

确定有限自动机

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确定有限自动机

- 确定有限自动机的概念
- 确定有限自动机的定义
- 扩展转移函数
- 正则语言
- DFA的构造

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确定有限自动机

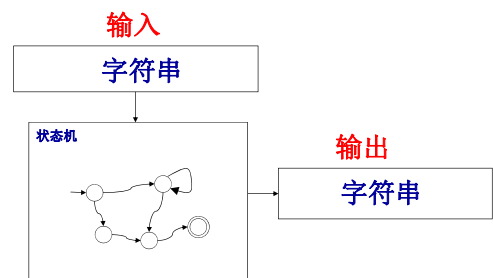
- 确定有限自动机的概念
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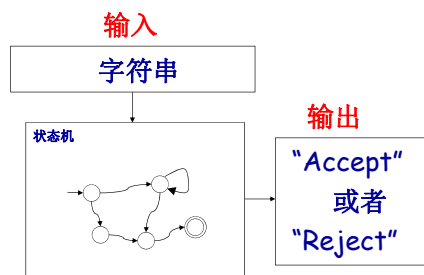


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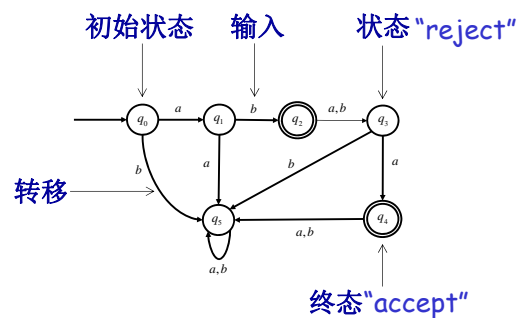


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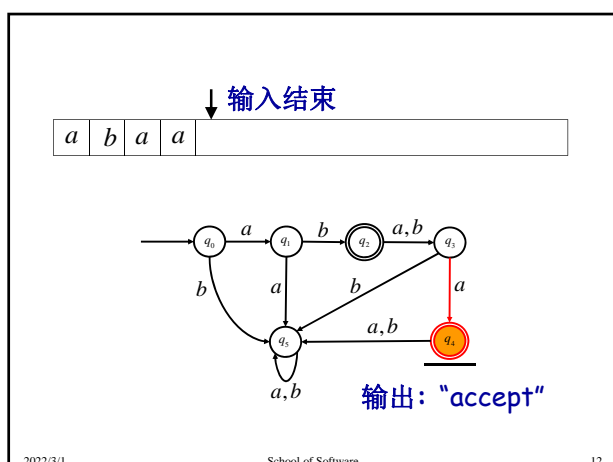
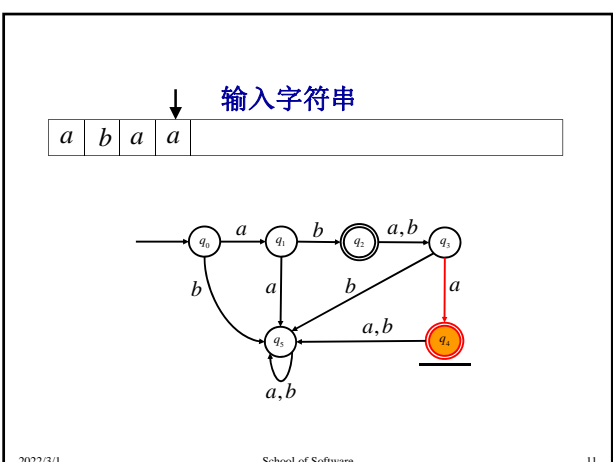
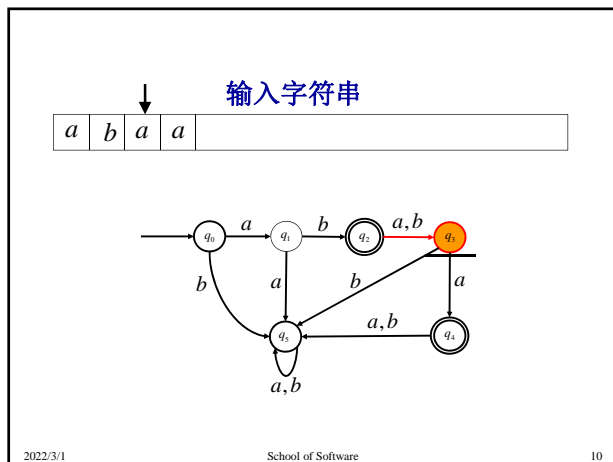
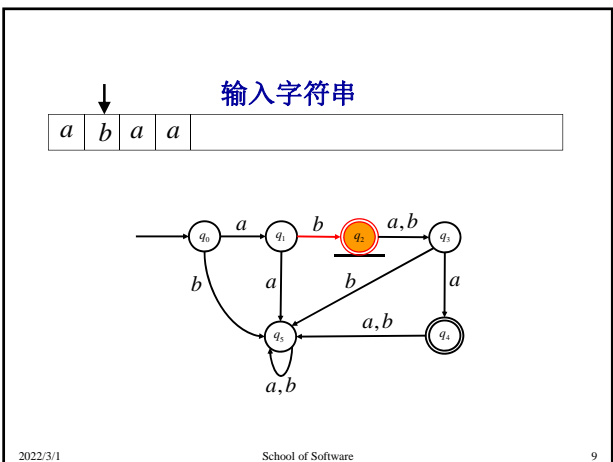
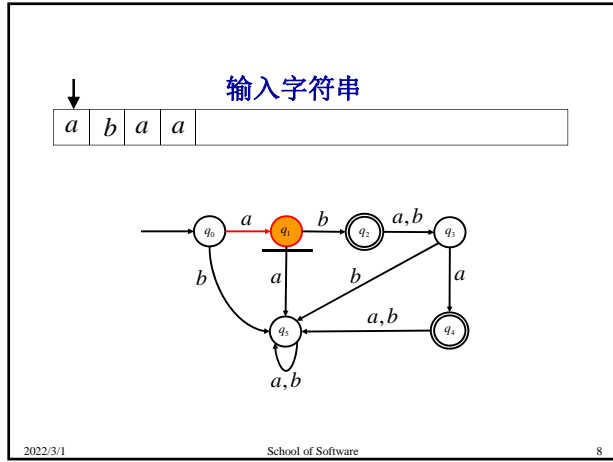
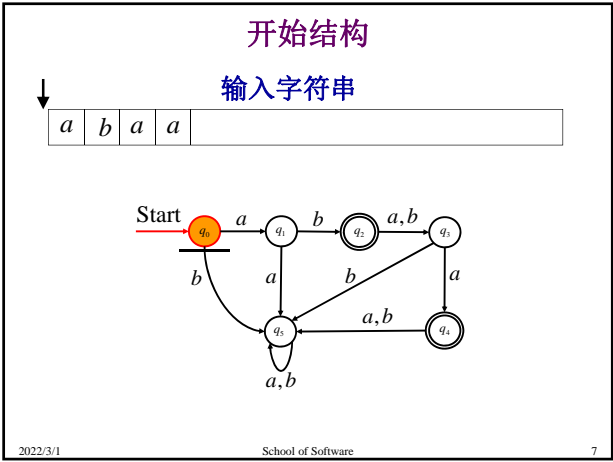
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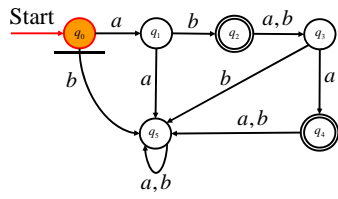
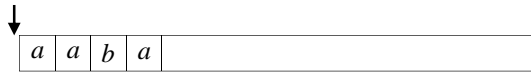
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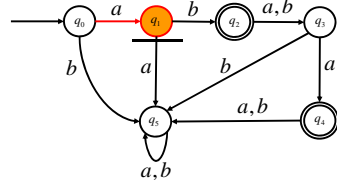
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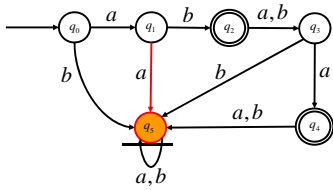
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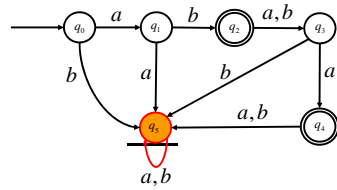
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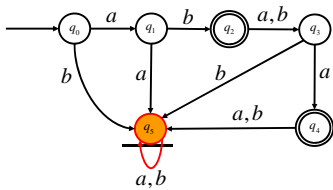
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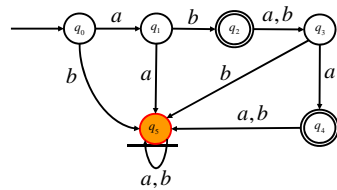
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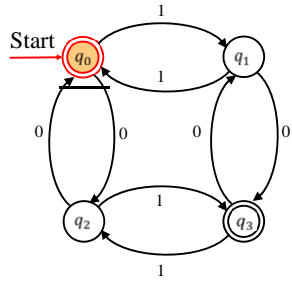
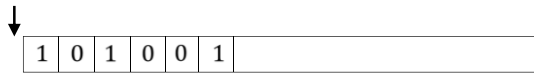
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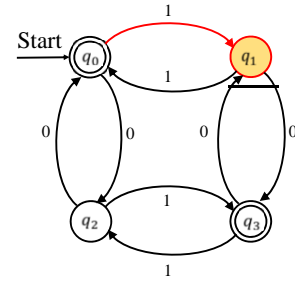
另一个例子



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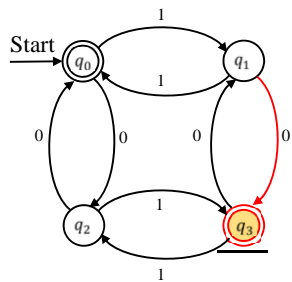
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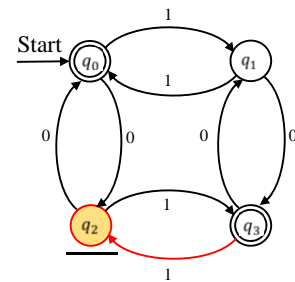
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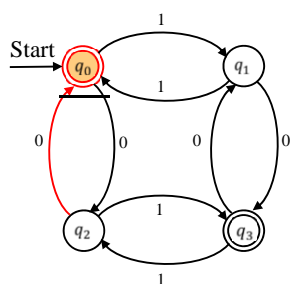
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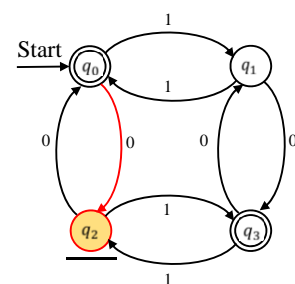
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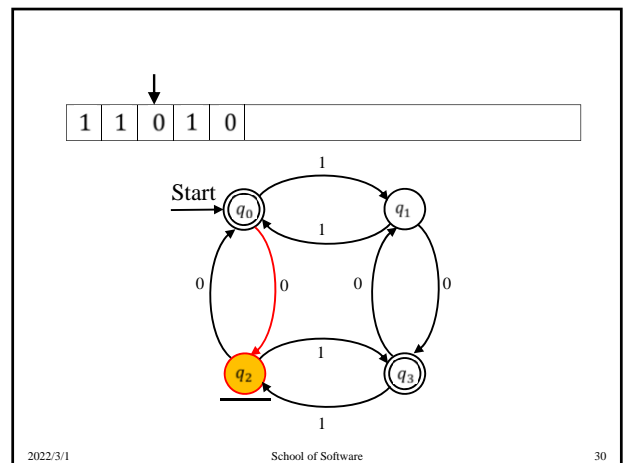
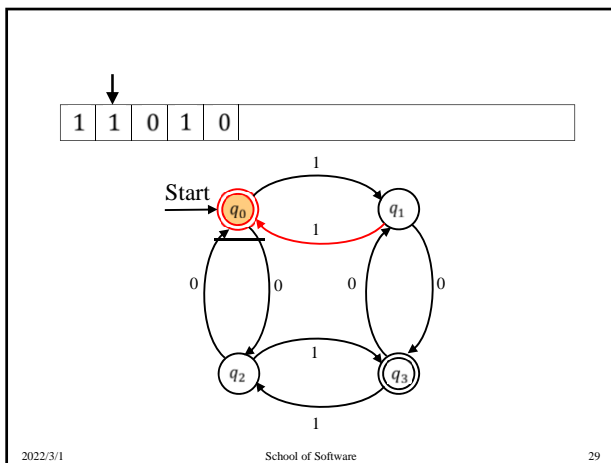
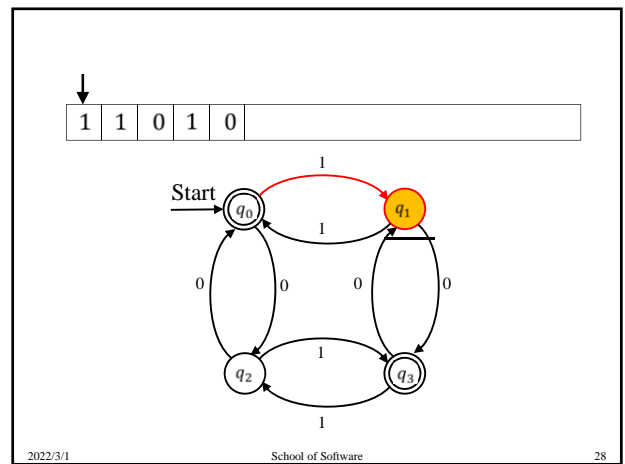
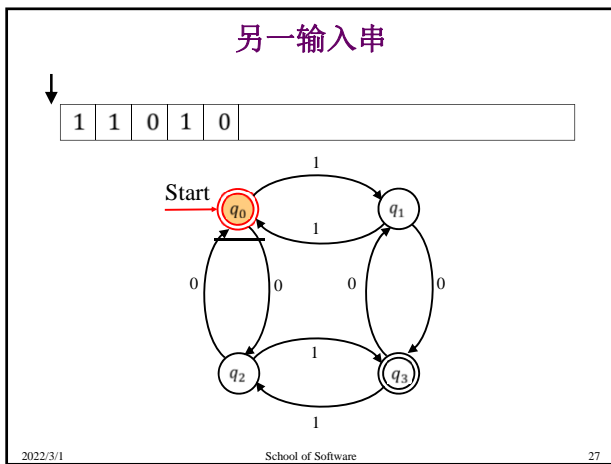
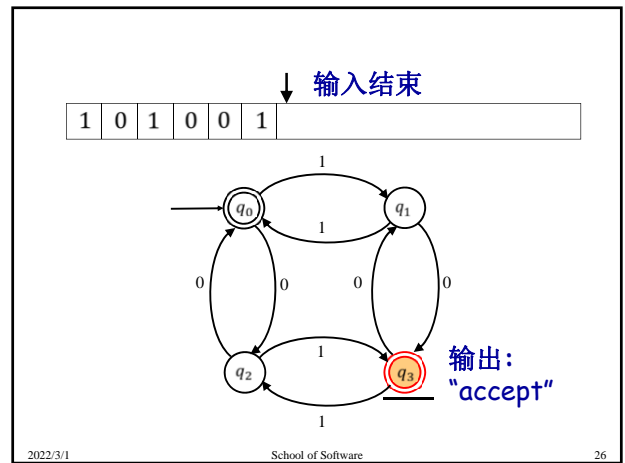
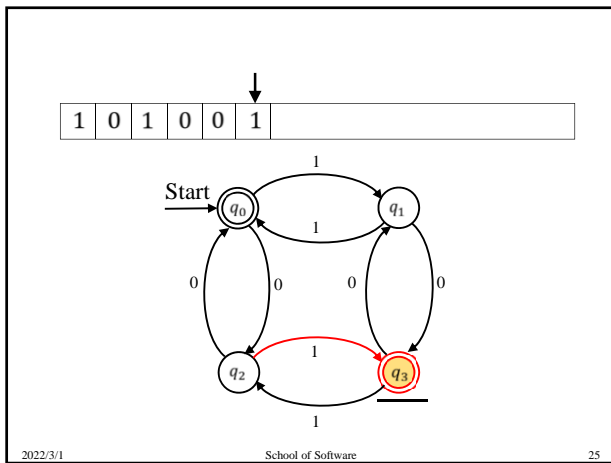
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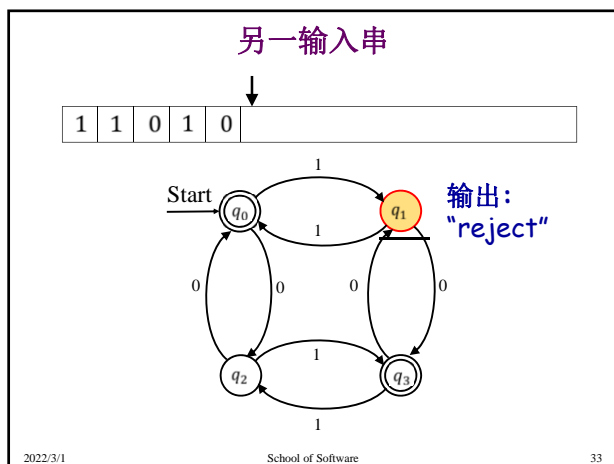
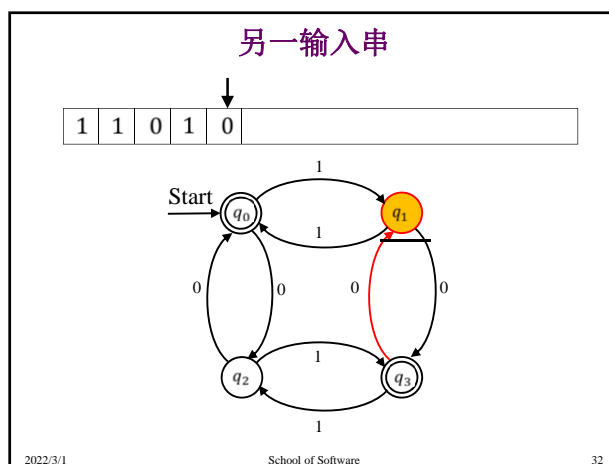
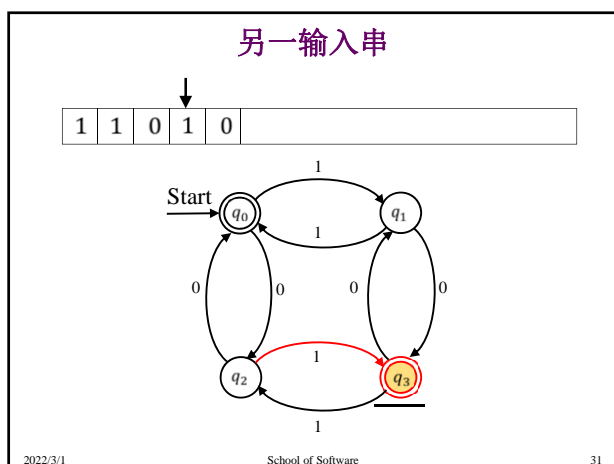


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确定有限自动机有哪些特征?

确定有限自动机怎样定义?

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- ## 确定有限自动机
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确定有限自动机的定义

确定有限自动机 **DFA** (**deterministic finite automata**) 是五元组 $A = (Q, \Sigma, \delta, q_0, F)$.

有限状态集 Q

输入符号集 Σ

转移函数 δ

开始状态 q_0

终态集合 F

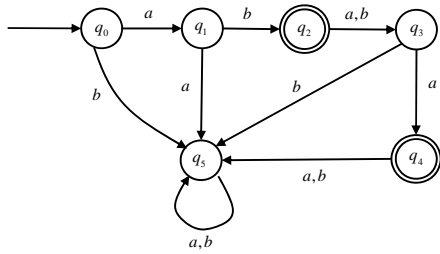
$q_0 \in Q, F \subseteq Q$

$\delta: Q \times \Sigma \rightarrow Q$

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输入字母表 Σ

$$\Sigma = \{a, b\}$$



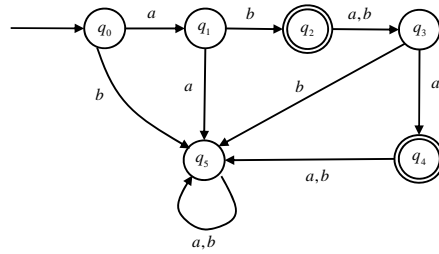
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状态集合 Q

$$Q = \{q_0, q_1, q_2, q_3, q_4, q_5\}$$

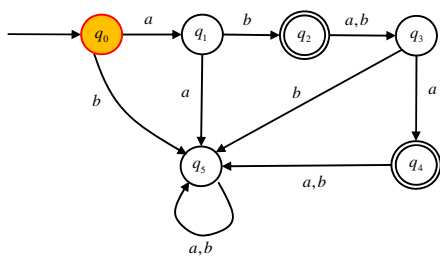


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初始状态 q_0



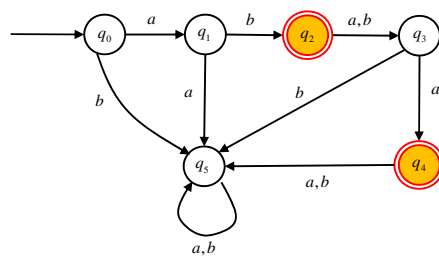
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终态集合 F

$$F = \{q_2, q_4\}$$



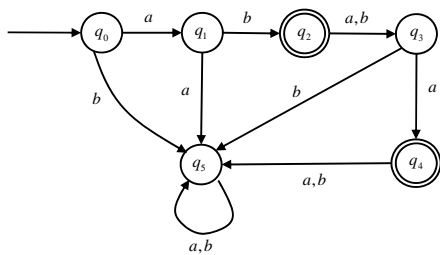
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转移函数 δ

$$\delta: Q \times \Sigma \rightarrow Q$$

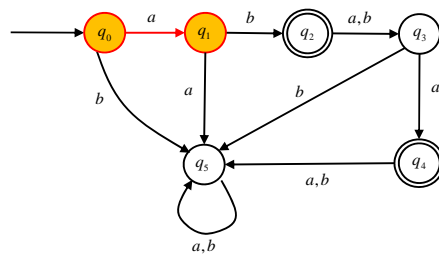


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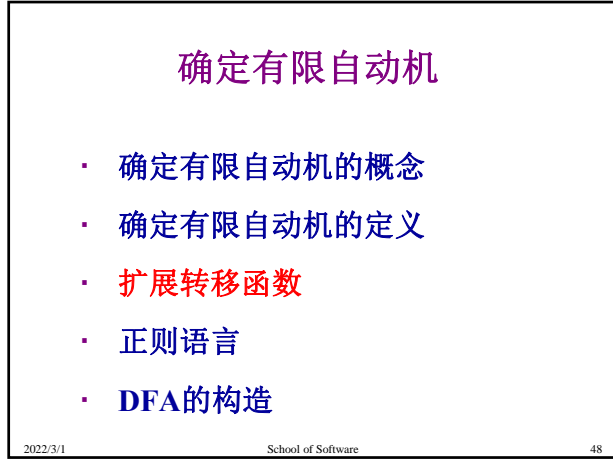
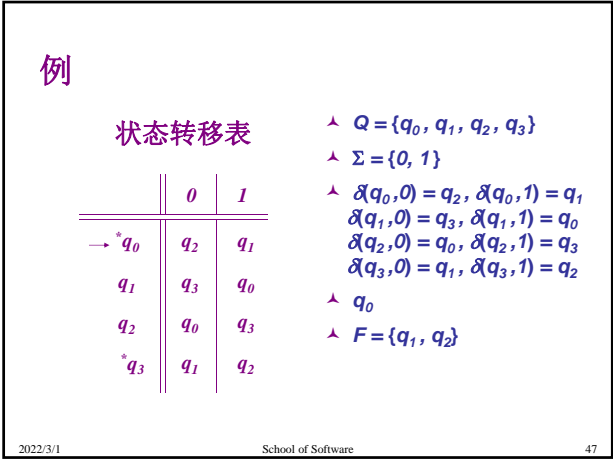
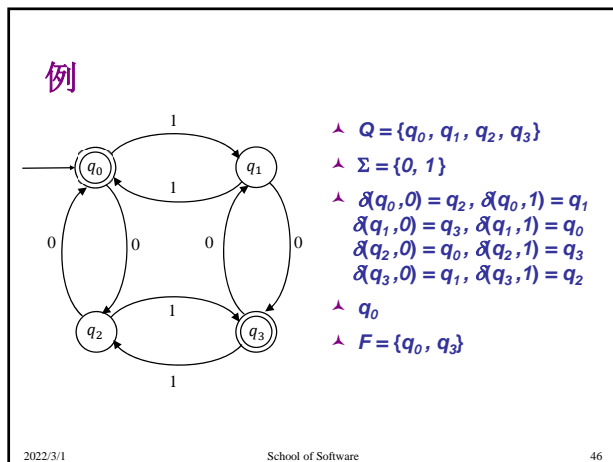
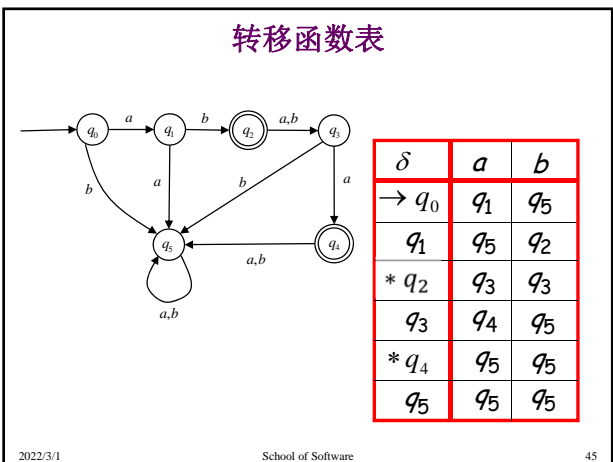
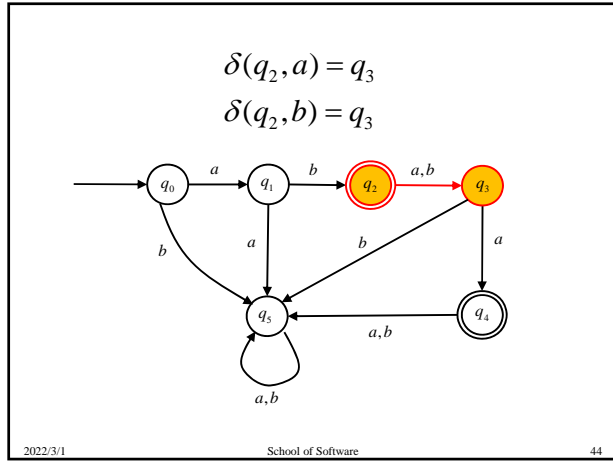
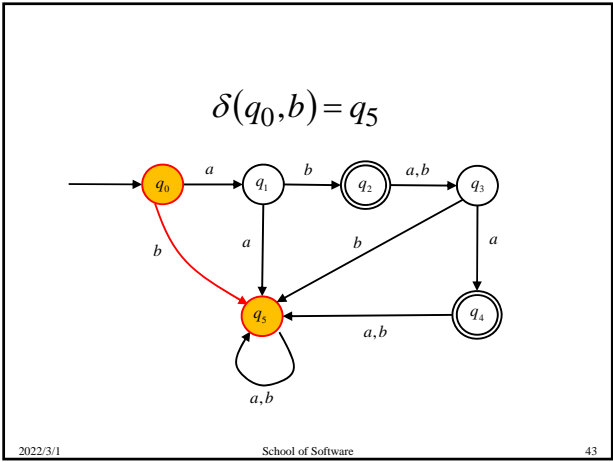
$$\delta(q_0, a) = q_1$$



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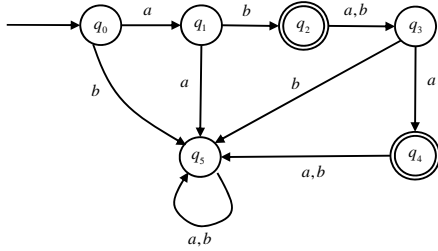
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扩展转移函数 δ^*

$$\delta^*: Q \times \Sigma^* \rightarrow Q$$

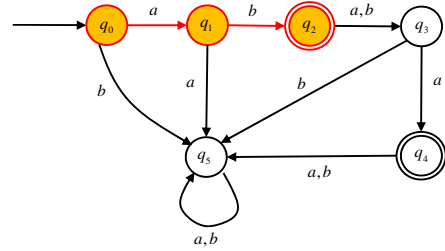


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$$\delta^*(q_0, ab) = q_2$$

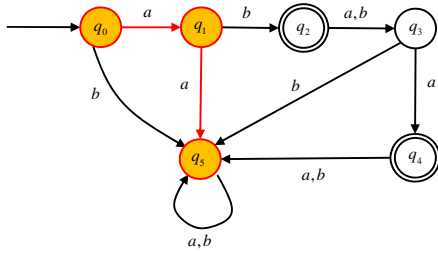


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$$\delta^*(q_0, aa) = q_5$$

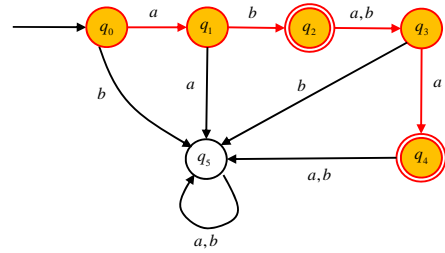


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$$\delta^*(q_0, abba) = q_4$$



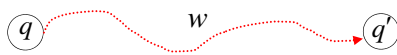
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显然：存在一条从 q 到 q' 且标记为 w 的路径

$$\delta^*(q, w) = q'$$



$$w = \sigma_1 \sigma_2 \cdots \sigma_k$$



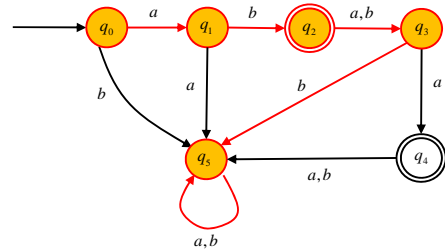
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例：从 q_0 到 q_5 标记 $ababab$ 的路径

$$\delta^*(q_0, ababab) = q_5$$



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递归定义

基础: $\delta^*(q, \varepsilon) = q$

递归: $\delta^*(q, w\sigma) = \delta(\delta^*(q, w), \sigma)$



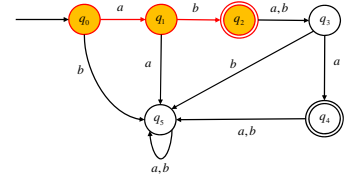
$$\left. \begin{array}{l} \delta^*(q, w) = q_1 \\ \delta(q_1, \sigma) = q' \end{array} \right\} \Rightarrow \left. \begin{array}{l} \delta^*(q, w\sigma) = \delta(q_1, \sigma) \\ \delta^*(q, w\sigma) = q' \end{array} \right\}$$

$$\delta^*(q, w\sigma) = \delta(\delta^*(q, w), \sigma)$$

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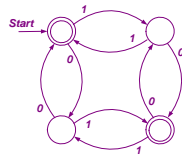
$$\begin{aligned} \delta^*(q_0, ab) &= \delta(\delta^*(q_0, a), b) \\ &= \delta(\delta(\delta^*(q_0, \varepsilon), a), b) = \delta(\delta(q_0, a), b) \\ &= \delta(q_1, b) = q_2 \end{aligned}$$

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扩展转移函数例



	0	1
$\rightarrow q_0$	q_2	q_1
q_1	q_3	q_0
q_2	q_0	q_3
$*q_3$	q_1	q_2

$$\begin{aligned} \delta^*(q_0, \varepsilon) &= q_0 \\ \delta^*(q_0, 0) &= \delta(q_0, 0) = q_2 \\ \delta^*(q_0, 00) &= \delta(q_2, 0) = q_0 \\ \delta^*(q_0, 001) &= \delta(q_0, 1) = q_1 \\ \delta^*(q_0, 0010) &= \delta(q_1, 0) = q_3 \end{aligned}$$

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DFA接受的语言

定义:

- 设 DFA 为 M , 由 M 接受的所有字符串构成的集合称为 M 的语言, 记为 $L(M)$, 即:
 $L(M) = \{M \text{ 中从初态到终态的串}\}$
- DFA 接受的语言称为正则语言 (Regular Language), 即:
 正则语言 = $\{L(M) \mid M \text{ 是 DFA}\}$

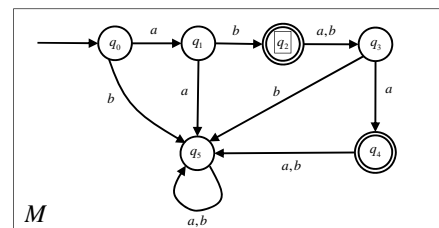
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例

$$L(M) = \{ab, abaa, abba\}$$



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语言的形式化定义

对 DFA $M = (Q, \Sigma, \delta, q_0, F)$

M 接受的语言为:

$$L(M) = \{w \in \Sigma^* : \delta^*(q_0, w) \in F\}$$



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显然, 不被 DFA M 接受的语言:

$$\overline{L(M)} = \{w \in \Sigma^* : \delta^*(q_0, w) \notin F\}$$

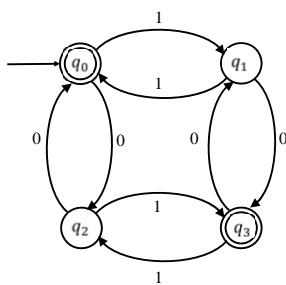


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例



$$L = \{\epsilon, 11, 01, 101001, \dots\}$$

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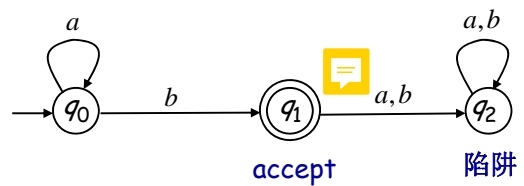
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例1:

$$L(M) = \{a^n b : n \geq 0\}$$



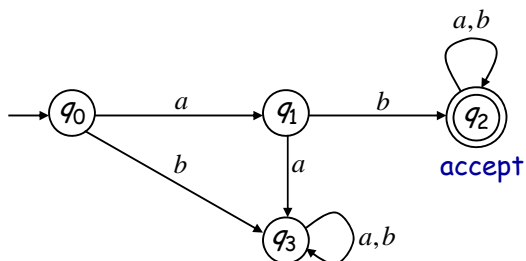
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例2:

$$L(M) = \{w \in \{a, b\}^* \mid w \text{ 前缀为 } ab\}$$



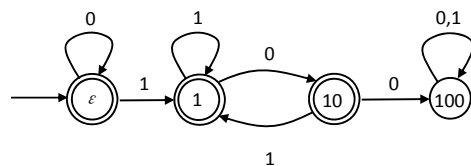
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例3:

$$L(M) = \{w \in \{0, 1\}^* \mid w \text{ 中不含字符串 } 100\}$$



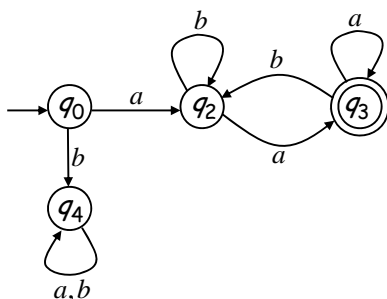
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例4:

$$L(M) = \{awa \mid w \in \{a, b\}^*\}$$



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如何说明DFA是所求?

例: $\Sigma = \{0, 1\}$ 上的语言

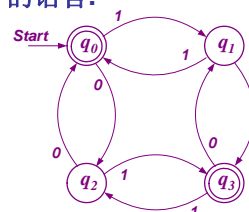
$$L = \{w \mid w \text{ 中 } 0、1 \text{ 数目的奇偶性相同} \}$$

$$= \{w \mid w \text{ 的长度为偶数} \}$$

解: 则 L 是如下DFA 的语言.

证明:

采用互归纳法



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Examples



$\Sigma = \{0, 1\}$. 分别构造下列语言的DFA.

- $L = \{w \mid \text{最后字母为 } 1\}$
- $L = \{w \mid w \text{ 倒数第二个字母为 } 1\}$
- $L = \{w \mid w \text{ 倒数第三个字母为 } 1\}$
- $L = \{w \mid w \text{ 倒数第十个字母为 } 1\}$

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课后练习

必做题:

- P-53: Ex.2.2.2
- P-54: Ex.2.2.4 (b), (c)
- P-54: Ex.2.2.5 (a), (c), (d)
- P-54: Ex.2.2.10
- 构造接受倒数第三个字符是1的DFA。

思考题:

- P-54: Ex.2.2.5 (b)
- P-54: Ex.2.2.6
- $L = \{w \mid w \text{ 中 } 0, 1 \text{ 数目的奇偶性相同} \}$ (PPT 65页)
是 $\Sigma = \{0, 1\}$ 上的语言。证明 L 是正则语言。

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Thank You

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