Let $L_1 = \{a^i b^j \mid i, j \geq 0, i + j \text{ is even}\}$

At any stage, remember $i + j$ even or odd. Also remember whether we are in $a$'s or $b$'s.

Let $L_4 = \{x \in \{a, b, c\}^* \mid x \text{ is a palindrome} \}$

At any stage, remember $\#a + \#b + \#c \pmod{3}$. Also remember whether we are in $a$'s, $b$'s or $c$'s.

Let $L_1 = \{x \in \{0, 1, 2^* \mid x \text{ is 12 or 21} \}$

At any stage, remember $\#1 + 2 \#2 \pmod{3}$.
\( L_{20} = \{ a^n b a, a \in \{0,1\}, \text{occurs exactly 2 times}\} \)

Remember whether in 1st or 2nd occurrence. Afterwards track for 3rd occurrence

\[ L_1 = \{ a^i b^j \mid i \neq j \} \]

Assume that \( L_1 \) can be accepted by a DFA, let it have \( S \) states. Consider the set

\[ S = \{ a, a^2, \ldots, a^3 \} \]

of \( S \) distinct strings. By the pumping lemma, two of the strings are not in \( L_1 \). Let they be

\[ a^m, a^n, \text{ } m \neq n \]

By the definition of \( L_1 \), for every \( z \in \{0,1\}^* \),

\[ a^l z \in L_1 \iff a^m z \in L_1 \]

Let \( z = a^l \). Then \( a^l b \in L_1 \), but \( a^m b \notin L_1 \).

Hence \( L_1 \) cannot be accepted by a DFA,

\[ L_2 = \{ a^i b^j \mid i, j \geq 1 \text{ and } i \neq j \} \]

Proceed as above with same \( S \).

Let \( a^l, a^m, \text{ } l \neq m \) be not in \( L_1 \).

Then \( a^l z \in L_2 \iff a^m z \in L_2 \).
\[ Z = b^2 \]

Then \( a^2 b^2 \in L_8 \) but \( a^{m} b^2 \notin L_8 \).

Hence \( L_8 \) is not a DFA lang.

\[ L_9 = \{ a^i b^j | i,j \geq 1, i \leq j \leq i^2 \} \]

Proceed as above with the base \( S \).

Let \( a^i, a^m, l < m, \) be 1st cong.

Then \( a^i z = \in L_9 \iff a^m z = \in L_9 \)

Let \( z = \in L_9 \). Then \( a^i b^l \in L_9 \) but \( a^m b^l \notin L_9 \).

Hence \( L_9 \) is not a DFA lang.

\( (Z = b^2) \) is incorrect since \( a^2 b^2 \in L_9 \) but \( a^m b^2 \)

is not guaranteed not to be in \( L_9 \).

\( \{ a^{2n} b^{2n} | n \geq 1 \} \)

Proceed as above with \( S = \{ ab, a^2, \ldots, ab^m \} \)

Let \( a^l \) and \( ab^m, l \neq m, \) be 1st cong.

Then for every \( z \in S \), \( a^l z \in L_9 \iff ab^m z \in L_9 \).

Choose \( l = a^2 l \). Then \( a^l z \in L_9 \) but \( ab^m z \notin L_9 \).

Hence \( L_9 \) is not a DFA lang.

\[ L_{19} = \{ z \in S | z = a^i b^j k \} \]

Proceed as above with the base \( S \).

Let \( a^l, a^m, l \neq m, \) be 1st cong.

Then \( a^l z \in L_{19} \iff a^m z \in L_{19} \).
Let \( z = ca^l \).

Then \( a^l \in L_19 \), but \( a^m \notin L_19 \).

Hence \( L_19 \) is not a DFA language.