Decisively: Application of Quantitative Analysis and Decision Science in Agile Requirements Engineering

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***Abstract*—While many mature Requirements Engineering (RE) tools for Agile exist, RE professionals at large have not been able to benefit from Quantitative Analysis and Decision Science (QUADS) techniques in this context. In this paper we present an Agile RE tool, *Decisively*, which brings a new perspective to automation in the RE process through application of QUADS to address Requirement Discovery, Analysis, Estimation and Prioritization. Techniques explored in *Decisively* include Analytical Hierarchical Process (AHP) for prioritization and estimation, Lorenz function to shortlist user stories by analyzing the distribution of votes, Box Plot Analysis to predict velocity, and Text Mining to discover implied requirements from documents.**

***Index Terms*—Agile, Quantitative Analysis & Decision Science, Requirements Prioritization, Story Points Estimation, Velocity Prediction, Box Plot, Text Mining, AHP, SPAN.**

I. Introduction

There are many mature industrial-strength RE tools for Agile, but the application of Quantitative Analysis and Decision Science (QUADS) in these tools has been largely limited to analytics and creation of data visualizations. The direct use of specific QUADS tools in the process of RE has been minimal due to the inaccessibility of affordable tools and the complexities involved in their usage. For instance, (a) in order to text-mine implied requirements from a policy document [1], a tool like R is required along with the knowledge of mining techniques, and R-scripting; (b) to prioritize using Analytical Hierarchical Process (AHP), specialized tools are needed and it presents challenges in the process of achieving consistency together with consensus in a group setting [2, 3]; and (c) even the simple task of short listing multi-voted items needs analysis of distribution of votes.

Decisively is an initiative to remove these barriers in large-scale adoption of QUADS techniques, and is an extension of earlier research [4] to aid non-decision science professionals in decision-making. It is a web-based tool with a special focus on usability, which is achieved by masking the complexities of QUADS techniques from end-users. It deploys (a) Text Mining to extract implied requirements from documents, and to detect similar users stories during ideation; (b) Lorenz curve to shortlist user stories by analyzing the distribution of votes; (c) AHP for prioritization and estimation, along with fast algorithms to provide real time feedback on inconsistent judgments; (d) Clustering to identify different schools of thoughts during prioritization and estimation; (e) Successive Proportional Additive Numeration (SPAN) to arrive at consensus [5]; and (f) Box Plot Analysis to detect outliers, and predict velocity with confidence interval from past iterations.

Prior to initiating the research and development on the current version of *Decisively*, these techniques were presented and discussed with practitioners in a SCRUM Alliance approved conference where it was received very well [6]. Application of *Decisively* in Agile projects in context of RE is outlined in the next section.

II. Application of Decisively

A. Identification of user stories

User stories are typically created in brainstorming sessions involving the stakeholders. The focus of such sessions is to eventually build a complete and mutually exclusive set of stories. These stories must be mutually exclusive to achieve flexibility in prioritization & sprint planning. *Decisively* provides an intelligent, near real-time ideation mechanism to make this possible. It aids each participant as s/he enters a new story by detecting and displaying similar stories in real time (Figure 1). This is extremely useful when participants are collaborating remotely or in several small sessions instead of a common one. In order to review the completeness and mutual exclusivity of stories, *Decisively* extracts roles, and clusters similar goals and similar reasons by mining the user stories.

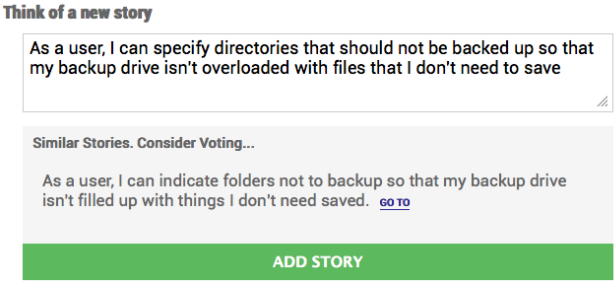

Fig. 1. Detection of similar story using text mining during ideation

In addition, *Decisively* provides a mechanism to rapidly sift through large documents using text mining. Discovering details for stories from policy, rule and/or compliance documents is a very tedious, time consuming and error prone tasks. To counter this, apart from highlighting important content,

Decisively provides smart navigation mechanisms within the document for discovery of information. By identifying frequently used text patterns, *Decisively* allows users to navigate sentences and paragraphs against a pattern they select. This reduces the time and tedium needed to uncover critical requirements, thereby reducing the probability of missing them.

B. Prioritization

In most scenarios, Prioritization happens based on subjective judgments, except in few cases where a quantifiable economic case may be available. Subjective judgments inherently suffer from varying degrees of inconsistency arising out of human thinking. It is further complicated when multiple stakeholders are involved. They can belong to different schools of thought, and this makes discussing differences meaningfully and arriving at a group priority, difficult.

Decisively leverages AHP for prioritization. Unique pairs of requirements are successively presented to stakeholders and they have to indicate their degree of preference towards one story on a scale of 1 to 9. While making a choice, if there is any inconsistency with the previous judgments they have made, it is highlighted in real time (Figure 2). *Decisively* aggregates judgments from all stakeholders to form a Group Priority. During the aggregation process, clusters of similar rankings from different stakeholders are automatically identified to display different schools of thought, if there are any. Any group level inconsistencies arising out of differences in viewpoints are also highlighted, along with recommendations on how they can be resolved. In extreme situations where differences cannot be resolved even after discussions, *Decisively* offers a mechanism of arriving at a general agreement using techniques like SPAN to reach a consensus on priority rankings.

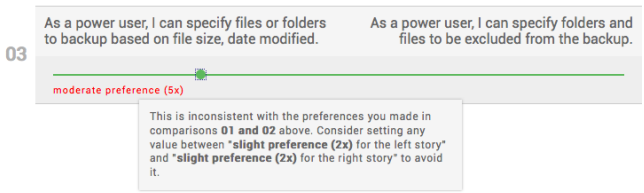

Fig. 2. Real time feedback of inconsistency during AHP based prioritization

C. Estimation

Similarly, *Decisively* utilizes AHP for estimation of story points. All stories that need to be estimated are presented to the user with one or two stories of known size for pair-wise comparison. Using the relative weights determined by the pair-wise comparison, and the story points of the known user stories, *Decisively* is able to compute their story points. The system speeds up such discussions considerably because it clearly explains the difference or alignment in views (Figure 3). It also allows effective estimation of more than one user story in a single comparison session.

Further, *Decisively* is very useful in determining the number of stories that can be completed in an upcoming iteration of development. It analyzes the variation in velocities of past iterations, detects any outliers, and then predicts the number of story points that can be covered with a confidence interval.

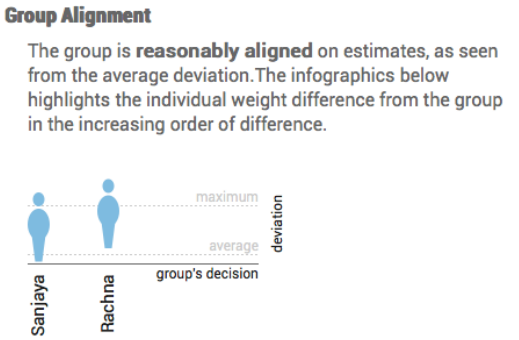

Fig. 3. Alignment of group's view during AHP based estimation

III. CONCLUSION & FUTURE WORK

In creating Decisively, QUADS techniques have been optimally leveraged to address real-world Agile RE challenges. Initial user testing confirms that users were able to make the best use of Decisively even without any prior knowledge of QUADS techniques. Users also appreciated the unique simplicity of Decisively, the meaningful inferences drawn by the tool, and acknowledged its potential in improving their productivity. Work is in progress for releasing a beta version. Its future roadmap includes addressing the scalability of prioritization using AHP, addition of TOPSIS and KANO model as alternatives, and development of an API for integration with other tools.

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