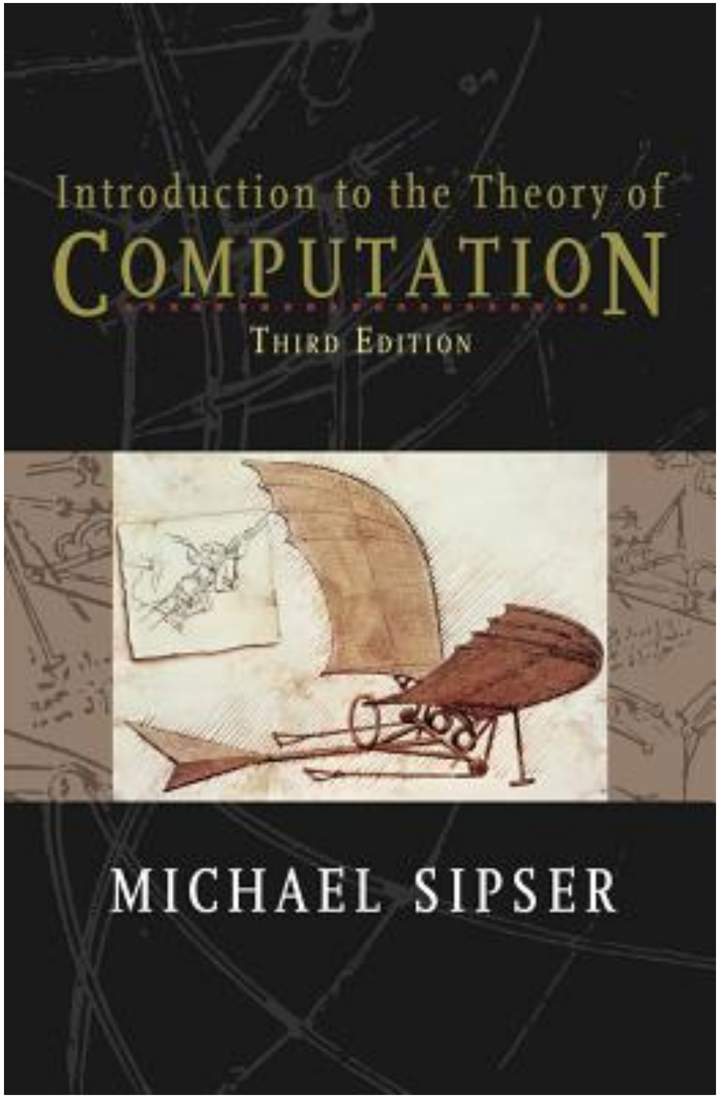
MCS 441
Theory of Computation I
Spring 2014

Lev Reyzin

Basic Info

- Professor: Lev Reyzin
- MWF 12-12:50pm
- Taft Hall 219
- website: math.uic.edu/~lreyzin/s14_mcs441/
- office hours: TBD. Will be on class site
- prerequisites: MATH 215 (or equivalent e.g. CS 201/202)

Textbook


Introduction to the Theory of
COMPUTATION
THIRD EDITION
MICHAEL SIPSER

Grading

- problem sets (20%)
- 2 in class midterms (20%-20%)
- final exam (40%)

may be adjusted by “bonus points” and slightly by class participation or absence

More on Problem Sets

- expect one every week or two
- all problem sets weighted equally
- undergraduate and graduate students may sometimes get different problems
  - undergraduates will get a small bonus for doing the graduate problems (correctly)
- some problems will be hard, just do your best

Collaboration Policy

- must do the problems on your own
- no searching for answers online!
- of course, no collaboration on exams

- Come to office hours if you need help!

Late Work Policy

- Homework will not be accepted late

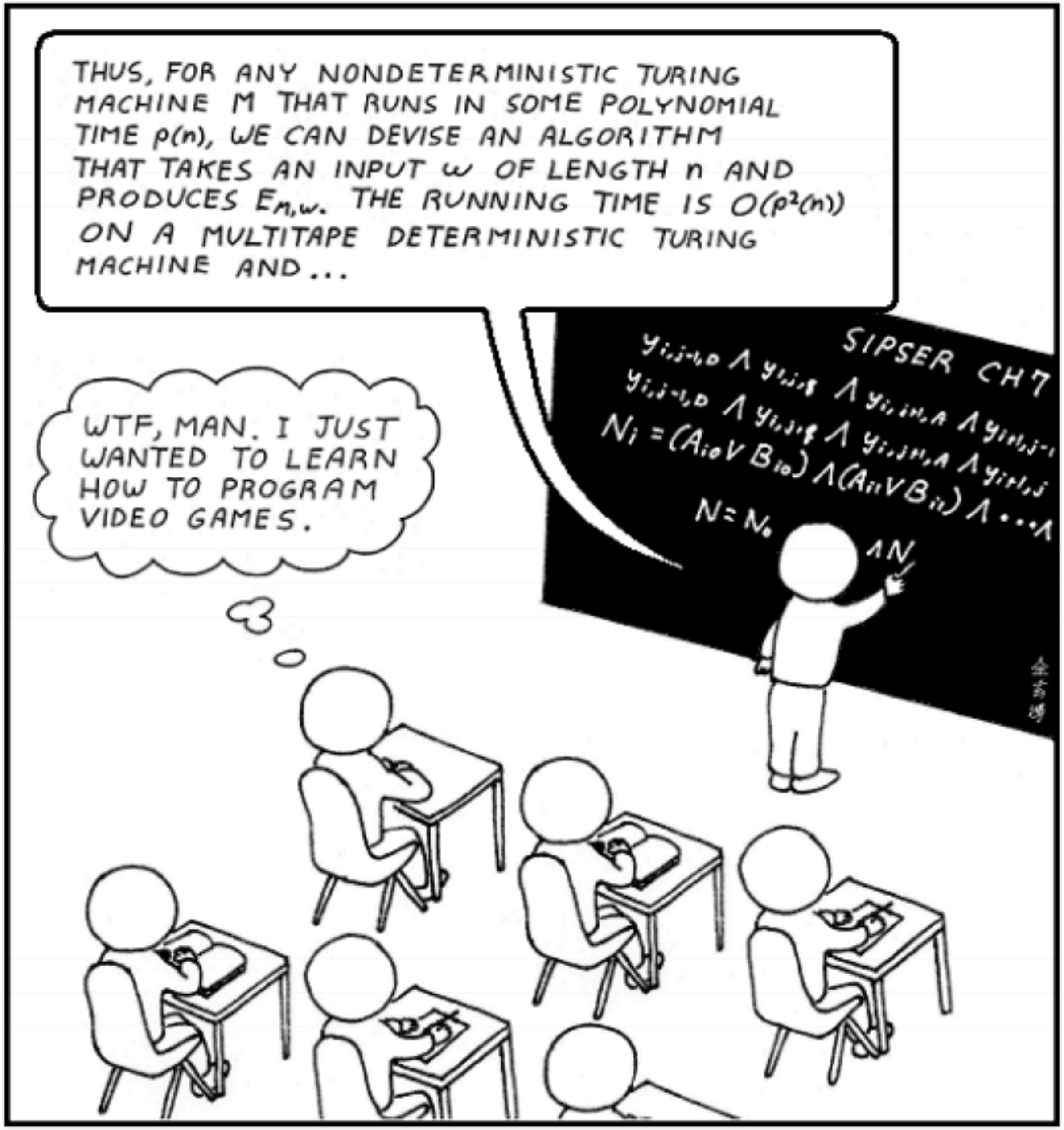
- Submit homework in beginning of class or in my mailbox (3rd floor SEO)

- I will make exceptions on a case-by-case basis. But email me *before* the homework is due.

What is the Theory of Computation?

- What is a computer?
- What can computers in principle?
- What can a computer do in practice? (efficiently)

- Fundamental ideas from the last two centuries:
  - diagonalizaton, Godel's incompleteness, mechanizing math, Hilbert's problems, P vs NP, nondeterminism, the nature of the universe, human creativity, basis of cryptography



abstruse goose

Topics

- Finite Automata
  - a very simple type of computer, no dynamic memory
  - capture regular expressions but also quite limited

- Pushdown Automata
  - have a stack for memory
  - capture context free languages, but still limited

- Turing Machines
  - still simple but very powerful
  - hypothesis: can simulate any real computation
  - still have limitations!

Decidability

- some problems are not decidable by Turing machines, e.g.
  - Is this program a virus?
  - Is this mathematical expression true?
  - Can you tile the plane with these tiles?
  - Many many others…

Complexity

- Some problems can be solved in polynomial time (P).
- Some problems can be verified in polynomial time (NP).
- Are these sets (P and NP) the same?
  - You can win $1,000,000 if you solve this.
- What if these two sets of problems are the same? What if they are different? Can creativity be mechanized?

Advanced Topics

- What if we limit a computer's space, not time?
- What if we are only looking for approximate answers to our questions?

What you should know

- Basic set theory
- Functions and Relations
- What is a graph
- Some Boolean logic
- Proofs
  - Induction, construction, contradiction, etc.

- To refresh your memory, read Chapter 0.