In Search of Touch-Typing

Touchscreen Keyboards

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Who here can type faster on an iPad than a laptop?
Hypothetically Humid Conditions will make the bread rise more.

Materials:
- 6 to 7 cups all-purpose flour
- 3 tablespoons of sugar
- 1 tablespoon of salt
- 2 tablespoons of shortening
- 2 packages of regular or quick-acting active dry yeast
- 2 1/4 cups warm water
Touchscreen Typing Challenges

reduced tactile cues  no travel distance  unintended input
Advantage: Software-based

Keyboard layout can **dynamically adapt** to each user.
Can touchscreen text input be improved through **automatic personalization**?
Adaptation Using Language Models

This is not necessarily personalization

http://www.flickr.com/photos/horiavarlan/4268897748
Adaptation Using Language Models

Combine the two sources to adjust letter probabilities

[Goodman et al. 2002]

http://www.flickr.com/photos/horiavarlan/4268897748
OUR ADAPTIVE KEYBOARDS

Dimensions of adaptation

- Key-press classification model
- Visual representation
- Adaptation to location of hands
Key-Press Classification Model

Previous work on ten-finger typing used distance-to-centroid [Go & Endo 2007; Findlater et al. 2011]

Can we do better?
DIMENSION I: KEY-PRESS CLASSIFICATION MODEL

Touch Features Beyond (x,y)

Microsoft Surface
DIMENSION 1: KEY-PRESS CLASSIFICATION MODEL

Touch Features Beyond (x,y)

**DOWN**
- tip
- minor axis
- major axis
- center

**UP**
- tip
- center

**Other features**
- Location
- Area
- Movement
- Previous touch
- Hand & arm

**J48 decision tree classifier**
Adapt underlying model, but retain static visual layout. vs. Adapt model and visual representation.

Challenges with adaptive user interfaces: e.g., predictability
Predictability of “Aimed” Key Presses

One approach: Use center anchors [Gunawardana et al. 2010]

Our approach: Disable classifier after a backspace or when typing slower than 1 keystroke / second

Is the output predictable?
DIMENSION 3
Adapting to Location of Hands
Online Adaptation Process

1. Start state

2. Adapt key-press classification model as user types
   After 10+ strikes per key
   History per key: 100 strikes

3. Optionally, adapt visual layout
STUDY METHOD

Do the personalized keyboards improve performance and subjective experience compared to a conventional keyboard?

How does non-visual adaptation compare to visual adaptation?
Controlled lab study
Controlled lab study

Three keyboard conditions

Adaptive, non-visual
Adaptive, visual
Conventional (static)
Controlled lab study

Three keyboard conditions

Three 1.5-hour sessions per participant

3 x 3 within-subjects factorial design
Controlled lab study

Three keyboard conditions

Three 1.5-hour sessions per participant

Twelve participants

Touch-typists on physical keyboards
79.2 WPM (SD = 16.6)
0.2% (SD = 0.2) uncorrected errors

All had experience with touch devices
Controlled lab study
Three keyboard conditions
Three 1.5-hour sessions per participant
Twelve participants
Phrase transcription task
MacKenzie & Soukoreff (2003), plus pangrams
4500 total phrases entered
Controlled lab study

Three keyboard conditions

Three 1.5-hour sessions per participant

Twelve participants

Phrase transcription task
Controlled lab study
Three keyboard conditions
Three 1.5-hour sessions per participant
Twelve participants
Phrase transcription task

**Instructions**
Participants were not told which keyboards were adaptive, only that the keyboards may or may not adapt based on their typing patterns.
RESULTS
Layouts for Adaptive, Visual
Adaptive, Non-Visual (e.g., P7)

Shown to participant

Underlying adaptation

Adaptive, visual

More adaptation with visual portrayal

Not shown to participants
Speed (WPM)

Adaptive, non-visual was fastest (p < .05) 31.0 vs. 26.9 WPM for Conventional

Main learning effect across session (p < .05)

Error bars: 95% confidence intervals

(Uncorrected error rates near 0%)
Comments at End of Session 3

Adaptive, Visual

8/12 participants remarked negatively on the visual adaptation
“I felt I was constantly looking at my hands.” (P8)

“[Adaptive, visual] seemed easiest this time—as long as I didn’t look and see the odd spacing.” (P9 after session 3)

Adaptive, Non-Visual

Most participants preferred this keyboard but generally had trouble defining how it was different from Conventional
Summary

1 Adapt underlying model, but not visually...
   Improved typing speed over the conventional and visually adaptive keyboards
   Subjectively offered good performance but participants couldn't tell why

2 ...versus adapt model & visual
   Seemed to require more visual attention, but perceived to be comfortable and natural to use

3 Conventional keyboard (not adaptive)
A personalized key-press classification model improves ten-finger touchscreen typing performance

*How this personalization is visualized has a significant impact*
What’s next?

Further classifier exploration
Combining with language models
Gestures & mobile sensors

[CHI 2012: Findlater, Lee, Wobbrock]
[CHI 2012: Goel, Findlater, Wobbrock]
What can typing be like if we’re not constrained by a physical keyboard?
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