University of Antwerp
Faculty of Science

muMLE - Demo

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Defining a Meta-Model: Classes

```
Course:Class {
    lower_cardinality = 1;
    upper_cardinality = 5;
    constraint = ‘‘‘
        get_slot_value(this, "students") > 0
    ‘‘‘;
}

Instructor:Class

CourseType:Class {
    abstract = True;
}
Lab:Class
:Inheritance (Lab -> CourseType)
Lecture:Class
:Inheritance (Lecture -> CourseType)
```

Defining a Meta-Model: Attributes

```
Course_coursename:AttributeLink (Course -> String) {
    name = "coursename";
    optional = False;
}

Course_students:AttributeLink (Course -> Integer) {
    name = "students";
    optional = False;
}

Room_seats:AttributeLink (Room -> String) {
    name = "seats";
    optional = False;
}
```

Defining a Meta-Model: Associations

```
courseroom:Association (Course -> Room) {
    target_lower_cardinality = 1;
    target_upper_cardinality = 1;
    source_upper_cardinality = 3;
```

Defining a Meta-Model: Associations (cont.)

```
  constraint = ‘‘‘
    course = get_source(this)
    room = get_target(this)

    roomtype_valid = True
    roomtype = get_type_name(room)
    if roomtype == "ComputerRoom":
      course_type = get_target(get_outgoing(course, "
        coursetype")[0])
      typename = get_type_name(course_type)
      roomtype_valid = typename == "Lab"

    enough_seats = get_slot_value(course, "students") <=
      get_slot_value(room, "seats")

    roomtype_valid and enough_seats
  ‘‘‘;
}
```

Defining a Meta-Model: Global Constraints

```
totalStudentUnder200:GlobalConstraint {
    constraint = ‘‘‘
        total_students = 0
        for _, course_id in get_all_instances("Course"):
            total_students += get_slot_value(course_id, "
                students")

        total_students <= 200
    ‘‘‘;
}
```

Defining a Model: Instantiation

```
smith:Instructor
meyer:Instructor

labtype:Lab
lecturetype:Lecture

comproom:ComputerRoom {
    seats = 20;
}
auditorium1:Auditorium {
    seats = 50;
}
auditorium2:Auditorium {
    seats = 100;
}
```

Defining a Model: Associating

```
programming1:Course {
    coursename = "Programming 1";
    students = 30;
}
:courseinstructor (programming1 -> smith)
:coursetype (programming1 -> lecturetype)
progroom:courseroom(programming1 -> auditorium1)

programmingLab:Course {
    coursename = "Programming Lab";
    students = 15;
}
:courseinstructor (programming1 -> meyer)
:coursetype (programmingLab -> labtype)
:courseroom(programmingLab -> comproom)
```

Parsing and Checking the Model

```
from state.devstate import DevState
from bootstrap.scd import bootstrap_scd
from concrete_syntax.textual_od import parser
from framework.conformance import Conformance,
    render_conformance_check_result

state = DevState()
mmm = bootstrap_scd(state) # Class Diagram Meta-Model
mm = parser.parse_od(state, m_text=mm_classes, mm=mmm) # Our
    Meta-Model
m = parser.parse_od(state, m_text=m1, mm=mm) # Our Model

print("Valid?")
conf = Conformance(state, m, mm)
print(render_conformance_check_result(conf.check_nominal()))
```

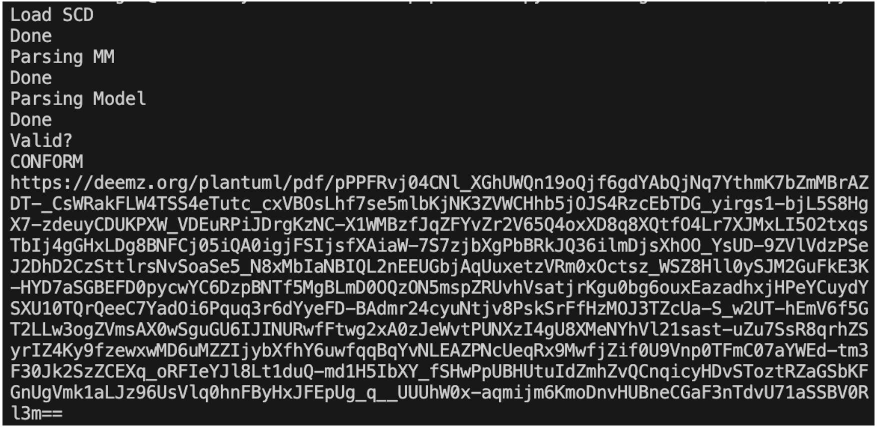
Render to PlantUML (with conformance links)

```
from concrete_syntax.plantuml import renderer as plantuml
from concrete_syntax.plantuml.make_url import make_url

uml = plantuml.render_package("Courses Meta-model", plantuml.
    render_class_diagram(state, mm))
uml += plantuml.render_package("Courses Model", plantuml.
    render_object_diagram(state, m, mm))
uml += plantuml.render_trace_conformance(state, m, mm)
print(make_url(uml))
```

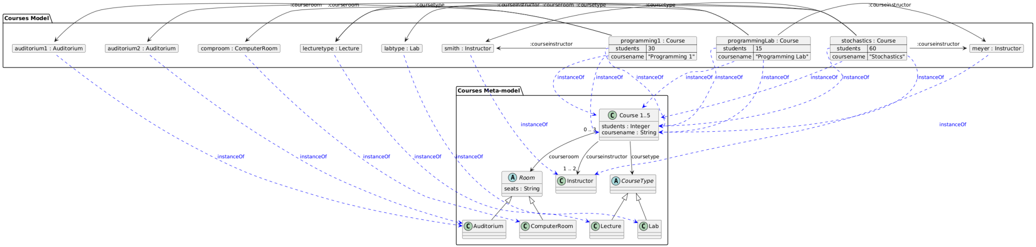
The printed URL can be called directly or otherwise pasted on
https://www.plantuml.com/plantuml/uml

Output (valid)

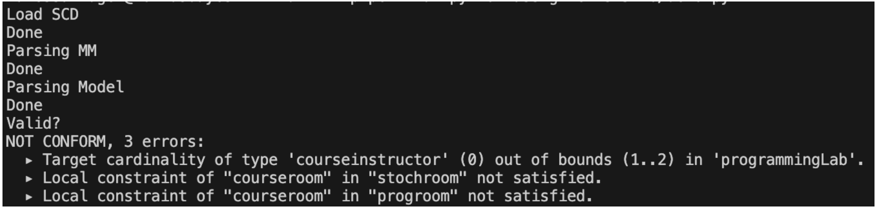


```
Load SCD
Done
Parsing MM
Done
Parsing Model
Done
Valid?
CONFORM
https://deemz.org/plantuml/pdf/pPPFRvj04CNl_XGhUWQn19oQjf6gdYAbQjNq7YthmK7bZmMBrAZ
DT-_CsWRakFLW4TSS4eTutc_cxVBOsLhf7se5mlbKjNK3ZVWCHhb5jOJS4RzcEbTDG_yirgs1-bjL5S8Hg
X7-zdeuyCDUKPXW_VDEuRPiJDrgKzNC-X1WMBzfJqZFYvZr2V65Q4oxXD8q8XQtfO4Lr7XJMxLI5O2txqs
TbIj4gGHxLDg8BNFCj05iQA0igjFSIjsfXAiaW-7S7zjbXgPbBRkJQ36ilmDjsXhOO_YsUD-9ZVlVdzPSe
J2DhD2CzSttlrsNvSoaSe5_N8xMbIaNBIQL2nEEUGbjAqUuxetzVRm0xOctsz_WSZ8Hll0ySJM2GuFkE3K
-HYD7aSGBEFD0pycwYC6DzpBNTf5MgBLmD0OQzON5mspZRUvhVsatjrKgu0bg6ouxEazadhxjHPeYCuydY
SXU10TQrQeeC7YadOi6Pquq3r6dYyeFD-BAdmr24cyuNtjv8PskSrFfHzMOJ3TZcUa-S_w2UT-hEmV6f5G
T2LLw3ogZVmsAX0wSguGU6IJINURwfFtwg2xA0zJeWvtPUNXzI4gU8XMeNYhVl21sast-uZu7SsR8qrhZS
yrIZ4Ky9fzewxwMD6uMZZIjybXfhY6uwfqqBqYvNLEAZPNcUeqRx9MwfjZif0U9Vnp0TFmC07aYWEd-tm3
F30Jk2SzZCEXq_oRFIeYJl8Lt1duQ-md1H5IbXY_fSHwPpUBHUtuIdZmhZvQCnqicyHDvSToztRZaGSbKF
GnUgVmk1aLJz96UsVlq0hnFByHxJFEpUg_q__UUUhW0x-aqmijm6KmoDnvHUBneCGaF3nTdvU71aSSBV0R
l3m==
```

Generated PlantUML Diagram



Output (invalid)



```
Load SCD
Done
Parsing MM
Done
Parsing Model
Done
Valid?
NOT CONFORM, 3 errors:
  ▸ Target cardinality of type 'courseinstructor' (0) out of bounds (1..2) in 'programmingLab'.
  ▸ Local constraint of "courseroom" in "stochroom" not satisfied.
  ▸ Local constraint of "courseroom" in "progroom" not satisfied.
```