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### Motivation

During the height of the COVID-19 pandemic millions of individuals were tested, with <10% positivity. These tests may use grouped testing for faster results. Grouped testing works by:

- Pooling samples together. Pools are tested and negative pools are removed as they contain no positive samples
- Pools subdivided and tested again, negative pools are removed.
- Final single samples are tested to identify the positive cases.

Each group removed saves n - 1 sample tests (n: group size). This algorithm, has been codified by Dr. Furstenau. However, there are problems in grouped testing. The problems are:

- There is not an easy way to separate different groups visually
- Lab users must manually input information from lab notebooks
- This manual data transfer leads to mistakes within the lab
- Takes many days with many lab users involved

A solution to these problems will allow for more efficient pathogen testing. While COVID-19 may be coming to an end, the next disease event is always on the horizon.

### Solution Overview

We propose a laboratory assistant application that remedies the problems highlighted above by:

- Allowing users to generate and share protocols and experiments.
- Visually representing the experiment with an interactive well-plate page (figure 3).
- Use Dr. Furstenau's algorithm to generate group sizes.
- Making collaboration easier by saving in-progress experiments and making experiment data exportable to a single document.
- Using the power of the internet with an online solution, to allow access from anywhere, with an internet connection

### Architecture and Technology

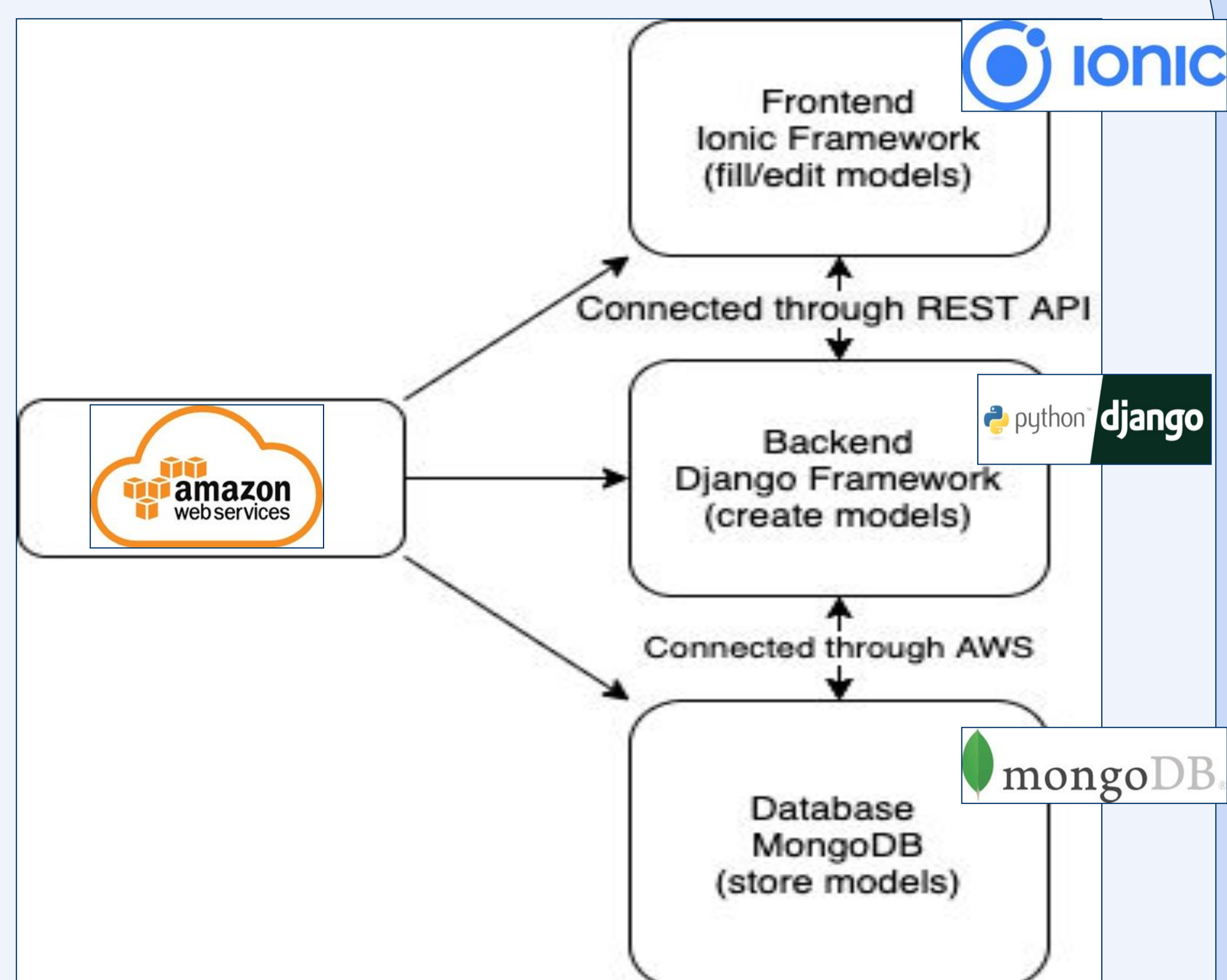


Figure 4: Architecture of application frameworks and how they interact. All of these features run on the AWS cloud, allowing access from anywhere.

Figure 1: Protocol page. Create protocols, which are specific to their lab group. If selected, the user will be taken to the experiments page.

Figure 2: Users are able to create experiments based on a protocol. When an experiment is selected, the user is directed to the well-plate page.

Figure 3: Well-plate interaction page

### Key Features

- Visual display of the configured protocol, as well as user's progress through it
- On mobile devices users will use touch interaction with all pieces of the application, including the well-plate image
- System provides multi-function "lab notebook" for researchers.
- Refined GUI for visualizing protocols, monitoring protocol execution, and reviewing results.
- Protocols that lab worker have previously designed can be saved/cloned/edited and re-used.
- This application helps facilitate efficient and accurate sample pooling for high throughput processing of pathogen samples.

### Challenges

Challenges	Solutions
Link main ionic pages with well-plate image	Create additional logic and django page linking our main ionic application
Store users' information	Use JSON token
Connect mongoDB and Django	Using an API and proper configuration to ensure communication between the two
Export notes and image	Python script and markdown file to export notes and images into PDF

Table 1: Challenges and Solutions

### Testing

Our testing was three fold: unit testing, usability testing, and integration testing.

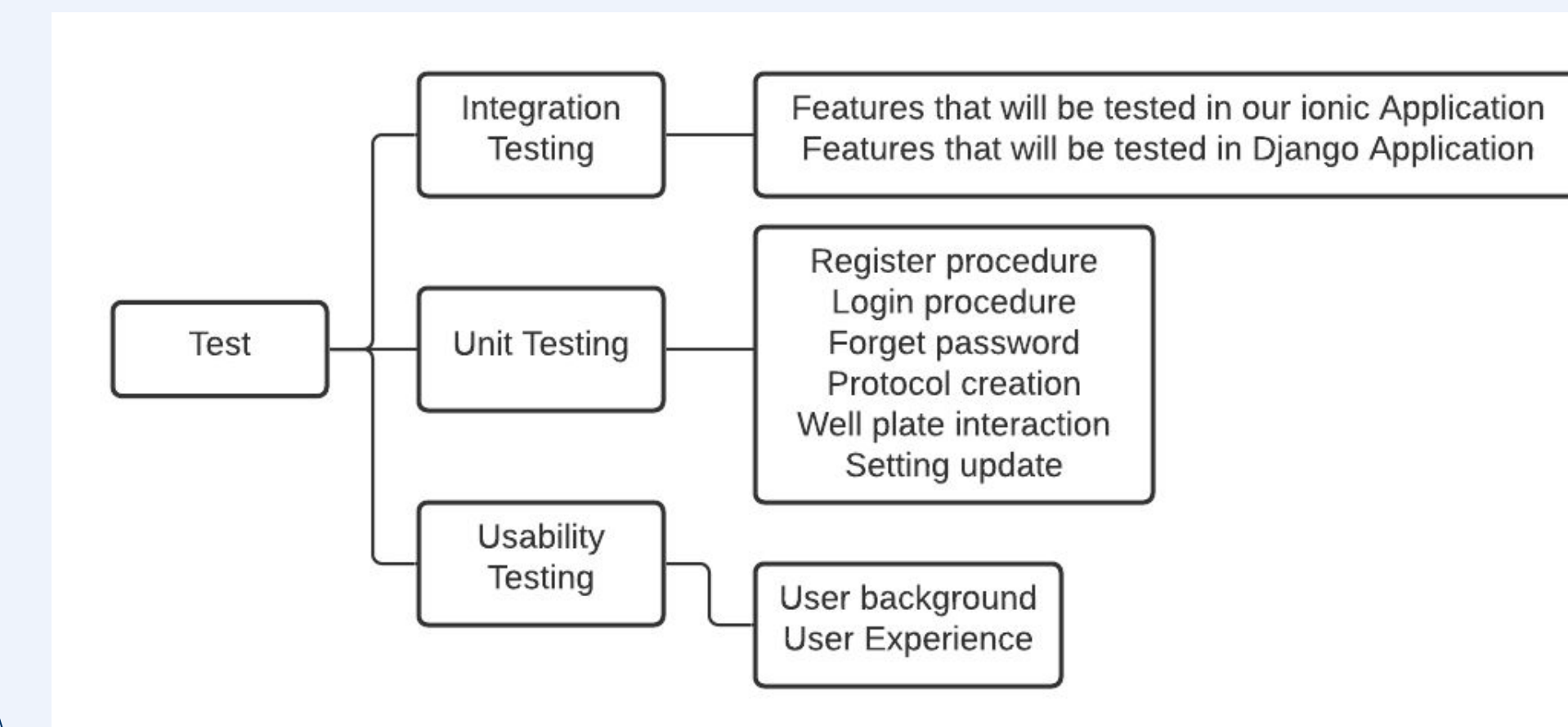


Figure 5: Testing Capabilities

### Moving Forward

Discussions with the client and potential users have led to some potentially useful features in the future:

- Ability to import and export to an excel spreadsheet
- Metadata information about the DNA that exists in each well
- More comprehensive lab notebook

### Outcome

With our application, lab workers are able to use:

- A GUI-based well-plate tool to effectively capture and correctly record experiment results
- An optimal pooling strategy from existing algorithms with the assistance of the application.
- Process pathogen samples efficiently and without error
- Manage user groups and correctly separate experiments based on the lab in which they are used

### Acknowledgements

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