1. A student was trying to show that the language 
\[ L = \{ \langle M; w \rangle : M(w) \text{ halts after an even number of steps} \} \]
is not decidable. His “solution” was: to take an instance \( \langle M; w \rangle \) of \text{HALTING} and create an instance of \( L \) by doing nothing (ie \( M' = M \) and \( w' = w \)). Show that this is incorrect by finding a particular \( \langle M; w \rangle \in \text{HALTING} \), but with \( \langle M; w \rangle \notin L \).

Let \( M \) be the machine which steps to the right once and accepts regardless of the word. Let \( w = a \).

Notice that \( M(w) \) halts, but that \( M(w) \) does not halt after an even number of steps.

2. A student was trying to show that the language \( \text{EQUAL} = \{ S : S \text{ can be partitioned into sets which sum to the same value} \} \) is \( \text{NP-complete} \). His “solution” was to take an instance \( \langle S, t \rangle \) of \text{SubsetSum} and convert it to an instance of \text{EQUAL} by letting \( S' = S \). Show that this is incorrect by finding a particular \( \langle S, t \rangle \in \text{SUBSETSUM} \) but \( S \notin \text{EQUAL} \).

Let \( S = \{1, 3\} \) and \( t = 1 \). It is clear that \( \langle S, t \rangle \in \text{SubsetSum} \). However, \( S' = S \) cannot be split into two equally sized sets.

3. A student was trying to show that the language \( \text{EQUAL} = \{ S : S \text{ is a set of integers which can be split into two sets which sum to the same value} \} \) is \( \text{NP-complete} \). His “solution” was to take an instance \( \langle S, t \rangle \) of \text{SubsetSum} and convert it to an instance of \text{EQUAL} by letting \( S' = S \). Show that this is incorrect by finding a particular \( \langle S, t \rangle \notin \text{SUBSETSUM} \), but with \( S' \in \text{EQUAL} \).

Let \( S = \{1, 3\} \) and \( t = 2 \). It is clear that \( \langle S, t \rangle \notin \text{SubsetSum} \), but \( S' = \{1, 1, 3, 3\} \in \text{EQUAL} \), since \( 1+3=1+3 \).

4. A student was trying to show that the language \( \text{BINPACKING} = \{(S;b,t) : S \text{ can be split into } b \text{ sets each of which sums to at most } t \} \) is \( \text{NP-complete} \). His “solution” was to take an instance \( \langle S, t \rangle \) of \text{SubsetSum} and convert it to an instance of \text{BINPACKING} by letting \( S' = S \), \( b = 2 \), and \( t' = t \). Show that this is incorrect by finding a particular \( \langle S, t \rangle \notin \text{SUBSETSUM} \), but with \( \langle S', b, t' \rangle \notin \text{BINPACKING} \).

Let \( S = \{1, 3\} \) and \( t = 1 \). It is clear that \( \langle S, t \rangle \notin \text{SubsetSum} \), but \( S' = S \) cannot be packed into 2 bins with capacity 1.

5. Show that the language \( \text{TRIPARTITION} = \{ S \in \text{S can be split into 3 sets which all sum to the same value} \} \) is \( \text{NP-complete} \).

Given an instance of \text{EQUAL}, \( S \). Create an instance of \text{TRIPARTITION}, \( S' \) where \( S' = S \cup \{h\} \) where \( h = \sum_{s \in S} s/2 \).

If \( S \) can be divided into two equal sets then \( S' \) can be divided into 3 equal sets (the same 2 plus the single item \( h \)).

If \( S' \) can be divided into three equal sets then one of them must consist of only \( h \). The other two sets are a partition of \( S \) into two equally sized sets.