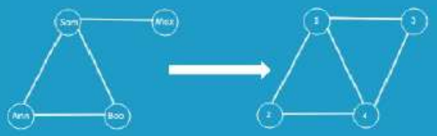
A Constraint Programming Approach to Optimal Network Anonymization

Andrei Ionita   Supervisor: Anna L.D. Latour

Problem scenario

We are trying to make network data public and free to use. To do so, we need to ensure the privacy of the represented individuals by **anonymizing our networks.**



The **goal** is to alter the original graph as little as possible, so that future analysis and studies are realistic and provide useful results.

Preliminaries

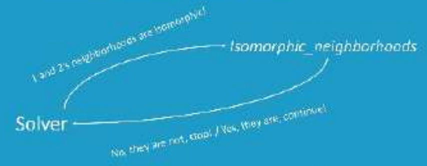
- Attacker's knowledge: *1*-neighborhoods of each node
- ***k*-anonymity**: each node has at least k-1 equivalent nodes
- Node equivalence: two nodes having isomorphic *1*-neighborhoods

- **Constraint programming**: model the problem using a declarative language
- We model the problem's characteristics through **constraints**

Imperative programming
Declarative programming
MAKE A SOUP FOLLOWING THESE EXACT STEPS: 1. BOIL WATER INSIDE A PAN. 2. CUT AND ADD VEGETABLES 3. ADD BROTH
MAKE ME A SOUP

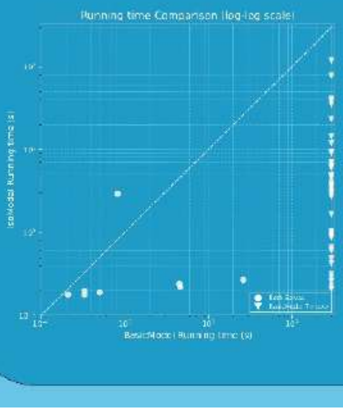
Methodology

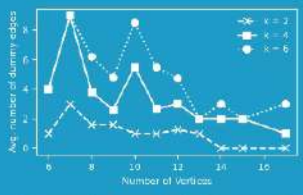
- Initially, simple CP model (BasicModel) - heavily limited by the graph size (n<7)
- Novel *isomorphic_neighborhoods* constraint that checks neigborhood isomorphisms:


1 and 2's neighborhoods are isomorphic!
Isomorphic_neighborhoods
Solver
No, they are not, stop! / Yes, they are, continue!

- We compared BasicModel against a model using our new constraint (IsoModel)

Results





Influence of the anonymization factor *k* over the anonymization cost

- IsoModel outperforms BasicModel in terms of running time
- Our solution is optimal and feasible for small (n<20) or highly dense graphs
- Increasing *k* leads to an increase in anonymization cost ⇒ higher graph alteration

Conclusions and Future Work

- Our approach can be used to guarantee fully-anonymized graphs that are as close to the original as possible
- Users can easily tweak the model for their specific problem definition

- Currently, our solution can only be used on small graphs
- New constraints ⇒ future improvements in the form of custom propagators