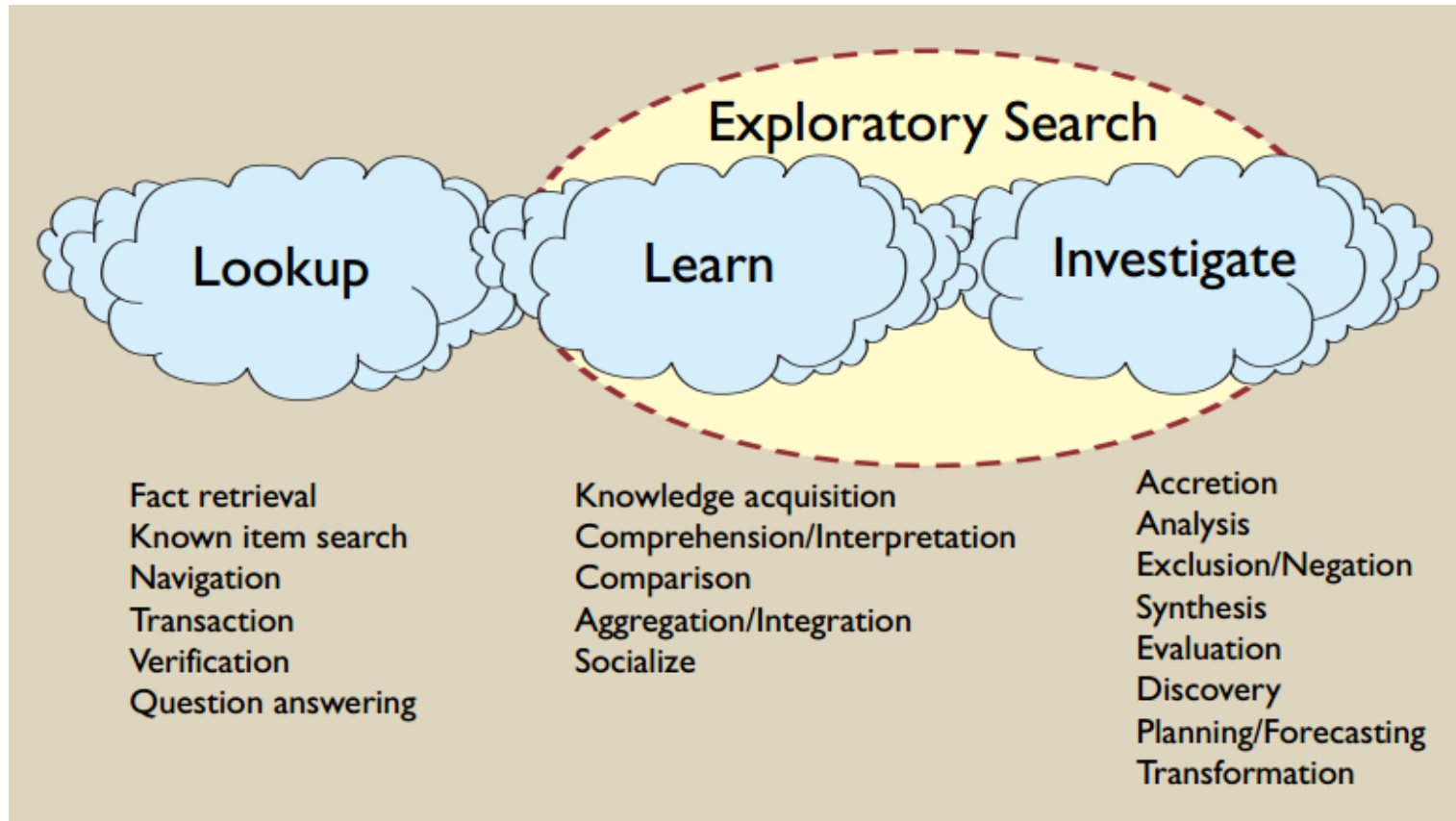


# **Towards Fine-grained Adaptation of Exploration/Exploitation in Information Retrieval**

Alan Medlar, Joel Pyykko, Dorota Glowacka

University of Helsinki

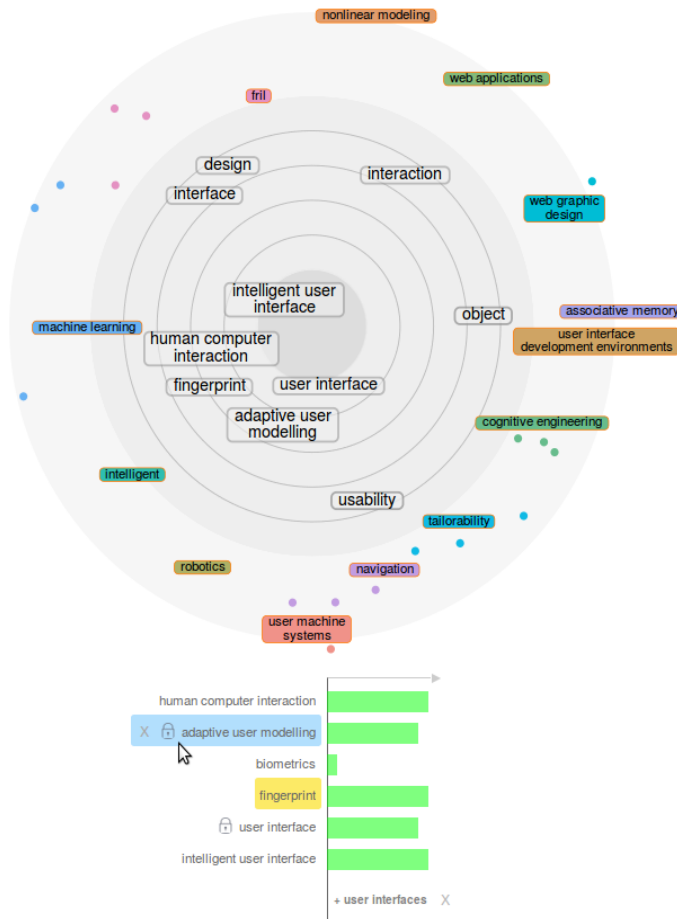
# Exploratory Search



G. Marchionini. Exploratory search: from finding to understanding. Comm. ACM, 49(4):41–46, 2006

# Complex Interface, Single Modes (IUI 2013, 2015, 2016)

HIIT SCINET



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**Human-machine interaction through an intelligent user interface based on Contention Architecture**

*A Agah, K Tanie* (RO-MAN '96 - 5TH IEEE INTERNATIONAL WORKSHOP ON ROBOT AND HUMAN COMMUNICATION, PROCEEDINGS, 1996-01-01T00:00:00)

human-machine interaction intelligent user interface human-computer interaction software agents graphical user interface agent user interface

A new approach to the utilization of intelligent control to the enhancement of an interface for huma...

**Research on interaction-modes of user interface and development trend**

*X Fang, L Fang, B Z Zhou* (APPLICATIONS OF DIGITAL TECHNIQUES IN INDUSTRIAL DESIGN ENGINEERING-CAID&CD' 2005, 2005-01-01T00:00:00)

human-computer interface user interface interaction style speech recognition virtual multimodal interface interaction design manipulator multimodal user interface human-computer interaction multimedia computer interface

In the past half century, the human-computer interface style has gone through command language interface, direct manipulation interface, Graphics User Interface, multimedia user interface, etc. main stage and is progressing in the direction of virtual reality and multimodal user interface at present. What's more, someone predicts that the automatic speech recognition technology can change the key fields of technology in the future. This text sketches several kinds of commonly used human-computer interaction forms, probes into the design principles of ideal human-computer interface, and looks forward to the human-computer interaction in the future.

**Single robot - Multiple human interaction via intelligent user interfaces**

*S Kumar, A Sekmen* (KNOWLEDGE-BASED SYSTEMS, 2008-01-01T00:00:00)

human-robot interaction mobile robots navigation graphical user interface intelligent user interface robotics interface interaction design learning user interface adaptivity

This project addresses some research issues concerning design of intelligent user interfaces for imp...

**Fingerprint identification for enhanced user interface and for secure internet services**

*K Uchida* (IEICE TRANSACTIONS ON INFORMATION AND SYSTEMS, 2001-01-01T00:00:00)

biometrics fingerprint user interface networked services interface interaction object human-machine interaction

This paper discusses an application of fingerprint identification technology to enhanced human-machine interaction, and also to information systems, specifically to a mobile authentication terminal for secure networked services and to digital appliances. A "Fingerprint User Interface (FpUI)," exploits information regarding not only who put a finger oil its sensor but which specific finger it was. With this user-friendly interface, a user can assign commands, data objects, status, or personalized settings to individual fingers. A functional architecture for a mobile authentication terminal, "Pocket-PID," with fingerprint identification capability is proposed which features: an easy-to-use FpUI and high security, where the identification function is totally enclosed within the unit. This enables a user's identity authenticated without any possibility of actual fingerprint data. being disclosed. The rocket-PID facilitates implementation of networked services based on secure biometric user identification.

# Problem Definition

- Specialised interfaces to support exploratory search are often not ideal for lookup tasks.
- Users need to know in advance that they will conduct an exploratory search.
- Users need to switch between systems based on task type.
- Research shows that users prefer the simple interfaces used to support lookup tasks.

# Simple Interface, Multiple Modes (IUI 2016)

× machine learning classification search results

Next →

## A Brief Review of Data Mining Application Involving Protein Sequence Classification

Authors: Suprativ Saha, Rituparna Chaki Venue: arXiv

Data mining techniques have been used by researchers for analyzing protein sequences. In protein analysis, especially in protein sequence classification, selection of feature is most important.

## New Sequence Sets with Zero-Correlation Zone

Authors: Xiangyong Zeng, Lei Hu, Qingchong Liu Venue: arXiv

A method for constructing sets of sequences with zero-correlation zone (ZCZ sequences) and sequence sets with low cross correlation is proposed. The method is to use families of short

## Approximation of Classification and Measures of Uncertainty in Rough Set on Two Universal Sets

Authors: B. K. Tripathy, D. P. Acharjya Venue: arXiv

The notion of rough set captures indiscernibility of elements in a set. But, in many real life situations, an information system establishes the relation between different universes. This gave the

## Comparing Pattern Recognition Feature Sets for Sorting Triples in the FIRST Database

Authors: D. D. Proctor Venue: arXiv

Pattern recognition techniques have been used with increasing success for coping with the tremendous amounts of data being generated by automated surveys. Usually this process involves

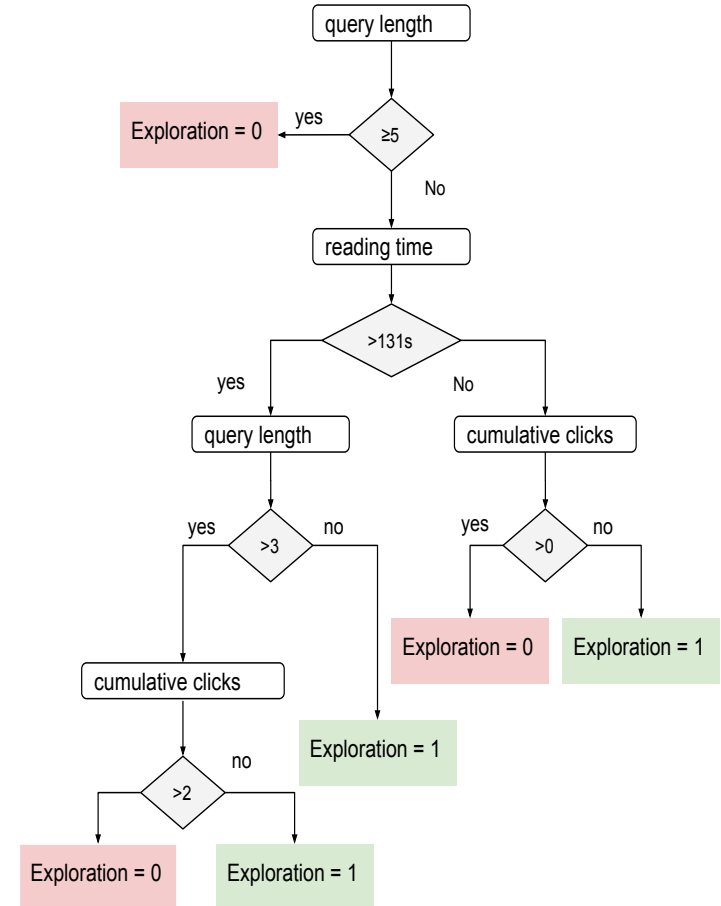
## The dependence of the abstract boundary classification on a set of curves I: An algebra of sets on bounded parameter property satisfying sets of curves

Authors: B. E. Whale Venue: arXiv

## Remarks on small sets related to trigonometric series

Authors: Tomek Bartoszynski, Marion Scheepers Venue: arXiv

We show that several classes of sets, like  $N_0$ -sets, Arbault sets,  $N$ -sets and pseudo-Dirichlet sets are closed under adding sets of small size.



# Document Exploration

In each iteration  $t$ , LinRel calculates:

$$\mathbf{a}_i = \mathbf{x}_i \cdot \left( \mathbf{X}_t^T \mathbf{X}_t + \mu \mathbf{I} \right)^{-1} \mathbf{X}_t^T$$

for each document  $i$  in dataset and selects for presentation top  $n$  documents that maximize:

$$\arg \max_x \left\{ \mathbf{a}_i \cdot \mathbf{y}_t + \frac{c}{2} \|\mathbf{a}_i\| \right\}$$

for some constant  $c > 0$

# Adaptive Document Ranking

- To help the user to explore the document space, we use the LinRel algorithm (Auer 2002)
- The algorithm contains parameter *alpha* which controls how diverse the presented documents are: the higher the value of *alpha*, the more diverse the results.
- In our classifier-based system, if a search is classified as exploratory, the value of *alpha* = 1.
- For lookup tasks,  $\alpha = 0$ .

# This study

- Previous work used classifier to select between lookup and exploratory tasks
- Single exploration rate per task type, but are search types really discrete categories?
- Can we build a regression model instead of a classifier?

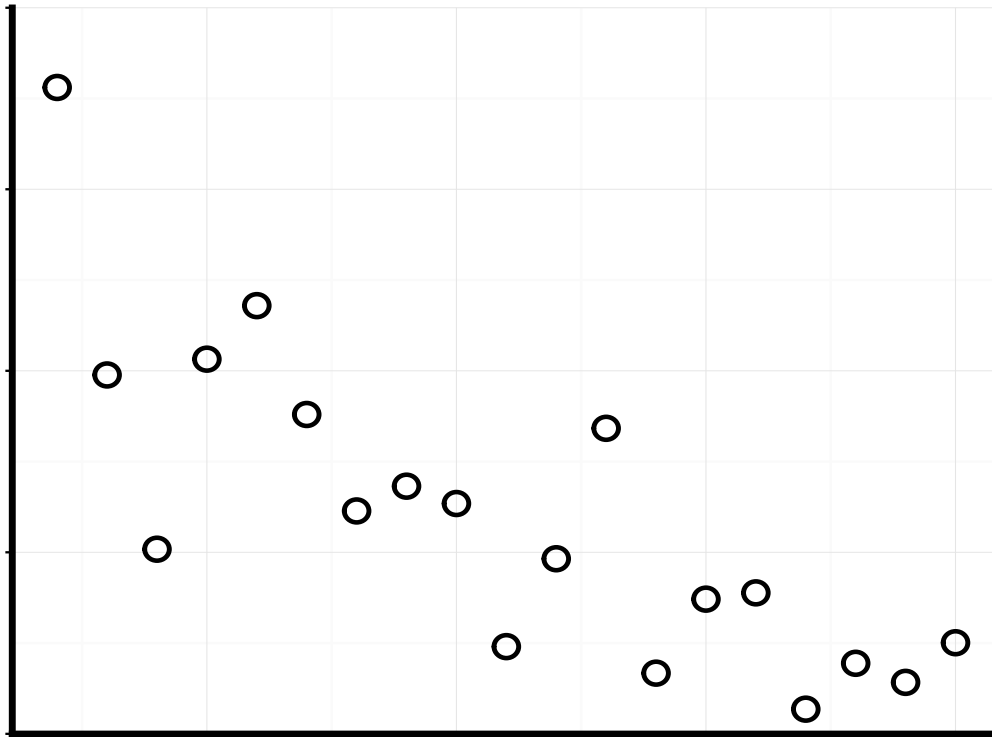


# Approach

- Ordinary regression fits a model based on linear relationships between response variable and exploratory values
- Problem: we don't know a priori optimal exploration rate for given user and can't observe their behaviour under these conditions.
- Solution: instead of using specific exploration rates as the response variable, we created censored intervals based on user feedback

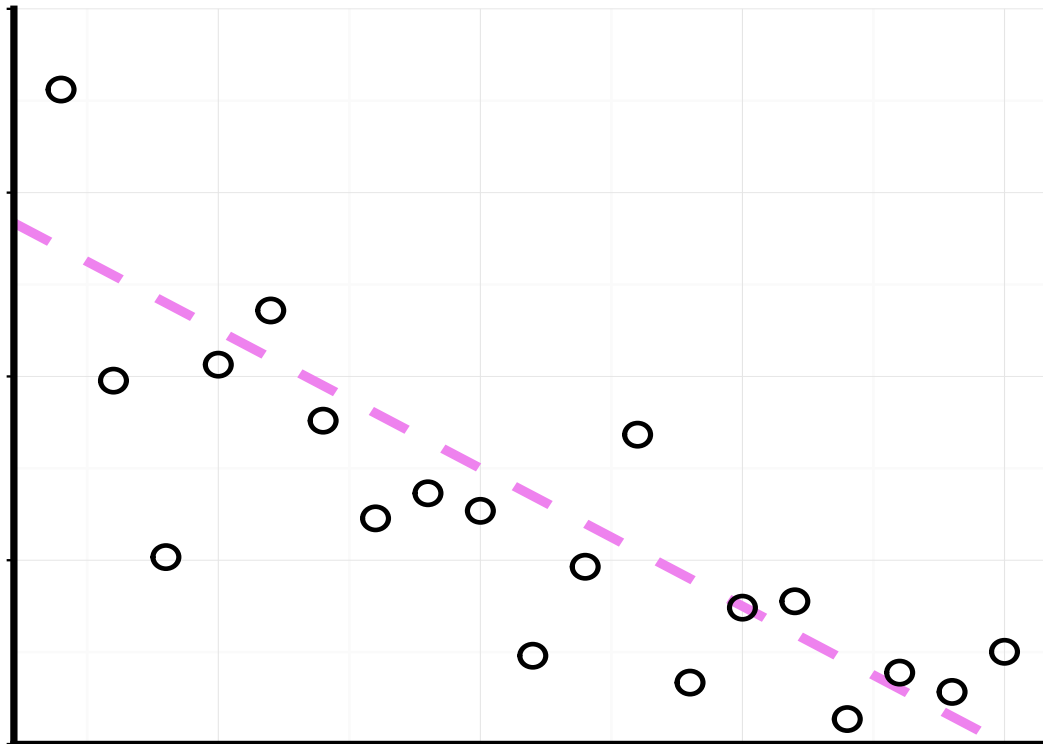
# Approach

Ordinary regression fits a model based on linear relationships between response variable and explanatory values



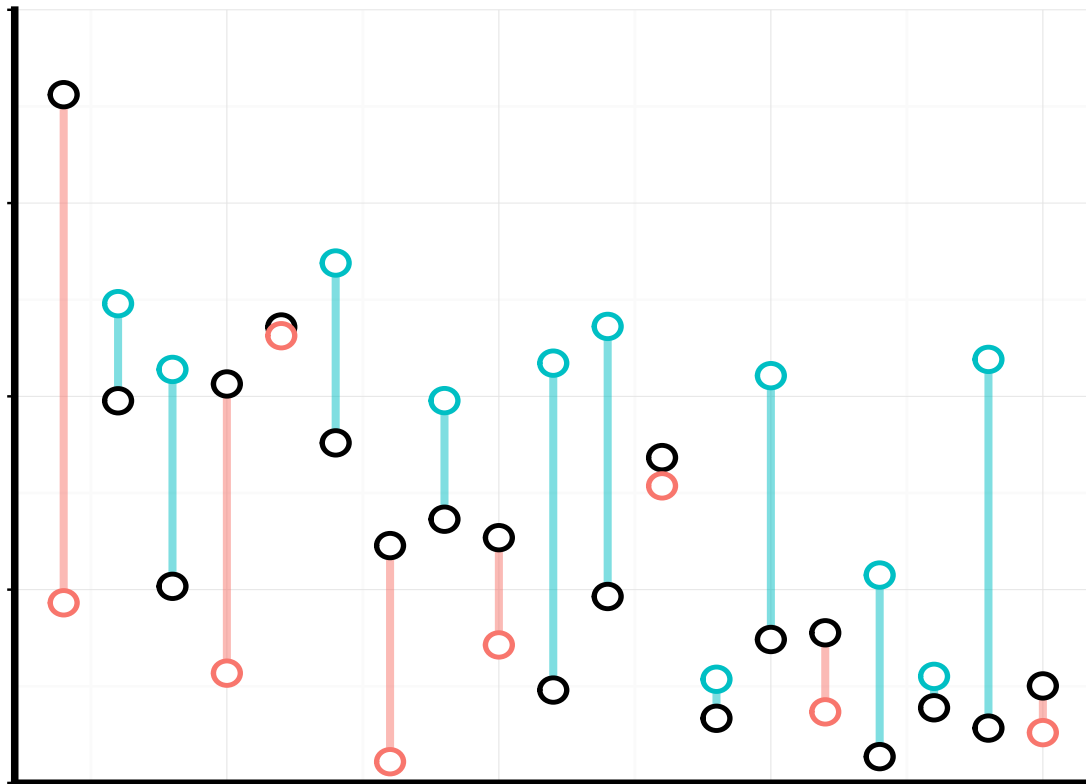
# Approach

Ordinary regression fits a model based on linear relationships between response variable and explanatory values



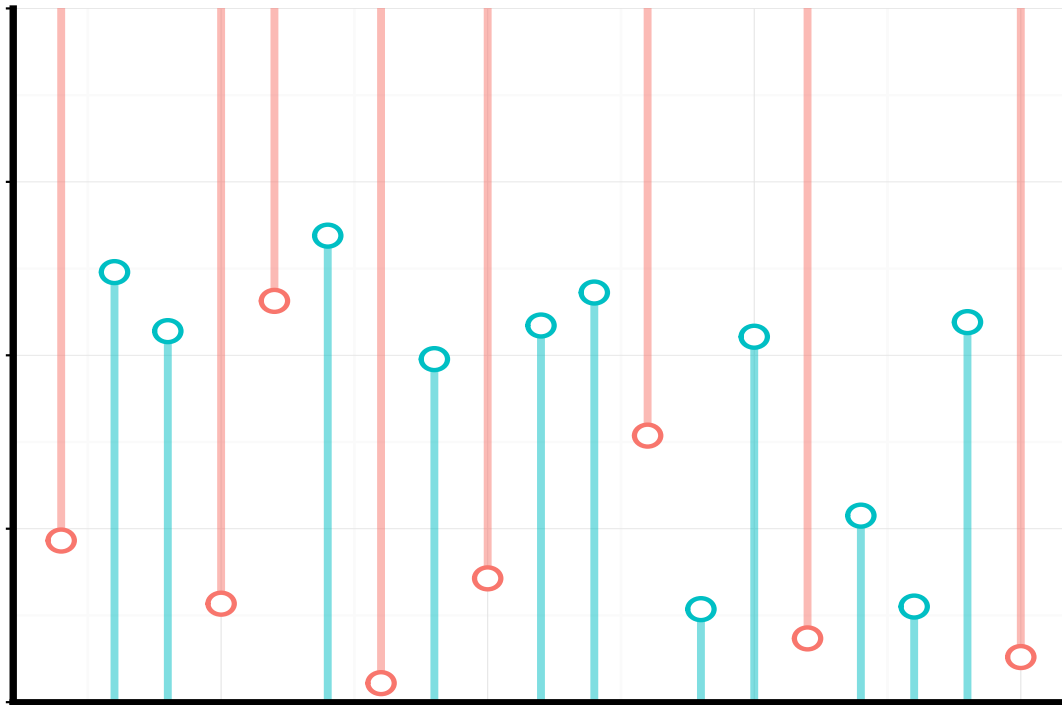
# Problem

We don't know apriori optimal exploration rate for given user and can't observe their behaviour under these conditions.



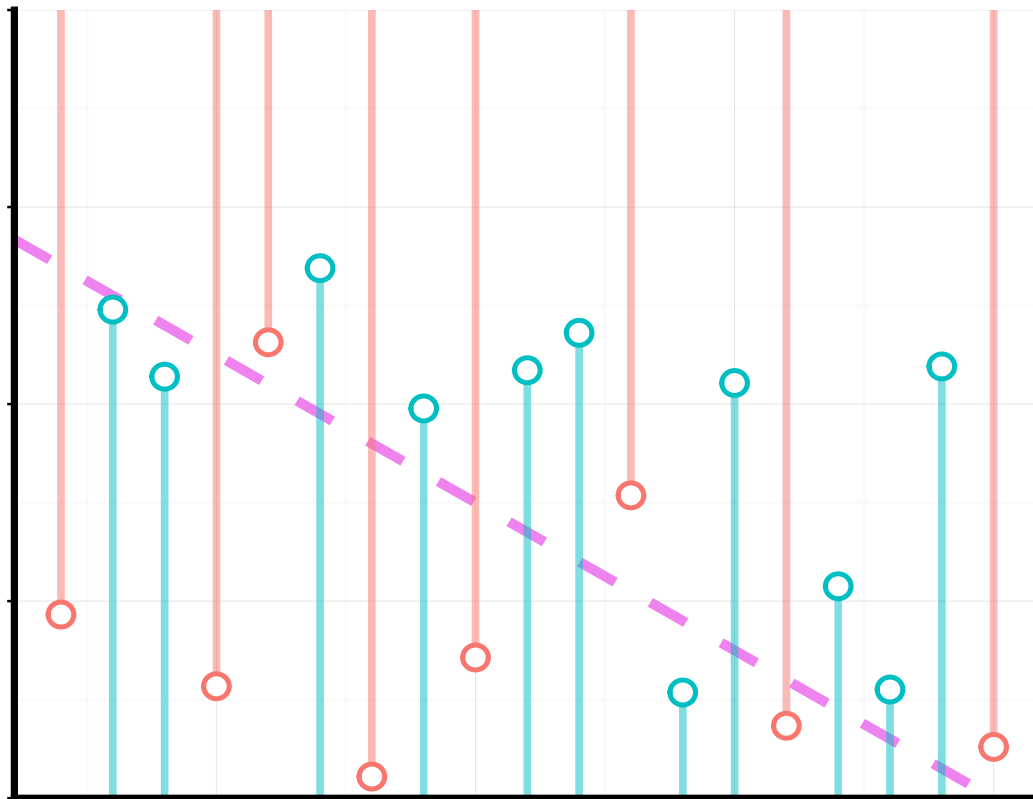
# Solution

Instead of using specific exploration rates as the response variable, we created censored intervals based on user feedback.



# Solution

Instead of using specific exploration rates as the response variable, we created censored intervals based on user feedback.



# User Study Design

- Random exploration rate
- Participants asked to rate knowledge of topic
- Collect simple metrics: clicks, reading time, etc.
- Participants: 20 MSc students from a CS dept. performing two searches
- Data: 1.1 million arXiv documents
- After each search, participants completed a short questionnaire

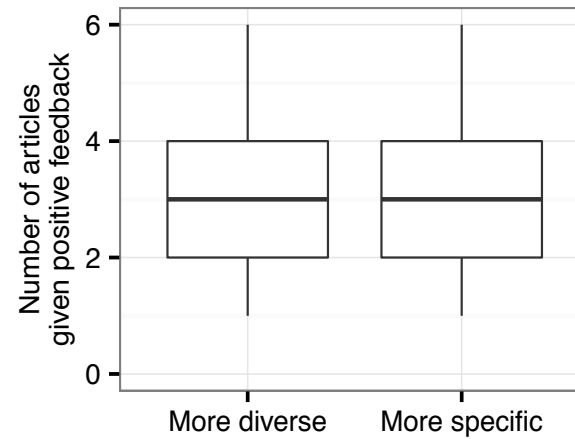
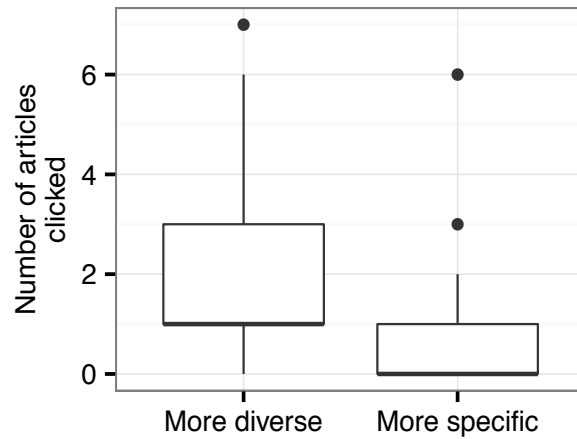
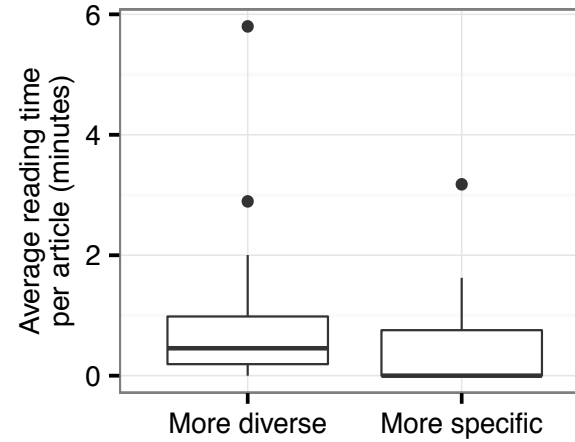
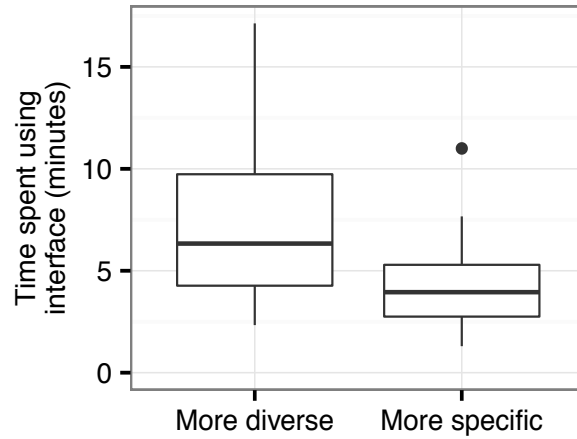
*“The search results recommended by the system contained documents closely related to the initial search query as well as articles related to other topics with varying degrees of relevance to the initial query. Based on the search session that you have just completed, would you prefer the search results to contain: a) more articles closely related to the initial search query; b) more articles related to other topics with varying degrees of relevance to the initial search query”*



# Interval Regression

- Left-censored interval  $[0, c]$  for *more specific* documents and right-censored interval  $[c, +inf]$  for *more diverse documents*
- Three significant predictor variables: time spent with interface, number of clicked articles, self-reported knowledge
- Interval regression performed with Survival R package.

# Experimental Results



# Regression Model

$$c = 0.29 \ln(x_1) + 0.22 \ln(x_2) - 0.44x_3 - 0.29x_4 + 0.06$$

X1 = time spent with interface

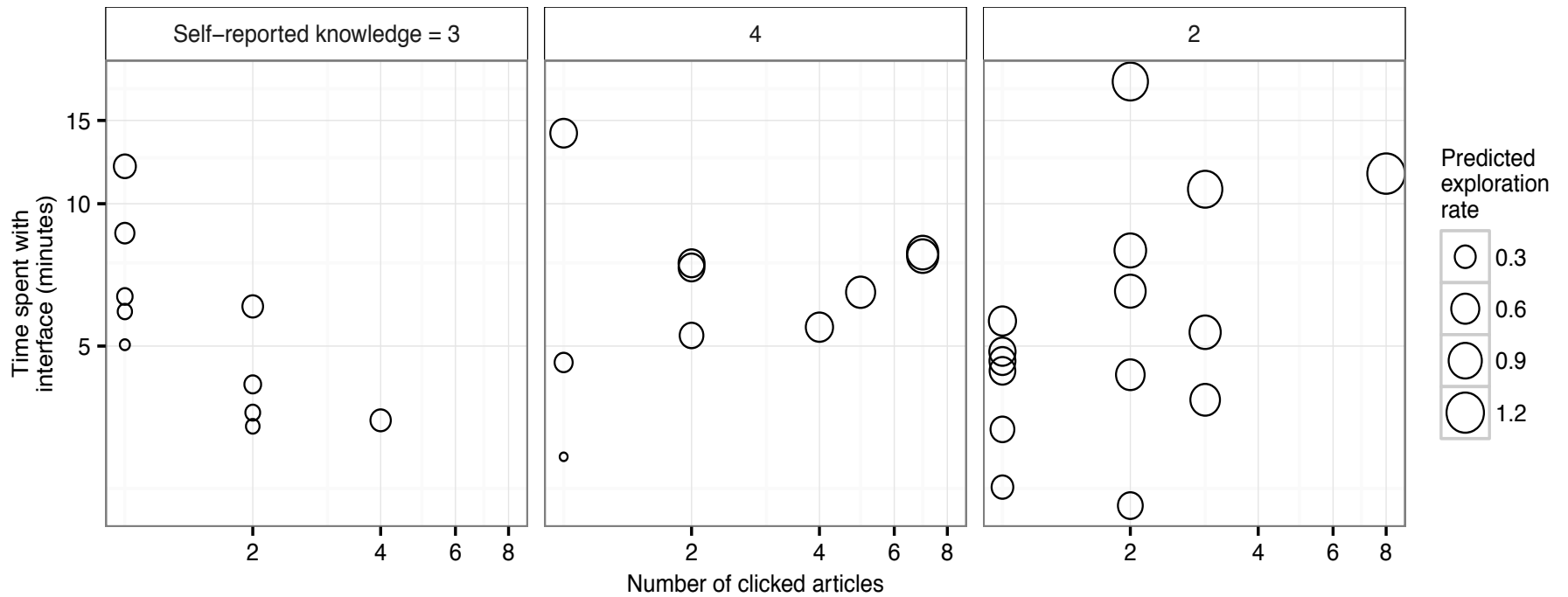
X2 = number of documents clicked

X3 = dummy variable for self-reported knowledge level 3

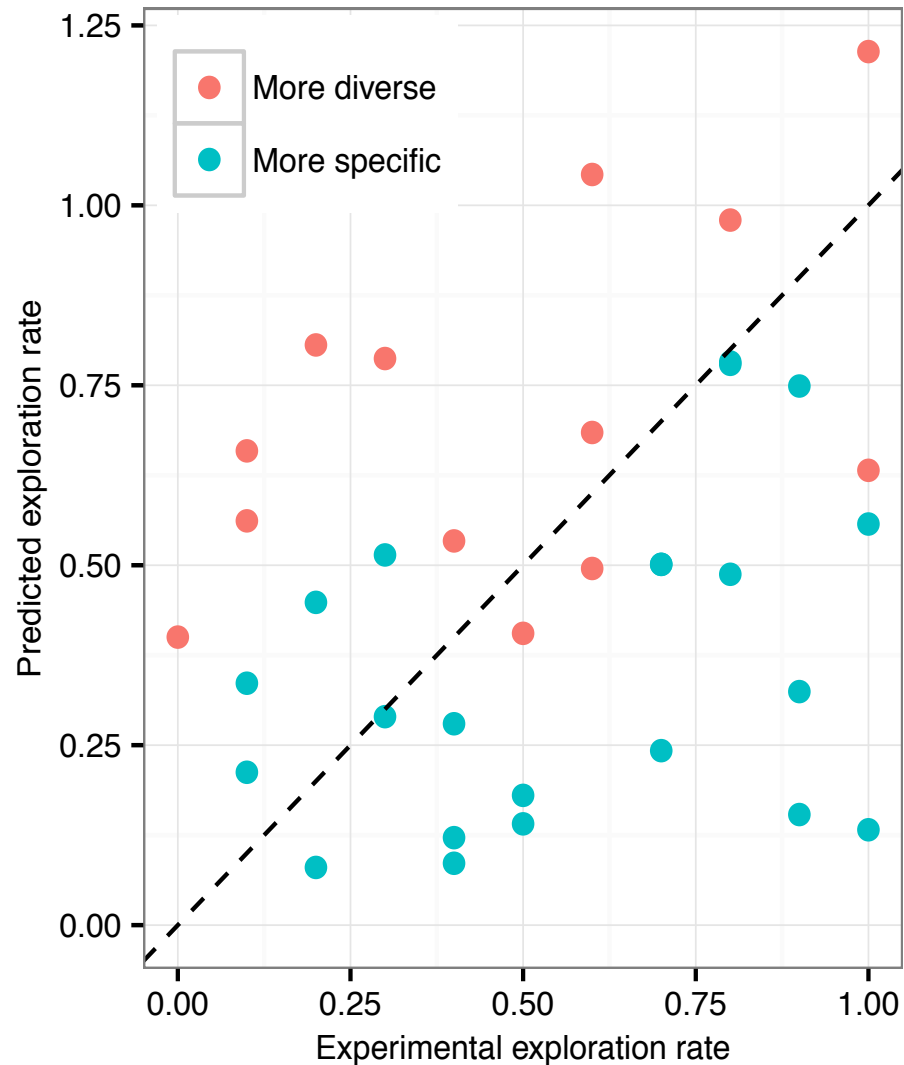
X4 = dummy variable for self-reported knowledge level 4

Note: level knowledge 2 is used as the base-line

# Graphical Representation of Model



# Model Predictions and User Feedback



# Summary

- We presented an approach for automatically adjust exploration rate in IR systems based on user and a specific search task.
- The model is based on easy to collect interaction data, such as clicks and reading time.
- Initial results show model's predictions highly consistent with users' perception of appropriate level of diversity of displayed documents.