Heart of Gold – an XML-based middleware for the integration of deep and shallow natural language processing components

User and Developer Documentation

September 2009 (V1.5 and SVN trunk)

Ulrich.Schaefer@dfki.de

http://heartofgold.dfki.de

http://www.delph-in.net/heartofgold

Contents

Part 1: Overview

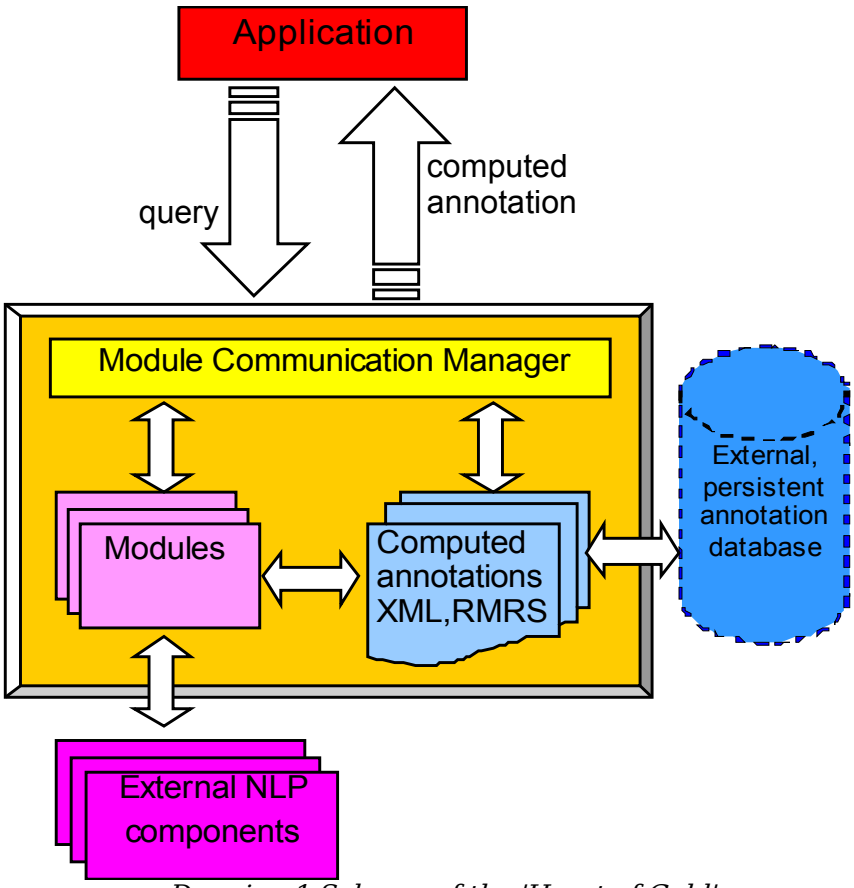
The Heart of Gold[1] is an XML-based middleware for the integration of deep and shallow natural language processing components. It provides a uniform and flexible infrastructure for building applications that use RMRS-based and/or XML-based natural language processing components.

The main design goals where:

- flexible integration of NLP components
- simple application interface
- RMRS as uniform representation language (XML-encoded)
- open to other XML standoff annotation formats
- integration of non-RMRS-aware NLP components through annotation transformation
- external annotation database for storage and retrieval of computed linguistic analyses (optional)
- network-enabled architecture with distributed components (optional)
- lightweight, platform- and programming language-independent communication through XML-RPC
- based on current technology like XML, XML-RPC, XSLT, XML:DB, XPath

The figure on the next page depicts the general architecture. Heart of Gold acts as mediator between applications and NLP components, abstracting from component-specific interfaces and representations. Applications send queries on text documents to the middleware which in turn passes the queries to one or more components according to an application-specific configuration. The resulting annotation, which can also be taken from the annotation database, is then returned to the application.

1 for related literature, see http://www.bbc.co.uk/cult/hitchhikers/guide/heartofgold.shtml



Drawing 1 Schema of the 'Heart of Gold'

Module Communication Manager

Applications communicate with the Heart of Gold middleware through the Module Communication Manager (MoCoMan) via a Java API (Java applications) or XML-RPC (remote applications or applications written in programming languages other than Java).

XML-RPC is a lightweight protocol that is supported – through additional libraries – by most current programming languages on various platforms. It is built on top of HTTP and hence can also be used for communication through firewalls which otherwise would have to be opened for specific ports other than the standard HTTP port. For the same reasons, XML-RPC can also be used for the integration of natural language processing components into the architecture. In other words, XML-RPC provides an easy and portable means to network-enable architecture and applications.

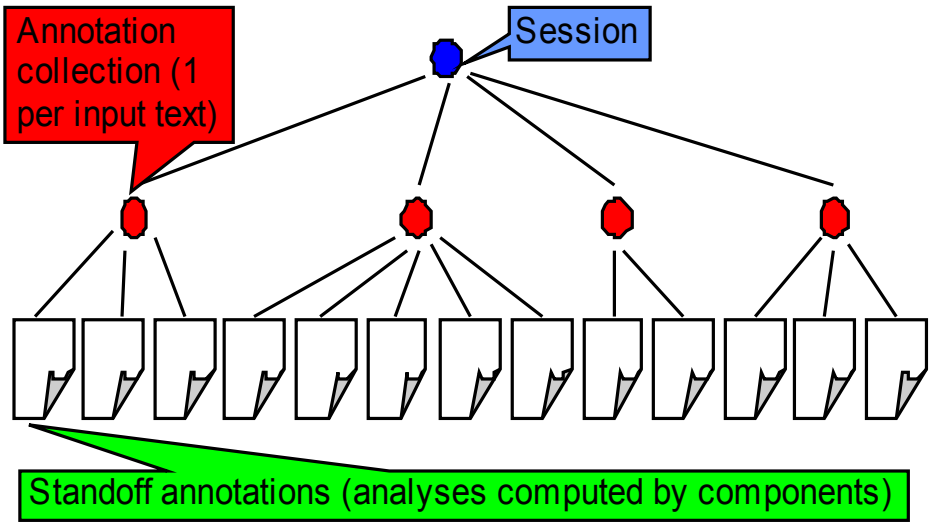
Modules and Components

Initially, an application starts an instance of the Heart of Gold architecture with a configuration setting for the required components. The MoCoMan then starts (or remotely connects to) the appropriate components. From the viewpoint of MoCoMan, components are Modules (local Java-based components) or XmlRpcModules (remote, possibly non-Java, components). I.e., in order to integrate a new component in the architecture, it must

inherit from either Module or XmlRpcModule. The remote counterparts of an XmlRpcModule are called adapters. A Java class can be used to implement remote Java adapters. Moreover, remote adapters can also be implemented in other programming languages and communicate with MoCoMan via XML-RPC.
The Module configuration, abstract Module and Registry classes are based on some basic classes of the Memphis architecture [Memphis]. If a component does not provide XML or RMRS output, then translation to and (possibly) from XML or RMRS should be implemented in the Module classes.

Sessions and Annotations

MoCoMan provides a session management so that different input sessions with multiple documents (input texts) can be referenced. MoCoMan manages a collection of sessions where a session consists of a collection of annotation collections (one annotation collection corresponds to one input text or sentence) that contain RMRS/standoff annotations computed by the components of the configured architecture instance. Sessions, annotation collections and annotations are referenced through context-unique IDs. Sessions, annotation collections and computed annotations can optionally be stored in an XML database.



Drawing 2 Structured annotation storage

NLP Analysis

After the system configuration is finished, analysis requests can be passed to the MoCoMan.
Analysis request parameters comprise

- (initially) an input text or (later) a reference to the input text
- language
- depth of requested analysis (integer)
- token span [not implemented yet; will probably become character span instead]

MoCoMan passes the request to the modules that are configured in the architecture instance and that are appropriate for the requested depth of analysis and language. The RMRS annotations computed by the modules are then returned to the application (and optionally stored in the XML database).
If a query is passed to the MoCoMan that has already been computed (i.e., with the same input text and query parameters), then the pre-computed result is returned by MoCoMan.

Default Processing Strategy

- Shallowest component first (e.g. tokenizer).
- Then other components with increasing depth, up to requested depth.
- Fallback to result of previous component if no result from component with requested depth.
- Each component gets the output of previous component as input plus the output from other components if configured.
- The result of the query is the result of the deepest component in the sequence.
- Analyses results from previous components are returned on request (getAnnotation()).

Metadata

Metadata on date, time, source, parameters, and processing options of annotation are stored together with the session and annotation collections.
Metadata can contain structured XML, e.g.

```
<metadata>
  <id>
     <entry name="acid" value="collection0002"/>
     <entry name="component" value="PET"/>
     <entry name="created" value="Do, 4 Dez 2003 18:25:16 +0100"/>
     <entry name="processingtime" value="00:08,140"/>
     <entry name="sessionid" value="session0001"/>
     <entry name="diagnosis" value="OK"/>
  </id>
  <conf>
     <entry name="module.rootelement" value="pet"/>
     <entry name="module.language" value="en"/>
     <entry name="module.depth" value="100"/>
```

```
      <entry name="pet.grammarprefix" value="english"/>
      <entry name="pet.options" value="-mrs=xml"/>
      <entry name="pet.inputencoding" value="ISO-8859-1"/>
      <entry name="pet.outputencoding" value="ISO-8859-1"/>
      <entry name="pet.inputannotation" value="rawtext"/>
    </conf>
  </metadata>
```

diagnosis String starts with either `"OK"` or `"Error"`.

```
DTD fragment of Metadata:

<!ELEMENT metadata ( id , conf )>

<!ELEMENT id (entry)* >
<!ELEMENT conf (entry)* >

<!ELEMENT entry EMPTY >
<!ATTLIST entry name NMTOKEN #REQUIRED
                value CDATA #REQUIRED >
```

Annotation database

The Heart of Gold middleware optionally provides a database interface for XML annotation storage. The main purpose is persistent storage of computed annotations for the automatic creation or enrichment of linguistic corpora etc.
The annotation database interface uses XML:DB [XML:DB] which is a vendor-independent interface to XML databases. The current implementation uses the free (but disappointingly slow) Xindice 1.1b [Xindice], but other XML databases such as dbxml, Tamino could be used instead. An interface class is provided that can be implemented in order to support other XML databases.
The Heart of Gold XML database interface (abstract class AnnotationDatabase) supports organisation of XML annotation reflecting the session and annotation collection tree hierarchy of MoCoMan. Standard operations like inserting, deleting collections and XML annotations, and a standardized query language based on XPath [XPath] is supported. Existing annotation can also be modified using the XUpdate query language [XUpdate]. However, this is currently not actively supported by the XML:DB interface.
An important feature of XML databases is indexing of XML document elements with respect to efficient retrieval. Depending on the structure of the annotation, indexers can be defined through the database interface. This should be done when integrating new Modules and can be stored as part of the Module configuration which in turn is part of the annotation metadata.
In the current implementation based on Xindice, the XML database can easily be separated physically from the rest of the architecture. The database can reside on a server different from the middleware server and provide its services through the tomcat web application server. The XML database interface of MoCoMan then acts as a client to the XML database.

For most practical cases, a simple storage and retrieval mechanism based on annotation ID and annotation collection ID is sufficient. It can (and probably will in the future) be implemented on file system basis being a subclass of AnnotationDatabase.

Annotation Transformation with class TransformationService

For the integration of non-RMRS-aware components, XSLT [XSLT] can be employed in order to transform component-specific XML output, e.g., of a chunker or a named entity recognition component, into the RMRS format (cf. [WHAT]). The transformation is performed in the module's process() method. A special class with name TransformationService provides to the standard XSLT transformation with an extension for seamless access to Heart of Gold annotation from within XSLT stylesheets.

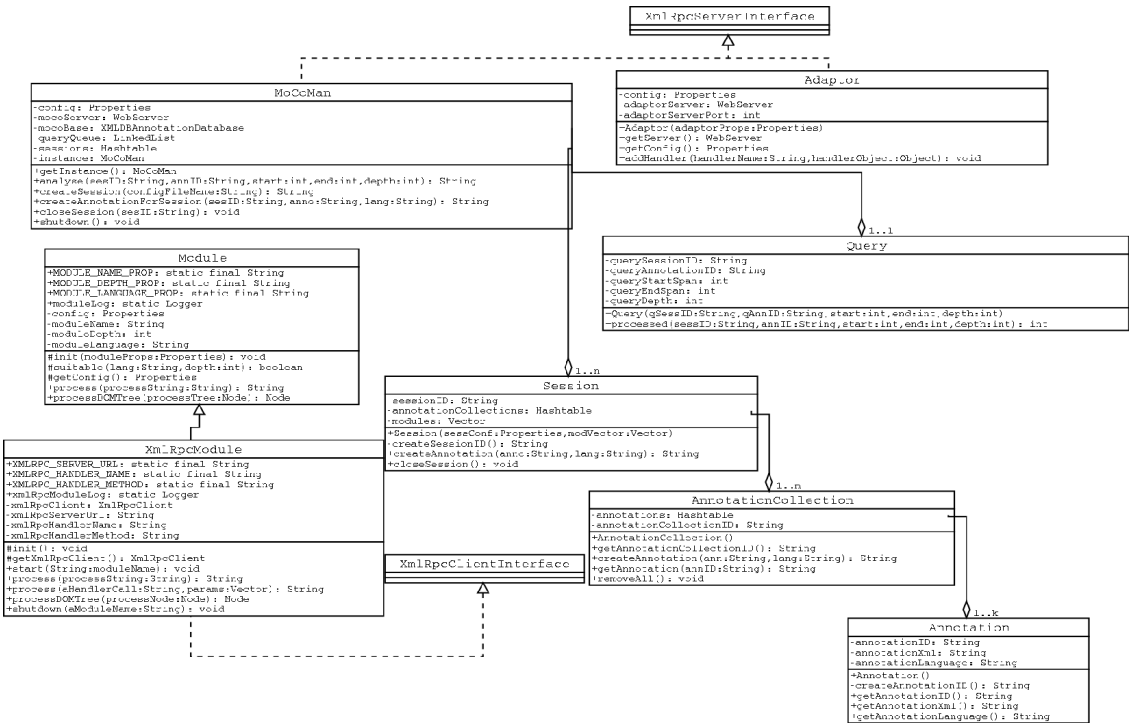


Illustration 1UML diagram of the Heart of Gold core classes

Part 2: Installation of the Middleware

Release Notes for SVN trunk Version

V1.5 has moved to tags/1.5 in the subversion repository.
The SVN trunk directory now contains the current development version, mainly with changes for the new PET chart mapping interface. It currently requires a PET from https://pet.opendfki.de/repos/pet/branches/cm instead of components-pet-binlib.tar.gz and components-pet-erg.tar.gz. The libraries tar for the HoG trunk version is available from http://heartofgold.dfki.de/pkg/hog-lib.tar.gz.

Release Notes for Version 1.5

We have uploaded a new version of Heart of Gold to http://heartofgold.dfki.de. Under the Download menu, you'll find new versions of the middleware and components packages (for RASP, PET including ERG, GG, JACY grammars, German shallow topoparser).

There is a now also a public Subversion repository for the middleware source code embedded in the trac environment at http://heartofgold.opendfki.de. Checking out the source code is as easy as

```
svn checkout https://heartofgold.opendfki.de/repos/trunk hog-trunk

for the latest development snapshot or

svn checkout https://heartofgold.opendfki.de/repos/tags/1.5 hog-1.5
```

for the latest release version (1.5), roughly as of August 2008 with three minor additions since then.

Read access is open to everyone. To get write access, you'll have to register via https://config.opendfki.de .
I would like to encourage you to make use of the trac-based ticketing system for code-related communication, feature and bugfix requests etc. Posting to this mailing list can then be reserved to general (i.e. less technical) discussion or questions, and announcements.

Here is an overview of the new features:

Core middleware

- Directory tree slightly restructured:
  - The `conf/LL` directories have been split into `conf/LL/modules/` and `conf/LL/sessions/` to separate module from session configurations (`LL`=two-letter ISO language code). Example: `conf/en/xmlrpcsession.cfg` has moved to `conf/en/sessions/default.cfg`

    - The files `conf/en/sessions/rasp2.cfg` and `conf/de/sessions/topo.cfg` contain separate session configurations for RASP and the German topoparser, their content can be copied to the respective default.cfg files, omitting those lines that are already present (jtok, chunkie).
    - The `xindice` directory has been removed from the distribution to get rid of dependencies and conflicts with Java XML libraries. This means that there is currently no direct support for an XML annotation database until we find a replacement. As Xindice is slow, we do not consider this a serious loss at the moment.
- Server startup and shutdown handling now ant-less:
    - `source bin/setup.sh` sets paths once at the beginning
    - then `hog start` resp. `hog stop` for starting/stopping the XML-RPC server
    - `analyzeGUI`/`analyzeAll` script (Python) also moved to `bin`, with modified parameter handling
    - default browser for `analzeGUI` is now `firefox` (can be modified in the script variable `browser`)
- Bugfix: now multiple Modules of the same class are supported within a session (e.g. for generic modules such as `SproutModule`, `SdlModule`)
- The Java middleware code now requires JDK 1.5 or 1.6.

Deep Parser/Grammars

- New PET version (cheap, flop, libraries) as of Spring 2008.
- New versions of complied GG, ERG and JACY grammars as of Spring 2008.
- `PetModule`: now also supports the MRX output format (xml-encoded MRS). As there seem to be at least two different MRX formats (Utool is expecting a slightly different syntax), we provide a stylesheet `xsl/mrx/mrx2utool.xsl` that transforms the output of cheap for Utool (V3.1.1).
- There are now 5 different input formats supported by cheap/PetModule (some experimental; details in the PET Delph-in wiki):
    - raw text (option in conf/LL/modules/pet.cfg)
    - PET input chart (aka pixml or pic) (option in conf/LL/modules/pet.cfg)
    - SPPP (via transformation xsl/pic/sppp2pic.xsl)
    - SMAF (option in conf/LL/modules/pet.cfg; xsl/smaf/pixml2smaf.xsl)
    - FSC (developed in the Checkpoint project by Peter Adolphs). The new XSL stylesheet `xsl/fsc/pic2fsc.xsl` (experimental version) can be used to transform the PET input chart format into the FSC format.

LingPipe2Module

- made compatible with recent LingPipe versions (from 2.4 on)

Rasp2Module

- For RASP3 aka rel 2 (Web download version)
- The RASP-to-RMRS conversion is no longer part of the core RASP distribution, but is contained in a conversion server (part of LKB sources) that has to be started externally before a RASP session is started in Heart of Gold. We provide an executable for this server built using an LKB CVS version snapshot (Spring 2008).
- The new XSL stylesheet `xsl/rmrs/removeanchors.xsl` can be used to transform the RMRS output of the converter into the `old' RMRS format without `<anchor>` elements (mainly for getting results viewable with the rmrs2html stylsheet). Due to the underspecified documentation of the new format, this stylesheet can only be called experimental. Spurious multiple args of the same name and free args may appear.This is why this postprocessing transformation can be switched of in rasp.cfg.

LoParModule/Whiteboard Topoparser (for German only)

- This new module is a wrapper for LoPar (PCFG parser by Helmut Schmid, U. Stuttgart, to be downloaded separately) as well as the topoparser pipeline from the Whiteboardsystem. However, as there is currently no integration with the deep parser as was in Whiteboard, we consider it a standalone shallow module (session). Whether the computed brackets for the (old) GG version are output or not, can be configured in the module cfg file (default: off).

Installation (change: components packages no longer contain the hog directory prefix!)
A preliminary installation script can be downloaded via the URL

https://heartofgold.opendfki.de/repos/trunk/maint/install

Please check the script (comment out unnecessary parts) before running it.
Manual installation:

1. Ubuntu/Debian user may install required packages using the following command:
   `sudo apt-get install subversion python-tk sun-java6-jdk ant ipadic chasen firefox`
2. download hog-*.tar.gz and components-*.tar.gz packages (if you use the svn version instead of `hog-XXX-src.tar.gz`, an additional `ant generate_xsl` is necessary after step 5)
3. unpack hog-*.tar.gz, then `cd hog-XXX` and unpack components-*.tar.gz packages there
4. adjust Python (and Java) paths in `bin/setup.sh` unless they are already in the standard PATH
5. `source bin/setup.sh` (once per login; extends the search path for commands)

Using the following command line, you can start the server, the browser and the python client with the default workflow for English (JTok, TnT, SProUT, PET, RMRSmerge):

```
hog start && firefox && analyzeGUI -m localhost -p 8411 -l en
```

```
python/en_test.txt
```

Shutdown HoG using the command `hog stop`.

EN, DE, JA configurations (including ChunkieRMRS EN+DE, topoparser DE) have been successfully tested on

- SuSE 9.3 bigsmp 32 bit on an Intel multiprocessor server
- SuSE 10.2 32 bit on Intel Dual Core (Thinkpad)
- Ubuntu 8.04 on AMD Athlon X2 64 bit (Java@64 bit, rest@32 bit ;-)), RASP seemed not to work on this machine, but we did not further investigate; maybe a problem with a missing 32bit library.

Finally, please note that PET, ERG, GG, JACY and the RASP RMRS converter server were built on CVS or subversion snapshots as of Spring 2008, i.e. they may out of sync with the latest versions available.

Installation, File System Structure

Prerequisites
Hardware: i686 architecture (Intel or AMD, ~2 GHz recommended) with 1 GByte of RAM for the full system with 'GUI' clients for German or English (the other languages currently require less memory), if the memory usage of other programs (e.g. window manager) is economical, 512 MB RAM can be sufficient.

1. Linux
2. Sun Java Development Kit (JDK) 1.5 or 1.6
3. Python 2.5 or higher and (for the Python GUI client) `tkinter`, typically in packages named python and python-tk, sometimes called tkinter
4. for the Python GUI client: Firefox, Seamonkey, Mozilla > V1.3 or Netscape (note that remote controlling the browser works on X11 systems only, i.e. not on MS Windows!)
5. Apache ant (e.g. V 1.7; only required if you need to build HoG on your own, i.e. for compiling Java or generating XSLT code).

In Debian/Ubuntu, you may install the packages using the following command line:

```
sudo apt-get install subversion python-tk sun-java6-jdk ant ipadic
chasen firefox
```

From now on in this documentation, paths are specified relative to the root directory for the Heart of Gold installation (path prefix hog/ is no longer included in the tar.gz archives). E.g., **`conf/en/modules/pet.cfg`** refers to the real directory

/path/to/where/you/unpacked/archives/**conf/en/modules/pet.cfg**
This convention is also used throughout the Heart of Gold itself, e.g. in configuration files etc. I.e., absolute paths should be avoided whereever possible (readlink -f and dirname can be used to compute absolute paths; this is e.g. done in the RASP start script).

Currently, the Heart of Gold middleware consists of the following separate packages.

- `hog-XXX-lib.tar.gz` (core binary and library files for Heart of Gold middleware, JTok tokenizer; archive contains root directory `hog-XXX/`).
- source files snapshot from svn: `https://heartofgold.opendfki.de/repos/trunk` Alternatively, a file named `hog-XXX-src.tar.gz` contains the source files of the middleware and modules below the root directory `hog-XXX/` (`java/`, `python/`, `xsl/`, default config files in `conf/`, ant build file `build.xml`).
- The archives `components-*.tar.gz` contain the `components/` subdirectories for specific components (without the `hog-XXX/` prefix!). The adapters classes ('modules') and configuration files are part of `hog-XXX-src.tar.gz`. Some components not downloadable from DFKI have to be copied, compiled or installed to manually created subdirectories below `components/`, e.g., `lingpipe/`, `freeling/`, `rasp/`.

By checking out the subversion repository and unpacking these files, the following directory structure is established below the root directory:

```
bin/                        -- scripts for managing start/build (SVN)
doc/                        -- doc files from repository (SVN)
doc/javadoc/                -- for generated javadoc
components/                 -- installation directory for components
conf/${lang}/modules/       -- configuration files for modules (SVN)
conf/${lang}/sessions/      -- configuration files for sessions (SVN)
java/                       -- java source files (SVN)
lib/java/                   -- jar archives
lib/classes/                -- for generated class files
log/                        -- log file directory
maint/                      -- maintenance scripts etc. (SVN)
php/                        -- PHP source of online demo (SVN)
python/                     -- python client scripts (SVN)
[xindice/                   -- XML DB client installation directory]
xsl/                        -- stylesheets for various transformations (SVN)
```

Directories and files like java sources, doc files, default configurations files that are marked with “(SVN)” come from the subversion repository, the other files and directories come from `hog-XXX-lib.tar.gz` and `components-*.tar.gz` (binary, jar and component-specific files).

Sample Installation and Test

(Default) Installation for components with English and German resources:

Download the following archives from
http://heartofgold.dfki.de/Download.html and extract them:

```
tar xzf hog-XXX-src.tar.gz              # all languages
#alternatively:
#svn checkout https://heartofgold.opendfki.de/repos/trunk hog-XXX
# or svn checkout https://heartofgold.opendfki.de/repos/tags/1.6 hog-1.6
tar xzf hog-XXX-lib.tar.gz              # all languages
cd hog-XXX
tar xzf components-pet-binlib.tar.gz    # all languages
tar xzf components-pet-erg.tar.gz       # EN HPSG grammar
tar xzf components-pet-german.tar.gz    # DE HPSG grammar
tar xzf components-sprout.tar.gz        # DE, EN (NE + chunkieRMRS), EL, JA
(NE)
tar xzf components-chunkiermrs.tar.gz   # DE, EN (SProUT source files only)
tar xzf components-chunkie.tar.gz       # DE, EN
tar xzf components-tnt.tar.gz           # DE, EN
cd hog
```

For English, you may additionally install LingPipe to `components/lingpipe` and RASP2 to `components/rasp2` (see the corresponding module description below for more details). For Japanese, ChaSen is assumed to be installed centrally (part of most current Linux distributions). Likewise FreeLing, available from `http://www.lsi.upc.es/~nlp/freeling/`.

Before testing the installation, make sure that only the installed components are activated by editing `conf/${lang}/sessions/default.cfg`. These files contain the default configurations for the Python clients that are connected via XML-RPC. E.g., if you don't have RASP, comment the RASP line out in `conf/en/sessions/default.cfg`:

```
de.dfki.lt.hog.modules.JTokModule=conf/en/modules/jtok.cfg
de.dfki.lt.hog.modules.TnTModule=conf/en/modules/tnt.cfg
de.dfki.lt.hog.modules.ChunkieModule=conf/en/modules/chunkie.cfg
de.dfki.lt.hog.modules.SdlModule=conf/en/modules/chunkiermrs.cfg
de.dfki.lt.hog.modules.SproutModule=conf/en/modules/sprout.cfg
#de.dfki.lt.hog.modules.LingPipe2Module=conf/en/modules/lingpipe2.cfg
de.dfki.lt.hog.modules.Rasp2Module=conf/en/modules/rasp2.cfg
de.dfki.lt.hog.modules.PetModule=conf/en/modules/pet.cfg
de.dfki.lt.hog.modules.SdlModule=conf/en/modules/rmrsmerge.cfg
```

For PET (currently English only), a dependency from the configured NE recognizer must be configured manually. I.e., if you use LingPipe for NE recognition, set

```
pet.inputannotation=TnTpiXML,LingPipepiXML
```

in `conf/en/modules/pet.cfg`
If you use SProUT (default), set

```
pet.inputannotation=TnTpiXML,SProUTpiXML
```

Otherwise, PET won't work. SProUT is required anyway if the chunkieRMRS module is activated.

You may then check the XML-RPC server port (default is 8411) in `conf/mocoman.cfg` and the logging configuration in the same file which by default points to `conf/logging/html.cfg` (for the first tests, setting log to DEBUG is recommended; later INFO may be sufficient and more compact). The actual logging setting can now be selected in the hog start script `bin/hog`. Instead of HTML, other logging targets may be chosen, e.g. console, textfile, chainsaw GUI, sockets, SNMP etc., for details see the log4j documentation (http://logging.apache.org/log4j).

Once per login, you'll have to set paths etc. using the following command:
`source bin/setup.sh`

The following commands start the Heart of Gold XML-RPC server in background, then the web browser (here: Firefox) for viewing results and then the Python GUI client for English

```
hog start && firefox && analyzeGUI -m localhost -p 8411 -l en
python/en_test.txt
```

A German session (latin1 encoded input file) can be started with
`analyzeGUI -m localhost -p 8411 -l de -e latin1 python/de_test.txt`

There is a non-GUI Python client to process text files similar to analyzeGUI. It is called analyzeAll and expects linefeed-separated sentences in the input file.

```
analyzeAll -m localhost -p 8411 -l en python/en_test.txt
```

The output can be configured (XML and/or HTML files or no output selectable for each of the available annotations; configuration at the beginning of the Python code). The generated files are stored in the current working directory and have the following file name format

`aaaaaa-nnn.{xml,html}`

where aaaaaa is the annotation name (aid) and nnn is the sentence number, e.g. Sprout-002.xml.
For details on preprocessing and sentence splitting, see page 66.

The Ant Build File build.xml

Ant is a platform-indepedent make utility for (Java-based) applications, for details see `http://ant.apache.org`. The following targets are defined in `./build.xml` for the Heart of Gold (this is the output of the command `ant -projecthelp`):

```
Buildfile: build.xml Main targets:

 aa                shortcut to analyzeAll
 all               compile, make jar and javadoc
```

```
analyzeAll        analyze all sentences in a given file
chainsaw          run chainsaw log viewer
chunkiermrs       compile chunkie rmrs sdl cascade -Dlang=XX [-Dsdl.file=Y]
clean             delete files generated by this script
compile           compile main project
generate_xsl      generate XSL stylesheet for SProUT2RMRS/PiXml translation
init              misc setup etc.
jar               generate project jar file
javadoc           generate javadoc
mocomanserver     run mocoman as an XML-RPC server
ms                shortcut to mocomanserver
rmrsmerge         compile rmrsmerge sdl cascade [-Dsdl.file=Y]
shutdown          shut down mocoman (via XML-RPC)
```

E.g., to compile the project, generate a jar file and javadoc, just type ant in the hog directory. The default target is `all` which performs the mentioned actions.

`ant chainsaw &` runs the chainsaw log viewer GUI

Part 3: Implementing Modules and Applications

Writing an application

An example is given in the file
`java/de/dfki/lt/hog/test/SproutPetApplication.java`
An instance of MoCoMan is created which is configured using the properties file conf/test/sproutpetapp.cfg.
Two lines in this properties file configure the architecture instance to start 3 modules which control 3 local Java components installed in the components/ directory, namely Jtok, SproUT and PET.

```
de.dfki.lt.hog.modules.SproutModule=conf/en/modules/sprout.cfg
de.dfki.lt.hog.modules.JTokModule=conf/en/modules/jtok.cfg
de.dfki.lt.hog.modules.PetModule=conf/en/modules/pet.cfg
```

The class names on the left indicate the local Java modules to create. The config property file names on the right specify startup configuration options for the modules and/or components.
The components are initialized through MoCoMan according to the configuration file. More precisely, a launcher creates the specified Module classes and registers them in the Registry. The init() methods of the Module classes are executed that start the real components.

Applications can also be connected with the MoCoMan through XML-RPC (java class XmlRpcApplication).
After the initializations, texts can be passed to the MoCoMan using the analyze() method.
Session, annotation collections and annotations ID are used to generate and refer to hierarchically organized XML annotations.

Analyze() takes input text, token range and depth of required analysis (integer value, where a higher number means deeper analysis). The MoCoMan then selects modules using the suitable() method, taking into account language and depth of analysis. The text is then passed as input to the process() method of the first selected component. Then, in a cascade, the output annotation of a preceeding module is taken as the input annotation of a subsequent module's process() method until all configured and (through depth and language) suitable components have returned their results.

If annotation database storage is enabled (through configuration of `xmldb.usage` in conf/mocoman.cfg), computed annotation can be stored persistently in the XML:DB annotation database. Hierarchical structure of sessions, annotation collections and annotation documents is automatically taken over from the MoCoMan.
A web browser can be used to inspect (in a very limited way) the contents of the Xindice database (see Xindice documentation below).

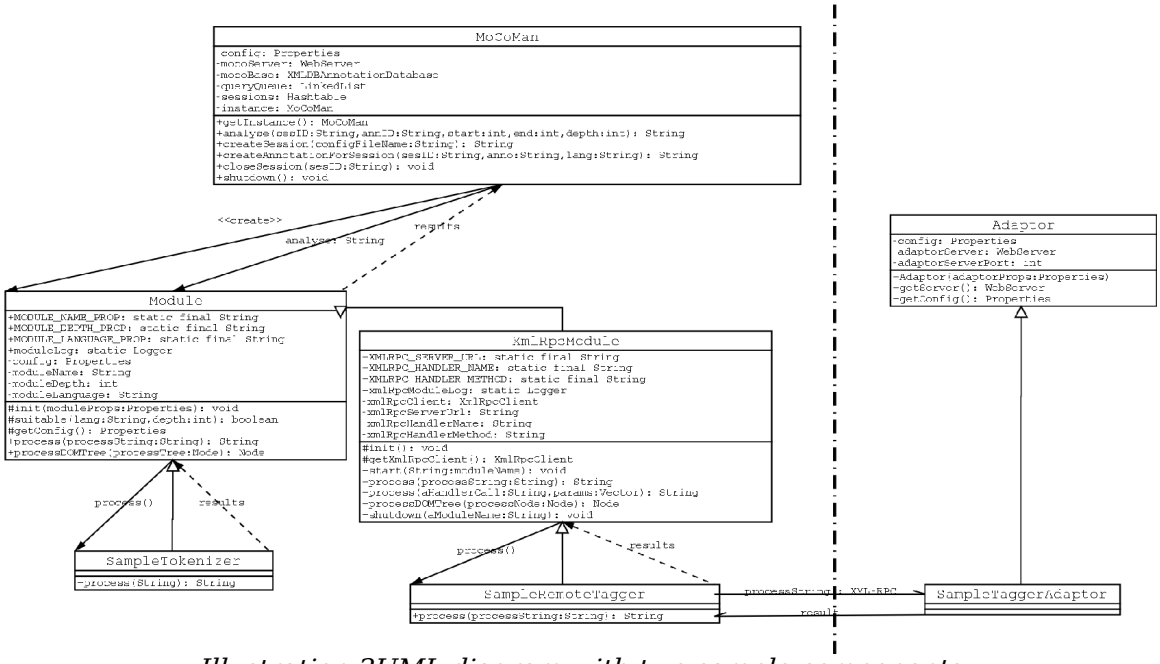


Illustration 2UML diagram with two sample components

Writing a Module

NLP components can be integrated by implementing a Java class inheriting from the abstract class `de.dfki.lt.hog.Module`.
New subclasses should be stored in the `de.dfki.lt.hog.modules` package.
The following methods can/should be refined:

- `init(configProperties)`
- `process()`
- `shutdown()`

Configuration of a module can be stored in a config properties file which is automatically passed to the module upon initialization through the Launcher.

The minimal configuration comprises these properties (with sample values)

```
module.name=Sprout
module.depth=40
module.language=en
module.rootelement=SPROUTPUT
```

but can be extended e.g., with a location for a component-specific configuration file in the ./components subdirectory such as

```
sprout.configfile=components/sprout/Project/en.cfg
```

If the XML annotation database is enabled, indexers for the XML format generated by the module should also be defined here, e.g.,

```
module.annotationindexers=(indexer1 MATCHINFO@start) (indexer2 DISJ)...
```

As modules act as mediators between (existing) NLP components and the middleware, input and output conversion, e.g., from or to RMRS should be implemented here in `adapter' methods. Common conversion methods can be shared by introducing an additional inheritance layer between the Module and their `real-world' subclasses for specific components.

Transformation Service

The `TransformationService` class supports XSL transformations plus a special handling for access to Heart of Gold-internal annotations for the XSLT (or XPath) document() function. The syntax in XPath expressions is:

```
document('hog://sid/acid/aid')
```

where sid is a sessionID, acid is a collection ID and aid is an annotation identifier such as Chunkie or JTok.
The TransformationService can be used from modules, from client applications, or from the SDL `XsltModules` (sub)classes.

To use the `TransformationService` in a `Module` subclass, create a field variable for a `TransformationService` object, say `transformationService`.

```
private TransformationService transformationService = null;
```

In the body of process(), add

```
if (this.transformationService==null) {
   this.transformationService = new TransformationService(getMoCoMan());
   myTransformer = this.transformationService.createTransformer(xslfile);
}

myTransformer.setParameter("sessionID", sid);
myTransformer.setParameter("collectionID", acid);
myTransformer.setParameter("annotationID", aid);
String result = transformationService.transform(myTransformer,xmlinput);
```

Access to multiple input annotations can be obtained by adding further parameters with unique names for annotationIDs (e.g., `annotationID2` etc.).

There are also DOM-based variants of `createTransformer()` and `transform()`. The method `getTransformerFactory()` gives access to the underlying `TransformerFactory`. Cf. javadoc for `TransformationService`.

Location of the stylesheets
The XSLT stylesheets are stored in subdirectories of the `xsl/` directory of the Heart of Gold distribution, ordered according to the target transformation format, e.g.

- `html/`: HTML visualization of RMRS structures
- `latex/`: LaTeX visualization of RMRS structures
- `mapping/`: named entity type to HPSG type mappings (no stylesheets; configuration input for automatic stylesheet generation for SProUT NER to PIC and RMRS transformation)
- `pic/`: transformation to PET input chart format
- `preproc/`: preprocessing of input texts in XML format, sentence splitting
- `rmrs/`: transformation of e.g. named entity recognizer output formats

(SProUT, LingPipe) to RMRS, partly automatically generated, cf. description of SProUTmodule below
- `sdl/`: stylesheets for XSLT transformations as part of SDL subarchitecture processing cascades, with project-wise subdirectories
- `xml/`: auxiliary stylesheets e.g. for XML prettyprinting
- `mrx/`: mrx conversion (mrx2utool.xsl)
- `fsc/`: pic to fsc conversion
- `smaf/`: pic (pet, sprout) to smaf conversion
- `sleepy/`: auxiliary stylesheets for SleepyModule
- `topoparser/`: transformation and merging stylesheets for LoParModule/Whiteboard Topoparser

Writing XML-RPC Modules and Adapters

In cases where a component should not share the JVM with MoCoMan, either because it is running on a different machine, or because it is implemented in a programming language other than Java, MoCoMan can communicate with components through XML-RPC. From the viewpoint of MoCoMan, XmlRpcModules behave like Modules. Instead of Module, XmlRpcModule is used as superclass for implementing a module.
An example is given in the dummy test application
`java/de/dfki/lt/hog/test/SampleApplication.java`

In this example, the remote TaggerAdaptor (XML-RPC) is started from the application main method (Alternatively, a special start() method could be implemented as part of the XmlRpcModule subclass). Class TaggerAdaptor
`java/de/dfki/lt/hog/modules/test/TaggerAdapter.java`
inherits from the abstract class Adaptor which in turn implements the XmlRpcServer interface, i.e., the TaggerAdaptor is the remote counterpart of a Module class called RemoteTagger
`java/de/dfki/lt/hog/modules/test/RemoteTagger.java`
that inherits from XmlRpcModule. In other words, RemoteTagger is a proxy for the remote TaggerAdapter. Global configurations for XML-RPC are stored in conf/mocoman.cfg.

MoCoMan configuration file conf/mocoman.cfg
contains the configuration for the own XML-RPC server port and the XML:DB database:

```
# server port for XML-RPC communication
xmlrpc.server.port=8411

# a boolean value whether the XML database is used
xmldb.usage=true

# location of XML database
xmldb.location=xmldb:xindice://clavinova:8080/db
```

Utility class

The Utility class (`de.dfki.lt.hog.util.Utility`) contains static methods and constants for conversion (e.g. XML), formatting, logging standardized output etc.

Logging

Logging in MoCoMan is provided through log4j; for details see http://logging.apache.org/log4j. New local classes should use the same mechanism, cf. e.g. The source code of implemented Modules.
Logging output can be configured to be HTML file, XML file, or a remote log viewer like chainsaw (which is part of log4j) can be used via socket or XML files. The Chainsaw GUI client is part of log4j and can be started with `ant chainsaw &`.
For configuration details cf. Javadoc of log4j. Here is an example for the default HTML logging defined in `conf/logging/html.cfg`:

```
# logger configuration for Heart of Gold
# (log4j property file; see http://jakarta.apache.org/log4j/docs/)
#
log4j.rootLogger=INFO, html
log4j.appender.html=org.apache.log4j.FileAppender
log4j.appender.html.layout=org.apache.log4j.HTMLLayout
log4j.appender.html.file=log/hoglog.html
log4j.appender.html.append=false
log4j.logger.de.dfki.lt.sprout=WARN
log4j.logger.de.dfki.lt.hog.modules.PetModule=DEBUG
```

The logging configuration can be easily modified by switching to a different log4j configuration file via the property `log.cfg` in conf/mocoman.cfg (recommended), build.xml, or via command line:
`ant ms -Dlog.cfg=file:/path/to/conf/logging/textfile.cfg &`

XML-RPC API for Application Clients

The XML-RPC interface published by the MoCoManServer class makes the following functions available. In principle, all public methods of the following Java classes are accessible via XML-RPC:

```
de.dfki.lt.hog.MoCoMan          as  mocoman
de.dfki.lt.hog.util.Utility     as  util
de.dfki.lt.hog.Metadata         as  metadata
```

For further details please cf. Javadoc (generate with `ant javadoc`).
The order of these most-used methods is also the order in which a typical client application will access them. For a working application, e.g. See the python code in bin/`analyzeGUI`. In the following, sid stands for sessionID, acid for annotationCollectionID, aid for annotationID (annotation name).

String **sayHello**()
: returns the String “Hello” in case the server is running

String **createSession**(String cfg)
: creates a new session with the specified configuration. The cfg String specifies the configuration file name on the server, relative to the hog/ directory. The return value is the session ID generated by the server.

String **createAnnotationCollection**(String sid)
: creates a new annotation collection which is container for all annotation Heart of Gold will produce for an input text (or input sentence).
Annotation collections can be re-used to save space on the server.
The return value is the session ID generated by the server.

String **createInitialAnnotation**(String sid, String acid, String input, String lang, String clientName)
: Creates two initial annotations in an existing session sid and annotation collection acid from input text 'input':
1. the raw text from the String input with annotationID “rawtext”.
2. The XMLified raw text including metadata with the annotationID “xmltext”. Use this method for initially putting new text into MoCoMan.

String lang contains the ISO 639 language code (cf. Appendix) of the desired analysis language, clientName is an identifier indicating the requesting client or application. The annotation ID 'xmltext' of the generated annotation is returned.

String **analyse**(String sid, String acid, String aid, int startSpan, int endSpan, int depth, String lang)
: Analyses the input annotation (specified via sid, acid and aid, where aid usually equals to 'xmltext') using the modules configured with createSession() up the specified depth and in the specficied language lang. The parameters for a span are ignored at the moment. The result

of the analyses, i.e., the deepest annotation that cold be computed, is returned as XML string. Other computed annotations can be retrieved with subsequent getAnnotation() calls.
Variant for text encoded binary (recommended as some XML-RPC implementations cannot handle 8bit/multibyte encodings correctly): **analyseBinary** with optional encoding parameter (String, last parameter, optional, default is "utf-8").

String **getAnnotation**(String sid, String acid, String aid)
Retrieves a computed annotation specified via sid, acid and aid, where aid is the name of the Module (value of property `module.name` in the Module's configuration file) that produced the annotation, or 'rawtext' or 'xmltext'.
Variant for text encoded binary (recommended as some XML-RPC implementations cannot handle 8bit/multibyte encodings correctly): **getAnnotationBinary** with optional encoding parameter (String, last parameter, optional, default is "utf-8").

String **getAnnotation7bit**(String sid, String acid, String aid)
same as getAnnotation(), but converts any Unicode character > 127 in the markup to XML entities of the form “&#nnnnn;” where nnnnn is the Unicode code. With the binary transport of annotations (via XML-RPC), the should now be obsolete. See “Character Encoding Issues”.

String **xml2htmlTransformer**(String sid, String acid, String aid,
String stylesheetfilename, String flag)
Transforms the annotation specficied via sid, acid and aid, with an XSLT stylesheet located on the server (stylesheetfilename must be specified relative to the hog/ directory). Currently supported stylesheets are
1. "xsl/html/xml2html.xsl" with flag set to “no” which produces prettyfied XML as HTML
2. "xsl/html/rmrs2html.xsl" with flag set to “yes” which produces the graphical RMRS view as HTML.

The flag indicates that special XML elements are inserted before transformation containing information on the input text on the basis of the 'rawtext' input annotation. Setting this flag to “yes” only makes sense in conjunction with the rmrs2html.xsl stylsheet.
The returned string contains the generated HTML code.

String **getStatus**()
Returns a String containing a text representing the status of mocoman (contained annotations in a tree view).

boolean **closeSession**(String sid)
Closes the specified session. Return value is true in case of success.

boolean **shutdown**()

Shuts down the whole MoCoMan server. Return value is true in case of success. Use carefully!

Character Encoding Issues

The Heart of Gold core is implemented in Java and hence XML markup which is internally represented as String (or DOM which is currently not fully supported for all modules) is encoded in 16 bit Unicode (UCS-2). However, raw text or XML markup exchange with external NLP component processes or applications clients often requires conversion to 8 bit character set encodings such as ISO-8859-x, UTF-8, EUC-JP (for Japanese), etc.
In the case of Heart of Gold components, the conversion can easily be handled by the wrapping Java module. Java supports character set conversions by simply naming the source or target encoding as an additional parameter in the process or file stream reading or writing methods. If necessary, the input and output character set can be made part of the module configuration, as is the case e.g. in PetModule, ChasenModule, RaspModule, or TnTModule
(configuration property `<modulename>.inputencoding` and `<modulename>.outputencoding`).

UTF-8 transport of annotations via XML-RPC has been problematic in earlier implementations (prior to June 2006), depending on the system environment (default encoding) and XML-RPC implementations. A workaround consisted of a routine that translated any character with Unicode > 127 in the markup to XML entities of the form "`&#nnnnn;`" where `nnnnn` is the Unicode code (`getAnnotation7bit()` and `analyse7bit()`).
This should now be obsolete as the new XML-RPC interface of HoG uses UTF-8 transport via the binary (base-64-encoded byte array) variant of XML-RPC parameter passing. This should be unique and compatible with all XML-RPC implementations (PHP not yet tried), while transporting UTF-8 via the String data type can only be guaranteed to work for US-ASCII (Unicode < 128), although many, but not all implementations assume UTF-8, or can at least be configured in that way.

The Binary versions are currently implemented for MoCoMan XML-RPC server and Python clients only, the Java clients still have to be checked and probably adapted in the same way (Java byte array parameters correspond to the Binary XML-RPC types).

Part 4: Description of Integrated Modules

Overview

The following modules with language resources are currently implemented

Name of component	*Purpose*	*Depth e.g.*	*Language resources*	*Implemented in*
JTok	tokenizer	10	en, de, it	Java
ChaSen	morph,WBR	10	ja	C
TnT	PoS tagger	20	en, de	C
TreeTagger	PoS tagger	20	en, de, es, it, ...	C
FreeLing	PoS, morph, NE	20	en, es, ca, gl, it	C++
Chunkie	chunker	30	en, de	C
ChunkieRmrs	chunks	35	en, de	XTDL, XSLT, SDL*
SProUT	morph,NER,IE,...	40	en, de, el, ja	Java
LingPipe	NER	40	en	Java
Corcy	coref. resolver	45	en	Python
LoPar/wbtopo	PCFG	50	de	C, XSLT
RASP	stat. parser	50	en	C, Lisp
SDL	subarchitectures			Java
Sleepy	shallow parser	50	de	OCaml
PET	deep parser	100	en, de, el, it, ja, no	C, C++, Lisp
RMRSmerge	merge RMRSes	110		XSLT, SDL/Java

*: ChunkieRmrs is not a proper module, but an instance of a SdlModule, based on the sub-architecture defined by an SDL description.

Sample configurations per language are in conf/${lang}/sessions/default.cfg These files comprise all modules for which implementations in the specified language ${lang} exist. The corresponding module configuration files are examples, too! Modules can be (de)activated by simply commenting in/out (#) the corresponding configuration line. Note that deactivating a module may have an impact on depending modules as well (their configuration will have to modified, too; e.g. PET depends on input of NE recognizers).

The Module classes described on the subsequent pages are defined in the package de.dfki.lt.hog.modules.

Their class name has to be mentioned fully in the session configuration file, e.g. `conf/${lang}/sessions/default.cfg`

Module dependencies:
DE: PetModule requires JTokModule, TnTModule and SproutModule
ChunkieRMRS requires JTokModule, TnTModule, ChunkieModule and SproutModule
LoParModule (with Whiteboard Topoparser cascade) requires JTokModule, TnTModule (with tnt-topo configuration) and ChunkieModule
EN: PetModule requires JTokModule, TnTModule and SproutModule OR LingPipe2Module
ChunkieRMRS requires JTokModule, TnTModule, ChunkieModule and SproutModule
Rasp2Module requires JTokModule
JA: PetModule requires ChasenModule and SproutModule
EL: PetModule requires PicModule and SproutModule

JTokModule

- depth 10
- purpose: Tokenization, Sentence boundary recognition
- supported language resources: de, en, it (others can be defined in a JTok XML configuration file)
- runs JTok API
- init(): initialization with configured resources
- process(): Tokenization with jtok, XML output
- developers: JTok: Jörg Steffen (DFKI), JTokModule: Ulrich Schäfer, Özgür Demir
- path: `components/jtok`
- Installation: part of middleware-lib.tar.gz

Output DTD:

```
<!ELEMENT jtok ( metadata p* ) >

<!ELEMENT p ( tu )+ >

<!ELEMENT tu ( Token )+ >
<!ATTLIST tu id ID >

<!ELEMENT Token EMPTY >
<!ATTLIST Token string CDATA #REQUIRED
                type NMTOKEN #REQUIRED
                offset NMTOKEN #REQUIRED
                length NMTOKEN #REQUIRED >
```

Configuration file conf/en/modules/jtok.cfg:

```
# configuration file for JTok module
#
module.name=JTok
module.depth=10
module.language=en
# root element for XML output
module.rootelement=jtok
# ----- common modules settings end here -----
# config file for JTok API
jtok.configfile=components/jtok/conf/jtok.cfg
```

ChasenModule

- depth 10
- purpose: morphology and word boundary recognition for Japanese
- supported language resources: ja
- init(): initialization with configured resources
- process(): start chasen script
- developers: AIST Nara (Matsumoto et al.), http://chasen.aist-nara.ac.jp ChasenModule: Ulrich Schäfer
- path: `components/chasen`
- Installation: central RPM installation assumed, alternatively download & compile sources from AIST, adapt configuration `conf/ja/modules/chasen.cfg`, `conf/ja/modules/chasenrc-xml`, `components/sprout/Project/ja.cfg`

Output DTD:
The output format is PiXML DTD (see page).

It is defined for ChaSen in a configuration file that can be generated as follows (the central installation paths for ChaSen may differ from distribution to distribution).
`cp /usr/share/chasen/dic/ipadic/chasenrc hog/conf/ja/modules/chasenrc-xml`
set the output format in the copied file `hog/conf/ja/modules/chasenrc-xml` as follows (on a single line):

```
(OUTPUT_FORMAT "<w cstart=\"%ps\" cend=\"%pe\"><surface>
%m</surface><pos tag=\"%P-+%Tn-%Fn\" prio=\"%c\"/></w>")
```

Configuration file conf/ja/modules/chasen.cfg:

```
module.name=ChaSen
module.depth=10
module.language=ja
# root element for XML output
module.rootelement=chasen
#
# ----- common modules settings end here -----
#
# command line options for ChaSen server
chasen.options=-r conf/ja/modules/chasenrc-xml
#
# path to server binary
chasen.binary=/usr/bin/chasen
#
# path to libraries for server
chasen.libs=/usr/lib/chasen
#
# input encoding
chasen.inputencoding=EUC-JP
```

```
#
# output encoding
chasen.outputencoding=EUC-JP
#
# input annotation ID
chasen.inputannotation=rawtext
```

SproutModule requires the ChaSen binary as well (and independently of the ChasenModule). The path to chasen in the configuration file for the Japanese NE grammar has to be adapted as follows.

In `hog/components/sprout/Project/ja.cfg:`

```
MorphologyApplicationPath=/usr/bin/chasen
```

TnTModule

- depth 20
- purpose: Statistical PoS tagging
- supported language resources: de, en (others could be trained)
- developers: TnT: Thorsten Brants (Saarland U.), http://www.coli.uni-saarland.de/~thorsten/tnt/ TnTModule: Özgür Demir
- path: `components/tnt`
- Installation: unpack components-tnt.tar.gz

TnT is a statistical PoS tagger. The module uses the JTok tokenization of the Heart of Gold as input and returns XML output of TnT analyses including probability values for PoS tags.

Output DTD:

```
<!ELEMENT tnt ( metadata tokens ) >

<!ELEMENT tokens ( w )* >

<!ELEMENT w ( p )* >
<!ATTLIST w str CDATA #REQUIRED
            cstart NMTOKEN #REQUIRED
            cend NMTOKEN #REQUIRED >

<!ELEMENT p EMPTY >
<!ATTLIST p pos NMTOKEN #REQUIRED
            p   CDATA #REQUIRED >
```

Example:

```
<tnt>
 <metadata>
  <tokens>
<w str="How" cstart="0" cend="2">
  <p pos="WRB" p="1.000000e+00"/>
</w>
<w str="cold" cstart="4" cend="7">
  <p pos="NN" p="6.513877e-01"/>
  <p pos="JJ" p="3.486123e-01"/>
</w>
<w str="should" cstart="9" cend="14">
  <p pos="MD" p="1.000000e+00"/>
</w>
<w str="a" cstart="16" cend="16">
  <p pos="DT" p="1.000000e+00"/>
</w>
<w str="refrigerator" cstart="18" cend="29">
  <p pos="NN" p="1.000000e+00"/>
</w>
<w str="be" cstart="31" cend="32">
  <p pos="VB" p="1.000000e+00"/>
```

```
</w>
<w str="?" cstart="33" cend="33">
  <p pos="." p="1.000000e+00"/>
</w>
</tokens>
</tnt>
```

Additionally, PET input chart XML format is generated according to the PiXML DTD (see PET section).

Configuration file conf/en/modules/tnt.cfg:

```
module.name=TnT
module.depth=20
module.language=en
# root element name for XML output
module.rootelement=tnt
# ----- common modules settings end here -----
# path to tnt startscript
tnt.script=components/tnt/scripts/tnt.sh
# command line options for tnt
tnt.options=-z20 -v0 models/wsj
# input encoding
tnt.inputencoding=ISO-8859-1
# output encoding
tnt.outputencoding=ISO-8859-1
# name of generated Pet input chart XML annotation
tnt.piXMLoutputannotation=TnTpiXML
#
# root element name of PET input chart XML annotation
#
tnt.piXMLrootelement=pet-input-chart
#
```

FreeLingModule

- depth 20
- purpose: PoS tagger, NER and morphology
- supported language resources: es, ca, en, it, gl
- developers: FreeLing and LKB sppp wrapper: Lluis Padró. FreeLingModule, sppp2pic.xsl: Ulrich Schäfer,
- installation: centrally installed FreeLing RPM, LKBwrapper has to be compiled into components/freeling/bin (paths must be adapted in Makefile, cf. documentation in components/freeling/src/wrapper/README), then adapt paths in conf/es/modules/freeling.cfg and conf/es/modules/sppp.cfg
- http://www.lsi.upc.es/~nlp/freeling/.

Output DTD:
The LkbWrapper (needs to be compiled) natively produces the LKB SPPP format (documentation: http://wiki.delph-in.net/moin/LkbSppp).
PET input chart XML format is generated according to the PiXML DTD (see PET section) using the stylesheet xsl/pic/sppp2pic.xsl

Configuration file conf/es/modules/freeling.cfg:

```
# configuration file for FreeLingModule (Spanish)
# 2006-06-17 ulrich.schaefer@dfki.de
#
module.name=FreeLing
module.depth=20
module.language=es
#
# root element name for XML output
module.rootelement=freeling
#
# ----- common modules settings end here -----
#
# path to cheap binary
freeling.binary=components/freeling/LKBanalyzer
#
# additional library search path for cheap
#freeling.libs=components/freeling/lib
#
# command line options for cheap
freeling.options=-f conf/es/modules/sppp.cfg
#
# character set encoding for PET input
freeling.inputencoding=ISO-8859-1
#
# character set encoding for PET output
freeling.outputencoding=ISO-8859-1
#
# input annotation for FreeLing
freeling.inputannotation=xmltext
```

```
#
# stylesheet for PET XML input chart generation
freeling.picstylesheet=xsl/pic/sppp2pic.xsl
#
```

PicModule

- depth 10
- purpose: dummy module that generates Pet Input Chart format out of raw text
- supported language resources: - (currently only used for modern Greek)
- developers: Ulrich Schäfer
- path: Java module definition only

Output DTD:
PET input chart XML format is generated according to the PiXML DTD (see PET section).

Configuration file conf/el/modules/pic.cfg:

```
# configuration file for PicModule (modern Greek)
# 2004-10-13 ulrich.schaefer@dfki.de
#
module.name=Pic
module.depth=10
module.language=el
# root element name for XML output
module.rootelement=pet-input-chart
#
# ----- common modules settings end here -----
#
# name of raw text input annotation
pic.inputtextannotation=rawtext
#
```

ChunkieModule

- depth 30
- purpose: Statistical chunking
- supported language resources: de, en (others could be trained)
- developers: Chunkie: Wojciech Skut (DFKI) and Thorsten Brants (Saarland U.), ChunkieModule: Özgür Demir
- path: `components/chunkie`
- Installation: unpack components-chunkie.tar.gz

ChunkieModule uses Jtok tokenization as input and returns XML output of Chunkie chunk analyses including the selected PoS tags from TnT.

Output DTD:

```
<!ELEMENT chunkie ( metadata chunks ) >

<!ELEMENT chunks ( s )* >

<!ELEMENT s ( w | chunk )* >
<!ATTLIST s id ID
            cstart NMTOKEN #REQUIRED
            cend   NMTOKEN #REQUIRED >

<!ELEMENT w ( #PCDATA ) >
<!ATTLIST w pos    NMTOKEN #REQUIRED
            cstart NMTOKEN #REQUIRED
            cend   NMTOKEN #REQUIRED >

<!ELEMENT chunk  ( w )+ >
<!ATTLIST chunk cat    NMTOKEN #REQUIRED
                cstart NMTOKEN #REQUIRED
                cend   NMTOKEN #REQUIRED >
```

Example:

```
<chunkie>
<metadata>
    <id>
        <entry name="created" value="Sa, 12 Mrz 2005 16:46:00 +0100"/>
        <entry name="processingtime" value="00:00,803"/>
        <entry name="sessionid" value="session1"/>
        <entry name="acid" value="collection1"/>
        <entry name="component" value="Chunkie"/>
        <entry name="diagnosis" value="OK"/>
        <entry name="empty" value="false"/>
    </id>
    <conf>
        <entry name="chunkie.script"
value="components/chunkie/scripts/chunkie.sh"/>
        <entry name="module.depth" value="30"/>
        <entry name="chunkie.options" value="data/wsj-pos data/wsj-chunk-
convert"/>
```

```
        <entry name="module.rootelement" value="chunkie"/>
        <entry name="module.language" value="en"/>
        <entry name="chunkie.inputencoding" value="ISO-8859-1"/>
        <entry name="chunkie.outputencoding" value="ISO-8859-1"/>
        <entry name="chunkie.phrasalcats" value="--|ADJP|ADVP|CONJP|EMPTY|
FRAG|INTJ|NAC|NP|NX|PP|PRN|PRT|QP|SBARQ|SINV|UCP|WHADJP|WHADVP|WHNP|WHPP|X"/>
        <entry name="module.name" value="Chunkie"/>
    </conf>
</metadata>
<chunks>
<s id="S0" cstart="0" cend="33">
  <w pos="WRB" cstart="0" cend="2">How</w>
  <w pos="NN" cstart="4" cend="7">cold</w>
  <w pos="MD" cstart="9" cend="14">should</w>
  <chunk cat="NP" cstart="16" cend="29">
    <w pos="DT" cstart="16" cend="16">a</w>
    <w pos="NN" cstart="18" cend="29">refrigerator</w>
  </chunk>
  <w pos="VB" cstart="31" cend="32">be</w>
  <w pos="$PUNCT" cstart="33" cend="33">?</w>
</s>
</chunks>
</chunkie>
```

Configuration file conf/en/modules/chunkie.cfg:

```
module.name=Chunkie
module.depth=30
module.language=en
# root element name for XML output
module.rootelement=chunkie
# ----- common modules settings end here -----
# path to chunkie startscript
chunkie.script=components/chunkie/scripts/chunkie.sh
# command line options for rasp
chunkie.options=data/wsj-pos data/wsj-chunk-convert
# input encoding
chunkie.inputencoding=ISO-8859-1
# output encoding
chunkie.outputencoding=ISO-8859-1
```

LingPipe2Module

- depth 40
- purpose: statistical named entity recognition
- supported language resources: multilingual, depending on trained models
- runs LingPipe (original lingpipe archive copied to `components/lingpipe`)
- init(): initialization of variables
- process(): runs lingpipe NER and generates XML output
- developers: Bob Carpenter / alias-i Inc. http://www.alias-i.com/lingpipe. LingPipeModule: Özgür Demir
- path: `components/lingpipe`
- Installation: unpack LingPipe distribution into `components/lingpipe/`

Configuration file conf/en/modules/lingpipe2.cfg:

```
# configuration file for LingPipe2 module

module.name=LingPipe2
module.depth=40
module.language=en

# root element name for XML output
module.rootelement=LINGPIPE

lingpipe2.modelsdir=components/lingpipe/lingpipe-3.5.0/demos/models

lingpipe2.modelfile=ne-en-news-muc6.AbstractCharLmRescoringChunker

lingpipe2.pixmlannotation=LingPipepiXML
lingpipe2.rawannotation=LingPipeRaw

lingpipe2.stylesheet4pic=xsl/pic/en_news_lingpipe2pixml.xsl
lingpipe2.stylesheet4rmrs=xsl/rmrs/en_news_lingpipe2rmrs.xsl
```

DTD

```
<!ELEMENT LINGPIPE ( metadata NE* ) >

<!ELEMENT NE EMPTY >
<!ATTLIST NE id     NMTOKEN #REQUIRED
             type   NMTOKEN #REQUIRED
             string CDATA   #REQUIRED
             cstart NMTOKEN #REQUIRED
             cend   NMTOKEN #REQUIRED >
```

Additionally, PET input chart XML format is generated according to the PiXML DTD (see PET section).

SproutModule

- depth 40
- purpose: rule-based named entity recognition, information extraction
- supported language resources: multilingual, depending on grammar and required morphology etc.
- runs SProUT runtime API
- init(): initialization of SProUT API with configured resources
- process(): SProUT analysis & transformation of XML output to RMRS DTD syntax
- developers: SProUT group, http://sprout.dfki.de, SproutModule: Ulrich Schäfer
- path: `components/sprout`
- Installation: unpack components-sprout.tar.gz (or use ant sprout2hog if you have access to SProUT development environment)

SproutModule runs an instance of the SProUT interpreter (runtime API) with a configured grammar and other resources. The output of the interpreter is converted to the RMRS and PET Input Chart (or SMAF) formats using XSLT stylesheets that have been generated automatically at compile time from SProUT named entity grammar output type definitions using the ant target

`ant generate_xsl` [`-Dproject=`*sproutprojectsuffix*]

The optional -Dproject=*sproutprojectsuffix* parameter can be used to specify a suffix name for SProUT named entity grammars, e.g. `ltworld` or `soccer`. Currently, this only holds for the English and German project-specific grammars. The corresponding ant command in the SProUT (not HoG!!) source tree (from the SProUT subversion repository) is

`ant sprout2hog` [`-Ddomain=`*sproutprojectsuffix*]

The SProUt NE type to HPSG type mappings are defined in `xsl/mappings/`. The format for a mapping is

```
sprout_ne_type=hpsg_type
```

Types not mentioned in the mapping files are not mapped by the generated stylesheets. If a SProUT NE type is to be translated to RMRS, but not to the PET Input Chart, then the RHS of the mapping must be left empty:

```
sprout_ne_type=
```

The SProUT runtime subsystem for use in the Heart of Gold is generated by the SProUT source ant target 'sprout2hog', and currently comprises the runtime jar, 4 named entity grammars for EL, EN, DE, JA, and 8 ChunkieRMRS cascade grammars (in components/sprout). Cf. the SProUT manual and ant documentation for further information.

Multiple and cascaded SProUT grammars can be included via the new SdlModule (page 51).

Configuration file conf/en/modules/sprout.cfg:

```
module.name=Sprout
module.depth=40
module.language=en
# root element name for XML output
module.rootelement=SPROUTPUT
#
# ----- common modules settings end here -----
#
#
# config file for SProUT runtime API
sprout.configfile=components/sprout/Project/de.cfg
#
# stylesheet for transformation of FS-XML to RMRS
sprout.stylesheet=xsl/rmrs/de_types-sprout2rmrs.xsl
#
# feature path to output structure
# if undefined, the root FS (including IN and OUT) is returned
# feature separator in the path can be . or | (as in TFS API)
sprout.outputpath=
#
# name of raw text input annotation for Sprout
sprout.inputtextannotation=rawtext
#
# name of feature structure output annotation
sprout.outputfsannotation=SproutFS
#
# ----- The following configurations are for PET input chart mode only
-----
# The subsequent settings are ignored if sprout.output4pic is not set
#
# name of output annotation for PET input chart (pic) format
# no pic annotation is generated if this value is omitted
sprout.output4pic=SProUTpiXML
#
# stylesheet for transformation of FS-XML (Sproutput) to PET input
chart format
# (ignored if sprout.output4pic is not set)
sprout.stylesheet4pic=xsl/pic/de_types-sprout2pixml.xsl
#
# ----- End of configurations for PET input chart mode -----
```

Sprout output ('SproUTput') DTD:

```
<!-- Sproutput DTD Version 2004
     AUTHOR : uschaefer@dfki.de
     VERSION: 2.1
     DATE:    2004-01-21
-->

<!ELEMENT SPROUTPUT ( metadata DISJ* ) >

<!ELEMENT DISJ ( MATCHINFO )+ >
<!ATTLIST DISJ id ID >

<!ELEMENT MATCHINFO ( FS ) >
<!ATTLIST MATCHINFO id     ID      #IMPLIED
                    rule   NMTOKEN #IMPLIED
                    cstart NMTOKEN #IMPLIED
                    cend   NMTOKEN #IMPLIED
                    start  NMTOKEN #IMPLIED
                    end    NMTOKEN #IMPLIED >

<!ELEMENT FS ( F )* >
<!ATTLIST FS type  CDATA #REQUIRED
             coref NMTOKEN #IMPLIED >

<!ELEMENT F  ( FS | SET ) >
<!ATTLIST F  name NMTOKEN #REQUIRED >

<!ELEMENT SET ( FS | SET )* >
<!ATTLIST SET coref NMTOKEN #IMPLIED >
```

SProUT RMRS DTD:
see RMRS DTD on page 74. Structure:

<rmrs-list>
  <metadata>
  <rmrs .../>
</rmrs-list>

SProUT PiXML DTD:
Additionally, the PET input chart XML format is generated according to the PiXML DTD (see PET section).
Alternatively, the SMAF format can be generated (configuration in sprout.cfg):

Recently, sprout_morph configurations have been added. These are SProUT grammars passing the SProUT (mmorph-based) morphological analysis for each input token.

CorcyModule

- depth 45
- purpose: coreference resolver
- init(): configuration
- process(): runs a python program (via script)
- developed by: Özgür Demir
- path: `components/corcy`
- Installation: unpack components-corcy.tar.gz

Corcy is a coreference resolver implementation along the lines of [CardieWagstaff]. A copy of the article is to be found in `components/corcy/doc`.
Corcy uses a heuristic clustering algorithm to determine coreference relationships (also uses TnT and Chunkie).

Sample output:

```
<corcy>
  <metadata .../>
  <clusters>
  <COREF cluster="0">John</COREF> loves <COREF cluster="2">Mary</COREF>
and <COREF cluster="2">her</COREF> <COREF cluster="3">sister</COREF>.
  </clusters>
</corcy>
```

Output DTD:

```
<!ELEMENT corcy ( metadata clusters ) >

<!ELEMENT COREF #PCDATA >
<!ATTLIST COREF cluster NMTOKEN #REQUIRED >
```

Configuration file conf/en/modules/corcy.cfg:

```
module.name=Corcy
module.depth=45
module.language=en
# root element name for XML output
module.rootelement=corcy
# ----- common modules settings end here -----
# path to corcy start script
corcy.script=components/corcy/corcy.sh
# command line options for corcy
corcy.options=
# input encoding
corcy.inputencoding=ISO-8859-1
# output encoding
corcy.outputencoding=ISO-8859-1
```

Rasp2Module

- depth 50
- purpose: medium-depth analysis
- runs RASP in a local subprocess, RMRS conversion in separate Socket server
- init() starts RASP process via shell script
- process() sends input text to the RASP process
- developed by: RASP: U. Sussex / John Carroll, Ted Briscoe et al.
  http://www.informatics.susx.ac.uk/research/nlp/rasp/
  RASPModule: U. Schäfer
  Adaptations for RASP2: Torsten Marek, thanks to CJ Rupp for his help
- path: `components/rasp2`
- Installation (requires `rasp_rel2.tgz` from RASP download page AND `components-rasp2.tar.gz` from HoG download page)
  - `tar xzf components-rasp2.tar.gz`
  - `cd components/rasp2`
  - `tar xzf .../rasp_rel2.tgz`
  - `mv components/rasp2/rasp_int_hog.sh components/rasp2/scripts/`
  - in `components/rasp2/scripts/rasp_parse.sh` replace line
    `RASP=/local/scratch/`whoami`/rasp3`
    by
    `R=$(readlink -f $0)`
    `RASP=${R%/*/*}`

Currently, the RMRS converter server has to be started manually before starting a HoG session using Rasp2Module. The start script is

`components/rasp2/rasp-rmrs-converter/start_server`

You also may wish to adapt the host name in `conf/en/modules/rasp2.cfg`.

Configuration file `conf/en/modules/rasp2.cfg`:

```
module.name=RASP2
module.depth=50
module.language=en
# root element name for XML output
module.rootelement=rasp
# ----- common modules settings end here -----
# path to rasp startscript
rasp2.script=components/rasp2/scripts/rasp_int_hog.sh
#
# character set encoding for RASP input
rasp2.inputencoding=ISO-8859-1
#
# character set encoding for RASP output
rasp2.outputencoding=ISO-8859-1
#
# stylesheet for postprocessing transformation
# (comment for no transformation)
```

```
rasp2.postprocstylesheet=xsl/rmrs/remove_rasp_anchors.xsl
#
# host and port of rmrs converter server
rasp2.converter_host=localhost
rasp2.converter_port=8891
```

RASP DTD (subset of RMRS DTD, cf. Appendix). Structure:

```
<rasp2>
  <metadata>
  <rmrs .../>
</rasp2>
```

To build the RASP RMRS converter server (Lisp Image) from the LKB source tree in `components/rasp2/rasp3-rmrs/src/`, a Lisp (e.g. Allegro Common Lisp) is required.

```
cd components/rasp2/rasp3-rmrs/src/rmrs/rasp3/
build_standalone_image.sh DIRECTORY
```

where DIRECTORY is the target installation directory for the image.
It may be necessary to also adapt paths to the Lisp installation in the script. Adapt variable `lkb_home` in the start script `start_rasp3_rmrs_server.sh` to the direcory containing the LKB src tree (src/...).

The script `start_rasp3_rmrs_server.sh` starts the RMRS converter server.

The postprocessing stylesheet `xsl/rmrs/remove_rasp_anchors.xsl` configurable in rasp2.cfg is currently experimental. It serves to remove the <anchor> elements to make the module output compatible with the (now old) RMRS DTD and the rmrs2html.xsl visualization stylesheet. However, this leads to spurious double ARGs and free_args. The postprocessing stylesheet can be turned off by commenting the configuration line:

```
#rasp2.postprocstylesheet=xsl/rmrs/remove_rasp_anchors.xsl
```

in rasp2.cfg.

LoParModule
(LoPar + German topoparser cascade from the Whiteboard project)

- depth 50
- purpose: German shallow topological parsing, combined with chunker, tagger output
- requires preparatory TntModule with configuration file conf/de/modules/tnttopo.cfg (depth 20)
- supported language resources: de
- developers: LoPar: Helmut Schmid (http://www.ims.uni-stuttgart.de/projekte/gramotron/SOFTWARE/LoPar.html) LoParModule: Daniel Contag, Whiteboard topoparser cascade: Anette Frank, U. Schäfer
- paths: `components/lopar, xsl/topoparser/`

Configuration:

```
the following modules need to be activated (session configuration):
de.dfki.lt.hog.modules.JTokModule=conf/de/modules/jtok.cfg
de.dfki.lt.hog.modules.TnTModule=conf/de/modules/tnttopo.cfg
de.dfki.lt.hog.modules.ChunkieModule=conf/de/modules/chunkie.cfg
de.dfki.lt.hog.modules.LoParModule=conf/de/modules/lopar.cfg

# configuration file for LoPar

module.name=LoPar
module.depth=50
module.language=de

lopar.binary=components/lopar/bin/lopar
lopar.model=-in components/lopar/data/topo-tnt-nbest-relevant/topo-tnt
lopar.options=-viterbi -quiet -quote
lopar.xsldir=xsl/topoparser/
lopar.tmpDir=components/lopar/data/tmp

lopar.topotree.annotationname=TopoTree
lopar.topoflat.annotationname=TopoFlat
lopar.topochunks.annotationname=TopoChunks

# input encoding
lopar.inputencoding=ISO-8859-1
#
# output encoding
lopar.outputencoding=ISO-8859-1
#
# needed because of analysis inside the module uses chunkie
chunkie.moduleDepth=30
#
# stylesheet for postprocessing transformation
# (comment for no transformation)
#lopar.postprocstylesheet=xsl/topoparser/topo2brackets_chunks.xsl
```

LoPar is a PCFG parser. Its output

Output DTD (roughly; may be incomplete):

```
<!ELEMENT LoPar ( metadata, ROOT ) >

<!ELEMENT ROOT ( CL )* >

<!ELEMENT CL ( VF?, LK?, MF?, RK?, NF? ) >
<!ATTLIST CL fn NMTOKEN #REQUIRED >

<!ELEMENT VF ( CHUNK | W )* >
<!ATTLIST VF fn NMTOKEN #REQUIRED >

<!ELEMENT MF ( LK | RK | CHUNK | W )* >

<!ELEMENT NF ( LK | RK | CHUNK | W )* >

<!ELEMENT LK ( VAFIN | VVPP | KOUS | CHUNK | W )* >
<!ATTLIST LK fn NMTOKEN #REQUIRED >

<!ELEMENT RK ( VAFIN | VVPP | CHUNK | W )* >
<!ATTLIST RK fn NMTOKEN #REQUIRED >

<!ELEMENT KOUS ( W )* >
<!ELEMENT VAFIN ( W )* >
<!ELEMENT VVPP ( W )* >

<!ELEMENT CHUNK ( W )* >
<!ATTLIST CHUNK cat NMTOKEN #REQUIRED
                cstart NMTOKEN #REQUIRED
                cend NMTOKEN #REQUIRED >

<!ELEMENT W ( #PCDATA ) >
<!ATTLIST W id ID #REQUIRED
            pos NMTOKEN #REQUIRED
            cstart NMTOKEN #REQUIRED
            cend NMTOKEN #REQUIRED >
```

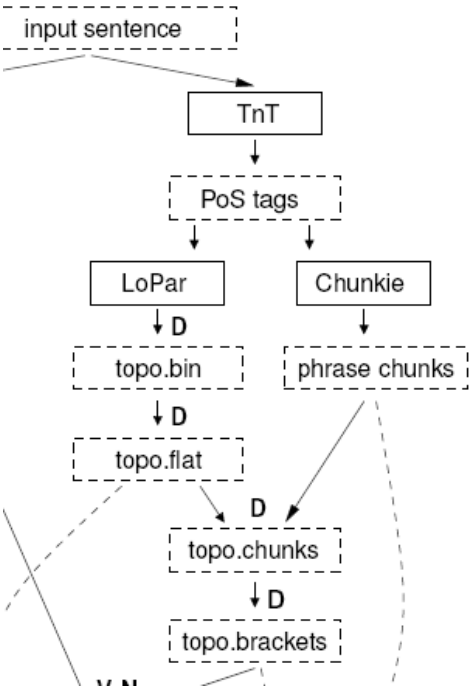
Installation:

- unpack HoG package components-lopar.tar.gz
- LoPar is not part of this archive, download separately from ftp://ftp.ims.uni-stuttgart.de/pub/corpora/LoPar/lopar-3.0.linux.tar.gz
- copy lopar-3.0/bin/lopar to components/lopar/bin. The model and grammar files below data/ are part of components-lopar.tar.gz; they are different from those in the original distribution's data directory and have been produced in the Whiteboard project by Anette Frank.
- Directory structure below components/lopar/:

```
|-- bin/
|   `- lopar
`-- data/
```

```
|-- tmp/
|-- topo-tnt-nbest-relevant/
    |-- topo-tnt.OC
    |-- topo-tnt.gram
    |-- topo-tnt.lex
    |-- topo-tnt.oc
    |-- topo-tnt.results
    |-- topo-tnt.start
    |-- topo-tnt.tnt-tags-relevant
    |-- topo-tnt.tnt-unique-tags
    `-- topo-tnt.txt
```

The Whiteboard topo parser XSLT cascade is described in [Topo2HPSG] and [WHAT].
Please note that currently the integration of the shallow topoparser cascade with the deep parser (German HPSG grammar) is not implemented in Heart of Gold. The most useful shallow topological annotations produced by the LoParModule is (presumably) TopoChunks, maybe also TopoTree and TopoFlat. The computed brackets in TopoBrackets, however, are not compatible with the recent versions of the German HPSG grammar, moreover, the PET interface has changed compared to the PET version employed in Whiteboard.



TreeTagger
(very experimental; integrated mainly for SleepyModule)
- depth 20
- purpose: Statistical PoS tagging
- supported language resources: de, en, es, it (others could be trained)
- developers: TreeTagger: Helmut Schmid, http://www.ims.uni-stuttgart.de/projekte/corplex/TreeTagger/DecisionTreeTagger.html
  TreeTaggerModule: Özgür Demir
- path: `components/treetagger`
- Installation: unpack components-treetagger.tar.gz

Configuration:

```
module.name=TreeTagger
module.depth=25
module.language=de
# root element name for XML output
module.rootelement=treetagger
# ----- common modules settings end here -----
# path to treetagger startscript
treetagger.script=components/treetagger/cmd/tree-tagger-german
#
# command line options for treetagger
treetagger.options=-token -lemma -sgml -pt-with-lemma
#
# input encoding
treetagger.inputencoding=ISO-8859-1
#
# output encoding
treetagger.outputencoding=ISO-8859-1
#
# annotation name for synchronization with tokenization
treetagger.tokenization=JTok
#
```

TreeTagger is a statistical PoS tagger. The module uses the Jtok tokenization of the Heart of Gold as input and returns XML output of TreeTagger analyses.

Output DTD:

```
<!ELEMENT treetagger ( metadata tokens ) >

<!ELEMENT tokens ( t )* >

<!ELEMENT t ( #PCDATA )* >
<!ATTLIST t pos NMTOKEN #REQUIRED
            lemma CDATA #REQUIRED
            cstart NMTOKEN #REQUIRED
            cend NMTOKEN #REQUIRED >
```

Installation
Download TreeTagger, the scripts archive and necessary parameter files. Unpack to hog/components/treetagger/ (subdirs are contained in archives), the directory tree structure should be as follows.

```
|-- FILES
|-- LICENSE
|-- README
|-- README.script
|-- bin
|   |-- separate-punctuation
|   |-- train-tree-tagger
|   `-- tree-tagger
|-- cmd
|   |-- filter-chunker-output.perl
|   |-- filter-german-tags
|   |-- lookup.perl
|   |-- mwl-lookup.perl
|   |-- tagger-chunker-english
|   |-- tagger-chunker-german
|   |-- tree-tagger-english
|   |-- tree-tagger-french
|   |-- tree-tagger-german
|   |-- tree-tagger-italian
|   `-- tree-tagger-spanish
|-- doc
|   |-- nemlap94.ps
|   `-- sigdat95.ps
`-- lib
    |-- english-abbreviations
    |-- english-lexicon.txt
    |-- english.par
    |-- german-abbreviations
    |-- german-lexicon.txt
    |-- german.par
    |-- italian.par
    |-- spanish-abbreviations
    `-- spanish-mwls
```

add the following two lines and edit the variables BIN/CMD/LIB in the treetagger scripts (e.g. cmd/tree-tagger-german) as follows:

```
TTHOME=`dirname \`dirname \\\`readlink -f $0\\\`\``
cd $TTHOME

BIN=./bin
CMD=./cmd
LIB=./lib
```

SleepyModule

- depth: 50
- purpose: probabilistic shallow parser for German
- runs sleepy (implemented in OCaml)
- init(): start Sleepy binary, load model
- developed by: Sleepy: Amit Dubey, http://www.coli.uni-saarland.de/~adubey/sleepy/, SleepyModule: Özgür Demir
- path: components/sleepy
- Installation: Unpack components-sleepy.tar.gz.

SleepyModule parses German sentences by using a probabilistic model (configurable). Currently, Sleepy uses JTok tokenization

```
module.name=Sleepy
module.depth=50
module.language=de
# root element name for XML output
module.rootelement=sleepy
#
# ----- common modules settings end here -----
#
# path to sleepy startscript
sleepy.script=components/sleepy/scripts/sleepy.sh
#
# command line options for chunkie
#sleepy.options=--model-file ./data/tiger.model --multipass-smooth2
--witten-bell --max-sentence 40 --beam 1000 --pos-beam 3000 --use-
parse-cache
#sleepy.options=--max-sentence 40 --turbo --gen-lossy-binarization
--beam 1000 --model-file ./data/tiger.nosmooth.model
sleepy.options=--max-sentence 40 --gen-lossy-binarization --beam 1000
--model-file ./data/tiger.nosmooth.model
#
# input encoding
sleepy.inputencoding=ISO-8859-1
#
# output encoding
sleepy.outputencoding=ISO-8859-1
#
# annotation name for synchronization with tokenization
sleepy.tokenization=JTok
#
# stylesheet for postprocessing
sleepy.postprocstylesheet=xsl/sleepy/insertLemma.xsl
#
# name of input annotation to include in postprocessing, e.g.
TreeTagger
sleepy.postprocinputannotation=TreeTagger
#
```

Output DTD:

```
<!ELEMENT sleepy ( metadata parse ) >

<!ELEMENT parse ( node )* >

<!ELEMENT node ( #PCDATA | ( node )* ) >
<!ATTLIST node cat CDATA #REQUIRED
               lb CDATA #IMPLIED
               lemma CDATA #IMPLIED
               id NMTOKEN #REQUIRED
               cstart NMTOKEN #REQUIRED
               cend NMTOKEN #REQUIRED >
```

Installation:

Here is the directory structure below hog/components/sleepy/:

```
|-- bin
|   `-- sleepy
|-- data
|   |-- negra.model
|   |-- tiger.model
|   `-- tiger.nosmooth.model
`-- scripts
    `-- sleepy.sh
```

SdlModule

- depth: depending on instance
- purpose: general module, sub-architectures with access to other Heart of Gold annotations
- runs a class compiled from an SDL description
- init(): initialization of a compiled SDL description with configured resources
- process(): Sprout analysis & transformation of XML output to RMRS DTD syntax
- developed by: SDL: Hans-Ulrich Krieger, SDLModule: Ulrich Schäfer
  ChunkieRMRS cascade: Anette Frank and Kathrin Spreyer
  RMRSmerge cascade: Anette Frank
- path: xsl/sdl (part of middleware-src.tar.gz)
- Installation: Unpack middleware-src.tar.gz. The file components-chunkiermrs.tar.gz contains the SProUT grammar sources (not necessary for runtime).

SdlModule provides a generic interface (as a kind of `meta module') to sub-architectures defined in SDL with additional access to other annotations / components via the Heart of Gold TransformationService.
The Chunkie RMRS cascade is described in [ChunkieRMRS].
For details on SDL, cf. Krieger's DFKI report RR-03-01 [SDL].

Implemented submodules for SDL so far:

- package `de.dfki.lt.sdl.sprout`: SProUT SDL submodules
- package `de.dfki.lt.sdl.xslt`: XSLT SDL submodules (using TransformationService of MoCoMan)

Note that modules need not be integrated as SDL submodules. It is possible to access any (existing) annotation in HoG through the hog:// URI in XPath document() functions from within XSLT stylesheet. The following XsltModule subclasses support this features (indicated by the Encapsulated suffix in class names):

```
de.dfki.lt.sdl.xslt.XsltModulesDomDomEncapsulated
de.dfki.lt.sdl.xslt.XsltModulesDomStringEncapsulated
de.dfki.lt.sdl.xslt.XsltModulesStringDomEncapsulated
de.dfki.lt.sdl.xslt.XsltModulesStringStringEncapsulated
```

Please note that the parameter to be used in the stylesheet is called `uri`, while the annotation name to be passed as parameter to `XsltModulesXXXEncapsulated` has to be named `aid` (for annotation identifier). The `uri` parameter value is assembled by the `XsltModulesXXXEncapsulated` from the current session and annotation collection ID plus the `aid` parameter.

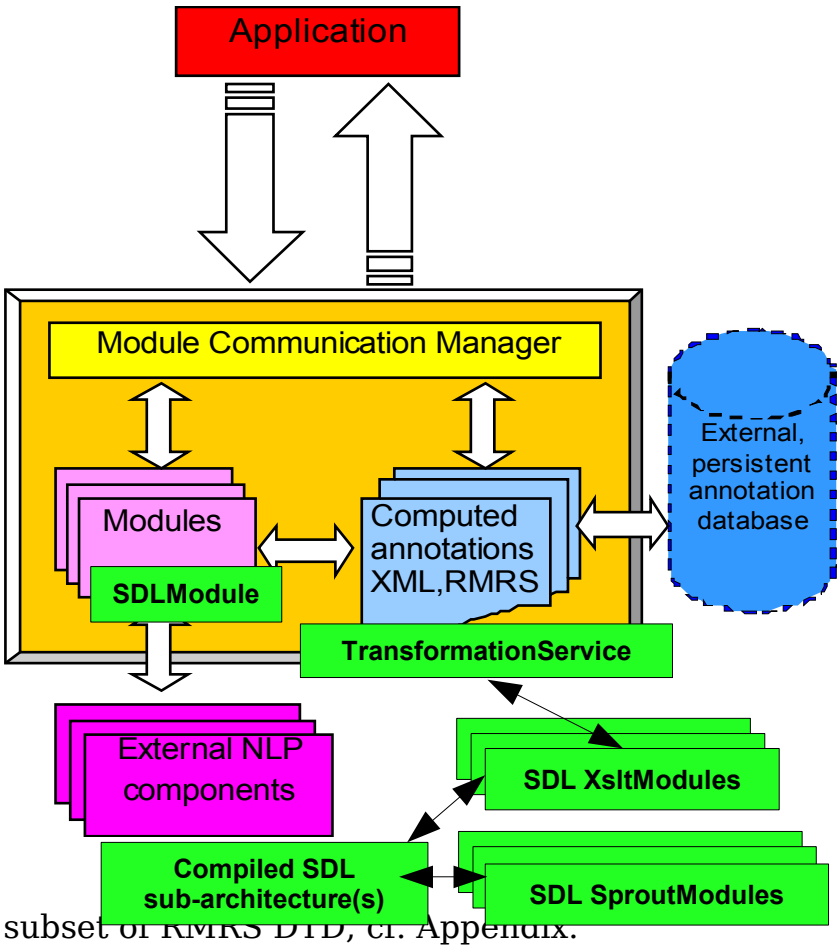
Auxiliary classes (mocoman package):
AnnotationEncapsulator encapsulates Heart of Gold-specifc parameters like sessionID, annotationCollectionID, language, MoCoMan object.

ChunkieRMRS

An instance of an SDL-based sub-architecture is the Chunkie RMRS conversion cascade consisting of 4 SProUT interpreter instances and 4 XSLT transformations (`xsl/sdl/chunkiermrs` and SProUT sources in SProUT source repository; copy available as archive : components-chunkiermrs.tar.gz).
`ant chunkiermrs -Dlang={en,de}` compiles an SDL description and the generated java code for Heart of Gold.

Configuration file conf/en/modules/chunkiermrs.cfg (the SDL definition is in `xsl/sdl/chunkiermrs/en/chunkiermrs.sdl`):

```
module.name=ChunkieRmrs
module.depth=35
module.language=en
module.rootelement=chunkiermrs
# ----- common modules settings end here -----
# name of input annotation (raw text for first cascade/SProUT)
sdl.inputannotation=rawtext
# class name of compiled SDL definition
# (same as class name at beginning of .sdl file)
# can be compiled using 'ant chunkiermrs'
sdl.classname=de.dfki.lt.hog.sdlgen.chunkiermrs_en
```



Output DTD is a subset of RMRS DTD, cf. Appendix.

RmrsMerge

Another instance of an SDL-based sub-architecture is the RMRSmerge cascade consisting of 5 XSL transformations (in `xsl/sdl/rmrsmerge`).
It merges a configurable (in `rmrsmerge.sdl`) secondary RMRS annotation (typically from a named entity recognition component such as SProUT or LingPipe) into a configurable (in `rmrsmerge.cfg`) main RMRS annotation (typically from RASP or PET) by using character span information and adjusting RMRS variables.

`ant rmrsmerge` compiles an SDL description and the generated java code for Heart of Gold.

Configuration file conf/en/modules/rmrsmerge.cfg (merge PET with SProUT):

```
module.name=RmrsMerge
module.depth=110
module.language=en
# root element name for XML output
module.rootelement=merged-rmrs
# ----- common modules settings end here -----
# name of input annotation (PET or RASP)
```

```
sdl.inputannotation=PET
# class name of compiled SDL definition
# (same as class name at beginning of .sdl file)
# can be compiled using 'ant rmrsmerge'
sdl.classname=de.dfki.lt.hog.sdlgen.rmrsmerge
```

The SDL definition is in `xsl/sdl/rmrsmerge/rmrsmerge.sdl`:

```
de.dfki.lt.hog.sdlgen.rmrsmerge = ( rmrs_ep_rargs2rels + adjust_nespans +
merge_ne_to_petrasp + rmrs_rels2ep_rargs + reorder_rmrs_dtrs )

rmrs_ep_rargs2rels = de.dfki.lt.sdl.xslt.XsltModulesStringDomEncapsulated
("xsl/sdl/rmrsmerge/rmrs_ep_rargs2rels.xsl", "SDLx_rargs2rels")

adjust_nespans = de.dfki.lt.sdl.xslt.XsltModulesDomDomEncapsulated
("xsl/sdl/rmrsmerge/adjust_nespans.xsl", "SDLx_adjustnespans", "aid",
"Sprout")

merge_ne_to_petrasp = de.dfki.lt.sdl.xslt.XsltModulesDomDomEncapsulated ("xsl/
sdl/rmrsmerge/merge-ne-to-rasp.xsl", "SDLx_netorasp", "aid", "Sprout")

rmrs_rels2ep_rargs = de.dfki.lt.sdl.xslt.XsltModulesDomDomEncapsulated
("xsl/sdl/rmrsmerge/rmrs_rels2ep_rargs.xsl", "SDLx_rels2rargs")

reorder_rmrs_dtrs = de.dfki.lt.sdl.xslt.XsltModulesDomStringEncapsulated
("xsl/sdl/rmrsmerge/reorderrmrsdtrs.xsl", "SDLx_reorderdtrs", "aid",
"xmltext")
```

Output DTD is a subset of RMRS DTD, cf. Appendix.

PetModule

- depth 100
- purpose: HPSG parsing
- runs PET HPSG parser (cheap) in a local subprocess
- init() starts cheap with resources configured in pet.cfg in a subprocess, using stdin/stderr for communication
- process() reads input sentence and returns RMRS(es) computed by PET.
- developed by: Ulrich Callmeier, U. Saarland/DFKI with extensions by Bernd Kiefer (DFKI) and Stephan Oepen+ LKB RMRS frontend by Ann Copestake, Stephan Oepen, Dan Flickinger. PetModule: Ulrich Schäfer
- path: `components/pet`
- Installation: unpack components-pet-binlib.tar.gz and grammar packages

Configuration file conf/en/modules/pet.cfg:

```
# configuration file for PET module
# 2003-11-25 ulrich.schaefer@dfki.de
#
module.name=PET
module.depth=100
module.language=en
#
# root element name for XML output
module.rootelement=pet
#
# ----- common modules settings end here -----
#
# path to cheap binary
pet.binary=components/pet/bin/cheap
#
# additional library search path for cheap
pet.libs=components/pet/lib
#
# working directory (where the grammar is)
pet.grammardir=components/pet/erg
#
# prefix for grammar file
pet.grammarprefix=english
#
# command line options for cheap
#pet.options=-tok=smaf -mrs=rmrx -partial -nsolutions=3 -results=3
-default-les -limit=70000
pet.options=-tok=pic_counts -mrs=rmrx -results=3 -default-les
-limit=70000
#
# character set encoding for PET input
pet.inputencoding=UTF-8
#
# character set encoding for PET output
pet.outputencoding=UTF-8
```

```
#
# input annotation(s), comma-separated
# use either "rawtext", PET XML input chart (piXML)
# or SMAF formats in accordance with pet.options
# raw text input:
#pet.inputannotation=rawtext
# piXML: comma-separated list of piXML annotations
#pet.inputannotation=TnTpiXML,LingPipepiXML
pet.inputannotation=TnTpiXML,SProUTpiXML
# SMAF: comma-separated list of secondary SMAF annotations
#pet.inputannotation=SProUTsmaf
#
# primary SMAF input annotation (use either smaf or pic)
# SMAF is only used if this and -tok=smaf (in pet.options) is defined
#pet.primarysmafinputannotation=TnTsmaf
#
# stylesheet for XML input chart or SMAF combination
# use this for piXML
pet.combinestylesheet=xsl/pic/combinepixml.xsl
# use this for SMAF
#pet.combinestylesheet=xsl/smaf/combinesmaf.xsl
#
# stylesheet for preprocessing the PET input chart
# no transformation if unset
#pet.preprocstylesheet=xsl/pic/remove-subspan-items.xsl
#
# stylesheet for postprocessing (filtering) of partial RMRSes
# return only the n longest fragments
# return all (=no stylesheet application) if unset
pet.postprocstylesheet=xsl/rmrs/extract-longest-fragment.xsl
#
# stylesheet parameter: number of fragments to return
# return all (=no stylesheet application) if unset
pet.postprocfragments=5
#
```

PET input

There are now 5 different input formats supported by cheap/PetModule (some experimental; details in the PET Delph-in wiki):

- raw text (option in conf/LL/modules/pet.cfg)
- PET input chart (aka pixml or pic) (option in conf/LL/modules/pet.cfg)
- SPPP (via transformation xsl/pic/sppp2pic.xsl)
- SMAF (option in conf/LL/modules/pet.cfg; xsl/smaf/pixml2smaf.xsl)
- FSC (developed in the Checkpoint project by Peter Adolphs). The XSL stylesheet `xsl/fsc/pic2fsc.xsl` (experimental version) can be used to transform the PET input chart format into the FSC format.

PET input chart DTD

Next page; for details see the PET input chart documentation by Bernd Kiefer.

```
<!-- PET input chart DTD                       -->
<!-- {Bernd.Kiefer,Ulrich.Schaefer}@dfki.de    -->
<!-- Version 2004-12-21                        -->

<!DOCTYPE pet-input-chart [
  <!ELEMENT pet-input-chart ( w | ne )* >

  <!-- base input token -->
  <!ELEMENT w ( surface, path*, pos*, typeinfo* ) >
  <!ATTLIST w         id ID      #REQUIRED
                  cstart NMTOKEN #REQUIRED
                    cend NMTOKEN #REQUIRED
                    prio CDATA   #IMPLIED
                constant (yes | no) "no" >
  <!-- constant "yes" means: do not analyse, i.e., if the tag contains
       no typeinfo, no lexical item will be build by the token -->

  <!-- The surface string -->
  <!ELEMENT surface ( #PCDATA ) >

  <!-- numbers that encode valid paths through the input graph (optional) -->
  <!ELEMENT path EMPTY >
  <!ATTLIST path     num NMTOKEN #REQUIRED >

  <!-- every typeinfo generates a lexical token -->
  <!ELEMENT typeinfo ( stem, infl*, fsmod* ) >
  <!ATTLIST typeinfo   id ID     #REQUIRED
                     prio CDATA  #IMPLIED
                 baseform (yes | no) "yes" >
  <!-- Baseform yes: lexical base form; no: type name -->

  <!-- lexical base form or type name -->
  <!ELEMENT stem ( #PCDATA ) >

  <!-- type name of an inflection rule-->
  <!ELEMENT infl  EMPTY >
  <!ATTLIST infl    name CDATA   #REQUIRED >

  <!-- put type value under path into the lexical feature structure -->
  <!ELEMENT fsmod  EMPTY >
  <!ATTLIST fsmod   path CDATA   #REQUIRED
                   value CDATA   #REQUIRED >

  <!-- part-of-speech tags with priorities -->
  <!ELEMENT pos  EMPTY >
  <!ATTLIST pos      tag CDATA   #REQUIRED
                     prio CDATA   #IMPLIED >

  <!-- structured input items, mostly to encode named entities -->
  <!ELEMENT ne  ( ref+, pos*, typeinfo+ )  >
  <!ATTLIST ne        id ID      #REQUIRED
                     prio CDATA   #IMPLIED >

  <!-- reference to a base token -->
  <!ELEMENT ref  EMPTY >
  <!ATTLIST ref      dtr IDREF   #REQUIRED >
]>
```

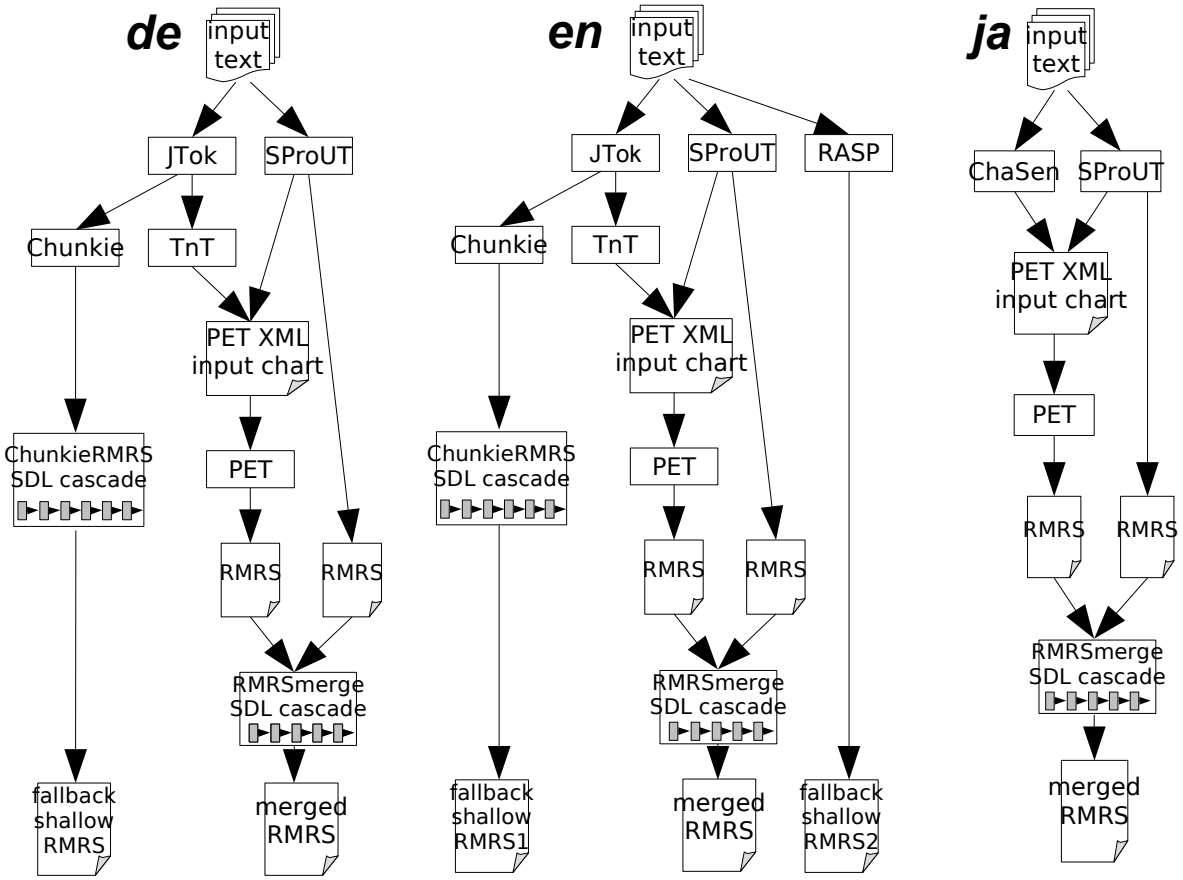
PET output DTD: RMRS DTD cf. Appendix (page 74)

```
<pet readings="n">
  <metadata>
  <rmrs .../>
</pet>
```

Following is a sample PET input chart for "Dr. Mike Smith went to New York" (this is one possibility to encode it; a second one would be to use the <ne> tags referring to the <w> tokens for multi-token expressions like named entities, phrases etc.

```
<?xml version="1.0"?>
<pet-input-chart>
  <w id="TNT0" cstart="0" cend="2">
    <surface>Dr.</surface>
    <pos tag="NNP" prio="1.000000e+00"/>
  </w>
  <w id="TNT1" cstart="4" cend="7">
    <surface>Mike</surface>
    <pos tag="NNP" prio="1.000000e+00"/>
  </w>
  <w id="TNT2" cstart="9" cend="13">
    <surface>Smith</surface>
    <pos tag="NNP" prio="1.000000e+00"/>
  </w>
  <w id="TNT3" cstart="15" cend="18">
    <surface>went</surface>
    <pos tag="VBD" prio="1.000000e+00"/>
  </w>
  <w id="TNT4" cstart="20" cend="21">
    <surface>to</surface>
    <pos tag="TO" prio="1.000000e+00"/>
  </w>
  <w id="TNT5" cstart="23" cend="25">
    <surface>New</surface>
    <pos tag="NNP" prio="1.000000e+00"/>
  </w>
  <w id="TNT6" cstart="27" cend="30">
    <surface>York</surface>
    <pos tag="NNP" prio="1.000000e+00"/>
  </w>
  <w id="SPR2.1" cstart="0" cend="13" constant="yes" prio="0.5">
    <surface>Dr. Mike Smith</surface>
    <typeinfo id="TIN2.1" baseform="no">
      <stem>$generic_name</stem>
    </typeinfo>
  </w>
  <w id="SPR3.1" cstart="23" cend="30" constant="yes" prio="0.5">
    <surface>New York</surface>
    <typeinfo id="TIN3.1" baseform="no">
      <stem>$generic_name</stem>
    </typeinfo>
  </w>
</pet-input-chart>
```

Sample Hybrid Workflows for English, German, Japanese



Part 5: Python Clients and Pre-Processing

Python XML-RPC client

There are several Python scripts demonstrating the use of the middleware from an XML-RPC client.

A simple, low-level non-GUI client that nicely shows how applications communicate with the MoCoMan server is

`./python/sampleRpcClient.py`

The user can *interactively* create sessions, annotation collections, annotations, analyse input texts and retrieve computed annotations. Caveat: The purpose of the script is to give examples how to analyse texts and retrieve result programmatically, not to provide a user-friendly UI (for this, use analyzeGUI described below).
The configuration of modules is passed from the Python client to the server, i.e., for each session, a different configuration could be specified (in principle; in the sample script, the config file is fixed in a variable at the beginning).
By default, the same configuration as for the Sprout-Pet-JTok sample Java application is used (conf/test/sproutpetapp.cfg).

A typical session is as follows (user commands in red):

```
hog start   #starts MoCoMan XmlRpc Server (port configuration in
./conf/mocoman.cfg)
./python/sampleRpcClient.py↲
Message from MoCoManServer on localhost: Hello
Connected to server localhost on port 8411
Command (h for help): h
  cs     create a new session
  cc     create a new collection
  ca     create a new annotation
  a      analyze an annotation
  g      get a computed annotation
  p      print final result of analysis
  s      status report
  x      shutdown mocoman
  q      quit
Command (h for help): cs

 New session created: id = 'session1'
Command (h for help): cc
 Session ID [session1]:
 New annotation collection added to session1: 'collection1'
Command (h for help): ca
 Session ID [session1]:
 Collection ID [collection1]:
 Input (text): The manager in New York who evaluated his programmers is more
competent than the one who had consultants evaluate them
```

```
 New annotation 'rawtext' created and added to 'session1.collection1'
 New annotation 'xmltext' generated for xmlified text with metadata.
Command (h for help): a
 Session ID [session1]:
 Collection ID [collection1]:
 Annotation ID [xmltext]:
 Result ready. 'p' to print.
Command (h for help): g
 Session ID [session1]:
 Collection ID [collection1]:
 Annotation ID [xmltext]: JTok
 <jtok><metadata created="Di, 13 Jan 2004 10:20:42 +0100"
processingtime="00:00,01" sessionid="session1" acid="collection1"
component="JTok" diagnosis="OK"/>
  <p>
    <tu id="0">
      <Token string="The" type="TOK" offset="0" length="3" />
      <Token string="manager" type="TOK" offset="4" length="7" />
      <Token string="in" type="TOK" offset="12" length="2" />
      <Token string="New" type="TOK" offset="15" length="3" />
      <Token string="York" type="TOK" offset="19" length="4" />
      <Token string="who" type="TOK" offset="24" length="3" />
      <Token string="evaluated" type="TOK" offset="28" length="9" />
      <Token string="his" type="TOK" offset="38" length="3" />
      <Token string="programmers" type="TOK" offset="42" length="11" />
      <Token string="is" type="TOK" offset="54" length="2" />
      <Token string="more" type="TOK" offset="57" length="4" />
      <Token string="competent" type="TOK" offset="62" length="9" />
      <Token string="than" type="TOK" offset="72" length="4" />
      <Token string="the" type="TOK" offset="77" length="3" />
      <Token string="one" type="TOK" offset="81" length="3" />
      <Token string="who" type="TOK" offset="85" length="3" />
      <Token string="had" type="TOK" offset="89" length="3" />
      <Token string="consultants" type="TOK" offset="93" length="11" />
      <Token string="evaluate" type="TOK" offset="105" length="8" />
      <Token string="them" type="TOK" offset="114" length="4" />
    </tu>
</jtok>

Command (h for help): p
 <rmrs readings="3"><metadata created="Di, 13 Jan 2004 10:20:42 +0100"
processingtime="00:00,142" sessionid="session1" acid="collection1"
component="PET" dignosis="OK"/><rmrs reading="0" cfrom='-1' cto='-1'><label
vid='1'/><ep cfrom='-1' cto='-1'><ame>RSTR</rargname> ... </rmrs></rmrs>
Command (h for help): s
Uptime: 33 minutes 52 seconds 87 milliseconds
logger.host: localhost
logger.path: log
xmldb.usage: false
xmldb.location: xmldb:xindice://clavinova:8080/db
logger.port: 4445
logger.level: DEBUG
logger.file: hoglog.html
logger.format: html
xmlrpc.server.port: 8411

|--session1
|  |--collection1
|  |  |--result
```

```
|   |   |--rawtext
|   |   |--JTok
|   |   |--PET
|   |   |--Sprout
|   |   |--xmltext
|--session2
|   |--collection1
|   |   |--result
|   |   |--rawtext
|   |   |--JTok
|   |   |--PET
|   |   |--Sprout
|   |   |--xmltext

Command (h for help): q
```

Shutting down the server (via XML-RPC)

Use the script
hog stop [<host> <port>]

or
ant shutdown [-Dxmlrpc.server.host=localhost] [-Dxmlrpc.server.port=8411]
(defaults values in conf/mocoman.cfg)

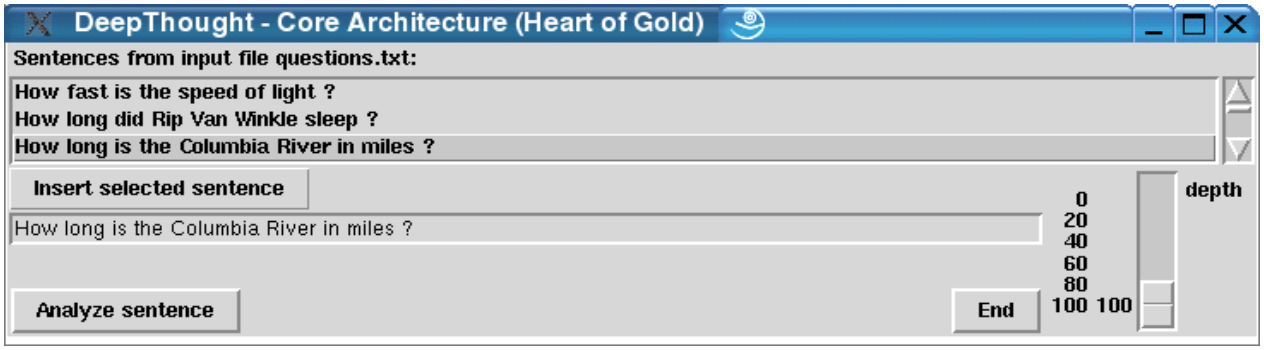
GUI Client

A python/TK GUI for choosing sentences from an input file, selecting depth.

- **`hog start`** starts MoCoMan XmlRpc Server (port configuration in conf/mocoman.cfg)
- configure path to mozilla/netscape/firefox/seamonkey at the beginning of the python script (e.g. `browser = "seamonkey -remote"` if you use seamonkey).
- configure the requested annotation names
- start the mozilla, netscape, firefox or seamonkey browser (Unix only; Windows Mozilla does not support remote control)
- analyzeGUI [-m hostname] [-p port] [-l lang] [-e encoding] textfile

<lang> is a two-character (ISO 639) language identifier that is used as prefix for a language-specific session configuration on the server.
en (or nothing) selects conf/en/sessions/default.cfg
de selects conf/de/sessions/default.cfg
no selects conf/no/sessions/default.cfg
etc.
<encoding> is the name of the <textfile>'s character encoding.

analyzeGUI:



Sample output of analyzeGUI:

TEXT Show me a picture of a Nokia phone
TOP h1

RELS { imp_m_rel [LBL h1 ARG0 h5], pronoun_q_rel [LBL h6 ARG0 x7 RSTR h9 BODY h8], pron_rel [LBL h10 ARG0 x7], _show_v [LBL h11 ARG0 e2 ARG1 x7 ARG2 x13 ARG3 x12], pron_rel [LBL h14 ARG0 x12 CARG me], pronoun_q_rel [LBL h15 ARG0 x12 RSTR h17 BODY h16], _a_q [LBL h18 ARG0 x13 RSTR h19 BODY h20], _picture_n [LBL h21 ARG0 x13 ARG1 x22 CARG picture], _of_p [LBL h10001 ARG0 e23 ARG2 x22], _a_q [LBL h25 ARG0 x22 RSTR h27 BODY h26], compound_rel [LBL h28 ARG0 e30 ARG1 x22 ARG2 x29], proper_q_rel [LBL h31 ARG0 x29 RSTR h33 BODY h32], named_rel [LBL h34 ARG0 x29 CARG nokia], _phone_n [LBL h10002 ARG0 x22 CARG phone] }

HCONS {h5 qeq h11, h9 qeq h10, h17 qeq h14, h19 qeq h21, h27 qeq h28, h33 qeq h34}

ING {h21 ing h10001,h28 ing h10002}

TEXT Show me a picture of a Nokia phone
TOP h36

RELS { imp_m_rel [LBL h36 ARG0 h38], pronoun_q_rel [LBL h39 ARG0 x40 RSTR h43 BODY h42], pron_rel [LBL h41 ARG0 x40], _show_v [LBL h1 ARG0 e2], pronoun_q_rel [LBL h3 ARG0 x4 RSTR h6 BODY h7], pron_rel [LBL h5 ARG0 x4], _a_q [LBL h8 ARG0 x9], _picture_n [LBL h10 ARG0 x11], _of_p [LBL h12 ARG0 e13 ARG2 x25], _a_q [LBL h14 ARG0 x15], proper_q_rel [LBL h16 ARG0 x17 RSTR h19 BODY h20], named_rel [LBL h18 ARG0 x17 CARG nokia], _phone_n [LBL h23 ARG0 x24], free_args [ARG1 x40] }

HCONS {h38 qeq h35, h43 qeq h41, h6 qeq h5, h19 qeq h18}

ING {}

TEXT Nokia
TOP h22

RELS { ne-product [LBL h22 ARG0 x22 CARG Nokia] }

HCONS {}

ING {}

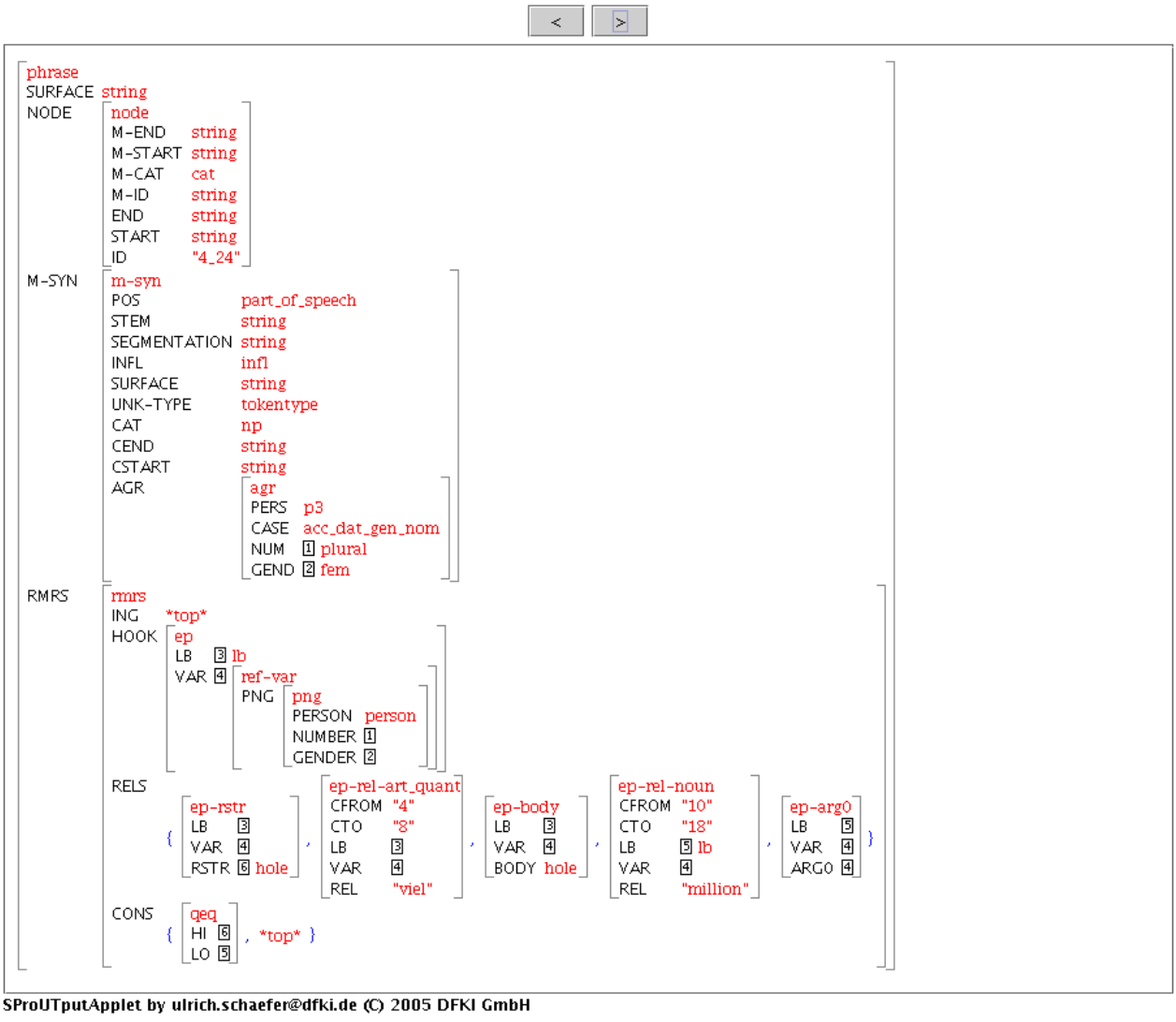
SProUT Feature Structure Viewer (SProUTput applet)

There is an applet showing SProUT results in graphical AVM notation. It is automatically activated by analyzeGUI when XML files conforming to the SProUTput DTD are to be visualized.

Installation of the JRE Java applet plugin for the web browser (Mozilla, Firefox, Netscape or Seamonkey) if not already done:

```
cd ~/.mozilla/plugins
ln -s $JAVA_HOME/jre/plugin/i386/ns610-gcc32/libjavaplugin_oji.so
```

Example (feature structure visualization of SProUTput DTD):



The applet is inserted into an HTML document as follows.

```
<applet archive="fsapplet.jar" code="de.dfki.lt.rendering.SproutputApplet"
     width="900" height="700">
  <param name="xmlfile" value="SProUTputFile.xml">  <!-- SProUTput DTD -->
  <param name="encoding" value="utf-8">
</applet>
```

Feature structure and RMRS visualization stylesheets (HTML, LaTeX)

In the xsl/ subdirectory, there are subdirectories containing XSLT stylesheets for HTML and LaTeX code generation from the SProUTput, XTDL-XML, TFS-XML and RMRS DTDs. The xml2html.xsl stylesheet is taken from the Apache Cocoon project (under Apache Software License 1.1) and only slightly modified for module name extraction in the Heart of Gold.

file name	*input DTD*	*output format*
xsl/html/rmrs2html.xsl	RMRS	HTML w/ Javascript
xsl/html/xml2html.xsl	any XML document	HTML w/ Javascript
xsl/latex/fs2latex.xsl	SProUTput, XTDL, TFS-XML	LaTeX
xsl/latex/rmrs2latex.xsl	RMRS	LaTeX

Most stylesheets take (optional) parameters. Please also see the following web page for more details and documentation of the FS2LaTeX package:

http://www.dfki.de/~uschaefer/fs2latex/

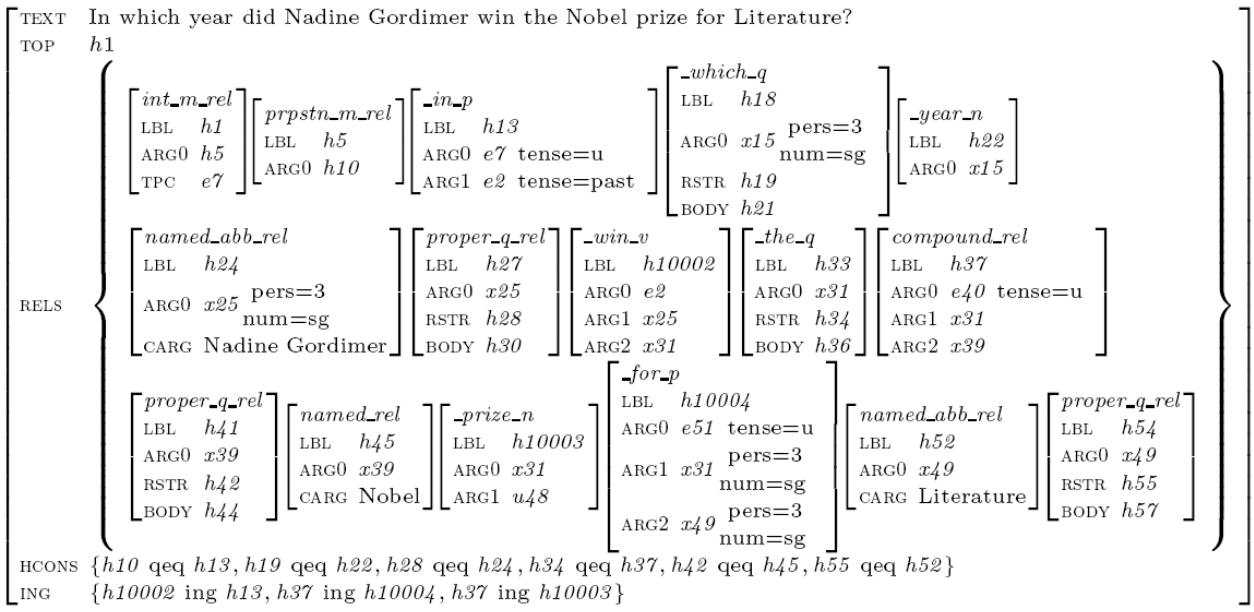


Figure 1 Example for LaTeX generated from RMRS with rmrs2latex.xsl

Raw Input Text Preprocessing and Sentence Splitting

As the HPSG parser parses sentence-wise, input documents have to be segmented into sentences, and analyze() has to be called seperately sentence by sentence in order to analyse a whole document.

Moreover, some of the Heart of Gold components are (still) not very robust with respect to arbitrary characters in input text and cannot directly use XML input files. We shortly address these 3 kinds of problems here.

Problem 1: confusing characters in input text, e.g. (,) seem to confuse TnT/Chunkie under some circumstances, a " confuses the current German HPSG grammar.

Solution: use a sed script like the following to remove the confusing characters (a more elegant solution would be to preserve the original character positions which this script doesn't do):

```
s#(afp)\|(dpa)\|(Reuter)\|(ap)##g
s/  / /g
s/"\|_\|\*\|(\|---\|)/ /g
s/--//g
s/ 000/000/g
```

Problem 2: Sentence splitting

Solution: Pre-processing can be done by the application, by calling (only) JTok or SProUT or another component on the whole input document first, using the segmentation in the returned XML document to process then deeply sentence by sentence. Sample stylesheet for JTok:

```
<?xml version="1.0"?>
<xsl:stylesheet version="1.0"
xmlns:xsl="http://www.w3.org/1999/XSL/Transform">
  <xsl:output method="text"/>
  <xsl:strip-space elements="*"/>

  <xsl:template match="tu">
    <xsl:for-each select="Token">
      <xsl:value-of select="@string"/>
      <xsl:text> </xsl:text>
    </xsl:for-each>
    <xsl:text>
</xsl:text>
    <xsl:apply-templates/>
  </xsl:template>

  <xsl:template match="text()"/>

</xsl:stylesheet>
```

Problem 3: Input is not plain text, but XML file
Solution: use a XSLT-stylesheet that generate a text file extracting the input text from the XML input document and inserting a newline character at sentence boundary. The example stylesheet extracts #PCDATA children under element path relevant/qa-pair/retrieved/context/sent and stores each text with <sent> elements in a separate line in an ISO-8859-1-encoded output file (for use in analyzeGUI or analyzeAll).

```
<?xml version="1.0"?>
<xsl:stylesheet version="1.0"
xmlns:xsl="http://www.w3.org/1999/XSL/Transform">
  <xsl:output method="text"/>
  <xsl:strip-space elements="*"/>

  <xsl:template match="relevant">
    <xsl:for-each select="qa-pair">
      <xsl:for-each select="retrieved/context">
        <xsl:for-each select="sent">
          <xsl:value-of select="."/>
          <xsl:text>
</xsl:text>
        </xsl:for-each>
      </xsl:for-each>
    </xsl:for-each>
    <xsl:apply-templates/>
  </xsl:template>

  <xsl:template match="text()"/>

</xsl:stylesheet>
```

Both stylesheets can be found in xsl/preproc/
They could be applied by an application client using
xml2htmlTransformer(sid, acid, "JTok", "xsl/preproc/jtok-sbr.xsl", "no")
(in this case, the output is not HTML, but plain text).

The Python script

```
analyzeAll -n [-m host] [-p port] [-l lang] [-e encoding] textfile
```

can be used to process a textfile containing each sentence to be processed by PET in a seperate line.

GUI variant:
```
analyzeGUI [-m host] [-p port] [-l lang] [-e encoding] textfile
```

Part 6: Literature, Links

see also http://heartofgold.dfki.de/Publications.html

[DTLREC] Ulrich Callmeier , Andreas Eisele ,Ulrich Schäfer and Melanie Siegel. 2004. The DeepThought Core Architecture Framework. In: Proceedings of LREC-2004, Lisbon, Portugal.

[Diss] Ulrich Schäfer: *Integrating Deep and Shallow Natural Language Processing Components - Representations and Hybrid Architectures*. Doctoral dissertation. Faculty of Mathematics and Computer Science, Saarland University, Saarbrücken, Germany. June 2007.

[Middleware] Ulrich Schäfer: *Middleware for Creating and Combining Multi-dimensional NLP Markup*. Proceedings of the EACL-2006 workshop on Multi-dimensional Markup in Natural Language Processing, pages 81-84. April 2006, Trento, Italy.

[Memphis] Walter Kasper and Jörg Steffen. 2002. *Multilingual flexible and robust summarization*. In: Proceedings der 6. Konferenz zur Verarbeitung natürlicher Sprache (KONVENS 2002), pp. 215-218, Saarbrücken, Germany.

[Sprout] Witold Drozdzynski, Hans-Ulrich Krieger, Jakub Piskorski, Ulrich Schäfer and Feiyu Xu. 2004. Shallow Processing with Unification and Typed Feature Structures – Foundations and Applications. Künstliche Intelligenz. pp 17-23. Bremen.

[Chunkie] W. Skut and T. Brants. 1998. Chunk tagger: statistical recognition of noun phrases. In Proceedings of ESSLLI-1998 Workshop on Automated Acquisition of Syntax and Parsing. Saarbrücken, Germany.

[TnT] Thorsten Brants. 2000. TnT - A statistical part-of-speech tagger. Proceedings of the Sixth Applied Natural Language Processing Conference ANLP, Seattle, WA.

[ChaSen] Y. Matsumoto, A. Kitauchi, T. Yamashita, Y. Hirano, H. Matsuda, K. Takaoka, and M. Asahara. 2000. *Morphological Analysis System ChaSen version* 2.2.1 Manual. Nara Institute of Science and Technology. Nara, Japan.

[CardieWagstaff] Claire Cardie, Kiri Wagstaff. 1999. Noun Phrase Coreference as Clustering. In Proceedings of the Joint Conference on Empirical Methods in Natural Language Processing and Very Large Corpora, Association for Computational Linguistics. pp. 82-89.

[SDL] Hans-Ulrich Krieger. 2003. SDL-A Description Language for Specifying NLP Systems. Proceedings of the 3rd AMAST Workshop on Algebraic Methods in Language Processing (AMiLP-3), Verona, Italy.

[ChunkieRMRS] Anette Frank, Kathrin Spreyer, Witold Drozdzynski, Hans-Ulrich Krieger, Ulrich Schäfer. 2004. Constraint-Based RMRS Construction from Shallow Grammars. Proceedings of the HPSG04 Conference. CSLI Publications, Stanford, CA, Leuven, Belgium.

[WHAT] Ulrich Schäfer. 2003. *WHAT: An XSLT-based Infrastructure for the Integration of Natural Language Processing Components*. Proc. of the Workshop on

the Software Engineering and Architecture of Language Technology Systems (SEALTS), HLT-NAACL03, pp. 9-16, Edmonton, Canada.

[RASP] Briscoe, Edward J. and Carroll, John. Robust accurate statistical annotation of general text. Proceedings of LREC-2002. Las Palmas, Gran Canaria. 2002. pp. 1499-1504.

[RASP2] Ted Briscoe, John Carroll, and Rebecca Watson: The second release of the RASP system. Proceedings of the COLING/ACL on Interactive presentation sessions, Sydney, Australia. 2006. pp. 77-80.

[Sleepy] Amit Dubey and Frank Keller. Parsing German with Sister-Head Dependencies. In 41st Annual Meeting of the Association for Computational Linguistics, Sapporo, Japan, 2003.

[TreeTagger] Helmut Schmid. Probabilistic Part-of-Speech Tagging Using Decision Trees. Proceedings of International Conference on New Methods in Language Processing. September 1994.

[LoPar] Helmut Schmid. LoPar: Design and Implementation. Arbeitspapiere des Sonderforschungsbereiches 340, No. 149, IMS Stuttgart, July 2000.

[SMAF] Ben Waldron, Ann Copestake, Ulrich Schäfer, Bernd Kiefer: *Preprocessing and Tokenisation Standards in DELPH-IN Tools*. Proceedings of the 5th International Conference on Language Resources and Evaluation LREC-2006, pages 2263-2268. May 2006, Genoa, Italy.

[Topo2HPSG] Anette Frank, Markus Becker, Berthold Crysmann, Bernd Kiefer, Ulrich Schäfer: *Integrated Shallow and Deep Parsing: TopP meets HPSG*. Proceedings of ACL-2003, pages 104-111, July 2003, Sapporo, Japan.

[LingPipe] http://www.alias-i.com/lingpipe/
[Xindice] http://xml.apache.org/xindice
[XML:DB] http://www.xmldb.org/xapi
[XPath] http://www.w3.org/TR/xpath
[XSLT] http://www.w3.org/TR/xslt
[XUpdate] http://www.xmldb.org/xupdate

Part 7: Contributors

Concept: Ulrich Callmeier, Andreas Eisele, Ulrich Schäfer, Melanie Siegel
Implementation: Robert Barbey, Özgür Demir, Ulrich Schäfer
JTok, Module configuration and Launcher: based on code by Jörg Steffen (MEMPHIS project)
PET extensions (XML input chart): Bernd Kiefer
SDL: Hans-Ulrich Krieger
RMRS construction from chunks: Anette Frank and Kathrin Spreyer
RMRS merging stylesheets, Whiteboard topoparser: Anette Frank
rmrs2html.xsl: Thomas Klöcker and Ulrich Schäfer, with ideas and styles borrowed from Stephan Oepens Javascript code for MRS (lkb.js)
PHP-based Web demo: Özgür Demir
Web Service Wrapper, LingPipe configuration extensions: Gregory Gulrajani
LoParModule, Port of the Whiteboard topoparser XSLT pipeline: Daniel Contag
Deployment, RASP2Module, RASP RMRS converter server package: Torsten Marek

APPENDIX 1: XML Annotation Database

Installation and Usage instructions for the XML annotation database

1. Using an existing XML-DB database

We assume that the XML-DB database is already running on host `dbhost`.

There are two scripts, `startdb.sh` and `stopdb.sh`, that start and stop the underlying tomcat application server and the xindice database engine.

In order to avoid conflicts, the database test programs developed so far append the username ($USER) to the root collection database path, e.g. `xmldb:xindice://dbhost:8080/db/uschaefer/`
Please use this convention in your applications as well (until user access management is available in Xindice).

A sample class theat illustrates how to write your own database client is in `de/dfki/lt/hog/database/testdb.java`.
The main class to employ in applications is `de.dfki.lt.hog.database.XMLDBAnnotationDatabase`.

It includes methods to open a database, add, remove collections and documents (collections that contain XML annotations), or add, remove, retrieve, or query XML annotations. Two standard query types are supported: XPath and XUpdate. For details see the javadoc that can be generated using the ant script described below.

The database clients can run on a machine different from the database server. You only need some class files from hogskeleton.tar.gz and the sources from the cvs repository. Here is how to install and run your own (test) client:

```
cd hog
ant all     # creates jar, javadoc
ant testdb  # test database (R/W access, XPath query)
ant checkdb # check database root collection
```

testdb (de.dfki.lt.hog.database.testdb) inserts some test collections and XML annotation.

checkdb uses the xindice command line administration tool (`org.apache.xindice.tools.XMLTools`) and outputs the top collection(s) of the database.

You can browse the collection hierarchy in your web browser through the URL `http://dbhost:8080/Xindice` (the "Ugly debug tool"), but inspection of XML content is not supported.

The database currently will be lost when tomcat is restarted - so exporting data to an XML file is recommended if annotation data is to be kept persistently.

If a method is missing from the XMLDBAnnotationDatabase class that you would like to have, please let me know (instead of writing your own code on the basis of the lower-level class XMLDBAccess).

2. Installation of Xindice from scratch (i.e., from the sources)

Tested with JDK 1.4.1 and 1.4.2 / `uschaefer 2003-09-23`

Build Xindice V1.1b2-pre as of 2003-07-25

```
---------------------------------------
tar xzf xindice11-checkout-20030725.tar.gz
mv xml-xindice xindice
cd xindice
#edit build.sh: add JAVA_HOME
./build.sh
./build.sh javadoc # goes to build/api/
```

add JAVA_HOME and XINDICE_HOME to
./xindice.sh and ./bin/xindice

Build tomcat V4.1.24

```
-------------------
tar xzf tomcat-4.1.24-LE-jdk14.tar.gz
mv jakarta-tomcat-4.1.24-LE-jdk14 tomcat
cd tomcat
#edit ./bin/catilina.sh: add JAVA_HOME and CATILINA_HOME
cd ..
#insert content of xindice/dist/xindice-1.1b2.xml before </Host> in
tomcat/conf/server.xml
ln -s xindice/dist/xindice-1.1b2.war tomcat/webapps/xindice-1.1b2.war
```

Here is an example for a startup script (startdb.sh)

```
hog=/local/deepthought/CoreArchitecture
dtusers="uschaefer eisele siegel"
#ps -p `cat $hog/xindice/logs/xindice.pid`
umask 002
cd $hog/tomcat/bin
./startup.sh
cd $hog/xindice
./xindice.sh start
echo "sleeping for 10 seconds..."
sleep 10
cd ./bin
for dtmember in $dtusers ; # add user collections
```

```
  do
    echo "adding collection for $dtmember"
    ./xindice ac -c /db -n $dtmember
  done
```

and shutdown script (stopdb.sh)

```
hog=/local/deepthought/CoreArchitecture
umask 002
cd $hog/tomcat/bin
./shutdown.sh
cd $hog/xindice
./xindice.sh stop
```

currently, the database should be exported before tomcat shutdown
as a tomcat restart seems to destroy its content

APPENDIX 2: RMRS DTD

(by Ann Copestake)

taken from http://lingo.stanford.edu:8000/rmrs.dtd (as of 2004-07-21)

```
<!ELEMENT rmrs-list (rmrs)*>

<!ELEMENT rmrs (label, (ep|rarg|ing|hcons)*)>
<!ATTLIST rmrs
          cfrom CDATA #REQUIRED
          cto   CDATA #REQUIRED >

<!ELEMENT ep ((realpred|gpred), label, var)>
<!ATTLIST ep
          cfrom CDATA #REQUIRED
          cto   CDATA #REQUIRED >


<!ELEMENT realpred EMPTY>

<!ATTLIST realpred
          lemma CDATA #REQUIRED
          pos (v|n|j|r|p|q|c|x|u) #REQUIRED
          sense CDATA #IMPLIED >

<!ELEMENT gpred (#PCDATA)>

<!ELEMENT label EMPTY>

<!ATTLIST label
          vid CDATA #REQUIRED >

<!ELEMENT var EMPTY>
<!ATTLIST var
          sort (x|e|h|u|l) #REQUIRED
          vid  CDATA #REQUIRED
          num  (sg|pl|u) #IMPLIED
          pers (1|2|3|1-or-3|u) #IMPLIED
          gender (m|f|n|m-or-f|u) #IMPLIED
          divisible (plus|minus|u) #IMPLIED
          cogn-st (type-id|uniq-id|fam|activ|in-foc|uniq-or-less|uniq-
or-fam|fam-or-activ|active-or-more|fam-or-less|uniq-or-fam-or-activ|
fam-or-more|activ-or-less|uniq-or-more|u) #IMPLIED
          tense (past|present|future|non-past|u) #IMPLIED
          telic (plus|minus|u) #IMPLIED
          protracted (plus|minus|u) #IMPLIED
          stative (plus|minus|u) #IMPLIED
          incept (plus|minus|u) #IMPLIED
          imr (plus|minus|u) #IMPLIED
          boundedness (plus|minus|u) #IMPLIED
          refdistinct (plus|minus|u) #IMPLIED >
```

```
<!ELEMENT rarg (rargname, label, (var|constant))>

<!ELEMENT rargname (#PCDATA)>

<!ELEMENT constant (#PCDATA)>

<!ELEMENT ing (ing-a, ing-b)>
<!ELEMENT ing-a (var)>
<!ELEMENT ing-b (var)>

<!ELEMENT hcons (hi, lo)>
<!ATTLIST hcons
          hreln (qeq|lheq|outscopes) #REQUIRED >

<!ELEMENT hi (var)>
<!ELEMENT lo (label|var)>
```

APPENDIX 3: ISO 639 Codes

(only selected codes, mostly European and Asian)

Technical contents of ISO 639:1988 (E/F)
"Code for the representation of names of languages".
The Registration Authority for ISO 639 is Infoterm, Osterreichisches Normungsinstitut (ON), Postfach 130, A-1021 Vienna, Austria.

af	Afrikaans
ar	Arabic
be	Byelorussian
bg	Bulgarian
br	Breton
ca	Catalan
cs	Czech
cy	Welsh
da	Danish
de	German
el	Greek
en	English
eo	Esperanto
es	Spanish
et	Estonian
eu	Basque
fa	Persian
fi	Finnish
fr	French
fy	Frisian
ga	Irish
gd	ScotsGaelic

gl	Galician
ha	Hausa
he	Hebrew
hi	Hindi
hr	Croatian
hu	Hungarian
id	Indonesian
is	Icelandic
it	Italian
ja	Japanese
ka	Georgian
kl	Greenlandic
kn	Kannada
ko	Korean
ku	Kurdish
la	Latin
lt	Lithuanian
lv	Latvian
mk	Macedonian
mo	Moldavian
mt	Maltese
nl	Dutch

no	Norwegian
oc	Occitan
pl	Polish
pt	Portuguese
rm	Rhaeto-Romance
ro	Romanian
ru	Russian
sa	Sanskrit
sh	Serbo-Croatian
sk	Slovak
sl	Slovenian
sq	Albanian
sr	Serbian
sv	Swedish
tr	Turkish
uk	Ukrainian
vi	Vietnamese
yi	Yiddish
zh	Chinese

Heart of Gold FAQ

Q: Which Java version do I need?
1.4.2 currently

Q: JRE or JDK14?
JDK required

Q: Which platform should I use?
If you would like to see a running HoG quickly, try to get a linux system.

The middleware itself is Java and hence platform-independent (although there may be problems with process pipe mechanism used for some component adapters which has been reported not to be stable under Windows).
JTok, Sprout and LingPipe are pure Java should also run under Windows without changes.

However, we currently only provide linux executables in the components-*.tar.gz files of PET, TnT and Chunkie.

PET once worked perfectly with Solaris, but hasn't been tested with new additional libraries (Xerces, Boost, ECL) yet.
If you would like to compile from the sources (download from http://heartofgold.dfki.de/PET.html), try with g++ 3.3.1.
Boost, ICU and Xerces libraries should compile without problems. Bernd told me that ECL might cause problems and could require some adaptations, but he would be happy to include patches for Solaris.

Q: Are LKB and PET compatible? I mean, can I develop my grammar in LKB and then use it with HoG?

A: Yes, that's the case. Develop with LKB, then generate a grammar image with flop (this program is not part of the packages on the heart of gold download page, but the sources can be downloaded via the PET-src-link).

However, handling of NEs and unknown words with guessed PoS is best done within Heart of Gold (you will have to define generic/prototypical lexicon entries for them).

Q: How do I get these nice HTML, LaTeX and FS applet visualization tools?

A: See pages 64 and 65.

Q: I don't see HTML visualizations of analysis results in my browser using analyzeGUI.

Make sure the browser variable at the beginning of the Python code is set to a working browser on your machine. Note that the browser needs to be running before pressing the analyze button. Moreover, remote controlling the browser only works on Linux/Unix this way. A recent Mozilla-compatible browser is required (Firefox, Seamonkey, Mozilla or Netscape).

Q: I need MRSes instead of RMRSes from PET.

Heart of Gold currently only supports the RMRS output mode (XMLified MRS is planned for a future release). For an interim solution, see the batch mode solution for the next question (cheap -mrs produces MRS instead of RMRSes).

Q: How do I combine PET input charts offline (batch)?

Here is a quick & dirty script, expecting a preceding analyzeAll with TnTpiXML and SProUTpiXML annotations written as XML files (configured at the beginning of analyzeAll), PET should be configured off in the session configuration - otherwise, it would run in vain and waste your time.

```
#!/bin/bash
analyzeAll -m localhost -p 8411 -l de sentences.txt
/bin/rm pet-input-charts
echo "<a/>" > dummy.xml
for file in TnTpiXML-*.xml ;
  do
    echo "<?xml version='1.0'?>" >> pet-input-charts
    cat xsl/pic/pet-input-chart.dtd >> pet-input-charts
    xsltproc --stringparam urilist "$file,`echo $file | sed -e \
      's/TnT/SProUT/g'`" xsl/pic/combinepixml.xsl dummy.xml >> pet-input-
charts
    echo >> pet-input-charts
  done
echo >> pet-input-charts
cat pet-input-charts | LD_LIBRARY_PATH=components/pet/lib \
  components/pet/bin/cheap -tok=xml_counts -mrs -default-les -limit=70000 \
  -results=3  components/pet/german/german > mrses.txt
```

Q: I have problems with encodings and the Python clients. What's wrong?

This may be the case when you use an old version of the Python clients. Solution: upgrade to the new versions.

Heart of Gold will now transport both input text and generated annotations as binary objects with Unicode encoding instead of just text via XML-RPC.

Q: TnT doesn't seem to run because of insufficent permissions.

For some unknown reason, TnT requires group-executable permissions, i.e. being in the same group as the TnT executable should help (man newgrp).

Q: HoG does not work with UTF-8 (Fedore Core 1 problem only)

Stephan Oepen reported a problem with Fedora Core1 and Python TK (i.e, independent of the Heart of Gold Java code!). Here the Python and the TKinter seem to use incompatible encodings (error message: "SystemError: Py_UNICODE and Tcl_UniChar differ in size") - Details:

http://mail.python.org/pipermail/python-list/2003-November/195577.html