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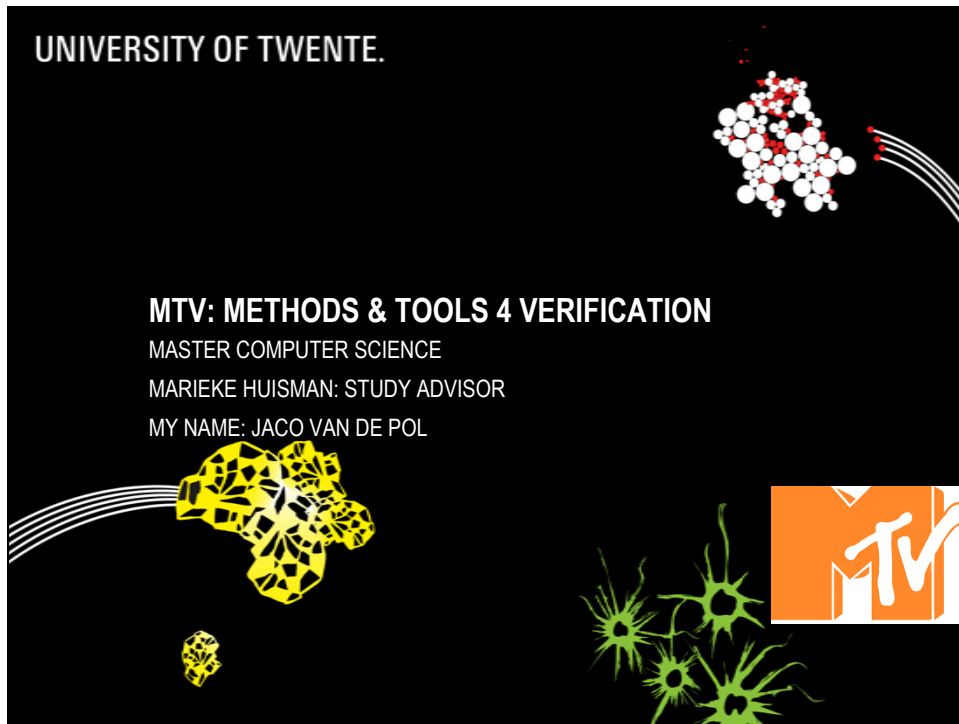
MTV: METHODS & TOOLS 4 VERIFICATION
MASTER COMPUTER SCIENCE
MARIEKE HUISMAN: STUDY ADVISOR
MY NAME: JACO VAN DE POL

OVERVIEW

- Motivation

- Program

- Tools and Techniques

- Waarom wel/niet MTV kiezen

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MoTiVation: ICT creates a new world, but…
software problems are omnipresent

Software bugs can cost millions
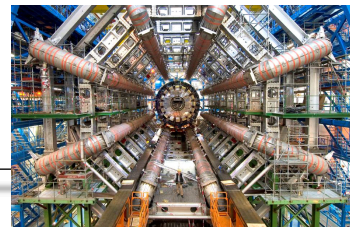and even more importantly: lives

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Large Hadron Collider, CERN

WHY?
METHODS & TOOLS 4 VERIFICATION

- Complexity of systems is increasing
  - Networks
  - Multi-core systems
  - Devices

- ICT is important everywhere in society

- How do we check if our systems are:
  - Correct?
  - Safe?
  - Efficient?
  - Reliable?

MRI scanner

Ariana 5
Before   After

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Methods & Tools

VERIFICATION ENGINEERS & SCIENTISTS
METHODS & TOOLS 4 VERIFICATION

- "verification engineer": 441.000 hits in Google

- Skills:

  1. Modeling of software, systems, requirements

  2. Reasoning, logic, theorem proving, model checking

  3. Systematic testing, run-time monitoring

  4. Algorithm design for high-performance, automated reasoning

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PROGRAM
METHODS & TOOLS 4 VERIFICATION

- Basic courses:
  - systematic testing, logic, modeling, and validation techniques
- Specialization:
  - Program verification or model checking technology
  - Quantitative analysis (risk, time, chance, …)

- Plenty of choice subjects:
  - Theoretical (e.g. mathematics, graph theory, optimization)
  - Practical (e.g. embedded systems, software, risk analysis)
- Going outside U Twente:
  - Internships within Companies
  - International Research Internship

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SPECIFYING CONCURRENT DATA STRUCTURES

Tools and Techniques:
Software Specification and Verification

Annotated Java program

```
public class Animal implements Gendered {
  // ...
  protected /*@ spec_public @*/ int age = 0;

  /*@  requires 0 <= a && a <= 150;
   @    ensures age == a;
   @ also
   @    requires a < 0;
   @    ensures age == \old(age);   @*/
  public void setAge(final int a) {
    if (0 <= a) { age = a; }
  }
}
```

jmldoc

Web pages

jmlunit

Unit tests

jmlc

Class file

XVP, BML

Warnings

ESC/Java2

Daikon

Data trace file

JACK, Jive, Krakatoa, KeY, LOOP

Correctness proof

Bogor

Model checking

- Generation of specifications
- Verification of concurrent software
- Verification of bytecode

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By courtesy of Gary Leavens

HIGH PERFORMANCE MODEL CHECKING

| Specification Languages | mCRL2 | Promela | DVE | UPPAAL |

PINS

| Pins2pins Wrappers | Transition caching | Variable reordering Transition grouping | Partial−order reduction |

PINS

| Reachability Tools | Distributed | Multi−core | Symbolic |

Binary decision diagram
Multi-core graph algorithms

QUANTITATIVE SYSTEM ASPECTS
IMPORTANT FOR ALL APPLICATIONS

Sending over unreliable channel
Probing every 5 seconds until ack

x = 3
Retry
SendProbe!
x:=0
0.1
0.9 Success
RecAck?

| How man	How fast is your system? Are all deadlines met?
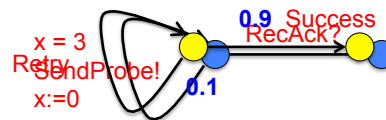
- **Not only:** does it work correctly?

- **But also:** How reliable is the system? How much bandwidth, memory, is used? What is the probability of a failure? How much energy is needed? Survival until next battery recharge?

- **Techniques:** annotate with quantitative system information: real-time clocks, probabilities, costs/rewards

- **Tools:** Update analysis techniques with these quantities

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Graph-Based Verification

State space (each state is a graph):
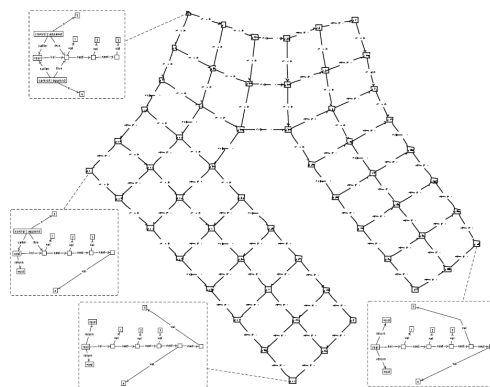
Hot research topics:
- Isomorphism checking
- Abstraction (identify patterns)
- Certified transformation

Applications:
- Objects / relations in SW
- Sensors / radiolinks
- Computers / network
- …

Essential for Model-Driven Engineering
Certified model transformations?

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APPLICATIONS
ANALYSIS & SYNTHESIS & OPTIMIZATION

- Safety:
  - A safe railway system, with smart maintenance and high capacity
    - Also: health, storm surge barrier, automotive, nuclear, …

- Energy / optimization:
  - Design a schedule so your phone-battery / nano-satellite run longer
  - Design a maintenance strategy: cheap and efficient

- High-performance computing:
  - How to verify GP-GPU applications?
  - Also: use GP-GPU, Multi-core, Hadoop, …
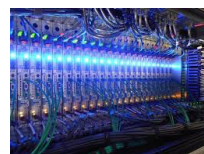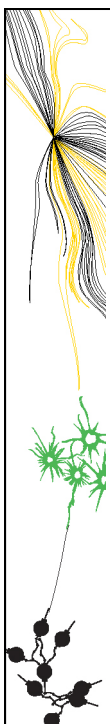
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WHY CHOOSE MTV? AND WHEN NOT TO CHOOSE IT?

- You want more computer science (not less)
  - Think: BaMI, FMSE, ADC, CDP, VB, VE
  - Next level: logical reasoning, modeling and analysis, algorithms
  - Many challenging problems and joining competitions

- You might start a good track towards a scientific career
  - Staff members of dedicated international researchers
  - but we also offer practical internships in 'verification engineering'
    - Vb: BetterBe, Nedap, ProRail/Movares, …

- Great teachers
- Join a great team of MSc and PhD students

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TEACHERS AND RESEARCHERS

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YOU ARE WELCOME
JOIN MTV!

- We look forward to you:
  - To teach you
  - Developing research together
  - To have fun in a nice group

- Society needs you:
  - As a professional verification engineer & scientist

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More information

- Do not forget the flyer
- MTV webpage
  http://fmt.cs.utwente.nl/education/mtv
- Overview of past, present and future final projects
  http://fmt.cs.utwente.nl/education/master
- Talk with the programme mentor
  - Marieke Huisman
  - M.Huisman@utwente.nl
  - Zilverling, room 5031, tel. 4662

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