Better Caching for Better Model Counting

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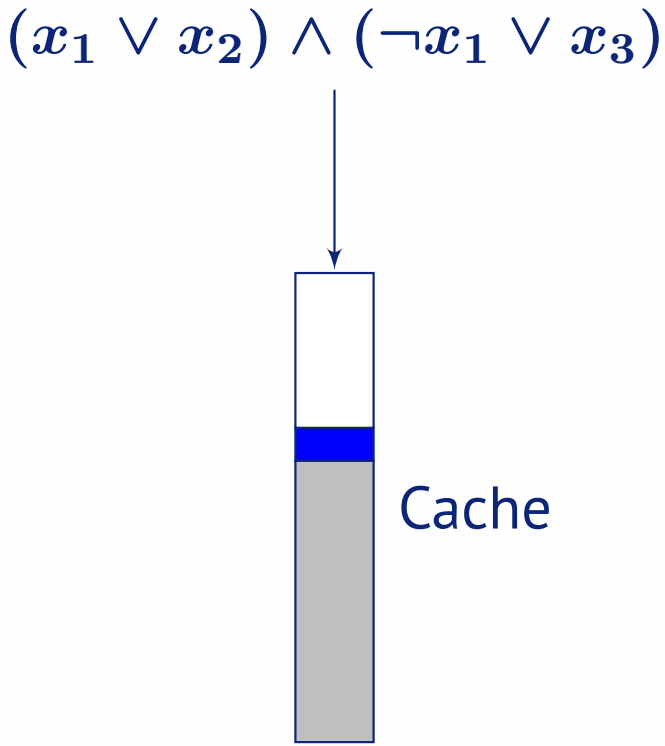
Exact Model Counting

- DPLL
- Knowledge compilation
- Tree decomposition
- **CDCL with component caching**

Contributions

- Parameter configuration on a highly configurable version of Ganak under constrained memory. [Sharma et al.,2019]
- Exploratory analysis of caching behaviour.

Component caching



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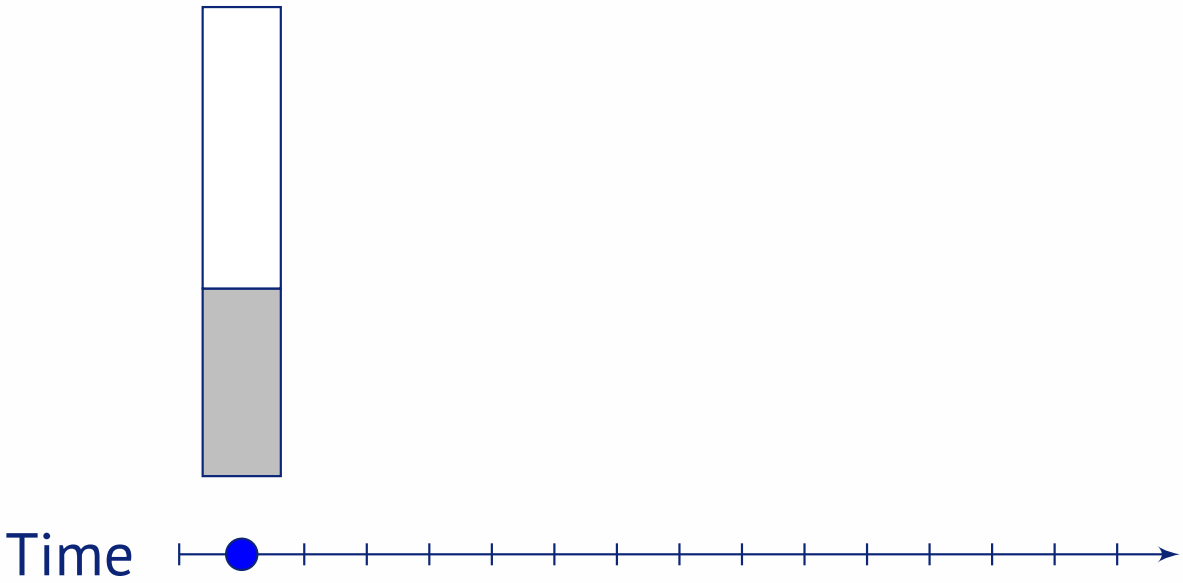
- sharpSAT 2013 [Thurley,2006]
- GANAK [Sharma et al.,2019]



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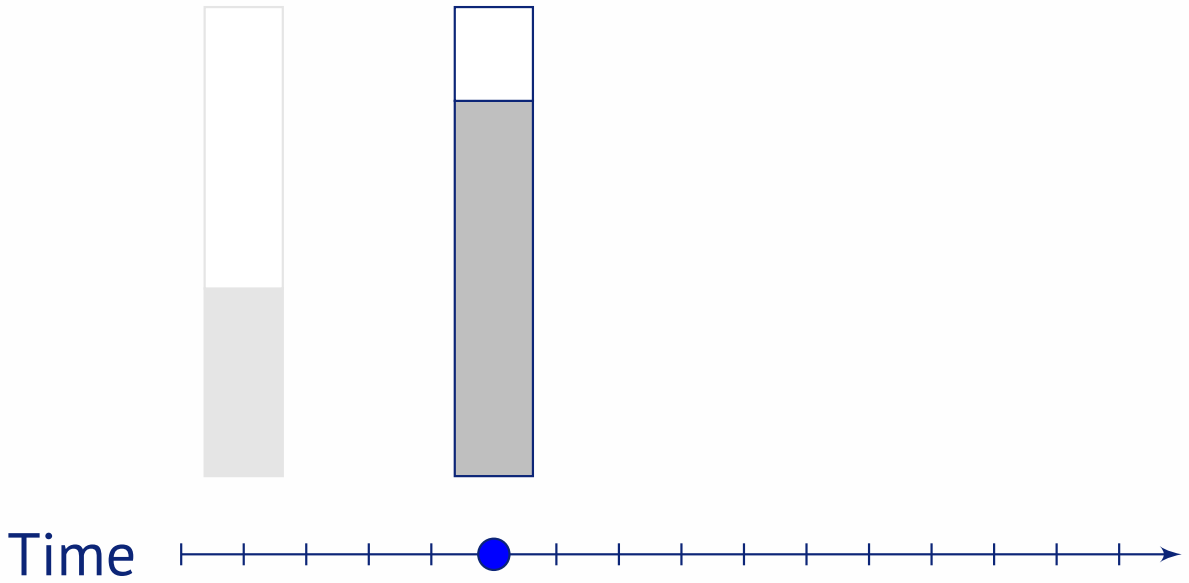

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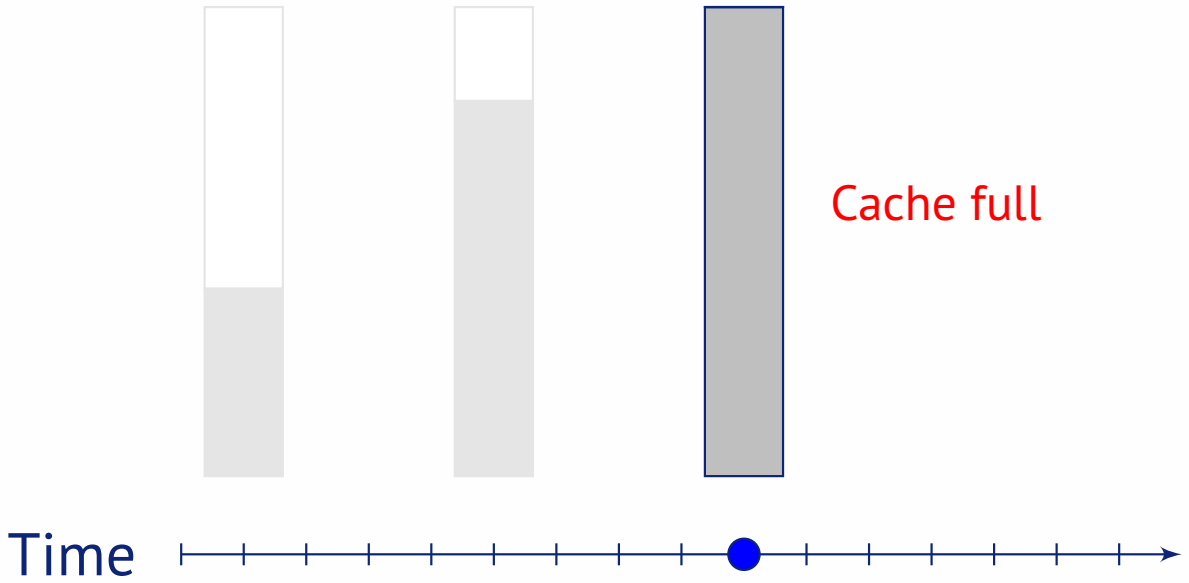

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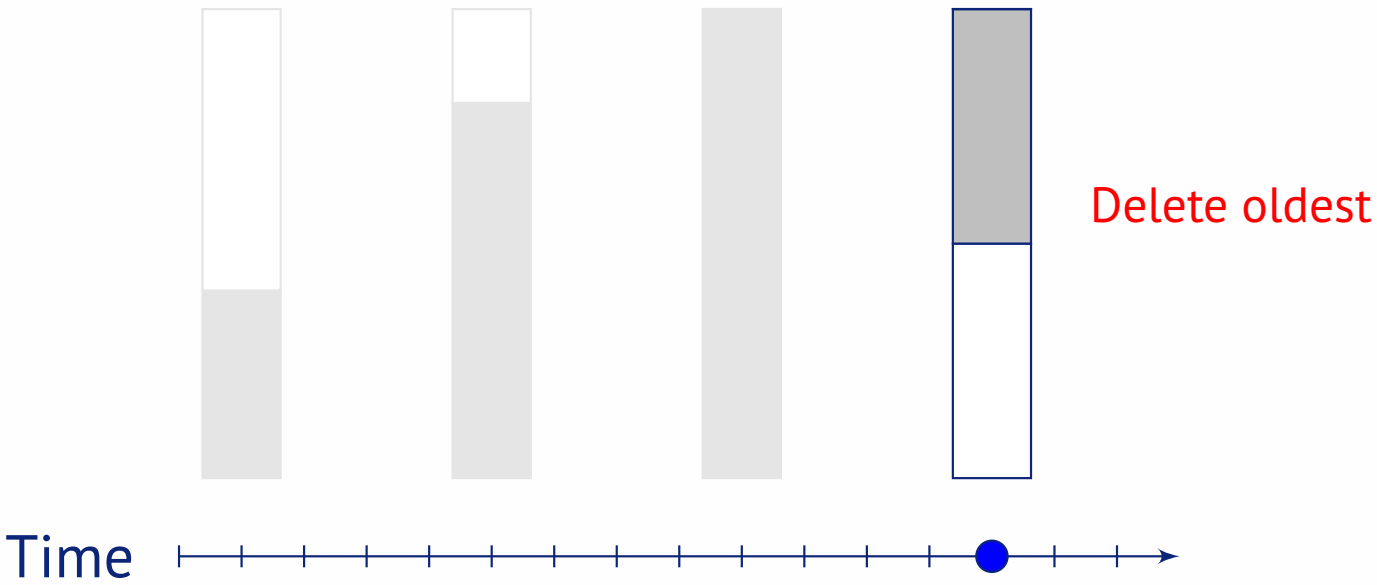
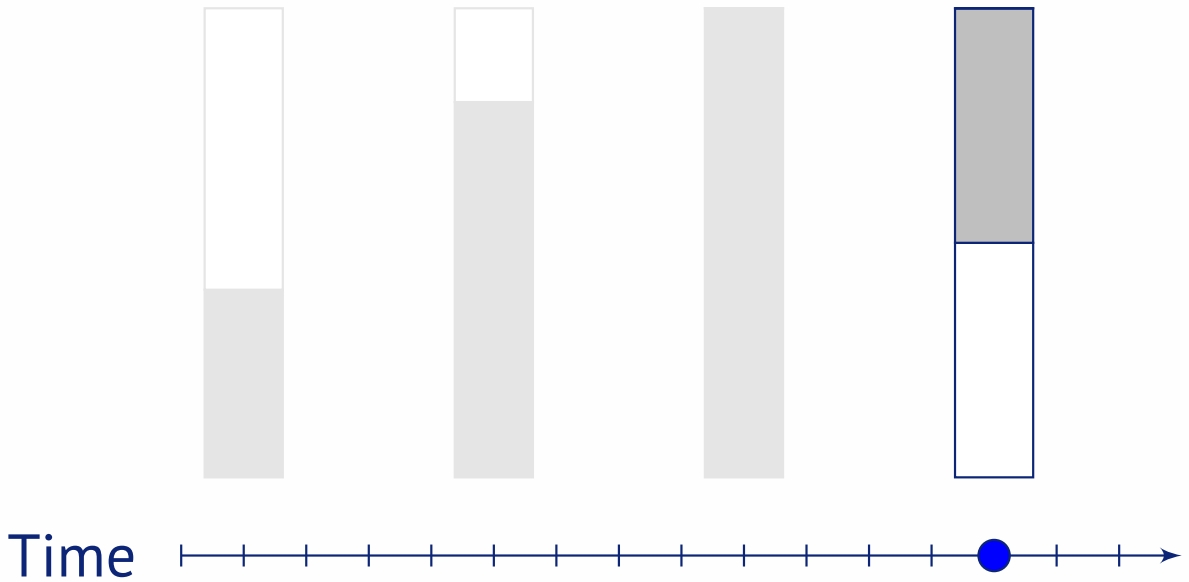
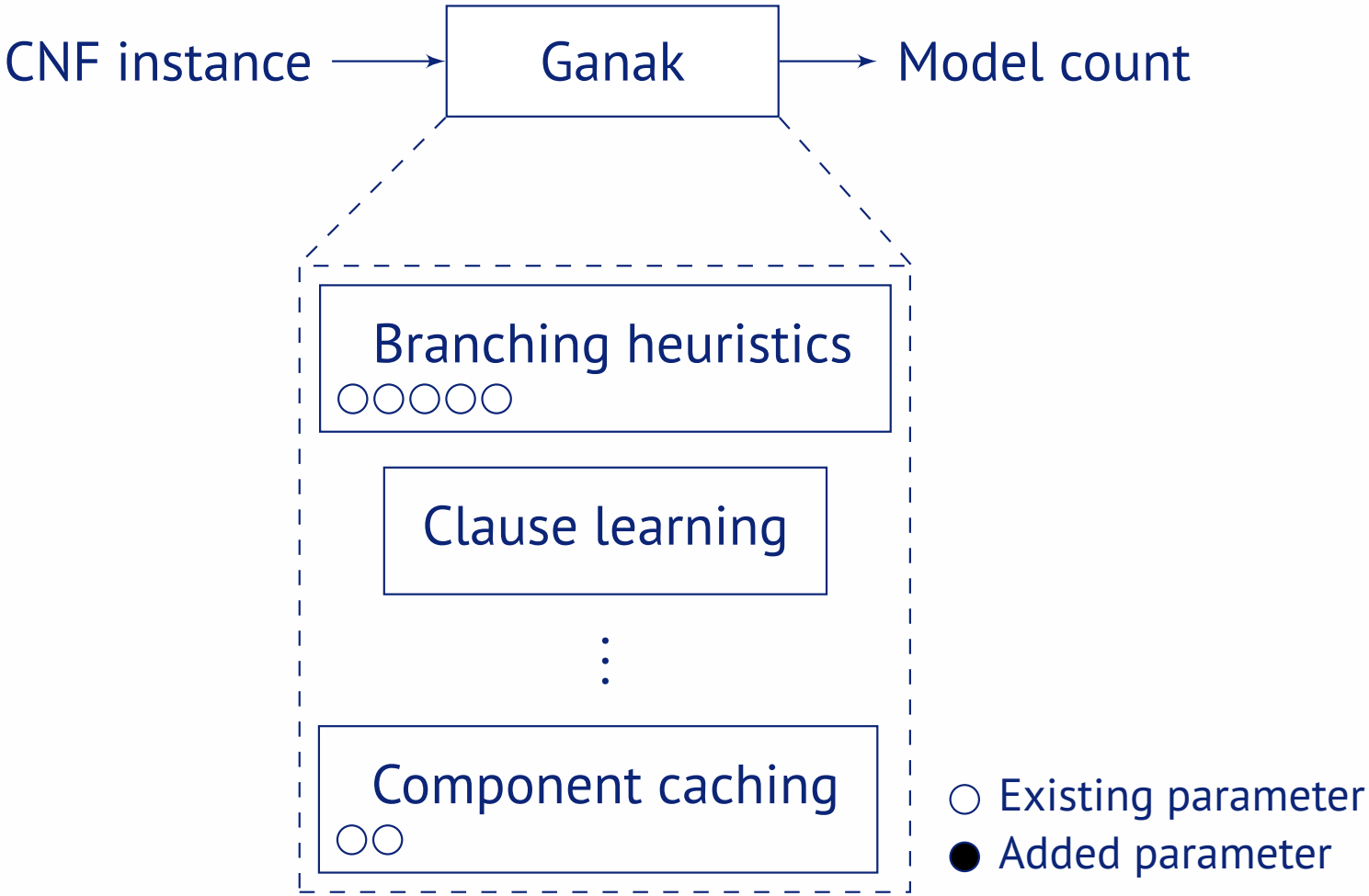


Component caching

- Removed components need to be solved again when they are seen again.
- Every found component is cached, regardless of their reusability.



Ganak


CNF instance
Ganak
Model count
Branching heuristics
Clause learning
Component caching
Existing parameter
Added parameter

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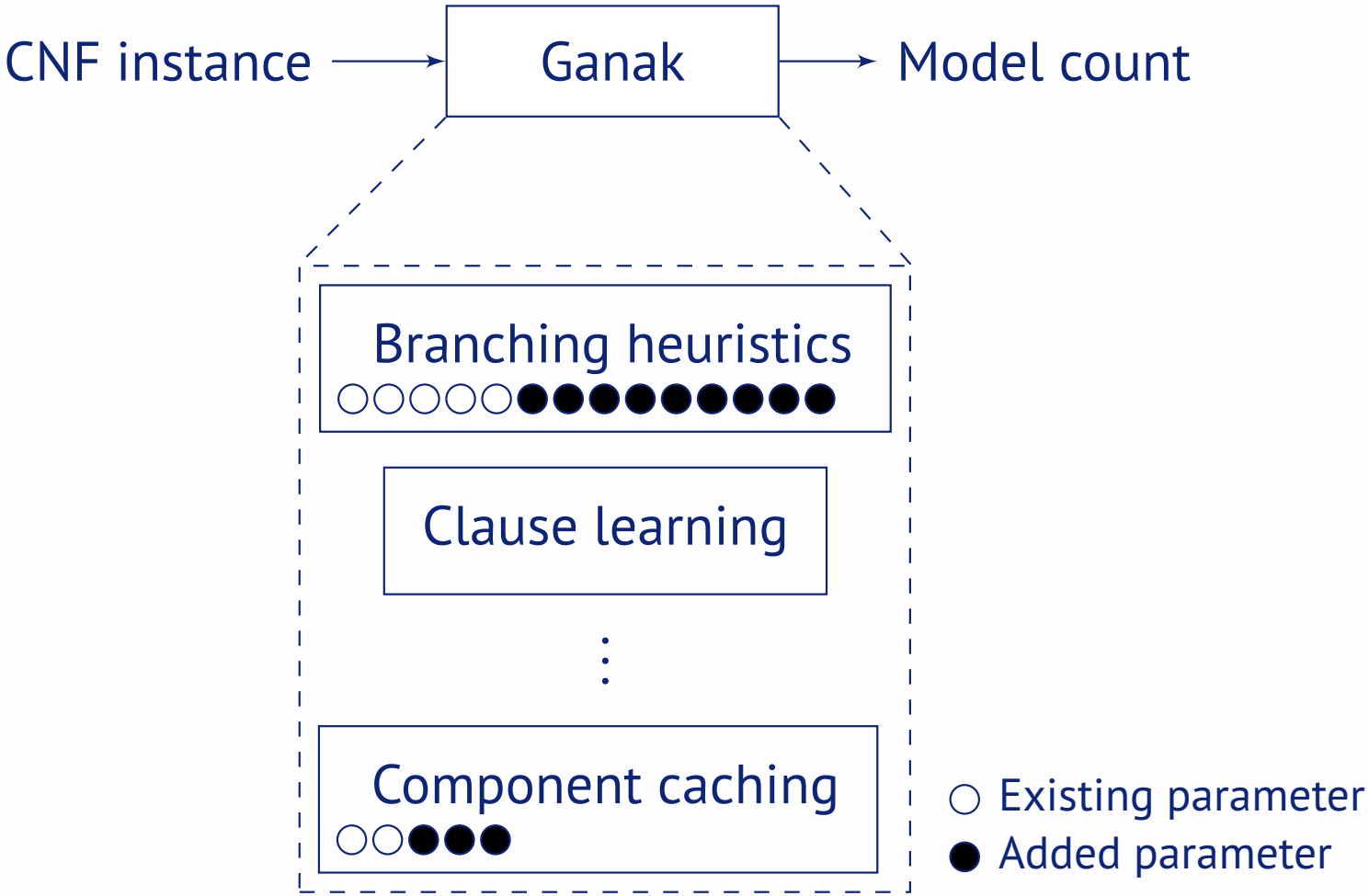
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Automated Algorithm Configuration

Given an **algorithm** with **parameter space** find a configuration that minimises a **target measure** on a given **instance set**.

[Hoos,2012]

Benchmarks

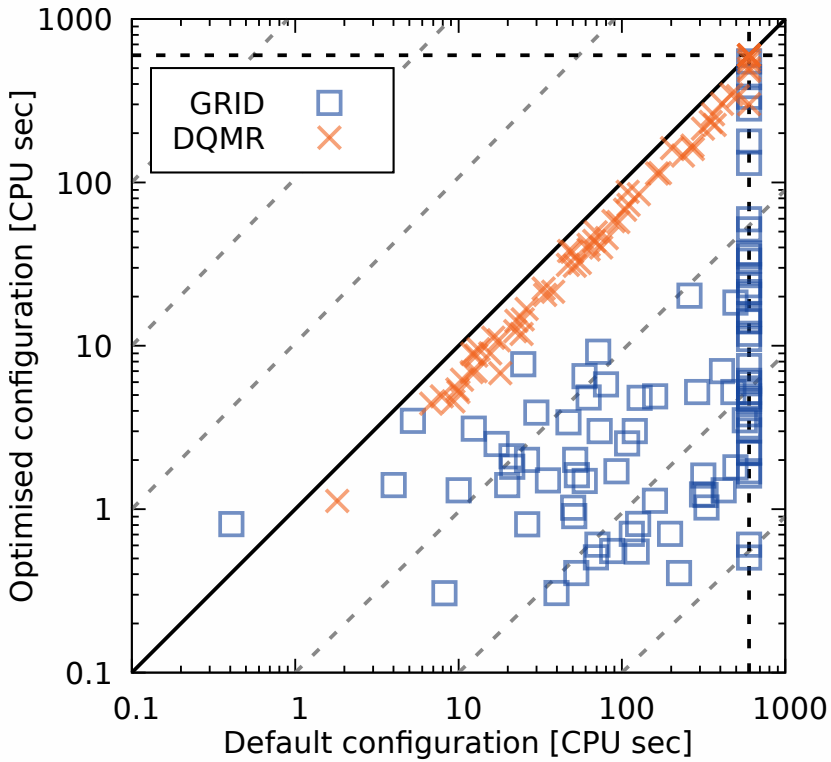
- Unweighted DQMR and GRID benchmarks. [Sang et al.,2005]
- Solving time between $\sim 5s$ and $3600s$ with default parameters.
- Cache size of 100MB to ensure limited cache behaviour.

Automated Algorithm Configuration

Cache size **100MB**, cutoff time **600s**

	GRID	90
	PAR10	timeout
Default	2483	36
Optimised	28	0

	DQMR	62
	PAR10	timeout
Default	949	9
Optimised	481	4

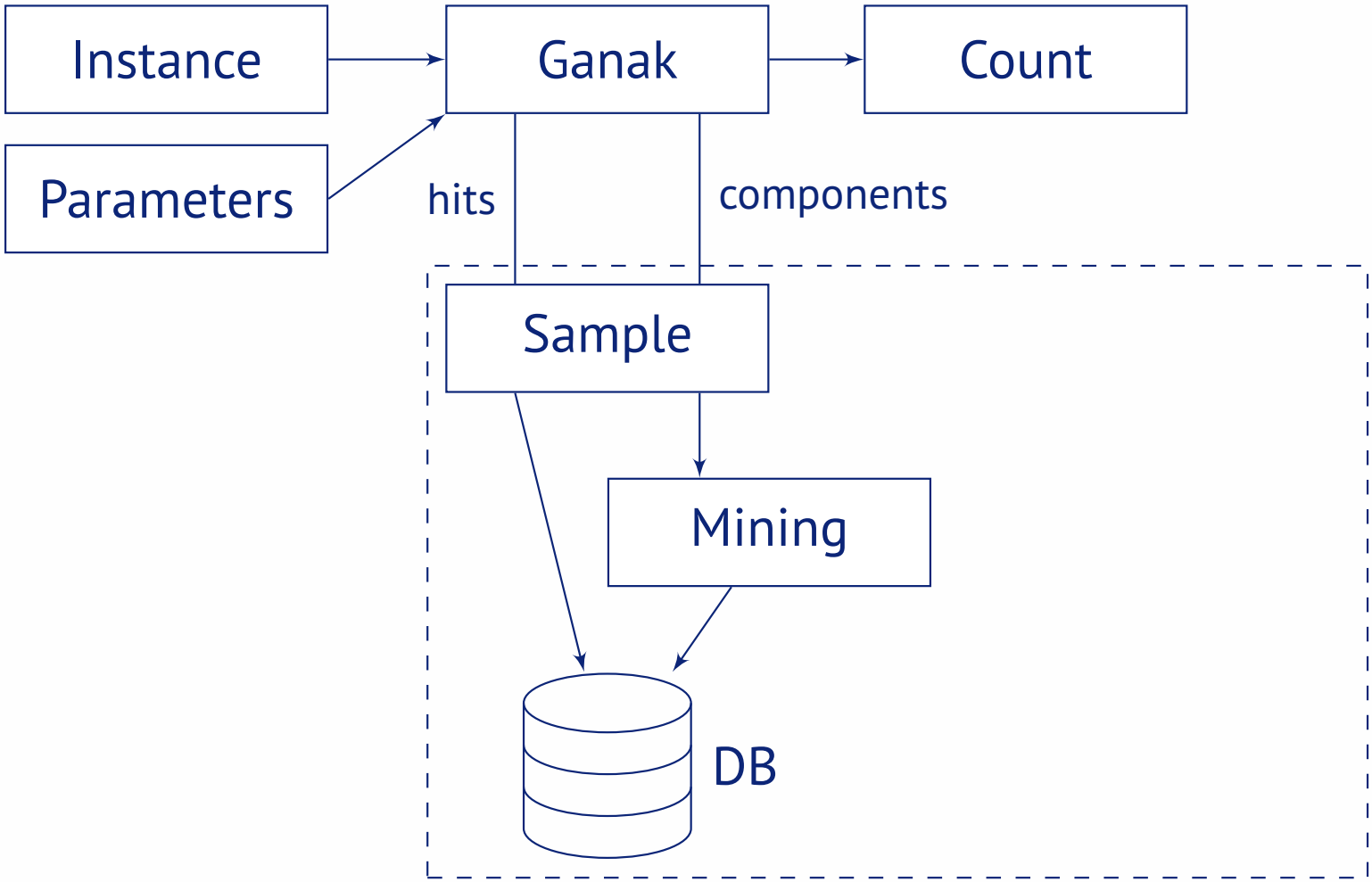


AAC Observations

- Different instances are affected by different parameters.
- Branching heuristics contribute most to the decrease of PAR10.

Mining the cache

Inspired by CrystalBall [Soos et al.,2019]



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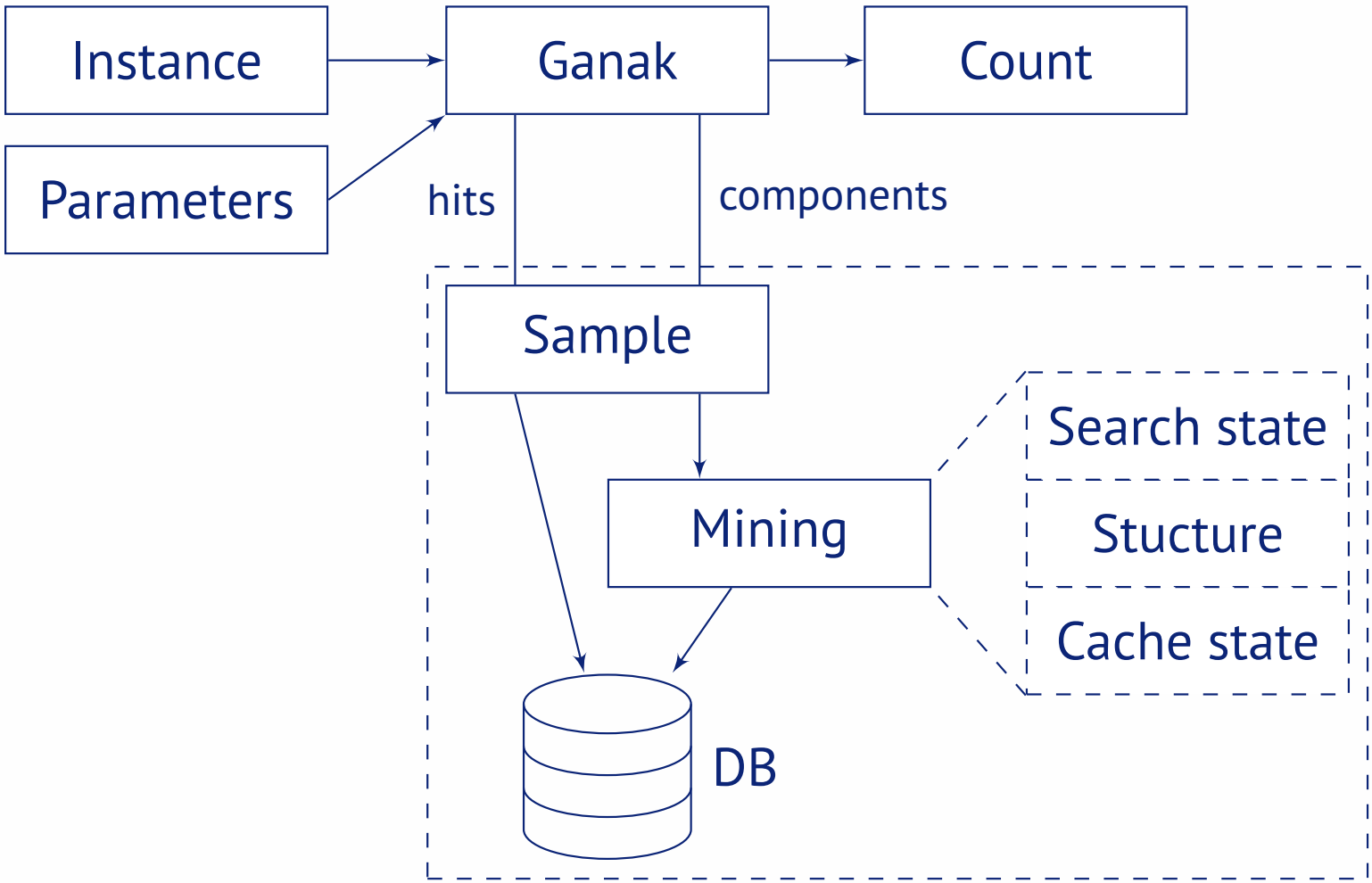

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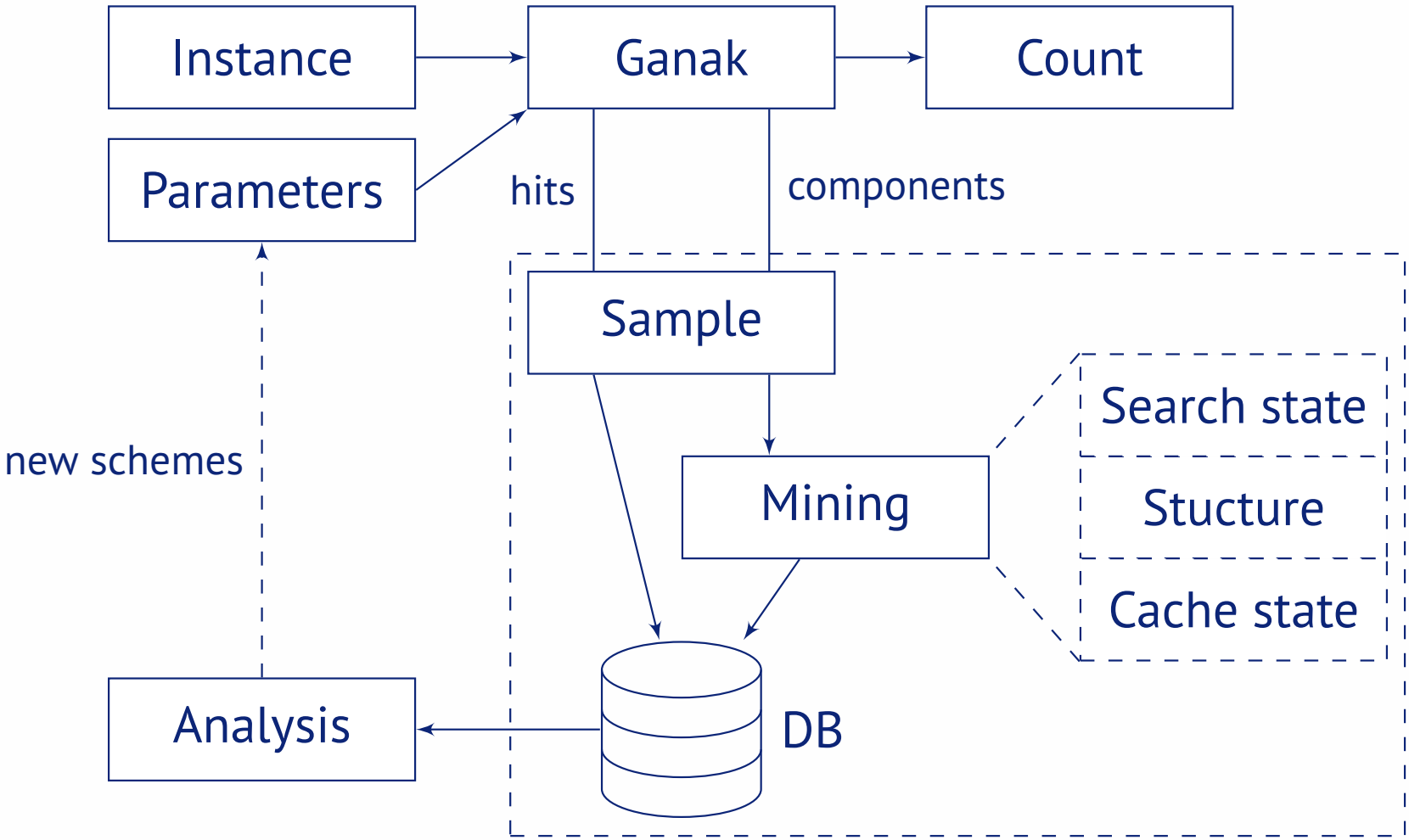

Initial analysis

For `or-60-20-3.cnf`

How much of all cached components are actually reused?

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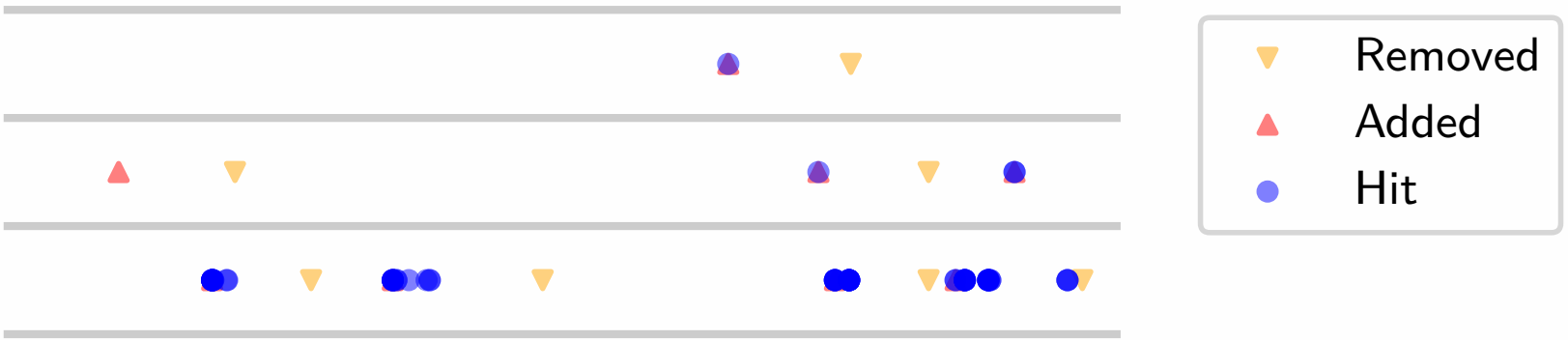
What is the impact of cache removal on the number of decisions?

	Decisions	
Total	4,078,392	
Recomputation	910,030	*22.3%*

Initial analysis

For `or-60-20-3.cnf`

Can we characterize different component profiles?



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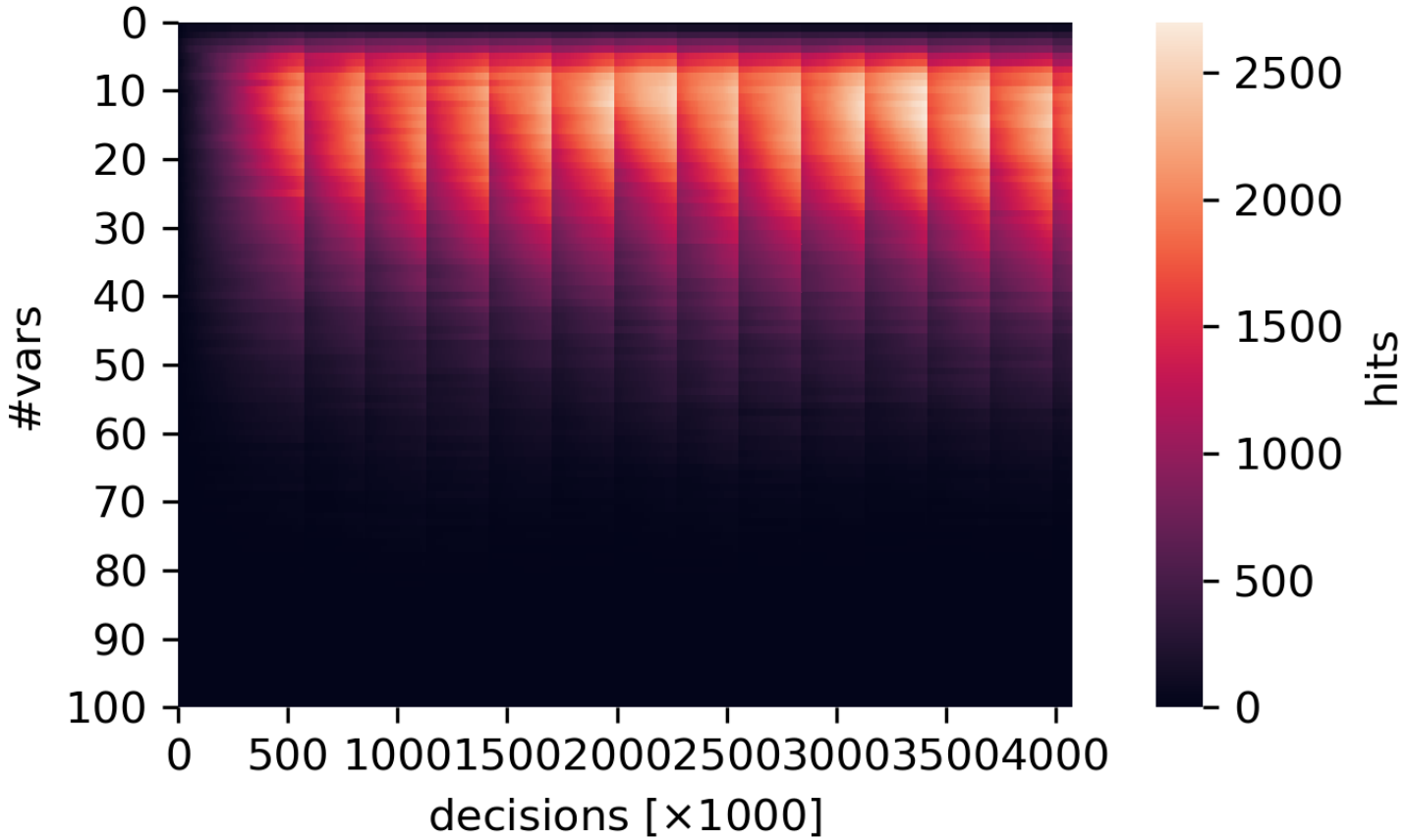

Future work

- Include component dependencies.
- Leverage machine learning to predict component reusability.
- Scale to harder and more diverse benchmark sets.

Take aways

- Current caching schemes can negatively impact solver running time performance.
- Only a small fraction of cached components is frequently reused.
- Cache behaviour is influenced by instances and solver parameters.

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