



H2020-MSCA-ITN Grant Agreement N. 721321



# A Quantum Model for Interactive Search and Retrieval

based on Information Foraging Theory

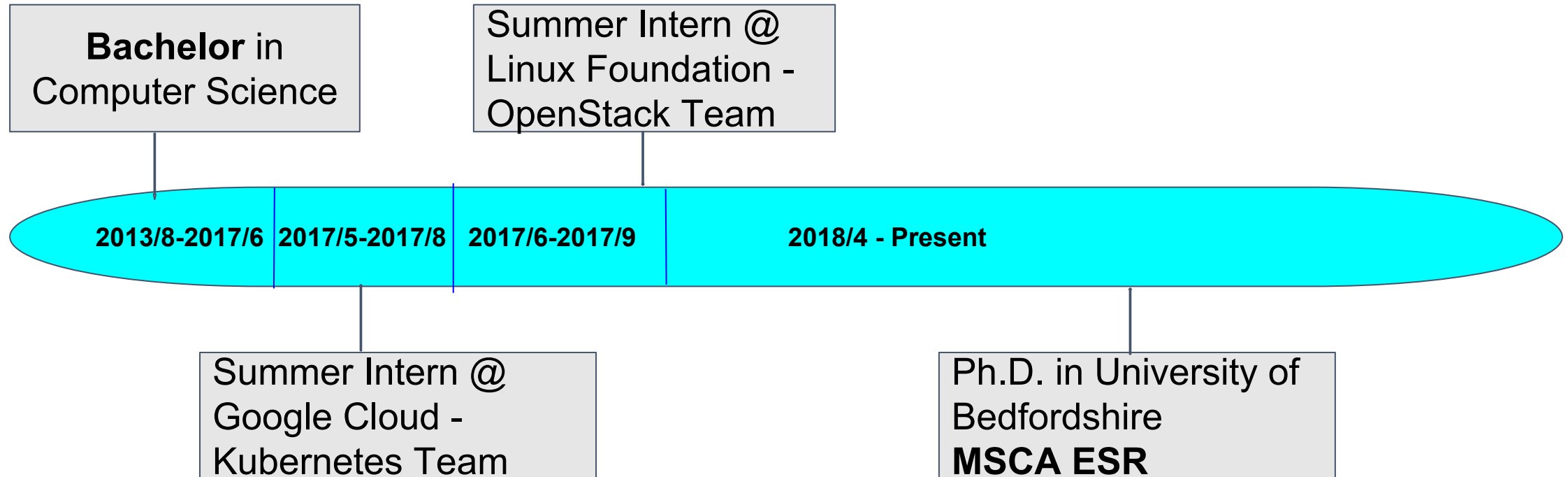
## (ESR-3)

**Amit Kumar Jaiswal**

University of Bedfordshire

Mid-term review meeting, Italy, 07/12/2018

# Background



# Training Experiences

## Workshops and Conferences

- Autumn School [1]
  - Workshop in Luton, UK - Academic / Presentation Training
  - Workshop in Cottbus, Germany - Academic Training
- Lernen, Wissen, Daten, Analysen (**LWDA**) 2018, Mannheim, Germany
- The 4th ACM SIGIR International Conference on the Theory of Information Retrieval (**ICTIR**) 2018, Tianjin, China

## Seminars organized by QUARTZ

- The theory of open quantum systems in cognitive psychology by Irina Basieva, University of Bedfordshire
- AI in the wild by Erik Graf (Cortical.io), University of Bedfordshire

## Miscellaneous

- Teaching Assistant of Intelligent Systems and Data Mining (MSc level) UoB: Oct 2018 - Present

## Foreseen secondments

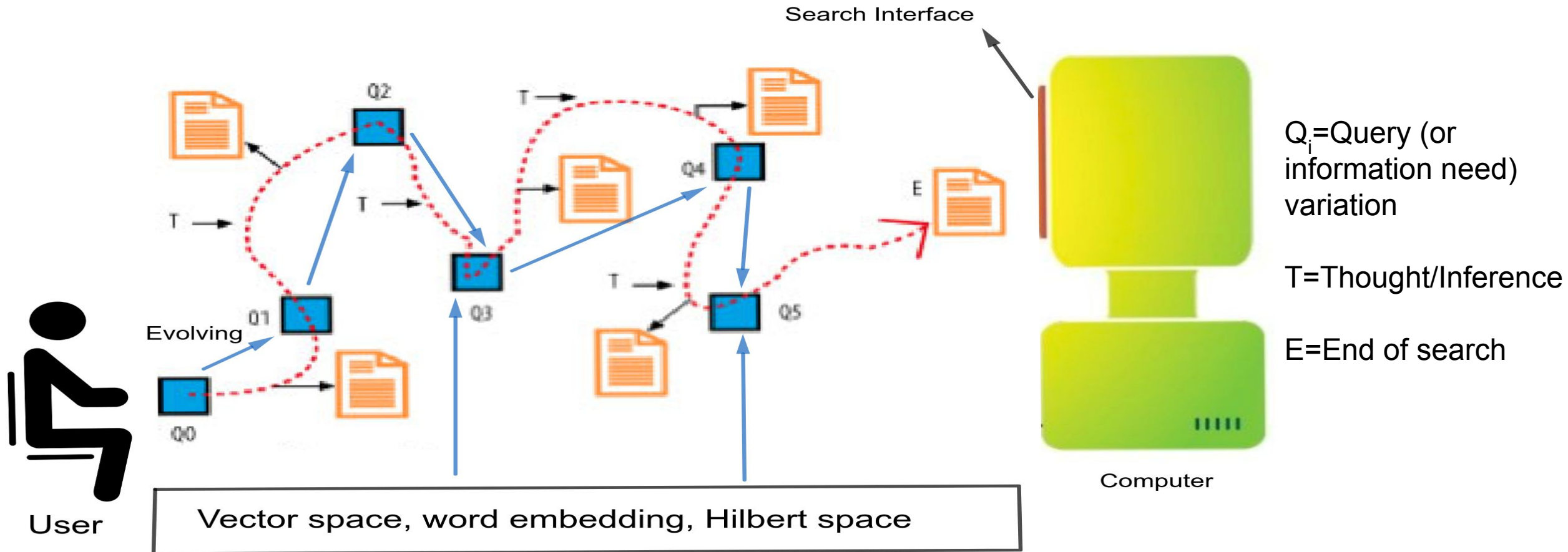
- University of Padova: Early Summer 2019

1. QUARTZ Autumn School: <http://www.quartz-itn.eu/training>



# Research Project - ESR3

A Quantum Model for Interactive Search and Retrieval based on **Information Foraging Theory**



# Research Objectives

Design and evaluate a Quantum model for Interactive Information Retrieval (IR) based on Information Foraging Theory.

- Combine information foraging theory [3] with quantum IR framework [1,2]
  - Modeling users' search behavior using Hilbert Space: User context, Cognitive process
  - Relevance Feedback (Explicit/Implicit): learning from user interaction [4]
  - Modeling users' evolving information need using Hilbert space formalism [1]
- Effectiveness Evaluation
  - Users: Behavior understanding [3], Modeling/Simulation, Log Analysis
  - Metrics: Session evaluation, Relevance/Satisfaction

- 
1. Melucci, M. (2008). A basis for information retrieval in context. *ACM Transactions on Information Systems (TOIS)*, 26(3), 14
  2. Frommholz, I., Larsen, B., Piwowarski, B., Lalmas, M., Ingwersen, P., & Van Rijsbergen, K. (2010, August). Supporting polyrepresentation in a quantum-inspired geometrical retrieval framework. In *Proceedings of the third symposium on Information interaction in context* (pp. 115-124). ACM.
  3. Pirolli, P. (2007). *Information foraging theory: Adaptive interaction with information*. Oxford University Press.
  4. Liu, H., Mulholland, P., Song, D., Uren, V., & Rüger, S. (2010, August). Applying information foraging theory to understand user interaction with content-based image retrieval. In *Proceedings of the third symposium on Information interaction in context* (pp. 135-144). ACM.

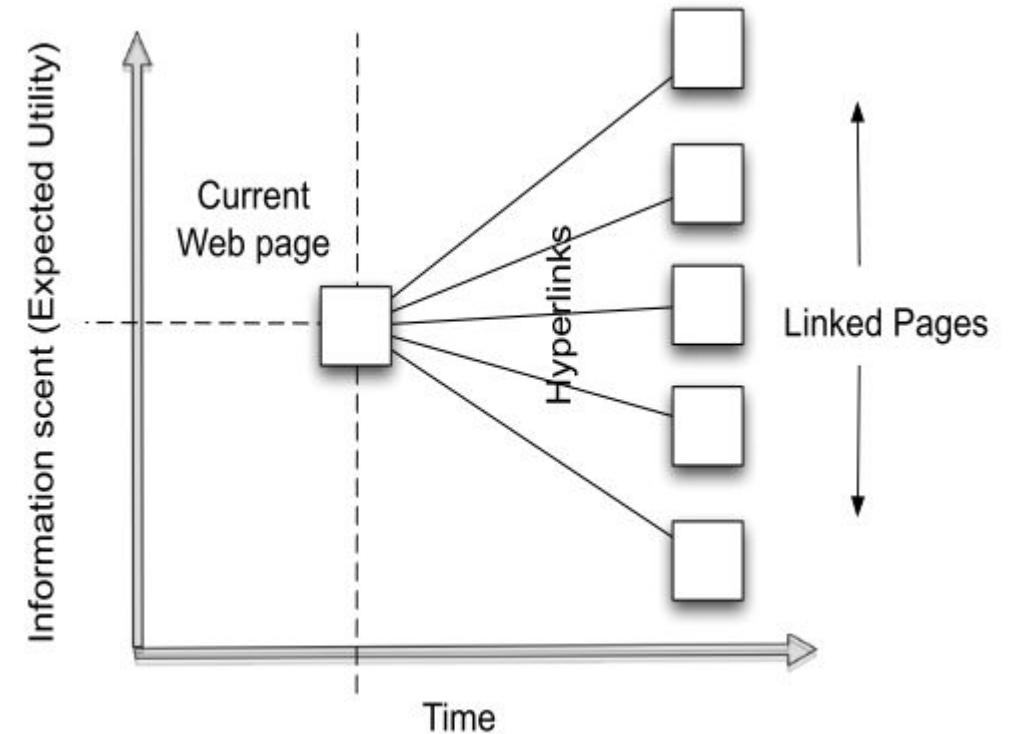


# Methodology/1

## Mathematical description of Information Scent

$$S_{ji} \approx \log\left(\frac{P(i|j)}{P(i)}\right)$$

$$A_i = \sum_{j \in q} \log\left(\frac{P(i|j)}{P(i)}\right)$$



### Information Scent and WWW

**Adapted from** Pirolli, P. (2009). Information foraging theory: Adaptive interaction with information: Oxford University Press

# Methodology/2

## Mapping Information Foraging Theory (IFT) to IR An Analogy

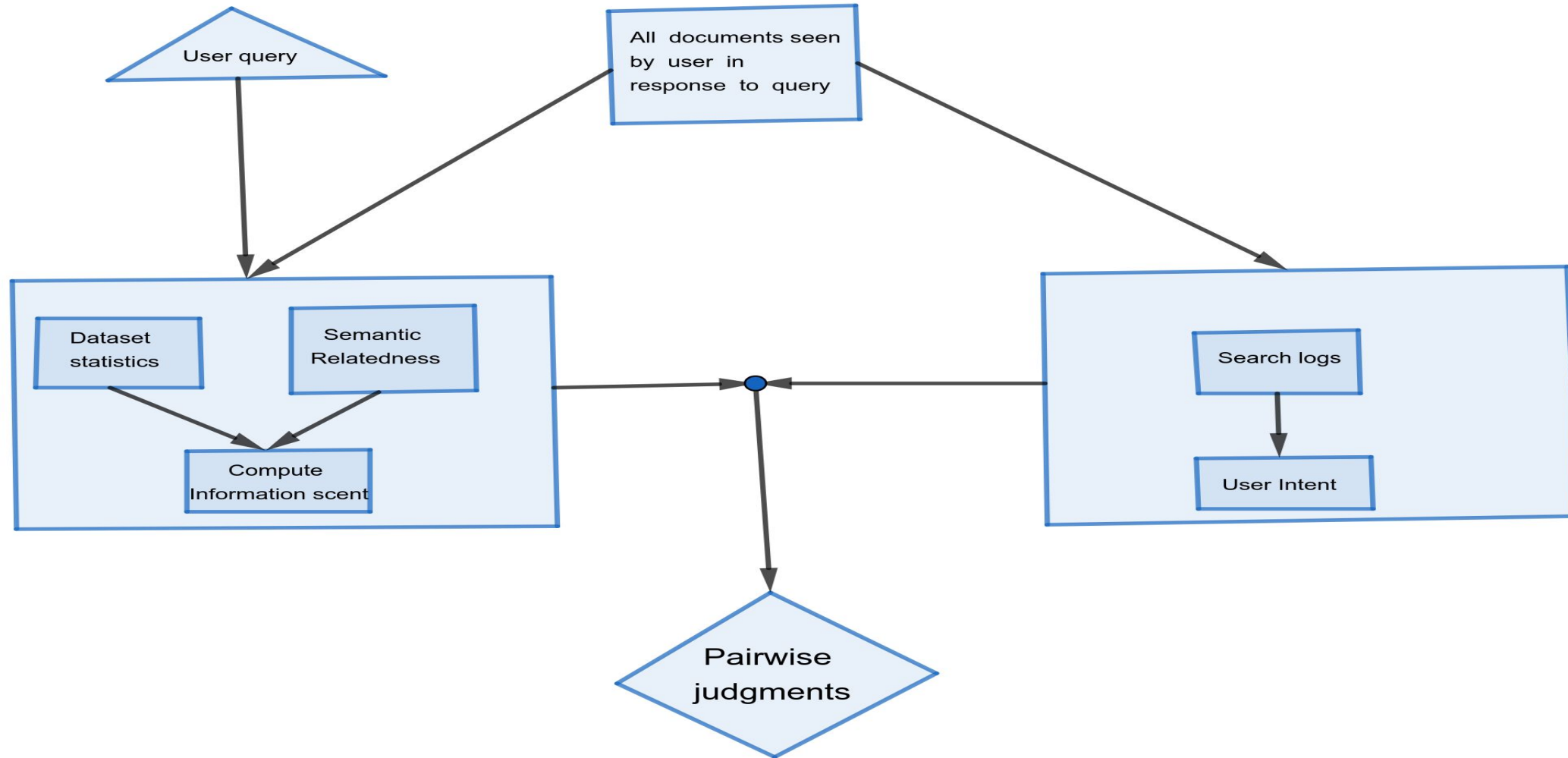
IFT Constructs	Information Retrieval	Web Search
Forager	Searcher	Searcher
Information Patch	Information features	Web Page
Topology	$f(\text{document/query space/sim}(d,q))$	WWW
Information Scent	Information source / snippets (context based)	Searches/Links
Gain	Net retrieved information	Net information increase
Information Diet	SERP/Supporting Information objects	SERPs / Information

## Search Behavior Features (Based on Query Logs)

- QueryActivity
  - Reformulation
  - Pagination
  - Stopping
- Termination
- NumQuery
- NumPagination
- Time
- NumDocument
- NumPrediction
  - Relevant
  - Non-relevant

# Ongoing Work/1

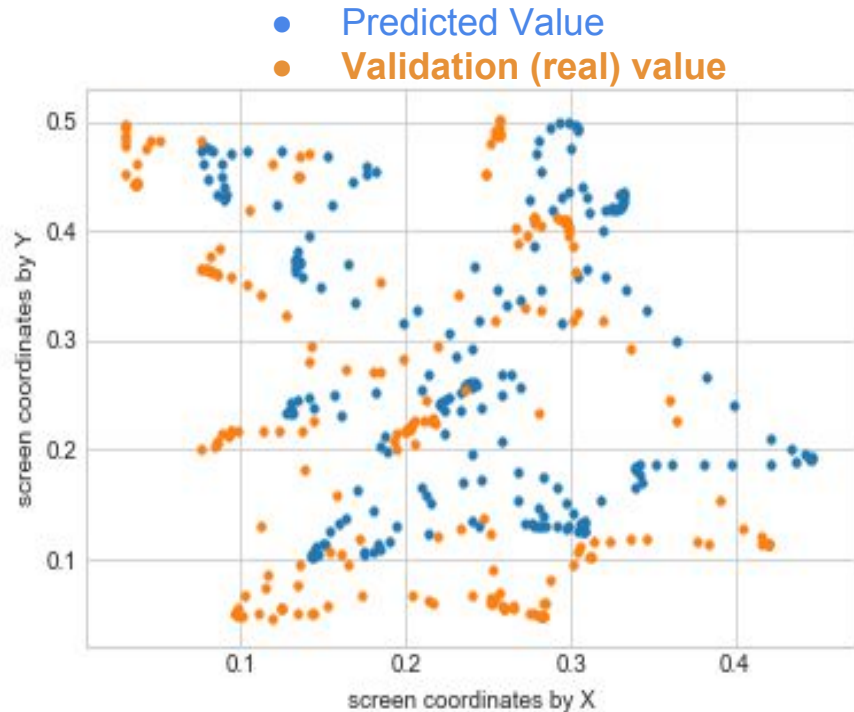
## Info Scent-intent based model to predict document relevance





# Ongoing Work/2

## Understanding User Behavior based on Information Foraging Theory



**Prediction: The ratio of the movement of the mouse along the two axes X, Y**

Button	State
Left	Down
Middle	Drag
No Button	Move
Right	Pressed
Scroll	Released
	Up

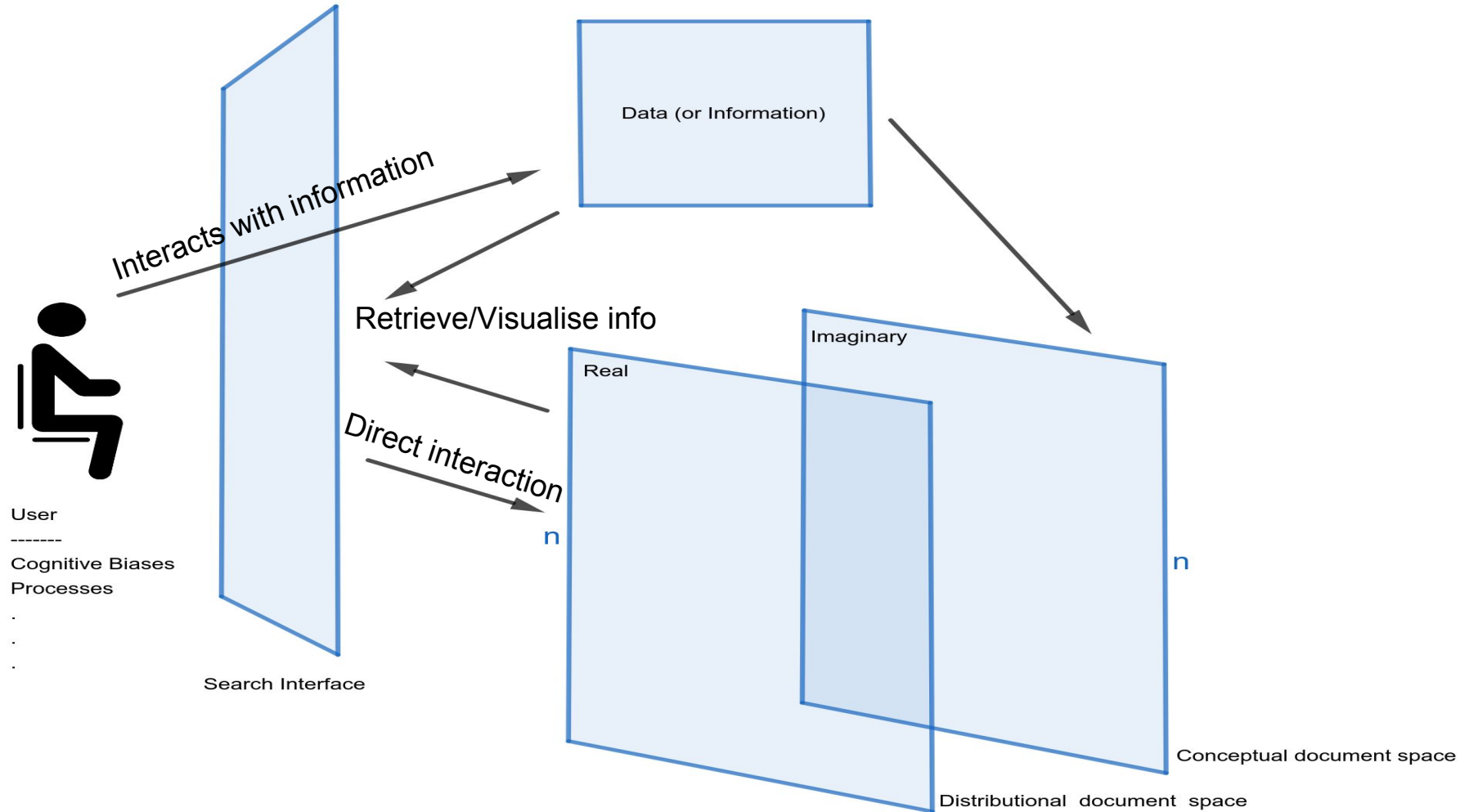
**Categorical data types**

Field	Description
Event	Cursor move or click
Click Position	x- and y-coordinates of the cursor
Timestamp	Elapsed time
Button	Mouse button state
State	Mouse movement state
User	User id
Session	Session id

**Dataset description**

Amit Kumar Jaiswal, Haiming Liu, Ingo Frommholz Predicting Users' Behavior using Mouse Movement Information: An Information Foraging Perspective. **ACM IUI 2019 Submission**

# Ongoing Work/3 - Modeling Information Objects<sup>1</sup> in Hilbert Space



## 1. Documents and Queries

# Expectations on the possible impact on future career

- Short-term plan
  - Quantum-like user interaction model
  - To address contextuality and order effects in modeling user behavior
  - Dynamic users' information need model based on IFT
  - A first prototypical implementation of a quantum-theoretic framework that incorporates user interaction and behaviours powered by IFT
- Post Ph.D.
  - Interdisciplinary postdoc experience (2+ years)
  - Establish own line of research



Thanks for your time.

Q&A

