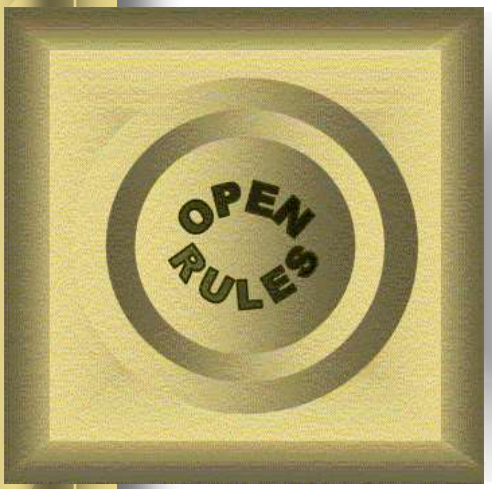
Decision CAMP

RuleML 2016



10th International Rule Challenge 2016

July 7-8, 2016 at Stony Brook University, New York, USA

What-If Analyzer

for DMN-based Decision Models

Dr. Jacob Feldman, CTO, OpenRules Inc.

Specification Lead for JSR-331

jacobfeldman@openrules.com

www.OpenRules.com

www.JSR331.org

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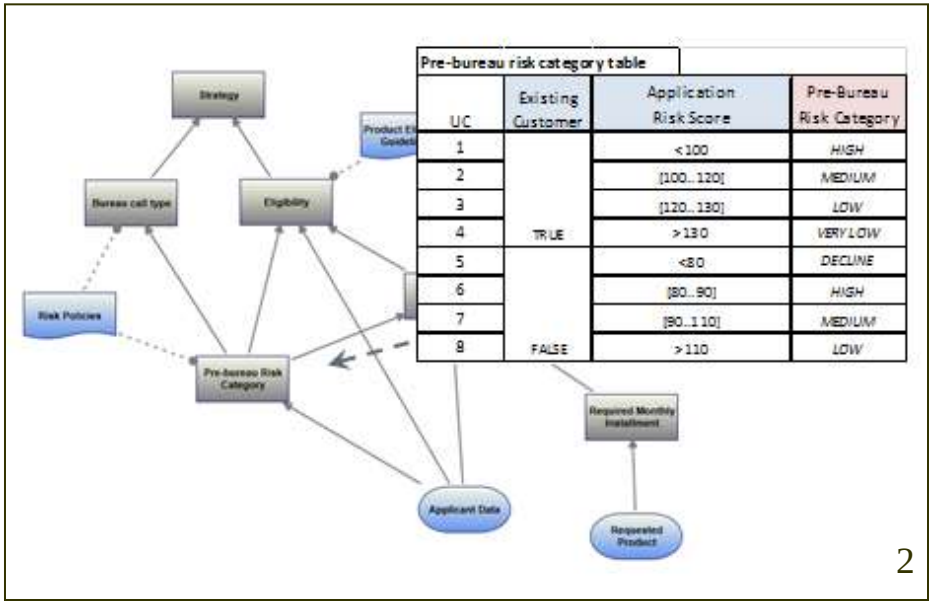
The OMG Standard "DMN" for Decision Model and Notation

- Specifies key concepts and constructs for business decision modeling
- Available since Sep-2013
- New Release 1.1 just published
- Many vendors announced their DMN support



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Orientation to a Single Decision

- DMN expects to produce one output decision for any feasible input
- It requires decision models to be complete covering ALL (!) possible combinations of decision variables
- It is unrealistic requirement as even small decision models may require thousands and thousands of manually created rules

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Static vs. Dynamic Decision Models

- Traditional Business Decision Models:
  - *Static by nature*
  - All business rules are already defined and activated

- Modern Decision Models:
  - Should be *dynamic*
  - Changes in rules are propagated in real time
  - Possible conflicts among rules are immediately diagnosed

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Decision Models need Real-Time What-If Analysis

- A business friendly graphical interface that supports “what-iffing” to:
  - Allowing a user to activate or deactivate business rules with a simple click
  - Showing immediately how rules activation/deactivation modifies all related decision variables
  - Showing possible conflicts

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Decision Optimization

- Business decision models do not have to be complete! Instead they should be able to produce multiple alternative solutions
- When DMN specifies an **optimization objective**, a decision model should be able to find a solution that optimize this objective

Optimal Decision?

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Alternative and Optimal Decisions

- Complex real-world decisioning applications require to:
  - Generate and compare alternative decisions
  - Find an optimal decision that maximizes or minimizes a certain business objective
- Typical application domains:
  - product configuration, pricing, scheduling and resource allocation

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Optimization Tools

- There are many highly successful mathematical optimization techniques and supporting products
- Optimization Tool Catalogs:
  - Constraint Programming (35 products)
  - Linear and Mixed Integer Programming (13 products)
- DMN may help to bring these tools to the business decisioning domain

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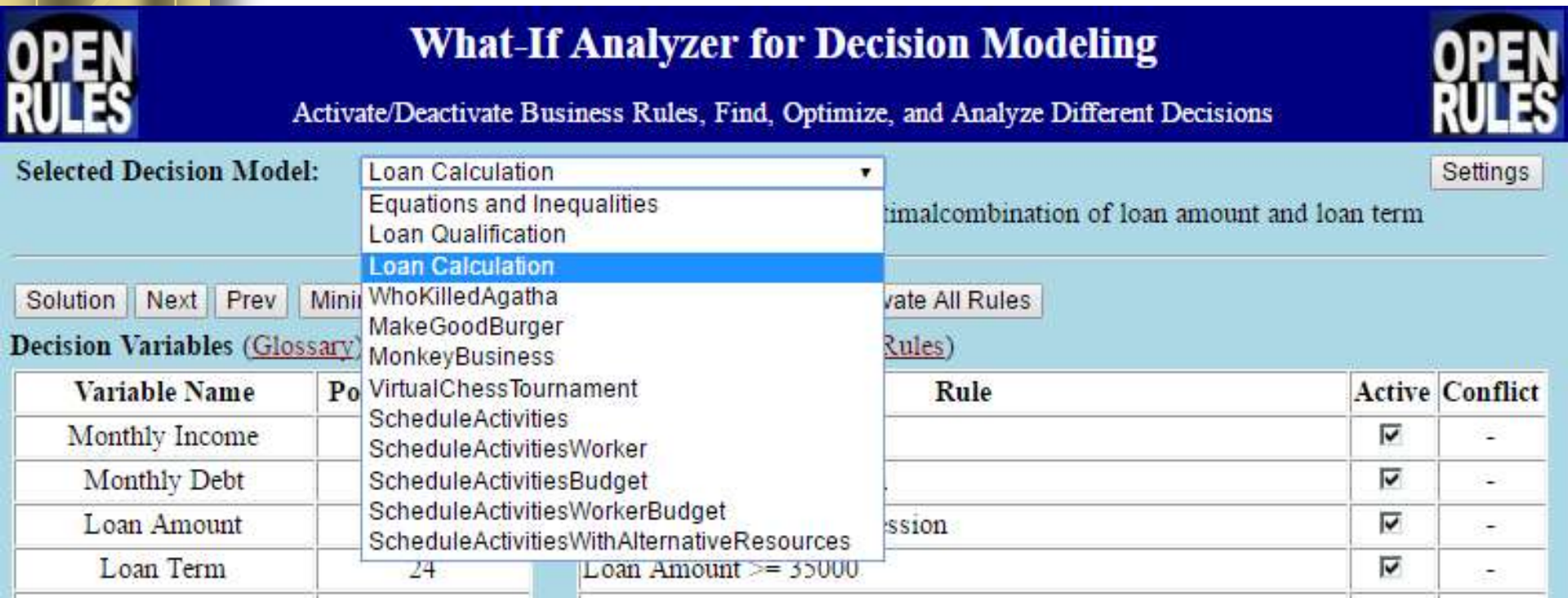
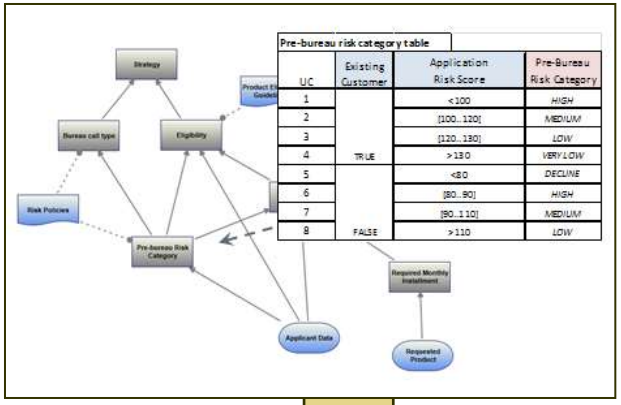
Introducing “What-If Analyzer”

- OpenRules has developed a new graphical tool “What-If Analyzer for Decision Modeling”
- It is oriented to business analysts who create and maintain DMN-based decision models



What-If Analyzer for DMN

DMN Decision Model



Import

What-If Analyzer for Decision Modeling

Activate/Deactivate Business Rules, Find, Optimize, and Analyze Different Decisions

Selected Decision Model: Equations and Inequalities ▾ Settings

This simple decision model allows you to activate/deactivate various arithmetic constraints on integer decision vaiables

Solution | Next | Prev | Minimize | Maximize | Activate All Rules | Deactivate All Rules

Decision Variables (Glossary)

Variable Name	Possible Values
X	4
Y	5
Z	9
Objective	11

Business Rules (Original Rules)

Rule	Decision Table	Active	Conflict
X+Y=Z	XplusYeqZ	☑	-
Objective = X*Y-Z	DefineObjective	☑	-
X < Y	BinaryConstraints	☑	-
Z > 5	BinaryConstraints	☑	-
Z < 5	BinaryConstraints	☐	-
X > 4	BinaryConstraints	☐	-
Y < 6	BinaryConstraints	☑	-
Z < 8	BinaryConstraints	☐	-

Maximized solution #4 found

OpenRules Release 6.3.4

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What-If Analyzer Key Features

- Downloading and showing DMN-based decision models
- Activation/Deactivation of different rules and with an immediate propagation of these actions
- Finding and navigating through multiple feasible solutions
- Finding optimal solutions for the defined business objectives

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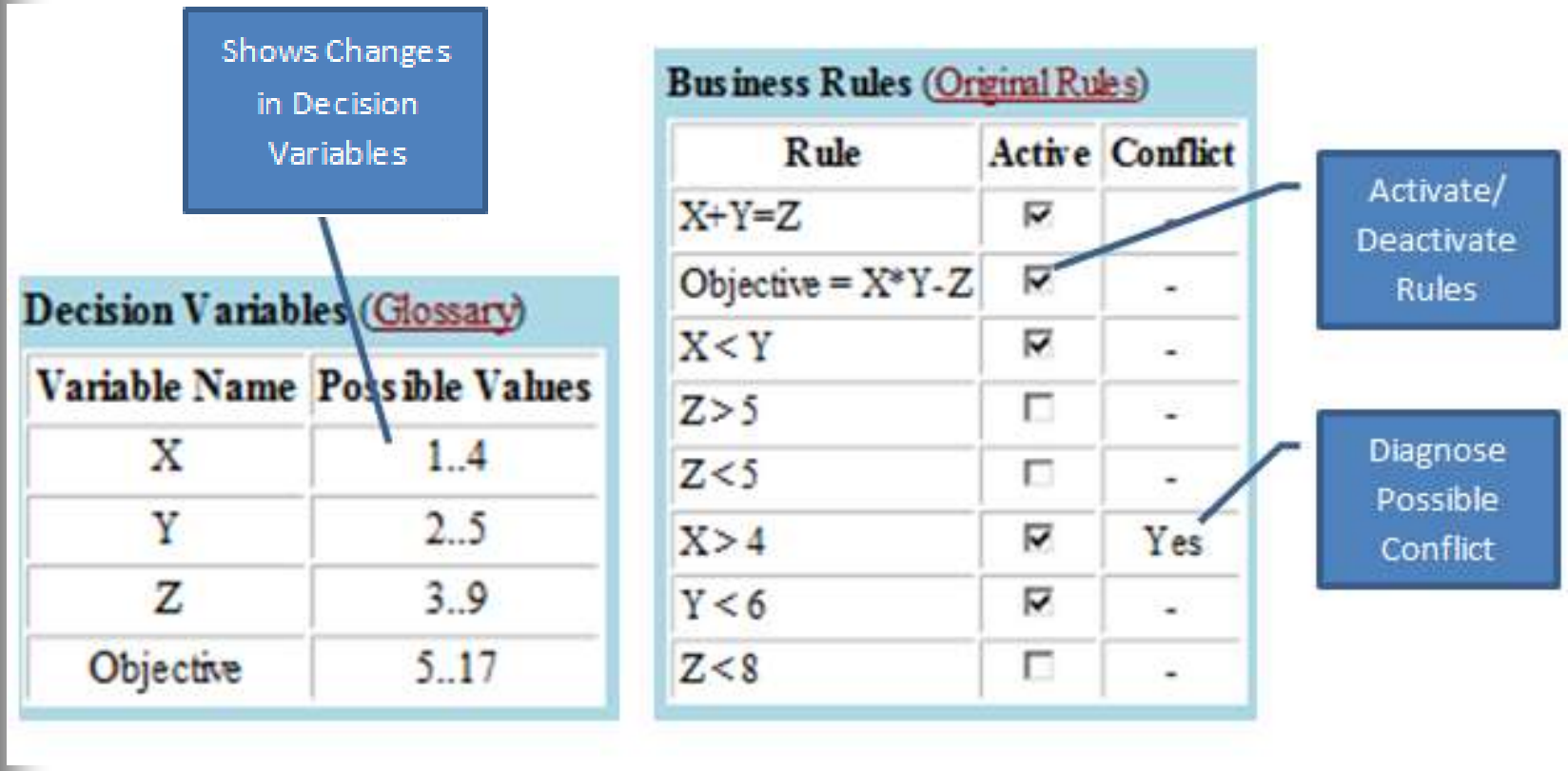
What-If Analyzer: Major Features



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Live Demonstration

- Demonstration Decision Models:
  - Simple Arithmetic Problem
  - Loan Approval Application
  - How to Make a Good Burger
  - Several Scheduling Problems

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Decision Model "Simple Arithmetic Problem"

- There are 3 variables X, Y, and Z defined from 0 to 10
- Constraints:
  - **X < Y**
  - **X + Y = Z**
- Variable "Objective" is defined from 5 to 20:
  - **Objective = X*Y - Z**
- Find values of X, Y and Z that maximize or minimize Objective

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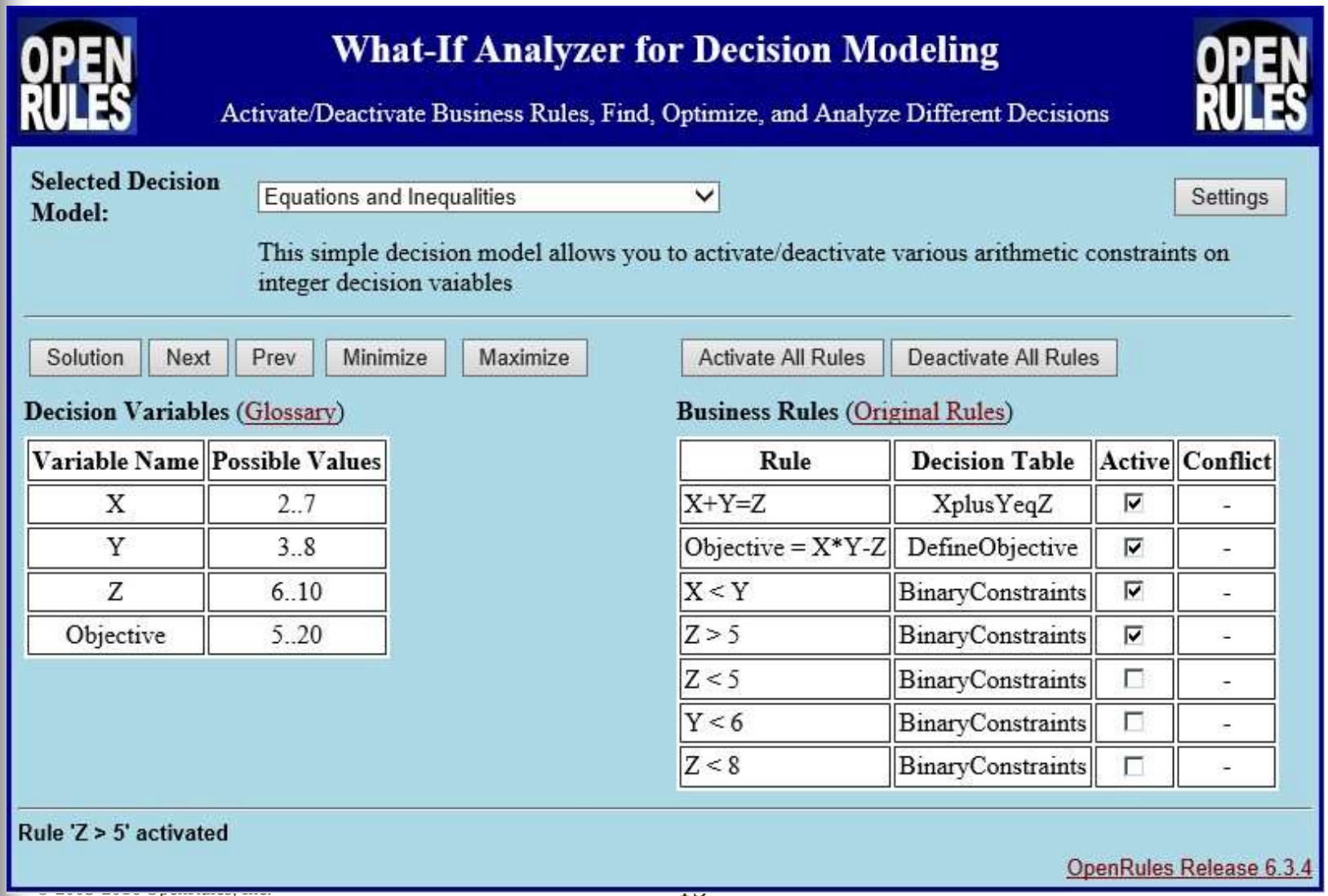
Decision Model "Simple Arithmetic Problem"



What-If Analyzer for Decision Modeling

Activate/Deactivate Business Rules, Find, Optimize, and Analyze Different Decisions

Selected Decision Model: Equations and Inequalities — Settings

This simple decision model allows you to activate/deactivate various arithmetic constraints on integer decision vaiables

Solution | Next | Prev | Minimize | Maximize | Activate All Rules | Deactivate All Rules

Decision Variables (Glossary)

Variable Name	Possible Values
X	2..7
Y	3..8
Z	6..10
Objective	5..20

Business Rules (Original Rules)

Rule	Decision Table	Active	Conflict
X+Y=Z	XplusYeqZ	☑	-
Objective = X*Y-Z	DefineObjective	☑	-
X < Y	BinaryConstraints	☑	-
Z > 5	BinaryConstraints	☑	-
Z < 5	BinaryConstraints	☐	-
Y < 6	BinaryConstraints	☐	-
Z < 8	BinaryConstraints	☐	-

Rule 'Z > 5' activated

OpenRules Release 6.3.4

Decision Model "Loan Calculation"

- A borrower provides the requested loan amount, loan term and personal info financial information as an input
- Usually the decision model produces one of two possible decision outputs:
  - the borrower is qualified for the loan
  - the borrower is not qualified for the loan with an explanation.

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Decision Model "Loan Calculation"

- In real-world you do not want to lose a potential customer by simply rejecting the loan application
- Your decision model should offer the best possible loan amount and loan term when the application still will be accepted

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Decision Model "Loan Calculation"

Decision Variables (Glossary)

Variable Name	Possible Values
Monthly Income	4100
Monthly Debt	2600
Loan Amount	35000..35999
Loan Term	24
Total Income	98400
Total Debt	62400
Accumulated Debt	97400..98399
Income Validation Result	SUFFICIENT

Business Rules (Original Rules)

Rule	Active	Conflict
Total Debt = expression	☑	-
Total Income = expression	☑	-
Accumulated Debt = expression	☑	-
Loan Amount >= 35000	☑	-
Loan Amount = 50000	☐	-
Loan Amount <= 75000	☑	-
Loan Amount >= 40000	☐	-
Loan Amount >= 50000	☐	-
Loan Amount >= 60000	☐	
Loan Term = 24	☑	
Loan Term = 36	☐	
Loan Term = 72	☐	
Loan Term <= 36	☐	
IF Total Income > Accumulated Debt THEN Income Validation Result = SUFFICIENT	☑	
IF Total Income <= Accumulated Debt THEN Income Validation Result = UNSUFFICIENT	☑	
Income Validation Result = SUFFICIENT	☑	

Rule 'Loan Amount = 50000' deactivated

Decision Variables (Glossary)

Variable Name	Possible Values
Monthly Income	4100
Monthly Debt	2600
Loan Amount	53999
Loan Term	36
Total Income	147600
Total Debt	93600
Accumulated Debt	147599
Income Validation Result	SUFFICIENT

Maximized solution #2 found

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Decision Model "Make a Good Burger"

- Offered as a DMCommunity.org Challenge
- Burger ingredient list:

Item	Sodium(mg)	Fat(g)	Calories	Item cost($)
Beef Patty	50	17	220	$0.25
Bun	330	9	260	$0.15
Cheese	310	6	70	$0.10
Onions	1	2	10	$0.09
Pickles	260	0	5	$0.03
Lettuce	3	0	4	$0.04
Ketchup	160	0	20	$0.02
Tomato	3	0	9	$0.04

- **Question:** What is the most or least expensive burger you can make?

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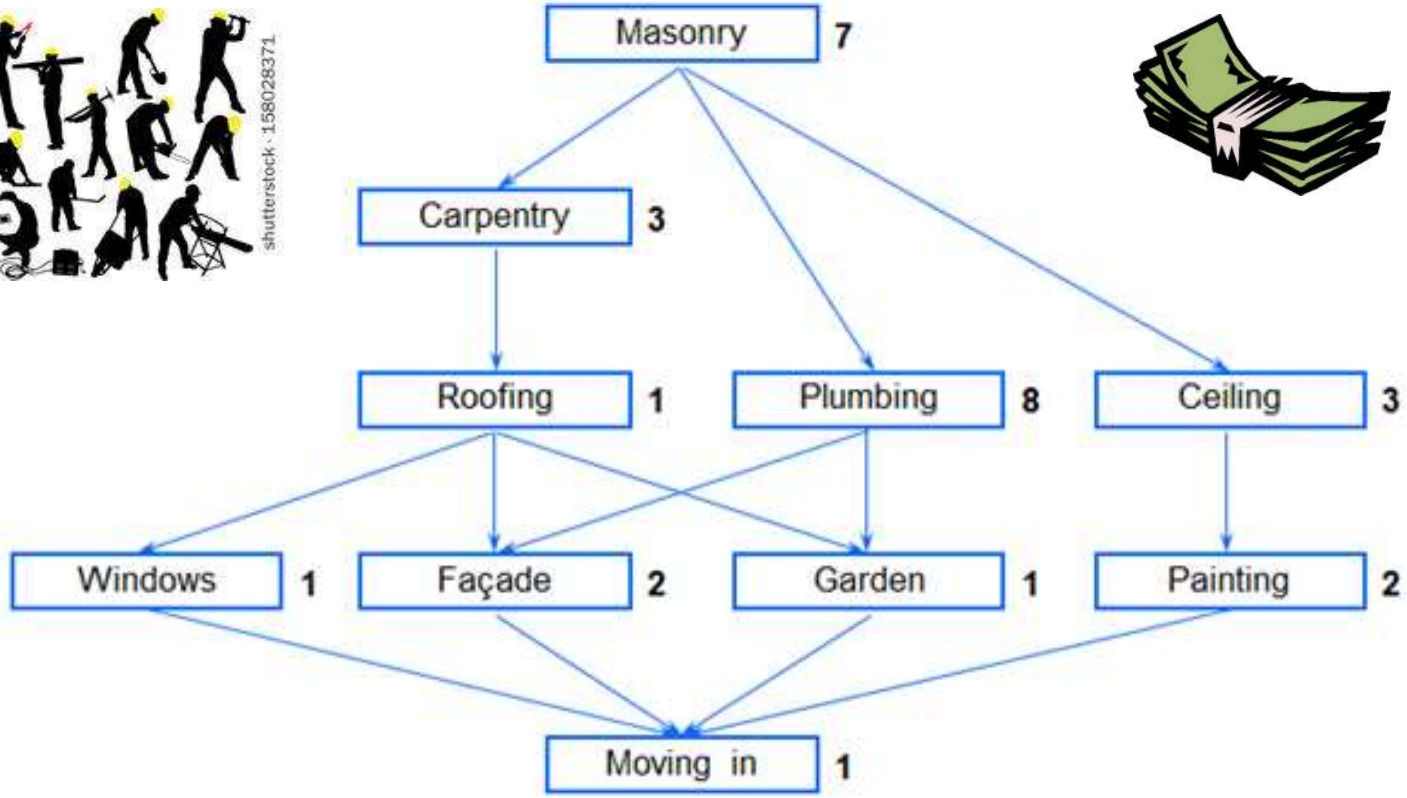
House Construction Problems

Resources:
Workers w/Skills

Activities:



Resource:
Limited Budget

Underlying Model

- Decision Model as Constraint Satisfaction Problem:
  - a set of variables, $X = \{ X_1, X_2, \ldots, X_n \}$
  - a set of rules, $R = \{ R_1, R_2, \ldots, R_m \}$.
  - Each variable X_i has a nonempty domain D_i of possible values.
  - Each rule R_i defines relationships between different variables and specifies the allowable combinations of values
  - A decision is an assignment of values to variables, $\{ X_i=v_i, X_j=v_j, \ldots \}$, that satisfies all the rules.

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How What-If Analyzer is Implemented

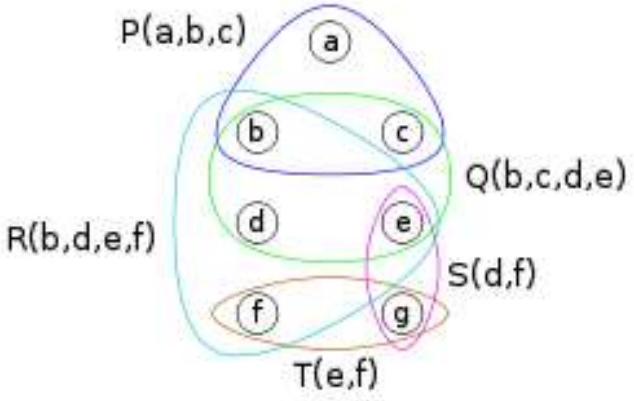
- OpenRules Solver:

  Decision Model => Constraint Satisfaction Problem

- JSR-331 - compliant constraint solver:

  Rules Activation = Constraint Propagation

  Finding Decisions = Finding Feasible and Optimal Solutions



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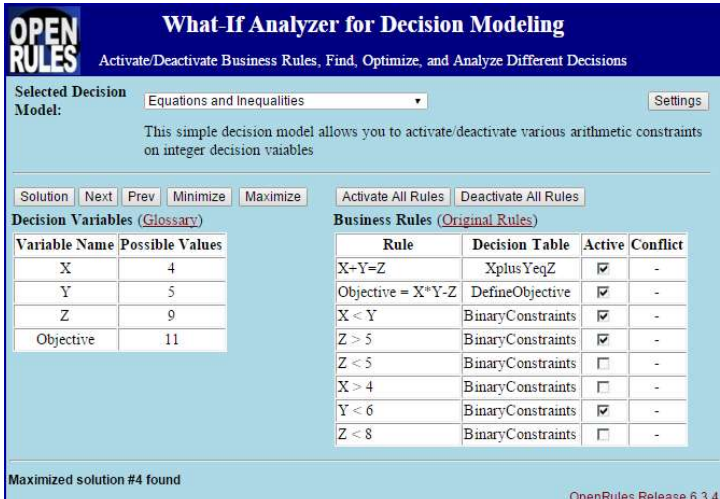
What-If Analyzer GUI

- Real-world decision models may require specialized Graphical User Interfaces
- What-If Analyzer designed as a framework for development of different analyzers:
  - GUI can be easily modified using OpenRules Dialog
  - Underlying logic remains the same



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Conclusion

- What-If Analyzer for Decision Modeling demonstrates how to add new practical functionalities to DMN-based decision models:
  - Dynamic Decision Modeling with live Rules Activation/Deactivation and Conflict Diagnosis
  - Finding Alternative and Optimal Decisions

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- Contact: jacobfeldman@openrules.com

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