Assignment 5

Keyboard layout optimization

Keyboard Layout

- I have used the same layout as the last assignment which I generated myself

```
keyboard_layouts = {
    'qwerty': [
        {'chars': ['q', 'Q'], 'position': (1.6, 2.8), 'dimensions': (1, 1),
'side': 'L', 'start': 'a'},
        {'chars': ['w', 'W'], 'position': (2.7, 2.8), 'dimensions': (1, 1),
'side': 'L', 'start': 's'},
        {'chars': ['e', 'E'], 'position': (3.8, 2.8), 'dimensions': (1, 1),
'side': 'L', 'start': 'e'},
        {'chars': ['r', 'R'], 'position': (4.9, 2.8), 'dimensions': (1, 1),
'side': 'L', 'start': 'u'},
        {'chars': ['t', 'T'], 'position': (6.0, 2.8), 'dimensions': (1, 1),
'side': 'L', 'start': 'u'},
        ...
```

- It contains the character present within each, key, its position and dimensions as well. It allows me to add intricate details to my keyboard
- It also says wether the key is in the right side or the left side of the keyboard, so that I can assign the shift key in the opposite side
- The layout is imported from `layouts.py`. The folowing layouts are available - 'QWERTY', 'Dvorak', 'Colemak', 'Ergodox', 'best_layout'.
- The last layout was created from this code

Keyboard Display

- `display_keys` function displays the keys while `draw_keyboard_layout` function displays the heatmap over the keyboard
- It is again same as the last assignment but there is one change
- It takes an `order` argument which tells the order of the keys. It is used to display the modified keyboard.

Input processing

- The input is a string which is taken from `string.txt`
- It is made sure that unusual characters are not read from the file
- `calc_frequency` function takes the string and calculates the frequency of each key
- The frequencies are stored in `char_freq` list, for further use

Simulated Annealing

Swapping keys

- The annealing process starts with the given layout (qwerty, ergodox, etc), which is represented by a list of indices (`order`).
- In each iteration, we swap two keys randomly using the `get_neighbour` function
- I have allowed the function to only swap the alphabet and puncutation keys
- The numeric and control keys remain fixed as I felt moving those keys would just make it harder to type for the user

Evaluating travel distance

- In the beginning of the program, the travel distance of each key in the keyboard is calculated and stored in `key_travel` list. It does not change with the swapping of the characters
- After each swap, we calculate the total travel distance of the new layout
- This is done by `calc_total_travel` function by multiplying the frequency of a character (stored in `char_freq`) with the travel of its current key (stored in `key_travel`) for each key and summing up

Updating layout

- If the new total travel is less the the previous total travel then the layout is updated
- else we proceed with the previous layout
- We also calculate a probability `p` using he current and previous travels
- With probability `p` the layout is updated regardless of wether the travel distance is better or not
- The probaility `p` is decreased with iterations with a factor `cooling_rate`

After performing the specified number of iterations, the optimized order is obtained

Animation

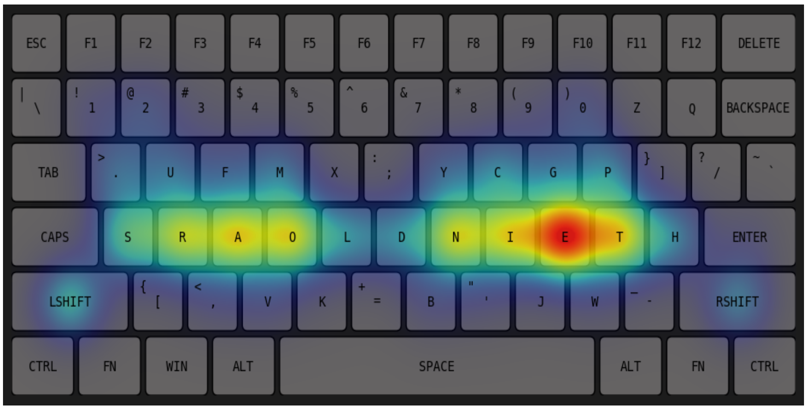
- Animation is done using matplotlib's `funcAnimation`.
- Same structure as given by sir is used
- The interval is such that the total time for animation is 10 seconds irrespective of the number of iterations
- the run function has an `animate` parameter which toggles the animation display
- Animation can be rendered till 600 iterations but not more that that

Saving

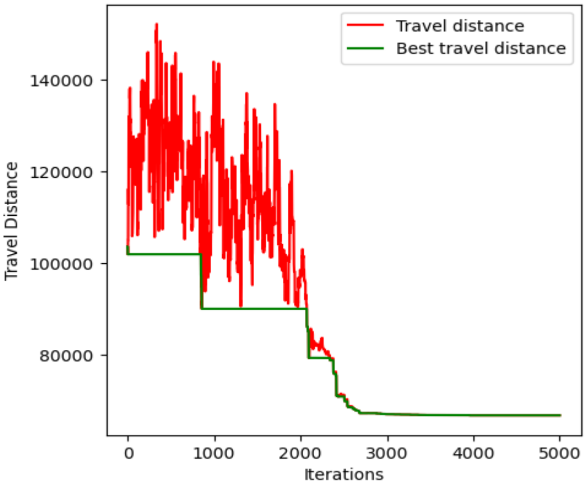
- the optimized keyboard can be saved into a text file for later use using the `

Output

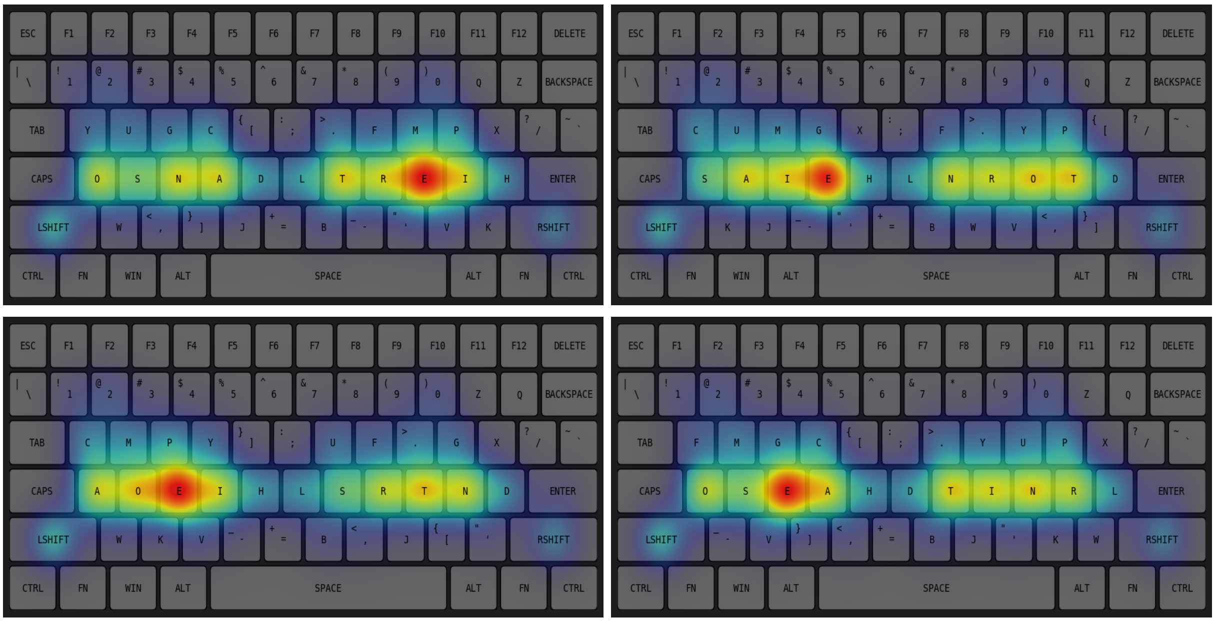
I trained on a large dataset(`string.txt`) with **1,00,000 characters** for **10,000** iterations and obtained the following optimized layout



- It is apparent that the high frequency keys are place in the home row for minimizing the travel distance
- The graph of travel distance while performing annealing is as follows



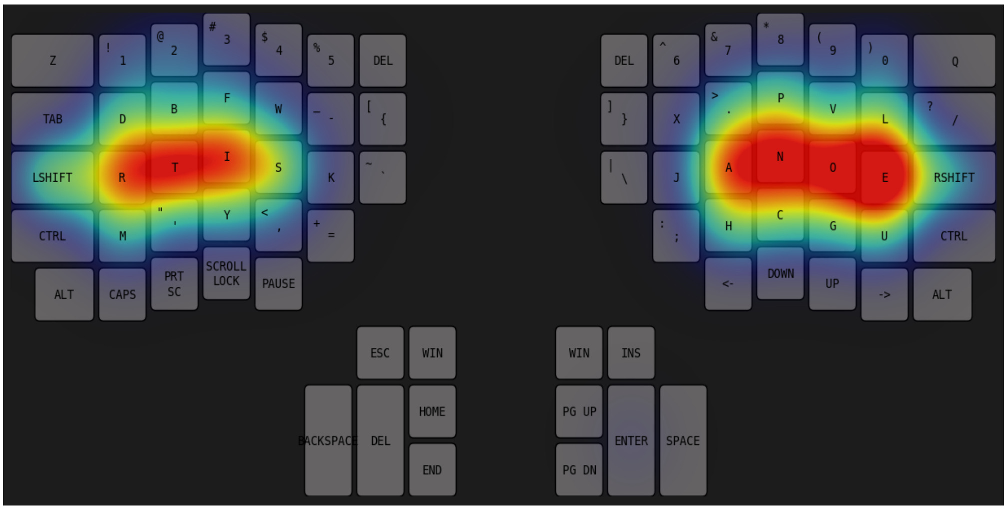
- The layout of the above keyboard is stored as `'best_layout'` in **layouts.py**
- The travel distance reduced from 10.3k to 66.8k, that is by **35%**
- On running the annealing multiple times, similar layouts are obtained, meaning the layout is as optimized as it can be



- Also the decrease in total travel distance is lesser when starting from dvorak and least when starting from colemak, again proving that they are better layouts

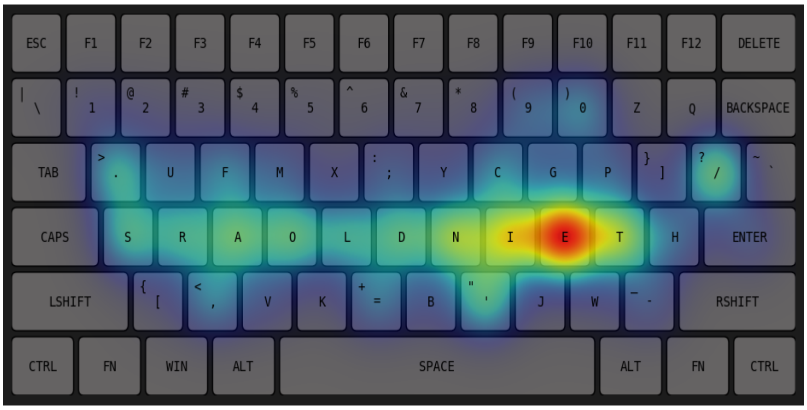
Ergodox layout

On doing the same procedure for ergodox architecture, the following layout si obtained for the same text



Programmer keyboard

- Here I considered numerical keys along with the character and punctuaion keys
- This is layout is suitable for programmers
- I trained it with text from several programming languages saved in `programming_string.txt`



Files Submitted

```
zip file
    /~ layouts.py - contains the layouts of the keyboards
    /~ ee23b016.ipynb -  contains the ython script
    /~ string.txt - data for training
    /~ programming.txt - data for training programming layout
    /~ README.md
```