CSCE 222-200 Discrete Structures for Computing

Fall 2024

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Assignment # 6

(Due November 26)

1. Let X be the random variable that equals the sum of the numbers that appear when n fair dice are rolled. What is the expected value of X?

2. Find the conjunctive normal form of the Boolean function $F(x, y, z)$ that is equal to 1 if and only if (a) $x = y = 1$, $z = 0$; (b) $x = y = z = 0$, (c) $x = z = 0$, $y = 1$, and (d) $x = 0$, $y = z = 1$.

3. Construct circuits using inverters, AND gates, and OR gates to produce the following outputs:

(a) $\overline{x} + y$; (b) $\overline{(x + y)}x$; (c) $xyz + \overline{x}\,\overline{y}\,\overline{z}$; (d) $\overline{(\overline{x} + z)(y + \overline{z})}$.

4. Determine whether each of the following Boolean functions is satisfiable.

(a) $(x_1 + x_2 + \overline{x}_3)(x_1 + \overline{x}_2 + \overline{x}_4)(x_1 + \overline{x}_3 + \overline{x}_4)(\overline{x}_1 + \overline{x}_2 + \overline{x}_4)(x_1 + x_2 + \overline{x}_4)$

(b) $(\overline{x}_1+\overline{x}_2+x_3)(\overline{x}_1+x_2+\overline{x}_4)(x_1+\overline{x}_2+\overline{x}_4)(\overline{x}_1+\overline{x}_3+\overline{x}_4)(x_1+x_2+\overline{x}_3)(x_1+\overline{x}_3+\overline{x}_4)$

(c) $(x_1 + x_2 + x_3)(x_1 + \overline{x}_2 + \overline{x}_4)(x_1 + \overline{x}_3 + x_4)(\overline{x}_1 + x_3 + x_4)(\overline{x}_1 + x_2 + \overline{x}_4)$
$(x_1 + \overline{x}_2 + \overline{x}_3)(\overline{x}_1 + \overline{x}_2 + x_4)(\overline{x}_1 + \overline{x}_3 + \overline{x}_4)$

5. (a) Construct a deterministic finite-state automaton that recognizes the set of all bit strings that contain at least three 0s.

(b) Construct a deterministic finite-state automaton that recognizes the set of all bit strings that contain an even number of 1s.