COMPLIANCE CHECKING
OF PROJECT DATA AGAINST BUILDING REGULATIONS

COMPLIANCE CHECKING

- Why compliance checking of building regulations?
- Building Blocks/Rule Categorization.
- Technologies/Do domain experts code?
- Decision Model Notation, what?
- Let's Code !

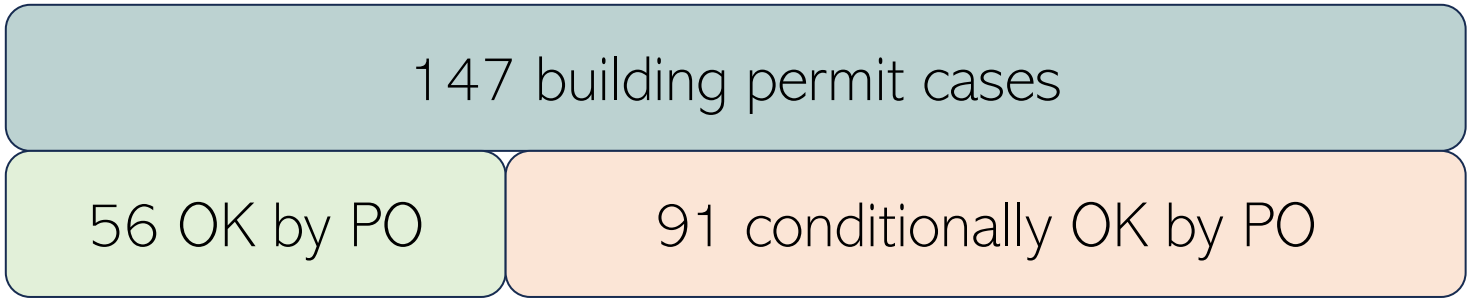
Why compliance checking

- Growing amount of complexity in AEC regulation
- Example: Flemish Accessibility Regulation study

147 building permit cases

Why compliance checking

- Growing amount of complexity in AEC regulation
- Example: Flemish Accessibility Regulation study
- Designers versus Permit Officers (PO)



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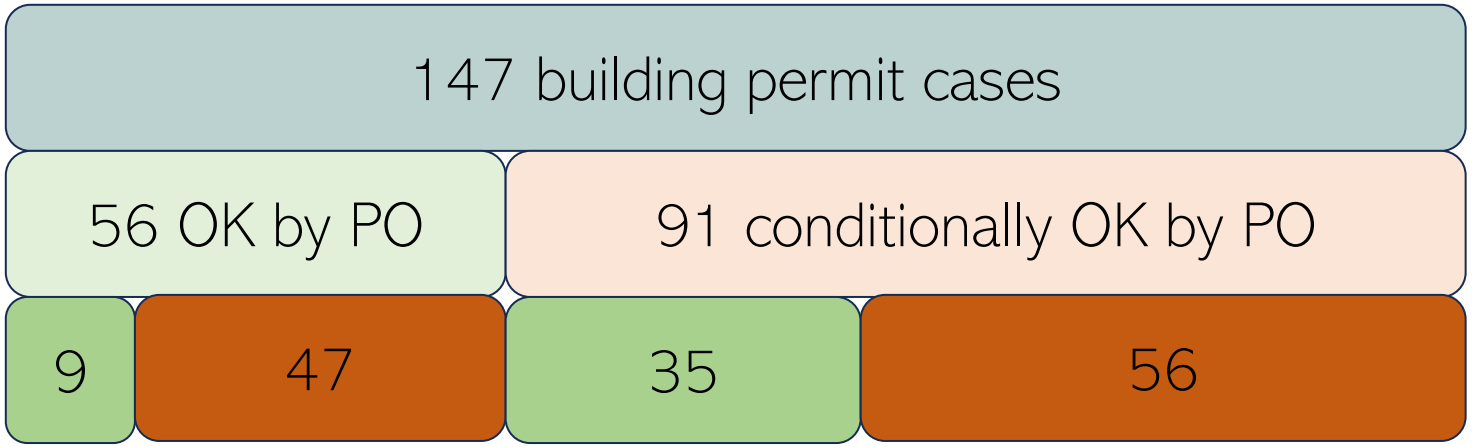

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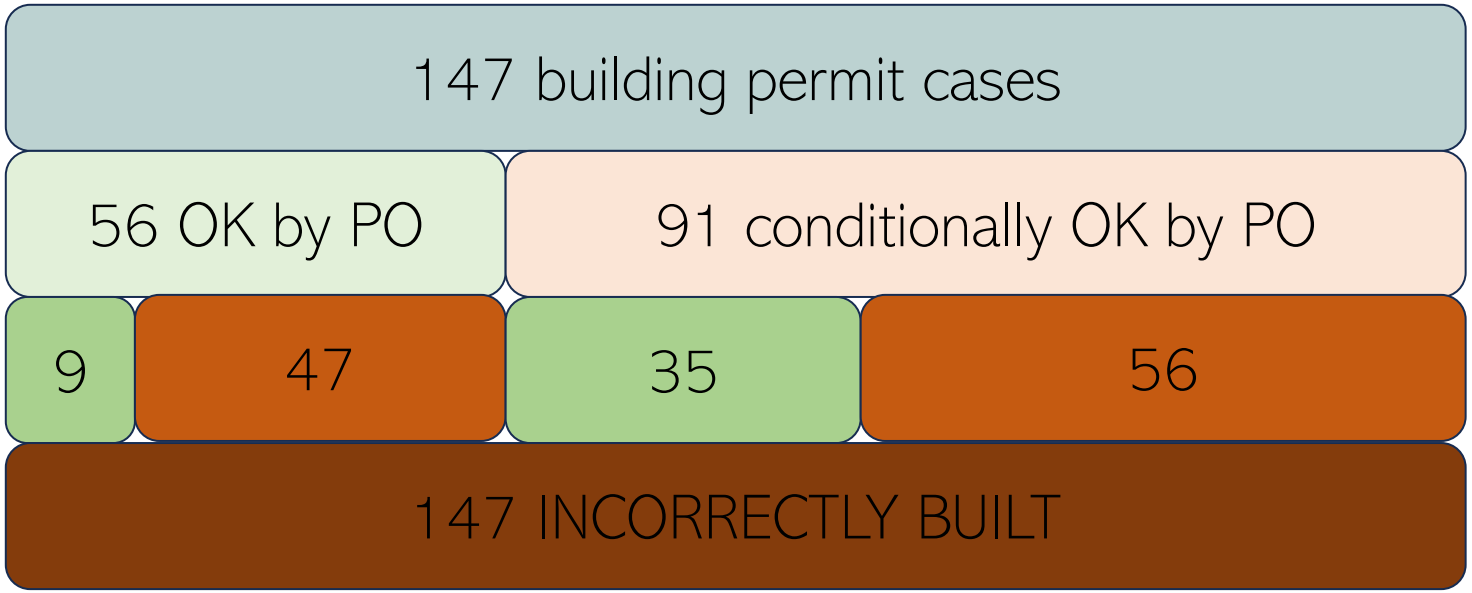


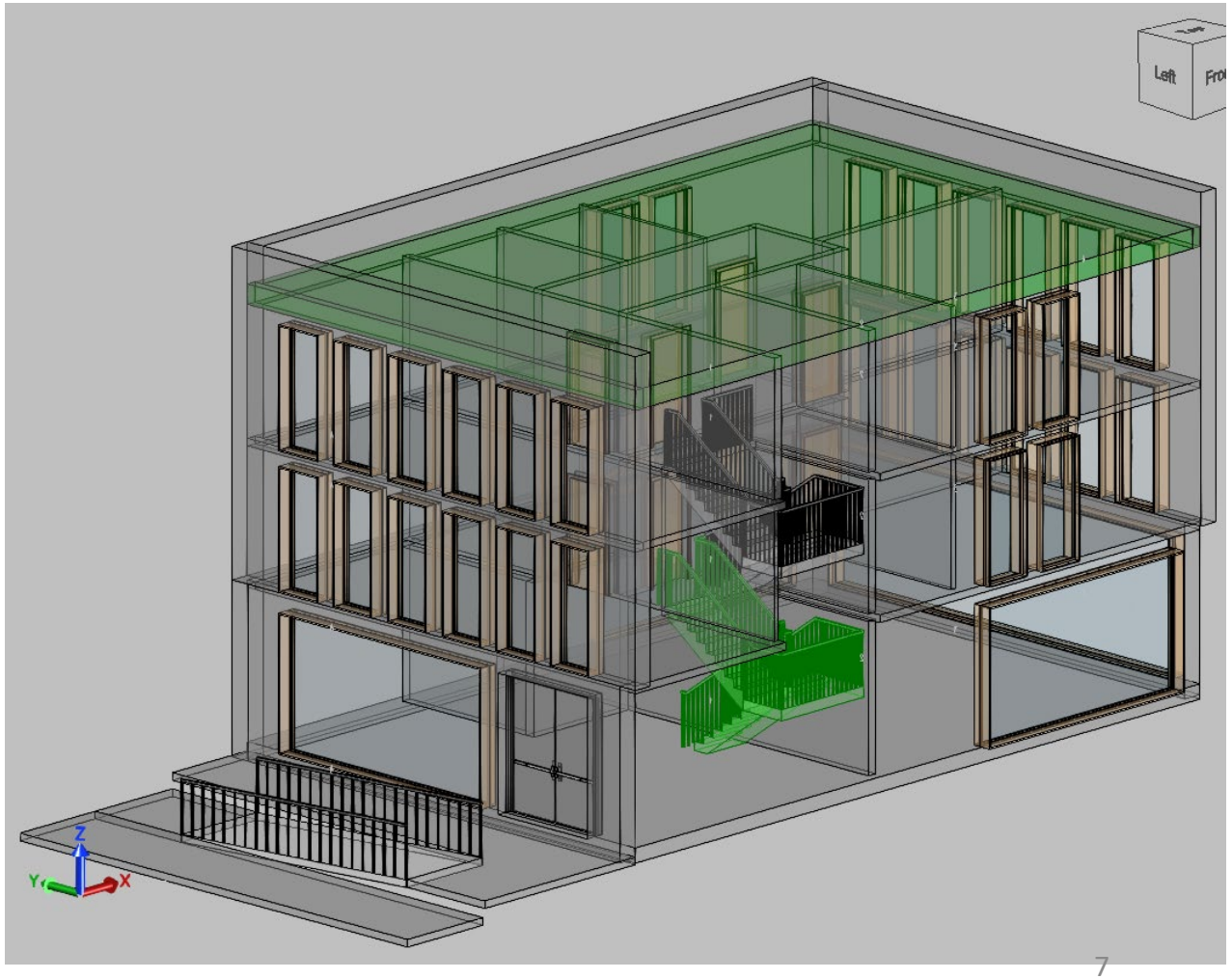
Project Data

We want to check if the staircase complies to the accessibility regulation.

Two rules :

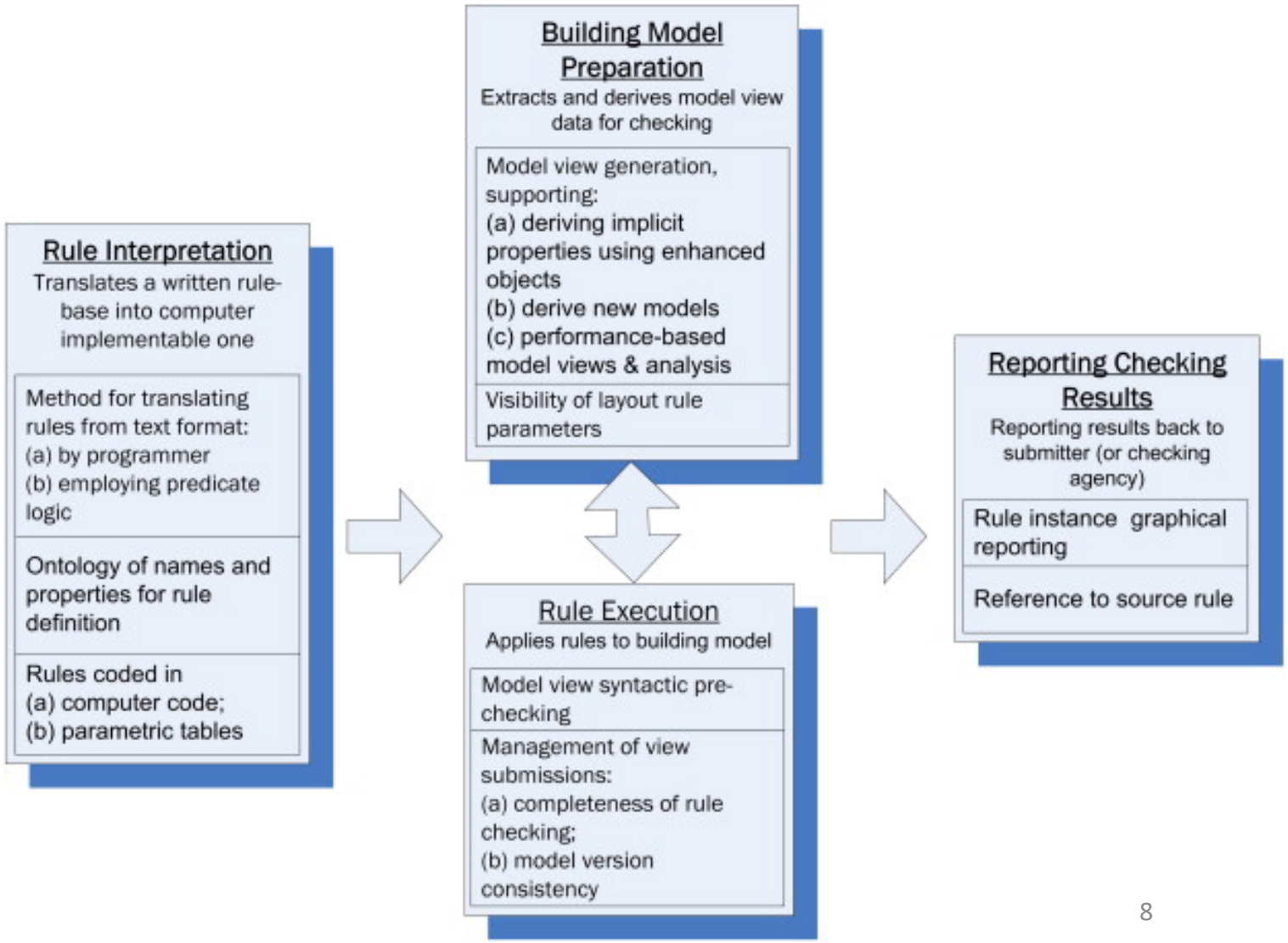
- does the staircase have two railings attached?

- Does the thread and riser proportion comply with the stair flight formula?



Building Blocks/Rule Categorization

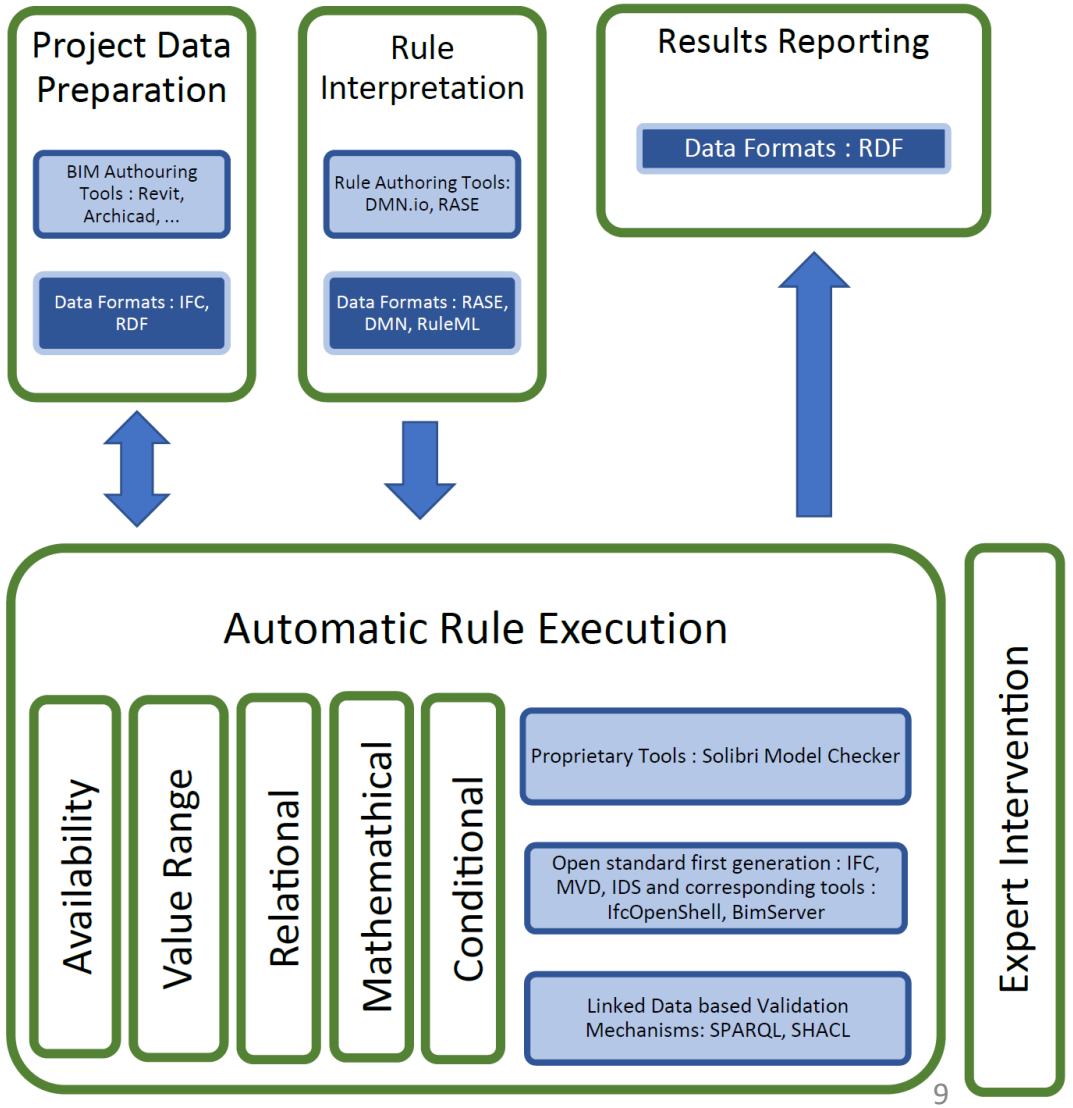
- Four main blocks by Eastman et al, 2009



Building Blocks/Rule Categorization

- Four main blocks by Digichecks, 2023.

  - Project data preparation
  - Rule interpretation
  - Rule execution
  - Result reporting



Rule Categorization

- Data Availability
- Value Range
- Mathematical
- Relational
- Conditional
- Expert Intervention

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We want to check a staircase in a given project dataset.. e.g. the width of the staircase

Is the flightwidth property available in the first place?

Is the data provided in the correct datatype?

Rule Categorization

- Data Availability
- Value Range
- Mathematical
- Relational
- Conditional
- Expert Intervention

We want to check a staircase in a given project dataset.. e.g. the width of the staircase

Is the flightwidth property between the expected range?

Rule Categorization

- Data Availability
- Value Range
- Mathematical
- Relational
- Conditional
- Expert Intervention

We want to check a staircase in a given project dataset..

We can calculate the proportion between the riserheight and threadlength..

Formula = 2 x riserheight + threadlentgh

Rule Categorization

- Data Availability
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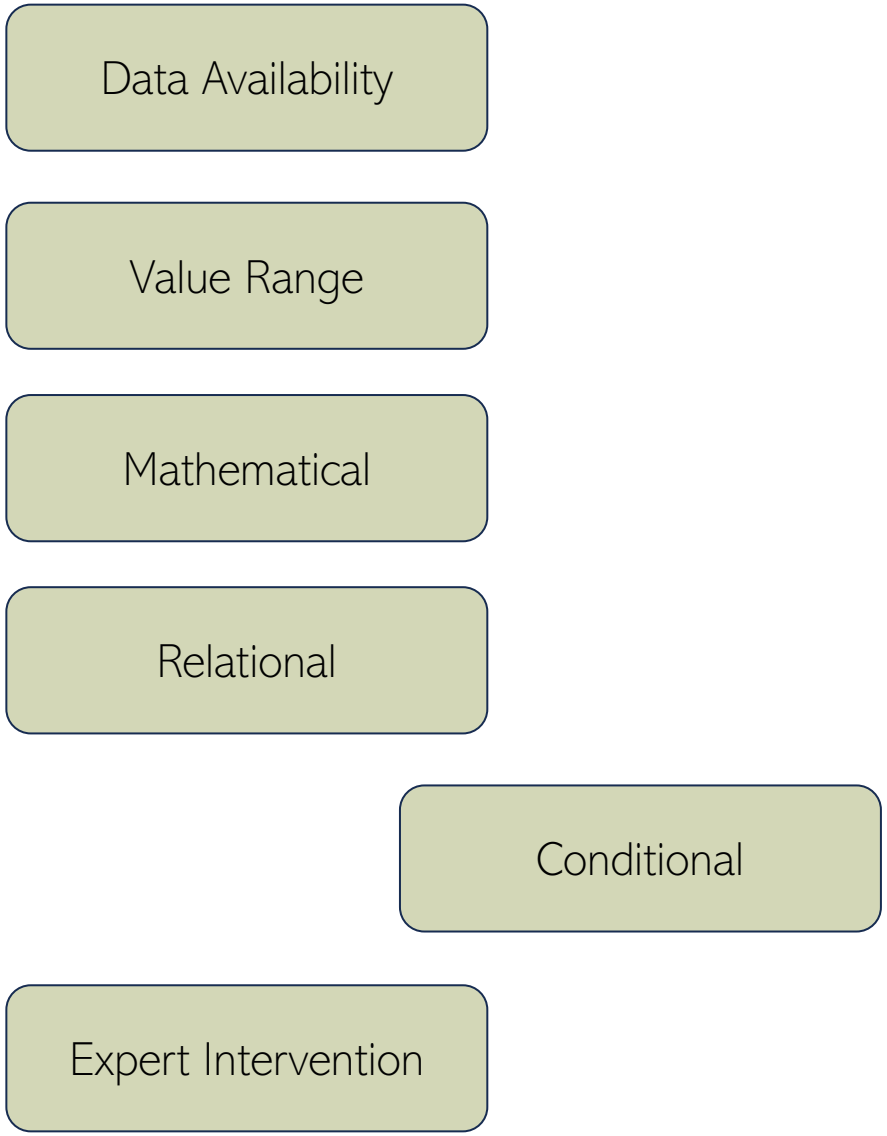
- Expert Intervention

We want to check a staircase in a given project dataset..

Do we find 2 railings for the staircase? Is the relationship explicitly provided?

Rule Categorization



We want to check a staircase in a given project dataset..

IF the stairformula value is between 590 and 630, THEN the stair is accessible.

Rule Categorization

- Data Availability
- Value Range
- Mathematical
- Relational
- Conditional
- Expert Intervention

We want to check a staircase in a given project dataset..

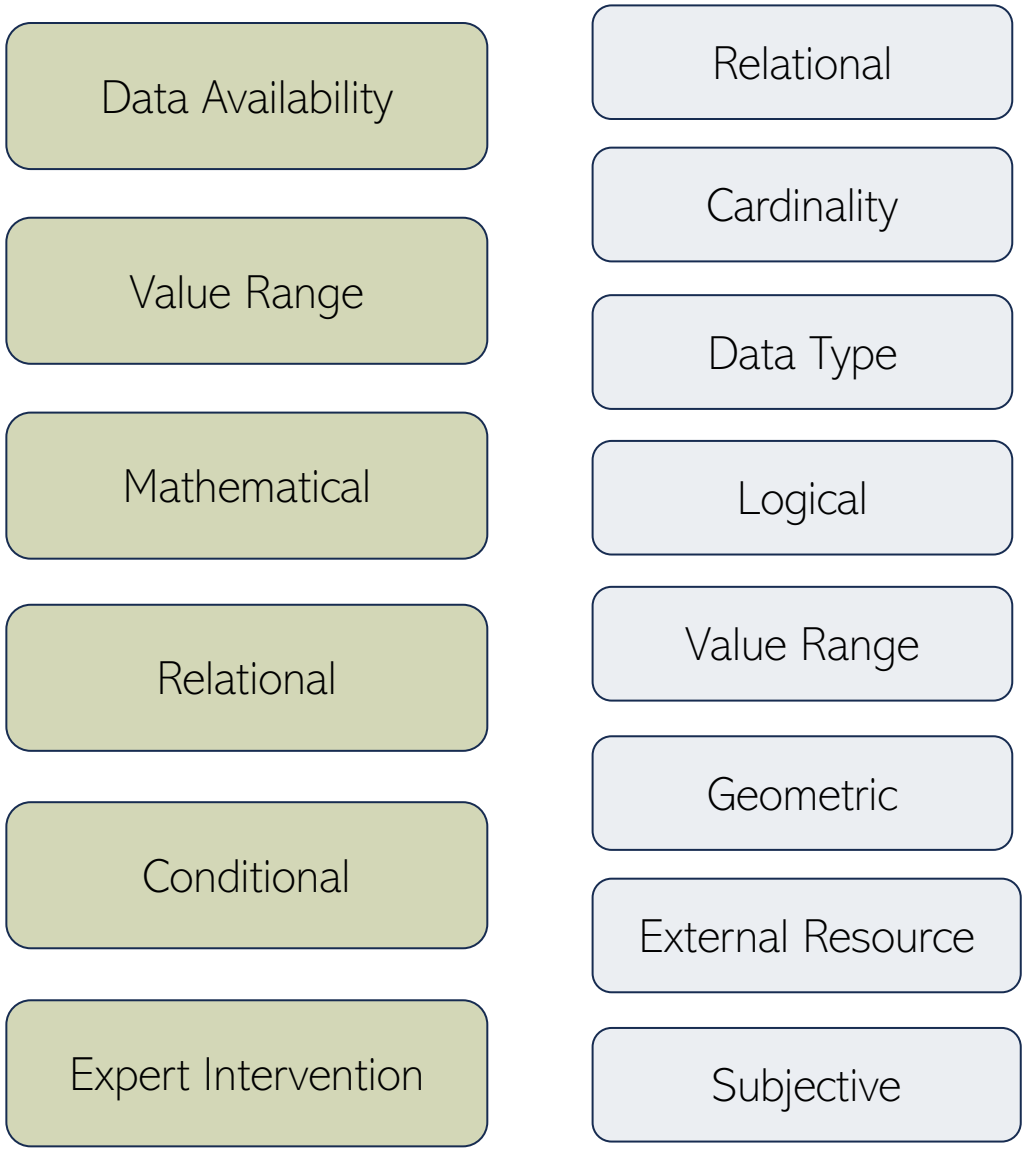
There are more geometric complex issues to check when considering a staircase..

Does the staircase provide added value to the project in a spatial or esthetic fashion?

Rule Categorization

- Data Availability
- Value Range
- Mathematical
- Relational
- Conditional
- Expert Intervention

Rule Categorization



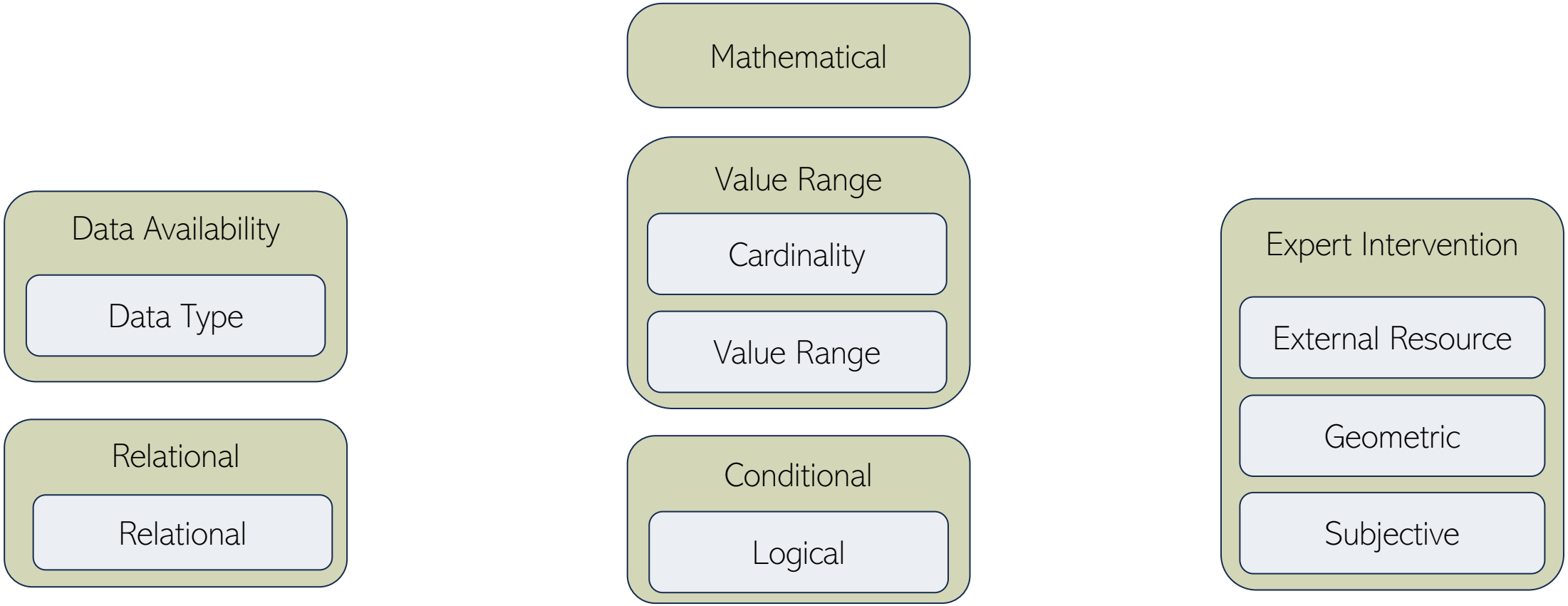
A more fine-grained distinction has recently been proposed at the Technical University of Eindhoven.

Rule Categorization

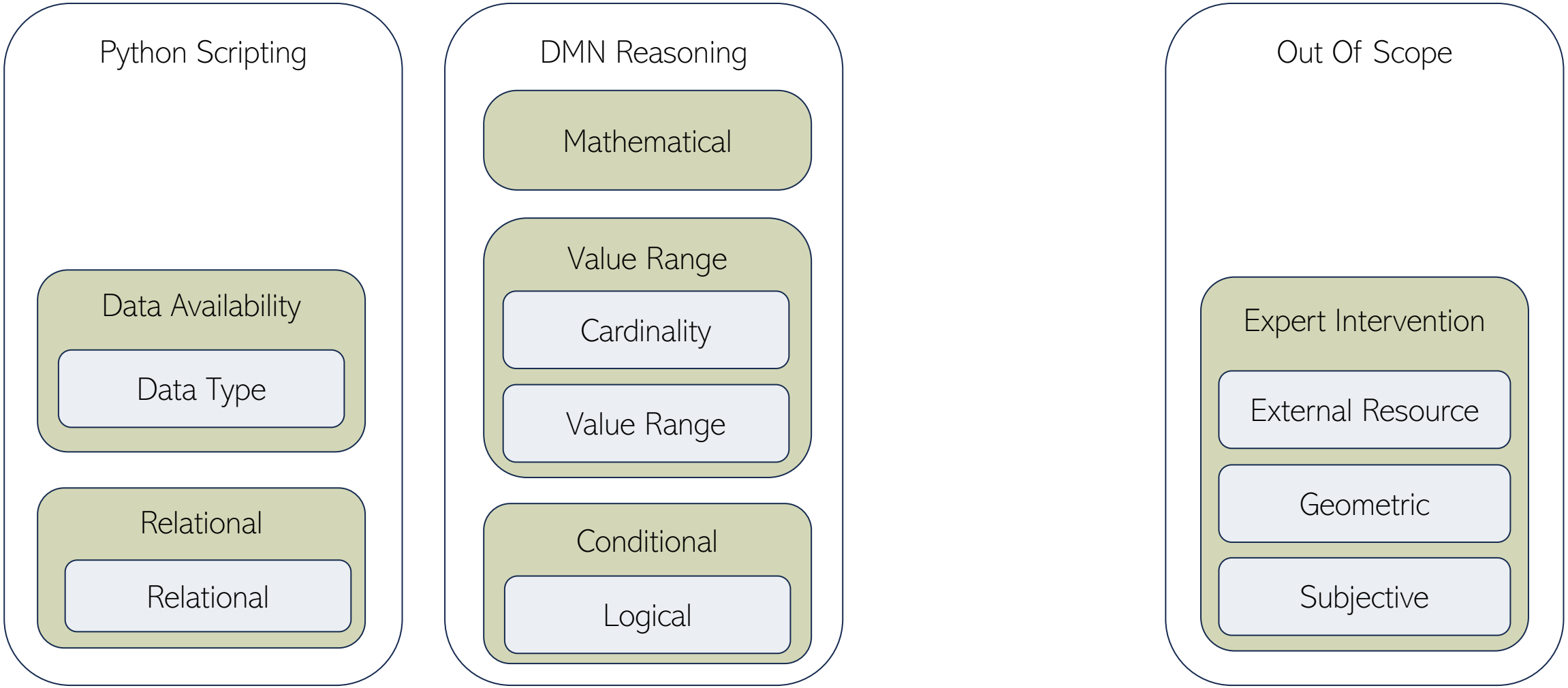
- Data Availability
  - Relational
  - Cardinality
  - Data Type
  - Logical
  - Value Range
- Value Range
- Mathematical
- Relational
- Conditional

- Expert Intervention
  - External Resource
  - Geometric
  - Subjective

Rule Categorization



Technological approach



Do domain experts code?

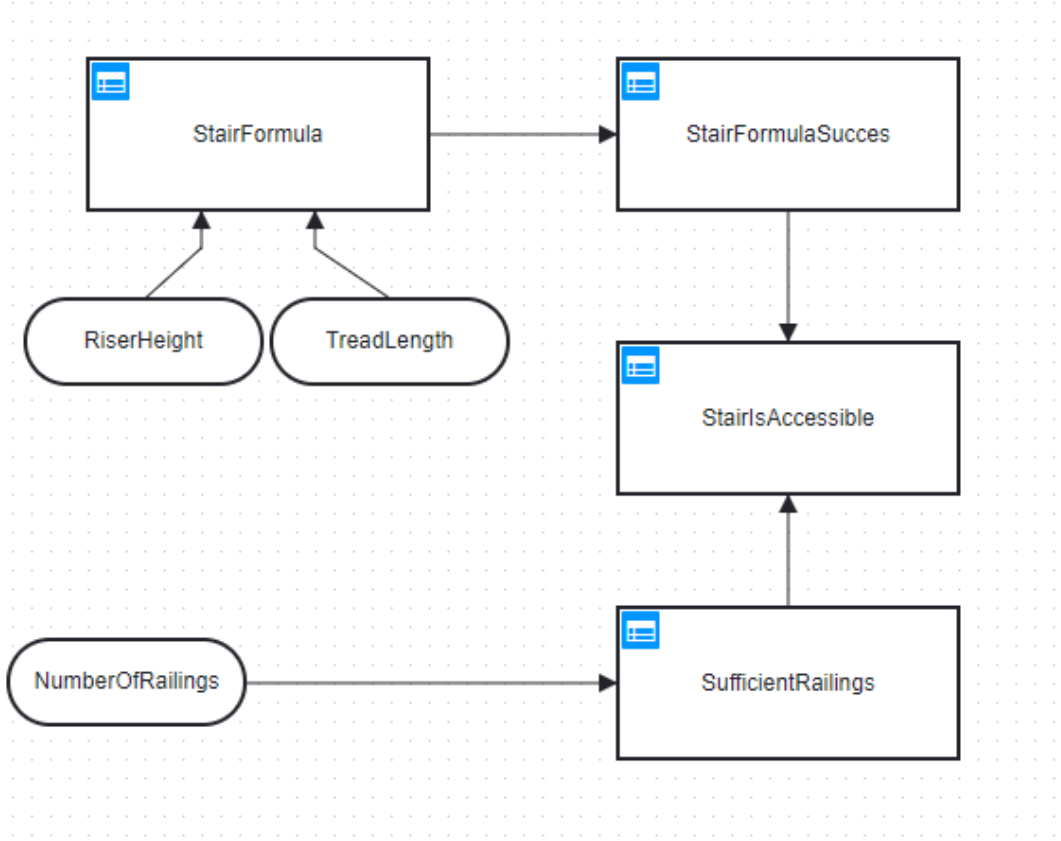
- Summarizing Validation Strategies

Method to review	Info availability	Value	Relational	Mathematical	Conditional	Expert
Solibri Model Checker	Possible	Possible	Possible	Possible	Possible	Partially possible
QL4BIM	Possible	Possible	Possible	?	?	?
DMN with IDP-Z3	Possible	Possible	Possible	Possible	Possible	Partially possible
MVD	?	?	?	?	?	?
buildingSMART IDS	Possible	Possible	Possible	Not possible	Not possible	Not possible
JSON schema	Possible	Possible	Partially possible	Not possible	Possible	Not possible
XSD	Possible	Possible	Possible	Possible	Possible	Not possible
OWL (+SPARQL)	Possible	Possible	Possible	Not possible	Possible	Not possible
SWRL (+SPARQL)	Possible	Possible	Possible	Possible	Possible	Not possible
SPARQL	Possible	Possible	Possible	Possible	Possible	Not possible
SHACL	Possible	Possible	Possible	Possible	Possible	Not possible

Decision Model Notation

- A modelling language for business rules, developed and maintained by OMG.
- Graphical approach.
- International accepted standard.
- Complementary with BPMN.
- Online modellers (DMN.io, Camunda), open-source reasoning engines (Drools, IDP)

Decision Model Notation



StairFormula — Hit Policy: Unique

	When RiserHeight (number)	And TreadLength (number)	Then StairFormula (number)	Annotations
1	-	-	`2*RiserHeight+TreadLength`	
+				

StairFormulaSucces — Hit Policy: Unique

	When StairFormula (number)	And StairFormula (number)	Then StairFormulaSucces (boolean)	Annotations
1	`<570`	-	`false`	
2	`>=570`	`<=630`	`true`	
3	`>630`	-	`false`	
+				

Let's code!

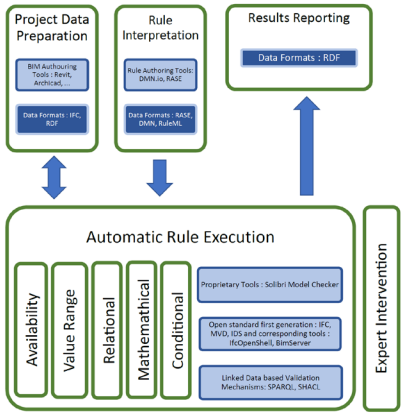
Four building blocks:

Project Data

Rule Interpretation

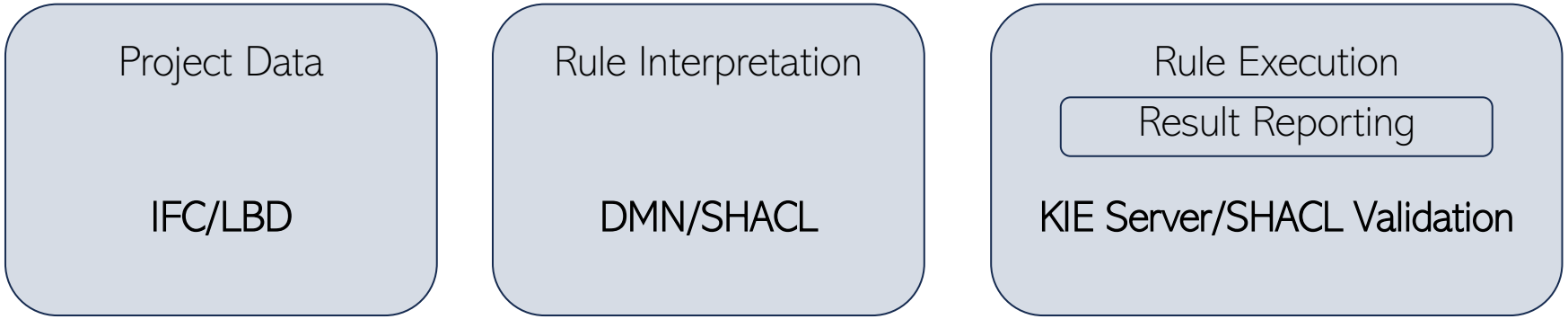
Rule Execution

Result Reporting



Let's code!

Three components:



Let's code!

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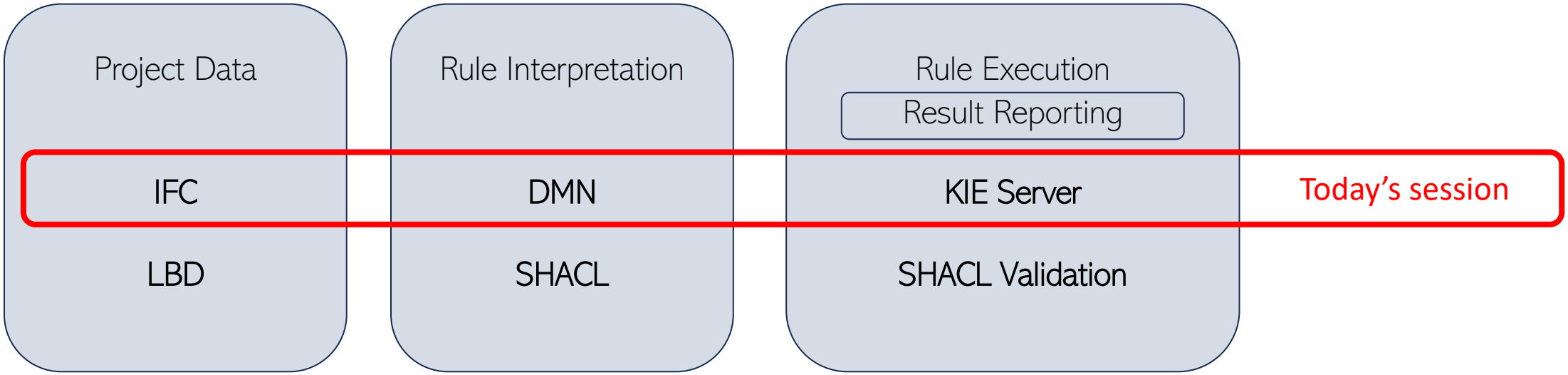

Let's code!

- Project Data : Heartbreak Hotel
- OpenIfcViewer
- Python 3.11, IfcOpenShell and KIE server
- DMN.new