



Leveraging Multi-Level Modeling for Multi-Domain Quality Assessment

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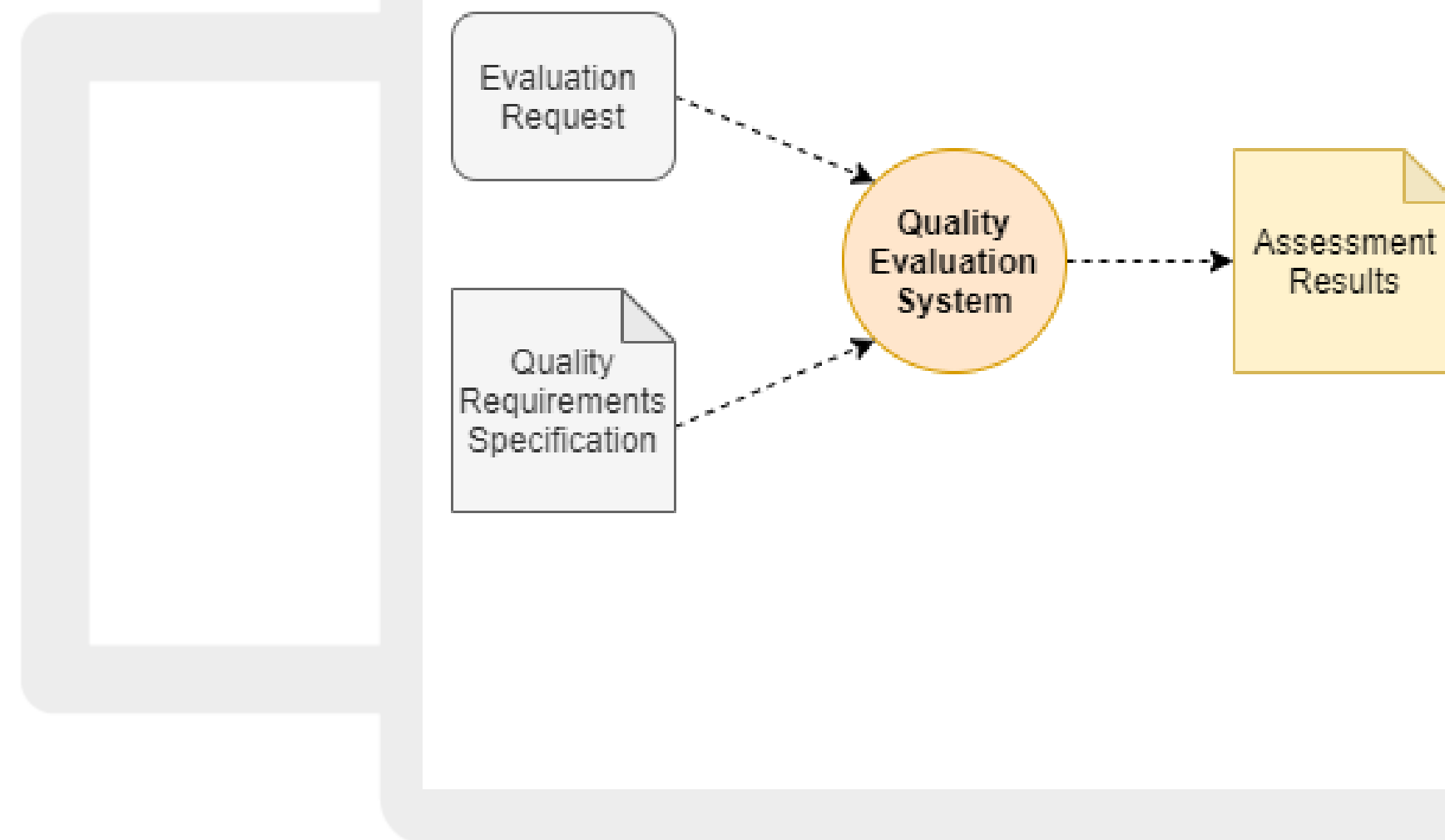
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Quality Evaluation Systems

Quality Evaluation Systems (QESs) are software systems providing *domain-specific quality evaluation* results of given *subjects*.

Quality models express quality as a set of attributes, establishing relationships between them.



Quality Assessment Process

A subject quality assessment process can be formalised as:

$$A_{req}(Subject, Q_m) \rightarrow EQ_m$$

Where:

- A_{req} is the assessment request;
- *Subject* represent the subject under evaluation;
- Q_m is the quality definition model;
- EQ_m is the results of the request as an evaluated quality model.

Running Examples

We identified three case studies sharing similar requests and expected results:

- *Smart City KPIs Evaluation* [1]

$$\text{instanceOf}(\mathbf{SmartCity}, \text{Subject}) \wedge \text{instanceOf}(\mathbf{KPI}_m, Q_m)$$

- *Research Institute Social Impact*

$$\text{instanceOf}(\mathbf{Institute}, \text{Subject}) \wedge \text{instanceOf}(\mathbf{SocialMetrics}_m, Q_m)$$

- *Geographical Region Covid-19 Risk*

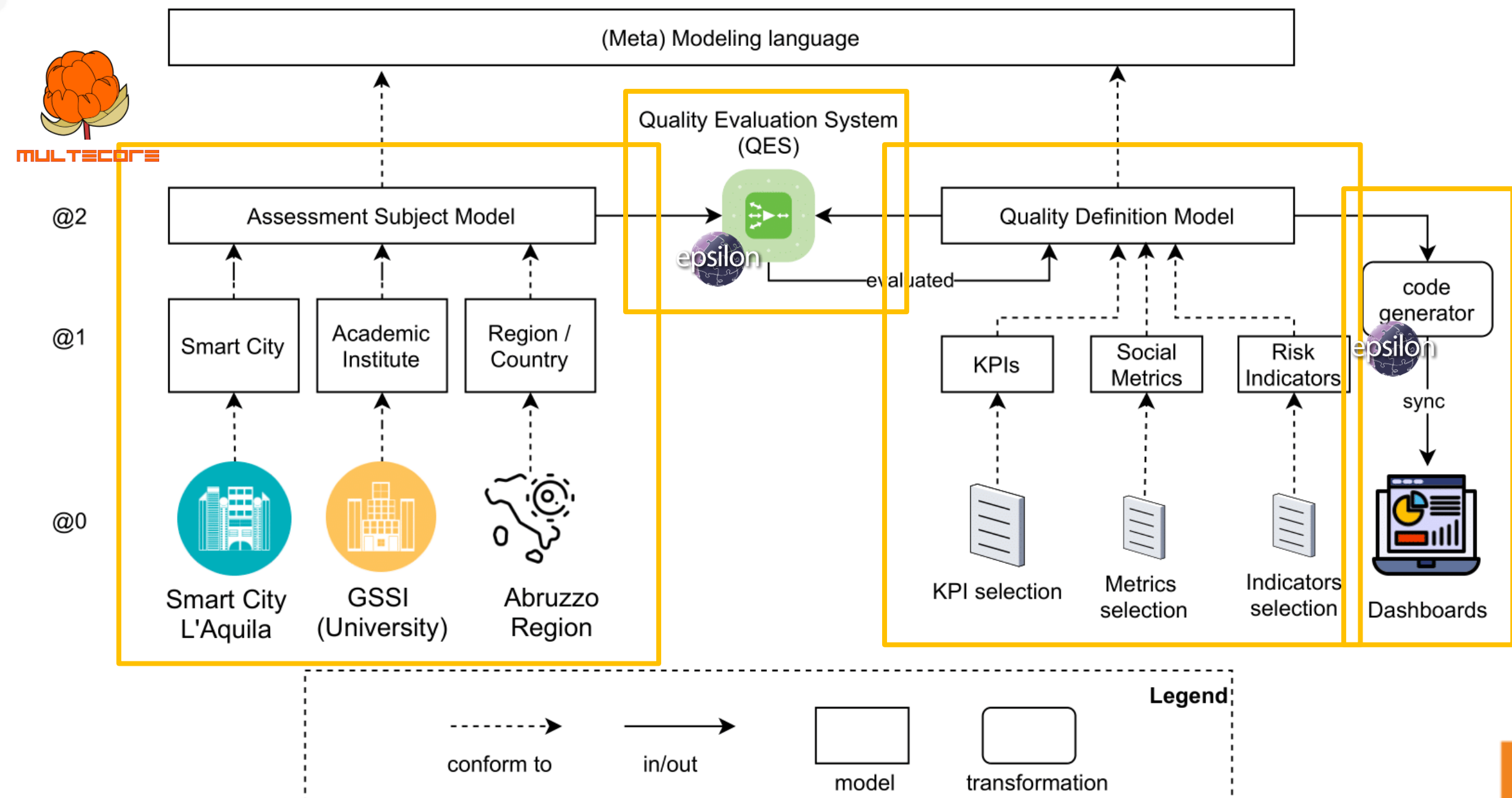
$$\text{instanceOf}(\mathbf{Region}, \text{Subject}) \wedge \text{instanceOf}(\mathbf{RiskIndicators}_m, Q_m)$$

[1] De Sanctis M. et al., *MIKADO - A Smart City KPIs Assessment Modeling Framework*, in Software & Systems Modeling (SoSyM), 2021. **(J1ST@MODELS21)**

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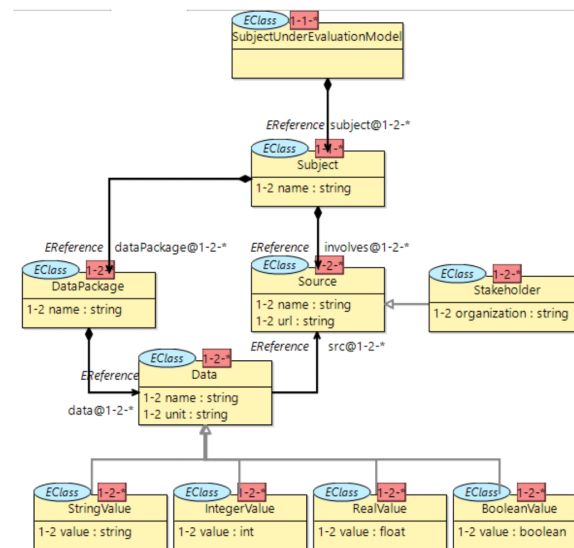
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The Multi-Level Quality Assessment Framework

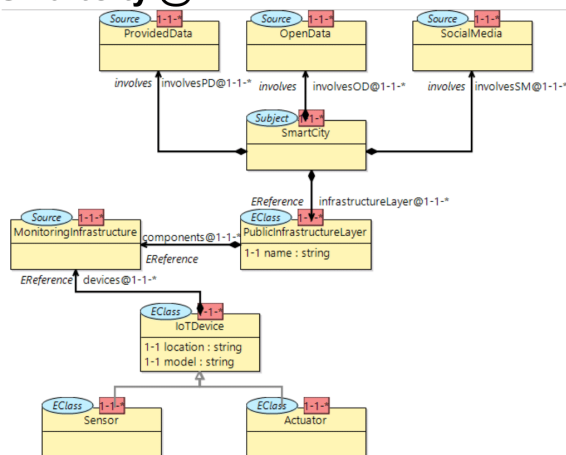


Multi-Level Subject Definition

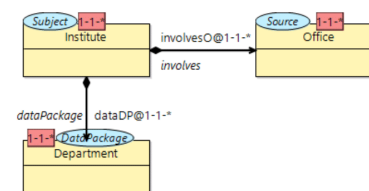
Subject @2



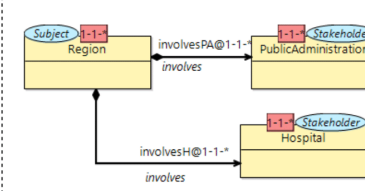
SmartCity @1



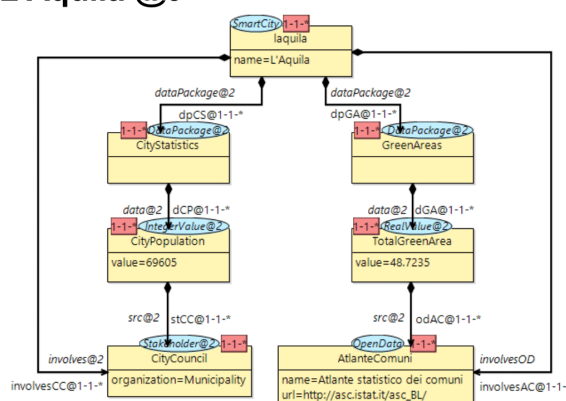
Institute @1



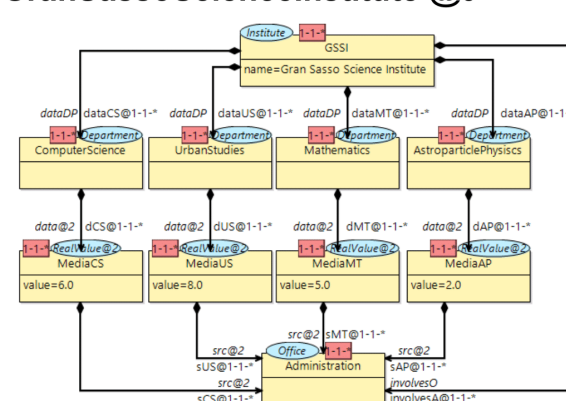
Region @1



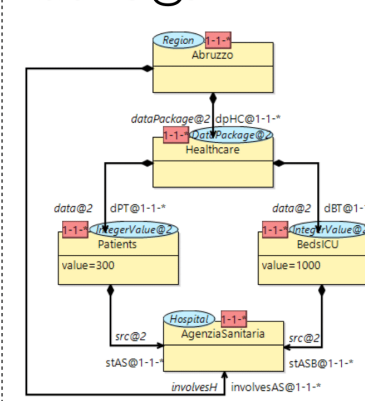
L'Aquila @0



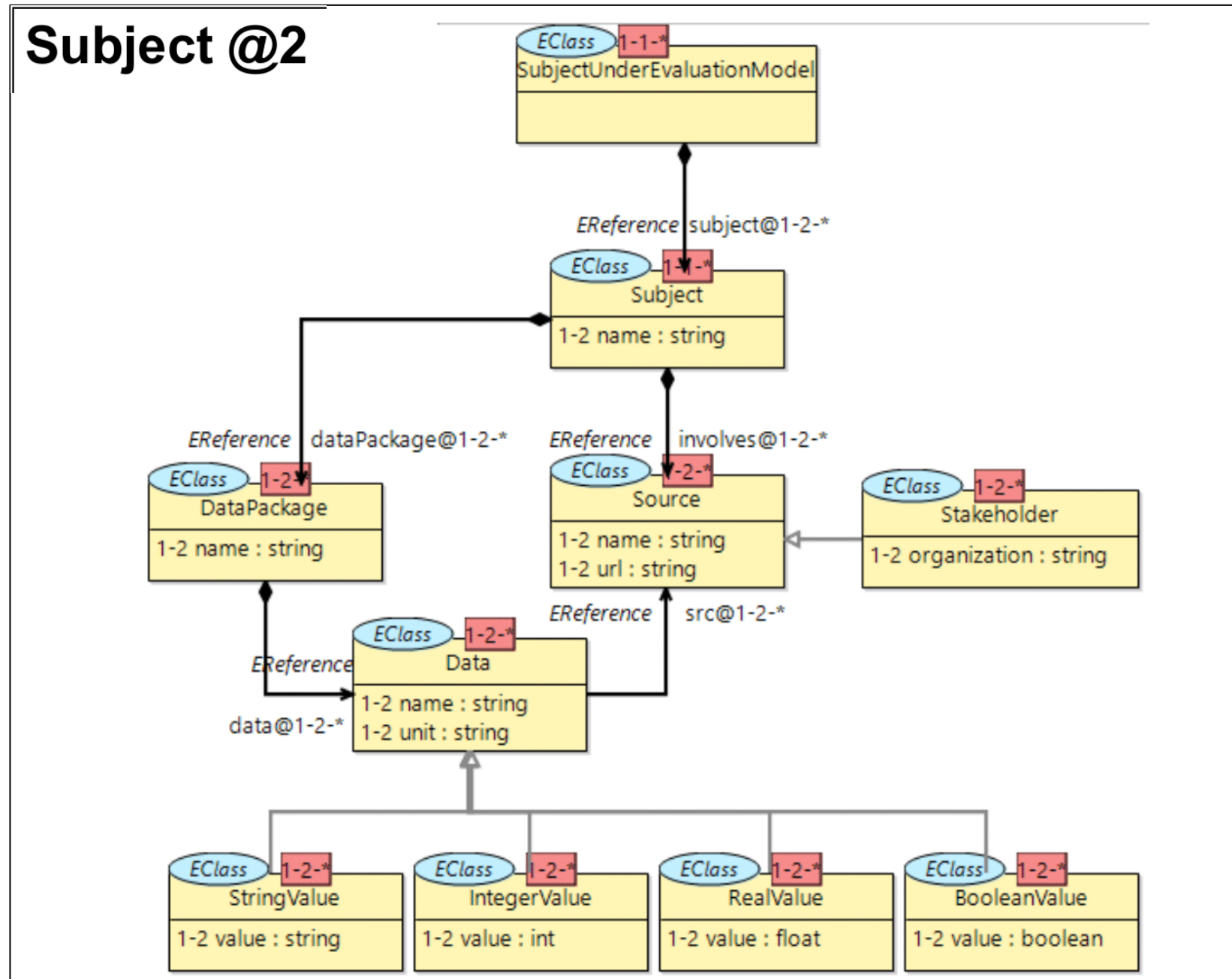
GranSassoScienceInstitute @0



Abruzzo @0

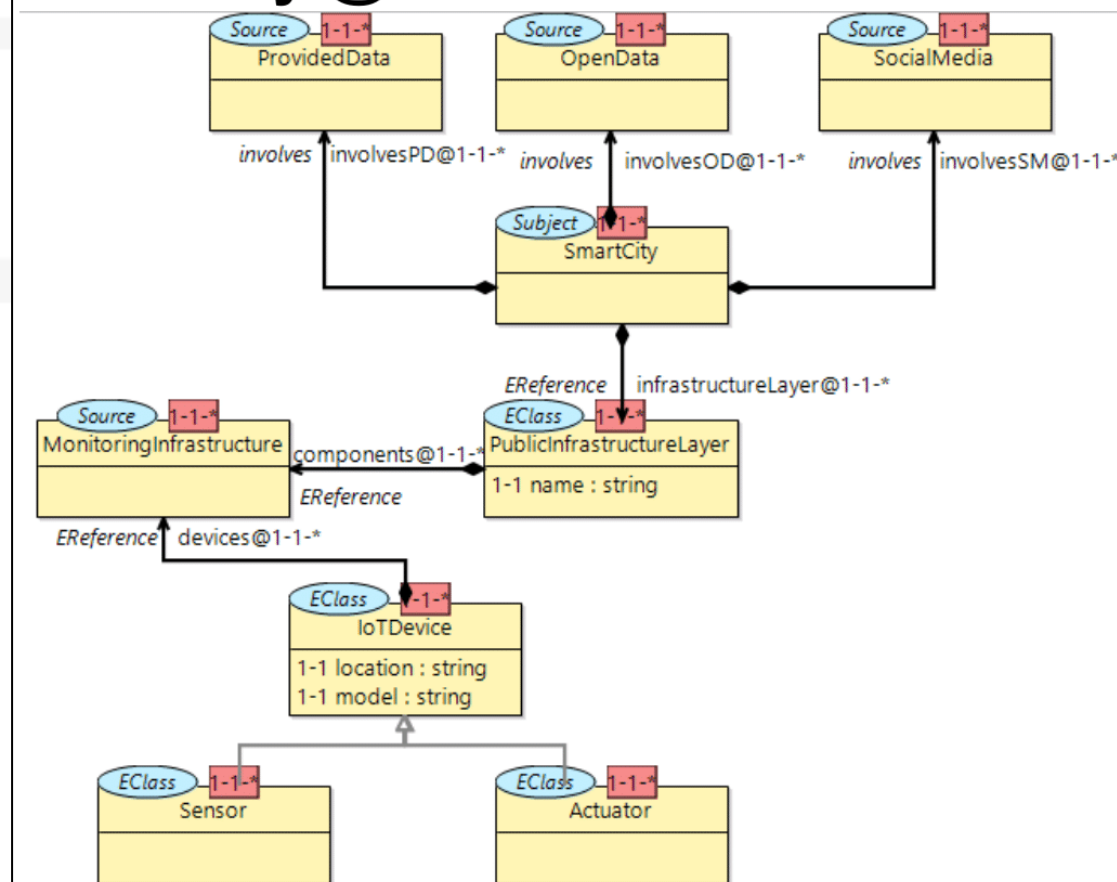


Multi-Level Subject Definition

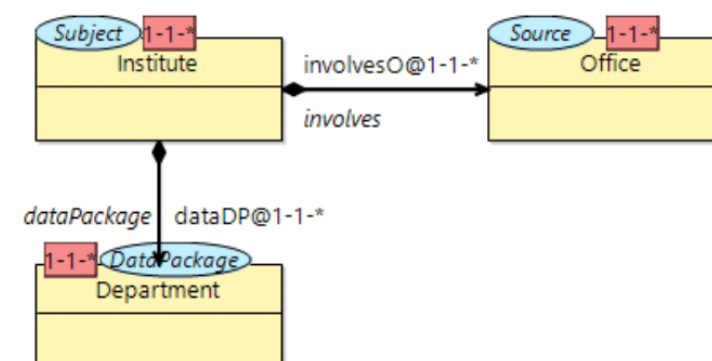


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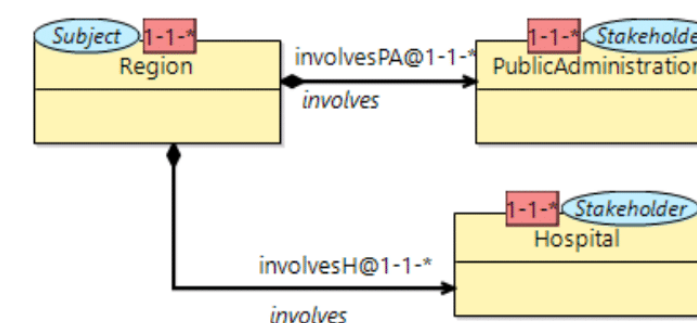
SmartCity @1



Institute @1

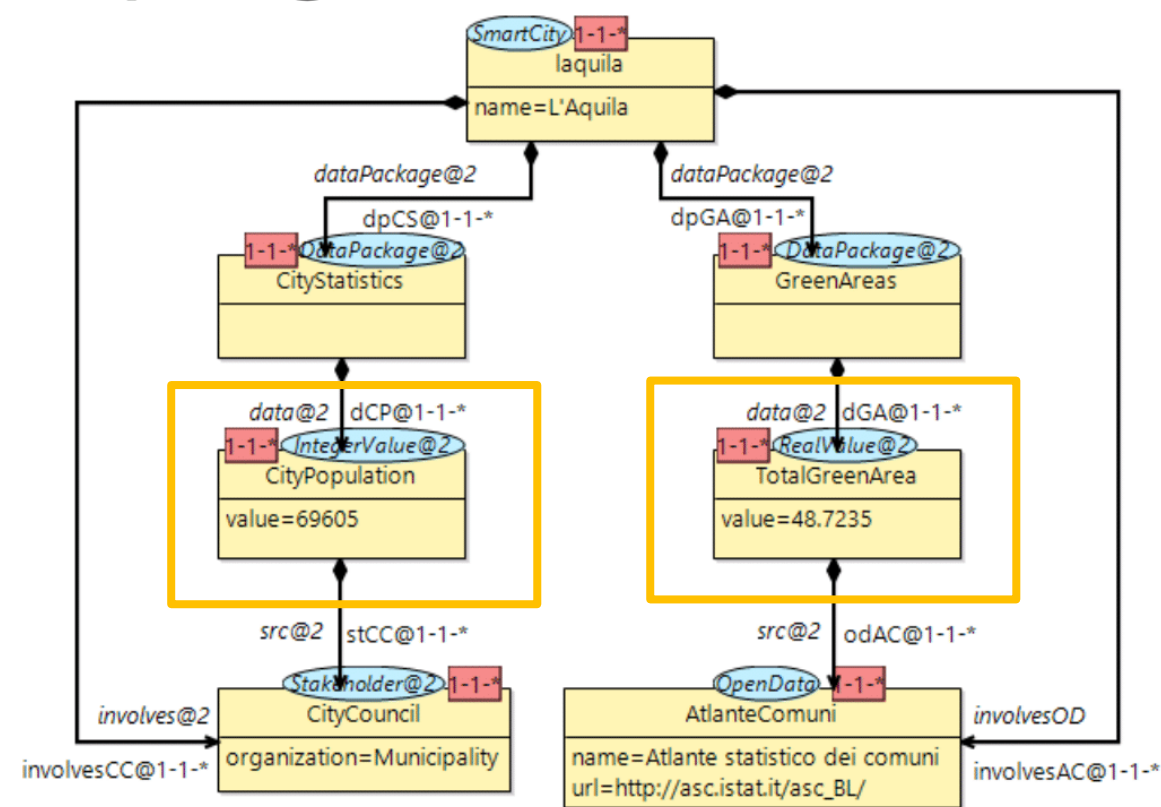


Region @1

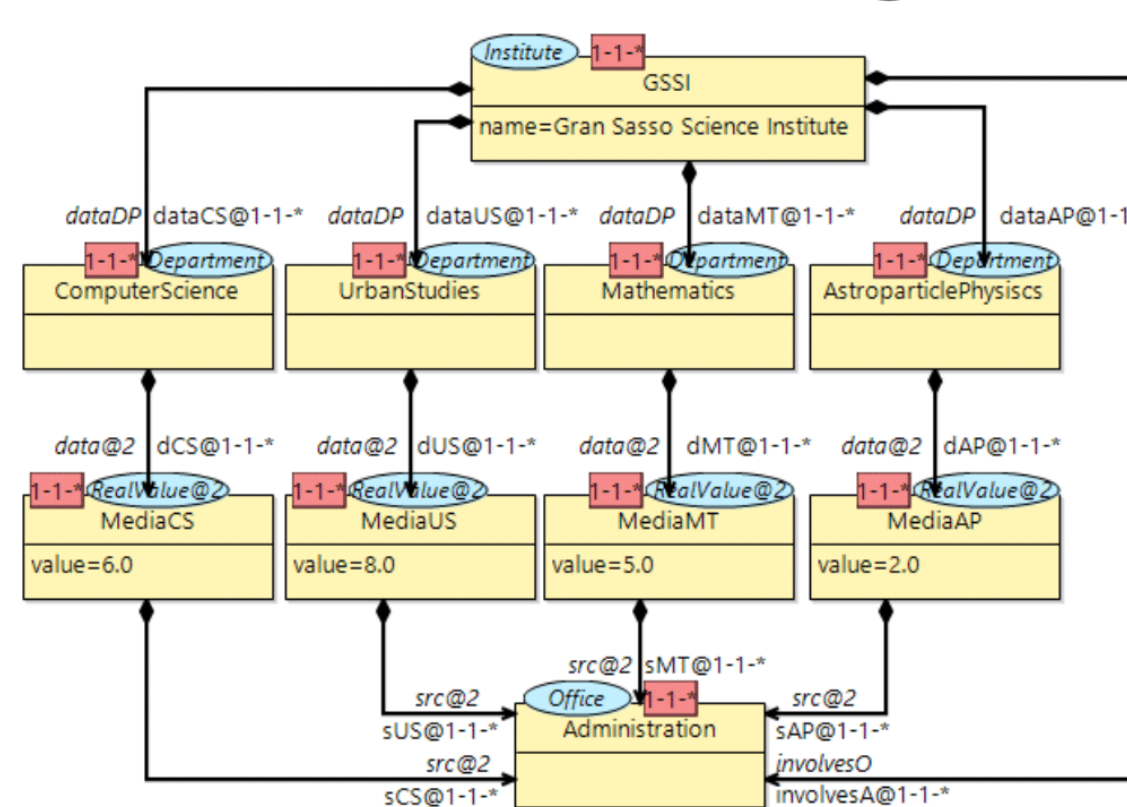


Multi-Level Subject Definition

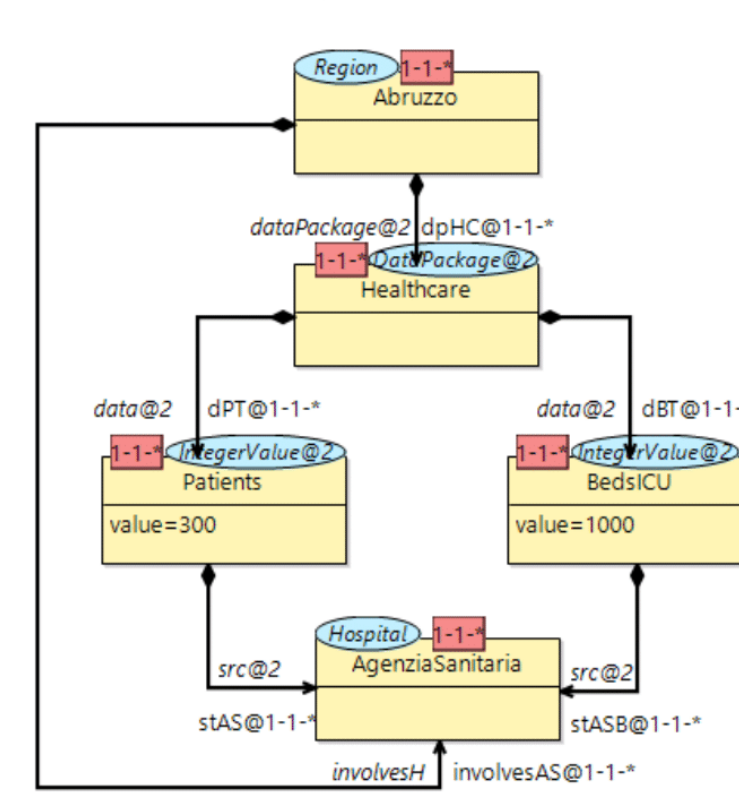
L'Aquila @0



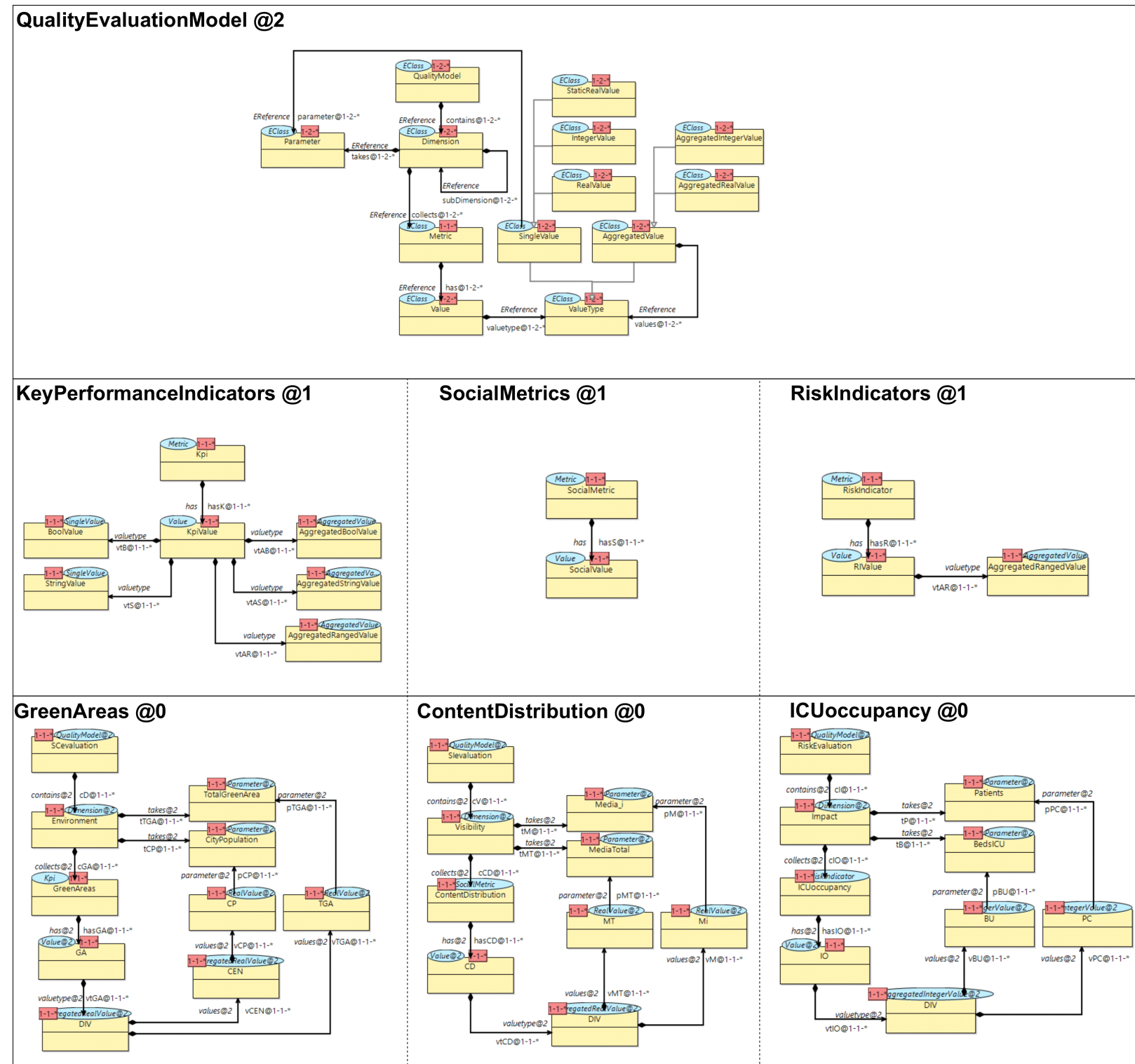
GranSassoScienceInstitute @0



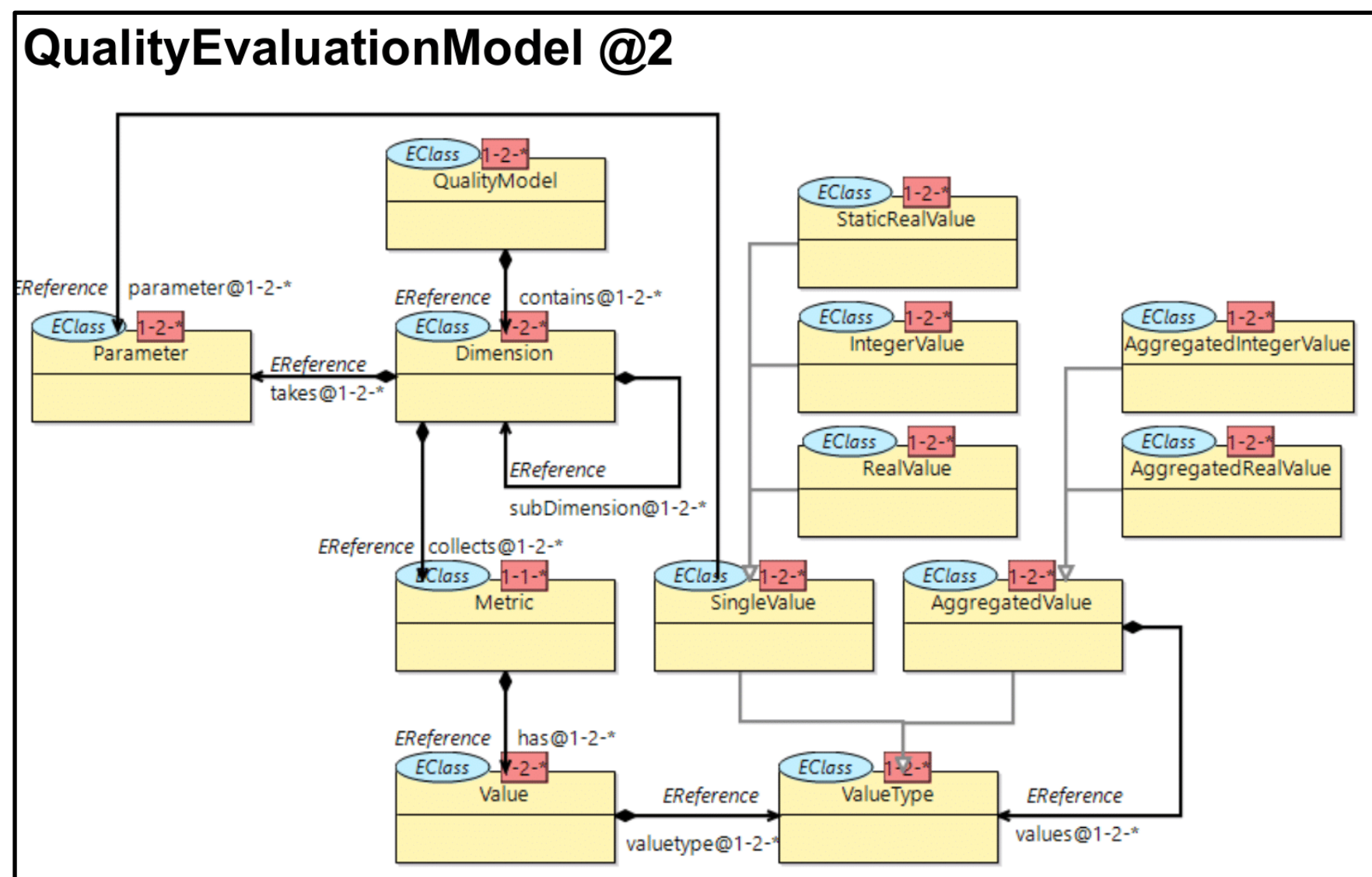
Abruzzo @0



Multi-Level Quality Definition

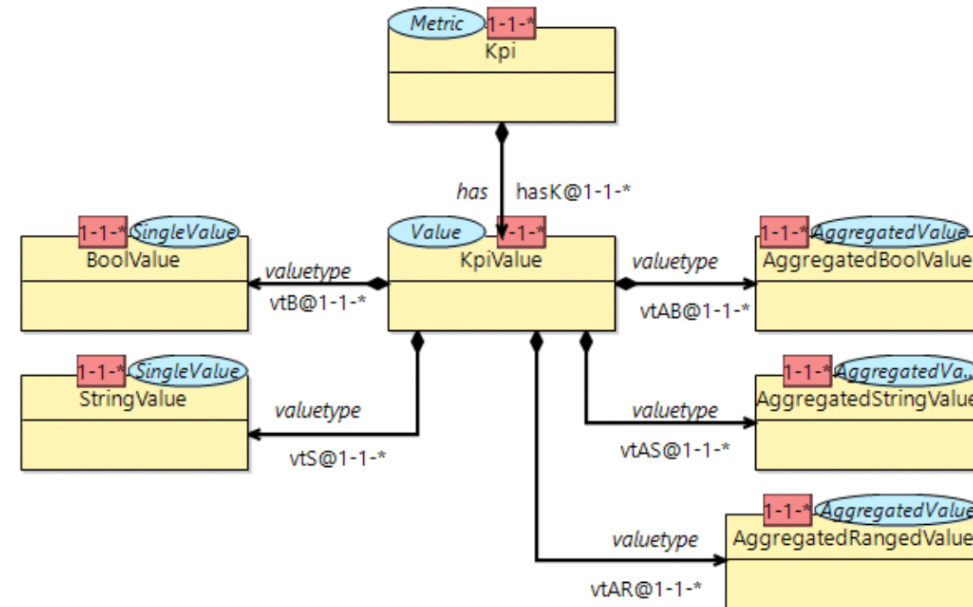


Multi-Level Quality Definition

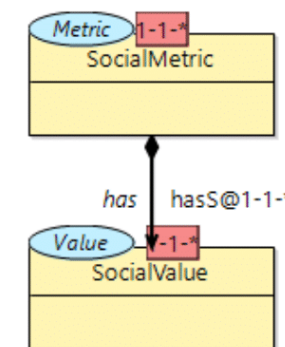


Multi-Level Quality Definition

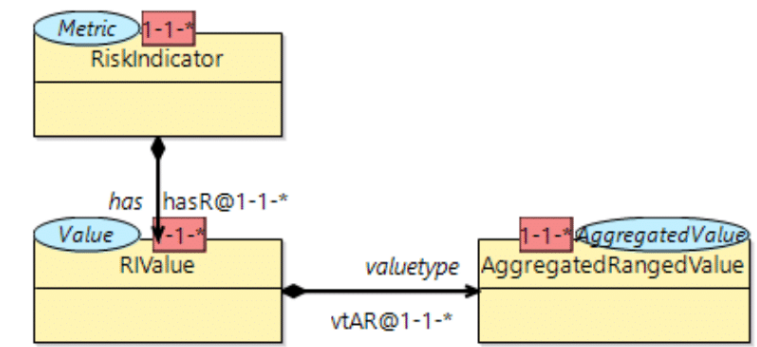
KeyPerformanceIndicators @1



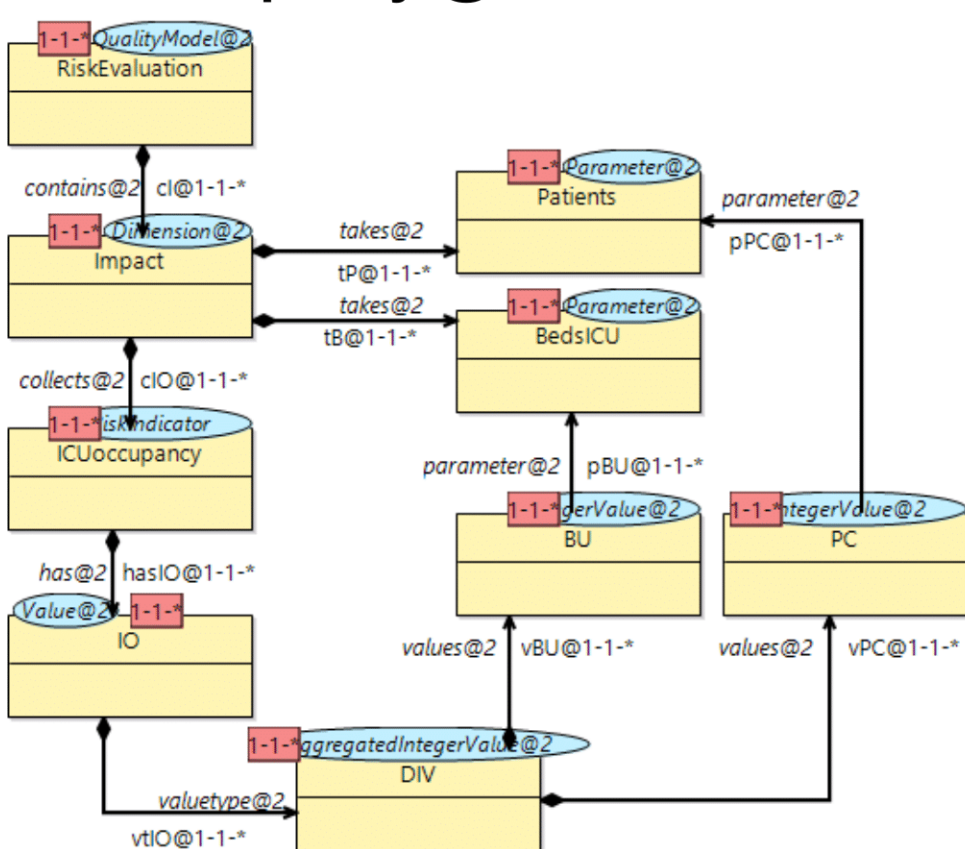
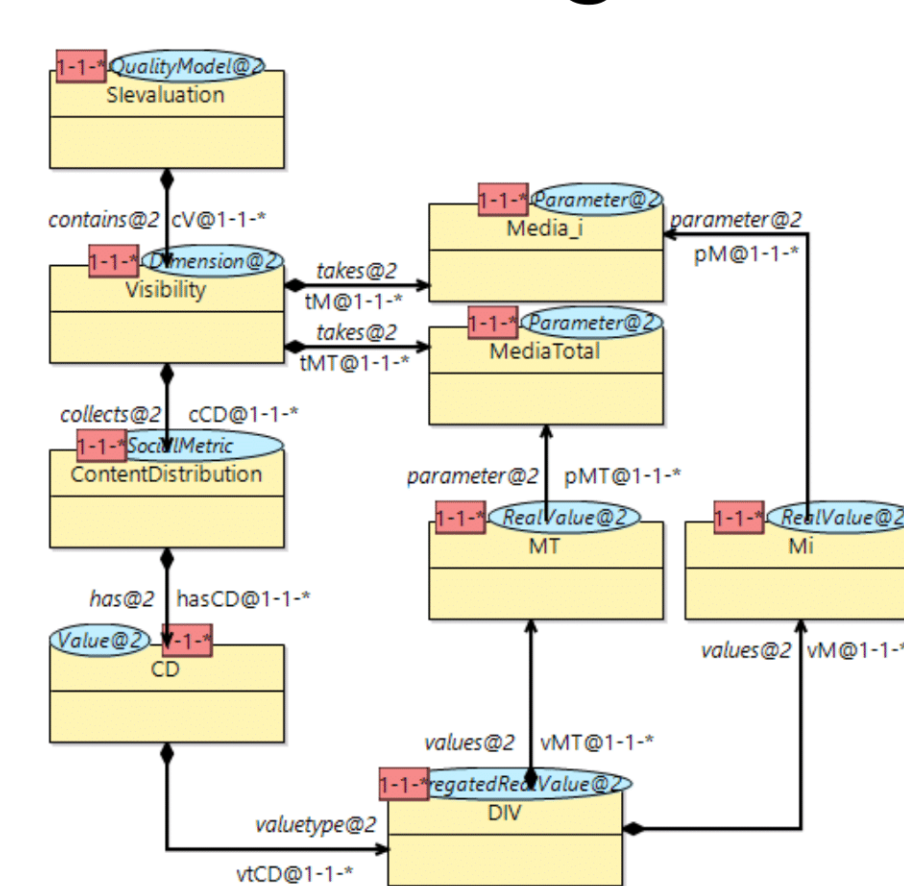
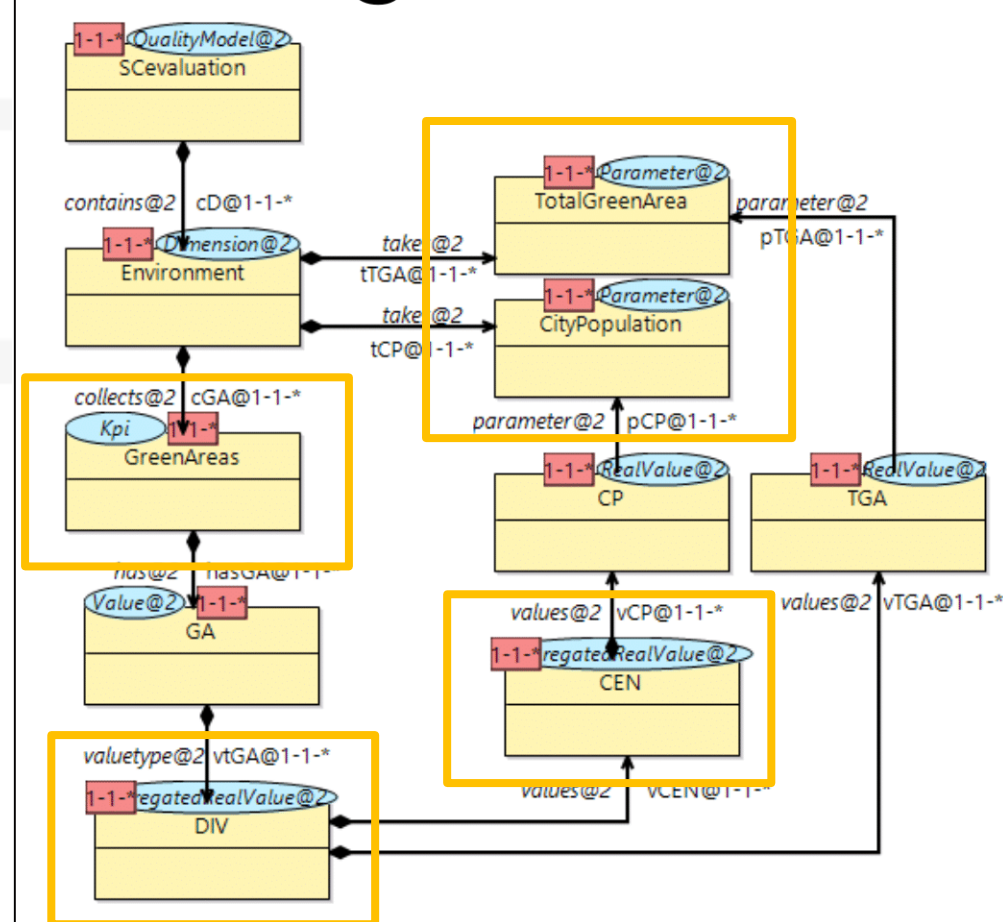
SocialMetrics @1



RiskIndicators @1



Multi-Level Quality Definition



$$GA = \frac{TotalGreenArea}{\frac{1}{100000}} \times CityPop$$

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QES engine

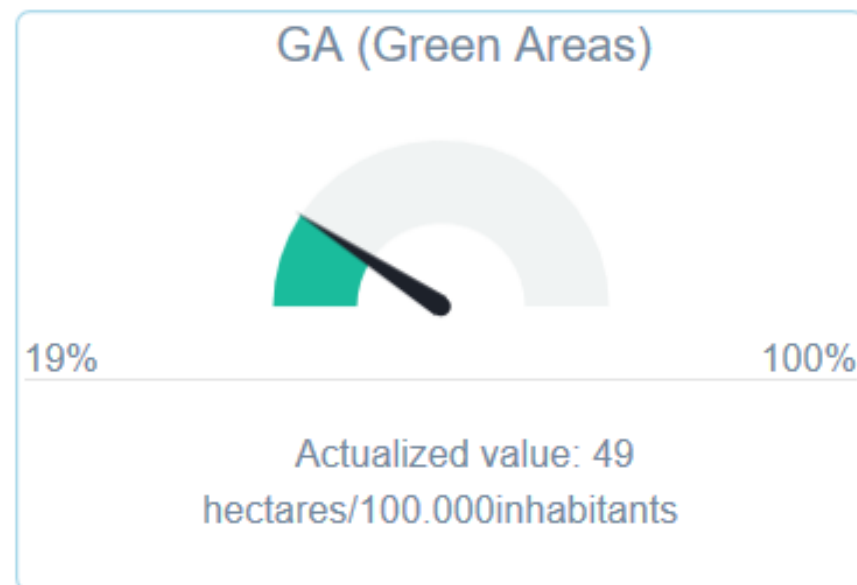
```
1 var root=qm0!EClass.all.selectOne(c|c.name="Root");
2 var qmlpackagename =
    root.eAnnotations.selectOne(ea|ea.source.
3         matches("om=[A-Za-z]*")).source.split("=").second;
4 var mm=qm1!EPackage.all.selectOne(p|p.name=qmlpackagename);
5 var metricclass=
    mm.eClassifiers.selectOne(c|c.eAnnotations.source.
6         flatten().includes("type=Metric"));
7 var qm0metric=metricclass.name;
8 ...
9 for (metric in getMetrics(qm0metric)) {
10     ("Calculating..." + qm0metric + "-->" + metric.name).println();
11     var value=metric.getValue(subject);
12 }
13 ...
14 operation getMetrics(qm0metric:String) {
15     var metrics=qm0!EClass.all.select(c|c.eAnnotations.
16         source.flatten().includes("type="+qm0metric));
17     return metrics;
18 }
19 ...
```

Assessment Results

We performed a total of 3 assessment:

- KPIs over the city of L'Aquila;
- Social metrics over the Gran Sasso Science Institute;
- Risk indicators over the Abruzzo Italian region.

Dashboard - Environment



Dashboard - Activity



Dashboard - Impact

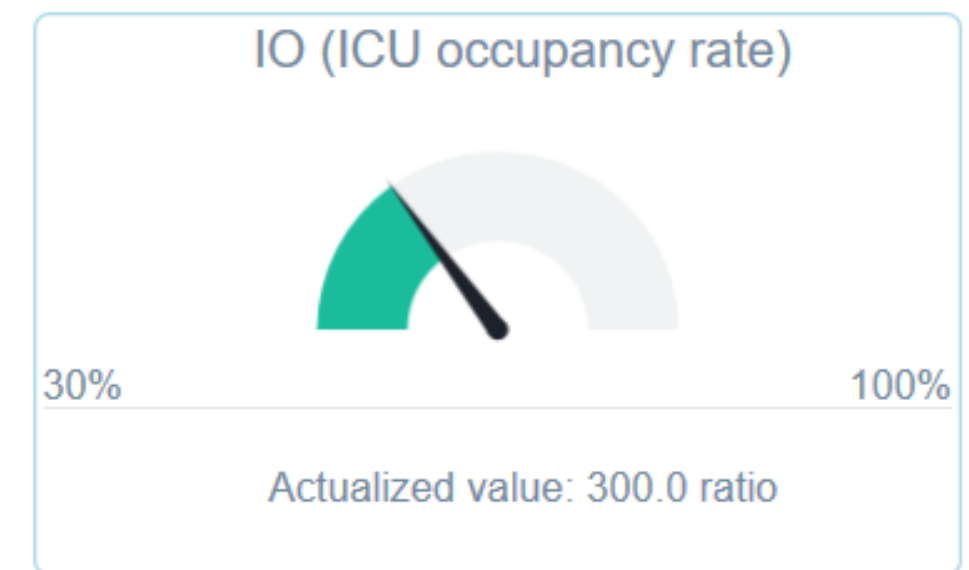


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Conclusion

We presented a *MLM* approach for implementing a **domain-independent QES**.

We showed its feasibility by applying it on three different domains:

- Smart city KPIs assessment;
- Research institute social impact;
- Geographical region covid-19 risk.

Future Work

Finalization of a **Multi-level framework** for quality assessment by:

- Improving the evaluation process relying on String-based annotations;
- Automating the currently manual steps of the process (e.g., manual models export from MultEcore).

Test the approach with a larger number of subjects and requested evaluation metrics.



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Thank you for your
attention.