[Weinbergsquelle, Hohenwarthe]

How Easy is SAT-Based Analysis of a Feature Model?

VaMoS 2024 — February 7–9 — Bern, Switzerland

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University of Magdeburg[1], Ulm[2], Germany

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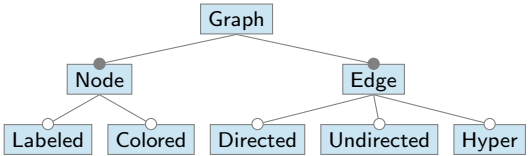
Recap: Product-Line and Feature-Model Analysis



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$\mathit{Hyper} \rightarrow \mathit{Undirected}$

$\mathit{Directed} \not\leftrightarrow (\mathit{Undirected} \wedge \mathit{Hyper})$

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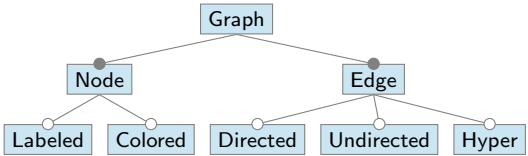

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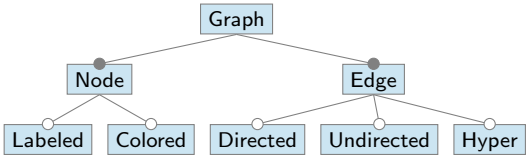

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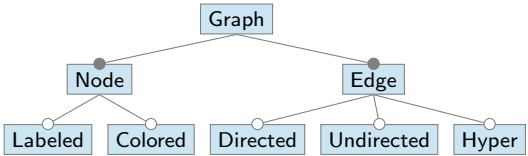

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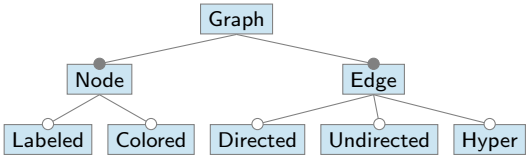

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- A sample covering all ***t*-wise interactions**? [ref]
- **How large** is the configuration space? [ref]
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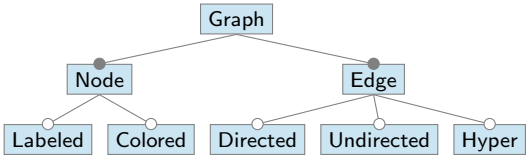

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. . . which often rely on **SAT solving** (et al.)!

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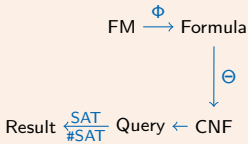

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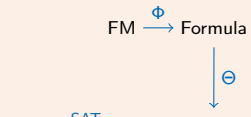
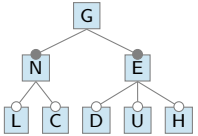


A Feature Model *FM*



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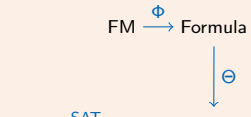

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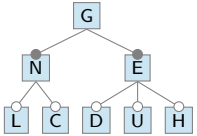

$\xrightarrow{\Phi}$

As a Formula $\Phi(FM)$

$$
\begin{aligned}
& G \\
\wedge\ & (N \leftrightarrow G) \wedge (E \leftrightarrow G) \\
\wedge\ & ((L \vee C) \rightarrow N) \\
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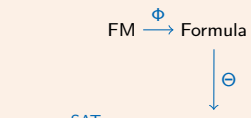

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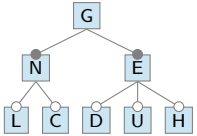

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$\downarrow \Theta$

As a CNF $\Theta(\Phi(FM))$

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\begin{aligned}
& \{\{G\}, \{\neg N, G\}, \{N, \neg G\}, \\
& \{\neg E, G\}, \{E, \neg G\}, \{\neg L, N\}, \\
& \{\neg C, N\}, \{\neg D, E\}, \{\neg U, E\}, \\
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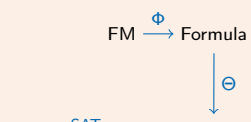

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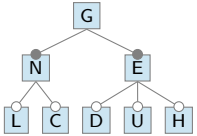

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Core Features

$\{G, N, E\}$

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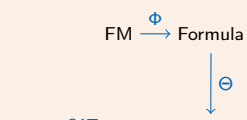

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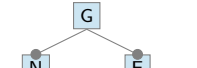

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Core Features

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Products in *FM*?

$\#SAT(\Theta(\Phi(FM)))$

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Feature Model Cardinality

8

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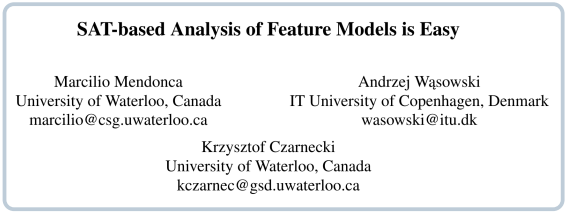

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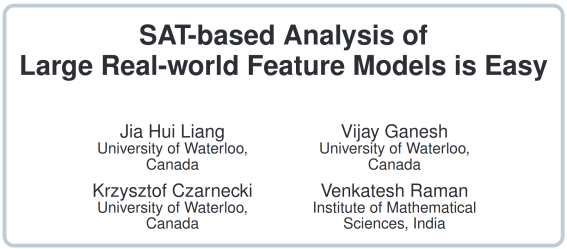

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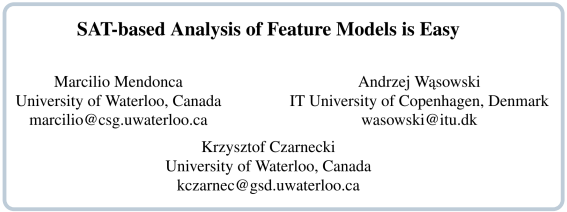

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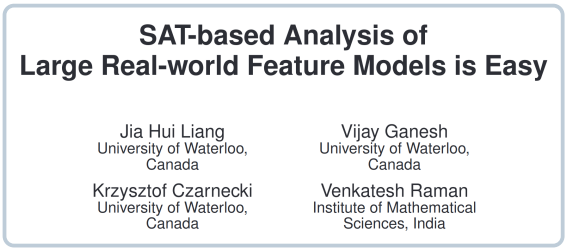

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as in

“performs much better than expected despite being NP-complete”

(because no phase transition is observed on typical feature models)

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- are **non-SAT analyses** also easy?
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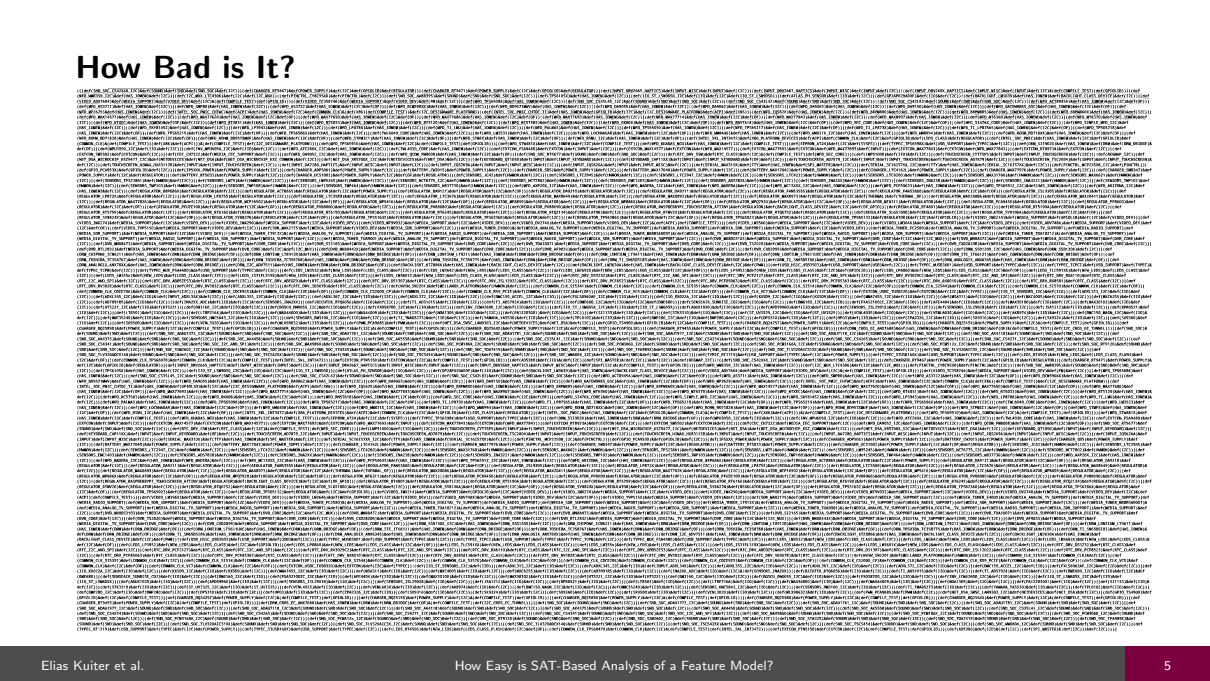

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- **Linux kernel**
- number of configurations **unknown** past 2007
- family-based type checking **infeasible** [ref]
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solvers get **faster** – but feature models grow **more complex**!

⇒ need better understanding of **feature-model complexity**

⇒ perspective shift to **instance-based meta-analysis**

Asking Meta-Analysis Questions

Feature-Model Meta-Analysis

the practice of **asking** and answering questions **about** feature-model analyses

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From Class-Based Meta-Analysis ...

... to Instance-Based Meta-Analysis

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... to Instance-Based Meta-Analysis

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... to Instance-Based Meta-Analysis

- "How much time does analysis X need on feature model Y when using solver Z?"
- "Which algorithm is most memory-efficient for computing X on Y?"

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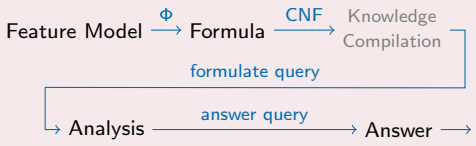

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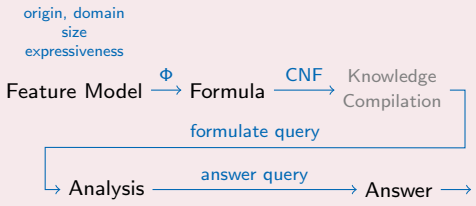

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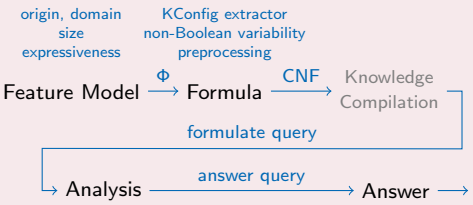

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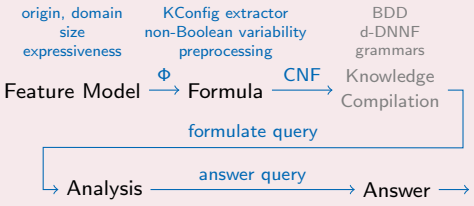

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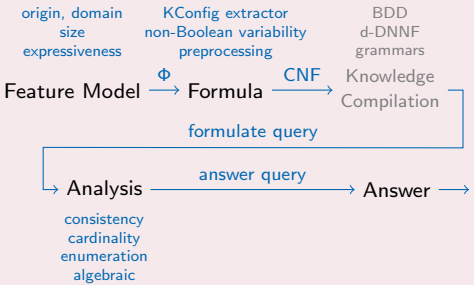

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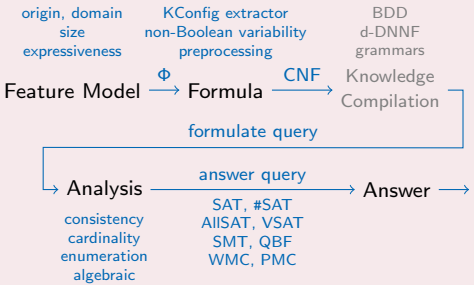

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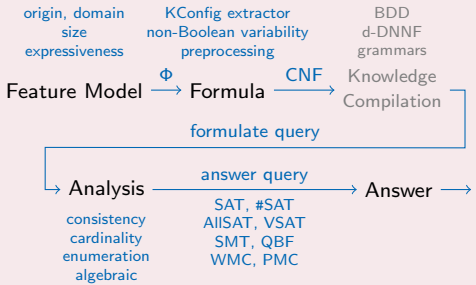

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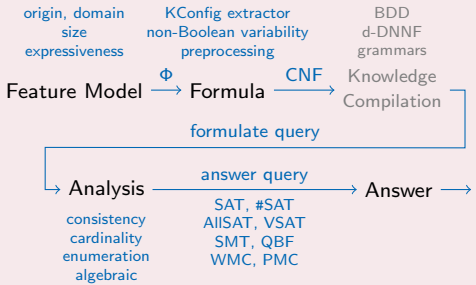

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for practical analysis tasks, there are many **analysis plans**

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Conclusion

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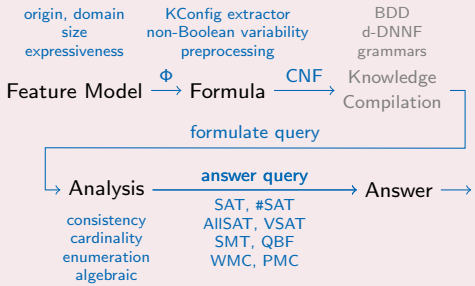

Your opinion?

Does feature-model complexity matter for your work?
Are you doing meta-analysis?
How would you answer a meta-analysis question?

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