Zen and the Art of Bicycle Maintenance

JOOST-PIETER KATOEN ALUMNI DAY

Matthias Volk

Formal System Analysis

TU/e EINDHOVEN UNIVERSITY OF TECHNOLOGY

Failures …

„I found the paper to be very dry […]
and felt like I did not learn much.“

… and lots of success

Tour de France

Spare management

- need spare bikes in case of failures
- how many spares to have on stock?

Spare management

- 21 stages,
- 8 riders
- failure during stage
  → use spare
- failure without available spare
  → costly loss
- restock after each stage

- **Tradeoff**:
  storage cost vs cost of loss

[Dursun, Akcay, v. Houtum, 2024]

Spare management with signals

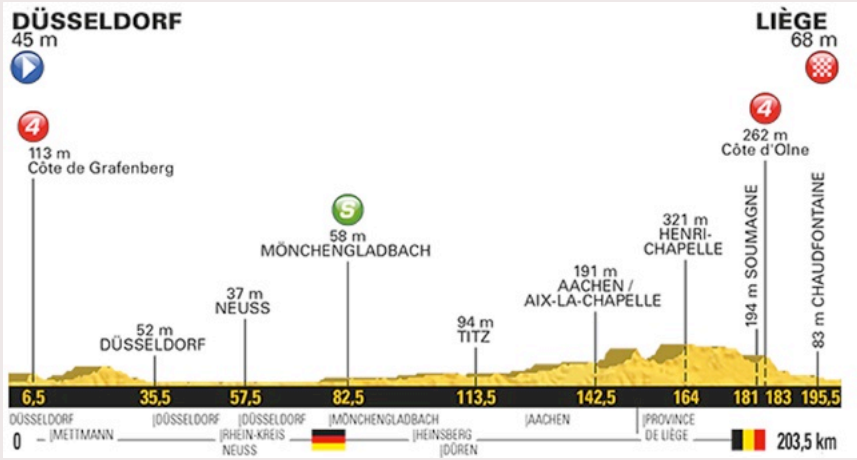
- signals can indicate failure in near future
- signals have demand lead time D

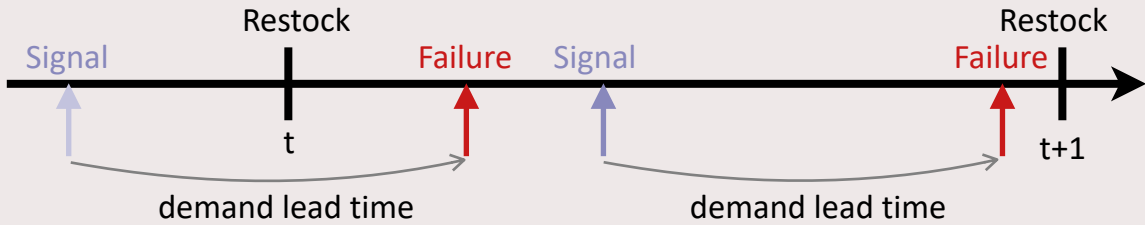
Signals are not perfect:

- false positives

  precision: $p = \frac{TP}{TP + FP}$
- unpredicted failures

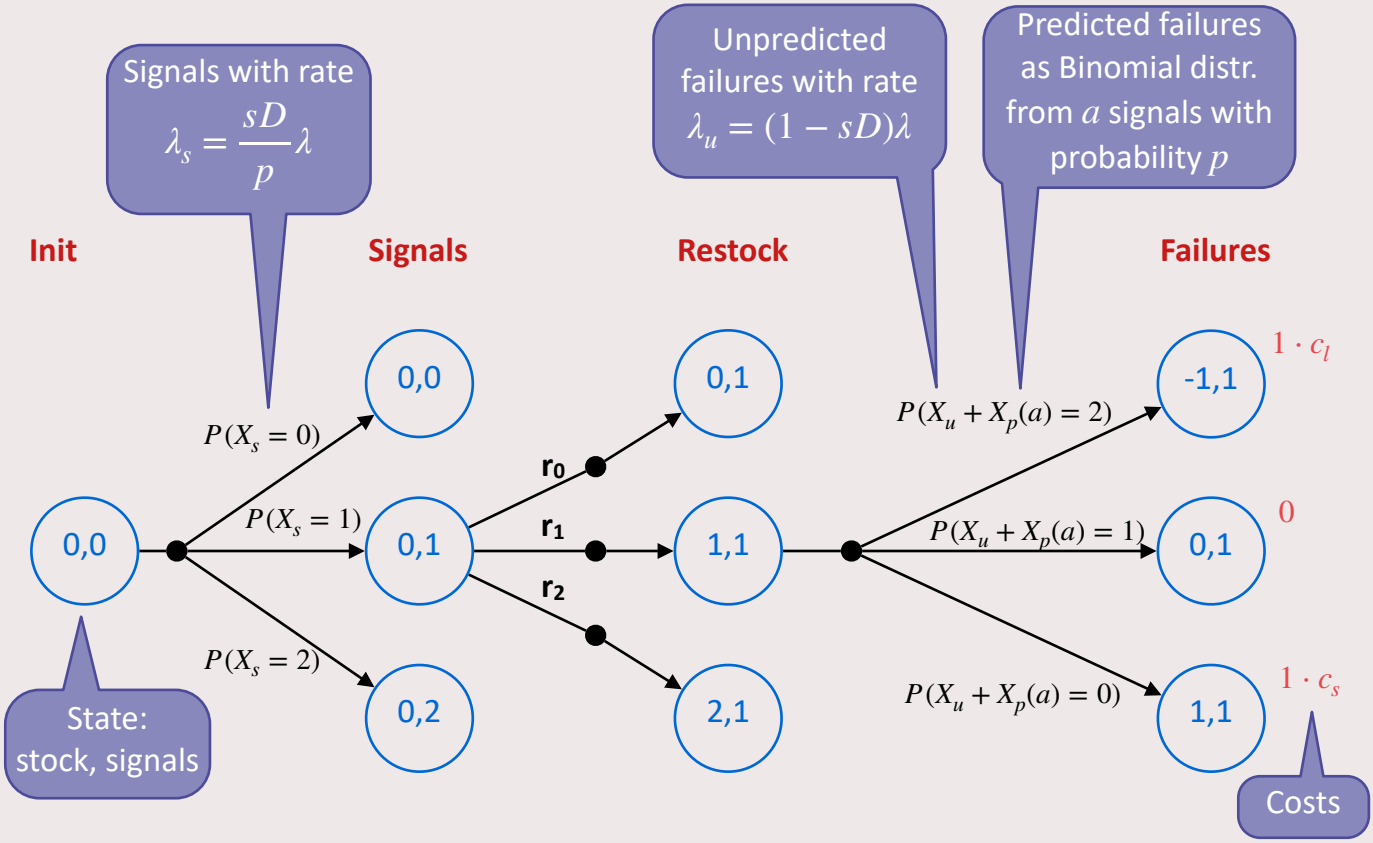
  sensitivity: $s = \frac{TP}{TP + FN}$





M(v)DP

Pun by Brice, Bruss, Majumdar, Raskin

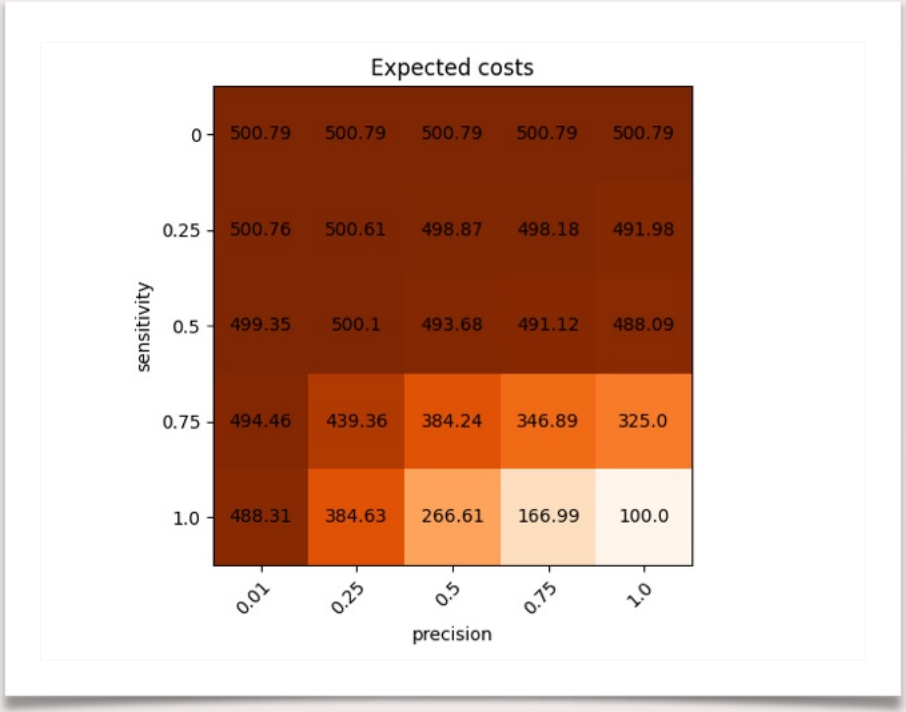


Implementation

- Generate Prism file for given configuration
  - 21 rounds
  - 8 components
  - cost storage c_s = 500€, cost loss c_l = 10,000€
  - failure rate $\lambda = 0.1$
  - demand lead time $t = 0.9$ (of a stage)
  - precision $p = 0.9$ and sensitivity $s = 0.9$

- Model checking with Storm
- Calculate expected cost per stage

Results: Sensitivity



Results: Stock capacity

Future extensions

- Fixed intervals in CTMCS
  → allows to natively integrate Poisson distributions
- Parametric analysis
  → use storm-pars to analyze complete parameter space