Snoopy - A Tool to Design and Animate/Simulate Graph-based Formalisms

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http://www-dssz.informatik.tu-cottbus.de/software/snoopy.html

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Basic Properties

extensible

- generic design facilitates the addition of new graph classes

adaptive

- simultaneous use of several graph types in a homogeneous environment
- GUI adopts dynamically to graph type in active window

platform independent

- implementation in C++ and wxWidgets framework
- supported for Windows, Linux, and Mac
Model Editor

Model Creation

- graph constraints are considered
- hierarchy by subgraphs
- logical (fusion) nodes
- interaction between graphs
Model Editor

Model Exploration

- forward and backward animation with different firing rules
- dedicated simulation using different algorithms
- various shapes and colours for net elements
- dynamic colouring of graph elements (e.g. paths or invariants)
- automated layout (graphviz)
Model Editor

File Handling

- generic XML file format
- digital signature for graphs by MD5-checksum
- conversion between contained graph classes
- export to external analysis tools
- import from convenient file formats
Reachability Graph

- simple graph class
- one node and one edge type
- furthermore comment nodes
- constructable from Petri net animation
Petri Net

- contains places and transitions as well as hierarchy and logical nodes
- animation of the token game
- interaction manager allows to construct the reachability graph
- export to a wide range of external analysis tools (INA, Lola, Maria, MC-Kit, Pep, Prod, Charlie...) 
- import of a restricted APNN file format
Stochastic Petri Net

- stochastic Petri nets
- generalized stochastic Petri nets
- deterministic and stochastic Petri nets
- biochemically propensity functions (mass-action, level)
- multiple initial markings, parameter sets, and function sets
- Gillespie algorithm for simulation
- export to PRISM, TimeNet, and Dizzy is in preparation
Continuous Petri Net

- corresponds to a set of ordinary differential equations
- visualizes the structure
- for a quantitative description of biochemical reaction networks
- six stiff and six unstiff solvers are available
- multiple initial markings and parameter sets
- export to SBML
Further Petri Net Classes

Extended Petri Net

- with additional arcs (inhibitor, read, reset, equal)

Time Petri Net

- up to now time intervals or durations for transitions
- export to INA

Modulo Net

- Petri net with modulo arc for counting transitions firing
Fault Tree

- for risk management of dependable systems
- describes dependencies of component based systems
- qualitative and quantitative analysis
- several dependability measures may be computed

Diagram:
- Top node labeled with \( \geq 1 \)
- Nodes labeled with \( e_1, e_2, e_3, v \)
- Connectors labeled with \&
Other Graph Classes

**MTBDD**
- for documentation and small case studies

**EDL Signature Nets**
- describes patterns of computer network attacks
Case Studies

academic

dining philosophers
Case Studies

academic

solitaire game

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Case Studies

technical

transportation system with 2 pushers

PUSHER control program

RELAY R1

RELAY R2

concurrent pusher

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Snoopy
Case Studies

technical

case study of the full refined closed system

control program of a production cell
Case Studies

biological - metabolic networks

glycolysis
Case Studies

biological - metabolic networks

starch production in potato tuber
Case Studies

biological - signal transduction networks

haemostasis
Case Studies

biological - signal transduction networks

RKIP/MEK-ERK signalling pathway
Case Studies

biological - signal transduction networks

Levchenko model
Case Studies

biological - gene transcription networks

biosensor: award winning model in the 2007 iGEM competition (MIT)
Implementation

- based on the experience of the predecessor PED
- Snoopy was started 1997 as student project
- now 120,000 lines of code
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Snoopy
Availability

- free of charge for non-commercial use
- source code is available on request
- further informations:
  http://www-dssz.informatik.tu-cottbus.de/software/snoopy.html
Future Works

- import from bio databases
- import and animation of counter examples or witnesses from external model checkers
- automatic conversion between stochastic and continuous Petri nets
- hybrid models
- PNML support
Thanks for your attention.

Questions?

See you for a tool demo.