Jointly published by Akadémiai Kiadó, Budapest and Springer, Dordrecht

Scientometrics, Vol. 64, No. 1 (2005) 101–109

Correspondence

Academic ranking of world universities using scientometrics – A comment to the "Fatal Attraction"

NIAN CAI LIU, YING CHENG, LI LIU

Institute of Higher Education, Shanghai Jiao Tong University, Shanghai (China)

The Institute of Higher Education, Shanghai Jiao Tong University published on the web the Academic Ranking of World Universities and attracted wide attentions worldwide. 60% of their criteria are based on the databases using scientometrics. They were aware of all possible technical problems, have gone through "clean up" processes and made necessary corrections. Highly cited researchers and articles published in *Nature* and *Science* were identified one by one and attributed to the correct institutions. They are confident that errors including human ones in their data are less than two percent. They will continue their ranking efforts, improve their ranking methodologies and provide more choices on the ranking lists.

Introduction

In order to find out the gap between Chinese universities and world-class universities, the Institute of Higher Education, Shanghai Jiao Tong University (hereafter called the Jiao Tong Group) has tried to rank research universities in the world by their academic or research performance based on internationally comparable data that everyone could check.

Upon the request of many colleagues from different countries, the Jiao Tong Group decided to publish its ranking on the web as the Academic Ranking of World Universities (hereafter called the Ranking).[1] Since the initial publication of the Ranking, the Jiao Tong Group have received numerous emails, about one third of the emails simply applaud the Ranking, 60% of the emails are positive about the Ranking and offer suggestions on how to improve the Ranking. Only about 5% of the emails have negative views on the Ranking. In addition, many well-known institutions, organizations, government agencies and the media have reported or cited the Ranking.

Received October 12, 2004

Address for correspondence:
NIAN CAI LIU
Institute of Higher Education, Shanghai Jiao Tong University, Shanghai 200240, China
E-mail: ncliu@sjtu.edu.cn

0138–9130/US $ 20.00

Recently, Anthony F. J. van Raan of Leiden University (hereafter called the Leiden Group) published an article "Fatal attraction: Ranking of universities by bibliometric methods" (hereafter called the Fatal Attraction) in *Scientometrics*.[2] In the Fatal Attraction, the Leiden Group raised many doubts about the Ranking. Before going into the technical problems related to scientometrics of the Ranking and the methodological problems of the Ranking, the methodologies of the Ranking have to be explained.

Methodologies of the ranking

Ranking criteria and weights

The Jiao Tong Group ranks universities by several indicators of academic or research performance, including alumni and staff winning Nobel Prizes and Fields Medals, highly cited researchers, articles published in *Nature* and *Science*, articles indexed in Science Citation Index-Expanded and Social Science Citation Index, and academic performance with respect to the size of an institution. Table 1 gives the details of the criteria and weights.

Table 1. Criteria and weights for the academic ranking of world universities – 2004

Criteria	Indicator	Code	Weight
Quality of education	Alumni of an institution winning Nobel Prizes and Fields Medals	*Alumni*	10%
Quality of faculty	Staff of an institution winning Nobel Prizes and Fields Medals	*Award*	20%
	Highly cited researchers in 21 broad subject categories	*HiCi*	20%
Research output	Articles published in *Nature* and *Science*	*N&S*	20%
	Articles Indexed in Science Citation Index-Expanded and Social Science Citation Index	*SCI*	20%
Size of institution	Academic performance with respect to the size of an institution	*Size*	10%
Total			100%

For institutions specialized in humanities and social sciences such as London School of Economics, *N&S* is not considered, and the weight of *N&S* is relocated to other indicators.

Definition of indicators

Alumni indicates the total number of the alumni of an institution winning Nobel Prizes and Fields Medals. Alumni are defined as those who obtain bachelor, Master's or

doctoral degrees from the institution. Different weights are set according to the periods of obtaining degrees. The weight is 100% for alumni obtaining degrees in 1991–2000, 90% for alumni obtaining degrees in 1981–1990, 80% for alumni obtaining degrees in 1971–1980, and so on, and finally 10% for alumni obtaining degrees in 1901–1910. If a person obtains more than one degrees from an institution, the institution is considered once only.

Award indicates the total number of the staff of an institution winning Nobel prizes in physics, chemistry, medicine and economics and Fields Medals in Mathematics. Staff is defined as those who work at an institution at the time of winning the prize. Different weights are set according to the periods of winning the prizes. The weight is 100% for winners in 2001–2003, 90% for winners in 1991–2000, 80% for winners in 1981–1990, 70% for winners in 1971–1980, and so on, and finally 10% for winners in 1911–1920. If a winner is affiliated with more than one institution, each institution is assigned the reciprocal of the number of institutions. For Nobel prizes, if a prize is shared by more than one person, weights are set for winners according to their proportion of the prize.

HiCi indicates the number of highly cited researchers in 21 broad subject categories in life sciences, medicine, physical sciences, engineering and social sciences. These individuals are the most highly cited within each category for the period of 1981–1999. The definition of categories and detailed procedures can be found at the website of Institute of Scientific Information (ISI).

N&S indicates the number of articles published in *Nature* and *Science* between 1999 and 2003. To distinguish the order of author affiliation, a weight of 100% is assigned for corresponding author affiliation, 50% for first author affiliation (second author affiliation if the first author affiliation is the same as corresponding author affiliation), 25% for the next author affiliation, and 10% for all other author affiliations. Only publications of article type in the ISI database are considered.

SCI indicates the total number of articles indexed in Science Citation Index-Expanded and Social Science Citation Index in 2003. Only publications of article type in the ISI database are considered.

Size indicates the total scores of the above five indicators divided by the number of full-time equivalent academic staff. If the number of academic staff for institutions of a country cannot be obtained, the weighted total scores of the above five indicators is used. For ranking 2004, the number of full-time equivalent academic staff are obtained for institutions in USA, China (mainland), Italy, Netherlands, Sweden, and Belgium etc.

Scoring procedures

For each indicator, the highest scoring institution is assigned a score of 100, and other institutions are calculated as a percentage of the top score. The distribution of data

for each indicator is examined for any significant distorting effect; standard statistical techniques are used to adjust the indicator if necessary.

Scores for each indicator are weighted to arrive at a final overall score for an institution. The highest scoring institution is assigned a score of 100, and other institutions are calculated as a percentage of the top score. The scores are then placed in descending order. An institution's rank reflects the number of institutions that sit above it.

About the technical problems

The Jiao Tong Group were aware of all possible problems

The Jiao Tong Group were aware of all possible problems including the matching of citing publications with cited publications, the unification of institutional addresses and the attribution of publications to specific institutions, and the definition of institutions. Since the Ranking did not include citation as an indicator, therefore it will not be discussed here.

Attribution of publications to specific institutions

Indeed, the attributions of publications to specific institutions are cumbersome and extremely difficult. In addition to the problems and examples provided in the Fatal Attraction by the Leiden Group, more problems and examples are described as follows.

Many universities themselves have more than one commonly used names. In France, for example, University of Paris 7 is also called University Denis Diderot, University of Bordeaux 2 is the same as University of Victor Segalen. In the United States, University of Tennessee Health Science Center is also called University of Tennessee Memphis, Virginia Tech is the same as Virginia Polytechnic and State University. In China, traditional spelling of names are used for a number of institutions, such as Peking University for Beijing University and Tsinghua University for Qinghua University.

For institutions in non-English speaking countries, there often exists different names for the same institution due to variations in translation. For example, 'Universittat zu Koln' in Germany may be translated to University of Koeln or University of Cologne; University of Thessaloniki in Greece also has the name of University of Salonika. In addition, institution names are often written in different ways such as 'Universiteit Leiden' and Leiden University in the Netherlands.

Abbreviated names are commonly used in the ISI database for a large number of institutions. For example, RWTH Aachen for the Technical University of Aachen in Germany, ENSMP for the 'Ecole des Mines de Paris' in France, UNAM for 'Universidad Nacional Autonoma' in Mexico.

Other technical problems with institutional addresses

One must be very careful about the keywords in searching data for institutions in the same cities. For example, if one simply search Beijing University, he would obtain the results for several dozens of universities in the city of Beijing.

Merging and splitting of institutions continue to occur. For example, Cardiff university and University of Wales college of Medicine were merged into one institution in August 2004. University of Kwazulu-Natal in South Africa was a result of merger between University of Natal and University of Durban-Westville in January 2004. University of Innsbruck in Austria was splited into two independent universities, the University of Innsbruck and the Innsbruck Medical University.

Occasionally, obvious errors were found in the ISI database. For example, during the search for *Nature* and *Science* articles, addresses such as "Univ Jordan, Marine Sci Stn, Aqaba, Japan" (*Nature*, **413**, 726, 2001) and "Harvard Univ, Dept Earth & Planetary Sci, Cambridge, 02138 England" (*Nature*, **389**, 371, 1997) were found, in which the country names are obviously incorrect.

Definition of institutions

Institutions in the multi-campus university systems of United States are treated as separate institutions according to the Integrated Postsecondary Education Data System (IPEDS) of the National Center for Education Statistics (NCES) and the Carnegie Classification of Institutions of Higher Education. For example, University of California – Berkeley, University of Texas Southwestern Medical Center, University of Massachusetts – Amherst etc. are ranked as independent institutions. Similarly, the colleges of University of London are ranked separately.

Institutions or research organizations affiliated to a university are treated according to their own expression in the author affiliation of an article. If the authors identify themselves as members of a university in their affiliation, the article will be considered accordingly. Examples include the 'Ecole Polytechnique' of Montreal and 'Ecole Des Hautes Etudes Commercials de Montreal' (HEC Montreal) affiliated to University of Montreal in Canada, Lawrence Berkeley National Laboratory affiliated to the University of California – Berkeley in the United States. Similar treatment has been performed to national research organizations such as CNRS in France.

Hospitals affiliated to universities are very complex problems in many countries. Some hospitals operate rather independently and do not wish to include the university name in their affiliation. Therefore, hospitals affiliated to a university are also treated according to their own expression in the author affiliation of an article. Furthermore, it's the responsibility of the university and the hospital to write the proper affiliation in their publication; it should not be the responsibility of database manufactures and users.

Technical problems related to other criteria

In addition to the technical problems related to the scientometrics, similar problems were encountered in the attribution of Nobel Prizes to specific institutions. The names of institutions changed significantly in the past century as a result of merging, splitting, discontinuing, and name changing of universities.

The Jiao Tong Group solved most of the problems

For the Highly Cited Researchers, the Jiao Tong Group downloaded the full list from the ISI database and identified the affiliation of every researcher one by one. Researchers in a regular department, institute or school of a university without mentioning the university in their affiliation were carefully attributed to the right university. Therefore, the Jiao Tong Group are confident that 99% of the attribution is correct, though they can not guarantee 100% correctness due to possible human errors.

For articles published in *Nature* and *Science*, the Jiao Tong Group searched the ISI database country by country and counted every article one by one. Articles in a regular department, institute or school of a university without mentioning the university in their affiliation were carefully attributed to the right university. Again, the Jiao Tong Group are confident that 99% of the attribution is correct. In addition to the attribution problem, there could be human errors in assigning weight to different order of author affiliations, nevertheless, the error should be less than 1%.

For articles indexed in the Science Citation Index Expanded and Social Science Citation Index, the Jiao Tong Group tried every possible means to find solutions for the possible problems and solved most of the problems, they are confident that the error in the attribution should be less than 2%.

However, there are unsolved problems. The most important one is the distinguishment of 'Vrjie Universiteit Brussel' and 'Universite Libre Bruxelles' during the attribution of articles, both institution have the same English name of Free University of Brussels in the ISI database. They can not be distinguished from postal code either since some of their campuses have the same postal code.

There also exist remaining problem for the attribution of Nobel Prizes, particularly for those of earlier years. For example, Berlin University have won several Nobel Prizes before the second world war, both Humboldt University of Berlin and Free University of Berlin claim the right of inheriting the Nobel Prizes of the Berlin University.

Methodological problems

The controversy of ranking

Any ranking is controversial and no ranking is absolutely objective. Despite the controversy, the *US News* rankings become more and more popular in and outside the United States. College and university ranking become popular in many other countries. United Kingdom have several League tables including the *Sunday Times University Guide* and the *Guardian's Guide to Universities*. Others include the Maclean's University Ranking in Canada, the German University Ranking (*Die Besten Unis*) in Germany, the Asia Week's Best Universities in Asia. There are also several university rankings in China.

The controversy really arises from the question that whether the quality of universities can be precisely measured by mere numbers. This is similar to the complaint that whether the quality of a student can be precisely measured by scores. Universities and professors are continuing to score students without any significant changes, however, the students are usually informed that they will not be judged by scores absolutely, the university and the potential employers will have the capacity to make sophisticated, independent judgments.

People should be cautious about any ranking and should not rely on any ranking either, including the Academic Ranking of World Universities. Instead, people should use rankings simply as one kind of reference and read the ranking methodology carefully before looking at the ranking lists. The Jiao Tong Group really hopes that more ranking of world universities will appear, so that students, faculties, institutions, governments and the public in general may have a variety of choices from different aspects.

The Jiao Tong Group tried their best

It would be impossible to have a comprehensive ranking of universities worldwide, because of the huge differences of universities in the large variety of countries and the technical difficulties in obtaining internationally comparable data. The Jiao Tong Group chose to rank research universities in the world by their academic or research performance based on internationally comparable data that everyone could check. No subjective measures were taken.

Although the Jiao Tong Group have tried their best to figure out potential indicators and to obtain internationally comparable data for the thousands of research universities in the world, there are many limitations in the ranking methodology. In addition to the ones mentioned in the Fatal Attraction by the Leiden Group, there are concerns on the history of an institution, the total number of awards or articles, the institution for

winning an award and that for doing the research, the institution for obtaining a degree and that for pursuing the study, the focus of an institution, the type of academic faculty (teaching or research), etc.

Continuing efforts

Improving methodology

The Jiao Tong Group will continue their efforts in the Academic Ranking of World Universities. They will listen to opinions and suggestions from all over the world carefully and modify their ranking next summer again. The Jiao Tong Group is investigating the concerns mentioned above and will modify their ranking methodology accordingly.

Providing more choice

The Jiao Tong Group are studying on the classification of universities and will provide lists of top universities with engineering (technology) or medical orientation, extracted from the list of top 500 world universities. The Jiao Tong Group also plan to provide ranking with and without the *size* indicator, for the ranking with the *size* indicator, the weight of the *size* indicator will be as high as 50%. In addition, lists of institutions ranked by single indicators may be provided.

Final remarks

In the Fatal Attraction, the Leiden Group considered the Jiao Tong Group as "persons who do not have clear competence and experience in the field of quantitative studies of science". Actually, the Jiao Tong Group did not even regard themselves as researchers in the field of scientometrics or bibliometrics at all. Nevertheless, ranking of universities is becoming more and more influential on the development of higher education in the world. There will appear other rankings of world universities in the future. Therefore, the Jiao Tong Group do wish that the competent and experienced persons in the field of quantitative studies of science provide sufficient cleaned and corrected databases for the public and provide enough help (instead of criticism) for beginners in the fields or others using scientometrics or bibliometrics.

References

1. INSTITUTE OF HIGHER EDUCATION, SHANGHAI JIAO TONG UNIVERSITY, *Academic Ranking of World Universities.* See website http://ed.sjtu.edu.cn/ranking.htm
2. VAN RAAN, A. F. J. (2005), Fatal attraction: ranking of universities by bibliometric methods, *Scientometrics,* 62 (1): 133–143.
3. EDUCATION AND SOCIAL SCIENCE LIBRARY, UNIVERSITY OF ILLINOIS AT URBANA CHAMPAIGN, *College and University Rankings*. See website http://www.library.uiuc.edu/edx/rankings.htm