Epidemiological Modeling Portal
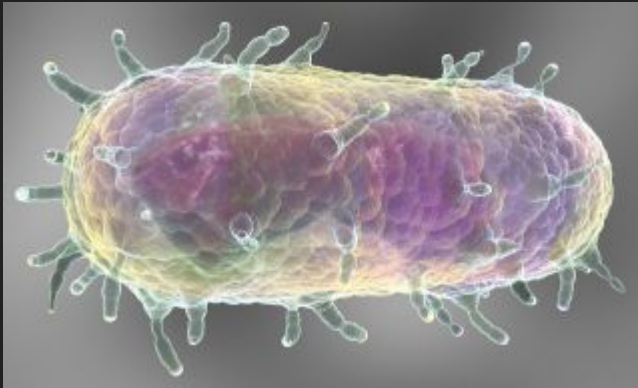
Pandemic Processing

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Introduction

Plagues
- Plague of Justinian in 541 and lasted 200 years.
  - 25-50 million deaths
- Black Death during 1347-1350
 - Killed ~60% of the European population

West Africa Ebola Outbreak
- Occurred December 2013 - June 2016
- 11,310 total deaths

How epidemiologists alleviate this issue

- Epidemiologists generate mathematical models to show the spread of infectious disease.

- These models can be used to predict the best time to vaccinate against infectious diseases.

- Proper timing is imperative to prevent the spread of infection.

SIR Model for Ebola
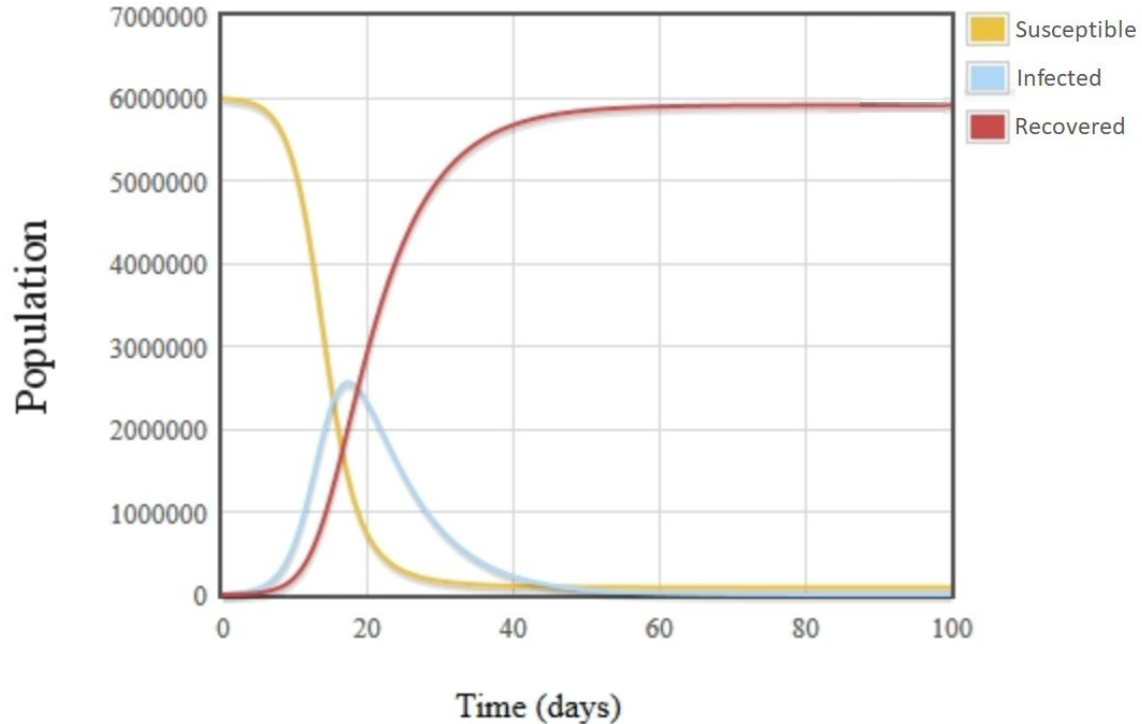
Assumptions made:

- 6 million person population
- 100 day timeline
- Death or recovery 7 days after initial infection begins

Pathological Modeling Workflow

Collect Data	Model Data	Model Implications	Preventative Measures

Data Sets
Researched Data

Develop Model

Build Predictions

Distribute Vaccine

Our Client

Dr. Joseph Mihaljevic:

- Assistant professor in SICCS
- Researches and collects data concerning the spread of infectious disease
- Primary focus:
  - Ecological preservation through biocontrol
  - Controlling outbreaks of infectious disease

Modeling in Reality
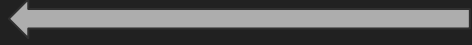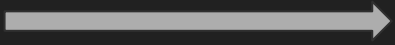
The Problem

The current methodology doesn't allow:

- Epidemiologists lack an efficient way to share their models
- These models can only appear in static form
- Discussion with the entire community only begins at publication
- Tension between collaboration and competition in research
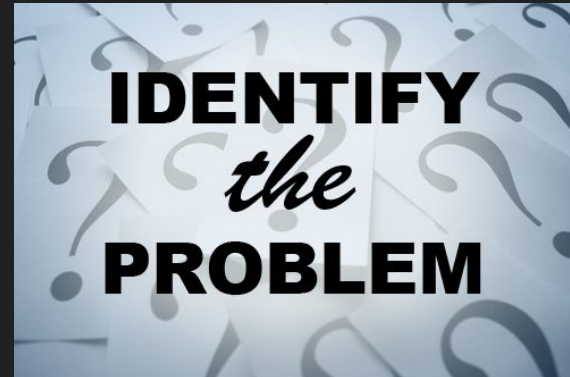
EON: Epidemic Observation Network

Key Requirements

Key top-level requirements:

- User accounts and management
- Model creation, manipulation, and exploration
- Forums for model discussion
- Must be able to securely run and execute model code
- Fine grained access control to models and discussions

Total number of requirements and sub-requirements: 152

EON System Architecture

Prototype Review

Prototype Review

Prototype Review

Epidemiological Modeling Portal

Welcome joe! | logout
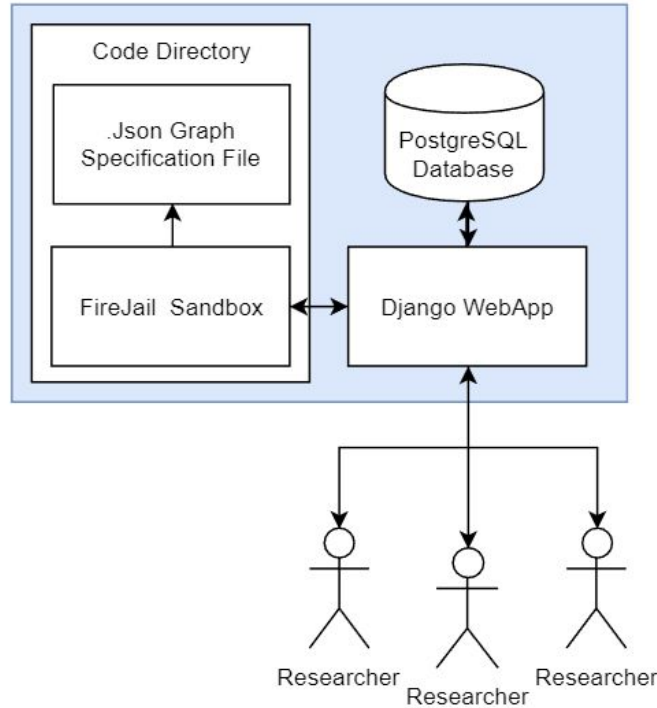
Home

Users

Forums

Models

Groups

Group name: Biocontrol Patrol
About: A group to explore ecological preservation through biocontrol

Members: Edit Member Privleges

joe view

Invite Friends:

No Friends outside the group found!!

Join Group Requests: Search for users to Invite

Prototype Review

Testing and Validation

Unit Testing

- Validate the View, Model, and HTML Template for each individual Django application.
- 23 different Unit tests.

Integration Testing

- Test functionality that requires multiple applications.
- 7 Integration tests.

Usability Testing

- Evaluate the ease of use, with UserTesting.
- About 15 test users from Dr.M's class.

User Testing methodology

- We asked test users to perform various tasks such as:

Task 4: Create a group
1. Navigate to the "Groups" page
2. It doesn't seem like you are in a group, create your own.
3. Verify your group now has a dashboard and appears on the groups page.

Question 4: To prove our system has successfully created your group, what is your group name and did you seem to have any trouble?

- 15+ unique issues found through user testing.

Challenges and Solutions

✓ Individuals uploading/downloading malicious code
  ➢ Models will be ran within a FireJail Sandbox.

✓ Difficult entry: New users may find the platform challenging to use.
  ➢ Creation of online resources to help guide new users.

✓ Users wish to maintain IP rights to code
  ➢ Models have preferences, allowing users to set models as private.

✓ Singular point of reference
  ➢ User testing with outside perspective.

Project Schedule
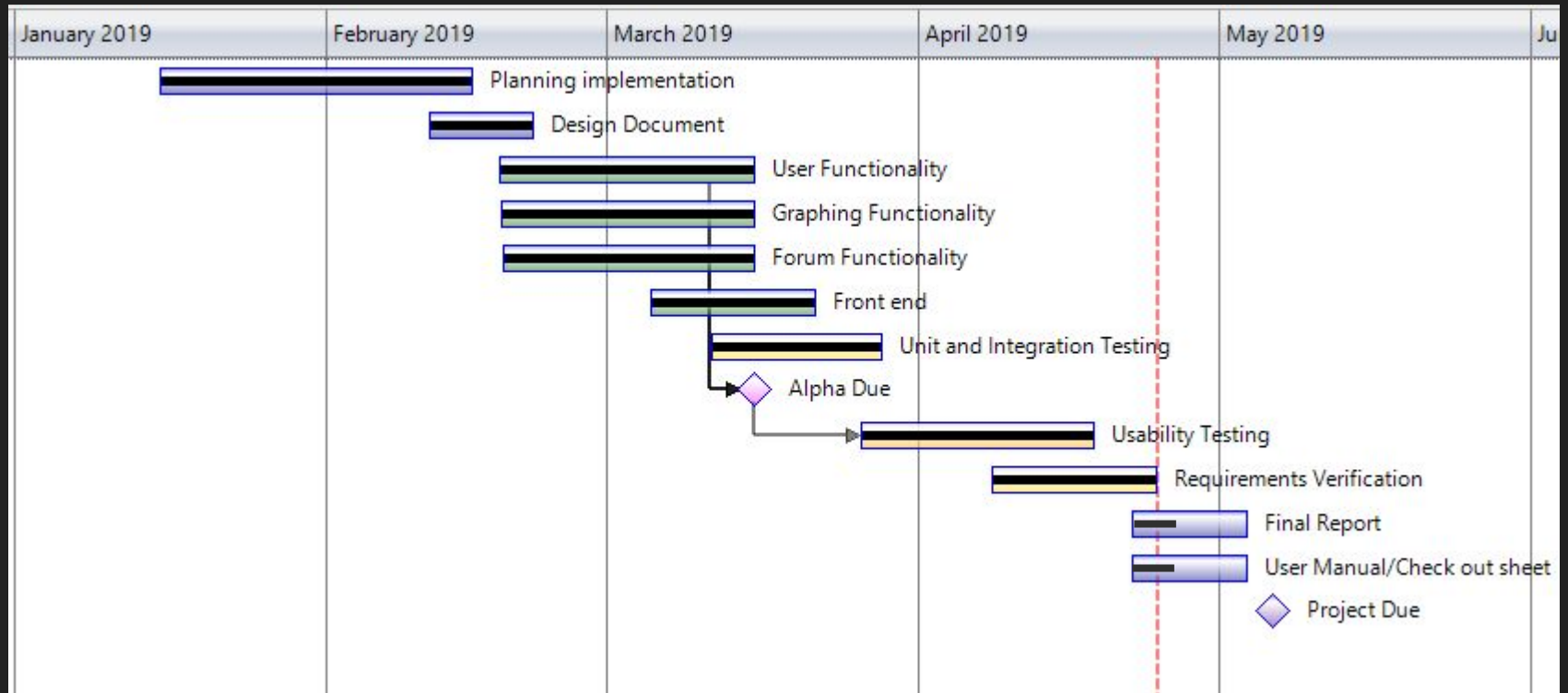
EON's Effects

- Epidemiology is important when it comes to lessening the number of deaths due to infectious disease.
- EON will be a valuable resource for the future of epidemiology

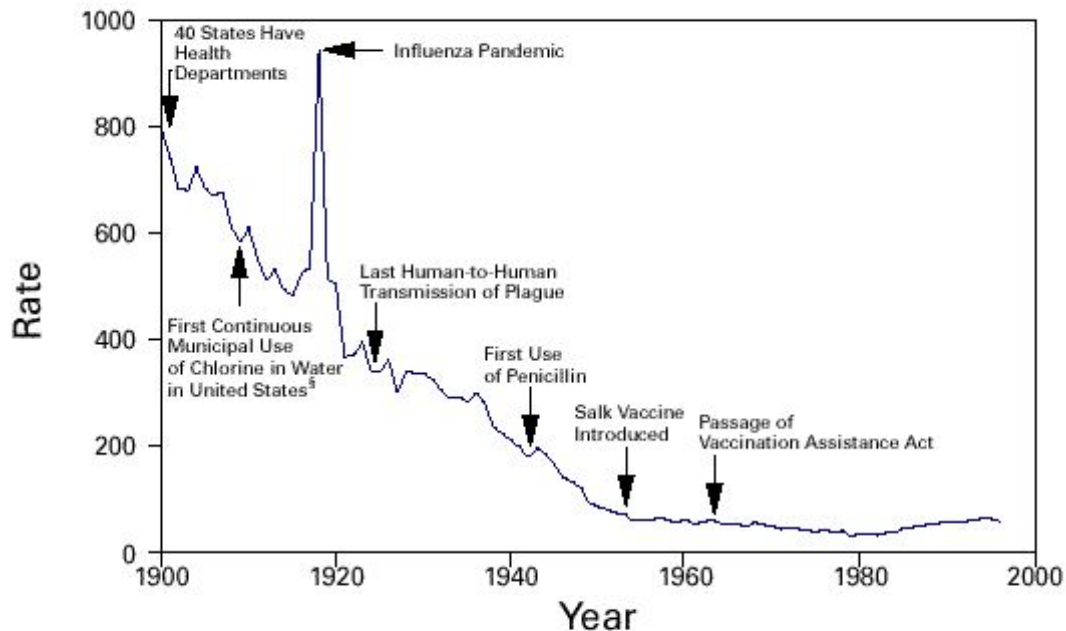**Impacts**
- Informatics cornerstone for the community
- Product that could be adopted by CDC

Value to Client
- Plans to pursue further funding to develop our prototype
- As a team we have put in 500+ hours for product development

Conclusion

FIGURE 1. Crude death rate* for infectious diseases — United States, 1900–1996†

*Per 100,000 population per year.
†Adapted from Armstrong GL, Conn LA, Pinner RW. Trends in infectious disease mortality in the United States during the 20th century. JAMA 1999:281;61–6.
§American Water Works Association. Water chlorination principles and practices: AWWA manual M20. Denver, Colorado: American Water Works Association, 1973.
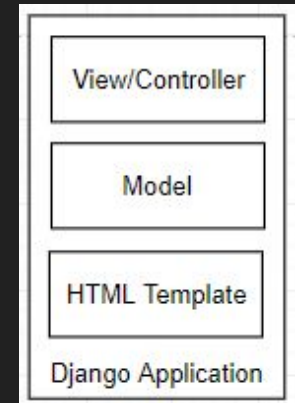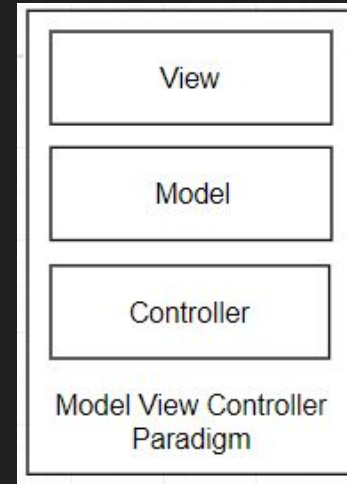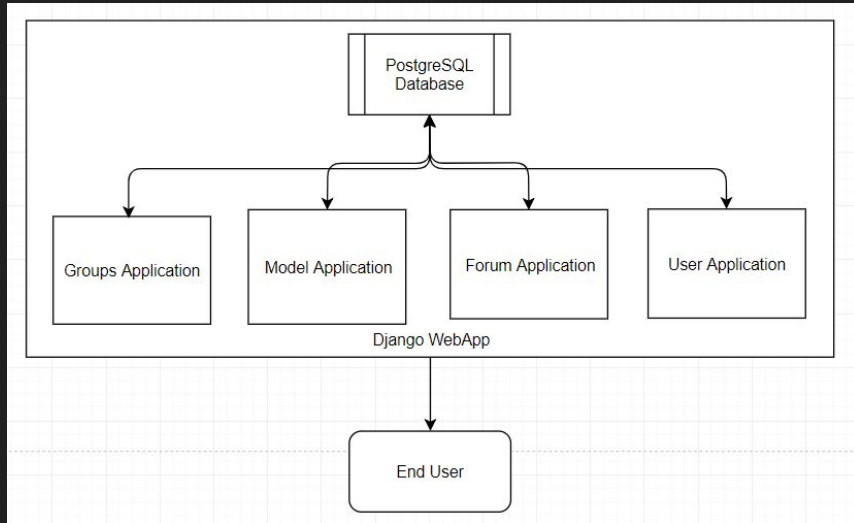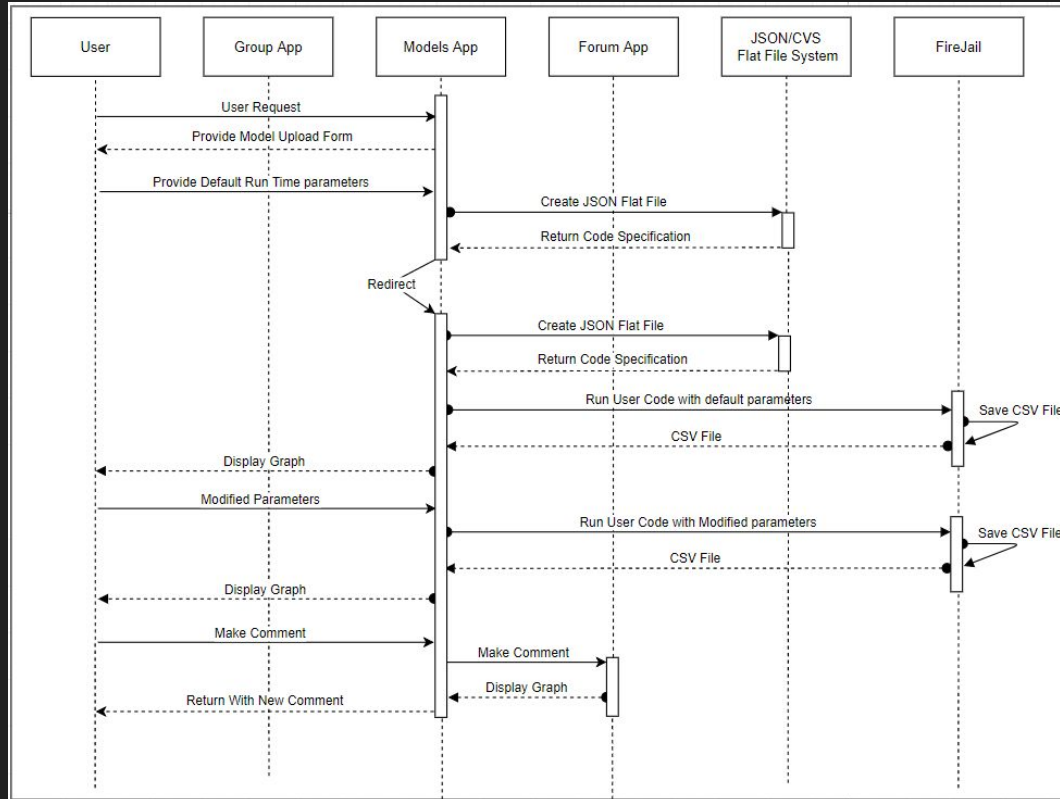
An In-depth View of Models
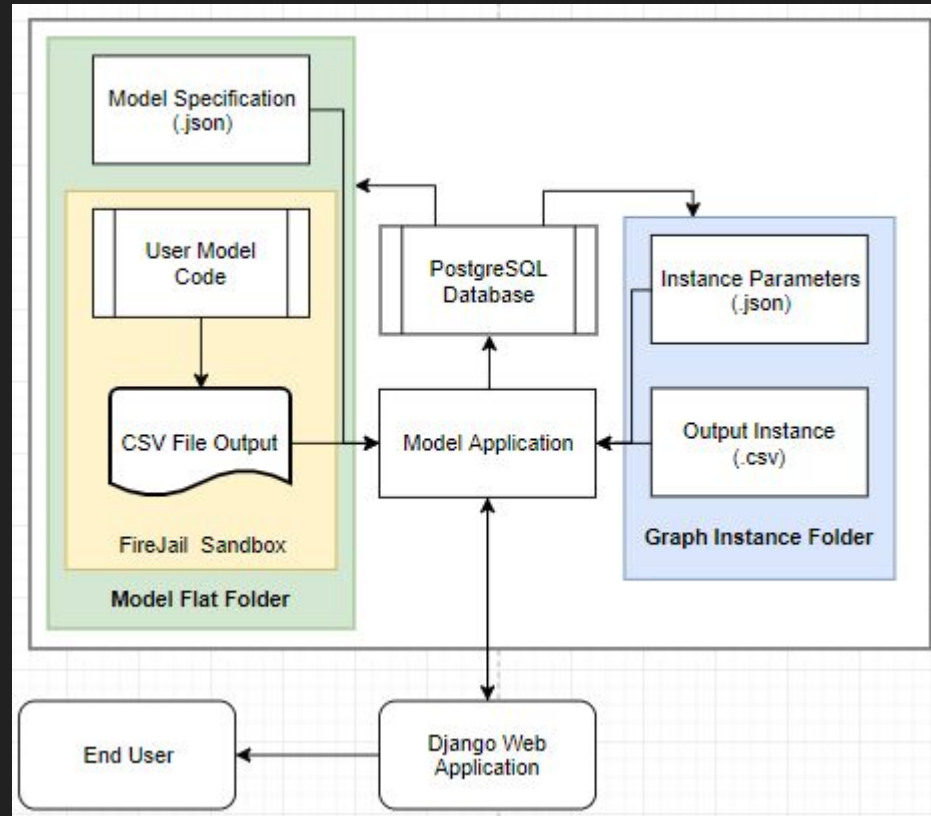
Django applications
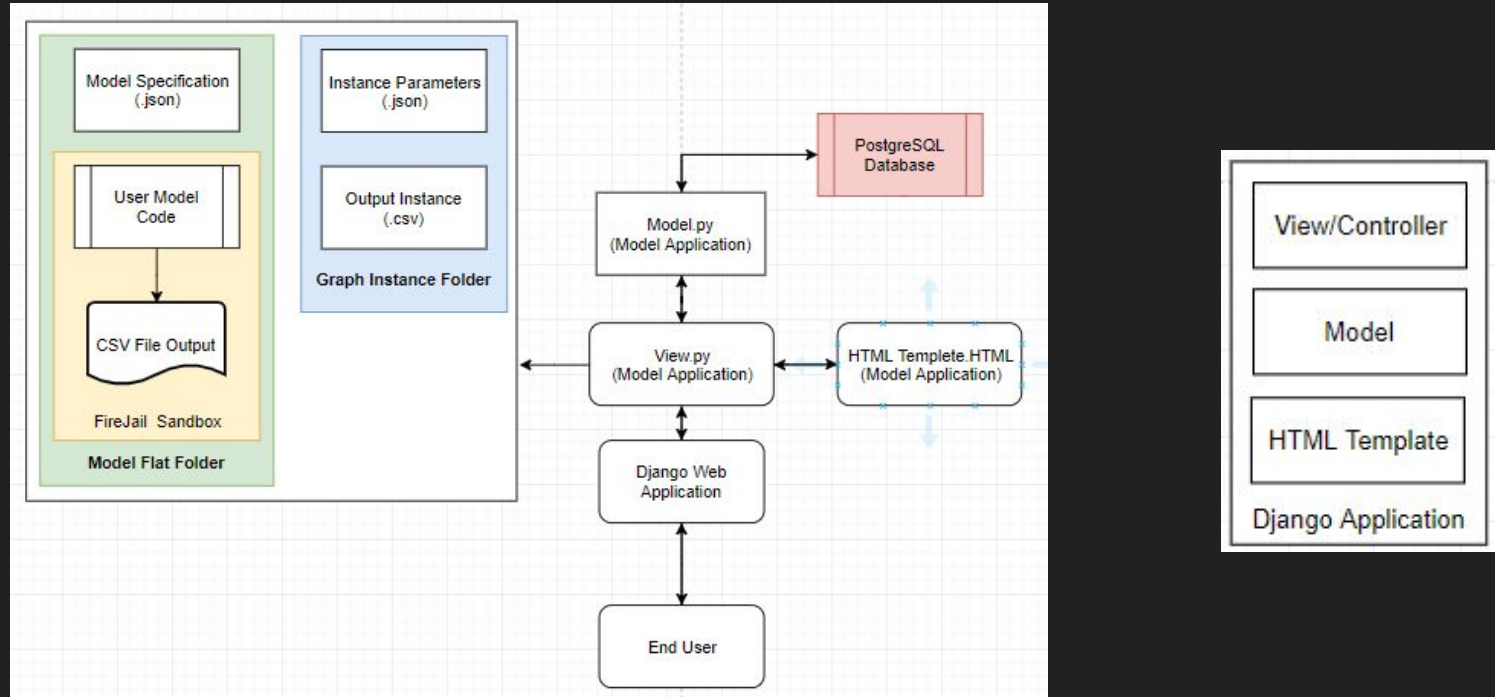
Django applications

Upload and Run Model: Sequence Diagram

Risks/Feasibility

Risk	Severity	Likelihood
Individuals uploading/downloading malicious code	High	~~Low~~ → None
User's programming language not supported	Medium	~~Medium~~ → Low
Server overloaded with running models	Medium	Low
Difficult entry: New users may find the platform challenging to use	High	~~Medium~~ → Low
Users wish to maintain IP rights to code	Medium/High	~~Medium~~ → Low
Singular point of reference	High	~~High~~ → Low