

AN003: Analysis of Technical Operations Job Tasks Final Report

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16. Abstract This project developed a search tool to identify matches, or a lack thereof, of course material, within a corpus of FAA course materials, that would match job task statements from the Job Task Analysis (JTA) data, which is a set of Excel spreadsheets. The method behind the matching analysis is detailed in the AN002 portion of this report. This portion of the report, corresponding to the AN003 project, largely discusses interface options and the interface implementation. The actual implementation is a simple output format intended to be a starting point for further development.					
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EXECUTIVE SUMMARY

This report describes the AN003 portion of the Automated Analysis of Technical Operations Job Tasks project. AN003 was focused on providing a display option for the search tool which is built on a formal language method. The overall goal of this work is to support the FAA's desire to develop a model for integrating job task analysis (JTA) data into courses that have no task alignment with course material. The objective of the search tool within this work is to identify whether or not job task statements within the JTA appear within the course material. In the first stage, the JTA for eight courses was studied so that the alignment of task statements within the JTA and course material could be evaluated manually. In the second stage, a natural language processing method was used to search for job task statements or equivalents within the course material. The output of this method identify task statements that may fully or partially match, or are missing from the curriculum materials of interest. A simple output method was utilized to ensure a product could be delivered, while studying more state-of-the-art methods for displaying search results that would be the basis for future recommendations. Despite a large amount of work on displaying search results, there is only general guidance for developing an improved output display.

INTRODUCTION

The aim of this portion is to provide an in-depth view of search processes and propose options for the search output presentation. In this work, we divide the search processes into activities which are connected with the points where we make decision and run through JTA data and curriculum material directory.

This report is organized in standard format of a technical report. First, the problem, the issue of search output presentation, is introduced. This is followed by a background section where we discuss literature relating to the output of a search process such as this, and a methodology section where we present the way that is used to analyze the search processes. Next, in the analysis section, we depict the search process in a flowchart. The chart includes activities, the JTA, decision points, and the document corpus in three separate processes. Display options are then provided for the different search tasks in the result section, followed by a discussion section. Additional measures of matching are suggested. The report closes with a conclusion that summarizes the key findings.

PROBLEM

The problem was how to identify and display whether one or more columns of data in the JTA matched or did not match with relevant materials in a subset of the corpus of course materials. The difficulties with this problem related primarily to (1) the mechanics of searching for a text string within heterogeneous file types while not missing content that is functionally the same but not identical to the search string; and (2) the result of a negative (“no match”) finding from such a search is likely to be inconclusive due to the limitations of current methods. At least the first of these problems is discussed in the ANOO2 portion of this report.

Of more relevance to this part of the report is, once a result is obtained from the method, how should its output be presented? The search process would produce information on the alignment/unalignment search results, such as the exact matching words/phrases and its location in the corpus of course material. What information to display in the search results and in what format needed to be identified and an interface built. We viewed the latter problem as of primary importance; that is, rather than spend considerable time researching how to best output search results and then build an interface, we decided to build a simple interface, so that something was completed, and then consider how that output format might be improved. That consideration would include both past published scholarly work and user feedback.

BACKGROUND/LITERATURE REVIEW

The AN002 report contains a number of references on searching in general. For this portion of the report, we focus on what human-computer interaction scholars have said about the presentation of search results. This review will be short, because while a considerable amount of published work exists that discusses, at least in part, output of search results, no practical, implementable guidance is provided in that work. References are provided to that volume of work, but it is not discussed at length because it is not relevant to the practical interface problem the FAA faces.

Published work on search output provides taxonomies and considerations (see Wilson, Kules, schraefel, and Shneiderman, 2010 and Elbedweihy, Wrigley, Clough, Ciravegna, 2015 for reviews), mainly for web searching, which is a different task than this one. Web searching can be “open-ended,” in that users do not necessarily know for what they are looking, so search output must accommodate this possibility (White and Roth, 2009; Thudt, Hinrichs, and Carpendale, 2015; Zamir and Etzioni, 1999) Additional work studies the processes individuals use when searching (e.g., Albertson, 2015).

In general, search output interfaces are designed by graphical designers, following some general principles provided by HCI researchers. As such, it is largely an artistic process, rather than an engineering one. One can identify interfaces that are effective for the particular task, but few, if any, general principles can be extracted from them for use in other interfaces because they are specifically designed for the original problem context. As a result, what one finds in the literature are specific examples of methods used for particular tasks (e.g., Hearst, 1995; Shneiderman, Byrd, and Croft, 1997; , rather than an exposition of principles for developing an interface. The common approach to developing such interfaces is to build the interface (graphical design), and then apply usability methods to evaluate and improve it, rather than initially build the interface from established principles (Chen and Gross, 2017).

METHODOLOGY

The search tool could be applied to conduct three kinds of search tasks, as follows:

1. Cross-referencing search: cross-referencing the JTA data (Excel spreadsheets) and the course materials (corpus). This is, effectively, a one-time operation, with a report on the matching that is identified. This is the overall picture of the alignment of the two sources of data – what is in the JTA data that is not in the

corpus and vice-versa.

2. Refined cross-referencing search: cross-referencing from a topic list, which is selected from the "Task Statement" column.
3. Keyword search: This search is similar to using Google standards – quotation marks, AND, OR, plus have a checkbox for whether or not to use semantic searching.

Therefore, for proposing output presentations. We conduct the analysis of the search processes based on the requirements. Then, we suggested options of the output presentation for a particular search task.

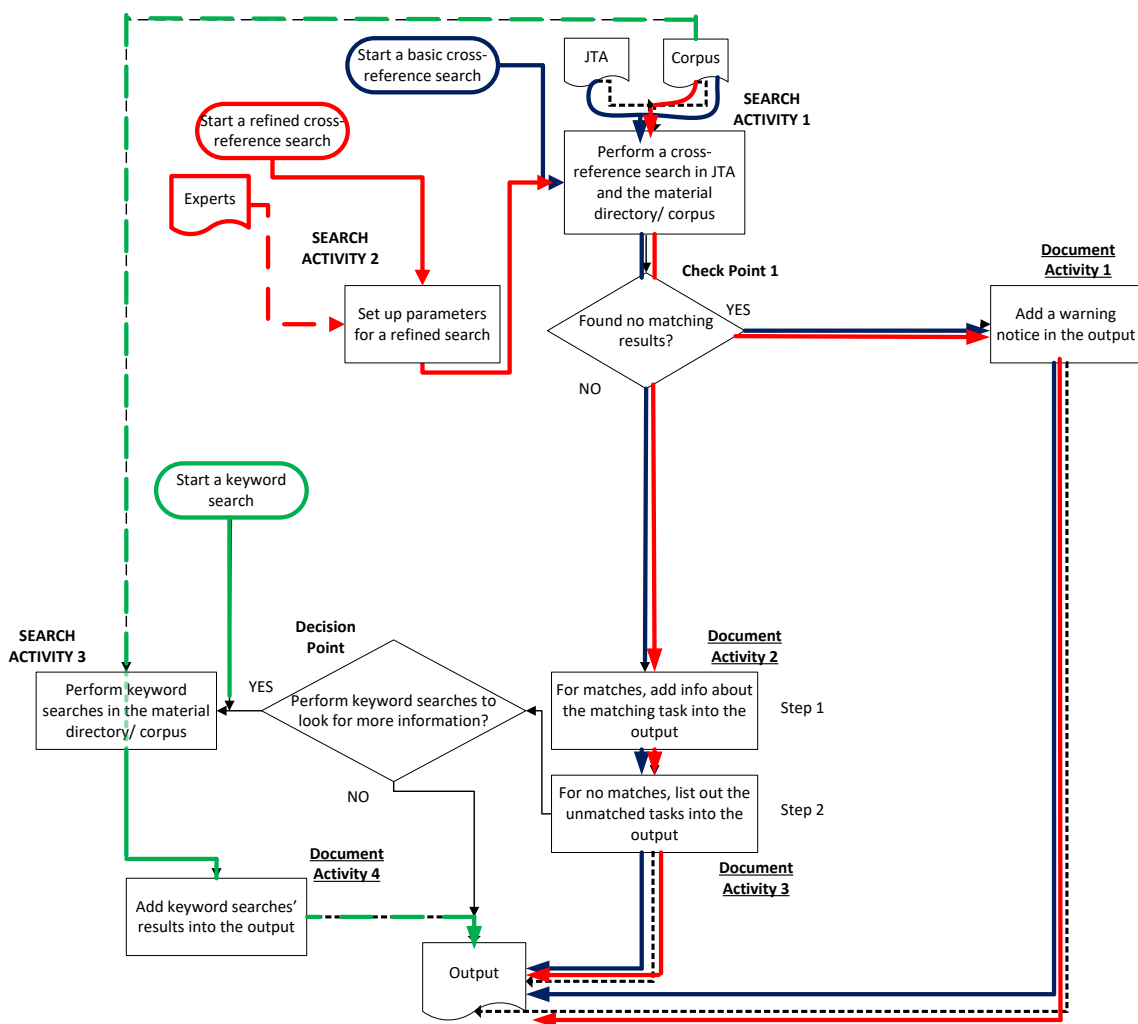


Figure 1. Flowchart of the search process.

Flowchart Legend.

Decision Point. The decision point, denoted by a diamond shaped sign, is where the users make a selection decision: to perform a particular task or not-to perform this task. For example, the users decide to select an additional keyword

search.

Check Point. The check point is also denoted by a diamond shaped sign, is a step in the search process that the users have to inspect the result of a search task. The tool has a function to check if the search result is attained.

Search Activity. Search activity, denoted by a rectangular shaped sign, describes an action that the users can perform or this action being programmed in the search tool.

- Set up parameters from the input portals
- Perform a cross-reference search depending on the inputs
- Perform a keyword search

Document Activity. Document activity is the action about the document when the document was created or edited.

- Document Activity 1: Add the notice into the output
- Document Activity 2: For matching tasks, add info about the task into the output.
- Document Activity 3: For nonmatching tasks, list out the tasks into the output.
- Document Activity 4: Add keyword searches' results into the output.

The analysis of search processes is depicted in Figure 1. This flowchart describes three options for search activity that were considered.

In the first option, the cross-referencing search performs a search from the course materials (corpus) to match the “task statement” column in the JTA database. This basic search is highlighted in the flow chart by the dark blue color. In the second option, a refined cross-referencing search will search a topic list within the courses' corpus and then it returns the search results. The topic list is selected from the "task statement" column by the decision makers. A refined search is highlighted in the flow chart by the red color. In the last option, a keyword search is performed by inputting one keyword or a list of keywords. A keyword search is highlighted in the flow chart by the green color.

The other activity and decision points in the chart indicates the additional action options the decision makers could select if they want to execute an extra search task instead of restarting another new search from the beginning.

RESULTS

Depending on the purpose of using the search tool, such as basic search, refined search or keyword search, the output would include the information identified in Table 1.

Table 1. Output based on search type.

Basic search	Refined Search	Keyword Search
<p>Return the search result for a basic search (exact match)</p> <ul style="list-style-type: none"> • If the search task returns a 100% match, display information about matching terms in the output report <ol style="list-style-type: none"> 1. Frequency of each term, ranked from the highest rate to the lowest rate 2. Location of each term in the corpus (for checking duplicate content/terms): Course number, folder name, folder location • If the search task returns partial matches, display what is not found, and what is found <ol style="list-style-type: none"> 1. Frequencies of each term 2. Location of each term in the corpus (for checking duplicate content/terms): Course number, folder name, folder location • If the tool return no matching results, propose the following suggestions: <ol style="list-style-type: none"> 1. Perform a refined search with a list of task statements 2. Perform a key word search with single keyword or a list of keywords 	<p>Return the search result for a refined search (exact match)</p> <ol style="list-style-type: none"> 1. Display what is not found 2. Display what is found: <i>frequency</i> of each term and <i>location</i> of each term in the corpus (for checking duplicate content/terms): Course number, folder name, folder location <ul style="list-style-type: none"> • If the search task returns no matching results, propose the following suggestions: <p style="margin-left: 20px;">Perform a key word search with single keyword or a list of keywords</p> 	<p>Return matching phrases (exact matches), or close variations of that phrases (close matches).</p>

An example of the search output is shown in Figure 2.

Search Information			
	Match results	156	
	No matching results	4132	
Output Command			
	Including no-matching results	<input checked="" type="checkbox"/>	
	Sort match results ABC	<input checked="" type="radio"/>	
	Frequency	<input type="radio"/>	

	Score	Task Statement	Frequency	Status	Location	JTA Scalar
1	23	Perform the overall common duties	200	Found		TO.A1
2	22	Identify the opportunities for vertical and horizontal career movement within technical operations	12	Found		TO.ST1

Figure 2. Example output.

This is a very simple output, displaying the simple results and location, but it provides a starting point for usability evaluations and for improvement.

DISCUSSION

Additional options to be considered for output are shown in Table 2.

Table 2. Additional search output options.

Metric	Description
Total search files	Total number of search files in the corpus
DIF Analysis	<p>If the tool finds a match/matches, the task information is displayed in the output:</p> <ol style="list-style-type: none"> 1. DIF: task's difficulty level, task's important level and task's frequency's level <ol style="list-style-type: none"> a. DL: Difficult to Learn (levels: 1-5, from least to most difficult) b. DP: Difficult to Perform (levels: 1-5, from least to most difficult) c. I: Important (levels: 1-5, from least to most important) d. F: Frequency (levels: 1-5, from least to highest frequent) 2. Print out the location (folders' locations or files' locations) where the matching terms are found in the corpus
Additional Task Data	<ol style="list-style-type: none"> 1. Knowledge or Performance 2. Knowledge Proficiency 3. Proficiency 4. Media Recommendation 5. Task Priority 6. Audience Identification

FUTURE WORK

The output shown in Figure 2 should undergo standard usability testing to improve it. This would include heuristic analysis and cognitive walkthrough testing with human-computer interaction experts and users.

Additionally, work should be done on improving the evaluation of matching. Currently a single column is chosen (job task statements), and a semantic search is used to identify matches in the corpus of course material. However, a negative finding (no match) may simply be a failure of the method to identify what a human evaluator would consider a match, but which is not identified by the semantic search.

Such “false negatives” could potentially be reduced by incorporating other columns’ information, as well as other “context” information in the course material. The type of information that could be useful, and how it could be useful, is currently unknown and should be the basis for future work.

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