Assesment Scheduler

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Abstract

A programming department offers several UG courses each with three to seven assessments during a semester. The average student reads for five course. Due dates tend to clash when each course schedules their assessments independently. For example, in week 10 of a 12 week semester, it is typical for students to have two course work exams and one assignment due on the same day. This paper proposes a model which assigns due dates for assessments that minimizes clashes, overall coursework percentage due on a given day, and maximizes the time between due dates, given each course's assessment details (possible start and end dates and weightings), timetable information, and student enrollment. These optimized due dates are designed to better distribute the student load, reduce anxiety, and allow course administrators to plan course activities effectively. Specifically, it schedules a course's proctored assessments according to its timetable without clashing with its non-proctored assessment's due dates.

1. Introduction

2. Related works

3. Proposed Scheme

3.1. Notation

i = course index ($i = 1 \cdots I$)
j = assessment index ($j = 1 \cdots J$)
k = time index ($k = 1 \cdots K$)
$c_{i,i'}$ = the number of students registered for courses i and i'
$w_{i,j}$ = the weight of course i's assessment j
$t_{k,i}$ = 1 if i is timetable at time k, 0 otherwise
$s_{i,j}, e_{i,j}$ = the start and end time indices for the possible due dates for course i's assessment j
These times are set by course facilitators
$p_{i,j}$ = 1 if j is a a proctored assessment (synchronous) for course i, 0 otherwise (asynchronous)

Additional parameters for stage 2
$\phi_{i,i'}$ = 1 if there is at least one student registered for courses i and i', 0 otherwise
d = size of time window $k, \ldots, k+d$, ($d = 1, 2, \ldots, 5$)
M = a large value

$x_{k,i,j}$ = 1 if course i's assessment j, due at time k, 0 otherwise

Additional decision variables for stage 2
y_k = 1 if at most one assessment is scheduled in time window $k, \cdots, k+d$, 0 otherwise

3.2. Model

The model is broken down into two stages. Stage 1 determines lowest maximum load U^* for any given day. This value indicates an upper bound on the worst day for a student in the semester. Stage 2 uses this bound to distribute the assessments so no time index exceeds U^* while trying to maximize Y^* the amount of d size time windows (i.e., indices $k, \ldots, k+d$ for $k = 1, \ldots, K-d$, where at most 1 assessment is scheduled.

3.2.1. *Stage 1*

$$
\begin{aligned}
U^* = \min_{x_{k,i,j}} \max_{k,i} \left\{ \sum_{i'=1}^{I} \sum_{j=1}^{J} x_{k,i',j} c_{i,i'} w_{i,j} \right\} & \\
\text{s.t.} \sum_{k=1}^{K} x_{k,i,j} = 1 & \qquad \text{for all } i, j \text{ pairs} \\
x_{k,i,j} = 0 & \qquad \text{for all } i, j, k < s_{i,j} \text{ or } k > e_{i,j} \\
p_{i,j} x_{k,i,j} \leq t_{k,i} & \qquad \text{for all } i, j, k \\
\sum_{j=1}^{J} p_{i,j} x_{k,i,j} + \sum_{j=1}^{J} (1 - p_{i,j}) x_{k,i,j} \leq 1 & \qquad \text{for all } i, k
\end{aligned}
\tag{1}
$$

3.2.2. *Stage 2*

$$
\begin{aligned}
Y^* = \max_{x_{k,i,j}} \sum_{k=1}^{K-d} y_k & \\
\text{s.t.} \sum_{i'=1}^{I} \sum_{j=1}^{J} x_{k,i',j} c_{i,i'} w_{i,j} \leq U^* & \qquad \text{for all } i, k \\
y_k = 0 & \qquad \text{for } k = K-d+1, \ldots, K \\
\sum_{k'=k}^{k+d} \sum_{i'=1}^{I} \sum_{j=1}^{J} \phi_{i,i'} x_{k',i',j} \leq y_k + (1 - y_k) M & \qquad \text{for all } i, k = 1, \ldots, K-d \\
\text{Constraints from Stage 1} & \\
\sum_{k=1}^{K} x_{k,i,j} = 1 & \qquad \text{for all } i, j \text{ pairs} \\
x_{k,i,j} = 0 & \qquad \text{for all } i, j, k < s_{i,j} \text{ or } k > e_{i,j} \\
p_{i,j} x_{k,i,j} \leq t_{k,i} & \qquad \text{for all } i, j, k \\
\sum_{j=1}^{J} p_{i,j} x_{k,i,j} + \sum_{j=1}^{J} (1 - p_{i,j}) x_{k,i,j} \leq 1 & \qquad \text{for all } i, k
\end{aligned}
\tag{2}
$$

Given Y^* we can calculate the probability of scheduling at most one assessment in a $d+1$ time period as $\dfrac{Y^*}{K-d}$.

3.3. Metric

Thinking about the expected number of CW $\%$ due in any $d + 1$ day period for any student...

3.4. Illustrative Example

In this illustrative example assume proctored assessments can occur on day between Monday to Friday. Non-proctored can be due on day. Consider the case of scheduling the five assessments across the three courses described in Tables 2 and 1 over a 12 week semester (i.e, $K = 84$). Expect for taking C1601 and C1603 together, there is at least one student reading for the remaining combinations of the three courses. Table 3 shows the assessment schedule after stage 1. The least maximum coursework load of any one day is $U^* = 9000$, which occurs on day 80 (i.e., week 12 day 3) when 450 C1601 students take their 20% CW2 exam. While this schedule reduces the maximum mental demand for any day, it does not consider the spread of the assessments. For example, from the stage 1 schedule, the C1603 the CW2 exam is also on day 80 followed by the C1602 CW2 exam on day 81. However, one possible improvement without exceeding U^* would be to move the C1602 CW2 exam to day 82 which would give students reading for C1601 and C1603 together with C1602 one extra day to study. Table 4 presents the schedule where for any two day period (i.e., $d = 1$) at most one assessment is scheduled.

Now if $d = 2$ then the $\dfrac{Y^*}{K - d}$ drops to 0.975 as presented in Table 5. In this schedule, all assessments expect for CW2 for C1602 and C1603 have at least two days between them. Specifically the assessments between days 61 and 78 were shifted to accomodate the increase spacing between assessments. Table 6 presents the schedule With $d = 4$. Here, $\dfrac{Y^*}{K - d}$ drops to 0.962 and see the assessments for C1601 and C1603 move closer together. This adjustment is allowed as there are no students who are in both of these classes. In the 12th week, the CWE2 for these courses are scheduled for the same say, to increase the CWE2s for C1602 students reading for either C1601 or C1603. As d increases the value of $\dfrac{Y^*}{K - d}$ will drop as it becomes increasingly less likely to increase the time interval between consecutive assessments over all course combinations.

4. Experimental Results

	C1601			C1602			C1603		
Assessment	%	S	E	%	S	E	%	S	E
A1	5	(3,1)	(4,7)	6	(3,1)	(4,7)	6	(3,1)	(4,7)
A2	5	(7,1)	(8,7)	6	(8,1)	(9,7)	6	(6,1)	(7,7)
A3	6	(10,1)	(11,7)	7	(10,1)	(11,7)	7	(10,1)	(11,7)
CW1 (P)	10	(8,1)	(9,7)	10	(6,1)	(7,7)	10	(8,1)	(9,7)
CW2 (P)	20	(12,1)	(12,7)	20	(12,1)	(12,7)	20	(12,1)	(12,7)

Table 1: Course assessment details. S and E indicate the start and E (Week, Day)'s respectively in which the assessment must be due. P indicates a proctored (in person) assessment.

Class Sizes			
	C1601	C1602	C1603
C1601	450	100	0
C1602	100	350	150
C1603	0	150	300

Table 2: Class Sizes

Stage 1 Schedule. $U^* = 9000$			
K	WK	DAY	Assessment
16	3	2	C1601-A1-(5)
24	4	3	C1602-A1-(5)
25	4	4	C1603-A1-(6)
41	6	6	C1603-A2-(7)
44	7	2	C1602-CW1-(10)
55	8	6	C1601-A2-(6)
57	9	1	C1601-CW1-(10)
57	9	1	C1603-CW1-(10)
59	9	3	C1602-A2-(6)
76	11	6	C1602-A3-(6)
77	11	7	C1601-A3-(6)
77	11	7	C1603-A3-(7)
80	12	3	C1601-CW2-(20)
80	12	3	C1603-CW2-(20)
81	12	4	C1602-CW2-(20)

Table 3: Assessment schedule after Stage 1. The least amount of coursework marks due on any one day $U^* = 9000$.

Stage 2 Schedule. $U^* = 9000, d = 1, \dfrac{Y^*}{K-d} = 1$			
K	WK	DAY	Assessment
15	3	1	C1602-A1-(5)
20	3	6	C1603-A1-(6)
26	4	5	C1601-A1-(5)
37	6	2	C1602-CW1-(10)
44	7	2	C1601-A2-(6)
47	7	5	C1603-A2-(7)
50	8	1	C1601-CW1-(10)
57	9	1	C1602-A2-(6)
61	9	5	C1603-CW1-(10)
66	10	3	C1602-A3-(6)
68	10	5	C1601-A3-(6)
71	11	1	C1603-A3-(7)
78	12	1	C1601-CW2-(20)
80	12	3	C1602-CW2-(20)
82	12	5	C1603-CW2-(20)

Table 4: Assessment schedule after Stage 2, with $d = 1$.

Stage 2 Schedule. $U^* = 9000, d = 2, \dfrac{Y^*}{K-d} = 0.975$			
K	WK	DAY	Assessment
15	3	1	C1602-A1-(5)
20	3	6	C1603-A1-(6)
26	4	5	C1601-A1-(5)
37	6	2	C1602-CW1-(10)
44	7	2	C1601-A2-(6)
47	7	5	C1603-A2-(7)
50	8	1	C1601-CW1-(10)
57	9	1	C1602-A2-(6)
61	9	5	C1603-CW1-(10)
65	10	2	C1601-A3-(6)
71	11	1	C1603-A3-(7)
75	11	5	C1602-A3-(6)
78	12	1	C1601-CW2-(20)
80	12	3	C1602-CW2-(20)
82	12	5	C1603-CW2-(20)

Table 5: Assessment schedule after Stage 2, with $d = 2$.

Stage 2 Schedule. $U^* = 9000, d = 3, \dfrac{Y^*}{K-d} = 0.962$			
15	3	1	C1602-A1-(5)
20	3	6	C1603-A1-(6)
26	4	5	C1601-A1-(5)
37	6	2	C1602-CW1-(10)
43	7	1	C1601-A2-(6)
47	7	5	C1603-A2-(7)
52	8	3	C1601-CW1-(10)
57	9	1	C1602-A2-(6)
61	9	5	C1603-CW1-(10)
65	10	2	C1602-A3-(6)
72	11	2	C1601-A3-(6)
76	11	6	C1603-A3-(7)
80	12	3	C1602-CW2-(20)
82	12	5	C1601-CW2-(20)
82	12	5	C1603-CW2-(20)

Table 6: Assessment schedule after Stage 2, with $d = 3$.