

May 7 Problems that are harder to solve than NP-Complete

HALTING PROBLEM

Input: Program P , Input I for P

(P, I) is pair of strings

Output: Yes if P terminates on I
No o/w

Q: Does there \exists an algo to solve the halting problem?
 \downarrow
in any finite time

THM: No!

PF: By contradiction.

Assume \exists algo h s.t.

$h(P, I) = \begin{cases} \text{Yes if } P(I) \\ \text{terminates} \\ \text{No o.w} \end{cases}$

def $c(x)$:

if $h(x, x) = \text{Yes}$:
loop forever

else

return

Consider the call $c(c)$

Case 1: $h(c, c) = \text{Yes} \Rightarrow c(c)$ loops forever

Case 2: $h(c, c) = \text{No} \Rightarrow c(c)$ terminates

\Rightarrow contradicts with solving the halting problem!

————— END —————