Optimization of Text Input

Anna Maria Feit, Aalto University, Helsinki

Anna Maria Feit
Doctoral student finishing early 2018
Optimization, Text entry, modeling, eye tracking,

Aalto University

annafeit.de
anna.feit@aalto.fi

Many HCI Problems are NP-Hard

New sensing technologies and computing devices offer exciting opportunities to design efficient and easy to use input methods but also increase the already large design spaces. For example, it is unclear how to best assign letters to hand gestures to efficiently enter text in mid-air. With just 32 different characters and gestures, the number of possible designs is:

$$32! > 10^{35} =$$
$$100{,}000{,}000{,}000{,}000{,}000{,}000{,}000{,}000{,}000{,}000$$

As a result, designers explore these design spaces only sparsely, for example by using elicitation studies or recreating existing methods with other modalities.

Benefits of Optimization

- Handle very large design spaces
- Efficiently search and evaluate designs
- Guarantees and bounds on goodness
- Quantitatively assess different trade-offs, design criteria and objectives
- Explore diverse alternatives
- Answer questions such as what is the one best thing to change

Formulation

Mathematical formulation of the design problem and space

$$\underset{K}{\operatorname{argmin}} \sum_{k \epsilon K} \sum_{l \epsilon K} C_K(k,l)$$

Challenges:
identification of design variables and constraints, computational generation of designs

Objectives

Modeling of evaluation criteria such as performance, ergonomics, learnability, intuitiveness, accessibility, or user experience

Challenges:
Combining multi-objective criteria in a cost function to efficiently evaluate designs.

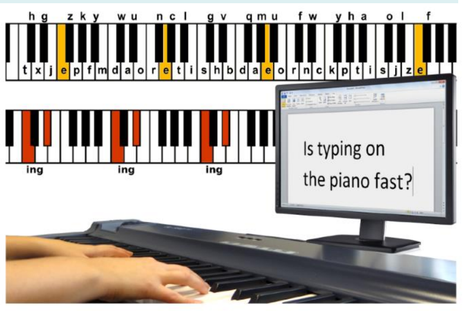
Optimization

Mathematical solver or approximation algorithm to efficiently and thoroughly search the design space

Challenges:
Search method that covers the full design space, dealing with noisy input data and contradiciting objectives

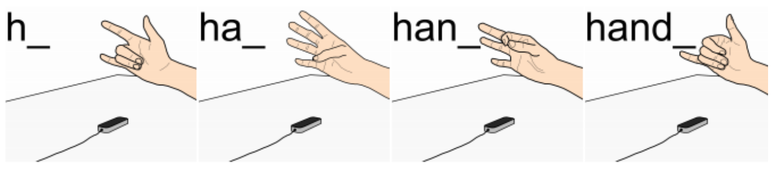
Pianotext: Optimal Transfer of Expertise

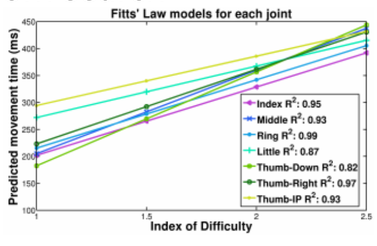
[Feit and Oulasvirta, DIS 14]
Optimal transfer of motor expertise in piano playing to text entry.
Formulation: quadratic assignment problem,
Objectives: speed and music similarity
Optimization: greedy approximation



Optimizing Mid-Air Gestures for Text Entry

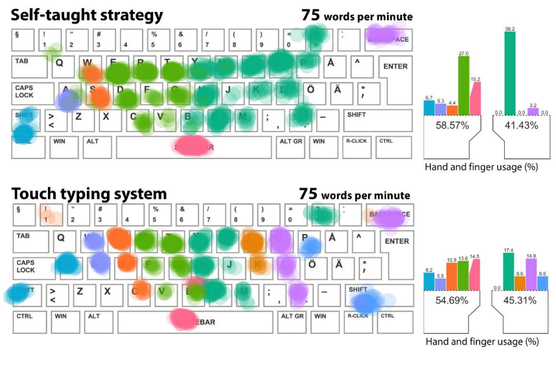
[Sridhar, Feit, Theobalt, and Oulasvirta, CHI 15]
Optimize hand gestures for text entry in mid-air, modeling performance and anatomcial constraints of finger gestures.
Formulation: quadratic assignment problem,
Objectives: speed, anatomical comfort, memorability, learnability
Optimization: approximation with multi-start random search





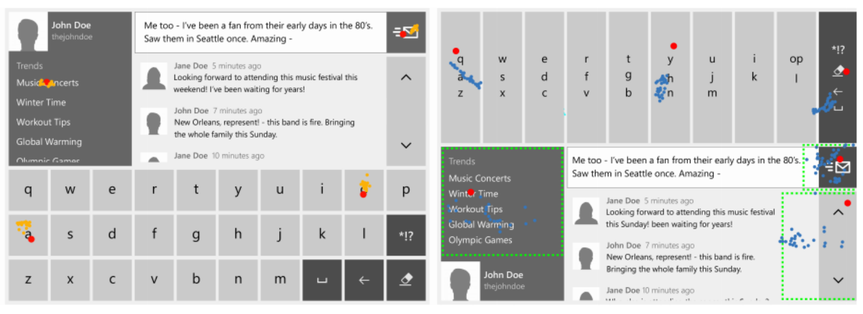
How We Type: Movement Strategies and Performance in Everyday Typing

[Feit, Weir, and Oulasvirta, CHI 16] + [Upcoming] Understand the factors that influence performance in everyday typing on physical keyboard in order to find the optimal input strategy to operate a physical keyboard.



Optimal Adaptation of Gaze Keyboard to Eye Tracking Quality

[Feit, Williams, Toledo et al. CHI 17] + [Upcoming]
Understand the extent of variations in eye tracking quality in order to design an adaptive gaze keyboard that minimizes the expected mistakes due to technical problems.



Optimizing Special Character Entry on the French Keyboard

[Upcoming]
A new, easy to learn standard for the French keyboard to facilitate typing correct French. Large, real-life problem with up to 122 characters.

Formulation: linear and quadratic assignment problem,
Objectives: speed, association, Azerty similarity, ergonomics
Optimization: Mathematical solver for Integer Programs