

Thm 3.2 (Landau). If vertex u has maximum score in a tournament (V, A) , then for all $v \in V$, either $(u, v) \in A$ or there exists $w \in V$ such that $(u, w) \in A$ and $(w, v) \in A$.

Or in other words if u has maximum score than for every other player v , either u beats v or u beats another player, w , who beats v .

Proof: Take $v \in V$.

Case 1: If $(u, v) \in A$, then the conclusion holds.

Case 2: Suppose $(u, v) \notin A$. Then we need to find $w \in V$ such that $(u, w) \in A$ and $(w, v) \in A$.

Suppose $s(u) = k$ and $\{w_1, \dots, w_k\}$ is the set of all vertices such that $(u, w_i) \in A$.

We need a j such that $(w_j, v) \in A$.

Proof by contradiction. Assume there does not exist a j such that $(w_j, v) \in A$.

Hence for all j , $(w_j, v) \notin A$.

Since (V, A) is a tournament, $(w_j, v) \notin A$ implies $(v, w_j) \in A$. [Thus $s(v) \geq k$].

Since (V, A) is a tournament, $(u, v) \notin A$ implies $(v, u) \in A$.

Thus $s(v) \geq k + 1 > s(u)$.

But this contradicts the hypothesis that u has maximum score.

Hence our assumption is wrong and there does exist a j such that $(w_j, v) \in A$.