



# Visualization for Explanations in Decision Support

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## Summary

**Goal:** Support reasoning and explanation in intelligent decision making, and foster creativity.

**Task:** Design visualizations that summarize the behavior of problem-solving algorithms, strategies, and heuristics in the context of solving combinatorial decision problems using Constraint Processing.

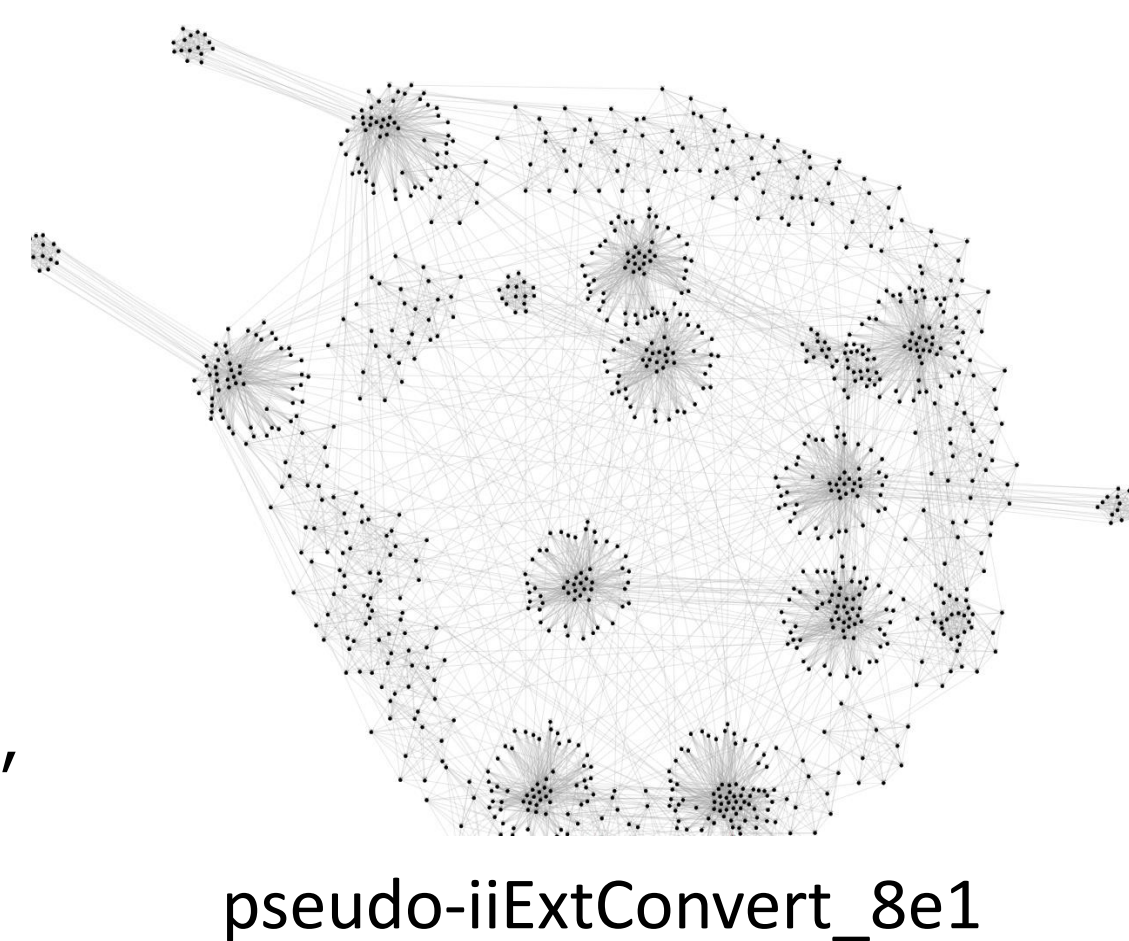
### Contributions:

1. We Developed a web interface to retrieve information about problem instances and generate various visualizations reflecting problem-solving performance on these instances. Visualization are linked to experiment-specific metrics, allowing the tool and visualizations to evolve with ongoing research.
2. Our work allowed the development of a new heuristic, MaxClique, which demonstrated superior preliminary performance.

## Motivation

Our web interface displays large graphs revealing their structure and connectivity.

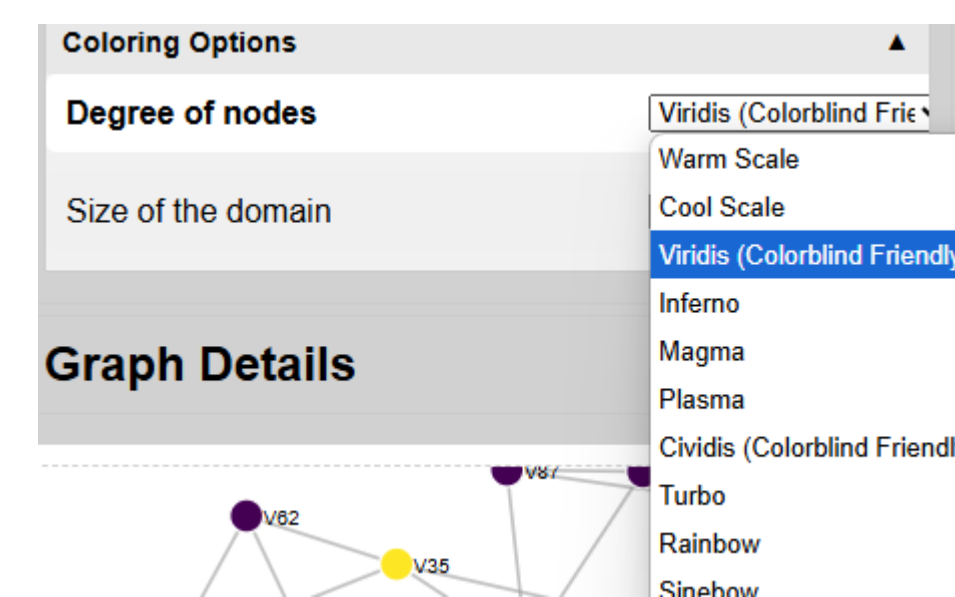
Overlaying the operations of an algorithm on the graph structure reveals bottlenecks and inspires new solving techniques, strategies, and heuristics.



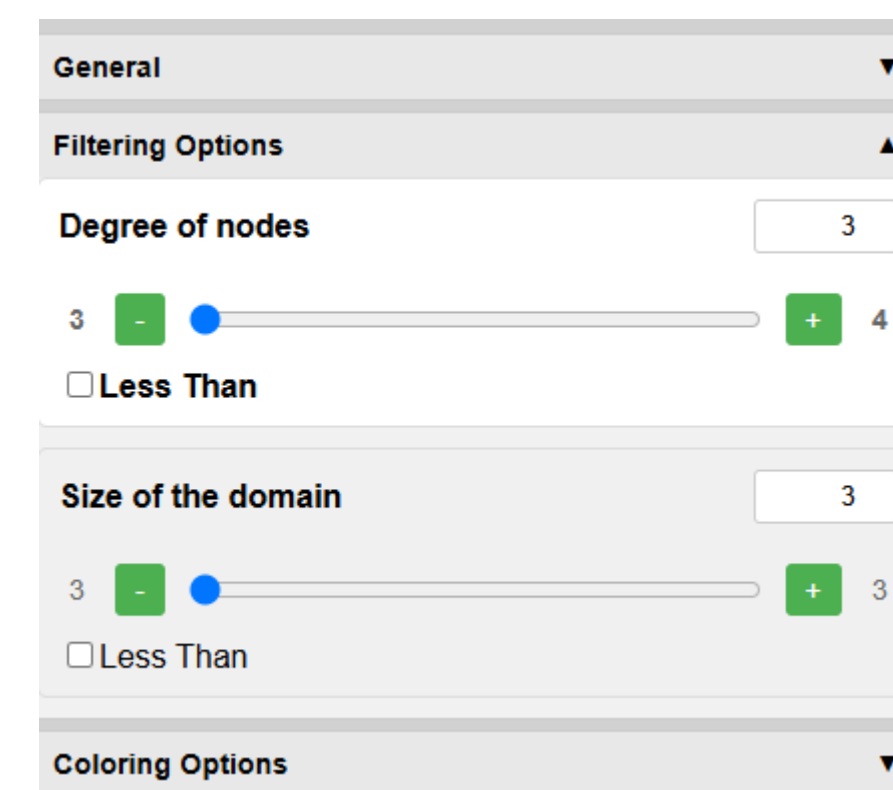
## Controlling Visualizations



General viewing options, and freeze nodes to stop force simulation.



Color options derived from provided metrics data, with support for accessibility.



Filtering options relative to the instance and metrics data provided.

### Graph Information

Benchmark: graphColoring-mugExtConvert  
Instance: normalized-mug88-1-3-ext

- Number of Constraints: 146
- Number of Variables: 88
- Graph Density: 3.81%
- Average Degree: 3.32
- Maximum Degree: 4

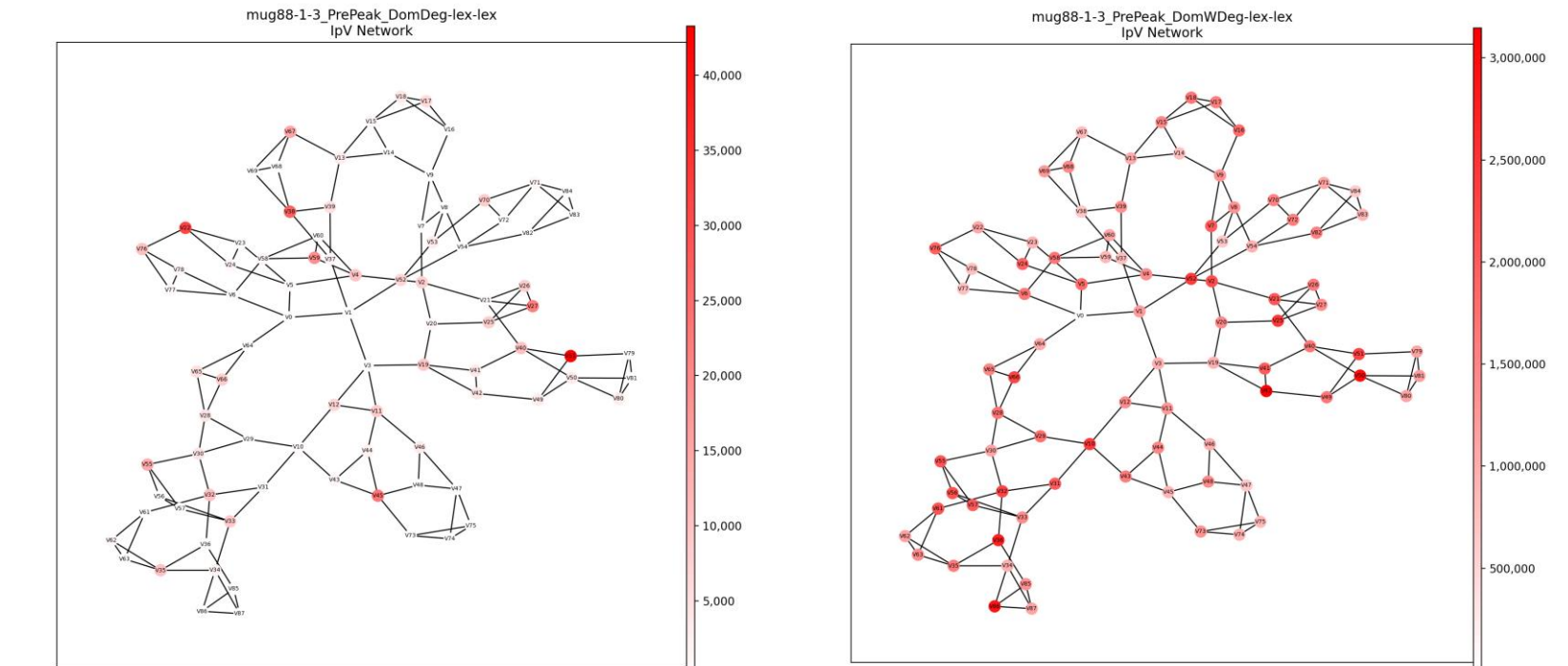
General data about considered instance.

V66  
Domain Size: 3  
Degree: 3

Displays metrics available per node

## Revealing Bad Performance

DomWDeg is the facto standard for variable ordering, but it sometimes degenerates. Displaying the activity of DomWDeg and DomDeg on the vertices the constraint network reveals how DomWDeg loses time while DomDeg focuses on 'key' vertices.



## MaxClique Heuristic

We designed MaxClique as a pre-filter to DomWDeg. It significantly improving performance by prioritizing vertices that appear in the largest number of maximal cliques of the constraint network.

Algorithm	APOAC						PrePeak with POAC					
	#Solved			CPU Time [sec]			#Solved			Time (#cycles/2.9 Ghz)		
Benchmark (#Instances)	dd	dwd	mcClq	dd	dwd	mcClq	dd	dwd	mcClq	dd	dwd	mcClq
graphColoring-mug (8)	8	6	8	4,926.7	16,371.0	<b>2,835.3</b>	8	7	8	266.1	15,964.6	<b>37.0</b>
jobShop-e0ddr1 (10)	3	4	<b>6</b>	56,557.6	54,428.4	<b>35,555.2</b>	4	5	<b>7</b>	50,301.8	44,347.3	<b>25,306.0</b>
jobShop-e0ddr2 (10)	4	4	<b>8</b>	59,880.9	59,786.6	<b>32,803.3</b>	4	5	<b>8</b>	50,250.6	48,513.3	<b>16,704.1</b>
jobShop-enddr2 (6)	3	3	<b>6</b>	35,340.4	35,344.9	<b>22,176.2</b>	3	3	<b>6</b>	25,183.4	25,185.9	<b>163.6</b>
pseudo-fpga (21)	0	3	<b>20</b>	174,301.7	157,065.4	<b>9,241.5</b>	0	3	<b>20</b>	176,697.1	154,991.1	<b>8,846.8</b>

## Future Work

- Develop 'fisheye' views on the constraint network
- Develop tools to view and animate search performance along time (e.g., history of regimes [1]).

[1] I.S. Howell, B.Y. Choueiry, and H. Yu "Visualizations to Summarize Search Behavior," Proc. CP 2000, pp. 392–409.

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