Temporal Logics

http://d3s.mff.cuni.cz

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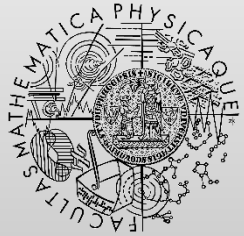

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Modal logic

- Possibly
  - <> P
- Necessarily
  - [] P

Dynamic logic

- Formulas
  - <a> P
  - [a] P
- Special actions
  - Constant: [1] P
  - Block: [0] P

Temporal logic

- Variants: LTL, CTL, ...
- Operators
  - Globally: G p
  - Eventually: F p
  - Next step: X p
- Details: course NSWI101

TLA: Temporal Logic of Actions

- TLA+ specification language
  - Low-level language based on logic and sets
  - Enables users to define a transition system
- PlusCal algorithm language
  - Syntax much closer to C/C#/Java
  - Writing and testing pseudo-code

- Home page
  - http://lamport.azurewebsites.net/tla/tla.html

- TLA Toolbox (IDE)
  - http://lamport.azurewebsites.net/tla/tools.html

PlusCal

- Features
  - control-flow statements, non-determinism, simple identification of atomic steps (for concurrency), procedure call and return
- Example algorithms
  - Euclid's GCD, mutual exclusion, alternating bit
- Translation into TLA+ specification
- Analyzing with TLC model checker
- Further reading
  - L. Lamport. **The PlusCal Algorithmic Language.** ICTAC 2009
    - http://lamport.azurewebsites.net/pubs/pubs.html#pluscal

TLA+

- Features
  - variables, constants, arithmetic
  - common set and logic operators
  - functions, control statements
  - sequences, tuples, arrays, records
  - non-deterministic choice
  - basic temporal operators

- Example translation: Euclid's GCD

- Further reading
  - L. Lamport. **Euclid Writes an Algorithm: A Fairytale**
    - http://lamport.azurewebsites.net/pubs/pubs.html#euclid

Advanced topics

- Liveness (termination)
- Fairness (scheduling)

- See the course NSWI101
  - http://d3s.mff.cuni.cz/teaching/nswi101

Practice

- Analyzing distributed concurrent algorithms, protocols and systems

- Case study: Amazon
  - C. Newcombe, T. Rath, F. Zhang, B. Munteanu, M. Brooker, and M. Deardeuff. **How Amazon Web Services Uses Formal Methods.** Communications of the ACM, 58(4), April 2015
  - http://doi.acm.org/10.1145/2699417