Self-reproducing programs. And Introduction to logic.

COS 116: 3/13/2007

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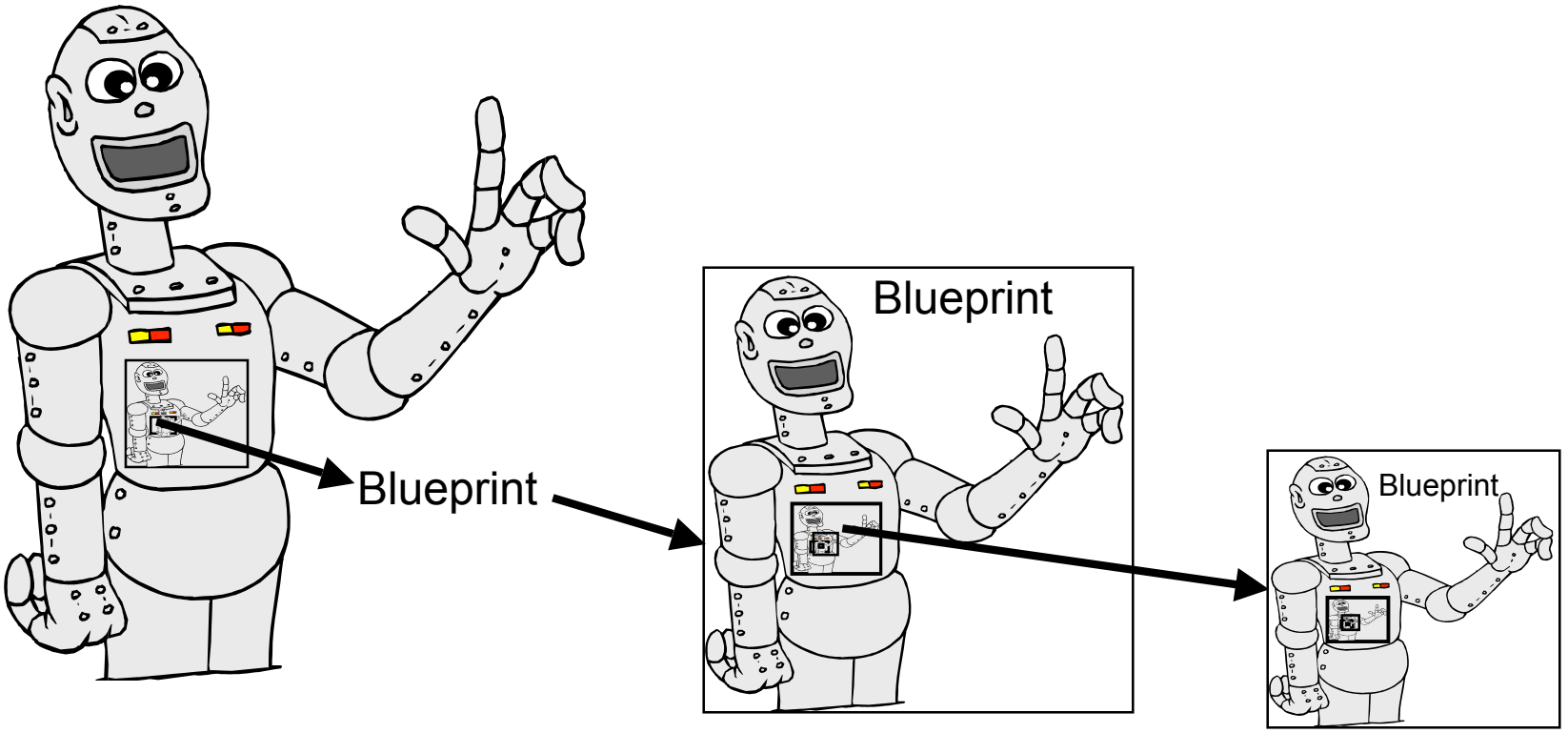
Discussion

- Did “Theory of Everything” article make you look at something in a new way?
- What is the Church-Turing thesis and how convincing is it to you?

Self-Reproduction

Fallacious argument for impossibility:



M.C. Escher

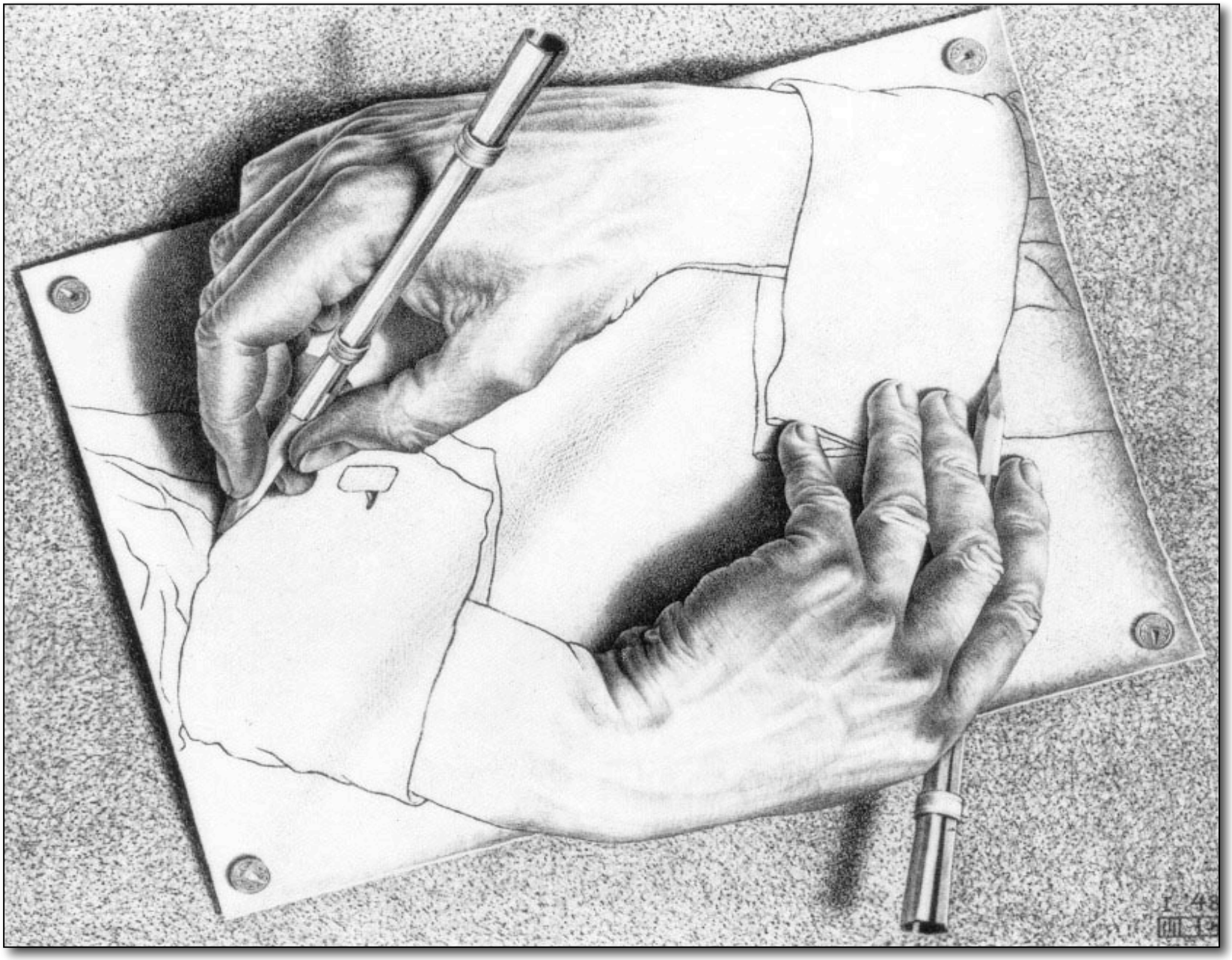
Print Gallery

Also, see:
TINYURL.COM/2X4QM2

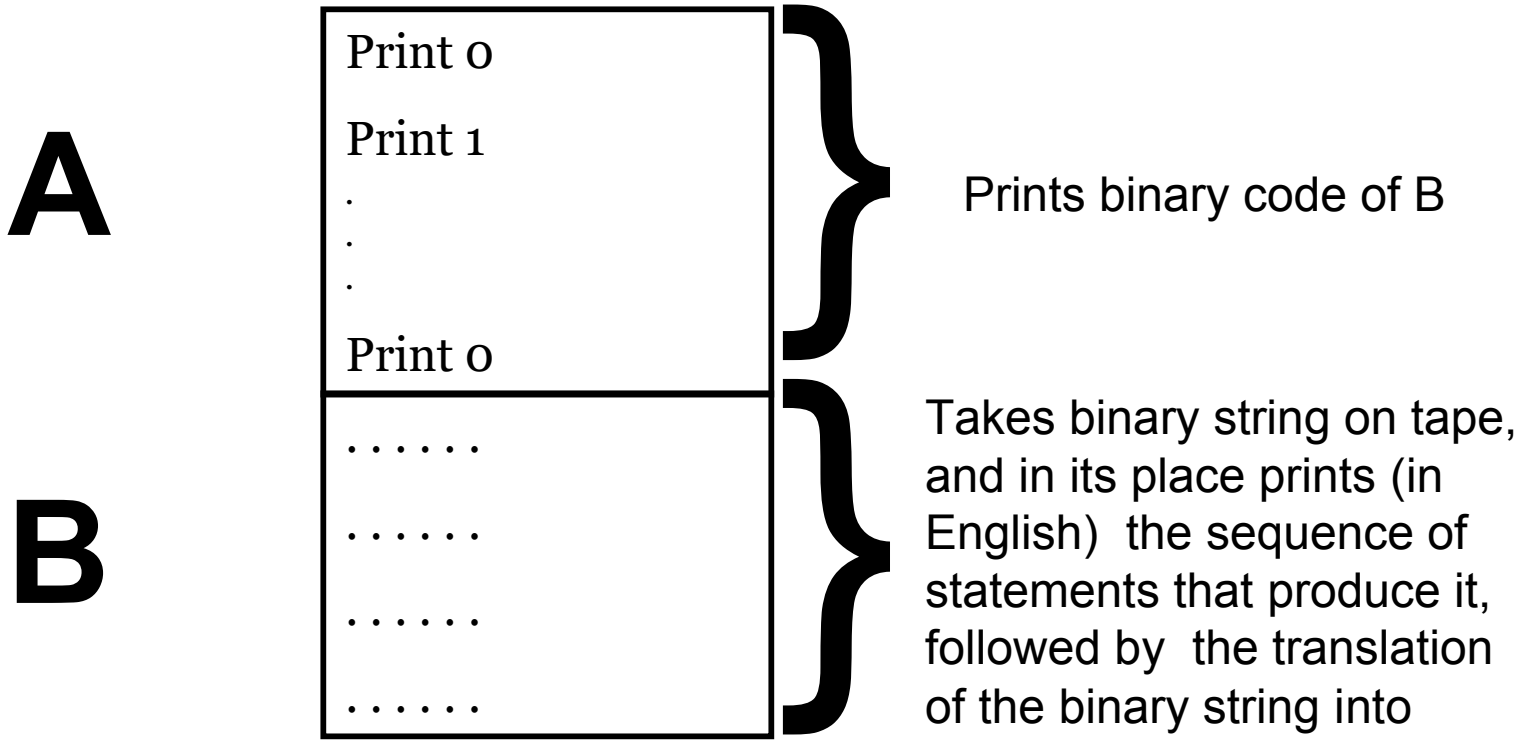
Fallacy Resolved:

"Blueprint" can involve *computation*; need not be an exact copy!

Print the following sentence twice, the second time in quotes. "Print the following sentence twice, the second time in quotes."



High-level view of self-reproducing program



Upcoming lectures:
Computational Hardware

- Boolean logic and Boolean circuits
- Sequential circuits (circuits with memory)
- Clocked circuits and Finite State Machines
- CPUs
- Operating System
- Networks, Internet

Logical Reasoning

Ben only rides to class if he overslept, but even then if it is raining he'll walk and show up late (he hates to bike in the rain). But if there's an exam that day he'll bike if he overslept, even in the rain.

It is raining today, Ben overslept, and there's an exam. Will Ben bike today?

"*Propositional logic*."

Propositional Logic: History

- Aristotle – Law of excluded middle,
  Law of contradiction.
- Stoic Philosophers (3rd century BC) –
  Basic inference rules (*modus ponens* etc.)
- Some work by medieval philosophers
- De Morgan and Boole (19th century):
  Symbolic logic – “automated”, “mechanical”
- C. Shannon (1930s) –
  Proposal to use digital hardware

Example

Ed goes to the party if
Dan does not and Stella does.

Choose “Boolean variables” for 3 events:

E: Ed goes to party
D: Dan goes to party
S: Stella goes to party

Each is either TRUE or FALSE

E = S **AND** (**NOT** D)

Alternately: E = S **AND** $\bar{D}$

Logical “OR”

Ed goes to the party if Dan goes **or** Stella goes

E = D **OR** S

E is TRUE if one or both of D and S are TRUE

Note: Different from everyday meaning of OR!

Example: You can eat an orange or an apple

Boolean expressions

Composed of boolean variables, **AND**, **OR**, and **NOT**

Examples:

D **AND** (P **OR** (**NOT** Q))

C **OR** D **OR** E

Truth table

Lists the truth value of the Boolean expression for all combinations of values for the variables.

Boolean Expression $E = S \text{ AND } \overline{D}$

Truth table

0 = FALSE

1 = TRUE

Write E for all possible values of D, S.

D	S	E
0	0	0
0	1	1
1	0	0
1	1	0

Let's work an example…

Boolean Expression $E = D \text{ OR } \overline{S}$

What are x and y ?!?

Click A for x=0, y=0
Click B for x=0, y=1
Click C for x=1, y=0
Click D for x=1, y=1
Click E for none of these

D	S	E
0	0	1
0	1	x
1	0	y
1	1	1

Boolean “algebra”

A **AND** B written as A · B

A **OR** B written as A + B

$0 \cdot 0 = 0$

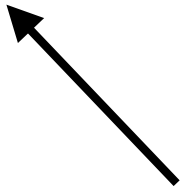
$0 \cdot 1 = 0$

$1 \cdot 1 = 1$

$0 + 0 = 0$

$1 + 0 = 1$

$1 + 1 = 1$



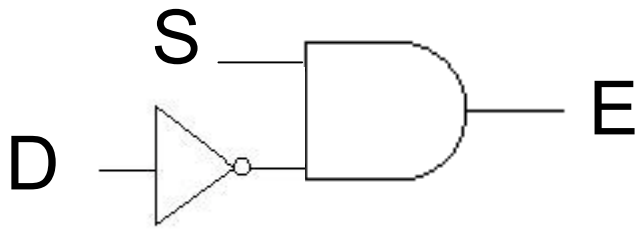
Funny arithmetic

Will provide readings on this…

Three Equivalent Representations

Boolean Expression $E = S \text{ AND } \overline{D}$

Boolean Circuit



Truth table:
Value of E for every possible D, S.
TRUE=1; FALSE= 0.

D	S	E
0	0	0
0	1	1
1	0	0
1	1	0

Ed goes to the party if

Dan doesn't AND Stella doesn't

E = $\bar{D}$ **AND** $\bar{S}$

Is this equivalent to:

Ed goes to the party if

NOT (Dan goes OR Stella goes)

….?

(De Morgan's Laws)

Ben Revisited

Ben only rides to class if he overslept, but even then if it is raining he'll walk and show up late (he hates to bike in the rain). But if there's an exam that day he'll bike if he overslept, even in the rain.

B: Ben Bikes
R: It is raining
E: There is an exam today
O: Ben overslept

Give Boolean expression for B in terms of R, E and O