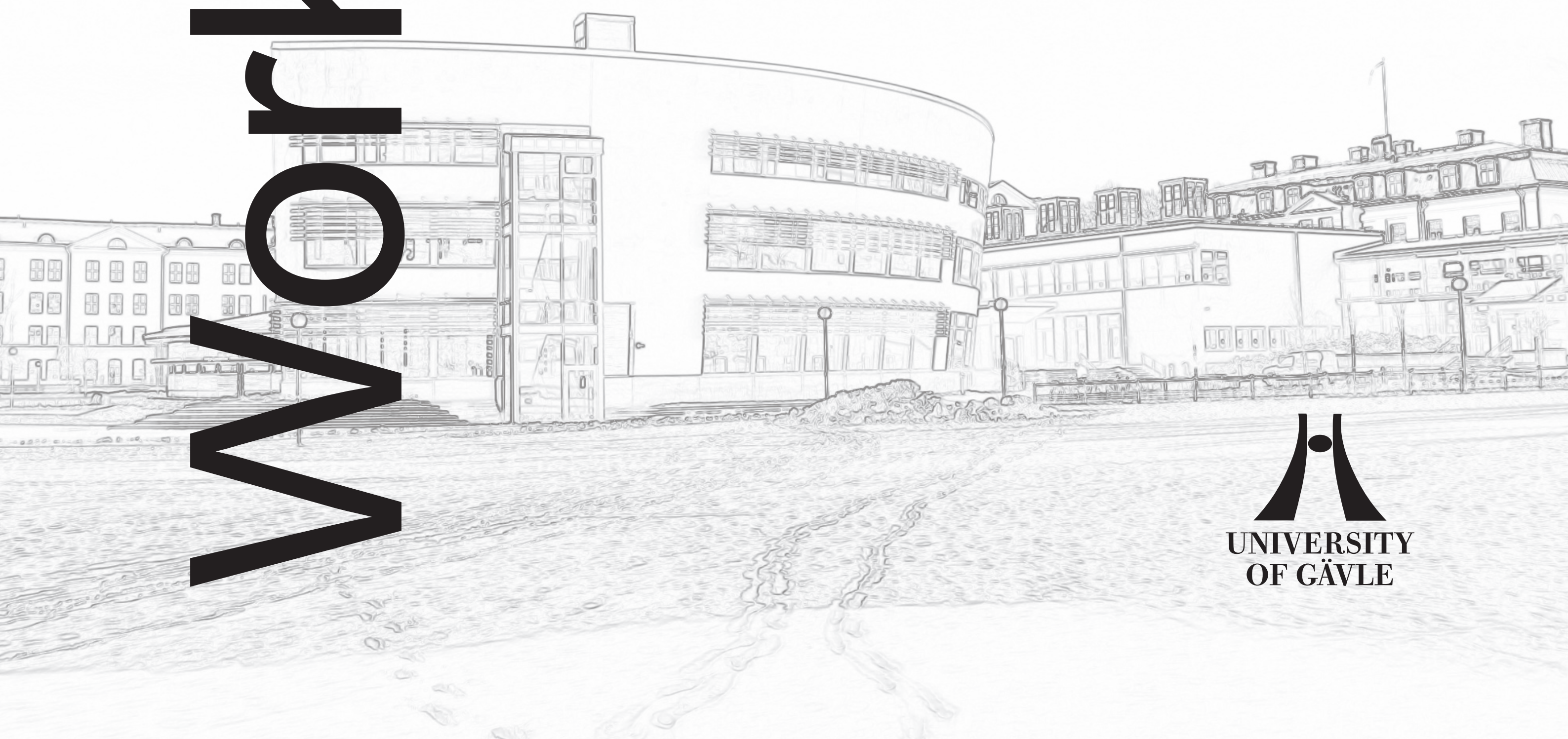
Working Paper

No 38

Magnus Isaksson

A Measure to Characterize the Impact of Sets of Scientific Papers



UNIVERSITY OF GÄVLE

A Measure to Characterize the Impact of Sets of Scientific Papers

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Abstract

A figure-of-merit for quantifying a comparable scientific value ranking the output of a set researchers work is proposed. The method is based on the Garfield Factor (*GF*) and thus related to the expected number of citations rather than the real ones. The measure allow comparisons of the scientific outputs between different sets of scientists where some papers are joint works between the comparative sets or between constellations with other sets. It has the advantages of having a rather small time-lag and that it is comparable between different subject categories. The measure is very easy to calculate and is complementing the existing indices or measures in an adequate way.

I Introduction

Nowadays, there are many ways for a scientist to publish a scientific result. Among the possibilities are scientific conference proceedings, workshop proceedings, directly on the internet, and scientific journals etc. One of the main interests of a scientist is that his or hers results will be read, accepted, and used by other researchers in the scientific community. It is, thus, not enough to only have a strong result but also to publish the result in a way that the spread and the scientific impact are maximized. One acknowledged scheme is to publish the result in a well-cited so-called peer-reviewed international scientific journal.

Something that has attracted great interest for a long time is how to evaluate a scientific work and obtain an unbiased and fair criterion. The early work of Eugene Garfield [1] showed a method to evaluate journals and the Garfield Factor (GF) is today one of the most frequently used scientometric indicators [2]. The GF can be calculated by

$$GF_y = \frac{C_y}{P_{y-1} + P_{y-2}} \tag{1}$$

where GF_y is the Garfield factor of a journal in year y, C_y is the total number of citations (self-citations included) received in year y by the papers published in the respective journal in years $y-1$ and $y-2$, and P_{y-1} and P_{y-2} stand for the number of papers published in the respective years [3].

During the last five years the number of publications within the field of ranking scientists, groups of scientists, or journals has exploded, see e.g. [3-15], mostly due the fact of the increasing amount of digital libraries with a large amount of bibliographic data available. However, all citation indices have their pros and cons. Some of the major drawbacks that is often mentioned are: i) they don't measure the impact of papers, ii) they penalize authors that work alone, iii) they cannot measure productivity, and iv) they include a relatively long time lag [16-19].

This paper gives a method of how to rank the scientific output of a set of researchers based on the *expected* number of citations in international scientific journals. The scientific output of a researcher is calculated and given as a figure-of-merit called the *Scientific Value* (ScV). The measure uses the GF [1] which has been proven previously to correspond to the expected value of citedness [2], and has the major advantage to exclude all the drawbacks mentioned above (i - iv) at the same time. Moreover, the ScV will include a normalization that allow comparisons by researchers from different fields.

The paper is organized as follows. In II the figure-of-merit ScV is presented, in III a calculation example is given, and Chapters IV-V include discussion and conclusions.

II The Scientific Value, ScV

Even though impact factor's meaning has not been definitely analyzed in the literature [20] it has been stated that the GF is the most prominent journal citation measure [17] and that it is one of the most frequently used scientometric indicators [2]. The GF could be used not only to measure the impact of a journal but also to measure the impact of a set of researchers without the disadvantage of the introduced time lag by counting real citations; the GF has been proved to correspond to the expected value of citedness [2]. Most of the methods ranking individuals are counting real citations which will penalize young research groups that have not yet reached their steady state. One example is the h- and g-indices, see e.g. [18, 19, 21-23], that can be used to find the most accomplished scientist out of two individuals *of the same scientific age* [18].

To make the ScV comparable between set of researchers belonging to different subject categories a normalization factor is introduced. One scientometric set could be the journals belonging to the category of e.g. electrical engineering. This subset does not exist in practice because of multidisciplinarity and overlaps etc. and only certain journals are selected by Institute of Scientific Information. A subset is an approximation. A world standard could be to use the median value of the GFs of journals in this subset as the normalizing factor [2]. Figure 1 shows a schematic illustration of the citation distributions of two example journals and two different subject categories, i.e. engineering, electrical and electronics and applied physics. After normalization both the example journals got a normalized GF equal to 1.3.

Based on the above argumentation the ScV is defined as

$$\mathrm{ScV} = \sum_{k=1}^{K} \left(GF \big/ \overline{GF} \right)_k c_k \tag{2}$$

where $\overline{GF}$ is the median GF of the GFs within that specific subject category, K is the total number of papers in the set, and c_k is the distributing factor for paper k and is calculated by

$$\begin{aligned} c_k &= \frac{2r_k(N_k - 1) - 2(r_k - 1)(p_k - 1)}{N_k(N_k - 1)(r_k + 1)}, && \text{if } N_k > 1 \\ c_k &= 1, && \text{if } N_k = 1 \end{aligned} \tag{3}$$

with the ratio $r_k, (r_k \geq 1)$,

$$r_k = \frac{c_{k,p_k=1}}{c_{k,p_k=N_k}}, \tag{4}$$

where N_k is the number of authors and p_k the author's contributing position of paper k, respectively. The ScV will, thus, split the total impact over the authors in a controlled manner, and the expected number of citations could therefore be said to be shared in a consistent way.

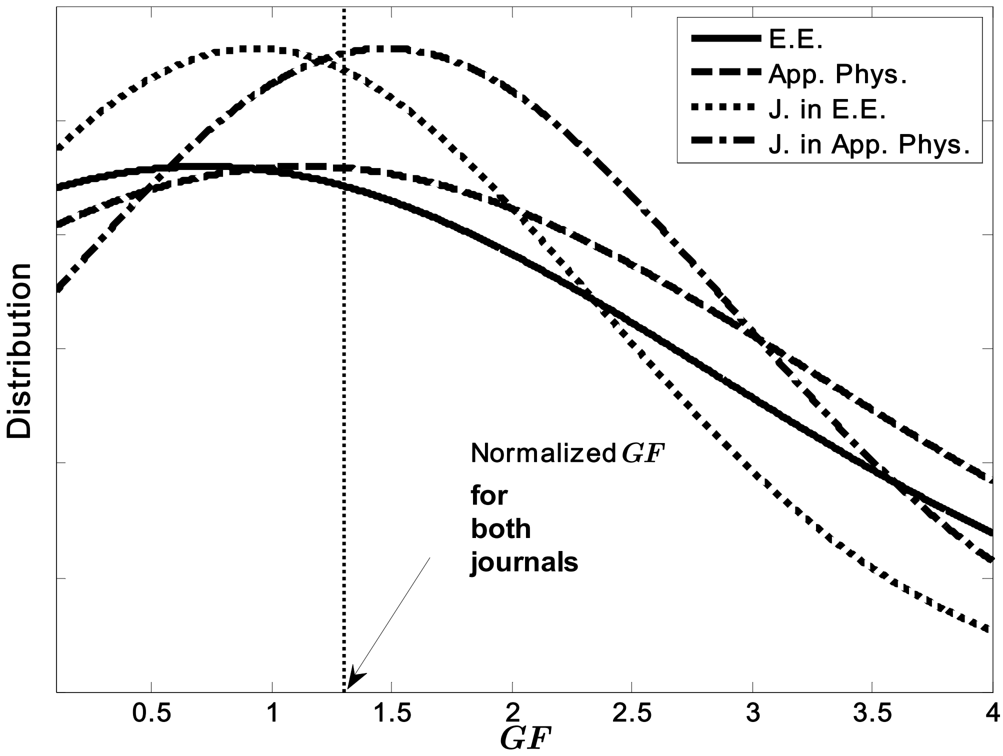

Figure 1. Schematic illustration of the citation distributions of two example journals and two different subject categories, i.e. engineering, electrical and electronics and applied physics. The subject categories have median GFs equal to 0.720 and 1.138, respectively. After normalization both the example journals got normalized $GF = 1.3$.

The contribution factor's role is important and allow comparisons of the scientific outputs between different sets of scientists where some papers are joint works between the comparative sets or between constellations with other sets. One expected citation is in the ScV only calculated one time. One property of the distribution factor c_k is thus

$$\sum_{i=1}^{N_k} c_{k,i} = 1. \tag{5}$$

Moreover, the ScV is generalized in a way that it has the capability to differentiate the impact between co-authors in a paper. The contribution from the co-authors are not always equally distributed and is often, but not always, visualized by the order in the author list. The differentiating influence is set by the ratio r in (4). The interpretation of r is that the leading author achieves r times higher impact compared with the last author. If a uniform distribution of the impact is wanted, i.e. $r = 1$, (3) simplifies to $1/N_k$.

III A Calculation Example

The ScV has been calculated for the research group in the department of electronics, University of Gävle from the period 2005-2007. During the period, 13 papers are considered. The paper references are given in Appendix B. The result of the study is tabulated in Table I. The results are calculated using (2)-(4) with $r = 2$.

From the data given in Table I many conducting lines of arguments can be performed. The over all sum for the studied period is, which can be interpreted as the output of 14.4 equivalent journals with a GF equal to one.

With the Matlab function (source code included in Appendix A) the ScV can be calculated very easily. With the input argument matrix $\mathbf{A}$ as the 23×3 matrix defined by the columns 3, 4, and 5 in Table I the ScV sum is calculated by entering

$$\text{ScV} = \text{scientvalue}([\mathbf{A}])$$

in the Matlab command window.

In Table II give relevant efficiency measures for the studied years 2005-2007, the efficiency measure is interpreted as *Swedish crowns per equivalent one-author-paper with normalized GF equal to one*. For the period, the studied research group consumed 4.513 million Swedish crowns of the university's private means. External means are not included.

TABLE I. THE CALCULATED SCIENTIFIC VALUE FOR THE PERIOD 2005 TO 2007 FOR THE DEPARTMENT OF ELECTRONICS, UNIVERSITY OF GÄVLE.

Paper	**Author**	**Total Num. Au.**	**Place in Au. List**	$GF/\overline{GF}$	**ScV**
1 (*)	C. Beckman	2	1	3.664	**2.443**
2	M. Isaksson	3	1	3.160	**1.404**
	D. Wisell		2		**1.053**
	D. Rönnow		3		**0.702**
3	M. Isaksson	3	1	2.815	**1.251**
	D. Wisell		2		**0.938**
	D. Rönnow		3		**0.626**
4	D. Rönnow	2	1	1.476	**0.984**
	M. Isaksson		2		**0.492**
5 (*)	P. Händel	3	3	0.738	**0.164**
6	P. Händel	1	1	0.643	**0.643**
7	N. Björsell	2	1	0.677	**0.451**
	P. Händel		2		**0.226**
8	M. Isaksson	2	1	0.627	**0.418**
	D. Rönnow		2		**0.209**
9	D. Rönnow	3	1	0.738	**0.328**
	D. Wisell		2		**0.246**
	M. Isaksson		3		**0.164**
10	D. Wisell	3	1	0.738	**0.328**
	D. Rönnow		2		**0.246**
	P. Händel		3		**0.164**
11 (*)	D. Wisell	3	1	0.738	**0.328**
	D. Rönnow		3		**0.164**
12 (*)	D. Rönnow	5	5	1.061	**0.142**
13 (*)	J. Chilo	5	1	1.040	**0.277**
SUM					**14.4**

(*) Some authors of the paper will not contribute to the ScV in this study, i.e. they where not with the dept. of electronics, UG, at the time of paper writing.

TABLE II. EFFICIENCY MEASURES FOR THE DEPARTMENT OF ELECTRONICS, UNIVERSITY OF GÄVLE, FOR THE GIVEN PERIOD 2005-2007.

Year	ScV	Means [kSEK]	Efficiency [kSEK/ScV]
2005	5.6	1458	260
2006	4.5	1245	279
2007	4.3	1810	421
SUM	**14.4**	**4513**	**314**

IV Discussion

All measurement types of the kind presented in this paper will have their pros and cons. Therefore, the method should be used wisely. The *Scientific Value* (ScV) will of course not include all information about the quality of a research work but it has at least two major advantages; i) there is no room for any subjective thinking, ii) the ScV is precisely defined and very easy to calculate. In spite of this, the ScV will undoubtedly say very much of the outcome of a scientific work.

The ScV will not include any impact from scientific work published in conference proceedings etc. That kind of publication is not easy to find, not cited much compared with journals, and therefore of low scientific impact. The author believes, however, that it is important that a mixed bag of both journal articles and conference presentations exist. The correlation between the two quantities is often strongly positive and the ScV is, thus, still a relevant figure-of-merit.

The proposed method could possibly be used when ranking the scientific outputs of researchers or research groups is needed. Much effort is often exerted by the hand of experts in their relevant field. ScV is easily calculated in Matlab and needs no field-specific expertise, which will economize on the means. The author thinks that a comparative study of ranking lists, of the above type, performed in the traditional way and by the proposed method would be of interest in the future.

V Conclusions

A figure-of-merit for quantifying a comparable scientific value ranking the output of a set researchers work is proposed. The method is based on the Garfield Factor (*GF*) and thus related to the expected number of citations rather than the real ones. This paper has pointed out in what way the new measure bridge over a set of limitations found in previous measures and it is concluded that the proposed measure complements those in an adequate way.

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[2] P. Vinkler, "Characterization of the impact of sets of scientific papers: the Garfield (impact) factor," *J. American Society for Information Science,* vol. 55, pp. 431-435, 2004.

[3] P. Vinkler, "Evaluation of the publication activity of research teams by means of scientometric indicators," *Current Science,* vol. 79, pp. 602-612, 2000.

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Appendix A

```
% scientvalue.m
%
% Magnus Isaksson, HiG, 2006-08-22
%
% F=scientvalue(A); The ratio, R, is defined to 2.
% F=scientvalue(A, R);
%
% Calculates the scientific value.
%
% Example: ScV = scientvalue([5 2 1.5 ; 1 1 0.8])
%           means two papers in total (number of rows in A). First paper
%           have 5 authors in total and the Author have place number 2
%           in the author list. The publishing journal has
%           "impact factor" 1.5 etc. The ratio is predefined to 2.
%
%           ScV = scientvalue([5 2 1.5 ; 1 1 0.8], 3)
%           The ratio is now equal to 3.
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%
% INPUT
%
% A                    Data of published papers. A is a (number of papers)x3
%                      matrix with columns:
%
%    ["number of authors"   "place in the author list"   "impact factor" ].
%
% R                    The scientific value ratio of the first and last
%                      author
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%
% OUTPUT
%
% ScV                       The scientific value
%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%


function ScV = scientvalue(A, varargin)

N = nargin;
if N > 1
    R = varargin{:};
end

if N == 1
    R = 2;
end
[a,b]=size(A);
c=[];

for k=1:a
    if A(k,1)==1
        c(k)=A(k,3);
    else
    c(k)=A(k,3)*(2*R*(A(k,1)-1)-2*(R-1)*(A(k,2)-1))/(A(k,1)*(A(k,1)-1)*(R+1));
    end
end
ScV = sum(c);
```

Appendix B

ITB/Electronics, UG, 2005–2007

Journal Articles in International Scientific Journals

2005

[1] C. Beckman and G. Smith, "Shared Networks: Making Wireless Communication Affordable," *Wireless Commun.*, Vol. 12, No. 2, pp. 78–85, Apr. 2005.

Full Journal Title	Publisher	ISSN	Subject Categories	Median GF	$\overline{GF}$	GF (05)	$GF/\overline{GF}$
IEEE WIRELESS COMMUNICATIONS	IEEE-INST ELECTRICAL ELECTRONICS ENGINEERS INC	1536-1284	COMPUTER SCIENCE, HARDWARE & ARCHITECTURE	0.694	0.713	2.638	3.664
			COMPUTER SCIENCE, INFORMATION SYSTEMS	0.830			
			ENGINEERING, ELECTRICAL & ELECTRONIC	0.720			
			TELECOMMUNICATIONS	0.607			

[2] M. Isaksson, D. Wisell, and D. Rönnow, "Wide-Band Dynamic Modeling of Power Amplifiers Using Radial-Basis Function Neural Networks," *IEEE Trans. Microwave Theory Tech.*, vol. 53, no. 11, pp. 3422-3428, Nov. 2005.

Full Journal Title	Publisher	ISSN	Subject Categories	Median GF	$\overline{GF}$	GF (05)	$GF/\overline{GF}$
IEEE TRANSACTIONS ON MICROWAVE THEORY AND TECHNIQUES	IEEE-INST ELECTRICAL ELECTRONICS ENGINEERS INC	0018-9480	ENGINEERING, ELECTRICAL & ELECTRONIC	0.720	0.720	2.275	3.160

2006

[3] M. Isaksson, D. Wisell, and D. Rönnow, "A Comparative Analysis of Behavioral Models for RF Power Amplifiers," *IEEE Trans. Microwave Theory Tech.*, vol. 54, no. 1, pp. 348-359, Jan. 2006.

Full Journal Title	Publisher	ISSN	Subject Categories	Median GF	$\overline{GF}$	GF (06)	$GF/\overline{GF}$
IEEE TRANSACTIONS ON MICROWAVE THEORY AND TECHNIQUES	IEEE-INST ELECTRICAL ELECTRONICS ENGINEERS INC	0018-9480	ENGINEERING, ELECTRICAL & ELECTRONIC	0.720	0.720	2.027	2.815

[4] D. Rönnow and M. Isaksson, "Digital predistortion of radio frequency power amplifiers using a Kautz-Volterra model," *Electron. Lett.*, vol. 42, no. 13, pp. 780-782, June 2006.

Full Journal Title	**Publisher**	**ISSN**	**Subject Categories**	**Median** GF	$\overline{GF}$	GF **(06)**	$GF/\overline{GF}$
ELECTRONICS LETTERS	INSTITUTION ENGINEERING TECHNOLOGY-IET	0013-5194	ENGINEERING, ELECTRICAL & ELECTRONIC	0.720	0.720	1.063	1.476

[5] H. Lundin, M. Skoglund, and P. Händel, "On the Estimation of Quantizer Reconstruction Levels," *IEEE Trans. Instrum. Meas.*, vol. 55, no. 6, pp. 2176-2182, Dec. 2006.

Full Journal Title	**Publisher**	**ISSN**	**Subject Categories**	**Median** GF	$\overline{GF}$	GF **(06)**	$GF/\overline{GF}$
IEEE TRANSACTIONS ON INSTRUMENTATIO N AND MEASUREMENT	IEEE-INST ELECTRICAL ELECTRONICS ENGINEERS INC	0018-9456	ENGINEERING, ELECTRICAL & ELECTRONIC	0.720	0.775	0.572	0.738
			INSTRUMENTS & INSTRUMENTATION	0.829			

2007

[6] P. Händel, "Power Spectral Density Error Analysis of Spectral Subtraction Type of Speech Enhancement Methods," *EURASIP Journal on Advances in Signal Processing*, vol. 2007, pp. Article ID 96384, 9, Jan. 2007.

Full Journal Title	**Publisher**	**ISSN**	**Subject Categories**	**Median** GF	$\overline{GF}$	GF **(06)**	$GF/\overline{GF}$
EURASIP JOURNAL ON APPLIED SIGNAL PROCESSING	HINDAWI PUBLISHING CORPORATION	1110-8657	ENGINEERING, ELECTRICAL & ELECTRONIC	0.720	0.720	0.463	0.643

[7] N. Björsell and P. Händel, "Truncated Gaussian noise in ADC histogram tests," *Measurement*, vol. 40, pp. 36-42, Jan. 2007.

Full Journal Title	**Publisher**	**ISSN**	**Subject Categories**	**Median** GF	$\overline{GF}$	GF **(06)**	$GF/\overline{GF}$
MEASUREMENT	ELSEVIER SCI LTD	0263-2241	ENGINEERING, ELECTRICAL & ELECTRONIC	0.720	0.775	0.525	0.677
			INSTRUMENTS & INSTRUMENTATION	0.829			

[8] M. Isaksson and D. Rönnow, "A Parameter-Reduced Volterra Model for Dynamic RF Power Amplifier Modeling based on Orthonormal Basis Functions," *Int. J. RF and Microwave Computer-Aided Eng.*, vol. 17, no. 6, pp. 542-551, Nov. 2007.

Full Journal Title	**Publisher**	**ISSN**	**Subject Categories**	**Median GF**	$\overline{GF}$	**GF (06)**	$GF/\overline{GF}$
INTERNATIONAL JOURNAL OF RF AND MICROWAVE COMPUTER-AIDED ENGINEERING	111 RIVER ST, HOBOKEN, NJ 07030	1096-4290	ENGINEERING, ELECTRICAL & ELECTRONIC	0.720	0.791	0.496	0.627
			COMPUTER SCIENCE, INTERDISCIPLINARY APPLICATIONS	0.862			

[9] D. Rönnow, D. Wisell, and M. Isaksson, "Three-Tone Characterization of Nonlinear Memory Effects in Radio Frequency Power Amplifiers," *IEEE Trans. Instrum. Meas.*, vol. 56, no. 6, pp. 2646-2657, Dec. 2007.

Full Journal Title	**Publisher**	**ISSN**	**Subject Categories**	**Median GF**	$\overline{GF}$	**GF (06)**	$GF/\overline{GF}$
IEEE TRANSACTIONS ON INSTRUMENTATIO N AND MEASUREMENT	IEEE-INST ELECTRICAL ELECTRONICS ENGINEERS INC	0018-9456	ENGINEERING, ELECTRICAL & ELECTRONIC	0.720	0.775	0.572	0.738
			INSTRUMENTS & INSTRUMENTATION	0.829			

[10] D. Wisell, D. Rönnow and P. Händel, "A Technique to Extend the Bandwidth of a Power Amplifier Test-bed," *IEEE Trans. Instrum. Meas.*, vol. 56, no. 4, pp. 1488-1494, Aug. 2007.

Full Journal Title	**Publisher**	**ISSN**	**Subject Categories**	**Median GF**	$\overline{GF}$	**GF (06)**	$GF/\overline{GF}$
IEEE TRANSACTIONS ON INSTRUMENTATIO N AND MEASUREMENT	IEEE-INST ELECTRICAL ELECTRONICS ENGINEERS INC	0018-9456	ENGINEERING, ELECTRICAL & ELECTRONIC	0.720	0.775	0.572	0.738
			INSTRUMENTS & INSTRUMENTATION	0.829			

[11] D. Wisell, B. Rudlund and D. Rönnow, "Characterization of Memory Effects in RF Power Amplifiers Using Digital Two-Tone Measurements," *IEEE Trans. Instrum. Meas.*, vol. 56, no. 6, pp. 2757-2766, Dec. 2007.

Full Journal Title	Publisher	ISSN	Subject Categories	Median GF	$\overline{GF}$	GF (06)	$GF/\overline{GF}$
IEEE TRANSACTIONS ON INSTRUMENTATION AND MEASUREMENT	IEEE-INST ELECTRICAL ELECTRONICS ENGINEERS INC	0018-9456	ENGINEERING, ELECTRICAL & ELECTRONIC	0.720	0.775	0.572	0.738
			INSTRUMENTS & INSTRUMENTATION	0.829			

[12] X. M. Feng, J. Olsson, M. Swanberg, J. Schnürer, and D. Rönnow, "Image analysis for monitoring the barley tempeh fermentation process," *J. Appl. Microbiol.*, vol. 103, no. 4, pp. 1113-1121, Oct. 2007.

Full Journal Title	Publisher	ISSN	Subject Categories	Median GF	$\overline{GF}$	GF (06)	$GF/\overline{GF}$
JOURNAL OF APPLIED MICROBIOLOGY	BLACKWELL PUBLISHING	1364-5072	BIOTECHNOLOGY & APPLIED MICROBIOLOGY	1.938	2.080	2.206	1.061
			MICROBIOLOGY	2.221			

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Full Journal Title	Publisher	ISSN	Subject Categories	Median GF	$\overline{GF}$	GF (06)	$GF/\overline{GF}$
NUCLEAR INSTRUMENTS & METHODS IN PHYSICS RESEARCH SECTION A-ACCELERATORS SPECTROMETERS DETECTORS AND ASSOCIATED EQUIPMENT	ELSEVIER SCIENCE BV	0168-9002	INSTRUMENTS & INSTRUMENTATION	0.829	1.139	1.185	1.040
			NUCLEAR SCIENCE & TECHNOLOGY	0.632			
			PHYSICS, PARTICLES & FIELDS	1.564			
			SPECTROSCOPY	1.532			

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Printed by Reproavdelningen at University of Gävle

ISSN 1403-8757

Published by:
Office for Education and Research
University of Gävle

January 2008

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OF GÄVLE

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