

Apache UIMA Lucene CAS Indexer Documentation

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Version 2.3.0

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Introduction

The Lucene CAS Indexer (Lucas) is a UIMA CAS consumer that stores CAS data in a Lucene index. Lucas allows to exploit the results of collection processing for information retrieval purposes in a fast and flexible way. The consumer transforms annotation objects from annotation indexes into Lucene token objects and creates token streams from them. Token streams can be further processed by token filters before they are stored into a certain field of a index document. The mapping between UIMA annotations and Lucene tokens and token filtering is configurable by a xml file, whereas the index writer is configured by a properties file.

To use Lucas, at first a mapping file must be created. You have to decide which annotation types should be present in the index and how your index layout should look like, or more precisely, which fields should be contained in the index. Optionally you can add token filters for further processing. Its also possible to deploy your own token filters.

Lucas can run in multiple deployment scenarios where different instances share one index writer. This shared index writer instance is configured via a properties file and managed by the resource manager.

Chapter 1. Mapping Configuration

This chapter discusses the mapping between UIMA annotations and Lucene tokens in detail.

1.1. Token Sources

The mapping file describes the structure and contents of the generated Lucene index. Each CAS in a collection is mapped to a Lucene document. A Lucene document consists of fields, whereas a CAS contains multiple annotation indexes on different sofas. An annotation object can mark a text, can hold feature values or reference other feature structures. For instance, an annotation created by an entity mapper marks a text area and may additionally contain a identifier for the mapped entity. For this reason Lucas knows three different sources of Lucene token values:

- The covered text of a annotation object.
- One or more feature values of a annotation object.
- One or more feature values of a feature structure directly or indirectly referenced by an annotation object.

If a feature has multiple values, that means it references a FSArray instance, then one token is generated for each value. In the same manner tokens are generated from each feature value, if more then one feature is provided. Alternatively, you can provide a *featureValueDelimiterString* which is used to concatenate different feature values from one annotation object to generate only one token. Each generated Lucene token has the same offset as the source annotation feature structure.

1.1.1. Covered Text

As mentioned before represents the covered text of annotation objects one possible source for Lucene token values. The following example creates a index with one *title* field which contains covered texts from all token annotations which are stored in the *title* sofa.

```
<fields>
  <field name="title" index="yes">
    <annotations>
      <annotation sofa="title" type="de.julielab.types.Token"/>
    </annotations>
  </field>
</fields>
```

1.1.2. Feature Values

The feature values of annotation objects are another source for token values. Consider the example below.

```
<fields>
  <field name="cells" index="yes">
    <annotations>
      <annotation sofa="text" type="de.julielab.types.Cell">
        <features>
          <feature name="specificType">
        </features>
      </annotation>
    </annotations>
  </field>
</fields>
```

The field *cells* contains a token stream generated from the annotation index of type *de.julielab.types.Cell* . Each generated token will contain the value of the feature *specificType* of the enclosing annotation object.

The next example illustrates how multiple feature values can be combined by using a *featureValueDelimiterString* . If no *featureValueDelimiterString* is provided, a single token is generated from each feature value.

```
<fields>
  <field name="authors" index="no" stored="yes">
    <annotations>
      <annotation sofa="text" type="de.julielab.types.Author"
        featureValueDelimiterString=", ">
        <features>
          <feature name="forename"/>
          <feature name="surname"/>
        </features>
      </annotation>
    </annotations>
  </field>
</fields>
```

1.1.3. Feature Values of referenced Feature Structures

Since annotation objects may reference other feature structures, it may be desirable to use these feature structures as source for Lucene token values. To achieve this, we utilize feature paths to address these feature structures. Consider the example below.

```
<fields>
  <field name="cities" index="yes">
    <annotations>
      <annotation sofa="text" type="de.julielab.types.Author"
        featurePath="affiliation.address">
        <features>
          <feature name="city">
        </features>
      </annotation>
    </annotations>
  </field>
```



```
</fields>
```

The type *de.julielab.types.Author* has a feature *affiliation* which points to a *affiliation* feature structure. This *affiliation* feature structure in turn has a feature *address* which references a *address* feature structure. This path of references is expressed as the feature path *affiliation.address*. A feature path consists of feature names separated by a ".". Please consider that the *city* feature is a feature of the "address" feature structure and not of the *author* annotation object.

1.1.4. Supported feature types

At the moment not all feature types are supported. Only this feature types are currently supported:

- String
- String Array
- Number Types: Double, Float, Long, Integer, Short

Consider that you need to provide a number format string if you want to use number types.

1.2. Token Stream Alignment

In the examples above all defined Lucene fields contain only one annotation based token stream. There are a couple of reasons for the fact that the simple mapping of each annotation index to separate Lucene fields is not a optimal strategy. One practical reason is that the lucene highlighting will not work for scenarios where more than one annotation type are involved. Additionally, the tf-idf weighting of terms does not work probably if annotations are separated from real text. Lucas is able to merge token streams and align them according to their token offsets. The resulting merged token stream is then stored in a field. The next example demonstrates this merging feature.

```
<fields>
  <field name="text" index="yes" merge="true">
    <annotations>
      <annotation sofa="text" type="de.julielab.types.Token"/>
      <annotation sofa="text" type="de.julielab.types.Cell"/>
    <features>
      <feature name="specificType">
    </features>
    </annotation>
  </annotations>
</field>
</fields>
```

Consider the merge attribute of the field tag. It causes the alignment of the two token streams generated from the *de.julielab.types.Token* and *de.julielab.types.Cell* annotations.

If this attribute is set to false or it is left, then the annotation token streams were concatenated.

1.3. Token Filters

Token filters are the Lucene approach to enable operations on token streams. In typical Lucene applications token filters are combined with a tokenizer to build analyzers. In a typical Lucas application the tokenization is already given by annotation indexes. Lucas allows to apply token filters to certain annotation token streams or to the merged or concatenated field token stream as whole. The following example demonstrates how token filters are defined in the mapping file.

```
<fields>
  <field name="text" index="yes" merge="true">
    <filters>
      <filter name="lowercase"/>
    </filters>
  </field>
  <annotation sofa="text" type="de.julielab.types.Token">
    <filters>
      <filter name="stopwords"
        filePath="resources/stopwords.txt"/>
    </filters>
  </annotation>
  <annotation sofa="text" type="de.julielab.types.Cell">
    <features>
      <feature name="specificType">
    </feature>
    </features>
  </annotation>
</annotations>
</fields>
```

The lowercase token filter is applied to the complete field content and the stopword filter is only applied to the annotation token stream which is generated from the `de.julielab.types.Token` annotation index. Both filters are predefined filters which are included in the Lucas distribution. A reference of all predefined token filters is covered in [Chapter 2, Mapping File Reference \[7\]](#).

1.3.1. Deploying your own Token Filters

For scenarios where the built in token filters were not sufficient, you can provide your own token filters. Simple token filters which don't need any further parameterization, need to have a public constructor, which takes a token stream as the only parameter. The next example shows how a such a token filter is referenced in the mapping file.

```
<fields>
  <field name="text" index="yes">
  </field>
</fields>
```

```
<annotation sofa="text" type="de.julielab.types.Cell">
  <filters>
    <filter className="org.example.MyFilter" />
  </filters>
  <features>
    <feature name="specificType">
    </feature>
  </features>
</annotation>
</annotations>
<field>
</field>
</fields>
```

The attribute *className* must reference the canonical class name of the filter. In cases where the token filter has parameters we need to provide a factory for it. This factory must implement the *org.apache.uima.indexer.analysis.TokenFilterFactory* interface. This interface defines a method *createTokenFilter* which takes a token stream and a *java.util.Properties* object as parameters. The properties object will include all attribute names as keys and their values which are additionally defined in the filter tag. Consider the example below for a demonstration.

```
<fields>
  <field name="text" index="yes">
  </field>
</fields>
<annotations>
  <annotation sofa="text" type="de.julielab.types.Cell">
    <filters>
      <filter factoryClassName="org.example.MyTokenFilterFactory"
        parameter1="value1" parameter2="value2" />
    </filters>
    <features>
      <feature name="specificType">
      </feature>
    </features>
  </annotation>
</annotations>
<field>
</field>
</fields>
```

In the example above the token filter factory is new instantiated for every occurrence in the mapping file. In scenarios where token filters use large resources, this will be a waste of memory and time. To reuse a factory instance we need to provide a name and a reuse attribute. The example below demonstrate how we can reuse a factory instance.

```
<fields>
  <field name="text" index="yes">
  </field>
</fields>
<annotations>
  <annotation sofa="text" type="de.julielab.types.Cell">
    <filters>
      <filter factoryClassName="org.example.MyTokenFilterFactory"
        name="myFactory" reuse="true"
        myResourceFilePath="pathToResource" />
    </filters>
    <features>
    </features>
  </annotation>
</annotations>
<field>
</field>
</fields>
```

```
<feature name="specificType">  
  </features>  
</annotation>  
  </annotations>  
<field>  
</fields>
```

Chapter 2. Mapping File Reference

After introducing the basic concepts and functions this chapter offers a complete reference of the mapping file elements.

2.1. Mapping File Structure

The raw mapping file structure is sketched below.

```
<fields>
  <field ..>
  <filters>
    <filter ../>
    ...
  </filters>

  <annotations>
    <annotation ..>
      <filters>
        <filter ../>
        ...
      </filters>
      <features>
        <feature ..>
        ...
      </features>
    </annotation>
    ...
  </annotations>
  <field>
  ...
</fields>
```

2.2. Mapping File Elements

This section describes the mapping file elements and their attributes.

- *fields element*
 - fields container element
 - contains: field+
- *field element*
 - describes a Lucene [field](#)¹
 - contains: filters?, annotations

Table 2.1. *field element attributes*

name	allowed values	default value	mandatory	description
name	string	-	yes	the name of the field ²
index	yes no no_norms no_tf no_norms_tf	no	no	See Field.Index ³
termVector	no positions offsets positions_offsets	no	no	See Field.TermVector ⁴
stored	yes no compress	no	no	See Field.Store ⁵
merge	boolean	false	no	If this attribute is set to true, all contained annotation token streams are merged according to their offset. The tokens position increment are adopted in the case of overlapping.

- *filters element*
 - container element for filters
 - contains: filter+
- *filter element*
 - Describes a [token filter](#)⁶ instance. Token filters can either be predefined or self-provided.

Table 2.2. *filter element attributes*

name	allowed values	default value	mandatory	description
name	string	-	no	the name to reference either a predefined filter (see predefined filter reference) or a reused filter
className	string	-	no	The canonical class name of a token filter. the token filter class must provide a single argument constructor which takes the token stream as parameter.
factoryClassName	string	-	no	The canonical class name of a token filter factory. the token filter factory class must implement the <code>org.apache.uima.indexer.ar</code> See Section 1.3, “Token Filters” [4] for an example.
reuse	boolean	-	false	Enables token filter factory

name	allowed values	default value	mandatory	description
				reuse. This makes sense if a token filter use resources which should be cached. Because token filters where referenced by their names, you need also to provide a name.
*	string	-	-	Filters may have their own parameter attributes which are explained in the Chapter 2, Mapping File Reference [7] ..

- *annotations element*
 - container element for annotations
 - contains: annotation+
- *annotation element*
 - Describes a token stream which is generated from a CAS annotation index.
 - contains: features?

Table 2.3. annotation element attributes

name	allowed values	default value	mandatory	description
type	string	-	yes	The canonical type

name	allowed values	default value	mandatory	description
				name. E.g. "uima.cas.Annotation"
sofa	string	InitialView	yes	Determines from which sofa the annotation index is taken
featurePath	string	-	no	Allows to address feature structures which are associated with the annotation object. Features are separated by a ".".
tokenizer	cas white_space standard	cas	no	Determines which tokenization is used. "cas" uses the tokenization given by the contained annotation token streams, "standard" uses the standard tokenizer ⁷
featureValueDelimiter	string	-	no	If this parameter is provided all feature values of the targeted feature structure are

name	allowed values	default value	mandatory	description
				concatenated and delimited by this string.

- *features element*
 - Container element for features.
 - contains: feature+
- *feature element*
 - Describes a certain feature of the addressed feature structure. Values of this features serve as token source.

Table 2.4. feature element attributes

name	allowed values	default value	mandatory	description
name	string	-	yes	The feature name.
numberFormat	string	-	no	Allows to convert number features to strings. See DecimalNumberFormat ⁸ .

2.3. Filters Reference

Lucas comes with a couple of predefined token filters. This section provides a complete reference for this filters.

2.3.1. Addition Filter

Adds suffixes or prefixes to tokens.

```
<filter name="addition" prefix="PRE_" />
```

Table 2.5. addition filter attributes

name	allowed values	default value	mandatory	description
prefix	string	-	no	A pefix which is added to the front of each token.
postfix	string	-	no	A post which is added to the end of each token.

2.3.2. Hypernyms Filter

Adds hypernyms of a token with the same offset and position increment 0.

```
<filter name="hypernyms" filePath="/path/to/myFile.txt"/>
```

Table 2.6. hypernym filter attributes

name	allowed values	default value	mandatory	description
filePath	string	-	yes	The hypernym file path. Each line of the file contains one token with its hypernyms. The file must have the following format: TOKEN_TEXT=HYPERNYM1 HYPERNYM2 . . .

2.3.3. Position Filter

Allows to select only the first or the last token of a token stream, all other tokens are discarded.

```
<filter name="position" position="last"/>
```

Table 2.7. *position filter attributes*

name	allowed values	default value	mandatory	description
position	first last	-	yes	If position is set to first the only the the first token of the underlying token stream is returned, all other tokens are discarded. Otherwise, if position is set to last, only the last token is returned.

2.3.4. Replace Filter

Allows to replace token texts.

```
<filter name="replace" filePath="/path/to/myFile.txt"/>
```

Table 2.8. *replace filter attributes*

name	allowed values	default value	mandatory	description
filePath	string	-	yes	The token text replacement file path. Each line consists of the original token text and the replacement and must have the following format: TOKEN_TEXT=REPLACEMENT_TEXT .

2.3.5. Snowball Filter

Integration of the [Lucene snowball filter](http://lucene.apache.org/java/2_4_0/api/org/apache/lucene/analysis/snowball/SnowballFilter.html)⁹

⁹ http://lucene.apache.org/java/2_4_0/api/org/apache/lucene/analysis/snowball/SnowballFilter.html

```
<filter name="snowball" stemmerName="German"/>
```

Table 2.9. snowball filter attributes

name	allowed values	default value	mandatory	description
stemmerName	snowball stemmer names.	English	no	See snowball filter documentation ¹⁰ .

2.3.6. Splitter Filter

Splits tokens at a certain string.

```
<filter name="splitter" splitString=","/>
```

Table 2.10. splitter filter attributes

name	allowed values	default value	mandatory	description
splitString	string	-	yes	The string on which tokens are split.

2.3.7. Concatenate Filter

Concatenates token texts with a certain delimiter string.

```
<filter name="concatenate" concatString=";"/>
```

Table 2.11. concatenate filter attributes

name	allowed values	default value	mandatory	description
concatString	string	-	yes	The string with which token texts are concatenated.

2.3.8. Stopword Filter

Integration of the [Lucene stop filter](#)¹¹

```
<filter name="stopwords" filePath="/path/to/myStopwords.txt"/>
```

¹¹ http://lucene.apache.org/java/2_4_1/api/org/apache/lucene/analysis/StopFilter.html

Table 2.12. stopwords filter attributes

name	allowed values	default value	mandatory	description
filePath	string	-	no	The stopwords file path. Each line of the file contains a single stopwords.
ignoreCase	boolean	false	no	Defines if the stop filter ignores the case of stop words.

2.3.9. Unique Filter

Filters tokens with the same token text. The resulting token stream contains only tokens with unique texts.

```
<filter name="unique"/>
```

2.3.10. Upper Case Filter

Turns the text of each token into upper case.

```
<filter name="uppercase"/>
```

2.3.11. Lower Case Filter

Turns the text of each token into lower case.

```
<filter name="lowercase"/>
```

Chapter 3. Index Writer Configuration

The index writer used by Lucas can be configured separately. To allow Lucas to run in multiple deployment scenarios, different Lucas instances can share one index writer instance. This is handled by the resource manager. To configure the resource manager and the index writer properly, the Lucas descriptor contains a resource binding `indexWriterProvider`. A `IndexWriterProvider` creates a index writer from a properties file. The file path and name of this properties file must be set in the `LucasIndexWriterProvider` resource section of the descriptor.

The properties file can contain the following properties.

- `indexPath` - the path to the index directory
- `RAMBufferSize` - (number value), see [IndexWriter.ramBufferSize](#)¹
- `useCompoundFileFormat` - (boolean value), see [IndexWriter.useCompoundFormat](#)²
- `maxFieldLength` - (boolean value), see [IndexWriter.maxFieldLength](#)³
- `uniqueIndex` - (boolean value), if set to `true`, host name and process identifier are added to the index name. (Only tested on linux systems)

Chapter 4. Descriptor Parameters

Because Lucas is configured by the mapping file, the descriptor has only one parameter:

- `mappingFile` - the file path to the mapping file.

