Ash Training

Supercharge Your Elixir Apps with Ash

CodeBEAM America Training 2025

Ash Training Agenda

Time	Event
08:30	Registration/Breakfast
09:00	**Session 1**
10:30	Tea and Coffee Break
11:00	**Session 2**
12:30	Lunch
13:30	**Session 3**
15:30	Tea and Coffee Break
16:00	**Session 4**
17:00	Finish!

Resources

What is a Resource?

- the primary concept in Ash
- usually a **domain object** in your system
  - but doesn't have to be
- a **noun** or **entity** in your domain model (eg **User**, **Order**, **Product**)
- "Model your domain (with Resources), and derive the rest"

Resources define the following

Actions: the verbs or commands for your Resources

Attributes: the data fields (with validations)

Relationships: the relationships between Resources

Data Layer: how Ash will persist data (by default it doesn't)

Note: *Resources define much, much more that we'll cover later*

Resource example

A minimal `Profile` resource with a `UUID` primary key, a `string` attribute `name`, and `create` and `read` actions.

```
defmodule Account.Profile do
  use Ash.Resource, domain: Account

  actions do
    read :read
    create :create do
      accept [:name]
    end
  end

  attributes do
    uuid_primary_key :id
    attribute :name, :string
  end
end
```

Domain

Domains are **groupings of related resources** with shared configuration.

You can think of them like a **Phoenix Context** or a **Service**.

Note: *Was previously called **"Api"** before Ash 3.0*

Domain example

Resources must also be defined in a Domain.

```
defmodule Account do
  use Ash.Domain

  resources do
    resource Account.Profile
  end
end
```

Actions are the foundation of a Resource

- Ash Resources model both data and operations (data access and transformation)
- This a fundamental difference between Ash and Ecto
- All access to a Resource's data is done via an Action
    - This allows Ash to consistently apply rules like validation, authorisation, etc

Remember: A Resource without Actions is useless!

Mandatory Attributes

By default `name` is optional. How can we enforce it?

```
attribute :name, :string do
  allow_nil? false
end
```

Keyword List vs Block syntax

This is called block syntax, and is usually preferred.

```
attribute :name, :string do
  allow_nil? false
end
```

can also be written inline using keyword list syntax

```
attribute :name, :string, allow_nil?: false
```

Constraining Attribute values

We want to add an attribute called `status` to our profile.

- type `:atom`
- can only be the values `:published` or `:unpublished`
- defaults to `:unpublished`
- cannot be `nil`

Published Attribute

```
attribute :status, :atom do
  allow_nil? false
  constraints [one_of: [:unpublished, :published]]
  default :unpublished
end
```

Timestamps

Ash provides create_timestamp and update_timestamp to keep track of when the Resource was first created, and when it was last updated.

```
create_timestamp :created_at
update_timestamp :updated_at
```

Putting the Attributes together

```
attributes do
  uuid_primary_key :id
  attribute :name, :string, allow_nil?: false
  attribute :status, :atom do
    allow_nil? false
    constraints [one_of: [:unpublished, :published]]
    default :unpublished
  end

  create_timestamp :created_at
  update_timestamp :updated_at
end
```

Data Layers

What is a Data Layer?

By default Ash does not persist any data.

An Ash Data Layer specifies where your Resource's data will be stored.

Which Data Layer?

- AshPostgres
- AshSqlite
- AshCsv
- Ets
- Mnesia

More to come!

💡 You should generally default to `AshPostgres`

Specifying a Data Layer

```
defmodule Account.Profile do
  use Ash.Resource,
    domain: Account,
    data_layer: AshPostgres.DataLayer

  postgres do
    table "profiles"
    repo Account.Repo
  end

  ...
end
```

Ash Generators (new!)

Composable, source patching generators powered by **Igniter**.

```
mix ash.gen.domain     # Generates an Ash.Domain
mix ash.gen.resource   # Generate and configure an Ash.Resource.
mix ash.extend         # Adds extensions to the given domain/resource
mix ash.gen.enum       # Generates an Ash.Type.Enum
```

```
❯ mix ash.gen.resource Twitter.Tweets.Tweet

Igniter:
Update: lib/twitter/tweets.ex

     ...|
12 12   |
13 13   |  resources do
   14 + |    resource Twitter.Tweets.Tweet
14 15   |  end
15 16   |end
     ...|


Create: lib/twitter/tweets/tweet.ex

1 | defmodule Twitter.Tweets.Tweet do
2 |   use Ash.Resource,
3 |     otp_app: :twitter,
4 |     domain: Twitter.Tweets
5 | end
6 |

Proceed with changes? [Yn] y
```

Questions?

🔬 Lab 0

Setup and Intro to Resources

- Clone the repo
  `git clone git@github.com:ash-project/ash_training`
- `cd ash_training`
- `mix setup`
- open `labs/0-resources.md` in your editor (Markdown preview is helpful)
- or open in GitHub
  - https://github.com/ash-project/ash_training/blob/main/labs/0-resources.md
- follow the instructions!

Actions

What is an Action?

- An operation or command that can be performed on a Resource
- 5 main types **Create, Read, Update, Destroy** or **Generic**
- Can and should be named using Domain language where possible
- Actions can also be defined on the Domain using Code Interfaces *(since Ash 3.0)*

Use Domain Language (Not just CRUD)

For example:

- `publish` an `Article` resource making it publicly visible
- `like` or `unlike` a `Tweet` by updating the `User`/`Tweet` relationship
- `archive` an `Article` by soft-deleting it

These are really `update` action types

Default Actions Example

Actions are defined on a **Resource** in an `actions` block

If you just need CRUD actions, the defaults are all you need:

```
actions do
  defaults [
    :read,
    :destroy,
    create: [:name],
    update: [:name]
  ]
end
```

Accepted Attributes

Create and Update **Action**s must explicitly accept attributes they will set

```
actions do
  create :create do
    accept [:name]
  end
end
```

Profile Resource

```elixir
defmodule Account.Profile do
  use Ash.Resource, domain: Account

  actions do
    read :read
    create :create do
      accept [:name]
    end
  end

  attributes do
    uuid_primary_key :id
    attribute :name, :string, allow_nil?: false
    attribute :status, :atom do
      allow_nil? false
      constraints [one_of: [:unpublished, :published]]
      default :unpublished
    end

    create_timestamp :created_at
    update_timestamp :updated_at
  end
end
```

Calling `create` Actions

To call a create Action, we use `Ash.Changeset.for_create/3` to create a changeset. Then we call `Ash.create!()`

```
profile =
  Account.Profile
  |> Ash.Changeset.for_create(:create, %{name: "My Name"})
  |> Ash.create!()
```

Note: There are nicer ways to call actions, that we'll get to later on

Action errors

Now if we create a Profile we should see an error:

```
Account.Profile
|> Ash.Changeset.for_create(:create, %{})
|> Ash.create!()
```

produces the following:

```
** (Ash.Error.Invalid) Input Invalid

* attribute name is required
```

Read All Profiles

Now, read all the generated Profiles.

```
Account.Profile
|> Ash.read!()
```

Filtered Reads

Fetching the "Joe Armstrong" Profile requires a filter

```
require Ash.Query

[joe] =
  Account.Profile
  |> Ash.Query.filter(name == "Joe Armstrong")
  |> Ash.read!()
```

Sorting and Limits

What if we want to get the latest Profile?

We set our `created_at` timestamp now we can sort on it.

```
Account.Profile
|> Ash.Query.sort(created_at: :desc)
|> Ash.Query.limit(1)
|> Ash.read_one!()
```

Generic Actions

Generic actions accept input arguments, execute custom logic, and return a value.

Minimal structural constraints, useful for arbitrary business logic. A generic action is structured using `Ash.ActionInput` to manage inputs and `Ash.run_action` for execution.

```
action :say_hello, :string do
  argument :name, :string, allow_nil?: false
  run fn input, _ ->
    {:ok, "Hello: #{input.arguments.name}"}
  end
end
```

🔬 Lab 1
Basic Actions and Attributes

- 💡 Review existing application UI

Break time!

Relationships

Relationships

Relationships describe the connections between resources, they enable:

- Loading related data
- Filtering on related data
- Managing related records through changes on a single resource
- Authorizing based on the state of related data

Relationship Basics

A Relationship exists between a source resource and a destination resource. They are defined in the `relationships` block of the source resource.

```
defmodule Content.Post do
  use Ash.Resource

  attributes do
    uuid_primary_key :id
    attribute :title, :string
  end

  relationships do
    belongs_to :author, Account.Profile
  end
end
```

Kinds of Relationships

There are 4 kinds of relationships:

- `belongs_to`
- `has_one`
- `has_many`
- `many_to_many`

Belongs To

`belongs_to` links a `source_attribute` to a `destination_attribute` on another Resource

```
# on Content.Post
belongs_to :author, Account.Profile
```

The source attribute on `Content.Post` is `:author_id` and the destination attribute on `Account.Profile` is `:id`.

Has One

has_one is similar to a belongs_to except the reference attribute is on the destination resource, instead of the source.

```
# on Account.Profile
has_one :avatar, Account.Avatar
```

The source attribute on Account.Profile is :id and the destination attribute on Account.Avatar is :profile_id. This expects that profile_id is unique on Avatar.

Has Many

has_many relationship is similar to a has_one except that the destination attribute is not unique, and will produce a list of related items.

```
# on Account.Profile
has_many :posts, Content.Post
```

The source_attribute on Account.Profile is :id and the destination_attribute on Content.Post is :profile_id.

Many To Many

A `many_to_many` relationship can be used to relate many source resources to many destination resources.

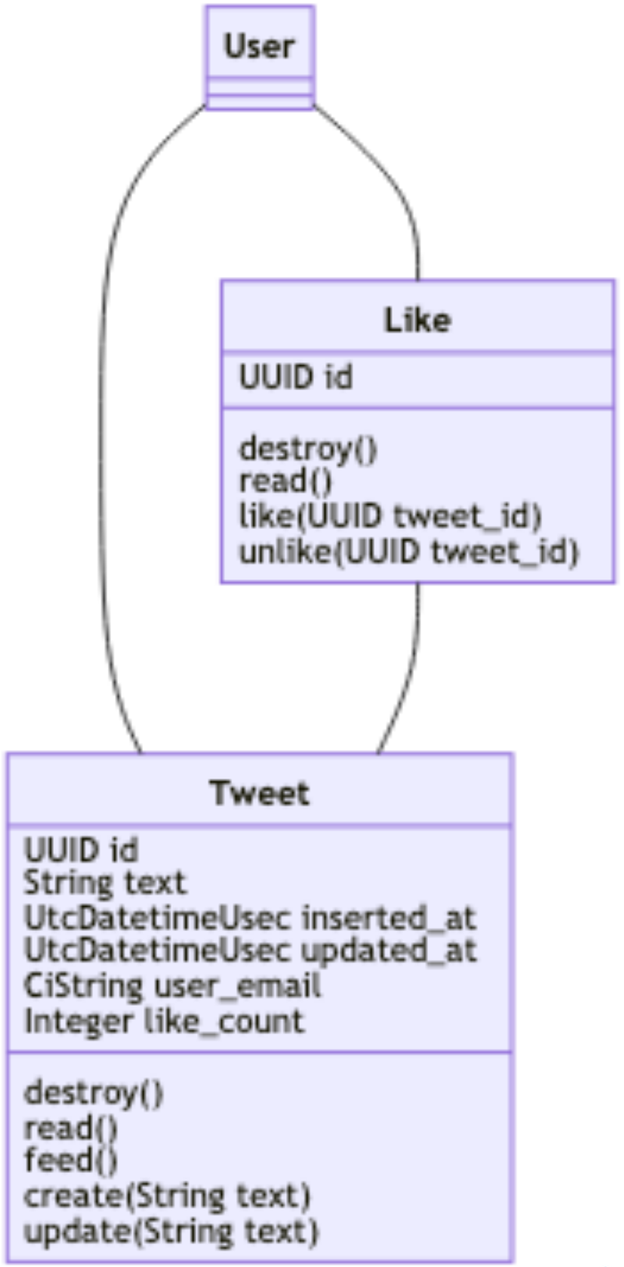
To achieve this, the `source_attribute` and `destination_attribute` are defined on a **join resource**.

A `many_to_many` relationship can be thought of as a combination of a `has_many` relationship on the source/destination resources and a `belongs_to` relationship on the join resource.

Lab 2

Relationships

Mermaid Resource Diagrams



Advanced Actions

Custom Read Actions with `prepare`

For `read` Actions, you can add custom behavior with `prepare`.

Let's create a meaningful `latest` Action which sorts by the most recently created Profiles.

```
read :latest do
  prepare build(sort: [created_at: :desc])
end
```

Remember: **actions should be meaningful in your domain, not just CRUD**.

Running the Actions

```
Account.Profile
|> Ash.Query.for_read(:latest)
|> Ash.read!()
```

Builtin vs Custom `prepare`s

`build` is a builtin `prepare` function (or "preparation")

```
prepare build(sort: [created_at: :desc])
```

but we can call our own code by providing a Module

```
prepare Account.Profile.Preparations.SortByMostRecentlyCreated
```

Custom prepare Module

To define a Preparation we use `Ash.Resource.Preparation` and define a `prepare/3` function.

```
defmodule Account.Profile.Preparations.SortByMostRecentlyCreated do
  use Ash.Resource.Preparation

  def prepare(query, _, _) do
    Ash.Query.build(query, sort: [created_at: :desc])
  end
end
```

Custom Actions with `change` and `validate`

For `create`, `update` and `destroy` Actions, you can add custom behavior with `change` and validations with `validate`.

Let's create a meaningful `publish` Action for Profile which changes the `status`.

```
update :publish do
  # We don't want to accept any input here
  accept []

  change set_attribute(:status, :published)
  validate string_length(:name, min: 2, max: 255)
end
```

Running the Actions

Given a Profile in a `profile` variable

```
profile
|> Ash.Changeset.for_update(:publish)
|> Ash.update!()
```

Builtin vs Custom change

`set_attribute` is a builtin change

```
change set_attribute(:status, :published)
```

but we can call our own code by providing a Module

```
change Account.Profile.Changes.Publish
```

Custom change Module

To define a change we use `Ash.Resource.Change` and define a change/3 function.

```
defmodule Account.Profile.Changes.Publish do
  use Ash.Resource.Change

  def change(changeset, _, _) do
    Ash.Changeset.force_change_attribute(changeset, :status, :published)
  end
end
```

Builtin vs Custom `validate`

`string_length` is a builtin validation

```
validate string_length(:name, min: 2, max: 255)
```

but we can call our own code by providing a Module

```
validate Account.Profile.Validations.CheckNameLength
```

Custom `validate` Module

To define a validation we use `Ash.Resource.Validation` and define a `validate/3` function.

```
defmodule Account.Profile.Validations.CheckNameLength do
  use Ash.Resource.Validation

  def validate(changeset, _, _) do
    name = Ash.Changeset.get_attribute(changeset, :name)
    length = String.length(name)

    if length >= 2 and length <= 255 do
      :ok
    else
      {:error, field: :name, message: "must be at least 2 characters and less than 255"}
    end
  end
end
```

Identities

What is an Identity?

Identities declare that a record can be uniquely identified by some attributes.

The primary key of the Resource is an Identity by default.

```
identities do
  identity <name>, <keys>
  ...
end
```

Identity example

To make the Profile name unique add this section to the Resource

```
identities do
  identity :profile_name, [:name]
end
```

How Does Ash Handle Identities?

Allows fields to be passed to `Ash.get/3`

```
Ash.get(Resource, %{email: "foo@bar.com"})
```

Create unique constraints in the database automatically for each identity (AshPostgres)

Upserts

Ash automatically handles upserting on primary key, but you need to specify upsert behaviour for other attributes.

```
create :create_or_publish do
  accept [:name]
  change set_attribute(status: :published)
  upsert? true
  upsert_identity :profile_name
end
```

Lab 3

Advanced Actions

Lunch!

Calculations and Aggregates

Calculations

Calculations are derived fields. They can reference attributes, calculations and aggregates.

```
defmodule Resource do
  ...

  calculations do
    calculate <name>, <type>, expr(<expression>)
  end
end
```

Split `name` in the `Profile` resource

```elixir
defmodule Account.Profile do
  use Ash.Resource, domain: Account

  actions do
    defaults [:read]

    create :create do
      accept [:first_name, :last_name]
    end
  end

  attributes do
    uuid_primary_key :id
    attribute :first_name, :string, allow_nil?: false
    attribute :last_name, :string, allow_nil?: false
  end
end
```

Calculate `full_name`

Add the `calculations` section to the Resource

```
calculations do
  calculate :full_name, :string, expr(first_name <> " " <> last_name)
  # or reference a Module
  calculate :full_name, :string, Account.Profile.Calculations.FullName
end
```

`full_name` can now be loaded on demand or used in filters, sorts, or other calculations.

Module Calculations

Not every calculation can be created with an expression.

```
defmodule Account.Profile.Calculations.FullName do
  use Ash.Resource.Calculation

  def load(_, _, _), do: [:first_name, :last_name]

  def calculate(records, _, _) do
    Enum.map(records, fn record ->
      record.first_name <> " " <> record.last_name
    end)
  end
end
```

Expressions with `expr`

Ash expressions give you a way to define **portable calculations**.

This means that they are data layer independent!

```
expr(first_name <> " " < > last_name)
```

This can be run in Elixir *or* within a data layer for efficient sorting and filtering.

Expression Examples

```
Account.Profile
|> Ash.Query.filter(full_name == "Joe Armstrong")
|> Ash.read!()
```

```
SELECT *
FROM users
WHERE (first_name || ' ' || last_name) = 'Joe Armstrong'
```

Expression Examples

```
expr = Ash.Expr.expr(first_name <> " " <> last_name)

profile = %Account.Profile{
  first_name: "Joe",
  last_name: "Armstrong"
}

Ash.Expr.eval(expr, record: profile)
# {:ok, "Joe Armstrong"}
```

Calculation example

Let's put that together

```
joe =
  Account.Profile
  |> Ash.Changeset.for_create(:create, %{first_name: "Joe", last_name: "Armstrong"})
  |> Ash.create!()
  |> Ash.load!([:full_name])
```

Loading the `full_name` calculates the field, and concats the attributes.

Aggregates

Aggregates in Ash allow for retrieving summary information over groups of related data.

Some examples:
- count of published Posts for a User
- sum of all read counts across all Posts for a User
- total count of likes for a tweet

Aggregate Example

Given a user `Profile` resource with related `Posts`:

```
aggregates do
  count :count_of_posts, :posts do
    filter expr(published == true)
  end
end
```

Aggregate Types

- `count` - counts related items meeting the criteria.
- `exists` - checks if any related items meet the criteria.
- `first` - gets the first related value matching the criteria. Must specify the `field`.
- `sum` - sums the related items meeting the criteria. Must specify the `field`.
- `list` - lists the related values. Must specify the `field`.

Aggregate Types (more)

- `max` - gets the maximum related value. Must specify the `field`.
- `min` - gets the minimum related value. Must specify the `field`.
- `avg` - gets the average related value. Must specify the `field`.
- `custom` - allows for a custom aggregate. Implementation depends on the data layer. Must provide an `implementation`.

Lab 4 & 5

Calculations and Aggregates

Actors, Authorization & Policies

Actors & Authorization

Authorization in Ash involves three things:

- `actor` - the entity (i.e User, Org, Device) performing an action
- `authorize?` - a flag that tells Ash to run authorization.
- `authorizers` - the extensions on a resource that can modify or forbid the action.

Setting actor and authorize?

All functions in Ash that may perform authorization and/or wish to use the actor accept an `actor` and an `authorize?` option.

```
Ash.Changeset.for_create(
  Post,
  %{title: "Post Title"},
  actor: current_user,
  authorize?: true
)
```

Set the actor on the query/changeset/input

The hooks on a query/changeset/input to an action may need to know the actor

```
# DO THIS
Post
|> Ash.Query.for_read(:read, actor: current_user)
|> Ash.read!()

# DON'T DO THIS
Post
|> Ash.Query.for_read!(:read)
|> Ash.read!(actor: current_user)
```

Authorizers

Authorizers are in control of what happens during authorization.

Generally, you won't need to create your own authorizer, as the builtin policy authorizer `Ash.Policy.Authorizer` works well for any use case.

```
use Ash.Resource, authorizers: [Ash.Policy.Authorizer]
```

💡 If you don't add at least one Authorizer, your Resource allows any actor to call any action.

Policies

Policies determine what actions on a resource are permitted for a given actor.

They can also filter the results of read actions to restrict the results to only records that should be visible.

Setup

You'll need to add the extension to your resource, like so:

```
use Ash.Resource, authorizers: [Ash.Policy.Authorizer]
```

Then you can start defining policies for your resource.

Policy Example

```
policies do
  policy always() do
    authorize_if always()
  end

  policy action_type(:create) do
    authorize_if IsSuperUser
    forbid_if Deactivated
    authorize_if IsAdminUser
    authorize_if HasCreatorRole
  end
end
```

Anatomy of a Policy

Each Policy defined in a resource has two parts:

1. a condition, or a list of conditions such as `action_type(:read)` or `always()`. If the condition(s) are true for an attempted action, then the policy will be applied to the action.
2. a set of **Checks**, each of which will be evaluated individually if a Policy applies to the attempted action.

How a Policy is processed

If more than one policy applies to any given attempted action (eg. an admin actor calls a read action) then **all applicable policies must pass** for the action to be performed.

A Policy will evaluate to either:

- `:forbidden`
- `:authorized`

Policy checks

If no check produces a result then the Policy result is `:forbidden`

- `authorize_if`
  - if `true` the whole policy is `:authorized`
  - else move to next check
- `authorize_unless`
  - if `false` the whole policy is `:authorized`
  - else move to next check
- `forbid_if`
  - if `true` the whole policy is `:forbidden`
  - else move to next check
- `forbid_unless`
  - if `false` the whole policy is `:forbidden`
  - else move to next check

Policy Example

```
policies do
  policy action_type(:create) do
    authorize_if IsSuperUser
    forbid_if Deactivated
    authorize_if IsAdminUser
    authorize_if HasCreatorRole
  end
end
```

We check those from top to bottom, so the first one of those that returns `:authorized` or `:forbidden` determines the entire outcome.

Bypass Policies

A bypass Policy is just like a regular policy, except if a bypass passes, then other policies after it *do not need to pass*.

This can be useful for writing complex access rules, or for a simple rule like "an admin can do anything" without needing to specify it as part of every other policy.

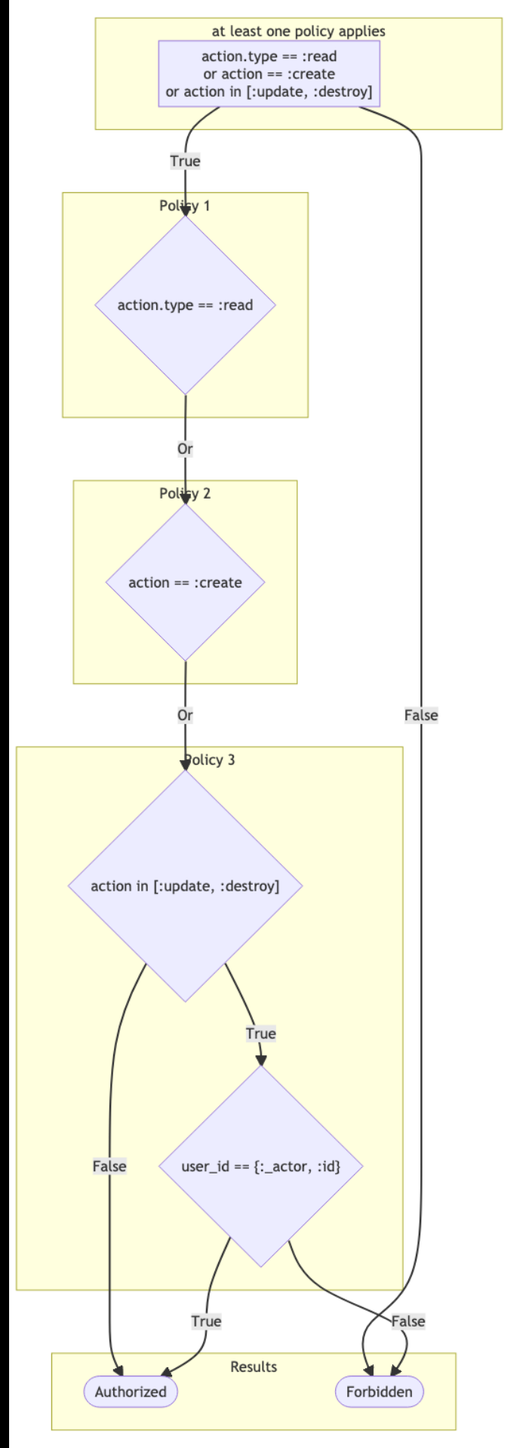
Bypass Example

```
policies do
  bypass IsSuperUser do
    authorize_if always()
  end
end
```

Lab 6

Policies

Mermaid Policy Flowcharts



Code Interfaces

Why do we need Code Interfaces?

Using `Changesets` and `Querys` directly to act on resources is a bit unwieldy.

Code Interfaces simplify how we use our defined actions, and offer a clean and rich interface to our Domain.

They can be defined on **Resources** (*or* the **Domain** since Ash 3.0)

Code Interface Example

In this example, we will define it on the **Domain**.

```
defmodule Account do
  use Ash.Domain

  resources do
    resource Account.Profile do
      define :create_profile, args: [:name], action: :create
    end
  end
end
```

Using Code Interfaces

Create a profile with 1 line. (Remember we defined it on the Account domain)

```
Account.create_profile!("Joe Armstrong")
```

instead of 3 lines

```
Account.Profile
|> Ash.Changeset.for_create(:create, %{name: "Joe Armstrong"})
|> Ash.create!()
```

Nice! the bang version of the function is created as well as the normal version

Lab 7

Code Interfaces

Ecosystem Overview

The Ash Ecosystem

The Ash ecosystem consists of numerous hex packages, all of which have their own documentation.

If you can't find something in this documentation, don't forget to search in any potentially relevant package.

Data Layers

- AshPostgres | PostgreSQL data layer
- AshSqlite | SQLite data layer
- AshCsv | CSV data layer
- AshCubdb | CubDB data layer
- AshMysql | MySQL data layer (alpha)

API Extensions

- AshJsonApi | JSON:API builder
- AshGraphql | GraphQL builder

Web

- AshPhoenix | Phoenix integrations
- AshAuthentication | Authenticate users with password, OAuth, and more
- AshAuthenticationPhoenix | Integrations for AshAuthentication and Phoenix

Finance

- AshMoney | A money data type for Ash
- AshDoubleEntry | A double entry system backed by Ash Resources

Resource Utilities

- AshOban | Background jobs and scheduled jobs for Ash, backed by Oban
- AshArchival | Archive resources instead of deleting them
- AshStateMachine | Create state machines for resources
- AshPaperTrail | Keep a history of changes to resources
- AshCloak | Automatically encrypt (and decrypt) resource attributes

Admin & Monitoring

- AshAdmin | A push-button admin interface
- AshAppsignal | Monitor your Ash resources with AppSignal

Testing

- Smokestack | Declarative test factories for Ash resources

Lab 8, 9 & 10
Form Helpers and APIs

💡 Try out Ash Admin! Hint: `/admin`

Dispelling Myths and Misconceptions!

- Ash works with Phoenix, it's not a replacement
- Ash does more than CRUD
- The investment is definitely worth it, but hard to tell on toy apps
- Ash doesn't lock you in, escape hatches everywhere
- Ash is not just about creating APIs
- Ash has various test helpers, but you can test apps the way you normally do

Bonus Content

- Navigating the docs
  - Testing guide
- Pagination
- get_by
- Document your model
- PubSub
- Spark
- Extensions
- Q&A and General Discussion