

# Sequential Circuits

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*CS-226: Digital Logic Design*

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Lecture 22: 18 March 2021

**CADSL**

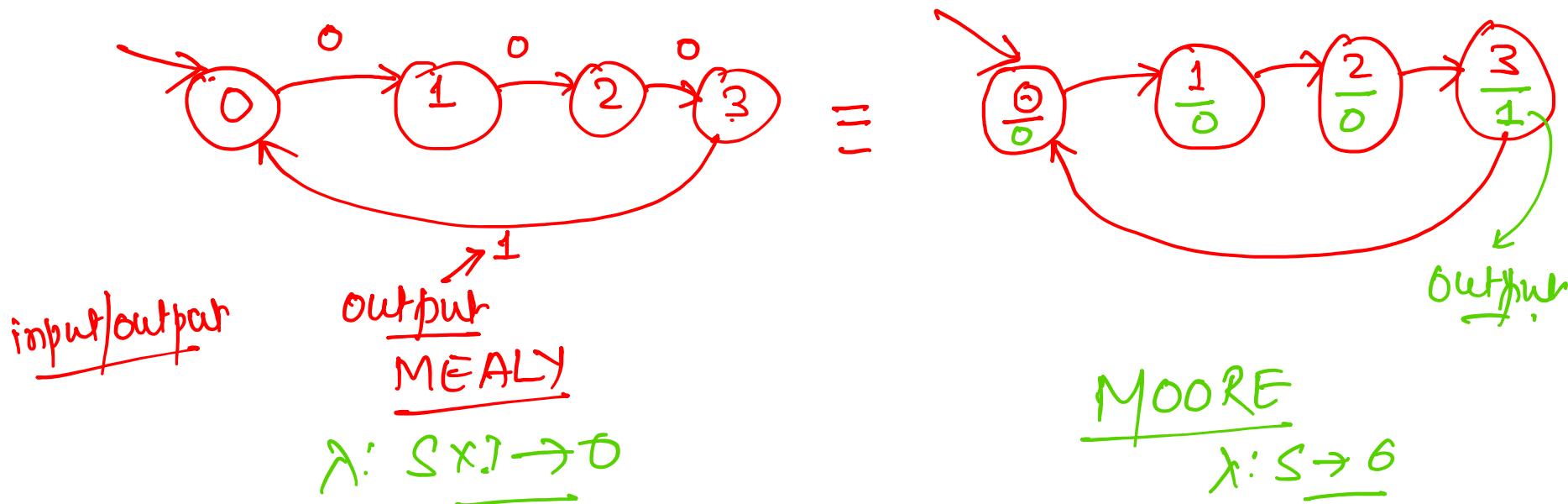
# Finite State Machine

$$M = (I, O, S, S_0, \delta, \lambda)$$

$$\delta: S \times I \rightarrow S$$

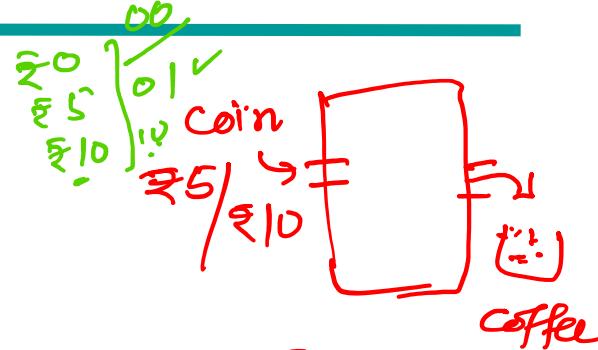
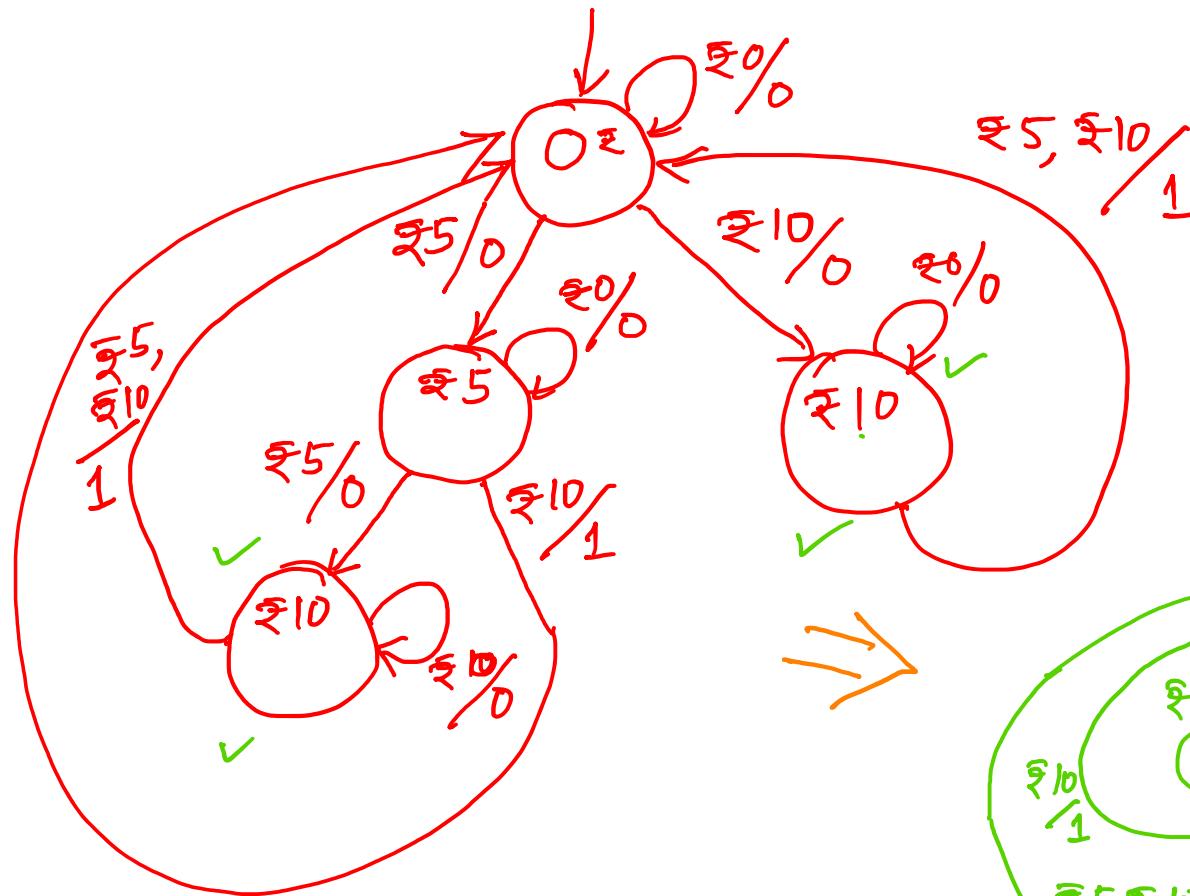
$$\lambda: S \times I \rightarrow O \quad \text{MEALY MACHINE}$$

$$\lambda: S \rightarrow O \quad \text{MOORE MACHINE}$$



# Finite State Machine

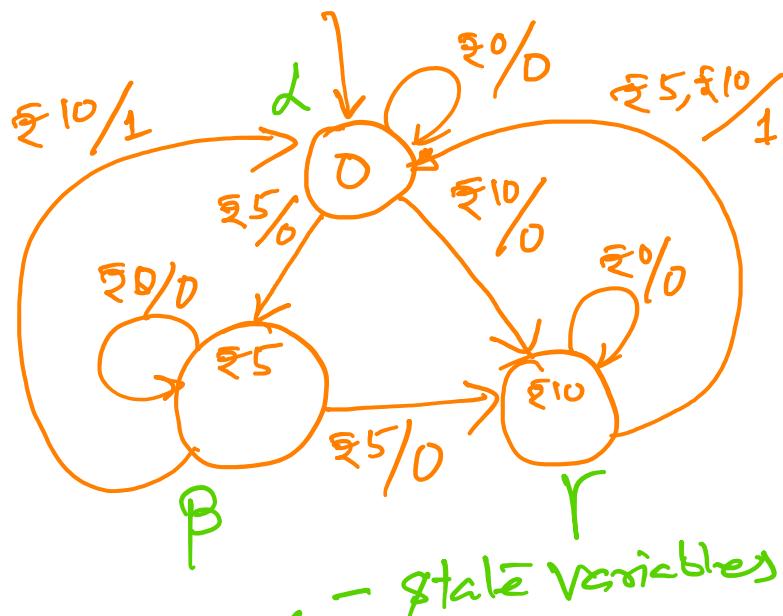
VENDING MACHINE



State transition graph.



# Finite State Machine



$\delta_1, \delta_0$

$\alpha_{00}$

$\beta_{01}$

$\gamma_{10}$

$$\begin{aligned} & \delta^1(\delta_1, \delta_0, a_1, a_0) \\ & \delta^0(\delta_1, \delta_0, a_1, a_0) \\ & \lambda(\delta_1, \delta_0, a_1, a_0) \end{aligned}$$

PS	$\bar{\epsilon}_0(00)$	$\bar{\epsilon}_5(01)$	$\bar{\epsilon}_{10}(10)$
$\alpha_{(00)}$	$\alpha_{00}$	$\beta_{01}$	$\gamma_{10}$
$\beta_{01}$	$\beta_{01}$	$\gamma_{10}$	$\alpha_{00}$
$\gamma_{10}$	$\gamma_{10}$	$\alpha_{00}$	$\alpha_{00}$

$\underline{\delta_1, \delta_0}$        $\overbrace{a_1, a_0}^{\text{input}}$



# Finite State Machine

PS	NS, QW		
d	$\delta_{00}$	$\delta_{01}$	$\delta_{10}$
$\beta$	$\beta_{01}$	$\beta_{10}$	$\beta_{00}$
r	$r_{10}$	$r_{00}$	$r_{00}$

$\delta_1 = \delta_1 a_1 a_0 + \delta_0 a_0 + \bar{\delta}_1 \bar{a}_1 q_1$

$a_1 a_0$	00	01	11	10
$\delta_1$	0	0	X	1
$\delta_0$	0	1	X	0
11	X	X	X	X
0	1	0	X	0

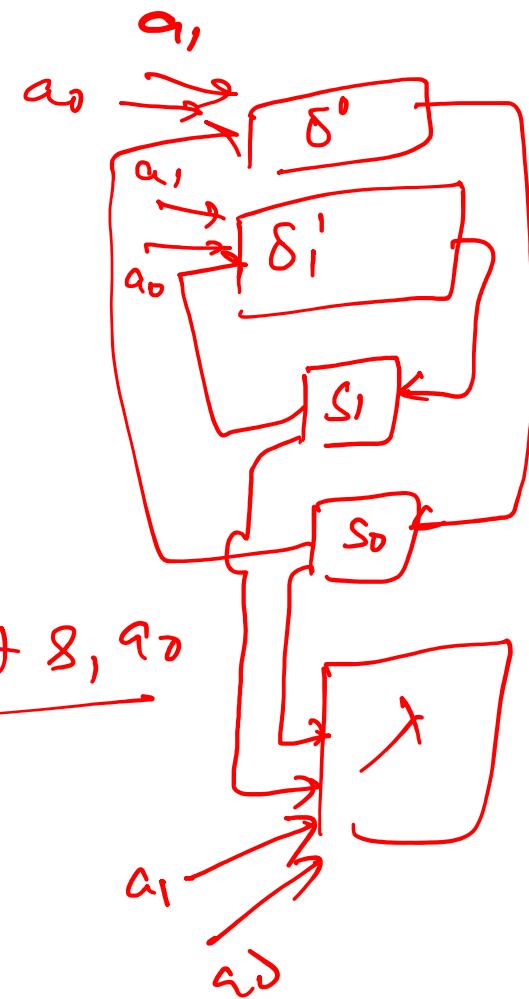
$$\delta^0 = \delta_0 \bar{a}_1 \bar{a}_0 + \bar{\delta}_1 \bar{a}_0 q_0$$

$a_1 a_0$	00	01	11	10
00	0	1	X	0
01	1	0	X	0
11	X	X	X	X
10	0	0	X	0



# Finite State Machine

$\delta_1 \delta_D$	$a_1, a_0$	00	01	11	10
00	0	0	X	0	0
01	0	0	X	1	1
11	X	X	X	X	1
10	0	1	X	1	1

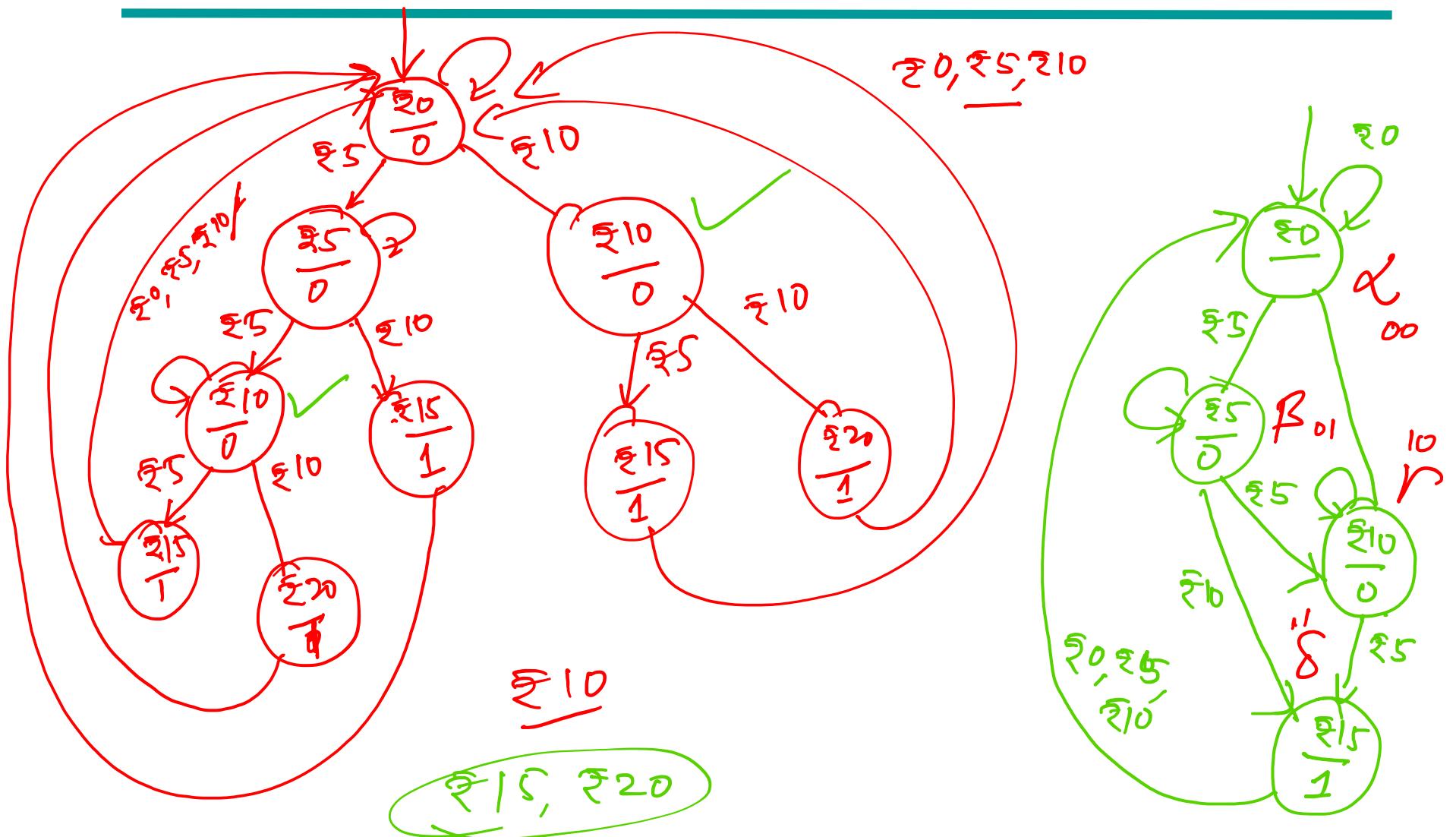


$$\lambda(\delta_1, \delta_0, q_1, q_0) = \underline{\delta_0 a_1 + \delta_1 a_1 + \delta_1 a_0}$$

Mealy machine

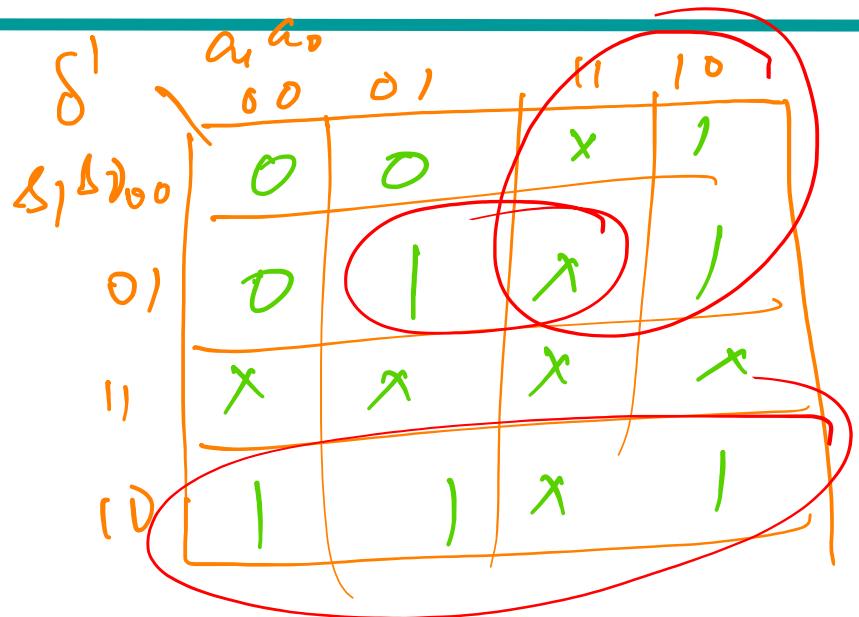


# Finite State Machine



# Finite State machine

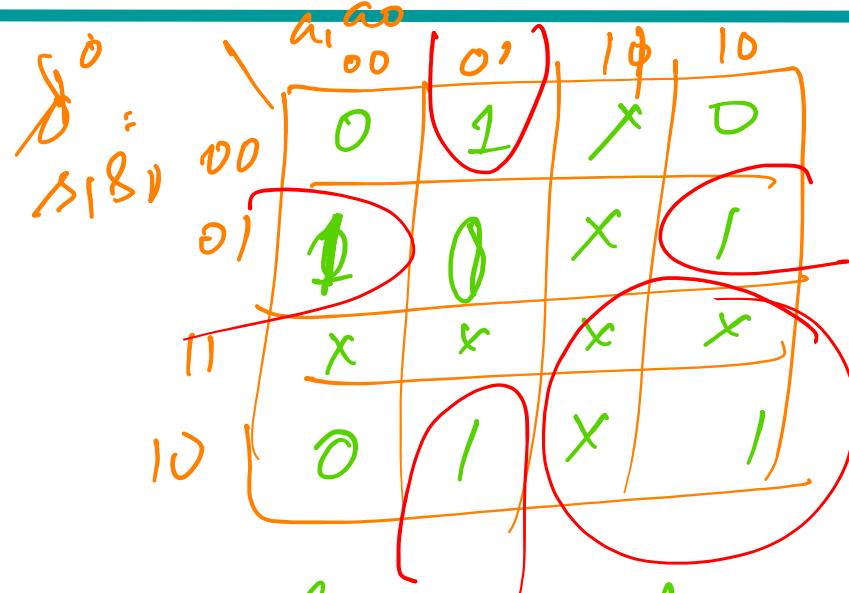
PS	$\xi^0$	$\xi^0$	$\text{NS, out}$	$\xi^{10}$
$\alpha$	$\alpha_{00}$	$\alpha_{00}$	$\beta_{01}$	$\gamma_{10}$
$\beta$	$\beta_{01}$	$\beta_{01}$	$r_{10}$	$\delta_{11}$
$r$	$r_{10}$	$r_{10}$	$\delta_{11}$	$\delta_{11}$
$\delta$	$\delta_{11}$	$\delta_{00}$	$\alpha_{00}$	$\alpha_{00}$



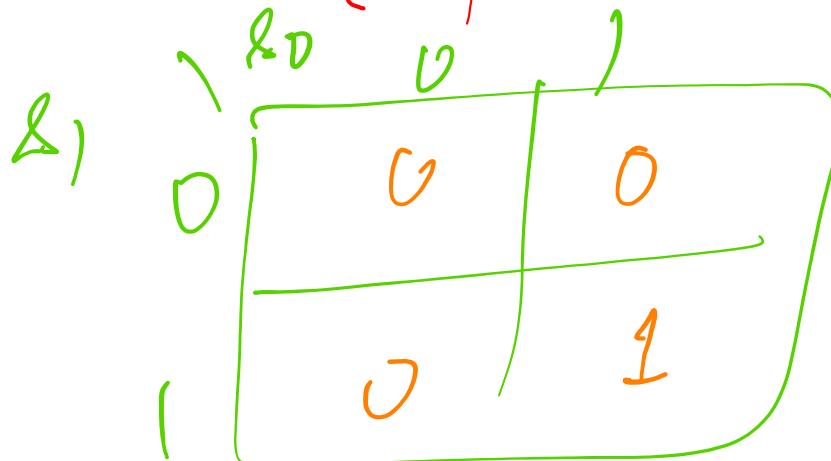
$$\begin{aligned}
 \alpha &= \theta_1 \theta_0 \xrightarrow{\delta_1 \delta_0} \delta^1(\theta_1, \theta_0, q_1, q_0) \\
 \beta &= \theta_1 \xrightarrow{\delta^2(\theta_1, \theta_0, q_1, q_0)} \lambda(\theta_1, \theta_0) \\
 r &= \theta_0 \xrightarrow{\delta^2(\theta_1, \theta_0, q_1, q_0)} \lambda(\theta_1, \theta_0) \\
 \delta &= \theta_1 \theta_0 \xrightarrow{\delta_1 \delta_0 + \bar{\delta}_1 q_1 + \bar{\delta}_0 q_0} \delta = \underline{\delta_1 \delta_0 + \bar{\delta}_1 q_1 + \bar{\delta}_0 q_0}
 \end{aligned}$$



# Finite State Machine



$$\delta^0 = \bar{\delta}_0 \bar{a}_1 a_0 + \bar{\delta}_1 \bar{a}_0 \bar{a}_1$$

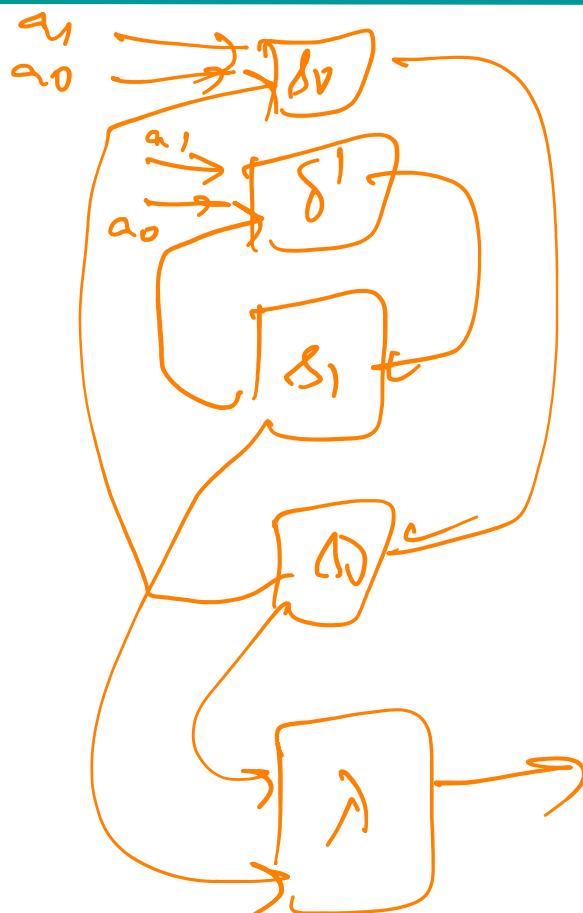


$$f = \underline{\delta_1 \delta_0}$$



# Finite State Machine

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# Thank You

