How to Complete an
Interactive Configuration Process?
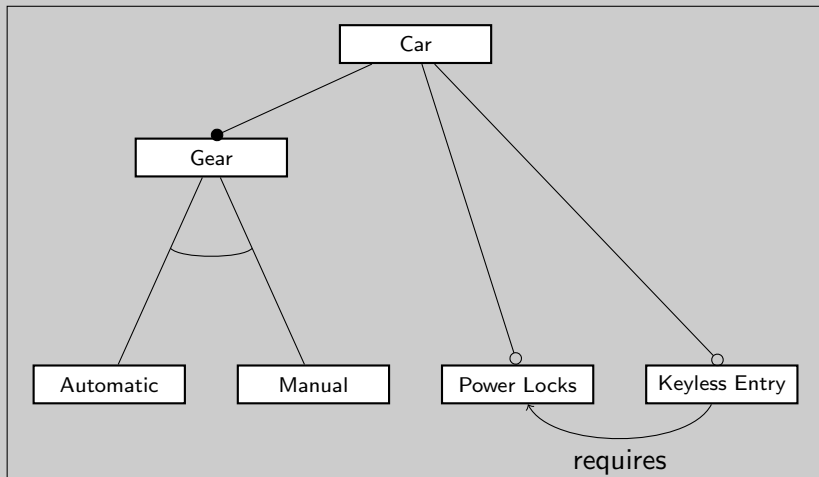
<u>Mikoláš Janota</u>   Goetz Botterweck
Radu Grigore   Joao Marques-Silva

Lero
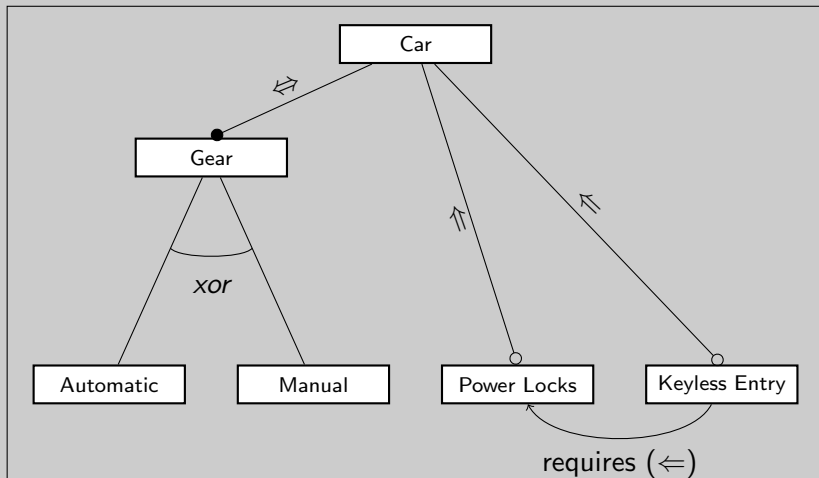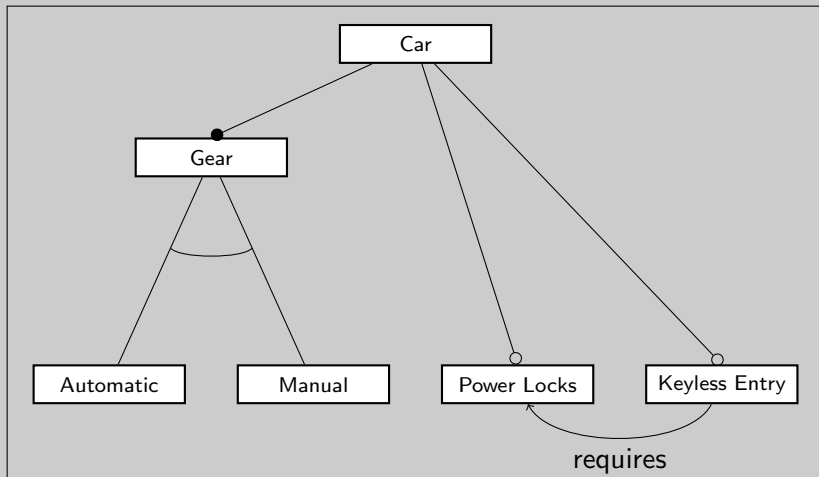University College Dublin
Ireland

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Feature Diagrams

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Configuration

Legend

Configuration

Configuration

Configuration

Car

Gear

Automatic   Manual   Power Locks   Keyless Entry

requires
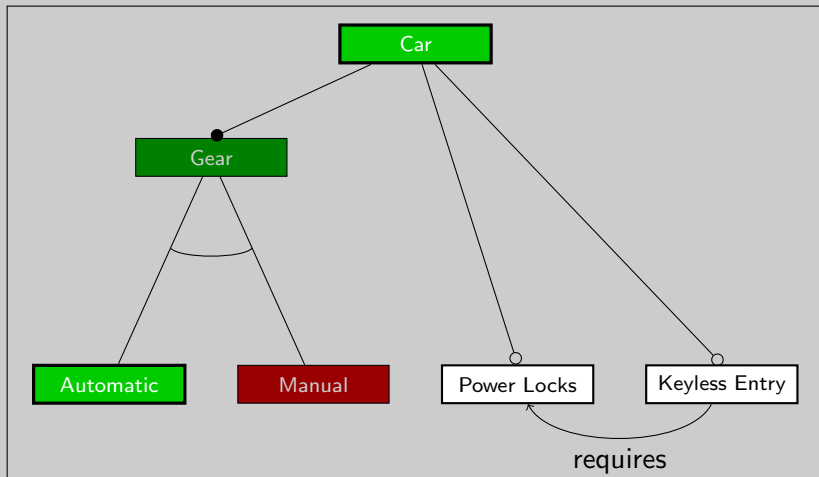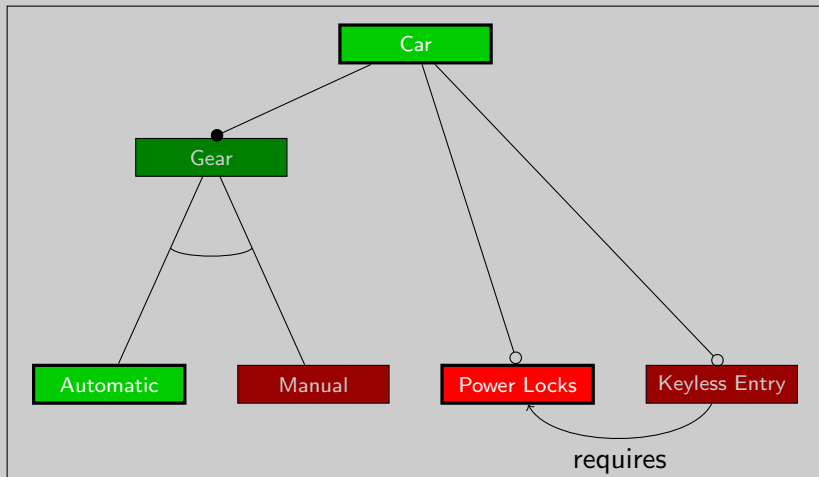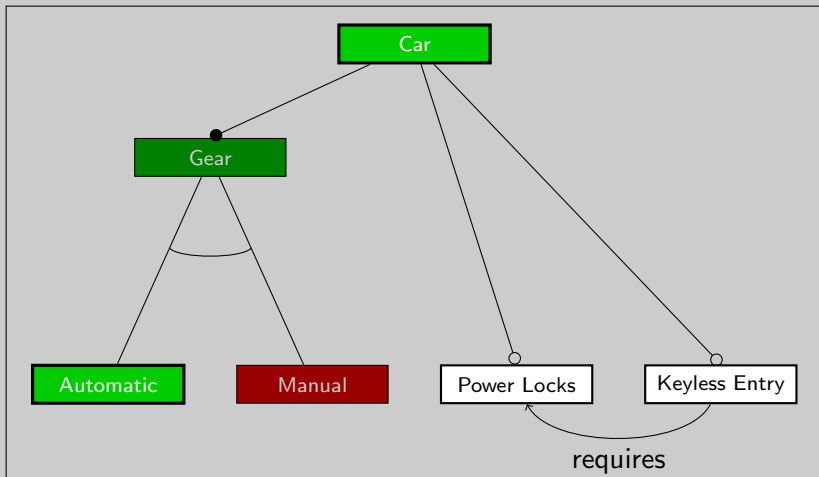
Legend

Selection   Deselection   Autoselect   Autodeselect

"I'm Done"

Legend
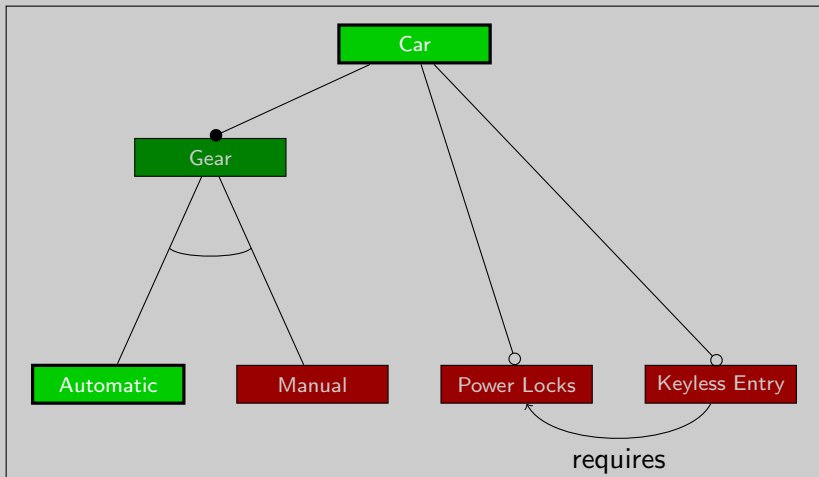
| Selection | Deselection | Autoselect | Autodeselect |

"I'm Done" sometimes doesn't work
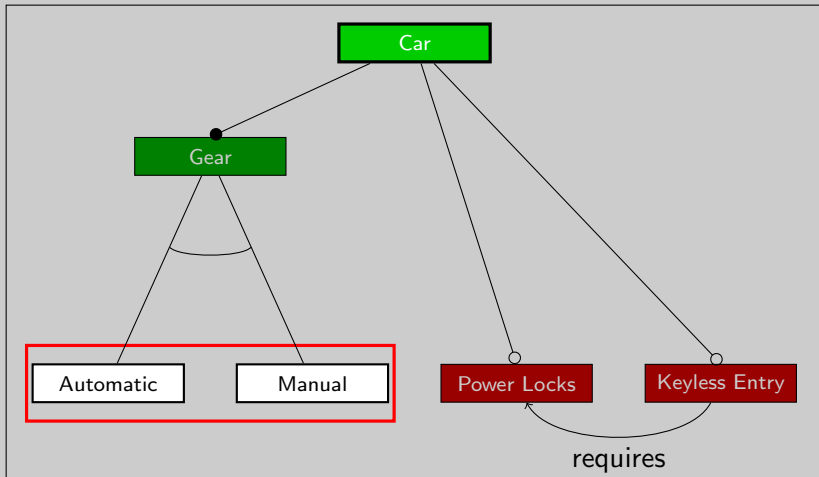
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How is a configuration process completed?

Conditions

- All features must have a value.
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- **manual** — user fills in everything
- **blind completion** — automated tool fills in everything
- **smart completion** — automated tool fills as much as possible *without making decisions* for the user

Smart Completion
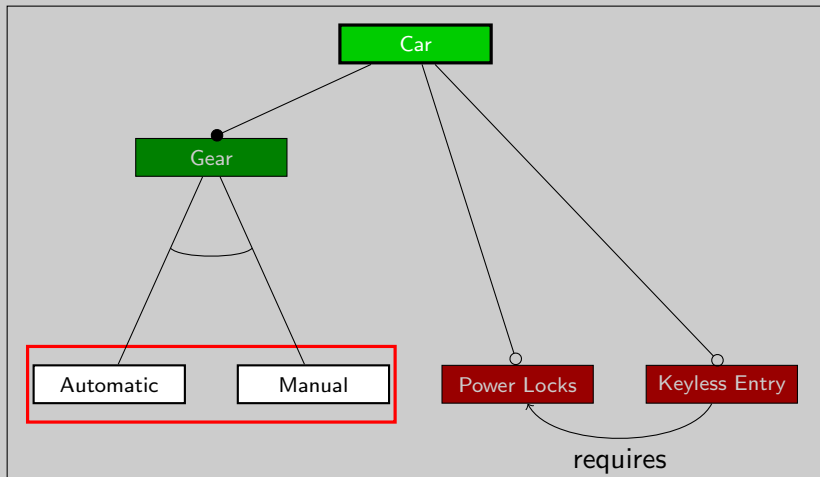
Decisions and Dispensable Variables

- A set of variables is deselectable *iff* they can be all deselected all at once.

$$\mathcal{D}(\phi, X) \stackrel{\text{def}}{=} SAT \left(\phi \land \bigwedge_{v \in X} \neg v \right)$$

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  1. X it is not deselectable.
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- A variable is **dispensable** *iff* it does not belong to any set that must be decided.

Examples

$\mathbf{x} \vee \mathbf{y} \vee \mathbf{z}$

- Deselectable: $\{x, y\}$, $\{x, z\}$, $\{y, z\}$, $\{x\}$, $\{y\}$, $\{z\}$, and $\emptyset$
- Not deselectable: $\{x, y, z\}$
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$(\mathbf{x} \Rightarrow (\mathbf{y} \vee \mathbf{z})) \wedge \mathbf{x}$

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Relation to Minimal Models

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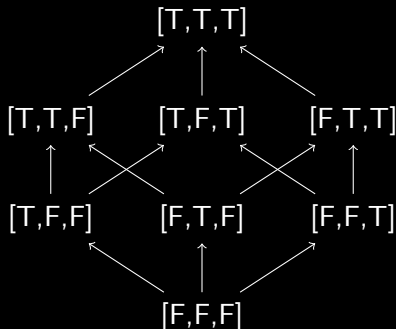
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Relation to Minimal Models

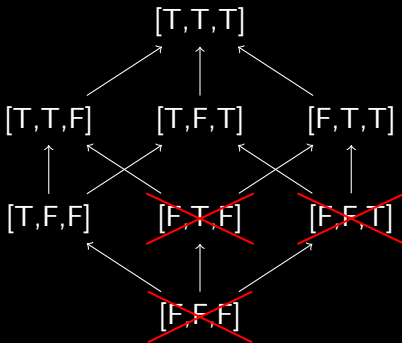- A model of a formula is (point-wise) minimal *iff* flipping some **T**rue values to **F**alse, yields a non-model.

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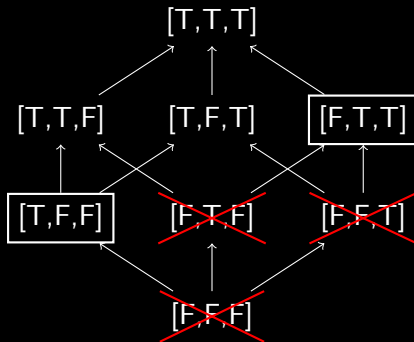
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T	F	F
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$x \Rightarrow (y \lor z)$

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Non-monotonic Reasoning

- Propositional Circumscription
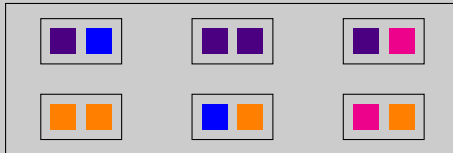
$$\phi \models_{\min} \psi$$

- Generalized Closed World Assumption (GCWA)

What about non-boolean configuration?

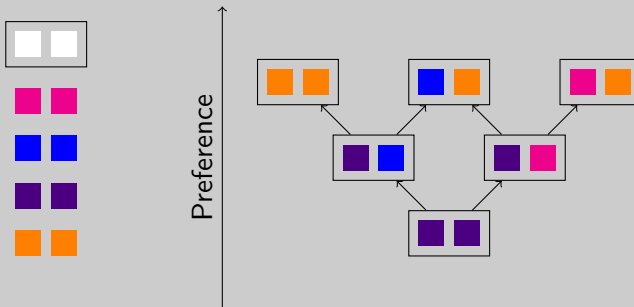- For a general set of possibilities, it is hard to help the user.

Allowed Possibilities

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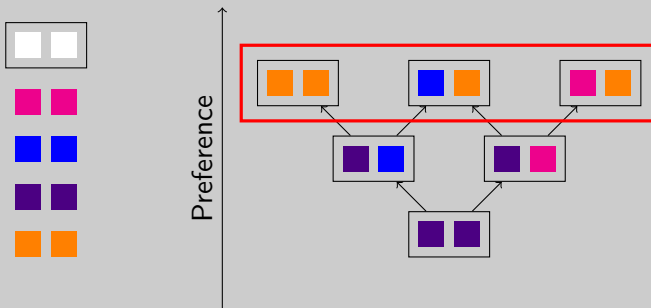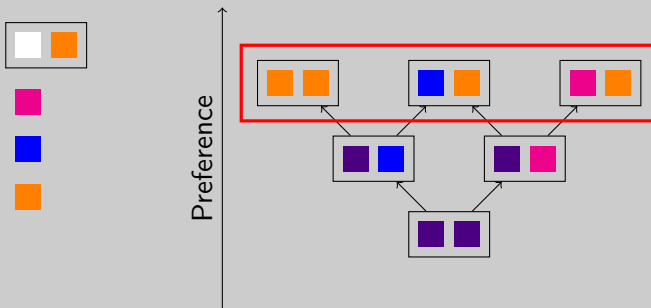- We can focus on the most preferred possibilities.

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Settled Values and Dispensable Variables

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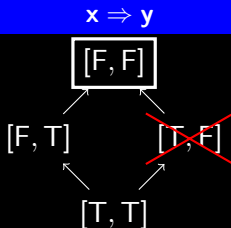## Settled Values and Dispensable Variables

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x ⇒ y

$[F, F]$

$[F, T]$ $[T, F]$

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- In configuration of Boolean constraints it led to defining dispensable variables.
- Dispensable variables are closely related to CWA.
- In non-Boolean case, smart completion can be provided in the presence of preference.
- Dispensable variables can be seen as a *preference for deselecting*.
- Analogously CWA as a preference for False.

Experimental Results

Name	Features	Clauses	Length	Done	Minimal models
tightvnc	21	22	5.5	5.5	1.0 ± 0.0
apl	27	41	12.2	11.9	1.0 ± 0.0
gg4	58	139	10.0	3.8	15.3 ± 22.6
berkeley	94	183	26.6	17.9	1.7 ± 1.1
violet	170	341	56.1	47.1	1.6 ± 0.9
E-shop	287	420	143	N/A	N/A