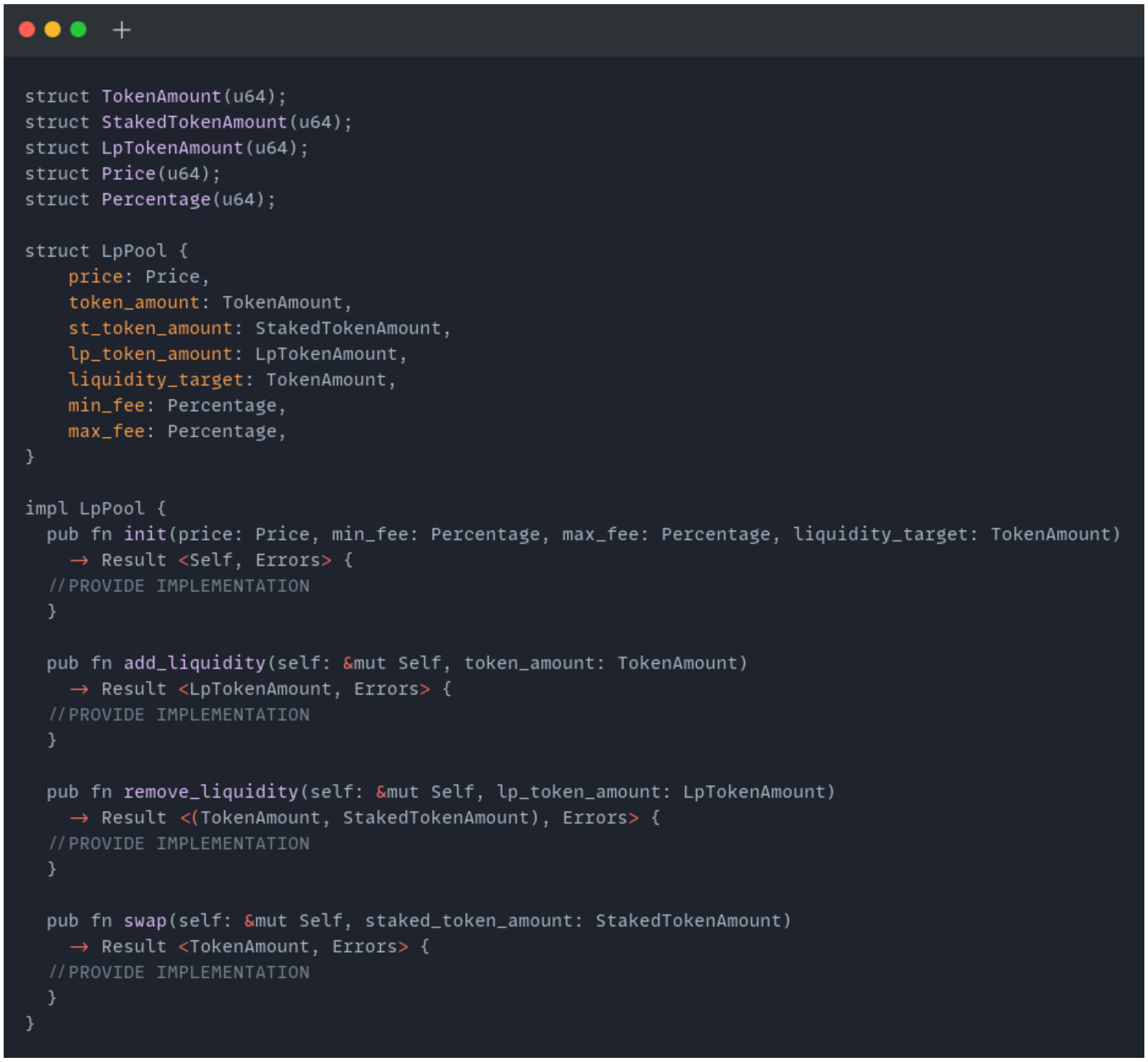
1. Programing, math, problem solving

Submission:

- Once you have completed your implementation, upload it to the GitHub and then share the repository link

Overview:

- Implement a math model of a Liquidity Pool in the Rust programming language, which provides immediate liquidity unstaking. The model originated from the Marinade Protocol and is described here: https://docs.marinade.finance/marinade-protocol/system-overview/unstake-liquidity-pool
- Your task involves implementing functions based on structures similar to the ones outlined below:



```rust
struct TokenAmount(u64);
struct StakedTokenAmount(u64);
struct LpTokenAmount(u64);
struct Price(u64);
struct Percentage(u64);

struct LpPool {
    price: Price,
    token_amount: TokenAmount,
    st_token_amount: StakedTokenAmount,
    lp_token_amount: LpTokenAmount,
    liquidity_target: TokenAmount,
    min_fee: Percentage,
    max_fee: Percentage,
}

impl LpPool {
  pub fn init(price: Price, min_fee: Percentage, max_fee: Percentage, liquidity_target: TokenAmount)
    -> Result <Self, Errors> {
  //PROVIDE IMPLEMENTATION
  }

  pub fn add_liquidity(self: &mut Self, token_amount: TokenAmount)
    -> Result <LpTokenAmount, Errors> {
  //PROVIDE IMPLEMENTATION
  }

  pub fn remove_liquidity(self: &mut Self, lp_token_amount: LpTokenAmount)
    -> Result <(TokenAmount, StakedTokenAmount), Errors> {
  //PROVIDE IMPLEMENTATION
  }

  pub fn swap(self: &mut Self, staked_token_amount: StakedTokenAmount)
    -> Result <TokenAmount, Errors> {
  //PROVIDE IMPLEMENTATION
  }
}
```

Details:

- Assume there are 3 types of tokens: Token, StakedToken, LPToken and corresponding token amounts: TokenAmount, StakedTokenAmount, LPTokenAmount. These tokens can be defined as follows:
    - Token: base unit.
    - StakedToken: unit backed by specific amounts of the Token. The exchange ratio is determined by the Price.
    - LpToken: unit represents a share of the liquidity pool. You can mint LpTokens by invoking the "add_liquidity" function, which requires a certain amount of Token. Conversely, you can redeem LpTokens using the "remove_liquidity" function, resulting in proportional amounts of Token and StakedToken being returned.
- The Liquidity Pool functions as a mechanism for exchanging StakedTokens for Tokens. The LpPool serves as a system where actors can exchange with each other. However, the actual swapping doesn't happen directly among these involved actors. Instead, the LpPool acts as a trusted third party responsible for settling the transactions.
- The liquidity pool involves two actors: the Swapper and the Liquidity Provider:
    - The swapper is an actor that uses LpPool to exchange StakedToken for Tokens.
    - A Liquidity Provider is an actor that supplies Tokens to the Liquidity Pool, enabling these exchanges. As compensation for the provided Tokens, the Liquidity Provider receives a share of ownership in the liquidity pool, represented as LpTokens. Importantly, the Liquidity Pool charges a fee after each transaction, with the fee percentage varying based on factors such as available Tokens in the LpPool and target liquidity.
- The LpPool methods are analyzed in terms of their interface: passed arguments, instance state changes, and return type:
    - LpPool::init
        - Params: Configuration parameters such as price, fee_min, fee_max, liquidity target
        - State change: Initializes all LpPool fields
        - Return: instance of LpPool
    - LpPool::add_liquidity
        - Params: Amount of Token that the liquidity provider wants to add to the LpPool
        - State change: Increases the Token reserve and the amount of LpToken
        - Return: New amount of minted LpToken
    - LpPool::remove_liquidity
        - Params: Amount of LpToken that the liquidity provider wants to redeem from the LpPool
        - State change: Decreases Token reserve, decreases StakedToken reserve, and decreases the amount of LpToken
        - Return: Specific amounts of Token and StakedToken. The amount of returned tokens is proportional to the LpToken passed, considering all LpTokens minted by the LpPool
    - LpPool::swap

        - Params: Amount of StakedToken that the Swapper wants to exchange
        - State change: Decreases Token reserve and increases StakedToken reserve in the LpPool
        - Return: Amount of Token received as a result of the exchange. The received token amount depends on the StakedToken passed during invocation and the fee charged by the LpPool.

Requirements:

- Use fixed-point decimals based on the u64 type for all of these parameters, instead of floating points.
- Assume that the price is constant for simplicity.
- Implement a math model in pure Rust; integration with blockchain or UI is not necessary.
- Include unit tests for at least the most important functions.
- Choose any implementation paradigm (such as OOP, functional programming, etc.) based on your preferences.

Story example:
Here is a brief overview of calls made on the LpPool instance, demonstrating operations using example data:

1. LpPool::init(price=1.5, min_fee=0.1%, max_fee9%, liquidity_target=90.0 Token) -> return lp_pool
2. lp_pool.add_liquidity(100.0 Token) -> return 100.0 LpToken
3. lp_pool.swap(6 StakedToken) -> return 8.991 Token
4. lp_pool.add_liquidity(10.0 Token) -> 9.9991 LpToken
5. lp_pool.swap(30.0 StakedToken) -> return 43.44237 Token
6. lp_pool.remove_liquidity(109.9991) -> return (57.56663 Token, 36 StakedToken)

Tips:

- Please take note of how to deal with fixed-point decimals in a smart contract: https://medium.com/asecuritysite-when-bob-met-alice/dealing-with-decimals-in-smart-contracts-fd27eea9209a
- If you're having trouble understanding staked tokens, you can refer to some additional information (though it's not essential for completing the task). Check out the Marinade documentation:
  https://docs.marinade.finance
- Marinade is an open-source project, and the implementation, including the Liquidity Pool, is available here: https://github.com/marinade-finance/liquid-staking-program
- If you encounter any issues, you can always ask Marinade developers on Discord: https://discord.gg/pdNvswE4
- Alternatively, you can contact us via email at contact@invariant.app or on Telegram: @WojciechCichocki

If you have trouble understanding the concept of the task, familiarizing yourself with these terms will help:

- DeFi (Decentralized Finance)
- DEX (Decentralized Exchange)
- Tokens (such as ERC20 or SPL standards)
- LP (Liquidity pool), LP tokens
- Proof of Stake / Staking
- Liquid Staking / LSD (Liquid Staking Derivatives)

2. Smart contract development

Submission:

- Once you have completed your implementation, upload it to the GitHub and then share the repository link

Overview:

- Create a contract using one of the following ecosystems: Solana or Aleph Zero. Your task is to implement the Escrow pattern (third-party; middleman).
- Choose one ecosystem from the following options:

1. Solana (Anchor framework, Rust programing language)
2. Aleph zero (Ink! framework, Rust programing language)

Details:

- Escrow contracts should maintain separate accounts for each user, allowing efficient handling of multiple users simultaneously
- Escrow contracts allow for the multi-call of entrypoints: deposit and withdraw
- Only the owner of an account should be able to withdraw funds from their respective escrow account.

Requirements:

- Utilize a generic token type (SPL Token, PSP22) based on your chosen ecosystem.
- Address potential security concerns, particularly vulnerabilities like reentrancy.
- Include unit tests.
- Bonus points if you add end-to-end tests in TypeScript.
- Bonus points if you implement deposit and withdrawal in a single transaction (swap). The swap may have different levels of complexity, e.g., always 1 to 1, AMM, order book, depending on your skills.

Useful links:

- Solana:
  - Solana docs: https://docs.solana.com/
  - Anchor docs: https://www.anchor-lang.com/
- Aleph zero:
  - Aleph Zero docs: https://docs.alephzero.org/aleph-zero/
  - Ink docs: https://use.ink/

If you're interested in checking out our projects as examples within those ecosystems, below are the links:

- Solana: https://github.com/invariant-labs/protocol
- Aleph zero: https://github.com/invariant-labs/protocol-a0

Tips:

- Check out simple escrow example (solidity based): https://www.geeksforgeeks.org/what-is-escrow-smart-contract/
- Try to ask questions on the discord channels if you get stuck.
- Alternatively, you can contact us via email at contact@invariant.app or on Telegram: @WojciechCichocki

3. Full-stack web development - X(Twitter) API integration

Submission:

- Once you've completed your implementation, upload it to GitHub and send the repository link via email.

Overview:

- Your task is to build a straightforward mechanism for collecting EVM wallet addresses from users, which includes a validation process to confirm that each user follows a specified account on X.

  This mechanism will involve allowing users to authenticate via X account, checking if they follow the designated account, and if so, enabling them to submit their wallet address. The system should be able to verify this following status automatically and only allow wallet submission once the requirement is met.

User Interface Requirements:

- The web interface should be simple, as the frontend design will not impact the evaluation.
- Users should be able to authenticate via X account.
- After logging in, a prompt should inform users that they need to follow an Invariant X account(https://x.com/invariant_labs) to submit their wallet address.
  - This prompt should include a button that redirects them to the Invariant X account).
- If the X(Twitter) API response* confirms that the user is following the Invariant account, a modal should appear, allowing the user to enter their EVM wallet address.
  - This address will then be saved to the database.
- If the API response indicates that the user is not following the account, they should see a message prompting them to follow the specified account to submit their wallet address.
- There should be an option available to download(query) all addresses that have been added to the database.

  *(The mechanism works such that the API, on behalf of the authenticated user, checks if the user is following a specified entity (Invariant). If so, the user can add their EVM address to the database.)

API Requirements:

- API should have following entrypoints:
  - api/users/add
  - api/users/all

- The backend should be implemented as an API, allowing:
    - Adding an EVM wallet address to the database.
    - Confirming if the logged-in user follows the Invariant X account before adding an address.
    - Validating the format of the submitted EVM wallet address.
- The API should ensure that only one address is added per logged-in user.
    - Before adding an address, it should confirm if the user has already added an address.
- The API should provide a response indicating whether:
    - The user is following the specified X account.
    - The user is allowed to enter their wallet address.
- The API should include an endpoint to retrieve all wallet addresses added to the database.

Tech Stack:

- **Frontend** - Any framework of your choice (React/Next.js preferred).
- **Backend** - Use TypeScript or Rust.
- **Database** - Any database of your choice.

Bonus Points:

- Bonus point for hosting this site and providing a link to it.

Tips:

- Familiarize yourself with EVM wallets and wallet addresses in crypto. https://shardeum.org/blog/what-is-evm-wallet/
- Review the Twitter API docs for reference. https://developer.x.com/en/docs/x-api/getting-started/about-x-api
- Alternatively, reach out via email at contact@invariant.app or on Telegram: @WojciechCichocki.

4. Frontend development (external service integration)

Task submission:

- The task is based on adding a new feature to an existing repository: https://github.com/invariant-labs/webapp
- To submit the task, you have two options: (1) create a private fork of the above-mentioned repository, or (2) create a new repo copying the master branch.
- Once you have completed your implementation, upload it to the master branch of your GitHub repository, grant access to the user wojciech-cichocki, and share the repository link.

Tech stack:

- React
- Storybook
- Material UI
- Nivo

Task details:

- Your objective is to enhance the user experience by modifying the "open new position" view to include an indicator showing whether a specific market (liquidity pool) has been indexed by the Jupiter aggregator. When a pool is indexed by Jupiter, it should be indicated by a glowing Jupiter icon. Conversely, if a pool is not indexed by Jupiter, the icon should remain unlit.
- You can find the design mockup for this task here: https://www.figma.com/file/UKTXdLNJnNa6OSupcrLTda/FRONTEND-TASK-2?type=design&node-id=0-1&mode=design&t=30ABhzMOylCtt5oQ-0
  Please note that this mockup includes a feature that has not yet been implemented, namely, the icon indicating whether the pool is indexed by Jupiter. Components necessary for implementation within the task are marked with a red circle.
- Determining whether a pool is indexed by Jupiter is straightforward as Jupiter exposes an API providing information about all indexed pools. You can access a list of indexed pools via this link: https://cache.jup.ag/markets?v=3
- For instance, within the JSON data, an entry like *{"pubkey":"5dX3tkVDmbHBWMCQMerAHTmd9wsRvmtKLoQt6qv9fHy7",...}* indicates that the pool with the address *"5dX3tkVDmbHBWMCQMerAHTmd9wsRvmtKLoQt6qv9fHy7"* has been indexed. Consequently, all positions on the USDC/USDT 0.01% pool should feature the illuminated Jupiter icon.

Tips:

- The pool address serves as a unique identifier for a pool, designated for a token pair A/B and fee tiers specifying the percentage level of fees for exchanges.
- Market ID, pool address, and pair address essentially refer to the same thing, and these terms are interchangeable.

- For instance, the address for the USDC/USDT pool at a 0.01% fee tier is "*5dX3tkVDmbHBWMCQMerAHTmd9wsRvmtKLoQt6qv9fHy7*". You can find this address for each pair under the label Market ID. You can also find it at this link: https://invariant.app/newPosition/USDC/USDT/0_01
- The presence of the pool address at https://cache.jup.ag/markets?v=3 is sufficient information to determine whether the pool has been indexed.
- To access the "open new position" feature, simply navigate to the *newPosition/pair* path. For instance: https://invariant.app/newPosition/USDC/USDT/0_01. You can also do this locally using localhost: http://localhost:3000/newPosition/USDC/USDT/0_01.
- To complete the task, you don't need to have any funds, tokens, or cryptocurrencies. However, you do need to install a wallet as a browser extension. We recommend installing either the Phantom Wallet or Nightly Wallet. Remember, to access certain features within the application, it's essential to connect your wallet using the "connect wallet" option located in the top right corner.
- To easily verify whether the task has been performed correctly, you can compare two pools: one that is always indexed and another that is never indexed. On the pool https://invariant.app/newPosition/USDC/USDT/0_01, the Jupiter icon should illuminate, while on the pool https://invariant.app/newPosition/6DSqVXg9WLTWgz6LACqxN757QdHe1sCqkUfojWmxWtok/8FU95xFJhUUkyyCLU13HSzDLs7oC4QZdXQHL6SCeab36/0_01, the Jupiter icon should not illuminate.
- Ensure that you have the correct settings in the application. The suggested parameters are as follows: Nightly RPC and Mainnet as Network.
- To run the app in the repository, simply execute: "*npm i*" followed by "*npm run vite*".
- Alternatively, you can contact us via email at contact@invariant.app or on Telegram: @WojciechCichocki

5. Frontend development (component creation)

Task submission:

- The task is based on adding a new feature to an existing repository: https://github.com/invariant-labs/webapp
- To submit the task, you have two options: (1) create a private fork of the above-mentioned repository, or (2) create a new repo copying the master branch.
- Once you have completed your implementation, upload it to the master branch of your GitHub repository, grant access to the user wojciech-cichocki, and share the repository link.

Tech stack:

- React
- Storybook
- Material UI
- Nivo

Task details:

- Modify the existing liquidity chart component, which is used on the new position creation page, by adding a **trading volume heatmap.** The heatmap will display trading volume distributed across various price ranges. Each price range has corresponding trading volume from the last 24 hours denominated in USD.
- You can see the design here: https://www.figma.com/file/RaVaqGb73H4kMoPdd9f71p/frontend-task?type=design&node-id=0%3A1&mode=design&t=aMD5PuDgI7yKvEEB-1
  There are two mock-ups. On the first mockup, the volume heatmap is shown as disabled, and on the second one, an example of the enabled heatmap is presented. As you can see, there is a heatmap containing five price ranges.
- Price ranges should be indicated by green rectangles with varying levels of transparency. The heatmap is displayed only when the Volume Heatmap switch is enabled. When hovering over a specific range, a tooltip should appear showing its corresponding volume value. The price ranges are categorized into 5 groups based on concentration, which is the ratio of volume to price difference. The higher this ratio, the less transparent the color of the range should be in that category. If the number of ranges is less than or equal to five, each of them should be assigned to a different category; otherwise there should be at least one range in each category. The formula expressing the previously mentioned concentration is as follows:
  $c = \frac{v}{|p_1 - p_2|}$, where c is concentration, v is the trading volume corresponding to the price range (p1, p2).
- This task involves updating the UI of a component and does not require connecting the component to real data. To verify the changes, please use Storybook. After adding the

heatmap, make sure that the existing functionality of the chart, such as setting the price range for a new position, works properly.

Input example:

- Below are sample mocked data sets to help you test the component. The data is presented in the form of distinct price ranges along with their corresponding volume values
    - i1 = (-5, -1), v1 = 40 000 usd
    - i2 = (-1, 1), v2 = 60 000 usd
    - i3 = (1, 2), v3 = 15 000 usd
    - i4 = (2, 4), v4 = 10 000 usd
    - i5 = (5, 10), v5 = 15 000 usd

  You can calculate the concentration of these intervals as a result:
    - c1 = 10 000 usd
    - c2 = 30 000 usd
    - c3 = 15 000 usd
    - c4 =   5 000 usd
    - c5 =   3 000 usd

Terms:

- Trading volume, in the context of the financial market, is a measure that expresses the amount of assets exchanged for a specific market pair during a given period of time. It can be denominated in the amount of this asset or USD

Tips:

- Within the PriceRangePlot component, there are already layers overlaid on the chart, containing elements, whose positions and sizes are dependent on the currently observed range. Check out how these layers are created and what elements they can consist of.
- Alternatively, you can contact us via email at contact@invariant.app or on Telegram: @WojciechCichocki