Def.: An Condorcet method returns a Condorcet winner (i.e., a candidate that wins all pairwise comparisons to other candidates) if one exists, and some candidate, otherwise.

# Schulze Method

**Notation:** $d(X, Y)$ = number of pairwise comparisons won by $X$ over $Y$.

**Def.:** For candidates $X$ and $Y$, there exists a path $X = C_1, C_2, \ldots, C_n = Y$ of strength $z$ if

- $d(C_i, C_{i+1}) > d(C_{i+1}, C_i)$ for all $i = 1, \ldots, n-1$.
- $d(C_i, C_{i+1}) \geq z$ f.a. $i = 1, \ldots, n-1$, and $d(C_i, C_{i+1}) = z$ for <u>some</u> $i = 1, \ldots, n-1$.

Def.: Let $p(X, Y)$ be the maximal value $z$ such that there exists a path of strength $z$ from $X$ to $Y$, if such a path exists, and 0, otherwise.

Then the Schulze winner is the Condorcet winner, if it exists. Otherwise, a potential winner is a candidate $a$ with $p(a, X) \geq p(X, a)$ f.a. $X \neq a$.

Tie-Breaking to select pot. winner as Schulze winner.

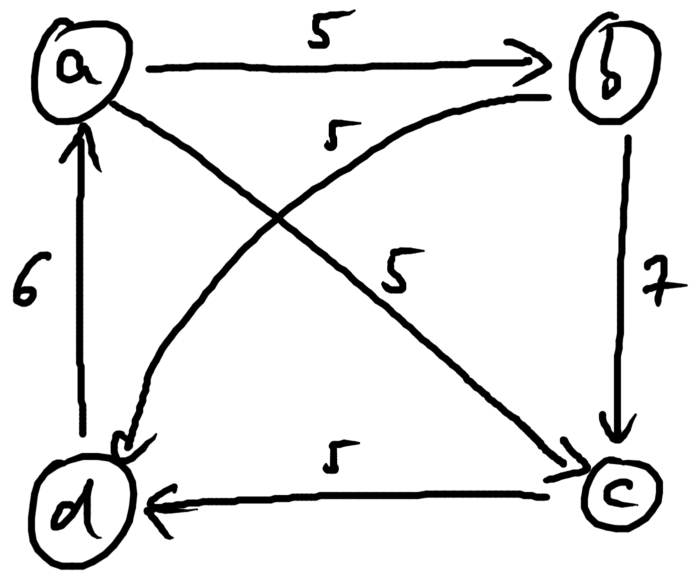
Example:

| # voters | 3 | 2 | 2 | 2 |
| --- | --- | --- | --- | --- |
| 1st | a | d | d | c |
| 2nd | b | a | b | b |
| 3rd | c | b | c | d |
| 4th | d | c | a | a |

Condorcet winner:

a? no, loses to d.
b? no, loses to a.
c? no, loses to b.
d? no, loses to c.

no C. winner!



$d(a,b) = 5$

$d(b,a) = 4$

potential winners:

b, d

$p(X,Y)$:

| | a | b | c | d |
|---|---|---|---|---|
| ~~a~~ | | ~~5~~ | ~~5~~ | ~~5~~ |
| b | 5 | | 7 | 5 |
| ~~c~~ | ~~5~~ | ~~5~~ | | ~~5~~ |
| d | 6 | 5 | 5 | |