## Measuring research impact: citation metrics in scholarship Chinmay Shah

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## CITATION METRICS

- What Types of Data are best for which Purposes?
  - There are no all-purpose indicators
  - Start by identifying the question the results are supposed to answer, then collect data
  - Clearly define
    - Purpose of the evaluation
    - Types of data required
    - How the results will be used

#### WHAT DO INSTITUTIONS WANT TO FIND OUT FROM CITATION METRICS

- What is the university's research performance?
- Are we competitive compared with our peers?
- How can the university forecast growth?
- Which are our centers of excellence?
- What is our citation ranking?
- What is the influence of our research?
- Which are our most influential papers?
- Which are our top researchers?

## Other use

- > In the digital age it's increasingly "Get cited or perish"
- > Departments track citation counts for individuals/subgroups
- Noticeable increase in requests for citation metrics from faculty, especially for tenure and promotion & graduate students
- Emphasis on quantitative data & evaluating output to make decisions in academic units
- Citation counts used in tenure & funding decisions by institutions
- > To consider a broad range of "usage" and "metrics"

- To discuss what shapes success (or lack thereof)
- > Does "value" shift across disciplines?
- connection between *impact | quality | importance*?
- Rank or visualize impact of publications, scholars & journals
- > Discover new research areas and trends by *mapping*
- See which journals are most important, and publish in those journals

## How is citation analysis done?

citation, Journal & Author Metrics are part of field called bibliometrics

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- Biometrics s "discipline of measuring performance of a researcher, collection of articles, journal, research discipline or institution". It involves "application of statistical analyses to study patterns of authorship, publication, and literature use" (Lancaster 1977)
- What is being counted? # papers published per individual, institutional aggregated # of citations, cites per paper, cites per journal, cites per book, cites per book chapter ...& so on

## **Traditional Impact Measures**

- . Journal impact factor (<u>Web of Science</u>, <u>Eigenfactor</u>)
- Individual scholar impact: h-index,(<u>Web of Science</u>, also <u>Google Scholar</u>), G-index
   Individual scholar impact: <u>i10-index</u> (<u>Google Scholar</u>)
- Individual article impact: Citation count (<u>Web of</u> <u>Science</u>; <u>Google Scholar</u>)
  - <u>InCites</u>

#### Impact Factor

Impact Factor



Journal Impact Factor 🕖		
Cites in 2007 to articles published in: 200	6 = 10096	Number of articles published in: 2006 = 352
20	5 = 9958	2005 = 319
Su	n: 20054	Sum: 671
Calculation: <u>Cites to recent articles</u> Number of recent articles	<u>20054</u> =2 671	29.887

#### Journal Immediacy Index D

Cites in 2007	7 to articles published in 200	7=2343
Number of a	ticles published in 2007	=366
Calculation:	Cites to current articles	<u>2343</u> =6.402
	Number of current articles	366

## The h-index is defined by how many **h** of a researcher's publications (Np) have at least **h** citations each

Citation Report Author=(Hirsch JE)

mespaneAll Years: Databases=SCI-EXPANDED, SSCI, A&HCI.

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.



Ļ	Use the checkboxes to remove individual items from this Citation Report or restrict to items processed between 1975 v and 2009 v Go	2005	2006	2007	2008	2009 ► 601	Total 10,869	Average Citations per Year 319.68
51.	Title: KONDO EFFECT VERSUS INDIRECT EXCHANGE IN THE 2- IMPURITY ANDERSON MODEL - A MONTE-CARLO STUDY Author(s): FYE RM, HIRSCH JE, SCALAPINO DJ Source: PHYSICAL REVIEW B Volume: 35 Issue: 10 Pages: 4901-4908 Published: APR 1 1987	1	2	1	2	4	58	2.52
52.	Title: SPIN AND CHARGE CORRELATIONS AROUND AN ANDERSON MAGNETIC IMPURITY Author(s): GUBERNATIS JE, HIRSCH JE, SCALAPINO DJ Source: PHYSICAL REVIEW B Volume: 35 Issue: 16 Pages: 8478-8485 Published: JUN 1 1987	1	3	1	0	3	57	2.48
□ 53.	Title: SUBLATTICE-SYMMETRIC SPIN-WAVE THEORY FOR THE HEISENBERG-ANTIFERROMAGNET Author(s): TANG S, LAZZOUNI ME, HIRSCH JE Source: PHYSICAL REVIEW B Volume: 40 Issue: 7 Pages: 5000-5006 Part Part B Published: SEP 1 1989	3	0	3	1	1	52	2.48

## Variation

- The m-index, introduced by the creator of the h-index, is defined as the h-index divided by the number of years since the researcher's first publication. The index is meant to normalize the h-index so that early- and late-stage scientists can be compared. The m-index averages periods of high and low productivity throughout a career, which may or may not be reflective of the current situation of the scientist.
- The h-index is relatively unaffected by a small number of exceptionally well-cited articles (eg, reviews). But the case can be made that researchers who have published a landmark paper should get the proper credit for it.

- The g-index was developed for this reason. Like the hindex, when a researcher's publications are listed in decreasing order of citations received, the g-index is the largest number such that the top g articles received, in total, at least g<sup>2</sup> citations. Therefore, a few well-cited papers can significantly increase the g-index relative to the corresponding h-index.
- Like the g-index, the <u>e-index</u> aims to address the number of "excess" citations above and beyond the h-index. The e-index is defined as the square root of the sum of the "excess" citations in the papers that contributed to the h-index.

## **Eigenfactor metrics**

 While Impact Factor has a one year census period and uses the two previous years for the target window, the Eigenfactor metrics have a one year census period and use the five previous years for the target window

#### **Eigenfactor Metrics**



5-Year Journal Impact Factor	)	
Cites in {2007} to items published in	: 2006 = 1783	Number of items published in: 2006 = 167
	2005 = 2224	2005 = 190
	2004 = 3092	2004 = 274
	2003 = 2857	2003 = 289
	2002 = 2280	2002 = 195
	Sum: 12236	Sum: 1115
Calculation: <u>Cites to recent items</u> Number of recent items	<u>12236</u> = <b>1</b> 1115	0.974

## The i10-index

 This indicates the number of <u>academic</u> <u>publications</u> an author has written that have at least ten citations from others. It was introduced in July 2011 by <u>Google</u> as part of their work on <u>Google Scholar</u>, a search engine dedicated to academic and related papers

## DISCIPLINARITY INDEX

• A measure of the concentration of a set of papers over a set of categories. The index ranges from 0 to 1, where the higher the number, the more concentrated the set. For example, an index of .9 indicates a high level of concentration. This index is based on the Herfindahl index, which is commonly used in economics to assess market share

- 1. Cites: Total citation count for selected paper.
- 2. Cites2: 2<sup>nd</sup> generation cite count based on total citations received by the *citing* articles.
- **3.** Expected Citation Rate: An average rate of citation for all the papers of that document type (articles, reviews, letters, etc.), in that journal, for that selected year. This is a metric to evaluate citation counts.
- 4. Ratio: Ratio of expected cites to actual cites
- 5. Field: Subject area for the journal in which the paper appeared.
- 6. %: Percentile position of the paper based on citations in the same field.

1. Cites: Total citation count for selected paper.

View Source Papers One at a Time Print Ourrent Screen		
Buller, KM Crane, JW Day, TA Dayas, CV Xu, J	EUR J NEUROSCI, vol:14, pg:1143-1152, 2001. Stressor categorization: acute physical and ps stressors elicit distinctive recruitment pattern amygdala and in medullary noradrenergic cell	vchological s in the groups percentile: 3.454%
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type author P Reprint Dayas, CV	address Univ Queensland, Dept Phys	siol & Pharmacol, Sch Biomed Sci, Brisbane, Qld 4072, Australia
abstract It has been hypothesized that the brr response pathways that vary in accor true, stressors should elicit patterns of category-specific. Data from previous studies have hinted that this is the ca- render conclusions tenuous. In the pr expression of c-fos was used as a ma by hearnortrage, immune challenge, elicited c-fos expression in 25-30% of corticotrophin-releasing-factor cells, comparable strength, at least with reg	in categorizes stressors and utilizes neural dance with the assigned category. If this is of neuronal activation within the brain that are Immediate-early gene expression mapping es, but interstudy differences in methodology resent study, immunolabelling for the rker of neuronal activity elicited in the rat brain noise, restraint and forced swim. All stressors f hypothalamic paraventricular nucleus suggesting that these stimuli were of pard to their ability to activate the	author keywords / keywords plus forced swim haemorrhage hypothalamic-pituitary-adrenal axis immune challenge noise rat restraint CORTICOTROPIN-RELEASING FACTOR PITUITARY-ADRENAL AXIS C-F0S EXPRESSION PARAVENTRICULAR NUCLEUS
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Cites: 85

2. Cites2: 2nd generation cite count based on total citations received by the *citing* articles.

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Buller, KM Crane, JW Day, TA		EUR J NEUROSCI, vo	ol:14, pg:1143-1152, 2	001.	cites: 85	xcr: 20.82	cites2: 574
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Cites: 85

Cites2: 574

**3.** Expected Citation Rate: An average rate of citation for all the papers of that document type (articles, reviews, letters, etc.), in that journal, for that selected year. This is a metric to compare peer journal papers.

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Buller, KM Crane, JW Day, TA Dayas, CV Xu, J	cites: 85 rchological in the roups	xcr: 20.82 otes2: 574 Code: JEINCES	
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Cites:	85
Cites2:	574

#### **Expected Citation Rate: 20.8**

(All Articles from European Journal of Neuroscience in 2001 received on average 20.8 cites through year-end 2006.)

4. Ratio: Ratio of expected cites to actual cites

View Source Papers One at a Time				
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Buller, KM Crane, JW Day, TA	EUR J NEUROSCI, vol:14, pg:1143-1152, 2001	cites: 85	xcr: 20.82	cites2: 574
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Cites:	85
Cites2:	574

#### Expected Citation Rate: 20.8

Ratio: 4.1 [85: 20.8 = 4.1]

5. Field: Subject area for the journal in which the paper appeared.

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Buller, KM Grane, JW Day, TA Dayas, CV Xu, J	EUR J NEUROSCI, vol:14, po Stressor categorization: a stressors elicit distinctive r amygdala and in medullary	1:1143-1152, 2001. ute physical and psycho ecruitment patterns in t noradrenergic cell grou	logical he ps ps cites: 85 Category Code NEUROSCIENC percentile: 3,	xor: 20.82 oites2: 574 : ES 45446
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	First Back Next L	ast	End View	

Cites: 85 Cites2: 574 Expected Citation Rate: 20.8 Ratio: 4.1

#### Field: Neuroscience

[Note: For the multidisciplinary journals Science, Nature and PNAS, all articles and reviews are reassigned based on the primary category to which the article's citing and cited journals are assigned.]

6. Percentile: position of the paper based on citations in the same field and year.

Buller, KM       Cane, JW         Day, TA       Dayas, CV         XL, J       Stressor categorization: acute physical and psychological stressors elicit distinctive recruitment patterns in the arrygdala and in medullary noradrenergic cell groups       Category Code: NEUROSCIENCES         Image: CV       Stressor categorization: acute physical and psychological stressors elicit distinctive recruitment patterns in the arrygdala and in medullary noradrenergic cell groups       Category Code: NEUROSCIENCES         Image: CV       Univ Queensland       Department       City       State Country         Image: View of the provide stressors and utilizes neural response pathways that vary in accordance with the assigned category. If this is true, stressors should elicit patterns of neuronal activation within the brain that are category-specific. Data from previous Immediate-are ygene spressons in Cos was used as a marker of neuronal activide for the pressons for took subme challenge, noise, restraint and forced swim. All stressors elicited cfos expression in 25-30% of thypothalamic praventricular nucleus or conclusions tenuous. In the present study, immunolabeling for the restraint of Core coles sing-factor cells, suggesting that these stimuli were of conclusions tenuous. In the present study, immunolabeling for the conclusions tenuous. In the present study, immunolabeling for the conclusions tenuous. In the present study, immunolabeling for the cells suggesting that these stimuli were of conclusions tenuous. In the present study, immunolabeling for the conclusions tenuous. In the present study, immunolabeling for the cells suggesting that these stimuli were of conclusions tenuous. In the present study, immunolabeling for the cells stressors on theodology ender conclusions	View Source Papers O Print Current Screen	ne at a Time					
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type       author       address         Reprint       Dayas, CV       Univ Queensland, Dept Physiol & Pharmacol, Sch Biomed Sci, Brisbane, Qld 4072, Australia         abstract       author keywords / keywords plus         It has been hypothesized that the brain categorizes stressors and utilizes neural response pathways that vary in accordance with the assigned category. If this is true, stressors should elicit patterns of neuronal activation within the brain that are category-specific. Data from previous Immediate-early gene expression mapping studies have hinted that this is the case, but interstudy differences in methodology render conclusions tenuous. In the present study, immunolabelling for the expression of c-fos was used as a marker of neuronal activity elioted in the rat brain by hæmorrhage, immune challenge, noise, restraint and forced swim. All stressors elidete d-fos expression of c-fos was used as a marker of neuronal activity elioted in the rat brain by nemorrhage, factor cells, suggesting that these stimuli were of comparable strength, at least with regard to their ability to activate the work of the averaging that these stimuli were of comparable strength, at least with regard to their ability to activate the	Organization Univ Queensla	and	Department Dept Physiol & Pharmacol	City Brisb	State	Zountry Lustralia	
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Cites: 85 Cites2: 574 Expected Citation Rate: 20.8 Ratio: 4.1 Field: Neuroscience

#### Percentile: 3.5%

[The 85 cites to this Neuroscience paper places it in the top 3.5% based on the citation distribution to all papers published in this field in 2001. ]

#### Metrics for groups of papers

- 1. Total # papers and total # cites: combined numbers for the set
- 2. Mean times cited: Total cites divided by total papers. [average impact]
- 3. Median times cited: Midpoint for citations
- 4. H-Index: Number of papers (*N*) in a given dataset having *N* or more citations.
- 5. C-Index: Sum of all actual citations divided by sum of all expected citations.
- 6. Average Percentile: average of the field percentile measures which are based on field and year of publication
- 7. Disciplinarity: reflects the level of multidisciplinarity in a set of papers, ranging from 0 to 1, where the lower the number, the greater the multidisciplinarity. (Herfindal Index)

#### H-Index: Number of papers (*N*) in a given dataset having *N* or more citations.

14 papers in thisset had14 or morecitations



# C-Index: Sum of all actual citations divided by sum of all expected

C index = 1.98

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#### Average Percentile: average of the field percentile measures which are based on field and year of publication

#### Average Percentile = 31.62

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0	n	0.28	0.00	GAS	N/A	Shuber, AP	GASTROENTEROLOGY	120	A98-A99	2001	M Accurate

## Disciplinarity

 Reflects the level of multidisciplinarity in a set of papers, ranging from 0 to 1, where the lower the number, the greater the multidisciplinarity. (Herfindal Index)