AI based prognosis and diagnosis negation detection in health records using Natural Language Processing

INT 400 Internship 3

Final Review

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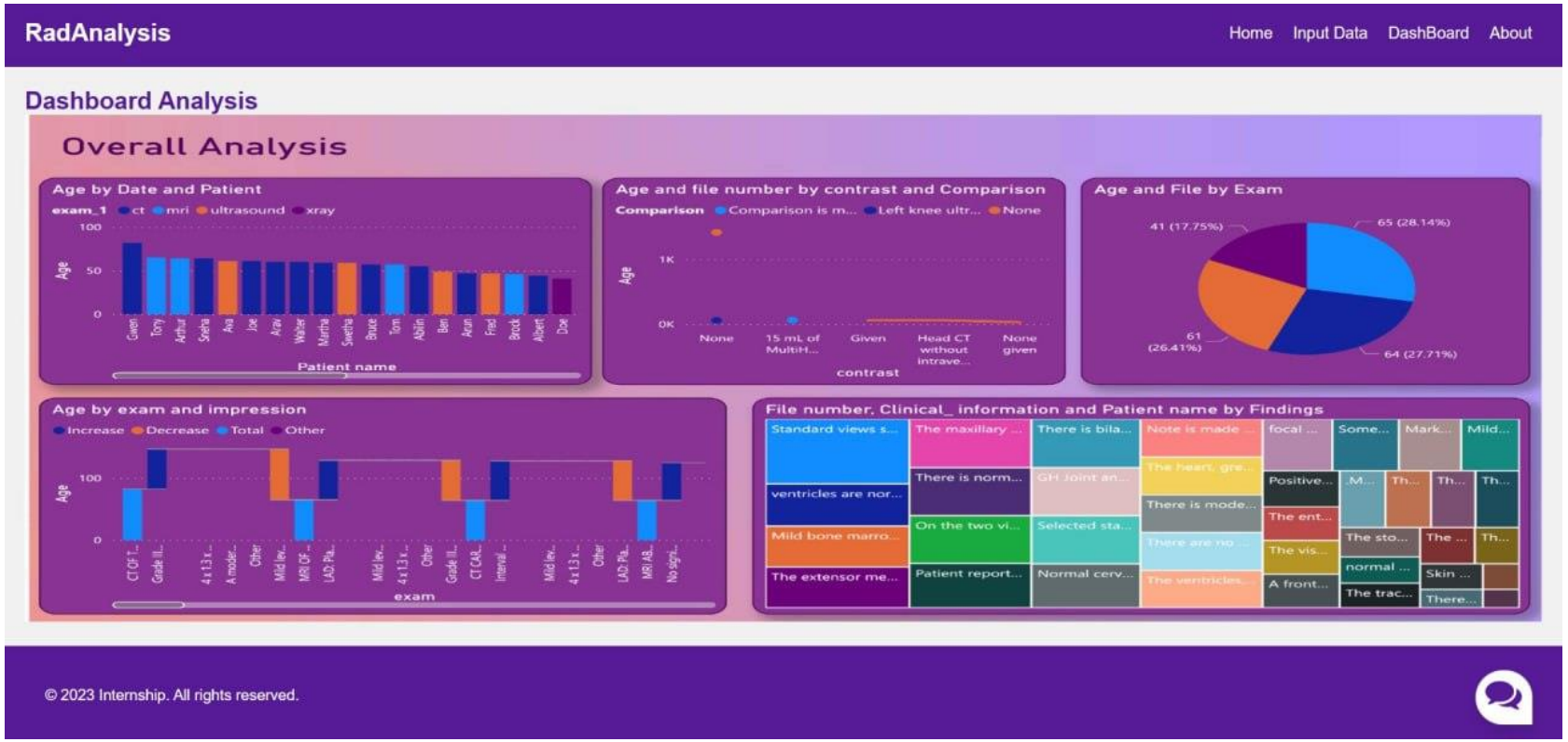
Introduction

- Natural Language Processing (NLP) is a transformative field that leverages AI to decode human language. In healthcare, it plays a crucial role in improving diagnosis and prognosis.
- Negation detection within NLP focuses on accurately identifying instances where patients deny symptoms or conditions, a vital step in healthcare data analysis.
- In this presentation, we delve into the power of NLP and AI for precise diagnosis and prognosis by addressing the challenge of negation detection in health records.

Work done

- In a prior project, I designed an interactive dashboard powered by NLP to extract insights from radiology reports.

- Leveraging NLP, we transformed unstructured radiology data into actionable information, enhancing medical decision-making.



Objectives

- One of the primary objectives of our project is to harness the power of negation detection in healthcare records to achieve precise symptom identification.
- Patients often provide critical information by negating the presence of symptoms, conditions, or experiences.
- Our AI-driven approach ensures that negated symptoms are accurately recognized, allowing us to build a more comprehensive and accurate profile of a patient's health.
- By coupling negation detection with symptom identification, we aim to improve the precision of diagnoses and prognoses, ultimately enhancing patient care.

Dataset

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SPECIALISTS IN DIAGNOSTIC IMAGING

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PATIENT: JOHN SMITH
DOB: 5/5/1955
FILE #: 12345
PHYSICIAN: REFERRING
EXAM: MRI LEFT KNEE
DATE: 1/1/2011

CLINICAL INFORMATION

Left medial knee pain and swelling for 2 weeks, injured during football, assess for medial meniscal tear, initial visit.

COMPARISON

None

TECHNIQUE

Axial PD FS, coronal T1 and STIR, sagittal PD and PD FS imaging is performed through the left knee without contrast.

FINDINGS

FLUID / INTRA-ARTICULAR BODIES: There is a small knee effusion and a small popliteal cyst present. There is circumferential soft tissue edema and swelling at the level the knee most prominent posteriorly.

MENISCI:
Medial: The medial meniscus is normal.
Lateral: The lateral meniscus is normal.

CRUCIATE LIGAMENTS: The anterior cruciate ligament contains mild intrasubstance edema suggestive of a grade 1 sprain but there is no high-grade or full-thickness tear. The PCL is normal.

COLLATERAL LIGAMENTS: The medial collateral ligament is normal. The iliotibial band and fibular collateral ligament are normal. There is grade 1 strain/contusion involving the proximal gastrocnemius muscle and the distal biceps femoris muscle.

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EXTENSOR MECHANISM: The patellar and quadricep tendons are normal.

CARTILAGE:
Patellofemoral compartment: The patellofemoral articular surfaces are normal.
Medial tibiofemoral compartment: The medial compartment articular surfaces are normal.
Lateral tibiofemoral compartment: The lateral compartment articular surfaces are normal.

BONE MARROW: There are extensive bone contusions involving the distal femur and proximal tibia. There is a nondisplaced Salter II fracture through the distal femoral growth plate with fluid within the growth plate and extensive adjacent marrow edema and bone contusion within the metaphysis. The metaphyseal component of the fracture is noted along the peripheral margin of the lateral femoral condyle with a large subperiosteal hematoma and uplifting and displacement of the periosteum along the posterolateral aspect of the distal femoral metaphysis. There is extensive bone contusion within the epiphyseal region of the proximal tibia. There is a small linear area of low signal abnormality adjacent to the growth plate posteriorly suggestive of a small incomplete nondisplaced transverse fracture through the posterior metaphyseal region of the proximal tibia seen on image 11 of series 9.

IMPRESSION

1. There are extensive bone contusions of the distal femur and proximal tibia. There is a nondisplaced Salter II fracture through the growth plate of the distal femur with the metaphyseal component of the fracture located along the posterior peripheral aspect of the lateral femoral condyle. There is a subperiosteal hematoma with displacement of the periosteum along the posterolateral aspect of the distal femoral metaphysis.

2. Extensive bone contusion of the proximal tibia with a small incomplete nondisplaced transverse fracture line noted along the posterior margin of the proximal tibial metaphysis.

3. Small knee effusion and popliteal cyst with posterior soft tissue edema and swelling.

4. Grade 1 sprain of the anterior cruciate ligament but no high-grade tear or disruption.

5. Grade 1 strain of the proximal gastrocnemius muscle and distal biceps femoris muscle.

6. No meniscal tear.

7. The articular surfaces are well preserved.

[NationalRad Musculoskeletal Radiologist]
Board Certified Radiologist

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Prognosis and Diagnosis

- Diagnosis is the process of identifying a medical condition, while prognosis is the prediction of how that condition is likely to progress.

- Both are crucial aspects of medical practice, as an accurate diagnosis informs appropriate treatment options, and an understanding of prognosis helps patients and healthcare providers make informed decisions regarding care and management.

Significance of the project

- Radiologists must be meticulous in recognizing negated findings in the radiology reports, as the absence of certain abnormalities is just as crucial as identifying their presence.
- Negations play a pivotal role in mitigating uncertainty by clarifying that specific abnormalities or conditions have not been observed in the images.
- This underscores the need for structured reporting systems that allow radiologists to clearly indicate negations, ensuring that clinicians have a accurate understanding of the prognostic and diagnostic picture.
- In the intricate landscape of radiology, where uncertainty is inherent, effective negation handling emerges as a critical component in the quest for precise and reliable diagnoses.

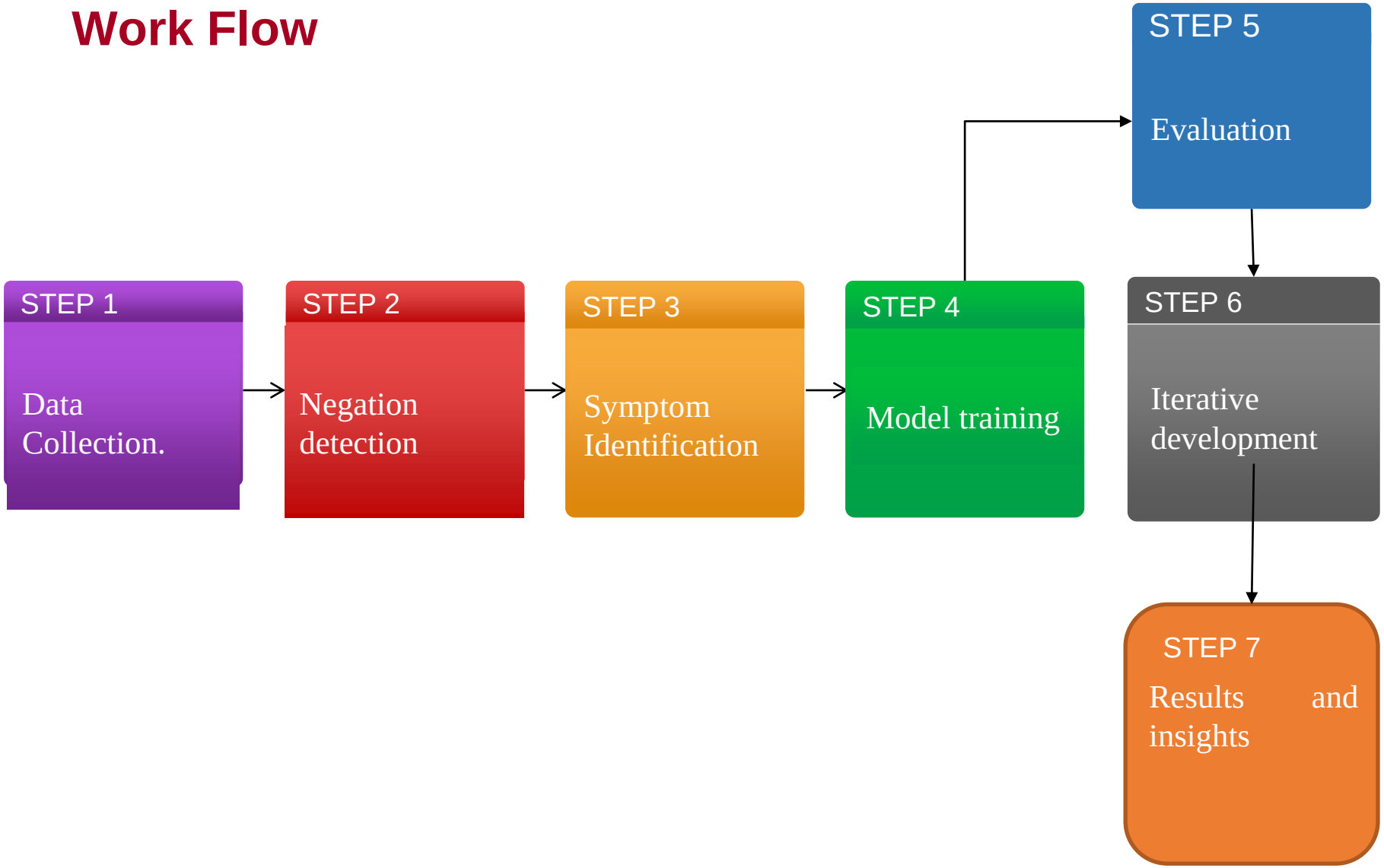
Research

Methods	Description	Appications
negspacy	A pre-trained transformer-based model specifically designed for the biomedical domain	NegSpacy is a Python library for negation detection in clinical text.
ScispaCy	A specialized version of spaCy that is trained specifically on scientific and biomedical text, which makes it ideal for processing medical text.	Entity recognition, relationship extraction, and concept mapping

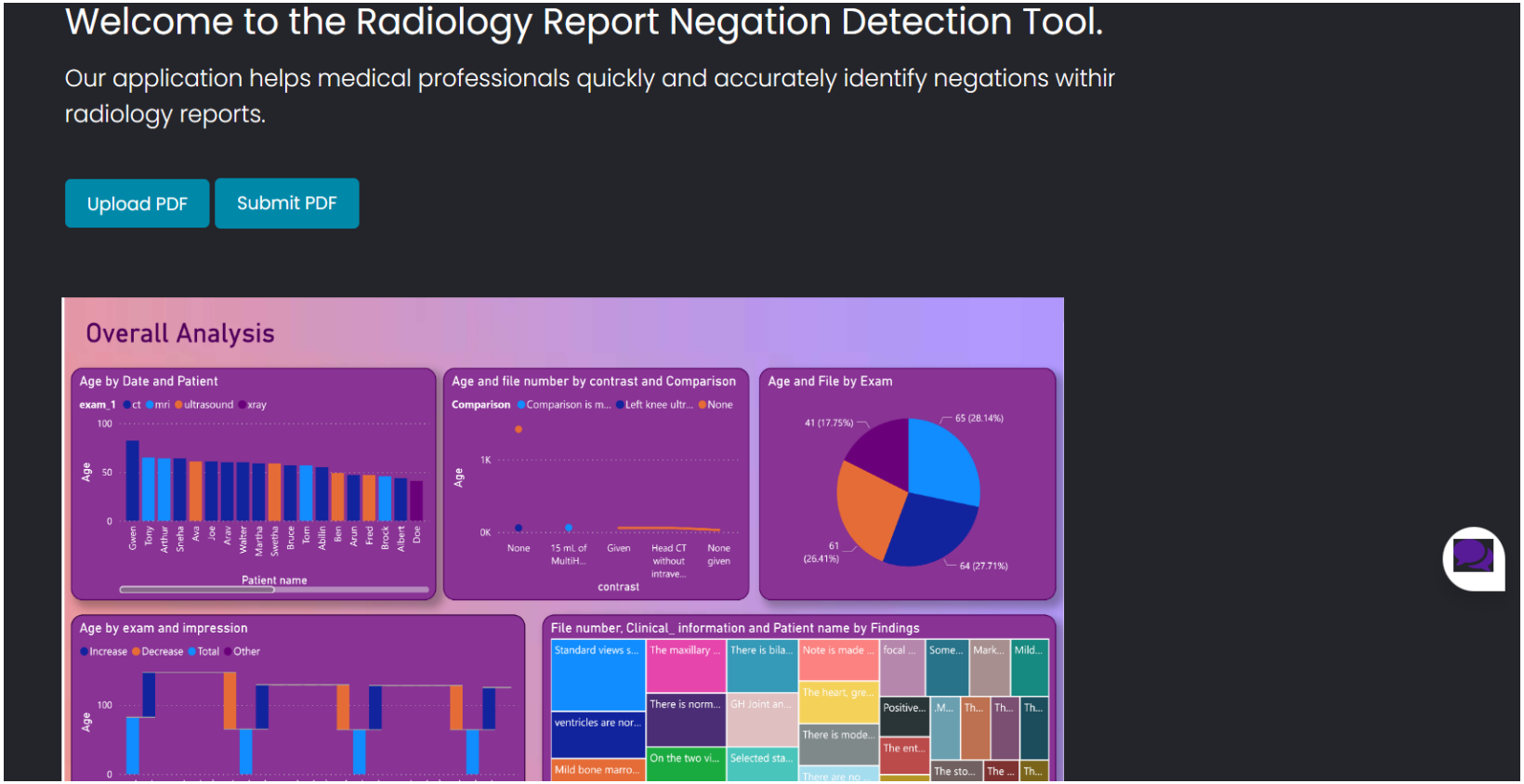
Literature Survey

Author	Year	Title	Methods	Datasets	Research Challenges addressed	Results
Elena Sergeeva	2019	Negation Scope Detection in Clinical Notes and Scientific Abstracts	CNN, LSTM	Cincinnati Children's Hospital Medical Center	LSTM-based system that makes use of syntactic data and does not require any human-derived cue annotation at the time of inference. When the gold cue annotation is available, the system enables its use as an extra feature and produces outcomes on the BioScope corpus that are on par with cutting-edge techniques.	Gold negation cue independent hierarchical LSTM based model that uses local syntactic features for negation scope detection in biomedical texts.
Bram van Es	2023	Negation detection in Dutch clinical texts	biLSTM, MedCAT, RoBERT	Erasmus Medical Center Dutch clinical corpus	The need for more representative training data and improved context handling for negation detection in electronic health records, as well as addressing data imbalance and ambiguity in clinical language.	From the 12419 medical terms in 5365 medical records, 1748 medical terms were marked as negated by the annotators. Of these, 1687 concepts were identified by at least one of the negation detection models.
Maite Taboada	2020	Negation detection for sentiment analysis	NegEx	Spanish SFU Review corpus	Words correctly identified as scope by the Spanish negation detector thatare present in the SO-CAL dictionary, but are not sentiment words in the domain understudy	Automatically identifies negation cues and their scope in Spanish review texts and we investigate whether accurate negation detection helps to improve the results of a sentiment analysis system.

Work Flow


STEP 1
Data Collection.
STEP 2
Negation detection
STEP 3
Symptom Identification
STEP 4
Model training
STEP 5
Evaluation
STEP 6
Iterative development
STEP 7
Results and insights

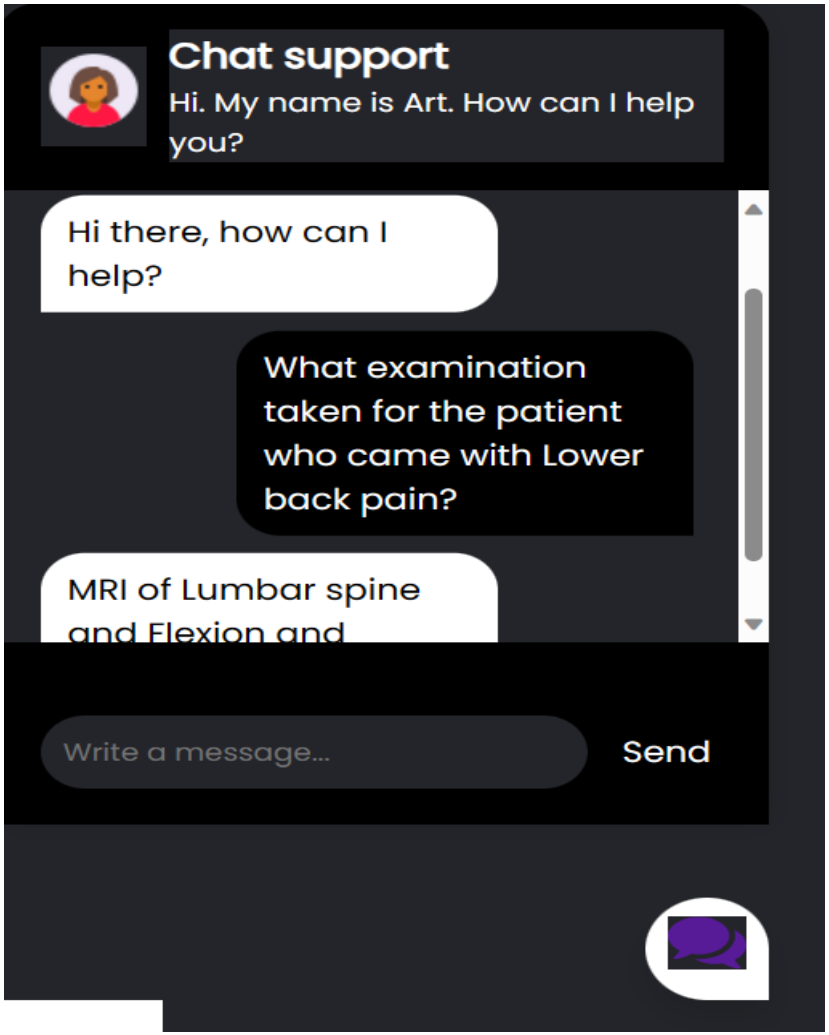
Result


Welcome to the Radiology Report Negation Detection Tool.
Our application helps medical professionals quickly and accurately identify negations withir radiology reports.
Upload PDF
Submit PDF
Overall Analysis
Age by Date and Patient
exam_1 ct mri ultrasound xray
Age
Patient name
Gwen Tony Arthur Sneha Ava Joe Arav Walter Martha Swetha Bruce Tom Ablin Ben Arun Fred Brock Albert Doe
Age and file number by contrast and Comparison
Comparison Comparison is m... Left knee ultr... None
Age
contrast
None 15 mL of MultiH... Given Head CT without intrave... None given
Age and File by Exam
41 (17.75%)
65 (28.14%)
61 (26.41%)
64 (27.71%)
Age by exam and impression
Increase Decrease Total Other
Age
File number, Clinical_ information and Patient name by Findings
Standard views s...
ventricles are nor...
Mild bone marro...
The maxillary ...
There is norm...
On the two vi...
There is bila...
GH Joint an...
Selected sta...
Note is made ...
The heart, gre...
There is mode...
There are no ...
focal ...
Positive...
The ent...
Some...
Mark...
Mild...
.M...
Th...
The sto...
The ...

Result

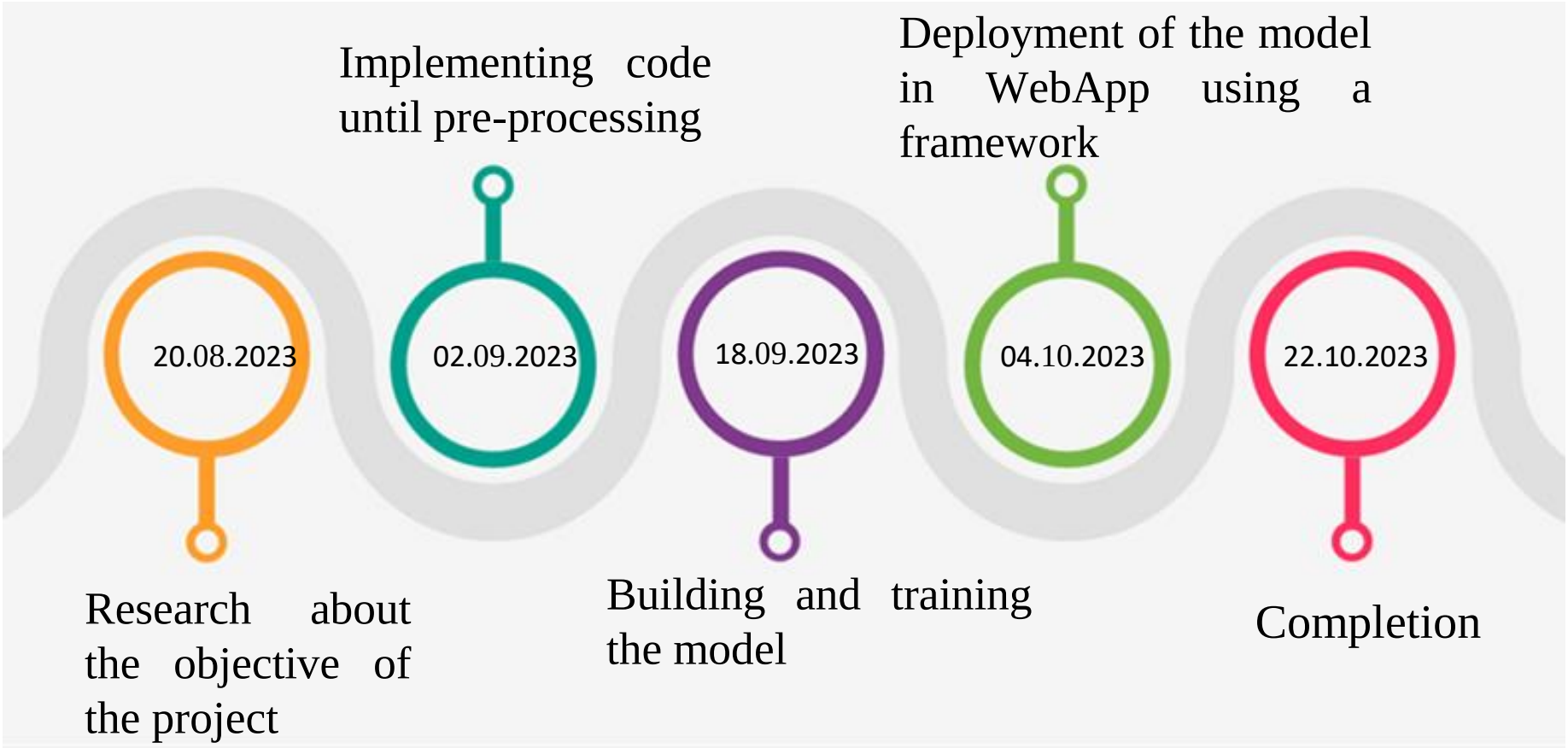

Negation Detection:
('Affirmed', '| Confidence: 78.5079%')
('Negated', '| Confidence: 99.6490%')
('Negated', '| Confidence: 99.6490%')
('Negated', '| Confidence: 99.6490%')
('Affirmed', '| Confidence: 51.8933%')
('Negated', '| Confidence: 99.6490%')
('Negated', '| Confidence: 99.6490%')
('Negated', '| Confidence: 99.6490%')
('Affirmed', '| Confidence: 99.9368%')
('Affirmed', '| Confidence: 99.1371%')
('Affirmed', '| Confidence: 74.0599%')
('Affirmed', '| Confidence: 99.6213%')
('Affirmed', '| Confidence: 99.8946%')
('Negated', '| Confidence: 99.8069%')
('Affirmed', '| Confidence: 94.7827%')
('Negated', '| Confidence: 99.9380%')
('Affirmed', '| Confidence: 97.6163%')
('Affirmed', '| Confidence: 96.6704%')
('Affirmed', '| Confidence: 99.7017%')
('Affirmed', '| Confidence: 99.3382%')
('Affirmed', '| Confidence: 99.5702%')

Result


Chat support
Hi. My name is Art. How can I help you?
Hi there, how can I help?
What examination taken for the patient who came with Lower back pain?
MRI of Lumbar spine
Write a message...
Send

Demo

Timeline of the work



Conclusion

- Our project is to deploy a negation detection model through a Flask-based web interface represents a significant step toward facilitating the understanding of negations in Radiology reports data.
- By enabling users to input text and promptly identify the presence and scope of negations, our application contributes to more accurate diagnosis of the patient's clinical data
- While we have achieved a successful deployment, ongoing work is needed to fine-tune the model for higher accuracy, enhance the user interface for a better experience, and ensure robust performance as user demand grows.

Reference

- https://medium.com/@MansiKukreja/clinical-text-negation-handling-using-negspacy-and-scispacy-233ce69ab2ac#:~:text=Negspacy%20%3A%20spaCy%20pipeline%20object%20for,scope%20of%20the%20trigger%20terms.
- https://paperswithcode.com/task/negation-detection/codeless
- https://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=9179807
- https://www.ajnr.org/content/42/10/1755

Thank you