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NIFU Norwegian Institute for Studies in Research and Higher Education

Review of Research in *Mathematics* and *Information and Communication Technology* at Norwegian Universities and Colleges 2001/2002

Expenditure on Research and Experimental Development (R&D)
Academic Staff
Bibliometric Indicators

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Contents

1 Introduction

The following tables present data on R&D expenditure and research personnel in Mathematics and Information and Communication Technology at Norwegian universities and colleges. The Norwegian R&D Statistics is the source for the statistical data in chapter 2 and 3. Data refer to 1999. The following units[1] are included:

Mathematics

University[1]	Faculty	Department
University of Oslo	Faculty of Mathematics and Natural Sciences	Department of Mathematics
University of Bergen	Faculty of Mathematics and Natural Sciences	Department of Mathematics
Norwegian University of Science and Technology	Faculty of Physics, Mathematics and Informatics	Department of Mathematical Sciences
University of Tromsø	Faculty of Science	Department of Mathematics and Statistics
Agricultural University of Norway		Department of Mathematical Sciences
Norwegian School of Economics and Business Administration		Department of Finance and Management Sciences

1 Incl. Agricultural University of Norway and Norwegian Scool of Economics and Business Administration, usually classified as specialised university institutions.

Information and Communication Technology

University	Faculty	Department
University of Oslo	Faculty of Mathematics and Natural Sciences	Department of Informatics
University of Bergen	Faculty of Mathematics and Natural Sciences	Department of Informatics
	Faculty of Social Science	Department of Information Science
Norwegian University of Science and Technology	Faculty of Physics, Mathematics and Informatics	Department of Computer and Information Science
	Faculty of Electrical Engineering and Telecommunication	Department of Telematics
		Department of Telecommunications
		Department of Physical Electronics
		Department of Engineering Cybernetics
University of Tromsø	Faculty of Science	Department of Computer Science
Centre for Technology at Kjeller - UniK		

1 The list of units is set up by the Science and Technology Division at the Research Council of Norway.

Information and Communication Technology

University colleges		
Agder University College	Faculty of Engineering and Science Faculty of Economics and Social Sciences	
Østfold University College	Faculty of computer Science	
Stavanger University College	School of Science and Technology	Department of Electrical and Computer Engineering
Molde University College		Institute of Computer Science

2 R&D expenditure

R&D statistics[2] in Norway are produsced every second year on commission from the Research Council of Norway. The statistics are compiled in accordance with the international guidelines in the "Frascati Manual", issued by the OECD (*The measurement of Scientific and Technological Activities: Proposed Standard Practice for Surveys of Research and Development*).

Norwegian R&D statistics for 1999 were completed in January 2001. The figures in this presentation are based on the R&D statistics in the Higher Education Sector (HES).

2.1 Higher Education Sector – all fields of science and technology

In this short presentation of expenditure on R&D in *mathematics* and *information and communication technology* we have included some tables showing total expenditure in the HES, including R&D, teaching, administration and other activities[3] and for the departments selected. Total expenditure is based on the accounts for the institutions in this sector. However, some calculations have been made in order to prepare the accounts for R&D statistics according to the guidelines in the Frascati-Manual, and thus the figures will not be identical to the amounts in the institutions' accounts.

Some definitions of terms used in tables dealing with expenditure:

- *GUF*: General University Funds
- *Direct funding*: External sources; The Research Council of Norway, industry, private funds, funding from abroad etc.
- *Labour costs*: Includes salaries for personnel performing R&D, contribution to pension funds and other social security payments.
- *Direct current costs*: Expenditure directly related to the research personnel's daily work; non-capital purchases of materials, supplies and equipment to support R&D, participation at conferences, laboratory material etc.
- *Indirect current costs*: Water, fuel (maintenance of buildings), administrative and other overhead costs, as well as labour costs of persons providing indirect services for R&D.
- *Other current costs*: Sum of direct and indirect current costs.
- *Instruments and equipment:* Major instruments and equipment aquired for use in the performance of R&D. R&D share is estimated, based on scheduled use.

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2 The Norwegian Institute for Studies in Research and Higher Education, NIFU, is responsible for the statistics in the Higher Education Sector and the Institute Sector, while Statistics Norway does the statistics for the Industry Sector.

3 Also included in total expenditure are social costs, university hospitals, private funds.

- *Land and buildings:* New buildings constructed or purchased, where R&D is part of the acivity to take place in the building. R&D share is estimated, based on scheduled use.

Table 2.1 shows total expenditure for the higher education institutions in 1999 by type of cost and funding. General university funds (GUF) account for almost 90 per cent of the expenditure, and the main source of funding for GUF is the Ministry of Education, Research and Church Affairs. The figures on total expenditure include all activities (teaching, research and development, administration, supervison etc.) that took place at the institutions in 1999. Table 2.2 shows expenditure on R&D only, which amounts to 32 per cent of total expenditure and 25 per cent of GUF. The R&D share of direct funding is 85 per cent.

Table 2.1 Total expenditure in the Higher Education Sector in 1999 by main source of funding and type of cost. NOK million.

Funding	Total	Labour costs	Other current costs	Instruments and equipment	Land and buildings
GUF	15 926.5	7 498.1	6 072.4	174.5	2 181.5
Direct funding	2 113.2	1 137.3	841.0	134.9	-
• *of which the Research Council of Norway*	*829.0*	*501.8*	*240.0*	*87.2*	-
Total	18 039.7	8 635.4	6 913.4	309.4	2 181.5

Table 2.2 R&D expenditure in the Higher Education Sector in 1999 by main source of funding and type of cost. NOK million.

Funding	Total	Labour costs	Other current costs	Instruments and equipment	Land and buildings
GUF	4 035.0	1 729.2	1 525.9	92.5	687.4
Direct funding	1 784.4	1 008.5	652.7	123.2	-
• *of which the Research Council of Norway*	*753.7*	*457.9*	*213.9*	*81.8*	-
Total	5 819.4	2 737.7	2 178.6	215.7	687.4

Almost 80 per cent of total expenditure on R&D in 1999 was related to the universities, as seen in table 2.3, and specialised university institutions and university colleges had shares of 11 and 10 per cent of total R&D, respectively. The Research Council of Norway financed 42 per cent of direct funded R&D in the HES in 1999.

Table 2.3 R&D expenditure in the Higher Education Sector in 1999 by main source of funding and type of institution. NOK million.

Funding	Total	Universities	Specialised university institutions	University colleges
GUF	4 035.0	3 137.1	420.1	477.8
Direct funding	1 784.4	1 463.3	228.5	92.6
• *of which the Research Council of Norway*	*753.7*	*637.6*	*93.6*	*22.5*
Total	5 819.4	4 600.4	648.6	570.4

2.2 Mathematics

For the selected departments in mathematics tables 2.4 and 2.5 show figures for total expenditure and expenditure on R&D in 1999. Figure 2.2 illustrates the relation between total expenditure and expenditure for R&D. The R&D share of total expenditure is much higher in mathematics than for the HES as a whole; a little over 50 per cent compared to 32 per cent for the whole sector. Figure 2.1 shows that labour costs represent a 55 per cent share of total expenditure on R&D, while direct current costs have a share of 9 per cent.

Table 2.4 Total expenditure at university departments in *mathematics* in 1999 by main source of funding and type of cost. NOK million.

Funding	Total	Labour costs	Direct current costs	Indirect current costs	Instruments and equipment
GUF	185.8	110.9	10,6	60,9	3,4
Direct funding	24.2	15,6	7,4	-	1,2
• *of which the Research Council of Norway*	*15.4*	*10,9*	*3,7*	-	*0,9*
Total	210.0	126,5	18,0	60,9	4,6

Table 2.5 R&D expenditure at university departments in *mathematics* in 1999 by main source of funding and type of cost. NOK million.

Funding	Total	Labour costs	Direct current costs	Indirect current costs	Instruments and equipment
GUF	86.8	44.3	4.6	35.1	2.7
Direct funding	21.2	14.8	5,3	-	1.2
• *of which the Research Council of Norway*	*14.7*	*10.5*	*3,3*	-	*0.9*
Total	108.0	59.1	9,9	35,1	3.9

Figure 2.1 R&D expenditure at university departments in *mathematics* in 1999 by type of cost. Per cent.

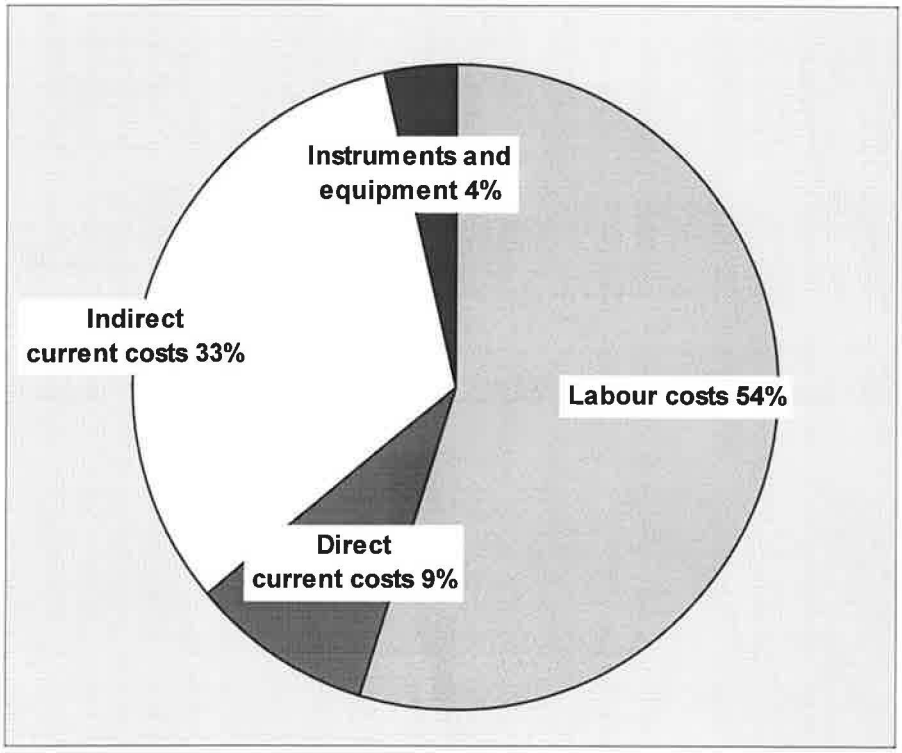
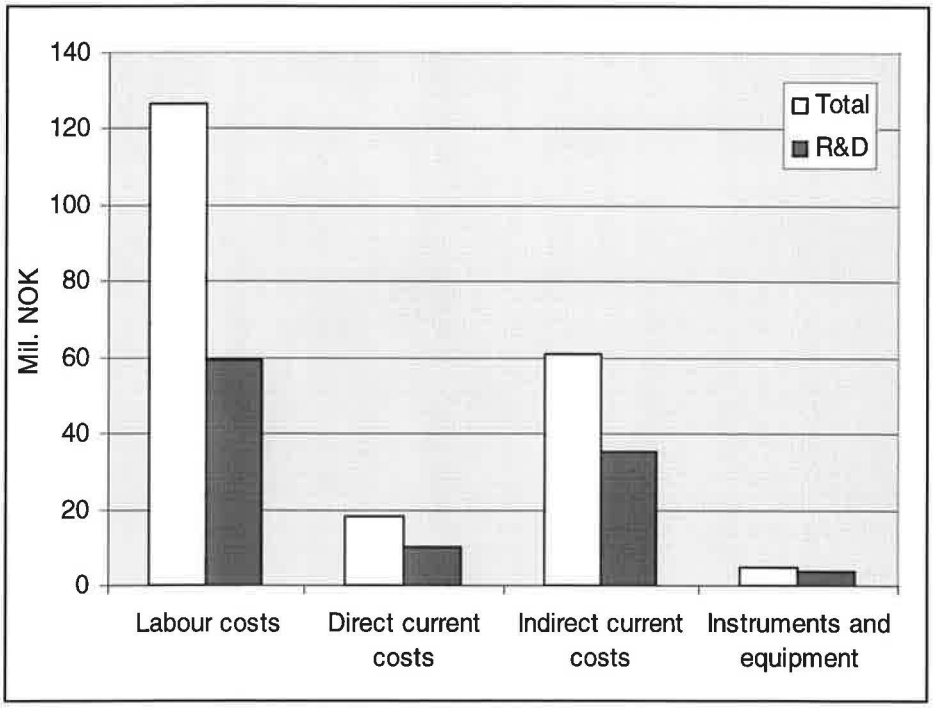
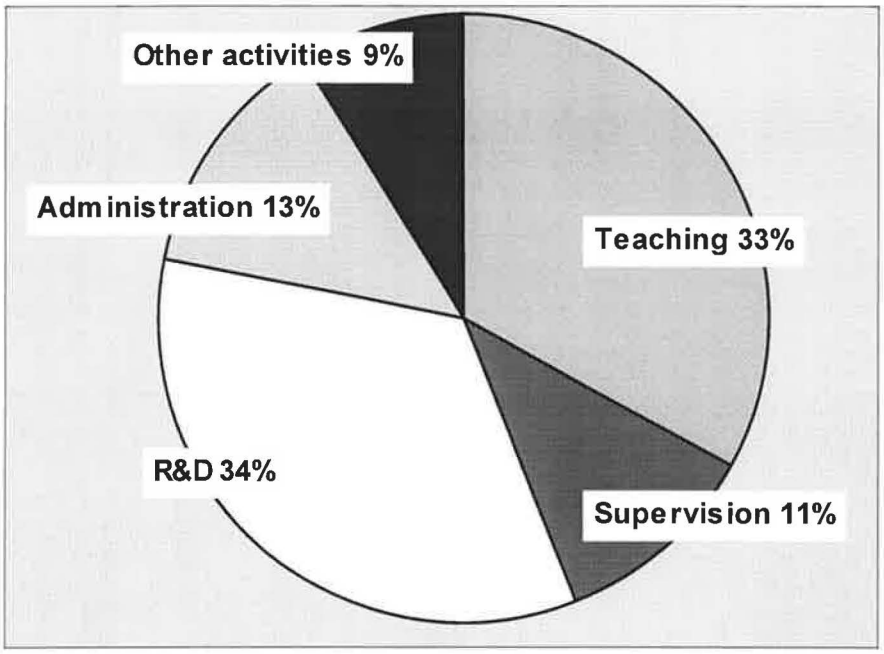


Figure 2.2 Total expenditure and expenditure on R&D at university departments in *mathematics* in 1999 by type of cost. NOK million.



The university survey[4] *on academic staff 2000* provides information on distribution of working time for tenured personnel at the four universities and the largest specialised university institutions. Figure 2.3 shows the results for the university departments in mathematics. The distribution is based on data from 75 persons at these departments.

Figure 2.3 Distribution of working time at university departments in *mathematics* in 1999 by type of activity. Per cent.



[4] Similar surveys have been conducted for the years 1981 and 1991. These surveys form the basis for calculation of the R&D share which is essential for estimation of R&D expenditure and FTE (full time equivalent) in R&D statistics in the HES. When compiling R&D statistics, R&D's relative shares of administration and supervision are included in the R&D share.

2.3 Information and Communication Technology

R&D statistical data in information and communication technology are in this review presented in two groups according to type of institution; universities and university colleges. Tables 2.6 and 2.7 show total expenditure and R&D expenditure at university departments, while tables 2.8 and 2.9 present similar data from departments at university colleges. However, for university colleges it is not possible to split other current costs into direct and indirect current costs.

In figures 2.4 and 2.7 R&D expenditure is distributed by type of cost for university departments and departments at university colleges, respectively. Figures 2.5 and 2.8, relating total expenditure to R&D expenditure, show that R&D is a much larger part of the activity at university than at the university colleges.

Table 2.6 Total expenditure at university departments in *information and communication technology* in 1999 by main source of funding and type of cost. NOK million.

Funding	Total	Labour costs	Direct current osts	Indirect current costs	Instruments and equipment
GUF	277.8	153.5	29.6	80.3	14.4
Direct funding	52.7	32.9	13.5	-	6.3
• *of which the Research Council of Norway*	*41.6*	*26.8*	*8,7*	-	*6.1*
Total	330.5	186.4	43.1	80,3	20.7

Table 2.7 R&D expenditure at university departments in *information and communication technology* in 1999 by main source of funding and type of cost. NOK million.

Funding	Total	Labour costs	Direct current costs	Indirect current costs	Instruments and equipment
GUF	112.8	60.4	11.4	33.4	7.6
Direct funding	47.1	29.1	11,7	-	6.3
• *of which the Research Council of Norway*	*37.0*	*23.6*	*7,3*	-	*6.1*
Total	159.9	89.5	23.1	33.4	13.9

Figure 2.4 R&D expenditure at university departments in *information and communication technology* in 1999 by type of cost. Per cent.

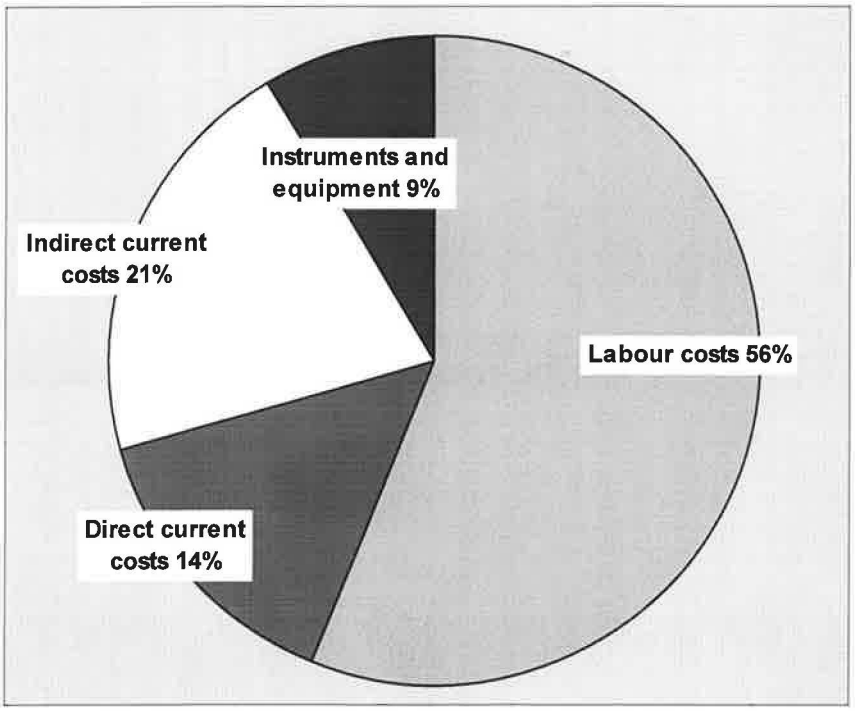


Figure 2.5 Total expenditure and expenditure on R&D at university departments in *information and communication technology* in 1999 by type of cost. NOK million.

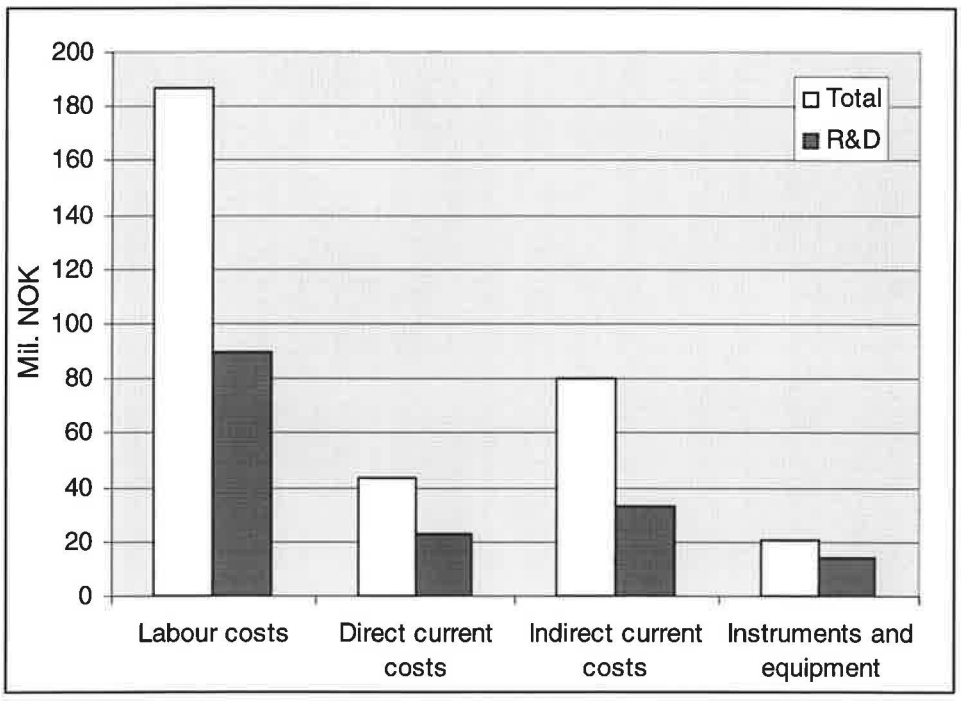


Figure 2.6 shows how tenured personnel in information and communication technology at university departments distributed their working time in 2000 (*University survey on academic staff*, see footnote 4). The results are based on data from 80 persons at these departments.

Figure 2.6 Distribution of working time at university departments in *information and communication technology* in 1999 by type of activity. Per cent.

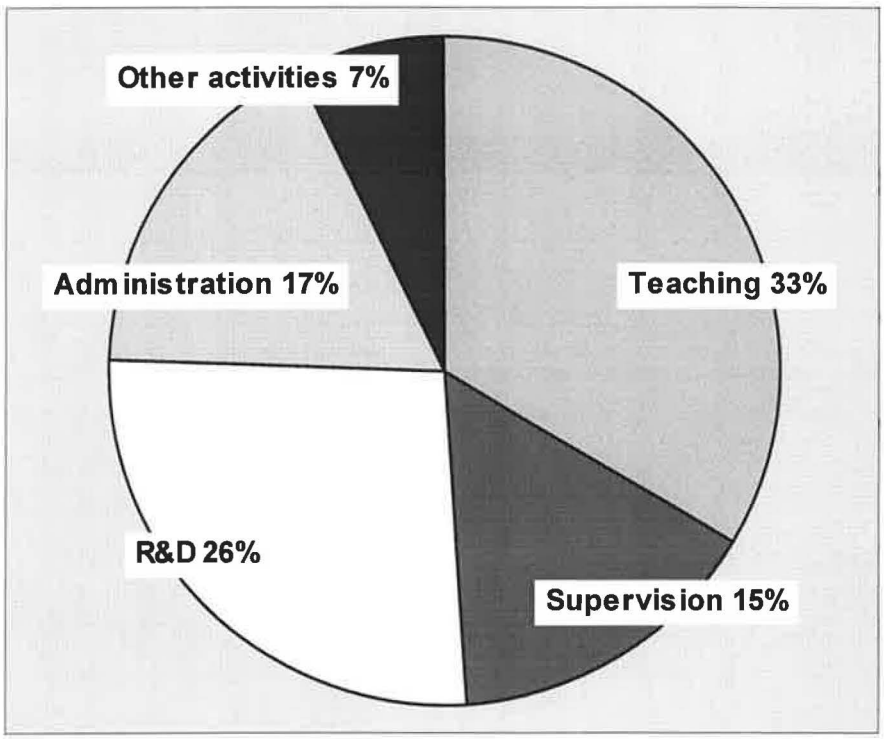


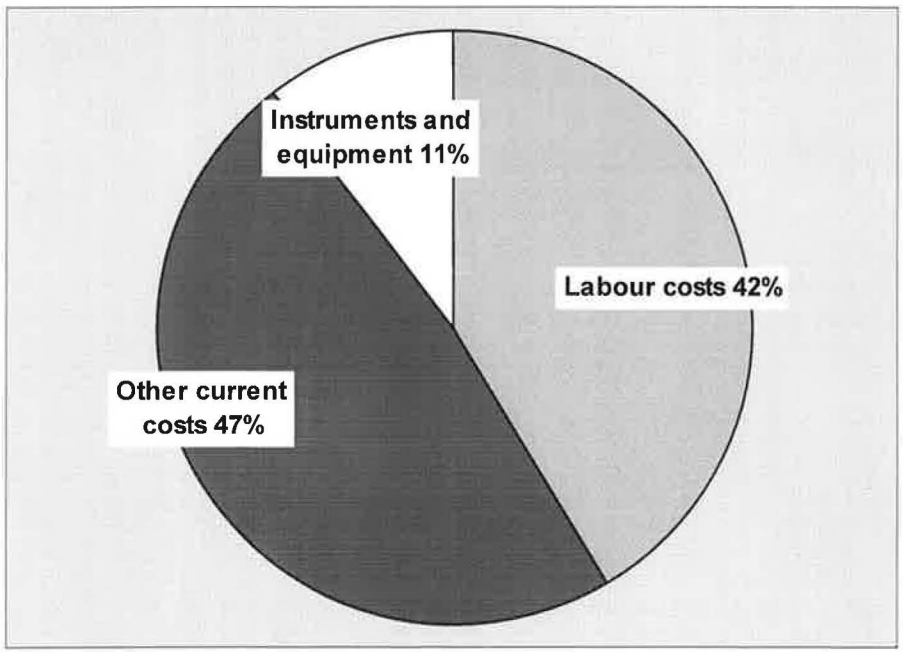
Table 2.8 Total expenditure at university colleges in *information and communication technology* in 1999 by main source of funding and type of cost. NOK million.

Funding	Total	Labour Costs	Other current costs	Instruments and equipment
GUF	305.4	160.3	137.5	7.6
Direct funding	9.6	5.6	3.6	0.4
• *of which the Research Council of Norway*	*3.2*	*1.5*	*0.7*	*1.0*
Total	315.0	165.9	141.1	8.0

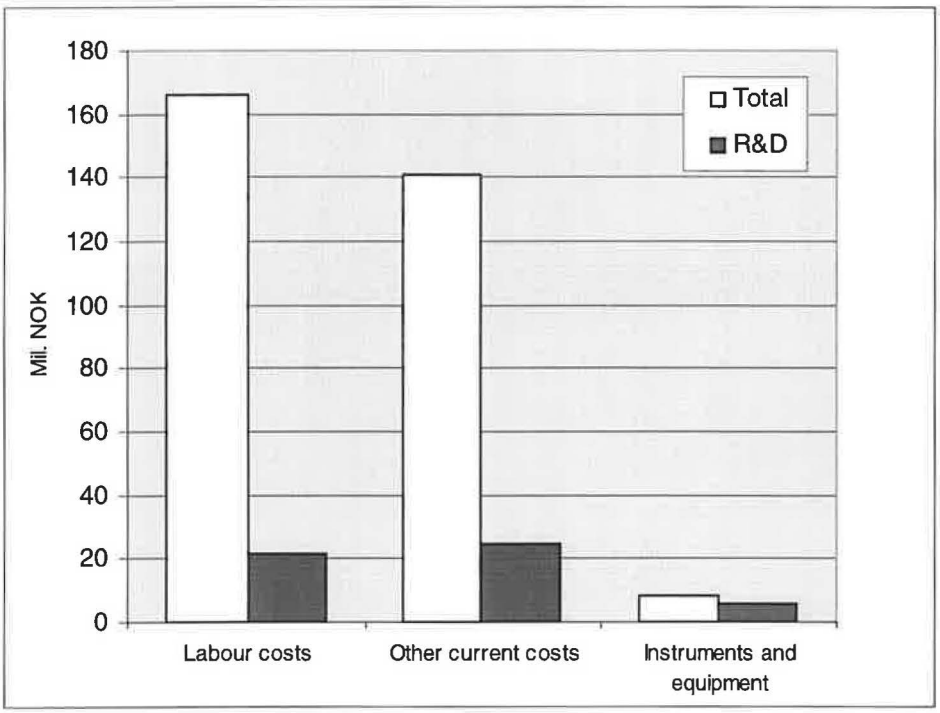
Table 2.9 R&D expenditure at university colleges in *information and communication technology* in 1999 by main source of funding and type of cost. NOK million.

Funding	Total	Labour costs	Other current costs	Instruments and equipment
GUF	44.5	18.1	22.1	4.3
Direct funding	7.3	3.4	2.7	1.2
• *of which the Research Council of Norway*	*2.8*	*1.3*	*0.6*	*0.9*
Total	51.8	21.5	24.8	5.5

Figure 2.7 R&D expenditure at university colleges in *information and communication technology* in 1999 by type of cost. Per cent.



Figur 2.8 Total expenditure and expenditure on R&D at university colleges in *information and communication technology* in 1999 by type of cost. NOK million.



3 R&D personnel

3.1 Higher Education Sector – all fields of science and technology

Table 3.1 shows the professional rank of the academic staff in the higher education sector in 1999, all fields of science and technology. Tenured personnel had a 63 per cent share of total academic staff for the sector as a whole; 44 per cent at the universities and as high as 95 per cent at the university colleges.

Table 3.1 Academic staff in the Higher Education Sector in 1999 by professional rank and type of institution. Number of persons and per cent women.

Position	Total		Universities		Specialised university institutions		University colleges	
	Number	Women %	Number	Women %	Number	Women %	Number	Women %
Full professor	2 155	12	1 727	12	301	9	127	7
College reader	58	12	-	-	1	-	57	12
Associate professor	2 675	26	1 396	29	393	23	886	22
Assistant professor	588	32	273	38	94	31	221	25
Senior lecturer	304	25	31	42	5	60	268	22
University/college lecturer	3 270	50	305	41	263	51	2 702	52
Total tenured personnel	9 050	32	3 732	23	1 057	27	4 261	40
Externally paid researchers[1]	1 045	38	812	38	163	34	70	45
Physicians at university hospitals	1 115	22	1 115	22	-	-	-	-
Recruitment personnel	3 154	42	2 646	42	357	44	151	38
Total	14 364	34	8 305	31	1 577	32	4 482	40

1 Includes post.doc. scholars.

3.2 Mathematics

As seen in table 3.2 the share of women in mathematics at university departments is low compared to the average share of women at the universities, only 7 per cent for tenured personnel, compared to 23 per cent for all fields of science.

Figure 3.1 shows distribution of age for tenured personnel in mathematics at university departments. For the 154 persons in tenured positions over 50 per cent were fifty years old or more. Table 3.3 shows age distribution by institution.

Table 3.2 Academic staff at university departments in *mathematics* by professional rank in 1999. Number of persons and per cent women.

Position	Number	% women
Full professor	81	4
Associate professor	68	9
Assistant professor	3	67
University/college lecturer	2	0
Total tenured personnel	154	7
Recruitment personnel	94	14
Externally paid researchers[1]	13	15
Total	261	10

1 Includes post.doc. scholars.

Figure 3.1 Age distribution for tenured personnel at university departments in *mathematics* in 1999. Total personnel and women.

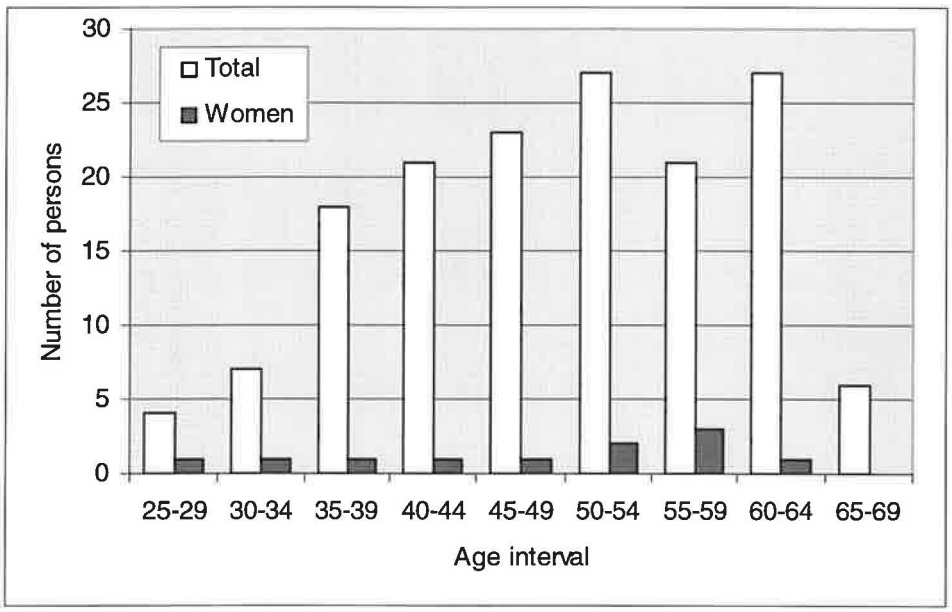


Table 3.3 Age distribution for tenured personnel in *mathematics* per institution and age interval in 1999. Number of persons.

Institution	Total	Age interval								
		25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69
University of Oslo	41	-	3	2	6	6	9	3	9	3
University of Bergen	24	-	1	2	3	2	1	6	9	-
Norwegian University of Science and Technology	42	2	2	9	3	6	7	8	3	2
University of Tromsø	14	2	-	1	4	3	2	1	1	-
Agricultural University of Norway	13	-	-	-	2	5	3	1	1	1
Norwegian School of Economics and Business Administration	20	-	1	4	3	1	5	2	4	-
Total	154	4	7	18	21	23	27	21	27	6

3.3 Information and Communication Technology

As in mathematics, the share of women among academic staff in information and communication technology is low, both at universities and university colleges (table 3.4). A total of 389 persons were employed in tenured positions in this field of science, 40 per cent at university departments and 60 per cent at university colleges. Age distribution for this staff is given in figures 3.2 and 3.3. Tenured personnel at the universities are younger than at university colleges as the share of persons over fifty is 36 and 53 per cent, respectively. Table 3.5 shows age distribution in information and communication technology by institution.

Table 3.4 Academic staff at departments at universities and university colleges in *information and communication technology,* by professional rank and type of institution in 1999. Number of persons and per cent women.

Position	Total		Universities		University colleges	
	Number	% women	Number	% women	Number	% women
Full professor	112	4	74	3	38	8
College reader	9	0	-	-	9	0
Associate professor	154	11	60	15	94	9
Assistant professor	52	17	16	19	36	17
Senior lecturer	13	0	1	0	12	0
University/college lecturer	49	24	7	29	42	24
Total tenured personnel	389	11	158	10	231	12
Recruitment personnel	209	17	183	14	26	11
Externally paid researchers[1]	19	26	16	31	3	0
Total	617	14	357	13	260	15

1 Includes post.doc. scholars.

Figure 3.2 Age distribution for tenured personnel at university departments in *information and communication technology* in 1999. Total personnel and women.

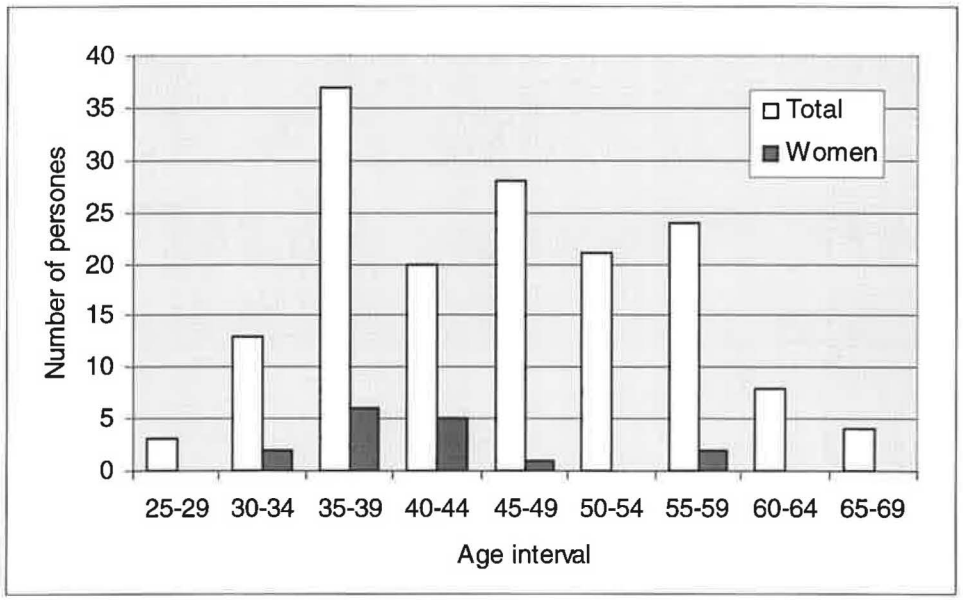


Figure 3.3 Age distribution for tenured personnel at university colleges in *information and communication technology* in 1999. Total personnel and women.

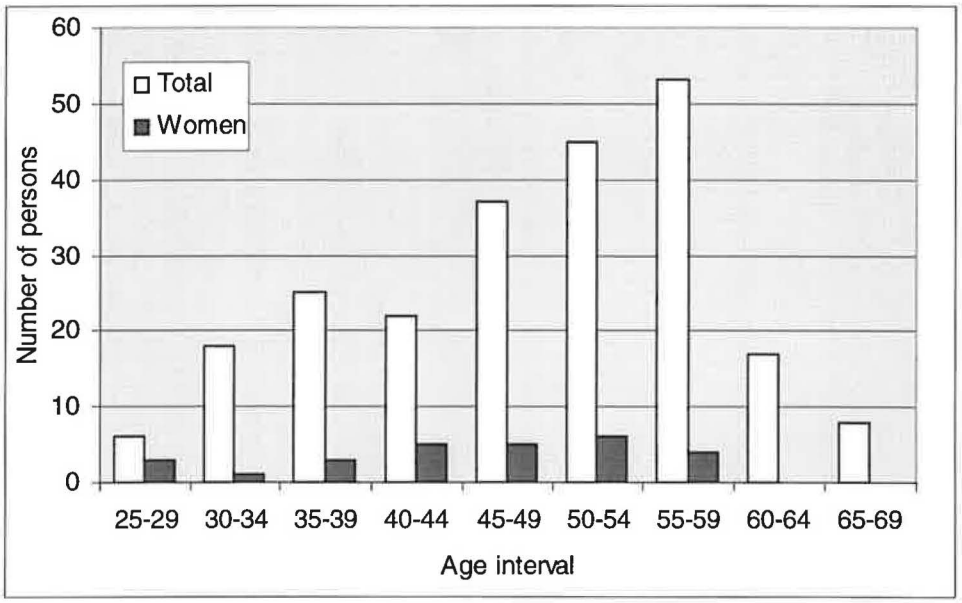


Table 3.5 Age distribution for tenured personnel in *information and communication technology* per institution and age interval in 1999. Number of persons.

Institution	Total	Age interval								
		25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69
University of Oslo[1]	39	-	1	8	7	11	7	3	-	2
University of Bergen	29	-	2	9	3	6	4	3	2	-
Norwegian University of Science and Technology	80	-	10	15	10	9	10	18	6	2
University of Tromsø	10	3	-	5	-	2	-	-	-	-
Agder University College	108	3	6	13	10	20	23	23	6	4
Østfold University College	19	1	3	1	4	2	3	4	1	-
Stavanger University College	85	2	7	7	7	13	18	19	8	4
Molde University College	19	-	2	4	1	2	1	7	2	-
Total	389	9	31	62	42	65	66	77	25	12

1 Incl. Centre for Technology at Kjeller – UniK.

4 Bibliometric indicators

Data for the evaluation of mathematics and information and communication technology

4.1 Introduction

In this section we will present bibliometric indicators for mathematics and information and communication technology. These indicators measure: 1) the extent of publishing in international scientific journals, and 2) the extent to which these papers have been referred to or cited in the subsequent scientific literature. Thus, the indicators can be used as an indirect measure of knowledge production and for assessing aspects related to scientific impact and international visibility. Within the framework of the study, it has only been possible to give a very short and aggregated overview of the scientific publishing in these fields. Furthermore, very few comments have been included.

4.2 Highlights

The overall picture emerging from the bibliometric analyses is that Norway has a relatively low scientific production in Mathematics and Information and Communication Technology: The number of articles measured per capita is lower than in the majority of the OECD countries and Norway contributes to a lower share of the world production in these fields than what is the average for Norway in other fields. Furthermore, in Information and Communication Technology the Norwegian articles are cited below the world average of the field. In Mathematics, however, the publications are cited above average.

4.2.1 International comparisons

- The annual global production of articles in Mathematics is approx. 12000 (articles in ISI-indexed international scientific and technical journals). In Computer science the total production is 4000 articles, while 3000 articles are being produced annually in Information technology and communications.
- In total, Norway accounts for 0.66% of the world's scientific production in the period 1996-2000. In Mathematics Norway accounts for 0.51% of the world production in the field. In Computer science the corresponding percentage is 0.31 and in Information technology and communications 0.40. Thus, in all these fields the relative production is lower than the average for Norway and the country has a "negative" specialisation in the fields.
- In terms of total number of publications per capita (1996-2000) Norway ranks as number 10 among 22 OECD countries. In comparison Norway ranks as number 13 in Mathematics, as number 19 in Computer science and as number 14 in

Information technology and communications. Thus, the production using this indicator is lower than it is in the majority of the OECD-countries.

4.2.2 Publication and citation indicators for Norway

In the analyses of publications and citation indicators for Norway (extended subject categories) we find:

- In Mathematics Norwegian researchers published 544 journal articles (excluding journal marginalia) during the 5-year period 1996-2000. The articles were distributed on 172 different journals.
- In Information and Communication Technology Norwegian scientists published 453 journal articles during the 5-year period 1996-2000. The articles were distributed on 144 different journals.
- The international impact and visibility as indicated by citations is higher than the world average in Mathematics, but lower than average in Information and Communication Technology. The information value of such indicators is, however, reduced because of a low general citation rate in these fields.
- Publications by Norwegian researchers are present in most of the journals with highest impact factors in both fields. However, most the production is distributed on a wider range of journals.
- In Mathematics 42% of the articles by Norwegian researchers (1996-2000) did also have authors from other countries. This is somewhat higher than the average for Norway (all fields), which is 39%. In Information and Communication Technology the percentage of international co-authorship is 34. Thus, international collaboration is widespread, particularly in Mathematics.

4.3 Data and methods

The analysis is based on data provided by Institute for Scientific Information (ISI). The database covers 16,000 specialised and multidisciplinary journals, including all influential peer reviewed journals in the natural sciences, medicine and technology (Testa 1997).
In general, the ISI database is regarded as constituting a satisfactory representation of international mainstream research (Katz and Hicks 1998). Thus, it allows the construction of comparable indicators on e.g. the scientific output, productivity and impact of a country.

In the study we have applied the database National Science Indicators (NSI), containing aggregated publication and citation counts for different scientific fields. The database counts articles, notes, reviews, and proceedings papers (but not other types of items such as editorials, abstracts etc.) in all journals indexed. An article is assigned to a particular country when it has at least on author address from this country. In addition we have applied the database National Citation Report (NCR) for Norway.

Bibliometric indicators have certain limitations that are important to consider when interpreting the results. Generally, the ISI-database is most suitable with respect to

academic research in which publication in international journals represents the main mode of communication. The coverage varies between different subjects. Highest coverage is obtained for physics, chemistry, biomedicine and clinical medicine. In mathematics and the information and communication technology in particular, the coverage is lower. Although all the main and important international research journals probably are included, many applied and less known journals are not. In addition, other types of output such as reports are important in these fields. In consequence, ISI-based bibliometric indicators can only give a partial picture of the publication activity in these fields.

In the analyses we have applied the three relevant predefined subject fields: Mathematics, Computer Science, and Information Technology & Communications. These categories are based on journal assignments, meaning that all publications in a particular journal are assigned to one (as a rule) subfield. The journals used as basis for each of these subjects are listed in the appendix.

The Mathematics category includes journals that cover pure mathematics, applied mathematics, statistics and probability. The Computer Science category includes journals on computer hardware and architecture, computer software, software engineering and design, computer graphics, programming languages, theoretical computing, computing methodologies, broad computing topics, and interdisciplinary computer applications. The Information Technology & Communications category includes journals on the technical aspects of information systems and information technology, including the acquisition, processing, storage, management, and dissemination of information. This category also covers literature on the technical aspects of communications via various devices and systems.

The basis for the citation indicators is the citations to former scientific publications, which can be identified from the reference lists of the research publications. Such data are systematically collected by ISI, and this makes it possible to conduct studies of citation patterns at aggregated levels. One standard indicator is the average number of citation received by a country's scientific papers. Although there are different opinions on the meaning and validity of citations as indicators, such indicators are generally considered as an indirect measure of the attention given a nation's research results by the international scientific community. Thus, they are used in order to assess aspects related to scientific impact and international visibility.

The average citation rate in mathematics and information and communication technology is, however, very low. Furthermore, the citation habit differs from many other scientific fields. Within a 5-year period an article in these fields have obtained an average of 3 citations, and more than 30% are being uncited. Thus, some researchers have argued that citation counts do not provide useful information in these fields and that conclusions regarding research performance cannot be drawn from citation counts. On the other hand, a validation study showed that in Mathematics expert's view on top publication and top

journals corresponded well with bibliometric indicators based on citation counts (Korevaar and Moed 1996). In any case precautions should be taken when interpreting the results.

4.4 International comparisons – scientific knowledge production

A standard indicator for the output of the public research system is the number of research articles in international scientific and technical journals.

In table 4.1 we have calculated the total scientific production for selected OECD countries (total all fields) for the 5-year period 1996-2000. We have also calculated the countries' shares of the total world production. To adjust for differences in population size, we have in addition calculated the number of articles per million capita. Of course, differences in population size may not necessarily correspond to differences in research efforts (e.g. amount invested on R&D). Because of methodological restraints, it is, however, difficult to produce proper indicators on input-output ratios.

Table 4.1 Scientific publishing. Number of articles in the period 1996-2000. TOTAL ALL FIELDS.

Country	Number of articles	Percentage of world production	Number of articles per mill. capita
Australia	98673	2.83	5262
Austria	31077	0.89	3847
Belgium	45640	1.31	4473
Canada	161541	4.64	5332
Denmark	35704	1.02	6733
Finland	33020	0.95	6408
France	221024	6.34	3659
Germany	302767	8.69	3691
Greece	20444	0.59	1945
Iceland	1396	0.04	5095
Ireland	11792	0.34	3183
Italy	140901	4.04	2447
Japan	326876	9.38	2584
Netherlands	89441	2.57	5697
New Zealand	20361	0.58	5355
Norway	**22902**	**0.66**	**5167**
Portugal	11879	0.34	1192
Spain	95843	2.75	2434
Sweden	70658	2.03	7983
Switzerland	64427	1.85	9036
UK	327379	9.39	5527
USA	1221435	35.05	4539

Source NIFU. Data ISI (NSI). Population: OECD (1998 figures)

In tables 4.2-4.4 we have presented similar indicators for Mathematics, Computer Science, and Information Technology & Communications. For these fields we have also calculated the relative citation index. This index is an indicator showing whether a country's articles are cited more or less than the world average (1.00). Thus, a value far below/above 1.00 indicates that the country's publications in this field have been cited far below/above what is the worldwide average.

Table 4.2 Scientific publishing. Number of articles in the period 1996-2000. MATHEMATICS.

Country	**Number of articles**	**Percentage of all papers in the field**	**Number of articles per mill. capita**	**Relative citation index***
Australia	1695	2.79	90	1.10
Austria	526	0.87	65	1.20
Belgium	768	1.26	75	1.44
Canada	3113	5.12	103	1.13
Denmark	469	0.77	88	1.31
Finland	380	0.63	74	1.06
France	7447	12.25	123	1.01
Germany	6056	9.96	74	1.06
Greece	444	0.73	42	0.75
Iceland	16	0.03	58	0.44
Ireland	268	0.44	72	0.89
Italy	3052	5.02	53	1.05
Japan	3196	5.26	25	0.78
Netherlands	1063	1.75	68	1.17
New Zealand	298	0.49	78	0.92
Norway	**311**	**0.51**	**70**	**1.16**
Portugal	297	0.49	30	1.04
Spain	2542	4.18	65	0.84
Sweden	796	1.31	90	0.99
Switzerland	757	1.25	106	1.15
UK	4157	6.84	70	1.24
USA	21539	35.43	80	1.28

Source NIFU. Data ISI (NSI). Population: OECD (1998 figures). *) Citations within the same 5-year period.

Table 4.3 Scientific publishing. Number of articles in the period 1996-2000. COMPUTER SCIENCE.

Country	**Number of articles**	**Percentage of all papers in the field**	**Number of articles per mill. capita**	**Relative citation index***
Australia	640	2.69	34	0.79
Austria	246	1.03	30	1.04
Belgium	284	1.19	28	1.14
Canada	1216	5.11	40	1.11
Denmark	187	0.79	35	1.18
Finland	201	0.84	39	1.10
France	1255	5.27	21	0.96
Germany	1758	7.39	21	0.98
Greece	265	1.11	25	0.65
Iceland	9	0.04	33	0.69
Ireland	76	0.32	21	0.52
Italy	1162	4.88	20	0.95
Japan	913	3.84	7	0.81
Netherlands	663	2.79	42	1.18
New Zealand	108	0.45	28	0.77
Norway	**73**	**0.31**	**16**	**0.95**
Portugal	88	0.37	9	0.85
Spain	463	1.95	12	0.73
Sweden	306	1.29	35	0.91
Switzerland	306	1.29	43	1.28
UK	1921	8.07	32	0.88
USA	10990	46.19	41	1.25

Source NIFU. Data ISI (NSI). Population: OECD (1998 figures). *) Citations within the same 5-year period.

Table 4.4 Scientific publishing. Number of articles in the period 1996-2000. INFORMATION TECHNOLOGY & COMMUNICATIONS.

Country	Number of articles	Percentage of all papers in the field	Number of articles per mill. capita	Relative citation index*
Australia	450	2.69	24	0.95
Austria	86	0.51	11	1.17
Belgium	229	1.37	22	0.93
Canada	781	4.67	26	1.15
Denmark	111	0.66	21	1.67
Finland	173	1.03	34	1.20
France	825	4.94	14	1.13
Germany	1136	6.80	14	0.88
Greece	202	1.21	19	0.76
Iceland	3	0.02	11	2.46
Ireland	54	0.32	15	0.44
Italy	873	5.22	15	1.30
Japan	2984	17.85	24	0.26
Netherlands	326	1.95	21	1.25
New Zealand	80	0.48	21	1.22
Norway	**67**	**0.40**	**15**	**1.13**
Portugal	30	0.18	3	1.12
Spain	189	1.13	5	0.79
Sweden	236	1.41	27	1.43
Switzerland	204	1.22	29	1.62
UK	1140	6.82	19	1.25
USA	5594	33.46	21	1.64

Source NIFU. Data ISI (NSI). Population: OECD (1998 figures). *) Citations within the same 5-year period.

4.5 Publication and citation indicators for Norway

In this part we present some additional publication and citation indicators for Norway. We have here used an extended journal set as basis for our analyses. That is, in comparison to the analyses above some additional journals are included in these analyses (see appendix for details). We have applied a classification system consisting of two broad categories: Mathematics and Information and Communication technology.

Firstly, we have analysed the journal distributions. We have identified the most important journals, that is, the journals that publish the most Norwegian articles for the 5-year period 1996-2000. Furthermore, we have calculated the journal impact factors. We have than listed the journals with highest impact factors and calculated the number of Norwegian publications in these journals.

The journal impact factor is an indicator of the mean citation rates for journals, calculated as the mean number of citations to the journal items published. The standard

SCI journal impact factor is calculated over 2-year period. In this study we have calculated the impact factors over a longer period, using publication counts for the period 1994-98 (counting citations up to 2000). This is more adequate in respect to the citation characteristics of the fields we are analysing. Although the journal impact factor is often used as an indicator of journal quality, this is not well founded. It is not within the scope of this presentation to discuss this issue, but the impact factor can more adequately be seen as a measure of the usage and utility potential of the articles being published in the journal. For example, in mathematics we find that the most highly cited journals are journals within applied mathematics and statistics (such journals may for example obtain citations from articles outside mathematics (e.g. biology)). Prestigious journals within pure mathematics may, on the other hand, not appear high on the list.

Table 4.5 Journal rankings. Journals with highest number of Norwegian articles, total 1996-2000.

Mathematics			Information and Communication Technology		
Journal	**Journal impact factor***	**Number of Norw. articles****	**Journal**	**Journal impact factor***	**Number of Norw. articles****
JOURNAL OF COMPUTATIONAL AND APPLIED MATHEMATICS	1.8	19	LECTURE NOTES IN COMPUTER SCIENCE	1.0	75
ANNALS OF OPERATIONS RESEARCH	1.4	17	IEEE TRANSACTIONS ON INFORMATION THEORY	6.2	23
SCANDINAVIAN JOURNAL OF STATISTICS	2.6	17	KLUWER INTERNATIONAL SERIES IN ENGINEERING AND COMPUTER SCIENCE	0.1	21
BIT	2.7	16	ELECTRONICS LETTERS	4.1	17
JOURNAL OF FUNCTIONAL ANALYSIS	3.9	12	INTERNATIONAL FEDERATION FOR INFORMATION PROCESSING	-	14
SIAM JOURNAL ON SCIENTIFIC COMPUTING	5.2	11	IEEE TRANSACTIONS ON GEOSCIENCE AND REMOTE SENSING	6.5	10
MATHEMATICA SCANDINAVICA	1.0	11	IEEE TRANSACTIONS ON POWER DELIVERY	1.7	9
DISCRETE MATHEMATICS	1.1	11	ANALOG INTEGRATED CIRCUITS AND SIGNAL PROCESSING	1.8	9
NUMERICAL ALGORITHMS	1.5	9	RADIO SCIENCE	4.0	8
MATHEMATICS OF COMPUTATION	3.6	9	FRONTIERS IN ARTIFICIAL INTELLIGENCE AND APPLICATIONS	-	7
JOURNAL OF PURE AND APPLIED ALGEBRA	1.9	9	TELETRAFFIC SCIENCE AND ENGINEERING	-	7
JOURNAL OF MATHEMATICAL ANALYSIS AND APPLICATIONS	1.8	9	NATO ADVANCED SCIENCE INSTITUTE SERIES, SUB-SERIES 3, HIGH TECH	0.3	7
ACTA APPLICANDAE MATHEMATICAE	1.7	9	LECTURE NOTES IN ARTIFICIAL INTELLIGENCE	0.9	7
MATCH-COMMUNICATIONS IN MATHEMATICAL AND IN COMPUTER CHEMISTRY	-	8	LECTURE NOTES IN CONTROL AND INFORMATION SCIENCES	0.2	6
PROCEEDINGS OF THE AMERICAN MATHEMATICAL SOCIETY	1.4	8	COMPUTER COMMUNICATIONS	0.8	5
JOURNAL FUR DIE REINE UND ANGEWANDTE MATHEMATIK	3	8	IEEE TRANSACTIONS ON ELECTRON DEVICES	6.1	5
PROGRESS IN PROBABILITY	-	8	IEEE TRANSACTIONS ON POWER SYSTEMS	2.4	5
SIAM JOURNAL ON NUMERICAL ANALYSIS	5.2	8	IEEE TRANSACTIONS ON DIELECTRICS AND ELECTRICAL INSULATION	3.1	5
BIOMETRIKA	7.2	7			
STOCHASTIC PROCESSES AND THEIR APPLICATIONS	2.0	7			
JOURNAL OF ALGEBRA	2.0	7			
K-THEORY	1.5	6			
NUMERISCHE MATHEMATIK	4.4	6			
POTENTIAL ANALYSIS	1.9	6			
COMPUTATIONAL STATISTICS & DATA ANALYSIS	1.4	6			

Source NIFU. Data ISI (NCR). *) Based on publication counts for the period 1994-98 (counting citations up to 2000). **) Counting articles, notes, reviews, and proceedings papers, but not marginalia as editorials etc.

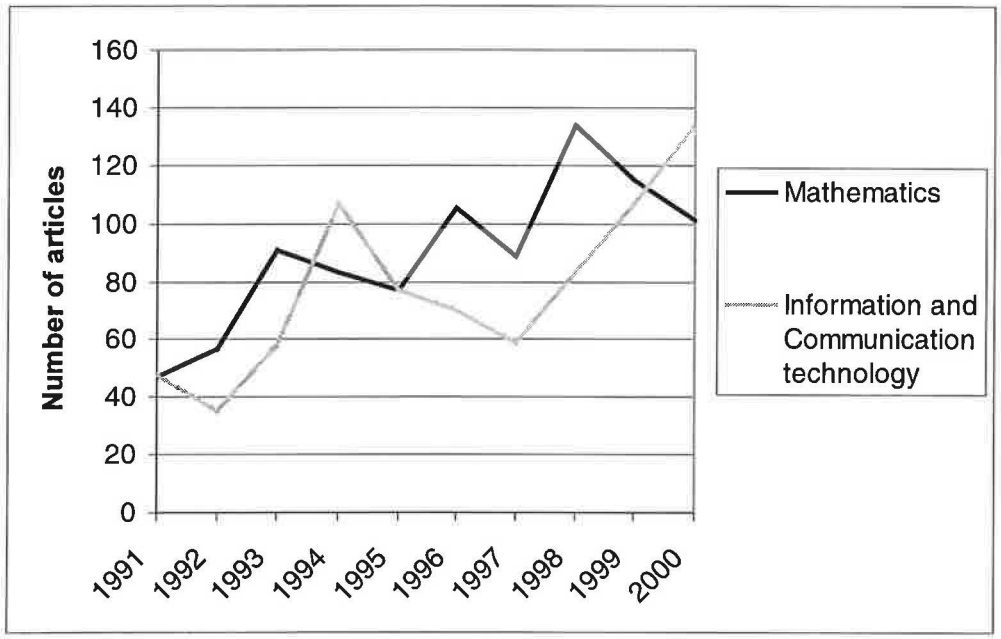
Table 4.6 Journal rankings. The distribution of Norwegian articles in the journals with highest impact factors, total 1996-2000.

Mathematics				Information and Communication Technology			
Journal	Journal impact factor*	Num. of art.**	Num. of Norw. art.**	Journal	Journal impact factor*	Num. of art.**	Num. of Norw. art.**
JOURNAL OF THE ROYAL STATISTICAL SOCIETY SERIES B-STATISTICAL M	10.6	250	1	PROCEEDINGS OF THE IEEE	10.15	548	1
ANNALS OF MATHEMATICS	8.7	219	0	JOURNAL OF THE ACM	8.11	153	1
JOURNAL OF THE AMERICAN STATISTICAL ASSOCIATION	8.6	727	3	IEEE JOURNAL OF SELECTED TOPICS IN QUANTUM ELECTRONICS	7.98	693	2
STATISTICAL SCIENCE	7.9	105	0	IEEE TRANSACTIONS ON IMAGE PROCESSING	7.46	671	0
ANNALS OF STATISTICS	7.5	533	2	IEEE TRANSACTIONS ON CIRCUITS AND SYSTEMS FOR VIDEO TECHNOLOGY	7.45	514	1
BIOMETRIKA	7.2	422	7	IEEE JOURNAL OF QUANTUM ELECTRONICS	7.29	1204	3
ACTA MATHEMATICA	7.2	80	1	IEEE JOURNAL ON SELECTED AREAS IN COMMUNICATIONS	7.22	790	3
COMMUNICATIONS ON PURE AND APPLIED MATHEMATICS	6.7	235	0	ACM TRANSACTIONS ON GRAPHICS	6.57	69	0
SIAM JOURNAL ON OPTIMIZATION	6.6	333	1	IEEE TRANSACTIONS ON GEOSCIENCE AND REMOTE SENSING	6.45	1002	10
BULLETIN OF THE AMERICAN MATHEMATICAL SOCIETY	6.4	50	0	IEEE TRANSACTIONS ON INFORMATION THEORY	6.17	938	23
APPLIED AND COMPUTATIONAL HARMONIC ANALYSIS	6.3	117	4	COMMUNICATIONS OF THE ACM	6.14	727	3
JOURNAL OF THE AMERICAN MATHEMATICAL SOCIETY	5.8	175	2	IEEE TRANSACTIONS ON SIGNAL PROCESSING	6.12	1459	2
INVENTIONES MATHEMATICAE	5.6	414	1	IEEE TRANSACTIONS ON ELECTRON DEVICES	6.07	1746	5
NONLINEARITY	5.5	472	2	ACM TRANSACTIONS ON INFORMATION SYSTEMS	5.81	68	0
MATHEMATICAL PROGRAMMING	5.5	425	3	ACM TRANSACTIONS ON PROGRAMMING LANGUAGES AND SYSTEMS	5.72	151	0
INTERNATIONAL JOURNAL FOR NUMERICAL METHODS IN ENGINEERING	5.3	1157	5	IEEE TRANSACTIONS ON SOFTWARE ENGINEERING	5.60	314	1
SIAM REVIEW	5.2	196	1	IBM JOURNAL OF RESEARCH AND DEVELOPMENT	5.19	224	0
SIAM JOURNAL ON SCIENTIFIC COMPUTING	5.2	599	11	IEEE JOURNAL OF SOLID-STATE CIRCUITS	4.58	1270	2
SIAM JOURNAL ON NUMERICAL ANALYSIS	5.2	604	8	IEEE TRANSACTIONS ON ANTENNAS AND PROPAGATION	4.52	1050	2
TECHNOMETRICS	5.2	139	0	COMPUTER-AIDED DESIGN	4.49	408	0
OPERATIONS RESEARCH	5.0	413	4	IEEE TRANSACTIONS ON MICROWAVE THEORY AND TECHNIQUES	4.43	1805	2
MATHEMATICS OF OPERATIONS RESEARCH	4.8	243	0	ACM TRANSACTIONS ON MATHEMATICAL SOFTWARE	4.31	143	3
SIAM JOURNAL ON CONTROL AND OPTIMIZATION	4.5	526	2	IEEE TRANSACTIONS ON COMMUNICATIONS	4.23	1185	4
NUMERISCHE MATHEMATIK	4.4	388	6	IEEE TRANSACTIONS ON VEHICULAR TECHNOLOGY	4.15	652	0
ADVANCES IN MATHEMATICS	4.1	377	1	JOURNAL OF CRYPTOLOGY	4.10	82	1

Source NIFU. Data ISI (NCR). *) Based on publication counts for the period 1994-98 (counting citations up to 2000). **) Counting articles, notes, reviews, and proceedings papers, but not marginalia as editorials etc.

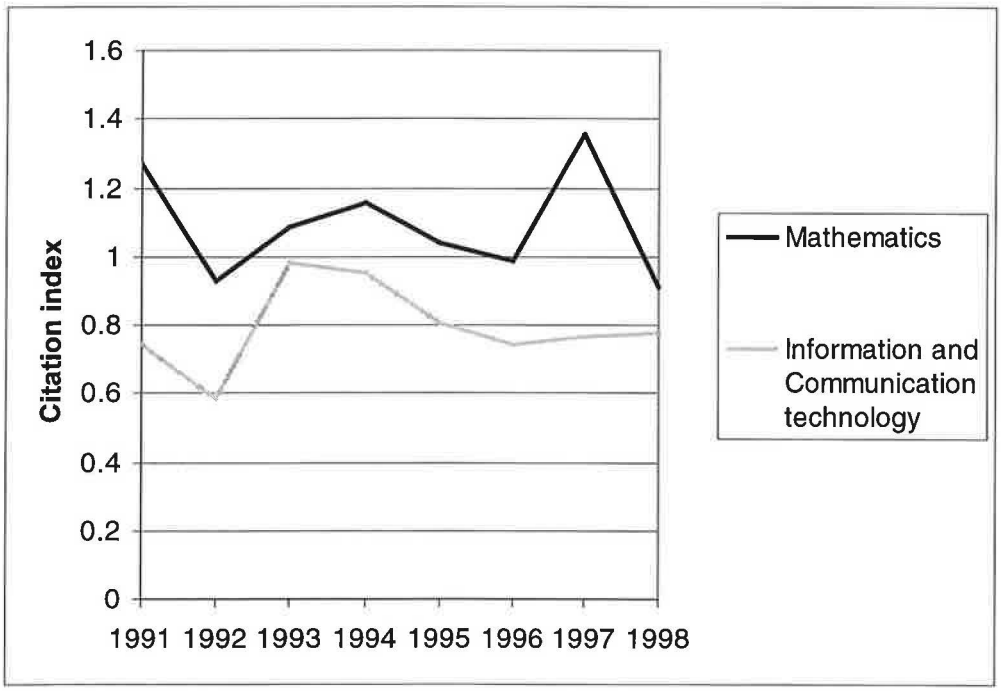
In figure 4.1 we have analysed the annual production of Norwegian papers in Mathematics and Information and Communication Technology. In figure 4.2 the annual relative citation index has been calculated for these fields.

Figure 4.1 Scientific publishing, Norway, 1991-2000.



Source NIFU. Data ISI (NCR). (Counting articles, notes, reviews, and proceedings papers, but not marginalia as editorials etc.)

Figure 4.2 Relative citation index, Norway, 1991-98.



Source NIFU. Data ISI (NCR). (Counting articles, notes, reviews, and proceedings papers, but not marginalia as editorials etc., counting citations up to 2000)

4.6 Scientific co-operation

When researchers from different countries jointly produce a scientific article, this reflects the involvement international collaboration. In this way, international co-authorships may be applied as an indicator of international scientific co-operation – particularly reflecting the collaborative structures of academic research (see e.g. Melin and Persson 1996).

There has been a significant increase in the number of internationally co-authored papers the last decades. Norway is no exception in this respect. Table 4.7 shows the collaboration patterns for Norway in Mathematics and Information and Communication Technology. The United States is the most important country of collaboration in both fields, reflecting the dominating role of this nation on the scientific arena. In Mathematics 13% of the "Norwegian articles" had co-authors from this country.

Table 4.7 International co-authorships in "Norwegian" articles, 1996-2000. Most important countries.

Mathematics		Information and Communication Technology	
Country	**% of co-authored articles**	**Country**	**% of co-authored articles**
US	13%	US	9%
GERMANY	7%	UK	6%
UK	4%	FRANCE	5%
SPAIN	3%	SWEDEN	3%
FRANCE	3%	GERMANY	3%
DENMARK	2%	BELGIUM	2%
ITALY	2%	ITALY	2%
SWEDEN	2%	SWITZERLAND	2%
UKRAINE	2%	FINLAND	1%
NETHERLANDS	2%	DENMARK	1%

Source NIFU. Data ISI (NCR).

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Appendix – List of journals

Mathematics (167 journals)

ACTA APPLICANDAE MATHEMATICAE

ACTA ARITHMETICA

ACTA MATHEMATICA

ACTA MATHEMATICA SINICA-ENGLISH SERIES

ADVANCES IN APPLIED MATHEMATICS

ADVANCES IN APPLIED PROBABILITY

ADVANCES IN MATHEMATICS

AMERICAN JOURNAL OF MATHEMATICS

AMERICAN MATHEMATICAL MONTHLY

AMERICAN STATISTICIAN

ANNALS OF APPLIED PROBABILITY

ANNALES DE L INSTITUT FOURIER

ANNALES DE L INSTITUT HENRI POINCARE-ANALYSE NON LINEAIRE

ANNALES DE L INSTITUT HENRI POINCARE-PROBABILITES ET STATISTIQUES

ANNALS OF MATHEMATICS

ANNALS OF PROBABILITY

ANNALS OF PURE AND APPLIED LOGIC

ANNALES SCIENTIFIQUES DE L ECOLE NORMALE SUPERIEURE

ANNALS OF STATISTICS

ANZIAM JOURNAL

APPLIED AND COMPUTATIONAL HARMONIC ANALYSIS

APPLIED MATHEMATICS LETTERS

APPLIED MATHEMATICS AND OPTIMIZATION

APPLIED NUMERICAL MATHEMATICS

ARCHIV DER MATHEMATIK

ARCHIVE FOR MATHEMATICAL LOGIC

ARCHIVE FOR RATIONAL MECHANICS AND ANALYSIS

BULLETIN OF THE AMERICAN MATHEMATICAL SOCIETY

BULLETIN OF THE BELGIAN MATHEMATICAL SOCIETY-SIMON STEVIN

BULLETIN OF THE LONDON MATHEMATICAL SOCIETY

BULLETIN DES SCIENCES MATHEMATIQUES

BERNOULLI

BIOMETRIKA

CALCULUS OF VARIATIONS AND PARTIAL DIFFERENTIAL EQUATIONS

CANADIAN JOURNAL OF MATHEMATICS-JOURNAL CANADIEN DE MATHEMATIQUES

COMMUNICATIONS ON PURE AND APPLIED MATHEMATICS

COMBINATORICA

COMMUNICATIONS IN ALGEBRA

COMMENTARII MATHEMATICI HELVETICI

COMMUNICATIONS IN PARTIAL DIFFERENTIAL EQUATIONS

COMMUNICATIONS IN ANALYSIS AND GEOMETRY

COMMUNICATIONS IN CONTEMPORARY MATHEMATICS

COMPOSITIO MATHEMATICA

CONSTRUCTIVE APPROXIMATION

COMPTES RENDUS DE L ACADEMIE DES SCIENCES SERIE I-MATHEMATIQUE

DISCRETE AND CONTINUOUS DYNAMICAL SYSTEMS

DOKLADY MATHEMATICS

DUKE MATHEMATICAL JOURNAL

ELECTRONIC RESEARCH ANNOUNCEMENTS OF THE AMERICAN MATHEMATICAL SOCIETY

ERGODIC THEORY AND DYNAMICAL SYSTEMS

ESAIM-MATHEMATICAL MODELLING AND NUMERICAL ANALYSIS-MODELISATION MATHEMATIQUE ET ANALYSE NUMERIQUE

EUROPEAN JOURNAL OF APPLIED MATHEMATICS

EXPERIMENTAL MATHEMATICS

FINITE FIELDS AND THEIR APPLICATIONS

FORUM MATHEMATICUM

GEOMETRIC AND FUNCTIONAL ANALYSIS

ILLINOIS JOURNAL OF MATHEMATICS

IMA JOURNAL OF APPLIED MATHEMATICS

IMA JOURNAL OF NUMERICAL ANALYSIS

INDIANA UNIVERSITY MATHEMATICS JOURNAL

INFINITE DIMENSIONAL ANALYSIS QUANTUM PROBABILITY AND RELATED TOPICS

INTERNATIONAL JOURNAL OF MATHEMATICS

INTERNATIONAL MATHEMATICS RESEARCH NOTICES

INTERNATIONAL STATISTICAL REVIEW

INTEGRAL EQUATIONS AND OPERATOR THEORY

INVENTIONES MATHEMATICAE

ISRAEL JOURNAL OF MATHEMATICS

JOURNAL OF ALGEBRAIC GEOMETRY

JOURNAL OF ALGEBRA

JOURNAL OF THE AMERICAN MATHEMATICAL SOCIETY

JOURNAL OF THE AMERICAN STATISTICAL ASSOCIATION

JOURNAL OF APPLIED PROBABILITY

JOURNAL OF APPROXIMATION THEORY

JOURNAL OF THE AUSTRALIAN MATHEMATICAL SOCIETY SERIES A-PURE MATHEMATICS AND STATISTICS

JOURNAL OF COMBINATORIAL OPTIMIZATION

JOURNAL OF COMBINATORIAL THEORY SERIES A

JOURNAL OF COMBINATORIAL THEORY SERIES B

JOURNAL OF COMPUTATIONAL AND GRAPHICAL STATISTICS

JOURNAL OF CONVEX ANALYSIS

JOURNAL OF DIFFERENCE EQUATIONS AND APPLICATIONS

JOURNAL OF DIFFERENTIAL EQUATIONS

JOURNAL OF DIFFERENTIAL GEOMETRY

JOURNAL OF FOURIER ANALYSIS AND APPLICATIONS

JOURNAL OF FUNCTIONAL ANALYSIS

JOURNAL OF GEOMETRY AND PHYSICS

JOURNAL OF GRAPH THEORY

JOURNAL OF GROUP THEORY

JOURNAL OF INEQUALITIES AND APPLICATIONS

JOURNAL OF KNOT THEORY AND ITS RAMIFICATIONS

JOURNAL OF THE LONDON MATHEMATICAL SOCIETY-SECOND SERIES

JOURNAL OF MATHEMATICAL ANALYSIS AND APPLICATIONS

JOURNAL OF THE MATHEMATICAL SOCIETY OF JAPAN

JOURNAL DE MATHEMATIQUES PURES ET APPLIQUEES

JOURNAL OF MULTIVARIATE ANALYSIS

JOURNAL OF NONLINEAR SCIENCE

JOURNAL OF NONPARAMETRIC STATISTICS

JOURNAL OF NUMBER THEORY
JOURNAL OF OPERATOR THEORY
JOURNAL OF PURE AND APPLIED ALGEBRA
JOURNAL FUR DIE REINE UND ANGEWANDTE MATHEMATIK
JOURNAL OF THE ROYAL STATISTICAL SOCIETY SERIES B-STATISTICAL METHODOLOGY
JOURNAL OF THE ROYAL STATISTICAL SOCIETY SERIES C-APPLIED STATISTICS
JOURNAL OF SYMBOLIC LOGIC
JOURNAL OF THEORETICAL PROBABILITY

JAPAN JOURNAL OF INDUSTRIAL AND APPLIED MATHEMATICS
LINEAR ALGEBRA AND ITS APPLICATIONS
LINEAR & MULTILINEAR ALGEBRA
MANUSCRIPTA MATHEMATICA
MATHEMATISCHE ANNALEN
MATHEMATICS OF COMPUTATION
MATHEMATICAL INTELLIGENCER
MATHEMATICAL METHODS IN THE APPLIED SCIENCES
MATHEMATICAL MODELS & METHODS IN APPLIED SCIENCES
MATHEMATISCHE NACHRICHTEN
MATHEMATICS OF OPERATIONS RESEARCH
MATHEMATICAL PROCEEDINGS OF THE CAMBRIDGE PHILOSOPHICAL SOCIETY
MATHEMATICAL PROGRAMMING
MATHEMATICAL RESEARCH LETTERS
MATHEMATISCHE ZEITSCHRIFT
MATHEMATIKA
MEMOIRS OF THE AMERICAN MATHEMATICAL SOCIETY
MICHIGAN MATHEMATICAL JOURNAL
MONATSHEFTE FUR MATHEMATIK
NAGOYA MATHEMATICAL JOURNAL
NONLINEAR ANALYSIS-THEORY METHODS & APPLICATIONS
NONLINEARITY
NUMERICAL LINEAR ALGEBRA WITH APPLICATIONS
NUMERISCHE MATHEMATIK
PROCEEDINGS OF THE AMERICAN MATHEMATICAL SOCIETY
PROCEEDINGS OF THE EDINBURGH MATHEMATICAL SOCIETY
PROCEEDINGS OF THE LONDON MATHEMATICAL SOCIETY
PROCEEDINGS OF THE ROYAL SOCIETY OF EDINBURGH SECTION A-MATHEMATICS
PACIFIC JOURNAL OF MATHEMATICS
POSITIVITY
POTENTIAL ANALYSIS
PROBABILITY THEORY AND RELATED FIELDS
QUARTERLY JOURNAL OF MATHEMATICS
ROCKY MOUNTAIN JOURNAL OF MATHEMATICS
RAMANUJAN JOURNAL
RANDOM STRUCTURES & ALGORITHMS
REVISTA MATEMATICA IBEROAMERICANA
RUSSIAN MATHEMATICAL SURVEYS
SBORNIK MATHEMATICS
SCANDINAVIAN JOURNAL OF STATISTICS
SIAM JOURNAL ON APPLIED MATHEMATICS
SIAM JOURNAL ON CONTROL AND OPTIMIZATION
SIAM JOURNAL ON MATHEMATICAL ANALYSIS
SIAM JOURNAL ON MATRIX ANALYSIS AND APPLICATIONS
SIAM JOURNAL ON NUMERICAL ANALYSIS
SIAM JOURNAL ON OPTIMIZATION
SIAM JOURNAL ON SCIENTIFIC COMPUTING
SIAM REVIEW
STUDIA SCIENTIARUM MATHEMATICARUM HUNGARICA
STATISTICAL SCIENCE
STATISTICA SINICA
STATISTICS
STOCHASTIC PROCESSES AND THEIR APPLICATIONS
STUDIES IN APPLIED MATHEMATICS
STUDIA MATHEMATICA
TRANSACTIONS OF THE AMERICAN MATHEMATICAL SOCIETY
TAIWANESE JOURNAL OF MATHEMATICS
TECHNOMETRICS
TOHOKU MATHEMATICAL JOURNAL
TOPOLOGY
TRANSFORMATION GROUPS
ZEITSCHRIFT FUR ANALYSIS UND IHRE ANWENDUNGEN
ZEITSCHRIFT FUR ANGEWANDTE MATHEMATIK UND PHYSIK

Additional journals included in the bibliometric analyses of Norway

ACTA MATHEMATICA HUNGARICA
ADVANCES IN COMPUTATIONAL MATHEMATICS
ANNALES ACADEMIAE SCIENTIARUM FENNICAE-MATHEMATICA
ANNALI DI MATEMATICA PURA ED APPLICATA
ANNALS OF MATHEMATICAL LOGIC
ANNALS OF THE INSTITUTE OF STATISTICAL MATHEMATICS
ARKIV FOR MATEMATIK
ARS COMBINATORIA
ASTERISQUE
BIOMETRICAL JOURNAL
BIT
BOLLETTINO DELLA UNIONE MATEMATICA ITALIANA
BULLETIN DE LA SOCIETE MATHEMATIQUE DE FRANCE
CANADIAN JOURNAL OF STATISTICS-REVUE CANADIENNE DE STATISTIQUE
CANADIAN MATHEMATICAL BULLETIN-BULLETIN CANADIEN DE MATHEMATIQU
CHAPMAN & HALL/CRC RESEARCH NOTES IN MATHEMATICS SERIES
COMPUTATIONAL AND APPLIED MATHEMATICS
COMPUTATIONAL STATISTICS
COMPUTATIONAL STATISTICS & DATA ANALYSIS
COMPUTERS & MATHEMATICS WITH APPLICATIONS-PART B
CRYPTOLOGIA
DIFFERENTIAL GEOMETRY AND ITS APPLICATIONS
DISCRETE MATHEMATICS
EUROPEAN CONSORTIUM FOR MATHEMATICS IN INDUSTRY
EUROPEAN JOURNAL OF COMBINATORICS
FIBONACCI QUARTERLY

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GEOMETRIAE DEDICATA
HOUSTON JOURNAL OF MATHEMATICS
IMA JOURNAL OF MATHEMATICAL CONTROL AND INFORMATION
INNOVATIONS IN APPLIED MATHEMATICS
INSTITUTE OF MATHEMATICS AND ITS APPLICATIONS CONFERENCE SERIES
INTERNATIONAL COLLOQUIUM ON PROCESS SIMULATION
INTERNATIONAL SERIES OF NUMERICAL MATHEMATICS
ISKOS
JOURNAL D ANALYSE MATHEMATIQUE
JOURNAL OF APPLIED STATISTICS
JOURNAL OF COMPUTATIONAL AND APPLIED MATHEMATICS
JOURNAL OF GEOMETRIC ANALYSIS
JOURNAL OF LOGIC AND COMPUTATION
JOURNAL OF STATISTICAL COMPUTATION AND SIMULATION
JOURNAL OF STATISTICAL PLANNING AND INFERENCE
JOURNAL OF THE ROYAL STATISTICAL SOCIETY SERIES D-THE STATISTIC
K-THEORY
LECTURE NOTES IN ECONOMICS AND MATHEMATICAL SYSTEMS
LECTURE NOTES IN MATHEMATICS
LECTURE NOTES IN PURE AND APPLIED MATHEMATICS
MATCH-COMMUNICATIONS IN MATHEMATICAL AND IN COMPUTER CHEMISTRY
MATHEMATICA SCANDINAVICA
MATHEMATICAL GAZETTE
MATHEMATICAL INEQUALITIES & APPLICATIONS
MATHEMATICAL MODELLING
MATHEMATICAL PROGRAMMING STUDY
MATHEMATICS AND ITS APPLICATIONS
MONOGRAPHS AND TEXTBOOKS IN PURE AND APPLIED MATHEMATICS
NEW ICMI STUDIES SERIES
NUMERICAL ALGORITHMS
NUMERICAL FUNCTIONAL ANALYSIS AND OPTIMIZATION
OR SPEKTRUM
PROBABILITY AND ITS APPLICATIONS
PROCEEDINGS OF SYMPOSIA IN PURE MATHEMATICS
PROGRESS IN MATHEMATICS
PROGRESS IN PROBABILITY
PUBLICACIONS MATEMATIQUES
PUBLICATIONS OF THE RESEARCH INSTITUTE FOR MATHEMATICAL SCIENCE
REVUE ROUMAINE DE MATHEMATIQUES PURES ET APPLIQUEES
SET-VALUED ANALYSIS
SIMULATION SERIES
STATISTICS & PROBABILITY LETTERS
STATISTICS AND COMPUTING
STOCHASTIC ANALYSIS AND APPLICATIONS
STOCHASTICS MONOGRAPHS : THEORY AND APPLICATIONSOF STOCHASTIC P
STUDIES IN LOGIC AND THE FOUNDATIONS OF MATHEMATICS
SYMPOSIA GAUSSIANA (SERIES)
THEORY AND DECISION LIBRARY, SERIES B : MATHEMATICAL AND STATIS
THEORY OF PROBABILITY AND ITS APPLICATIONS
TOPOLOGY AND ITS APPLICATIONS
TRENDS IN MATHEMATICS
WILEY SERIES IN PROBABILITY AND MATHEMATICAL STATISTICS
ZEITSCHRIFT FUR MATHEMATISCHE LOGIK UND GRUNDLAGEN DER MATHEMAT

Computer Science (103 journals)

ACM COMPUTING SURVEYS
ACM SIGPLAN NOTICES
ACM TRANSACTIONS ON COMPUTER SYSTEMS
ACM TRANSACTIONS ON DATABASE SYSTEMS
ACM TRANSACTIONS ON DESIGN AUTOMATION OF ELECTRONIC SYSTEMS
ACM TRANSACTIONS ON GRAPHICS
ACM TRANSACTIONS ON MATHEMATICAL SOFTWARE
ACM TRANSACTIONS ON PROGRAMMING LANGUAGES AND SYSTEMS
ACM TRANSACTIONS ON SOFTWARE ENGINEERING AND METHODOLOGY
ADVANCES IN ENGINEERING SOFTWARE
ANNALS OF SOFTWARE ENGINEERING
COMBINATORICA
COMMUNICATIONS OF THE ACM
COMPUTER AIDED GEOMETRIC DESIGN
COMPUTER SYSTEMS SCIENCE AND ENGINEERING
COMPUTER VISION AND IMAGE UNDERSTANDING
COMPUTERS AND ARTIFICIAL INTELLIGENCE
COMPUTER-AIDED DESIGN
COMPUTERS & ELECTRICAL ENGINEERING
COMPUTER GRAPHICS-US
COMPUTER GRAPHICS FORUM
COMPUTERS & GRAPHICS-UK
COMPUTERS IN INDUSTRY
COMPUTER LANGUAGES
COMPUTERS & MATHEMATICS WITH APPLICATIONS
COMPUTING IN SCIENCE & ENGINEERING
COMPUTERS & SECURITY
COMPUTER
COMPUTER JOURNAL
COMPUTING
CONCURRENCY-PRACTICE AND EXPERIENCE
DESIGN AUTOMATION FOR EMBEDDED SYSTEMS
DESIGNS CODES AND CRYPTOGRAPHY
DISPLAYS
DISTRIBUTED COMPUTING
DISTRIBUTED AND PARALLEL DATABASES
ENGINEERING WITH COMPUTERS
FUTURE GENERATION COMPUTER SYSTEMS
GRAPHICAL MODELS
HUMAN-COMPUTER INTERACTION
IBM JOURNAL OF RESEARCH AND DEVELOPMENT
IBM SYSTEMS JOURNAL
IEE PROCEEDINGS-COMPUTERS AND DIGITAL TECHNIQUES
IEEE ANNALS OF THE HISTORY OF COMPUTING
IEEE COMPUTER GRAPHICS AND APPLICATIONS
IEEE TRANSACTIONS ON COMPUTERS
IEEE CONCURRENCY
IEEE DESIGN & TEST OF COMPUTERS
IEEE INTERNET COMPUTING
IEEE MICRO
IEEE MULTIMEDIA
IEEE TRANSACTIONS ON PARALLEL AND DISTRIBUTED SYSTEMS
IEEE TRANSACTIONS ON SOFTWARE ENGINEERING
IEEE SOFTWARE
IEEE TRANSACTIONS ON VISUALIZATION AND COMPUTER GRAPHICS
INFORMATION AND SOFTWARE TECHNOLOGY
INFORMS JOURNAL ON COMPUTING
INTERNATIONAL JOURNAL OF COMPUTER APPLICATIONS IN TECHNOLOGY
INTERNATIONAL JOURNAL OF GENERAL SYSTEMS
INTERNATIONAL JOURNAL OF HUMAN-COMPUTER INTERACTION
INTERNATIONAL JOURNAL OF HIGH PERFORMANCE COMPUTING APPLICATIONS
INTERNATIONAL JOURNAL OF HIGH SPEED COMPUTING
INTERNATIONAL JOURNAL OF PARALLEL PROGRAMMING
INTEGRATED COMPUTER-AIDED ENGINEERING
INTEGRATION-THE VLSI JOURNAL
INTERACTING WITH COMPUTERS
JOURNAL OF THE ACM
JOURNAL OF ALGORITHMS
JOURNAL OF COMPUTER AND SYSTEM SCIENCES
JOURNAL OF CRYPTOLOGY
JOURNAL OF LOGIC PROGRAMMING
JOURNAL OF PARALLEL AND DISTRIBUTED COMPUTING
JOURNAL OF SOFTWARE MAINTENANCE-RESEARCH AND PRACTICE
JOURNAL OF SUPERCOMPUTING
JOURNAL OF SYSTEMS ARCHITECTURE
JOURNAL OF SYSTEMS AND SOFTWARE
JOURNAL OF VISUAL COMMUNICATION AND IMAGE REPRESENTATION
JOURNAL OF VISUALIZATION AND COMPUTER ANIMATION
JOURNAL OF VISUAL LANGUAGES AND COMPUTING
MICROPROCESSORS AND MICROSYSTEMS
MULTIDIMENSIONAL SYSTEMS AND SIGNAL PROCESSING
MULTIMEDIA TOOLS AND APPLICATIONS
MULTIMEDIA SYSTEMS
NETWORKS
NEW GENERATION COMPUTING
PARALLEL COMPUTING
PERFORMANCE EVALUATION
REAL-TIME IMAGING
REAL-TIME SYSTEMS
SCIENCE OF COMPUTER PROGRAMMING
SIAM JOURNAL ON COMPUTING
SIGMOD RECORD
SIMULATION
SOFTWARE-PRACTICE & EXPERIENCE
SOFTWARE TESTING VERIFICATION & RELIABILITY
SPEECH COMMUNICATION
TRANSACTIONS OF THE SOCIETY FOR COMPUTER SIMULATION INTERNATIONAL
THEORY OF COMPUTING SYSTEMS
THEORETICAL COMPUTER SCIENCE
THEORY AND PRACTICE OF OBJECT SYSTEMS
USER MODELING AND USER-ADAPTED INTERACTION
VISUAL COMPUTER
VLDB JOURNAL

Information Technology & Communications (51 journals)

ACM TRANSACTIONS ON INFORMATION SYSTEMS
ACTA INFORMATICA
AEU-INTERNATIONAL JOURNAL OF ELECTRONICS AND COMMUNICATIONS
ALCATEL TELECOMMUNICATIONS REVIEW
ANNALES DES TELECOMMUNICATIONS-ANNALS OF TELECOMMUNICATIONS
BELL LABS TECHNICAL JOURNAL
BT TECHNOLOGY JOURNAL
COMPUTER COMMUNICATION REVIEW
COMPUTER COMMUNICATIONS
COMPUTER NETWORKS-THE INTERNATIONAL JOURNAL OF COMPUTER AND TELECOMMUNICATIONS NETWORKING
ELECTRONICS AND COMMUNICATIONS IN JAPAN PART I-COMMUNICATIONS
ETRI JOURNAL
EUROPEAN TRANSACTIONS ON TELECOMMUNICATIONS
IEE PROCEEDINGS-RADAR SONAR AND NAVIGATION
IEEE-ACM TRANSACTIONS ON NETWORKING
IEEE TRANSACTIONS ON ANTENNAS AND PROPAGATION
IEEE TRANSACTIONS ON BROADCASTING
IEEE COMMUNICATIONS LETTERS
IEEE COMMUNICATIONS MAGAZINE
IEEE TRANSACTIONS ON COMMUNICATIONS
IEEE TRANSACTIONS ON INFORMATION THEORY
IEEE JOURNAL ON SELECTED AREAS IN COMMUNICATIONS
IEEE NETWORK
IEEE PERSONAL COMMUNICATIONS
IEICE TRANSACTIONS ON INFORMATION AND SYSTEMS
IEICE TRANSACTIONS ON COMMUNICATIONS
INFORMATION AND COMPUTATION
INFORMATION PROCESSING & MANAGEMENT
INFORMATION PROCESSING LETTERS
INFORMATION SCIENCES
INFORMATION SYSTEMS
INTERNATIONAL JOURNAL OF COOPERATIVE INFORMATION SYSTEMS
INTERNATIONAL JOURNAL OF SATELLITE COMMUNICATIONS
INTERNET RESEARCH-ELECTRONIC NETWORKING APPLICATIONS AND POLICY
JOURNAL OF COMMUNICATIONS AND NETWORKS
JOURNAL OF COMMUNICATIONS TECHNOLOGY AND ELECTRONICS
JOURNAL OF INFORMATION STORAGE AND PROCESSING SYSTEMS
JOURNAL OF INFORMATION TECHNOLOGY
JOURNAL OF THE INSTITUTION OF BRITISH TELECOMMUNICATIONS ENGINEERS
JOURNAL OF INTELLIGENT INFORMATION SYSTEMS
JOURNAL OF ORGANIZATIONAL COMPUTING AND ELECTRONIC COMMERCE
MOBILE NETWORKS & APPLICATIONS
NTT REVIEW
PHOTONIC NETWORK COMMUNICATIONS
RAIRO-INFORMATIQUE THEORIQUE ET APPLICATIONS-THEORETICAL INFORMATICS AND APPLICATIONS
SMPTE JOURNAL
SPACE COMMUNICATIONS
TELECOMMUNICATION SYSTEMS
TELECOMMUNICATIONS POLICY
WIRELESS NETWORKS
WIRTSCHAFTSINFORMATIK

Information and Communication technology (136 additional journals)

ADVANCES IN CONCURRENT ENGINEERING
ADVANCES IN DESIGN AND MANUFACTURING
ANALOG INTEGRATED CIRCUITS AND SIGNAL PROCESSING
ANNUAL REVIEW IN AUTOMATIC PROGRAMMING
ASIAN JOURNAL OF BUSINESS & INFORMATION SYSTEMS
BULLETIN OF THE AMERICAN SOCIETY FOR INFORMATION SCIENCE
COMMUNICATION & BROADCASTING
COMPUTER DESIGN
COMPUTER PERFORMANCE
COMPUTER STANDARDS & INTERFACES
COMPUTER SUPPORTED COOPERATIVE WORK
COMPUTER VISION GRAPHICS AND IMAGE PROCESSING
COMPUTER-BASED MEDICAL SYSTEMS : PROCEEDINGS OF THE ANNUAL IEEE
COMPUTERS ENVIRONMENT AND URBAN SYSTEMS
COMPUTING SYSTEMS
CONCURRENT SYSTEMS ENGINEERING SERIES
CONFERENCE RECORD OF THE ASILOMAR CONFERENCE ON SIGNALS, SYSTEM
CUTTER IT JOURNAL-THE JOURNAL OF INFORMATION TECHNOLOGY MANAGEM
CVGIP-GRAPHICAL MODELS AND IMAGE PROCESSING
DATAMATION
EDN
EDP ANALYZER
ELECTRONIC DESIGN
ELECTRONIC ENGINEERING
ELECTRONICS
ELECTRONICS & WIRELESS WORLD
ELECTRONICS AND BIOTECHNOLOGY ADVANCED (EL B A) FORUM SERIES
ELECTRONICS AND POWER
ELECTRONICS INFORMATION & PLANNING
ELECTRONICS LETTERS
ELECTRONICS WORLD & WIRELESS WORLD
ERICSSON REVIEW
ESPRIT BASIC RESEARCH SERIES
EUROPEAN JOURNAL OF INFORMATION SYSTEMS
EUROPEAN TRANSACTIONS ON ELECTRICAL POWER
FRONTIERS IN ARTIFICIAL INTELLIGENCE AND APPLICATIONS
GLOBAL TELECOMS BUSINESS
IEE PROCEEDINGS-A-SCIENCE MEASUREMENT AND TECHNOLOGY
IEE PROCEEDINGS-C GENERATION TRANSMISSION AND DISTRIBUTION
IEE PROCEEDINGS-CIRCUITS DEVICES AND SYSTEMS
IEE PROCEEDINGS-COMMUNICATIONS
IEE PROCEEDINGS-I COMMUNICATIONS SPEECH AND VISION
IEE PROCEEDINGS-MICROWAVES ANTENNAS AND PROPAGATION

IEE PROCEEDINGS-SCIENCE MEASUREMENT AND TECHNOLOGY
IEEE ANTENNAS AND PROPAGATION MAGAZINE
IEEE CIRCUITS & DEVICES
IEEE CONFERENCE ON INFORMATION VISUALIZATION - PROCEEDINGS
IEEE ELECTRICAL INSULATION MAGAZINE
IEEE INTERNATIONAL SYMP ON CIRCUITS AND SYSTEMS
IEEE JOURNAL OF QUANTUM ELECTRONICS
IEEE JOURNAL OF SELECTED TOPICS IN QUANTUM ELECTRONICS
IEEE JOURNAL OF SOLID-STATE CIRCUITS
IEEE MICROWAVE AND GUIDED WAVE LETTERS
IEEE POWER ELECTRONICS SPECIALISTS CONFERENCE RECORDS
IEEE TRANSACTIONS ON CIRCUITS AND SYSTEMS
IEEE TRANSACTIONS ON CIRCUITS AND SYSTEMS FOR VIDEO TECHNOLOGY
IEEE TRANSACTIONS ON CIRCUITS AND SYSTEMS II-ANALOG AND DIGITAL
IEEE TRANSACTIONS ON DIELECTRICS AND ELECTRICAL INSULATION
IEEE TRANSACTIONS ON EDUCATION
IEEE TRANSACTIONS ON ELECTRICAL INSULATION
IEEE TRANSACTIONS ON ELECTROMAGNETIC COMPATIBILITY
IEEE TRANSACTIONS ON ELECTRON DEVICES
IEEE TRANSACTIONS ON GEOSCIENCE AND REMOTE SENSING
IEEE TRANSACTIONS ON IMAGE PROCESSING
IEEE TRANSACTIONS ON MICROWAVE THEORY AND TECHNIQUES
IEEE TRANSACTIONS ON POWER APPARATUS AND SYSTEMS
IEEE TRANSACTIONS ON POWER DELIVERY
IEEE TRANSACTIONS ON POWER SYSTEMS
IEEE TRANSACTIONS ON RELIABILITY
IEEE TRANSACTIONS ON SIGNAL PROCESSING
IEEE TRANSACTIONS ON VEHICULAR TECHNOLOGY
IEEE TRANSACTIONS ON VERY LARGE SCALE INTEGRATION (VLSI) SYSTEM
IEICE TRANSACTIONS ON FUNDAMENTALS OF ELECTRONICS COMMUNICATION
IFIP TRANSACTIONS A-COMPUTER SCIENCE AND TECHNOLOGY
IFIP TRANSACTIONS B-APPLICATIONS IN TECHNOLOGY
IFIP TRANSACTIONS C-COMMUNICATION SYSTEMS
INFORMATION AND CONTROL
INTEGRAL TRANSFORMS AND SPECIAL FUNCTIONS
INTERFACES IN COMPUTING
INTERNATIONAL CONFERENCE ON DISTRIBUTED COMPUTING SYSTEMS - PRO
INTERNATIONAL CONFERENCE ON SOFTWARE ENGINEERING
INTERNATIONAL FEDERATION FOR INFORMATION PROCESSING
INTERNATIONAL JOURNAL OF ELECTRICAL POWER & ENERGY SYSTEMS
INTERNATIONAL JOURNAL OF ELECTRONICS
INTERNATIONAL JOURNAL OF SOFTWARE ENGINEERING AND KNOWLEDGE ENG
INTERNATIONAL SERIES IN INTELLIGENT TECHNOLOGIES
INTERNATIONAL SERIES ON MICROPROCESSOR-BASED AND INTELLIGENT SY
INTERNATIONAL SYMPOSIUM ON FAULT-TOLERANT COMPUTING
JAVA REPORT
JOURNAL OF ELECTROMAGNETIC WAVES AND APPLICATIONS
JOURNAL OF ELECTRONICS MANUFACTURING
JOURNAL OF ELECTROSTATICS
JOURNAL OF EXPERIMENTAL & THEORETICAL ARTIFICIAL INTELLIGENCE
JOURNAL OF HIGH SPEED NETWORKS
JOURNAL OF MICROWAVE POWER AND ELECTROMAGNETIC ENERGY
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JOURNAL OF THE INSTITUTION OF ELECTRONIC AND RADIO ENGINEERS
KLUWER INTERNATIONAL SERIES IN ENGINEERING AND COMPUTER SCIENCE
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LECTURE NOTES IN COMPUTATIONAL SCIENCE AND ENGINEERING
LECTURE NOTES IN COMPUTER SCIENCE
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MICROCOMPUTING
MICROELECTRONIC ENGINEERING
MICROELECTRONICS JOURNAL
MICROELECTRONICS RELIABILITY
MICROPROCESSING AND MICROPROGRAMMING
MICROWAVE JOURNAL
NATO ADVANCED SCIENCE INSTITUTE SERIES, SUB-SERIES 3, HIGH TECH
NATO ADVANCED SCIENCE INSTITUTES SERIES, SERIES F, COMPUTER AND
PROCEEDINGS - ANNUAL IEEE INTERNATIONAL ASIC CONFERENCE AND EXH
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PROCEEDINGS - INTERNATIONAL COMPUTER SOFTWARE & APPLICATIONS CO
PROCEEDINGS - INTERNATIONAL SYMPOSIUM ON ADVANCED RESEARCH IN A
PROCEEDINGS OF THE IEEE
PROCEEDINGS OF THE SUMMER COMPUTER SIMULATION CONFERENCE
PROCEEDINGS: CONFERENCE ON ARTIFICIAL INTELLIGENCE FOR APPLICAT
RADIO SCIENCE
RESEARCH IN HUMANITIES COMPUTING
RESEARCH REPORTS ESPRIT
SHARE EUROPE PROCEEDINGS
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SIGNAL PROCESSING
SIGPLAN NOTICES
SPRINGER COMPUTER SCIENCE
STUDIES IN FUZZINESS AND SOFT COMPUTING

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TELETRAFFIC SCIENCE AND ENGINEERING
WAVE ELECTRONICS
WIRELESS WORLD

WORKSHOPS IN COMPUTING