STAM: Working with stand-off annotations on text

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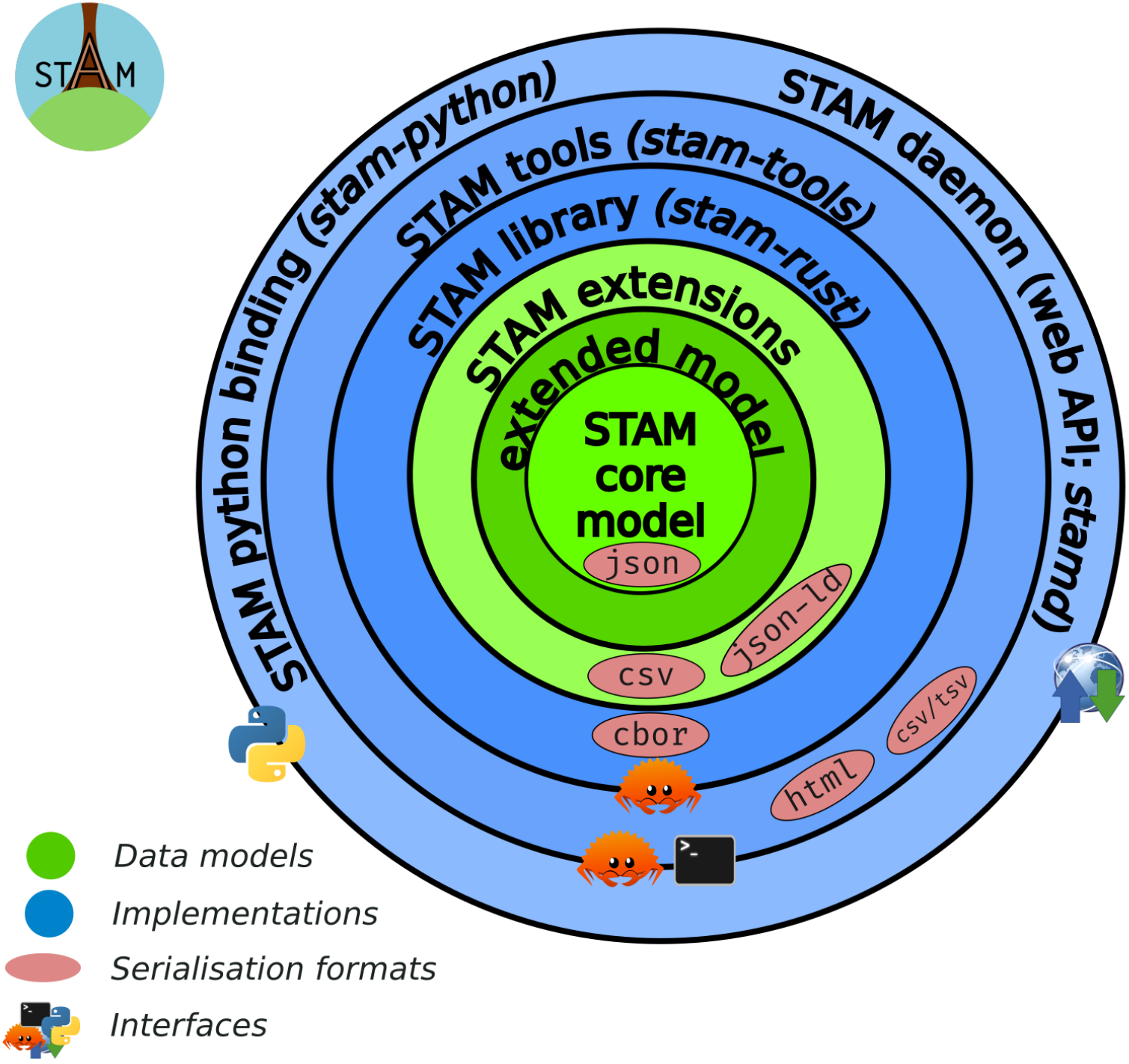
Introduction

What is STAM?

1. A **data model** for **stand-off annotation** on **text**
2. A set of low-level **software tools** for working with **stand-off annotation** on **text**

Theory & Practise go hand in hand, STAM aims to provide a *solid generic foundation upon which you can build*.


STAM python binding (stam-python)
STAM tools (stam-tools)
STAM library (stam-rust)
STAM extensions
extended model
STAM core model
STAM daemon (web API; stamd)
json
json-ld
csv
cbor
csv/tsv
html
Data models
Implementations
Serialisation formats
Interfaces

Core Data Model

What basic concepts and relations are needed to express stand-off annotation on text?

- . . . whilst keeping the concepts to a basic yet flexible enough **minimum** *(minimalism)*
  - . . . **extensions** are formulated separately *(modularity)*
- . . . without **dependencies** on other complex models *(standalone model)*
- . . . without prescribing any domain-specific **vocabulary** *(separation from semantics)*
- . . . not tied to any single **serialisation format** *(separation from syntax)*

STAM's **core model** is our answer to this.

- It is documented in a precise technical **specification** *(separation from implementation)*

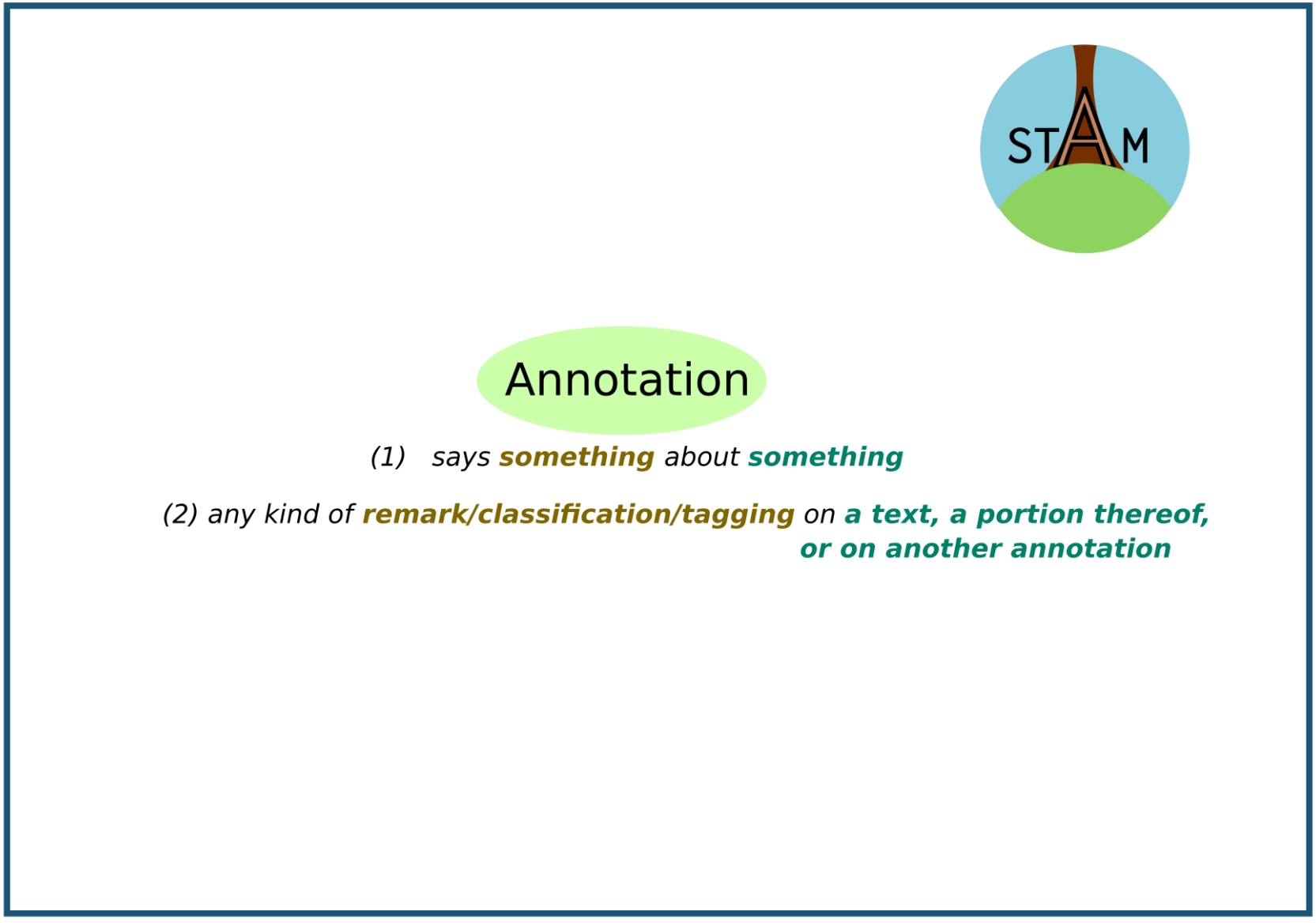


Figure 2: Annotations are central

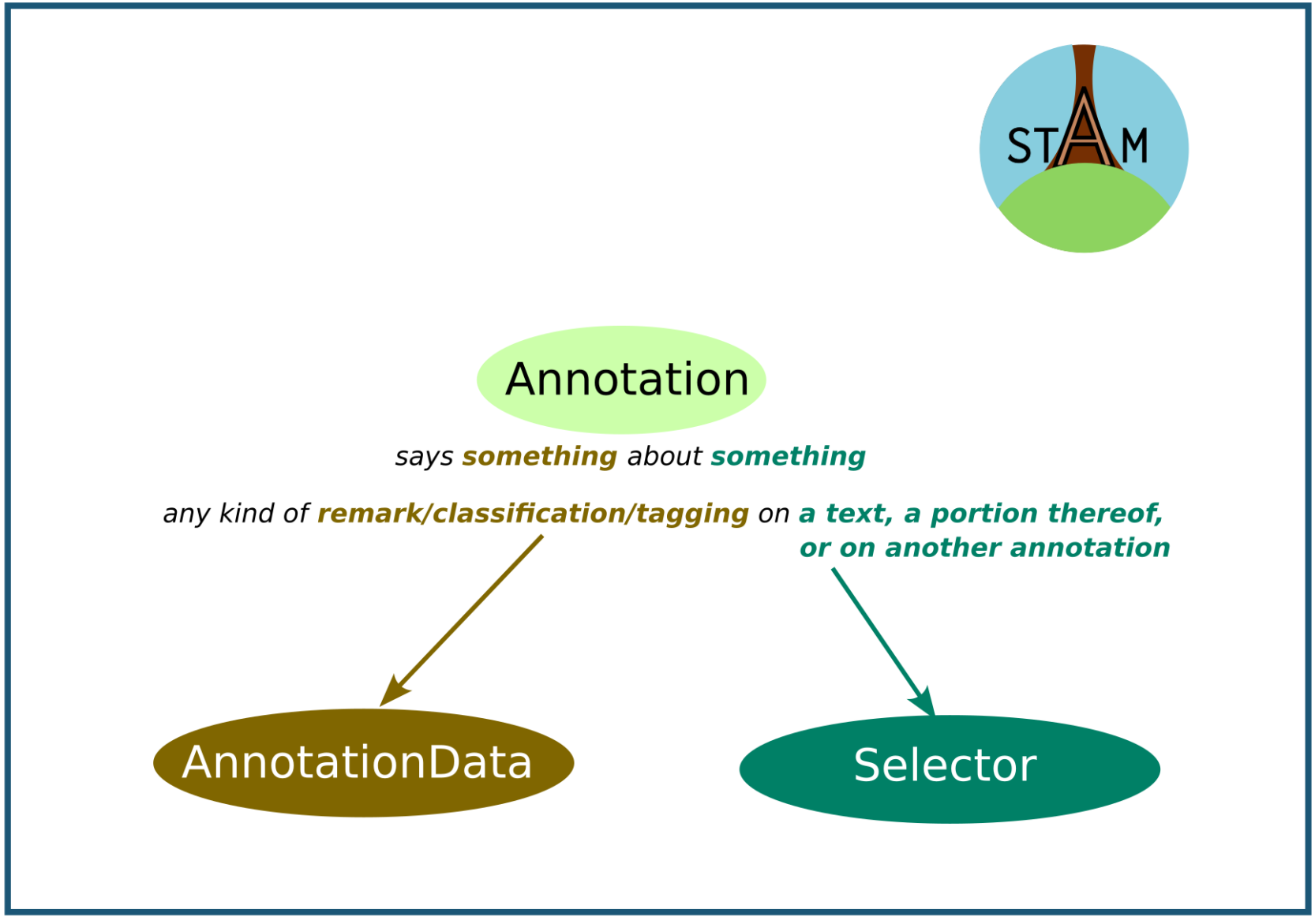


Figure 3: AnnotationData and Selectors

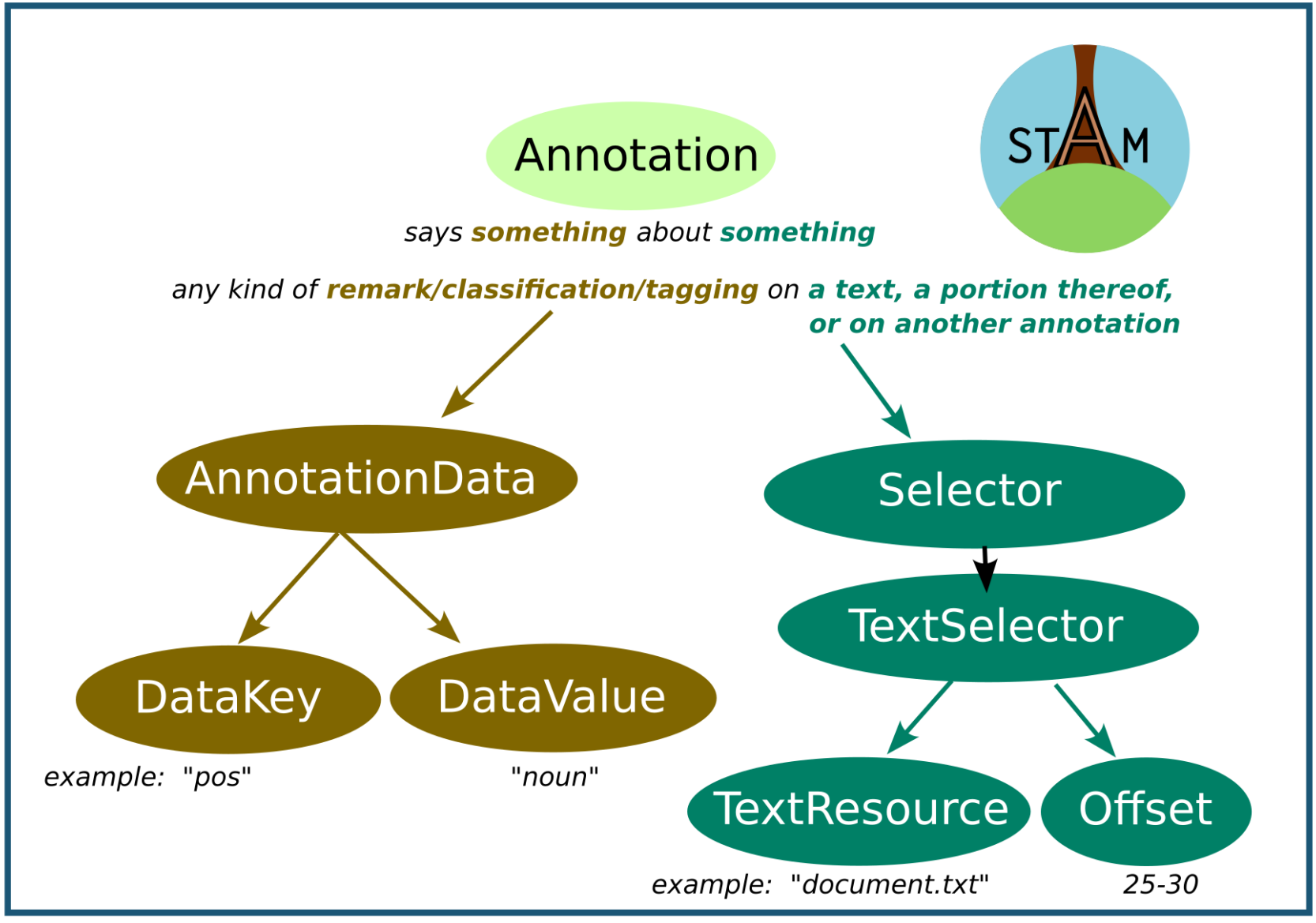


Figure 4: Keys, values and selector types

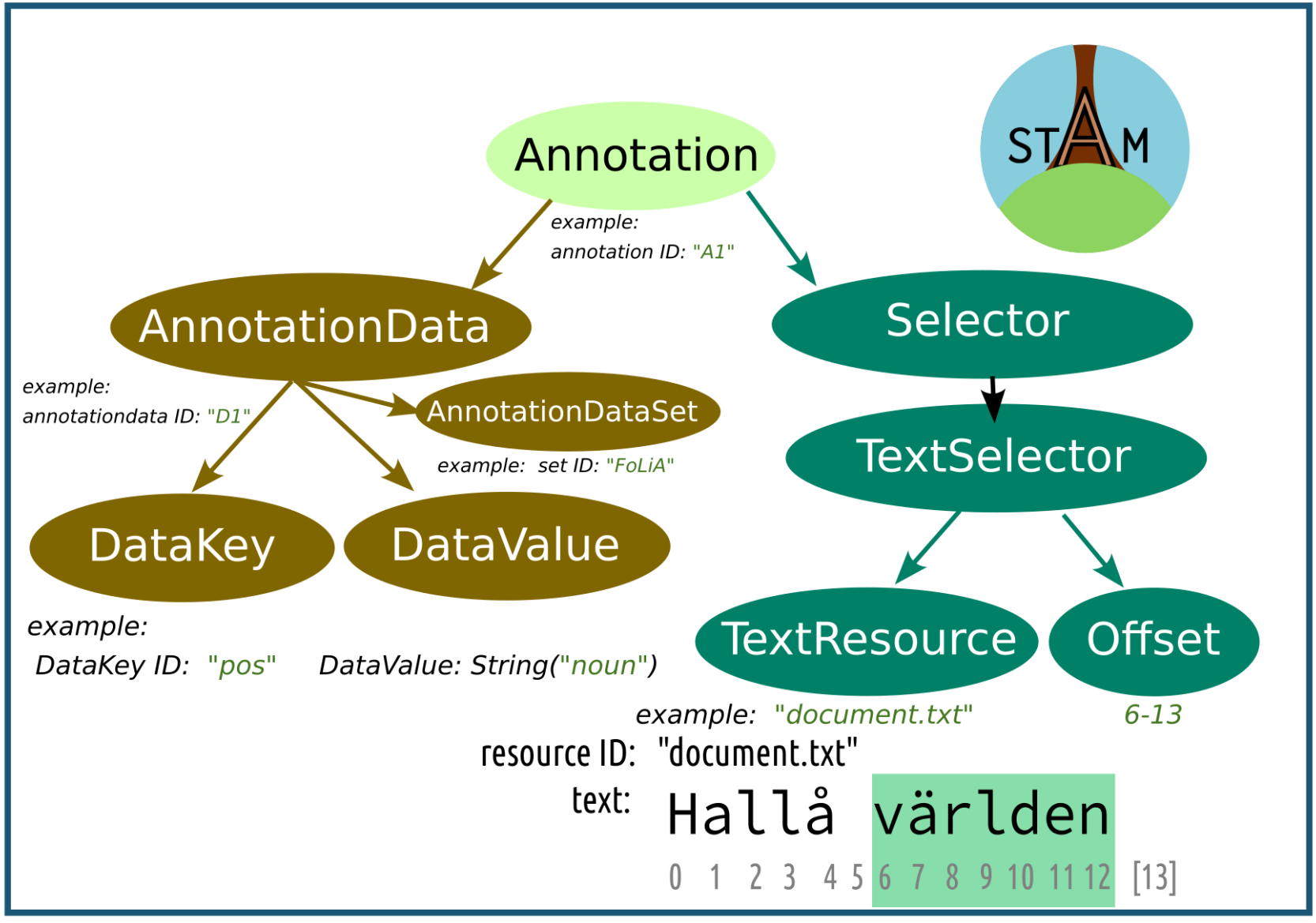


Figure 5: Example

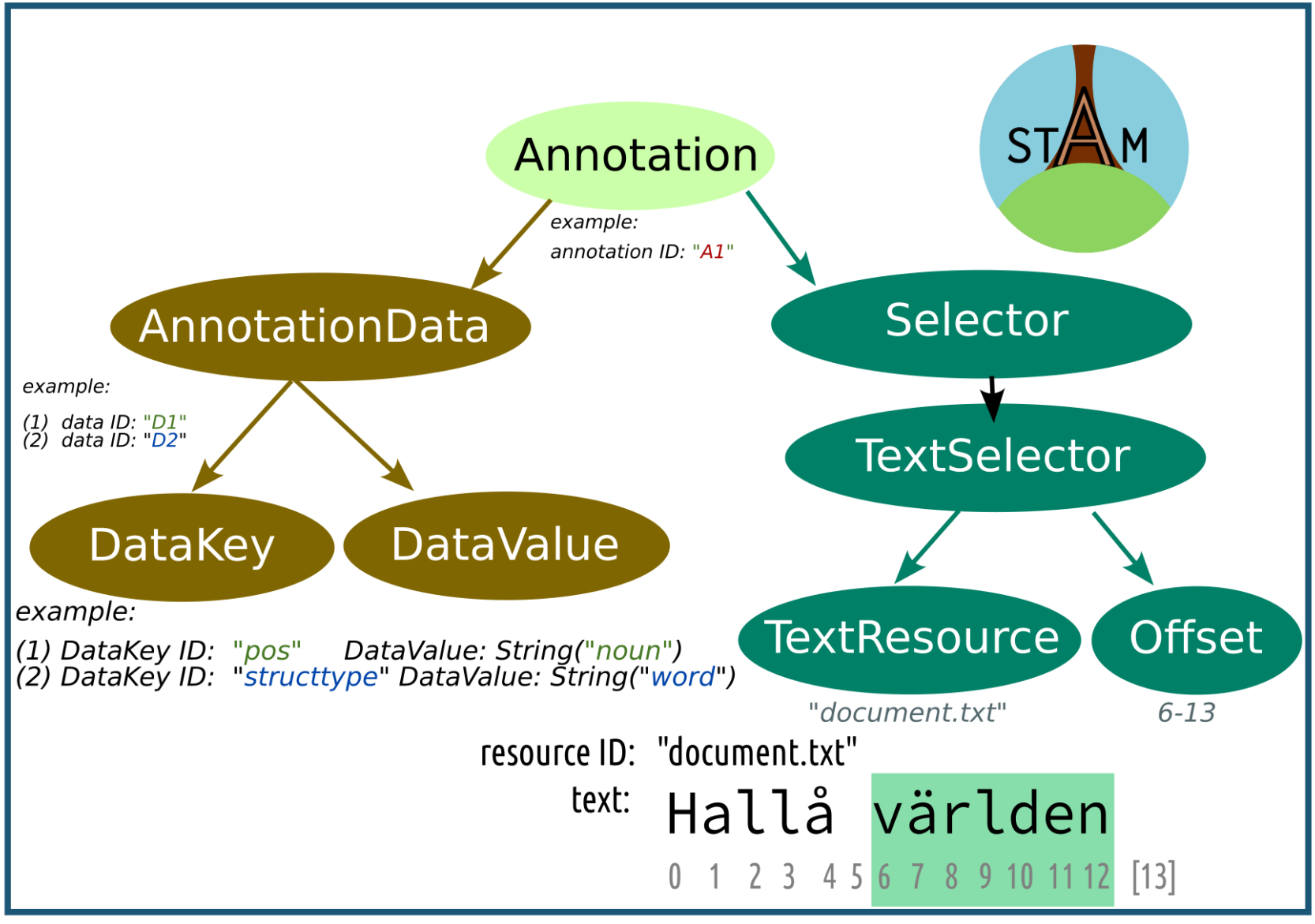


Figure 6: Example: Multiple AnnotationData

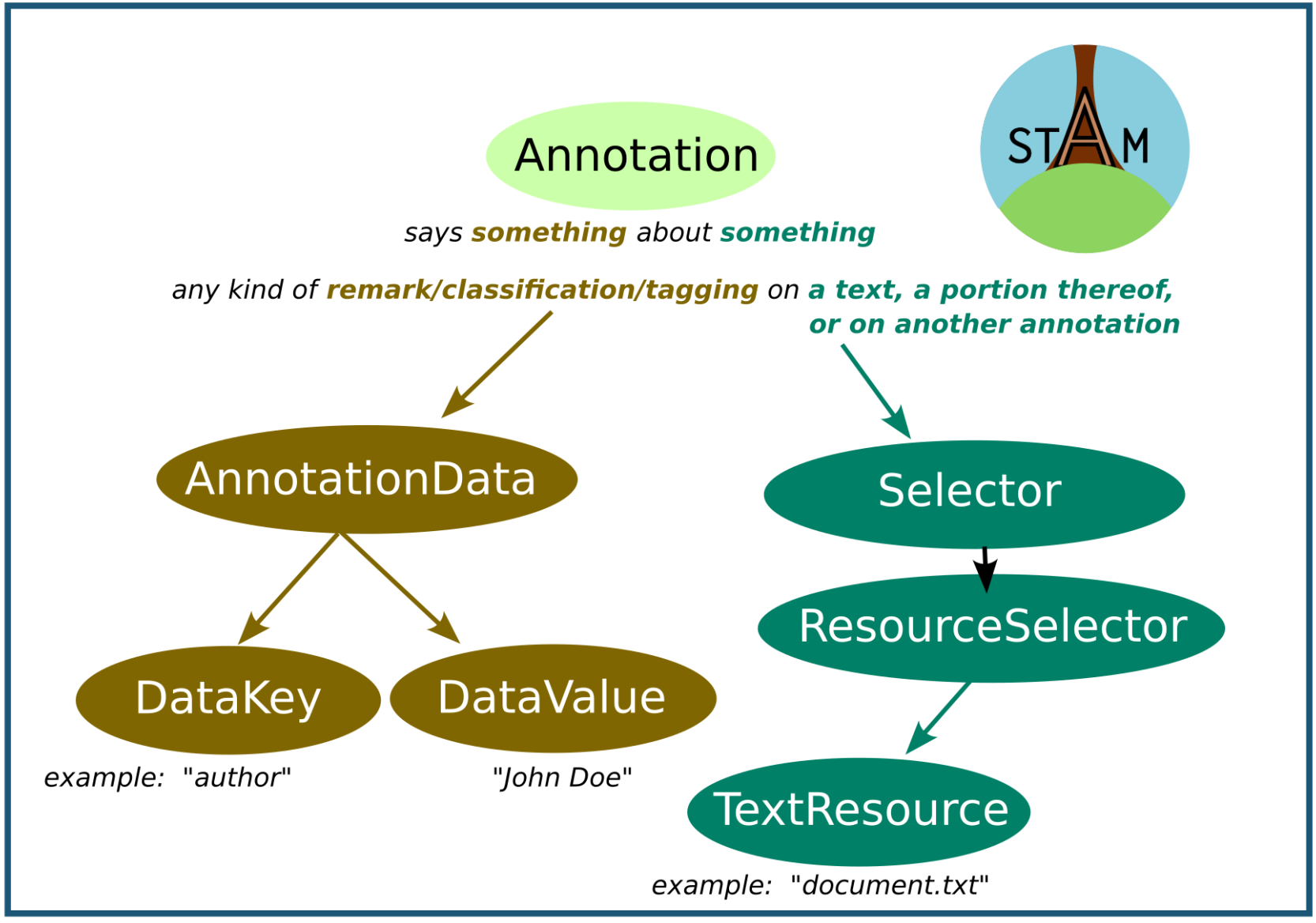


Figure 7: Example: ResourceSelector

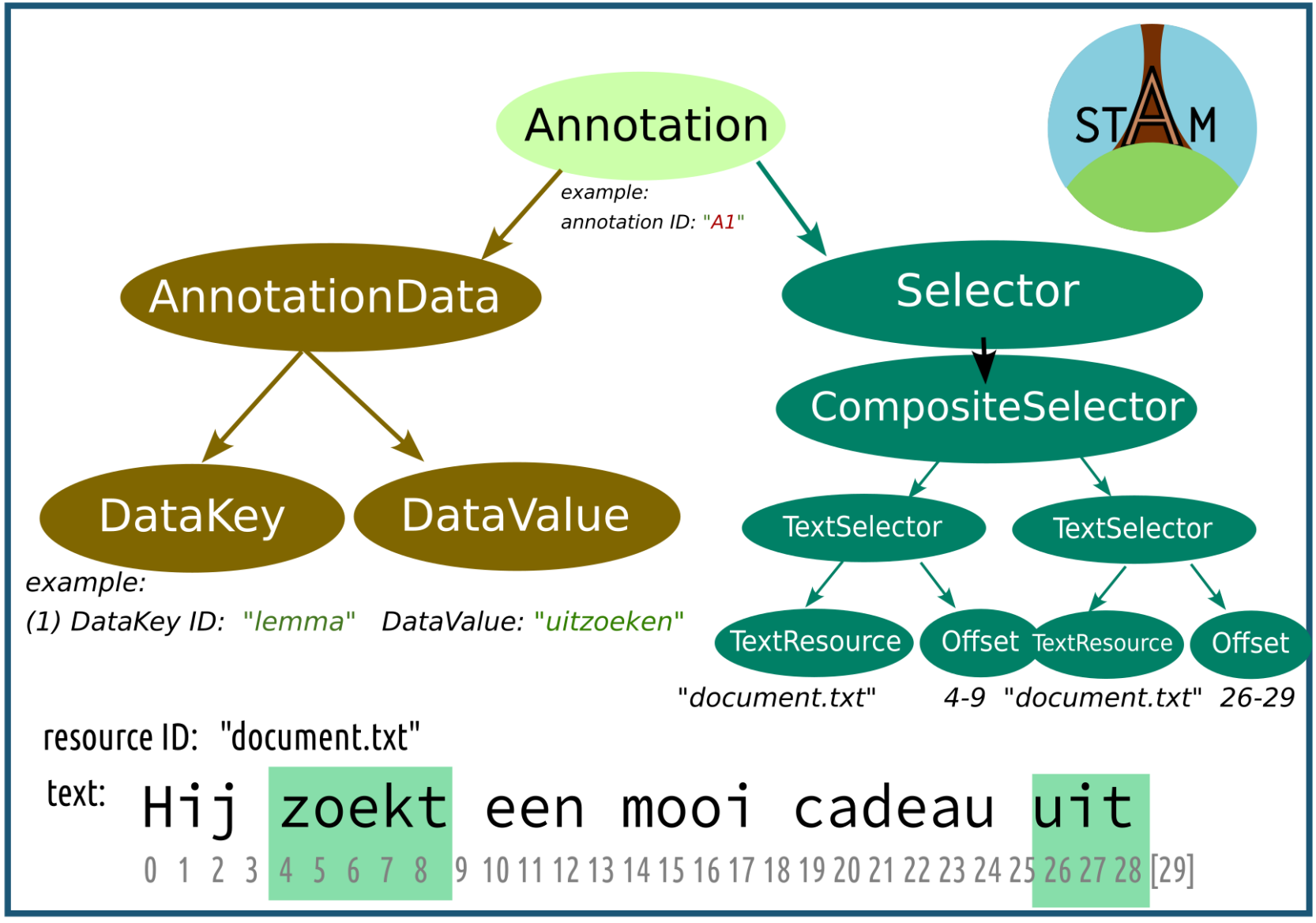


Figure 8: Example: CompositeSelector

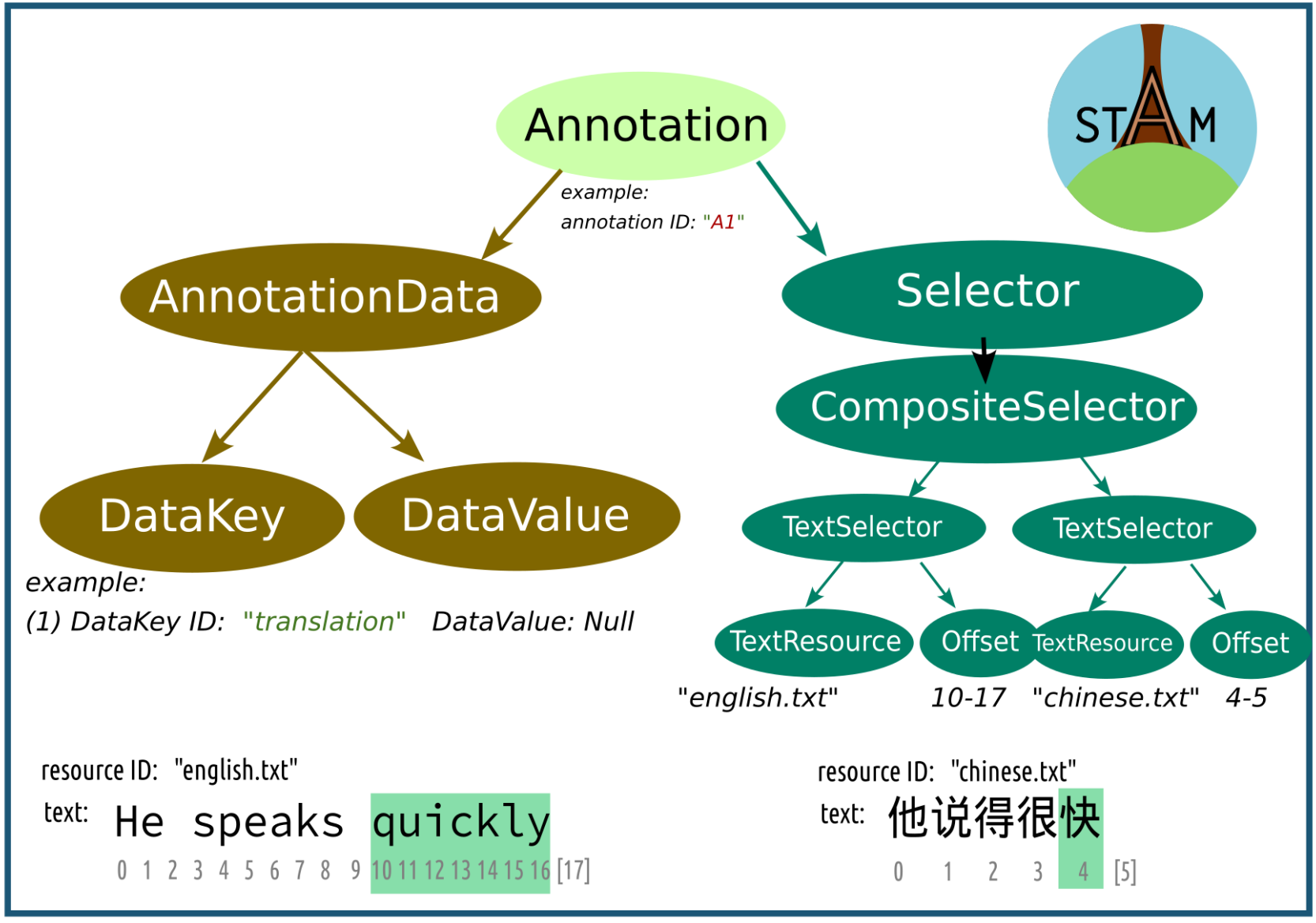


Figure 9: Example: CompositeSelector (2)

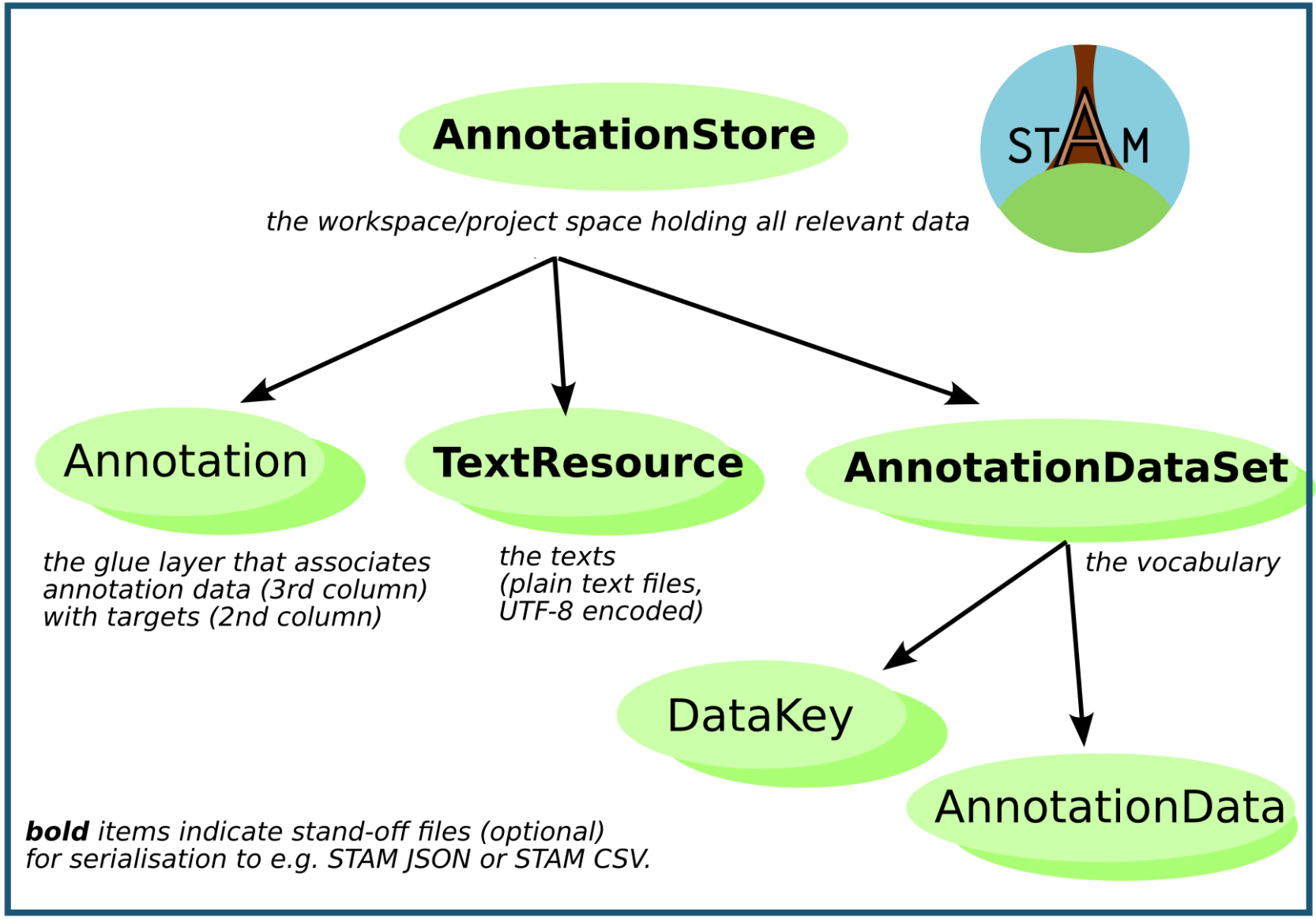


Figure 10: Collections

Data Model Characteristics

Technical:

- Directed Acyclic Graph
- Annotations should be regarded as immutable
- Optimised for efficient memory use
- Optimised for (reverse) search indices
- Almost everything is an annotation

STAM offers a framework to build upon, not the full solution:

- You have to choose **how to model** your data using STAM
- You have to choose what **vocabulary** to use for your data

Serialisation

	size	r/w speed	stand-off	readability	support
JSON	huge	normal	optional	good	canonical
CSV	medium	normal	always	good	extension
CBOR	small	fast	never	bad	implementation

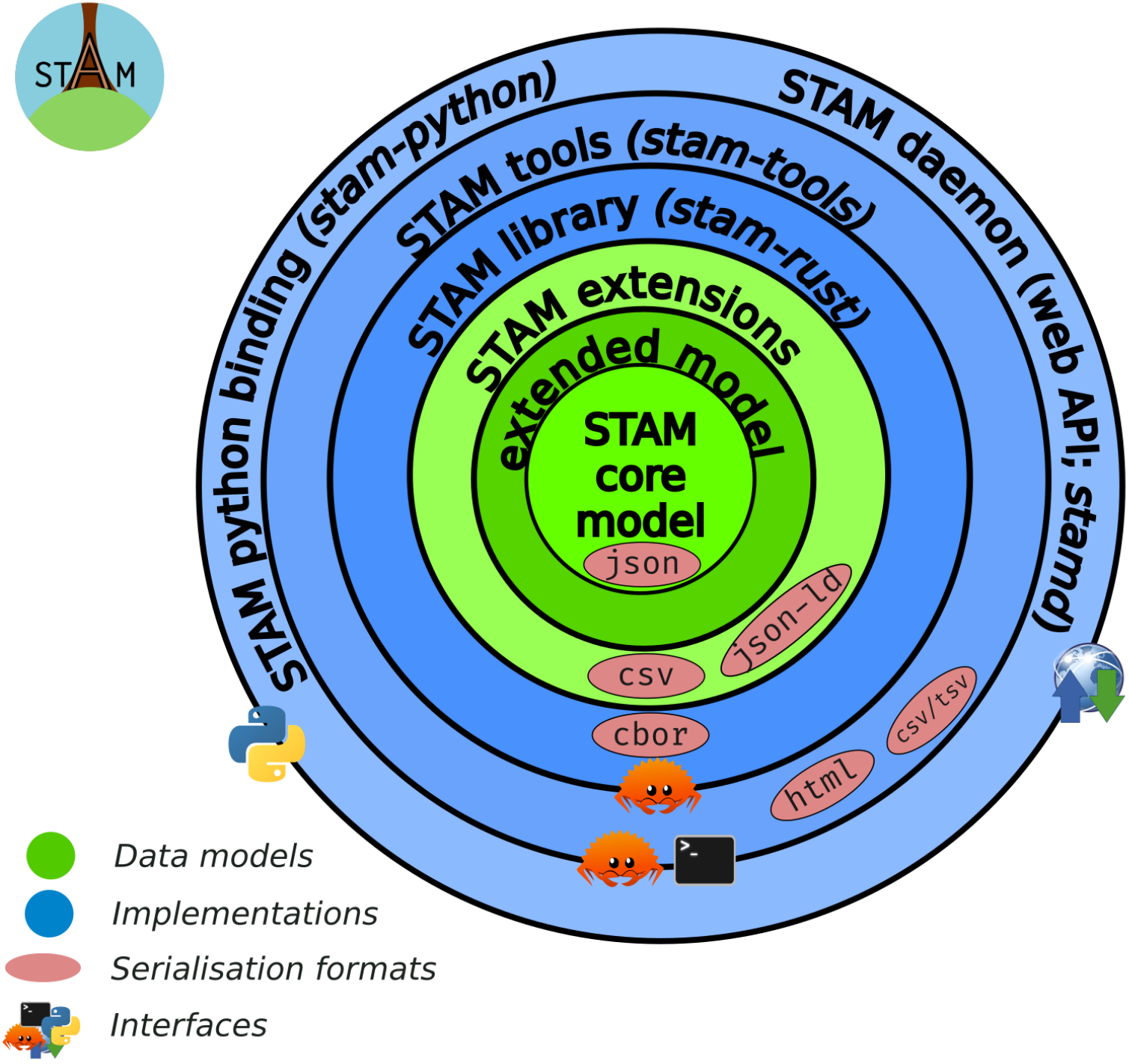
- *Stand-off*: Annotation Stores, Annotation Datasets, Text resources (plain text) can be stored in separate files.
- in the current STAM library (in-memory model), after parsing memory usage will be identical regardless of serialisation

```
{
  "@type": "AnnotationStore", "@id": "example",
  "resources": [ { "@type": "TextResource", "@id": "document.txt", "text": "Hallå världen" }],
  "annotationsets": [ { "@type": "AnnotationDataSet", "@id": "testset",
  "keys": [ { "@type": "DataKey", "@id": "pos" }],
  "data": [ { "@type": "AnnotationData", "@id": "!D0", "key": "pos", "value": { "@type": "String", "value": "noun" } } ] } ],
  "annotations": [
    {
      "@type": "Annotation", "@id": "!A0",
      "target": {
        "@type": "TextSelector",
        "resource": "document.txt",
        "offset": { "@type": "Offset", "begin": { "@type": "BeginAlignedCursor", "value": 6 },
            "end": { "@type": "BeginAlignedCursor", "value": 13 } }
      },
      "data": [ { "@type": "AnnotationData", "@id": "!D0", "set": "testset" } ]
    }
  ]
}
```


Figure 11: STAM JSON

Tooling

- focus on **performance**: efficient usage of computing resources (memory, cpu)
- focus on **reusability**: implement once, and re-use, core logic needed for annotations on text
- **standalone**: runs on a wide variety of systems and independent of any wider service infrastructure: does NOT depend on any software services.
- **accessibility**: clean APIs/CLIs and thoroughly documented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Implementations & Interfaces

Reference implementations and their interfaces:

- `stam-rust`: a high-performant library that implements the core model and all currently defined extensions
  - memory-based implementation, scalability constraints
  - reference implementation
- `stam-tools`: command line tools for working with STAM
  - unix principle: one tool (subcommand) for one thing
- `stam-python`: a Python-binding to stam-rust and stam-tools
  - good for technical data scientists
- `stamd`: STAM service offering a Web API

All target a technical audience and all are fully written in Rust (compiles to native machine code)

Core functionality

The software library. . .

- . . . exposes all concepts from the data model and holds data in memory efficiently
  - . . . parses and serialises from/to disk
- . . . allows editing data or creating it from scratch
- . . . can retrieve texts for annotations, annotations for text, annotations for annotations
- . . . can retrieve annotations based on *spatial* properties *(overlap, embedding, adjacency, proximity)*
- . . . can retrieve annotations given annotation data (data indices)
- . . . can search for text (regular expressions)
- . . . can convert offset information between different reference frames
- . . . can do validation

Functionality from extensions

- **STAM Vocab** – Express and validate against user-defined vocabularies
- **STAM Webannotations** – Allows modelling W3C Web Annotations using STAM (full export support)
- **STAM Textvalidation** – Adds an extra redundancy layer that helps protecting data integrity and aids readability of serialisations
- **STAM CSV** – Tabular serialisation format
- **STAM Query Language (STAMQL)** – A query language that allows end-users to formulate and subsequently execute searches on a STAM model.
- **STAM Transpose** - Links identical textual parts across resources, allows *transposition* of annotations from one to another.
- **STAM Translate** - Links non-identical parts of texts, allows *translation* of annotations from one to another.

All extensions have their **own specifications** *(separation from implementation)*

Functionality in the tooling

Import & Export

- **CSV/TSV** with custom column layout (`stam import`/`stam export`):

```
Text    part-of-speech  part-of-sentence
I       pronoun         subject
see     verb            main verb
you     pronoun         object
```

- **W3C Web Annotations**; JSON-LD (`stam export`, *export only*)
- **XML** (`stam fromxml`, *import only*) – *e.g. for TEI XML, PageXML, FoLiA XML*
- **HTML** (`stam view`, *export only, visualisation*)

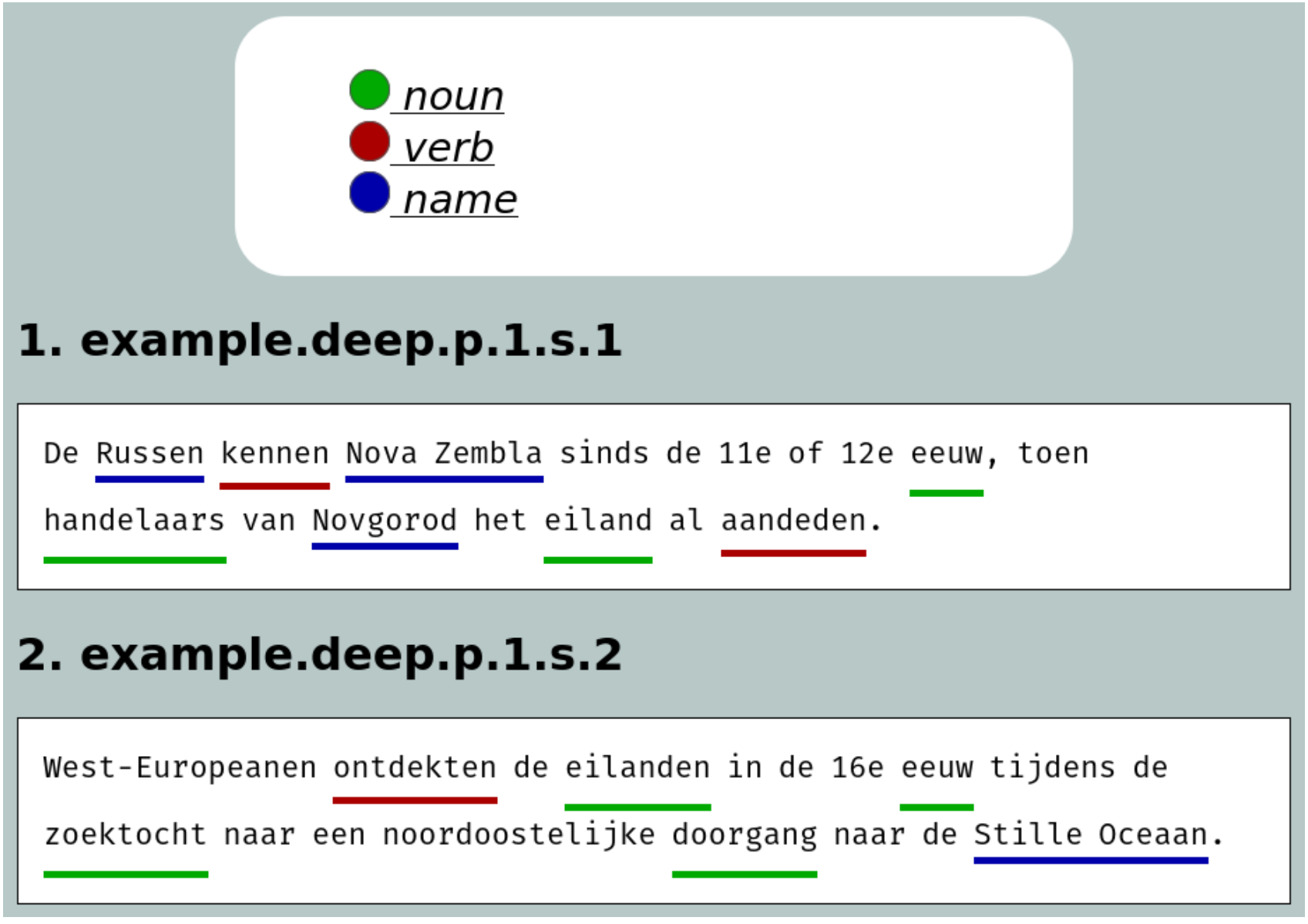

Figure 13: STAM HTML visualisation (`stam query -F html`)

Querying

STAMQL is an *extensive* query language that exposes most functionality in the STAM library:

```
SELECT TEXT ?noun WHERE
    DATA "myset" "type" = "word";
    DATA "myset" "pos" = "noun"; {

    SELECT TEXT ?adj WHERE
        RELATION ?noun SUCCEEDS;
        DATA "myset" "type" = "word";
        DATA "myset" "pos" = "adj";
}
```

Figure 14: A STAMQL query for adjective-noun word pairs

Querying and exporting often go hand-in-hand:

```
$ stam view --query 'SELECT RESOURCE ?res' \
  --query '@KEYVALUETAG SELECT ANNOTATION ?a WHERE
          RESOURCE ?res;
          DATA "testset" "pos" = "noun";' \
   example.stam.store.json
Hallå [världen|pos: noun]
```

Figure 15: A query and HTML visualisation via `stam view`

Searching and tagging text

- **Searching text** (`stam grep`) – Search for text (e.g. with regular expressions) and tag
- **Tagging** (`stam tag`) – `...` and tag matches as annotations!

Alignment, Transposition & Translation

- **Alignment** – (`stam-align`) Align two similar texts (Smith-Waterman / Needleman-Wunsch)
  - *produces transpositions or translations*
- **Normalisation** – (`stam translatetext`) Change a text based on simple rewrite rules
  - *produces translations*
- **Translation & Transposition** – Copy annotations from one text to another over a translation/transposition
  - `stam translate` & `stam transpose`

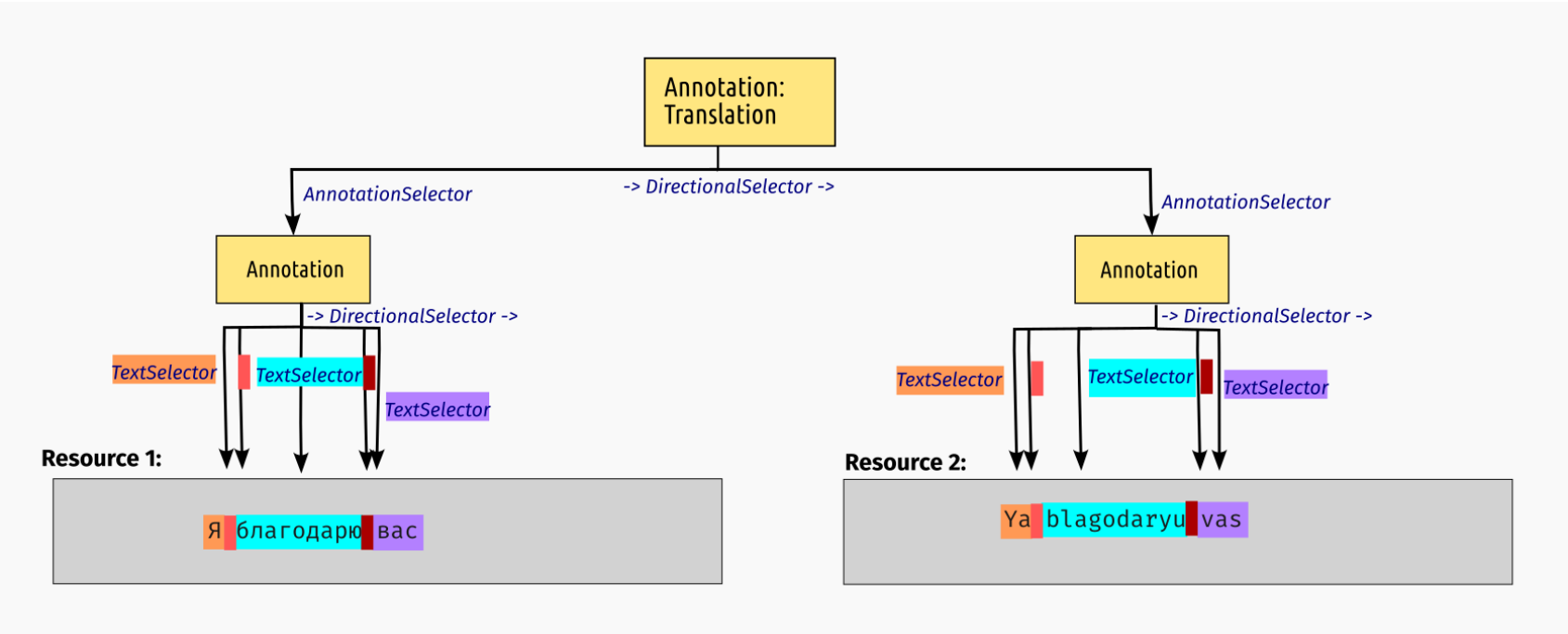

Figure 16: A translation annotation

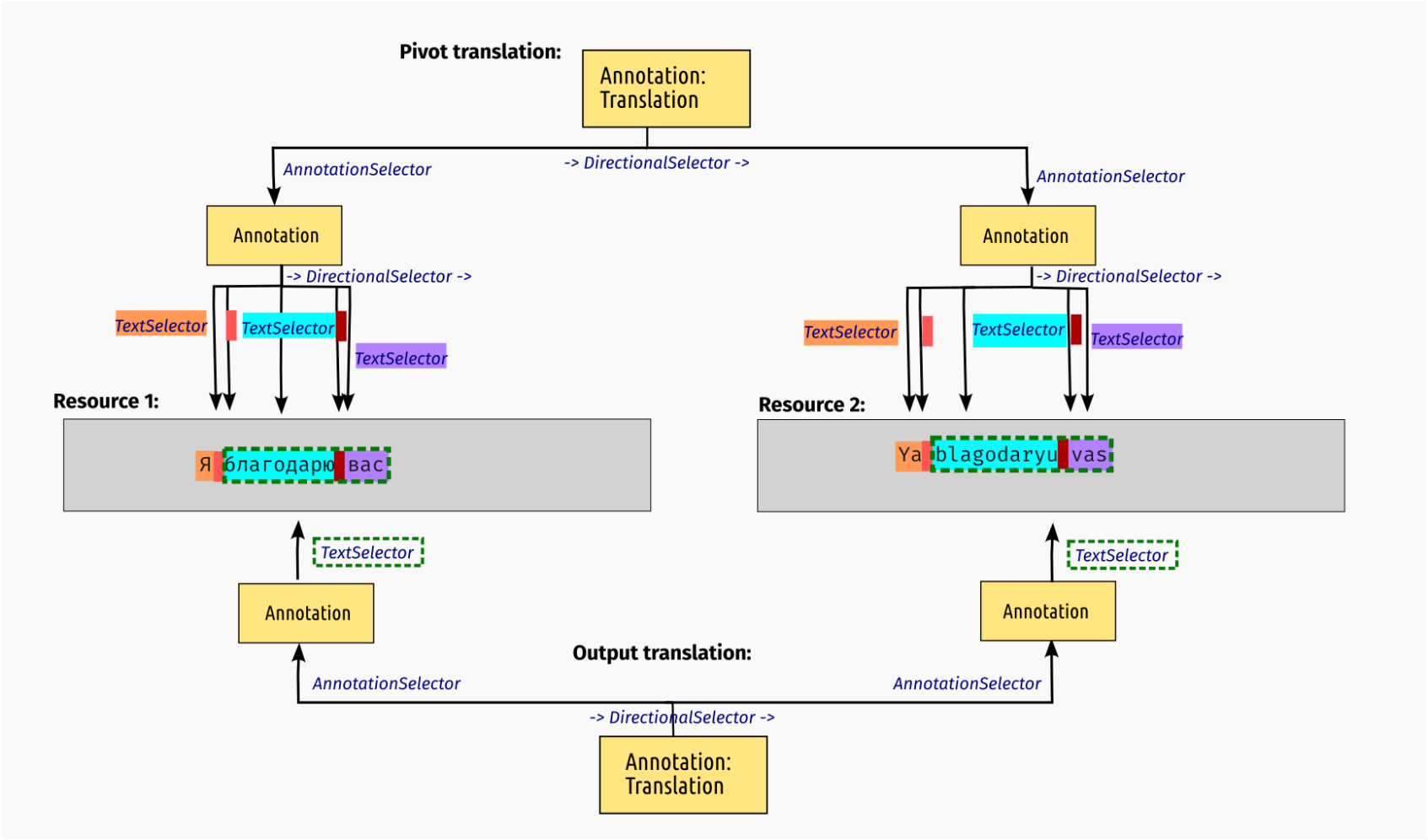

Figure 17: Copying an annotation over a pivot translation

Other functionality

- **Introspection** – View the raw data in the model and its memory consumption
- **Merging and splitting annotation stores**
- **Validation**

Conclusion

STAM . . .

- . . . offers a **solid generic foundation** upon which you can build higher-level applications for working with stand-off annotation on text
- . . . is **modular**; pick and use the parts you need for your task
- . . . is **flexible**; you decide how to model your data and bring **your own vocabulary**
- . . . takes cares of the boring **computational groundwork** so you don't have to
- . . . provides different **interfaces** for different **audiences**
- . . . has focus on **performance** and implementations are written in Rust
- . . . is **free open source software** (GNU General Public License v3) and open to contributors.
- . . . has had well over 1500 development hours since january 2023 (in part funded by CLARIAH)