -->
  <list id="contacts-list">
    {% include 'hv/rows.xml' %}
  </list>
</form>
```

- ❶ Trigger the behavior on event dispatch

- ② Trigger the behavior for dispatched events with the name "contact-updated"
- ③ When triggered, replace the contents of the `<list>` element with rows from the backend

Any time the user edits a contact, the Contacts List screen will update to reflect the edits. The addition of these two `<behavior>` elements fixes the bug: the Contacts List screen will correctly show "Joseph Blow" in the list. Note that we intentionally added the new behavior inside the `<form>` element. This ensures the triggered request will preserve any search query. To show what I mean, let's revisit the set of steps that demonstrated the buggy behavior. Assume that before pressing on "Joe Blow", the user had searched the contacts by typing "Joe" in the search field. When the user later updates the contact to "Joseph Blow", our template dispatches the "contact-updated" event, which triggers the `replace-inner` behavior on the contact list screen. Due to the parent `<form>` element, the search query "Joe" will be serialized with the request: `GET /contacts?rows_only=true&q=Joe`. Since the name "Joseph" doesn't match the query "Joe", the contact we edited will not appear in the list (until the user clears out the query). Our app's state remains consistent across our backend and all active screens.

Events introduce a level of abstraction to behaviors. So far, we've seen that editing a contact will cause the list of contacts to refresh. But the list of contacts should also refresh after other actions, such as deleting a contact or adding a new contact. As long as our HXML responses for deletion or creation include a behavior to dispatch a `contact-updated` event, then we will get the desired refresh behavior on the contacts list screen. The screen doesn't care what causes the `contact-updated` event to be dispatched. It just knows what it needs to do when it happens.

7.4. Deleting a Contact

Speaking of deleting a contact, this is a good next feature to implement. We will let users delete a contact from the Edit UI. So let's add a new button to `edit.xml`.

Listing 7. 25. Snippet of hv/edit.xml

```
<view style="button">
  <behavior trigger="press" action="replace-inner" target="form-fields"
href="/contacts/{{contact.id}}/edit" verb="post" />
  <text style="button-label">Save</text>
</view>
<view style="button">
  <behavior trigger="press" action="reload" href="/contacts/{{contact.id}}/" />
  <text style="button-label">Cancel</text>
</view>
<view style="button"> ❶
  <behavior
    trigger="press"
    action="append" ❷
    target="form-fields"
    href="/contacts/{{contact.id}}/delete" ❸
    verb="post"
  />
  <text style="button-label button-label-delete">Delete Contact</text>
</view>
```

- ❶ New Delete Contact button on the edit screen
- ❷ When pressed, append HXML to a container on the screen
- ❸ The HXML will be fetched by making a POST `/contacts/<contact_id>/delete` request

The HXML for the Delete button is pretty similar to the Save button, but there are a few subtle differences. Remember, pressing the Save button results in one of two expected outcomes: failing and showing validation errors on the form, or succeeding and switching to the contact details screen. To support the first outcome (failing and showing validation errors), the save behavior replaces the contents of the `<view id="form-fields">` container with a re-rendered version of `form_fields.xml`. Therefore, using the `replace-inner` action makes sense.

Deletion does not involve a validation step, so there's only one expected outcome: successfully deleting the contact. When deletion succeeds, the contact no longer exists. It doesn't make sense to show the edit UI or contact details for a non-existent contact. Instead, our app will navigate back to the previous screen (the contacts list). Our response will only

include behaviors that trigger immediately, there's no UI to change. Therefore, using the `append` action will preserve the current UI while Hyperview runs the actions.

Listing 7. 26. Snippet of `hv/deleted.xml`

```
<view>
  <behavior trigger="load" action="dispatch-event" event-name="contact-updated" /> ❶
  <behavior trigger="load" action="back" /> ❷
</view>
```

❶ On load, dispatch the `contact-updated` event to update the contact lists screen

❷ Navigate back to the contacts list screen.

Note that in addition to behavior to navigate back, this template also includes a behavior to dispatch the `contact-updated` event. In the previous chapter section, we added a behavior to `index.xml` to refresh the list when that event is dispatched. By dispatching the event after a deletion, we will make sure the deleted contact gets removed from the list.

Once again, I'm going to skip over the changes to the Flask backend. Suffice it to say, we will need to update the `contacts_delete()` view to respond with the `hv/deleted.xml` template. And we need to update the route to support POST in addition to DELETE, since the Hyperview client only understands GET and POST.

We now have a fully functioning deletion feature! But it's not the most user-friendly: it takes one accidental tap to permanently delete a contact. For destructive actions like deleting a contact, it's always a good idea to ask the user for confirmation. We can add a confirmation to the delete behavior by using the `alert` system action described in the previous chapter. As you recall, the `alert` action will show a system dialog box with buttons that can trigger other behaviors. All we have to do is wrap the delete `<behavior>` in a behavior that uses `action="alert"`.

Listing 7. 27. Delete button in hv/edit.xml

```
<view style="button">
  <behavior ❶
    xmlns:alert="https://hyperview.org/hyperview-alert"
    trigger="press"
    action="alert"
    alert:title="Confirm delete"
    alert:message="Are you sure you want to delete {{ contact.first }}?"
  >
    <alert:option alert:label="Confirm"> ❷
      <behavior ❸
        trigger="press"
        action="append"
        target="form-fields"
        href="/contacts/{{contact.id}}/delete"
        verb="post"
      />
    </alert:option>
    <alert:option alert:label="Cancel" /> ❹
  </behavior>
  <text style="button-label button-label-delete">Delete Contact</text>
</view>
```

- ❶ Pressing "Delete" triggers an action to show the system dialog with the given title and message.
- ❷ The first pressable option in the system dialog
- ❸ Pressing the first option will trigger contact deletion
- ❹ The second pressable option has no behavior, so it only closes the dialog.

Unlike before, pressing the delete button will not have an immediate effect. Instead, the user will be presented with the dialog box and asked to confirm or cancel. Our core deletion behavior didn't change, we just chained it from another behavior.

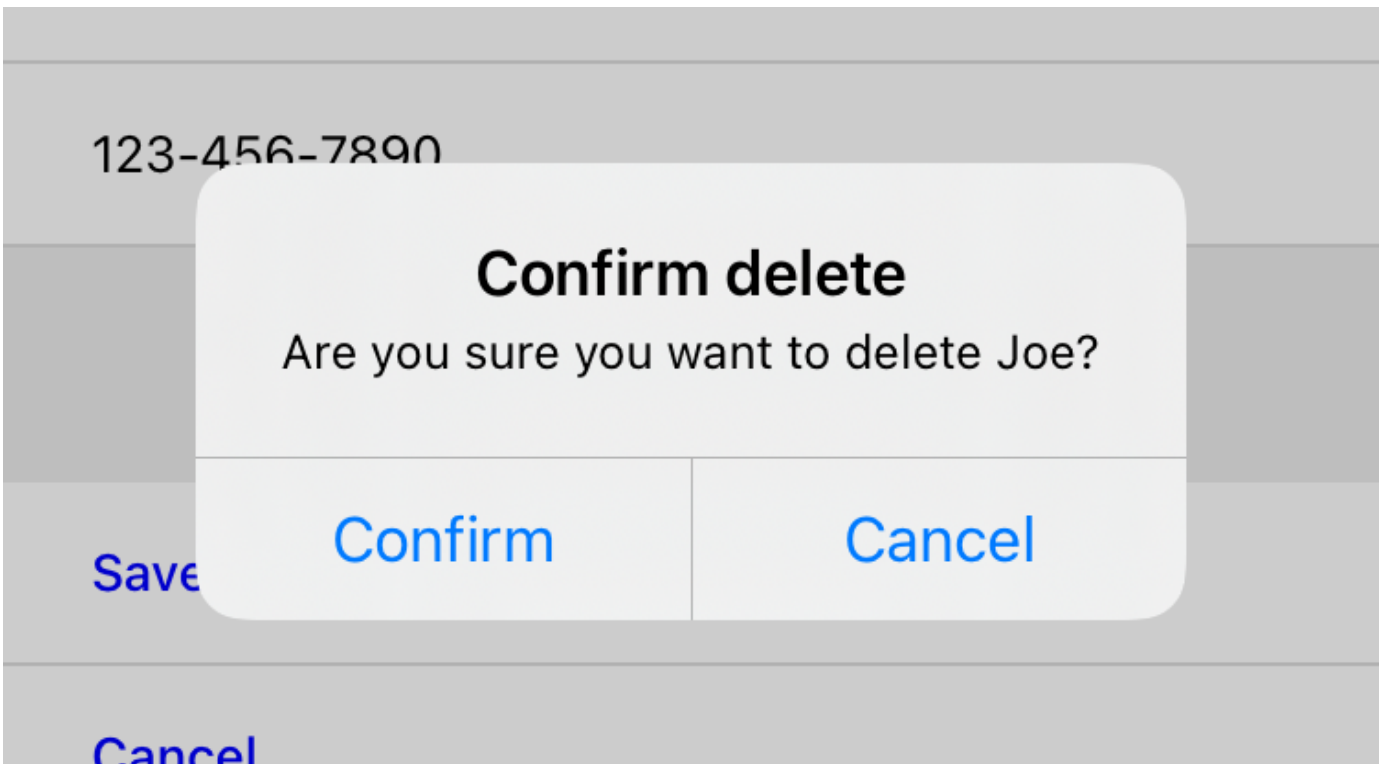


Figure 7. 6. Delete Contact confirmation

7.5. Adding a New Contact

Adding a new contact is the last feature we want to support in our mobile app. And luckily, it's also the easiest. We can reuse the concepts (and even some templates) from features we've already implemented. In particular, adding a new contact is very similar to editing an existing contact. Both features need to:

- Show a form to collect information about the contact
- Have a way to save the entered information
- Show validation errors on the form
- Persist the contact when there are no validation errors

Since the functionality is so similar, I'm going to summarize the changes here without showing the code. Hopefully, you can follow along:

1. Update `index.xml`.
 - Override the header block to add a new "Add" button.
 - Include a behavior in the button. When pressed, push a new screen as a modal by using `action="new"`, and request the screen content from `/contacts/new`.

2. Create a template `hv/new.xml`.

- Override the header block to include a button that closes the modal, using `action="close"`.
- Include the `hv/form_fields.xml` template to render empty form fields
- Add a "Add Contact" button below the form fields.
- Include a behavior in the button. When pressed, make a POST request to `/contacts/new`, and use `action="replace-inner"` to update the form fields.

3. Update the Flask view.

- Change `contacts_new_get()` to use `render_to_response()` with the `hv/new.xml` template.
- Change `contacts_new()` to use `render_to_response()` with the `hv/form_fields.xml` template. Pass `saved=True` when rendering the template after successfully persisting the new contact.

By reusing `form_fields.xml` for both editing and adding a contact, we get to reuse some code and ensure the two features have a consistent UI. Also, our "Add Contact" screen will benefit from the "saved" logic that's already a part of `form_fields.xml`. After successfully adding a new contact, the screen will dispatch the `contact-updated` event, which will refresh the contacts list and show the newly added contact. The screen will reload itself to show the Contact Details.

Carrier 2:48 PM

Close

First name

Last name

Email

Phone number

Add Contact

Q W E R T Y U I O P

A S D F G H J K L

↑ Z X C V B N M ↵

123 😊 🎤 space return

Figure 7. 7. Add Contact modal

7.6. Deploying the App

With the completion of the contact creation UI, we have a fully implemented mobile app! It supports searching a list of contacts, viewing the details of a contact, editing & deleting a contact, and adding a new contact. But so far, we've been developing the app using a simulator on our desktop computer. How can we see it running on a mobile device? And how can we get it into the hands of our users?

To see the app running on a physical device, let's take advantage of the Expo platform's app preview functionality.

1. Download the Expo Go app on an Android or iOS device.
2. Restart the Flask app, binding to an interface accessible on your network. This might look something like `flask run --host 192.168.7.229`, where the host is your computer's IP address on the network.
3. Update the Hyperview client code so that `ENTRY_POINT_URL` (in `demo/src/constants.js`) points to the IP and port that the Flask server is bound to.
4. After running `yarn start` in the Hyperview demo app, you will see a QR code printed in the console, with instructions on how to scan it on Android and iOS.

Once you scan the QR code, the full app will run on the device! As you interact with the app, you will see HTTP requests made to the Flask server. You can even use the physical device during development. Any time you make a change in the HXML, just reload the screen to see the UI updates.

So we have the app running on a physical device, but it's still not production ready. To get the app into the hands of our users, there's a few things we need to do:

1. Deploy our backend in production. We need to use a production-grade web server like Gunicorn instead of the Flask development server. And we should run our app on a machine reachable on the Internet, most likely using a cloud provider like AWS or Heroku.
 2. Create standalone binary apps. By following the instructions from the Expo project, we can create a `.ipa` or `.apk` file, for the iOS and Android platforms. Remember to update `ENTRY_POINT_URL` in the Hyperview client to point to the production backend.
-

3. Submit our binaries to the iOS App Store or Google Play Store, and wait for app approval.

Once the app is approved, congratulations! Our mobile app can be downloaded by Android and iOS users. And here's the best part. Because our app uses the hypermedia architecture, we can add features to our app by simply updating the backend. The UI and interactions are completely specified with the HXML generated from server-side templates. Want to add a new section to a screen? Just update an existing HXML template. Want to add a new type of screen to the app? Create a new route, view, and HXML template. Then, add a behavior to an existing screen that will open the new screen. To push these changes to your users, you just need to re-deploy the backend. Our app knows how to interpret HXML, and that's enough for it to understand how to handle the new features.

7.7. One Backend, Multiple Hypermedia formats

To create a mobile app using the hypermedia architecture, we started with the web-based contacts app and made a few changes, primarily replacing HTML templates with HXML templates. But in the process of porting the backend to serve our mobile app, we lost the web application functionality. Indeed, if you tried to visit <http://0.0.0.0:5000> in a web browser, you would see a jumble of text and XML markup. That's because web browsers don't know how to render plain XML, and they certainly don't know how to interpret the tags and attributes of HXML to render an app. It's a shame, because the Flask code for the web application and mobile app are nearly identical. The database and model logic are shared, and most of the views are unchanged as well.

At this point you're surely wondering: is it possible to use the same backend to serve both a web application and mobile app? The answer is yes! In fact, this is one of the benefits of using a hypermedia architecture across multiple platforms. We don't need to port any client-side logic from one platform to another, we just need to respond to requests with the appropriate Hypermedia format. To do this, we will utilize content negotiation built into HTTP.

7.7.1. What is Content Negotiation?

Imagine a German speaker and Japanese speaker both visit <https://google.com> in their web browser. They will see the Google home page localized in German and Japanese, respectively. How does Google know to return a different version of the homepage based

on the user's preferred language? The answer lies in the REST architecture, and how it separates the concepts of resources and representations.

In the REST architecture, the Google homepage is considered to be a single "resource", represented by a unique URL. However, that single resource can have multiple "representations". Representations are variations on how the content of the resource is presented to the client. The German and Japanese versions of the Google homepage are two representations of the same resource.. To determine the best representation of a resource to return, HTTP clients and servers engage in a process called "content negotiation". It works like this:

- Clients specify the preferred representation through **Accept-*** request headers.
- The server tries to match the preferred representation as best it can, and communicates back the chosen representation using **Content-***.

In the Google homepage example, the German speaker uses a browser that is set to prefer content localized for German. Every HTTP request made by the web browser will include a header **Accept-Language: de-DE**. The server sees the request header, and it will return a response localized for German (if it can). The HTTP response will include a **Content-Language: de-DE** header to inform the client of the language of the response content.

Language is just one factor for resource representation. More importantly for us, resources can be represented using different content types, such as HTML or HXML. Content negotiation over content type is done using the **Accept** request header and **Content-Type** response header. Web browsers set **text/html** as the preferred content type in the **Accept** header. The Hyperview client sets **application/vnd.hyperview+xml** as the preferred content type. This gives us our backend a way to distinguish requests coming from a web browser or Hyperview client, and serve the appropriate content to each. There are two main approaches: fine-grained and global.

7.7.2. Approach 1: Template Switching

When we ported the Contacts app from the web to mobile, we kept all of the Flask views but made some minor changes. Specifically, we introduced a new function `render_to_response()` and called it in the return statement of each view. Here's the function again to refresh your memory:

Listing 7. 28. app.py

```
def render_to_response(template_name, *args, **kwargs):
    content = render_template(template_name, *args, **kwargs)
    response = make_response(content)
    response.headers['Content-Type'] = 'application/vnd.hyperview+xml'
    return response
```

`render_to_response()` renders a template with the given context, and turns it into an Flask response object with the appropriate **Hyperview Content-Type** header. Obviously, the implementation is highly-specific to serving our Hyperview mobile app. But we can modify the function to do content negotiation based on the requests's **Accept** header:

Listing 7. 29. app.py

```
HTML_MIME = 'text/html'
HXML_MIME = 'application/vnd.hyperview+xml'

def render_to_response(html_template_name, hxml_template_name, *args, **kwargs): ❶
    response_type = request.accept_mimetypes.best_match([HTML_MIME, HXML_MIME],
    default=HTML_MIME) ❷
    template_name = hxml_template_name if response_type == HXML_MIME else
    html_template_name ❸
    content = render_template(template_name, *args, **kwargs)
    response = make_response(content)
    response.headers['Content-Type'] = response_type ❹
    return response
```

- ❶ Function signature takes two templates, one for HTML and one for HXML
- ❷ Determine whether the client wants HTML or HXML
- ❸ Select the template based on the best match for the client
- ❹ Set the **Content-Type** header based on the best match for the client

Flask's request object exposes an `accept_mimetypes` property to help with content negotiation. We pass our two content MIME types to `request.accept_mimetypes.best_match()` and get back the MIME type that works for our client. Based on the best matching MIME type, we choose to either render an HTML template or HXML template. We also make sure to set the **Content-Type** header to the appropriate MIME type. The only difference in our Flask views is that we need to

provide both an HTML and HXML template:

Listing 7. 30. app.py

```
@app.route("/contacts/<contact_id>")
def contacts_view(contact_id=0):
    contact = Contact.find(contact_id)
    return render_to_response("show.html", "hv/show.xml", contact=contact) ❶
```

❶ Template switching between an HTML and HXML template, based on the client.

After updating all of the Flask views to support both templates, our backend will support both web browsers and our mobile app! This technique works well for the Contacts app because the screens in the mobile app map directly to pages of the web application. Each app has a dedicated page (or screen) for listing contacts, showing and editing details, and creating a new contact. This meant the Flask views could be as-is without major changes. But what if we wanted to re-imagine the Contacts app UI for our mobile app? Perhaps we want the mobile app to use a single screen, with rows that expanded in-line to support viewing and editing the information? In situations where the UI diverges between platforms, Template Switching becomes cumbersome or impossible. We need a different approach to have one backend serve both hypermedia formats.

7.7.3. Approach 2: The Redirect Fork

If you recall, the Contacts web app has an `index` view, routed from the root path `/`:

Listing 7. 31. app.py

```
@app.route("/")
def index():
    return redirect("/contacts") ❶
```

❶ Redirect requests from `/` to `/contacts`

When someone requests to the root path of the web application, Flask redirects them to the `/contacts` path. This redirect also works in our Hyperview mobile app. The Hyperview client's `ENTRY_POINT_URL` points to <http://0.0.0.0:5000/>, and the server redirects it to <http://0.0.0.0:5000/contacts>. But there's no law that says we need to redirect to the same path in our web application and mobile app. What if we used the `Accept` header to redirect to decide on the redirect path?

Listing 7. 32. app.py

```
HTML_MIME = 'text/html'
HXML_MIME = 'application/vnd.hyperview+xml'

@app.route("/")
def index():
    response_type = request.accept_mimetypes.best_match([HTML_MIME, HXML_MIME],
default=HTML_MIME) ❶
    if response_type == HXML_MIME:
        return redirect("/mobile/contacts") ❷
    else:
        return redirect("/web/contacts") ❸
```

- ❶ Determine whether the client wants HTML or HXML
- ❷ If the client wants HXML, redirect them to `/mobile/contacts`
- ❸ If the client wants HTML, redirect them to `/web/contacts`

The entrypoint is a fork in the road: if the client wants HTML, we redirect them to one path. If the client wants HXML, we redirect them to a different path. These redirects would be handled by different Flask views:

Listing 7. 33. app.py

```
@app.route("/mobile/contacts")
def mobile_contacts():
    # Render an HXML response

@app.route("/web/contacts")
def web_contacts():
    # Render an HTML response
```

The `mobile_contacts()` view would render an HXML template with a list of contacts. Tapping a contact item would open a screen requested from `/mobile/contacts/1`, handled by a view `mobile_contacts_view`. After the initial fork, all subsequent requests from our mobile app go to paths prefixed with `/mobile/`, and get handled by mobile-specific Flask views. Likewise, all subsequent requests from the web app go to paths prefixed with `/web/`, and get handled by web-specific Flask views. (Note that in practice, we would want to separate the web and mobile views into separate parts of our codebase:

`web_app.py` and `mobile_app.py`. We may also choose not to prefix the web paths with `/web/`, if we want more elegant URLs displayed in the browser's address bar.)

You may be thinking that the Redirect Fork leads to a lot of code duplication. After all, we need to write double the number of views: one set for the web application, and one set for the mobile app. That is true, which is why the Redirect Fork is only preferred if the two platforms require a disjoint set of view logic. If the apps are similar on both platforms, Template Switching will save a lot of time and keep the apps consistent. Even if we need to use the Redirect Fork, the bulk of the logic in our models can be shared by both sets of views. In practice, you may start out using Template Switching, but then realize you need to implement a fork for platform-specific features. In fact, we're already doing that in the Contacts app. When porting the app from web to mobile, we didn't bring over certain features like archiving functionality. The dynamic archive UI might is a power feature that wouldn't make sense on a mobile device. Since our HXML templates don't expose any endpoints to the Archive functionality, we can treat it as "web-only" and not worry about supporting it in Hyperview.

7.8. Summary

- Creating a Hyperview-powered mobile app is as simple as cloning a Git repo and configuring a single endpoint URL.
 - Flask is perfectly suited for serving a Hyperview mobile app. The Jinja templating system can generate dynamic HXML based on the context from a view.
 - Using elements like `<view>`, `<text>`, `<list>`, and `<item>`, we can create native-feeling screens in HXML.
 - Using behaviors, we can implement interactions on the contacts list such as infinite scroll, search-as-you-type, and pull-to-refresh.
 - Events are a client-side feature of Hyperview that allows triggering behaviors across screens. They are useful to keep state in sync throughout the app, such as after editing or deleting a contact.
 - A Hyperview-powered mobile app can be bundled and released through the iOS and Android app stores. New screens and features can be added to the app just by updating the backend!
 - The same Flask backend can support both web and mobile apps. Using HTTP content
-

negotiation, a server can render either HTML or HXML responses from the same view. More complex apps may require the use of redirects and platform-specific views.