The regular language \( \Sigma^* \) where the alphabet is \( \Sigma = \{0, 1\} \) is not bounded. Suppose, for a contradiction, that \( \Sigma^* \) is bounded.

Let \( w_1, w_2, \ldots, w_n \) be a finite number of words such that \( \Sigma^* \subseteq w_1^* \ldots w_n^* \). Suppose \( w_i \neq \epsilon \) for \( 1 \leq i \leq n \) since any empty members may simply be removed without changing the language \( w_1^* \ldots w_n^* \). Count the number of words of a given length \( x \) in each language.

In \( \Sigma^* \) there are \( 2^x \) words of length \( x \).

Any word in \( w_1^* \ldots w_n^* \) may be represented in the form of \( w_1^{a_1} \ldots w_n^{a_n} \) for non-negative integers \( a_1, \ldots, a_n \). Since the length of every base \( w_i \), \( 1 \leq i \leq n \) is at least 1, the exponent \( a_i \) is at most \( x \), so \( 0 \leq a_i \leq x \), so there are at most \( x + 1 \) choices for each exponent \( a_i \). Since there are \( n \) exponents, the total number of words of length \( x \) in \( w_1^* \ldots w_n^* \) is at most \( (x + 1)^n \).

Since \( 2^x \) is exponential in \( x \) and \( (x + 1)^n \) is polynomial in \( x \), there exists an \( x \) such that \( 2^x > (x + 1)^n \) for which there must then be a word \( w \) of length \( x \) such that \( w \in \Sigma^* \) and \( w \notin w_1^* \ldots w_n^* \), which contradicts \( \Sigma^* \subseteq w_1^* \ldots w_n^* \).

Therefore, by contradiction \( \Sigma^* \) is not bounded.