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) == Halt }
       Loop Forever;
  else
       Return;
```

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) == Halt }
       Loop Forever;
  else
       Return;
```

If we run 'C' on itself:

C (C)

- H (C,C) == Halt → Not Halt
- H (C,C) == Not Halt → Halt