Automata: Theory and Practice

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Automata and Computability Theory

The science of computability

Explored first by logicians and mathematicians (Hilbert, Godel, Church, Turing, Post, Kleene, ...)

- Modelling computation
- Basic computing mechanisms and their Expressive power
  – Simulation of one mechanism by another.
- Analysis of computational models

Some Computation Mechanisms

- Finite state automata
- Push Down Automata
- Turing Machines
- 2-counter machines
- Godel's Mu Recursive Functions
- Lambda Calculus
- Post system
- Context-Free, Context sensitive and Unrestricted Grammars

Programming Languages: Fortran, Pascal, C, Lisp, Java.

Some famous results:

- Universal Turing Machine
- Undecidability of Halting Problem
- Church-Turing Thesis

Relevance

Widely applicable in all aspects of modern theoretical computer science.

Automata Theory has been extended in many directions.

- Complexity Theory
- Concurrency Theory and Process Algebras
- Modelling Real-Time and Embedded Systems
- Logics and Automata

Automata and Formal Methods

- Building abstract model M of behaviour of a computational system
- Specifying properties (in logic) of the system as S
- Verifying that the system meet its desired properties $M \models S$
- Model Checking: Algorithmic verification of $M \models S$

Automata Thoery is heavily used in Formal Verification especially in Model Checking.

Course Topics

- Finite State Automata on finite words
- Logics and Automata
- Automata Over Infinite Words
- Timed and Hybrid Automata
- Tools: MONA, Uppaal.

Details: Finite State Automata

(Two lectures)

- DFA, NFA and Equivalence
- Closure Properties and Decision Problems
- Regular Expressions and McNaughton Yamada Lemma
- Homomorphisms
- DFA minization
- Pumping Lemma
- Myhill Nerode Theorem
- Bisimulation and collapsing nondeterministic automta

Textbook: Dexter Kozen, *Automata and Computability*. Springer, 1997.

References

Finite State Automata

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Automata over Infinite Words

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