A FUZZY BICRITERIA APPROACH FOR JOURNAL DESELECTION IN A HOSPITAL LIBRARY

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A Fuzzy Bicriteria Approach for Journal Deselection in a Hospital Library

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Abstract

Collection management is an important duty of librarians. In the last years journal prices have increased and library decision-makers have been forced to consider cancelling some journal subscriptions as budgets have not increased always by the same ratio. This fact has made it essential to supply reliable and efficient measures about the importance of different journals for in-house users in order to help the decision-makers to cancel subscriptions.

Many journal-use studies can be found in the literature providing methods for making these kinds of decisions, but usually they consider only one single and precise decision criterion. Nevertheless, it is common knowledge that any real decision usually considers more than one criterion, and so the problem of choosing a set of journals to cancel is compounded by the existence of conflicting criteria, such as the cost of the journal and demand for the journal.

As predicting possible number of users of a certain journal is a complex task, the expert's judgments could be vital elements. Fuzzy Set theory could be a useful tool in dealing with these kinds of real decisions based on the expert's knowledge and characterized by some level of subjectivity, in which the decision maker has imprecise and/or vague data and/or incomplete information.

In this paper a fuzzy bi-criteria optimisation method is proposed to determine the optimal shape of the printed journal collection in a medical library in a Spanish public hospital. We jointly consider two criteria: maximising a *usage function* and also an *opportunity coefficient of purchase* function, both defined for each printed journal. Budget constraints and minimum availability constraints are taken into account.

The proposed model is flexible, incorporates expert knowledge and can be easily extended to other hospital libraries.

Keywords: Multi-objective Programming, Fuzzy Sets, Decision-Making, Journal Deselection, Weighting method.

1. Introduction

Journal prices have increased at a much higher rate than most library budgets in recent years, resulting in an inability to maintain existing journal subscriptions. This has made it essential for libraries to have reliable and efficient measures about the importance of different journals, in order to local clientele with which to make cancellation and retention decisions.

In a medical library, periodical collections are especially important, and careful considerations are necessary before purchasing or cancelling titles; collection management has therefore become one of the most important duties of librarians. Journal *usage studies* provide data for making such decisions.

There are several works that deal with this problem using different approaches. Gross and Talavage [1] proposed a mathematical planning model for information service managers to allocate scarce financial resources. Kraft *et al*. [2] used a zero-one linear programming model to address the problem as to which journals a library should acquire, given a particular demand pattern exhibited by users and a set of limited resources. In [3] dynamic programming techniques are used to solve the selection problem proposed by [4]. In 1973, Rothstein [5] proposed a model for choosing an optimal periodical allocation based on a criterion to determine the maximum utility of the periodicals and the same year Goyal [6] published a library fund allocation model using Goal Programming for solving the problem of allocating library funds to different departments of a university. But, as is stated by Wise and Perushek [7], each of these models includes only a single objective and ignores the journal cancellation problem.

Hannan in 1978 [8] published a pioneer work on the allocation of library funds between books and standing orders using Goal Programming (GP) as a multiple criteria approach. Hannan excluded journals from his allocation model, arguing that “if a journal has been purchased by a library, it behoves the library to continue subscribing for a moderate period of time in order for the journal holdings to be of any value” (see [7]). But Fry and White in 1979 [9] had demonstrated that librarians were increasingly cancelling journals due to funding problems [10] (for some details about GP see [11], [12], [13], [14])

Wise and Perushek [7] identify Beilby and Mott’s work published in 1983 (see [15]) as the first in which a library acquisition allocation problem was formulated and solved using GP. The proposed model incorporated criteria relating to information access, user demand, circulation and cost to determine the number of periodical titles and books to be purchased under certain conditions. This work was “the first serious attempt by librarians to mathematically find an optimal solution within a context of conflicting and incommensurate fund allocation objectives” ([7]).

Schiniederjans and Santhanam [16] propose a zero-one goal programming approach that is able to consider conflicting criteria such us cost of the journal, demand for the journal and the rating of the journal, and provides a “satisficing” solution using a GP model to solve a university library's journal cancellation problem.

Wise and Perushek (see [17], [7]) developed a model showing how Goal Programming techniques can be used to provide an optimal solution to the allocation of acquisition funds in academic libraries within the context of conflicting and incommensurate goals.

As regards the journal selection problem, the library DM must decide which journals should be purchased on the basis of given information concerning demand patterns exhibited by users and resources available to the library. Thus, the main objective regarding this problem is to maximise the total expected utility of acquiring journals over a fixed period subject to budget constraint. But as has been mentioned above, other objectives are usually considered when making selection-deselection journal real decisions such as the cost of the journal, the demand for the journal, the rating of the journal and/or the opportunity to purchase a journal that perhaps, because of use, is cheaper to request via a loan.

As stated by Bar-Ilan and Fink [18], since the introduction of the World Wide Web, the use of electronic journals (e-journals) has increased. Tenopir et al. [19] describe this phenomena as an “evolutionary process” and distinguish three different phases: an introductory phase when e-journals are firstly introduced (1990-1993); an evolving phase during which the majority of scientific journals are available in electronic format (from the late 1990s to 2005) and an advanced phase where searching capabilities and advanced features are integrated in a complete system.

At the time of this study, the scientific journal system in Spanish Hospital Libraries was undergoing transition to the second phase and in the particular case of the Hospital requesting this study, the number of electronic subscriptions was practically zero at the time of the study due to that library’s small budget. Additionally, few computers were available at the hospital for searching for papers electronically. Therefore, e-journals have been excluded from this particular study although they will be considered in future research because of their advantages - accessibility or desktop access, home access and ease of retrieval and hyperlinks to outside content - librarians can benefit significantly in the areas of cost per use.

In this paper, instead of using a MCDM technique based on a "satisficing" philosophy, we propose using the *Weighting Method*, underpinned by an optimisation philosophy, for solving a journal selection problem in a public hospital.

The *Weighting Method* is a generating technique which approximates the feasible set in Multiple Criteria Decision Making problems (MCDM). Zadeh (1963) demonstrated that within a Multi-objective Programming problem, a non-negative weight is associated with each objective and then the weighted objectives are aggregated into a composite objective function. The optimisation of this objective function generates an extreme efficient point. Through the parameterisation of the weights the efficient set is approximated. As was stated by Ballestero and Romero (Ballestero and Romero, 1998) it is interesting to notice that this method only generates corner or extreme efficient points.

The aim of this study, based on in-house use and interlibrary loan activity and on the available budget, is to provide the librarian of a Spanish public hospital with enough information in order to decide whether or not to buy circulating print journals. For this reason, the Weighting Method (WM) is proposed in order to obtain extreme efficient points for the proposed problem.

2. Problem scenario: data and methodology.

2.1 Obtaining data.

The number of scientific journals combined with increasingly subscription prices makes it difficult for librarians to maintain current levels of collections (Daval, 1994; Kyrillidou, Rodriguez and Stubbs, 1997). Due to this situation, librarians are forced to cancel some scientific journal subscriptions.

Since specific information is needed to support cancellation suggestions, the library decision-makers (DM) of a local Spanish public hospital contacted us to carry out an in-depth study into the use and utility of the current journal collection of the medical library. The hospital is a postgraduate teaching one and has 500 beds. There are also several research groups working there.

The medical library that requested this study subscribes to 270 periodical print publications, which are non-circulating - that is, they cannot be extracted from the library room - and thus, they are, in principle, permanently available. The library is open weekdays from 8:30 to 19:30 and open access is provided to copies of subscribed journals.

Most requests for articles from journals are internal and come from members of the medical faculty, which consists of 315 people. Analysis of these requests for titles will enable the librarian to adjust them to the needs of the hospital's faculty.

In this work 157 printed titles have been analysed belonging to the Library's collection (see tables 1.1 and 1.2 in the appendix). Library journals excluded from the work were new subscriptions or those that are provided free of charge.

In the print environment, usage has been measured by re-shelving statistics and by analyses of cost per article or cost per published page. But as stated by Cox (2003), neither really accurately measures the number of times an article is "used".

Considering that readers have free access to journals and must put them back on the shelves once used, data reflecting this use was collected for this study by asking users not to re-shelve the items they used and tabulating each one before they were re-shelved. This was done over a period of three years, from 1997 to 1999. However, users often re-shelve items despite instructions to the contrary and, if one item is off its shelf, it may be used more than once or more than one article may be consulted without control.

Nevertheless, the in-house use data was gathered using this sampling technique because continuous tabulation was not possible due to personnel time limitations. Journal usage was counted for two weeks a month over three years. During the study period, the staff tabulated the global use for each title by totalling the number of use per year.

To compensate for the possible missing data due to the collecting system, we have made some adjustment to data. We estimated the weighting mean of annual uses giving increasing weights to different years studied. Subscription rates of the journals for the study period and the foreseeable rate for the year 2000 are known.

Payments were, for many journals, made in USA dollars, and so changes in exchanges rates have a major influence on our purchasing power. This factor lends some special features to the data in the model.

As predicting possible number of users of a certain journal is a complex task and the human capability to understand and analyse imprecise events (which are not easily incorporated into existing analytical methods) is also troublesome, the expert's judgments are vital elements in evaluating advertising strategies. Thus, most of these strategies are dependent on expert's subjective judgments based on different criteria. Many DMs in this field would argue that several quantitative models could not be reliable because their use of historical data requires the unrealistic assumption that usage of a journal will follow the same pattern as in the past. Others may argue that obtaining the information required by analytical probabilistic methods is too difficult or impossible. Fuzzy Set Theory provides a useful tool in dealing with decisions in which we have imprecise and/or vague data and/or incomplete information.

With all these considerations we have formulated a fuzzy bi-objective problem to determine the optimal shape of this specific library's journal collection.

2.2 Methodology

Previous fuzzy concepts

The main idea of Fuzzy Set Theory is quite intuitive and natural: instead of determining the exact boundaries as in an ordinary set, a fuzzy set allows for no sharply defined boundaries because of the generalisation of a characteristic function to a membership function.

By letting X denote a universal set, a fuzzy set $\widetilde{A}$ of X can be characterised as a set of ordered pairs of element x and the grade of membership of x in $\widetilde{A}$, $\mu_{\widetilde{A}}(x)$, and is often written: $\widetilde{A} = \{(x, \mu_{\widetilde{A}}(x)) / x \in X\}$. Note that the membership function is an obvious extension of the idea of a characteristic function of an ordinary set because it takes on values between 0 and 1, not only 0 and 1.

A fuzzy number is one of the most common forms of fuzzy set application (Kaufmann and Gupta, 1988); it is defined as a fuzzy set defined on the real line IR with a convex, continuous and normalised membership function. Based on the properties of convexity and normality, the level set of a continuous fuzzy number is an interval represented by $\lfloor L_{\widetilde{A}}(\alpha),\ R_{\widetilde{A}}(\alpha) \rfloor$ consisting of all the elements where the grade of membership is at least α. The $\alpha -$ level set of a fuzzy number is defined as:

$$A_\alpha = \{ x / \mu_{\widetilde{A}}(x) \geq \alpha \} \quad \alpha \in [0,1] \tag{1}$$

There are different types of fuzzy numbers, but the triangular and trapezoidal fuzzy numbers are the most commonly used ones applied to decision-making problems. By letting $\widetilde{A}$ be a triangular fuzzy number, characterised by the triplet $\left(a^1, a^2, a^3\right)$, the membership function $\widetilde{A}$ is represented as:

$$\mu_{\tilde{A}}(x)=\begin{cases}0 & x<a^1\\ \dfrac{x-a^1}{a^2-a^1} & a^1\le x\le a^2\\ 1 & x=a^2\\ \dfrac{a^3-x}{a^3-a^2} & a^2\le x\le a^3\\ 0 & x>a^3\end{cases} \tag{2}$$

Figure 1 shows the representation of the triangular fuzzy number.

Fuzziness must be considered in decision-making where human estimation is influential. Since Zadeh (1978) introduced the concept of possibility, the fuzziness of several decision making problems has been handled by possibility distributions. A possibility distribution can be defined in the following way. Let $\widetilde{A}$ be a fuzzy set of a universe of discourse X characterised by its membership function $\mu_{\widetilde{A}}$. Let x be a variable of X. Then $\mu_{\widetilde{A}}(x)$ can be interpreted as the degree of possibility of the proposition "x is $\widetilde{A}$". Thus, the possibility distribution (π_x) of x is defined as being numerically equal to the membership function of $\widetilde{A}$, i.e. $\pi_x=\mu_{\widetilde{A}}$. Therefore, fuzzy numbers can be also considered as possibility distributions (Dubois and Prade, 1988).

Defuzzification methods aim to obtain a value or a set of crisp values representing a fuzzy number, fuzzy rule or a fuzzy system. Several methods have been developed for this task. The most simple consider only the most possible value representing the fuzzy number. On the other hand, the most sophisticated take into account more information from the fuzzy parameter. In this paper, we have chosen to work with the expected value of a fuzzy number which fulfills suitable properties such as linearity, which is easy to apply and which gives us a good representation of fuzzy numbers. Heilpern (1992) defined the expected value of a fuzzy triangular number $\tilde{A}=\left(a^1,a^2,a^3\right)$ as:

$$EV\left(\tilde{A}\right)=\frac{a^1+2a^2+a^3}{4} \tag{3}$$

Multiple criteria decision-making (MCDM) is a quantitative paradigm in decision sciences whose most important aspect is that the decision-maker (DM) does not consider one single criterion, but rather seeks an optimal compromise between several conflicting ones.

An objective function is a quantitative expression of a criterion that reflects the preference of DM by associating a number to each possible decision. Multi-objective Programming (MOP) is an MCDM approach that deals with the problem of simultaneous optimisation of several objectives subject to a set of constraints.
Simultaneous optimisation of several objectives, one by one, is not possible due to the existing conflict between then. MOP tries to find the set of Pareto-optimal solutions; i.e. solutions such that any other possible solution to the same problem can achieve the same or better performance for all considered criteria, being better at least for one criterion.

Formally, the general setting of a MOP problem can be expressed as follows:

$$\begin{aligned} &Eff \quad f(x) = \left[f_1(x), \ldots, f_i(x), \ldots, f_q(x) \right] \\ &subject\ to: \quad x \in F \end{aligned} \tag{4}$$

Where:

Eff means the search for efficient solutions in a maximising sense where “more is better” or in a minimising sense where “less is better”

$f_i(x) =$ mathematical expression for the *ith* objective

x = vector of decision variables

F = feasible set defined by the constraints of the problem.

Considering the fact that a real DM has to take into account more than one criterion to determine the shape of the hospital library journal collection that we are aiming for, we will use the MOP approach. Specifically, in this paper we will formulate and solve a bi-objective optimisation model using the *Weighting Method* that leads to the following parametric programming model:

$$\begin{aligned} &\max \quad \alpha_1 f_1(x) + \ldots + \alpha_i f_i(x) + \alpha_q f_q(x) \\ &subject\ to: \\ &x \in F \\ &W > 0 \end{aligned} \tag{5}$$

where $W = (\alpha_1, \ldots, \alpha_i, \ldots, \alpha_q)$ is the vector of non-negative weights.

For a given set of weights, this method detects as efficient point the tangency point of the efficient frontier and the family of hyperplanes $\sum_{i=1}^{q} \alpha_i f_i(x)$.

The computational burden of this technique is large. In fact, its implementation requires R^{q-1} computer runs of the model, R being the number of values given to the weights. As was stated by Ballestero and Romero (1998) the computational burden can be considerably reduced by using parametric mathematical programming codes.

Nevertheless, this technique can leave efficient points unexplored and to avoid this it is necessary to considerably reduce the scales of the weights. In any case, this is a technique devised simply to *approximate* the efficient set and this is our objective in this work.

We aim for the maximisation of two objective functions simultaneously. One of them reflects an economic criterion and to construct it, an opportunity coefficient of purchases of a certain journal will be constructed. The other objective function may be considered as a use-worth function, in the sense that each journal is weighted by a coefficient that is a use indicator and therefore, we will give more importance to buying journals with more relative use.

The set of constraints is established by budget limitations and by the fact that the journal's collection should verify some availability parameters.

3. Problem formulation.

For the development of this case study, the following variables, coefficients, objectives and constraints will be considered:

Variables

R_i= binary variable representing the decision about each journal $R_i \in \{0,1\} \quad \forall i = 1,...,157$. If the solution of the problem gives R_i value one, this means that the *i*th journal will be purchased and if R_i takes value zero, it would not be purchased.

Data and coefficients

SP_i = foreseeable annual subscription rate for year 2000.

U_i = weighted mean of annual usages. It represents the total number of times that a journal *i* was consulted over one year during the study period.

$P\tilde{U}_i$ = number of potential users of each journal. The number of users of each journal is uncertain data. The DM considers that historical data is not enough. For this reason, potential users are considered as fuzzy data and handled by triangular fuzzy numbers described by their possibility distributions, estimated by the librarian based on her expert knowledge:

$$P\tilde{U}_i = \left(PU_i^1, PU_i^2, PU_i^3\right) \tag{6}$$

where PU_i^2, is a *corrected average* number of users for journal *i*, which has been determined using historical data and the librarian's expert knowledge, and PU_i^1 and PU_i^3 are the best and the worst estimations given by the librarian. In figure 2, $\mu_{P\tilde{U}_i}$, with $0 \leq \mu_{P\tilde{U}_i} \leq 1$, represents the possibility degree of occurrence of parameter $P\tilde{U}_i$ which represents the number of users of journal *i*. Thus, the DM considers that the value with a higher possibility degree of occurrence, the central value of the fuzzy triangular number, is the *corrected average* which is $\mu_{P\tilde{U}_i} = 1$. We can also observe that the DM believes that more users than the best and less than the worst estimations have no possibility of occurrence, thus $\mu_{P\tilde{U}_i} = 0$. Remaining values for the time spent on processes have intermediate possibility degrees of occurrence.

In order to determine this data, we have considered not only the specialists that the journal is directly aimed at, but also those with a secondary interest in the speciality from among all the medical staff.

LP_i = average price of acquiring a copy of an individual article requested through interlibrary loan. We know the total number of articles requested annually via this service.

CO_i = opportunity coefficient CO_i of purchase for each journal. We have defined CO_i as a ratio that provides a measure of the effectiveness of subscribing to a journal, comparing the cost of owning a journal with the cost of acquiring individual articles via interlibrary loan, at a given level of use:

$$CO_i = \frac{U_i \quad LP_i}{SP_i} \tag{7}$$

$C\tilde{U}_i$ = usage ratio. This coefficient reflects the relationship between real users compared to possible ones. We will define it as follows:

$$C\tilde{U}_i = \frac{U_i}{P\tilde{U}_i} \tag{8}$$

All the above coefficients are displayed in tables 2, 3 and 4.

Objectives

Once the above coefficients have been defined from library data, the deselection problem is addressed as a bi-objective programming problem, whose objectives are stated as follows:

- ✓ Maximise a function f_1 reflecting a global measure of the opportunity of subscribing to a set of journals, represented as:

$$f_1 = \sum_{i=1}^{157} CO_i \cdot R_i \tag{9}$$

- ✓ Maximise a function $\tilde{f}_2$ that represents in-house journal-use at this library, that is:

$$\tilde{f}_2 = \sum_{i=1}^{157} C\tilde{U}_i \cdot R_i \tag{10}$$

Constraints

The constraints of the problem, only two in this approach, are generated by limited resources and by DM's preferences:

- ✓ *Budget constraint*: the librarian considers that is useful not to spend all the money available on acquiring the present journal collection, because it is necessary to save some for new titles and other eventual needs. So, for titles in this study we will invest only 85% of the total budget (i.e. 956250 monetary units):

$$\sum_{i=1}^{157} SP_i \cdot R_i \leq 956250 \tag{11}$$

- ✓ The second constraint reflects the fact that DM aims to cover at least 75% of the internal demands (5143 units) through own funds; that is:

$$\sum_{i=1}^{157} U_i \cdot R_i \geq 5143 \tag{12}$$

4. Solution.

Once all the equations have been developed, in order to find the set of Pareto-optimal solutions, we have worked with the convex combination of the objective functions. Then, the problem to be solved is the following one:

$$\begin{aligned} \max \quad & \lambda f_1 + (1-\lambda)\,\tilde{f}_2, \quad \lambda \in [0,1] \\ s.t. \quad & \sum_{i=1}^{157} SP_i \cdot R_i \leq 956250 \\ & \sum_{i=1}^{157} U_i \cdot R_i \geq 5143 \\ & R_i \in \{0,1\} \end{aligned} \tag{13}$$

We will handle the fuzzy objective $\tilde{f}_2$ by its expected value, which is a linear operator that verifies suitable features, allowing us to write (see table 4):

$$EV\left(\tilde{f}_2\right) = \sum_{i=1}^{157} EV\left(C\tilde{U}_i\right) \cdot R_i \tag{14}$$

Each solution of (13) is a Pareto optimal one, it is efficient in the classical sense that it is not possible to select any other collection of a journal's shape that simultaneously achieves better results on both objectives. This is ensured by the Weighting method which, as is well known, always generates efficient solutions for positive weights (Cohon, 1978). In our case, a bio-objective problem, solutions for $\lambda = 0$ and $\lambda = 1$ are also efficient solutions.

The problem, formulated as an integer linear programming problem in binary variables, was computed using HYPERLINDO. 150 efficient extreme points were obtained which is considered to be a good approximation of the efficient frontier.

Space prevents us from outlining the complete solution, so we will only comment on it generally (detailed solutions for 11 different values of λ can be found in the appendix).

First of all, we want to point out that our model selects, as was predicted, the world's most prestigious clinical journals to be purchased, such as *New England Journal of Medicine* or *Lancet*, and also the best Spanish language ones, such as *Revista Clínica Española* and *Medicina Clínica*. It is possible then to conclude that the usage of these journals is a generalised one and it is impossible to think of a medical Spanish Library without them.

The results obtained show how small yet active research groups consolidate purchase decisions related to specific journals in their field.

On the other hand, we can observe how there are decision variables corresponding to some journals that take value zero in all efficient solutions (see table 6 in the appendix). This means that they must be suggested for deselection, so it is supposed that these journals will be deselected as a first step. They correspond to less-used journals or to the most expensive ones, in terms of their hospital use-worth, e.g. *American J. Hypertension*, *Annals of Urology or Clinical Neurophysiology*.

Some other titles have value R_i equal zero only in some of the efficient solutions and in trade-off with others, so a careful analysis is necessary in order to make any decision. In an interactive process with the library decision-maker, this analysis was carried out by studying the efficient frontier and selecting the points that best reflected her preferences (see table 7). This process leads us to the final decision in which 27 journals were included in a cancellation proposal and 19 were cancelled, saving 2,199,079 monetary units (see table 6 in the appendix). The reasons for not cancelling the remaining 8 journals were that they were not in any other collection in the geographic area, or because they were considered basic for the services affected.

Budget saving allowed the library to:

- Subscribe to 5 new journals

- Subscribe to the *UptoDate* database, of special interest to all medical staff.

- Have a certain amount of money to acquire monographic works over the year.

5. Conclusions and final remarks.

The aim of this paper is to present a formulation and solution for the problem of choosing the appropriate shape of the journal collection in a medical library. By using a multiple criteria technique, two different objectives pursued by the librarian decision-maker, have been simultaneously considered. Additional objectives may easily be considered, if desired, without difficulty.

The results have been presented to and discussed with the library decision-maker who, before taking any final decision, personally explained the study and the results to medical staff.

The decision-maker guaranteed departments affected by deselection that journal content summaries would be available to them on request. Furthermore, individual copies of any article on a deselected journal would be provided within 48 hours and, moreover, the hospital agreed to pay 60% of the interlibrary loan cost whenever that cost exceeded the average cost of the previous year.

The effect of this decision on day-to-day hospital work will be discussed with medical staff, the principal user of journals. Our future aim is to evaluate in-house demand of cancelled titles over the next two years in order to evaluate the repercussions of this decision.

An important property in our model is the fact that it can easily be made adaptable to other technical libraries. Also, if we have new information about current data, it is possible to adapt the model in such a way that it incorporates the new information in replacement of the old, and we can obtain updated values after optimisation to support new decisions.

The model constitutes a valid tool, not only for print journals, but also for electronic ones. It not only allows cancellation decision to be made objectively, but also presents data to medical staff about their borrowing or consulting behaviour. This makes them think about their uses of available scientific information and thus enables the librarian to obtain useful information in order to adjust the library resources to the needs of its users.

Such information cannot be easily obtained trough staff surveys. However, if all the staff come together to discuss cancellation proposals, their joint opinion should be borne in mind by the librarian in order to develop adequate management policies.

We are presenting the results obtained with data from 1997-1999, which can be that considered thus far, because we wanted to evaluate the usefulness of our model for the public hospital. The proposed model was used during 2000-05 by the librarian DM at the hospital and it is considered by her as a useful tool for journal selection within an institution with the characteristics of this public hospital. We have therefore considered this to be the proper moment to send our results to a journal.

Even though we have yet to carry out a deeper study including e-journals, the decision-maker's opinion is very positive (she had previously doubted whether she would be able to comply with all the conditions).

Future research will include the impact of e-journals, which is more visible in many small and medium-sized libraries' collections, and which can quickly become two or three times larger thanks to electronic-resource acquisition strategies such as bundling and consortia purchasing. These resources shared via cooperative legal agreements and consortia between libraries and institutions could be very beneficial to hospital libraries, by increasing the number of titles and reducing duplication and costs (San José and Pacios, 2005).

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Figure Captions and Tables

Figure 1. Triangular fuzzy number membership.

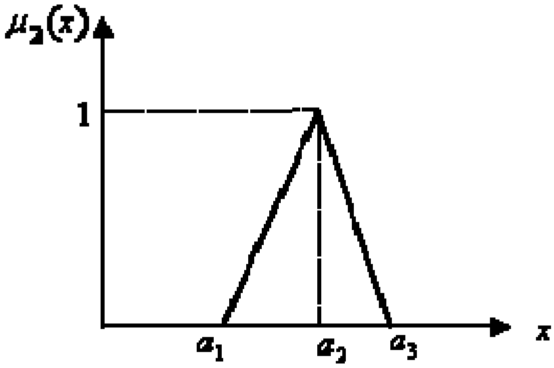

Figure 2. Possibility distribution of the number of users of journal i.

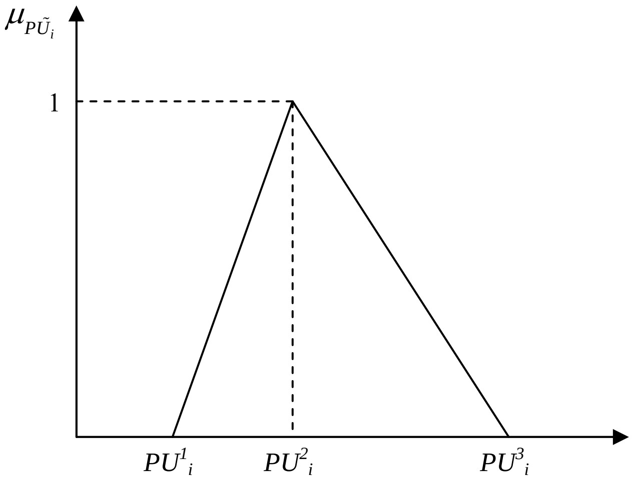

Table 2. Journal fuzzy estimations about potential users.

i	PU_i^1	PU_i^2	PU_i^3	*i*	PU_i^1	PU_i^2	PU_i^3	*i*	PU_i^1	PU_i^2	PU_i^3	*i*	PU_i^1	PU_i^2	PU_i^3
1	20	22	23	**43**	15	17	20	**79**	17	19	22	**121**	15	17	20
2	20	21	23	**44**	63	65	68	**80**	15	17	20	**122**	9	11	14
3	20	21	23	**45**	15	17	20	**81**	17	19	22	**123**	15	17	20
4	10	12	13	**46**	22	24	27	**82**	13	15	18	**124**	63	65	68
5	24	26	28	**47**	18	20	23	**83**	25	27	30	**125**	25	27	30
6	24	26	28	**48**	15	17	20	**84**	20	22	25	**126**	25	27	30
7	17	19	20	**49**	25	27	30	**85**	20	22	25	**127**	20	22	25
8	10	11	14	**50**	13	15	18	**86**	20	22	25	**128**	10	12	15
9	15	17	18	**51**	15	17	20	**87**	20	22	25	**129**	19	21	24
10	20	21	24	**52**	15	17	20	**88**	15	17	20	**130**	19	21	24
11	10	11	12	**53**	15	17	20	**89**	20	22	25	**131**	19	21	24
12	7	12	14	**54**	24	26	29	**90**	10	12	15	**132**	19	21	24
13	63	65	68	**55**	19	21	24	**91**	17	19	22	**133**	19	21	24
14	9	11	14	**56**	17	19	22	**92**	14	16	19	**134**	9	11	14
15	25	27	30	**57**	15	17	20	**93**	25	27	30	**135**	25	27	30
16	14	16	19	**58**	20	22	25	**94**	13	15	18	**136**	21	23	26
17	15	17	20	**59**	19	21	24	**95**	20	22	25	**137**	21	23	26
18	18	20	23	**60**	22	24	27	**96**	17	19	22	**138**	13	15	18
19	13	15	18	**61**	63	65	68	**97**	21	23	26	**139**	63	65	68
20	21	23	26	**62**	25	27	30	**98**	18	20	23	**140**	17	19	22
21	19	21	24	**63**	19	21	24	**99**	20	22	25	**141**	0	2	5
22	10	12	15	**64**	19	21	24	**100**	17	19	22	**142**	22	24	27
23	15	17	20	**65**	14	16	19	**101**	15	17	20	**143**	20	22	25
24	22	24	27	**66**	19	21	24	**102**	24	26	29	**144**	19	21	24
25	15	17	20	**67**	13	15	18	**103**	19	21	24	**145**	18	20	23
26	13	15	18	**68**	9	11	14	**104**	19	21	24	**146**	18	20	23
27	16	18	21	**69**	19	21	24	**105**	20	22	25	**147**	15	17	20
28	22	24	27	**70**	17	19	22	**106**	13	15	18	**148**	15	17	20
29	38	40	43	**71**	10	12	15	**107**	21	23	26	**149**	20	22	25
30	63	65	68	**72**	20	22	25	**108**	14	16	19	**150**	15	17	20
31	15	17	20	**67**	63	65	68	**109**	15	17	20	**151**	19	21	24
32	19	21	24	**68**	11	13	16	**110**	63	65	68	**152**	13	15	18
33	19	21	24	**69**	38	40	43	**111**	9	11	14	**153**	20	22	25
34	19	21	24	**70**	17	19	22	**112**	63	65	68	**154**	13	15	18
35	63	65	68	**71**	17	19	22	**113**	20	22	25	**155**	63	65	68
36	15	17	20	**72**	20	22	25	**114**	17	19	22	**156**	13	15	18
37	14	16	19	**73**	15	17	20	**115**	11	13	16	**157**	13	15	18
38	15	17	20	**74**	63	65	68	**116**	63	65	68				
39	19	21	24	**75**	15	17	20	**117**	14	16	19				
40	16	18	21	**76**	17	19	22	**118**	63	65	68				
41	19	21	24	**77**	17	19	22	**119**	10	12	15				
42	22	24	27	**78**	20	22	25	**120**	18	20	23				

Table 3. Journal data.

i	SP_i	U_i	LP_i	CO_i	i	SP_i	U_i	LP_i	CO_i	i	SP_i	U_i	LP_i	CO_i	i	SP_i	U_i	LP_i	CO_i
1	42797	5	1420	0.033180	43	169863	26	7384	0.043470	79	19610	89	25276	1.288934	121	203484	31	8804	0.043266
2	88435	47	13348	0.150936	44	85012	127	36068	0.424270	80	136913	36	10224	0.074675	122	103584	112	31808	0.307074
3	9648	24	6816	0.706468	45	92201	46	13064	0.141690	81	65290	40	11360	0.173993	123	70066	337	95708	1.365969
4	39388	24	6816	0.173048	46	65521	15	4260	0.065017	82	108309	49	13916	0.128484	124	57378	15	4260	0.074244
5	66657	16	4544	0.068170	47	45944	17	4828	0.105084	83	64285	9	2556	0.039760	125	76750	12	3408	0.044404
6	75558	22	6248	0.082691	48	163773	15	4260	0.026012	84	103584	59	16756	0.161762	126	43176	10	2840	0.065777
7	45448	1	284	0.006249	49	56883	19	5396	0.094861	85	42040	9	2556	0.060799	127	42229	7	1988	0.047077
8	82375	63	17892	0.217202	50	79074	22	6248	0.079015	86	50561	35	9940	0.196594	128	80481	15	4260	0.052932
9	14203	1	284	0.019996	51	14203	15	4260	0.299937	87	89388	43	12212	0.136618	129	50372	42	11928	0.236798
10	69984	54	15336	0.219136	52	124036	58	16472	0.132800	88	46395	10	2840	0.061213	130	155098	31	8804	0.056764
11	67491	3	852	0.012624	53	59071	8	2272	0.038462	89	129906	52	14768	0.113682	131	40714	90	25560	0.627794
12	100933	9	2556	0.025324	54	112674	35	9940	0.088219	90	63249	18	5112	0.080823	132	33139	52	14768	0.445638
13	70445	65	18460	0.262048	55	24270	15	4260	0.175525	91	32761	17	4828	0.147370	133	19071	19	5396	0.282943
14	105351	6	1704	0.016175	56	168462	22	6248	0.037088	92	107947	31	8804	0.081559	134	28511	17	4828	0.169338
15	69498	21	5964	0.085815	57	105421	3	852	0.008082	93	21399	3	852	0.039815	135	51319	48	13632	0.265633
16	73664	4	1136	0.015421	58	140889	28	7952	0.056442	94	65711	20	5680	0.086439	136	51129	52	14768	0.288838
17	56053	12	3408	0.060800	59	47531	40	11360	0.239002	95	33286	49	13916	0.418074	137	80949	37	10508	0.129810
18	47342	12	3408	0.071987	60	31414	5	1420	0.045203	96	86541	31	8804	0.101732	138	15890	121	34364	2.162618
19	58704	58	16472	0.280594	61	35224	23	6532	0.185442	97	113242	9	2556	0.022571	139	9988	4	1136	0.113736
20	53970	58	16472	0.305207	62	30597	18	5112	0.167075	98	49236	31	8804	0.178812	140	13195	3	852	0.064570
21	63059	13	3692	0.058548	63	42281	24	6816	0.161207	99	142651	62	17608	0.123434	141	21540	12	3408	0.158217
22	114567	41	11644	0.101635	64	19884	67	19028	0.956950	100	128249	39	11076	0.086363	142	28254	30	8520	0.301550
23	37095	5	1420	0.038280	65	64574	41	11644	0.180320	101	283711	50	14200	0.050051	143	16074	23	6532	0.406371
24	76694	13	3692	0.048139	66	71392	51	14484	0.202880	102	71764	18	5112	0.071233	144	12481	8	2272	0.182037
25	44809	9	2556	0.057042	67	39767	94	26696	0.671310	103	92033	19	5396	0.058631	145	44480	10	2840	0.063849
26	62517	3	852	0.013628	68	46395	10	2840	0.061213	104	66279	72	20448	0.308514	146	22473	18	5112	0.227473
27	58868	3	852	0.014473	69	41881	16	4544	0.108498	105	64006	11	3124	0.048808	147	45259	16	4544	0.100400
28	51240	14	3976	0.077596	70	71960	17	4828	0.067093	106	109265	44	12496	0.114364	148	54375	16	4544	0.083568
29	43744	45	12780	0.292154	71	248450	21	5964	0.024005	107	65957	13	3692	0.055976	149	58704	11	3124	0.053216
30	64574	95	26980	0.417815	72	157175	23	6532	0.041559	108	58329	4	1136	0.019476	150	55674	7	1988	0.035708
31	45448	7	1988	0.043742	67	37495	17	4828	0.128764	109	93451	94	26696	0.285668	151	61999	28	7952	0.128260
32	87298	11	3124	0.035785	68	259001	56	15904	0.061405	110	76573	123	34932	0.456192	152	195806	18	5112	0.026107
33	47710	51	14484	0.303584	69	8989	32	9088	1.011013	111	184633	13	3692	0.019996	153	86887	78	22152	0.254952
34	96264	108	30672	0.318624	70	28973	12	3408	0.117627	112	109391	176	49984	0.456930	154	10667	9	2556	0.239618
35	76573	57	16188	0.211406	71	41282	23	6532	0.158229	113	59966	26	7384	0.123136	155	46016	8	2272	0.049374
36	85950	57	16188	0.188342	72	68921	25	7100	0.103016	114	42715	9	2556	0.059838	156	72907	32	9088	0.124652
37	19016	7	1988	0.104544	73	169863	26	7384	0.043470	115	14415	4	1136	0.078807	157	203484	31	8804	0.043266
38	85950	19	5396	0.062781	74	85012	127	36068	0.424270	116	16277	174	49416	3.035940					
39	76573	65	18460	0.241077	75	92201	46	13064	0.141690	117	14755	19	5396	0.365707					
40	58325	16	4544	0.077908	76	65521	15	4260	0.065017	119	52644	53	15052	0.285921					
41	76573	10	2840	0.037089	77	45944	17	4828	0.105084	120	85026	15	4260	0.050102					
42	79724	50	14200	0.178114	78	163773	15	4260	0.026012	121	37163	26	7384	0.198692					

Table 4. Expected Value of the fuzzy usage ratio.

i	$EV(CU_i)$	i	$EV(CU_i)$	i	$EV(CU_i)$	i	$EV(CU_i)$
1	0.23	**43**	1.53	**79**	4.68	**121**	2.59
2	2.24	**44**	1.95	**80**	2.12	**122**	2.82
3	1.14	**45**	2.71	**81**	2.11	**123**	6.59
4	2.00	**46**	0.63	**82**	3.27	**124**	5.18
5	0.62	**47**	0.85	**83**	0.33	**125**	0.56
6	0.85	**48**	0.88	**84**	2.68	**126**	0.44
7	0.05	**49**	0.70	**85**	0.41	**127**	0.45
8	5.25	**50**	1.47	**86**	1.59	**128**	0.58
9	0.06	**51**	0.88	**87**	1.95	**129**	0.71
10	2.45	**52**	3.41	**88**	0.59	**130**	2.00
11	0.27	**53**	0.47	**89**	2.36	**131**	1.48
12	0.82	**54**	1.35	**90**	1.50	**132**	4.29
13	1.00	**55**	0.71	**91**	0.89	**133**	2.48
14	0.55	**56**	1.16	**92**	1.94	**134**	1.73
15	0.78	**57**	0.18	**93**	0.11	**135**	0.63
16	0.25	**58**	1.27	**94**	1.33	**136**	2.09
17	0.71	**59**	1.90	**95**	2.23	**137**	2.26
18	0.60	**60**	0.21	**96**	1.63	**138**	2.47
19	3.87	**61**	0.35	**97**	0.39	**139**	1.86
20	2.52	**62**	0.67	**98**	1.55	**140**	0.21
21	0.62	**63**	1.14	**99**	2.82	**141**	1.50
22	3.42	**64**	3.19	**100**	2.05	**142**	0.50
23	0.29	**65**	2.56	**101**	2.94	**143**	1.36
24	0.54	**66**	2.43	**102**	0.69	**144**	1.10
25	0.53	**67**	6.27	**103**	0.90	**145**	0.40
26	0.20	**68**	0.91	**104**	3.43	**146**	0.50
27	0.17	**69**	0.76	**105**	0.50	**147**	1.06
28	0.58	**70**	0.89	**106**	2.93	**148**	0.94
29	1.13	**71**	1.75	**107**	0.57	**149**	0.73
30	1.46	**72**	1.05	**108**	0.25	**150**	0.65
31	0.41	**67**	0.26	**109**	5.53	**151**	0.33
32	0.52	**68**	4.31	**110**	1.89	**152**	1.87
33	2.43	**69**	0.80	**111**	1.18	**153**	0.82
34	5.14	**70**	0.63	**112**	2.71	**154**	5.20
35	0.88	**71**	1.21	**113**	1.18	**155**	0.14
36	3.35	**72**	1.14	**114**	0.47	**156**	0.53
37	0.44	**73**	1.53	**115**	0.31	**157**	2.13
38	1.12	**74**	1.95	**116**	2.68		
39	3.10	**75**	2.71	**117**	1.19		
40	0.89	**76**	0.63	**118**	0.82		
41	0.48	**77**	0.85	**119**	1.25		
42	2.08	**78**	0.88	**120**	1.30		

Table 5. Efficient solutions obtained in the objective space.

λ	f_1	$EV(f_2)$
0	30.9144	229.3170
0.1	30.9254	229.3830
0.2	30.9469	229.2590
0.3	30.9770	229.1520
0.4	30.9997	229.0680
0.5	31.0922	228.4460
0.6	31.1067	228.1510
0.7	31.1243	227.7730
0.8	31.1526	226.8620
0.9	31.1534	226.8390
1	31.1581	225.2300

Table 7. Librarian's criteria for journal deselection.

Importance	Criteria
1	Average annual usage of the journal
2	Actual subscription cost of the journal
3	Next's year subscription cost of the journal
4	Possibility of interlibrary loan for the journal
5	Accessibility and availability of the journal i.e. presence in databases such as Medline
6	Up-to-date nature and institutional, research, teaching and clinic interest of the journal
7	Journal rating in the main journal rankings

Appendix

Table 1.1 Journal list.

i	Journal Title	*i*	Journal Title
1	*Acta Orthopaedica Scandinavica*	**61**	*Clinicas Medicas De N-A.*
2	*Acta Paediatrica*	**62**	*Clinicas Obstetricas Y Ginecologicas De N-A.*
3	*Acta Pediatrica Española*	**63**	*Clinicas Quirurgicas De N-A.*
4	*Advances In Anatomic Pathology*	**64**	*Contemporary Pediatrics*
5	*American Heart Journal*	**65**	*Critical Care Medicine*
6	*American J Cardiology*	**66**	*Current Opinion In Pediatrics*
7	*American J Clinical Nutrition*	**67**	*Chest*
8	*American J Clinical Pathology*	**68**	*Dermatologic Clinics*
9	*American J. Electroneurodiagnostic Technology*	**69**	*Developmental Medicine And Child Neurology*
10	*American J Gastroenterology*	**70**	*Diabetes Care*
11	*American J Hypertension*	**71**	*Diagnostic Cytopathology*
12	*American J Kidney Diseases*	**72**	*Digestive Diseases And Sciences*
13	*American J Medicine*	**73**	*Disease A Month*
14	*American J Neprhology*	**74**	*Drugs*
15	*American J Obstetrics And Gynecology*	**75**	*Emergencias*
16	*American J Ophthalmology*	**76**	*Endocrine Reviews*
17	*American J Otology*	**77**	*Endocrinology And Metabolism Clinics Of N-A*
18	*American J Public Health*	**78**	*Endoscopy*
19	*American J Respiratory An Critical Care*	**79**	*Enfermedades Infecciosas Y Microbiologia Clinica*
20	*American J Roentgenology*	**80**	*Epilepsia*
21	*American J Surgery*	**81**	*European J. Clinical Microbiology Infect. Diseases*
22	*American J Surgical Pathology*	**82**	*European Respiratory J.*
23	*Anales Otorrinolaringologicos Ibero-Americanos*	**83**	*Fertility And Sterility*
24	*Anesthesiology*	**84**	*Gastroenterology*
25	*Annales D´Oto-Laryngologie Et Chirug. Cervico-Faciale*	**85**	*Gastroenterology Clinics Of N-A.*
26	*Annales D´Urologie*	**86**	*Gastrointestinal Endoscopy*
27	*Annales De Readaptation Et De Medecine Physique*	**87**	*Gut*
28	*Annales Francaises D´Anesthesie Et De Reanimation*	**88**	*Hematology Oncology Clinics Of N-A.*
29	*Annals Of Emergency Medicine*	**89**	*Hepatology*
30	*Annals Of Internal Medicine*	**90**	*Human Pathology*
31	*Annals Of Otology, Rhinology And Laryngology*	**91**	*Infection Control And Hospital Epidemiology*
32	*Annals Of Surgery*	**92**	*Intensive Care Medicine*
33	*Archives De Pediatrie*	**93**	*International J. Fertility And Women's Medicine*
34	*Archives Of Disease In Childhood*	**94**	*J Allergy And Clinical Inmunology*
35	*Archives Of Internal Medicine*	**95**	*J Bone And Joint Surgery (Vol. Am. Y Vol. Brit.)*
36	*Archives Of Neurology*	**96**	*J Clinical Endocrinology And Metabolism*
37	*Archives Of Ophthalmology (Edición Español)*	**97**	*J Computer Assisted Tomography*
38	*Archives Of Otolaryngology-Head And Neck Surgery*	**98**	*J Family Practice*
39	*Archives Of Pediatrics And Adolescent Medicine*	**99**	*J Hepatology*
40	*Archives Of Physical Medicine And Rehabilitation*	**100**	*J Infectious Diseases*
41	*Archives Of Surgery*	**101**	*J Neurology*
42	*Arthritis And Rheumatism*	**102**	*J American College Of Cardiology*
43	*Blood*	**103**	*J Pediatric Orthopaedics*
44	*Bmj.British Medical Journal*	**104**	*J Pediatrics*
45	*Brain*	**105**	*J Trauma, Injury, Infection And Critical Care*
46	*Britsh J Anaesthesia*	**106**	*J Urology*
47	*British J General Practice*	**107**	*J De Radiologie*
48	*British J Haematology*	**108**	*J Francaise D´Ophtalmologie*
49	*British J Obstetrics And Gynaecology*	**109**	*J Neurology, Neurosurgery And Psychiatry*
50	*British J Urology*	**110**	*Jama*
51	*Canadian J Neurological Sciences*	**111**	*Kidney International*
52	*Cancer*	**112**	*Lancet*
53	*Cancer Treatment Reviews*	**113**	*Liver*
54	*Circulation*	**114**	*Medecine Et Maladies Infectieuses*
55	*Cirugia Española*	**115**	*Medical Letter (Ed. Española)*
56	*Clinical Endocrinology*	**116**	*Medicina Clinica*
57	*Clinical Neurophysiology*	**117**	*Medicina Intensiva*
58	*Clinical Orthopaedics And Related Research*	**118**	*Medicine*
59	*Clinical Pediatrics*	**119**	*Modern Pathology*
60	*Clinicas De Anestesiologia De N-A*	**120**	*Morbidity And Mortality Weekly Report*

Table 1.2 Journal list.

i	Journal Title	*i*	Journal Title
121	*Muscle And Nerve*	**140**	*Revista De Diagnostico Biologico*
122	*Nephron*	**141**	*Revista De Logopedia Y Fonoaudiologia*
123	*Neurology*	**142**	*Revista Española De Anestesiologia Y Reanimacion*
124	*New England Journal Of Medicine*	**143**	*Revista Española De Enfermedades Digestivas*
125	*Obstetrical And Gynecological Survey*	**144**	*Revista Española De Pediatria*
126	*Obstetrics And Gynecology*	**145**	*Revista Panamericana De Salud Publica*
127	*Orthopedic Clinics Of North America*	**146**	*Revue D´Epidemiologie Et De Sante Publique*
128	*Pathology Case Reviews*	**147**	*Sangre*
129	*Pediatric Dermatology*	**148**	*Seminars In Hematology*
130	*Pediatric Emergency Care*	**149**	*Seminars In Liver Diseases*
131	*Pediatric Radiology*	**150**	*Seminars In Oncology*
132	*Pediatrics*	**151**	*Seminars In Perinatology*
133	*Pediatrics In Review*	**152**	*Seminars In Respiratory And Critical Care Medicine*
134	*Piel*	**153**	*Spine*
135	*Progresos De Obstetricia Y Ginecologia*	**154**	*Thorax*
136	*Radiologic Clinics Of North America*	**155**	*Todo Hospital*
137	*Radiology*	**156**	*Urologic Clinics N-A*
138	*Respiratory Medicine*	**157**	*Urology*
139	*Revista Clinica Española*		

Table 6. Solution obtained in the decision space.

i	Solution 1	Solution 2	Solution 3	Solution 4	Solution 5	Solution 6	Solution 7	Solution 8	Solution 9	Solution 10	Solution 11
1	0	0	0	0	0	1	1	1	1	1	1
2	1	1	1	1	1	1	1	1	1	1	1
3	1	1	1	1	1	1	1	1	1	1	1
4	1	1	1	1	1	1	1	1	1	1	1
5	1	1	1	1	1	1	1	1	1	1	1
6	1	1	1	1	1	1	1	1	1	1	1
7	0	0	0	0	0	0	0	0	0	0	0
8	1	1	1	1	1	1	1	1	1	1	1
9	0	0	1	0	1	1	1	1	1	1	1
10	1	1	1	1	1	1	1	1	1	1	1
11	0	0	0	0	0	0	0	0	0	0	0
12	1	1	1	0	0	1	0	1	1	0	1
13	1	1	1	1	1	1	1	1	1	1	1
14	0	0	0	0	0	0	0	0	0	0	0
15	1	1	1	1	1	1	1	1	1	1	1
16	0	0	0	0	0	0	0	0	1	0	0
17	1	1	1	1	1	1	1	1	1	1	1
18	1	1	1	1	1	1	1	1	1	1	1
19	1	1	1	1	1	1	1	1	1	1	1
20	1	1	1	1	1	1	1	1	1	1	1
21	1	1	1	1	1	1	1	1	1	1	1
22	1	1	1	1	1	1	1	1	1	1	1
23	1	1	0	1	1	1	1	1	1	1	1
24	0	1	1	1	1	1	1	1	1	1	1
25	1	1	1	1	1	1	1	1	1	1	1
26	0	0	0	0	0	0	0	0	0	0	0
27	0	0	0	0	0	0	0	0	0	0	0
28	1	1	1	1	1	1	1	1	1	1	1
29	1	1	1	1	1	1	1	1	1	1	1
30	1	1	1	1	1	1	1	1	1	1	1
31	1	1	1	1	1	1	1	1	1	1	1
32	0	0	0	0	0	0	1	1	1	1	1
33	1	1	1	1	1	1	1	1	1	1	1
34	1	1	1	1	1	1	1	1	1	1	1
35	1	1	1	1	1	1	1	1	1	1	1
36	1	1	1	1	1	1	1	1	1	1	1
37	1	1	1	1	1	1	1	1	1	1	1
38	1	1	1	1	1	1	1	1	1	1	1
39	1	1	1	1	1	1	1	1	1	1	1
40	1	1	1	1	1	1	1	1	1	1	1

i	**Solution 1**	**Solution 2**	**Solution 3**	**Solution 4**	**Solution 5**	**Solution 6**	**Solution 7**	**Solution 8**	**Solution 9**	**Solution 10**	**Solution 11**
41	1	0	0	1	0	1	1	1	1	1	1
42	1	1	1	1	1	1	1	1	1	1	1
43	1	1	1	1	1	1	1	0	1	1	1
44	1	1	1	1	1	1	1	1	1	1	1
45	1	1	1	1	1	1	1	1	1	1	1
46	1	1	1	1	1	1	1	1	1	1	1
47	1	1	1	1	1	1	1	1	1	1	1
48	0	0	0	0	0	0	0	0	0	0	0
49	1	1	1	1	1	1	1	1	1	1	1
50	1	1	1	1	1	1	1	1	1	1	1
51	1	1	1	1	1	1	1	1	1	1	1
52	1	1	1	1	1	1	1	1	1	1	1
53	1	1	1	1	1	1	1	1	1	1	1
54	1	1	1	1	1	1	1	1	1	1	1
55	1	1	1	1	1	1	1	1	1	1	1
56	0	0	0	0	0	0	0	0	0	0	0
57	0	0	0	0	0	0	0	0	0	0	0
58	1	1	1	1	1	1	1	1	1	1	1
59	1	1	1	1	1	1	1	1	1	1	1
60	1	1	1	1	1	1	1	1	1	1	1
61	1	1	1	1	1	1	1	1	1	1	1
62	1	1	1	1	1	1	1	1	1	1	1
63	1	1	1	1	1	1	1	1	1	1	1
64	1	1	1	1	1	1	1	1	1	1	1
65	1	1	1	1	1	1	1	1	1	1	1
66	1	1	1	1	1	1	1	1	1	1	1
67	1	1	1	1	1	1	1	1	1	1	1
68	1	1	1	1	1	1	1	1	1	1	1
69	1	1	1	1	1	1	1	1	1	1	1
70	1	1	1	1	1	1	1	1	1	1	1
71	0	0	0	0	0	0	0	0	0	0	0
72	0	0	0	0	0	0	0	0	0	1	1
73	1	1	1	1	1	1	1	1	1	1	1
74	1	1	1	1	1	1	1	1	1	1	1
75	1	1	1	1	1	1	1	1	1	1	1
76	1	1	1	1	1	1	1	1	1	1	1
77	1	1	1	1	1	1	1	1	1	1	1
78	1	1	1	1	1	1	1	1	1	1	1
79	1	1	1	1	1	1	1	1	1	1	1
80	1	1	1	1	1	1	1	1	1	1	1
81	1	1	1	1	1	1	1	1	1	1	1
82	1	1	1	1	1	1	1	1	1	1	1

i	Solution 1	Solution 2	Solution 3	Solution 4	Solution 5	Solution 6	Solution 7	Solution 8	Solution 9	Solution 10	Solution 11
83	0	0	0	0	1	0	1	1	1	1	1
84	1	1	1	1	1	1	1	1	1	1	1
85	1	1	1	1	1	1	1	1	1	1	1
86	1	1	1	1	1	1	1	1	1	1	1
87	1	1	1	1	1	1	1	1	1	1	1
88	1	1	1	1	1	1	1	1	1	1	1
89	1	1	1	1	1	1	1	1	1	1	1
90	1	1	1	1	1	1	1	1	1	1	1
91	1	1	1	1	1	1	1	1	1	1	1
92	1	1	1	1	1	1	1	1	1	1	1
93	0	0	1	1	1	1	1	1	1	1	1
94	1	1	1	1	1	1	1	1	1	1	1
95	1	1	1	1	1	1	1	1	1	1	1
96	1	1	1	1	1	1	1	1	1	1	1
97	0	0	0	0	0	0	0	0	0	0	1
98	1	1	1	1	1	1	1	1	1	1	1
99	1	1	1	1	1	1	1	1	1	1	1
100	1	1	1	1	1	1	1	1	1	1	1
101	1	1	1	1	1	1	1	1	0	0	0
102	1	1	1	1	1	1	1	1	1	1	1
103	1	1	1	1	1	1	1	1	1	1	1
104	1	1	1	1	1	1	1	1	1	1	1
105	1	1	1	1	1	1	1	1	1	1	1
106	1	1	1	1	1	1	1	1	1	1	1
107	1	1	1	1	1	1	1	1	1	1	1
108	0	0	0	0	0	0	0	0	1	1	1
109	1	1	1	1	1	1	1	1	1	1	1
110	1	1	1	1	1	1	1	1	1	1	1
111	0	0	0	0	0	0	0	0	0	0	0
112	1	1	1	1	1	1	1	1	1	1	1
113	1	1	1	1	1	1	1	1	1	1	1
114	1	1	1	1	1	1	1	1	1	1	1
115	1	1	1	1	1	1	1	1	1	1	1
116	1	1	1	1	1	1	1	1	1	1	1
117	1	1	1	1	1	1	1	1	1	1	1
118	1	1	1	1	1	1	1	1	1	1	1
119	1	1	1	1	1	1	1	1	1	1	1
120	1	1	1	1	1	1	1	1	1	1	1
121	1	1	1	1	1	0	0	0	0	0	0
122	1	1	1	1	1	1	1	1	1	1	0
123	1	1	1	1	1	1	1	1	1	1	1
124	1	1	1	1	1	1	1	1	1	1	1

i	**Solution 1**	**Solution 2**	**Solution 3**	**Solution 4**	**Solution 5**	**Solution 6**	**Solution 7**	**Solution 8**	**Solution 9**	**Solution 10**	**Solution 11**
125	1	1	1	1	1	1	1	1	1	1	1
126	0	0	0	0	0	1	1	1	1	1	1
127	1	1	1	1	1	1	1	1	1	1	1
128	1	1	1	1	1	1	1	1	1	1	1
129	1	1	1	1	1	1	1	1	1	1	1
130	1	1	1	1	1	1	1	1	1	1	1
131	1	1	1	1	1	1	1	1	1	1	1
132	1	1	1	1	1	1	1	1	1	1	1
133	1	1	1	1	1	1	1	1	1	1	1
134	1	1	1	1	1	1	1	1	1	1	1
135	1	1	1	1	1	1	1	1	1	1	1
136	1	1	1	1	1	1	1	1	1	1	1
137	1	1	1	1	1	1	1	1	1	1	1
138	1	1	1	1	1	1	1	1	1	1	1
139	1	1	1	1	1	1	1	1	1	1	1
140	1	1	1	1	1	1	1	1	1	1	1
141	1	1	1	1	1	1	1	1	1	1	1
142	1	1	1	1	1	1	1	1	1	1	1
143	1	1	1	1	1	1	1	1	1	1	1
144	1	1	1	1	1	1	1	1	1	1	1
145	1	1	1	1	1	1	1	1	1	1	1
146	1	1	1	1	1	1	1	1	1	1	1
147	1	1	1	1	1	1	1	1	1	1	1
148	1	1	1	1	1	1	1	1	1	1	1
149	1	1	1	1	1	1	1	1	1	1	1
150	1	1	1	1	1	1	1	1	1	1	1
151	0	0	0	0	0	1	0	1	1	1	1
152	1	1	1	1	1	1	1	1	1	1	1
153	0	0	0	0	0	0	0	0	0	0	0
154	1	1	1	1	1	1	1	1	1	1	1
155	1	1	1	1	1	1	1	1	1	1	1
156	1	1	1	1	1	1	1	1	1	1	1
157	1	1	1	1	1	1	1	1	1	1	1

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