Funding Proposal Overlap Mapping: A Tool for Science and Technology Management

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The visualization of knowledge or technological landscapes can not only benefit non-expert users to obtain a basic landscape of domain field, but also offer an incorporation of advanced visual perception for scholars in the field.

**Mapping**, as an effective visual interfaces to immense collections of data, depicting myriad objects in ways that allow us to effectively discern apparent outliers, clusters and trends.
In the past many years, most scholars emphasis on outcomes in research evaluation in part represents an evolution in the nature of research. Compared to research publications that report the narrow outcomes that emerge from ongoing research programs and limit the scope of the reporting to specific findings or results, research proposals provide valuable research intelligence "upstream" of analyses of research outputs.

Funding proposals have the following typical advantages:

- Contain a broader scope of data on the people, inputs and processes of science;
- Describe overarching research programs, which typically generate multiple publications.

*Program Element Codes (PEC)* and *Program Reference Codes (PRC)* to track which NSF programs funded specific awards.
## Technology background

<table>
<thead>
<tr>
<th>Type</th>
<th>Science overlay mapping</th>
<th>Patent overlay mapping</th>
<th>Funding proposal overlap mapping</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data source</td>
<td>Publication (Web of Science)</td>
<td>Patent (EPO, USPTO)</td>
<td>Awards (NSF)</td>
</tr>
<tr>
<td>Classification basic</td>
<td>Content-based classification; ISI subject category; Web of Science category</td>
<td>IPC</td>
<td>PEC</td>
</tr>
<tr>
<td>Purposes</td>
<td>Locate bodies of research within the sciences, both at each moment of time and dynamically and explore the ongoing sociocognitive transformations of science and technology systems.</td>
<td>Visualize the global innovation landscape as well as a method to locate the patent data of individual organizations, countries and technological fields on the global map.</td>
<td>Show changes in distribution of proposals on a given subject matter or by a research unit over time and contrast the emphases of different research units for science and technology management.</td>
</tr>
<tr>
<td>Factor relationship</td>
<td>Citing-to-Cited relationship</td>
<td>Citing-to-Cited relationship</td>
<td>Co-occurrence relationship</td>
</tr>
<tr>
<td>Cluster method</td>
<td>Cosine similarity matrix and factor analysis</td>
<td>Cosine similarity matrix and factor analysis</td>
<td>Maximum membership degree</td>
</tr>
</tbody>
</table>
The **National Science Foundation (NSF)**, as a United States government agency that supports research and education in all the *non-medical fields of science and engineering*, has tried to narrow the gap between science and society with its broader impacts criteria.

Three data search methods:
- Simple Search;
- Advanced Search;
- Popular Search (for ARRA Awards)

ARRA: American Recovery and Reinvestment Act

**Timespan:**
- **2000 to 2014**

**Results:**
- **171074 awards**
## Data Source

<table>
<thead>
<tr>
<th>Non-research directorate (12.41%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Administration-related (3.29%)</td>
</tr>
<tr>
<td>Research-related (84.31%)</td>
</tr>
</tbody>
</table>

**Non-research directorate:**
- Office of the Director (O/D);
- National Science Board (NSB);
- Office of the Inspector General (OIG);
- Directorate for Education & Human Resources (HER);
- Office of Budget, Finance, and Award Management (BFA);
- Office of Information & Resource Management (IRM).

**Two type of PECs:**
- Research-related funding;
- Administration-related funding;
## Methodology

### PEC Processing

<table>
<thead>
<tr>
<th>Type</th>
<th>PEC Number</th>
<th>Award Records</th>
<th>Rate</th>
<th>Cumulative number</th>
<th>Acculate rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000=&lt;Award</td>
<td>43</td>
<td>62332</td>
<td>43.48%</td>
<td>62332</td>
<td>43.48%</td>
</tr>
<tr>
<td>500=&lt;Award&lt;1000</td>
<td>60</td>
<td>39731</td>
<td>27.72%</td>
<td>95654</td>
<td>66.73%</td>
</tr>
<tr>
<td>100=&lt;Award&lt;500</td>
<td>264</td>
<td>56363</td>
<td>39.32%</td>
<td>136805</td>
<td>95.43%</td>
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<td>50=&lt;Award&lt;100</td>
<td>101</td>
<td>6939</td>
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<tr>
<td>10=&lt;Award&lt;50</td>
<td>195</td>
<td>4926</td>
<td>3.54%</td>
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<tr>
<td>Award&lt;10</td>
<td>248</td>
<td>656</td>
<td>0.46%</td>
<td>142821</td>
<td>100.00%</td>
</tr>
</tbody>
</table>
## Methodology

### Category Method

**Previous category method:**

- *Cosine similarity matrix;*
- *Factor analysis;*

**Current category method:**

- *Maximum membership degree;*
- *Manual check;*
Results

Basemap (6 factors)
Graphene WoS (2000-2014)
Graphene DII
(2000-2014)
Graphene NSF (2000-2014)
Interdisciplinarity: Georgia Tech VS Harvard University
Funding Proposal Overlap Mapping offers some potential advantages:

◆ Provides an effective visualization way in showing changes over time, as in distribution of proposals on a given technology;

◆ Contrasts the emphases of different research units, including academic institutes and universities;

◆ Contributes a new approach to measuring interdisciplinarity;
Funding Proposal Overlap Mapping has some limitations:

- Only frequent PECs have been considered to building the co-occurrence network;
- Discipline categories are mainly based on the organization NSF divisions;
- NSF cannot comprehensively reflects the all funding activities.
Thanks you for your attention!  
Question & Comments

Ying Huang¹ • Yi Zhang¹ • Luciano Kay²• Alan L. Porter³ • Jan Youtie⁴ • Donghua Zhu¹

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