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Abstract

This document outlines the development and functionalities of Material Atlas for Coastal Construction, a platform designed to revolutionize the sharing and visualization of construction material data specifically for coastal environments.

Developed using Next.js and React for the front end, and .NET Core with C# for user management, the platform features a secure and intuitive interface. At the core of its architecture is a Neo4j graph database, which facilitates seamless navigation and exploration of interconnected data, primarily sourced from research papers.

A standout feature of this platform is the integration of the OpenAI API with Langchain, which leverages GPT's natural language processing capabilities to automate the extraction of data from material science research paper PDFs.

This innovative approach significantly streamlines the process of populating the database, enhancing the efficiency of data assimilation for research purposes. Designed to cater to professionals such as engineers, material scientists, and architects, the atlas serves as an indispensable resource for accessing, comparing, and utilizing material science data to promote sustainable and resilient coastal construction practices. Through its user-friendly interface and advanced data processing capabilities, Material Atlas aims to empower experts across disciplines to make informed decisions and drive positive change in coastal development projects.

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Introduction

Welcome to the documentation for Material Atlas for Coastal Construction. This guide provides a comprehensive overview of our interdisciplinary platform, created to revolutionize the sharing and visualization of material science data specifically for coastal regions. Developed using a combination of advanced technologies, including Next.js, React, and Neo4j, Material Atlas offers a secure, intuitive, and feature-rich environment for professionals across various disciplines. In this documentation, you will find detailed explanations of the platform's architecture, functionalities, and implementation. From understanding the core technologies powering Material Atlas to exploring its innovative features, such as automated data extraction using the OpenAI API with Langchain, this documentation serves as your complete resource for navigating and effectively utilizing the platform.

Whether you are a researcher aiming to access and analyze material data for coastal construction projects or an engineer/architect looking to make informed decisions regarding sustainable and resilient construction practices, this documentation provides you with the knowledge and tools necessary to fully leverage Material Atlas.

Current System

In the field of coastal construction and environmental sustainability, the current system faces substantial challenges. With climate change, rising sea levels, and the increasing vulnerability of coastal regions, there is an urgent need for a thorough understanding of sustainable materials and construction techniques. However, the existing landscape is fragmented, with research and knowledge dispersed across multiple disciplines such as Marine Engineering, Material Science, Civil Engineering, and Environmental Engineering. This fragmentation creates significant obstacles in accessing, correlating, and effectively applying crucial data in coastal construction projects. The lack of a centralized repository or platform for sharing and analyzing information about construction materials, their properties, applications, and environmental impacts greatly hampers the potential for innovative and sustainable coastal development.

The current system, with the implementation of the following changes, marks a significant advancement in the Material Atlas platform. By integrating a fully functional OpenAI data extraction and analysis tool, users can now effortlessly upload research papers and extract relevant material data with exceptional efficiency. This enhancement not only simplifies the process of populating the database but also ensures the accuracy and reliability of the extracted information. Additionally, the incorporation of advanced login security features, including password hashing, underscores the platform's commitment to protecting user data and maintaining privacy. Alongside these improvements, the user interface has been significantly

enhanced to improve usability and aesthetics, providing a seamless and intuitive experience for users navigating the platform. These collective changes have transformed Material Atlas into a robust and user-friendly resource, enabling professionals across disciplines to access, compare, and utilize material data with unprecedented ease and efficiency.

Purpose of New System

The main objective of this system is to connect diverse fields of expertise involved in coastal construction and environmental sustainability. By offering a centralized platform for knowledge sharing and collaboration, it aims to enable the exchange of information among professionals in Engineering, Material Science, Architectural Design, Ecology, and other areas. The system employs cutting-edge technologies, such as Next.js with React for the front end, .NET Core with C# for robust user management, and a mix of PostgreSQL and Neo4j graph databases for handling user data and research content. A notable innovation of the platform is the use of the OpenAI API with Langchain for automated data extraction from research papers, which simplifies the integration of extensive information into the Neo4j database. This feature not only boosts the efficiency of data integration but also aids in visualizing complex relationships between materials and their applications. The Material Atlas aspires to be a pioneering tool in the industry, providing graphical representations and comparisons of materials, thereby promoting more informed, sustainable, and resilient coastal construction practices.

User Stories

- Research AI tools for extracting formulas/methods from research papers.
- Set up a local instance of the previous website.
- Gather project requirements from Product Owner.
- Familiarize the team with the chosen tech stack.
- Develop a strategic plan for project execution.

Implemented User Stories

- Develop and refine a data extraction tool.
- Test the data extraction tool with research papers.
- Fix login and sign-up features.
- Implement encryption for security.
- Finished creating an API to interact between the data extraction script and ChatGPT API.
- Started and finished creating an Admin Dashboard for editing and tracking traffic on the website
- Successfully integrated LangChain dependency to enhance the extraction of data from PDFs.
- Continue to improve the data extraction algorithm through refinement and optimization in order to maintain a high level of accuracy.
- Testing of diverse research papers for comprehensive testing of the tool for data extraction to ensure it achieves robust performance.
- Make sure to fix identified bugs with the login and sign-up features, thus improving user experience.
- Configured and implemented encryption protocols in the login database in order to strengthen security measures.
- Complete work on the development and deployment of Admin Dashboard for efficient content management and traffic monitoring.

- Test, validate, and make sure the accuracy of material and property identification is on point with ChatGPT API.
- Contribute in research of image analysis using ChatGPT API and OpenCV to translate graph interpretation.
- Keep refining ChatGPT prompts to improve its accuracy and relevance.
- Always keep looking at efficiency and reliability of API integration between data extraction and ChatGP

Pending User Stories

- Implementing Material Repository into live website
- Formatting response output for ChatGPT API

Project Plan

The project was meticulously designed and executed, employing agile development methodologies for optimal flexibility and efficiency. This chapter provides an in-depth look at the project's planning and implementation, balancing structure and adaptability to address every project aspect. Sprint planning was crucial, guiding the development process and allowing for necessary modifications. Each sprint was meticulously planned and executed. Additionally, this section discusses the selection process for project components, including both software and hardware. Each component was selected for its compatibility, functionality, and alignment with the project's objectives, thereby establishing a robust foundation for the project team.

Hardware and Software Resources

The following is a list of all hardware and software resources that were used in this project:

Hardware:

- Not applicable
- Online clouding

Every member of the group used their personal computers.

Software:

- Neo4j
- Python
- JavaScript
- React
- Visual Studio Code
- Next.js
- OpenAI API

Sprints Plan

Sprint 1

- User Story #1 - Work on Website Front End (Dashboard)
- User Story #2 - Database setup
- User Story #3 - Analyzing code/documents from last team
- User Story #4 - Github setup
- User Story #5 - Add image wrap to mobile view

Sprint 2

- User Story #1 - Keep working on Website Front End (Dashboard)
- User Story #2 - Domain Setup
- User Story #3 - Continue researching and working with backpropagation AI model
- User Story #4 - Registration should be completed (locally)

- User Story #5 - Implementing last team code in the new domain

Sprint 3

- User Story #1 - Keep working on Website Admin Dashboard
- User Story #2 - Discovery work and implementation of the User Dashboard
- User Story #3 - Continue researching and working with AI data extraction and upload file
- User Story #4 - Integrate the sign-in features to the current deployed site
- User Story #5 - Creating a complete manual material input tab in the website
- User Story #6 - Implementing a blob storage server

Sprint 4

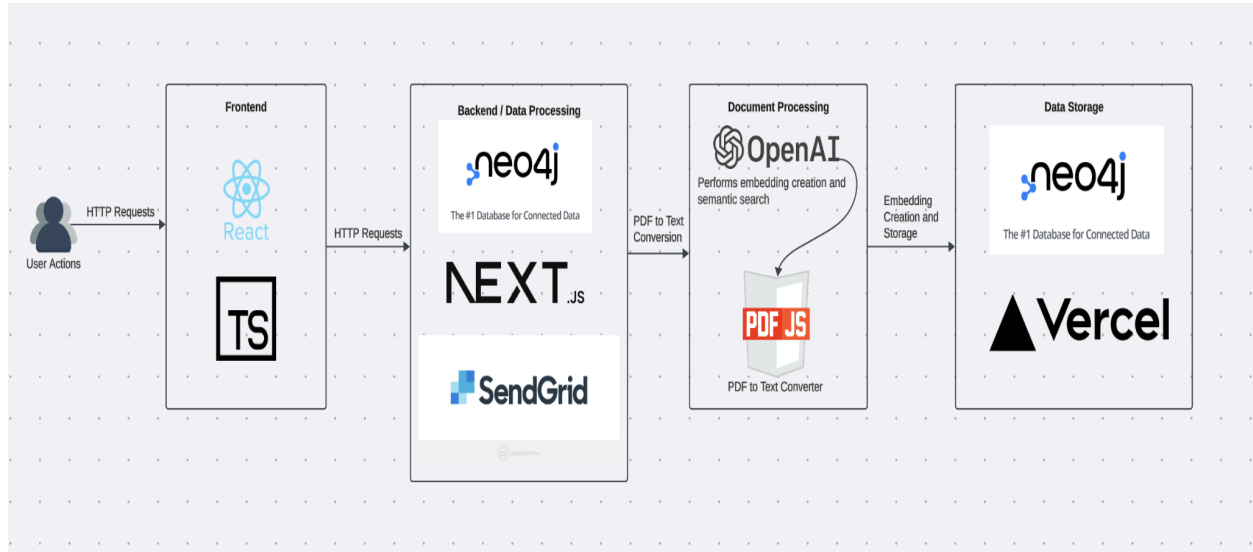
- User Story #1 - Keep working on Website Admin Dashboard
- User Story #2 - Discovery work and implementation of the User Dashboard
- User Story #3 - Continue researching and working with AI data extraction and upload file
- User Story #4 - Integrate the sign-in features to the current deployed site
- User Story #5 - Implementing a functional data visualization page to the site
- User Story #6 - Implementing a blob storage server
- User Story #7 - Material Dashboard for Admin Panel
- User Story #8 - Quality Control for User Directory on Admin Panel

Sprint 5

- User Story #1 - Discovery work and implementation of the User Dashboard
- User Story #2 - Continue researching and working with AI data extraction and upload file
- User Story #3 - Fixing and improving data visualization on the site
- User Story #4 - Quality Control for User Directory on Admin Panel
- User Story #5 - Troubleshooting on email validation
- User Story #6 - Completing pdf extraction
- User Story #7 - Support

System Design

Upon receiving submission of a PDF document, the backend system basically extracts and segregates the information contained therein into components. After this, such components are processed through the ChatGPT API as embeddings, with a given prompt to provoke responses. This response, crafted with information such as material names, properties, etc., derived from the research paper PDF submitted.



Architectural Patterns

System and Subsystem Decomposition

Deployment Diagram

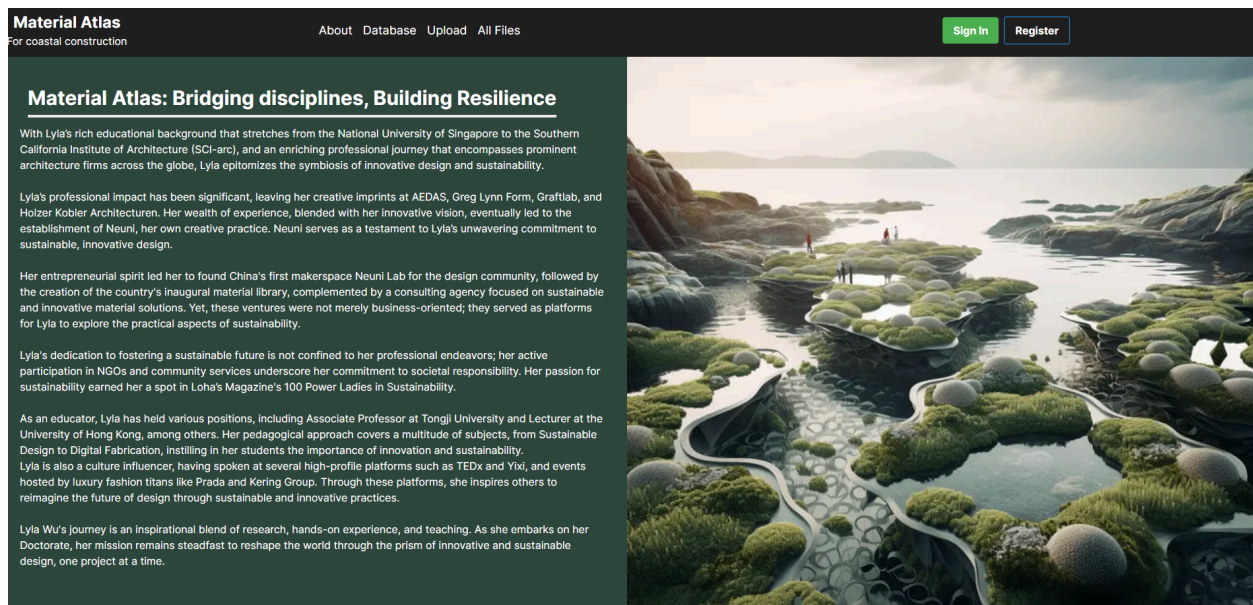
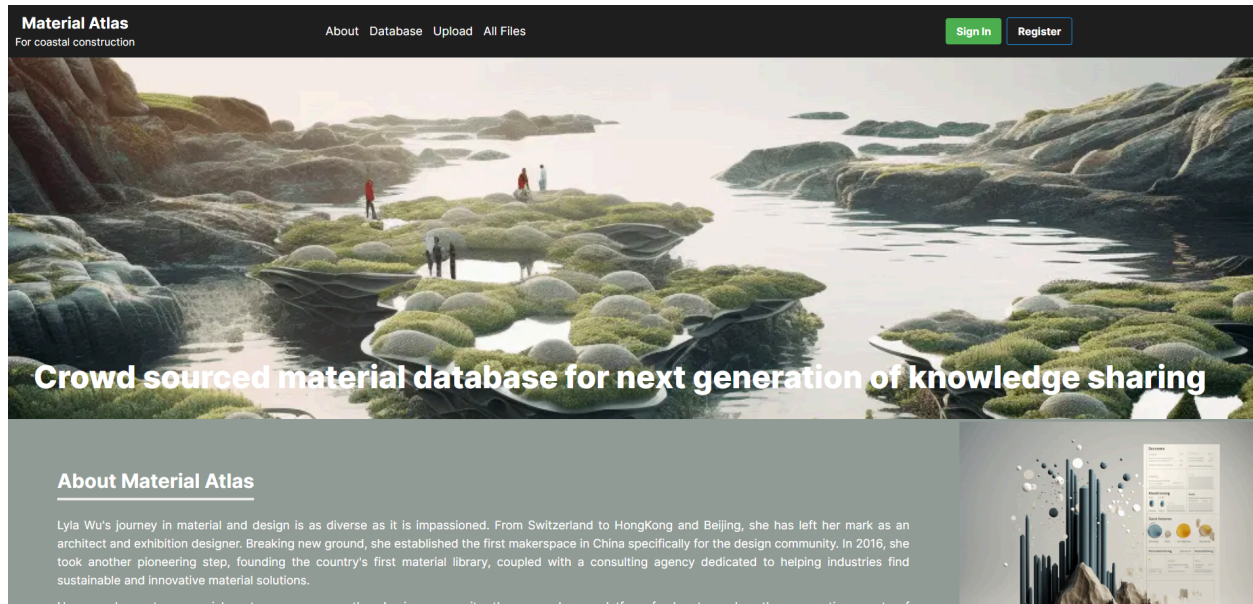
Design Pattern

System Validation

Glossary

Appendix

Appendix A - User Interface Design



Material Atlas

For coastal construction

[About](#) [Database](#) [Upload](#) [All Files](#)[Sign In](#)[Register](#)**Instructions**

Click on a paper in the graph to see its materials. If you have a material selected, the details will appear in the right-side drawer. Explore the paper database visualization, which provides a graphical representation of papers and their relationships. Click on nodes in the graph to interact with specific papers. If you want to filter the content or customize your view, click on the "Filters" text in the "Paper Database" section.

[Graph](#) [Table](#)[filters](#)

Demo

**material database**

● Testing

● DemoVideo...

Material: demovideo...

**Material Atlas**

For coastal construction

[About](#) [Database](#) [Upload](#) [All Files](#)[Sign In](#)[Register](#)**Instructions**

Upload a research paper to get started. Our AI will extract the information from the paper and prefill the form for you. Once completed, click the "Submit" button to add the material to the database.



Click or drag file to this area to upload

Our AI can help extract information by uploading a pdf of the research paper.

Reference

DOI

DOI, product datasheet reference, or patent number

Year

Year

Year of publication

Title

Title

Report title or material name for commercial purposes

Author

Authors

First author, or manufacturer name for commercial materials

Report Type

Scientific Report

Formula Name**Ingredients and Related Fields****Mix 1**

Cement Type

Elements:

Element Name

Amount



Sign In

Email:

Password:

[Sign In](#)[Forgot Password?](#)**Register**

First Name

Last Name

User Name

Email

Password

Institution

Research Area

Role and Position

[Register](#)

Material Atlas

For coastal construction

AboutDatabaseUploadAll FilesDashboard

dbriez008

Admin Dash

ADMINPANEL

Material Dashboard

User Directory

Admin Nav

User List

ID	Username	Email	First Name	Last Name	Institution	Research Area	Role	Is Admin	Created At
2	Atlas	lpenz001@fiu.edu	Laura	Penza	Columbia College (SC)	Marine Science	Student	Revoke Admin	N/A
4	lylawu	dww023@fiu.edu	Lyla	Wu	Florida International University	Marine Science	Professor	Revoke Admin	N/A
18	Salvatore	hello@fiu.edu	Laura	Penza	Florida International University	Biomedical	Professor	Revoke Admin	N/A
26	DIAZD	ddiaz329@fiu.edu	Dominick	Diaz	Florida International University	Marine Science	Student	Make Admin	N/A
29	dbriez008	dbriez008@fiu.edu	Daniel	Brizuela	Florida International University	Marine Science	Student	Revoke Admin	N/A
32	DDINO	Dino@fiu.edu	Dino	Penza	Miami Dade College	Biomedical	Other	Make Admin	N/A

Material Atlas

For coastal construction

AboutDatabaseUploadAll FilesDashboard

dbriez008

Admin Dash

UserDashboard

Profile

Contributions

Material Input

Your Profile

Profile Picture

Select file

First Name

Daniel

Last Name

Brizuela

Email Address

dbriez008@fiu.edu

Institution

Florida International University

Location

Role

Student

Twitter URL

LinkedIn URL

Instagram URL

Material Atlas

For coastal construction

AboutDatabaseUploadAll FilesDashboard

dbriez008

Admin Dash

UserDashboard

Profile

Contributions

Material Input

Contribute to the materials database

Make a contribution

Read contribution guide

Create new recipe

Create new ingredient

Manage Your Contributions

Select

Draft

No recipes

Your contributions will appear here!

Material Atlas

For coastal construction

AboutDatabaseUploadAll FilesDashboard

dbriez008

Admin Dash

UserDashboard

Profile

Contributions

Material Input

Material Name

Enter material name

Material Mix Name

Enter material mix name

Description

Enter description

Category

Elements

+ Add Element

Material Density

Enter Density

kg/m³

Material Compressive Strength

Enter Compressive Strength

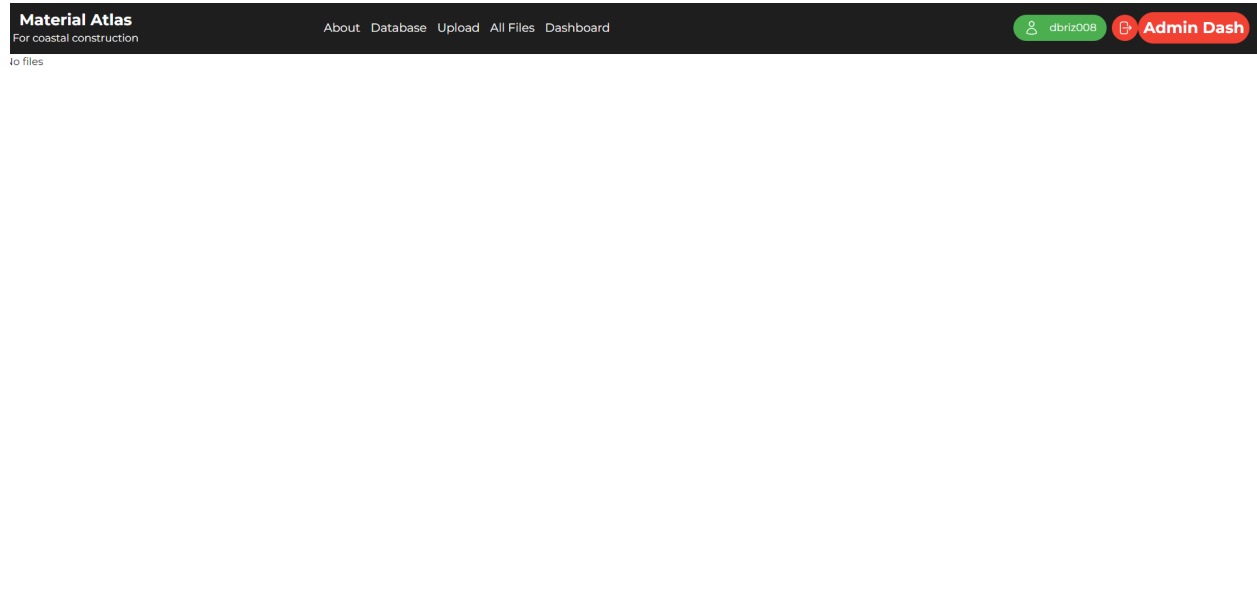
MPa

Material Shrinkage

Enter Shrinkage

%

Material Permeability



Appendix B - Sprint Review Reports

Appendix C - User Manuals, Installation/Maintenance Document, Shortcomings/Wishlist Document and other documents

Shortcomings/Wishlist

- Further enhancing the UI of the Material Atlas website
- Solving issue that causes the Database display main graph to not separate the nodes in the website
- Expanding the database to include a wider range of materials and properties
- Implementing user feedback mechanisms to continuously improve the platform
- Enhancing data visualization tools for clearer presentation of material-property relationship

- Implementing PDF to Text for OpenAI usage
- Implement Material Dashboard to link which users contributed a material
- Implement Material Dashboard to review newly uploaded materials
- Implement Contribution management tools to user dashboard
- Implement User profile pictures and use it across the relevant webpages
- Add a material database for knowledge management for new users
- Implement a blog system for easily making new blog posts