Information Retrieval Boosted by Category for Troubleshooting Search System

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1. Outline

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◆ Background:

✓ Information extraction for troubleshooting system in maintenance activities.

✓ Except for titles and documents, rich domain-specific category codes are available.

◆ Motivation:

✓ In maintenance logs, much information is redundant.

✓ In faceted search, information restricted to selected categories is displayed. The information related to the selected categories is important but not displayed.

◆ Idea:

✓ Extend a text-summarization method with a word-category graph and a category-category graph.

✓ The frequencies in the two graphs influence the words' scores.

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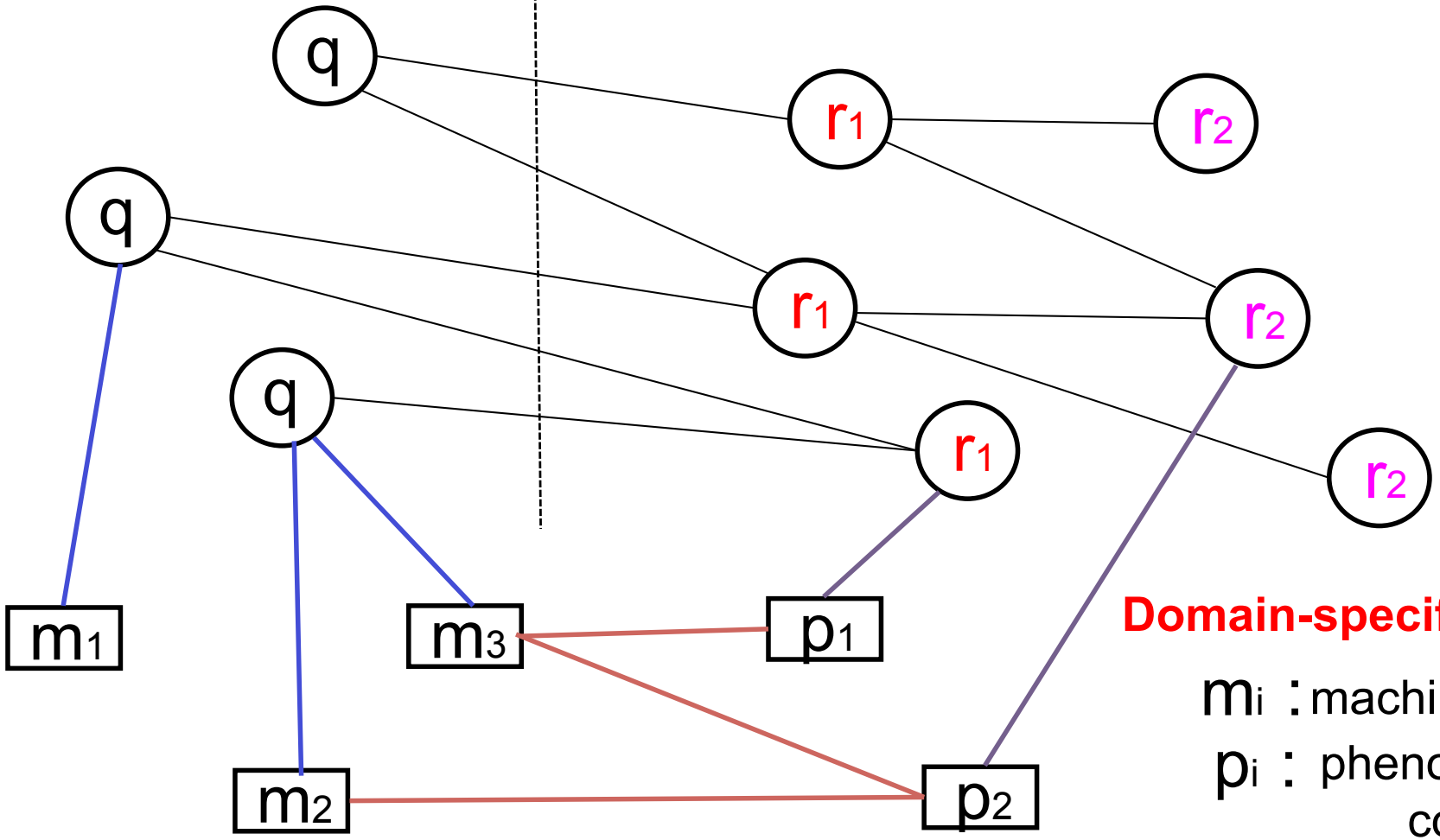
Titles

Hydraulic oil over heat

Documents

Hydraulic oil over heat cause fan pump damaged…
Check RMP fan motor.. Replace fan pump.



Domain-specific codes

m_i : machine mode

p_i : phenomenon code

3. Assumption:

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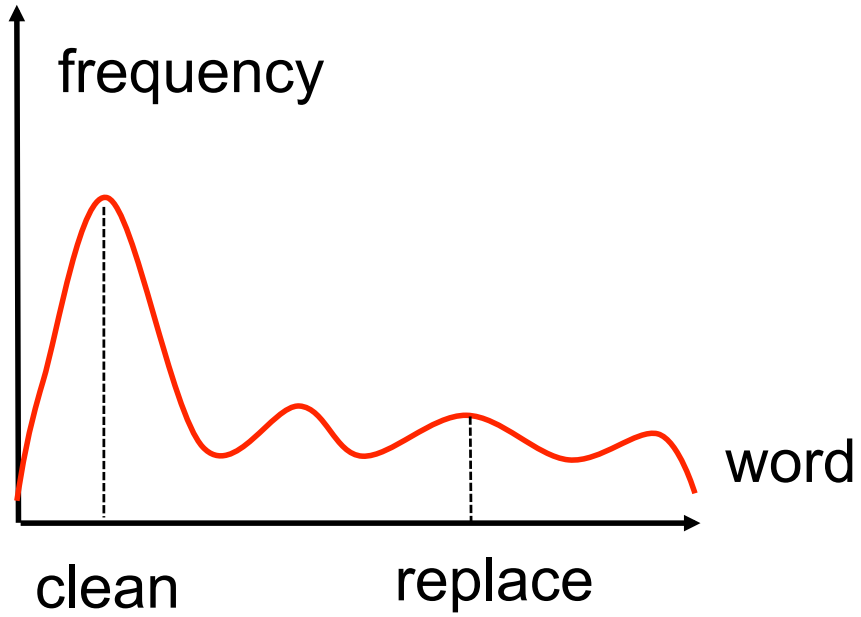
◆ The frequencies of words with respect to a category code are different.

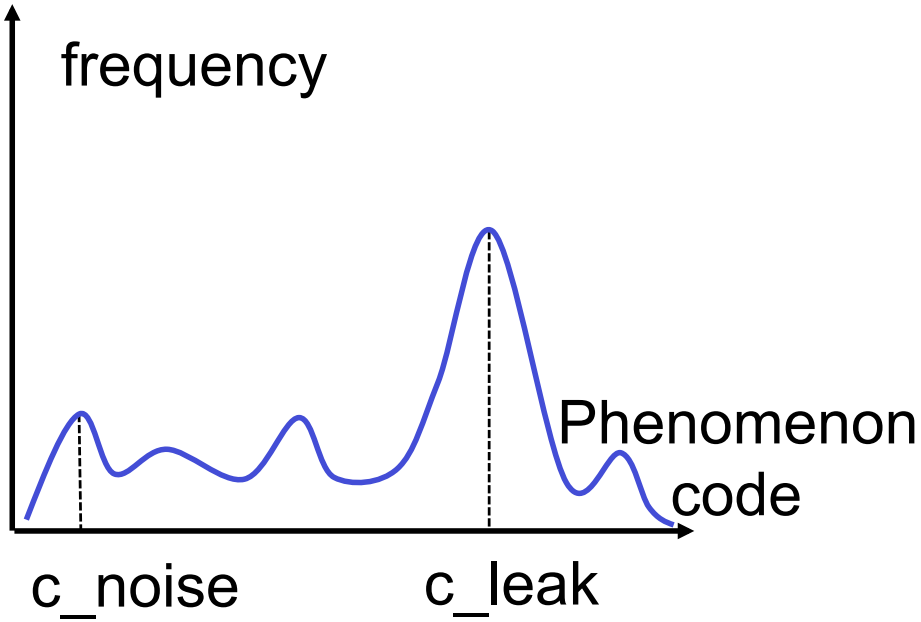
◆ The frequencies of categories with respect to a category code are different.

Mode Code: mc-1505

word-category graph



category-category graph



4. Baseline: Query Snowball (QSB)

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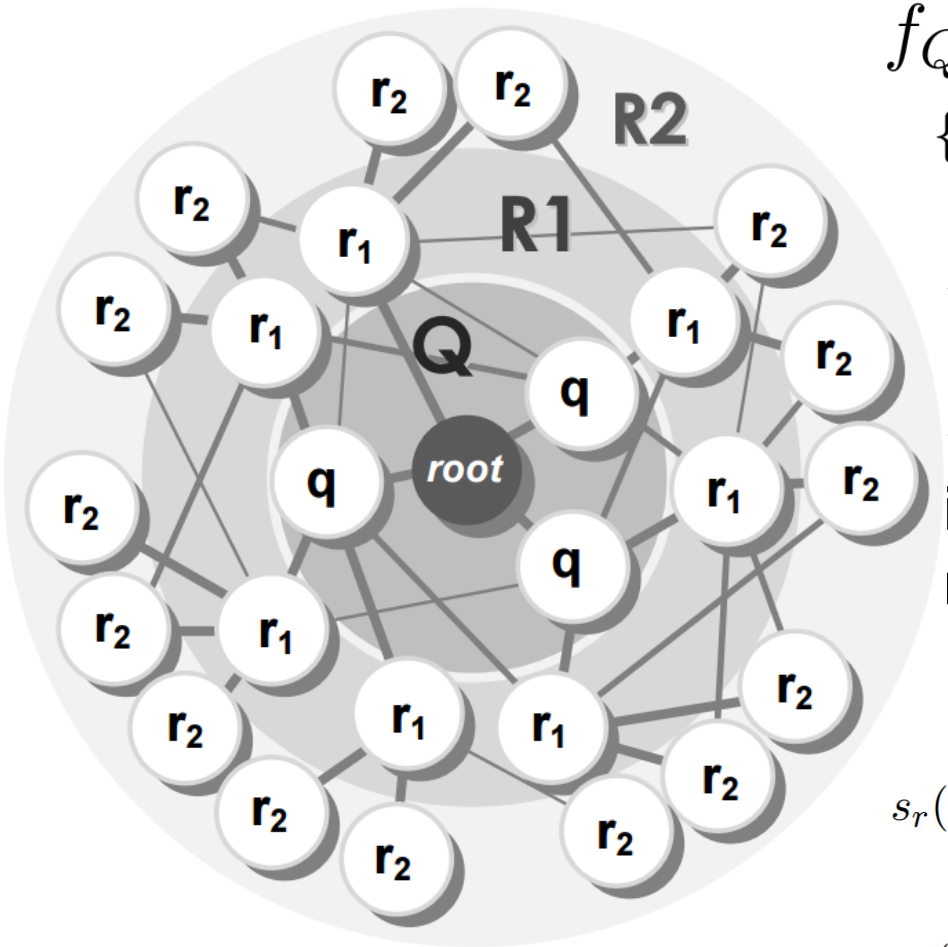
A Text Summarization Method



$$f_{QSBP}(S) = \sum_{\{w_1,w_2|w_1 \neq w_2 \text{ and } w_1,w_2 \in u \text{ and } u \in S\}} s_p(w_1, w_2)$$

- ✓ The score of a sentence depends on scores of words.
- ✓ The score of a word is related to its frequency and closeness with respect to query words.

$$s_r(r1) = \sum_{q \in Q} s_b(r1) \left(\frac{s_b(q)}{sum_Q} \right) \left(\frac{freq(q, r1)}{distance(q, r1) + 1.0} \right)$$

$$s_r(r2) = \sum_{r1 \in R1} s_b(r2) \left(\frac{s_r(r1)}{sum_{R1}} \right) \left(\frac{freq(r1, r2)}{distance(r1, r2) + 1.0} \right)$$

5. Our approach: Category-based QSB

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◆ The frequencies of query words with respect to a category code influence the score of a document word.
◆ The frequencies of categories with respect to a category code influence the score of a document word.

$$cqsb(w) = qsb(w)\exp(\lambda \cdot s_{ctg}(w))$$

category-based factor

Example:

$$s_{ctg}(r_1) = s_{wc}(r_1, Q^{r_1}_{C_M}) + s_{cc}(r_1, Q^{r_1}_{C_M})$$

$$s_{wc}(r_1, Q^{r_1}_{C_M}) = \sum_{q \in Q^{r_1}_{C_M}} \sum_{i=1}^{|C^q_{MN}|} \theta \frac{freq(c_i, q)}{freq(c_i)}$$

$$s_{cc}(r_1, Q^{r_1}_{C_M}) = \sum_{q \in Q^{r_1}_{C_M}} \sum_{\theta \in \Gamma} \sum_{c_i, c_j} \theta \frac{freq(c_i, c_j)}{freq(c_i)}$$

$$\Gamma = \{\beta, 1-\beta\}$$
$$c_i \in C^{r_1}_J$$
$$c_j \in C^q_M$$

6. Experiment

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- **Data:**
  - ✓ Maintenance logs of construction machines
  - ✓ A title set and a document set are included.
  - ✓ A title is generally a problem statement. Each title corresponds to only one document, in which solutions of the problem are described.
  - ✓ **Domain-specific codes:** machine code, trouble code, phenomenon code, and countermeasure code.
  - ✓ Use the data of four dominated trouble codes.
- **Goal:**
  - ✓ Given a query and selected category codes, extract the most **informative** sentences from documents, which are useful for solving the problem a query states.
- **Evaluation:**
  - ✓ Macro Recall, Mean Average Precision (MAP), and F-score.
  - ✓ Recall is important in trouble shooting.

7. Experiment Results:

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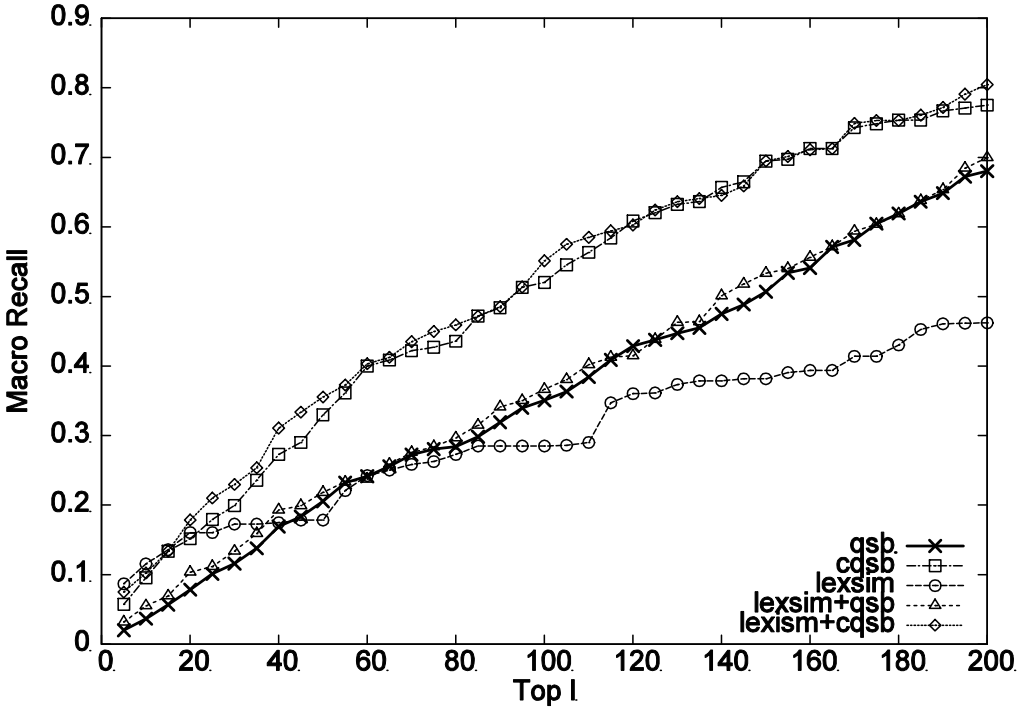
◆ The change of Macro Recall when increasing the number of the top l ranking sentences.



. Experiment Results

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◆ The F_3 scores and MAPs when the top l ranking sentence is set to be 100.

Table 1: F_3 scores in trouble code 03 data set (best case)

Methods	Macro Recall	MAP	F_3 score
lexsim+cqsb	.5513	.0690	.3244
lexsim+qsb	.3665	.0407	.2036
lexsim	.2849	.0957	.2379
cqsb	.5200	.0609	.2964
qsb	.3503	.0312	.1731

Table 2: F_3 scores in trouble code 05 data set (worst case)

Methods	Macro Recall	MAP	F_3 score
lexsim+cqsb	.4645	.0557	.2679
lexsim+qsb	.3893	.0383	.2031
lexsim	.3431	.1346	.2971
cqsb	.4128	.0370	.2049
qsb	.3746	.0299	.1739

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