Norbert Wiener, His Collaborators, and the Definition of the Wiener Number

RICHARD D. BRAATZ

One way to obtain a historical perspective on a researcher is through exploring their collaborations with other researchers. This essay discusses software that can assist in the discovery of such collaborative relationships, which is then applied to Norbert Wiener.

This column is the third in a series associated with various aspects of the career of Norbert Wiener [1], [2]. The column begins with a discussion of another well-known mathematician, Paul Erdős, and applies software for visualizing research collaborations to draw connections between Wiener, Erdős, and other renowned theoreticians.

Paul Erdős was a prolific mathematician whose coauthorship of papers with over 500 different collaborators over his lifetime was recognized by the definition of the *Erdős number*, which is the minimum number of collaboration relationships to connect an author with Paul Erdős [3]. For example, a person who coauthored a paper with Paul Erdős would have an Erdős number of one; a person who coauthored a paper with someone who coauthored a paper with Paul Erdős would have an Erdős number of two. Paul Erdős coauthored about 1500 papers in a wide range of fields, which resulted in a very large proportion of current mathematicians having Erdős numbers fewer than ten [4].

Microsoft Academic Research (MAR) is software that uses graphs to show various relationships between authors and citations to papers [5]. MAR can visualize coauthor relationships between individuals, which can be used to assist in the determination of a person's Erdős number. For example, Figure 1 is a visualization of the coauthor paths between Norbert Wiener and Paul Erdős, as identified on July 14, 2013. According to Figure 1, Norbert Wiener has an Erdős number of three.

The visualizations are attractive but the results produced by the software are only as good as its database, and the database used by MAR has many mistakes, such as listing the same person multiple times and assigning the publications of multiple authors to one composite author. The Web site [5] indicates that Microsoft is working with various vendors to improve its database. For now, it is better to treat the software as listing only *possible* coauthor paths between individuals. The listing of specific authors usually provides some information for each author so that accuracy of the coauthor path can be checked by searching the Internet or separate electronic journal databases, such as Google Scholar, Thomas Reuters Web of Knowledge, or SciFinder.

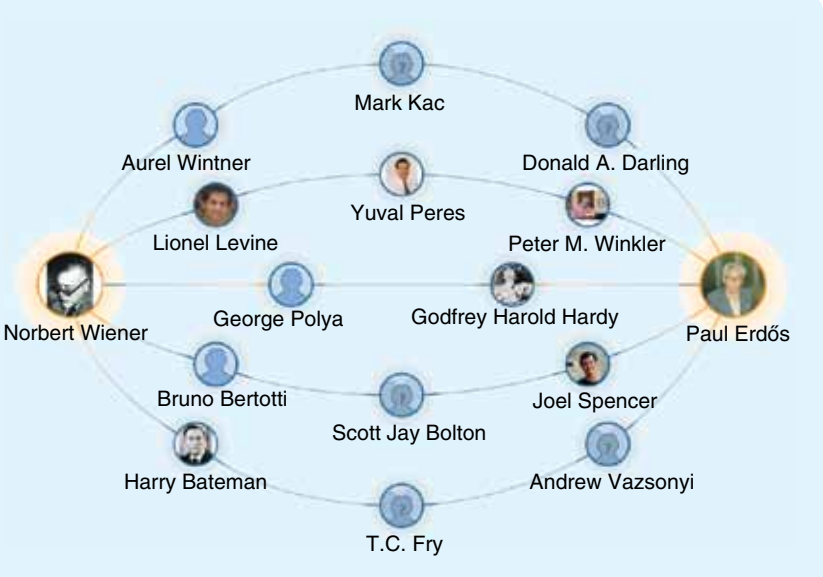

FIGURE 1 Coauthor path between Norbert Wiener and Paul Erdős as determined by the Microsoft Academic Research software on July 14, 2013.

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For example, Figure 1 shows that the Oxford/Cambridge mathematician Godfrey Harold Hardy coauthored a paper with Paul Erdős but no such publication appears in Web of Knowledge or in the list of coauthors maintained by the Erdős Number Project hosted by Oakland University [4]. A Web search indicates that Erdős did interview Hardy at some point so perhaps that interview somehow found its way into the database used by MAR. A search of the Erdős Number Project data indicates that Aurel Friedrich Wintner, who was a mathematician at Johns Hopkins University, coauthored at least one paper with Paul Erdős, which can be confirmed by an electronic journal search. Aurel Wintner also coauthored papers with Norbert Wiener, so Norbert Wiener actually has an Erdős number of two. (An extensive search of multiple databases did not locate any paper by Wiener coauthored by Erdős, so Wiener does not have an Erdős number of one.)

Of course, different individuals can be used to define different numbers. For example, since Norbert Wiener has an Erdős number of two, it could equally be said that Paul Erdős has a *Wiener number* of two. Since the Erdős number was originally defined only to apply to papers on mathematical theory, the Wiener number could be considered a more relevant metric for drawing collaborative connections between researchers in the systems and control field.

For instance, consider connections to Hendrik W. Bode, whose name is associated with the annual named lecture of the IEEE Control Systems Society. Figure 2 shows the coauthor paths between Bode and Wiener according to MAR, with the shortest path being at the top. Bode coauthored a paper with Princeton mathematician John W. Tukey in 1949, who was awarded the IEEE Medal of Honor in 1982 for the development of the fast Fourier transform. Tukey published with Harvard mathematician Ralph P. Boas, Jr., who published with another Harvard mathematician David Vernon Widder, who published with Norbert Wiener. The top coauthor path is confirmed to be valid so Hendrik Bode has a Wiener number no greater than four.

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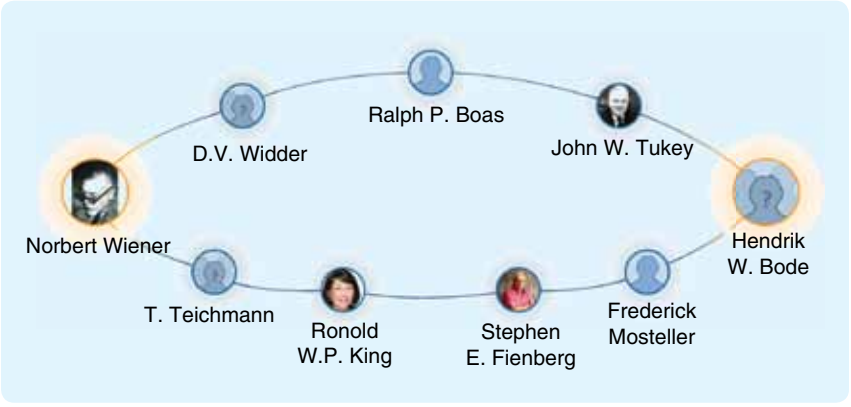

FIGURE 2 Coauthor path between Norbert Wiener and Hendrik W. Bode as determined by the Microsoft Academic Research software on July 14, 2013. (Note that the photo for Ronold W. P. King is incorrect. MAR uses a Web search of images to fill in the photos and in some cases shows photos that do not match the individuals.)

Norbert Wiener coauthored publications with significantly fewer people than Paul Erdős did, and the MAR software is unable to compute a Wiener number for as many individuals. Individuals with a Wiener number of one are easy to generate by listing the coauthors of papers published by Norbert Wiener in any comprehensive electronic journal database. One interesting element noted when doing such a search is that the individuals with a Wiener number of one include Max Born, who coauthored a paper on quantum theory with Wiener in 1926 [6] and went on to receive the Nobel Prize in Physics for his work in quantum physics in 1954. Two conclusions can be immediately drawn from this research collaboration. First, Wiener really was a polymath, as evidenced by his publishing a paper on a topic of high interest among the top theoretical physicists at the time. Second, Wiener has a Born number of one.

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