Let I be the (compact) intervall, and let $S \subset I$ be infinite. Suppose S has no limit points in I. Then there is an open U_x for each $x \in I$ such that $x \in U_x$ and $(U_x - \{x\}) \cap S = \emptyset$. Since $\{U_X | x \in I\}$ forms an open cover of I, Heine-Borel tells us that there are $x_1, \ldots, x_n$ such that $I \subset U_{x_1} \cup \cdots \cup U_{x_n}$. Each U_{x_i} contains at most one point from S and therefore S must be finite – a contradiction.

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