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On optimising the solution for evaluation of scientific quality in Polish higher education system using a 2D cutting problem representation

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Abstract. This paper discusses the problem of optimising the solution to find the possibly best estimate of the value of C1 criterion in the evaluation process of scientific quality in higher education in Poland, which has been exercised by its author during the evaluation of Polish universities in 2022 as a vice dean for scientific evaluation and teaching quality at his faculty. The second edition of evaluation in Poland is expected to start in 2026 again, making this task an interesting problem, again. On the basis of the approach described in the paper, it was possible to ensure continuous monitoring and estimation of the effectiveness of the publication policy to make decisions along the way. An adopted strategy used a simple formulation of the problem, allowing one to obtain the close-to-optimal solution in a matter of seconds, in comparison with a tedious computational campaign to adopt, when presenting the precise value for C1 criterion, actually disabling not only the on-demand monitoring capacity, but also making alteration of the result in a close to online manner virtually impossible. The paper actually deploys a 2D cutting problem in strip tasks solver to mimic the steps to be taken to pursue with the scientific evaluation process.

Key words: evaluation of scientific quality; higher education; 2D cutting; optimisation.

1. INTRODUCTION AND LITERATURE REVIEW

Modern countries pay great attention to ensuring sustainable development of their societies, and education, including higher education which is by all means a factor ensuring the sustainability of the development by itself. It is a scientific research outcome to play a major role in bringing well-educated and aptly-skilled graduatees to the market, producing new knowledge and admitting to the development of hi-tech solutions. The research outcome would be nothing without publications in scientific journals which are well-recognised in the world, e.g., the ones presented in Scopus or Web of Science databases.

Markets, societies and economies have specific expectations towards the universities, and vice versa. Universities expect to obtain sufficient funds for their research activities, are under pressure both of their students to become excellent in teaching, and of the society to cooperate with their socio-economic surrounding. This supports a sustainable development by creating new tools, solutions and technologies, impossible to appear without achieving high quality research at first. The question which arises – namely what the criterion of research quality actually is, and how to design a system of such an evaluation to ensure best recognition of top universities [1]. One can obviously list a number of evaluation indices of scientific research, such as these of ARWU, the Times Higher Education Rankings, US News World University Rankings or QS World University Rankings [2, 3, 4, 5].

Presence of a university at the top of the ranking might be taken as some indicator to offer higher funds for research and development activities to such a scientific unit, and to offer lower funds (if any) for these closing the line. This calls for a proper design of an evaluation system, and to set all the objectives for such a procedure. One of such procedures was the Research Assessment Exercise of UK's, along with French, Swedish or Portuguese solutions [6]. There is always an issue how to design such a process. The ministerial lists in expert reports (peer-review report), quantitative approach related to number of publications or approach based on the impact of publications (by observing citation databases) might one among multiple solutions. At the same time, a quantitative approach should be taken into account, what is a reason of presence of mixed evaluation models [7].

Since the staff of universities publishes in journals, books, applies for either domestic of international projects, takes part in conferences, is granted patent pending laws and has an impact on the society, there is not a single path to pursue with the evaluation as a process to decide about funding action [8]. Of course, there are some indicators of 'quality' of a publication channel, such as the H-index of a journal, the CORE rank of a conference, the impact factor of a journal, CiteScores, SNIPs or SJRs ones. Obviously, larger groups of researchers accumulate better result, and smaller research groups have lower publication output. In order to make the evaluation process fair, all the activities and their results must be referred to the 'size' of a group.

The same process had been observed in Poland, where the evaluation of scientific activities and their output has been initially based on evaluation within encapsulated faculties, gathering groups of people of different scientific interests and with different publication output. In addition, gathering staff from different scientific fields, though employed at the same faculty. The comparison between universities and making rankings has been impeded by the fact that numerous research groups have

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Table 1. Relative weights of the criteria (C1, C2, C3), with respect to the followign scientific fields: S1 – human, social and theological, S2 – natural, medical and health, S3 – engineering and technology, S4 – the arts sciences.

Criterion/sciences	S1	S2	S3	S4
C1	70%	60%	50%	80%
C2	10%	20%	35%	n/a
C3	20%	20%	15%	20%

had a better publication record, and have outperformed the other, i.e. smaller, ones. In the new system of evaluation of scientific quality in Poland, which has recently been adopted to evaluate research activities in the publication-time window 2017–2021, universities have been screened from the viewpoint of separate research fields, meaning that potentially a faculty can represent a number of research fields, or on the opposite – a single one only. Such an approach enabled comparison between different universities, in a field by field manner. By using modern means of gathering information about publication output, it has been possible to make this process virtually automatic.

However, the 'exact' implementation of the algorithm to provide the entity with the final assessment grade is kept secret, what is a major reason why estimation of the evaluation results, along with its monitoring is of a paramount importance. In the upcoming evaluation window, 2022–2025, the lack of access to the 'exact' optimisation algorithm implementation repeats, unfortunately.

The evaluation procedure designed with special attention to amending the situation as Polish visibility in global rankings is strongly limited by recognising Poland as a place for research and development plans [9, 10]. As a result, the research quality, publication output, etc., is not directly referred to the 'size' of a research group (research field), but to the importance of research output in a global discourse. To stimulate this action, not only obtaining public funds from the government is a function of scientific excellence now, but also capability to award scientific degrees is (granting Ph.D. or D.Sc. degrees) [7].

The activities which are evaluated in the process include scientific papers, scientific books, granted patent pending laws or protection rights in the so-called first evaluation criterion (C1). The second criterion (C2) processes the information considering scientific projects and grants, commercialisation of the results of scientific research or R&D actions development works, or funds obtained by entities not belonging to the system of higher education. In the third criterion (C3), the impact on the socio-economic development of the society is evaluated. All these three criteria are weighed and the final evaluation result is eventually produced with reference to a virtual number N of research group members (see Tab. 1 for relative weights of the criteria). The number is virtual, as it is referred to the average number of employees of the entity, taking part in scientific activities in the evaluated period, taking the share of the working time of employees into account with relation to a specific scientific field (which is yet another share factor).

This paper describes the evaluation process and its optimisation with reference to C1 criterion, in which the following research output is evaluated:

- scientific papers published in the journals mentioned in the lists provided by the Ministry of Higher Education and Science in Poland, including conference proceedings where papers published using publication channels not mentioned in the Ministerial lists are granted lower number of points;
- scientific books published by publishing houses mentioned in the other lists provided by the Ministry;
- editorships of such books;
- chapters in such books;
- granted patent pending or protections laws with different categories of these.

As a result, the entity can be granted a number of points in C1 for a publication related to their researchers with respect to the percentile value of the journal, e.g., 200 points if the percentile value is at least 97, 140 points if the percentile value is at least 90 but less than 97 or 100 points if the percentile value is at least 75 but less than 90, etc, for papers from 2019 and later. For the range of dates 2017–2018 the other grading scale has been used (approx. 75% reduction in the number of points per publication is applied). Scientific books are evaluated with reference to publication house quality (so-called level I publishers score 80 points per book, and level II – 200 points). Similarly, conference proceeding are also granted points with reference to which CORE categories they are connected to, and so: 200 points are granted, provided that the conference has an A* category, 140 points for category CORE A, 70 points – CORE B, and 20 points – CORE C. It is to be remarked, however, the percentile values which aimed to guide point assigment rules have been much overriden throughout the years, and there are multiple examples where this mapping is strongly violated by some group interests which must have been passed to the Ministry.

Similar rules apply the editorships of scientific books, authorships of chapters in scientific books, or applications for patent protection rights.

Again, as per unavailability of the exact implementation details of the algorithm, which are known to the Ministry only, or due to the need to obtain the C1 criterion value by tedious, usually taking hours, calculations, it is vital to develop an alternative approach. Such an approach would enable continuous monitoring, providing the results in a number of seconds by using simple heuristics, as a useful, daily-use tool to test, monitor, simulate and take well-supported decisions, making decisions almost on-demand.

Not all publication results can be presented for evaluation, as this number is related to the N number (representing the 'size' of the entity to evaluate, in rough), calling for the optimisation within the scientific field. The problem is definitely not trivial, and requires extensive calculations. Its exact solution usually calls for trade-offs at the university level or at the level of scientific field (i.e. number of points for books, and chapters in the specified monographs cannot exceed the total point value of the book itself). In the paper, the fast and reliable solution to this problem is presented, enabling one to obtain the rapid evaluation estimate for a scientific field with,

say $N = 200$. Having even taken thousands of publications in the evaluated period, the result is obtained in range of single seconds, providing an insight into the strategy which university should adopt, enabling continuous partial evaluation during the evaluated period, etc., what is a major contribution.

The latter is a major reason why the related work is not reported in the literature, as the universities do not exchange the ideas about their approaches to evaluate entities, due to obvious reasons. It is to be borne in mind, the paper presents how to adopt simple heuristics to solve the optimisation problem stated. Characteristics of the evaluation of scientific quality outputs in Polish higher education system is given, making it tractable not only for people specialised in algorithmics, but also for those not connected to information sciences, e.g. from social sciences, willing to understand the evaluation process better. At the same time, the paper presents a proof of concept approach to streamline the solution of a more complex optimisation task.

2. HOW TO ESTIMATE A 'VALUE' OF A PUBLICATION?

According to the rules of the Polish system of evaluation of research outcomes in C1, all the publications are connected to the number of points, subsequently related to percentile values of the journals. It makes actually no sense at this point to discuss the differences between point values assigned to papers from the period 2017–2018 and 2019–2021, since the basic rule remains the same. A specific author (for the sake of brevity – a researcher or a student of a doctoral school) can authorize their home university to have their publication included in the list of publications to be taken for evaluation provided that they have declared to choose a specific scientific field A, are included in the number N in the field A on 31st of December of the year when the specific publication was published, and they were active employees on 31st of December of that year (or were students of a doctoral school on the same day). This short procedure attaches the number k of authors of the publication from scientific field A (this also refers to scientific books, editorship or chapters in books), knowing the number m of all the authors of the publication.

On the basis of the pair (k, m), a journal paper or a conference paper has the partial point value P assigned, as in Table 1, or as in Table 2 in the case of scientific books. The partial point value P is connected to a total number of points P_T assigned to the publication, as presented before, and indirectly related either to its percentile value, or a rank of the publishing house.

As far as journal papers or conference papers from the period 2017–2018 are concerned, these, as already remarked, before have approximately 75% lesser value range for P_T in comparison with such papers from the period of 2019 and later. The presentation of the range does not impede a general idea about the algorithm.

Using these numbers not only the points are splitted between k authors, but also the so-called unit share $0.1 \leq U \leq 1$ is calculated

$$U = \frac{P}{kP_T}, \tag{1}$$

Table 2. Calculation of the partial point value P – journal and conference papers (* – the overall value cannot be lower that $0.1P_T$)

P_T	P
200	
140	P_T
100	
70	$P_T\sqrt{\frac{k}{m}}$ *
40	
20	$P_T\frac{k}{m}$ *
5	

Table 3. Calculation of the partial point value P – scientific books (* – overall value cannot be lower than $0.1P_T$)

type of publication	P_T	P
Scientific book (lev. II)	200	
Editorship of the book (lev. II)	100	P_T
Chapter in the book (lev. II)	50	
Scientific book (lev. I)	80	
Editorship of the book (lev. I)	20	$P_T\sqrt{\frac{k}{m}}$ *
Chapter in the book (lev. I)	20	
Scientific book (no lev. assigned)	20	
Editorship of the book (no lev. assigned)	5	$P_T\frac{k}{m}$ *
Chapter in the book (no lev. assigned)	5	

representing the (a fractional value, in general) number of unit shares to be filled by each of the authors with respect to a personal limit of unit shares. For single-author publications one has $U = 1$, whereas for multi-authored publications one has $0.1 \leq U \leq 1$ at all times. On the basis of the unit share U, the corresponding share in points $0.1P_T \leq P_U \leq P_T$ is calculated as

$$P_U = \frac{P}{k}. \tag{2}$$

Thus every publication record fills a fraction of the limit of its author (U), and is connected to a share P_U in points.

Calculation of U, P and P_U is carried out with precision of 4 decimal digits, as a rule. It also needs to be noted that e.g. social sciences have different P_T values for scientific books, but the overall rule of splitting the points, and the shares, remains the same (this also applies to e.g. human sciences, book chapters in social sciences, and the other, making the intention of the Ministry untractable).

Once all the publications stored in the period of evaluation are taken for consideration, with their k, m, P, P_U and U values calculated, they are ready to be used in the other procedure, imposing constraints in the optimisation problem.

The overall number of P_Us subject to the limits with an additional sum of the points obtained for the granted patent pending laws divided by N gives the final value of C1 (the granted patent pending laws are treated here as not optimizable, as a single granted patent pending law appears in the scientific fields of their authors, but the possiblity to use just one pantent pending law for multiple patents assigned to a single invention, is omitted here). One should note that the number of patent pending laws presented by the entity in a single scientific field

cannot exceed $\lceil N \rceil$.

There are also additional limits concerning publication records to be taken into consideration, outlined in the next Section.

3. LIMITS/OPTIMISATION CONSTRAINTS, FORMULATION OF THE OPTIMISATION TASK

3.1. L1 – maximum cumulative U of an author

Let us assume that an author is given who worked as a researcher, and was included in the N number on all 31st Decembers across the years 2017–2021, with $S = 100\%$ share in scientific field A, and employed in full-time ($J = 100\%$). In such a case, they are limited to allow the university to present their cumulative Us as a sum of partial values of U_l, each connected to their l–th publication, in the evaluation period as 4. This means that for full-time employees having 100% share in a particular research field across all the years of the evaluation period, a single year is worth 0.8 in the sum. Every author can declare 25%, 50%, 75%, or 100% support/share for up to 2 research fields every 2 years at a minimum.

Should the i-th employee be a partial-time employee, or their share $J_{(i,j)}$ is 25%, 50%, 75%, or 100%, than

$$L_i = 0.8 \sum_{j=2017}^{2021} S_{(i,j)} J_{(i,j)} \tag{3}$$

is the limit L_i of cumulative Us attached to i–th employee. Eventually, the other cut-off limit is imposed, meaning that $1 \leq L_i \leq 4$ must hold. It is to be remarked that the 0.8 coefficient is characteristic only to the 2017–2021 evaluation period since due to COVID measures taken, the evaluation period is 5- instead of 4-years long, thus in 2022–2025 evaluation it is dropped).

3.2. L2 – scientific books constraint of an author

In addition, $0.5L_i$ of Us at a maximum for the i-th author can correspond to scientific books, editorships of the books or chapter authorships in these books with $P_T \leq 100$.

Should $L_i < 2$, than cumulative sum of Us connected to the authorship of scientific books, editorships or chapters in the books, for which $P_T \leq 100$ cannot exceed 1.

3.3. L3 – cumulative U connected to 2019–2021 papers of an author

During the evaluation carried out in 2022, for every author their cumulative Us connected to 2019–2021 papers (including conference papers), scientific book authorships, editorships or chapters in these books could not exceed $0.55L_i$.

3.4. L4 – cumulative P_U connected to book chapters in a scientific field

Should there be multiple chapters in a single scientific book originating from the same scientific field and its employees, the cumulative P_U cannot exceed that of P_T connected to this scientific book, which is, in turn, related to the level of the publishing house.

3.5. L5 – cumulative U connected to scientific books in a scientific field

An additional constraint to be taken into account is the cumulative U connected to scientific books, aditorships and their chapters with $P_T \leq 100$ that cannot exceed $0.60N$ or $0.15N$, depending on scientific filed (different threshold for, e.g., technical sciences, and social sciences.

3.6. L6 – cumulative U connected to a scientific field

Apart from a limit connected to each of the authors, there is also a limit at the level of a scientific field, related to cumulative Us used to assess C1. This limit is set at the level of $3N$. At this level, a penalty is also included to $3N$ for the employees in N who had, with some simplification, no publication output or has not allowed the entity to consider any of their publications for the purpose of evaluation, which lowers the value of $3N$.

3.7. Additional comment from the historical perspective

At the time of evaluation in 2022, in the middle of this period, as per no information from the Ministry of Higher Education explaining the details, two possibilities were considered, namely – each author either had L_i discrete slots (each of length not exceeding 1, with $\lfloor L_i \rfloor$ of length no smaller than 1), or an author had a single, continuous slot (limit of unit shares) of length L_i to fill with their P_Us and Us. The adopted flexible approach allowed easily to obtain the solutions for both the configurations, as they were clearly connected to cutting-like tasks.

As an example, please consider Figure 1a, where the rectangular shapes correspond to P_Us (height) and Us (width) of publications for the author with $L_i = 2$, not violating the limits considering the authors. Figure 1b presents the selection of 'the best' solution with discrete slots and Figure 1c with a continuous slot.

Obviously, selection of the variant of slots (cumulative Us for each author) implies the overall solution of the optimisation task.

Shortly before the end of the prior evaluation period, the Ministry presented the results of their optimisation environment, SEDN, which actually verified the continuous slots to be the only option, either way easily solvable by cutting problem-related solvers.

3.8. Type of the optimisation task to solve

During the evaluation process connected to the C1 criterion, the information concerning authors, their full- or partial-time employment, share in a scientific field, as well as all their publication background is gathered. Since not all publication fractions (expressed as P_U and U pairs) can be taken into consideration, there is an optimisation process needed. What is more, the existence of limits (or constraints, from the optimisation problem viewpoint) makes the problem difficult to solve, as per limits at the level of the author, and by at the level of the scientific field.

Performing exact optimisation calls for a binary or mixed integer linear programming solver [11] usually with tens of thou-

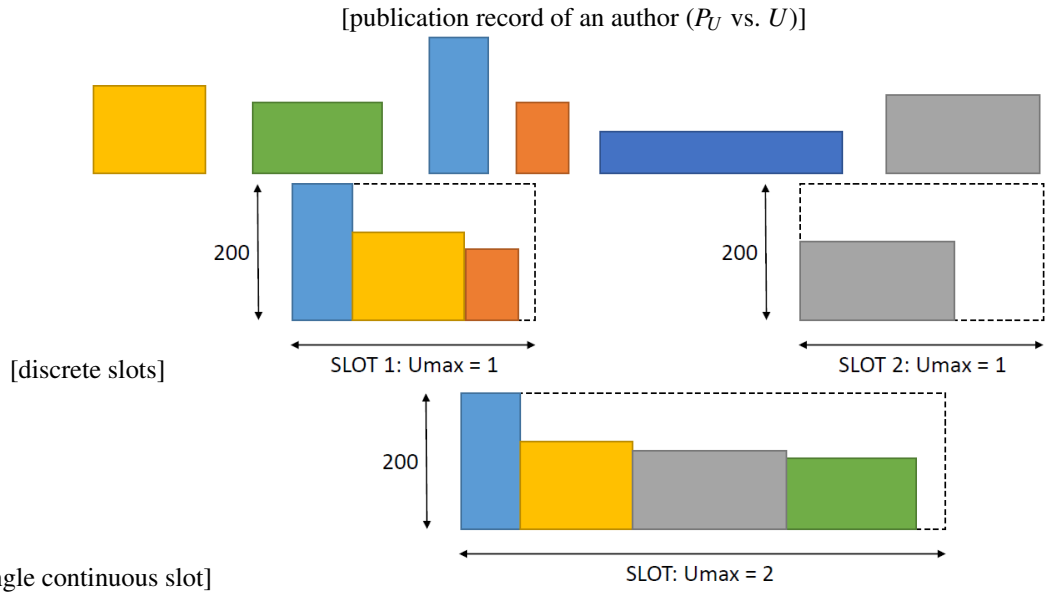

Fig. 1. Possible optimisation solutions at the level of an author ($U_{\max}$ denotes the maximum share sum/number of slots of an author)

sands of decision variables, making the process of reaching the global optimum a truly time consuming task. One could use, e.g., GUROBI [12] environment to model the problem, and solve it, though whenever such an optimisation needs to be done on demand, e.g. to test whether it is advantageous to remove an employee at a particular year from N number, or make any other analysis, there is no reason to wait a couple of hours on a traditional PC to get the answer.

On the contrary to this approach, in the paper, a far simpler method is proposed, taking a couple of seconds to finish, making it an attractive solution to get a near-optimal answer. From the internal evaluation at the university of the authors, it has turned out that this approach gives the optimal value of C1 criterion 2-5% smaller than the one calculated exactly. The benefit of such an approach is obvious – time consumption.

The basic solution simply adopts easy-to-implement heuristic optimisation methods, such as Next Fit Decreasing Height (NFDH), First Fit Decreasing Height (FFDH) and Best Fit Decreasing Height (BFDH) which provide concurrent solutions. Among these, the single solution is selected, related to a maximum value of the performance function (number of point shares gathered). Using simple and tractable heuristics admits to the running time of the optimisation procedure, resulting with the on-demand optimisation property of the solution.

3.9. Formal statement of the problem

As remarked in the Introduction, as per the fact that the current paper is actually the first one to present the optimisation procedure in full, there is no related work. The other reason for no state of the art review, is that the entities perform optimisation on their own, and do not present exact solving methods, if they exist.

The considered optimisation problem here is related to a knapsack problem [13], where the maximum value of points shares is to be gathered respecting constraints, with the limit imposed amongst the other to the cumulative number of unit shares, which are connected to each of the authors.

This knapsack-like [14] problem can be easily cast to a strip packing problem (a limited width of a strip, items placed to maximize the area occupied on a strip) [15, 16, 17]. Provided the maximum height of an item is kept at all times below P_T, say 200 points, one naturally gets support for optimal selection of publications in the considered decision problem.

Let us introduce the following notation of sets containing specific indices:

M a total number of authors in the research field across the years considered within the evaluation window,

$\mathscr{P}_{(i,j)}$ a set defining indices of publications of i-th author in j-th year,

$\mathscr{P}_i$ a set defining indices of publications of i-th author in the evaluation period,

$\mathscr{B}_{(i,j)}$ a set defining indices of publications of i-th author in j-th year referring to books (authorships, chapters, editorships) with $P_T \leq 100$,

$\mathscr{B}_i$ a set defining indices of publications of i-th author in the evaluation period (authorships, chapters, editorships) with $P_T \leq 100$,

$S_{(i,j)}$ a share of i-th author in j-th year in a particular research field,

$J_{(i,j)}$ full- or part-time share of i-th author in j-th year in a particular research field,

U_k unit share of an author referring to a publication,

P_{Uk} share in points of an author referring to a publication,

P_T^k total point value for a publication being a book,

x_k binary decision variable referring to a publication share (at least one decision variable refers to a particular publication since the publication might have multiple authors and thus multiple decision variables are related to a single publication).

Clearly, it holds that:

$$\mathscr{P} = \bigcup_{i=1}^{M} \bigcup_{j=2017}^{2021} \mathscr{P}_{(i,j)} = \bigcup_{i=1}^{M} \mathscr{P}_i ,$$

$$\mathscr{B} = \bigcup_{i=1}^{M} \bigcup_{j=2017}^{2021} \mathscr{B}_{(i,j)} = \bigcup_{i=1}^{M} \mathscr{B}_i ,$$

$$\mathscr{B} \subseteq \mathscr{P} .$$

The final form of the optimisation problem becomes:

$$\max_{x_k} \quad \sum_k x_k P_{Uk} \tag{4}$$

$$\text{s.t.} \quad L_i = 0.8 \sum_{j=2017}^{2021} S_{(i,j)} J_{(i,j)} \quad \forall_{1\le i\le M} , \tag{5}$$

$$1 \le L_i \le 4 \quad \forall_{1\le i\le M} , \tag{6}$$

$$\sum_k x_k U_k \le 0.5 L_i \quad \forall_{\substack{k\in\mathscr{P}_i \\ k\in\mathscr{B}_i \\ 1\le i\le M}} \text{ (when } L_i \le 2) , \tag{7}$$

$$\sum_k x_k U_k \le 1 \quad \forall_{\substack{k\in\mathscr{P}_i \\ k\in\mathscr{B}_i \\ 1\le i\le M}} \text{ (otherwise)} , \tag{8}$$

$$\sum_k x_k U_k \le 0.55 L_i \quad \forall_{k\in\left(\bigcup_{j=2019}^{j=2021} \mathscr{P}_{(i,j)}\right) \atop 1\le i\le M} , \tag{9}$$

$$\sum_k x_k P_{U_k} \le P_T^k \quad \forall_{k\in\left(\bigcup_{j=2019}^{j=2021} \mathscr{P}_{(i,j)}\right) \atop 1\le i\le M} , \tag{10}$$

$$\sum_{k\in\mathscr{B}} x_k U_k \le 0.6N , \tag{11}$$

$$\sum_k x_k U_k \le 3N , \tag{12}$$

$$x_k \in \{0, 1\} . \tag{13}$$

4. A PROPOSAL OF THE PROCEDURE TO CHOOSE THE BEST SOLUTION FOR MAXIMIZING THE C1 CRITERION

Section 3 has outlined the major constraints during the optimisation task. The next step, knowing the performance, capabilities and the structure of necessary input data to the strip-packing solvers, is to prepare the input data to the solving procedure.

It is assumed that prior to the optimisation, the following data is prepared:

- a table presenting in rows all the authors who are included in the N number of the considered scientific field across the years of the evaluation process, as in Table 4 (FT stands for full- and PT for part-time jobs);
- a table including all the publications for the authors in N across the years of the evaluation process, with their IDs, properly calculated k, m, P_U, U values, type of publication (to impose additional limits), and the ID of the parent publication (in the case of scientific book chapters or editorships);
- information about the N number, as well as considering possible penalties adopted at the level of picking up $3N$ among the reported Us.

On the contrary to a standard optimisation procedure, the problem here is solved in the following steps:

S1 for each author and their L_i calculate using NFDH, FFDH and BFDH concurrent solutions and information about the publication records sorted in descending P_U to U ratio; pick the solution with the maximum number of points within L_i limit;

S2 for each author and the information from Step 1, verify whether L2 and L3 constraints are satisfied; if not, remove in the loop, in item per item fashion, the items with the lowest P_U to U ratio (related actually to P_T) from the solution for the author and try to replace it with the publication record not violating the constraints from the sorted list in S1; naturally P_Us for 2019–2021 are higher than for scientific books, thus removing the items from the end of the sorted list works either on L2 or L3; adding items from the ones removed, also affects L2 or L3, thus decision is made locally upon consideration of a specific publication record;

S3 select $3N$ point shares and unit shares (P_Us and Us) decreased by the penalty from the obtained list, sorted in descending order with respect to P_U to U ratio, verify L4; remove the items from the sorted list in item per item fashion, and replace them with those removed from the final list until L4 is satisfied (the rest of the list is above $3N$ minus penalty Us level);

S4 take the modified list from Step 3, verify L5; remove the items from the sorted list in item per item fashion, and replace them with those removed from the final list until L5 is satisfied and L4 not violated;

S5 calculate the final partial value of C1 connected to publications.

It is to be strongly stressed that after Step 2 all the actions do not impede the optimised selection of the publications at the level of authors, but those at the level of the scientific field. Thus, the solution maximizing C1 always exists, and no constraints are eventually violated.

The decision is obviously not globally optimal, but as our internal evaluations shows, it is truly close to the real maximum, making it an attractive, fast, and reliable approach.

In Step S1, the algorithms NFDH, FFDH and BFDH with complexity of $O(n\log n)$ [18] are used in sequence, what defines the overall complexity here. Assuming the unit U_i and point $P_{U,i}$ shares satisfy $U_i \le L_i$ and $P_{U,i} \le 200$, as an example with n items considered to place them on the rectangle of width L_i and height 200, with f_i^* as the optimal value of the cost function (i.e. area taken by the 'rectangles'), one gets

$$f_{\text{NFDH},i} \le \frac{1}{2} f_i^* ,$$

$$f_{\text{FFDH},i} \le \frac{1}{1.7} f_i^* ,$$

$$f_{\text{BFDH},i} \le \frac{1}{1.7} f_i^* ,$$

leading to the worst-case scenario of $\frac{1}{1.7} f_i^* \approx 0.588\, f_i^*$ bound [19, 20]. However, during the calculations carried out for 9 research fields over the referred 5-year period, all the results proved be close to the tight optimum, as previously referred approx. by 2-5% of the optimal value. The actions taken in

Author	2017		2018		2019		2020		2021		L_i
	FT/PT	Share	FT/PT	Share	FT/PT	Share	FT/PT	Share	FT/PT	Share	
D1	0	0	50	100	100	100	100	100	0	0	2.0
D2	100	100	100	100	100	100	100	100	0	0	3.2
D3	100	100	100	100	100	100	100	100	100	100	4.0
D4	0	0	20	50	20	25	0	0	0	0	1.0
⋮											

Table 4. Sample table to present L_i of authors (FT/PT and Share in %)

Step S2 and using sorted lists, resulted in filling the gaps related to dropping particular elements of the set of publication records, due to various constraint violation.

5. A WORKED-OUT EXAMPLE

Let us assume, a group of people in an entity, who have picked research field X is considered. Their publication records are scattered across the years, with the following publication types: 1 – authorship of a monograph, 2 – editorship of a monograph, 3 – chapter in a monograph, 4 – scientific paper (in the journal or in a conference). In a considered example, $N = 13.05$ in the research field X with shares presented as below, author per author (also see the Appendix).

The complete publication record lists are provided in the Appendix.

Having performed the first pass of the optimisation, each author is assigned the optimal choice of their publication records to maximize their cumulative number of points.

Author: A01 ($L_1 = 4.0000$)

Authors	U	P_U	Type	Title
A01	1.0000	200.0000	4	P2021_23
A02, A11, A01	0.3333	46.6667	4	P2021_34
A01	1.0000	45.0000	4	P2018_41
A01	1.0000	35.0000	4	P2018_04
A16, A01	0.5000	17.5000	4	P2017_20

Author: A02 ($L_2 = 4.0000$)

Authors	U	P_U	Type	Title
A02	1.0000	140.0000	4	P2019_49
A02	1.0000	140.0000	4	P2020_59
A02	1.0000	140.0000	4	P2021_03
A02, A11	0.5000	70.0000	4	P2020_40
A11, A02	0.5000	70.0000	4	P2021_33

Author: A03 ($L_3 = 2.4000$)

Authors	U	P_U	Type	Title
A03	1.0000	200.0000	4	P2020_46
A03	1.0000	200.0000	4	P2021_16
A02, A13, A17, A03	0.2500	7.5000	4	P2017_10

Author: A04 ($L_4 = 2.4000$)

Authors	U	P_U	Type	Title
A04	1.0000	200.0000	4	P2019_08
A04	1.0000	200.0000	4	P2020_05
A08, A04, A15	0.3333	46.6667	4	P2020_10

Author: A05 ($L_5 = 3.8000$)

Authors	U	P_U	Type	Title
A05	1.0000	200.0000	4	P2021_19
A05	1.0000	140.0000	4	P2019_35
A05	1.0000	140.0000	4	P2020_48
A05, A12	0.5000	70.0000	4	P2020_26
A11, A04, A05	0.2887	20.2073	4	P2020_13

Author: A06 ($L_6 = 4.0000$)

Authors	U	P_U	Type	Title
A06	1.0000	140.0000	4	P2019_01
A06	1.0000	140.0000	4	P2020_47
A06	1.0000	140.0000	4	P2021_04
A06	1.0000	100.0000	4	P2019_16

Author: A07 ($L_7 = 2.4000$)

Authors	U	P_U	Type	Title
A07	1.0000	140.0000	4	P2019_24
A07	1.0000	140.0000	4	P2020_03
A07, A12, A13	0.3333	33.3333	4	P2020_16

Author: A08 ($L_8 = 3.8000$)

Authors	U	P_U	Type	Title
A08	1.0000	200.0000	4	P2019_03
A08	1.0000	140.0000	4	P2020_20
A08	1.0000	140.0000	4	P2021_02
A08, A04, A15	0.3333	46.6667	4	P2020_10
A08	0,3780	26.4575	4	P2019_33

Author: A09 ($L_9 = 3.0000$)

Authors	U	P_U	Type	Title
A09	1.0000	140.0000	4	P2020_11
A09	1.0000	140.0000	4	P2020_21
A09, A05	0.5000	70.0000	4	P2021_14
A09	0.4472	35.7771	1	P2021_26

Author: A10 ($L_{10} = 4.0000$)

Authors	U	P_U	Type	Title
A10	1.0000	140.0000	4	P2019_07
A10	1.0000	140.0000	4	P2019_09
A10	1.0000	140.0000	4	P2020_41
A10	1.0000	140.0000	4	P2021_18

Author: A11 ($L_{11} = 2.4000$)

Authors	U	P_U	Type	Title
A02, A11	0.5000	70.0000	4	P2020_40
A11, A02	0.5000	70.0000	4	P2021_33
A02, A11	0.5000	50.0000	4	P2021_40
A02, A11, A01	0.3333	46.6667	4	P2021_34
A02, A11	0.2887	20.2073	4	P2019_45

Author	2017		2018		2019		2020		2021		L_i
	FT/PT	Share	FT/PT	Share	FT/PT	Share	FT/PT	Share	FT/PT	Share	
A01	1	100	1	100	1	100	1	100	1	75	4.0
A02	1	100	1	100	1	100	1	100	1	100	4.0
A03	1	75	0	0	1	75	1	75	1	75	2.4
A04	0	0	0	0	1	100	1	100	1	100	2.4
A05	1	100	1	100	1	100	1	100	1	75	3.8
A06	1	100	1	100	1	100	1	100	1	100	4.0
A07	0	0	0	0	1	100	1	100	1	100	2.4
A08	1	100	1	100	1	100	1	100	1	75	3.8
A09	1	100	0	0	1	100	1	100	1	75	3.0
A10	1	100	1	100	1	100	1	100	1	100	4.0
A11	0	0	0	0	1	100	1	100	1	100	2.4
A12	1	100	0	0	1	100	1	100	1	75	3.0
A13	1	100	0	0	1	100	1	100	1	100	3.2
A14	1	100	1	100	1	100	0	0	0	0	2.4
A15	1	100	1	100	1	100	1	100	1	75	3.8
A16	1	100	1	100	1	100	1	100	1	75	3.8
A17	1	100	1	100	1	100	1	100	1	75	3.8

Author: A12 ($L_{12} = 3.0000$)

Authors	U	P_U	Type	Title
A12	1.0000	140.0000	4	P2019_26
A12	1.0000	140.0000	4	P2019_34
A12	1.0000	140.0000	4	P2020_50

Author: A13 ($L_{13} = 3.2000$)

Authors	U	P_U	Type	Title
A13	1.0000	140.0000	4	P2019_44
A13, A06	0.5000	70.0000	4	P2019_13
A04, A13	0.5000	50.0000	4	P2021_37
A07, A12, A13	0.3333	33.3333	4	P2020_16
A13	0.3780	26.4575	4	P2021_21
A13, A06	0.3536	14.1421	4	P2020_58

Author: A14 ($L_{14} = 2.4000$)

Authors	U	P_U	Type	Title
A14	1.0000	140.0000	4	P2019_10
A14	1.0000	140.0000	4	P2019_14

Author: A15 ($L_{15} = 3.8000$)

Authors	U	P_U	Type	Title
A15	1.0000	140.0000	4	P2019_11
A15	1.0000	140.0000	4	P2020_45
A15	1.0000	100.0000	4	P2019_27
A08, A04, A15	0.3333	46.6667	4	P2020_10
A15	0.3333	23.3333	4	P2019_51

Author: A16 ($L_{16} = 3.8000$)

Authors	U	P_U	Type	Title
A16	1.0000	200.0000	4	P2020_29
A16	1.0000	100.0000	4	P2020_09
A16	1.0000	100.0000	4	P2020_31
A16, A02	0.4082	28.5774	4	P2020_61
A16	0.2500	3.7500	4	P2017_15

Author: A17 ($L_{17} = 3.8000$)

Authors	U	P_U	Type	Title
A17	1.0000	200.0000	4	P2019_52
A17	1.0000	140.0000	4	P2020_28
A17	1.0000	140.0000	4	P2020_55
A17	0.5000	20.0000	4	P2020_33
A02, A13, A17, A03	0.2500	7.5000	4	P2017_10

The above can be summarized in the following list at the level of 4N achievements of the each author, ranked according the the greatest sum of points gathered.

Rank	Author	L_i	ΣP_u	$\Sigma U/L_i$
1	A05	3.8	570.2073	0.9970
2	A02	4.0	560.0000	1.0000
3	A10	4.0	560.0000	1.0000
4	A08	3.8	553.1242	0.9767
5	A06	4.0	520.0000	1.0000
6	A17	3.8	507.5000	0.9868
7	A15	3.8	450.0000	0.9649
8	A04	2.4	446.6667	0.9722
9	A16	3.8	432.3274	0.9627
10	A12	3.0	420.0000	1.0000
11	A03	2.4	407.5000	0.9375
12	A09	3.0	385.7771	0.9824
13	A01	4.0	344.1667	0.9583
14	A13	3.2	333.9329	0.9578
15	A07	2.4	313.3333	0.9722
16	A14	2.4	280.0000	0.8333
17	A11	2.4	256.8740	0.8842

Finally, from this dataset, the final choice to make the optimal decision is made, summing up to $3N$ shares. The ID tag denotes the 'donor' of the specific share.

The final value of the C1 becomes 357.8225 points. This simple example, when worked using exact approach has 306 decision variables and 56 constraints in the case of just 17 authors and 254 publications considered (76, 42, 58, 78, 51 decision variables for years 2017–2022, respectively). A standard

size of a research discipline at the entity is usually around 80–100, and the number of publications reaches a couple of thousands (splitted across the authors in different configurations), giving up to tens of thousands of constraints and a couple of thousands of variables.

ID	U	P_U	Type	Title
A01	1.0000	200.0000	4	P2021_23
A03	1.0000	200.0000	4	P2020_46
A03	1.0000	200.0000	4	P2021_16
A04	1.0000	200.0000	4	P2019_08
A04	1.0000	200.0000	4	P2020_05
A05	1.0000	200.0000	4	P2021_19
A08	1.0000	200.0000	4	P2019_03
A16	1.0000	200.0000	4	P2020_29
A17	1.0000	200.0000	4	P2019_52
A02	1.0000	140.0000	4	P2019_49
A02	1.0000	140.0000	4	P2020_59
A02	1.0000	140.0000	4	P2021_03
A05	1.0000	140.0000	4	P2019_35
A05	1.0000	140.0000	4	P2020_48
A06	1.0000	140.0000	4	P2019_01
A06	1.0000	140.0000	4	P2020_47
A06	1.0000	140.0000	4	P2021_04
A07	1.0000	140.0000	4	P2019_24
A07	1.0000	140.0000	4	P2020_03
A08	1.0000	140.0000	4	P2020_20
A08	1.0000	140.0000	4	P2021_02
A09	1.0000	140.0000	4	P2020_11
A09	1.0000	140.0000	4	P2020_21
A10	1.0000	140.0000	4	P2019_07
A10	1.0000	140.0000	4	P2019_09
A02	0.5000	70.0000	4	P2020_40
A02	0.5000	70.0000	4	P2021_33
A05	0.5000	70.0000	4	P2020_26
A09	0.5000	70.0000	4	P2021_14
A01	0.3333	46.6667	4	P2021_34
A04	0.3333	46.6667	4	P2020_10
A08	0.3333	46.6667	4	P2020_10
A11	0.3333	46.6667	4	P2021_34
A15	0.3333	46.6667	4	P2020_10
A01	1.0000	45.0000	4	P2018_41
A01	1.0000	35.0000	4	P2018_04
A01	0.5000	17.5000	4	P2017_20
A03	0.2500	7.5000	4	P2017_10
A17	0.2500	7.5000	4	P2017_10
A16	0.2500	3.7500	4	P2017_15

6. CONCLUSIONS

Taking optimal decisions is crucial in the referred process of scientific evaluation. In the paper, a fully worked-out example is presented along with the complete algorithm to find the estimate of the C1 criterion.

The adopted methods are computationally simple, take little time to provide the solution, and can easily give rise to further development in the field. In addition, presentation of the algorithm can stimulate the other approaches to be reported as well, opening a discourse on how to estimate the overall score in the evaluation process of scientific quality in Poland, and also in the other countries which might adopt a similar approach.

The presented approach, enables the entity to estimate its evaluation outcome, allowing at the same time, to consider possible publication strategy changes in due course of the publication process, moving employees outside the N number, changing shares, or making well-supported decisions whether a specific person should be employed (and their publications in the year when employments starts can improve the overall assessment grade) or not. Such a policy of preparing the input data to the optimisation algorithm along with possible changes in a k number of a publication (number of authors who allowed the entity to present their, e.g., paper during the evaluation of a specific scientific field, not only changes shares, but also enables to power up the point shares for the authors lower in the raking of cumulative P_us, replacing shares with lower number of points, with these highly-ranked).

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APPENDIX

Solved out problem data

Publication records in 2017

Authors	k	m	P_T	Type	ID
A08, A12, A13	3	6	30	4	P2017_01
A05	1	6	13	4	P2017_02
A15	1	8	40	4	P2017_03
A14	1	3	35	4	P2017_04
A06	1	2	13	4	P2017_05
A08	1	8	30	4	P2017_06
A06, A13	2	3	15	4	P2017_07
A02	1	8	30	4	P2017_08
A02	1	6	15	4	P2017_09
A02, A13, A17, A03	4	9	30	4	P2017_10
A03	1	4	30	4	P2017_11
A03	1	4	30	4	P2017_12
A16	1	4	15	4	P2017_15
A02	1	8	25	4	P2017_16
A06	1	4	13	4	P2017_17
A09	1	5	35	4	P2017_18
A08	1	3	25	4	P2017_19
A16, A01	2	3	35	4	P2017_20
A02	1	5	30	4	P2017_21
A08	1	3	25	4	P2017_22
A03	1	5	30	4	P2017_23
A03, A05	2	4	35	4	P2017_24
A12	1	3	35	4	P2017_25
A17	1	6	30	4	P2017_26
A06, A13	2	5	15	4	P2017_27
A08	1	4	45	4	P2017_28
A09	1	3	35	4	P2017_29
A02, A12	2	6	30	4	P2017_30
A06	1	5	30	4	P2017_31
A12	1	3	45	4	P2017_33
A17	1	4	12	4	P2017_34
A17	1	4	13	4	P2017_35
A02, A06	2	4	25	4	P2017_36
A08	1	4	45	4	P2017_37
A17	1	3	35	4	P2017_38
A17	1	3	40	4	P2017_39
A16	1	4	35	4	P2017_40
A02	1	7	20	4	P2017_41
A12	1	4	30	4	P2017_42
A16	1	7	40	4	P2017_43
A13, A06	2	3	30	4	P2017_44
A06, A13	2	4	1	4	P2017_45
A16	1	5	30	4	P2017_46
A02	1	3	30	4	P2017_47
A14	1	6	35	4	P2017_48
A03	1	3	35	4	P2017_49
A05	1	1	20	3	P2017_50
A12, A02	2	6	15	4	P2017_51
A09	1	1	35	4	P2017_52
A06	1	2	5	3	P2017_53
A14	1	6	35	4	P2017_54
A06	1	8	25	4	P2017_55
A13	1	1	35	4	P2017_56
A17	1	3	12	4	P2017_57
A08	1	8	1	4	P2017_58
A09	1	5	35	4	P2017_59
A02	1	6	15	4	P2017_60
A14	1	2	20	4	P2017_61
A15	1	5	30	4	P2017_62
A10	1	5	20	4	P2017_63

Publication records in 2018

Authors	k	m	P_T	Type	ID
A06	1	1	5	3	P2018_01
A02	1	4	20	3	P2018_02
A15	1	6	20	3	P2018_03
A01	1	8	35	4	P2018_04
A02	1	3	20	3	P2018_05
A08	1	8	15	4	P2018_06
A17	1	3	15	4	P2018_07
A08	1	5	20	4	P2018_08
A02	1	5	30	4	P2018_09
A17	1	7	20	4	P2018_10
A16	1	5	30	4	P2018_11
A16	1	5	40	4	P2018_12
A08	1	4	15	4	P2018_13

Authors	k	m	P_T	Type	ID
A06	1	5	20	4	P2018_14
A17	1	5	20	3	P2018_15
A02	1	7	30	4	P2018_16
A14	1	8	35	4	P2018_17
A10	1	6	20	3	P2018_18
A08	1	3	20	4	P2018_19
A14	1	3	25	4	P2018_20
A16	1	5	45	4	P2018_21
A06	1	5	25	4	P2018_22
A17	1	3	25	4	P2018_23
A06	1	8	30	4	P2018_24
A15	1	5	35	4	P2018_25
A15	1	6	35	4	P2018_26
A05	1	4	20	3	P2018_27
A02	1	3	20	3	P2018_28
A02	1	5	20	3	P2018_29
A02	1	6	25	4	P2018_30
A16	1	5	35	4	P2018_31
A10	1	4	30	4	P2018_32
A08	1	4	25	4	P2018_33
A16	1	5	35	4	P2018_34
A06	1	5	25	4	P2018_35
A02	1	3	20	3	P2018_36
A17	1	3	30	4	P2018_37
A02	1	10	40	4	P2018_38
A16	1	5	45	4	P2018_39
A06	1	4	35	4	P2018_40
A01	1	3	45	4	P2018_41
A05	1	7	30	4	P2018_42

Publication records in 2019

Authors	k	m	P_T	Type	ID
A06	1	10	140	4	P2019_01
A02	1	4	70	4	P2019_02
A08	1	3	200	4	P2019_03
A05	1	6	70	4	P2019_04
A05	1	4	20	3	P2019_05
A10	1	4	40	4	P2019_06
A10	1	4	140	4	P2019_07
A04	1	4	200	4	P2019_08
A10	1	5	140	4	P2019_09
A14	1	5	140	4	P2019_10
A15	1	7	140	4	P2019_11
A03	1	4	100	4	P2019_12
A13, A06	2	6	140	4	P2019_13
A14	1	3	140	4	P2019_14
A06	1	3	100	4	P2019_16
A08	1	2	20	3	P2019_18
A05	1	5	100	4	P2019_19
A04, A08	2	5	70	4	P2019_20
A17	1	6	100	4	P2019_21
A04	1	3	100	4	P2019_22
A04	1	2	5	3	P2019_23
A07	1	4	140	4	P2019_24
A14	1	2	100	4	P2019_25
A12	1	4	140	4	P2019_26
A15	1	7	100	4	P2019_27
A09	1	5	40	4	P2019_28
A06, A13	2	8	40	4	P2019_29
A05	1	10	70	4	P2019_30
A06	1	1	80	1	P2019_31
A05	1	6	20	3	P2019_32
A08	1	7	70	4	P2019_33
A12	1	4	140	4	P2019_34
A05	1	7	140	4	P2019_35
A04	1	2	20	3	P2019_36
A04	1	2	5	3	P2019_37
A12	1	4	70	4	P2019_38
A05	1	4	20	4	P2019_39
A05	1	6	70	4	P2019_40
A14	1	9	140	4	P2019_41
A09	1	1	70	4	P2019_42
A14	1	4	140	4	P2019_43
A13	1	1	140	4	P2019_44
A02, A11	2	6	70	4	P2019_45
A12, A02	2	6	100	4	P2019_46
A17	1	4	100	4	P2019_47
A12	1	6	100	4	P2019_48
A02	1	4	140	4	P2019_49
A12	1	3	100	4	P2019_50
A15	1	9	70	4	P2019_51
A17	1	4	200	4	P2019_52
A05	1	6	40	4	P2019_53

Publication records in 2020

Authors	k	m	P_T	Type	ID
A02	1	8	70	4	P2020_01
A08	1	1	70	4	P2020_02
A07	1	8	140	4	P2020_03
A08	1	4	100	4	P2020_04
A04	1	3	200	4	P2020_05
A08, A04	2	7	70	4	P2020_06
A04	1	2	140	4	P2020_07
A04	1	5	140	4	P2020_08
A16	1	6	100	4	P2020_09
A08, A04, A15	3	8	140	4	P2020_10
A09	1	5	140	4	P2020_11
A09	1	3	70	4	P2020_12
A11, A04, A05	3	4	70	4	P2020_13
A02	1	6	70	4	P2020_14
A02	1	6	100	4	P2020_15
A07, A12, A13	3	6	100	4	P2020_16
A17	1	3	100	4	P2020_17
A02	1	10	70	4	P2020_18
A08	1	1	140	4	P2020_20
A09	1	1	140	4	P2020_21
A03	1	4	100	4	P2020_22
A03	1	4	100	4	P2020_23
A10	1	4	70	4	P2020_24
A04	1	3	100	4	P2020_25
A05, A12	2	6	140	4	P2020_26
A03	1	8	100	4	P2020_27
A17	1	8	140	4	P2020_28
A16	1	7	200	4	P2020_29
A17	1	6	40	4	P2020_30
A16	1	7	100	4	P2020_31

Authors	k	m	P_T	Type	ID
A05	1	6	100	4	P2020_32
A17	1	4	40	4	P2020_33
A08, A04	2	7	70	4	P2020_34
A10	1	4	100	4	P2020_35
A17	1	1	100	4	P2020_36
A12	1	14	100	4	P2020_37
A05	1	4	20	3	P2020_38
A08	1	2	70	4	P2020_39
A02, A11	2	6	140	4	P2020_40
A10	1	5	140	4	P2020_41
A04	1	4	200	4	P2020_43
A04	1	7	100	4	P2020_44
A15	1	6	140	4	P2020_45
A03	1	4	200	4	P2020_46
A06	1	1	140	4	P2020_47
A05	1	7	140	4	P2020_48
A08, A04	2	6	100	4	P2020_49
A12	1	4	140	4	P2020_50
A08	1	3	140	4	P2020_51
A17	1	7	100	4	P2020_52
A17	1	5	100	4	P2020_53
A08	1	3	100	4	P2020_54
A17	1	1	140	4	P2020_55
A05, A07	2	11	100	4	P2020_56
A04	1	4	140	4	P2020_57
A13, A06	2	4	40	4	P2020_58
A02	1	4	140	4	P2020_59
A04, A08	2	8	70	4	P2020_60
A16, A02	2	3	70	4	P2020_61
A06	1	1	5	2	P2020_62
A05	1	5	70	4	P2020_63

Publication records in 2021

Authors	k	m	P_T	Type	ID
A08	1	8	5	3	P2021_01
A08	1	4	140	4	P2021_02
A02	1	6	140	4	P2021_03
A06	1	4	140	4	P2021_04
A04	1	2	140	4	P2021_05
A15	1	5	100	4	P2021_07
A03	1	4	100	4	P2021_08
A03	1	3	100	4	P2021_09
A08	1	4	20	4	P2021_10
A17	1	4	140	4	P2021_11
A08	1	5	20	4	P2021_12
A17	1	2	100	4	P2021_13
A09, A05	2	3	140	4	P2021_14
A17	1	1	100	4	P2021_15
A03	1	57	200	4	P2021_16
A04	1	5	40	4	P2021_17
A10	1	4	140	4	P2021_18
A05	1	9	200	4	P2021_19
A09	1	4	100	4	P2021_20
A13	1	7	70	4	P2021_21
A05	1	5	140	4	P2021_22
A01	1	5	200	4	P2021_23
A04	1	3	5	3	P2021_24
A04	1	2	70	4	P2021_25
A09	1	5	80	1	P2021_26
A04	1	4	140	4	P2021_27
A03	1	4	70	4	P2021_28
A16	1	3	100	4	P2021_29
A08, A04, A01	3	9	40	4	P2021_31
A02	1	8	70	4	P2021_32
A11, A02	2	5	140	4	P2021_33
A02, A11, A01	3	7	140	4	P2021_34
A02	1	12	70	4	P2021_36
A04, A13	2	6	100	4	P2021_37
A02, A11	2	5	100	4	P2021_40
A04	1	4	20	4	P2021_41
A02	1	14	100	4	P2021_42
A04	1	3	5	3	P2021_43