Title: Lecture - Quantum Information, PHYS 635

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Subject: Quantum Information

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URL: https://pirsa.org/25030021

Lecture 10 - Theory of computation

TOC ≠ computer programming

Today + next lecture - classical

f computation

g

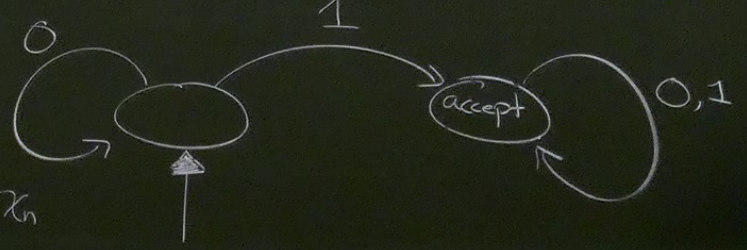
cal

Model of computation

"Finite automaton"

$x = x_1 x_2 \ldots x_n$

M1



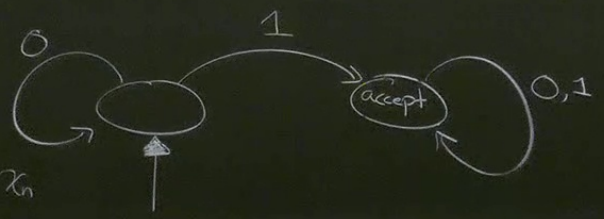
Def 1 A (formal) **language** is a subset of strings formed from some alphabet Σ

Model of computation

"Finite automaton"

$x = x_1 x_2 \ldots x_n$

M1



M1 accepts

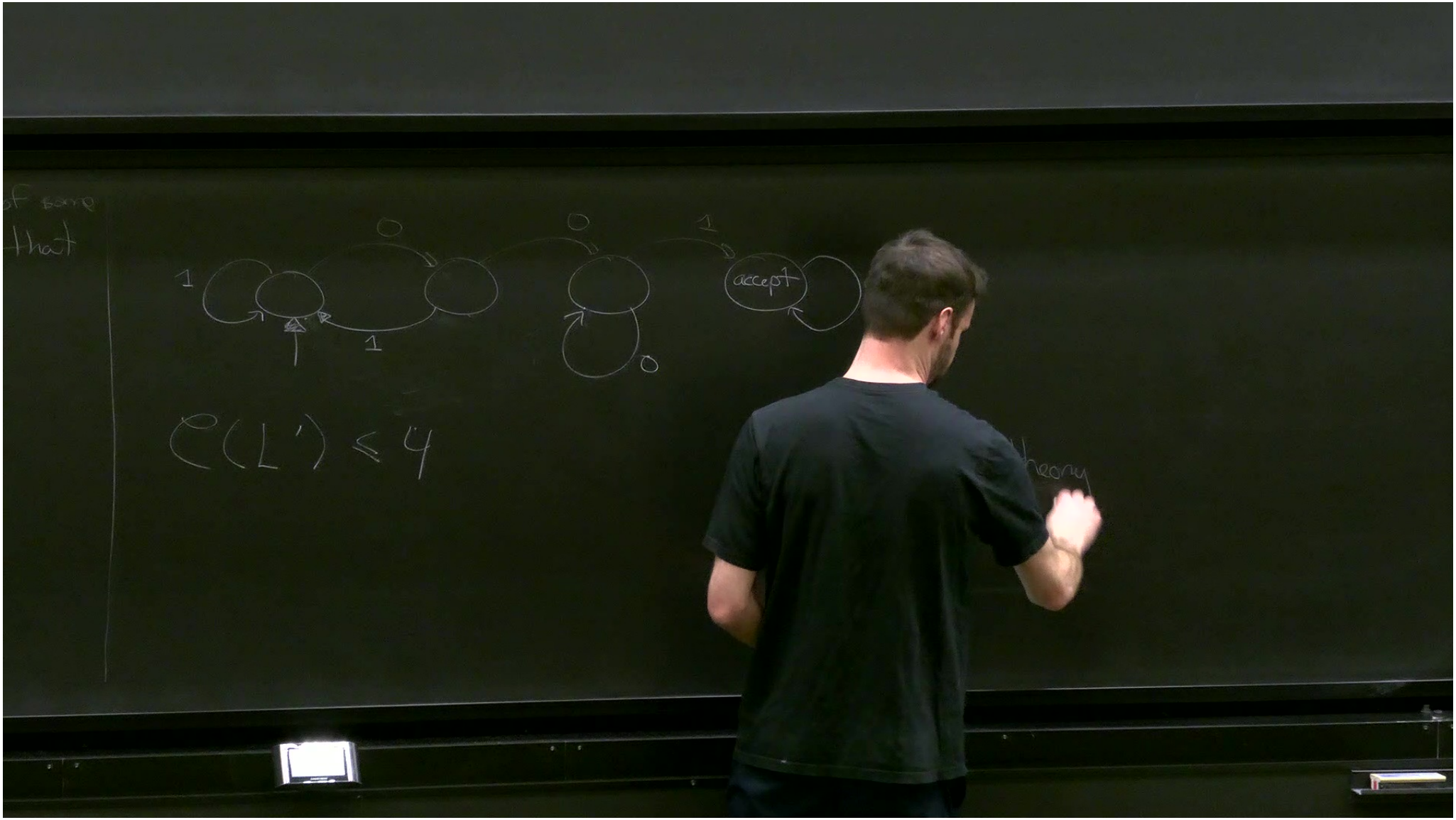
$L = \{x : x \neq 00\ldots0\}$

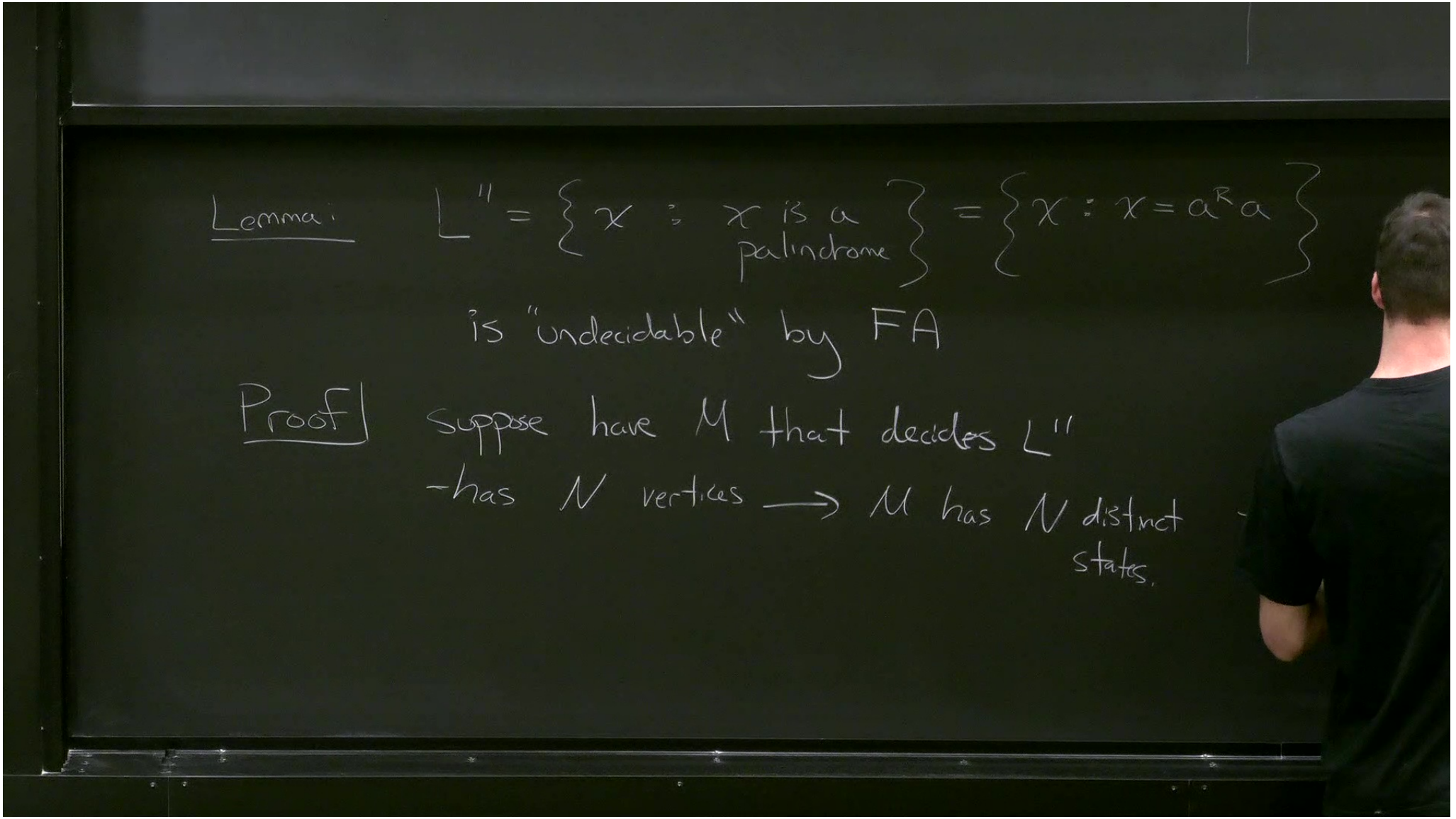
$\{f_n\}_n$

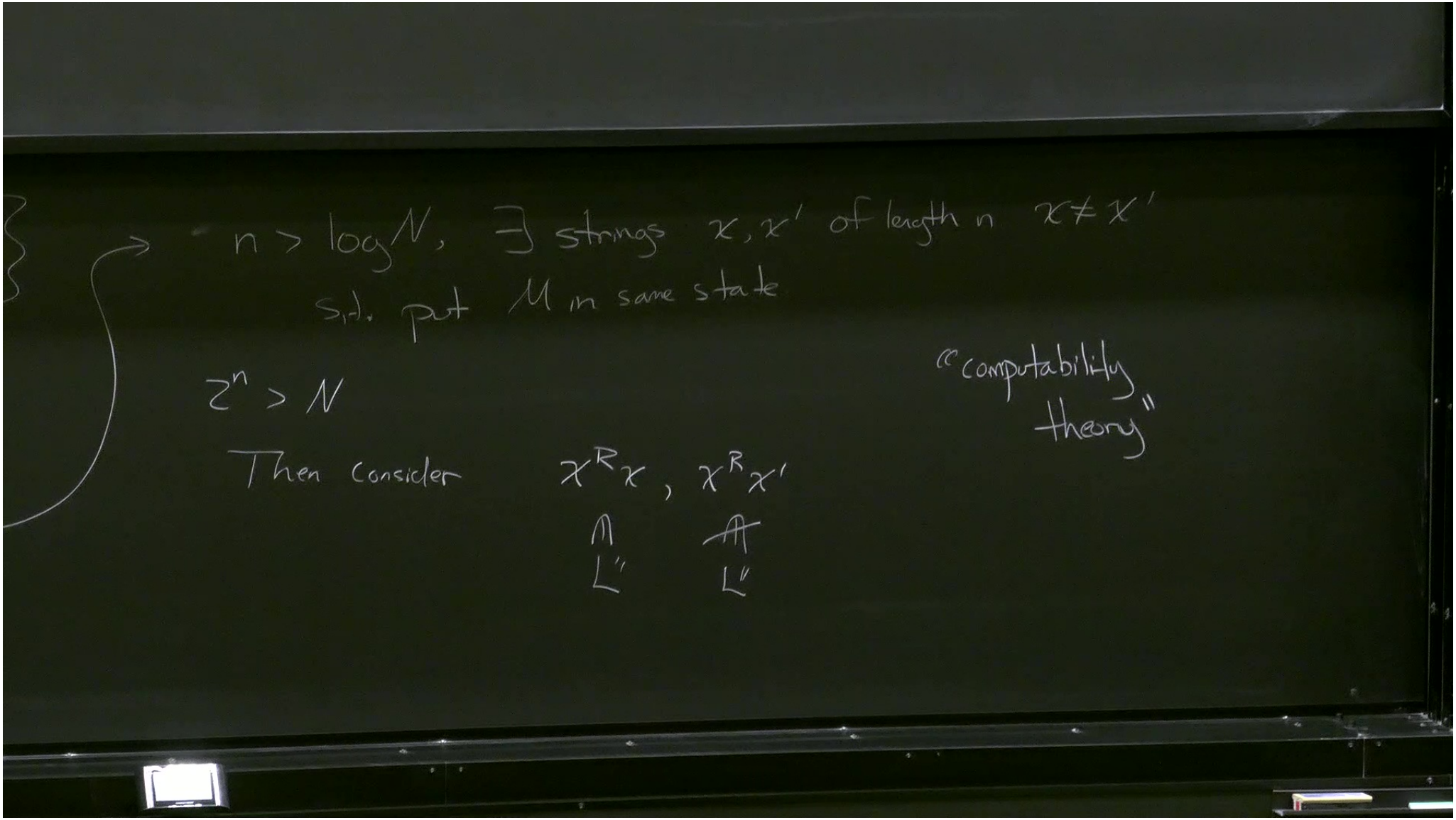
Def 1 A (formal) language is a subset of strings formed from some alphabet Σ

Complexity(L) = minimal "size" / amount of some resource of an instance that decides L.

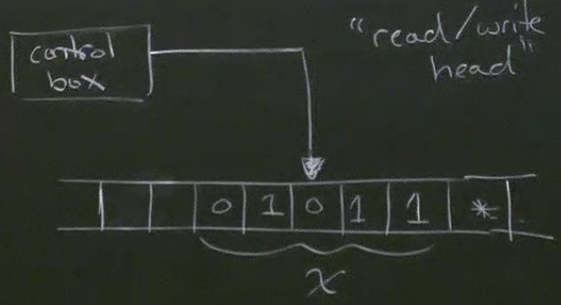
Ex) $L' = \{ x : \text{contain } 001 \text{ as substring} \}$


accept
1
0
1
0
1
1
0
$c(L') \leq 4$


Lemma: $L'' = \{x : x \text{ is a palindrome}\} = \{x : x = a^R a\}$
is "undecidable" by FA
Proof: Suppose have M that decides L''
-has N vertices → M has N distinct states.

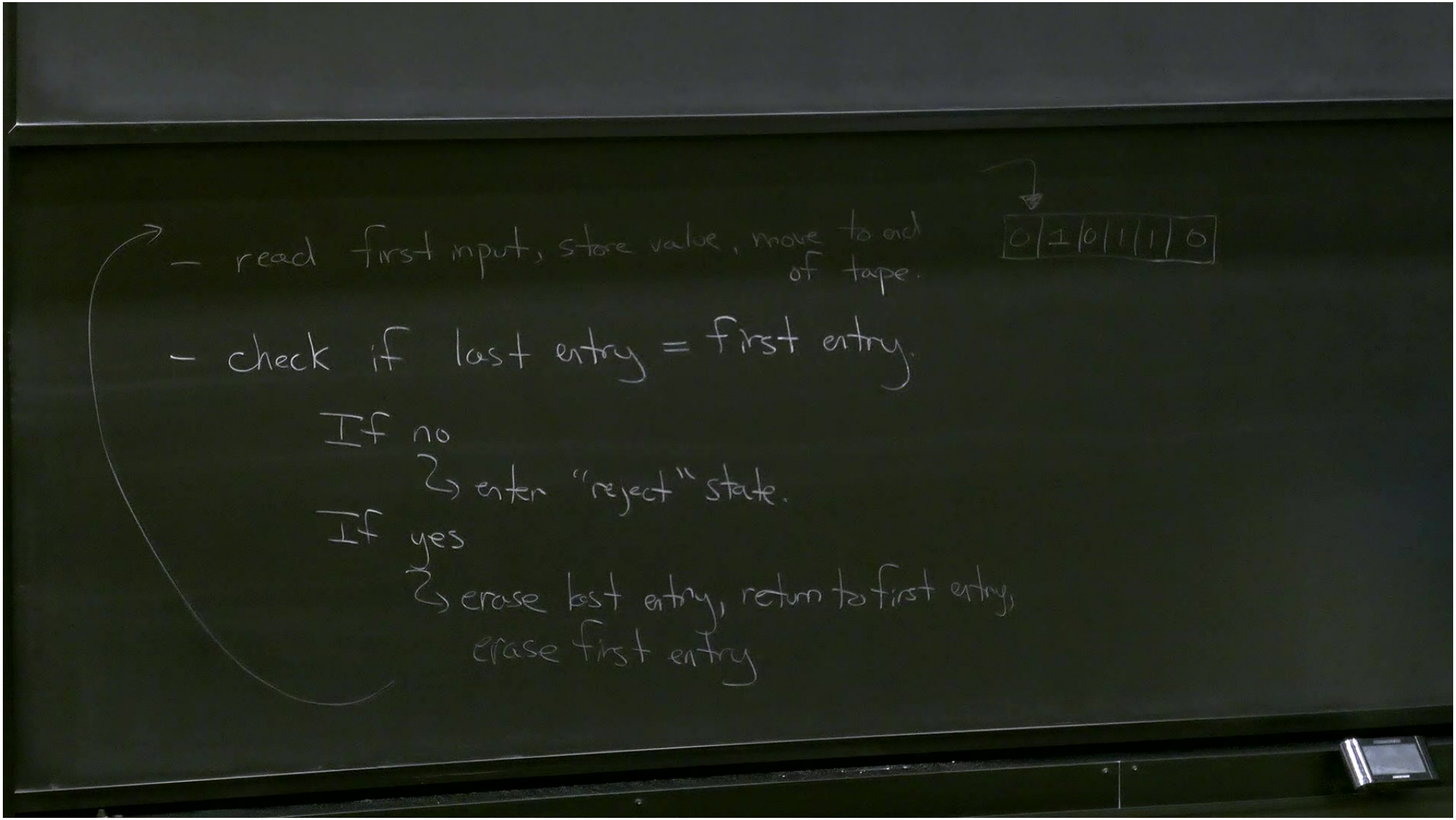

$n > \log N$, $\exists$ strings x, x' of length n $x \neq x'$
s.t. put M in same state
$2^n > N$
Then consider $x^R x$, $x^R x'$
L'' L''
"computability theory"

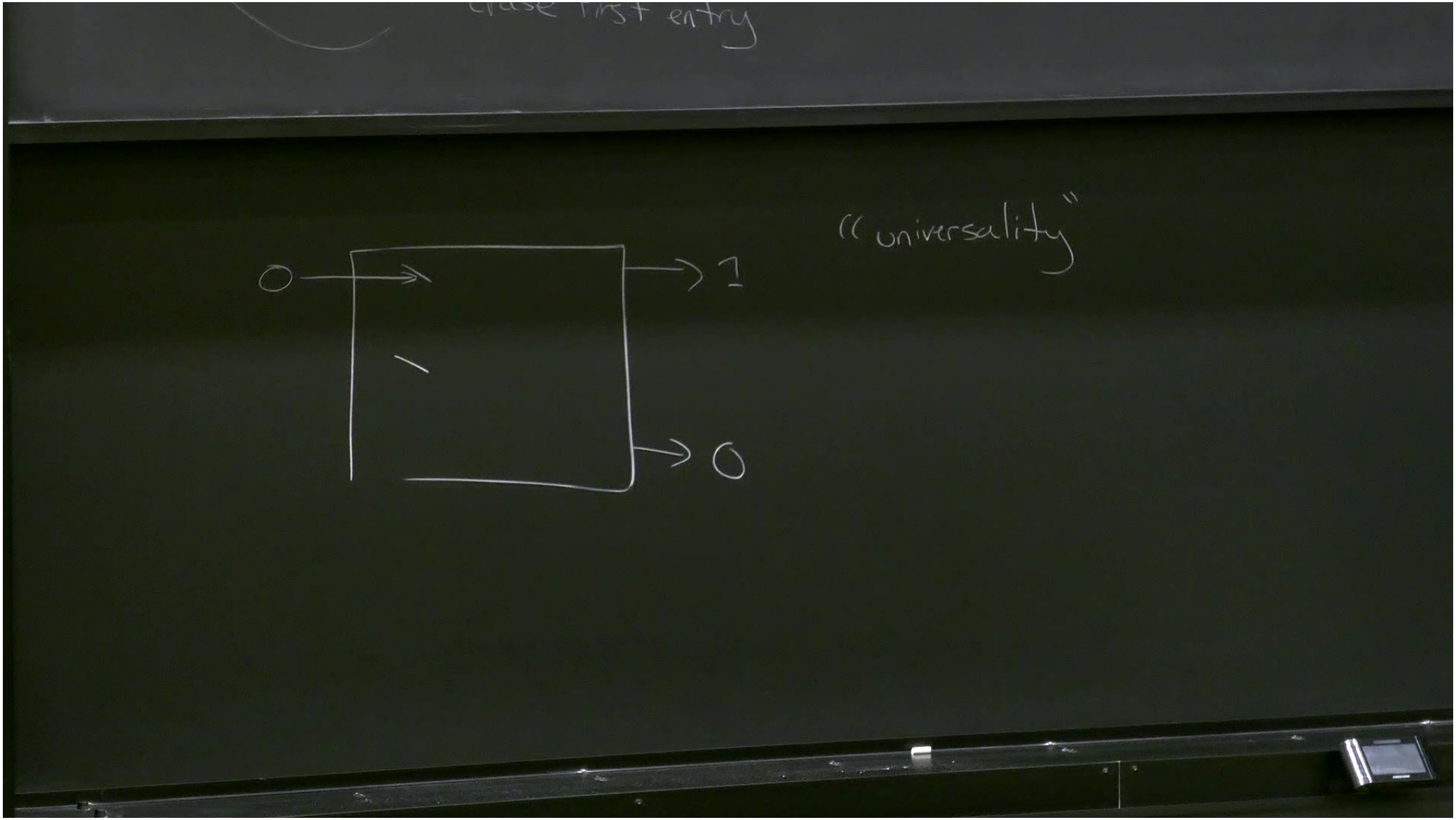
Turing Machine

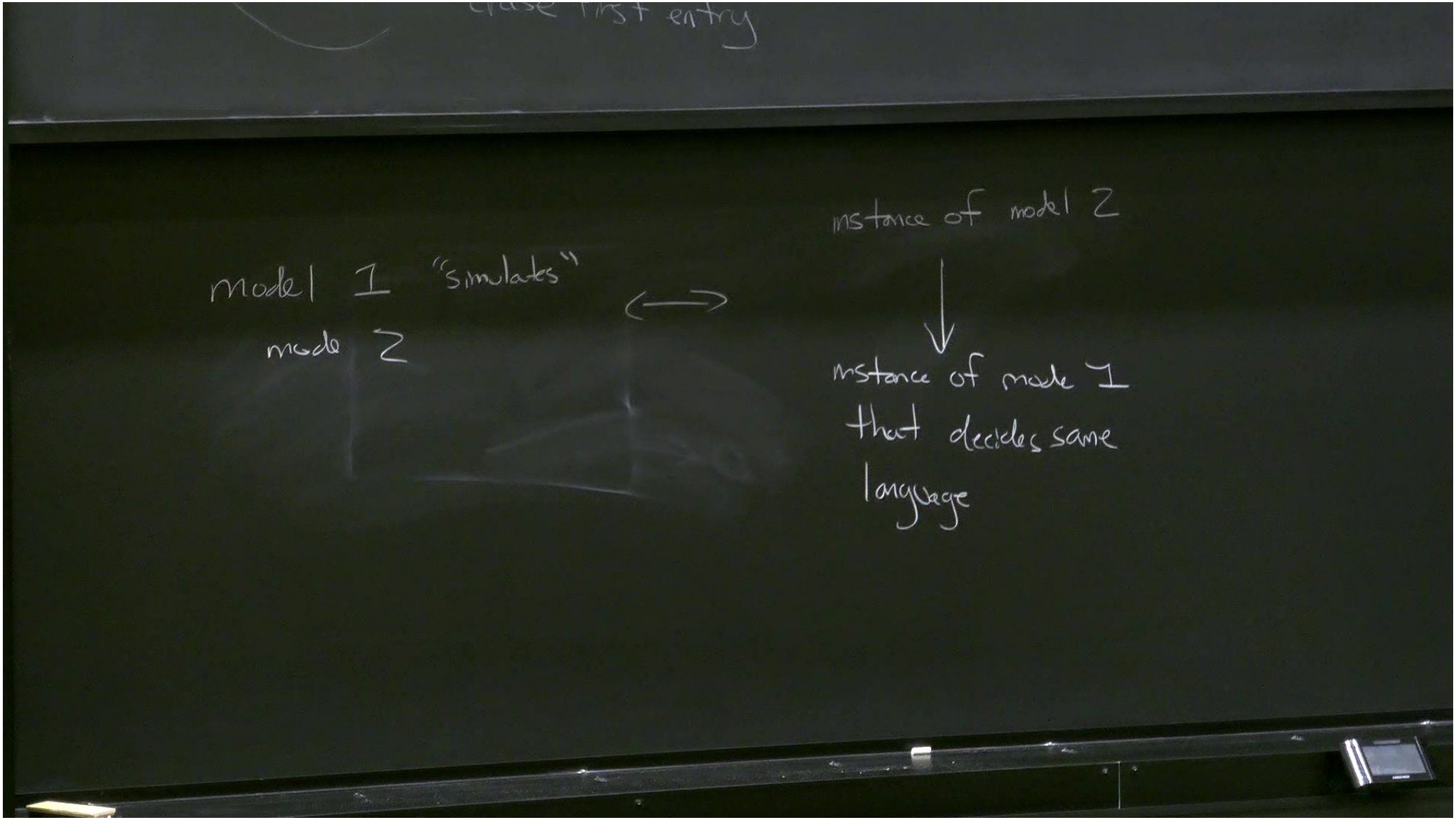


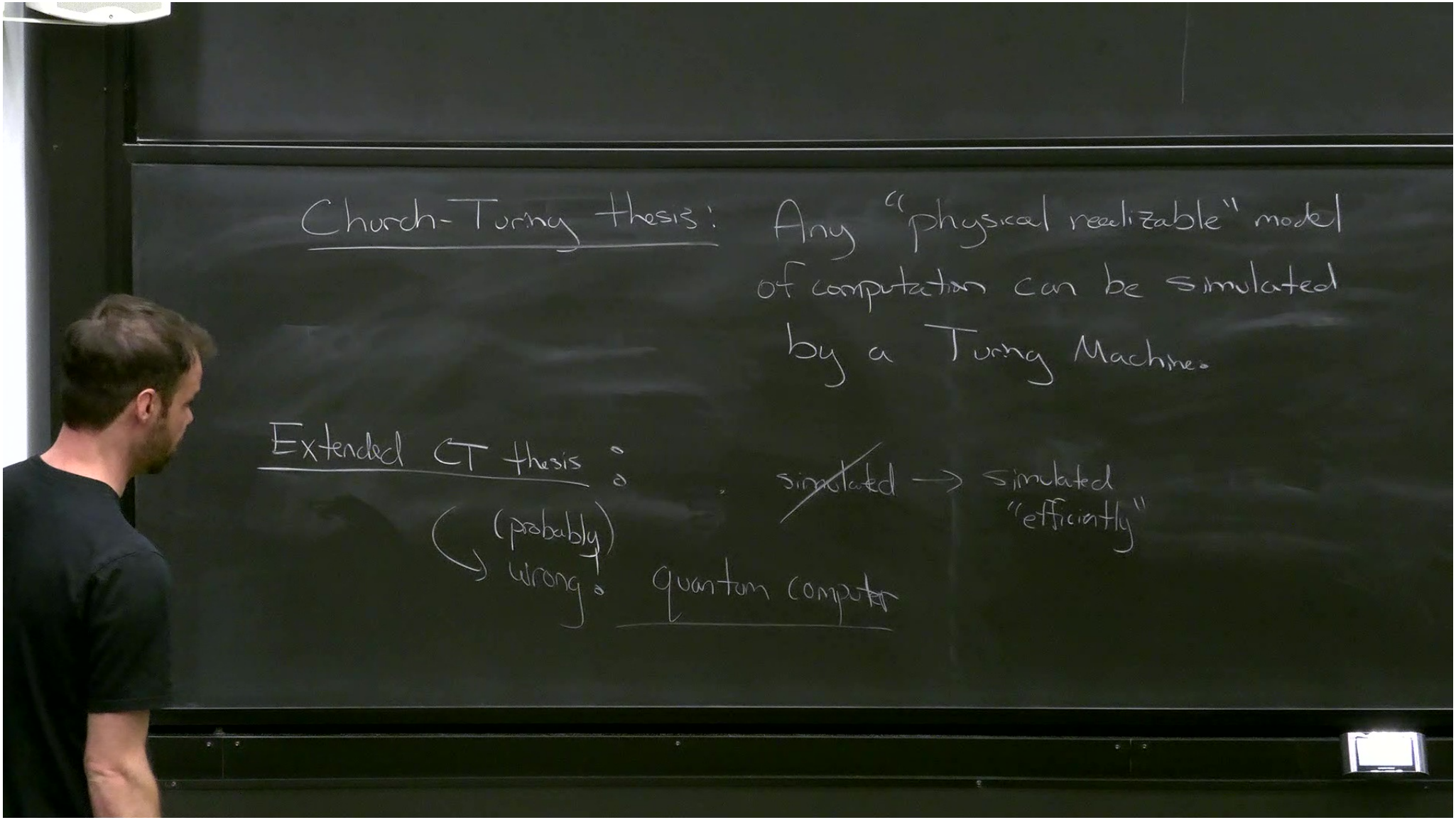
(current state box , current value of cell being read)

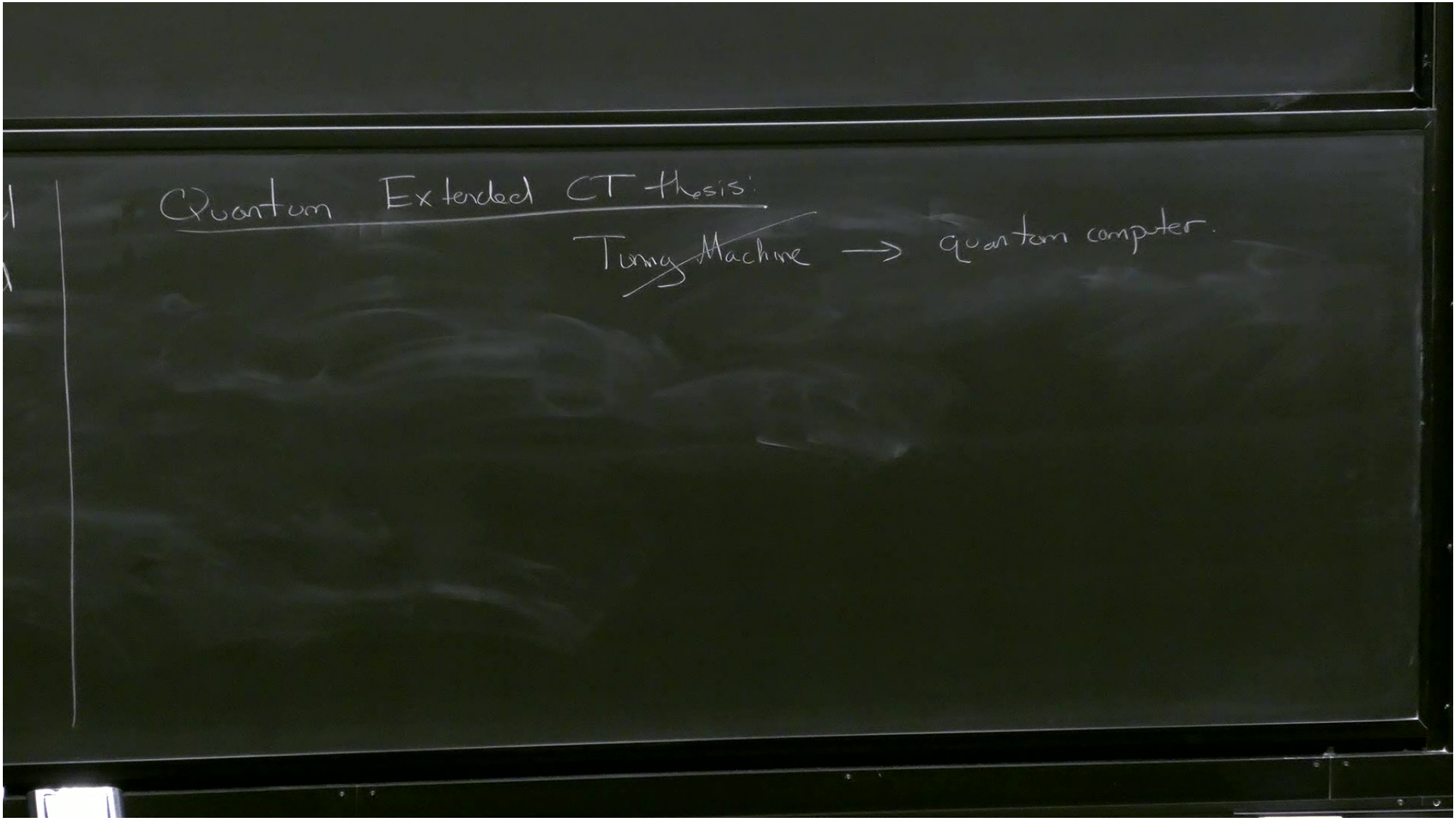
→ (new state of box , new value for cell , direction to move head)


- read first input, store value, move to end of tape.
0 1 0 1 1 0
- check if last entry = first entry.
If no
↳ enter "reject" state.
If yes
↳ erase last entry, return to first entry, erase first entry


first entry
"universality"
0
1
0


erase first entry
model 1 "simulates"
model 2
instance of model 2
instance of model 1
that decides same
language


Church-Turing thesis: Any "physical realizable" model of computation can be simulated by a Turing Machine.
Extended CT thesis:
simulated → simulated "efficiently"
(probably) wrong: Quantum computer


Quantum Extended CT thesis:
Turing Machine → quantum computer.