

# An Exploratory Web Log Study of Multitasking

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## ABSTRACT

The Web search multitasking study based on automatic task session detection procedure is described. The results of the study: 1) multitasking is very rare, 2) it usually covers only 2 task sessions, 3) it is frequently formed into a temporal inclusion of an interrupting task session into the interrupted session, 4) the quantitative characteristics of multitasking greatly differ from the characteristics of sequential execution of one and several tasks. A searcher minimizes task switching costs: he avoids multitasking and while multitasking he uses cheapest manner of task switching.

## Categories and Subject Descriptors

H.3.3 [Information Search and Retrieval]: Search process.

## General Terms

Algorithms, Experimentation, Human Factors.

## Keywords

Multitasking, Web log analysis.

## 1. INTRODUCTION

Multitasking is one of the processes mostly actively investigated by cognitive science (e.g. [3]). While multitasking considered previously (driving, dispatching, etc) is mostly *externally triggered* multitasking, the Web search is an area of free choice of tasks execution. Multitasking is an expensive manner. So the conclusion “*multitasking information searching is a common behavior*” [5] seems surprising. However, [4,5] consider all cases of different tasks execution as ‘multitasking’ and make no distinction between multitasking and *sequential* search, in which a searcher executes tasks one-by-one: he starts and ends one task, then starts and ends next task. During multitasking a user executes tasks, interrupting one and returning to the interrupted task later. A true multitasking search is rare and cannot be investigated manually [4,5]. To study it we elaborated an automatic procedure of task session detection. Then the results were checked manually.

**Terms Used.** In this paper, we use the notions: 1) a *temporal session* as a sequence of the single client's transactions with the search engine cut from previous and successive sessions by certain cut-off interval; 2) a *task* as a search of the same or of similar objects; 3) a *task session* as all transactions of a temporal

session executed the same task; 4) We distinct between *sequential* execution of several task sessions when the tasks are executed one-by-one and a *parallel* execution when a searcher switches between unfinished tasks (multitasking). 5) A maximum number of unfinished tasks during a temporal session is called a session *width*. If the width of a temporal session is bigger than 1 this session is referred to as “*wide*”.

**Data Used.** To detect real-life multitasking search we use log samples of 2 search engines: the Russian *Yandex* (2005, a week sample, 175,000 clients) and the *Excite* (2001, a day sample, 305,000 clients). The latter data are used to yield the results comparable with both *Yandex* results yielded by the same tool and the results previously elaborated on the same log. On the pre-processing stage, the clients, who are likely to be local area networks, were eliminated. To segment a time series of a client's transactions into temporal sessions we use 15min cut-off.

## 2. QUESTIONS AND HYPOTHESES

(a) How frequent are parallel task sessions? How are temporal sessions distributed over a session width?

(b) *Patterns of task session switching.* For unfinished task sessions it is less likely that a transaction of one unfinished session be followed by a transaction of another session. In particular, transactions of parallel task sessions or remaining parts of these sessions are not randomly ordered over time.

(c) *Patterns of task session resumption.* How is an interrupted task session resumed in multitasking — by a new query or by viewing the results of the interrupted query? Does this manner differ from a manner of a “continuation” of a sequential session?

(d) Do quantitative characteristics of multitasking sessions (length, duration, query length, etc.) significantly differ from the characteristics of the sessions executed one-by-one?

## 3. METHOD

To study multitasking Web search we use 2-stage approach. The first stage includes an automatic tasks and multitasking detection. These results are manually verified at the second stage.

A similarity between *any* queries may be detected indirectly, as a similarity between sets of documents relevant to the queries. A similarity between queries *of the same user* submitted in the *same session* may be detected also directly. We follow the former approach and our first-stage procedure 1) fills a matrix of pairwise orthographic similarity of queries; 2) makes a transitive closure of this relation and considers any connected component as a single

task; 3) detects wide temporal sessions and stores them. While other ways to detect queries similarity exist [1,2], the direct approach is simple and effective for multitasking detection.

To detect similarity the procedure converts a source queries into low letters, deletes blanks and punctuators (e.g. query <Jozeph-Lui +Gay-Lussac> is glued into *gjozephluigaylussac*) and finds high correlated substrings in each pair of these strings. If a pair of substrings is found, the procedure checks (1) if the substring of at least one string doesn't intersect with an auxiliary part of speech in the original query and (2) if both substrings don't intersect with inflective endings (for the inflective Russian language). If yes, the original queries are marked as similar, otherwise the next pair of correlated substrings is checked.

This approach doesn't cover synonymy. However, the logs present a lot of misprints, variations and non-vocabulary words rather than synonyms. The procedure covers these problems. During an active search users frequently describe in different queries *different* sides of the same object (queries are "compatible" rather than similar): The procedure detects doesn't detect compatibility. Besides, since the procedure doesn't recognize *branches of the same task* it may not detect parallel execution of these branches.

**Table 1. Sequential and parallel tasks in 2 search engines logs**

	Yandex, 2005			Excite, 2001		
Type and number of tempor.sessions	1-task	>1 task	wide	1-task	>1 task	wide
	166508	34138	2069	296491	40750	4046
Tasks/temp.session	1	2.19	2.30	1	2.21	2.35
Task continuation by new query (%)	26.9	53.1	52.4	26.8	52.4	52.8
Unique queries / task session	1.3	1.2	1.5	1.3	1.2	1.5
Unique queries / temporal session	1.3	2.6	3.4	1.3	2.6	3.5
Transactions/query	1.6	1.5	2.0	1.7	1.6	2.0
Terms / query	2.6	2.8	2.3	2.5	2.7	2.0
Duration (min)	1.7			1.2		
of 2-query session	5.6	6.9	13.6	4.5	5.7	11.5
of 3-query session	9.0	11.0	14.3	7.4	8.9	11.8

#### 4. RESULTS OF AUTOMATIC ANALYSIS

The analysis of automatically detected multitasking answers research questions. Searchers follow the principle of least effort and select the cheapest tactics in any situation; (a) more than 98% of temporal sessions are sessions of sequential execution; (b) during multitasking a searcher uses only 2 tasks and (c) he frequently executes them in an "enveloped manner": he interrupts one task session, starts and completes the second task session and returns to the unfinished task.

(d) We consider separately 3 types of temporal sessions 1) sessions which include only one task ("1 task" column in Table 1); and 2 types of sessions containing more than 1 task and which, therefore, may be executed either 2) *sequentially* one-by-one (">1 task" column); or 3) in parallel (*wide* sessions). Table 1 shows quantitative characteristics of the search. First of all, logs of both search engines show surprisingly similar characteristics. Next, the

characteristics of *all* types of temporal sessions are very different: not only multitasking differs from both types of sequential execution but also execution of 1 task differs from execution of more tasks. The "queries/task", "transactions/query" and "terms/query" characteristics show an interesting non-monotonicity over different types of sessions: sequentially executed task sessions are shorter than task sessions of both other types but queries of these sessions are longer. This fact cannot be completely explained by task complexity and searcher's estimates of it.

#### 5. CONCLUSION

The procedure reveals great differences between each 3 types of sessions. However, *are these differences real differences of real task sessions rather than procedural artifacts?* Also, *are automatically discovered multitasking properties real properties?*

The procedure doesn't always detect queries similarity and doesn't detect compatibility. As a result, the number of detected task sessions turns out to be bigger and the width of temporal sessions is overestimated. However, we can use this *systematic* bias as an *advantage*: to check the results of automatic multitasking extraction we should manually verify *only those* temporal sessions, which were detected as wide. 200 wide temporal sessions were manually verified. The results are: 1) the automatic procedure overestimates the number of wide sessions near *twice*; 2) an automatic detection of sessions whose width is bigger than two is an artifact and may be explained by the *active search*: when a user searches actively he frequently reformulates queries of the same task in new terms; 3) in other respects manually approved multitasking shows the same dependencies as automatically detected multitasking.

Thus, multitasking is *very uncommon* behavior (1%). However, the final question is "Does multitasking search exist?" and the final diagnosis may be "non-existing". Indeed, (1) 1% of multitasking sessions may be the artifact resulted from non-exclusion of local area networks; (2) multitasking *usually* is more expensive than sequential execution of the same tasks. A cost-motivated user may select multitasking when it is less expensive (he submits a query not to forget the task) or when he estimates these costs as negligible.

#### 6. REFERENCES

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