Finding Geometrically Concise Representations of Homology
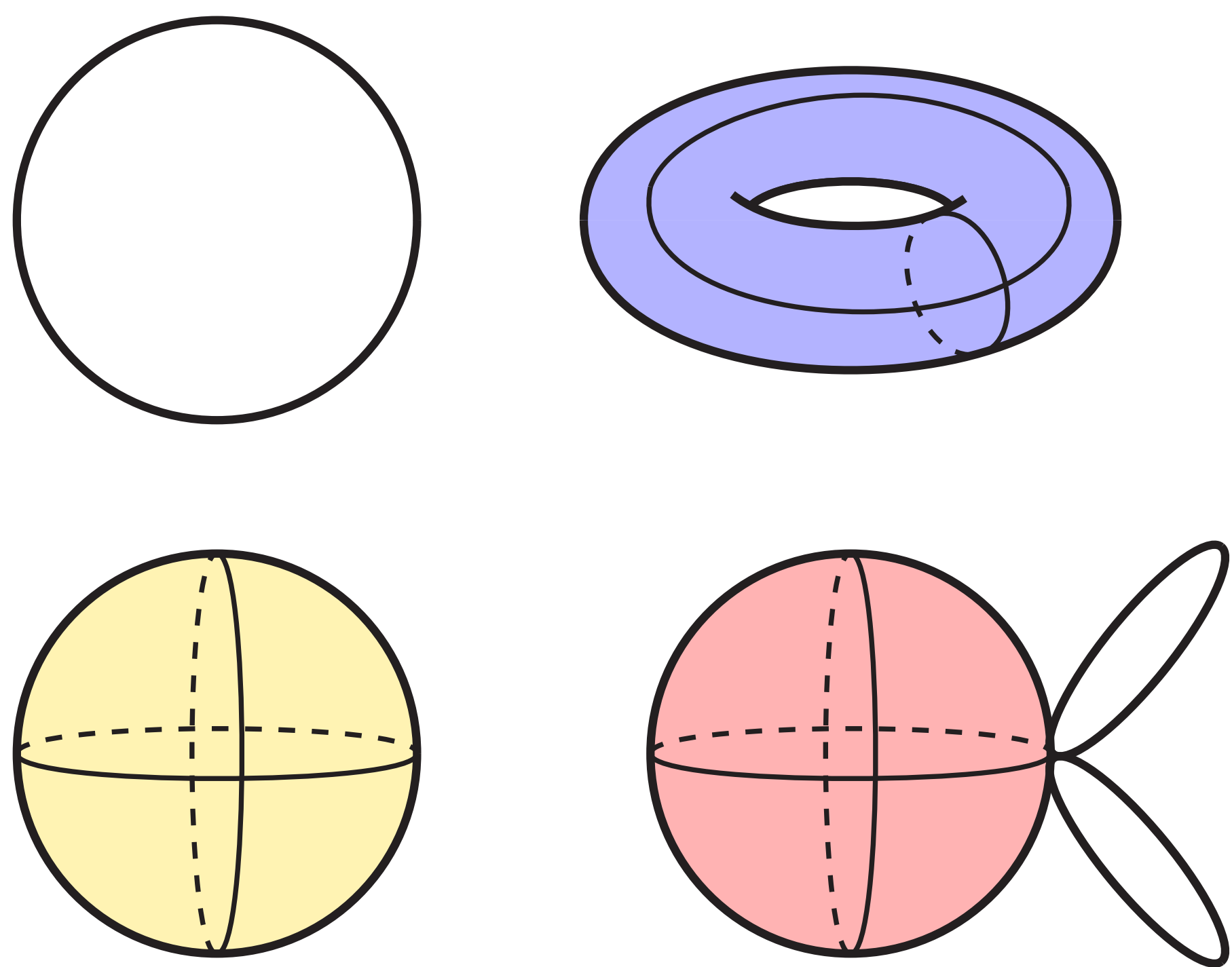
Erlend Raa Vågset, Nello Blaser
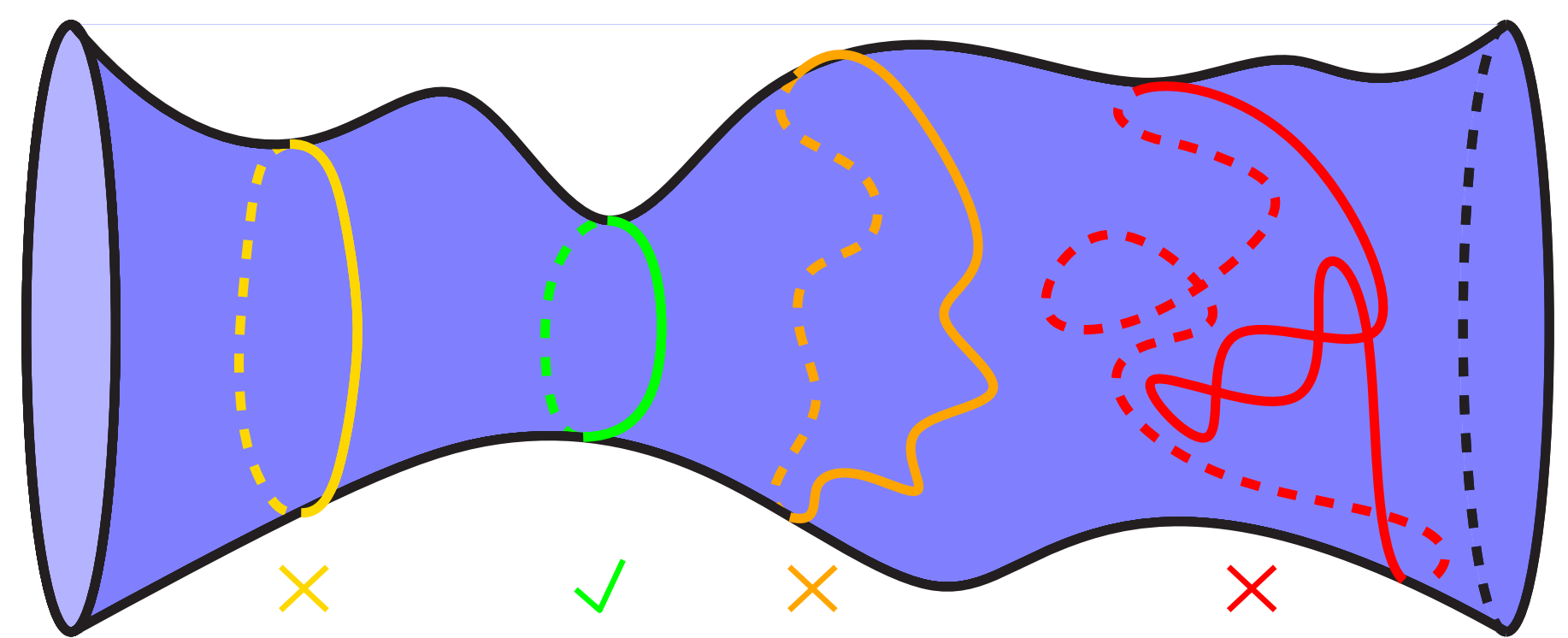
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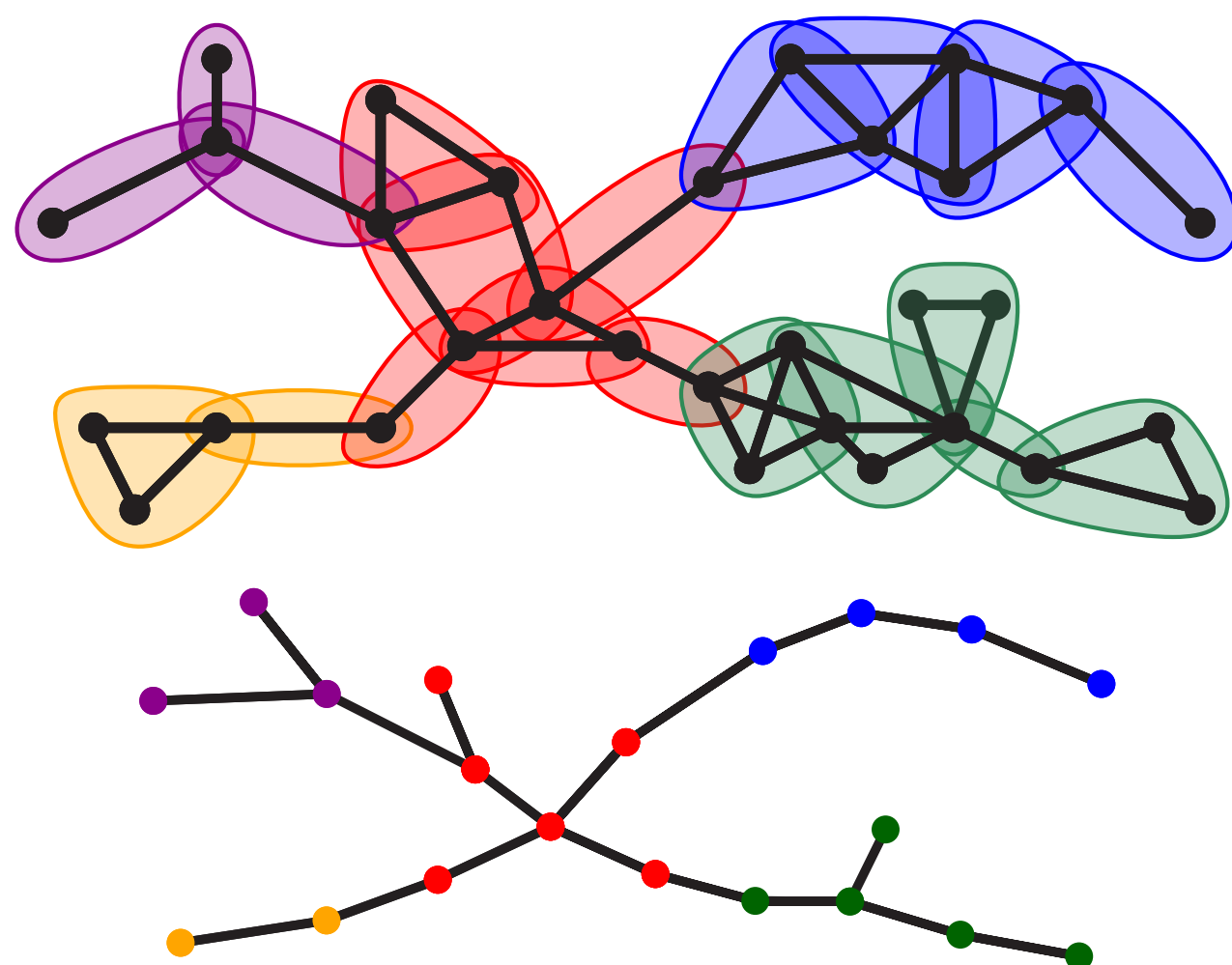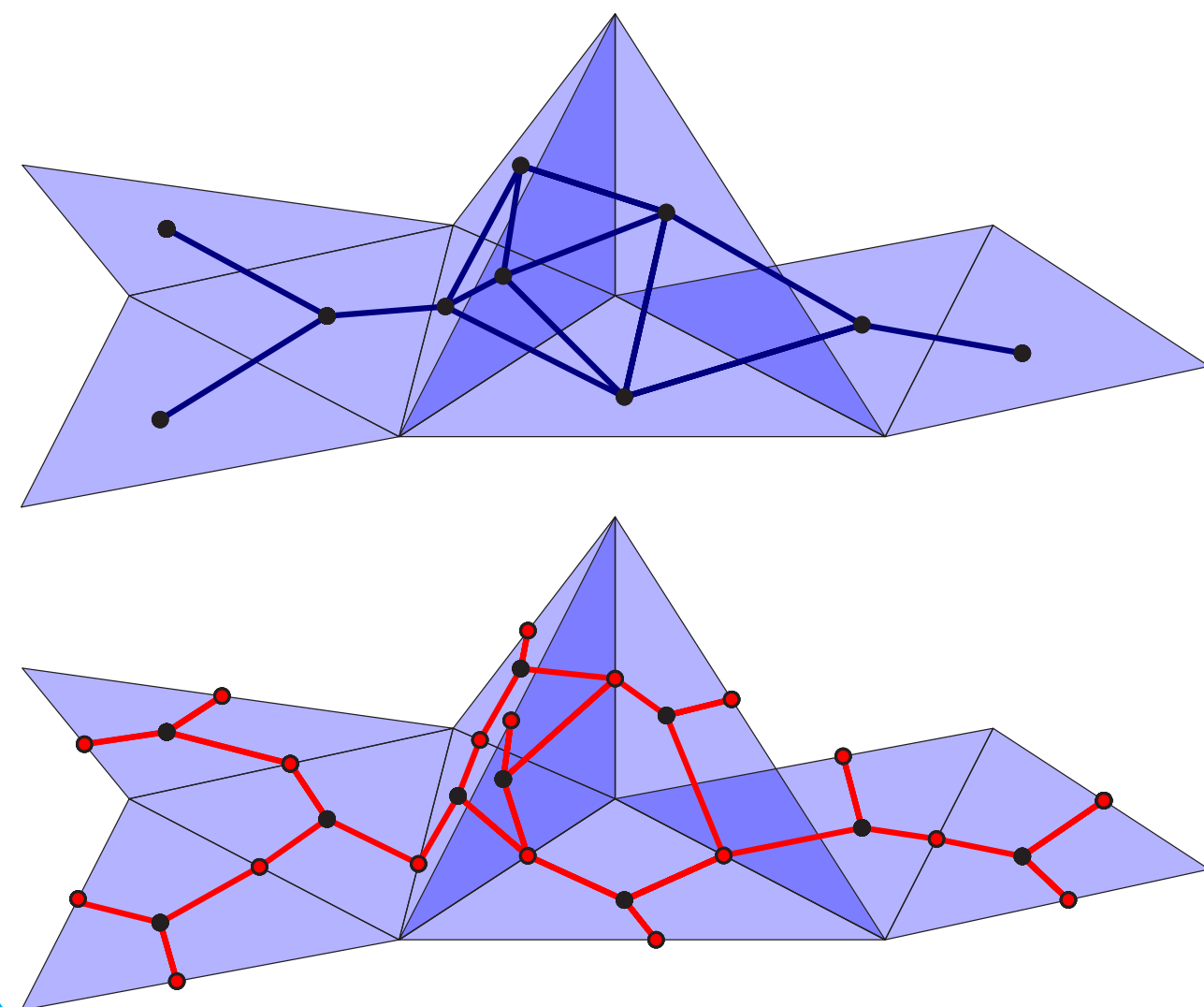## We count holes using homology...

but where are they located?

Are these holes hard to find?

In general, yes. To find a constant factor approximation is NP-hard[1] and W[1]-hard when parameterized by solution size. The good news is that:
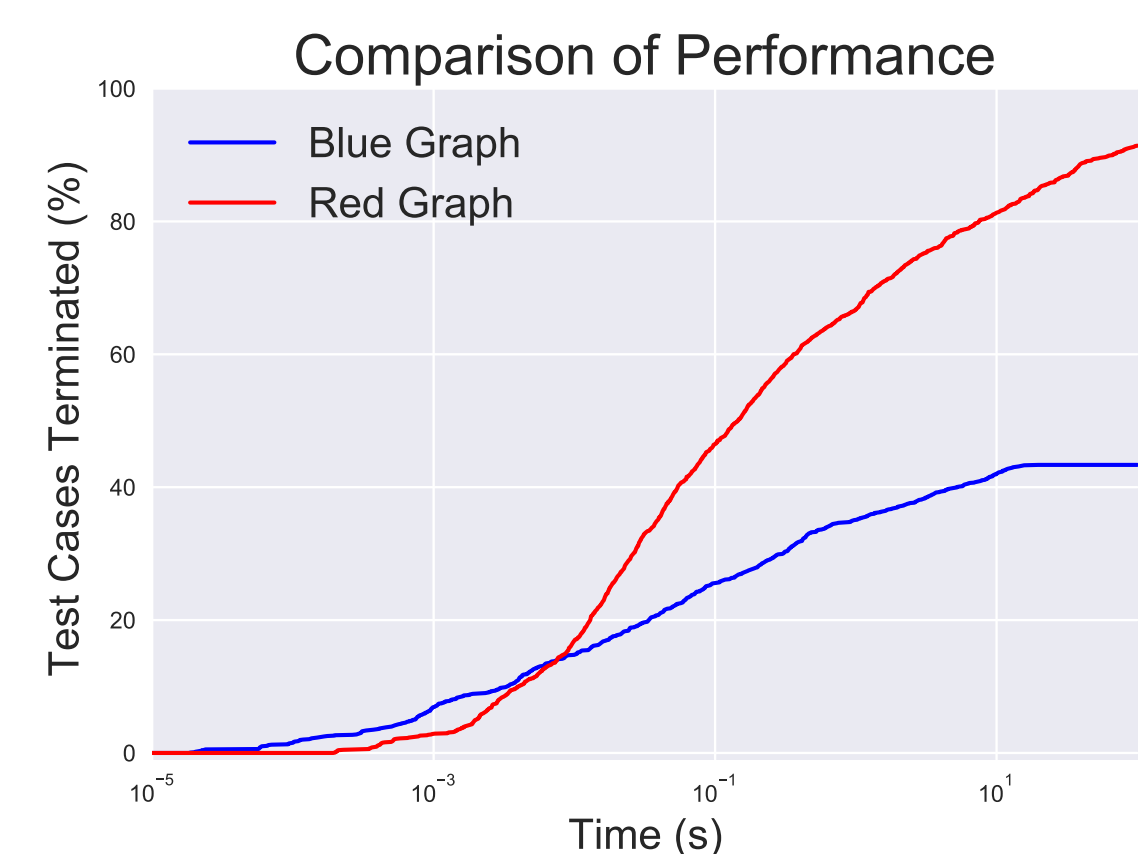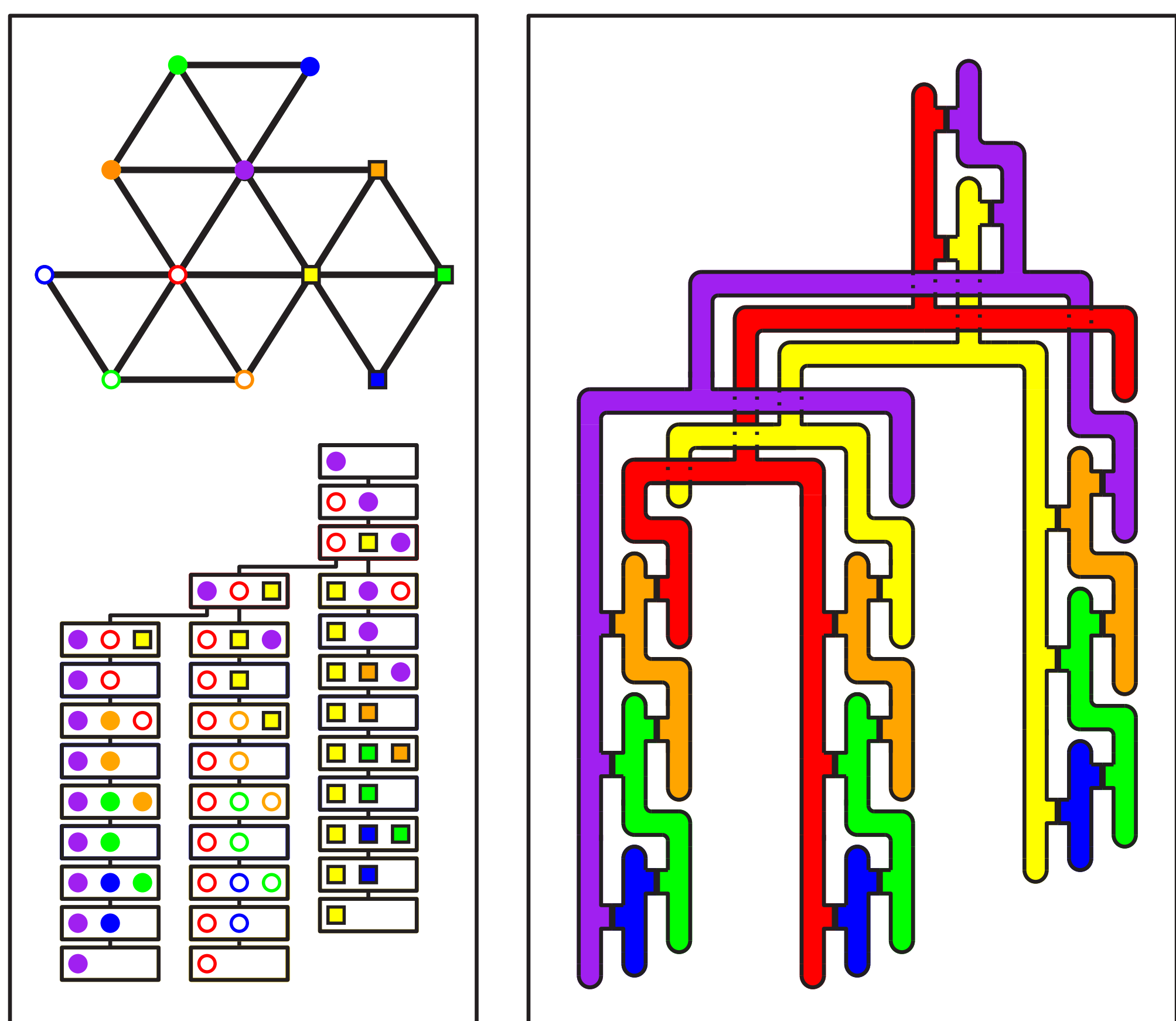
Using the **treewidth**...

of either **graph**...

as a parameter k

We invented two algorithms that locate homology in $2^{\mathcal{O}(k)}n$ time!

Comparison of Performance

- Blue Graph
- Red Graph

Test Cases Terminated (%)

Time (s)

Both algorithms are ETH-optimal...

but many questions are still open:

- Can homology be located in $\mathcal{O}(2^k n^c)$ time?
- Is this work generalizable to CW-complexes?
- Which other parameters should we investigate?

Sources & Funding

[1] Chen, C., & Freedman, D. (2011). Hardness results for homology localization. Discrete & Computational Geometry, 45(3), 425-448.