Analysis and Simulation Tools for Probabilistic Real-Time Systems

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$\Rightarrow$ deduce **schedulability** (yes/no)

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Studying the schedule, we can get :

$\Rightarrow$ a distribution of worst-case response times $\mathcal{R}_i$

$\Rightarrow$ deduce deadline miss probability of τ_i

Probabilistic Tools

We present two open-source[1] tools :

- PanSim for analysis and simulation
- extension of SimSo for simulation

[1] Free and GNU GPL compatible

PanSim

Implementation of probabilistic analysis and simulator

- collection of Matlab functions
- fixed-priority task scheduling in uniprocessor
- provides pRTA[2] analysis as well as empirical response time distributions (from simulation)

[2] Maxim and Cucu, *Response time analysis for fixed-priority tasks with multiple probabilistic parameters*, RTSS 2013

PanSim

How to use it ?

```
c1=[2 ; 1] ; t1=[5, 6 ; 0.2, 0.8] ;
tau1={c1, t1} ;

c2=[3, 4 ; 0.9, 0.1] ; t2=[7 ; 1] ;
tau2={c2, t2} ;

taskSet={tau1, tau2} ;

numberOfJobsToSimulate = 100 ;

[responseTimes,_,_] = simulate( taskSet, numberOfJobsToSimulate) ;
pWCRT = probabilisticWorstCaseResponseTime(taskSet,... ) ;
```

Run it in Matlab !

PanSim

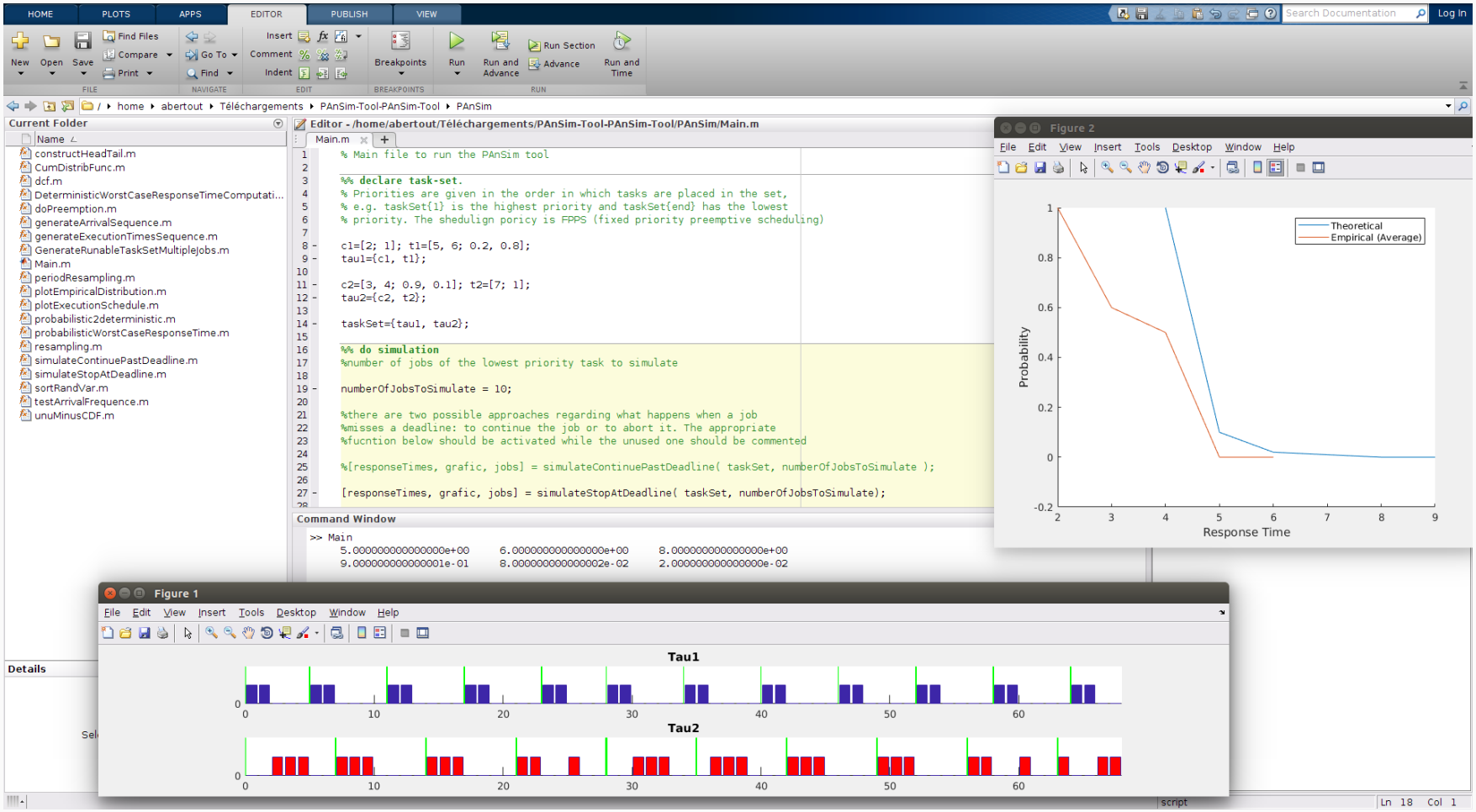


Fig. 1 : PanSim in Matlab.

pSimso

Extension based on SimSo[3] :

- free and open-source written in Python
- multiprocessor scheduling simulator
- modular, independent specification of scheduling algorithm (25 policies available)
- rich set of available metrics (response times, context switches, preemptions, etc.)

[3] Cheramy et al., *SimSo : A simulation tool to evaluate real-time multiprocessor scheduling algorithms*, WATERS 2014

pSimso

```
Ouvrir                                                    Enregistrer
#!/usr/bin/python3

"""
Example of a script that uses SimSo.
"""

import sys
from simso.core import Model
from simso.configuration import Configuration


def main(argv):
    if len(argv) == 2:
        # Configuration load from a file.
        configuration = Configuration(argv[1])
    else:
        # Manual configuration:
        configuration = Configuration()

        configuration.cycles_per_ms = 1

        configuration.etm = "pwcet"

        configuration.duration = 100 * configuration.cycles_per_ms

        # Add tasks:
        configuration.add_task(name="T1", identifier=1,
                               activation_date=0, pwcet=[(2,1)],pmit=[(5,0.2),(6,0.8)], deadline=6,
task_type = "Probabilistic",abort_on_miss=False)

        configuration.add_task(name="T2", identifier=2,
                               activation_date=0, pwcet=[(3,0.9),(4,0.1)],pmit=[(7,1)], deadline=7,
task_type = "Probabilistic",abort_on_miss=False)
        # Add a processor:
        configuration.add_processor(name="CPU 1", identifier=1)

        # Add a scheduler:
        configuration.scheduler_info.filename = "../simso/schedulers/DM_mono.py"

    # Check the config before trying to run it.
    configuration.check_all()

    # Init a model from the configuration.
    model = Model(configuration)

    # Execute the simulation.
    model.run_model()

    # Print logs.
    for log in model.logs:
        print(log)

main(sys.argv)
                                Python  Largeur des tabulations : 8  Lig 51, Col 15  INS
```

Fig. 2 : Text mode configuration.

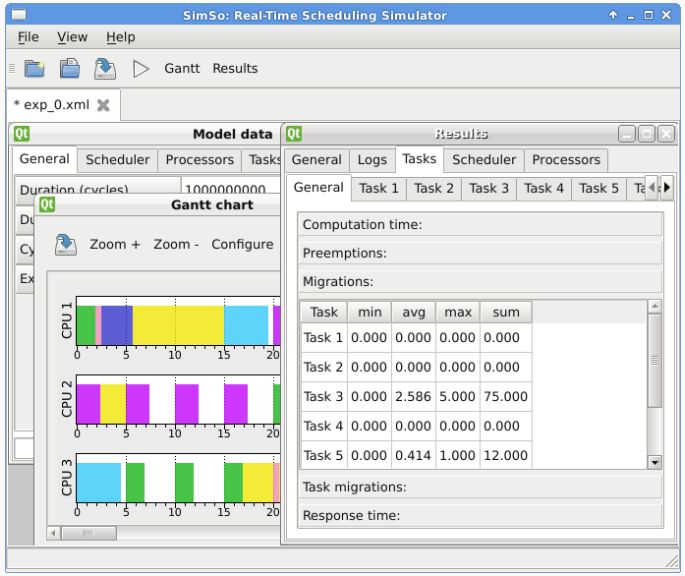


Fig. 3 : SimSo GUI.

pSimso

Probabilistic extension of SimSo :

- new execution time model and use of the sporadic behaviour
- performed on text mode
- fully compatible with all original features

How to use it ?

```
   ...
   configuration.etm = "pwcet"
   ...
   configuration.add_task(name="T1", identifier=1,
                          activation_date=0, pwcet=[(2,1)],pmit=[(5,0.2),(6,0.8)],
↪    deadline=6, task_type = "Probabilistic",abort_on_miss=False)

   configuration.add_task(name="T2", identifier=2,
                          activation_date=0, pwcet=[(3,0.9),(4,0.1)],pmit=[(7,1)],
↪    deadline=7, task_type = "Probabilistic",abort_on_miss=False)

   configuration.add_processor(name="CPU 1", identifier=1)
   configuration.scheduler_info.filename = "../simso/schedulers/DM_mono.py"

   model.run_model()
           for i,task in enumerate(model.task_list) :
                for j,job in enumerate(task.jobs) :
                    print(job.response_time)
```

Execute it as a python script !

Examples

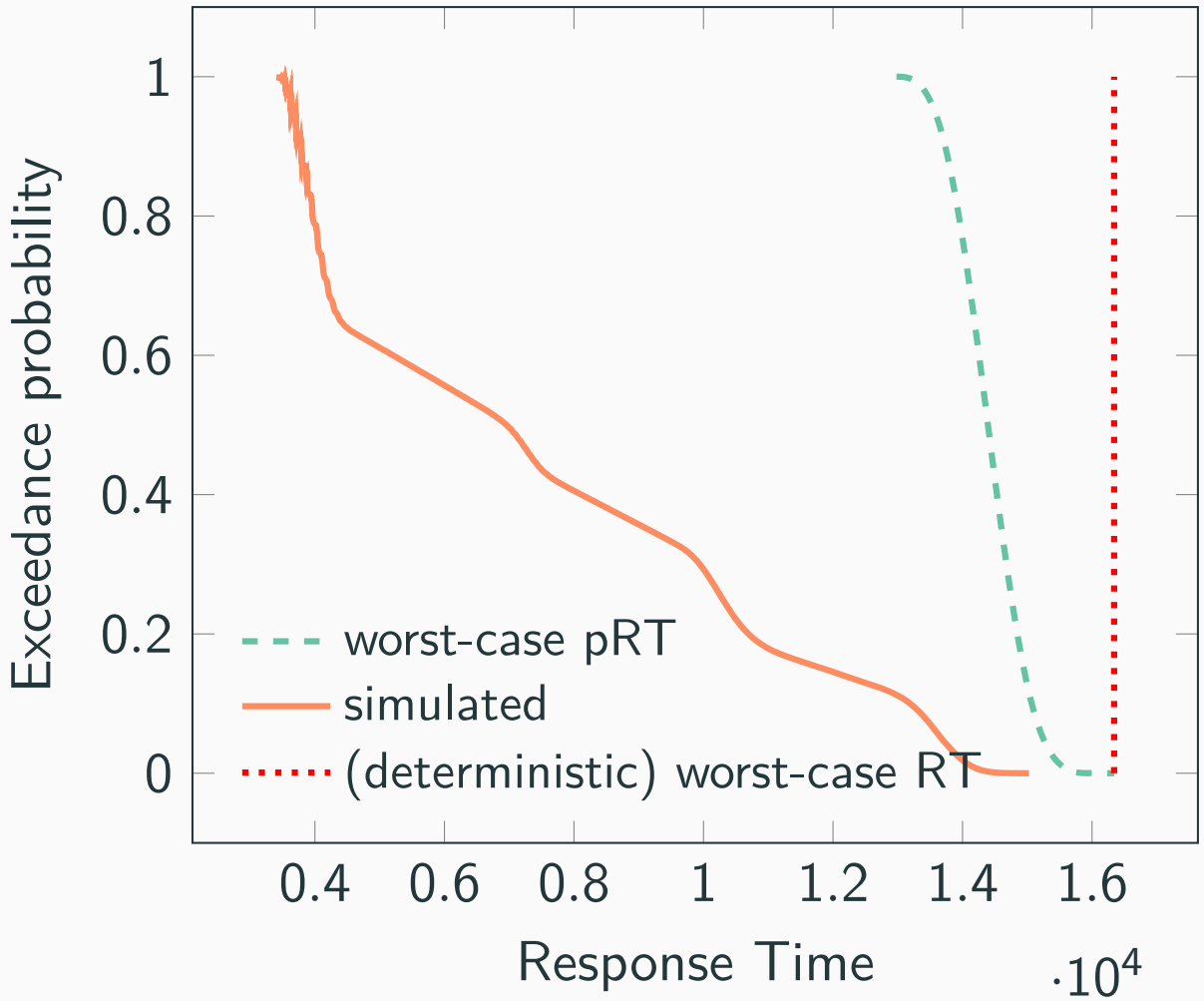
Considering a five tasks set with probabilistic parameters, we are interested in :

- computing an empirical response times distribution of the least priority task, τ_5 [4]
- computing an empirical distribution of the response time of the second job of τ_5

[4] Bertout et al., *Average Probabilistic Response Time Analysis of Tasks with Multiple Probabilistic Parameters*, WiP session RTSS 2016

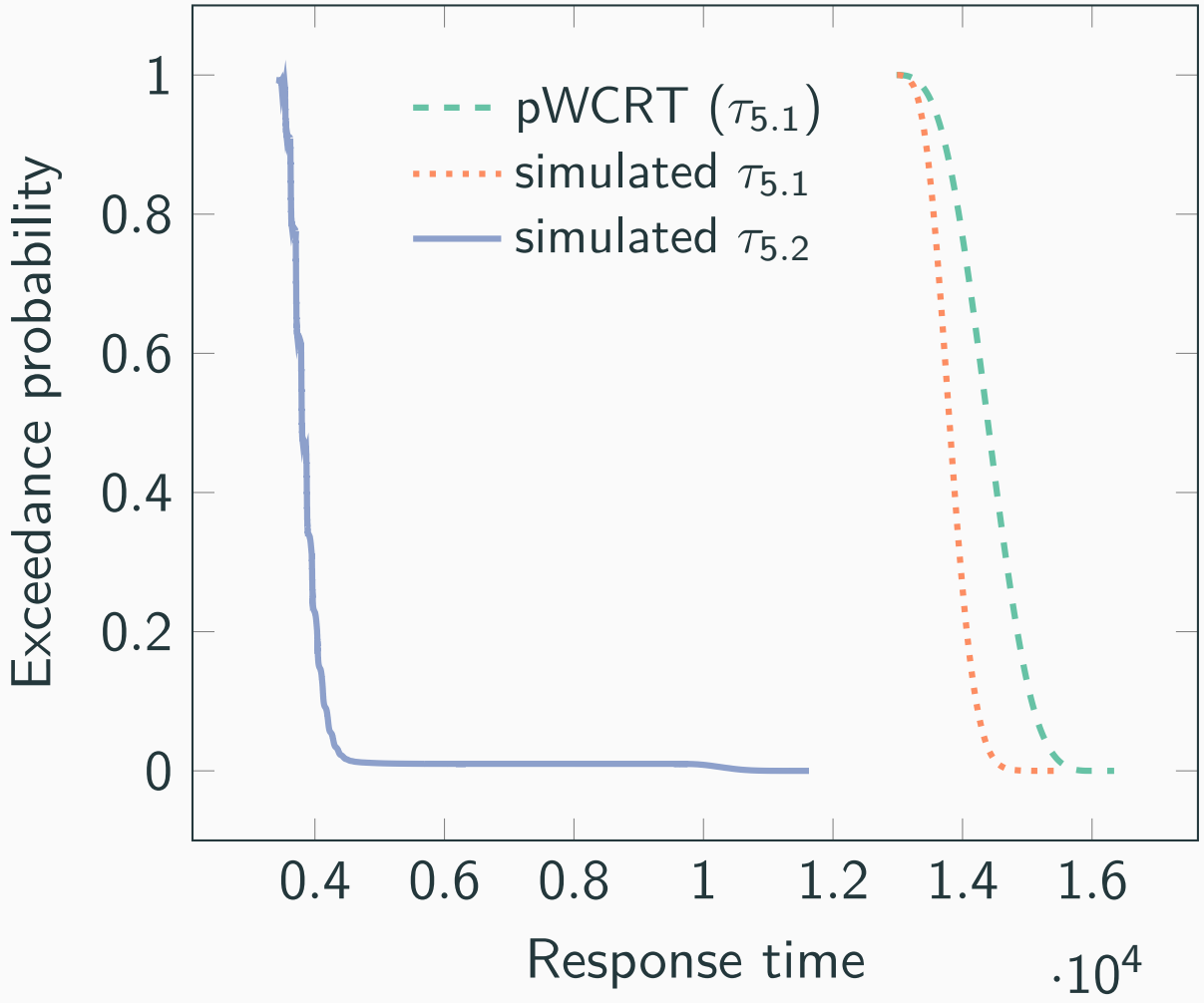
Examples

Response time distribution of task τ_5



Examples

Jobs ($\tau_{5.1}$ and $\tau_{5.2}$) response time distributions



Conclusion

We presented two tools for probabilistic real-time systems :

- PanSim for analysis and simulation[5]
- a probabilistic extension of SimSo for simulation[6]
- different tools for different uses
- feel free to use it and contributions are welcome !

[5] https://github.com/dorinmaxim/PAnSim-Tool
[6] https://github.com/abertout/simso

Questions ?

Contributions wish list

- adding scheduling policies to PanSim
- integrating other analysis techniques (e.g technique [7]) to PanSim
- extending existing system model or adding other model
- integration of the probabilistic extension to the SimSo GUI

[7] Diaz et al., *Stochastic analysis of periodic real-time systems*, RTSS 2002