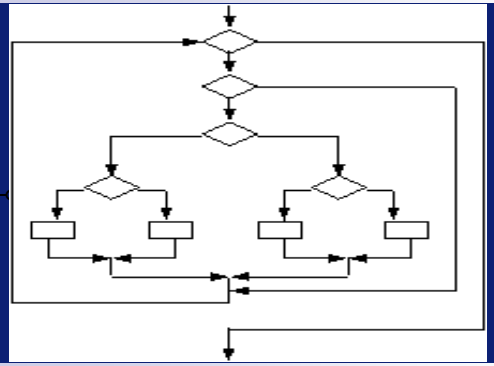
Spring 2008



Program correctness

Overview and motivation

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Course Information

- My e-mail: marcello@liacs.nl
- My office: 155a

- All important information on
  www.liacs.nl/~marcello/penc.html
  - Schedule
  - Grades
  - …

Visit it regularly

Lectures

- Where: room WI312
- When: Friday (11:15 - 13:00)

February	8	15	22	29
March	7	14		28
April	~~4~~	11	18	25
May		9	16	

Class participation is important

Practice

- Where: room WI312
- When: Friday (13:45 - 15:30)

February	8	15	22	29
March	7	14		28
April	4	11	18	25
May		9	16	

Class participation is essential

Grading

- This course is worth 5 ECTS
- Evaluation by home assignment (20%)
  +
  written examination (80%)

  max {0.2*HA + 0.8 WE, 1.0*WE}
- Written examination
  - when: Wednesday 11 June from 14:00 to 17:00
  - where: room ???

  and also

  - when: Thursday 21 Augustus from 10:00 to 13:00
  - where: room ???

Reading

Logic in Computer Science:

Modelling and Reasoning about Systems

Michael R. A. Huth and Mark D. Ryan

Cambridge University Press, 2004

ISBN 0 521 54310 X paperback

Expected Background

- Propositional logic
- Predicate logic
- Sets and functions
- Induction
- Recursion

- Imperative programming

Course Organization

- The course cover model and proof-based techniques for proving programs correct

- The course combines
  - theory (logics)
  - practice (program and system modeling)

- Course goals:
  - introduction to fundamental concepts of formal methods
  - usage of formal methods in software engineering

Formal Methods

- Formal methods includes all applications of mathematics to software engineering problems.
  - type checking
  - model checking
  - program correctness
  - semantics

Formal Methods

- We consider formal methods for verifying the correctness of computer systems (hardware and/or software)

- Logics provide a mean for mechanizing verification details

computer aided verification

  - fully automated (e.g. model checking)
  - interactive (e.g. program correctness)

Why?

- Avoid loss of life

  Therac 25, a computer-controlled radiation therapy machine made by Atomic Energy of Canada killed 6 people by radiation overdoses between 1985 and 1987 because of a timing problem on a data entry:

  "An operator mistake could be fixed within 8 seconds, but even though the monitor reflected the operator change, the change did not affected a part of the program"

Why?

- Save costs

  In 1994, 2 million Intel Pentium V had a bug in the FDIV operation. It could be detected by the following MS-Excel operation:

(4195835/3145727)x3145727-4195835 = 512 !!!

  - Cost to Intel: $475 million
  - From 1994 Intel applies formal verification techniques to its products

Why?

- Guarantee security

  In 1998 several e-mail systems did not check for the length of e-mail addresses, and allowed their buffers to overflow causing the applications to crash.

  Hostile hackers used this fault to trick the operating system into running a malicious program in its place.

Do you trust your system?

The real wonder is that the system works as well as it does

(Peterson, 1996)

but remember that software systems provide the infrastructure in virtually all industries today:

- air traffic control
- water level management
- energy production and distribution
- ...

Why Formal Methods?

- Testing and simulation techniques are never exhaustive

- Formal verification proves that a system works based on:
  - mathematical principles
  - exhaustive verification techniques
  - mathematical model structures

Warning

- The use of formal methods does not solve all these problems
  - proof: hand-checked or machine supported?
  - modelling task: difficult and yet crucial!
- Formal methods should be part of a methodology together with
  - Reviews (of requirements, design, and code)
  - Testing (of software units and their integration)