API Governance Support through the Structural Analysis of REST APIs

University of Stuttgart
Universitätsstr. 38
70569 Stuttgart
Germany

Florian Haupt, Frank Leymann,
Karolina Vukojevic-Haupt

Institute of Architecture of Application Systems
{firstname.lastname}@iaas.uni-stuttgart.de

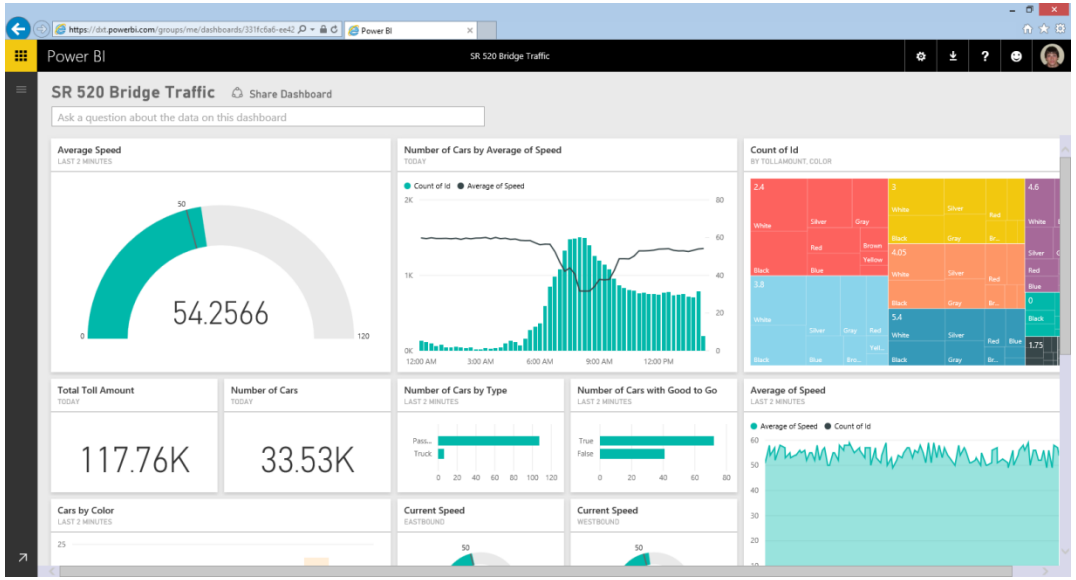
Phone +49-711-685 88205
Fax +49-711-685 88472

SimTech
Cluster of Excellence

Agenda

- Motivation
- HATEOAS & REST API Structure
- Analysis Framework
- Perceived Complexity of REST APIs
- Summary

Motivation



Atlassian Bitbucket
api.bitbucket.org/2.0

api.instagram.com/v1

wikimedia.org/api/rest_v1

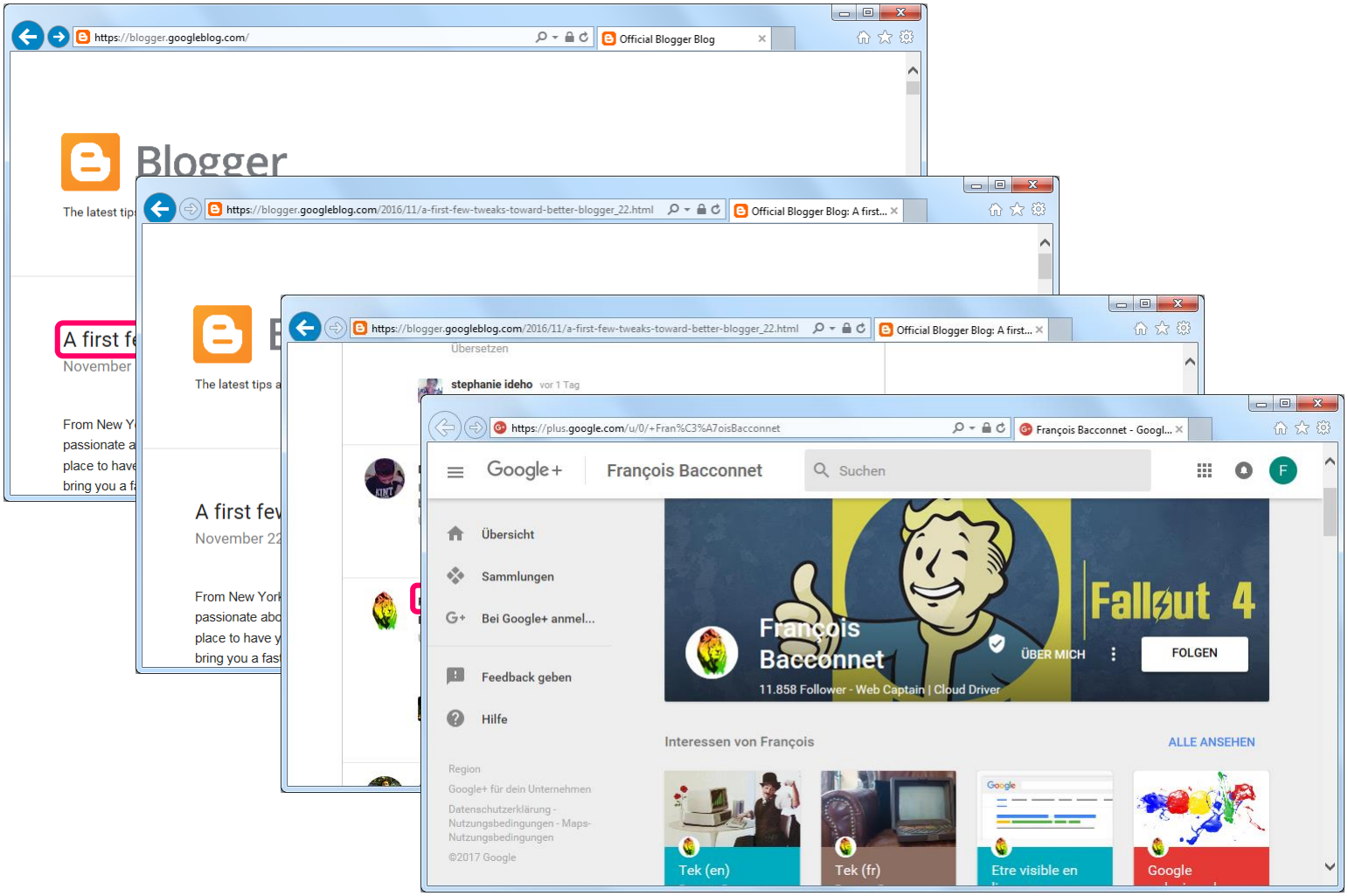
api.github.com

www.googleapis.com/gmail/v1/users
acceleratedmobilepageurl.googleapis.com
www.googleapis.com/adexchangebuyer/v1.4
adexchangebuyer.googleapis.com
www.googleapis.com/adexchangeseller/v2.0
www.googleapis.com/admin/reports/v1
www.googleapis.com/adsense/v1.4
www.googleapis.com/adsensehost/v4.1
www.googleapis.com/analytics/v3

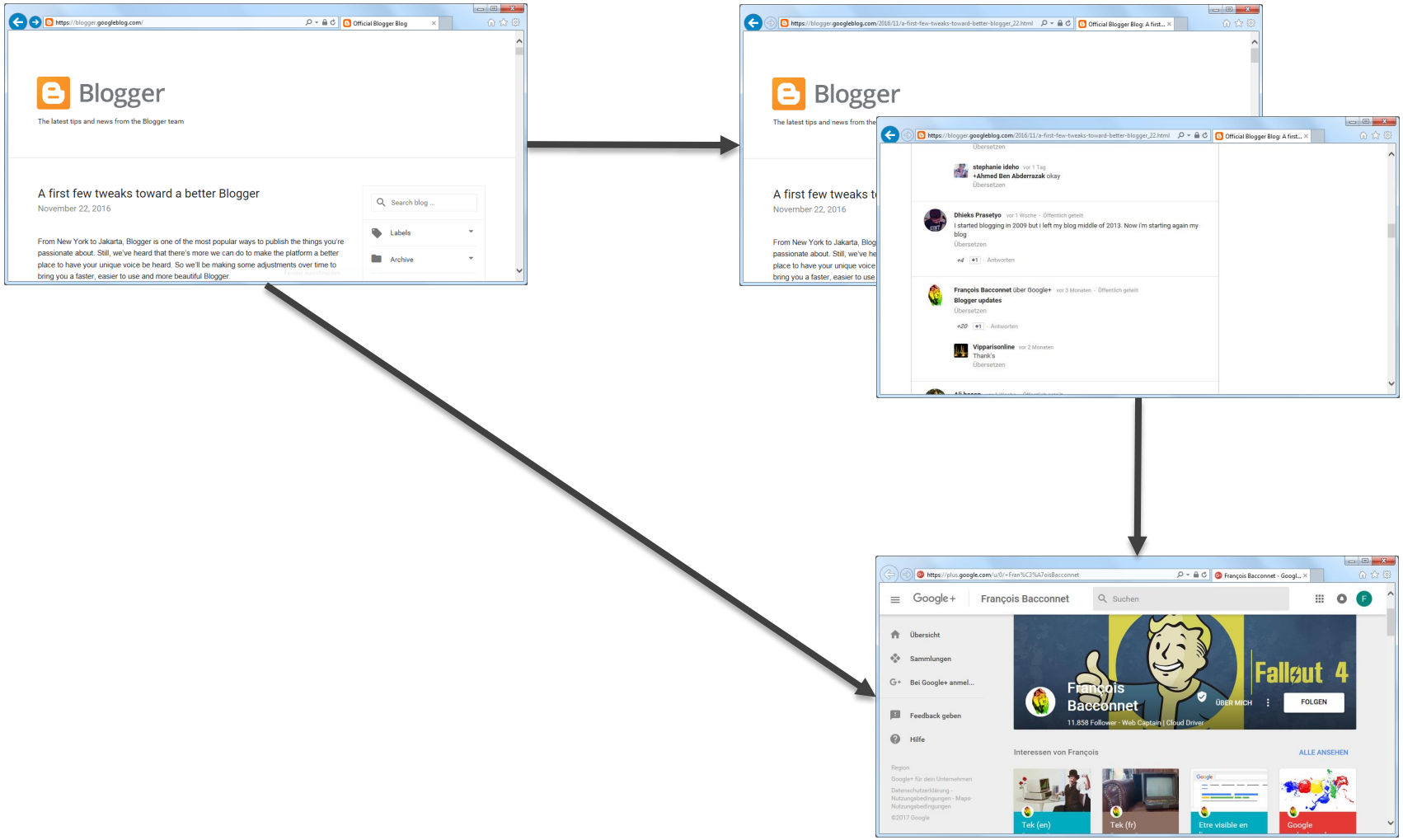
HATEOAS & REST API Structure

HATEOAS (for humans)

"Hypermedia as the Engine of Application State"



HATEOAS (for humans)



HATEOAS (for computers)

GET https://www.googleapis.com/blogger/v3/blogs/2399953

```
{
  "kind": "blogger
  "id": "2399953",
  "name": "Blogge
  "selfLink": "htt
  "posts": {
    "totalItems":
    "selfLink": "
  },
  "pages": {…},
  "locale": {…}
}
```

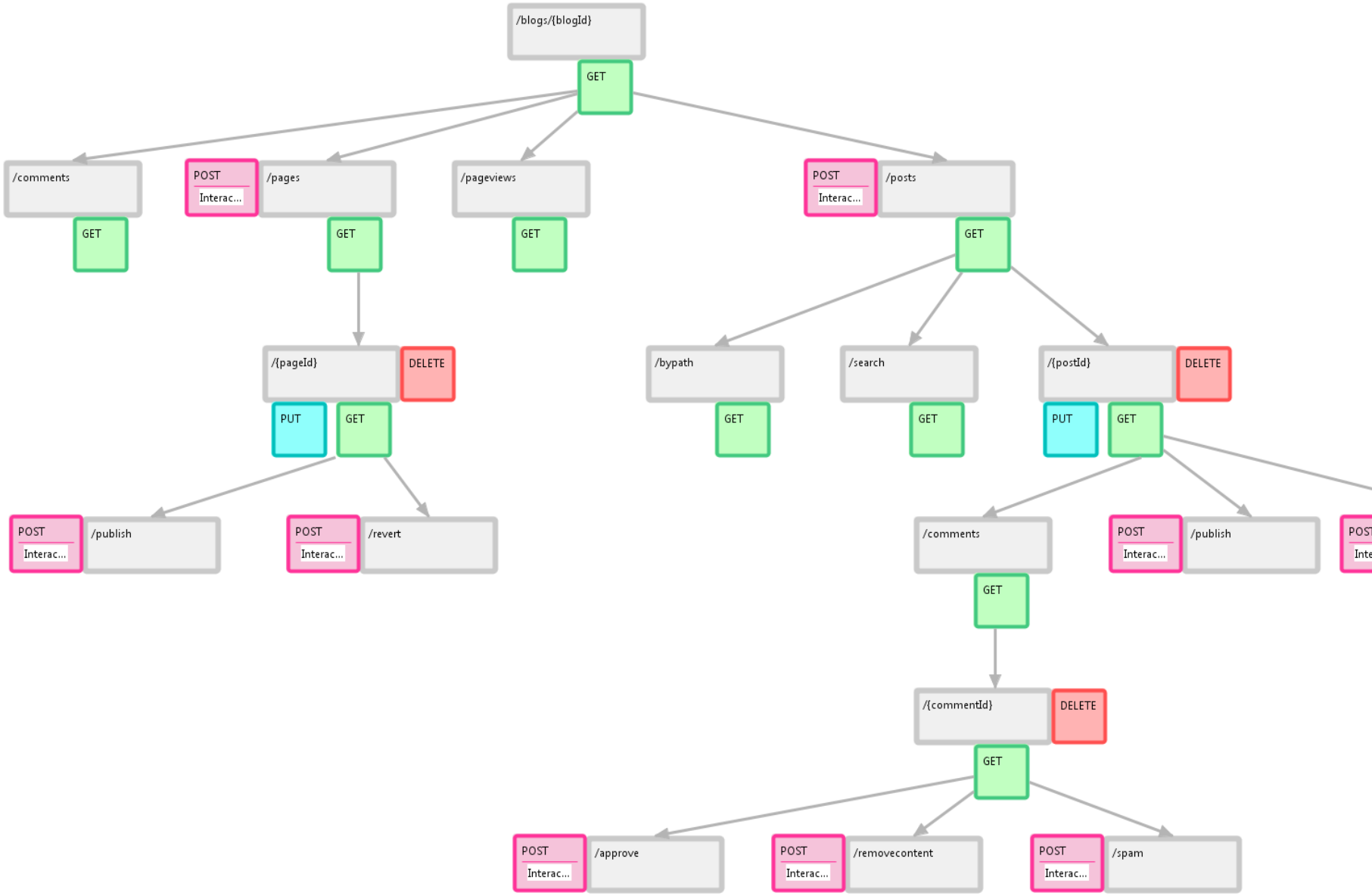
```
{
  "kind": "blogger#postList",
  "items": [
    {
      "kind": "blogger#post",
      "id": "7706273476706534553"
```

```
{
  "kind": "blogger#post",
  "id": "7706273476706534553"
```

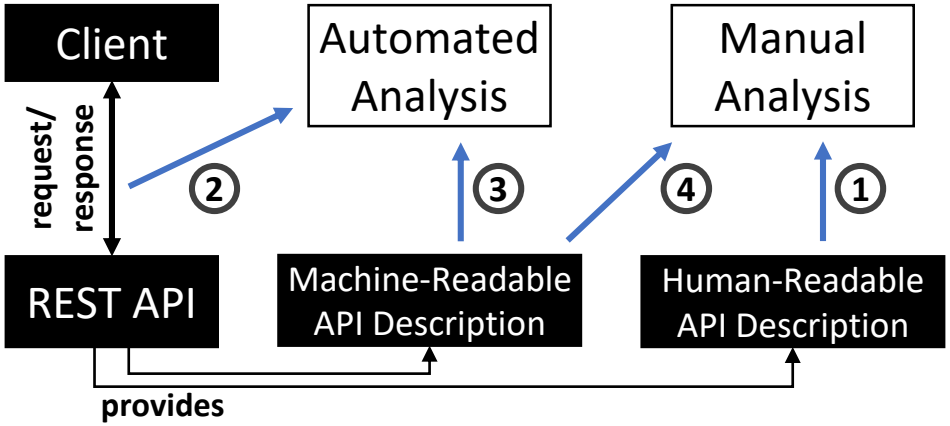
```
{
  "kind": "blogger#commentList",
  "items": [
    {
      "kind": "blogger#comment",
      "id": "9200761938824362519",
      "selfLink": "https://www.googleapis.com/blogger/v3/blogs2399953
                   /posts/6069922188027612413/comments/9200761938824362519",
      "content": "elided",
      "author": {
        "id": "530579030283",
        "displayName": „…",
        "url": "https://plus.google.com/u/0/+Fran%C3%A7oisBacconnet",
        "image": {
          "url": „…"
        }
      }
    },
    {
      "kind": "blogger#comment",
      "id": "400101178920857170",
      elided for readability
    }
  ]
}
```

HATEOAS (for computers)

REST API Structure

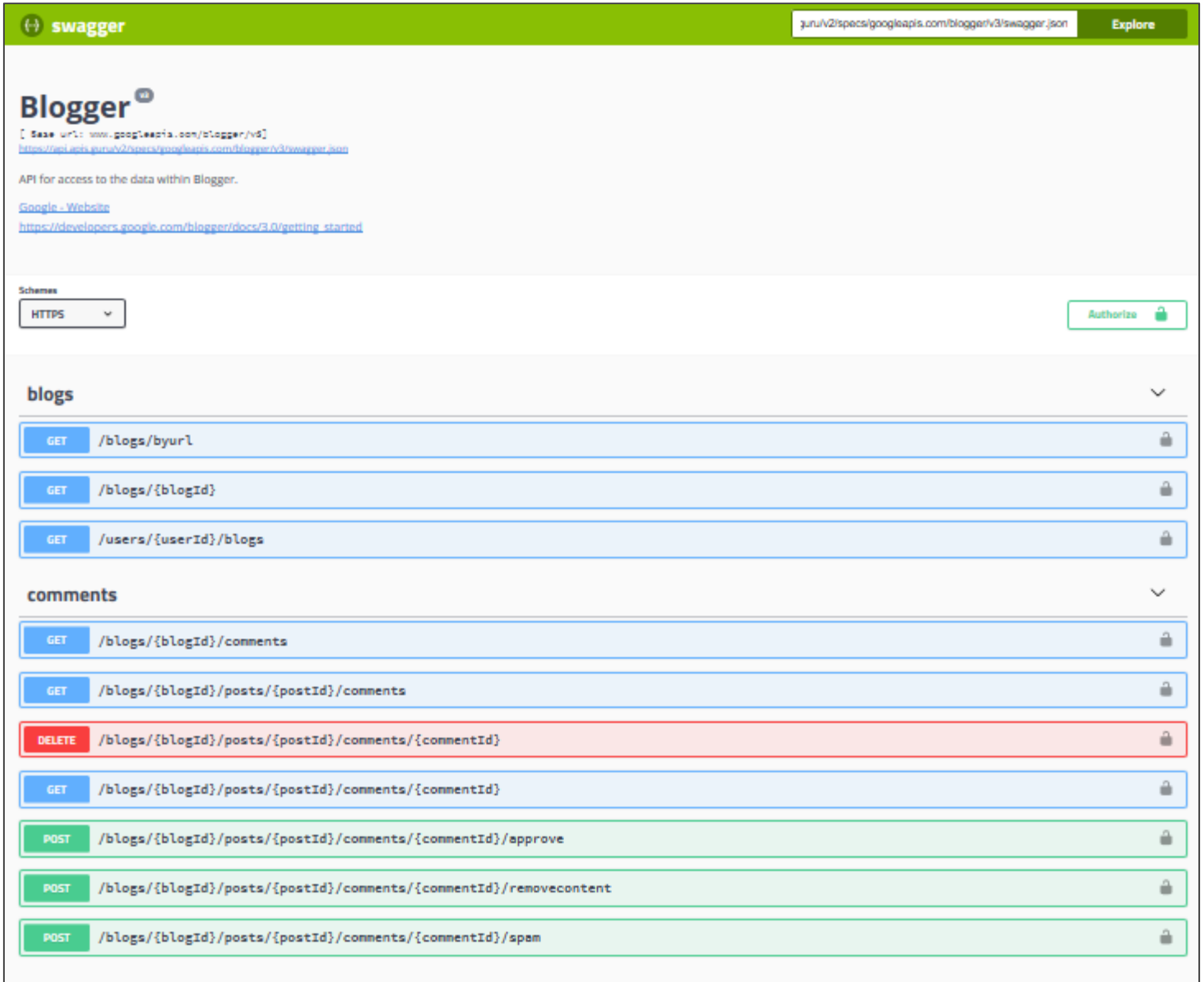


Related Work

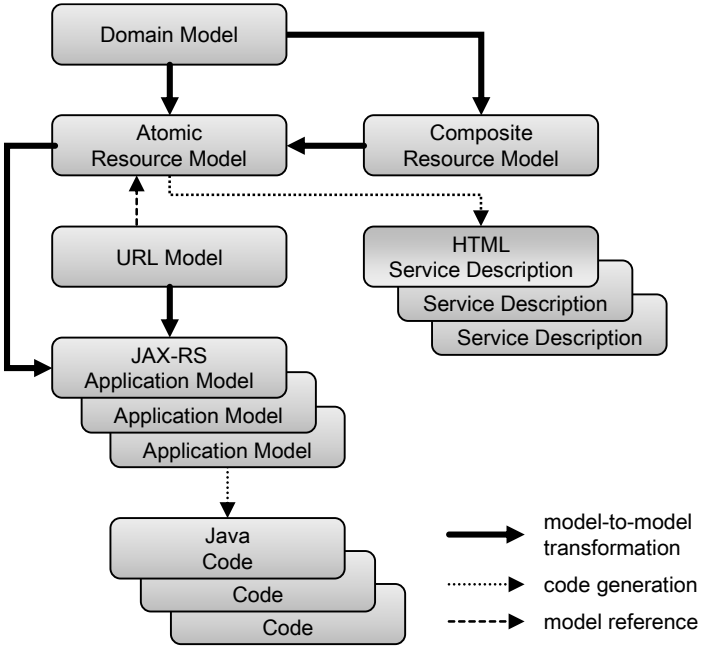


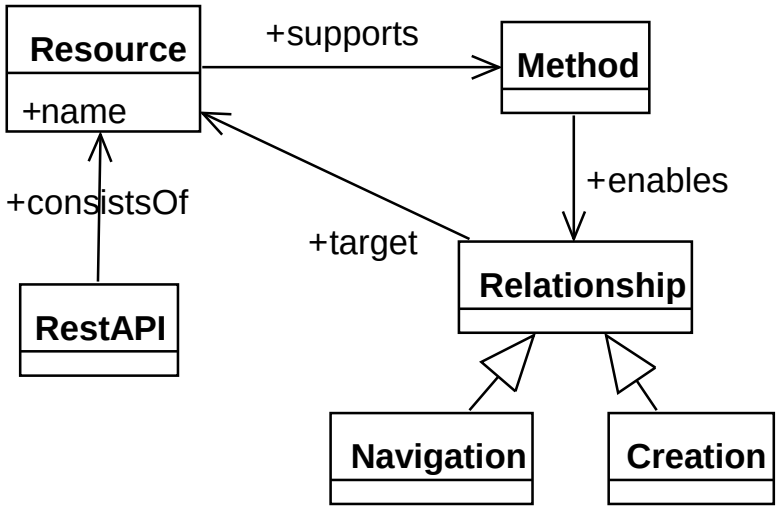
- Existing analysis approaches focus on request/response or URIs
- API description documents enable analysis at design time

Swagger / OpenAPI



Canonical Metamodel for REST APIs



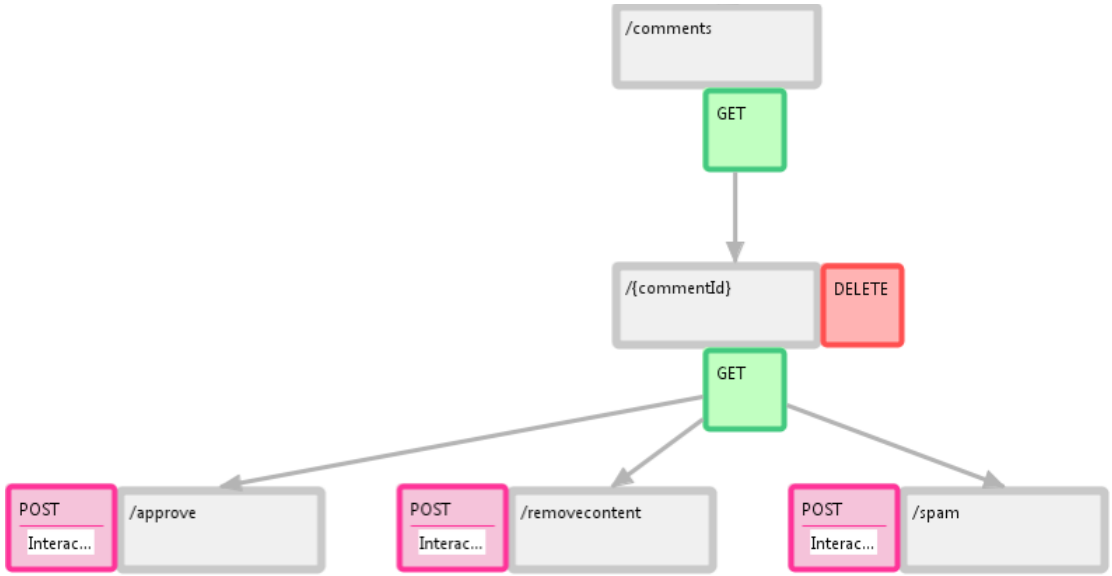


F. Haupt, D. Karastoyanova, F. Leymann, and B. Schroth, "*A model-driven approach for REST compliant services*", ICWS 2014.
F. Haupt, F. Leymann, and C. Pautasso. "*A conversation based approach for modeling REST APIs*" WICSA 2015.

Resource Structure

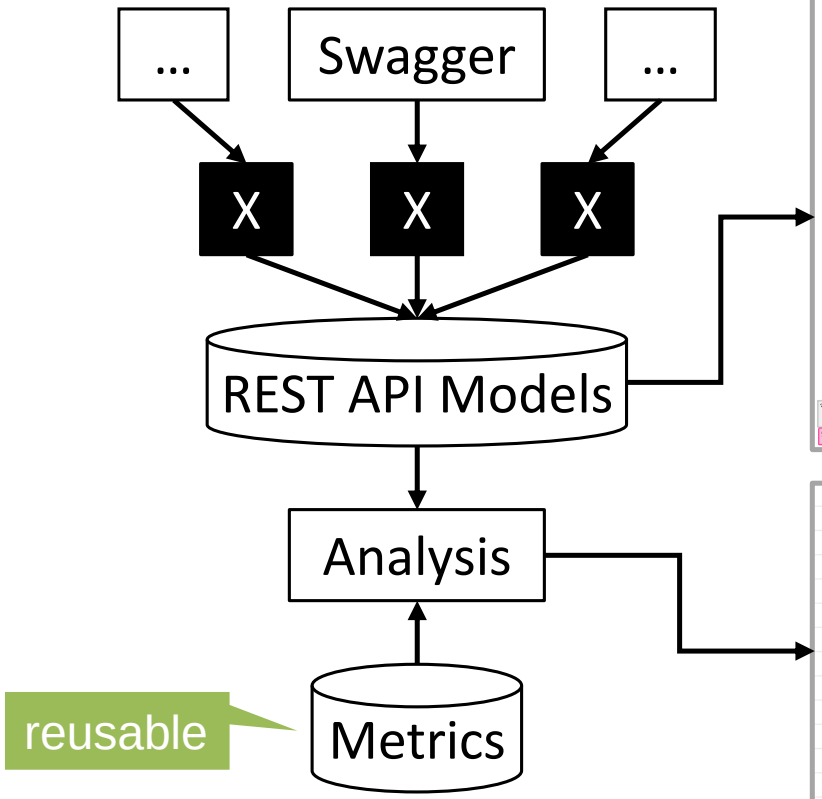
comments

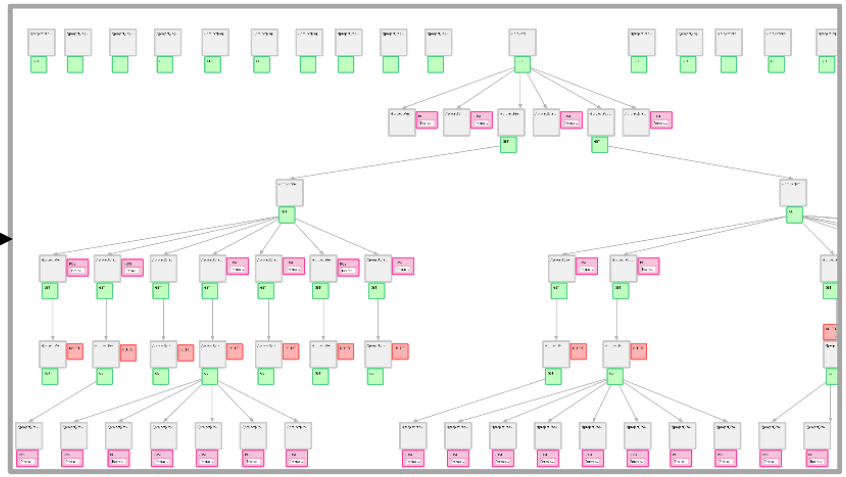
GET	/blogs/{blogId}/comments
GET	/blogs/{blogId}/posts/{postId}/comments
DELETE	/blogs/{blogId}/posts/{postId}/comments/{commentId}
GET	/blogs/{blogId}/posts/{postId}/comments/{commentId}
POST	/blogs/{blogId}/posts/{postId}/comments/{commentId}/approve
POST	/blogs/{blogId}/posts/{postId}/comments/{commentId}/removecontent
POST	/blogs/{blogId}/posts/{postId}/comments/{commentId}/spam



Analysis Framework

The Framework





	A	B	C	D	E
1	ApiName	Transformed?	#Links	#Mappings	#Resources
2	apis-guru.github.io	true	0	0	1
3	audiosear.ch	true	3	3	13
4	backupify.com	true	21	21	29
5	bbc.com	true	0	0	15
6	beanstream.com	true	7	7	11
7	bikewise.org	true	2	2	4
8	blackberry.com	true	41	41	52
9	bufferapp.com	true	0	0	18
10	cambase.io	true	0	0	8
11	citrixonline.com:gotoassistseeit	true	1	1	2
12	citrixonline.com:gotomeeting	true	13	13	18
13	citrixonline.com:gototraining	true	11	11	17

comparable

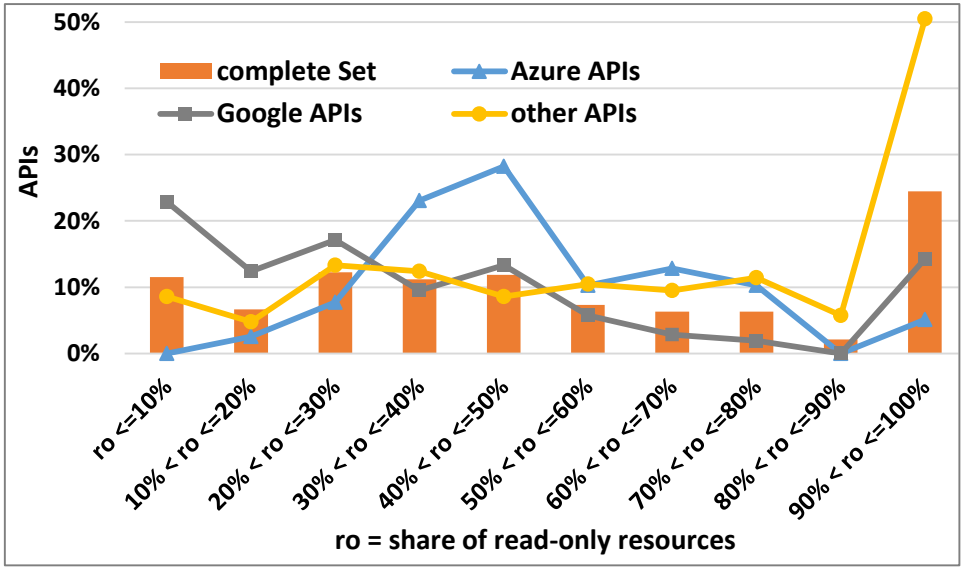
F. Haupt, F. Leymann, A. Scherer and K. Vukojevic-Haupt. "*A Framework for the Structural Analysis of REST APIs*" ICSA 2017.

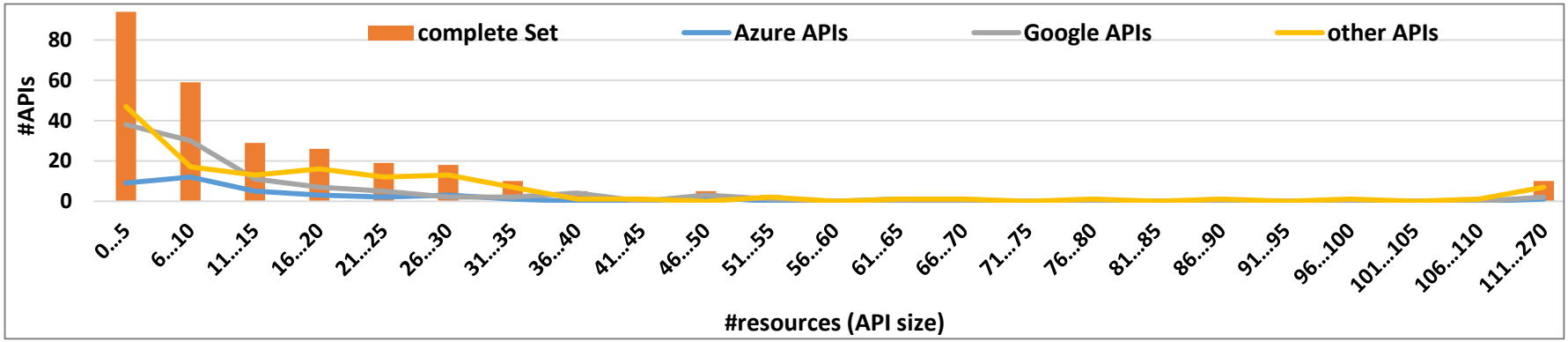
First Results

“APIs.guru - Wikipedia for WEB APIs”

https://apis.guru/openapi-directory
286 APIs in total
105 from Google, 39 from Azure, 142 from others

	MIN	MAX	MEAN	MEDIAN
#Resources	1	264	20,3	9
#ReadOnlyResources	0	227	10,4	4
#POST	0	93	6,5	3
#DELETE	0	40	2,6	1
#roots	1	227	8,1	4
#Links	0	248	12,2	4
maxDepth	0	7	1,8	1





F. Haupt, F. Leymann, A. Scherer and K. Vukojevic-Haupt. "*A Framework for the Structural Analysis of REST APIs*" ICSA 2017.

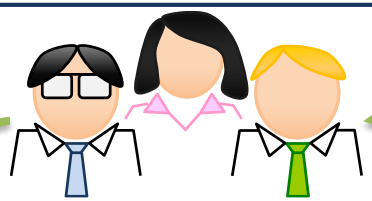
API Governance Support

API Governance Support

- Rule compliance
  - Non-functional properties, best practices support, documentation quality, …
- Low-level metrics → higher-level aggregated metrics
- (API) Complexity
  - Descriptive complexity
    - Objective truth
  - Perceived complexity
    - Subjective

How can we determine the perceived complexity of REST APIs in an automated way?

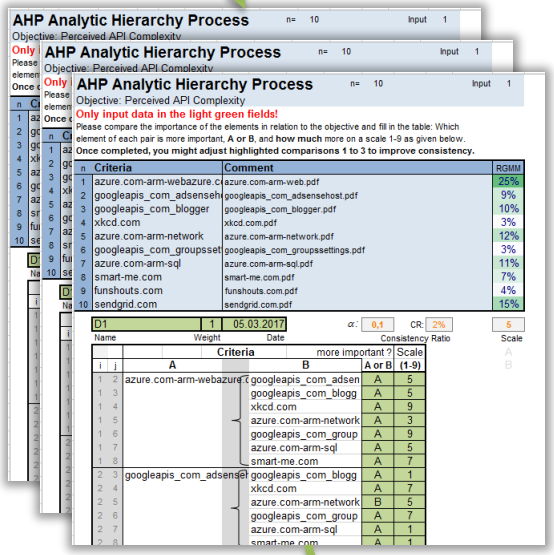
Methodology

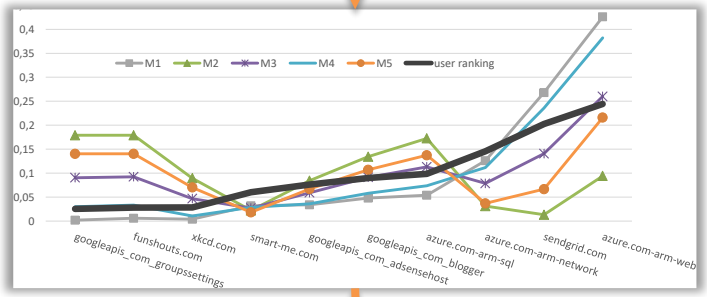


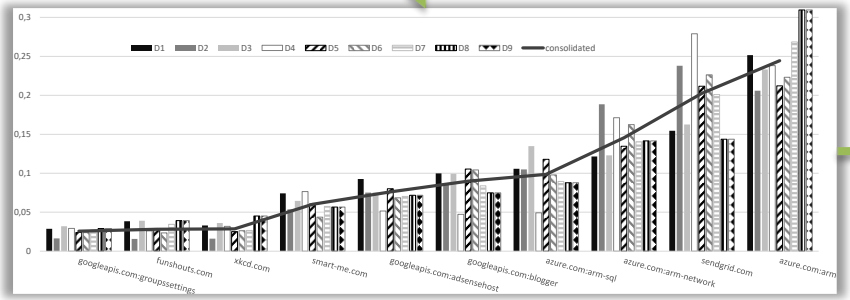
REST API Models

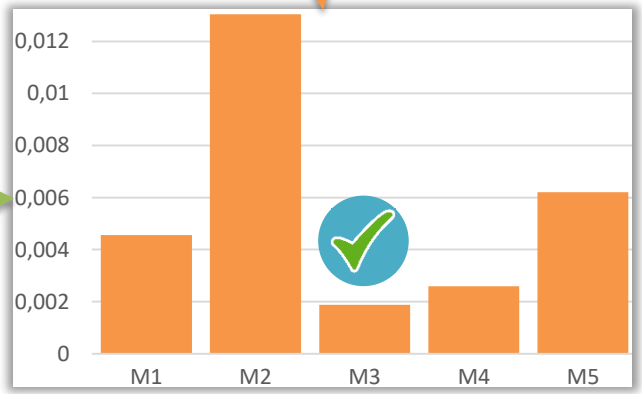
Analysis

Metrics



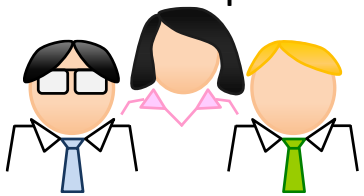


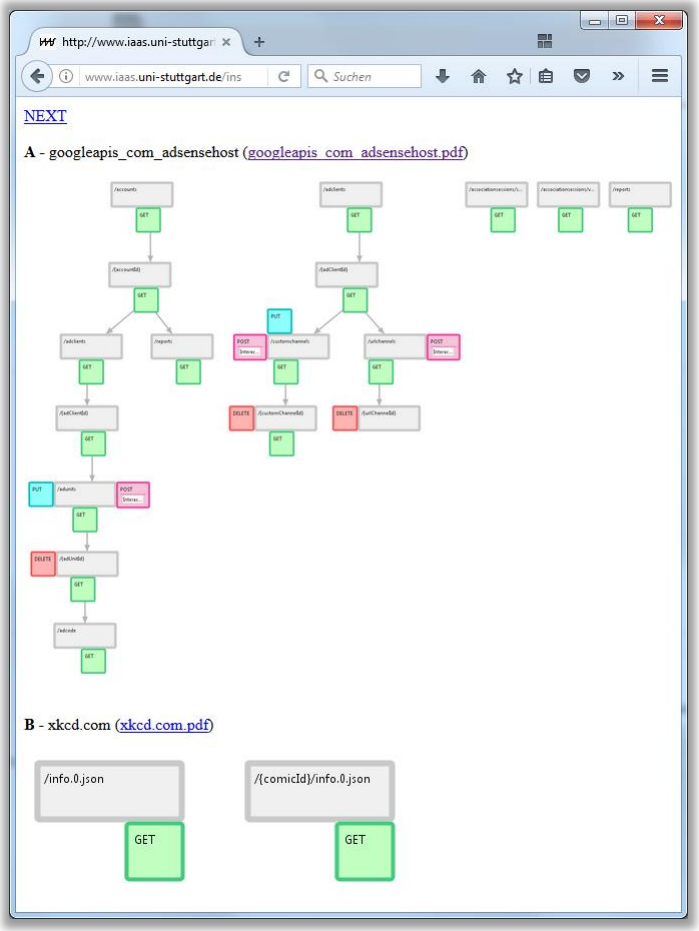




AHP – Procedure

9 Developers





AHP Analytic Hierarchy Process n= 10 Input 1

Objective: Perceived API Complexity

Only input data in the light green fields!

Please compare the importance of the elements in relation to the objective and fill in the table: Which element of each pair is more important, **A or B**, and **how much** more on a scale 1-9 as given below.

Once completed, you might adjust highlighted comparisons 1 to 3 to improve consistency.

n	Criteria	Comment	RGMM
1	azure.com-arm-webazure.c	azure.com-arm-web.pdf	25%
2	googleapis_com_adsenseh	googleapis_com_adsensehost.pdf	9%
3	googleapis_com_blogger	googleapis_com_blogger.pdf	10%
4	xkcd.com	xkcd.com.pdf	3%
5	azure.com-arm-network	azure.com-arm-network.pdf	12%
6	googleapis_com_groupsset	googleapis_com_groupssettings.pdf	3%
7	azure.com-arm-sql	azure.com-arm-sql.pdf	11%
8	smart-me.com	smart-me.com.pdf	7%
9	funshouts.com	funshouts.com.pdf	4%
10	sendgrid.com	sendgrid.com.pdf	15%

D1 | 1 | 05.03.2017 — Name | Weight | Date

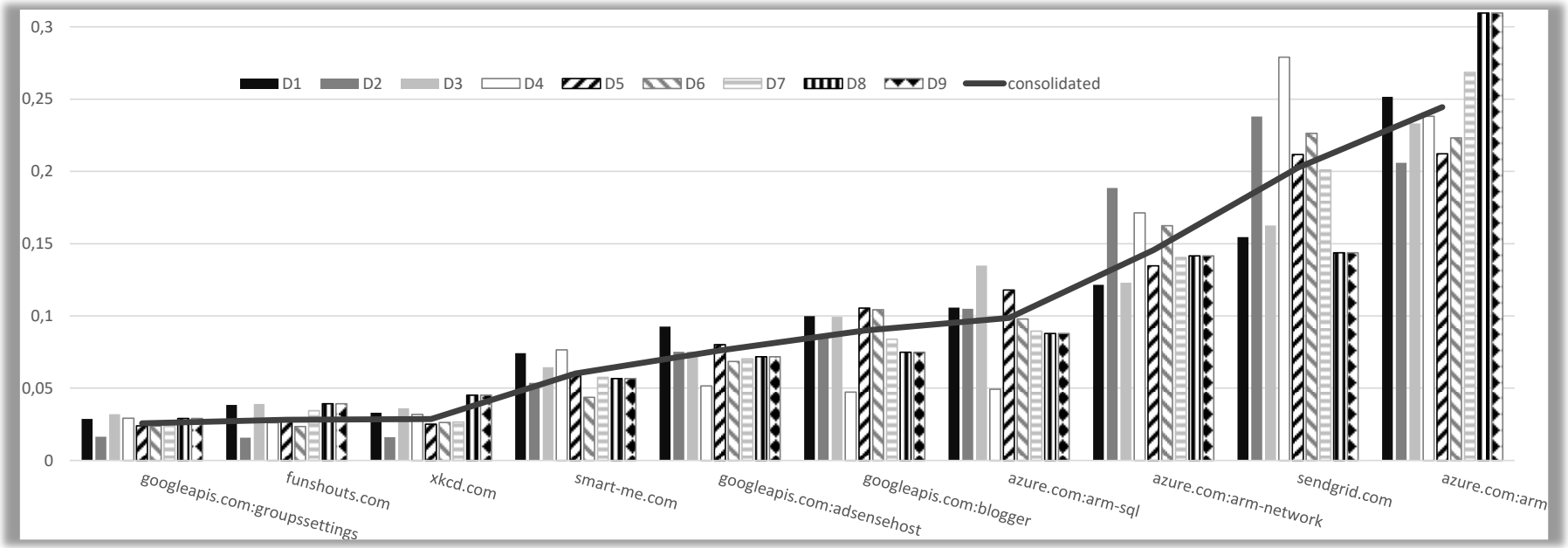
α: 0,1 CR: 2% — Consistency Ratio

5 — Scale

i	j	Criteria A	Criteria B	more important ? A or B	Scale (1-9)
1	2	azure.com-arm-webazure.c	googleapis_com_adsen	A	5
1	3		googleapis_com_blogg	A	5
1	4		xkcd.com	A	9
1	5		azure.com-arm-network	A	3
1	6		googleapis_com_group	A	9
1	7		azure.com-arm-sql	A	5
1	8		smart-me.com	A	7
2	3	googleapis_com_adsensel	googleapis_com_blogg	A	1
2	4		xkcd.com	A	7
2	5		azure.com-arm-network	B	5
2	6		googleapis_com_group	A	7
2	7		azure.com-arm-sql	A	1
2	8		smart-me.com	A	1

http://bpmsg.com/new-ahp-excel-template-with-multiple-inputs/

AHP – Results


0,3
0,25
0,2
0,15
0,1
0,05
0
D1
D2
D3
D4
D5
D6
D7
D8
D9
consolidated
googleapis.com:groupssettings
funshouts.com
xkcd.com
smart-me.com
googleapis.com:adsensehost
googleapis.com:blogger
azure.com:arm-sql
azure.com:arm-network
sendgrid.com
azure.com:arm

Candidate Metrics (1)

$M_1 = \#resources$

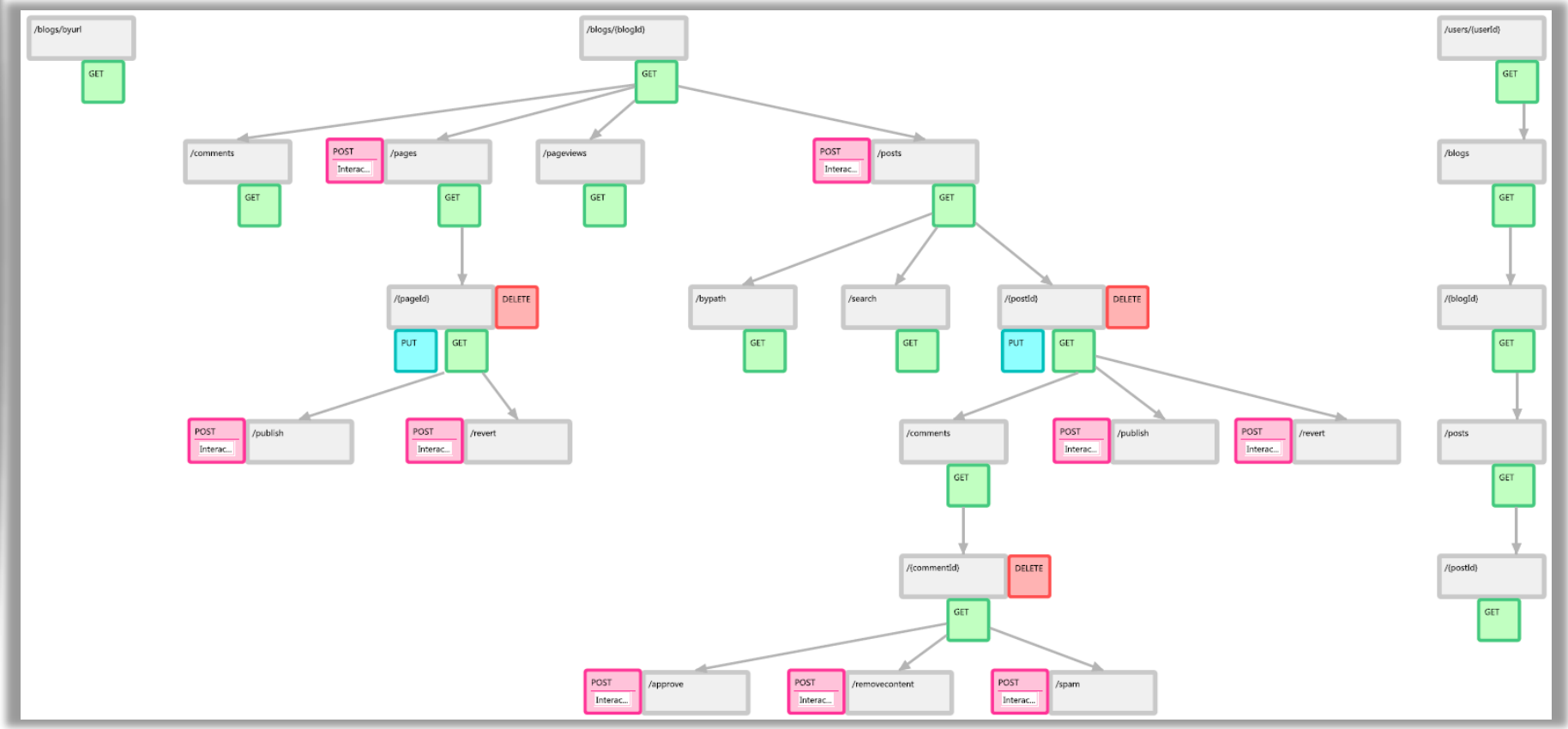
$M_2 = BiggestComponentCoverage$

$M_3 = M_1 + M_2$

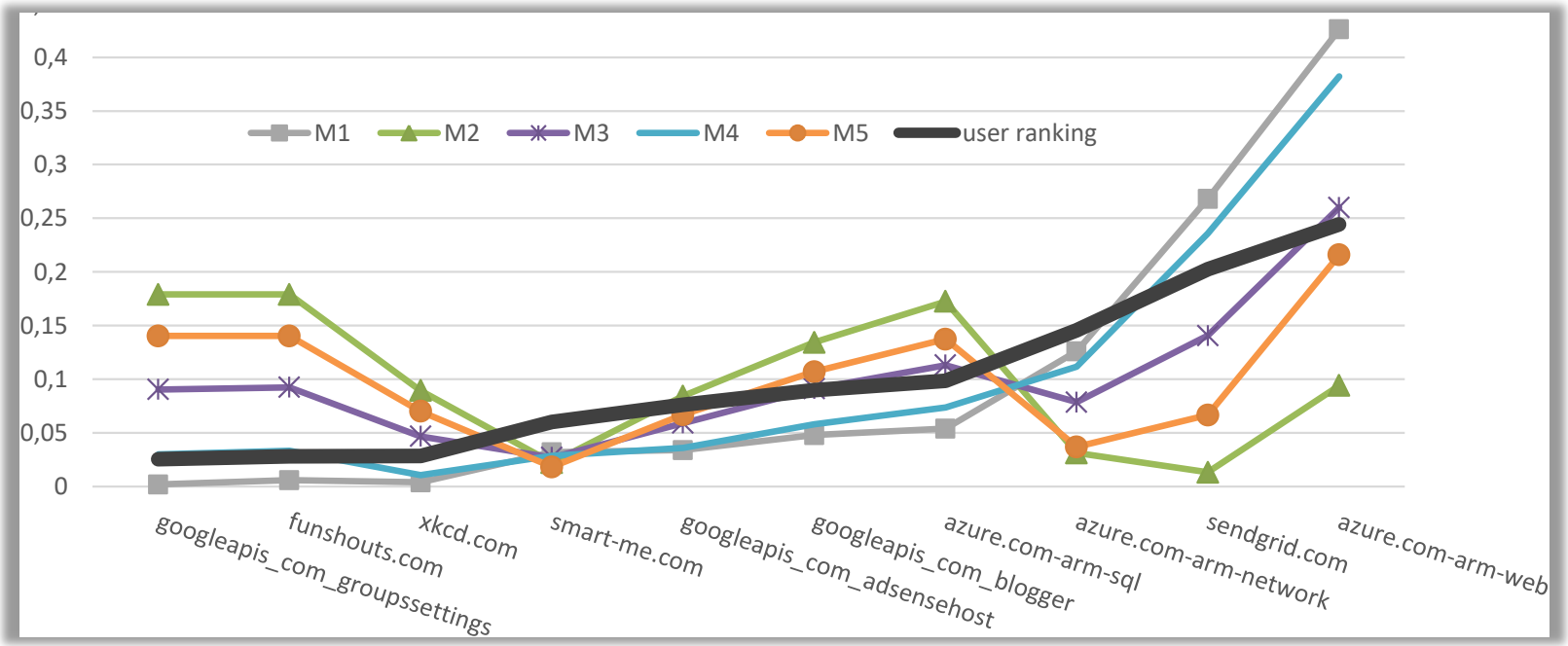
$M_4 = M_1 + M_2^2$

$M_5 = M_1^2 + M_2$

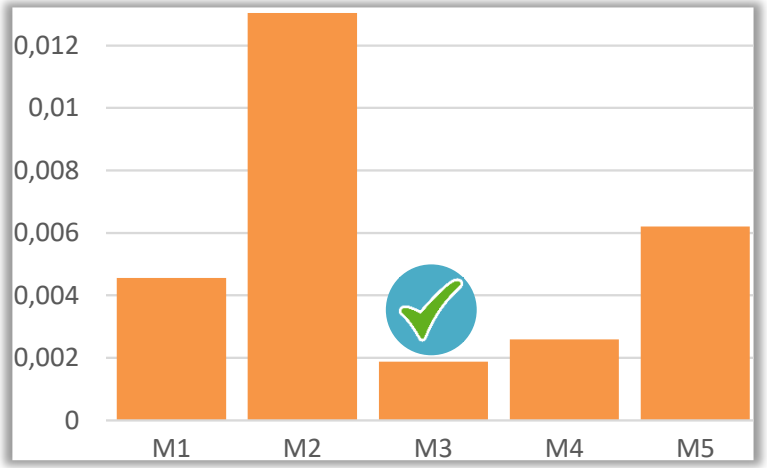
All metrics are normalized for comparability.



Candidate Metrics (2)



$$M_1 = \#resources$$
$$M_2 = BiggestComponentCoverage$$
$$M_3 = M_1 + M_2$$
$$M_4 = M_1 + M_2^2$$
$$M_5 = M_1^2 + M_2$$



Summary

Summary

florian.haupt@iaas.uni-stuttgart.de
www.iaas.uni-stuttgart.de