



Text Analytics & Business Application

Text Analytics in Healthcare

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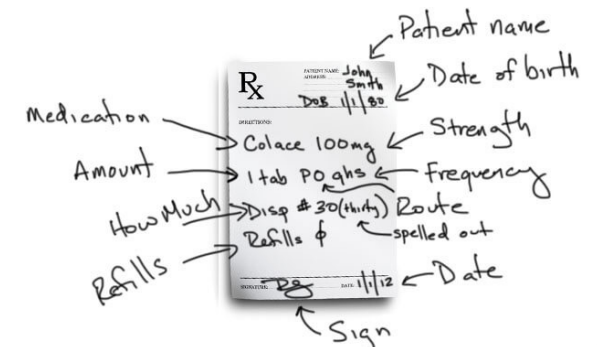
Outline of Today's Class

- Health and medical records
- Applications
- Electronic health records
- Two examples
 - Medical information extraction and analysis
 - Mental healthcare monitoring



Health and Medical Records

- A large proportion of health and medical data is often collected and stored in unstructured text formats.
- Health and medical records make the data hard to search, organize, study, and understand in its raw form.
- **Unstructured text**
 - Nursing notes
 - Clinical agreements
 - Medical publications



Use Cases by Chilmark Research

Research	Treat	Capture	Population Health	Revenue Cycle Management	Analytics/Reporting
Data Mining					
Cohost Discovery	Clinical Decision Support	Speech Recognition	Pharmacosurveillance	Computer Assisted Coding	Registry Reporting
Clinical Trial Matching	Computations Phenotyping	Clinical Documentation Improvement (CDI)	Population Surveillance	Prior Authorization	Descriptive Analytics
Drug Discovery	Biomarker Discovery	Patient Reported Outcomes	Adverse Event Detection	Risk Adjustment	Predictive Analytics
Precision Medicine	Virtual Therapy	Ambient Virtual Scribe	Social Determinants of Health	Payer Provider Convergence	Prescriptive Analytics
	Triage		Readmissions		



Next-Generation



Emerging



Proven

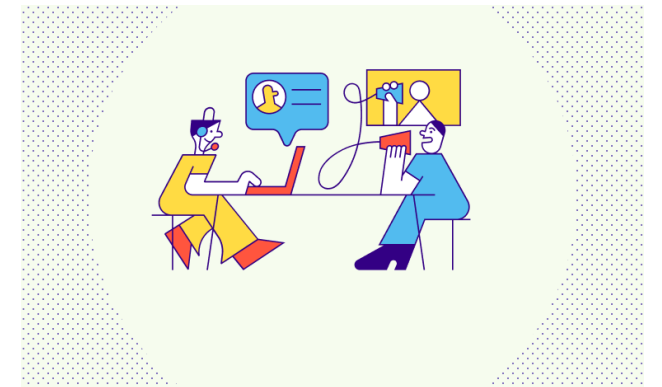


Applications of Text Mining in Healthcare



Patient Prioritization and Billing

- NLP techniques can be used on physician notes to understand their state and urgency to prioritize various health procedures and checkups.
- This can minimize delays and administrative errors and automate processes.
- Similarly, parsing and extracting information from unstructured notes to identify medical codes can facilitate billing.



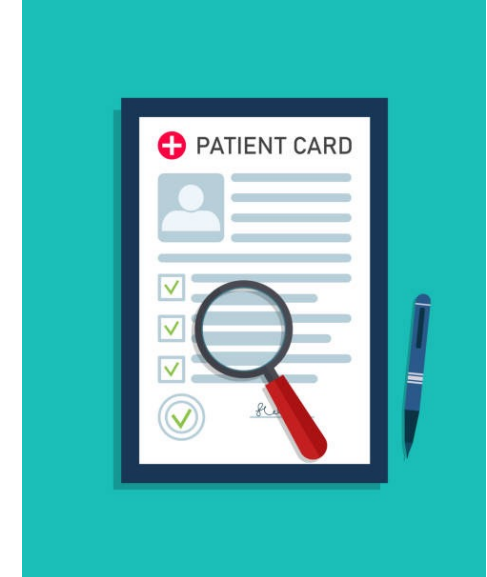
Pharmacovigilance



- Pharmacovigilance entails all activities that are needed to ensure that a drug is safe.
- This involves collection and detection and monitoring of adverse drug or medication reactions.
- With increasing use of **social media**, more of such side effects are being mentioned in social media messages; monitoring and identifying these is part of the solution.

Patient Profile Analytics

- Patient profile analytics is used to identify individuals who would benefit from proactive care or lifestyle changes.
- Using text analytics, we can extract patient's data from various sources and store the information in a patient profile graph.



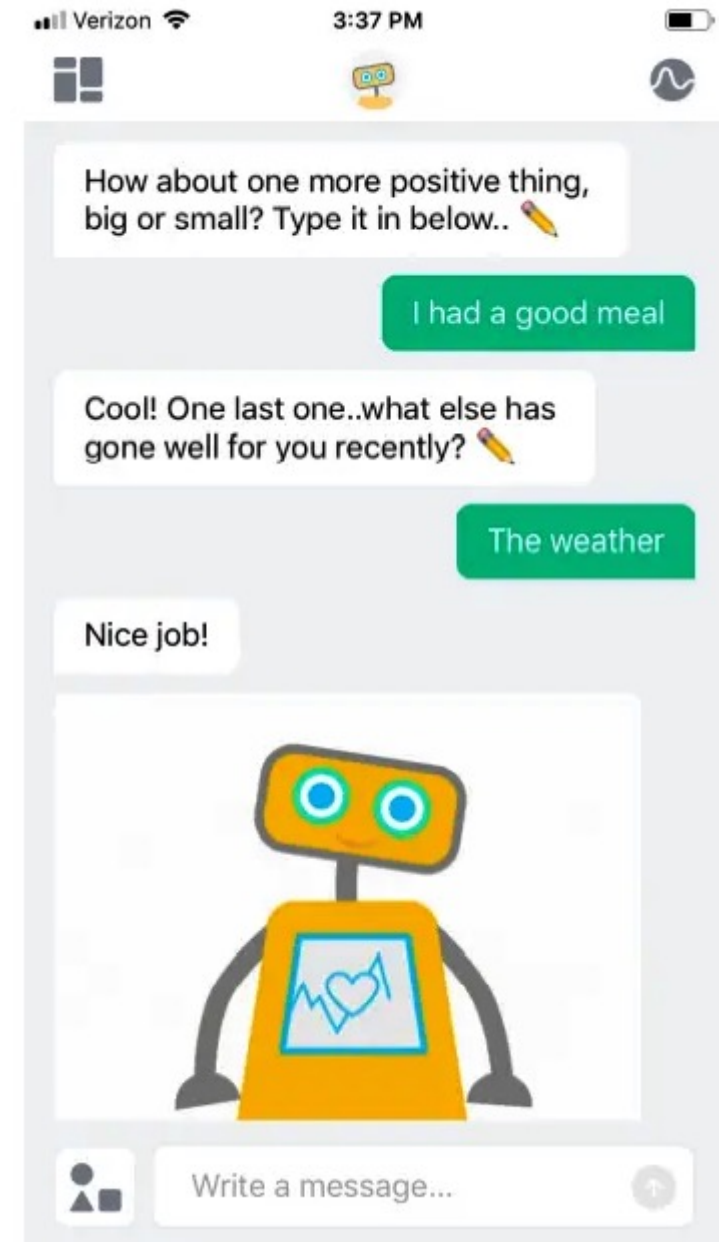
Clinical Decision Support Systems

- Decision support systems assist medical workers in making healthcare-related decisions.
 - These include screening, diagnosis, treatments, and monitoring.
- Various text data can be used as an input to these systems, including electronic health records, column-tabulated laboratory results, and operative notes.
- NLP is utilized on all of these to improve the decision support systems.



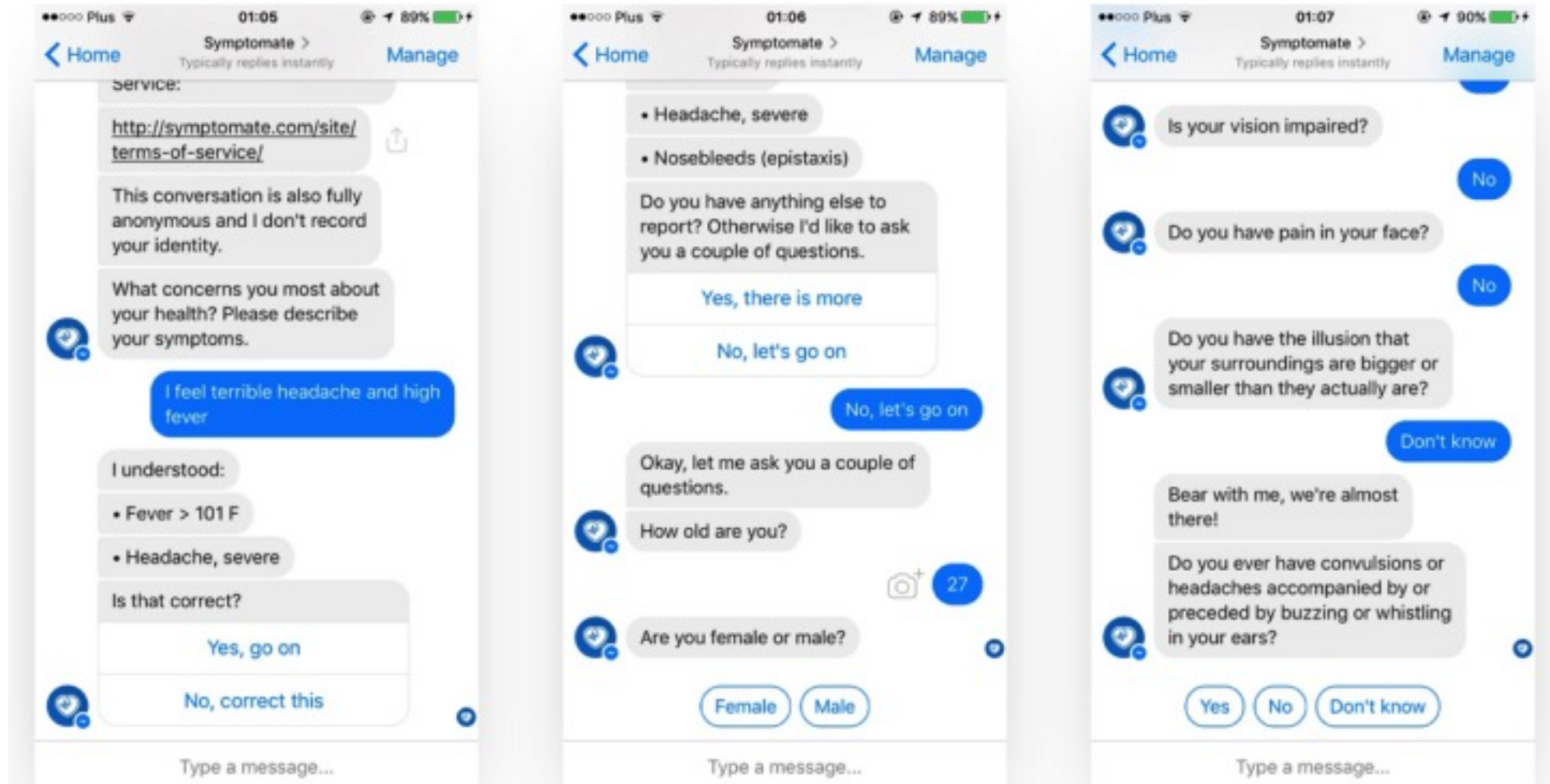
Health Assistants

- Health assistants and chatbots can improve the patient and caregiver experiences by using various aspects of expert systems and NLP
- For instance, services like Woebot can keep the spirits of patients suffering from mental illness and depression.
- Health assistants can also assess patients' symptoms to **diagnose** potential medical issues.



Health Assistants: Examples

- Diagnosis chatbot made by Infermedica API:



Electronic Health Records



Electronic Health Records

- Increased adoption of storing clinical and healthcare data electronically has led to an explosion of medical data and overwhelmingly large personal records.
- With this increasing adoption and larger document size and history, it's getting harder for doctors and clinical staff to access this data, leading to an information overload.
 - This, in turn, leads to more errors, omissions, and delays and affects patient safety.



HARVEST: Longitudinal Report Understanding

- HARVEST has been built to overcome the informational overload we mentioned earlier from Columbia University.
- The tool has been used extensively across hospitals in New York City.
- To start with, however, we need to cover how a standard clinical information system works.



Example

The standard clinical information review system at iNYP:

iNYP Logout Search

Patient List **Registry** **Patient Data**

Profile **History/Timelines** **Data Review** **Summaries**

EMPI: NYP/CU: CMC:

Laboratory Apr 23
Radiology 20 Jul
Pathology 20 Feb
Note
 Eclipsys Note (NYP/CU) Apr 17
 WebCIS Note 20
 WebCIS Signout 2008
Discharge Sum
 Eclipsys DSum (NYP/CU) 20 Jul
 WebCIS DSum 20
Admission
 Eclipsys Admit (NYP/CU) 20 Jul
 WebCIS Admit 20
Operative
 Operative Report Add
 OR Note (NYP/CU) 20
Neurophys
Cardiology Mar 7
Ob/Gyn
GI Endo
HEENT
Pulmonary
Dem Path
Endocrinol
Alerts 20
Pharmacy 20 Jul
Billing Diagnoses Apr 23
All Data

Filter: **Go** **Eclipsys Note - Columbia University (20 -10-17,20 -05-08)** **Newer** **Pg#5** **Older**

Cardiology Consult Follow-Up Free Text Note	20	-10-15 17:32	Final	NYP/CU
SW High Risk Screen	20	-10-15 13:34	Final	NYP/CU
Pastoral Visit Adult	20	-10-15 13:07	Final	NYP/CU
Milstein Hospitalist Resident/PA Follow-Up Free Text Note	20	-10-15 11:00	Final	NYP/CU
Procedure Note, Time Out Not Required	20	-10-14 19:44	Final	NYP/CU
Medicine Follow-Up Free Text Note	20	-10-14 08:06	Final	NYP/CU
Transfusion Nursing Note	20	-10-14 00:32	Final	NYP/CU
Nephrology Consult Free Text Note	20	-10-13 18:52	Final	NYP/CU
Milstein Hospitalist Attending Follow-Up Free Text Note	20	-10-13 15:27	Final	NYP/CU
Critical Test/Values Results Reporting	20	-10-13 11:13	Final	NYP/CU
Cardiology Consult Follow-Up Free Text Note	20	-10-12 15:40	Final	NYP/CU
Milstein Hospitalist Resident/PA Follow-Up Free Text Note	20	-10-12 11:02	Final	NYP/CU
Milstein Hospitalist Attending Follow-Up Free Text Note	20	-10-11 19:17	Final	NYP/CU
Milstein Hospitalist Resident/PA Follow-Up Free Text Note	20	-10-11 16:43	Final	NYP/CU
Cardiology Consult Free Text Note	20	-10-10 14:14	Final	NYP/CU
Medicine Follow-Up Free Text Note	20	-10-10 14:10	Final	NYP/CU
Case Manager Plan Of Care	20	-10-10 09:31	Final	NYP/CU
Initial Nutrition Assessment	20	-10-09 16:25	Final	NYP/CU
Milstein Hospitalist Resident/PA Follow-Up Free Text Note	20	-10-09 11:58	Final	NYP/CU
Milstein Hospitalist Resident/PA Follow-Up Free Text Note	20	-10-08 11:21	Final	NYP/CU
Cardiology Free Text Note	20	-10-08 09:19	Preliminary	NYP/CU
Nursing Adult Admission History	20	-10-07 06:24	Final	NYP/CU
Medicine Admission Free Text Note	20	-10-07 03:30	Final	NYP/CU
Transfer Note	20	-10-07 00:55	Final	NYP/CU
Emergency Department Disposition Note	20	-10-06 21:42	Preliminary	NYP/CU
Emergency Resident / Nurse Practitioner / Attending Note (Milstein)	20	-10-06 19:04	Final	NYP/CU

Expand **Print**

Cardiology Consult Free Text Note **20** **-10-10 14:14**

Cardiology Consult

Requested by: Dr. [REDACTED]

Reason: Fluid overload

HPI: 57 yo woman with a pmhx significant for morbid obesity, HTN, HLD, DM2, CKD (stage V) not on RRT and making urine, CAD s/p mLAD DES in 7/20 [REDACTED], and pulmonary HTN (based on RHC on 7/20 [REDACTED]) who presents with signs and symptoms of fluid overload. Cardiology is being asked to consult for further management. In regards to the patient's functional status, the patient lives a sedentary lifestyle and is now on disability. Over the course of the past month, she has had increasing fluid accumulation with a weight gain of over 25 kg, with worsening LE edema and facial puffiness. Prior to 1 month ago, her ET was 2 blocks, but has now decreased to 15 feet limited by SOB and occasionally with CP. Furthermore, she has a 6 pillow orthopnea that has been stable for 4 years but has had worsened PND this past month. The patient also reports 3 months of intermittent chest pain. She describes the pain as sharp, retrosternal, and located in the center of the chest, lasting 5 minutes with 1-2 episodes per week. These episodes occur at rest, and improved by sitting up and taking an aspirin.

PMHx:

1. Morbid obesity
2. HTN
3. HLD
4. DM2
5. CKD (stage V) not on RRT and making urine
6. CAD s/p mLAD DES in 7/20 [REDACTED]



HARVEST

In contrast, HARVEST parses all of the medical data to make it easy to analyze and can sit on top of any medical system.

HARVEST system for the same patient from:

inyP

Patient List Registry Patient Data Research

Profile History/Timelines Data Review Summaries

Visits
Timeline - Problems

Timeline: 8/1/20 to 10/24/20

Admitted: 8/2/20
Visit Type: Clinic
Attending:
Dx: CHEST PAIN NOS

Admitted: 9/21/20
Visit Type: REFERRED AMBULATORY SERVICE
Attending:
Dx: PERFORATION GALLBLADDER

Admitted: 9/27/20
Visit Type: Clinic
Attending:
Dx: ACUTE DIASTOLIC HEART FAILURE

Admitted: 10/6/20
Visit Type: Inpatient
Attending:
Dx: ACUTE CHRNC DIASTOLIC HRT FAIL

stable angina pulmonary hypertension ESRD dyspnea influenza abdominal pain DM CAD
edema volume overload obese OSA chest pain lymphadenopathy morbid obesity pruritis weight gain hypertension DM2 LVH
leg cramps chest discomfort vitamin D deficiency CKD hyponatremia agitation fistula nausea facial swelling hypoglycemia ischemia
CHF Dyslipidemia abdominal mass scar hyperphosphatemia anasarca angina hypoventilation ...

Notes about **dyspnea** 8/1/20 - 10/24/20

Cardiology Consult Follow-up Free Text Note	10/15/20	1:32 PM
Milstein Hospitalist Resident/PA Follow-up Free Text Note	10/15/20	7:00 AM
Medicine Follow-Up Free Text Note	10/14/20	4:06 AM
Nephrology Consult Free Text Note	10/13/20	2:52 PM
Milstein Hospitalist Attending Follow-up Free Text Note	10/13/20	11:27 AM
Cardiology Consult Follow-up Free Text Note	10/12/20	11:40 AM
Milstein Hospitalist Resident/PA Follow-up Free Text Note	10/12/20	7:02 AM
Milstein Hospitalist Resident/PA Follow-up Free Text Note	10/11/20	12:43 PM
Cardiology Consult Free Text Note	10/10/20	10:14 AM
Medicine Follow-Up Free Text Note	10/10/20	10:10 AM
Case Manager Plan of Care	10/10/20	5:31 AM
Milstein Hospitalist Resident/PA Follow-up Free Text Note	10/09/20	7:58 AM
Milstein Hospitalist Resident/PA Follow-up Free Text Note	10/08/20	7:21 AM
Nursing Adult Admission History	10/07/20	2:24 AM
Medicine Admission Free Text Note	10/06/20	11:30 PM
ED Resident/NP/Attending Note (Milstein)	10/06/20	3:04 PM

Cardiology Consult Free Text Note

Cardiology Consult

Requested by: Dr.
Reason: Fluid overload

HPI: 57 yo woman with a pmhx significant for morbid obesity, HTN, HLD, DM2, CKD (stage V) not on RRT and making urine, CAD s/p mLAD DES in 7/20, and pulmonary HTN (based on RHC on 7/20) who presents with signs and symptoms of fluid overload. Cardiology is being asked to consult for further management. In regards to the patient's functional status, the patient lives a sedentary lifestyle and is now on disability. Over the course of the past month, she has had increasing fluid accumulation with a weight gain of over 25 kg, with worsening LE edema and facial puffiness. Prior to 1 month ago, her ET was 2 blocks, but has now decreased to 15 feet limited by SOB and occasionally with CP. Furthermore, she has a 6 pillow orthopnea that has been stable for 4 years but has had worsened PND this past month. The patient also reports 3 months of intermittent chest pain. She describes the pain as sharp, retrosternal, and located in the center of the chest, lasting 5 minutes with 1-2 episodes per week. These episodes occur at rest, and improved by sitting up and taking an aspirin.

PMHx:
1. Morbid obesity
2. HTN
3. HLD
4. DM2

HARVEST

- All historical observations (from doctors, nurses, nutritionists, etc.) related to that patient are run through a **named entity recognizer** called HealthTermFinder.
- This finds all healthcare-related terms, which are then mapped to the Unified Medical Language System (UMLS) semantic group.
- The larger to smaller font sizes indicate the degree and frequency of the various issues a patient has been carrying.

stable angina **pulmonary hypertension** ESRD **dyspnea** influenza abdominal pain DM CAD
edema volume overload obese OSA chest pain lymphadenopathy morbid obesity pruritis weight gain hypertension DM2 LVH
leg cramps chest discomfort vitamin D deficiency CKD hyponatremia agitation fistula nausea facial swelling hypoglycemia ischemia
CHF Dyslipidemia abdominal mass scar hyperphosphatemia anasarca angina hypoventilation ...

More



Two Examples of Text Analytics Applications in Healthcare



1. Medical Information Extraction and Analysis

- **Medical information extraction (IE)** helps to identify clinical syndromes, medical conditions, medication, dosage, strength, and common biomedical concepts from health records, radiology reports, and discharge summaries, as well as nursing documentation and medical education documents.
- We can use both **cloud APIs** and **pre-built models** for it



Named Entity Recognition

Text analytics for health detects medical concepts in the following categories:

- Anatomy
- Demographics
- Examinations
- External Influence
- General attributes
- Genomics
- Healthcare
- Medical condition
- Medication
- Social
- Treatment



Examples

Anatomy entities:

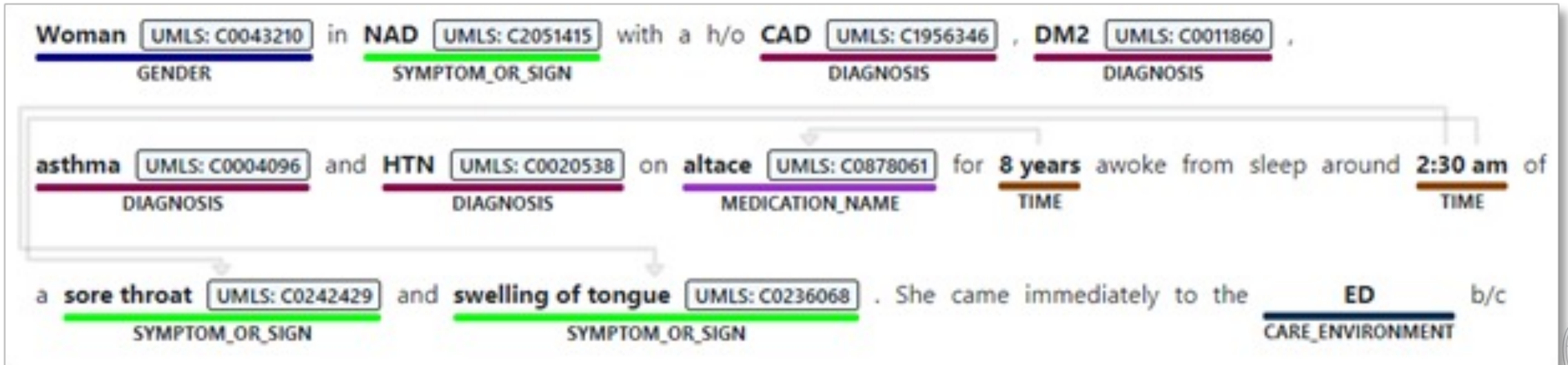
- BODY_STRUCTURE: Body systems, anatomic locations or regions, and body sites. For example, arm, knee, abdomen, nose, liver, head, respiratory system, lymphocytes



Examples

Medical condition entities:

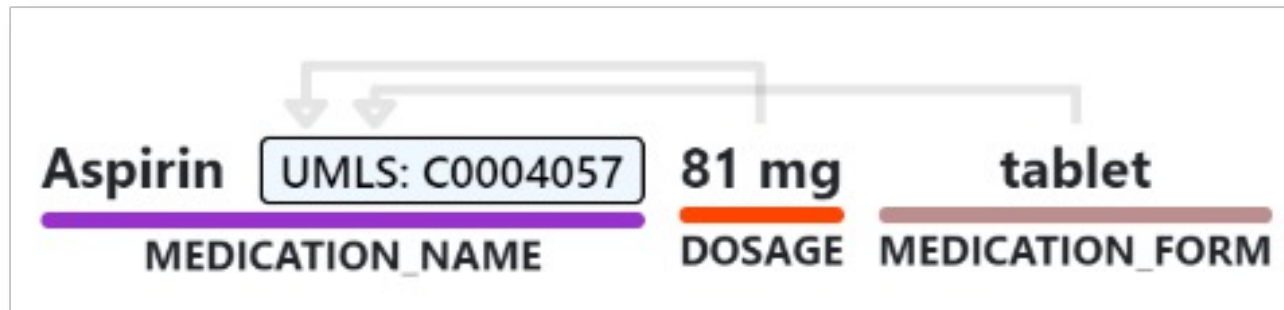
- DIAGNOSIS – Disease, syndrome, poisoning. For example, breast cancer, Alzheimer's, HTN, CHF, spinal cord injury.
- SYMPTOM_OR_SIGN – Subjective or objective evidence of disease or other diagnoses. For example, chest pain, headache, dizziness, rash, SOB, abdomen was soft, good bowel sounds, well nourished.



Examples

Medication entities:

- MEDICATION_NAME – Medication mentions, including copyrighted brand names, and non-brand names. For example, Ibuprofen.
- DOSAGE - Amount of medication ordered. For example, Infuse Sodium Chloride solution 1000 mL.
- MEDICATION_FORM - The form of the medication. For example, solution, pill, capsule, tablet, patch, gel, paste, foam, spray, drops, cream, syrup.



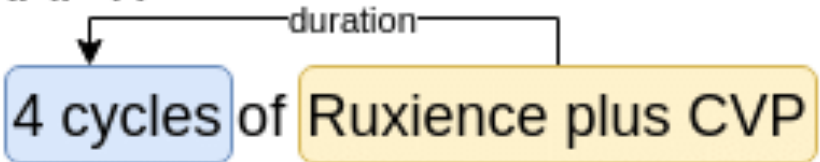
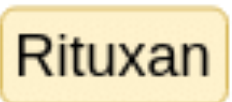
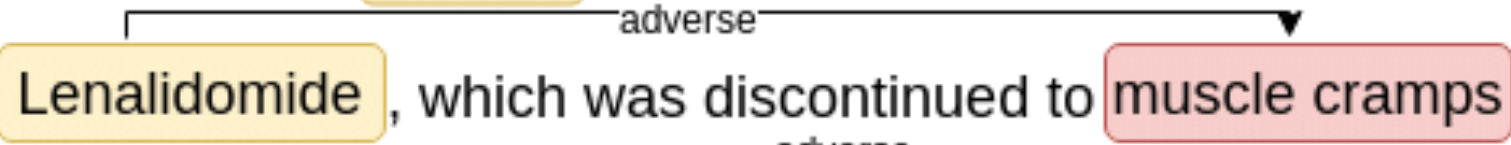
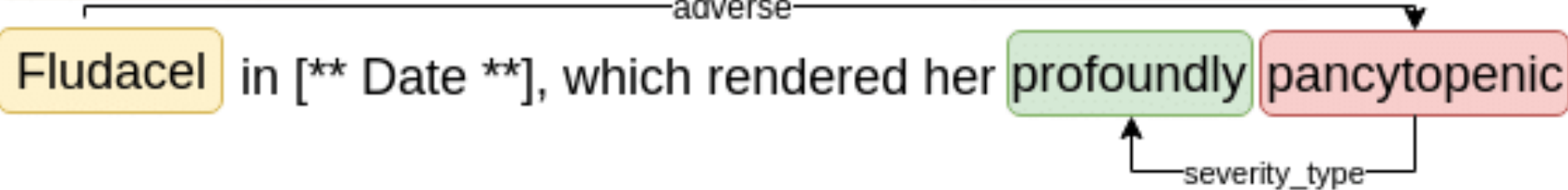
Relation Extraction

- Extracted relationships usually occur between two or more entities of a certain type (e.g., Person, Organization, Location) and fall into a number of semantic categories (e.g., married to, employed by, lives in).
- Text analytics for health recognizes relations between different concepts, including relations between attribute and entity (for example, direction of body structure, dosage of medication) and between entities (for example, abbreviation detection).



Example

PAST CHEMOTHERAPY:

1. She has received **4 cycles** of **Ruxience plus CVP** completed in [** Date **].

2. Maintenance **Rituxan** completed in [** Date **].

3. **Lenalidomide**, which was discontinued to **muscle cramps**

4. **Fludacel** in [** Date **], which rendered her **profoundly** **pancytopenic**




2. Mental Healthcare Monitoring

- It is the process of tracking, recording, and analyzing data related to a person's mental health over a period of time.
- It involves collecting information about a person's behavior, symptoms, and mood through various tools such as surveys, wearables, and mobile apps, allowing for early intervention and treatment.



Examples & Exercises using Google Colab

