

Perfect Simulation of Finite Queueing Networks

Ψ^2 a Free Software Tool

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- 1 Software architecture
- 2 Modelling queueing systems
- 3 Simulation kernel
- 4 Simulation control and parameters

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Aim of the software

- finite capacity queueing network simulator
- rare events estimation (rejection, blocking,...)
- statistical guarantees (independence of samples)

⇒ Simulation kernel

- open source (C, GPL licence)
- extensible library of events
- multiplatforms (linux (debian), mac OSX,...)

General architecture

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General architecture

Software architecture

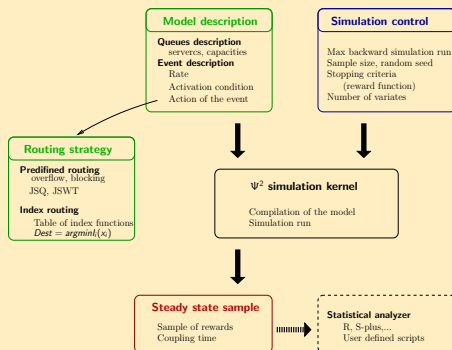
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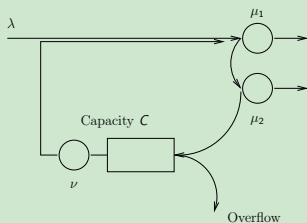
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General architecture



Queueing network description

Constrained communications



Events types

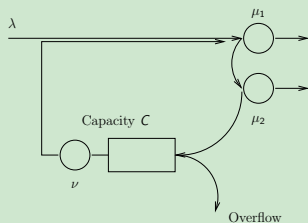
type	action
1	Server departure
2	External arrival to the first empty room in the list DQ
3	Multi-server departure to DQ
4	Join the shortest queue in DQ
5	Index routing according an index table
6	Routing to the first empty room in the list DQ and overfl
7	Routing to the first empty room in the list DQ and blocking in the origin queue

Description file

```
# Number of queues
3
# Queues capacities
1 1 50
# queues minimal initial state
0 0 0
# queues maximal initial state
1 1 50
# Number of events
4
# Index file - N for No index file
File: N
# table of events
# id type rate nbq origin d1 d2 d3 d4
0 2 0.8 5 -1 : 0 1 2 -1
1 1 0.6 2 0 : -1
2 1 0.4 2 1 : -1
3 7 2.0 5 2 : 0 1 2 -1
```

Queueing network description

Constrained communications



Events types

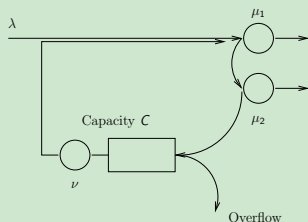
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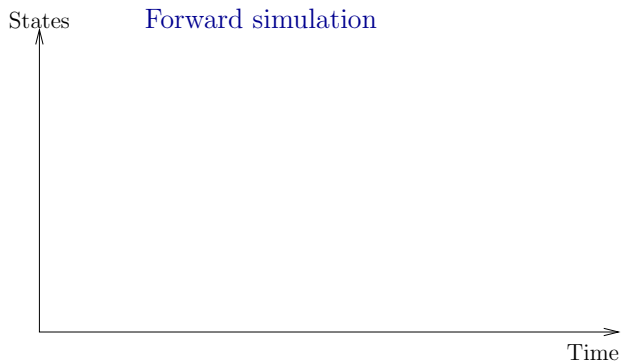
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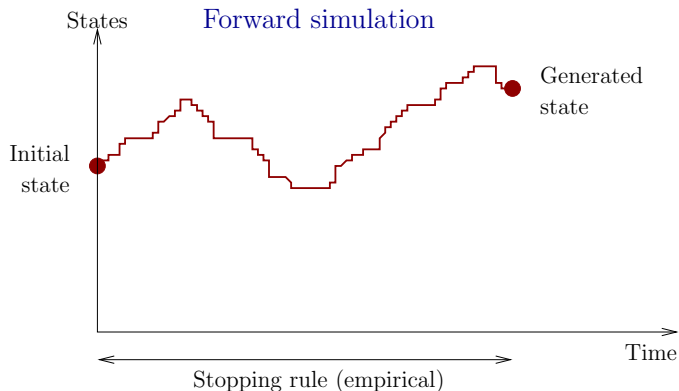
Simulation method

Perfect simulation (Propp & Wilson 1996) $X_{n+1} = \Phi(X_n, e_{n+1})$



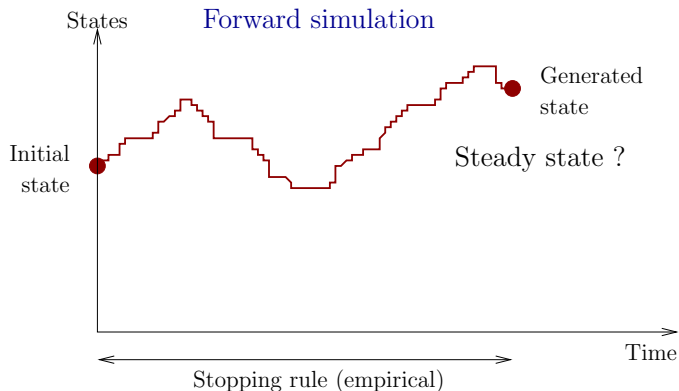
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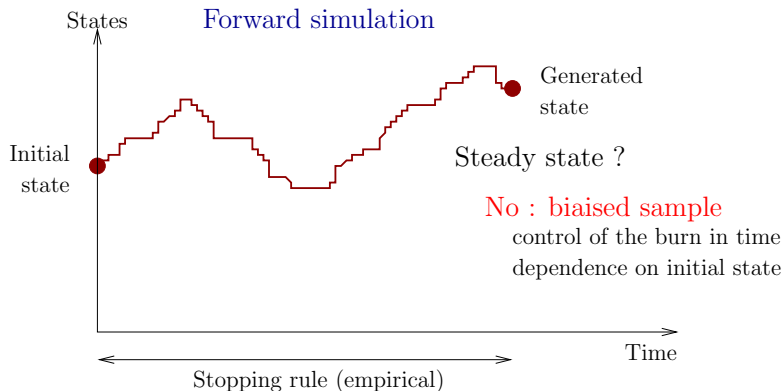
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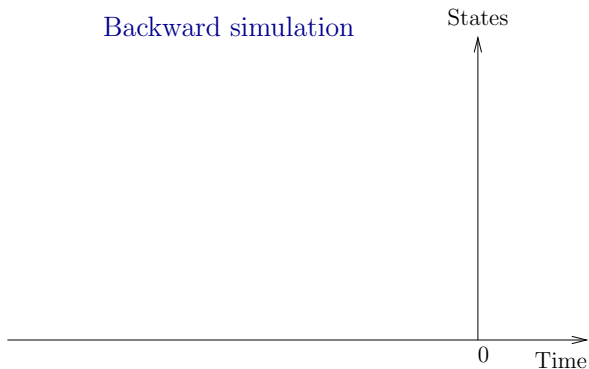
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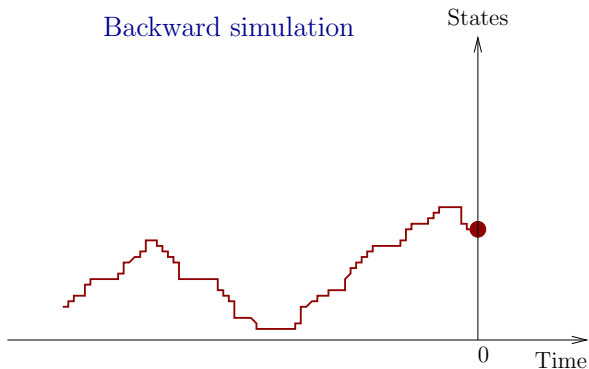
Backward simulation



Simulation method

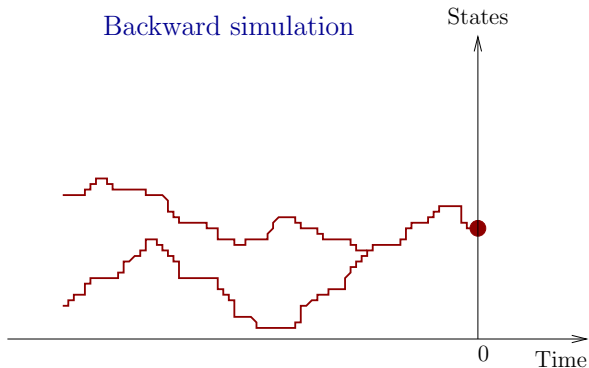
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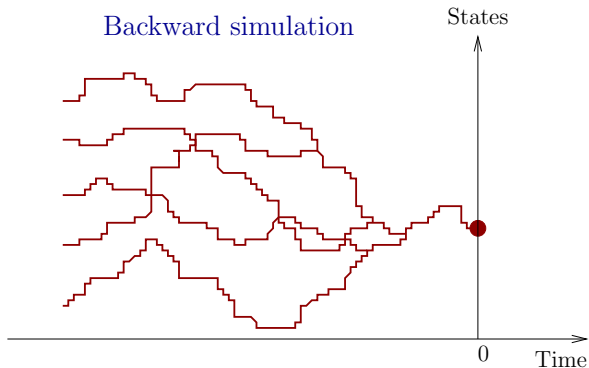
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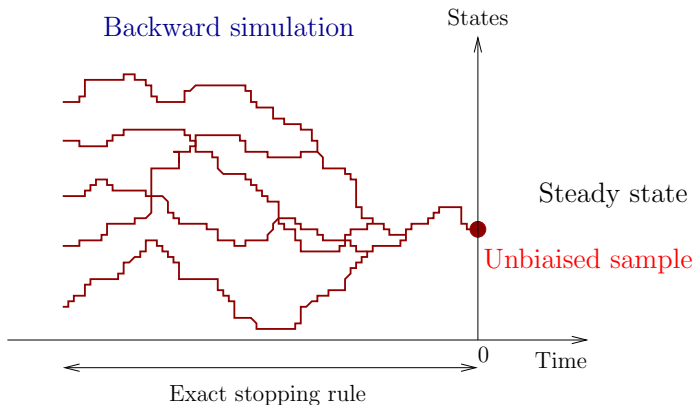
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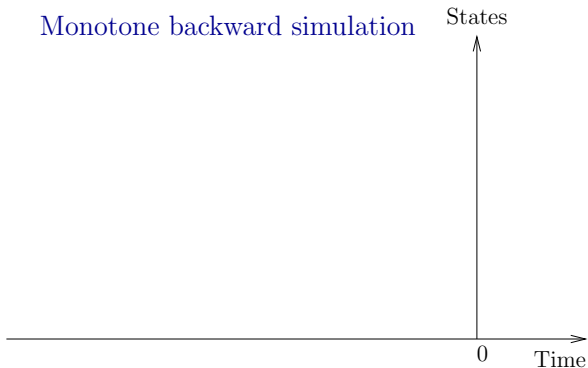
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Simulation method

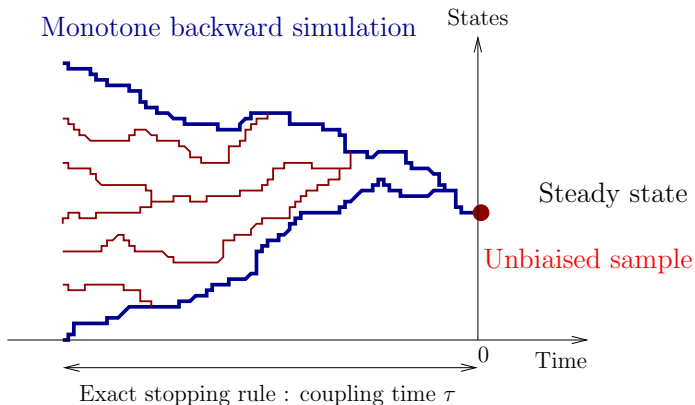
Perfect simulation (Propp & Wilson 1996) $X_{n+1} = \Phi(X_n, e_{n+1})$

Monotone backward simulation



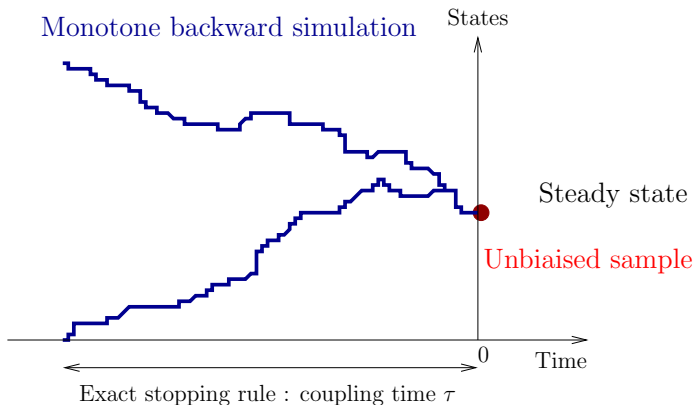
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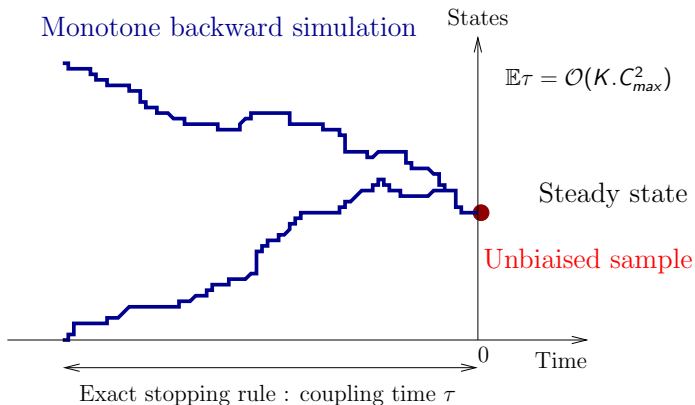
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Simulation control and output

Control parameters

```
# Sample number
10000
# Number of Antithetic variable
1
# Size of maximal trajectory
3000000
# Random generator seed
5
# Coupling file name
File: No file
```

Output

```
# P.S.I.2 version 4.4.4
# Data Network model
# Number of queues
...
# Parameters
# Sample number
# 10000
# Number of Antithetic variates
...
# =====
0 [ [ 0 1 10 ] ]
1 [ [ 1 1 13 ] ]
2 [ [ 1 1 2 ] ]
3 [ [ 1 1 33 ] ]
...
9999 [ [ 1 1 2 ] ]
# Size 10000 Sampling time :
3809.202000 micro-seconds
# Seed Value 5
```

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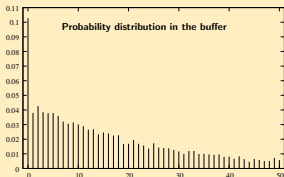
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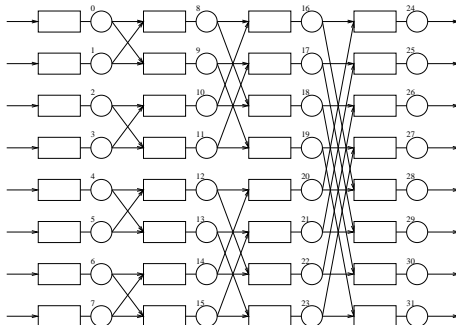
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Statistical analysis



Example

Delta interconnection network, $C = 10$ $\rho = 0.9$



```
9999 [ [ 0 2 5 7 2 8 7 4 0 7 10 3 3 2 1 5 0 0 6 3 3 6 0 3 9 1 2 4
3 1 3 6 ] ]
```

Size 10000 Sampling time : 4302.413600 micro-seconds

Variance reduction

- functional coupling
- antithetic trajectories

Models extensions

- multiple servers
- index routing strategies
- batch arrival
- non monotone events
- ...

Applications

- networking : rare events
- call center dimensioning
- grid scheduling
- ...

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Download : <http://gforge.inria.fr/projects/psi>

The screenshot shows a web browser window displaying the project page for PSI on the Inria GForge platform. The browser's address bar shows the URL <https://gforge.inria.fr/projects/psi/>. The page features the Inria logo and a navigation menu with tabs for 'Accueil', 'Ma page', 'Arbre des projets', 'Demande d'aide', and 'Perfect Simulator'. Below the navigation, there are sub-tabs for 'En bref', 'Administration', 'Suivi', 'Listes', 'Tâches', 'Annonces', 'Sources', and 'Fichiers'. The main content area includes a description of PSI as a software simulator of Markov chains, a list of metadata (Intended Audience, Kind, License, Natural Language, Operating System, Programming Language, Research center, Topic), registration details (Enregistré le: 24/11/2005 17:37, Taux d'activité: 34.64%), and a table of published files. A sidebar on the right lists the project team members and provides links to view members and request to rejoin the project. At the bottom, there are sections for 'Zones publiques' and 'Dernières annonces'.

INRIA

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En bref Administration Suivi Listes Tâches Annonces Sources Fichiers

PSI is a software simulator of Markov chains on large discrete state space. It samples steady state distribution in finite time by the method "coupling from the past".

- Intended Audience: [End Users/Desktop, Other Audience](#)
- Kind: [Software](#)
- License: [GNU General Public License \(GPL\)](#)
- Natural Language: [English, French](#)
- Operating System: [MacOS, Linux](#)
- Programming Language: [C](#)
- Research center: [Montbonnot](#)
- Topic: [Scientific/Engineering](#)

Enregistré le : 24/11/2005 17:37
Taux d'activité : 34.64%
Voir les [statistiques d'activité du projet](#).
View list of [RSS feeds](#) available for this project

Equipe-Projet

Administrateurs :
Jérôme Vienne
Jean-Marc Vincent
Thais Webber
Vincent Danjean
Développeurs :
Arnaud Legrand
Florentine Dubois
Noémie Sidaner
Vandy BERTEN

[\[Voir les membres\]](#)
[\[Demander à rejoindre le projet\]](#)

Derniers fichiers publiés

Paquet	Version	Date	Remarques / Surveillance	Téléchargement
psi	4.4.3	May 10, 2007		Téléchargement

[\[Voir tous les fichiers du projet\]](#)

Zones publiques **Dernières annonces**

Disponibilité



CALL FOR PAPERS

SIMUTools 2008

First International Conference on Simulation Tools and Techniques for Communications, Networks, and Systems

March 3-7, 2008, Marseille, France

<http://www.simutools.org/>

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SIMUTools 2008 is the first international conference focusing on Simulation Tools and Techniques for Communications, Networks, and Systems. The conference will address all aspects of simulation modelling and analysis. Papers are sought on the topics of methodology, tools, applications, and practices. Particular emphasis will be given to papers that bridge multiple areas. Possible topics include, but are not limited to:

- o **Methodology/Simulation Art:** Web based simulation, Agent based simulation, Petri Nets simulation, Fluid flow simulation, Bond Graphs simulation, Simulation-based Scheduling
- o **Application areas:** Telecommunication, Network Security, Health Care, Transportation, Manufacturing, Public Systems, Education and Training
- o **Tools:** OPNET, NS-2, interconnected simulation platforms, ATDI ICS, Qualnet, OMNET++, NIIST, Dymola, Matlab/Simulink, open source tools...

Extended versions of selected papers will be published in relevant special issues of leading journals. Authors of accepted papers should register and present their work at the conference. A poster session will accommodate short papers and works in progress.

Important Dates

- o Full Papers due: **October 15, 2007**
- o Notification of Acceptance: **December 14, 2007**
- o Camera-ready Manuscripts due: **January 18, 2008**
- o Conference Dates: **March 3-7, 2008**

Submission Instructions & Reviewing Policy

Authors are invited to submit either Regular Papers or Short Papers, in a PDF file, complying with the ACM conference proceedings format through COCUS (<http://cocus.create-net.it>). Regular papers are 6 to 10 pages long, are eligible for Best Paper award, and may be selected for publication in a Journal. Short papers are 4 to 6 pages long and do not compete for Best Paper award or Journal Selection. Short Papers are intended for authors that wish to present their ongoing work or new open issues. Each paper will be peer reviewed for quality and correctness by at least three reviewers. Only original papers, written in English, which have not been published previously elsewhere, will be accepted.

Call for Workshops

We solicit workshop proposals on new and emerging topics in Simulation Tools and Techniques for Communications, Networks and Systems. We are seeking high-quality submissions that focus on a specific theme of current interest. Proposals for one-day workshops to be held in conjunction with the main conference are solicited and should be forwarded to the workshops chairs workshop.simutools@icst.org by **September 21, 2007**. Acceptance notification by **October 1, 2007**.

Call for Panel Sessions

Panel sessions proposals should be submitted to panel.simutools@icst.org, by **September 21, 2007**. Proposals should state the session title, a description of the topic, and the names of key organizers and potential panelists. Panel Session topics will be decided by **November 10, 2007**.

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In addition to the main technical program, the conference will hold a parallel exhibition, **EXPOTools**. This will be a unique opportunity for industry researchers and professionals to exhibit simulation tools.