NLP @ CFILT

Computation for Indian Language Technology

Indian Institute of Technology Bombay
Mumbai

www.cfilt.iitb.ac.in

NLP

IF you have used:

- Autocomplete while typing
- Google Translate
- Siri, Google Assistant, Alexa *etc.*
- **Google Search**

Then

“You have experienced Natural Language Processing (NLP)”

http://www.cfilt.iitb.ac.in (since 2000)

Computation for Indian Language Technology (CFILT) was set up with a generous grant from the Department of Information Technology (DIT), Ministry of Communication and Information Technology, Government of India in 2000 at the Department of Computer Science and Engineering, IIT Bombay. Prior to this the Natural Language Processing (NLP) activity of the CSE Department, IIT Bombay took off in 1996 with a grant from the United Nations University, Tokyo to create a multilingual information exchange system for the web. The project called Universal Networking Language (UNL; www.undl.org) was participated in by 15 research groups across continents.

At any point of time about 30 research members work in CFILT, which includes PhD , masters and bachelor students, faculty members, linguists and lexicographers.

Deep semantics and multilinguality has throughout played a pivotal role in the activities of CFILT. The stress on semantics has led to research in the following fronts:

- **Lexical Resources:** Multilingual wordnets and ontologies and their linking
- **Lexical and Structural Disambiguation:** Resolve word and attachment ambiguities
- **Shallow Parsing:** Identifying correct parts of speech, named entities and non-recursive noun phrases for Marathi and Hindi

Brief Introduction to CFILT

- NLP@IIT Bombay started in 1996
- Work started with support from United Nations University, Tokyo for Universal Networking Language
- The Center was established in 2000
- Four Associated Faculty (Prof. Pushpak Bhattacharyya, Prof. Preethi Jyothi, Prof. Malhar Kulkarni, Prof. Ganesh Ramakrishnan)
- 400~ students graduated (45 PhDs, 350+ masters)
- Many faculty members & Ph.D, M.Tech, B.Tech students and linguists associated with the lab
- Supports courses on Basic NLP and DL for NLP: 250+ enrolment
- Close to 450 publications- ACL, EMNLP, NAACL, AAAI, IJCAI, CL, JMT and such top fora

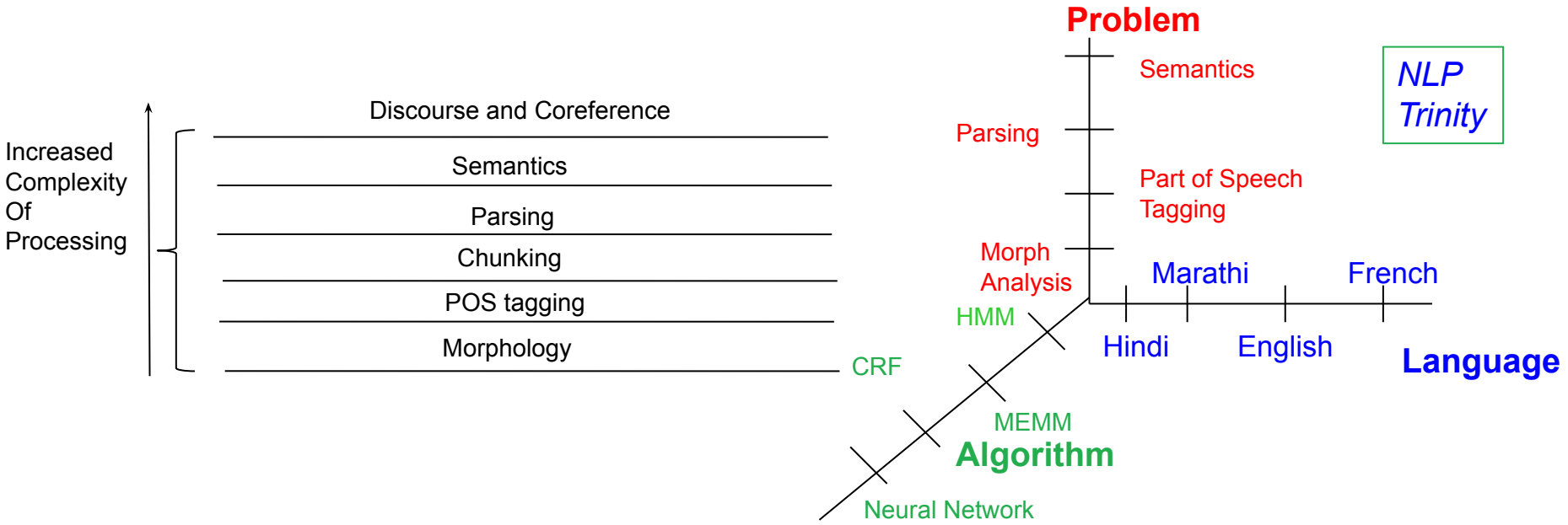
Natural Language Processing

Art, science and technique of making computers understand and generate language

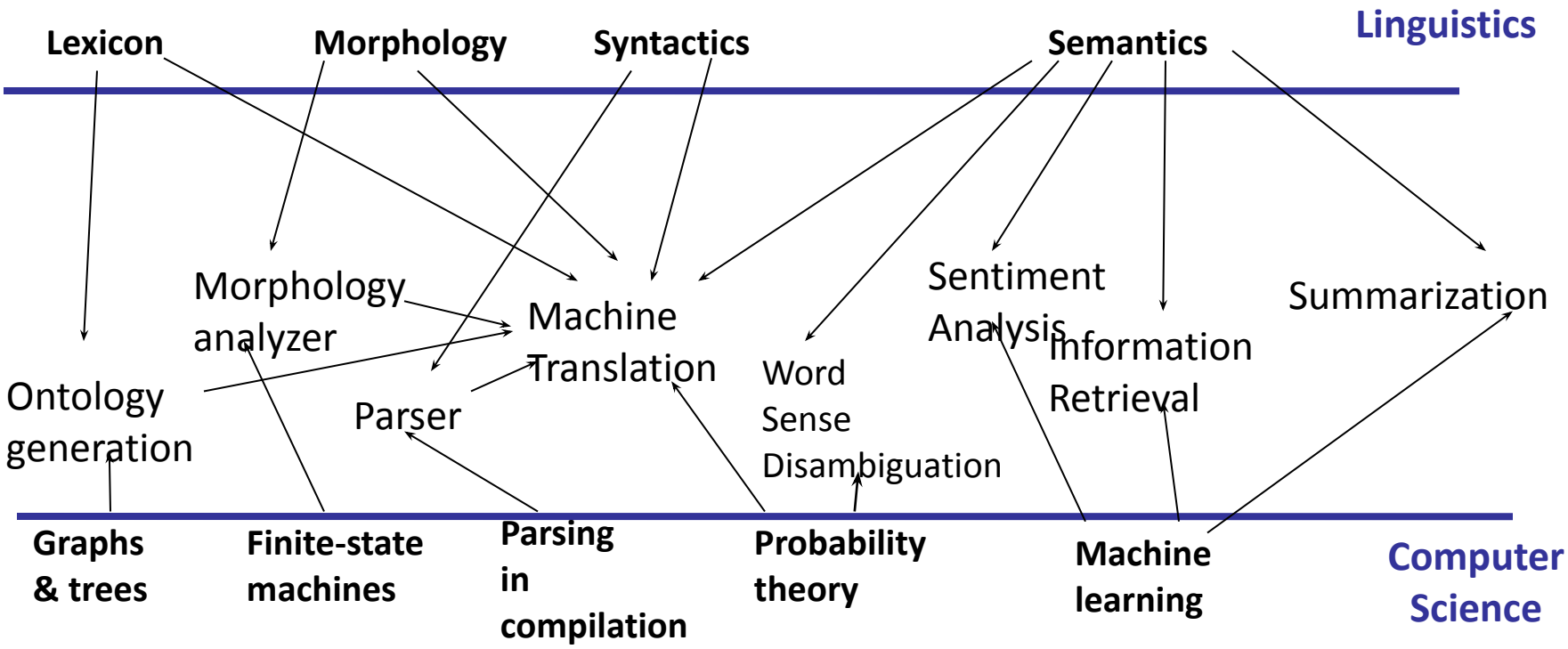
Main Challenge: Ambiguity

- Natural languages are highly ambiguous
  - As opposed to programming languages (formal languages)
- Examples
  - I saw a boy with a telescope.
    - Who has the telescope?
  - *The cat went near the dog, and it bit it.*
    - *who bit whom?*
  - वह पेड़ के नीचे पत्ते खेल रहे थे
    - Is पत्ते leaves of the tree or playing cards ?
  - पूजा ने पूजा से पूजा के लिए फूल खरीदे -> Pooja bought flowers from Pooja for worship?
    - Which पूजा to translate (worship) and which पूजा to transliterate (Pooja)

NLP is Layered Processing, Multidimensional too



NLP: At the confluence of linguistics & computer science



Linguistics is the eye and computation the body

Importance of NLP: a practical situation- Start up on **Call-Center-Analytics**

- A property and casualty insurance company has a call center
- Deal with customer complaints; cannot handle volume
- Call center too cannot! !
  - AUTOMATION called for
    - Automatic Speech Recognition
    - Natural Language Understanding
    - Sentiment
    - Machine Translation
    - Text to Speech conversion

Key Research Areas

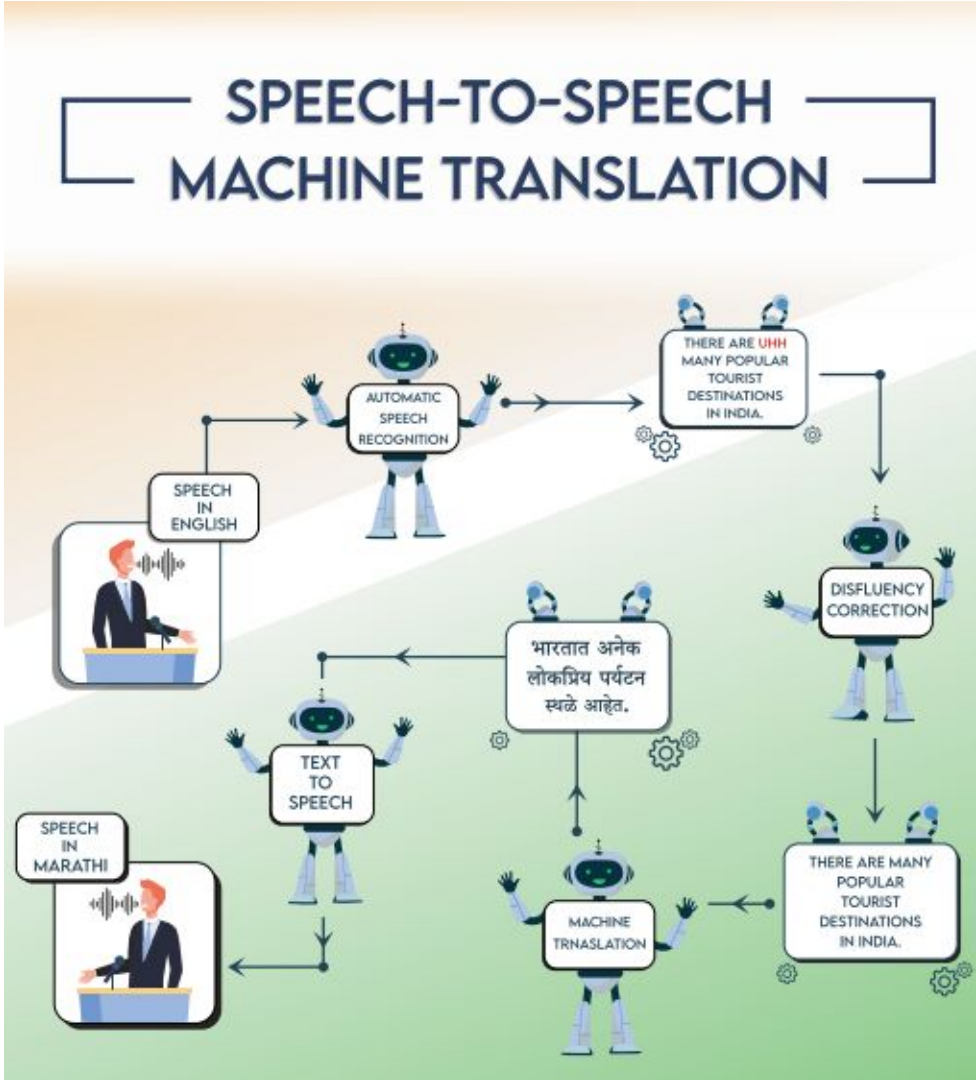
- **Machine Translation**
- **Sentiment Analysis**
- **Information Retrieval**
- **Lexical Semantics**
- **Information Extraction**
- **Cognitive NLP**

Linguistics is the eye and computation the body!

Machine Translation

- Phrase pair injection in NMT (EMNLP 2022)
- Unsupervised Neural Machine Translation for Indian Languages (JMT 2021)
- Filtering Back-Translated Data in Unsupervised NMT (COLING 2020)
- Addressing Word Order Divergence (NAACL 2019)
- Old work on Statistical MT
  - Source Reordering: En-IL, IL-En, various representations (IJCNLP'08)
  - Factor-based: Dependency parse information for generating case markers correctly (ACL'09)
  - Handling morphologically rich languages: unsupervised segmentation (ICON'14)
  - Post-ordering: Mainly for IL-En translation (ICON'15)

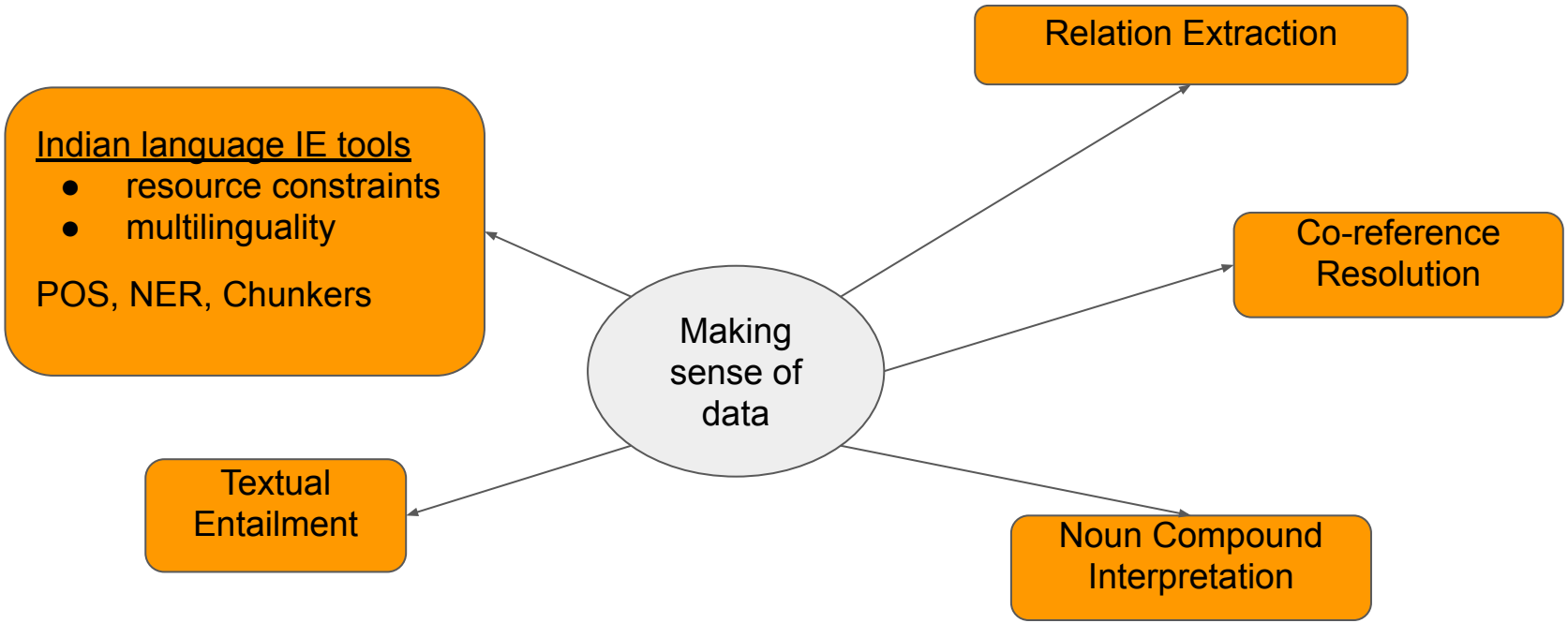
Speech to Speech MT



Lexical Resources

- Indo Wordnet
  - Linked lexical knowledge base of wordnets of various Indian languages
  - It covers 17 Indian languages linked to English WordNet
  - Upto 40k synsets per language
  - IndoWordNet: http://www.cfilt.iitb.ac.in/indowordnet/
  - Data creation, word sense disambiguation
- English-Hindi parallel corpus
- Hindi NER corpus

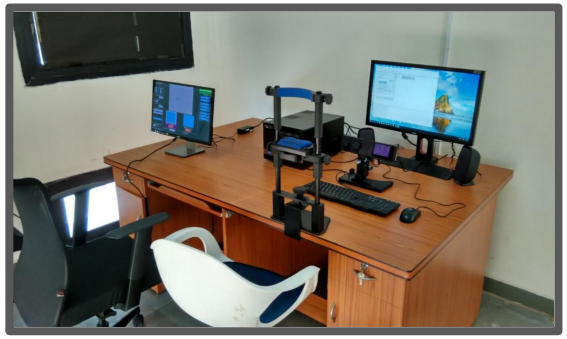
Information Extraction



Sentiment Analysis

- Aspect based sentiment analysis
- Sentiment analysis in cross-lingual and multilingual environment
- Sentiment analysis in code-mixed environments
- Sarcasm detection

Cognitive NLP



Linguistic tasks: Translation, SA, Sarcasm Detection, WSD

Understanding the phenomenon by analyzing Cognitive Information through **Eye-tracking**/~~EEG/Key logging~~

Translating the insights into better NLP/NLU algorithms/systems.

Labeling data with cognitive information for supervised learning

Better feature-engineering for NLP systems

http://www.cfilt.iitb.ac.in/cognitive-nlp/

Research Themes

- Lexical Resources
- Lexical and Structural Disambiguation
- Parsing
- Information retrieval
- Machine Translation
- Textual Entailment
- Cognitive studies
- Sentiment Analysis
- Sarcasm Detection
- Data and Model Bias Detection
- Natural Text Generation
- Text Summarization
- Disfluency Correction
- Neural Reasoning
- Multimodal NLP
- Education Technology

Government Projects

- MEITY: **Bahubhashak-** Speech to Speech Machine Translation involving English and Indian Languages**:** consortium of IITs, IISc, CDAC, Startups
- MEITY: **ISHAAN**: Bidirectional Text-to-Text Machine Translation System between
  - English-Assamese, Bodo, Manipuri, Nepali
  - Hindi-Manipuri
  - Assamese-Bodo
- MEITY: **VIDYAAPATI**: Bidirectional Text-to-Text Machine Translation System between
  - Hindi-Bengali, Konkani, Maithili, Marathi
- MEITY: ***IMPRINT-2 Knowledge Graph for Aircraft Accident Analysis and Monitoring***: Consortium of IITB-IITP-Honeywell
  - Search system cum Question Answering System for aviation safety domain using KG and DL

Earlier Significant Govt. Projects

- MEITY: **HEMAT- Human Aided MT in Judicial Domain**: consortium of IITs, IIITs, CDAC
- MEITY: **Anuvadaksh- English-Indian_Language MT**: consortium of IITs, IIITH, CDAC
- MEITY: **Sampark- Indian_Language-Indian_Language MT**: consortium of IITs, IIITH, CDAC
- MEITY: **Sandhan- Cross Lingual Search in Indian_Languages**: consortium of IITs, IIITH, CDAC
- MEITY: **Indowordnet**: consortium of IITs and Universities
- DST: **Indo Japan Project on MT**: IITB-Kyoto University
- DST: **Indo Russia Project on Deep Semantics and Ontology**: IITB-Russian Science Academy
- United Nations University: **Universal Networking Language**: consortium of Universities across the world

Summary

- Dedicated to overcoming language barrier
- Trying to accomplish by focusing on
  - Lexical resources
  - Multilinguality
  - Low resource constraints
- Tackling a large variety of challenges in NLP
- Diverse set of problems
- Importance given to
  - Cognitive
  - Linguistics
  - Machine Learning

+

“Good Compute Facilities” ;)

Bias Detection

Bias: Definition & Types

Bias is a prejudice in favor of or against an idea, a person, a group or community that is considered unfair. It is of 2 types.

Statistical Bias

Statistical bias is a feature of a statistical technique or of its results whereby the expected value of the results differs from the true underlying quantitative parameter being estimated.

Cognitive Bias

A **cognitive bias** is a systematic pattern of deviation from norm or rationality in judgment. Individuals create their own "subjective reality" from their perception of the input.

Why Bias Detection is necessary?

- AI assisted solutions is a common practice today.
- If the AI model is biased, decision making can be faulty.

Image credit:

-https://gizmodo.com/amazons-secret-ai-hiring-tool-reportedly-penalized-resu-1829649346

-https://www.adweek.com/performance-marketing/seemingly-sexist-ad-targeting-offers-more-men-women-high-paying-executive-jobs-165782/

Race Bias

LGBTQ bias

Bollywood film banned in India over fear of unrest

Aarakshan, a Bollywood film about India's controversial quota system for disadvantaged groups has been banned in three states, for fear that its discriminatory language may cause protests

https://www.theguardian.com/film/2011/aug/12/bollywood-film-ban-india

Eternals banned in Saudi Arabia, Qatar and Kuwait after Disney refuses gay cuts – reports

The Marvel adventure has been pulled from Gulf region markets after sources claim the studio refused to remove a same-sex kiss

Image credit:https://www.theguardian.com/film/2021/nov/04/eternals-banned-middle-east-same-sex-kiss

Religious Bias

Censors Ban "Last Temptation of Christ"

October 25, 1988

https://apnews.com/article/885a94b3a5d50bd6db4bf51bd5579117

Types of Social Biases (1 /4)

1. **Gender bias** : Prejudice towards or against one gender over the other. Relates to gendered role, societal perception and sexist remarks. Binary in nature.
    - **Example** : *It was a very important discovery, one you wouldn't expect from a female astrophysicist*

2. **Race bias**: Prejudice against or towards a group of people having common physical traits, common origins, language etc. It is related to dialect, color, appearance, regional or societal perception.
    - **Example** : *You are just like all the other African American voodoo women, practicing with mumbo Jumbo nonsense*

Types of Social Biases (2 /4)

3. **Religious bias:** Prejudice towards or against individuals or communities on the basis of their respective religion or belief. e.g. Christianity, Islam etc.

    - **Example** : *The crafty Jews made a plan to steal the money so they could become richer and more powerful, they are such greedy people.*

4. **Occupation bias**: Unequal treatment at workplace based on identity, such as, gender, race, sex etc. It can be related to economic bias, administrative bias or societal perception.

    - **Example** : *EDWARD: I hate to point out the obvious, but you are, in fact, a hooker!*

Types of Social Biases (3 /4)

5. **Ageism bias**: Discrimination based on age. It appears as societal perception, and comments on physical features or behaviour.
    - **Example** : *We were especially upset that there were so many gross old people at the beach.*

6. **LGBTQ bias**: Bias towards LGBTQ community. It can be due to societal perception or physical appearance
    - **Example** : *I mean, perform fellatio once and you're a poet, twice and you're a homosexual.*

Types of Social Biases (4 /4)

7. **Other biases:** Miscellaneous category of all other type of biases.

- Personality bias *e.g. my boss is like a Hitler.*
- Body shaming e.g. *PRINCE CHARMING: Mabel, remember how you couldn't get your little fat foot into that tiny glass slipper?*
- Mental disability e.g. *she was a flake.*
- Physical Disability e.g. *TOFFEL: A one-armed machinist, Oskar?*

Computational Part: Automatic Bias Detection

Hierarchical Approach

1) Binary: biased or not

2)If biased, detect category

3)Target group and rationale

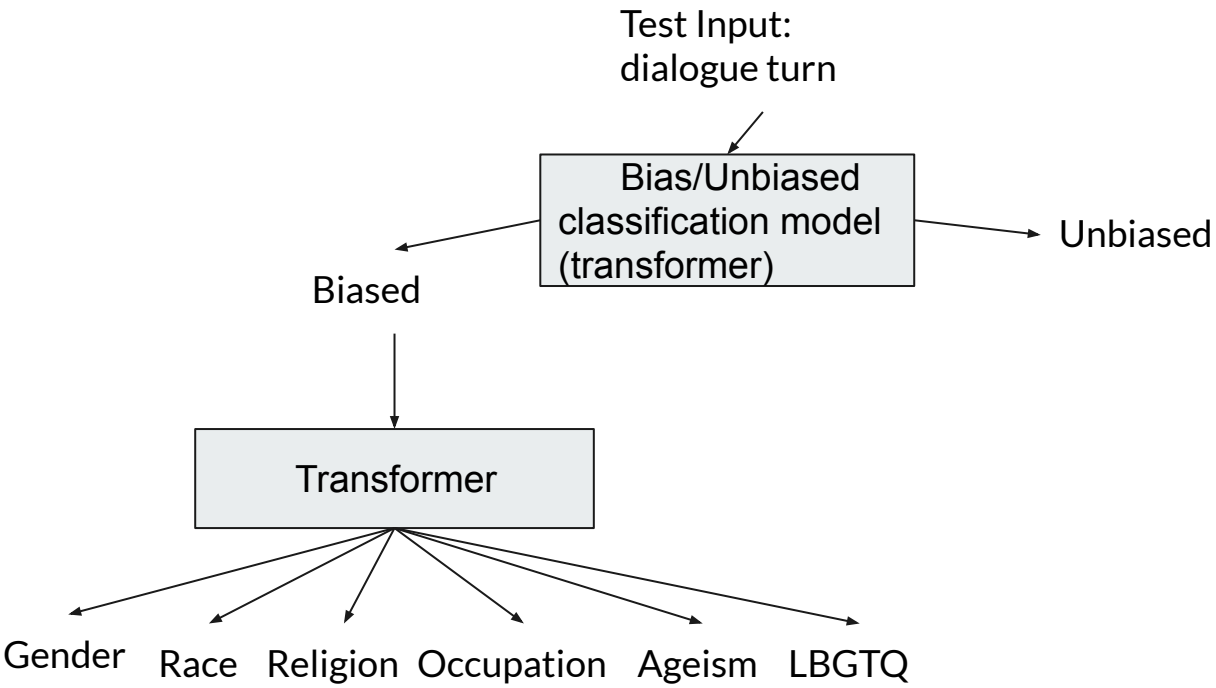
Example : We shouldn't lower our standards just to hire more woman

Bias - Yes

Bias Category - Gender

Target group - women
Rationale - women are less qualified

Process


Test Input:
dialogue turn
Bias/Unbiased
classification model
(transformer)
Unbiased
Biased
Transformer
Gender
Race
Religion
Occupation
Ageism
LBGTQ

Results and Error Analysis (2 /2)

Sentence	Ground Truth	Predicted
LT: If you think you're not getting on this bus, you're dead wrong. No fucking way are you gonna miss this bus, man! You were probably the kind of kids who had your father drive you to school cause you couldn't catch the fucking bus. But no more, man. You're getting on this bus and you're taking it to the last fucking stop. So get on the fucking bus, man, 'cause you're life ain't worth shit in this town.	Unbias	Bias
NEGRO WOMAN: You talk to the man nice now, hear? He's going to help you.	Unbias	Bias
GUIDE: You think you're tough? I got a son twice your size and I can still handle him.	Unbias	Bias
NAKIA: I would make a great queen because I am so stubborn .	Bias	Unbias
OKOYE: Let us consider that we heal him. It is his duty to report back to his country. And as King, it is your duty to protect ours.	Bias	Unbias

Results and Error Analysis (1 /2)

Sentence	Ground Truth	Predicted
KLAUE: You know, you really shouldn ' t trust the Wakandans. I'm much more your speed.	Bias	Bias
KRISHNA: No way! You're a bloody Muslim. Get away from me!	Bias	Bias
BRANDON: This is some bullshit. Yall not even the real police. You way too cute to be a cop anyway...	Bias	Bias
DONKEY: This is gonna be fun! We can stay up late, swappin' manly stories, and in the mornin' I'm makin' waffles.	Unbias	Unbias
DONKEY: (singing) On the road again. Sing it with me, Shrek. I can't wait to get on the road again.	Unbias	Unbias

Image Caption Generation

Problem Definition (1/3)

- **Image Captioning:**
  - Describe the image features using natural language.

Image source: Vinyals, Oriol et al. “Show and tell: A neural image caption generator.” 2015 IEEE Conference on Computer Vision and Pattern Recognition (CVPR) (2015)

Problem Definition (2/3)

- **Context Assisted Image Captioning:**

  - **Aim**: To develop a model that can generate captions for a given image as a function of the image and its context.

  - **Input**: Image + News article that contains the image
  - **Output**: A caption that includes information from both the image and the news article.

Problem Definition (3/3)

- **Example:**

Context: A day after banks remained closed on account of Guru Nanak Jayanti, Mumbaikars on Tuesday again thronged banks and ATMs and were seen making a beeline for exchanging their old currency notes and withdrawing cash as the old Rs. 500 and Rs. 1000 had been demonetized.

Caption: Mumbaikars standing in a long queue to exchange old demonetized currency notes.

Context: It has been ten days since the Reliance Jio SIMs have been made available for purchase for all, however, the sheer demand has exceeded supply. That has not deterred people from trying to get their hands on the cheapest 4G service in the country. This morning, we found a fairly large line outside a Reliance Digital Mini store, which only grew as time passed.

Caption: People standing in a long queue outside Reliance Digital Mini store to get Jio 4G SIM to avail cheap 4G services.

Image source: http://www.ptinews.com/news/8078714_Demonetisation--Qs-outside-banks--ATMs-continue-nbsp

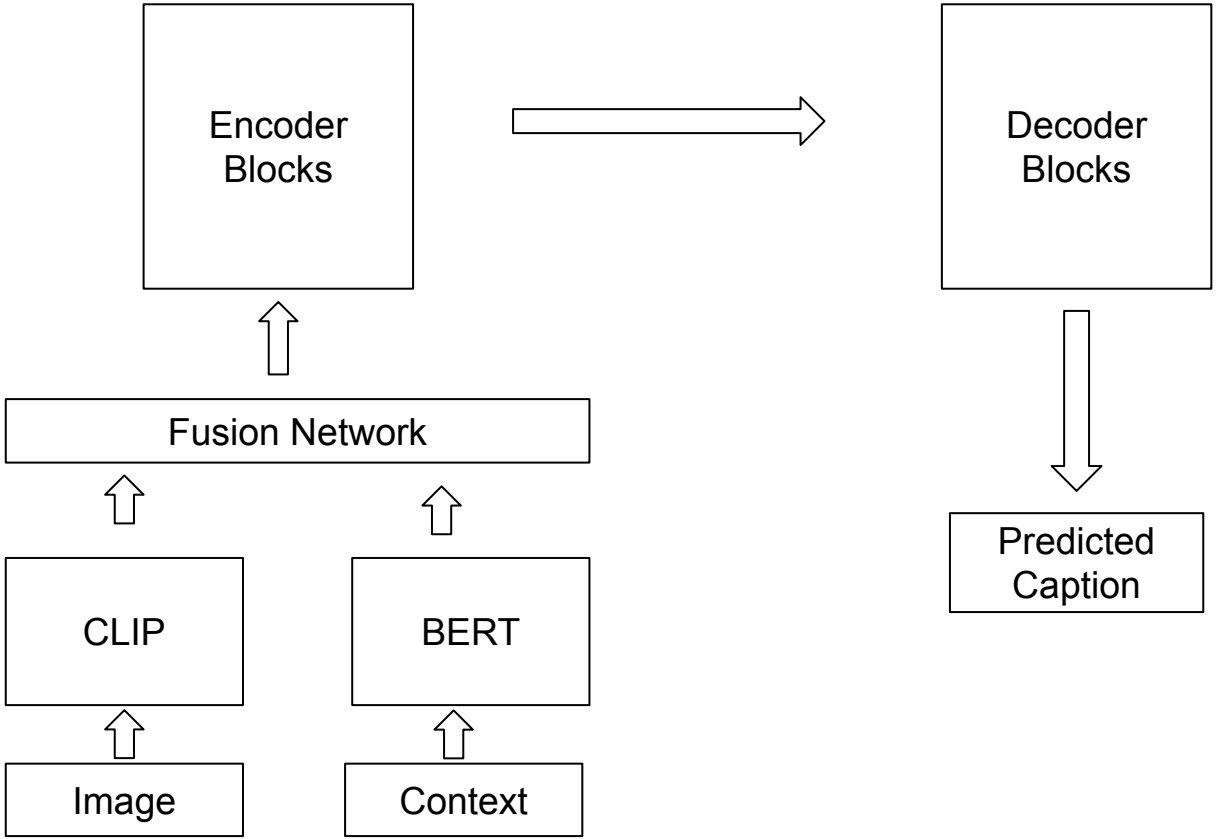
Motivation and Application

- An image can be better understood with its surrounding context.

Are the people in the picture on vacation or are they being escorted out for defrauding banks?

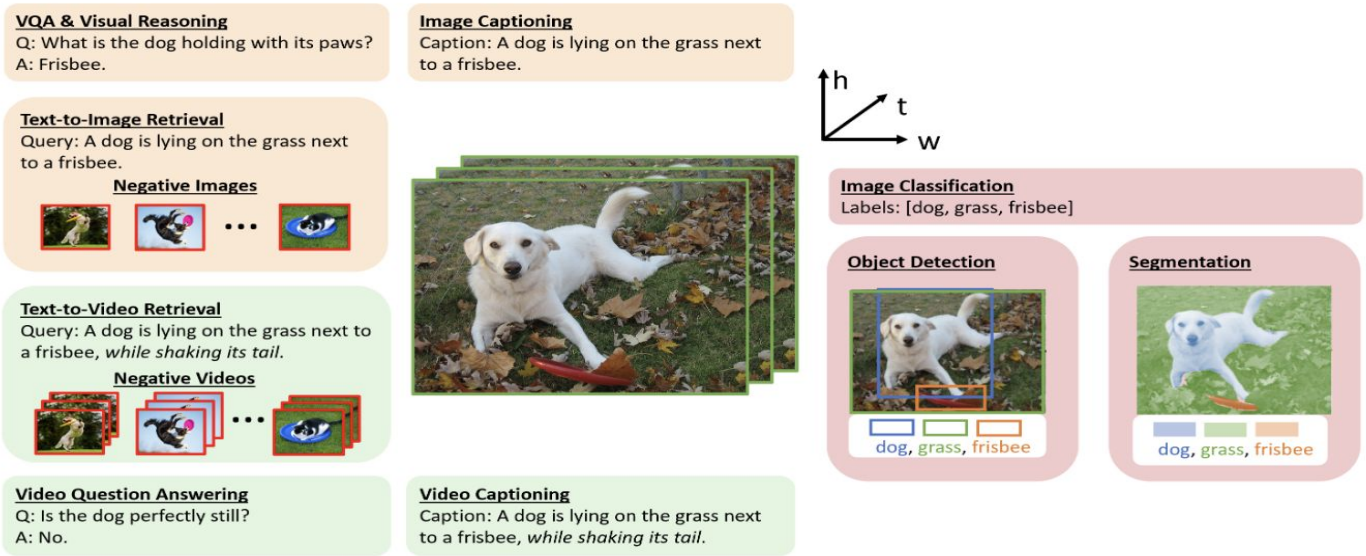
- **Applications:**
  - News Image Captioning
  - Captions in personalized documents

Early Approach

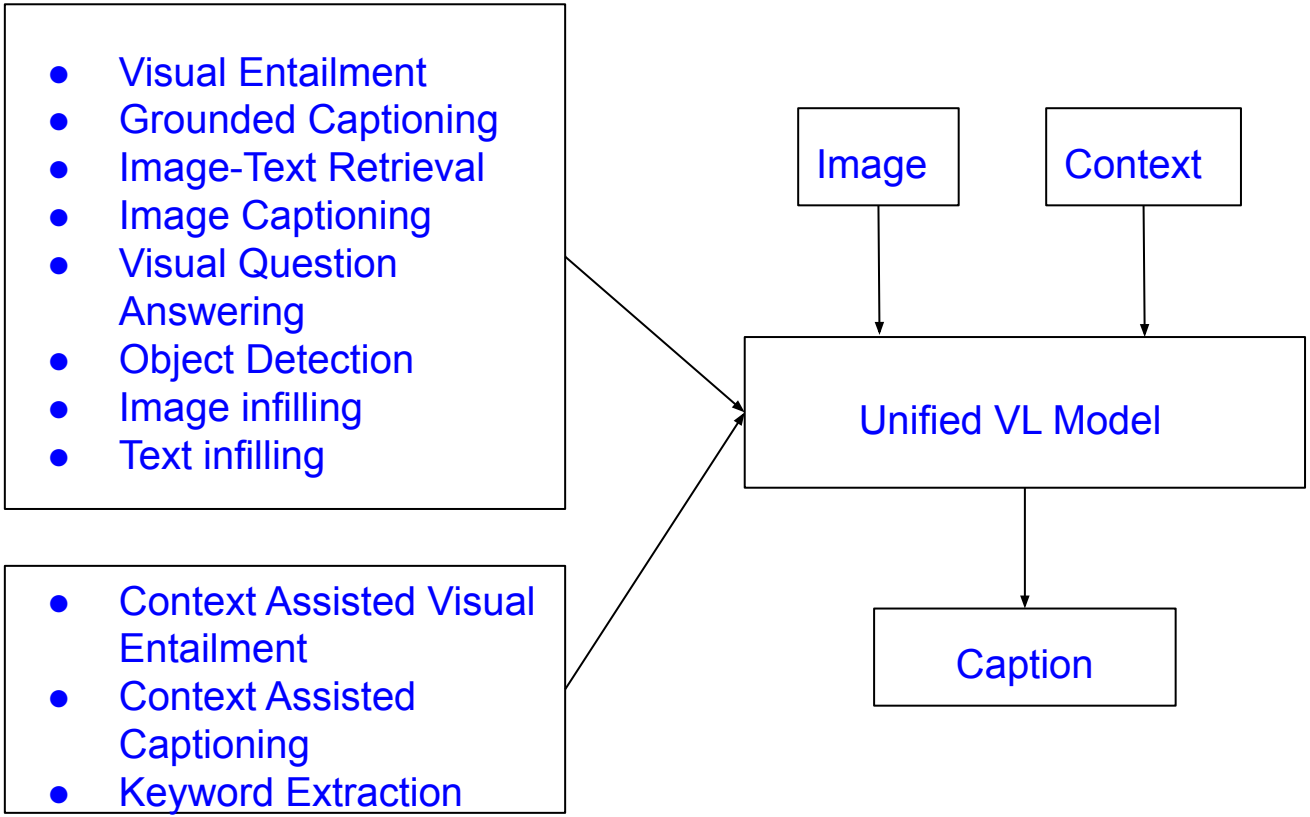


Vision-Language Pretraining

- Train Models on large scale image-text corpus.
- VL pretraining helps in Vision-only, Language-only, and Vision-Language tasks.
- The knowledge gained in one task helps other tasks.



Unified VL Pretrainining for Context Assisted Image Captioning



Challenge: Disambiguating Named Entities

- A named entity can occur in different forms.
    - Eg: “Obama, Barack Obama, President Obama” denotes the same person.
    - During training, the model might learn different representations for the same named entity.

- Solution: Named Entity Linking
    - The task of linking different forms of named entities to a data source.
    - Link all named entities to an external knowledge repository like wikidata.
    - Named entities will be represented by the unique id in the data repository.
    - For example, “Obama” will be replaced by the id “Q76”.

Results

- Our Unified VL model generates very informative captions.
- It achieves **65.1** CIDEr score which is better than the current SOTA 61.22 on the GoodNews dataset.
- It achieves **27.16** F1-score on named entity prediction.

Examples (1/2)

Context:
Diana Douglas an actress for six decades and a model who was Kirk Douglass first wife and Michael Douglass mother has died in Los Angeles. She was 92. The cause was cancer, according to Michael Douglass production company Furthur Films citing Ms Douglass husband Donald A Webster Sources vary as to whether she died on Friday or SaturdayBorn Diana Love Dill on Jan 22 1923 in Bermuda where her father was the attorney general. Ms Douglas moved to New York and met Kirk Douglas while they were both studying at the American Academy of Dramatic Arts. She later went to California on a 200 a week contract with Warner Bros against Mr Douglass advice.

Generated Caption:

Ms Douglas with her husband Kirk Douglas in an undated photograph

Examples (2/2)

Context:
Los Angeles: As people began to digest the Republican health care plan on Tuesday a few things became clear. This isnt an Obamacare repeal its a Medicaid repeal as the political writer Jonathan Allen put it. Many Republicans have long viewed Medicaid a health insurance program for the poor the disabled and some elderly with skepticism. This plan would make very large cuts to the program. The details are somewhat technical and Edwin Park of the Center on Budget and Policy Priorities explains them. But the realworld effects will be concrete. Many people will lose coverage and some kinds of care if the bill becomes law.

Generated Caption:
Demonstrators in Los Angeles protested the Republican health care bill.

Text Summarization

Problem Definition (1/2)

Document

String pool is nothing but a storage area in Java heap where string literals stores. It is also known as String Intern Pool or String Constant Pool. It is just like object allocation. By default, it is empty and privately maintained by the Java String class. Whenever we create a string the string object occupies some space in the heap memory. Creating a number of strings may increase the cost and memory too which may reduce the performance also. The JVM performs some steps during the initialization of string literals that increase the performance and decrease the memory load. To decrease the number of String objects created in the JVM the String class keeps a pool of strings. When we create a string literal, the JVM first check that literal in the String pool. If the literal is already present in the pool, it returns a reference to the pooled instance. If the literal is not present in the pool, a new String object takes place in the String pool.

Query

What is String Pool in Java?

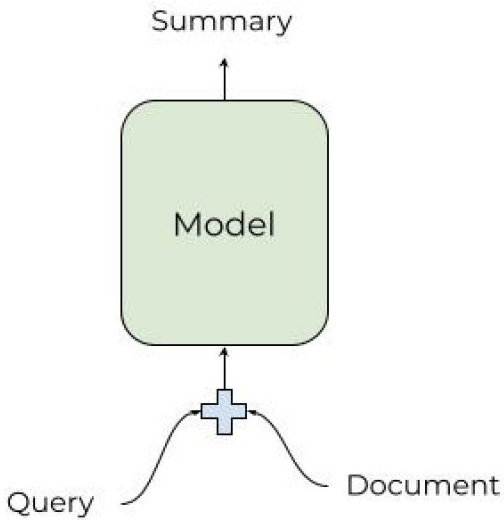
Summary

String Pool is specific area in the memory allocated to the process used to store String literal declared within Java program. It is used to reduce the memory footprint of a Java program.

Problem Definition (2/2)

- Aims at *summarizing* a document, given a *query*

- Input → Query + Document
- Output → Summary



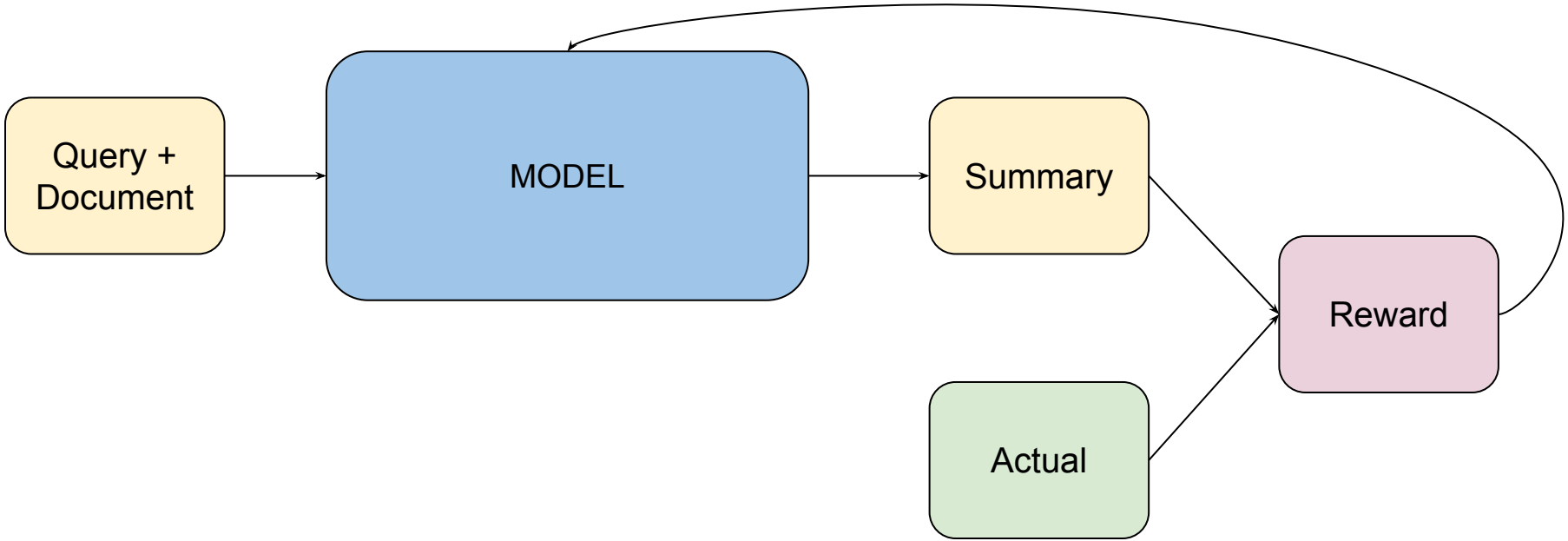
Motivation and Application

- Helps querying a large document to get not just factoid information, but also lengthy, subjective information!!

- Applications-
  - Doubt resolvers for students
  - Extracting targeted reports from documents (financial, legal, etc)

Approach

$$y^* = \text{argmax}\,[P\,(y \mid q, x)]$$



Rewards

- What rewards do we use?
  - ROUGE:
    - Recall oriented reward
    - How much of the human written summary is generated by the model?
  - BLEU:
    - Precision oriented reward
    - How much of the generated summary actually matches the human written summary?

Challenges

String Pool is specific area in the memory allocated to the process used to store String literal declared within Java program. It is used to reduce the memory footprint of a Java program.

String literals specified in Java programmes are stored in a particular section of memory designated as the String Pool. A Java program's memory footprint is decreased using it.

- Lexical matching- not optimal way to reward?
- How to match semantically similar (lexically different) summaries?

Example (1/2)

Discipline is the obedience to organisational rules and employment agreement which are necessary for the working of the organisation. According to Fayol, discipline requires good superiors at all levels, clear and fair agreements and judicious application of penalties. Suppose management and labour union have entered into an agreement whereby workers have agreed to put in extra hours without any additional payment to revive the company out of loss. In return the management has promised to increase wages of the workers when this mission is accomplished. Here discipline when applied would mean that the workers and management both honour their commitments without any prejudice towards one another.

According to Fayol there should be one and only one boss for every individual employee. If an employee gets orders from two superiors at the same time the principle of unity of command is violated. The principle of unity of command states that each participant in a formal organisation should receive orders from and be responsible to only one superior. Fayol gave a lot of importance to this principle. He felt that if this principle is violated “authority is undermined, discipline is in jeopardy, order disturbed and stability threatened”. The principle resembles military organisation. Dual subordination should be avoided. This is to prevent confusion regarding tasks to be done. Suppose a sales person is asked to clinch a deal with a buyer and is allowed to give 10% discount by the marketing manager. But finance department tells her/him not to offer more than 5% discount. Now there is no unity of command. This can be avoided if there is coordination between various departments.

Example (2/2)

Query → How is the Principle of 'Unity of Command' useful to management?

Summary → According to Fayol there should be one and only one boss for every individual employee. If an employee gets orders from two superiors at the same time the *principle of unity of command is violated*. This can be avoided if there is coordination between various departments. Suppose a sales person is asked to clinch a deal with a buyer and is allowed to give 10% discount by the marketing manager. But finance department tells her/him not to offer more than 5% in order to ensure that the buyer is satisfied with the price of the product and hence the customer will pay less than the advertised price. There is a contradiction between the orders given to the salesperson and the instructions issued to him/her by his/her superiors in the finance and marketing departments which is called 'dual subordination'. It is impossible to achieve the desired result without the coordination of different departments in a formal organisational structure. Dual subordinating is not a good idea in an organisation that is hierarchical and hierarchies are necessary for organisation to function efficiently and effectively.

Automatic Radiology Report Generation

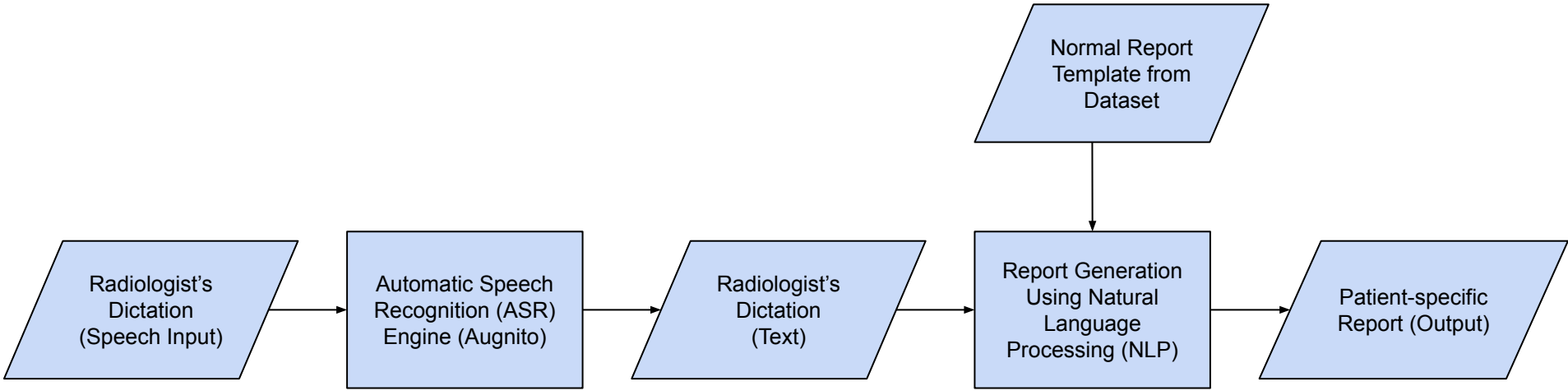
Current Radiology Workflow

- Conventionally, radiologists prepare the diagnosis notes by either dictating on a voice recording device or by writing it on paper.
- The notes are then shared with the transcriptionist.
- The transcriptionist converts the notes into a preliminary formatted report either by listening to the dictation or referring to the written notes.
- The preliminary report is passed back to the radiologist for review.
- The radiologist reviews the report, corrects the errors and finally signs off.
- At last, the final report is made available to a clinician or a patient for further possible treatment.

Motivation and Challenges

- Radiologist to Patient ratio in India is, 1:100,000, the corresponding ratio in the US is 1:10,000, and for China, it is 1:14,772.
- It results in very high patient inflows, making radiologists incredibly busy and stressed out.
- Currently adopted workflow causes
  - significant delays in report turnaround time,
  - errors in the reports, and
  - burnout.

Workflow


Normal Report Template from Dataset
Radiologist's Dictation (Speech Input)
Automatic Speech Recognition (ASR) Engine (Augnito)
Radiologist's Dictation (Text)
Report Generation Using Natural Language Processing (NLP)
Patient-specific Report (Output)

Problem Statement 1 (pertains to Ultrasound)

Design a system that generates a structured patient-specific report from radiologist's dictation and domain knowledge.

- **Input**
  1. Input text (radiologist's dictation)
  2. Generic radiology report with all normal findings (normal report template)
- **Output**
  1. Radiology report with patient-specific findings

Domain knowledge comes from the Knowledge Graph (KG).

Sub-Problem:

Develop a system that automatically constructs a KG of essential medical information from radiology free-text reports.

- **Input:** Radiology free-text report corpus
- **Output:** A formalized representation of the essential medical information contained within the free-text reports in the form of a hierarchical KG

Male Abdomen Pelvis Normal Report Template

Liver is normal in size and echotexture. No focal areas of altered echotexture or mass lesion. No intrahepatic biliary radicles dilatation seen. Portal vein appears normal. Portal vein measures _. common duct at porta measures _ .

Gall bladder is physiologically distended reveals normal wall thickness. No evidence of calculi/calculus or sludge or polyp.

Spleen is normal in size with normal echotexture. The contours are smooth. The splenic vein and portal vein are normal in caliber.

Pancreas appears normal in size and echotexture.

Right Kidney measures _ x _. Left Kidney measures _ x _. Both the kidneys are normal in position, size, shape and contour. Cortical echogenicity is normal, corticomedullary differentiation is well maintained. No obvious calculus or mass is seen. No hydronephrosis noted.

Ureters are not dilated.

Urinary bladder appears normal. Wall thickness is normal. No evidence of calculus or mass is seen. Pre void is _ cc. Post void is _ cc.

The prostate is normal in size and echotexture measuring _.

Example of Normal Report and Patient Specific Report

Male Abdomen Pelvis Ultrasound Report

Liver shows moderate increase in echogenicity. No focal areas of altered echotexture or mass lesion. No intrahepatic biliary radicles dilatation seen. Portal vein appears normal. Portal vein measures _. common duct at porta measures _ .

Gallbladder is distended reveals wall thickening. feature of note is presence of a calculus measuring 3 mm noted in lumen of gallbladder.

Spleen is normal in size with normal echotexture. The contours are smooth. The splenic vein and portal vein are normal in caliber.

Pancreas is slightly small, reveals thin inhomogenous paranchyma. the pancreatic duct is dilated.

Right Kidney measures _ x _. Left Kidney measures _ x _. Both the kidneys are normal in position, size, shape and contour. Cortical echogenicity is normal, corticomedullary differentiation is well maintained. No obvious calculus or mass is seen. No hydronephrosis noted.

Ureters are not dilated.

Urinary bladder appears normal. Wall thickness is normal. No evidence of calculus or mass is seen. Pre void is _ cc. Post void is _ cc.

The prostate is normal in size and echotexture measuring _.

Impression:

i) chronic pancreatitis, ii) cholecystitis and iii) grade ii fatty liver

Problem Statement 2 (pertains to X-ray)

Design a system that generates a structured patient-specific report from radiology image, image tags (findings expressed in the image as per the radiologist) and domain knowledge.

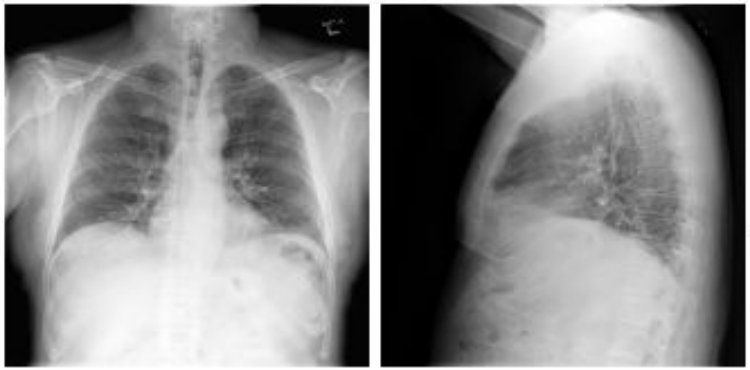
- **Input**
    1. Radiology images
    2. Tags
- **Output**
    1. Radiology report with patient-specific findings

Domain knowledge comes from the Knowledge Graph.

X-ray Report Generation- Input & Output

Input

Frontal Image **Lateral Image**



Tags: Pulmonary Atelectasis, base, Spondylosis, thoracic vertebrae, Arthritis, cervical vertebrae

Output: Report

Findings:
The cardiac contours are normal. Basilar atelectasis. The lungs are clear. Thoracic spondylosis. Lower cervical arthritis.

Impression:
Basilar atelectasis. No confluent lobar consolidation or pleural effusion.

Examples of Radiologist's Dictation and Pathological Description

1. **Radiologist's dictation:** *Chronic pancreatitis.*

   Pathological description: *Pancreas is slightly small, reveals thin inhomogenous parenchyma. The pancreatic duct is dilated.*

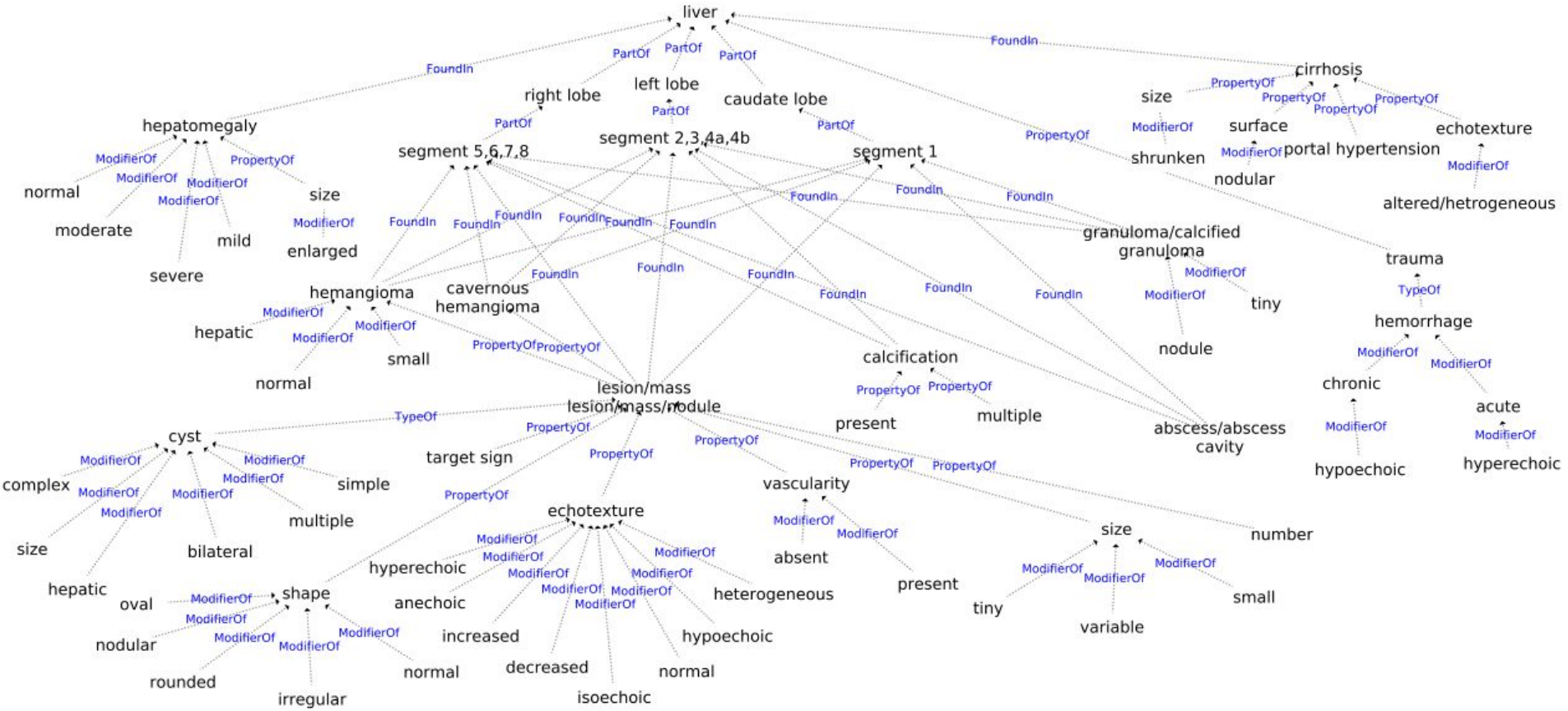
2. **Radiologist's dictation:** *Cholecystitis with 3 mm gallbladder calculus in lumen.*

   Pathological description: *Gallbladder is distended reveals wall thickening. Feature of note is presence of a calculus measuring 3 mm noted in lumen of gallbladder.*

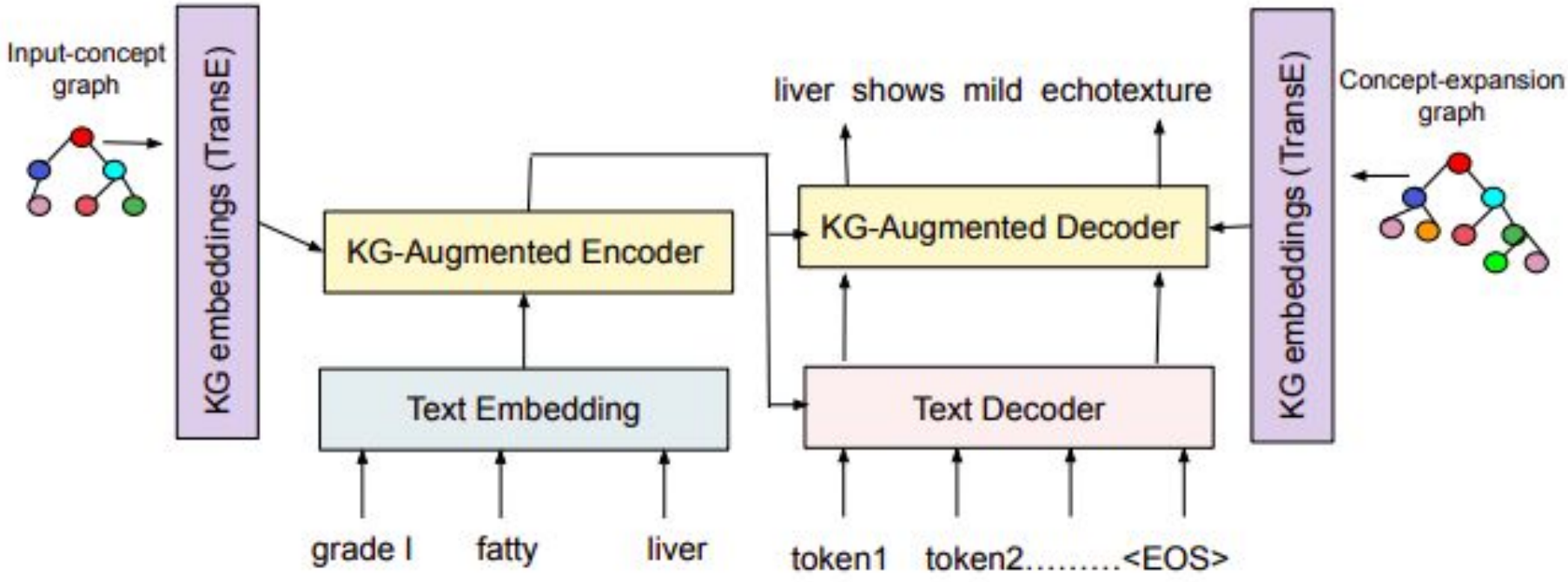
3. **Radiologist's dictation:** *Grade ii fatty liver.*

   Pathological description: *Liver shows moderate increase in echogenicity.*

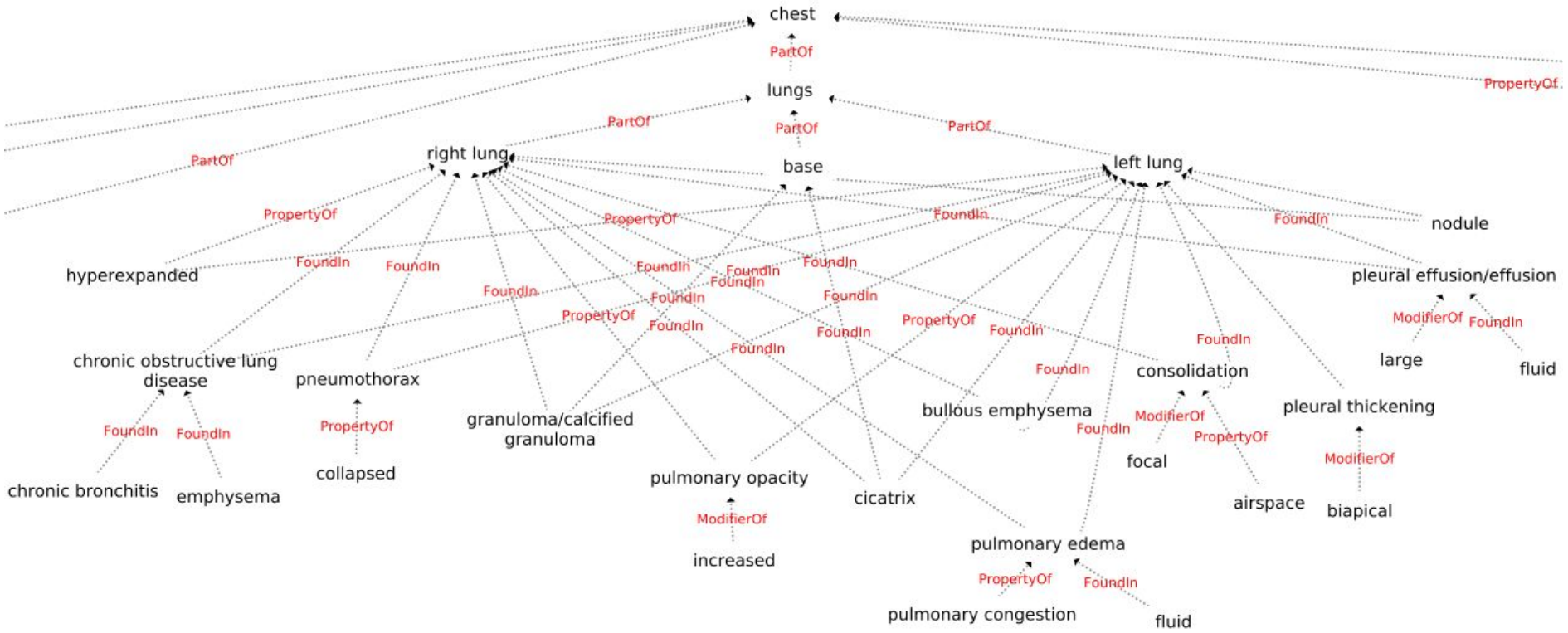
Liver Ultrasound KG



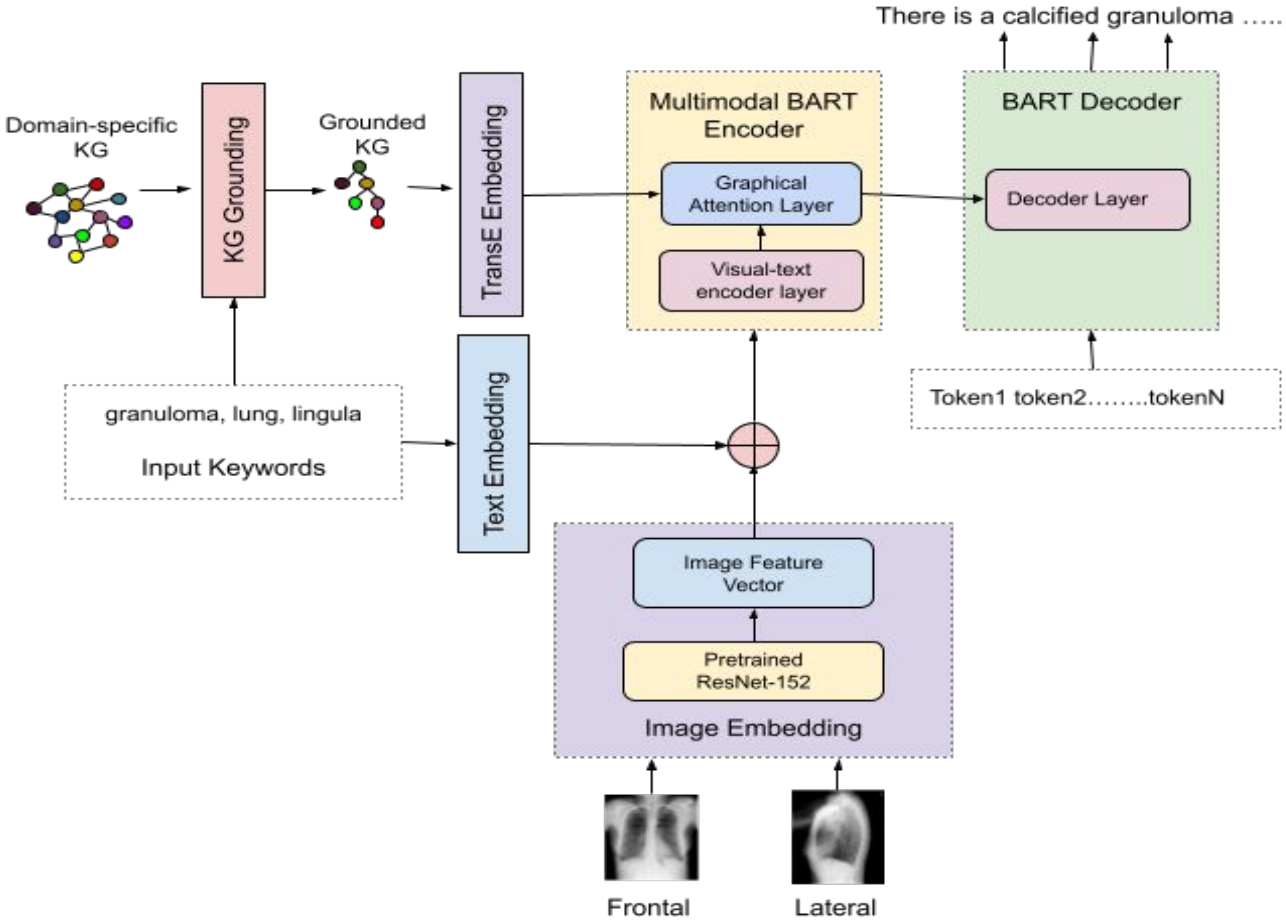
KG-BART (Ultrasound)



Chest X-ray KG



KGVL-BART (X-ray)



National Language Translation Mission (NLTM)

NLTM: Aim and Objectives

- Aim: To develop Machine Translation system for all directions between scheduled Indian languages.
- Objectives:
  - To build a National Public Digital Platform for Indian languages
  - To provide universal access to digital content
  - Creation of a knowledge-based society where information is freely and readily available
  - Create an ecosystem for “Aatmanirbhar Bharat”

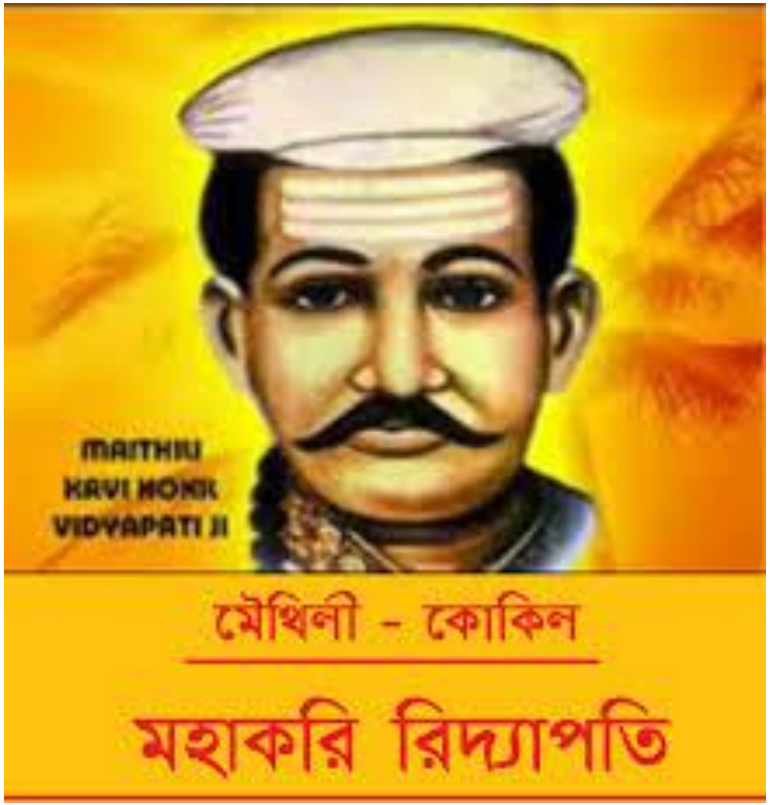
NLTM Projects

VIDYAAPATI	ISHAAN
IIT Bombay (Consortium Leader)	
Jadavpur University	Gauhati University
Indian Statistical Institute	NIT Silchar
Goa University	IIIT Manipur
IIT Patna	University of North Bengal
CDAC Kolkata	IIIT Hyderabad
CDAC Pune	
Jawaharlal Nehru University	

Chief Investigator:- Prof. Pushpak Bhattacharyya

VIDYAAPATI

(Hindi-Bengali, Konkani, Maithili, Marathi MT)



जय जय भैरवि

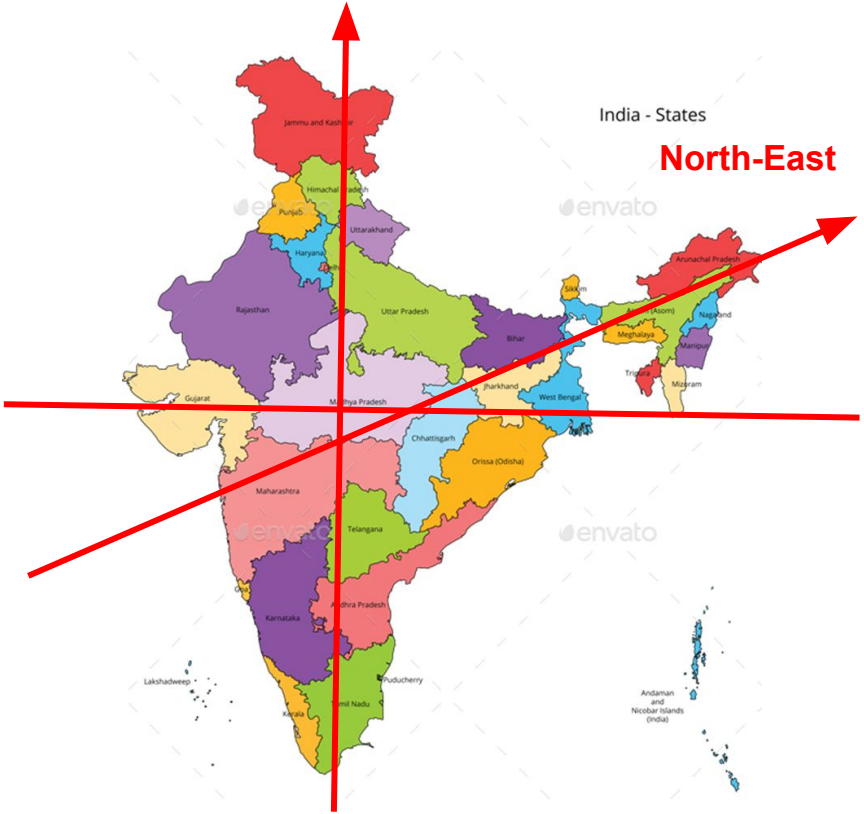
जय जय भैरवि असुरभयावनि
पसुपतिभामिनि माया ।
सहजसुमतिवर दियहु गोसाइनि
अनुगतगति तुअ पाया ॥ १
वासररैनशवासनशोभित-
चरणचन्द्रमणिचूडा ।
कँटकदैत्य मारि मुख में लेल
कटउ उँगली करि कुडा ॥ २
सागरवरननयन अनुरञ्जित
जलदजोगफल कोंका ।
कटकटविकट होंठ फरकटलि
सिन्धूर फेन उठि फोंका ॥ ३
घनघनघनन घुँघरु कट बाजत
हनहन कर तुअ काटा ।
विद्यापति कवि तुअ पदसेवक
पुत्रबिसारि जनि माता ॥ ४

VIDYAAPATI: Languages and Linguistics

- Bengali: Indo Aryan (IA)- evolved from Magadhi Prakrit and Sanskrit- 5th in the world in terms of speaker population (300 million)
- Konkani: IA with influence of Marathi, Kannad, Portugese, English- speaker population 30 million
- Marathi: IA with Dravidian influence- 10th in terms of speaker population (83 million)
- Maithili: IA- 30 million (script- both brahmi and Devanagari)

ISHAAN

- **ISHAAN:** A System for Bidirectional Machine Translation Between
  - English-Assamese
  - English-Bodo
  - Assamese-Bodo
  - English-Manipuri
  - Hindi-Manipuri
  - English-Nepali



ISHAAN: Languages and Linguistics

- Assamese: Indo Aryan- spoken in Assam (15 million as per 2011 census)
- Bodo: Sino Tibetan- co-official language of Assam (1.2 million)
- Manipuri (also called Meiteilon): Central Tibeto Burman- spoken in Manipur (1.3 million)
- Nepali: Indo Aryan (lot of similarity with Hindi)- spoken in Nepal, Sikkim, North Bengal, NE states (2 million speakers)

Deliverables

- Bidirectional MT systems between language pairs of interest
- Mobile App, Web-service, and APIs of the MT systems
- Parallel Corpora of each language pair
- MW, NER and POS tagged corpus of 25K sentences in each language
- Releasing code, data and models in open-source
- Evaluation metrics and framework
- Deployment strategy in language technology

NLTM-Bahubhashak

- Bahubhashak: A pilot NLTM project
- Primary Language Pair: English-Marathi
- Bidirectional Text-to-Text MT Systems developed:
  - English-Marathi
  - English-Hindi
  - Hindi-Marathi

- BLEU score comparison of the English-Marathi MT systems from the BHASHINI on the FLORES test set:
  - IITB: 16.91
  - Google: 20.16
  - Bing: 18.34

Achievements in Bahubhashak Pilot (1/2)

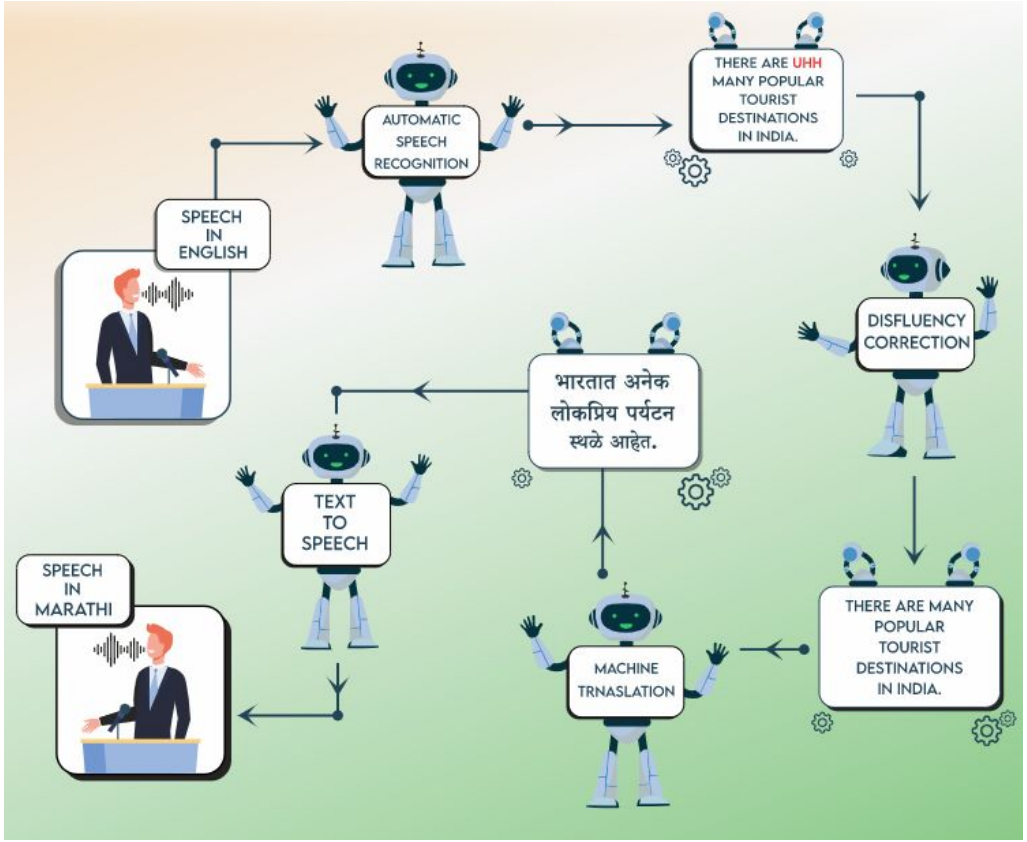
- English-Marathi MT system is developed using advanced NMT techniques.
- BLEU scores of the MT systems across various domains are in the range of: English-Marathi: 15-27, Marathi-English: 23-31, Hindi-Marathi (Hindi is a pivot): 15-35.
- A parallel corpus of around 60L parallel sentences has been collected through various resources. The LaBSE technique is used to select good sentence pairs.
- Startups have translated and submitted more than 1.3 lakh sentences from English to Marathi.

Achievements in Bahubhashak Pilot (2/2)

- A MT web-service is in place. The APIs are integrated on IIITH Canvas web-service.
- Disfluency correction system for English with BLEU score of 95.01
- Development of English ASR and Marathi Text-to-Speech (TTS) system.
- Maharashtra State Innovation Society onboarded for pan Maharashtra rollout.
- Onboarded DKTE Society's Textile and Engineering College for the beta launch of the college reach-out process in Maharashtra.
- **IITB Speech-to-Speech MT (SSMT) web-service for English-Marathi, English-Hindi and Hindi-Marathi directions.**

IITB SSMT System

- Components:
  - ASR: CLSRIL-23 model by Vakyansh
  - DC: Binary token classification using BERT-based model
  - NMT: Transformer-based NMT system with embellishments
  - TTS: ForwardTacotron model and CARGAN vocoder



Industry Projects

- LG**: Dialogue State Tracking in Conversational AI**
  - Determining at each turn of dialogue what the user wants
- Honeywell: **Knowledge Graph and DL for Question Answering**
- Erosnow: **Automatic Movie Script Generation**
- IBM: **AI Horizon Projects in MT, Sarcasm detection, Explainability**
- CDOT: **Multilingual Sentiment and Emotion Analysis**
- Google Research: **Indian Language Embedding and Application to Morphology Analysis**
- Scribetech: **Radiologist Productivity Improvement (Abdul Kalam Fellowship Project)**
- Accenture: **Bias Detection in Movie Scripts**
- FreshGravity: **Adverse Drug Reaction Detection**
- Viacomm: **ASR and MT for subtitling**

Earlier Significant Industry Projects

- BluePool (an offshoot of BNP Paribas): **Financial Sentiment Analysis**
- Yahoo: **Information Extraction from Cricket Commentaries**
- LG: **Knowledge Graph and Summarization**
- Media Lab Asia: **Meaning Based Search**
- TCS: **Intelligent Search Systems**
- HP Labs: **Large Scale Knowledge Bases for NLP**
- Microsoft Research: **Indian Language POS Tagset Design**
- IBM: **UIMA NLP Pipeline**

Weblinks

https://www.cfilt.iitb.ac.in/mtsystem/translate

https://www.cfilt.iitb.ac.in/ssmt/speech2speech

Links

http://www.cfilt.iitb.ac.in

http://www.cse.iitb.ac.in/~pb

Thank You!