CMSC 141 Automata and Language Theory

Turing Machines

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Closure Properties

If A and B are **Turing-decidable** languages, then they are closed under:

- Union
- Concatenation
- Kleene star
- Complement
- Intersection

Closure Properties

If A and B are **Turing-recognizable** languages, then they are closed under:

- Union
- Concatenation
- Kleene star
- Intersection

Notes:

- Turing-recognizable languages are not closed under complement
- If a language L and its complement $L^{\complement}$ are both Turing-recognizable, then L is Turing-decidable

Church Turing Thesis

Church Turing (Markov) Thesis

Anything that is intuitively computable can be computed by any of the formal model of computation

- All (current) formal model of computations are equally powerful
- It is just a hypothesis, or conjecture, and cannot be proven because of the vague nature of what is "effectively computable"

Formal Models of Computation

- Turing Machines
- Lambda Calculus
- Markov Algorithm
- Unrestricted Grammars
- etc

Can these models "compute" everything?

- Are all mathematical functions computable?
- Is there a grammar for any language?
- Are all well-defined problems solvable?
- Can computers be programmed to do anything/everything?

No, all these powerful models have their limitations

Algorithmically Unsolvable

Is there a problem that cannot be solved by a computer? One that is not very theoretical which can be useful somehow?

Halting Problem

Lets define a Turing Machine A that takes as input, a Turing Machine M and a string x as input for M. A will accept if M will halt on input x and reject if M will not halt on input x.

The language described by A is Turing-recognizable but not Turing-decidable.

A program that checks if your code have an infinite loop in it.

Proof of Undecidability

REFERENCES

- Previous slides on CMSC 141
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- JFLAP, www.jflap.org
- Various online LaTeX and Beamer tutorials