Information

Level of achievement	Apollo 11
Team name	SolidLah
Project name	Bazaar
GitHub	https://github.com/SolidLah/Bazaar
Link to app	https://bazaar-solidlah.vercel.app

Motivation

Through responsive web development and modern technology and tools, we hope to make the arts more accessible to everyone and create a platform for creators to express themselves and get rewarded for it. Creators can solidify legacies and make concrete impacts, imprinting their work into the everlasting blockchain, building reputation and sharing their work with the world.

Aim

We aim to create an accessible platform for:

1. Creators to mint and list their work as NFTs on the marketplace quickly and easily.
2. Buyers to find artworks of interest and participate in smooth transactions.

User Stories

- As a creator, I can mint new NFTs
- As a creator / seller, I can list NFTs for sale on the marketplace
- As a buyer, I can add NFTs on my watchlist
- As a buyer, I can showcase owned NFTs on my page
- As a buyer, I am able to follow creators who produce artwork that I admire
- As a creator / seller/ buyer, I can take part in transactions through trading NFTs in the Bazaar app
- As a creator / seller/ buyer, I want to be able to flag
- As a buyer, I am able to search for NFTs by collections and creators

Technology Stack

Frontend	
Next	**Testing**
Chakra UI	React Testing Library
Backend	
Firebase	**Testing**
	Mocha
	Chai
Blockchain	
Ethers	**Testing**
Hardhat	Mocha
Openzeppelin	Chai

Reasons for technology stack

Frontend

For the frontend, we chose Next as our web framework as it is a robust, popular, and well documented framework. It has many optimisations built in (e.g.: SSR, SSG), which can also help in the speed of our site.

For styling, we chose Chakra UI as it has a great range of base components to choose from, giving us a good foundation of building blocks to build and style our site. It also includes useful react hooks that implement many functionalities, such as toasts, overlays and popups.

Backend

As our backend, we chose Firebase as it has many features built in that facilitate our development process. Its authentication module allows us to quickly spin up email authentication, and opens up possibilities for other forms of sign up methods (google, github, …). Firestore is a noSQL database that firebase provides and combining it with the authentication module allows for easy linking of data to users.

Blockchain

As we are using the Polygon network, we will write our smart contracts in Solidity. Hardhat is a great framework for doing Solidity programming, with built in functions for compiling, deploying and testing smart contracts.

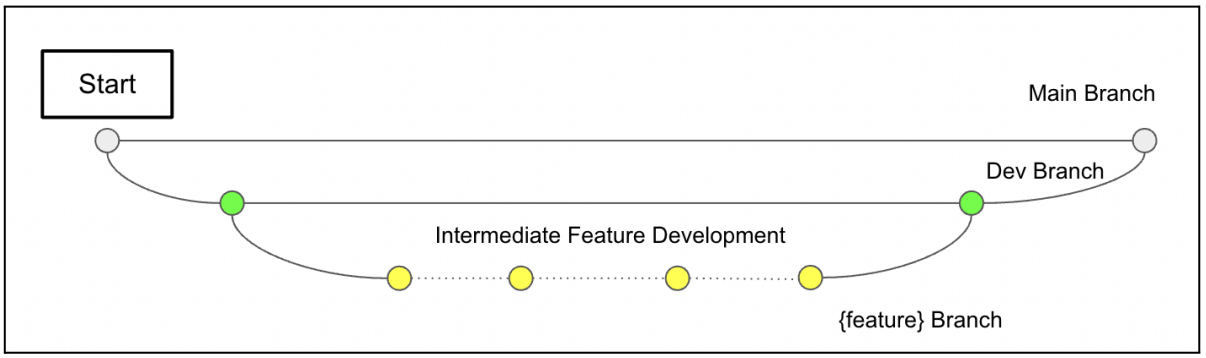
For our smart contracts, we use the contracts from Openzeppelin as a base for them, as they are widely regarded as the standard when writing smart contracts for tokens (e.g.: ERC20, ERC721). Openzeppelin contracts have security features built in (safeMint, safeTransfer, ReentrancyGuard), which protects our users from malicious actors or unintentional actions.

To interact with our smart contracts in the browser, we use Ethers library to create instances of our smart contracts in the browser, allowing us to call their functions from the browser itself.

Software Engineering Practices

Git workflow

Branching



For our git workflow, initially we have 2 branches, main and dev. Our workflow starts when we want to implement a new feature

1. Create new feature branch from dev
2. Implement the feature
3. Pull changes from dev and resolve merge conflicts
4. Create a pull request to merge the feature branch into dev
5. Test the changes and fix bugs
6. Merge the pull request into dev and delete the feature branch
7. At each milestone, dev is cleaned up and merged into main
8. A tag is created for each milestone

Issues

When we encounter a bug during testing, we file an issue under the related pull request. All bugs should be addressed and fixed before merging pull requests.

Projects

In Github, we have 3 projects, and 2 main ones, namely “Bugs and refactors” and “New features”. When creating issues for bugs, they are listed under the “Bugs and refactors” project, and Github’s projects can update the status of the issue automatically. This applies to new features as well, where pull requests for new features are listed under the “New features” project and automatically tracked there.

Deployment

Our deployment is done through Vercel. In Vercel, the main branch is set as production, and preview deployments are created at every commit (in batches) to facilitate CI/CD.

Testing strategy

Unit testing is employed in our project to test all the components and functions in both frontend and in smart contracts. For the frontend, we will choose not to do unit testing on the screens because there is a lot of information and states handled in each screen, and it is not practical to test all of them independently. Thus, we chose to abstract out shared components such as headers, buttons and perform unit tests on those before applying them to our screens. In addition, we only write unit tests for components that render differently based on props passed to them. (e.g: button to have text login or logout based on current auth state, passed as a prop).

We also employed **manual testing** to help us identify issues with the app during actual usage and visually identify test results from the Frontend and Backend. Through this, we can better tailor the app to users by acting as users ourselves. Placing ourselves in the shoes of users will enable us to empathise with any pain points encountered and implement user-friendly changes. Any major bugs that may have slipped through unit testing can also be detected at this stage.

Frontend testing

Unit Tests

Description	Test case	Expected	Passed
Error layout			
Error message is rendered correctly	test	test	T
Follow button			
Renders “Follow” if user not followed	Not following user	“Follow”	T

Renders “Unfollow” if user followed	Following user	“Unfollow”	T
Auth button			
Renders logout button if logged in	User logged in	Renders logout button	T
Renders login button if logged out	User logged out	Renders login button	T
Password input			
Password is hidden if set to hide	Password hidden	type=”password”	T
Password is shown if set to shown	Password shown	type=”text”	T
Header (collections page)			
Render signup button if not logged in	User not logged in	Renders signup button	T
Don’t render signup button if logged in	User logged in	Don’t render signup button	T

Manual Tests

Description	Test case	Expected	Passed
User account forms			
General			
Email validation	Empty string	Missing fields error	T
	test	Invalid email error	T
	test@gmail	Invalid email error	T
	gmail.com	Invalid email error	T
	.com	Invalid email error	T
	@gmail	Invalid email error	T
	test@gmail.com	Successful	T
Username validation	Empty string	Missing fields error	T
	A	Successful	T
	a	Successful	T
	A test	Successful	T
	A test testing	Successful	T

Password validation	Empty String	Missing fields error	T
	String of length <= 5	Weak Password error	T
	String of length >= 6	Successful	T
Signup			
Confirm password	Not the same	Passwords do not match	T
	Same as password	Successful	T
Metamask wallet	Metamask not connected	Missing fields error	T
	Same metamask wallet used	Address is already used	T
Email	Duplicate email	Email already used	T
Update details			
Background	No file	Missing field error	T
	Have file	Successful	T
Avatar	No file	Missing field error	T
	Have file	Successful	T
Confirm password	Not the same	Passwords do not match	T
	Same as password	Successful	T
Send verification email button	Email not verified	Rendered	T
	Email verified	Not rendered	T
Email	Duplicate email	Email already used	T
Connect wallet button			
Connect a Metamask wallet	No Metamask extension	Install Metamask	T
	Have Metamask extension	Successful	T
Browser storage	Persists user information	Successful	T
User NFT interactions			
General			
Wallet address	No wallet connected	Connect wallet	T
	Metamask wallet not the same as user	Addresses are not the same	T

	Metamask wallet same as user	Successful	T
Create collection form			
Collection name field	Empty	Missing fields error	T
	“test”	Successful	T
Collection symbol field	Empty	Missing fields error	T
	“test”	Successful	T
Single mint form			
Image file	No file	Missing fields error	T
	Have file	Successful	T
Name field	Empty	Missing fields error	T
	“test”	Successful	T
Description field	Empty	Missing fields error	T
	“test”	Successful	T
Batch mint form			
Zip file	No file	Missing fields error	T
	Have file	Successful	T
Description field	Empty	Missing fields error	T
	“test”	Successful	T
Marketplace interactions			
General			
Wallet address	No wallet connected	Connect wallet	T
	Metamask wallet not the same as user	Addresses are not the same	T
	Metamask wallet same as user	Successful	T
Listing			
Price field	Empty	Missing fields error	T
	String	Not a number	T
	Number	Successful	T

List button	Not owner of NFT	Disabled	T
	Owner of NFT	Enabled	T
Buying			
Buy button	Insufficient funds	Error out	T
Watchlist			
Add to watchlist button	Is owner of NFT	Disabled	T
	Already added	Set to active state, and removes from watchlist when clicked	T

Smart contract testing

Description	Test case	Expected	Passed
NFT Contract			
Deployment	Name is set correctly	Successful	T
	Symbol is set correctly	Successful	T
Minting	Check balance of minter	Successful	T
	Check token URI	Successful	T
Batch minting	Check balance of minter	Successful	T
	Check token URIs	Successful	T
Data fetching	Check fetchNFT function	Successful	T
Marketplace Contract			
Deployment	Commission is set correctly	Successful	T
Create market item function	Check details of market item	Successful	T
	Price is set to zero	Reverted	T
	Not NFT owner	Reverted	T
Create many market items function	Correct number of items	Successful	T
List market item	Transfer ownership of	Successful	T

	NFT		
	Check details of listed market item	Successful	T
	Not market item owner	Revert	T
Purchase market item function	Transfer ownership of NFT	Successful	T
	Balances of parties set correctly	Successful	T
	Check details of transaction	Successful	T
	Invalid listing id	Reverted	T
	Insufficient MATIC	Reverted	T
	Market item already sold	Reverted	T
Data fetching	Check fetchMarketItems function	Successful	T
	Check fetchCollectionItems	Successful	T
	Check fetchUserItems function	Successful	T

Software Engineering Principles

Abstraction

In our codebase, we wrote functions to encapsulate code often reused throughout our project such as Authentication functions as well as functional React components, keeping Abstraction and reusability of code in mind.

Incremental Development

Throughout the development process of our web application, we ensure that there is never a situation where multiple functionalities are added in a single Pull Request. Instead, as explained in our ‘Branching Workflow’, we branch off the dev branch for each functionality to be added, ensuring that we can test these functionalities independently in later stages, without having to worry about bugs being difficult to trace.

Single Responsibility Principle

We have designed our codebase such that every function only has responsibility over its intended functionality. For example, the functions which are called for writing to Firestore only write the corresponding data without modifying anything beyond the scope of the function's responsibility.

Anticipation of Change

In accordance with the Single Responsibility Principle and Abstraction Principle, the codebase is modularised and abstractions are written in a way to allow for changes to be easily implemented without breaking other functionalities. By doing so, we can easily tailor functionalities to fit specific needs if the need arises, without having to worry about having to rewrite the whole function.

Timeline

Milestone 1 (30 May)

Frontend	Backend
[Marketplace] Minting page	- Connect Metamask wallet - Link minting function in smart contract
[Users] Login page	- Authenticate users
[Users] Sign up page	- Add new users

Milestone 2 (27 June)

Frontend	Backend
[Marketplace] All listings view	- Fetch listings from blockchain
[Marketplace] Details view	- Fetch metadata of individual NFTs from blockchain - Business logic for purchasing NFTs (buy button)
[Marketplace] Minting page	- Feature to upload image
[Users] Profile and details view	- Name - Email - (Optional) Link a wallet to the account - If wallet is linked, display owned and listed NFTs

Milestone 3 (25 July)

Frontend	Backend
[Marketplace] Watchlist view	- Allow accounts to add and remove NFT listings in watchlist - Pull watchlist from accounts
[Marketplace] Details view (if wallet is connected to site account, show name alongside address)	- Fetch account linked to given address
[Marketplace] Details view (allow users to click on the seller's account and view their profile)	- Protected routing to show different UI when viewing a profile externally

[Marketplace] Filtering NFTs	- Pull listings by different categories, through details that were declared during Minting
	  - Price Range
	  - Genre of Art
	  - Minter

[Marketplace] Search Bar	- Pull listings through keywords in the input field
[Users] Following creators	- Update User's document with creator's UID in a 'Following' collection
[Users] Verify email address to access user functionalities	- Enable functionality in firebase
[Users] Users can customise Profile Page with uploaded banners & Profile picture	- Update fields in Firebase with the uploaded media
Good to have	
[Marketplace] Mint in batches (collection)	- Change ethers implementation to allow for minting by collections
[Users] Additional sign up options	- Enable functionality in firebase
[Users] Use Metamask to sign login tokens for easy logins	- Interface with Metamask to send appropriate requests to sign messages

Use Cases

Description	Done
Site account	

Sign up for the site	T
Login to the site	T
Reset password	T
Connect a wallet to account	T
Showcase owned NFTs on a “shelf”	T
Add NFTs to watchlist	T
Follow other creators	T
View other creators profiles	T
Add a custom banner on user profile	T
Add a custom avatar	T
Update user details (e.g.: name, email, password)	T
Metamask wallet	
Connect a Metamask wallet	T
Mint a NFT	T
Mint a NFT collection	T
Buy a NFT	T
List a NFT	T
Marketplace	
See all listed NFTs	T
See details of individual NFTs	T
Filter NFTs by name	T
Filter NFTs by price range	T

Explanation of systems

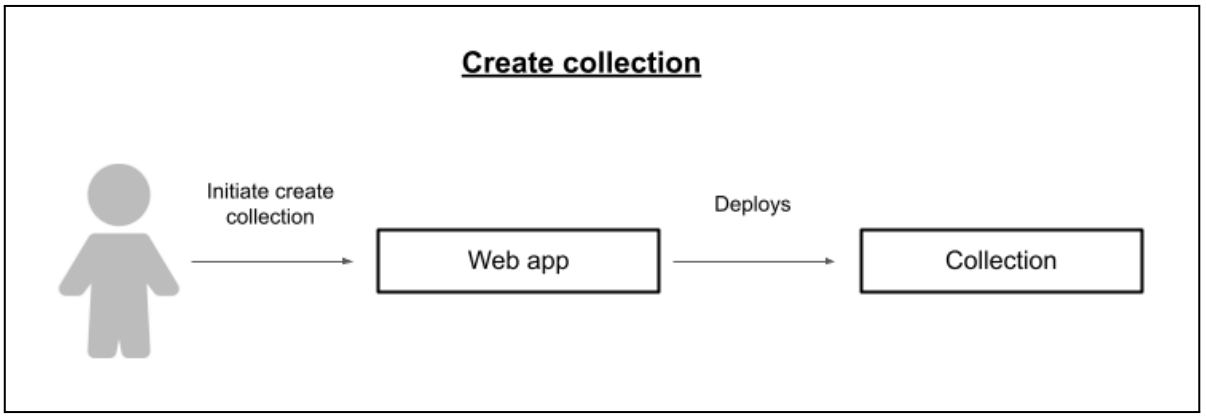
Blockchain

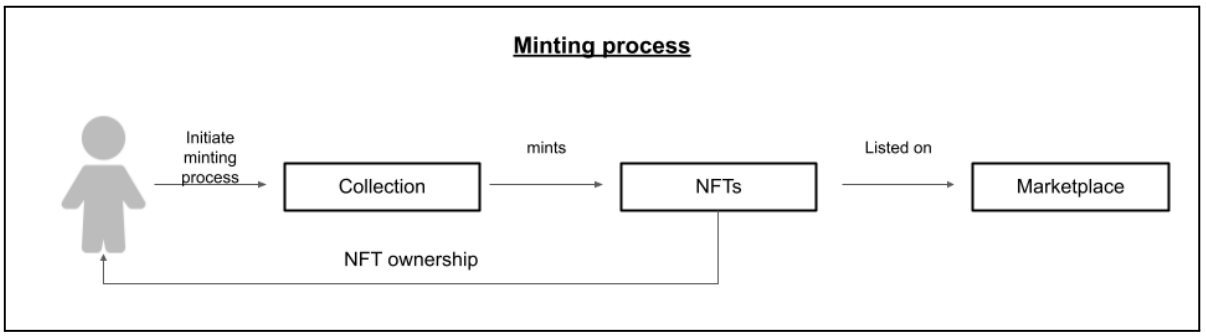
Legend

- Collection: A smart contract that can mint NFTs that will be associated to it via name and symbol
- NFT: The token minted through the collection

- Marketplace: A smart contract that contains a mapping of IDs to NFTs, with additional metadata
- Market item: The object associated to each ID in the marketplace

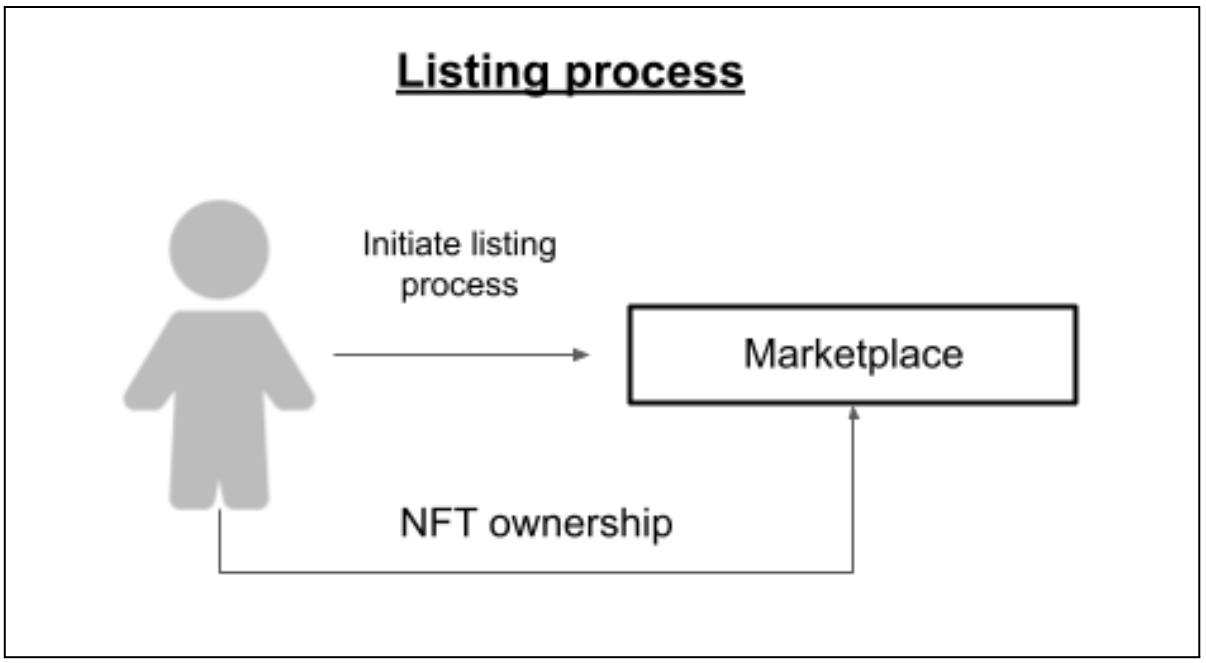
Minting Process





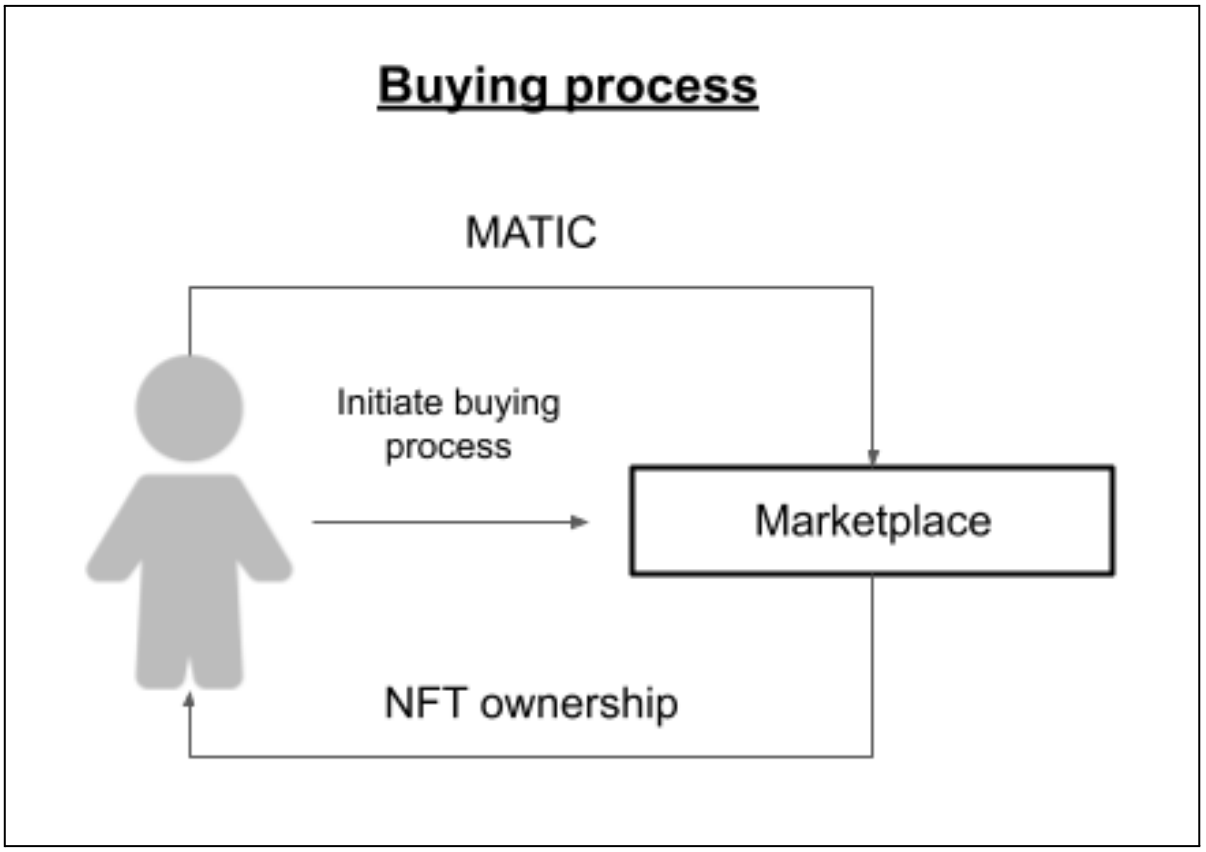
1. A user creates a collection by deploying a NFT contract through the site.
2. The user then mints NFT(s) on the newly created collection. NFTs minted are then associated with this collection.
3. When minting, a market item is created on the marketplace. With metadata like the collection information, original minter, and current status of the market item (inactive).

Listing Process



1. The user gives the NFT a price and the market item associated with that NFT will have its metadata updated (price, status).
2. The NFT is then transferred from the user's balance to the marketplace.

Buying Process



1. The appropriate amount of MATIC will be withdrawn from the buyer's wallet and the status of that listing is updated in the marketplace smart contract
2. The withdrawn MATIC is then transferred to the user that listed that NFT
3. Once the MATIC is transferred, the NFT is transferred from the marketplace to the buyer

Backend

API

Services

Moralis
Service for pinning NFT metadata on InterPlanetary File System (IPFS).

Maticvigil
Polygon network node used to send requests to the blockchain.

Ethers
Interface to interact with smart contracts and call their functions.

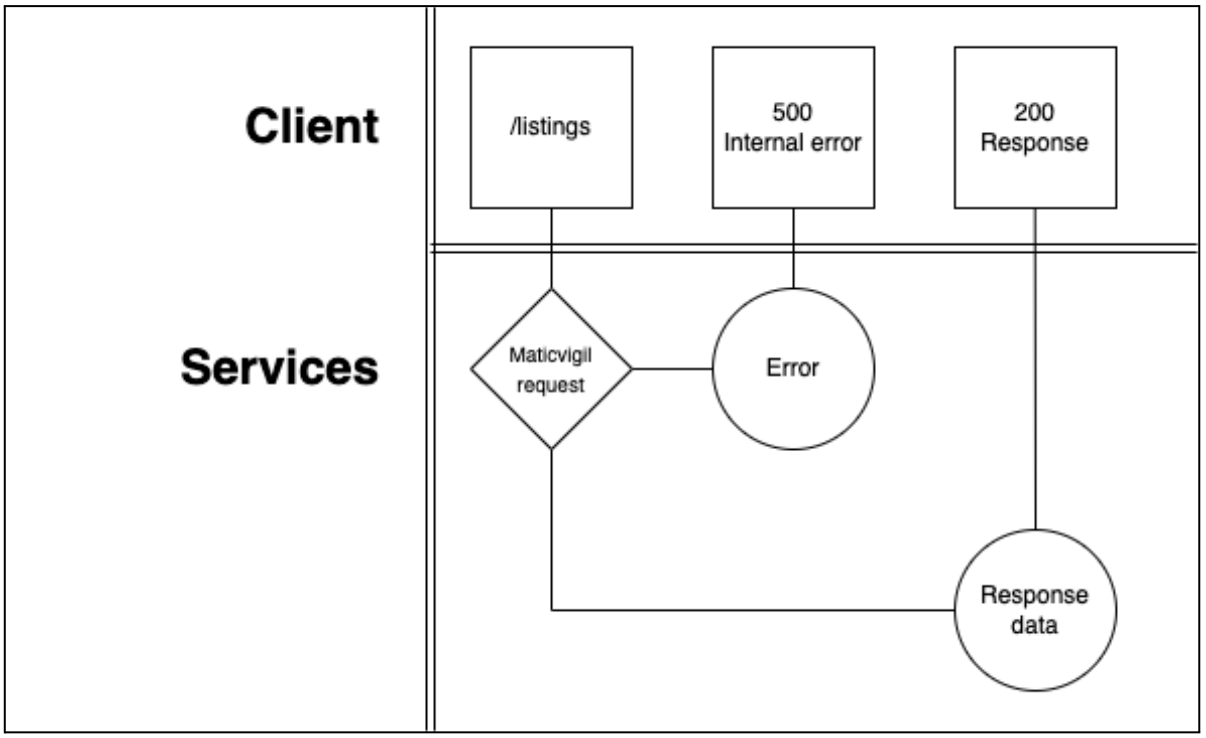
Endpoints

API endpoint	Description
/api/listings	Request: NIL Response: Array of all current unsold NFTs in the marketplace
/api/listings/[id]	Request: ID of market item Response: JSON object of data related to the queried ID
/api/listings/user/[address]	Request: Public wallet address of user Response: JSON object of user's listings and user's owned NFTs
/api/collections/[address]	Request: Address of the collection Response: JSON object of data related to the collection

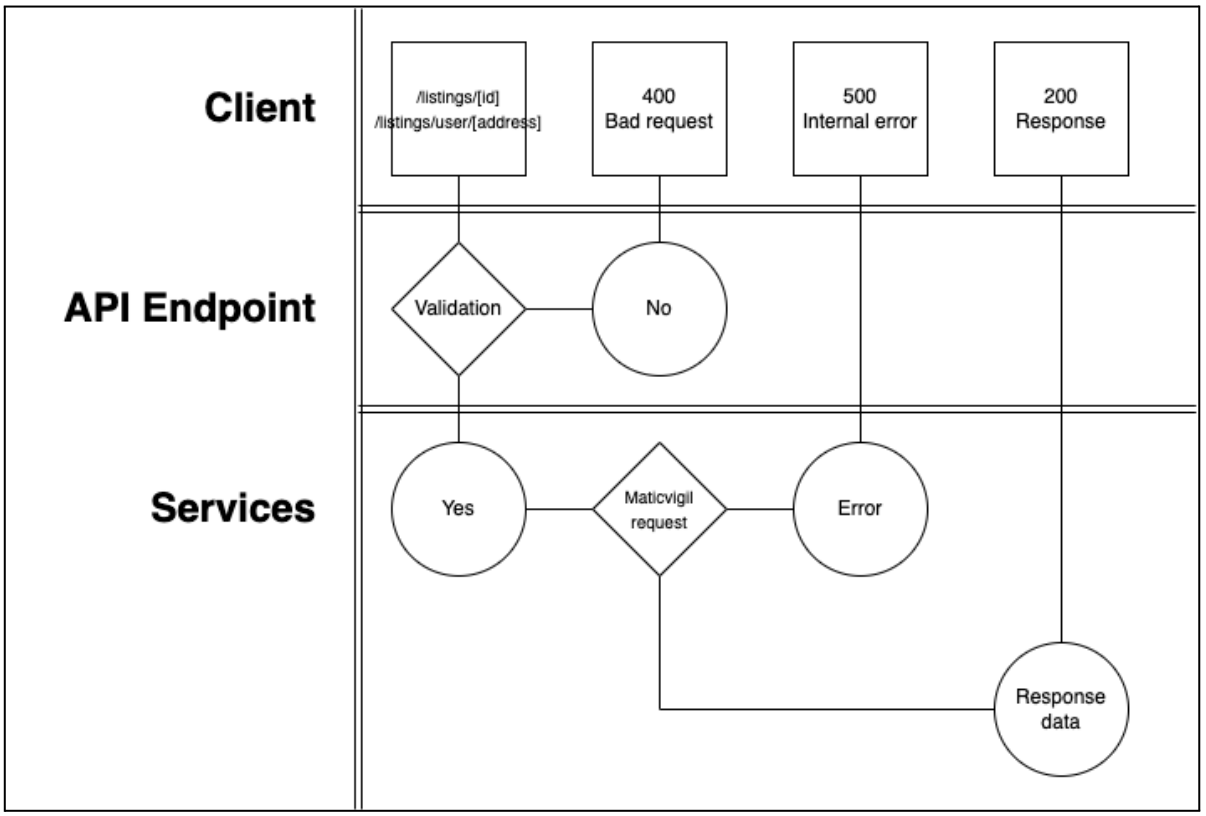
/api/image	Request: Image Name Description Response: IPFS URL to metadata
/api/images	Request: Zip Description Response: Array of IPFS URLs for each image in zip

Flow

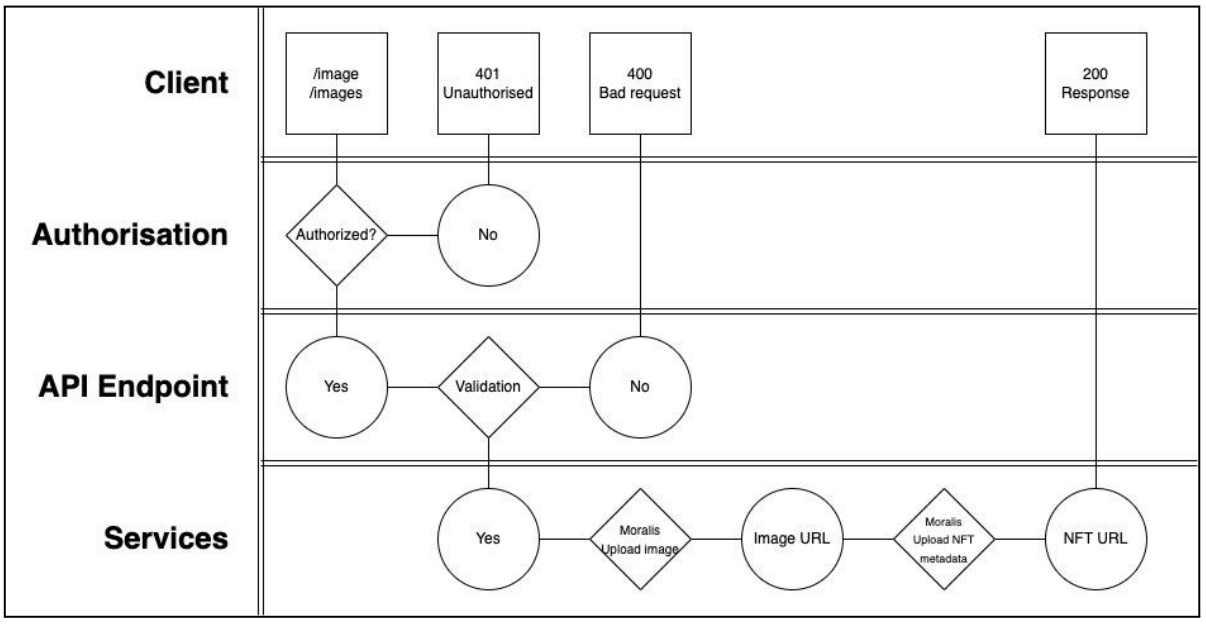
/api/listings



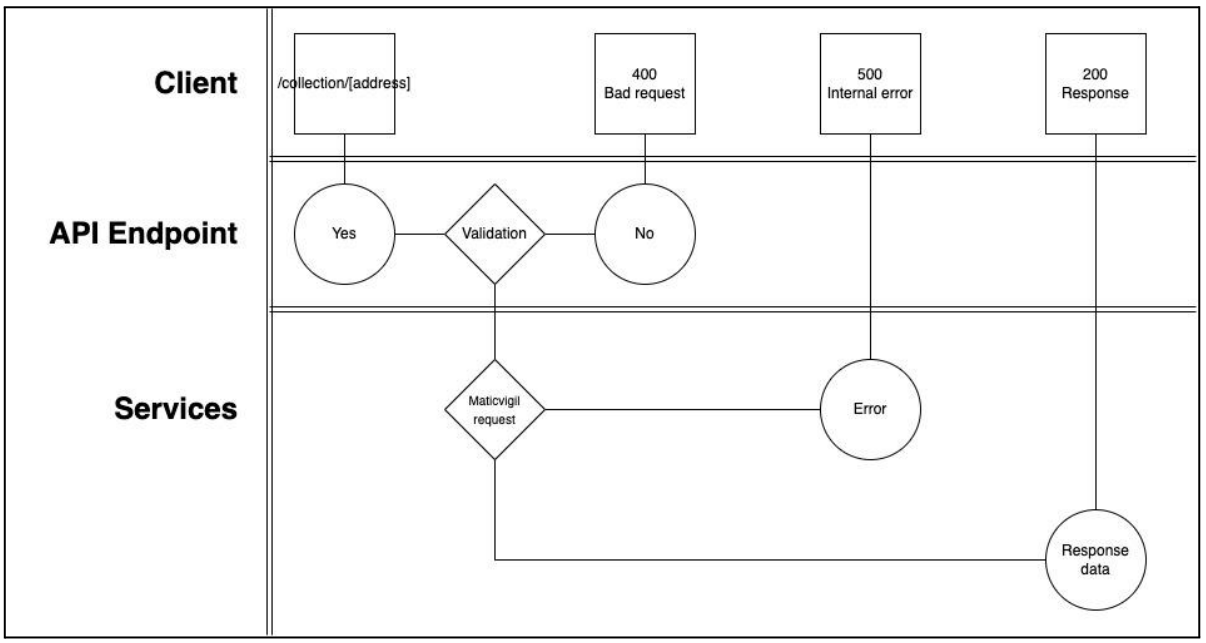
/api/listings/[id], /api/listings/user/[address]



/image, /images



/collection



Note about the minting and listing CRUD API

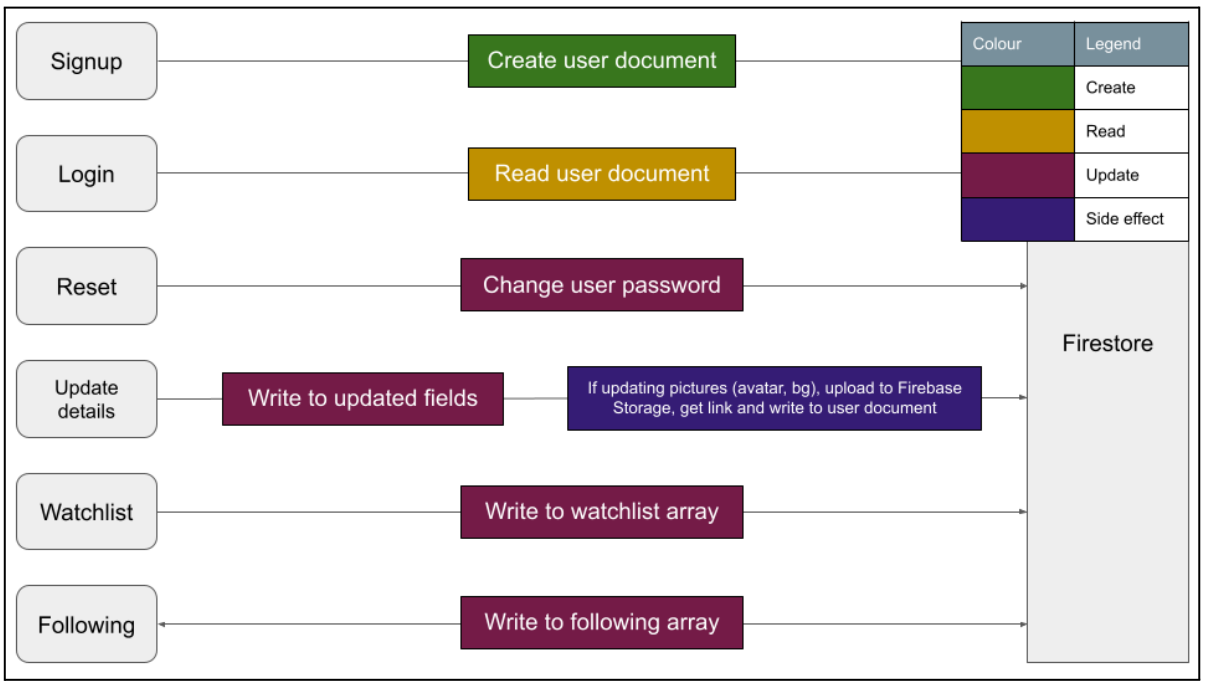
During development, we realised that to create a minting and listing CRUD API, authorisation through Metamask is not possible as the browser is not involved in the API. We have decided that this is out of the scope of what we planned for our project as we planned for a webapp, and not something that can be used on the command line or through services like Postman.

Database

Documents

Document	Fields
User	ID: string
	Name: string
	Email: string
	Wallet address: string
	Watchlist: array
	Following: array
	Avatar: string
	Background: string

Flow



For our data flow design, we primarily use Firestore as our database to track user details. The first
instance being when a user signs up for an account on our webapp. A new document in the ‘users’ collection is created for every user, with a unique UID being assigned to each document. Thus, when a user wants to reset their password or sign into our webapp, data is read from their corresponding document to verify information for sign in or to update the document.

As for functions that can only be accessed after users have been signed in, users are also able to connect their Metamask wallet to their account or add an NFT from the Marketplace into their own ‘Watchlist’. We will utilise the authentication state from Firebase to update the current user’s document with the Wallet Address or TokenID into an array labelled ‘Watchlist’ respectively.

Frontend

Sitemap

URL	Description
Home	
/	Home page
Marketplace	
/marketplace	All listings page

/marketplace/[id]	Individual details page by id
Collection	
/collection/[address]	Individual collection page by address
/collection/[address]/mint	Minting form by address
/collection/new	Collection creation form
User	
/user/[id]	User profile page by id
/user/login	Login form
/user/signup	Sign up form
/user/reset	Password reset form
/user/update	Update user details form
Creator	
/creators	Page for all users with at least 1 collection