



The  
Paraphrased,  
Human-  
Readable  
Adaptation of  
SED-ML

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# Purpose

- Allow fast creation of SED-ML documents
- Allow viewing of SED-ML documents in human-readable form
- Integrate with Python/Tellurium for model creation and simulation.
- SED-ML L1v2

# Example

```
//Created by libphrasedml v0.4 beta
// Models
model_1 = model "00001-sbml-l3v1.xml"

// Simulations
simulation_1 = simulate uniform(0, 5, 51)

// Tasks
task_1 = run simulation_1 on model_1

// Outputs
plot time vs S1 / compartment, S2 / compartment
report time, S1 / compartment, S2 / compartment
```

# General format:

[variable] = [keyword] [details]

model\_1 = model "00001-sbml-l3v1.xml"

simulation\_1 = simulate uniform(0, 5, 51)

task\_1 = run simulation\_1 on model\_1

# Models:

[variable] = model "[filename]"

model\_1 = model "00001-sbml-l3v1.xml"

# Models:

[variable] = model "[filename]"

[variable] = model [othermodel]

model\_1 = model "00001-sbml-l3v1.xml"

model\_2 = model model\_1

# Models:

[variable] = model "[filename]"

[variable] = model [othermodel] with [changes]

model\_1 = model "00001-sbml-l3v1.xml"

model\_2 = model model\_1 with S1=3

# Models:

[variable] = model "[filename]"

[variable] = model [othermodel] with [changes]

model\_1 = model "00001-sbml-l3v1.xml"

model\_2 = model model\_1 with S1=3, S2=S1+4



# Models:

[variable] = model "[filename]"

[variable] = model [othermodel] with [changes]

model\_1 = model "00001-sbml-l3v1.xml"

model\_2 = model model\_1 with S1=3, S2=S1+4

Translates to  
attribute change

# Models:

[variable] = model "[filename]"

[variable] = model [othermodel] with [changes]

model\_1 = model "00001-sbml-l3v1.xml"

model\_2 = model model\_1 with S1=3, S2=S1+4

Translates to  
computeChange

# Models:

[variable] = model "[filename]"

[variable] = model [othermodel] with [changes]

model\_1 = model "00001-sbml-l3v1.xml"

model\_2 = model model\_1 with  $x=3$ ,  $S2=x^2$

# Models:

[variable] = model "[filename]"

[variable] = model [othermodel] with [changes]

model\_1 = model "00001-sbml-l3v1.xml"

model\_2 = model model\_1 with  $x=3$ ,  $S2=x^2$

No 'x' in model:  
becomes local  
parameter

# Models:

[variable] = model "[filename]"

[variable] = model [othermodel] with [changes]

model\_1 = model "00001-sbml-l3v1.xml"

model\_2 = model model\_1 with x=3, S2=x<sup>2</sup>

Still translates to  
computeChange

# Models (future work?):

[variable] = model "[filename]"

[variable] = model [othermodel] with [changes]

model\_1 = model "00001-sbml-l3v1.xml"

model\_2 = model model\_1 with ~~add~~ p1=3

model\_2 = model model\_1 with ~~remove~~ J0

# Simulations:

[variable] = simulate [simulation]

sim1 = simulate steadystate

# Simulations:

[variable] = simulate [simulation]

sim1 = simulate steadystate

sim2 = simulate uniform(0,10,100)

sim3 = simulate uniform(0,5,10,50)



# Simulations:

[variable] = simulate [simulation]

sim1 = simulate steadystate

sim2 = simulate uniform(0,10,100)

sim3 = simulate uniform(0,5,10,50)

sim4 = simulate uniform\_stochastic(0,10,100)

sim5 = simulate uniform\_stochastic(0,5,10,50)

# Simulations:

[variable] = simulate [simulation]

sim1 = simulate steadystate

sim2 = simulate uniform(0,10,100)

sim3 = simulate uniform(0,5,10,50)

sim4 = simulate uniform\_stochastic(0,10,100)

sim5 = simulate uniform\_stochastic(0,5,10,50)

sim6 = simulate onestep(0.5)

# Tasks:

[variable] = run [simulation] on [model]

task1 = run sim1 on model1

# Repeated Tasks:

[variable] = repeat [task] for [loop]

task1 = run sim1 on model1

task2 = repeat task1 for S1 in uniform(1,10,50)

# Repeated Tasks:

[variable] = repeat [task] for [loop]

task1 = run sim1 on model1

task2 = repeat task1 for S1 in uniform(1,10,50)

task3 = repeat task1 for S1 in logUniform(1,10,20)

# Repeated Tasks:

[variable] = repeat [task] for [loop]

task1 = run sim1 on model1

task2 = repeat task1 for S1 in uniform(1,10,50)

task3 = repeat task1 for S1 in logUniform(1,10,20)

task4 = repeat task1 for S1 in [1, 3, 6, 10]

# Repeated Tasks:

```
[variable] = repeat [task] for [loop], reset=true
```

```
task1 = run sim1 on model1
```

```
task2 = repeat task1 for S1 in [1,3,6], reset=true
```

# Repeated Tasks:

[variable] = repeat [task] for [loop], [changes]

task1 = run sim1 on model1

task2 = repeat task1 for S1 in [1,3,6], S2=3



# Repeated Tasks:

[variable] = repeat [task] for [loop], [changes]

task1 = run sim1 on model1

task2 = repeat task1 for S1 in [1,3,6], S2 in [3,6,7]

# Repeated Tasks:

[variable] = repeat [task, task, ...] for [loop]

task1 = run sim1 on model1

task2 = run sim1 on model2

task3 = repeat [task1, task2] for S1 in [1,3,6]

# Repeated Tasks:

[variable] = repeat [task, task, ...] for [loop]

task1 = run sim1 on model1

task2 = run sim1 on model2

task3 = repeat [task1, task2]  
for model1.S1 in [1,3,6],  
model2.S1 in [5,5,8]

# Output:

plot [variable] vs [variable]

plot S1 vs S2

# Output:

plot [variable] vs [variable]

plot S1 vs S2

plot task1.S1 vs task1.S2

# Output:

```
plot [xvariable] vs [yvariable1], [yvariable2]
```

```
plot time vs S1, S2
```

# Output:

plot [xvariable] vs [yvariable] vs [zvariable]

plot S1 vs S2 vs S3

# Output:

```
plot [xvariable] vs [yvariable1] vs [zvariable1],  
      [yvariable2] vs [zvariable2]
```

```
plot time vs S1 vs S2, p1 vs p2
```



# Output:

`plot [formula] vs [formula]`

`plot time vs S1/compartment1`

`plot time vs p1, p1^2, p1^4`

`plot S1/compartment1 vs S2/compartment1`

# Output:

report [formula], [formula], [formula] [...]

report time, S1, S2, S3/comp1

# Examples: 1d parameter scan

```
model1 = model "oscli.xml"  
timecourse1 = simulate uniform(0, 20, 1000)  
task0 = run model1 with timecourse1  
task1 = repeat task0 for J0_v0 in [8, 4, 0.4] with reset  
plot task1.time vs task1.S1, task1.S2
```

# Examples: 2d parameter scan

```
model_3 = model "borisejb.xml"  
sim_repeat = simulate steadystate  
task_1 = run model_3 with sim_repeat  
repeatedtask_1 = repeat task_1 for J1_KK2  
                in [1, 5, 10, 50, 60, 70, 80, 90, 100]  
repeatedtask_2 = repeat repeatedtask_1 for J4_KK5  
                in uniform(1, 40, 100)  
plot repeatedtask_2.J4_KK1 vs repeatedtask_2.MKK_1,  
    repeatedtask_2.MKK_P_1
```

# Integration with Python/Tellurium

- API:
  - `convertFile("filename")`
  - `convertString("model")`
  - `getLastError()`
  - `setWorkingDirectory("path/to/files")`

# Integration with Python/Tellurium

```
import phrasedml as pml
phrasedmlstr = """
    model_1 = model "00001-sbml-l3v1.xml"
    simulation_1 = simulate uniform(0, 5, 51)
    task_1 = run simulation_1 on model_1
    plot time vs S1 / compartment, S2 / compartment
    report time, S1 / compartment, S2 / compartment
    """
sedml = pml.convertString(phrasedmlstr)
```



# Integration with Python/Tellurium

```
import tellurium as te
antimonystr = """
model ex1
  S1 -> S2; k1*S1
  S1=10; S2=0; k1=0.1
end
"""

phrasedmlstr = """
model_1 = model "ex1"
simulation_1 = simulate uniform(0, 5, 50)
task_1 = run simulation_1 on model_1
plot time vs S1, S2
"""

exp1 = te.experiment(antimonystr, phrasedmlstr)
exp1.execute()
```





# Repeated Tasks:

[variable] = repeat [task, task, ...] for [loop]

task1 = run sim1 on model1

task2 = run sim1 on model2

task3 = repeat [task1, task2]  
          for model1.S1 in [1,3,6],  
              model2.S1 in [5,5,8]

# Repeated Tasks:

[variable] = repeat [task, task, ...] for [loop]

task1 = run sim1 on model1

task2 = run sim2 on model1

task3 = repeat [task1, task2]  
for task1.S1 in [1,3,6],  
task2.S1 in [5,5,8]

Technically illegal  
in SED-ML L1v2

# SIDEBAR: referencing nested model variables

[variable] = repeat [task, task, ...] for [loop]

t1 = run sim1 on mod1

t2 = run sim1 on mod2

t3 = run sim2 on mod1

t4 = repeat [t1, t2, t3] for mod1 S1 in [1,3,6]

Which mod1?

# SIDEBAR: referencing nested model variables

[variable] = repeat [task, task, ...] for [loop]

t1 = run sim1 on mod1

t2 = run sim1 on mod2

t3 = run sim2 on mod1

t4 = repeat [t1, t2, t3] for t1.mod1 S1 in [1,3,6]

Illegal in L1v2,  
but possible

# SIDEBAR: referencing nested model variables

[variable] = repeat [task, task, ...] for [loop]

t1 = run sim1 on mod1

t2 = run sim1 on mod2

t3 = run sim2 on mod1

t4 = repeat [t1, t2, t3] for t1.mod1.S1 in [1,3,6]

t5 = repeat [t1, t2, t3] for t3.mod1.S1 in [3,6,10]

t6 = repeat [t4, t5] for t4.t2.mod2.S1 in [0,1,10]



Impossible in L1v2 (and not implemented in phraSED-ML)

# Output:

plot [variable] vs [variable]

plot S1 vs S2

plot task1.S1 vs task1.S2

# Output:

plot [variable] vs [variable]

plot S1 vs S2

plot task1.S1 vs task1.S2

plot task1.mod1.S1 vs task1.mod2.S2

# Output:

plot [variable] vs [variable]

plot S1 vs S2

plot task1.S1 vs task1.S2

plot task1.mod1.S1 vs task1.mod2.S2

plot task4.task1.mod2.S1 vs task4.task2.mod1.S2



# Output:

plot [variable] vs [variable]

plot S1 vs S2

plot task1.S1 vs task1.S2

plot task1.mod1.S1 vs task1.mod2.S2

~~plot task4.task1.mod2.S1 vs task4.task2.mod1.S2~~

# Issues

- ‘FunctionalRange’ seems to be useless
  - Repeats ‘computeChange’ functionality without adding anything
  - Does not actually allow dynamically-sized ranges (?)
- Impossible to reference deeply-nested models in repeatedTasks.



# Examples: comparisons

```
model1 = model "BIOMD0000000021.xml"
```

```
model2 = model model1 with V_mT = 0.28, V_dT = 4.8
```

```
simulation1 = simulate uniform(0, 380, 1000)
```

```
task1 = run simulation1 on model1
```

```
task2 = run simulation1 on model2
```

```
plot task1.time vs task1.Mt
```

```
plot task2.time vs task2.Mt
```

```
plot task1.Cn vs task1.Mt
```

```
plot task2.Cn vs task2.Mt
```

# Examples: repeated stochastic

```
model1 = model "C:\borisejb.xml"
```

```
timecourse1 = simulate uniform_stochastic(0, 4000, 1000)
```

```
task0 = run model1 with timecourse1
```

```
task1 = repeat task0 for uniform(0, 10, 10) with reset
```

```
plot task1.time vs task1.MAPK, task1.MAPK_P,  
task1.MAPK_PP, task1.MKK,  
task1.MKK_P, task1.MKKK, task1.MKKK_P
```