Increasing QWERTY Efficiency with Predictive Color Cues

Mason D'Arcy,
Sachin Khargie,
Kai Xu

Dept. of Electrical Engineering and Computer Science
York University
Toronto, Ontario, Canada M3J 1P3
masond@my.yorku.ca
sachin.khargie@gmail.com
kevxu@my.yorku.ca

ABSTRACT

This paper analyses an innovation within the soft keyboard ecosystem. It takes the traditional predictive text system used in many soft keyboards found on both iOS and Android, and merges it with the soft keyboard UI itself. In order to determine its effectiveness, trials are done with 5 participants. Each testing in different groups speed and accuracy when using the new predictive element integrated into the soft keyboard UI.

Keywords

Soft keyboard, predictive keys, QWERTY, android, typing speed, typing accuracy, color cues

INTRODUCTION

The QWERTY keyboard layout was designed over a century ago with little thought towards the efficiency of text input. The layout of QWERTY was determined to prevent jamming in typewriters. Typewriter keys were placed far apart if they were commonly typed in sequence. [7] In spite of not being designed for speed, QWERTY became recognized in 1971 by the International Standards Organization. It is largely perceived as the de facto standard keyboard layout for computer interfaces, and dominates hard and soft keyboards to this day. [8]

There have been successful attempts to create a more efficient keyboard layout than QWERTY. For example, Norman and Fisher [7] showed the Dvorak keyboard layout has approximately a 5% advantage in performance over QWERTY for expert users. Zhai et al. [10] confirmed the CHUBON, FITALY, and OPTI keyboards outperform QWERTY. With respect to learning, alphabetically organized keyboards have an initial advantage over non-alphabetically organized keyboards for novices. [7] Alphabetically organized keyboards become similar in efficiency to non-alphabetically organized keyboards as the typist becomes proficient. [7]

Although some keyboards layouts have been shown to outperform QWERTY, it has yet to be dethroned. Thus, the industry is stuck with QWERTY and the bottleneck of user text-input in computer interfaces. The number of devices and users inputting text has massively increased in recent years, making finding methods of faster text input an important area of focus and interest. To increase throughput, there have been a slew of features, tools, and augmentations created to enhance or be used in tandem with QWERTY.

One of the major tools to increase text-entry speeds and accuracy has been predictive systems. [3] These systems are varied and widely used, enabled as a default setting in many desktop, iOS, and Android environments. [3] Many modern soft keyboards have an interface component called a "suggestion bar" where either fully completed words, corrected spellings, or phrases are suggested. [3]

While the suggestion component is useful for efficiency, Arnold et al. [3] suggests that these kinds of predictive systems have an effect on the content that users write. Predictive text suggestions are taken as queues, and may cause users to write short, predictable language. [3] Most experiments regarding these systems only focus on words per minute and accuracy using transcription studies. The effect on the content that users write is not studied, only the speed and accuracy of their input. [3] One idea to avoid this issue, while still leveraging the power of a predictive system, would be to integrate the suggestion component directly into a soft keyboard itself. Since QWERTY is dominant, it seems a fitting candidate for the layout choice.

A method to integrate the suggestion component into a soft keyboard is by dynamically mutating attributes of each key. Instead of a discrete phrase completion component, each key will change color on a spectrum between red and green. This color change would be a function of how likely a key is to be the next candidate of being pressed. Using a natural language processing model, a prototype will map the probability of each letter to a hexadecimal color value in order to aid a user.

The predictive color strategy is meant to improve the accuracy and text input speed of users on a QWERTY soft keyboard, without polluting the content of what the user is inputting. Thus, a comparison will be drawn between a regular QWERTY soft keyboard, and a QWERTY soft keyboard with dynamic coloring. The study will focus on amateur typists, who may stand to benefit more significantly from the feature. The related work section describes studies focusing on similar techniques and tools meant to increase user text input speed. The method section gives an overview of the predicting coloring apparatus, procedure, and participants.

Related Work

Magnien and Vigouroux [6] conducted a study with soft keyboards that uses visual clues such as highlighting keys with a bold font. Twelve subjects were asked to enter lists of words as quickly and accurately as possible. Different keyboard layouts were used such as AZERTY and one similar to METROPOLIS. They found that by highlighting the next likely keys that may be pressed, it increased text-input speed for amateur typists. [6]

Another innovation in soft keyboard features includes dynamic key resizing, as opposed to key recoloring. Gunawardana et al. [5] developed an algorithm which dynamically resizes the hidden target space of soft keyboard keys as a function of probability. The hidden geometry of the layout is also modified. A predictive component and algorithm determines the both the resizing amount and change in layout geometry, which was shown to increase the accuracy of soft keyboard inputs for users. [5] There are many studies that have explored key target resizing, however they often can be frustrating for users if the resizing is too aggressive. [5] A similar issue could arise with predictive coloring of the keys. A user may be typing a word that the predictive model is unfamiliar with, making it difficult to find the correct next letter that would be darkly colored red.

Al Faraj and Vigouroux. [1] created an apparatus that dynamically increased the size of the keys on a soft keyboard, as opposed to just modifying the key-target space. This apparatus used a QWERTY keyboard as the layout for the participants. [1] It was shown that not only were users more accurate, but they also had higher typing speeds. [1]

Pandey et al. [9] created a system for creating numerical suggestions in the suggestion bar of soft keyboards. Deep learning algorithms are used to predict numerical data using information from text messages [9]. For example, if the content of a text concerns different food prices, price suggestions for food will pop up in a suggestion bar component. [9]. Another example would be the distance from one destination to another [9]. If the conversation is about how far Algonquin Park is, the system will try to accurately predict how far your current location is to Algonquin Park and display that information in the bar above the soft keyboard [9].

Alharbi et al. [2] demonstrated that error correction in mobile communication is difficult to regulate [2]. Predictive keyboards offer solutions to reducing errors, but also negatively affect speed, perception and the quality of spelling [2]. Constant change of user focus between keyboard keys and the suggestion bar is a primary drawback of the suggestion bar component. [2]

Gong et al. [4] designed an improved Multitap text entry system called PNLH. PNLH mainly has two features: next-letter highlighting and next-letter prediction. [4] PNLH will make predictions based on what the user has entered and highlight the three most likely next letters. [4] Experiments prove that PNLH has faster input speed and better accuracy than traditional predictive keyboards. [4] As the number of experiments increases, this difference will be enlarged. [4]

METHOD

Participants

Six volunteer participants were provided by each group member collectively. Participants will be a roughly equal mix of male and female, but their ages have yet to be determined. Ideally we would like to focus on novice soft keyboard users.

The data gathered from the participants will be stored in an SD2 file, the initials of the volunteers will be used to mark each set of data.

Apparatus

Predictive Key Coloring aims to innovate on already existing predictive keyboard elements. Many predictive keyboards on Android devices display text suggestions in a dedicated GUI component. *Predictive Key Coloring* integrates predictive suggestions into the keys of the layout. For example, a user begins to type the word "brown". Upon pressing the "B" key, the predictive model scans a dictionary and extracts probabilities for each potential next keystroke. Then, letter probabilities will be mapped to a spectrum of color between red and green. Each key will have its view color mutated as a function of its likelihood. Android studio will be used for development, and participants will be tested on *SamSung Galaxy S10*s.

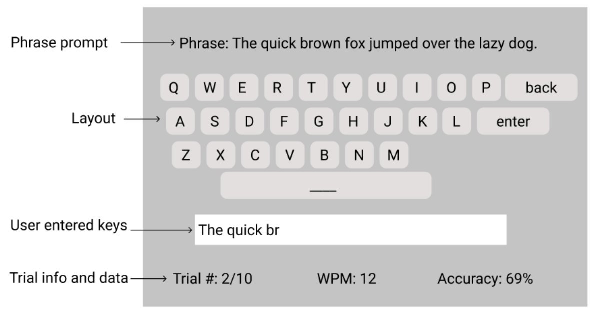


Figure 1. Mockup of a regular QWERTY soft keyboard in our test application.

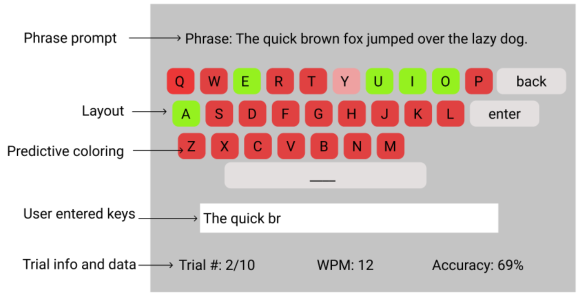


Figure 2. Mockup of a QWERTY soft keyboard in our test application with predictive coloring.

Procedure

Predictive Key Coloring, will test both speed and accuracy. When testing speed and accuracy, users will be assigned phrases to type. When the user starts typing, the app will actively track both speed and accuracy. Obtaining this data is vital, since it shows whether or not *Predictive Key Coloring* is too complex, or it is working as intended.

Design

The user study will employ a 1 × 3 within-subjects design.

There is one independent variable, the soft QWERTY keyboard, with three levels

- Red-green color cue spectrum
- Green color cues only (no negative color information)
- No color cues

The dependent variables will be time per trial and error rate.

In order to counterbalance the order of testing and offset learning effects, participants will be divided into six groups with one participant in each group. The groups will respectively try each of the three different keyboards, but in different orders. Thus, each permutation will be tried.

Each keyboard session will be composed of typing in five phrases.

RESULTS AND DISCUSSION

The results for *Predictive Key Colouring* suggest that users preferred a keyboard which did assist them but did not have such a busy UI. For example, the Green Red keyboard variant had the second best results with 95.7% accuracy. While the Green Only keyboard scoring 97.7% in accuracy.

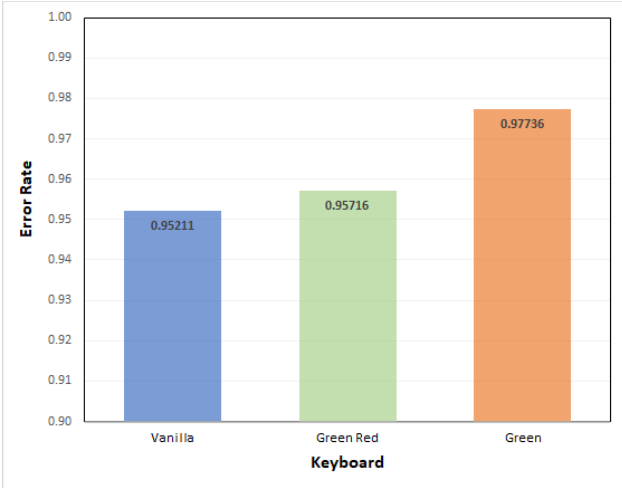


Figure 3. Graph which indicates error rate for all three keyboards

Participants who used the Green Only keyboard also said that it was less distracting than the Green Red. The Red would sometimes distract them, or error rate would increase due to users pressing red buttons over the green buttons.

CONCLUSION

Soft Keyboards are essential to any smartphone or smart device. Without them, users would not be able to navigate or type anything into the OS or in Apps such as Instagram, Google etc. Shortly after the creation of softkeyboards, predictive elements were implemented into iOS and Android softkeyboards; the algorithm would display the words which it thinks the user may type in on the top of the soft keyboard UI. However, ever since the creation of this algorithm, there has not been much innovation. The goal with *Predictive Colour Cues* was to innovate on that very same algorithm, but instead of displaying the information on top of the soft keyboard UI; it is integrated as part of the keys which the users types with.

The way in which the predictive algorithm was integrated into the soft keyboard is through the use of colour changing keys. Letters that the algorithm thought the user was going to click next would turn green, letters that the algorithm did not think the user would click would turn red. The colour strength would change based on how high the probability was for that specific key to be clicked. The trials tested three different types of keyboards. One was without any predictive element, this was called the “vanilla keyboard”. One showed both the keys which were used and which were not, this was called the “green red keyboard”. Lastly, there was one which only showed the keys which the algorithm deemed were potentially going to be clicked, this was called the “green only keyboard”.

After the trials had been conducted; there were some interesting findings within the data. Users preferred the keyboard which only showed the green keys, rather than showing both green and red. From the data and from user testimonies, it was more efficient and had less visual noise, when compared to the green and red keyboard. The keyboard without any predictive element had a good reception, but overall, the green only keyboard was the choice for all the participants.

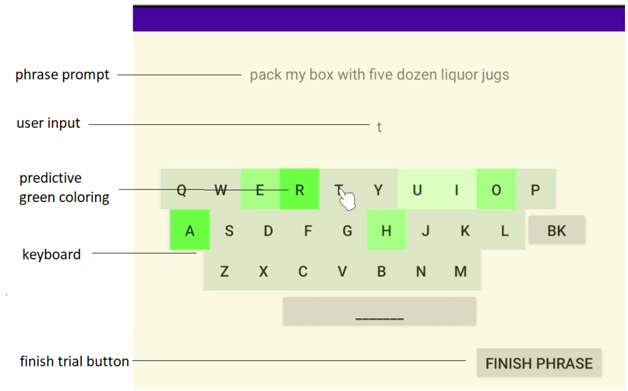
The aim for *Predictive Colour Cues* was to try and innovate on an already existing concept. The trials helped show what was efficient and what was not. It is an indicator of where improvements can be made. Hopefully in the future, the *Predictive Colour Cues* could be the new standard in texting on soft keyboards.

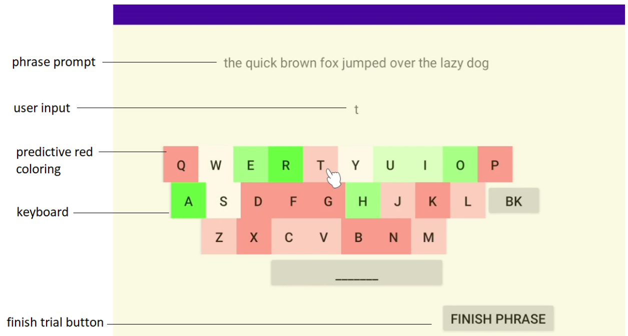
ACKNOWLEDGMENT

To Professor Scott Mackenzie and TA Saurabh Garg for helping us learn about developing on Android.

REFERENCES

1. Al Faraj, M., and Vigouroux, N., A virtual keyboard for mobile devices. *Proceedings of the 13th International Conference on Human-Computer Interaction - MobileHCI 2011*, (New York: ACM, 2011), 3-10
2. Alharbi, O., Stuerzlinger, W., and Putze, F., (2020, November). The Effects of Predictive Features of Mobile Keyboards on Text Entry Speed and Errors. *Proceedings of the ACM on Human Computer Interaction*, (New York: ACM, 2020) 4(183), 1-16. https://doi.org/10.1145/3427311
3. Arnold, K., Chauncey, K., and Gajos, K., Predictive Text Encourages Predictable Writing, *Proceedings of the 2th International Conference on intelligent user interfaces - IUI 2020*, (New York: ACM, 2020), 128-138.
4. Gong, J., Haggerty, B., and Tarasewich, P., An enhanced multitap text entry method with predictive next-letter highlighting. *Extended Abstracts Proceedings of the 2005 Conference on Human Factors in Computing Systems - CHI 2005*, (New York: ACM, 2005), 1399-1402.
5. Gunawardana, A., Paek, T., and Meek, C., Usability guided key-target resizing for soft keyboards. *Proceedings of the 15th International Conference on intelligent user interfaces - IUI 2010,* (New York: ACM, 2010), 111-118.
6. Magnien, L., and Vigouroux, N., Mobile text input with soft keyboards: optimization by means of visual clues. *Proceedings of the 6th International Symposium of Mobile Human-Computer Interaction - MobileHCI 2004*, (New York: ACM, 2004), 197-218.
7. Norman, D., and Fisher, D., Why Alphabetic Keyboards Are Not Easy to Use: Keyboard Layout Doesn’t Much Matter. *Human Factors*, (1984, January), 509-519.
8. Noyes, J., The QWERTY Keyboard: A Review. International Journal of Man-Machine Studies, (1983), 265-281.
9. Pandey, L., Alizadeh, A., and Arif, A. S., Enabling Predictive Number Entry and Editing on Touchscreen - Based Mobile Devices. *Proceedings of the 2020 Conference on Human Information Interaction and Retrieval - CHIIR 2020*, (New York: ACM, 2020), 13-22.
10. Zhai, S., Hunter, M., and Smith, B., The Metropolis Keyboard -- An Exploration of Quantitative Techniques for Virtual Keyboard Design, *Proceedings of the 13th annual symposium on User interface software and technology - UIST 2000*, (New York: ACM, 2000), 119-128.





Two screencaps from the prototype