PROMETHEE-GAIA Statistics

12/09/2020 – 2393 papers
Bertrand Mareschal
bmaresc@ulb.ac.be
http://www.promethee-gaia.net

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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.

The papers are gathered from several sources:
- ScienceDirect,
- Scopus,
- EBSCO,
- DOAJ (Directory of Open Access Journals),
- SpringerLink,
- data directly contributed by members of the **PROMETHEE** Community.

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 2393 papers. The median year of publication is 2015 which means that more than half of the papers have been published during the last 5 years. More precisely 1261 papers (53%) have been published since 2015.
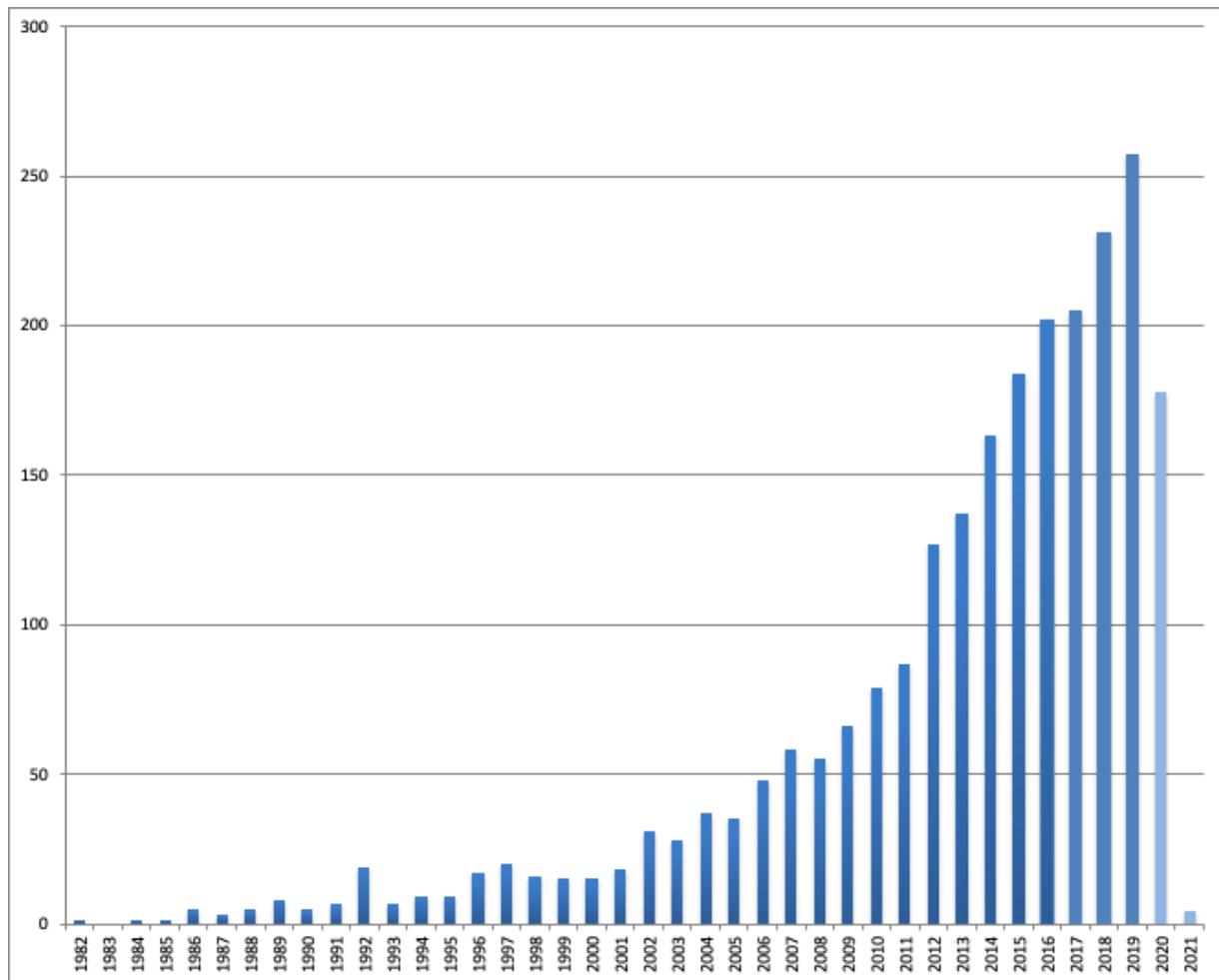
Number of papers published per year from 1982 to 2021(current)

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 87 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 257 papers in 2019. This can probably be associated with the availability of the new **Visual PROMETHEE** software and of its companion web site www.promethee-gaia.net
- As of today (September 12, 2020), 178 papers have already been recorded for 2020 (and 4 for 2021).

Fields of interest

The 2393 papers cover many different topics:

- 493 papers (20.6%) are theoretical papers about the **PROMETHEE** methodology, including many proposals for extensions or new models.
- 1947 papers (81.4%) are related to applications of **PROMETHEE** in various fields:
    - 469 papers (19.6%) are related to services and/or public applications.
    - 457 papers (19.1%) are related to environmental problems.
    - 347 papers (14.5%) are related to industrial applications.
    - 227 papers (9.5%) are related to energy.
    - 153 papers (6.4%) are related to water.
    - 124 papers (5.2%) are related to finance.
    - 116 papers (4.8%) are related to transportation.
    - 77 papers (3.2%) are related to procurement.
    - 75 papers (3.1%) are related to health care.
    - 30 papers (1.3%) are related to mining.
    - 101 papers (4.2%) 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 (57.7%) of the applied papers are in the "societal" field (including environment, energy, water, public sector and health), which is naturally multicriteria oriented.

The next bar chart shows the distribution of theoretical (in blue) and applied (in red) papers over time from 1982 to 2021. 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).
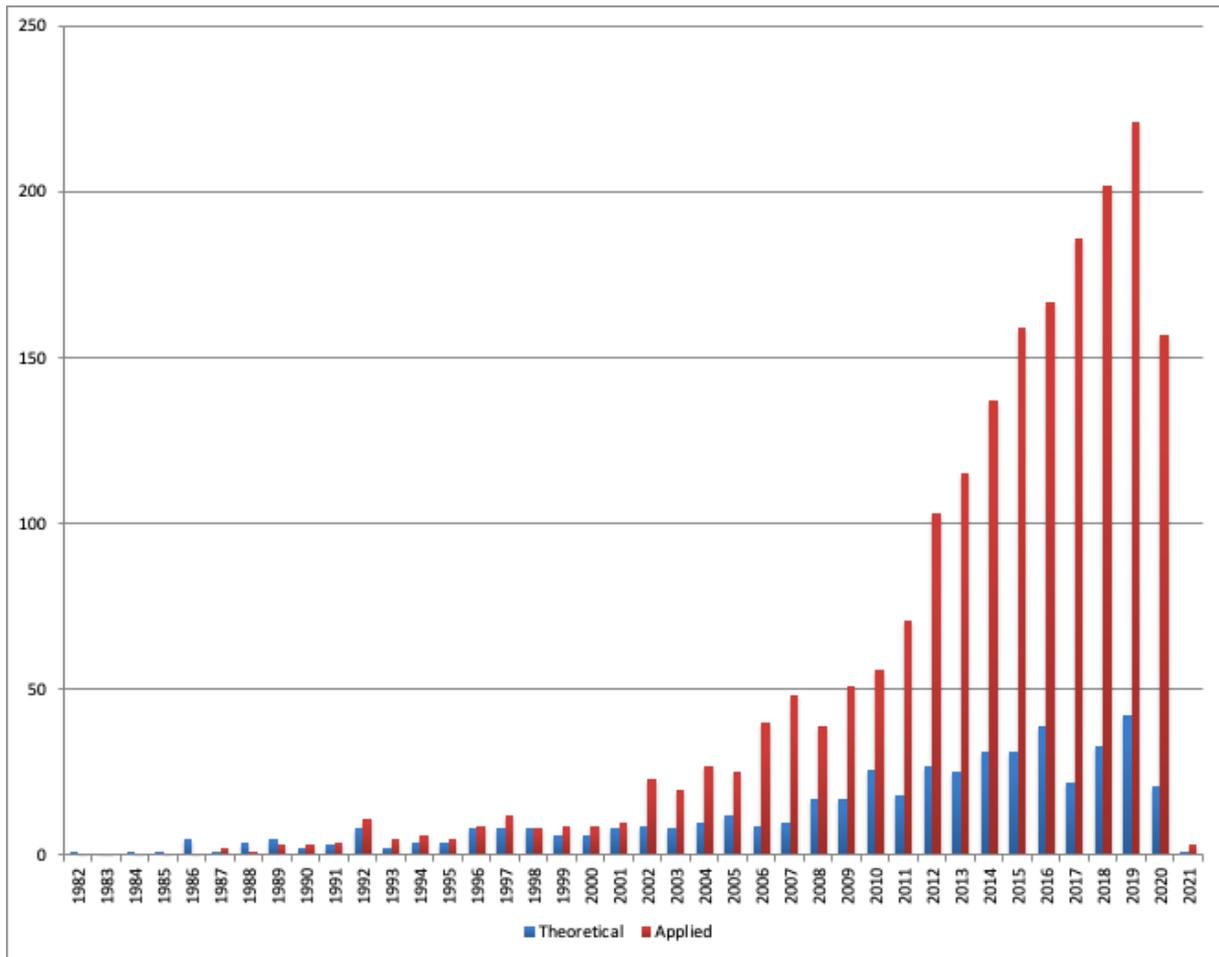
Number of papers (theoretical - applied) published per year from 1982 to 2021(current)

Worldwide interest

Looking at the nationality of their first authors, the 2393 papers originate from 86 different countries from all continents, over a worldwide total of 195 countries – including the Holy See (no papers available yet…) and not including Taiwan (35 papers).

The following table shows the continental distribution of the papers: as expected, most papers (41.7%) come from European countries, but 38.2% of the papers originate from Asian countries as well. At the opposite, Africa has the smallest contribution with 84 papers (3.5%) only.

| Continent	Papers	Percentage
Africa	84	3,5%
Asia	913	38,2%
Europe	999	41,7%
North America	137	5,7%
South America	173	7,2%
Australia	87	3,6%

Continental distribution by first authors

The next table shows the distribution of the papers by country (international country codes are used – see e.g. https://www.countrycode.org for a list): 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 230 papers, India is second with 175 papers, Brazil is third with 161 papers and Iran fourth with 158 papers, thus leaving Belgium fifth with 154 papers. Actually, almost two thirds of the papers (64.9%) originate from only 12 countries (China, India, Brazil, Iran, Belgium, Turkey, Greece, Serbia, Australia, Germany, Croatia and Canada) located on 4 different continents. And more than four quarters (75.8%) of the papers originate from just 16 countries, adding Spain, Poland, Indonesia and Great Britain to the previous list.

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

The TOP 10 countries (TOP 5 + TR, GR, RS, AU, DE) account for 58.8% of the papers.

There are only 7 countries which have produced more than 100 papers:

- China: 230 papers
- India: 175 papers
- Brazil: 161 papers
- Iran: 158 papers
- Belgium: 154 papers
- Turkey: 148 papers
- Greece: 121 papers
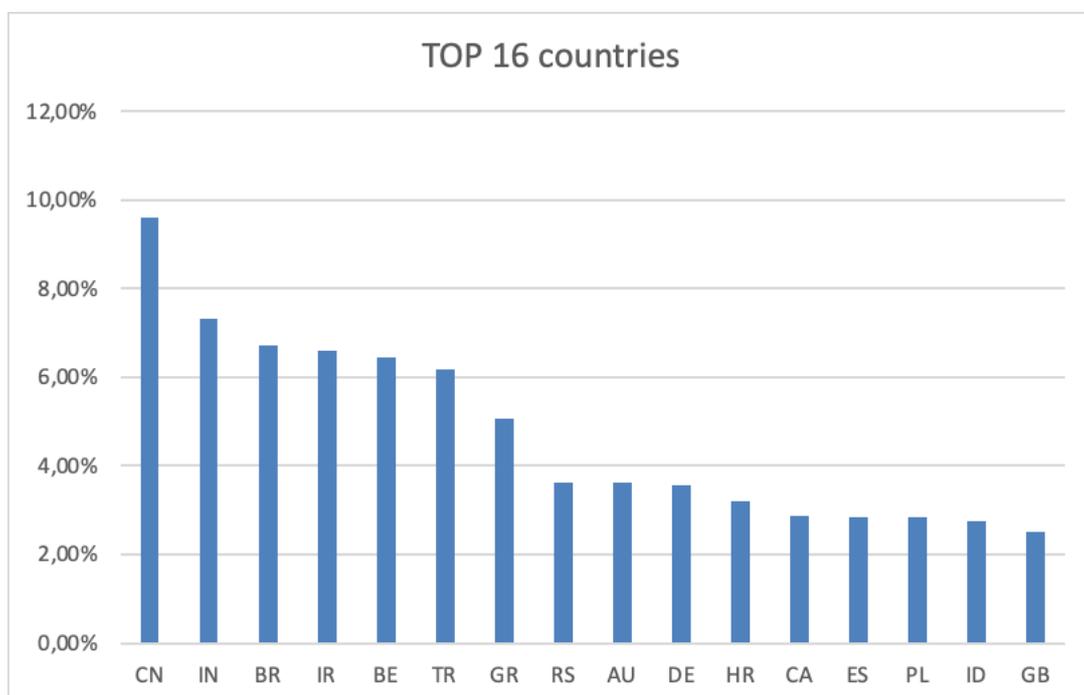
TOP 16 countries – Number (%) of papers published

| Country	Papers	Percentage	Country	Papers	Percentage
CN	230	9,61%	PK	6	0,25%
IN	175	7,31%	CL	5	0,21%
BR	161	6,73%	RO	5	0,21%
IR	158	6,60%	TH	5	0,21%
BE	154	6,44%	SI	5	0,21%
TR	148	6,18%	SG	4	0,17%
GR	121	5,06%	NO	4	0,17%
RS	87	3,64%	GH	4	0,17%
AU	87	3,64%	NG	4	0,17%
DE	85	3,55%	HU	4	0,17%
HR	77	3,22%	JP	3	0,13%
CA	69	2,88%	BA	3	0,13%
ES	68	2,84%	CM	2	0,08%
PL	68	2,84%	LK	2	0,08%
ID	66	2,76%	MD	2	0,08%
GB	60	2,51%	ZA	2	0,08%
IT	57	2,38%	BD	2	0,08%
US	56	2,34%	BF	2	0,08%
FR	51	2,13%	PS	2	0,08%
TW	35	1,46%	CO	2	0,08%
PT	25	1,04%	IE	1	0,04%
DZ	23	0,96%	IL	1	0,04%
TN	23	0,96%	KZ	1	0,04%
MY	19	0,79%	TT	1	0,04%
CY	15	0,63%	LU	1	0,04%
CZ	15	0,63%	LV	1	0,04%
MA	15	0,63%	ME	1	0,04%
KR	14	0,59%	MM	1	0,04%
LT	13	0,54%	MU	1	0,04%
FI	12	0,50%	NP	1	0,04%
BG	12	0,50%	CU	1	0,04%
NL	11	0,46%	VE	1	0,04%
MX	11	0,46%	YE	1	0,04%
CH	10	0,42%	AR	2	0,08%
SA	9	0,38%	IQ	1	0,04%
DK	8	0,33%	OM	1	0,04%
SK	8	0,33%	AL	1	0,04%
AT	8	0,33%	MK	1	0,04%
JO	8	0,33%	AZ	1	0,04%
HK	8	0,33%	EC	1	0,04%
EG	8	0,33%	LB	1	0,04%
RU	7	0,29%	PH	1	0,04%
SE	6	0,25%	XK	1	0,04%

Country distribution by first author

Of course, larger countries such as China or India are at an advantage in the previous ranking because they count larger numbers of scholars. Considering the population of the countries, a quite different ranking is obtained: 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 34 countries and 92.8% of the papers). The top ranked countries appear in the next figure, with Croatia well above the other countries, followed by Belgium, Greece, Cyprus and Serbia.
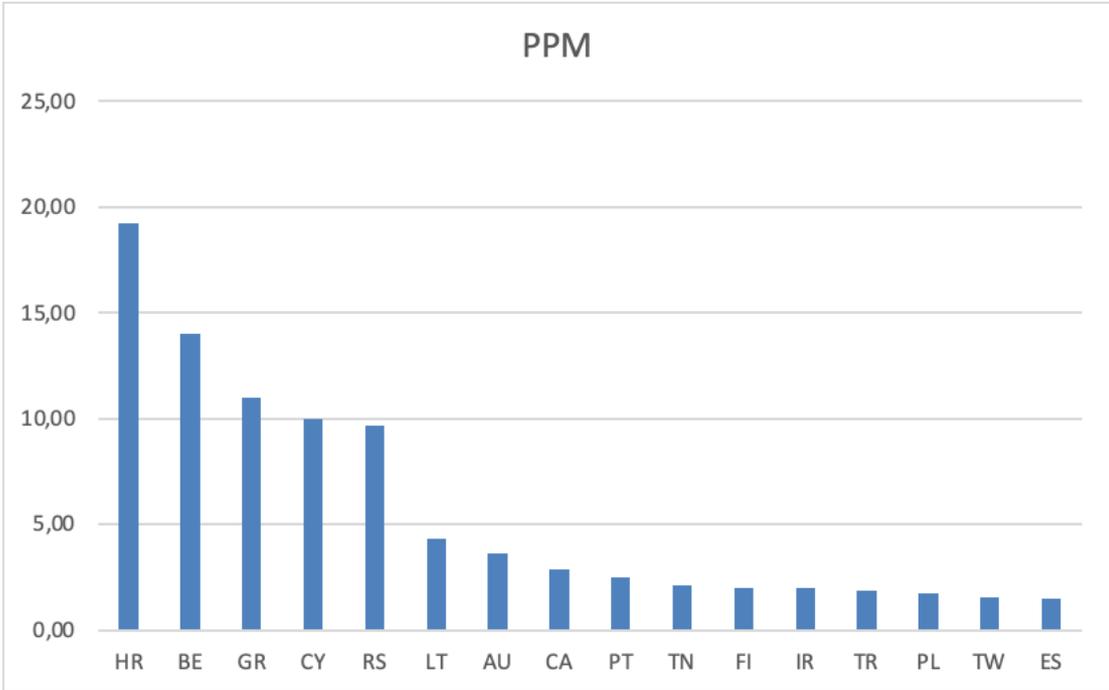
TOP 16 countries – Papers per million inhabitants (PPM)

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. (Cyprus is not included in this ranking because we don't know their number of researchers)
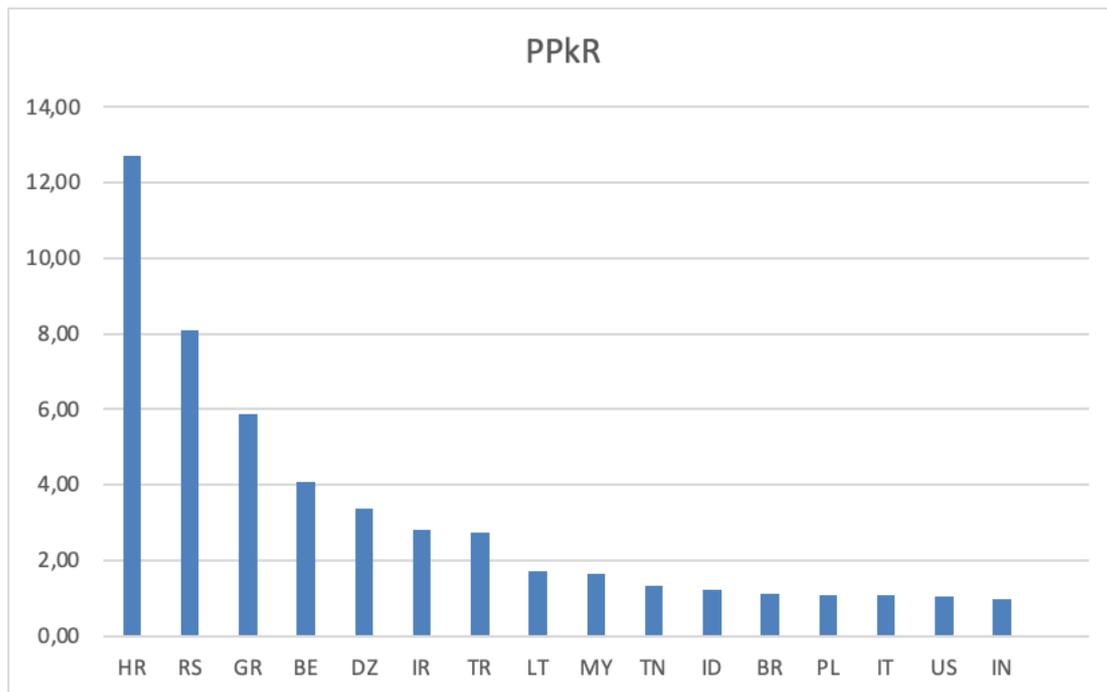
TOP 16 countries – Papers per thousand researchers (PPkR)

Age of the papers

The average age of the papers is 2013 while the median is 2015, 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.
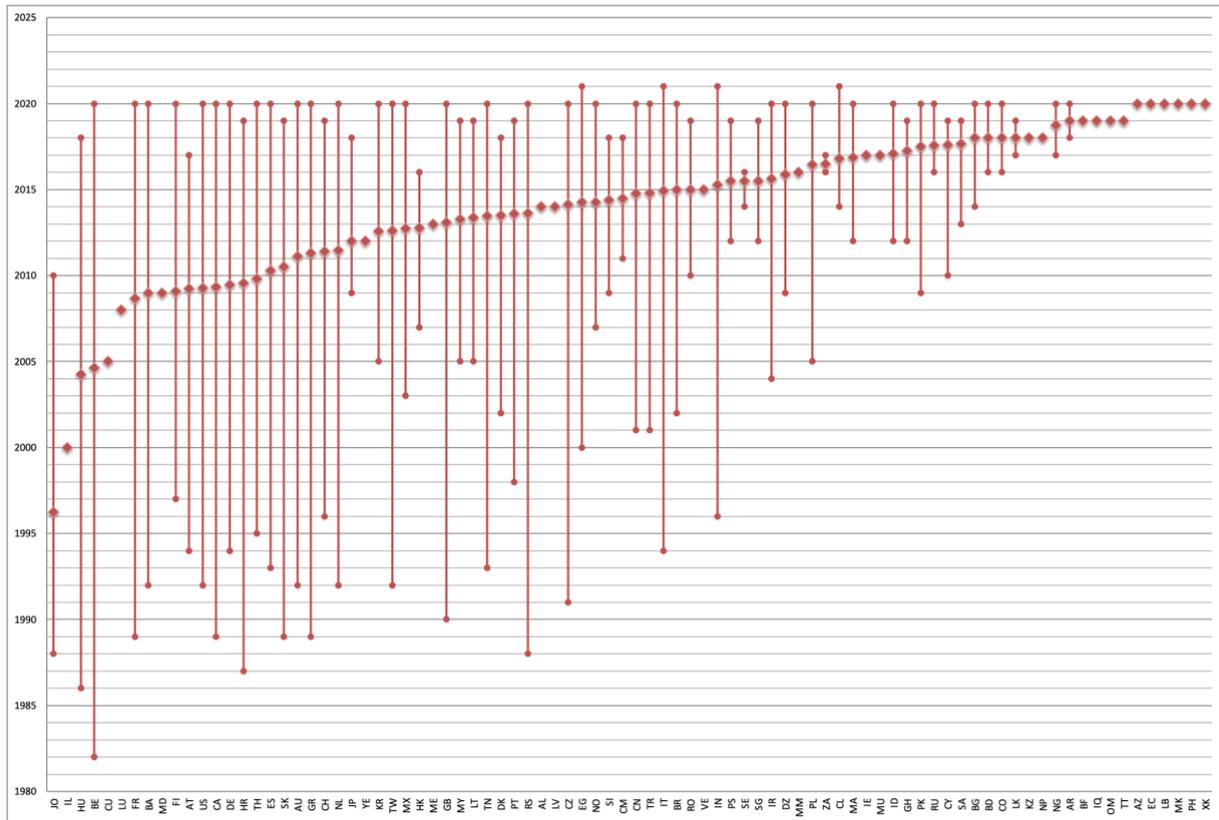
Years of publication (min, max and average) per country

The countries are ranked from left to right according to their increasing 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, and MD, which account for a total of only 4 papers). This means that recent publications originate from many different countries.
- 69 lines reach or are located above the year 2018 which means that papers have been published from 69 different countries (over a total number of 86 identified countries, i.e. 80% of the countries) during the last three 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 11 of them have produced papers in 2017 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 2393 papers. They belong to the **PROMETHEE Community**.

There is a total of 4469 individual authors from 93 countries. This corresponds to an average of 1.87 authors per paper or 0.54 papers per author (PPA ratio). This confirms the diversity of the origins of the papers.

The following table shows the continental distribution of the authors.

| Continent	Authors	Percentage
Africa	159	3,6%
Asia	1840	41,2%
Europe	1678	37,6%
North America	313	7,0%
South America	335	7,5%
Oceania	143	3,2%

Continental distribution of authors

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

Country	Authors	Percentage	Cumulative	PPA	APM
CN	492	11,0%	11,0%	0,47	0,36
IR	320	7,2%	18,2%	0,49	4,00
IN	310	6,9%	25,1%	0,56	0,23
BR	283	6,3%	31,4%	0,57	1,35
TR	261	5,8%	37,3%	0,57	3,26
GR	198	4,4%	41,7%	0,61	18,00
RS	191	4,3%	46,0%	0,46	21,22
ID	161	3,6%	49,6%	0,41	0,62
US	156	3,5%	53,1%	0,36	0,48
DE	145	3,2%	56,3%	0,59	1,79
AU	142	3,2%	59,5%	0,61	5,92
BE	137	3,1%	62,6%	1,12	12,45
CA	135	3,0%	65,6%	0,51	5,63
GB	129	2,9%	68,5%	0,47	1,98
FR	118	2,6%	71,1%	0,43	1,82
ES	113	2,5%	73,7%	0,60	2,46
IT	113	2,5%	76,2%	0,50	1,88
HR	89	2,0%	78,2%	0,87	22,25
PL	79	1,8%	79,9%	0,86	2,03
PT	67	1,5%	81,4%	0,37	6,70
MY	46	1,0%	82,5%	0,41	1,48
TW	42	0,9%	83,4%	0,83	1,83
DZ	41	0,9%	84,3%	0,56	1,03
TN	36	0,8%	85,1%	0,64	3,27
NL	35	0,8%	85,9%	0,31	2,06

Distribution of the authors by country (top 25 countries)

More than 50% of the authors are concentrated in the top 9 countries (CN, IR, IN, BR, TR, GR, RS, ID and US) while the top 25 countries include close to 90% of the authors (85,9%).

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 population 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 chart shows the top 16 countries ranked according to their APM.
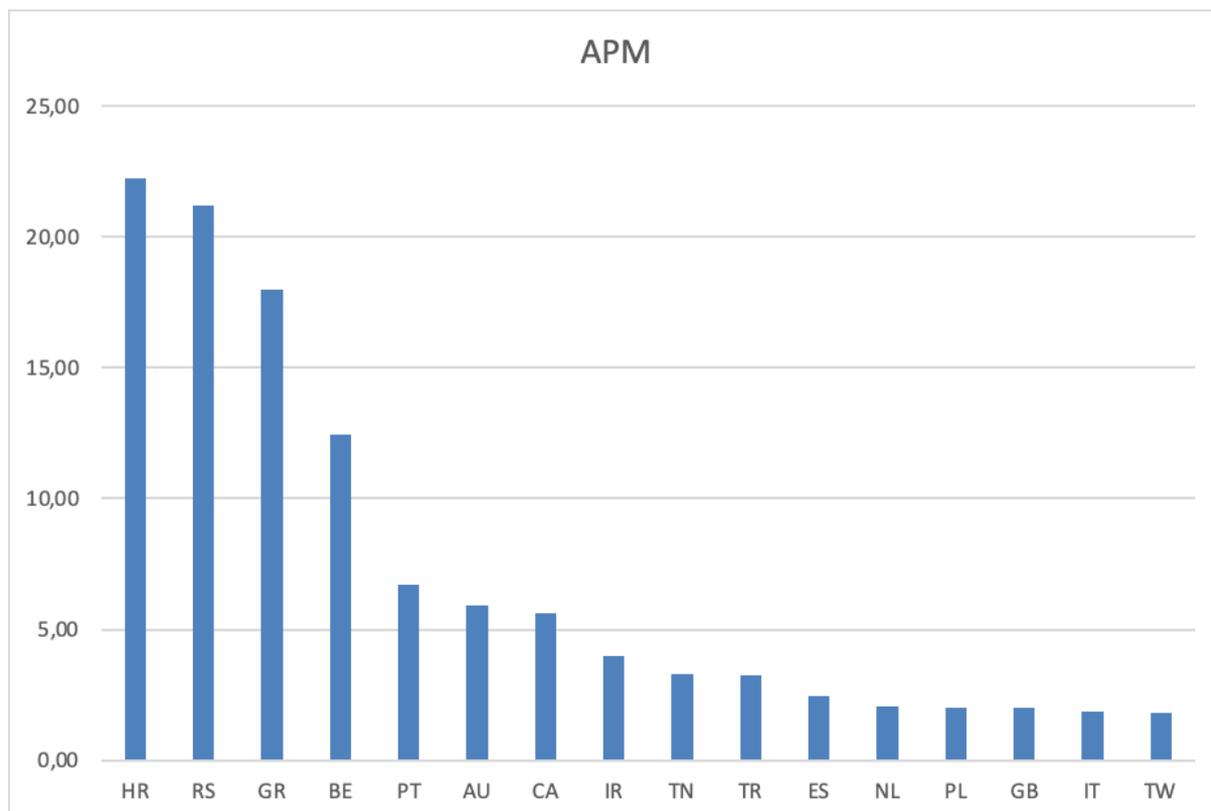
Top 16 countries – Authors per million inhabitants (APM)

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.

Trends

The statistics presented in this document have been published for several years, starting in 2015, and it is interesting to have a look at the trends for some key data.

As the next table shows:
- The total number of papers published is steadily increasing.
- The percentage of applied papers is slowly increasing. This is expected from a long term well-established methodology.
- Societal applications take a major and increasing place.
- Paper publication is progressively spreading to new countries.
- **PROMETHEE** methods and more generally outranking methods started in Europe (mostly France and Belgium). There is still a lot of activity related to **PROMETHEE** in Europe, but the percentage is slowly decreasing, which means that **PROMETHEE** and outranking get a wider scope of users, especially from Asian countries.
- The average age of the papers (measured by the publication year) increases progressively with an increasing number of new contributions.
- More and more people become part of the **PROMETHEE Community** and publish **PROMETHEE**-related papers.

- The PPA ratio is very slowly decreasing: there is a trend to have papers with more co-authors (probably a side-effect of the general pressure for scholars to have more published works).
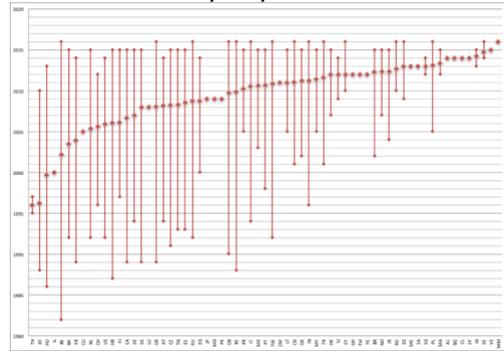
Date	23/11/2015	12/03/2016	03/12/2016	19/03/2017	26/06/2018	03/11/2018	02/03/2019	23/09/2019	12/09/2020
Papers	1236	1317	1469	1526	1827	1912	2000	2137	2393
% applied	74.5 %	75.3 %	76.9 %	77.2 %	79.4 %	79.6 %	80.1%	80,3 %	81.4%
% societal	53.1 %	53.9 %	55.2%	55.4 %	56.3 %	56.5 %	56.5%	56,9 %	57.7%
# countries	63	65	68	70	75	75	75	79	86
% Europe	48.1 %	48.1 %	46.6 %	46.4 %	44.9 %	44.2 %	43.7%	43,5 %	41.%
Average age	-	2009	2009	2010	2011	2011	2012	2012	2013
Authors	2138	2272	2564	2681	3256	3426	3604	3851	4469
PPA ratio	0.58	0.58	0.57	0.57	0.56	0.56	0.56	0,56	0.54

The next table shows the evolution of the age graph. On such a short time period (four years) the shape of the diamond curve doesn't change much but there is a visible upward shift of the whole diagram.
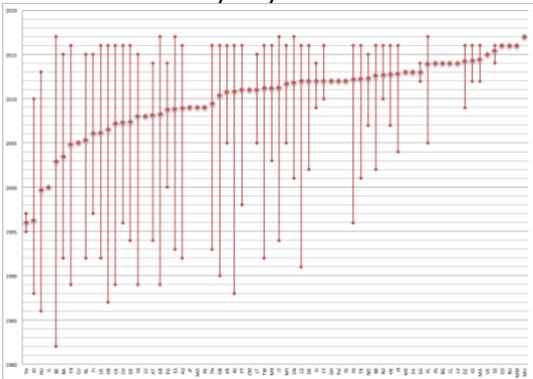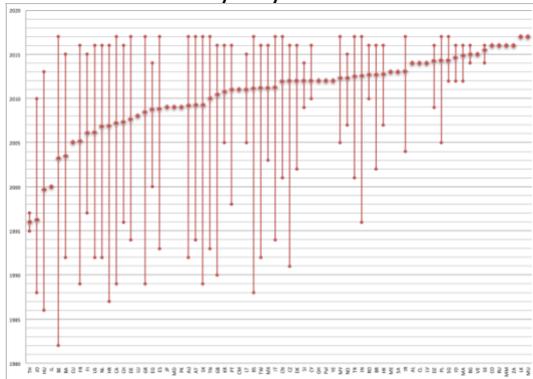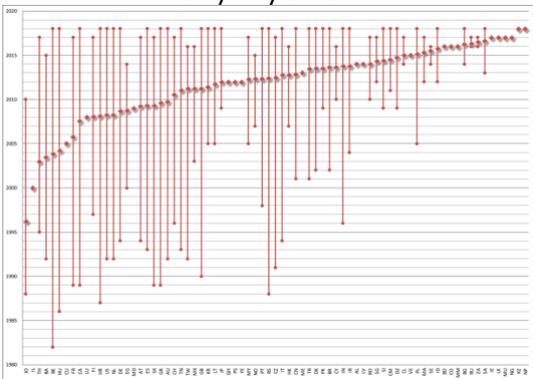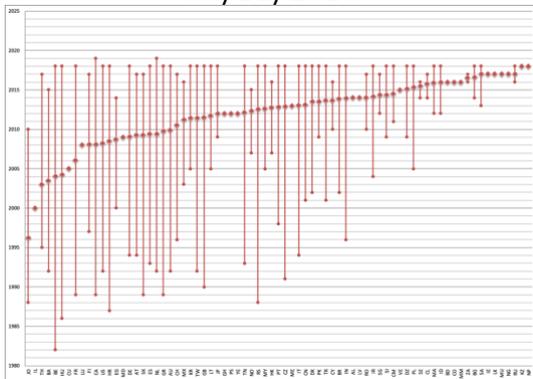
23/11/2015
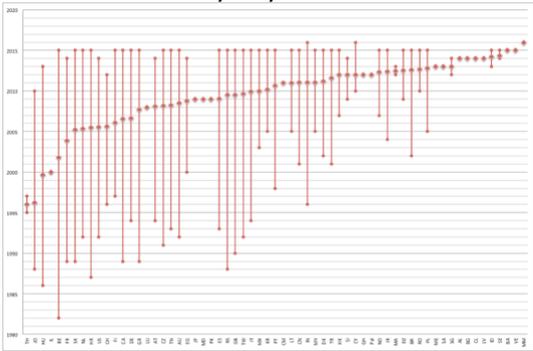
12/03/2016

03/12/2016

19/03/2017

26/06/2018

03/11/2018

31/01/2019

02/03/2019