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SOLVING THE PREFERENCE-BASED CONFERENCE SCHEDULING PROBLEM THROUGH DOMAIN TRANSFORMATION APPROACH

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ABSTRACT. Conference scheduling can be quite a simple and straightforward problem if the number of papers to be scheduled is small. However, the problem can be very challenging and complex if the number of papers is large and various additional constraints need to be satisfied. Conference scheduling with regard to satisfying participants' preferences can be understood as to generate schedule to minimize the clashes between slots or sessions that participants are interested to attend. Motivated by the current research trend in maximizing participants' satisfactions, the study looks at the possibility of scheduling papers to sessions without any conflict by considering preferences by participants. In this research, preferences refer to the papers chosen by participants that they would like to attend its' presentations sessions. Domain Transformation Approach (DTA), which has produced very encouraging results in our previous works, is used in this study to solve preference-based conference scheduling problem. The purpose of utilizing the method is to test the generality and universality of the approach in producing feasible schedule, given a different scheduling problem. The results obtained confirm that DTA efficiently generated feasible schedule which satisfies hard constraints and also fulfills all the preferences. With the generated schedule, all participants are able to attend their sessions of interest. In the future work, additional constraints will be taken into account in optimizing the schedules, for example balancing the number of papers assigned to each timeslot, and minimizing assignment of presenters to different timeslots. Other datasets could also be tested in order to test the generality of the proposed approach.

Keywords: conference scheduling, preference-based, domain transformation approach

INTRODUCTION

Attending academic seminars or conferences is considered an important activity among academics and researchers. Conference or seminar is a formal gathering or meeting among academic and research peers normally in the same field of interests, where the participants confer or discuss the outcomes of their research works, exchange ideas and opinions. For a particular academic conference, there will be research papers that will be presented and normally just simply being referred to as 'papers'. Each paper will be presented in a "session" at a specific time and location which is referred to as a "timeslot". Each of these sessions can be assigned to a track and typically there are a few tracks depending on the organization of the conference, where each track represents an area of research and usually arranged in such a way that they are executed parallel to one another. Conference committees will identify the track for each paper and will need to schedule the presentation papers into timeslots.

Conferences will be incomplete without people attending the conference and usually they attend with two main intentions. First type of attendee during the conference is known as "presenter", where this refers to the author (or co-author) of the research paper that will be presenting or giving the talk on the research with regard to that particular paper. The second type of attendee is known as "participant", which refers to the person who registered and attended the conference, normally taking part as audience to the talks given by the "presenters", and attending other events organized during the conference. Interestingly, presenters are also considered as participants, due to the fact that they are also participating in the events at the conference. In short, we can say that presenters are the subset of participants.

Initially, conference scheduling problem can be assumed as quite a simple and straightforward problem if the number of papers to be scheduled is small. Nevertheless, the problem can be very challenging and complex if the number of papers is big and certain constraints need to be satisfied. Hard constraints in the conference scheduling problem include the presenters' ability to present only one paper at one time, and the time limit of a session which limits the number of papers that can be presented in a day. Another type of constraint is the soft constraints which can be considered into the scheduling criteria or not. One of the soft constraint in the conference scheduling problem is to maximize participants' satisfaction in terms of being able to attend their sessions of interest (Gulati and Sengupta, 2004). Some conferences' organizers nowadays allow the participants to choose the papers of interests, where they would like to attend its' presentations' sessions.

LITERATURE REVIEW

Research into solving the conference scheduling problem has attracted quite a lot of attentions among researches, even though this problem is believed not to be so critical to research and solve as compared to other types of scheduling problem, for example examination scheduling problem and class scheduling problem. Conference scheduling problem with regard to satisfying participants' preferences can be understood as to generate schedule to minimize the clashes between slots or sessions that participants are interested to attend.

Sampson and Weiss (1996) mentioned in their paper that participants often were quite frustrated with the way the conference was scheduled. This was supported by Thompson (2002) who mentioned that some conference participants complained that sometimes there are several sessions of particular interests are scheduled concurrently, whereas at other times there are no sessions scheduled in which they are interested. According to Gulati and Sengupta (2004), conference schedule is supposed to maximize the participants' satisfaction especially in attending their favourite sessions. Thompson (2002) stated that historically conferences have been scheduled according to presenter-based perspective (PBP), in which scheduling objective was to avoid time conflicts and meet preferences for the session presenters. The author also stated another different approach to conference scheduling, which is known as the attender-based perspective (ABP). As mentioned by Gulati and Sengupta (2004), the trend has shifted to ABP in order to maximize participants' satisfactions.

Constructing conference schedules when taking preferences of participants into considerations would be very challenging, and this will somehow complicate the task of the conference committees (Eglese and Rand, 1987). Due to this fact, computer program should be developed to automate the scheduling process. Zulkipli et. al (2013) proposed a goal programming model to automate the preference-based conference scheduling problem. Their focus of study is the capacity planning problem in order to assign papers to be presented into timeslots based on participants' preferences. In their study, they had used the SKSK06 dataset, in which participants were required to rank papers of interest from 1 to 10, and the value contributes to the weight of the paper selected. The weight for each paper in the dataset was then calculated based on all the preferences made by participants. Average weight for each timeslot was also calculated. A schedule is then generated by assigning papers to timeslots in such a way that it minimized the undesired deviations in terms of weight for each time slot.

Recent work in solving the preference-based conference scheduling problem include using an integer programming model to minimize participants' RSVP conflicts (Quesnelle and Steffy (2015)). Another recent work includes another integer programming model to maximize attendance and minimize session hopping (Vangerven et. al, 2016).

MOTIVATION AND OBJECTIVES OF STUDY

Motivated by the current research trend in maximizing participants' satisfactions that is to maximize the number of sessions of interests that can be attended by participants, the study looks at the possibility of scheduling papers to sessions without any conflict by considering preferences by participants. In this research, preferences refer to the papers chosen by participants that they would like to attend its' presentations.

In brief, the objective of this study is to produce a feasible conference schedule by satisfying two constraints. The first constraint is to ensure that all papers for each presenter in the problem are not scheduled concurrently. The next constraint is to satisfy the participants' preferences, in terms of ensuring that all the papers chosen as preferences by participants are also not being scheduled concurrently. Though the participants' preferences are originally considered as a soft constraint, but in this study we would like to consider the preferences as a hard constraint which means participants will definitely be able to attend all presentations' sessions for the papers of interests without any clashes. Hence, in short, this study is aiming at satisfying two types of hard constraints. By considering and satisfying these constraints, participants' satisfactions can certainly be increased.

METHODLOGY

Domain Transformation Approach (DTA) that has produced very encouraging results on benchmark datasets and randomly generated university examination scheduling problem (ESP) in our previous works (Rahim et. al, 2012, 2013, 2016; Rahim, 2015) will be re-used in this study to solve preference-based conference scheduling problem. The purpose of utilizing the method is to test the generality and universality of the approach in producing feasible schedule, given a different domain of problem. DTA proposed based on the insights derived from the Granular Computing (Bargiela and Pedrycz, 2002, 2008) transformed complex scheduling problem into smaller problem domains, letting the problems to be conquered or solved in stages, making it less complex that can be solved in a reasonable amount of time (Rahim, 2015). DTA transforms the original problem into a less-complex problem represented by different variables or newly constructed data structure. Pre-processing which is one of the important phase in DTA ensures that laborious searching and cross-referencing during scheduling is avoided (Rahim, 2015).

Our previous DTA designed specifically for ESP problem has successfully mapped the multi-dimensional space of exams and students into a reduced dimensionality space of exams and exam-slots. With this approach, it was observed that feasible schedules were generated successfully and efficiently, even on complex and large datasets problems (Rahim et. al, 2012, 2013, 2016; Rahim, 2015). DTA for ESP comprises of a few main steps, 1) pre-processing, 2) scheduling and 3) optimization. Details of the procedures in DTA can be found in our previous works (Rahim et. al, 2012, 2013, 2016; Rahim, 2015). However, in this study, we will only execute *pre-processing* and *scheduling* on the conference scheduling problem to achieve the objective of the study. The optimization stage will not be executed and will be part of our continuing work to further improve the existing stage of the research.

Though in this paper, the domain that will be used is different, i.e. preference-based conference scheduling problem, however there are some similar characteristics with regard to ESP. In ESP, students are enrolled for a few exam papers, where as in the preference-based conference scheduling problem, presenters and participants are "enrolled" for certain conference papers. Of course, the term "enrolled" in conference scheduling problem is not really suitable, however it refers to the papers that the presenters will be presenting during the conference, and for the participants, it merely means the papers that have been selected by the participants as their preferences. We hypothesize that by having similar characteristics, DTA on ESP should be able to produce feasible solutions on the newly tested domain in this study. Nonetheless, we are aware that this preference-based conference scheduling problem could be more complex and challenging to be solved if both the numbers of papers and participants' preferences are quite high, especially when they need to be scheduled in a limited number of timeslots.

DATA, EXPERIMENT, RESULT AND DISCUSSIONS

The dataset used in this study is the actual preference survey conducted during the Seminar Kebangsaan Sains Kuantitatif 2006 (SKSK'06) (Zulkipli, 2007; Zulkipli et. al, 2013). This dataset comprised of 60 papers and 26 preference respondents. Respondents were allowed to choose 10 papers (out of 60 papers) that they would like to attend its' presentation, in which the 10 papers should be ranked according to their preferences (1 to 10; 1 being the highest preference and 10 the lowest preference). Respondents in the dataset comprised of presenters and participants where presenters only selected other papers which were not self-authored. Table 1 presents the characteristics of the dataset.

Table 1. Characteristics of the Preference-Based Conference Scheduling Problem.

a - Name of Dataset, b - Total No of Papers to Be Presented, c - No of Preferences by Presenters, d - No of Preferences by Participants, e - Total No of Data, f - Maximum No of Preferences

a	b	c	d	e	f
SKSK06	60	8	18	78	10

Table 2 below lists the papers associated with the presenters and participants in the SKSK06 dataset. Initially there were 60 presenters who were authors that will be presenting their papers during the conference. According to Zulkipli (2007) and Zulkipli et. al (2013), out of the 60 presenters, 8 presenters had taken part in answering the survey conducted, thus were considered as part of the respondents. Another 18 respondents were the participants who just attended the conference as audience (without authoring any papers).

As mentioned previously, each respondent was given the flexibility to choose a maximum of 10 papers according to their preferences, and those papers shall be ranked according to the preference level (1 to 10), with the most-preferred paper having a value of 1, and the least-preferred paper having a value of 10. The respondents were allowed to skip any number within the range if they have less than 10 preferred paper. As can be seen in Table 2, the first 60 data represent the participants (presenters) who are presenting (authoring a paper). The next

18 data represent the participants who just attended the conference as audience. We observe that the first 8 entry in the list (Table 2) has more than one selected paper representing the presenters that participated in the survey. It is worth noting here that, though the respondents could choose 10 papers in total, but some selected less. Thus, when observed carefully, for certain respondents, the number of papers listed in the preference list was less than 10.

Table 2. List of Papers Associated with Presenters and Participants.

ID*	Paper ID**	ID*	Paper ID**	ID*	Paper ID**
1	1, 3, 42, 33, 21, 19, 49, 47, 8, 23, 9	27	27	53	53
2	2, 12, 5, 13, 57, 47, 49, 58, 60, 48, 55	28	28	54	54
3	3, 9, 11, 22, 44, 26, 24, 15, 51, 25, 10	29	29	55	55
4	4, 7, 12, 20, 5, 49, 10, 43, 31, 26, 6	30	30	56	56
5	5, 11, 10, 7, 25, 36, 15, 0, 30, 32, 12	31	31	57	57
6	6, 26, 32, 9, 22, 18, 17, 57, 0, 43, 1	32	32	58	58
7	7, 24, 44, 5, 45, 22, 19, 30, 46, 15, 9	33	33	59	59
8	8, 3, 44, 52, 13, 12, 59, 26, 18, 60, 28	34	34	60	60
9	9	35	35	61	42, 23, 41, 5, 15, 9, 57, 43, 48, 31
10	10	36	36	62	51, 24, 2, 11, 55, 1, 17, 12, 57, 60
11	11	37	37	63	47, 24, 29, 48, 57, 32, 23, 15, 55, 3
12	12	38	38	64	46, 50, 21, 41, 56, 54, 51, 18, 14, 20
13	13	39	39	65	43, 36, 49, 33, 12, 16, 10, 58, 2, 15
14	14	40	40	66	48, 58, 41, 56, 21, 27, 6, 37, 4, 55
15	15	41	41	67	57, 44, 24, 26, 3, 0, 19, 55, 7, 33
16	16	42	42	68	12, 43, 11, 29, 6, 13, 28, 53, 58, 50
17	17	43	43	69	29, 49, 41, 8, 48, 40, 44, 36, 3, 47
18	18	44	44	70	48, 41, 43, 9, 16, 56, 49, 53, 17, 57
19	19	45	45	71	11, 46, 43, 15, 1, 9, 12, 55, 59, 31
20	20	46	46	72	49, 42, 57, 11, 43, 0, 21, 20, 17, 2
21	21	47	47	73	41, 29, 49, 44, 10, 60, 39, 8, 47, 57
22	22	48	48	74	12, 47, 23, 55, 60, 57, 46, 56, 13, 7
23	23	49	49	75	49, 8, 46, 53, 0, 9, 11, 58, 56, 50
24	24	50	50	76	30, 48, 57, 51, 49, 12, 15, 44, 52, 56
25	25	51	51	77	51, 12, 4, 48, 11, 30, 55, 13, 34, 49
26	26	52	52	78	27, 8, 46, 15, 7, 59, 44, 5, 55, 1

*: *Participants' ID*
**: *Paper ID as selected as preferences by participants*

In summary, the presenters who were also respondents will have a maximum of 11 number of papers associated with them, 1 paper which they self-authored is added and must also be taken into consideration in order to generate a feasible schedule. This is to ensure that the paper that they will be presenting is not scheduled concurrently with the papers that they have chosen to attend its session. It should be mentioned here that the order of the papers listed above for each "ID" (representing presenter and participants) are sorted from the highest preference to the lowest preference. If "0" (zero) is found in any of the list, it indicates that for that particular ranking, the respondent have not selected any paper. One important observation that we made in the dataset is that each presenter has authored only one paper. Even if we have a dataset with presenters authored more than one paper, the algorithm will be able to accept by just adding the paper index number to the authors selected papers.

Table 3 shows the results obtained by utilizing DTA on SKSK06 dataset. By executing pre-processing of constraints and followed by scheduling, DTA efficiently generated feasible schedule in 15 timeslots, and managed to fulfill all the preferences made successfully. This result is considered as very encouraging since the number of timeslots needed to schedule this preference-based problem (by considering 10 papers of preferences by the participants'), is the same with the number of timeslots needed to satisfy 3 papers of preferences on the same dataset in the literature (Zulkipli, 2007). Recall that 26 respondents have chosen certain papers as their preferences. Even though the number of respondents was quite small, however by having quite a high number of preferences, the complexity of the problem has increased greatly. Therefore, the schedule generated by DTA in this experiment which managed to satisfy both hard constraints can be considered as a very good quality conference schedule. With the schedule, all participants with preferences, are able to attend their sessions of interest.

Table 3. Results Obtained From the Experiment (Assignment of Papers to TimeSlot).

TimeSlot	Papers Scheduled (Based on Paper's ID)						
1	12	22	35	38	41		
2	24	49					
3	4	25	40	45	50	57	59
4	11	16	18	27	47		
5	9	13	20	36	39		
6	6	14	15	34	60		
7	10	42	52	53	54	55	
8	1	28	48				
9	3	5	56				
10	8	37	43	51			
11	17	23	44	58			
12	2	7	29				
13	19	31	32				
14	21	26	30				
15	33	46					

DTA represents the scheduling problem at numerous levels of abstraction. For instance, at the fine resolution we may deal with individual participants associated with papers (which is a standard problem definition) as illustrated in Figure 1. On the other hand, at the coarser resolution we deal with groups of papers (non-conflicting papers) and formalize the problem description using these groups as shown in Figure 2. In effect, we deal with some complementary problem descriptions at different levels of accuracy and generality. The more general descriptions serve to facilitate an approximate problem solution in a smaller search space and more detailed representations preserve the possibility of refinement of the solutions. DTA is opposed with the basic, detailed level of problem representation which requires deployment of numerous heuristic methods to deal with with computational complexity (Rahim, 2015). Pre-processing through DTA transformed the initial data into a new solution space in which the problem is solved more easily. The aggregated data from the altered data space which have been grouped appropriately will be much relaxed to handle.

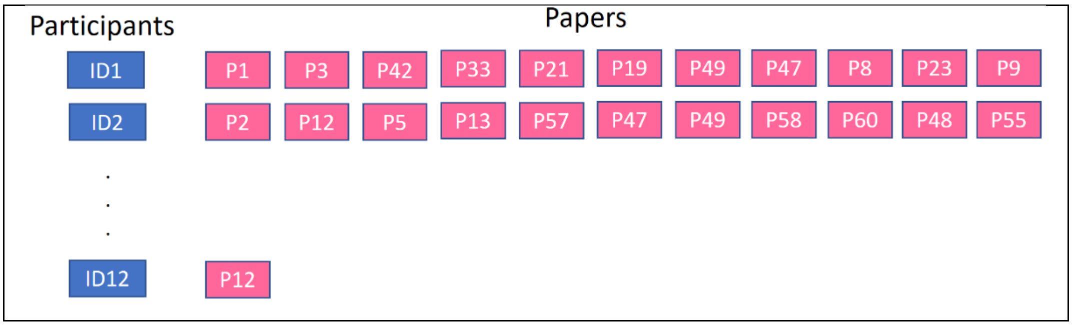

Figure 1. Illustration of the Preference-Based Conference Scheduling Problem (Fine Resolution Level).

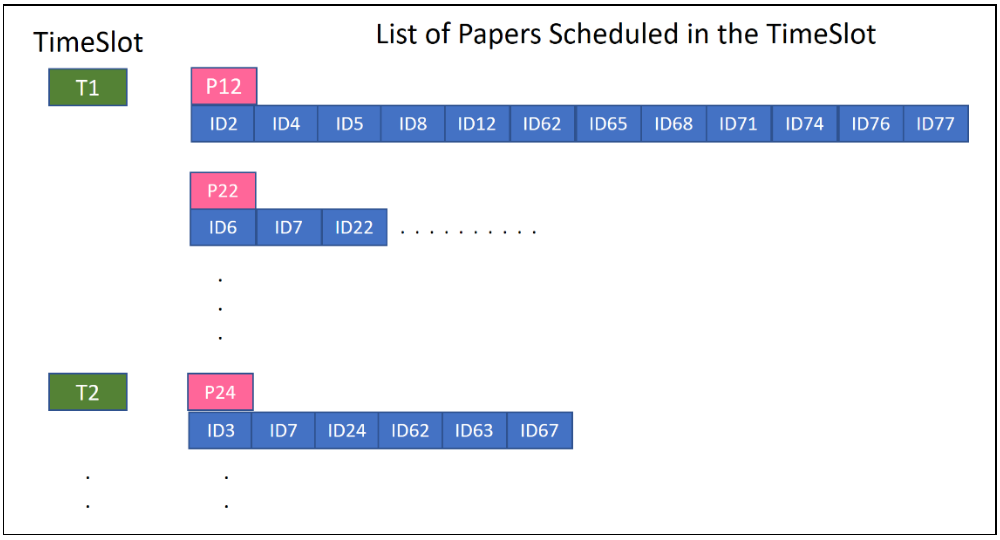

Figure 2. Illustration of Groups of Papers - Group of Non-Conflicting Papers Associated with Participants (Coarser Resolution).

Notwithstanding the good quality schedule obtained, of course we can observe that the assignments of papers to timeslots are not even in terms of the numbers in each timeslot (refer to Table 3). Some timeslots have more papers assigned to them, on the other hand less papers were assigned to other timeslots. Anyway, since the focus of the paper is just on generating a feasible schedule based on participants' preferences, consequently we will omit this observation. However, this matter could definitely be improved in the future research by doing some optimizations to balance out the assignments of papers to timeslots.

CONCLUSIONS AND FUTURE WORK

To summarize, in this study, DTA on ESP has been re-used to generate a conference schedule on SKSK06 dataset, which is considered as a preference-based conference scheduling problem. The purpose on why DTA on ESP was used is mainly because we would like to test the generality and flexibility of DTA on different problem domain with similar characteristics. This study was driven and inspired by the research trend in the literature that aimed to maximize the participants' satisfaction in terms of increasing the number of sessions of interests that can be attended by participants.

Having two objectives in mind, in which two hard constraints on the problem tested were aimed to be satisfied, two phases in DTA: *pre-processing* and *scheduling* were executed on the dataset. Based on the results obtained, it was observed that a feasible conference schedule was generated successfully by DTA and managed to satisfy both hard constraints imposed. By satisfying both constraints and was scheduled in a reasonable number of timeslots, the solution generated is considered to be feasible and of a high quality. With the schedule, all papers associated with both presenters and participants were scheduled without any clashes. This will definitely benefit the participants, and of course the conference organizer as well.

Despite the good quality feasible schedule generated through this study, we are aware some improvements need to be done to improve the quality of the schedule. For example, the schedule that we obtained through the experiment itself could be improved in terms of balancing the numbers of paper in each timeslot to ensure all papers are able to be presented in a limited amount of time in each session or slot. Other possible future works are to group timeslots into sessions and to parallelize these sessions. Other improvements could also be considered, which include to group papers to timeslots based on key-words of the research papers and minimize hopping of presenters between timeslots (or rooms). Moreover, other preference-based conference scheduling problem can also be used in the future research.

In conclusion, DTA for ESP has been executed successfully on a different domain, i.e. preference-based conference scheduling problem. Good quality feasible schedule generated by using DTA in this study (and previous studies) evidenced that DTA for ESP is very robust, universal and efficient in producing solution on real-world datasets with particular characteristics. In terms of contribution of this research to the practitioners, the proposed approach obviously could ease the conference committee in assigning conference papers to slots efficiently by satisfying hard constraints and participants' preferences.

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