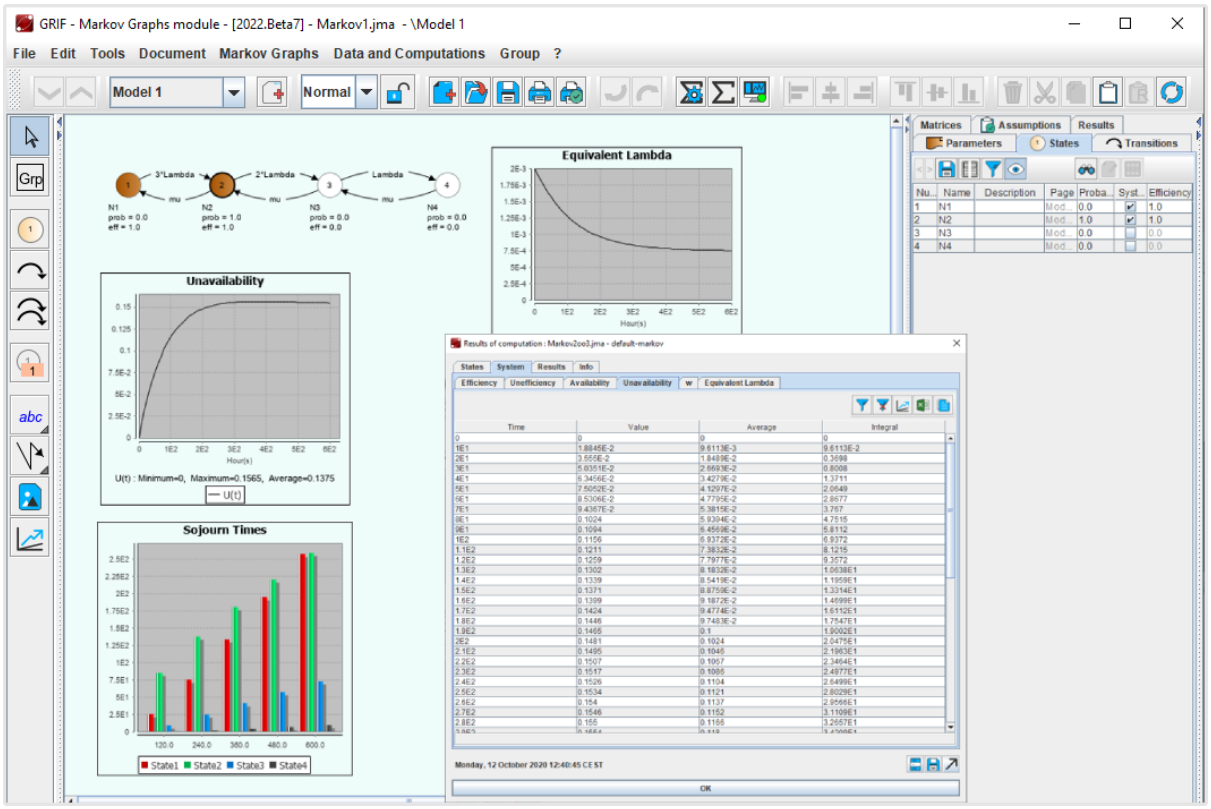
GRIF | Markov module

Technical sheet

To evaluate system architectures using Markov graphs

GRIF (GRaphical Interface for reliability Forecasting), a technology of TotalEnergies since the 80s, includes 3 packages and 12 modules allowing the user to choose the most appropriate modelling technique for the resolution of the studied system. Markov module is the only module belonging to Markovian package.

Markov is used to model systems as **Markov graphs**. It produces simple models suited to all industrial sectors (aeronautics, automobile, railways, oil & gas, etc.) and provides a large amount of data, including the availability and Lambda Equivalent of a system over time. The Markov module uses **ALBIZIA**, the Markov and BDD computation engine developed by TotalEnergies that is based on efficient matrix computation algorithms.



Modelling and computations using the Albizia engine:

- **The Markov module delivers a number of results:**
  - The probability of being in a state.
  - The sojourn times in each state.
  - The availability/reliability of the system.
  - The failure rate and Lambda Equivalent of the system over time.

- **You can easily create a Markov graph via an intuitive graphical interface in which the different states of the system can be entered and connected via transitions**. For each state of the graph, they can indicate whether or not the system is available. For production efficiency studies, users can indicate the efficiency of the system in each state. Lastly, when the transition rate between states has been entered, the Markov graph is complete, and computations can then begin.

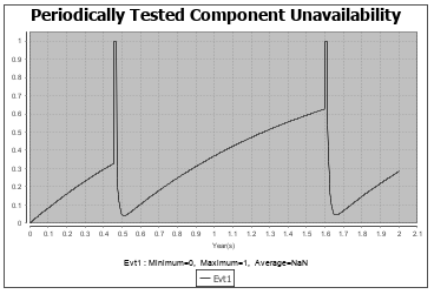
GRIF
GRaphical Interface for reliability Forecasting
August 2022

TotalEnergies SE
CSTJF
64018 Pau Cedex - FRANCE
Phone : +33 (5) 59 83 40 00
grif.totalenergies.com

Hardware requirement: Intel Core i3 or faster, 4 GB of free RAM, 1 GB of free space, no internet connection needed. **Software requirements**: Windows 10 or Linux or MacOS X with Java 11. **Licenses**: standalone with USB dongle or Floating licenses with Sentinel server. Installable, laptop.

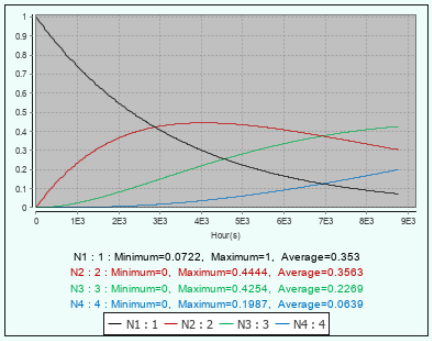
Specificities and strengths:

- **Computation of system efficiency**: When a state in the graph indicates that the system is available, it is possible to specify the efficiency of the system in this state. This means that downgraded states can be taken into account and production availability computations performed.



- **Value over time**: over a given operating period, knowing the probability of a system being in a state at the end of a task is interesting but knowing its evolution over time is even more useful.

  The figure on the right is a graphical example obtained for a system comprising 3 components. Each curve represents the probability of the system being in one of the 4 states below (at t=0, a component has failed):
  - *State1: the 3 components are working.*
  - *State2: 1 component has failed.*
  - *State3: 2 components have failed.*
  - *State4: 3 components have failed.*



Markov multi-phase chains:

A system does not follow the model throughout its lifetime. It may undergo tests or repairs during which time the system is represented by a different Markov graph. These different phases in the life of a component can be modelled in the Markov module, which can be used, for example, to display the availability of a system that is periodically tested, taking into account a large number of parameters: duration and efficiency of the test, reconfiguration errors, etc.

Markov can interact with all modules of GRIF Boolean package:

Markov graphs can be used to describe a component failure in a GRIF Boolean module (Tree, ETree, BFiab, Reseda, SIL and Risk).

Using data and results:

- Possibility of automating calculations (batch runs) and drawing variations for sensitivity analyses.
- Results are stored in the document and can be exported in a variety of formats (csv, XML, Excel, etc.).
- Results can be viewed as line graphs, pie charts or histograms.
- Vectorial printing in PDF format generates high-quality pictures but the files are small enough to be sent by e-mail, even if they contain hundreds of pages.
- External files (PDF certificates, system pictures, etc.) can be included in the document and be part of the full report.
- Interaction with the operating system: possibility of copying/pasting to or from word processing software, spreadsheets, or presentation tools.

TotalEnergies

Trial version available on
grif.totalenergies.com