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Date _ :
Page _ :

** Computability and decidability

→ Only Halting TM are considers as Algorithm.

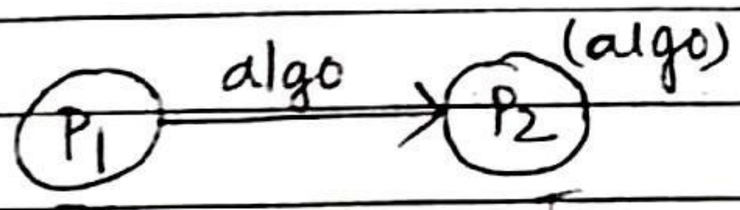
{ TM - countable
{ HTM - countable - (Algo)

• diff between computability and decidability:

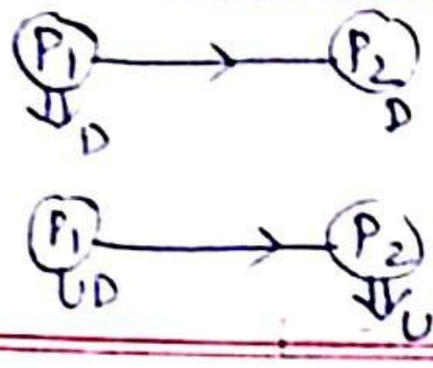
Computability	decidability
→ function $f(n) = n^2+1$. (domain = n) → If there are exist a TM to which the Input is given on its tape then again it produce output on the same tape and then it is going to halt for every Input given, then that function called computable.	→ Problem: a state-ment whose output will be either True or false. Ex- If 'n' a prime. Domain(D) = set of all natural number. • Given an Instance of a problem It is always decidable.

and there is an algo to

→ If there is a problem P_1 convert into a problem P_2 such way that If the answer P_1 is true then P_2 should be true. And there is an algorithm A such that it is as good as solve the problem of P_1. (to solve P_2)



→ this procedure is called reducibility. means Converting

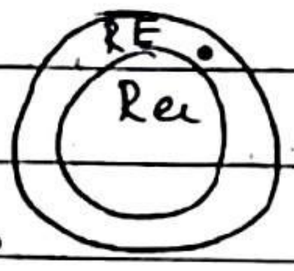


one problem to another problem using Algorithm on halting Turing machine.

** → If P_2 is Decidable, then P_1 is Decidable.
→ If problem P_1 is undecidable, then P_2 should be undecidable.
already proven to be definitly

- Turing machine halting problem : Given the description of a TM 'm' and an i/p 'w', does 'm' when started with 'w' as its i/p eventually halts ?

Theorem : If the halting problem were decidable, then every RE (Recursively enumerable) language would be recursive consequently, the halting problem is undecide
at least
→ already proved there is some language which is RE and which not Recursive language.



→ Halting problem for TM is undicidable.

- Some undecidable problems based on TM halting :

→ The state entry problem is given a TM, a state $q \in Q$ and $w \in \Sigma^+$, decide whether or not the sate q is ever entered when M is applied to 'w' This is undecidable.

→ Given a Tm M, whether or not M halts if started with a blank tape This undecidable.

→ Almost any problem related to RE language is Undecidable.

• Post Correspondence problem — (undecidable)

→ Given two sequences of 'n' strings on some alphabet Σ, say $A = w_1 w_2 w_3 w_4 \cdots w_n$ and $B = v_1 v_2 v_3 \cdots v_n$, we say there exists a pc-solution for pair (A, B) if there is a non empty sequence of integers $i, j, \cdots K$ such that

$$w_i w_j \cdots w_K = v_i v_j \cdots v_K$$

PC problem is to device an algorithm that will tell us for any (A, B), whether or not there exist a pc-solution.

Ex-

$A =$	w_1	w_2	w_3
	a	ab	bba

$B =$	v_1	v_2	v_3
	baa	aa	bb

PC-solution is (3, 2, 3, 1)

$w_3 w_2 w_3 w_1 =$ bba ab bba a

$v_3 v_2 v_3 v_1 =$ bb aa bb baa

atlantis

Date
Page

• Complexity classes :

P class : The set of all languages that are accepted by some deterministic TM in polynominal time.
$O(n^k)$

NP-class : The set of all languages accepted by non-deterministic TM is polynomial time is NP.

**** • Decidability Table —**

Problem	RL	DCFL	CFL	CSL	Rec_L	REL
1) Does $w \in L$? (membership problem)	D	D	D	D	D	UD
* 2) Is $L = \emptyset$? (Emptiness problem)	D	D	D	UD	UD	UD
* 3) Is $L = \Sigma^*$? (completeness problem)	D	D	UD	UD	UD	UD
* 4) Is $L_1 = L_2$? (~~Subset~~ equility problem)	D	UD	UD	UD	UD	UD
5) Is $L_1 \subseteq L_2$? (subset problem)	D	UD	UD	UD	UD	UD
6) $L_1 \cap L_2 = \emptyset$	D	UD	UD	UD	UD	UD
7) Is L is finite or not? (Finiteness)	D	D	D	UD	UD	UD
* 8) Is complement of 'L' a language of same type or not?	D	D	UD	D	D	UD
9) Is intersection of two languages of same type.	D	UD	UD	UD	UD	UD
* 10) Is L regular language	D	D	UD	UD	UD	UD