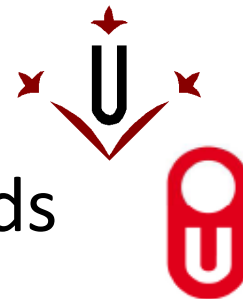


**Measuring cognitive processes
involved in the web search:
log files, eye-movements
and cued retrospective reports
compared**

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Introduction

Information Problem Solving

Define the problem

Search for Information

Scan information

Process information

Organize and present information

Involved cognitive processes

How to unravel them?

Brand-Gruwel, Wopereis & Vermetten (2005)



Introduction

**LOG
FILES**

**EYE-
MOVEMENTS**

*Involved cognitive
processes*

How to unravel
them?

**CUED
RETROSPECTIVE
REPORTS**



Introduction

LOG FILES

Digital recordings of the changes over time on the screen

Provide information on *overt actions* made on the screen during the task

😊 Several participants can be recorded at the same time

😊 Real interactions by real users without intrusion

😊 Free and easy use

😞 Eye-movements not registered

😞 Thoughts not registered



Introduction

☺ Provide overt actions but also provide unique information concerning what is visually attended to, in what order, and for how long (Van Gog & Scheiter, 2010)

EYE-MOVEMENTS

- ☹ Expensive
- ☹ Can not be used in a natural setting
- ☹ Not with more than one person at the same time
- ☹ Thoughts not registered



Introduction

Capture verbalizations of thought processes after task performance cued by a replay of one owns eye movements

☺ Less inferences about underlying cognitive processes

**CUED
RETROSPECTIVE
REPORTS**



Introduction

Research question:

‘What kind of cognitive processes involved in web-based problem solving can be retrieved using the three evaluation techniques:
Log files,
Eye movements,
and Cued retrospective reports?’



Method

N = 17

Materials

Participant questionnaire

Interest questionnaire

Prior knowledge questionnaire

During task performance:

- ↑ Log-files were captured
- ↑ Eye-movements were tracked

Afterwards:

- ↑ Some participants reported on their thoughts during a sub task while reviewing their overt actions and eye-movements in a 75% speed (recorded)

Task

A web-based activity

to complete a concept map about the planet Mars

and to explain the conditions must have a planet for life could be held in it

using information from the WWW



Method

Data analyses procedure

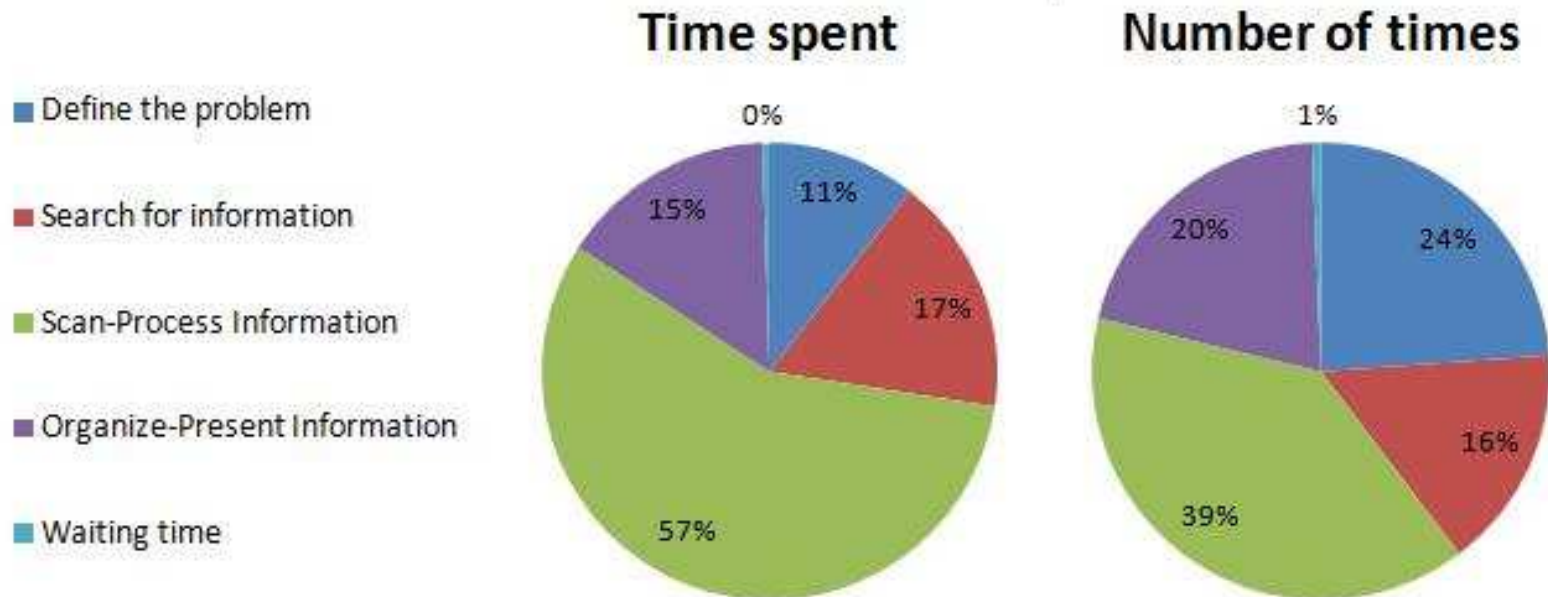
1st level: surface analyses

2nd level: in depth analyses



Results

LOG - First level



Time spent on and number of times performed each constituent process



Results

LOG - Second level

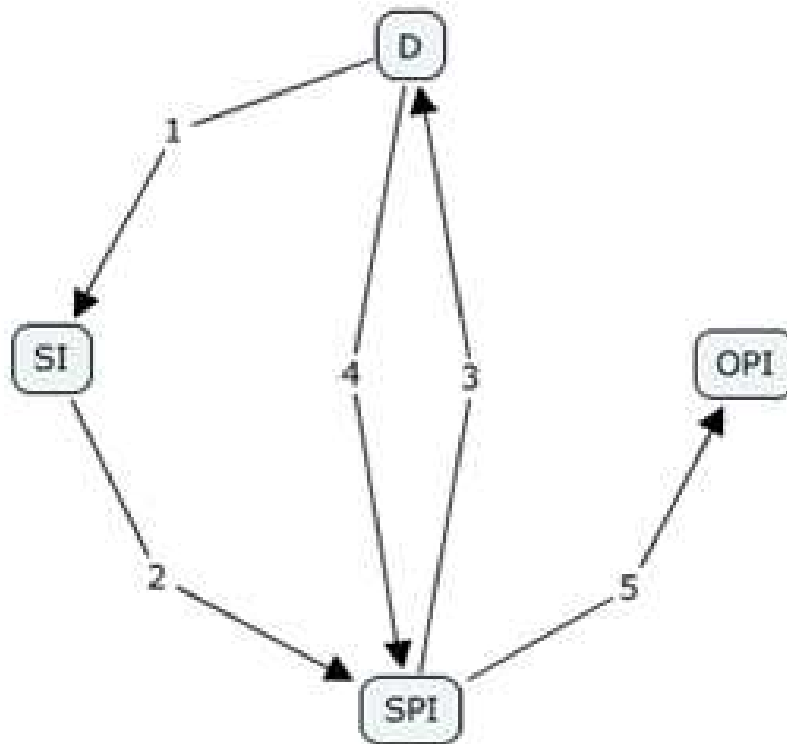
Sub processes performed by participant 10 in her/his first sub task: time spent (in minutes) and number of times

Constituent processes	Sub processes	Time spent	Number of times
Define the problem	Analyses of the Demand (AD)	0:36	2
	AD-Reading the task (AD-READ)	0	0
	AD-Determinig the information needed (AD-NEED)	0	0
	Consulting of the Demand (CD)	0:09	1
	CD-Reading the task (CD-READ)	0	0
	CD- Determininig the information needed (CD-NEED)	0	0
Search for Information	Web Adress Typing (WAT)	0	0
	Search Terms Typing (STT)	0:08	1
	Search-engine Options Use (SOU)	0	0
	Select a Result (SR)	0:46	3
Scan and Process Inf.	Look at the Web Page (LWP)	1:35	2
	SCAN-SCroll (SCAN-SC)	0	0
	SCAN-Follow Words (SCAN-FW)	0	0
	READ-Follow Sentences (READ-FS)	0	0
	Look at an IMAGE (IMAGE)	0	0
Organize and Present Inf.	Objective Answers (OA)	0	0
	Explanation Answers (EA)	0:16	1
Other actions	Adjust the Page (AP)	0:01	1
	Select a Link (SL)	0	0
	Click (CK)	0:16	6
	Technical Aspects (TA)	0	0
	Waiting Time (WT)	0	0
	Total		3:47



Results

LOG - Second level



LEGEND
D: Define the problem
SI: Search for information
SPI: Scan and Process Information
OPI: Organize and present information

Search Terms Used:
1. mars

Answer given:
Channels
CORRECT

Graphical representation of the first sub task
performed by the participant 10



Results

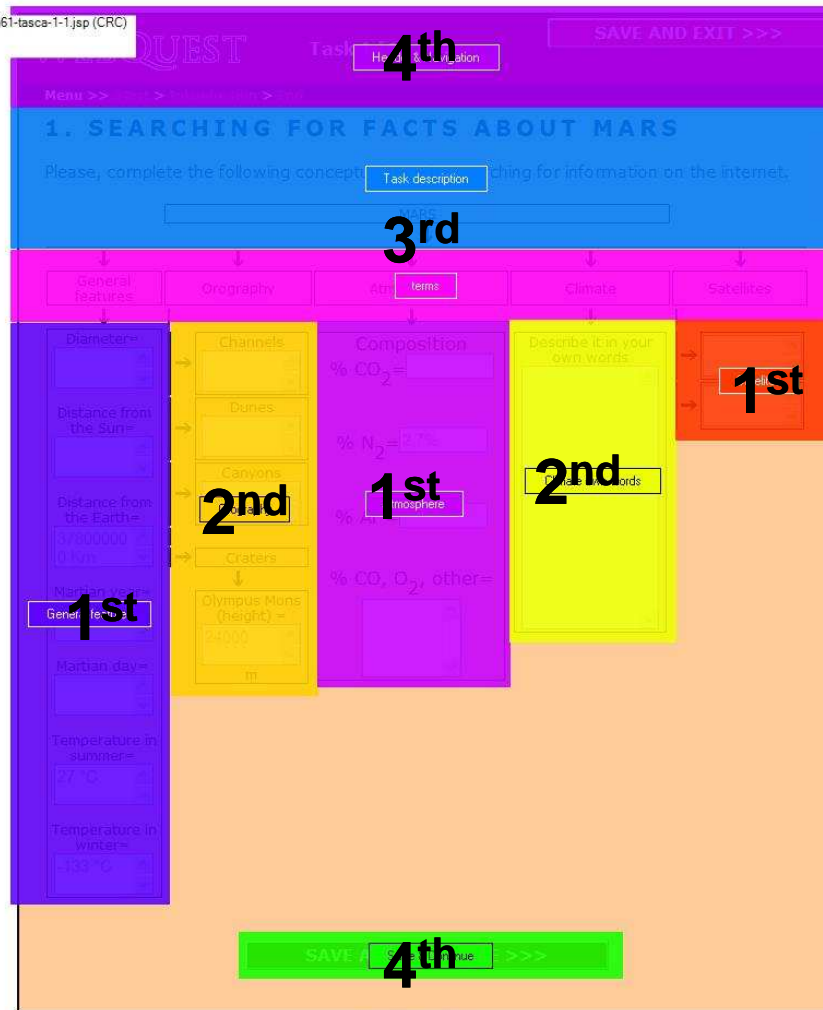
AOI hits

Time to first fixation

EYE - First level

Total fixation duration

Media: <http://webquest.udl.cat/Activitat-61/a61-tasca-1-1.jsp> (CRC)
Time: 00:00:00,000 - 00:00:00,000
Participant filter: All



1st

“present information: fact finding” (76.06 sec, *SD* = 39.56)

2nd

“present information: explanation / organization” (62.54 sec, *SD* = 55.13)

3rd

“define problem” (24.51 sec, *SD* = 12.75)

4th

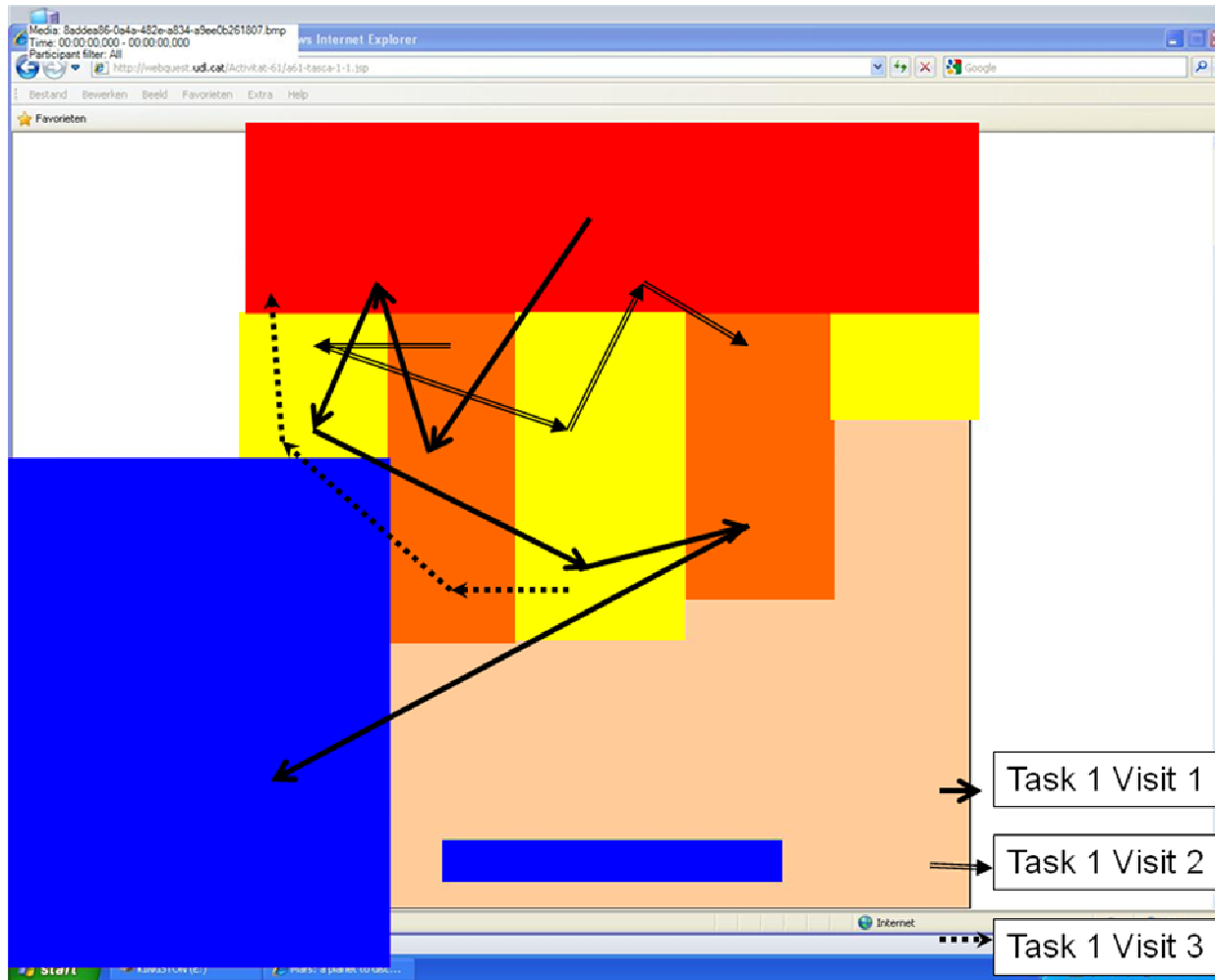
“navigation” (3.27 sec, *SD* = 3.28)

4th



Results

EYE - Second level

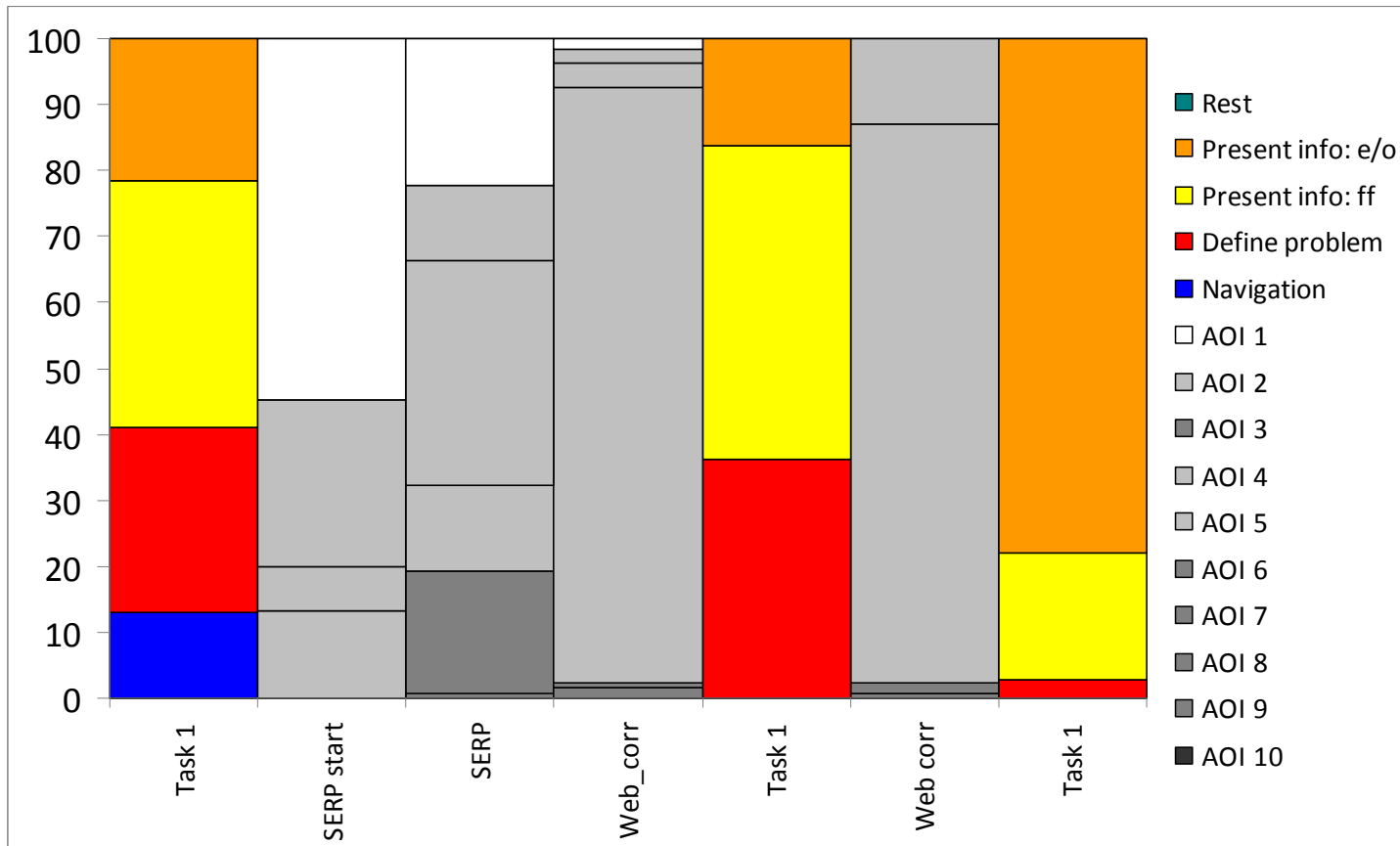


Viewing order over time for participant 10 in her/his first sub task (Task 1)



Results

EYE - Second level



Viewing pattern over time for participant 10 in her/his first sub task (Task 1)



Results

CRR - Second level Constituent processes and sub processes

Constituent processes	Sub processes	Number of utterances	
Define the problem	Analyses of the Demand (AD)	1	
	AD-Reading (AD-READ)	3	
	AD-Information Needed (AD-NEED)	3	
	AD-Formulating questions (AD-QUEST)	0	
	AD-Activating prior knowledge (AD-PRIOR)	0	
	AD-About the product (AD-PROD)	0	
	Consulting of the Demand (CD)	0	
	CD- Reading (CD-READ)	0	
	CD- Information Needed (CD-NEED)	3	
	CD- Formulating questions (CD-QUEST)	0	
	CD- Activating prior knowledge (CD-PRIOR)	0	
	CD- About the product (CD-PROD)	0	
	Search for Information	Web Address Typing (WAT)	0
		Search Engine Chosing (SEC)	0
Search Terms Typing (STT)		1	
Search-engine Options Use (SOU)		0	
Select a Result – Assessing by Usability (SR-A-U)		0	
Select a Result – Assessing by Reliability (SR-A-R)		1	
Select a Result – Assessing by U & R (SR-A-UR)		0	
Select a Result – Assessing no specifying (SR-A)		5	
(...)			

Sub processes reported by participant 10 in her/his first sub task:
number of utterances given



Results

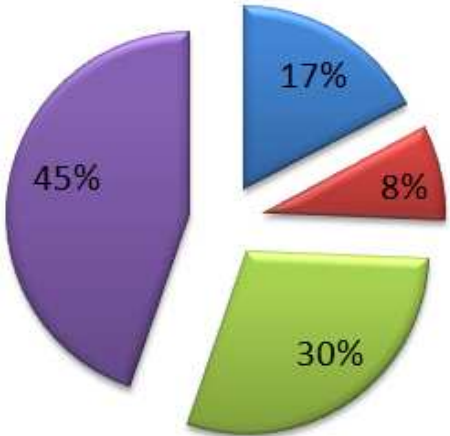
CRR - Second level Regulation activities

		Number of utterances
Orientation	Orientation on the task (O-TASK)	0
	Orientation on the time (O-TIME)	0
MS	Monitoring-Steering (MS)	16
Testing	Checking the size of the text (T-SIZE)	0
	Checking the quality (T-QUAL)	0
	Checking the style (T-STYLE)	0
	Checking the completeness (T-COMP)	0
	Checking the overlap ideas (T-OVER)	0
Total		16

Regulation activities reported by participant 10 in her/his first sub task:
number of utterances given



Comparison

LOG	EYE	CRR										
<ul style="list-style-type: none"> -Time spent by each action. -Number of actions. -Search terms typed. -Web pages visited. -Answers given. <p>Overt actions that give insight about cognitive processes.</p>	<ul style="list-style-type: none"> -Time to first fixation. -Total fixations. -Total time fixations. -Order of fixations. <p>Attentional processes and give insight about cognitive processes.</p>	<p>Utterances about:</p> <ul style="list-style-type: none"> -actions ■ -attentional processes ■ -cognitive processes ■ -regulation activities ■ <p>Number of utterances:</p>  <table border="1" style="display: none;"> <caption>Data for Pie Chart: Number of utterances</caption> <thead> <tr> <th>Category</th> <th>Percentage</th> </tr> </thead> <tbody> <tr> <td>Regulation activities (purple)</td> <td>45%</td> </tr> <tr> <td>Cognitive processes (green)</td> <td>30%</td> </tr> <tr> <td>Actions (blue)</td> <td>17%</td> </tr> <tr> <td>Attentional processes (red)</td> <td>8%</td> </tr> </tbody> </table>	Category	Percentage	Regulation activities (purple)	45%	Cognitive processes (green)	30%	Actions (blue)	17%	Attentional processes (red)	8%
Category	Percentage											
Regulation activities (purple)	45%											
Cognitive processes (green)	30%											
Actions (blue)	17%											
Attentional processes (red)	8%											

Information retrieved by each technique



Discussion

The kind of information retrieved by each technique can give a distinctive contribution into the understanding of the IPS task. Complementarity.

	LOG	EYE	CRR
Advantages	<ul style="list-style-type: none">☺ All the actions are retrieved☺ Not intrusive technique☺ Objectivity☺ Easy to be used by educators	<ul style="list-style-type: none">☺ All the attentional processes are retrieved	<ul style="list-style-type: none">☺ Overt actions are retrieved☺ Attentional processes are retrieved☺ Cognitive processes are retrieved☺ Regulative activities are retrieved
Caution	Cognitive process overt actions!	Calibration! Definition of AOIs!	Previous training is needed to reduce risks! Short tasks!



Thank you for your attention!

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