Using Social Network Analysis to Portray the Trajectory of Research in Evaluation Theory — Antecedents, Now, and Future

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Evaluation Roots

In the *Evaluation Roots: Tracing Theorists' Views and Influence*, the Evaluation Tree (Figure 1) to present the "relationships between evaluation theorists" and how evaluation "theories built upon other theories" (Alkin, 2004, p. ix). The contemporary theorists (including those who deceased) were classified on the branches, and their placement on the tree informed readers about their similarities and differences in evaluation perspectives.

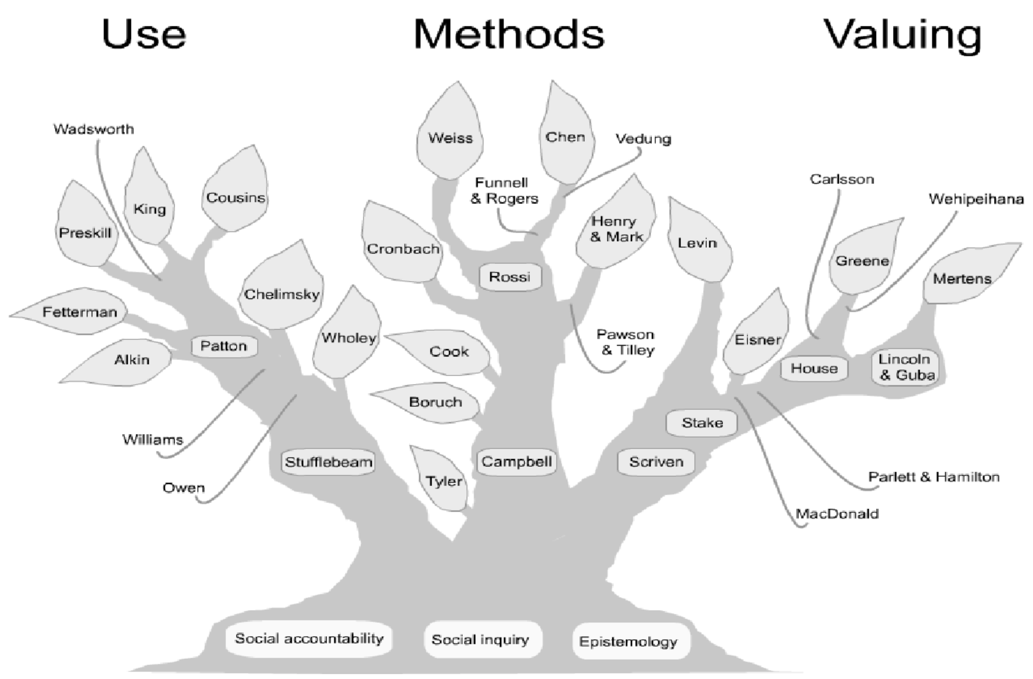

Figure 1. Evaluation Theory Tree
Alkin, M. C (2012). Evaluation roots (2nd ed.). Thousand Oaks, CA: Sage.

Although the classification is widely accepted in the field if evaluation theory, the supporting evidences (as well as in other theoretical study articles in this topic) are largely anecdotal. The connections of theorists and theories have been identified, but not quantified. Although in the two editions of *Evaluation Roots*, evolving of theories have been recognized, the merging patterns are not fully presented, nor the theorists' temporal-spacial connections have been discussed. A network analysis of the evaluation tree is in need as a component for the post-second edition.

The Social Network Analysis Approach

To portray the temporal-spacial trajectory of research in evaluation theory, the first step is to explore if the current branch structure hold in general. In response to this question, this pilot study proposed to perform social network analysis (SNA) to explore the inter-connections among evaluation theorists. We used two editions of Evaluation Roots to select the influential theorists. The criterion is to look at all the evaluators whose evaluation theory were discussed in one full chapter in any of the edition. For example, Jennifer Greene wrote a chapter to describe Cronbach's theory in evaluation, and one chapter about herself; we included both Cronbach and Greene as the theorists in our study. Madaus wrote a chapter about Ralph Tyler, and instead of including Madaus, we included Tyler in the study. We identified 30 theorists, and used their within-network citation frequency to represent their interconnections.

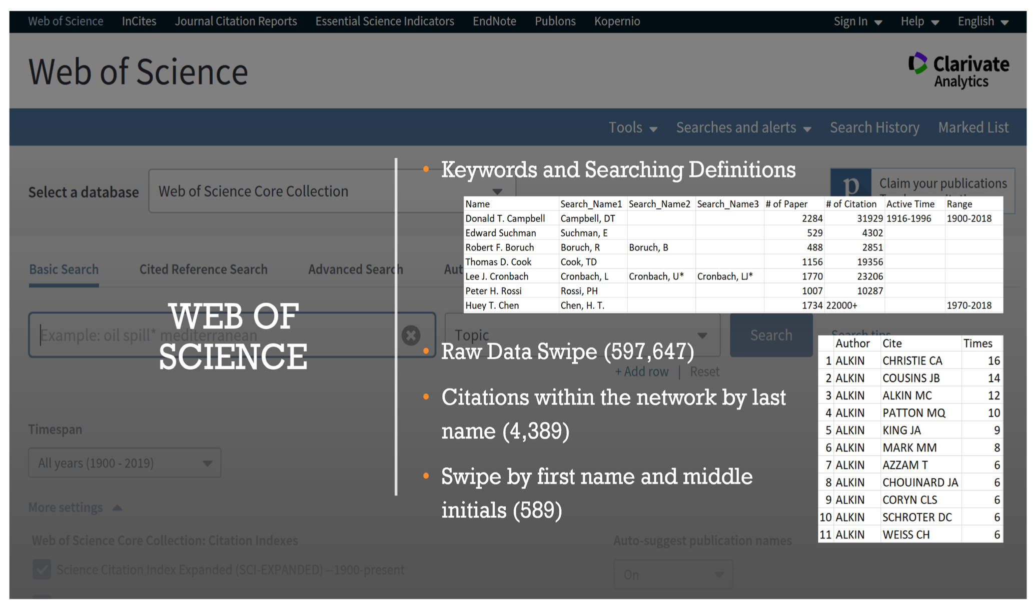

Figure 2. Data collection from the Web of Science

SNA Data Collection

In this study, we collected data from the Web of Science (1900 - 2018). We majorly focused on citation frequency within the tree network (30 nodes). We started from name and keywords searching of the 30 theorists, and then limited the citations within the network and obtain 589 data points (Figure 2). We started to test the network structure, and eventually, as a pilot study, we defined that if a theorist was cited by another theorist at least 5 times (≥ 5), this theorist formed a "frequent citation" relation with the other theorist who cited his/her work, i.e., this theorist has an outgoing tie pointing at the other theorist. With the consideration of citation frequency, we used 153 data points.

The Evaluation Theory Tree Network

Using the above dataset, we created a directed network with 30 vertices, 153 edges, and defined the branch that the theorists belonged to as a vertex attribute. Although we defined 5 and above as the magic number of being considered as having a tie, we believed that the numbers of citations are important. Therefore, we added the total number of being cited for each theorist as a vertex attribute, and the number of being cited for each row of the edgelist as an edge attribute.

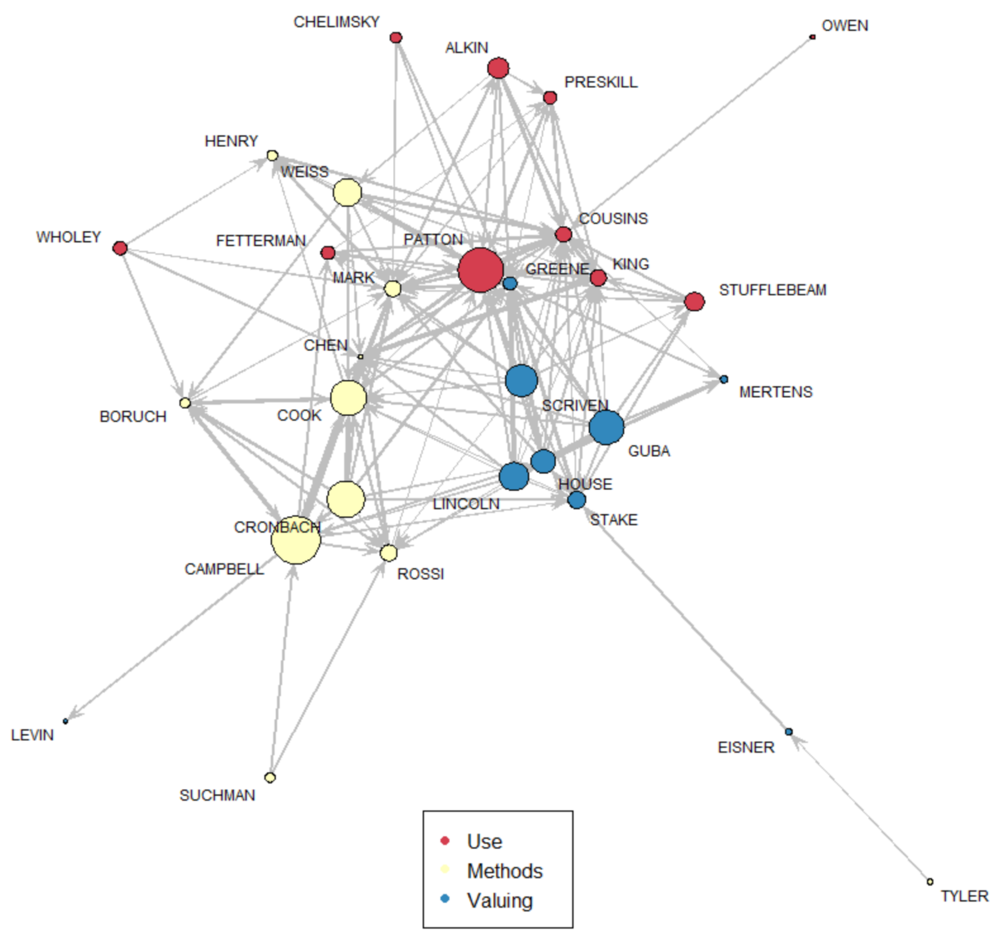

Figure 3. The Evaluation Theory Network

In the network plot (Figure 3), we used the size of the nodes to represent the total citations (by others) of the theorists. We used the thickness of a tie to illustrate the number of citation for that particular tie, and the arrow to represent the "cited by" direction. For example, Cronbach has been cited by many others, and therefore, he has a large node size and many outgoing ties; Tyler was cited by Eisner, and this action brought him into the network; Levin cited Campbell, and then involved into the network. From the visualization, we sensed that the indegree and outdegree would not be very highly corelated, since we noticed that some theorists, such as Cronbach, Scriven, and Wholey tended to be cited by other theorists, but not cited others. We intentionally plotted the node colors by their branches. From the colors, we observed that theorists within the same branch tend to cluster and share more citations. Some of the nodes, however, seem to be more connected with theorists on other branches than with those on their own. For example, Wholey, a use focus theorist, was more connected with those on the method branch.

Centered Theorists From SNA

To explore the centrality and connectivity, we assessed the network density, degrees, betweenness, closeness, and eigenvalue centrality. The network density is 0.176, indicating the existing ties takes 17.6% of all possible ties. At network level, the indegree is 0.255, outdegree is 0.44, betweenness is 0.17, closeness is 0, and eigenvalue centrality is 0.238. We observed that the closeness for all nodes are 0, and thus, we did not have its correlations with others. The indegree and outdegree did not have a strong correlation. The degree and betweenness had high correlations with other indexes. The outdegree had extremely high correlation with the eigenvalue centrality. The indegree had low correlations with the outdegree and with the eigen value centrality.

Table 1. Centered Theorists from SNA

Indegree	*COUSINS, MARK, GREENE*
Outdegree	*PATTON, SCRIVEN, GUBA*
Betweenness	*CAMPBELL, COOK, COUSINS, PATTON*
Eigenvalue	*CRONBACH, GUBA, LINCOLN, PATTON, SCRIVEN*
Cutpoints	*CAMPBELL, COUSINS, EISNER*

To identify the "centered theorists" in the network, we find the theorists with large indegree, outdegree, betweenness, closeness, eigenvalue centrality, and cutpoints (Table 1). The names identified in Table 1 are aligned with what we observed from the network plot (those with large node sizes), apart from some names identified from the "Indegree" and "Cutpoints" categories. Specially, the cutpoints are from the three branches each.

Structure Testing

To test if the three-branch structure would be more reasonable than a simple random structure, we used the Monte Carlo approximation – simulated the distribution based on the current network density for 10000 times to obtain the network density distribution, and indegree and outdegree distributions, and then assessed the p-values and the positions of observed values from our network in the Monte Carlo distributions. The purpose is to test the density statistic and if the network plot is different from a simple random graph based on degree centralization.

Table 2. Results from Monte Carlo Approximation

	Observed Value	Simulated Mean	p-value
Density	0.1759	0.1760	0.5161
Indegree	0.2549	0.1655	0.0289
Outdegree	0.4397	0.1653	0.0000

The results reported in Table 2 proves that the observed density is pretty much in the center of the simulated density values. If the network follows a simple random structure, the indegree and outdegree would be similar to the simulated mean values, or at least, not significantly different from the mean. Small p-values in Table 2 and the histograms in Figure 4 indicates that the observed indegree and outdegree (red lines) are unlikely from a simple random graph. Therefore, the network is not a simple random graph.

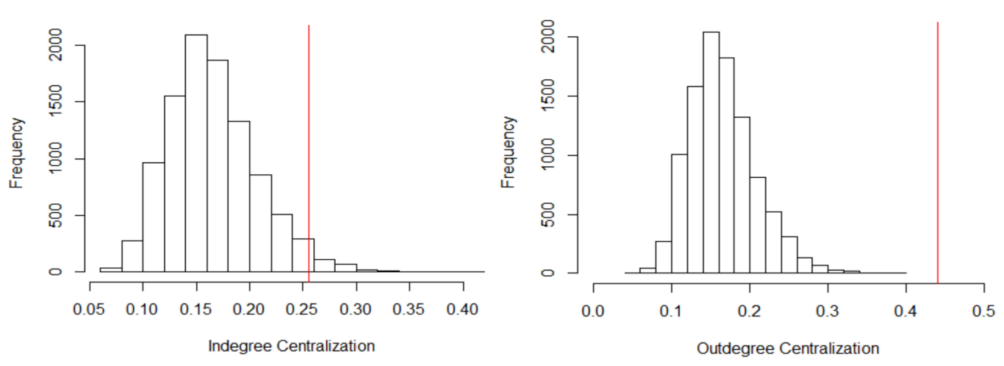

Figure 4. Indegree and Outdegree Centralizations

Latent Space Modeling

To further explore the potential model structure, we fitted the data to 1-, 2-, 3-, 4-dimensional clusters (unable to extract 5-deminsions and above), and compare the BIC values. With the lowest absolute BIC value, 3-dimentional clustered latent social space model fitted the best. After confirming the 3-group structure, we plotted the network, and colored the nodes by their fitted latent group structure, and compared the grouping structure with the three-branch structure (Figure 5).

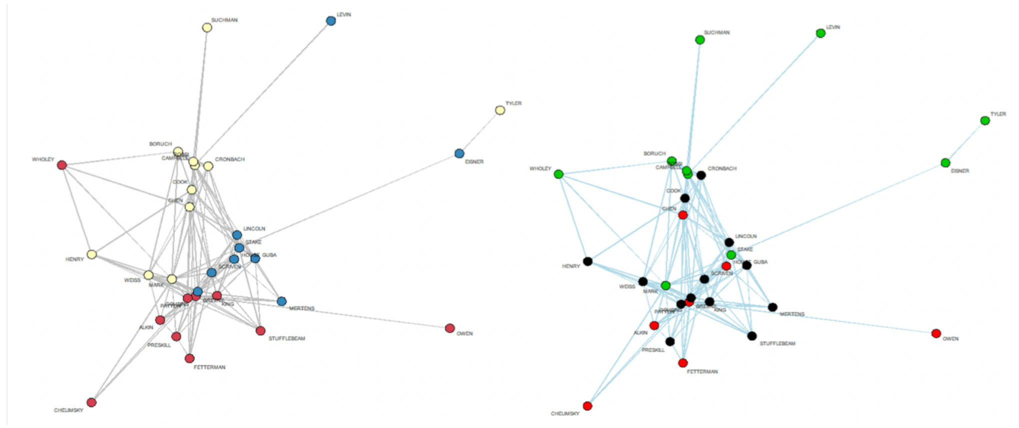

Figure 5. Tree Network vs. 3-Group Random Structure

Figure 6 presented the latent positions of the nodes. Based on the geographical positions, we plotted the cluster circles. The latent positions were somewhat influenced by the "lone wolves" in the network, i.e., Levin, Tyler, Owen, and Eisner. The blue circle seemed to reflect the popularity or connectivity property.

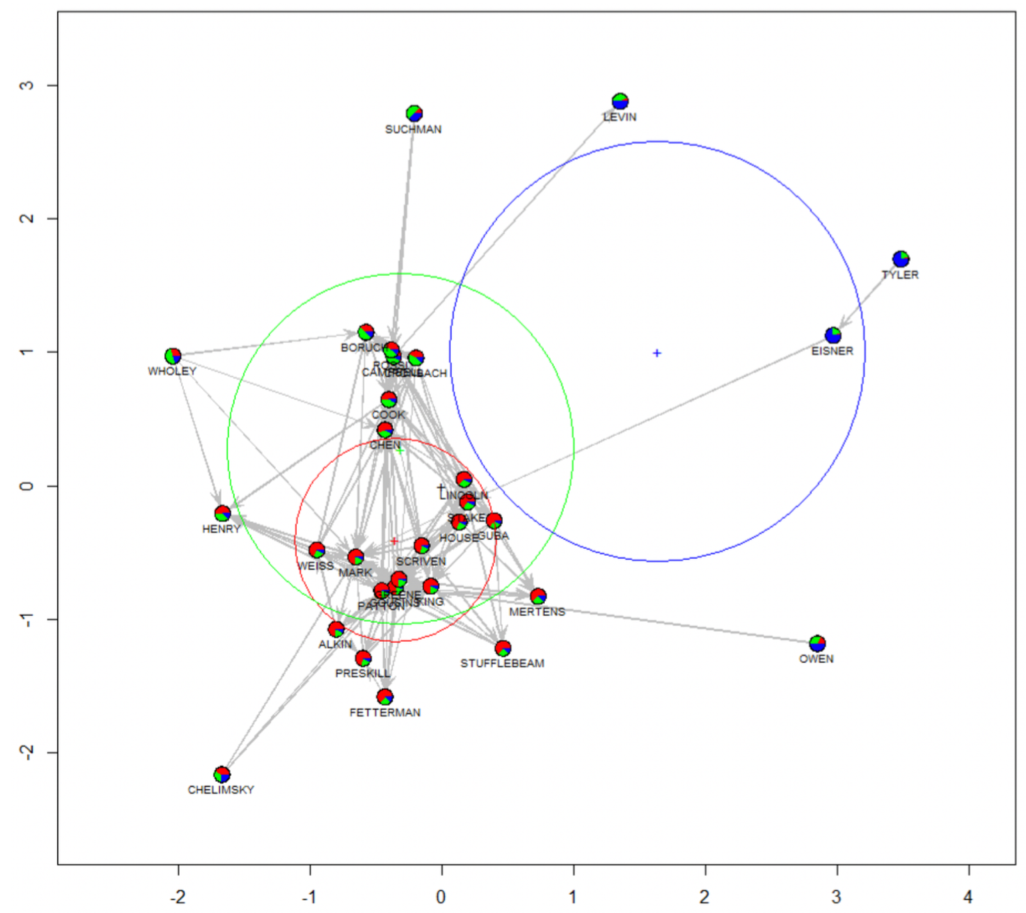

Figure 6. Latent Positions of the Theorists

Major Findings

This study is the beginning of a series of studies that focus on using social network analysis to explore the development of evaluation theory, and therefore, it focuses more on trying different approaches and does not take much space to explain the framework the theory. Even so, we have several noticeable findings:

- Firstly, judging from the directions of the ties and the difference between indegree and outdegree, we find that the "citing" and "being cited" frequencies of the same theorists are not balanced.
- Secondly, this study identifies the important nodes, i.e., theorists, and the results are somewhat aligned with the theorists' contributions in each branch. The network analysis provides supporting evidence for existing literature of identifying theorists' contribution.
- Lastly, this study justifies the three-branch structure from a network analysis perspective. We observed that 3-group cluster structure was supported by the latent modeling comparisons, and the latent grouping somewhat reflected the three-branch structure.