intermediacy of **publications**

"pomembnost prispevkov za razvoj znanstvene tematike"

Lovro Šubelj
University of Ljubljana
Faculty of Computer and Information Science

Ludo Waltman
Leiden University
Centre for Science and Technology Studies

Vincent Traag
Leiden University
Centre for Science and Technology Studies

Nees Jan van Eck
Leiden University
Centre for Science and Technology Studies

AI seminar '19

summer research visits


CWTS in Leiden, Vincent, Ludo & Nees

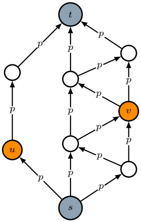



Tjaša, Nevi & Mažo, biking, boating & skating etc.

introduction & motivation

algorithmic historiography for evolution of field (**Garfield, 1964–**)

relying on **citations** between scientific **publications** from **WoS** & **Scopus**



existing approaches include **main paths** (**Hummon & Doreian, 1989**)

(**longest/shortest paths**) many **irrelevant**/miss **relevant** publications

(**intermediacy**) important publications should only be **well-connected**

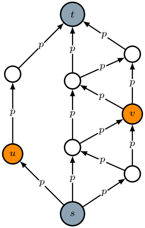
intermediacy measure

(**input**) selected **source** & **target** publications **s** & **t**

(**method**) each citation is relevant/active with **probability p**

(**measure**) importance of **publication u** called **intermediacy** ϕ_u

$$\phi_u = \Pr(X_{st}^u) = \Pr(X_{su})\Pr(X_{ut})$$

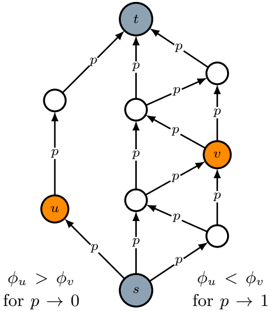


$\mathbf{X_{st}}$ exists path **from s to t** & $\mathbf{X_{st}^u}$ exists path **through u**

intermediacy for $p \to 0$

for $p \to 0$ intermediacy ϕ **governed by ℓ** (**proof**)

for $p \to 0$ if $\ell_u < \ell_v$ then $\phi_u > \phi_v$

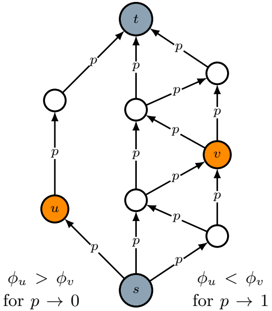


ℓ_u is **length** of **shortest paths** from s to t through u

intermediacy for $p \to 1$

for $p \to 1$ intermediacy ϕ **governed by σ** (**proof**)

for $p \to 1$ if $\sigma_u < \sigma_v$ then $\phi_u < \phi_v$

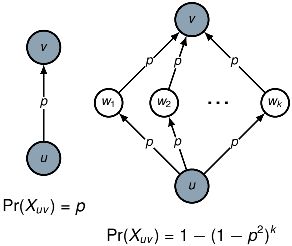


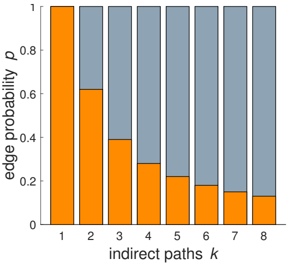
σ_u is **number** of **edge-disjoint paths** from s to t through u

intuition for p

for what p is **direct citation** equivalent to k **indirect citations**

$$\Pr(X_{uv}) = p = 1 - (1 - p^2)^k$$



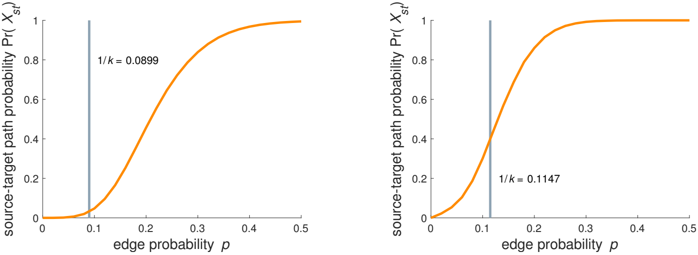


k is **number** of **indirect paths** from u to v

p phase transition

for what p source-target path $\mathbf{Pr(X_{st}) > 0}$ & intermediacy $\exists \mathbf{u} : \phi_{\mathbf{u}} > \mathbf{0}$

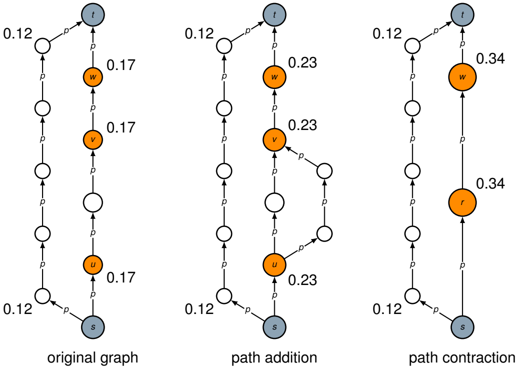
$$p \geq n/2m = 1/k$$



k is **average** number of **citations**/**references**

properties of intermediacy

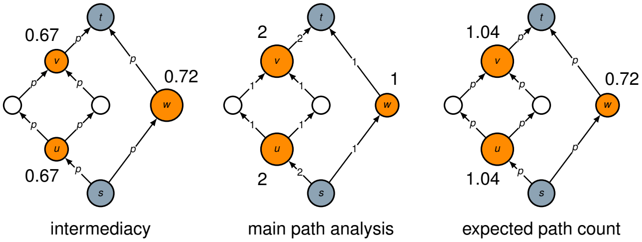
path **addition** & **contraction** increase intermediacy (**proof**)



path from source to target becomes **"easier"** (**intuition**)

alternatives to intermediacy

alternatives are **main paths** & **expected paths** (**state of the art**)

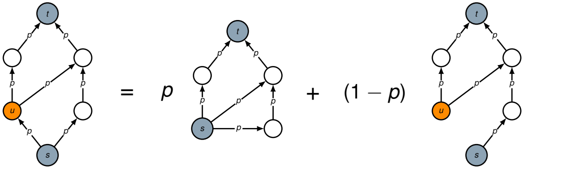


alternatives **violate** path contraction property (**example**)

exact algorithm

decomposition algorithm by edge **contraction** & **removal** (**Ball, 1979**)

$$\Pr(X_{st} \mid G) = p \Pr(X_{st} \mid G/(s,u)) + (1-p) \Pr(X_{st} \mid G - (s,u))$$



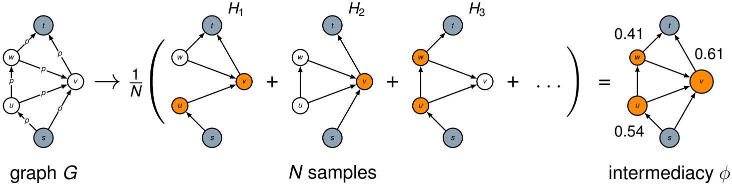
graph G contraction $G/(s,u)$ removal $G - (s,u)$

runs in **exponential time** since NP-hard even in DAG (**Johnson, 1984**)

approximate algorithm

simple **Monte Carlo** simulation algorithm by edge **sampling**

$$\phi_u = \Pr(X_{st}^u \mid G) = \frac{1}{N}\sum_{k=1}^{N} \mathrm{I}(X_{st}^u \mid H_k)$$



runs in quasi **linear time** using probabilistic DFS over say **10^6 samples**

intermediacy $\neq$ centrality

correlation coefficient between **intermediacies ϕ** & **citations**/**references**

$p = 0.1$	1.00	0.69	0.28	0.16	0.12	0.19	0.20
$p = 0.3$	0.69	1.00	0.78	0.58	0.44	0.49	0.43
$p = 0.5$	0.28	0.78	1.00	0.92	0.77	0.50	0.36
$p = 0.7$	0.16	0.58	0.92	1.00	0.94	0.43	0.26
$p = 0.9$	0.12	0.44	0.77	0.94	1.00	0.35	0.19
cit.	0.19	0.49	0.50	0.43	0.35	1.00	0.00
ref.	0.20	0.43	0.36	0.26	0.19	0.00	1.00

Pearson correlation

$p = 0.1$	1.00	0.42	0.21	0.10	0.04	0.16	0.03
$p = 0.3$	0.42	1.00	0.80	0.45	0.19	0.19	0.10
$p = 0.5$	0.21	0.80	1.00	0.78	0.39	0.18	0.14
$p = 0.7$	0.10	0.45	0.78	1.00	0.77	0.26	0.23
$p = 0.9$	0.04	0.19	0.39	0.77	1.00	0.26	0.24
cit.	0.16	0.19	0.18	0.26	0.26	1.00	0.01
ref.	0.03	0.10	0.14	0.23	0.24	0.01	1.00

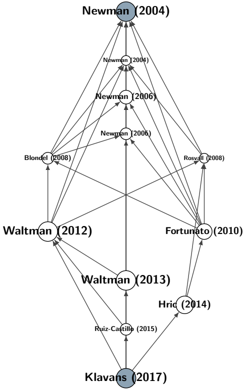
Pearson correlation

intermediacy ϕ **uncorrelated** with standard **centrality measures**

modularity example

(**target**) Newman & Girvan (2004), **Finding and evaluating community...**, *Phys. Rev. E* **69**(2), 026113.

(**source**) Klavans & Boyack (2017), **Which type of citation analysis generates...**, *JASIST* **68**(4), 984-998.



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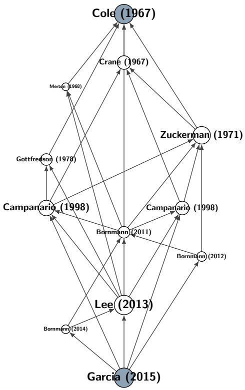
in-house version of Scopus database at **CWTS**

peer review example

(**target**) Cole & Cole (1967), **Scientific output and recognition**, *Am. Sociol. Rev.* **32**(3), 377-390.

(**source**) Garcia et al. (2015), **The author-editor game**, *Scientometrics* **104**(1), 361-380.



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2 Zuckerman & Merton (1971), Patterns of evaluation in science: Institutionalisation, structure and functions. . . , *Minerva* **9**(1), 66-100.

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7 Bornmann (2011), Scientific peer review, *Annu. Rev. Inform. Sci.* **45**(1), 197-245.

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snapshot of WoS collected by (**Batagelj et al., 2017**)

sensing example

(**target**) Eagle & Pentland (2006), **Reality mining: Sensing complex social systems**, *Pers. Ubiquit. Comp.* **10**(4), 255-268.

(**source**) Mohr et al. (2017), **Personal sensing: Understanding mental health using ubiquitous sensors and machine learning**, *Annu. Rev. Clin. Psychol.* **13**, 23-47.

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9 Eagle (2008), Behavioral inference across cultures: Using telephones as a cultural lens, *IEEE Intell. Syst.* **23**(4), 62-64.

10 Piwek et al. (2016), The rise of consumer health wearables: Promises and barriers, *PLoS Med.* **13**(2), e1001953.

suggested by **Veljko Pejović** for Scopus database

rendering example

(**target**) Wenger et al. (2004), **Interactive volume rendering of thin thread structures within multivalued scientific data sets**, *IEEE T. Vis. Comput. Gr.* **10**(6), 664-672.

(**source**) Eid et al. (2017), **Cinematic rendering in CT: A novel, lifelike 3D visualization technique,** *Am. J. Roentgenol.* **209**(2), 370-379.

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10 Díaz et al. (2010), Real-time ambient occlusion and halos with Summed Area Tables, *Comput. Graph.* **34**(4), 337-350.

suggested by **Ciril Bohak** for Scopus database

chess example

(**target**) Guid & Bratko (2006), **Computer analysis of world chess champions**, *ICGA J.* **29**(2), 65-73.

(**source**) Mohr et al. (2017), **Personal sensing: Understanding mental health using ubiquitous sensors and machine learning**, *Annu. Rev. Clin. Psychol.* **13**, 23-47.

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suggested by **Matej Guid** for Scopus database

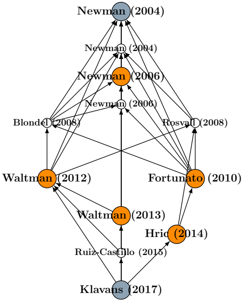
conclusions & future work

(**proposal**) measure of importance of publications called **intermediacy**

(**theory**) conceptually clear & provable behavior in **extreme cases**

(**practice**) intermediacy shows promising results in **case studies**

(**future**) online **research app**! applicability to **other networks**?



(**paper**) arxiv.org/abs/**1812.08259**

(**code**) github.com/lovre/**intermediacy**

Lovro Šubelj
University of Ljubljana
lovro.subelj@fri.uni-lj.si
http://lovro.lpt.fri.uni-lj.si

Ludo Waltman
Leiden University
waltmanlr@cwts.leidenuniv.nl
http://www.ludowaltman.nl

Vincent Traag
Leiden University
v.a.traag@cwts.leidenuniv.nl
http://www.traag.net

Nees Jan van Eck
Leiden University
ecknjpvan@cwts.leidenuniv.nl
http://www.neesjanvaneck.nl