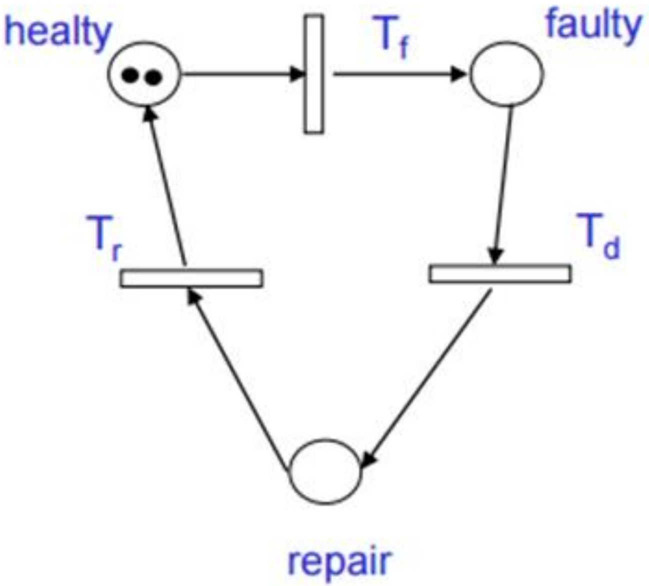
Stochastic Activity Networks in Moebius

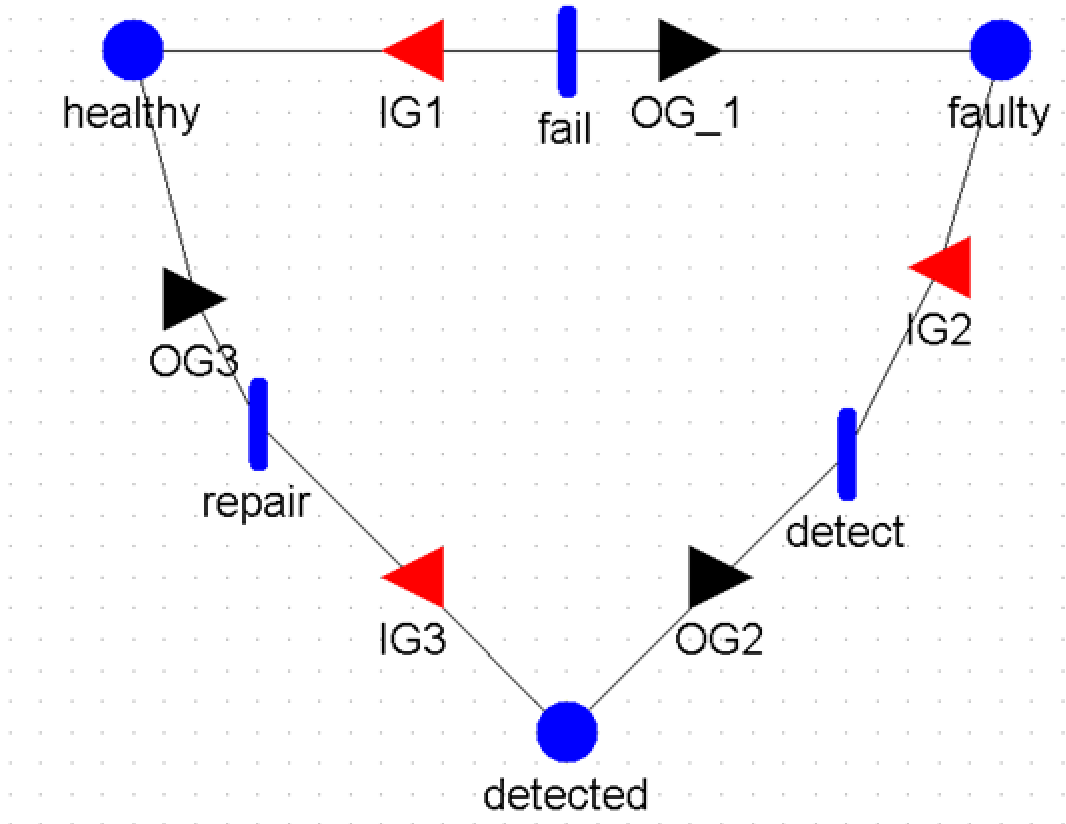
Failure-Detection-Repair

- Two identical CPUs
- **Failure of the CPU:** exponentially distributed with parameter λ
- **Fault detection:** exponentially distributed with parameter δ
- **CPU repair:** exponentially distributed with parameter μ



Evaluate Availability of the system during steady state, considering that the system is working if at least one CPU is healthy

Atomic Model



Remember to edit three global variables

(lambda, mu and delta)

Set the initial state for places)

(healthy = 2, faulty = 0, detected = 0)

Set the rate of each event as the number of token in the input place times the rate of the event

Set the input enabling function, stating that the activities are enabled if there is at least one token in the input place

Set the output function, so that it decreases the number of tokens in the input place and increases the ones of the output place by one

Fail example

Input Predicate

```
healthy->Mark() > 0
```

Output Function

```
faulty->Mark()++;
healthy->Mark()--;
```

Name: fail

Time distribution function: Exponential

1

Rate

```
return lambda*healthy->Mark();
```

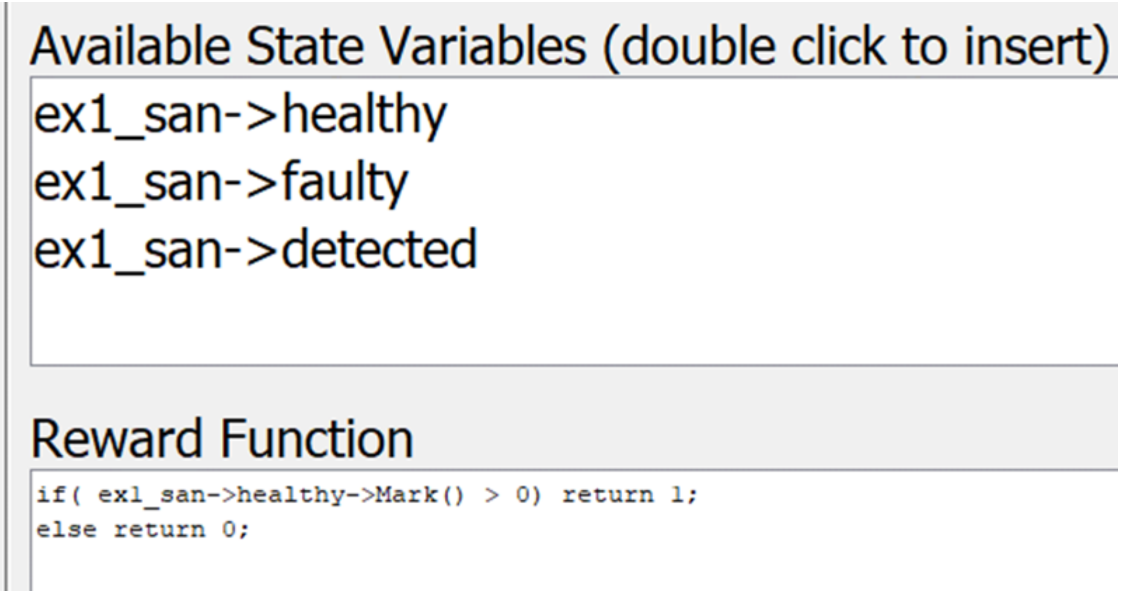
Case quantity: 1

Case 1

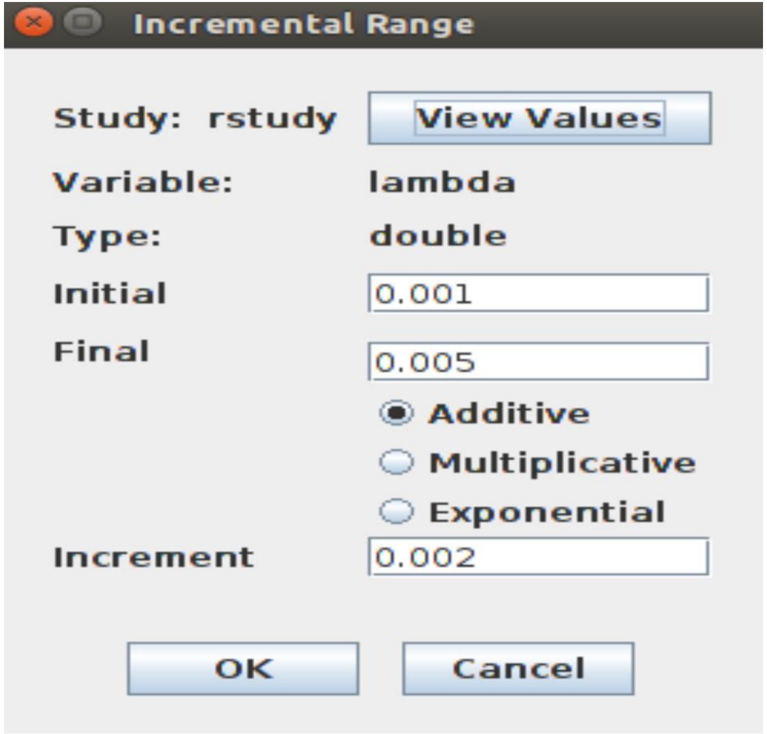
```
1
```

Reward model

- Create a performance variable called **availability.**
- Express its **reward function** according to the condition of correctness of the system.
- Set a steady-state **Time** option with default configurations.



Study model

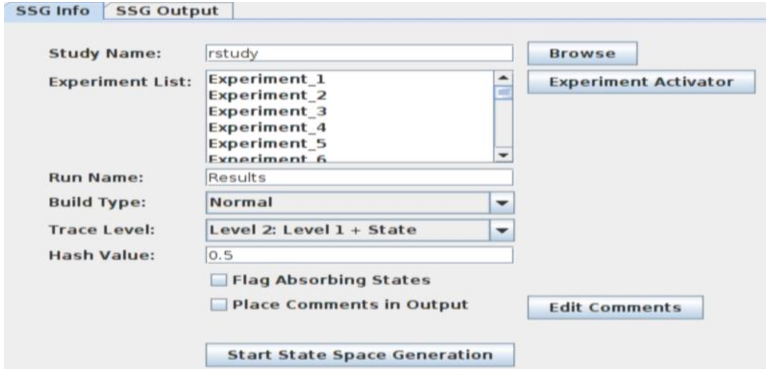


Set a **range study** model where all the three rates vary from 0.01 to 0.05 with a step of 0.02.

All the possible combinations lead to **27 experiments**

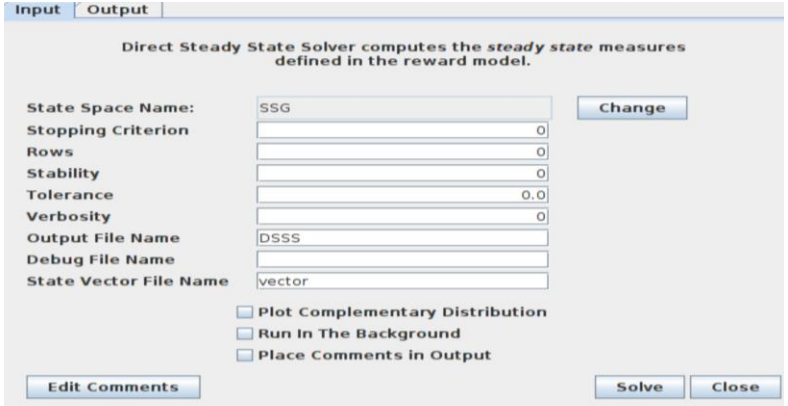
Transformer and Solver

Again use the State Space Generator (NOT Symbolic) as transformer



Then, for simplicity,

select the Direct Steady State Solver.



Results

- Experiment 1:

lambda = 0.001, **delta** = 0.001, **mu** = 0.001 → Availability = 0.5

- Experiment 14:

lambda = 0.003, **delta** = 0.003, **mu** = 0.003 → Availability = 0.5

- Experiment 4:

lambda = 0.003, **delta** = 0.001, **mu** = 0.001 → Availability = 0.224

- Experiment 3:

lambda = 0.001, **delta** = 0.005, **mu** = 0.001 → Availability = 0.582

- Experiment 19:

lambda = 0.001, **delta** = 0.001, **mu** = 0.005 → Availability = 0.696

Exercise

- Evaluate steady state availability of the **TMR with repair** and **ideal voter**
- ***Study*** the availability with different repair rate values w.r.t. the same failure rate

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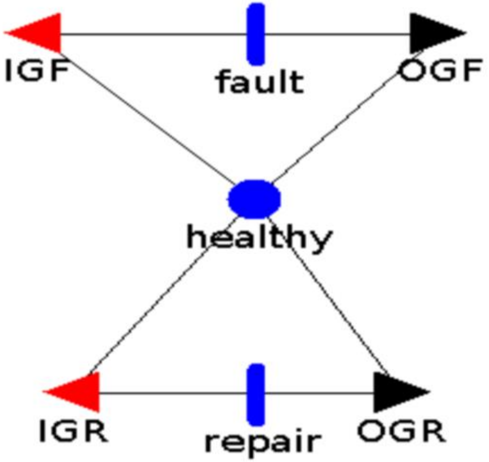

Reward Function

```
if (TMRrep->healthy->Mark() > 1) return 1;
else return 0;
```

References

William H. Sanders and John F. Meyer, ``Stochastic Activity Networks:formal definitions and concepts'', in Lectures on formal methods and performance analysis: first EEF/Euro summer school on trends in computer science, 2002.

https://www.mobius.illinois.edu/wiki/index.php/Möbius_Documentation

Thanks to prof. Andrea Domenici for previous version of the slides.