TIPSTER Text Phase II Architecture Design

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1.0 GOALS

The TIPSTER Program aims to push the technology for access to information in large (multi-GB) text collections, in particular for the analysts in Government agencies. Technology is being developed for document detection ("information retrieval") and for data extraction from free text.

The primary mission of the TIPSTER Common Architecture is to provide a vehicle for efficiently delivering this detection and extraction technology to the Government agencies. The Architecture also has a secondary mission of providing a convenient and efficient environment for research in document detection and data extraction.

To accomplish this mission, the TIPSTER Architecture is being designed to:

- provide APIs for document detection, data extraction, and the associated document management functions
- support monolingual and multilingual applications
- allow the interchange of modules from different suppliers ("plug and play")
- apply to a wide range of software and hardware environments
- scale to a wide range of volumes of document archives and of document flow
- support appropriate application response time
- support incorporation of multi-level security
- enhance detection and extraction through the exchange of information, and through easier access to linguistic annotations

2.0 CONCEPTS

The architecture is described by a set of object classes and a set of functions associated with these objects. In addition, there is a "functional" section which indicates how data typically flows between these functions.

2.1 Object Classes

An object class is characterized by a class name, a set of named properties, and a set of operations. Unless explicitly noted otherwise, there is an operation (the property accessor function) associated with each property for reading that property's value. If the property is followed by (R, W), operations are provided both for reading and for writing that property. If the property is followed by (~~R~~), no functions are provided for reading or writing the property.

Each property has a value, which may be

- an object (of one or several classes)
- a sequence of objects (ordered), denoted by "sequence of..."
- a string (of characters)
- an integer
- a byte
- a Boolean value (true or false)
- a member of an enumerated type, denoted by "one of { ... }"
- *nil*

The operations will include both procedures (which do not return a value) and functions (which do). The notation is

procedure (type of arg1, type of arg2, ...)

function (type of arg1, type of arg2, ...): type of result

To indicate the significance of particular arguments, an argument position may contain

argument name: argument type

If a class C_1 is a subclass of another class C_2 (indicated by the notation Type of C_2 in the definition of C_1) then C_1 inherits all the properties and operations of C_2.

The designation of a class as an **Abstract Class** indicates that the class is not intended to be instantiated but is intended to serve as a superclass for other classes (which will be instantiated).

A class C can include operations whose name has the form "class.C". If D is a type of C (i.e., class D includes the specification Type of C), then the operation as inherited by D has the name "class.D". This facility is provided to allow for the specialization of operations which create new instances of a class.

2.2 Optionality

Some objects and functions will be required: they must be implemented by any system conforming to the architecture. Some objects and functions will be *optional*: they need not be included, but if they are, they must conform to the standard. This allows us to define standards, for example, for some linguistic annotations, without requiring all systems to generate such annotations.

2.3 Correspondence to Interface Specifications

This document provides an abstract definition of the architecture in terms of classes and operations. This architecture will be implemented in a number of programming languages; currently implementations are being

developed in C, Tcl, and Common Lisp. This section describes the correspondence between the set of operations described in this document and the APIs for implementations of this architecture in these programming languages.

Common Lisp: The classes, properties, and operations defined herein correspond to those of a Common Lisp implementation of the TIPSTER Architecture as follows:

1. (because Lisp is normally not case sensitive) each capital letter in the name of a class, property, or operation, except for the first letter in a name, will be preceded by a "-" in Lisp
2. each class, property, and operation corresponds to a Lisp class, property, and function
3. each argument of the form "*class*" becomes a positional argument; each argument of the form "name: *class*" becomes a keyword argument with the keyword name
4. sequences are represented as lists

In Lisp, the name of the property accessor function is formed from the class name, a hyphen, and the property name (e.g., **attribute-name** and **attribute-value**). If the property is writable, the property accessor function acts as a "generalized variable" which can be set by **setf**; e.g., **(setf (collection-owner collection1) "Mitchell")**.

C: Each operation defined herein corresponds to a C function, with the same name as in the abstract architecture. All arguments in the C implementation are positional; the argument names ("keywords") in the abstract architecture are not used. If property *Comp* of a class is readable, it is accessed by the function Get *Comp*; if it is also writeable, it is set by the function Set *Comp*.

Note that the abstract architecture occasionally "overloads" operations: the same operation name may apply to different classes of arguments. To support such overloading, the C implementations of the various classes, as well as sets and sequences, should employ a generic container structure which will allow a C function to determine the class of an actual argument.[1]

The C-language typing, including the overloading of various functions, is spelled out in Appendix C.

Tcl: Operation names and argument lists in Tcl shall be the same as in the C implementation.

2.3.1 Optional Arguments

In addition to the arguments which are specified for each operation in this document and which are required, an implementation of the Architecture may provide optional keyword or positional arguments for any of the operations. The operation must be able to complete and to perform the specified function even if only the required arguments are given, but use of the optional arguments may provide enhanced performance or a greater range of functionality.

2.3.2 Implementation of Sequences

The architecture includes the notion 'sequence of X', where X is a type, as one of the possible values of an argument to an operation or the value of a property. In describing an implementation of the Architecture (an API), it is necessary to specify the representation or set of operations for such sequences.

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[1] The overloading does not extend to basic C data types (char, int, float), since these could not be differentiated from structures by a called procedure.

The C language interface (Appendix C) defines types *AttributeSet, AttributeValueSet, DocumentCollectionIndexSet, QueryCollectionIndex, SpanSet,* and *stringSet*, corresponding to `sequence of Attribute', `sequence of AttributeValue', `sequence of DocumentCollectionIndex', `sequence of QueryCollectionIndex', `sequence of Span', and `sequence of string' in the Architecture[2]. These are referred to collectively as *XSets*, where X may be *Attribute, Span*, etc. An empty *XSet* is created by the operation

CreateXSet (): *XSet*

(i.e., by one of the operations CreateAttributeSet, CreateSpanSet, etc.). The following operations apply to *XSets:*

Nth (XSet, n: integer): X

returns the nth element of *XSet* (where the first element of sequence has index 0)

Push (XSet, X)

adds X to the end of sequence *XSet*

Pop (XSet): X

removes and returns the last element of XSet

Length (XSet): integer

returns the length of XSet

In addition, the operation *Free,* described just below, applies to all types of objects, including *XSets.*

2.4 Storage Management

A *free* operation must be provided for *every* class of object to release the memory associated with that object as well as to perform any necessary implementation specific cleanup operations.

2.5 Error Handling

A number of operations in the architecture describe error conditions (generally with the phrase "it is an error if..."). Such errors should be implemented by signaling an error rather than by returning an error value (this could be performed in C by using the **longjmp** function and in Common Lisp by the **error** function).

The C implementation provides utility routines which simplify the use of **longjmp** for this purpose.

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[2] Annotation sets are treated as a separately defined class in the Architecture, but its Nth and Length operations are designed to parallel those of the other sets.

3.0 BASIC CLASSES

3.1 Attributes

A number of classes will have "attributes". This is a list of feature-value pairs, where the feature names are arbitrary strings and the values can be any of a number of types:

Class Attribute

Properties

Name: string

Value: AttributeValue

Operations

CreateAttribute (name: string, value: AttributeValue): Attribute

Class AttributeValue

Properties

Value: string OR ObjectReference OR sequence of AttributeValue

Operations

CreateAttributeValue(string OR ObjectReference OR sequence of AttributeValue): AttributeValue[3]

TypeOf (AttributeValue): one of {**string, sequence, CollectionReference, DocumentReference, AnnotationReference, AttributeReference**}

returns a member of the enumerated type, indicating the type of AttributeValue

Note: AttributeValue is made a separate class, with an explicit TypeOf operator, out of deference to languages such as C without dynamic type identification. Because AttributeValue can take on multiple types, including types such as strings which would not use a generic container structure, implementations in such languages must provide an explicit type discriminator here, accessible through the TypeOf operator.

The value of an attribute may be (*inter alia*) a reference to a collection, document, annotation, or attribute:

Abstract Class ObjectReference

Class CollectionReference

Type of ObjectReference

Properties

CollectionName: string

Operations

CreateCollectionReference (Collection): CollectionReference

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[3] For implementation in languages which cannot determine the type of the argument at run time, such as C, this operation requires two arguments. The additional argument (the first of the two arguments) is of enumerated type "one of {string, sequence, CollectionReference, DocumentReference, AnnotationReference, AttributeReference}" and specifies the type of the second argument, which is the value itself.

Class Document Reference

Type of ObjectReference

Properties

CollectionName: string

DocumentId: string

Operations

CreateDocumentReference (Document): DocumentReference

Class AttributeReference

Type of ObjectReference

Properties

CollectionName: string

DocumentId: string

AttributeName: string

Operations

CreateAttributeReference (Document, AttributeName: string): AttributeReference

Class AnnotationReference

Type of ObjectReference

Properties

CollectionName: string

DocumentId: string

AnnotationId: string

Operations

CreateAnnotationReference (Document, Annotation): AnnotationReference

ObjectReferences are references to (names of) persistent collections, documents, etc., and not to the object instances created by opening a collection, etc. It is therefore possible to have ObjectReferences to documents in collections which are not currently open; it is even possible to have references to documents which have been deleted from a collection. Because of the variety of objects which can be referenced, the Architecture does not provide a single dereferencing operator. Dereferencing must be done explicitly by the Application using the property accessors — opening the collection, accessing the document, accessing the annotation in the document, etc.

An abstract class for objects which have attributes is defined as:

Abstract Class AttributedObject

Properties

Attributes: sequence of Attribute

Operations

PutAttribute (AttributedObject, name: string, value: AttributeValue)

assign *value* as the current value of attribute *name* of *object*, overwriting any prior assignment of a value to that attribute

GetAttribute (AttributedObject, name: string): AttributeValue OR *nil*

if attribute *name* of *object* has been assigned a value by a prior PutAttribute operation, return that value, else return *nil*

RemoveAttribute(AttributedObject, name: string)

if AttributedObject has an Attribute whose Name property is name, remove that attribute from AttributedObject (otherwise do nothing)

3.2 Persistent Objects

The TIPSTER Architecture assumes a name space of persistent objects; each persistent object is assigned a unique name (a string). If the Architecture is operating in a networked environment, this name will presumably consist of a host name and a unique name on that host.

The (abstract) class *Persistent Object* is introduced, which is a superclass of any class of persistent objects.

Abstract Class PersistentObject

Properties

Name: string

Operations

Create.PersistentObject (name: string): PersistentObject

creates a new object of a specified class, and returns that object (it is an *error* if *name* is the name of an existing persistent object)

Open.PersistentObject (name: string): PersistentObject

name should be the name of an object of class PersistentObject, created by a prior Create.PersistentObject operation; the object with that name is returned

Close (object: PersistentObject)

saves any changes made to object in persistent storage and frees any local memory associated with this object *the Architecture assumes that all Persistent Objects will be automatically closed on system termination*

Sync (object: PersistentObject)

saves any changes made to *object* in persistent storage

Destroy (name: string)

erases the persistent instance of the object (it is an *error* if *name* is not the name of a persistent object)

The architecture does not require us to identify persistent object names with file names, but this may be the simplest way to manage initial implementations. In the present architecture DocumentCollectionIndexes and QueryCollectionIndexes are persistent; Collections are optionally persistent (Documents are not persistent objects themselves but have persistence as a part of a Collection).

3.3 Byte Sequences

The decision about the representation of a sequence of bytes, which constitutes the contents of a document, should be hidden from most applications. To do so, the class ByteSequence is introduced. The minimal requirement for an

implementation of the Architecture is to be able to obtain the length of a ByteSequence, and to convert between a ByteSequence and a string:

Class ByteSequence

Operations

Length (ByteSequence): integer

returns the number of bytes in ByteSequence

ConvertToString (ByteSequence): string

CreateByteSequence (string): ByteSequence

(In fact, the simplest implementation of a ByteSequence will probably be as a string, so the conversion will be an identity operation.) Implementations may choose to supplement these with additional operations for creating and accessing ByteSequences, for two reasons:

1. For applications involving large documents, the implementation may wish to provide the ability to directly access portions of the document. This may be done through operations which retrieve substrings of a ByteSequence, or through operations which allow a ByteSequence to be opened to a stream (for subsequent read and write operations).

2. A collection of documents needs to be converted into a TIPSTER Collection prior to processing within the Architecture. For large collections which are already in place on some data store, such as a file system or a data base, it may be highly desirable to create the TIPSTER Collection without copying the document text. A TIPSTER implementation can support this capability by allowing a ByteSequence to be created as a reference to a portion of this data store. For example, the implementation could define a "file segment" as a portion of a file (with start and end positions), and support operations for creating a ByteSequence from a file segment. Alternatively, an application based on a data base could define an operation for creating a ByteSequence from a data base field.

4.0 DOCUMENTS AND COLLECTIONS

4.1 Documents

The document is the central object class in the TIPSTER architecture. As a unit of information, it serves several basic functions within the architecture:

- it is the repository of information about a text, in the form of attributes and annotations (although annotations will in general refer to portions of documents)
- it is the atomic unit in building collections
- it is the atomic unit of retrieval in detection operations

Each Document is part of one or more Collections (see Section 4.2). A Document has persistence by virtue of being a member of a Collection, and can be accessed only as a member of a Collection. Each document is given a unique identity by its *Id* property, which is copied by the CopyDocument and CopyBareDocument operations, and is also copied when a new collection is created by document retrieval operations.

Class Document

Type of AttributedObject

Properties

Parent: Collection

the Collection of which this Document is a member;

Id: string

an internal document identifier, assigned automatically when a new Document is created, which is unique within an entire TIPSTER system (to insure uniqueness in a distributed system, an implementation may choose to include a host name as part of the Id)

ExternalId: string (**R, W**)

a document identifier assigned by the application

RawData: ByteSequence

the contents of the document prior to any TIPSTER processing. The byte-sequence may include subsequences representing text in multiple languages, as well as non-text material such as pictures, audio, and tables

Annotations: AnnotationSet

information about portions of the document (information about the document as a whole is stored in Attributes; a Document inherits an Attributes property by virtue of being a type of Attributed Object)

Operations

CreateDocument (Parent: Collection, ExternalId: string, RawData: ByteSequence, annotations: AnnotationSet, attributes: sequence of Attribute): Document

creates a new document within the Collection Parent and assigns the document a new unique Id

CopyBareDocument (NewParent: Collection, Document): Document

makes a copy of *Document*, including only its internal Id, ExternalId, and RawData, and places the copy in collection *NewParent.* The attributes and annotations of the original document are not copied by this operation.

CopyDocument (NewParent: Collection, Document): Document

makes a copy of *Document*, including its internal Id, ExternalId, RawData, attributes, and annotations, and places the copy in collection *NewParent*.

Annotate (Document, AnnotatorName: string)

invokes annotation procedure AnnotatorName on the Document; see Section 5.6.

WriteSGML (Document, AnnotationSet, AnnotationPrecedence: sequence of string): string

Converts a document together with a set of Annotations into SGML format. AnnotationPrecedence, which is a list of annotation types, is used to resolve conflicts when two annotations cover the same span: the tag corresponding to the annotation type which appears first in the list is written out first. The resulting document is in a "normalized" SGML, with all attributes and end tags explicit.[4]

ReadSGML (string, Parent: Collection, ExternalId: string): Document

Reads a string marked up with "normalized" SGML, with all attributes and end tags explicit, and generates a Document with the specified *ExternalId*, no attributes, and an AnnotationSet containing one annotation for each SGML text element marked in the input text. If the input violates these constraints (e.g., unmatched start tags) or violates SGML syntax (e.g., unmatched quotation marks within tags), an error will be signaled.[5]

As noted earlier, new sources of data will need to be converted by the application into Collections of Documents before they can be processed within the TIPSTER Architecture. The functions which perform these conversions will necessarily be specific to the type of data source, and hence a TIPSTER application will be required to provide these conversion operations when a new type of data source is to be used.

4.2 Collections

Documents are gathered into Collections, which may have attributes on the collection level as well as on the individual documents. Collections provide a permanent repository for documents within the TIPSTER Architecture.

Collections in general are persistent and hence have names; however, the Architecture also provides for volatile, unnamed Collections.

Class Collection

Type of PersistentObject, AttributedObject

Properties

Owner: string (**R, W**)

Contents: sequence of Document (**R**)

Operations

CreateCollection (name: string, attributes: sequence of Attribute): Collection

creates a named, persistent collection

CreateVolatileCollection (attributes: sequence of Attribute): Collection

creates an unnamed, volatile collection

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[4] The specification of this operation is subject to revision based on the experience of implementors in using these SGML representations in applications.

[5] The specification of this operation is subject to revision based on the experience of implementors in using these SGML representations in applications.

Length (Collection): integer

returns the number of documents in a collection

RemoveDocument (Collection, Id: string)

removes the Document with Id *Id* from the Collection; if no such Document is present, the Collection is unchanged

GetDocument (Collection, Id: string): Document OR *nil*

returns the Document in the Collection with the given *Id,* or *nil* if no such Document exists

FirstDocument (Collection): Document OR nil

returns the `first' document within a collection and initializes data structures internal to the collection so that NextDocument can be used to iterate through the documents in a collection. Returns **nil** if no documents are found in the collection.

NextDocument (Collection): Document OR nil

returns the `next' document within a collection. Normally used to iterate through all documents in a collection. Returns **nil** if no more documents are found in the collection. FirstDocument and NextDocument must be well behaved in the presence of calls to CreateDocument and RemoveDocument. This means that a loop using FirstDocument and NextDocument must visit all documents which were in the collection when FirstDocument was called if and only if the documents are not deleted before the loop reaches them. Documents added after FirstDocument is called may or may not be encountered during the loop.

GetByExternalId (Collection, ExternalId: string): Document OR *nil*

returns the Document in the Collection with the given *ExternalId;* if several Documents have the same ExternalId, returns one of them; if none have this ExternalId, returns *nil.*

AnnotateCollection (which: Collection, destination: Collection, AnnotatorName: string)

invokes annotation procedure A*nnotatorName* on a subset of Collection *destination*; see Section 5.6 for further information.

5.0 DOCUMENT ANNOTATIONS: GENERAL STRUCTURE

Annotations, along with attributes, provide the primary means by which information about a document is recorded and transmitted from module to module within a system. This chapter elaborates the general structure of annotations, noting some of the issues which arise at each stage.

5.1 What Is Annotated?

An annotation provides information about a portion of the document (including, possibly, the entire document). The portion of the document is specified by a set of spans. Each span consists in turn of a pair of integers specifying the starting and ending byte positions in the RawData of the document (with the first byte of the document counting as byte 0).

Class Span

Properties

Start: integer

End: integer

Operations

CreateSpan (start: integer, end: integer): Span

The current span design is intended for character-based text documents which may contain additional types of information such as graphical images, audio, or video, which needs to be retained and displayed, but which would not be further processed by components of the TIPSTER Architecture. For documents which do not contain text in the form of a sequence of characters, the meaning of a span will not necessarily be compatible with this start byte/end byte convention. For instance, in compressed video, the information contained in a sequence of frames cannot be located using starting and ending byte. Similarly, in a graphical image of a document, such as a fax, the most natural definition of a primitive subimage is likely to be a rectangle. Note that the data in a fax is not even byte aligned. All of these considerations indicate that eventually an opaque type for spans with a subclass being TextSpan will be needed.

Most annotations will be associated with a single contiguous portion of the text, and hence with a single span. However, a set of spans is provided for in order to be able to refer to non-contiguous portions of the text. For example, an event might be described at the beginning of an article and again later in the article, but not in the intervening text; using a set of spans allows us to have an annotation for the event refer to these two passages. It would also allow for discontinuous linguistic elements, such as verb plus particle pairs ("I *gave* my gun *up*.").

5.1.1 Code Sets and Character Positions

Positions in the RawData are represented internally in terms of byte offsets, rather than characters. This is necessary because the RawData may contain non-text data, such as graphics or sounds, for which character addressing would not be meaningful. However, once a text has been segmented into text and non-text portions, and the text portion into segments involving different character codes, it should be possible to provide operations at the character level (i.e., operations which are sensitive to the different sizes of characters in different codes). This segmentation into regions using different character code sets is to be recorded in the TIPSTER Architecture as Annotations on the document (see Section 6.1). By accessing these Annotations, an application can determine the code set employed at a specific position in a document, and hence the size of the character at that position. This information can be used to implement operations to extract a single character or advance to the next character position.

More work is required on the multi-lingual design of the Architecture before such operations can be incorporated into the Architecture itself.

5.1.2 Modification of the Text

To allow annotations to modify the text (and, in particular, to insert characters) in such a way that subsequent accesses to the text see the modified text in place of the original text, it is necessary to require a representation of positions in a document which allows for insertions (e.g., by using integers above the length of the original string to refer to inserted elements). The current architecture does not allow for such changes; corrections to the text must be recorded as attributes on text elements which are explicitly accessed by subsequent processes. Alternatively, the application can create a new Document with a new RawText property which incorporates these modifications.

5.2 Information Associated With an Annotation

An annotation associates a *type* with a span of the document. Examples of possible types are *token*, *sentence*, *paragraph*, and *dateline*. In addition, one or more attributes may be assigned to each annotation.

Class Annotation

Type of AttributedObject

Properties

Id: string

the identifier of an Annotation, which is nil when the Annotation is created and which is set when the Annotation is added to a Document; the value assigned is unique among the Annotations on that Document.

Type: string

Spans: sequence of Span

Operations

CreateAnnotation (Type: string, Spans: sequence of Span, attributes: sequence of Attribute): Annotation

Examples of simple attributes on annotations (attributes whose values are single strings) include a *type-of-name* attribute on name annotations, which might take on such values as "person , country", "company", etc.; a *pos* (part of speech) attribute on *token* annotations, which might take on the Penn Tree Bank values, such as "NNS" and "VBG", and a root attribute on token annotations, which would record the root (uninflected) form of a token.

An example of an attribute whose value is another annotation would be a coreference pointer. An even more complex attribute value would be a template object, which may in turn contain pointers to several other annotations (for the text elements filling various slots in the template object).

5.3 Accessing Annotations

Because annotations are central to the TIPSTER architecture, it is expected that applications will have frequent need to access, search, and select annotations on a document. To meet this need, the Architecture defines a class AnnotationSet and a number of operations operating on such sets of annotations. In particular, operations are provided to support the sequential scanning of a document (AnnotationsAt, NextAnnotations) and to support the extraction of annotations meeting certain criteria (SelectAnnotations).

Although AnnotationSets are logically just sets of annotations, and could be implemented like other sets (e.g., as lists), a special class is provided in the expectation that implementations may wish to choose a more elaborate implementation (such as a sorted list or tree with one or more indexes) in order to implement the operations more efficiently.

Each Document includes as one property an AnnotationSet, holding the annotations on that Document. Most of the operations on AnnotationSets can also be applied to Documents, and in that case apply the same operation to the AnnotationSet property of the Document.

Class AnnotationSet

Properties

Members: sequence of Annotation (**R**)

the individual annotations in the set

Operations

CreateAnnotationSet (): AnnotationSet

creates an empty AnnotationSet

AddAnnotation (Document, Annotation): string

adds an annotation to a document. If the *Id* slot of *Annotation* is *nil*, this operation creates a new annotation Id (unique for this document) and assigns it to the id field of Annotation. If the *Id* field of *Annotation* is filled (not *nil*), and there is an existing annotation on the document with the same *Id*, the new annotation replaces the existing annotation. The *Id* field of the annotation is returned.

RemoveAnnotation (Document OR AnnotationSet, Id: string)

removes the annotation with the specified *Id* from the Document or AnnotationSet. It is an error if the document does not have an annotation with that Id.

GetAnnotation (Document OR AnnotationSet, Id: string): Annotation

returns the annotation whose id slot is equal to the desired value. It is an error if no annotation has the specified identifier.

Length (AnnotationSet): integer

returns a count of the number of annotations in *AnnotationSet*

Nth (AnnotationSet, n: integer): Annotation

returns the *Nth* annotation in AnnotationSet, where the first annotation has index 0.

SelectAnnotations (Document OR *AnnotationSet*, type: string OR *nil*, constraint: sequence of Attribute): AnnotationSet

returns the (possibly empty) set of annotations from the Document or AnnotationSet which are of type *type* and which satisfy *constraint*. *constraint* is a sequence of attributes, where the *i*th attribute has name a_i and value v_i. An annotation satisfies the constraint if (for each i), attribute a_i of the annotation has value v_i. If *constraint* is the empty sequence, no constraint is placed on the attributes: all annotations of the given type are selected. If *type* is *nil*, annotations of all types satisfying the attribute constraints are included.

DeleteAnnotations (Document OR AnnotationSet, type: string OR *nil*, constraint: sequence of Attribute)

removes from the Document or AnnotationSet all annotations which are of type *type* and which satisfy *constraint*. These arguments have the same significance as for *SelectAnnotations*, above.

AnnotationsAt (Document OR AnnotationSet, Position: integer): AnnotationSet

returns the set of annotations from *Document* or *AnnotationSet* which start at the specified position.

NextAnnotations (Document OR AnnotationSet, Position: integer): AnnotationSet

Returns the set of annotations from *Document* or *AnnotationSet* which have the smallest starting point that is greater than or equal to *Position*.

MergeAnnotations (AnnotationSet, AnnotationSet): AnnotationSet

returns the union of the Annotations in the two AnnotationSets.

5.4 Annotation Type Declarations

5.4.1 Introduction

A central goal in creating the TIPSTER architecture is for different modules to be able to share information about a document through the use of annotations. Such information sharing will be workable only if there are precise, formal descriptions of the structure of these annotations, and if the modules which create annotations adhere to these descriptions.

Therefore, *annotation type declarations* are introduce here which serve to document the information associated with different types of annotations. In the present architecture these declarations only serve as documentation; future generations of the architecture may seek to do type checking based on these declarations (see Appendix A.1).

Type declarations are organized into *packages*. A package will typically include a set of related annotation types. For example, a package may declare all the types of annotations used to represent the document structure for one message format (header, dateline, author, etc.). Another package, associated with an extraction system, would represent the annotation types corresponding to the template objects created by that system.

The declaration of a package of annotation types would consist of a package name declaration followed by one or more annotation type declarations. The package name declaration has the form

type package *identifier*

An annotation type declaration defines an annotation type; it specifies the attributes which such annotations may have and the type of value of each attribute. The declaration has the form

annotation type *identifier (attribute-spec$_1$ attribute-spec$_2$, ... }*;

where each attribute specification, attribute-spec,., has the form

attribute-name: type-spec

The *type-spec* specifies the type of allowable values of the attribute. The type spec may specify a basic type:

Boolean

string

integer

real

document

collection

annotation (a reference to an annotation of any type)

it may specify an enumerated type by giving its alternative values:

(value$_1$, value$_2$ ...)

it may specify a union of types by listing the alternative types:

(type$_1$ or *type$_2$* or ...)

to indicate that the value may be of any one of the types listed; it may specify a compound type, either

sequence of *type*

which allows for a sequence of zero or more instances of type *type*, or

optional *type*

whose value may be either of *type* or be *nil*. Finally, *type-spec* may be a previously defined annotation type, specifying a reference to an annotation of that type.

One or more white-space characters (blanks, tabs, or newlines) are required between successive identifiers and alphabetic names; zero or more white-space characters are allowed before and after the separator characters ": ; ()". Any text between a left bracket and a right bracket ([...]) is considered a comment.

Here is a simple example based on the mini-MUC organization template (more elaborate template examples are given in Section 8):

```
type package organizations;
annotation type organization    {org_name:      string,
                                 org_aliases:   sequence of string,
                                 org_type:      {government, company, other},
                                 org_location:  sequence of typed_location}:
annotation type typed_location  {location:      string;
                                 type:          {country city landregion province
                                                 waterregion address oth-unk}};
```

5.5 Examples of Annotations

This section shows some simple examples of annotated documents. Each example is shown in the form of a table. At the top of the table is the document being annotated; immediately below the line with the document is a ruler showing the position (byte offset) of each character. Underneath this appear the annotations, one annotation per line. For each annotation is shown its Id, Type, Span, and Attributes. Integers are used as the annotation Ids. Also, for simplicity only a single Span for each Annotation is shown. The attributes are shown in the form *name = value*.

At the end of this section the type declaration packages which would be used to describe these annotations is shown.

The first example shows a single sentence and the result of three annotation procedures: tokenization with part-of-speech assignment, name recognition, and sentence boundary recognition. Each token has a single attribute, its part of speech (pos), using the tag set from the University of Pennsylvania Tree Bank; each name also has a single attribute, indicating the type of name: person, company, etc.

Text

```
Cyndi savored the soup.
|0...|5...|10..|15..|20
```

Annotations

Id	Type	Span Start	Span End	Attributes
1	token	0	5	pos=NP
2	token	6	13	pos=VBD
3	token	14	17	pos=DT
4	token	18	22	pos=NN
5	token	22	23	
6	name	0	5	name_type=person
7	sentence	0	23	

Annotations will typically be organized to describe a hierarchical decomposition of a text. A simple illustration would be the decomposition of a sentence into tokens. A more complex case would be a full syntactic analysis, in which a sentence is decomposed into a noun phrase and a verb phrase, a verb phrase into a verb and its complement, etc. down to the level of individual tokens. Such decompositions can be represented by annotations on nested sets of spans. Both of these are illustrated in our second example, which is an elaboration of our first example to include parse information. Each non-terminal node in the parse tree is represented by an annotation of type parse.

Text Cyndi savored the soup. |0...|5...|10..|15..|20				
Annotations				
Id	Type	Span Start	Span End	Attributes
1	token	0	5	pos=NP
2	token	6	13	pos=VBD
3	token	14	17	pos=DT
4	token	18	22	pos=NN
5	token	22	23	
6	name	0	5	name_type=person
7	sentence	0	23	constituents= [1],[2],[3].[4],[5]
8	parse	0	5	symbol="NP",constituents= [1]
9	parse	14	22	symbol="NP",constituents=[3],[4]
10	parse	6	22	symbol="VP",constituents=[2],[9]
11	parse	0	22	symbol="S",constituents=[8],[10]

In most cases, the hierarchical structure could be recovered from the spans. However, it may be desirable to record this structure directly through a *constituents* attribute whose value is a sequence of annotations representing the immediate constituents of the initial annotation. For the annotations of type *parse,* the constituents are either non-terminals (other annotations in the parse group) or tokens. For the sentence annotation, the constituents attribute points to the constituent tokens. A reference to another annotation is represented in the table as "[*Annotation Id*]"; for example, "[3]" represents a reference to annotation 3. Where the value of an attribute is a sequence of items, these items are separated by commas. No special operations are provided in the current architecture for manipulating constituents.

At a less esoteric level, annotations can be used to record the overall structure of documents, including in particular documents which have structured headers, as is shown in our third example[6]:

[6] Incounting characters, count one character for the *newline* between lines

Text

```
 To: All Barnyard Animals
|0...|5...|10..|15..|20..
 From:  Chicken  Little
|25..|30..|35..|40..|45..
 Date: November 10, 1194
....|50..|55..|60..|65..
 Subject: Descending Firmament
|70..|75..|80..|85..|90..|95..
 Priority :  Urgent
.|100.|105.|110.|115.
 The sky is falling. The sky is falling.
....|120.|125.|130.|135.|140.|145.|150.
```

Annotations

Id	Type	Span Start	Span End	Attributes
1	Addressee	4	24	
2	Source	31	45	
3	Date	53	69	ddmmyy=101194
4	Subject	78	98	
5	Priority	109	115	
6	Body	116	155	
7	Sentence	116	135	
8	Sentence	136	155	

If the *Addressee, Source, ...* annotations are recorded when the document is indexed for retrieval, it will be possible to perform retrieval selectively on information in particular fields.

Our final example involves an annotation which effectively modifies the document. The current architecture does not make any specific provision for the modification of the original text. However, some allowance must be made for processes such as spelling correction. This information will be recorded as a *correction* attribute on *token* annotations and possibly on name annotations:

Text Topster tackles 2 terrorbytes. |0...|5...|10..|15..|20..|25..				
Annotations				
Id	Type	Span Start	Span End	Attributes
1	token	0	7	pos=NP correction=TIPSTER
2	token	8	15	pos=VBZ
3	token	16	17	pos=CD
4	token	18	29	pos=NNS correction=terabytes
5	token	29	30	

The sample annotations shown here would require the following type declarations:

```
type package basic;
annotation type token:      {pos: string, correction: optional string};
annotation type name:       {name_type: {person, organization, other}};
annotation type sentence:   {constituents: optional sequence of token};

type package parse;
annotation type parse:      {symbol: string, constituents: sequence of (parse or token or name)};

type package message;
annotation type addressee;
annotation type source;
annotation type date:    {ddmmyy: string};
annotation type subject;
annotation type priority;
annotation type body;
```

5.6 Invoking Annotators

Each TIPSTER system will be provided with a number of "annotators" procedures for generating annotations. There will be annotators for different types of annotations; for example, for tokenization, for sentence segmentation, for name recognition, etc. In addition, there may be multiple annotators of a single type; e.g., multiple tokenizers.

Each annotator is assigned a name (a string). It is invoked by

Annotate (Document, AnnotatorName: string)

or

AnnotateCollection (which: Collection, destination: Collection, AnnotatorName: string)

The first form annotates a single Document. The second form annotates a Collection or a subset thereof. This uses Collection *which* to determine which documents to process, and Collection *destination* to record the annotations. For each document in collection *which*, if the same document (a document with the same Id) appears in *destination*, annotate that document in collection *destination*. This calling sequence allows us to selectively apply annotators to subsets of a collection, but to keep all the annotations together in the "original" collection. If *which* and *destination* are identical, the entire collection is annotated.

Note: Future versions of the architecture will include operations for managing the set of annotators: for adding an annotator to the set of annotators, for recording the types of annotations produced by an annotator, and for searching the set of annotators.

5.7 External Representation of Annotations

The TIPSTER architecture provides an external, character-based representation of annotated documents, so that such documents can be interchanged among modules (possibly as part of different TIPSTER systems on different machines) without regard to the internal representation used on particular machines. A representation based on SGML has been selected in order to be able to make use of the large number of existing applications which can operate on SGML documents.

In this representation, if the document consists of the text "aaaa bbbb cccc", and the span corresponding to "bbbb" has been assigned an annotation of type *atype* with id *ident*, and this annotation has attributes *attribute1, attribute2,* ... with values *value1, value2*, ... then the external representation of the annotated document will be

aaaa <atype id=ident attribute1=value1 attribute2=value2 . . . >bbbb</atype> cccc

This representation is produced by the *WriteSGML* operation, which takes as arguments a document, an AnnotationSet, and a precedence list among annotation types. This precedence list is used to determine the nesting of SGML tags if two annotations involve the same span. A complementary operation, *ReadSGML*, reads a SGML document which conforms to this format (with all attributes and end tags explicit) and creates a document with annotations.

The specification of these operations is subject to revision based on the experience of implementors in using these SGML representations in applications.

It may be desirable to have a second external representation which much more closely parallels the internal property structure of the annotations, particularly if annotations are to be exchanged over a network.

5.8 Annotation Schemata and Style Sheets

Different groups of annotations normally exist in some fixed structural relationships to one another. Thus, a text body may consist of paragraphs, a paragraph of sentences, a sentence of tokens, etc. For an SGML document, these relationships are provided by a DTD. At present, the Architecture includes a very limited amount of such information in the form of the PrecedenceList argument to WriteSGML; it may be desirable to include in later versions of the architecture an AnnotationSchema more analogous to a DTD.

When an SGML form is generated from an annotated document, rules must be applied to realize each type of annotation as a sequence of characters. In the present version, these rules are assumed to be built in to the WriteSGML operation, but in later versions it may be desirable to provide these rules explicitly as a StyleSheet. A TIPSTER System would have a default StyleSheet, but it may be necessary to extend the WriteSGML operation to use a different, explicitly specified style sheet.

6.0 TYPES OF DOCUMENT ANNOTATIONS

The TIPSTER Architecture defines a number of standard annotations; these are divided into structural and linguistic annotations. If these particular annotation type names are used, they must be used for the purpose designated. However, a TIPSTER system is free to create and use any other annotation types that it wishes.

These annotations all have to be described in further detail.

6.1 Structural Annotations

1. The raw document may contain several types of information, including text, tables, and graphics. The TIPSTER Architecture needs to preserve all this information in the document, but for the present will only process the text information (at a subsequent stage other structures with embedded text information, such as tables, may also be processed).

   To delimit these different types of information, the TIPSTER Architecture will use annotations of type *TextSegment*, each subsuming a maximal contiguous sequence of text (and possibly other annotations, such as *GraphicsSegment*, which would be ignored in subsequent processing).

2. A text segment may consist of text in one or more languages and character codes. This information would be recorded by annotations of type *MonolingualTextSegment* which each have *Language* and *CharacterSet* attributes.

3. A document may be divided into a header and a body. The body would be annotated with a *body* annotation. The header may include a document identifier (to be annotated with a docid annotation) and such other properties as a title or headline, a dateline, etc.

4. A body may be divided into paragraphs; the p annotation type will be used to identify paragraphs.

5. A paragraph may be divided into sentences; the s annotation type will be used to identify sentences.

6. A sentence may be divided into tokens. The rules for tokenization for English will follow those used by the Penn Tree Bank. Tokens will be denoted by the *token* annotation.

The capability to annotate sentences and tokens will be obligatory for a TIPSTER System, since so many other properties may be expected to assume their existence. Other levels of annotation will be optional.

6.2 Linguistic Annotations

1. Names, as defined for MUC-6. This includes company names, people's names, locations, currencies, and dates.

2. Part of speech labels, using the Penn TreeBank set as a standard for English.

3. Coreference tagging, as is being defined for MUC-6. Standards for other linguistic annotations, such as phrase structure, word senses, and predicate-argument structure, may be added as more progress is made in defining these annotations for MUC evaluation.

All of these linguistic annotations would be optional: the architecture would be used to establish standards whereby people who want to generate or use these annotations could communicate, but (except possibly for name recognition) this would not obligate anyone to produce these annotations.

7.0 DETECTION

7.1 Object Classes

7.1.1 Detection Needs and Queries

The user's request for documents is initially prepared in the form of a DetectionNeed: a document with a variety of SGML-delimited fields. A DetectionNeed is a type of Document, and so partakes of all the operations which can be applied to Documents. As a specialization of Collections, the Architecture includes DetectionNeedCollections; these are required primarily for routing operations, which typically involve sets of DetectionNeeds.

The DetectionNeed is transformed in two stages: it is first transformed into a DetectionQuery, and thence into either a RetrievalQuery or a RoutingQuery. DetectionNeeds are independent of the specific retrieval engine employed, while DetectionQueries, RetrievalQueries, and RoutingQueries are specific to a particular retrieval engine. The DetectionQuery is specific to the retrieval engine but independent of the collection over which retrieval is to be performed, and the operation (retrieval or routing) to be performed; the RetrievalQuery and RoutingQuery are specific to the retrieval engine, to the operation, and to a collection (they may incorporate, for example, term weights based on the Inverse Document Frequencies in a collection). The transformation process is divided into these two stages because a retrieval system may provide specialized tools for modifying the DetectionQuery.

7.1.2 Detection Needs

Class DetectionNeed

Type of Document

Description

A system-independent description of the contents of the documents that the user would like to retrieve. The description may be in natural language, expressed with query language operators (described below), or a combination of natural language and query language operators.

Operations

QueryGenerator (DetectionNeed): DetectionQuery

Generate a system-specific DetectionQuery from an analysis of the DetectionNeed; the DetectionQuery has the same ExternalId as the DetectionNeed.

Query language operators are represented within the DetectionNeed using SGML-style tags. Each query language operator has the following syntax.

<OPERATOR> argument + </OPERATOR>

That is, an operator consists of an operator field marker (e.g. **<OPERATOR>**), one or more arguments, and an ending field marker (e.g. **</OPERATOR>**). Operators may be nested arbitrarily. Operator characteristics can be altered as shown. When alternatives are given (e.g. **EXACT** or **FUZZY**), the first one listed is the default. The default value for numeric arguments is 1.

It is not necessary for a system to implement each operator exactly as described below. A compliant system is one that can translate any valid DetectionNeed into its own query language, and that documents how each operator is handled. A system may ignore operators that it does not implement, or it may map them to the nearest reasonable alternative in that system's query language.

Any text not explicitly encapsulated in a query language operator is assumed to be implicitly encapsulated by the **<SUM>** operator (described below).

When it is necessary to distinguish among two or more DetectionNeeds, for example when they are stored in an ASCII file, the **<DETECTION-NEED>** SGML tag indicates the beginning of a DetectionNeed, and the

</DETECTION-NEED> SGML tag indicates the end of the DetectionNeed. Text that is not enclosed between these tags is handled in a system-dependent (i.e. not defined by the TIPSTER architecture) manner.

The operators are listed below, in alphabetic order.

<AND MATCH=[EXACT | FUZZY]>
Document should contain all arguments. **EXACT** match means that each document must contain all of the arguments. **FUZZY** match means that a document may be returned if it lacks one or more arguments, but the document is presumably ranked lower than documents that match all arguments.

<AND-NOT MATCH=[EXACT | FUZZY]>
Document should contain the first argument but not the second. Only two arguments can be specified for this operator.

<COMMENT>
All tokens until **</COMMENT>** are comments, to be ignored when creating DetectionQuery objects.

<DOC-ANNOTATION=name>
The arguments are to be matched against that portion of the document annotated with the annotation of type "name". Note that annotations may denote document structure, so that this operator may be used to restrict the match to within a single phrase, sentence, paragraph, section, etc.

<DOC-ATTRIBUTE=name>
The arguments are to be matched against the value of attribute "name".

<NL>
The arguments are a natural language description of part of the information need. No other query operator can occur in the **<NL>** description of the information need. (Any operators encountered are to be treated as text.) **</NL>** ends the field, unless it is escaped (see below).

<ESCAPE>
All tokens until **</ESCAPE>** are query terms, not operators. If the next token is **</ESCAPE>** then it is a query term, and not the end of the **<ESCAPE>**.

<NONRELEVANT>
The arguments are the Ids of documents that the user has judged to be not relevant to the information need.

<OR MATCH=[EXACT | FUZZY]>
Document should contain at least one argument.

<PARAGRAPH MATCH=[EXACT | FUZZY], DISTANCE=n, [UNORDERED | ORDERED]>
Document should contain all arguments within n paragraphs.

<PHRASE MATCH=[EXACT | FUZZY], DISTANCE=n, [UNORDERED | ORDERED]>
Document should contain all arguments within n phrases.

<RELEVANT>
The arguments are the Ids of documents that the user has judged to be relevant to the information need.

<SENTENCE MATCH=[EXACT | FUZZY], DISTANCE=n, [UNORDERED | ORDERED]>
Document should contain all arguments within n sentences.

<SUM>
Functionally, this operator is like an **<OR>** operator: The document must contain one or more arguments. However, the user may assume that documents that match more arguments are generally ranked higher than documents that match fewer arguments. (Typically used with vector-space or probabilistic systems.)

<SYNONYM>
The arguments are considered synonyms.

<WEIGHT n>
Applies a weight of n to its argument. May affect a document's score, depending upon the retrieval algorithm used.

<WORDS MATCH=[EXACT | FUZZY], DISTANCE=n, [UNORDERED | ORDERED]>

Document should contain all arguments within n words.

An SGML-like syntax was chosen because it is expressive, relatively easy to read, and system neutral. It allows the operator characteristics to be tailored without introducing a large number of special-purpose operators.

Class DetectionNeedCollection

Type of Collection

Description

A Collection of Documents, all of which are DetectionNeeds.

7.1.3 Queries

Class DetectionQuery

Type of Document

Description

the system-specific (but collection-independent) translation of a DetectionNeed.

Properties

DetectionNeed: DocumentReference

a reference to the DetectionNeed from which this query is derived

Operations

FormRetrievalQuery (DetectionQuery, sequence of DocumentCollectionIndex): RetrievalQuery

translate the DetectionQuery into an RetrievalQuery by using the information (e.g., document frequencies of terms, similarities between terms) in the set of DocumentCollectionIndexes; the RetrievalQuery has the same ExternalId as the DetectionQuery

FormRoutingQuery (DetectionQuery, sequence of DocumentCollectionIndex): RoutingQuery

translate the DetectionQuery into a RoutingQuery by using the information (e.g., document frequencies of terms, similarities between terms) in the set of DocumentCollectionIndex; the RetrievalQuery has the same ExternalId as the DetectionQuery

EditQuery (DetectionQuery)

optional: this system-specific operation allows the user to modify the query, providing information which cannot be provided through the (system-independent) DetectionNeed

Class RetrievalQuery

Description

the translation of a DetectionQuery which is based on a particular DocumentCollectionIndex and intended for use in retrospective retrieval

Properties

DetectionNeed: DocumentReference

a reference to the DetectionNeed from which this query is derived

Operations

ScoreDocuments (Collection, RetrievalQuery)

assign to each Document in *Collection* an attribute *relevance* whose value indicates the relevance of the document to the query

UpdateUsingRelevanceFeedback (RetrievalQuery, relevant_docs: Collection, sequence of DocumentCollectionIndex): RetrievalQuery

this operation updates the RetrievalQuery using relevance feedback, and returns the updated (or new) Query. The relevance feedback is provided through the *relevant_docs* argument. Each document in this collection should have an Attribute *relevant* with the value "true" or "false". Furthermore, if that value is "true", the entry may also have one or more Annotations of type *relevant-section* whose Spans indicate the relevant sections of the document.

RetrievalQueryFromRelevanceJudgements (relevant_docs: Collection, sequence of DocumentCollectionIndex, DetectionNeed): RetrievalQuery

this operation is similar to Update *UsingRelevanceFeedback*, but creates a new RetrievalQuery from scratch based on the relevance judgments recorded in *relevant_docs*. The DetectionNeed parameter is required since each query must point to the original DetectionNeed; this DetectionNeed may contain a narrative characterization of the query being created, but no information from the DetectionNeed is used in creating the query

Class RoutingQuery

Description

the translation of a DetectionQuery which is based on a particular DocumentCollectionIndex and intended for use in routing.

Properties

DetectionNeed: DocumentReference

a reference to the DetectionNeed from which this query is derived

Operations

UpdateUsingRelevanceFeedback (RoutingQuery, relevant_docs: Collection, sequence of DocumentCollectionIndex): RoutingQuery

RoutingQueryFromRelevanceJudgments (relevant_docs: Collection, sequence of DocumentCollectionIndex, DetectionNeed): RoutingQuery

these operations are exact analogs of the operations with the same names which apply to RetrievalQueries.

7.1.4 Document and Query Indexes

The TIPSTER Architecture provides for two types of document detection operations: retrieval and routing. In essence, retrieval involves the comparison of a single query against a large number of documents, while routing involves the comparison of a single document against a large number of queries (or "user profiles").

As a preliminary step for retrieval, generally, the set of documents must be pre-processed. Typically, this involves the creation of a term index, but it may also involve the gathering of various statistics about the set of documents (such as term document frequencies, term co-occurrence frequencies, and even term similarities based on co-occurrence). The result of all this preprocessing is a *DocumentCollectionIndex*. Retrieval is then performed by sending a query (in the form of an RetrievalQuery) to the DocumentCollectionIndex; the DocumentCollectionIndex returns a list of relevant documents.

Class DocumentCollectionIndex

Type of PersistentObject

Description

a form of a Collection which is capable of responding to DetectionQuery. For most systems, this involves the annotation of the documents in the collection with approach-specific annotations, and then the creation of an inverted index involving these annotations. For some systems, however, an "index" might just be a normalized copy of the original text in a form which can be scanned by high speed search software.

Operations

Augment (DocumentCollectionIndex, Collection)

adds all the documents in Collection to the DocumentCollectionIndex

RetrieveDocuments (sequence of DocumentCollectionIndex, RetrievalQuery, NumberToRetrieve: integer, Monitor or nil): Collection

returns a collection of Documents (of maximal length *NumberToRetrieve*) which are most closely related to the DetectionNeed from which the Retrieval Query is derived. The DocumentCollectionIndex will provide progress updates as requested by the Monitor. A nil argument means that no progress monitoring is required. A retrieval operation canceled by the Monitor object's MonitorProgress operation returns a Collection of accumulated documents

In routing, a set of queries or user profiles (in the form of RoutingQueries) are pre-processed to create a QueryCollectionIndex. Routing is then performed by sending a Document to a QueryCollectionIndex; what is returned is a set of relevant profiles (in the form of a DetectionNeedcollection).

Class QueryCollectionIndex

Type of PersistentObject

Description

the translation of a collection of RoutingQueries into a format which is efficient for performing document routing

Operations

AddQuery (QueryCollectionIndex, RoutingQuery)

adds a single query (in the form of an RoutingQuery) to a QueryCollectionIndex; if an existing query in the QueryCollectionIndex is based on the same DetectionNeed as *RoutingQuery*, the existing query is replaced by *RoutingQuery*

RemoveQuery (QueryCollectionIndex, RoutingQuery)

if *QueryCollectionIndex* includes a query based on the same DetectionNeed as *RoutingQuery*, that query is removed from the Index

RetrieveQueries (sequence of QueryCollectionIndex, Document, NumberToRetrieve: integer): DetectionNeedCollection

returns the collection of DetectionNeeds (of maximal length *NumberToRetrieve*) which are most closely related to Document

7.1.5 Query Monitoring

The Monitor object is intended as an advisory object in the Architecture. If no Monitor object is provided, no monitoring or interruption of the RetrieveDocuments operation is possible. The RetrieveDocuments operation will not fail due solely to the absence of a *nil* Monitor argument.

Class Monitor

Description

Tracks the progress of requests to a Detection component. Some programmatic control is provided via StatusType and IntervalType

Properties

StatusType: one of {NumDocs (number of documents processed), Time (estimated time to complete - seconds), Percent (% of documents processed)}

IntervalType: one of {NumDocs (number of documents processed), Time (interval in seconds between status reports), Percent (% of documents processed)}

Interval: Integer

ClientData: set of string

Operations

CreateMonitor (StatusType: one of {NumDocs, Time, Percent}, IntervalType: one of {NumDocs, Time, Percent}, Interval: integer, ClientData: set of string): Monitor

StatusType is the type of report requested. If the type is not supported a reasonable default shall be provided with the type indicated. IntervalType indicates the desires type of interval which may differ from StatusType. Interval indicates the frequency of status information. The Interval value behaves according to the IntervalType. If IntervalType is Percent then Interval = 5 means provide status when each 5% of the documents are processed. ClientData is optional user data for the MonitorProgress operation

MonitorProgress (Monitor, DCIName: string, Status: integer, MaxStatus: integer, Type: one of{NumDocs, Time, Percent}): Boolean

DCIName is the name of the DocumentCollectionIndex which is being monitored. Status is the current status consistent with type. MaxStatus indicates the maximum value Status may have for DCIName. Type is the type of progress update provided to the function

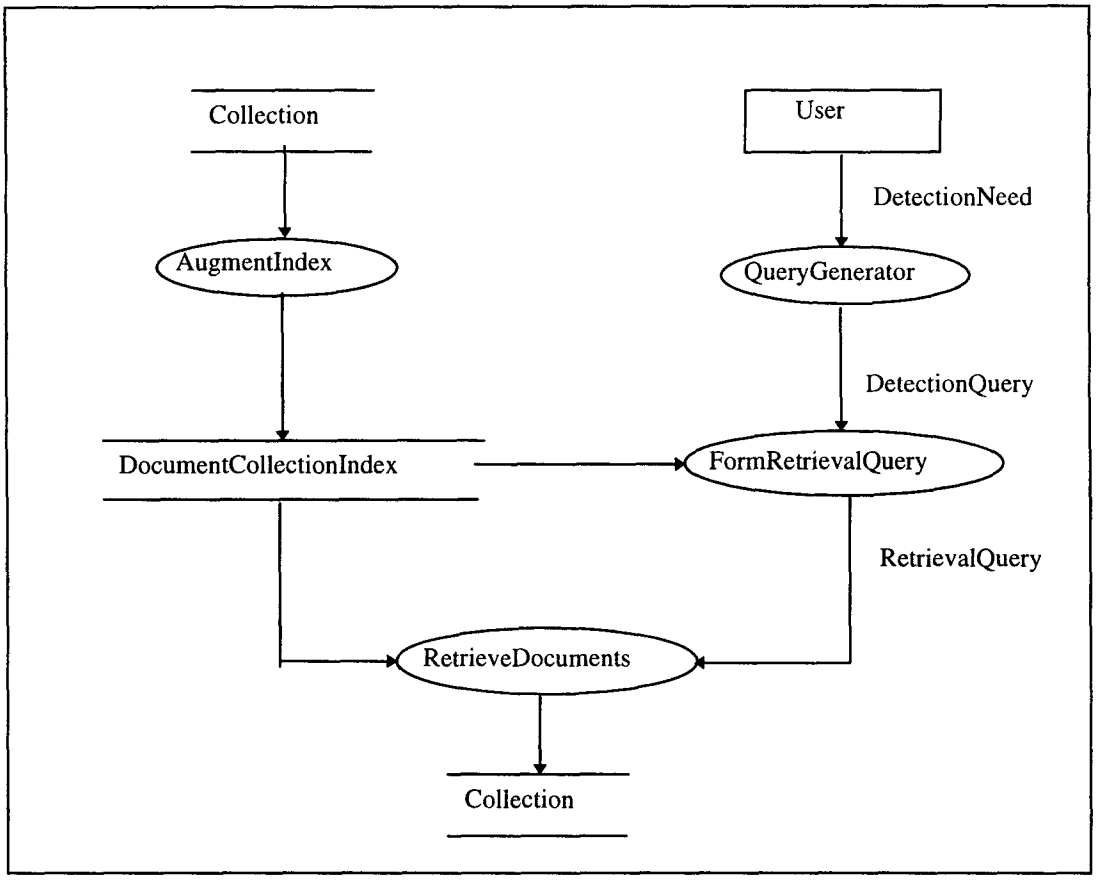
Returns FALSE to terminate the search, returns TRUE to continue the search

7.2 Functional Model

The following functional model diagrams are based on the notation used by Rumbaugh et al. Ovals represent processes (operations); boxes with only a top and bottom represent "data stores" — persistent repositories of data; fully enclosed boxes represent "actors" — active sources of data.

7.2.1 Retrospective Retrieval

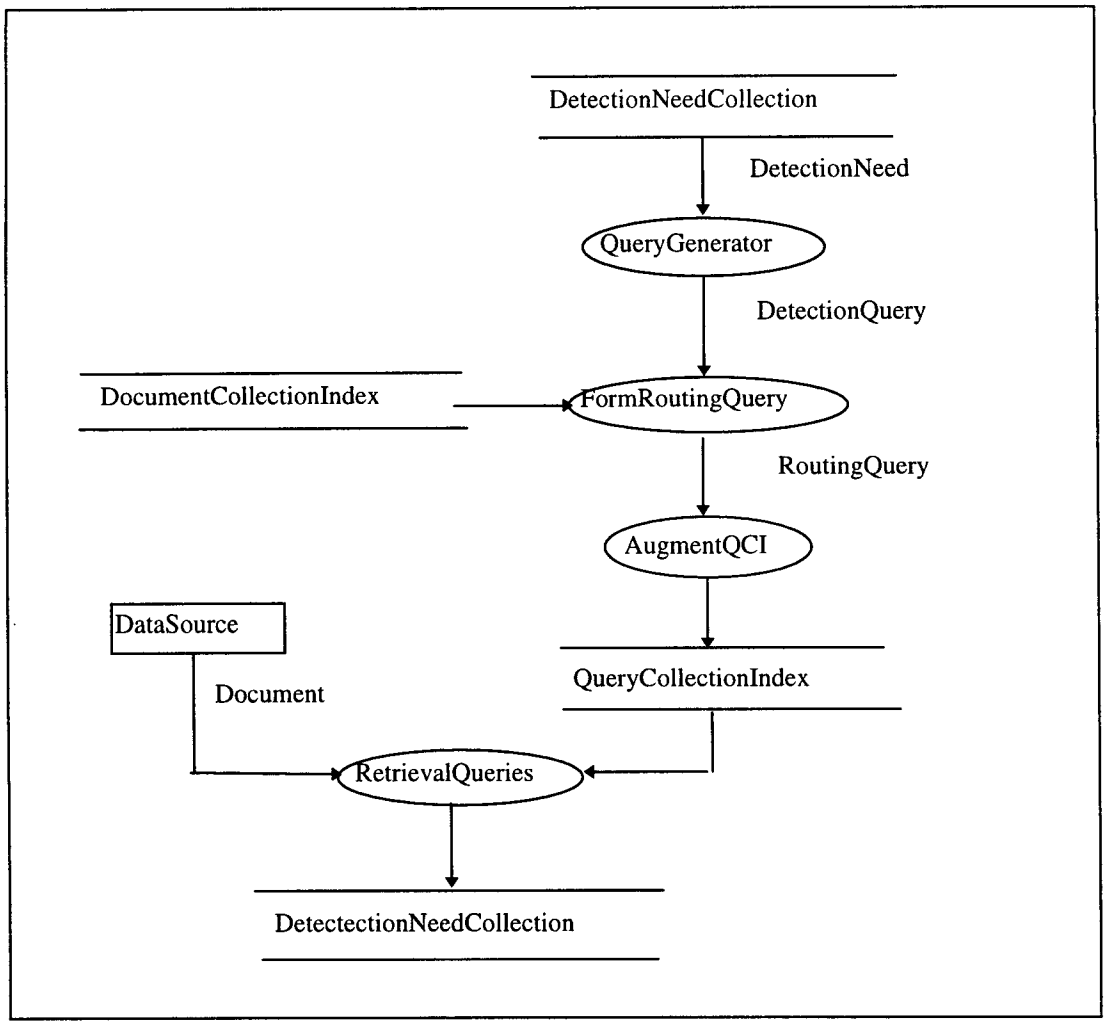
The system begins by converting the DocumentCollection(s) into DocumentCollectionIndex(es), as shown on the left side. To retrieve information from this collection, the User produces a DetectionNeed. This DetectionNeed is converted in two stages, first to a DetectionQuery and then to an RetrievalQuery, as shown in the right column (the latter step may use information, for example, on term weights, from the DocumentCollectionIndex). Finally, the RetrievalQuery is run against the DocumentCollectionIndex to retrieve the documents; this produces a Collection of relevant documents, with a *relevance* attribute for each document.



7.2.2 Routing

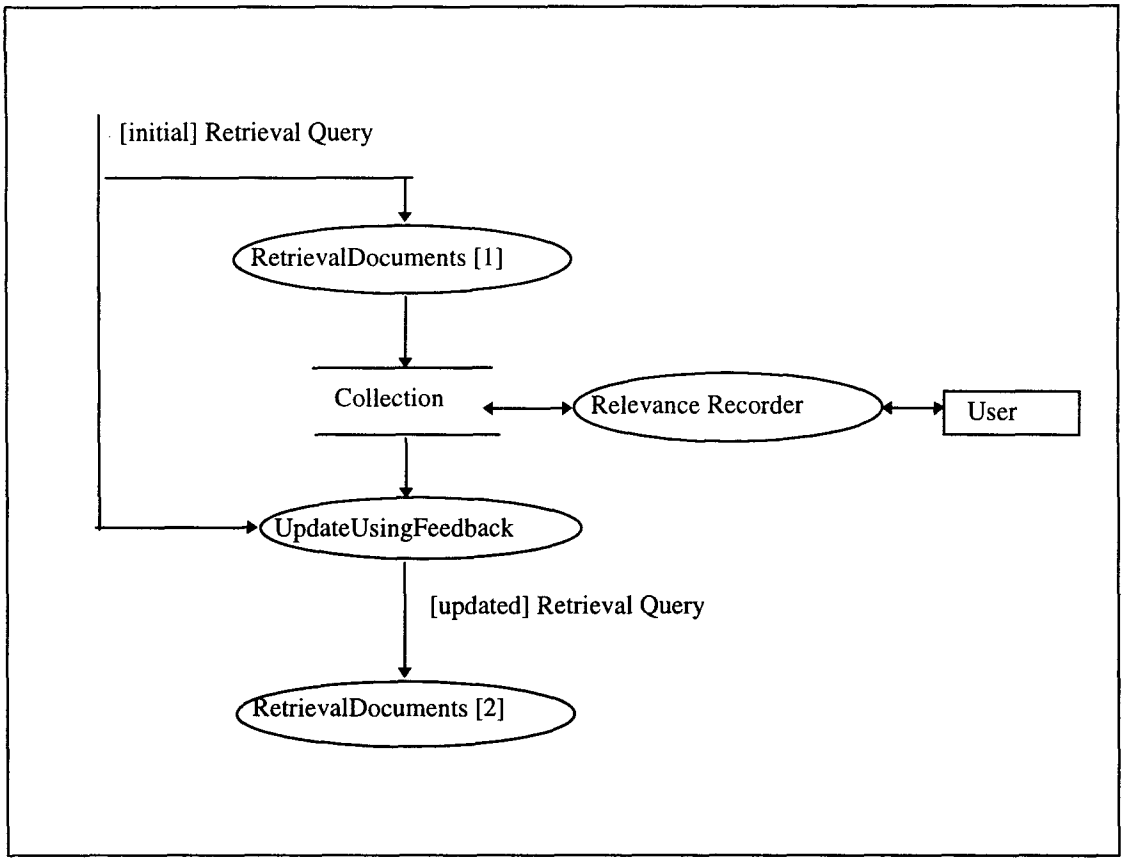
Routing requires a DocumentCollectionIndex which is used to determine weights for the translation of a DetectionQuery into an RoutingQuery. Typically an application will be able to use a pre-existing index (for a Collection of content comparable to the documents to be routed).

Each DetectionNeed (user profile) in the DetectionNeedCollection is translated in two stages: first to a DetectionQuery, and then into a RoutingQuery. These RoutingQueries are then stored and indexed in a QueryCollectionIndex. Finally, this QueryCollectionIndex can be run against a Document to produce a set of relevant queries (profiles), in the form of a DetectionNeedCollection.



7.2.3 Relevance Feedback

Relevance feedback begins with an initial RetrievalQuery, which is used to retrieve a set of documents. This operation is shown as "Retrieve Documents [1]" in the figure below (the DocumentCollectionIndex input is not shown), and produces a Collection. A human judge (or possibly an alternative source of relevance judgments, such as an extraction system) then reviews the retrieved documents and records relevance judgments on the Collection using the *relevant* Attribute. This is done using a Relevance Recorder, which is *not* part of the Architecture but would be part of any application system which wished to support relevance feedback. The Collection is then fed, along with the original query, to an UpdateUsingRelevanceFeedback operation, producing an updated query. Finally, the updated query can be used to retrieve a new set of documents (shown as "Retrieve Documents [2]" at the bottom of the figure).


[initial] Retrieval Query
RetrievalDocuments [1]
Collection
Relevance Recorder
User
UpdateUsingFeedback
[updated] Retrieval Query
RetrievalDocuments [2]

8.0 EXTRACTION

Information extraction the extraction from a document of information concerning particular classes of events is a form of document annotation. An extraction engine adds annotations describing the events and their participants. Extraction therefore does not require any operations and classes beyond those already presented. However, because extraction will be a major component of many systems built using the Architecture, this section describes how extraction fits into the current Architecture.

At present the development of extraction engines from a description of a class of events (a "scenario") is a black art practiced by a cadre of information extraction specialists. It is expected that in the future it will be possible for experienced users to customize extraction systems to new scenarios; this would be an interactive process which would draw upon a library of predefined template objects. Appendix A.2 presents the additional object classes which would be needed to support such customization.

8.1 Representing Templates as Annotations

In the terminology developed by the Message Understanding Conferences, the information extracted from a document is stored in a (filled) template, which in turn consists of a set of template objects. A template object may contain information about a real-world object (such as a person, product, or organization), a relationship, or an event.

Each such template object provides information about a portion of a document and is therefore represented in the TIPSTER Architecture by an annotation. A particular extraction task will involve several kinds of template objects, for events, people, organizations, etc. Each kind of template object corresponds to a *type* of annotation. Thus the formal specification of a set of template objects corresponds to a set of annotation type declarations. This formal specification is supplemented by a large amount of narrative (the "fill rules") describing the circumstances under which a template object is to be created and the information to be placed in each slot.

Each slot/value pair in the template object is represented as an attribute/value pair on the annotation. Note that the values of attributes can be lists (thus allowing for slots with multiple values) and can be references to other annotations (thus allowing for a hierarchy of filled objects, and allowing for references to other annotations, such as names which have been identified by a prior annotation process). Furthermore, each annotation has a span which can link the object to the text from which it has been derived.

Some applications may want to link an individual slot in the template object to text in the document. This can be done by introducing additional annotations. Instead of having the value of the attribute corresponding to that slot be a string, it would be a reference to an annotation of type *string-annotation*. That annotation would (like all annotations) have a set of spans referencing the text; it would also have a *value* attribute holding the value of the template slot (the "slot filler"). This has been done for one of the slots in the example below, the *role* slot of *personnel*, but could have done it for others.

If an application system involves extractions for multiple scenarios (multiple classes of events),it will be necessary to distinguish the annotations corresponding to different extraction scenarios (so that, for example, one can display all the annotations for one scenario). This can be done by adding a scenario attribute to each annotation. In similar fashion, in an application environment integrating annotation modules from different suppliers, it would be desirable to record the source of particular annotations using an annotator attribute. These additional attributes are not shown in the example below.

8.2 An Example

As an illustration of this approach, consider the result of annotating a document consisting of the sentence

> The KGB kidnapped ARPA program manager Umay B. Funded.

with an information extraction system covering terrorist events. The MUC-style template for such an event might look like[7]

<EVENT-1> :=
    EVENT_TYPE: KIDNAPPING
    PERPETRATOR: <ORG-1>
    TARGET: <PERSONNEL-1>
<ORG-1> :=
    ORG_NAME: "KGB"
    ORG_NATIONALITY: USSR
<PERSONNEL-1> :=
    PERSON: <PERSON-1>
    ORGANIZATION: <ORG-2>
    ROLE: "PROGRAM MANAGER"
<ORG-2> :=
    ORG_NAME: ARPA
    ORG_NATIONALITY: USA
<PERSON-1> :=
    PER_NAME: "Umay B. Funded"

These might be encoded as a set of annotations as follows:

[7] The templates shown here are loosely based on those for the MUC-6 information extraction task.

Text				
The KGB kidnapped ARPA program manager Umay B. Funded. |0...|5...|10..|15..|20..|25..|30..|35..|40..|45..|50..				
Annotations				
Id	Type	Span Start	Span End	Attributes
1	Name	4	7	name_type=organization
2	Name	18	22	name_type=organization
3	Name	39	53	name_type=organization
4	Event	0	53	event_type=kidnapping, perp=[5], target=[6]
5	Org	4	7	org_name=[1], org_nationality=USSR
6	Personnel	18	53	person=[9], organization=[8], role=[7]
7	String-annotation	23	38	value="program manager"
8	Org	18	22	org_name=[2], org_nationality=USA
9	Person	39	53	per_name=[3]

The type declaration package for these annotations is as follows:

```
type package terrorist_event;
annotation type event:          {event_type: {kidnapping, murder, ...},
                                    perp: org,
                                    target: personnel};
annotation type org:            {org_name: name,
                                    org_nationality: string};
annotation type personnel:      {person: person,
                                    organization: org,
                                    role: string-annotation};
annotation type person:         {per_name: name};
annotation type name:               {name_type: {person, organization, other}};
annotation type string-annotation: {value: string};
```

APPENDIX A POSSIBLE EXTENSIONS TO THE ARCHITECTURE

A.1 Enforcing Type Declarations

In the current Architecture, annotation type declarations serve only as documentation; they are not processed by any component of the Architecture. It may be desirable in future versions of the Architecture to perform type checking based on such declarations. This could involve:

1. creation of a new class of document, **TypeDeclarationDocument**, containing a package of type declarations
2. associating a set of declaration packages with a Collection
3. requiring that any annotation added to a document in a collection conform to the associated type declaration

A number of issues would need to be resolved to implement such a scheme, including the name scoping of annotation types, and the implications of modifying a type declaration after annotations of that type have been created. The overall type checking mechanism would be fairly complex and so has not been included in the current Architecture.

A.2 Customizable Extraction Systems

The present Architecture treats extraction engines as modules which have been hand-coded for specific tasks (extraction scenarios). In the future, it is expected that there will be more general extraction engines which can be customized *by users* to specific needs. This section considers the additional object classes and data flow which would be entailed.

A.2.1 Object Classes

The user would prepare an ExtractionNeed, using a combination of formal specification and narrative description comparable to the "fill rules" for MUC-5. This would then be "translated" to produce a CustomizedExtractionSystem. This translation would be performed by a component which will guide an analyst in producing a CustomizedExtractionSystem; this interactive translation component is labeled *Customize* below. Once a CustomizedExtractionSystem is created, it can be applied to documents in a collection (like other, pre-existing annotators) and will produce templates for the documents.

The Extraction Need would include annotation type declarations for the annotations to be produced. These type definitions will be supplemented by fill rules in the form of *comments*. As the process of translating ExtractionNeeds becomes more formalized, the fill rules will accordingly also become more formalized. For example, the specifications may include the semantic class of particular slot fills. For the present, however, an ExtractionNeed is a kind of TypeDeclarationDocument:

Class ExtractionNeed

Type of TypeDeclarationDocument

Class CustomizedExtractionSystem

Description

a system-specific structure, containing patterns, rules, etc.

Operations

Customize (ExtractionNeed): CustomizedExtractionSystem

an interactive process which will guide the user in converting an ExtractionNeed into a CustomizedExtractionSystem

Extract (which: Collection, destination: Collection, CustomizedExtractionSystem)

the operation which generates templates from documents. Extraction is a special type of annotation, and accordingly the Extract operation is a variant of the Annotate operation (Section 5.6). For each document in collection *which*, if the same document (a document with the same Id) appears in *destination*, annotate that document in collection *destination* with the information extraction templates generated for that document.

Class Template Object Library

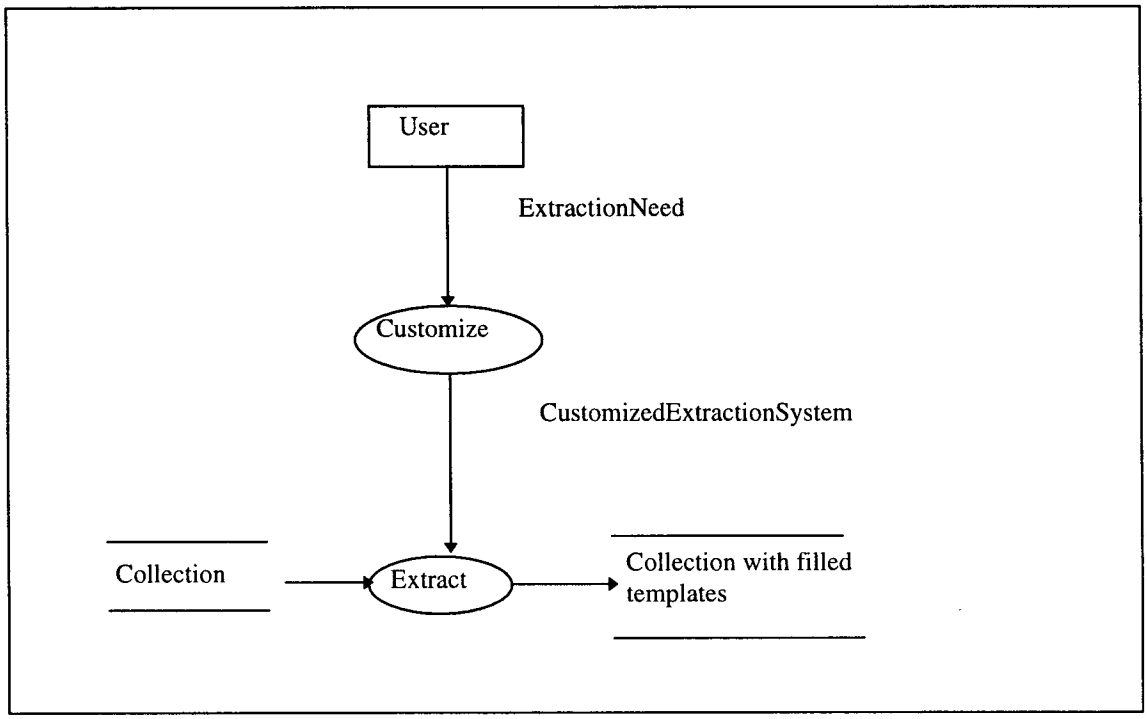
Description

a set of system-specific rules for extracting various classes of objects, such as persons or organizations; this library could be used in customizing an extraction system to a particular task

A.2.2 Functional Model

The analyst begins by preparing an ExtractionNeed. The ExtractionNeed would serve as the starting point for customization, which would be performed by the analyst using an interactive customization tool and drawing upon the Template Object Library. The result of this process would be a CustomizedExtractionSystem.

Once a CustomizedExtractionSystem has been created, it can be given a Collection specifying the documents to be annotated (the "*which*" argument) and a Collection where the annotations shall be placed (the "*destination*" argument); it will add to each document of the destination Collection the appropriate templates (in the form of annotations).



APPENDIX B CLASSES AND THEIR OPERATIONS

This appendix lists all the classes and their operations in an "expanded" form. Instead of showing the properties associated with a class, this appendix explicitly lists the operations to access (and, in some cases, to write) these properties. If property *Comp* of a class is readable, it is accessed by the operation Get*Comp*; if it is also writeable, it is set by the operation Set*Comp*. In addition, the inheritance of operations from abstract classes has been made explicit: the abstract classes themselves have been removed, and the operations are shown explicitly as part of each class which directly inherited them from the abstract class.

Class Annotation

Operations

CreateAnnotation (Type: string, Spans: sequence of Span, attributes: sequence of Attribute): Annotation
GetAttribute (Annotation, name: string): AttributeValue OR *nil*
GetAttributes (Annotation): sequence of Attribute
GetId (Annotation): string
GetSpans (Annotation): sequence of Span
GetType (Annotation): string
PutAttribute (Annotation, name: string, value: AttributeValue)
RemoveAttribute (Annotation, name: string)

Class AnnotationReference

Operations

CreateAnnotationReference (Document, Annotation): AnnotationReference
GetAnnotationId (AnnotationReference): string
GetCollectionName (AnnotationReference): string
GetDocumentId (AnnotationReference): string

Class AnnotationSet

Operations

AddAnnotation (Document, Annotation): string
AnnotationsAt (Document OR AnnotationSet, Position: integer): AnnotationSet
CreateAnnotationSet (): AnnotationSet
DeleteAnnotations (Document OR AnnotationSet, type: string OR nil, constraint: sequence of Attribute)
GetAnnotation (Document OR AnnotationSet, Id: string): Annotation
Length (AnnotationSet): integer
MergeAnnotations (AnnotationSet, AnnotationSet): AnnotationSet
NextAnnotations (Document OR AnnotationSet, Position: integer): AnnotationSet
Nth (AnnotationSet, n: integer): Annotation
RemoveAnnotation (Document OR AnnotationSet, Id: string)
SelectAnnotations (Document OR AnnotationSet, type: string OR *nil*, constraint: sequence of Attribute): AnnotationSet

Class Attribute

Operations

CreateAttribute (name: string, value: AttributeValue): Attribute
CreateAttributeValue (string OR ObjectReference OR sequence of AttributeValue): AttributeValue
GetName (Attribute): string

GetValue (Attribute): AttributeValue

Class AttributeReference

Operations

CreateAttributeReference (Document, AttributeName: string): AttributeReference
GetAttributeName (AttributeReference): string
GetCollectionName (AttributeReference): string
GetDocumentId (AttributeReference): string

Class AttributeValue

Operations

GetValue (AttributeValue): string OR CollectionReference OR DocumentReference OR AttributeReference OR AnnotationReference OR sequence of AttributeValue
TypeOf (AttributeValue): one of (**string, sequence, CollectionReference, DocumentReference, AnnotationReference, AttributeReference**)

Class ByteSequence

Operations

ConvertToString (ByteSequence): string
CreateByteSequence (string): ByteSequence
Length (ByteSequence): integer

Class Collection

Operations

AnnotateCollection (which: Collection, destination: Collection, AnnotatorName: string)
Close (object: Collection)
CreateCollection (name: string, attributes: sequence of Attribute): Collection
CreateVolatileCollection (attributes: sequence of Attribute): Collection
Destroy (name: string)
FirstDocument (Collection): Document OR *nil*
GetAttribute (Collection, name: string): AttributeValue OR *nil*
GetAttributes (Collection): sequence of Attribute
GetByExternalId (Collection, ExternalId: string): Document OR *nil*
GetDocument (Collection, Id: string): Document OR *nil*
GetName (Collection): string
GetOwner (Collection): string
Length (Collection): integer
NextDocument (Collection): Document OR *nil*
OpenCollection (name: string): Collection
PutAttribute (Collection, name: string, value: AttributeValue)
RemoveDocument (Collection, Id: string)
SetOwner (Collection, string)
Sync (object: Collection)
RemoveAttribute (Collection, name: string)

Class CollectionReference

Operations

CreateCollectionReference (Collection): CollectionReference
GetCollectionName (CollectionReference): string

Class DetectionNeed

Type of Document

Operations

QueryGenerator (DetectionNeed): DetectionQuery

Class DetectionNeedCollection

Type of Collection

Class DetectionQuery

Type of Document

Operations

EditQuery (DetectionQuery)
FormRetrievalQuery (DetectionQuery, sequence of DocumentCollectionIndex): RetrievalQuery
FormRoutingQuery (DetectionQuery, sequence of DocumentCollectionIndex): RoutingQuery
GetDetectionNeed (DetectionQuery): DocumentReference

Class Document

Operations

Annotate (Document, AnnotatorName: string)
CopyBareDocument (NewParent: Collection, Document): Document
CopyDocument (NewParent: Collection, Document): Document
CreateDocument (Parent: Collection, ExternalId: string, RawData:
ByteSequence, annotations: AnnotationSet, attributes: sequence of Attribute): Document
GetAnnotations (Document): AnnotationSet
GetAttribute (Document, name: string): AttributeValue OR *nil*
GetAttributes (Document): sequence of Attribute
GetExternalId (Document): string
GetId (Document): string
GetParent (Document): Collection
GetRawData (Document): ByteSequence
PutAttribute (Document, name: string, value: AttributeValue)
ReadSGML (string, Parent: Collection, ExternalId: string): Document
SetExternalId (Document, string)
WriteSGML (Document, AnnotationSet, AnnotationPrecedence: sequence of string): string
RemoveAttribute (Document, name: string)

Class DocumentCollectionIndex

Operations

Augment (DocumentCollectionIndex, Collection)
Close (object: DocumentCollectionIndex)
CreateDocumentCollectionIndex (name: string): DocumentCollectionIndex

Destroy (name: string)
GetName (DocumentCollectionIndex): string
OpenDocumentCollectionIndex (name: string): DocumentCollectionIndex
RetrieveDocuments (sequence of DocumentCollectionIndex, RetrievalQuery, NumberToRetrieve: integer): Collection
Sync (object: DocumentCollectionIndex)

Class Document Reference

Operations

CreateDocumentReference (Document): DocumentReference
GetCollectionName (DocumentReference): string
GetDocumentID(DocumentReference):string

Class Monitor

Operations

CreateMonitor (StatusType :one of {NumDocs, Time, Percent}, IntervalType one of{NumDocs, Time, Percent}, Interval :integer, ClientData :string) :Monitor
MonitorProgress (Monitor, DCIName :string, Status: integer, MaxStatus :integer, Type :one of(numDocs, Time, Percent}) :Boolean

Class QueryCollectionIndex

Operations

AddQuery (QueryCollectionIndex, RoutingQuery)
Close (object: QueryCollectionIndex)
CreateQueryCollectionIndex (name: string): QueryCollectionIndex
Destroy (name: string)
GetName (QueryCollectionIndex): string
OpenQueryCollectionIndex (name: string): QueryCollectionIndex
RemoveQuery (QueryCollectionIndex, RoutingQuery)
RetrieveQueries (sequence of QueryCollectionIndex, Document, NumberToRetrieve: integer): DetectionNeedcollection
Sync (object: QueryCollectionIndex)

Class RetrievalQuery

Operations

UpdateUsingRelevanceFeedback(RetrievalQuery, relevant_docs: Collection, sequence of
GetDetectionNeed (RetrievalQuery): DocumentReference
RetrievalQueryFromRelevanceJudgements (relevant_docs: Collection, sequence of DocumentCollectionIndex, DetectionNeed): RetrievalQuery
ScoreDocuments (Collection, RetrievalQuery)
UpdateUsingRelevanceFeedback (RetrievalQuery, relevant_docs: Collection, sequence of DocumentCollectionIndex): RetrievalQuery

Class RoutingQuery

Operations

GetDetectionNeed (RoutingQuery): DocumentReference
RoutingQueryFromRelevanceJudgments (relevant_docs: Collection, sequence of DocumentCollectionIndex, DetectionNeed): RoutingQuery

UpdateUsingRelevanceFeedback (RoutingQuery, relevant_docs: Collection, sequence of DocumentCollectionIndex): RoutingQuery

Class Span

Operations

CreateSpan (start: integer, end: integer): Span
GetEnd (Span): integer
GetStart (Span): integer

APPENDIX C C LANGUAGE HEADER FILE

This appendix shows the C language header file corresponding to the classes defined in the TIPSTER Architecture.

Each concrete TIPSTER class has been mapped into a C language type of the same name. However, classes. *DetectionNeed, DetectionQuery*, and *DetectionNeedCollection,* are not realized as separate C language types. The first two are subtypes of Document in the Architecture, and are treated as instances of the *Document* type; the last is a subtype of Collection, and is treated as a *Collection* in the C language specifications.

Any functional argument which can be of more than one TIPSTER class is declared of type **void*** in the C-language declarations (however, arguments which can either point to an object of class **X** or be **NULL** are declared as being of class X).

Instances of such overloading, and instances where a specific TIPSTER class is represented by a more general C type (e.g., DetectionNeed by Document) are noted in comments immediately preceding the function type declaration.

```
/* Tipster Architecture header file (tipster.h) */

typedef char* tip_string;

typedef int tip_integer;

typedef int tip_Boolean

enum tip_AttributeValueType {STRING, SEQUENCE, COLLECTION_REFERENCE,
    DOCUMENT_REFERENCE, ANNOTATION_REFERENCE,   ATTRIBUTE_REFERENCE};

typedef void* tip_Annotation;

typedef void* tip_AnnotationReference;

typedef void* tip_AnnotationSet;

typedef void* tip_Attribute;

typedef void* tip_AttributeReference;

typedef void* tip_AttributeSet;

typedef void* tip_AttributeValue;

typedef void* tip_AttributeValueSet;

typedef void* tip_ByteSequence;

typedef void* tip_Collection;

typedef void* tip_CollectionReference;

typedef void* tip_Document;

typedef void* tip_DocumentCollectionIndex;

typedef void* tip_DocumentCollectionIndexSet;

typedef void* tip_DocumentReference;

typedef void* tip_Monitor;

typedef void* tip_QueryCollectionIndex;

typedef void* tip_QueryCollectionIndexSet;

typedef void* tip_RetrievalQuery;

typedef void* tip_RoutingQuery;

typedef void* tip_Span;
```

```
typedef void* tip_SpanSet;
typedef void* tip_stringSet;

void tip_Free(void*);

tip_string tip_AddAnnotation(tip_Document, tip_Annotation);

void tip_AddQuery(tip_QueryCollectionIndex, tip_RoutingQuery);

void tip_Annotate(tip_Document, tip_string);

void tip_AnnotateCollection(tip_Collection, tip_Collection,
      tip_string);

/* Type of argument 1 of AnnotationsAt can be  tip_Document or
tip_AnnotationSet  */
tip_AnnotationSet tip_AnnotationsAt(void*, tip_integer);

void tip_Augment(tip_DocumentCollectionIndex, tip_Collection);

/* Type of argument 1 of Close can be tip_QueryCollectionIndex or
tip_Collection or tip_DocumentCollectionIndex  */
void tip_Close(void*);

tip_string tip_ConvertToString(tip_ByteSequence);

tip_Document tip_CopyBareDocument(tip_Collection, tip_Document);

tip_Document tip_CopyDocument(tip_Collection, tip_Document);

tip_Annotation tip_CreateAnnotation(tip_string, tip_SpanSet,
      tip_AttributeSet);

tip_AnnotationReference tip_CreateAnnotationReference(tip_Document,
      tip_Annotation);

tip_AnnotationSet tip_CreateAnnotationSet(void);

tip_Attribute tip_CreateAttribute(tip_string, tip_AttributeValue);
```

```
/* Type of argument 2 of CreateAttributeValue can be tip_string or tip_CollectionReference or
tip_DocumentReference or tip_AttributeReference or tip_AnnotationReference or tip_AttributeValueSet  */
tip_AttributeValue tip_CreateAttributeValue (enum tip_AttributeValueType, void*)

tip_AttributeReference tip_CreateAttributeReference(tip_Document,
      tip_string);


tip_AttributeSet tip_CreateAttributeSet(void);


tip_AttributeValueSet tip_CreateAttributeValueSet(void);


tip_ByteSequence tip_CreateByteSequence(tip_string);


tip_Collection tip_CreateCollection(tip_string, tip_AttributeSet);


tip_CollectionReference tip_CreateCollectionReference(tip_Collection);


tip_Document tip_CreateDocument(tip_Collection, tip_string,
      tip_ByteSequence, tip_AnnotationSet, tip_AttributeSet);


tip_DocumentCollectionIndex


tip_CreateDocumentCollectionIndex(tip_string);


tip_DocumentCollectionIndexSet
      tip_CreateDocumentCollectionIndexSet(void);


tip_DocumentReference tip_CreateDocumentReference(tip_Document);


tip_QueryCollectionIndex tip_CreateQueryCollectionIndex(tip_string);


tip_QueryCollectionIndexSet tip_CreateQueryCollectionIndexSet(void);


tip_Span tip_CreateSpan(tip_integer, tip_integer);


tip_SpanSet tip_CreateSpanSet(void);


tip_Collection tip_CreateVolatileCollection(tip_AttributeSet);
```

```
tip_stringSet tip_CreatestringSet(void);


/* Type of argument 1 of DeleteAnnotations can be tip_Document or
tip_AnnotationSet */
/* Type of argument 2 of DeleteAnnotations can be tip_string or NULL */
void tip_DeleteAnnotations(void*, tip_string, tip_AttributeSet);


void tip_Destroy(tip_string);


/* tip_Document as argument 1 represents Tipster class DetectionQuery
*/
void tip_EditQuery(tip_Document);


/* Result of FirstDocument can be tip_Document or NULL */
tip_Document tip_FirstDocument(tip_Collection);


/* tip_Document as argument 1 represents Tipster class DetectionQuery */
tip_RetrievalQuery tip_FormRetrievalQuery(tip_Document,
      tip_DocumentCollectionIndexSet);


/* tip_Document as argument 1 represents Tipster class DetectionQuery */
tip_RoutingQuery tip_FormRoutingQuery(tip_Document,
      tip_DocumentCollectionIndexSet);


/* Type of argument 1 of GetAnnotation can be tip_Document or
tip_AnnotationSet */
tip_Annotation tip_GetAnnotation(void*, tip_string);


tip_string tip_GetAnnotationId(tip_AnnotationReference);


tip_AnnotationSet tip_GetAnnotations(tip_Document);


/* Result of GetAttribute can be NULL or tip_AttributeValue */
/* Type of argument 1 of GetAttribute can be tip_Annotation or
tip_Collection or tip_Document */
tip_AttributeValue tip_GetAttribute(void*, tip_string);


tip_string tip_GetAttributeName(tip_AttributeReference);


/* Type of argument 1 of GetAttributes can be tip_Annotation or
```

```
tip_Collection or tip_Document  */
tip_AttributeSet tip_GetAttributes(void*);


/* Result of GetByExternalId can be tip_Document or NULL  */
tip_Document tip_GetByExternalId(tip_Collection, tip_string);


/* Type of argument 1 of GetCollectionName can be
tip_AnnotationReference or tip_AttributeReference or
tip_DocumentReference or tip_CollectionReference  */
tip_string tip_GetCollectionName(void*);


/* tip_Document as argument 1 represents Tipster class DetectionQuery  */
/* Type of argument 1 of GetDetectionNeed can be tip_RoutingQuery or
tip_RetrievalQuery or tip_Document*/
tip_DocumentReference tip_GetDetectionNeed(void*);


/* Result of GetDocument can be  tip_Document or NULL  */
tip_Document tip_GetDocument(tip_Collection, tip_string);


/* Type of argument 1 of GetDocumentId can be tip_DocumentReference or
tip_AnnotationReference or tip_AttributeReference  */
tip_string tip_GetDocumentId(void*);


tip_integer tip_GetEnd(tip_Span);


tip_string tip_GetExternalId(tip_Document);


/* Type of argument 1 of GetId can be tip_Annotation or tip_Document  */
tip_string tip_GetId(void*);


/* Type of argument 1 of GetName can be tip_Collection or
tip_DocumentCollectionIndex or tip_QueryCollectionIndex or
tip_Attribute  */
tip_string tip_GetName(void*);


tip_string tip_GetOwner(tip_Collection);


tip_Collection tip_GetParent(tip_Document);


tip_ByteSequence tip_GetRawData(tip_Document);
```

```
tip_SpanSet tip_GetSpans(tip_Annotation);


tip_integer tip_GetStart(tip_Span);


tip_string tip_GetType(tip_Annotation);


/* Result of GetValue can be  tip_AttributeReference or
tip_AnnotationReference or tip_AttributeValueSet or tip_AttributeValue
or tip_string or tip_CollectionReference or tip_DocumentReference  */
/* Type of argument 1 of GetValue can be  tip_AttributeValue or
tip_Attribute  */
void* tip_GetValue(void*);


/* Type of argument 1 of Length can be  tip_Collection or tip_SpanSet
or tip_DocumentCollectionIndexSet or tip_AttributeSet or
tip_ByteSequence or tip_AnnotationSet or tip_stringSet or
tip_AttributeValueSet or tip_QueryCollectionIndexSet  */
tip_integer tip_Length(void*);


tip_AnnotationSet tip_MergeAnnotations(tip_AnnotationSet,
      tip_AnnotationSet);


/* Type of argument 1 of NextAnnotations can be  tip_Document or
tip_AnnotationSet  */
tip_AnnotationSet tip_NextAnnotations(void*, tip_integer);


/* Result of NextDocument can be  tip_Document or NULL  */
tip_Document tip_NextDocument(tip_Collection);


/* Result of Nth can be tip_DocumentCollectionIndex or tip_Attribute
or tip_Annotation or tip_string or tip_AttributeValue or
tip_QueryCollectionIndex or tip_Span  */
/* Type of argument 1 of Nth can be  tip_DocumentCollectionIndexSet or
tip_AttributeSet or tip_AnnotationSet or tip_stringSet or
tip_AttributeValueSet or tip_QueryCollectionIndexSet or tip_SpanSet  */
void* tip_Nth(void*, tip_integer);


tip_Collection tip_OpenCollection(tip_string);


tip_DocumentCollectionIndex
      tip_OpenDocumentCollectionIndex(tip_string);


tip_QueryCollectionIndex tip_OpenQueryCollectionIndex(tip_string);
```

```
/* Result of Pop can be  tip_Attribute or tip_string or
tip_AttributeValue or tip_QueryCollectionIndex or tip_Span or
tip_DocumentCollectionIndex  */
/* Type of argument 1 of Pop can be  tip_AttributeSet or tip_stringSet
or tip_AttributeValueSet or tip_QueryCollectionIndexSet or tip_SpanSet
or tip_DocumentCollectionIndexSet  */
void* tip_Pop(void*);


/* Type of argument 1 of Push can be  tip_AttributeSet or tip_stringSet
or tip_AttributeValueSet or tip_QueryCollectionIndexSet or tip_SpanSet
or tip_DocumentCollectionIndexSet  */
/* Type of argument 2 of Push can be  tip_Attribute or tip_string or
tip_AttributeValue or tip_QueryCollectionIndex or tip_Span or
tip_DocumentCollectionIndex  */
void tip_Push(void*, void*);


/* Type of argument 1 of PutAttribute can be  tip_Annotation or
tip_Collection or tip_Document  */
void tip_PutAttribute(void*, tip_string, tip_AttributeValue);


/* tip_Document as result  represents Tipster class DetectionQuery  */
/* tip_Document as argument 1 represents Tipster class DetectionNeed  */
tip_Document tip_QueryGenerator(tip_Document);


tip_Document tip_ReadSGML(tip_string, tip_Collection, tip_string);


/*Type of argument 1 of RemoveAttribute can be tip_Collection OR tip_Document OR tip_Annotation  */
void tip_RemoveAttribute (void*, tip_string)


/* Type of argument 1 of RemoveAnnotation can be  tip_Document or
tip_AnnotationSet  */
void tip_RemoveAnnotation(void*, tip_string);


void tip_RemoveDocument(tip_Collection, tip_string);


void tip_RemoveQuery(tip_QueryCollectionIndex, tip_RoutingQuery);


/* tip_Document as argument 3 represents Tipster class DetectionNeed  */
tip_RetrievalQuery
      tip_RetrievalQueryFromRelevanceJudgements(tip_Collection,
      tip_DocumentCollectionIndexSet, tip_Document);


tip_Collection tip_RetrieveDocuments(tip_DocumentCollectionIndexSet,
```

```
    tip_RetrievalQuery, tip_integer);


/* tip_Collection as result  represents Tipster class
DetectionNeedCollection  */
tip_Collection tip_RetrieveQueries(tip_QueryCollectionIndexSet,
    tip_Document, tip_integer);


/* tip_Document as argument 3 represents Tipster class DetectionNeed  */
tip_RoutingQuery
tip_RoutingQueryFromRelevanceJudgements(tip_Collection,
    tip_DocumentCollectionIndexSet, tip_Document);


void tip_ScoreDocuments(tip_Collection, tip_RetrievalQuery);


/* Type of argument 1 of SelectAnnotations can be  tip_Document or
tip_AnnotationSet  */
/* Type of argument 2 of SelectAnnotations can be  tip_string or NULL
*/
tip_AnnotationSet tip_SelectAnnotations(void*, tip_string,
    tip_AttributeSet);


void tip_SetExternalId(tip_Document, tip_string);


void tip_SetOwner(tip_Collection, tip_string);


/* Type of argument 1 of Sync can be  tip_QueryCollectionIndex or
tip_Collection or tip_DocumentCollectionIndex  */
void tip_Sync(void*);


enum tip_AttributeValueType tip_TypeOf(tip_AttributeValue);


/* Result of UpdateUsingRelevanceFeedback can be  tip_RoutingQuery or
tip_RetrievalQuery  */
/* Type of argument 1 of UpdateUsingRelevanceFeedback can be
tip_RoutingQuery or tip_RetrievalQuery  */
void* tip_UpdateUsingRelevanceFeedback(void*, tip_Collection,
    tip_DocumentCollectionIndexSet);


tip_string tip_WriteSGML(tip_Document, tip_AnnotationSet,
    tip_stringSet);

/*Arguments 1 & 2 of CreateMonitor can be number of documents, seconds, percent*/
tip_Monitor tip_CreateMonitor(tip_integer, tip_integer, tip_integer, tip_string);
```

```
/*Argument 4 of MonitorProgress can be number of documents, seconds, percent*/
    tip_Boolean MonitorProgress(tip_Monitor, tip_string, tip_integer, tip_integer);
```