

(Indirect) Self-Reference and Quines

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Self-Reproducing Machines/Programs

- ▶ Self-reproducing machines – Edward Moore (1956), Freeman Dyson (1970)
- ▶ Self-reproducing automata – John von Neumann (1948)

Quines

- ▶ Self-reproducing programs that do not take any input.
- ▶ Exist in any Turing-complete language.
- ▶ 'Quine' coined by Douglas Hofstadter
- ▶ Named after philosopher Willard van Orman Quine who studied indirect self-reference

Quine's Paradox

Liar's Paradox

"This statement is false"

"Every man is a liar"

Quine's Paradox

A sentence can be paradoxical even without direct/explicit self-reference

"yields falsehood when preceded by its quotation" yields falsehood when preceded by its quotation.

Quines and Self-Reference

Print out two copies of the following, the second one in quotes:
“Print out two copies of the following, the second one in quotes:”

- ▶ Part B is the clause **Print out two copies of the following, the second one in quotes:**
- ▶ Part A is same within quotes.

Examples in C

```
#include<stdio.h>

int main(){
    char *s = "#include<stdio.h>%c%cint main(){%c  char *s = %c%s%c;
%c printf(s,10,10,10,34,s,34,10,10,10);%c return 0;%c}";
    printf(s,10,10,10,34,s,34,10,10,10);
    return 0;
}
```

Short

```
char *s="char *s=%c%s%c;%cmain(){printf(s,34,s,34,10,10);}%c";
main(){printf(s,34,s,34,10,10);}
```

Shorter

```
main(p){printf(p="main(p){printf(p=%c%s%c,34,p,34);}",34,p,34);}
```

Applications

- ▶ Quines – hackers' amusement
- ▶ (Indirect) self-reference – important applications

Gödel's incompleteness theorem

- ▶ Kurt F. Gödel in 1938
- ▶ Inherent limitations of formal axiomatic systems of mathematics
- ▶ Two parts
 - ▶ In **any** consistent formal system, there are true statements that are unprovable
 - ▶ The system cannot demonstrate its own consistency
- ▶ More history and details next week!