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EXPANDING THE FRONTIERS OF SPACE ASTRONOMY

The JWQL Web Application

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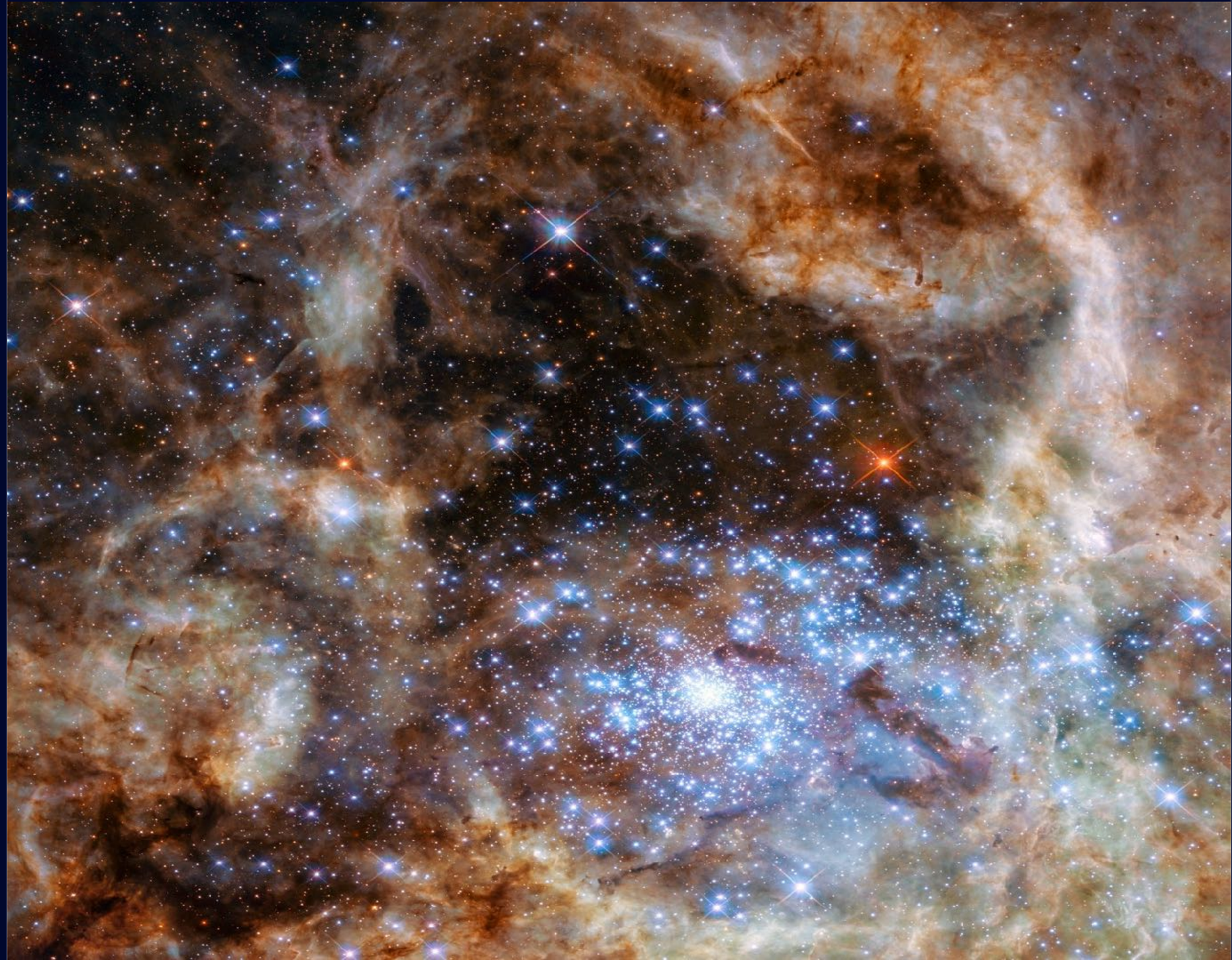
The JWQL **web application** is built upon Python **Django,** a **Model-View-Controller web framework**. The front-end is written in **HTML** with embedded **JavaScript** and styled using **Bootstrap** and **CSS**. The web app will interact with databases using an **Object-Relational Mapper**. It will run on a **server** that ITSD will set up.



Outline

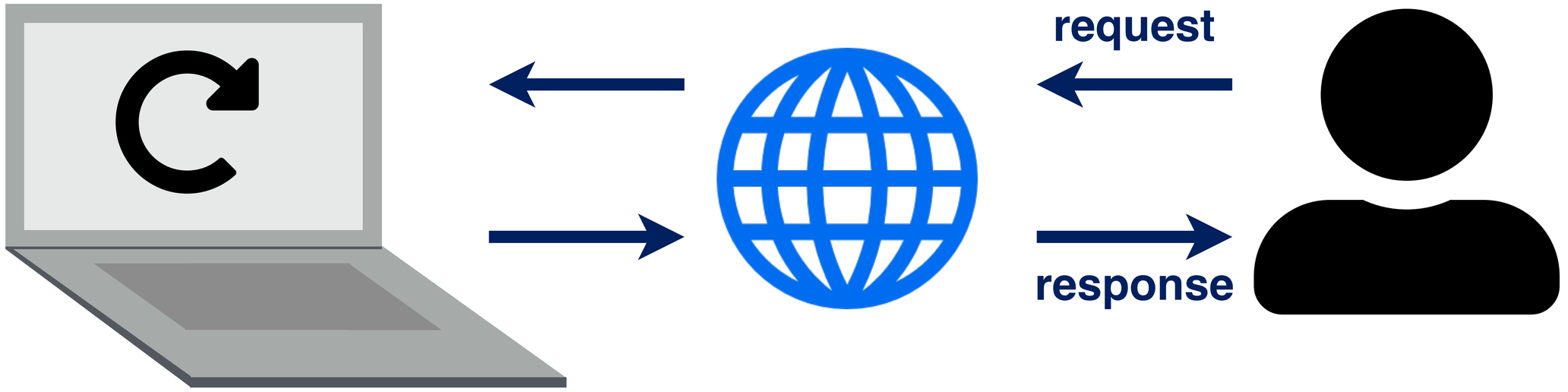
- Web application basics
- Django: a Python web framework
- The JWQL web app
  - Front end specifics
  - Back end specifics
  - Directory structure
  - Mini-code review: thumbnails

Web Application Basics

Web applications

“In computing, a web application or web app is a client–server computer program which the client (including the user interface and client-side logic) runs in a web browser.”

- Wikipedia



Web applications

What is the difference between a “website” and “web application”?

Some say it’s just a question of semantics.

Some say:

- Websites are built to serve content (e.g. news websites)
- Web apps are built to allow user interaction (e.g. gmail)

Web Applications

Front End

- HTML
- CSS
- JS

Back End

- HTTP
- Python
- SQL

HTTP

“at the end of the day, all a web application really does is send HTML to browsers.”

- Jeff Knupp, Python guru

Hypertext Transfer Protocol, or HTTP, is a protocol for interacting with the web. It uses a request-response protocol.

Methods

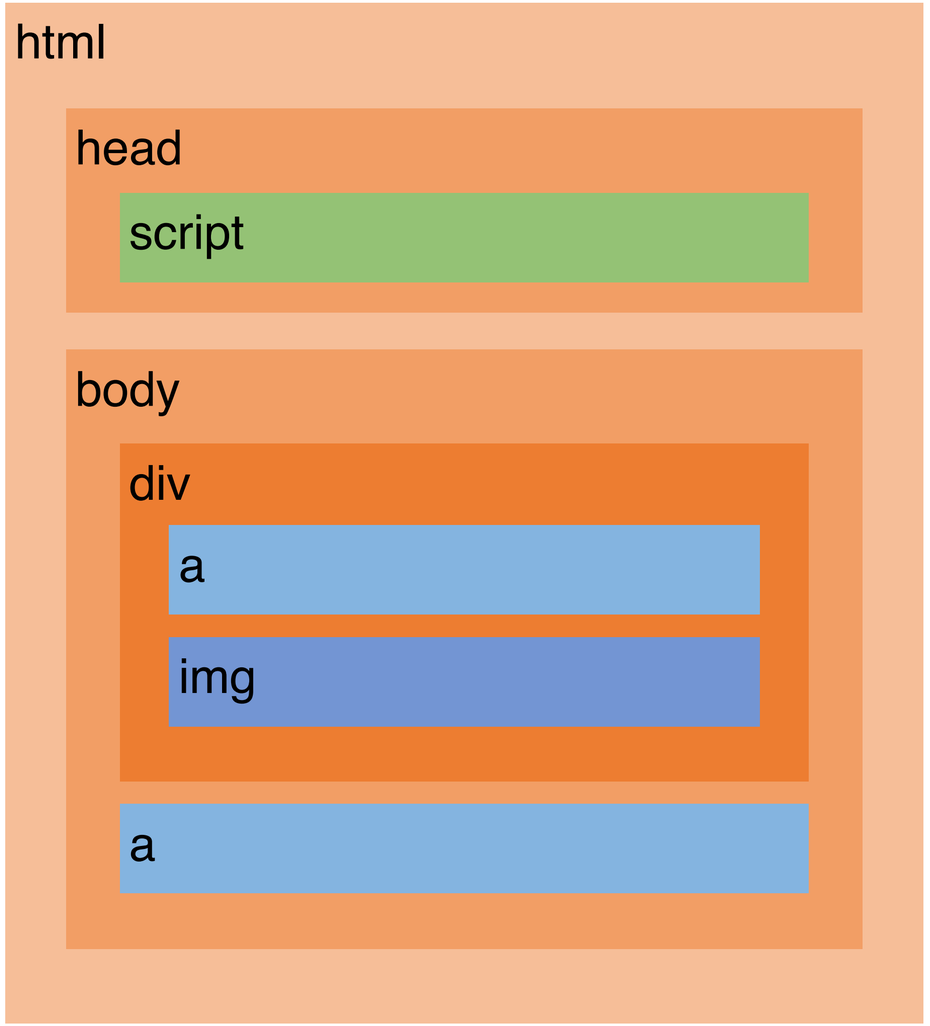
- GET - client requests a webpage’s HTML from web server
- POST - client sends data to a webpage through a form; changes the application state

Response Codes

- 200 - everything went fine!
- 404 - everything did not go fine.

HTML

- “Hypertext Markup Language (HTML) is the standard markup language for creating web pages and web applications.” - Wikipedia
- HTML files are made up of elements (“head”, “main”, “div”, “h1”, etc.)
- Normally, HTML just allows embedding of CSS and JavaScript
- Django and Jinja2 expand this to enable HTML “template” syntax
  - Basically include variables in HTML, like in Python: `‘my string {}’.format(string_number)`



CSS

- “Cascading Style Sheets (CSS) is a style sheet language used for describing the presentation of a document written in a markup language like HTML.” - Wikipedia
- CSS can control layout, colors, fonts, sizing, spacing, and more
- Using CSS files separates the content of a webpage from the definitions of how to present that content.
- CSS can also enable “responsive” design, allowing for different presentations in different situations (i.e. desktop versus mobile phone)

CSS

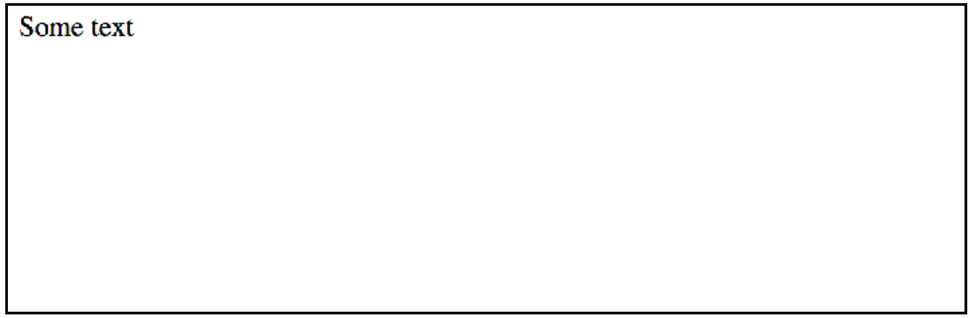
HTML file:

```
<a class='example_name'> Some text</a>
```

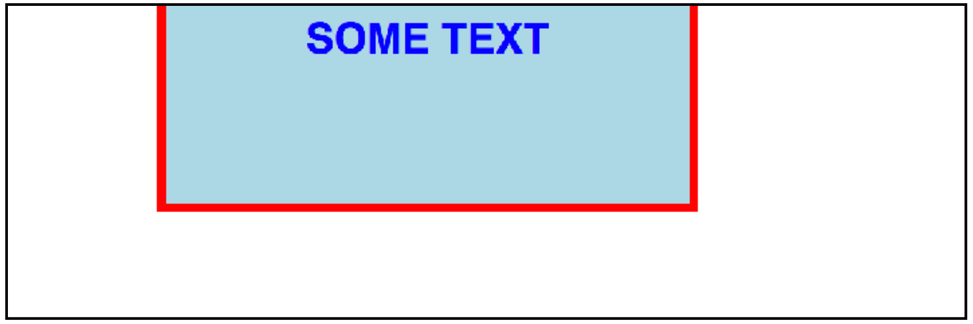
CSS file:

```
.example_name {
    color: blue;
    background-color: lightblue;
    margin: 5rem;
    padding: 5rem;
    font-size: 24px;
    font-weight: bold;
    font-family: sans-serif;
    border: 5px solid red;
    text-transform: uppercase
}
```

Before CSS:



After CSS:

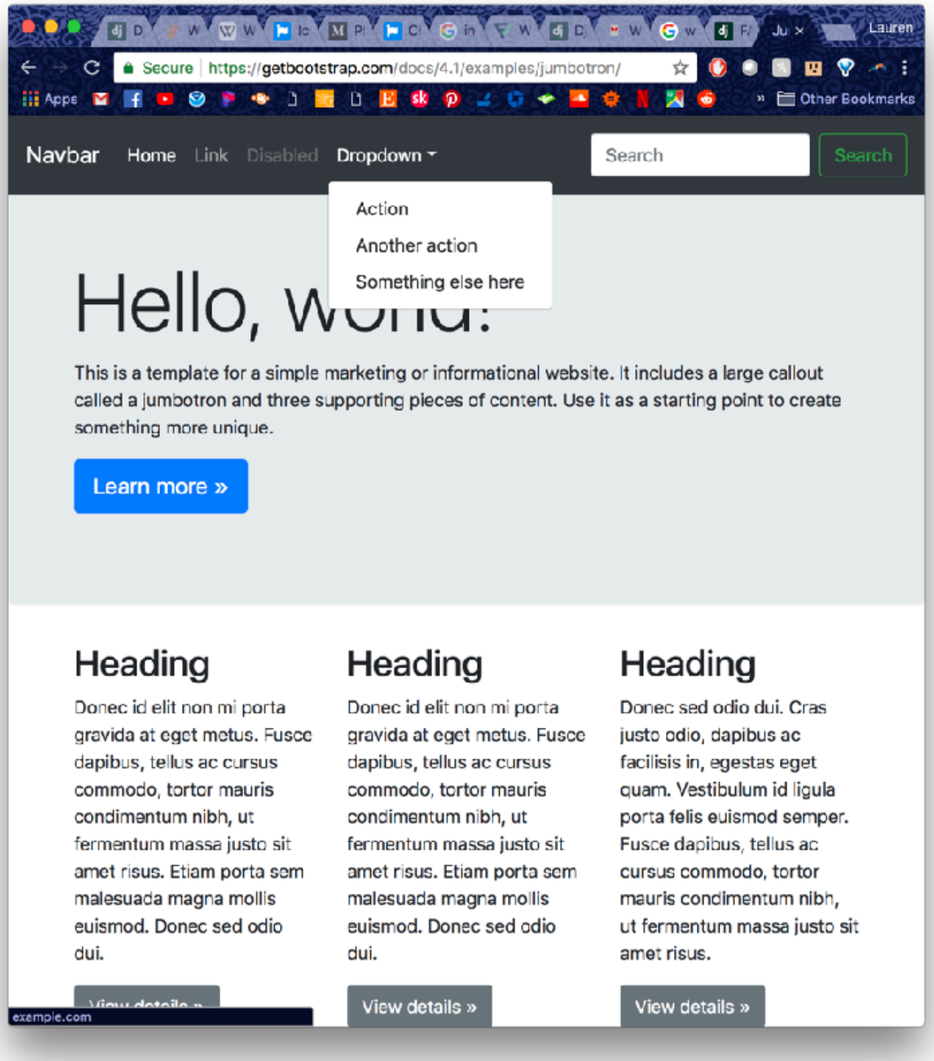


JavaScript

- A programming, not style, language
- NOT the same as Java!
- “JavaScript supports event-driven, functional, and imperative (including object-oriented and prototype-based) programming styles.” - Wikipedia
- Allows webpages to be interactive
  - e.g. If you click a button, sort the images by date
  - e.g. As the user types, display only the images whose titles match the seach criteria
- Syntactically obnoxious

Bootstrap

- “Bootstrap is a free and open-source front-end framework (library) for designing websites and web applications.” - Wikipedia
  - Includes design templates that use HTML, CSS, and JS
  - Default styles for things like:
    - Navigation bars
    - Buttons & dropdown menus
    - Grid layouts
    - Headings
  - Enables responsive design



Web Frameworks

- Turns out, developing web applications is hard.
  - Handling POST requests securely
  - Sessions? Cookies?
  - Handling many concurrent connections
  - Accessing databases
  - Dynamically generating new HTML
  - Routing (mapping URL to content/pages)
- “A web framework (WF)… is a software framework that is designed to support the development of web applications including web services, web resources, and web APIs.” - Wikipedia
- A web framework is a scaffold upon which to build a web application.

Django

Python Django

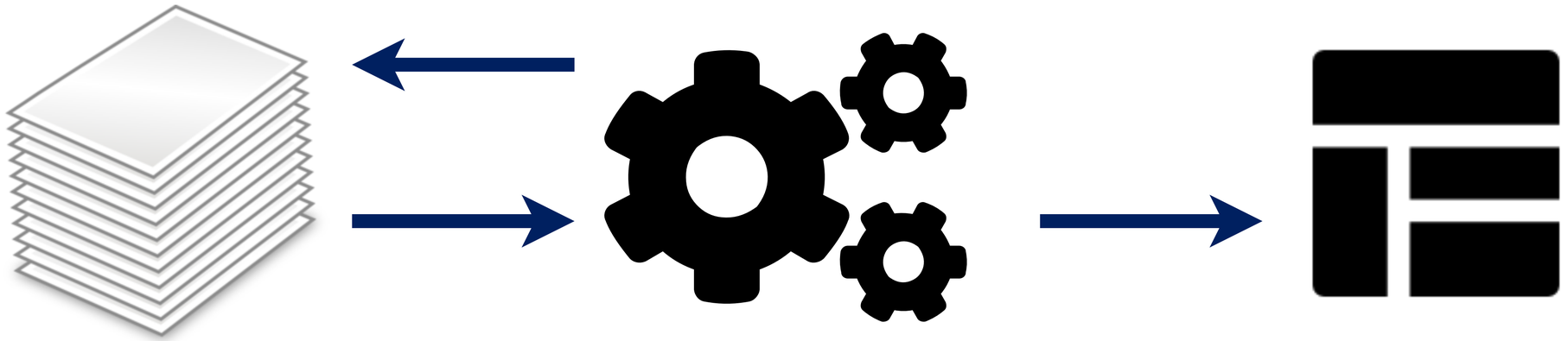
- Model-View-Controller web framework
- Python-based
- Uses regular expressions to map URLs to particular functions/pages (routing)
- Uses a Object Relational Mapper (ORM) to map Python classes to a database
- Dynamically serving content (querying a database to get latest values) using HTML templates
- Provides an “admin” interface for developers/maintainers to interact with “models” (data)

Django's Model-View-Controller Pattern

model:
database

controller:
Python function

view:
HTML template



Models with Django - Object-Relational Mapper

```
from django.db import models

class ImageData(BaseModel):
    """A model that collects image file paths, instrument labels, and
    publishing date/time. Just an example used for learning Django.
    """


   # Create columns for the instrument, publication date, and filepath
    inst = models.CharField('instrument', max_length=6,
                            choices=INSTRUMENT_LIST, default=None)
    pub_date = models.DateTimeField('date published')
    filepath = models.FilePathField(path='/user/lchambers/jwql/')

    def filename(self):
        return os.path.basename(self.filepath)
```

(Not currently being used in the web app, but it will be once we integrate Joe's anomaly database.)

Controllers (Views) with Django

```
from django.shortcuts import render

def view_header(request, inst, file):
    template = 'view_header.html'
    header = get_header_info(file)
    file_root = '_'.join(file.split('_')[:-1])

    return render(request, template,
                  {'inst': inst,
                   'file': file,
                   'header': header,
                   'file_root': file_root})
```

Views (Templates) with Django

```
{% extends "base.html" %}

{% block content %}

   <h5>{{ file }}</h5>

    <p><a class="btn btn-primary" href={{ url('jwql:view_image', args=[inst, file_root]) }}>View
        Image</a></p>

    {% autoescape false %}
         <font face="Courier">{{ header | replace("\n", "<br/>") }}</font>
    {% endautoescape %}

    <p>
         <a class="btn btn-primary" href='{{ static("") }}{{ file[:7] }}/{{ file }}'>Download
            FITS</a>
         <a class="btn btn-primary" href='{{ static("") }}{{ file[:7] }}/{{ jpg }}'>Download
            JPEG</a>
    </p>

{% endblock %}
```

URLs with Django - Regular Expressions

```
from django.urls import path

from . import views

urlpatterns = [
    path('', views.home, name='home'),
    path('about/', views.about, name='about'),
    path('dashboard/', views.dashboard, name='dashboard'),
    path('<str:inst>/', views.instrument, name='instrument'),
    path('<str:inst>/archive/', views.archived_proposals, name='archive'),
    path('<str:inst>/unlooked/', views.unlooked_images, name='unlooked'),
    path('<str:inst>/<str:file_root>/', views.view_image, name='view_image'),
    path('<str:inst>/<str:file>/hdr/', views.view_header,
name='view_header'),
    path('<str:inst>/archive/<str:proposal>', views.archive_thumbnails,
name='archive_thumb'),
]
```

The JWQL web app

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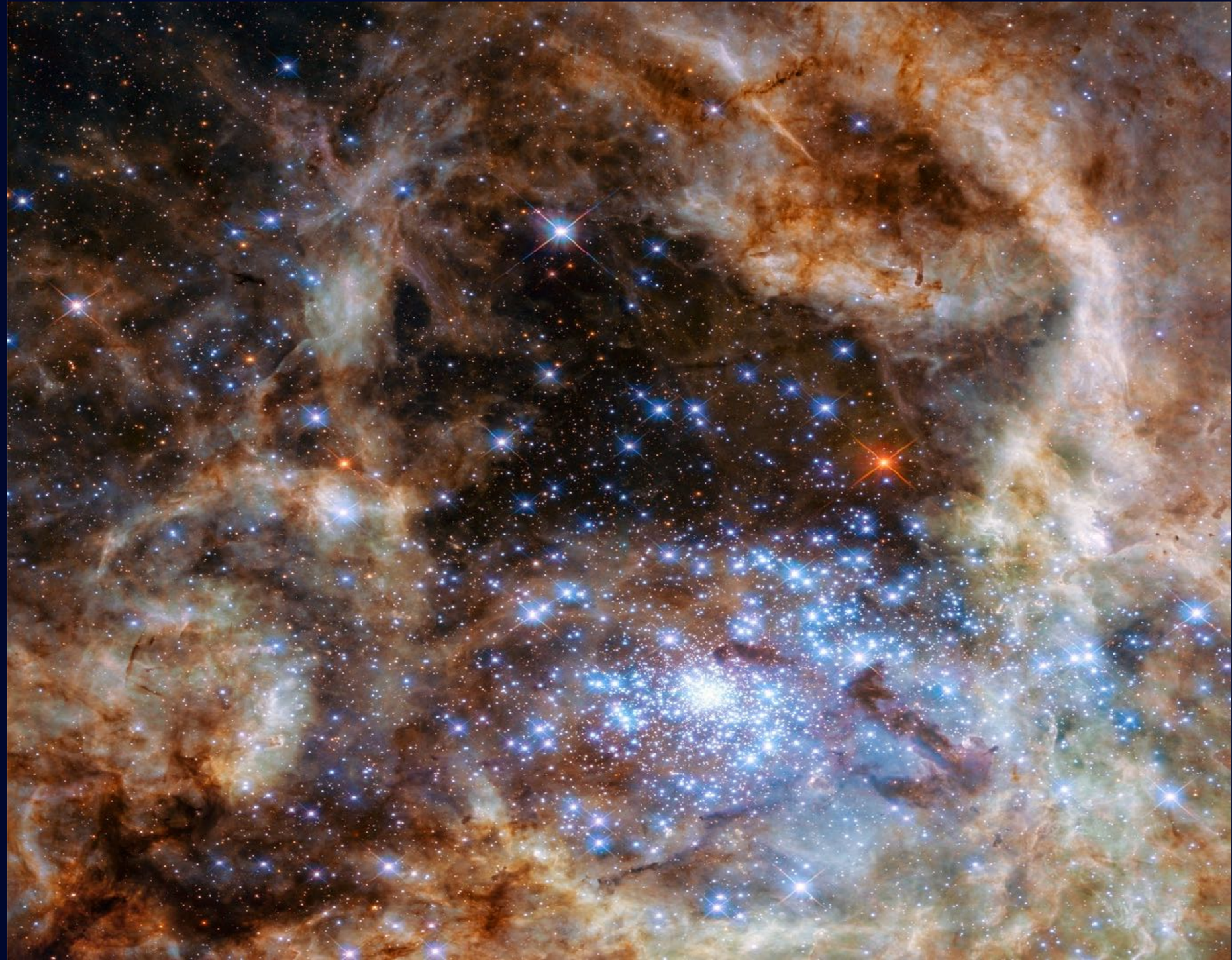
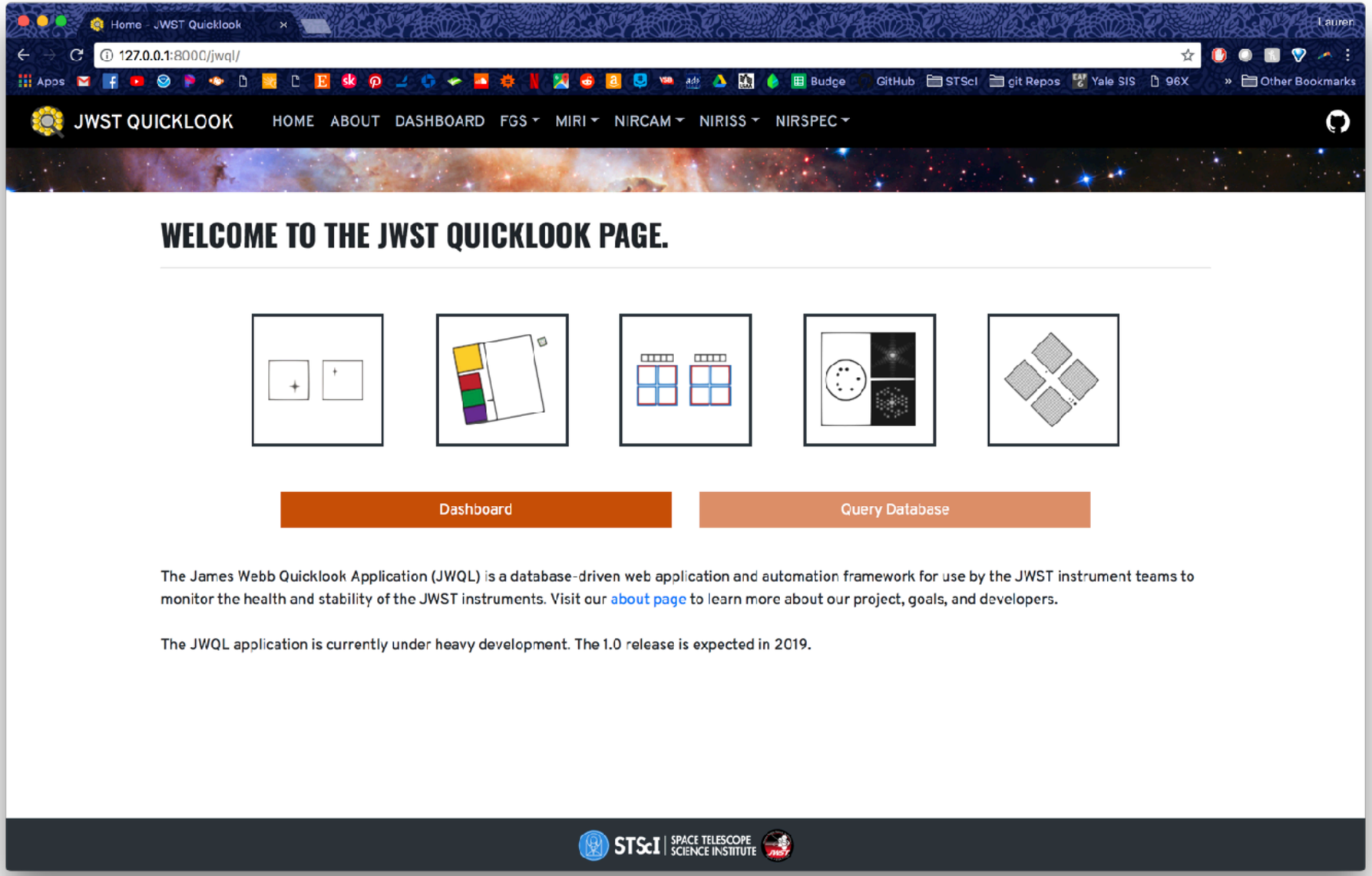
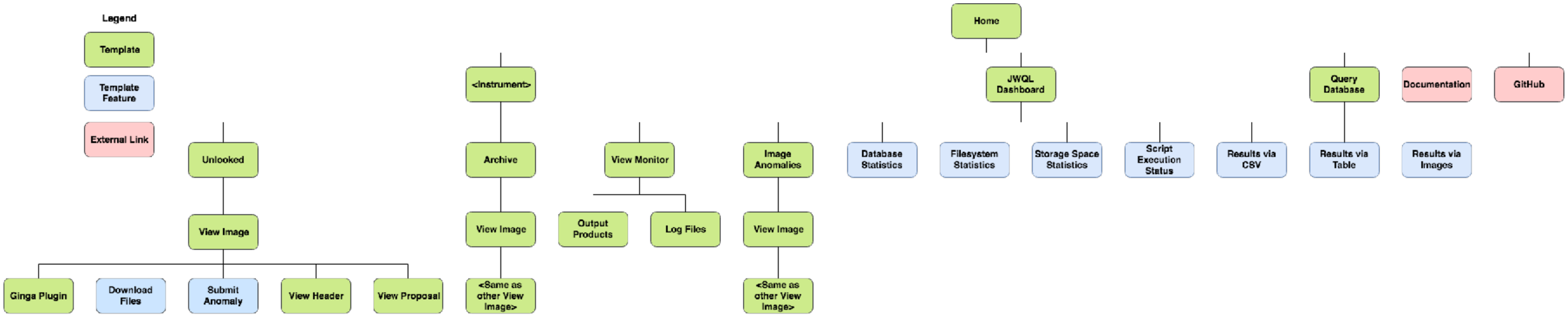


Front End: Current Home Page



Front End: Site Map



GitHub issue: https://github.com/spacetelescope/jwql/issues/35

Front End: JWQL Style Guide

TYPOGRAPHY

H1 - PAGE HEADING

Oswald Bold; 2.5rem size; 0.05em spacing; all caps

H2 - SECTION HEADING

Oswald Bold; 2rem size; all caps

H3 - SUBHEADING

Oswald Bold; 1.75rem size; all caps

H4 - SUBHEADING

Oswald Bold; 1.5rem size; all caps

H5 - Subheading

Oswald Bold; 1.25rem size

H6 - Subheading

Oswald Bold; 1rem size

TEXT HEADINGS

Overpass; all caps

Body Text

Overpass

BUTTONS

Primary | Disabled | Outline

COLOR PALETTE

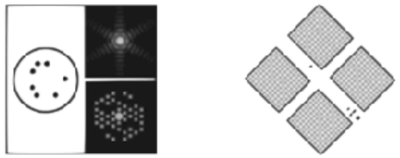
#F2CE3A	#000000	#BEC4D4
#2D353C	#C85108	#4C8BD8

ICONOGRAPHY

Favicon/Brand

STScI Logo

FGS MIRI NIRCam



NIRISS NIRSpec

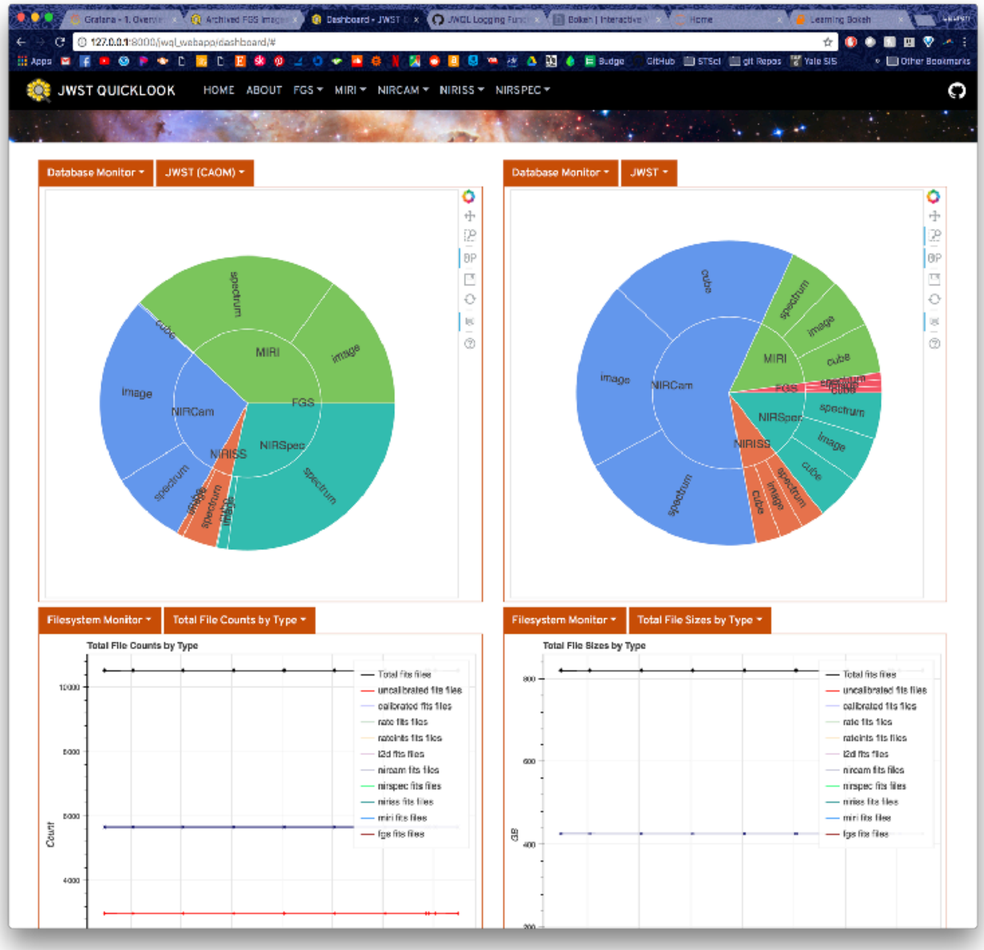
Back End: Views (Templates) with Jinja2

- Jinja2 is another template syntax, for the most part with similar functionality as Django templates
  - Django: `{% url 'jwql_webapp:home' %}`
  - Jinja: `{{ url('jwql_webapp:home') }}`
- BUT it might be easier to embed Bokeh plots in templates:

```
<div class="col-md-4 col-sm-4 col-xs-12">
  <div class="x_panel">
    <div class="x_title">
      <h2>By Region</h2>
      <div class="clearfix"></div>
    </div>
    {{ embed(roots.region) }}
  </div>
</div>
```

Back End: Embedding plots with Bokeh

- “Bokeh is an interactive visualization library that targets modern web browsers for presentation.” -Bokeh
- It allows for users to display and interact with data in a web page (including built-in features like pan, zoom, export to file, etc.)
- Will be used for dashboard and FITS viewers in JWQL



JWQL Web App Directory Structure

```
website/
    __init__.py
    manage.py
    jwql_proj/
        jinja2.py
        settings.py
        urls.py
        wsgi.py
    apps/
        __init__.py
        jwql/
            __init__.py
            apps.py
            data_containers.py
            db.py
            models.py
            tests.py
            urls.py
            views.py
            static/
                css/
                js/
                img/
            templates/
```

JWQL Web App Directory Structure

- `website/` - Main website directory
  - `__init__.py` - subpackage marker
  - `manage.py` - Django-generated file that performs operations such as running a local server, starting an interactive iPython shell, or running tests on the project
  - `jwql_proj/` - directory containing the project-specific files
  - `apps/` - directory containing different “applications”, kind of like reusable Python packages

```
website/
    __init__.py
    manage.py
    jwql_proj/
        jinja2.py
        settings.py
        urls.py
        wsgi.py
    apps/
        __init__.py
        jwql/
            __init__.py
            apps.py
            data_containers.py
            db.py
            models.py
            tests.py
            urls.py
            views.py
            static/
                css/
                js/
                img/
            templates/
```

JWQL Web App Directory Structure

- `jwql_proj/` - Django project directory
  - `jinja2.py` - Configures how the app will handle Jinja2 templates
  - `settings.py` - Defines project settings
  - `urls.py` - Defines URL-to-view mappings for the project
  - `wsgi.py` - Configures how to deploy the server with WSGI (Web Server Gateway Interface)…?

```
website/
    __init__.py
    manage.py
    jwql_proj/
        jinja2.py
        settings.py
        urls.py
        wsgi.py
    apps/
        __init__.py
        jwql/
            __init__.py
            apps.py
            data_containers.py
            db.py
            models.py
            tests.py
            urls.py
            views.py
            static/
                css/
                js/
                img/
            templates/
```

JWQL Web App Directory Structure

- `apps/` - directory containing all apps in project
  - `__init__.py` - subpackage marker
  - `jwql/` - directory of the JWQL web app app 🙃

```
website/
    __init__.py
    manage.py
    jwql_proj/
        jinja2.py
        settings.py
        urls.py
        wsgi.py
    apps/
        __init__.py
        jwql/
            __init__.py
            apps.py
            data_containers.py
            db.py
            models.py
            tests.py
            urls.py
            views.py
            static/
                css/
                js/
                img/
            templates/
```

JWQL Web App Directory Structure

- `jwql/` - directory containing the JWQL app app
  - `__init__.py` - subpackage marker
  - `apps.py` - Optionally defines an AppConfig class that can be called in settings.py
  - `data_containers.py` - Python functions written by Matt and I that are used in views.py (located here for cleanliness' sake)
  - `db.py` - Defines Python classes as interfaces between the web app and any databases (e.g. MAST)
  - `models.py` - Defines Python classes that represent the structure of a Django database
  - `tests.py` - Define unit tests for testing the web app
  - ...

```
website/
    __init__.py
    manage.py
    jwql_proj/
        jinja2.py
        settings.py
        urls.py
        wsgi.py
    apps/
        __init__.py
        jwql/
            __init__.py
            apps.py
            data_containers.py
            db.py
            models.py
            tests.py
            urls.py
            views.py
            static/
                css/
                js/
                img/
            templates/
```

JWQL Web App Directory Structure

- `jwql/` - directory containing the JWQL app app
  - `...`
  - `urls.py` - Defines URL-to-view mappings for the app
  - `views.py` - Defines views: Python functions that process HTTP URL requests, do something based on the request, and return an HTTP response and template
  - `static/` - Directory containing static files: CSS style files, JavaScript files, and images. Note that `static/css/jwql.css` and `static/js/jwql.js` include custom styles and functions.
  - `templates/` - Directory containing HTML/Jinja2 templates

```
website/
    __init__.py
    manage.py
    jwql_proj/
        jinja2.py
        settings.py
        urls.py
        wsgi.py
    apps/
        __init__.py
        jwql/
            __init__.py
            apps.py
            data_containers.py
            db.py
            models.py
            tests.py
            urls.py
            views.py
            static/
                css/
                js/
                img/
            templates/
```

How do *you* contribute?

How to run the web app on a local server

- `cd` into the `website/` directory
- Launch the server: `python manage.py runserver`
- Open the web app in a browser: http://127.0.0.1:8000/jwql/

How to add a webpage to the web application

- Create a new template (`my_template.html`) in `website/apps/jwql/templates/`
  - If needed, add new CSS to `website/apps/jwql/static/css/jwql.css` or new JavaScript functions to `website/apps/jwql/static/js/jwql.js`
- Create a new view (Python function) in `website/apps/jwql/views.py`
- Add your desired URL, linking to the view, to `website/apps/jwql/urls.py`

Helpful References

- Blog on web frameworks: https://jeffknupp.com/blog/2014/03/03/what-is-a-web-framework/
- Documentation and examples for HTML, CSS, JS: https://www.w3schools.com/
- Sandbox for writing HTML alongside CSS and JS: https://jsfiddle.net/
- Bootstrap documentation: https://getbootstrap.com/docs/4.1/getting-started/introduction/
- Django 7-Part Tutorial: https://docs.djangoproject.com/en/2.1/intro/tutorial01/

Code Review