Karlsruher Institut für Technologie

DeNom

A Tool to Find Problematic Nominalizations using NLP

Mathias Landhäußer, Sven J. Körner, Walter F. Tichy, Jan Keim, Jennifer Krisch

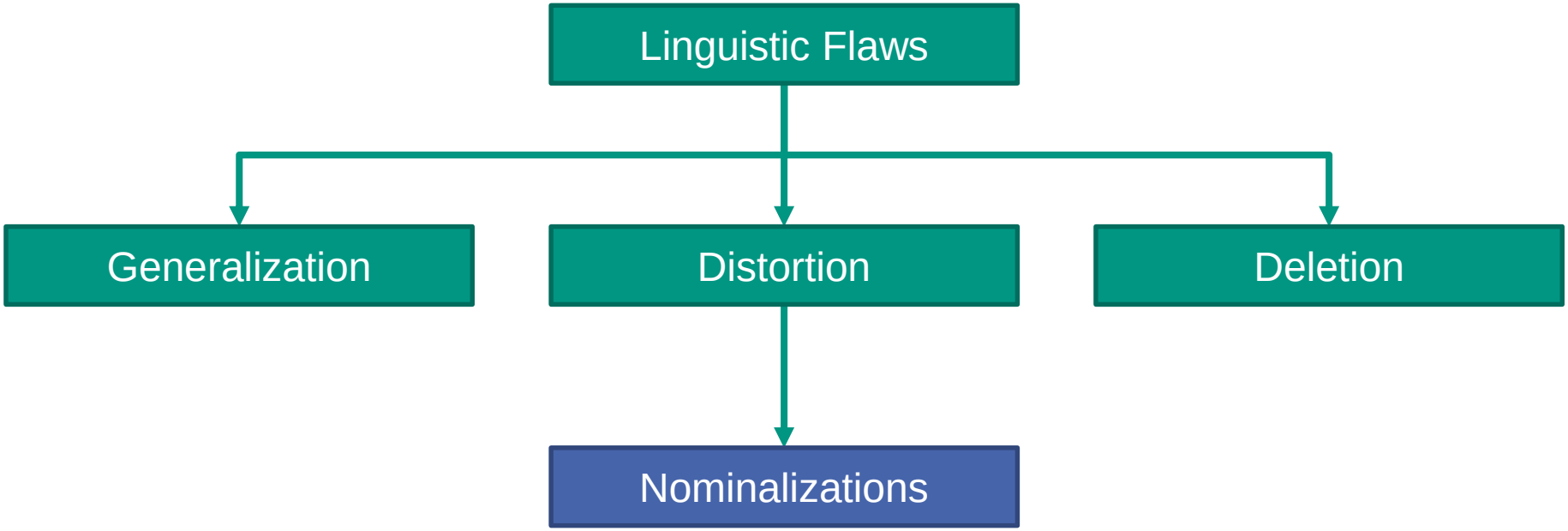
IPD Tichy, Fakultät für Informatik

ENGINEERS

are no

poets

Linguistic Flaws in Requirements



[RUPP]

Who?

How?

To whom?

Nominalizations: Problematic yet often overlooked

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

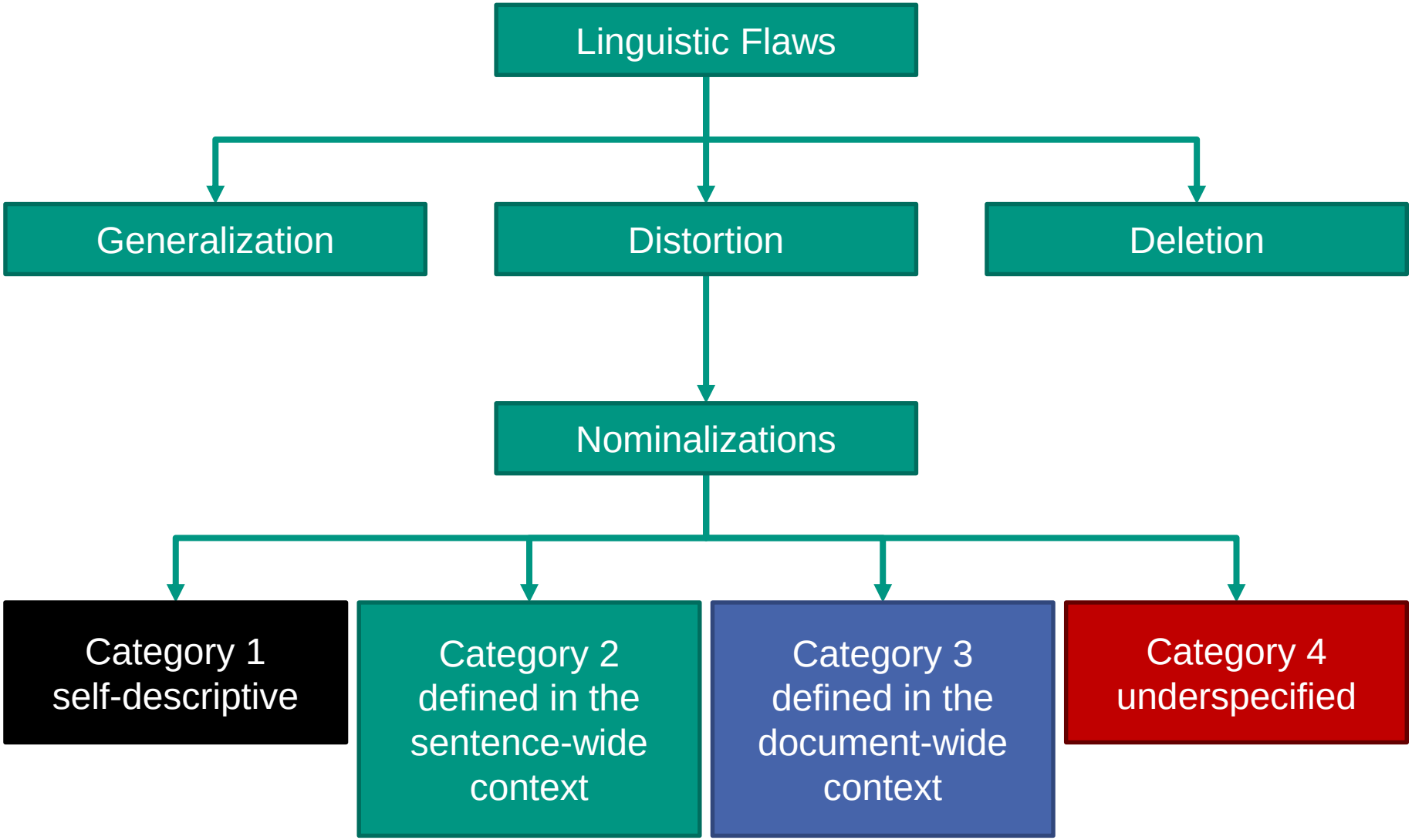
- A requirements engineer's writing rule:
  Though shall not use nominalizations!
  - Ok ☺
  - Solves the problem…

- 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?

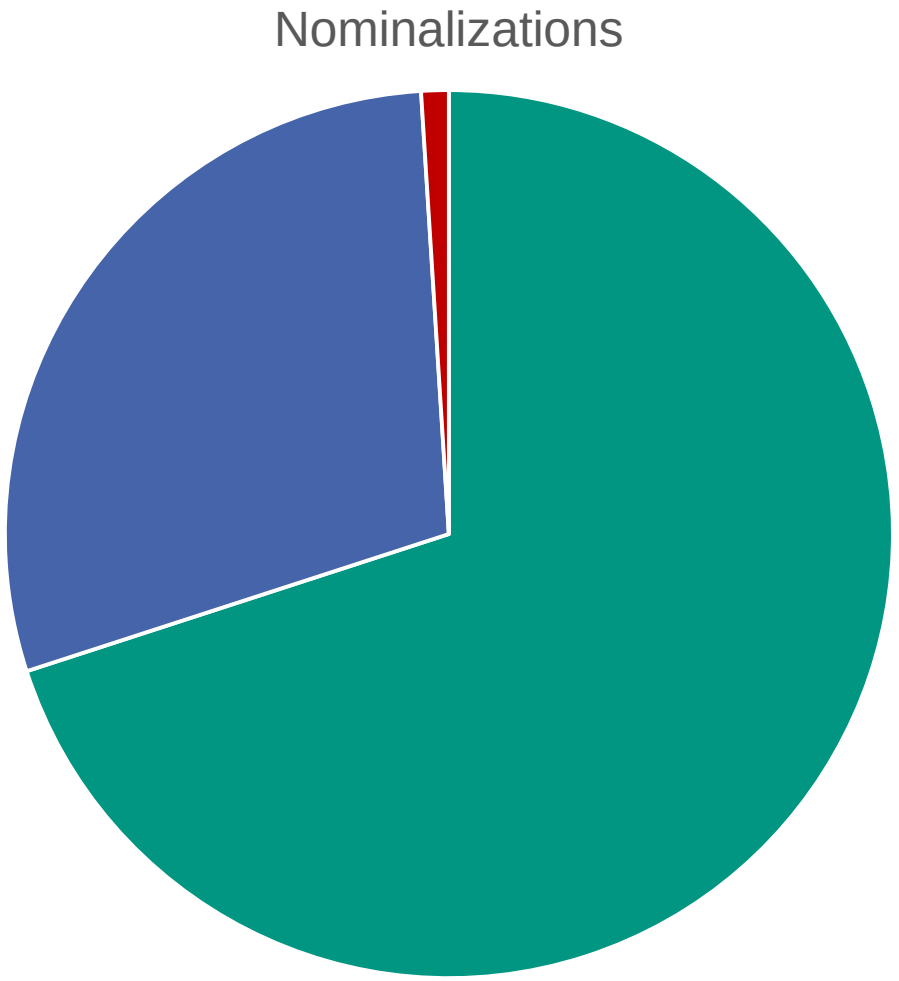
Linguistic Flaws in Requirements



Results of the (Manual) Preparatory Study

5 specifications
>40,000 words
356 nominalizations in total

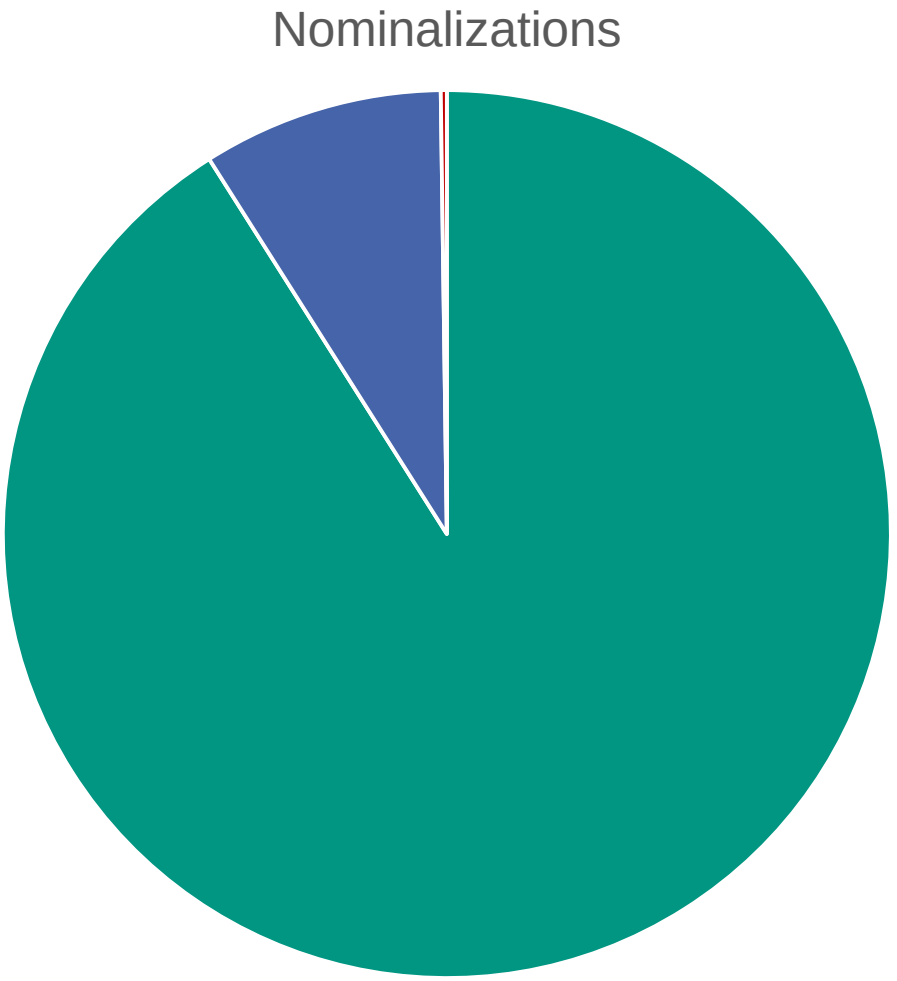
0 % Category 1 (!)
70 % Category 2
29 % Category 3
1 % Category 4



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

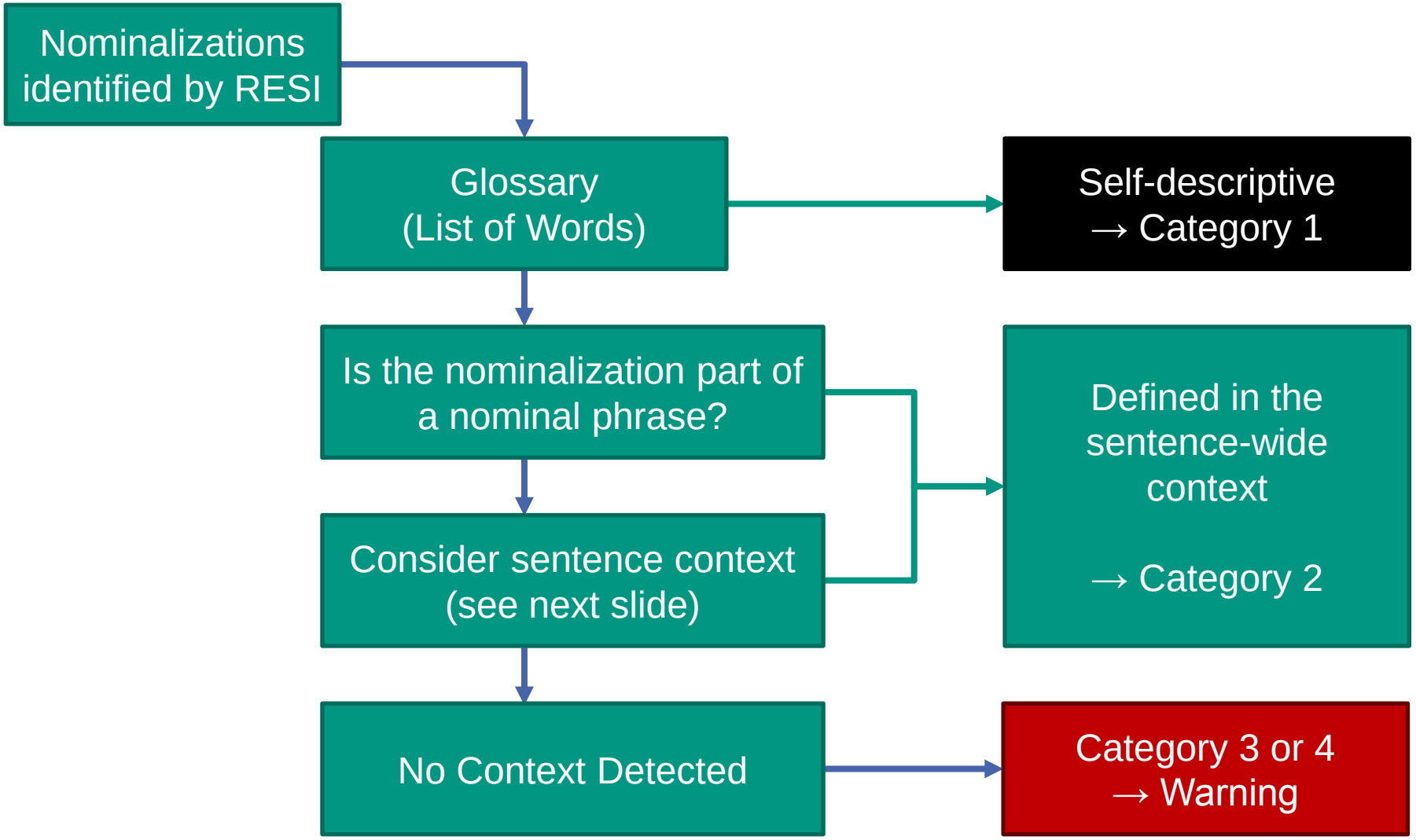
CAN WE IDENTIFY *ACCEPTABLE* NOMINALIZATIONS AUTOMATICALLY?

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

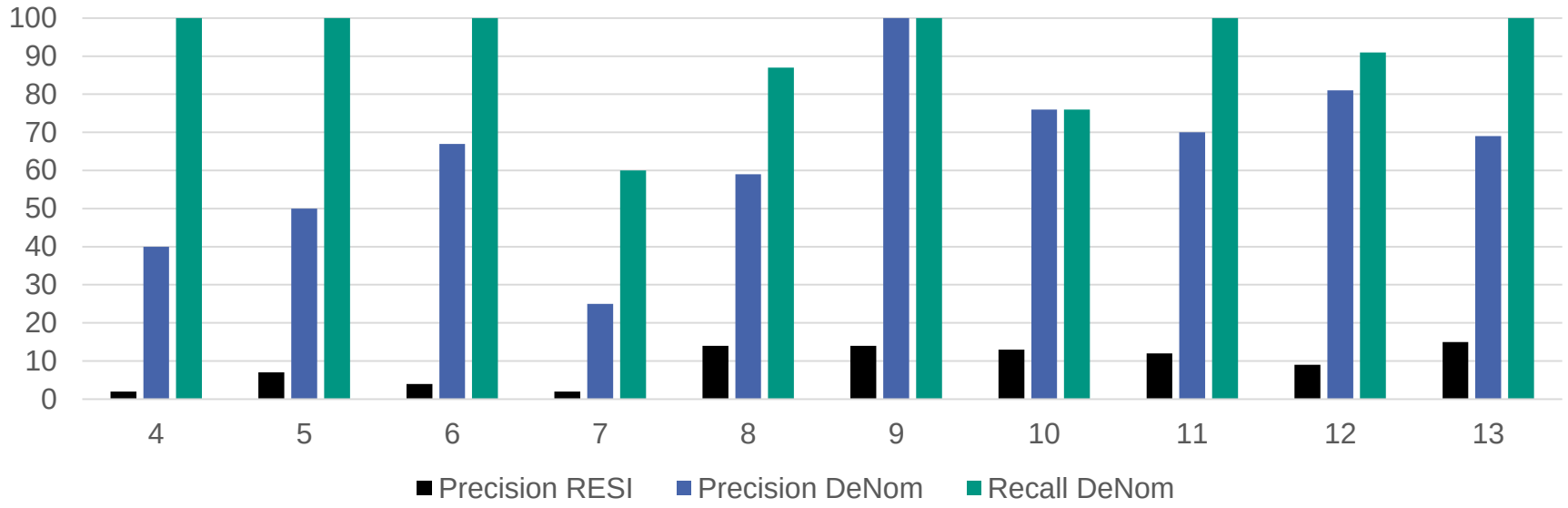


How do we do it?
Category 2: Defined in the intra-sentence context

- 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?

Evaluation



- 10 specifications, >59,000 words
- 1,136 nominalizations
  - only 84 of them are problematic
  - DeNom shows 129 warnings
- Precision of RESI on average: 8% (F_1=15%)
- Precision of DeNom on average: 65% (with a recall of 88%, F_1=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

- [Rupp] C. Rupp, *Requirements-Engineering und -Management. Professionelle, iterative Anforderungsanalyse für die Praxis*, 5., aktualisierte und erw. Aufl. Hanser Fachbuchverlag, 2009.
- [RESI] S. J. Körner and T. Brumm, “Natural Language Specification Improvement with Ontologies,” *International Journal of Semantic Computing (IJSC)*, vol. 03, no. 04, pp. 445–470, 2010.
- [PVMyth] J. Krisch and F. Houdek, “The Myth of Bad Passive Voice and Weak Words -- An Empirical Investigation in the Automotive Industry,” in *RE’15:23rd IEEE International Requirements Engineering Conference*, Ottawa, Ontario, Canada, 2015.
- [RESI@Automotive] S. J. Körner, M. Landhäußer, and W. F. Tichy, “Transferring Research Into the Real World: How to Improve RE with AI in the Automotive Industry,” in *1st International Workshop on Artificial Intelligence for Requirements Engineering*, 2014.

Figure 4
An overview of DeNom's processing steps

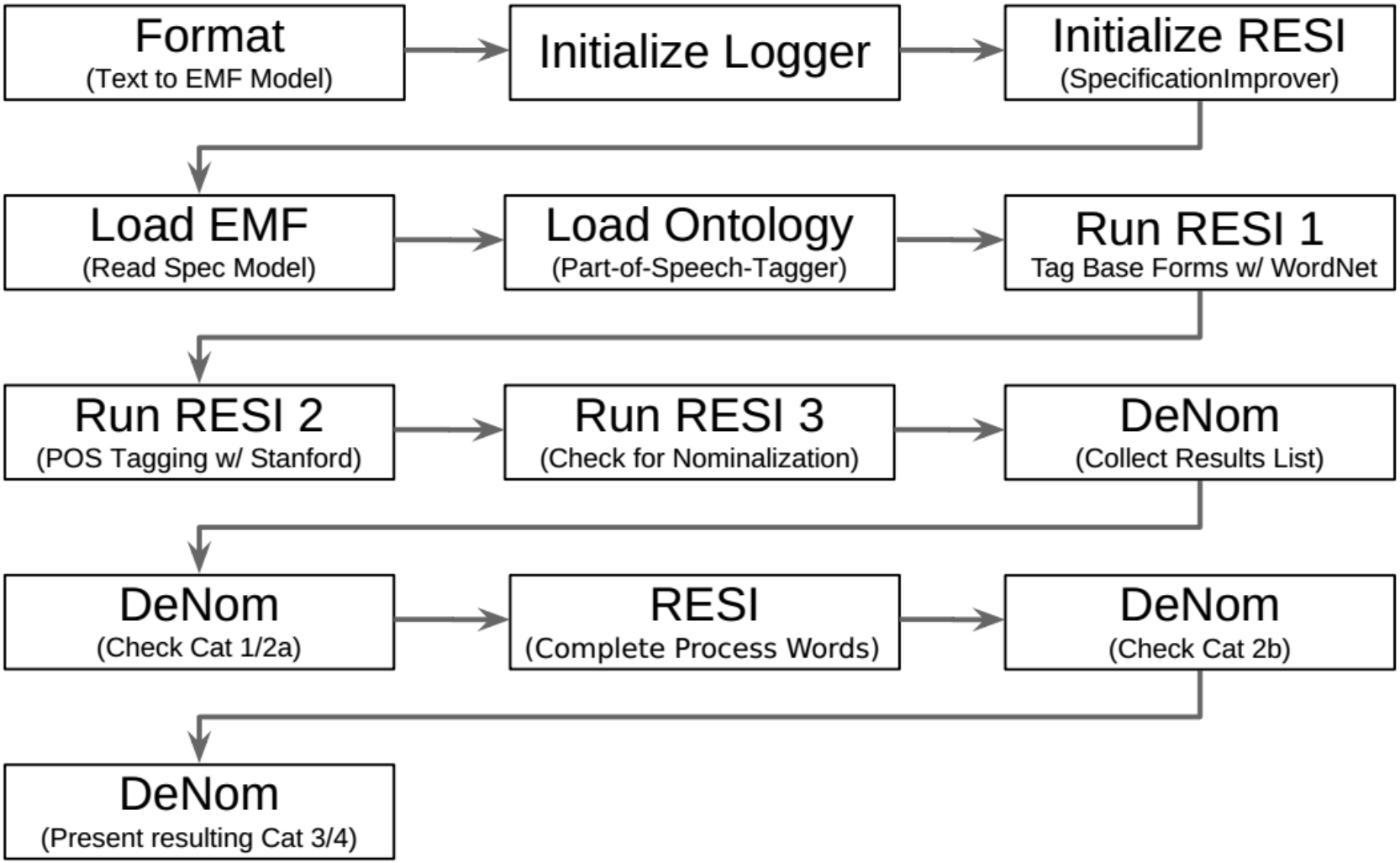


Table 1
Results of the Manual Preparatory Study

	Words	Nom.	Cat. 1	Cat. 2	Cat. 3	Cat. 4
SRS 1	9,942	85	0.0%	70.6%	29.4%	0.0%
SRS 2	23,104	158	0.0%	59.5%	36.7%	2.5%
SRS 3	2,129	21	0.0%	81.0%	14.3%	0.0%
SRS 4	3,687	62	0.0%	95.2%	4.8%	0.0%
SRS 5	1,598	30	0.0%	56.7%	43.3%	0.0%
Sum	40,460	356	0	247	102	4
			0.0%	69.4%	28.7%	1.1%

Table 2
RESI's Results in the Preparatory Study

	Words	Nom.	Cat. 1	Cat. 2	Cat. 3	Cat. 4
SRS 3	2,158	25	0.0%	88.0%	8.0%	0.0%
SRS 4	3,687	56	0.0%	83.9%	1.8%	0.0%
SRS 5	1,598	15	0.0%	73.3%	6.7%	6.7%
SRS 6	6,069	116	0.0%	91.4%	5.2%	0.0%
SRS 7	12,581	133	0.0%	84.2%	5.3%	0.0%
SRS 8	7,403	154	0.0%	74.7%	16.2%	0.0%
Sum	33,496	499	0	413	42	1
			0.0%	82.8%	8.4%	0.2%

Table 3
Results of the Evaluation for DeNom (D) and RESI (R). We calculated DeNom's recall with respect to RESI's results.

Doc.	# Words	Nom.		probl.	Precision		Recall
		R	D	Nom.	R	D	D
SRS 4	3,687	81	5	2	2%	40%	100%
SRS 5	1,598	15	2	1	7%	50%	100%
SRS 6	6,069	108	6	4	4%	67%	100%
SRS 7	12,580	246	12	3	2%	25%	60%
SRS 8	7,403	167	34	20	14%	59%	87%
SRS 9	2,923	28	4	4	14%	100%	100%
SRS 10	8,098	130	17	13	13%	76%	76%
SRS 11	2,590	57	10	7	12%	70%	100%
SRS 12	10,444	243	26	21	9%	81%	91%
SRS 13	4,094	61	13	9	15%	69%	100%
Sum	59,486	1,136	129	84	8%	65%	88%