(4)

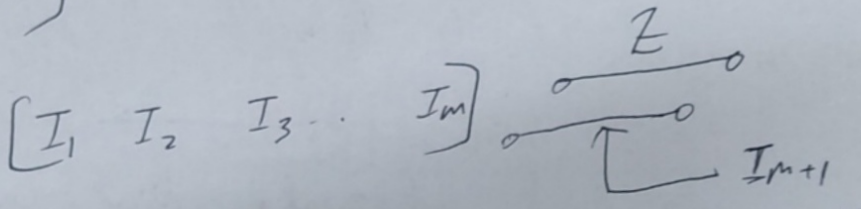
Why is it correct ?? Generally by Contradiction
my soln $I_1 \dots I_K$ is not optimal

There can be multiple optimal soln, we select one OPTIMAL which has maximum intervals common with our solution

fact
↳ let till $[I_1 \dots I_m]$ ↳ (m<K) common in OPT and my soln.

my soln next interval is I_{m+1}. which is different from OPTIMAL's $(m+1)^{th}$ let OPTIMAL has interval Z (at next) at $(m+1)^{th}$.

[All intervals which overlaps with $[I_1 \dots I_m]$ are not present in OPTIMAL and my soln either.]



I_{m+1} ends before Z, else my algo will pick Z. Since Z doesn't intersect with any intervals (right of it), I_{m+1} will also not intersect.

Thus, we get another OPTIMAL SOLUTION with I_{m+1}.
⇒⇐ (fact)