

# Package ‘RWebServices’

March 26, 2013

**Type** Package

**Title** Expose R functions as web services through Java/Axis/Apache

**Version** 1.22.0

**Author** Nianhua Li, MT Morgan

**Maintainer** Martin Morgan <mtmorgan@fhcrc.org>

**Description** This package provides mechanisms for automatic function prototyping and exposure of R functionality in a web services environment.

**Depends** SJava (>= 0.69-4), TypeInfo, methods, tools (>= 2.10.0), R (>= 2.5.0)

**Imports** RCurl

**License** file LICENSE

**biocViews** Infrastructure

## R topics documented:

RWebServices-package	2
ArrayAndMatrix-class	2
converters	4
createMap	9
FileReferences	11
FileReferences-class	12
generateDataMap	13
generateDataTest	14
generateFunctionMap	15
getRSessionInfo	16
printLookup	17
register-converters	17
retrieve-methods	18
RJavaPkgFunctions-class	19
RJavaSignature-class	20
SinkOutput-class	21
sinkSetup, sinkRetrieve	22
Test utilities	23
typeInfo2Java	23
unpackAntScript	26

**Index**[27](#)


---

RWebServices-package    *Expose R functions as web services through Java/Axis/Apache*

---

**Description**

This package provides mechanisms for automatic function prototyping and exposure of R functionality in a web services environment.

**Details**

Package: RWebServices  
 Type: Package  
 Version: 1.0  
 Date: 2005-12-23  
 License: What license is it under?

**Author(s)**

Written by Nianhua Li, MT Morgan. Maintainer: Robert Gentleman <rgentle@fhcrc.org>

**See Also**

The TypeInfo package.

---

ArrayAndMatrix-class    *Class "NumericMatrix" and friends*

---

**Description**

Classes providing [matrix](#) and [array](#) functionality, but allowing stronger type specification, e.g., NumericMatrix is a matrix whose members must be of type "numeric". A "matrix" is two-dimensional; an "array" is any dimensions, but R treats two-dimensional arrays as "matrix" and one-dimensional arrays as "vector" so "XxxArray" is most useful for specifying arrays with greater than 2 dimensions.

Available classes are "RawMatrix" "CharMatrix" "LogicalMatrix" "IntegerMatrix" "NumericMatrix" "ComplexMatrix" "RawArray" "CharArray" "LogicalArray" "IntegerArray" "NumericArray" "ComplexArray".

**Details**

The following illustrates how to use these classes in R and Java, using NumericMatrix as an example.

The examples assume that mapping between R and Java uses the "javalib" type mode.

Suppose you would like an R function to return a matrix of numeric (double) values, and that you are using the “javalib” mode for mapping between R and Java (typeMode=“javalib” in `createMap`, or typemode=javalib in the ant configuration file `RWebServicesTuning.properties`). For this type mode, specifying “matrix” as a return type is insufficient: a matrix could contain any basic type (raw, character, integer, double, complex, etc.), so there is not enough information to map to a Java object. The solution is to specify more clearly what the type of the return value is, for instance, if the return type is a matrix of numeric (double) values, then arrange for the function to return an object of class `NumericMatrix`.

In R the basic properties of `NumericMatrix` can be seen here:

```
> nm=new("NumericMatrix", matrix(as.double(50:1),10,5))
> dim(nm)
[1] 10 5
> nm[7,3]
[1] 24
> as.vector(nm)
 [1] 50 49 48 47 46 45 44 43 42 41 40 39 38 37 36 35 34 33
[19] 32 31 30 29 28 27 26 25 24 23 22 21 20 19 18 17 16 15
[37] 14 13 12 11 10 9 8 7 6 5 4 3 2 1
> as.vector(nm)[(3-1)*nrow(nm)+7]
[1] 24
```

The last line is meant to illustrate that the ‘matrix’ data in R is stored as a single vector, in ‘column-major’ order, i.e., elements `1:nrow(nm)` are the first column, `(nrow(nm)+1):(2*nrow(nm))` are the second column, etc.

In Java, `dim=getDim()` returns an `int[]`, containing the number of rows and the number of columns, e.g., `int[] = {10, 5}` for the example above of columns in the matrix (like `dim()` would do on a matrix in R).

`value=getValue()` will return `double[]`, containing all the data, like the result of `as.vector` above. Remembering that Java starts indexing at 0, we can get the element in row `i` and column `j` as

```
value[i * dim[0] + j]
```

We (or you) could write methods `getMatrix / setMatrix` returning / taking `double[][]` to do this, or `getElement / setElement` to access specific elements; it’s worthwhile remembering that this does require quite a bit of memory allocation (for big arrays), so in some ways it’s better to force the client to just give the data in the expected format anyway.

### Objects from the Class

Objects can be created by calls of the form `new("NumericMatrix",...)`. To create an instance from an existing, untyped, “matrix” or “array”, use forms like `new("NumericMatrix", m)` or `unclass` and update the mode of the object. See examples for additional detail.

### Slots

None.

### Extends

Class “matrix”, from data part. Class “structure”, by class “matrix”, distance 2. Class “array”, by class “matrix”, distance 2. Class “vector”, by class “matrix”, distance 3, with explicit coerce. Class “vector”, by class “matrix”, distance 4, with explicit coerce.

**Methods**

Use "NumericMatrix" and friends as replacements for "matrix" or "array".

**Author(s)**

Martin Morgan <mtmorgan@fhcrc.rog

**Examples**

```
## creating an empty instance
obj <- new("ComplexMatrix")
obj
mode(obj)
## Converting between array and typed Array
new("RawArray", array(raw(), dim=c(5,2,3)))

## Converting between types
obj <- new("NumericMatrix", matrix(numeric()))
obj <- unclass(obj)           # retrieve underlying matrix
mode(obj) <- "raw"
obj <- new("RawMatrix", obj)
validObject(obj)
obj
```

---

converters

*Convert between R objects and their Java representation.*

---

**Description**

These functions are not intended for the end user. They are used to match objects being translated between R and Java to functions that perform the conversion. They are useful for understanding the overall conversion process, and as examples for writing custom conversions.

**Usage**

```
# 'object' converters
cvtCharacterFromJava(x, thisClassName)
cvtCharacterToJava(x, ...)
matchCharacterToJava(x, ...)

cvtIntegerFromJava(x, thisClassName)
cvtIntegerToJava(x, ...)
matchIntegerToJava(x, ...)

cvtLogicalFromJava(x, thisClassName)
cvtLogicalToJava(x, ...)
matchLogicalToJava(x, ...)

cvtNumericFromJava(x, thisClassName)
cvtNumericToJava(x, ...)
matchNumericToJava(x, ...)
```

```
cvtRawFromJava(x, thisClassName)
cvtRawToJava(x, ...)
matchRawToJava(x, ...)

cvtComplexFromJava(x, thisClassName)
cvtComplexToJava(x, ...)
matchComplexToJava(x, ...)

cvtVectorFromJava(x, thisClassName)
cvtVectorToJava(x, ...)
matchVectorToJava(x, ...)

cvtListFromJava(x, thisClassName)
cvtListToJava(x, ...)
matchListToJava(x, ...)

cvtArrayFromJava(x, thisClassName)
cvtArrayToJava(x, ...)
matchArrayToJava(x, ...)

cvtMatrixFromJava(x, thisClassName)
cvtMatrixToJava(x, ...)
matchMatrixToJava(x, ...)

cvtFactorFromJava(x, thisClassName)
cvtFactorToJava(x, ...)
matchFactorToJava(x, ...)

cvtDataFrameFromJava(x, thisClassName)
cvtDataFrameToJava(x, ...)
matchDataFrameToJava(x, ...)

cvtEnvFromJava(x, thisClassName)
cvtEnvToJava(x, ...)
matchEnvToJava(x, ...)

cvtUnknownFromJava(x, thisClassName)
cvtUnknownToJava(x, ...)
matchUnknownToJava(x, ...)

cvtFileReferencesFromJava(x, thisClassName)
cvtFileReferencesToJava(x, ...)
matchFileReferencesToJava(x, ...)

## 'javalib' converters
cvtCharacterToJava2(x, ...)
matchCharacterToJava2(x, ...)

cvtIntegerToJava2(x, ...)
matchIntegerToJava2(x, ...)

cvtLogicalToJava2(x, ...)
```

matchLogicalToJava2(x, ...)

cvtNumericToJava2(x, ...)  
matchNumericToJava2(x, ...)

cvtRawToJava2(x, ...)  
matchRawToJava2(x, ...)

cvtComplexFromJava2(x, thisClassName)  
cvtComplexToJava2(x, ...)  
matchComplexToJava2(x, ...)

cvtListToJava2(x, ...)  
matchListToJava2(x, ...)

cvtFactorFromJava2(x, thisClassName)  
cvtFactorToJava2(x, ...)  
matchFactorToJava2(x, ...)

cvtDataFrameFromJava2(x, thisClassName)  
cvtDataFrameToJava2(x, ...)  
matchDataFrameToJava2(x, ...)

cvtCharArrayFromJava2(x, thisClassName)  
cvtCharArrayToJava2(x, ...)  
matchCharArrayToJava2(x, ...)

cvtIntegerArrayFromJava2(x, thisClassName)  
cvtIntegerArrayToJava2(x, ...)  
matchIntegerArrayToJava2(x, ...)

cvtNumericArrayFromJava2(x, thisClassName)  
cvtNumericArrayToJava2(x, ...)  
matchNumericArrayToJava2(x, ...)

cvtLogicalArrayFromJava2(x, thisClassName)  
cvtLogicalArrayToJava2(x, ...)  
matchLogicalArrayToJava2(x, ...)

cvtRawArrayFromJava2(x, thisClassName)  
cvtRawArrayToJava2(x, ...)  
matchRawArrayToJava2(x, ...)

cvtComplexArrayFromJava2(x, thisClassName)  
cvtComplexArrayToJava2(x, ...)  
matchComplexArrayToJava2(x, ...)

cvtCharMatrixFromJava2(x, thisClassName)  
cvtCharMatrixToJava2(x, ...)  
matchCharMatrixToJava2(x, ...)

cvtIntegerMatrixFromJava2(x, thisClassName)

```

cvtIntegerMatrixToJava2(x, ...)
matchIntegerMatrixToJava2(x, ...)

cvtNumericMatrixFromJava2(x, thisClassName)
cvtNumericMatrixToJava2(x, ...)
matchNumericMatrixToJava2(x, ...)

cvtLogicalMatrixFromJava2(x, thisClassName)
cvtLogicalMatrixToJava2(x, ...)
matchLogicalMatrixToJava2(x, ...)

cvtRawMatrixFromJava2(x, thisClassName)
cvtRawMatrixToJava2(x, ...)
matchRawMatrixToJava2(x, ...)

cvtComplexMatrixFromJava2(x, thisClassName)
cvtComplexMatrixToJava2(x, ...)
matchComplexMatrixToJava2(x, ...)

cvtEnvFromJava2(x, thisClassName)
cvtEnvToJava2(x, ...)
matchEnvToJava2(x, ...)

cvtFileReferencesFromJava2(x, thisClassName)
cvtFileReferencesToJava2(x, ...)
matchFileReferencesToJava2(x, ...)

```

### Arguments

x	Either a reference to the Java object to be converted (e.g. <code>cvtArrayFromJava</code> ), or a R object.
...	Additional arguments passed to SJava
thisClassName	Character representation of the class of the Java object that x refers to.

### Details

The `cvt*` functions take an instance of an object of one language (R or Java) and convert it to an instance of the other language.

The `match*` functions take an instance of an object, and return a logical indicating whether the match criterion is satisfied.

The convention used in RWebServices is to name the functions as `<RObject>ToJava` or `<RObject>FromJava`.

RWebServices installs one of two types of converters. The the function `regAddonCvt` installs converters for the ‘object’ model, where R objects are represented in a hierarchy of Java objects that attempt to capture important attributes of the R instances. The mapping is as follows:

R	Java
raw	RRaw
logical	RLogical
character	RChar
integer	RInteger
numeric	RNumeric
complex	RComplex

list	RList
factor	RFactor
data.frame	RDataFrame
environment	REnvironment
array	RArray
matrix	RMatrix
'other'	RUnknown

The 'other' converter is invoked when no other converter matches. `cvtUnknownToJava` creates an instance of the Java class `rservices.RUnknown` to hold the class, length, and string representation (i.e., the result of `print`) of the contents of the R object. `cvtUnknownFromJava` converts `rservices.RUnknown` instance to a R S4 instance if the original R object is a S4 instance, otherwise the function returns a list with the same class and length as the original R object. This is likely to be very unsatisfactory.

The function `regAddonCvt2` installs converters for the 'javalib' model, where R objects are represented by Java primitive types where possible; NA values are not permitted. The mapping is as follows:

R	Java
raw	byte[]
logical	boolean[]
character	String[]
integer	int[]
numeric	double[]
complex	RJComplex
list	Object[]
factor	RJFactor
data.frame	RJDataFrame
environment	java.util.HashMap
'*'Array,	RJ'*'Array
'*'Matrix,	RJ'*'Matrix
FileReferences	RJFileReferences

The '\*'Array and '\*'Matrix and array entries represent instances of the `ArrayAndMatrix-class`, which provide strong type information about the type of elements (raw, logical, character, integer, numeric, complex) in arrays and matrices.

## Value

The `cvt*ToJava` functions return references to Java objects. The `cvt*FromJava` functions return instances of R objects. `match*` return TRUE when the match criterion is satisfied, FALSE otherwise.

## Author(s)

Nianhua Li

## References

<http://www.omegahat.org/RSJava/index.html>



**See Also**

[setJavaFunctionConverter](#), [regAddonCvt](#), [regAddonCvt2](#)

---

createMap

*Create Java function signatures from R functions*

---

**Description**

createMap extracts type information from R function definitions, and uses this to create Java-style function calls with appropriately typed arguments. Types are then converted to Java objects.

A side effect is to create or modify a directory structure in the current working directory containing Java class information.

There are three methods defined:

createMap(standardGeneric, missing, ...) Intended to dispatch on S4 generics, creating maps for all currently visible methods.

createMap(character, missing, ...) Intended to dispatch on a character vector of function names, creating maps for each function.

createMap(missing, pkgs=character, ...) Intended to map all functions in pkgs with typeInfo applied. pkgs can be a character vector of package names, or in conjunction with the argument splitPkgsToVector=TRUE a comma-delimited list of packages. The latter behavior is meant to facilitate use with the ant command line, as ant -Dpkg=caDNAcopy,caPROcess gen-map-from-package.

**Usage**

```
createMap(funcs, pkgs, generateTests = TRUE,
          outputDirectory = stop("specify outputDirectory"),
          typeMode = "javalib", deployMode = "jms",
          verbose = FALSE, ...)
## S4 method for signature 'missing,character'
createMap(funcs, pkgs, generateTests = TRUE,
          outputDirectory = stop("specify outputDirectory"),
          typeMode = "javalib", deployMode = "jms",
          verbose = FALSE, splitPkgsToVector=TRUE, ...,
          extraClasses=character())
```

**Arguments**

funcs	Function or list of functions with typeInfo already applied, or S4 generic method.
pkgs	Character string or vector of package names. Package namespaces are parsed for functions with TypeInfo, and R-Java maps are created for these.
generateTests	Logical. Should test code be generated?
outputDirectory	Directory where Java hierarchy will be created.
typeMode	Character, either "robject" or "javalib". How Java objects should be generated; see <a href="#">generateDataMap</a> and <a href="#">converters</a> . typemode may be over-written by values in system.file("rservices", "properties.R", package=pkg).
deployMode	Character, either "demo" or "jms". How the service will be deployed. "demo" is no longer supported.

verbose	Print information during mapping generation; useful for debugging.
...	Additional arguments, e.g., <code>S4DefaultTypedSig</code> used for providing type specifications for S4 functions when <code>functns</code> is of class <code>standardGeneric</code> , or <code>splitPkgsToVector=TRUE</code> to treat <code>pkgs</code> as a comma-delimited list of packages.
<code>splitPkgsToVector</code>	Parse <code>character(1) pkgs</code> as <code>split(pkgs, ",")</code> , primarily for ant-based integration.
<code>extraClasses</code>	A character vector of extra classes to map, in addition to those specified in the <code>TypeInfo</code> signature. <code>extraClasses</code> for this method are augmented by any classes defined in the file <code>system.file("rservices","properties.R", package=pkg)</code> .

## Details

`createMap` operates either on functions with [typeInfo](#) applied, or on S4 generic methods.

Some coercion occurs with `typeInfo` functions. All signatures have an explicit return type. [IndependentTypeSpecification](#) classes are 'expanded' to a complete set of typed signatures.

Function signatures for S4 methods are created from information used in generic method construction, supplemented by an optional default type signature supplied as a named argument `S4DefaultTypedSig`. Each method defined for a generic results in a Java signature. Arguments used for method dispatch are typed according to the dispatch rules for the function. Return types are determined by the `valueClass` of the generic (the `valueClass` of methods seem not to be defined, despite what the documentation indicates). Default values for other arguments, and for return values if `valueClass` is not used, can be created with a [TypedSignature](#) passed as a named argument `S4DefaultTypedSig`. Values implied by S4 method definitions override the defaults.

See [typeInfo2Java](#) for additional information on how conversion occurs.

## Value

Primarily invokes for the side-effect of creating a Java class hierarchy reflecting the data and methods present in the call to `createMap`. Returns a list of Java signatures function definitions..

## Author(s)

Martin Morgan <[mtmorgan@fhcrc.org](mailto:mtmorgan@fhcrc.org)>

## See Also

[createMap,missing,character-method](#)

## Examples

```
library(RWebServices)

## S4
## Not run:
setClass("A", representation(x="character"))
setGeneric("foo", function(obj) standardGeneric("foo"))
setMethod("foo", "numeric", function(obj) new("A", x=as.character(obj)))
setMethod("foo", "character", function(obj) new("A", x=obj))

createMap(foo, outputDirectory=tempdir(), S4DefaultTypedSig=TypedSignature(returnType="A"))
```

```
## End(Not run)
```

---

FileReferences

*FileReferences constructor and accessors*


---

## Description

Functions for creating and manipulating FileReferences-class objects.

## Usage

```
FileReferences(urls = character(), localNames = basename(urls),
              types = character(length(urls)), ...)
urls(object, ...)
localNames(object, ...)
types(object, ...)
## S4 method for signature 'FileReferences'
length(x)
```

## Arguments

urls	A character vector of urls of the files to be referenced. The urls are the actual locations of the files.
localNames	A (optional) character vector of local names of the files to be references. Local names are the names used to refer to the files internally, e.g., by functions wanting to use file names as a label for data frame rows. The length of the local names argument must match that of the urls; the default is to take the file name portion of the url as the local name.
types	A (optional) character vector of length equal to that of the urls, containing the type each file represents. Type might normally come from a controlled vocabulary; the default is a length zero character string, representing an unspecified type.
object	An object of class FileReferences, from which urls, local names, or types are to be extracted.
x	An object of class FileReferences, from which the length (number of file references) is to be determined.
...	Additional arguments, passed to the class initialization method or (currently) ignored by the accessors.

## Value

FileReferences	Object of class <a href="#">FileReferences</a> .
urls, localNames, types	character vector of urls, local names, or file types.
length	integer scalar of the number of references in the object.

**Author(s)**

Martin Morgan [mtmorgan@fhcrc.org](mailto:mtmorgan@fhcrc.org)

**See Also**

[FileReferences-class](#)

**Examples**

```
obj <- FileReferences(c("/foo/bar", "/foo/baz"), type=rep("CEL", 2))
localNames(obj)
length(obj)
```

---

FileReferences-class	<i>Class "FileReferences"</i>
----------------------	-------------------------------

---

**Description**

FileReferences represents a collection of urls at which files can be referenced, the local names by which the files are to be referred to (to allow the file name portion of the url to differ from the name used to refer to the file), and the types (e.g., CEL, xls, etc.) of the files.

**Objects from the Class**

Objects can be created by calls to the constructor [FileReferences](#). Objects are constructed with equal-length character vectors.

Elements can be accessed with [urls](#), [localNames](#), and [types](#).

**Slots**

**urls:** Object of class "character" containing the urls where the files can be located

**localNames:** Object of class "character" containing the local names by which the files will be referred.

**types:** Object of class "character" containing information on the file 'type', for instance indicating that the files are CEL files (for gene expression analysis). Usually file types will be from a controlled vocabulary of types defined elsewhere.

**Methods**

See [FileReferences](#)

**Author(s)**

Martin Morgan [mtmorgan@fhcrc.org](mailto:mtmorgan@fhcrc.org)

**See Also**

[FileReferences](#) for object construction, accessors [urls](#), [localNames](#), and [types](#)

**Examples**

```
showClass("FileReferences")
FileReferences()
```

---

generateDataMap      *Create java beans and mapping functions for a R data type*

---

### Description

The generateDataMap function generates java beans and R–Java data type conversions for a R data type if they are not available in the environment lookup. All java mappings are output as files under CurrentWorkingDir/biocJavaMap, where CurrentWorkingDir is the result of getwd(). This function also updates environments lookup and cvtImport (see arguments below) as a side effect.

### Usage

```
generateDataMap(rType, javaToR, deployMode, typeMode, lookup)
```

### Arguments

rType	a character vector containing a R data type name. The data type is either a S4 class or a ClassUnion.
javaToR	logical, TRUE if want to convert Java data to R, FALSE if want to convert R data to Java.
deployMode	Character, either "demo" or "jms". How the service will be deployed. "demo" is no longer supported.
typeMode	Character, either "robject" or "javalib". How Java objects should be generated; see <a href="#">generateDataMap</a> and <a href="#">converters</a>
lookup	environment, key is rType, value is of type RJMap. RJMap provides the java type, java package, and java–R conversion function names for the key. By default, lookup only contains mapping information for vector, list, factor, data frame, array, matrix, environment and NULL

### Value

returns updated environment lookup.

### Author(s)

Nianhua Li

### See Also

[printLookup](#)

### Examples

```
## used internally
```

---

generateDataTest	<i>Create a Java program to test R - Java data type mapping</i>
------------------	---

---

### Description

The generateDataTest function is used to validate the results of function [generateDataMap](#). Given the name of a R data type, and the lookup environment updated by generateDataMap, function generateDataTest creates a test program in Java. The test program creates a java companion of the R data type, converts it to the R data type, and converts it back to Java. This round-trip can test both the Java bean and the convert functions.

### Usage

```
generateDataTest(mainServ, mainPkg, lookup, addonType, verbose)
```

### Arguments

mainServ	Name of web service; used to generate class name and properties files.
mainPkg	Package name, used in Java package hierarchy and usually the same as the R package name where the data object is defined.
lookup	environment containing mapping between R and Java types; see <a href="#">generateDataMap</a>
addonType	character. Additional types required for creating the data test, e.g., to test conversion of an R list containing particular S4 classes requires that the particular classes be named as addonType.
verbose	logical. Report progress to console?

### Value

returns NULL.

### Author(s)

Nianhua Li

### See Also

[generateDataMap](#)

### Examples

```
## see '?generateDataMap' for an example of generating java test program
```

---

generateFunctionMap    *Create java wrapper functions for a list of R functions*

---

### Description

The generateFunctionMap function generates java wrapper functions for a list of R functions. It also generates java beans and R–Java data type conversions for any R data types that are related to the function but unavailable in the environment lookup. This function also updates environments lookup and cvtImport (see arguments below) as a side effect.

### Usage

```
generateFunctionMap(rTypeInfo, genTest = TRUE, workDir = getwd(),
  verbose = FALSE,
  deployModeName = "jms", typeModeName = "javalib",
  wsdlStyle = "WRAPPED", wsdlUse = "LITERAL",
  extraClasses = "", pkgRoot="org.bioconductor", ...)
```

### Arguments

rTypeInfo	a list, each component is an instance of <a href="#">RJavaSignature-class</a> and represents the signature of a R function.
genTest	logical, TRUE if want to generate a java program to test the java wrapper functions generated by generateFunctionMap, FALSE otherwise.
workDir	a character string, the path of the directory where this function generates all its outputs.
verbose	logical, TRUE if want to print out debug information, FALSE otherwise.
deployModeName	Character, either "demo" or "jms". How the service will be deployed. "demo" is no longer supported.
typeModeName	Character, either "robject" or "javalib". How Java objects should be generated; see <a href="#">generateDataMap</a> and <a href="#">converters</a>
wsdlStyle	Style of wsdl to create. A value of "WRAPPED" adds "_PortType" to the short name of the main service interface; all other values do not add "_PortType".
wsdlUse	Whether SOAP bindings are document/literal (value "LITERAL" or document/encoded (any other value). Only "LITERAL" is currently supported.
extraClasses	character. Extra classes required to convert function argument or return values, e.g., an argument of type list might require information about the classes present in the list. Usually this argument is not required, as S4 classes are parsed to their constituent parts
pkgRoot	character. Root package name of the java classes classes being created. It should be a sequence of one or more character strings delimited by dot, and no dot after the last string
...	Additional arguments, to be compatible with <a href="#">createMap</a> .

**Details**

The java mappings generated under workDir are organized as following:

- biocJavaMap The base directory
- biocJavaMap/package1 Java mappings for functions and data types defined in R package1
- biocJavaMap/package1/data Java beans and java <-> R mapping functions (in R) for data types defined in package1
- biocJavaMap/package1/function Java wrapper functions for functions defined in package1
- biocJavaMap/package2 Java mappings for functions and data types defined in package2
- biocJavaMap/mainService Main java API, which invokes the java mapping functions for package1, package2, etc. mainService value is provided by user as input.

**Value**

A list, each component is an instance of [RJavaSignature-class](#) and represents the signature of a java wrapper function. The return value has a one-to-one mapping relation with input parameter rTypeInfo, i.e. the java wrapper function that is represented by the ith component in the return list, is the wrapper for the R function that is represented by the ith component in rTypeInfo.

**Author(s)**

Nianhua Li

**Examples**

```
## This function is usually invoked by createMap.
```

---

getRSessionInfo

*Report R session information in a web-services friendly format.*

---

**Description**

This function has TypeInfo applied, and so is mapped as a web service in the org.bioconductor.packages.rservices name space.

**Usage**

```
getRSessionInfo(verbose = FALSE)
```

**Arguments**

verbose            A logical(1), with FALSE returning a character vector of packages with (for non-base packages) version number appended and TRUE returning a character vector capturing the output of sessionInfo().

**Value**

A character vector containing information on all attached and loaded packages in the current R session.



**Author(s)**

Martin Morgan [mtmorgan@fhcrc.org](mailto:mtmorgan@fhcrc.org)

**Examples**

```
getRSessionInfo(FALSE)
```

---

printLookup	<i>Print R-Java data type mapping information</i>
-------------	---

---

**Description**

printLookup prints the R-Java data type mapping information.

**Usage**

```
printLookup(lookup, all = TRUE)
```

**Arguments**

lookup	environment, the environment contains the R-Java data type mapping information. It is generated by <a href="#">generateDataMap</a> .
all	logical, FALSE to just print the mappings for user-defined data types, TRUE to print the mappings for basic R data types as well.

**Author(s)**

Nianhua Li

**Examples**

```
# please try the example under examples/s4Map
```

---

register-converters	<i>Load R - Java data converters.</i>
---------------------	---------------------------------------

---

**Description**

When invoking R from Java, data type conversions between R and Java are handled by SJava. But SJava only supports conversions for limited R data types, the conversions for other R data types are specified by user converters and interpreted by SJava. `regAddonCvt` and `regTestCvt` help to load user converters.

**Usage**

```
regAddonCvt()  
regAddonCvt2()  
regTestCvt()
```

## Details

These functions are usually used by the auto-generated codes from [generateFunctionMap](#). Users do not need to deal with them. `regAddonCvt` and `regAddonCvt2` load converters for R character, logical, integer, numeric, raw, complex, array, matrix, data.frame, list, environment, and factor. The `regAddonCvt` converters follow the 'robject' model whereas `regAddonCvt2` follows the 'javalib' model; see [converters](#) for more information. `regTestCvt` are used for low-level testing.

## Author(s)

Nianhua Li

---

retrieve-methods

*Retrieve file references from remote locations*

---

## Description

This method retrieve files referenced by its first argument to locations determined by its second argument. The return value is a [FileReferences](#) object summarizing the destination.

## Usage

```
retrieve(from, to, ...)
```

## Arguments

<code>from</code>	The source from which objects will be retrieved; typically (or exclusively, depending on method) 'remote' locations accessible via, e.g., http.
<code>to</code>	The destination to which files will be copied; typically on the local file system.
<code>...</code>	Additional arguments, passed to the function performing the download.

## Methods

**from = "FileReferences", to = "character"** `from` contains remote urls; files must be retrievable using `getBinaryURL` from the `RCurl` package. ... arguments are passed to `getBinaryURL`. `to` is a directory name to which files will be copied; the directory is created if it does not exist. File names will be unique.

**from = "FileReferences", to = "FileReferences"** `from` is as in `retrieve,FileReferences,character-method`. `to` specifies destination urls; `urls(to)` must have the same number of elements as `urls{from}`, must not already exist on the local file system, and must not require creation of new directories. `localNames` and `types of to` are replaced by corresponding elements from `from`.

**from = "FileReferences", to = "missing"** `from` is as in the `retrieve,FileReferences,character-method`. The destination is created using `tempfile()`, and forwarding this as the second argument to `retrieve,FileReferences,character-method`. The effect is to retrieve files to R's temporary directory; these files will be removed when the R session ends.

**Examples**

```
try({ # fails when no internet available
  from <- FileReferences(c("http://bioconductor.org/biocLite.R",
                          "http://bioconductor.org/index.html"))
  ## to R's temporary directory
  to <- retrieve(from)
  urls(to)
  localNames(to)

  ## tell R where to copy files to
  toDir <- tempfile()
  dir.create(toDir, recursive=TRUE)
  toUrls <- file.path(toDir, localNames(from))
  retrieve(from, FileReferences(toUrls))
  list.files(toDir)
})
```

---

RJavaPkgFunctions-class

*Java signatures derived from R methods*


---

**Description**

Class RJavaPkgFunctions contains elements of Java signatures, including the source R package, the corresponding java class, and type information about the Java function.

Create this class using [createMap](#) or [generateFunctionMap](#).

**Slots**

rPackage Character vector of R source packages  
javaClass Character vector of corresponding Java classes  
javaTypeInfo List of Java function signatures.

**Author(s)**

MT Morgan <mtmorgan@fhcrc.org>

**See Also**

[generateFunctionMap](#), [createMap](#)

**Examples**

```
library(RWebServices)

oneWayAnova <- function( response, predictor ) {
  if ( is.character( predictor ) )
    return( oneWayAnova( response, as.factor( predictor ) ) )
  formula <- as.formula( substitute( response ~ predictor ) )
  result <- lm( formula )
  anova( result )
}
```

```

typeInfo(oneWayAnova) <-
  SimultaneousTypeSpecification(
    TypedSignature(
      response = "numeric",
      predictor = "factor"),
    TypedSignature(
      response = "numeric",
      predictor = "character"),
    returnType = "anova" )

## Not run:
res <- createMap("oneWayAnova", outputDirectory=tempdir(),
typeMode="robjct", verbose=TRUE)

## End(Not run)

```

---

RJavaSignature-class      *String representations of R type signatures from R functions*

---

### Description

Class "RJavaSignature" contains elements of java-style function signature, including return type, function name, and argument names/types

Create this class using [typeInfo2Java](#).

### Slots

**returnType** Character string describing the return type of the function. This must be defined.

**funcName:** Function name as character string.

**args:** Vector of character strings providing argument types. Argument names are stored as name attributes.

### Author(s)

MT Morgan <mtmorgan@fhcrc.org>

### See Also

[link{typeInfo2Java}](#)

### Examples

```

library(RWebServices)

oneWayAnova <- function( response, predictor ) {
  if ( is.character( predictor ))
    return( oneWayAnova( response, as.factor( predictor )))
  formula <- as.formula( substitute( response ~ predictor ))
  result <- lm( formula )
  anova( result )
}

```

```
typeInfo(oneWayAnova) <-  
  SimultaneousTypeSpecification(  
    TypedSignature(  
      response = "numeric",  
      predictor = "factor"),  
    TypedSignature(  
      response = "numeric",  
      predictor = "character"),  
    returnType = "anova" )  
  
res <- typeInfo2Java(oneWayAnova)  
  
res  
  
summary(res)
```

---

SinkOutput-class

*Results captured by calls to sinkSetup and sinkRetrieve*

---

### Description

Create this class using [sinkSetup](#) and [sinkRetrieve](#). A typical use is to wrap function evaluation calls in such a way as to redirect screen output to character variables.

### Slots

**stdout** Vector of type character containing each line of output destined for the 'console', excepting error and warning messages. Each element in the vector is a 'line' of string output, as determined by R.

**stderr**: As with stdout, but capturing warning and error messages

### Author(s)

MT Morgan <mtmorgan@fhcrc.org>

### See Also

link{sinkSetup}, [sinkRetrieve](#)

### Examples

```
library(RWebServices)  
  
sinkSetup()  
ls()  
try( fails())  
f <- function() stop("fails in function f")  
try( f())  
sinkRetrieve()
```

---

sinkSetup, sinkRetrieve *Capture and retrieve screen output*

---

## Description

sinkSetup establishes temporary files to capture output that would normally be directed toward the screen, and redirects both standard and error output to these files. sinkRetrieve retrieves the output, and removes screen redirections so output again appears on the screen.

## Usage

```
sinkSetup()  
sinkRetrieve()
```

## Details

These functions are used to redirect and then retrieve screen output. Redirection is to objects created with `file`, with no arguments (i.e., a temporary file, unlinked from the file system). Both standard output and error output are redirected.

User-level calls of `sink` between calls to `sinkSetup` and `sinkRetrieve` may confuse screen (especially error) capture, likely resulting in warnings when `sinkRetrieve` is called.

## Value

sinkRetrieve returns an object of `SinkOutput-class`, the slots of which contain vectors of the lines of text directed toward the screen.

## Author(s)

MT Morgan

## Examples

```
library(RWebServices)  
  
sinkSetup()  
ls()  
try( fails())  
f <- function() stop("fails in function f")  
try( f())  
sinkRetrieve()
```

**Description**

These functions provide utilities that are useful when testing different aspects of R / Java communication.

**Usage**

```
checkJava2R(javaData, rVariable)
checkPkgVersion(pkgName, expVersion)
reflectObj(x, verbose=FALSE)
```

**Arguments**

javaData	Object translated from Java
rVariable	R variable containing an instance that is supposed to be identical to javaData. rVariable might have been created in previous calls, or loaded from a data file.
pkgName	Name of package whose version will be determined.
expVersion	Character string with expected package version.
x	Object to be returned to Java.
verbose	Logical, indicating whether R reports information about the object.

**Value**

checkJava2R returns TRUE if javaData is identical to rVariable, or signals an error otherwise.  
checkPkgVersion returns true if the installed package matches the expected package, or signals a warning otherwise.  
reflectObj returns the object.

**Author(s)**

Nianhua Li

**Description**

The typeInfo2Java methods convert functions or TypeInfo structures to a Java-like signature, without coercion to Java types. See [createMap](#) to convert functions and coerce arguments.

These functions are primarily for internal use.

**Usage**

```
typeInfo2Java(x, ...)
```

**Arguments**

x	function with typeInfo already applied, S4 function, or any TypeInfo class.
...	Additional arguments specific to different methods. These are usually funcName (the name of the function) or args (a list of argument names)

**Details**

TypeInfo offers greater flexibility in type specification than can easily be implemented in Java. This function fails with DynamicTypeTest, and treats StrictIsTypeTest as InheritsTypeTest (issuing a warning in the process). See [NamedTypeTest-class](#) of TypeInfo for more information.

**Value**

An object of [RJavaSignature-class](#), containing return type, function name, and argument type/name as slots with named character vectors.

**Author(s)**

MT Morgan

**Examples**

```
library(RWebServices)

func <- function( response, predictor ) {
  if ( is.character( predictor ) )
    return( oneWayAnova( response, as.factor( predictor ) ) )
  formula <- as.formula( substitute( response ~ predictor ) )
  result <- lm( formula )
  anova( result )
}

## this indirection makes it easier to apply typeInfo
oneWayAnova <- func

typeInfo(oneWayAnova) <-
  SimultaneousTypeSpecification(
    TypedSignature(
      response = "numeric",
      predictor = "factor"),
    returnType = "anova" )

typeInfo2Java(oneWayAnova)

oneWayAnova <- func

typeInfo(oneWayAnova) <-
  SimultaneousTypeSpecification(
    TypedSignature(
      response = "numeric",
      predictor = "factor"),
    TypedSignature(
      response = "numeric",
      predictor = "character"),
    returnType = "anova" )
```



```

typeInfo2Java(oneWayAnova)

oneWayAnova <- func

typeInfo(oneWayAnova) <-
  IndependentTypeSpecification(
    response = c("numeric"),
    predictor = c( "factor", "character", "numeric" ),
    returnType = "anova"
  )

typeInfo2Java(oneWayAnova)

oneWayAnova <- func

typeInfo(oneWayAnova) <-
  SimultaneousTypeSpecification(
    TypedSignature(
      response = "numeric",
      predictor = "factor",
      returnType = "matrix"),
    TypedSignature(
      response = "numeric",
      predictor = "character"),
    returnType = "anova" )

typeInfo2Java(oneWayAnova)

oneWayAnova <- func

typeInfo(oneWayAnova) <-
  IndependentTypeSpecification(
    response = c("numeric"),
    predictor = c( "factor", "character", "numeric" ),
    returnType = c("anova")
  )

typeInfo2Java(oneWayAnova)

# Warning about StrictIsTypeTest
oneWayAnova <- func
typeInfo(oneWayAnova) <-
  IndependentTypeSpecification(
    response = StrictIsTypeTest("numeric"),
    predictor = c( "factor", "character", "numeric" ),
    returnType = c("anova")
  )
typeInfo2Java(oneWayAnova)

oneWayAnova <- func
typeInfo(oneWayAnova) <-
  IndependentTypeSpecification(
    response = "numeric",
    predictor = quote( ( length(predictor) == length(response)) && is( predictor, "factor" ) ),
    returnType = c("anova")
  )

```

```
)  
typeInfo2Java(oneWayAnova)
```

---

unpackAntScript	<i>Unpack script for building, testing, and installing packages.</i>
-----------------	--

---

### Description

RWebServices includes a number of scripts and files to be used to develop, test, and deploy services. This function unpacks a 'master' script and partly configured properties files to a convenient directory location.

### Usage

```
unpackAntScript(toDir = stop("specify destination directory for unpacking"), overwrite=FALSE)
```

### Arguments

toDir	Destination (top-level) directory. Warnings are issued if files already exist.
overwrite	Overwrite output?

### Value

This function is used for its side effect.

### Author(s)

Martin Morgan <mtmorgan@fhcrc.org>

### Examples

```
## Not run: unpackAntScript("/tmp/ants")  
## Not run:  
## From the command line  
echo "library(RWebServices); unpackAntScript('~ /tmp/ants') | R --vanilla  
  
## End(Not run)
```

# Index

## \*Topic **classes**

- ArrayAndMatrix-class, [2](#)
- FileReferences-class, [12](#)
- RJavaPkgFunctions-class, [19](#)
- RJavaSignature-class, [20](#)
- SinkOutput-class, [21](#)

## \*Topic **documentation**

- createMap, [9](#)
- sinkSetup, sinkRetrieve, [22](#)
- typeInfo2Java, [23](#)

## \*Topic **interface**

- converters, [4](#)
- generateDataMap, [13](#)
- generateDataTest, [14](#)
- generateFunctionMap, [15](#)
- printLookup, [17](#)
- register-converters, [17](#)

## \*Topic **manip**

- FileReferences, [11](#)
- getRSessionInfo, [16](#)
- unpackAntScript, [26](#)

## \*Topic **methods**

- retrieve-methods, [18](#)

## \*Topic **package**

- RWebServices-package, [2](#)

## \*Topic **programming**

- createMap, [9](#)
- sinkSetup, sinkRetrieve, [22](#)
- Test utilities, [23](#)
- typeInfo2Java, [23](#)

array, [2](#)

ArrayAndMatrix-class, [2](#)

CharArray (ArrayAndMatrix-class), [2](#)

CharArray-class (ArrayAndMatrix-class), [2](#)

CharMatrix (ArrayAndMatrix-class), [2](#)

CharMatrix-class (ArrayAndMatrix-class),  
[2](#)

checkJava2R (Test utilities), [23](#)

checkPkgVersion (Test utilities), [23](#)

ComplexArray (ArrayAndMatrix-class), [2](#)

ComplexArray-class

(ArrayAndMatrix-class), [2](#)

ComplexMatrix (ArrayAndMatrix-class), [2](#)

ComplexMatrix-class

(ArrayAndMatrix-class), [2](#)

converters, [4](#), [9](#), [13](#), [15](#), [18](#)

createMap, [3](#), [9](#), [15](#), [19](#), [23](#)

createMap,character,missing-method  
(createMap), [9](#)

createMap,missing,character-method  
(createMap), [9](#)

createMap,standardGeneric,missing-method  
(createMap), [9](#)

cvtArrayFromJava (converters), [4](#)

cvtArrayToJava (converters), [4](#)

cvtCharacterFromJava (converters), [4](#)

cvtCharacterToJava (converters), [4](#)

cvtCharacterToJava2 (converters), [4](#)

cvtCharArrayFromJava2 (converters), [4](#)

cvtCharArrayToJava2 (converters), [4](#)

cvtCharMatrixFromJava2 (converters), [4](#)

cvtCharMatrixToJava2 (converters), [4](#)

cvtComplexArrayFromJava2 (converters), [4](#)

cvtComplexArrayToJava2 (converters), [4](#)

cvtComplexFromJava (converters), [4](#)

cvtComplexFromJava2 (converters), [4](#)

cvtComplexMatrixFromJava2 (converters),  
[4](#)

cvtComplexMatrixToJava2 (converters), [4](#)

cvtComplexToJava (converters), [4](#)

cvtComplexToJava2 (converters), [4](#)

cvtDataFrameFromJava (converters), [4](#)

cvtDataFrameFromJava2 (converters), [4](#)

cvtDataFrameToJava (converters), [4](#)

cvtDataFrameToJava2 (converters), [4](#)

cvtEnvFromJava (converters), [4](#)

cvtEnvFromJava2 (converters), [4](#)

cvtEnvToJava (converters), [4](#)

cvtEnvToJava2 (converters), [4](#)

cvtFactorFromJava (converters), [4](#)

cvtFactorFromJava2 (converters), [4](#)

cvtFactorToJava (converters), [4](#)

cvtFactorToJava2 (converters), [4](#)

cvtFileReferencesFromJava (converters), [4](#)

cvtFileReferencesFromJava2 (converters), [4](#)

- cvtFileReferencesToJava (converters), 4
  - cvtFileReferencesToJava2 (converters), 4
  - cvtIntegerArrayFromJava2 (converters), 4
  - cvtIntegerArrayToJava2 (converters), 4
  - cvtIntegerFromJava (converters), 4
  - cvtIntegerMatrixFromJava2 (converters), 4
  - cvtIntegerMatrixToJava2 (converters), 4
  - cvtIntegerToJava (converters), 4
  - cvtIntegerToJava2 (converters), 4
  - cvtListFromJava (converters), 4
  - cvtListToJava (converters), 4
  - cvtListToJava2 (converters), 4
  - cvtLogicalArrayFromJava2 (converters), 4
  - cvtLogicalArrayToJava2 (converters), 4
  - cvtLogicalFromJava (converters), 4
  - cvtLogicalMatrixFromJava2 (converters), 4
  - cvtLogicalMatrixToJava2 (converters), 4
  - cvtLogicalToJava (converters), 4
  - cvtLogicalToJava2 (converters), 4
  - cvtMatrixFromJava (converters), 4
  - cvtMatrixToJava (converters), 4
  - cvtNumericArrayFromJava2 (converters), 4
  - cvtNumericArrayToJava2 (converters), 4
  - cvtNumericFromJava (converters), 4
  - cvtNumericMatrixFromJava2 (converters), 4
  - cvtNumericMatrixToJava2 (converters), 4
  - cvtNumericToJava (converters), 4
  - cvtNumericToJava2 (converters), 4
  - cvtRawArrayFromJava2 (converters), 4
  - cvtRawArrayToJava2 (converters), 4
  - cvtRawFromJava (converters), 4
  - cvtRawMatrixFromJava2 (converters), 4
  - cvtRawMatrixToJava2 (converters), 4
  - cvtRawToJava (converters), 4
  - cvtRawToJava2 (converters), 4
  - cvtUnknownFromJava (converters), 4
  - cvtUnknownToJava (converters), 4
  - cvtVectorFromJava (converters), 4
  - cvtVectorToJava (converters), 4
- file, 22
- FileReferences, 11, 11, 12, 18
- FileReferences-class, 12
- generateDataMap, 9, 13, 13, 14, 15, 17
- generateDataTest, 14
- generateFunctionMap, 15, 18, 19
- getRSessionInfo, 16
- IndependentTypeSpecification, 10
- IntegerArray (ArrayAndMatrix-class), 2
- IntegerArray-class (ArrayAndMatrix-class), 2
- IntegerMatrix (ArrayAndMatrix-class), 2
- IntegerMatrix-class (ArrayAndMatrix-class), 2
- length,FileReferences-method (FileReferences), 11
- localNames, 12
- localNames (FileReferences), 11
- LogicalArray (ArrayAndMatrix-class), 2
- LogicalArray-class (ArrayAndMatrix-class), 2
- LogicalMatrix (ArrayAndMatrix-class), 2
- LogicalMatrix-class (ArrayAndMatrix-class), 2
- matchArrayToJava (converters), 4
- matchCharacterToJava (converters), 4
- matchCharacterToJava2 (converters), 4
- matchCharArrayToJava2 (converters), 4
- matchCharMatrixToJava2 (converters), 4
- matchComplexArrayToJava2 (converters), 4
- matchComplexMatrixToJava2 (converters), 4
- matchComplexToJava (converters), 4
- matchComplexToJava2 (converters), 4
- matchDataFrameToJava (converters), 4
- matchDataFrameToJava2 (converters), 4
- matchEnvToJava (converters), 4
- matchEnvToJava2 (converters), 4
- matchFactorToJava (converters), 4
- matchFactorToJava2 (converters), 4
- matchFileReferencesToJava (converters), 4
- matchFileReferencesToJava2 (converters), 4
- matchIntegerArrayToJava2 (converters), 4
- matchIntegerMatrixToJava2 (converters), 4
- matchIntegerToJava (converters), 4
- matchIntegerToJava2 (converters), 4
- matchListToJava (converters), 4
- matchListToJava2 (converters), 4
- matchLogicalArrayToJava2 (converters), 4
- matchLogicalMatrixToJava2 (converters), 4
- matchLogicalToJava (converters), 4
- matchLogicalToJava2 (converters), 4
- matchMatrixToJava (converters), 4
- matchNumericArrayToJava2 (converters), 4
- matchNumericMatrixToJava2 (converters), 4
- matchNumericToJava (converters), 4
- matchNumericToJava2 (converters), 4
- matchRawArrayToJava2 (converters), 4

- matchRawMatrixToJava2 (converters), 4
- matchRawToJava (converters), 4
- matchRawToJava2 (converters), 4
- matchUnknownToJava (converters), 4
- matchVectorToJava (converters), 4
- matrix, 2
- NumericArray (ArrayAndMatrix-class), 2
- NumericArray-class
  - (ArrayAndMatrix-class), 2
- NumericMatrix (ArrayAndMatrix-class), 2
- NumericMatrix-class
  - (ArrayAndMatrix-class), 2
- printLookup, 17
- RawArray (ArrayAndMatrix-class), 2
- RawArray-class (ArrayAndMatrix-class), 2
- RawMatrix (ArrayAndMatrix-class), 2
- RawMatrix-class (ArrayAndMatrix-class), 2
- reflectObj (Test utilities), 23
- regAddonCvt, 7, 9
- regAddonCvt (register-converters), 17
- regAddonCvt2, 8, 9
- regAddonCvt2 (register-converters), 17
- register-converters, 17
- regTestCvt (register-converters), 17
- retrieve (retrieve-methods), 18
- retrieve,FileReferences,character-method
  - (retrieve-methods), 18
- retrieve,FileReferences,FileReferences-method
  - (retrieve-methods), 18
- retrieve,FileReferences,missing-method
  - (retrieve-methods), 18
- retrieve-methods, 18
- RJavaPkgFunctions-class, 19
- RJavaSignature-class, 20
- RWebServices (RWebServices-package), 2
- RWebServices-package, 2
- set.JavaFunctionConverter, 9
- show,RJavaPkgFunctions-method
  - (RJavaPkgFunctions-class), 19
- show,RJavaSignature-method
  - (RJavaSignature-class), 20
- sink, 22
- SinkOutput-class, 21
- sinkRetrieve, 21
- sinkRetrieve (sinkSetup, sinkRetrieve), 22
- sinkSetup, 21
- sinkSetup (sinkSetup, sinkRetrieve), 22
- sinkSetup, sinkRetrieve, 22
- Test utilities, 23
- TypedSignature, 10
- typeInfo, 10
- typeInfo2Java, 10, 20, 23
- typeInfo2Java,ANY-method
  - (typeInfo2Java), 23
- typeInfo2Java,character-method
  - (typeInfo2Java), 23
- typeInfo2Java,DynamicTypeTest-method
  - (typeInfo2Java), 23
- typeInfo2Java,function-method
  - (typeInfo2Java), 23
- typeInfo2Java,genericFunction-method
  - (typeInfo2Java), 23
- typeInfo2Java,IndependentTypeSpecification-method
  - (typeInfo2Java), 23
- typeInfo2Java,InheritsTypeTest-method
  - (typeInfo2Java), 23
- typeInfo2Java,list-method (typeInfo2Java), 23
- typeInfo2Java,SimultaneousTypeSpecification-method
  - (typeInfo2Java), 23
- typeInfo2Java,standardGeneric-method
  - (typeInfo2Java), 23
- typeInfo2Java,StrictIsTypeTest-method
  - (typeInfo2Java), 23
- typeInfo2Java,TypedSignature-method
  - (typeInfo2Java), 23
- types, 12
- types (FileReferences), 11
- unpackAntScript, 26
- urls, 12
- urls (FileReferences), 11