Probabilistic Model Checking (PMC)

PMC ∈ Formal Verification (FV)
- modelling and analyzing engineering systems

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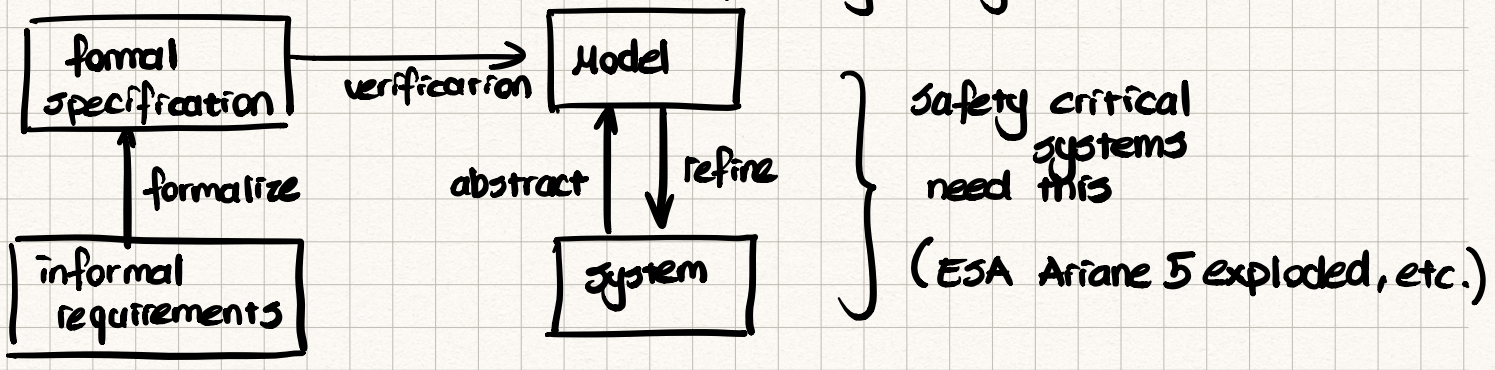
modelling and analyzing systems that exhibit probabilistic behavior

- validation & testing is needed for bug-free software

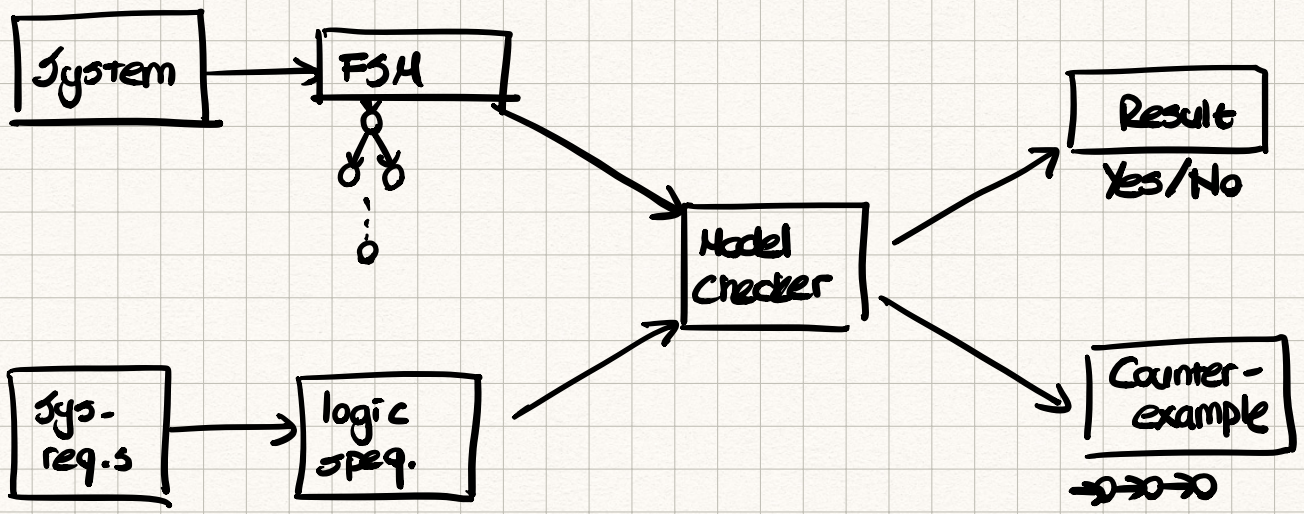
Rigorous Software Engineering:
- formalise specification
- derive model of system
- formally verify correctness



"Formal verification proves the absence of errors."

"Testing can only show the presence of errors."

- Automatic verification ∈ FV
  - ↓ no human intervention



- many properties other than correctness are also important: safety, reliability, performance, security, fairness, etc.

Probabilistic Verif. ∈ Quantitative Verif.

- Randomisation is used in many algo.s (security, etc)

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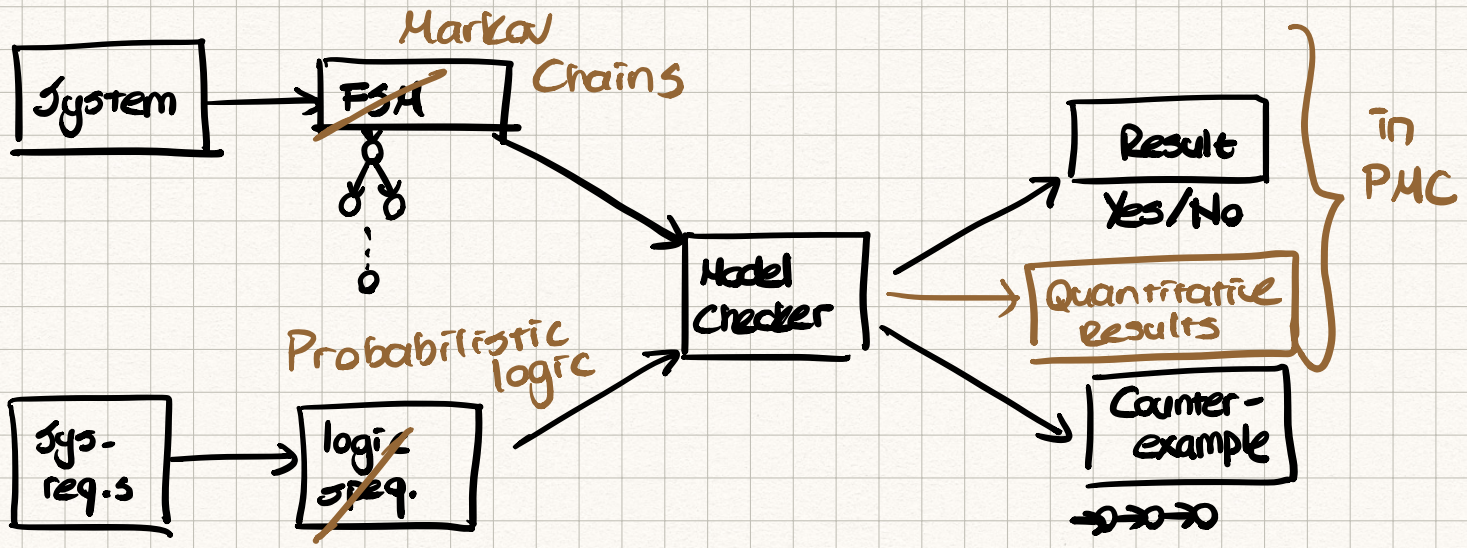
Computer systems become Stochastic

- Prob. can be used to model uncertainty



- PRISM: a PMChecker
(max. model size: 170 mio states)

PMC Models:

Models: Variants of Markov Chains (MCs)

- discrete-time MCs (DTMCs)
- continuous time MCs (CTMCs)
- Markov decision processes (MDPs): DTMCs + non-determinism

Specifications: Probabilistic temporal logics (PCTLs)

Algo.s:
- Graph Algo.s
- Numerical Computations
- Automata for regular languages
- Statistical Analysis

- Practicals will involve PRISM programming
- Course is mix of theory + practice

Outline:

- Discrete-time Markov chains (DTMCs) and their properties
- Probabilistic temporal logics: PCTL, LTL, etc.
- PCTL model checking for DTMCs
- The PRISM model checker
- Costs & rewards
- Continuous-time Markov chains (CTMCs)

- Markov decision processes (MDPs)
- Strategy synthesis
- Probabilistic LTL model checking

- Applications and vistas

Course information

- Prerequisites/background
  - basic computer science/maths, no probability knowledge assumed
- Lectures
  - 20 lec: recorded
- Classes/practicals (please sign up)
  - 4 probl. sets + 1hr class + hand in Monday 5pm
    Group 1 (rm LTA): Mon 3-4pm (wks 4,5,7,8)
    Group 2 (online): Thu 12-1pm (wks 4,5,7,8)
  - class tutors: Edon Kelmendi (grp 1) and Mirco Giacobbe (grp 2)
  - 4 practical exercises, based on PRISM, online
    4 x 2 hr sessions (Fri 9-11am wks 3,4,6,8), + work outside lab
  - practical tutors: Gabriel Santos and Maciek Olejnik
- Assessment
  - sit down examination (sample papers available) in TT21
- Discussions on Teams group (you'll be added from Minerva)