DeNom
A Tool to Find Problematic Nominalizations using NLP
Mathias Landhäußer, Sven J. Körner, Walter F. Tichy, Jan Keim, Jennifer Krisch
ENGINEERS are no poets
Linguistic Flaws in Requirements

- Generalization
- Distortion
- Deletion

Nominalizations
...return of pallets...

Who?
How?
To whom?
Nominalizations:
Problematic yet often overlooked

- Nominalizations
  - are a problem often overlooked
  - can lead to serious problems during development

- A requirements engineer’s writing rule:
  Though shall not use nominalizations!
  - Ok 😊
  - Solves the problem…

- Inspection rule: Find and eliminate all nominalizations!
  - Can be identified automatically using RESI [RESI]
  - RESI is picky and produces many warnings
  - Effort to high for real-world scenarios [RESI@Automotive]
Research Question 1

**ARE ALL NOMINALIZATIONS PROBLEMATIC?**
Linguistic Flaws in Requirements

- Generalization
- Distortion
- Deletion

Nominalizations

- Category 1: self-descriptive
- Category 2: defined in the sentence-wide context
- Category 3: defined in the document-wide context
- Category 4: underspecified
5 specifications
>40,000 words
356 nominalizations in total

0 % Category 1 (!)
70 % Category 2
29 % Category 3
1 % Category 4

Results of the (Manual) Preparatory Study
Results of the (Half-Automated) Preparatory Study

6 specifications
>33,000 words
499 nominalizations detected

- 0 % Category 1 (!)
- 83 % Category 2
- 8 % Category 3
- 0.2 % Category 4
+ some false positives
Research Question 2

**CAN WE IDENTIFY ACCEPTABLE NOMINALIZATIONS AUTOMATICALLY?**
Working with RESI and DeNom

- When working with RESI, the user
  - must import the specification from a text file and preprocess it
  - connect to an ontology
  - choose the inspection rule(s)
    (nominalizations, ambiguous words, complete process words, determiners)
  - carry out the inspection

- DeNom automates most of the repetitive work
  - Import of specifications from DOORS
  - Preprocessing
  - Connecting and configuring the ontology
DeNom’s Workflow

Nominalizations identified by RESI

Glossary (List of Words)

Is the nominalization part of a nominal phrase?

Consider sentence context (see next slide)

No Context Detected

Self-descriptive → Category 1

Defined in the sentence-wide context → Category 2

Category 3 or 4 → Warning
How do we do it?

Category 2: Defined in the intra-sentence context

- DeNom uses RESI’s completeness test for process words (i.e. verbs)
  - Transform the nominalization to the corresponding verb
  - Ask the ontology which arguments are needed by the verb
  - Check if the arguments are given in the sentence

... return of pallets...

- Verb frame for return:
  (and
    (objectGiven :ACTION :OBJECT) ← what?
    (isa :ACTION ReturningSomething)
    (giver :ACTION :SUBJECT) ← who?
    (givee :ACTION :OBLIQUE-OBJECT)) ← to whom?
10 specifications, >59,000 words
1,136 nominalizations
  - only 84 of them are problematic
  - DeNom shows 129 warnings
Precision of RESI on average: 8% (F₁=15%)
Precision of DeNom on average: 65% (with a recall of 88%, F₁=75%)
Conclusions and Future Work

- Improved user-experience
  - Improved performance (precision: 8% → 65%)
  - Less manual work

- Improve DeNom
  - Consider document wide context
  - Only one of RESI’s four automatic inspections considered
  - Further reduce user interaction

- Large scale evaluation
  - In situ evaluation @Daimler
  - Integrate DeNom into Daimler’s requirements inspection tool
References


Figure 4
An overview of DeNom’s processing steps

1. Format (Text to EMF Model)
2. Initialize Logger
3. Initialize RESI (SpecificationImprover)
4. Load EMF (Read Spec Model)
5. Load Ontology (Part-of-Speech-Tagger)
6. Run RESI 1 (Tag Base Forms w/ WordNet)
7. Run RESI 2 (POS Tagging w/ Stanford)
8. Run RESI 3 (Check for Nominalization)
9. DeNom (Collect Results List)
10. DeNom (Check Cat 1/2a)
11. RESI (Complete Process Words)
12. DeNom (Check Cat 2b)
13. DeNom (Present resulting Cat 3/4)
Table 1
Results of the Manual Preparatory Study

<table>
<thead>
<tr>
<th></th>
<th>Words</th>
<th>Nom.</th>
<th>Cat. 1</th>
<th>Cat. 2</th>
<th>Cat. 3</th>
<th>Cat. 4</th>
</tr>
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<tbody>
<tr>
<td>SRS 1</td>
<td>9,942</td>
<td>85</td>
<td>0.0%</td>
<td>70.6%</td>
<td>29.4%</td>
<td>0.0%</td>
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<tr>
<td>SRS 2</td>
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<td>158</td>
<td>0.0%</td>
<td>59.5%</td>
<td>36.7%</td>
<td>2.5%</td>
</tr>
<tr>
<td>SRS 3</td>
<td>2,129</td>
<td>21</td>
<td>0.0%</td>
<td>81.0%</td>
<td>14.3%</td>
<td>0.0%</td>
</tr>
<tr>
<td>SRS 4</td>
<td>3,687</td>
<td>62</td>
<td>0.0%</td>
<td>95.2%</td>
<td>4.8%</td>
<td>0.0%</td>
</tr>
<tr>
<td>SRS 5</td>
<td>1,598</td>
<td>30</td>
<td>0.0%</td>
<td>56.7%</td>
<td>43.3%</td>
<td>0.0%</td>
</tr>
<tr>
<td>Sum</td>
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<td>356</td>
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<td>247</td>
<td>102</td>
<td>4</td>
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</table>

0.0% 69.4% 28.7% 1.1%
### Table 2
RESI’s Results in the Preparatory Study

<table>
<thead>
<tr>
<th>Words</th>
<th>Nom.</th>
<th>Cat. 1</th>
<th>Cat. 2</th>
<th>Cat. 3</th>
<th>Cat. 4</th>
</tr>
</thead>
<tbody>
<tr>
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<td>2,158</td>
<td>25</td>
<td>0.0%</td>
<td>88.0%</td>
<td>8.0%</td>
</tr>
<tr>
<td>SRS 4</td>
<td>3,687</td>
<td>56</td>
<td>0.0%</td>
<td>83.9%</td>
<td>1.8%</td>
</tr>
<tr>
<td>SRS 5</td>
<td>1,598</td>
<td>15</td>
<td>0.0%</td>
<td>73.3%</td>
<td>6.7%</td>
</tr>
<tr>
<td>SRS 6</td>
<td>6,069</td>
<td>116</td>
<td>0.0%</td>
<td>91.4%</td>
<td>5.2%</td>
</tr>
<tr>
<td>SRS 7</td>
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<td>0.0%</td>
<td>84.2%</td>
<td>5.3%</td>
</tr>
<tr>
<td>SRS 8</td>
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<td>16.2%</td>
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<td>0</td>
<td>413</td>
<td>42</td>
</tr>
</tbody>
</table>

|       |        | 0.0%   | 82.8%  | 8.4%   | 0.2%   |

DeNom | Landhäußer, Körner, Tichy, Keim, Krisch | AIRE'15
Table 3
Results of the Evaluation for DeNom (D) and RESI (R). We calculated DeNom’s recall with respect to RESI’s results.

<table>
<thead>
<tr>
<th>Doc.</th>
<th># Words</th>
<th>Nom.</th>
<th>probl. Nom.</th>
<th>Precision R</th>
<th>Precision D</th>
<th>Recall D</th>
</tr>
</thead>
<tbody>
<tr>
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<td>81</td>
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<td>2%</td>
<td>40%</td>
<td>100%</td>
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<tr>
<td>SRS 5</td>
<td>1,598</td>
<td>15</td>
<td>2</td>
<td>7%</td>
<td>50%</td>
<td>100%</td>
</tr>
<tr>
<td>SRS 6</td>
<td>6,069</td>
<td>108</td>
<td>6</td>
<td>4%</td>
<td>67%</td>
<td>100%</td>
</tr>
<tr>
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<td>246</td>
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<td>60%</td>
</tr>
<tr>
<td>SRS 8</td>
<td>7,403</td>
<td>167</td>
<td>34</td>
<td>14%</td>
<td>59%</td>
<td>87%</td>
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<tr>
<td>SRS 9</td>
<td>2,923</td>
<td>28</td>
<td>4</td>
<td>14%</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
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<td>8,098</td>
<td>130</td>
<td>17</td>
<td>13%</td>
<td>76%</td>
<td>76%</td>
</tr>
<tr>
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<td>2,590</td>
<td>57</td>
<td>10</td>
<td>12%</td>
<td>70%</td>
<td>100%</td>
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<tr>
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<td>243</td>
<td>26</td>
<td>9%</td>
<td>81%</td>
<td>91%</td>
</tr>
<tr>
<td>SRS 13</td>
<td>4,094</td>
<td>61</td>
<td>13</td>
<td>15%</td>
<td>69%</td>
<td>100%</td>
</tr>
<tr>
<td>Sum</td>
<td>59,486</td>
<td>1,136</td>
<td>129</td>
<td>84</td>
<td>65%</td>
<td>88%</td>
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</tbody>
</table>