Product Customization as Linked Data

François-Paul Servant (francois-paul.servant@renault.com)
Edouard Chevalier (edouard.chevalier@renault.com)
01 Publishing descriptions of customizable products
A challenging issue

02 Configuration as Linked Data
The Configuration Ontology

03 Use cases, applications
and benefits
Publishing product descriptions on the web of data

- has recently gained momentum
  - schema.org
  - GoodRelations

- Use rich data for Web marketing

- in order to increase the visibility of commercial offers
  - talking to all kinds of devices and agents
  - search engines, price comparators, recommendation applications
  - SEO ("search engine optimization")
The pleasure of finding things out: the best short works of...
by Richard Phillips Feynman, Jeffrey Robbins - Basic Books (2005.04.06) - paperback - 288
The Pleasure of Finding Things Out is a magnificent treasury of the best short works of Richard P. Feynman—from interviews and speeches to...
★★★★☆ 73 reviews - Add to Shopping List

The Pleasure of Finding Things Out
The Pleasure of Finding Things Out is a magnificent treasury of the best short works of Richard P. Feynman, including interviews, speeches ...
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The pleasure of finding things out: the best short works of ...
The Pleasure of Finding Things Out is a magnificent treasury of the best short works of Richard Feynman—from interviews and speeches to lectures ...
★★★★☆ 73 reviews - Add to Shopping List

Pleasure Of Finding Things Out, The [Book]
This collection of the best short works of rule-breaking genius Richard Feynman shows his passion for knowledge and sense of fun at their most ...
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The pleasure of finding things out: the best short works of ...
by Richard Phillips Feynman, Jeffrey Robbins - Perseus Books (1999.09.16) - hardback - 270
The Pleasure of Finding Things Out is a magnificent treasury of the best short works of Richard P. Feynman—from interviews and speeches to lectures ...
★★★★☆ 73 reviews - Add to Shopping List
What's about cars?
For cars, especially for new cars, results are a bit disappointing...

Google search results for "small new car gas air conditioning sunroof mp3 connection plug".
Books

- Completely Defined Products
- Few search criteria
- Comparisons of the offers on a small number of criteria
- ISBN
- <130.000.000 different books*


Cars

- Partially Defined Products
- Many criteria
- Comparisons on many criteria (C02 emission level?...)
- No id
- and... a huge diversity
Product ranges in the automotive industry are huge

$10^{20}$

different cars for sale at Renault
Product ranges in the automotive industry are huge

Body styles × Engines × Gearboxes

- x Colors
- x Air Conditioning systems
- x Radios
- x Navigation systems
- x Electronic Stability System?
- x ABS?
- x Sun-roof?
- x ...

= $10^{25}$
Huge, and complex

Body styles \(\times\) Engines \(\times\) Gearboxes

\(\times\) Colors
\(\times\) Air Conditioning systems
\(\times\) Radios
\(\times\) Navigation systems
\(\times\) Electronic Stability System?
\(\times\) ABS?
\(\times\) Sun-roof?
\(\times\) ...

Every combination of features is not possible:
technical, industrial and legal constraints, marketing policy

- "Unglazed rear doors exclude rear wipers"
- "Rear electric windows imply front electric windows" - ...
Huge, and complex

Body styles \times Engines \times Gearboxes
\quad \times Colors
\quad \times Air Conditioning systems
\quad \times Radios
\quad \times Navigation systems
\quad \times Electronic Stability System?
\quad \times ABS?
\quad \times Sun-roof?
\quad \times ...

\begin{align*}
\text{Every combination of features is not possible:} & \\
\text{technical, industrial and legal constraints, marketing policy} & \\
\end{align*}

\begin{align*}
1 \text{ chance upon } 100,000 & \text{ to get an existing car,} \\
& \text{if you choose its features without taking the constraints into account.}
\end{align*}
Propagation of constraints
Propagation of constraints

Side Impact Airbags

Electric mirrors
Description of an automotive range

- The range cannot be enumerated: defined "in intention"
- A set of Variables and Constraints:
  - a "Constraint Satisfaction Problem" (CSP)
    - Computationally hard!
- Automatic reasoning software required
How to publish such descriptions?

- The CSP can be represented using Semantic Web languages

- But publishing such data on the web is too demanding of the clients
  - Reasoning better hosted on the server

- So?
Configuration as Linked Data
Configurators: an effective way of presenting a range to human users

<table>
<thead>
<tr>
<th>LA GAMME RENAULT</th>
<th>Véhicules Particuliers</th>
</tr>
</thead>
<tbody>
<tr>
<td>TWINGO</td>
<td>NOUVELLE TWINGO</td>
</tr>
<tr>
<td>WIND</td>
<td>RENAULT WIND</td>
</tr>
<tr>
<td>CLIO</td>
<td>CLIO CAMPUS BYEBYE</td>
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<tr>
<td></td>
<td>CLIO</td>
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<td>CLIO ESTATE</td>
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<td>MODUS</td>
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</tr>
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<td></td>
<td>GRAND MODUS</td>
</tr>
<tr>
<td>KANGOO</td>
<td>KANGOO</td>
</tr>
</tbody>
</table>
Configurators: interactive definition of a car, one choice after the other
The configuration process

- at each step: list of the possible choices, given the choices made so far
Configuration service

- ConfigurationService?spec=spec1&spec=spec2&... (*)

  Previous selections

  returns: Possible choices

  = the specifications compatible with previous selections

  to choose spec3: append "&spec=spec3" to (*)

(*) identifies a state of the configuration process

  = a "Configuration"

  = a Partially Defined Car

(*) : URI of configuration
Configuration as Linked Data

- `ConfigurationService?spec=spec1&spec=spec2&...` (*)

- returns the list of

  [compatible specification, URI of the linked (modified) configuration]

  - eg. `[spec3, ConfigurationService?spec=spec1&spec=spec2&spec=spec3]`

- Configuration Process = Traversal of a graph of linked Configurations

  = Linked Data!

- Reasoning handled by the server, complexity hidden to the client
Example

I want a Clio 3...
http://conf.renault.com/CL3 : "I want a Clio 3"

```json
{
  model: http://conf.renault.com/doc/CL3,
  choices: [
    specChoice: [ ]
  ],
  minPrice: 13950,
  impact: [
    possibilities: [
      possibilities: [ ]
    ],
    impossibles: [ ]
  ],
  possibilities: [
    possibilities: [ ]
  ],
  impossibles: [ ]
}
```
http://conf.renault.com/CL3: "I want a Clio 3..."

```json
{
  model: http://conf.renault.com/doc/CL3,
  choices: [
    specChoice: [],
  ],
  minPrice: 13950,
  impact: [
    possibles: [
      specCode: "DIESEL",
      next: http://conf.renault.com/CL3/DIESEL
    ],
    specCode: "GASOLINE",
    next: http://conf.renault.com/CL3/GASOLINE
  ],
  impossibles: []
},
possibles: [
  specCode: "AIR_CONDITIONING",
  next: http://conf.renault.com/CL3/AIR_CONDITIONING
],
  specCode: "NO_AIR_CONDITIONING",
  next: http://conf.renault.com/CL3/NO_AIR_CONDITIONING
],
  specCode: "CLIMATE_CONTROL",
  next: http://conf.renault.com/CL3/CLIMATE_CONTROL
],
  impossibles: []
},
  ...
...diesel

```json
{
    model: http://conf.renault.com/doc/CL3,
    choices: {
        specChoice: [
            specCodes: [
                "DIESEL"
            ]
        ],
        minPrice: 16250,
        impact: [
            possibles: [
                {
                    specCode: "AIR_CONDITIONING",
                },
                {
                    specCode: "NO_AIR_CONDITIONING",
                    next: http://conf.renault.com/CL3/DIESEL-NO_AIR_CONDITIONING
                }
            ],
            impossibles: [
                {
                    specCode: "CLIMATE_CONTROL"
                }
            ]
        ]
    }
}
```
http://conf.renault.com/CL3/DIESEL : "I want a Clio 3, diesel...

...with air conditioning

```json
{
    model: http://conf.renault.com/doc/CL3,
    choices: [
        { specChoice: [
            { specCodes: [ "DIESEL" ] },
            { specCodes: [ "AIR_CONDITIONING" ] }
        ] },
        minPrice: 17250,
        impact: [ { possibilities: [ { specCode: "SUN_ROOF",
        },
            { specCode: "NORMAL_ROOF",
        ] },
            impossibilities: [] },
        ]
    }
}
```

Made selections

Possible choices
Configuration ontology

- http://purl.org/configurationontology

- The configuration process as the traversal of a graph of Configurations
  - 2 main classes: Specification and Configuration
  - properties: chosenSpec, impliedSpec, possible, impossible, defaultSpec, etc

```mermaid
ex:Conf1 a co:Configuration ;
  co: chosenSpec :CL3 , cl3:Diesel ;
  co: possible [:possibleSpec cl3:AirConditioning ; :linkedConf ex:Conf1PlusAirConditioning.]
  [:possibleSpec cl3:SunRoof ; :linkedConf ex:Conf1PlusSunRoof.],
```

- A generic, domain independent ontology
  - not limited to the automotive industry
  - doesn't depend on the vocabulary used for the specifications
  - most online configurator applications can use it
Integration with GoodRelations

- **A Configuration**:
  - A "Partially Defined Product"
    - can be completed to a product that can be ordered - without changing any of the current selections
    - has a "starting price" = min(corresponding completely defined products)
  - a commercial offer
  - the expression of a customer’s wish list (constrained by the definition of the range)
    - BTW: an important thing, in a marketing point of view!

- **Can seamlessly be described using GoodRelations**
  - as a Product or as a Commercial offer
    
    ex:Conf1 a co:Configuration ;
    co: chosenSpec :CL3 , cl3:Diesel ;
    gr:hasPriceSpecification [a gr:UnitPriceSpecification ; gr:hasCurrency "EUR". gr:hasCurrencyValue
Benefits & applications
Benefits

- Improved Architecture of the configuration server
  - Web architecture

- Decreased development costs of web applications
  - No need to understand the concepts underlying configuration
  - No need to learn an API
  - Just "display the data and follow the links"

- Data published on the web of data for e-business
  - ready to be used by agents (eg. range comparators)

- Configuration URI: a global identifier for Partially Defined Products
  - Tagging web content

- Advertising

- Easy sharing of configurations between applications, devices, media
  - link between web site and corporate applications (eg. ordering system...)
  - Facebook
Sharing configurations between applications, devices, media

Configuration URI Server

Marketing tools
Indexing configurations

- Accurate description of the range, that can be explored by crawlers
  - just a matter of following links.

- But $10^{20}$ is huge!
  - Partial indexing
  - Based on the specifications
  - Beware to the semantics of the properties!
    - spec1 and spec2 can both be compatible with a given configuration, but not (spec1 and spec2)
      - only way to know: query the configuration service

- Choose the indexing strategy
  - some specifications have more value than others

- Sitemap
  - which configurations should be included to get the most of it from a marketing point of view?
Conclusion

- Ranges of customizable products can be described as Linked Data
- URIs for Partially Defined Products
- A generic ontology
- Renault has begun to publish such data about its range
  - http://{fr,de,it,es}.co.rplug.renault.com/docs
  - JSON in Germany and Italy for the moment, more to come soon
  - RDF really soon now
  - RDFa in the web sites coming a little bit later
- Todo (?): linking our specifications to vocabularies such as VSO or dbPedia?
- Agents can crawl and use these data
  - eg. range comparators
Compiled Range

Compilation (offline)

Configuration Engine

Range as Linked Data (generated on the fly)

Jersey REST service

HTTP

Configurator web app

Crawler

Agent
Configuration as Linked Data

Possible choices

- http://.../CL3/DIESEL
- "Clio 3 diesel"
- 16.250 €
- "Clio 3, diesel, with air conditioning"
- http://.../CL3/DIESEL-CLIM
- http://.../CL3/DIESEL-SUNROOF
- http://.../CL3/DIESEL-CLIM-SUNROOF
Renault and Semantic Web

- **Linking Enterprise Data**
  
  - "Semantic Web Technologies in Automotive Repair and Diagnostic"
    
  
  - "Linking Enterprise Data"
    
    LDOW 2008 (Linked Data On the Web, WWW 2008 Workshop)
    
  
  - "Euro 5", first application in production based on Linked Data (2010)
    
    After-sales technical documentation
  
  - "A Semantic Web Representation of a Product Range Specification based on Constraint Satisfaction Problem in the Automotive Industry"
    
    
    A vocabulary to represent Constraint Satisfaction Problems
    
    - http://vocab.deri.ie/csp

- **Product customization as Linked Data**