1 Line of Code to Use 200+ State-of-the-Art Clinical & Biomedical NLP Models

September 16

pip install nlu

John Snow LABS

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Introducing Spark NLP

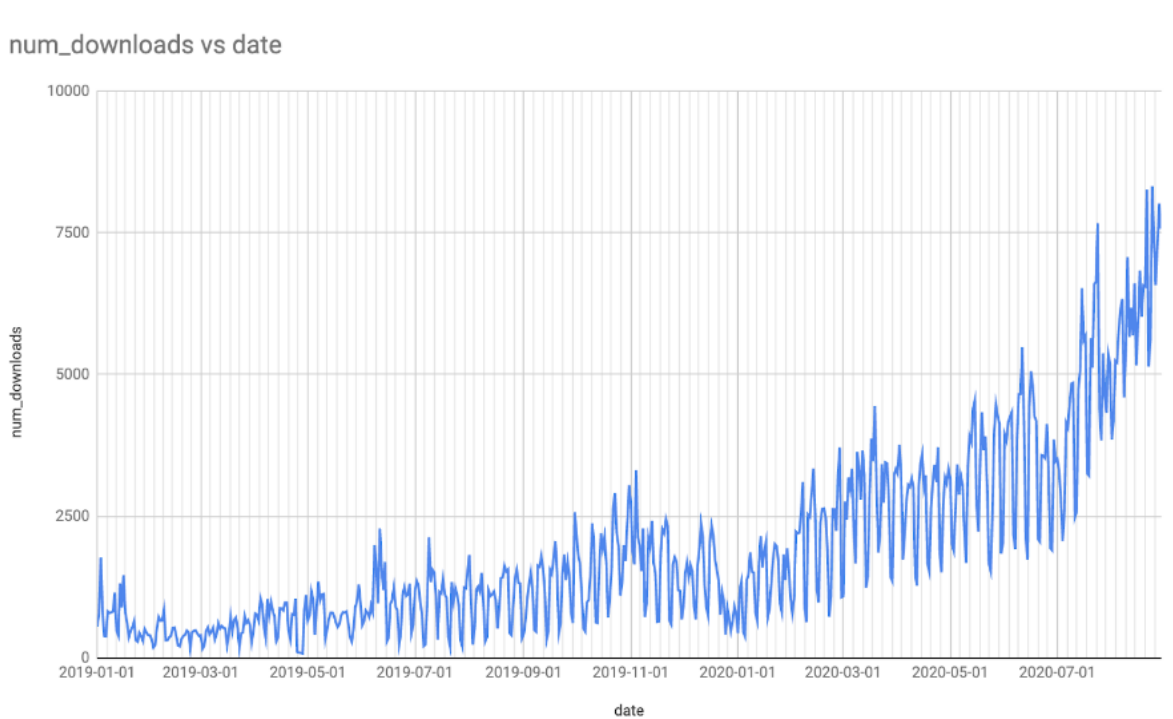
Daily ~ 20K
Monthly ~ 600K

PyPI link	https://pypi.org/project/spark-nlp
Total downloads	3,976,595
Total downloads - 30 days	656,474
Total downloads - 7 days	152,742

State of the art NLP:

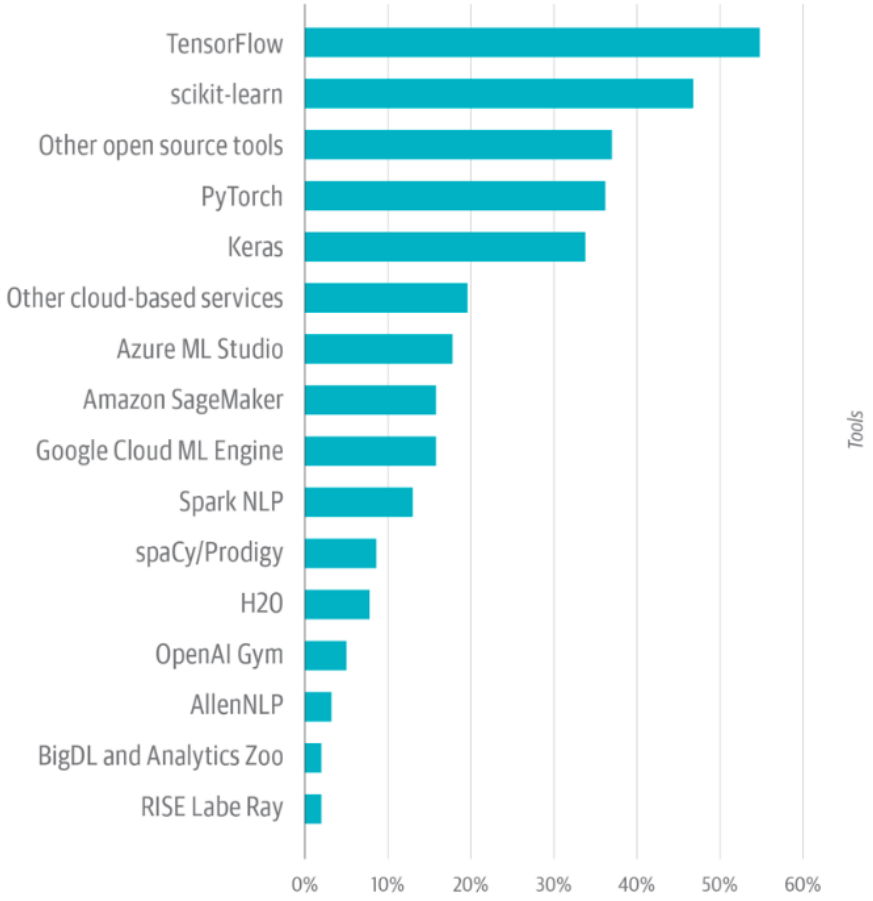
1. **Accuracy**
2. **Speed**
3. **Scalability**

Open-Source Python, Java & Scala Libraries
200+ Pre-Trained Models & Pipelines
Vibrant: 26 new releases in 2018, 28 in 2019

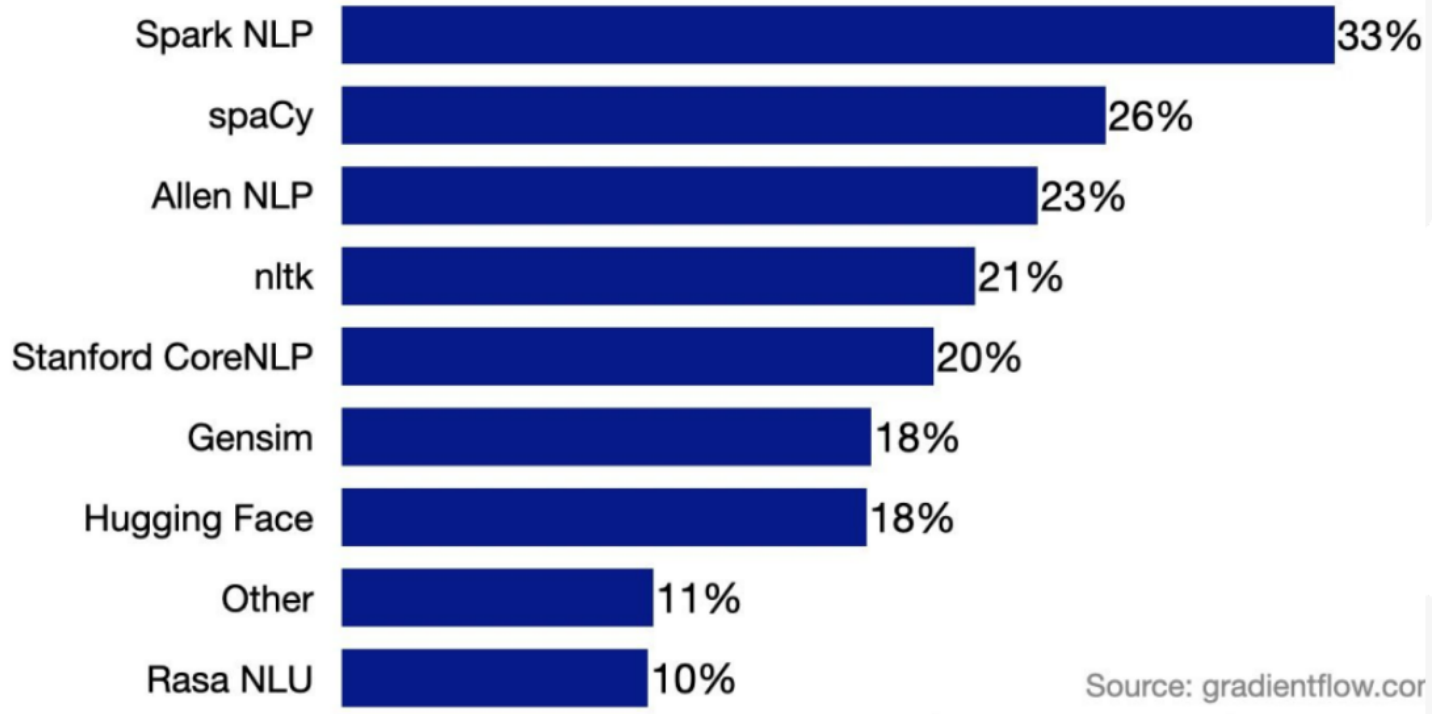


Spark NLP in Industry

Which of the following AI tools do you use?



Which NLP libraries does your organization use?



NLP Industry Survey by Gradient Flow,
an independent data science research & insights company, September 2020

TRUSTED BY


Microsoft


Google


amazon


intel


IBM


databricks


verizon


indeed


CapitalOne


viacom


McKESSON


MERCK


Roche


selectdata


UiPath
Reboot
Work.


ASCO
CANCER·LINQ
DISCOVERY


cnrs


Imperial College
London


Georgia
Tech


STANFORD
UNIVERSITY

AI
ARTIFICIAL INTELLIGENCE
EXCELLENCE
AWARD
2020

"John Snow Labs wins our best AI product or service award thanks to **exceptional success turning AI research into real & dependable systems for a global community**."

"An open source project, tool, or contribution that **significantly advances the state of data science** is recognized with this award."

HEALTHCARE ANALYTICS
PROVIDER OF THE YEAR 2020
Healthcare
Tech OUTLOOK

"By all accounts, John Snow Labs has created **the most accurate software in history** to extract facts from unstructured text."

NLU & Spark NLP

- A single **unified** library for all your **NLP/NLU** needs
- 4000+ Models,
- 200+ Languages
- 1 Line of code
- Active **community** on **Slack** and **GitHub**

NLP Feature	NLU/ Spark NLP	spaCy	NLTK	CoreNLP	Hugging Face
Tokenization	**Yes**	Yes	Yes	Yes	Yes
Sentence segmentation	**Yes**	Yes	Yes	Yes	**No**
Steeming	**Yes**	Yes	Yes	Yes	**No**
Lemmatization	**Yes**	Yes	Yes	Yes	**No**
POS tagging	**Yes**	Yes	Yes	Yes	**No**
Entity recognition	**Yes**	Yes	Yes	Yes	Yes
Dep parser	**Yes**	Yes	Yes	Yes	**No**
Text matcher	**Yes**	Yes	**No**	**No**	**No**
Date matcher	**Yes**	**No**	**No**	**No**	**No**
Sentiment detector	**Yes**	**No**	Yes	Yes	Yes
Text classification	**Yes**	Yes	Yes	**No**	Yes
Spell checker	**Yes**	**No**	**No**	**No**	**No**
Language detector	**Yes**	**No**	**No**	**No**	**No**
Keyword extraction	**Yes**	**No**	**No**	**No**	**No**
Pretrained models	**Yes**	Yes	Yes	Yes	Yes
Trainable models	**Yes**	Yes	Yes	Yes	Yes

What will we learn today

- Learn how to leverage the 200+ healthcare models for 50 + domains
- Quick NLU basics recap
- All Medical Named Entity Recognizer Domains
- All Assertion Model Domains
- De-Identification
- All Resolution Model Domains
- All Relation Model Domains

Clinical Entity Recognition

40 units **DOSAGE** of
insulin glargine **DRUG**
at night **FREQUENCY**

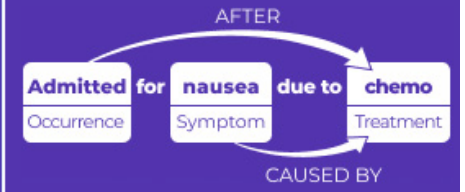
Clinical Entity Linking

Suspect diabetes	SNOMED-CT:	473127005
Lisinopril 10 MG	RxNorm:	316151
Hyponatremia	ICD-10:	E87.1

Assertion Status

Fever and sore throat	→ PRESENT
No stomach pain	→ ABSENT
Father with Alzheimer	→ FAMILY

Relation Extraction



Algorithms

Extract Knowledge
- Entity Linker
- Entity Disambiguator
- Document Classifier
- Contextual Parser

De-Identity Text
- Structured Data
- Unstructured Text
- Obfuscator
- Generalizer

Split Text
- Sentence Detector
- Deep Sentence Detector
- Tokenizer
- nGram Generator

Clean Medical Text
- Spell Checking
- Spell Correction
- Normalizer
- Stopword Cleaner

Clinical Grammar
- Stemmer
- Lemmatizer
- Part of Speech Tagger
- Dependency Parser

Find in Text
- Text Matcher
- Regex Matcher
- Date Matcher
- Chunker

Content

Medical Transformers

JSL-BERT-Clinical | BioBERT | ClinicalBERT | GloVe-Med | GloVe-ICD-O | BlueBert

Linked Medical Terminologies

SNOMED-CT | CPT | UMLS | ICD-10-CM | RxNorm | HPO | ICD-10-PCS | ICD-O | LOINC

200+ Pretrained Models

Clinical:
Signs, Symptoms, Treatments, Procedures, Tests, Labs, Sections

Anatomy:
Organ, Subdivision, Cell, Structure Organism, Tissue, Gene, Chemical

Drugs:
Name, Dosage, Strength, Route, Duration, Frequency, Poisons, Adverse Effects

Demographics:
Age, Gender, Height, Weight, Race, Ethnisity, Marital Status, Vital Signs

Risk Factors:
Smoking, Obesity, Diabetes, Hypertension, Substance Abuse

Sensitive Data:
Patient Name, Address, Phone, Email, Dates, Providers, Identifiers

How does it work?

model= nlu.**load**(model)

- Returns a nlu pipeline object

model.**predict**(data)

- Returns a pandas DF

How does it work?

```
model = nlu.load('emotion')
```

- Returns a nlu pipeline object

```
model.predict('I love NLU!')
```

- Returns a pandas DF

EMOTION DETECTION

```
nlu.load('emotion').predict('I love NLU!')
```

sentence_embeddings	category_sentence	category_surprise	category_sadness	category_joy	category_fear	sentence	category	id
[0.027570432052016258, -0.052647676318883896, ...]	0	0.012899903	0.0015578865	0.9760173	0.0095249	I love NLU!	joy	1

NER Models Overview

Domain	Description	Sample NLU Spells	Sample Entities	Sample Predicted Labels	Reference Links
ADE (Adverse Drug Events)	Find adverse drug event (ADE) related entities	med_ner.ade_biobert	Aspirin , vomiting	DRUG, ADE	CADEC, Twimed
Anatomy	Find body parts, anatomical sites a nd reference related entities	med_ner.anatomy	tubules, nasopharyngeal aspirates, embryoid bodies, NK cells, Mitochondrial, tracheoesophageal fistulas, heart, colon cancer, cervical, central nervous system	Tissue structure, Organism substance, Developing anatomical structure, Cell, Cellular component, Immaterial_anatomical_entity, organ, Pathological formation, Organism_subdivision, Anatomical_system	AnEM
Cellular/ Molecular Biology	Find Genes, Molecules, Cell or general Biology related entities	med_ner.cellular.biobert	human T-cell leukemia virus type 1 Tax-responsive , primary T lymphocytes, E1A-immortalized, Spi-B mRNA, zeta-globin	DNA, Cell_type, Cell_line, RNA, Protein	JNLPBA
Chemical/Genes/ Proteins	Find Chemical, Gene and Protein related entities	med_ner.chemprot.clinical	nitrogen , β-amyloid , NF-kappaB	CHEMICAL, GENE-Y, GENE-N	ChemProt
Chemical Compounds	Find general chemical compound related entities	med_ner.chemicals	resveratrol , β-polyphenol	CHEM	Dataset by John Snow Labs
Drug Chemicals	Find chemical and drug related entities	med_ner.drugs	potassium , anthracyclines, taxanes	DrugChem. DrugChem.DrugChem	i2b2 + FDA
Posology/Drugs	Find posology and drug related entities	med_ner.posology.biobert	5000 units, Aspirin, 14 days, tablets, daily, topically, 30 mg	DOSAGE, DRUG, DURATION, FORM, FREQUENCY, ROUTE, STRENGTH.	i2b2 + FDA
Risk Factors	Find risk factor of patient related entities	med_ner.risk_factors.biobert	coronary artery disease, hypertension, Smokes 2 packs of cigarettes per day, morbid obesity, Actos, Works in School, diabetic, diabetic	CAD, HYPERTENSION, SMOKER, OBESE, FAMILY HIST, MEDICATION, PHI, HYPERLIPIDEMIA, DIABETES	De-identification and Heart Disease Risk Factors Challenge datasets
cancer Genetics	Find cancer and genetics related entities	med_ner.cancer	human, Kir 3.3, GIRK3, potassium, GIRK, chromosome 1q21-23, pancreas, tissues, fat andskeletal muscle, KCNJ9, Type II, breast cancer, patients, anthracyclines, taxanes, vinorelbine, patients, breast, vinorelbine inpatients, anthracyclines	Amino acid, Anatomical_system, cancer, Cell, Cellular component, Developing anatomical Structure, Gene or gene product, Immaterial anatomical_entity, Multi-tissue structure, Organ, Organism , Organism_subdivision, Simple_chemical, Tissue	CG TASK of BioNLP 2013
Diseases	Find disease related entities	med_ner.diseases.biobert	the cyst, a large Prolene suture, a very small incisional hernia, the hernia cavity, omentum, the hernia, the wound lesion, The lesion, the existing scar, the cyst, the wound, this cyst down to its base, a small incisional hernia, The cyst	Disease	CG TASK of BioNLP 2013
Bacterial Species	Find bacterial species related entities	med_ner.bacterial_species	Neisseria wadsworthii, N. bacilliformis, Spirochaeta litoralis	SPECIES	Dataset by John Snow Labs
Medical Problem/Test/Treatment	Find medical problem,test and treatment related entities	med_ner.healthcare	respiratory tract infection , Ourexpression studies, atorvastatin	PROBLEM, TEST, TREATMENT	i2b2
Clinical Admission Events	Find clinical admission event related entities	med_ner.admission_events	2007, 12 AM, Headache, blood sample, presented, emergency room, daily	DATE, TIME, PROBLEM, TEST, TREATMENT, OCCURENCE, CLINICAL DEPT, EVIDENTIAL, DURATION, FREQUENCY, ADMISSION, DISCHARGE	Custom i2b2, enriched with Events
Genetic Variants	Find genetic variant related entities	en.med_ner.genetic_variants	rs1061170, p.S45P, T13046C	DNAMutation, ProteinMutation, SNP	TMVAR
PHI (Protected Healthcare Information)	Find PHI(Protected Healthcare) related entities	en.med_ner.deid	2093-01-13, David Hale, Hendrickson,</br> Ora, 7194334, 01/13/93, Oliveira, 25-year-old, 1-11-2000, Cocke County Baptist Hospital, 0295 Keats Street., (302) 786-5227, Brothers Coal-Mine	MEDICALRECORD, ORGANIZATION, DOCTOR, USERNAME, PROFESSION, HEALTHPLAN, URL, CITY, DATE, LOCATION-OTHER, STATE, PATIENT, DEVICE, COUNTRY, ZIP, PHONE, HOSPITAL, EMAIL, IDNUM, SREET, BIOID, FAX, AGE	n2c2 i2b2-PHI
Social Determinants / Demographic Data	Find Social Determinants and Demographic Data Related Entities	med_ner.jsl.enriched	21-day-old, male, congestion, mom, suctioning yellow discharge, she, problems with his breathing, perioral cyanosis, retractions, mom, Tylenol, His, his, respiratory congestion, He, tired, fussy, albuterol	Age, Diagnosis, Dosage, Drug_Name, Frequency, Gender, Lab_Name, Lab_Result, Symptom_Name	Dataset by John Snow Labs

NER Models Overview - Continued

Domain	Description	Sample NLU Spells	Sample Entities	Sample Predicted Labels	Reference Links
General Clinical	Find General Clinical Entities	med_ner.jsl.wip.clinical.modifier	28-year-old, female, gestational, diabetes, mellitus, eight, years, prior, type, two, diabetes, mellitus, T2DM, HTG-induced, pancreatitis, three, years, prior, acute, hepatitis, obesity, body, mass, index, BMI, kg/m2, polyuria, polydipsia, poor, appetite, vomiting, Two, weeks, prior, she, five-day, course	Injury or Poisoning, Direction, Test, Admission Discharge, Death Entity, Relationship Status, Duration, Respiration, Hyperlipidemia, Birth Entity, Age, Labour_Delivery, Family_History_Header, BMI, Temperature, Alcohol, Kidney Disease, Oncological, Medical History Header, Cerebrovascular_Disease, Oxygen_Therapy, O2 Saturation, Psychological Condition, Heart Disease, Employment, Obesity, Disease Syndrome Disorder, Pregnancy, ImagingFindings, Procedure, Medical Device, Race Ethnicity, Section Header, Symptom, Treatment, Substance, Route, Drug Ingredient, Blood Pressure, Diet, External body part or region, LDL, VS Finding, Allergen, EKG Findings, Imaging Technique, Triglycerides, RelativeTime, Gender, Pulse, Social History Header, Substance_Quantity, Diabetes, Modifier, Internal organ or component, Clinical Dept, Form, Drug_BrandName, Strength, Fetus NewBorn, RelativeDate, Height, Test Result, Sexually Active or Sexual Orientation, Frequency, Time, Weight, Vaccine, Vital Signs Header, Communicable Disease, Dosage, Overweight, Hypertension, HDL, Total_Cholesterol, Smoking,`	Dataset by John Snow Labs
Radiology	Find Radiology related entities	med_ner.radiology.wip_clinical	Bilateral, breast, ultrasound, ovoid mass, 0.5 x 0.5 x 0.4, cm, anteromedial aspect, left, shoulder, mass, isoechoic echotexture, muscle, internal color flow, benign fibrous tissue, lipoma	ImagingTest, Imaging Technique, ImagingFindings, OtherFindings, BodyPart, Direction, Test, Symptom, Disease Syndrome Disorder, Medical_Device, Procedure, Measurements, Units	Dataset by John Snow Labs, MIMIC-CXR and MT Radiology texts
Radiology Clinical JSL-V1	Find radiology related entities in clinical setting	med_ner.radiology.wip_greedy_biobert	Bilateral, breast, ultrasound, ovoid mass, 0.5 x 0.5 x 0.4, cm, anteromedial aspect, left, shoulder, mass, isoechoic echotexture, muscle, internal color flow, benign fibrous tissue, lipoma	Test Result, OtherFindings, BodyPart, ImagingFindings, Disease Syndrome Disorder, ImagingTest, Measurements, Procedure, Score, Test, Medical Device, Direction, Symptom, Imaging_Technique, ManualFix, Units	Dataset by John Snow Labs,
Genes and Phenotypes	Find Genes and Phenotypes (the observable physical properties of an organism) related entities	med_ner.human_phenotype.gene_biobert	APOC4 , polyhydramnios	GENE, PHENOTYPE	PGR_1, PGR_2
Normalized Genes and Phenotypes	Find Normalized Genes and Phenotypes (the observable physical properties of an organism) related entities	med_ner.human_phenotype.go_biobert	protein complex oligomerization , defective platelet aggregation	GO, HP	PGR_1, PGR_2
Radiology Clinical JSL-V2	Find radiology related entities in clinical setting	med_ner.jsl.wip.clinical.rd		Kidney Disease, HDL, Diet, Test, Imaging Technique, Triglycerides, Obesity, Duration, Weight, Social History Header, ImagingTest, Labour_Delivery, Disease Syndrome Disorder, Communicable Disease, Overweight, Units, Smoking, Score, Substance Quantity, Form, Race Ethnicity, Modifier, Hyperlipidemia, ImagingFindings, Psychological Condition, OtherFindings, Cerebrovascular Disease, Date, Test_Result, VS Finding, Employment, Death Entity, Gender, Oncological, Heart Disease, Medical Device, Total Cholesterol, ManualFix, Time, Route, Pulse, Admission Discharge, RelativeDate , O2 Saturation, Frequency, RelativeTime, Hypertension, Alcohol, Allergen, Fetus NewBorn, Birth Entity, Age, Respiration, Medical History Header, Oxygen Therapy, Section Header, LDL, Treatment, Vital Signs Header, Direction, BMI, Pregnancy, Sexually Active or Sexual Orientation, Symptom, Clinical Dept, Measurements, Height, Family_History_Header, Substance, Strength, Injury or Poisoning, Relationship Status, Blood Pressure, Drug, Temperature, , EKG Findings, Diabetes, BodyPart, Vaccine, Procedure, Dosage	Dataset by John Snow Labs,
General Medical Terms	Find general medical terms and medical entities.	med_ner.medmentions		Qualitative Concept, Organization, Manufactured_Object, Amino Acid, Peptide or Protein, Pharmacologic Substance, Professional or Occupational Group, Cell Component, Neoplastic Process, Substance, Laboratory_Procedure, Nucleic Acid Nucleoside or Nucleotide, Research Activity, Gene or Genome, Indicator_Reagent_or_Diagnostic_Aid, Biologic Function, Chemical, Mammal, Molecular Function, Quantitative Concept, Prokaryote, Mental or Behavioral Dysfunction, Injury or Poisoning, Body Location or Region, Spatial Concept, Nucleotide Sequence, Tissue, Pathologic Function, Body Substance, Fungus, Mental Process, Medical Device, Plant, Health Care Activity, Clinical Attribute, Genetic Function, Food, Therapeutic_or_Preventive_Procedure, Body Part Organ, Organ Component, Geographic Area, Virus, Biomedical or Dental Material, Diagnostic_Procedure, Eukaryote, Anatomical Structure, Organism Attribute, Molecular Biology Research Technique, Organic_Chemical, Cell, Daily or Recreational Activity, Population Group, Disease or Syndrome, Group, Sign_or_Symptom, Body_System	MedMentions

Assertion Models Overview

Domain	Description	Spell	Predicted Entities	Examples	Reference Dataset
Radiology	Predict status of Radiology related entities	`assert.radiology`	`Confirmed`, `Negative`, `Suspected`	- `Confirmed` : X-Ray scan shows `cancer` in lung. - `Negative` : X-Ray scan shows no sign of `cancer` in lung. - `Suspected` :X-Ray raises `suspicion of cancer` in lung but does not confirm it.	Internal Dataset by Annotated by John Snow Labs
Healthcare/Clinical extended and Family JSL powerd	Predict status of, Healthcare/Clinical/Family related entities. Additional training with JSL Dataset	`assert.jsl`	`Present`, `Absent`, `Possible`, `Planned`, `Someoneelse`, `Past`, `Family`, `Hypotetical`	- `Present` : Patient diagnosed with `cancer` in 1999 - `Absent` : No sign of `cancer` was shown by the scans - `Possible` : Tests indicate patient might have `cancer` - `Planned` : `CT-Scan` is scheduled for 23.03.1999 - `Someoneelse` : The patient gave `Aspirin` to daugther. - `Past` : The patient has no more `headaches` since the operation - `Family` : The patients father has `cancer`. - `Hypotetical` : `Death` could be possible.	2010 i2b2 + Data provided by JSL
Healthcare/Clinical JSL powerd	Predict status of Healthcare/Clinical related entities. Additional training with JSL Dataset	`assert.jsl_large`	`present`, `absent`, `possible`, `planned`, `someoneelse`, `past`	- `present` : Patient diagnosed with `cancer` in 1999 - `absent` : No sign of `cancer` was shown by the scans - `possible` : Tests indicate patient might have `cancer` - `planned` : `CT-Scan` is scheduled for 23.03.1999 - `someoneelse` : The patient gave `Aspirin` to daugther - `past` : The patient has no more `headaches` since the operation	2010 i2b2 + Data provided by JSL
Healthcare/Clinical classic	Predict status of Healthcare/Clinical related entities	`assert.biobert`	`present` , `absent`, `possible`, `conditional`, `associated_with_someone_else` ,`hypothetical`	- `present` : Patient diagnosed with `cancer` in 1999 - `absent` : No sign of `cancer` was shown by the scans - `possible` : Tests indicate patient might have `cancer` - `conditional` If the test is positive, patient has `AIDS` - `associated with someone else` : The patients father has `cancer`. - `hypothetical` : `Death` could be possible.	2010 i2b2

Resolution Models Overview

Domain/Terminology	Description	Sample NLU Spells	Sample Entities	Sample Predicted Codes	Reference Links
ICD-10 / ICD-10-CM (International Classification of Diseases - Clinical Modification)	Get ICD-10-CM codes of Medical and Clinical Entities. The ICD-10 Clinical Modification (ICD-10-CM) is a modification of the ICD-10, authorized by the World Health Organization, used as a source for diagnosis codes in the U.S. Be aware, ICD10-CM is often referred to as ICD10	resolve.icd10cm.augmented	hypertension, gastritis	I10, K2970	ICD-10-CM, WHO ICD-10-CM
ICD-10-PCS (International Classification of Diseases - Procedure Coding System)	Get ICD-10-PCS codes of Medical and Clinical Entities. The International Classification of Diseases, Procedure Coding System (ICD-10-PCS), is a U.S. cataloging system for procedural code It is maintaining by Centers for Medicare & Medicaid Services	resolve.icd10pcs	hypertension, gastritis	DWY18ZZ, 04723Z6	ICD10-PCS, CMS ICD-10-PCS
ICD-O (International Classification of Diseases, Oncollogy) Topography & Morphology codes	Get ICD-0 codes of Medical and Clinical Entities. The International Classification of Diseases for Oncology (ICD-O), is a domain-specific extension of the International Statistical Classification of Diseases and Related Health Problems for tumor diseases.	resolve.icdo.base	metastatic lung cancer	9050/3+C38.3, 8001/3+C39.8	ICD-O Histology Behaviour dataset
HCC (Hierachical Conditional Categories)	Get HCC codes of Medical and Clinical Entities. Hierarchical condition category (HCC) relies on ICD-10 coding to assign risk scores to patients. Along with demographic factors (such as age and gender), insurance companies use HCC coding to assign patients a risk adjustment factor (RAF) score.	resolve.hcc	hypertension, gastritis	139, 188	HCC
ICD-10-CM + HCC Billable	Get ICD-10-CM and HCC codes of Medical and Clinical Entities.	resolve.icd10cm.augmented_billable	metastatic lung cancer	C7800 + ['1', '1', '8']	ICD10-CM HCC
CPT (Current Procedural Terminology)	Get CPT codes of Medical and Clinical Entities. The Current Procedural Terminology(CPT) is developed by the American Medical Association (AMA) and used to assign codes to medical procedures/services/diagonstics. The codes are used to derive the amount of payment a healthcare provider may receives from insurance companies for the provided service.receives	resolve.cpt.procedures_measurements	calcium score, heart surgery	82310, 33257	CPT
LOINC (Logical Observation Identifiers Names and Codes)	Get LOINC codes of Medical and Clinical Entities. Logical Observation Identifiers Names and Codes (LOINC) developed by the U.S. organization Regenstrief Institute	resolve.loinc	acute hepatitis ,obesity	28083-4,50227-8	LOINC
HPO (Human Phenotype Ontology)	Get HPO codes of Medical and Clinical Entities.	resolve.HPO	cancer, bipolar disorder	0002664, 0007302, 0100753	HPO
UMLS (Unified Medical Language System) CUI	Get UMLS codes of Medical and Clinical Entities.	resolve.umls.findings	vomiting, polydipsia, hepatitis	C1963281, C3278316, C1963279	UMLS
SNOMED International (Systematized Nomenclature of Medicine)	Get SNOMED (INT) codes of Medical and Clinical Entities.	resolve.snomed.findings_int	hypertension	148439002	SNOMED
SNOMED CT (Clinical Terms)	Get SNOMED (CT) codes of Medical and Clinical Entities.	resolve.snomed.findings	hypertension	73578008	SNOMED
SNOMED Conditions	Get SNOMED Conditions codes of Medical and Clinical Entities.	resolve.snomed_conditions	schizophrenia	58214004	SNOMED
RxNorm and RxCUI (Concept Uinque Indentifier)	Get Normalized RxNorm and RxCUI codes of Medical, Clinical and Drug Entities.	resolve.rxnorm	50 mg of eltrombopag oral	825427	[RxNorm Overview] [November 2020 RxNorm Clinical Drugs ontology graph]

Relation Domains

Domain	Description	Sample NLU Spells	Predictable Relationships and Explanation
Dates and Clinical Entities	Predict binary temporal relationship between Date Entities and Clinical Entities	relation.date	- 1 for Date Entity and Clinical Entity are related. - 0 for Date Entity and Clinical Entity are not related
Body Parts and Directions	Predict binary direction relationship between Bodypart Entities and Direction Entities	relation.bodypart.direction	- 1 for Body Part and Direction are related - 0 for Body Part and Direction are not related
Body Parts and Problems	Predict binary location relationship between Bodypart Entities and Problem Entities	relation.bodypart.problem	- 1 for Body Part and Problem are related - 0 for Body Part and Problem are not related
Body Parts and Procedures	Predict binary application relationship between Bodypart Entities and Procedure Entities	relation.bodypart.procedure	- 1 for Body Part and Test/Procedure are related - 0 for Body Part and Test/Procedure are not related
Adverse Effects between drugs (ADE)	Predict binary effect relationship between Drugs Entities and Adverse Effects/Problem Entities	relation.ade	- 1 for Adverse Event Entity and Drug are related - 0 for Adverse Event Entity and Drug are not related
Phenotype abnormalities,Genes and Diseases	Predict binary caused by relationship between Phenotype Abnormality Entities, Gene Entities and Disease Entities	relation.humen_phenotype_gene	- 1 for Gene Entity and Phenotype Entity are related - 0 for Gene Entity and Phenotype Entity are not related
Temporal events	Predict multi-class temporal relationship between Time Entities and Event Entities	relation.temporal_events	- AFTER if Any Entity occured after Another Entity - BEFORE if Any Entity occured before Another Entity - OVERLAP if Any Entity during Another Entity
Dates and Tests/Results	Predict multi-class temporal cause,reasoning and conclusion relationship between Date Entities, Test Entities and Result Entities	relation.test_result_date	- relation.test_result_date - is finding of for Medical Entity is found because of Test Entity - is result of for Medical Entity reason for doing Test Entity - is date of for Date Entity relates to time of Test/Result - 0 : No relationship
Clinical Problem, Treatment and Tests	Predict multi-class cause,reasoning and effect relationship between Treatment Entities, Problem Entities and Test Entities	relation.clinical	- TrIP : A certain treatment has improved/cured a medical problem - TrWP : A patient's medical problem has deteriorated or worsened because of treatment - TrCP : A treatment caused a medical problem - TrAP : A treatment administered for a medical problem - TrNAP : The administration of a treatment was avoided because of a medical problem - TeRP : A test has revealed some medical problem - TeCP : A test was performed to investigate a medical problem - PIP : Two problems are related to each other
DDI Effects of using Multiple Drugs (Drug Drug Interaction)	Predict multi-class effects, mechanisms and reasoning for DDI effects(Drug Drug Interaction) relationships between Drug Entities	relation.drug_drug_interaction	- DDI-advise when an advice/recommendation regarding a Drug Entity and Drug Entity is given - DDI-effect when Drug Entity and Drug Entity have an effect on the human body (pharmacodynamic mechanism). Including a clinical finding, signs or symptoms, an increased toxicity or therapeutic failure. - DDI-int when effect between Drug Entity and Drug Entity is already known and thus provides no additional information. - DDI-mechanism when Drug Entity and Drug Entity are affected by an organism (pharmacokinetic). Such as the changes in levels or concentration in a drug. Used for DDIs that are described by their PK mechanism - DDI-false when a Drug Entity and Drug Entity have no interaction mentioned in the text.
Posology (Drugs, Dosage, Duration, Frequency, Strength)	Predict multi-class posology relationships between Drug Entities, Dosage Entities, Strength Entities, Route Entities, Form Entities, Duration Entities and Frequency Entities	relation.posology	- DRUG-ADE if Problem Entity Adverse effect of Drug Entity - DRUG-DOSAGE if Dosage Entity refers to a Drug Entity - DRUG-DURATION if Duration Entity refers to a Drug Entity - DRUG-FORM if Mode/Form Entity refers to intake form of Drug Entity - DRUG-FREQUENCY if Frequency Entity refers to usage of Drug Entity - DRUG-REASON if Problem Entity is reason for taking Drug Entity - DRUG-ROUTE if Route Entity refer to administration method of Drug Entity - DRUG-STRENGTH if Strength Entity refers to Drug Entity
Chemicals and Proteins	Predict Regulator, Upregulator, Downregulator, Agonist, Antagonist, Modulator, Cofactor, Substrate relationships between Chemical Entities and Protein Entities	relation.chemprot	- CPR:1 if One ChemProt Entity is Part of of Another ChemProt Entity - CPR:2 if One ChemProt Entity is Regulator (Direct or Indirect) of Another ChemProt Entity - CPR:3 if One ChemProt Entity is Upregulator/Activator/Indirect Upregulator of Another ChemProt Entity - CPR:4 if One ChemProt Entity is Downregulator/Inhibitor/Indirect Downregulator of Another ChemProt Entity - CPR:5 if One ChemProt Entity is Agonist of Another ChemProt Entity - CPR:6 if One ChemProt Entity is Antagonist of Another ChemProt Entity - CPR:7 if One ChemProt Entity is Modulator (Activator/Inhibitor) of Another ChemProt Entity - CPR:8 if One ChemProt Entity is Cofactor of Another ChemProt Entity - CPR:9 if One ChemProt Entity is Substrate and product of of Another ChemProt Entity - CPR:10 if One ChemProt Entity is Not Related to Another ChemProt Entity

Relation Domain Examples

Domain	Sentence With Relationships	Predicted Relationships for Sample Sentence	Reference Links
Dates and Clinical Entities	This 73 y/o patient had CT on 1/12/95 , with cognitive decline since 8/11/94 .	- 1 for CT and 1/12/95 - 0 for cognitive decline and 1/12/95 - 1 for cognitive decline and 8/11/94	Internal Dataset by Annotated by John Snow Labs
Body Parts and Directions	MRI demonstrated infarction in the upper - brain stem , left cerebellum and right basil ganglia	- 1 for uppper and brain stem - 0 for upper and cerebellum - 1 for left and cerebellum	Internal Dataset by Annotated by John Snow Labs
Body Parts and Problems	Patient reported numbness in his left hand and bleeding from ear .	- 1 for numbness and hand - 0 for numbness and ear - 1 for bleeding and ear	Internal Dataset by Annotated by John Snow Labs
Body Parts and Procedures	The chest was scanned with portable ultrasound and amputation was performed on foot	- 1 for chest and portable ultrasound - 0 for chest and amputation - 1 for foot and amputation	Internal Dataset by Annotated by John Snow Labs
Adverse Effects between drugs (ADE)	Taking Lipitor for 15 years, experienced much sever fatigue ! Doctor moved me to voltaren 2 months ago , so far only experienced cramps	- 1 for sever fatigue and Liptor - 0 for sever fatigue and voltaren - 0 for cramps and Liptor - 1 for cramps and voltaren	Internal Dataset by Annotated by John Snow Labs
Phenotype abnormalities,Genes and Diseases	She has a retinal degeneration , hearing loss and renal failure , short stature, Mutations in the SH3PXD2B gene coding for the Tks4 protein are responsible for the autosomal recessive.	- 1 for hearing loss and SH3PXD2B - 0 for retinal degeneration and hearing loss - 1 for retinal degeneration and autosomal recessive	PGR aclAntology
Temporal events	She is diagnosed with cancer in 1991 . Then she was admitted to Mayo Clinic in May 2000 and discharged in October 2001	- OVERLAP for cancer and 1991 - AFTER for additted and Mayo Clinic - BEFORE for admitted and discharged	Temporal JSL Dataset and n2c2
Dates and Tests/Results	On 23 March 1995 a X-Ray applied to patient because of headache , found tumor in brain	- is finding of for tumor and X-Ray - is result of for headache and X-Ray - is_date_of for 23 March 1995 and X-Ray	Internal Dataset by Annotated by John Snow Labs
Clinical Problem, Treatment and Tests	- TrIP : infection resolved with antibiotic course - TrWP : the tumor was growing despite the drain - TrCP : penicillin causes a rash - TrAP : Dexamphetamine for narcolepsy - TrNAP : Ralafen was not given because of ulcers - TeRP : an echocardiogram revealed a pericardial effusion - TeCP : chest x-ray for pneumonia - PIP : Azotemia presumed secondary to sepsis	- TrIP for infection and antibiotic course - TrWP for tumor and drain - TrCP for penicillin and rash - TrAP for Dexamphetamine and narcolepsy - TrNAP for Ralafen and ulcers - TeRP for echocardiogram and pericardial effusion - TeCP for chest x-ray and pneumonia - PIP for Azotemia and sepsis	2010 i2b2 relation challenge
DDI Effects of using Multiple Drugs (Drug Drug Interaction)	- DDI-advise : UROXATRAL should not be used in combination with other alpha-blockers - DDI-effect : Chlorthalidone may potentiate the action of other antihypertensive drugs - DDI-int : The interaction of omeprazole and ketoconazole has been established - DDI-mechanism : Grepafloxacin may inhibit the metabolism of theobromine - DDI-false : Aspirin does not interact with Chlorthalidone	- DDI-advise for UROXATRAL and alpha-blockers - DDI-effect for Chlorthalidone and antihypertensive drugs - DDI-int for omeprazole and ketoconazole - DDI-mechanism for Grepafloxacin and theobromine - DDI-false for Aspirin and Chlorthalidone	DDI Extraction corpus
Posology (Drugs, Dosage, Duration, Frequency, Strength)	- DRUG-ADE : had a headache after taking Paracetamol - DRUG-DOSAGE : took 0.5ML of Celstone - DRUG-DURATION : took Aspirin daily for two weeks - DRUG-FORM : took Aspirin as tablets - DRUG-FREQUENCY : Aspirin usage is weekly - DRUG-REASON : Took Aspirin because of headache - DRUG-ROUTE : Aspirin taken orally - DRUG-STRENGTH : 2mg of Aspirin	- DRUG-ADE for headache and Paracetamol - DRUG-DOSAGE for 0.5ML and Celstone - DRUG-DURATION for Aspirin and for two weeks - DRUG-FORM for Aspirin and tablets - DRUG-FREQUENCY for Aspirin and weekly - DRUG-REASON for Aspirin and headache - DRUG-ROUTE for Aspirin and orally - DRUG-STRENGTH for 2mg and Aspirin	Magge, Scotch, Gonzalez-Hernandez (2018)
Chemicals and Proteins	- CPR:1 (Part_of) : The amino acid sequence of the rabbit alpha(2A)-adrenoceptor has many interesting properties. - CPR:2 (Regulator) : Triacsin inhibited ACS activity - CPR:3 (Upregulator) : Ibandronate increases the expression of the FAS gene - CPR:4 (Downregulator) : Vitamin C treatment resulted in reduced C-Rel nuclear translocation - CPR:5 (Agonist) : Reports show tricyclic antidepressants act as agnonists at distinct opioid receptors - CPR:6 (Antagonist) : GDC-0152 is a drug triggers tumor cell apoptosis by selectively antagonizing LAPs - CPR:7 (Modulator) : Hydrogen sulfide is a allosteric modulator of ATP-sensitive potassium channels - CPR:8 (Cofactor) : polyinosinic:polycytidylic acid and the IFNα/β demonstrate capability of endogenous IFN. - CPR:9 (Substrate) : ZIP9 plays an important role in the transport and toxicity of Cd(2+) cells - CPR:10 (Not Related) : Studies indicate that GSK-3β inhibition by palinurin cannot be competed out by ATP	- CPR:1 (Part_of) for amino acid and rabbit alpha(2A)-adrenoceptor - CPR:2 (Regulator) for Triacsin and ACS - CPR:3 (Upregulator) for Ibandronate and FAS gene - CPR:4 (Downregulator) for Vitamin C and C-Rel - CPR:5 (Agonist) for tricyclic antidepressants and opioid receptors - CPR:6 (Antagonist) (Antagonist) for GDC-0152 and LAPs - CPR:7 (Modulator) for Hydrogen sulfide and ATP-sensitive potassium channels - CPR:8 (Cofactor) for polyinosinic:polycytidylic acid and IFNα/β - CPR:9 (Substrate) for ZIP9 and Cd(2+) cells - CPR:10 (Not Related) for GSK-3β and ATP	ChemProt Paper

Coding time

- https://github.com/JohnSnowLabs/nlu/tree/master/examples/webinars_conferences_etc/healthcare_webinar

NLU Ressources

- Join our Slack
- NLU Website
- NLU Github
- Many more NLU example tutorials
- Overview of every powerful nlu 1-liner
- Checkout the Modelshub for an overview of all models
- Checkout the NLU Namespace where you can find every model as a tabel
- Intro to NLU article
- Indepth and Easy Sentence Similarity Tutorial, with StackOverflow Questions using BERTology embeddings
- 1 line of Python code for BERT, ALBERT, ELMO, ELECTRA, XLNET, GLOVE, Part of Speech with NLU and t-SNE
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Thank you.

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