

The SPECIALIST NLP Tools

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Dec., 2010

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Introduction - NLP

- Natural Language
 - is ordinary language that humans use naturally
 - may be spoken, signed, or written
- Natural Language Processing
 - NLP is to process human language to make their information accessible to computer applications
 - The goal is to design and build software that will analyze, understand, and generate human language
 - Most NLP applications require knowledge from linguistics, computer science, and statistics

Introduction - Applications

- **Word-term level applications:**
lexical variants generation, morphological segmentation, stemming, Part-Of-Speech tagging, word segmentation, sentence breaking, syntax and parsing, lexical semantics, etc.
- **Document level applications:**
text classification, automatic summarization, text simplification, text-proofing, natural language understanding, truecasing, coreference resolution, etc.
- **Sophisticated applications:**
Web search engine, word sense disambiguation, machine (automatic text) translation, query expansion, question answering, information retrieval (IR), information extraction (IE), natural language generation, etc.

Introduction – Core NLP Tasks

- Ex: Web search engine for biomedical information
 - **Software:**
 - o keyword search
 - break inputs into words
 - POS tagging
 - other annotation
 - o spelling check
 - suggest correct spelling for misspelled words
 - o lexical variants
 - spelling variants, inflectional/uninflectional variants, synonyms, acronyms/abbreviations, expansions, derivational variants, etc.
 - o semantic knowledge
 - map text to Metathesaurus concepts
 - Word Sense Disambiguation (WSD)
 - **Data:**
 - o corpus: annotation/tagging

Introduction – NLP Tools

- Ex: Web search engine for biomedical information
 - **Software:**
 - o keyword search
 - break inputs into words (**Text Tools**)
 - POS tagging (**dTagger**)
 - Other annotation (**Visual Tagging Tool, VTT**)
 - o spelling check
 - suggest correct spelling for misspelled words (**gSpell**)
 - o lexical variants
 - spelling variants, inflectional/uninflectional variants, synonyms, acronyms/abbreviations, expansions, derivational variants, etc. (**Lexical Tools**)
 - o semantic knowledge
 - map text to Metathesaurus concepts (**MetaMap, MMTX**)
 - Word Sense Disambiguation (**TC - StWSD**)
 - **Data: corpus**
 - o annotation/tagging (**Text Tools, dTagger, VTT, Lexical Tools**)

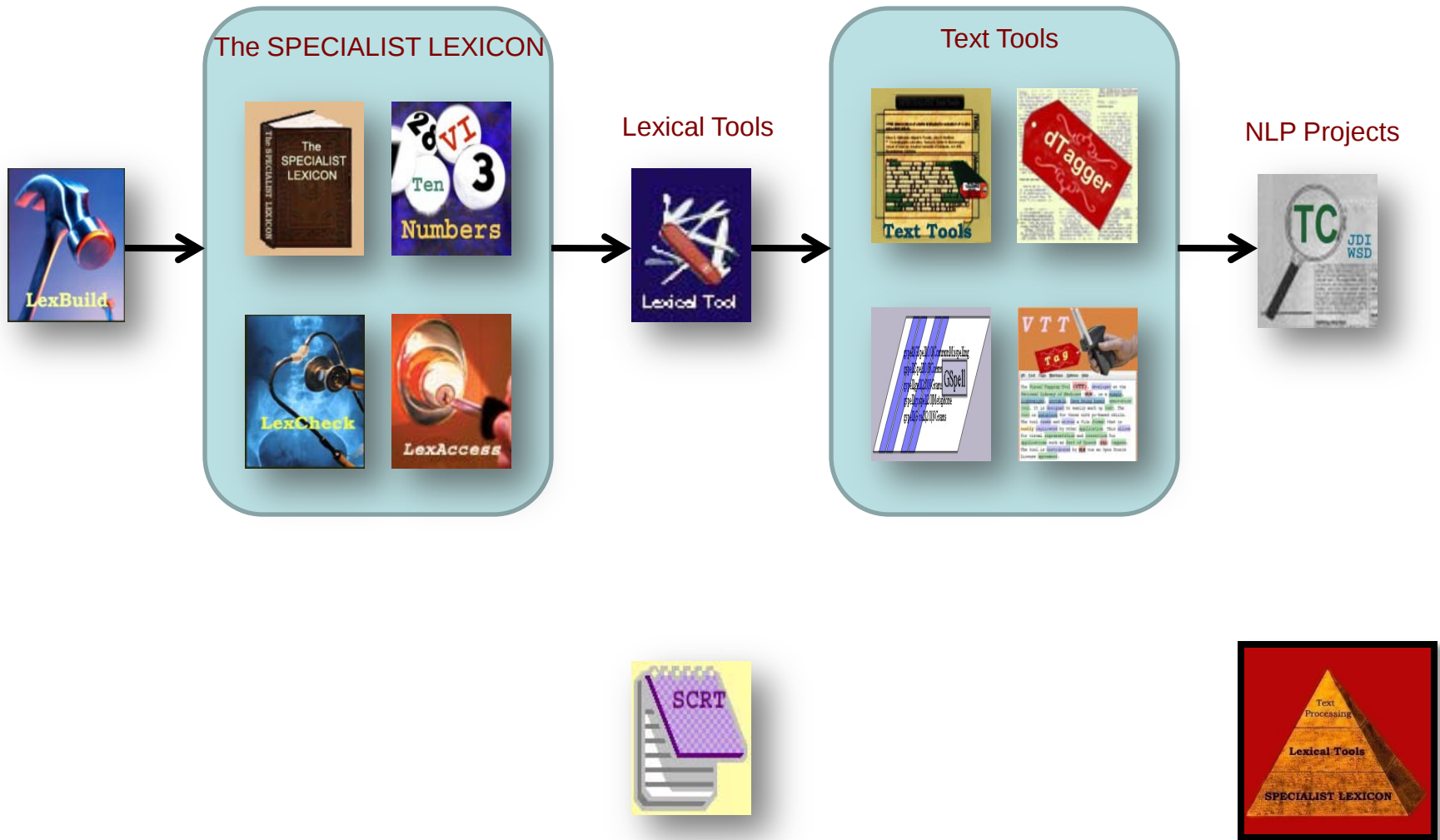
Introduction – Core NLP Tools

- Ex: Web Search Engine for biomedical information
 - Software:
 - o keyword search
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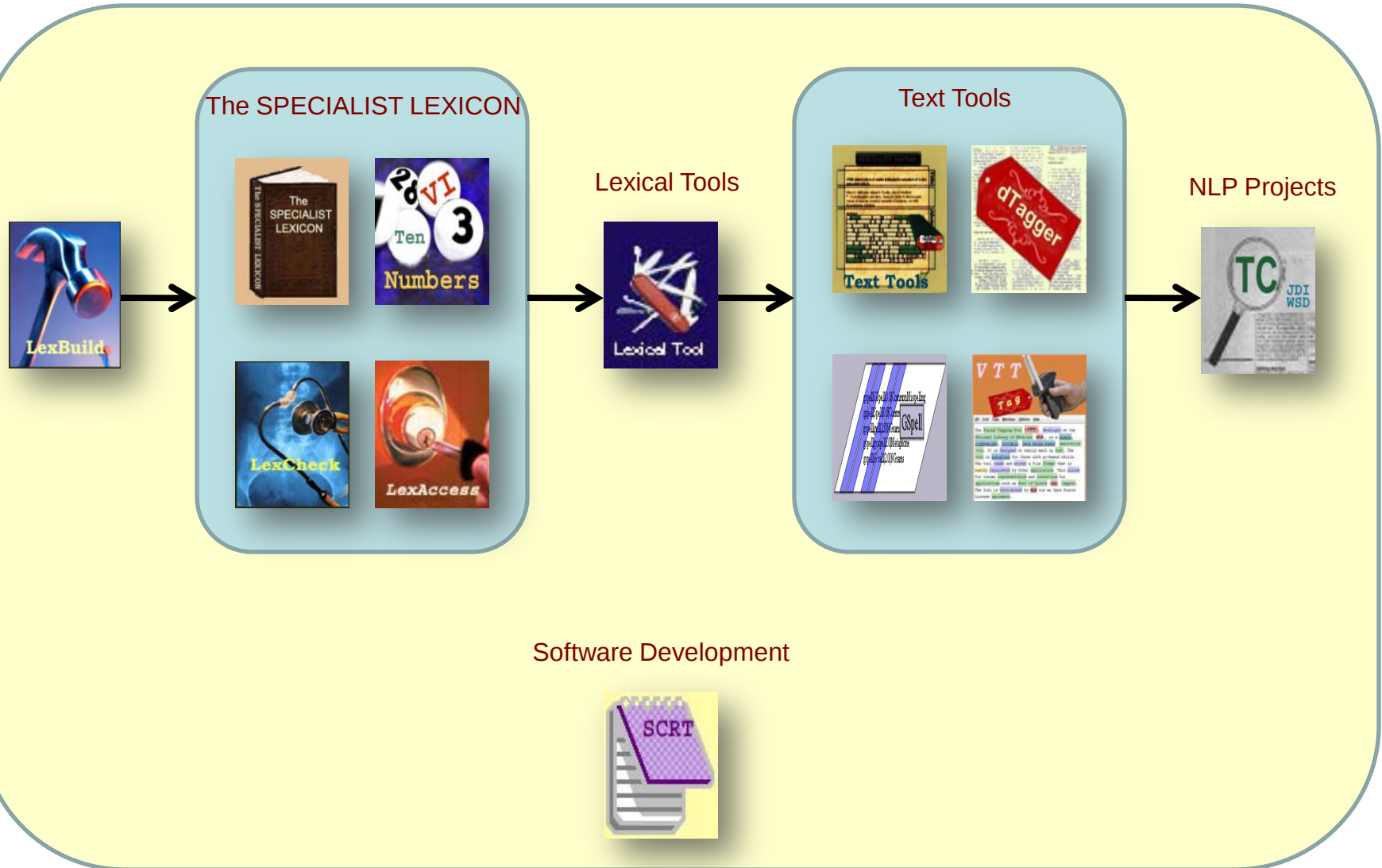
Introduction



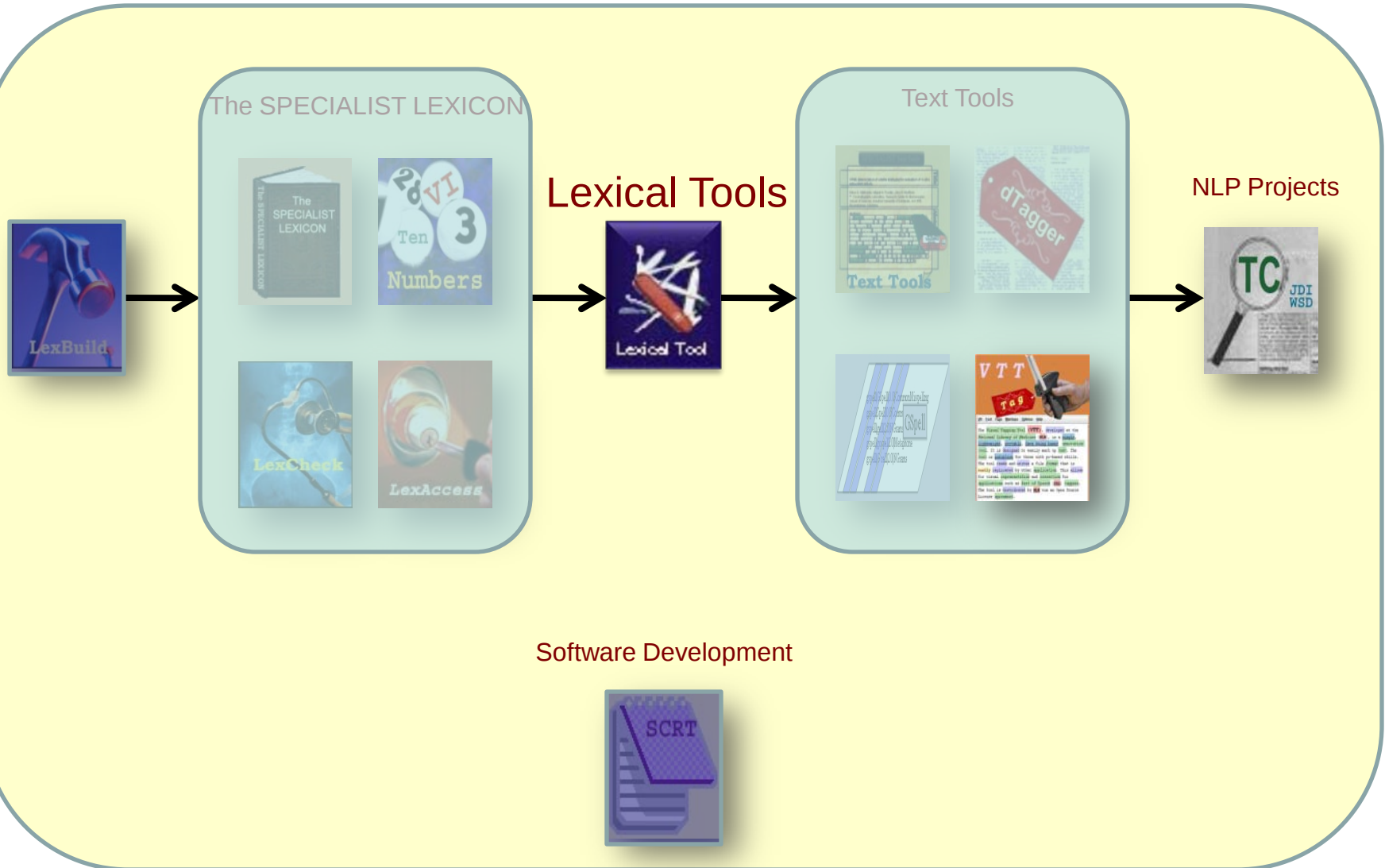
Introduction – NLP Tools



Introduction – NLP Tools



Introduction – NLP Tools



Lexical Tools



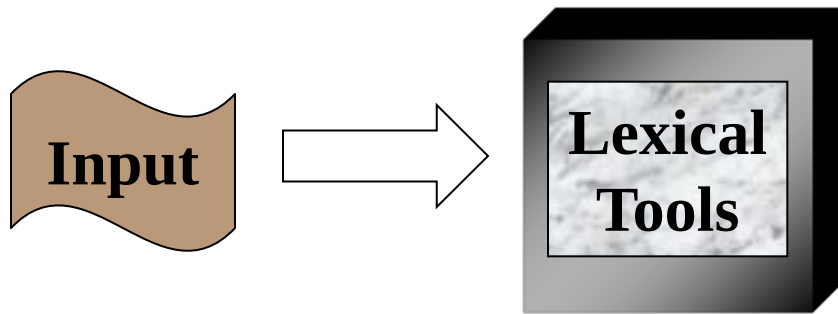
<http://SPECIALIST.nlm.nih.gov/lvg>

Lexical Tools



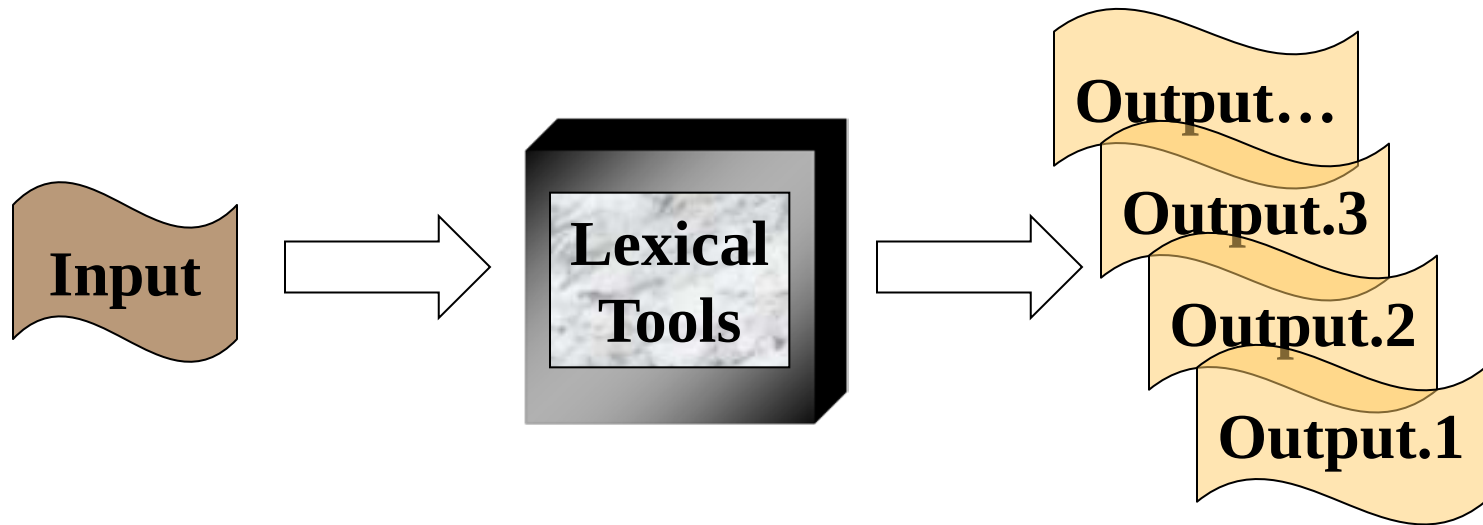
- A suite of text utilities

Lexical Tools



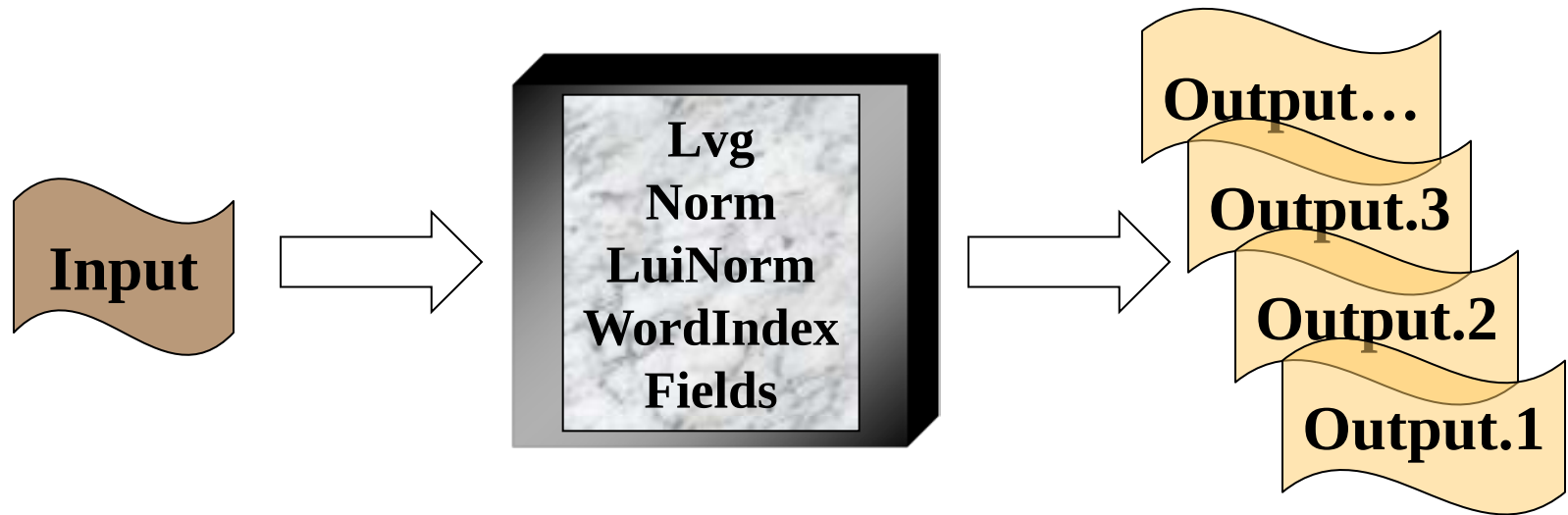
- A suite of text utilities take the given input

Lexical Tools



- A suite of text utilities that generate, mutate, and filter out lexical variants from the given input

Four Tools



Tool Types

- Command line tools
 - [lvq](#) (Lexical Variants Generation)
 - [norm](#)
 - [luiNorm](#)
 - [wordInd](#)
 - fields
- [Lexical Gui Tool](#) (lgt)
- [Web Tools](#)
- [Java API's](#)

Functions

- Used in nature language processing for
 - aggressive text pattern matching
 - creating normalized and expanded terms
 - making word, term, phrase indexes
 - matching queries with indexed entries
 - increasing recall and/or precision

Facts

- Release annually
- Free distributed with open source code
- 100% Java (since 2002)
- Run on different platforms
- One complete package
- Documents & supports

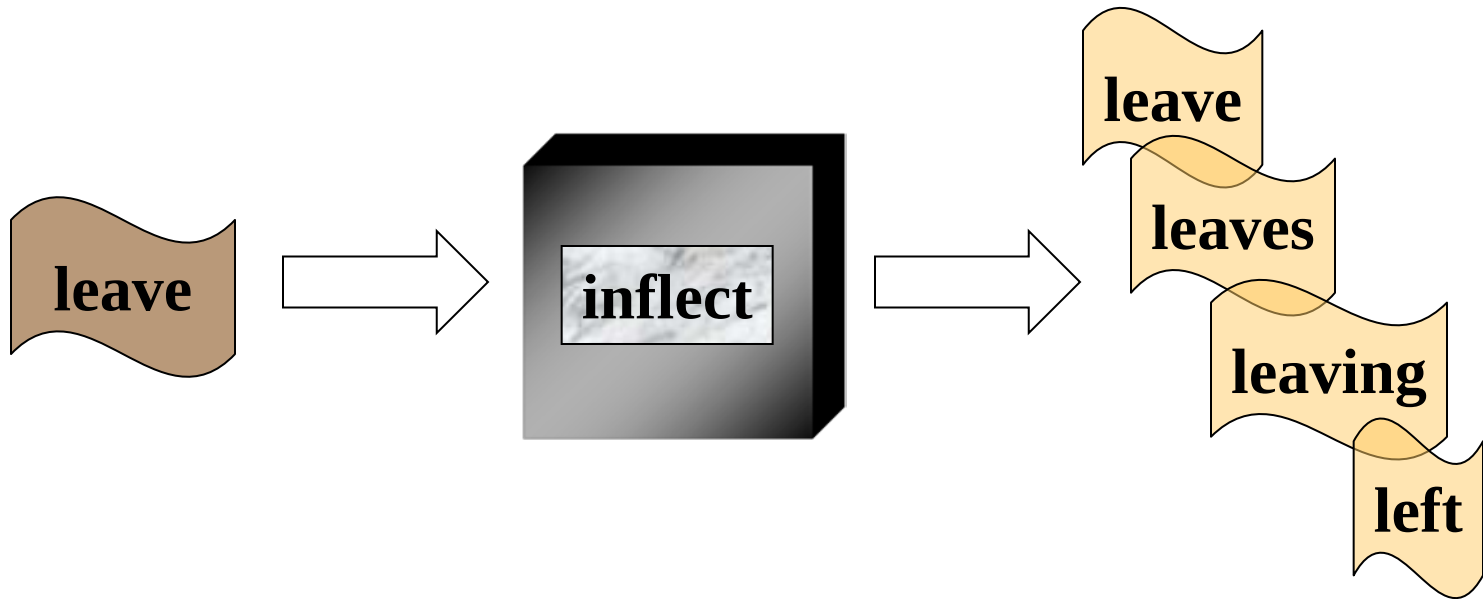
Lexical Variants Generation



LVG - 2011

- 62 flow components
- 36 options
 - input filter options (3)
 - global behavior options (12)
 - flow specific options (2)
 - output filter options (19)

Flow Components

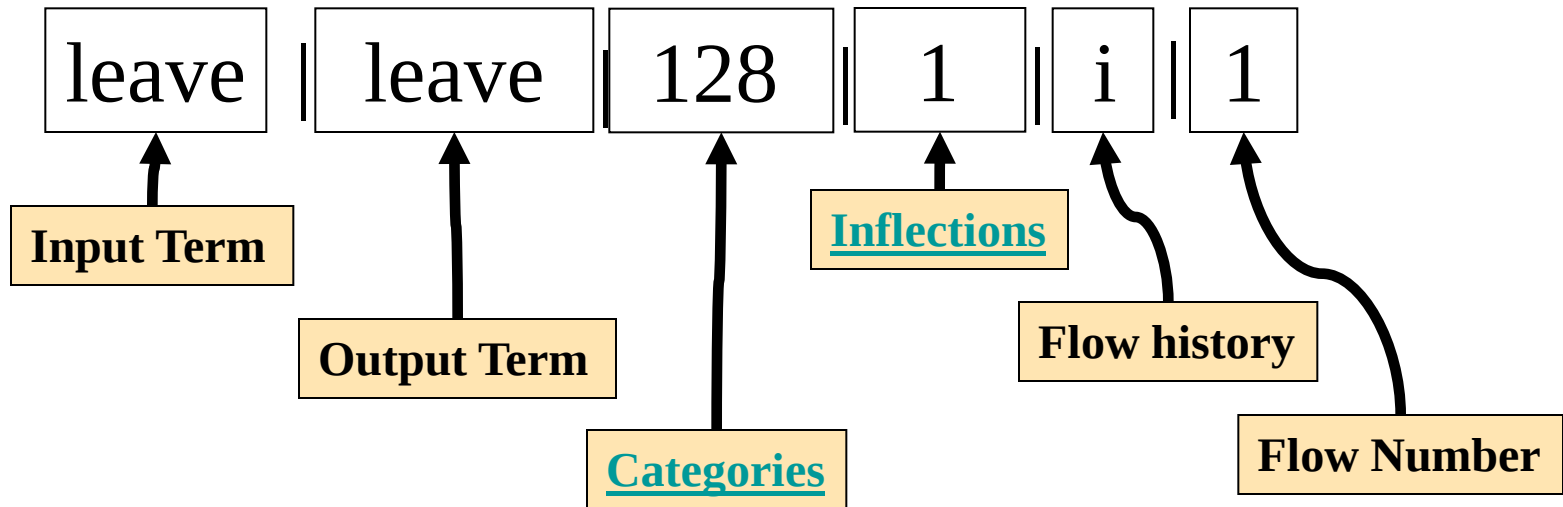


Command Line Tool

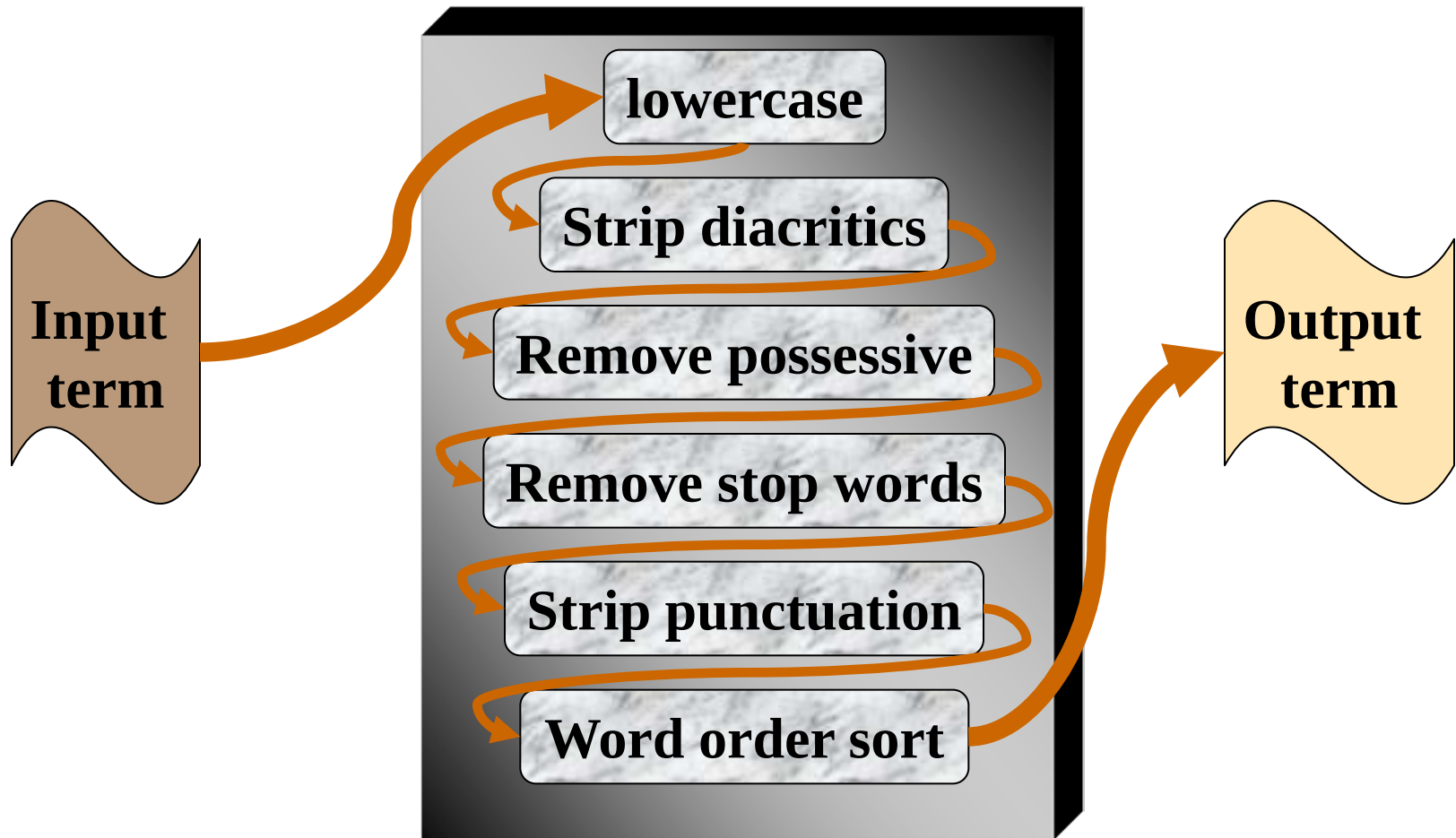
```
> lvg -f:i  
leave  
leave|leave|128|1|i|1|  
leave|leave|128|512|i|1|  
leave|leaves|128|8|i|1|  
leave|left|1024|64|i|1|  
leave|left|1024|32|i|1|  
leave|leave|1024|1|i|1|  
leave|leave|1024|262144|i|1|  
leave|leave|1024|1024|i|1|  
leave|leaves|1024|128|i|1|  
leave|leaving|1024|16|i|1|
```

Fielded Output

> lvg -f:i
leave



A Serial Flow



- Flow components can be arranged so that the output of one is the input to another.

A Serial Flow - Example

```
> lvg -f:l:q:g:t:p:w
```

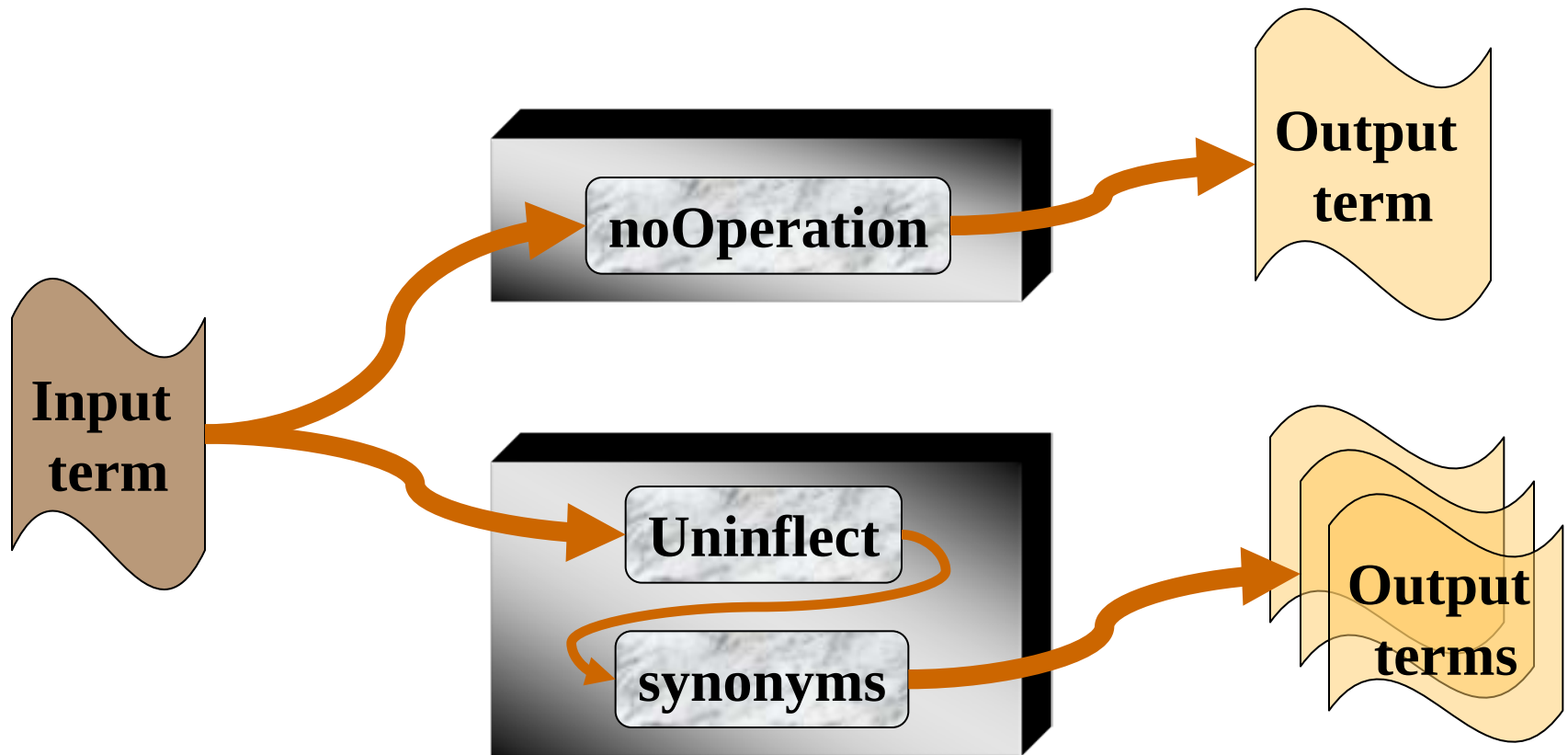
```
The Gougerot-Sjögren's Syndrome
```

```
The Gougerot-Sjögren's Syndrome|
```

```
gougerotsjogren syndrome|2047|
```

```
16777215|l+q+g+t+p+w|1|
```

Parallel Flows



- Multiple flows can be defined

Parallel Flows - Example

```
> lvg -f:n -f:B:y
```

```
ear
```

```
ear|ear|2047|1048575|n|1|
```

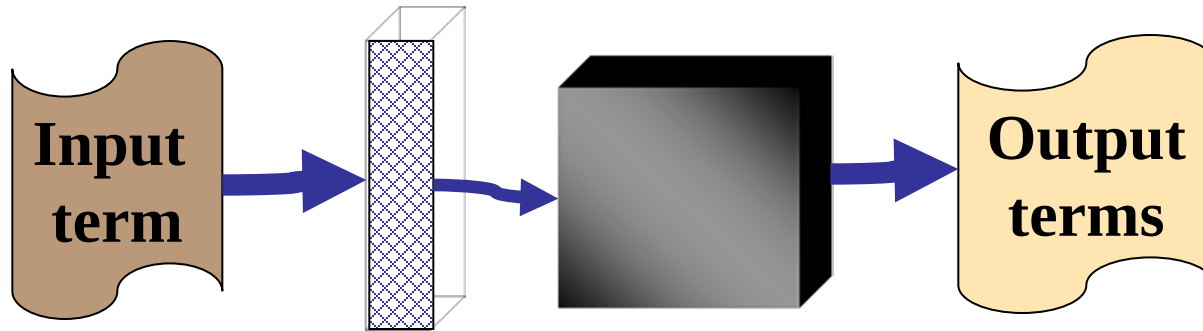
```
ear|aural|1|1|B+y|2|
```

```
ear|auricularis|1|1|B+y|2|
```

```
ear|otic|1|1|B+y|2|
```

```
ear|otor|1|1|B+y|2|
```

Input Filter Options



Take field 7 from the input

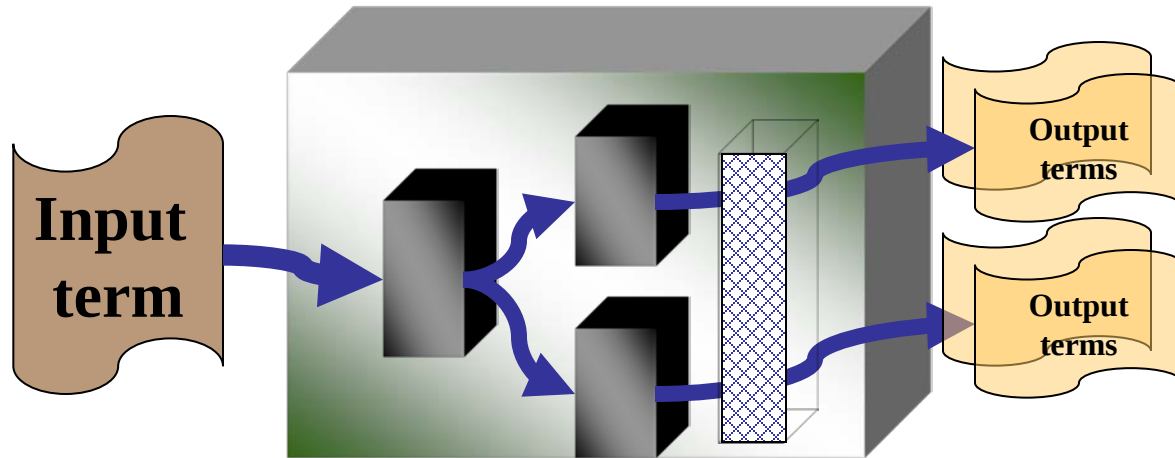
> lvg -f:u **-t:7** -F:8:6

C0035440|ENG|S|L0035434|VW|S0003894|

Rheumatic carditis, acute

acute Rheumatic carditis|S0003894

Global Behavior Options



```
> lvg -f:L -f:E -s:"\"
```

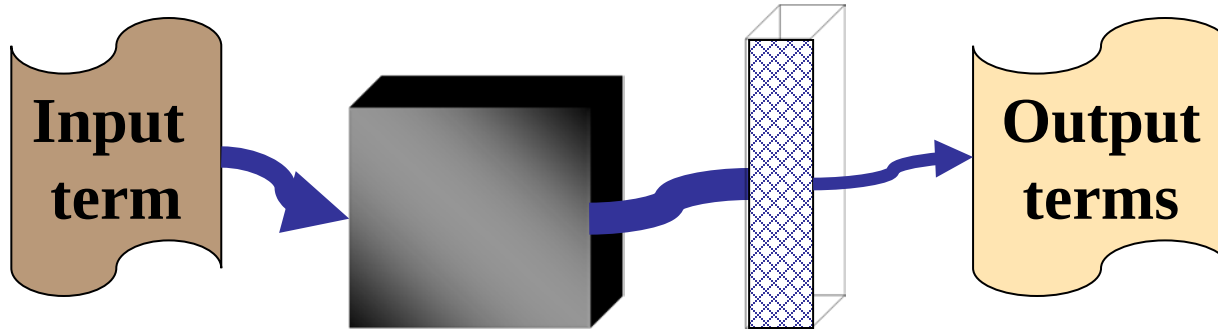
Change separator to "\"

```
otitis
```

```
otitis\otitis\128\513\L\1
```

```
otitis\E0044452\128\513\E\2
```

Output Filter Options



> lvg -f:L

-SC -SI

Show the category and
inflection names

hot

hot|hot|<adj+verb>|<base+positive+infinitive+pres1p23p>|L|1|

Norm

- Composed of 11 Lvg flow components to abstract away from:
 - case
 - punctuation
 - possessive forms
 - inflections
 - spelling variants
 - stop words
 - Diacritics, ligatures & symbols (Unicode to ASCII)
 - word order

Norm

q0: map Unicode symbols to ASCII

g: remove genitives

rs: remove parenthetical plural forms

o: replace punctuation with spaces

t: strip stop words

l: lowercase

B: uninflect each words in a term

Ct: retrieve citations

q7: Unicode core Norm

q8: strip or map non-ASCII char

w: sort words by order

Norm

Hodgkin's Diseases, NOS

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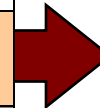
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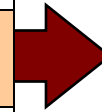
w: sort words by order

Hodgkin's Diseases, NOS

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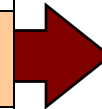
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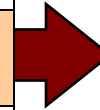
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Hodgkin Diseases



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hodgkin diseases

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hodgkin disease

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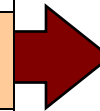
Hodgkin Diseases NOS

Hodgkin Diseases

hodgkin diseases

hodgkin disease

hodgkin disease



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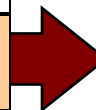
Hodgkin Diseases

hodgkin diseases

hodgkin disease

hodgkin disease

hodgkin disease



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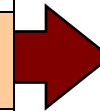
hodgkin diseases

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Hodgkin Diseases

hodgkin diseases

hodgkin disease

hodgkin disease

hodgkin disease

hodgkin disease

disease hodgkin

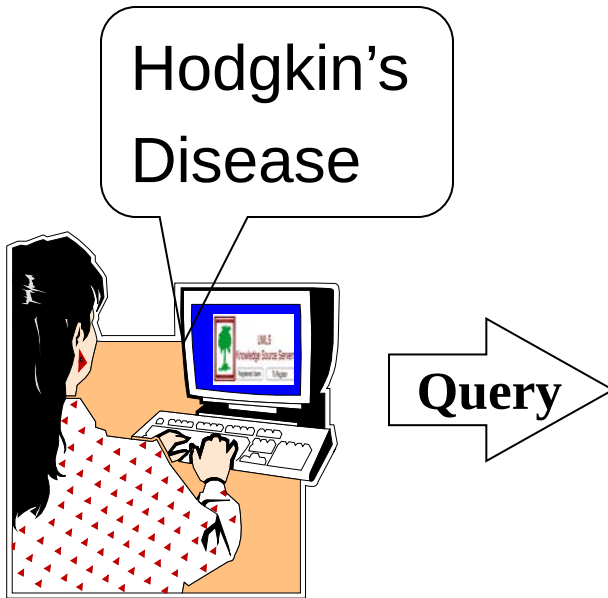
Norm: Example

- Hodgkin Disease
- HODGKINS DISEASE
- Hodgkin's Disease
- Disease, Hodgkin's
- HODGKIN'S DISEASE
- Hodgkin's disease
- Hodgkins Disease
- Hodgkin's disease NOS
- Hodgkin's disease, NOS
- Disease, Hodgkins
- Diseases, Hodgkins
- Hodgkins Diseases
- Hodgkins disease
- hodgkin's disease
- Disease;Hodgkins
- Disease, Hodgkin
- ...

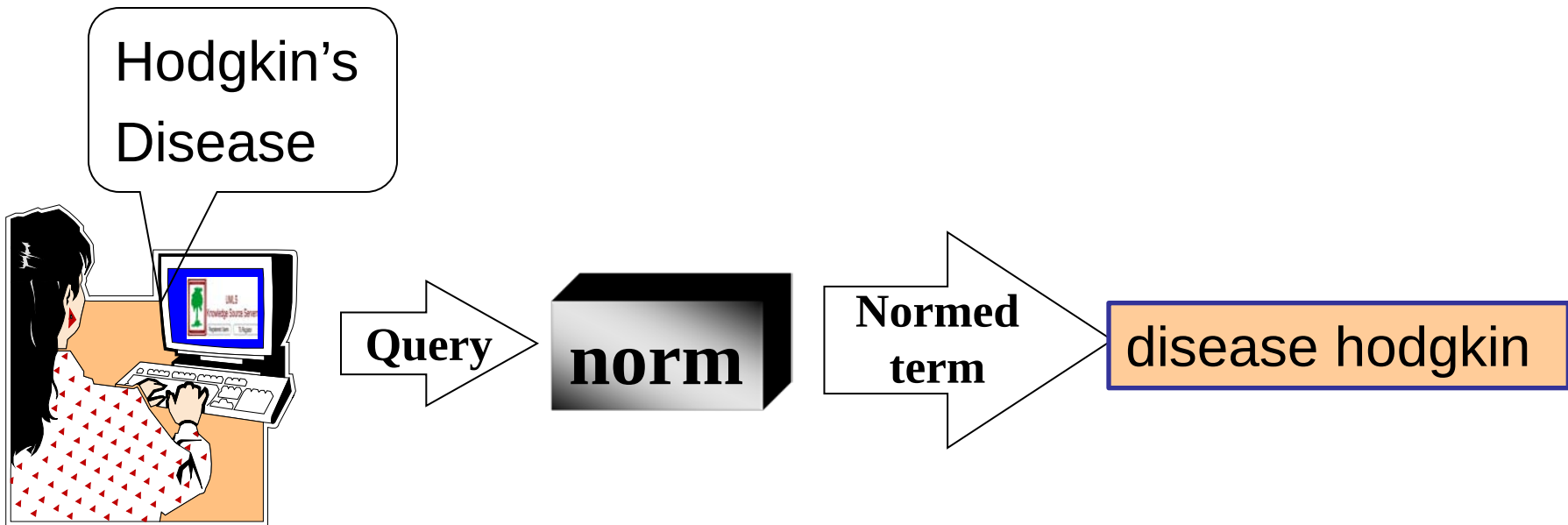


disease hodgkin

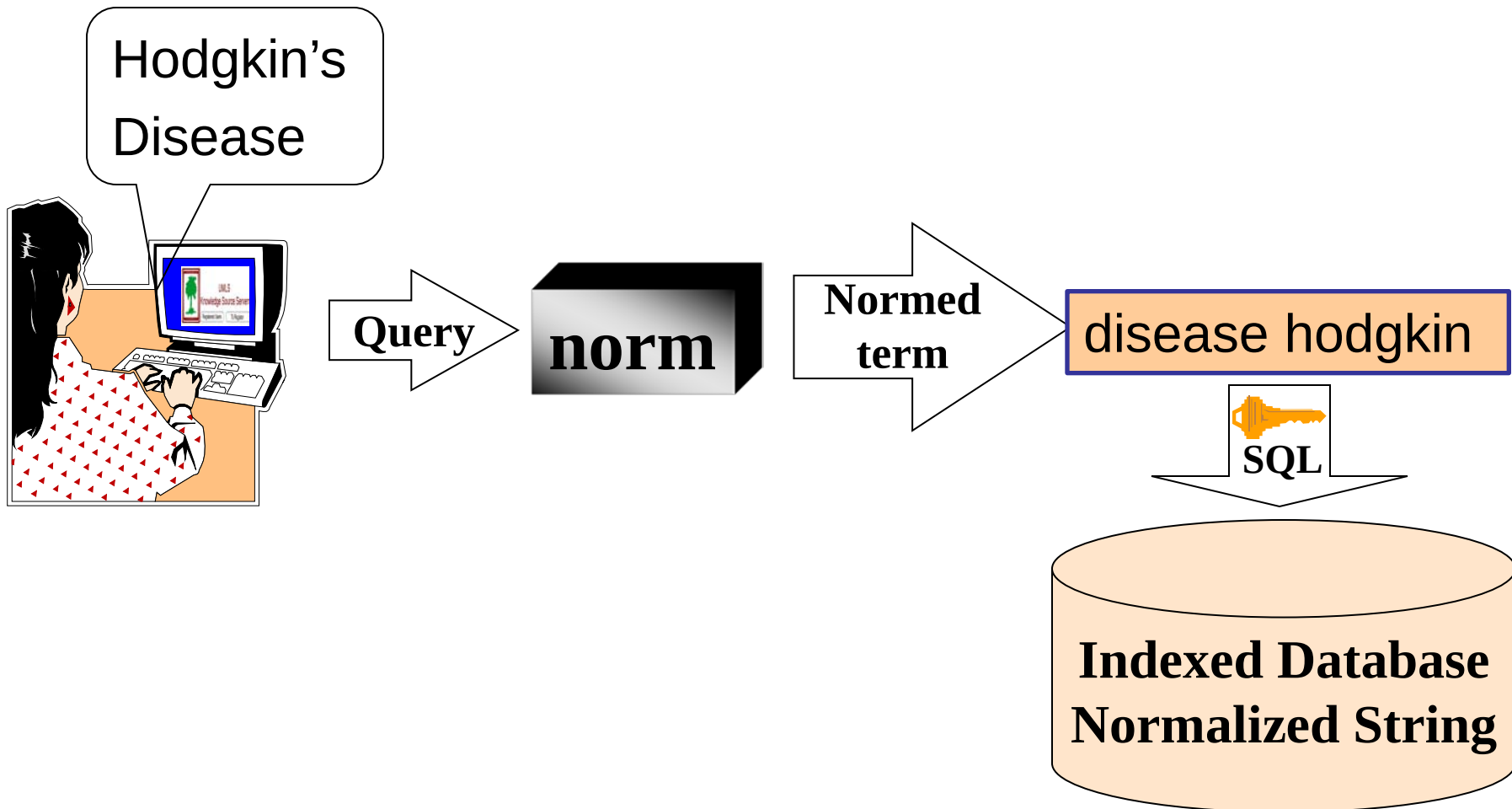
Example - Norm



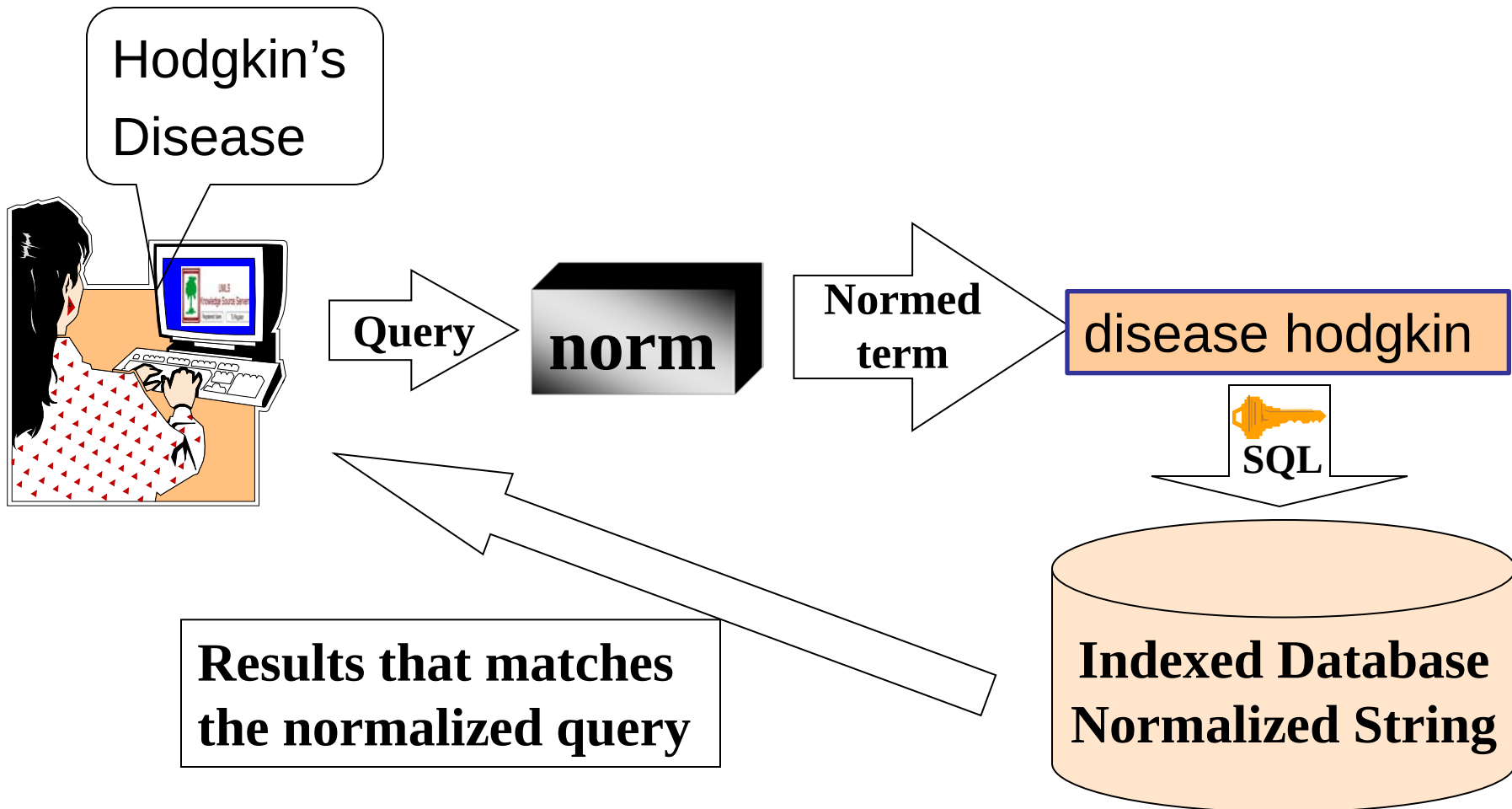
Example - Norm



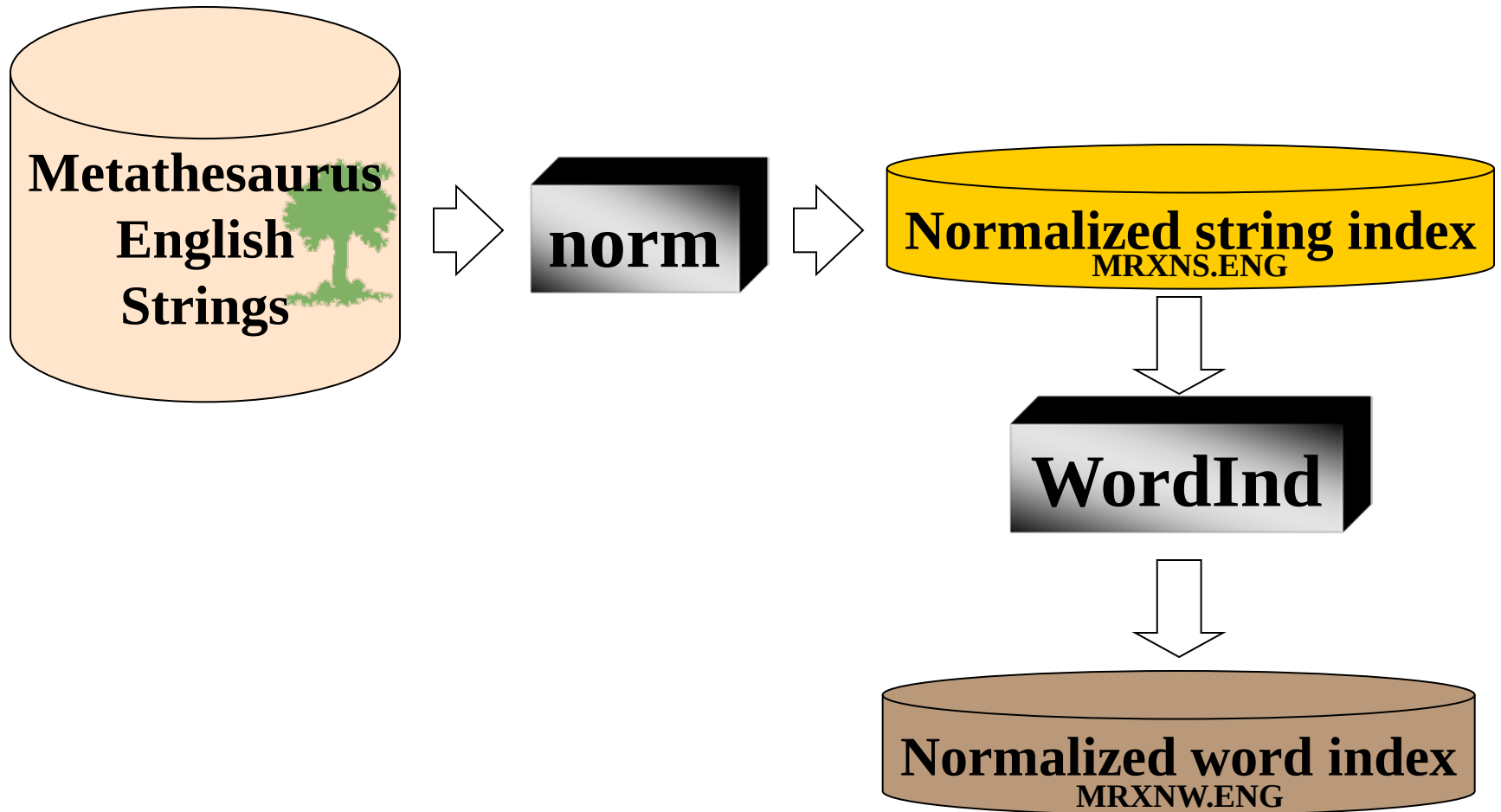
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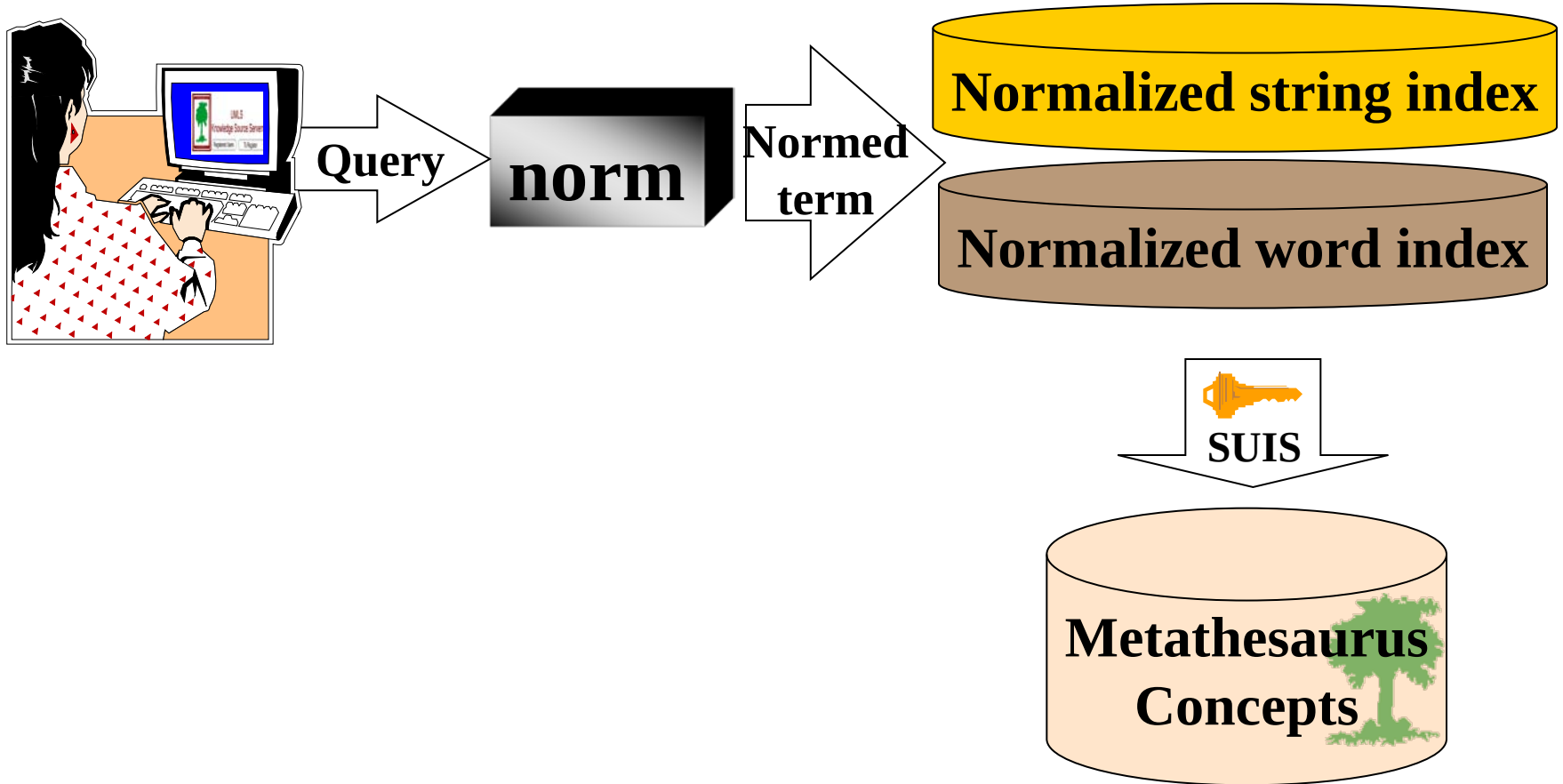
Example - Norm



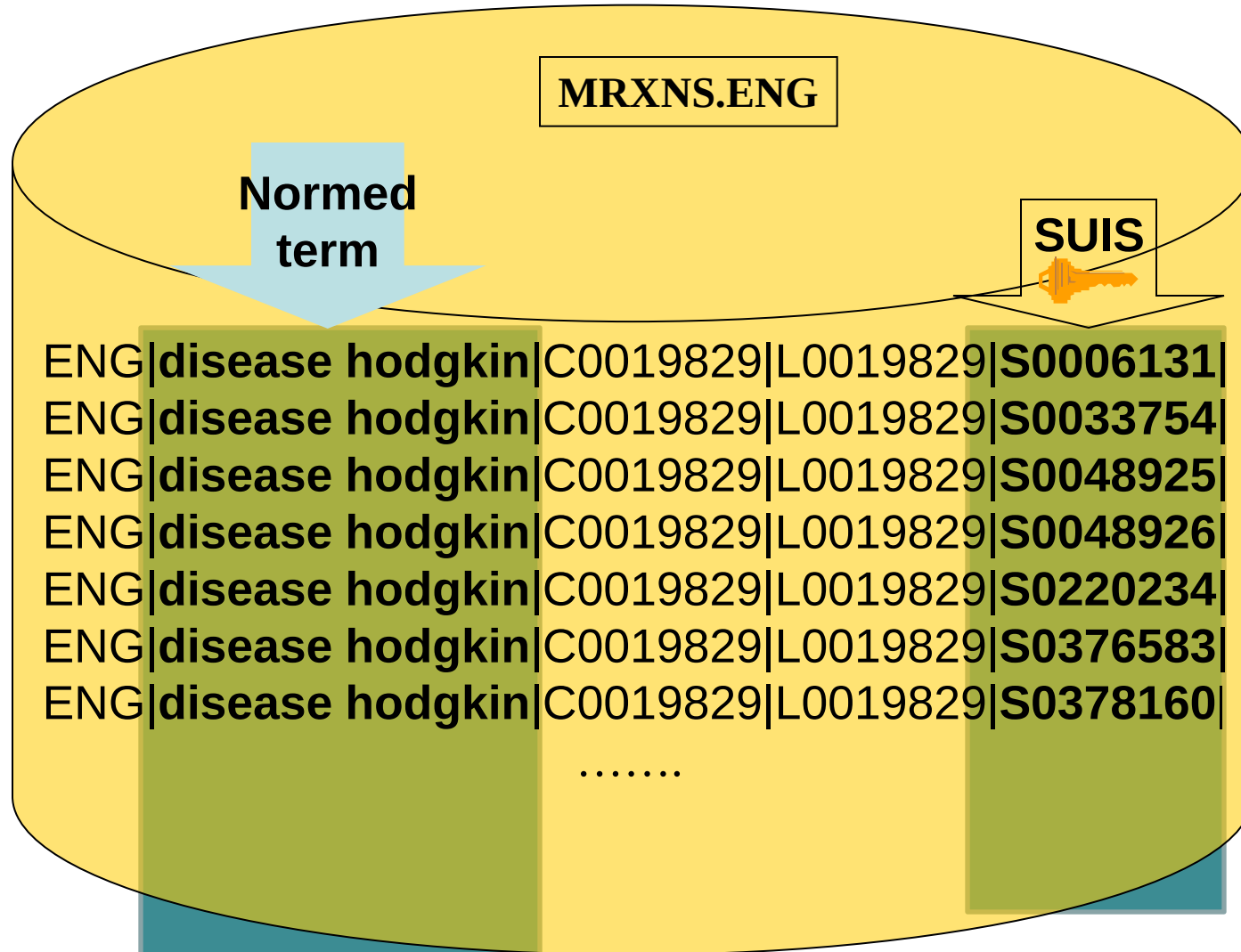
Example 2 – UMLS Metathesaurus



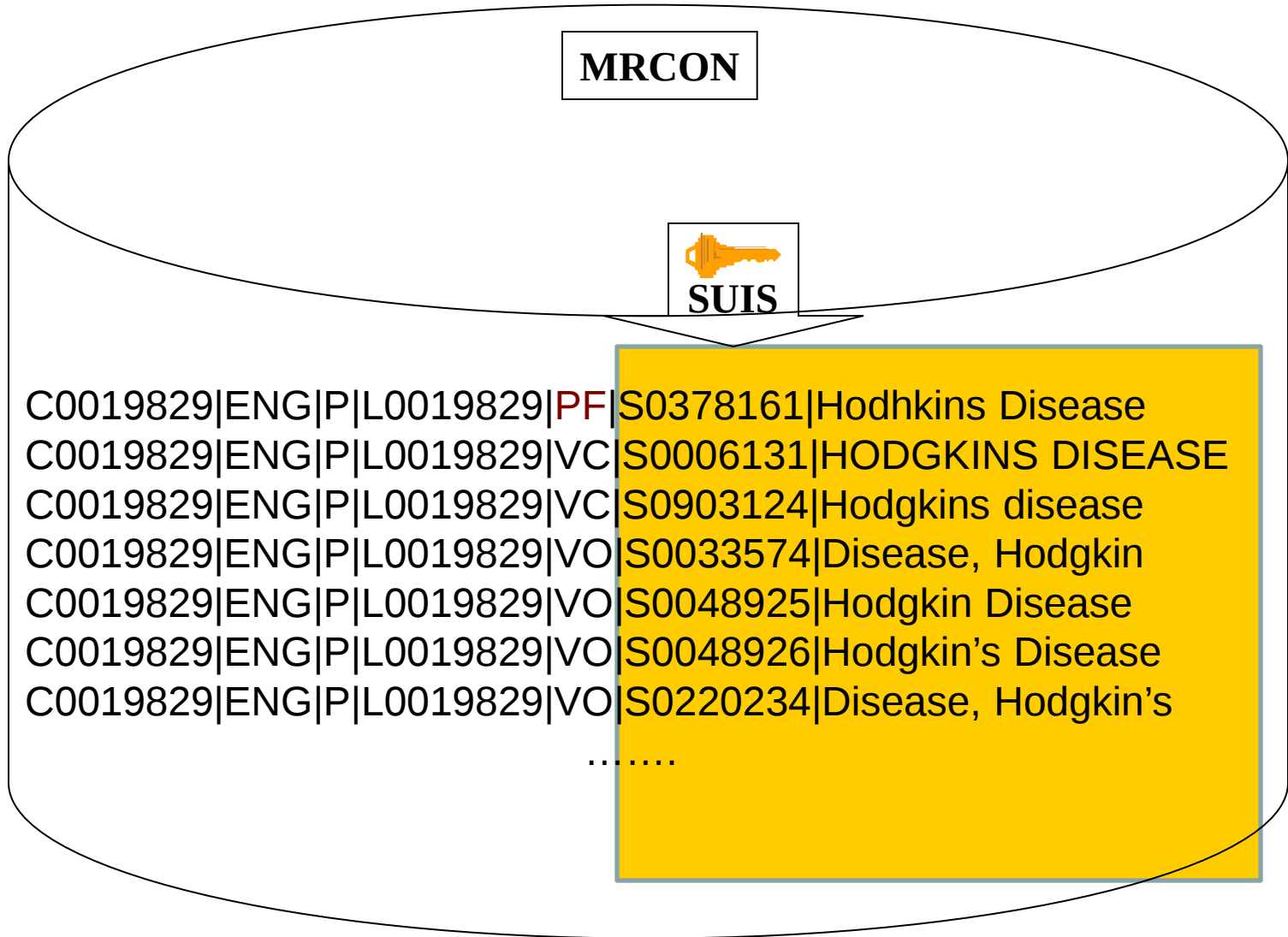
Example 2



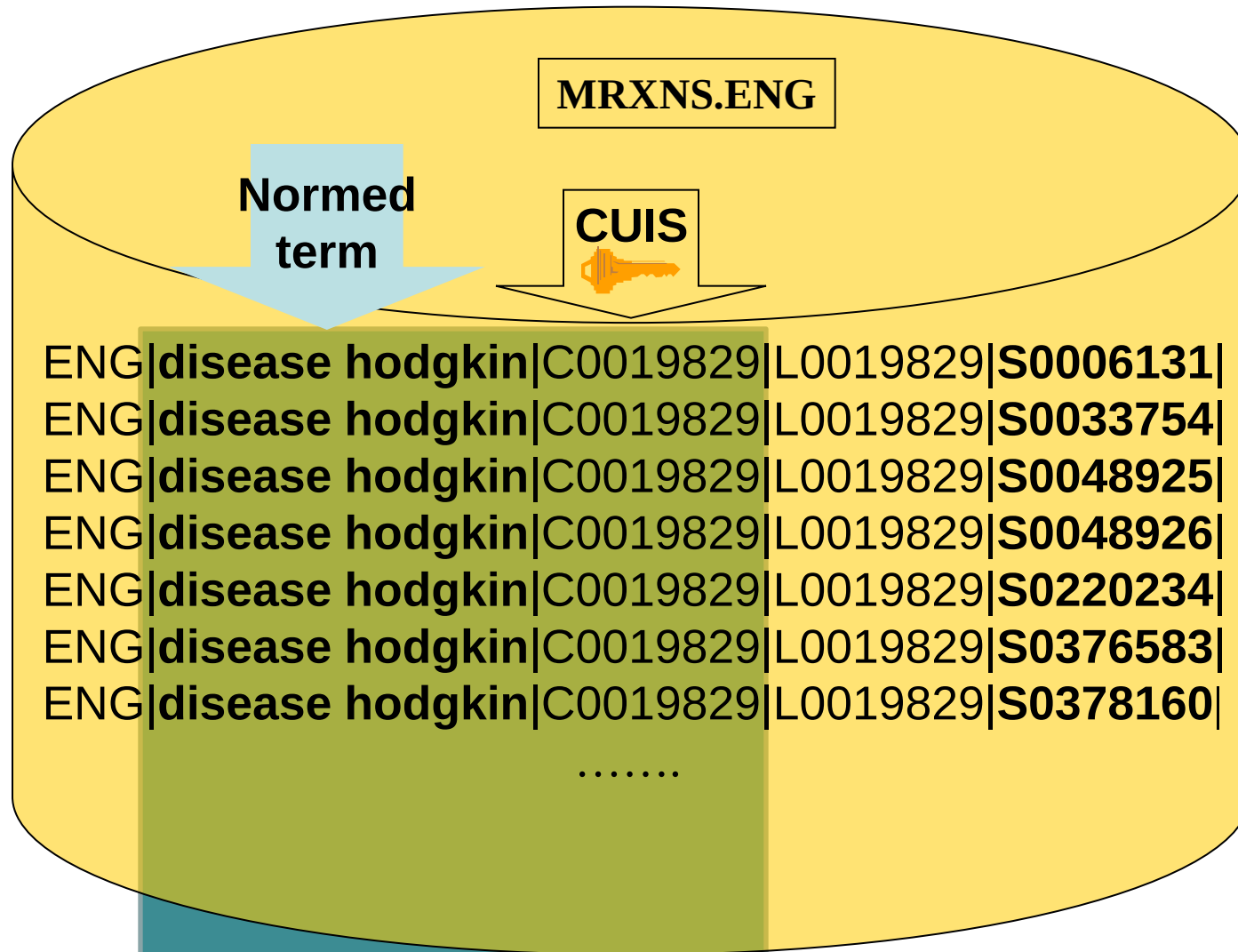
Example 2 – String Name



Example 2 – String Name



Example 2 – Concept Name



Example 2

MRCON

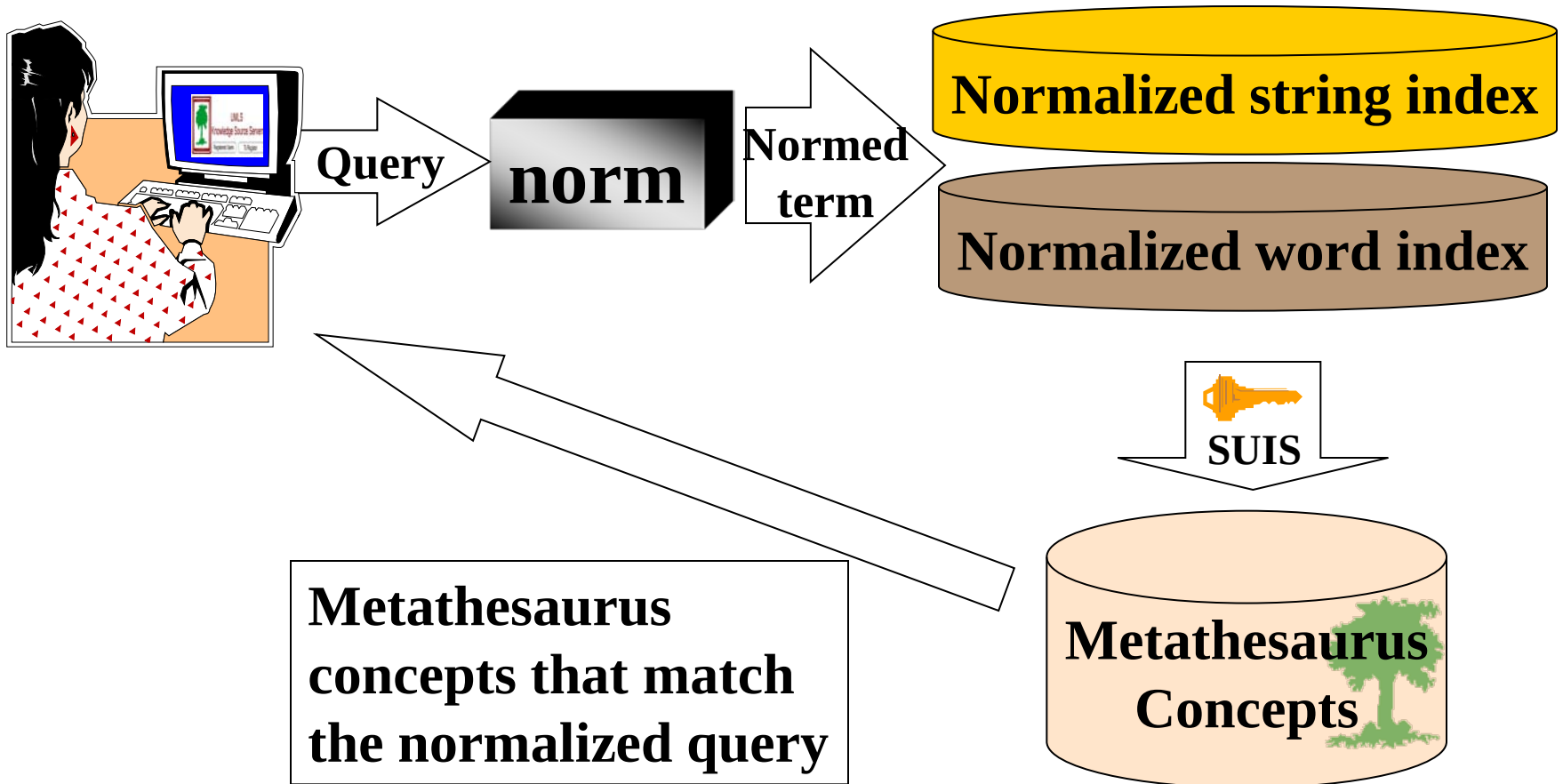


CUIS

C0019829|ENG|P|L0019829|PF|S0378161|Hodhkins Disease
C0019829|ENG|P|L0019829|VC|S0006131|HODGKINS DISEASE
C0019829|ENG|P|L0019829|VC|S0903124|Hodgkins disease
C0019829|ENG|P|L0019829|VO|S0033574|Disease, Hodgkin
C0019829|ENG|P|L0019829|VO|S0048925|Hodgkin Disease
C0019829|ENG|P|L0019829|VO|S0048926|Hodgkin's Disease
C0019829|ENG|P|L0019829|VO|S0220234|Disease, Hodgkin's

.....

Example 2

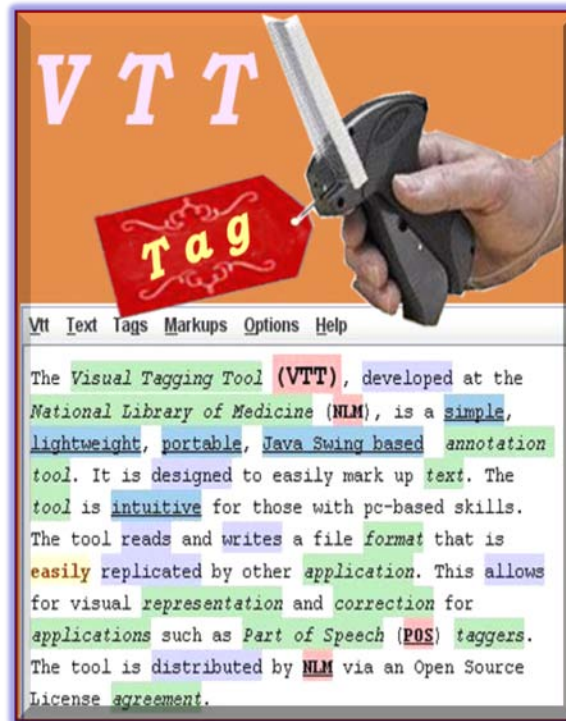


Questions



- Lexical Systems Group: <http://umlslex.nlm.nih.gov>
- The SPECIALIST NLP Tools: <http://specialist.nlm.nih.gov>

Visual Tagging Tool (VTT)



<http://SPECIALIST.nlm.nih.gov/vtt>

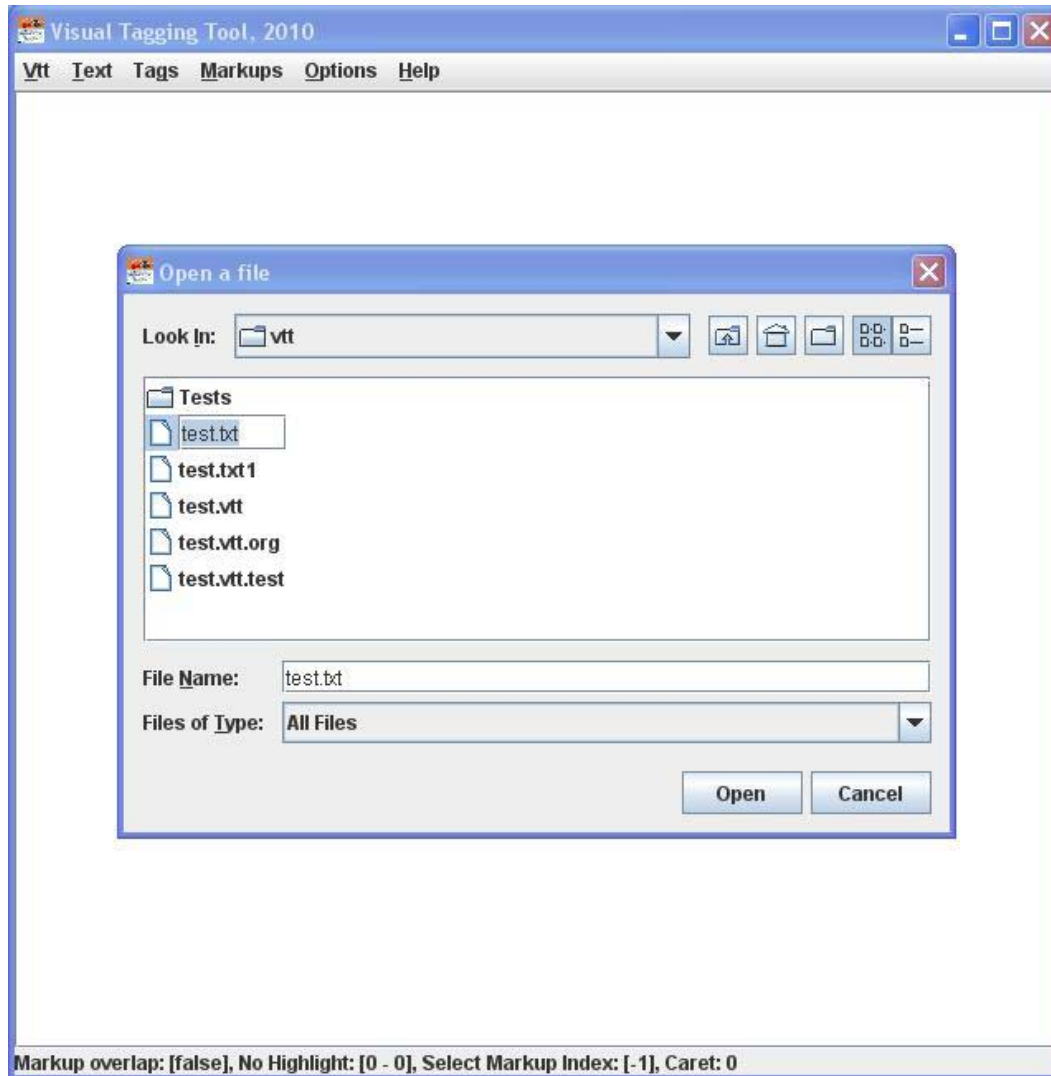
VTT

- A simple, easy, lightweight, portable, Java Swing based annotation tool
- Shows tagged text in different visual effects: **color**, **font**, size, **bold**, *italic*, underline, etc.
- Developed to ease the human tagging process (markup text)
- Can be integrated with other NLP programs
- Full documents & supports
- Free distributed with open source code (since 2009)

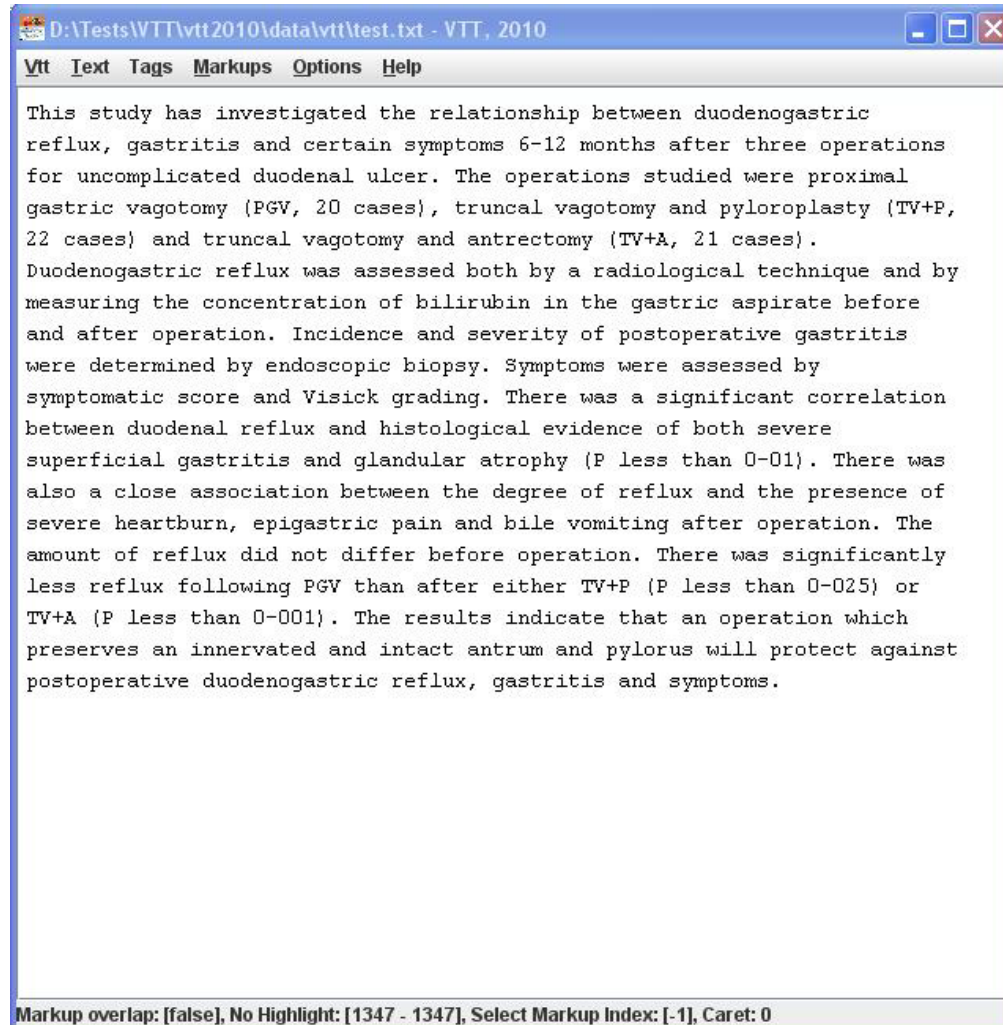
Basic Steps to Use VTT?

- 1) Open a plain unmarked text
 - Vtt -> Open (O)
- 2) Define or import tags
 - Tags -> Setup
 - Tags -> Setup -> Import
- 3) Start to markup (assign tag to plain text)
 - Select text: smear, double clicks, triple clicks, quick keys, etc.
 - Assign tag: quick keys, pull-down menu

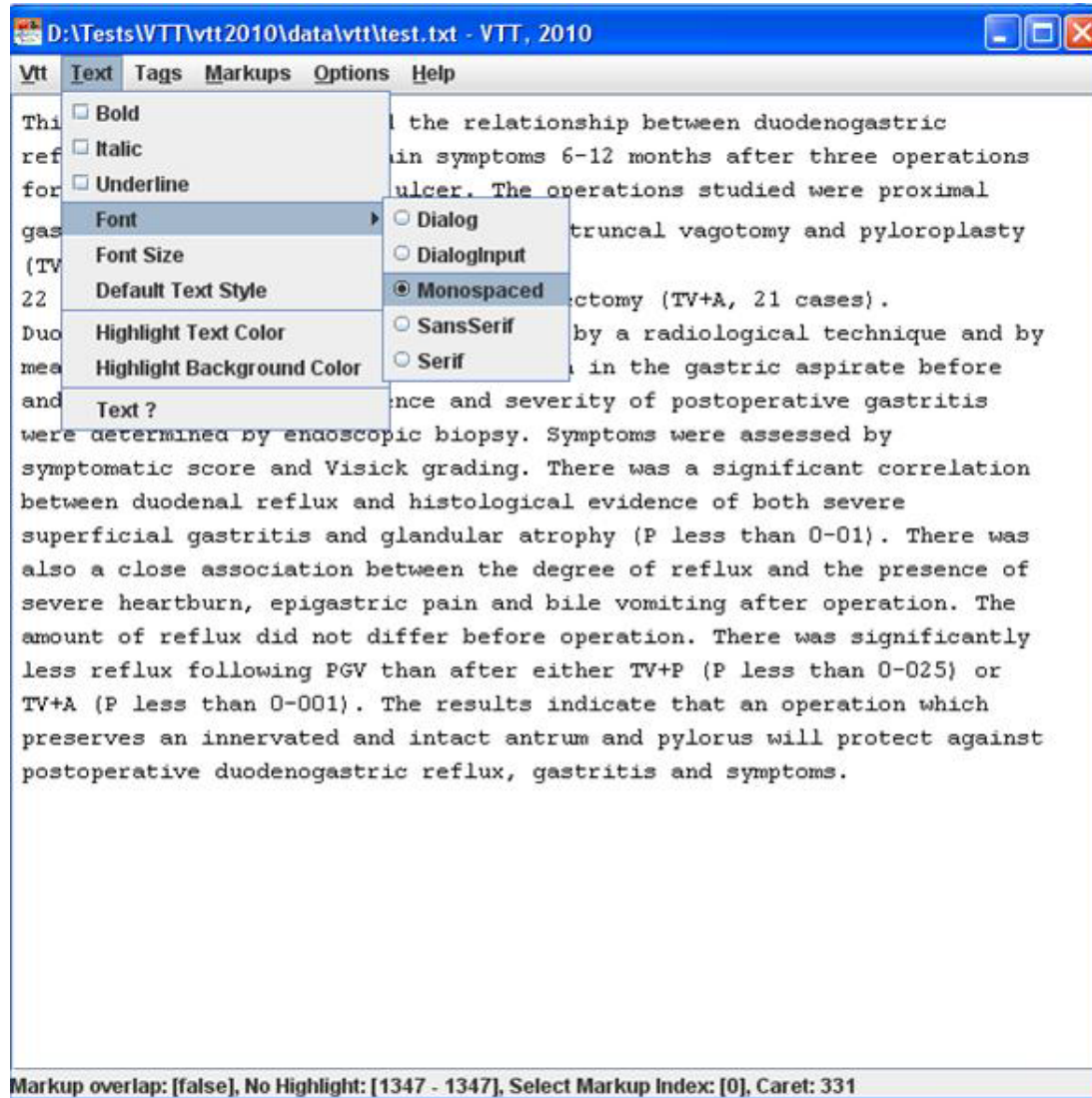
Text - Open



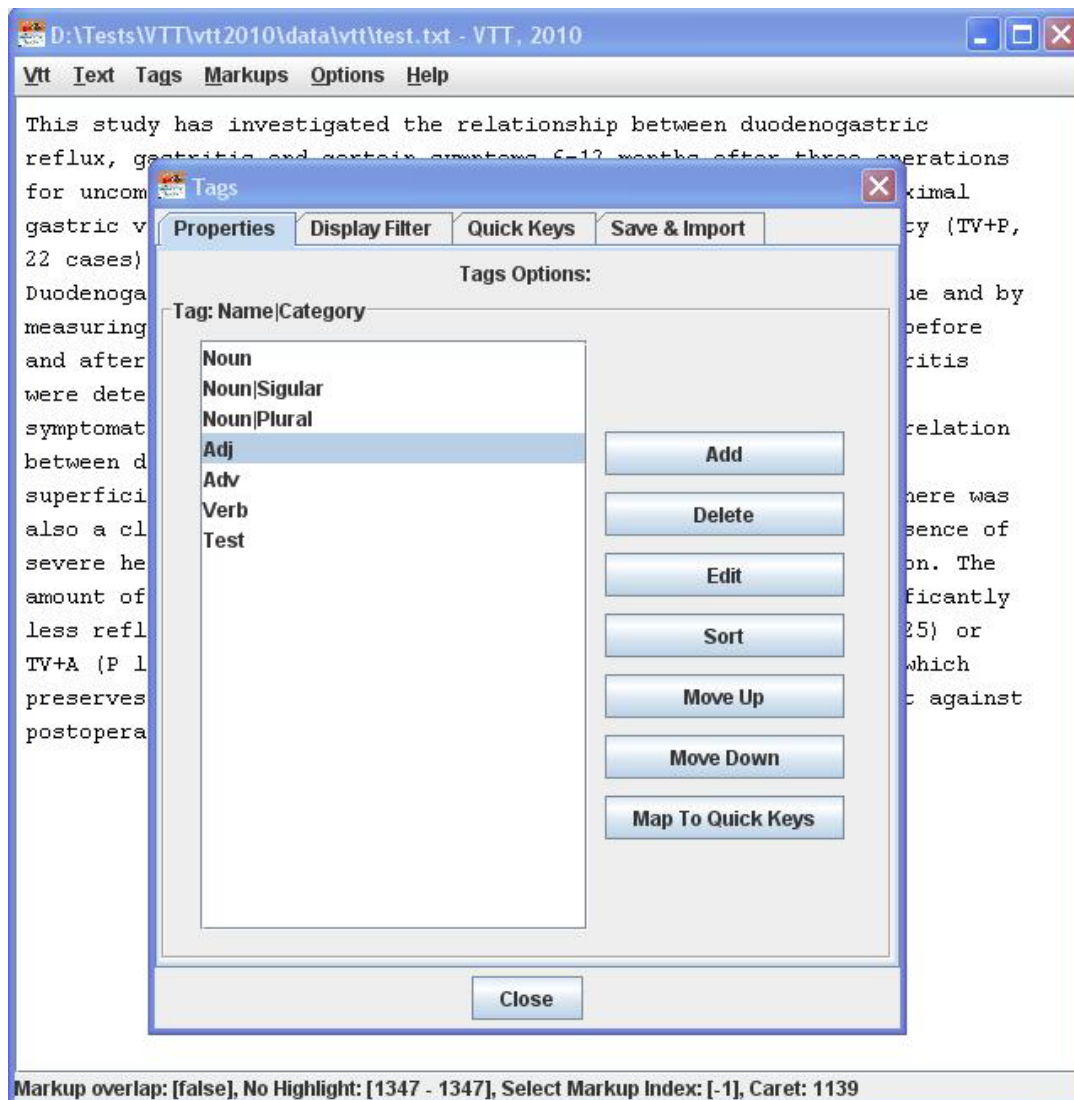
Text – Open (Cont.)



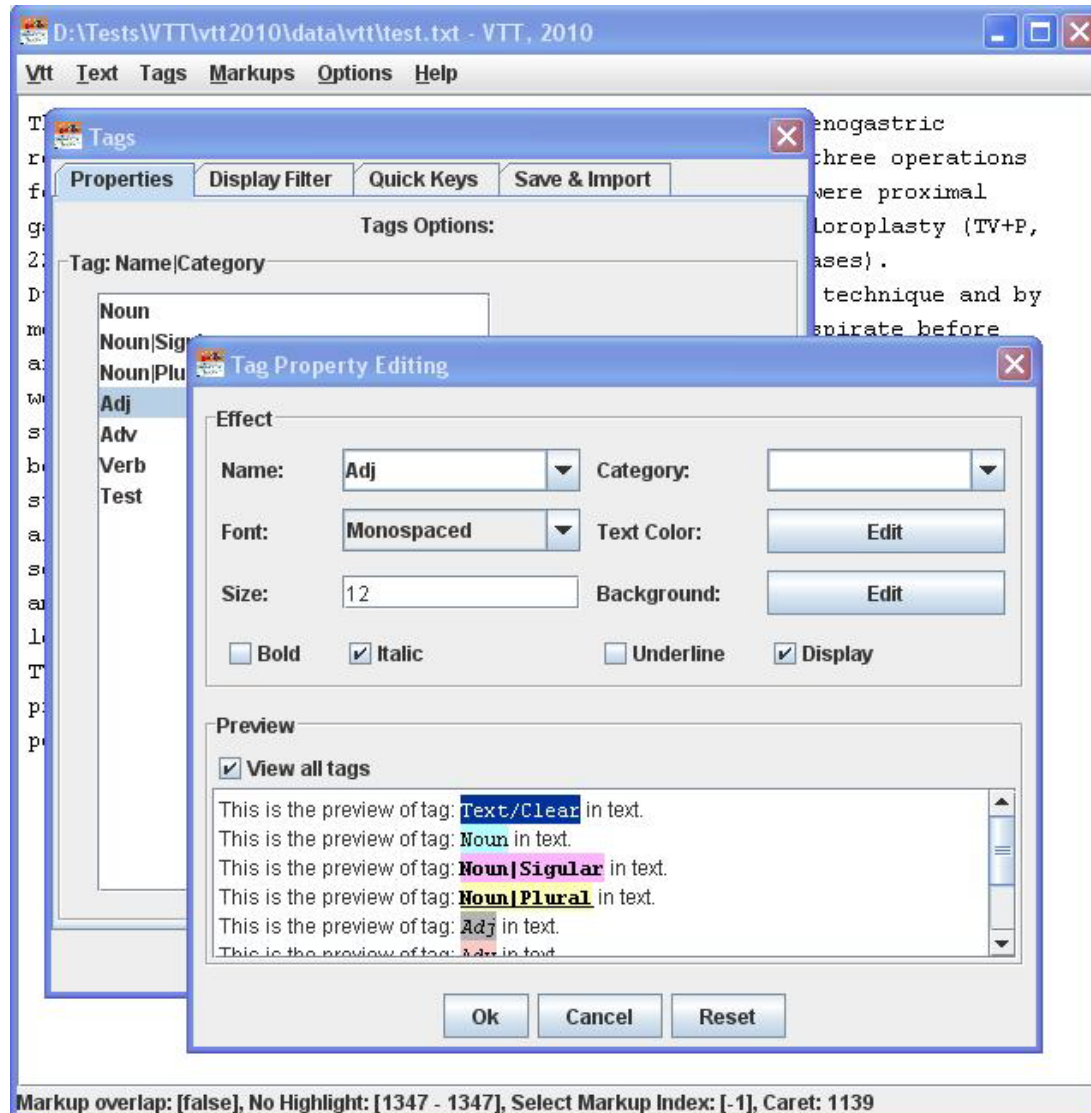
Text - Options



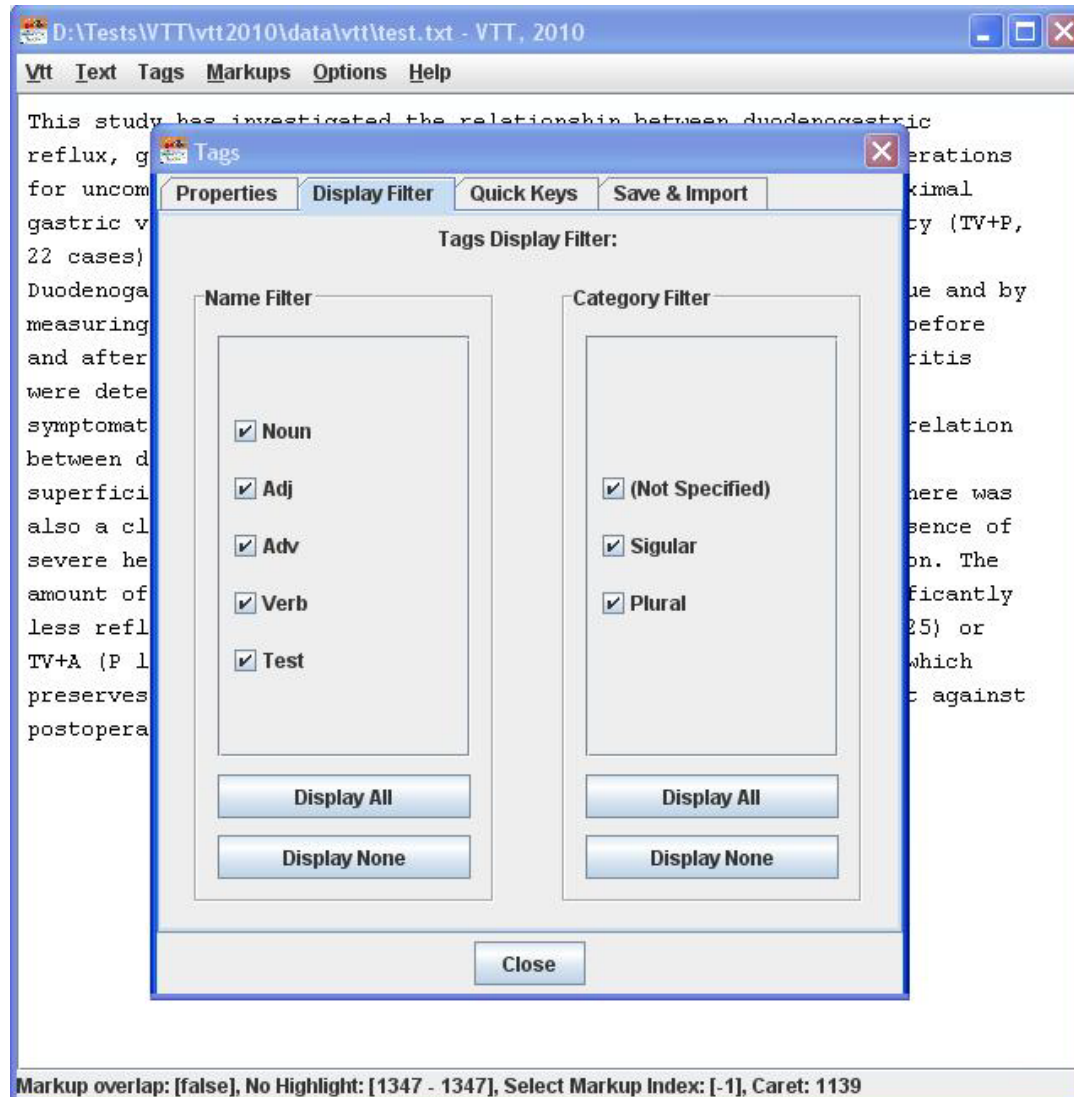
Tags - Setup



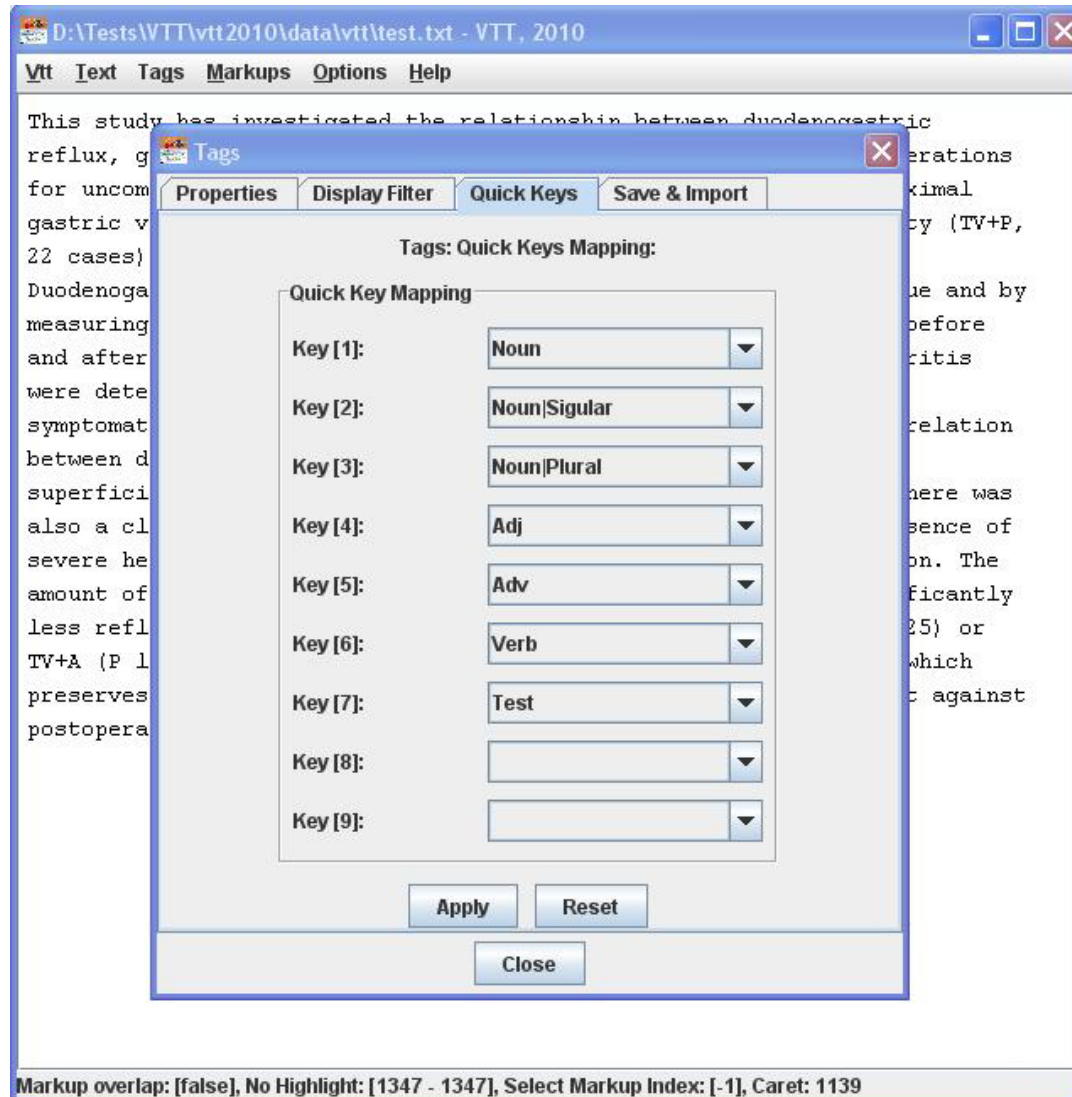
Tags - Edit



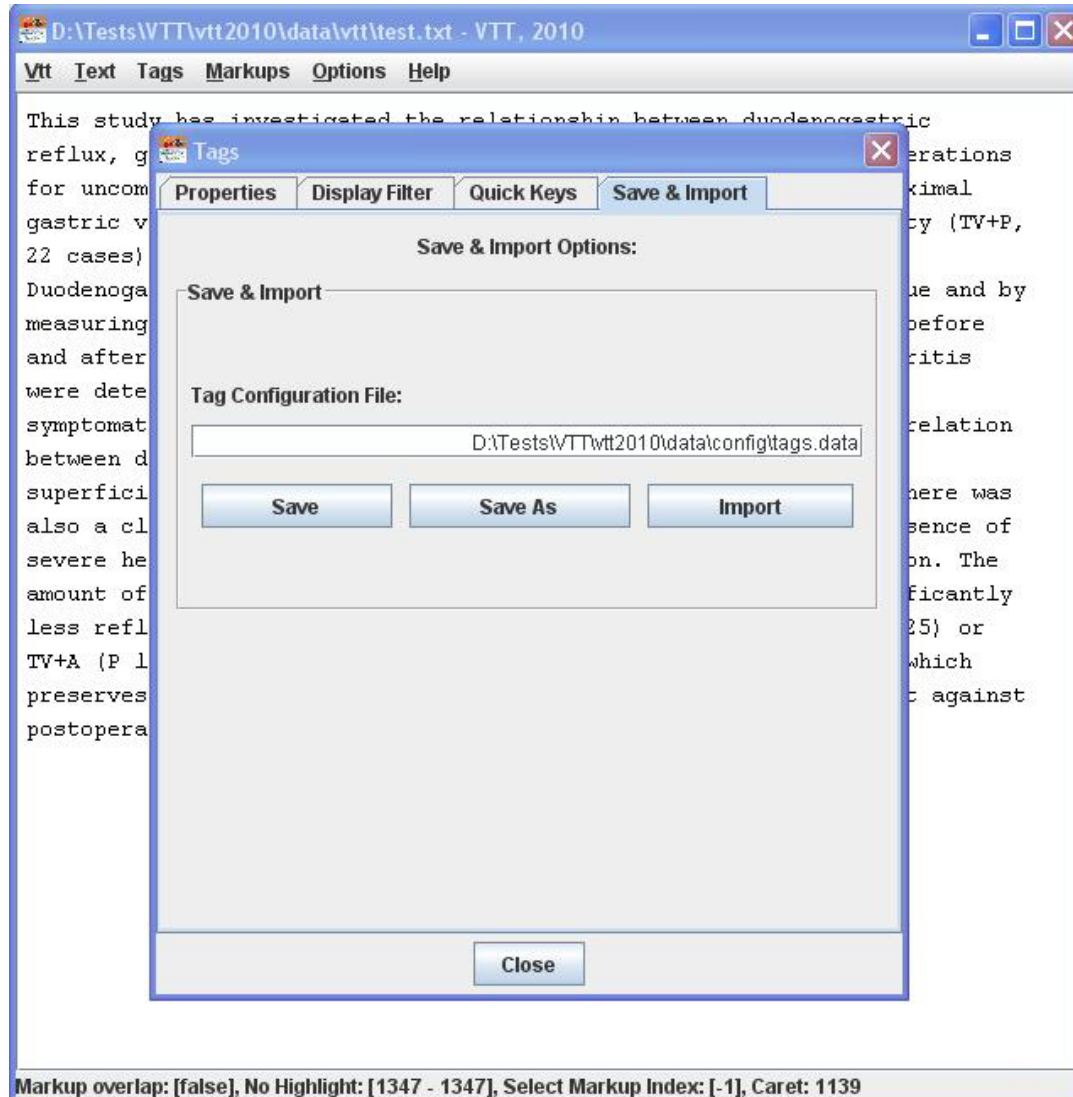
Tags – Display Filter



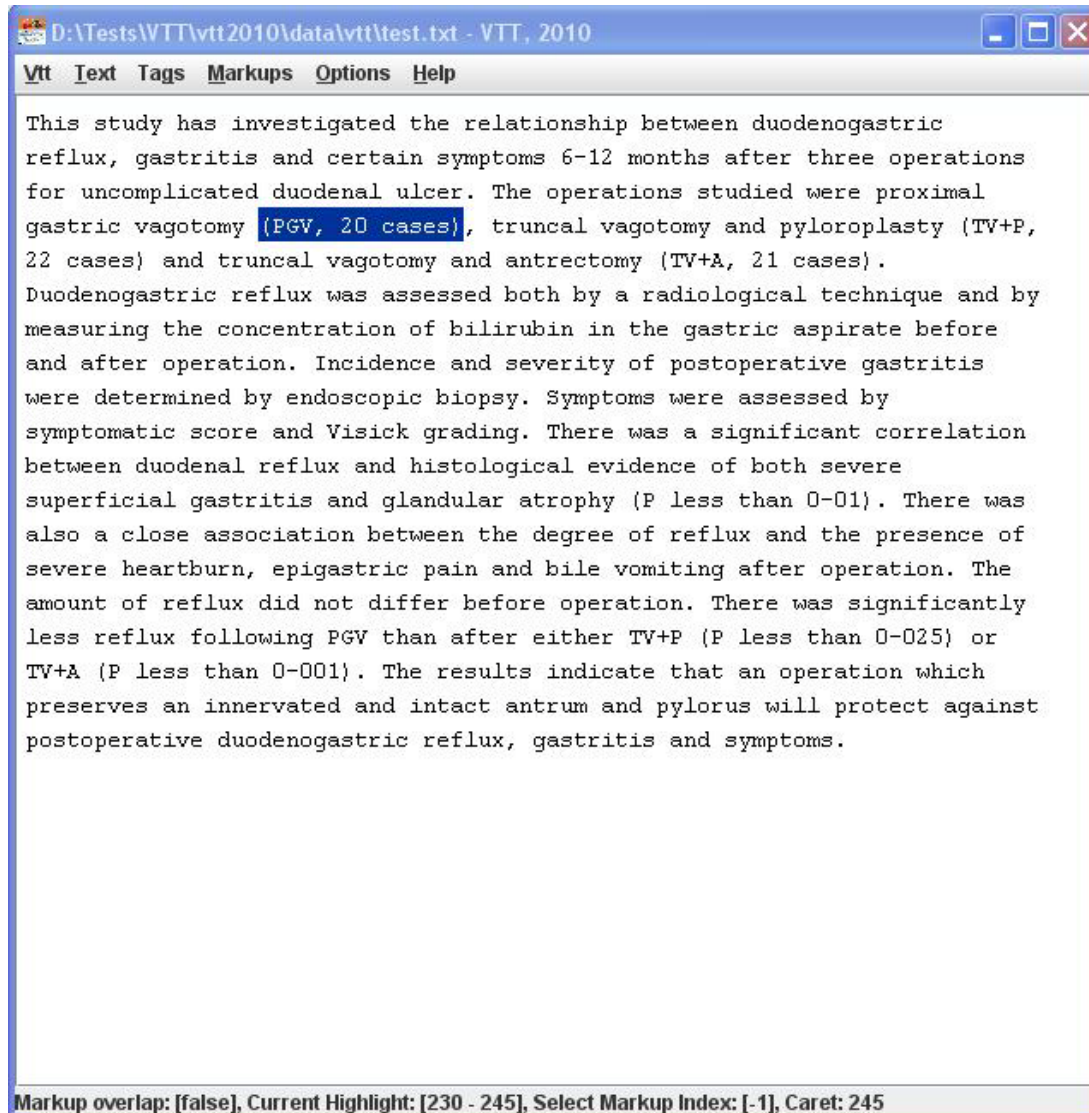
Tags - Quick Keys



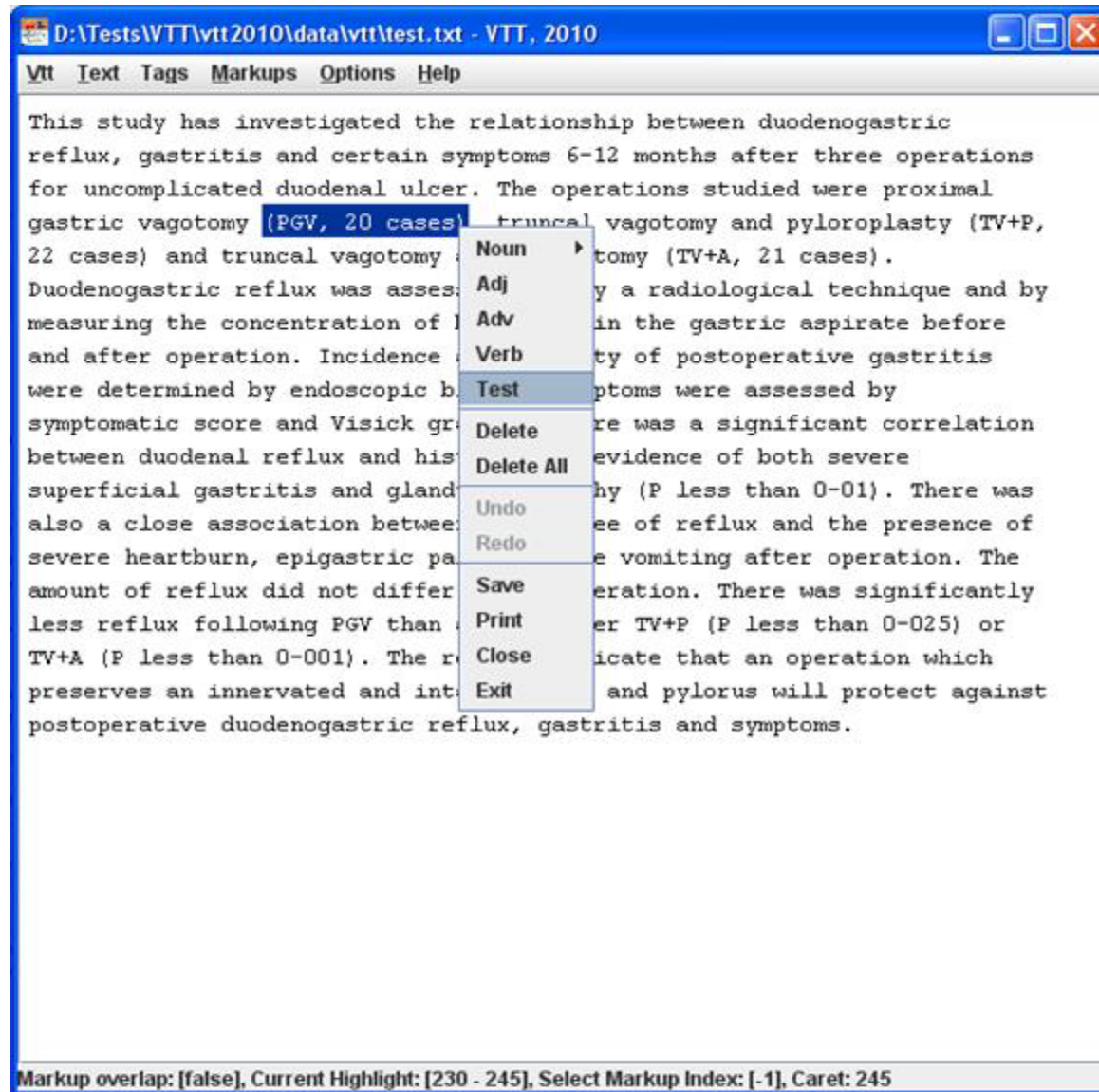
Tags – Save & Import



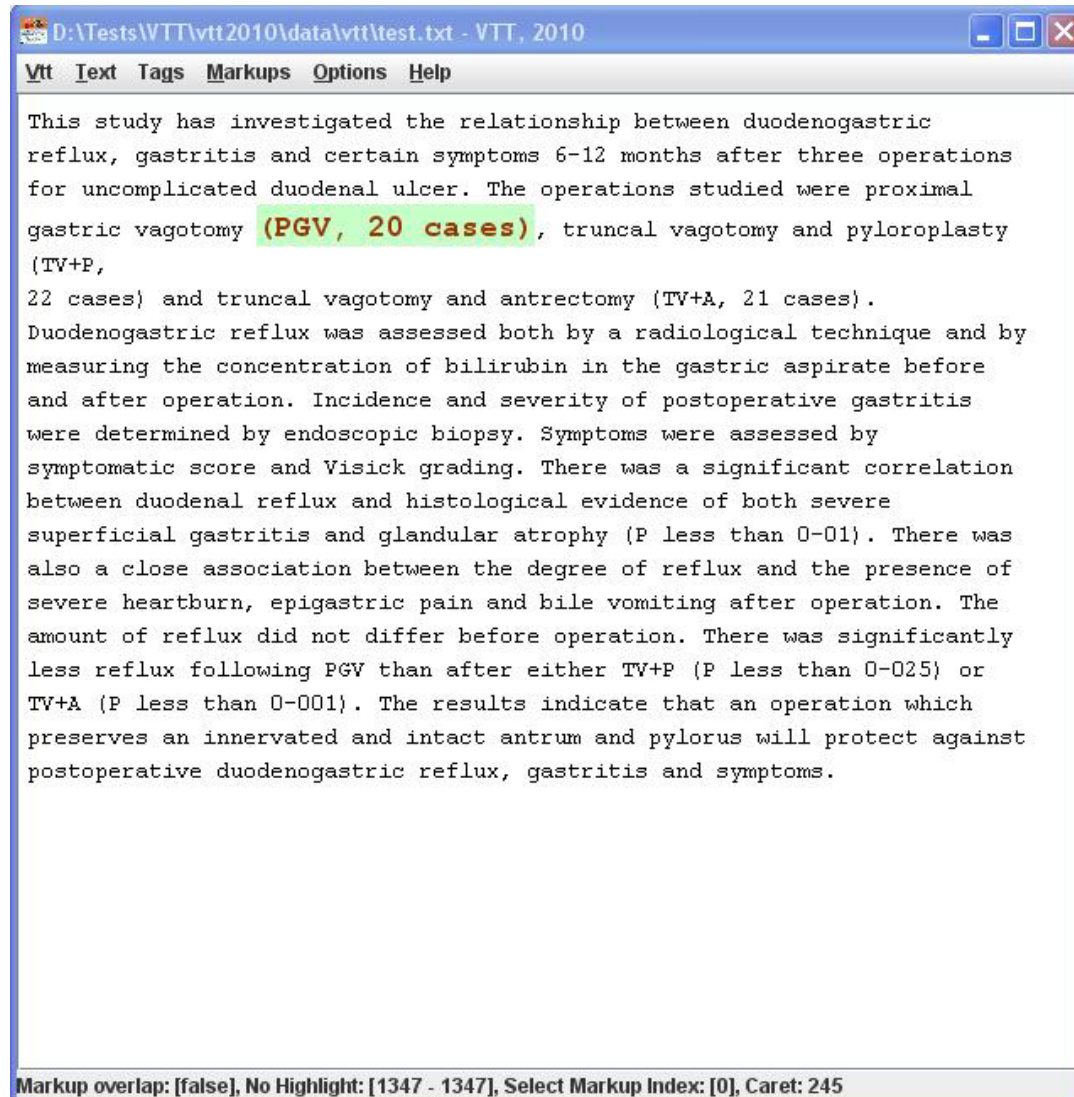
Markups – Select Text



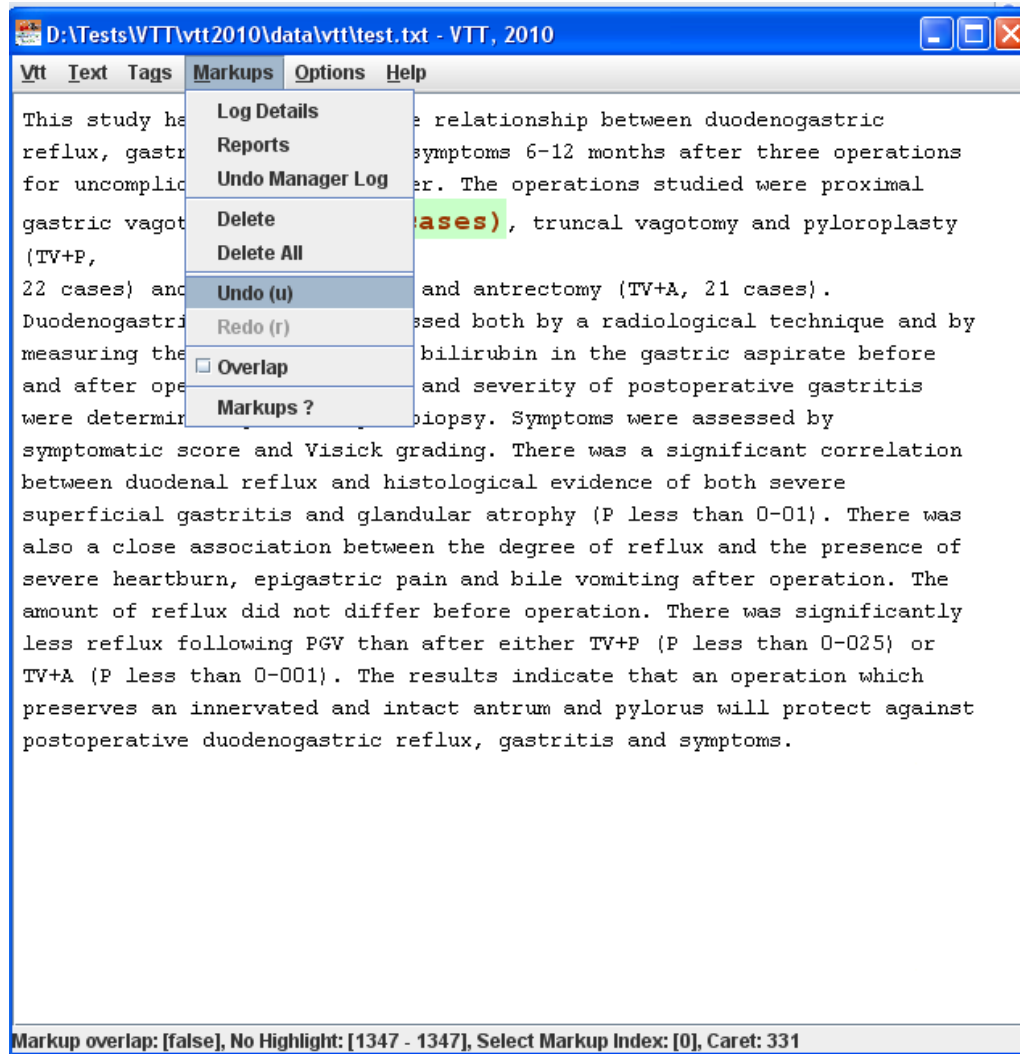
Markups - Assign a Tag



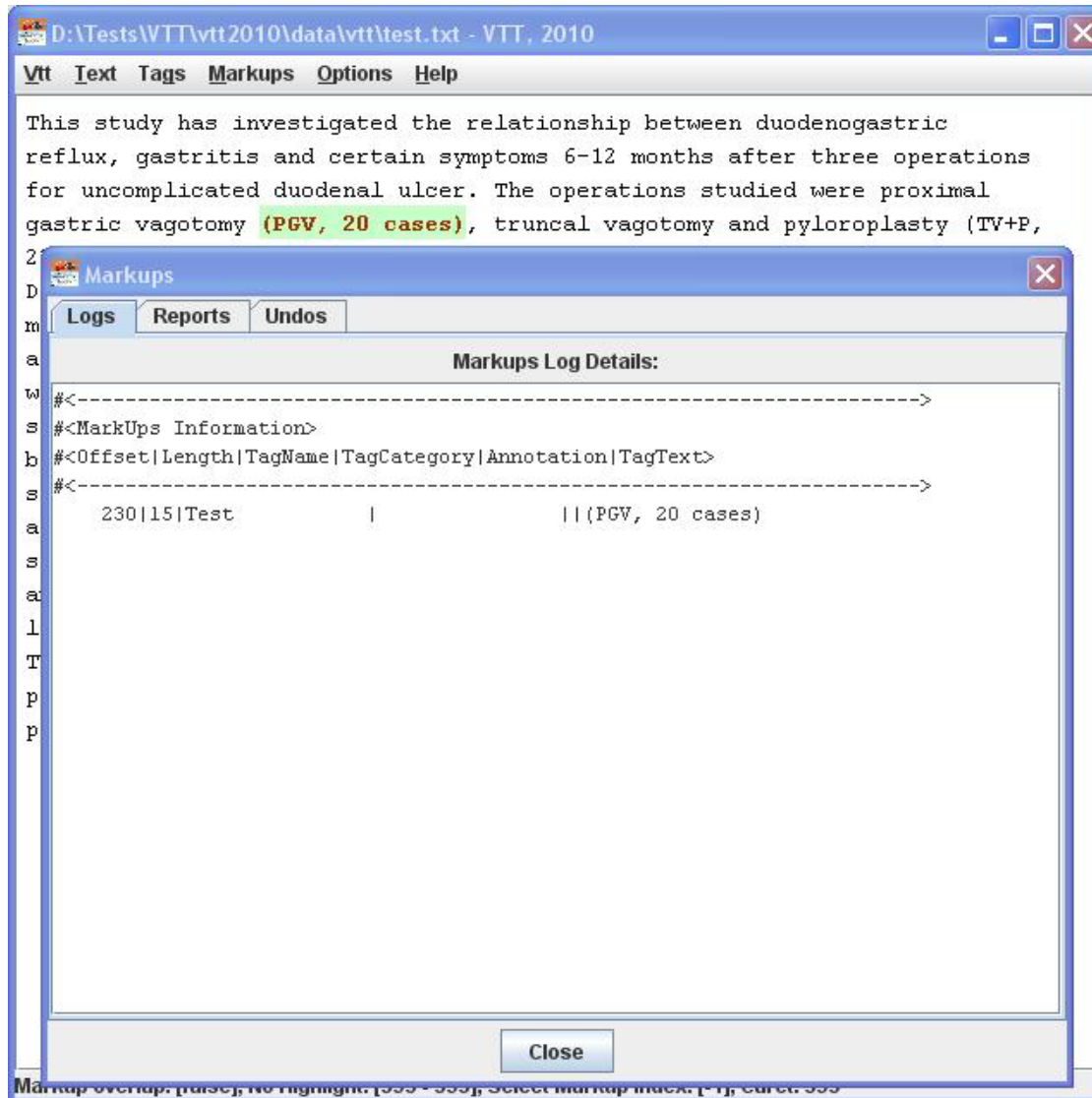
Markups - Assign a Tag



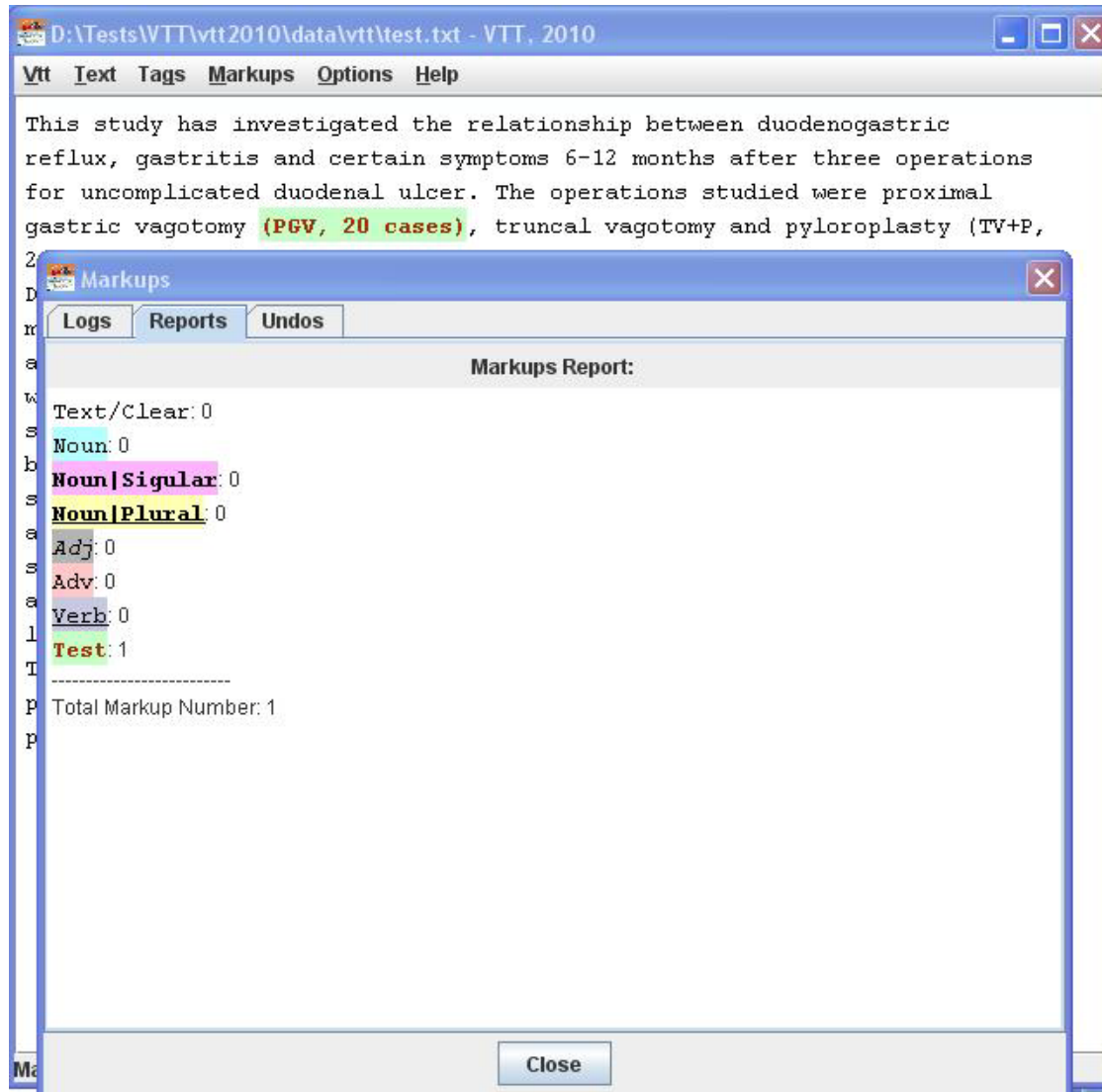
Markups - Options



Markups – Logs



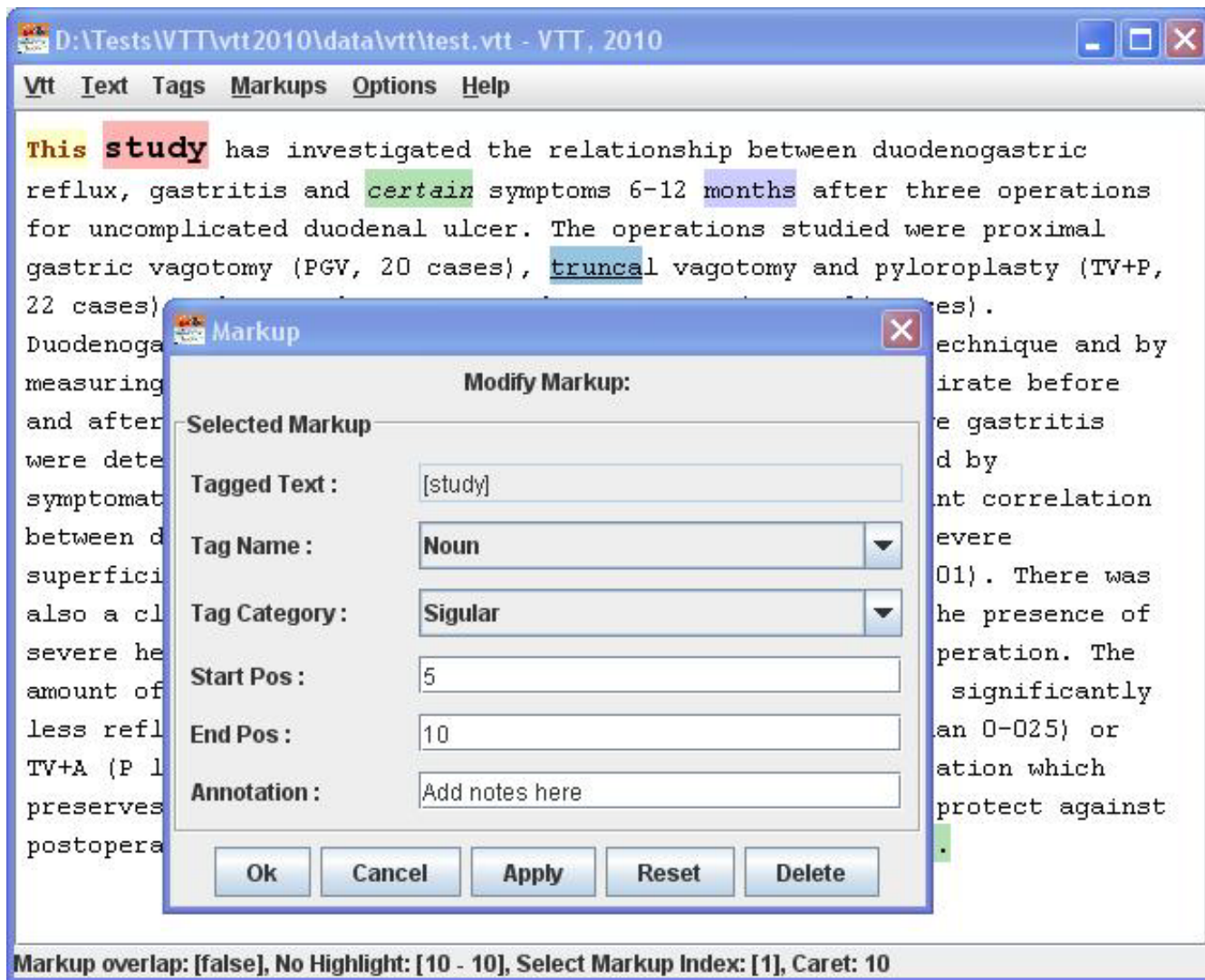
Markups – Reports



Markups – More Features

- Delete selected markup (0)
- Assign a tag by quick keys (1~9)
- Markup redo (r) /undo (u)
- Markups join (j)
- Markups movement control by keys
- Selected Markup Information (m)

Markups – Informations

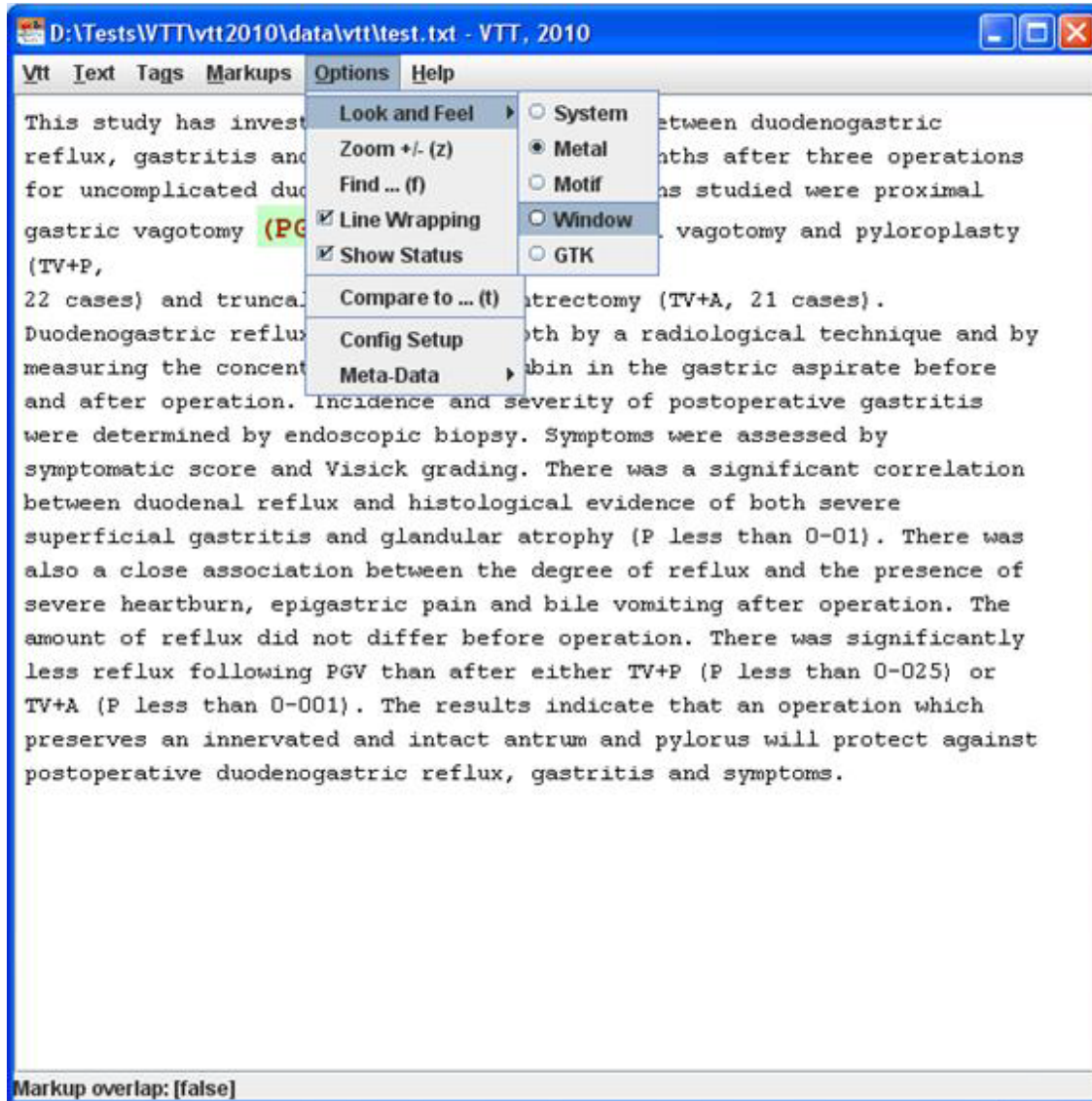


Markups – Movement

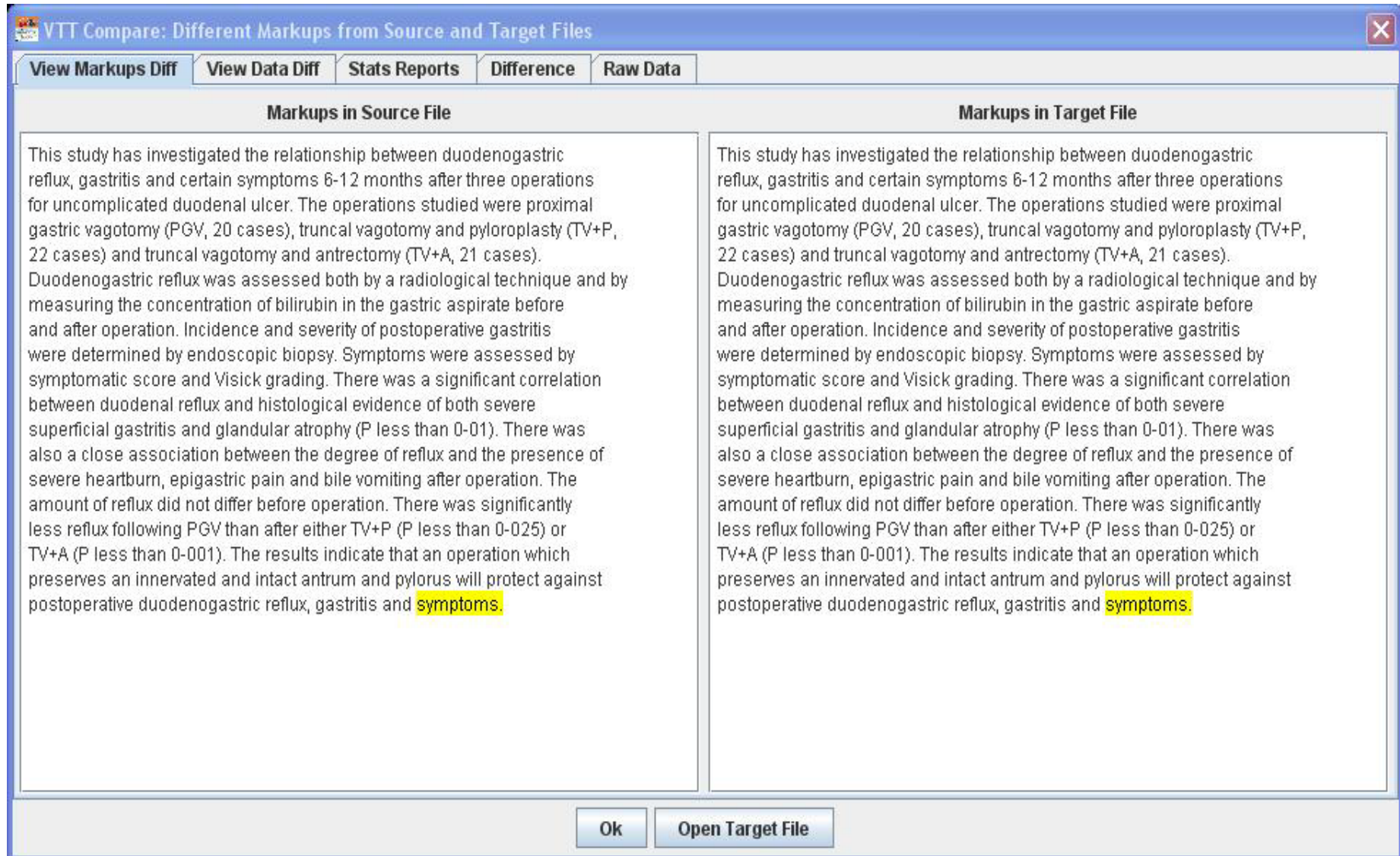
- Markups related

Key	Action
[	Set selected markup to the first markup
]	Set selected markup to the last markup
.	Backward selected markup
,	Forward selected markup
{	Set selected markup to the first displayed markup
}	Set selected markup to the last displayed markup
<	Backward selected displayed markup
>	Forward selected displayed markup
j	Join the selected markup and the next markup
m	Shows markup detail dialog on the selected markup
r	Redo markup operation
u	Undo markup operation
0	Delete selected markup
1 ~ 9	Set selected markup/highlight text to tag (1 ~ 9)

Other Options



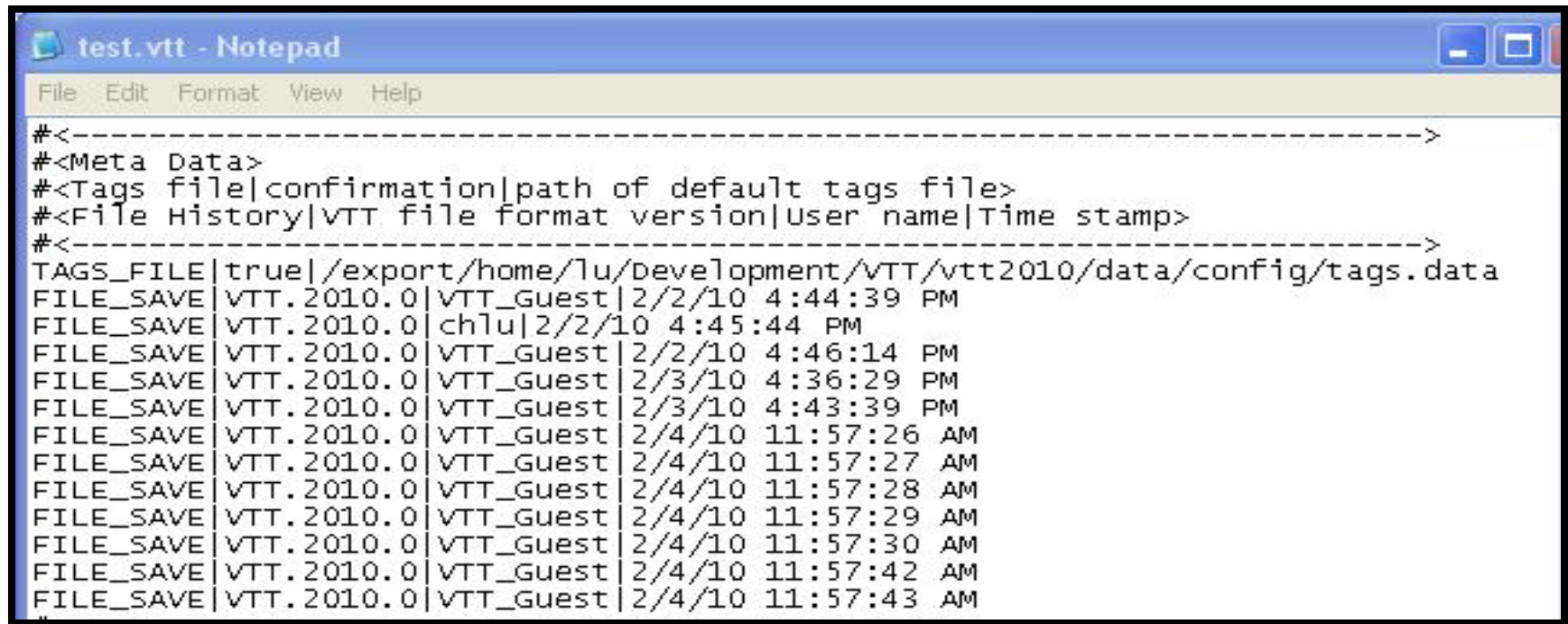
Compare Option



VTT – File Format

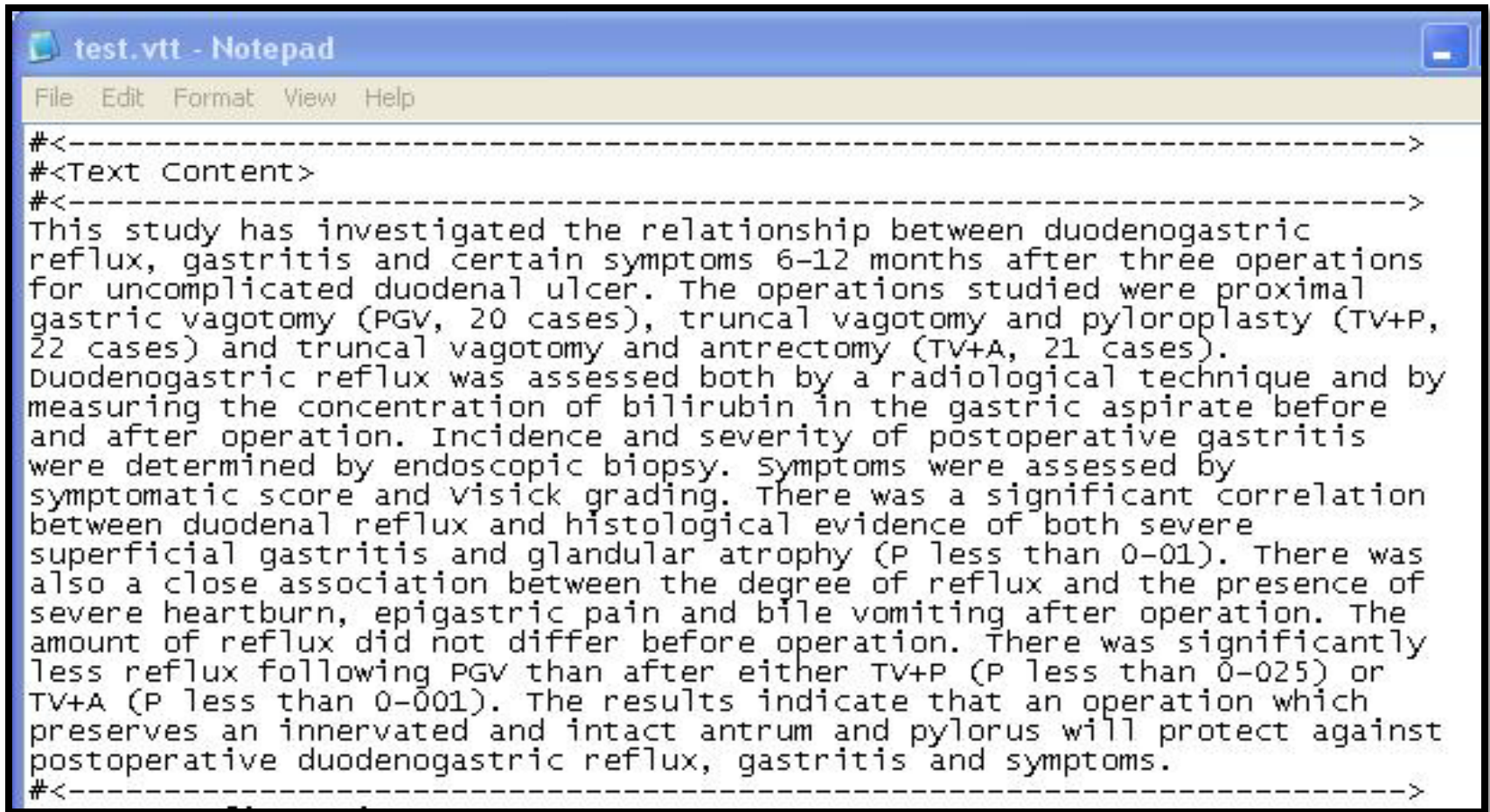
- **Meta Data**
 - Default tag file (3 fields)
 - History (4 fields)
- **Text Content**
 - Original plain text
- **Tags Configuration (14 fields)**
 - Name and category
 - Bold, italic, underline, display, font family, font size
 - Foreground and background colors (RGB)
- **Markups Information (6 fields)**
 - Offset and length
 - Assign tag (name and category)
 - Annotation and tagged text

File Format – Meta Data



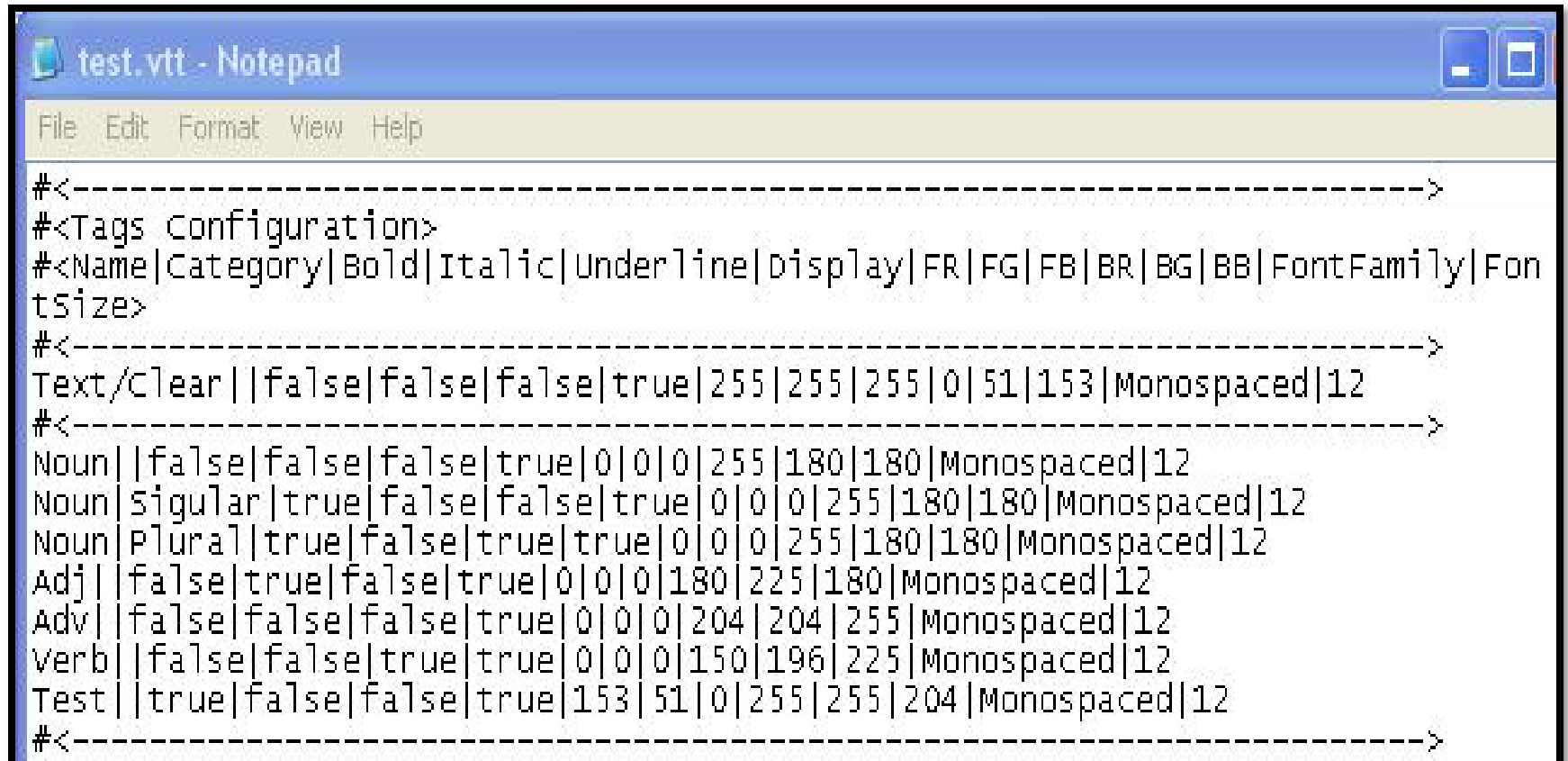
```
#<----->
#<Meta Data>
#<Tags file|confirmation|path of default tags file>
#<File History|VTT file format version|User name|Time stamp>
#<----->
TAGS_FILE|true|/export/home/lu/Development/VTT/vtt2010/data/config/tags.data
FILE_SAVE|VTT.2010.0|VTT_Guest|2/2/10 4:44:39 PM
FILE_SAVE|VTT.2010.0|chlu|2/2/10 4:45:44 PM
FILE_SAVE|VTT.2010.0|VTT_Guest|2/2/10 4:46:14 PM
FILE_SAVE|VTT.2010.0|VTT_Guest|2/3/10 4:36:29 PM
FILE_SAVE|VTT.2010.0|VTT_Guest|2/3/10 4:43:39 PM
FILE_SAVE|VTT.2010.0|VTT_Guest|2/4/10 11:57:26 AM
FILE_SAVE|VTT.2010.0|VTT_Guest|2/4/10 11:57:27 AM
FILE_SAVE|VTT.2010.0|VTT_Guest|2/4/10 11:57:28 AM
FILE_SAVE|VTT.2010.0|VTT_Guest|2/4/10 11:57:29 AM
FILE_SAVE|VTT.2010.0|VTT_Guest|2/4/10 11:57:30 AM
FILE_SAVE|VTT.2010.0|VTT_Guest|2/4/10 11:57:42 AM
FILE_SAVE|VTT.2010.0|VTT_Guest|2/4/10 11:57:43 AM
```

File Format – Text



```
test.vtt - Notepad
File Edit Format View Help
#<----->
#<Text Content>
#<----->
This study has investigated the relationship between duodenogastric
reflux, gastritis and certain symptoms 6-12 months after three operations
for uncomplicated duodenal ulcer. The operations studied were proximal
gastric vagotomy (PGV, 20 cases), truncal vagotomy and pyloroplasty (TV+P,
22 cases) and truncal vagotomy and antrectomy (TV+A, 21 cases).
Duodenogastric reflux was assessed both by a radiological technique and by
measuring the concentration of bilirubin in the gastric aspirate before
and after operation. Incidence and severity of postoperative gastritis
were determined by endoscopic biopsy. Symptoms were assessed by
symptomatic score and visick grading. There was a significant correlation
between duodenal reflux and histological evidence of both severe
superficial gastritis and glandular atrophy (P less than 0.01). There was
also a close association between the degree of reflux and the presence of
severe heartburn, epigastric pain and bile vomiting after operation. The
amount of reflux did not differ before operation. There was significantly
less reflux following PGV than after either TV+P (P less than 0.025) or
TV+A (P less than 0.001). The results indicate that an operation which
preserves an innervated and intact antrum and pylorus will protect against
postoperative duodenogastric reflux, gastritis and symptoms.
#<----->
```

File Format – Tags



```
#<----->
#<Tags Configuration>
#<Name|Category|Bold|Italic|Underline|Display|FR|FG|FB|BR|BG|BB|FontFamily|FontSize>
#<----->
Text/Clear||false|false|false|true|255|255|255|0|51|153|Monospaced|12
#<----->
Noun||false|false|false|true|0|0|0|255|180|180|Monospaced|12
Noun|singular|true|false|false|true|0|0|0|255|180|180|Monospaced|12
Noun|Plural|true|false|true|true|0|0|0|255|180|180|Monospaced|12
Adj||false|true|false|true|0|0|0|180|225|180|Monospaced|12
Adv||false|false|false|true|0|0|0|204|204|255|Monospaced|12
Verb||false|false|true|true|0|0|0|150|196|225|Monospaced|12
Test||true|false|false|true|153|51|0|255|255|204|Monospaced|12
#<----->
```

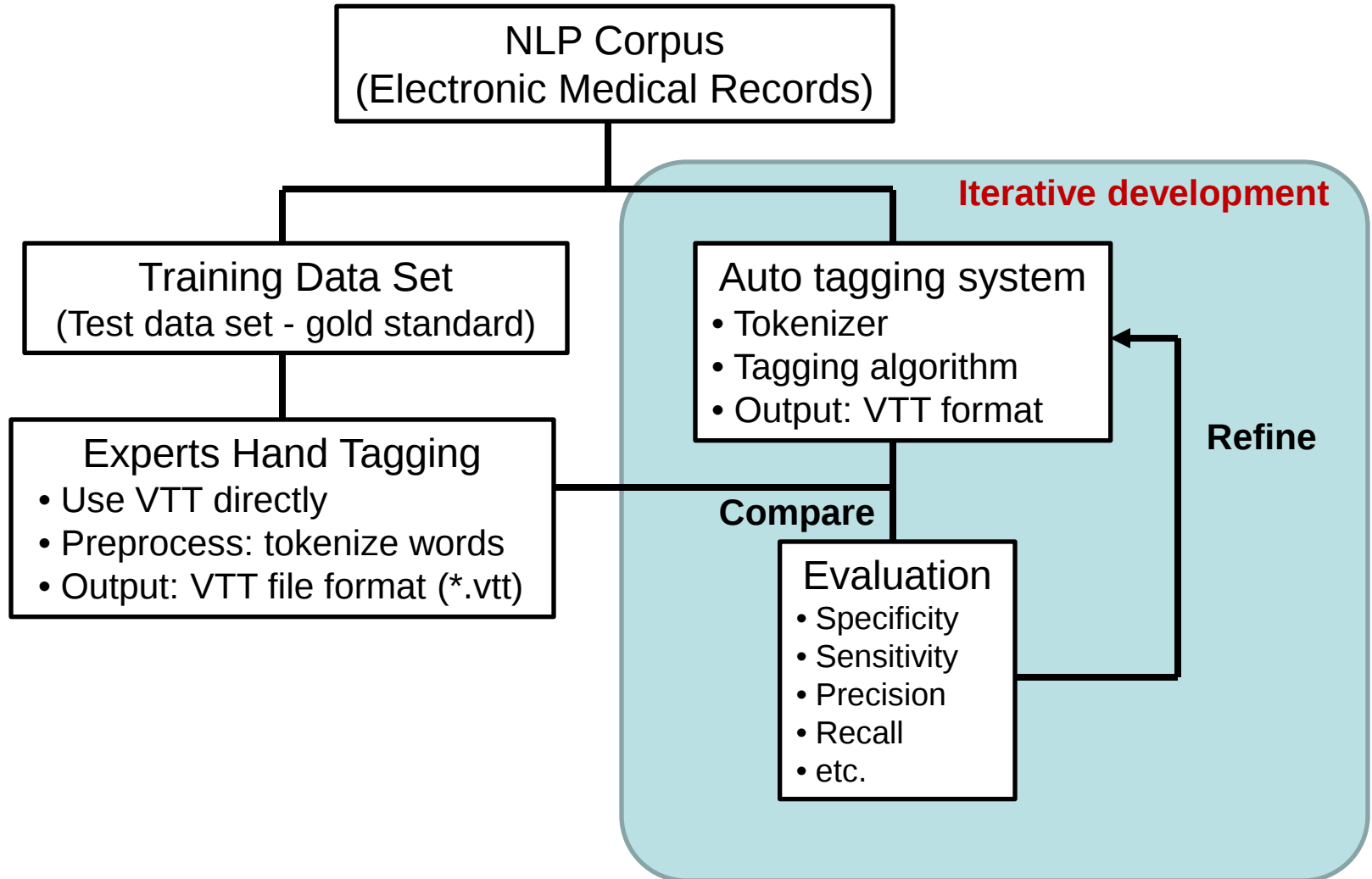
File Format - Markups

```

test.vtt - Notepad
File Edit Format View Help
#<----->
#<MarkUps Information>
#<Offset|Length|TagName|TagCategory|Annotation|TagText>
#<----->
    0| 4| Test                |          | First Test|This
    5| 5| Noun                | singular | study
   90| 7| Adj                  |          | certain
  112| 6| Adv                  |          | months
  247| 6| verb                |          | trunca
  367| 6| Adv                  |          | reflux
  373| 1| Noun                | singular |
  374| 3| Adv                  |          | was
  377| 1| Noun                |          |
  378| 8| Test                |          | assessed
  387| 4| Adv                  |          | both
  392| 2| Noun                | plural   | by
  397|12| Adj                  |          | radiological
  509|12| Adj                  |          | operation. I
  519| 2| Text/clear          |          | I
  600| 7| Adv                  |          | Extra space and S, need to
delete|biopsy.
  617| 4| Noun                | singular | were is a be verb|were
  736|12| Noun                | singular | histological
  894| 6| Noun                | plural   | reflux
  939|10| Noun                |          | epigastric
  955| 3| verb                |          | and
 1337| 9| Adj                  |          | Last test|symptoms.

```

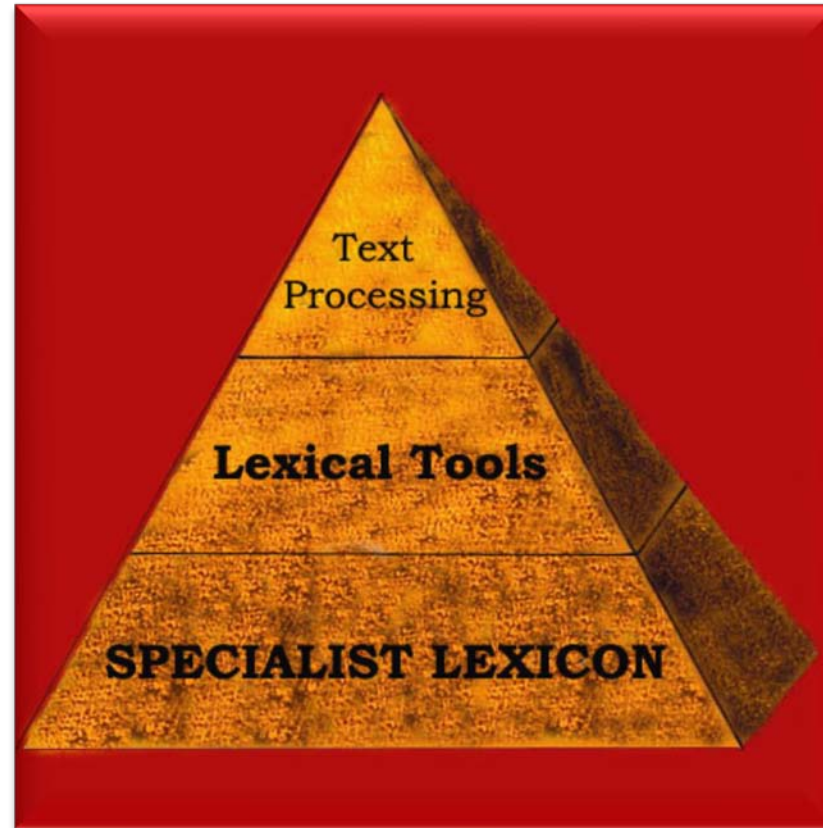
VTT – Example



VTT – Integration

- Integrate with words/terms tokenizer (text tools) for less key strokes
- Use VTT file format as the application standard output
- Apply evaluation software on VTT file(s)
 - File level
 - Corpus level

Questions



- Lexical Systems Group: <http://umlslex.nlm.nih.gov>
- The SPECIALIST NLP Tools: <http://specialist.nlm.nih.gov>

Text Categorization Tools



<http://SPECIALIST.nlm.nih.gov/tc>

TC Tools

- Based on Journal Descriptor Indexing (JDI) methodology (by Susanne Humphrey)
- Uses a small set of high level descriptors:
 - Journal Descriptors (JDs)
 - Semantic Types (STs)
- Used for categorizing text, indexing contents, retrieving records, and word sense disambiguation (WSD)

Facts for TC Tools

- Release annually (since 2007)
- Free distributed with open source code
- 100% Java
- Run on different platforms
- One complete package
- Documents & supports
- Provides Java APIs, command line tools, GUI tools, and Web tools

TC Tools

- Two types of categorization:
 - Journal Descriptor Indexing (JDI):
categorizes text according to Journal Descriptors (JDs)
 - Semantic Type Indexing (STI):
categorizes text according to Semantic Types (STs)
- St WSD tool (since 2009)

Journal Descriptors (JDs)?

- Set of 122 MeSH descriptors representing high-level categories, mostly biomedical disciplines.
- Used for indexing journals *per se*
- Assigned by human indexer to the 4100 journals
- Source is from: List of Serials for Online Users file (lsi.xml)

Journal Descriptors

- Examples of JD from Isi.xml
 - JID - 03132144
TA - Transplantation (the journal *Transplantation*)
JD - Transplantation
 - JID - 9802574
TA - Pediatr Transplant
(the journal *Pediatric Transplantation*)
JD - Pediatrics; Transplantation
 - JID - 0052631
TA - J Pediatr Surg (the *Journal of Pediatric Surgery*)
JD - Pediatrics; Surgery

JDI Methodology

- Training set is about 3.4 million MEDLINE documents (3 years)
- JDI uses statistical associations between words in MEDLINE training set record TI/AB and the JD/s corresponding to the journal in the training set record
- But
 - JDs are not in a MEDLINE record
 - JDs are in the NLM serial record from Isi2007.xml

JDI – Link to JDs

- Example of link between MEDLINE records and JDs
 - Training set MEDLINE record:
PMID - 10919582
TI - Combined liver and kidney transplantation in children.
JID - 0132144
SO - *Transplantation*. 2000 Jul 15;70(1):100-5.
 - *Transplantation* serial record:
JID - 0132144
JD - Transplantation

JDI – Link to JDs

- Example of Training set MEDLINE record with “imported” JD Transplantation:
 - **PMID - 10919582**
 - TI** - **Combined liver and kidney transplantation in children.**
 - SO** - *Transplantation*. 2000 Jul 15;70(1):100-5.
 - JD** - **Transplantation**

JDI - JD Score (Word)

- JDI of the word “transplantation”

1|0.275691|Transplantation

2|0.070315|Hematology

3|0.044303|Nephrology

4|0.031517|Pulmonary Disease (Specialty)

5|0.029425|Gastroenterology

- Transplantation score

$$\begin{aligned} & \frac{\text{no. of docs in training set in which TI/AB} \\ & \quad \text{word transplantation co-occurs with JD Transplantation}}{\text{no. of docs in training set in which the} \\ & \quad \text{word transplantation occurs in TI/AB}} \\ & = 0.275691 \end{aligned}$$

JDI - JD Score (Word)

- JDI of the word “kidney”

1|0.140088|Nephrology

2|0.080848|Transplantation

3|0.057162|Urology

4|0.032341|Toxicology

5|0.024398|Pharmacology

- Nephrology score

$$\begin{aligned} & \text{no. of docs in training set in which TI/AB} \\ & \text{word kidney co-occurs with JD Nephrology} \\ = & \frac{\text{no. of docs in training set in which the} \\ & \text{word kidney occurs in TI/AB}}{\text{no. of docs in training set in which the} \\ & \text{word kidney occurs in TI/AB}} \\ = & 0.140088 \end{aligned}$$

JDI - JD Score (Phrase)

- JDI of the phrase “kidney transplantation”

1|0.178269|**Transplantation**

2|0.092195|Nephrology

3|0.037875|Hematology

4|0.034381|Urology

5|0.017438|Gastroenterology

- Score for **Transplantation** is **average** of
Transplantation score for **word kidney** and
Transplantation score for **word transplantation**
- A JD score for a phrase is the average of that JD's
score across the words in the phrase

STI - Semantic Types

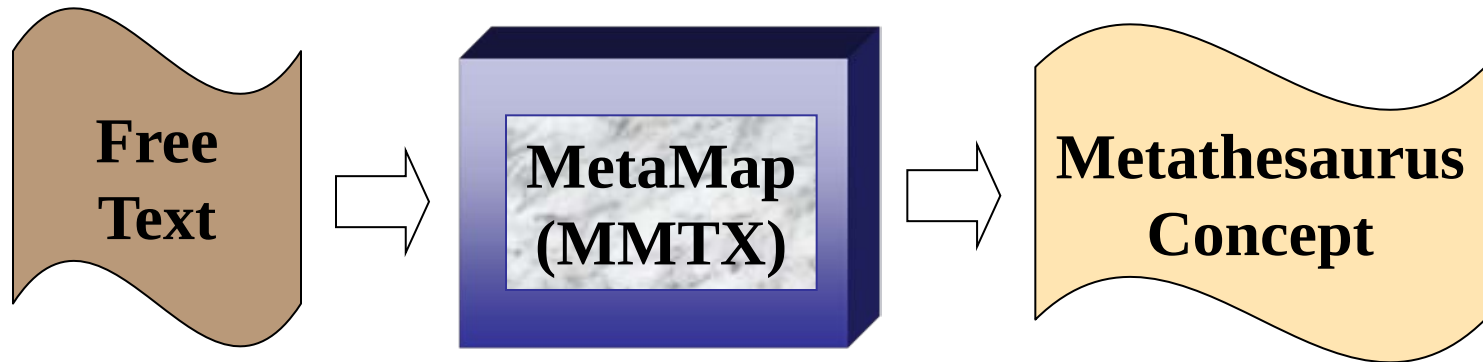
- What are Semantic Types (STs)?
- Set of 135 semantic types in the Semantic Network in NLM's Unified Medical Language System (UMLS).
- Concepts in the UMLS Metathesaurus are assigned one or more STs which semantically characterize those concepts
- For example, “aspirin” is assigned the STs Pharmacologic Substance (phsu) and Organic Chemical (orch).

Semantic Type Indexing (STI)

- JDI has word-JD vectors representing JD indexing of each of the 304,000 words in the training set.
- STI also has word-ST vectors representing ST indexing of each training set word.
- Thus, STI of text can be performed exactly the same way as JDI of text. An ST score for a text is the average of that ST's score for words in the text. The scores for all the STs comprise the ST vector for the text.

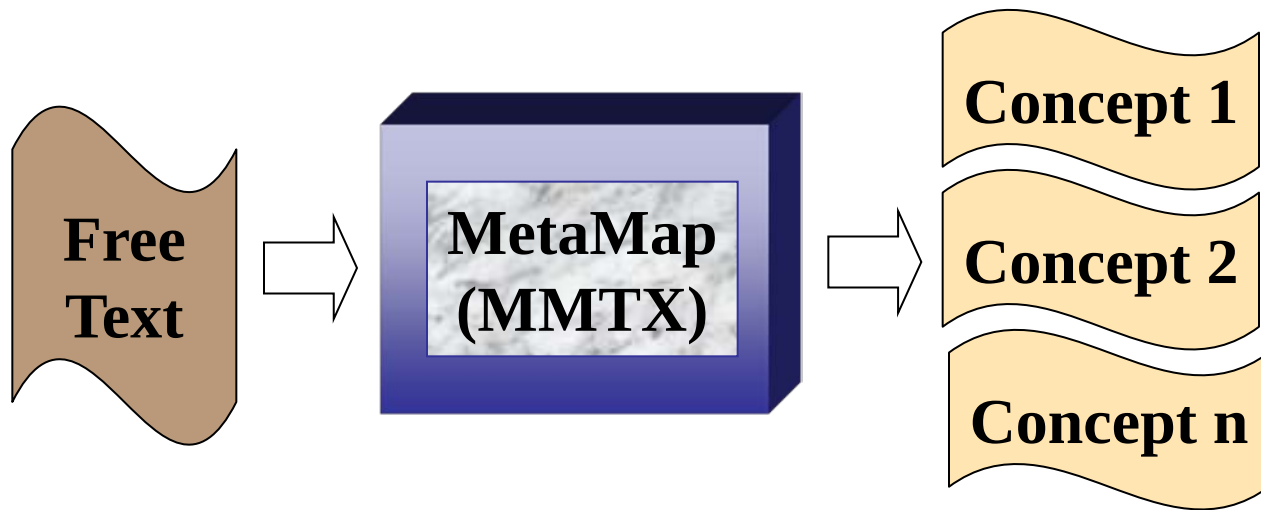
TC – St WSD

- Words Senses disambiguation (WSD)



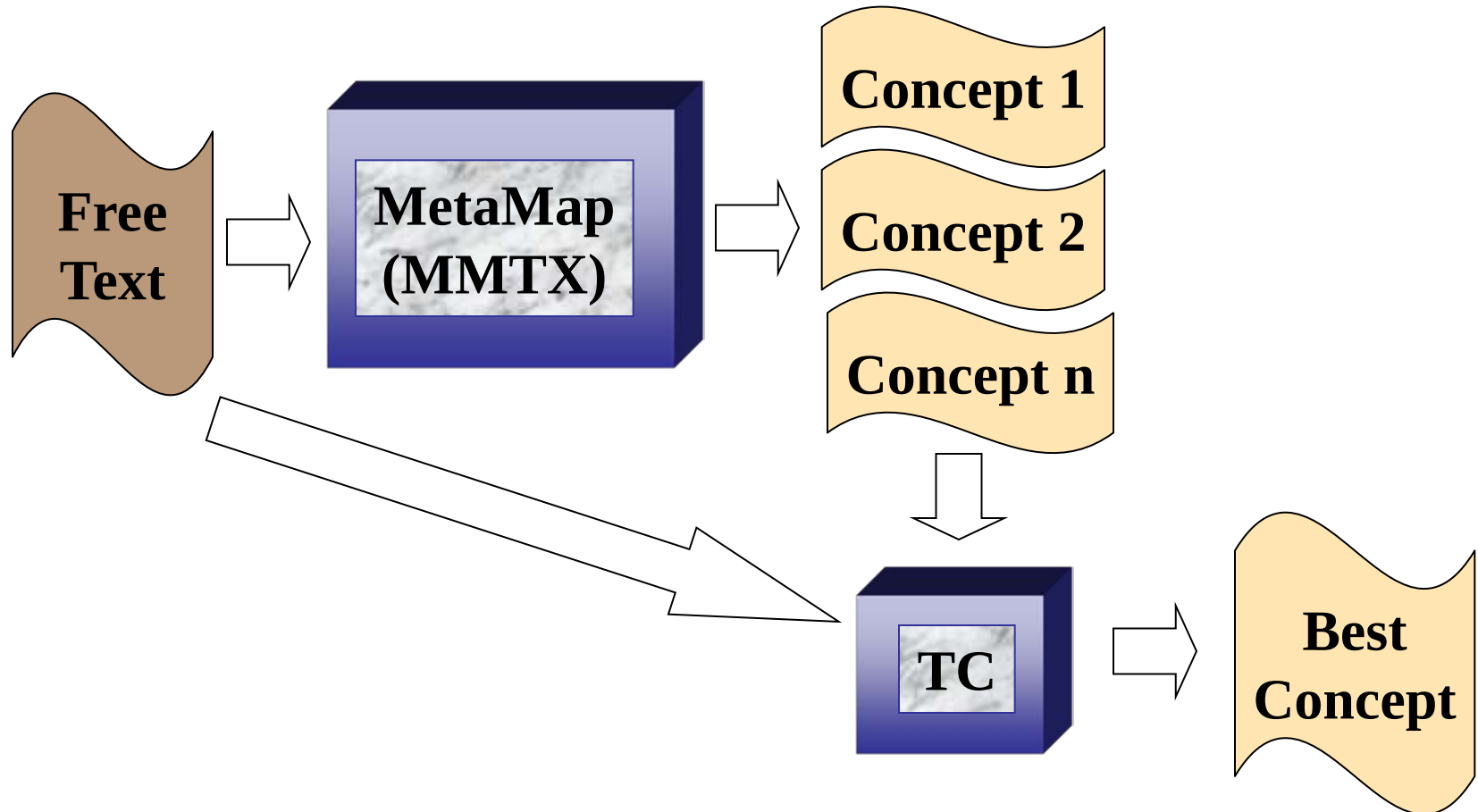
TC – St WSD

- Words Senses disambiguation (WSD)



TC – St WSD

- Words Senses disambiguation (WSD)



Example – St WSD

- “transport” is ambiguous:
 - Biological Transport (ST is Cell Function, **celf**)
 - Patient Transport (ST is Health Care Activity, **hlca**)
- STI of text results in ranked list of STs.
 - If **celf** ranks higher than **hlca**, then meaning is Biological Transport.
 - If **hlca** ranks higher than **celf**, then meaning is Patient Transport.

Example – St WSD

STI of PMID 9674486 in WSD collection

Input: Preliminary results of bedside inferior vena cava filter placement: safe and cost-effective. The use of inferior vena cava filters (IVCFs) is increasing in patients at high risk for venous thromboembolism; however, there is considerable controversy related to their cost. We inserted eight percutaneous IVCFs at the bedside. The hospital charges for bedside IVCF insertion were substantially lower compared with those for IVCF insertion performed in the Radiology Department or operating room. There was one death (unrelated to the procedure) and one asymptomatic caval occlusion believed to be caused by thrombus trapping. Bedside IVCF insertion is safe and cost-effective in selected patients. This practice averts the potential complications associated with **transporting** critically ill patients.

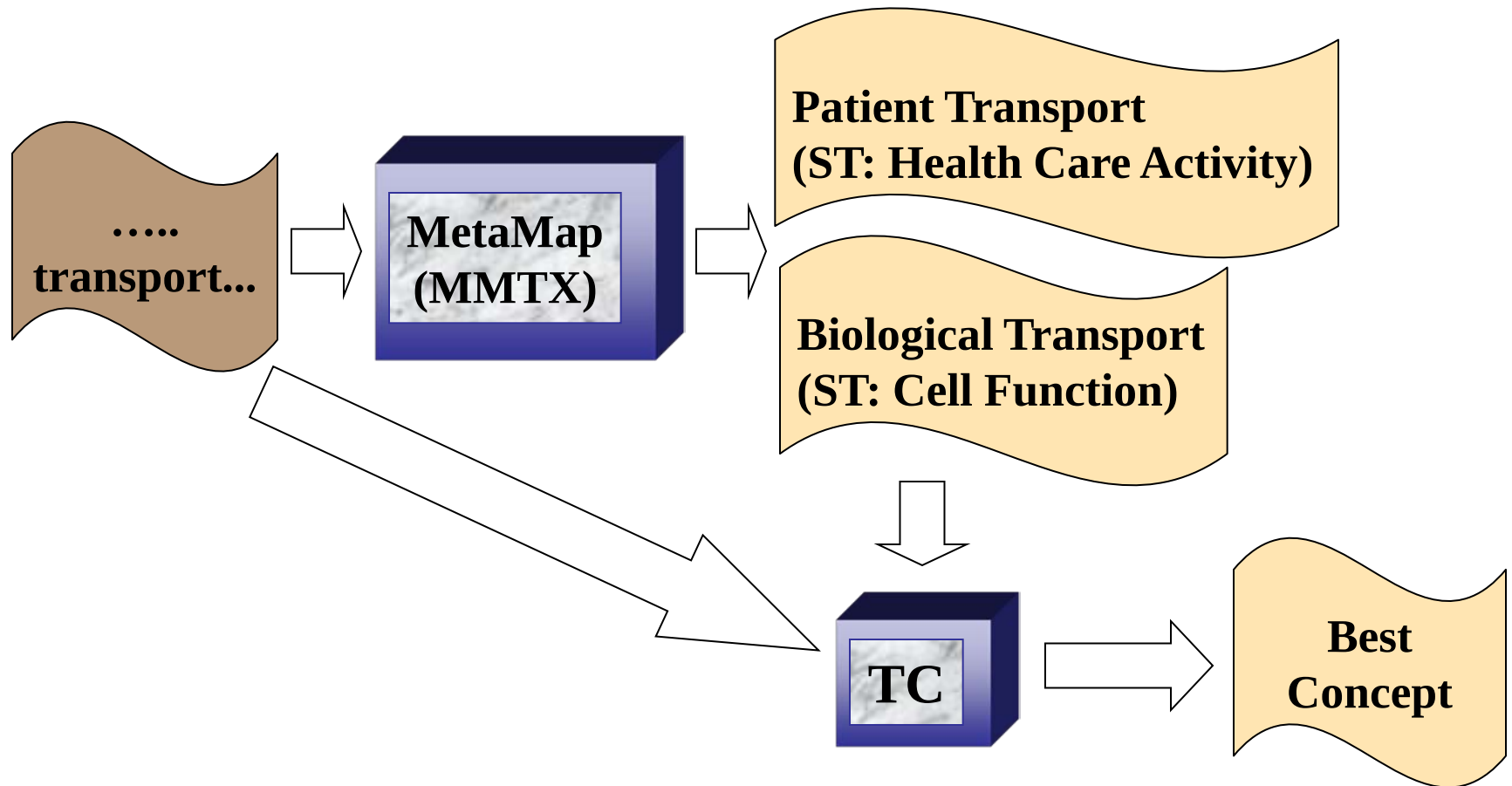
--- ST scores and rank based on document count for word ---

27|0.4897|hlca|Health Care Activity <= Patient Transport

46|0.4086|celf|Cell Function (Biological Transport)

TC – St WSD

- Words Senses Disambiguation (WSD)



TC – St WSD

- Three methods for contexts of the ambiguity:
 - ambig-sentence - sentence with ambiguity
 - ambig-sentences - all sentences with ambiguity
 - doc - entire MEDLINE document
- Three score systems:
 - DC: document count
 - WC: word count
 - CS: combines score

TC – St WSD

- Published research on STI as a tool for word sense disambiguation (WSD) in natural language processing (NLP) using UMLS Metathesaurus, disambiguating 45 ambiguous strings from NLM's WSD collection.
- Best unsupervised WSD methods
 - 2007: 75.39%
 - 2008: 75.00%
 - 2009: 77.37%
 - 2010: 77.36%
- First release in 2009.

Questions



- Lexical Systems Group: <http://umlslex.nlm.nih.gov>
- The SPECIALIST NLP Tools: <http://specialist.nlm.nih.gov>