

## PROMETHEE-GAIA Statistics – 1801 papers

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<http://www.promethee-gaia.net>

### Introduction

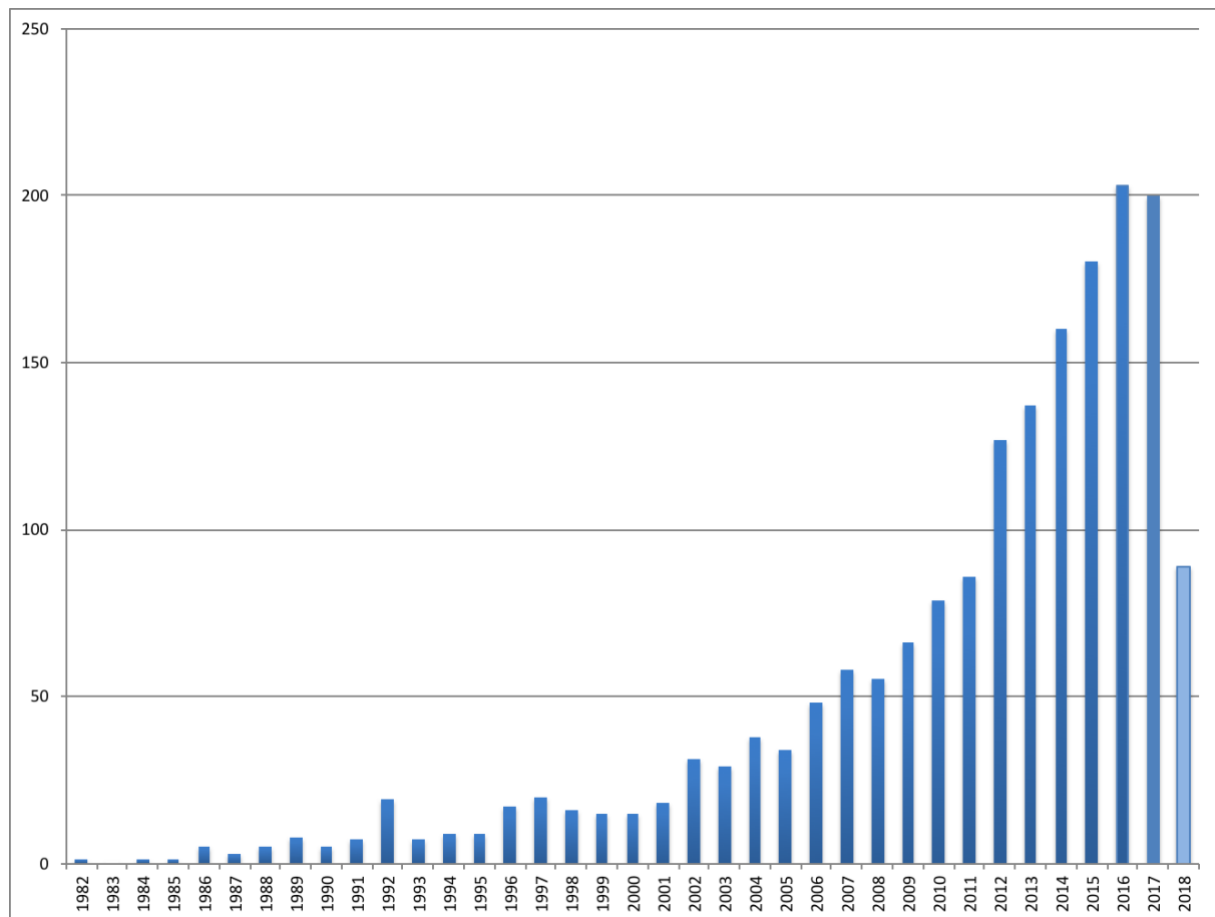
The **PROMETHEE** method was first introduced by Professor Jean-Pierre Brans in 1982.

Much seminal work has been done in the 1980's by Professors Jean-Pierre Brans and Bertrand Mareschal to develop the methodology. Two important steps were the introduction of the **GAIA** descriptive analysis and the implementation of **PROMETHEE** and **GAIA** in the interactive software **PROMCALC**.

The **PROMETHEE** Bibliographical Database tracks the scientific papers related to the **PROMETHEE-GAIA** methodology, its development, its analysis and its application.

### Timeline

As shown in the following bar chart, there has been an ever-increasing interest for the **PROMETHEE** methodology in the literature: as of today, we have recorded a total number of 1801 papers. The median year of publication is 2013 which means that more than half of the papers have been published during the last 5 years. More precisely 969 papers (54%) have been published since 2013.



Number of papers published per year from 1982 to 2018(current)

A closer look at the bar chart reveals three distinct periods:

- From 1982 to 2001, the number of papers published is low and is increasing slowly. 1992 is a special year in this period, perhaps because of the evolution of the **PromCalc** software at that time.
- From 2002, the number of papers starts to increase more rapidly, up to 86 papers published in 2011. This can probably be associated with the launch of the **Decision Lab** software in 2000: indeed, this was the first Windows-based and productivity-oriented **PROMETHEE** implementation.
- From 2012, we see a sharp increase of the number of papers published, up to the maximum of 203 papers in 2016. This can probably be associated with the availability of the new **Visual PROMETHEE** software and of its companion web site [www.promethee-gaia.net](http://www.promethee-gaia.net)
- As of today (May 18, 2018), 89 papers have already been recorded for 2018. This extrapolates to over 240 expected papers for the whole year.

### Fields of interest

The 1801 papers cover many different topics:

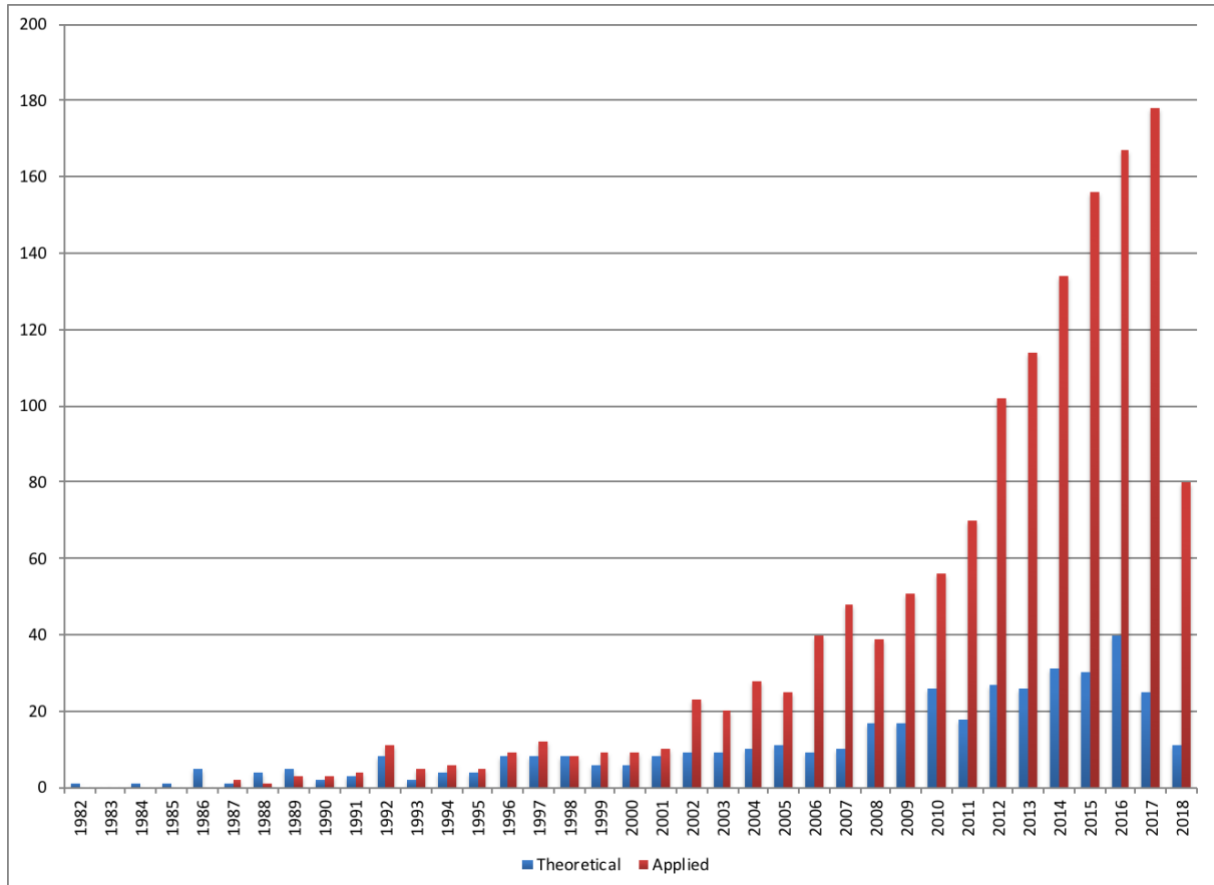
- 411 papers (22.8%) are theoretical papers about the **PROMETHEE** methodology, including many proposals for extensions or new models.
- 1428 papers (79.3%) are related to applications of **PROMETHEE** in different fields. They belong to various fields:
  - o 359 papers (19.9%) are related to environmental problems.

- 340 papers (18.9%) are related to services and/or public applications.
- 276 papers (15.3%) are related to industrial applications.
- 164 papers (9.1%) are related to energy.
- 118 papers (6.6%) are related to water.
- 106 papers (5.9%) are related to finance.
- 77 papers (4.3%) are related to transportation.
- 60 papers (3.3%) are related to procurement.
- 32 papers (1.8%) are related to health care.
- 20 papers (1.1%) are related to mining.
- 57 papers (3.2%) are related to other fields of application.

(note: some papers are related to multiple fields so that the total of the above percentages is larger than 100%)

It is interesting to note that more than half (56.2%) of the applied papers are in the “societal” field (including environment, energy, water, public sector and health).

The next bar chart shows the distribution of theoretical (in blue) and applied (in red) papers over time from 1982 to 2018. From 1982 to 2001, the numbers of theoretical and applied papers published achieve similar relatively low levels. From 2002 until today the number of theoretical papers has continued to increase but seems to level in the last years. By contrast there is a much sharper and continuous increase of the number of applied papers published. This certainly corresponds to the availability of user-friendly and full-featured **PROMETHEE** software (**Decision Lab** in 2000 and **Visual PROMETHEE** in 2011).



Number of papers (theoretical - applied) published per year from 1982 to 2018(current)

## Worldwide interest

Looking at the nationality of the first authors, the 1801 papers originate from 75 different countries from all continents.

The following table shows the continental distribution of the papers: as expected, most papers (44.9%) come from European countries, but 34.6% of the papers originate from Asian countries as well. At the opposite, Africa has the smallest contribution with 54 papers (3.0%) only.

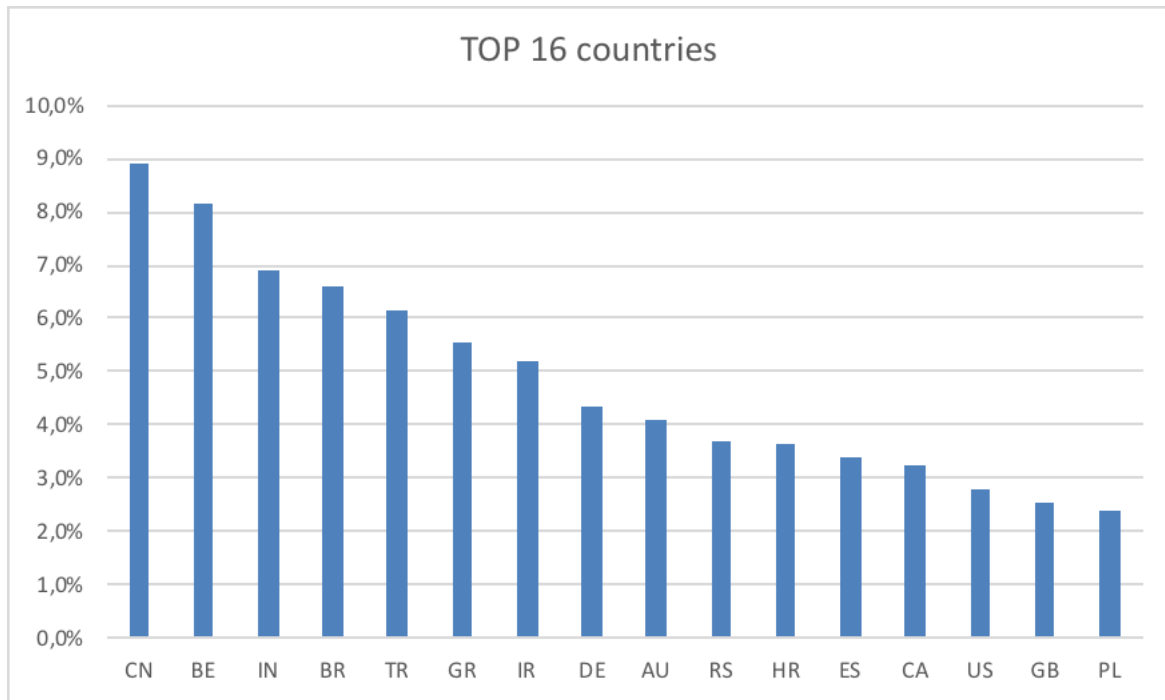
Continent	Papers	Percentage
Africa	54	3,0%
Asia	623	34,6%
Europe	808	44,9%
North America	118	6,6%
South America	124	6,9%
Australia	74	4,1%

Continental distribution by first authors

The next table shows the distribution of the papers by country: for a long time, the country with the largest number of published papers has been Belgium, which is the “home country” of PROMETHEE, but more recently China has become the first country in this ranking with currently 160 papers. Actually, more than two thirds of the papers (66.7%) originate from only 12 countries (China, Belgium, India, Brazil, Turkey, Greece, Iran, Germany, Australia, Serbia, Croatia and Spain) located on 4 different continents. And more than four quarters (77.6%) of the papers originate from just 16 countries, adding Canada, the United States, Great Britain and Poland to the previous list.

The TOP 5 countries (CN, BE, IN, BR and TR) account for 36.7% of the papers.

The TOP 10 countries (TOP 5 + GR, IR, DE, AU, RS) account for 59.6% of the papers.



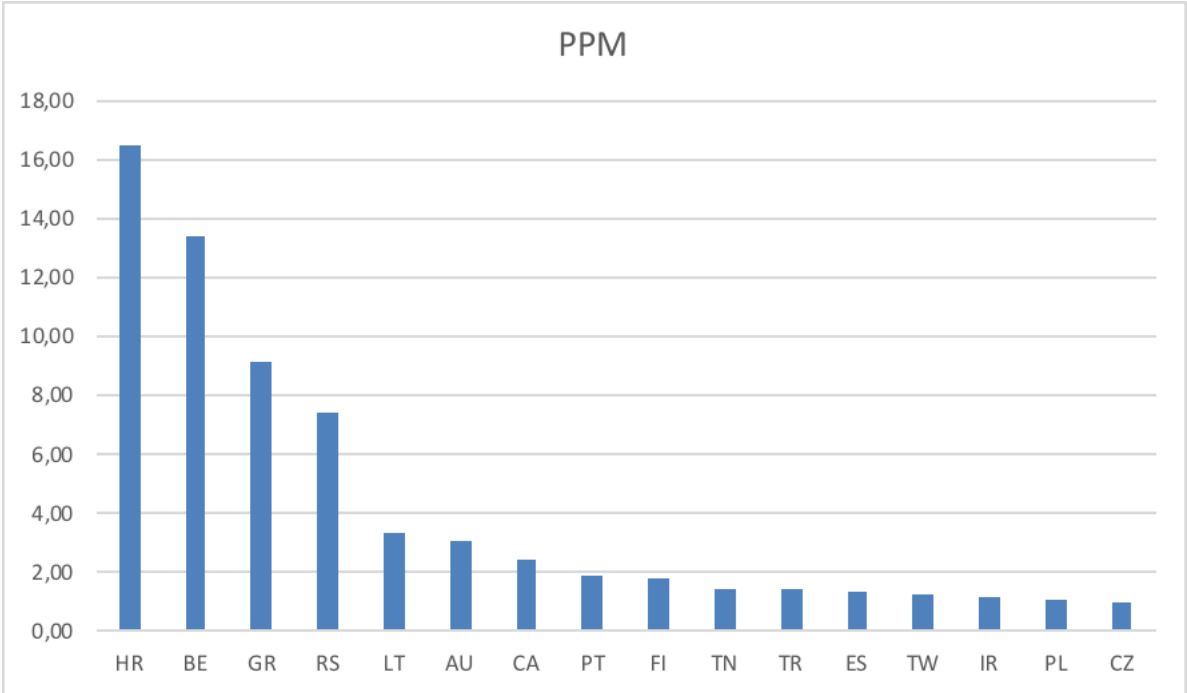
TOP 16 countries – Number of papers published

Country	Papers	Percentage	Country	Papers	Percentage
CN	160	8,9%	CY	4	0,2%
BE	147	8,2%	BG	4	0,2%
IN	124	6,9%	EG	4	0,2%
BR	119	6,6%	HU	4	0,2%
TR	111	6,2%	RO	4	0,2%
GR	100	5,6%	SA	4	0,2%
IR	94	5,2%	SI	4	0,2%
DE	78	4,3%	CL	3	0,2%
AU	74	4,1%	RU	3	0,2%
RS	67	3,7%	SG	3	0,2%
HR	66	3,7%	NO	3	0,2%
ES	61	3,4%	TH	3	0,2%
CA	58	3,2%	JP	3	0,2%
US	50	2,8%	BA	2	0,1%
GB	46	2,6%	MD	2	0,1%
PL	43	2,4%	NG	2	0,1%
FR	40	2,2%	ZA	2	0,1%
IT	35	1,9%	CM	2	0,1%
ID	34	1,9%	AL	1	0,1%
TW	29	1,6%	BD	1	0,1%
PT	19	1,1%	IE	1	0,1%
DZ	17	0,9%	KZ	1	0,1%
MY	16	0,9%	LK	1	0,1%
TN	16	0,9%	ME	1	0,1%
KR	12	0,7%	MM	1	0,1%
CZ	11	0,6%	MU	1	0,1%
FI	11	0,6%	CU	1	0,1%
LT	10	0,6%	IL	1	0,1%
MX	9	0,5%	LU	1	0,1%
CH	9	0,5%	LV	1	0,1%
MA	9	0,5%	CO	1	0,1%
AT	8	0,4%	GH	1	0,1%
HK	8	0,4%	PS	1	0,1%
JO	8	0,4%	PK	1	0,1%
SK	7	0,4%	VE	1	0,1%
NL	7	0,4%	YE	1	0,1%
DK	7	0,4%	NP	1	0,1%
SE	6	0,3%			

Country distribution by first author

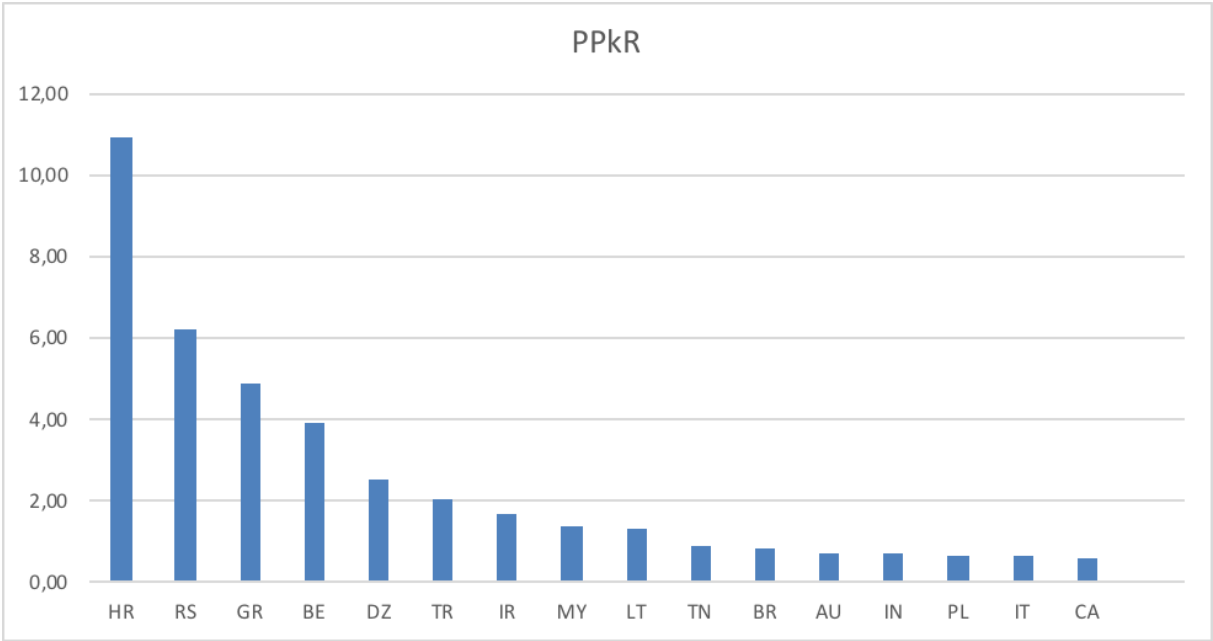
Of course, larger countries such as China or India are at an advantage in the previous ranking because they have larger numbers of scholars. Considering the population of the countries, a quite different ranking is obtained: to this purpose we have computed the number of papers published per million inhabitants (PPM) for each country having at least ten papers listed in the database (which makes for 28 countries and 91,5% of the

papers). The top ranked countries appear in the next figure, with Croatia and Belgium well above the other countries, followed by Greece and Serbia.



TOP 16 countries – Papers per million inhabitants (PPM)

A slightly different ranking is obtained when the number of academics (researchers) is used instead of the total population of the countries: the next chart shows the number of papers per thousand researchers (PPkR) for the top 16 ranked countries. In this ranking, Croatia is the absolute leader.

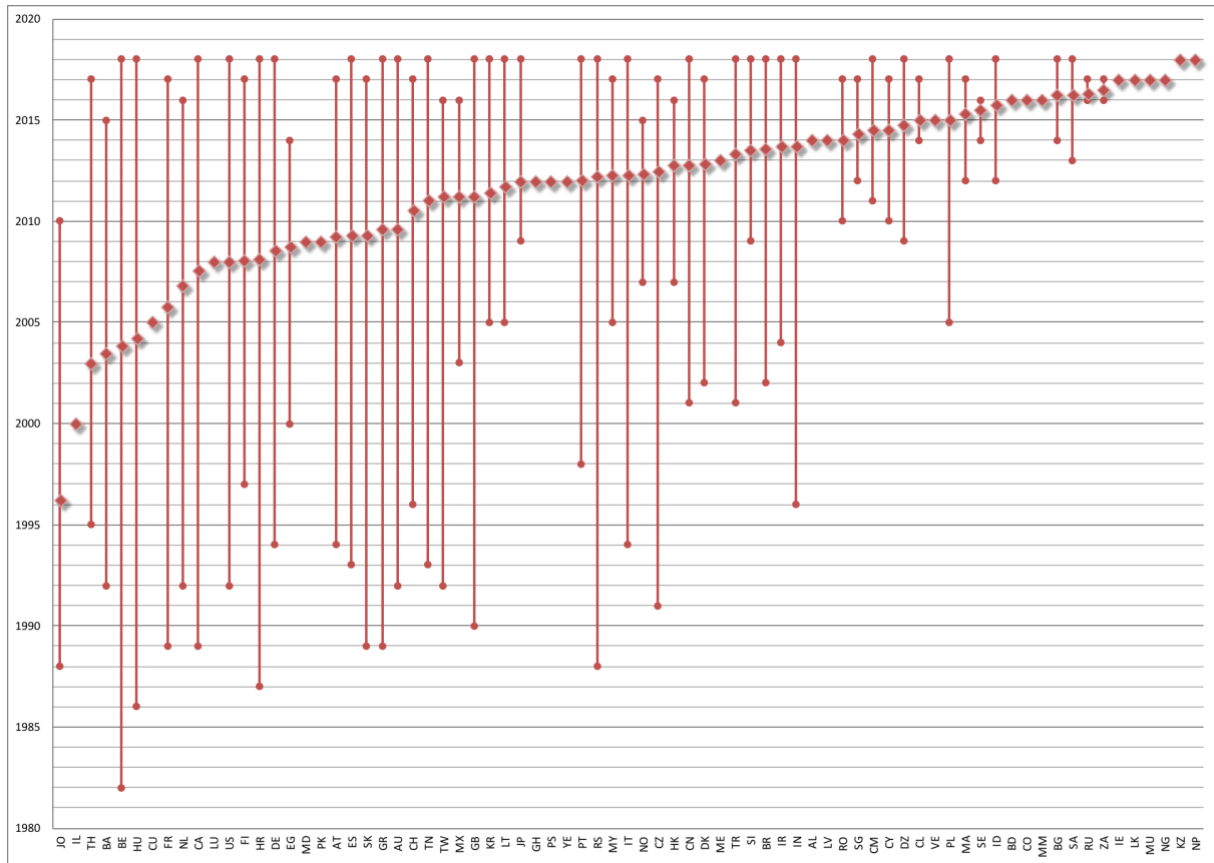


TOP 16 countries – Papers per thousand researchers (PPkR)

## Age of the papers

The average age of the papers is 2011 while the median is 2013, which indicates a skewed distribution of ages with many recent papers.

For each country, we have analyzed the dates of publication of the papers and have obtained the oldest, most recent and average years of publication. The results are presented in the next chart.



Years of publication (min, max and average) per country

The countries are ranked from left to right according to their average year of publication. For each country, a vertical line is drawn from the first year of publication (at the bottom) to the last year of publication (at the top). The position of the diamond drawn on this line corresponds to the average year of publication.

Some comments:

- The longest line is for Belgium, as expected. Indeed, the first paper was published in 1982 and publication is still active today.
- Most lines reach or are above the year 2010 (all countries except IL, CU, LU, MD and PK, which account for a total of only 5 papers). This means that recent publications originate from many different countries.
- 59 lines reach or are located above the year 2016 which means that papers have been published from 59 different countries (over a total number of 75 identified countries, i.e. 79% of the countries) during the last two years.
- There are many long lines, meaning that « early adopters » remain faithful to **PROMETHEE** and continue to generate publications today: for instance, all the



11 countries which started publishing papers during the ten first years (1982-1991) were still active in 2010 and 10 of them have produced papers in 2016 or later.

- Most shorter lines are located to the right of the chart and correspond to « new adopters » for which publications started more recently.
- Several very short lines appear at the right: these are new countries and it shows that **PROMETHEE** publications are still expanding to other countries.

### Authors

We have analyzed the number and origin of the authors of the 1801 papers. They belong to the **PROMETHEE Community**.

There is a total of 3203 individual authors coming from 82 countries. This corresponds to an average of 1.78 authors per paper or 0.56 papers per author (PPA ratio). It confirms the diversity of the origins of the papers.

The following table shows the continental distribution of the authors.

Continent	Authors	Percentage
Africa	101	3,2%
Asia	1184	37,0%
Europe	1324	41,3%
North America	272	8,5%
South America	206	6,4%
Oceania	116	3,6%

Continental distribution of authors

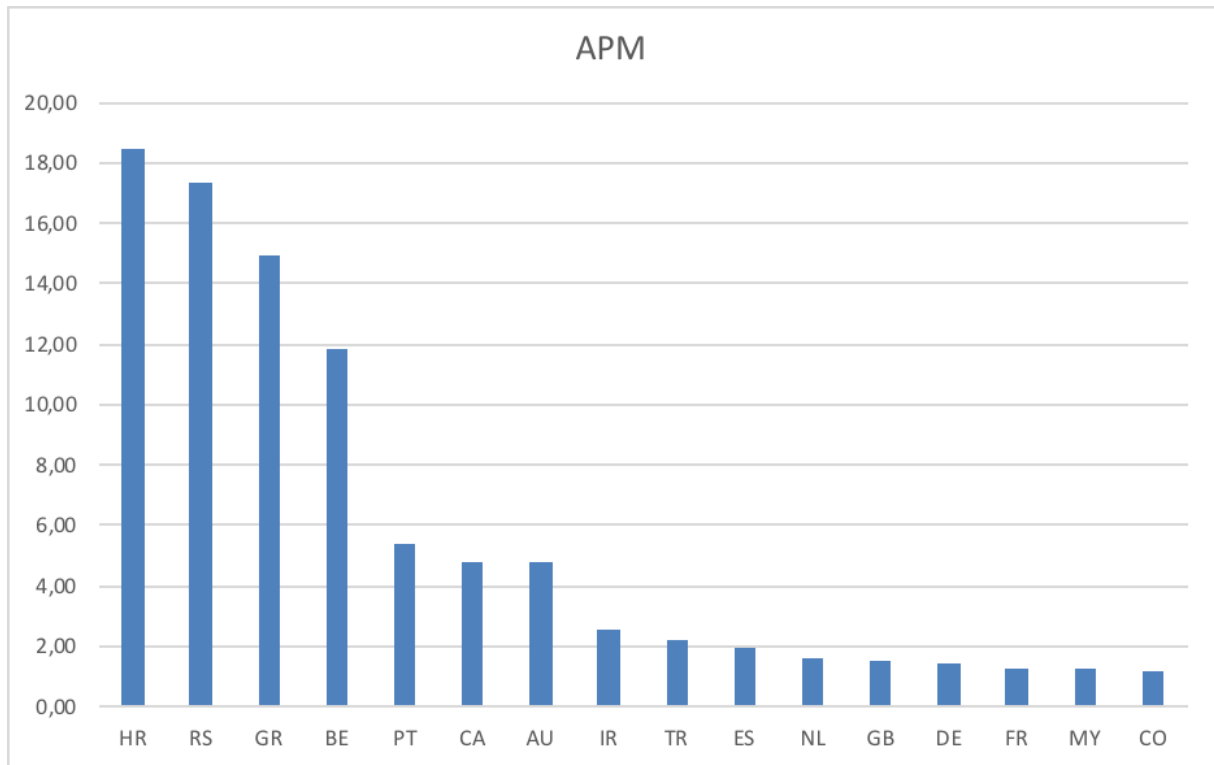
The next table shows the distribution by country of the authors, for the top 25 countries.

Country	Authors	Percentage	Cumulative	PPA	APM
CN	315	9,8%	9,8%	0,51	0,23
IN	208	6,5%	16,3%	0,60	0,16
IR	206	6,4%	22,8%	0,46	2,58
BR	183	5,7%	28,5%	0,65	0,87
TR	176	5,5%	34,0%	0,63	2,20
GR	164	5,1%	39,1%	0,61	14,91
RS	156	4,9%	44,0%	0,43	17,33
US	139	4,3%	48,3%	0,36	0,43
BE	130	4,1%	52,4%	1,13	11,82
DE	120	3,7%	56,1%	0,65	1,48
CA	116	3,6%	59,7%	0,50	4,83
AU	115	3,6%	63,3%	0,64	4,79
GB	98	3,1%	66,4%	0,47	1,51
ES	92	2,9%	69,2%	0,66	2,00
FR	85	2,7%	71,9%	0,47	1,31
HR	74	2,3%	74,2%	0,89	18,50
ID	69	2,2%	76,4%	0,49	0,26
IT	68	2,1%	78,5%	0,51	1,13
PT	54	1,7%	80,2%	0,35	5,40
PL	46	1,4%	81,6%	0,93	1,18
MY	40	1,2%	82,9%	0,40	1,29
CO	34	1,1%	83,9%	0,85	1,17
DZ	32	1,0%	84,9%	0,53	0,80
NL	28	0,9%	85,8%	0,25	1,65
KR	27	0,8%	86,6%	0,44	0,53

Distribution of the authors by country (top 25 countries)

More than 50% of the authors are concentrated in the top 9 countries (CN, IN, IR, BR, TR, GR, RS, US and BE) while the top 25 countries include close to 90% of the authors (86,6%).

The higher PPA (papers/authors) ratio observed for Belgium is easily explained by the number of original papers (20) published by Jean-Pierre Brans and Bertrand Mareschal. Again, it is interesting to consider the size of the countries in this ranking. To this purpose, we have computed the number of authors per million inhabitants (APM) for these 25 countries. The next table shows the top 16 countries ranked according to their APM.



Top 16 countries – Authors per million inhabitants (APM)

The top of the APM ranking is quite similar to that of the PPM ranking, with HR, RS, GR and BE well above the other countries.