Using semantic rules for generating SPARQL from semantic mark-up

Nicholas Nisbet [1]

[1] *AEC3 Ltd, London, UK*

AEC 3

R Requirement

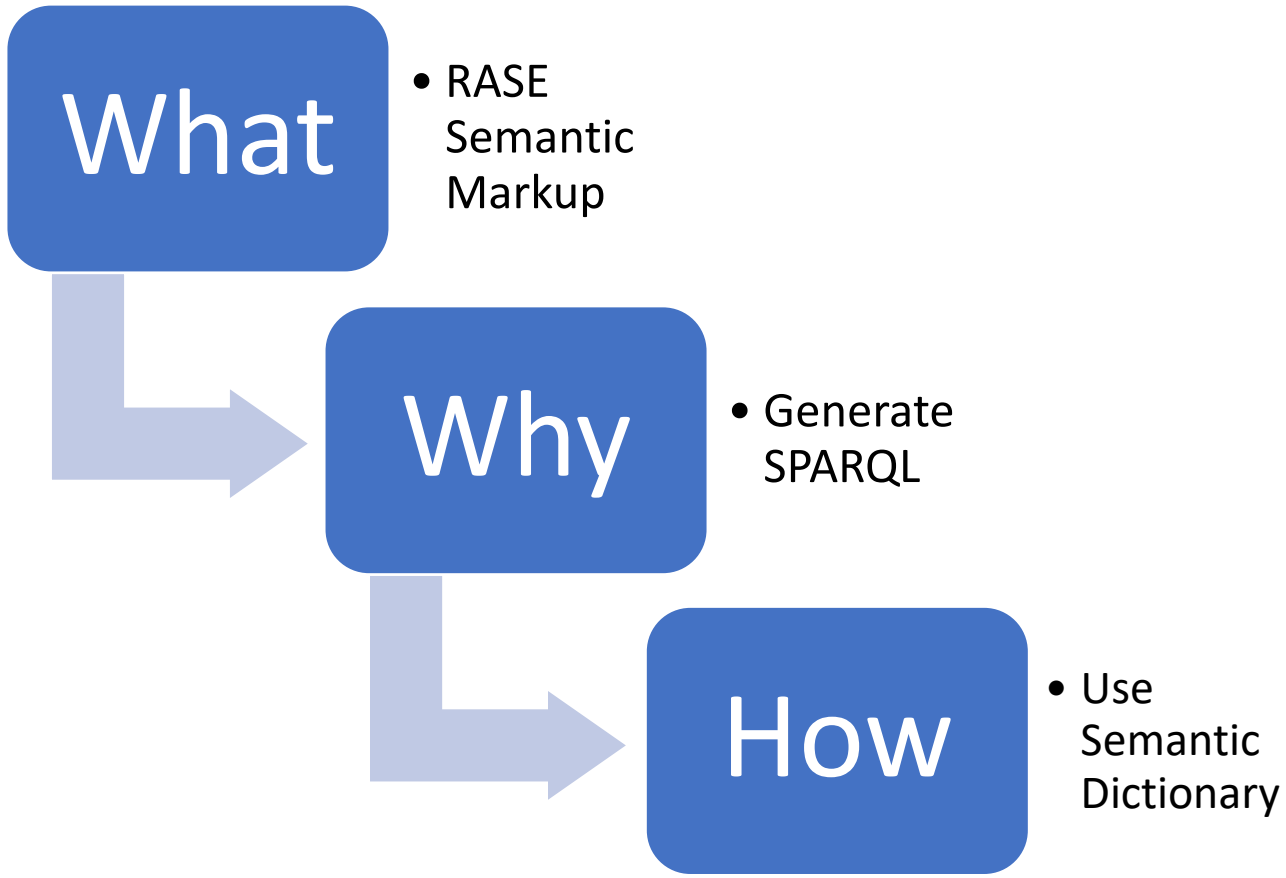
A Application

S Selection

E Exception

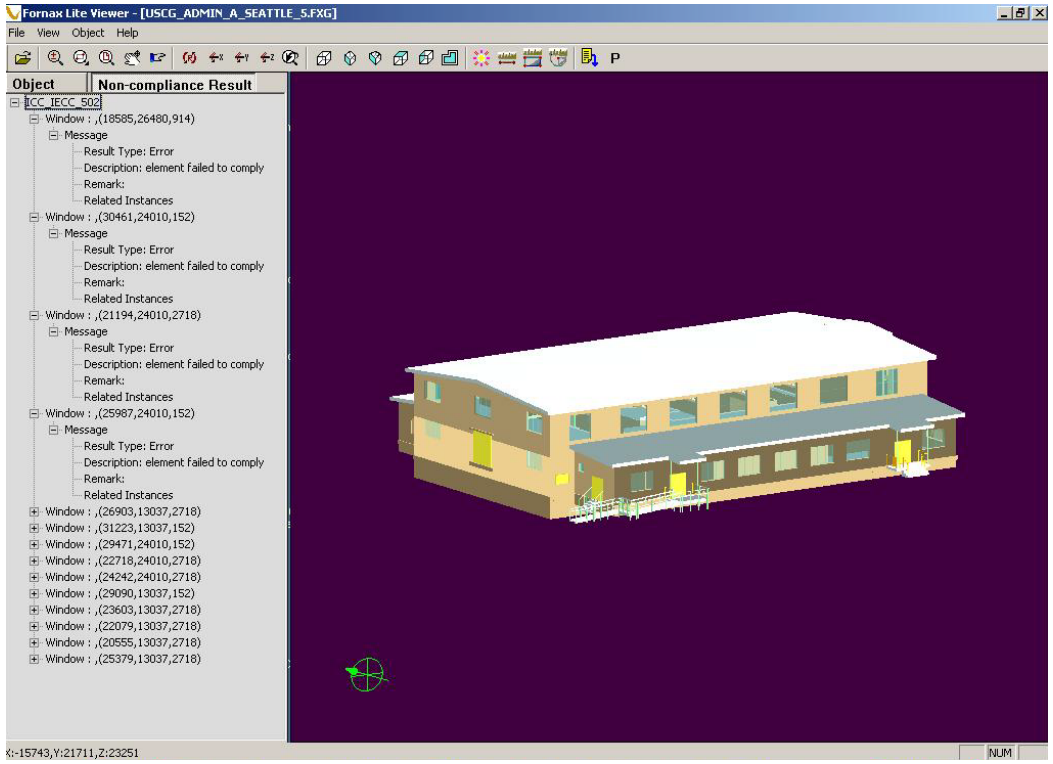
http://www.aec3.eu/

Using semantic rules (how?)
for generating SPARQL (why?)
from semantic mark-up (what?)



Rule-based applications for the built environment are:

- **Not trusted**
  - Separation of source text and programming
  - Lack of explanation of results or options
- **Un-economic to develop, validate and maintain**
  - Subject matter (inspectorate) experts
  - Application programmers
  - Target domain (BIM) experts
- **Limited**
  - Bound to specific scope
  - Bound to specific target formats
  - Bound to specific workflow.



- Example: Singapore ePlanCheck 2000

What: Semantic mark-up

Provisions

2.13 Doors to accessible entrances will satisfy requirements M1 and M2 if:

a. where required to be self-closing, a power operated door opening system is used when through calculation and experience it appears that it will not be possible otherwise for a person to open the door using a force no greater than **20N** at the leading edge;

b. the effective clear width through a single leaf door or one leaf of a double door is in accordance with Table 2, and the rules for measurement are in accordance with Diagram 9;

c. unless it can be argued otherwise in the Access Statement, e.g. for reasons of security, door leaves and side panels towards the leading edge of the door whose vertical dimensions include at least the minimum zone or zones of visibility between 500mm and 1500mm from the floor, if necessary interrupted between 800mm and 1150mm above the floor, e.g. to accommodate an intermediate rail (see Diagram 9).

Table 2	Minimum effective clear widths of doors	
Direction and width of approach	New buildings (mm)	Existing buildings (mm)
Straight On (without a turn or oblique approach)	800mm	750mm
At right angles to an access route at least 1500mm wide		
At right angles to an access route at least 1200mm wide	825mm	775mm
External doors to buildings used by general public	1000mm	

Example: RASE mark-up (UK Approved Document M 2015)

Example: RASE mark-up (UK CDM Regulation 2015)

Excavations 22.

1. All practicable steps must be taken to prevent danger to any person, including,
   where necessary, the provision of
   supports or battering
   , to ensure that:
   a. no excavation or part of an excavation collapses;
   b. no material forming the walls or roof, or adjacent to, any excavation is dislodged or falls; and
   c. no person is buried or trapped in an excavation by material which is dislodged or falls.
2. Suitable and sufficient steps must be taken to prevent any person, work equipment, or any accumulation of material from falling into any excavation.
3. Suitable and sufficient steps must be taken, where necessary, to prevent any part of an excavation or ground adjacent to it from being overloaded by work equipment or material.
4. Construction work must not be carried out in an excavation where any supports or battering have been provided in accordance with paragraph (1) unless:
   a. the excavation and any work equipment and materials which may affect its safety have been inspected by a competent person:
      i. at the start of the shift in which the work is to be carried out;
      ii. after any event likely to have affected the strength or stability of the excavation; and
      iii. after any material unintentionally falls or is dislodged; and
   b. the person who carried out the inspection is satisfied that construction work can be safely carried out there.
5. Where the person carrying out an inspection informs the person on whose behalf the inspection is carried out of any matter about which they are not satisfied (under regulation 24(1)), construction work must not be carried out in the excavation until the matter has been satisfactorily remedied.

AEC 3

R Requirement
A Application
S Selection
E Exception

Three kinds of knowledge

- RASE has been applied to three kinds of knowledge :

- **definitive Registers, (how?)**
  - such as dictionaries, look-ups and classifications
  - for semantic correction, enhancement and enrichment
- **normative Requirements, (what?)**
  - such as building regulations and client requirements,
  - for automated compliance checking.
- **descriptive/narrative Reports (why?)**
  - such as BIM and GIS information.
  - for model summarization

Example 1

External doors and windows shall be at least 1200mm wide unless featuring a lock

Example clause without and with semantic mark-up

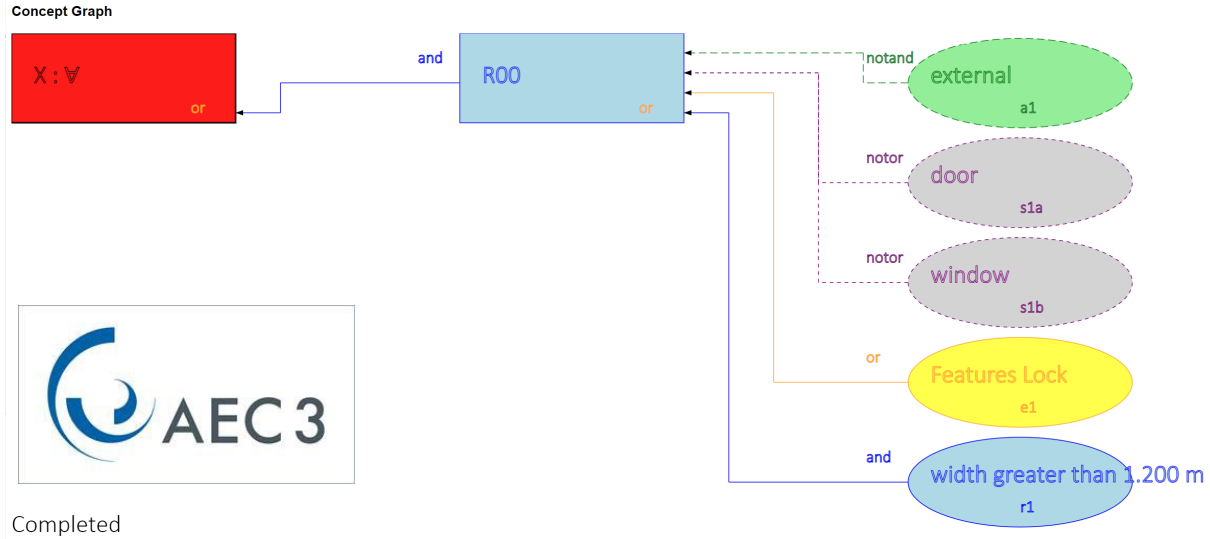
Example 1

External doors and windows shall be at least 1200mm wide unless featuring a lock

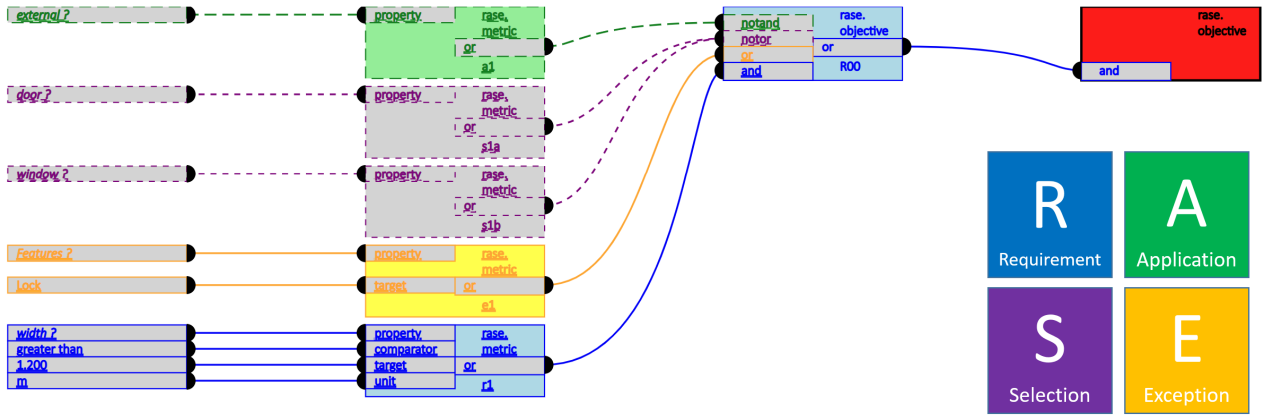
Example 1

- unnamed is unknown
  - unknown
    - *either firstly*
      - *not External* ***external*** unknown unknown
    - *or secondly*
      - *neither doors* ***door*** unknown unknown
      - *nor windows* ***window*** unknown unknown
    - *or thirdly*
      - *featuring a lock* ***Features*** unknown ***Lock*** unknown
    - *or lastly*
      - *at least 1200mm wide* ***width*** unknown ***greater than 1.200 m*** unknown

Dynamic page with input and output boxes



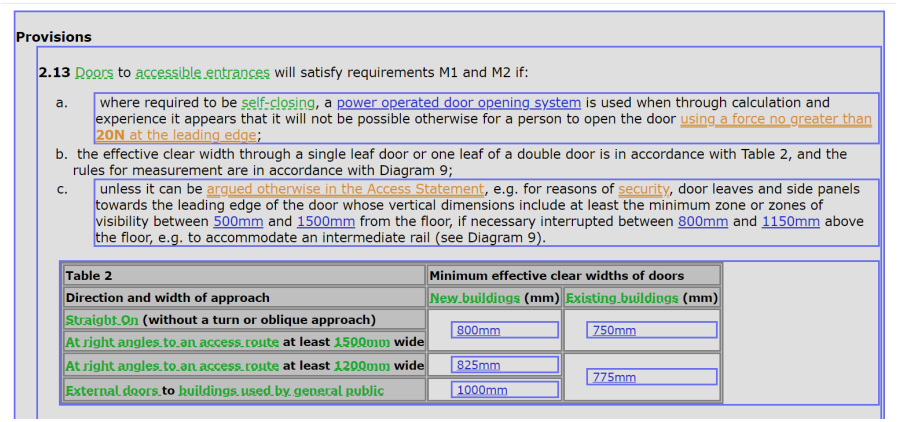
Concept graph (developed from Sowa 1992, Solihin et al 2016)



Visual programming (developed from Preidal et al 2016)

How: Trees and Mice

- RASE is an **tree** ontology of knowledge in text and tables
  - **objective sections (boxed) branches** containing
    - metric phrases
    - and other objective sections.
  - **metric phrases (underlined) leaves** identifying
    - properties,
    - comparators
    - and target values.



Provisions

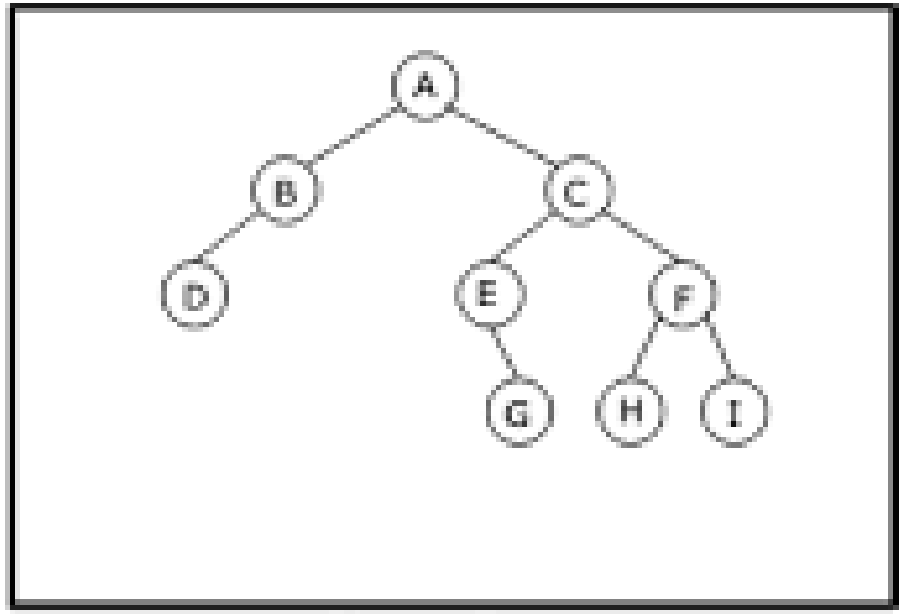
2.13 Doors to accessible entrances will satisfy requirements M1 and M2 if:

a. where required to be self-closing, a power operated door opening system is used when through calculation and experience it appears that it will not be possible otherwise for a person to open the door using a force no greater than **20N** at the leading edge;

b. the effective clear width through a single leaf door or one leaf of a double door is in accordance with Table 2, and the rules for measurement are in accordance with Diagram 9;

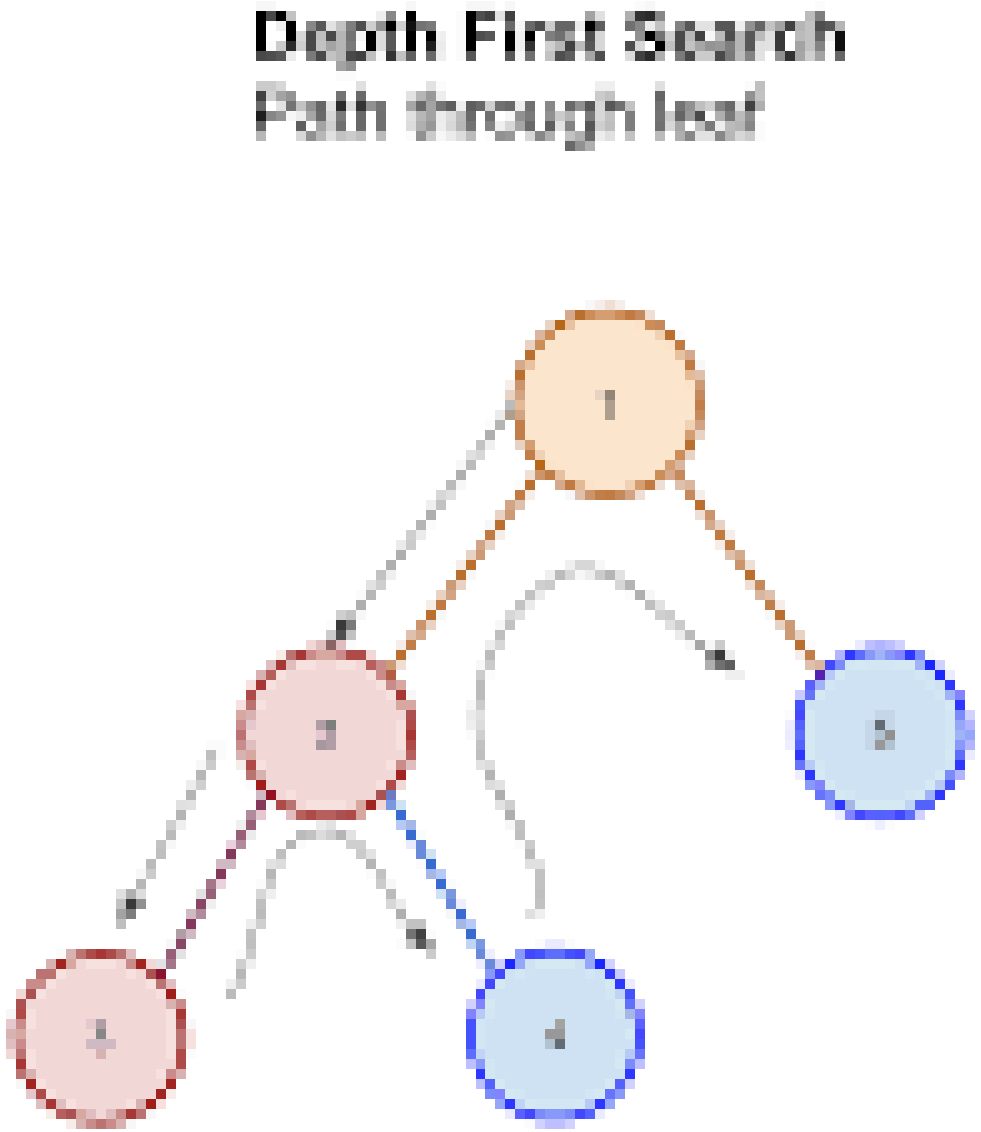
c. unless it can be argued otherwise in the Access Statement, e.g. for reasons of security, door leaves and side panels towards the leading edge of the door whose vertical dimensions include at least the minimum zone or zones of visibility between 500mm and 1500mm from the floor, if necessary interrupted between 800mm and 1150mm above the floor, e.g. to accommodate an intermediate rail (see Diagram 9).

Table 2	Minimum effective clear widths of doors	
Direction and width of approach	New buildings (mm)	Existing buildings (mm)
Straight On (without a turn or oblique approach)	800mm	750mm
At right angles to an access route at least 1500mm wide	825mm	775mm
At right angles to an access route at least 1200mm wide		
External doors to buildings used by general public	1000mm	



Trees and Mice

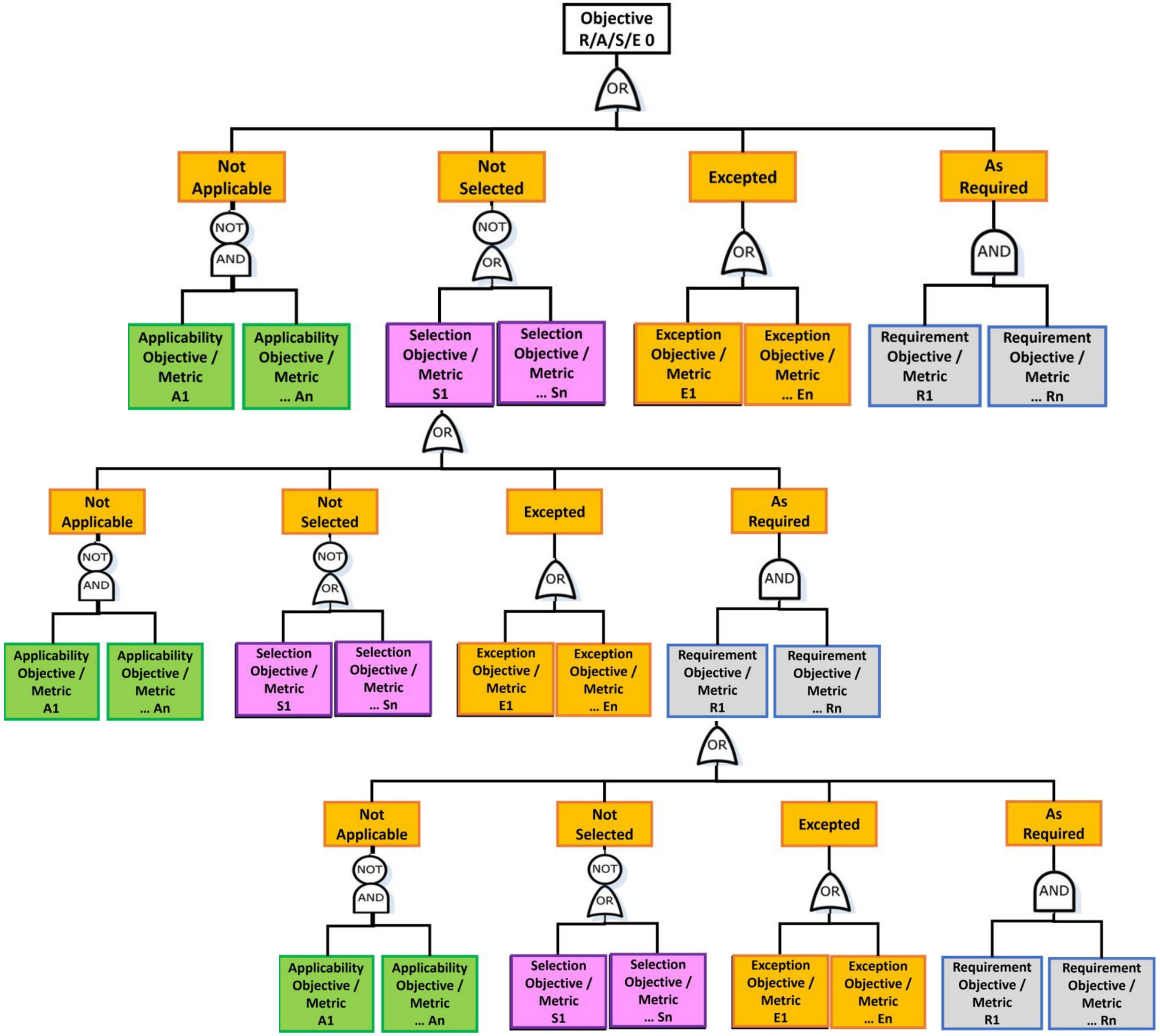
- To visit the whole tree, a mouse has to make **decisions**.
- Each decision is an **event.**
  - Set off
  - Go ‘up’ to the next branches
  - Go to a neighbouring branch or leaf
  - Come ‘down’ towards the trunk
  - Finish



Trees and Mice

- Branches and leaves have four flavours.

- The mouse likes to visit the nicest leaves and branches first.
  - quickest to eat = ASER
  - most satisfying: sometimes the mouse can skip a branch or leaf!



RASE mark-up, events, and SHACL syntax

RASE markup | Events | SPARQL/ SHACL

Pre-pass

HTML+RASE		SPARQL
[blank]	Start	SELECT DISTINCT ?object1?result WHERE {
[blank]	Metric phrase with target	?object1 ?@property* ?@id .
[blank]	Metric phrase without target	[blank]

Main pass

HTML+RASE		SPARQL
<html><body>	Start	BIND ((
	Begin tier	(
data-raseType="Requirement"	Before first requirement	(
data-raseType="Exception"	Before first exception	(
data-raseType="Selection"	Before first selection	! (
data-raseType="Application"	Before first application	! (
data-raseType="Requirement"	Before subsequent requirement	&&
data-raseType="Exception"	Before subsequent exception	||
data-raseType="Selection"	Before subsequent selection	||
data-raseType="Application"	Before subsequent application	&&
[text]	Metric phrase with target	?@id @comparator @target .
[text]	Metric phrase without target	EXISTS{ ?object1 a @property}
<span data-raseType="...Section"	Objective section	[drop down a tier]
[blank]	After last requirement	)
[blank]	After last exception	)
[blank]	After last selection	)
[blank]	After last application	)
	End tier	) [revert up a tier]
</body></html> [eof]	End	) AS ?result) . FILTER (?result != 'true'^^xsd:boolean) . }

Example

Example clause

Example 1

External doors and windows shall be at least 1200mm wide unless featuring a lock.

```
<concept type="entity">
            <term context="en-GB">window</term>
            <term context="SPARQL">ifc:IfcWindow</term>
```

```
BIND ( (
(
  ! ( ( ?a1  = 'true'^^xsd:boolean) )
||                                          # not selected ?
  ! ( EXISTS{ ?this a ifc:IfcDoor  } || EXISTS{ ?this a ifc:IfcWindow  } )
||                                          # excepted ?
   ( ?e1  =  'Lock'^^xsd:string )
||                                          # as required ?
   ( ?r1 > '1.200'^^xsd:double )
)
)  AS ?result) .
```

Generated SPAQL decision

```
# Title: Example 1
# Date:  2023-06-04
# (c)2022   AEC3 UK Ltd.

PREFIX xsd:  <http://www.w3.org/2001/XMLSchema#&>
PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
PREFIX rdf:  <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX bot:  <https://w3id.org/bot#>
PREFIX ifc:  <http://ifcowl.openbimstandards.org/IFC2X3_Final#>
PREFIX kbt:  <https://w3id.org/kobl/building-topology#>
PREFIX inst: <https://web-bim/resources/>

SELECT DISTINCT ?this ?result WHERE {
      ?this a bot:Element .

OPTIONAL{ ?this inst:external ?a1 } .
OPTIONAL{ ?this inst:width ?r1 } .
OPTIONAL{ ?this inst:Features ?e1 } .

BIND ( (
(
  ! ( ( ?a1  = 'true'^^xsd:boolean) )
||
  ! ( EXISTS{ ?this a ifc:IfcDoor  } ||  EXISTS{ ?this a ifc:IfcWindow  } )
||
   ( ?e1  =  'Lock'^^xsd:string )
||
   ( ?r1 > '1.200'^^xsd:double )
)
)  AS ?result) .

FILTER ( ?result != 'true'^^xsd:boolean) .    # failed (!=) or passed (=)
}
ORDER BY ?this
```

SPARQL query

RASE-based applications for the built environment are:

- **Accurate**
  - No programming.
  - Full explanation of results or options.
- **Efficient to maintain**
  - Building Inspectors (SMEs)
  - -
  - Target domain (BIM) experts.
- **Complete**
  - Any source document.
  - Any workflow.
  - Any target domain.

Example: LD-BIM (Rasmussen 2022)

Using semantic rules for generating SPARQL from semantic mark-up

Nicholas Nisbet

AEC3 Ltd, London, UK
nn@aec3.com

AEC 3

R Requirement

A Application

S Selection

E Exception

What
- RASE Semantic Markup

Why
- Generate SPARQL

How
- Use Semantic Dictionary

Thank you.
Any questions?