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A GOAL PROGRAMMING MODEL TO OPTIMIZE DEPARTMENTAL PREFERENCE IN COURSE ASSIGNMENTS

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Scope and Purpose—The purpose of this paper is to present an application of goal programming as an aid in course–faculty teaching assignments. The model examines the conflicting objectives of departmental course and teaching load goals with those of faculty course preferences. The model is applied in a real-world setting and implementation results are discussed.

Abstract—This paper describes an application of a zero–one goal programming approach at the University of Nebraska to allocate teaching staff to specific courses based on departmental needs and the personal preferences of departmental faculty. The results of the application demonstrate the model's capability to provide an assignment that satisfies departmental course offerings and teaching load objectives, while at the same time recognizing the personal preferences of the faculty concerned in the assignment process.

INTRODUCTION

One of the most important decision situations for some administrators or departmental chairpersons is the semesterly course assignment of teaching staff. Assigning full time faculty, part time faculty, instructors, teaching assistants or any teaching staff to specific courses each semester can become a very time consuming task for some departmental chairpersons, particularly as their departments expand to meet ever increasing student demand. In addition to changes in student enrollment, other factors as presented in Fig. 1, can increase the size and complexity of the faculty assignment problem. Fortunately, much of the faculty–course assignment problem is decreased by historic and predetermined assignments. Yet, for some departmental chairpersons, the remaining or residual faculty assignments might require several hours of tedious "pencil-and-paper" allocation effort.

Another consideration in the assignment process, and perhaps one of the most important, is the personal preferences of the teaching staff in specific course assignments. Despite the subjugation by the more primary departmental goals of providing necessary course offerings and meeting contractual agreements on teaching loads, there can exist considerable latitude in assigning the teaching staff to specific courses during a particular semester. Without a clear statement of course teaching preferences by the faculty, this latitude in the decision making process can cause both the departmental chairperson and the teaching staff some consternation.

This type of assignment problem commonly exists in all of the major departments of universities and colleges. At the University of Nebraska, the department used for modeling purposes‡, faced the usual changes in faculty assignments each semester because of changes in staffing. While contractual arrangements permitted some of the faculty to teach the same specific course(s) each semester, there still existed a considerable problem in assigning the remaining courses in such a way that it satisfied the departments course offering goals and teaching load requirements, while at the same time allowing faculty personal preferences in course selection.

To resolve this type of assignment problem a zero–one goal programming model, developed at the University of Nebraska, was designed to assign faculty to courses at the department planning level. The model is applied to resolve a faculty assigning problem at the university of Nebraska. The purpose of the application is to illustrate the ease of implementation of the model to any type of department, in any university.

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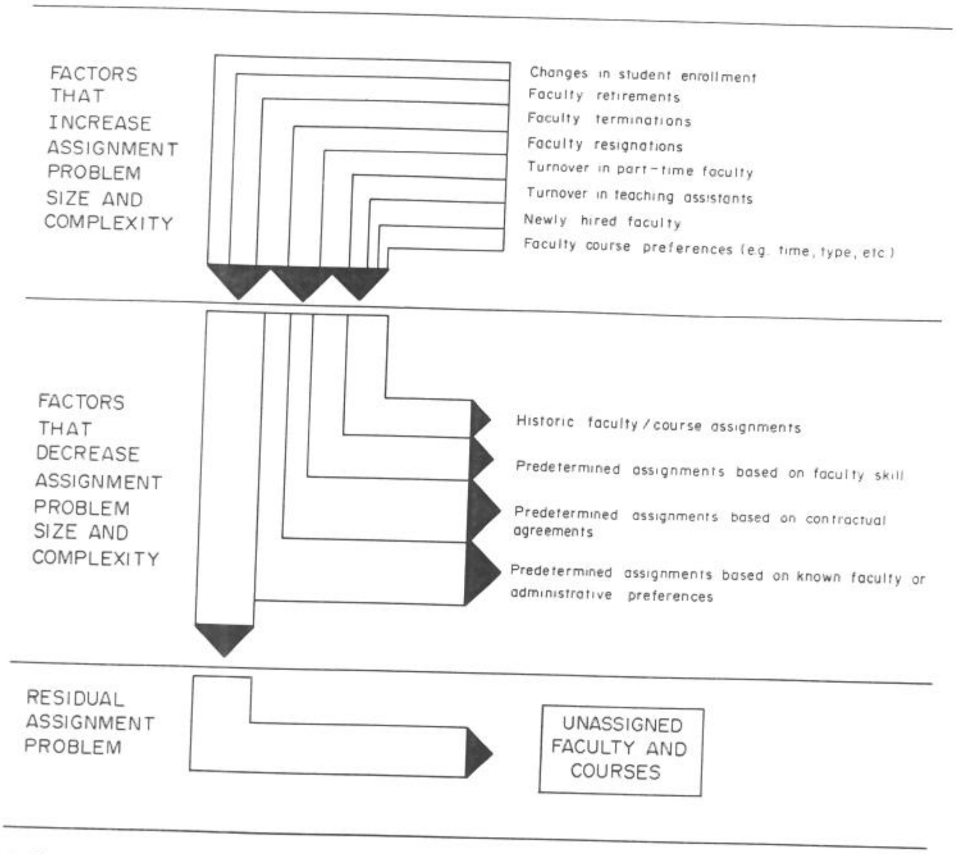

Fig. 1. Factors that increase and decrease the size and complexity of the departmental faculty assignment problem.

RELATED RESEARCH

While most institutions of higher learning are increasingly using model-based approaches to aid in their resource planning allocation problems, few department level formal planning models have appeared in the literature. Recent modeling approaches tend to be directed towards aggregate planning of human, financial, and physical resources in the higher levels of academic administration planning [1–5]. Planning models for resource allocation at the college level, and particularly at the department level are significantly lacking. Because of the nature of decision making at the department level, many of the modeling approaches used in the higher levels of a university's organization can not be easily applied at the department level. As some colleges and departments expand or change, necessary modeling approaches need to be made available to support decision making at all levels of the university.

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Some departmental level modeling techniques, such as Bentley's student-to-project assignment model [6], include preference information, but allocations are based on uni-objective criteria (i.e. a single goal). One multi-objective modeling technique that has been successfully used to model organization members personal preferences is goal programming [7, 8]. The natural conflict in the course assignment problem between competing individual faculty (i.e. faculty wanting to teach the same course or section), represents an ideal application of the goal conflicting resolution properties inherent in goal programming. Goal programming not only permits a model to include the preferences (i.e. individual's goals), but also is commonly available to university staff via their decision support systems and published software sources [9].

There has been several faculty–course assignment models presented in the literature [10–14]. Some of these studies required the development of complex utility functions to express faculty preferences [10, 12–14]. The complexity and time necessary to develop a utility function of faculty preferences could limit their application when used on a practical reoccurring basis on department level in a university organization. These prior studies also require significant modeling effort. Recent research by McClure and Wells [12] demonstrated how excessive the number of constraints and variables were for some of these proposed models (i.e. [10, 13, 14]) when used in practical assignment applications. Finally, most of the prior research did not include consideration of conflicting goals in the assignment problem. The Harwood and Lawless [11] model though did use goal programming to examine the conflicting goals in the faculty–course assignment problem. Their model assigned faculty to courses consistent with several organizational and personal preference goals. These goals included satisfying organization teaching load requirements, and teaching staff personal preferences in (1) selecting specific courses, (2) minimizing the number of teaching preparations, (3) minimizing the number of teaching days of the week, (4) minimizing the number of night classes, and (5) maximizing different sections of the same course for variety. The major drawback to the Harwood and Lawless model is that it may be very difficult to implement. First, the small application they presented modeling the assignment of only seven faculty members resulted in a model having over one thousand constraints and almost 200 variables. Department chairpersons do not always have the time or necessarily the expertise to develop such a model. Second, the Harwood and Lawless study used several surveys to collect data on ranking systems. The development of the ranking of numerous criteria each semester for priority weighting systems might create more effort in data collection for the departmental chairpersons, than the time savings provided by using the model. Finally, the multitude of criteria discussed in the Harwood and Lawless model are *not* goals that can be under-achieved, but in most cases are strict requirements that must be fully satisfied for accreditation or university policy reasons. While illustrative, these criteria add needless complication and data collection requirements to the model.

THE MODEL

The proposed model seeks to overcome the possible implementation limitations of the Harwood and Lawless model. In addition to satisfying departmental goals on the number and types of course offerings required, as well as the faculty teaching load requirements, the proposed model also deals with faculty course teaching preferences. The preferences are easily obtained by having each member of the department rank the courses they can teach, during a particular semester, in their order of preference.

The definitions of the goal programming model's variables, constants, constraints and objective function are presented.

Variables

$$x_{ij} = \begin{cases} \text{if 1, then the } i\text{th course is assigned to the } j\text{th faculty member} \\ \text{if 0, then the } i\text{th course is not assigned to the } j\text{th faculty member} \end{cases}$$

d_i^{s-} = negative deviation from the ith course offering (assigning less course sections than desired)

d_i^{s+} = positive deviation from the ith course offering (assigning more course sections than desired)

d_j^{t-} = negative deviation from the teaching load for the jth faculty member (assigning faculty a less than desired teaching load)

d_j^{t+} = positive deviation from the teaching load for the jth faculty member (assigning faculty a more than desired teaching load)

d_k^{r-} = negative deviation from the number of course section offerings at the same faculty assigned kth preference level

d_k^{r+} = positive deviation from the number of course section offerings at the same faculty assigned kth preference level.

Constants

n = total number of faculty to assign
m = total number of courses to assign
q = total number of ranks used by faculty to define their course preferences
s_i = number of sections of each of ith course to be offered in a semester (the sections can be separated by time of day to permit faculty their preference of choice)
t_j = teaching load in courses for each of jth faculty members
r_k = number of course sections permitted within the same kth ranking
w_k = ranked weight given by faculty on the preference to be assigned to teach a specific course.

Constraints

The constraints can be grouped into three categories. The first category of constraints represents a set of goals that need to be satisfied to insure that a department offers all of the desired sections of courses for a particular semester. In situations where multiple sections are offered at different times of the day, the s_is can be divided to permit faculty an opportunity to choose a specific time of day for their course.

$$\sum_{j=1}^{n} x_{ij} + d_i^{s-} - d_i^{s+} = s_i \qquad (\text{for } i = 1, 2, \ldots, m). \tag{1}$$

Equation (1) establishes the s_i sections for each of the m courses. The model permits any number of sections and courses to be included in the formulation.

$$\sum_{i=1}^{m} x_{ij} + d_j^{t-} - d_j^{t+} = t_j \qquad (\text{for } j = 1, 2, \ldots, n). \tag{2}$$

Equation (2) represents the assignment of the x_{ij} faculty to courses, constrained by their respective t_j course teaching load. While the present formulation defines teaching load in courses, the model could just as easily have been defined in terms of a semester hour teach load.

$$\sum_{i=1}^{m} \sum_{j=1}^{n} x_{ij} + d_k^{r-} - d_k^{r+} = r_k \qquad (\text{for } k = 1, 2, \ldots, q). \tag{3}$$

Equation (3) builds into the model the faculty course teaching preferences. The r_k right-hand-side values seeks to restrict the assignment of the courses to those chosen by the faculty at the highest priority first. This is accomplished by structuring the qth goal constraints in the order of the faculty ranking of course preferences, and using a weighting system in the objective function.

Objective function

The objective function in equation (4) below, has three priorities:

$$\text{minimize } Z = P_1 \sum_{i=1}^{m} (d_i^{s-} + d_i^{s+}) + P_2 \sum_{j=1}^{n} (d_j^{t-} + d_j^{t+}) + P_3 \sum_{k=1}^{q} w_k (d_k^{r-} + d_k^{r+}). \tag{4}$$

The first priority, P_1 in equation (4) is designed to satisfy course offering requirements of the department. As formulated the model seeks the exact number of s_i sections. If we did not have sufficient staff to cover all of the sections (i.e. permissible to offer less-than s_i sections), then only the d_i^{s+} would be included in the objective function. Similarly, if we had an excess supply of staff and felt we could offer more-than s_i sections, then only the d_i^{s-} would be included in the objective function. The second priority, P_2 represents the set of faculty teaching load assignment goals. The possibility of teaching load variation (i.e. more than or less than the specific t_j) can also be easily included in the model by dropping the appropriate d_j^{t-} or d_j^{t+} variable from the objective function. This accommodation permits the model to include part-time faculty and teaching assistants who do not always have to be assigned a full course load in a particular semester. The faculty course teaching assignment preference goal constraints are placed at the third priority (P_3) to logically position them as subordinate goals to those of the department. This model permits either the departmental chairperson or the faculty to establish the number of ranks used to express their preferences. The number of ranks defines q and w_k. Each of the q goal constraints includes only the decision variables that were attached to the specific ranks established by the faculty. That is, one goal constraint is used to model all of the courses with a rank of one, a second goal constraint is used to model all of the courses with a rank of two, and so on. The mathematical weights w_k used to differentiate the deviational variables in the objective function in equation (4), are simply the reversed order of the faculty rankings. For example, the decision variables placed in the goal constraint with a rank of one, received the most desirable mathematical weight of q for that goal constraint's deviational variables. The variables with a rank of two would receive a weight of $q - 1$, and so on.

APPLICATION

To illustrate the usefulness of the proposed goal programming model, it will now be applied to a departmental assignment problem at the University of Nebraska. The information used in this application was obtained for the Fall semester of 1985.

Background

The department used in this study utilizes both full-time and part-time faculty to staff their course offerings. After most of the full-time faculty were assigned their usual courses for the Fall semester (i.e. pre-arranged and special contracted courses), there still remained a total of 21 sections open for assignment. These 21 sections consisted of 20 different courses with 1 course having a multiple section. These course sections are listed by number in Table 1. To staff these sections, the department chairperson had a total of eight full-time faculty (i.e. some of which had part of their teaching load already assigned) and four part-time faculty. The twelve faculty and their remaining course teaching load available to be assigned are presented in Table 1. The part-time faculty (i.e. Faculty 9–12 on Table 1) consisted of teaching assistants who contractually could not have a course teaching load of more than 2 courses. As a matter of department routine, each semester the involved faculty (i.e. faculty who did not have their teaching load fully assigned) were asked to rank their preferences in teaching the balance of courses the department was expected to offer to university students. The ranks given for the Fall semester are presented in the columns of Table 1. The department chairperson would then subjectively try to come up with an assignment that came closest to satisfying most of the

Table 1. Faculty course preference rankings

Faculty / Course No.	Full-time faculty								Part-time faculty			
	1	2	3	4	5	6	7	8	9	10	11	12
101		4	4	4	4	4	4		1			
105				4	2			3	1		2	1
120	3	3			1	4			1	1		
202 (2 sections)		2	2	3	4		4	2		2	1	1
225		4			4			1				1
245	4	2			4							
275			2			1				2		
280			1							1		
290		1	3	4	2	4	4		2			
310		3	1		3	3	2		2	1		
320		3		2			3				2	
331				1		4						
340	1							2				2
350				3		2	2					2
375		2		4	2	4	3				2	
880		3			4			1				
890			2			3						
950				3			3					
970		3		1	4		3					
996				3		1	4					
Available teaching load in courses	1	3	2	2	2	2	2	2	≤2	≤2	≤2	≤2

highest ranked faculty course preferences. As an alternative to this time consuming subjective or heuristic assignment process, a goal programming model was developed to obtain an optimal solution that will consider the departmental needs of offering special courses and satisfying faculty teaching load requirements, while also permitting faculty course teaching preferences to be included in the decision process.

Required course section offerings

The decision variables for these constraints were assigned to only those courses that received a rank. The decision variable's subscripts are presented next to the ranks in Table 2. By assigning decision variables to just those courses with ranks, the entire model is significantly reduced in size over the more traditional m by n size assignment problem formulation, thus making it easier to solve in microcomputer programs [9]. This reduction in size also reduces the data input time for a computerized solution in more user-friendly computer codes.

In this assignment problem, a total of 20 courses were required. Also, Course No. 202 on Table 2 required two sections.

$$x_1 + x_2 + x_3 + x_4 + x_5 + x_6 + x_7 + d_1^- - d_1^+ = 1 \tag{5}$$

$$x_8 + x_9 + x_{10} + x_{11} + x_{12} + x_{13} + d_2^- - d_2^+ = 1 \tag{6}$$

$$x_{14} + x_{15} + x_{16} + x_{17} + x_{18} + x_{19} + d_3^- - d_3^+ = 1 \tag{7}$$

$$x_{20} + x_{21} + x_{22} + x_{23} + x_{24} + x_{25} + x_{26} + x_{27} + x_{28} + d_4^- - d_4^+ = 2 \tag{8}$$

$$x_{29} + x_{30} + x_{31} + x_{32} + d_5^- - d_5^+ = 1 \tag{9}$$

$$x_{33} + x_{34} + x_{35} + d_6^- - d_6^+ = 1 \tag{10}$$

$$x_{36} + x_{37} + x_{38} + d_7^- - d_7^+ = 1 \tag{11}$$

$$x_{39} + x_{40} + d_8^- - d_8^+ = 1 \tag{12}$$

$$x_{41} + x_{42} + x_{43} + x_{44} + x_{45} + x_{46} + x_{47} + d_9^- - d_9^+ = 1 \tag{13}$$

$$x_{48} + x_{49} + x_{50} + x_{51} + x_{52} + x_{53} + x_{54} + d_{10}^- - d_{10}^+ = 1 \tag{14}$$

$$x_{55} + x_{56} + x_{57} + x_{58} + d_{11}^- - d_{11}^+ = 1 \tag{15}$$

$$x_{59} + x_{60} + d_{12}^- - d_{12}^+ = 1 \tag{16}$$

$$x_{61} + x_{62} + x_{63} + d_{13}^- - d_{13}^+ = 1 \tag{17}$$

$$x_{64} + x_{65} + x_{66} + x_{67} + d_{14}^- - d_{14}^+ = 1 \tag{18}$$

$$x_{68} + x_{69} + x_{70} + x_{71} + x_{72} + x_{73} + d_{15}^- - d_{15}^+ = 1 \tag{19}$$

$$x_{74} + x_{75} + x_{76} + d_{16}^- - d_{16}^+ = 1 \tag{20}$$

$$x_{77} + x_{78} + d_{17}^- - d_{17}^+ = 1 \tag{21}$$

$$x_{79} + x_{80} + d_{18}^- - d_{18}^+ = 1 \tag{22}$$

$$x_{81} + x_{82} + x_{83} + x_{84} + d_{19}^- - d_{19}^+ = 1 \tag{23}$$

$$x_{85} + x_{86} + x_{87} + d_{20}^- - d_{20}^+ = 1. \tag{24}$$

In equations (5)–(24) each of the 20 courses are modeled with a separate goal constraint. The accommodation for multiple sections, such as the two sections for Course No. 202 on Table 2, are easily incorporated into the model by simply changing the right-hand side value as can be seen in equation (8).

Required teaching load

In this assignment problem, eight full-time and four part-time faculty were required to be assigned to the course 21 sections. The constraints were developed by taking the decision variables listed in

Table 2. Decision variable assignment of faculty course preference rankings†

Course No. \ Faculty	Full-time faculty								Part-time faculty			
	1	2	3	4	5	6	7	8	9	10	11	12
101		4(1)	4(2)	4(3)	4(4)	4(5)	4(6)		1(7)*			
105				4(8)	2(9)			3(10)	1(11)*		2(12)	1(13)
120	3(14)	3(15)			1(16)*	4(17)			1(18)	1(19)		
202 (2 sections)		2(20)	2(21)	3(22)	4(23)		4(24)	2(25)		2(26)	1(27)*	1(28)*
225		4(29)			4(30)			1(31)				1(32)*
245	4(33)	2(34)*			4(35)							
275			2(36)			1(37)*				2(38)		
280			1(39)*							1(40)		
290		1(41)	3(42)	4(43)	2(44)	4(45)	4(46)		2(47)			
310		3(48)	1(49)		3(50)	3(51)	2(52)		2(53)	1(54)		
320		3(55)		2(56)*			3(57)				2(58)	
331				1(59)*		4(60)						
340	1(61)*							2(62)				2(63)
350					3(64)		2(65)	2(66)				2(67)
375		2(68)*		4(69)	2(70)	4(71)	3(72)				2(73)	
880		3(74)			4(75)			1(76)*				
890			2(77)*			3(78)						
950				3(79)			3(80)*					
970		3(81)		1(82)*	4(83)		3(84)					
996					3(85)		1(86)	4(87)				
Available teaching load in courses	1	3	2	2	2	2	2	2	≤2	≤2	≤2	≤2

*Optimal faculty assignment.
†Value in parenthesis is the subscript of the decision variable.

each column in Table 2.

$$x_{14} + x_{33} + x_{61} + d_{21}^- - d_{21}^+ = 1 \tag{25}$$

$$x_1 + x_{15} + x_{20} + x_{29} + x_{34} + x_{41} + x_{48} + x_{55} + x_{68} + x_{74} + x_{81} + d_{22}^- - d_{22}^+ = 3 \tag{26}$$

$$x_2 + x_{21} + x_{36} + x_{39} + x_{42} + x_{49} + x_{77} + d_{23}^- - d_{23}^+ = 2 \tag{27}$$

$$x_3 + x_8 + x_{22} + x_{43} + x_{56} + x_{69} + x_{79} + x_{89} + d_{24}^- - d_{24}^+ = 2 \tag{28}$$

$$x_4 + x_9 + x_{16} + x_{23} + x_{30} + x_{35} + x_{44} + x_{50} + x_{59} + x_{64} + x_{70} + x_{75} + x_{83} + x_{85} + d_{25}^- - d_{25}^+ = 2 \tag{29}$$

$$x_5 + x_{17} + x_{37} + x_{45} + x_{51} + x_{71} + x_{78} + d_{26}^- - d_{26}^+ = 2 \tag{30}$$

$$x_6 + x_{24} + x_{46} + x_{52} + x_{57} + x_{60} + x_{65} + x_{72} + x_{80} + x_{84} + x_{86} + d_{27}^- - d_{27}^+ = 2 \tag{31}$$

$$x_{10} + x_{25} + x_{31} + x_{62} + x_{66} + x_{76} + x_{87} + d_{28}^- - d_{28}^+ = 2 \tag{32}$$

$$x_7 + x_{11} + x_{18} + x_{47} + x_{53} + d_{29}^- - d_{29}^+ = 2 \tag{33}$$

$$x_{19} + x_{26} + x_{38} + x_{40} + x_{54} + d_{30}^- - d_{30}^+ = 2 \tag{34}$$

$$x_{12} + x_{27} + x_{58} + x_{73} + d_{31}^- - d_{31}^+ = 2 \tag{35}$$

$$x_{13} + x_{28} + x_{32} + x_{63} + x_{67} + d_{32}^- - d_{32}^+ = 2. \tag{36}$$

Faculty course teaching preferences

The faculty ranks ranged from 1 (i.e. most desired course to teach) to 4 (least desired course). Some faculty did not use all of the ranks (e.g. Faculty No. 1 skipped the rank of 2) and some faculty did not use the full range of ranks (e.g. part-time faculty just used the ranks of 1 and 2). The model permits such deviations without any extra modeling effort. Indeed, the less ranks that are used by the faculty, the fewer the number of decision variables and goal constraints required in the model. Since four different ranks were used, four goal constraints are necessary to model the faculty preferences.

$$x_7 + x_{11} + x_{13} + x_{16} + x_{18} + x_{19} + x_{27} + x_{28} + x_{31} + x_{32} + x_{37} + x_{39} + x_{40} + x_{41} + x_{49} + x_{54} + x_{59} + x_{61} + x_{76} + x_{82} + x_{87} + d_{33}^- - d_{33}^+ = 14 \quad (37)$$

$$x_9 + x_{12} + x_{20} + x_{21} + x_{25} + x_{26} + x_{34} + x_{36} + x_{38} + x_{44} + x_{47} + x_{52} + x_{53} + x_{56} + x_{58} + x_{62} + x_{63} + x_{65} + x_{66} + x_{67} + x_{68} + x_{70} + x_{73} + x_{77} + d_{34}^- - d_{34}^+ = 11 \quad (38)$$

$$x_{10} + x_{14} + x_{15} + x_{22} + x_{42} + x_{48} + x_{50} + x_{51} + x_{55} + x_{57} + x_{64} + x_{72} + x_{74} + x_{78} + x_{79} + x_{80} + x_{81} + x_{84} + x_{85} + d_{35}^- - d_{35}^+ = 13 \quad (39)$$

$$x_1 + x_2 + x_3 + x_4 + x_5 + x_6 + x_8 + x_{17} + x_{23} + x_{24} + x_{29} + x_{30} + x_{33} + x_{35} + x_{43} + x_{45} + x_{46} + x_{60} + x_{69} + x_{71} + x_{75} + x_{83} + x_{87} + d_{36}^- - d_{36}^+ = 12. \quad (40)$$

In equation (37), the decision variables that were included are only those that were given a rank of one in Table 2. The right-hand side value of 14 was obtained by counting the number of courses that had received at least one rank of one (i.e. only Course Nos 101, 105, 120, 202, 225, 275, 280, 290, 310, 331, 340, 880, 970, 996).

Objective function

The resulting objective function for this problem is:

$$\text{minimize: } Z = P_1 \sum_{i=1}^{20} (d_i^- + d_i^+) + P_2 \sum_{j=21}^{28} (d_j^- + d_j^+) + P_2 \sum_{j=29}^{32} (d_j^+) + P_3 |4(d_{33}^- + d_{33}^+) + 3(d_{34}^- + d_{34}^+) + 2(d_{35}^- + d_{35}^+) + 1(d_{36}^- + d_{36}^+)|. \quad (41)$$

In equation (41) the P_2 priority level is divided into two sections. The second section of P_2 permits the four part-time faculty to possibly be assigned less-than a two-section teaching load. The weights used at P_3 are simply the inverse ordering of the four ranks established and assigned by the faculty.

RESULTS AND DISCUSSION

Having formulated the problem, which consisted of only 87 decision variables and 36 goal constraints, it was solved using a modified simplex program for goal programming on microcomputers [8]. Because this problems' formulation permits the right-hand side values to be integer and because of the unimodular structure of the decision variable coefficients (i.e. technological coefficients being equal to zero or one), this particular application did not require specialized zero–one goal programming computer support languages. Some faculty assignment applications might require a specialized computer program, particularly in situations where we have noninteger teaching loads. As observed by Schniederjans [9, p. 102], the type of assignment model presented in this paper can help force a zero–one solution, but such an outcome is not mathematically guaranteed.

This assignment problem required a total of 98 iterations and less than 20 min of execution time on a 512 K Macintosh. The solution for this application is denoted in Table 2 by the asterisk next to the decision variable subscripts. All other decision variables were equal to zero. The summarized goal deviation values are presented by priority level in Table 3. In the solution, the first departmental priority (P_1) of offering all of the desired semester courses was fully achieved. While the second priority (P_2) was also fully achieved, Faculty No. 10 was not assigned any courses and Faculty No. 11 was assigned only one, of a possible two course teaching load. Since these department members were part-time faculty, there were no penalties for not making an assignment. The weighted faculty preferences (P_3) for a specific course assignment were minimized in the resulting solution. Since the

Table 3. Analysis of objectives

Priority	Goal	Total weighted deviation from goal	Goal achievement
P_1	Required course section offering	0	Full
P_2	Required teaching load	0	Full
P_3	Faculty teaching preferences	55	Partial

P_3 rankings are conflicting by their very nature, this goal will usually not be completely achieved. The resulting solution on Tables 2 and 3 is easy to defend in light of the fact that of the eleven resulting faculty assigned to courses, eleven received at least one course to which they had given the highest rank.

The department chairperson chose to subjectively modify the model generated solution to accommodate the addition of a twelfth faculty member when implementing the solution. This was consistent with research that indicates the best decisions are usually those that combine objective information from a model, with subjective inputs from human beings [15]. Despite this modification to the solution, the model's resulting assignment of faculty to courses was generated more quickly than previous heuristic methods and with a minimum of faculty dissatisfaction. The data for the model was collected and input into the computer in a single day. In addition to saving the departmental chairperson's time in coming up with an initial faculty assignment schedule, the model's solution appeared to minimize post assignment change negotiation time. Since almost all of the faculty received their top two ranked courses, re-assignments or changes from the model generated schedule were not requested as much as in prior semesters.

The implementation of this decision support model was made very simple by the fact that it did not require any new or additional information to be collected within the department. The course offerings, teaching load requirements, and assignment preference information was always collected routinely and thus posed no unique collective requirements.

SUMMARY AND COMMENTS

The preceding application demonstrated how the goal programming model presented can be useful in assigning faculty specific courses to teach during a semester. The application illustrated how the faculty assignment problem could be structured into a relatively small model (i.e. relative to the models in prior research), requiring little expertise (i.e. goal programming is usually covered in undergraduate decision science courses), solutions required little investment in a decision support system (i.e. a micro program), and be processed by available staff support (i.e. students) with little or no expense of time by the departmental chairperson. The model presented generated a solution that recognizes the higher priority of departmental course assignment requirements while at the same time including faculty preference information in such a way that a superior assignment to currently used subjective methods is generated.

The application used in this paper only made assignments for those faculty that had not had their full course load exhausted. This would logically make the model smaller than other models that make the entire faculty assignment at one time. Research at the University of Nebraska and other schools has consistently shown that invariably specific courses are the "territory" of specific faculty and the more common decision situation faced by a departmental chairperson is in assigning the balance of courses after the known course assignments have been made. Of course, the model proposed in this paper can include any number of faculty and at a significant reduction in model size when compared with previously published models.

Prior assignment models permitted a number of other criteria (i.e. not teaching more than one night course) to be included in the modeling process. The proposed goal programming model can use most of the same constraints presented in the prior research by adding additional goal constraints and priorities to reflect the desired decision criteria. As such, this paper's model takes advantage of existing research and extends it by illustrating the means by which simplicity can be built into a faculty assignment model. This was not demonstrated in this paper, but is recommended as a topic for further research.

One final comment concerns the use and implementation of this paper's model by interested departmental chairpersons. Specifically, why would a departmental chairperson use the model presented in this paper as a faculty assignment aid, when it may only take them a few hours to work through the assignment on a pencil-and-paper basis? The model's reduced size (i.e. relative to other published models), its zero–one formulation (i.e. which permits all of the technological coefficients in the goal constraints to equal zero or one), and minimum departmental information requirements, permit the model to be an ideal candidate for a decision support system (DSS). A DSS that could reduce the repetitive faculty assignment problem from a few hours to a few minutes and could be structured so no prior information or goal programming is necessary. Indeed, the model also permits a quick and easy way to achieve a sensitivity analysis of faculty assignments by revising select preference rankings and re-running the same model. Research is currently underway at the University of Nebraska to convert this paper's model to a single program (i.e. a single diskette) for an IBM-PC as a DSS for faculty assignments. By precoding the names of faculty, course names and numbers, only minor information up-dates are required on semester basis. The primary information input requirements would consist of only three items [i.e. (1) teaching load requirements by faculty, (2) course requirements by section, and (3) faculty preference rankings] for the faculty who did not have a predetermined course assignment. Preliminary research on the time it might take to enter such information on a problem the size of the one presented in this paper, is currently a matter of minutes. It also appears that problems three or four times as large can be entered and solved in less than 30 min.

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