③ False

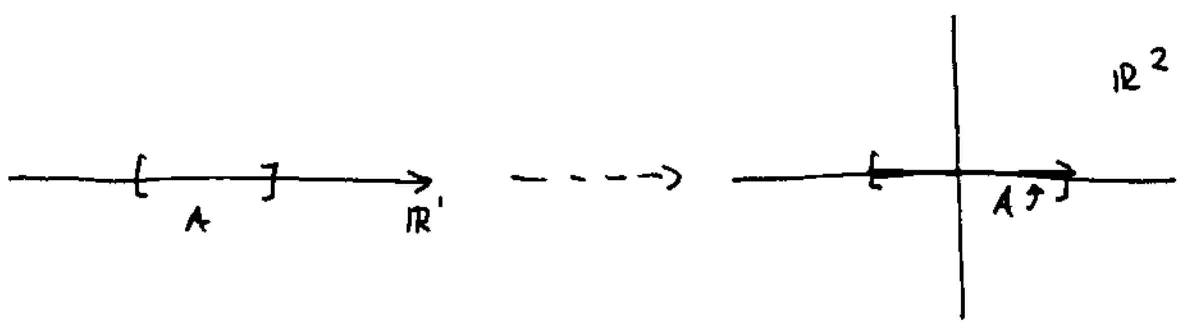
Suppose B is not open and $B \subset A$. If A is open then so is $A \cup B = A$, but B is still not open.

e.g. $B = (0,1]$ $A = \mathbb{R}$

④ We want to think of $A \subset \mathbb{R}^1$ as a subset of $\mathbb{R}^2$.

This is the set $\{ (x,y) \in \mathbb{R}^2 \mid x \in A, y = 0 \}$.

i.e.



We want show if A is closed in $\mathbb{R}^1$ then it is closed in $\mathbb{R}^2$.

Let $p = (x_1, y_1)$ be a point in the complement of A in $\mathbb{R}^2$.

- If $y_1 \neq 0$, then we set $r = |y_1|$ and note that the open ball $U_{r/2}(p)$ lies in the complement of A

i.e.