# Should we use bibliometric indices to evaluate research?

Denis Bouyssou
CNRS–LAMSADE

JIAF 2013, Aix-en-Provence
June 2013

(based on joint work with Thierry Marchant, Ghent University, Belgium)

LAMSADE
UMR CNRS 7243
Laboratoire d'analyse et modélisation de systèmes pour l'aide à la décision

# Outline

# Academia

## General context

- globalization
- knowledge economy
- financial and economic crisis

## Impacts on academia

- budget cuts
- arrival of new players (China, India)
- increased mobility of staff & students
- proliferation of evaluation & funding agencies
- proliferation of indices & rankings
- industrialization of academia

Agence Nationale de la Recherche ANR
aeres agence d'évaluation de la recherche et de l'enseignement supérieur
Education and Culture
Lifelong Learning Programme
ERASMUS

# Industrialization of academia

## Symptoms

- AERES + LRU + ANR + fusions of Universities + teaching in English
- students' demonstrations (*Printemps érable* & UK) + students' debt crisis
- fraud & plagiarism increase
- evaluation fever
  - bibliometric indices everywhere


# Bibliometrics

## Two extreme positions

- bibliometrics is an absolute evil
- bibliometrics brings objectivity and fairness

both positions are plainly wrong!

# Bibliometrics

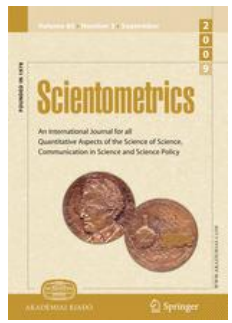
## Bibliometrics defined

- using mathematical and statistical techniques to study publishing and communication patterns

## The field of Bibliometrics

- active scientific field
  - journals: *Scientometrics*, *Journal of Informetrics*, *Journal of the American Society for Information Science and Technology*, *Research Policy*, ...
  - ISSI: International Society for Scientometrics and Informetrics
  - regular International Conferences



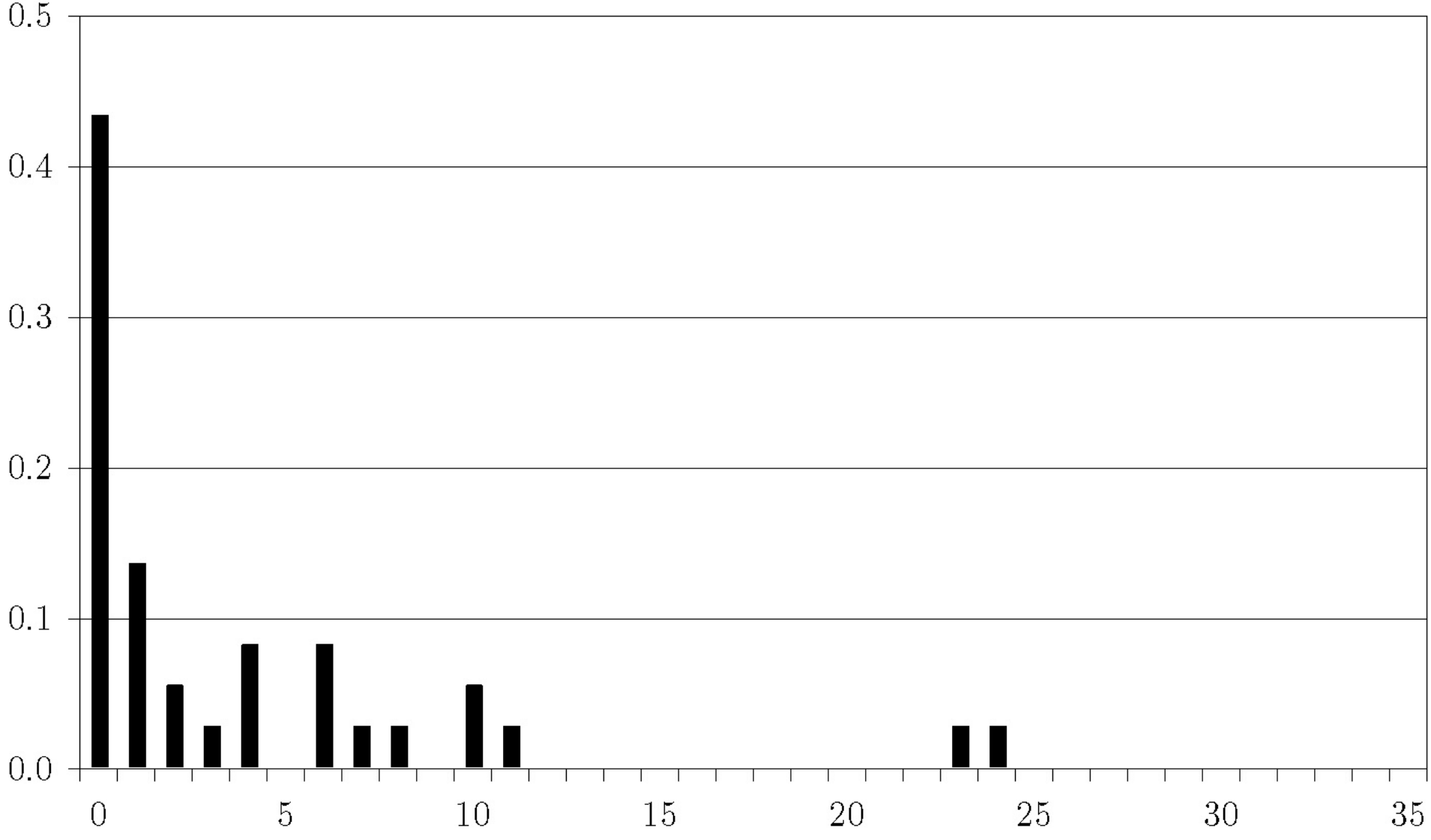


# Bibliometrics

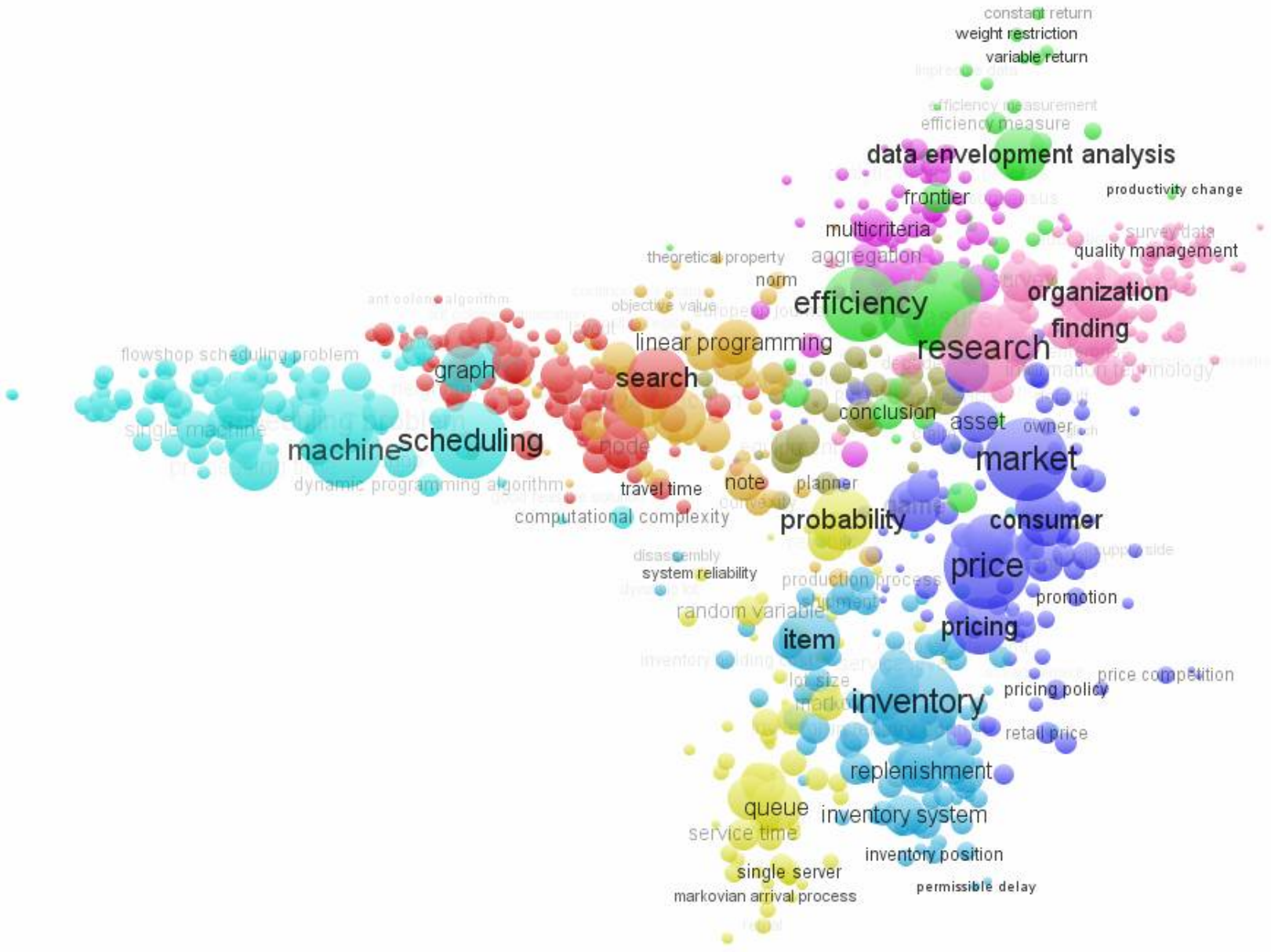
## Some research questions

- bibliometric laws: Lotka, Bradford
- social network of {scientists, papers, fields}
- efficiency of research policy of a country
- factors influencing transfer of knowledge towards industry
- which journals should libraries subscribe to?
- impact of open access on diffusion on knowledge
- strong and weak research fields of a country
- emerging fields

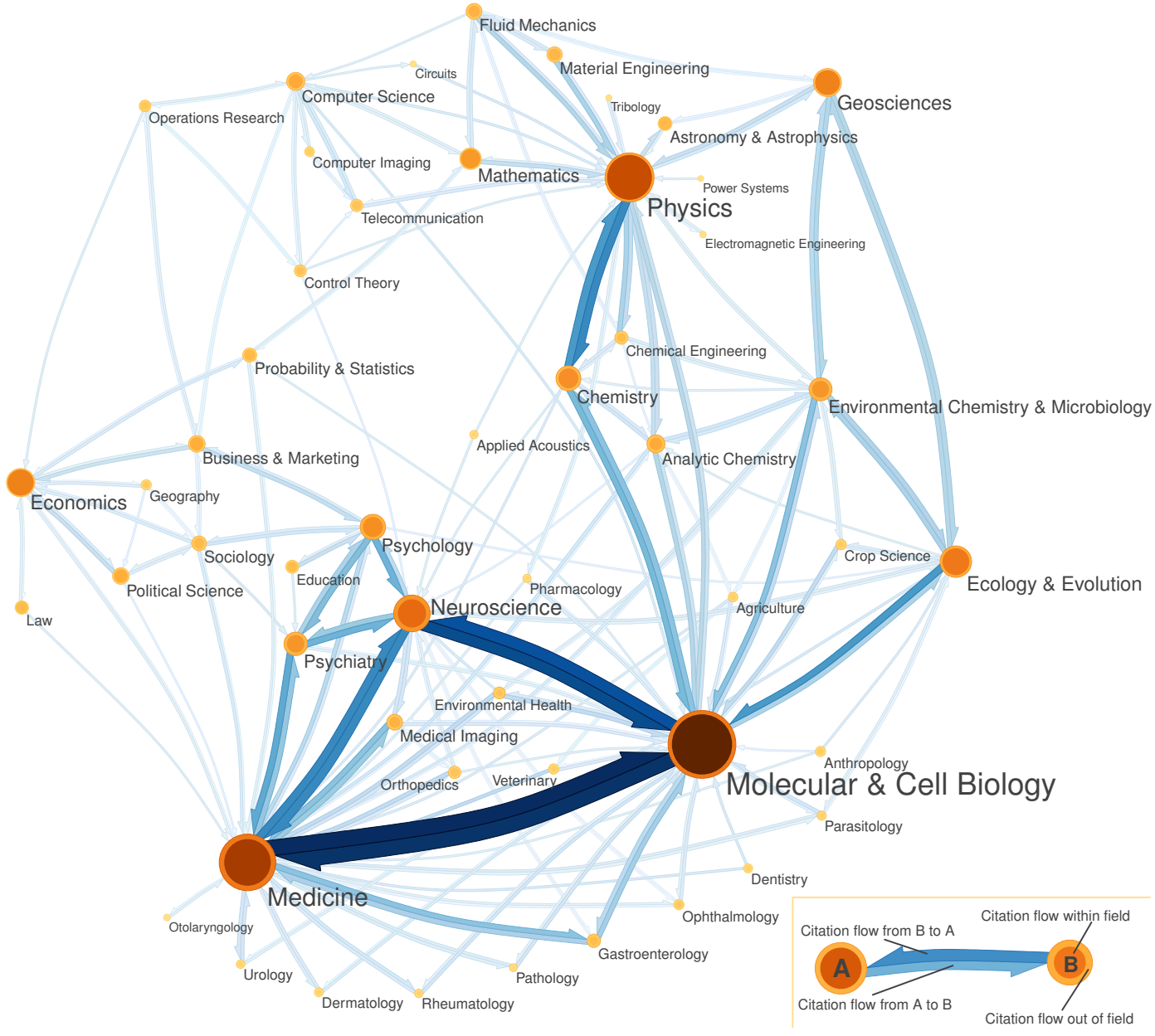
Journal of Economic Literature 2008 IF (3.65)
(cites in 2008 to paper published in 2006-2007)



Map of 800 terms based on co-occurrence in abstracts of OR journals (VOSviewer)



# Map of ISI fields (VOSviewer)



# Evaluative bibliometrics and bibliometric indices

## Evaluative bibliometrics

- publications in journals are the central research output
- citations to publications are important signs of recognition
- the more publication & citations you have the better

"bibliometrically limited view of a complex reality" (A. van Raan, 2005)

- count publications & citations
- summarize these counts by indices

# Evaluative bibliometrics and bibliometric indices

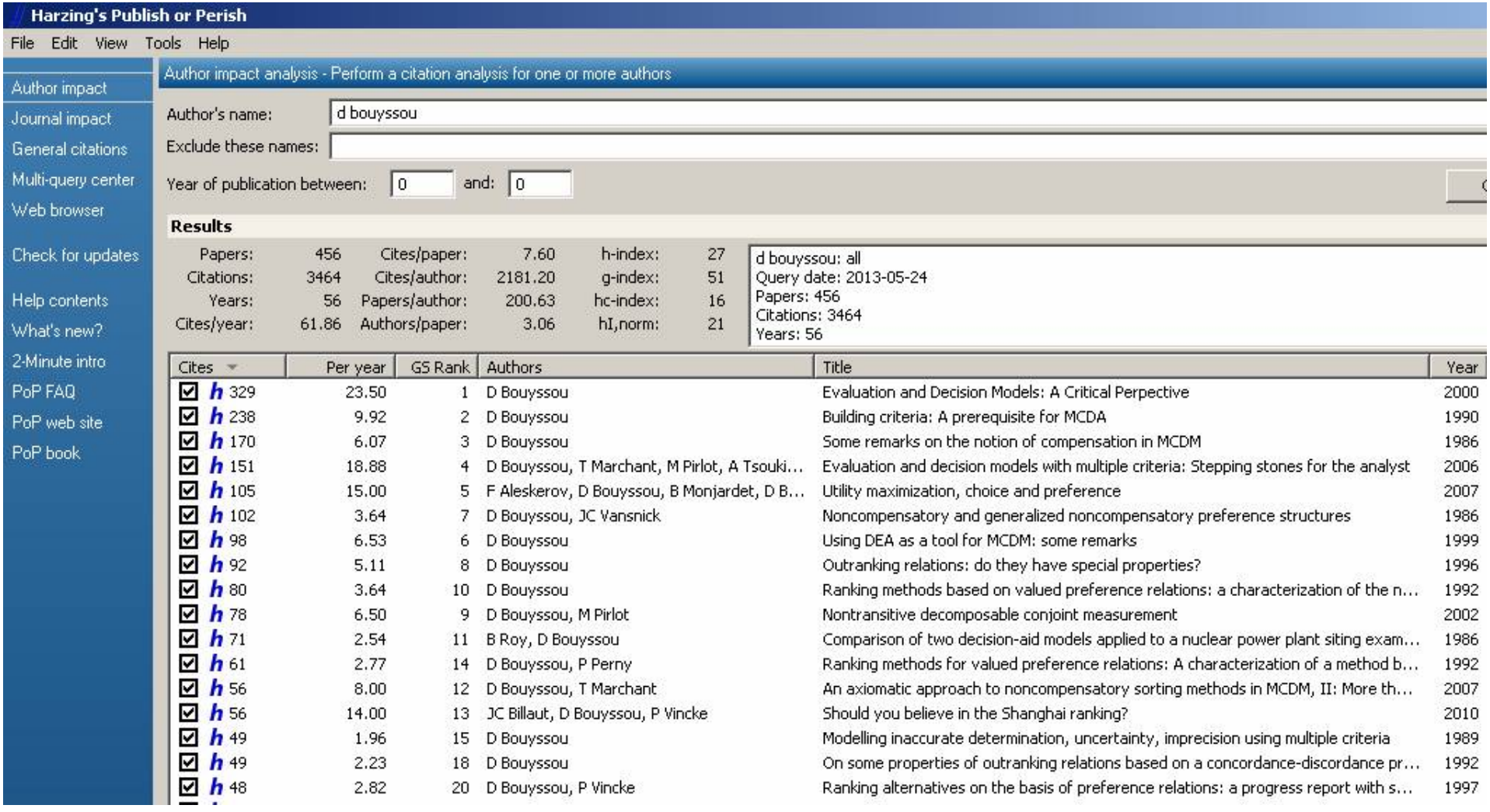
## Databases

- Web of Science (ISI, Thomson Reuters)
- Scopus (Elsevier)
- Google Scholar

Record publications and citations
Online uses during evaluation committees by often uninformed users



DB: 456 papers, 3464 citations, $h$-index = 27



Harzing's Publish or Perish

File Edit View Tools Help

Author impact
Journal impact
General citations
Multi-query center
Web browser
Check for updates
Help contents
What's new?
2-Minute intro
PoP FAQ
PoP web site
PoP book

Author impact analysis - Perform a citation analysis for one or more authors

Author's name: d bouyssou
Exclude these names:
Year of publication between: 0 and: 0

**Results**

| | | | | | |
|---|---|---|---|---|---|
| Papers: | 456 | Cites/paper: | 7.60 | h-index: | 27 |
| Citations: | 3464 | Cites/author: | 2181.20 | g-index: | 51 |
| Years: | 56 | Papers/author: | 200.63 | hc-index: | 16 |
| Cites/year: | 61.86 | Authors/paper: | 3.06 | hI,norm: | 21 |

d bouyssou: all
Query date: 2013-05-24
Papers: 456
Citations: 3464
Years: 56

| Cites | Per year | GS Rank | Authors | Title | Year |
|---|---|---|---|---|---|
| h 329 | 23.50 | 1 | D Bouyssou | Evaluation and Decision Models: A Critical Perpective | 2000 |
| h 238 | 9.92 | 2 | D Bouyssou | Building criteria: A prerequisite for MCDA | 1990 |
| h 170 | 6.07 | 3 | D Bouyssou | Some remarks on the notion of compensation in MCDM | 1986 |
| h 151 | 18.88 | 4 | D Bouyssou, T Marchant, M Pirlot, A Tsouki... | Evaluation and decision models with multiple criteria: Stepping stones for the analyst | 2006 |
| h 105 | 15.00 | 5 | F Aleskerov, D Bouyssou, B Monjardet, D B... | Utility maximization, choice and preference | 2007 |
| h 102 | 3.64 | 7 | D Bouyssou, JC Vansnick | Noncompensatory and generalized noncompensatory preference structures | 1986 |
| h 98 | 6.53 | 6 | D Bouyssou | Using DEA as a tool for MCDM: some remarks | 1999 |
| h 92 | 5.11 | 8 | D Bouyssou | Outranking relations: do they have special properties? | 1996 |
| h 80 | 3.64 | 10 | D Bouyssou | Ranking methods based on valued preference relations: a characterization of the n... | 1992 |
| h 78 | 6.50 | 9 | D Bouyssou, M Pirlot | Nontransitive decomposable conjoint measurement | 2002 |
| h 71 | 2.54 | 11 | B Roy, D Bouyssou | Comparison of two decision-aid models applied to a nuclear power plant siting exam... | 1986 |
| h 61 | 2.77 | 14 | D Bouyssou, P Perny | Ranking methods for valued preference relations: A characterization of a method b... | 1992 |
| h 56 | 8.00 | 12 | D Bouyssou, T Marchant | An axiomatic approach to noncompensatory sorting methods in MCDM, II: More th... | 2007 |
| h 56 | 14.00 | 13 | JC Billaut, D Bouyssou, P Vincke | Should you believe in the Shanghai ranking? | 2010 |
| h 49 | 1.96 | 15 | D Bouyssou | Modelling inaccurate determination, uncertainty, imprecision using multiple criteria | 1989 |
| h 49 | 2.23 | 18 | D Bouyssou | On some properties of outranking relations based on a concordance-discordance pr... | 1992 |
| h 48 | 2.82 | 20 | D Bouyssou, P Vincke | Ranking alternatives on the basis of preference relations: a progress report with s... | 1997 |

DB: 42 papers, 415 citations, $h$-index = 12

Web of Science®

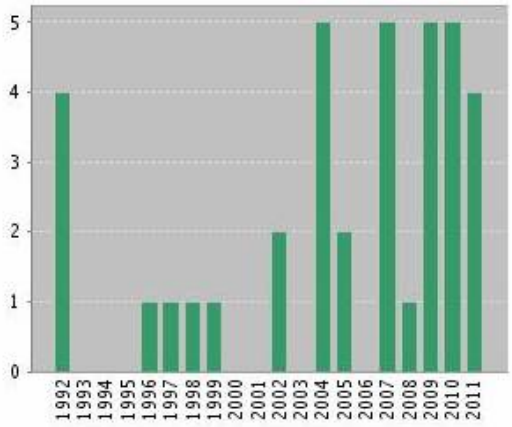
<< Back to previous page

Citation Report AU=(bouyssou d*)

Timespan=All years. Databases=IC, SCI-EXPANDED, A&HCI, SSCI, CPCI-SSH, CPCI-S.

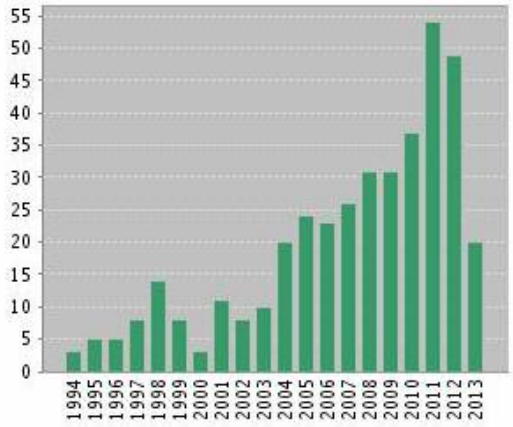
This report reflects citations to source items indexed within Web of Science. Perform a Cited Reference Search to include citations to items not indexed within Web of Science.

Published Items in Each Year




The latest 20 years are displayed.
View a graph with all years.

Citations in Each Year




The latest 20 years are displayed.
View a graph with all years.

| | |
|---|---|
| Results found: | 42 |
| Sum of the Times Cited [?]: | 415 |
| Sum of Times Cited without self-citations [?]: | 345 |
| Citing Articles[?]: | 288 |
| Citing Articles without self-citations [?]: | 262 |
| Average Citations per Item [?]: | 9.88 |
| h-index [?]: | 12 |

DB: 2929 citations, $h$-index = 27

Changer de photo

# Denis Bouyssou Modifier

CNRS LAMSADE Modifier

aide à la décision - analyse multicritère Modifier

Adresse e-mail validée de lamsade.dauphine.fr Modifier

Mon profil est privé Modifier Ajouter une page d'accueil

Google scholar

Rechercher des auteurs

Mes citations - Aide

**Citations**

| | Toutes | Depuis 2008 |
|---|---|---|
| Citations | 2929 | 1317 |
| indice h | 27 | 17 |
| indice i10 | 59 | 33 |

**Citations des articles de l'auteur**


Sélectionner : Tous, Aucun Actions Afficher : 20 1-20 Suivante >

| Titre/Auteur | Citée par | Année |
|---|---|---|
| Evaluation and Decision Models: A Critical Perpective<br>D Bouyssou<br>Kluwer Academic Pub | 330 | 2000 |
| Building criteria: A prerequisite for MCDA<br>D Bouyssou<br>Readings in multiple criteria decision aid, 58-80 | 238 | 1990 |
| Some remarks on the notion of compensation in MCDM<br>D Bouyssou<br>European Journal of Operational Research 26 (1), 150-160 | 170 | 1986 |
| Evaluation and decision models with multiple criteria: Stepping stones for the analyst<br>D Bouyssou, T Marchant, M Pirlot, A Tsoukias, P Vincke<br>International Series in Operations Research and Management Science 86 | 151 | 2006 |

**Ajouter les co-auteurs**

Pirlot Marc Ajouter -
Silvano Martello Ajouter -
Roman Slowinski Ajouter -
Elke Weber Ajouter -
birger Wernerfelt Ajouter -
Philip M. Parker Ajouter -
Mousseau Vincent Ajouter -
José Rui Figueira Ajouter -
Miguel Couceiro Ajouter -

Afficher tous les co-auteurs

**Co-auteurs**

Aucun co-auteur

Nom

E-mail

Inviter un co-auteur

Envoyer une invitation

DB: 42 papers, 390 citations, $h$-index = 9

# Bouyssou, Denis

Find potenti

## Personal

| | |
|---|---|
| Name | Bouyssou, Denis |
| Other formats | Bouyssou, D. |
| Author ID | 6701372324 |
| E-mail | bouyssou@lamsade.dauphine.fr |
| Affiliation | CNRS Centre National de la Recherche Scientifique,<br>Paris<br>France |

## Research

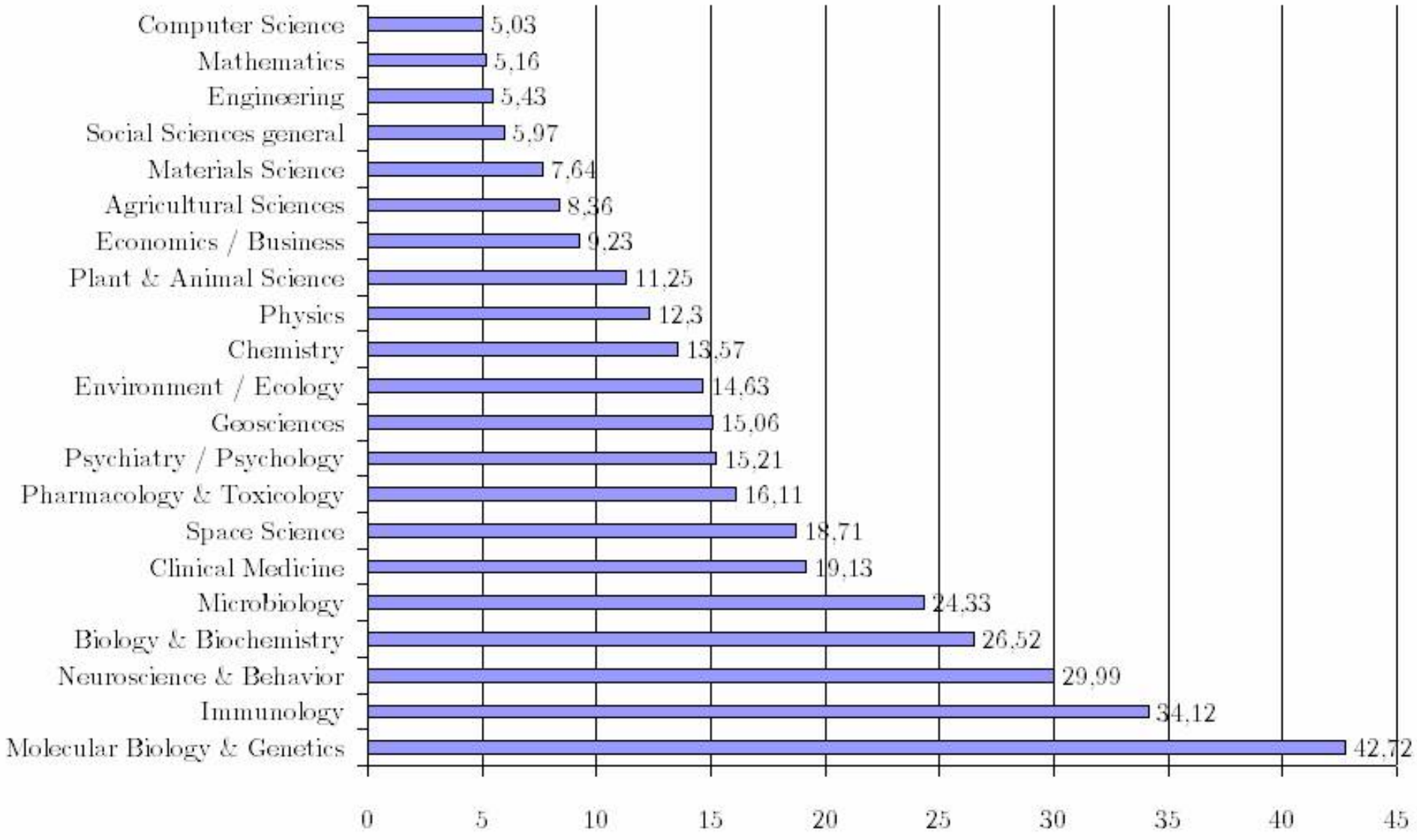
| | |
|---|---|
| Documents | 42 View Author Evaluator \| Add to my list \| Set alert \| Set feed |
| References | 748 |
| Citations | 390 total citations by 272 documents View citation overview \| Set alert |
| $h$ Index | 9 View h-Graph The $h$ Index considers Scopus articles published after 1995. |
| Co-authors | 21 |
| Web search | 1028 |
| Subject area | Decision Sciences<br>Mathematics<br>Social Sciences<br>More... |

# A few words of warning

## Databases

- cleaning is needed and not easy to do!
  - spelling errors + incorrect citations
  - names: diacritical signs, TEX ligatures, transliteration, homonyms (Martel in Québec, Park in Korea)
  - correct affiliations are extremely difficult to determine
  - counting: original articles, letters, notes, erratum, obituaries, reviews, editorials
  - lost citations (up to 30%)
- important differences between fields
  - publication intensity
  - citation intensity & behavior
  - longevity of papers (months vs decades)

# Citation intensity for the 21 ISI categories



# A few more words of warning

## Science is not immune to social effects

- peer review has documented defects (tests / retests)
- motives for citation are diverse (negative citations, perfunctory citations)
- self citations and network effects
- manipulation of the JIF by editors

Humbolt & Merton vs Bourdieu

## Nightmares

- how to deal with multiple authors (sometimes more than 1 000)
- how to deal with multiple affiliations
- what is an author? (ghost authors, unequal contributions, . . . )
- people react and adapt quickly: perverse effects are pervasive
- epistemology: normal science vs paradigm shifts (Kuhn)

# Examples of papers with many authors

| Papers with highest numbers of authors, by year, 2002-2011 | | |
|---|---|---|
| **Year** | **Paper** | **Number of authors** |
| 2011 | ATLAS Collaboration (G. Aad, *et al.*), "Search for quark contact interactions in dijet angular distributions in pp collisions at root s=7 TeV measured with the ATLAS detector," *Phys. Lett. B*, 694(4-5): 327-45, 2011. | 3,179 |
| 2010 | ATLAS Collaboration (G. Aad, *et al.*), "Charged-particle multiplicities in pp interactions at root s=900 GeV measured with the ATLAS detector at the LHC ATLAS Collaboration," *Phys. Lett. B*, 688(1): 21-42, 2010. | 3,221 |
| 2009 | LIGO Sci. Collaboration, Virgo Collaboration (B.P Abbott, *et al.*), "An upper limit on the stochastic gravitational-wave background of cosmological origin," *Nature*, 460(7258): 990-4, 2009. | 657 |
| 2008 | CMS Collaboration (S. Chatrchyan, *et al.*), "The CMS experiment at the CERN LHC," *J. Instrumentation*, 3: No. S08004, 2008. | 3,101 |
| 2007 | CMS Collaboration (G.L. Bayatian, *et al.*), "CMS physic technical design report, volume II: Physics performance," *J. Phys. G.-Nucl. Part. Phys.* | 2,011 |
| 2006 | ALEPH, DELPHI, L3, OPAL, and SLD Collaborations (S. Schael, *et al.*), "Precision electroweak measurements on the Z resonance," *Phys. Reports*, 427(5-6): 257-454, 2006. | 2,517 |
| 2005 | Antiretroviral Therapy Cohort Collaboration (D. Costagliola, *et al.*), "Incidence of tuberculosis among HIV-infected patients receiving highly active antiretroviral therapy in Europe and North America," *Clin. Infect. Diseases*, 41(12): 1772-82, 2005. | 859 |
| 2004 | MEGA Study Group (H. Nakamura, *et al.*), "Design and baseline characteristics of a study of primary prevention of coronary events with pravastatin among Japanese with mildly elevated cholesterol levels," *Circulation J.*, 68(9): 860-7, 2004. | 2,459 |
| 2003 | D. Acosta, *et al.* (CDF II Collaboration), "Measurement of the mass difference M(D(s)(+))-m(D(+)) at CDF II," *Phys. Rev. D*, 68(7): No 072004, 2003. | 818 |
| 2002 | B. Aubert, *et al.* (BABAR Collaboration), "The BABAR detector," *Nucl. Instr. Meth. Phys. Res. Sect. A*, 479(1): 1-116, 2002. | 824 |

# Bibliometric indices

## Hypotheses

- all above problems have been taken care of
- you have a good verified and cleaned database

## Many possible indices

- counting of papers
- counting of citations
- sum of Impact Factors
- Markovian indices (PageRank)
- $h$-index and its variants

# Properties of Bibliometric indices

## Bibliometric Indices

- what properties?
- how to compare them?
- how to combine them?

## Motivation

- choosing bibliometric indices should be a subject of scientific investigation
- this choice should not be in the hands of evaluation bureaucrats

# Potential problems with the $h$-index (1/2)

## Evaluation of authors

- $h$-index
  - the $h$-index of an author is $x$ if this author $x$ papers having at least $x$ citations each (and her other papers have at most $x$ citations each)
  - author $f$: 4 papers with 4 citations each
  - author $g$: 3 papers with 6 citations each
- $i_h(f) = 4 > i_h(g) = 3$

- both authors publish a new paper with 6 citations
- $i_h(f^*) = 4 = i_h(g^*) = 4$

- both authors publish a new paper with 6 citations
- $i_h(f^{**}) = 4 < i_h(g^{**}) = 5$

# Potential problems with the $h$-index (2/2)

## Evaluation of authors and departments

- $h$-index
  - the $h$-index of an author is $x$ if this author $x$ papers having at least $x$ citations each (and her other papers have at most $x$ citations each)

## Department $a = (a_1, a_2)$

- author $a_1$: 4 papers each one cited 4 times
- author $a_2$: 4 papers each one cited 4 times
  - $h$-index of both authors is 4
  - $h$-index of the department is 4

## Department $b = (b_1, b_2)$

- author $b_1$: 3 papers each one cited 6 times
- author $b_2$: 3 papers each one cited 6 times
  - $h$-index of both authors is 3
  - $h$-index of the department is 6

- the “best” department contains the “worst” authors!

# Model of Authors

## Authors

- an author is a function $f$ from $\mathbb{N}$ to $\mathbb{N}$
- $f(x)$ is the number of papers by this author having received $x$ citations

## Set of all Authors

- $\mathscr{A}$ is the set of all functions $f$ from $\mathbb{N}$ to $\mathbb{N}$ such that

$$\sum_{x \in \mathbb{N}} f(x) \text{ is finite}$$

## Objective

- build a binary relation $\succsim$ on $\mathscr{A}$
- $f \succsim g$ is "given their publication/citation record, scientists $f$ is at least as good as scientist $g$"

## Limitations

- coauthors are ignored in this talk

# Notation and remarks

## Notation

- $\mathbf{0}$ is an author without any paper
- $\mathbf{1}_x$ is an author with 1 paper having received $x$ citations

## Remarks

Authors are modelled as functions

- it makes sense to add two authors $f$ and $g$: $f + g$
- it makes sense to multiply an author $f$ by an integer $n$: $n \cdot f$

# Model of Departments

## Departments

- a department of size $k$ is an element of $\mathscr{A}^k$: $(f_1, f_2, \ldots, f_k)$

## Set of all Departments

$$\mathscr{D} = \bigcup_{k \in \mathbb{N}} \mathscr{A}^k$$

## Objective

- build a binary relation $\trianglerighteq$ on $\mathscr{D}$
- $A \trianglerighteq B$ is "given their publication/citation record of the scientists in departments $A$ and $B$, department $A$ is at least as good as department $B$"

## Limitations

- multiple affiliations are ignored
- field normalization is ignored

# Axioms

## Consistency

Let $A = (a_1, a_2, \ldots, a_k)$ and $B = (b_1, b_2, \ldots, b_k)$ be two departments of size $k$.
If $a_i \succsim b_i$, for all $i \in \{1, 2, \ldots, k\}$ then $A \trianglerighteq B$
Furthermore if $a_i \succ b_i$, for some $i \in \{1, 2, \ldots, k\}$ then $A \rhd B$

## Independence

For all $f, g \in \mathscr{A}$ and all $x \in \mathbb{N}$

$$f \succsim g \Leftrightarrow f + \mathbf{1}_x \succsim g + \mathbf{1}_x$$

## Transfer

For all $A = (a_1, a_2, \ldots, a_k) \in \mathscr{D}$, all $i, j \in \{1, 2, \ldots, k\}$ and all $x \in \mathbb{N}$

$$(a_1, \ldots, a_i + \mathbf{1}_x, \ldots, a_k) \triangleq (a_1, \ldots, a_j + \mathbf{1}_x, \ldots, a_k)$$

# Interpretation and Results

## Interpretation

- Consistency appears uncontroversial
- Independence appears uncontroversial
- Transfer is strong (but used quite often)
  - "Inequalities" within departments are ignored

## Proposition 1

If $\succsim$ and $\trianglerighteq$ are linked by Consistency and if $\trianglerighteq$ satisfies Transfer then $\succsim$ satisfies Independence

## Corollary

If $\succsim$ is the ranking of authors based on the $h$-index then there is no $\trianglerighteq$ such that Transfer and Consistency hold

# Scoring rules for scientists

## Definition 1

$\succsim$ is a scoring rule for scientists (s-scoring rule) if there is a real valued function $u$ on $\mathbb{N}$ such that

$$f \succsim g \Leftrightarrow \sum_{x\in\mathbb{N}} f(x)u(x) \geq \sum_{x\in\mathbb{N}} g(x)u(x)$$

- $u(x)$ gives the worth of one publication with $x$ citations
- many bibliometric indices are scoring rules (but not the $h$-index)
- all scoring rules satisfy independence

## Examples

- $u(x) = x$: number of citations
- $u(x) = 1$: number of publications
- $u(x) = 1$ if $x \geq \alpha$: number of highly cited publications

# Rules for departments

## Definition 2

$\trianglerighteq$ is a scoring rule for departments (d-scoring rule) if there is a real valued function $v$ on $\mathbb{N}$ such that

$$(a_1, a_2, \ldots, a_k) \trianglerighteq (b_1, b_2, \ldots, b_\ell) \Leftrightarrow \sum_{i=1}^{k} \sum_{x \in \mathbb{N}} a_i(x) v(x) \geq \sum_{i=1}^{\ell} \sum_{x \in \mathbb{N}} b_i(x) v(x)$$

## Definition 3

$\trianglerighteq$ is an averaging rule for departments (d-averaging rule) if there is a real valued function $v$ on $\mathbb{N}$ such that

$$(a_1, a_2, \ldots, a_k) \trianglerighteq (b_1, b_2, \ldots, b_\ell) \Leftrightarrow \frac{1}{k} \sum_{i=1}^{k} \sum_{x \in \mathbb{N}} a_i(x) v(x) \geq \frac{1}{\ell} \sum_{i=1}^{\ell} \sum_{x \in \mathbb{N}} b_i(x) v(x)$$

# Axioms

## Archimedeanness

For all $f, g, f', g' \in \mathscr{A}$ such that $f \succ g$ there is $n \in \mathbb{N}$ such that $f' + (n \cdot f) \succsim g' + (n \cdot g)$

## Dummy Scientist

For all $k \in \mathbb{N}$ and all $(a_1, a_2, \ldots, a_k) \in \mathscr{D}$

$$(a_1, a_2, \ldots, a_k) \triangleq (a_1, a_2, \ldots, a_k, \mathbf{0})$$

## Homogeneity

For all $k, n \in \mathbb{N}$ and all $(a_1, a_2, \ldots, a_k) \in \mathscr{D}$

$$(a_1, a_2, \ldots, a_k) \triangleq (\underbrace{a_1, a_1, \ldots, a_1}_{n}, \underbrace{a_2, a_2, \ldots, a_2}_{n}, \ldots, \underbrace{a_k, a_k, \ldots, a_k}_{n})$$

# Remarks

- all s-scoring rules satisfy Archimedeanness
- Dummy Scientist is satisfied by d-scoring rules but not by d-averaging rules
- Homogeneity is satisfied by d-averaging rules but not by d-scoring rules

# Some results

**Theorem 1 (B & Marchant, 2011)**

The relations $\succsim$ and $\trianglerighteq$ are linked by Consistency, $\trianglerighteq$ satisfies Transfer and Dummy Scientist, $\succsim$ satisfies Archimedeanness
if and only if
$\succsim$ is an s-scoring rule and $\trianglerighteq$ is a d-scoring rule with $u = v$

The function $u$ is unique up to the multiplication by a positive constant

**Theorem 2 (B & Marchant, 2011)**

The relations $\succsim$ and $\trianglerighteq$ are linked by Consistency, $\trianglerighteq$ satisfies Transfer and Homogeneity, $\succsim$ satisfies Archimedeanness
if and only if
$\succsim$ is an s-scoring rule and $\trianglerighteq$ is a d-averaging rule with $u = v$

The function $u$ is unique up to the multiplication by a positive constant

# Extensions

## Extensions

- add additional conditions to restrict the shape of $u$
  - $u$ is nondecreasing
  - $u$ is constant
  - $u$ is linear

Easy!

# Discussion of results

## Axioms

- Consistency is highly desirable
- Independence is highly desirable (but violated by the $h$-index)
- Archimedeanness is technical
- Transfer is more debatable (anonymity & inequality)

## Extensions

- coauthors
- multiple affiliations
- field normalization

## Warning

- beware of institutions using the $h$-index!

I will not use the h-index anymore
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# Messages

## Bibliometrics

- bibliometrics is not limited to evaluative bibliometrics
- evaluative bibliometrics is an interesting field of study
- many wrong beliefs are floating around

## Evaluative bibliometrics in practice

- it should be used with much care
- it should not be in the hands of laypersons
- it should not be entrenched in formal rules
- it can be useful if used together with careful and impartial peer review

## Excellence: IDEX, LABEX, PES

- excellence is another word for outliers
  - not everyone can be excellent!
  - what should we do with people that are not excellent?
  - is the mantra of excellence a good motivating tool?

# References



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*Statistical Science*, **24** (1), 1–14


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Bouyssou, D., Marchant, T. (2011)
Ranking scientists and departments in a consistent manner
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