

# Towards the Automatic Quality Evaluation of RESTful APIs Using Design Rule Violations

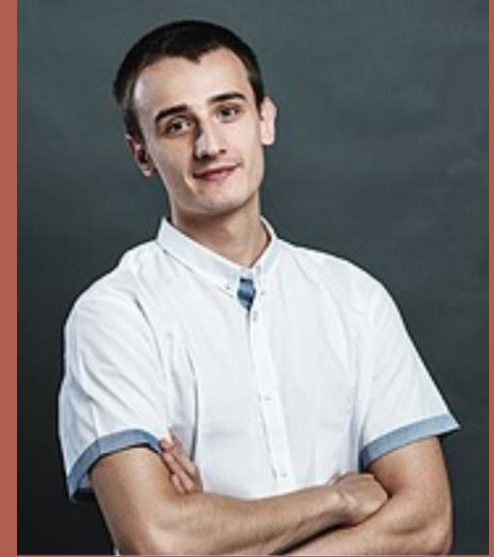
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Final presentation of MSc. research project



Manuel Merkel



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# Content



Background



Introduction



Project Management



Demo

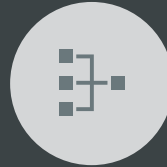


Verification & Validation



Conclusion & Outlook

# Background



REST is an architectural style for developing loosely coupled applications that run over the network



The application programming interface (API) is a means of providing access to data and services.



What makes an API a REST API depends on how closely it adopts the ideas (or constraints) of Fielding's dissertation



OpenAPI refers to a description of HTTP-based API. This comes usually in the form of a YAML or JSON file.

# Introduction

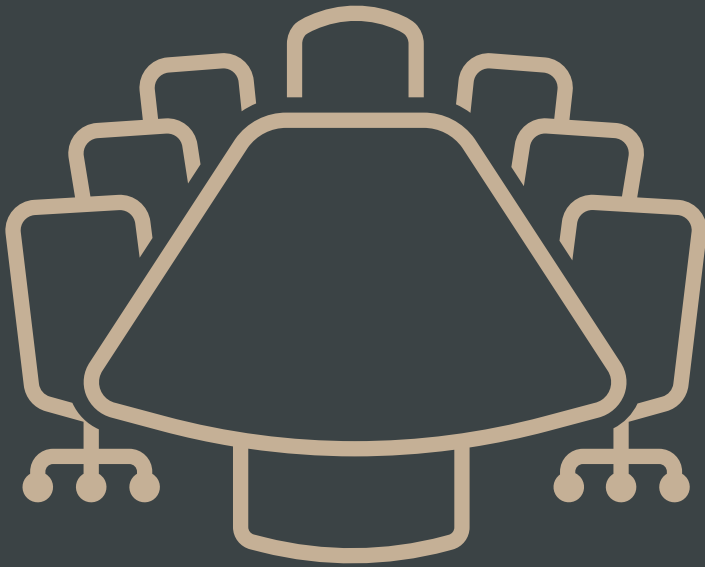
- Importance of REST APIs is increasing
- Design rules for REST APIs by Massé [1]
- Empirical study [2] provided evidence for the effectiveness of certain design rules
- Goal of study
  - Tool-support for analyzing OpenAPI definitions
  - Analyze and select existing REST API design rules
  - Link rules with quality attributes
  - Evaluation of the CLI regarding robustness, effectiveness and performance

[1] MASSE, Mark. *REST API design rulebook: designing consistent RESTful web service interfaces*. " O'Reilly Media, Inc.", 2011.

[2] KOTSTEIN, Sebastian; BOGNER, Justus. Which RESTful API design rules are important and how do they improve software quality? A Delphi study with industry experts.

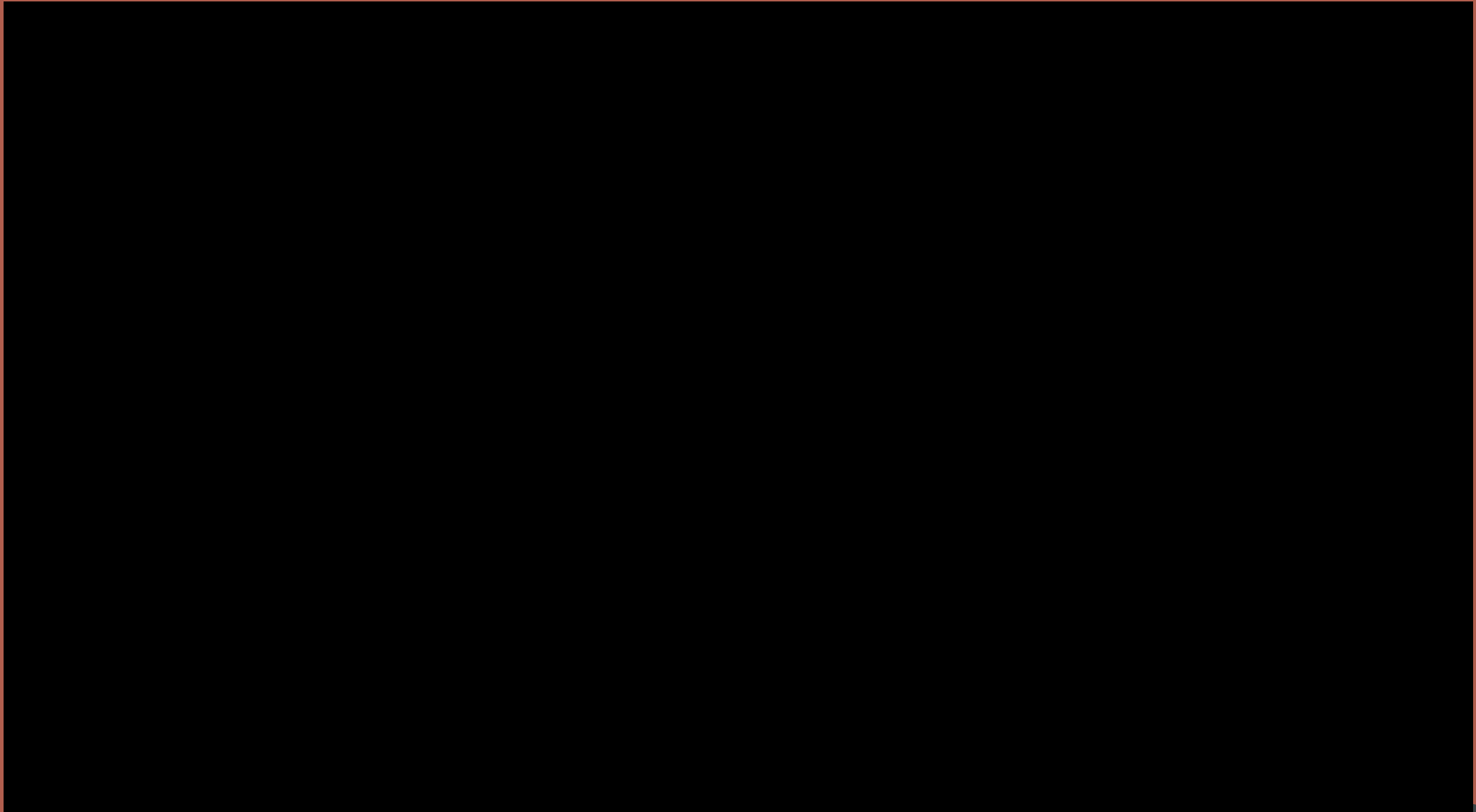
In: *Symposium and Summer School on Service-Oriented Computing*. Springer, Cham, 2021. S. 154-173.

# Management



- Scrum-like agile development
  - Sprint length of two weeks
  - Weekly meetings on site
  - Project board of GitHub as sprint backlog
  - Prototyping

# Use Case Demo



# Verification & Validation



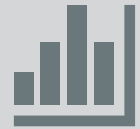
Unit Tests



Robustness



Effectiveness



Performance



# Unit Tests

Element	Missed Instructions	Cov.	Missed Branches	Cov.	Missed	Cxty	Missed	Lines	Missed	Methods	Missed	Classes
<a href="#">UnauthorizedRule</a>	<div><div></div></div>	46 %	<div><div></div></div>	37 %	30	45	61	108	8	15	0	1
<a href="#">ContentTypeRule</a>	<div><div></div></div>	90 %	<div><div></div></div>	86 %	17	67	22	178	5	22	0	1
<a href="#">HyphensRule</a>	<div><div></div></div>	86 %	<div><div></div></div>	68 %	18	42	20	117	5	15	0	1
<a href="#">RequestTypeDescriptionRule</a>	<div><div></div></div>	78 %	<div><div></div></div>	48 %	30	45	14	60	5	13	0	1
<a href="#">TunnelingRule</a>	<div><div></div></div>	81 %	<div><div></div></div>	58 %	13	30	19	62	5	13	0	1
<a href="#">VerbPhraseRule</a>	<div><div></div></div>	89 %	<div><div></div></div>	81 %	9	24	9	53	5	13	0	1
<a href="#">FileExtensionRule</a>	<div><div></div></div>	86 %	<div><div></div></div>	100 %	5	14	8	37	5	10	0	1
<a href="#">PluralNameRule</a>	<div><div></div></div>	93 %	<div><div></div></div>	83 %	10	27	9	61	5	12	0	1
<a href="#">SingularDocumentNameRule</a>	<div><div></div></div>	92 %	<div><div></div></div>	86 %	8	23	8	58	5	12	0	1
<a href="#">CRUDRule</a>	<div><div></div></div>	93 %	<div><div></div></div>	83 %	7	17	8	39	5	11	0	1
<a href="#">GetResourceRule</a>	<div><div></div></div>	93 %	<div><div></div></div>	88 %	8	25	6	46	5	12	0	1
<a href="#">SeparatorRule</a>	<div><div></div></div>	96 %	<div><div></div></div>	96 %	6	30	6	71	5	14	0	1
<a href="#">LowercaseRule</a>	<div><div></div></div>	88 %	<div><div></div></div>	100 %	5	14	6	33	5	10	0	1
<a href="#">TrailingRule</a>	<div><div></div></div>	85 %	<div><div></div></div>	100 %	5	13	6	28	5	11	0	1
<a href="#">UnderscoreRule</a>	<div><div></div></div>	99 %	<div><div></div></div>	83 %	1	14	1	34	0	11	0	1
Total	677 of 4.242	84 %	131 of 466	71 %	172	430	203	985	73	194	0	15

# Robustness

- Exploratory analysis of 2,346 OpenAPI definitions from “apis.guru”
- Python script to run tool with a list of OpenAPI definitions as input
- Second python script to collect OpenAPI definitions missing a report file
- Third python script to re-run failed OpenAPI definitions and collect error messages

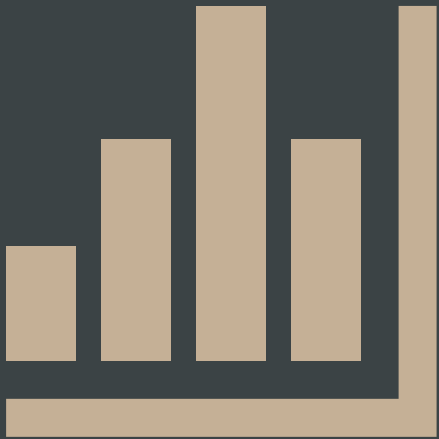


# Effectiveness

- True-positive (TP)
- Recall =  $\frac{TP}{TP+FN}$
- False-positive (FP)
- False-negative (FN)
  - Gold standard from experts and devs
- Precision =  $\frac{TP}{TP+FP}$ 
  - Manual analysis of rule violations

# Performance

- Exploratory analysis of 2,331 OpenAPI definitions
- Performance efficiency from ISO 25010
  - Resource utilization
  - Time behavior
- Script to run the analysis and the measurements



# Performance

- Python scripts for categorisation and analysis
- Library used for the resource utilisation measurement
  - psutil [3]

Type	Numbers of paths	Files
Very low	0-10	1448
Low	11-30	514
Medium	31-70	234
High	71-150	95
Very high	151+	40

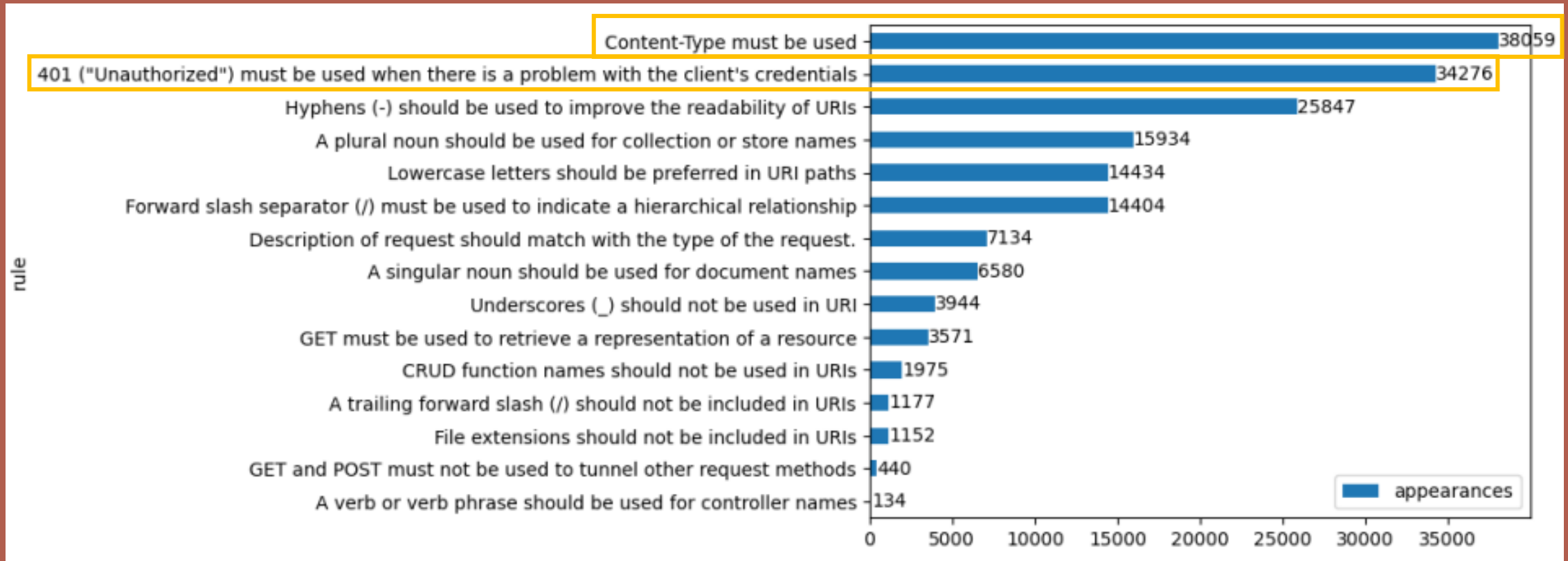
# Robustness Results

- Of 2346 OpenAPI definitions 2300 reports were generated
  - Success rate: 98.03%
- 46 Errors due to bugs, parsing errors or reaching RAM limit

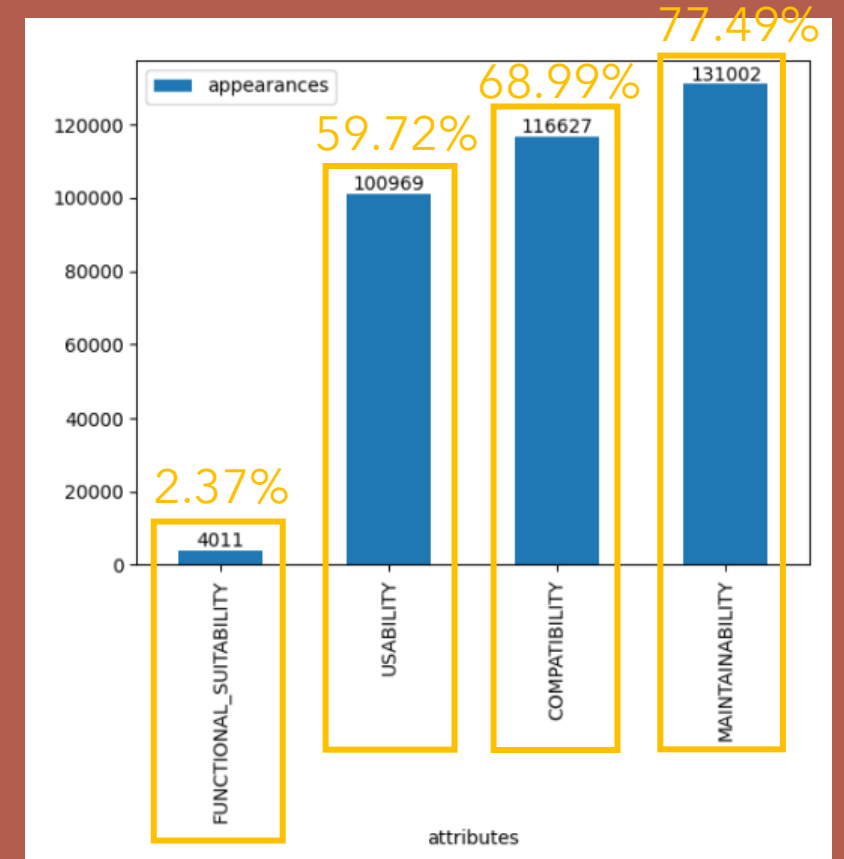
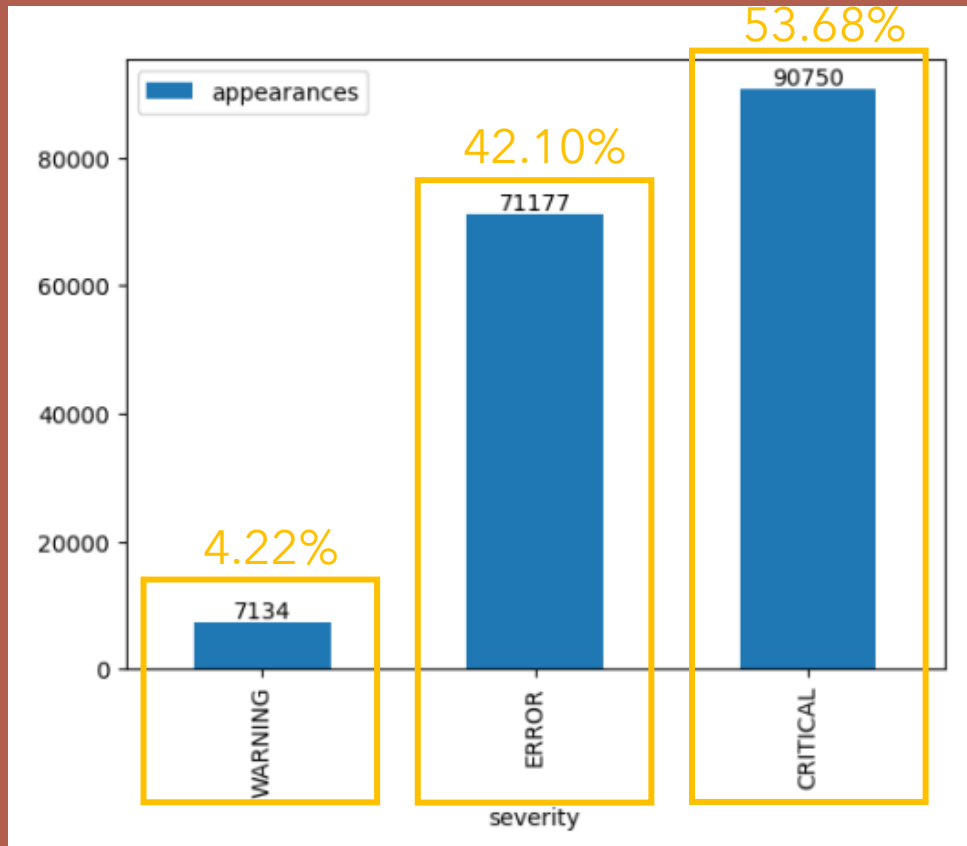
# Robustness Results

Content-Type: 22.51% of total violations

"Unauthorized": 20.27% of total violations



# Robustness Results





# Effectiveness Results: Precision

Rule	Violations	false-positives	true-positives	Precision
Underscores (_) should not be used in URI	20	0	20	1.000
Lowercase letters should be preferred in URI paths	140	0	140	1.000
401 (Unauthorized) must be used when there is a problem with the client's credentials	358	0	358	1.000
CRUD function names should not be used in URI	21	1	20	0.952
Forward slash separator (/) must be used to indicate a hierarchical relationship	202	10	192	0.951
Content-Type must be used	219	13	206	0.941
A plural noun should be used for collection or store names	176	16	160	0.909
Hyphens (-) should be used to improve the readability of URIs	285	51	234	0.821
A singular noun should be used for document names	40	12	28	0.700
GET and POST must not be used to tunnel other request methods	86	28	58	0.674
GET must be used to retrieve a representation of a resource	9	3	6	0.667
File extensions should not be included in URIs	15	6	9	0.600
A trailing forward slash (/) should not be included in URIs	0	0	0	–
A verb or verb phrase should be used for controller names	0	0	0	–
<b>Total</b>	<b>1,596</b>	<b>140</b>	<b>1,456</b>	<b>0.912</b>

# Effectiveness Results: Recall

		CLI			Zally		
Rule	Violations	false-negatives	true-positives	Recall	false-negatives	true-positives	Recall
Trailing slash	2	0	2	1.000	0	2	1.000
GET resource	8	0	8	1.000	–	–	–
Underscores	4	0	4	1.000	–	–	–
Lowercase	6	0	6	1.000	0	6	1.000
Hyphens	9	1	8	0.889	7	2	0.222
Unauthorized	6	1	5	0.833	–	–	–
Singular noun	9	3	6	0.667	–	–	–
Content-type	6	2	4	0.667	–	–	–
File extensions	8	3	5	0.625	–	–	–
CRUD function names	13	5	8	0.615	–	–	–
Plural noun	14	7	7	0.500	0	14	1.000
Verb for controller	4	2	2	0.500	–	–	–
Forward slash	9	5	4	0.444	–	–	–
Tunnel	13	7	6	0.462	–	–	–
<b>Total</b>	<b>111</b>	<b>36</b>	<b>75</b>	<b>0.676</b>	<b>7</b>	<b>24</b>	<b>0.774</b>

# Performance Results

Type	Time Median	Size Median	Paths Median	Memory Median	CPU Usage Median
Very low	7.25 s	0.03 MB	3	497 MB	8.4%
Low	23.52 s	0.14 MB	17	957 MB	8.4%
Medium	54.73 s	0.36 MB	43	1067 MB	8.4%
High	117.77 s	0.69 MB	89,5	1111 MB	8.4%
Very high	300.96 s	1.6 MB	206,5	1176 MB	8.4%

# Conclusion & Outlook

- Tool-support for analyzing an OpenAPI definition
- Evaluation of the tool through an explorative study
  - Robustness: 98.03% success rate
  - Effectiveness: 67.6% recall; 91.2% precision
  - Performance: Time required to perform an analysis for most definitions ranges from 7 to 23 seconds; RAM requirements range from 497 MB to 957 MB.
- The implemented rules from Massé are documented in GitHub for further development

Give us a star on GitHub

<https://github.com/restful-ma/rest-ruler>