Apache UIMA

PU Machine learning mit Java, Weka und UIMA

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January 12, 2021
Winter term 2020/21

Section 1

Looking Back

Exercise 8

Section 2

NLP Data Structures

NLP Data

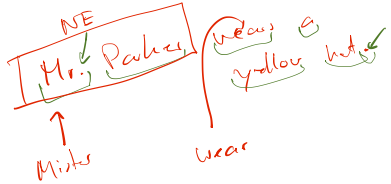
- Text and annotations
- Annotations: Meta data associated with specific locations in the text

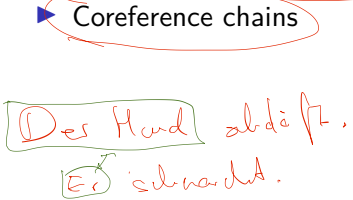
Storing Text

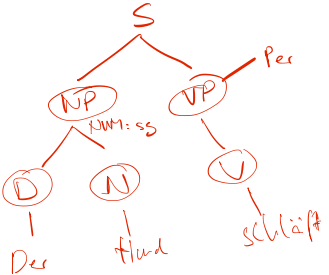
- Texts can be stored as strings
- Beware: Unicode
- (Theoretic) limitations on length

NLP Tasks

- Tokenization, sentence splitting
- Morphological analysis
- Part of speech-tagging, lemmatisation
- Named entity recognition
- Phrase structure and dependency syntax
- Coreference chains







NLP Tasks

- Tokenization, sentence splitting
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Tokens

- Many NLP data items rooted in tokens
  - E.g., named entities or phrases in syntactic annotation go over multiple tokens, coreference links are connect multiple multi-word expressions

Graph as Data Structure

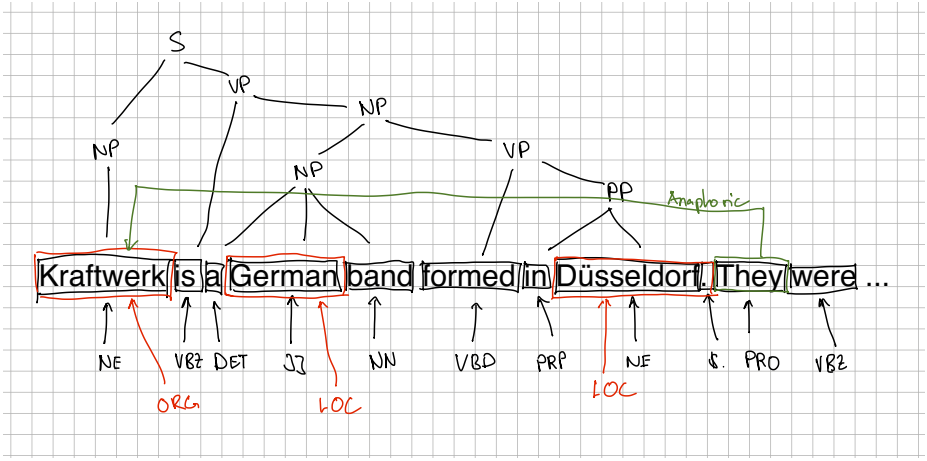

Figure: Beginning of Wikipedia article about Kraftwerk with (some) linguistic annotations

Section 3

Apache UIMA

UIMA

- UIMA: Unstructured Information Management Architecture
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- Apache Project: Open source

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  - Data structures, with efficient access
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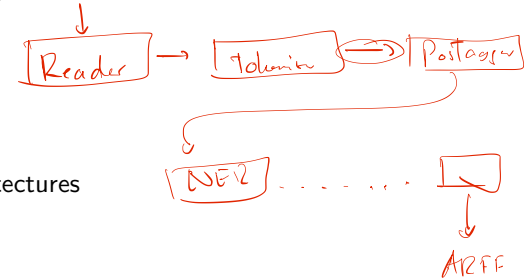
  - Modularization

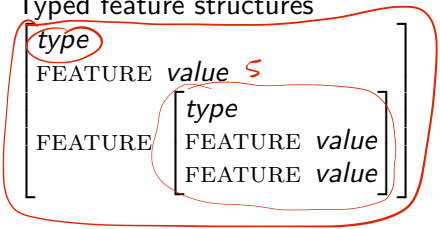


UIMA

- UIMA: Unstructured Information Management Architecture
- `https://uima.apache.org`
- Apache Project: Open source
- Framework for
  - Data structures, with efficient access
  - Processing, in particular pipeline architectures
  - Modularization
- Eco system
  - uimaFIT: Facilitates use of UIMA
  - DKPro: Prepackaged NLP components

UIMA Data Structures

- Typed feature structures



UIMA Data Structures

- Typed feature structures

$$\begin{bmatrix} \textit{type} & \\ \text{FEATURE} & \textit{value} \\ \text{FEATURE} & \begin{bmatrix} \textit{type} & \\ \text{FEATURE} & \textit{value} \\ \text{FEATURE} & \textit{value} \end{bmatrix} \end{bmatrix}$$

- Each FS represented as an object of class *type*
  - E.g., the class `Token` represents a FS of type 'Token'
  - Similar to java beans
- Types define which features instances of the type have
- Regular class hierarchy for inheritance

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  - E.g., the class `Token` represents a FS of type 'Token'
  - Similar to java beans
- Types define which features instances of the type have
- Regular class hierarchy for inheritance
- Types are defined in XML files ⚠

UIMA Data Structures

Pre-defined types

- `uima.cas.TOP`: Super type for all types
  - Only feature: JCAS – the 'document'

UIMA Data Structures

Pre-defined types

- `uima.cas.TOP`: Super type for all types
  - Only feature: JCAS – the 'document'
- `uima.cas.Annotation`: Super type for all annotation types
  - Inherits from `uima.cas.TOP`
  - Additional features: BEGIN and END
    - Character positions w.r.t. the document
  - Additional method `getCoveredText()` to retrieve text surface

UIMA Data Structures

Defining types

- Type system description in XML file
- JCasGen: Generate Java classes from XML files (integrates nicely with maven!)

```xml
<?xml version="1.0" encoding="UTF-8"?>
<typeSystemDescription xmlns="http://uima.apache.org/resourceSpecifier">
  <name>NAME</name>
  <description />
  <version>1</version>
  <vendor>VENDOR</vendor>
  <types>
    <!-- ... -->
  </types>
</typeSystemDescription>
```

UIMA Data Structures

Defining types

```
1   <typeDescription>
2     <name>de.ukoeln.idh.teaching.jml.Token</name>
3     <description />
4     <supertypeName>uima.tcas.Annotation</supertypeName>
5     <features>
6       <featureDescription>
7         <name>PartOfSpeech</name>
8         <description />
9         <rangeTypeName>uima.cas.String</rangeTypeName>
10      </featureDescription>
11    </features>
12  </typeDescription>
```

UIMA Data Structures

Defining types

typeDescription

name	fully qualified Java class name
description	natural language description
supertypeName	the type we inherit from (`TOP`, `Annotation` or another defined by us)
features	features our type has

UIMA Data Structures

Defining types

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features	features our type has

featureDescription

name	feature name (will be used for `get-` and `set` methods)
description	natural language description
rangeTypeName	the type of our feature: `uima.cas.String`, `uima.cas.Integer`, `uima.cas.Double`, `uima.cas.Boolean` – or any other type

UIMA Data Structures

Collection types

- UIMA defines two types of collection types for feature structures
  - In both cases, `elementType` element can be used to describe type of collection elements

UIMA Data Structures

Collection types

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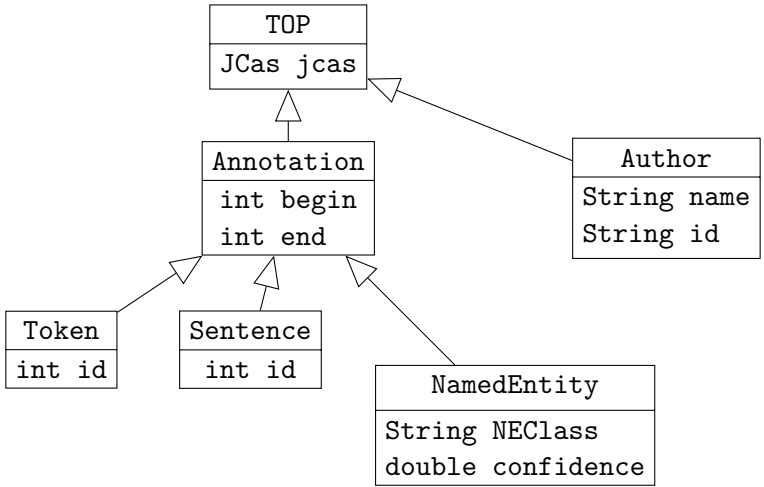
  - In both cases, `elementType` element can be used to describe type of collection elements
- `uima.cas.FSArray`, `uima.cas.StringArray`, `uima.cas.BooleanArray`, ...
  - Efficient access, length known at creation time
- `uima.cas.FSList`, `uima.cas.StringList`, `uima.cas.IntegerList`, ...
  - Linked lists: no random access, but variable length

UIMA Data Structures

Example

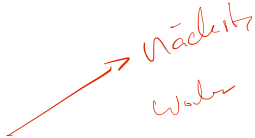


JCasGen: Generating Java Code from Type System Descriptions

- Documentation:
  `https://uima.apache.org/d/uimaj-current/tools.html#ugr.tools.jcasgen`
- GUI / command line program / Eclipse integration
- Maven plugin 👍
  - `mvn process-resources`
  - Allows to only commit XML files, not Java code

UIMA Data Structures

Access



- UIMA indexes all feature structures, such that we can efficiently access them
- This improved a lot with UIMA 3

```
1 SelectFSs<Token> selector = jcas.select(Token.class);
2 selector.asList(); // a list of all feature structures
3 selector.count(); // number of feature structures
4 selector.coveredBy(anotherAnnotation); // feature structures covered by another FS
5 selector.following(position); // first token after position
6 selector.get(index); // get nth token
7 selector.allMatch(predicate); // get tokens for which predicate is fulfilled
```

Section 4

Next Exercise

Exercise 09

`https://github.com/idh-cologne-machine-learning-mit-java/exercise-09`