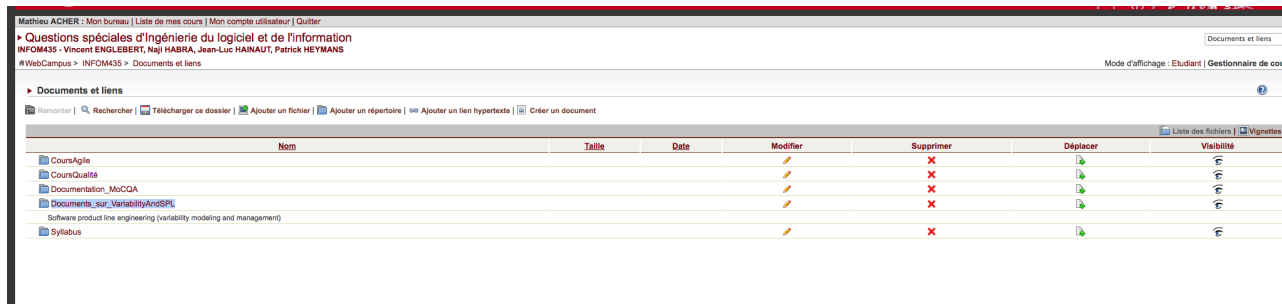




University of Namur
PReCISE Research Centre

Material

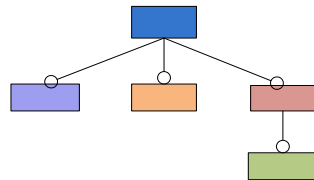
- http://www.fundp.ac.be/etudes/cours/page_view/INFOM435/
 - Folder: “Documents_sur_VariabilityAndSPL”
 - Slides, exercises, evaluation



- Email: macher@fundp.ac.be

Previously

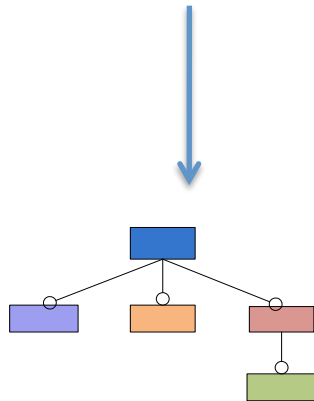
- **Feature Models (FMs)**
- **Practice**
 - Existing car configurators
 - TVL (FM language)
 - FAMILIAR (FM management)



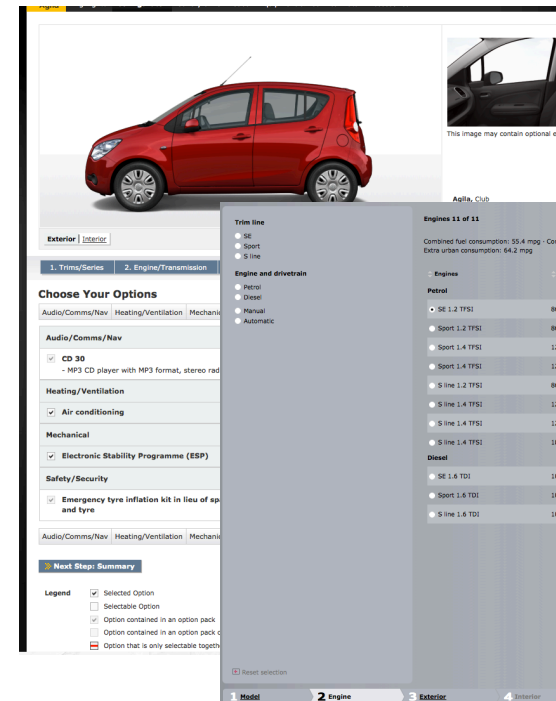
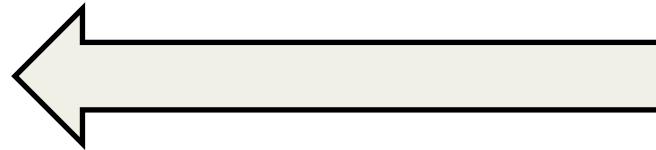
Feature Model

Previously

Language (TVL, FAMILIAR)



Feature Model

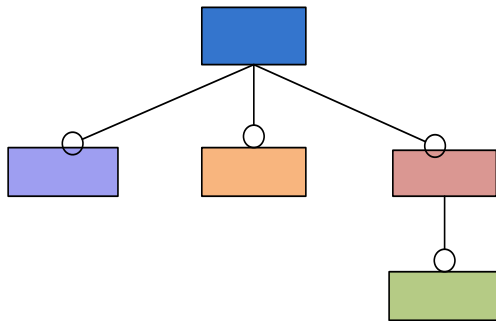


Automated reasoning

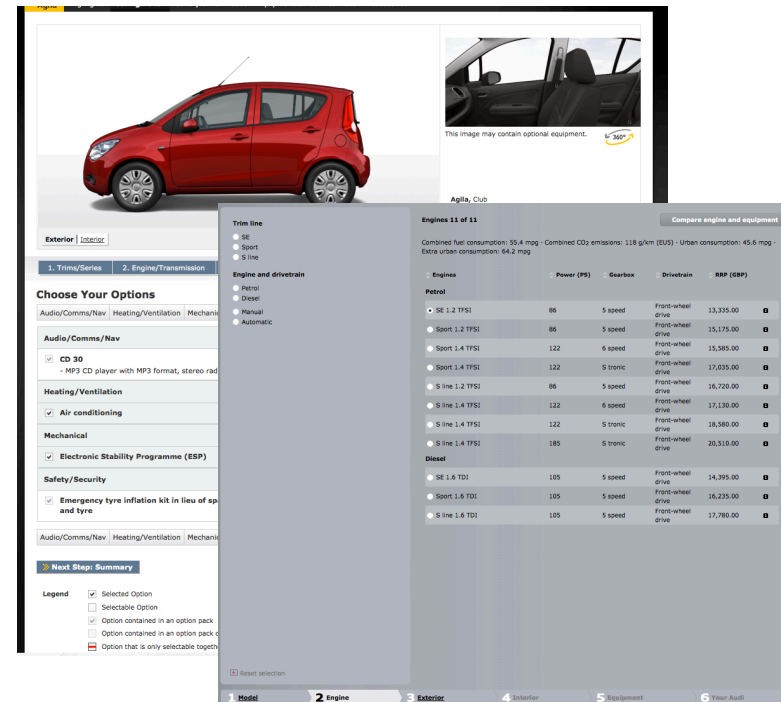
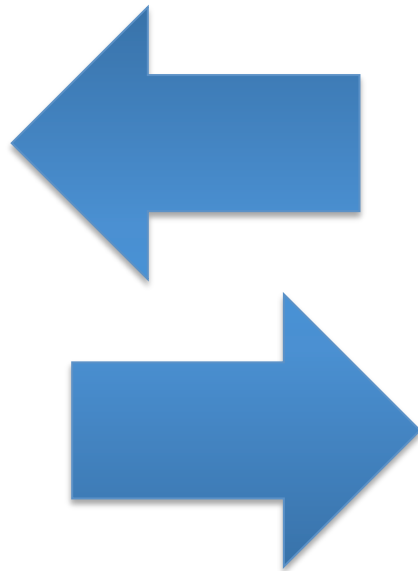


Running project

- Re-engineer a car configurator
 - we are making some progress, right?



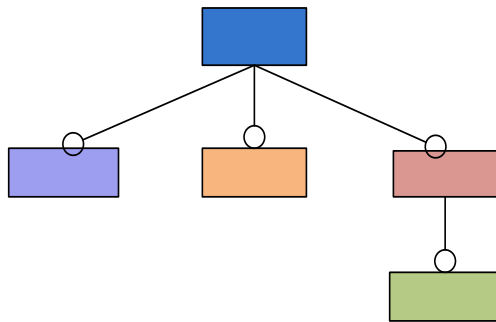
**Variability Model
(Feature Model)**



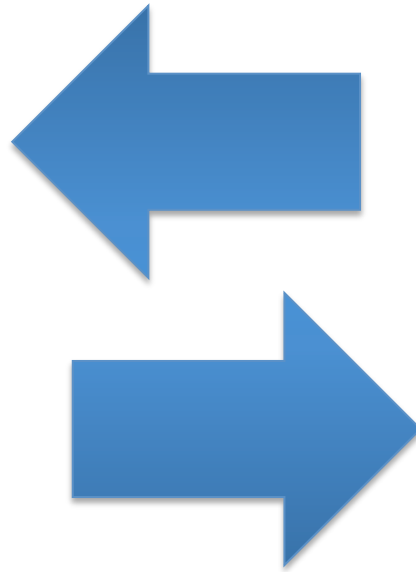
Today

- Back to our modeling experience
 - Feature model management (FAMILIAR)
 - Support to better understand and play with your specification
 - Existing techniques can be considered in your work (merging)
 - Building views (slicing)
- Project
 - Re-engineering configurators
 - « reverse engineering » + « engineering »
 - Now: From feature models to configurators
 - Model-based approach

Running project



**Variability Model
(Feature Model)**



Choose Your Options

Audio/Comms/Nav | Heating/Ventilation | Mechanical

☒ CD 30
- MP3 CD player with MP3 format, stereo radio

Heating/Ventilation

☒ Air conditioning

Mechanical

☒ Electronic Stability Programme (ESP)

Safety/Security

☒ Emergency tyre inflation kit in lieu of spare tyre

Audio/Comms/Nav | Heating/Ventilation | Mechanical

Next Step: Summary

Legend

- ☒ Selected Option
- ☐ Selectable Option
- ☒ Option contained in an option pack
- ☐ Option contained in an option pack (not selectable)
- ☐ Option that is only selectable together

Engines 11 of 11

Engines	Power (PS)	Gears	Drivetrain	RSP (GBP)
Petrol				
SE 1.2 TFSI	86	5 speed	Front-wheel drive	13,335.00
Sport 1.2 TFSI	86	5 speed	Front-wheel drive	15,175.00
Sport 1.4 TFSI	122	6 speed	Front-wheel drive	15,585.00
Sport 1.4 TFSI	122	5 tronic	Front-wheel drive	17,035.00
S line 1.2 TFSI	86	5 speed	Front-wheel drive	16,720.00
S line 1.4 TFSI	122	6 speed	Front-wheel drive	17,130.00
S line 1.4 TFSI	122	5 tronic	Front-wheel drive	18,580.00
S line 1.4 TFSI	185	5 tronic	Front-wheel drive	20,510.00
Diesel				
SE 1.6 TDI	105	5 speed	Front-wheel drive	14,395.00
Sport 1.6 TDI	105	5 speed	Front-wheel drive	16,235.00
S line 1.6 TDI	105	5 speed	Front-wheel drive	17,780.00

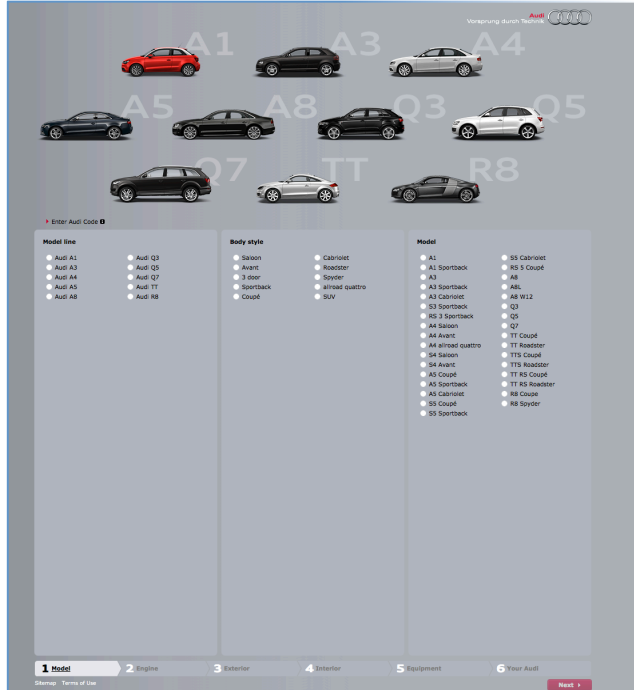
1 Model **2 engine** 3 Exterior 4 Interior 5 Equipment 6 Your Audi

Running project

- 70% of the final mark
- Expected output
 - Configurator artefacts (source code, metamodels/models, demo)
 - Presentation
 - “defense”
- Good properties
 - Solution that works
 - Reusable artefacts
 - Customizable solution
 - Close to existing configurator (“re-engineering”)
 - Or even better: “better”

Running project

- 1 configurator by group
 - the one you previously chose
- Expected
 - (mandatory) all configuration options in one place
 - (optional) “views”
 - Different containers / tabs / pages
 - Wizards (linear/sequential configuration process)



From feature models to configurators

- Configurator?
 - Graphical user interface (GUI)
 - Assist users
 - Select/deselect options
 - Propagation of choices
- Feature model?
 - Representation of the configuration “space”
 - Not a visually attractive solution!
- Filling the gap

The image shows two screenshots of a car configurator interface. The top screenshot displays the '1. Trims/Series' tab with radio button options: S (from € 19,495.00), SC (selected, from € 21,195.00), SRI (from € 22,495.00), SE (from € 23,495.00), and Elite (from € 25,495.00). Below this is a 'Standard Equipment Filter' dropdown set to 'Heating/Ventilation', followed by a section titled 'Heating/Ventilation' showing '- Air conditioning with particle filter, manual controls'. The bottom screenshot shows the '4. Options' tab with sub-tabs: Interior, Comfort/Convenience, Option Packs, Safety/Security (selected), Seating, and Audio/Comms/Nav. Under 'Safety/Security', there are five options with checkboxes: 'Emergency tire inflation kit' (checked, Standard), 'Active front seat head restraints' (unchecked, € 103.00, with a note '- also adds seat belt unfastened warning light for front passenger's seat'), 'Front and rear parking distance sensors' (unchecked, € 407.00), 'Tyre Pressure Monitoring System' (checked, € 155.00), and 'Remote control ultrasonic security alarm system' (unchecked, € 357.00).

1. Trims/Series	2. Engine/Transmission	3. Colour & Style	4. Options	5. Summary
<input type="radio"/> S				from € 19,495.00
<input checked="" type="radio"/> SC				from € 21,195.00
<input type="radio"/> SRI				from € 22,495.00
<input type="radio"/> SE				from € 23,495.00
<input type="radio"/> Elite				from € 25,495.00

Standard Equipment Filter: Heating/Ventilation

Heating/Ventilation

- Air conditioning with particle filter, manual controls

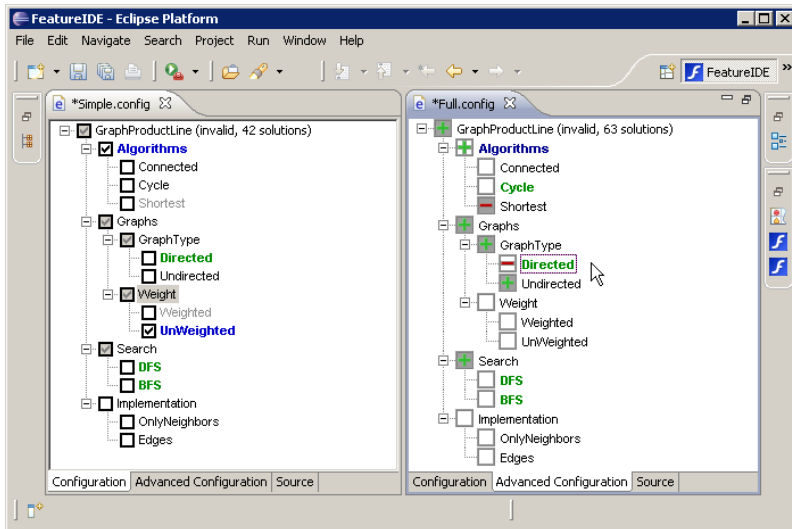
1. Trims/Series	2. Engine/Transmission	3. Colour & Style	4. Options	5. Summary	
Interior	Comfort/Convenience	Option Packs	Safety/Security	Seating	Audio/Comms/Nav
Heating/Ventilation	Mechanical	A-Z			

Safety/Security

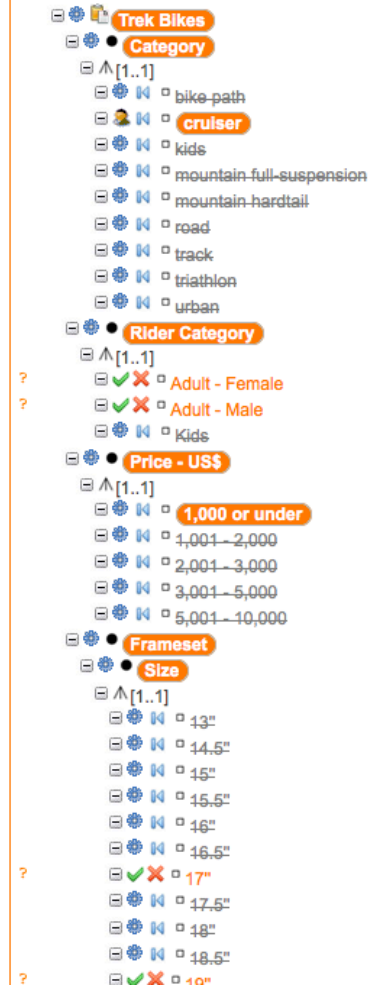
<input checked="" type="checkbox"/> Emergency tire inflation kit	Standard
<input type="checkbox"/> Active front seat head restraints - also adds seat belt unfastened warning light for front passenger's seat	€ 103.00
<input type="checkbox"/> Front and rear parking distance sensors	€ 407.00
<input checked="" type="checkbox"/> Tyre Pressure Monitoring System	€ 155.00
<input type="checkbox"/> Remote control ultrasonic security alarm system	€ 357.00

From feature models to configurators

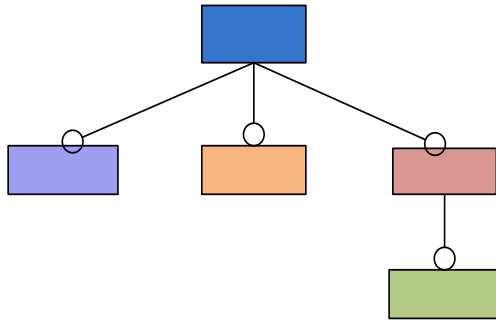
- Something like this



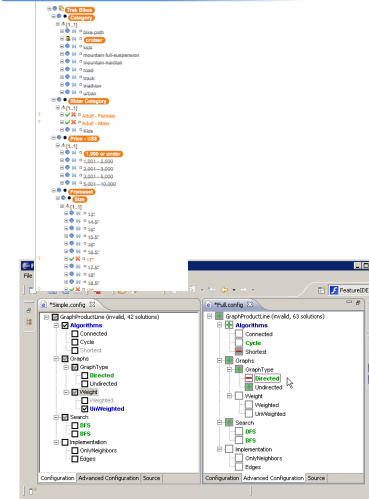
FEATURE MODEL



Generic, flexible solution



Feature Model



1. Trim/Style	2. Engine/Transmission	3. Colour & Style	4. Option	5. Summary
<input type="radio"/> S				from € 19,455.00
<input type="radio"/> SE				from € 21,155.00
<input type="radio"/> SE				from € 23,455.00
<input type="radio"/> SE				from € 25,455.00
<input type="radio"/> SE				from € 25,455.00

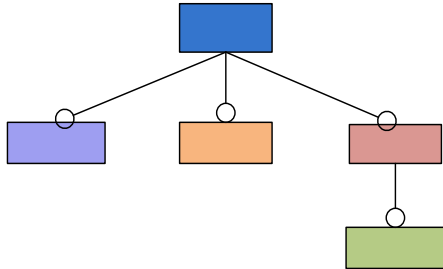
Standard Equipment Filter: Heating/Ventilation

Heating/Ventilation

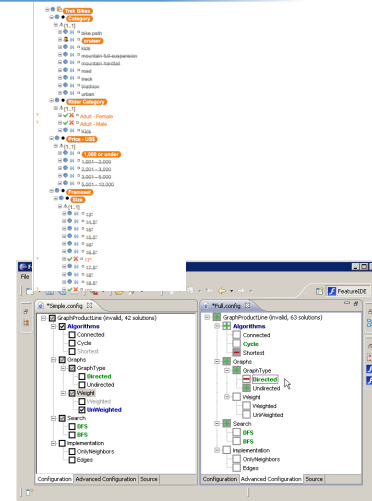
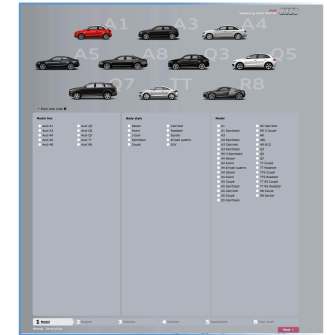
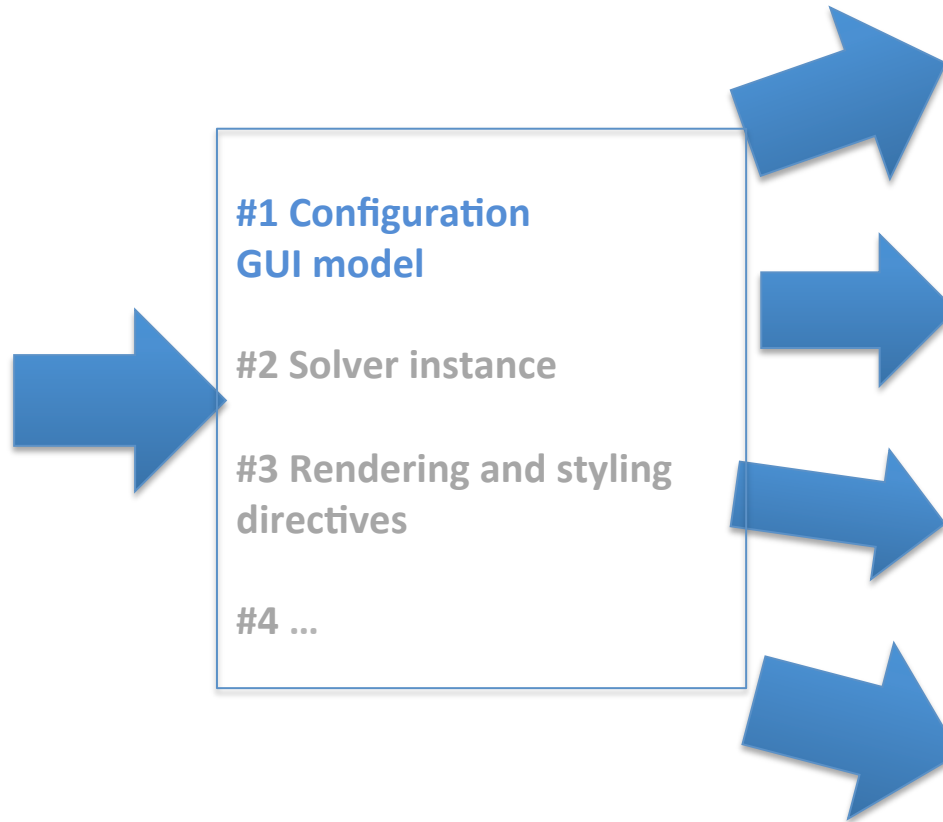
- Air conditioning with particle filter, manual controls

1. Trim/Style	2. Engine/Transmission	3. Colour & Style	4. Option	5. Summary
Interior Comfort/Convenience Option Packs Safety/Security Seating Audio/Comm/Nav				
Heating/Ventilation Mechanical A-Z				
Safety/Security				
<input checked="" type="checkbox"/>	Emergency tire inflation kit			Standard
<input checked="" type="checkbox"/>	Active front seat head restraints			€ 103.00
- also also seat belt unlatched warning light for front passenger's seat				
<input type="checkbox"/>	Front and rear parking distance sensors			€ 467.00
<input checked="" type="checkbox"/>	Tyre Pressure Monitoring System			€ 158.00
<input type="checkbox"/>	Remote control ultrasonic security alarm system			€ 357.00

Model-based approach



Feature Model



1. Trim/Style	2. Engine/Transmission	3. Colour & Style	4. Options	5. Summary
<input type="radio"/> S				from € 19,495.00
<input type="radio"/> SC				from € 23,595.00
<input type="radio"/> SRI				from € 23,495.00
<input type="radio"/> SE				from € 23,495.00
<input type="radio"/> EDC				from € 25,495.00

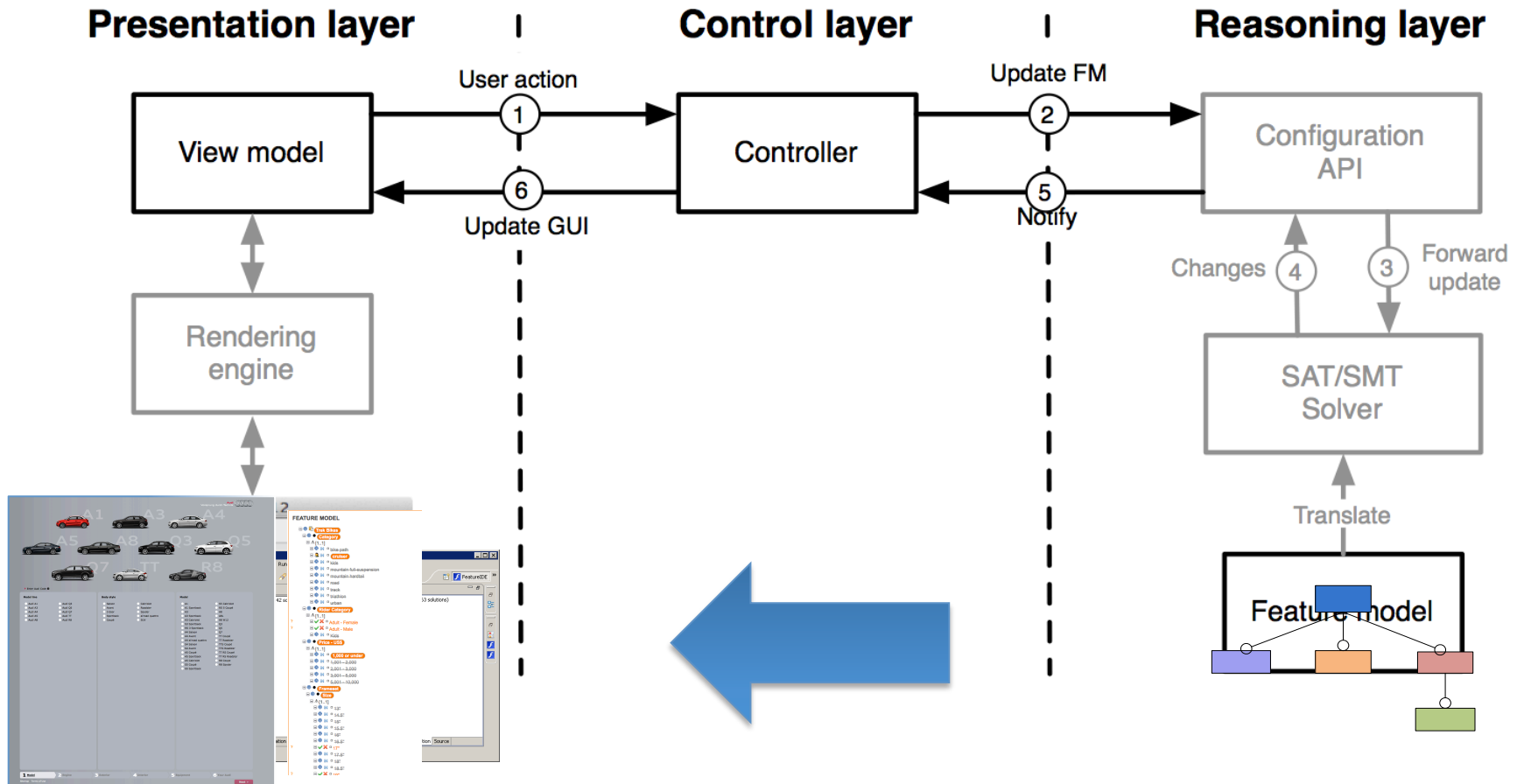
Standard Equipment Filter: Heating/Ventilation

Heating/Ventilation

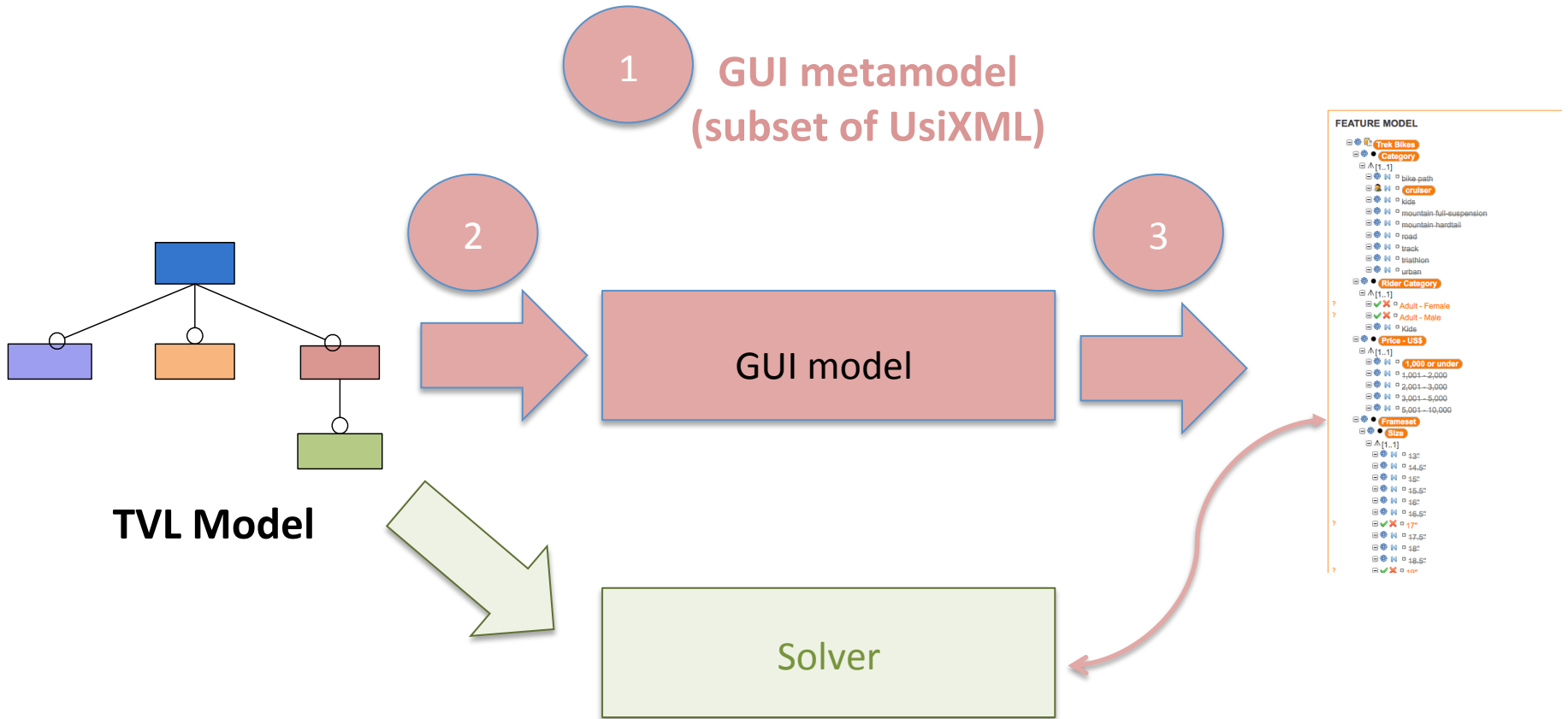
Air conditioning with particle filter, manual controls

1. Trim/Style	2. Engine/Transmission	3. Colour & Style	4. Options	5. Summary
Interior / Comfort/Convenience / Option Packs / Safety/Security / Seating / Audio/Comms/Nav				
Heating/Ventilation / Mechanical / A-Z				
Safety/Security				
<input checked="" type="checkbox"/> Emergency tire inflation kit Standard				
<input checked="" type="checkbox"/> Active front seat head restraints - also adds seat belt unlatched warning light for front passenger's seat € 193.00				
<input type="checkbox"/> Front and rear parking distance sensors € 497.00				
<input checked="" type="checkbox"/> Tyre Pressure Monitoring System € 155.00				
<input type="checkbox"/> Remote control ultrasonic security alarm system € 357.00				

MVC Architecture



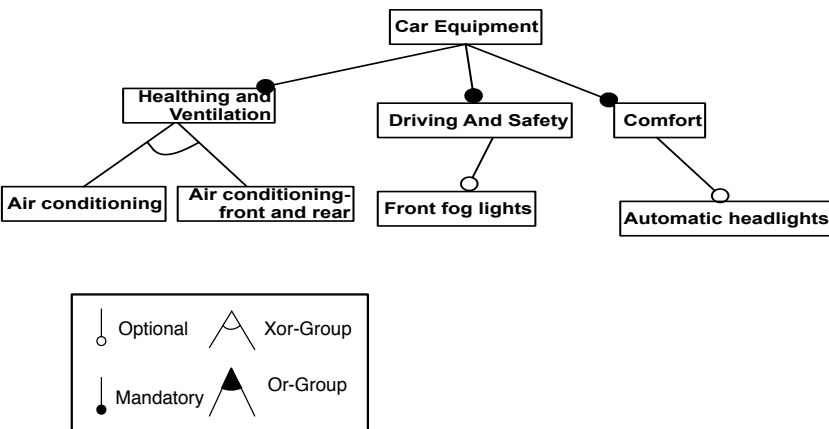
Model-based approach



Hierarchy: rooted tree

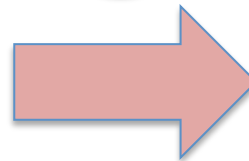
Variability:

- mandatory,
- optional,
- Groups: exclusive or inclusive features
- Cross-tree constraints



TVL-2-GUIModel Transformation

2



1

GUI metamodel (subset of UsiXML)



RENAULT VANS

CARS | VANS | ELECTRIC VEHICLES | RENAULT BUSINESS | USED CARS | OWNE

Renault UK > Renault Vans > New Kangoo Van Range > Kangoo Van > E

NEW KANGOO VAN RANGE

01 Preferences

02 Version

< Previous

> Next

OPTIONS

> AUDIO EQUIPMENT

- ☐ 4x20W radio CD MP3 Bluetooth with aux point and integrated display **£125.00**

> COMFORT

- ☐ Height adjustable drivers seat **£50.00**
- ☐ Climate control **£800.00**
- ☒ Central storage console & armrest between seats **£50.00**

> DRIVING

- ☐ Automatic headlights & wipers **£100.00**
- ☐ Glazed Tailgate and rear wiper **£150.00**
- ☐ Engine Speed Limiter (56mph/90kmh) **£50.00**
- ☐ Engine Speed Limiter (62mph/100kmh) **£50.00**

Concrete GUI (one technological space)

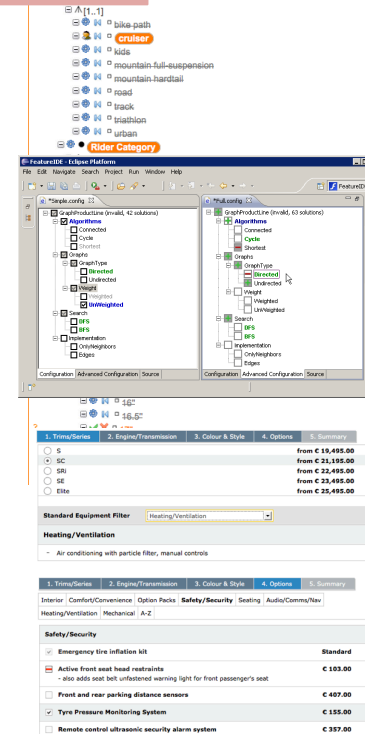
1 GUI metamodel
(subset of UsiXML)

GUIModel-2-concrete
Transformation

3

GUI model

Solver



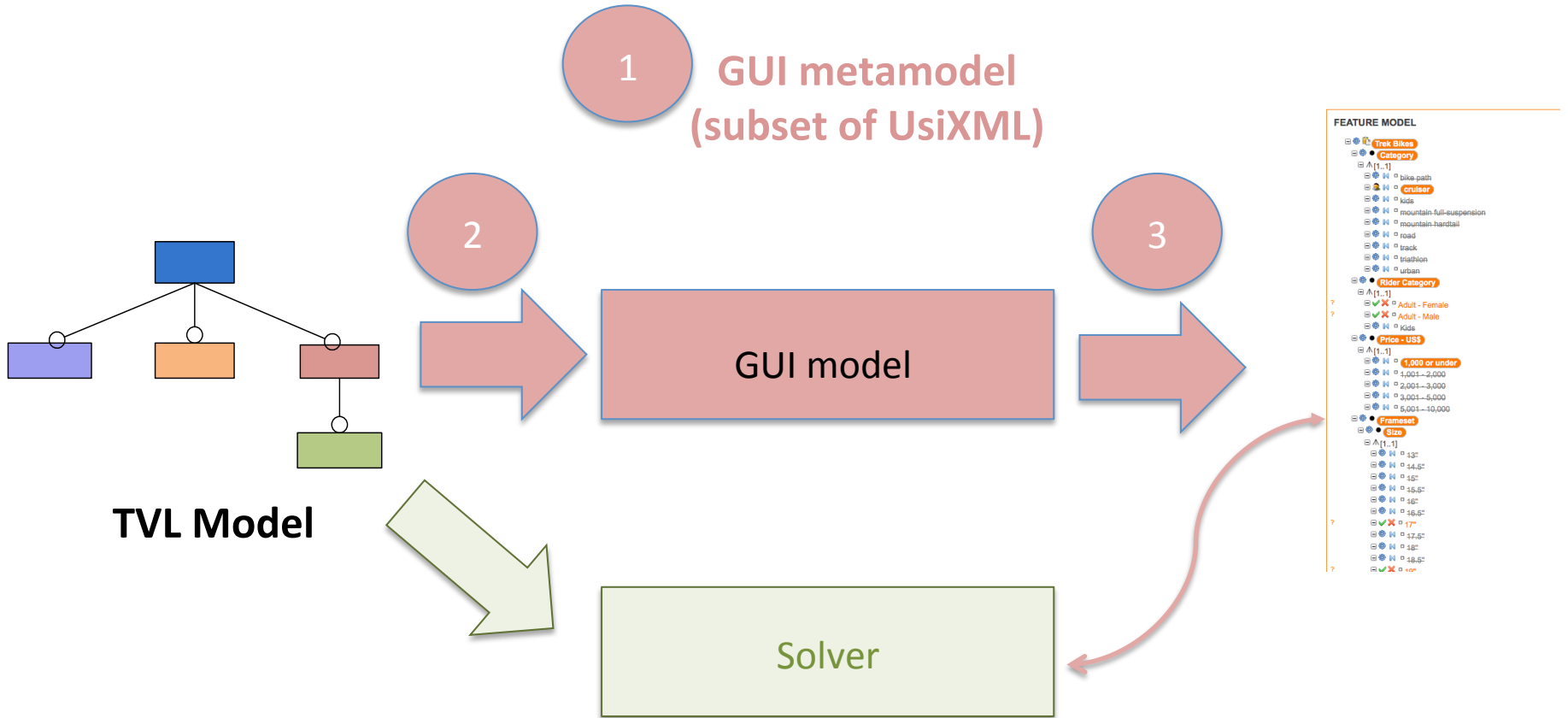
Running project

- Expected output
 - Configurator artefacts
 - TVL-2-GUIModel transformation
 - “generic rules”
 - API of TVL
 - metamodels/models
 - Analysis of your configurator and your technological space
 - Ideally: subset of UsiXML
 - Ideally(2): merge your efforts
 - GUIModel-2-concrete transformation
 - Connection with the solver
- Presentation
 - “Defense” (20’ + 10’ questions)
 - demo
 - Don’t forget to report on “open issues” or “difficult problems”

Running project

- Good properties
 - Solution that works
 - Reusable artefacts
 - Customizable solution
 - Close to existing configurator (“re-engineering”)
 - Or even better: “better”
- Be incremental
 - Simple metamodel, simple transformations
 - Working solution ASAP
 - then you can tackle more difficult problems
- Collaborative effort
 - Within the group
 - 3 main steps... but inter-related
 - (optional) Between the groups
 - Identify similarities (metamodel?) / reusable artefacts

Today



Ecore metamodel (Eclipse modeling)

Suggestion: all members should work on a first version of the metamodel (MM)

Simple MM first, then one member of the group focusing on UsiXML