PageRank-based prediction of award-winning researchers and the impact of citations

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Abstract: In this article some recent disputes about the usefulness of PageRank-based methods for the task of identifying influential researchers in citation networks are discussed. In particular, it focuses on the performance of these methods in relation to simple citation counts. With the aim of comparing these two classes of ranking methods, we analyze a large citation network of authors based on almost two million computer science papers and apply four PageRank-based and citations-based techniques to rank authors by importance throughout the period 1990-2014 on a yearly basis. We use ACM SIGMOD E. F. Codd Innovations Award and ACM A. M. Turing Award winners in our baseline lists of outstanding scientists and define four relevance weighting schemes with some predictive power for the ranking methods to increase the relevance of researchers winning in the future. We conclude that citations-based rankings perform better for Codd Award winners, but PageRank-based methods do so for Turing Award recipients when using absolute ranks and PageRank-based rankings outperform the citations-based techniques for both Codd and Turing Award laureates when relative ranks are considered. However, the two ranking groups show smaller differences if more weight is assigned to the relevance of future awardees.

Keywords: PageRank, scholars, citations, rankings, Web of Science, awards.

1. Introduction and related work

The PageRank algorithm by Brin and Page (1998) was intended to rank webpages by importance using the link structure of the web, but this recursive technique quickly gained popularity and found numerous other applications. Among other things, the citation networks

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of research papers were particularly well suited for the usage of methods based on PageRank because they could be easily modelled as directed graphs (Chen et al., 2007; Walker et al., 2007; Ma et al., 2008). From these graphs, however, further extended citation networks can be generated: those of authors (Liu et al., 2005; Fiala et al., 2008; Ding et al., 2009; Ding, 2011; Yan and Ding, 2011; Fiala, 2012b), journals (Bollen et al., 2006; Bergstrom, 2007; González-Pereira et al., 2010), institutions (Yan, 2014), countries (Fiala, 2012a), etc. On the other hand, these "bibliographic" networks differ from the web graph in some aspects. For instance, the citation networks of papers do (usually) not contain loops, which are common on the web, because the citation direction is always heading towards the past, i.e. newer papers cite older ones. And even if this feature has been weakened in recent years due the existence of online "ahead of print" publications, which at its most extreme enables citations pointing from the past to the future, it is still a distinctive property of paper citations. The other distinctive characteristic of citation networks is that they never get smaller with vertices disappearing or edges being removed. Unlike the web graph, which frequently changes its structure and commonly loses nodes as well as links, once a citation is made in a bibliographic network, it remains there for good. Therefore, most of the current PageRank-related methods employed in bibliometrics rely on some properties unique to bibliographic networks and cannot be applied to the web again. As a result, because of the now widely recognized merits of PageRank, both of the two most eminent academic databases presently make use of PageRank-based metrics in the assessment of journal impact: Web of Science as Eigenfactor Score (Bergstrom, 2007) and Scopus as SJR indicator (González-Pereira et al., 2010).

When the whole structure of the citation network is unknown or ignored, the prominence of a researcher may simply be based on the number of incoming citations from other scholars which determine that researcher's popularity. By contrast, if the whole citation network topology is considered and citation weights depend on the importance of citing scientists like in PageRank, prestige is measured rather than popularity. The techniques that determine popularity are sometimes called first-order methods and those that calculate prestige are called higher-order methods. The computational costs of the procedures in the latter group are by definition much larger beyond any doubt, but their practical benefits for the detection of prominent scholars are less clear. Having said that, recently, there have been some contradicting results with respect to the performance of PageRank-related methods in the task of identifying salient researchers compared to simple citations. Whereas Fiala et al. (2015) have reported that there is no evidence of PageRank outperforming citations, Nykl et al. (2014, 2015) and more recently Panagopoulos et al. (2017) have found the opposite to be true. While the difference in the findings by Nykl et al. may be caused by their different approach to the construction of the citation network (first, PageRank is computed on the paper citation network and its scores are then distributed to individual authors instead of being calculated directly on the author citation network like in the analysis by Fiala et al.), the disagreement with the outcomes by Panagopoulos et al. is more obscure given the complex methodology used in their study. Moreover, Dunaiski et al. (2016) have concluded something in between: that citations work better in general, but high-impact research itself is more frequently detected by PageRank. All in all, the above mentioned discrepancies have motivated us to formulate the following research question: Can the prediction of award-winning researchers be used to show the superiority of PageRank-based methods over simple citations in the ranking of scientists by their impact? Therefore, the goal of the present analysis is to shed some more light on the performance of citations and PageRank in identifying influential researchers in the past as well as in the future, rather than to just rank researchers to predict prizes. And even though some evaluation methods independent of citations will be tested too, the direct and indirect impact of citations on the standing of scientists seems inevitable because of their irreplaceable role in scholarly communication.

Due to the lack of a baseline ranking, different ranking methods must be compared to each other and/or to a reference set of outstanding scholars. This reference set of important scientists may consist of the winners of prestigious awards (Sidiropoulos and Manolopoulos, 2005), programme committee members of renowned conferences (Liu et al., 2005), or editorial board members of high-impact journals (Fiala et al., 2015). In this study we will use the recipients of the ACM SIGMOD E. F. Codd Innovations Award[1] in 1992-2016 and ACM A. M. Turing Award[2] in 1966-2015 as our reference-set researchers and later also add two other prizes for verification. Two PageRank-based methods (standard PageRank and time-weighted PageRank) and two citations-based techniques (*Citations* and *Indegree*) will be employed to rank researchers by influence based on a large citation graph with almost 0.7 million nodes and over 26.4 million edges. Because the data set was generated from nearly two million computer science papers indexed in the Web of Science (WoS) database covering the period 1945-2014 and the four rankings were cumulatively produced for each of the last 25 years in that time range, the identification of the award-winning researchers often results in the prediction of future awardees. The research question is whether PageRank-based methods outperform citations-based procedures in the detection of award-winning researchers by

[1] https://sigmod.org/sigmod-awards/#innovations
[2] http://amturing.acm.org/

assigning them better ranks and we will see that it can be answered positively when relative ranks are considered.

2. Methods

2.1. Standard and time-weighted PageRank

If there is a directed author citation graph $G = (V, E)$ with a set of vertices V as authors and a set of edges E as citations where any (non-zero) number of citations from author i ($i \in V$) to author j ($j \in V$) is represented by exactly one edge $(i, j) \in E$, the PageRank score PR(j) of author j depends on the scores of all authors citing j:

$$\mathrm{PR}(j) = \frac{1-d}{|V|} + d \sum_{(i,j)\in E} \frac{PR(i)}{D_{out}(i)} \tag{1}$$

where d is the damping factor, which was set to 0.85 in the original web experiments by Brin and Page (1998) but later recommended to be about 0.5 for citation networks (Chen et al. , 2007; Walker et al., 2007; Ma et al., 2008), and $D_{out}(i)$ is the out-degree of vertex i. Eq. (1) is the formula used iteratively in practical computations and, depending on the convergence criteria applied, a few dozen iterations are usually enough even for graphs with millions of nodes. (We restricted the number of iterations to 50 in our experiments.)

Other approaches to solving the recursive PageRank problem include linear algebra eigenvector calculations (Langville and Meyer, 2004; Bianchini et al., 2005) and probabilistic random walks (Diligenti et al., 2004). Because of the high correlation of various PageRank-based methods designed for bibliographic networks (Fiala et al., 2008; Fiala, 2012b; Fiala et al., 2015a), we decided to add only one more variant from this class of methods, which we will call the time-weighted PageRank (*PRtw*). *PRtw* is based on the "ageing of edges" (Fiala et al., 2015b) This scenario supposes that graph G is edge-weighted with the weight of edge (i, j) being denoted as w_{ij} and composed of all individual citations from i to j whose weights decrease exponentially over time. Thus, if $w_{ij}(t)$ is the citation weight in time t, $w_{ij}(0) = 1$ and

$$w_{ij}(t+\Delta t) = \begin{cases} w_{ij}(t)\, e^{-\theta\Delta t} & \text{when } w_{ij}(t)\, e^{-\theta\Delta t} > \varepsilon \\ 0 & \text{otherwise} \end{cases} \tag{2}$$

where $w_{ij}(t + \Delta t)$ is the weight of one individual citation from i to j after some time increment Δt ellapses, Θ is the "ageing factor" and ε is the value of a minimum threshold citation weight (e.g. 0.01). The ageing factor that determines the "ageing speed" is defined by $\Theta = \ln 2 / t_{1/2}$

where $t_{1/2}$ is the time span after which the citation weight decreases by 50% and was empirically set to 2 years in our previous experiments (see the cited work for more information). Therefore, unlike the standard *PR*, *PRtw* reflects the number of citations and their age in the weights of the edges in graph *G*, assigning generally more weight if citations occur more frequently and more recently.

The time complexity of a PageRank calculation (including its weighted modifications) depends linearly on the number of edges in the network and the space complexity relates in the same way to the number of vertices. For our largest graph with 0.7 million vertices and 26.4 million edges (see Section 3) the computation took about 24 hours on a common desktop PC. We believe that this is still acceptable for off-line computations. However, should the number of edges increase by a factor of 10 or more, which would actually mean a calculation lasting 10 days at least, the practical usability of PageRank-based methods would be dramatically reduced in favour of degree-based techniques.

2.2. Other approaches based on PageRank

In the studies by Nykl et al. (2014; 2015), the best evaluation techniques were found to be personalized PageRank-variants applied to the citation network of papers with the final score of each paper evenly distributed among its authors. In a strict sense, those methods thus fall within the category of paper assessment procedures (not author evaluation) and are directly comparable neither to the present study nor to our previous analyses (Fiala et al., 2015; Fiala, 2012; Fiala et al., 2008). In spite of this, let us have a look at some properties of this approach. If $G^P = (V^P, E^P)$ is a directed paper citation graph with a set of vertices V^P as papers and a set of edges E^P as citations between papers, the PageRank score PR(*v*) of paper *v* ($v \in V^P$) depends on the scores of all papers citing *v*:

$$\mathrm{PR}(v) = (1-d)F(v) + d \sum_{(u,v)\in E^P} PR(u)\frac{r(u)}{D_{out}(u)} \tag{3}$$

where *d* was the damping factor set to 0.55, $D_{out}(u)$ is the out-degree of *u*, *r*(*u*) is the input weight of edges from *u* set to 1, and *F*(*v*) is the “personalization factor” of paper *v* equal to the inverse of |V| in the standard formula (1). Out of the many tested variants of *F*(*v*), the PageRank score of the journal in which the paper appeared was found to work best. Thus, another citation network (of journals) was needed, further raising the complexity of computations. By contrast, instead of favouring papers from more prestigious journals in the personalized section of the PageRank formula, Dunaiski et al. (2016), also for the paper citation network, give more weight to more recent publications by setting

$$r(u) = \frac{\rho(u)}{\sum_{(u,v)\in V^P} \rho(v)} \text{ and } F(v) = \frac{r(v)}{\sum_{u\in V^P} r(u)} \tag{4}$$

where $\rho(u) = e^{-age(u)/\tau}$ with *age*(*u*) being the age of paper *u* and τ being the decay time of citations set between 4 and 32 in the experimental settings. The damping factor *d* was determined to be in the range from 0.35 to 0.85 for various network configurations. And as for the most recent relevant study mentioned earlier, Panagopoulos et al. (2017), the complex power "graph model" used by them makes it difficult to describe their approach within the same mathematical framework, but their small reference to eigenvector centrality and the lack of any PageRank-related equations indicate that the standard PageRank (1) was used in their extensive calculations. They then applied it to time-weighted co-authorship graphs and studied the dynamics of the resulting metric along other bibliometric measures over time to discover "rising stars". Using feature selection, they finally found that the number of papers and subsequently the clique weights in the time-weighted graph were the most informative features.

2.3. Degree-based techniques and Discounted Cumulative Gain

From the other group (citations-based or also degree-based ranking methods) we included two techniques in our study: simple citation counts (*Citations*) considering all citations from all authors and citing authors counts (*Indegree*) counting multiple citations from the same author as one, which corresponds to the in-degrees of nodes in graph *G*. More formally, if w_{ij} is the number of citations from author *i* to author *j* in graph *G* and is regarded as the weight of edge $(i, j) \in E$, the simple citation count of *j* is $\sum_{(i,j)\in E} w_{ij}$ and its citing authors count is $\sum_{(i,j)\in E} 1$. We thus have four ranking methods (*PR*, *PRtw*, *Citations*, and *Indegree*) that we will apply to 25 data subsets and evaluate on two reference sets of outstanding researchers. (See more information on this in the following sections.) As far as the evaluation is concerned, we will use an approach similar to that by Järvelin and Kekäläinen (2002) in information retrieval. We will measure how well the four methods will retrieve relevant "documents", i.e. how well they will rank award-winning researchers, and calculate the Discounted Cumulative Gain (DCG) for all rankings with DGC_p being the value of a scholar ranked at position *p*:

$$\mathrm{DCG}_p = \sum_{i=1}^{p} \frac{rel_i}{\log_2(i+1)} \tag{5}$$

where rel_i is the relevance score assigned to the scientist ranked at position *i*. Thus, "relevant" scholars placed at the top of a ranking contribute with a larger value to the DCG than those at the bottom and the decrease in the gain of researchers is proportional to the logarithm of their position. Considering that, we propose four relevance weighting schemes for the researchers ranked based on the criterion whether they have won or will win any of the two prestigious computer science awards and present them in the next section.

One reviewer of an earlier version of this paper asked that some additional ranking methods that do not directly depend on citations should be tested too. From this class of approaches, we chose *Collaborators*, *Publications*, *Journal Prestige*, and *Institution Prestige*. The former two count the number of collaborators (their distinct names) or publications of an author and the latter two calculate the prestige of journals (or venues) and institutions associated with an author's papers. For *Journal Prestige,* the mean impact factor (2014 Journal Citation Reports®, Thomson Reuters 2015) of journals in which an author's papers appeared was computed. The value of 1 was used for the journals and venues whose impact factor could not be determined. For *Institution Prestige*, first the mean number of citations per paper (CPP) for each institution in our data collection was computed and then the average CPP of all institutions associated with an author's papers was calculated. The resulting rankings of these four additional methods are compared in the appendix. As for the computational complexity of these techniques (as well as of *Indegree* and *Citations*), the calculation time depends linearly on the number of authors and it has never been longer than a few seconds even for the largest graphs.

2.4. Award-winning researchers and their weighting

The ACM SIGMOD E. F. Codd Innovations Award is received by researchers for their outstanding contributions in the specific discipline of databases and has been awarded since its inception in 1992 to 25 different scientists – one in each year with the most recent conferred in 2016. On the other hand, the ACM A. M. Turing Award is a general computer science prize (dubbed the "Nobel Prize in computer science") awarded since 1966 and most recently in 2015 (at the time of running our experiments in October 2016). Unlike the Codd Award, the Turing Award may be received by multiple scholars in a year and until now there have been 64 winners of this most prestigious computer science prize. Based on the advice of the reviewers of a previous version of this article we also added two more prizes extending the set of awardees from 89 to 193: ACM PODC & EATCS DISC Dijkstra Prize[3] conferred to distributed computing researchers annually since 2000 and ACM SIGACT & EATCS Gödel Prize[4] awarded to theoretical computer scientists every year since 1993 (the 2017 prizes are not yet taken into account). As both of these prizes are awarded to authors of outstanding papers in their respective fields, there can be several award-winning authors each year and even individuals winning the award multiple times. The results achieved with the recipients of these prizes will be shown in the appendix, however, and we remain concerned with the two main awards: Codd and Turing. The relevance weighting schemes designed for the awards are as follows:

$$rel_i^{Codd} \in \left\{ \begin{array}{l} \{0,1\} \\ \{0,1,2\} \\ \{0, \frac{1}{23}, \frac{1}{22}, \ldots, 1, 2, \ldots, 27\} \\ \{0,1,2,\ldots,28\} \end{array} \right\}, \; rel_i^{Turing} \in \left\{ \begin{array}{l} \{0,1\} \\ \{0,1,2\} \\ \{0, \frac{1}{49}, \frac{1}{48}, \ldots, 1, 2, \ldots, 26\} \\ \{0,1,2,\ldots,27\} \end{array} \right\}. \quad (6)$$

For both awards the first two weighting schemes are the same. In the first binary weighting, 1 is assigned to the award-winning researchers and 0 to the others. The second, ternary weighting, distinguishes between the scholars winning in the past obtaining the relevance score 1 and those honoured in the future gaining 2. The DCG using the ternary scheme is then the larger the better it ranks future awardees.

The third weighting differs for both prize winner sets because of the varying time span covered by the awards: 1992-2016 (Codd Award) and 1966-2015 (Turing Award). It assigns more weight to researchers winning in a more distant future (to further boost the predictive power) and less weight to scholars honoured in a more distant past (to reflect the "ageing" of awards). Since our study covers the time range 1990-2014, the most distant future for a Codd Award winner is 2016 – 1990 + 1 = 27 and it is 2015 – 1990 + 1 = 26 for a Turing Award winner. (In other words, in the 1990 ranking we assess the rank of the 2016 Codd Award recipient with the relevance score 27 and the rank of the 2015 Turing Award laureate with the score 26.) Similarly, the most distant past for a Codd Award winner is 2014 – 1992 + 1 = 23 (remember that the first ever Codd Award was conferred in 1992) and so in the 2014 ranking the first ever Codd Award winner will be allocated the score of 1/23 to decrease his relevance proportionally. For the Turing Award, the most distant past is 2014 – 1966 + 1 = 49 and the

[3] http://eatcs.org/index.php/dijkstra-prize
[4] http://sigact.org/Prizes/Godel/

first ever Turing Award recipient will be given the relevance score 1/49 in the 2014 ranking. In the last weighting scheme, the ageing of awards is not considered (all past awardees gain 1) and only more weight is assigned to the researchers winning in a more distant future, which increments the maximum relevance score by 1 compared to the preceding weighting. (Let us note that our weighting schemes generally regard the researchers winning in the current ranking year as future awardees and not as past winners.)

DCG does not necessarily need to be computed over the whole ranking of thousands of researchers but instead only include the most interesting top of a ranking, such as the top 100 authors. Then it is denoted as DCG@100. Also, we might wish to normalize the DCG values to fit into the interval [0, 1] in order to be able to compare otherwise incomparable DCGs (Järvelin and Kekäläinen, 2002). Such a normalized DCG is received by a division by the maximum (ideal) obtainable DCG in a given relevance weighting scheme and denoted as nDCG. And, last but not least, the rankings assessed do not need to be composed of "true" (or absolute) ranks but instead may involve "relative ranks" based on the original absolute ones. These relative ranks may be represented by percentiles or permilles (incremented by 1 to better reflect the notion of ranks) in the intervals [1, 100] and [1, 1000]. Thus, for instance, a researcher with the rank 1 is placed within the top 1% or 1‰ of researchers in a given ranking. The advantage of these ranks is that they enable the comparison of variously sized rankings and that they are more robust and less sensitive to small changes in the rankings. Therefore, we will see their usage in the section on results.

3. Data

In August 2015 we obtained textual records of metadata on journal articles and conference papers published from 1945 to 2014 and indexed in the well-known Web of Science (WoS) database in the computer science research area. The total number of records was 1,922,652 and it included document types Article, Proceedings Paper, and Review from Science Citation Index Expanded and Conference Proceedings Citation Index - Science. In the next step, we constructed a citation network of papers based on the references contained in the records retrieved. However, the references needed to be parsed and decoded to some extent because they often could not be linked to a cited item in a straightforward way. They never included an exact identifier of the cited paper in WoS (such as the WoS Accession Number), but generally just the surname and initials of the first author, publication year, short name of the journal (venue), volume, and start page of the paper in the volume. Nevertheless, some cited references also included a Digital Object Identifier (DOI) which could be used to link the citing paper to the cited paper unambiguously because articles with assigned DOIs had them as part of their textual metadata records. For instance, out of 32,137,613 total references, 12,319,981 (38.3%) had a DOI and thus no further work was necessary to link them correctly to the cited paper.

3.1. Citation matching and disambiguation

Of course, not all of the cited papers were part of our "core collection" of computer science articles and the references cited items from outside of our data set. The number of distinct DOI-based references within our data set was 4,368,154 and further 1,163,574 unique references could be added to them after decoding and linking some of the cited references without a DOI. These additional references were matched using the year, source, volume, and start page of a non-DOI cited reference typically having a form similar to this: "Meng WX, 2014, IEEE NETWORK, V28, P24". In this way, more than a half (57%) of the references potentially falling within the scope of the core collection (as to the time range and journal or conference title) were matched with the article records in our data set. The remaining references were unmatched, being mostly citations to proceedings papers, often with incomplete or erroneous data.

The first author name was not used for matching because the quadruple (year, source, volume, start_page) was itself sufficient to locate the cited reference precisely and author names are generally not spelled consistently. First names and middle names are often given in initials only and the latter are sometimes omitted. We found that only about 56% of author names were full names, with their much greater presence in more recent article records. Moreover, many (especially Chinese) surnames are shared by a very large number of different people and, on the other hand, several name variants may represent one person, which are well-known problems related to name disambiguation. That is, however, outside the scope of our research. In this study, we matched author names based on a full surname and first and middle name initials like in all of our previous papers. ResearcherID or ORCID could not be used for name disambiguation either due to the small share of authors having these identifiers (5.8% and 3.4%, respectively). An alternative approach would, therefore, need to employ some proper disambiguation methods surveyed by Ferreira et al. (2012) and an iterative citation matching process similar to that outlined in Olensky et al. (2016).

As a result, the citation graph of papers had 1,272,899 vertices and 5,530,476 edges. Based on this network, the citation graph of authors consisted of 662,310 vertices and 26,440,086 weighted edges. This corresponds to the figures for 2014 in Table 1 where the cumulative number of vertices and edges in the author citation graph over the whole period 1990-2014 is also shown. Note that the number of authors in the graph was as small as 62,376 in 1990 with 486,708 directed weighted edges between them. (The edge weights represent the actual citation counts between two authors up to a specific year with the self-citations of all authors removed.) The size of the author citation graph grew continuously between 1990 and 2014 as can be seen in Table 1.

Insert Table 1 here.

4. Results and discussion

Before delving into results, let us note that the approach based on prizes awarded has, of course, its limitations. The awards used in this study are certainly not entirely independent of citations and vice versa. An award may be given to a researcher partly on the basis of a large number of citations and award-winning scientists tend to attract more citations. Whether this happens intentionally or not, there may actually be a mutually reinforcing relationship between prizes and citations. Also, a very small fraction of "elite" scholars will ever get an important award while the overwhelming majority of all researchers will not. The prize-based approach can thus be applied only to leading researchers in their fields.

4.1. DCG plots

We split up our data set into 25 subsets that always included papers published before (or in) a specific year only and created 25 different author citation graphs that incrementally grew in size between 1990 and 2014 (see Table 1). By definition, the graph corresponding to 1991 contains all the authors and citations from graph 1990 plus newly emerging authors and citations from 1991. Graph 2014 is a superset consisting of all the preceding graphs. To each of the 25 graphs we applied four ranking methods to assess the importance of researchers: standard PageRank (*PR*), time-weighted PageRank (*PRtw*), simple citation counting (*Citations*[5]), and in-degree counts (*Indegree*). Moreover, we employed four different weighting schemes to determine the relevance scores of relevant (award-winning) authors as discussed in the section on methods. We used two reference sets of outstanding authors: the winners of the ACM SIGMOD E. F. Codd Innovations Award and the laureates of the ACM A. M. Turing Award. The Discounted Cumulative Gain (DCG) of the four ranking methods in various years and using different relevance weighting schemes is shown in Figure 1.

[5] We also tested a time-dependent version of *Citations*, in which older citations were given less weight, but the ranking for the largest graph (2014) did not change significantly (ρ = 0.9).

Insert Figure 1 here.

4.2. nDCG plots

The top two charts a) and b) in Figure 1 were produced with the binary weighting scheme {0, 1} where 0 was the relevance score of non-winning and 1 of award-winning researchers in the whole ranking generated by a specific ranking method on the cumulative data from a certain year. Note well that until about 2005 both *Citations* and *Indegree* yielded a larger DCG than both PageRank-based methods (*PR* and *PRtw*) based on Codd Award winners (left-hand) but almost a steadily smaller DCG throughout the whole period when measured on Turing Award winners (right-hand). This may be the result of the different nature of these two awards. Whereas the Codd Award is awarded to the researchers from a specific subdomain of computer science (databases), the Turing Award is much broader in scope and covers the whole field of computer science. Therefore, it would seem that domain-specific awards prefer popular researchers to prestigious ones (at least as documented by the Codd Award between 1990 and 2005). But it also appears that this trend may be reversing after 2005. A similar conclusion (although not so visually impressive) can be drawn from the charts c) and d) in Figure 1. These were created with the ternary relevance weighting scheme {0, 1, 2} where 1 was given to researchers winning in the past and 2 to scientists winning in the future (or in the current year) to boost the predictive power of the ranking method.

However, a different picture emerges in charts e) and f) of Figure 1 with the weighting schemes {0, 1/23, 1/22, ..., 1, 2, ..., 27} and {0, 1/49, 1/48, …, 1, 2, ..., 26} assigning more weight to the scholars winning in a more distant future and less weight to the researchers winning the award in a more distant past. Here all the curves take the form of a logarithmic descent, but *PR* (unlike *PRtw*) is outperformed by *Citations* even with Turing Award winners (albeit statistically insignificantly). And the same holds for the last plots g) and h) at the bottom of Figure 1, in which the weighting schemes {0,1, ..., 28} and {0,1, ..., 27} were used giving more weight to the scientists winning in a more distant future and equally weighting the researchers winning in the past. Let us remark that the DCG values achieved by the ranking methods are higher with the Turing Award than with the Codd Award, which is caused by the larger number of the winners of that prize (64 versus 25). After rescaling the DCG values to fit into the interval [0, 1] by dividing them by the maximum (ideal) discounted cumulative gain values, we obtain a Normalized Discounted Cumulative Gain (nDCG), which is visualized in Figure 2. The nDCG values measured on Turing Award winners are also higher here with the curve shapes remaining unchanged between Figure 1 and Figure 2.

Insert Figure 2 here.

4.3. DCG@100 plots

DCG (or nDCG too) may be computed for the whole rankings like in Figure 1 and Figure 2 or for some top-ranked positions only. The reason for this is that we are usually interested in the top places of a ranking (by importance) and do not care much about the rest of it. Therefore, Figure 3 presents DCG plots of the top 100 researchers (DCG@100) as determined by each of the four ranking methods. Even here we can see that *Citations* and *Indegree* outperform both *PR* and *PRtw* before 2005 with Codd Award winners but fail to do so with Turing Award winners when the simple binary relevance weighting is applied (see a) and b) in Figure 3) as well as when the ternary weighting is exploited (see c) and d) in Figure 3). The last two extended weighting schemes have a similar effect: *Citations* and *Indegree* are better than PageRank-based methods only until about 2000 with Codd Award laureates (see e) and g) in Figure 3) and are mostly worse than *PRtw* (but not *PR*!) with Turing Award winners throughout the whole period 1990-2014 (see f) and h) in Figure 3). The logarithmic decline is by far not so well visible in the bottom charts of Figure 3 as it is in the previous figures, nevertheless all eight plots in Figure 3 tend to decrease as they do in Figure 1 and Figure 2.

Insert Figure 3 here.

4.4. Rank permilles

The above feature results from the fact that the author citation network grows over the years – let us recall that there are ten times more authors in 2014 than in 1990 as shown in Table 1. Due to this fact the award-winning researchers have a tendency towards occupying higher ranks (worse ranks, in fact, if rank 1 is the best) in later years. In other words, it is easier for the awardees to be placed in the top 100 within 1000 scholars than within 10,000 scientists. Therefore, we need to correct for the increasing number of authors in the citation network. Because of this normalization need and because the number (100) of the first positions to observe in DCG@100 is somewhat arbitrary, we return to DCG again, but this time we do not calculate it based on the real ranks achieved but based on the so-called rank permilles. By analogy with percentiles ranging from 0 to 99, permilles belong to the interval [0, 999] and if we shift them by one to reflect well the notion of ranks, authors are assigned rank permilles between 1 and 1000 instead of their genuine ranks. Then, an author ranked first belongs to the best one thousandth of researchers irrespective of the number of authors in that particular ranking. (By definition, there can be tied ranks now.) An overview of the rank permilles of Codd Award winners yielded by PageRank in individual years is given in Table 2.

Insert Table 2 here.

The cells at the intersection of a specific year and a researcher winning in that year are highlighted in Table 2. In this way, it is easy to see whether the prize-giving had any effect on the standing of researchers in future years. In fact, the only visible impact of award winning on future ranks is the 1999 award to “Garcia-Molina, H”. This researcher was ranked 678th one year before the prize was awarded, 265th in the year of award, and 105th one year after the prize was awarded. He even did not appear at all in the rankings before 1997. We may speculate that his “sudden” award had to do with his work with the founders of Google, which had a tremendous impact on the field of databases. All other researchers in Table 2 did already have an excellent rank at the time of them being award winners, with “Ullman, JD” ranked 1st in 2006 and throughout the whole time range under study. The only other scientist starting in a similarly bad position as “Garcia-Molina, H” was “Chaudhuri, S” (ranked 614th in 1990) who was honoured only in 2011 when already ranked 2nd (the same as before and after the award). The worst rank of Codd Award recipients changed from 614 to 25 between 1990 and 2014 and very similar trends appear also in the rankings generated by the other three methods whose results are shown in the appendix: *PRtw* (Table A.1), *Citations* (Table A.2), and *Indegree* (Table A.3). On the other hand, the results of PageRank permilles for Turing Award winners are presented in Table 3.

Insert Table 3 here.

4.5. Permille plots

Compared to the Codd Award, the Turing Award is a general computer science prize given to one or more persons per year. Therefore, there sometimes may be a couple of highlighted cells in a year like 1993 or 2002 in Table 3. The effect of receiving the award on their future ranks seems to be negligible for most researchers except perhaps “Feigenbaum, EA” (award-winning in 1994), who was ranked 142nd, 105th, and 63rd in 1993, 1994, and 1995, respectively. Since the Turing Award is much older than the Codd Award, there are almost 30 “post-award” scholars appearing in Table 3 who received the distinction prior to 1990. These authors are generally excellently ranked throughout the whole period under study (1990 – 2014) with the exception of “Bachman, CW” (winning in 1973) and “Kahan, W” (honoured in 1989). The worst rank improved from 705 to 105 during the time period analyzed. This is quite similar to *PRtw* ranks shown in Table A.4 (in the appendix) but less so to *Citations* permilles with worst ranks ranging from 882 to 313 (Table A.5) and *Indegree* permilles with worst ranks between 876 and 323 (Table A.6). The DCG plots of the ranking methods based on the permilles discussed above can be seen in Figure 4.

Insert Figure 4 here.

In charts a) and b) of Figure 4 all the curves tend to increase except for Turing Award *Citations* and *Indegree* after 2000. This would reveal that in the recent years it has become quite insufficient to have a high number of citations (great popularity) to get the prize, but, instead, it is necessary to be acknowledged by reputed scholars (great prestige). *PR* and *PRtw* are constantly better than *Citations* and *Indegree* with the exception of a short period before 1995 with Codd Award recipients, which is in stark contrast to the previous figures where *Citations* and *Indegree* for Codd Award winners were prevalent. Moving from absolute to relative ranks (permilles) has thus resulted in the outperformance of *PR* and *PRtw* even for Codd Award laureates. The main difference between charts c) and d) of Figure 4 and the preceding two charts is the decline of all the curves starting around 2005 in c) and 2000 in d). The reason for this behaviour is the ternary weighting {0, 1, 2} used here that gives more weight to the researchers winning in the future and, obviously, in the more recent years fewer such researchers are known. As for the next charts, e) and f) of Figure 4, the better performance of PageRank-based methods over *Citations* and *Indegree* is less clear. With Turing Award winners, it would seem that *PRtw* outperforms *PR* and they both perform better than *Citations* and *Indegree*, but the differences are not statistically significant. And roughly the same holds for the last plots g) and h) in Figure 4.

Thus, adding more predictive power to the weighting of award-winning researchers actually makes the ranking methods perform quite comparably. To conclude this section, we may claim that *Citations* and *Indegree* outperform *PR* and *PRtw* if the absolute ranks of Codd Award winners are evaluated and the opposite is true for the Turing Award. However, if the relative ranks (permilles, taking into account the growing number of researchers in the citation network) are considered, the PageRank-based methods perform better than *Citations* and *Indegree* even for the Codd Award. This better performance generally becomes less obvious when more predictive power is added to the weighting of award-winning researchers, though. Table A.7 in the appendix presents the top 50 authors generated by the four ranking methods in 2014, with Turing Award winners highlighted (none of the rankings places a Codd Award winner in the top 50). The non-highlighted researchers (provided they are still alive) thus represent hot candidates for future awards. The next two tables in the appendix (Table A.8 and Table A.9) show the exact citation counts of prize winners before and after the award for verification and the last Table A.10 also includes some descriptive statistics of the data series shown in Figure 4.

4.6. Additional rankings

The performance of the four additional ranking methods (*Collaborators*, *Publications*, *Journal Prestige*, and *Institution Prestige*) is shown in Figure A.1. As a general feature, the method based on the prestige of authors' institutions outperforms the others, albeit statistically significantly (at the 0.05 level two-tailed) only in the first two weighting schemes b) and d) of the Turing Award. Regarding the Codd Award, its outperformance relative to measuring the prestige of journals in which authors publish is statistically significant in the first two weighting schemes a) and c) and in a) also relative to counting publications of the authors assessed. Compared to *Citations* and *PRtw* (see Figure 4), *Institution Prestige* is worse in all four weightings for the Turing Award, however, statistically significantly only in the first two weightings for both and in the last weighting layout for *PRtw*. As to the Codd Award, *Institution Prestige* is almost on par with *Citations* and significantly worse than *PRtw* in the first two weighting arrangements but insignificantly better than both by the last two weighting procedures. Thus, the additional evaluation techniques do not seem at all to result in an improvement of the rankings.

As far as the two supplementary prizes are concerned, the corresponding DCG permille charts are displayed in Figure A.2. We can see that *PRtw* basically performs better than the other ranking methods for both Dijkstra Prize and Gödel Prize winners. Nevertheless, there is no statistical significance between the rankings in the last two weighting layouts for both prizes, e) - h). With respect to the first two weightings, *Indegree* is significantly worse than all the other three rankings for Dijkstra Prize recipients in a) and c) and also than *PRtw* in b) and *PRtw* and *Citations* in d) for Gödel Prize awardees. These results would thus confirm a previous finding (see Figure 4) of the advantage of the PageRank-based methods over the degree-based ones, with a further shift in favour of the time-aware PageRank variant. And as to the performance of the additional techniques for those two awards (see Figure A.3), *Institution Prestige* is always the best, statistically significantly outperforming the other three methods in a) through d) and *Journal Prestige* further in e) through h). A summary of the mean DCG permille values achieved using all eight techniques for all four awards in all four weighting schemes is shown in Table 4.

Insert Table 4 here.

5. Conclusions and future work

Recently, there have been some contradictory findings regarding the usefulness of PageRank-based methods compared to simple citations-based techniques in the task of identifying outstanding researchers in a citation network of research papers. Some studies like Fiala et al. (2015a) have concluded that higher-order methods do not outperform first-order ones while other analyses, e.g. Nykl et al. (2015), have found the opposite. Because of different approaches to the construction of the citation network, to the treatment of self-citations, to the parameter setting of PageRank calculations and their convergence criteria, it is difficult to compare PageRank studies directly. Moreover, calculating PageRank is always much more computationally expensive than counting citations and, therefore, for practical reasons it may still be more convenient to use citations even if PageRank yields better results. Nevertheless, in the present study we tried to shed more light on the "PageRank versus citations" problem in the frequent process of finding influential researchers.

Among other things, we took the following steps to achieve the results reported:

- We retrieved almost two million textual metadata records on computer science papers from Web of Science and created a large author citation network consisting of nearly 0.7 million vertices and over 26.4 million edges.
- We split up the data set into 25 cumulative subsets covering the time period 1990-2014 with papers published until each specific year and ranked authors by importance using two PageRank-based methods (standard PageRank and time-weighted PageRank) and two citations-based techniques (*Citations* and *Indegree*) in each year.
- As a major contribution, we designed four different ranking evaluation schemes based on non-zero relevance scores for past and future Codd Award and Turing Award winners (thus having some predictive power) and compared the resulting rankings by means of discounted cumulative gains using absolute as well as relative ranks.

The results of our experiments showed that:

- Citations-based rankings perform better than their PageRank-based counterparts for Codd Award winners but not for Turing Award recipients if the absolute ranks of the outstanding researchers are considered.
- PageRank-based methods outperform citations-based techniques for both Codd Award and Turing Award winners if the relative ranks of the awardees are taken into account and this is also corroborated to a smaller extent by an additional assessment of Dijkstra Prize and Gödel Prize laureates.
- The rankings produced by the four distinct ranking methods, however, tend to show smaller differences if a greater emphasis in the assessment mechanism measuring their performance is put on the relevance weight of researchers winning in the future.

In our future work, we would like to extend our analysis and include also other PageRank-like ranking methods as well as HITS (Kleinberg, 1999) to confirm the assumption that due to their high correlation they would predict more or less the same future award-winning researchers. Also, the citations-based techniques may comprise citations from outside of computer science (similarly to “Times Cited” in Web of Science) or consider only citations from the first authors of publications, etc. And, last but not least, the reference sets of outstanding scholars might include the winners of many different prestigious awards, distinguished members of professional societies, editorial board members of high-impact journals, or programme committee members of influential conferences. In other words, some follow-up studies will be needed to corroborate or challenge our findings.

Acknowledgements

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Figure captions

Fig. 1 DCG plots of four ranking methods based on Codd Award (on the left) and Turing Award (on the right) winners using four relevance weighting schemes with a different predictive power

Fig. 2 nDCG plots of four ranking methods based on Codd Award (on the left) and Turing Award (on the right) winners using four relevance weighting schemes with a different predictive power

Fig. 3 DCG@100 plots of four ranking methods based on Codd Award (on the left) and Turing Award (on the right) winners using four relevance weighting schemes with a different predictive power

Fig. 4	DCG permille plots of four ranking methods based on Codd Award (on the left) and Turing Award (on the right) winners using four relevance weighting schemes with a different predictive power
Fig. A.1	DCG permille plots of four additional ranking methods based on Codd Award (on the left) and Turing Award (on the right) winners using four relevance weighting schemes with a different predictive power
Fig. A.2	DCG permille plots of four ranking methods based on Dijkstra Prize (on the left) and Gödel Prize (on the right) winners using four relevance weighting schemes with a different predictive power
Fig. A.3	DCG permille plots of four additional ranking methods based on Dijkstra Prize (on the left) and Gödel Prize (on the right) winners using four relevance weighting schemes with a different predictive power

Table captions

Table 1	Size of the data set under study: vertex and edge counts of the paper citation and author citation graphs
Table 2	Codd Award winners and their ranks in various years based on PageRank permilles with award years highlighted
Table 3	Turing Award winners and their ranks in various years based on PageRank permilles with award years highlighted
Table 4	Summary of mean DCG permille values achieved in various weighting schemes corresponding to charts a) and b), c) and d), e) and f), and g) and h) in Figure 4 and Figures A.1 – A.3.
Table A.1	Codd Award winners and their ranks in various years based on time-weighted PageRank permilles with award years highlighted
Table A.2	Codd Award winners and their ranks in various years based on *Citations* permilles with award years highlighted
Table A.3	Codd Award winners and their ranks in various years based on *Indegree* permilles with award years highlighted
Table A.4	Turing Award winners and their ranks in various years based on *twPageRank* permilles with award years highlighted
Table A.5	Turing Award winners and their ranks in various years based on *Citations* permilles with award years highlighted

Appendix A

Insert Table A.1 here.

Insert Table A.2 here.

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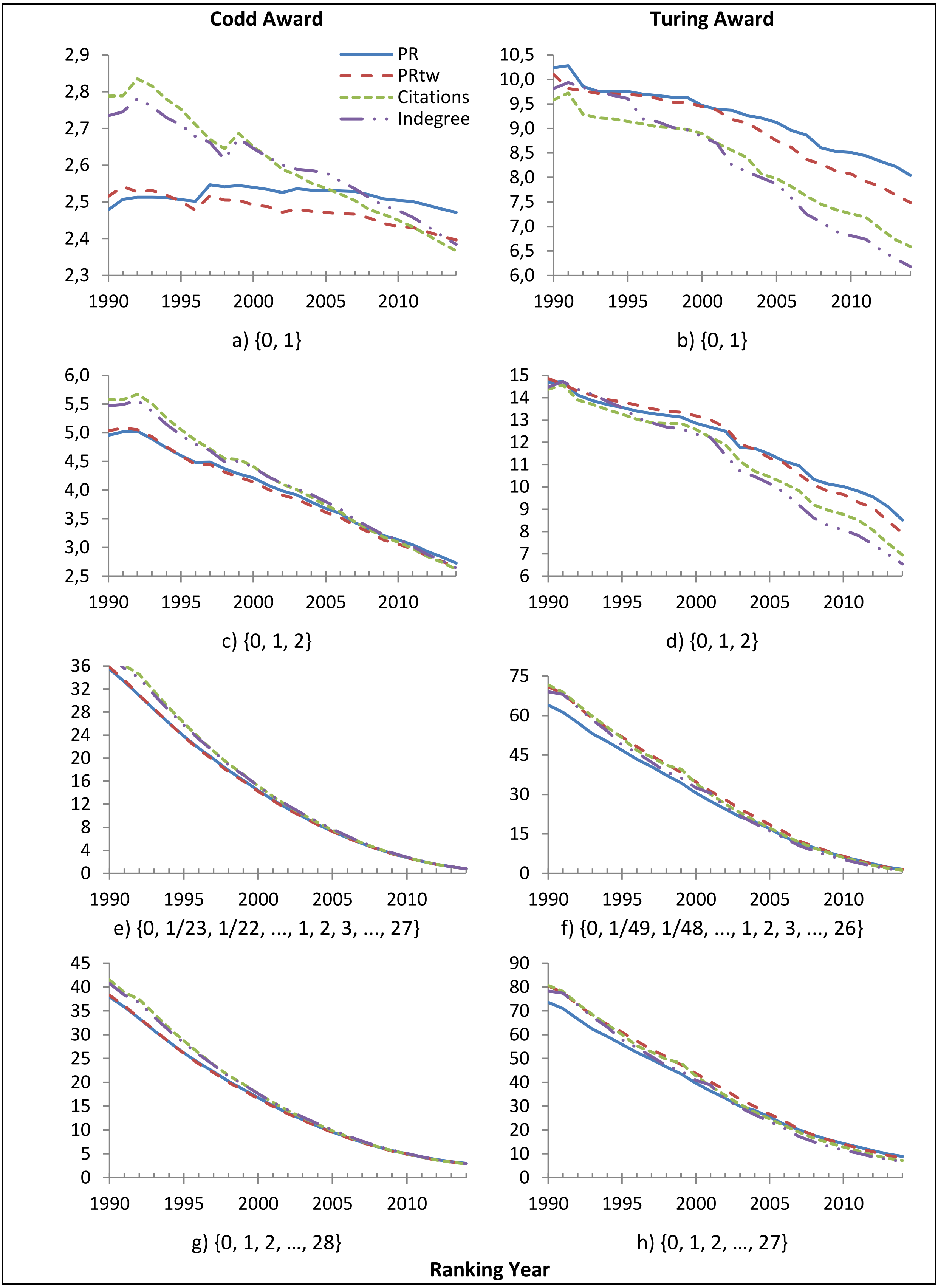


Fig. 1 DCG plots of four ranking methods based on Codd Award (on the left) and Turing Award (on the right) winners using four relevance weighting schemes with a different predictive power

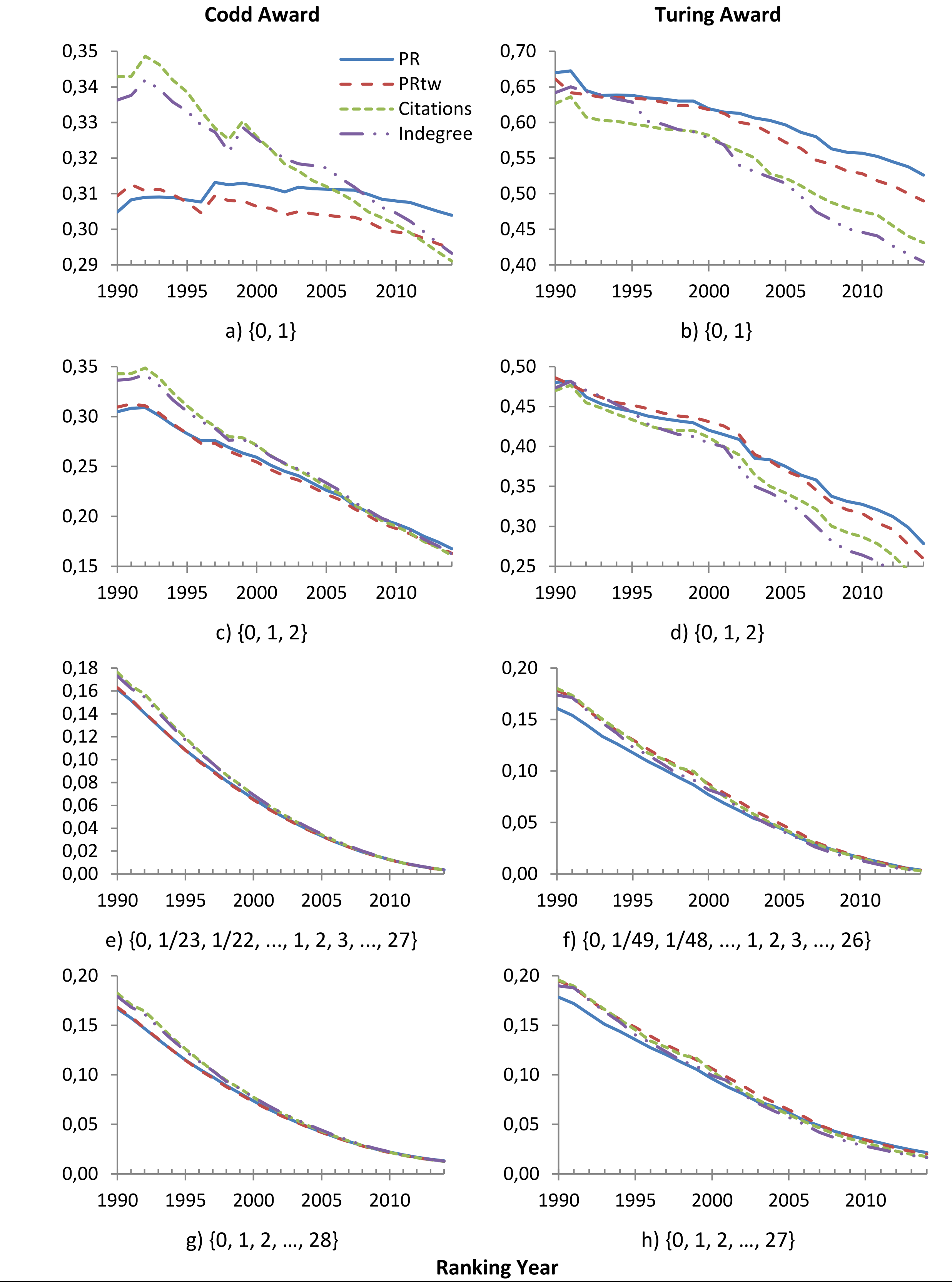


Fig. 2 nDCG plots of four ranking methods based on Codd Award (on the left) and Turing Award (on the right) winners using four relevance weighting schemes with a different predictive power

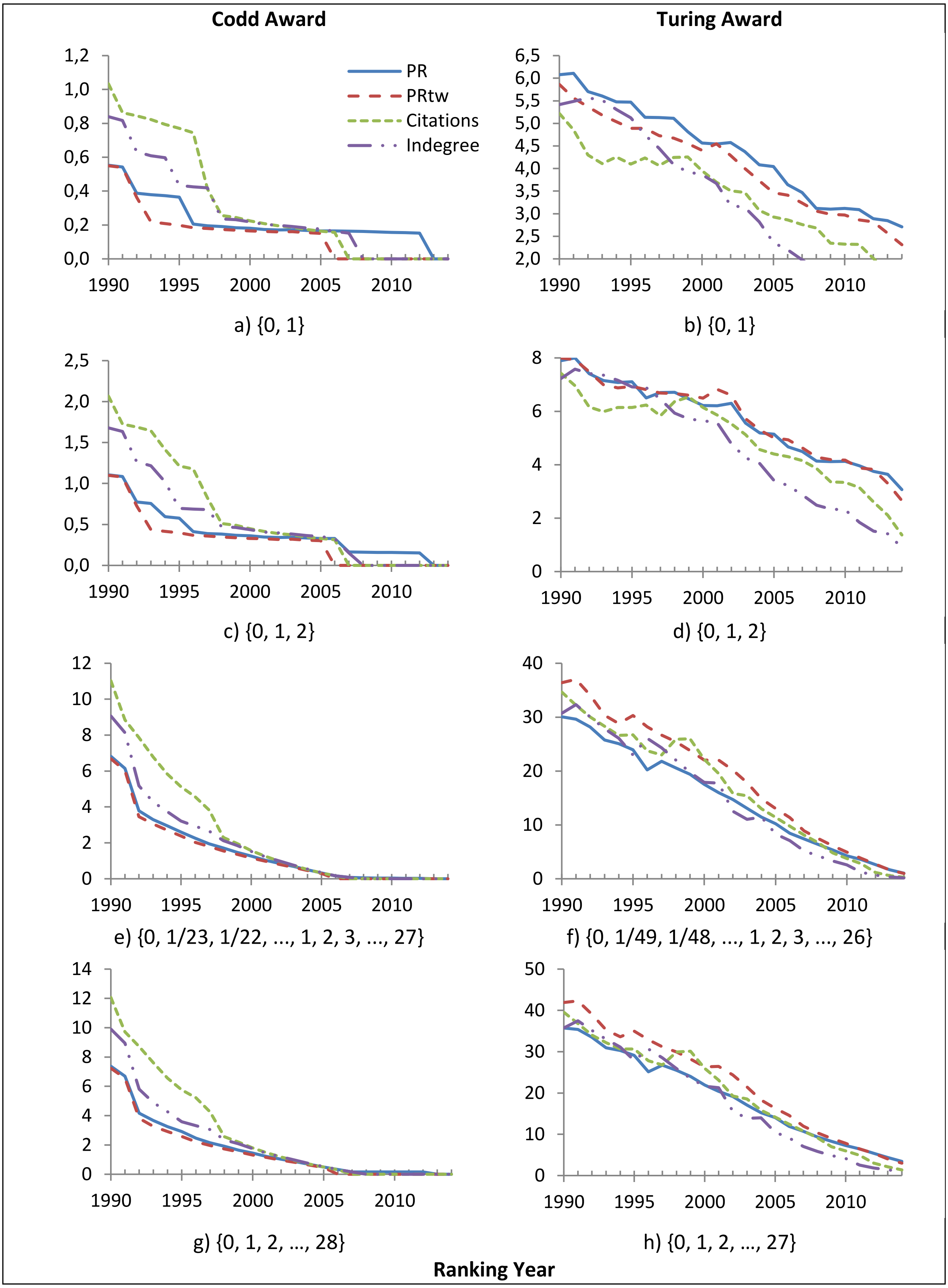


Fig. 3 DCG@100 plots of four ranking methods based on Codd Award (on the left) and Turing Award (on the right) winners using four relevance weighting schemes with a different predictive power

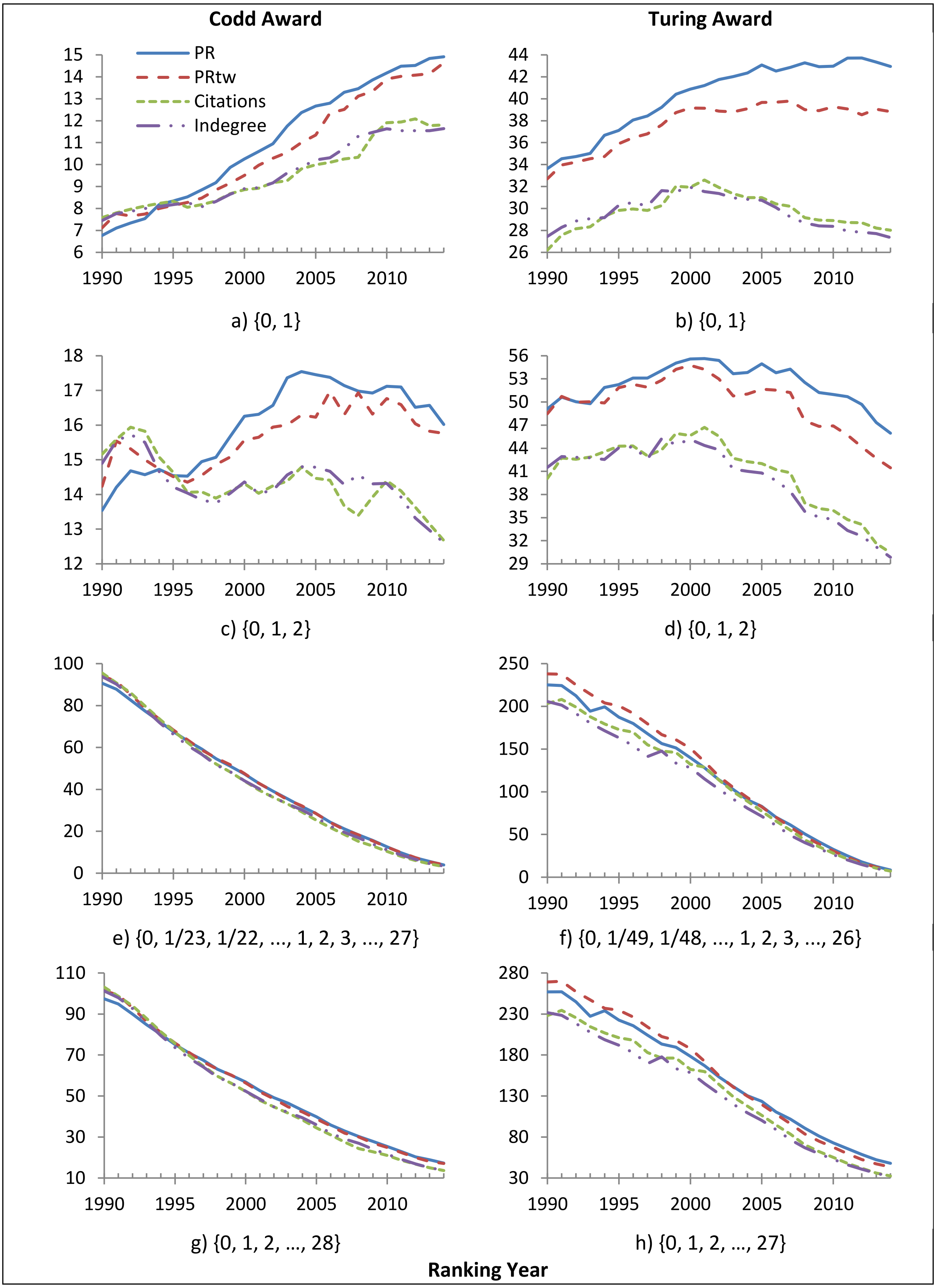


Fig. 4 DCG permille plots of four ranking methods based on Codd Award (on the left) and Turing Award (on the right) winners using four relevance weighting schemes with a different predictive power

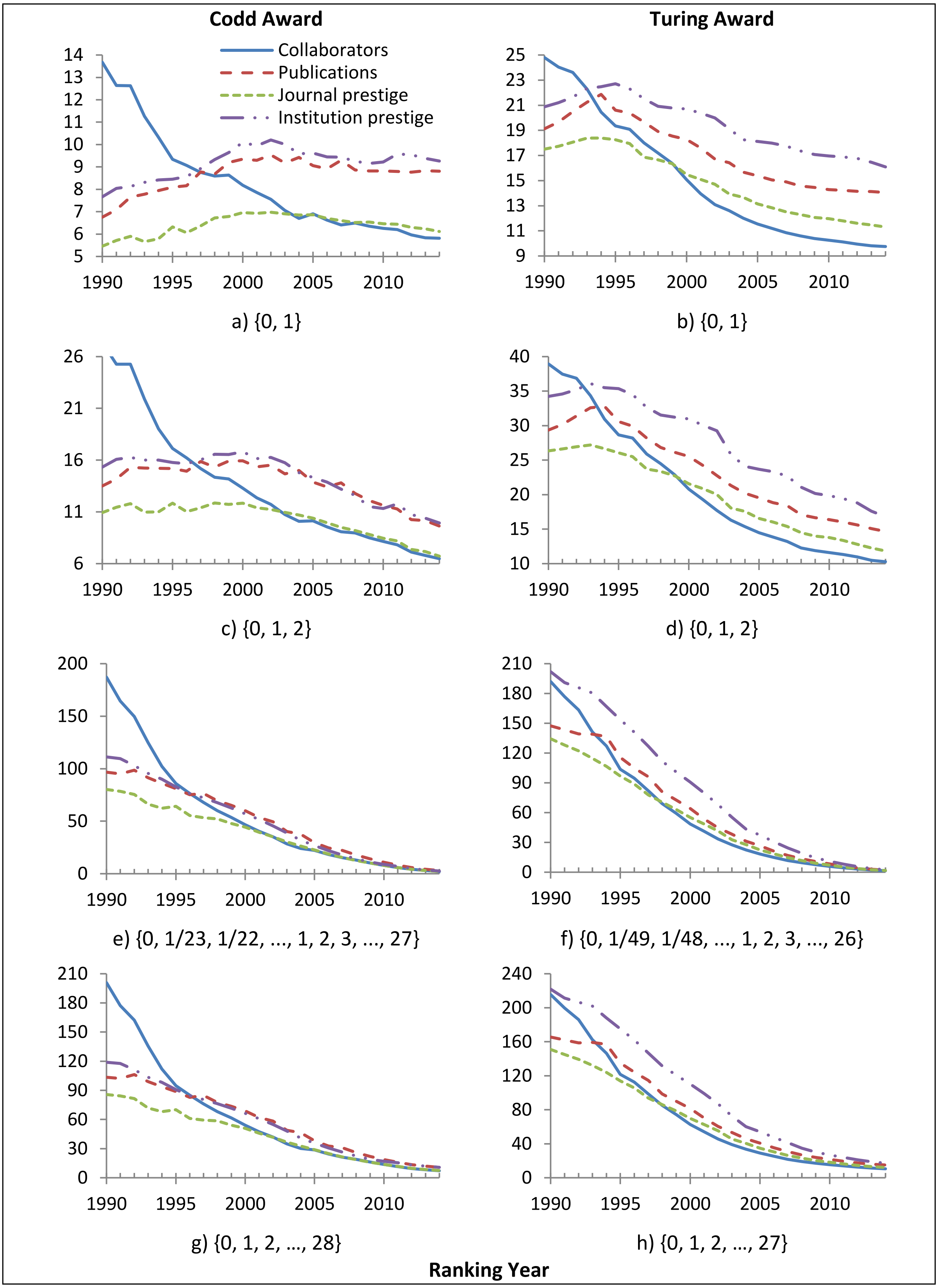


Fig. A.1 DCG permille plots of four additional ranking methods based on Codd Award (on the left) and Turing Award (on the right) winners using four relevance weighting schemes with a different predictive power

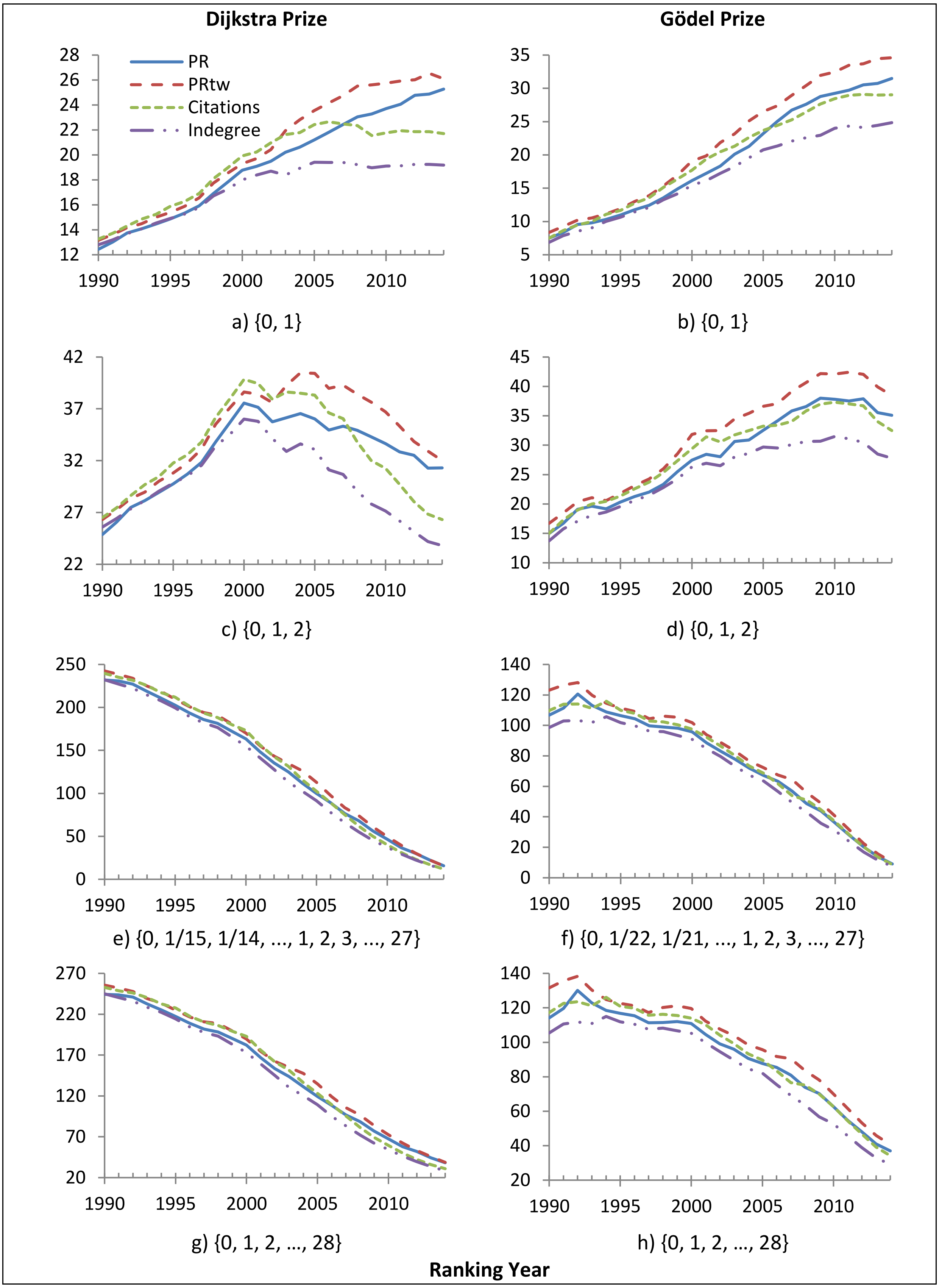


Fig. A.2 DCG permille plots of four ranking methods based on Dijkstra Prize (on the left) and Gödel Prize (on the right) winners using four relevance weighting schemes with a different predictive power

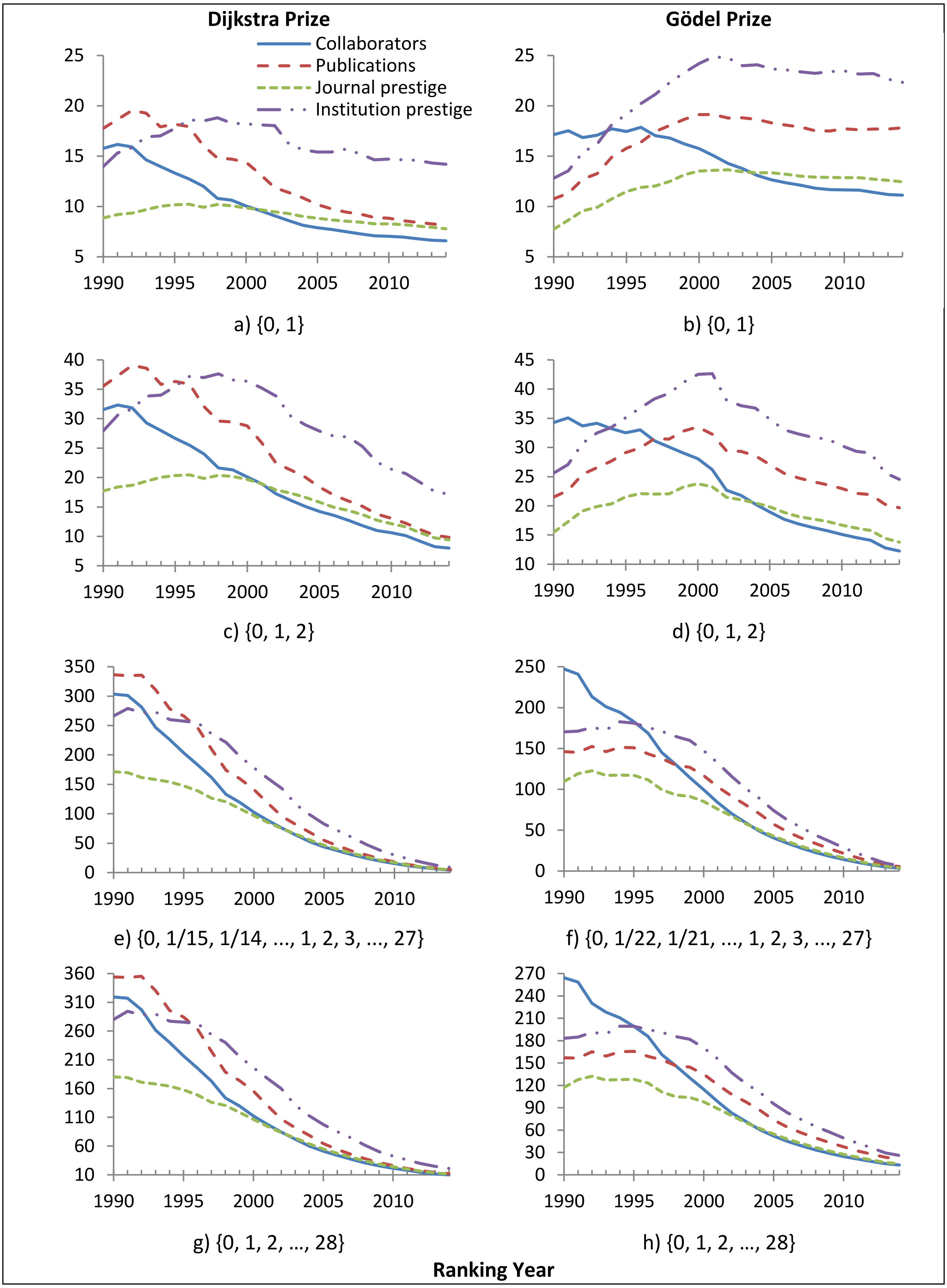
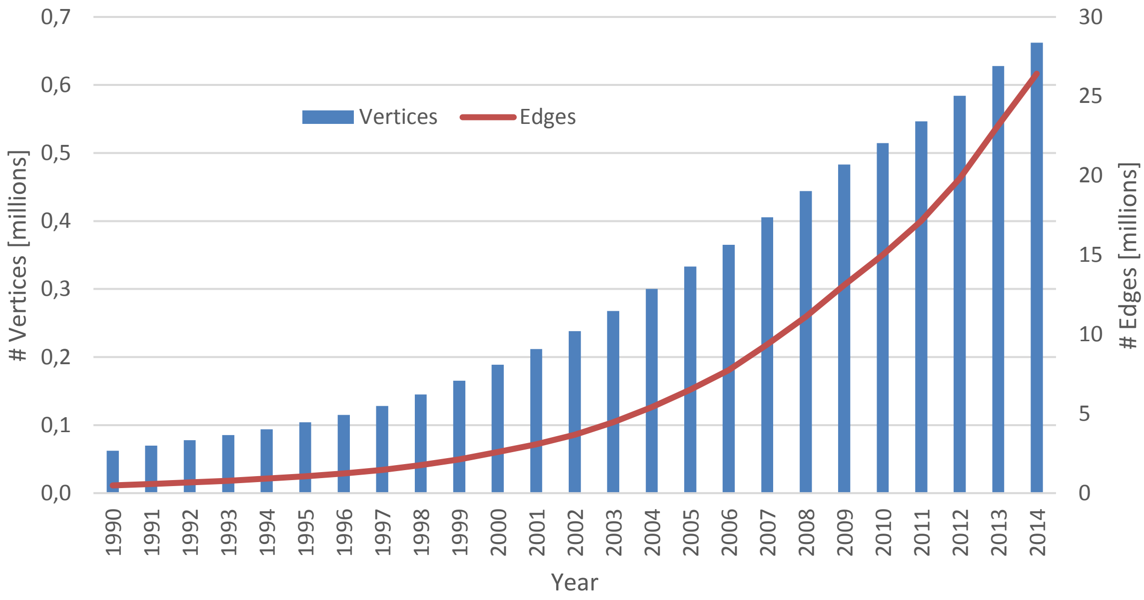


Fig. A.3 DCG permille plots of four additional ranking methods based on Dijkstra Prize (on the left) and Gödel Prize (on the right) winners using four relevance weighting schemes with a different predictive power

Table 1 Size of the data set under study: vertex and edge counts of the paper citation and author citation graphs

Paper Citation Graph						
# Publications obtained	# References	# References with DOI	# Internal DOI-based citations	# Internal decoded citations	# Vertices in the graph	# Edges in the graph
1,922,652	32,137,613	12,319,981	4,368,154	1,163,574	1,272,899	5,530,476
Author Citation Graph						



Preprint of "Fiala, D., & Tutoky, G. (2017). PageRank-based prediction of award-winning researchers and the impact of citations. *Journal of Informetrics*, 11(4), 1044-1068."

Table 2 Codd Award winners and their ranks in various years based on PageRank permilles with award years highlighted

Year & Awardee	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
1992 Stonebraker, M	4	4	3	3	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1993 Gray, J	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	1	1	1	1
1994 Bernstein, PA	5	4	4	3	3	3	3	3	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1
1995 DeWitt, DJ	8	6	5	5	5	5	5	5	5	5	5	4	4	4	4	4	4	4	4	4	4	4	4	3	3
1996 Mohan, C	94	34	31	28	24	22	21	17	15	13	11	10	9	9	8	8	8	7	7	7	7	7	6	6	5
1997 Maier, D	9	8	7	7	7	6	5	5	5	4	4	4	4	3	3	3	3	3	3	3	2	3	3	2	2
1998 Abiteboul, S	75	44	30	21	16	10	9	8	6	6	5	4	4	3	3	3	3	2	2	2	2	2	2	2	2
1999 Garcia-Molina, H								678	678	265	105	47	30	17	12	8	6	4	4	3	2	2	2	2	2
2000 Agrawal, R	147	70	51	43	38	33	19	11	8	5	4	3	2	2	1	1	1	1	1	1	1	1	1	1	1
2001 Bayer, R	21	20	18	17	16	14	14	14	13	12	11	12	12	12	11	11	11	11	12	12	12	12	12	12	12
2002 Selinger, P	15	15	14	14	14	13	12	12	12	11	11	11	11	11	11	11	12	12	12	12	12	12	12	12	12
2003 Chamberlin, D	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
2004 Fagin, R	6	5	5	5	4	4	4	3	3	3	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1
2005 Carey, MJ	233	132	94	68	54	48	34	32	24	19	15	12	11	11	10	9	9	9	9	8	8	8	8	7	7
2006 Ullman, JD	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2007 Widom, J	88	72	53	54	41	37	29	24	18	13	11	8	6	5	4	3	3	3	3	2	2	2	2	2	2
2008 Vardi, MY	27	22	19	15	14	12	11	10	8	7	6	5	5	3	3	3	3	2	2	2	2	2	2	2	2
2009 Kitsuregawa, M	136	112	91	85	73	69	70	66	67	69	69	66	64	63	59	57	53	51	49	47	39	35	32	27	25
2010 Dayal, U	172	82	64	51	47	35	35	30	26	22	22	20	18	15	13	12	10	8	7	7	6	5	5	5	4
2011 Chaudhuri, S	614	617	404	236	206	165	158	88	56	27	18	14	11	8	6	5	4	3	3	2	2	2	2	2	2
2012 Lindsay, B	10	9	9	8	8	8	7	7	7	7	7	7	6	6	6	6	6	6	6	6	6	6	6	6	6
2013 Ceri, S	47	35	34	30	27	23	18	16	15	13	10	8	6	5	4	3	3	3	2	2	2	2	2	2	2
2014 Kersten, M	79	79	68	67	64	62	61	57	55	48	44	42	36	33	30	25	20	17	15	14	13	13	12	10	10
2015 Haas, LM	52	33	32	29	26	26	25	23	21	20	20	19	17	15	13	9	8	7	7	6	6	6	6	5	5
2016 Weikum, G	341	342	299	236	206	175	85	80	75	37	27	25	18	14	11	10	10	9	8	7	6	5	5	4	4
minimum rank	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
median rank	27	22	19	17	16	13	12	12	12	11	10	8	6	5	4	4	4	3	3	3	2	2	2	2	2
maximum rank	614	617	404	236	206	175	158	678	678	265	105	66	64	63	59	57	53	51	49	47	39	35	32	27	25

Table 3 Turing Award winners and their ranks in various years based on PageRank permilles with award years highlighted

Year & Awardee	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
1966 Perlis, AJ	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2
1967 Wilkes, MV	17	17	18	15	14	14	14	14	13	13	13	12	13	13	12	12	12	12	14	13	14	14	14	14	14
1968 Hamming, RW	10	10	11	11	12	12	12	12	12	12	12	13	13	13	14	14	15	15	15	15	14	14	14	14	14
1969 Minsky, M	11	11	12	13	13	13	13	12	10	10	10	10	10	10	9	9	9	9	6	6	6	6	6	6	6
1970 Wilkinson, JH	4	4	4	4	4	4	4	4	4	4	5	6	6	6	7	6	6	6	7	7	7	7	7	7	7
1971 McCarthy, J	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1972 Dijkstra, EW	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1973 Bachman, CW	137	135	133	134	134	133	131	133	103	105	107	108	108	106	104	103	104	103	103	102	104	105	103	105	105
1974 Knuth, DE	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1975 Newell, A	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1975 Simon, HA	5	3	3	3	3	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	2
1976 Rabin, MO	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1976 Scott, DS	11	11	10	9	9	9	8	7	7	7	7	7	7	8	7	7	7	7	8	7	7	7	8	8	8
1977 Backus, JW	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4	4	5
1978 Floyd, RW	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1979 Iverson, KE	7	7	8	8	8	9	9	9	8	8	8	8	8	9	9	9	8	9	9	9	9	9	9	8	8
1980 Hoare, CAR	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1981 Codd, EF	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1982 Cook, SA	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
1983 Thompson, K	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1983 Ritchie, DM	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1984 Wirth, N	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1985 Karp, RM	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1986 Hopcroft, J	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
1986 Tarjan, RE	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1987 Cocke, J	10	8	7	7	6	6	5	5	5	4	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3
1988 Sutherland, IE	67	62	37	20	12	11	10	7	6	6	5	5	4	3	3	3	2	3	3	3	3	3	3	3	3
1989 Kahan, W	171	161	151	153	153	150	144	139	138	95	94	94	87	82	80	78	72	65	62	59	50	48	44	43	44
1990 Corbato, FJ	65	46	45	57	50	44	45	46	44	45	54	53	50	45	44	47	46	44	44	44	43	43	46	46	48
1991 Milner, R	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1992 Lampson, B	2	2	2	2	2	2	1	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1993 Hartmanis, J	17	16	15	14	14	14	14	14	14	14	13	13	12	12	12	12	12	12	12	12	11	11	11	12	12
1993 Stearns, RE	3	2	3	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
1994 Feigenbaum, EA	421	188	183	142	105	63	40	38	31	31	30	26	25	24	23	22	20	17	15	15	14	13	13	14	14
1994 Reddy, R	30	26	25	23	24	24	22	20	18	17	16	14	13	13	13	12	10	10	9	9	8	8	8	8	8
1995 Blum, M	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1996 Pnueli, A	3	3	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1997 Engelbart, D	112	116	118	109	110	109	109	111	111	108	108	106	107	108	98	97	92	89	87	84	82	81	82	83	79

Preprint of "Fiala, D., & Tutoky, G. (2017). PageRank-based prediction of award-winning researchers and the impact of citations. *Journal of Informetrics*, 11(4), 1044-1068."

Table 3 Turing Award winners and their ranks in various years based on PageRank permilles with award years highlighted (continued)

Year & Awardee	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
1998 Gray, J	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	1	1	1	1
1999 Brooks, FP	5	5	5	5	5	4	4	4	4	4	4	3	3	3	2	2	2	2	2	2	2	1	1	1	1
2000 Yao, AC	8	7	7	6	6	5	5	5	4	4	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2
2001 Dahl, O	8	7	7	7	7	6	6	5	5	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
2001 Nygaard, K	7	6	6	6	6	6	5	5	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
2002 Rivest, RL	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2002 Shamir, A	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2002 Adleman, LM	371	379	357	363	344	272	268	188	177	125	62	56	44	36	27	26	24	24	23	21	21	20	20	20	20
2003 Kay, A	117	112	105	77	67	56	59	56	51	49	37	36	33	24	21	18	18	16	16	16	16	17	16	16	16
2004 Cerf, VG	88	81	73	72	69	66	65	65	64	58	59	54	52	49	49	47	47	46	36	41	40	40	35	32	23
2004 Kahn, RE	705	487	508	494	497	494	481	459	434	154	104	102	92	82	71	62	60	60	58	61	59	60	56	56	55
2005 Naur, P	16	16	17	18	17	16	15	16	14	10	13	13	13	19	18	18	18	18	18	17	18	18	18	19	19
2006 Allen, F	16	15	14	14	13	13	12	12	11	11	11	10	10	10	8	8	8	8	8	8	8	8	8	8	8
2007 Clarke, EM	12	8	6	5	5	3	3	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2007 Emerson, EA	20	16	11	9	7	6	5	4	3	2	2	2	2	2	2	1	2	2	1	1	1	1	1	2	2
2007 Sifakis, J	40	39	36	33	31	25	21	15	11	8	7	6	5	4	4	4	4	3	3	3	3	3	3	3	3
2008 Liskov, B	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2009 Thacker, C	153	88	67	54	50	46	36	35	28	26	25	21	17	12	12	12	11	11	10	10	10	10	10	10	9
2010 Valiant, LG	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2011 Pearl, J	6	4	4	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2012 Micali, S	15	11	10	9	8	7	6	5	4	3	3	2	2	2	2	1	1	1	1	1	1	1	1	1	1
2012 Goldwasser, S	22	16	15	13	10	9	8	7	5	4	4	3	3	2	2	2	2	1	1	1	1	1	1	1	1
2013 Lamport, L	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2014 Stonebraker, M	4	4	3	3	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2015 Hellman, ME	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2015 Diffie, W	2	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
minimum rank	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
median rank	5	4	4	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	1	1	2	2
maximum rank	705	487	508	494	497	494	481	459	434	154	108	108	108	108	104	103	104	103	103	102	104	105	103	105	105

Table 4 Summary of mean DCG permille values achieved in various weighting schemes corresponding to charts a) and b), c) and d), e) and f), and g) and h) in Figure 4 and Figures A.1 – A.3.

	Codd Award	**Turing Award**	**Dijkstra Prize**	**Gödel Prize**	**Mean DCG**	**Codd Award**	**Turing Award**	**Dijkstra Prize**	**Gödel Prize**	**Mean DCG**
			a), b)					c), d)		
PR	11.06	40.29	19.25	19.41	**22.51**	15.99	52.19	32.70	28.34	**32.30**
PRtw	10.64	37.70	20.51	21.74	**22.65**	15.66	49.83	34.76	31.54	**32.95**
Citations	9.55	29.70	19.59	19.59	**19.61**	14.32	40.80	28.75	28.75	**28.16**
Indegree	9.56	29.60	16.88	16.88	**18.23**	14.31	40.01	25.13	25.13	**26.15**
Collaborators	8.20	15.06	10.12	14.45	**11.96**	13.47	20.74	18.76	23.99	**19.24**
Publications	8.64	17.21	13.05	16.87	**13.94**	13.84	23.21	24.20	26.55	**21.95**
Journal Prestige	6.41	14.80	9.12	12.16	**10.62**	10.24	19.75	16.44	19.27	**16.43**
Institution Prestige	9.17	19.47	16.24	21.45	**16.58**	14.38	27.38	29.31	33.57	**26.16**
			e). f)					g). h)		
PR	42.02	115.05	131.21	74.87	**90.79**	52.12	152.86	149.22	92.62	**111.71**
PRtw	42.57	120.34	138.06	80.84	**95.45**	52.29	155.75	157.21	100.65	**116.48**
Citations	40.89	107.70	76.19	76.19	**75.24**	49.63	135.54	94.07	94.07	**93.33**
Indegree	40.85	101.65	69.34	69.34	**70.30**	49.61	129.42	84.78	84.78	**87.15**
Collaborators	53.97	58.46	109.60	95.35	**79.34**	61.64	72.54	119.36	108.85	**90.60**
Publications	48.65	60.84	135.89	86.45	**82.96**	56.67	76.93	148.48	101.99	**96.02**
Journal Prestige	36.56	52.21	81.99	65.39	**59.04**	42.52	66.08	90.68	76.62	**68.97**
Institution Prestige	48.59	82.18	144.06	106.44	**95.32**	57.06	100.43	159.54	126.18	**110.80**

Table A.1 Codd Award winners and their ranks in various years based on time-weighted PageRank permilles with award years highlighted

Year & Awardee	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
1992 Stonebraker, M	4	4	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
1993 Gray, J	2	1	2	2	2	2	2	2	2	2	2	2	2	3	3	2	2	2	2	2	1	1	1	1	1
1994 Bernstein, PA	3	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2	1	1	1	1	1	1	1	1	1
1995 DeWitt, DJ	6	4	4	4	4	4	4	5	5	5	5	4	4	5	5	6	6	6	6	6	6	5	5	5	4
1996 Mohan, C	88	28	26	23	21	19	19	15	14	12	11	10	9	9	9	10	9	9	8	9	9	9	7	7	6
1997 Maier, D	7	7	5	5	5	5	5	5	4	4	4	4	4	4	3	3	3	3	3	3	3	3	3	3	3
1998 Abiteboul, S	69	40	26	18	14	9	8	7	5	5	4	4	3	3	3	3	2	2	2	2	2	2	2	2	2
1999 Garcia-Molina, H								674	674	213	80	37	25	15	10	7	5	4	3	3	2	2	2	2	2
2000 Agrawal, R	138	66	43	34	30	26	16	10	7	5	3	2	2	1	1	1	1	1	1	1	1	1	1	1	1
2001 Bayer, R	24	24	22	21	20	18	19	18	17	18	17	18	18	19	19	19	20	21	22	24	24	23	23	23	22
2002 Selinger, P	16	16	16	16	16	16	15	15	15	14	15	15	16	16	17	18	19	19	20	20	20	21	21	20	22
2003 Chamberlin, D	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	4	4	4	4	4	5
2004 Fagin, R	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1
2005 Carey, MJ	224	128	75	49	37	33	25	24	18	14	12	10	9	9	9	9	8	9	9	9	9	8	8	8	7
2006 Ullman, JD	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2007 Widom, J	74	63	48	57	42	39	32	28	21	14	11	9	6	5	4	3	3	3	3	2	2	2	2	2	2
2008 Vardi, MY	19	17	15	13	12	10	9	8	7	5	4	4	3	3	2	2	2	2	1	1	1	1	1	1	1
2009 Kitsuregawa, M	125	105	88	82	68	66	69	66	68	71	73	67	67	66	63	61	62	57	57	55	46	40	38	30	27
2010 Dayal, U	158	69	57	44	42	30	30	28	24	20	21	20	19	16	14	13	11	9	8	8	7	6	6	5	5
2011 Chaudhuri, S	610	613	404	226	204	169	168	91	57	27	16	11	10	7	5	4	4	3	3	2	2	2	2	2	1
2012 Lindsay, B	11	10	9	10	9	9	9	9	9	9	9	9	10	9	9	11	11	11	11	11	11	11	9	9	8
2013 Ceri, S	50	35	34	32	27	22	17	16	15	13	10	8	6	5	4	3	3	3	2	2	2	2	2	2	2
2014 Kersten, M	76	75	65	65	63	62	62	62	63	56	49	46	41	34	31	22	17	15	13	13	12	12	12	10	10
2015 Haas, LM	49	33	32	30	27	27	27	26	24	23	25	24	21	20	17	12	10	8	8	7	7	7	7	7	7
2016 Weikum, G	359	372	317	285	218	183	73	73	74	29	23	20	15	11	8	8	8	7	7	6	5	4	4	4	3
minimum rank	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
median rank	37	26	24	20	18	17	16	15	14	12	10	9	6	5	5	4	4	3	3	3	3	3	3	3	3
maximum rank	610	613	404	285	218	183	168	674	674	213	80	67	67	66	63	61	62	57	57	55	46	40	38	30	27

Table A.2 Codd Award winners and their ranks in various years based on *Citations* permilles with award years highlighted

Year & Awardee	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
1992 Stonebraker, M	7	7	6	5	5	5	4	4	4	3	3	3	4	4	4	4	5	5	5	5	5	5	4	4	4
1993 Gray, J	1	1	1	1	1	1	2	2	2	2	2	3	3	4	4	3	3	3	3	3	2	2	2	2	2
1994 Bernstein, PA	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	2	2
1995 DeWitt, DJ	6	5	5	6	5	5	6	6	6	7	7	7	7	8	8	9	9	9	10	10	11	11	11	10	10
1996 Mohan, C	66	48	48	40	35	32	32	24	21	18	16	15	14	14	14	15	15	14	14	13	13	12	12	12	12
1997 Maier, D	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4	4	4	4	4	4	4
1998 Abiteboul, S	57	28	19	14	11	7	6	5	4	4	4	3	3	4	4	4	4	4	4	4	4	4	5	5	5
1999 Garcia-Molina, H										368	159	65	37	21	12	9	7	5	4	3	3	3	2	2	2
2000 Agrawal, R	131	66	48	34	24	21	16	11	7	5	4	3	2	2	1	1	1	1	1	1	1	1	1	1	1
2001 Bayer, R	28	28	28	24	25	24	25	26	26	26	27	29	31	34	36	38	39	43	46	50	50	50	52	54	55
2002 Selinger, P	27	26	27	29	29	31	31	33	33	35	37	42	47	52	58	62	68	71	76	76	79	82	83	74	74
2003 Chamberlin, D	3	3	4	4	4	5	5	6	6	7	7	8	9	11	12	14	16	17	19	20	22	24	25	26	28
2004 Fagin, R	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1
2005 Carey, MJ	171	89	57	38	27	22	18	15	11	10	8	7	7	8	8	8	8	9	10	10	11	11	11	12	11
2006 Ullman, JD	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2007 Widom, J	268	217	146	138	135	123	110	90	61	40	23	15	11	9	7	6	5	5	4	4	3	3	3	3	3
2008 Vardi, MY	13	10	8	7	7	6	6	5	5	4	4	4	3	2	2	2	2	2	2	1	1	1	1	1	1
2009 Kitsuregawa, M	203	147	134	116	91	78	78	83	89	95	97	95	100	107	100	93	87	77	74	61	54	50	47	38	34
2010 Dayal, U	105	73	65	53	50	38	36	31	27	24	26	27	26	24	21	18	14	11	9	8	7	7	7	6	5
2011 Chaudhuri, S			544	264	180	152	150	80	57	27	16	11	8	6	5	4	4	3	3	2	2	2	2	2	2
2012 Lindsay, B	15	15	16	16	16	17	16	17	18	19	19	18	19	17	18	19	20	21	22	23	22	22	22	23	23
2013 Ceri, S	29	22	19	17	15	14	13	13	13	12	10	8	6	5	4	4	3	3	3	3	3	3	3	3	3
2014 Kersten, M	60	64	58	57	61	62	62	60	63	60	56	57	55	49	46	33	27	23	20	18	18	17	17	15	15
2015 Haas, LM	30	22	22	22	22	21	21	22	23	24	27	29	28	24	20	16	14	14	14	14	13	13	13	13	14
2016 Weikum, G	409	346	269	213	186	130	100	100	86	53	39	32	26	22	18	15	15	13	13	11	9	8	7	6	6
minimum rank	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
median rank	28	22	21	20	19	19	16	14	12	12	10	8	8	8	8	8	7	5	5	5	5	5	5	5	5
maximum rank	409	346	544	264	186	152	150	100	89	368	159	95	100	107	100	93	87	77	76	76	79	82	83	74	74

Table A.3 Codd Award winners and their ranks in various years based on *Indegree* permilles with award years highlighted

Year & Awardee	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
1992 Stonebraker, M	4	4	4	3	3	3	3	3	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3
1993 Gray, J	1	1	1	1	1	1	1	2	2	2	2	3	3	3	3	3	3	2	2	2	2	2	2	2	2
1994 Bernstein, PA	2	2	2	2	2	2	2	2	2	2	2	3	2	2	2	2	2	2	1	1	1	1	1	1	1
1995 DeWitt, DJ	9	6	6	6	6	6	6	7	7	8	7	7	8	8	8	8	9	9	10	10	10	10	10	9	9
1996 Mohan, C	58	41	41	35	31	28	28	22	18	15	13	13	13	12	13	13	13	13	13	12	12	11	12	11	11
1997 Maier, D	5	4	4	5	5	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	5	5	5
1998 Abiteboul, S	60	28	21	15	12	8	7	6	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	6	6
1999 Garcia-Molina, H										340	132	52	29	17	10	7	5	3	3	2	2	2	2	2	2
2000 Agrawal, R	128	66	45	33	25	22	15	10	7	5	3	2	2	1	1	1	1	1	1	1	1	1	1	1	1
2001 Bayer, R	24	23	23	21	22	20	22	22	22	21	22	25	26	28	30	32	33	36	40	43	43	43	46	48	49
2002 Selinger, P	20	20	21	22	22	24	23	25	25	27	28	32	36	41	46	49	54	56	61	63	65	69	71	70	75
2003 Chamberlin, D	2	2	3	3	3	4	4	4	5	5	6	7	8	9	10	11	13	14	16	17	19	21	22	24	25
2004 Fagin, R	5	4	4	4	4	4	4	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2
2005 Carey, MJ	182	88	60	40	31	26	19	18	14	12	9	8	8	9	9	9	9	10	11	11	11	12	12	12	11
2006 Ullman, JD	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2007 Widom, J	238	187	121	127	123	109	95	78	50	30	19	12	9	7	6	5	4	4	3	3	3	3	3	3	3
2008 Vardi, MY	23	20	15	14	13	11	10	9	8	6	6	5	5	4	3	3	3	3	3	3	2	3	3	2	2
2009 Kitsuregawa, M	198	133	118	99	76	69	74	79	86	93	93	90	96	102	91	89	80	76	73	60	52	47	42	34	30
2010 Dayal, U	102	62	54	43	41	30	31	26	23	20	22	23	21	19	17	14	11	8	7	6	6	6	5	5	4
2011 Chaudhuri, S			522	236	168	137	134	63	44	19	12	8	7	5	4	3	3	2	2	2	2	2	2	2	2
2012 Lindsay, B	11	11	11	12	12	13	13	13	14	14	15	15	15	15	16	16	18	18	19	20	19	19	20	20	20
2013 Ceri, S	23	18	15	14	14	13	12	11	11	10	8	6	5	4	3	3	3	3	2	2	2	2	2	3	3
2014 Kersten, M	51	56	52	51	54	55	57	54	56	52	51	52	53	46	37	26	21	19	17	15	15	14	14	13	13
2015 Haas, LM	26	19	19	19	20	21	21	21	22	23	25	27	24	20	16	13	12	11	11	11	11	11	11	11	11
2016 Weikum, G	382	318	241	184	159	117	85	86	79	51	38	32	25	20	16	14	14	12	12	10	8	6	5	5	4
minimum rank	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
median rank	23	20	20	17	17	17	14	12	13	12	9	8	8	8	8	7	5	5	5	5	5	5	5	5	4
maximum rank	382	318	522	236	168	137	134	86	86	340	132	90	96	102	91	89	80	76	73	63	65	69	71	70	75

Table A.4 Turing Award winners and their ranks in various years based on *twPageRank* permilles with award years highlighted

Year & Awardee	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
1966 Perlis, AJ	1	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	4	4	4	4	5
1967 Wilkes, MV	20	20	21	18	18	17	17	18	17	17	17	16	16	17	17	17	17	17	21	21	23	23	23	24	24
1968 Hamming, RW	16	16	17	17	17	18	18	17	18	18	18	20	20	21	23	23	23	23	23	23	23	23	22	22	22
1969 Minsky, M	24	24	25	24	26	26	25	25	19	19	18	18	19	18	17	15	16	16	7	7	7	8	8	7	7
1970 Wilkinson, JH	5	4	4	4	4	4	5	5	5	5	8	8	10	10	10	10	10	10	11	12	12	12	12	12	12
1971 McCarthy, J	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1972 Dijkstra, EW	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2
1973 Bachman, CW	155	155	154	157	158	161	160	163	106	130	137	137	143	142	142	140	139	141	139	141	147	150	136	147	146
1974 Knuth, DE	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1975 Newell, A	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1975 Simon, HA	7	5	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
1976 Rabin, MO	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1976 Scott, DS	11	13	11	11	11	11	10	9	9	9	9	10	10	12	11	11	10	11	11	11	11	11	11	11	11
1977 Backus, JW	6	7	7	6	6	6	6	6	6	6	7	7	7	7	8	8	8	9	10	10	10	10	12	12	13
1978 Floyd, RW	2	2	2	2	2	2	3	3	2	2	2	2	2	3	2	2	2	2	3	3	3	2	3	2	3
1979 Iverson, KE	9	9	11	12	13	13	14	14	13	12	13	13	13	14	14	14	13	13	13	14	14	14	14	12	13
1980 Hoare, CAR	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1981 Codd, EF	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1982 Cook, SA	3	3	2	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	5	5	5	5
1983 Thompson, K	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1983 Ritchie, DM	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3
1984 Wirth, N	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2
1985 Karp, RM	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1986 Hopcroft, J	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	4	3	3	4	4	4	4	4	4	4
1986 Tarjan, RE	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1987 Cocke, J	13	10	8	9	8	7	7	6	6	5	5	5	4	4	4	4	4	4	5	5	5	5	5	5	5
1988 Sutherland, IE	66	60	35	19	11	10	8	7	5	4	4	4	3	3	2	2	2	2	3	3	3	3	3	3	3
1989 Kahan, W	157	149	138	135	133	133	129	127	130	92	92	93	85	80	75	78	71	60	59	59	50	49	45	43	47
1990 Corbato, FJ	68	49	50	90	79	78	79	80	77	80	83	85	75	60	59	60	61	59	60	59	59	60	63	62	71
1991 Milner, R	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1992 Lampson, B	3	3	3	2	3	3	3	3	3	2	2	2	3	2	2	2	3	3	3	3	3	3	3	3	3
1993 Hartmanis, J	20	18	16	15	13	13	14	14	14	15	14	14	12	13	13	13	13	12	13	14	14	14	14	14	15
1993 Stearns, RE	5	5	5	5	6	6	6	6	6	7	6	7	6	6	6	5	5	5	5	6	5	6	6	6	6
1994 Feigenbaum, EA	436	198	196	149	102	41	28	30	25	27	26	24	24	23	23	21	19	17	15	16	13	13	13	14	14
1994 Reddy, R	31	29	28	27	29	30	28	22	20	19	17	15	14	15	15	13	11	12	10	10	10	10	10	10	11
1995 Blum, M	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1996 Pnueli, A	3	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1997 Engelbart, D	129	136	140	129	130	131	131	135	135	132	133	133	134	129	112	110	106	103	88	86	83	81	90	94	94

Table A.4 Turing Award winners and their ranks in various years based on *twPageRank* permilles with award years highlighted (continued)

Year & Awardee	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
1998 Gray, J	2	1	2	2	2	2	2	2	2	2	2	2	2	3	3	2	2	2	2	2	1	1	1	1	1
1999 Brooks, FP	6	7	7	7	6	6	6	6	6	5	5	4	4	4	3	3	3	2	2	2	2	2	2	2	2
2000 Yao, AC	8	7	7	7	6	5	6	6	5	5	4	4	4	3	4	3	3	3	3	3	3	2	2	2	2
2001 Dahl, O	8	7	7	8	9	8	7	6	6	5	5	6	6	6	6	6	6	7	7	8	8	8	8	8	8
2001 Nygaard, K	7	6	6	8	8	8	7	6	6	5	5	6	6	6	6	6	7	7	7	8	7	7	8	8	8
2002 Rivest, RL	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2002 Shamir, A	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2002 Adleman, LM	416	428	404	421	409	310	311	218	204	140	64	58	42	34	27	25	24	26	25	24	24	24	23	24	23
2003 Kay, A	103	102	97	80	72	56	57	62	52	52	37	38	35	22	19	16	16	15	15	17	18	18	18	18	18
2004 Cerf, VG	76	70	64	67	65	63	62	63	63	58	62	58	56	58	58	56	58	59	44	51	51	51	42	37	26
2004 Kahn, RE	702	481	514	494	500	509	504	474	482	158	105	108	102	96	82	75	76	79	81	87	82	85	79	83	83
2005 Naur, P	18	17	19	20	20	18	18	18	16	12	15	16	16	25	25	26	25	25	24	23	24	25	26	27	27
2006 Allen, F	18	17	16	19	17	17	16	16	16	15	15	16	17	17	4	4	4	4	4	4	4	4	4	4	5
2007 Clarke, EM	8	6	4	3	3	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2007 Emerson, EA	11	9	6	5	5	3	3	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2007 Sifakis, J	41	40	39	36	35	25	20	13	10	8	6	6	4	4	4	4	3	3	3	3	3	3	3	3	3
2008 Liskov, B	2	1	1	1	1	1	1	1	1	1	1	1	2	2	2	1	1	1	2	2	2	2	2	1	1
2009 Thacker, C	123	66	41	33	31	28	23	22	19	18	19	16	14	10	10	10	10	10	10	10	10	10	10	11	10
2010 Valiant, LG	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2011 Pearl, J	5	4	3	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2012 Micali, S	9	6	5	4	3	3	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2012 Goldwasser, S	12	9	8	6	5	4	4	3	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2013 Lamport, L	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2014 Stonebraker, M	4	4	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
2015 Hellman, ME	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2015 Diffie, W	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
minimum rank	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
median rank	6	5	4	4	3	3	3	3	3	2	2	2	3	3	3	2	3	2	3	3	3	3	3	3	3
maximum rank	702	481	514	494	500	509	504	474	482	158	137	137	143	142	142	140	139	141	139	141	147	150	136	147	146

Table A.5 Turing Award winners and their ranks in various years based on *Citations* permilles with award years highlighted

Year & Awardee	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
1966 Perlis, AJ	4	5	6	6	6	6	7	7	8	8	10	11	12	13	15	17	18	20	23	23	25	26	28	30	32
1967 Wilkes, MV	87	89	93	78	78	77	81	87	86	93	98	104	113	121	125	133	142	152	152	156	162	165	170	175	178
1968 Hamming, RW	91	99	106	112	117	124	130	137	146	155	167	179	192	206	219	232	244	255	261	253	261	263	263	274	283
1969 Minsky, M	79	86	92	91	96	101	89	90	82	88	94	93	100	94	93	89	85	82	79	78	78	74	74	73	73
1970 Wilkinson, JH	32	34	38	41	42	41	43	43	46	50	51	56	63	66	72	75	81	87	93	99	103	106	109	115	119
1971 McCarthy, J	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4	5	5	5	6	6	6	6	7	7	7
1972 Dijkstra, EW	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	3	3	3	3	3	3	3	4
1973 Bachman, CW	223	232	242	248	257	267	263	272	222	234	231	246	261	276	275	281	287	300	311	321	316	323	326	314	313
1974 Knuth, DE	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	4	4	4	4	4	4
1975 Newell, A	8	6	5	4	3	2	2	2	2	1	1	1	2	2	2	2	2	2	2	2	2	3	3	3	3
1975 Simon, HA	26	22	17	16	13	9	8	7	7	7	7	7	8	8	9	9	10	10	11	12	12	12	12	13	14
1976 Rabin, MO	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3
1976 Scott, DS	25	24	22	20	21	21	20	19	20	18	20	22	24	25	26	28	29	32	34	35	37	38	41	42	44
1977 Backus, JW	11	13	14	14	14	15	16	18	19	20	23	25	27	30	33	36	38	42	46	48	50	51	53	57	60
1978 Floyd, RW	6	6	6	6	7	7	7	7	7	8	7	7	8	9	9	10	10	10	11	11	11	11	11	12	12
1979 Iverson, KE	33	31	35	38	40	44	45	48	49	52	57	62	69	76	83	90	90	94	101	104	105	107	105	108	114
1980 Hoare, CAR	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1981 Codd, EF	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	3	3	3	3	3	3
1982 Cook, SA	2	2	1	2	1	1	2	2	2	2	2	2	2	3	3	3	4	4	4	5	5	5	5	6	7
1983 Thompson, K	2	2	3	3	3	3	4	4	4	4	4	3	3	3	3	3	3	4	4	4	4	4	4	4	5
1983 Ritchie, DM	3	3	4	4	5	5	5	6	6	6	7	8	9	11	13	14	15	17	18	20	21	22	23	26	27
1984 Wirth, N	2	2	2	2	2	3	3	3	3	3	4	4	4	5	5	6	7	7	8	9	9	10	10	11	12
1985 Karp, RM	4	4	3	3	2	2	2	2	2	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2
1986 Hopcroft, J	4	4	4	4	4	4	4	4	4	4	4	4	5	5	5	5	6	6	7	7	7	8	8	8	9
1986 Tarjan, RE	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1987 Cocke, J	14	13	11	11	9	9	8	8	7	7	7	7	8	8	9	9	10	10	11	11	12	12	12	13	14
1988 Sutherland, IE	141	119	93	49	32	26	21	18	17	14	14	12	10	9	8	8	8	8	9	9	10	10	11	12	13
1989 Kahan, W	484	438	344	354	337	326	336	326	337	194	208	220	212	198	187	163	160	158	155	145	133	132	131	126	127
1990 Corbato, FJ	180	187	198	188	161	163	171	179	162	172	185	197	201	201	214	226	224	205	214	220	221	227	235	242	251
1991 Milner, R	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1992 Lampson, B	6	6	6	6	6	6	6	6	6	6	6	7	8	8	8	9	9	8	8	8	8	8	9	9	9
1993 Hartmanis, J	16	12	9	9	8	8	7	6	6	6	6	6	7	8	8	8	9	10	11	12	13	13	14	15	16
1993 Stearns, RE	4	4	5	5	5	5	5	6	6	6	7	7	8	8	9	10	10	10	11	11	11	11	12	13	13
1994 Feigenbaum, EA	882	623	634	410	235	143	96	91	79	77	74	72	72	77	76	76	71	66	63	67	61	60	61	63	64
1994 Reddy, R	62	56	54	55	55	59	54	49	51	43	43	39	34	36	35	33	31	29	26	25	24	24	25	25	26
1995 Blum, M	3	3	3	3	3	2	2	2	2	2	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2
1996 Pnueli, A	3	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1997 Engelbart, D	381	389	402	348	357	370	379	389	401	390	278	233	228	220	218	218	221	225	205	214	221	208	208	217	209

Table A.5 Turing Award winners and their ranks in various years based on *Citations* permilles with award years highlighted (continued)

Year & Awardee	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
1998 Gray, J	1	1	1	1	1	1	2	2	2	2	2	3	3	4	4	3	3	3	3	3	2	2	2	2	2
1999 Brooks, FP	17	18	18	18	16	16	15	15	16	15	16	16	16	16	15	14	12	11	11	10	9	9	9	9	8
2000 Yao, AC	6	5	5	6	5	6	6	6	5	5	5	5	5	5	5	4	4	4	4	3	4	4	4	4	4
2001 Dahl, O	36	30	32	32	33	30	26	25	24	21	22	23	24	25	25	25	27	29	31	32	34	34	33	33	33
2001 Nygaard, K	28	24	26	26	27	26	26	26	26	25	28	30	32	35	34	35	37	40	42	43	45	45	46	50	53
2002 Rivest, RL	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2002 Shamir, A	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2002 Adleman, LM	696	701	610	618	555	424	434	337	348	261	95	87	70	61	55	49	50	52	54	56	54	53	52	54	51
2003 Kay, A	118	125	134	140	137	136	120	124	126	132	84	92	97	82	68	56	55	53	50	51	53	55	55	56	57
2004 Cerf, VG	293	302	272	280	289	300	310	320	331	212	225	219	200	171	165	156	155	166	159	168	156	156	139	122	97
2004 Kahn, RE		762	773	781	788	798	806	813	823	183	156	151	143	147	141	125	116	119	123	130	125	123	108	110	111
2005 Naur, P	62	64	63	62	65	67	67	72	70	72	79	86	94	99	104	112	112	114	111	107	107	111	115	119	123
2006 Allen, F	23	24	24	23	22	22	22	23	25	26	28	31	34	39	41	42	46	46	44	47	49	52	51	51	54
2007 Clarke, EM	7	5	3	3	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2007 Emerson, EA	9	7	5	4	3	3	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2
2007 Sifakis, J	29	25	25	24	24	20	15	10	7	6	5	4	4	4	3	3	3	3	3	3	3	3	3	3	3
2008 Liskov, B	1	1	1	1	1	1	1	2	2	2	2	2	2	3	3	3	3	3	3	3	4	4	4	4	4
2009 Thacker, C	142	70	55	47	43	43	37	38	35	34	34	28	23	19	18	16	16	16	17	17	18	19	19	20	21
2010 Valiant, LG	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2011 Pearl, J	8	7	6	5	3	3	2	2	2	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2
2012 Micali, S	6	4	3	3	3	3	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2012 Goldwasser, S	12	7	6	6	5	5	4	3	3	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2013 Lamport, L	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2014 Stonebraker, M	7	7	6	5	5	5	4	4	4	3	3	3	4	4	4	4	5	5	5	5	5	5	4	4	4
2015 Hellman, ME	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2015 Diffie, W	4	3	3	3	3	3	3	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1
minimum rank	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
median rank	7	7	6	6	5	6	6	6	6	6	6	6	6	7	7	7	8	8	8	9	9	9	9	9	9
maximum rank	882	762	773	781	788	798	806	813	823	390	278	246	261	276	275	281	287	300	311	321	316	323	326	314	313

Table A.6 Turing Award winners and their ranks in various years based on *Indegree* permilles with award years highlighted

Year & Awardee	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
1966 Perlis, AJ	3	3	3	3	4	4	5	5	5	6	6	7	8	9	10	12	13	15	17	18	19	20	22	24	26
1967 Wilkes, MV	83	84	88	68	69	68	73	78	76	82	87	91	99	106	108	117	125	134	134	137	143	146	153	160	163
1968 Hamming, RW	76	82	89	94	100	107	113	120	128	137	147	158	169	182	194	206	218	231	236	228	236	243	243	255	265
1969 Minsky, M	60	65	71	70	74	80	72	73	65	70	76	74	79	73	73	72	72	73	69	71	71	69	72	70	70
1970 Wilkinson, JH	29	31	35	37	38	37	40	42	44	48	47	52	58	59	65	67	73	79	85	91	94	98	103	109	114
1971 McCarthy, J	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	4	4	4	5	5	5	5	5	6	6
1972 Dijkstra, EW	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	3	3	3	3	3	3
1973 Bachman, CW	260	269	281	290	299	312	300	310	231	243	235	249	263	278	282	286	290	303	315	326	318	326	329	319	323
1974 Knuth, DE	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3
1975 Newell, A	4	3	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2
1975 Simon, HA	20	16	14	12	11	8	7	7	6	5	6	6	6	6	6	7	7	8	9	9	10	9	10	11	11
1976 Rabin, MO	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
1976 Scott, DS	27	28	25	23	22	23	21	20	21	19	20	21	24	25	26	28	29	32	34	36	37	39	41	43	46
1977 Backus, JW	7	8	9	10	10	11	12	13	14	15	17	19	20	22	25	27	30	33	37	40	41	43	46	50	53
1978 Floyd, RW	5	5	6	5	6	6	6	6	6	6	6	6	7	7	8	8	9	9	9	9	9	9	10	10	11
1979 Iverson, KE	27	26	29	32	34	37	38	41	41	44	49	53	58	65	72	78	80	84	90	94	96	98	97	101	107
1980 Hoare, CAR	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1981 Codd, EF	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	3
1982 Cook, SA	3	3	2	2	2	2	2	2	2	3	3	3	4	4	4	5	6	6	7	7	8	8	9	10	11
1983 Thompson, K	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3
1983 Ritchie, DM	2	2	2	2	3	3	3	4	4	4	5	6	7	8	9	10	11	12	13	15	16	17	18	20	22
1984 Wirth, N	1	1	1	1	1	2	2	2	2	2	2	3	3	3	4	4	5	5	6	7	7	8	8	9	9
1985 Karp, RM	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1986 Hopcroft, J	4	3	3	3	3	3	3	3	3	3	3	4	4	4	4	5	5	6	6	6	6	7	7	8	8
1986 Tarjan, RE	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1987 Cocke, J	11	10	9	9	8	7	7	7	7	6	6	6	7	7	8	8	9	10	11	11	12	12	13	13	14
1988 Sutherland, IE	115	108	84	48	30	24	21	18	18	15	15	13	10	10	9	9	9	10	10	11	11	12	12	14	15
1989 Kahan, W	459	413	316	325	309	298	308	318	329	166	178	189	179	173	185	159	154	157	157	147	130	128	127	123	125
1990 Corbato, FJ	171	179	190	177	147	148	156	165	145	154	165	176	178	181	194	205	203	184	194	200	201	207	216	223	233
1991 Milner, R	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2
1992 Lampson, B	4	4	4	4	4	4	4	4	4	4	5	5	5	6	6	6	7	7	8	8	8	8	9	9	10
1993 Hartmanis, J	29	24	17	17	17	16	16	15	15	17	16	17	18	19	20	21	23	26	28	31	32	34	35	37	39
1993 Stearns, RE	4	5	5	5	6	6	6	7	7	7	8	8	9	9	10	10	11	11	12	12	12	12	13	14	15
1994 Feigenbaum, EA	876	606	617	384	207	137	90	87	73	73	67	63	62	65	64	63	58	54	51	55	50	50	50	53	54
1994 Reddy, R	49	43	42	42	43	46	42	38	40	36	37	33	29	30	30	28	26	26	24	24	22	22	23	22	23
1995 Blum, M	4	5	5	5	5	5	5	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
1996 Pnueli, A	4	3	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2
1997 Engelbart, D	352	362	375	320	330	341	351	361	373	362	271	215	207	202	204	201	212	221	202	211	215	208	206	217	191

Table A.6 Turing Award winners and their ranks in various years based on *Indegree* permilles with award years highlighted (continued)

Year & Awardee	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
1998 Gray, J	1	1	1	1	1	1	1	2	2	2	2	3	3	3	3	3	3	2	2	2	2	2	2	2	2
1999 Brooks, FP	12	13	13	13	12	12	11	11	12	11	11	11	11	11	10	9	8	7	7	6	6	6	6	6	6
2000 Yao, AC	6	5	6	6	5	5	5	6	5	5	5	5	4	4	4	4	4	4	4	4	4	4	4	4	4
2001 Dahl, O	28	23	24	25	25	23	19	18	18	16	17	18	19	19	19	19	21	22	24	25	27	26	26	27	26
2001 Nygaard, K	21	18	19	19	19	19	19	19	20	19	21	22	24	25	24	25	27	29	31	33	34	35	36	39	42
2002 Rivest, RL	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2002 Shamir, A	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2002 Adleman, LM	683	688	590	600	533	397	407	309	320	231	94	91	73	63	56	50	51	52	54	55	54	52	54	57	56
2003 Kay, A	103	110	118	125	121	119	106	110	114	119	68	75	79	65	62	57	58	57	54	56	58	61	61	62	62
2004 Cerf, VG	287	296	262	271	280	291	302	312	323	190	203	193	173	156	151	142	148	159	150	159	145	145	129	120	103
2004 Kahn, RE		751	762	771	778	788	797	804	815	155	144	142	131	135	126	108	106	114	118	126	122	118	99	101	102
2005 Naur, P	66	67	67	65	67	68	68	73	71	71	78	85	93	96	99	107	106	106	105	100	103	107	111	115	119
2006 Allen, F	21	21	22	21	20	20	20	21	23	24	25	27	30	35	37	38	41	43	40	42	45	47	47	47	50
2007 Clarke, EM	9	6	4	4	3	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2007 Emerson, EA	17	13	9	7	6	5	4	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
2007 Sifakis, J	43	39	42	36	37	29	21	12	8	6	5	5	5	4	4	4	4	4	4	3	3	3	3	3	4
2008 Liskov, B	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	4
2009 Thacker, C	142	87	74	60	56	56	45	44	38	36	35	30	25	20	19	18	19	19	20	21	22	23	23	24	25
2010 Valiant, LG	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2011 Pearl, J	8	6	6	5	3	2	2	2	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2
2012 Micali, S	13	10	9	9	7	7	6	6	5	4	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2
2012 Goldwasser, S	19	15	14	13	11	10	9	8	6	5	4	4	3	3	3	2	2	2	2	2	2	2	2	2	2
2013 Lamport, L	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2014 Stonebraker, M	4	4	4	3	3	3	3	3	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3
2015 Hellman, ME	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2015 Diffie, W	4	4	3	3	3	3	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
minimum rank	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
median rank	7	6	6	6	6	6	6	6	5	5	5	5	5	5	5	6	7	7	7	7	8	8	9	9	10
maximum rank	876	751	762	771	778	788	797	804	815	362	271	249	263	278	282	286	290	303	315	326	318	326	329	319	323

Table A.7 Top 50 authors generated by four ranking methods in 2014, with Turing Award winners highlighted

	PR [* 10^{-4}]		***PRtw*** [* 10^{-4}]		***Citations***		***Indegree***	
1	Zadeh, LA	8.4314	Zadeh, LA	10.0962	Zadeh, LA	55,138	Jain, AK	19,397
2	Jain, AK	3.6559	Jain, AK	4.5153	Jain, AK	44,563	Zadeh, LA	18,071
3	Breiman, L	2.9633	Breiman, L	3.8992	Malik, J	26,304	Lowe, DG	12,493
4	**Shamir, A**	2.8466	**Shamir, A**	3.6059	Lowe, DG	25,712	Malik, J	12,212
5	**Lamport, L**	2.7939	**Lamport, L**	3.5318	**Shamir, A**	22,791	Vapnik, V	10,516
6	**Hoare, CAR**	2.6146	Lowe, DG	3.5243	**Lamport, L**	22,214	Breiman, L	10,427
7	Lowe, DG	2.4633	Malik, J	2.9304	Herrera, F	21,528	Wang, Y	10,212
8	Haralick, RM	2.3418	**Tarjan, RE**	2.6806	Scholkopf, B	20,755	Kim, J	10,006
9	**Tarjan, RE**	2.3081	Vapnik, V	2.6424	**Tarjan, RE**	20,280	Gupta, A	9,723
10	**Rivest, RL**	2.2955	Kanade, T	2.5424	Breiman, L	20,088	**Shamir, A**	9,667
11	Cover, TM	2.2884	Jordan, MI	2.5108	Kanade, T	19,615	Kanade, T	9,460
12	Mallat, SG	2.2752	Cover, TM	2.4331	Vapnik, V	19,036	Jordan, MI	9,437
13	Hart, PE	2.2118	Foster, I	2.3565	Sugeno, M	18,513	Akyildiz, IF	9,431
14	Canny, J	2.2077	Schapire, RE	2.3559	Kriegman, DJ	18,360	Scholkopf, B	9,422
15	Harel, D	2.1371	**Rivest, RL**	2.3453	Osher, S	18,273	Liu, Y	9,282
16	Geman, D	2.1176	Scholkopf, B	2.2575	Akyildiz, IF	18,083	Lee, J	9,224
17	Rosenfeld, A	2.0981	Donoho, DL	2.2569	Yager, RR	18,059	Lee, S	9,076
18	Vapnik, V	2.0918	**Hoare, CAR**	2.2562	Schmid, C	17,868	Wang, J	8,874
19	Kanade, T	2.0851	Gruber, TR	2.2003	Jordan, MI	17,630	**Lamport, L**	8,866
20	Hornik, K	2.0837	Sugeno, M	2.1958	Van Der Aalst, WMP	17,170	Kittler, J	8,677
21	Gruber, TR	2.0808	Harel, D	2.1804	Foster, I	16,760	Zhang, L	8,660
22	Malik, J	2.0531	Geman, D	2.1737	Rosenfeld, A	16,489	Rosenfeld, A	8,609
23	**Codd, EF**	2.0337	Akyildiz, IF	2.1608	Belhumeur, PN	16,318	Haralick, RM	8,398
24	Foster, I	2.0242	Osher, S	2.1205	Kittler, J	16,315	Li, J	8,362
25	Kohonen, T	1.8704	Grossberg, S	2.1156	Wang, Y	15,898	Foster, I	8,256
26	Grossberg, S	1.8612	Mallat, SG	2.1019	Deb, K	15,896	Zhang, J	8,246
27	Geman, S	1.8495	Haralick, RM	2.0890	Taylor, CJ	15,809	Jain, R	8,196
28	Jordan, MI	1.8093	Canny, J	2.0826	Gupta, A	15,469	Wang, L	8,135
29	Sugeno, M	1.8052	Tse, DNC	2.0175	Jennings, NR	15,395	Zhang, Y	8,125
30	Powell, MJD	1.7869	Hornik, K	2.0169	Schapire, RE	15,162	**Tarjan, RE**	8,069
31	Horn, BKP	1.7747	Rosenfeld, A	1.9819	Wang, J	15,135	Van Gool, L	8,047
32	**Valiant, LG**	1.7703	Hart, PE	1.9334	Liu, Y	15,065	Huang, TS	7,890
33	Jain, R	1.7562	Verdu, S	1.9175	Huang, TS	14,965	Schapire, RE	7,653
34	Akyildiz, IF	1.7287	Cortes, C	1.8931	Duin, RPW	14,952	Canny, J	7,579
35	**Hellman, ME**	1.7256	Jennings, NR	1.8816	Zhang, L	14,918	Yang, J	7,557
36	Donoho, DL	1.7125	Kohonen, T	1.8633	Kim, J	14,897	Li, H	7,545
37	White, H	1.6840	Schmid, C	1.8514	Pietikainen, M	14,821	Cortes, C	7,482
38	Schapire, RE	1.6780	**Hellman, ME**	1.8204	Tse, DNC	14,766	Zhang, H	7,408
39	Jang, JSR	1.6567	Sejnowski, TJ	1.8038	Van Gool, L	14,713	Duin, RPW	7,289
40	Gupta, A	1.6490	Paxson, V	1.7996	Jain, R	14,659	Meer, P	7,259
41	Nelder, JA	1.6400	Kim, J	1.7766	Cootes, TF	14,409	Lin, CJ	7,231
42	Mead, R	1.6333	Gupta, A	1.7644	Zhang, D	14,191	Kriegman, DJ	7,078
43	Cortes, C	1.6154	Kesselman, C	1.7640	Lee, J	13,791	Schmid, C	7,038
44	Kim, J	1.6062	Yager, RR	1.7572	Muller, KR	13,583	Jennings, NR	6,976
45	Gallager, RG	1.6022	Ziv, J	1.7527	Li, J	13,562	Kim, S	6,967
46	Kesselman, C	1.5788	Hyvarinen, A	1.7463	Prade, H	13,558	Osher, S	6,882
47	Parnas, DL	1.5745	Van Der Aalst, WMP	1.7363	Haralick, RM	13,537	Sugeno, M	6,837
48	Sejnowski, TJ	1.5720	Jain, R	1.7246	Szeliski, R	13,481	Li, Y	6,834
49	Stinchcombe, M	1.5633	Jang, JSR	1.7154	Dubois, D	13,416	**Rivest, RL**	6,766
50	Scholkopf, B	1.5622	**Codd, EF**	1.7120	Meer, P	13,303	Gruber, TR	6,713

Table A.8 Codd Award winners and their cumulative citation counts in various years with award years highlighted

Year & Awardee	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
1992 Stonebraker, M	256	291	321	376	427	463	515	595	666	771	861	941	1000	1061	1130	1211	1300	1441	1553	1692	1817	1970	2179	2406	2605
1993 Gray, J	647	695	757	792	837	886	918	948	967	996	1028	1035	1046	1058	1202	1410	1662	1969	2283	2606	2888	3212	3514	3874	4200
1994 Bernstein, PA	551	591	646	719	772	846	891	954	1008	1062	1124	1202	1295	1459	1786	2126	2418	2825	3258	3662	4078	4445	4761	5180	5449
1995 DeWitt, DJ	280	331	365	373	409	440	450	454	479	490	529	581	617	657	723	774	833	907	940	986	1013	1085	1181	1320	1471
1996 Mohan, C	47	66	72	90	105	119	128	168	203	248	296	338	389	453	493	535	578	654	731	827	897	1006	1082	1185	1271
1997 Maier, D	407	455	502	525	550	614	646	702	739	787	845	897	966	1056	1156	1260	1376	1563	1703	1869	2003	2128	2240	2418	2533
1998 Abiteboul, S	53	103	147	200	261	356	419	509	616	697	801	941	1034	1133	1238	1329	1465	1583	1721	1826	1936	2027	2143	2279	2369
1999 Garcia-Molina, H										11	37	103	187	332	547	784	1030	1396	1762	2142	2523	2875	3289	3638	3954
2000 Agrawal, R	25	50	72	101	140	164	210	297	437	579	795	1055	1335	1825	2310	2873	3339	3938	4508	5163	5624	6150	6794	7478	8139
2001 Bayer, R	94	101	112	131	134	150	154	161	172	187	202	207	216	225	238	251	266	270	274	275	290	309	316	325	342
2002 Selinger, P	98	108	113	117	123	123	132	135	142	147	154	154	155	155	155	160	160	168	168	180	184	184	194	234	248
2003 Chamberlin, D	393	423	439	446	453	456	469	479	488	495	506	514	524	527	541	551	559	574	574	593	597	599	612	633	637
2004 Fagin, R	541	604	668	721	780	851	914	980	1082	1172	1265	1377	1491	1671	1871	2162	2458	2878	3344	3885	4337	4922	5388	5951	6369
2005 Carey, MJ	19	38	61	94	128	156	194	237	312	377	483	575	640	681	756	809	888	922	959	1003	1044	1077	1131	1208	1321
2006 Ullman, JD	1233	1375	1519	1615	1744	1860	1954	2076	2194	2421	2617	2813	3009	3307	3535	3790	4027	4260	4566	4788	5039	5305	5552	5829	6072
2007 Widom, J	12	16	26	29	31	36	42	54	84	133	229	337	472	607	765	981	1204	1433	1738	2005	2225	2497	2759	2963	3212
2008 Vardi, MY	167	212	279	310	335	401	426	495	588	690	803	901	1085	1398	1714	2040	2363	2833	3262	3748	4205	4595	5080	5496	6031
2009 Kitsuregawa, M	16	24	28	34	45	55	58	58	58	59	63	71	74	76	90	106	123	153	172	227	268	305	350	451	538
2010 Dayal, U	31	46	55	69	79	105	118	140	168	196	207	217	253	301	358	458	596	820	985	1155	1328	1486	1677	1952	2228
2011 Chaudhuri, S			4	13	22	28	30	60	88	181	293	435	568	811	1035	1266	1504	1897	2209	2623	2965	3439	3943	4464	4989
2012 Lindsay, B	147	167	173	181	189	194	208	219	226	234	264	298	319	379	414	437	458	491	520	546	591	640	675	720	765
2013 Ceri, S	92	122	152	171	196	224	247	271	291	331	422	537	702	907	1123	1393	1645	1923	2158	2379	2596	2815	3030	3255	3436
2014 Kersten, M	51	52	61	65	65	68	72	78	81	92	107	116	132	164	192	278	362	453	550	656	708	777	843	988	1063
2015 Haas, LM	91	122	130	142	152	164	172	179	187	197	199	209	237	300	386	507	591	682	734	812	884	938	1000	1096	1152
2016 Weikum, G	7	9	13	18	22	34	46	49	61	103	149	191	250	321	421	515	581	699	784	941	1137	1380	1605	1909	2196

Table A.9 Turing Award winners and their cumulative citation counts in various years with award years highlighted

Year & Awardee	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
1966 Perlis, AJ	326	338	347	372	377	384	392	398	411	423	427	436	451	467	472	479	490	499	500	531	543	555	560	569	573
1967 Wilkes, MV	37	39	40	50	53	56	56	56	61	61	63	65	66	67	71	71	71	71	76	79	79	81	81	83	86
1968 Hamming, RW	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	36	40	40	41	43	43	43
1969 Minsky, M	40	40	40	43	43	43	51	54	63	64	65	72	74	87	97	111	126	143	160	175	186	206	217	237	251
1970 Wilkinson, JH	88	89	89	89	92	100	100	107	108	108	118	118	118	125	127	133	133	135	135	135	137	139	141	142	144
1971 McCarthy, J	417	452	504	545	582	617	657	709	772	804	862	911	946	1011	1087	1138	1217	1292	1344	1429	1526	1619	1681	1736	1807
1972 Dijkstra, EW	669	755	838	895	961	1013	1067	1138	1205	1293	1355	1437	1554	1681	1784	1925	2003	2121	2255	2349	2500	2622	2702	2793	2925
1973 Bachman, CW	14	14	14	14	14	14	15	15	21	21	23	23	23	23	25	26	27	27	27	27	29	29	30	34	36
1974 Knuth, DE	447	487	552	616	657	701	757	825	901	963	1065	1163	1261	1361	1477	1588	1701	1803	1903	2013	2134	2301	2400	2521	2660
1975 Newell, A	242	299	399	483	598	741	865	989	1157	1340	1436	1519	1614	1732	1887	2023	2194	2370	2509	2650	2804	2967	3076	3245	3363
1975 Simon, HA	102	125	161	183	224	320	368	402	449	494	522	554	594	654	702	752	799	836	866	908	955	1027	1074	1103	1127
1976 Rabin, MO	460	519	563	593	661	699	767	828	942	1015	1136	1217	1327	1447	1635	1838	1995	2194	2383	2569	2783	2973	3193	3395	3655
1976 Scott, DS	106	117	133	149	158	165	182	199	210	240	249	256	265	282	306	319	338	350	363	376	388	394	396	413	424
1977 Backus, JW	184	186	191	202	205	209	212	212	219	223	224	233	239	249	254	258	269	272	273	282	290	301	305	306	308
1978 Floyd, RW	283	297	319	340	345	355	378	407	433	453	532	559	592	622	668	725	774	834	899	969	1042	1117	1170	1218	1269
1979 Iverson, KE	84	94	94	94	94	94	97	97	102	105	105	107	108	108	109	110	119	123	123	127	133	137	147	152	152
1980 Hoare, CAR	2843	3160	3403	3608	3867	4085	4290	4501	4699	4939	5189	5392	5585	5875	6212	6519	6789	7133	7527	7905	8224	8517	8874	9327	9657
1981 Codd, EF	1207	1299	1381	1421	1486	1558	1632	1705	1760	1827	1858	1909	1963	2005	2069	2130	2178	2310	2439	2567	2662	2745	2840	2997	3112
1982 Cook, SA	469	590	703	753	817	902	957	1021	1084	1143	1217	1272	1311	1355	1423	1473	1531	1579	1634	1705	1791	1827	1890	1922	1953
1983 Thompson, K	455	500	514	539	553	585	599	625	659	729	802	924	1054	1168	1310	1454	1580	1714	1874	2012	2135	2235	2308	2391	2467
1983 Ritchie, DM	400	429	431	439	442	459	464	470	485	499	509	517	527	527	540	554	571	577	597	603	621	638	649	649	657
1984 Wirth, N	447	503	547	572	632	666	678	730	755	773	815	851	886	933	966	989	1005	1045	1077	1095	1136	1177	1218	1241	1283
1985 Karp, RM	349	409	495	541	657	747	860	999	1133	1292	1483	1618	1790	1998	2239	2501	2693	3033	3306	3631	3936	4300	4555	4928	5226
1986 Hopcroft, J	331	373	427	442	484	535	578	611	660	710	760	793	846	913	985	1045	1115	1167	1212	1285	1377	1424	1494	1569	1619
1986 Tarjan, RE	1459	1876	2377	2708	3178	3707	4218	4790	5455	6073	6821	7567	8459	9378	10388	11451	12380	13374	14300	15188	16349	17450	18346	19262	20280
1987 Cocke, J	152	186	220	242	286	317	350	366	425	465	510	564	604	640	696	755	794	845	871	925	976	1025	1072	1117	1151
1988 Sutherland, IE	24	30	40	76	114	140	178	209	238	289	322	390	500	587	728	807	884	971	1012	1084	1100	1140	1174	1200	1230
1989 Kahan, W	5	6	9	9	10	11	11	12	12	27	27	27	31	37	43	55	61	67	74	86	100	106	113	127	133
1990 Corbato, FJ	18	18	18	20	25	26	26	26	31	31	31	31	33	36	36	36	39	48	48	49	51	51	51	52	52
1991 Milner, R	738	915	1065	1153	1267	1420	1565	1707	1954	2213	2429	2667	2916	3265	3567	4070	4324	4694	5007	5369	5657	5903	6163	6317	6525
1992 Lampson, B	280	306	331	366	389	411	434	451	478	527	561	585	614	666	726	776	817	960	1088	1160	1252	1340	1397	1462	1527
1993 Hartmanis, J	143	189	253	281	308	346	374	440	494	517	565	606	640	687	746	808	851	876	890	909	929	936	960	982	1006
1993 Stearns, RE	363	388	401	421	436	455	465	480	500	518	545	571	614	646	686	727	783	833	890	950	1014	1052	1103	1130	1176
1994 Feigenbaum, EA	1	3	3	7	16	30	47	53	65	72	83	93	103	107	119	131	153	179	204	206	239	254	268	277	290
1994 Reddy, R	50	59	65	68	71	71	81	95	98	123	137	163	199	218	246	280	328	376	452	496	555	583	613	661	696
1995 Blum, M	412	451	508	546	609	688	784	883	1015	1178	1373	1565	1743	2014	2206	2437	2617	2887	3117	3351	3642	3836	4002	4219	4412
1996 Pnueli, A	425	535	668	760	863	1015	1109	1223	1388	1583	1798	1975	2156	2482	2891	3118	3406	3730	4000	4321	4678	4899	5157	5473	5809
1997 Engelbart, D	7	7	7	9	9	9	9	9	9	10	18	25	28	32	35	38	40	42	51	51	51	58	61	61	68

Preprint of "Fiala, D., & Tutoky, G. (2017). PageRank-based prediction of award-winning researchers and the impact of citations. *Journal of Informetrics*, 11(4), 1044-1068."

Table A.9 Turing Award winners and their cumulative citation counts in various years with award years highlighted (continued)

Year & Awardee	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
1998 Gray, J	647	695	757	792	837	886	918	948	967	996	1028	1035	1046	1058	1202	1410	1662	1969	2283	2606	2888	3212	3514	3874	4200
1999 Brooks, FP	137	143	157	165	193	205	226	236	249	274	295	325	354	397	464	564	666	777	881	1038	1200	1304	1396	1521	1636
2000 Yao, AC	282	329	351	371	400	426	444	482	525	574	637	711	790	943	1036	1276	1451	1640	1867	2057	2192	2359	2538	2713	2893
2001 Dahl, O	78	97	101	107	111	125	151	165	185	221	231	248	267	288	324	349	359	371	385	406	417	444	485	514	555
2001 Nygaard, K	96	115	119	125	131	140	152	162	172	189	193	202	211	222	250	268	275	287	301	315	322	338	352	352	352
2002 Rivest, RL	543	679	777	849	1003	1189	1433	1725	1997	2364	2822	3215	3667	4263	4984	5788	6550	7544	8500	9343	10197	10982	11763	12573	13293
2002 Shamir, A	550	696	777	832	959	1128	1382	1623	1936	2394	2982	3480	4134	4983	6092	7181	8244	9629	11178	12920	14805	16631	18562	20662	22791
2002 Adleman, LM	2	2	3	3	4	7	7	11	11	18	64	77	106	134	162	199	214	226	235	247	272	292	311	326	364
2003 Kay, A	28	28	28	28	30	32	38	39	41	42	73	73	76	100	134	176	197	222	254	270	276	282	297	311	328
2004 Cerf, VG	10	10	12	12	12	12	12	12	12	24	24	27	33	44	50	58	63	63	71	71	82	86	105	132	184
2004 Kahn, RE		2	2	2	2	2	2	2	2	29	38	43	50	53	61	76	90	94	98	98	108	116	142	149	157
2005 Naur, P	50	52	57	61	62	64	67	67	73	77	78	78	79	83	86	87	93	99	110	123	130	131	133	136	139
2006 Allen, F	110	117	124	135	148	157	167	173	179	186	192	195	199	199	212	227	230	252	283	288	295	298	321	345	348
2007 Clarke, EM	252	341	479	550	642	813	1064	1263	1568	1967	2445	2870	3354	3959	4496	4978	5388	5988	6497	6972	7339	7758	8145	8534	9000
2007 Emerson, EA	207	266	391	462	568	680	824	939	1115	1338	1585	1795	2063	2407	2705	2996	3266	3556	3829	4175	4437	4692	4957	5190	5453
2007 Sifakis, J	93	113	121	133	139	169	219	314	426	546	679	780	903	1062	1295	1486	1686	1890	2101	2418	2650	2874	3148	3416	3587
2008 Liskov, B	661	754	812	854	899	972	1002	1054	1091	1138	1204	1230	1283	1355	1437	1591	1708	1841	1943	2069	2202	2337	2490	2692	2846
2009 Thacker, C	24	48	64	79	90	96	114	120	137	151	165	212	271	361	410	500	542	593	636	681	708	727	763	807	834
2010 Valiant, LG	792	1007	1226	1449	1767	2040	2430	2852	3376	3858	4283	4638	5028	5450	5845	6232	6692	7085	7478	7848	8266	8603	9003	9470	9904
2011 Pearl, J	229	289	345	407	528	656	811	975	1129	1294	1528	1686	1908	2120	2383	2665	2840	3062	3291	3499	3699	3886	4102	4332	4544
2012 Micali, S	267	374	458	500	582	683	804	947	1201	1474	1886	2208	2557	3105	3694	4380	5010	5840	6517	7199	8067	8869	9314	9801	10445
2012 Goldwasser, S	179	260	328	356	417	490	582	678	861	1052	1360	1619	1901	2333	2821	3346	3798	4475	4976	5520	6243	6880	7287	7691	8208
2013 Lamport, L	1822	2203	2638	2998	3385	3771	4197	4717	5356	6135	6817	7521	8366	9358	10510	11591	12501	13750	14910	16121	17277	18725	19762	21127	22214
2014 Stonebraker, M	256	291	321	376	427	463	515	595	666	771	861	941	1000	1061	1130	1211	1300	1441	1553	1692	1817	1970	2179	2406	2605
2015 Hellman, ME	507	599	674	711	773	887	1031	1118	1305	1550	1811	2081	2363	2774	3231	3703	4160	4850	5546	6218	6742	7288	7912	8530	9060
2015 Diffie, W	346	426	490	520	564	643	747	825	974	1160	1370	1605	1845	2218	2649	3067	3408	4001	4511	5033	5484	5883	6252	6669	7064

Table A.10 Descriptive statistics of DCG permilles of Codd Award and Turing Award winners

	Codd Award					Turing Award				
	Min	**Max**	**Mean**	**Median**	**Std. dev.**	**Min**	**Max**	**Mean**	**Median**	**Std. dev.**
PR	6.77	14.91	11.06	10.95	2.70	33.62	43.71	40.29	41.76	3.23
PRtw	7.12	14.64	10.64	10.29	2.46	32.70	39.79	37.70	38.83	2.09
Citations	7.58	12.08	9.55	9.18	1.48	26.20	32.59	29.70	29.81	1.56
Indegree	7.45	11.64	9.56	9.16	1.47	27.35	31.94	29.60	29.23	1.45
PR	13.54	17.54	15.99	16.31	1.20	45.95	55.64	52.19	52.56	2.55
PRtw	14.24	16.97	15.66	15.76	0.80	41.46	54.76	49.83	50.79	3.48
Citations	12.67	15.94	14.32	14.25	0.76	30.45	46.71	40.80	42.58	4.49
Indegree	12.61	15.73	14.31	14.30	0.71	29.85	45.26	40.01	41.52	4.63
PR	3.93	90.63	42.02	39.12	26.96	8.39	225.11	115.05	113.90	70.82
PRtw	4.09	94.18	42.57	39.12	27.84	7.91	238.00	120.34	118.01	76.89
Citations	3.16	95.50	40.89	36.29	28.62	7.14	208.10	107.70	113.76	66.50
Indegree	3.38	93.76	40.85	36.29	27.79	6.94	205.60	101.65	102.92	64.31
PR	17.27	97.40	52.12	49.16	24.77	47.95	257.07	152.86	153.28	68.23
PRtw	17.09	101.30	52.29	48.57	25.97	43.46	269.93	155.75	154.82	75.58
Citations	13.64	103.08	49.63	44.70	27.67	32.45	234.45	135.54	144.11	66.81
Indegree	13.75	101.21	49.61	44.68	26.77	31.85	231.58	129.42	132.71	64.98