

Turing-Recognizable and Turing-Decidable Languages

Chapter 4: Turing machines

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Content

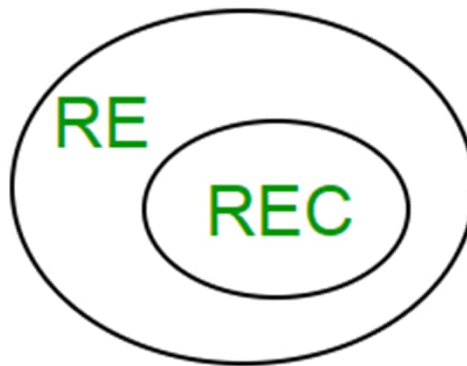
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Recursively Enumerable languages

- If any Turing Machine can be designed to accept all string of the given language, then the language is called recursively enumerable language.
- Recursively enumerable languages are the formal languages that can be decide-able, (fully or partially).
- According to the Chomsky hierarchy of formal languages, we can see the recursively enumerable languages as type 0 languages.
- An RE language can be accepted or recognized by Turing machine which means it will enter into final state for the strings of language and may or may not enter into rejecting state for the strings which are not part of the language.
- It means TM can loop forever for the strings which are not a part of the language. RE languages are also called as Turing recognizable languages.

Recursive Language (REC)

- A recursive language (subset of RE) can be decided by Turing machine which means it will enter into final state for the strings of language and rejecting state for the strings which are not part of the language.
- e.g.; $L = \{a^n b^n c^n \mid n \geq 1\}$ is recursive because we can construct a turing machine which will move to final state if the string is of the form $a^n b^n c^n$ else move to non-final state.
- So the TM will always halt in this case. REC languages are also called as Turing decidable languages.



Recognizable vs Decidable

Feature	Turing-Recognizable (RE)	Turing-Decidable (Recursive)
Halts on all inputs?	No	Yes
Accepts members?	Yes	Yes
Rejects non-members?	Not guaranteed	Yes
Example	Halting problem (RE)	Palindromes (Decidable)

Closure Properties: Turing-Decidable Languages

Closed under:

- Union
- Intersection
- Complement
- Concatenation
- Kleene star

Closure Properties: Turing-Recognizable Languages

Closed under:

- Union
- Intersection
- Concatenation
- Kleene star

✗ Not closed under: Complement

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