A Vision to identify Architectural Smells in Self-Adaptive Systems using Behavioral Maps

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Agenda

Motivation

Proposed approach

Behavioral Map

Processes

Algorithm

Framework

CASE STUDY

Motivation

- Self-adaptive systems **change** their **behavior depending** on **environmental changes** and **reconfiguration plans**.

- Dynamic Software Product Line (**DSPL**) engineering **implements self-adaptive systems** by dynamically **binding or unbinding features**.

- **Binding or unbinding features** as prescribed by a **feature model.**

Motivation

- **Challenges**
  - **Number of possible configuration** goes exponentially with the number of features;
  - The **(re)configuration** process **may add** a **new architectural solution** in an **inappropriate context** via new features loaded;
  - The **(re)configuration** process **may combine architectural fragments** with **undesirable behaviors.**
- **Problem**
  - Architectural Smell**.**

Motivation

- **Studies about Architectural Smell in SAS:**
  - C. Raibulet, F. A. Fontana, S. Carettoni, **A preliminary analysis of self-adaptive systems according to different issues**, Software Quality Journal (2020) 1–31.
  - M. A. Serikawa, A. d. S. Landi, B. R. Siqueira, R. S. Costa, F. C. Ferrari, R. Menotti, V. V. De Camargo, **Towards the characterization of monitor smells in adaptive systems**, in: X Brazilian Symposium on Software Components, Architectures and Reuse (SBCARS), IEEE, 2016, pp. 51–60.

Proposed approach

- We introduce **the** Behavioral Map

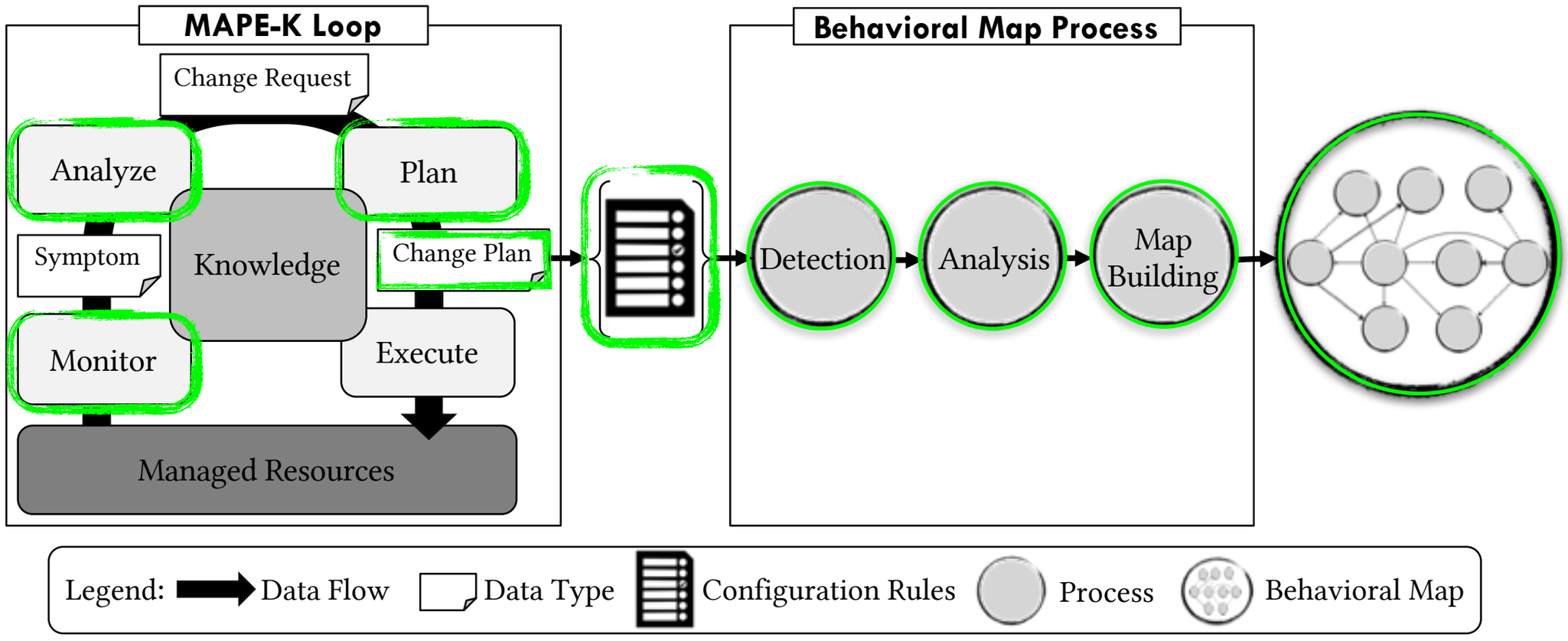
- A Behavioral Map (BM) can be seen as a *hybrid structure*, data, and control information about the self-adaptive system.

- BM maps the interactions and influences that a feature has on other features in a specific configuration for a given runtime context.

- The BM can support architectural bad smell identification at runtime.

Behavioral Map

Processes



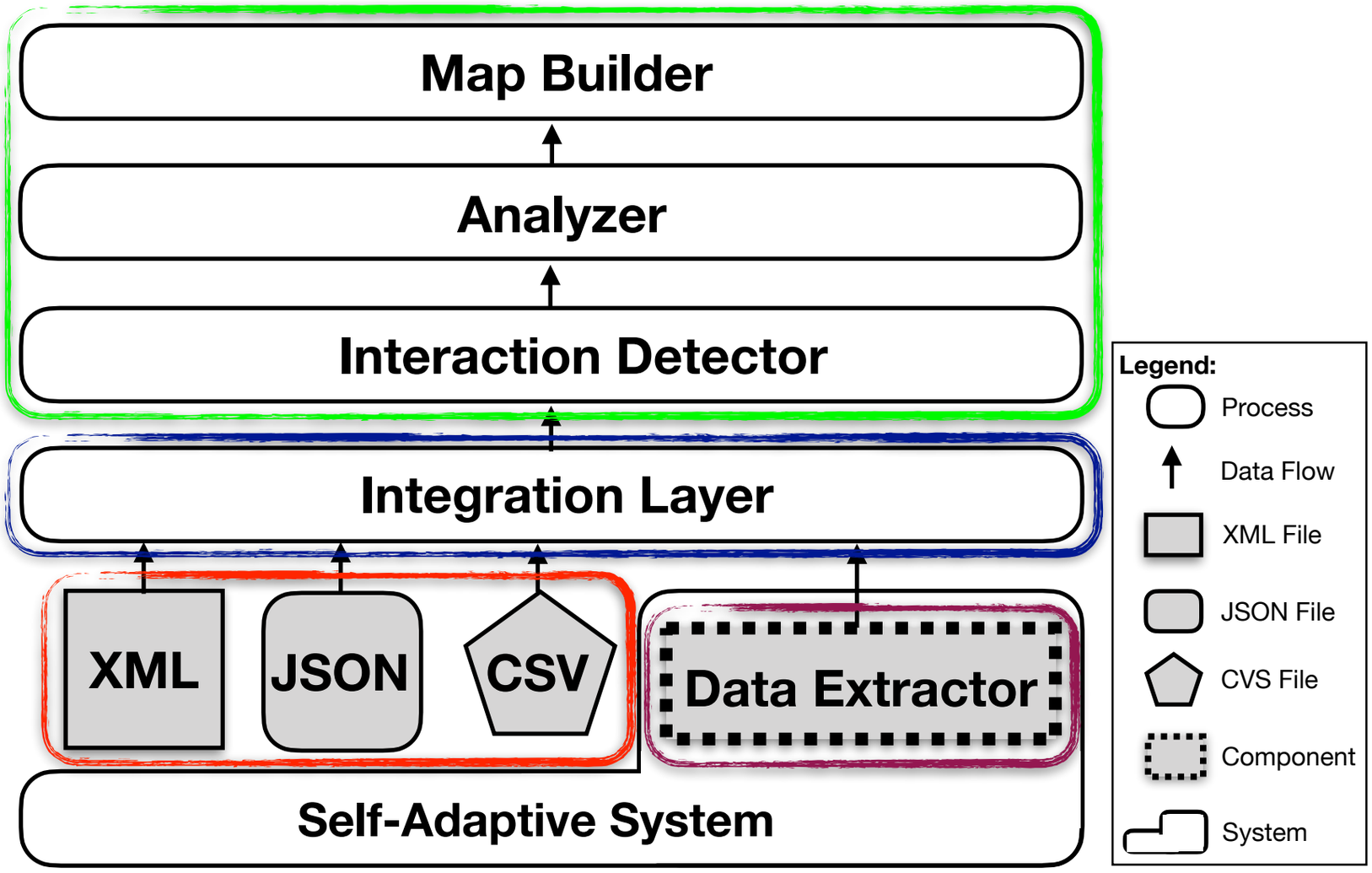
Behavioral Map

Algorithm

```
1  table ← loadConfigurationRulesFile(ℂℝfile);
2  verticesOnMap ← createVerticesOnMap(table);
3  foreach vertex in verticesOnMap do
4      foreach row in table do
5          if row.name.equals(vertex.name) then
6              foreach relation in row.getAllRelationships() do
7                  if relation.relationship is not null then
8                      createEdge(vertex, relation.relationship_type, relation.featureName);
9                  end
10             end
11         end
12     end
13 end
```

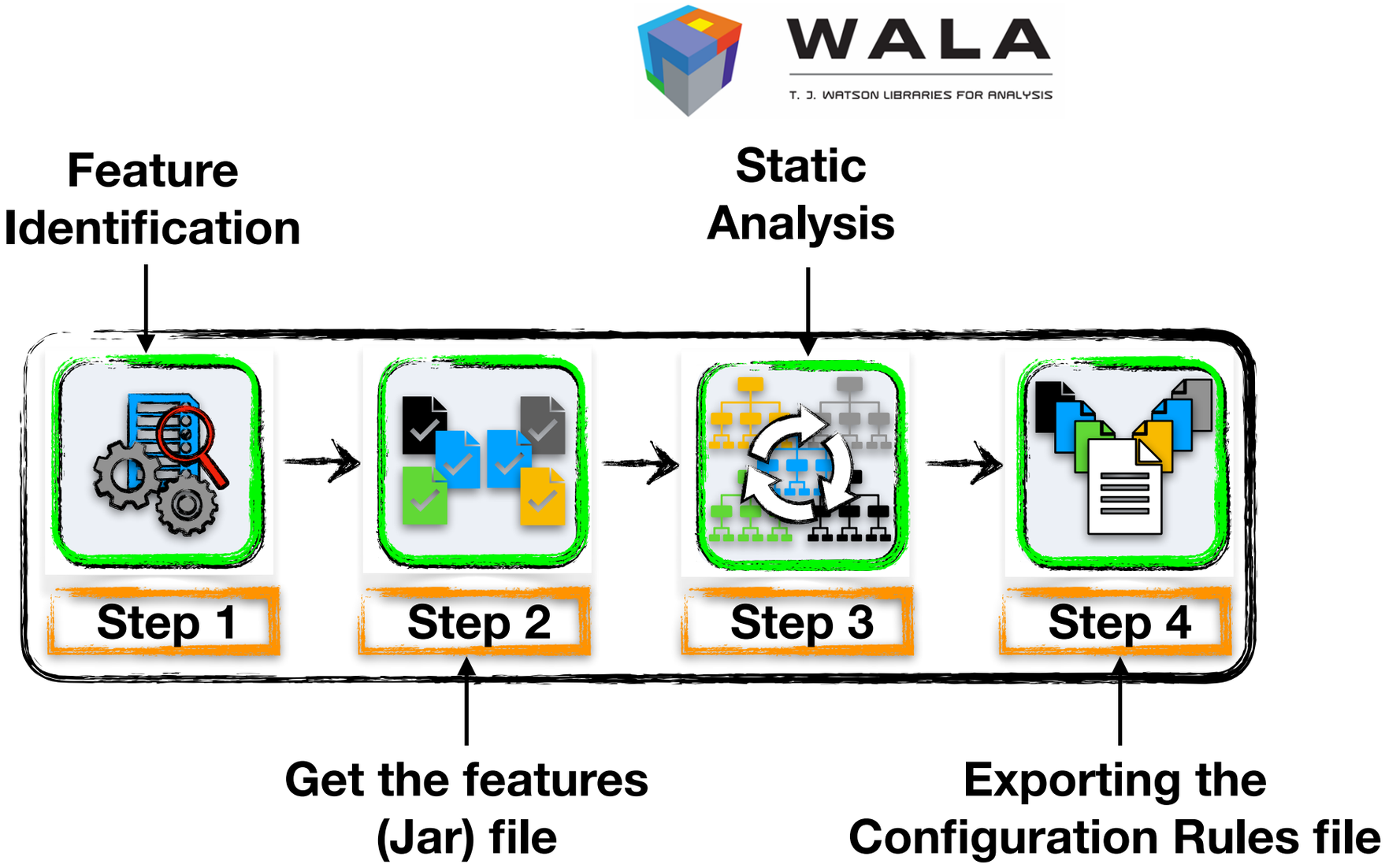
Behavioral Map

Framework Architecture



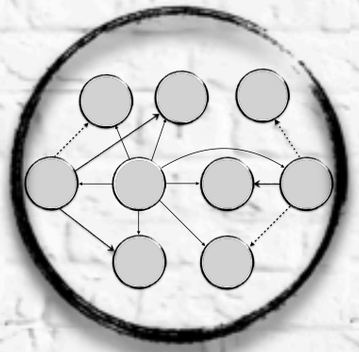
Behavioral Map

Data Extractor Process

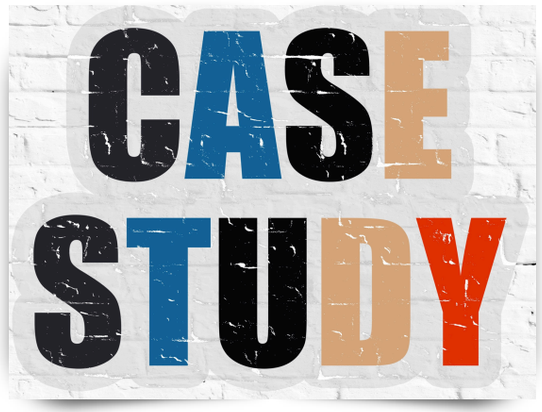


The Behavioral Map was implemented using neo4j

Behavioral Map



CASE STUDY



Architectural Smell List

Smell Name	Detection
Cyclic Dependency (CD) [16]	Full
Extraneous Connector (EC) [8]	Full
Hub-Like Dependency (HL) [16, 10]	Full
Oppressed Monitors (OM)[11]	Partial

C. Raibulet, F. A. Fontana, S. Carettoni, **A preliminary analysis of self-adaptive systems according to different issues**, Software Quality Journal (2020) 1–31.

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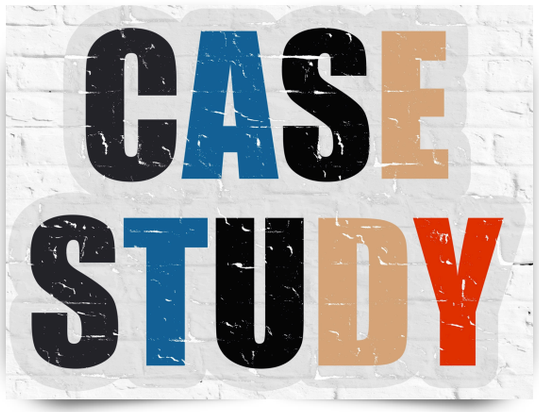
Behavioral Map



The SHE Smart Home System

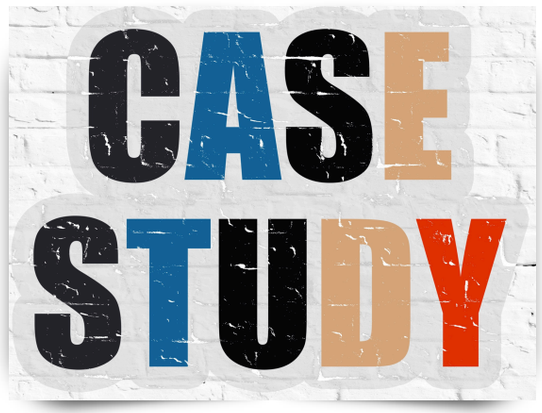
- We applied the **BM** framework on SHE smart home system based on MAPE-K loop and implemented using the publish-subscribe architecture.

- The SHE is composed by:

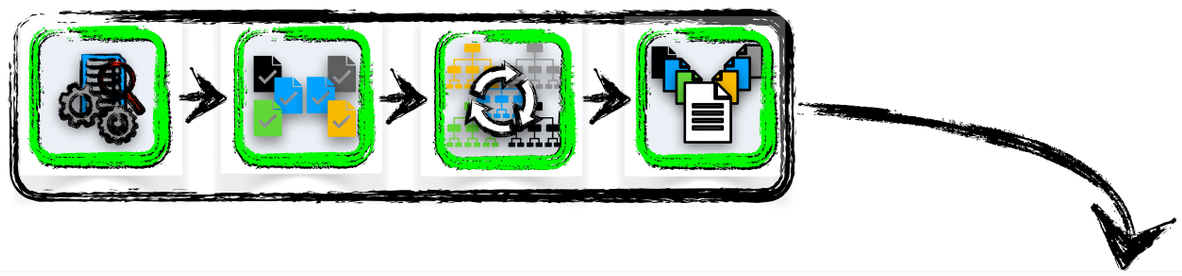
  - **Core features:** Manager, Listener, Loader, Installer, and Presentation Layer.
  - We included **four optional features** as follows:

    - **Luminosity:** used to read data from the luminosity sensor;
    - **Presence:** used to read data from the presence sensor;
    - **lampController:** responsible for controlling Lamp feature's behavior using the information read from Luminosity and Presence features;
    - **Lamp:** an actuator used to switch on and off lights based on the lampController feature's data.

Case study available in: https://github.com/edilton-santos/BehavioralMapExample

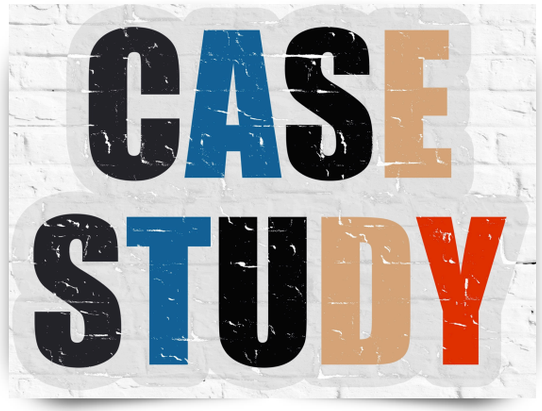


Running the Data Extractor




```
{
"imported_packages":["com.she.core.listener"],
"relationships":[
    {"relationship_type":"Requires","feature_name":"listener"},
    {"relationship_type":"Reads","feature_name":"lampController"},
    {"relationship_type":"Reads","feature_name":"luminosity"},
    {"relationship_type":"Reads","feature_name":"presence"},
    {"relationship_type":"Reads","feature_name":"lamp"}
   ],
"name":"presentation layer",
"type":"Core",
"version":"1.0.0",
"status":"Ativo",
"exported_packages":["com.she.core.presentation.layer","com.she.core.presentation.view"]
}
```

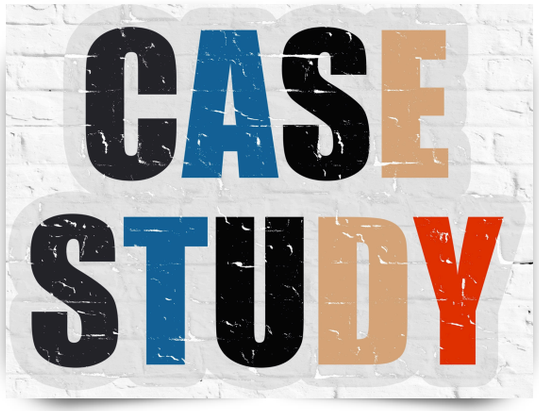

Behavioral Map



Identifying Architectural Bad Smells

Feature Types	Core(5) Feature(9) Controller(1) Sensor(2) Actuator(1)
Relationships	Requires(11) Reads(6) Controls(1)

Behavioral Map

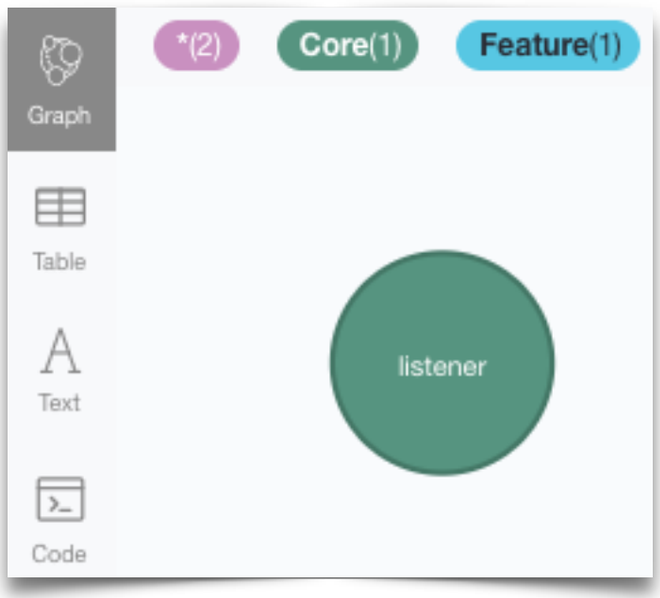


Identifying Architectural Bad Smells

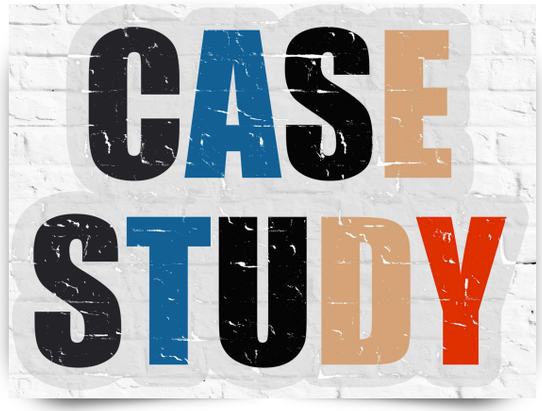
Cypher query:

```
// Hub-Like Dependency
MATCH (f:Feature)-[r:Requires]→(f2:Feature)
OPTIONAL MATCH (f2)-[r2:Requires]→(:Feature)
WITH f2, count(r) As Rtotal, count(r2) As Rtotal2
WHERE Rtotal ⩾ 5 and Rtotal > Rtotal2
RETURN f2, Rtotal, Rtotal2
```

Result:



Behavioral Map

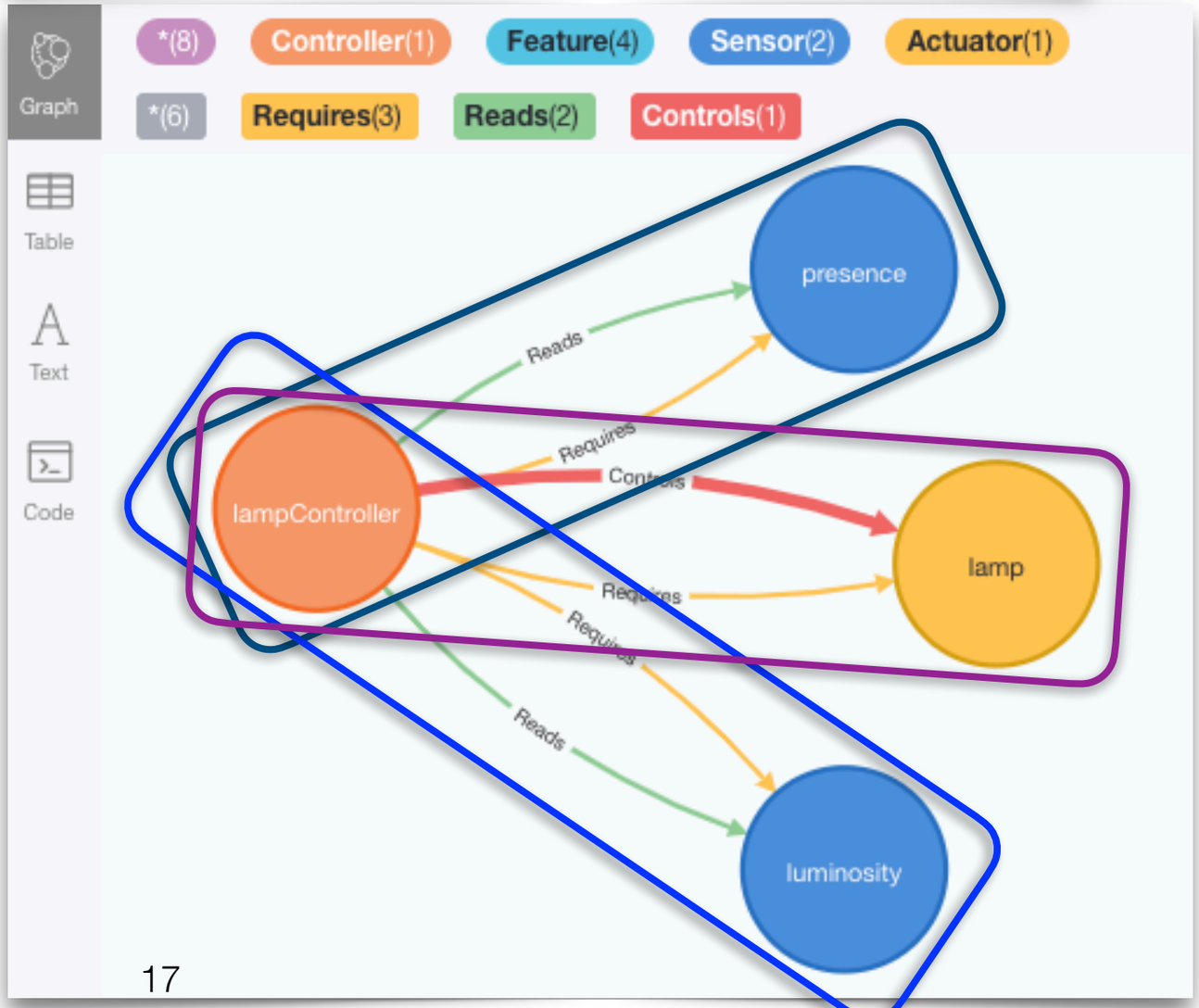


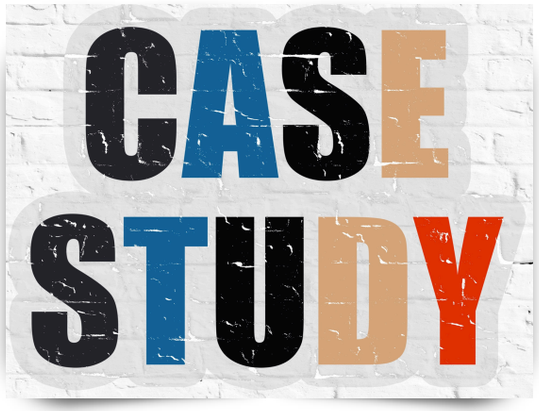
Identifying Architectural Bad Smells

Cypher query:

```
// Extraneous Connector
MATCH (f:Feature)-[r:Requires]→(f2:Feature)
WHERE exists((f)-[:Reads|Controls]→(f2))
RETURN f, r, f2
```

Result:



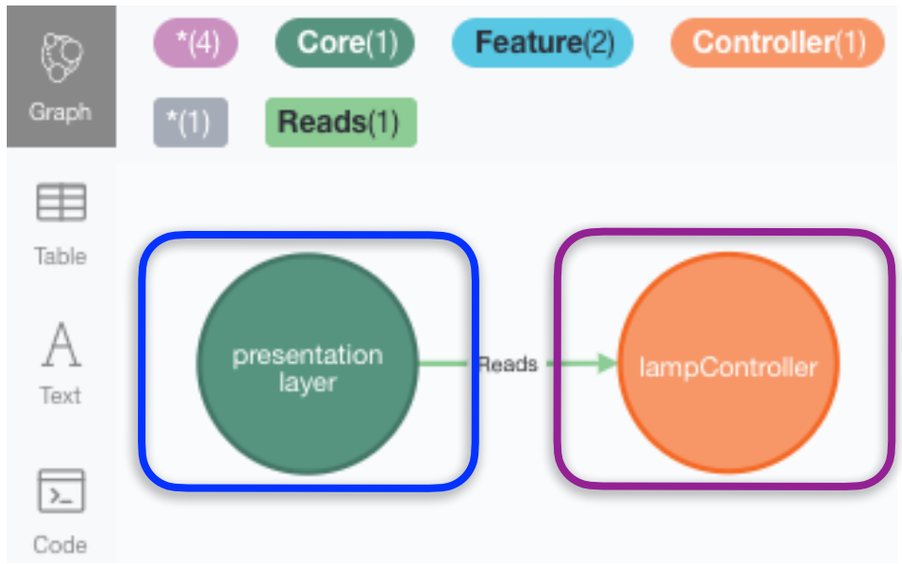


Identifying Architectural Bad Smells

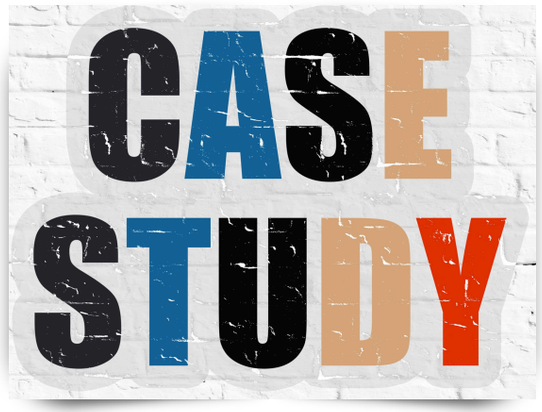
Cypher query:

```
// Look for Oppressed Monitors
MATCH (f1:Feature)-[r:Reads]→(:Feature)
WITH f1, count(r) As Rtotal
WHERE Rtotal ⩾ 2
RETURN f1, Rtotal
```

Result:



Behavioral Map

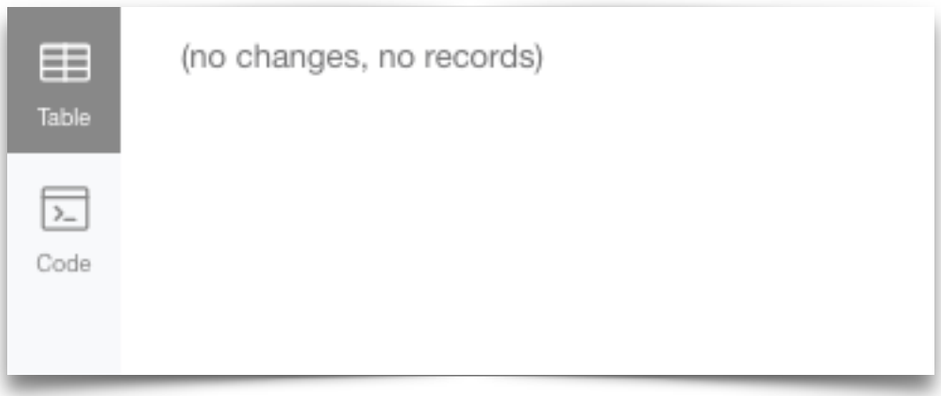


Identifying Architectural Bad Smells

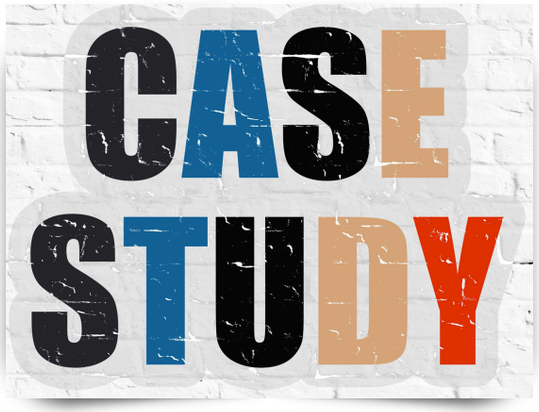
Cypher query:

```
// Cyclic Dependency
MATCH (f:Feature)-[:Requires]→(f2:Feature)-[:Requires]→(f)
OPTIONAL MATCH (f2)-[:Requires]→(f3:Feature)-[:Requires]→(f)
RETURN f, f2, f3
```

Result:

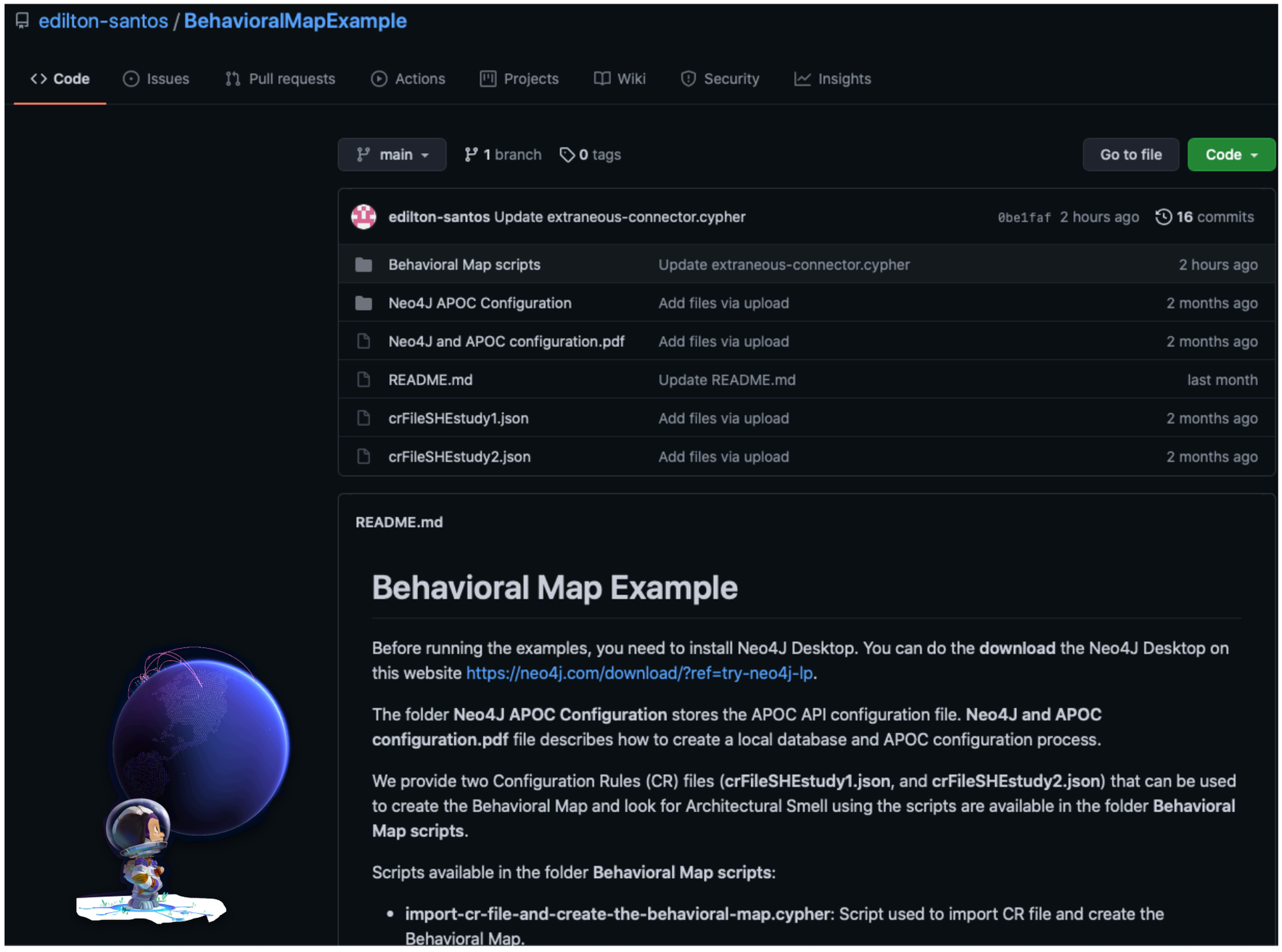


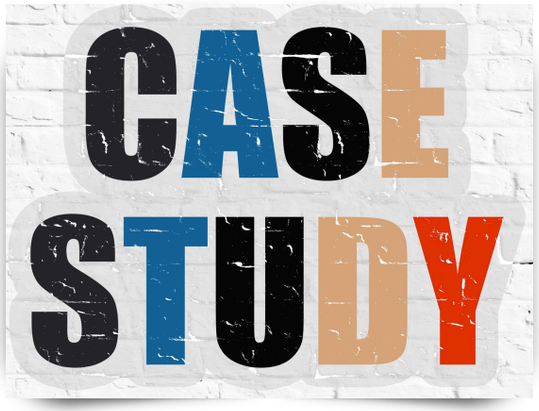
Behavioral Map



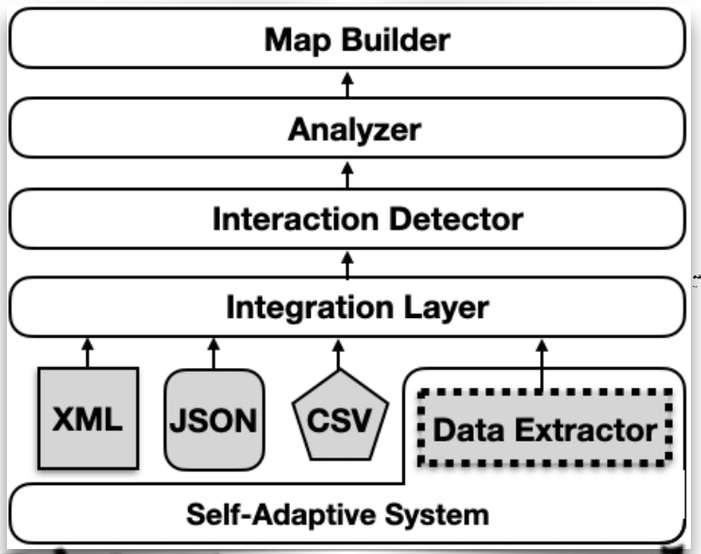
Identifying Architectural Bad Smells

https://github.com/edilton-santos/BehavioralMapExample

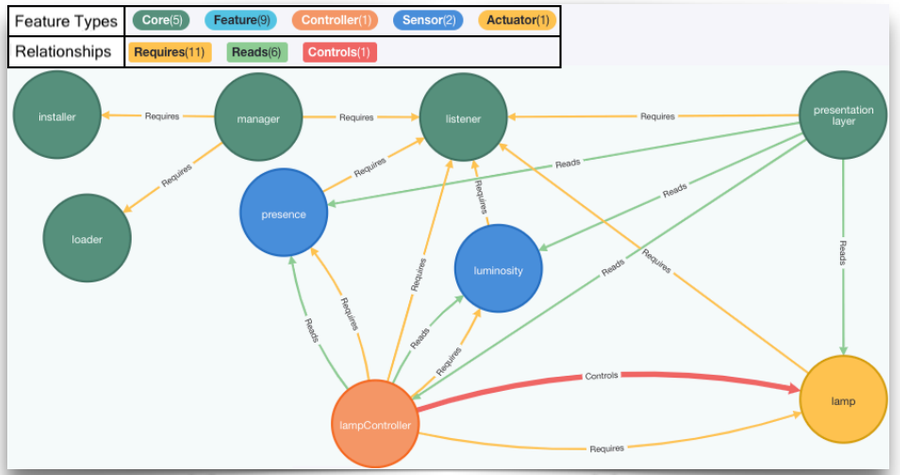




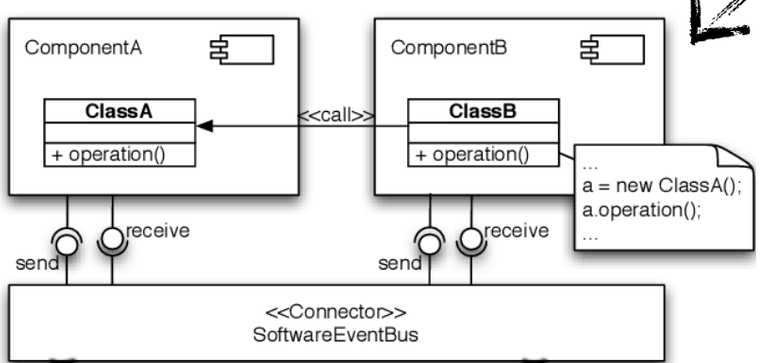
Conclusion



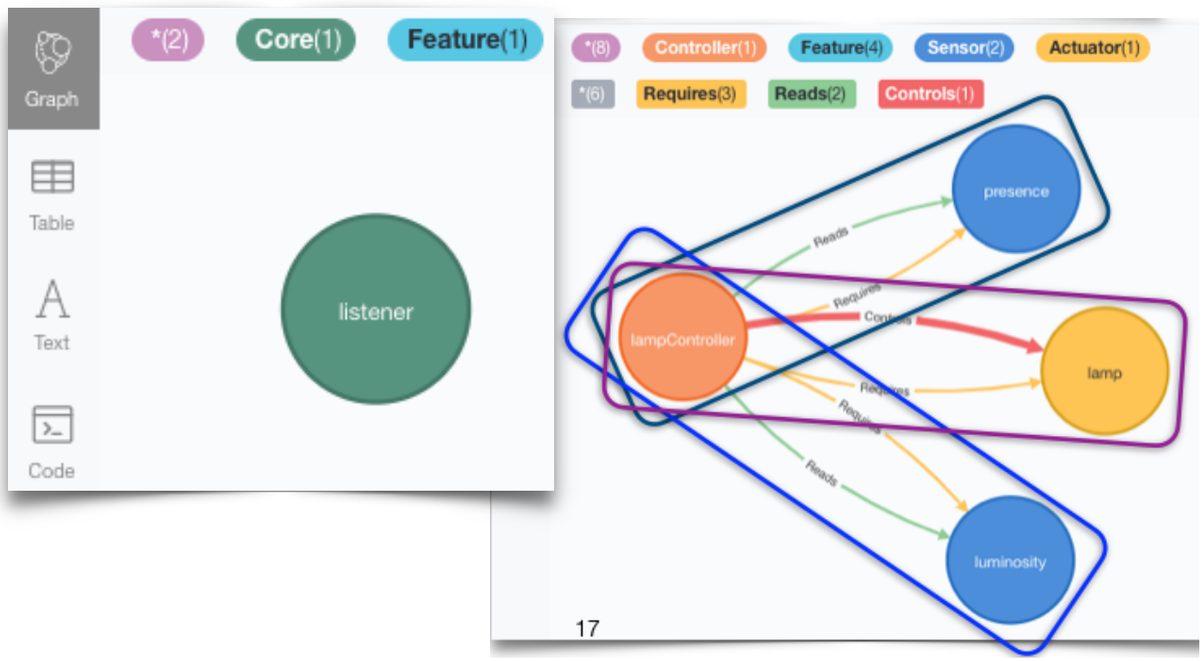
BM Framework



Behavioral Map



Architectural Smell

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Ви благодариме
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