A Short History of Configuration Technologies

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Contents

- Rule-based Configurators
- Early model-based Configurators
- Mainstream Configuration Environments
- Mass Customization Toolkits

Rule-based Configurators (1)

- Weak Artificial Intelligence („Weak AI“)
  - Narrow-sense interpretation of AI: support of specific problem solving tasks such as „configuration“.
- In the line of weak AI many expert systems were built in the 1970‘s.
- Examples:
  - R1/XCON (computer configurator for DEC VAX systems)
  - VT (vertical transportation for Westinghouse Elevator Company)
- Structure of a rule:
  - IF <condition> THEN <action>

Rule-based Configurators (2)

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ASSIGN-POWER-SUPPLY-1

IF:THE MOST CURRENT ACTIVE CONTEXT IS ASSIGNING A POWERSUPPLY
   AND AN SBIMODULE OF ANY TYPE HAS BEEN PUT IN A CABINET
   AND THE POSITION IT OCCUPIES IN THE CABINET IS KNOWN
   AND THERE IS SPACE IN THE CABINET FOR A POWER SUPPLY
   AND THERE IS NO AVAILABLE POWER SUPPLY
   AND THE VOLTAGE AND FREQUENCY OF THE COMPONENTS IS KNOWN

THEN: FIND A POWER SUPPLY OF THAT VOLTAGE AND FREQUENCY
      AND ADD IT TO THE ORDER
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- Example of a rule in R1/XCON configurator
  - Condition part: current configuration context
  - Action part: actions to extend the current configuration

Rule-based Configurators (3)

- Problem of rule-based knowledge representations
  - Intermingling between domain and problem solving knowledge
  - Outcome of a configuration process depends on rule ordering
- Model-based knowledge representations
  - Clear separation between domain and problem solving knowledge
  - For example: x>y defines a constraint but does not include directives how to instantiate x and y.
- Example of rule-based vs. model-based representations
  - x>y (x,y in [1..10]) (model-based)
  - IF x=10 THEN y=9 (rule-based)

Early Model-based Configurators

- Model-based Configuration
  - Domain knowledge and problem solving knowledge is separated
  - Domain knowledge = the model
  - Changes in the domain knowledge do not effect the problem solving knowledge and vice-versa.
- Knowledge Representations
  - Constraint Satisfaction (CSPs) [Lauriere, 1978; Mackworth, 1977]
  - First component-oriented knowledge representations
- Example Systems
  - COSSACK, COCOS, Beologic, Trilogy, Selectica, Cameleon, SAP

Mainstream Configuration Environments (1)

- Component-oriented
- Development & test environments
- ERP integration

- Often: support of generative configuration functionalities (= generation of components on-demand) [Fleischanderl et al., 1998; Stumptner et al., 1998]
- Example Systems
  - Tacton, ConfigIT, EngCon, ILOG, SAP, BAAN, ORACLE

Mainstream Configuration Environments (2)

- Challenge: increasing size and complexity of configuration models
- In interactive settings the response time should be below 1 sec. [Card et al., 1991]
- Knowledge compilation
  - Binary decision diagrams (BDDs) [Andersen et al., 2010]
  - Solution automata [Amilhastre et al., 2002]
- Divide & Conquer based algorithms
  - Conflict detection [Junker 2004]
  - Diagnosis [Felfernig et al. 2012]
- Intelligent Testing & Debugging [Felfernig et al., 2004]

Mass Customization Toolkits

- Mass Customization toolkits ≈ Configurators
- Personalization functionalities [Cöster et al., 2002; Ardissono et al., 2003; Tiihonen and Felfernig, 2010]
- Integration of „Open Innovation“ paradigm [Chesbrough, 2003]
  - Strategic exploitation of external resources for the improvement of the innovation potential of a company
  - Open Configuration: new product/component ideas can be directly entered by customers
  - Example: cooperative development of computer games [Piller et al. (2004)]

Further Configuration Approaches

- Resource-based configuration [Heinrich & Jüngst, 1991]
- Functional configuration approaches [Stein, 1995]
- Description logic based configuration [McGuinness and Wright, 1998]
- Overviews: Forza and Salvador (2002); Günter and Kühn (1999); Jannach et al. (2007); Sabin and Weigel (1998); Soininen et al. (1998); Stumptner (1997)

Summary

- **From** initial applications as rule-based expert systems,
- **Via** early model-based configurators, which allow a clear separation of domain knowledge and problem-solving knowledge,
- **To** mainstream model-based configuration environments integrated in supply chains and ERP systems,
- **And** mass customization toolkits.

Thank You!

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