

Diverse Contributions to Implicit Human-Computer Interaction

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UNIVERSITAT
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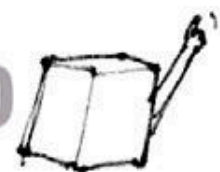
Presentation Outline

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Slides available at <http://personales.upv.es/luileito/phd/defense.pdf>

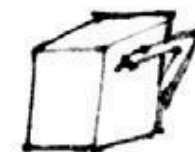
Introduction

FOREGROUND



**direct manipulation
command interfaces**

**alerts
direction**



REACTIVE



initiative

PROACTIVE

attentional demand

**abstraction
automation**

**ambient
agents**



BACKGROUND

Motivation

The intention of the user is mostly hidden.

Direct user feedback is difficult to gather *and* unreliable most of the time.

Users are unique, but some behaviors are common.

Making computers more useful and tailored to our needs.

Previous Work

- Ubiquitous Computing [Weiser, 1993]
- Calm Technology [Weiser and Brown, 1996]
- Proactive Computing [Tennenhouse, 2000]
- Ambient Intelligence [Hansmann, 2003]
- Perceptual Interface [Wilson and Oliver, 2005]

- Untold Feedback [Tan and Teo, 1998]
- Subsymbolic Behavior [Hofmann et al., 2006]
- Subconscious Awareness [Yoneki, 2006]
- Passive Actions [Grimes et al., 2007]
- Implicit Intentions [Kitayama et al., 2008]

Implicit Interaction

An action performed by the user that is not primarily aimed to interact with a computerized system but which such a system understands as input.

[Schmidt, 2000]

Thesis Statement

1) There is a lot of information inherently encoded in user interactions, which
2) can be measured and from which it is possible to extract meaningful
knowledge, and therefore 3) can be leveraged in a wide spectrum of
applications and tasks.

Interactive Usability Evaluation

Interactive Usability Evaluation

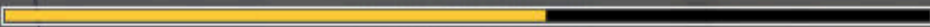

Development of Simple Mouse Tracking (smt2)

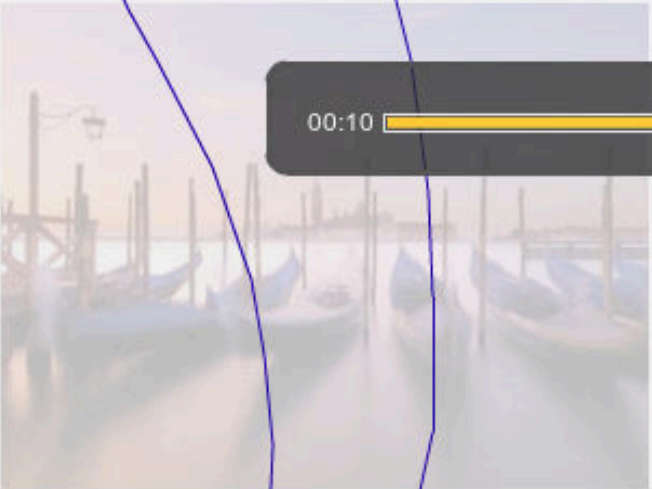
- Lowering usability costs
- Hypervideo-based visualization
- A tool for user modeling
- +100K downloads since 2009



BIENVENIDO

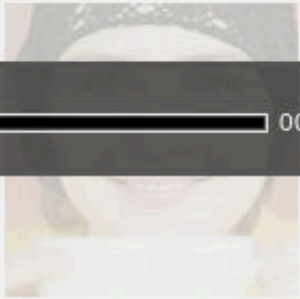
WELCOME PERSONAL ABOUT

00:10  00:08 



Eliquaturo dip tiros

lameture ut consecte dolesed etain ut dolor sevelit verito adionse uta magnisc.

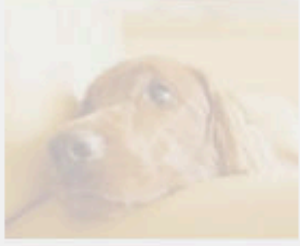


Retazos de mi vida ~~XX~~

Duis nonsequ... dolore facidunt, vullup tat lor volore consecte dolesed ar se veliter etiore te lortis dunt feugiam. Commodit dolorer iure te adionse quatet.blan henim exor aute enit alit, veliqua.

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User logs

client ID	location	page ID	date	aprr me	# clicks	action
AuMC4x	e9800998ecf8427e	15	2010-10-01 20:01:11	5.00	56	view analyze delete
AuMC4x	e9800998ecf8427e	15	2010-10-01 19:51:23	3.79	59	view analyze delete
AuMC4x	e9800998ecf8427e	1	2010-10-01 15:53:55	18.71	514	view analyze delete
8853a5cb1a413cca	b32c21fba0cb8d6	59	2010-10-01 15:19:43	14.04	140	view analyze delete
8853a5cb1a413cca	b32c21fba0cb8d6	59	2010-10-01 15:12:46	12.12	144	view analyze delete
8853a5cb1a413cca	b32c21fba0cb8d6	58	2010-10-01 15:02:34	10.07	102	view analyze delete
8853a5cb1a413cca	b32c21fba0cb8d6	57	2010-10-01 14:59:18	17.25	254	view analyze delete
8853a5cb1a413cca	b32c21fba0cb8d6	57	2010-10-01 14:56:33	9.42	88	view analyze delete
8853a5cb1a413cca	b32c21fba0cb8d6	56	2010-10-01 14:54:01	6.71	89	view analyze delete
8853a5cb1a413cca	b32c21fba0cb8d6	56	2010-10-01 14:53:55	6.04	73	view analyze delete

More results

Mine results

Leave fields blank for default values

Filter by

Page ID Client ID Operating System Browser Only first-time users

Grouping

Records per query Group result by

Date range

From To

Time range (seconds)

min. 123 — max. 368

Action

Export

Format: XML¹ TXT¹ CSV² TSV²

¹ each log is stored in a single file, then all are compressed in a ZIP file.
² all logs are dumped in a single file (logs are separated by a newline).

sortable columns

paginated results

segment users

group logs

November 2010 12:00 am

Su	Mo	Tu	We	Th	Fr	Sa	Hour	Minute
	1	2	3	4	5	6		
7	8	9	10	11	12	13		
14	15	16	17	18	19	20		
21	22	23	24	25	26	27		
28	29	30						

Today Done

export offline

BIENVENIDO

AUMC4x
08:26 PM

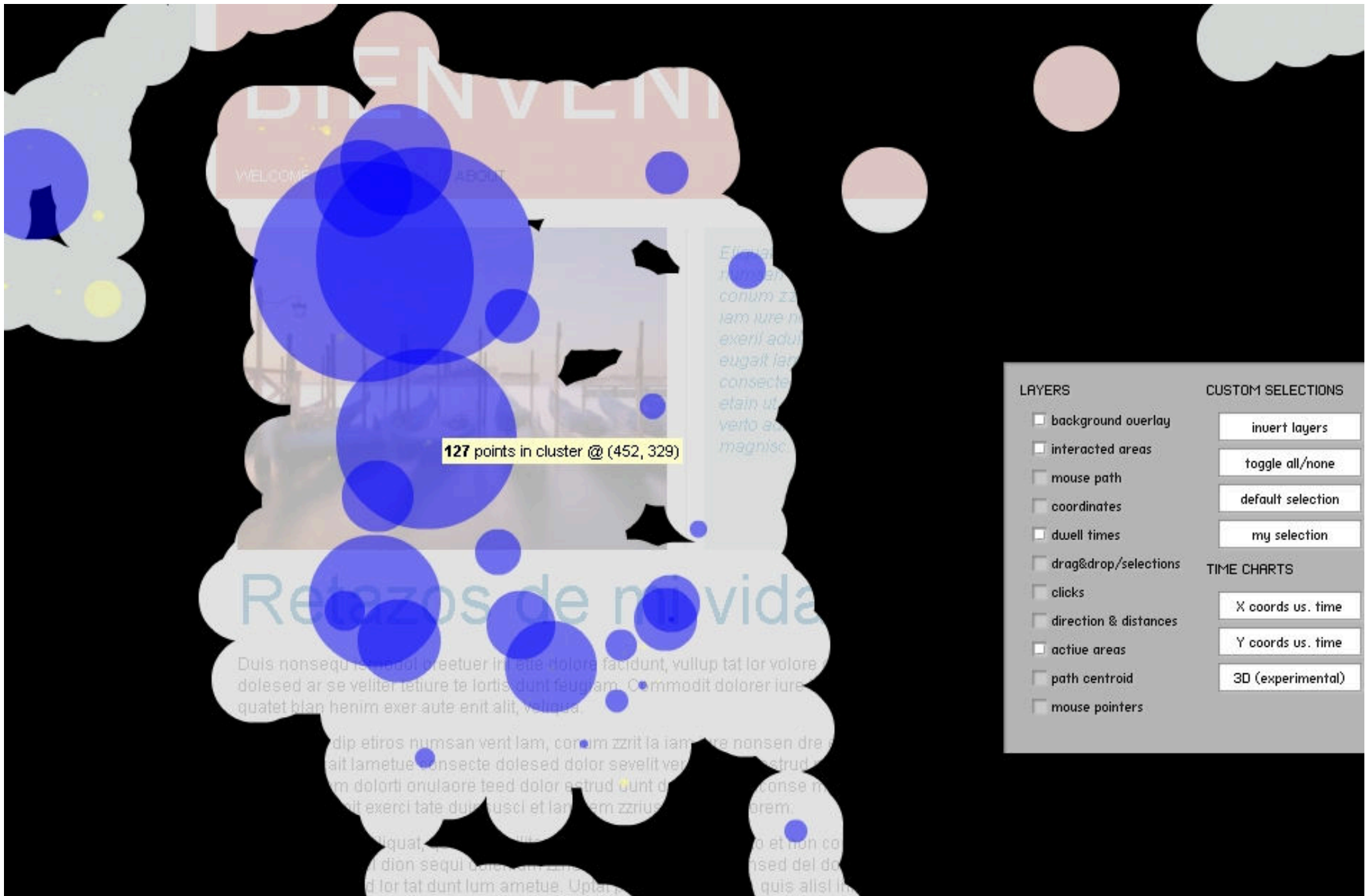
Eliquaturo dip tiros numsan vent et lam, conum zzrit laing iam iure nonsen de exenti aout te facip eugait iametue ut consecte doleresed etain ut dolor seveit vento adionse uta magnisc.

Retazasto mi vida

Duis nonsequi...
Eliquaturo dip...
Uptat prat...

AUMC4x
08:30 PM





← [Back to tracking index](#)

Raw Log Data

Client details

source URL	cache log	user agent	resolution	viewport	tracking accuracy
Volcán Eyjafjalla	20100503-201803.html	Firefox 3.6 on Windows	1280 x 800	1280 x 669	24 fps

Interacted elements

hovered elements (frequency)	clicked elements (frequency)
LI#list1_4 = 21.81%	LI#list1_2 = 33.33%
DIV.blanco-contenido FORM = 17.97%	LI#list1_3 = 33.33%
LI#list1_5 = 16.13%	LI#list1_4 = 33.33%
LI#list1_3 = 15.21%	
LI#list1_2 = 12.44%	
LI#list1_6 = 6.91%	
LI#list1_1 = 5.07%	

Interaction metrics

time (s)	activity	clicks	distance (px)	length (px)	amplitude (px)	scroll reach	entry point	exit point	centroid
14.04	0.58	8	4.52, 6.35	1504, 2114	467, 286	0.36, 0.43	390, 252	528, 134	59.18, 82.21
0	0	0	0	0	0	0	0	0	101.36, 74.56

Notes:

1. First row is μ , while second row is σ .
2. Values for activity and scroll reach are reported as per-unit: $0 < \text{value} < 1$.
3. Comma-separated values denote a column vector (X and Y components).

Click Path

Hover on each link to see more details. [show all](#) [hide all](#)

» [1] → [2] → [3] → [4] → [5] → [6] → [7 current (#151)] | [view](#) | [delete](#) → [8] → [9] → [10] → [11] → [12] → [13] → [14] → [15] → [16] → [17] → [18]

[report a bug](#)

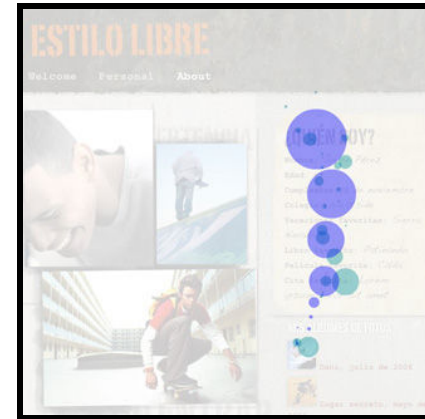
These people have tried smt2



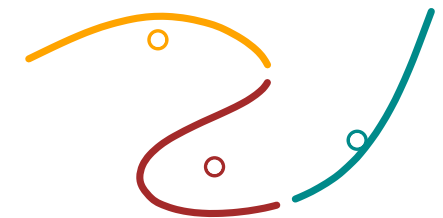
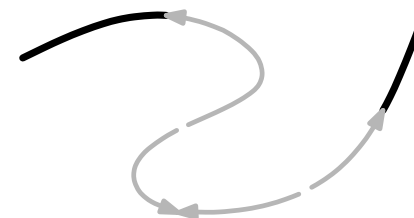
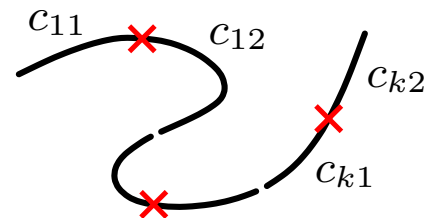
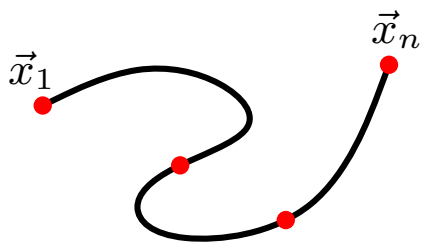
Behavioral Clustering

Behavioral Clustering

Website Modeling

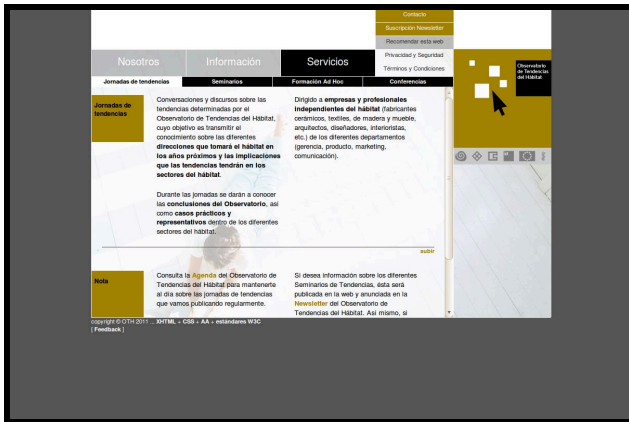


Subtrajectory Identification



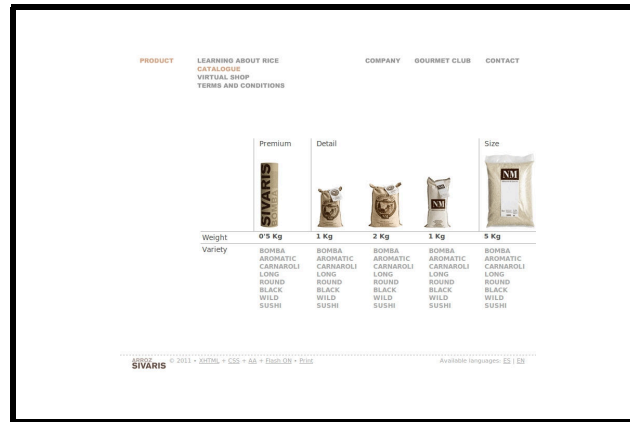
Website Modeling Evaluation

OTH



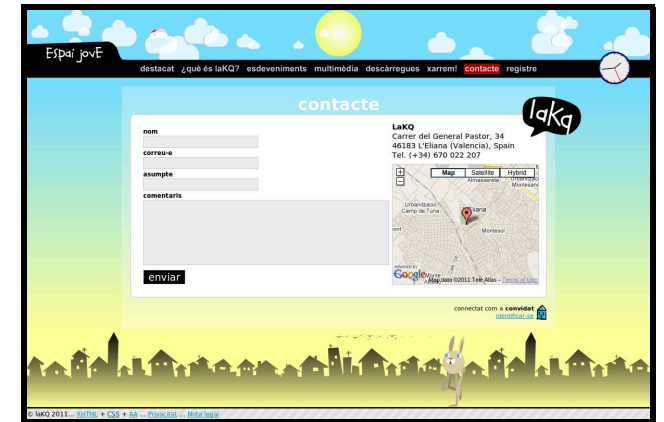
5K samples
60 URLs

NM



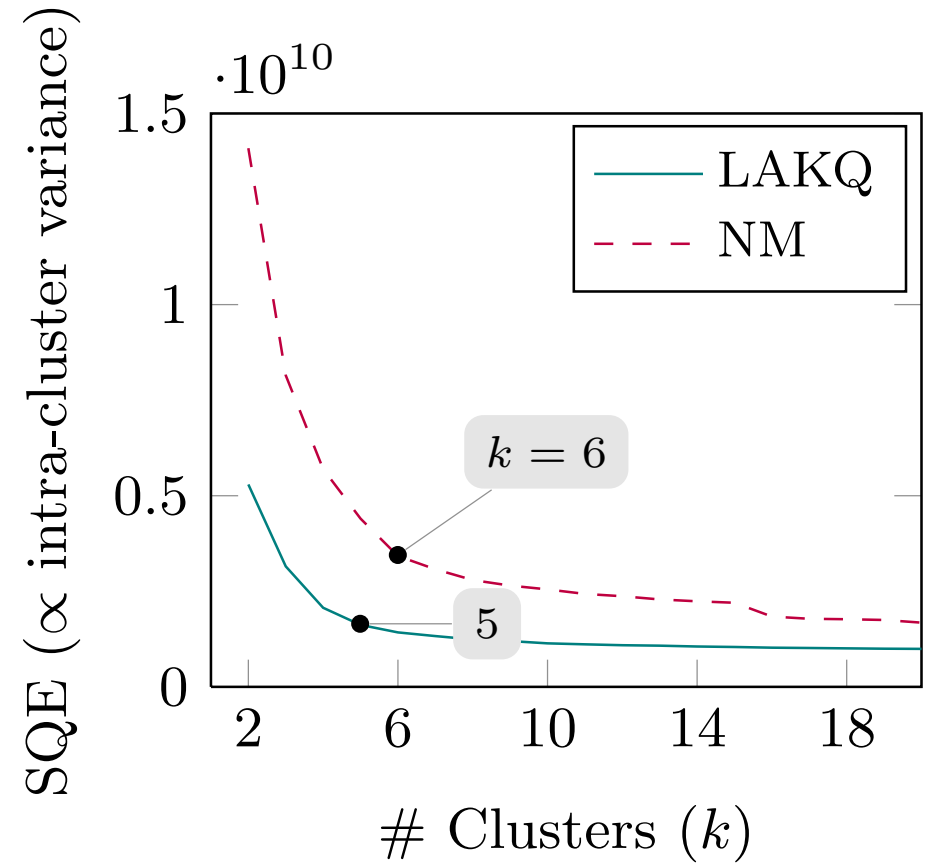
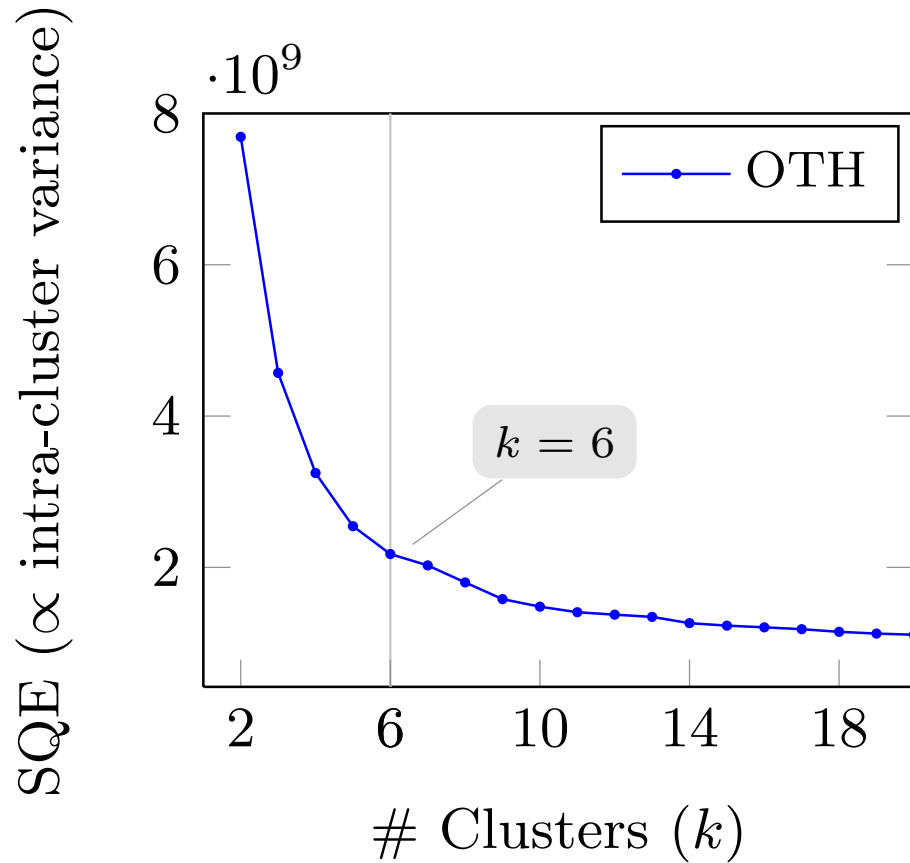
6K samples
40 URLs

LAKQ



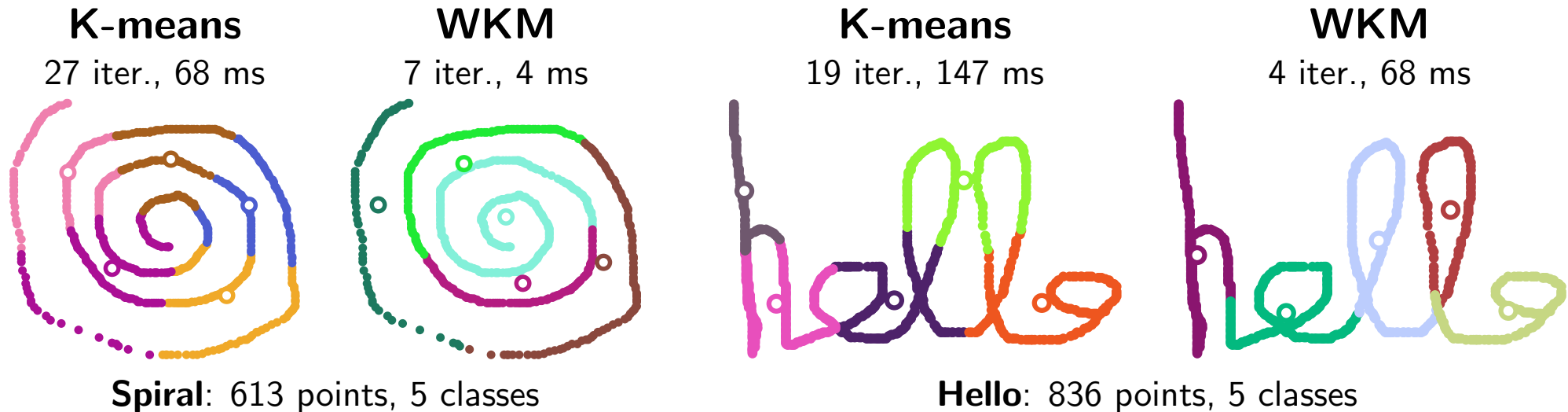
2K samples
20 URLs

Website Modeling Evaluation



Subtrajectory Identification Evaluation

WKM algorithm



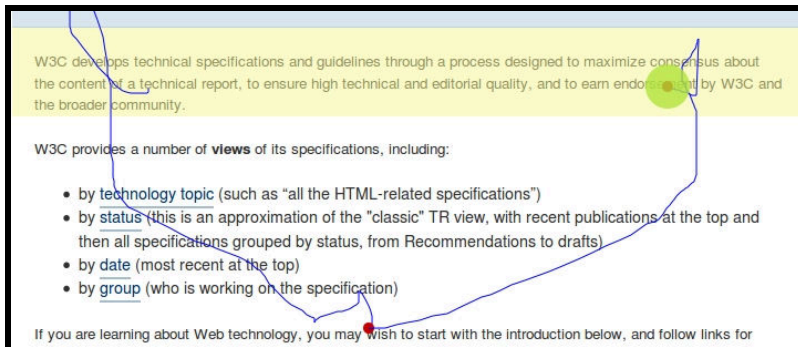
Other experiments with sensor data (UCI ML repository)

Human Multitasking

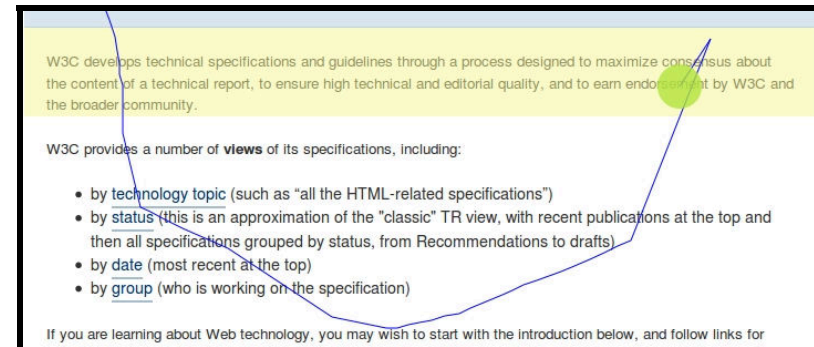
Human Multitasking

Multitasking is **costly**.

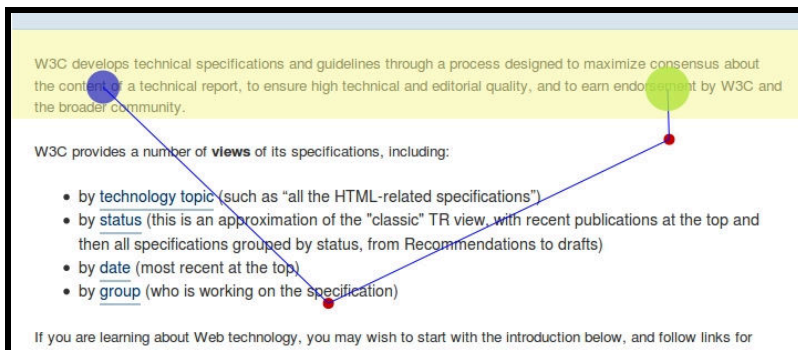
MouseHints: Using the mouse cursor as a proxy of attention.



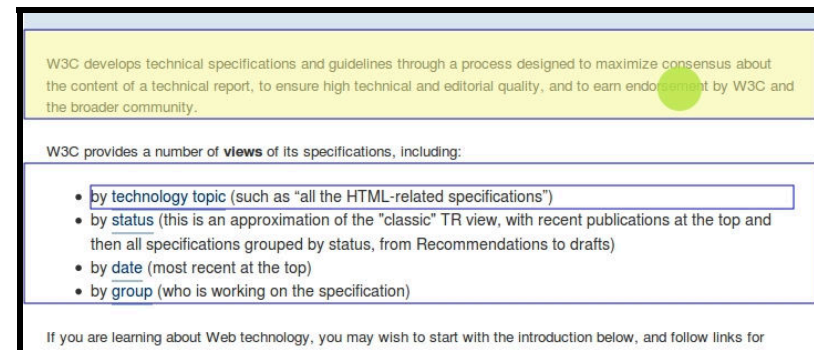
Raw trajectory viz



IDT viz

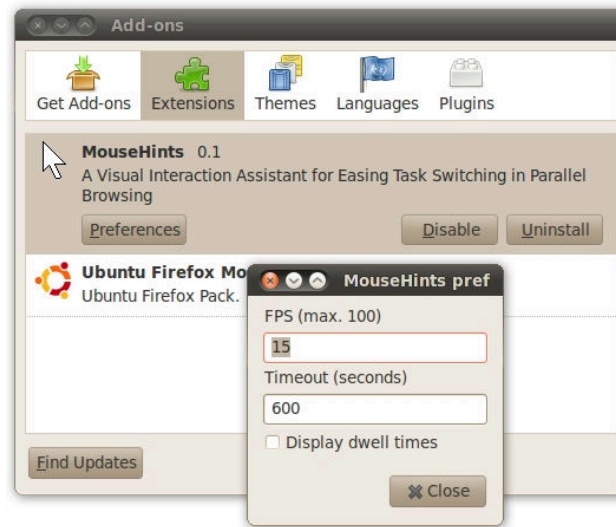


WKM viz



DOM-based viz

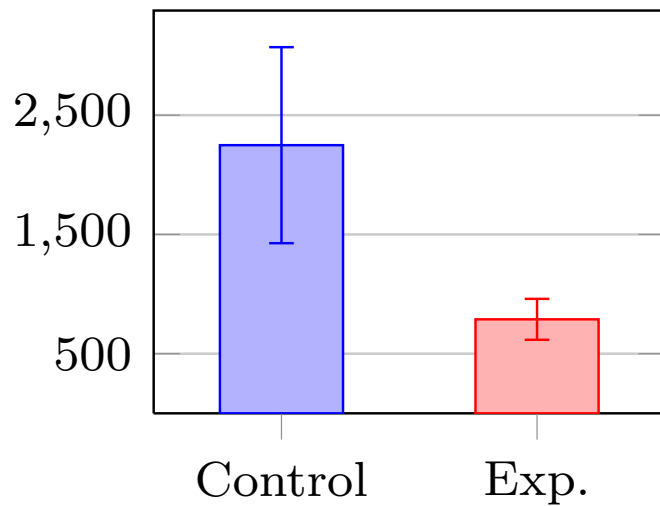
MouseHints



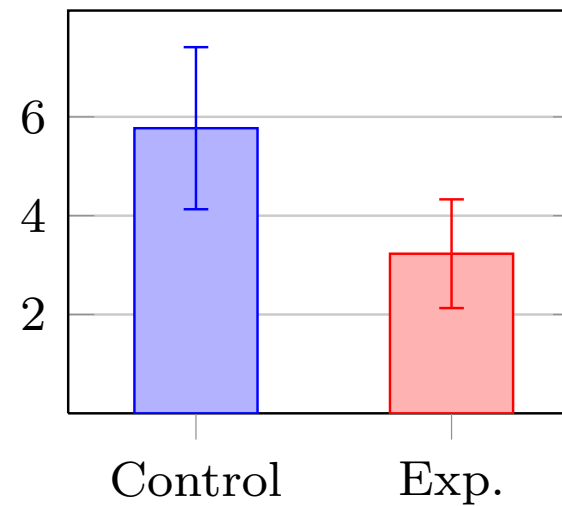
Evaluation Results

2 groups of 18 users each

Mean task resumption (ms)



Mean task completion (min)

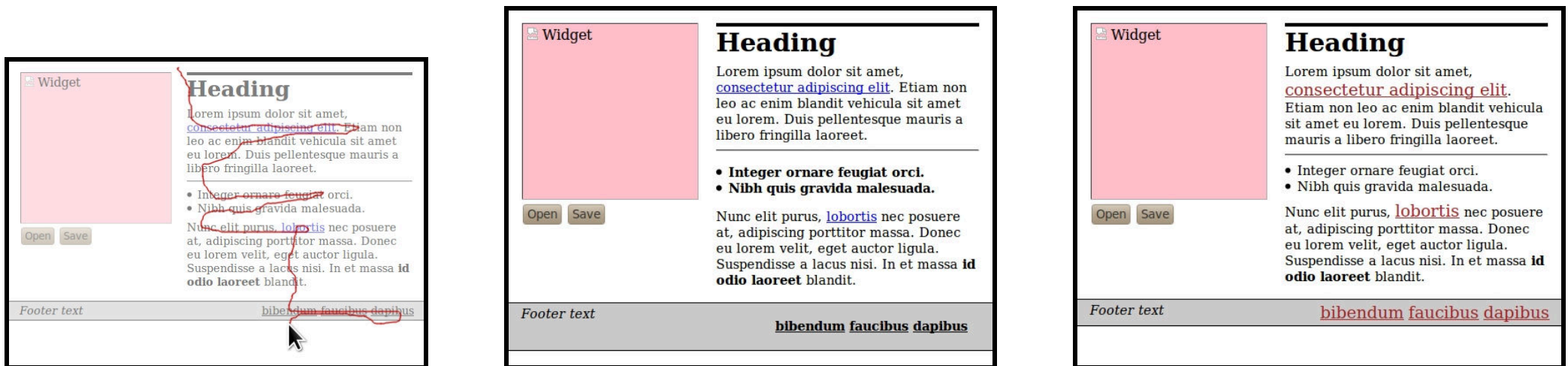


Adaptive User Interfaces

Adaptive User Interfaces

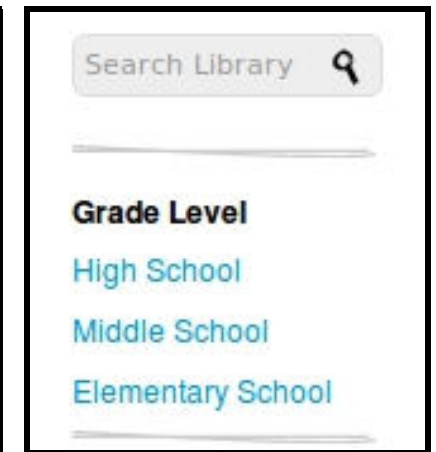
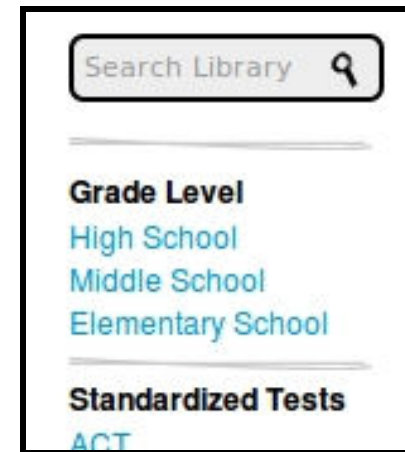
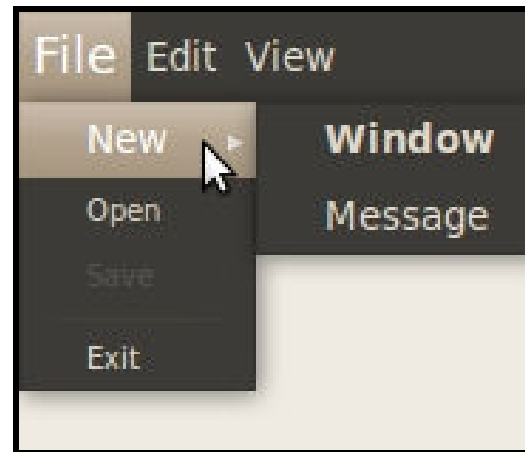
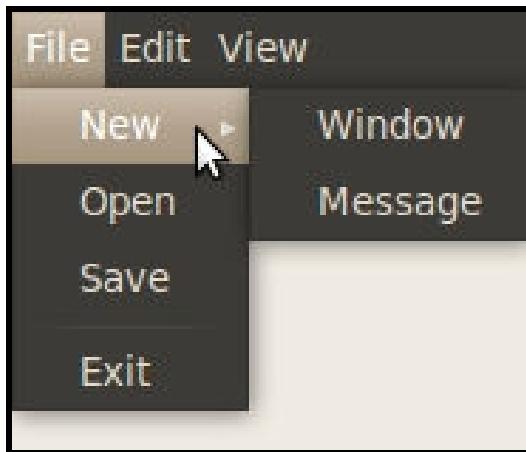
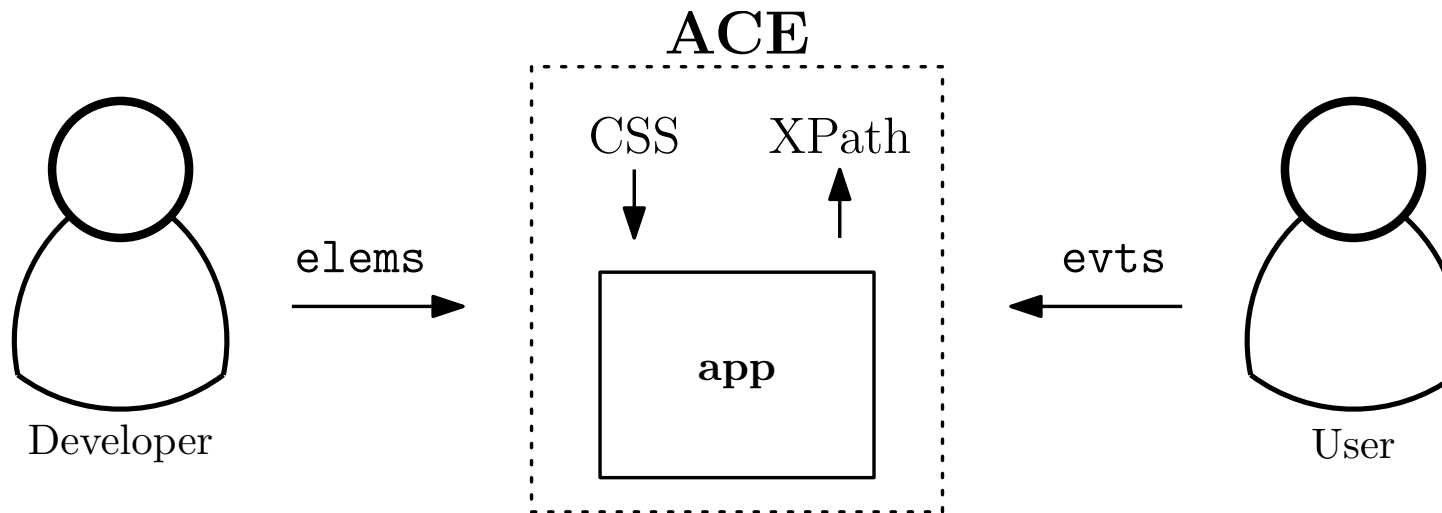
Interaction-based UI redesign.

Unattended + attentive + smooth adaptation.

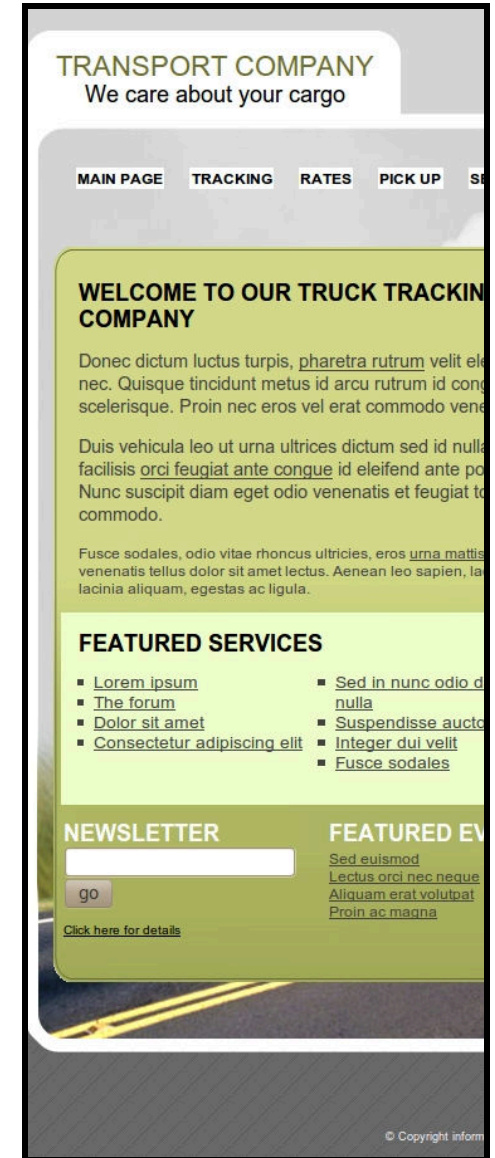
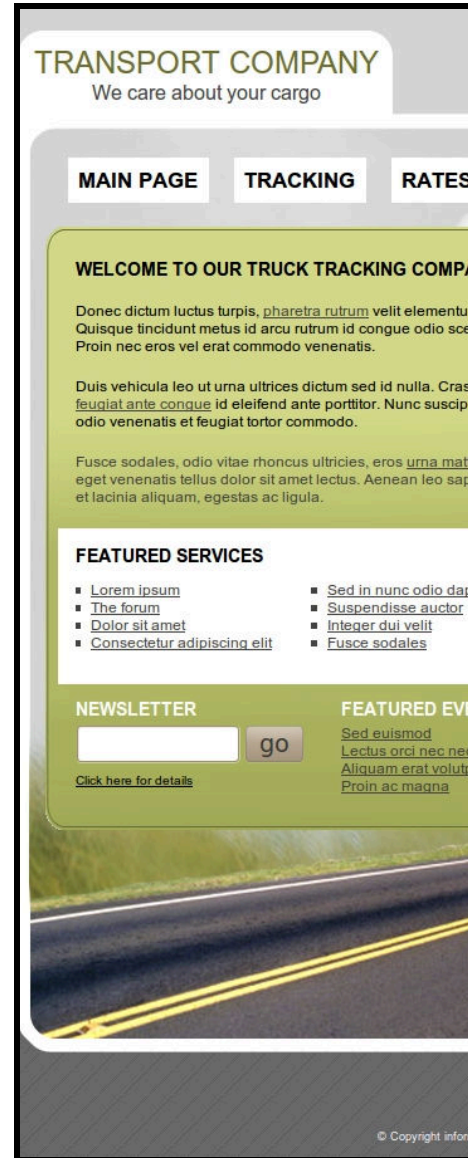
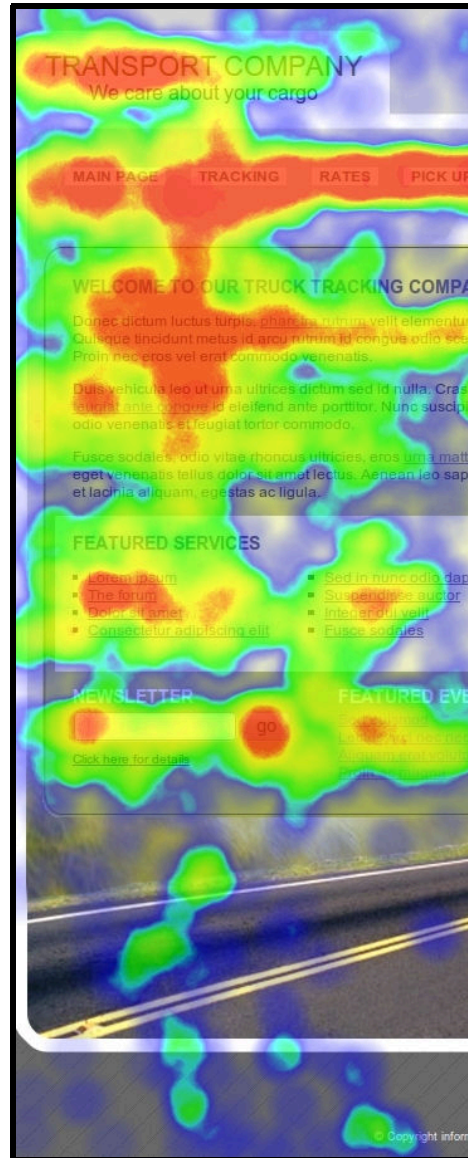
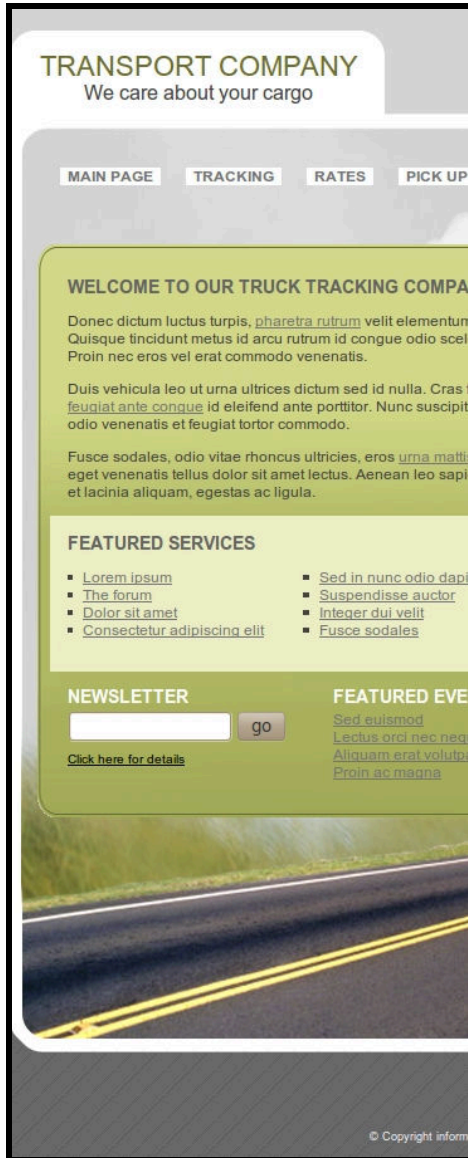


Because one size does not fill all.

ACE: Adaptive CSS Engine

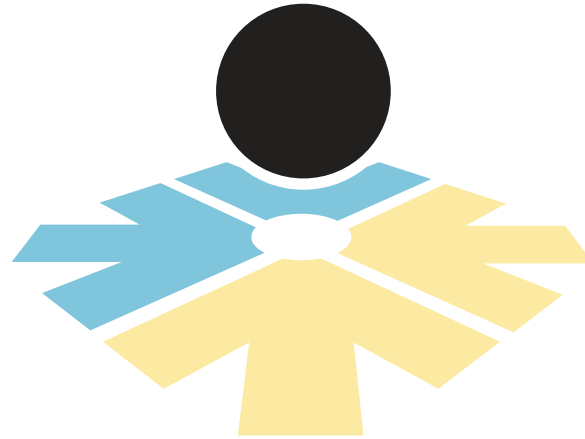


Fostering creativity



Interactive Pattern Recognition

Interactive Pattern Recognition

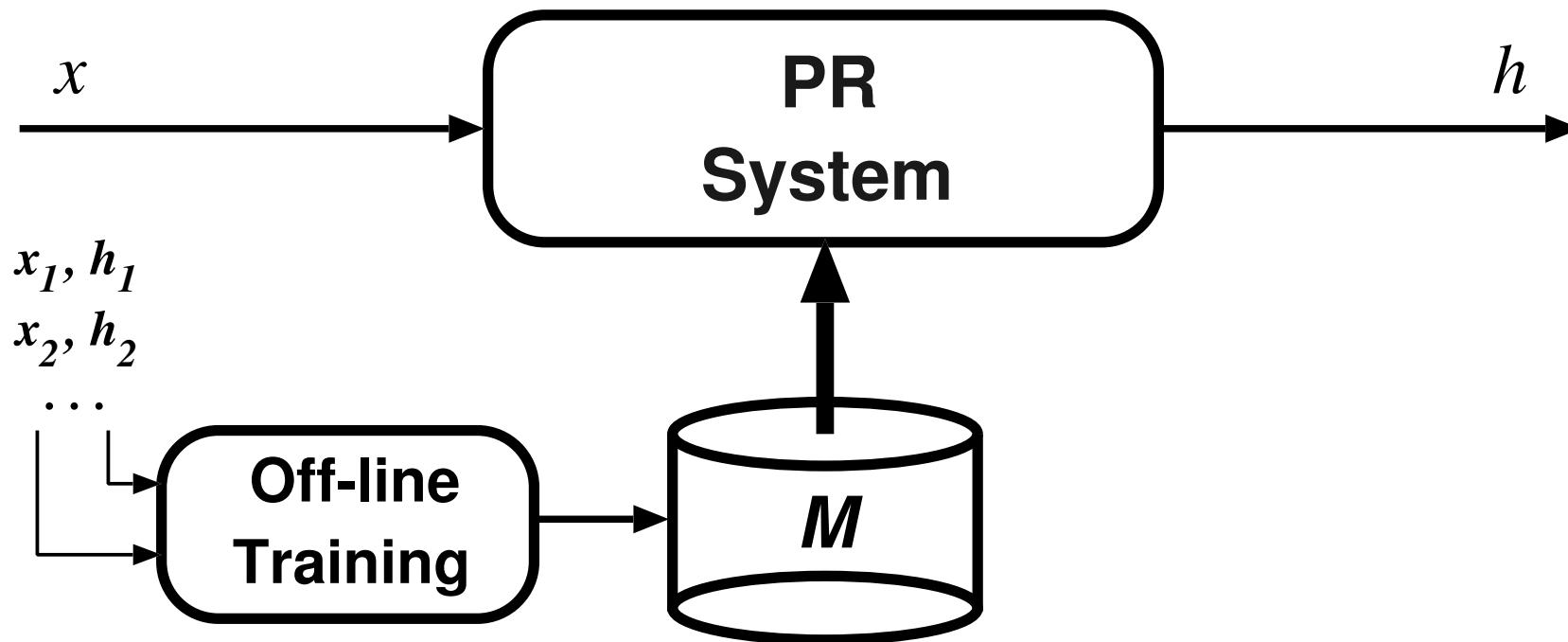


MIPARCVCV

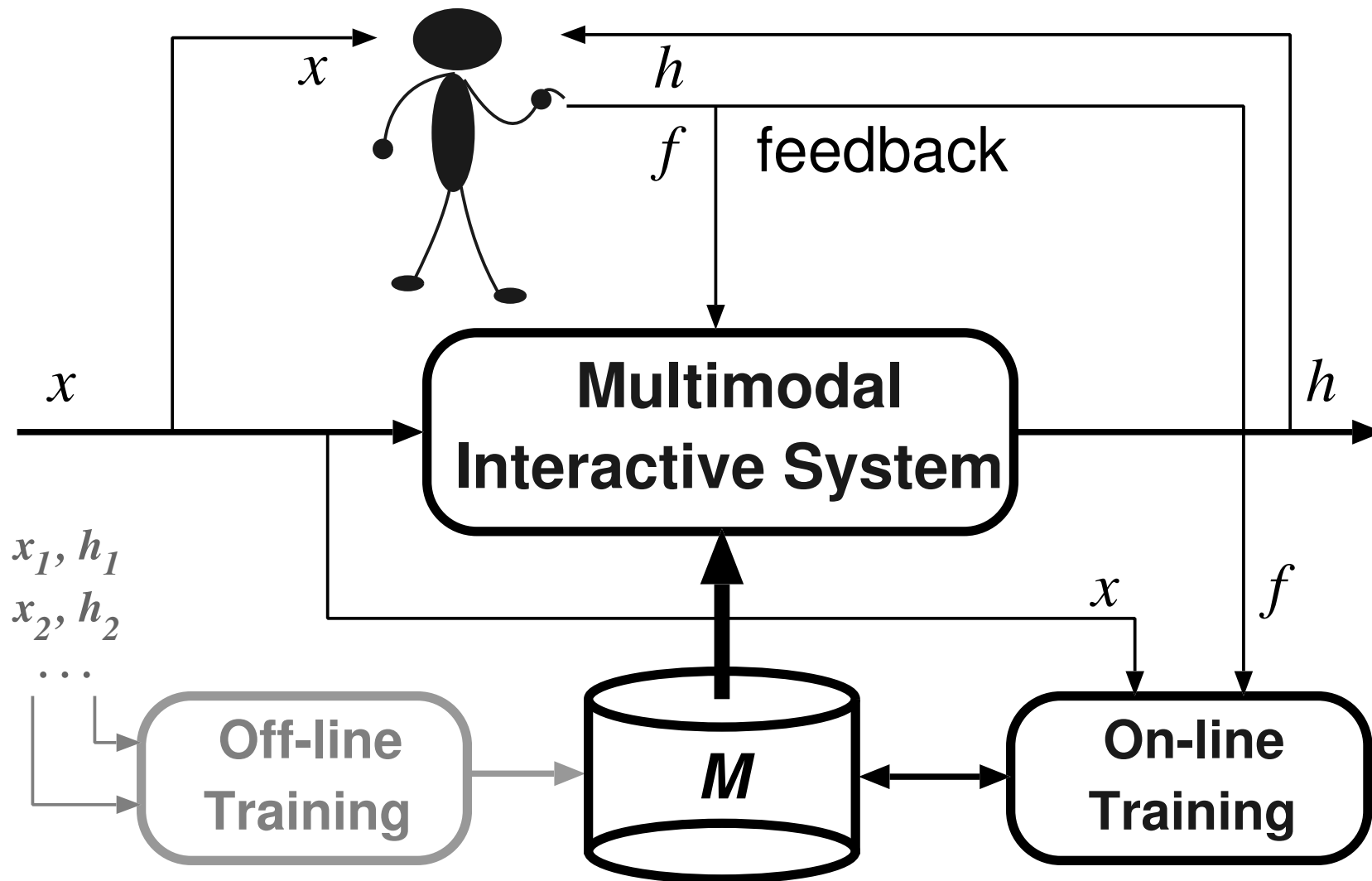
C O N S O L I D E R I N G E N I O 2 0 1 0
M u l t i m o d a l I n t e r a c t i o n i n P a t t e r n R e c o g n i t i o n a n d C o m p u t e r V i s i o n

Contributions: UI prototype development & user evaluation

General Framework



General Framework

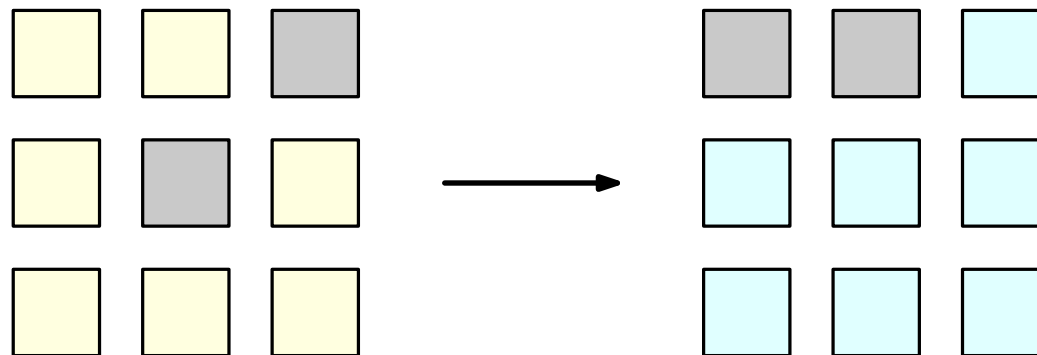


Deployed Interactive Protocols

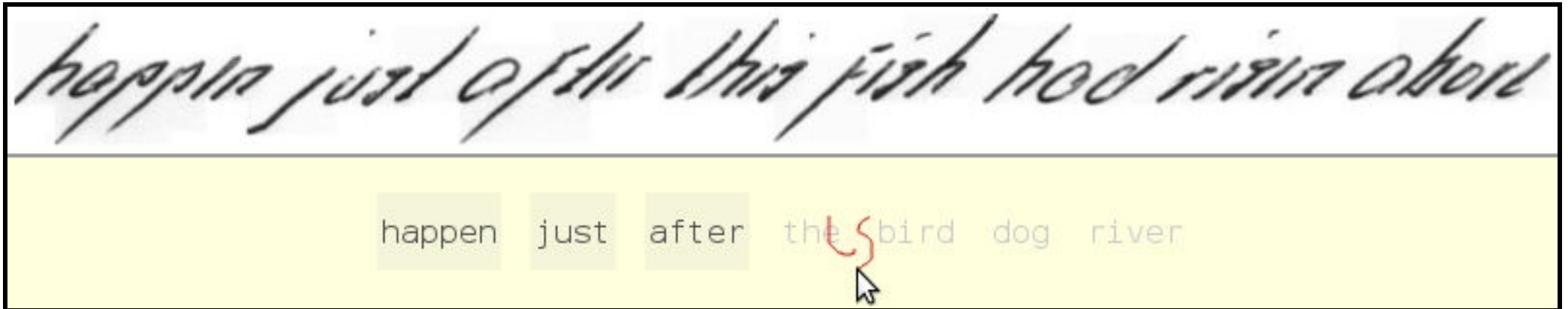
Structured input (fixed order)



Desultory input (no order)



Interactive Handwriting Transcription



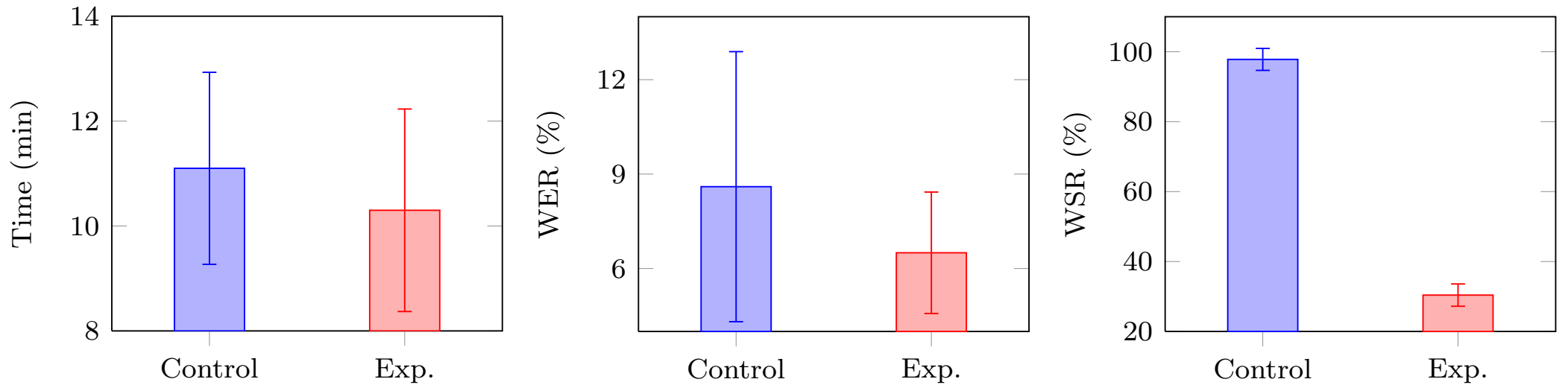
Automatic output: “Happen just after the bird dog river”

Corrective feedback: “Happen just after th” + pen strokes

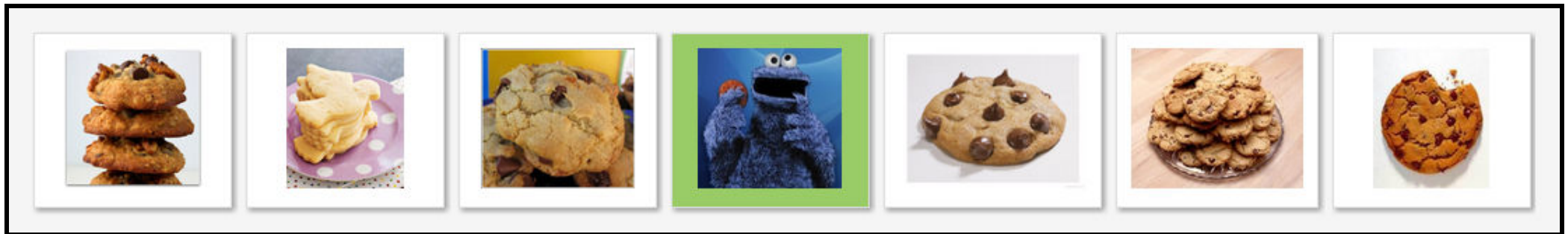
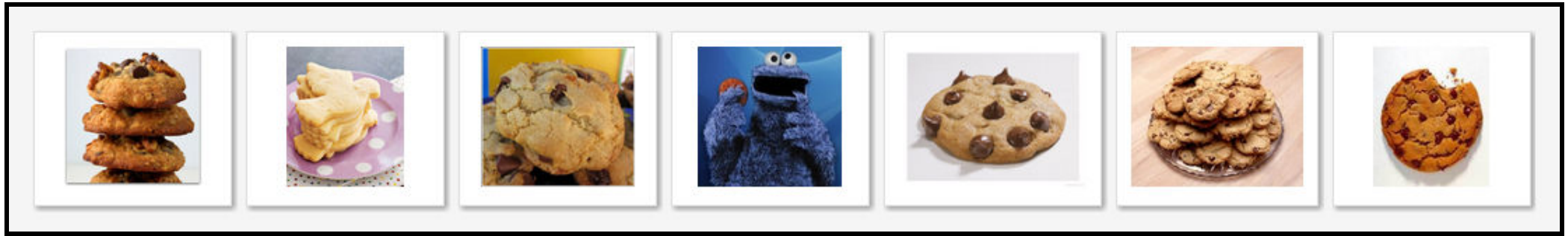
Amended output: “Happen just after this fish hod risen above”

Evaluation Results

2 groups of 13 users each



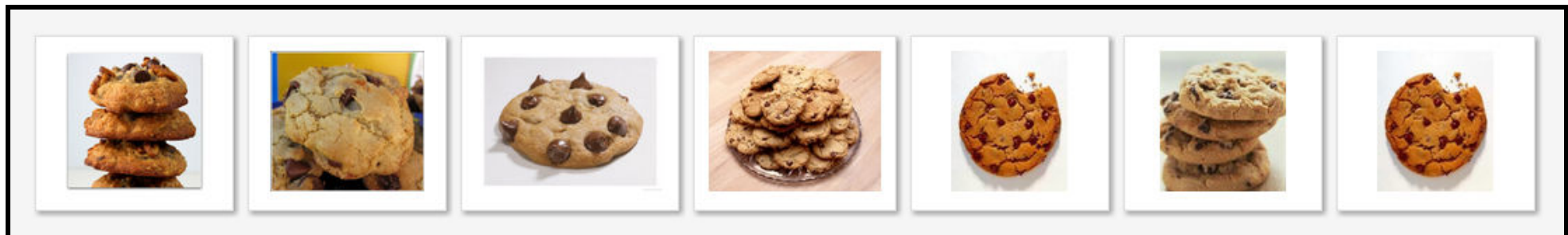
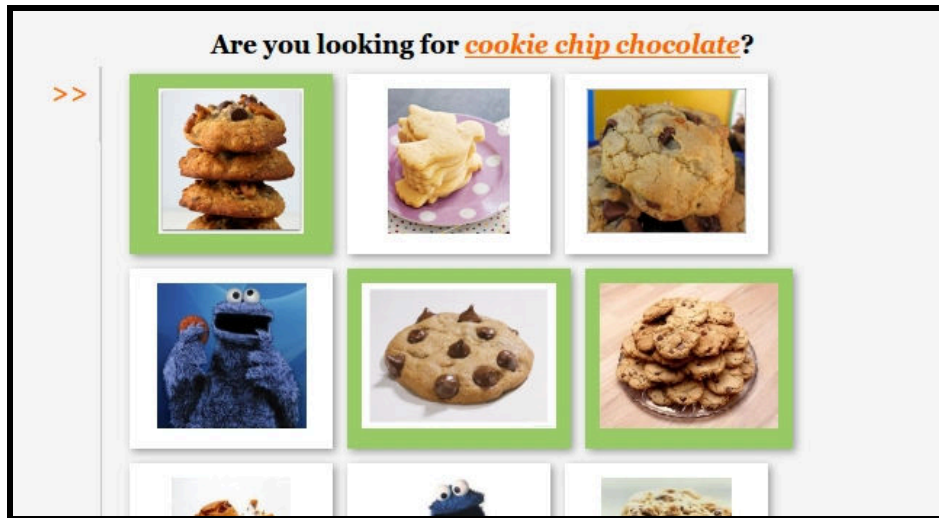
Interactive Image Retrieval



Interactive Image Retrieval

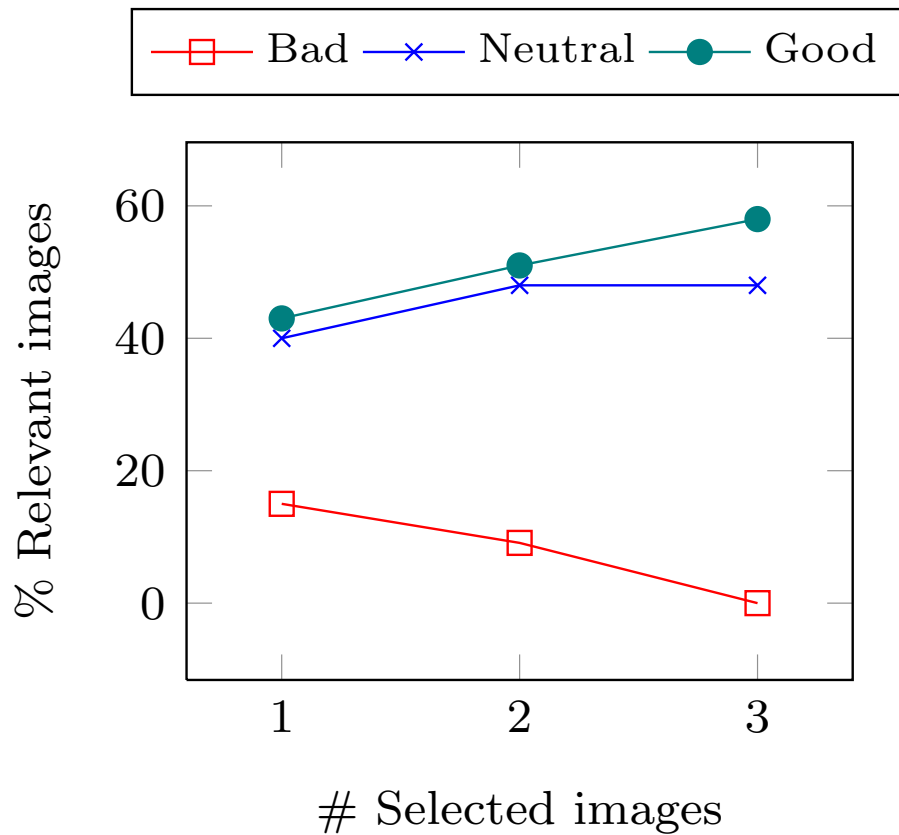
Query refinement suggestion

Tag cloud suggestion

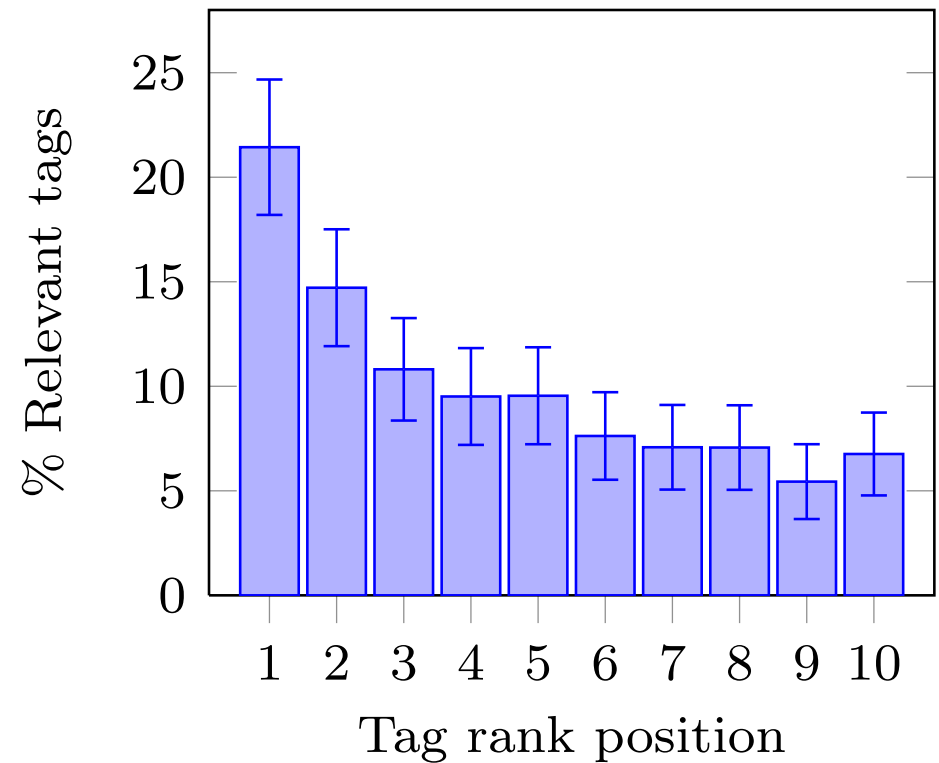


Evaluation Results

Query refinement suggestion



Tag cloud suggestion



Conclusions

Conclusions

Virtually any application can benefit from implicit interactions.

Advantages

- Every user interaction may contribute to enhance the system utility.
- They are a useful complementary tier.
- They can be gathered for free, without burdening the user.
- They are valuable to understand how people interact with computers.

Drawbacks

- They do not provide always clear information.
- Some assumptions need to be made.

Research Dissemination

In the **academia**:

- 23 Conference papers (plus 3 in preparation)
- 3 Journal papers (plus 4 in preparation)
- 3 Workshop papers
- 3 Book chapters
- 3 Research awards

In the **industry**:

- 4 Technology transfer projects¹
- 3 Issued patents (pending)

¹ Available at <http://www.upv.es/carta/>

Appendix

Available prototypes:

1. Interactive Usability Evaluation: <http://smt2.googlecode.com/>
2. Sequential Clustering: <http://personales.upv.es/luileito/wkm/>
3. Human Multitasking: MouseHints Firefox extension
4. Adaptive UIs: <http://personales.upv.es/luileito/ace/>
5. Interactive Image Retrieval: <http://rise.iti.upv.es/>
6. Other deployed MIPRCV prototypes: <http://cat.iti.upv.es/>

Acknowledgments



Outlook

Prevalence of web applications

Cursor data: mouse/pen vs. touch

Future work



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