Introduction to Building Conversational Agents (chatbots)

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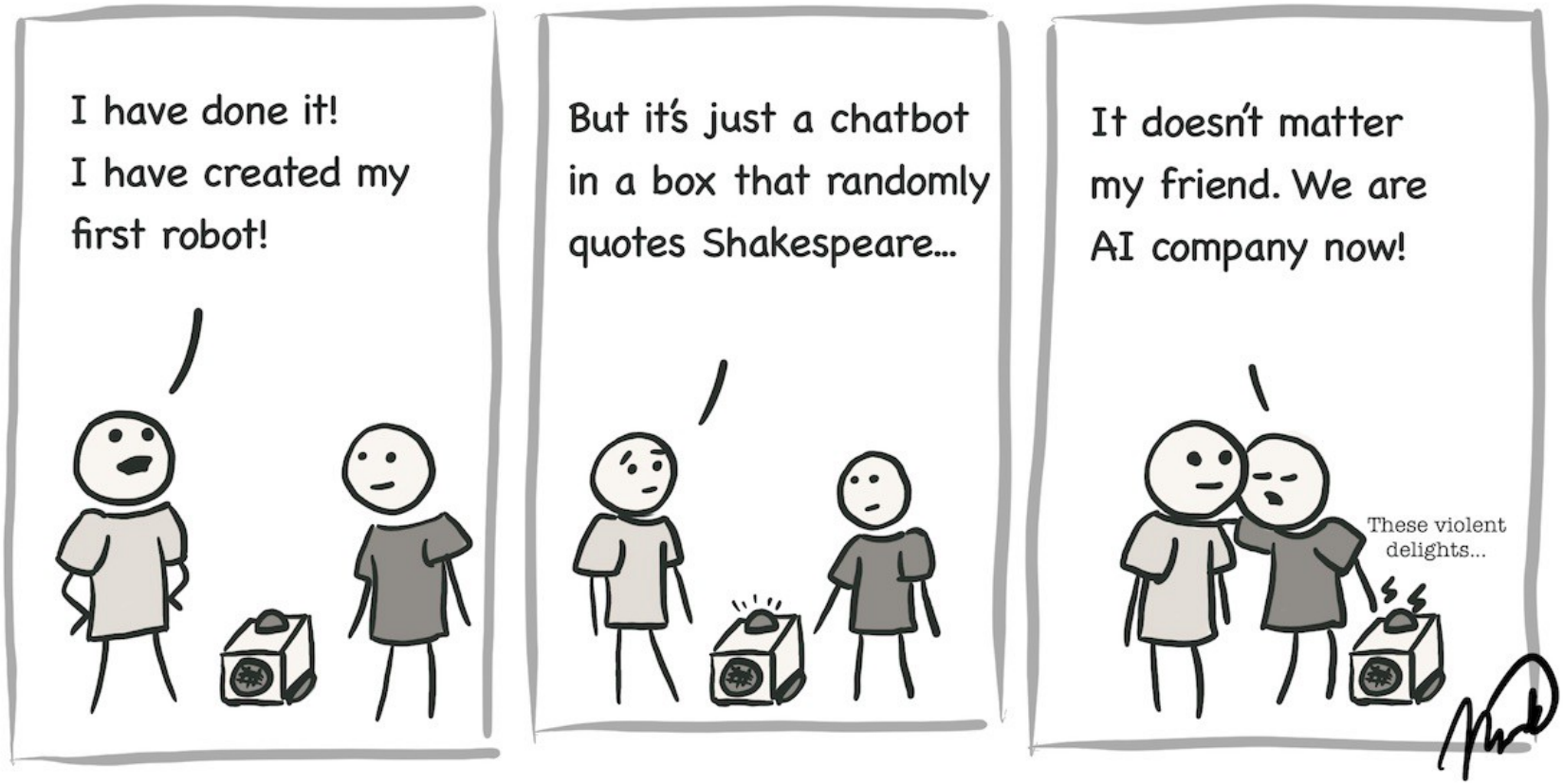
January 15, 2021

Introduction

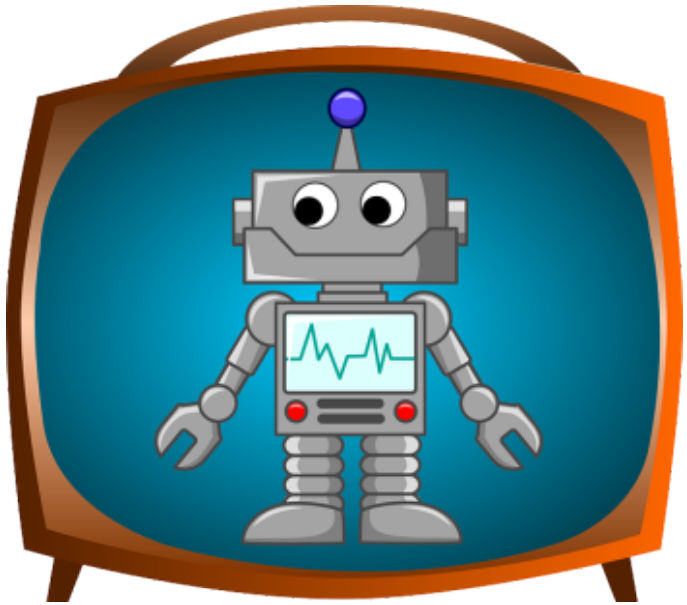
Chatbot == AI



(Ref: How to build awesome Rasa chatbot for a web - Martin Novak)

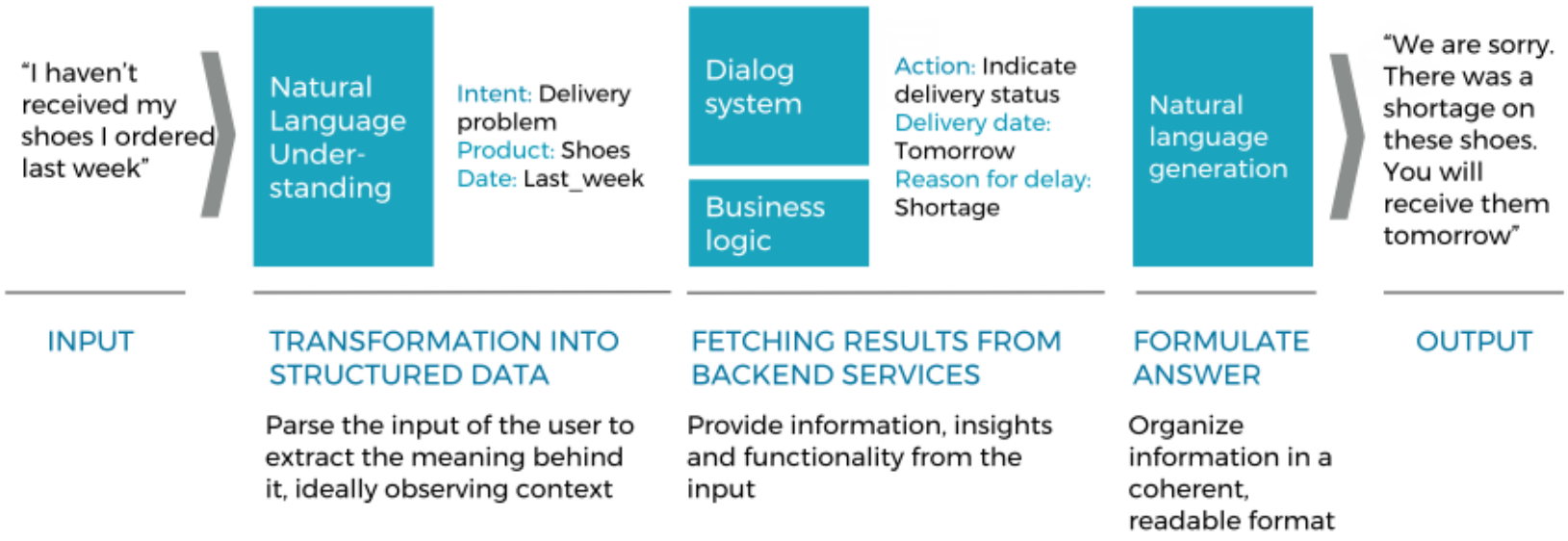
So, What is a Chatbot?

"Chatbots are a form of human-computer dialog system which operates through natural language via text or speech"- Deryugina, 2010; Sansonnet et al., 2006.



(Ref: Rasa - mdd01 course on github)

Anatomy of a Chatbot



(Ref: Chatbots and AI - botfuel)

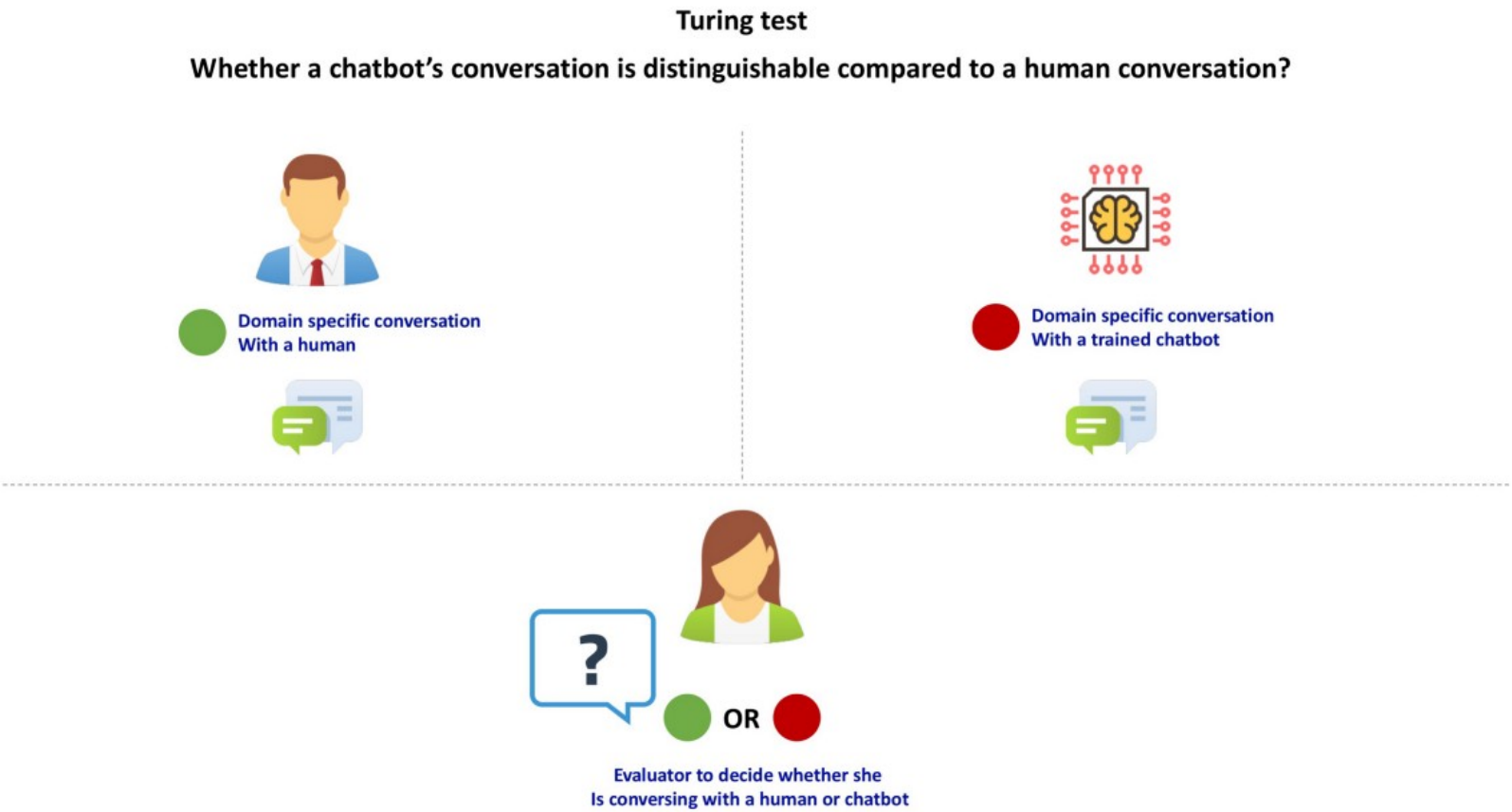
How difficult?

So what tools do developers need to do better than this?

(Ref: A New Approach to Conversational Software - Alan Nichol)

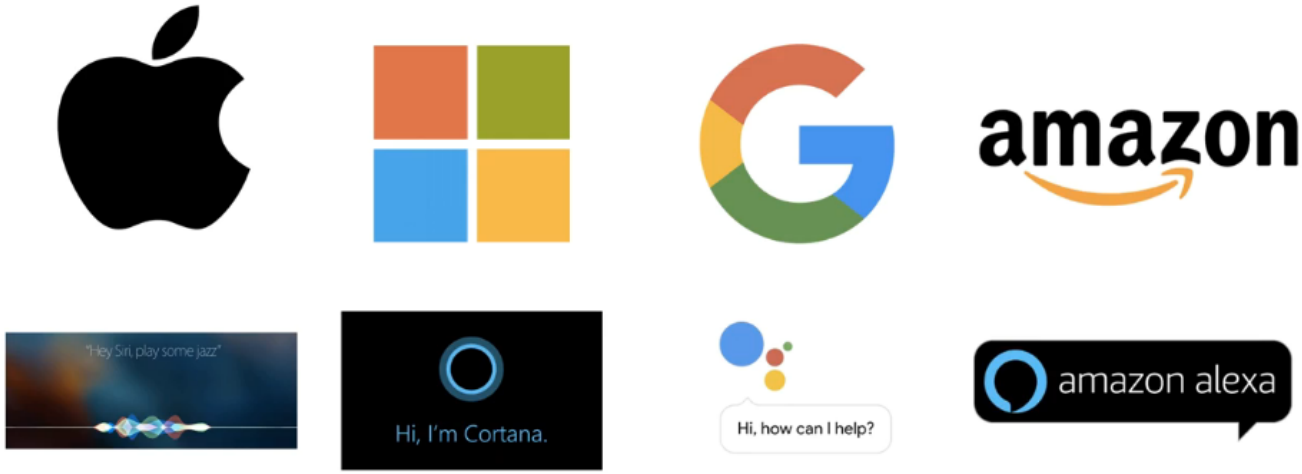
NLU is AI

Understanding Natural Language is Hallmark of Artificial Intelligence!!



(Ref: Conversational AI: Understanding the Basics and Building a Chatbot in Rasa module - Manikandan Jeeva)

The Giants are at it ...



(Ref: Deep Learning and NLP A-Z - Kirill Eremenko)

If you want to develop one

- Chatbots or QA systems, predominantly voice based,
- Underlying processing is primarily Natural Language Processing (NLP).
- You can have your own chatbot, specific to you!!
- NLP is the core skill needed.

Steps for building Chatbot

- Decide domain (better if smaller)
- Design conversations (list all possible questions, answers)
- List intents (verbs), entities (nouns), actions (call-backs), response (query results)
- Train AI/ML engine
- Write backend Db code
- Create and update knowledge-base (offline, with new info)
- Test scenarios and improve

Challenges for Chatbot

- Security: should ensure that only relevant data is being asked and captured as an input and also is being securely transmitted over the Internet.
- Making Chatbot stick, like-able and functioning
- Language Modeling: meaning based vectorization, even for vernacular.
- etc . . .

Chatbot Platforms

Bot Building Platforms

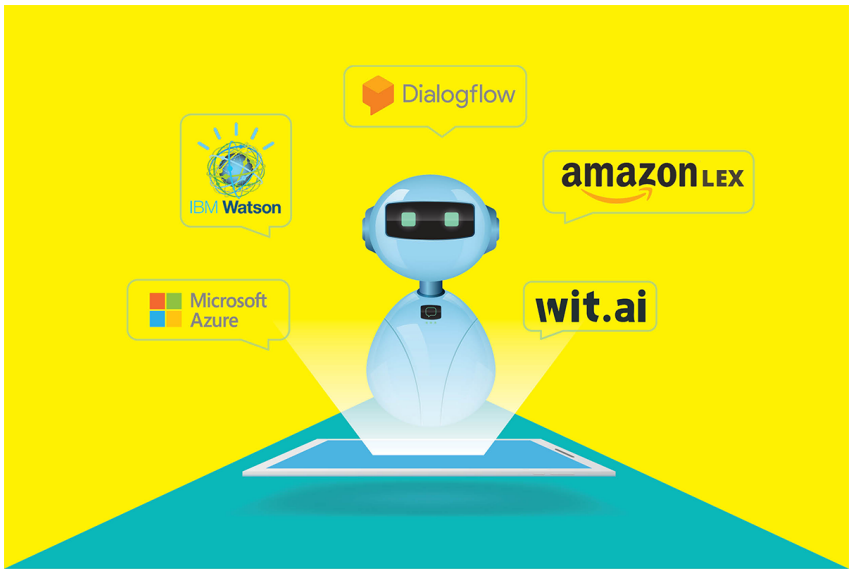
- Set of tools and architecture
- To help you design unique conversation scenarios, define corresponding actions and analyze interactions.
- Understand Natural language (NLU—Natural language understanding),
- Process the conversation text and extracts information (NLP—Natural Language Processing) and
- Respond to the user preserving the context of the conversation (NLG—Natural Language Generation).

(Ref: Chatbots 101 - Architecture & Terminologies - Bhavani Ravi)

Conversation Platforms

Established players

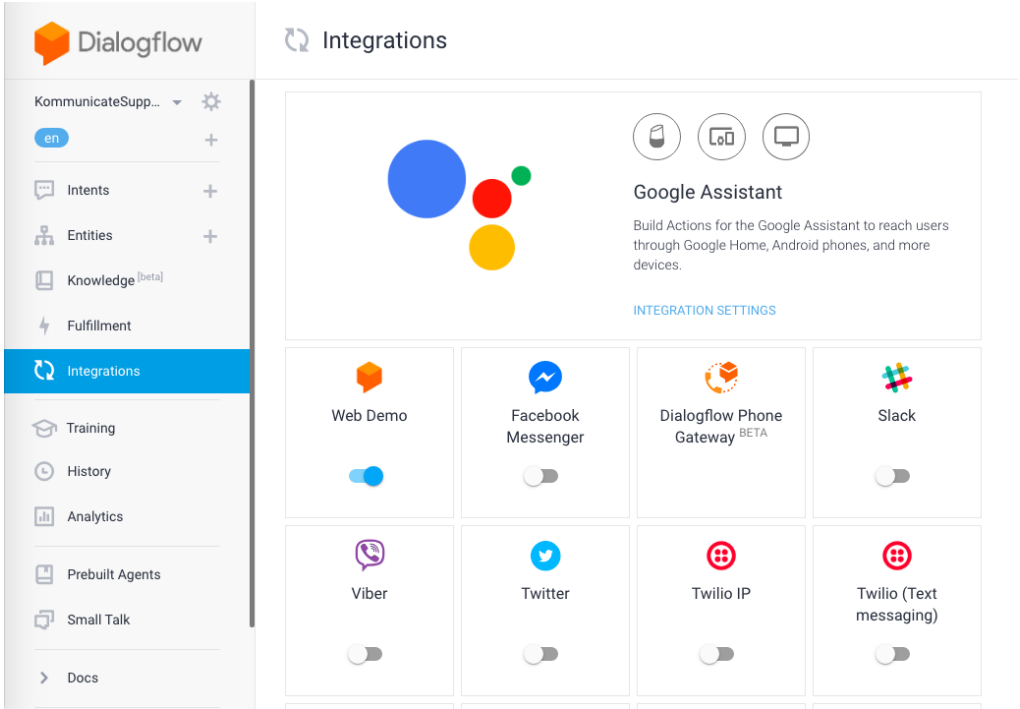
- Google DialogFlow : https://dialogflow.com
- Facebook Wit.ai : https://www.wit.ai
- IBM Watson Assistant : https://www.ibm.com/cloud/watson-assistant/
- Microsoft LUIS : https://www.luis.ai/
- Amazon Lex : https://aws.amazon.com/lex
- RASA : https://www.rasa.com/



(Ref : Dialogflow vs Lex vs Watson vs Wit vs Azure Bot — Which Chatbot Service Platform To Use?)

Google Dialogflow

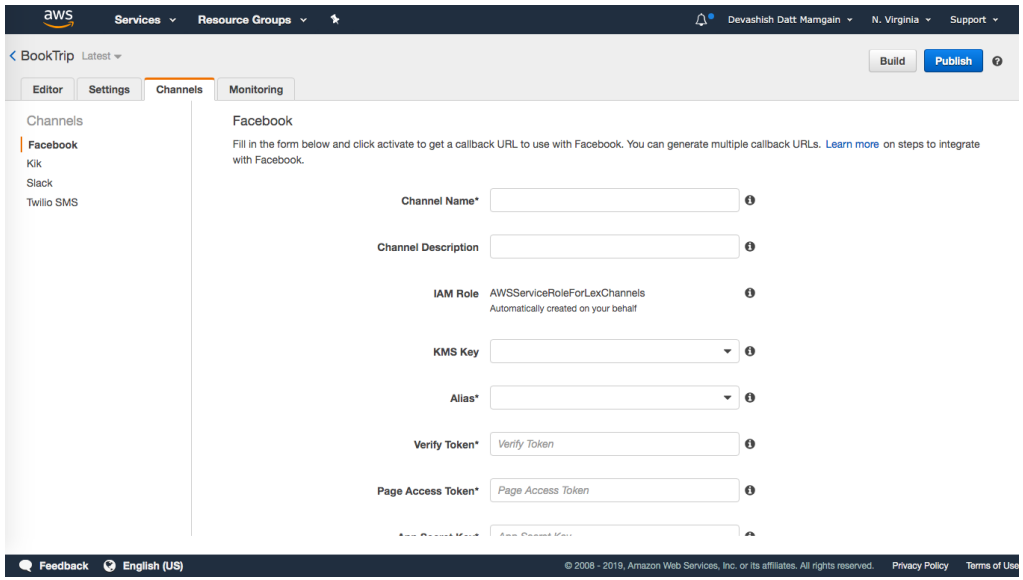
- Previous known as API.ai
- Completely closed-source product with APIs and web interface.
- Voice and text-based conversational interface
- Easy to even non-techies to create basic bots.



(Ref : Dialogflow vs Lex vs Watson vs Wit vs Azure Bot — Which Chatbot Service Platform To Use?)

Amazon Lex

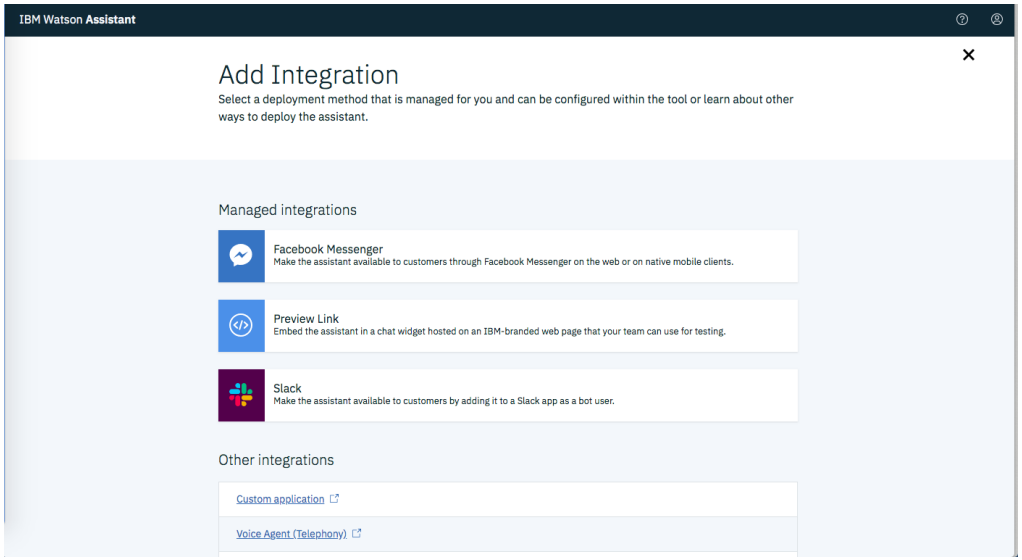
- Same deep learning technologies as Alexa
- Voice and text-based conversational interface
- Provides a web interface to create and launch bots.



(Ref : Dialogflow vs Lex vs Watson vs Wit vs Azure Bot — Which Chatbot Service Platform To Use?)

IBM Watson Assistant

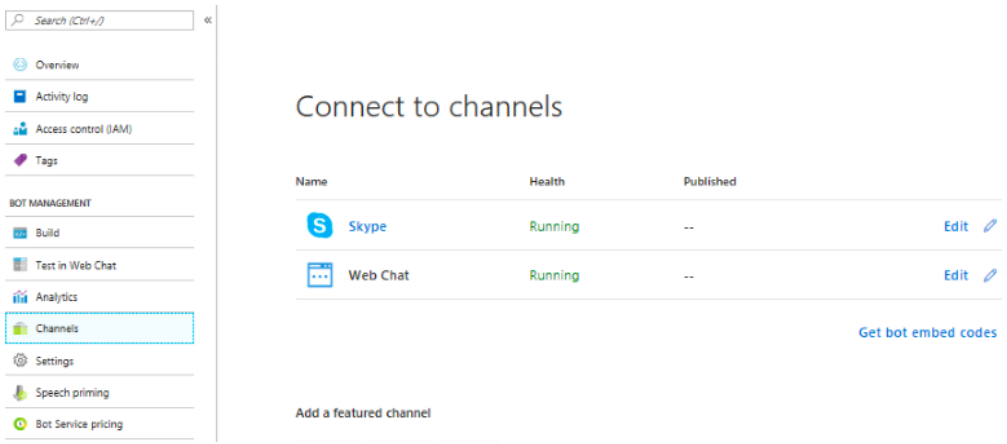
- Has support for searching for an answer from the knowledge base
- First, you need to create a Skill and then go to Assistant to integrate it with other channels.



(Ref : Dialogflow vs Lex vs Watson vs Wit vs Azure Bot — Which Chatbot Service Platform To Use?)

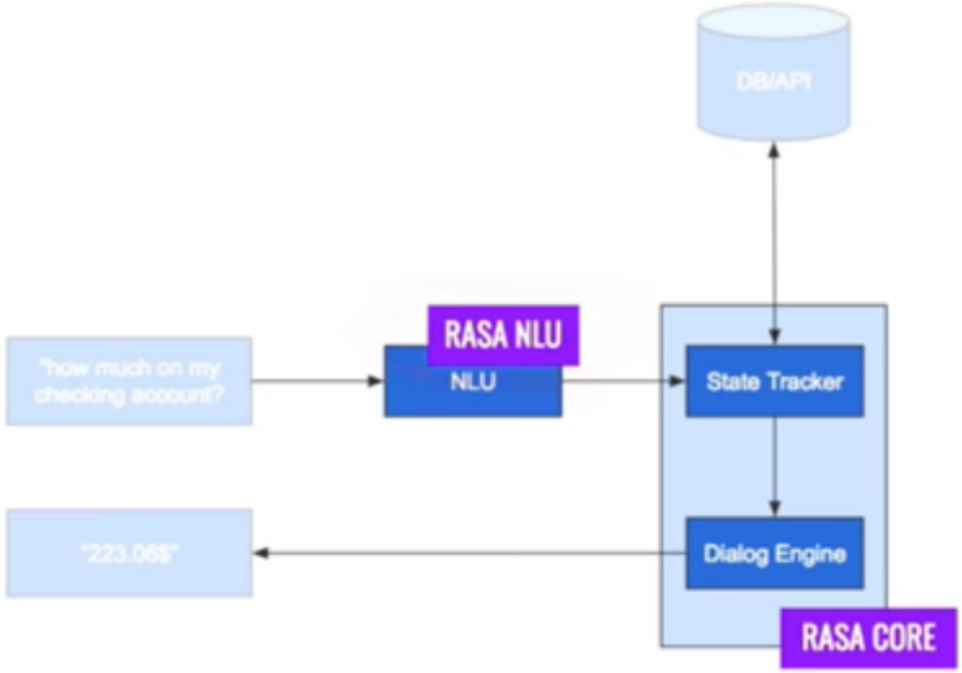
Microsoft LUIS, Azure Bot Service

- Web interface is available to create and publish bots which is fairly easy to understand.



(Ref : Dialogflow vs Lex vs Watson vs Wit vs Azure Bot — Which Chatbot Service Platform To Use?)

Rasa Chatbot Architecture



Machine Learning based and in Python.

(Ref: The talk would be about Rasa, an open-source chatbots platform - Nathan Zylbersztejn)

Theory Behind Rasa Platform

(Ref: Conversational AI:Building clever chatbots - Tom Bocklisch and Deprecating the state machine: building conversational AI with the Rasa stack - Justina Petraitytė)

NLU

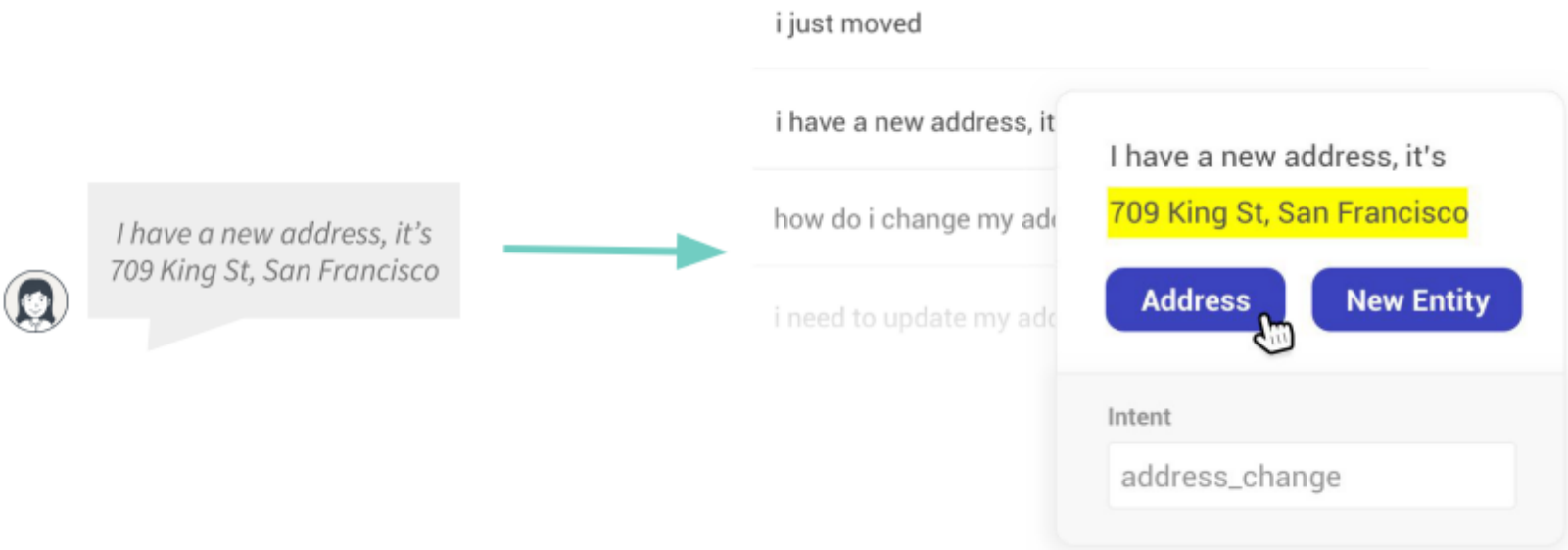
NLU Training

"train" function iterates through the pipeline and performs the NLP tasks

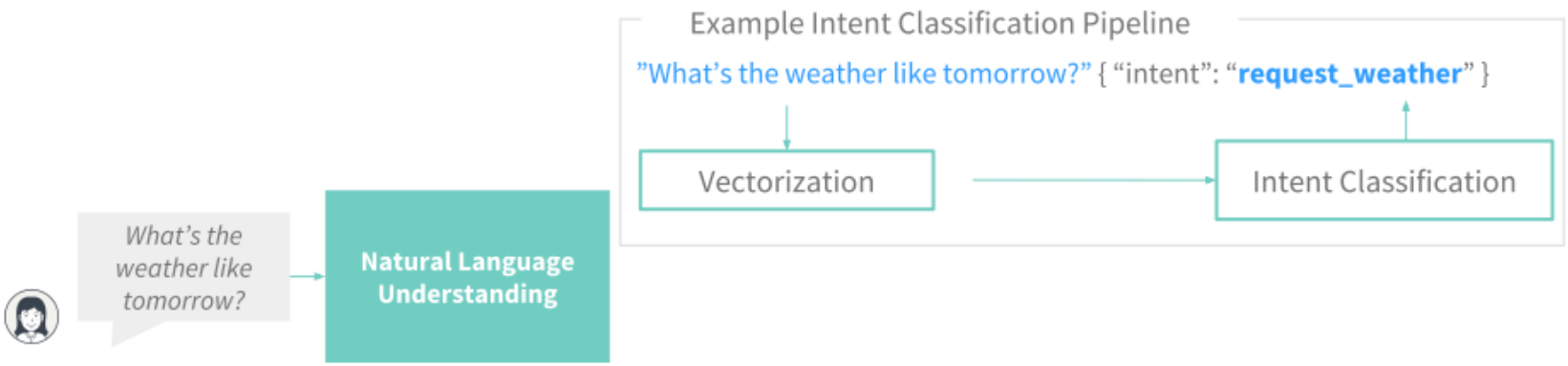
- The preprocessing step: Where the data is transformed to extract the required information. Eg. SpacyTokenizer, SpacyFeaturizer
- Entity Extractor & Intent Classifier: The preprocessed data is used to create the ML models that perform intent classification and entity extraction. NER_CRF EntityExactor, SklearnIntentClassifier
- Persistence : Storing the result

Natural Language Understanding (NLU)

Goal: create structured data



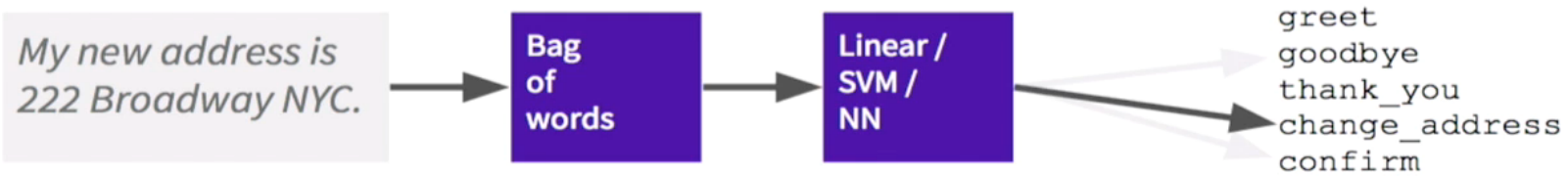
Intent Classification



Intent Classification

Intent Classification with GloVe

Bag of words sentence representation: $\{v_1, \ldots, v_s\} \rightarrow \frac{1}{s} \sum_i v_i$

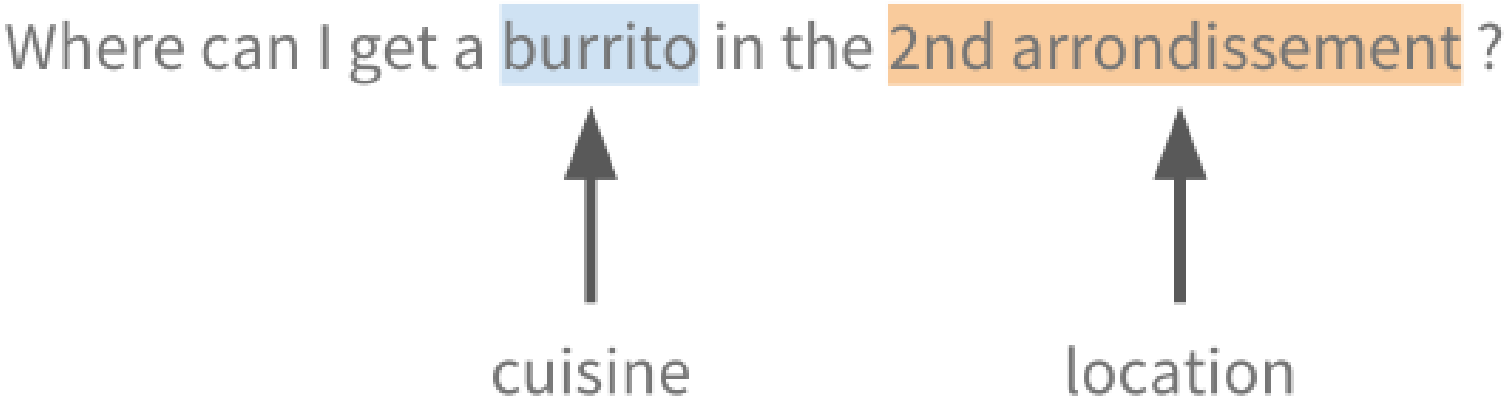


This works *embarrassingly* well, but has limitations:

- Out of vocab words: *"zanzusatzversicherung"*
- Domain-specific meaning: "balance" vs "cash"
- Single intent per message: *"yes please! Oh and can you .."*

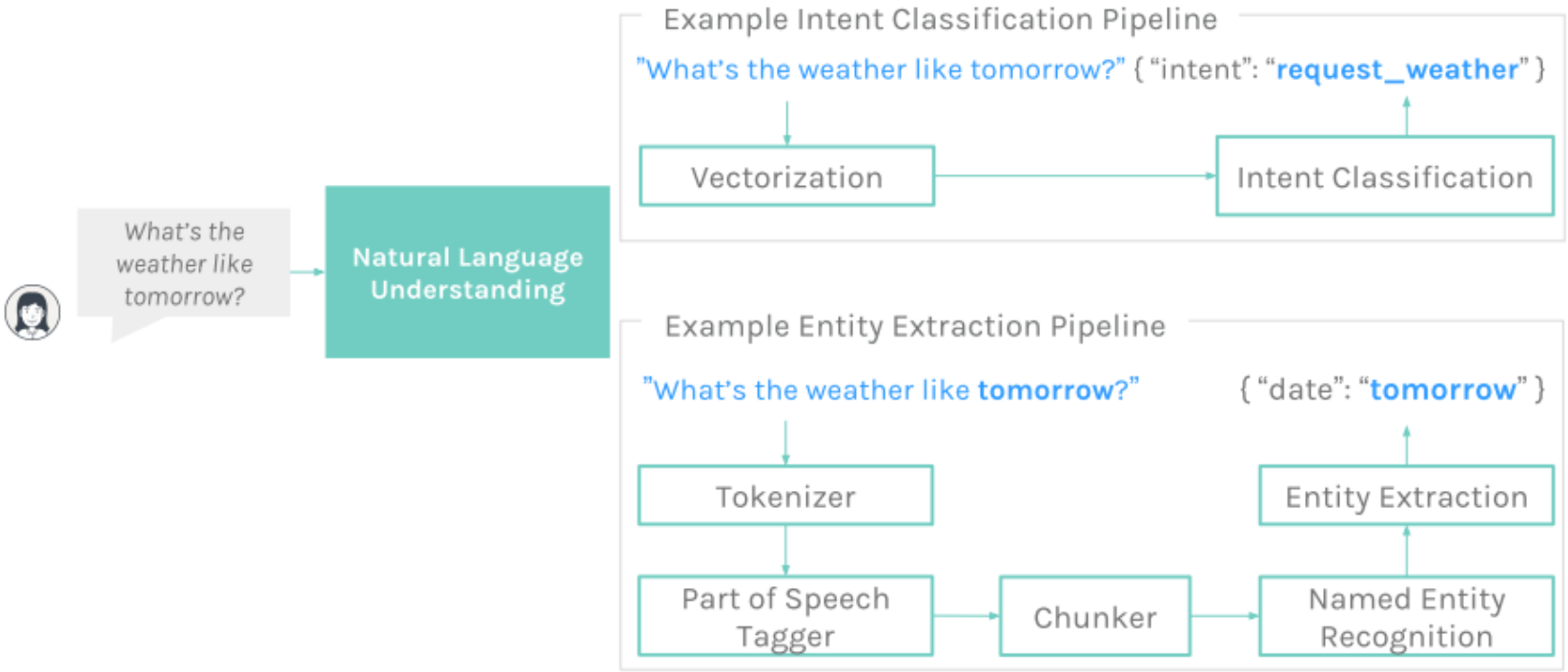
- Get word embeddings of each word, form sentence embeddings by averaging, run a classifier to find max probability intent.
- Classifier does not matter much but the quality of embedding does.
- Need domain specific vocab!!

Entity Extraction



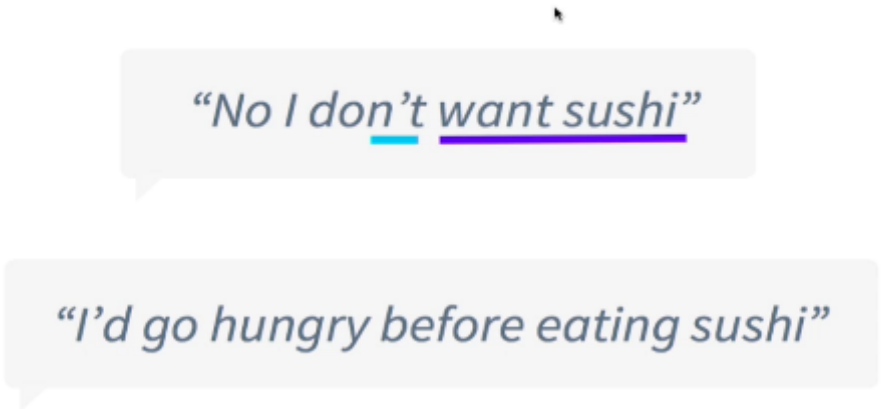
- Can be done in phases.
- First, have a Binary classifier just to detect if the sentence has entities or not.
- Next, it would be multi class classifier to find WHICH entity is there?
- NER with Conditional Random Fields

NLU Full Workflow



NLU is Hard

Especially negations:



- Both the sentences have same meaning, but how to detect!!
- First one is easy, find the negative "not" (LSTM can look for these associations), but how about the second one.

NLU is Impossible (*mushkil hi nahi*, *na mumkin hai*)
Some hopes: better (sentence level) embeddings.

Core

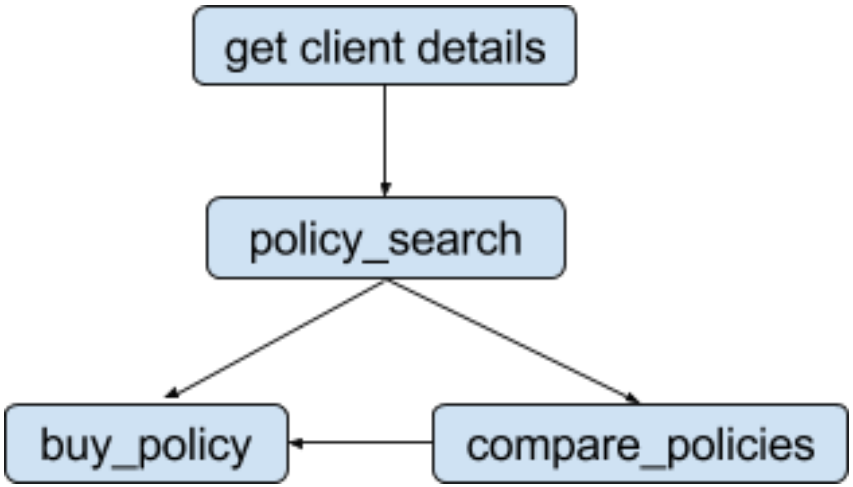
Rasa Core: Getting Rid of State Machines

The main idea behind Rasa Core:

- Thinking of conversations as a flowchart is WRONG
- Implementing conversations as state machine is WRONG
- You would need to come up with ALL possible conversations upfront and explicitly. Not possible!!

State Machines

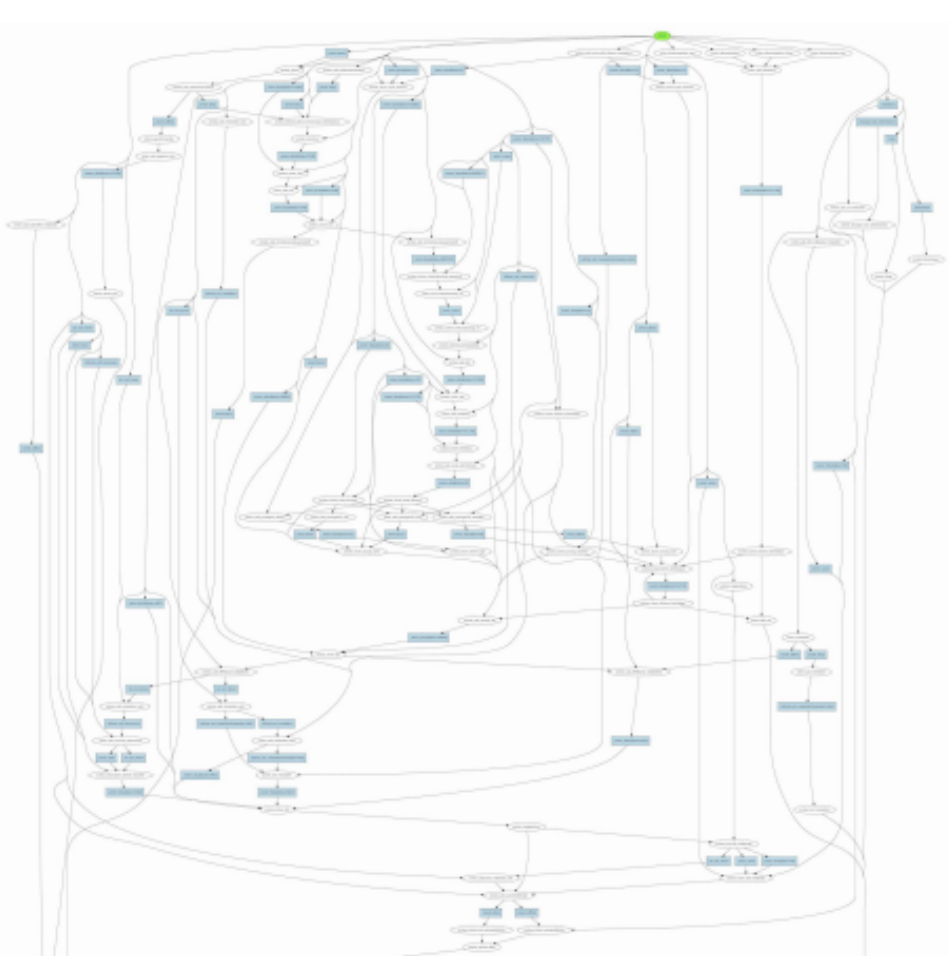
Say, for Insurance Purchase bot, the state machine could be:

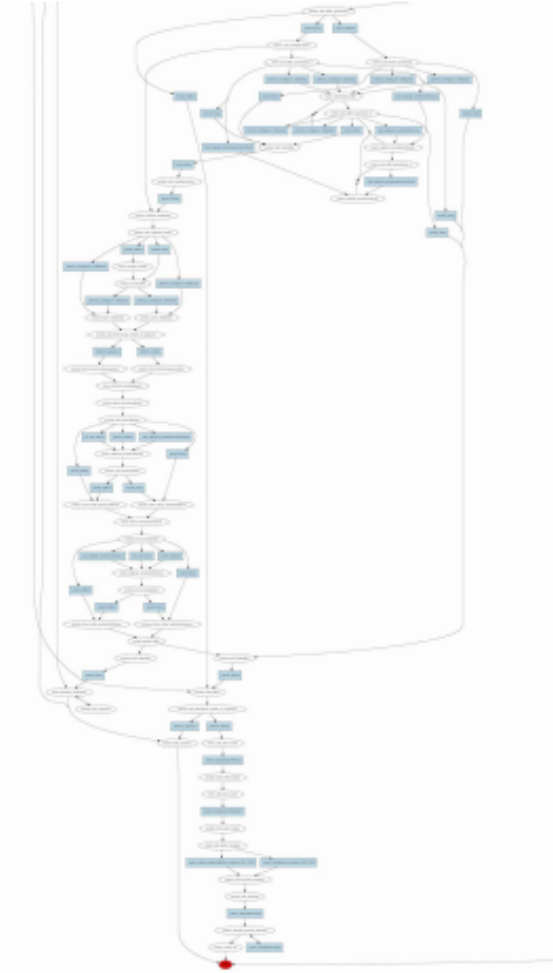


It can take any branch!! What's more likely at a particular state, can be learnt by past data only, ie Machine Learning.

State Machines

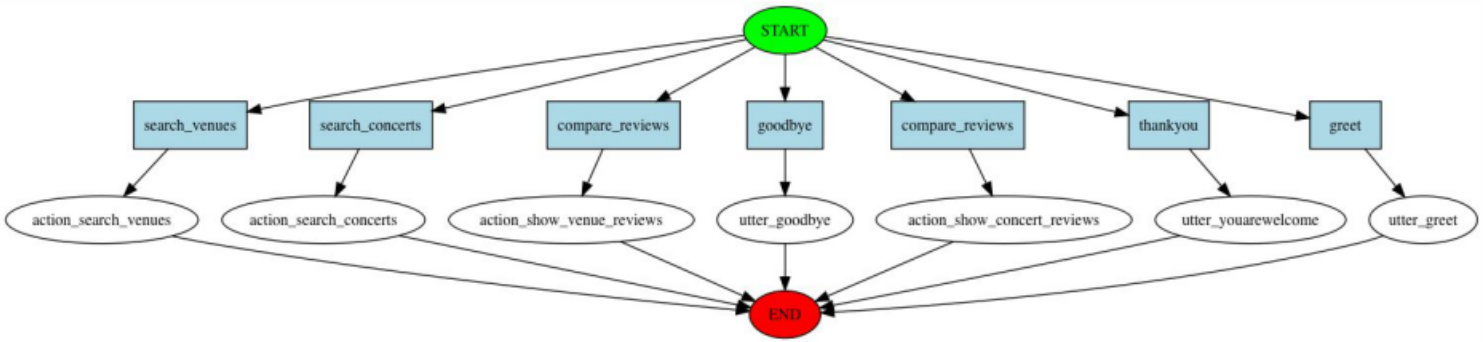
State Machines are infeasible



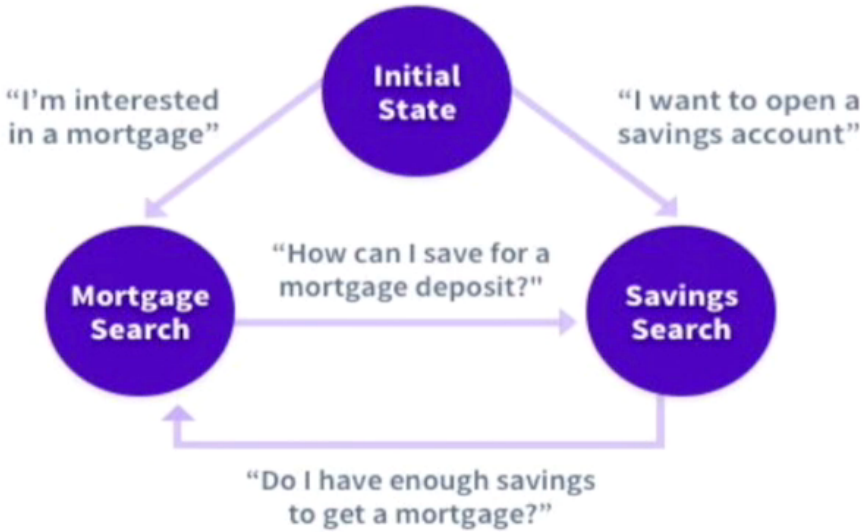


State Machines

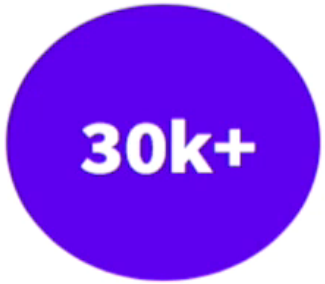
State Machines don't scale



Why Machine Learning?



DAY 1



Lines of XML

DAY 100

Example above is showing real numbers!!

(Ref: Building Conversational AI w Rasa Stack - Alan Nichol at PyBay2018)

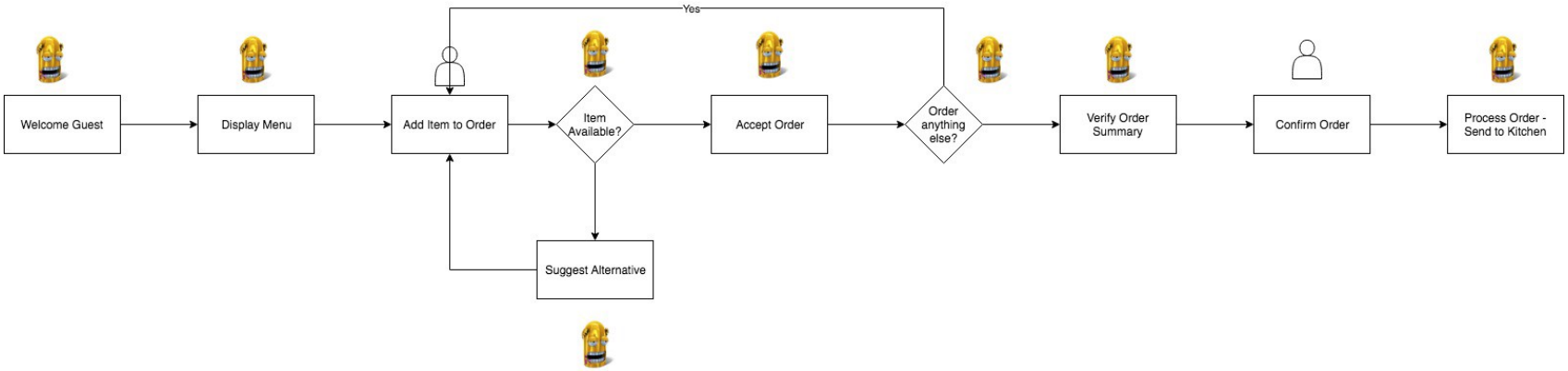
Rasa Core Approach

- Machine learning will be predicting the next action.
- But new approach cannot change radically an existing process: If you want a freaking pizza, you MUST tell a chatbot what type of base, what toppings you want and where you want it delivered.
- But let's be clever about it, there are always exceptions like in the case of pizza: ALLERGIES !! something unexpected.
- Sure you can define a logic around but how many such logic are you going to code each day.
- Keep in mind, Rasa core is not changing your process neither the machine is generating responses, it just allows you to handle exceptions better. Your rules still rule

(Ref: Contextual Conversational Engine— The Rasa Core Approach: Part 1 - Souvik Ghosh)

Example: Ordering Food

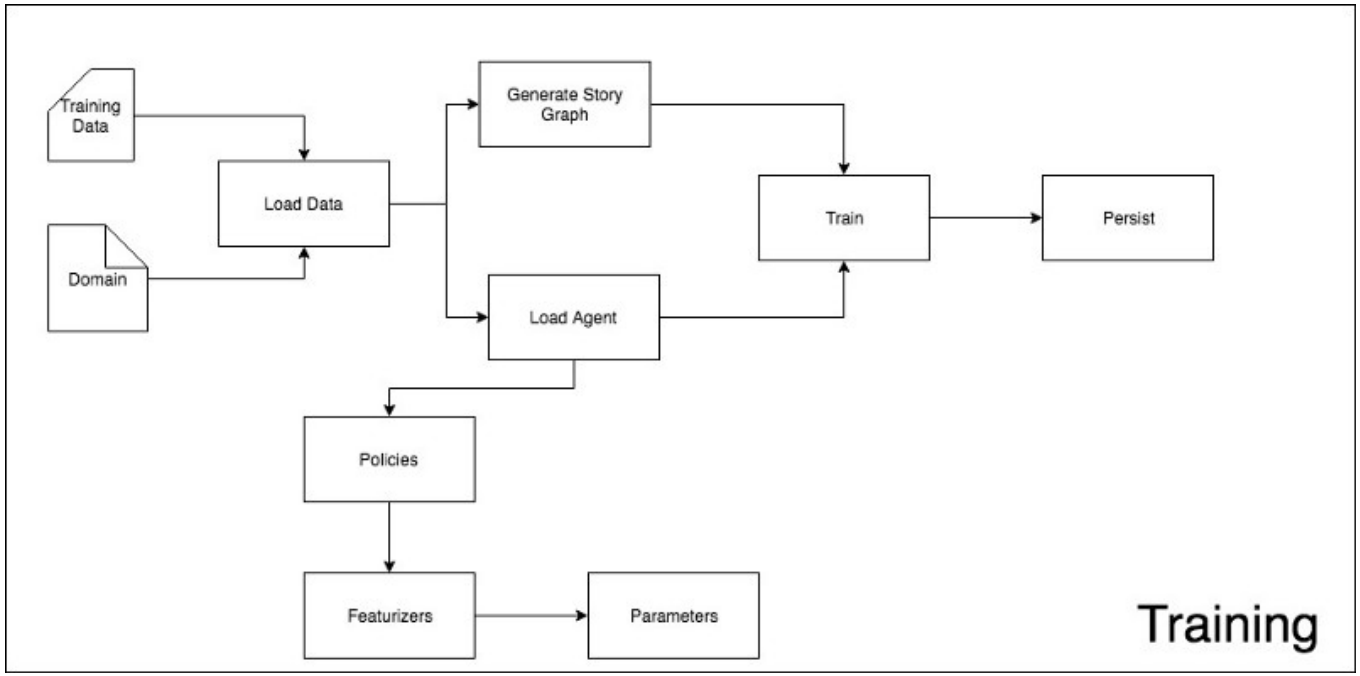
Let's build the different states



- As you can already see, a simple ordering conversation is quite complicated already,
- Covered one of the exceptions, where a given item is not available , the bot can suggest some alternatives.
- There could many such alternatives and how do we deal with item

(Ref: Contextual Conversational Engine— The Rasa Core Approach: Part 1 - Souvik Ghosh)

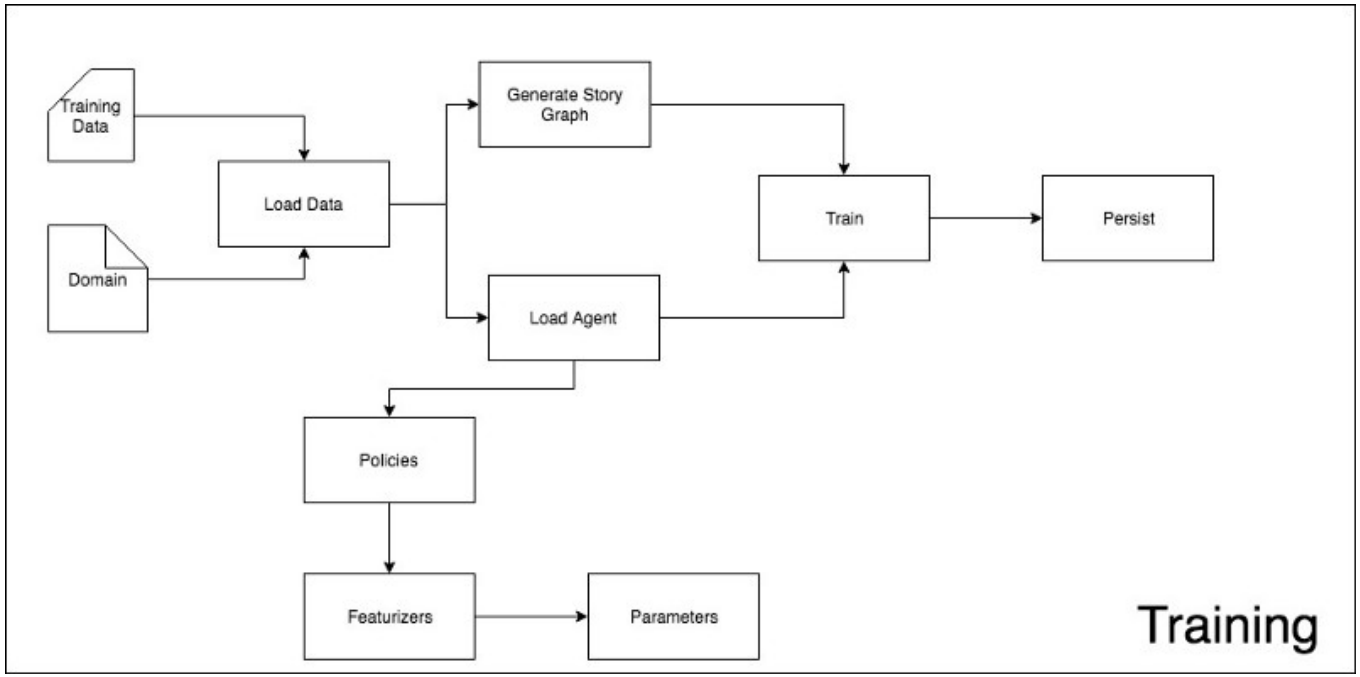
Training Steps



- Training Data: This is essentially all the stories where you typically define what is a normal conversation for your process.
- Domain basically determines what your chatbot should understand, what the chatbot can do and what kind of information is necessary for your chatbot's context so it understands the user better.

(Ref: Contextual Conversational Engine— The Rasa Core Approach: Part 1 - Souvik Ghosh)

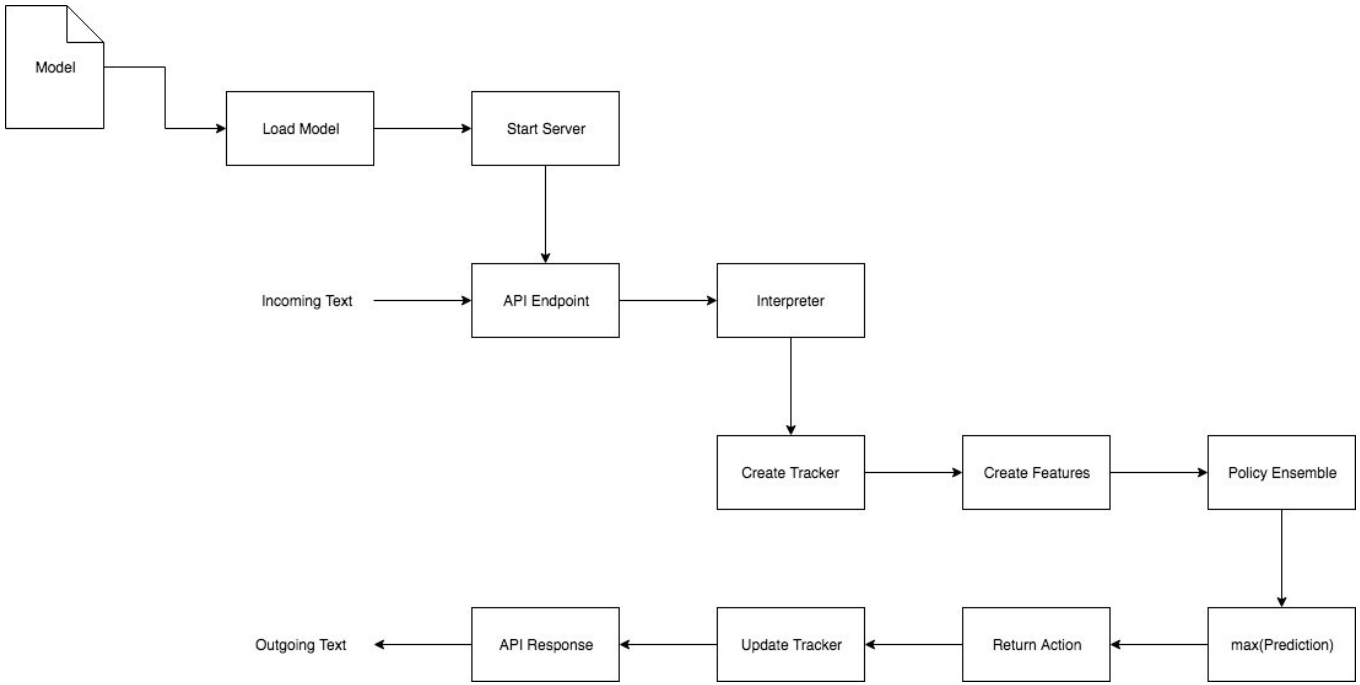
Training Steps



- Load Agent: Agent(or the bot) is first loaded with some parameters that determines how the training data will be converted into features for training the agent. Here, really important parameter is "Policy"
- A policy is what will define what is going to be the next action. As Rasa core is open-source, you can indeed create your own policy but let's get the basics right and see what are the already available policies that are used by default.

(Ref: Contextual Conversational Engine— The Rasa Core Approach: Part 1 - Souvik Ghosh)

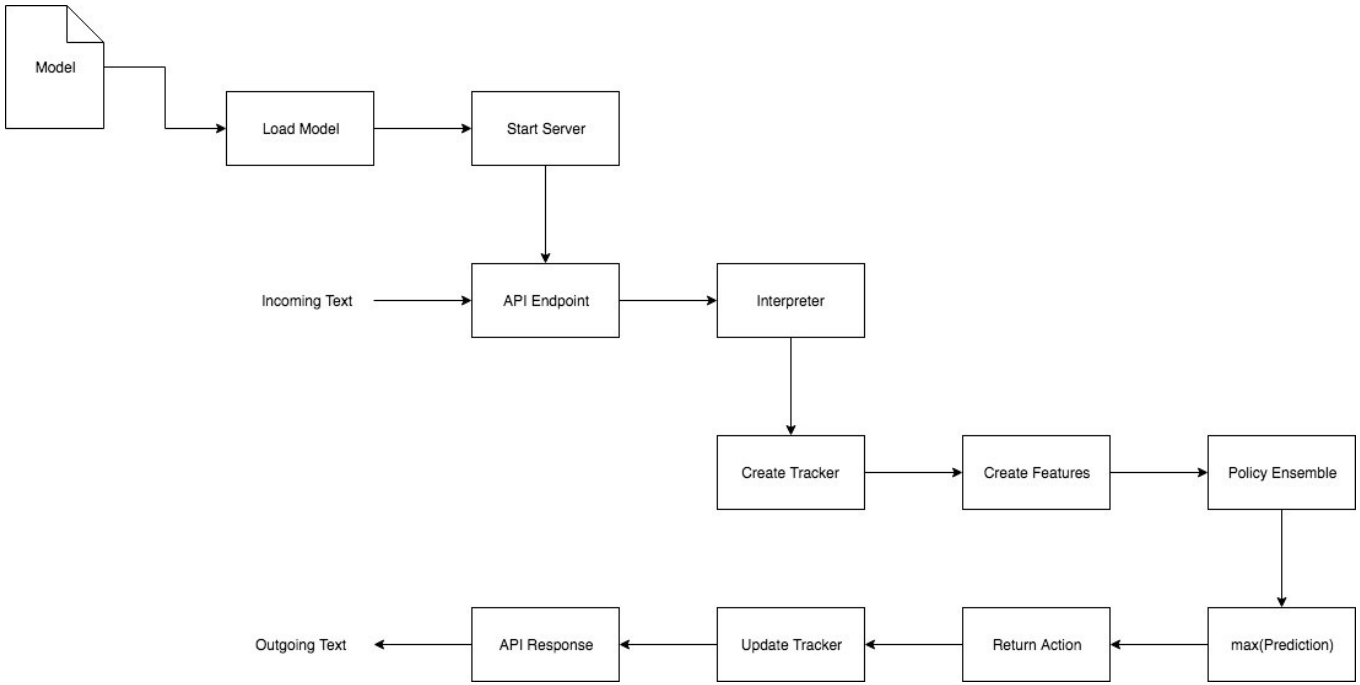
Prediction Process



- Load Model in memory before serving using a Server(Flask) and exposing an endpoint related to a particular channel, in our case we will deal with a REST API.
- Interpreter is able to read the raw text coming in from user and throw out the intention of the user along with some meaning entities, these entities which we are saving as slots that will drive the conversation.

(Ref: Contextual Conversational Engine— The Rasa Core Approach: Part 1 - Souvik Ghosh)

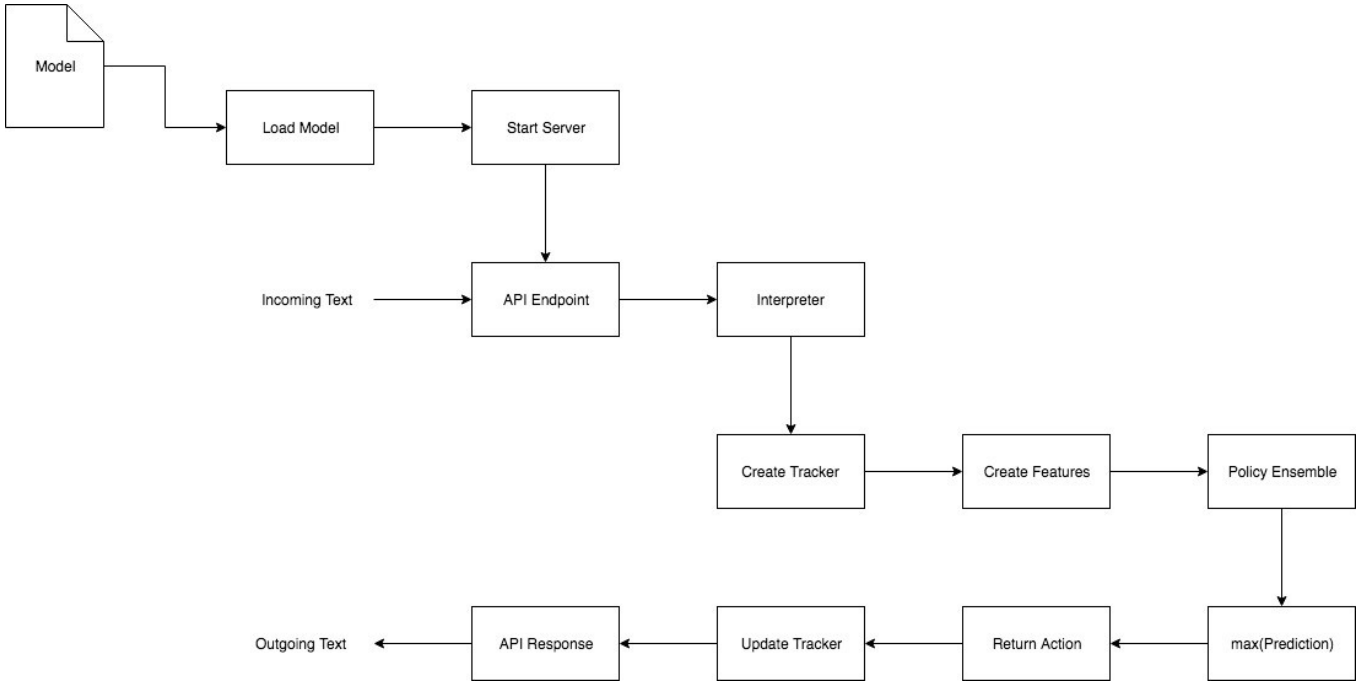
Prediction Process



- CreateOrUpdate Tracker: If this is the first message of the conversation, rasa core will create a tracker object with the key "sender_id" which is the incoming identifier of the user. Tracker object is usually stored in a tracker_store which is by default is in InMemory.
- Features are generated from contents of the tracker based on the policy
- Features will given to the policy ensemble which will determine the final outcome.

(Ref: Contextual Conversational Engine— The Rasa Core Approach: Part 1 - Souvik Ghosh)

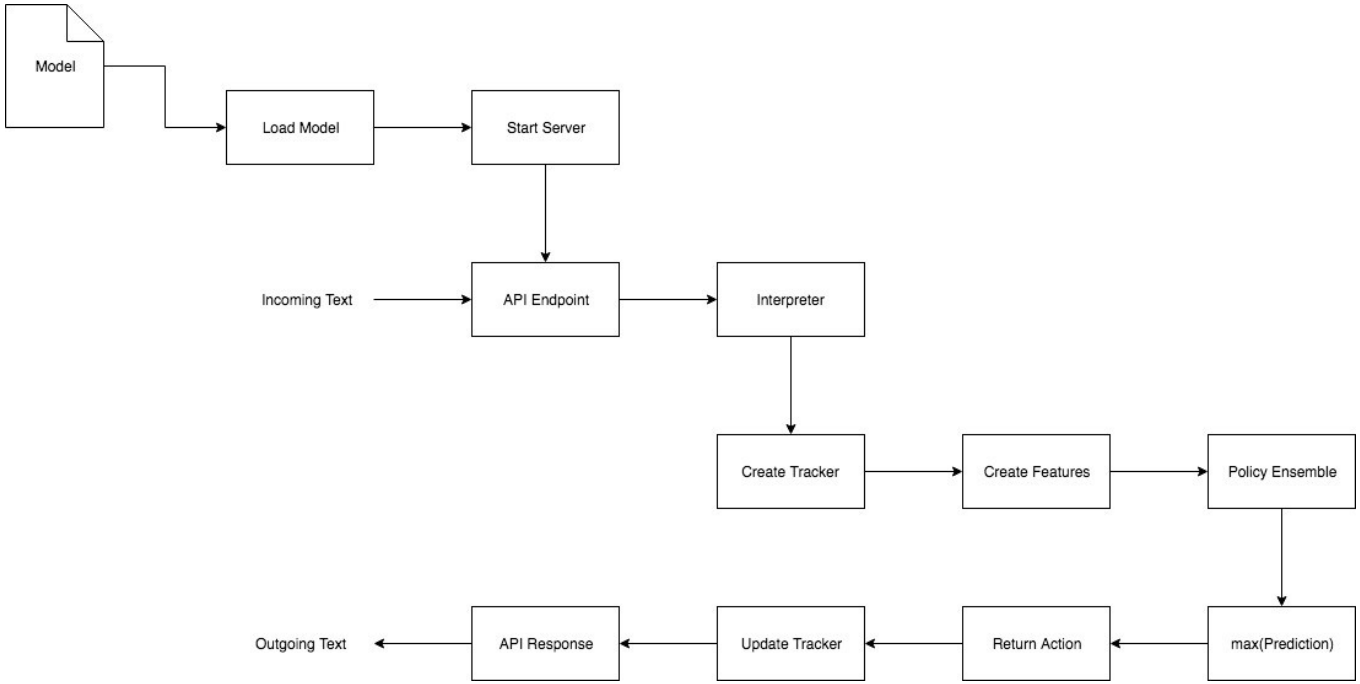
Prediction Process



- PolicyEnsemble: Since, we have trained different policies, when it comes to predicting the next action, each of these policies will provide a score for the particular action.
- Then there is a max taken from all scores given by every policy and whichever wins, will be the next action

(Ref: Contextual Conversational Engine— The Rasa Core Approach: Part 1 - Souvik Ghosh)

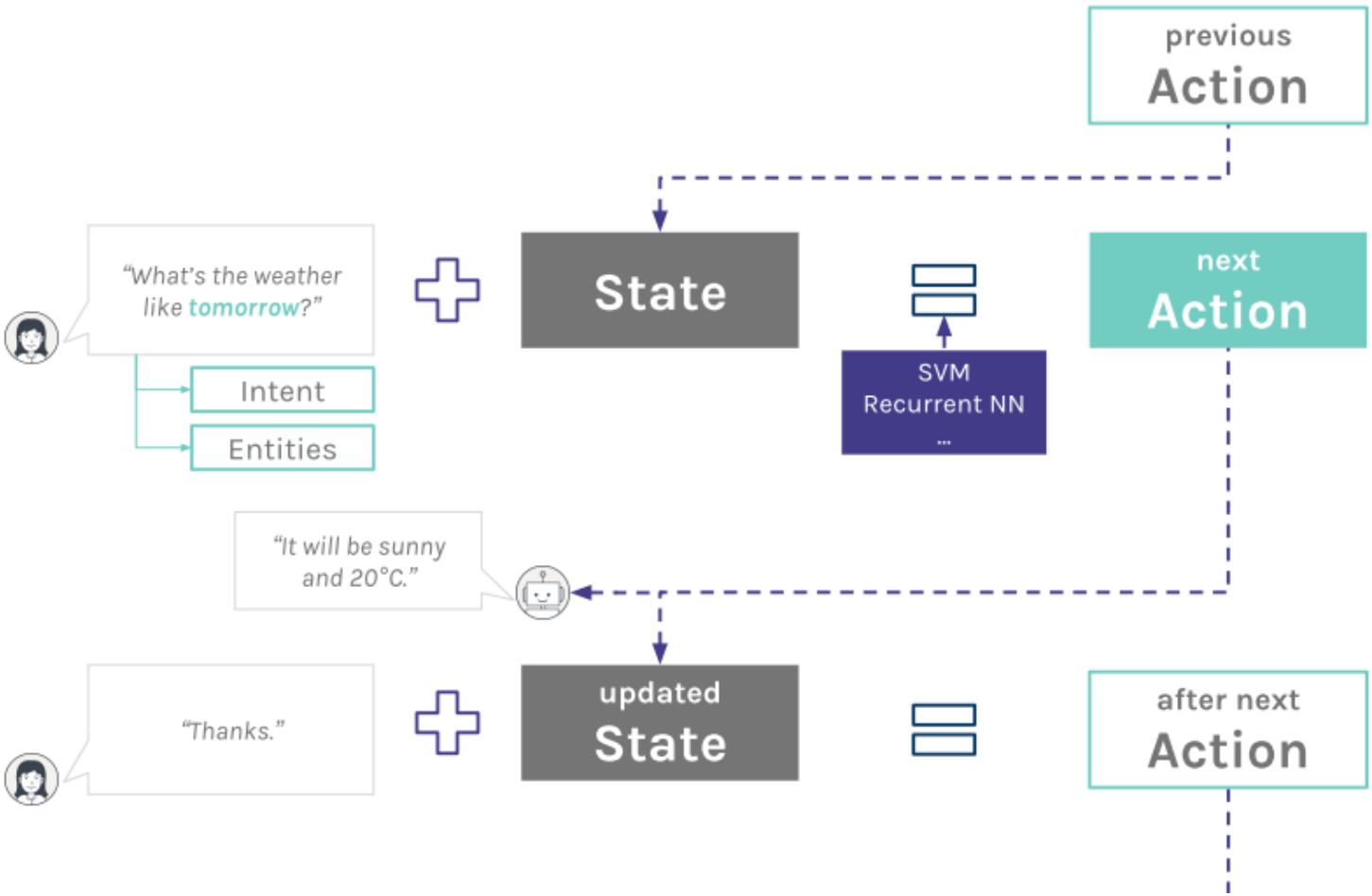
Prediction Process



- Update Tracker: Once you have the action predicted, you will need to update the tracker for the next turn
- ExecuteAction: Now you will be finally executing your action, be it an API call or a message sent back to the user

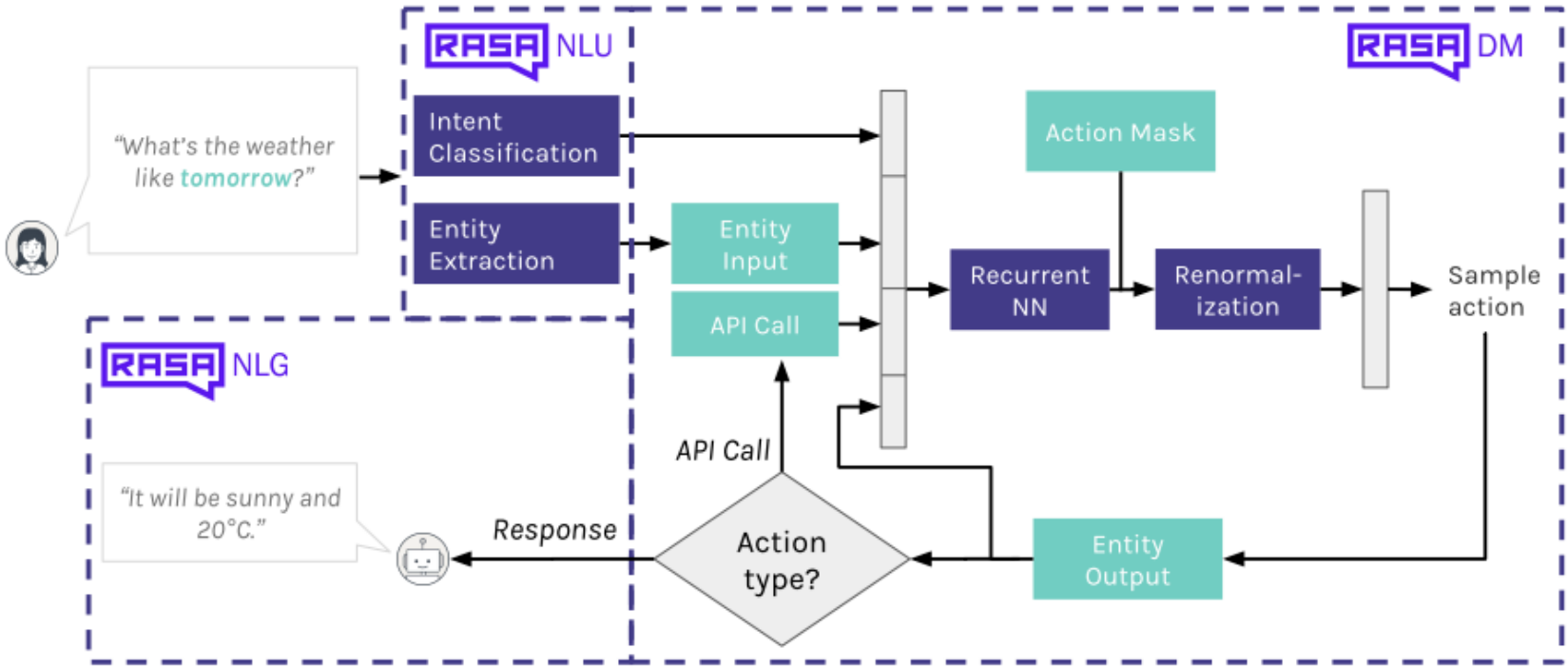
(Ref: Contextual Conversational Engine— The Rasa Core Approach: Part 1 - Souvik Ghosh)

Summary: Overall Workflow



Summary: Overall Workflow

Similar to LSTM-dialogue prediction paper: https://arxiv.org/abs/1606.01269



Demo

Rasa Init

```
mkdir firstbot
cd firstbot
activate rasa_env
rasa init  --no-prompt
```

- Creates project structure and dummy files.
- Good to run and execute
- You can run as is or add your data to nlu.md, stories.md and domain.yml; retrain and run.
- If you get any warnings replace “rasa” with “python -W ignore -m rasa ”

(Ref: How to build awesome Rasa chatbot for a web - Martin Novak)

Rasa Shell

To run the bot:

```
python -W ignore -m rasa shell --quiet --cors * -m models

# Sample Chat
Bot loaded. Type a message and press enter (use '/stop' to exit):
Your input ->  hi
Hey! How are you?
Your input ->  perfect
Great, carry on!
Your input ->  are you a bot?
I am a bot, powered by Rasa.
Your input ->  /stop
```

Now, sky is the limit . . .

References

Many publicly available resources have been refereed for making this presentation. Some of the notable ones are:

- RASA-NLU setup, installation, https://github.com/RASAHQ/rasa_nlu
- Chatbots 101 - Architecture & Terminologies - Bhavani Ravi and the event-bot code
- Building chatbots using Python/Django - Youtube video.
- GST FAQ http://www.cbec.gov.in/resources//htdocs-cbec/deptt_offcr/faq-on-gst.pdf
- "Building a Conversational Chatbot for Slack using Rasa and Python" - Parul Pandey
- "The next generation of AI assistants in enterprise" - Alan Nichol
- Top 8 Healthcare Predictions for 2019 - FROST & SULLIVAN/ Reenita Das
- How Artificial Intelligence is Changing the Healthcare Industry - Sumi menon
- Can Healthcare Chatbots Improve the Patient Experience? - Intakeq
- Pydata Berlin talk by Tom Bocklisch
- Conversational AI: Design & Build a Contextual AI Assistant - Mady Mantha

Thanks ... yogeshkulkarni@yahoo.com