Modeling Structural - Dynamics Systems in MODELICA/Dymola, MODELICA/Mosilab and AnyLogic

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Working task

Given:
The problem definition of the constrained pendulum like in ARGESIM Comparison 7.

Wanted:
Capable simulation environment with an easy to use, object oriented interface.
Problem definition

- What is standard in advanced modeling and simulation?
- Where are the problems?
- How to deal with them?
- Is there a standard test example?
Constrained pendulum
Basic formulars

\[ \dot{\phi} = \frac{v}{l}, \quad \dot{v} = -g \sin \phi - \frac{d}{m} v \]
Simulator - Dymola
Simulator - Mosilab
Solution methods

- Algorithm section
- Parameter state event
- Model switching
  - two instances of one model
  - two separate submodel definitions
Algorithm section

Benefits:
- Modelica standard notation (Dymola, Mosilab, OpenModelica, …)
- Fast modeling

Disadvantages:
- No graphical interface
- Limited applicability

```plaintext
algorithm
if (phi<=phipin) then
    length:=ls;
end if;
if (phi>phipin) then
    length:=l1;
end if;
```
Parameter state event

Simulators include the option of statechart in the model description interface:

- Textual (in Mosilab directly, in AnyLogic only in Java)
- Graphical (both simulators in UML)

```plaintext
equation
  lengthen=(phi>phi_in); shorten=(phi<=phi_in);
  ... here /*pendulum*/ -equations

statechart
  state LengthSwitch extends State;
      State Short,Long,Initial(isInitial=true);
transition Initial -> Long end transition;
transitionLong->Short event shorten action
    length := 1s;
end transition;
transitionShort->Long event lengthen action
    length := 11;
end transition;
end LengthSwitch;
```
Model switching

Constrained Pendulum

- Start
- Shorten
- Lengthen

Long

Short
Model switching

Constrained Pendulum

start

Pendel 1

shorten

Pendel 2

lengthen
Results
## Results

<table>
<thead>
<tr>
<th>Simulator</th>
<th>Time point</th>
<th>Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dymola/Modelica</td>
<td>6.72198</td>
<td>Dassl</td>
</tr>
<tr>
<td></td>
<td></td>
<td>500 intervals</td>
</tr>
<tr>
<td>Mosilab/Modelica Switch models</td>
<td>6.7204</td>
<td>IDA Dassl</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Min. step 1e-6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Max. step 0.08</td>
</tr>
<tr>
<td>Mosilab/Modelica Pure Modelica</td>
<td>6.7199</td>
<td>Impl. Trapez</td>
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<td>Min. step 1e-6</td>
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<td>Max. step 1e-4</td>
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<tr>
<td>Mosilab/Modelica Parameter</td>
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<td>IDA Dassl</td>
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<tr>
<td>switching</td>
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<td>Min. step 1e-6</td>
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<td></td>
<td></td>
<td>Max. step 0.08</td>
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<tr>
<td>AnyLogic</td>
<td>6.725</td>
<td>No influence</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Step size 0.001</td>
</tr>
</tbody>
</table>
Conclusion

• What is standard in advanced modeling and simulation?
  - Modelica standard for model exchange
  - UML
  - combination of both

• Problems in solution generation:
  - limited state event handling (Dymola)
  - restriction in the choose of simulation methods (Mosilab)
  - no state event finding, fixed solution method (AnyLogic)
THANK YOU FOR YOUR ATTENTION!