# Tracing Temporal Changes of Selection Criteria from Gaze Information



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# Introduction

#### **Motivation**

Making decisions among alternatives is a fundamental part of people's daily lives. However, people sometimes only have a fuzzy understanding of their selection criteria (a set of some criteria for that decision).

We aim to trace the temporal changes of selection criteria from gaze information in order to design a concierge system that can assist users' decision making.

#### **Problem**

- 1. How to estimate users' selection criteria during a short period
- 2. How to decide appropriate window size for analysis

## Approach

Propose the multiscale exact test to detect users' distinctive browsing behavior by its significance level to users' neutral browsing behavior

# Multiscale exact test

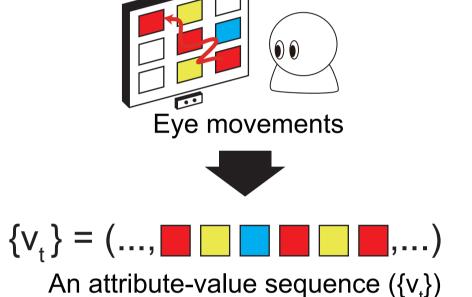
#### Situation:

A user is browsing a digital catalog on a screen

### Eye movements

Recoded gaze information is represented as a sequence of items (time *t* is decided by the transition of gaze targets)

⇒ An attribute-value sequence {v,} is obtained



## Users' neutral browsing behavior

We assume that users look at items randomly when they are in neutral browsing, they are not focusing on any specific criteria (attribute value).

The multinomial parameters, how the attribute value k is looked at can be represented as  $p_k = N_k / N$ .

N<sub>k</sub>: the number of items that have k N: the number of items on catalog The frequency distribution *x* in the neural browsing follows multinomial distribution

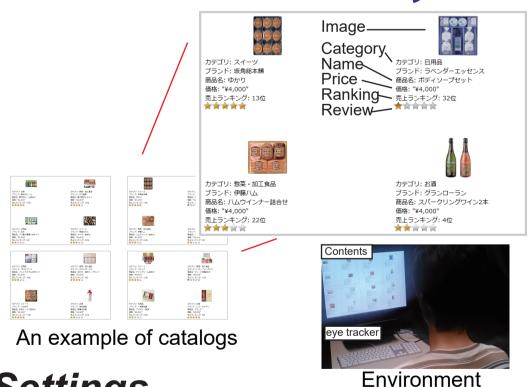
$$f(\boldsymbol{x}; n, \boldsymbol{p}) = n! \prod_{k=1}^{K} \frac{p_k^{x_k}}{x_k!}$$

x: frequency distribution, sum to np: multinomial parameter

#### p-value of multiscale exact test -Multiscale exact test $f(oldsymbol{\hat{x}};n,oldsymbol{p})$ $\hat{\boldsymbol{x}}:f(\hat{\boldsymbol{x}};n,\boldsymbol{p})\leq f(\boldsymbol{x}_{(n,t)};n,\boldsymbol{p})$ *~ n*:1 $\{v_t\} = (..., \blacksquare \blacksquare \blacksquare \blacksquare \blacksquare \blacksquare \blacksquare \blacksquare$ $0.01 < P_{(n,t)} \le 0.05$ time $P_{(n,t)} \leq 0.01$ p-values for each An attribute-value sequence ({v,}) frequency distribution are calculated ⇒ Distinctive periods Calculate frequency distributions n are detected by its significance level to neutral browsing frequency time p-values (P<sub>(n, t)</sub>) Calculate p-values Detect active criteria Active criteria are Frequency distributions $(x_{(n,t)})$ detected as specific attribute values in For each time *t*, frequency distinctive periods distributions with multiscale time are calculated

Traced selection criteria

# Preliminary experiments



#### Settings

- 16 items are displayed in each catalog
- Each item has four common attribute types
   Category, Price, Ranking, Review
- Participants selected an item based on given task
   Task: "Choose an item with the 4th category and more than 4-star review"
  - -- Three items were satisfied that specified task
- Items were grouped by their price (see above picture)

#### The participant first compared <u>items in same group (same price).</u> The participant first focused on Results Then the participant focused on "the 4th category", and compared items. "the 4th category" and compared items. $0.01 < P_{(n, t)} \leq 0.05$ Attribute value ID: Attribute value ID: 1 2 3 4 5 $P_{(n,t)} \leq 0.01$ $P_{(n,t)} \leq 0.01$ 2 3 4 5 Category Category Price Price Ranking Ranking Review Review p-values (P<sub>(n,t)</sub>) p-values (P<sub>(n,t)</sub>) Traced selection criteria Traced selection criteria

# Conclusion

We propose a method to detect users' distinctive browsing behavior by multiscale exact test so that proposed method can trace temporal changes of selection criteria.

## Future work

- Since the proposed method has some limitations because of several assumptions,
  - Each attribute type is categorical
  - Users browse content uniformly we will extend proposed model to consider ordinal variables and the effect of layouts.
- Apply the proposed method to interactive system that probes users' decision state by suggesting alternatives based on detected criteria.