

## 设计下面三题的Mealy型FSMD模型

数据有限状态机：带有数据流的有限状态机模型（a finite-state machine with datapath, FSMD）

### 1. 单部10层电梯控制系统。

- 状态集  $S = \{s1\}$
- 数据变量集  $X: \{cfloor, rfloor\}$ 
  - $cfloor$ : 存储电梯的楼层当前状态值
  - $rfloor$ : 存储请求要到达的楼层值
- 控制输入变量集  $I_C: \{\}$
- 数据输入变量集  $I_D: \{rfloor\}$
- 数据输入集  $\{1, 2, 3, 4, 5, 6, 7, 8, 9, 10\}$
- 控制输出变量集  $O_C: \{d, u, n\}$
- 数据输出变量集  $O_D: \{cfloor\}$
- 转移条件集  $TC: \{cfloor > rfloor, rfloor > cfloor, rfloor = cfloor\}$
- 转移函数  $f$  和输出函数  $h$

状态转移	转移条件	数据输出	控制输出
$(s1, cfloor) \rightarrow (s1, cfloor)$	$cfloor > rfloor$	$cfloor := rfloor$	$d \leq cfloor - rfloor$
$(s1, cfloor) \rightarrow (s1, cfloor)$	$cfloor < rfloor$	$cfloor := rfloor$	$u \leq cfloor - rfloor$
$(s1, cfloor) \rightarrow (s1, cfloor)$	$cfloor = rfloor$	$cfloor := rfloor$	$n \leq 0$



### 2. 南北东西两个方向交通路口交通灯正交控制系统：南北方向直行绿灯40秒，东西方向直行绿灯30秒，黄灯5秒，在直行时可以左转，右转始终是自由的。正交控制系统是指南北方向为绿灯时东西方向为红灯，南北方向为红灯时东西方向为绿灯。为了满足安全以及提高通行要求，规定交通灯转换顺序为黄灯-->绿灯-->红灯-->黄灯。

- 状态集  $S = \{s\}$
- 数据变量集  $X: \{t, nscolor, ewcolor\}$ 
  - $t$ : 记录南北方向时间的计时器
  - $nscolor$ : 南北方向红路灯颜色
  - $ewcolor$ : 东西方向红路灯颜色

- 控制输入变量集  $I_C$ :  $\{\}$
- 数据输入变量集  $I_D$ :  $\{t, \text{nscolor}, \text{ewcolor}\}$
- 数据输入集  $\{0, 1, 2, 3, \dots, 40, \text{green}, \text{yellow}, \text{red}\}$
- 控制输出变量集  $O_C$ :  $\{\text{ns直行和左转}, \text{ns右转}, \text{ew直行和左转}, \text{ew右转}\}$ 
  - 为 1 时表示可以通行
  - 为 0 时表示不可通行
- 数据输出变量集  $O_D$ :  $\{\text{nscolor}, \text{ewcolor}\}$
- 转移条件集 TC:

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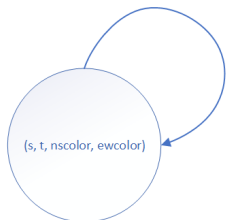
0 < t < 35; nscolor = green; ewcolor = red
t = 35; nscolor = green; ewcolor = red
35 < t < 40; nscolor = green; ewcolor = yellow
t = 40; nscolor = green; ewcolor = yellow
0 < t < 25; nscolor = red; ewcolor = green
t = 25; nscolor = red; ewcolor = green
25 < t < 30; nscolor = yellow; ewcolor = green
t = 30; nscolor = yellow; ewcolor = green
      
```

- 转移函数  $f$  和输出函数  $h$

| 状态转移                                                | 转移条件                                                 | 数据输出                                               | 控制输出                                              |
|-----------------------------------------------------|------------------------------------------------------|----------------------------------------------------|---------------------------------------------------|
| (s, t, nscolor, ewcolor) → (s, t, nscolor, ewcolor) | 0 < t < 35;<br>nscolor = green;<br>ewcolor = red     | nscolor := green;<br>ewcolor := red; t := t + 1    | ns直行和左转 <= 1; ns右转 <= 1; ew直行和左转 <= 0; ew右转 <= 1; |
| (s, t, nscolor, ewcolor) → (s, t, nscolor, ewcolor) | t = 35; nscolor = green;<br>ewcolor = red            | nscolor := green;<br>ewcolor := yellow; t := t + 1 | ns直行和左转 <= 1; ns右转 <= 1; ew直行和左转 <= 0; ew右转 <= 1; |
| (s, t, nscolor, ewcolor) → (s, t, nscolor, ewcolor) | 35 < t < 40;<br>nscolor = green;<br>ewcolor = yellow | nscolor := green;<br>ewcolor := yellow; t := t + 1 | ns直行和左转 <= 1; ns右转 <= 1; ew直行和左转 <= 0; ew右转 <= 1; |
| (s, t, nscolor, ewcolor) → (s, t, nscolor, ewcolor) | t = 40; nscolor = green;<br>ewcolor = yellow         | nscolor := red;<br>ewcolor := green; t := 0        | ns直行和左转 <= 1; ns右转 <= 1; ew直行和左转 <= 0; ew右转 <= 1; |
| (s, t, nscolor, ewcolor) → (s, t, nscolor, ewcolor) | 0 < t < 25;<br>nscolor = red;<br>ewcolor = green     | nscolor := red;<br>ewcolor := green; t := t + 1    | ns直行和左转 <= 0; ns右转 <= 1; ew直行和左转 <= 1; ew右转 <= 1; |
| (s, t, nscolor, ewcolor) → (s, t, nscolor, ewcolor) | t = 25; nscolor = red; ewcolor = green               | nscolor := yellow;<br>ewcolor := green; t := t + 1 | ns直行和左转 <= 0; ns右转 <= 1; ew直行和左转 <= 1; ew右转 <= 1; |
| (s, t, nscolor, ewcolor) → (s, t, nscolor, ewcolor) | 25 < t < 30;<br>nscolor = yellow;<br>ewcolor = green | nscolor := yellow;<br>ewcolor := green; t := t + 1 | ns直行和左转 <= 0; ns右转 <= 1; ew直行和左转 <= 1; ew右转 <= 1; |
| (s, t, nscolor, ewcolor) → (s, t, nscolor, ewcolor) | t = 30; nscolor = yellow;<br>ewcolor = green         | nscolor := green;<br>ewcolor := red; t := 0        | ns直行和左转 <= 0; ns右转 <= 1; ew直行和左转 <= 1; ew右转 <= 1; |

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0<t<35;nscolor=green;ewcolor=red/nscolor:=green;ewcolor:=red;t:=t+1;ns直行和左转<=1;ns右转<=1;ew直行和左转<=0;ew右转<=1;  
t=35;nscolor=green;ewcolor=red/nscolor:=green;ewcolor:=yellow;t:=t+1;ns直行和左转<=1;ns右转<=1;ew直行和左转<=0;ew右转<=1;  
35<t<40;nscolor=green;ewcolor=yellow/nscolor:=green;ewcolor:=yellow;t:=t+1;ns直行和左转<=1;ns右转<=1;ew直行和左转<=0;ew右转<=1;  
t=40;nscolor=green;ewcolor=yellow/nscolor:=red;ewcolor:=green;t:=0;ns直行和左转<=1;ns右转<=1;ew直行和左转<=0;ew右转<=1;  
0<t<25;nscolor=red;ewcolor=green/nscolor:=red;ewcolor:=green;t:=t+1;ns直行和左转<=0;ns右转<=1;ew直行和左转<=1;ew右转<=1;  
t=25;nscolor=red;ewcolor=green/nscolor:=yellow;ewcolor:=green;t:=t+1;ns直行和左转<=0;ns右转<=1;ew直行和左转<=1;ew右转<=1;  
25<t<30;nscolor=yellow;ewcolor=green/nscolor:=yellow;ewcolor:=green;t:=t+1;ns直行和左转<=0;ns右转<=1;ew直行和左转<=1;ew右转<=1;  
t=30;nscolor=yellow;ewcolor=green/nscolor:=green;ewcolor:=red;t:=0;ns直行和左转<=0;ns右转<=1;ew直行和左转<=1;ew右转<=1;



3. 饮料售货机可以售3种饮料：可乐、茶和水。每瓶可乐售4元、每瓶茶售3元、每瓶水售2元；线上（微信或支付宝）支付。每次可以购买1-3瓶饮料。

- 状态集  $S = \{s\}$
- 数据变量集  $X: \{x, n_{\text{可乐}}, n_{\text{茶}}, n_{\text{水}}\}$ 
  - $x$ : 记录支付钱数
  - $n_{\text{可乐}}$ : 可乐的数量
  - $n_{\text{茶}}$ : 茶的数量
  - $n_{\text{水}}$ : 水的数量
- 控制输入变量集  $I_C: \{\}$
- 数据输入变量集  $I_D: \{x, n_{\text{可乐}}, n_{\text{茶}}, n_{\text{水}}\}$
- 数据输入集  $\{2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12\}$
- 控制输出变量集  $O_C: \{\text{out}_C\}$
- 数据输出变量集  $O_D: \{\text{out}_{\text{可乐}}, \text{out}_{\text{茶}}, \text{out}_{\text{水}}\}$
- 数据输出集  $\{\text{open}, \text{close}\}$
- 转移条件集  $TC: \{x = 4 * n_{\text{可乐}} + 3 * \text{out}_{\text{茶}} + 2 * n_{\text{水}}, x \neq 4 * n_{\text{可乐}} + 3 * \text{out}_{\text{茶}} + 2 * n_{\text{水}}\}$
- 转移函数  $f$  和输出函数  $h$

| 状态转移                                                                                                                                                                    | 转移条件                                                                 | 数据输出                                                                                                                            | 控制输出                             |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------|----------------------------------|
| $(s, x, \text{out}_{\text{可乐}}, \text{out}_{\text{茶}}, \text{out}_{\text{水}}) \rightarrow (s, x, \text{out}_{\text{可乐}}, \text{out}_{\text{茶}}, \text{out}_{\text{水}})$ | $x = x + 4 * n_{\text{可乐}} + 3 * n_{\text{茶}} + 2 * n_{\text{水}}$    | $x := 0; \text{out}_{\text{可乐}} := n_{\text{可乐}}; \text{out}_{\text{茶}} := n_{\text{茶}}; \text{out}_{\text{水}} := n_{\text{水}}$ | $\text{out}_C \leq \text{open}$  |
| $(s, x, \text{out}_{\text{可乐}}, \text{out}_{\text{茶}}, \text{out}_{\text{水}}) \rightarrow (s, x, \text{out}_{\text{可乐}}, \text{out}_{\text{茶}}, \text{out}_{\text{水}})$ | $x \neq x + 4 * n_{\text{可乐}} + 3 * n_{\text{茶}} + 2 * n_{\text{水}}$ | $x := x; \text{out}_{\text{可乐}} := 0; \text{out}_{\text{茶}} := 0; \text{out}_{\text{水}} := 0$                                   | $\text{out}_C \leq \text{close}$ |

