Project Report on

Meeting Student's Demand for course Registration

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Introduction:

In this project, we dealt with a real scenario of challenges currently faced by the Kent State MIS department in regards to creating the most efficient schedule for students, faculty, and the university.
There are many courses offered to students each semester. There are some courses which become full which then causes some students to not be able to register for their desired/required courses. Faculty and budget must also be kept in mind when creating the schedule.
This problem is important to be addressed as it can affect the revenue of the college. Proper allocation of faculty is also taken into consideration in our project as there are scenarios where the faculty is not properly utilized and this also leads to increase in cost to the college in the form of hiring a new faculty whether full time or adjunct.

Our objective for this project was "To maximize the total number of students who are able to enroll for their desired courses by using currently available faculty,while minimizing the cost of faculty allocation for the demanded courses."

Model Development:

The first step we took for the model development was to preprocess the data given to us. We had various types of data, but extracting useful information always proves challenging. We had data for fall, spring and summer semesters of three consecutive years. This data included the courses, sections, professors teaching the particular course, number of seats full ,number of seats available and so on.
From this data we made a few assumptions to establish requirements for courses to be considered in high demand:

1. The course must have number of seats available as less than or equal to 1.
2. The courses must be offered only once per year (i.e in Fall or in Spring but not in both)

We used R for data preparation and cleaning.
We obtained the following table as the highly demanded courses per our above requirements:

Course No	Title	Instructor
44045	Information Systems Management	Conlon,Ryan J.
44183	Developing and training Human Resources in Organizations	Whitmore,Mark D.
44293	Workshop in Professional IS Certification	Howard,Geoffry S.

Table I: Insights of courses and their instructors

We also made some assumptions for our model on the faculty. The assumptions are as follows:

1. Faculty who have equivalent qualification can teach the same courses.
2. The cost of full time faculty is salary and is fixed.
3. The cost of hiring an adjunct faculty is $4000 per course.

Thus, by using the data given about various professors and their qualifications, we identified the professors with same qualifications. Some of the examples are as follows:

Area of Teaching	Faculty
IS	Brandyberry,Alan; Conlon;Datta,Pratim; Dragan, Natalia
HR	Knapp,Deborah; Levashina,Julia; Lozykowski,Mat
Management	Bolinger,Holly;Coleman,Robert;Cook-Euell, Veronica;Engelhardt,Charles
Management/Strategy	Arikan,Asli; Arikan,Ilgaz

Table II: Insights of faculty and their research areas

We also identified which faculty could be considered critical based on a few assumptions:

1. They teach a course which is in high demand.
2. There are no other faculty in the department teaching the same course and having the same qualifications.

Some of the critical faculties identified were as follows:

Faculty	**Course**
Conlon,Ryan J.	Information System Management
Howard,Geoffry S	Workshop in Professional IS Certification

Table III: Critical Faculties

After identifying the courses in high demand as well as the critical faculties. we dove further into the data.
As our objective was to maximize the number of students able to enroll for their desired courses, we had to find the workload of the faculty who taught the courses. This way, demand could be assigned to the faculty depending on their current workload.

From the 2016 Fall data we were given, we identified the workload of the faculty. Each course taught by the faculty was assumed to be of 3 credits, and the workload was calculated based on the total number of credit hours.

	Instructor	NoOfCourses	Workload
1		1	3
2	Amiruzzaman, Md	1	3
3	Bohan, George P.	1	3
4	Codispoti, Lisa S.	1	3
5	Coleman, Robert H.	2	6
6	Conlon, Ryan J.	1	3
7	Datta, Pratim	1	3
8	DeRubertis, Diane E.	1	3
9	Dragan, Natalia	1	3
10	Guiffrida, Alfred	1	3
11	Howard, Geoffry S.	1	3
12	Israeli, Aviad A.	1	3
13	Kibler, Marlo P.	1	3
14	Knapp, Deborah K.	3	9
15	Koparan, Ipek	1	3
16	Lozykowski, Mateusz H.	1	3
17	Nagarajan, Saravanan	1	3
18	Patuwo, B. Eddy	1	3
19	Peck, Jessica A.	1	3
20	Porr, Dean A.	1	3
21	Sams, Bonnie G.	1	3
22	Sinclair, Elizabeth A.	1	3
23	Smas, M J.	2	6
24	Smith, Alan D.	1	3
25	Steinberg, Geoffrey	3	9
26	Teeters, Brian E.	1	3
27	Whitmore, Mark D.	3	9

Fig I: Workload of Instructors

We found in the data provided that there were some courses with more than two sections open, and many of these sections were nowhere near full. Identifying those courses can be beneficial as the sections with open seats can potentially be combined which would free up some faculty to teach courses in high demand. However, we must keep in mind that multiple sections are sometimes necessary as not every student can make a certain time work for them to attend class. Courses with more than two sections which were not full are as follows:

	COURSENO	Sections	NoOfSeatsAvailable
1	24053	4	42
2	24056	22	32
3	24065	2	30
4	24163	3	54
5	34054	2	-13
6	34060	2	21
7	34068	2	4
8	34070	2	21
9	34092	2	0
10	34158	1	21
11	34159	1	22
12	34165	4	35
13	34175	1	8
14	34180	3	0
15	34185	2	-3
16	44009	2	24
17	44033	1	36
18	44042	1	13
19	44043	3	-3
20	44048	1	3
21	44049	1	2

Fig II: Availability of seats per course

From the above insights we saw in the data, we tried to build our model.

Variables:

1. i= faculty
2. j=course
3. t=semester(fall, spring, summer)
4. d=demand

Model:
Objective function 1:
Maximize Workload by assigning maximum of Teaching Activity, Service Activity as well as Research Activity to every full time faculty
Subject to following constraints

Demand. =1, if seat availability <=1
=0, if seat availability >1

Research activity + Teaching Activity + Service Activity <= 24.

The faculty assigned to teach the particular course should have the same area of

expertise.

For teaching a masters course, the assigned faculty should be atleast Phd holder and also having some research in that area.

Objective function 2:

Minimize Number of Sections by minimizing the number of seats available in Sections of Courses with low demand)

Subject to following constraints:

Low demand courses = Courses with number of sections >= 2 and sum of available seats for all sections <=X

If the course is only offered in one semester, the number of sections will not be minimized so student flexibility can be maintained.

We did not establish a standard for what the aggregated number of available seats should be set to, so we represented the variable with X. This may require a larger sample size and looking at each course individually to decide where the baseline for that course should be set.

Model Implementation:

The model implementation depends on different scenarios which we believed could potentially arise.

The first objective of the model is to maximize the workload of the current full time faculties. Faculty have a maximum threshold for what their workload should be in a given semester and given year. This can include their service activity, research activity and teaching activity. Full time faculty are allowed to take a certain amount of this workload in one semester. Now, if the assigned workload to such full time faculty is less than the optimum workload, the institution is going to need more manforce to handle the work.

Also, the remuneration offered to a certain faculty during one academic year cannot be less than the remuneration offered in previous year. So if the full time faculty is available, the best choice to reduce the expense on remuneration is make use of the full time faculty to its optimum level.

To achieve this goal, the model suggests first objective as:

Maximize Workload=∑(Teaching Activity + Service Activity + Research Activity)*(Demand)

[For full time faculty i for semester j]

The model gives solution for only those courses which are in high demand, and that is why demand is set to zero. This way, courses which are not in high demand would not be considered.

The second objective is to reduce the number of sections. This objective can be first or second, completely depends on the preferences. There can be a scenario where this objective can make things easier for the first objective stated above.

This objective is:

Minimize Number of Sections= ∑(Number of seats available in Sections of Courses with low demand)

The idea here is to minimize the number of seats available in a given semester. This is not minimizing the number of seats which are opened when the semester initially opens for enrollment, but rather minimizing the number of seats which go unfilled throughout the semester.

Model Usage:

To resolve the issue of high demand courses vs lesser availability, the model should be used in this way:

1. Prioritize the concerns
2. Find specific data as explained in model development section
3. Choose between the objectives 1 and 2, and decide which to evaluate first
4. Even after evaluation of model, the need of faculty for particular area is required, try hiring adjunct faculty rather than full time.

Before going to step 4, alternative methods as suggested below can be tried. This will also depend on the scenario and the problem you are dealing with. Each scenario will likely need to be handled on a case by case basis. The models job is to identify the critical scenarios which then allows the most rational decision to be made by heads of the MIS department.

Scenario 1:

For a subject in high demand, if the demand is less than 5 seats

The model would try to fit the students into the existing class.

The reason for doing this is that 5 students does not seem like a ton to take on. Now, for a given class it may be which again brings about managing on a case by case basis.

Scenario 2:

If the demand is more than 5 seats:

The model will check the workload of existing instructors. If it is not optimum, a new session under the same faculty could be started.

If the workload of existing instructor is optimum, a new session under the another instructor whose area is same and workload is not optimum could be started

If no such instructor is available, the model will try reducing the teaching workload of existing faculty by allocating the courses he/she is teaching to another faculty and which are NOT in high demand. This requires the other faculty to be of the same expertise as the currently optimized faculty. This way, the currently totally optimized faculty can be freed up for other work.

If nothing from above three solutions is possible, then a new instructor having the same area as that of existing instructor could be hired. The short term fix would likely be an adjunct. If an adjunct is repetitively being hired in the same area, it may be time to consider the addition of a full time faculty.

Conclusions and Future Work

Obviously, our main future goal would be to get this implemented in an LPsolve format to be run in R. While we feel we got off to a good start, there is a lot of work left to be done before the model can reach full implementation. So many constraints must be taken into account in order to achieve the desired goal. With the sheer number of constraints which must be considered, there must be assumptions made and some corners cut or the model will never reach its' final stage. When the model is completed, it will allocate the resources (faculty, budget, etc.) in the most efficient way possible to meet student demand. Remember, student demand includes the ability of the course to be offered at various times which we did not take into consideration while doing our current work.

The way we currently constructed the model, it is all based around the data we had on hand (current faculty, current courses, current budget, etc.). Achieving maximum efficiency in the current state would be the initial phase of our work. Once we are able to confidently say we know the best way to allocate current resources, we can then move to trying to prepare for future semesters. For example, the ability to begin prepping and understanding in Fall 2018 for what faculty will be needed, what courses need to be offered, etc. in Fall 2019 would be extremely beneficial. The model could also be constructed to choose the best avenue for when a faculty leaves or retires.

Now that we have established the first two phases, there is a third phase which would be way down the line. If the MIS department sees success in the implementation of this model, there is no reason it should not be rolled out campus wide. Kent could then become completely efficient in regards to their course scheduling construction. Doing so would attract both top faculty and students who may not have the easiest time scheduling courses at a college due to other obligations and responsibilities. In all, we were able to identify some of the trends and items of note in the data we had available. There is still a long road to achieving the end goal.