

Relative Effectiveness

Standard Models

- Turing machines
- Recursive functions
- Lambda calculus
- Abstract state machines (a.k.a. evolving algebras)

Oracles

- Turing described an extension of Turing machines including an oracle.
- Put an input on the oracle's tape, go to the oracle's state, and get an answer in one step.
- The oracle need not be computable.
- We may say that a function (or language) is computable relative to the oracle(s).

Halting Oracle

- All r.e. languages are computable relative to the halting oracle.

Relative Recursiveness

- In addition to the basic primitive recursive operations (0, successor, projections), there may be oracular operations on the natural numbers.

Abstract State Machines

- The oracles are the operations provided by initial states.

Computable Algebra

- An algebra (domain plus operations) is computable if there is a numerical representation of the domain such that all the basic operations are simulated by (partial) recursive numerical operations.
- Normally, one demands that the injective/bijective representation be “effective”, but that is not necessary.

Abstract State Machines

- As state evolves, the values of its locations evolve.
- The evolution depends only on the values of the critical terms.
- The value of each updated location, at each step, can be expressed in terms of the initial values.

בעצם כוונתו
 [בעצם הבעיה] \times $\frac{0}{1}$
 בעצם הבעיה -

\int Oracle
 \int Oracle₂
 \int Answer
 C10

C"Ni

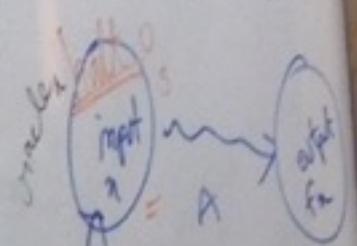
$\frac{0}{1}$

3x'

\times $\frac{0}{1}$ $\frac{0}{1}$
 Oracle
 $h(x,y)$
 $\{f(0, \dots) = 0\}$
 $\{f(s_n, \dots) = \text{Min}\}$

S^n π

ASM A

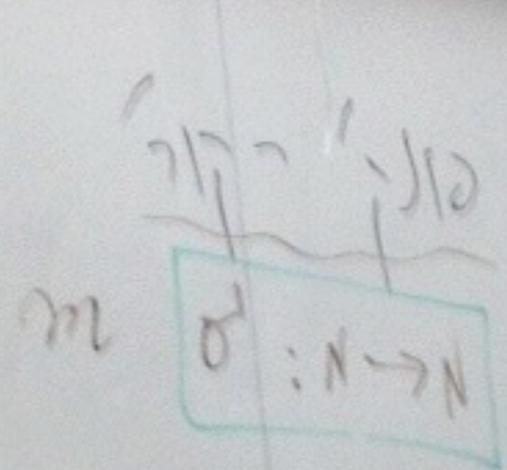
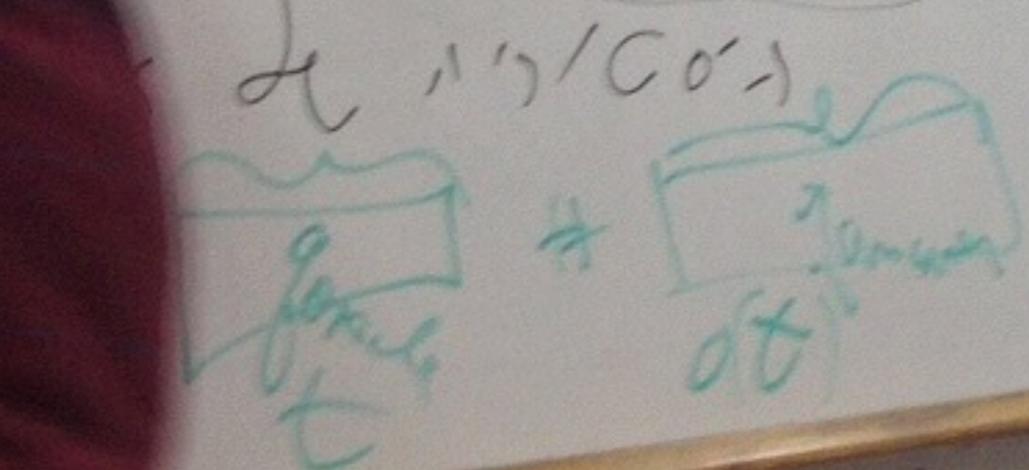
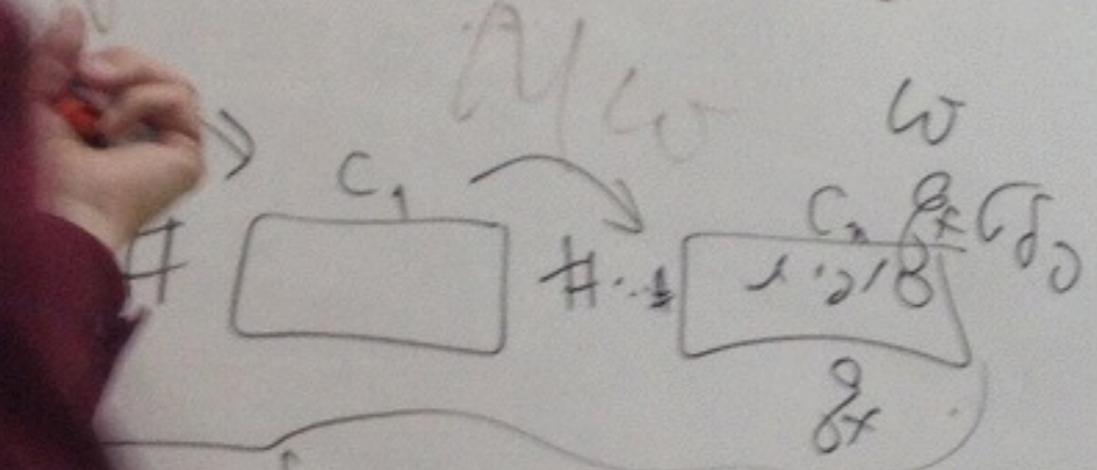
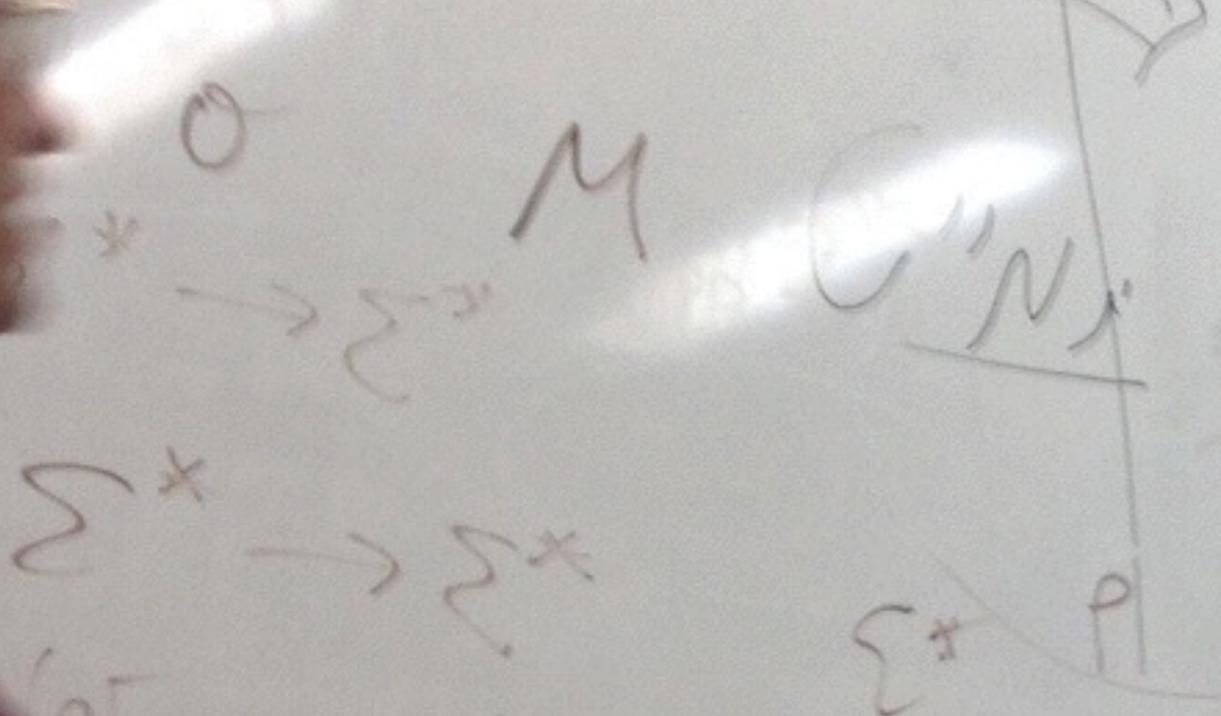


FOL \Leftrightarrow
 $\forall x \exists y =$

$F \cup \{h(0,0)=0\}$
 $\{h(0,1)=1\}$
 \dots
 $\{f(1)=0\}$

Oracle
 input
 output

binary

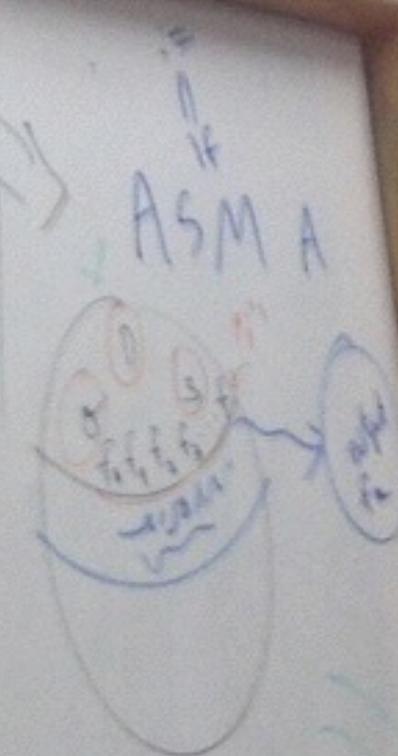


$S^m \cup \{ \epsilon \}$
 $\text{first}(h) = \text{first step}$
 $\text{step}(c, c') = \dots$
 $f = 0/1$

$\text{history}_M(x, h)$

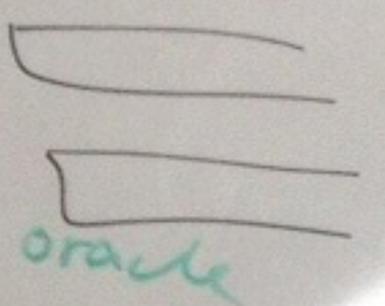
de x van h h
 x for M de x

$m(x) = \text{last conf}$

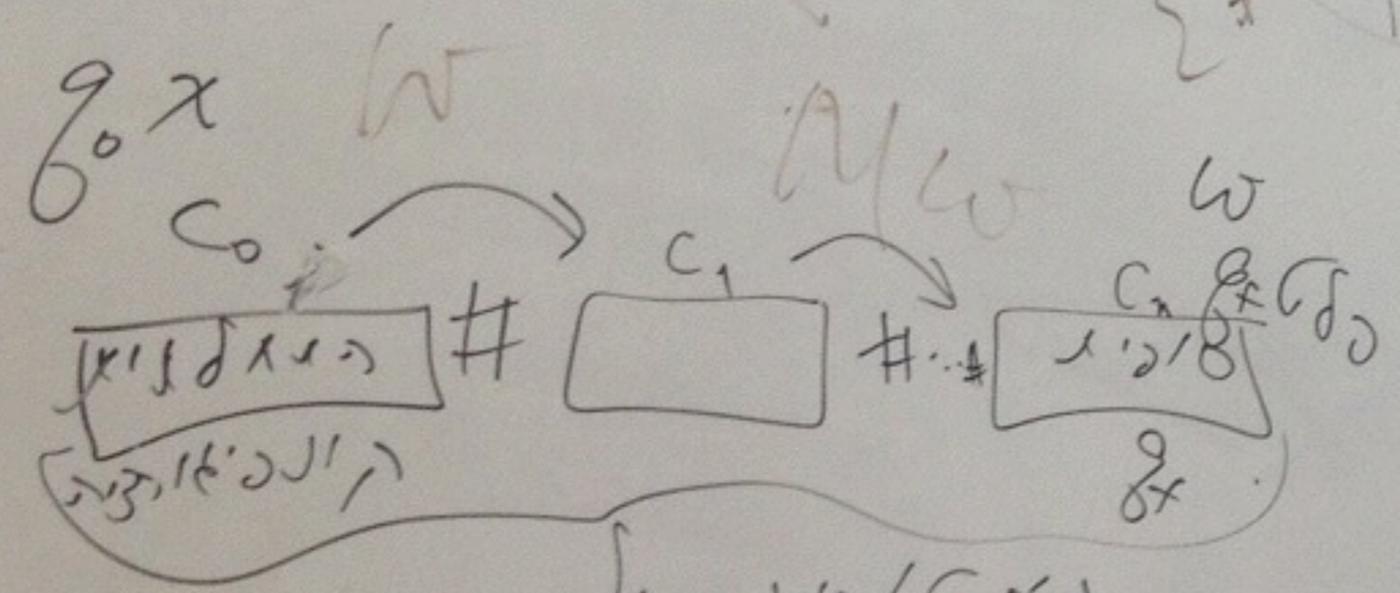
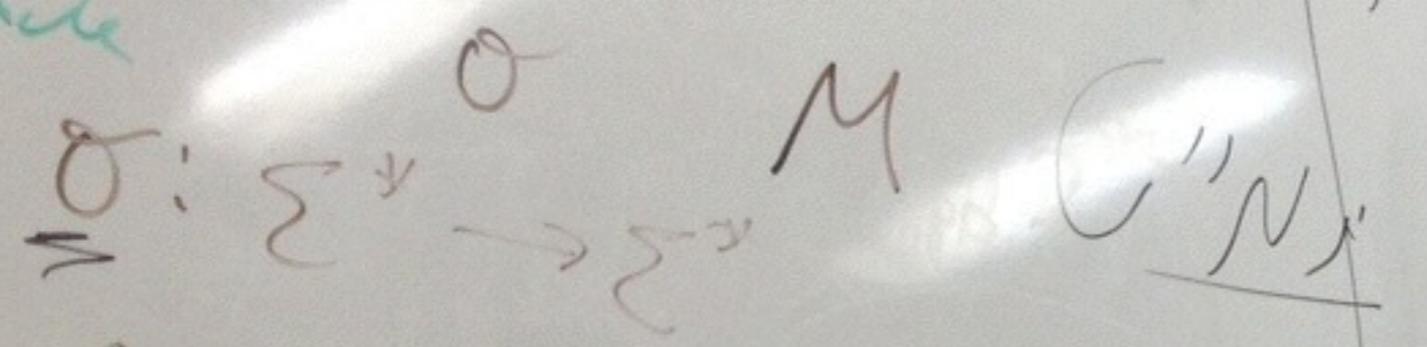


ω
 ω
 ω

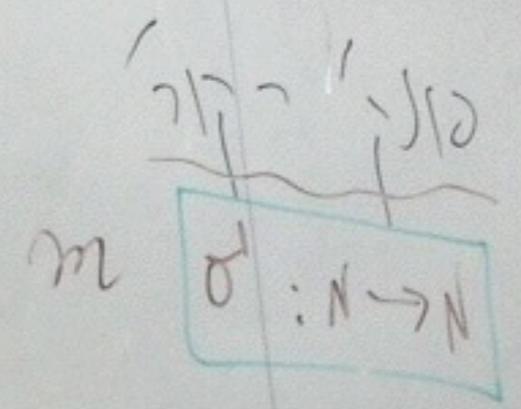
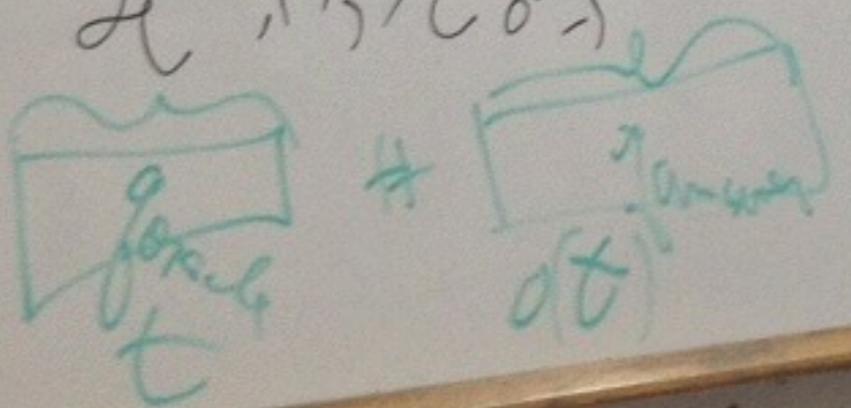
binary



oracle



bits of configuration



$S^n \cup \emptyset \cup \emptyset$
 $\text{first}(h) = \text{first step}$
 $\text{step}(c, c') = \dots$
 $\frac{1}{t} = \dots$

$\text{history}(\text{input}, h)$

x for M de \dots

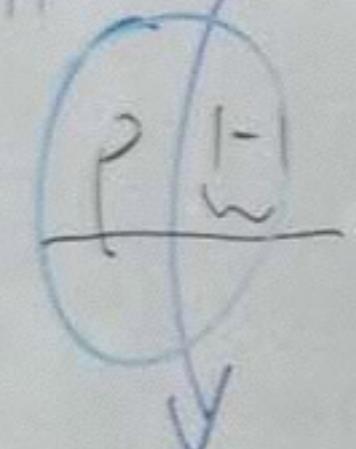
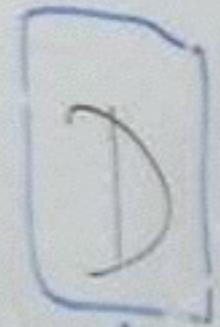
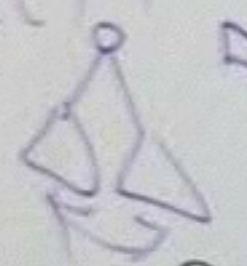
$m(x) = \text{last conf.}$

ω
 ω
 ω

תוכנית
 1/2
 2
 0
 1
 □
 □
 □

$b_n(x, t)$
 e^{-t}

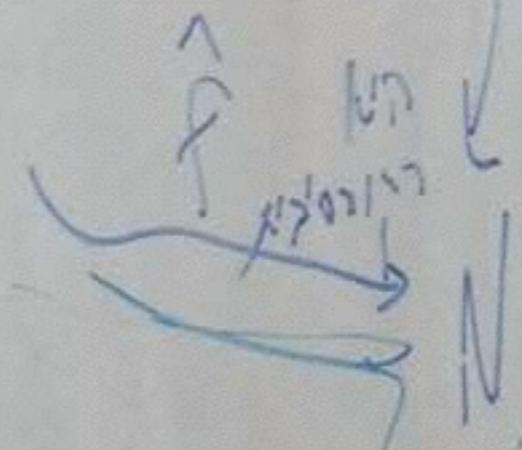
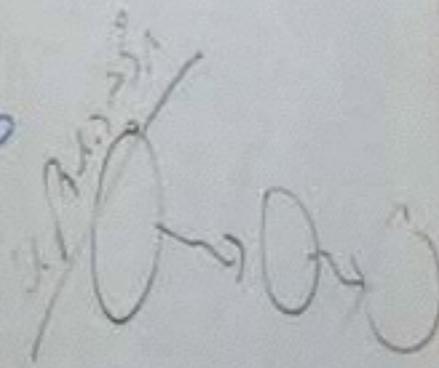
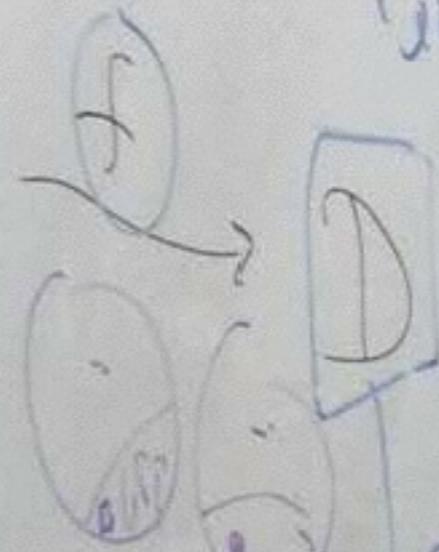
right(t)
 flip(t)



N

effective
 ASM

"הכל נגמל" ω
 במחיר הנאות



A קולט אלקטרוני

פקטור של יעילות מסתבר שהיא 100%

קיבלנו תשובה ברורה יותר מהמחשבה הראשונה (הקוויסטים)

Arithmetical Hierarchy

