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Choosing an SAT with SAnTA: A Recommender System for Informal Workplace Learning

Frank Linton
The MITRE Corporation

Mark Brown
The MITRE Corporation

Casey Falk
The MITRE Corporation

Mark Zimmermann
The MITRE Corporation

Sarah Beebe
Ascendant Analytics

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Choosing an SAT with SAnTA: A Recommender System for Informal Workplace Learning

Abstract

Current intelligence community analytic standards encourage the use of structured analytic techniques; these are taught in training programs and supported by analytic tradecraft cells. Yet resources are scarce, timely personalized help is not available to all when it is most needed, and conditions for the improper selection and misapplication of these techniques prevail. The Structured Analytic Technique Advisor (SAnTA) is an electronic interactive job aid that recommends structured analytic techniques to analysts, based on the current state of their analysis and on the synthesized expertise of tradecraft staff. SAnTA is undergoing formative evaluation and iterative development. When released, SAnTA will provide individualized support to a large number of analysts every day.

Introduction

Structured Analytic Techniques (SATs), including qualitative aids aimed at promoting critical thinking and mitigating cognitive mindsets and biases, are increasingly used by analysts in the US Intelligence Community (IC). Moreover, the techniques are officially encouraged in Intelligence Community Directive 203 on Analytic Standards,[1] and many IC agencies check for the use of SATs when evaluating the quality of analysts' reports. Example SATs include the familiar: analysis of competing hypotheses, argument mapping, and devil's advocacy; and the not so familiar: pre-mortem, SWOT (strengths, weaknesses, opportunities and threats), and bowtie.

SATs are currently taught in analytic training programs across the IC and in universities around the world. The growth of SAT usage throughout the IC has also been enabled in part by the emergence of analytic tradecraft cells and primers on the application of these techniques. Some IC agencies have staffed tradecraft cells with facilitators who help analysts select and apply SATs in their analyses. Facilitators guide analysts with a question-based approach to focus on the intelligence question, select relevant SATs, and apply the SATs to the resulting analytic process. These facilitators and analysts are aided in their work by several IC agency-published primers that detail when and how to use various SATs. Facilitators and analysts augment these internal resources along with publicly available resources on SATs.[2]

Nevertheless, barriers remain to the proper selection and use of structured analytic techniques. The high analyst-facilitator ratio and time-intensive facilitation process for many analyses means that a relatively small subset of analysts receive timely, personalized help with SAT selection and application early on in the conceptualization process. Also, the primers often provide static descriptions of techniques and offer little guidance on how to select the proper technique for the analytic challenge at hand. Analysts who do receive training may reach mechanically for techniques with which they have had training or prior experience rather than selecting SATs that aid their current analytic challenge. As a result, the conditions for improper selection and misapplication of SATs are ripe.

The process of increasing one's knowledge by referring to a tradecraft primer or working with a facilitator from a tradecraft cell to select and apply the most appropriate SAT to use in a given situation can be considered *informal workplace learning*,[3] that is, learning that is initiated by the individual at the time of need for the task at hand. Reference materials that assist analysts in their work processes are sometimes developed and made available for certain activities, including SAT selection and

[1] Office of the Director of National Intelligence, *Intelligence Community Directive 203 Analytic Standards* (Washington, D.C.: Office of the Director of National Intelligence, 2007).
[2] Beebe, Sarah M. and Randolph H. Pherson, *Cases in Intelligence Analysis: Structured Analytic Techniques in Action* (Washington, D.C.: CQ Press. 2014).
[3] Michael Eraut, "Informal Learning in the Workplace," *Studies in Continuing Education* 2:26 (2004): 247-273, DOI: 10.1080/1580370420002252 45; Cofer Jr., David A., *Informal Learning in the Workplace: A Brief Review of Practice and Application* (Columbus, OH: ERIC, 2000).

application; these are *job aids*.[4] From a pedagogical perspective, then, the Structured Analytic Technique Advisor (SAnTA), the software we have developed, can be considered a kind of electronic interactive job aid that supports informal workplace learning. However, SAnTA is designed to be used not only by analysts at work, but also by trainers and facilitators.

SAnTA: A Recommender System to Teach SAT Usage

From a technological perspective, SAnTA is best viewed as a recommender system. Before describing the details of SAnTA's design, a few words about recommender systems in general: Most recommender systems are used to help consumers make purchasing decisions, i.e., what to buy next.[5] These are based on finding and grouping people with similar tastes ("people who like the music you like also like…"), or similar items ("people who looked at this book ultimately bought…"). A few recommender systems are used to help people make learning decisions, i.e., what skills to acquire next.[6] The study of recommender systems as decision aids is rare.[7] Finally, the above-mentioned recommenders are all peer-based; however, sometimes knowledge- or expert-based recommenders are called for,[8] and SAnTA is one of these. SAnTA's recommendations are determined by the synthesized expertise of facilitators, based on conditions input by the analyst.

SAnTA is, perhaps, a unique recommender system in that it helps analysts decide how to proceed next, i.e., to decide which critical thinking tool (structured analytic technique) to apply in the analytic process. In the course of making that decision, SAnTA's users are compelled to reflect on the status of their analytic process and to make a defensible choice of SAT, a mindful effort that supports learning.

SAnTA is a knowledge-based recommender system that solicits user input as responses to questions and suggests most-likely-relevant SATs. The user must make the decision of which SAT(s) to use, if any. SAnTA (

Figure 1) provides brief descriptions of each SAT, explanations of how the user's responses influenced the SAT recommendations, and links to further resources on each SAT. SAnTA is written in JavaScript, a design decision that makes it easy to port the software to many environments. The recommendation algorithm is a simple one. To start with, subject matter experts (SMEs), typically the facilitators, rate the applicability

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[4] Rossett, Allison and Jeannette Gautier-Downes, *A Handbook of Job Aids* (New York: Pfeiffer, 1991).
[5] Jannach, Dietar, Markus Zanker, Alexander Felfernig, and Gerhard Friedrich, *Recommender Systems: An Introduction* (New York: Cambridge University Press, 2011).
[6] Frank Linton, "OWL: A System for the Automated Sharing of Expertise," in Mark Ackerman (ed.), *Beyond Knowledge Management: Sharing Expertise* (Cambridge, MA: MIT Press, 2003), 383-401.
Wei Li, Justin Matejka, Tovi Grossman, Joe Konstan and George Fitzmaurice, "Design and Evaluation of a Command Recommendation System for Software Applications," *ACM Transactions on Computer-Human Interaction* 2:18 (2011): 1-35.
[7] Li Chen, Marco de Gemmis, Alexander Felfernig, Pasquale Lops, Francesco Ricci, Giovanni Semeraro, "Human Decision Making and Recommender Systems," *ACM Transactions on Interactive Intelligent Systems* 3:3 (2013): 1-7.
[8] Jannach et al., *Recommender Systems*.

https://scholarcommons.usf.edu/jss/vol8/iss5/8
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of each SAT to each possible input (each response to each question) creating a matrix. Then, as users select their responses, SAnTA computes the ranking of each SAT based on the current response set. As more responses are entered, SAnTA becomes more certain of its recommendations. This design means SAnTA is easily customized. Sets of SATs and sets of questions and responses are easily exchanged.

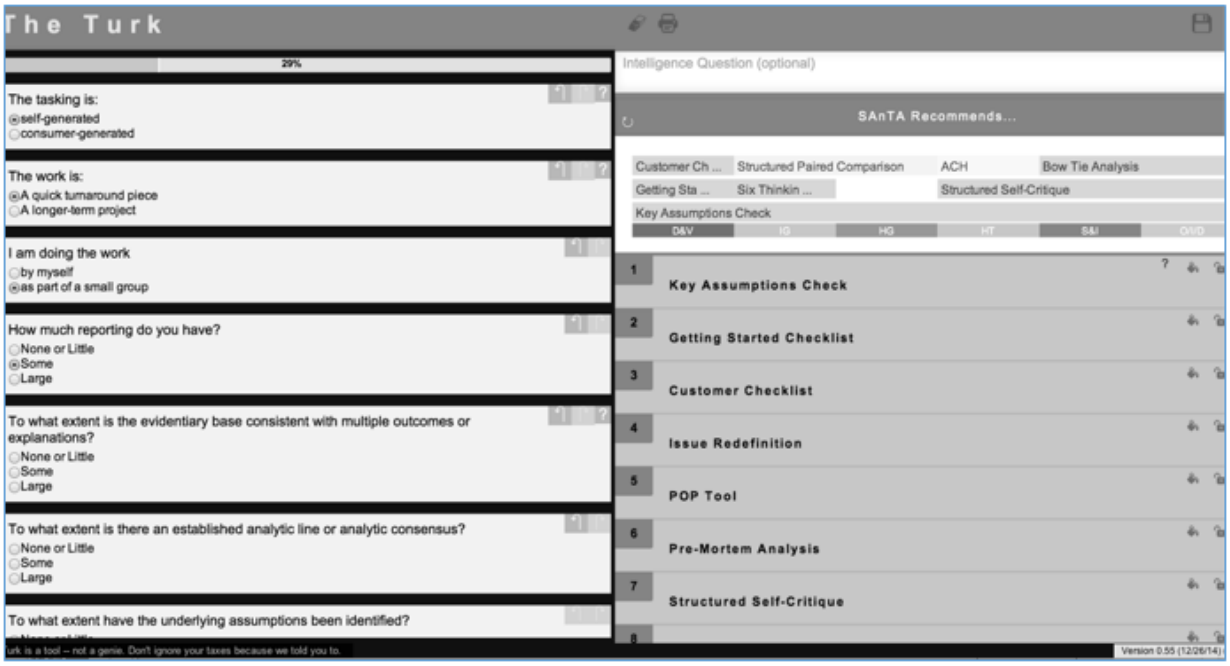

Figure 1. The SAnTA user interface (here: 'The TURK'). In this screenshot, the analyst has begun to describe her analytic situation to SAnTA by responding to the questions on the left side of the screen. On the right side of the screen SAnTA has begun to respond by returning a ranked list of SATs and a graphic depicting where in the analytic process the SATs apply. Not shown are popups describing each SAT, SAnTA's confidence in its recommendations, and popups explaining icons, abbreviated text, etc...

To develop SAnTA, we assembled a research team with strengths in analytic techniques, knowledge capture, and recommender systems. We began our research process by interviewing representatives from across the analytic community who were aiming to improve analytic quality. We discussed needs, approaches, opportunities, and constraints. We confirmed the importance of selecting and applying SATs appropriately and the perception that an SAT recommender could help in addressing the problem. While conducting these interviews we also learned that the likely end users would be not only analysts but also facilitators and instructors.

We decided to do applied research and decided that our success criteria for the design was that analysts would choose to use it. We prototyped and evaluated various designs for the user interface. We experimented with several representations of domain expertise. We enlisted an SME who is a former analyst and frontline manager of analysts, an instructor of SAT usage, and an author or co-author of several SAT how-to

texts. For a programmer we hired a summer intern who turned out to be extremely talented.

We created a series of prototypes (using pure JavaScript for ease of transfer to the end users' security-conscious environments) into which our SME input the various factors that influence SAT recommendations, a list of SATs to recommend, and a matrix characterizing the relationship: how each factor contributed to the strength of the recommendation of each SAT. The SME tested the pre-prototype using historical case studies. We demonstrated this pre-prototype version to the various representatives with whom we had spoken originally, and others, and obtained positive feedback on our approach.

We partnered with one analytic tradecraft group and supported them as they input their own set of SATs to recommend, their set of factors that influenced the recommendations, and the matrix indicating how each factor contributes to the recommendation of each SAT. The resulting version of SAnTA contained the synthesized expertise of this group in its real-world context. These SMEs are currently verifying that SAnTA makes sensible recommendations by giving SAnTA case studies - previously completed projects - and examining SAnTA's output. This version of SAnTA is also being piloted currently with a number of analysts to obtain their feedback.

We continue to iterate the software to improve the design of the user interface, the set of factors that influence recommendations, the set of SATs recommended, and the relationships among them. In order to make SAnTA easy to install in the customer's environment initially, we intentionally sacrificed the ability to log user activity - thereby losing the ability to obtain usage analytics as a basis for continuous design improvement. While an instrumented version of SAnTA would be more complex and harder to install and maintain, it would be a significant step forward in the long-term sustainability of the product.

To summarize, the project goal was to develop a prototype SAT recommender system that analysts and others choose to use. We began by building a prototype and having one SME identify key factors used when selecting SATs. With this as an example, we found a group of SMEs and had them, as a group, validate key factors and, for each factor, the corresponding SATs. We took pains to ensure that our software was modular and that SMEs from different, but related, domains could replace the factors and SATs with their own set. We developed and are distributing an evaluation form to obtain end user feedback. We are asking SMEs to validate SAnTA with previous cases, by comparing SAnTA's SAT recommendations with the SATs actually used.

Current Status

To date SAnTA research has accomplished several things. First, it documents corporate knowledge and best practices by requiring their articulation and synthesis. It does so in a software system that makes this knowledge easily accessible by analysts, trainers, and facilitators. Next, SAnTA contains, and can recommend when appropriate, more SATs than any single facilitator. Third, even if it should turn out to be the case that users need

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not apply an SAT, in the process of determining this they will have reviewed a number of questions that every analyst should consider when creating a product. Finally, SAnTA has been developed in a manner that makes it easy to edit or change out the knowledge base it uses.

At this point SAnTA's expertise and utility have been demonstrated to various members of the analytic community and their anecdotal response strongly favors SAnTA's design. When demonstrated to a group of trainers and facilitators SAnTA was seen as useful. The domain experts were easily able to express their synthesized expertise in SAnTA's representation. Their input is currently being validated using previously completed analytic products, and we will have analysts evaluate SAnTA's recommendations from their perspective as well.

Further research on SAnTA is required, especially developing a stronger validation approach, pursuing the best way to visualize SAnTA's recommendations, determining the factors that influence the use or non-use of SAnTA, and ensuring SAnTA is a robust shell for similar types of expertise.

Conclusion

In its role as an electronic job aid supporting informal workplace learning, SAnTA has several pedagogical functions. SAnTA first requires analysts to articulate their situation in tradecraft terms, that is, to pause and take a meta-level view of their work in responding to SAnTA's questions. Next, it captures their articulated inputs for later introspection and sharing. Finally, choosing which SAT(s) to use from the set of SAT recommendations prompts further reflection and discovery.

Giving analysts control when they use SAnTA, i.e., the ability to change their responses and observe the resulting change in recommendations, together with seeing reasons for the change, enable them to evaluate the specificity, generality, and robustness of the recommendations, to understand the applicability conditions of various SATs, and to begin to internalize this knowledge for later use. The ability of an analyst to save a SAnTA session, including their inputs and the resulting recommendations, enables users, and those reviewing their work later, to reflect on these perceptions and decisions, and may also lead the analyst toward 'just knowing' which SAT to select.

Finally, SAnTA exemplifies the value of recommender systems in the workplace. SAnTA is one of the few recommender systems that helps knowledge workers decide what to do next instead of helping consumers decide what to buy next. The power of recommender systems as instructional media, their ability to provide the exact information needed, at the moment it is needed, seems vastly underutilized. While the precise cost/benefit analysis of SAnTA remains to be calculated, it is easy to see that a few hours of work by the SMEs to input their synthesized expertise has resulted in a system that can provide individualized support to a large number of analysts every day.