

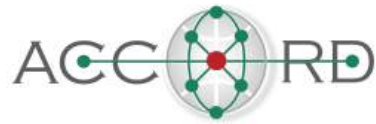
ACCORD



Digital Building Permit

Automated Compliance Checks for Construction,
Renovation or Demolition Works





AI-RFT

AI-POWERED Rule Formalisation Tool

Architectural Engineering and Construction

Training material

WP2: Semantisation of regulation and open format for machine-readable rules

On behalf of BCU research team: Hadeel Saadany
Faculty of Computing, Engineering and the Built Environment
Birmingham City University

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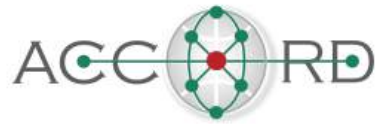
Funded by the
European Union

This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement no. 101056973



Innovate
UK

UK Participants in Horizon Europe Project ACCORD are supported by UKRI grant numbers 10040207 (Cardiff University), 10038999 (Birmingham City University and 10049977 (Building Smart International)



Outline

- **What** is the aim of the AI-RFT tool within ACCORD project?
- **How** are AI and NLP techniques deployed in rule formalization?
- **What** are the use-cases for AI-RFT?
- **To Whom** AI-RFT can be useful?



Aim of the Tool



Project Aim Digitalise building codes, regulations, and construction standards for compliance requirements.



Tool Aim Extract and analyse compliance requirements from natural language text through AI-assisted models and a semantic web technology.

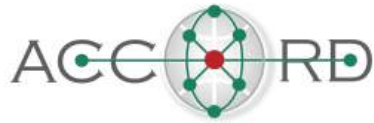


Where software can read, parse, and understand the structure of regulation documents.



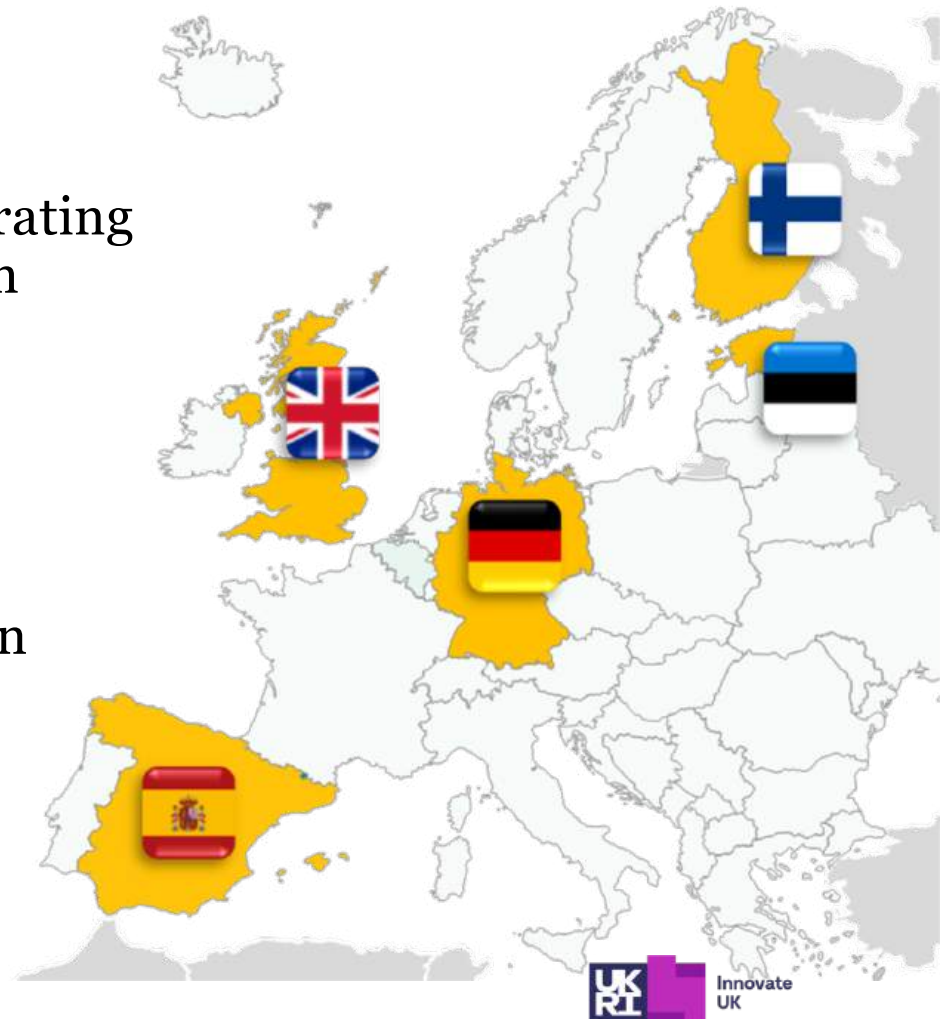
Where software can additionally execute actions based on the document.

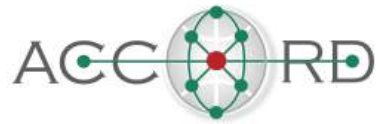




Who can use these outputs?

- Governmental bodies responsible for generating building codes and regulations in European countries.
- Any institution/experts handling building regulation data.
- Researchers.
- Architecture, Engineering and Construction (AEC) Community in general.





In Which use cases it can be applied?



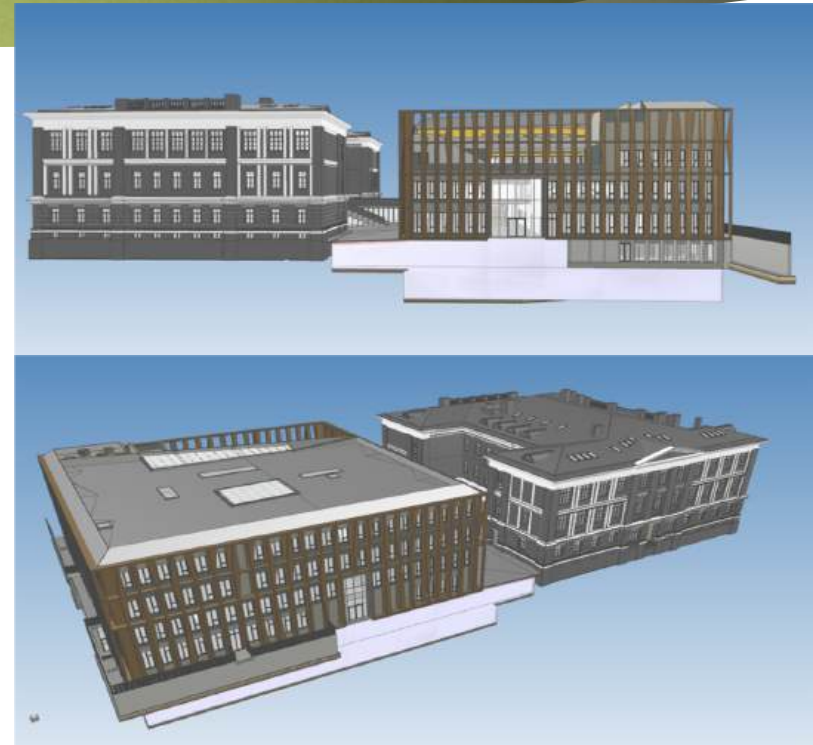
- ▶ **Use Case 1:** Automate the compliance checking of selected geometry-based requirements of fire safety for schools.



- ▶ **Use Case 2:** Requirements of accessibility for schools.



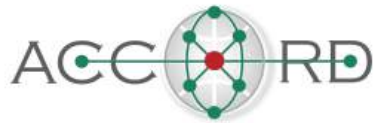
- ▶ **Use Case 3:** Develop and test a method for carbon footprint evaluation of the building permission.



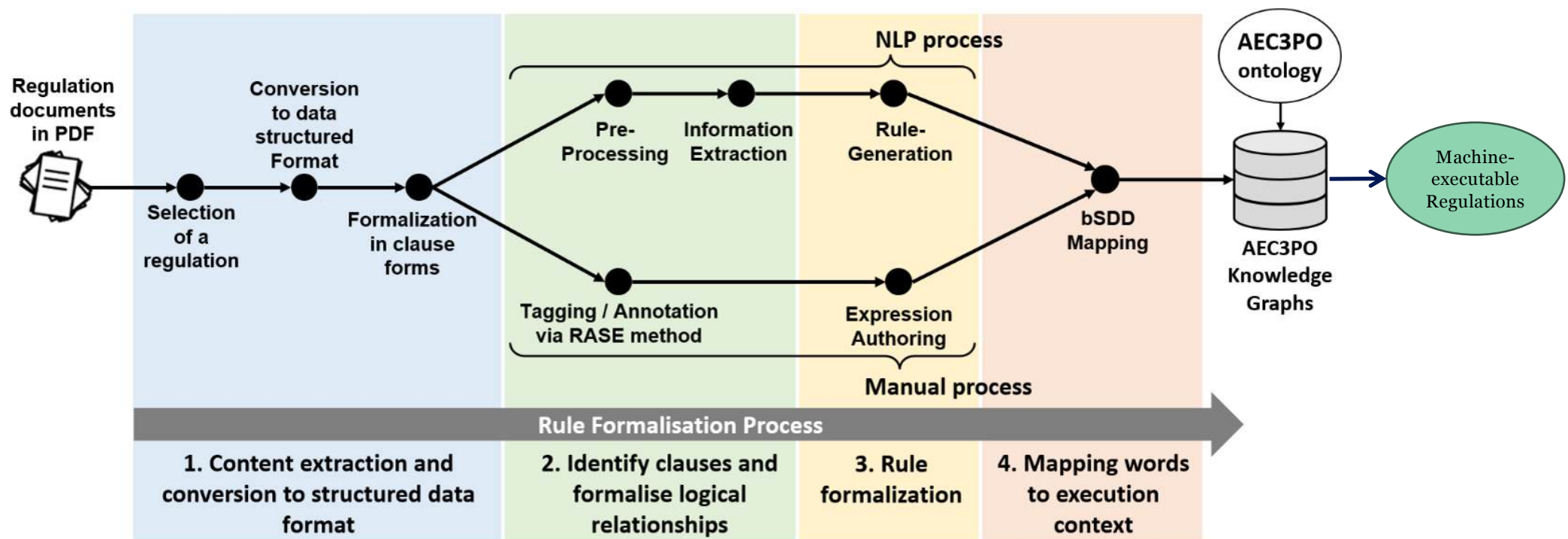
School house owned by Tallinn Property Department

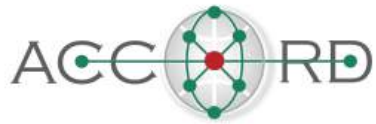


Methodology

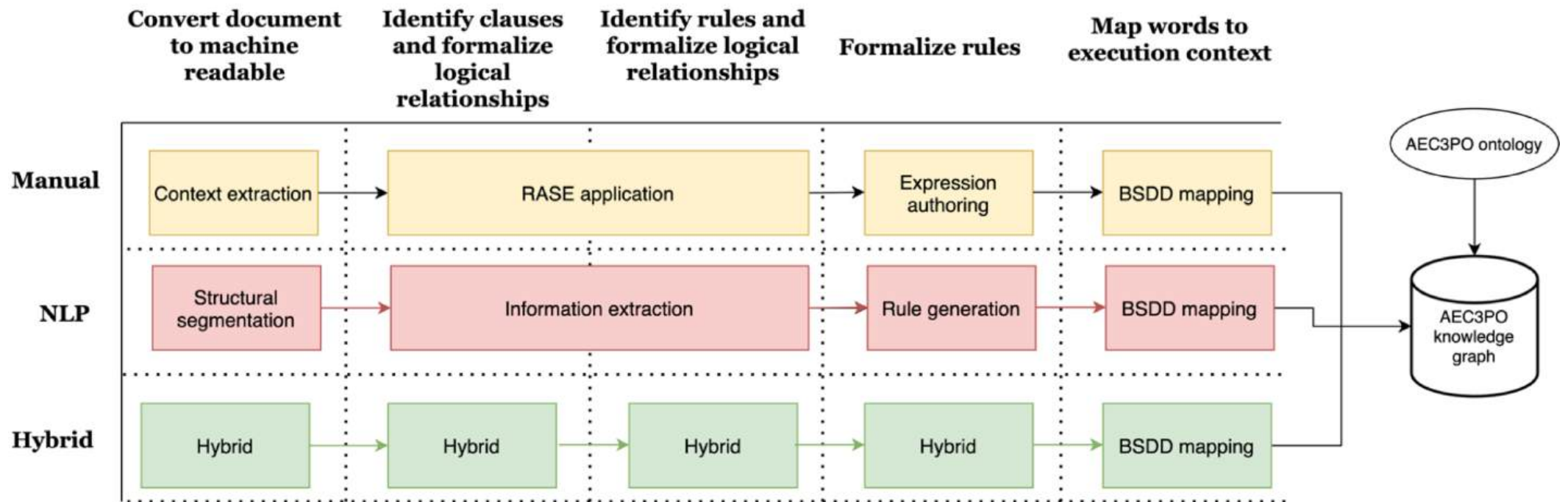


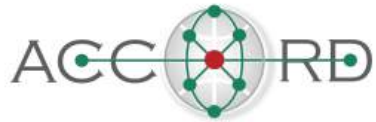
The tool integrated components





The AI-RFT Methodology

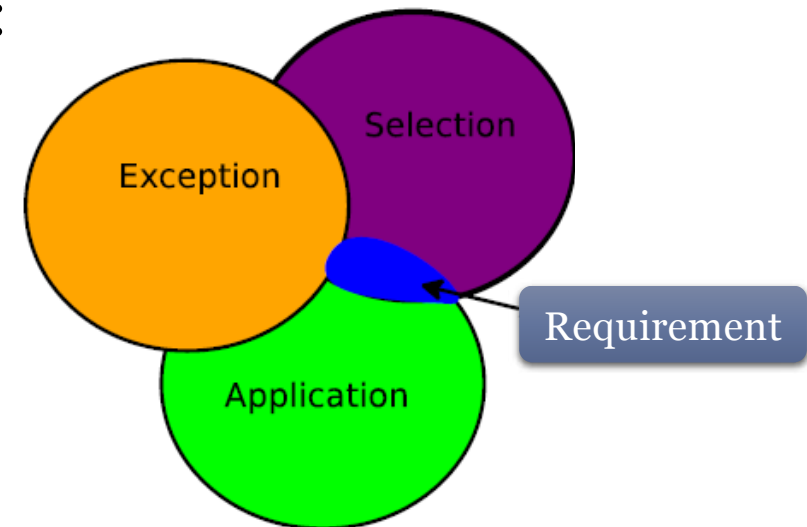




What is RASE application?

The RASE scheme is based on four operators:

- (1) R - requirement,
- (2) A - applicability,
- (3) S - selection and
- (4) E - exception.



Passageway leading to a building

There shall be an easily noticeable passageway with a width of at least 1,200 millimetres and a smooth, hard and non-slippery surface that leads to the building from the boundary of the plot or building site and from the space and area that serve the use of the building.

The gradient of the passageway located in an outdoor space may not exceed five per cent.

If there are steps on the passageway, there shall also be a ramp or a permanently installed device intended for lifting persons that is suitable for a user of a wheelchair and walking frame with wheels.

The provisions of this subsection do not apply to a detached house, semi-detached house or townhouse if providing an accessible passageway would be impossible considering the site and elevation differences.

Manual Methodology

	A	B	C	D	E
1					
2	Use case:	T5.1 UC F14	Operational safety		
3					Items to be checked in 1st sprint summer 2023
4	Chapter	Section	Clause	Text from the regulation	Translated text in English
5	1	1	1	Yleistä	Title:General
6	1	1	1	Soveltamisala	Title:Scope of application
7	1	1	1	Tämä asetus koskee uutta rakennusta, rakennuksen laajennusta ja rakennuksen kerrassalaa lisäävää tilaa sekä rakennuspaikan välitöntä ympäristöä.	This Decree shall apply to new buildings, additions to buildings and spaces increasing the floor area of buildings and to the immediate vicinity of building sites.
8	1	1	2	Rakennuksen korjaus- ja muutustyössä tätä asetusta on sovellettava, jos alkuperäinen ratkaisu on turvallisuuden tai terveydellisyiden kannalta ilmeisen haitallinen. Rakennuksen korjaus- ja muutustyöt voidaan muutoin tehdä alkuperäistä ratkaisua noudattaen. Muutokset eivät saa heikentää käyttöturvallisuutta.	This Decree is to be applied to renovation and alteration work only if the original solution is evidently unsuitable for reasons related to safety or health. In other cases, renovation and alteration work can be carried out according to the original solution. Alteration work must not weaken the safety of the building.
9	1	1	3	Tätä asetusta on sovellettava rakennuksen käyttötarkoituksen muutokseen, jos rakennuksen tai sen osan käyttötarkoitus muuttuu riskillisemmäksi.	This Decree shall apply to changes to the intended purpose of a building if the intended purpose of the building or part of the building is changed such that it is associated with a higher risk.
10	2	2	1	Rakennuksen käyttöturvallisuus	Title:Operational safety of buildings
11	2	2	1	Pääsuunnittelijan, rakennussuunnittelijan ja erityissuunnittelijan on tehtävänsä mukaisesti huolehdittava rakennuksen suunnittelusta siten, että rakennus käyttötarkoituksensa mukaisesti täyttää käyttöturvallisuudelle asetetut olennaiset tekniset vaatimukset.	According to their tasks, the principal designer, building designer and specialised designer must ensure that the building is designed in such a way that it fulfils the essential technical, functional and architectural safety requirements for its purpose.
12	2	3		Putoamisen ja harhaan astumisen estäminen	Title:Prevention of falls and missteps
13	2	3	1	Portas	Title:Staircases
14	2	3	1	Portaan on oltava turvallinen ja tarkoituksensa soveltuva. Portaan pinta ei saa olla liukas.	Staircases must be safe, sufficiently spacious and suitable for their purpose. The surface of stairs the must not be slippery.
15	2	3	2	Portumiesalueen sisäisen portaan vähimmäisleveys on 0,85 metriä. Tämän mitan sisäpuolelle voivat kuitenkin ulottua käsijohteet ja jalkalistat.	The minimum width of indoor stairs in an evacuation area is 0.85 metres. Handrails and skirting may, however, extend into this width.

Content Extraction



RASE Application

Passageway leading to a building

There shall be an easily noticeable **passageway** with a width of at least **1,200 millimetres** and a **smooth, hard and non-slippery** surface that leads to the **building** from the **boundary of the plot or building site** and from the **space and area that serve the use of the building**.

The gradient of the passageway located in an **outdoor space** may not **exceed five per cent**.

If there are **steps on the passageway**, there shall also be a **ramp** or a **permanently installed device intended for lifting persons that is suitable for a user of a wheelchair and walking frame with wheels**.

The provisions of this subsection do not apply to a **detached house, semi-detached house or townhouse** if providing an **accessible passageway would be impossible considering the site and elevation differences**.

YAML serialisation of RASE

```
- $id: Fire_safety_requirements_for_the_building/9
  identifier: 9
  $type: DocumentSubdivision
  title: Prevention of fire and its danger
  hasPart:
    - $type: Statement
      $id: Fire_safety_requirements_for_the_building/9.1
      identifier: 9.1
      asText: "In order to prevent fire and its risk, the possibility of fire is taken into account during the design, construction and use of the building, taking into account both internal and external effects, including the risk of fire and explosion caused by the technical systems and equipment located in the building."
    - $type:
      - Statement
      - RequirementStatement
      $id: Fire_safety_requirements_for_the_building/9.2
      identifier: 9.2
      hasInlinePart:
        - asText: Explosive
          $id: Fire_safety_requirements_for_the_building/9.2.1
          identifier: 9.2.1
          $type:
            - CheckStatement
            - ApplicationStatement
        - asText: rooms
          $id: Fire_safety_requirements_for_the_building/9.2.2
          identifier: 9.2.2
          $type:
            - CheckStatement
            - ApplicationStatement
        - $id: Fire_safety_requirements_for_the_building/9.2.3
          identifier: 9.2.3
          asText: are allowed in a building with types of use
          $type: Statement
```



Automatic Methodology

STAGE 1: NLP Information Extraction Mechanism

Scope

Information extraction pipeline to convert a regulatory sentence into a knowledge graph of its entities and relations

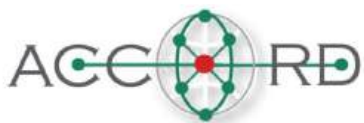
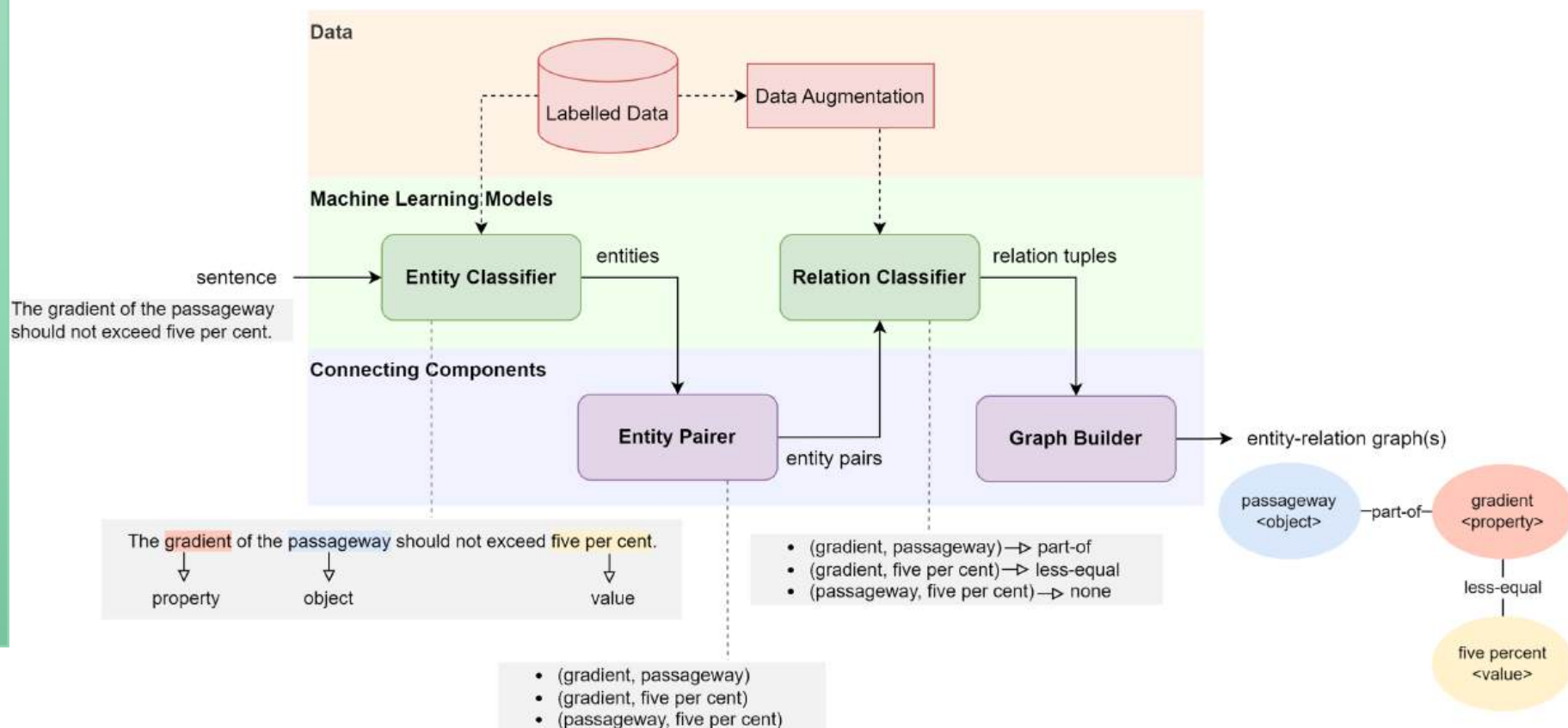
• *Input:* Complete-regulatory sentence

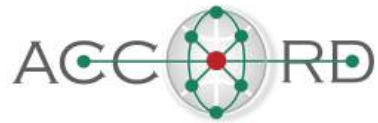
• *Output:* knowledge graph

• *Intermediate outputs:*

• Entities available in the input sentence

• Relations among entities

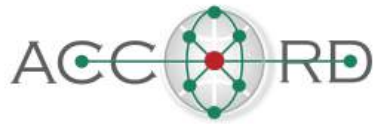




- ❑ Knowledge graphs are automatically generated by this pipeline.
- ❑ In. and Out. denotes the input to and output from the pipeline.

In.	Perimeter insulation should be continuous and have a minimum thickness of 25mm.	In a mechanical system, there shall be a clearly labelled stop switch, which shall be located in an easily accessible place.
Out.	<pre> graph TD A([Perimeter insulation <object>]) -- necessity --> B([continuous <quality>]) A -- part-of --> C([thickness <property>]) C -- greater-equal --> D([25mm <value>]) </pre>	<pre> graph TD A([mechanical <quality>]) -- selection --> B([system <object>]) B -- necessity --> D([stop switch <object>]) C([clearly labelled <quality>]) -- selection --> D D -- selection --> E([located in an easily accessible place <quality>]) </pre>





Stage 2: RASE Automation

- Automatically transform textual descriptions of building regulations into structured YAML formats annotated with the RASE labels.
- By fine-tuning and prompting both open-source and commercial Large Language Models (LLMs).

Open Source LLMs

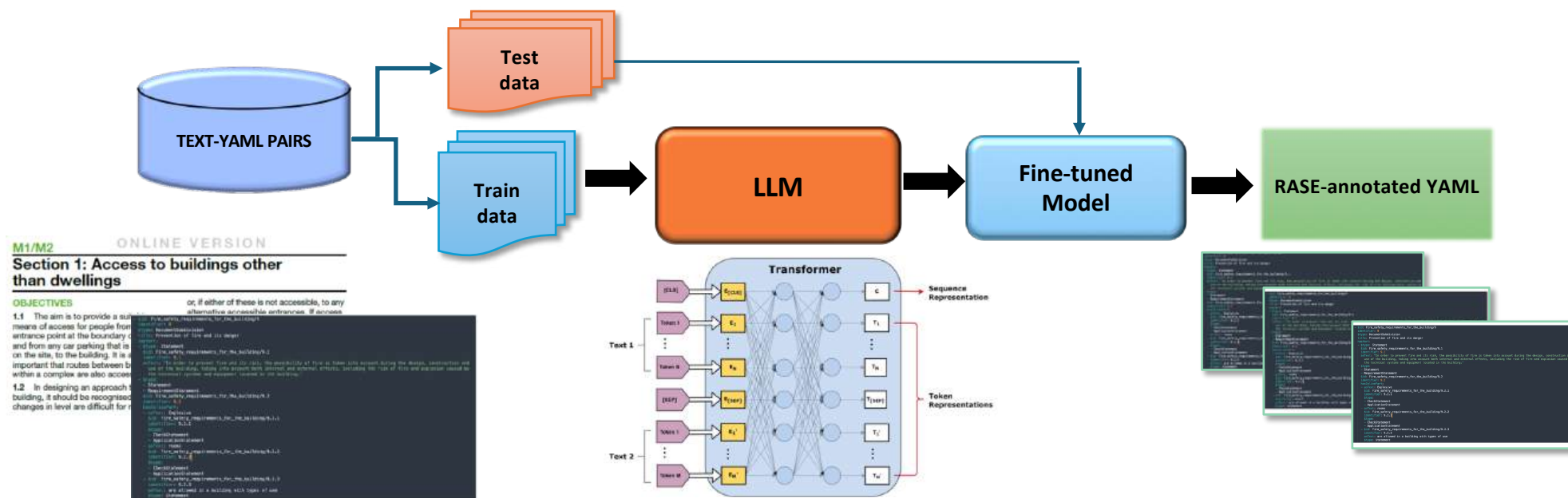


Commercial

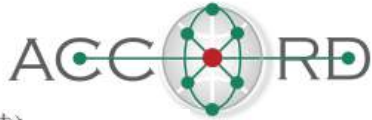




Regulation to RASE-annotated YAML



RASE Automation



Department
for Education

Fire Safety Design for Schools

Building Bulletin 100 (revised)

Section 4: Horizontal escape route design

- 4.1. Means of escape should be provided from any point on a floor to an exit from the floor. The general principle is that any person confronted by a fire within a building can turn away from it and escape safely.
- 4.2. In certain conditions, typically classrooms, a single direction of escape (a dead end condition) can be accepted as providing reasonable safety providing that the recommendations of Table 1 on travel distances in a single direction is met and the occupancy of the space is limited to 60.


```
- identifier: '1'
  $type: DocumentSubdivision
  title: Horizontal escape route design
  hasPart:
    - identifier: 1.tb1
      $type: Statement
      asText: Means of escape should be provided from any point on a floor to an exit
        from the floor. The general principle is that any person confronted by a fire
        within a building can turn away from it and escape safely.
    - identifier: 1.tb2
      $type:
        - Statement
        - CheckStatement
        - RequirementSection
      asText: In certain conditions , typically classrooms, a single direction of escape
        (a dead end condition) can be accepted as providing reasonable safety providing
        that the recommendations of Table 1 on travel distances in a single direction
        is met and the occupancy of the space is limited to 60 .
      hasInlinePart:
        - identifier: 1.tb2.ts1
          $type: Statement
          asText: In certain
        - identifier: 1.tb2.ts2
          $type:
            - CheckStatement
            - Application
          asText: conditions
          isOperationalizedBy:
            hasTarget: building area
            hasComparator: '='
            hasValue: 'true'
```



Tool Interface




AI-RFT Interface



Rule Formalization Tool

Login


[Forgot password?](#)

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 **Innovate UK**


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Rule Formalization Tool


Register

☐ I have read and agree to the terms and conditions *

* Required fields

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 **Innovate UK**

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PDF

PDF file

Choose file

FI2-AccessibilityOfBuildings_EN.pdf

Upload

Rule Formalization Tool

**Ready to start
the annotation process**

FI2-AccessibilityOfBuildings_EN.pdf

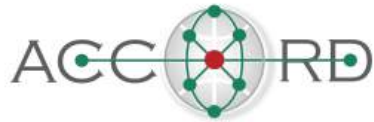


Select the type of extraction

Automated

Manual





Unofficial translation.
Legally binding only in Finnish and Swedish

Government Decree on Accessibility of Buildings

By decision of the Government, the following is enacted under section 117e, subsection 2 of the Land Use and Building Act (132/1999), as amended by Act 958/2012:

Section 1

Scope of application

This Decree applies to the construction of a new administrative, service, office, business, warehouse, production and residential building subject to permit under section 125 of the Land Use and Building Act (132/1999). However, only sections 2–4 apply to the construction of a detached and semi-detached house and only sections 2–5, 8, 10 and 11 apply to the construction of a warehouse and production building.

This Decree also applies to the repair and alteration work of an administrative, service, office, business, warehouse and production building and common spaces of a multi-storey residential building, extension or increasing the gross floor area of such a building, and alteration of the intended use of a building for administrative, service, office, business or residential use subject to permit under section 125 of the Land Use and Building Act, to the extent that improving accessibility is appropriate considering the attributes of the building as well as the type and scope of the measure. However, only sections 2–5, 8, 10 and 11 apply to the measures referred to above carried out in a warehouse and production building.

The provisions of this Decree concerning buildings intended for a specific use also apply to a space intended for a similar use in another building.

Section 2

Passageway leading to a building

There shall be an easily noticeable passageway with a width of at least 1,200 millimetres and



Rule Formalization Tool

Projects / Accessibility of Buildings (FULL) / Annotation

RASE boxes

RASE tags

Title

R A S E

R A S E

The gradient of the passageway located in an outdoor space may not exceed five per cent. If there are steps on the passageway, there shall also be a ramp or a permanently installed device intended for lifting persons that is suitable for a user of a wheelchair and walking frame with wheels.

The provisions of this subsection do not apply to a detached house, semi-detached house or townhouse if providing an accessible passageway would be impossible considering the site and elevation differences.

The ramp referred to in subsection 1 above shall be easily noticeable and straight with a smooth, hard and non-slippery surface, width of at least 900 millimetres and, if the ramp is not connected to a fixed structure, a protective edge of at least 50 millimetres in height. There shall be a horizontal landing with a length of at least 1,500 millimetres at the lower and upper end of the ramp. The gradient of the ramp may not exceed five per cent. However, if the elevation Directive 2015/1535/EU of the European Parliament and of the Council (32015L1535); OJ L 241, 17.9.2015, p. 1 difference is no more than 1,000 millimetres, the ramp may not have a gradient of more than eight per cent. In that case, the elevation difference of a continuous ramp may not be more than 500 millimetres, after which there shall be a horizontal intermediate landing with a length of at least 2,000 millimetres. However, in an outdoor area the ramp may have a gradient of more than five per cent only if it can be kept in a condition comparable with that of an indoor ramp. Provisions on railings, handrails and other arrangements intended to prevent falling down and misstepping are laid down by decree issued under section 117d, subsection 2 of the Land Use and Building Act.

ramp

Remove

☐ Expert Mode

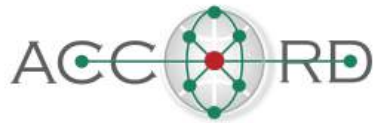
- ☒ Object
☐ Property
☐ Reference

Name


Ramp

Confirm

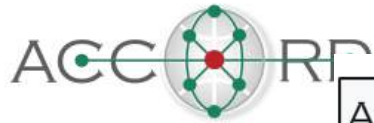







The interface to validate the BCRL expressions.

<div>  <div>Rule Formalization Tool</div> <div>🔍 ↗</div> </div>				
Projects / Accessibility of Buildings (FULL) / Annotation / Validation				
Validate				
Text	RaseType	RaseProperty	Identifier	Reference
passageway	Application	:type == :Passageway	3.1.1	-
smooth	Requirement	:Smooth == true	3.1.3	-
hard	Requirement	:Hard == true	3.1.4	-
non-slippery	Requirement	:Nonslippery == true	3.1.5	-
building	Application	:ConnectsWith exists ⇒ (:type == :Building)	3.1.6	-
boundary of the plot or building site	Selection	:ConnectsWith exists ⇒ (:type == :SiteBoundary)	3.1.7	-
space and area that serve the use of the building	Selection	:ConnectsWith exists ⇒ (:type == :ServiceArea)	3.1.8	-
outdoor space	Application	:IsExternal == true	3.1.9	-
may not exceed five per cent	Requirement	:Gradient <= 5 :percent	3.1.10	-
steps on the passageway	Application	:Contains exists ⇒ (:type == :Step)	3.1.11	-
ramp	Requirement	:Contains exists ⇒ (:type == :Ramp)	3.1.12	-
permanently installed device intended for lifting persons that is suitable for a user of a wheelchair and walking frame with wheels	Exception	:Contains exists ⇒ (:type == :LiftingDevice)	3.1.13	-





**Rule Formalization Tool**

Projects / Accessibility of Buildings / Annotation / Validation / Publish

Archive generated

[Open HTML file created](#)

[Open JSON-LD created](#)

Projects in repository Accord

No context in repository

Repository where to publish the project

<https://graphdb.accordproject.eu/resource/aec3po/Fl/ACC9582012/en-GB/17-09-2015>

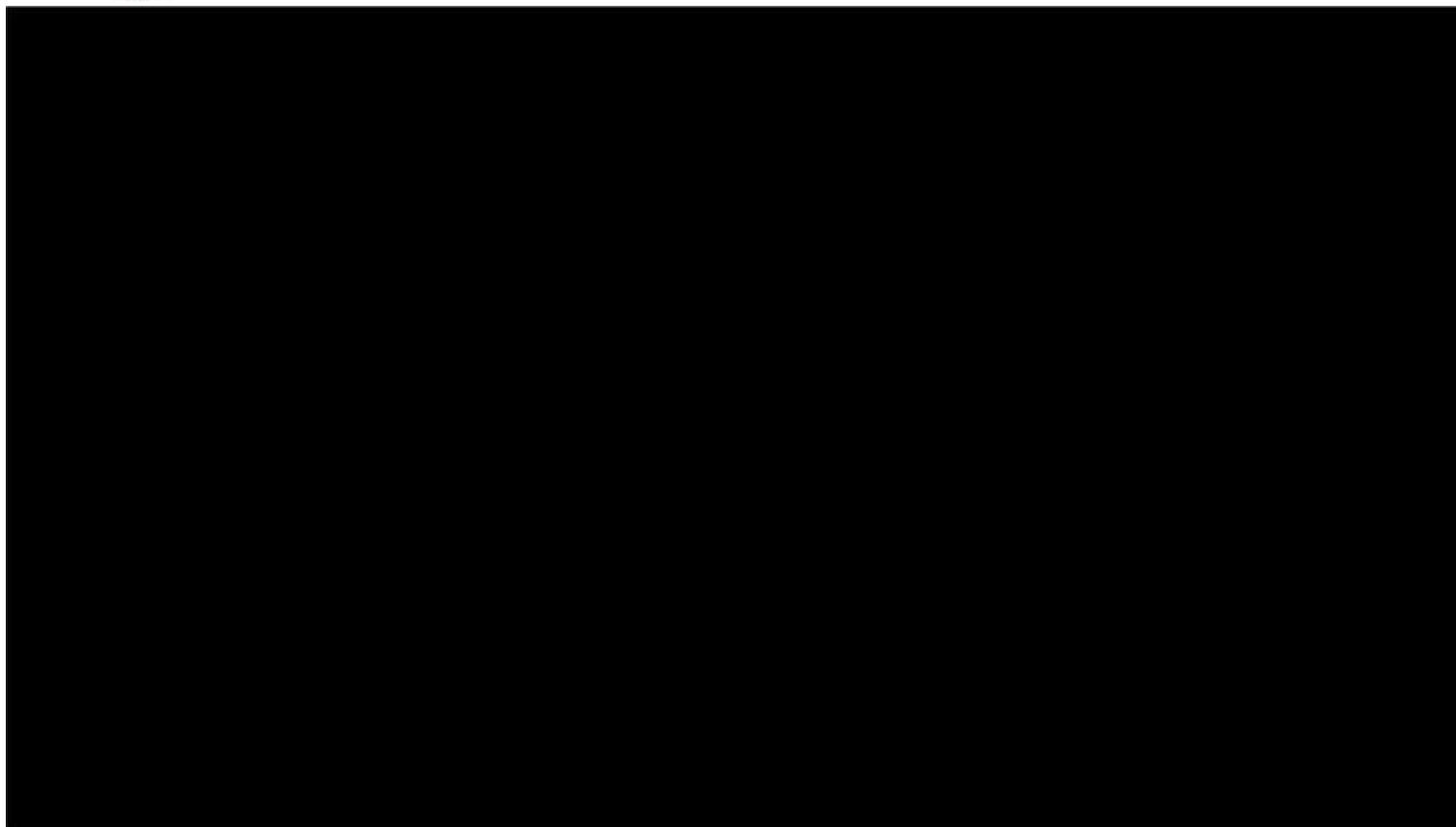
[Change publish date](#)

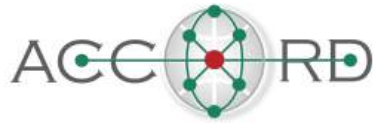
[Publish](#)





Text to YAML - Demo





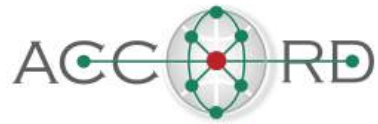
Artificial Intelligence for Natural Language Processing for Building Codes

1. CODE-ACCORD
2. SNOWTEC
3. Single Clause Classification
4. Text to RASE (course-grained level)
5. Rule Generation from Building Regulations (RASE to JSON)
6. RASE Automation

Useful Links

- ACCORD-NLP Codebase: <https://github.com/Accord-Project/accord-nlp>
- ACCORD-NLP Python Package: <https://pypi.org/project/accord-nlp/>
- Pre-trained Models: <https://huggingface.co/ACCORD-NLP>
- Information Extractor (SNOWTEC) Live Demo: <https://huggingface.co/spaces/ACCORD-NLP/information-extractor>



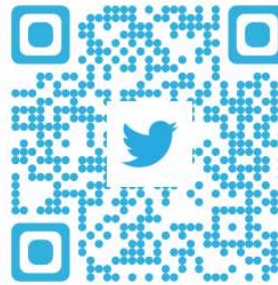


Thank you!

Dr. Hadeel Saadany

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Partners



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