International Journal on Applications in Engineering and Technology
Volume 1: Issue 4: April 2015, pp 1-3. www.aetsjournal.com ISSN (Online) : 2455-0523 -

Classification and Variants of Automata – A Review

Dr.P.Ezhilarasu, Prof.D.Satheesh Kumar, Prof.J.Prakash

***Abstract*—** This paper on Automata focuses on studying the classification and the variants of Automata. More than 25 variants/classification analyzed. The description for the each type automata also given. The variants/classification maximum based on the finite automata, and the fuzzy concept.

***Keywords*—** Automata, Classification, Variants, Description.

I. INTRODUCTION

The automata defined as the robots or machine that works by its own power. It doesn't need external force for doing its task [1]. There is a need for reducing the manual work in many places. Hence we need automata to complete the task without human intervention.

S. NO	AUTOMATA CLASSIFICATION/VARIANTS BASED ON	DESCRIPTION
1	Finite Automata [FA] Variants Automata & Transition	The Finite Automata [FA] is the simple abstract machine that gets an input. Then it recognizes the pattern based on the construction [2].
2	Deterministic Finite Automata Variants FA & Transition	The Finite State Machine (FSM), which accepts or rejects the input string through the completion of transition [3]. McCulloch and Pitts [1943] introduced the concepts similar to the Finite Automata [4].
3	Nondeterministic Finite Automata Variants FA & Transition	Rabin M O & Scott D [1959] introduced the Nondeterministic Finite Automata [5]. It is a quintuple. It can be used to derive DFA using subset construction method.
4	Single loop Nondeterministic Finite Automata Classification NFA & loop	Ezhilarasu et. al. [2014] classified the NFA based on single loop into three categories [6]. Those are 1. Starts with a substring (loop placed at the final state), 2.Ends with a substring, (loop placed at the start state) and 3. Starts with a substring and ends with a substring (loop placed at the intermediate state).
5	Double loop Nondeterministic Finite Automata Classification NFA &Loop	Ezhilarasu et. al. [2014] classified the NFA based on dual loop into three categories [7]. Those are 1. Starts with a substring & contains a substring (loop placed at the intermediate and the final state), 2.Contains a substring & ends with a substring, (loop placed at the start and the intermediate state) and 3. Contains a substring (loop placed at the start and final state).
6	More than Double loop Nondeterministic Finite Automata Classification NFA &loop	Ezhilarasu et. al. [2014] classified the NFA based on More than dual loop into three categories [8]. Those are 1.NFA that contains 2 or more substring (loop placed at start, >= one intermediate, and end state), 2. NFA that starts with a substring and contains 2 or more Substring (loop placed at >= two intermediate , and end state), and 3. NFA that ends with a substring and contains 2 or more Substring (loop placed at start, and >= two intermediate states).
7	Single substring Nondeterministic Finite Automata Classification NFA & substring	Ezhilarasu et. al. [2015] classified the NFA based on single substring into three categories [9]. Those are 1. NFA that starts with a substring 2. NFA that contains a substring 3. NFA that ends with a substring.
8	Double substring Nondeterministic Finite Automata Classification NFA & substring	Ezhilarasu & Krishnaraj [2015] classified the NFA based on the double substring into three categories [10]. NFA can be classified into three categories. Those are 1. Starts with a substring and ends with a substring 2.Starts with a substring and contains a substring 3. Contains a substring and Ends with a substring.
9	More than Double substring Nondeterministic Finite	Ezhilarasu & Krishnaraj [2015] classified the NFA based on the

Dr.P.Ezhilarasu, Prof.D.Satheesh Kumar, Associate Professor, Department of Computer Science and Engineering, Hindusthan College of Engineering and Technology, Coimbatore - 641032, India

Prof.J.Prakash , Assistant Professor, Department of Computer Science and Engineering, Hindusthan College of Engineering and Technology, Coimbatore - 641032, India. (Email: prof.p.ezhilarasu@gmail.com)

	Classification NFA & substring	triple substring into four categories [11]. Those are 1. Starts with a substring then contain a substring and ends with a substring 2. Starts with a substring and contains two substrings 3. Contains two substring and Ends with a substring 4. Contains three substrings.
10	Fuzzy State Automata Variants FA & Fuzzy concepts	Reyneri L M [1997] introduced the Fuzzy State Automata [12]. It is a combination of Finite State Automata and the neuro-fuzzy systems. The plant controlled and the characteristic of neuro-fuzzy system modified by the Finite State Automata.
11	Maximin automata Variants NFA & DFA	Santos E S [1968] introduced the Maximin automata [13]. It is similar to probabilistic automata. But it includes special cases as both NFA and DFA.
12	Kind of Fuzzy Finite Automata Classification FA & Fuzzy concepts	Cheng W & Mo Z W [2000] classified fuzzy finite automata into two categories [14]. Those are fuzzy finite automaton with the initial state and no output and the vice-versa.
13	Fuzzy semi automata Variants FA & Fuzzy concepts	Vasantha Kandaswamy W B [2003] defined the fuzzy semi automata as a triplet. It has group, finite set, and the subset [15].
14	Stochastic automata Variants Automata	It uses the concept of the timed automata and Generalized Semi Markov Process (GSMP)[16].
15	Fuzzy ω automata Variants Fuzzy concepts	Krithivasan & sharda [2001] explained the Fuzzy ω automata [17]. An accepting abstract device for Fuzzy - ω language.
16	Probabilistic automata Variants NFA	It is a generalization of NFA. It converts probability of the transition into stochastic matrix through the transition function [18].
17	Lattice-valued automata Variants Fuzzy	It is a combination of three components. Those are Fuzzy mathematics, lattice-ordered monoid and the automation[19].
18	Cellular Automata Variants Automata	The Cellular Automata (CA) is a discrete model. It has grid of cells. each cell represent one finite state(on or off) [20].
19	Turing Machine Variants FA	The turing machine is an enhanced abstract machine invented by Alan Turing. It can move in both direction [21].
20	Linear bounded Automata Variants	Partee B H et. Al. [1993] defined the linear bounded automata as the turing machine with the input
	FA	limitation [22]. The language accepted by the linear bounded automata is context sensitive
21	Pushdown Automata Variants FA	It is a combination of the Finite Automata and the stack. The Finite Automata has the memory limit. To overcome this stack used along with the FA. The Pushdown Automata has seven tuples. Five for representing the FA and the two for the stack [23].
22	Nondeterministic fuzzy automata Variants NFA & Fuzzy concepts	Cao H & Ezawa Y [2012] combined the fuzzy concept with the NFA. It is the NFA with or without epsilon moves and can recognize fuzzy language [24].
23	Hybrid Extended Finite Automata Variants FA	Bordihn H et. Al. [2006] defined the Hybrid Extended Finite Automata as an extension of the finite automata. It uses the operation on the remaining current input, considering the current state. It uses reversal and shift operation [25].
24	Structurally Unambiguous Finite Automata Variants FA	Leung H [2006] defined the Structurally Unambiguous Finite Automata as a NFA that has the path from q_0 to q that consumes w. Where q_0 is a start state, q any state, and w represent the input string [26].
25	Minimax Automata Variants Automata	Minimax algorithm is an evaluation function. It is used during draw or tie in a game. In two player game it evaluates both players best and weak moves [27].
26	Composite Automata Variants Cellular Automata	It is a collection of cellular automata. The composition will be any one the following.1. spatial composition, 2.Temporal composition, and 3.combined spatial and temporal composition [28].
27	Max-Product Automata Variants Fuzzy Automata	This Automata has uncontrolled behavior. The degrees of membership of the states go to zero and remain zero [29].
28	Fixed Automata Variants Time	Gajewski T [1991] defined the fixed automata as an automaton whose internal structure is not time varying called as fixed automata [30].

II. CONCLUSION

The classification and the variants of various automata studied. Normally these automata based on either Finite automata or fuzzy concepts. It shows that for designing any automata we should have basic knowledge in any one of the two topics. It is also possible to derive application based on various automata.

REFERENCES

[1] Available online at : http://www.yourdictionary.com/automata
[2] Available online at : https://www.cs.rochester.edu/~nelson/courses/csc_173/fa/fa.html
[3] Available online at : https://en.wikipedia.org/wiki/Deterministic_finite_automaton
[4] McCulloch, W. S.; Pitts, E. (1943). "A logical calculus of the ideas imminent in nervous activity". Bulletin of Mathematical Biophysics: 541–544.
[5] M. O. Rabin and D. Scott, "Finite Automata and their Decision Problems", IBM Journal of Research and Development, 3:2 (1959) pp. 115–125.
[6] Ezhilarasu P, Prakash J, Krishnaraj N, Satheesh Kumar D, Sudhakar K and Dhiyanesh B, "A Novel Approach to Classify Nondeterministic Finite Automata Based on Single Loop and its Position" International Journal of Advanced Research Trends in Engineering and Technology (IJARTET), Volume 1, Issue 4, 2014, pp. 7-10.
[7] Ezhilarasu P, Prakash J, Krishnaraj N, Satheesh Kumar D, Sudhakar K, Parthasarathy C, "A Novel Approach to Classify Nondeterministic Finite Automata Based on Dual Loop and its Position ",International Journal of Engineering Trends and Technology (IJETT), Volume-18 Number-3,2014, pp. 147-150.
[8] Ezhilarasu P, Prakash J, Krishnaraj N, Satheesh Kumar D, Sudhakar K, Parthasarathy C, "A Novel Approach to Classify Nondeterministic Finite Automata Based on More than Two Loops and its Position" SSRG International Journal of Computer Science and Engineering (SSRG-IJCSE), Volume1 Issue10 - December 2014, pp. 46-49.
[9] P.Ezhilarasu, E.Thirunavukkarasu, G.Karuppusami, N.Krishnaraj, "Single Substring Based Classification for Nondeterministic Finite Automata", International Journal on Applications in Information and Communication Engineering, Vol 1(10) pp. 29 - 31. 2015.
[10] P.Ezhilarasu, N.Krishnaraj, "Double Substring Based Classification for Nondeterministic Finite Automata", International Conference on Recent Advances in Engineering, Science & Technology –ICON"15", 2015.
[11] P.Ezhilarasu, N.Krishnaraj, "Triple Substring Based Classification for Nondeterministic Finite Automata", International Journal of Applied Engineering Research (IJAER), Vol.10(59), pp.177-182, 2015.
[12] L.M. Reyneri, An Introduction to Fuzzy State Automata, in Proc. of IWANN 97, Int'l Workshop on Artificial Neural Networks, Lanzarote (E), June 1997, pp. 273-283.
[13] Santos E S, Maximin Automata, Information and control, 13(4), 363-377, 1968.
[14] Cheng W, Mo Z W, "A Kind of Classification of fuzzy finite automata", BUSEFAL, 84,51-55.
[15] Vasantha Kandaswamy W B,"Smarandache Fuzzy Algebra",American Research Press, Rehoboth, 2003.
[16] D'Argenio, Pedro R. and Katoen, Joost-Pieter (2005) A theory of stochastic systems part I: Stochastic automata. Information and Computation, 203 (1). pp. 1-38.
[17] Krithivasan K, Sharda K,"Fuzzy ω automata ", Information sciences, 138(1-4),257-281,2001.
[18] Available online at: https://en.wikipedia.org/wiki/Probabilistic_automaton
[19] Available online at: https://en.wikipedia.org/wiki/Cellular_automaton
[20] Available online at: http://www.com-paper.com/?p=19957
[21] Available online at: https://en.wikipedia.org/wiki/Turing_machine
[22] Partee B H,Meulen A T,Wall R E,"Linear Bounded Automata, Context Sensitive Languages and Type 1 Grammars",Mathematical Methods in Linguistics Volume 30 of the series Studies in Linguistics and Philosophy pp 527-532,1993.
[23] Available online at: https://en.wikipedia.org/wiki/Pushdown_automaton
[24] Cao H, Ezawa Y,"Nondeterministic Fuzzy Automata", Information Sciences, Volume 191, Pages 86–97,2012.
[25] Bordihn H, Holzer M, and Kutrib M, "hybrid extended finite automata", Implementation and Application of Automata Volume 4094 of the series Lecture Notes in Computer Science pp 34-45,2006.
[26] Leung H,"Structurally Unambiguous Finite Automata", Implementation and Application of Automata, 11th International Conference, CIAA 2006, Taipei, Taiwan, August 21-23, 2006. Proceedings, pp 198-207,2006.
[27] Available online at: https://chessprogramming.wikispaces.com/Minimax
[28] Available online at: http://cell-auto.com/composite/
[29] Available online at: http://staff.cs.upt.ro/~todinca/VHDL_framework.pdf
[30] Gajewski T, Algebraic and Structural Automata Theory,Annals of discrete mathematics 44. Mikolajczak B(Editor), 1991.

BIOGRAPHY

Dr.P.Ezhilarasu received the B.E degree in Computer Science and Engineering from Bharathiar University Coimbatore; Then M.E degree in Computer Science and Engineering from Anna University Chennai. He commended his Ph.D in Faculty of Information and Communication from Anna University Chennai .He is having more than 30 years of parallel experience in Teaching, Research and Industry. He guided so many UG and PG students in his career. He handled more than 30 subjects in his career and also having more than 50 international/national publication in conference/journal. His area of interest includes Image Processing, Theory of Computation, Data mining, soft computing.

Prof.D.Satheesh Kumar received the B.E degree in Computer Science and Engineering from Anna University Chennai; Then M.E degree in Software Engineering from Anna University Coimbatorei. He is having more than 10 years of experience in Teaching, and Research. He guided so many UG and PG students in his career and also having more than 20 international/national publication in conference/journal.. He handled more than 25 subjects in his career. His area of interest includes Image Processing, Data Structures, and Object oriented programming.

Prof.J.Prakash received the B.E degree in Computer Science and Engineering from Anna University Chennai; Then M.E degree in Computer Science and Engineering from Anna University Coimbatore. He is having more than 7 years of experience in Teaching, and Research. He guided so many UG and PG students in his career and also having more than 15 international/national publication in conference/journal.. He handled more than 15 subjects in his career. His area of interest includes Theory of computation, Compiler design, and Internet programming.