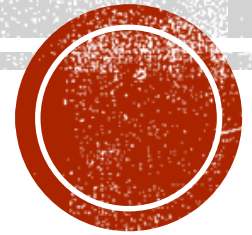


# CSC320 FINAL REVIEW

Summer 2015



# CSC320 FINAL EXAM

- Monday, August 10, 2pm-5pm
- ECS 116
- No aids, scrap paper provided



# SUPPLEMENTARY REVIEW SESSION

- Wednesday, August 5, 10:30am-11:30am
- DSB C108
- Will review sample final (to be posted on conneX)



# FINAL EXAM FORMAT

- 8 questions
- 4 “sections” – Regular Languages, Context Free Languages, TMs and Computability, Polynomial time and NP
- Each section has 2 questions – a 10 part multiple choice T/F question, and a 3-part long answer question (5/3/2 grading scheme – blank answers worth 2/1/0.5)
- MC questions worth 5 points each, long answer worth 10 points each
- All (and only) material covered in lectures or tutorials will be covered on the exam (except the Cook-Levin theorem!)
- There will be one (very easy) NP-hardness proof (3 points) and one (slightly more challenging) NP-completeness proof (2 points). These do not require a lot of cleverness – more checking that you understand the definitions.



# THINGS TO REMEMBER WHICH MAY MAKE LIFE EASIER

- Every language is the subset of *some* regular language (why?). Also, every language has *some* regular language as a subset (why?)
- $\text{REG} \subseteq \text{CFL} \subseteq \text{P} \subseteq \text{NP} \subseteq \text{REC} \subseteq \text{RE}$  (why?)
- $\text{P} \subseteq \text{NP} \cap \text{co-NP}$
- $\text{REC} = \text{RE} \cap \text{co-RE}$
- Using reductions: to show that  $L$  is undecidable, show that there is a known undecidable  $L'$  such that  $L' \leq_m L$  (note the direction!)
- To show that  $L$  is NP-complete, *first* show that  $L \in \text{NP}$  (i.e. show that  $L$  has poly-bounded certificates which can be validated in poly time) and *then* show that from some known NP-hard problem  $L'$ ,  $L' \leq_p L$  (note the direction!)
- Every poly-time reduction is a reduction



# MATERIAL COVERED

- All material covered in class on regular languages, including minimization
- DFAs, NFAs, Regular expressions, Regular languages
  - Constructions for closure properties of Regular languages (using DFA and NFA and RegExp)
  - NFA to DFA
  - RegExp to NFA
  - NFA to RegExp
  - DFA minimization
  - Pumping lemma, proving non-regularity via closure properties



# MATERIAL COVERED

- CFGs – derivations, ambiguous grammars, inherently ambiguous grammars
- $\text{REG} \subseteq \text{CFL}$
- Algorithms – Chomsky normal form, CYK algorithm
- PDAs – equivalence to CFGs
- Do *not* need to know pumping lemma for CFLs



# MATERIAL COVERED

- Turing machine – basic model, equivalence to extended models – complexity of simulations
- Recognizable (RE) languages – equivalence of recognition and enumeration
- Decidable languages,  $REC = RE \cap \text{co-RE}$
- Undecidability: encoding strings and machines,  $A_{TM}$  (proof that it is undecidable)
- Other undecidable languages –  $E_{TM}, EQ_{TM}, \text{HALT}_{TM}$
- Unrecognizability
- Reductions:
  - $M \leq_m L \Rightarrow \bar{M} \leq_m \bar{L}$
  - $M \leq_m L$  and  $L \leq_m N \Rightarrow M \leq_m N$
  - $M \leq_m L$  and  $L$  decidable  $\Rightarrow M$  decidable





# MATERIAL COVERED

- Polynomial time – input size, asymptotic running time, polynomial time TMs
- Determining the length of an input encoding
- NP – poly-time verification, poly-sized certificates, poly-time NDTMs
- SAT, CNFSAT, 3CNFSAT
- NP-completeness: NP-hard problems, reduction method
- Reductions (what are the running times?):
  - $M \leq_p L$  and  $L \leq_p N \Rightarrow M \leq_p N$
  - $M \leq_p L$  and  $L$  poly time  $\Rightarrow M$  poly time
  - $M \leq_p L \Rightarrow M \leq_m L$
  - NP-completeness proofs



# BOOK SECTIONS COVERED

- All of Chapter 1
- 2.1, 2.2
- All of Chapter 3
- All of Chapter 4
- 5.1 (excluding LBAs and computation histories)
- 5.3
- Chapter 7 (excluding Cook-Levin, and reductions not covered in the lecture)
- NOTE: There is some material not in the book which may be covered: DFA minimization, and CYK algorithm

