How we search for symmetry by breaking it

Rebecca Waldecker and Wilf Wilson
University of Halle-Wittenberg

Forum “Experiment!” 2019

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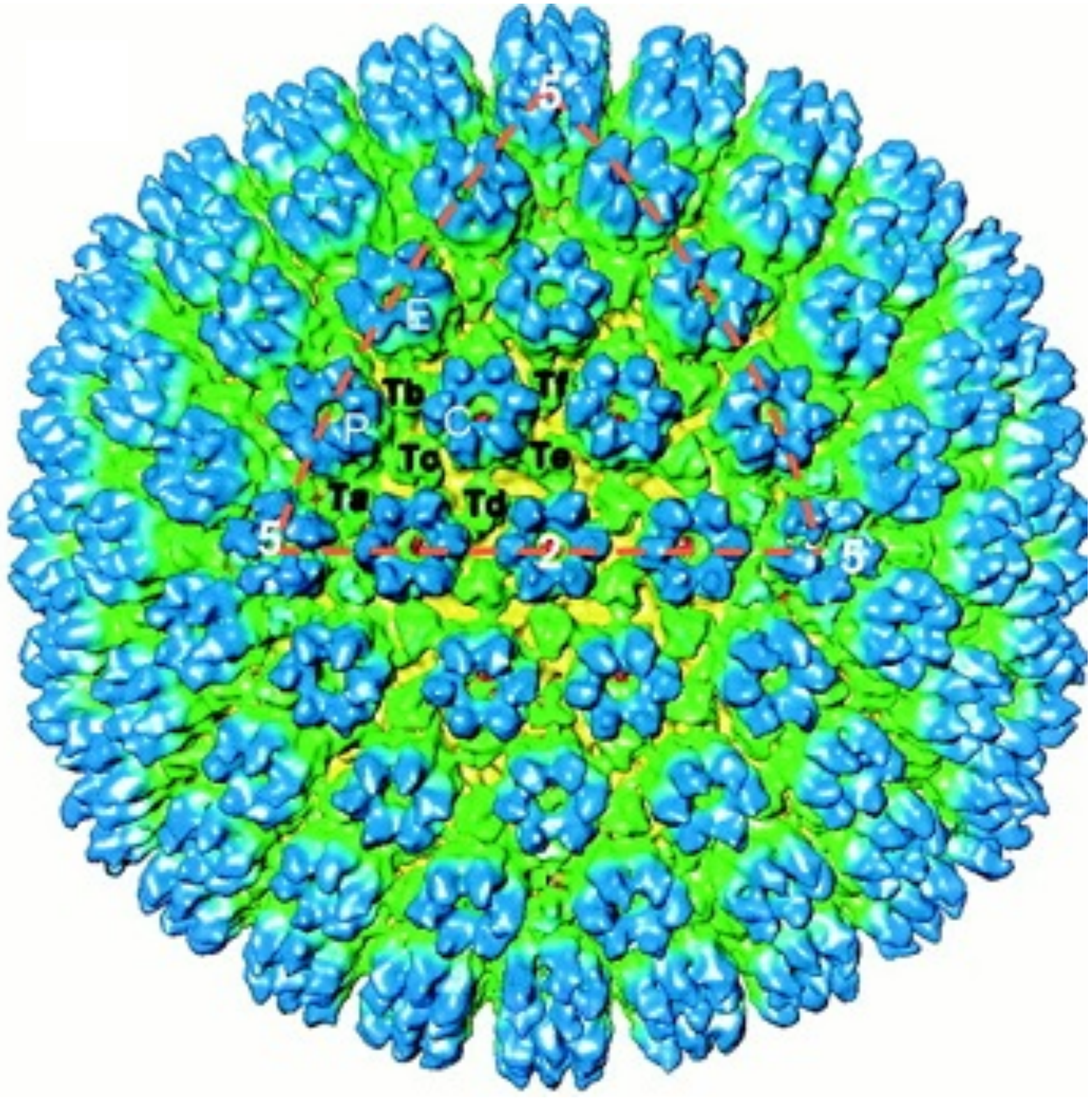
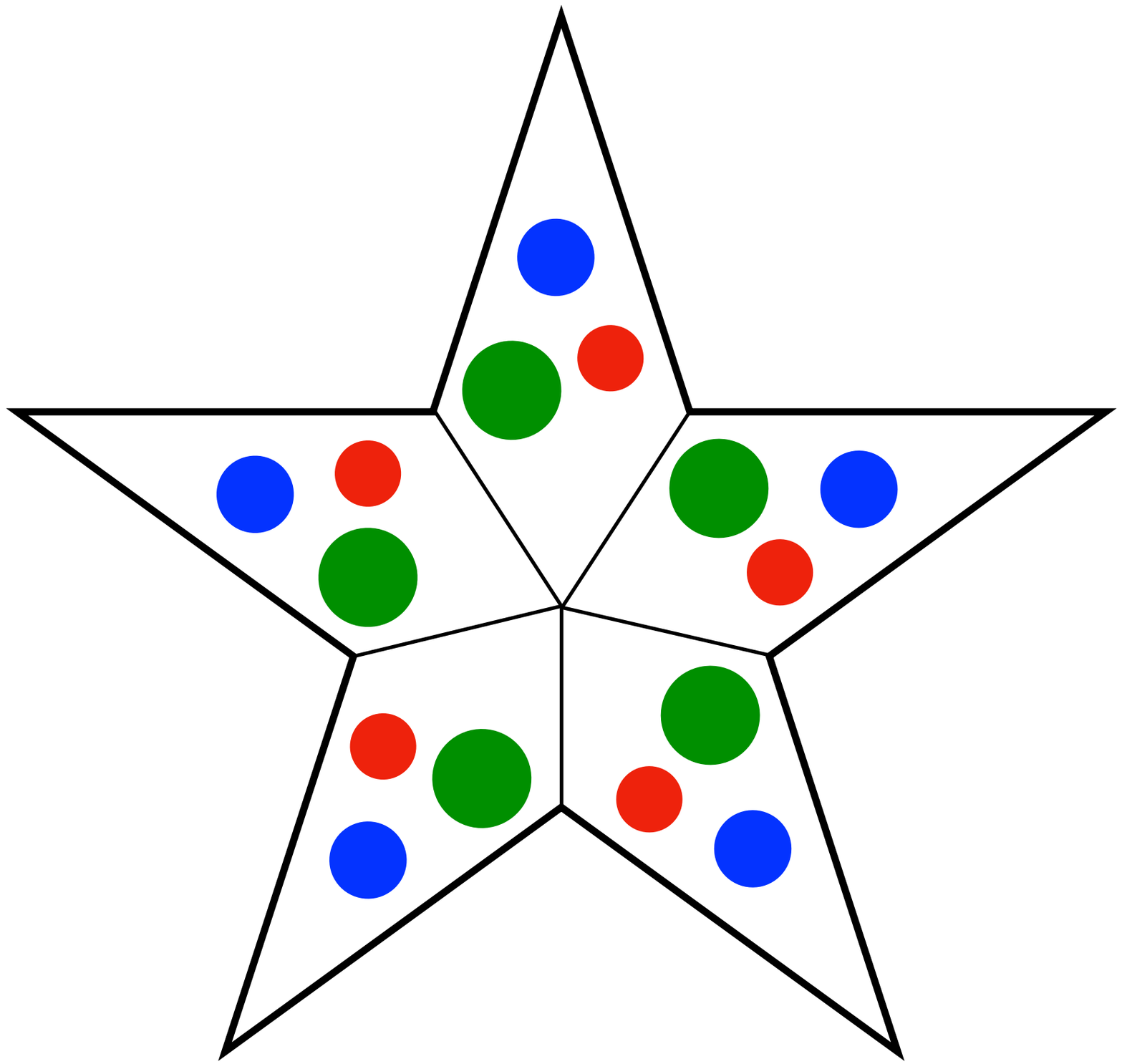


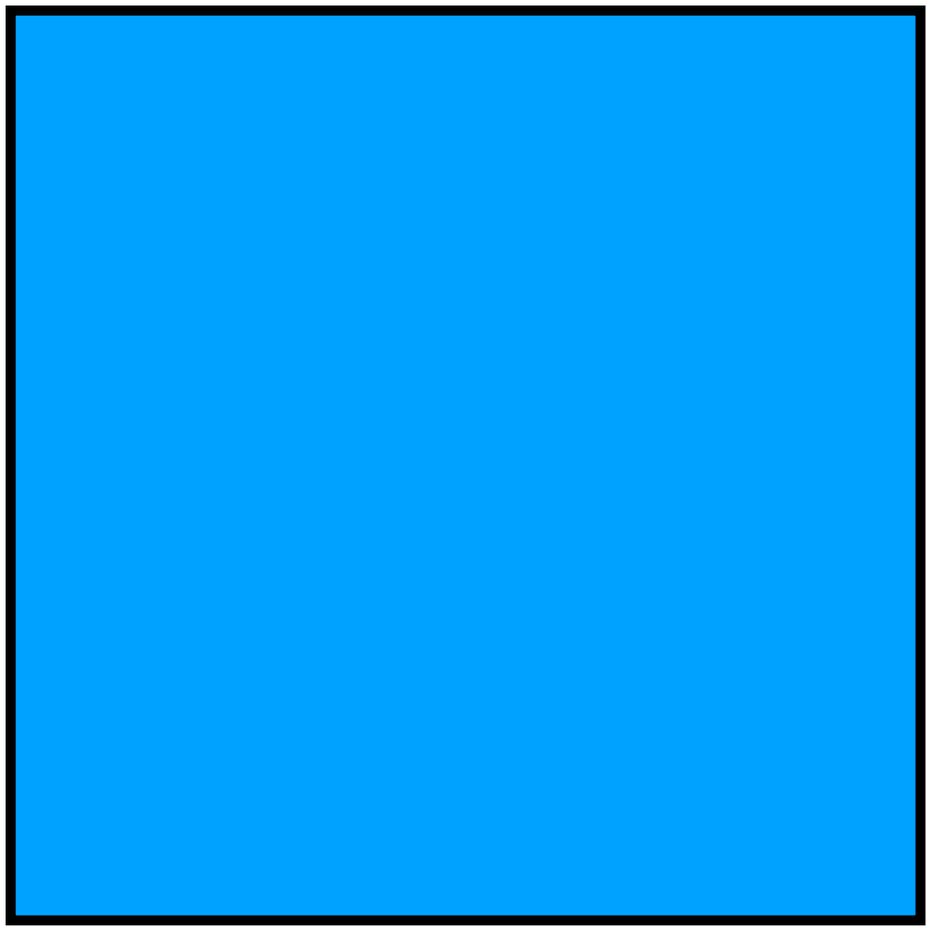
Three-Dimensional Structure of the Human Herpesvirus 8 Capsid (Journal of Virology 2000) by Lijun Wu, Pierrette Lo, Xuekui Yu, James K. Stoops, B. Forghani, and Z. Hong Zhou.

How many circles?



Symmetry with permutations

The symmetries of a square



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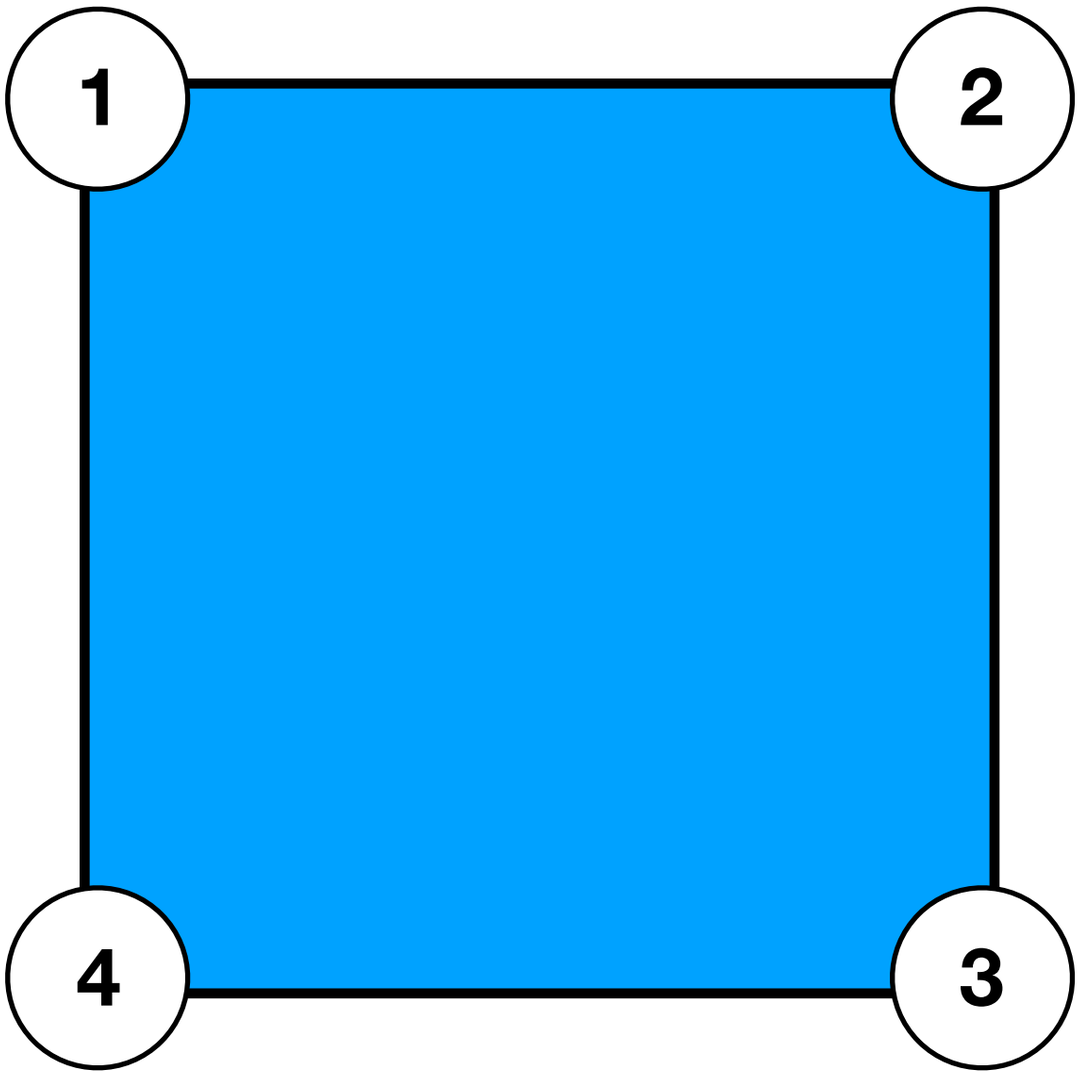

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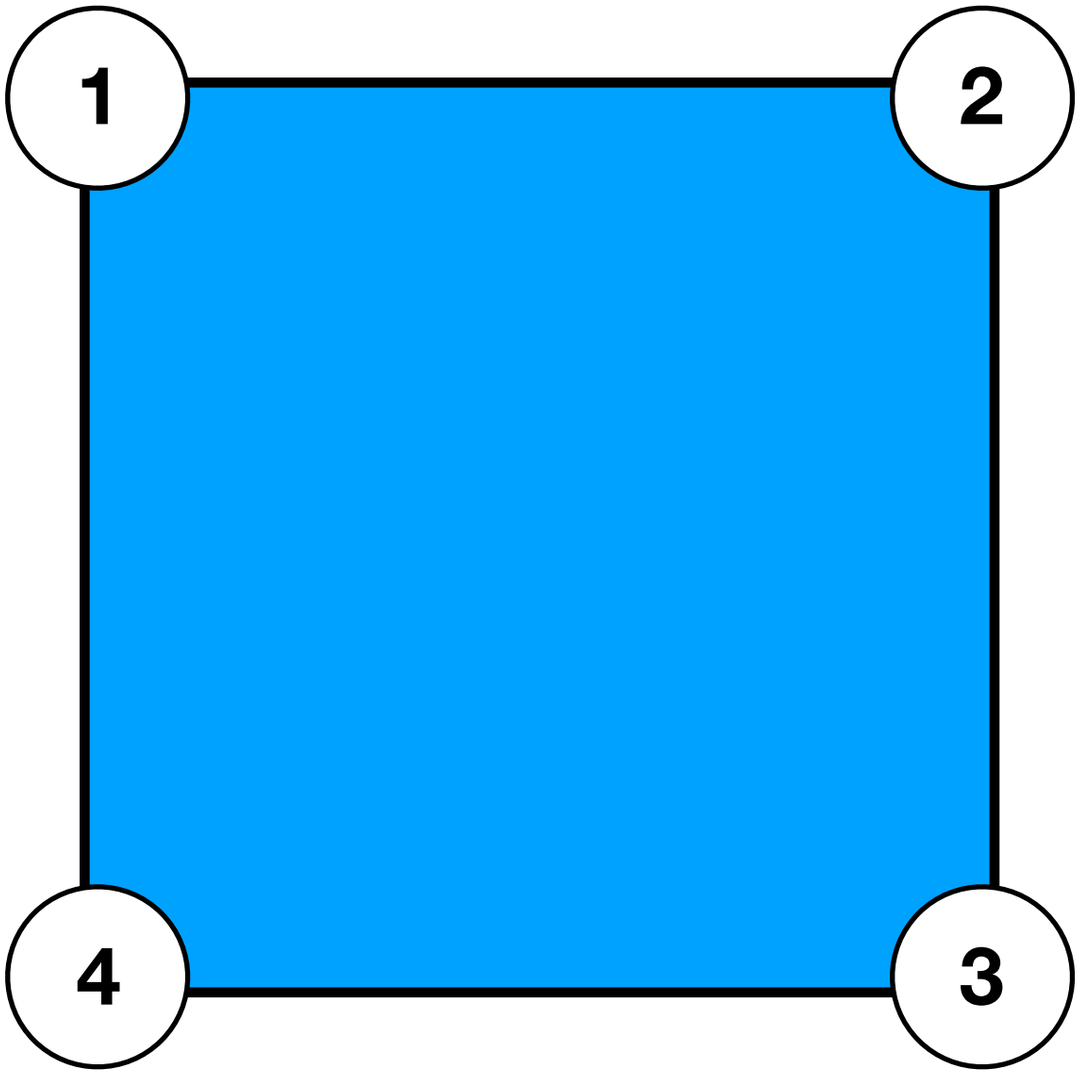

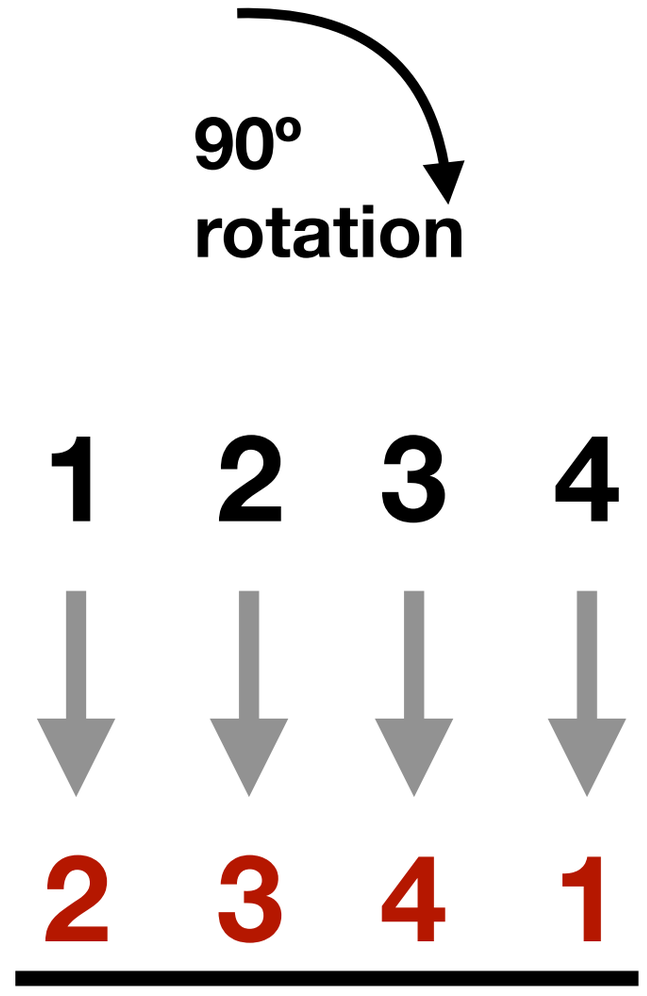

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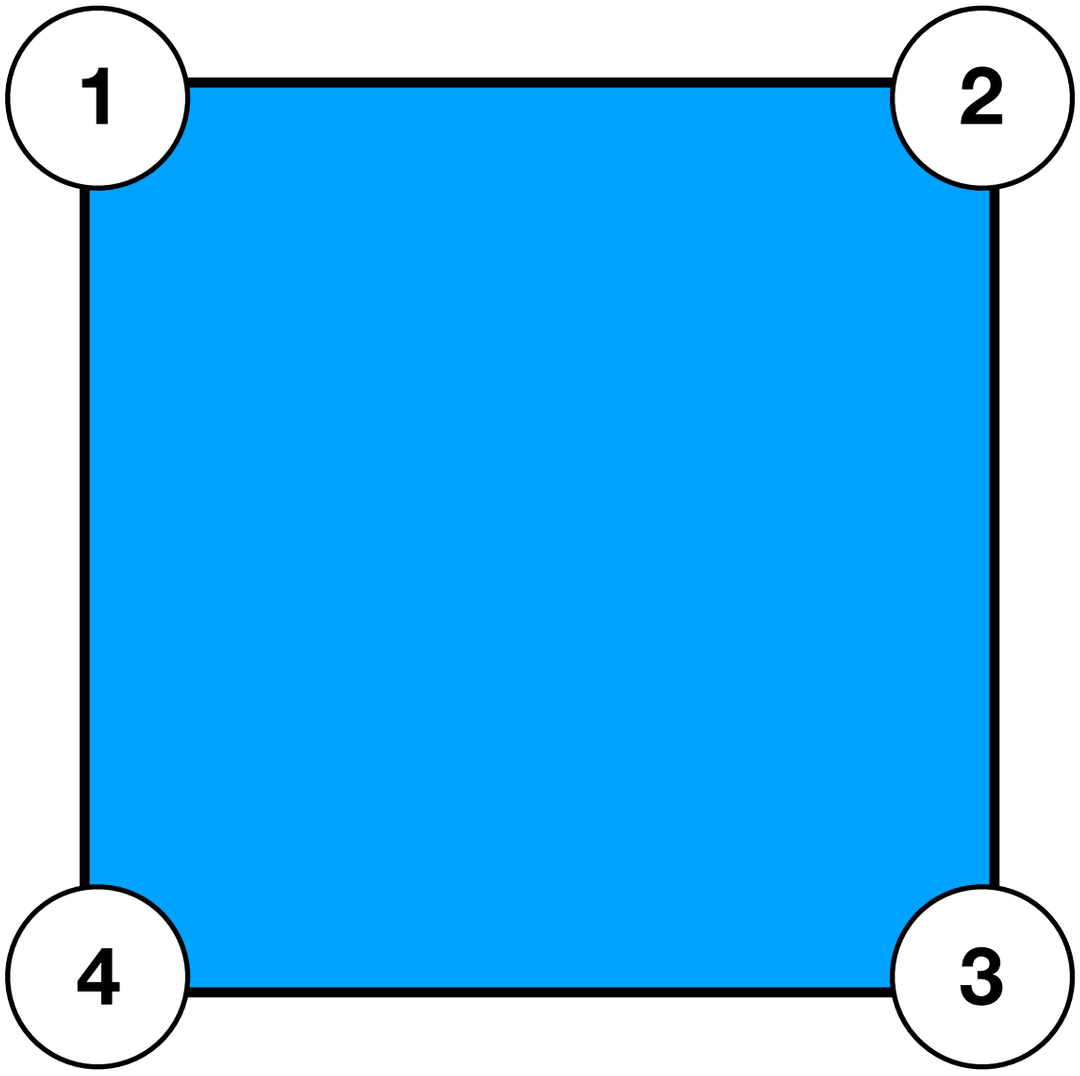

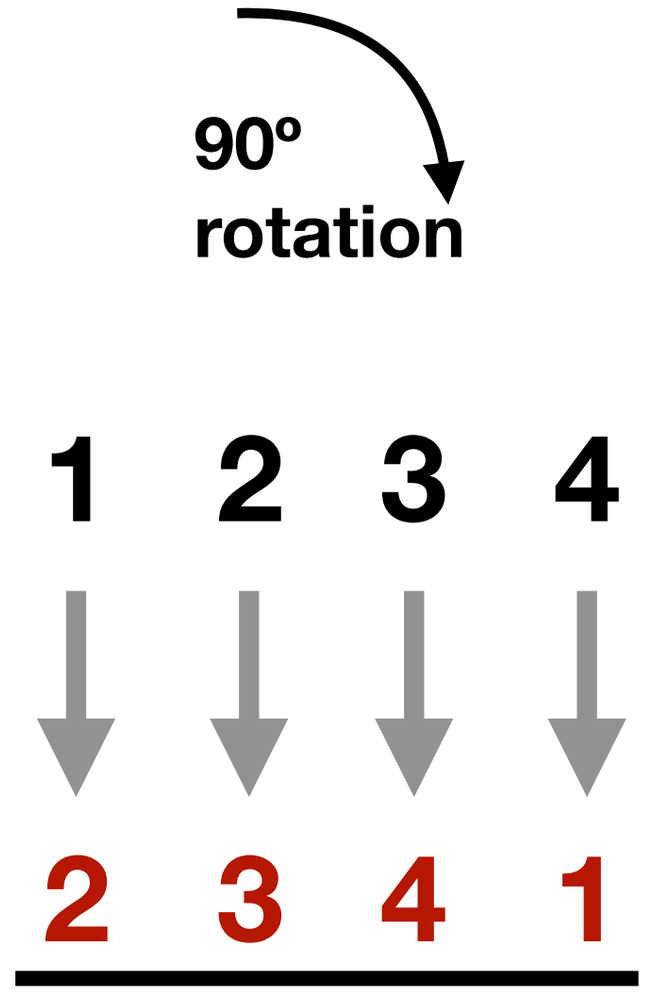

Which permutations of 1, 2, 3, 4 give symmetries?

There are…

$$n! = n \cdot (n - 1) \cdot (n - 2) \cdot \cdots \cdot 2 \cdot 1$$

…permutations of n **numbers**

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$5! = 120$

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$15! = 1307674368000$

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$$n! = n \cdot (n - 1) \cdot (n - 2) \cdot \cdots \cdot 2 \cdot 1$$

…permutations of n **numbers**

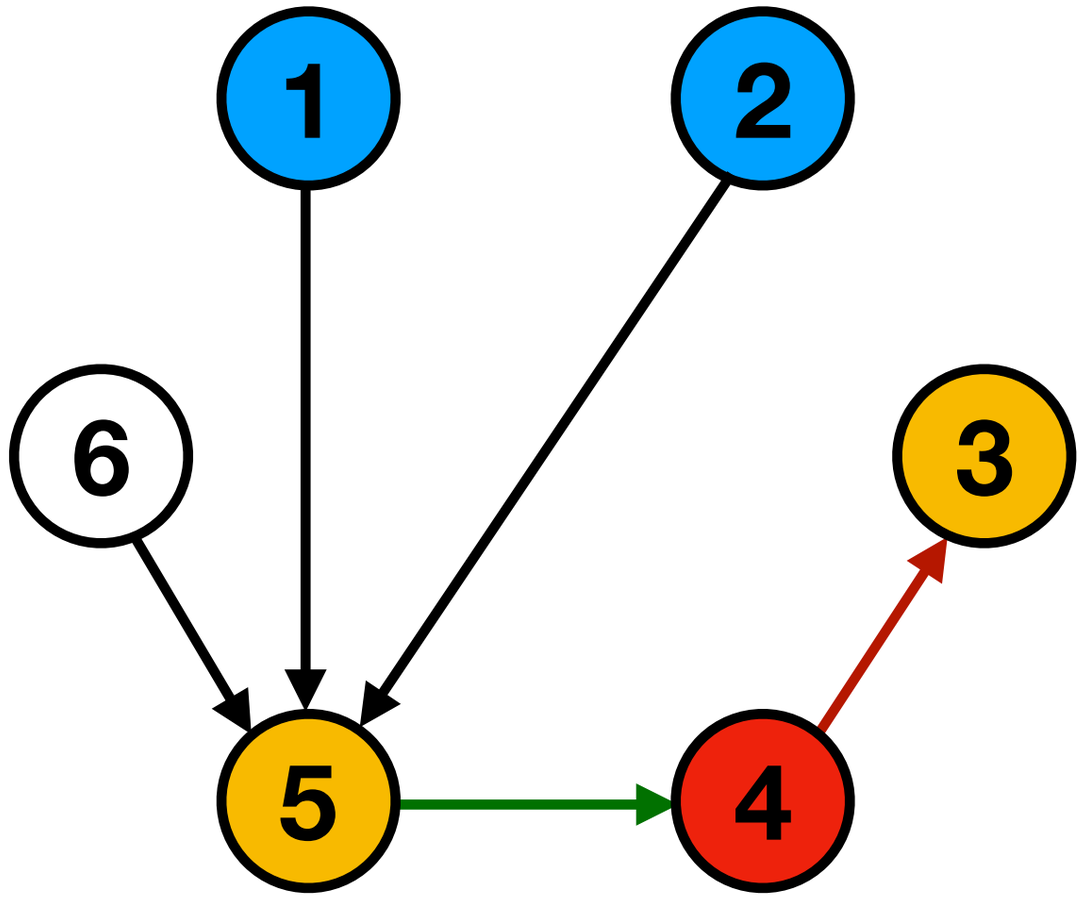
$5! = 120$

$15! = 1307674368000$

$30! = 265252859812191058636308480000…$

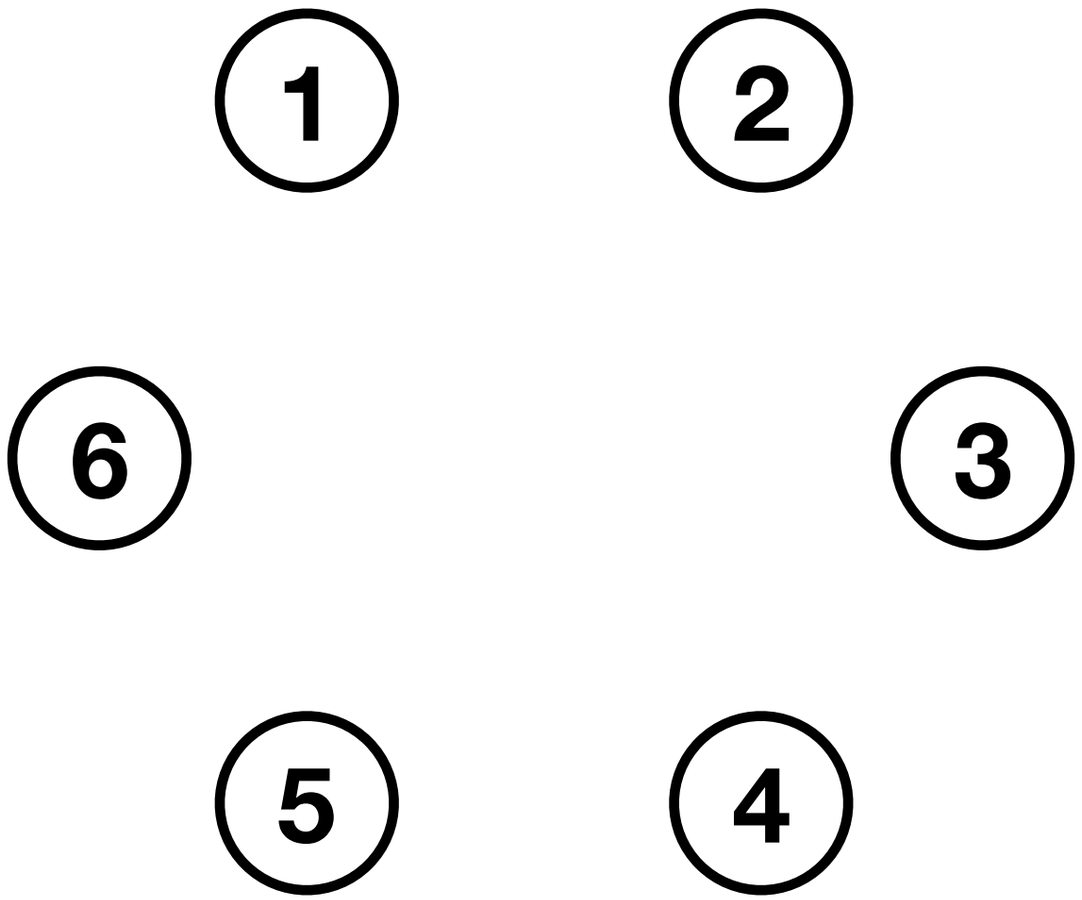
Graphs

Vertices (nodes)
Arcs (lines)

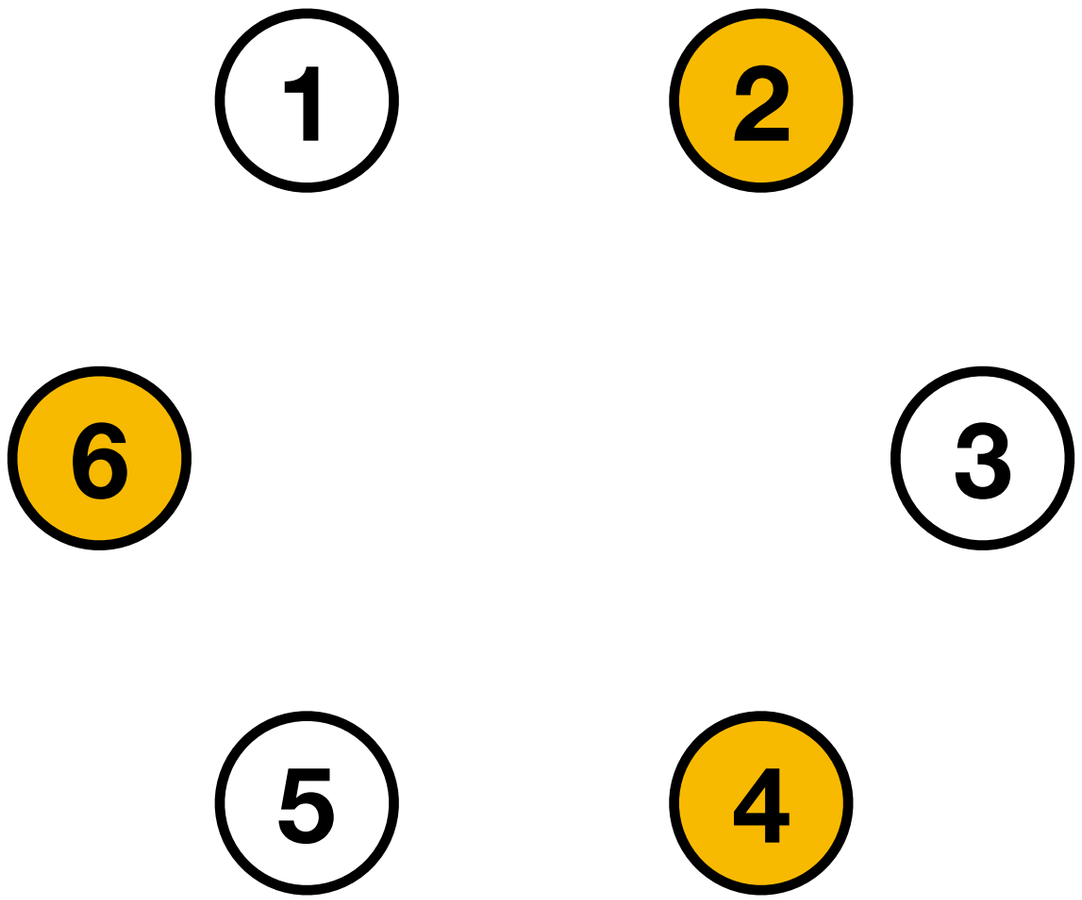


Can show ***relationships***

Searching with graphs



Searching with graphs



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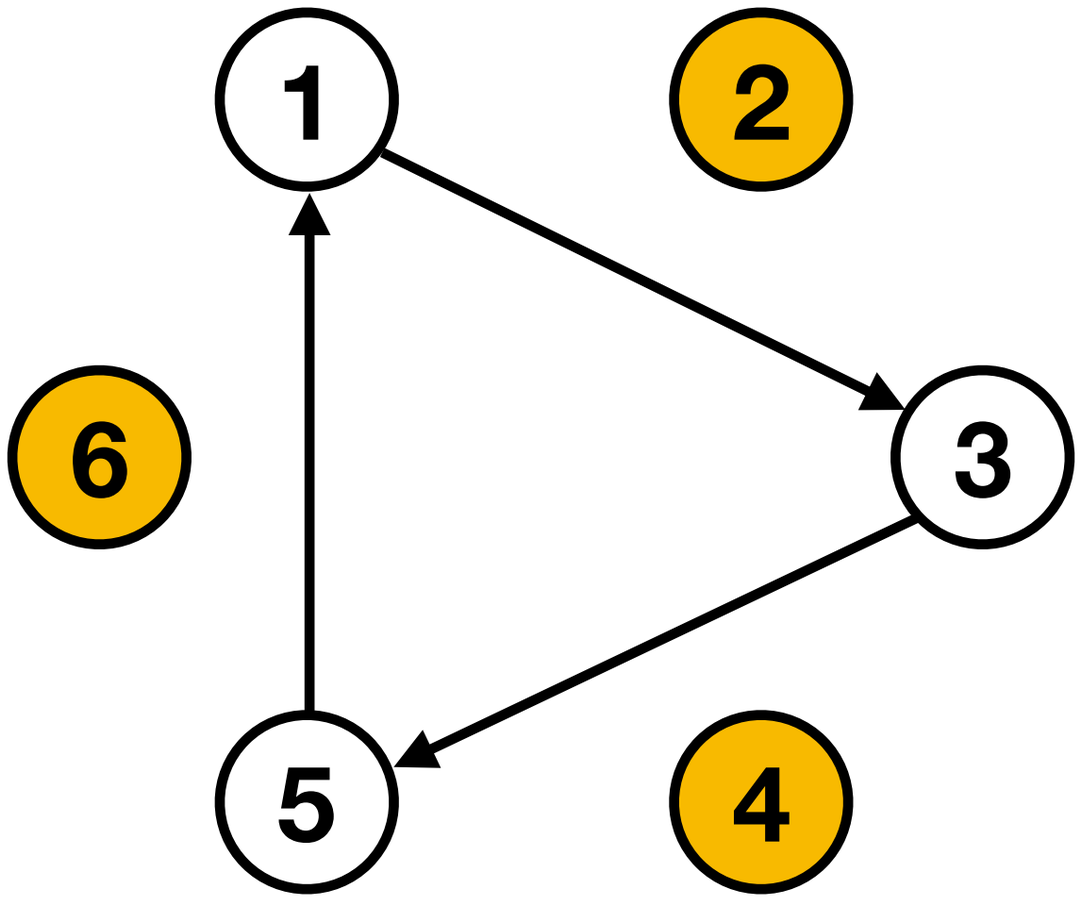

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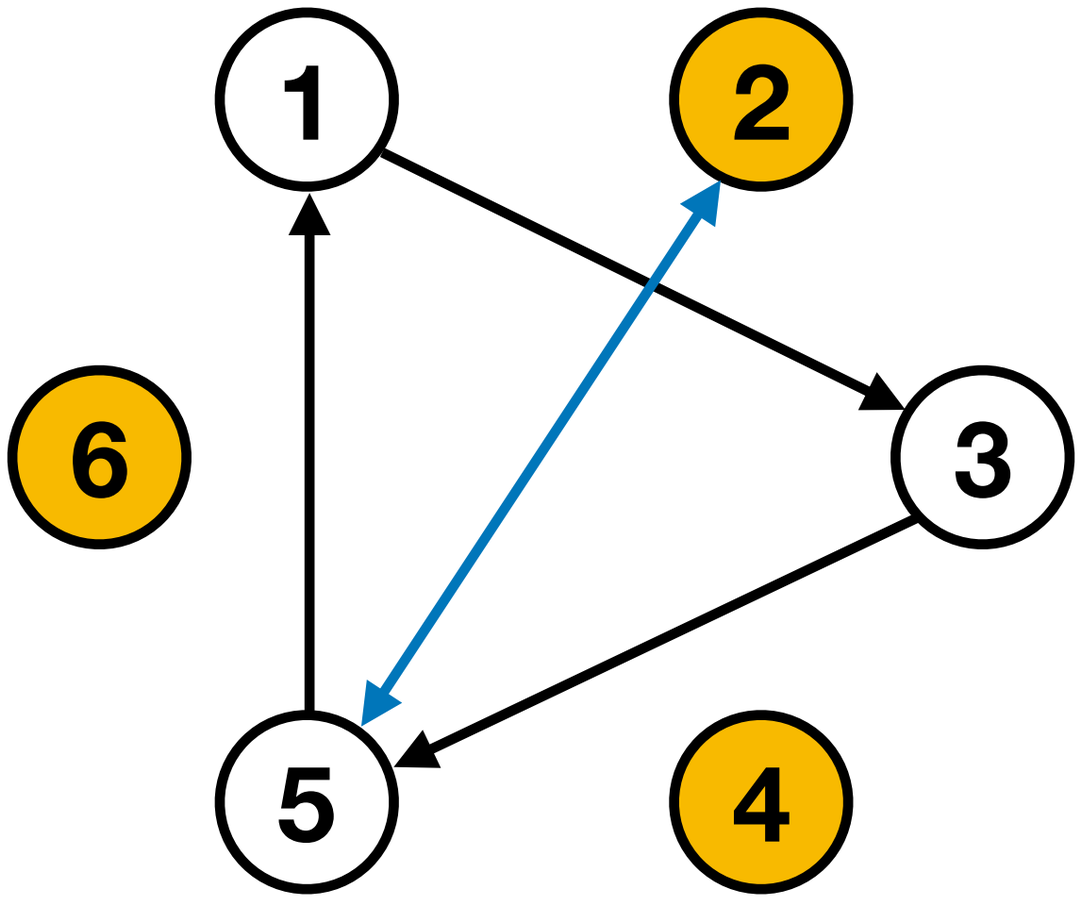

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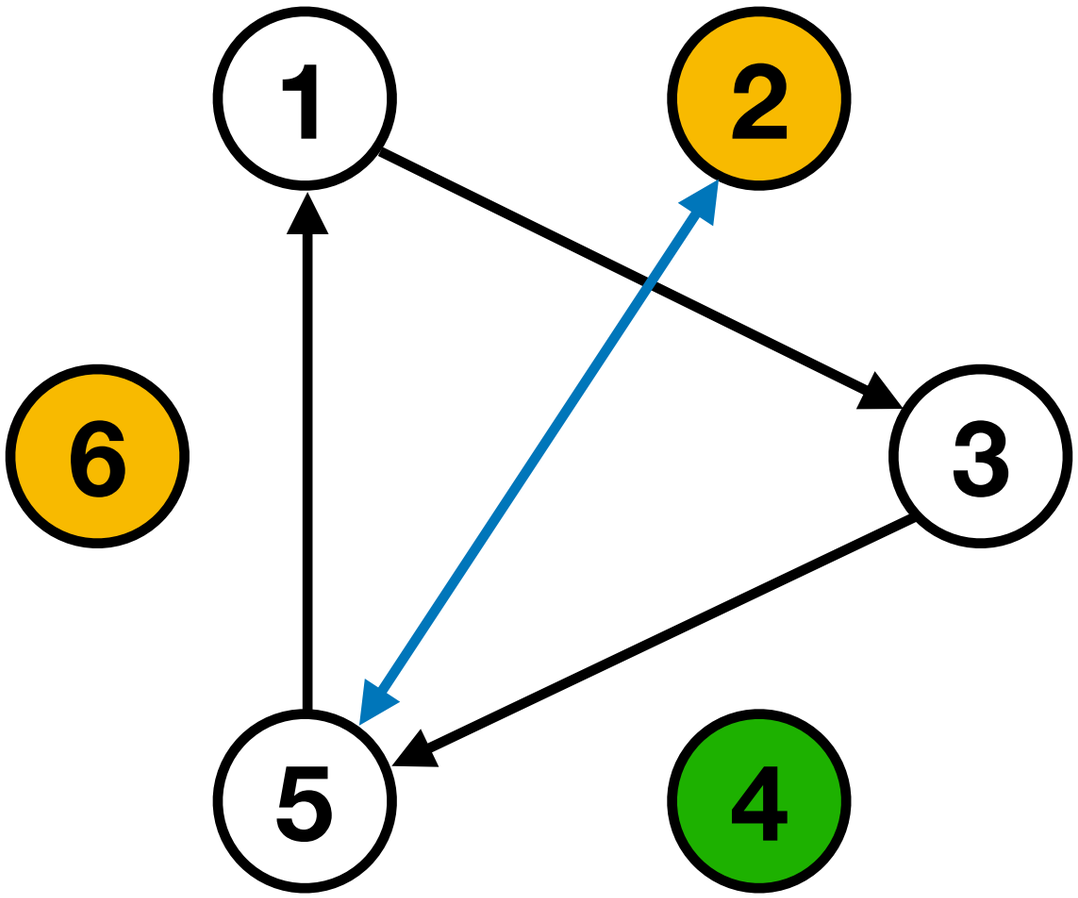


Is this Crazy?!

The Team

Rebecca Waldecker
Wilf Wilson
University of Halle-Wittenberg

Chris Jefferson
Markus Pfeiffer
University of St Andrews (Scotland)

Publications

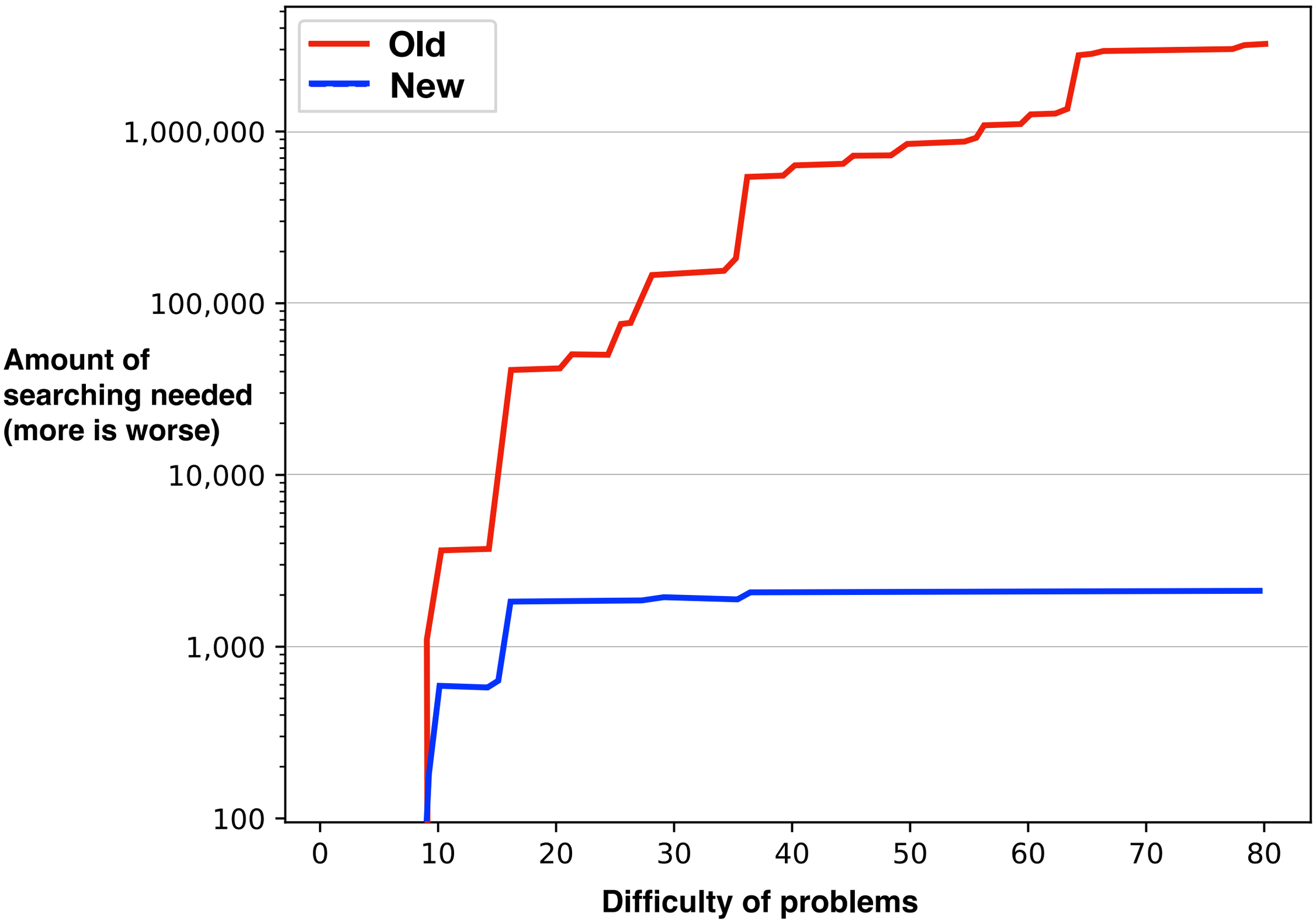
Paper:

“Permutation group algorithms based on directed graphs”
https://arxiv.org/abs/1911.04783

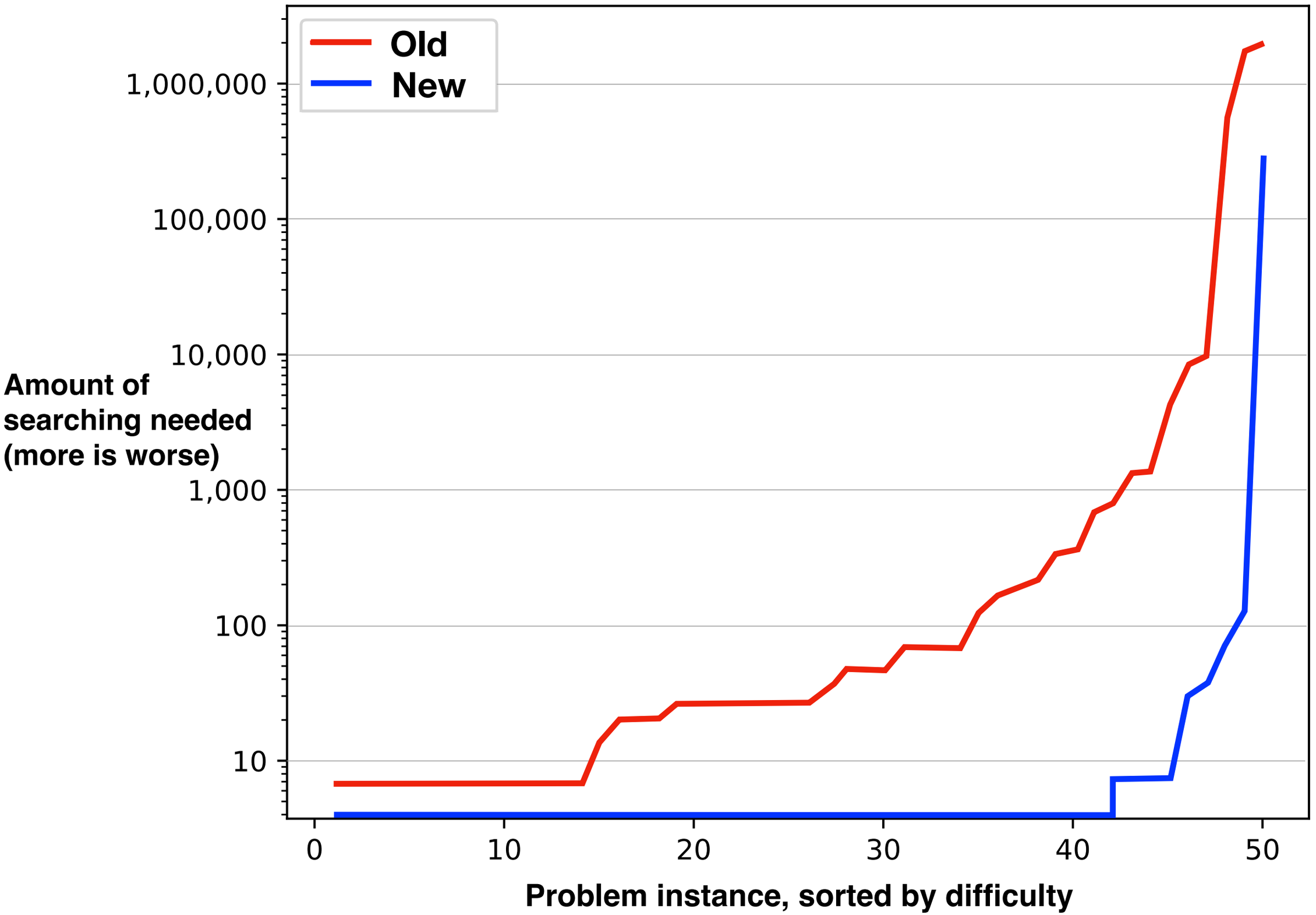
Software:

“GraphBacktracking” package for GAP
https://github.com/peal/GraphBacktracking

Experiments 1



Experiments 2



Our biggest challenges

What we learned

What’s next?

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Thank you!