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ML LAB PROJECT

# **IMPLEMENTATION OF BERT IN RASA**

## **Team Roomies**

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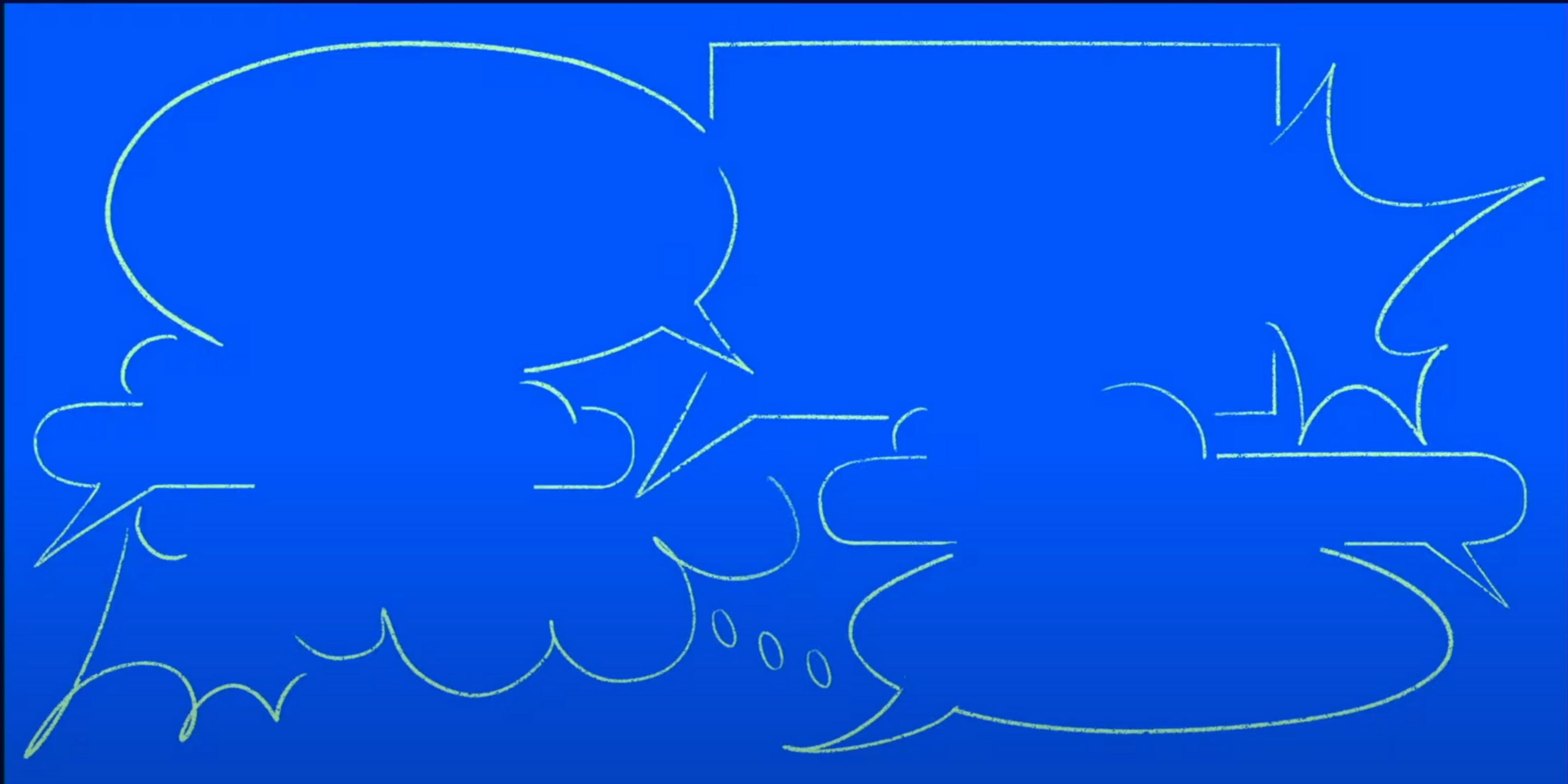
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# What we'll talk about

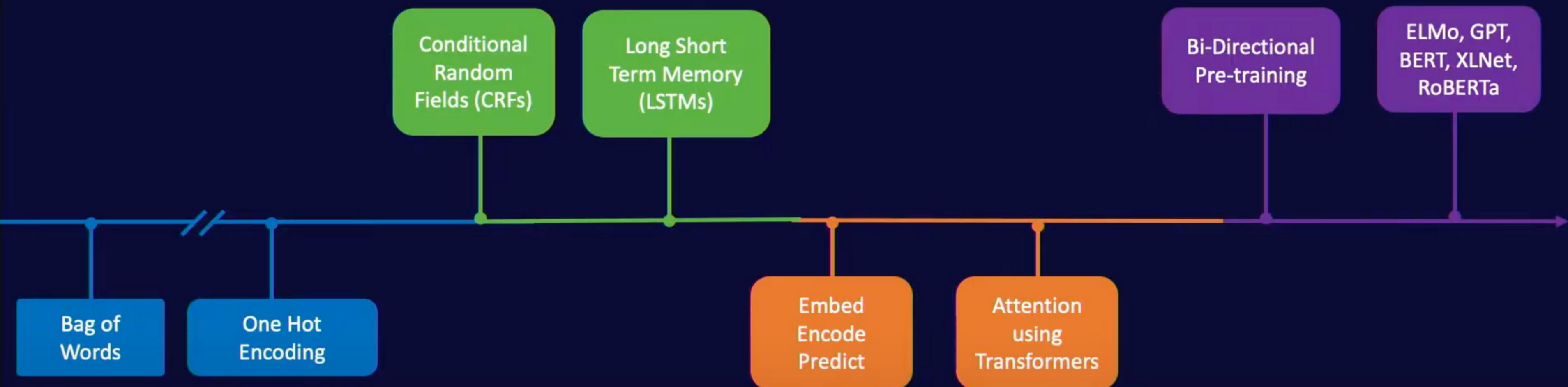
.....

- NLP overview
- Problem space
- Rasa-BERT integration
- How does BERT fare?
- Next Steps and Lessons Learned

# At the heart of this: NLP



# The NLP Revolution



# RASA

- Rasa is an open source machine learning framework to automate text-and voice-based conversations.
- Rasa helps you build contextual assistants capable of having layered conversations with lots of back-and-forth.
- In order for a human to have a meaningful exchange with a contextual assistant, the assistant needs to be able to use context to build on things that were previously discussed – Rasa enables you to build assistants that can do this in a scalable way.

It is a transformer-based machine learning technique for natural language processing (NLP) pre-training developed by Google.

# BERT

(Bidirectional Encoder Representations from Transformers)

Deep learning artificial neural network language model

BERT's key technical innovation is applying the bidirectional training of Transformer, a popular attention model, to language modelling.

# **ADVANTAGES**

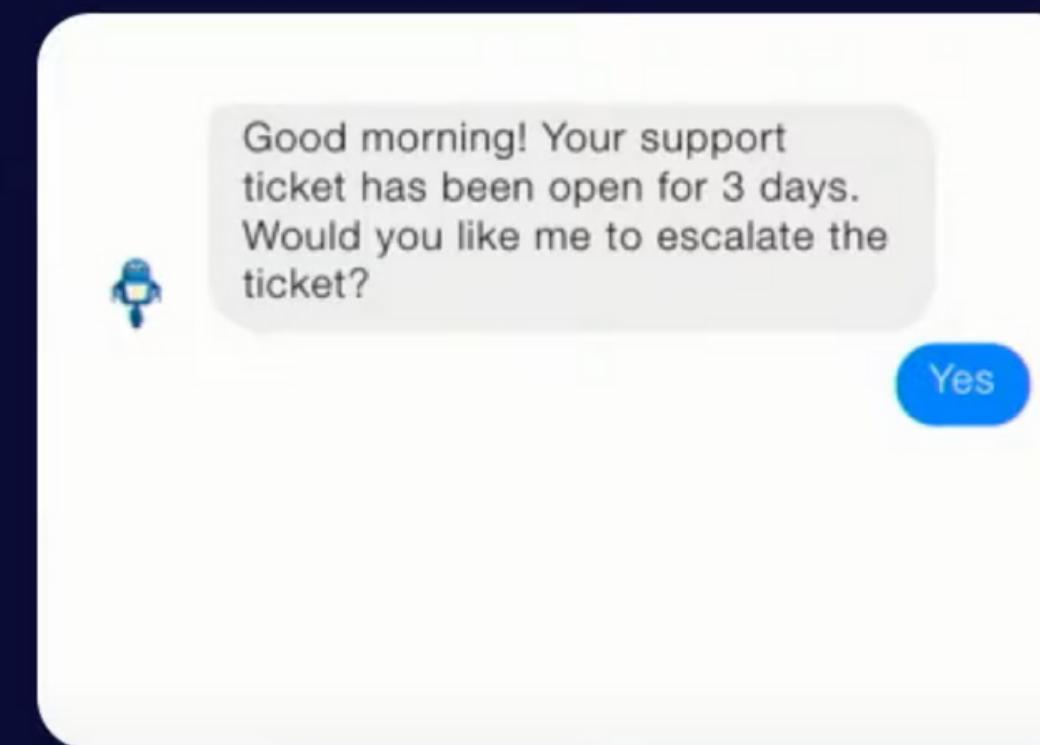
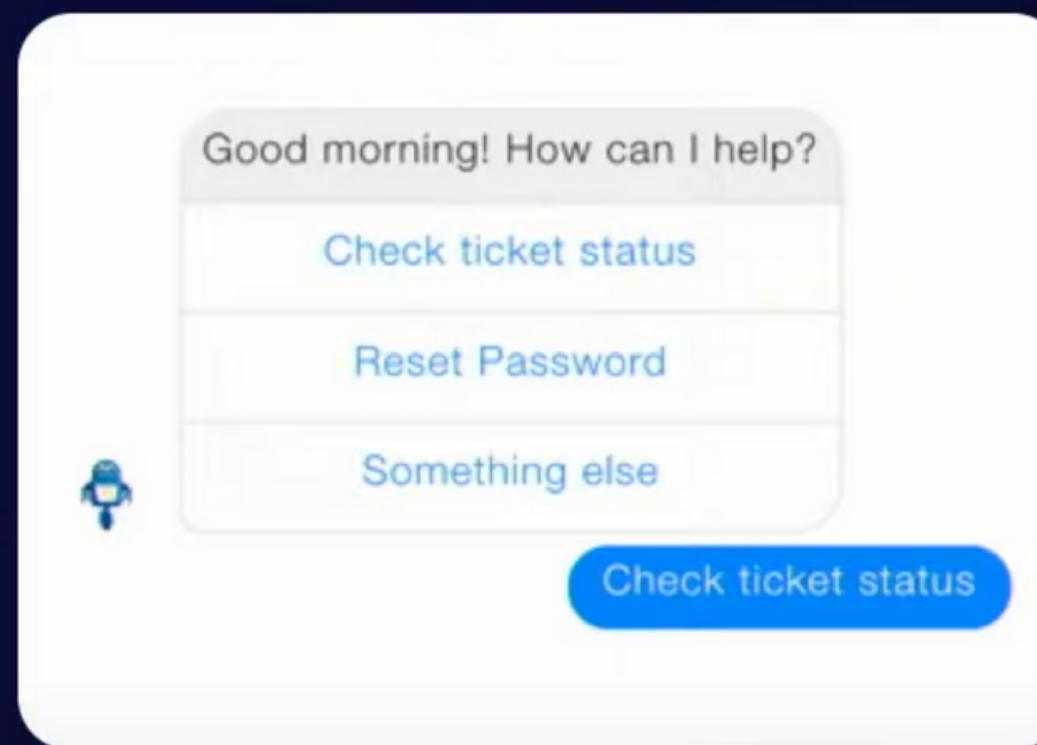
**Naturally  
Conversational**

**Thoughtfully  
Contextual**

**Learns and  
Evolve**

**Can solve almost  
all NLP tasks  
(11+ of the most  
common tasks)**

# Naturally conversational, contextual, intelligent assistants



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Q&A

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Intelligent conversations

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Proactive, contextual  
assistance

Surfacing the right information, at the right time, in the right channel

# Bidirectional Encoder Representations from Transformers (BERT)

- Method of pre-training language representations
- Unsupervised learning
- Contextual and Bidirectional
- Fine tune for downstream tasks like Q&A, NER, autosuggest



# Basic Overview

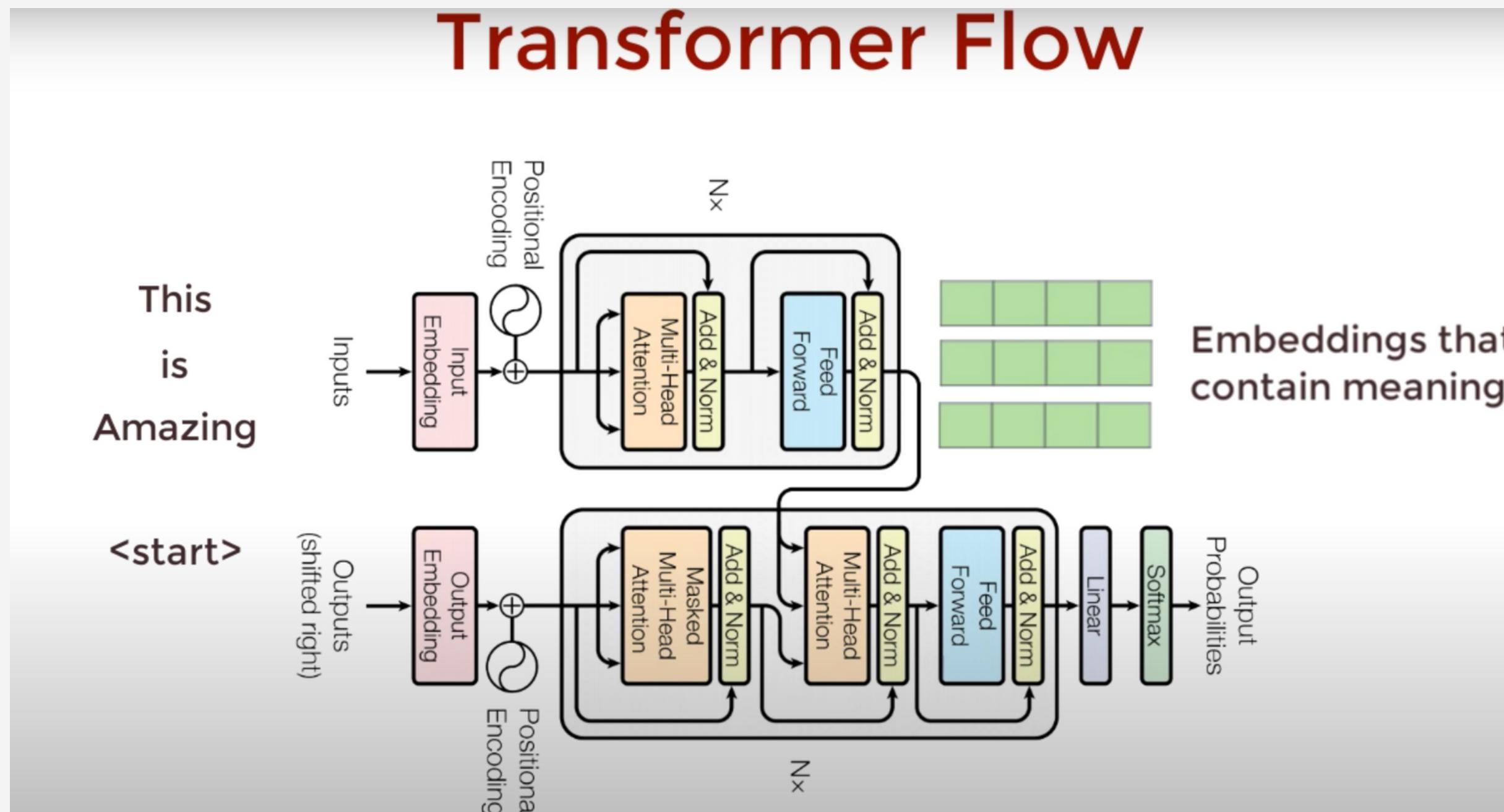
## 1. LSTM vs Transformers

LSTM Networks -

- Slow to train, words are passed sequentially
- Not the best at capturing the true meaning of words
- Even bidirectional LSTMs are not perfect as they are learning left-to-right & right-to-left and concatenating the results, so some of the context is lost

# Transformers -

- Are faster as words can be processed simultaneously.
- Deeply bidirectional - Contexts are better learnt.



Encoder - Learns what is english, what is grammer & what is context

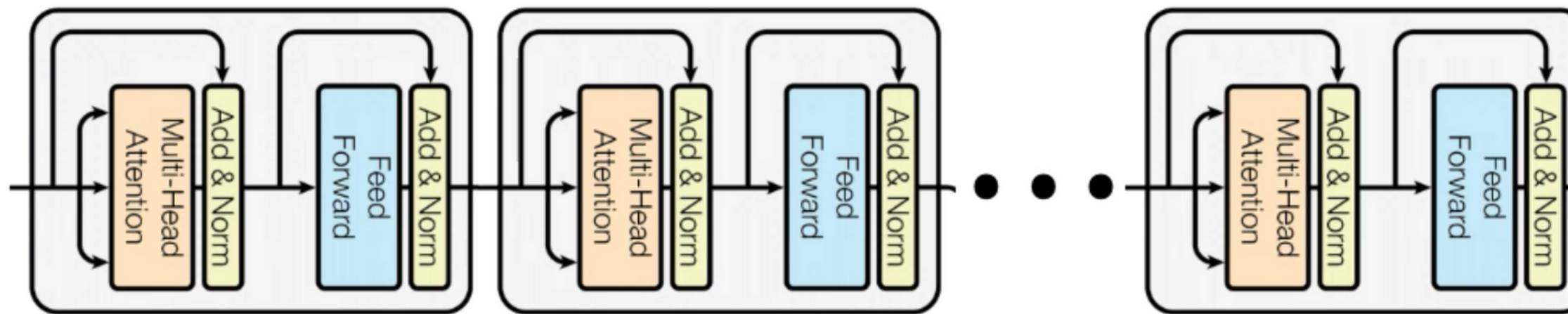
Decoder - Learns how does english relate to Hindi / French words?  
(mapping)

Both encoder & decoder (even separately) has an understanding of what is language.

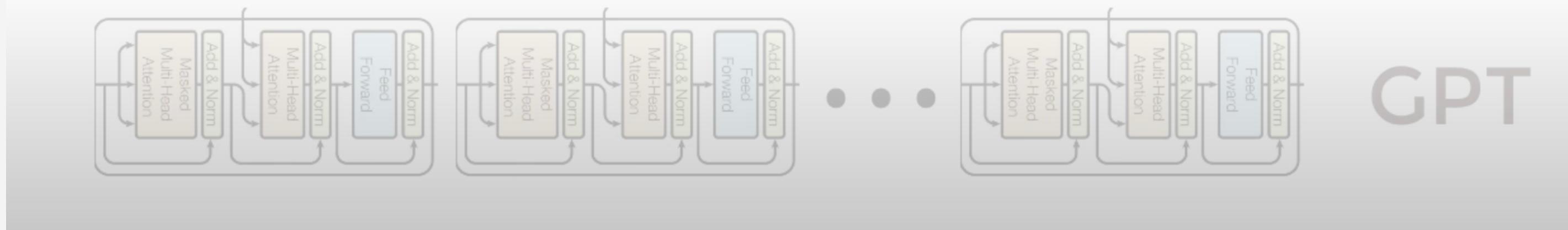
Stack the decoders together and we get GPT transformer architecture.

Stack the encoders together, we get BERT architecture.

# Transformer Flow



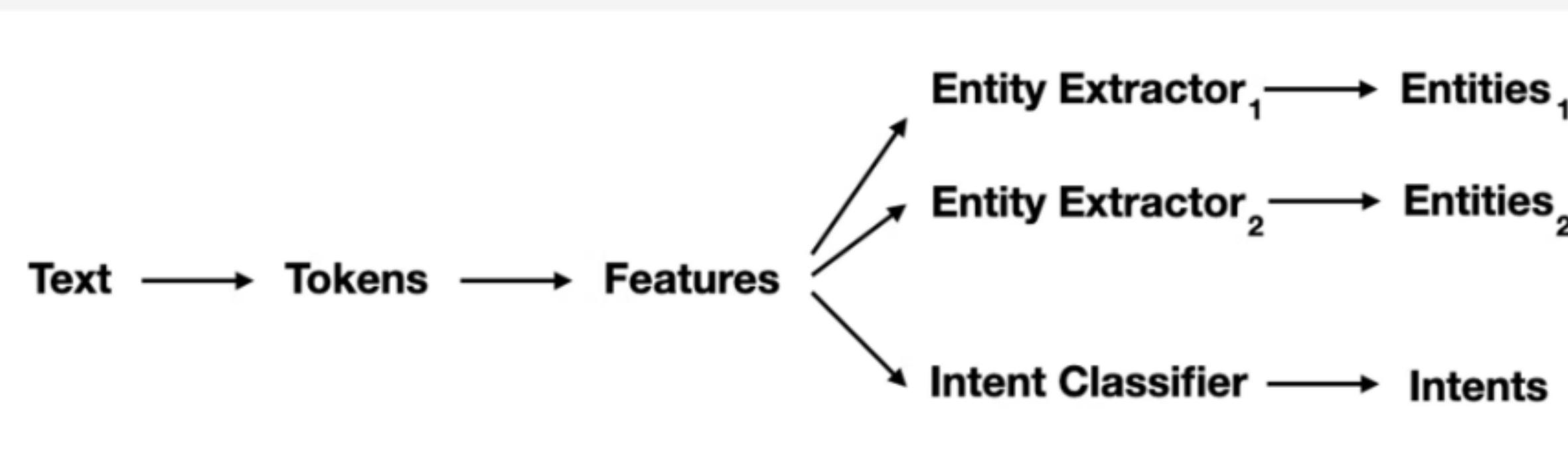
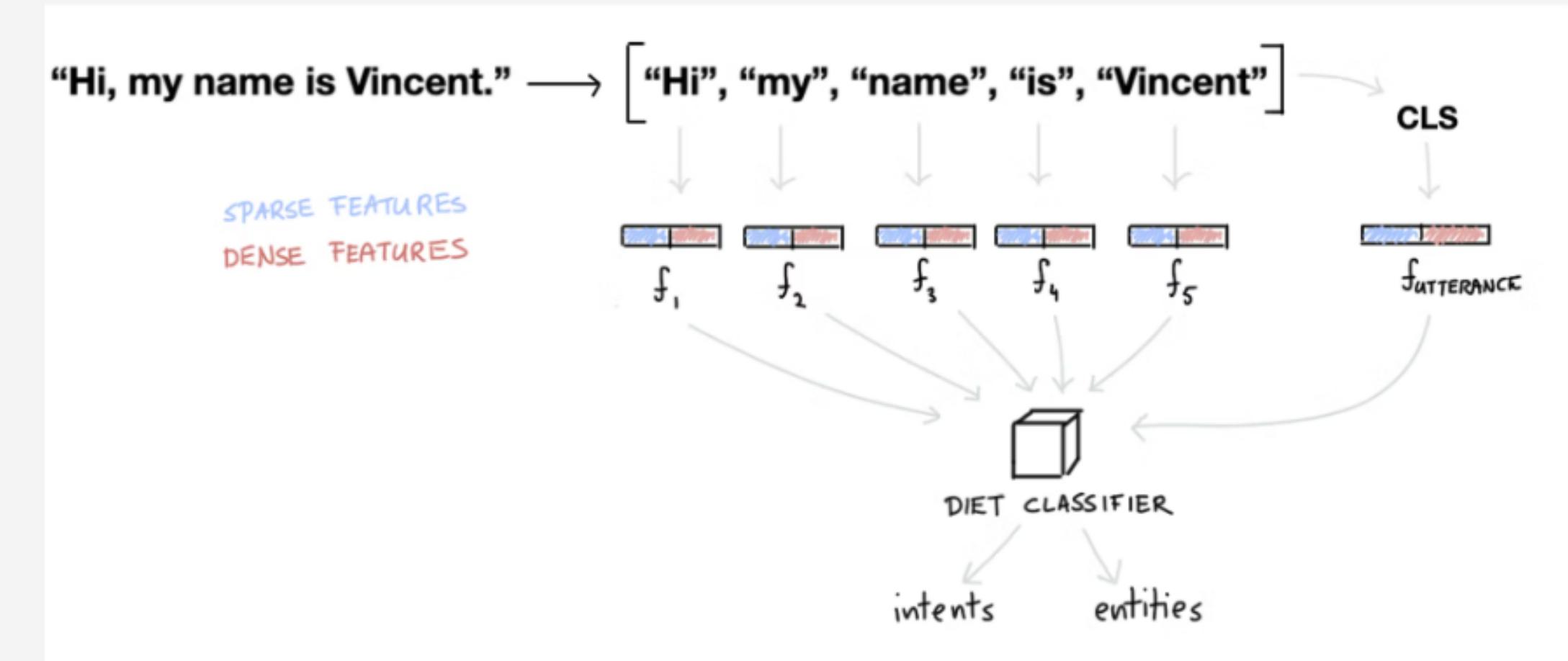
**B**idirectional **E**ncoder **R**epresentation from **T**ransformers



Literature Review 1: <https://ai.googleblog.com/2018/11/open-sourcing-bert-state-of-art-pre.html>

# Task at hand

- Intent Classification
- Entity Extraction



# Problems to solve

- Neural Machine Translation
- Question Answering
- Sentiment Analysis
- Text Summarisation

# How to solve problems?

- Pre-train BERT to understand language
- Fine-tune BERT to learn specific task (I know language , but how do I solve this problem)

# **Pre-training (Phase 1) : What is language and what is context?**

- Masked Language Model (MLM)
- Next Sentence Prediction (NSP)

# **Fine Tuning (Phase 2) : How to use language for specific task?**

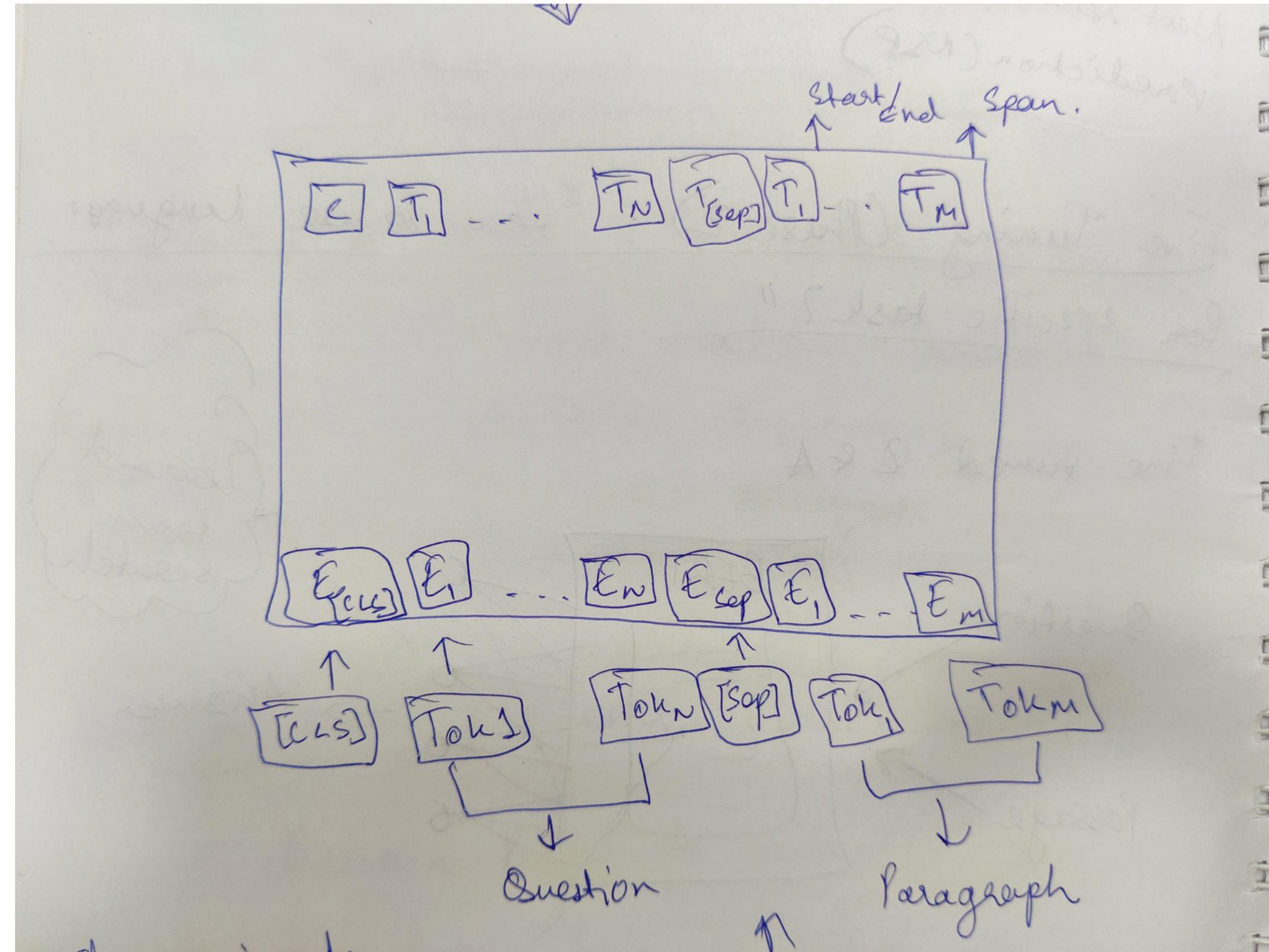
- Fine tuned Question and Answer

- One part is built from scratch and one part is fine tuned
- Training time is fast
- So for different bots, we just have to remove the output layers & train with specific dataset

## **Pre-training (Phase 2) : Problems to train on simultaneously**

- Masked Language Model (MLM)
- Next Sentence Prediction (NSP)

Word Vectors (Input) -----> Word Vectors (Output)



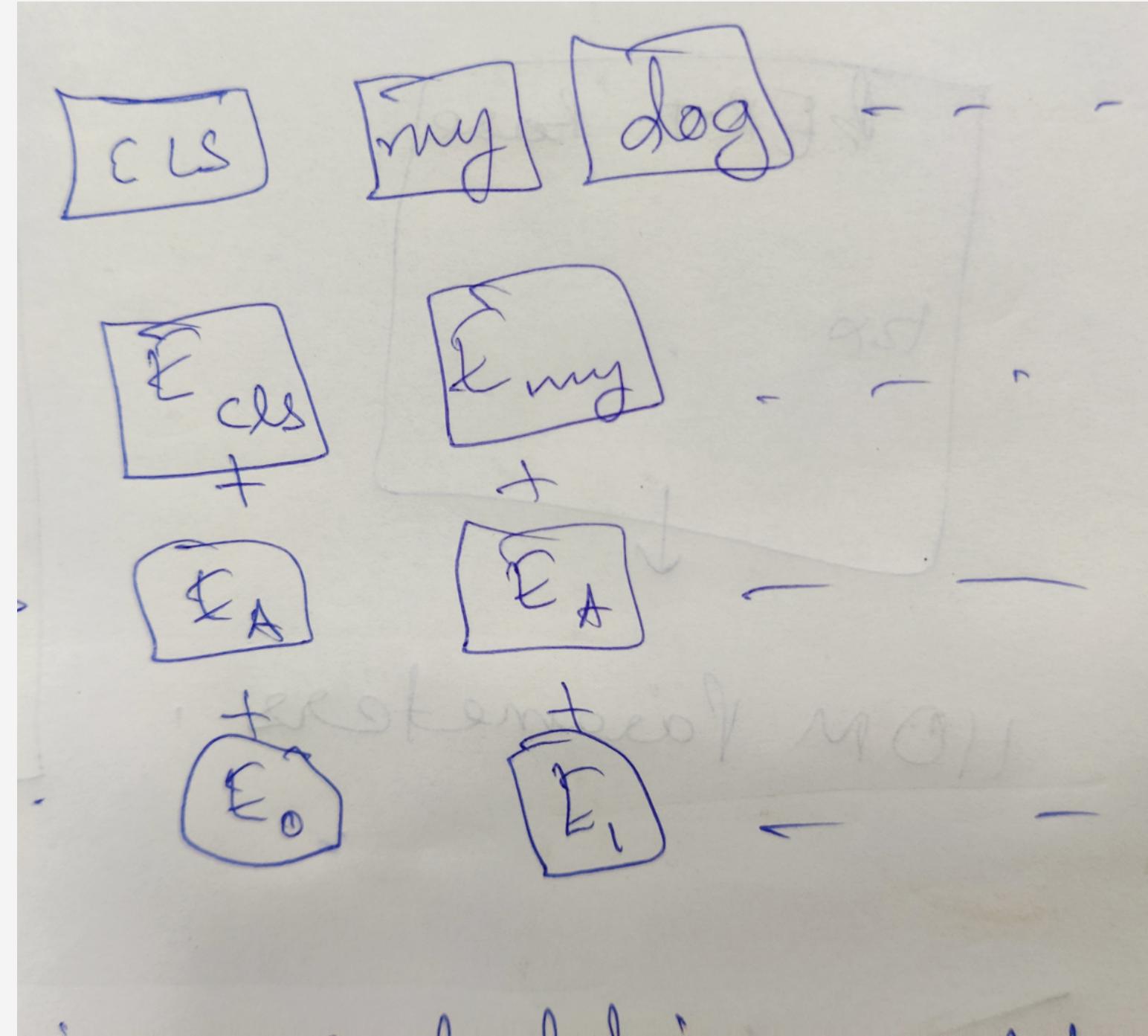
Change inputs to take  
in question, passage

Question / Answer pair ↗

# Pre-training (Phase 3)

## Input

- Token Embedding
- Segment Embeddings
- Position Embeddings



Segment + Position embedding add 'ordering' for inputs

# Tokenisation and Featurizers

Just Tokenisation

"He likes dogs" → ["He", "likes", "dogs"]

Tokenisation and Lemmatisation

"He likes dogs" → ["He", "like", "dog"]



# Output

- Word vector have same size
- Word vectors are generated simultaneously



Embedded Vector



Softmax layer with 30,000 neurons



Compare with cross entropy loss (for masked words only)

Actual word (onehot encoded, 30,000 elements)

# Intents

The screenshot shows a code editor interface with a dark theme. At the top, there's a menu bar with options like File, Edit, Selection, Find, View, Goto, Tools, Project, Preferences, and Help. Below the menu is a toolbar labeled "FOLDERS". The left pane displays a file tree with several folders and files under "data": nlu, lookups, responses, chitchat.yml, faq.yml, general.yml, iit\_dharwad.yml, nlu.yml, and out\_of\_scope.yml. The right pane contains the content of the "iit\_dharwad.yml" file, which is a YAML configuration for intents. The file starts with a version declaration and defines multiple intents, each with examples of user input. The code is color-coded for readability.

```
version: 0.0
iit-dharwad:
  - intent: iit_dharwad/greeting
    examples:
      - Hi
      - Hey
      - How are you
      - Is anyone there?
      - Hello
      - Good Day
  - intent: iit_dharwad/goodbye
    examples:
      - Bye
      - Goodbye
      - See you later
  - intent: iit_dharwad/thanks
    examples:
      - Thanks
      - Thank you
      - That's Helpful
      - Thanks a lot!
  - intent: iit_dharwad/courses
    examples:
      - What courses do you offer?
      - What streams are taught at IIIT Dharwad?
      - What streams are available?
      - What kinds of subjects are taught in this college?
      - Do you guys teach DSAI?
      - Is ML or AI taught in IIIT Dharwad?
      - What are the B.Tech programmes available at IIIT Dharwad
  - intent: iit_dharwad/payments
    examples:
      - Do you take credit cards?
      - Do you accept UPI
      - Do you accept checks?
      - Are you cash only?
      - How to pay semester fees?
      - How to pay admission fees?
      - How to pay mess registration fees?
      - Institute fee payment portal
      - IIIT Dharwad fee payment
      - How to pay fees?
      - Pay IIIT Dharwad fees
  - intent: iit_dharwad/contact
    examples:
      - Contact details of faculty
      - How do I contact IIIT Dharwad?
      - Phone number of Registrar
      - Contact Director of IIIT Dharwad
      - How to contact HoD of CSE branch
      - Contact admin
      - Contact details of incharge
      - Email id of Admin or incharge
      - Can't find answers, how do I contact the Institute?
      - Emergency contact details
  - intent: iit_dharwad/placements
    examples:
      - What are the placement statistics at IIIT Dharwad?
      - How are placements at IIIT Dharwad?
      - B.Tech CSE placement statistics
      - B.Tech ECE placement statistics
      - What companies come for placements at IIIT Dharwad?
      - B.Tech DSAI placement statistics
      - Placement percentage of IIIT Dharwad
      - Highest placement at IIIT Dharwad
      - Product based companies at IIIT Dharwad
      - How many students got internships at IIIT Dharwad?
```

Line 1, Column 1

# Responses

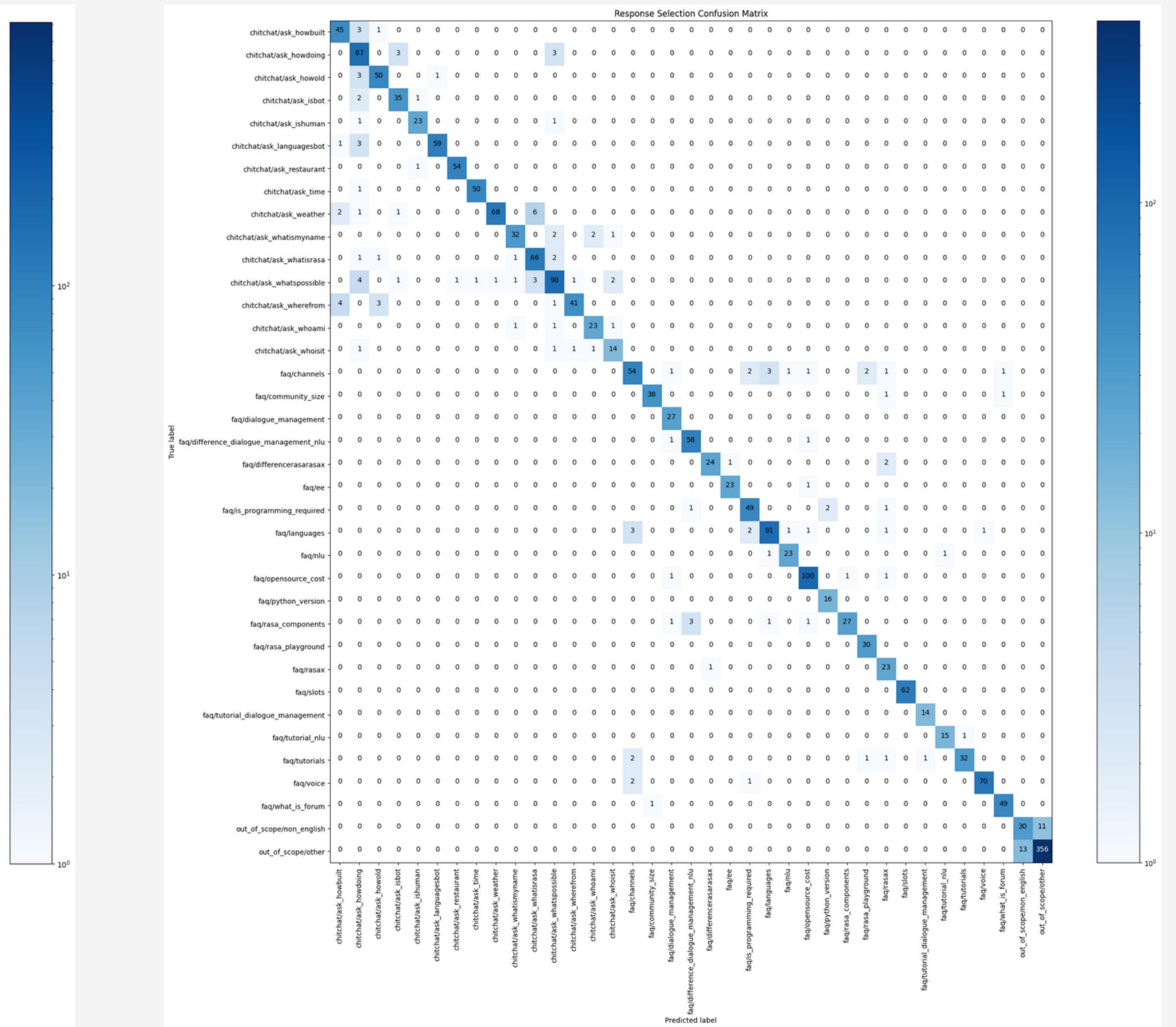
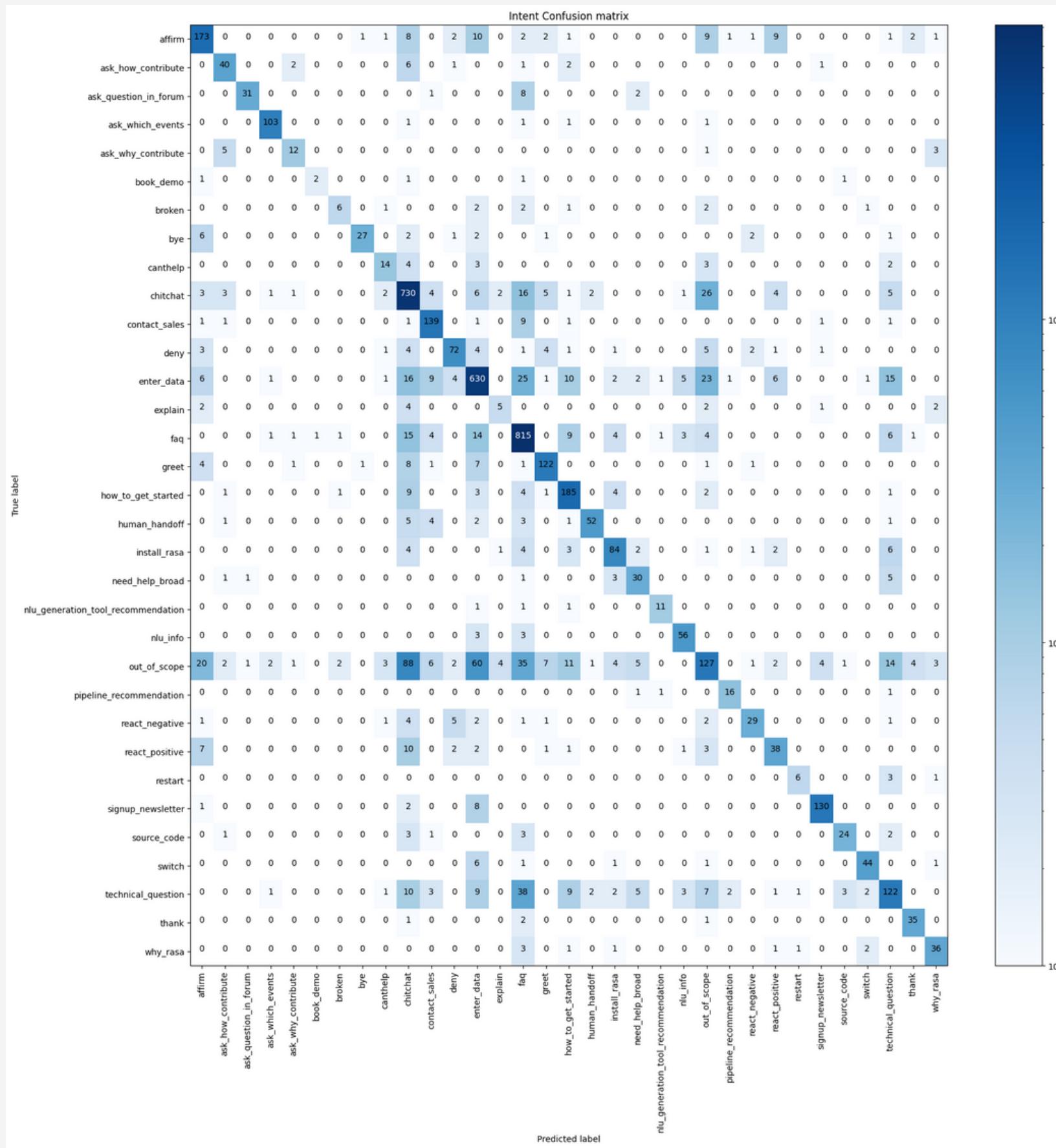
```
Find View Goto Tools Project Preferences Help
iiit_dharwad.yml responses.yml

157   utter chitchat/handleinsult:
158     - text: "That's not very nice 😠"
159     - text: "That wasn't very nice. Perhaps try an anger management class?"
160     - text: "I'll pretend I didn't process that mean comment."
161   utter chitchat/nicetomeetyou:
162     - text: "Likewise!"
163     - text: "Thank you. It is a pleasure to meet you as well!"
164     - text: "It is nice to meet you too!"
165     - text: "Pleased to meet you too!"
166     - text: "It's always a pleasure to meet new people!"
167     - text: "Nice to meet you too! Happy to be of help."
168   utter chitchat/telljoke:
169     - text: "Why are eggs not very much into jokes? - Because they could crack up."
170     - text: "What's a tree's favorite drink? - Root beer!"
171     - text: "Why do the French like to eat snails so much? - They can't stand fast food."
172     - text: "Why did the robot get angry? - Because someone kept pushing its buttons."
173     - text: "What do you call a pirate droid? - Arrrr-2-D2"
174     - text: "Why did the robot cross the road? - Because he was programmed to."
175   utter iiit_dharwad/greeting:
176     - text: "Hey :-)"
177     - text: "Hello, thanks for visiting"
178     - text: "Hi there, what can I do for you?"
179     - text: "Hi there, how can I help?"
180   utter iiit_dharwad/goodbye:
181     - text: "See you later, thanks for visiting"
182     - text: "Have a nice day"
183     - text: "Bye! Come back again soon."
184   utter iiit_dharwad/thanks:
185     - text: "Happy to help!"
186     - text: "Any time!"
187     - text: "My pleasure"
188   utter iiit_dharwad/courses:
189     - text: "We at IIIT Dharwad offer B.Tech programs in CSE, ECE and DSAI and PhD programs in CSE and ECE"
190     - text: "IIIT Dharwad has B.Tech CSE, ECE and DSAI curriculums and PhD programs in CSE and ECE"
191   utter iiit_dharwad/payments:
192     - text: "We accept Online Banking/Debit Cards/Credit Cards. Any issues regarding the fee payment contact@7026609000/ 9380019199/ 9538378392/ 9886090988"
193   utter iiit_dharwad/contact:
194     - text: "Contact Email: contact@iiitdwd.ac.in , Contact Number: 0836 2250879/ 0836 2357747"
195     - text: "Please reach out to us at contact@iiitdwd.ac.in or Ph: 0836 2250879/ 0836 2357747"
196   utter iiit_dharwad/placements:
197     - text: "Thank you for your interest regarding placements @ IIIT Dharwad. Please visit https://iiitdwd.ac.in/careerGuidance.php for detailed stats."
198     - text: "Check out our CGC Portal (https://iiitdwd.ac.in/careerGuidance.php) for detailed information regarding placements at IIIT Dharwad."
199   utter iiit_dharwad/location:
200     - text: "Our address is : IIIT Campus, Ittigatti Road, Near Sattur Colony, Dharwad 580009."
201     - text: "IIIT Campus is located at Ittigatti Road, Near Sattur Colony, Dharwad 580009."
```

# Vocabulary

```
lification.  
asa/shared/utils/io.py:97: UserWarning: The path '/home/iiitdwd/Desktop/rasa-demo-main/configs/config-h  
asa/utils/train_utils.py:641: UserWarning: constrain_similarities is set to 'False'. It is recommended  
urce 3.0.0 onwards.  
  
ent WhitespaceTokenizer  
ent.  
ent RegexFeaturizer  
ent.  
ent LexicalSyntacticFeaturizer  
ent.  
ent CountVectorsFeaturizer  
asa/shared/utils/io.py:97: UserWarning: The out of vocabulary token 'oov' was configured, but could no  
ing prediction.  
izer  
nt_vectors_featurizer - 1581 vocabulary items were created for text attribute.  
nt_vectors_featurizer - 394 vocabulary items were created for response attribute.  
ent.  
ent CountVectorsFeaturizer  
nt_vectors_featurizer - 7910 vocabulary items were created for text attribute.  
nt_vectors_featurizer - 3406 vocabulary items were created for response attribute.  
ent.  
ent DIETClassifier  
asa/utils/tensorflow/model_data_utils.py:395: VisibleDeprecationWarning: Creating an ndarray from ragged  
or shapes) is deprecated. If you meant to do this, you must specify 'dtype=object' when creating the ndarray  
asa/utils/tensorflow/model_data.py:750: VisibleDeprecationWarning: Creating an ndarray from ragged nested  
es) is deprecated. If you meant to do this, you must specify 'dtype=object' when creating the ndarray  
  
tensorflow/python/framework/indexed_slices.py:447: UserWarning: Converting sparse IndexedSlices(Indexed  
dtype=int32), values=Tensor("gradients/cond_grad/gradients/cond/GatherV2_grad/Reshape:0", shape=(None,  
shape=(1,), dtype=int32))) to a dense Tensor of unknown shape. This may consume a large amount of memory.  
| 11/200 [01:19<17:54, 5.68s/it, t_loss
```

# Performance



# Performance

```
.test
.rasa.nlu.test - Entity extractor: DIETClassifier
.rasa.nlu.test - test Accuracy: 0.981 (0.001)
.rasa.nlu.test - test F1-score: 0.817 (0.009)
.rasa.nlu.test - test Precision: 0.813 (0.001)
.rasa.nlu.test - test Selection evaluation results
```

```
2022-04-28 03:31:27 INFO rasa.nlu.test - Entity extractor: DIETClassifier
2022-04-28 03:31:27 INFO rasa.nlu.test - test Accuracy: 0.927 (0.001)
2022-04-28 03:31:27 INFO rasa.nlu.test - test F1-score: 0.927 (0.001)
2022-04-28 03:31:27 INFO rasa.nlu.test - test Precision: 0.931 (0.001)
(venv) iitdwd@iitdwd-ThinkCentre-M910t:~/Desktop/rasa-demo-main$
```

```
j.test - test Accuracy: 0.931 (0.003)
j.test - test F1-score: 0.929 (0.004)
u.test - test Precision: 0.936 (0.000)
```

# Future Scope

- Long passages as responses can be added in RASA which can be used by BERT to extract short answers from.
- For now we have used the base BERT model (12 encoders, 110M Parameters). We can use the 24 encoder BERT (340M Parameters) model in future.
- Besides BERT, GPT-3 (One of the largest neural networks ever created, 175B Parameters!), Chinchilla (Released in April 2022, rival to GPT-3 made by DeepMind, 70B Parameters!) can also be integrated. GPT-4 is also in works which can be used later on.
- Connecting the RASA BERT integration with a chatbot-like web app which can then be used for the IIIT Dharwad website.