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Citation Distance Matters: Towards a New Metric for Evaluating Journal Impact

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Extended Abstract

The evaluation of scientific impact is crucial for funding, hiring, and directing the course of research, yet dominant metrics like the Journal Impact Factor (JIF) have well-documented flaws [1]. By treating all citations equally, these metrics are vulnerable to manipulation through practices like *citation stacking*, where journals conspire to inflate each other's scores [2]. This work addresses these issues by proposing that the position of citations within the global structure of the journal citation network offers a powerful signal of quality, with citations from distant journals indicating broader, more significant impact, while an over-reliance on nearby journals may signal low-quality or even anomalous behavior.

To test this, we constructed a directed journal citation network from the OpenAlex database, encompassing over 21,000 journals. We introduce and compare five distinct measures of "citation distance" to capture different aspects of network topology and journal similarity: (D1) distance in a node2vec embedding space, which preserves local network structure; (D2) Euclidean distance in a t-SNE reduced-dimensionality space; (D3) a similarity measure based on the Intersection-over-Union (IoU) of journals' reference lists; (D4) a weighted shortest path distance in the network; and (D5) the subject entropy of incoming citations, which proxies for interdisciplinarity.

Our findings show a strong correlation between citation distance and journal quality. We validated our metrics against two expert-driven rankings (the Norwegian Register and the Finnish JUFO classification) and an algorithmic ranking (SCImago Journal Rank, SJR). Across most of our distance measures, highly-ranked journals exhibit significantly longer average incoming citation distances than their lower-ranked counterparts (Table 1). Conversely, journals flagged for anomalous citation behavior by Journal Citation Reports (JCR) or the CIDRE algorithm [3] tend to have significantly shorter citation distances. This confirms that network proximity is characteristic of citation stacking.

Crucially, incorporating citation distance can create more robust evaluation metrics, as weighting the standard JIF calculation with our distance measures significantly improves its ability to distinguish top-tier journals from lower-ranked ones, particularly in expert-based rankings (Figure 1). This demonstrates that accounting for the network context of citations makes the JIF less susceptible to gaming and better aligned with qualitative human judgment. Our work argues for a move beyond simple citation counts towards more nuanced, network-aware metrics that are inherently resistant to manipulation and better capture the far-reaching impact of high-quality science.

Ethical Considerations

Journal-ranking metrics have ethical implications, as they influence careers and funding. Our approach aims to reduce citation manipulation and foster fairness relying on open data. Since our approach has limitations, we caution against its use as a sole determinant of scientific quality without human oversight.

References

[1] Erin C McKiernan et al. "Use of the Journal Impact Factor in academic review, promotion, and tenure evaluations". In: *Elife* 8 (2019), e47338.

[2] Petr Heneberg. "From excessive journal self-cites to citation stacking: Analysis of journal self-citation kinetics in search for journals, which boost their scientometric indicators". In: *PloS one* 11.4 (2016), e0153730.

[3] Sadamori Kojaku, Giacomo Livan, and Naoki Masuda. "Detecting anomalous citation groups in journal networks". In: *Scientific Reports* 11.1 (2021), p. 14524.

Table 1: **High-impact journals receive citations from further away.** Mean incoming citation lengths for top- (1) and bottom-ranked (0) journals across five validation sets. Shaded cells indicate that top-ranked or non-anomalous journals have significantly longer mean citation distances ($p \leq 0.01$), supporting our hypothesis.

	NJR (Expert)			JUFO (Expert)			SJR (Algorithmic)			JCR (Anomalous)			CIDRE (Anomalous)		
Metrics	1	0	p	1	0	p	1	0	p	1	0	p	1	0	p
D_1 (node2vec)	0.55	0.50	0.0	0.56	0.48	0.0	0.51	0.52	0.0	0.50	0.48	0.28	0.49	0.47	0.0
D_2 (t-SNE)	0.58	0.53	0.0	0.59	0.50	0.0	0.54	0.56	0.0	0.53	0.49	0.0	0.52	0.50	0.0
D_3 (IoU)	0.64	0.61	0.0	0.64	0.59	0.0	0.46	0.43	0.0	0.64	0.65	0.03	0.63	0.67	0.0
D_4 (Shortest Path)	0.75	0.56	0.0	0.77	0.50	0.0	0.66	0.54	0.0	0.60	0.55	0.0	0.54	0.65	0.0
D_5 (Entropy)	0.52	0.44	0.0	0.54	0.44	0.0	0.50	0.43	0.0	0.47	0.47	0.61	0.48	0.42	0.0

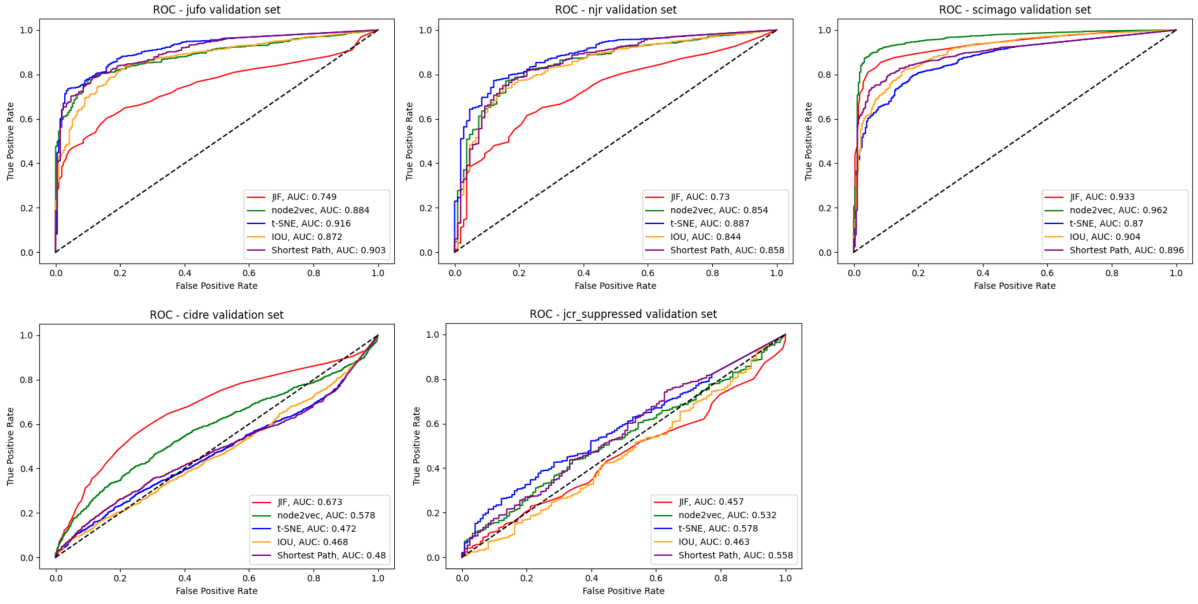

Figure 1: **Distance-weighting improves the Journal Impact Factor.** ROC curves show the ability of the unweighted JIF (black line) and four distance-weighted JIFs to identify top-ranked journals. For the expert-driven NJR and JUFO rankings, all weighted versions (colored lines) show a clear improvement in Area Under the Curve (AUC) over the baseline JIF, indicating better alignment with human evaluation.