Automating the Composition and Scheduling Process for Synoptic Assessment Panels

1. Introduction:
The Bachelor of Engineering (Honours) program of the Department of Computer Science and Engineering at the University of Moratuwa has a compulsory software engineering project course in the 5th semester. This course has specifically been designed to foster creativity and software engineering rigor (Weerawarana, Perera and Nanayakkara 2012).

Since this course (CS 3202) is offered in the semester preceding the 6th semester industrial training experience, the requisite individual project in the course is comparable to a mini Capstone project. Thus the course design straddles several program ILOs at a 5th semester level from a Bloom’s taxonomy cognitive skills perspective (Anderson, L. & Krathwohl, D. A. 2001), along with an emphasis on creativity. Therefore, devising a suitable evaluation framework was challenging. The underlying issues included, assessment of a significant number of interim deliverables from a large number of students (n=101), and assessment of the end-of-semester project demonstrations from technical and creative standpoints, which required evaluators with expertise in a wide range of technologies and application domains.

To address these concerns we adopted a synoptic assessment approach. Jackson (2003) noted that synoptic assessment “enables students to integrate their experiences, providing them with important opportunities to demonstrate their creativity”. Elton (2005) stated that assessment of creative work should be ‘viewed in light of the work’, highlighting important aspects as, “the ability of experts to assess work in their own field of expertise” and “the willingness to employ judgment”. Balchin (2006) said that the reliability of subjective evaluation is enhanced when a mechanism of, “consensual assessment by several judges” is used. Based on these relevant literature findings, we decided to incorporate evaluation panels comprising industry experts and internal faculty members.

We faced many practical problems in activating this evaluation framework including, the limited number of evaluators and conflicting time constraints among evaluators when scheduling the large number of project demonstrations (n=101). Compilation of a sufficient number of technically specialized panels based on the time constraints turned out to be a time consuming tedious task. It became practically impossible to dynamically accommodate frequent time constraint based change requests in the manual process and hence we decided to automate the panel composition and scheduling process.

2. Methods:
We devised and implemented an algorithm with the following primary objective: Each student will be assigned a ‘best fit’ panel of evaluators comprising external industry experts and internal faculty members considering the technologies used in the student’s project. The secondary objectives in the algorithm design included; (1) optimal allocation based on multiple and often conflicting evaluator availability constraints; (2) balance of external versus internal evaluators in the panels; (3) minimization of the number of panel composition reshuffles; (4) avoidance of the same internal evaluator who assessed the mid-semester project demonstration being included in the end-semester evaluation panel;
and (5) preventing internal evaluators who mentored specific projects being included in the end-semester evaluation panel for the same projects.

The basis of the algorithm was the well-known combinatorial optimization algorithm known as the “The Hungarian algorithm” (Kuhn, 1955), which is used to solve classical assignment problems in polynomial time. A second layer of indirection was placed over the core algorithm to return a pool of panel assignment schedules instead of a single schedule. The technical reason for this was to significantly reduce the possibility of unfairness as a consequence of the underlying randomness of the base ‘seed’ evaluation panel that was fed in to the core algorithm.

Students were asked to list the technologies that were used in their projects, resulting in a master list of 42 different technologies. The student requests were recorded in a matrix (Table 1). A simple calculation (Equation 1) provided the total number of student requests \(r=244\). The external evaluators \(e=9\) were asked to indicate their areas of technology expertise. The evaluator responses were also recorded in a matrix (Table 2). Analysis of these two data sources revealed that it would be feasible to satisfy 141 of the 244 student requests covering 18 technologies.

### Table 1: Student technology requests

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<th>Tech. 1</th>
<th>Tech. 2</th>
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<th>Tech. 42</th>
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<tr>
<td>Student 1</td>
<td>1</td>
<td>0</td>
<td>...</td>
<td>0</td>
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<tr>
<td>Student 2</td>
<td>0</td>
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<td>...</td>
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<td>Student 101</td>
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### Table 2: Evaluator technology expertise

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<td>Evaluator 1</td>
<td>0</td>
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<td>1</td>
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<td>Evaluator 2</td>
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<tr>
<td>Evaluator 9</td>
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<td>1</td>
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\[
\sum_{f=1}^{42} \sum_{g=1}^{101} x_{fg} = 244
\]

**Equation 1**: Total number of student requests

3. **Results:**

The algorithm was run on the collected data and it was able to match 120 of the total 141 feasible requests giving an 85.12% success rate. The average number of requests satisfied per student was 92.1% among the 83 students whose requests constituted the 141 feasible requests. The average number of requests satisfied per technology was 71.69% among the 18 technologies.

4. **Discussion and Conclusion:**

The advantage of automating the panel composition process was evident when some external evaluators notified us of sudden changes in their time constraints or cancelled their commitment mere hours prior to the commencement of the end-of-semester project demonstrations. In this critical situation the algorithm facilitated rapid recalculation that produced an alternate optimal schedule.

In conclusion, we were able to successfully implement a synoptic assessment approach for the CS3202 course by addressing the challenges surrounding the constitution of expert evaluation panels by automating the panel composition and scheduling process. The automation was achieved by implementing an algorithm to assign evaluators with heterogeneous areas of expertise to project-specific evaluation panels, where the projects concerned involved many different technologies.
References:


