Prove that if a sequence converges it has exactly one limit point. Is the converse true?

Proof: First if \( a_n \rightarrow c \) given an \( \varepsilon > 0 \) there is an \( N(\varepsilon) \) such that

\[
|a_n - c| < \varepsilon \text{ for all } n \geq N(\varepsilon),
\]

so \( c \) is the only limit point of the sequence.

The converse is not true. Set

\[
a_{2n} = 1 \\
a_{2n+1} = 2n+1
\]

The sequence \( \{a_n\} \) has one limit point, but does not converge.