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| Keyboard Optimization with Genetic Algorithm Author  School of Computing, KAIST |
| **Abstract** | |

**I. Introduction**

Nowadays, most people use "QWERTY" keyboard. However, current keyboard is not designed with considering typing sequence. For fast typing, it needs two condition. First condition is that to minimize the movement of the finger. When using the keyboard, humans' finger always locate middle line of keyboard. It means that, if users typing a sentence without moving finger on middle line, user can type fast. Second condition is that to use left hand and right hand alternately.

Figure 1 represents that comparing Dvorak keyboard with QWERTY keyboard. Dvorak keyboard is well known as faster keyboard than QWERTY keyboard. Dvorak keyboard satisfies two conditions which we mentioned above. First, frequently used alphabets locate middle line of keyboard. Alphabets which locate middle line of Dvorak keyboard use 70% English documents but alphabets which locate middle line of QWERTY keyboard use only 32% English documents. Also, all vowels locate left side of Dvorak keyboard therefore Dvorak keyboard has high potential to use left hand and right hand alternately because almost English words combine consonant, vowel, consonant, vowel… order.

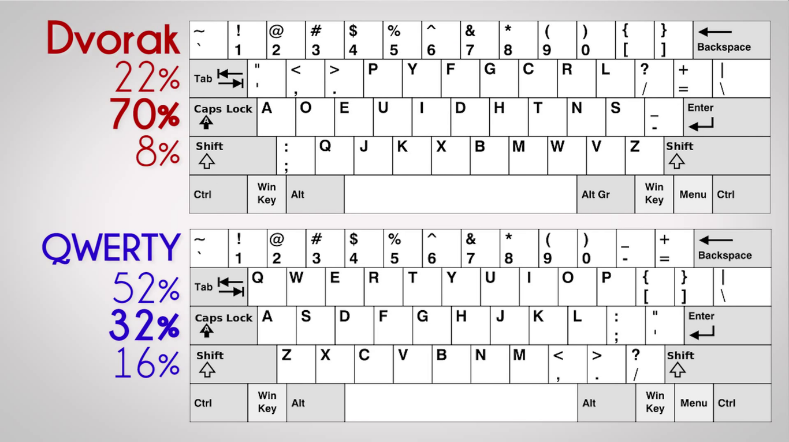


Figure 1. Compare Dvorak with QWERTY

The goal of this project is that to create optimizing keyboard layout using genetic algorithm. We use the Corpus of Contemporary American English (COCA) to optimizing target. We find the best keyboard layout when u9ser typing the COCA.

The contributions of our project are as follow:

1. Our method can apply different situation. We find the best layout for COCA but some people want find the best keyboard layout for writing paper. So, people can find the best keyboard layout that they want.
2. We use Voronoi diagram to make keyboard layout. We do not assume the best shape of keyboard buttons are square. We use Voronoi diagram to fine the best shape of keyboard buttons.
3. We implement crossover technique to apply keyboard layout. There are too many conditions to use crossover generally. So, we implement crossover technique to use keyboard layout.
4. We makes fit function to consider various situation. We consider kind on finger, area of keyboard and distance of finger movement with fitts law. We explain our fit function section 3.

The remainder of this paper is organized as follows. Section II explains background of our project such as Voronoi diagram and fitts law. Section III shows our fit function. Section IV shows our genetic algorithm, crossover and mutation method. Section V shows results our project and Section VI is discussion and conclusion.

**II. Background**

In this section, we explain Voronoi diagram and fitts law.

**II.I Voronoi Diagram**

**II.II Fitt’s law**

As long as our project is about optimizing keyboard layout, we need to evaluate our keyboard by using HCI(Human Computer Interaction) method. Fitt’s Law is a predictive model of human movement primarily used in HCI field. This is a metric to quantify the difficulty of target task, it predict the time that required to move and hit a target by function of distance and width of target object. Following formula is based on the Fitt’s Law.

* MT is the average time to complete the movement
* a and b are constants that depend on the environment, so usually these are determined empirically by regression
* D is distance between target and starting point
* W is width of the target object

This law imply that when the target gets bigger and closer, required time to hit the target object decrease, which means it gets faster. For example in case of QWERTY and Dvorak, QWERTY keyboard is slower than Dvorak because the default location of our finger is middle line (asdf…), but many of most frequent characters such like e,r,t,o is located far from the starting point. But in case of Dvorak, most of frequent words are located on the middle line, so it is faster than QWERTY keyboard.

 In this way, we can measure the usability of the physical UI that is for touching or pointing a target object by using limbs such as finger or pointing device.

**III. Fitness function**

1.

According to Fitt’s function, small size of key affect to usability of the key board. When the key gets too small, the operation speed get slower. In other word, bigger key get better usability. And in the case of keyboard, every finger has their own activity region so we can apply the Fitt’s law onto each finger.

So when the size of key gets smaller, it gets a penalty and at the and, loss function is calculated by weighted sum with considering frequency of character.

2.

One of the reason why Dvorak is faster than Qwerty is that Dvorak has better hand distribution with considering the sequence of word.

When we compare the standard Korean keyboard and English keyboard, Korean keyboard is faster than English keyboard because of the property of the language. In the case of English, there should be some word that has bad hand distribution such like ‘stewardesses’. But in case of Korean language, every character has a concrete structure that constants comes first and the following character should be a vowel. Which means there is a specific sequence of character, Constant-Vowel-Constant, so many sequences like ‘ㅍㅍ’ or ‘ㅏㅏ’ has 0 frequency in Korean language. Because of this property, we can evenly distribute the pressure to the hand, so it gets better and faster keyboard than English.

We got the sequence data by analyzing the general American English corpus ‘COCA’. Following loss function consider the frequency of every sequences and give a penalty to the sequence that has a bad hand distribution. When the sequence use different side of hand (in case of qwerty, such like ‘ao’, ‘me’) it is a best case so it gets 0 penalty. And when it use same side of hand but different finger, it gets 0.5 penalty. When it use same finger, in this case the operation is a bit different with other cases.

In other cases, we can press second key while holding the first key. (User usually press 2 or 3 key in the same time when they type) But when we use same finger, in order to press second key we should take off the finger from the first key and move the finger and hit the second key. So in this case, the sequence of the same key like ‘aaaaa’ is the fastest, and the sequence of the character that are far from each other such like ‘qzqzqz’ is worst. So it gets penalty from 0.5 to 1 with considering Fitt’s law.

3.

Corpus (sequence and frequency)

Distance from finger

Left / Right hand

**IV. Algorithm**

**(짧게나마 pseudo-code를 넣어도 괜찮을 듯)**

**IV.I Crossover**

**IV.II Mutation**

**V. Result**

**VI. Discussion and Conclusion**

References