



UNIVERSITY OF BELGRADE
FACULTY OF ORGANIZATIONAL SCIENCES

A New Approach to QS University Ranking Using Composite I-distance Indicator: Uncertainty and Sensitivity Analyses

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- 2. **A new approach to the QS university ranking using the composite I-distance indicator: Uncertainty and sensitivity analyses**

By: Dobrota, Marina; Bulajic, Milica; Bornmann, Lutz; et al.

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- 3. **RANKING INSTITUTIONS WITHIN A UNIVERSITY BASED PERCENTILE-BASED APPROACH**

By: Zomic, Nikola; Bornmann, Lutz; Maricic, Milica; et al.

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- University ranking methodologies
- QS World University Rankings
- Composite I-distance indicator (CIDI) methodology
- Results
- Conclusion, Limitations, Current & Future directions of study
- Final remarks
- References





University ranking methodologies

- People just love to rank
- Particularly interesting - university rankings
- Ranking lists provide a single number - allows, at a glance, to situate a given university (Saisana & D'Hombres, 2008)
- A global phenomenon
 - many different stakeholders - students, academic staff, politicians etc. (Bornmann et al., 2013)
 - indicator of a university's reputation and performance (Dobrota et al., 2016)
 - and in last decade their number has vastly increased (Hazelkorn, 2014)
 - Science or voodoo? (Paruolo et al., 2013)





University ranking methodologies

- 2003 - Academic Ranking of World Universities (ARWU)
- 2004 - Times Higher Education-QS World University Rankings THE-QS (since 2009. published separately)
- 2004 - Webometrics
- 2007 - CWTS Leiden
- 2007 - HEEACT - NTU
- 2009 - SCImago SIR
- 2010 - URAP
- 2014 - U-Multirank
-





QS World University Rankings

- QS World University Rankings 2013/14 edition
 - 800 universities are ranked
 - over 2 000 are assessed
 - the top 400 universities are given individual ranking positions
 - the other universities are placed within groups, starting from 401-410, up to group 701+
- Compares institutions across broad areas that are of interest to prospective students: research, teaching, employability and international outlook
- Rankings are compiled using six criteria (QS, 2013)





QS World University Rankings

QS Ranking Indicators	Weights
Academic reputation (AR)	40%
Employer reputation (ER)	10%
Student-to-faculty ratio (FS)	20%
Citations per faculty (CPF)	20%
International faculty ratio (IF)	5%
International student ratio (IS)	5%

- Huang (2012)
 - comprehensive discussion on the indicators and weightings adopted in the QS methodology
 - with heavy weightings of peer reviews the result might only reflect the reputation of the university rather than the actual performance
 - the questionnaire respondents might merely enumerate international renowned universities





QS World University Rankings

Radojicic, A., Jovanovic-Milenkovic, M., & Jeremic, V. (In Press). Academic performance vs. academic reputation: What comes first - how well you perform or how others see your performance? In *World University Rankings and the Future of Higher Education*, eds. Downing, K. & Ganotice, F.A.

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QS 2014 World University Rankings by subject (Mathematics and Medicine)

Whether the academic staff (participants in the QS Global Academic Survey - Academic Reputation QS Score), rank the universities according to their actual academic performance i.e. the number and the quality of published scientific papers

We analyzed two datasets which contained the data of the 50 leading universities - obtained the leading journals in which each university publishes its papers (selected on the number of published papers) and bibliometric indicators (IPP, JCR, SNIP)

The results show little correlation between the number of universities' papers/bibliometric quality of journals and the QS scores





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Task: Redefine weights, asap

Possible remedy to the issue:
Composite I-distance indicator (CIDI) methodology





Composite I-distance indicator (CIDI) methodology

One entity as a referent (the worst possible scenario for all the input indicators)

The ranking of the entities in the set - the calculated distance from the referent entity

$X^T = (X_1, X_2, \dots, X_k)$ - a set of variables chosen to characterize the entities.

I-distance between two entities $e_r = (x_{1r}, x_{2r}, \dots, x_{kr})$ and $e_s = (x_{1s}, x_{2s}, \dots, x_{ks})$

$$D(r, s) = \sum_{i=1}^k \frac{|d_i(r, s)|}{\sigma_i} \prod_{j=1}^{i-1} (1 - r_{ji.12\dots j-1})$$

$d_i(r, s)$ is the discriminate effect, $d_i(r, s) = x_{ir} - x_{is}$, $i \in \{1, \dots, k\}$,

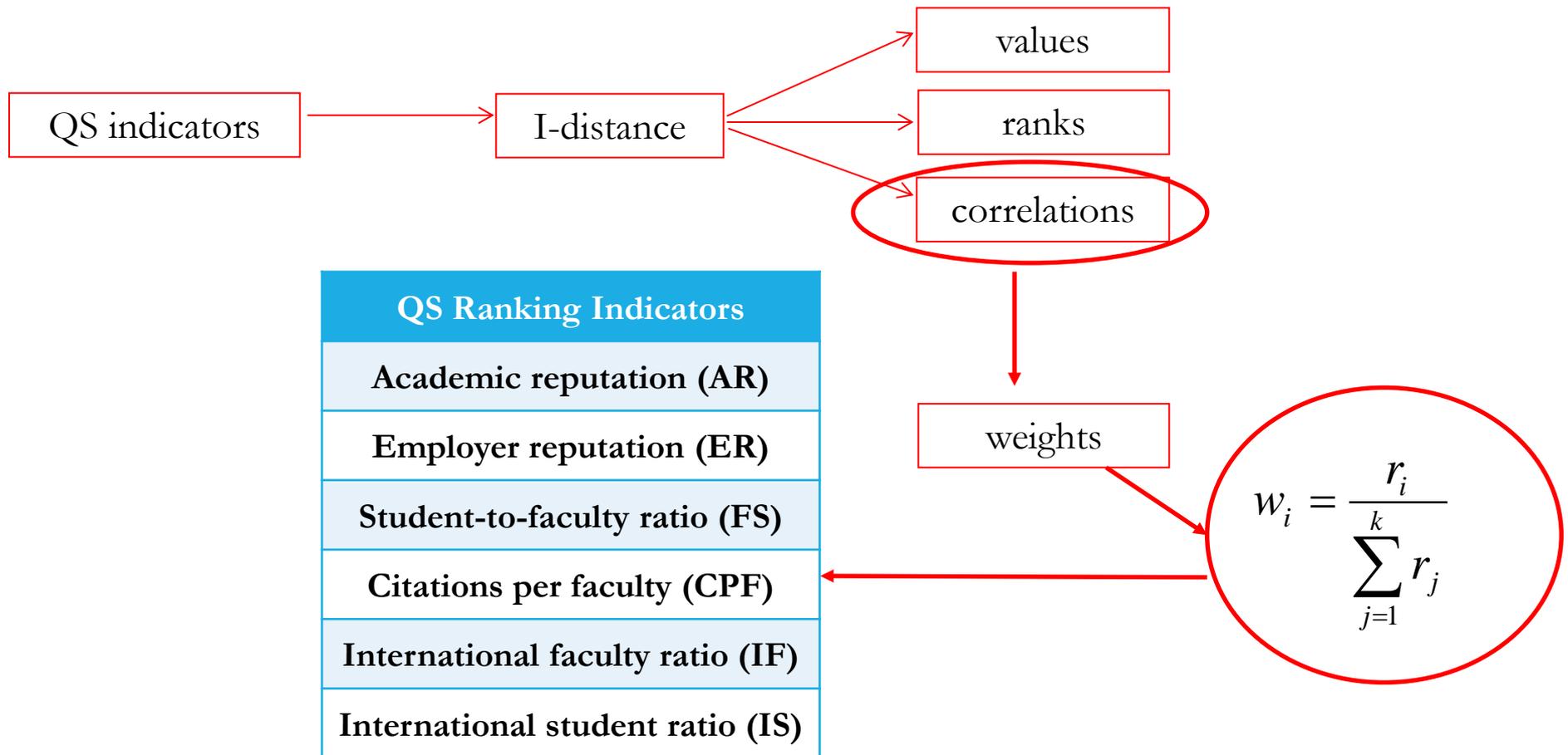
σ_i standard deviation of X_i ,

$r_{ji.12\dots j-1}$ is a partial correlation coefficient between X_i and X_j , ($j < i$) (Ivanovic, 1973; Ivanovic & Fanchette, 1973; Ivanovic, 1977; Jeremic et al., 2011).





Composite I-distance indicator (CIDI) methodology





Results

QS Ranking Indicators	2008	2009	2011	2012	2013	mean	SD
Academic reputation (AR)	0.201	0.189	0.202	0.189	0.212	0.199	0.009776
Employer reputation (ER)	0.194	0.217	0.171	0.211	0.195	0.198	0.017842
Student-to-faculty ratio (FS)	0.151	0.150	0.161	0.144	0.135	0.148	0.009700
Citations per faculty (CPF)	0.142	0.126	0.132	0.130	0.148	0.136	0.009310
International faculty ratio (IF)	0.146	0.146	0.155	0.142	0.140	0.146	0.006052
International student ratio (IS)	0.165	0.172	0.179	0.184	0.171	0.173	0.007175

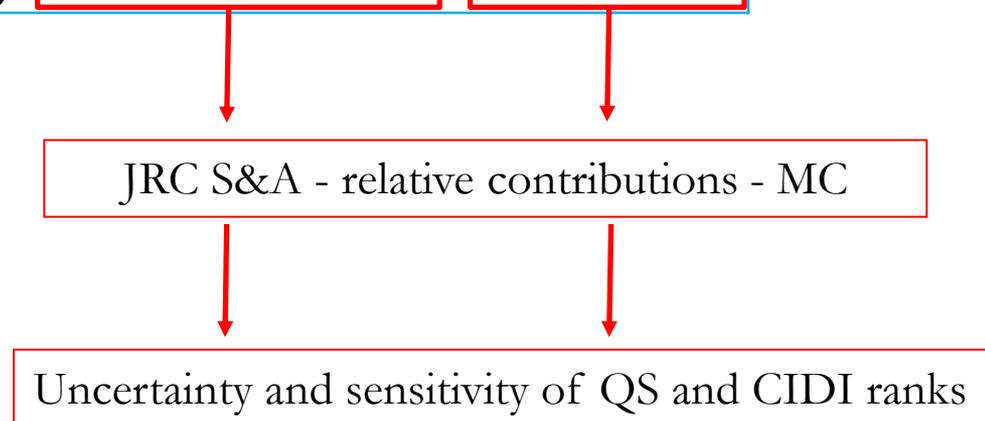
CIDI weights





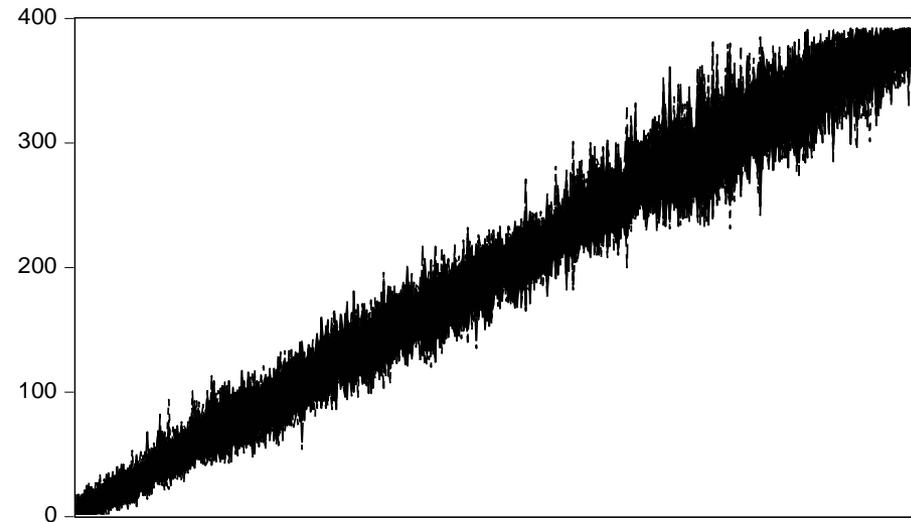
Results

QS Ranking Indicators	QS Ranking Weights	CIDI Weights
Academic reputation (AR)	40%	19.9%
Employer reputation (ER)	10%	19.8%
Student-to-faculty ratio (FS)	20%	14.8%
Citations per faculty (CPF)	20%	13.6%
International faculty ratio (IF)	5%	14.6%
International student ratio (IS)	5%	17.3%

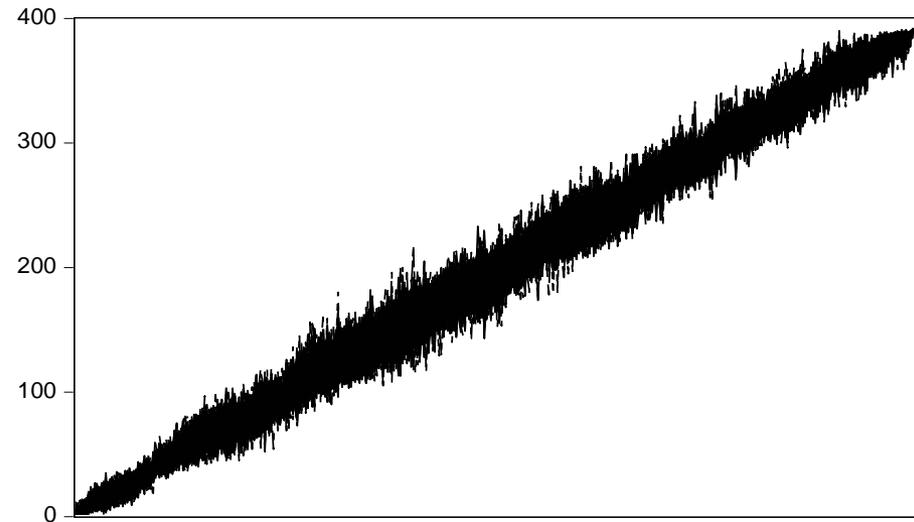




Results



Uncertainty and sensitivity of QS ranks



Uncertainty and sensitivity of CIDI ranks





Conclusion, Limitations, Current & Future directions of study

QS Ranking Indicators	QS Ranking Weights	CIDI Weights
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CIDI -
more balanced weights
-> less fluctuations of
ranks ?!?

Applying CIDI methodology on more balanced weight scheme

As a case study - the ICT Development Index (IDI)

Dobrota, M., Martić, M., Bulajić, M., & Jeremić, V. (2015). Two-phased composite I-distance indicator approach for evaluation of countries' information development, *Telecommunications Policy*, 39(5), 406-420.





Conclusion, Limitations, Current & Future directions of study

IDI Ranking Indicators	IDI Ranking Weights	CIDI Weights
Fixed-telephone subscriptions per 100 inhabitants	8%	9.5%
Mobile-cellular telephone subscriptions per 100 inhabitants	8%	8.2%
International Internet bandwidth (bit/s) per Internet user	8%	8.9%
Percentage of households with a computer	8%	10.1%
Percentage of households with Internet access	8%	10.1%
Percentage of individuals using the Internet	13.3%	9.9%
Fixed (wired)-broadband subscriptions per 100 inhabitants	13.3%	9.8%
Wireless-broadband subscriptions per 100 inhabitants	13.3%	8.9%
Adult literacy rate	6.7%	8.6%
Secondary gross enrolment ratio	6.7%	8.3%
Tertiary gross enrolment ratio	6.7%	7.6%

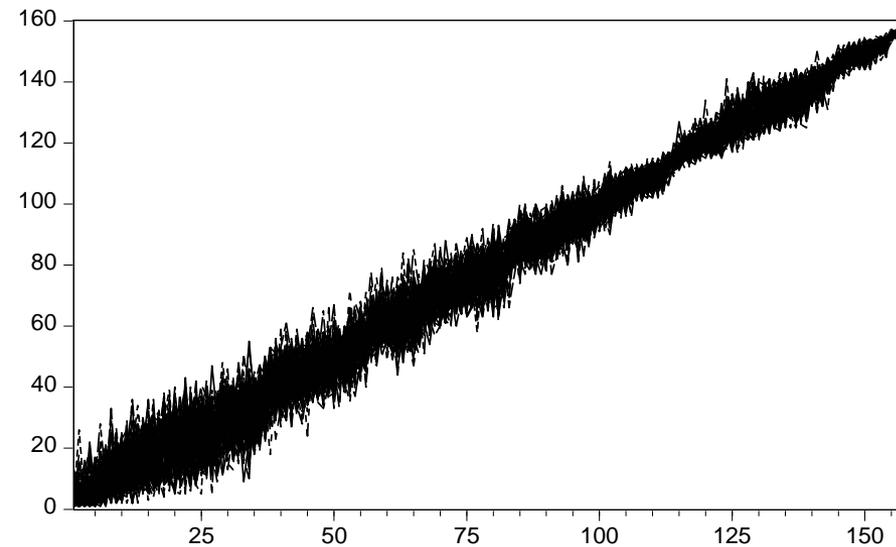
JRC S&A - relative contributions - MC

Uncertainty and sensitivity of IDI and CIDI ranks

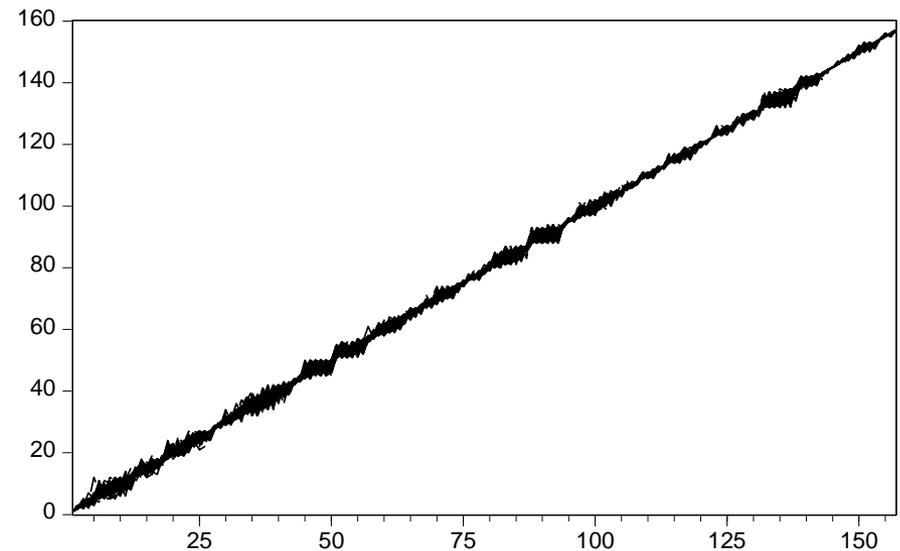




Conclusion, Limitations, Current & Future directions of study



Uncertainty and sensitivity of IDI ranks



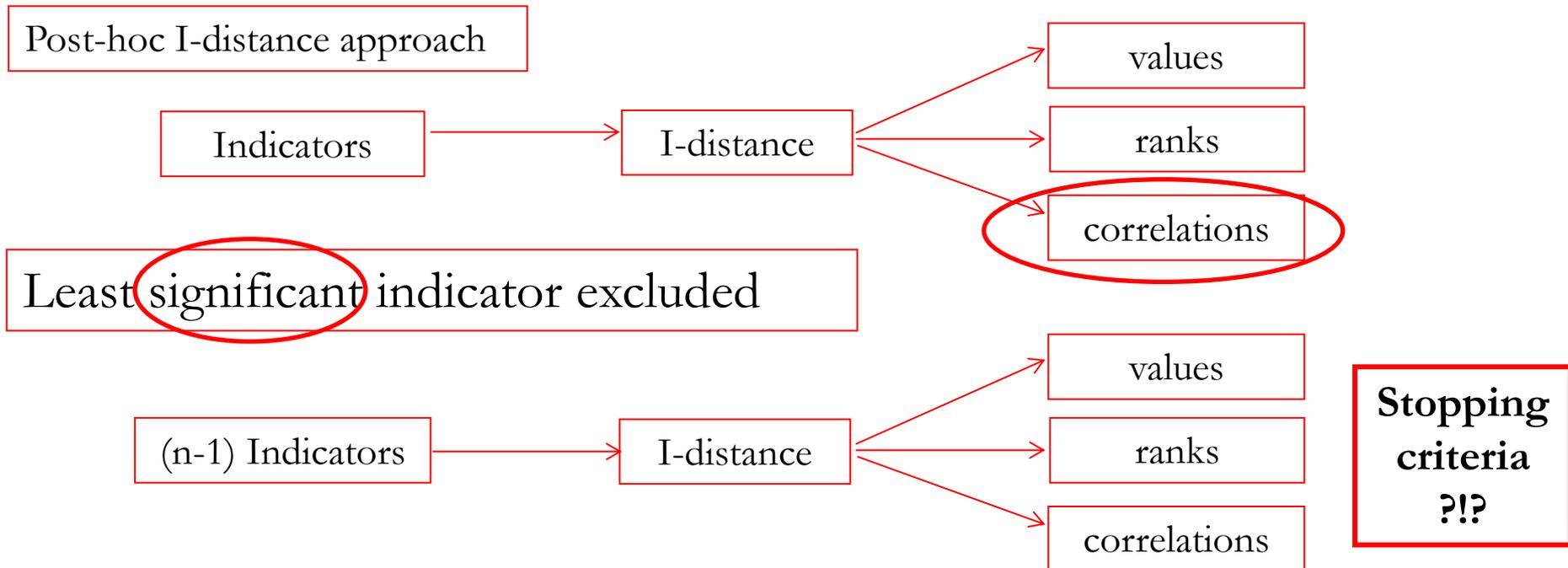
Uncertainty and sensitivity of CIDI ranks





Conclusion, Limitations, Current & Future directions of study

Large number of indicators -> I-distance as a data reduction method



Marković, M., Zdravković, S., Mitrović, M., & Radojičić, A. (2016). An iterative multivariate post hoc I-distance approach in evaluating OECD Better life index. *Social Indicators Research*, 126(1), 1-19.





Conclusion, Limitations, Current & Future directions of study

Marković et al., 2016

Indicator	1 st iteration	2 nd iteration	***	19 th iteration	20 th iteration
Indicator #1	r ²	r ²	***	0.709	0.801
Indicator #2	r ²	r ²	***	0.648	0.741
Indicator #3	r ²	r ²	***	0.686	0.663
Indicator #4	r ²	r ²	***	0.723	0.579
Indicator #5	r ²	r ²	***	0.679	0.551
Indicator #6	r ²	r ²	***	0.634	***
***	***	***	***	***	***
average r ²	0.335	0.350	***	0.680	0.667





Conclusion, Limitations, Current & Future directions of study

Indicator	1 st iteration	2 nd iteration	***	9 th iteration	10 th iteration
Nature & Science	0.865	0.887	***	0.903	0.924
Highly Cited Authors	0.806	0.822	***	0.851	0.883
Alumni	0.800	0.823	***	0.832	***
***	***	***	***	***	***
International outlook	0.288	0.286	***	***	***
Industry income	0.266	***	***	***	***
***	***	***	***	***	***
average r	0.655	0.709	***	0.862	0.903

Jeremic &
Martic, 2015





Conclusion, Limitations, Current & Future directions of study

13th Post-hoc I-distance iteration -> average $r^2=0.7156$
 14th Post-hoc I-distance iteration -> average $r^2=0.7248$

Should we eliminate one additional indicator, so we could “gain” 0.092 ??

13th	Var	var19	var5	var9	var4	var13	var15	var3	var2	Total
	Me	0.1432	0.1201	0.1428	0.1481	0.0949	0.1212	0.1162	0.1135	1.0
	SD	0.0158	0.0442	0.0189	0.0186	0.0269	0.0664	0.0701	0.0619	0.3228
14th	Var	var19	var9	var5	var4	var13	var15	var3		Total
	Me	0.1295	0.1674	0.1715	0.1156	0.1457	0.1358	0.1344		1.0
	SD	0.0487	0.0232	0.0226	0.0329	0.0787	0.0808	0.0741		0.3609

Relative contributions (mean & std)

Savic, D., Jeremic, V., & Petrovic, N. (2016). Rebuilding the Pillars of Sustainable Society Index: a Multivariate Post Hoc I-distance Approach. *Problemy Ekorożwoju - Problems of Sustainable Development*, 12(1), 125-134, IF (2014) - 0.804.





- CIDI as a viable asset in an never-ending quest for impartial results in world university ranking methodologies
- Additional effort is needed in order to establish CIDI as a widely accepted framework for evaluating composite indicators
- Post-hoc bootstrap applications as a way to go





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