

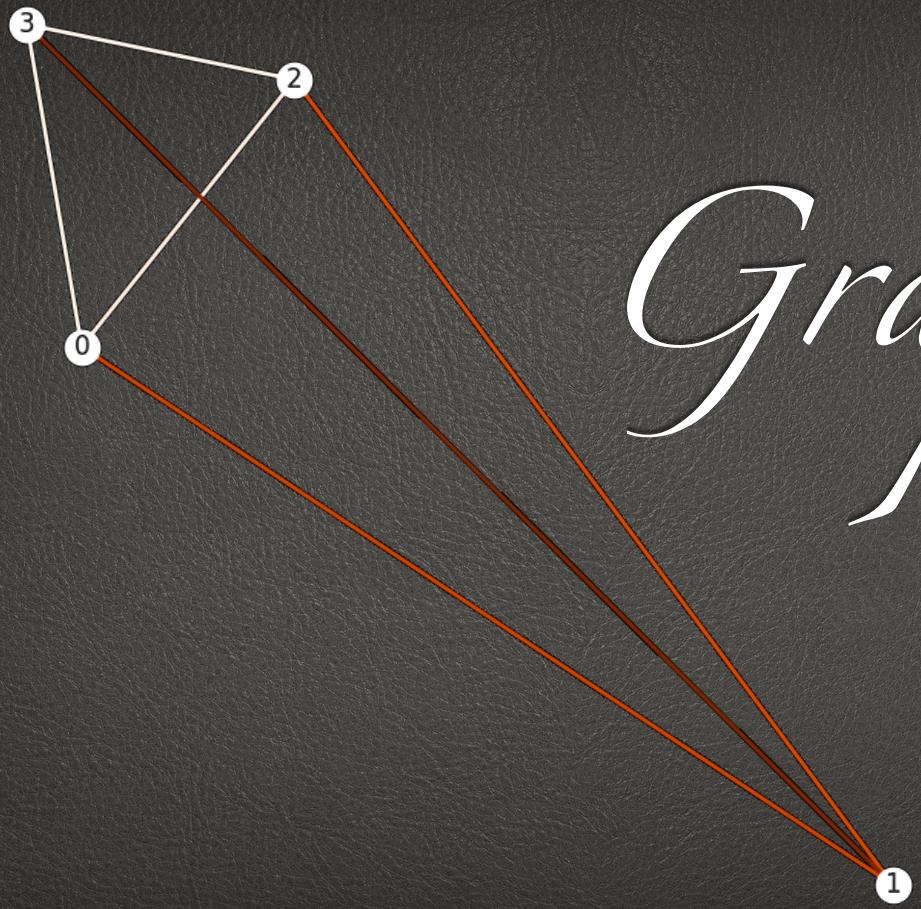
Solving hard problems

a hands-on case study

Solving hard problems

a hands-on case study

No previous knowledge required

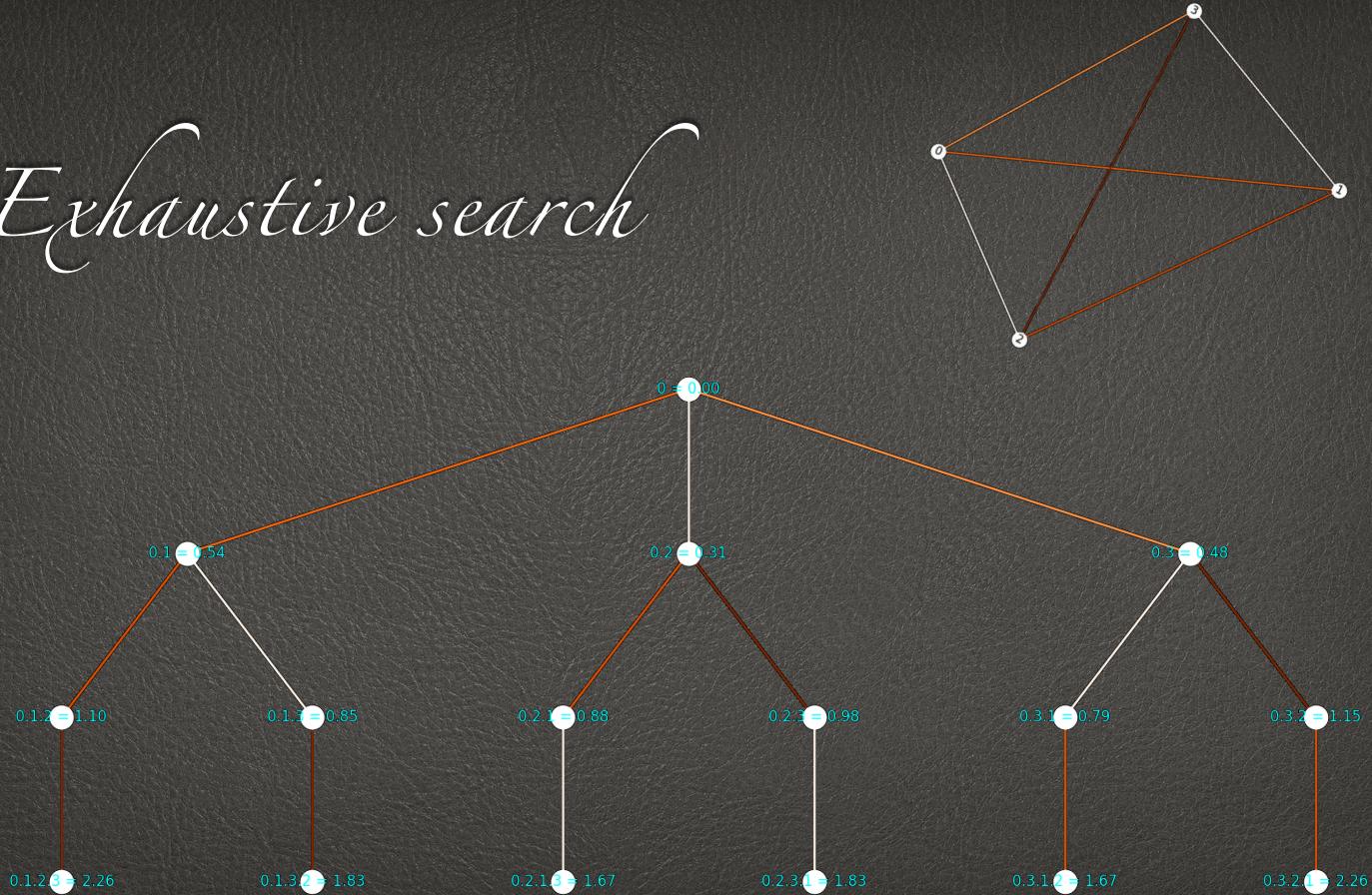


Graph

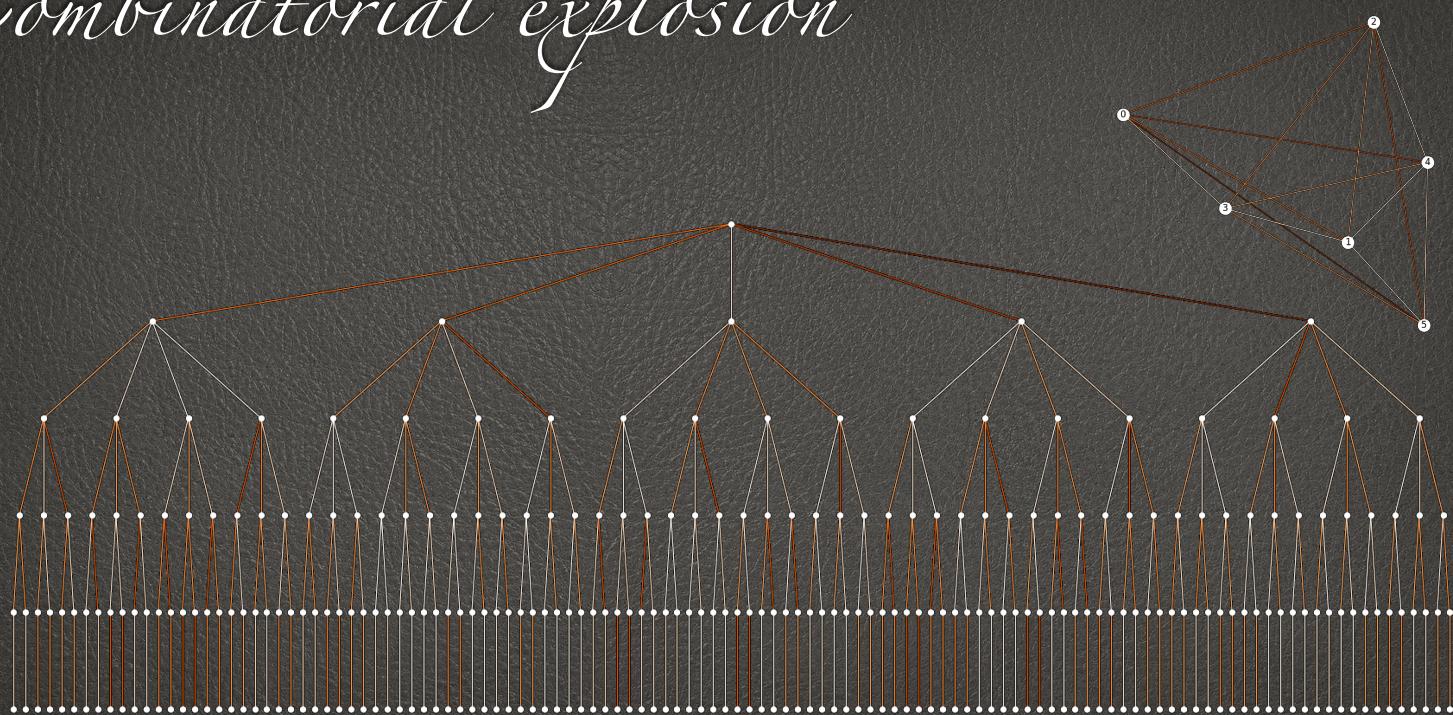


TRAVELLING SALESPERSON PROBLEM

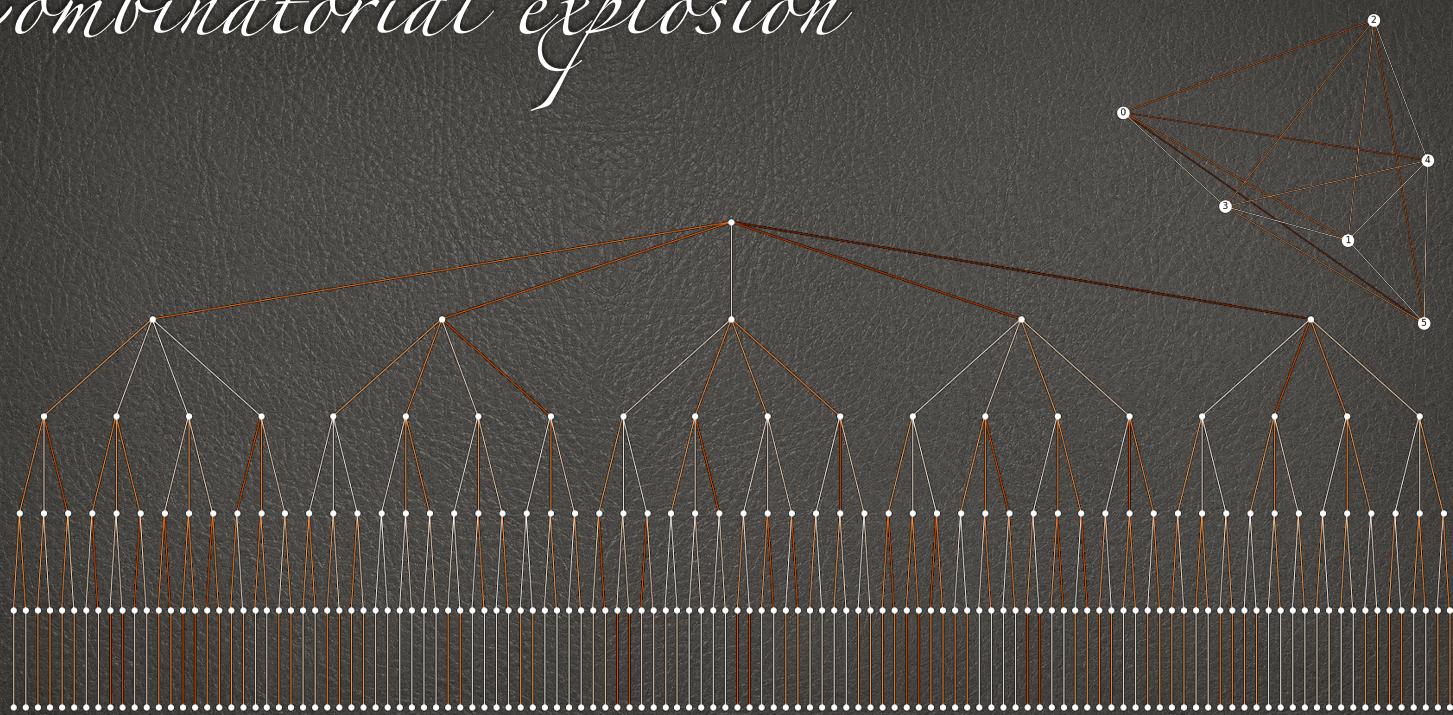
Exhaustive search



Combinatorial explosion

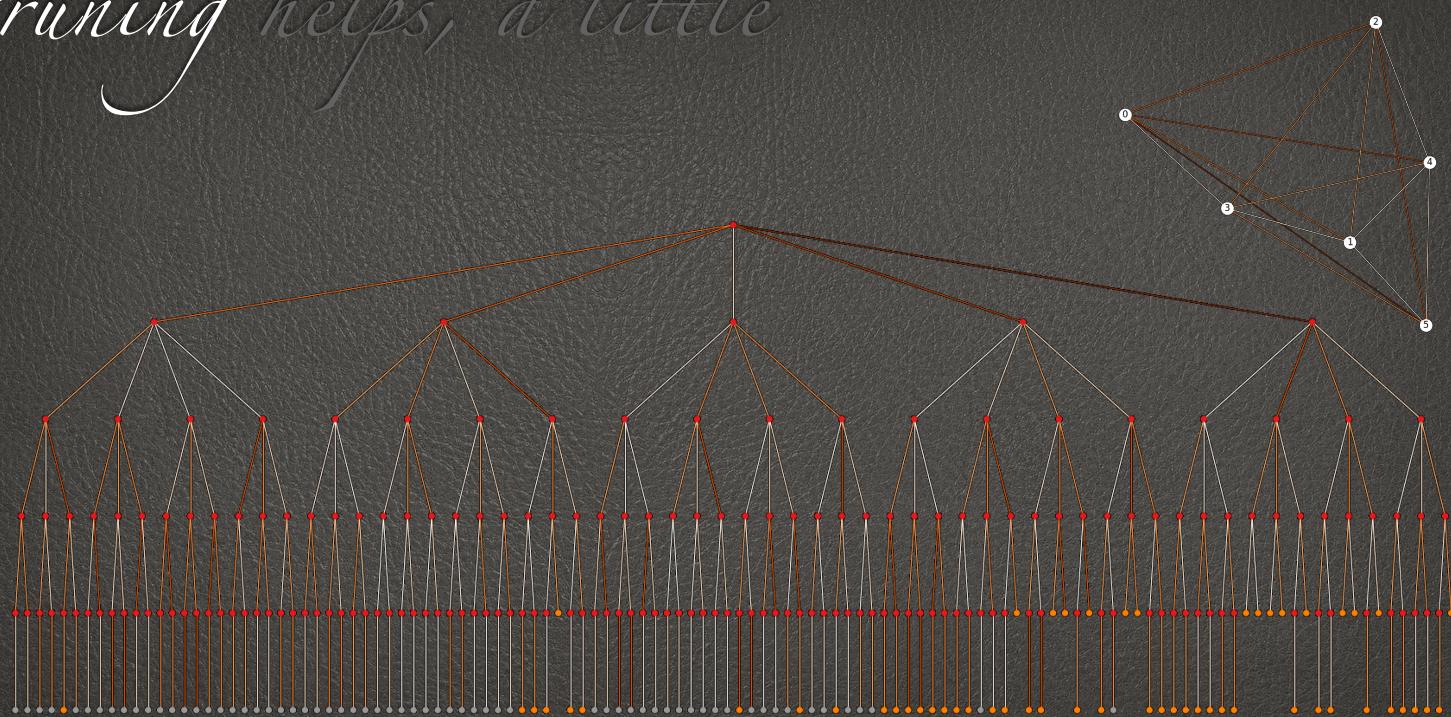


Combinatorial explosion



With just six 🐱

Pruning helps, a little



With just six 🐱

Global optimum

| n | Exhaustive | Pruned |
|-----|----------------------|----------------------|
| 8 | 88 | 30 |
| 9 | 825 | 264 |
| 10 | 9021 | 1371 |
| 11 | <i>lost patience</i> | 3234 |
| 12 | <i>lost patience</i> | 23815 |
| 13 | <i>lost patience</i> | <i>lost patience</i> |

Global optimum

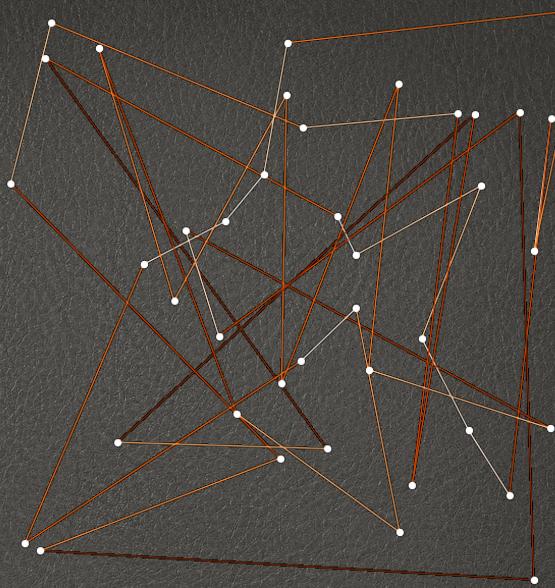
Example runtime in milliseconds

| n | Exhaustive | Pruned |
|-----|----------------------|----------------------|
| 8 | 88 | 30 |
| 9 | 825 | 264 |
| 10 | 9021 | 1371 |
| 11 | <i>lost patience</i> | 3234 |
| 12 | <i>lost patience</i> | 23815 |
| 13 | <i>lost patience</i> | <i>lost patience</i> |

😺 Nothing can produce a lower cost

Those trees grow too big 😓

*Replicas of
self-avoiding random walks*

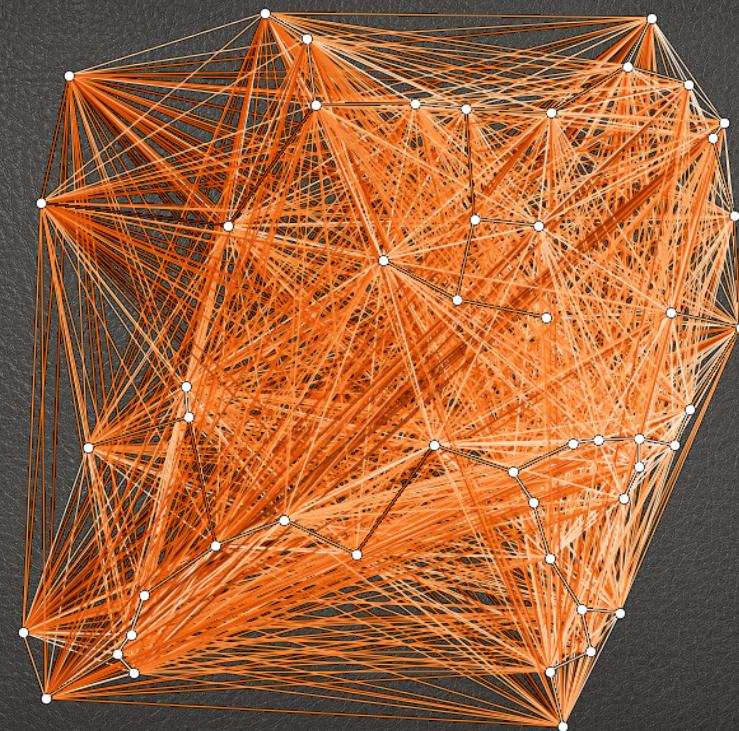


*Replicas of
self-avoiding random walks*

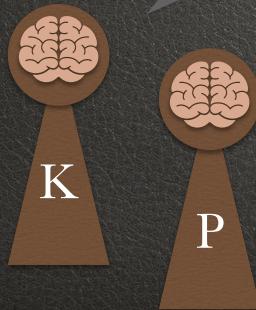
😺 Super fast even for large graphs

No guarantee of optimality 🐾

WHAT ELSE CAN WE DO THAT IS FAST TO COMPUTE?

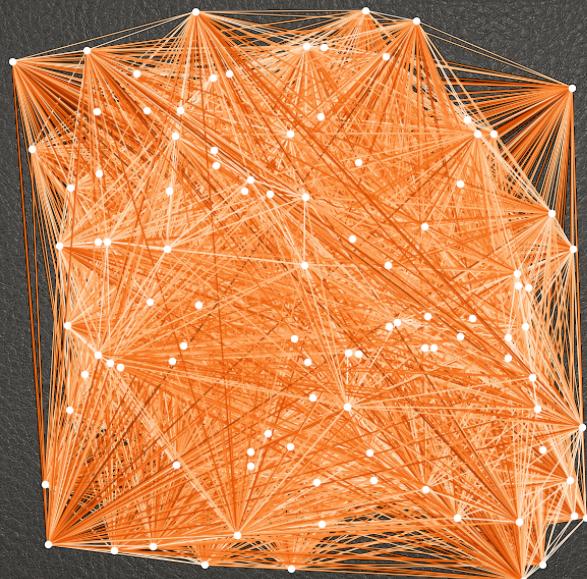


WHAT ELSE CAN WE DO THAT IS FAST TO COMPUTE?

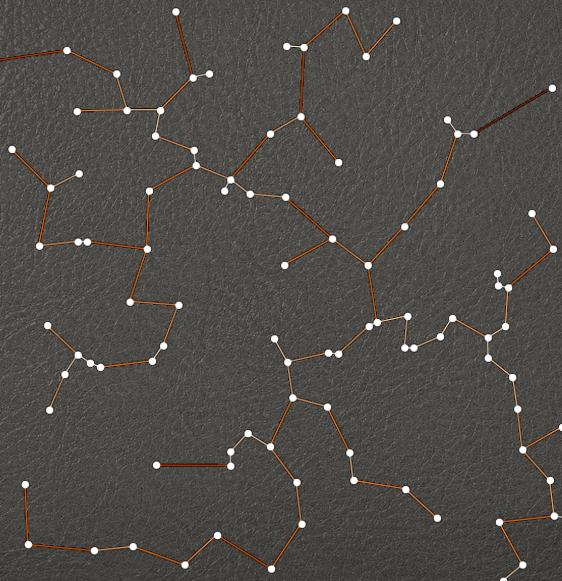
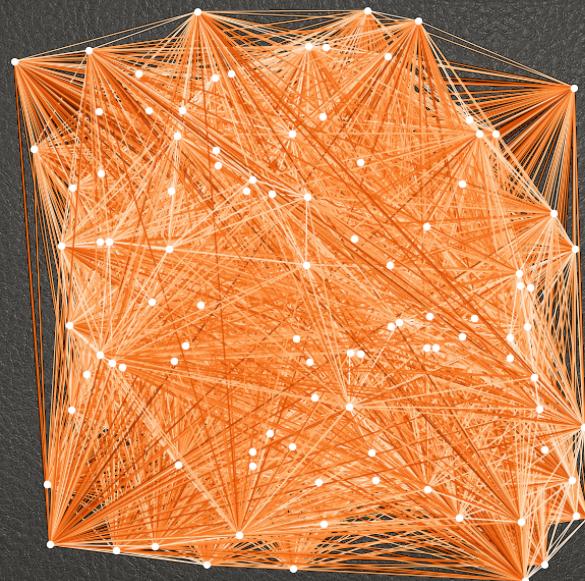


That's not a cycle, fellas 😺

Minimum spanning tree

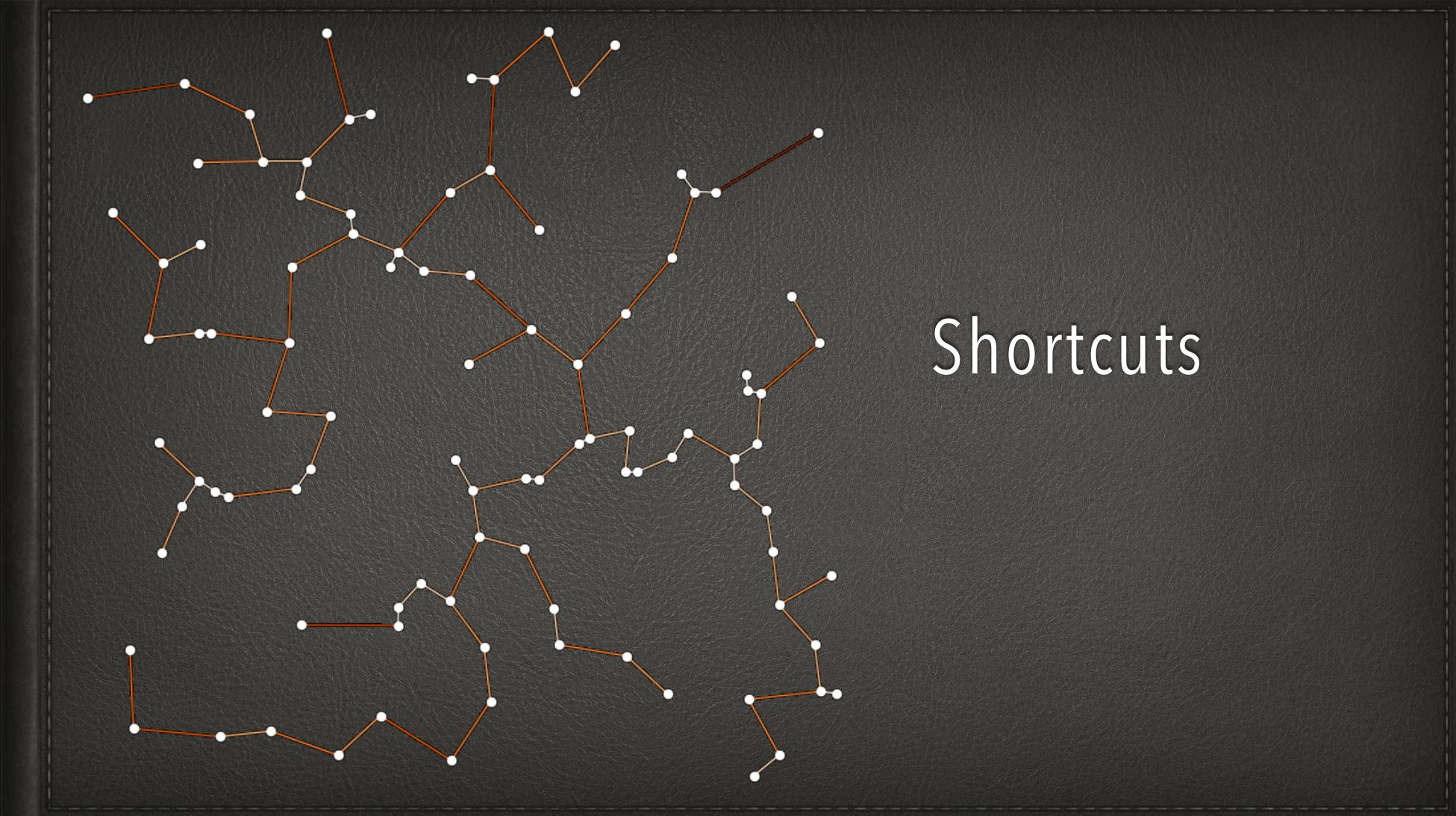


Minimum spanning tree

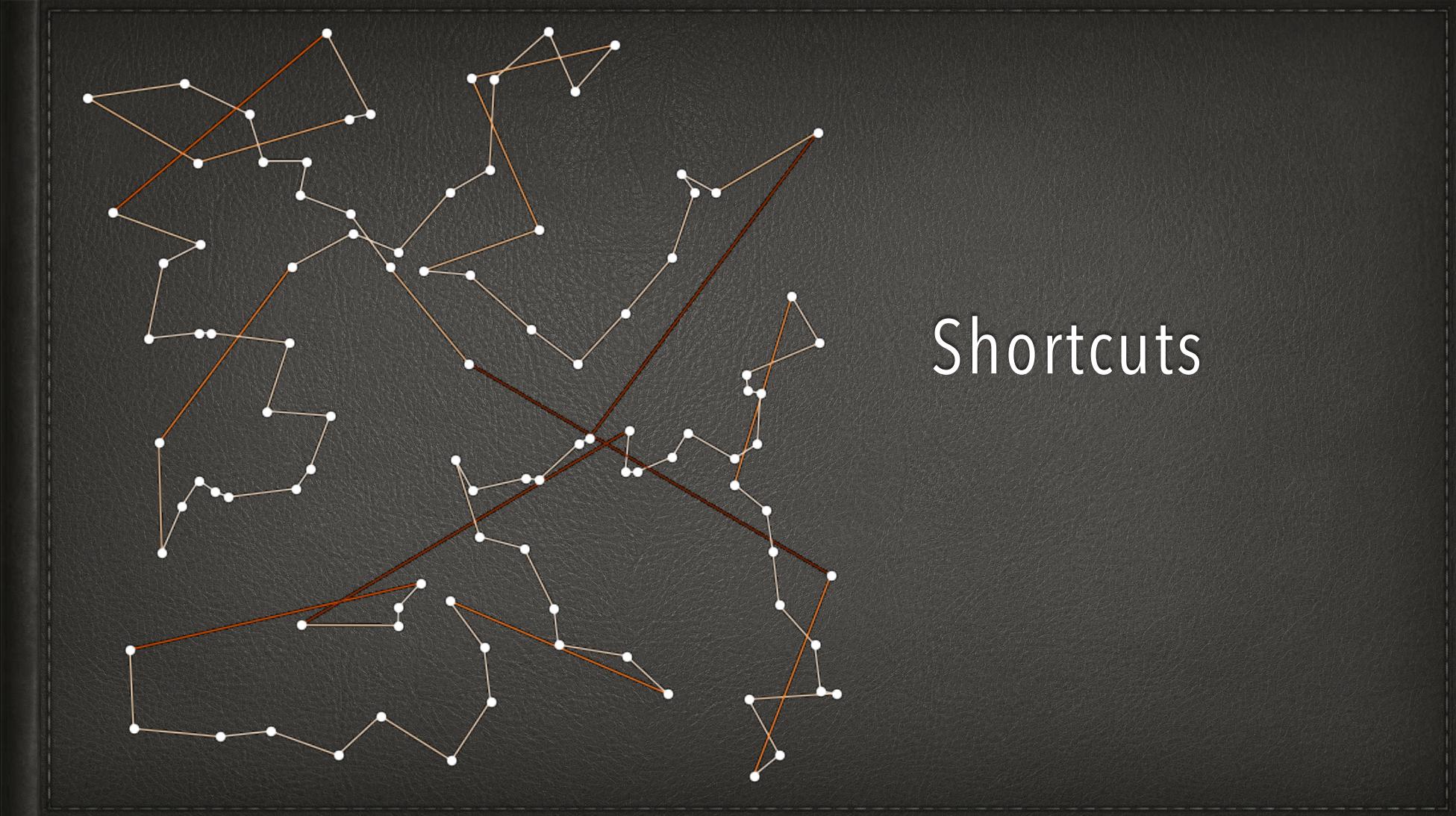


😺 This is quick to build and we can traverse it back and forth with a cost at most twice the optimum

That's a cycle, yes, but it is still infeasible 😞

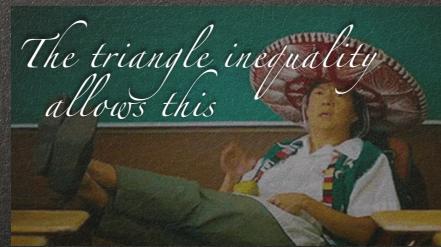


Shortcuts



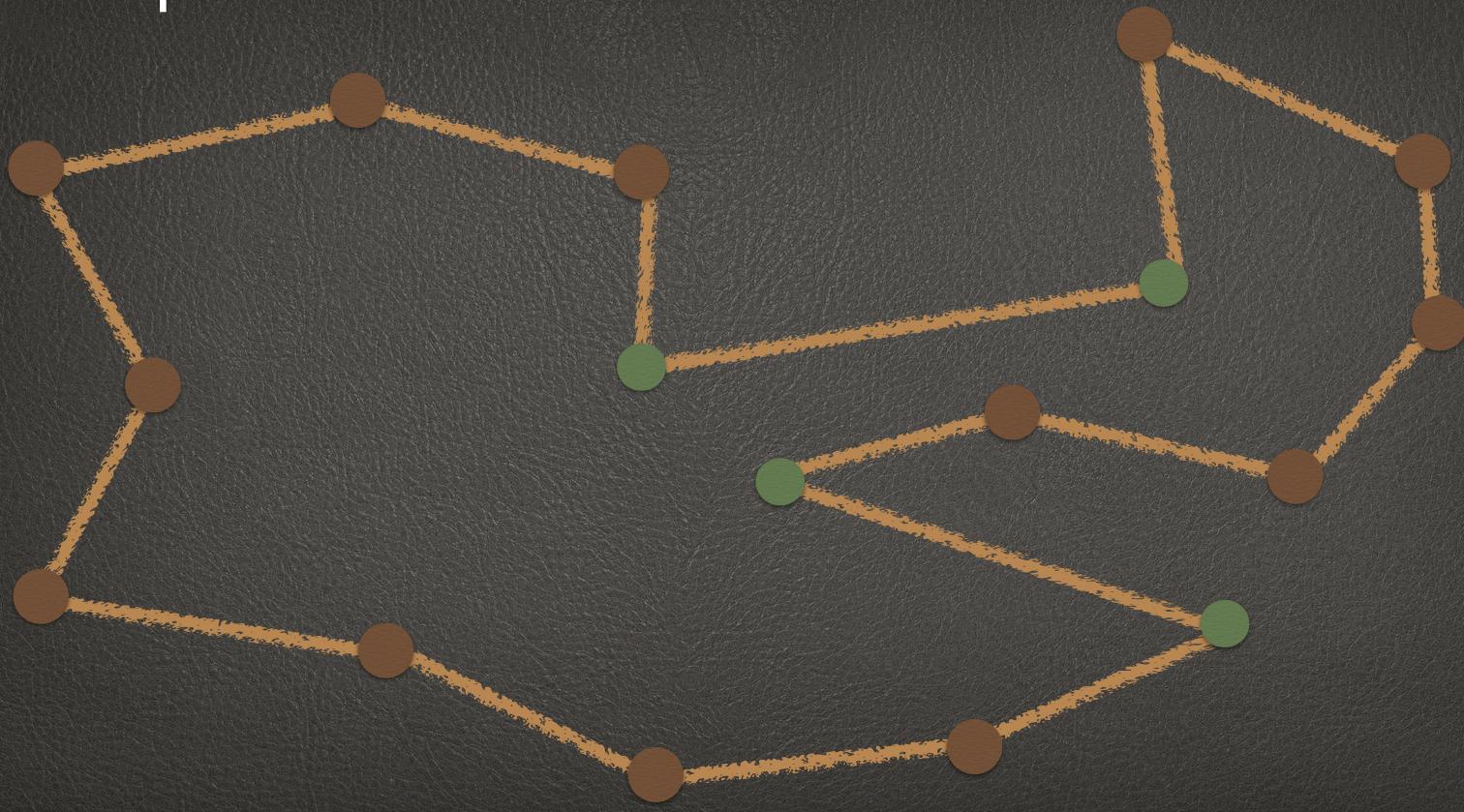
Shortcuts

Shortcuts

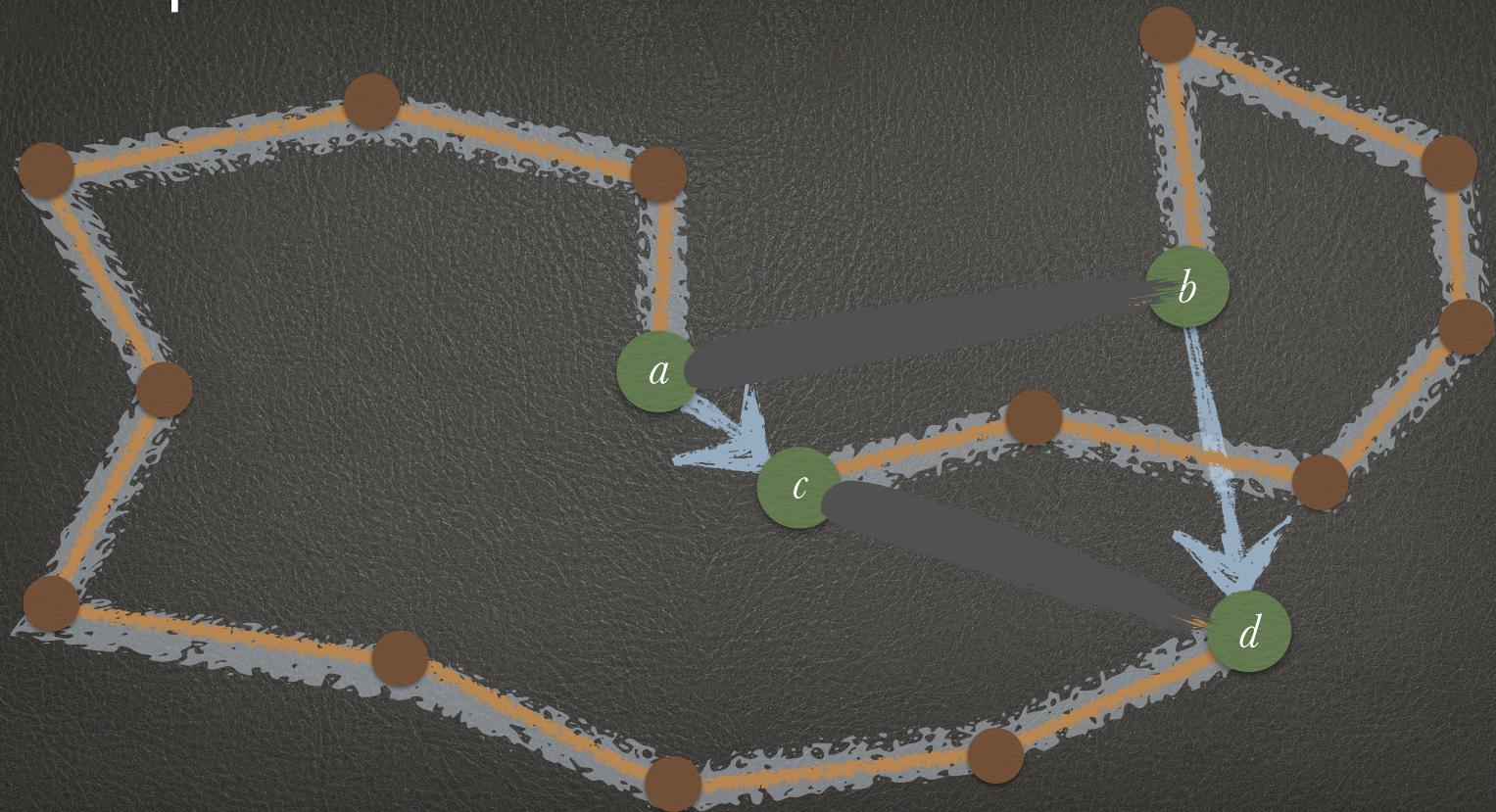


*The triangle inequality
allows this*

2-opt



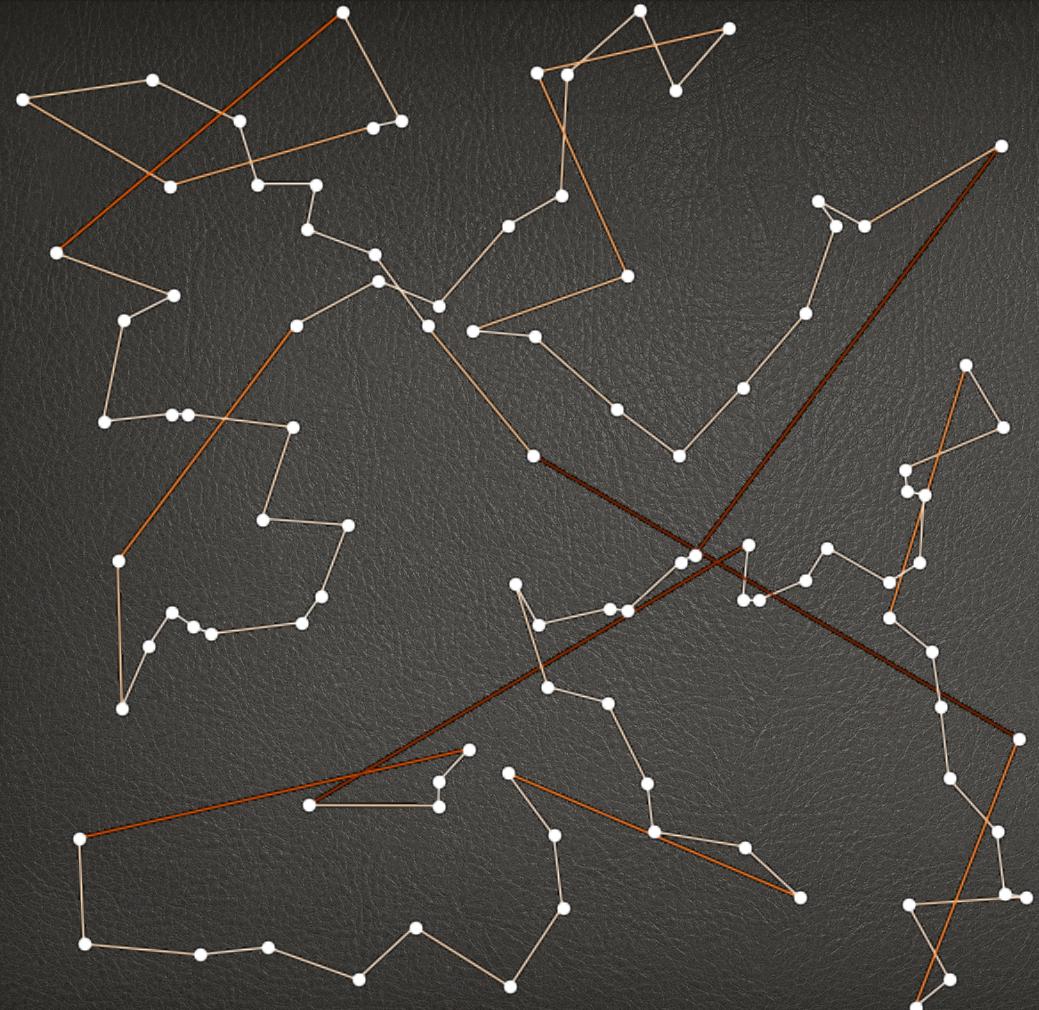
2-opt



😺 That could be cheaper than before

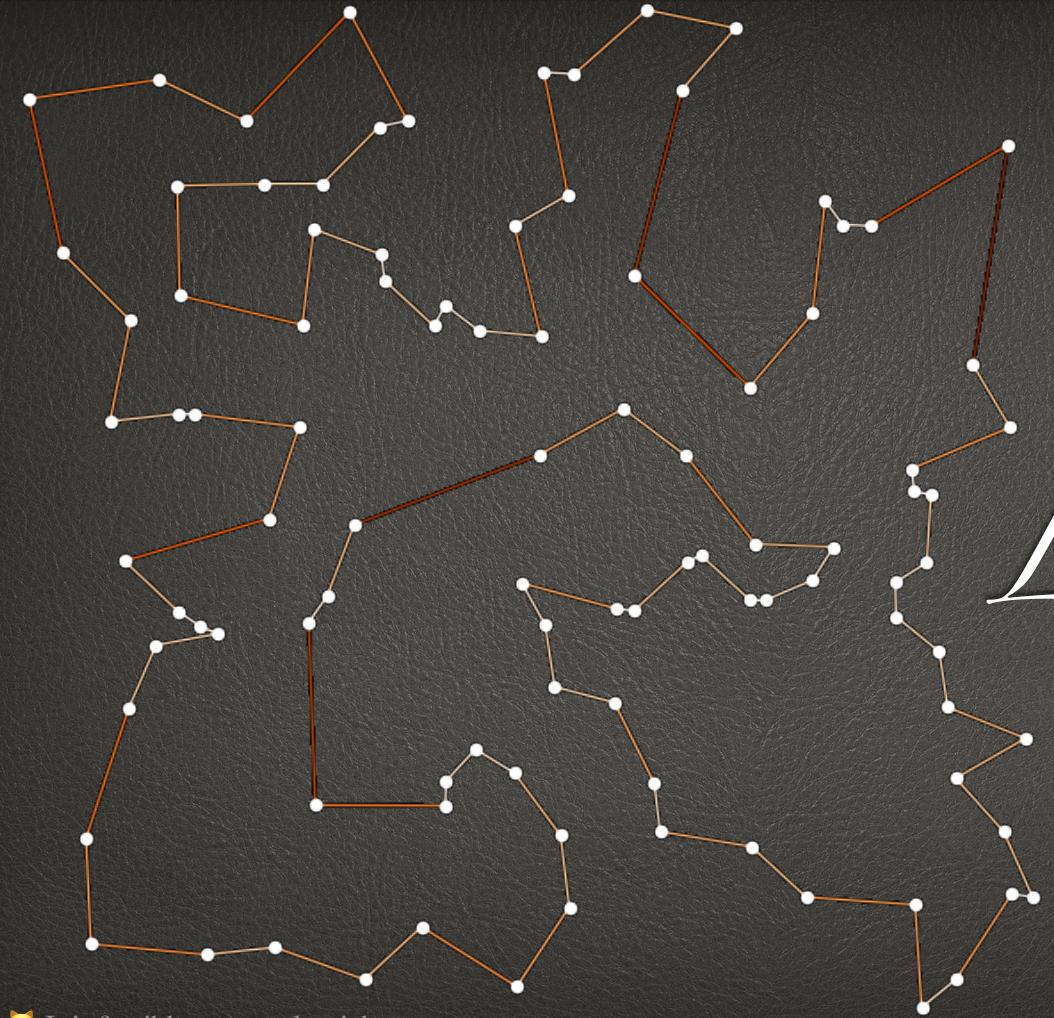
This was obviously never an MST, but just bear with me





😺 It is feasible now and quick to compute

Those shortcuts are not all that short 😺



Local search

😺 It is feasible now and quick to compute

Those shortcuts are not all that short 😺



*Simulated
annealing*



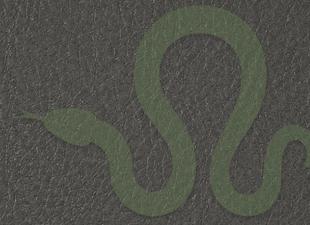
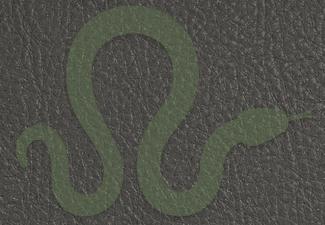
Simulated annealing

😺 Run it as long as you like

Those parameters, thou 🐱



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