## Purpose and Goals

Anagrams with Fiends is an online implementation of the word game Anagrams, in which players (called "fiends") draw letter tiles from a bag, and build words out of these tiles and previously-formed words. Fiends put the words they build into their stash, and they can swipe a word from another fiend stash if they add letters to that word, forming a new word. The winner is the fiend who has the most words in his stash when the bag runs out of tiles.

Anagrams is a fun game to play in person with physical tiles, but Anagrams with Fiends has several benefits over the physical version. Players don't have to be physically together to play it, and if the app becomes popular, it will be easy to find opponents to play with. Players will be spared from using physical tiles, which take effort to keep organized on the game table and to clean up. Anagrams with Fiends will also keep track of previous games played, potentially providing support for replays of old games, leaderboards, and assisted or automated matchmaking.

## Key Concepts

**Lobby:** The set of currently active tables and currently online users which serves as the hub for users to find games. A user may challenge another user within the lobby.

**Challenge:** From the lobby, a user may issue a challenge to another user or set of users (maximum game size TBD, the fallback in case of time shortage is 2 fiends). A challenge may be either accepted or rejected by each recipient. If all recipients accept the challenge, a game is created and started with those users; if any rejects, then the challenge is removed and no game is created.

**Fiend:** A fiend represents a single actor in a game of Anagrams; in each game, each user controls one fiend. Each fiend, during the game, owns a set of words, called their **stash**.

**Tile:** A tile is a representation of a letter which can be moved around to form words. At any point during a game, a tile is in one of three locations: inside the *bag*, in the *pool*, or inside a *word*. Unlike certain other word games, Anagrams with Fiends has no concept of the point value of a tile. Any two tiles with the same letter are functionally identical.

**Bag:** In each game, the bag is a set of tiles from which tiles are drawn to form the pool. Each game starts with approximately 180 tiles in the bag, which are either preset or drawn randomly from some distribution (TBD).

**Pool:** The pool is the set of free tiles which fiends can use to build new words, upgrade their own words, or swipe other fiends' words. A tile is added to the pool from the bag when one of three things happens: (1) when the pool is empty, after a short countdown; (2) after some fixed time has passed since the last tile was added to the pool, probably about 10 seconds, or (3) if all the players agree to add another tile to the pool.

**Word:** A word is a list of tiles whose letters spell out an English word, as defined by some predetermined wordlist (TBD, perhaps enable1). Words must be at least three letters long, and during a game each word belongs to one fiend. Fiends can *build* words by anagramming a subset of the tiles in the pool. Fiends can also *upgrade* one of their own words into another word, or *swipe* a word from another player by making another word.

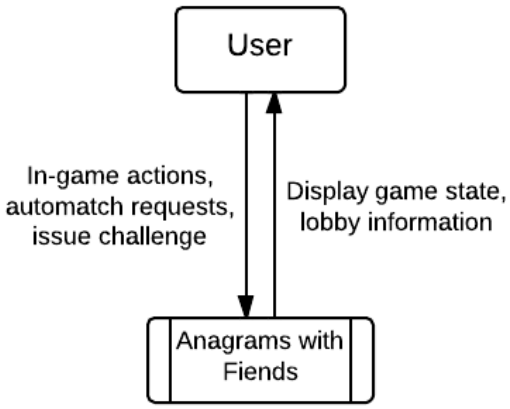
**Building:** A fiend may *build* a word from any subset of the tiles in the pool. Doing so removes the tiles from the pool and places the word in his stash.

**Upgrading/swiping:** A fiend combine an existing word with tiles from the pool and rearrange those tiles to create a new word, which then goes in her stash. If the word in question originally belonged to her, this is called *upgrading*; if it belonged to another player, it is called *swiping*.

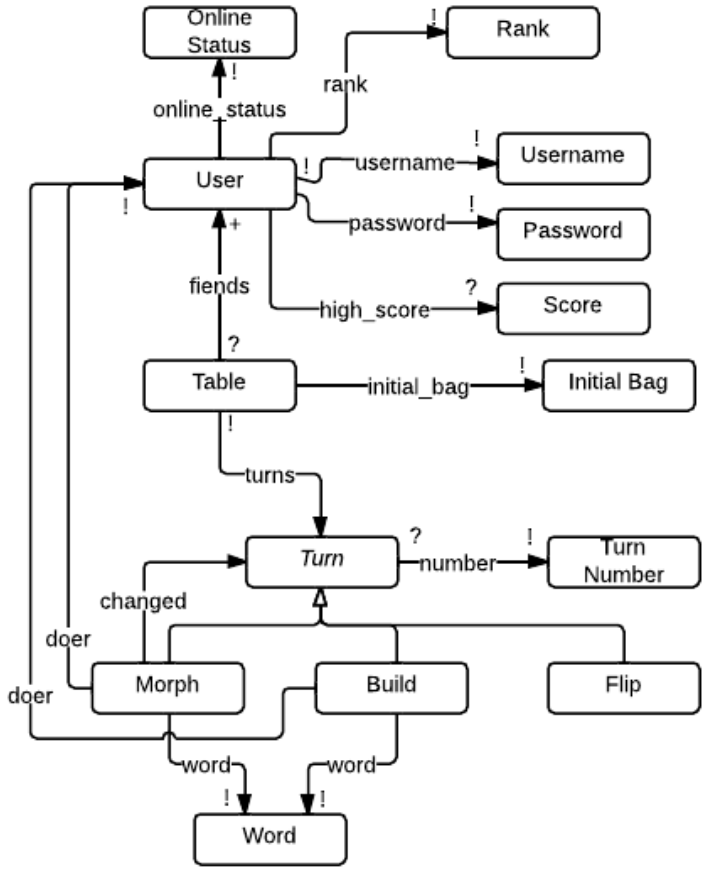
## Feature Descriptions

**Play Anagrams with anyone, or just by yourself.** Just sign up, and you can play Anagrams in single- or multi-player mode!
**Scores and leaderboard.** Aim for a high score in single-player mode! Compare yourself to the world on a global leaderboard.
**Match history.** Keep track of your performance in both game modes.
**Ranking and matchmaking.** Start games in multi-player mode by challenging other players in the lobby, or by being automatically matched to a player of similar skill.
**Recorded games.** Relive and publicly share your past anagramming glory.

## Context diagram



# Data Model




Extra constraints:
In the relation fiends: Table -> User, each Table maps to either 1 or 2 Users (there are no "empty tables").

In the relation changed: Morph -> Turn, the target Turn cannot be a Flip.

Notes:
The way in which rankings are determined has not yet been decided. We are planning to explore already-existing ranking systems and choose one that fits well with our project scope.

Tables are never "reused" -- a Table is created for each game instance, and remains attached to that game instance even after the game finishes.

The pool is determined by the sequence of Turns which have occurred at a given Table. The letter on a given flipped tile is determined by the initial bag and the sequence of Turns.

# Security

**Authentication:** Users must log in to join a table and play. When a game starts at a table, no other users may join the table. On the other hand, results and replays from past games are publicly available, though their URLs are obscured by hashes; that way, users can easily share past games with their friends.

**Privacy:** Only usernames will be visible in the lobby, in a table, and in past game results and replays.

**Risks:**

- Players may cheat by using a computer program to identify new words to build, upgrade, or swipe.
- In multi-player, players may conspire to artificially change their rank by purposely losing to one another.
- Players may attempt to cheat by sending illegal moves to the server.
- Players may try to masquerade as another user with a higher ranking

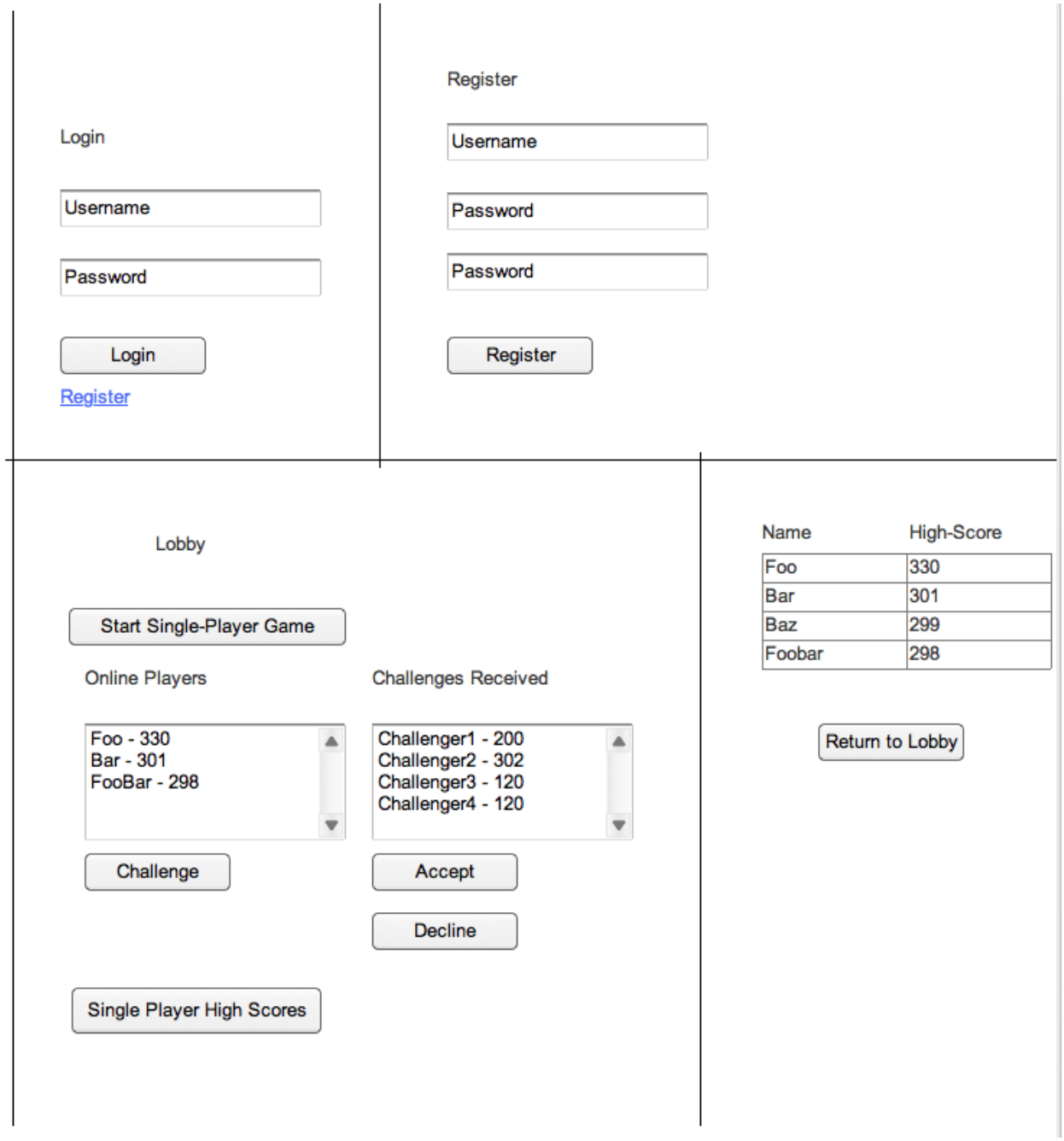
**Threat model:**

- We assume that users of our application are interested in playing Anagrams. There is nothing to gain from using the site for any other purpose, except:
    - To steal passwords
    - To feign reputation (by inflating their ranking or deflating another player's ranking)

**Mitigations:**

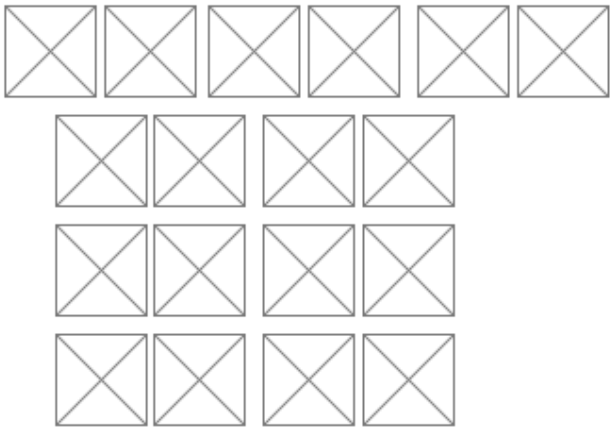
- We do not entrust clients with the handling of rules. There will be legality checks on both client side and server side.
- We use the standard "technical" mitigations, e.g. Rails's has_secure_password to store passwords safely in case of database compromise, and signed cookies to prevent session spoofing.
- We will use an existing ranking system which has stood the test of time. We cannot completely eliminate the possibility of collusion between players to manipulate rankings, but good ranking systems will minimize it.

# Wireframes

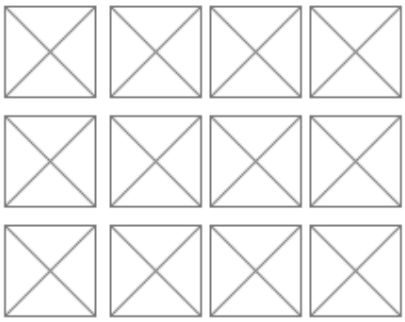

Login
Username
Password
Login
Register
Register
Username
Password
Password
Register
Lobby
Start Single-Player Game
Online Players
Foo - 330
Bar - 301
FooBar - 298
Challenge
Challenges Received
Challenger1 - 200
Challenger2 - 302
Challenger3 - 120
Challenger4 - 120
Accept
Decline
Single Player High Scores
Name
High-Score
Foo
330
Bar
301
Baz
299
Foobar
298
Return to Lobby

Bag

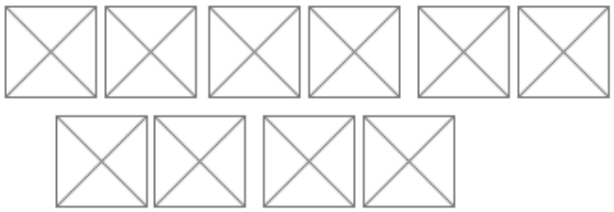
Opponent's Stash



Pool



Your Stash

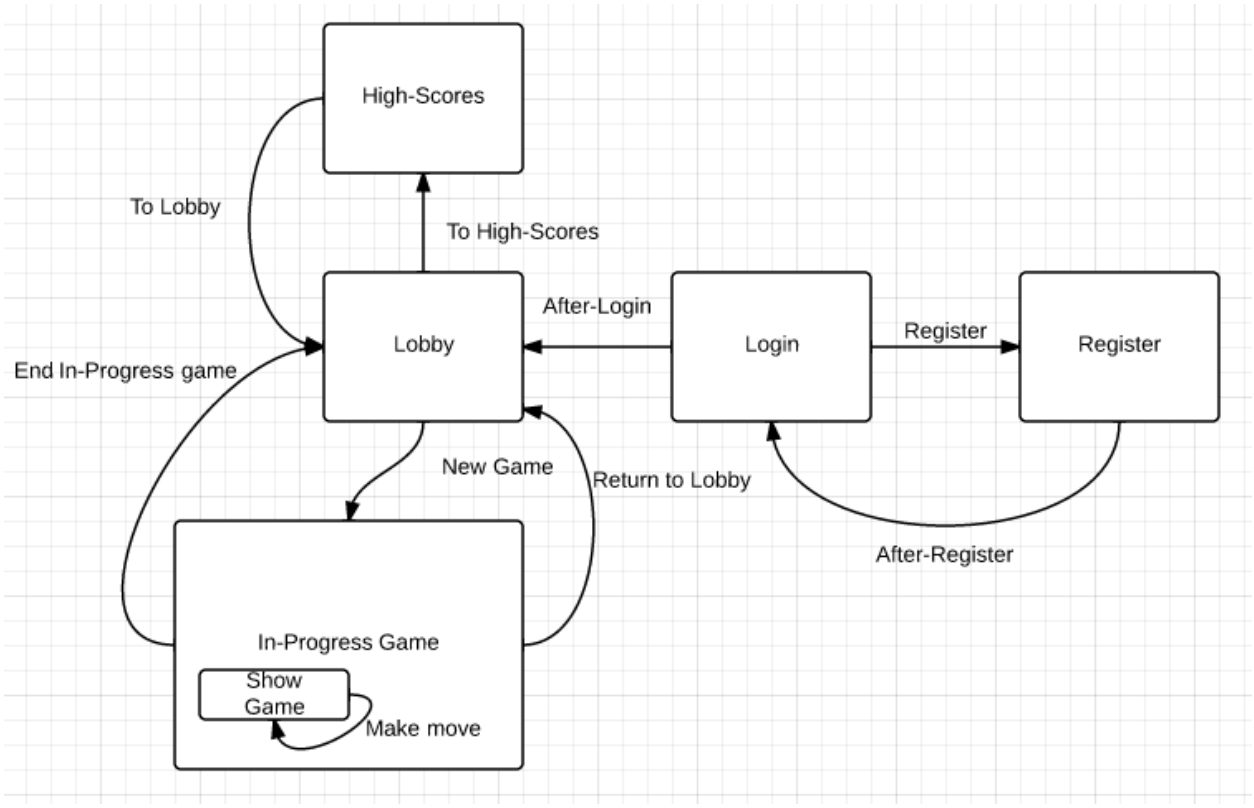


Enter a Word

Submit

Leave Game

# State Machine Diagram



# Design challenges

1. **Race conditions.** If Alice tries to make a move, the app will check the validity of her move, and will accept the move if valid. However, during this check, another player (Bob) may have already moved, and such a move may render Alice's move illegal! So we will need to prevent the occurrence of two moves at the same time.
    a. We could try to arrange for some sort of semaphore-based solution. (Not sure how that would work with Rails, though.)
    b. We could try to arrange for each game to run in a single thread, so that check/accept cycles are done in sequence. This would be difficult though, as multiple web sockets will be open simultaneously.
    c. *Decision taken*: Each turn has a "turn number." When Alice tries to make her move, the Turn object created has a turn number associated with it (say n), and the database will enforce that each Turn within a Table has a unique turn number. Thus, if Bob has already moved, the turn number n will be taken when we try to save Alice's move to database. The nice thing about this solution is that we can then see whether Alice's move would be legal as turn number n+1, and accept if so, giving the appearance of essentially "simultaneous" moves if such simultaneity is possible.
2. **Availability of past games and replays.** Who can view results and replays of past games?
    a. Only a user that participated in the game. This would require the user to be logged in, and would prevent players from sharing past games with others. However, this allows the user to hide potentially embarrassing replays.
    b. Only a logged-in user. This allows sharing past games, and ensures that only someone who actually plays the game can see replays. However, forcing a user to log in may be somewhat inconvenient if the user has not yet registered an account.
    c. *Decision taken*: Anyone who has a link to the replay or result of the past game. This makes sharing past games trivial. To try to maintain some privacy for the participants in the game, we can hash the id of the past game, so that one can only view games that he has a link to.
3. **Simultaneous games.** Can a user participate in multiple games simultaneously?
    a. Allowing a user to participate in multiple games simultaneously doesn't make much sense, because the game fundamentally depends on quick real-time reactions to tiles being added to the pool.
    b. *Decision taken*: A user may only play a single game at a time. If a user disconnects or leaves the page while in a game, logging back on will redirect to the game (if it has not yet ended.)
4. **Timing out of a game.** A game should certainly end after the bag is empty and sufficiently much time passes without a move being made (i.e. no one builds, swipes, or upgrades a word for a sufficient period of time). What if a fiend disconnects or quits when there are tiles remaining in the bag?

    a. Single-player:
        i. The game times out and ends automatically after a fixed length of time without a move, so that users can't continue single-player games after an extended period away.
        ii. *Decision taken*: The game "pauses" until the user returns. This allows users to leave a single-player and continue it later.
    b. Multi-player:
        i. If a user rejoins the table within a short period of time, he may rejoin. If a player is away for an extended period of time, he is dropped from the game and cannot rejoin. While away or dropped, a player's words may still be swiped. The dropped player is still scored at the end of the game, and is ranked accordingly.
        ii. Players are still dropped, as above, but receive a score of 0.
        iii. *Decision taken*: The game continues normally (regardless of the length of time a user is away), allowing disconnected players to rejoin the table if they reconnect and the game is still running.
5. **Single-player scoring.** How do we compute a fiend's score in a single-player game? (TBD)
    a. A fiend's score could be the number of words in his stash. In the physical, multi-player version of Anagrams, this is the standard. However, in single-player, this would not provide much differentiation between scores, and would reward the uninteresting strategy of forming as many short words as possible.
    b. We could use a Scrabble-like scoring system, where tiles are assigned point values; when a user builds or upgrades a word, his score increases by the sum of the point values of the letters in the word. This would encourage forming more uncommon words.
    c. We could use a Scrabble-like scoring system with bonuses for longer words; this is similar to the previous scoring method, but encourages forming long words.
    d. We could use a variation of one of the previous two methods, where the score is not incremented every time a user builds or upgrades a word, but is computed at the end.
6. **Multi-player victory condition.** How do we determine the winner of a multi-player game? (TBD)
    a. Use the same scoring system as in single-player, where swiping and upgrading words are treated identically. This would be intuitive, but perhaps swiping should be rewarded more greatly.
    b. Use a scoring system mentioned in the single-player section which is different from the single-player scoring system. This would be both unintuitive and harder to implement.
    c. Use a modified version of the single-player scoring system, but giving a bonus for swiping words. This could introduce a new element of strategy, where fiends prioritize taking other fiends' words.
7. **Ranking.** How is a user’s multiplayer ranking determined? (TBD)

a. There are a number of existing ranking algorithms, such as ELO and TrueSkill, with varying degrees of complexity and flexibility. Many also have implementations as Ruby gems. We'll choose one, probably TrueSkill, and use it.