Stochastic Functions Using Sequential Logic

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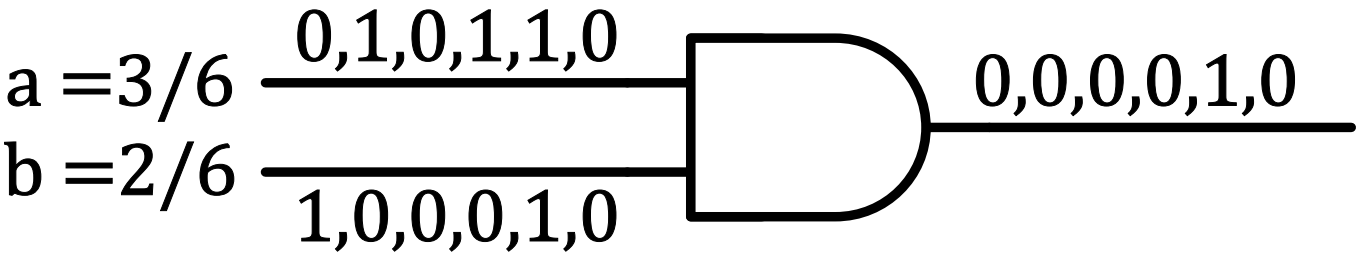
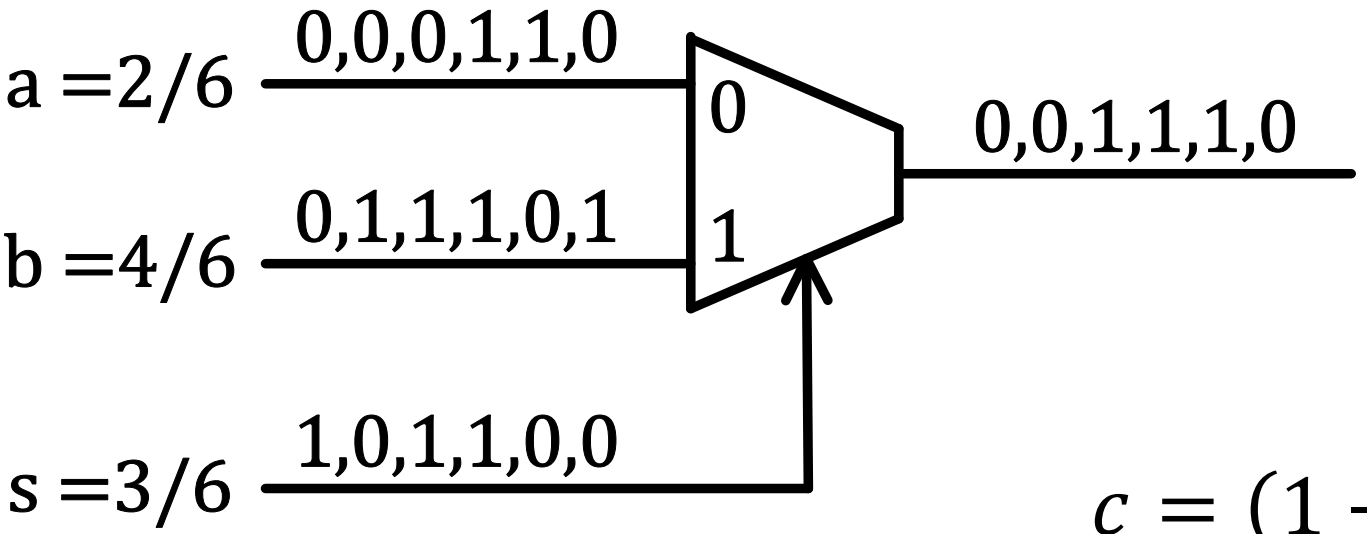
Stochastic Computing

Computing using random bit streams

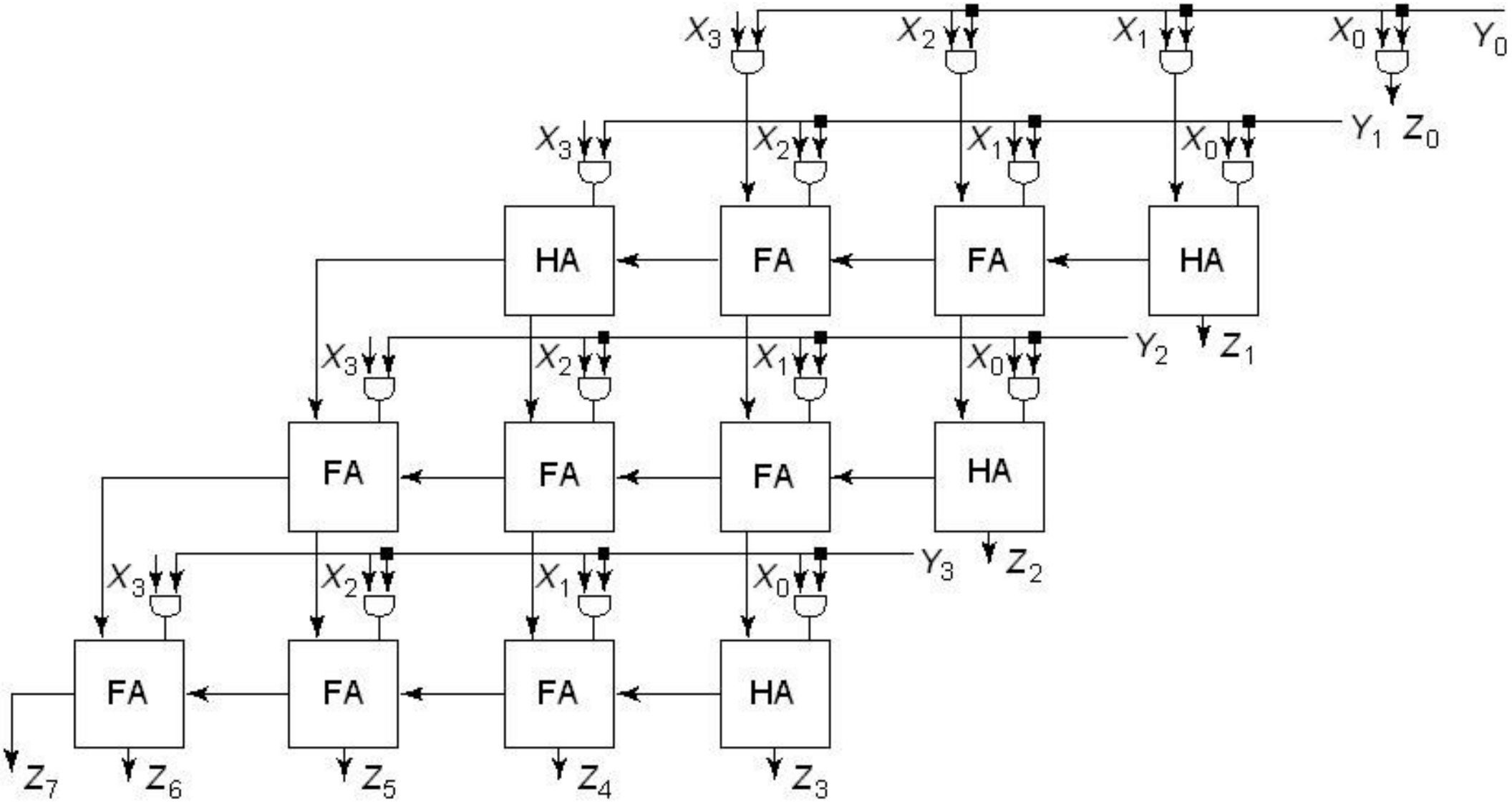


$$c = ab$$



$$c = (1 - s)a + sb$$

Conventional Computing



Fault Tolerance

- Largest error magnitude $1/2$ in an M-bit binary fraction.

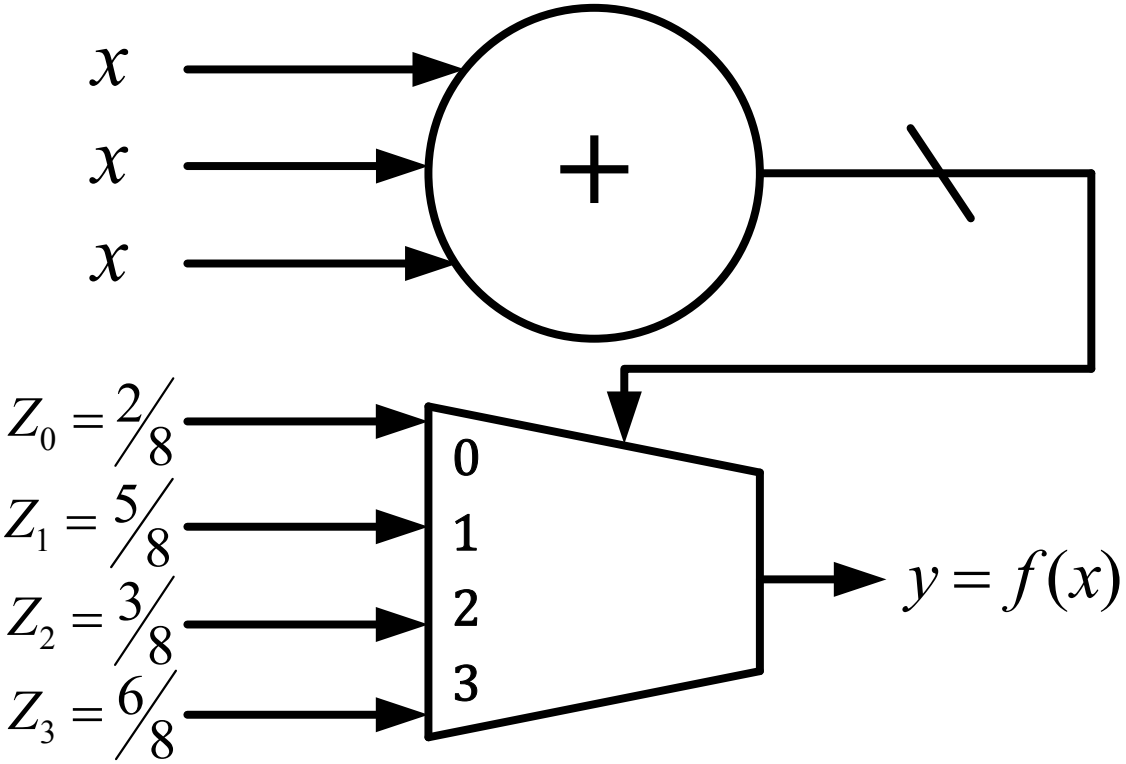
$$0.001 \longrightarrow 0.101$$

- Error in a random bit stream of length 2^M is always 2^{-M}.

$$00100000 \longrightarrow 00100010$$

Combinational Logic

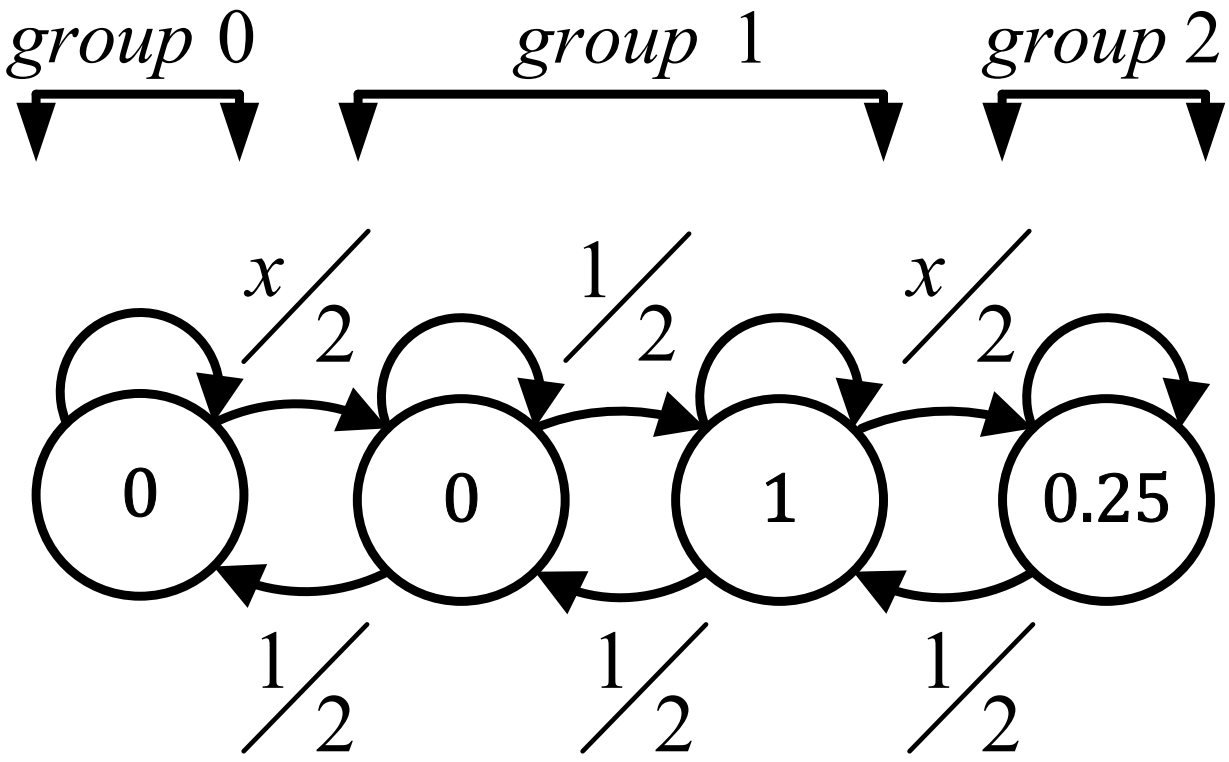
Input cost = degree of the polynomial



$$f(x) = {}^{1}/_{4} + {}^{9}/_{8}x - {}^{15}/_{8}x^2 + {}^{5}/_{4}x^3$$

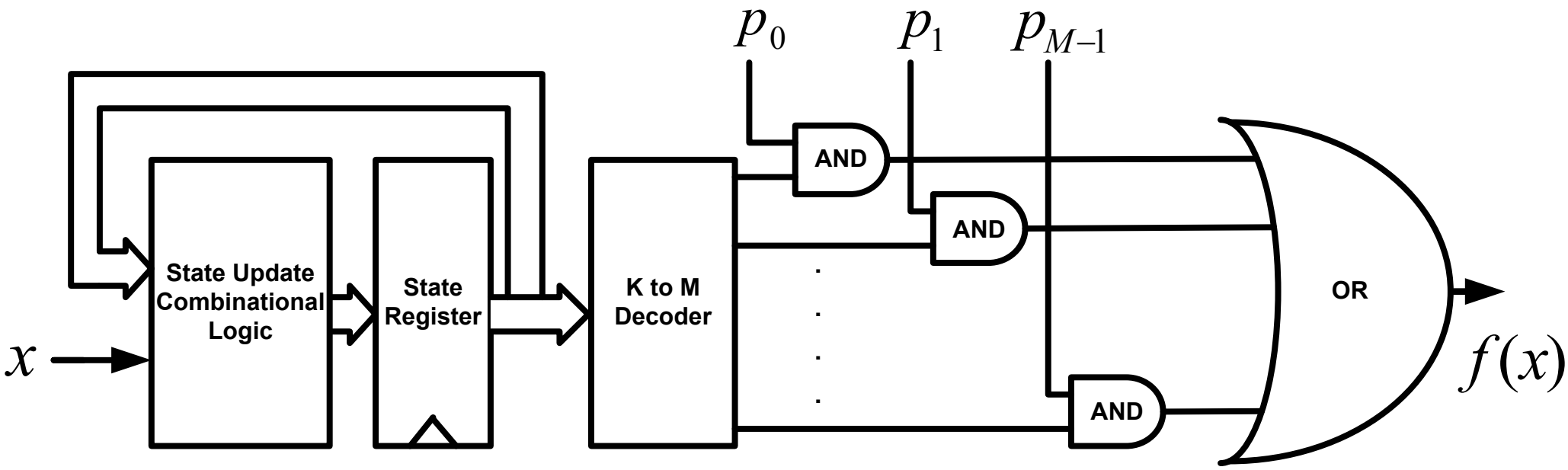
Sequential Logic

Input cost = *one* random source

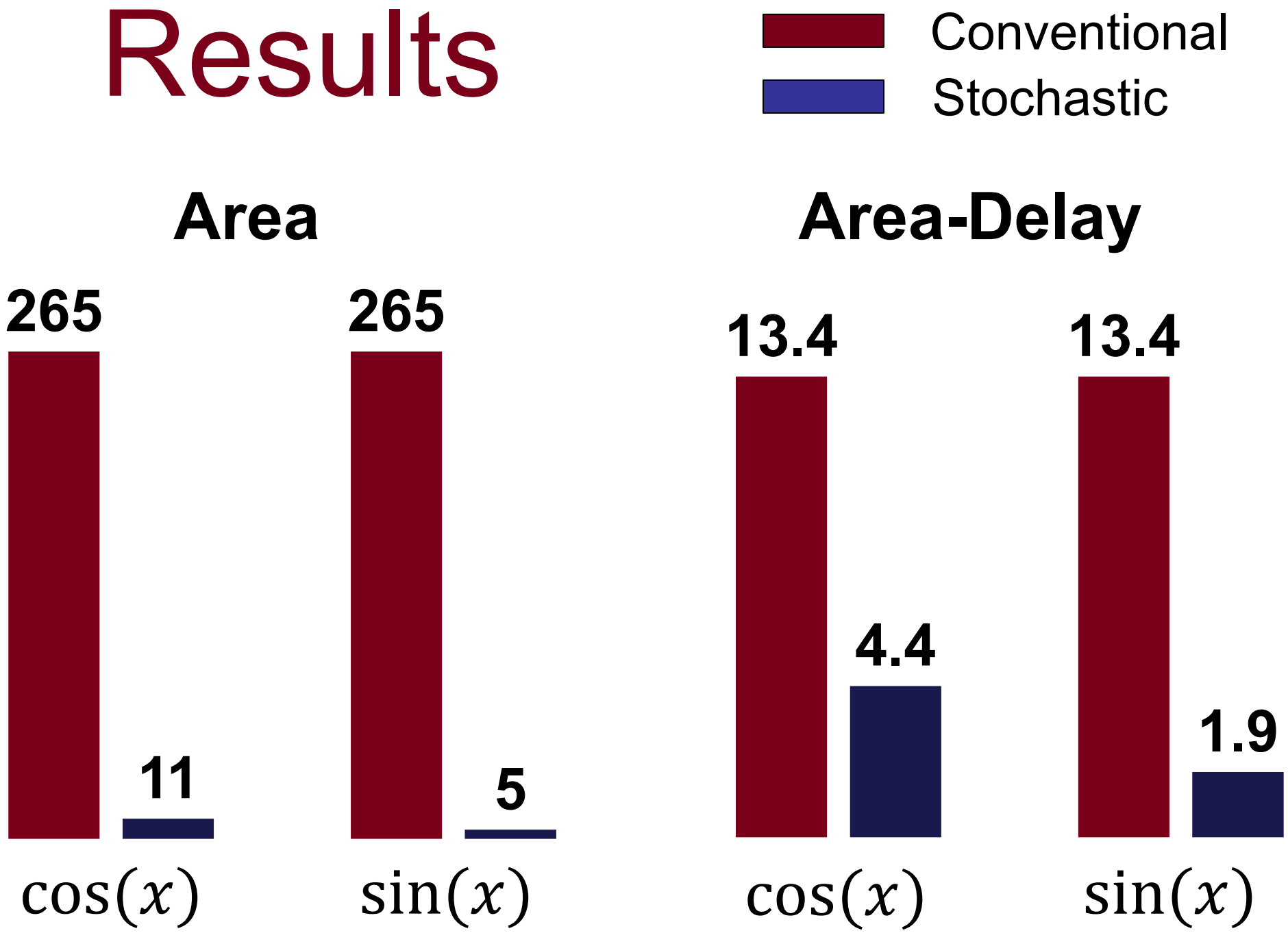


$$f_p(x) = (x + 0.25x^2)/(1 + 2x + x^2)$$

FSM Implementation



Results


Conventional
Stochastic
Area
Area-Delay
265
11
265
5
13.4
4.4
13.4
1.9
cos(x)
sin(x)
cos(x)
sin(x)