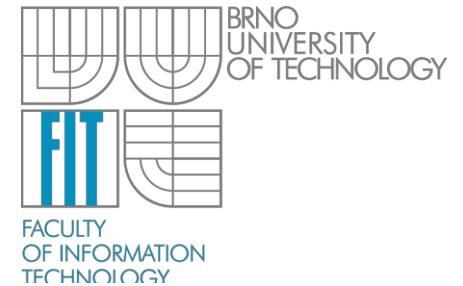


δ FAs for Packet Classification

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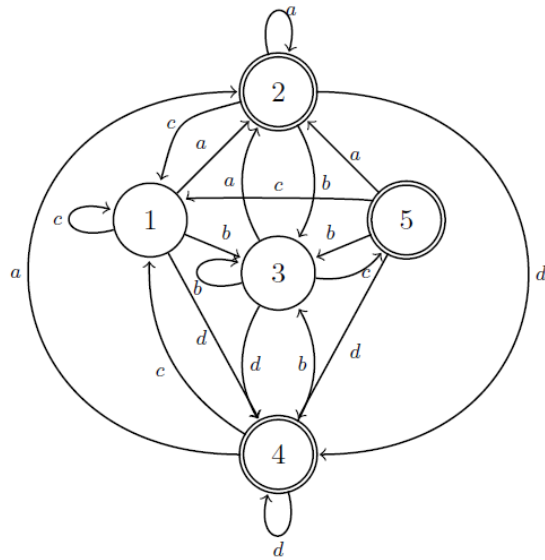
TeamIT session

INVESTICE DO ROZVOJE VZDĚLÁVÁNÍ

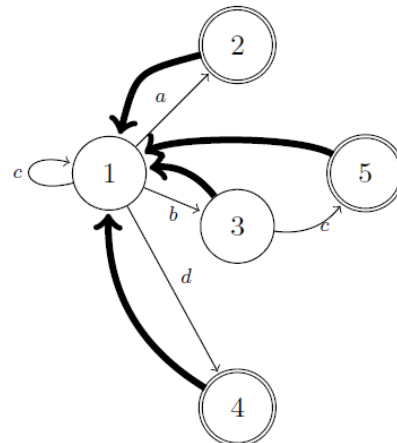
δ FA introduction

- deterministic FA
- inspired by D²FA (Delayed Input DFA)
- single memory access per character
- data structure stores differences between adjacent states
 - supplementary structure storing transition set of current state
- δ FA only stores transitions that **MUST** be defined for each state

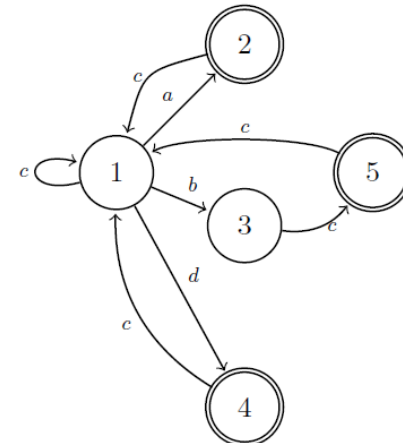
δ FA example



(a) The DFA



(b) The D^2 FA



(c) The δ FA

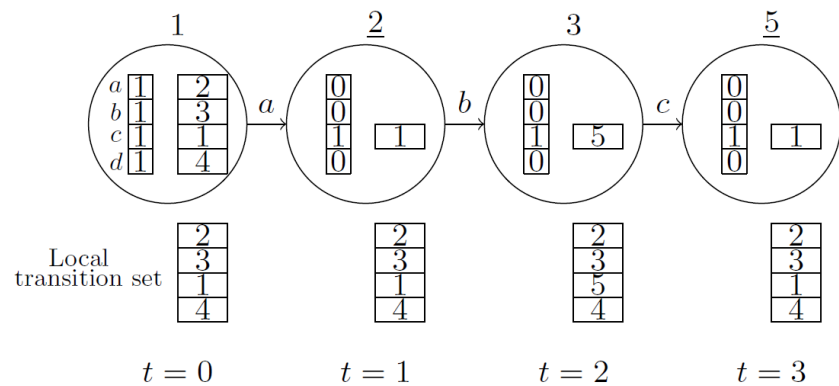
Automata recognizing (a^+) , (b^+c) , (c^*d^+)

	a	b	c	d
1	2	3	1	4
2	2	3	1	4
3	2	3	5	4
4	2	3	1	4
5	2	3	1	4

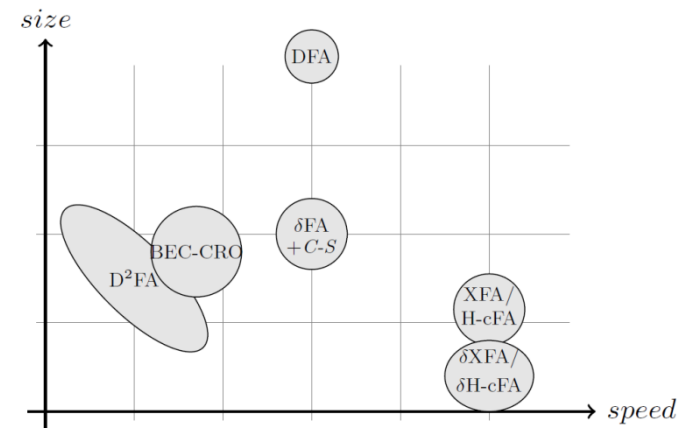
- 20 edges in full DFA
- 9 edges in D^2 FA
- 8 edges in δ FA

δ F A conclusion

- simple algorithm for construction
- simple next-state lookup
- orthogonal optimization to another approaches
 - XFA
 - H-cFA



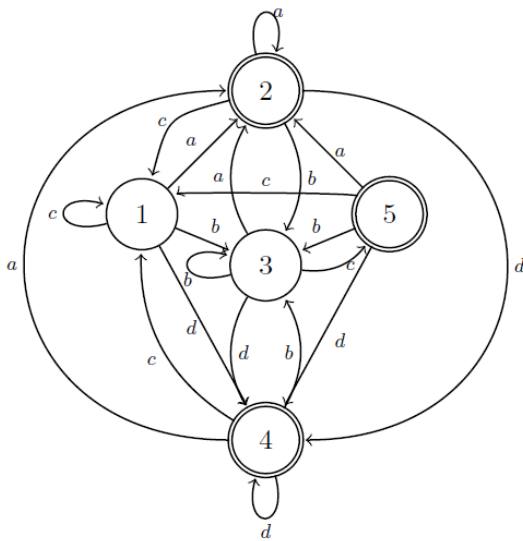
δ FA transition for abc input string



δ FA comparison with other approaches

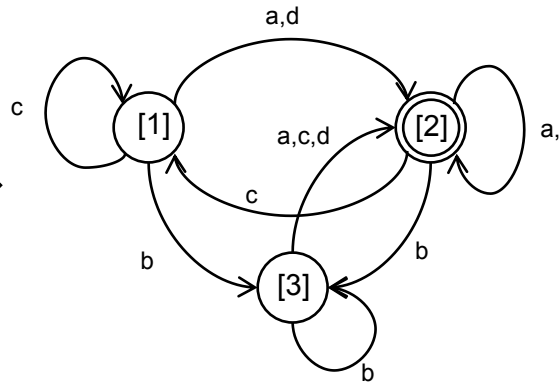
δ FA intermezzo

- what about minimization of DFA?

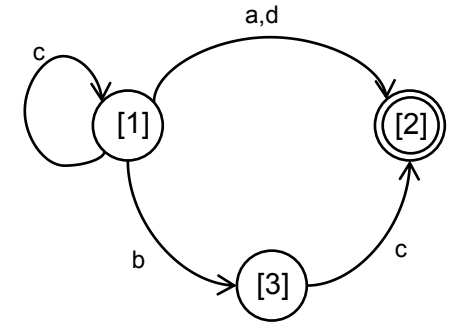


full DFA

Automata recognizing $(a^+), (b^+c), (c^*d^+)$



minimized DFA

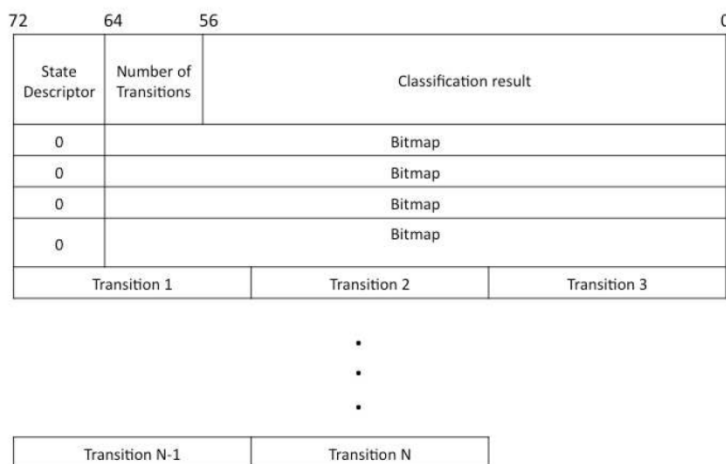


minimized δ FA

- 20 edges, 5 states in full DFA
- 12 edges, 3 states in minimized DFA
- 5 edges, 3 states in minimized δ FA

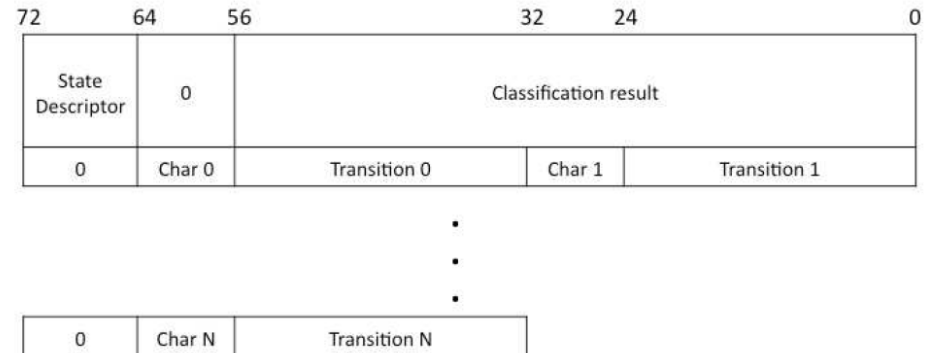
δ FA for packet classification

- packet classification addressed as more general pattern matching problem
 - applying pattern matching scheme over packet IP fields (5-tuple), rules are expanded to 8-bit characters
- 2 types of states (due to the bitmap size)



data structure for S_1 state

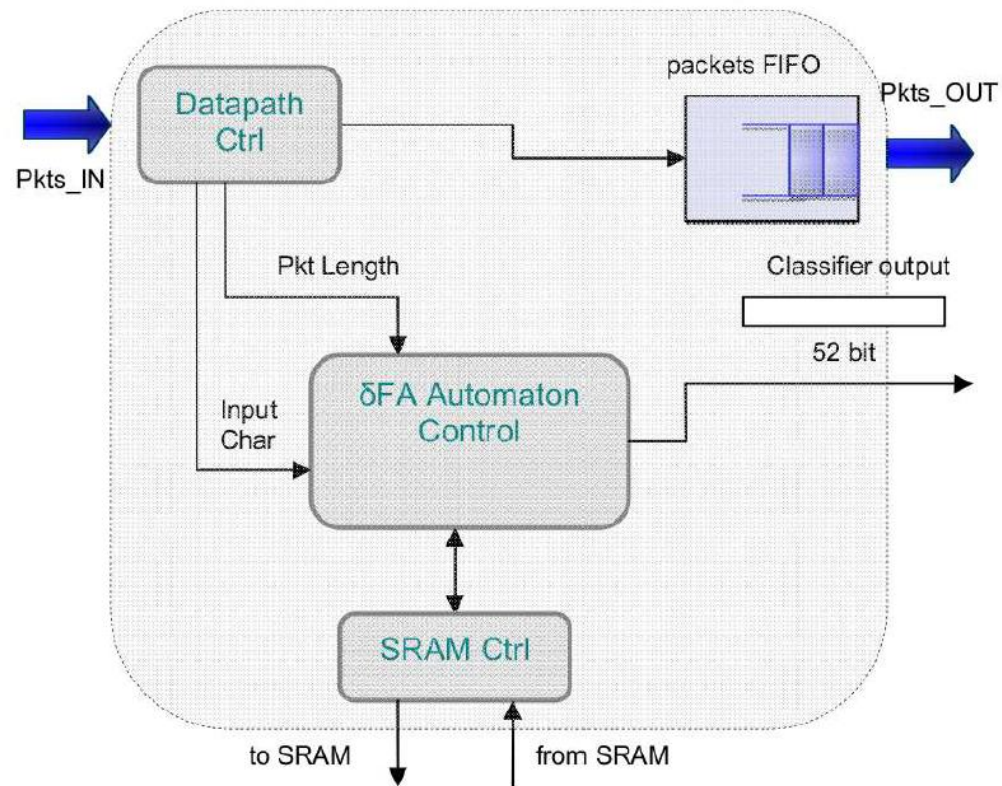
$$S_1 = 360 + 72 \cdot \left\lceil \frac{n}{3} \right\rceil$$



data structure for S_2 state

$$S_2 = 72 + 72 \cdot \left\lceil \frac{n}{2} \right\rceil$$

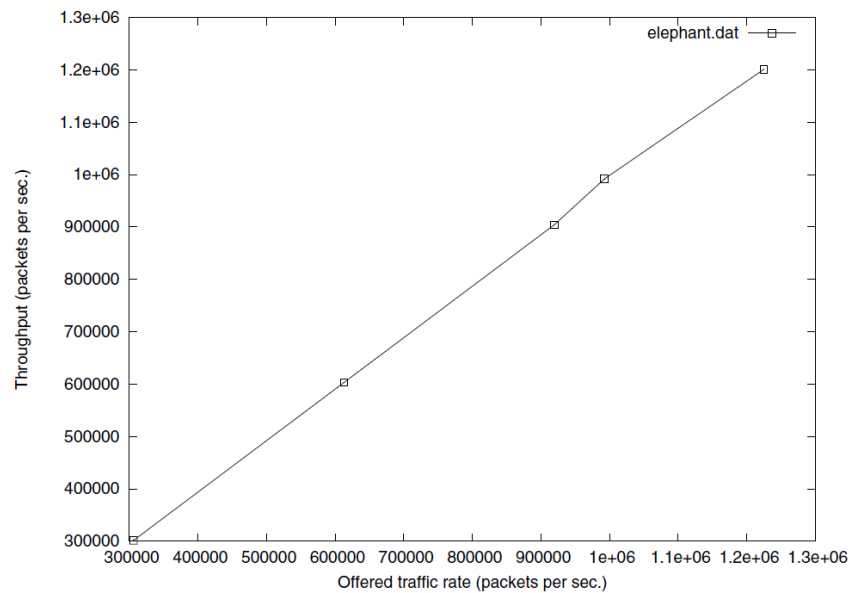
δ FA classifier HW structure



δ FA results

Algorithm	ACL1_100		FW1_100		IPC1_100	
	Mem. ref. mean	ref. max	Mem. ref. mean	ref. max	Mem. ref. mean	ref. max
HyperCuts-2	12.97	23	12.65	29	6.96	16
Hypercuts-4	10.2	17	11.5	26	5.76	13
HiCuts-2	6.17	17	15.02	28	6.1	17
Hicuts-4	6.47	16	11.5	26	4.85	18
BV	24	31	22	28	26	33
δ FA	9.78	13	8.69	13	12.2	13

performance in the terms of memory accesses



References

- An improved DFA for Fast Regular Expression Matching
- On the Use of Compressed DFAs for Packet Classification

Thank you for your attention!