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# *Communications of Adhikari Academy of Learning in Computer Science and Information Technology*

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Communications of Adhikari Academy of Learning
in
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# EDITORS



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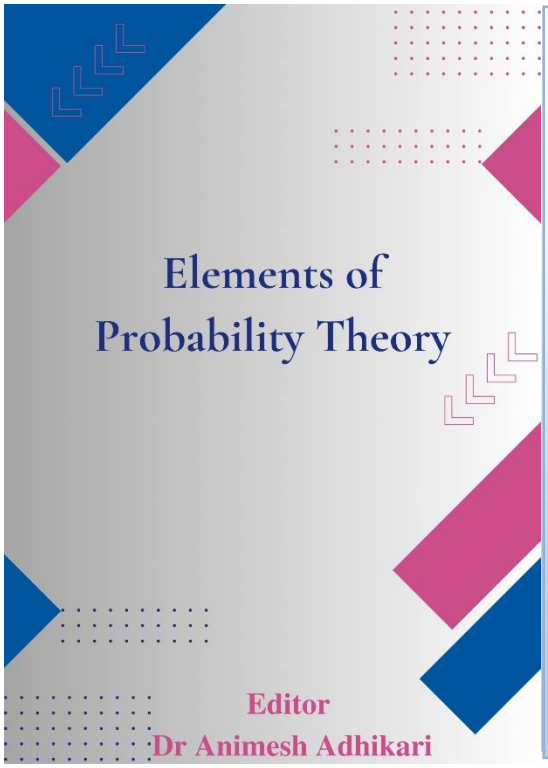
# News

We published the book *Elements of Probability Theory* (Second Edition) recently. Details of the book are given as follows.

The book includes interesting problems / solutions on probability theory and its applications. Probability theory has been a backbone of managing uncertainties. It has been a part of various disciplines, since the management of uncertainties becomes a common phenomenon in every domain. The selection of questions / problems is aimed at covering different aspects of probability theory. This book is also effective for students other than Computer Science, who have taken probability theory as a paper of their studies. We believe that a large number of students would get benefited from the book. The second edition of the book contains 277 questions / solutions.

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**Biography:** Dr Animesh Adhikari is Founder and Editor of Adhikari Academy of Learning Private Limited, Goa, India. Animesh received Master of Technology and Ph D degrees, both in Computer Science, from Indian Statistical Institute and Goa University, respectively.

Animesh has been working in both academia and software industry since 1993. In the past, he served to K L University, Guntur; Chowgule College, Margao; and Price Waterhouse Associates, Kolkata.

Animesh published three research monographs on *Data and Knowledge Engineering* with Springer, Germany, and twenty research papers in international journals and international conferences. He published twenty-nine books on various aspects of Computer Science and Information Technology with Adhikari Academy of Learning, Goa. Animesh also published a few derived books such as Mathematics for Computer Science and Information Technology, and GATE - Computer Science and Information Technology.

For more details about the book, please visit book webpage.

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| *JK flip-flop* | 4 | 2 |
| *left-regular grammar* | 1 | 1 |

***1. Consider the following two statements:***

**S1: $\{0^{2n} \mid n \geq 1\}$ is a regular language**

**S2: $\{0^m 1^n 0^{m+n} \mid m \geq 1,\ n \geq 1\}$ is a regular language**

**Which of the following statements is correct?**

**(d) Only S1 is correct** **(b) Only S2 is correct**

**(c) Both S1 and S2 are correct** **(d) None of S1 and S2 is correct**

*Communicated by Jhimli Adhikari*

***Answer:*** Set S1 can be generated by the left-regular grammar consisting of the following rules.
$S \rightarrow A0$
$A \rightarrow S0 \mid 0$
So, the statement S1 is true.
Now, consider the set S2. A finite automaton is not able to remember non-consecutive symbols. In this case, first $m$ zeros and $m$ zeros after consecutive 1s cannot be produced by a regular grammar. So, the statement S2 is false. A formal proof of statement that S2 is false is given in Question 2.
Thus, option (a) is correct.

***2. Show that the set S = $\{0^m 1^n 0^{m+n} \mid m \geq 1,\ n \geq 1\}$ is not regular language.***

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**Answer:** We assume that set S is regular. Let $p$ be a (pumping) constant. Let the generated string be $w = 0^p 1^p 0^{p+p}$, or, $w = 0^p 1^p 0^{2p}$, where, $n \leq p$ and $n$ being the number of states.

As per pumping lemma, $w = xyz$, where $|y| \geq 1$ and $|xy| \leq n$.

Thus, strings $x$ and $y$ contains only symbol 0.

Let $x = 0^\alpha$, $y = 0^\beta$, $z = 0^{p-\alpha-\beta} 1^p 0^{2p}$

Then any string of the form $xy^i z \in S$, for $i \geq 0$.

Now, $xy^i z = 0^\alpha 0^{i\beta} 0^{p-\alpha-\beta} 1^p 0^{2p} = 0^{i\beta-\beta+p} 1^p 0^{2p}$

Based on the structure of strings in $S$, we have the following condition.

$(i\beta - \beta + p) + p = 2p$

or, $i\beta - \beta = 0$

or, $i = 1$, for $\beta \neq 0$

Thus, string of the form $xy^i z \in S$, only for $i = 1$. This statement contradicts pumping lemma of regular language, where $xy^i z \in S$, for every $\geq 0$. So, the given set $S$ is not regular.

***3. What is the purpose of CMM? Discuss key aspects of this model.***

*Communicated by Animesh Adhikari*

***Answer:*** Capability Maturity Model (CMM) broadly refers to a process improvement approach based on a process model. It is a structured collection of practices that describe the characteristics of effective processes. These practices are effective as they are achieved through experiences. Five process maturity levels are used to judge an organization. Each level ranks the organization according to its

 

standardization of processes in the subject area being assessed. The subject areas include software engineering, systems engineering, project management, risk management, system acquisition, information technology (IT) services and personnel management.

A maturity model can be considered as a set of structured levels that describe how well the behaviours, practices and processes of an organization can reliably and sustainably produce required outcomes. There are five aspects in the model: maturity levels, key process areas, goals, common features and key practices.

*Maturity levels*: There are five maturity levels. At the last (fifth) level, processes would be systematically managed by a combination of process optimization and continuous process improvement.

*Key process areas*: It is a cluster of related activities when performed together, achieve a set of goals.

*Goals*: It summarizes the states that must exist. In order to achieve the states, the key process areas have to be implemented in an effective and lasting way. The extent to which the goals have been accomplished is an indicator of how much capability the organization has established at that maturity level.

*Common features*: They include practices that implement and institutionalize a key process area. Types of common feature are commitment to perform, ability to perform, activities performed, measurement and analysis, and verifying implementation.

*Key practices*: They describe the elements of infrastructure and practice that contribute most effectively to the implementation and institutionalization of the area. [Wikipedia]

***4. Implement JK flip-flop using a D flip-flop.***

*Communicated by Animesh Adhikari*

***Answer:*** The characteristic table of JK flip-flop is given in Table 1.

**Table 1:** Characteristic table of JK flip-flop

| J | K | Q(t) | Q(t+1) |
|---|---|---|---|
| 0 | $\phi$ | 0 | 0 |
| 1 | $\phi$ | 0 | 1 |
| $\phi$ | 1 | 1 | 0 |
| $\phi$ | 0 | 1 | 1 |

where, $\phi$ serves as a don't care condition. We also note characteristic table of D flip-flop in Table 2.

**Table 2:** Characteristic table of D flip-flop

| D | Q(t) | Q(t+1) |
|---|---|---|
| 0 | 0 | 0 |
| 0 | 1 | 0 |
| 1 | 0 | 1 |
| 1 | 1 | 1 |

We set D input of D flip-flop as Q(t+1) of JK flip-flop. Note that D input and output Q(t+1) of D flip-flop are the same. Output of D flip-flop does not depend on the state of Q(t). We then minimize Q(t+1) of D flip-flop (i.e., D) based on J, K and Q(t) of JK flip-flop. Karnaugh map minimization of D is shown in Fig. 1.

 

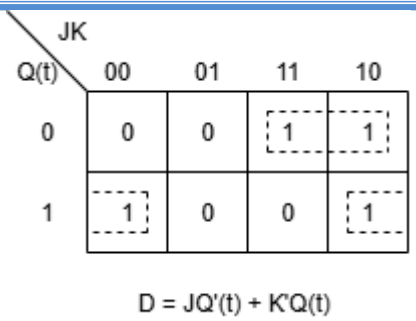


**Figure 1:** Karnaugh map minimization of Q(t+1) i.e., D input of D flip-flop

Note that we are supposed to implement output, i.e., Q(t+1) of D flipflop. As per characteristic table of D flip-flop, D input and output of D flipflop, i.e., Q(t+1) are the same. We present here the logic diagram of JK flip-flop using D flipflop in Fig. 2.

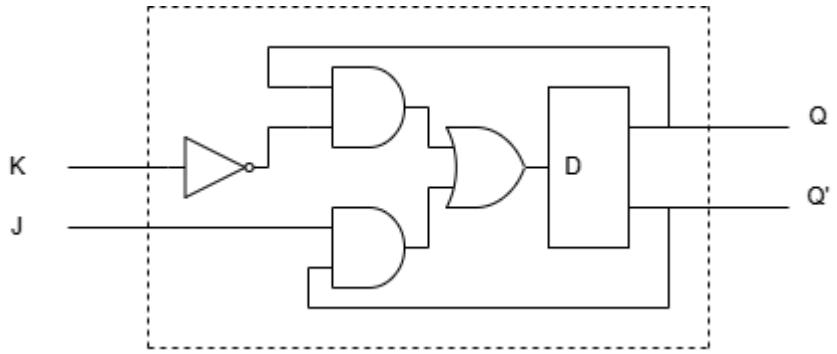


**Figure 2:** Circuit for implementing JK flip-flop using D flip-flop

***5. Assume that a 12-bit Hamming codeword consisting of 8-bit data and 4 check bits is $d_8d_7d_6d_5c_8d_4d_3d_2c_4d_1c_2c_1$, where the data bits and check bits are given in the following tables (Tables 3, 4).***

**Table 3:** Data bits

| $d_8$ | $d_7$ | $d_6$ | $d_5$ | $d_4$ | $d_3$ | $d_2$ | $d_1$ |
|---|---|---|---|---|---|---|---|
| *1* | *1* | *0* | *x* | *0* | *1* | *0* | *1* |

**Table 4:** Check bits

| $c_8$ | $c_4$ | $c_2$ | $c_1$ |
|---|---|---|---|
| *y* | *0* | *1* | *0* |

***Which one of the following choices gives the correct values of x and y?***
***(A) x is 0 and y is 0*** ***(B) x is 0 and y is 1***
***(C) x is 1 and y is 0*** ***(D) x is 1 and y is 1***

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***Answer:*** Combined tables of Tables 3, 4 is given in Table 5.

 

**Table 5:** 12-bit Hamming codeword

| *12* | *11* | *10* | *9* | *8* | *7* | *6* | *5* | *4* | *3* | *2* | *1* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $d_8$ | $d_7$ | $d_6$ | $d_5$ | $c_8$ | $d_4$ | $d_3$ | $c_4$ | $d_2$ | $d_1$ | $c_2$ | $c_1$ |
| *1* | *1* | *0* | $x$ | $y$ | *0* | *1* | *0* | *0* | *1* | *1* | *0* |

Significant digits in binary numbers from 1 to 12 are given in Table 6.

**Table 6:** Significant digits in binary numbers

| Location | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 12 | 13 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1st significant digit | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 |
| 2nd significant digit | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 |
| 3rd significant digit | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 |
| 4th significant digit | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 |

$c_1$ parity bit is deduced by checking all the bits with 1 in the least (first) significant digit. We consider the sequence of bits at 1, 3, 5, 7, 9, 11, and bits are 0, 1, 0, 0, $x$, 1 respectively. [Table 5].
We choose $x$ as 0 based on even parity method. . . . (1)
$c_8$ parity bit is deduced by checking all the bits with 1 in the fourth significant digit. We consider sequence of bits at 8, 9, 10, 11, 12 and bits are $y$, $x$, 0, 1, 1 respectively. [Table 5].
From (1), bit sequence is $y$, 0, 0, 1, 1.
We choose y as 0 based on even parity method. . . . (2)
Using (1) and (2), we conclude that option (A) is correct.

 

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