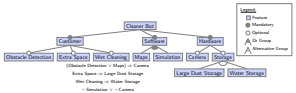
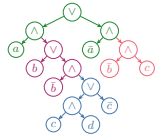


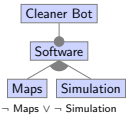
d-DNNF Compilation



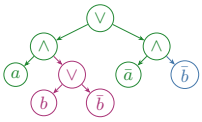
Slicing (Krieter 2016)

Projected d-DNNF Compilation

Slicing



d-DNNF Compilation (Darwiche 2002)



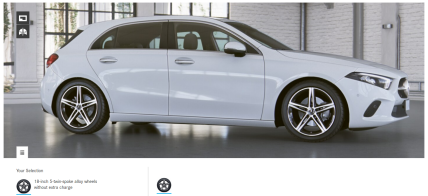
Efficient Slicing of Feature Models via Projected d-DNNF Compilation

ASE'24 Research Track | Chico Sundermann, Jacob Loth, Thomas Thüm | 2024/10/29

universität ulm

PADERBORN UNIVERSITY

Motivation Product Lines



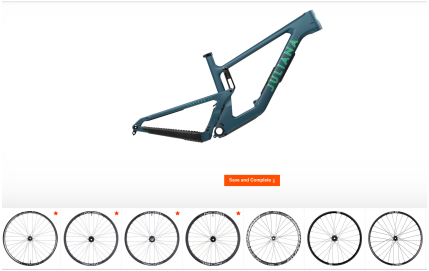
Motivation Product Lines

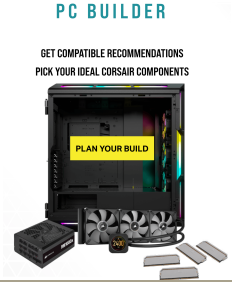
PC BUILDER

GET COMPATIBLE RECOMMENDATIONS

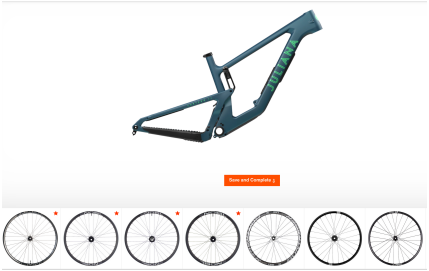
PICK YOUR IDEAL CORSAIR COMPONENTS

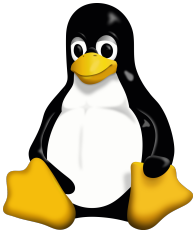
Motivation Product Lines



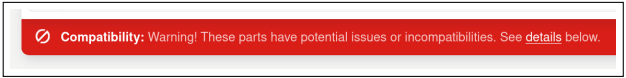


Motivation Product Lines

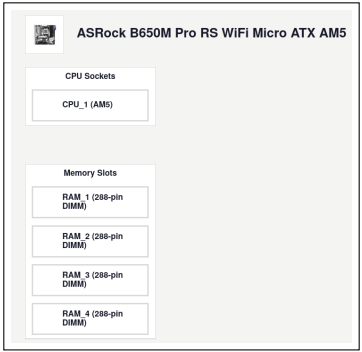




Motivation Feature Dependencies




```
config SECURITY_INFINIBAND
            bool "Infiniband Security Hooks"
            depends on SECURITY && INFINIBAND
```



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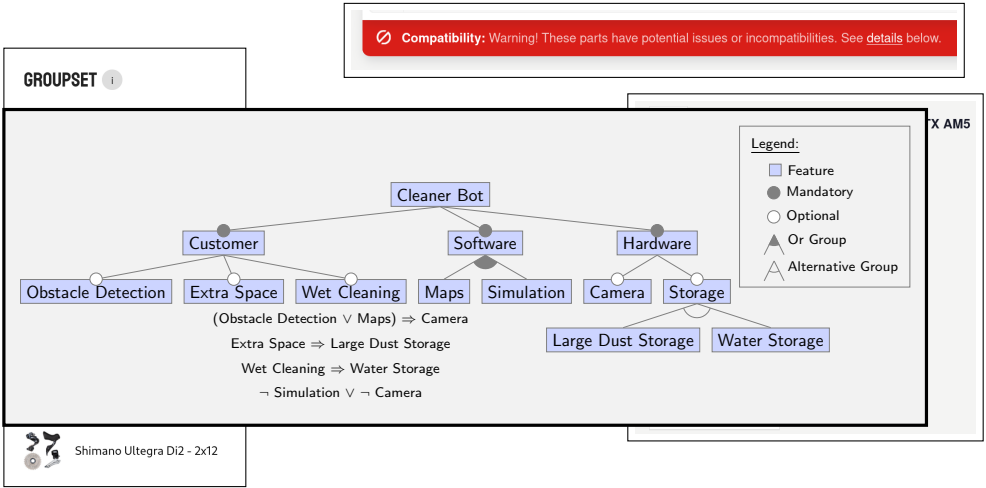
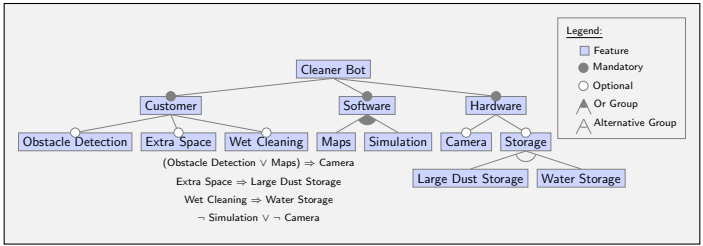
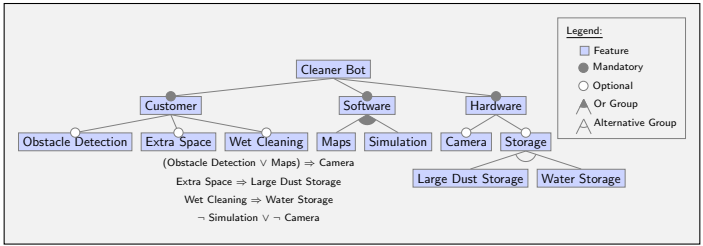


Motivation Plenty Analyses

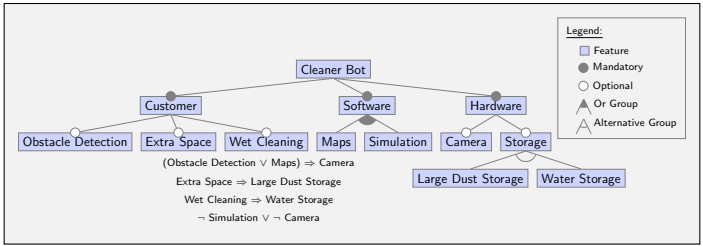


Motivation Plenty Analyses



Can we configure a robot?

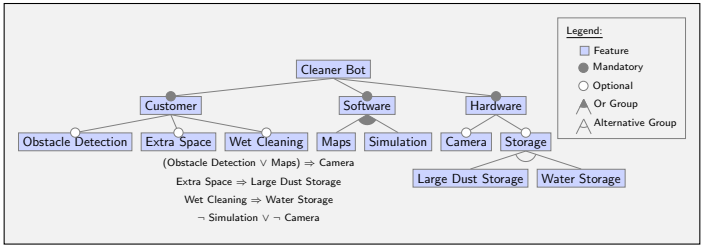
Motivation Plenty Analyses



Can we configure a robot?

Is there a robot with camera?

Motivation Plenty Analyses



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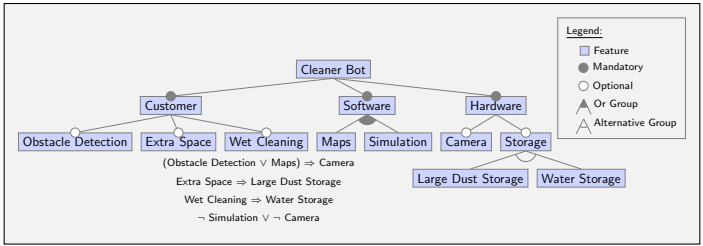

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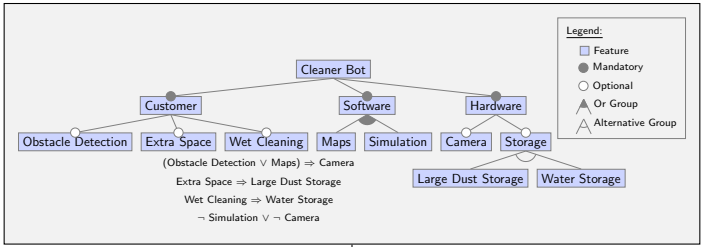

Customer ∧ Software ∧ (Maps ∨ Simulation) ∧ . . .

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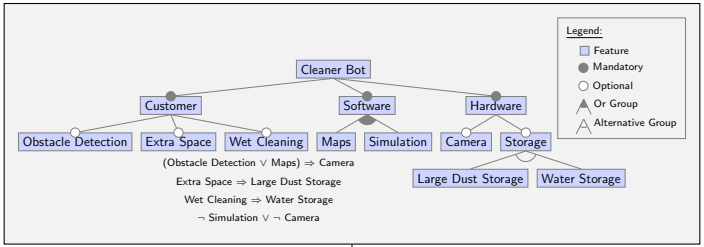

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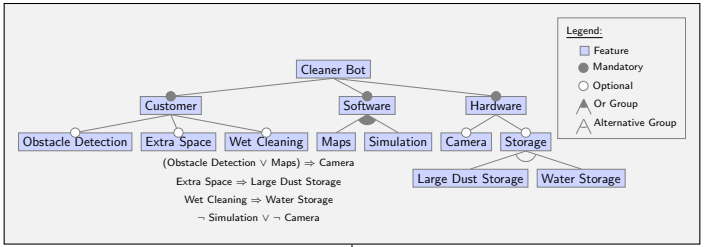

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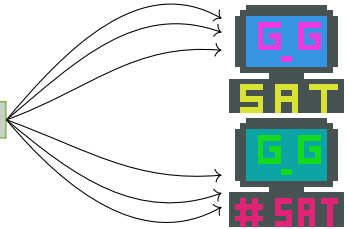
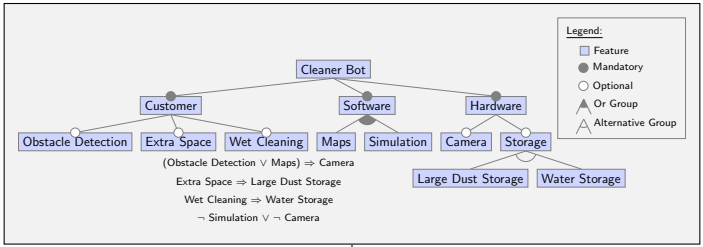
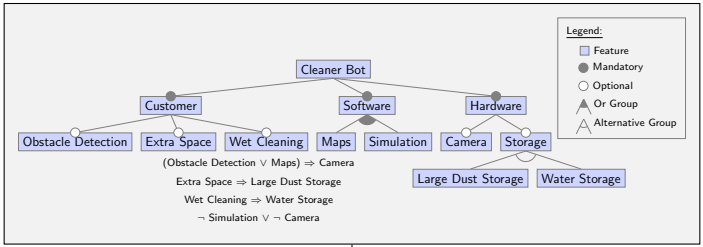


Motivation Knowledge Compilation



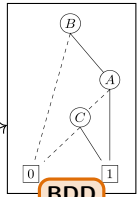
$$\text{Customer} \wedge \text{Software} \wedge (\text{Maps} \vee \text{Simulation}) \wedge \ldots$$

Motivation Knowledge Compilation



Customer ∧ Software ∧ (Maps ∨ Simulation) ∧ . . .

Compile



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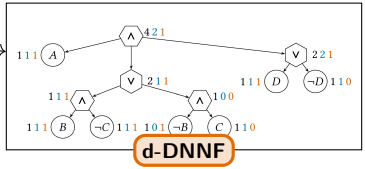

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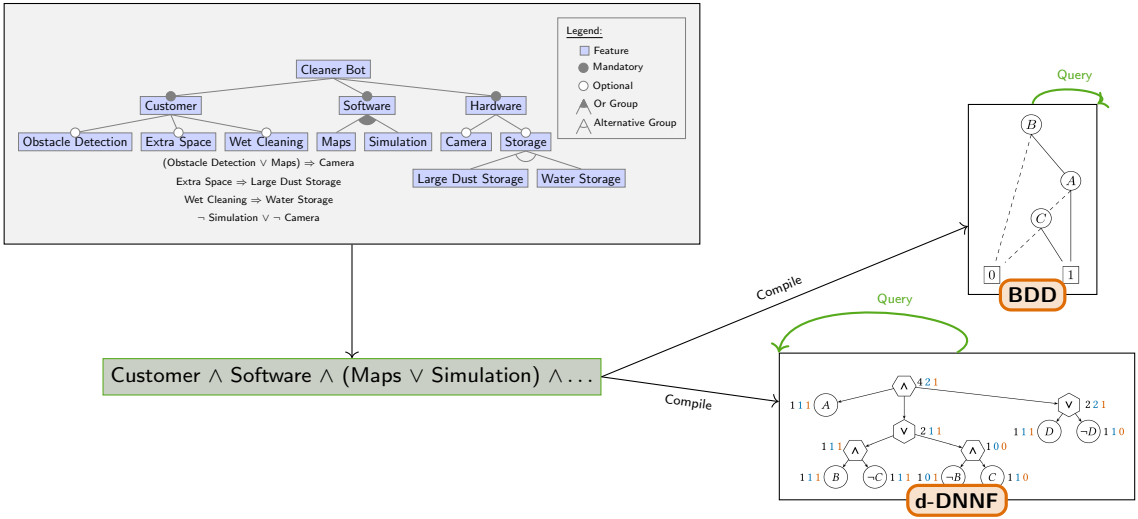
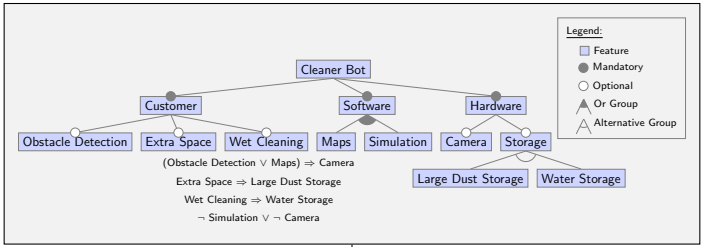


Motivation Knowledge Compilation



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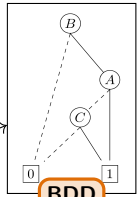

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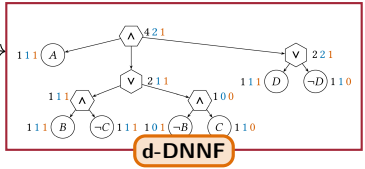
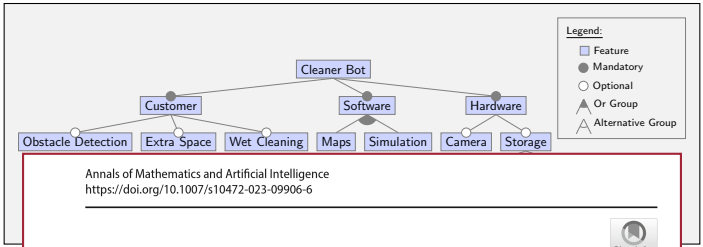


Motivation Knowledge Compilation



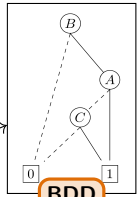
Annals of Mathematics and Artificial Intelligence
https://doi.org/10.1007/s10472-023-09906-6

Check for updates

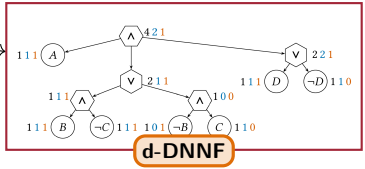
On the benefits of knowledge compilation for feature-model analyses

Chico Sundermann[1] · Elias Kuiter[2] · Tobias Heß[1] · Heiko Raab[1] · Sebastian Krieter[1] · Thomas Thüm[1]

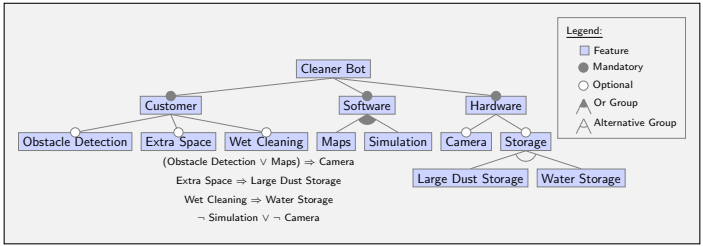
Compile



Compile



Decomposition for Stakeholders Slicing



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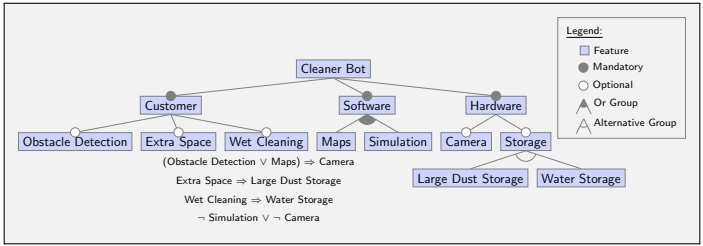

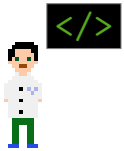

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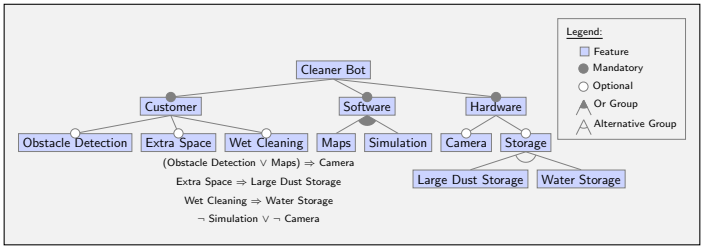

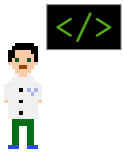

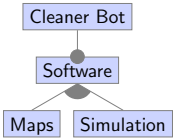

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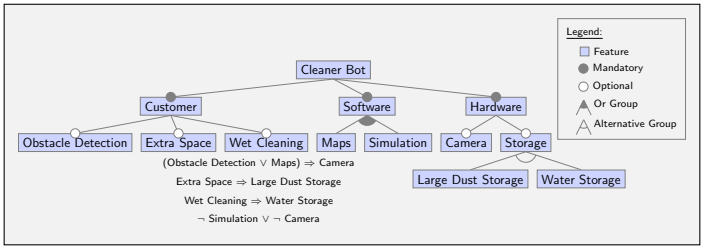

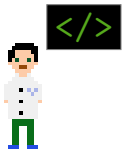

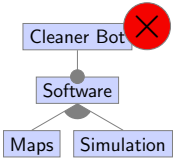

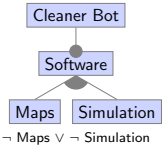

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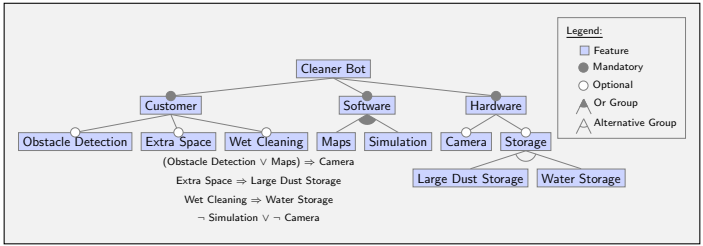

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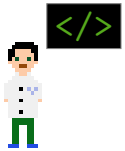
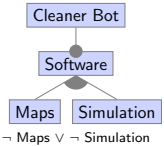
Is there a software with Maps?

Which software variants to test?





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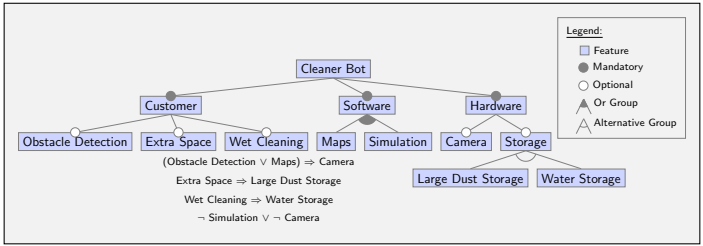

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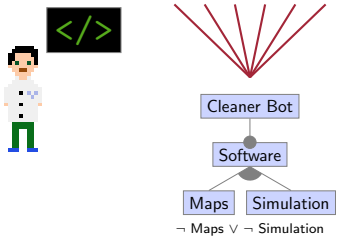

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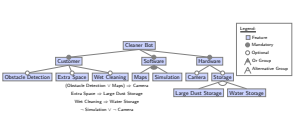
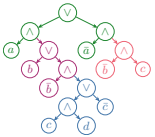


d-DNNF Compilation

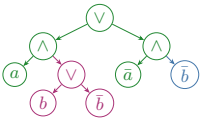


Slicing (Krieter 2016)

Slicing

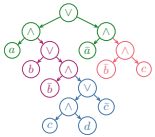
Cleaner Bot
Software
Maps
Simulation
¬ Maps ∨ ¬ Simulation

d-DNNF Compilation (Darwiche 2002)



Projected d-DNNF Compilation

d-DNNF Compilation



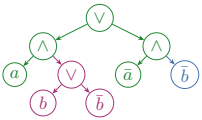
Slicing (Krieter 2016)

Projected d-DNNF Compilation

Slicing

Cleaner Bot
Software
Maps
Simulation
¬ Maps ∨ ¬ Simulation

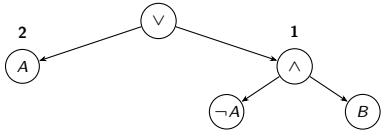
d-DNNF Compilation (Darwiche 2002)



How does this even work? d-DNNFs (Darwiche 2000)

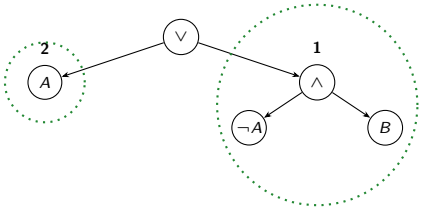
deterministic
decomposable
negation
normal
form

How does this even work? d-DNNFs (Darwiche 2000)



deterministic
decomposable
negation
normal
form

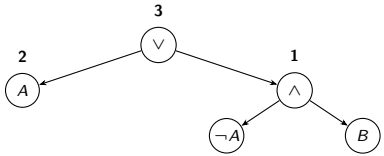
How does this even work? d-DNNFs (Darwiche 2000)



No shared solutions

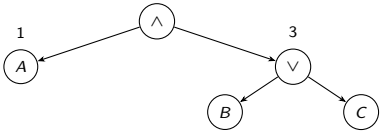
deterministic
decomposable
negation
normal
form

How does this even work? d-DNNFs (Darwiche 2000)



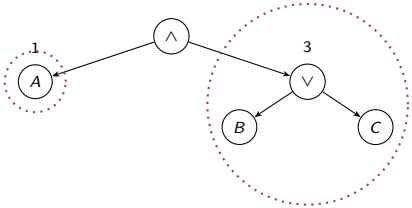
deterministic (Sum for ∨)
decomposable
negation
normal
form

How does this even work? d-DNNFs (Darwiche 2000)



deterministic (Sum for ∨)
decomposable
negation
normal
form

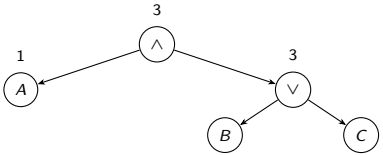
How does this even work? d-DNNFs (Darwiche 2000)



Independent
$\Rightarrow$ All pairs valid

deterministic (Sum for $\vee$)
decomposable
negation
normal
form

How does this even work? d-DNNFs (Darwiche 2000)

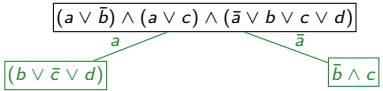


deterministic (Sum for $\vee$)
decomposable (Product for $\wedge$)
negation
normal
form

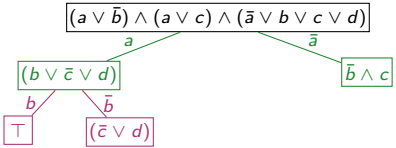
Regular d-DNNF Compilation

$$\boxed{(a \vee \bar{b}) \wedge (a \vee c) \wedge (\bar{a} \vee b \vee c \vee d)}$$

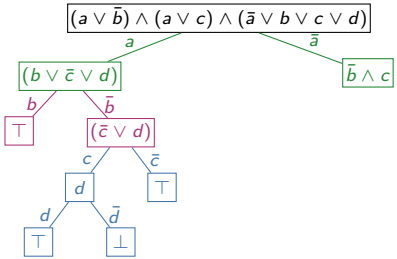
Regular d-DNNF Compilation



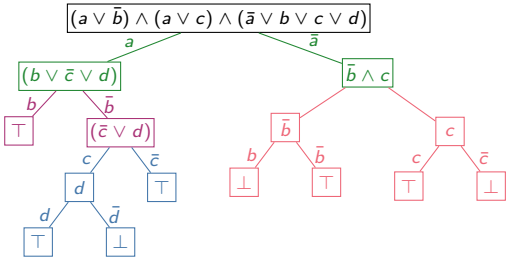
Regular d-DNNF Compilation



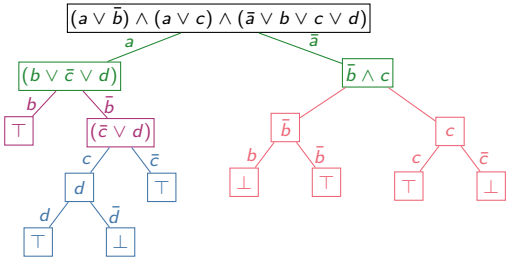
Regular d-DNNF Compilation

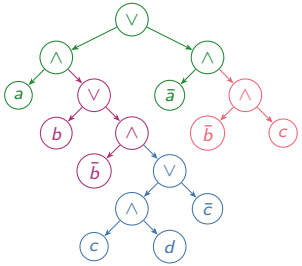


Regular d-DNNF Compilation



Regular d-DNNF Compilation





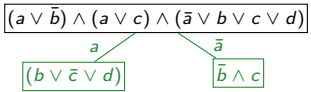
Projected d-DNNF Compilation

Slice c and d

$$(a \vee \bar{b}) \wedge (a \vee c) \wedge (\bar{a} \vee b \vee c \vee d)$$

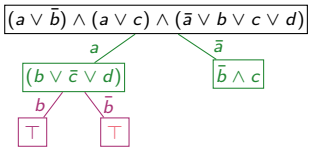
Projected d-DNNF Compilation

Slice c and d



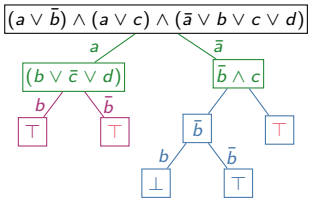
Projected d-DNNF Compilation

Slice c and d



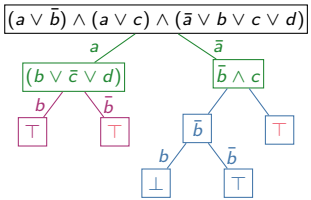
Projected d-DNNF Compilation

Slice c and d



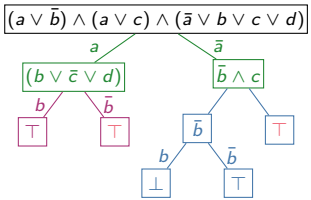
Projected d-DNNF Compilation

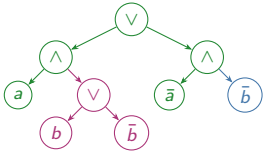
Slice c and d



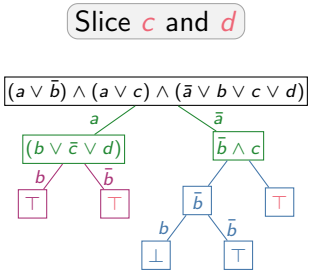
Projected d-DNNF Compilation

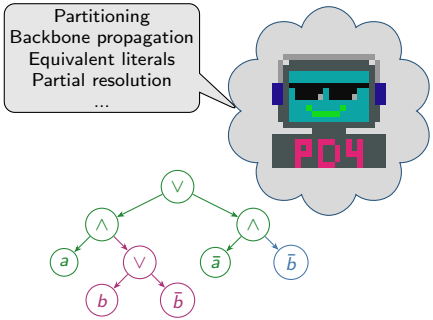
Slice c and d





Projected d-DNNF Compilation





Projected d-DNNF Compilation — Evaluation

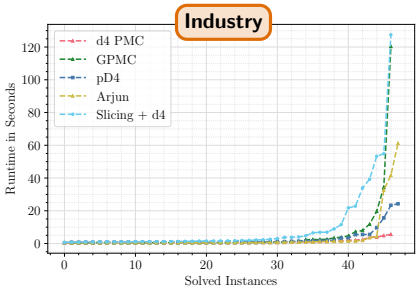
Instances

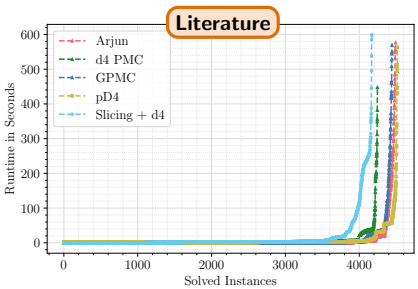
Track	Instances	Variables	Clauses
Industrial Models & Slices	$12 \cdot 4$	376–3,286	1,015–51,450
Literature Models & Random Slices	$49 \cdot 100$	17–62,482	16–350,221
Model Counting Competition Instances	200	100–3,423,788	545–6,163,392

Tools

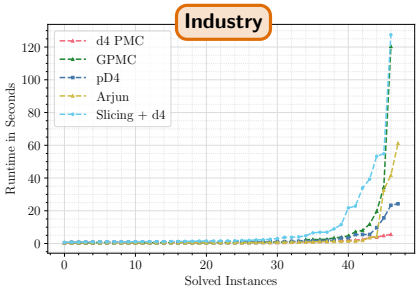
Name	Type	Origin
pd4	Projected d-DNNF Compiler	This work
Slicing FeatureIDE (v3.10)	Slicer via Resolution	[Krieter et al.(2016)]
d4 (v2)	d-DNNF Compiler	[Lagniez and Marquis(2017)]
GPMC (v1.1.1)	Projected Model Counter	[Fichte et al.(2021)]
d4-pmc (v2)	Projected Model Counter	[Lagniez and Marquis(2017)]
arjun (MCC Version)	Projected Model Counter	[Sharma et al.(2019), Soos and Meel(2022)]

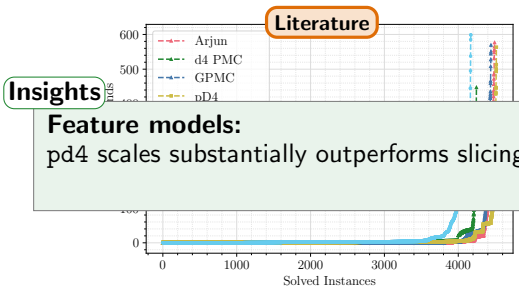
Projected d-DNNF Compilation Performance





Projected d-DNNF Compilation Performance



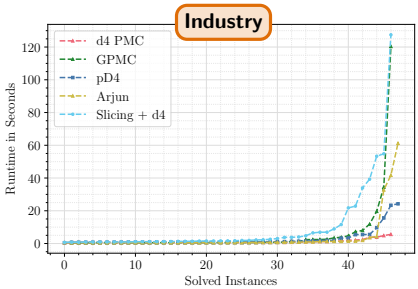


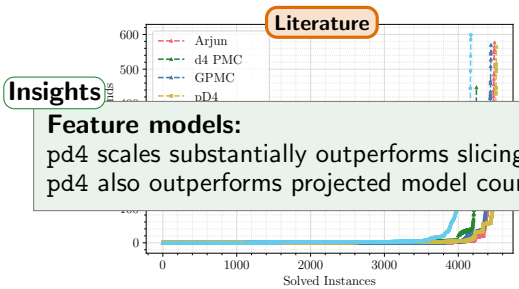
Insights

Feature models:
pd4 scales substantially outperforms slicing

Projected d-DNNF Compilation

Performance

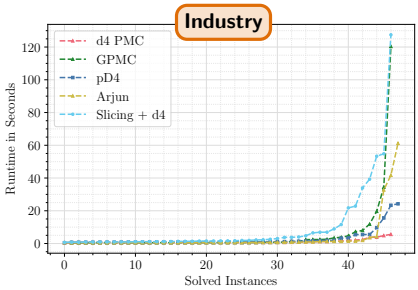


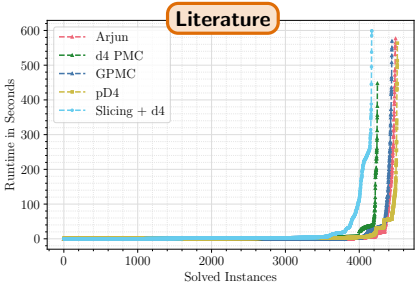


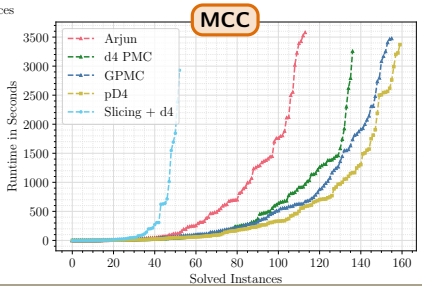
Insights

Feature models:
pd4 scales substantially outperforms slicing
pd4 also outperforms projected model counters

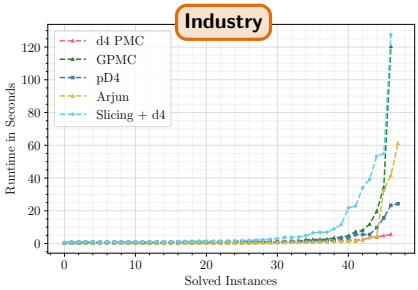
Projected d-DNNF Compilation Performance

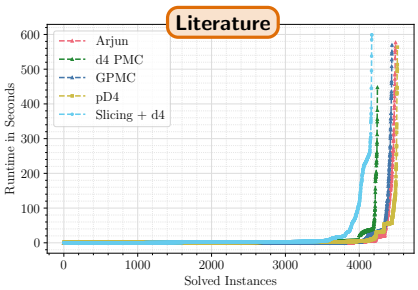


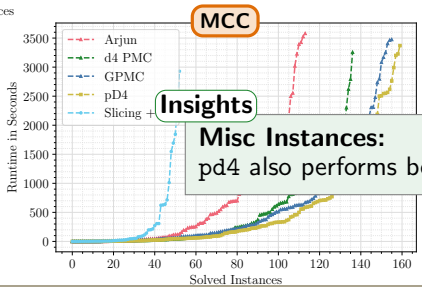




Projected d-DNNF Compilation Performance



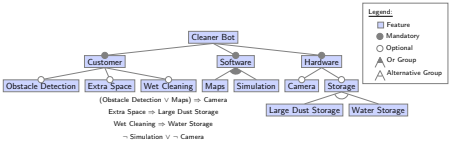




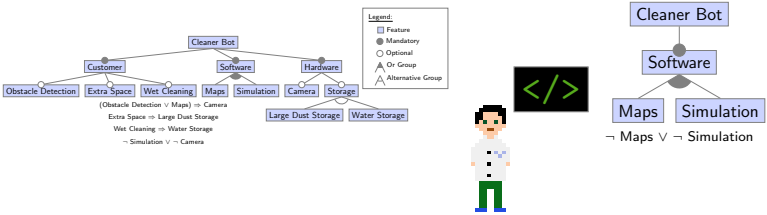
Insights

Misc Instances:
pd4 also performs best

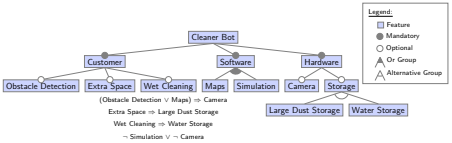
Efficient Slicing of Feature Models via Projected d-DNNF Compilation

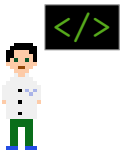


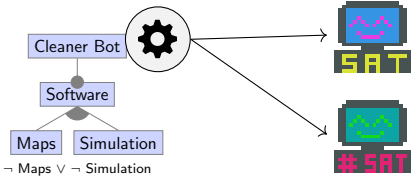
Efficient Slicing of Feature Models via Projected d-DNNF Compilation



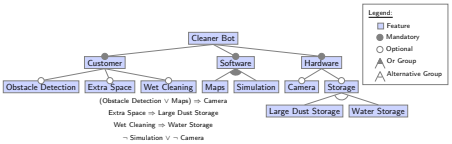
Efficient Slicing of Feature Models via Projected d-DNNF Compilation

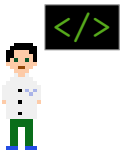


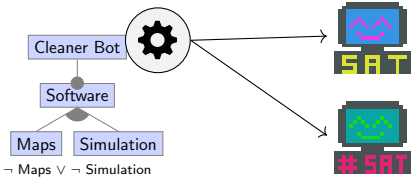


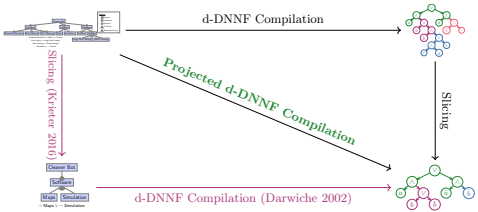


Efficient Slicing of Feature Models via Projected d-DNNF Compilation

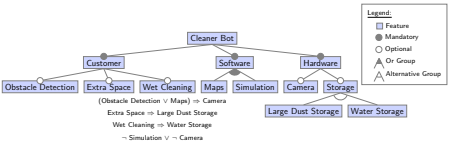


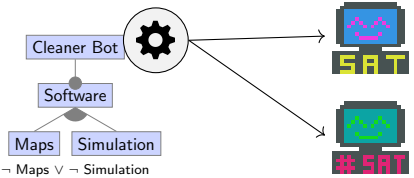


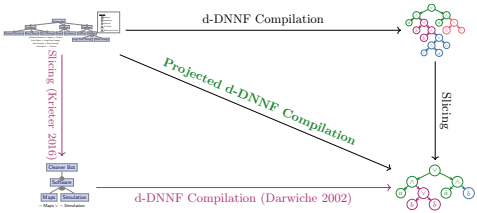


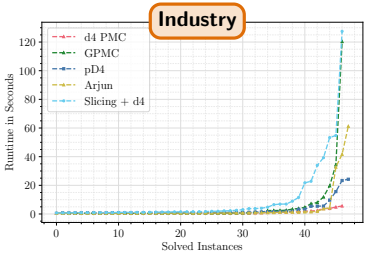


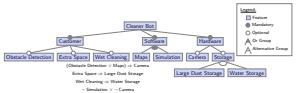
Efficient Slicing of Feature Models via Projected d-DNNF Compilation



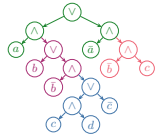








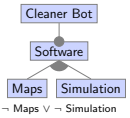
d-DNNF Compilation



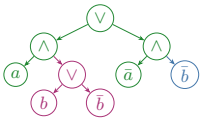
Slicing (Krieter 2016)

Projected d-DNNF Compilation

Slicing



d-DNNF Compilation (Darwiche 2002)



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