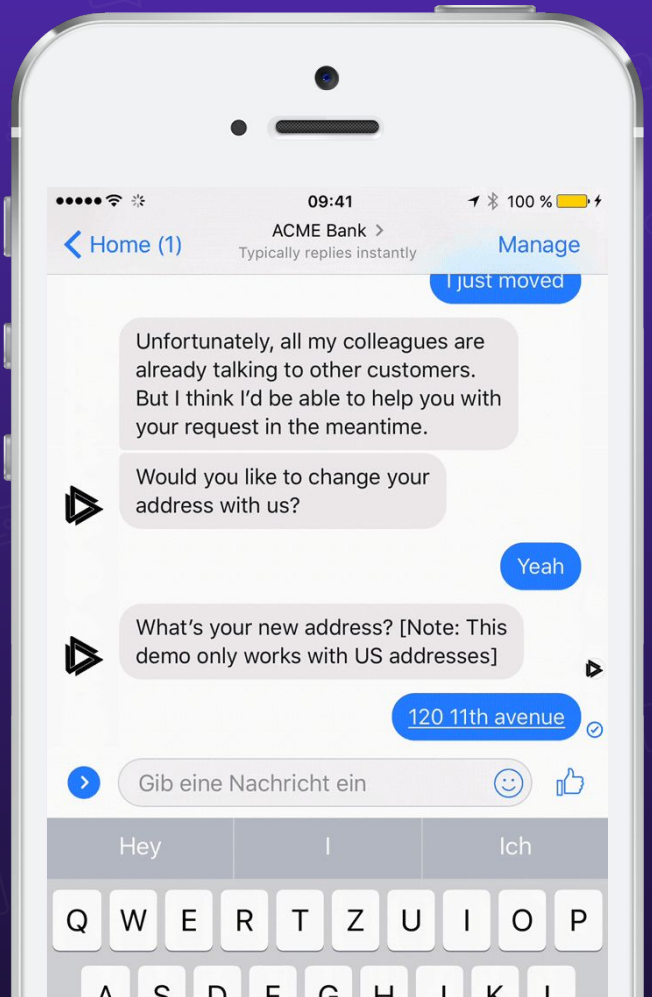
# Deprecating the state machine: building conversational AI with Rasa stack

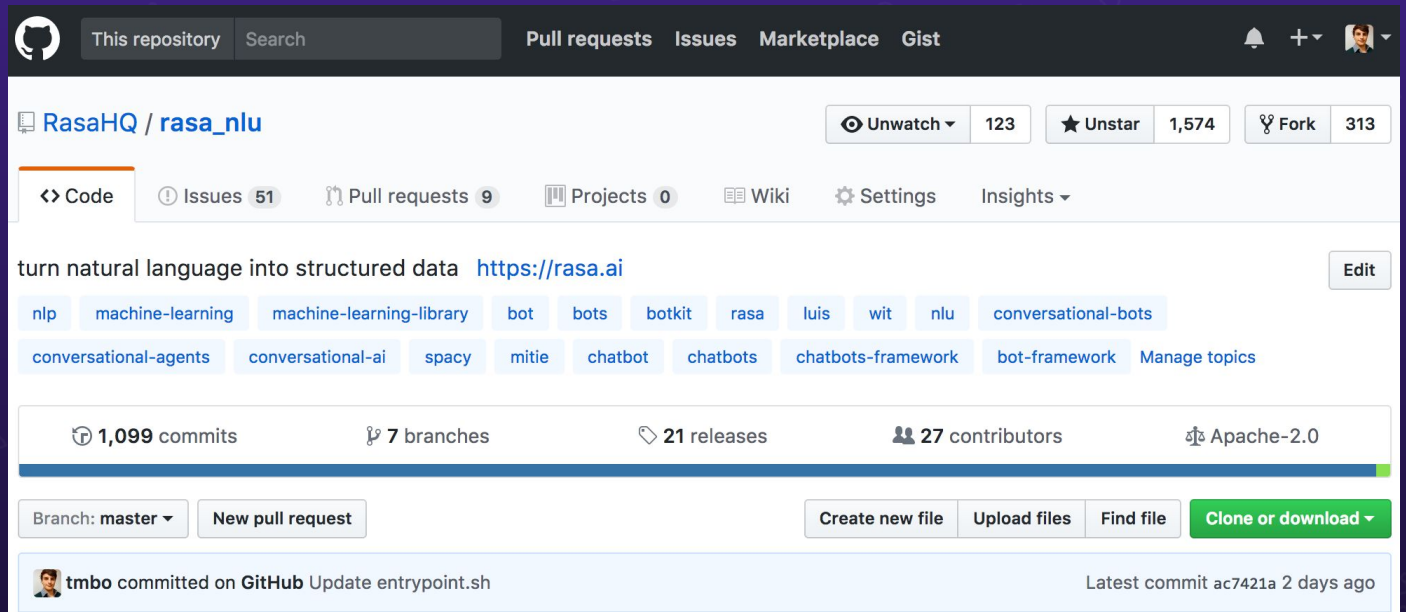
*Justina Petraityte, Developer Advocate*

# Conversational AI will dramatically change how your customers interact with you.

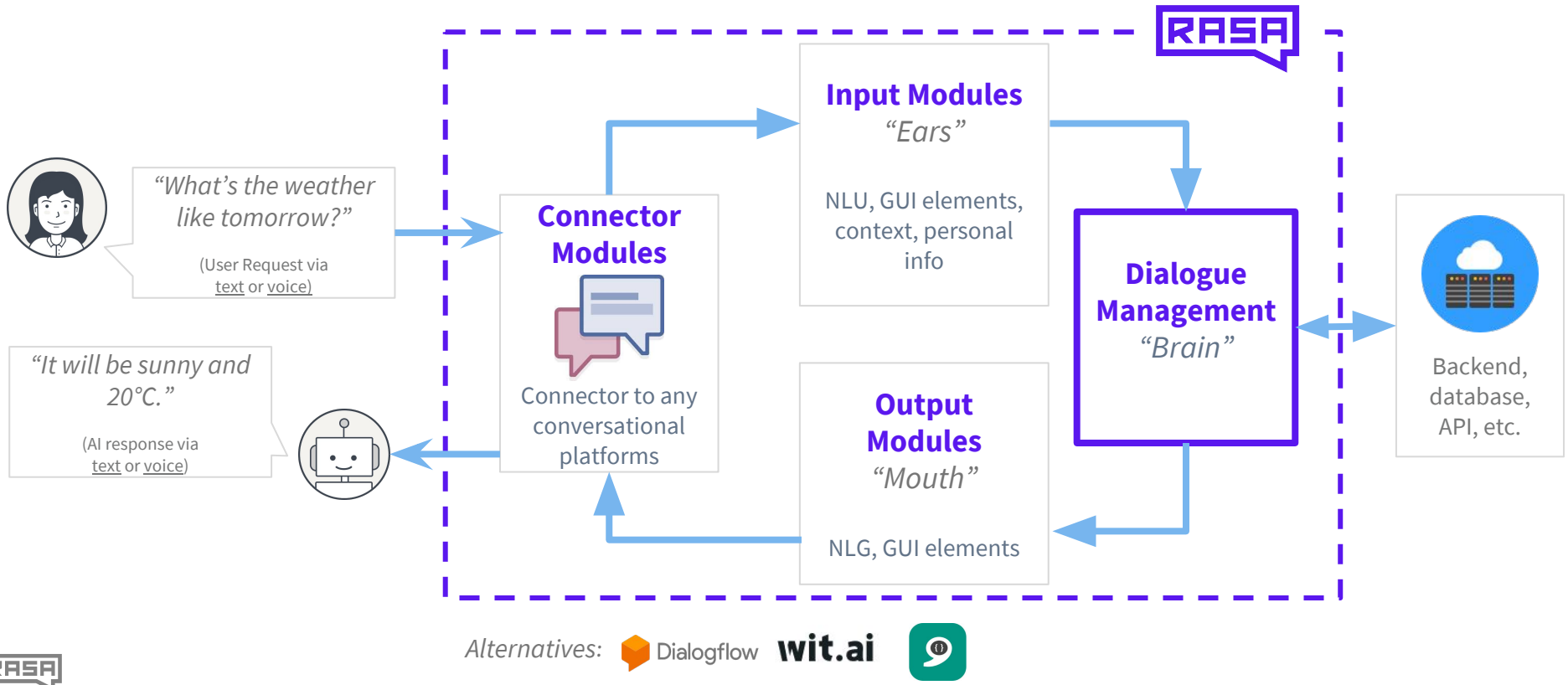
**Example of a live Skill:**
A customer can change her address via Facebook Messenger



# An open source, highly scalable ML framework to build conversational software



# Rasa the OSS to build conversational software with ML



# Why Rasa?

## Runs Locally

- No Network Overhead
- Control QoS
- Deploy anywhere

## Own Your Data

- Don’t hand data over to big tech co’s
- Avoid vendor lock-in

## Hackable

- Tune models for your use case

# What we are focusing on today

## Goal:

build & understand a bot based on machine learning

## Roadmap:

1. Natural Language Understanding
    i. Theory
    ii. Let’s Code
2. Dialogue Handling
    i. Theory
    ii. Let’s Code
3. Research
4. Questions

# Setup

1. Jupyter notebook in python 3.6 (2.7 should work as well)

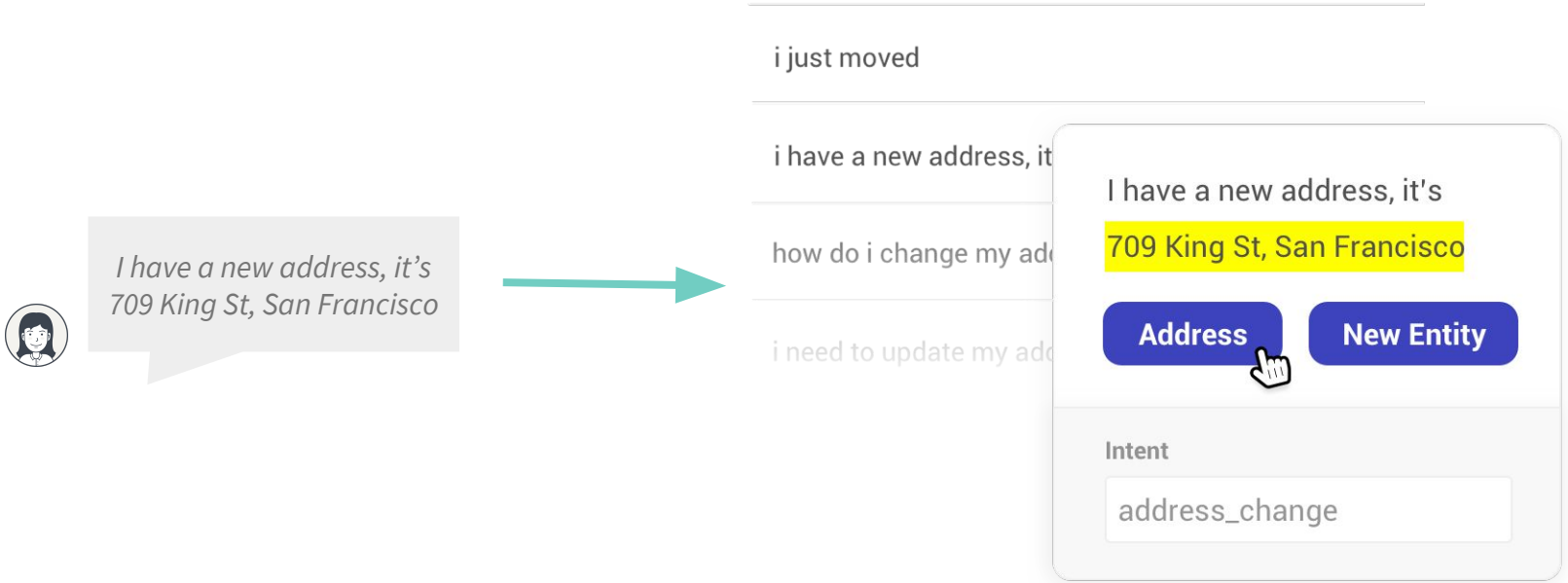
2. Download:
   Repository: https://github.com/RasaHQ/rasa-workshop-pydata-berlin

# Under the hood
# Natural Language Understanding

Under the Hood

# Rasa NLU: Natural Language Understanding

Goal: create structured data

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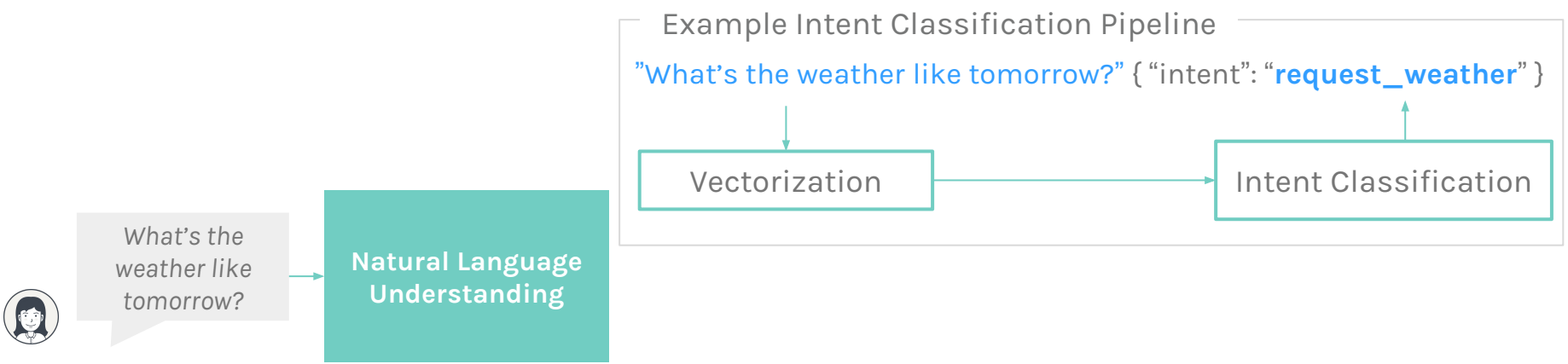
Under The Hood

# Natural Language Understanding

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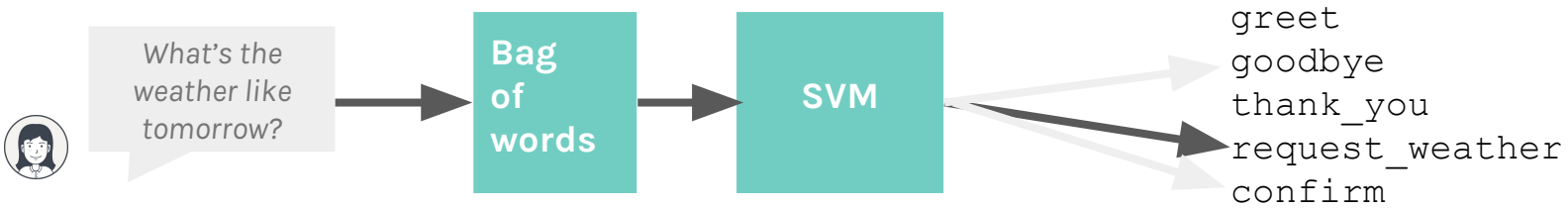
# Rasa NLU: Natural Language Understanding

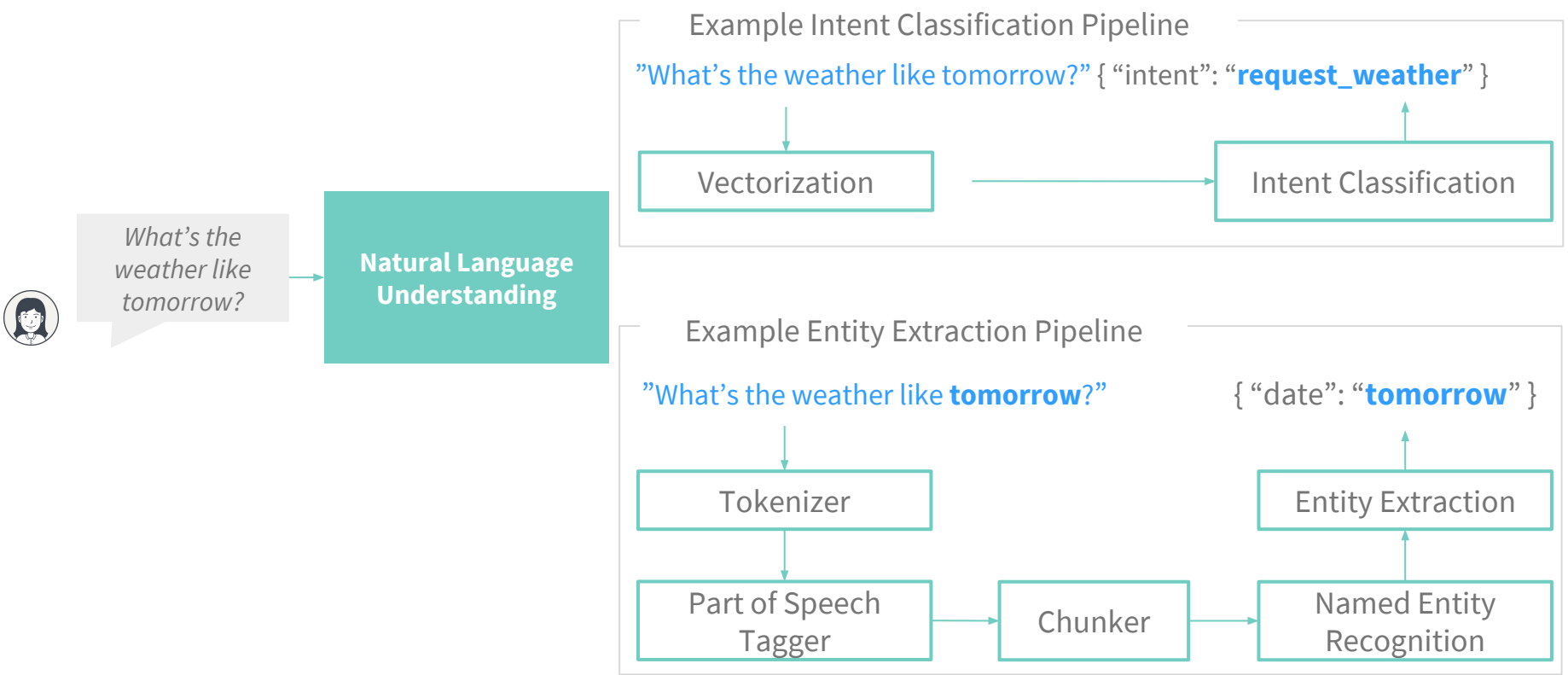
Bags are your friend

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



Under the Hood

# Rasa NLU: Natural Language Understanding

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# Rasa NLU: Entity Extraction

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

cuisine

location

averaged perceptron

$$\hat{y} = \text{sign}\left(\sum_{k=1}^{K} c^{(k)}\left(w^{(k)} \cdot \hat{x} + b^{(k)}\right)\right)$$

1. Binary classifier `is_entity` & then `entity_classifier`
2. Direct structured prediction

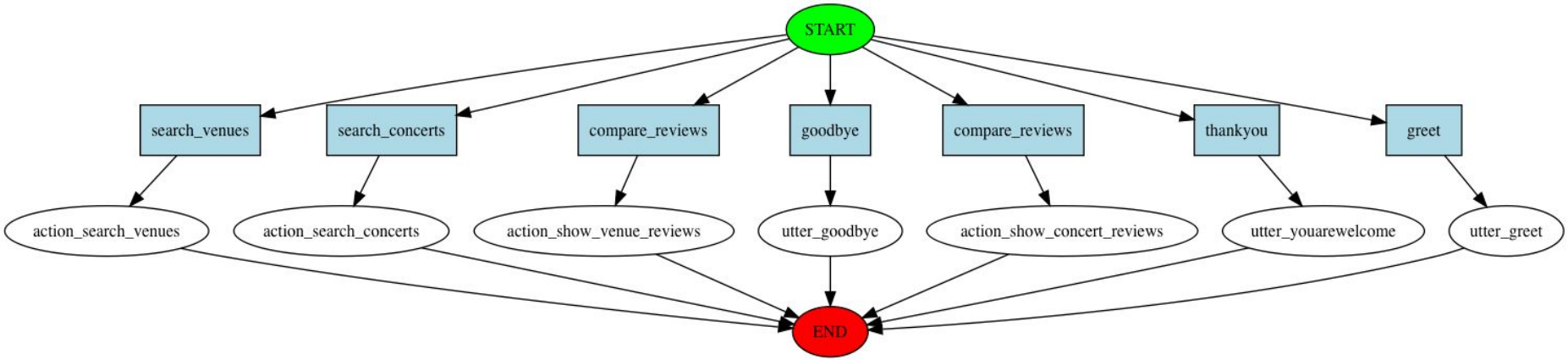
# Let’s code!

# Under the hood
# Dialogue Management

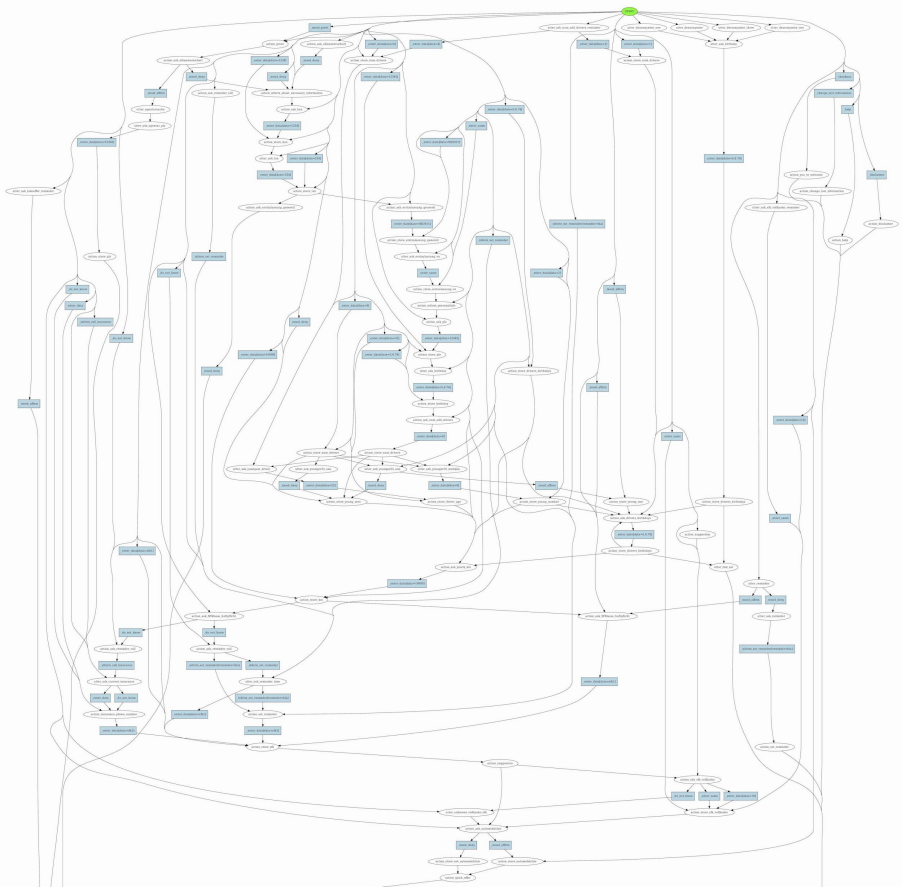
# Why Dialogue Handling with Rasa Core?

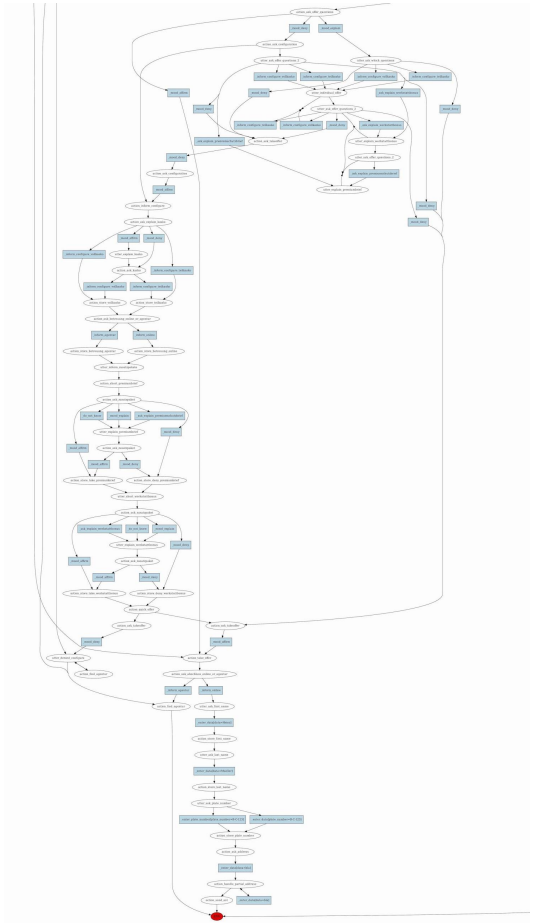
- No more state machines!
- Reinforcement Learning: too much data, reward functions...
- Need a simple solution for everyone

# Why Machine Learning?



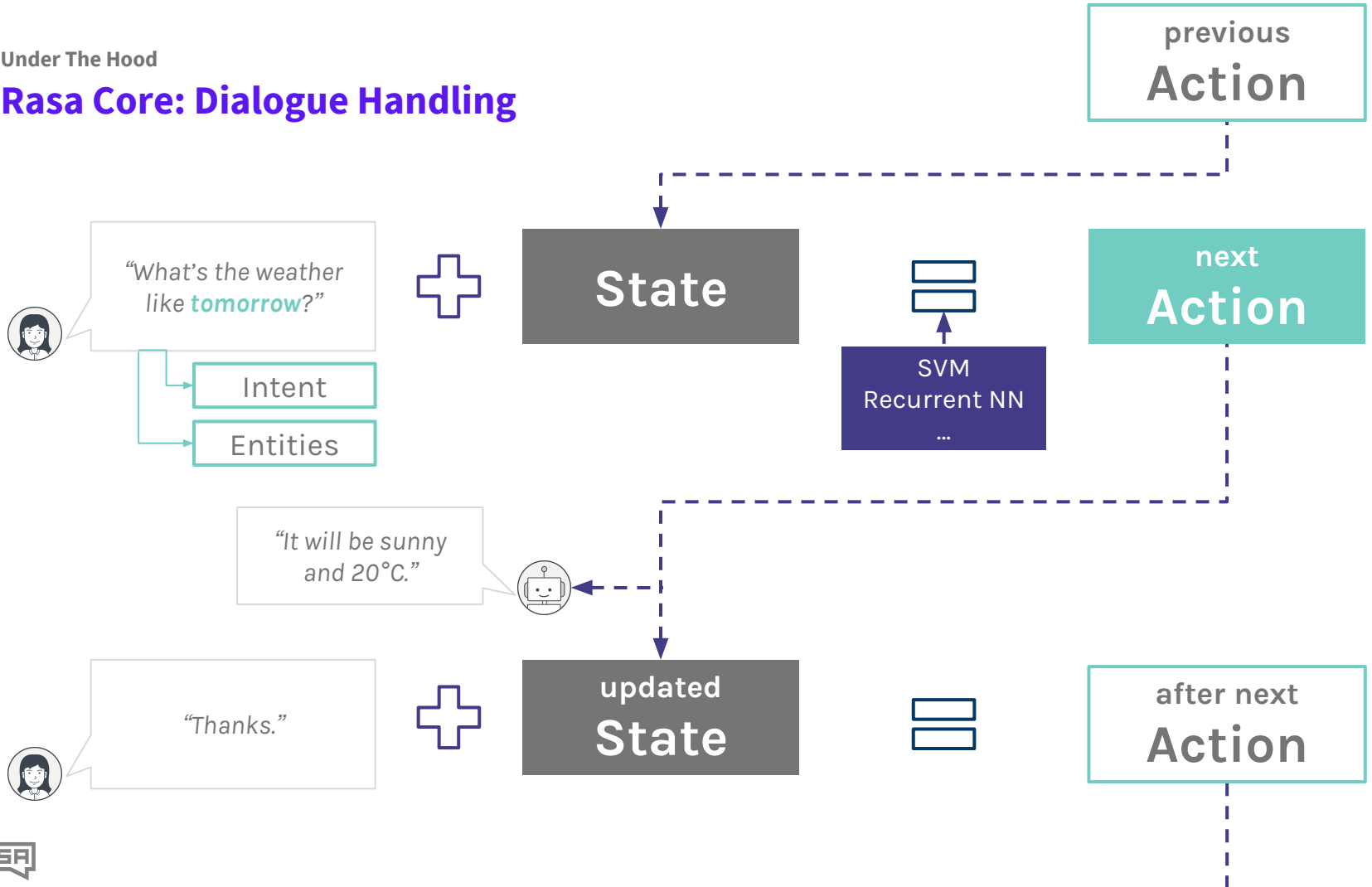
# State Machines are infeasible





Under The Hood

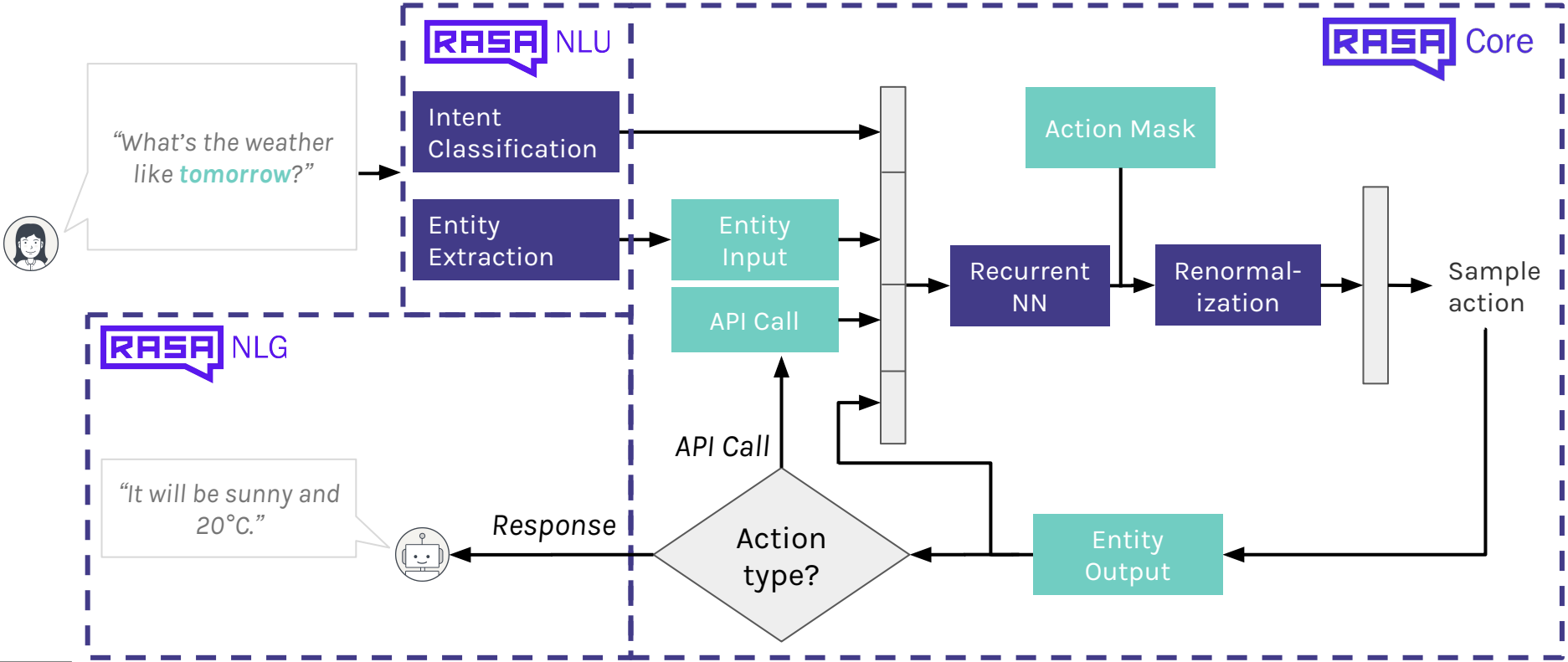
# Rasa Core: Dialogue Handling



Under The Hood

# Rasa Core: Dialogue Handling

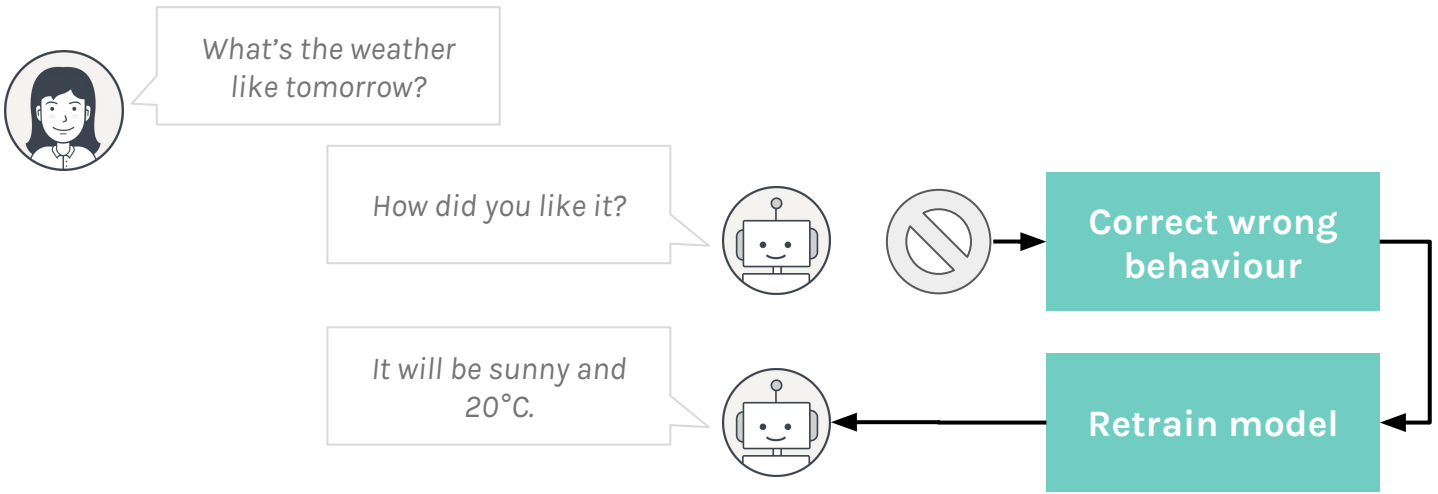
Similar to LSTM-dialogue prediction paper: https://arxiv.org/abs/1606.01269



# Let’s code!

# Rasa Core: Dialogue Training

Issue: How to get started? → Online Learning



# Let’s Code

Interactive Learning

# Research

Research

# Training NLU models without initial word vectors

**Goal**: Learn an **embedding** for the intent labels based on the user messages

- Learns joined embeddings for intents & words at the same time
- Allows multi-intent labels
- Knows about similarity between intent labels
- Based on Starspace Paper

https://medium.com/rasa-blog/supervised-word-vectors-from-scratch-in-rasa-nlu-6daf794efcd8

https://medium.com/rasa-blog/how-to-handle-multiple-intents-per-input-using-rasa-nlu-tensorflow-pipeline-75698b49c383

Research

# Training NLU models without initial word vectors

**Goal**: Learn an **embedding** for the intent labels based on the user messages

Multi-Intent:

| Text | Intent |
|---|---|
| Hey how are you? i don't really care | `greet+dontcare` |
| ok something else then? thanks a bunch | `deny+thankyou` |
| cool! Who is the mayor or New York City? | `state_happy+random` |

Evaluation:

| Pipeline | train F1-score | test F1-score |
|---|---|---|
| spacy (small) | 0.684 (0.020) | 0.325 (0.018) |
| tensorflow_embedding | 0.984 (0.001) | **0.898** (0.017) |

Research

# Generalisation *across* dialogue tasks

*Why do we need this complex architecture? For generalisation between domains!*

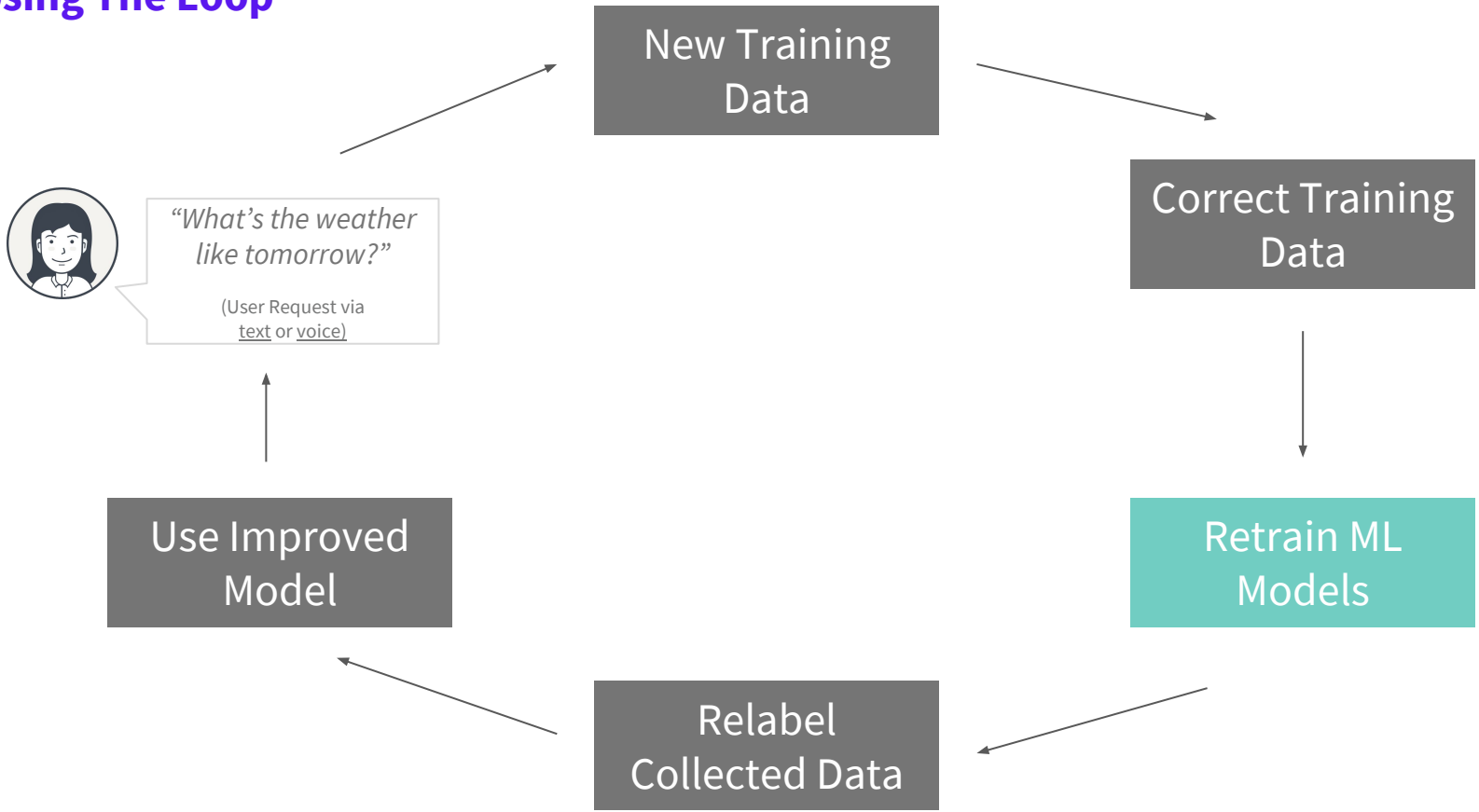
```
## hotel explain 1.3
* request_hotel
    - utter_ask_details
* inform{"location": "paris"}
    - utter_ask_people
* inform{"people": "4"}
    - utter_ask_price
* explain
    - utter_explain_price_hotel
    - utter_ask_price
```

```
## restaurant explain 1.3
* request_restaurant
    - utter_ask_details
* inform{"location": "paris"}
    - utter_ask_people
* inform{"people": "4"}
    - utter_ask_price
* explain
    - utter_explain_price_restaurant
    - utter_ask_price
```

# Final Thoughts

Final Thoughts

# Closing The Loop



# Open challenges

For those that are curious:

- Handling OOV words
- Multi language entity recognition
- Combination of dialogue models

We’re constantly working on improving our models!

# Current Research

Good reads for a rainy day:

- Last Words: Computational Linguistics and Deep Learning (blog)
  https://goo.gl/lGSRuj
- Starspace Embeddings (paper)
  https://arxiv.org/abs/1709.03856
- End-to-End dialogue system using RNN (paper)
  https://arxiv.org/pdf/1604.04562.pdf
- MemN2N in python (github)
  https://github.com/vinhkhuc/MemN2N-babi-python
- Sentence Embeddings (blog)
  https://medium.com/huggingface/universal-word-sentence-embeddings-ce48ddc8fc3a

# Summary

4 take home thoughts:

- Techniques to handle small data sets are key to get started with conversational AI
- Deep ML techniques help advance state of the art NLU and conversational AI
- Combine ML with traditional Programming and Rules where appropriate
- Abandon flow charts

# Get in touch!

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# We are hiring!

ML Product Success Engineer

Help the teams who are using Rasa Platform succeed.

ML Engineer

Help us push the limits of the conversational AI software.