Scientometric Mappings for Tentative Governance of Emerging Technologies

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Can scientometric mapping and overlay techniques be used as strategic intelligence tools for policy making of tentative governance of emerging science and technologies?
Emerging science and technologies have the potential to generate profound—both positive and negative—social changes such as creating new industries as well as dramatically reconfiguring or destroying existing ones (e.g. Freeman and Soete, 1997)
Theoretical Background

- **Uncertainties** and **rapid** dynamics feature in the emergence process – directionality and **visions, goals, and expectations of the actors involved** (e.g. Geels, 2002; Stirling, 2009)

- **De facto governance** as the set of intentional and un-intentional influences (Rip, 2010)

- **Tentative forms of governance** to address the complexity, interdependencies, and contingencies of the emergence are needed (e.g. Kuhlmann, 2001; Wiek et al., 2007)

- Defining tentative governance requires ‘strategic intelligence’, i.e. ‘intelligent inputs’ that timely feed, especially at the very early stage of an EST, the policy making process (Kuhlmann et al., 1999)

- Mapping and overlay techniques may serve as strategic intelligence tools to specifically inform the analyst on the **de facto** arrangements: i) ‘**distributed**’ strategic intelligence; ii) **flexibility**, and iii) **granularity**
An additional dimension to well-established mapping approaches (e.g., co-citation analysis, bibliographic coupling, co-words analysis).

(based on Rafols et al., 2010)
An additional dimension to well established mapping approaches (e.g. co-citation analysis, bibliographic coupling, co-words analysis).
Methods

Mapping and overlay techniques: Tracing dynamics
RNA interference (RNAi)

RNAi is a molecular process that can silence the expression of genes. By silencing specific genes one can stop the progression of a given disease. RNAi can be conceived therefore as a general purpose technology for research in labs (Fire et al., 1998).

HPV testing

HPV testing is a diagnostic technology for the detection of Humana Papilloma Virus (HPV). HPV infections (especially types 16 and 18) are strongly associated with cervical cancer (Casper and Clarke, 1998; Hogarth et al., 2012).

TPTM testing

TPMT testing technology is one of an emerging class of ‘pharmacogenetic tests’ which predict adverse events associated with pharmaceutical use. Its application for clinical utility is contested across medical fields (Hopkins et al., 2006).

Diversity in terms of context, scale, and position in the innovation chain
Scientometric mappings can provide strategic intelligence across three space of emergences (as well as combinations of those):

• Geographical
  (e.g. Bornmann & Leydesdorff, 2011)

• Social
  (e.g. Leydesdorff & Persson, 2010)

• Cognitive
  (e.g. Leydesdorff et al., 2012; Rafols et al., 2010)
## Methods

### Data sources

<table>
<thead>
<tr>
<th>Case Study</th>
<th>Data</th>
<th>Database</th>
<th>Search string</th>
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</thead>
<tbody>
<tr>
<td>RNAi</td>
<td>Publications</td>
<td>ISI WoS</td>
<td>Tl=sirNA or Tl=RNAi or Tl=“RNA interference” or Tl=“interference RNA”</td>
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<tr>
<td></td>
<td></td>
<td>MEDLINE/PubMed</td>
<td>siRNA[Title] or RNAi[Title] or “RNA interference”[Title] or “interference RNA”[Title]</td>
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<td></td>
<td>Patents</td>
<td>USPTO</td>
<td>ACLM/((siRNA or RNAi or &quot;RNA interference&quot; or &quot;interference RNA&quot;) )</td>
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<td>Publications</td>
<td>ISI WoS</td>
<td>(Tl=HPV* or Tl=&quot;Human Papilloma Virus**&quot; or Tl=&quot;Human Papillomavirus**&quot; or Tl=&quot;Human Papilloma<em>virus**&quot;) and (Tl=Cervical or Tl=Cervix) and (Tl=diagnos</em> or Tl=test* or Tl=assay or Tl=detect* or Tl=screen* or Tl=predict*)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>MEDLINE/PubMed</td>
<td>(HPV*[Title] or “Human Papilloma Virus***[Title] or &quot;Human Papillomavirus***[Title]) and (Cervical[Title] or Cervix[Title]) and (diagnos*[Title] or test*[Title] or assay[Title] or detect*[Title] or screen*[Title] or predict*[Title])</td>
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<tr>
<td></td>
<td>Patents</td>
<td>USPTO</td>
<td>ACLM/((HPV or &quot;Human Papilloma Virus$&quot; or &quot;Human Papillomavirus$&quot;) and (Cervical or Cervix) and (diagnos$ or test$ or assay or detect$ or screen$ or predict$))</td>
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<tr>
<td>TPMT testing</td>
<td>Publications</td>
<td>ISI WoS</td>
<td>Tl=TPMT or Tl= “Thiopurine Methyltransferase”</td>
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<td>TPMT[Title] or &quot;Thiopurine Methyltransferase&quot;[Title]</td>
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<td></td>
<td>Patents</td>
<td>USPTO</td>
<td>ACLM/(TPMT or &quot;Thiopurine Methyltransferase&quot;)</td>
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</tbody>
</table>

### Publication data

The mapping needs to be timely and provide relevant information with relatively low efforts – search of the keywords in titles rather than abstracts.

### Patent data

Search of keywords in fields where relevant information is provided – patent’s claims define “invention and are what aspects are legally enforceable” (USPTO Glossary)
The Vantage Point and the organisational names harmonisation

Methods

Grouping organisations by country

List Cleanup (country by country) → Thesauruses

Co-occurrence matrix to build network files
Mapping across the geographical and social spaces
Results

Mapping across the geographical and social spaces
Results

Mapping across the geographical and social spaces
Results

Mapping across the geographical and social spaces
Results

Mapping across the geographical and social spaces

HPV testing (co-authorship)
Results

Mapping across the geographical and social spaces

HPV testing (co-authorship)
Results

Mapping across the geographical and social spaces
Social space:
Micro-level analysis
Results

Social space: Micro-level analysis
# Results

## Social space: Micro-level analysis

<table>
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<td>Scientific articles</td>
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<td>137</td>
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<td>Nodes</td>
<td>20</td>
<td>130</td>
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<tr>
<td>Ties</td>
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<tr>
<td>Components</td>
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<td>7</td>
<td></td>
<td></td>
<td></td>
<td>25</td>
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<tr>
<td>Nodes in the giant component</td>
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<td>7</td>
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<td>504</td>
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<tr>
<td>Isolated nodes</td>
<td>(0.00%)</td>
<td>(5.38%)</td>
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<td></td>
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<td>(61.75%)</td>
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<td></td>
<td></td>
<td>(10.17%)</td>
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<tr>
<td>TPTM testing</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scientific articles</td>
<td>13</td>
<td>16</td>
<td>52</td>
<td>108</td>
<td>200</td>
<td>151</td>
</tr>
<tr>
<td>Nodes</td>
<td>6</td>
<td>8</td>
<td>36</td>
<td>111</td>
<td>200</td>
<td>232</td>
</tr>
<tr>
<td>Ties</td>
<td>5</td>
<td>3</td>
<td>28</td>
<td>123</td>
<td>203</td>
<td>413</td>
</tr>
<tr>
<td>Components</td>
<td>1</td>
<td>2</td>
<td>28</td>
<td>123</td>
<td>43</td>
<td>12</td>
</tr>
<tr>
<td>Nodes in the giant component</td>
<td>5</td>
<td>15</td>
<td>124</td>
<td>25</td>
<td>45</td>
<td>82</td>
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<tr>
<td>Isolated nodes</td>
<td>(83.33%)</td>
<td>(7.50%)</td>
<td>(2.52%)</td>
<td>(7.12%)</td>
<td>(21.50%)</td>
<td>(14.22%)</td>
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</tbody>
</table>

This table presents the results of the micro-level analysis for HPV and TPTM testing over different time periods. The data includes the number of scientific articles, nodes, ties, components, nodes in the giant component, and isolated nodes.
Cognitive space: Mapping scientific disciplines
Results

Cognitive space: Mapping scientific disciplines

TPTM

1982-1986

1987-1991

1992-1996

2002-2006

2007-2011

1997-2001
Similar mapping approaches can be built at different levels of analysis and using different data sources:

- **Journals map**
  
  (e.g. Leydesdorff et al, in press)

- **MeSH (Medical Subject Headings) map**
  
  (e.g. Leydesdorff et al, 2012)

- **IPC technological classes map (for patent data)**
  
  (e.g. Leydesdorff et al., in press)
Discussion and Conclusions

• The uncertainty, ambiguity, and rapid dynamics featuring in the process of emergence of novel science and technologies requires an investigation from multiple perspectives (Stirling and Scoones, 2009)

• The mapping and overlay techniques can serve as strategic intelligence tool by providing informative perspectives on the de facto governance across spaces of emergence – flexibility, granularity and distributed strategic intelligence

• Degree of freedom in the mappings: i) delineation of the boundaries of ESTs, ii) database(s) selection, iii) elements to analyse and categories assigned

• It is worth noting that the informative and interpretative perspectives often do not provide answers, but they suggest additional questions that may drive the analyst in the investigation process
Full working paper available at
www.interdisciplinaryscience.net/defactogov

... thank you ...

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