

Improving Target Selection on Touch Devices Using Statistical Principles

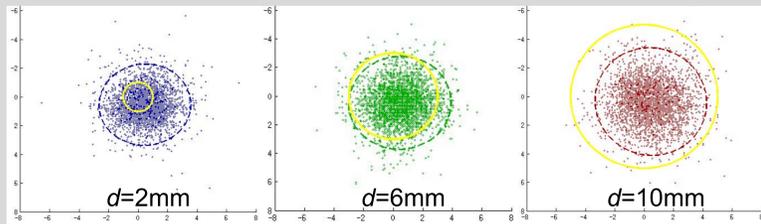
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Bayesian Touch Criterion

“Fat Finger” problem: the lack of precision when hitting small targets.



X. Bi, S. Zhai. Bayesian touch: a statistical criterion of target selection with finger touch. UIST '13

Bayesian Touch Criterion (BTC) improves the accuracy of touch input. For 2D circular targets:

$$BTD_s(s, t) = \frac{1}{2} \left[\frac{(s_x - c_x)^2}{0.0075d^2 + 1.68} + \frac{(s_y - c_y)^2}{0.0108d^2 + 1.33} \right]$$

Menu Item Probabilities

The menu usage follows a Zipfian distribution:

$$f(k; s, N) = \frac{1/k^s}{\sum_{n=1}^N (1/n^s)}$$

We learn the distribution by updating the probability of each target item dynamically.

The probabilities of each item are equal at the start,

$$\forall i, p_i = 1/n$$

and will change based on the number of times it was selected:

$$\forall i, p_i = t_i/t_t$$

W. Liu, G. Bailly, A. Howes. Effects of Frequency Distribution on Linear Menu Performance. CHI '17
A. Cockburn, C. Gutwin, and S. Greenberg. A predictive model of menu performance. CHI '07

Method

We propose to combine the Bayesian Touch Criterion and menu item probabilities to improve the accuracy for menu target selection.

Using Bayes' theorem, we can calculate the probability of a target t given a touch point s , where $P(t)$ is the menu item probability and $P(s|t)$ is given by the Bayesian touch distance.

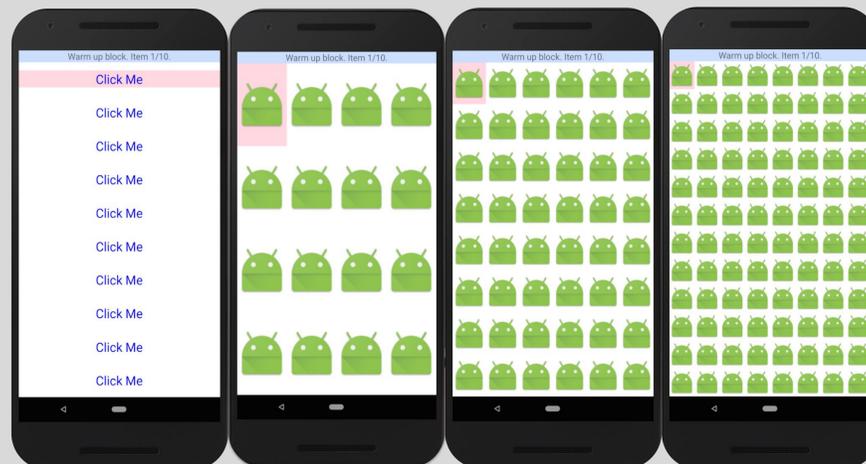
$$P(t|s) = \frac{P(t) \times P(s|t)}{P(s)}$$

Study Design

A within-subject user study.

Each participant will perform 40 item selection tasks with each of the four types of menus:

- 1D linear menu
- 2D grid menu with small, medium, or large targets.



Item Selection Task

A pink highlighted background will indicate which item is the intended target to the user.

Each time the user clicks an item, the coordinates of the touch point is recorded.

The coordinates will run through one of the two target selection algorithms to determine which item the user has selected.

- Proposed algorithm: the item with the highest probability is selected.
- Visual Boundary: an item is selected if and only if the touch point falls within its bounding box.

The intended targets are compared with the selected targets to calculate the overall error rate for each algorithm.

Expected Results

We expect the proposed algorithm will perform better than the Visual Boundary algorithm in determining the selected targets, especially for smaller targets.

We are also planning to derive the formula of the Bayesian Touch Criterion for older adults and different target shapes to improve the UI design for older adults.