ArsDigita University
Month 8: Theory of Computation
Professor Shai Simonson

Exam 2 (50 points)

1. _____ (10 points)

2. _____ (18 points)

3. _____ (7 points)

4. _____ (15 points)

Total _____ (50 points)

1. Decision Algorithms (10 points)

a. Given a CFG and a specific non-terminal symbol X, explain how to determine if X can generate the empty string?

b. Given a CFL, explain how to determine if the language contains an infinite number of strings.

2. Name that Set (18 points)

Decide which of the sets below is Deterministic Context Free, Context Free or not Context Free. Prove your answers. (Hint: There is one of each.)

a. The complement of $\{0^i1^j\}$ where $0 < i < j$.

b. $\{0^i1^j0^i1^j\}$ $i,j > 0$.

c. The set of all strings $0^i1^j2^k$ where either $i = j+k$ or $k = i+j$.

3. Chomsky Normal Form (7 points)

Convert the grammar below into Chomsky Normal Form. Explain all your steps.

S --> SAB | e
A --> 0S1 | CD | e
B --> 1S0 | e
C --> BC | AC | 0
D --> CD

4. Turing Machines and Complexity Theory (15 points)

a. Write a high level detailed English description of a single-tape-TM program that accepts the set of binary strings with an equal number of zeros and ones, and analyze its time and space complexity.

b. For each of the sets state whether it is recursive, recursively enumerable or not recursively enumerable.

i. The set of TM's whose languages contain 0*.

ii. The set of all TM's that accept themselves visiting at most 100 distinct tape cells.

iii. The set of all TM's whose languages are not empty.

iv. The set of all CFL's that are decidable languages.

v. The set of all CFL's that are not equal to Sigma*.

vi. The set of all Regular Sets that are a subset of 0^n1^n.

vii. The set of all TM's that are non-deterministic.

viii. The set of all TM's that do not accept themselves.

ix. The set of CFG's that are ambiguous.

x. The set of pairs of TM's that generate the same language.