Approximation Ratio

If I'm trying to find the minimum vertex cover, then to have a 2-approximation, I need to show:

If I'm trying to find the maximum clique, then the have an n-approximation, I need to show:

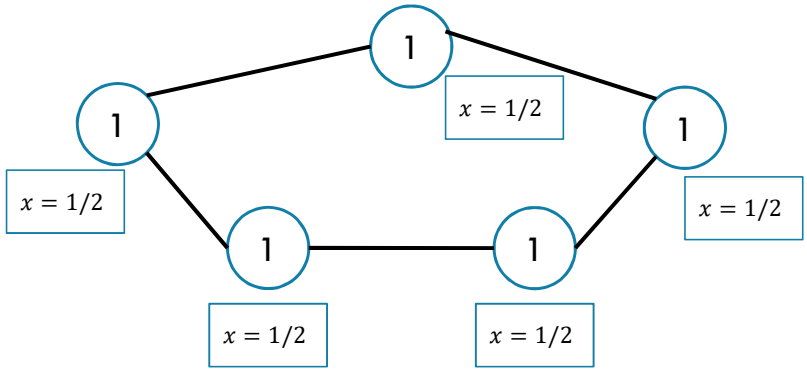
Summary

Coping with NP-hardness.

1. Understand your problem really well (make sure you're not solving an easy special case).
2. Prove the problem really is NP-hard.
3. Try a band-aid (SAT library, Integer programming library, etc.)
4. Try to find a good-enough exponential time algorithm or an approximation algorithm.

Non-Bipartite

What if our original graph isn't bipartite?



The LP finds a fractional vertex cover of weight 2.5

There's no "real"/integral VC of weight 2.5. – lightest is weight 3.

There's a "gap" between integral and fractional solutions.

So, what if the graph isn't bipartite?

Big idea:

Just round!

If $x_u \geq \frac{1}{2}$, round up to 1.

If $x_u < \frac{1}{2}$, round down to 0

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Minimize $\sum w(u) \cdot x_u$
Subject to:
$x_u + x_v \geq 1$ for all $(u, v) \in E$
$0 \leq x_u \leq 1$ for all u.

Two questions – is it a vertex cover? How far are we from the true minimum?