

Evaluating and Ranking Patents with Multiple Criteria: Methodology and Application in Chemical R&D Analytics

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Motivation

- Invest on chemical processes
- Find and evaluate most promising ideas
- Combine best ideas with company's goals to select the projects to invest on
- Optimize the portfolio of projects
- Estimate resource allocation

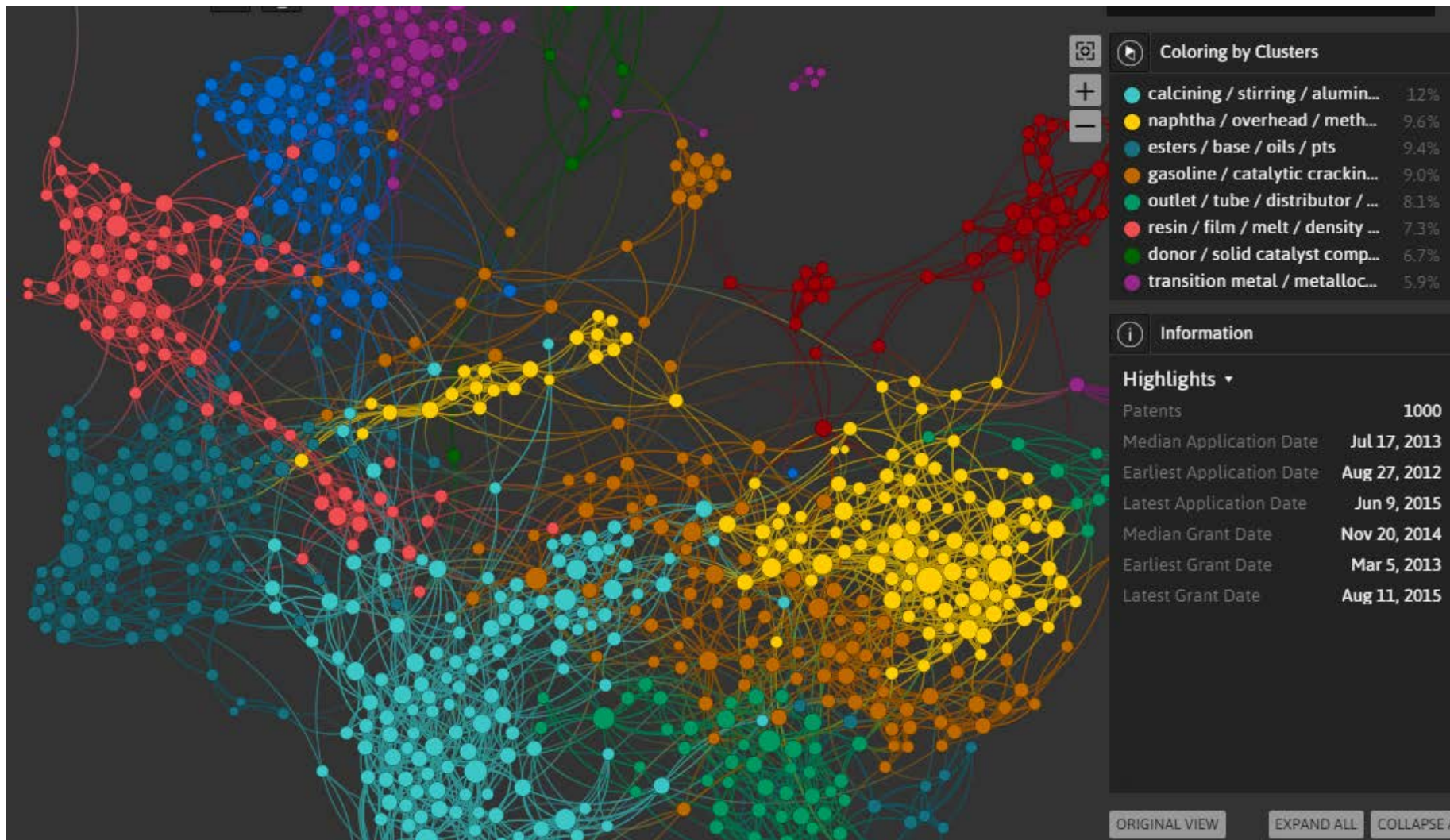
Problem statement

- Given a set of projects
 - Gather most relevant patents
 - Evaluate and rank patents
 - Estimate resource allocation
 - Optimize portfolio of projects
 - Develop an online DSS

Proposed methodology

- Define criteria for patent evaluation
- Define weights for the criteria
- Use NLP methods to search and retrieve relevant patents (Quid)
- Apply an MCDM method to evaluate and rank patents (custom web-based DSS)

Visualized patent network with Quid



Criteria selection

- Criteria related to a patent's connections
 - Degree
 - Betweenness centrality
 - Inter-cluster fraction
- Criteria related to a patent's neighbors
 - Flow
 - Pagerank
 - Triangles
- Criteria related to a patent's citations
 - Forward citations
 - Backward citations

Weight assessment

$$\min \sum_i s_i$$

$$s.t. \quad w_D + w_B + w_I - w_F - w_P - w_T + s_1 \geq 0$$

$$w_D + w_B + w_I - w_{FC} - w_{BC} + s_2 \geq 0$$

$$w_F + w_P + w_T - w_{FC} - w_{BC} + s_3 \geq \varepsilon$$

$$w_{FC} + w_{BC} + s_4 \leq 0.25$$

$$w_D - w_B - w_I + s_5 \geq 0$$

$$w_B - w_I + s_6 \geq 0$$

$$w_P - w_F - w_T + s_7 \geq \varepsilon$$

$$w_F - w_T + s_8 \geq \varepsilon$$

$$w_{FC} - 2w_{BC} + s_9 \geq 0$$

$$0.05 \leq w_k + s_k \leq 0.33, \quad k \in \{D, B, I, F, P, T, FC, BC\}$$

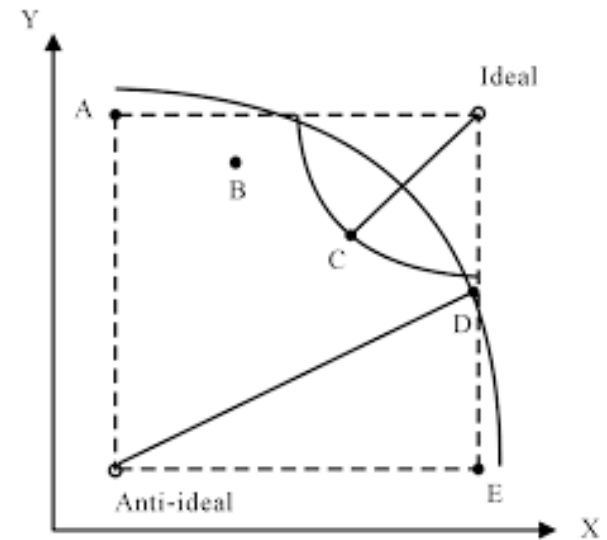
$$w_D + w_B + w_I + w_F + w_P + w_T + w_{FC} + w_{BC} = 1$$

$$w_D, w_B, w_I, w_F, w_P, w_T, w_{FC}, w_{BC} \geq 0$$

$$s_i \geq 0, \quad \text{for all } i$$

TOPSIS method

- Step 1. Calculation of the weighted normalized decision matrix
- Step 2. Determination of the ideal and anti-ideal solutions
- Step 3: Calculation of the distance from the ideal and anti-ideal solutions
- Step 4. Calculation of the relative closeness to the ideal solution
- Step 5: Rank the alternatives from best (highest relative closeness value C_i) to worst



Ammonia process synthesis

Set of weights	Top five patents				
	First	Second	Third	Fourth	Fifth
A	5	100	137	48	96
B	5	100	137	48	96
C	137	5	20	100	48

- 166 patents exported from Quid
- Most highly-ranked patents are very important
- Patents 5, 100 and 137 are dealing with generating syngas used in ammonia process
- Patent rankings do not change drastically with different weights

Conclusions

- A novel methodology to rank patents
 - Multiple criteria
 - Intuitive linear optimization formulation determines weights
- Web-based DSS automates our methodology
- Three case studies in chemical R&D analytics
 - Highly-ranked patents represent core processes in their field
 - Rankings are relatively consistent for our two optimal sets of weights