

Observational Health Data
Sciences and Informatics
(OHDSI)

**Natural Language Processing (NLP)
Working Group**

10/11/2017

AGENDA

- Presentations:
 - Jon Duke Lab

CLAMP GUI for Population of OMOP NLP Tables

Xu Lab

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- A general purpose clinical NLP system – **“CLAMP CMD”**
 - Built on proven methods
 - Good performance, high speed
- An IDE (integrated development environment) for building customized clinical NLP pipelines via GUIs – **“CLAMP GUI”**
 - Annotating/analyzing clinical text
 - Training of ML-based modules
 - Specifying rules
- An enterprise solution for NLP needs in healthcare organizations – **“CLAMP Enterprise”**
 - Fast deployment to various setting
 - Task management
 - Visual analytics

A track record of success in clinical NLP research

NLP Tasks		Ranking
Named entity recognition	2009 i2b2, medication	#2
	2010 i2b2 problem, treatment, test	#2
	2013 SHARe/CLEF abbreviation	#1
UMLS encoding	2014 SemEval, disorder	#1
Relation extraction	2012 i2b2 Temporal	#1
	2015 SemEval Disease-modifier	#1
	2015 BioCREATIVE Chemical-induced disease	#1

CLAMP CMD – performance

- Extract problems, treatments, and tests

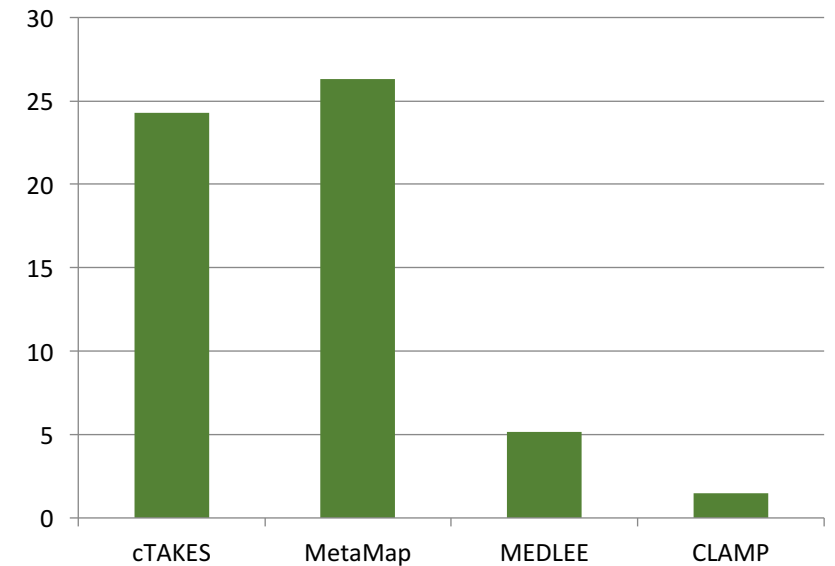
Corpus	Entity types	# entity	Exact match			Relaxed match		
			P	R	F1	P	R	F1
MTsamples	treatment, problem, test	25,531	0.841	0.811	0.826	0.921	0.890	0.905
i2b2	treatment, problem, test	72,846	0.891	0.861	0.876	0.958	0.925	0.941
UTNotes	treatment, problem, test	124,869	0.921	0.900	0.910	0.963	0.940	0.951
SemEval 2014	Disease_Disorder	10,077	0.861	0.791	0.824	0.870	0.799	0.833
SemEval 2015	Disease_Disorder	17,333	0.867	0.816	0.840	0.886	0.834	0.859

CLAMP CMD - speed

- Thread-safe

Pipeline	MAC		Linux		Windows	
	Single thread	Multi threads	Single thread	Multi threads	Single thread	Multi threads
clamp-ner	0.72	0.28	1.25	0.17	0.69	0.302
clamp-ner-attribute	0.93	0.38	1.59	0.24	0.90	0.422
disease-attribute	0.62	0.26	1.06	0.17	0.58	0.296
lab-attribute	0.62	0.26	0.99	0.16	0.56	0.286
medication-attribute	0.67	0.29	1.15	0.18	0.61	0.3

Test Data Mimic2 Data set (500 documents) Number of multi-threads 10



SemEval 2015 Corpus: 431 documents, avg doc size: 9.38k
SINGLE THREAD

CLAMP-GUI: Building your own pipeline

The screenshot displays the CLAMP-GUI interface, titled "Clamp Toolkit". The main window shows a pipeline configuration for "smokedemo.p...". The pipeline consists of several components, each with a name, a component type, and a description. A context menu is open over the "DF_Ruta_script_file" component, offering options like "save as component", "Export as jar", "Copy", "Paste", "Delete", "Move...", "Rename...", "Import...", "Export...", "Refresh", and "Properties".

Resource

- Machine_learning_components
- NLP_components
 - Assertion_classifier
 - Chunker
 - Named_entity_recogizer
 - POS_tagger
 - Ruta_rule_engine
 - Section_identifier
 - Sentence_detector

Corpus

- lab_corpus
- mtsamples

Pipeline

- defaultPipeline
- my_labtest
- sfasdf
- smokedemo
- Smoking_status

smokedemo.p...

candidate_s... defaultDict.txt config.conf config.conf

Move up Move down Delete Auto fix Edit

Name	Component	Description
DF_Detect_sentences_by_newline	Sentence detector	Detect sentences by Newline('\n')
DF_Clamp_tokenizer	Tokenizer	Rule based tokenizer
DF_OpenNLP_POS_tagger	POS tagger	OpenNLP based pos tagger
DF_Dictionary_lookup	Named entity recogizer	dictionary lookup algorithm
DF_NegEx_assertion	Assertion classifier	Assertion info detection using NegEx
DF_Ruta_script_file	Ruta rule engine	Ruta script

save as component
Export as jar
Copy ⌘C
Paste ⌘V
Delete ⌘X
Move...
Rename... F2
Import...
Export...
Refresh F5
Properties ⌘I

Console
CorpusInput:

CLAMP-GUI: Annotating/Re-training

The screenshot displays the CLAMP Toolkit interface. The main window shows a document titled "0005.xmi" with the following text and annotations:

27 The patient is an 80 year old female with **breast cancer**, status post lumpectomy / radiation therapy / Tamoxifen (2000), **hypertension**, **hyperlipidemia**, **multiple urinary tract infections** who presents with a four day prodrome of **dry cough**, **rhinorrhea**, **coryza**, **malaise**, **chills**, **headache**, **decreased p.o. intake**,

Annotations include "predict problem" labels above and "problem" labels below the highlighted text segments.

The interface includes several panels:

- File Explorer:** Shows a project structure with folders "i2b2corpus", "corpus", "test", "train", "models", and "output". The "output" folder contains files "0004.xmi", "0005.xmi", "0008.xmi", and "0010.xmi".
- PipelineView:** Shows a "newpipeline" entry.
- Outline:** A "Semantic" tree with checked items: Entity (problem, test, treatment), Relation, and Syntax.
- Console:** Displays the message: "INFO: load from file, filename=[L/Clc".
- Progress:** Shows a progress bar for "Train project i2b2corpus NER Training, Fold 2" and the text "Extracting features: Training NER model...".

CLAMP-GUI: Specifying rules

The screenshot displays the CLAMP Toolkit interface. The main window shows a code editor with the following rule definition:

```
TYPESYSTEM ClampTypeSystem;
//Auto generated by rule editor

BLOCK(ForEach) Sentence{FEATURE("segmentId", "medications")}{
  BaseToken{ REGEXP("Tamsulosin") -> UNMARK(ClampNameEntityUIMA, true),
              CREATE( ClampNameEntityUIMA, 1,1,"semanticTag" = "treatment")};
}
```

Below the code editor, a text snippet is shown with a green box highlighting the word "test" above the sentence: "81 1. Tamsulosin 0.4 mg Capsule , Sust . Release 24HR Sig : One (1) Capsule . Sust . Release 24HR PO HS (at bedtime) .".

A dialog box titled "Please specify the rule:" is open in the foreground. It contains the following configuration:

IF

	[TYPE]	[START OFFSET]	[END OFFSET]	[OPERATOR]	[VALUE]	
CONDITION	Token	0	0	=	Tamsulosin	Remove
AND	Section	0	0	=	medications	Remove

Buttons: Add condition

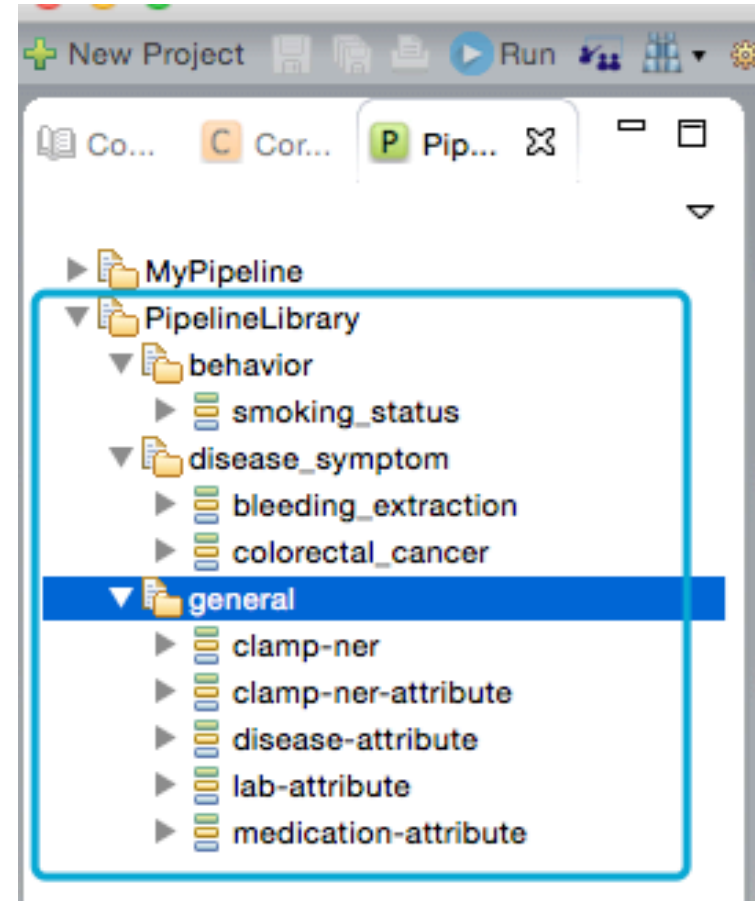
THEN

ASSIGN Tamsulosin TO treatment

Buttons: OK, Cancel

A Library of NLP Pipelines

- General
 - Problem/treatment/test
 - Diseases with modifiers
 - Medications with signature
 - Lab tests and values
- Disease-specific
 - Colorectal cancer
 - Bleedings
 - ...
- Behavior
 - Smoking status
 - ...



Some implementations

- ICD-10 Encoding
 - Assistance to medical coders
- Cancer Registry
 - ICD-O encoding at Cancer Registry
- Patient Safety Indicators:
 - Blood loss during surgery
 - Iatrogenic Organ Damage
 - Postop dehiscence

Applications



Meaningful use quality measurement – VTE detection at Memorial Hermann Hospital

Predicted 350502011 Acute massive pulmonary embolism

Annotation 350502011 Acute massive pulmonary embolism user ✓

Review Reviewer Co Reviewer Concept reviewer ?

Review Reviewer

None []	reviewer
None []	reviewer
Pulmonary embolism [98484016]	reviewer
Acute massive pulmonary embolism [350502011]	reviewer
None []	reviewer
None []	reviewer

Sensitivity (Recall): 0.98
Specificity : 0.94
PPV (Precision) : 0.89
Accuracy : 0.95

pulmonary angiography pulmonary embolism protocol). Subsequently, helical CT images were obtained from the thoracic inlet to the upper abdomen.

FINDINGS: Extensive pulmonary embolism is present bilaterally. No there are some small lymph nodes in the AP window and p is present in t is present in t distended. Cont visualized port lateral spleen irregular lesio IMPRESSION: 1. 2. Irregular sh 3. Mildly distended appearance of the right heart. 4. Mild mediastinal adenopathy. 5. Splenic hemangioma suspected with peripheral enhancement.

Close Save

CLAMP for CDM-NLP

NOTE

- The NOTE table captures unstructured information that was recorded by a provider about a patient in free text notes on a given date.
- Metadata

Field	Required	Type	Description
note_id	Yes	integer	A unique identifier for each note.
person_id	Yes	integer	A foreign key identifier to the Person about whom the Note was recorded. The demographic details of that Person are stored in the PERSON table.
note_date	Yes	date	The date the note was recorded.
note_datetime	No	datetime	The date and time the note was recorded.
note_type_concept_id	Yes	integer	A foreign key to the predefined Concept in the Standardized Vocabularies reflecting the type, origin or provenance of the Note.
note_class_concept_id	Yes	integer	A foreign key to the predefined Concept in the Standardized Vocabularies reflecting the HL7 LOINC Document Type Vocabulary classification of the note.
note_title	No	string(250)	The title of the Note as it appears in the source.
note_text	No	RBDMS dependent text	The content of the Note.
encoding_concept_id	Yes	integer	A foreign key to the predefined Concept in the Standardized Vocabularies reflecting the note character encoding type.
language_concept_id	Yes	integer	A foreign key to the predefined Concept in the Standardized Vocabularies reflecting the language of the note.
provider_id	No	integer	A foreign key to the Provider in the PROVIDER table who took the Note.
visit_occurrence_id	No	integer	Foreign key to the Visit in the VISIT_OCCURRENCE table when the Note was taken.

NOTE_NLP

- The NOTE table encodes all output of NLP on clinical notes.
- Each row represents a single extracted term from a note.

Field	Required	Type	Description
note_nlp_id	Yes	Big Integer	A unique identifier for each term extracted from a note.
note_id	Yes	integer	A foreign key to the Note table note the term was extracted from.
section_concept_id	No	integer	A foreign key to the predefined Concept in the Standardized Vocabularies representing the section of the extracted term.
snippet	No	string(250)	A small window of text surrounding the term.
offset	No	string(50)	Character offset of the extracted term in the input note.
lexical_variant	Yes	string(250)	Raw text extracted by the NLP tool.
note_nlp_concept_id	No	integer	Foreign key to Concept table. Represents the normalized concept for extracted term. Domain of the term is represented as part of the Concept table.
note_nlp_source_concept_id	No	integer	A foreign key to a Concept that refers to the code in the source vocabulary used by the NLP system.
nlp_system	No	string(250)	Name and version of the NLP system that extracted the term.
nlp_date	Yes	date	The date of the note processing.
nlp_date_time	No	datetime	The date and time of the note processing.
term_exists	No	Boolean	Term_exists is defined as a flag that indicates if the patient actually has or had the condition. Any of the following modifiers would make Term_exists false: Negation = true; Subject = [anything other than the patient]; Conditional = true; Rule_out = true; Uncertain = very low certainty or any lower certainties. A complete lack of modifiers would make Term_exists true. For the modifiers that are there, they would have to have these values: Negation = false; Subject = patient; Conditional = false; Rule_out = false; Uncertain = true or high or moderate or even low (could argue about low).
term_temporal	No	string(50)	Term_temporal is to indicate if a condition is "present" or just in the "past". The following would be past: History = true; Concept_date = anything before the time of the report.
term_modifiers	No	string(2000)	Describes compactly all the modifiers extracted by nlp system. For example, "son has rash" → "negated=no,subject=family,certainty=undef,conditional=false,general=false". Value will be saved as one of the modifiers.

	section_concept_id	snippet	offset	lexical_variant	nlp_system	note_nlp_concept_id	nlp_date	nlp_date_tim			
1 Sample Type / Medical Specialty: Discharge Summary											
3 Sample Name: Discharge Summary - 6											
5 Description: A white male veteran with multiple comorbidities, who has a history of bladder cancer diagnosed approximately two years ago by the VA Hospital.	description	: A white male veteran with multiple comorbidities , who has a history of bladder cancer	138-151	comorbidities	CLAMP	C0009488	09/12/2017	09/12/2017 16:24:23	True		
	description	comorbidities , who has a history of bladder cancer diagnosed approximately two years ago	174-188	bladder cancer	CLAMP	C0005684	09/12/2017	09/12/2017 16:24:23	True	two years ago	BDL=[bladder], temporal=[two years ago]
7 (Medical Transcription Sample Report)											
9 ADMISSION DATE: MM/DD/YYYY	history_present_illness	- old white male veteran with multiple comorbidities , who has a history of bladder cancer	432-445	comorbidities	CLAMP	C0009488	09/12/2017	09/12/2017 16:24:23	True		
11 DISCHARGE DATE: MM/DD/YYYY											
13 HISTORY OF PRESENT ILLNESS: Mr. ABC is a 60-year-old white male veteran with multiple comorbidities, who has a history of bladder cancer diagnosed approximately two years ago by the VA Hospital. He underwent a resection there. He was to be admitted to the Day Hospital for cystectomy. He was seen in Urology Clinic and Radiology Clinic on MM/DD/YYYY.	history_present_illness	comorbidities , who has a history of bladder cancer diagnosed approximately two years ago	468-482	bladder cancer	CLAMP	C0005684	09/12/2017	09/12/2017 16:24:23	True	two years ago	BDL=[bladder], temporal=[two years ago]
	history_present_illness	ago by the VA Hospital . He underwent a resection there . He was to be admitted to the	555-566	a resection	CLAMP	C0198907	09/12/2017	09/12/2017 16:24:23	True		
	history_present_illness	to be admitted to the Day Hospital for cystectomy . He	621-631	cystectomy	CLAMP	C0010651	09/12/2017	09/12/2017 16:24:23	True		

Discussion

- Section standardization
 - Normalization is tricky
 - Different note types requires different hierarchy
- `note_nlp_concept_id(integer)` – Standardized Vocabulary
`note_nlp_source_concept_id(integer)` -> CUI (string)
- `term_exists`: requires a special postprocessing
- `term_temporal`: present, past, future(?)
 - What's past?
 - Concrete point in time phrases
 - Relative events

Discussion

- term_modifiers
 - relationships?
 - Disease - body_location, medication – dose, lab - value
 - What if 2 terms are related to each other?
 - procedure – intent (disease)