HW02 Solution

$$Q=\{0,\ldots,pq-1\}.$$

$$Q = \{0, \dots, pq - 1\}.$$
$$\Sigma = \{a\}.$$

$$Q = \{0, ..., pq - 1\}.$$

 $\Sigma = \{a\}.$
 $s = 0.$

$$Q = \{0, \dots, pq - 1\}.$$

 $\Sigma = \{a\}.$
 $s = 0.$
 $F = \{1, \dots, pq - 1\}.$

$$Q = \{0, \dots, pq - 1\}.$$

 $\Sigma = \{a\}.$
 $s = 0.$
 $F = \{1, \dots, pq - 1\}.$
 $\delta(a, i) = i + 1 \pmod{pq}.$

$$Q = \{0, \dots, pq - 1\}.$$

 $\Sigma = \{a\}.$
 $s = 0.$
 $F = \{1, \dots, pq - 1\}.$
 $\delta(a, i) = i + 1 \pmod{pq}.$

Number of States: pq.

Intuition: NFA has *e*-transitions to a DFA for $\{a^i : i \not\equiv 0 \pmod{p}\}$ and $\{a^i : i \not\equiv 0 \pmod{q}\}$.

Intuition: NFA has *e*-transitions to a DFA for $\{a^i: i \not\equiv 0 \pmod p\}$ and $\{a^i: i \not\equiv 0 \pmod q\}$. $Q = \{s\} \cup \{s_0, s_1, \dots, s_{p-1}\} \cup \{t_0, \dots, t_{q-1}\}$.

Intuition: NFA has *e*-transitions to a DFA for $\{a^i: i \not\equiv 0 \pmod p\}$ and $\{a^i: i \not\equiv 0 \pmod q\}$. $Q = \{s\} \cup \{s_0, s_1, \dots, s_{p-1}\} \cup \{t_0, \dots, t_{q-1}\}$. Start state is *s*.

Intuition: NFA has *e*-transitions to a DFA for $\{a^i: i \not\equiv 0 \pmod p\}$ and $\{a^i: i \not\equiv 0 \pmod q\}$. $Q = \{s\} \cup \{s_0, s_1, \dots, s_{p-1}\} \cup \{t_0, \dots, t_{q-1}\}$. Start state is s. $\Delta(s, e) = \{s_0, t_0\}$.

Intuition: NFA has *e*-transitions to a DFA for $\{a^i: i \not\equiv 0 \pmod p\}$ and $\{a^i: i \not\equiv 0 \pmod q\}$. $Q = \{s\} \cup \{s_0, s_1, \ldots, s_{p-1}\} \cup \{t_0, \ldots, t_{q-1}\}$. Start state is s. $\Delta(s, e) = \{s_0, t_0\}$. $\Delta(s_i, a) = s_{i+1 \pmod p}$.

Intuition: NFA has *e*-transitions to a DFA for $\{a^i: i\not\equiv 0\pmod p\}$ and $\{a^i: i\not\equiv 0\pmod q\}$. $Q=\{s\}\cup\{s_0,s_1,\ldots,s_{p-1}\}\cup\{t_0,\ldots,t_{q-1}\}.$ Start state is s. $\Delta(s,e)=\{s_0,t_0\}.$ $\Delta(s_i,a)=s_{i+1\pmod p}.$ $\Delta(t_i,a)=t_{i+1\pmod q}.$

Intuition: NFA has e-transitions to a DFA for $\{a^i: i\not\equiv 0\pmod p\}$ and $\{a^i: i\not\equiv 0\pmod q\}$. $Q=\{s\}\cup\{s_0,s_1,\ldots,s_{p-1}\}\cup\{t_0,\ldots,t_{q-1}\}.$ Start state is s. $\Delta(s,e)=\{s_0,t_0\}.$ $\Delta(s_i,a)=s_{i+1\pmod p}.$ $\Delta(t_i,a)=t_{i+1\pmod q}.$ Number of States: p+q+1.

L is the set of all a^n such that

L is the set of all a^n such that The numb of $p \in \{3, 5, ..., 31\}$ that divides n is a square.

Prob 3: $L = \{a^n : \# \text{ of } p_i \ldots \}$

L is the set of all a^n such that The numb of $p \in \{3, 5, \ldots, 31\}$ that divides n is a square. Need DFA to keep track of n's $\equiv \pmod{p}$ for $p \in \{3, 5, \ldots, 31\}$.

Prob 3: $L = \{a^n : \# \text{ of } p_i \ldots \}$

L is the set of all a^n such that The numb of $p \in \{3, 5, ..., 31\}$ that divides n is a square.

Need DFA to keep track of n's $\equiv \pmod{p}$ for $p \in \{3, 5, \dots, 31\}$.

Prob 3: $L = \{a^n : \# \text{ of } p_i \ldots \}$

L is the set of all a^n such that The numb of $p \in \{3, 5, ..., 31\}$ that divides n is a square.

Need DFA to keep track of n's $\equiv \pmod{p}$ for $p \in \{3, 5, \dots, 31\}$.

$$Q = \{0,\ldots,p_1-1\} \times \cdots \times \{0,\ldots,p_k-1\}.$$

L is the set of all a^n such that The numb of $p \in \{3, 5, ..., 31\}$ that divides n is a square.

Need DFA to keep track of n's $\equiv \pmod{p}$ for $p \in \{3, 5, \dots, 31\}$.

$$Q = \{0, \dots, p_1 - 1\} \times \dots \times \{0, \dots, p_k - 1\}.$$

 $s = (0, 0, \dots, 0).$

L is the set of all a^n such that The numb of $p \in \{3, 5, ..., 31\}$ that divides n is a square.

Need DFA to keep track of n's $\equiv \pmod{p}$ for $p \in \{3, 5, \dots, 31\}$.

$$Q = \{0, \dots, p_1 - 1\} \times \dots \times \{0, \dots, p_k - 1\}.$$

$$s = (0, 0, \dots, 0).$$

$$\delta((i_1,\ldots,i_k),a)=(i_1+1\pmod{p_1},\ldots,i_k+1\pmod{p_k}).$$

L is the set of all a^n such that The numb of $p \in \{3, 5, ..., 31\}$ that divides n is a square.

Need DFA to keep track of n's $\equiv \pmod{p}$ for $p \in \{3, 5, \dots, 31\}$.

$$Q = \{0, \dots, p_1 - 1\} \times \dots \times \{0, \dots, p_k - 1\}.$$

$$s = (0, 0, \dots, 0).$$

$$\delta((i_1,\ldots,i_k),a)=(i_1+1\pmod{p_1},\ldots,i_k+1\pmod{p_k}).$$

$$F = \{(i_1, \dots, i_k) : \text{ the numb of } i \text{'s that are 0 is a square } \}.$$

L Reg via DFA $M = (Q, \Sigma, \delta, s, F)$. We do M^R NFA for L^R .

L Reg via DFA $M = (Q, \Sigma, \delta, s, F)$. We do M^R NFA for L^R . **Intuition:** Reverse arrows, old start state is new final state.

L Reg via DFA $M = (Q, \Sigma, \delta, s, F)$. We do M^R NFA for L^R . **Intuition:** Reverse arrows, old start state is new final state. **Start State:** New Start st has *e*-trans to all old final sts.

L Reg via DFA $M=(Q,\Sigma,\delta,s,F)$. We do M^R NFA for L^R . **Intuition:** Reverse arrows, old start state is new final state. **Start State:** New Start st has e-trans to all old final sts. $M^R=(Q\cup\{s'\},\Sigma\cup\{e\},\Delta,s',\{s\})\ s'\notin Q$.

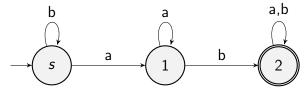
L Reg via DFA $M=(Q,\Sigma,\delta,s,F)$. We do M^R NFA for L^R . **Intuition:** Reverse arrows, old start state is new final state. **Start State:** New Start st has e-trans to all old final sts. $M^R=(Q\cup\{s'\},\Sigma\cup\{e\},\Delta,s',\{s\})\ s'\notin Q.$ $\forall p\in Q,\sigma\in\Sigma,\Delta(p,\sigma)=\{q\in Q:\delta(q,\sigma)=p\}$

L Reg via DFA $M=(Q,\Sigma,\delta,s,F)$. We do M^R NFA for L^R . **Intuition:** Reverse arrows, old start state is new final state. **Start State:** New Start st has e-trans to all old final sts. $M^R=(Q\cup\{s'\},\Sigma\cup\{e\},\Delta,s',\{s\})\ s'\notin Q.$ $\forall p\in Q,\sigma\in\Sigma,\,\Delta(p,\sigma)=\{q\in Q:\delta(q,\sigma)=p\}$ $\Delta(s',e)=F$

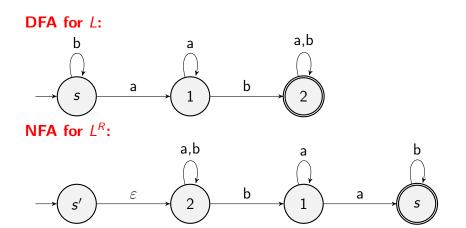
L Reg via DFA $M=(Q,\Sigma,\delta,s,F)$. We do M^R NFA for L^R . Intuition: Reverse arrows, old start state is new final state. Start State: New Start st has e-trans to all old final sts. $M^R=(Q\cup\{s'\},\Sigma\cup\{e\},\Delta,s',\{s\})\ s'\notin Q.$ $\forall p\in Q,\sigma\in\Sigma,\,\Delta(p,\sigma)=\{q\in Q:\delta(q,\sigma)=p\}$ $\Delta(s',e)=F$ Intuition \exists path $p\to q$ in $M\Longrightarrow\exists$ path $q\to p$ in M^R .

Prob 4: $L \text{ Reg} \implies L^R \text{ Reg. Example}$

DFA for *L*:



Prob 4: $L \text{ Reg} \implies L^R \text{ Reg. Example}$



L is **Sam-Reg** if \exists NFA M, no e-transitions: $x \in L$ iff M(x) run: numb of poss final states it ends in is PRIME.

DFA for L.

L is **Sam-Reg** if \exists NFA *M*, no *e*-transitions: $x \in L$ iff M(x) run: numb of poss final states it ends in is PRIME.

Show that If L is Sam-Reg than L is regular. L be SAM-regular using NFA $(Q, \Sigma, \Delta, s, F)$. We construct a

4 D > 4 D > 4 E > 4 E > E 990

L is **Sam-Reg** if \exists NFA *M*, no *e*-transitions:

 $x \in L$ iff M(x) run: numb of poss final states it ends in is PRIME.

Show that If L is Sam-Reg than L is regular.

L be SAM-regular using NFA $(Q, \Sigma, \Delta, s, F)$. We construct a DFA for *L*.

Do the subset construction to obtain DFA $M' = (2^Q, \Sigma, \delta, s, F')$

L is **Sam-Reg** if \exists NFA *M*, no *e*-transitions:

 $x \in L$ iff M(x) run: numb of poss final states it ends in is PRIME.

Show that If L is Sam-Reg than L is regular.

L be SAM-regular using NFA $(Q, \Sigma, \Delta, s, F)$. We construct a DFA for L.

Do the subset construction to obtain DFA

 $M' = (2^Q, \Sigma, \delta, s, F')$

Recall M'(x) is set of states x could be in if we ran M(x).

L is **Sam-Reg** if \exists NFA *M*, no *e*-transitions:

 $x \in L$ iff M(x) run: numb of poss final states it ends in is PRIME.

Show that If L is Sam-Reg than L is regular.

L be SAM-regular using NFA $(Q, \Sigma, \Delta, s, F)$. We construct a DFA for L.

Do the subset construction to obtain DFA

$$M' = (2^Q, \Sigma, \delta, s, F')$$

Recall M'(x) is set of states x could be in if we ran M(x). **Recall** In the usual construction

$$F' = \{A \subseteq Q : A \cap F \neq \emptyset\}.$$

L is **Sam-Reg** if \exists NFA *M*, no *e*-transitions:

 $x \in L$ iff M(x) run: numb of poss final states it ends in is PRIME.

Show that If L is Sam-Reg than L is regular.

L be SAM-regular using NFA $(Q, \Sigma, \Delta, s, F)$. We construct a DFA for L.

Do the subset construction to obtain DFA

$$M' = (2^Q, \Sigma, \delta, s, F')$$

Recall M'(x) is set of states x could be in if we ran M(x).

Recall In the usual construction

$$F' = \{ A \subseteq Q : A \cap F \neq \emptyset \}.$$

Our F'

$$F' = \{ A \subseteq Q : |A \cap F| \text{ is prime } \}.$$

