

Exercise prepared by Ashutosh Mahajan, Simran Lakhani and Mustafa Vora

Instructions: Try to solve the problems on your own. If you have difficulties, ask the instructor or TAs. Attempt at least one of the three exercises given below and submit it by 1159 pm on Thursday 10 November, 2022 on moodle.

Wordle is a popular single-player word-guessing game. A player gets six chances to guess a five-letter target word. After every guess, the player receives feedback for each letter in a word as follows:

- if the letter is at the correct position as in the target word, it appears green (G)
- if the letter is present in the target word, but is not at the correct position it appears yellow (Y)
- if the letter is not part of the target word, it appears black (B)

Based on the information provided after each guess, the player can make better subsequent guesses. If the player correctly guesses the word in six trials they win and lose otherwise. Wordle has a dictionary of words known to the player and the target word is selected from a subset of this dictionary. Following are a few examples of the color string that Wordle shows for every guess word corresponding to the target word:

- Target: POWER, Guess: ROPED. The resulting string is YGYGB
- Target: SMILE, Guess: SPREE. The resulting string is GBBBG. The first 'E' is black in the result and the second 'E' is at the correct position and there is only one 'E' in the target.
- Target: AMPLE, Guess: KAPPA. The resulting string is BYGBB. Note that the guess word contains 'A' twice. The first instance is yellow, whereas the other is black, and similar is the case with the letter 'P'.

You can look at <https://wordlegame.org/> for some practice games.

An OR Approach

One possible solution approach is to develop a rather simple “fixed” strategy of first discovering which letters appear in the target and then try to guess the target by rearranging the discovered letters. There are other interesting strategies that can be used to fully solve any given 5-letter wordle but they are more complicated. Since there are 26 letters in English, one needs six 5-letter words to discover all letters in the target. Even if one uses 6 such words, the letters appearing multiple times (for example, KAPPA) will not be known. Instead, one can try to pick four 5-letter words that cover the 20 most commonly occurring letters in the dictionary of all 5-letter words. This will at least cover many of the letters in the solution word.

Exercise 1: There is a database of all 5-letter words (e.g. Google Web Trillion Word corpus). Can you identify the frequency of letter usage from this?

A solution to this is available on the internet, for you to check.

Exercise 2: We would like to use words which are commonly used - let us assume that the wordle target word is picked at random from possibilities on the internet, and is therefore reflected in the word frequency. Assume that a list of such 5 letter words is available, in order of frequency. But we would like to avoid words in which a letter is used more than once. Can you filter out such words from the list given to you? Can you write a constraint system on words so that words with repeating letters are not allowed?

You can take a small set of words and test your logic, and the entire set of 5 letter words will be also available, if you want to test it in a full scale model.

Exercise 3: The constraint system above has no objective function, it is only a feasibility system. Can we use an objective function to choose 4 words of 5 letters, which have non-repeating letters and, which capture the most frequently used words that belong to such sets?

Discussions: What happens when the fixed number of words chosen is five, as then we have almost every alphabet? How does one optimally choose the set of words and then how do we evaluate that a given set of words are indeed optimal?

One might also be interested in maximizing the Greens or the weighted sum of green and yellow colors with more weight to green. How does one incorporate that into the objective function?