

The Halting Problem

Given a Program, **WILL IT HALT ?**

Given a Turing Machine, will it halt when run on some particular given input string?

Given some program written in some language (Java/C/ etc.) will it ever get into an infinite loop or will it always terminate?

Answer:

- In General we can't always know.
- The best we can do is run the program and see whether it halts.
- For many programs we can see that it will always halt or sometimes loop

BUT FOR PROGRAMS IN GENERAL THE QUESTION IS UNDECIDABLE.



Undecidability of the Halting Problem

Given a Program, **WILL IT HALT ?**

Can we design a machine which if given a program can find out or decide if that program will always halt or not halt on a particular input?

Let us assume that we can:

$H(P, I)$

├── Halt
└── Not Halt

This allows us to write another Program:

$C(X)$

if { $H(X, X) == \text{Halt}$ }

Loop Forever;

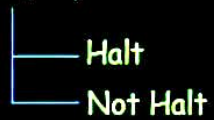
else

Return;



Let us assume that we can:

$H(P, I)$



This allows us to write another Program:

$C(X)$

```
if {  $H(X, X) == \text{Halt}$  }  
    Loop Forever;  
else  
    Return;
```

If we run 'C' on itself:

$C(C)$

