

# INTRODUCTION TO CHATBOT WITH RASA

Yogesh Kulkarni

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# Introduction

## Calling the Call Center

- ▶ Calling to an IVR (Integrated Voice Response)
- ▶ A pre-recorded menu selection.
- ▶ “Please press 1 for Account Details, Please press 2 for . . .”
- ▶ Till it comes to your option.
- ▶ Else, you are given access to a person to talk to.

Boring? Annoying? But still heavily used . . . , Why?



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

Instead, how about typing/saying your query directly and getting the answer right away?

# Solution

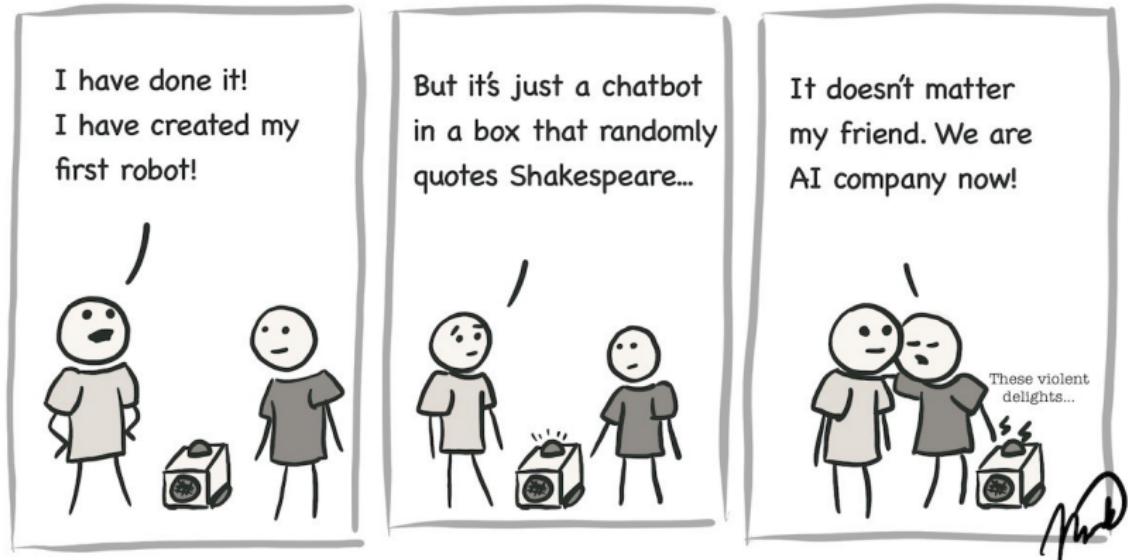
## Chatbots!!!

- ▶ Which problem of IVR it is solving?
- ▶ Advantages?
- ▶ Disadvantages?
- ▶ Gaining popularity ...
- ▶ Many platforms
- ▶ Any local chatbot companies/platforms?

## Crystal Ball

- ▶ 85% Of customer interactions will be managed without a human by 2020
  - Gartner prediction
- ▶ “The global chatbot market is expected to reach \$1.23 billion by 2025” - Business Insider

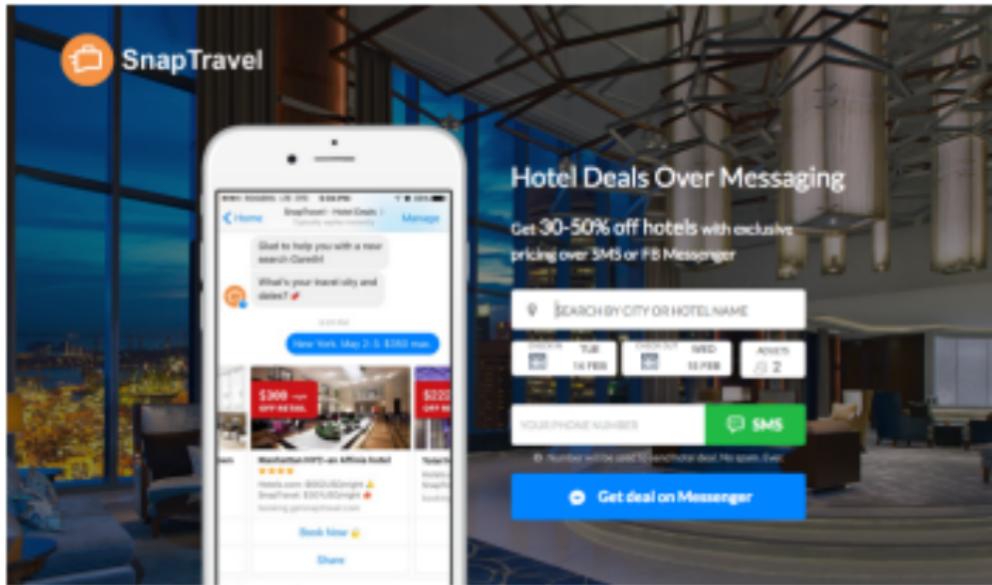
## Chatbot == AI



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

## Sample Application

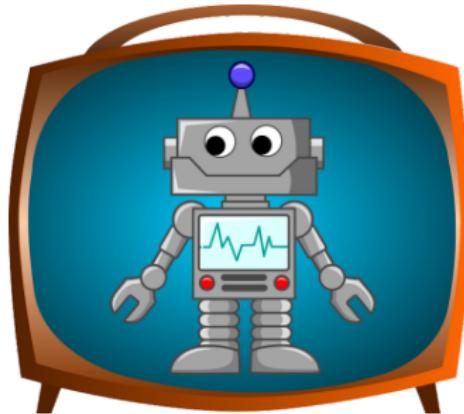
SnapTravel has processed \$1 million in hotel bookings inside Messenger.



(Ref: Innovation in Health - Ritesh Ptael, et al)

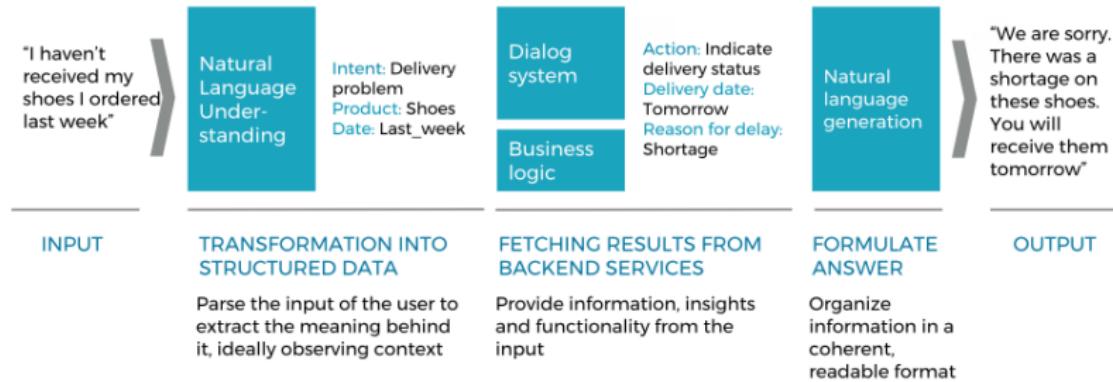
## So, What is a Chatbot?

"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 )

## Why so many chatbot startups?

- ▶ VCs appear excited with this new tool, more services, more opportunities, new battlegrounds for the big players (likely leading to acquisitions).
- ▶ So even without real technological breakthroughs, there is at least some money to be made investing in bot startups.
- ▶ But the real issue is : Truly 'conversational' software is a difficult problem to solve.

(Ref: We don't know how to build conversational software yet (Alan Nichol Apr 2016))

## How difficult?

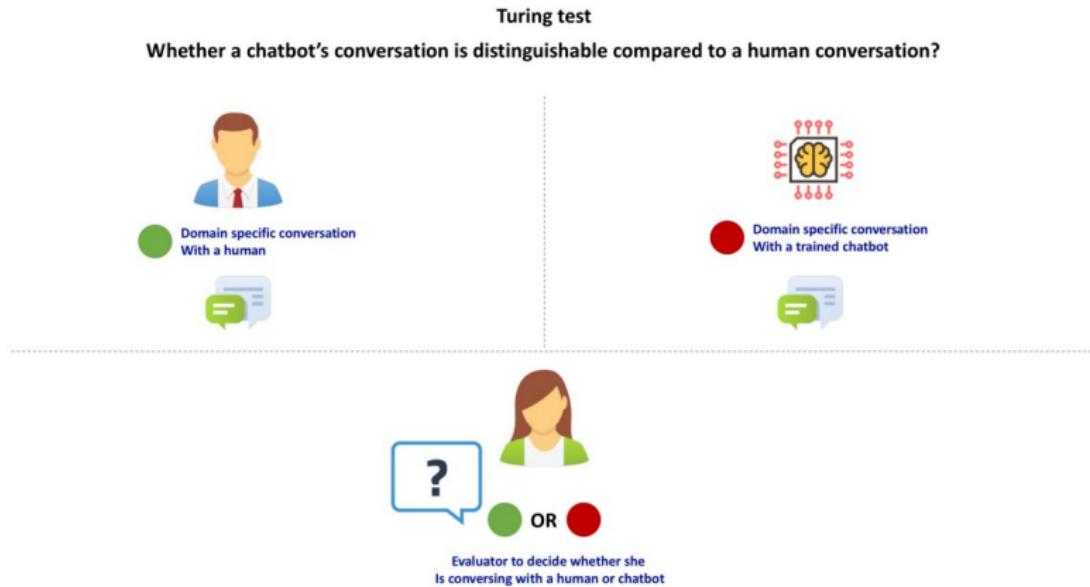


So what tools do developers need to do better than this?

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

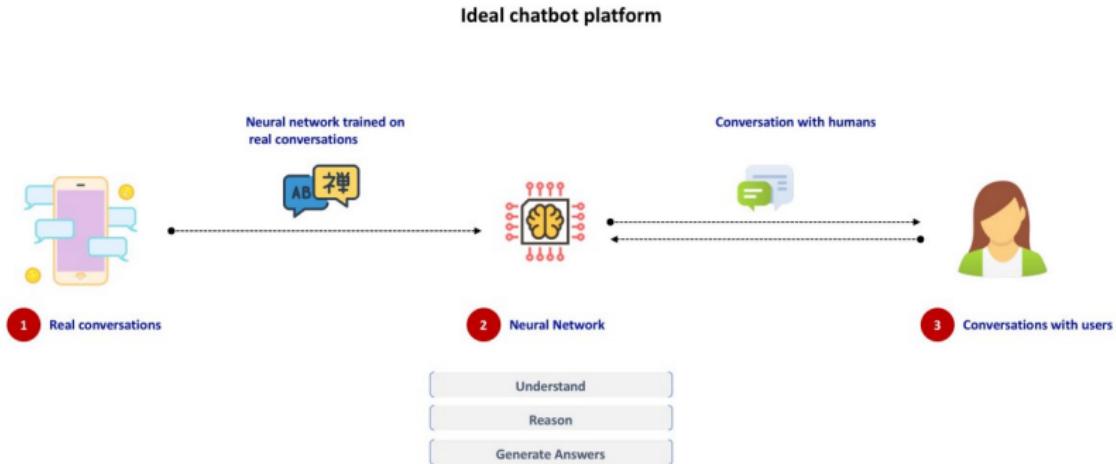
# NLU is AI

Understanding Natural Language is Hallmark of Artificial Intelligence!!



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

# NLU is AI



But the current bots are not this generic.

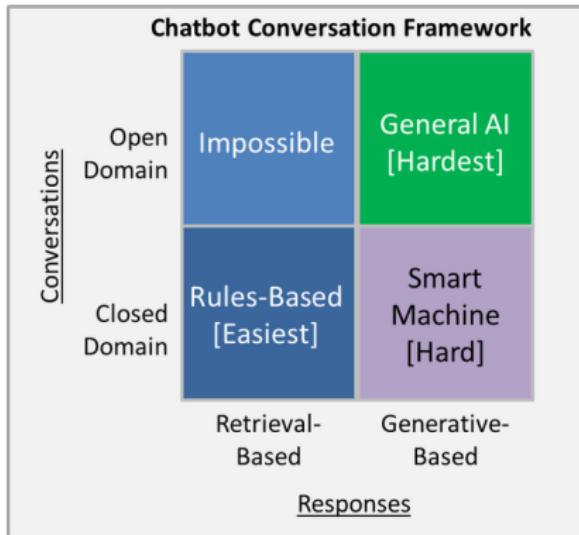
(Ref: Conversational AI: Understanding the Basics and Building a Chatbot in Rasa module - Manikandan Jeeva)

## Types of Chatbots

- ▶ Command & response: Stateless bots are essentially a command line app over HTTP
- ▶ Hard-coded conversation flows: navigate a flow chart defined. <http://superscriptjs.com/> allows that. Evi is an intelligent bot built with “knowledge base” technology.
- ▶ Fuzzy/continuous/fluid state: that's the goal. Human conversations don't follow a template

(Ref: We don't know how to build conversational software yet (Alan Nichol Apr 2016))

# Classification of Chatbots

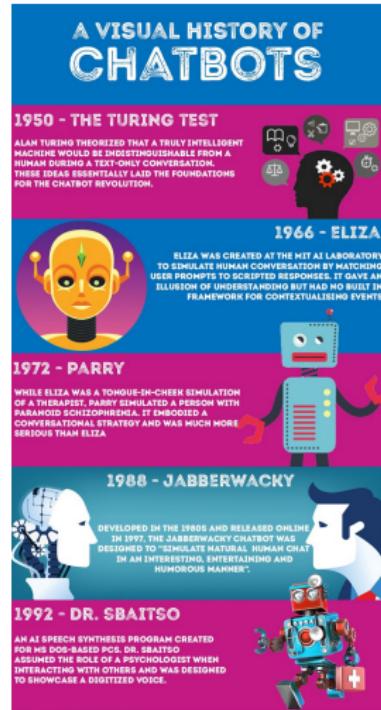


- ▶ Retrieval-based models (easier) use a repository of predefined responses and some kind of heuristic to pick an appropriate response based on the input and context.
- ▶ Generative models (harder) are based on Machine Translation techniques, but instead of translating from one language to another, we “translate” from an input to an output (response).

# History

- ▶ Chatbot history: starts in 1960s.
- ▶ Eliza by MIT professor Joseph Weizenbaum: a psychotherapist, Pattern based.
- ▶ ALICE ("Artificial Linguistic Internet Computer Entity"), 1995, Richard Wallace using AIML (artificial intelligence markup language)
- ▶ Then of course, most tech giants

(Ref: Understanding AI Chatbots, Challenges, Opportunities & Beyond - Pramod Chandrayan)



# History

**1995 - ALICE**  
THE "ARTIFICIAL LINGUISTIC INTERNET COMPUTER ENTITY" WAS A NATURAL LANGUAGE PROCESSING BOT. SHE COULD APPLY HEURISTIC PATTERN MATCHING RULES TO HUMAN INPUT IN ORDER TO HAVE A CONVERSATION, BUT WAS STILL NOT ABLE TO PASS THE TURING TEST.

**2001 - SMARTERCHILD**  
AN INTELLIGENT BOT WIDELY DISTRIBUTED ACROSS SMS NETWORKS AND BUDDY LISTS OF AOL AND MSN MESSENGERS USERS. IT OFFERED A FUN PERSONALIZED CONVERSATION AND WAS CONSIDERED A PRECURSOR TO APPLE'S SIRI AND SAMSUNG'S VOICE.

**2006 - IBM'S WATSON**  
WATSON WAS ORIGINALLY DESIGNED TO COMPETE ON THE TV SHOW JEOPARDY! IN WHICH HE BEAT TWO OF THE SHOW'S FORMER CHAMPIONS. WATSON HAS SINCE GONE ON TO BIGGER AND BETTER THINGS USING NATURAL LANGUAGE PROCESSING AND MACHINE LEARNING TO REVEAL INSIGHTS FROM LARGE AMOUNTS OF DATA.

**2010 - SIRI**  
SIRI IS AN INTELLIGENT PERSONAL ASSISTANT. IT IS PART OF APPLE'S IOS AND USES A NATURAL LANGUAGE UI TO ANSWER QUESTIONS AND PERFORM VARIOUS REQUESTS. SIRI DID THE GROUNDWORK FOR ALL LATER AI BOTS AND PERSONAL ASSISTANTS.

**2012 - GOOGLE NOW**  
DEVELOPED BY GOOGLE FOR THE GOOGLE SEARCH MOBILE APP, IT EMPLOYS A NATURAL LANGUAGE USER INTERFACE TO ANSWER QUESTIONS, MAKE RECOMMENDATIONS, AND PERFORM ACTIONS BY PASSING ON REQUESTS TO A SET OF WEB SERVICES

**2015 - ALEXA**  
AN INTELLIGENT PERSONAL ASSISTANT THAT INHABITS THE AMAZON ECHO DEVICE. ALEXA'S CAPABLE OF VOICE INTERACTION, USING NATURAL LANGUAGE PROCESSING ALGORITHMS TO RECEIVE, RECOGNIZE, AND RESPOND TO VOICE COMMANDS.

**2015 - CORTANA**  
MICROSOFT'S VERSION OF THE INTELLIGENT ASSISTANT THAT CAN SET REMINDERS AND ANSWER QUESTIONS USING THE BING SEARCH ENGINE. CORTANA RECOGNIZES NATURAL VOICE COMMANDS AND IS AVAILABLE IN A NUMBER OF DIFFERENT LANGUAGES.

**2016 - BOTS FOR MESSENGER**  
IN APRIL, FACEBOOK LAUNCHED A MESSENGER PLATFORM WHICH ALLOWS DEVELOPERS TO CREATE BOTS THAT CAN INTERACT WITH FACEBOOK USERS. AT THE END OF 2016, 34,000 BOTS WERE AVAILABLE COVERING A WIDE RANGE OF USE CASES.

**2016 - TAY**  
TAY WAS A CHATBOT CREATED BY MICROSOFT TO MIMIC THE SPEECH AND HABITS OF A TEENAGE GIRL. IT CAUSED CONTROVERSY WHEN IT BEGAN TO POST OFFENSIVE TWEETS AND BECAME INCREASINGLY PARANOIA. IT EVENTUALLY HAD TO BE SHUT DOWN JUST 16 HOURS AFTER LAUNCH.

## SOURCES

[HTTP://WWW.IBM.COM](http://www.ibm.com)  
[HTTP://EN.WIKIPEDIA.ORG](http://en.wikipedia.org)  
[HTTP://WWW.EVENTUREBEAT.COM](https://www.eventurebeat.com)  
[HTTP://WWW.FRESPR.COM](http://www.frespir.com)



**WIZU.COM**  
THE FIRST BOT FOR CUSTOMER FEEDBACK

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

## Comparison

- ▶ Rule Based (AIML)
  - ▶ Decision tree, with small samples ok
  - ▶ Pre-defined responses, so predictable
- ▶ ML Based (Rasa)
  - ▶ Large Samples a must
  - ▶ More natural responses, but initially unpredictable

Start with AIML, once data is received go with ML based

## Why so much popularity?

Chatbots are:

- ▶ Autonomous and Always Available
- ▶ Drive Conversation
- ▶ Able to handle millions of requests, scalable.

But to have a good Chatbot, at core, we would need expertise in NLP!!

# Forecasts

"Chatbots will fundamentally revolutionize how computing is experienced by everybody."  
- Satya Nadella

"In the next five to 10 years, AI is going to deliver so many improvements in the quality of our lives."  
- Mark Zuckerberg

"Robots will be able to do everything better than us."  
- Elon Musk

(Ref: Subro.io)

Through the Bill and Melinda Gates Foundation, Microsoft's co-founder and chairman has invested more than **\$240 million** to date in a developing field known as "personalized learning."



The global Chatbots market was valued at **USD 88.5 Million** in 2015 and is anticipated to witness a substantial compound annual growth rate (**CAGR**) of **35.08%** over the period 2016-2023.



**63%** of people would consider messaging an online chatbot to communicate with a business or brand.



**100,000 Facebook**

There are more than 100, 000 chatbots on Facebook Messenger.



# Forecasts

**1 / 2** More than half of consumers prefer business that use chat apps.



80% of businesses want chatbots by 2020.



By **2020**, an average person will have more conversions with chatbots than with his/her spouse.



**2022**  
Chatbots expected to cut business costs by \$8 billion by 2022.



59% of millennials & 60% of Gen Xers have used chatbots on a messaging app.



**38% ↗ 62%**

38% of enterprises are already using AI technologies and 62% will use AI technologies by 2018.



**75% ↗ 90%**

The success rates of bot interactions in the healthcare and banking sectors will reach over 75% and 90% respectively.



## Healthcare & Banking

providers using chatbots can expect average time savings of just over 4 minutes per enquiry.

## 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 ...

## Pros

- ▶ Anytime, day or night
- ▶ Can handle repetitive, boring tasks
- ▶ Scalable
- ▶ Consistent
- ▶ Can gather data

## Cons

- ▶ NLU is hard, AI is not GENERAL yet
- ▶ Cant design for ANY interaction
- ▶ Can be Risky
- ▶ Cant trust for sensitive data

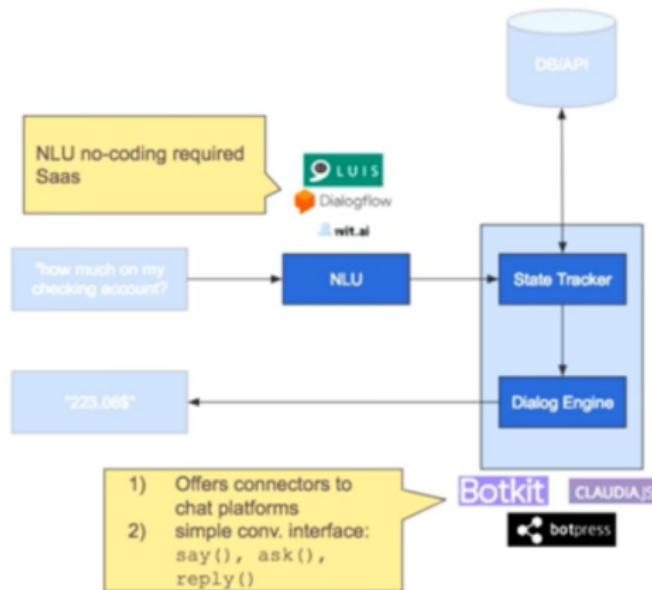
# Chatbot Platforms

## 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)

# Typical Chatbot Platform



NLU is over net and Dialog management is still if-and-else.

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

# Conversation Platforms

## Established players

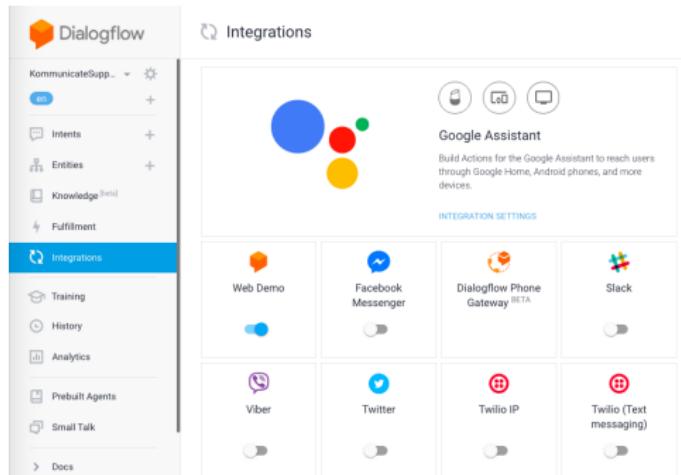
- ▶ Google DialogFlow : <https://dialogflow.com>
- ▶ Facebook Wit.ai : <https://www.wit.ai>
- ▶ IBM Watson Assistant : <https://www.ibm.com/cloud/watson-assistant/>
- ▶ Microsoft LUIS : <https://www.luis.ai/>
- ▶ Amazon Lex : <https://aws.amazon.com/lex>
- ▶ RASA : <https://www.rasa.com/>



(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.

The screenshot shows the AWS Lambda function configuration for the 'BootTrip' function. The 'Channels' tab is selected, showing the 'Facebook' channel configuration. The form fields include:

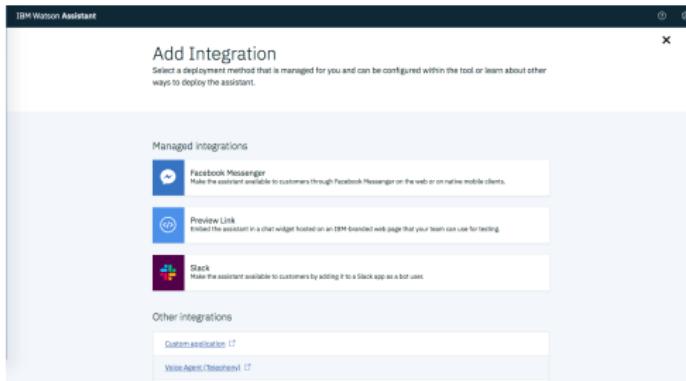
- Channel Name\*: [Input field]
- Channel Description: [Input field]
- IAM Role: `LexVSGenS3ReadForLexChannels` (Automatically created on your behalf)
- KMS Key: [Input field]
- Alias\*: [Input field]
- Verify Token\*: [Input field] (Value: VerifyToken)
- Page Access Token\*: [Input field] (Value: PageAccessToken)

At the bottom, there are links for Feedback, English (US), Privacy Policy, and Terms of Use.

(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

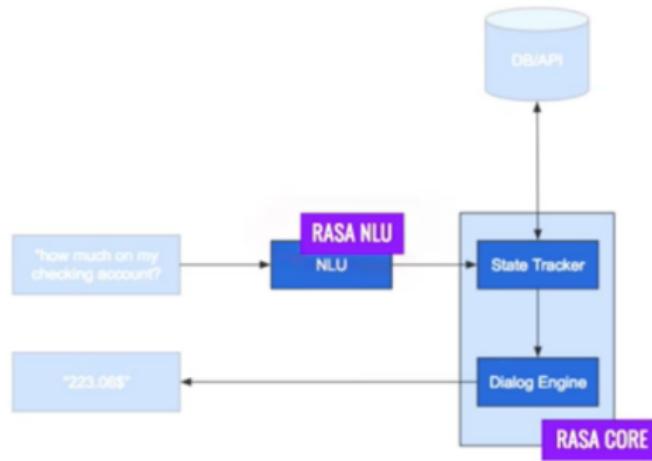
- ▶ Web interface is available to create and publish bots which is fairly easy to understand.

The screenshot shows the 'Channels' section of the Azure Bot Service interface. On the left, there's a sidebar with a search bar and a list of navigation items: Overview, Activity log, Access control (IAM), Tags, BOF MANAGEMENT (Build, Test in Web Chat, Analytics), and Channels (which is selected and highlighted in blue). Below the sidebar, the main content area is titled 'Connect to channels'. It lists two channels: 'Skype' and 'Web Chat', both marked as 'Running'. Each channel entry includes an 'Edit' button. At the bottom of the list, there's a link 'Get bot embed codes' and a button labeled 'Add a featured channel'.

Name	Health	Published	Action
Skype	Running	--	Edit
Web Chat	Running	--	Edit

(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 Zylbersztein)

# 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

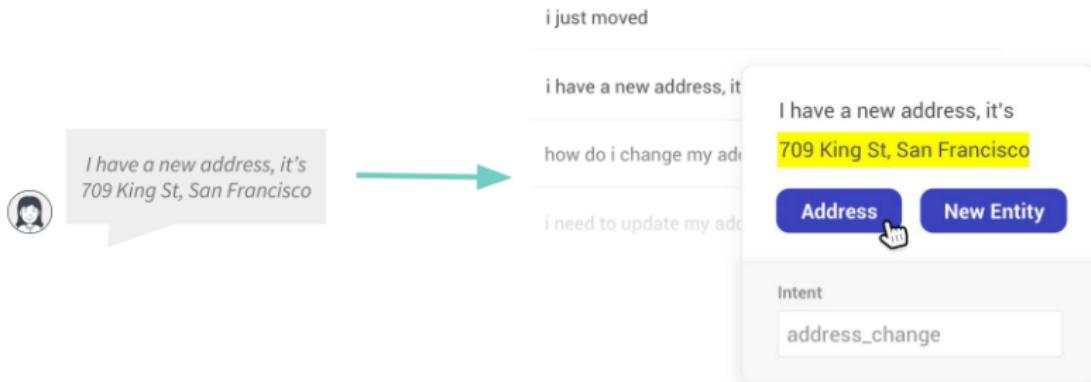
## NLU Training

“train” function iterates through the pipeline and performs the NLP tasks

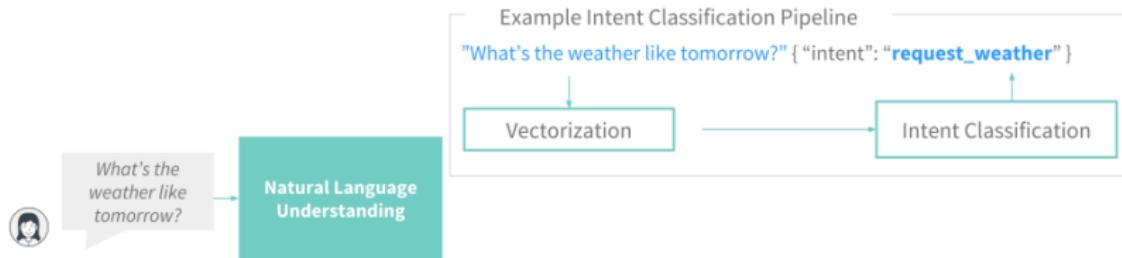
- ▶ The preprocessing step: Where the data is transformed to extract the required information. Eg. SpacyTokenizer, SpacyFeaturizer
- ▶ Entity Extractor & Intent Classifier: The preprocessed data is used to create the ML models that perform intent classification and entity extraction. NER\_CRF EntityExactor,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

# Natural Language Understanding (NLU)

Goal: create structured data



# Intent Classification

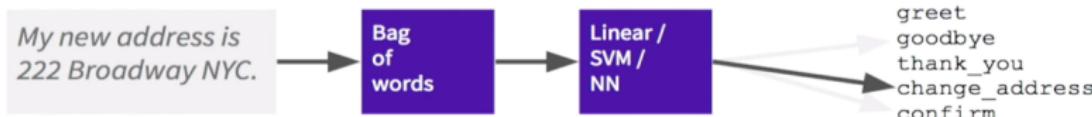


# Intent Classification

## Intent Classification with GloVe

Bag of words sentence representation:

$$\{v_1, \dots, v_s\} \rightarrow \frac{1}{s} \sum_i v_i$$



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!!

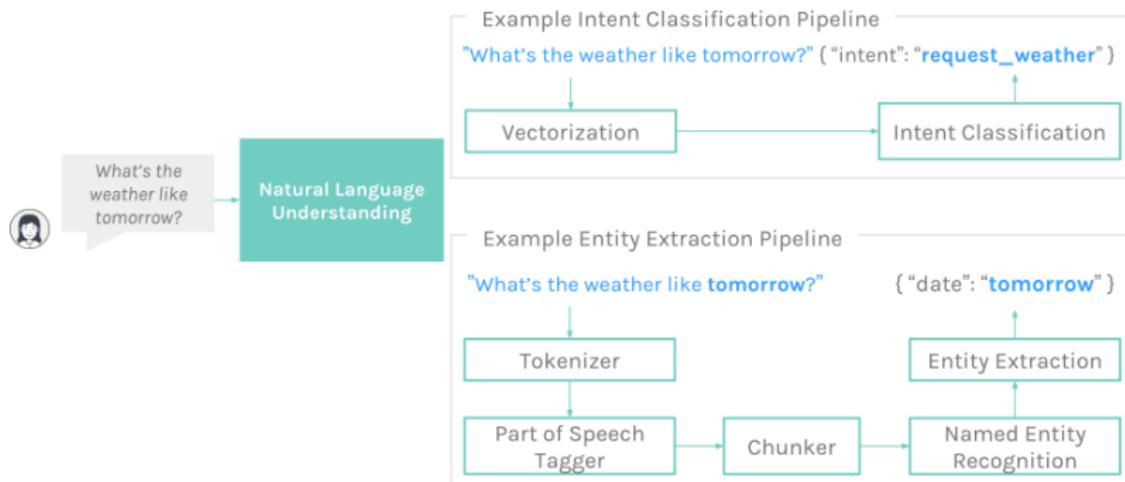
## Entity Extraction

Where can I get a burrito in the 2nd arrondissement?



- ▶ 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:

*"No I don't want sushi"*

*"I'd go hungry before eating sushi"*

- ▶ 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

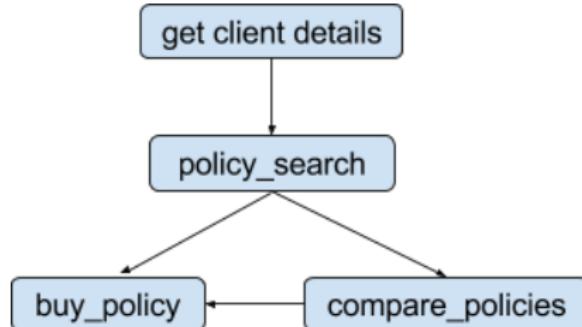
## Rasa Core: Getting Rid of State Machines

The main idea behind Rasa Core:

- ▶ Thinking of conversations as a flowchart is WRONG
- ▶ Implementing conversations as state machine is WRONG
- ▶ Its had to come up with ALL possible conversations upfront and explicitly.

## State Machines

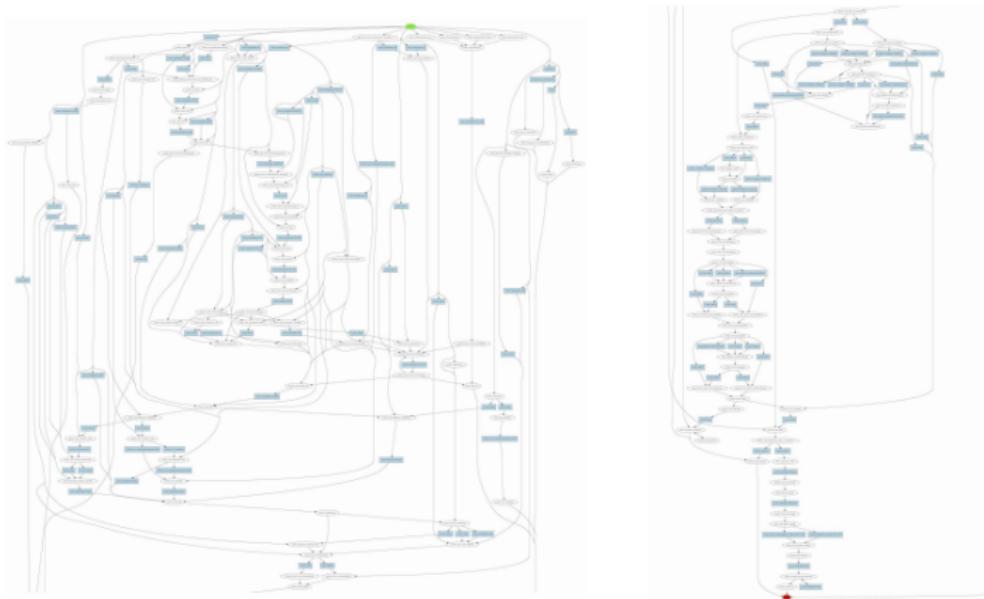
Say, for Insurance Purchase bot, the state machine could be:



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

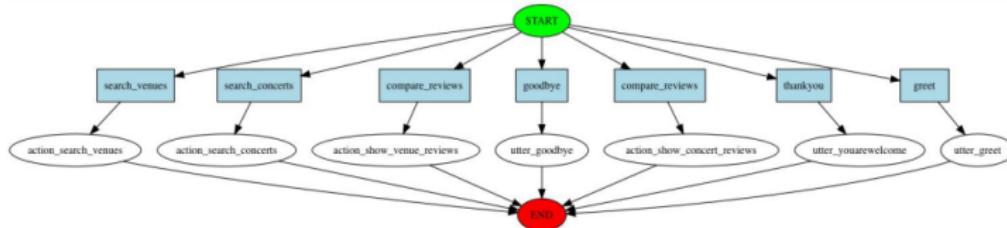
# State Machines

State Machines are infeasible



# State Machines

State Machines don't scale



# Why Machine Learning?



30k+

Lines of XML

DAY 1

DAY 100

Example above is showing real numbers!!

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

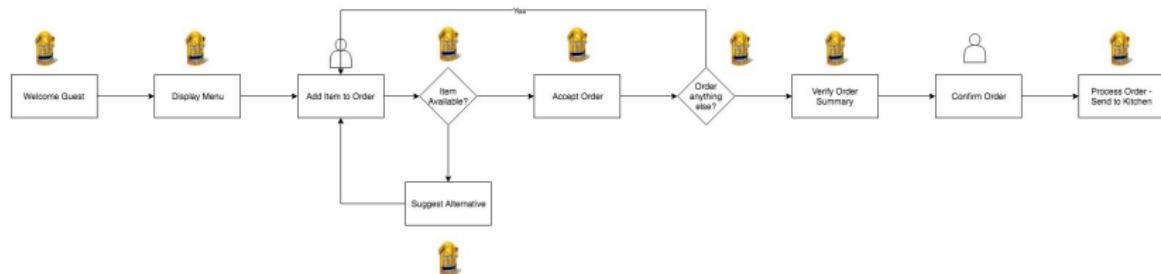
## Rasa Core Approach

- ▶ 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

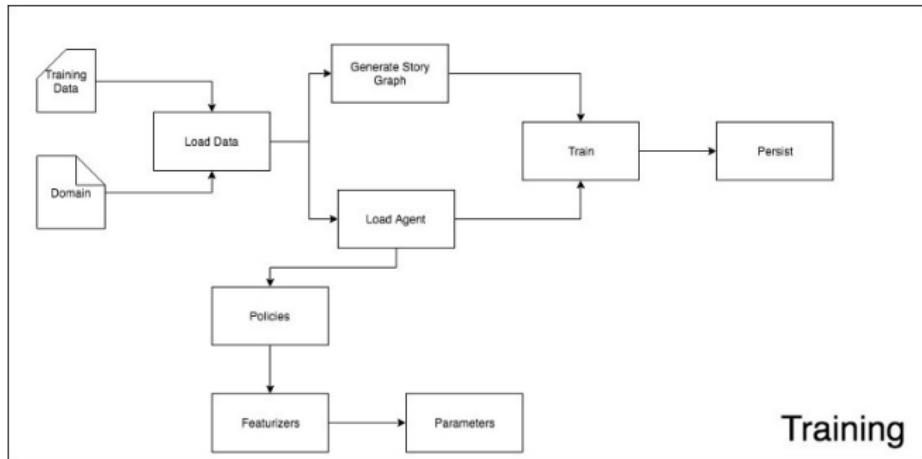
Let's build the different states



- ▶ 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)

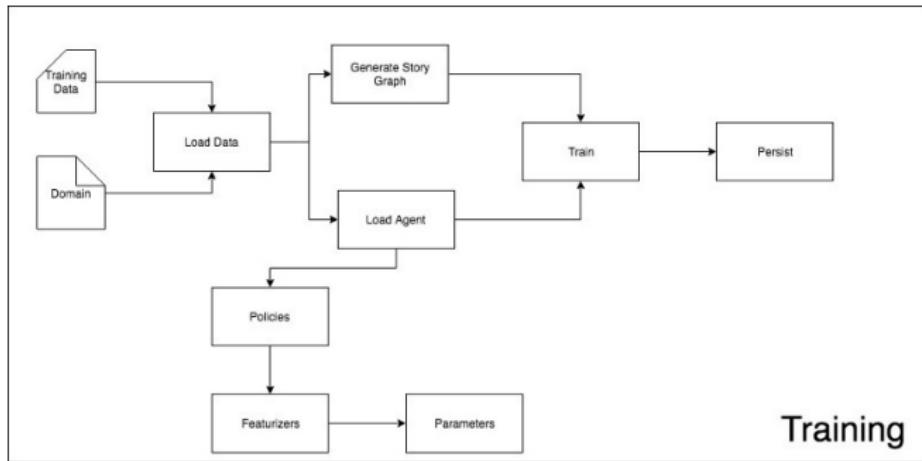
## Training Steps



- ▶ **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)

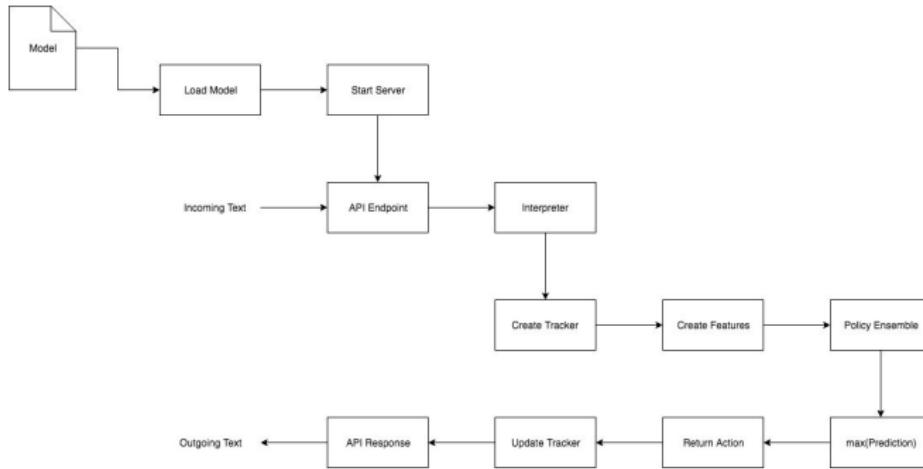
## Training Steps



- ▶ 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. One 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)

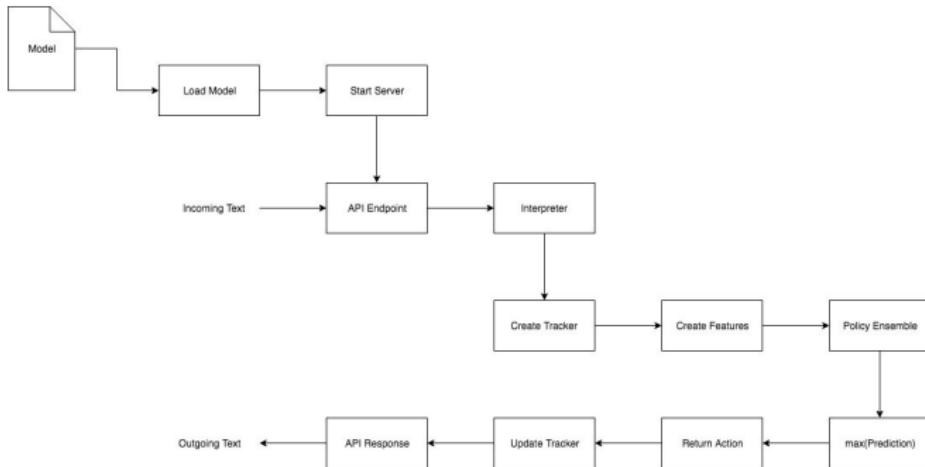
# Prediction Process



- ▶ 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)

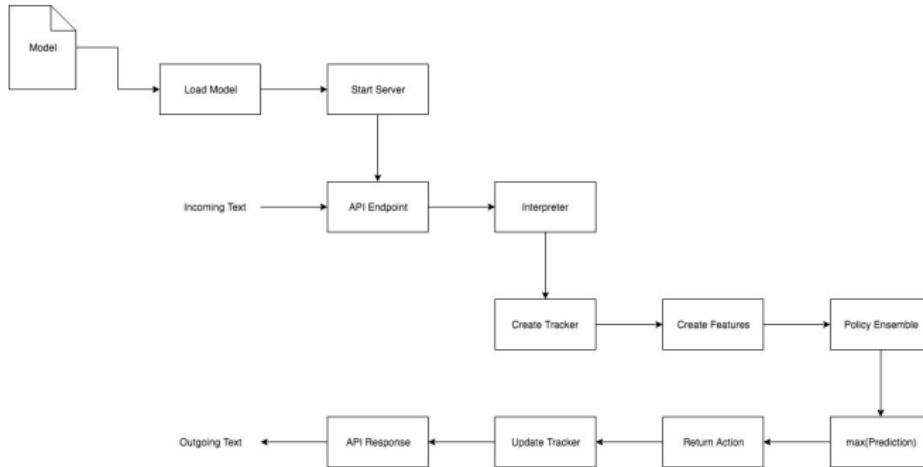
# Prediction Process



- ▶ **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 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)

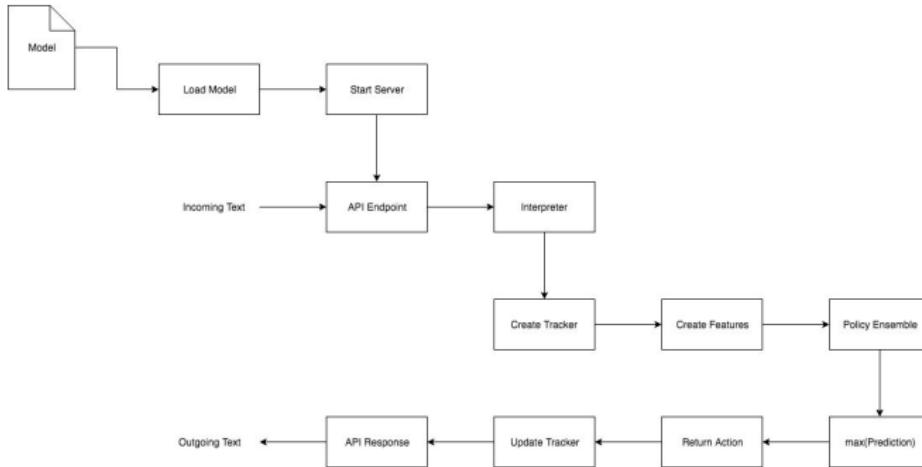
# Prediction Process



- ▶ **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)

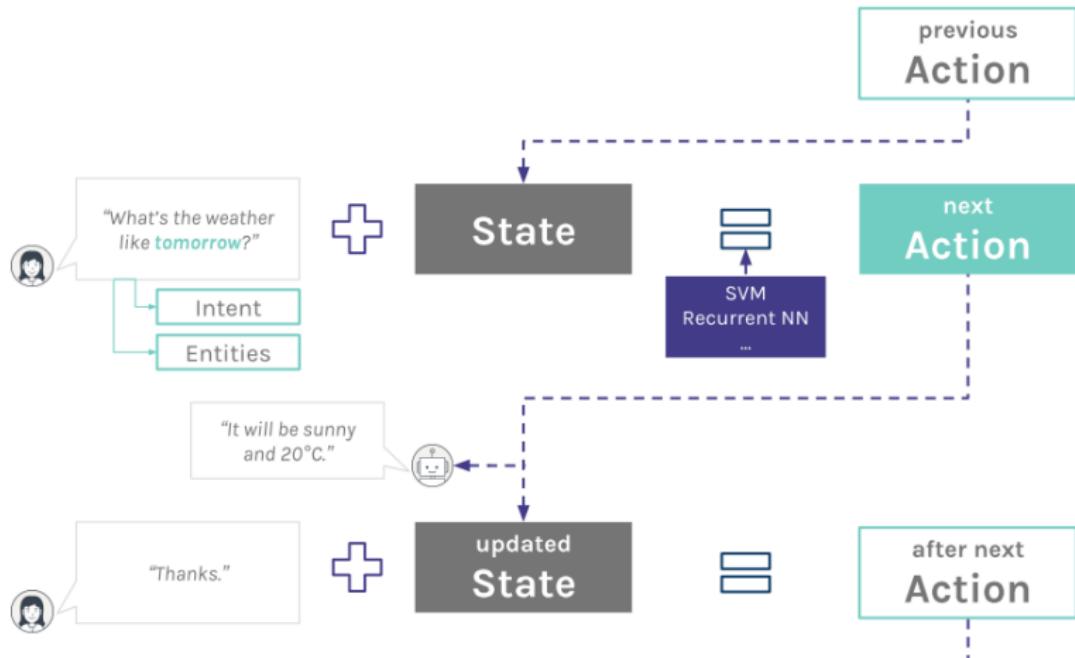
# Prediction Process



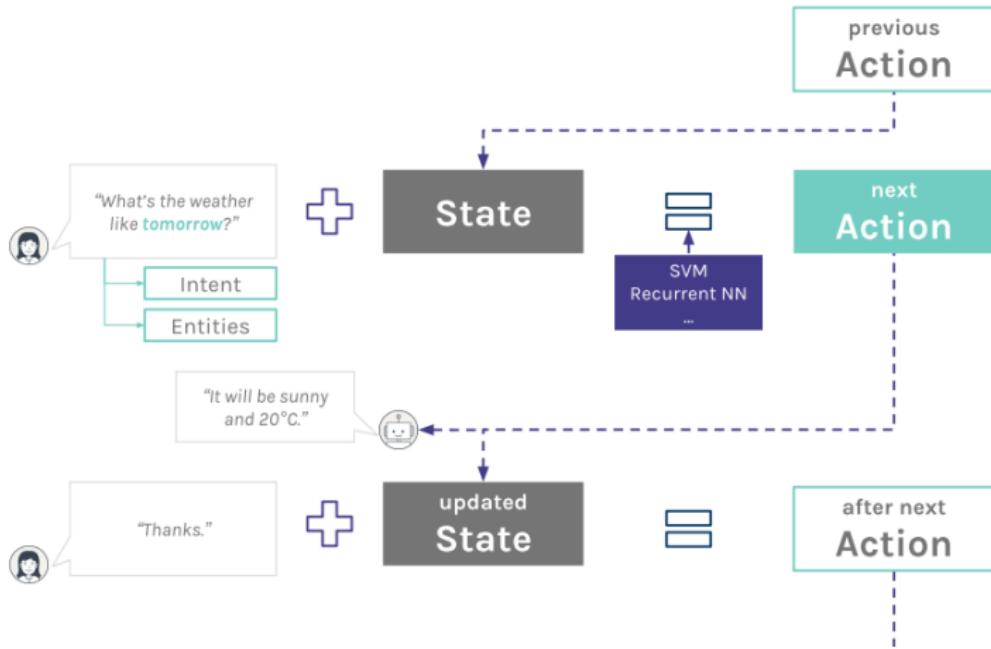
- ▶ **Update Tracker:** Once you have the action predicted, you will need to update the tracker for the next turn
- ▶ **ExecuteAction:** Now you will be finally executing your action, be it an API call or a message sent back to the user

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

# Machine Learning Workflow

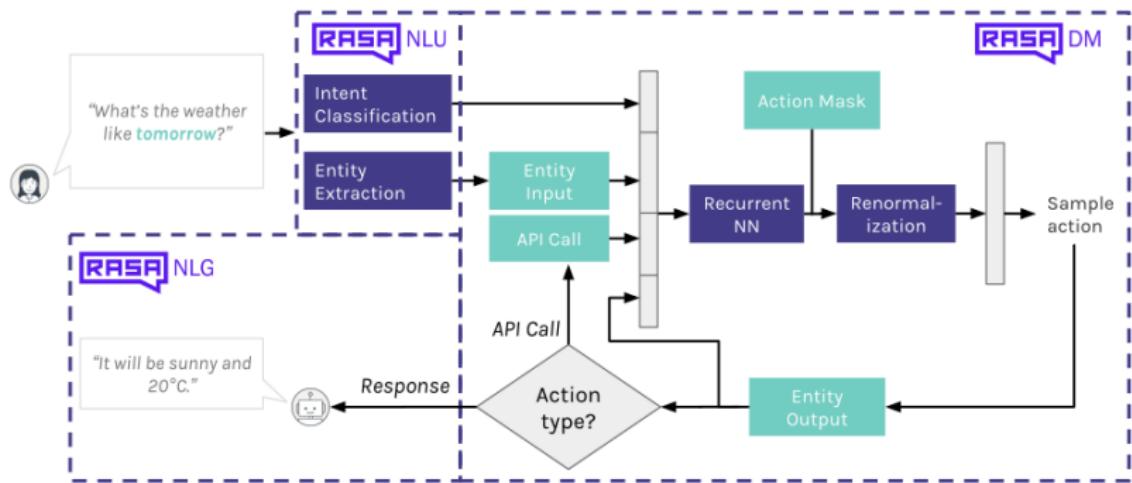


## Dialogue Handling (Core)



# Detailed Dialogue Handling (Core)

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



## Conclusions

## Take aways

3 take home thoughts:

- ▶ Conversational AI is a big part of the future
- ▶ ML techniques help advance state-of-the-art NLU and conversational AI
- ▶ Open source is strategically important for enterprises implementing AI

## Conclusions

- ▶ RASA Is an Open Sourced Python implementation for NLP Engine / Intent Extraction / Dialogue → in which all of the above run on your machine / On premise → NO CLOUD!
- ▶ RASA can be integrated with different front ends like Slack, Facebook Messenger, or your own web app.

## What Next?

- ▶ Try it out, tutorials ...
- ▶ Subscribe to Rasa Newsletter (Rasa X has arrived!! Rasa NLU and Core got merged into Rasa 1.0 ...)
- ▶ Build your own chatbot ...

## References

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

- ▶ RASA-NLU setup, installation, [https://github.com/RASAHQ/rasa\\_nlu](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](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