Why broad language understanding matters in vertical applications?

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The Converational User Experience (totally) depends on chatbot understanding

- Chatbot => vertical application, typically support a few intents (skills).
- Trained with ML to recognize intents, extract entities, etc (Alexa, Watson, etc).

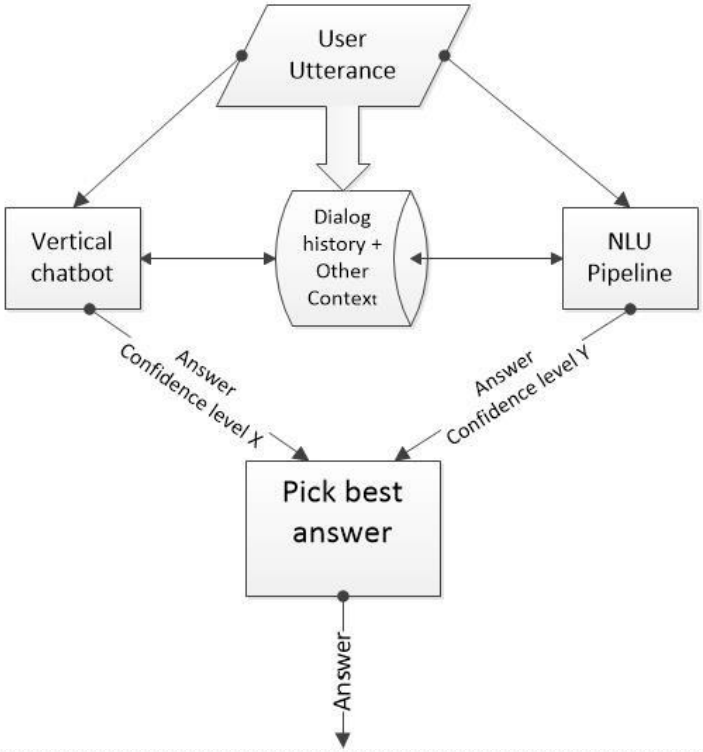
CHALLENGES OF VERTICAL CHATBOTS

- Users are unaware of the chatbot's limitations. They will say legitimate
  - things ***indirectly related*** to core intents
  - things ***unrelated*** to core intents
  - ***incomplete*** utterances
  - things in their ***own words*** (far from training set)
  - Etc

Chatbot doesn't understand = suboptimal user experience.

Solution: complement chatbot with a massively rule-based NLU pipeline

ML-based vertical chatbot with NLU pipeline integration



North Side NLU pipeline examples

- Bot Colony videogame (June 2014), situated (in 3D world) NLU

https://www.youtube.com/watch?v=8zV1r8VxWRM

(00:39 to 1:11) – 32 sec

- Conversational Access to any API for financial services (2016)

https://www.youtube.com/watch?v=GnYjNN0uXmQ

(00:00 to 1:24) – 1:24 min

Rule-based language analysis pipeline

- **Massively rule-based**, generic Natural Language Understanding (NLU) pipeline
- Analyzes utterances to *extract entities and key relations* (chatbots match intents with ML black box style)
- Analysis relies on millions of syntactic and semantic rules extracted from MRD's
- Syntactic rules are used for precise parsing, disambiguation, dialogue act identification
- Semantic Frames are assigned to utterances, to support many ways of saying something
- **Lexical and domain knowledge is used to** 1) simplify utterances and 2) bridge them to intents supported by a chatbot through *utterance analysis* and *task planning*.

=> Understand utterances about **everyday life situations**

Semantic frames and meaning simplification examples

Semantic Frame represent meaning independent of syntax and particular words. Examples (extended FrameNet)

- ‘pay off a loan’ will match ‘payout’
- ‘approve credit’ will match ‘adjudicate’,
- ‘not pay on time’ will match ‘skip a payment’ or ‘delinquency’.

Utterances are simplified using axioms in English extracted automatically:

- ‘pay loan before end of term’ simplifies ‘prepayment of the loan’
- ‘put the amount of the loan in the account’ simplifies ‘disburse the loan’

CHALLENGE 1: Answer (most) legitimate questions (fictitious pizza chatbot used to illustrate)

- Legitimate utterances may be difficult to match to the intents (*italics – challenging cases*).
- Meaning extraction from utterance and planning to a supported intent is required to answer.

  - Can I have the Napoletana ***without*** anchovies ?
  - Can you *pack* some spicy oil ***on the side***?
  - We’re staying *in a motel out of town*. Can you deliver *here*?
  - More folks showed up, can I *double* the *order*?”
  - What if you *come late*?"
  - If I don’t like *it*, can I *get my money back*?
  - Do you take *cash on delivery*?

CHALLENGE 2: Return an answer when the information is available

- The website may have the all the answers, but the chatbot won't return them.
- A semantic search/Question Answering capability is required to answer questions like below.

- Are you using *real* Mozzarella di Bufala?
- Do you cook it in a wood-fired oven? At what temperature?
- What brand of Parmesan cheese do you use?
- How many calories in a slice of Medium pizza XYZ?
- Do you have *glutten free*?

CHALLENGE 3: Prompt only for missing information

- People i) rarely offer all the information needed ii) but they do offer some.
- Only prompt for the missing information. Utterance analysis is required to reconcile intention slots.

➢ *I want a thin crust pepperoni pizza with mushrooms.*

Pizza variables:

- Size?
- Crust? (Thin Crust, Hand tossed, Handmade pan, Glutten free crust)
- Bake? (lightly, normal)
- Cut? (pie, square, none)
- Oregano?
- Cheese? (light, normal, extra, double, triple)
- Sauce? (BBQ, ranch, garlic,…)
- Sides?
- Drinks?

CHALLENGE 4: Handle out of turn clarification

- Before replying to a chatbot question, users may ask clarification questions (out of turn = user utterance is not the answer expected).
- Answering clarification questions or accommodating out of turn comments is important for a good experience.

- What do you mean by handmade pan?
- What's the bake?
- How big is the medium?
- So, how many toppings can I add?
- Is the sauce an extra sauce, or it's the only sauce I'm getting?

CHALLENGE 5: Handle frequent dialogue acts

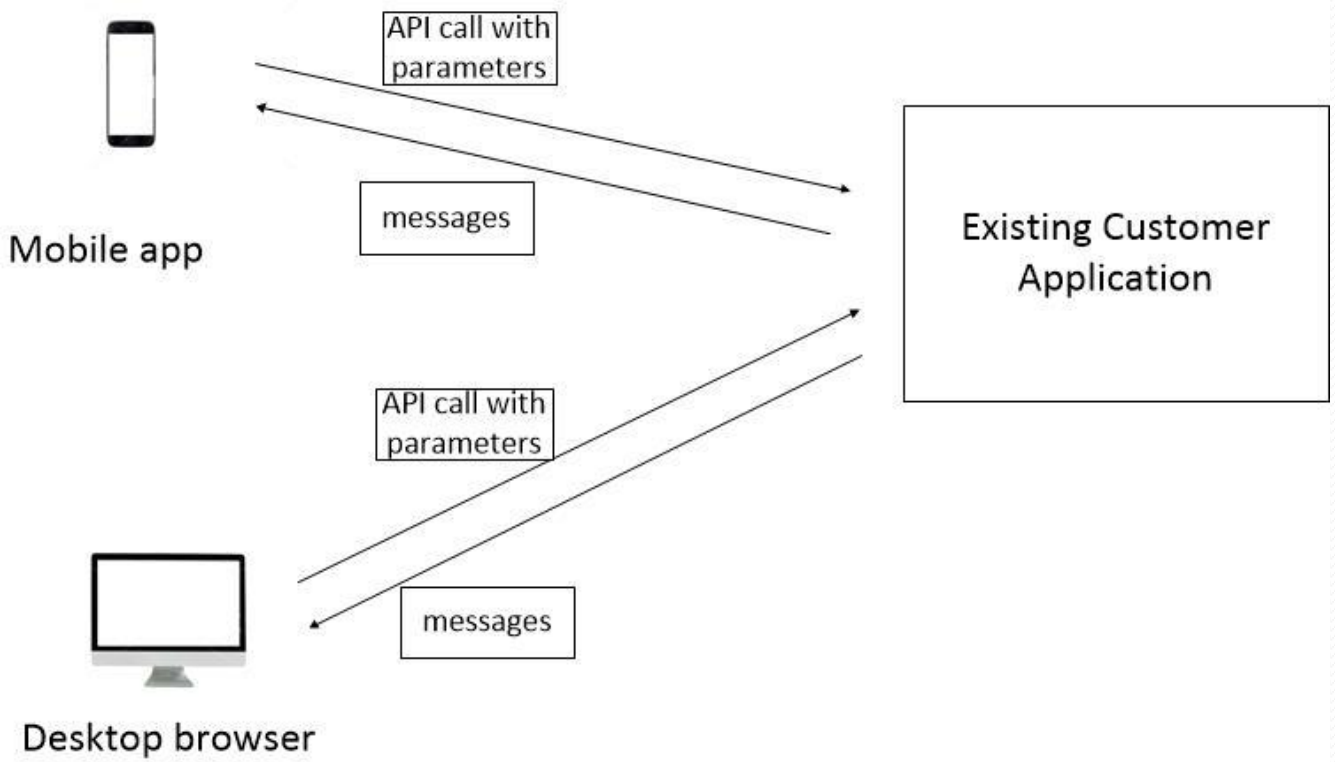
- People say many other things in conversations (called *dialog acts*), all of them out-of-turn.
- There are MANY of these and a vertical chatbot may not be able to handle them.

- Didn't get that…Come again? (didn't hear)
- That sounds really yummy! (appreciation)
- Only that? (CONTEXT)
- Not sure, maybe some wings and parmesan bites? (uncertainty, choice)
- Let me think…maybe some extra cheese? (stall)
- I have a gluten allergy. (important statement)

Advantages of using our pipeline (and/or integrating your chatbot with it)

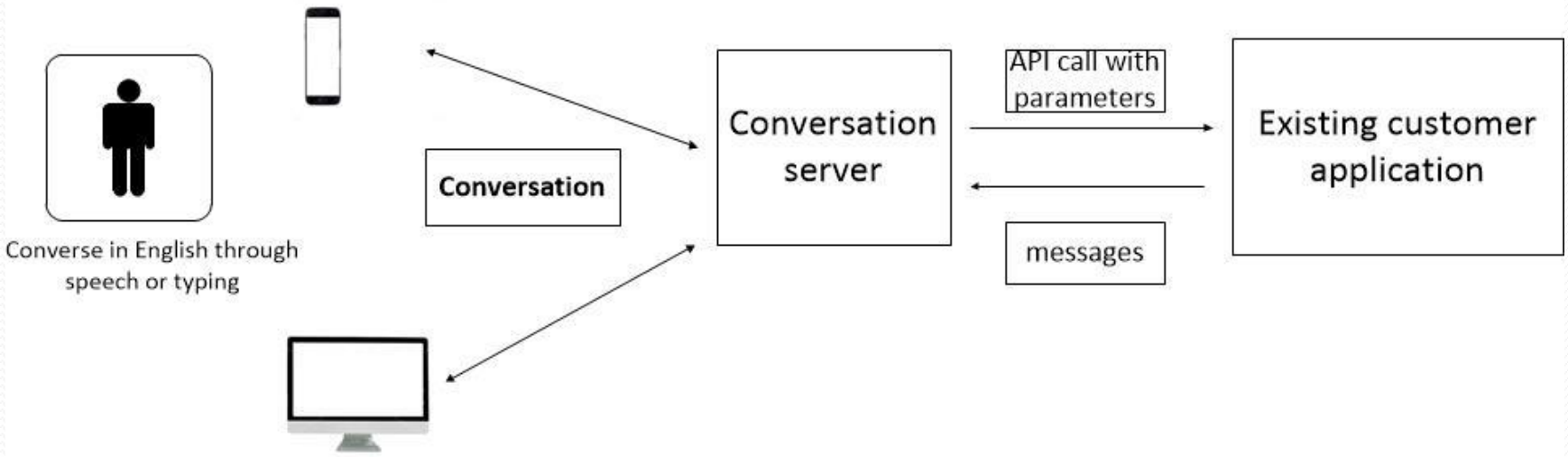
- Improve the user experience by
  - Making sense of more user utterances
  - Handling out-of- turn utterances
  - Handling more dialogue acts
  - Co-reference resolution of pronouns, nouns, adverbials, etc.
  - Using context to resolve ellipsis (missing verbs, nouns, etc) and do co-reference resolution
- Get instant **conversational** access to your **EXISTING API's, databases** and **free-text information**

Existing online applications already have mobile and browser interfaces



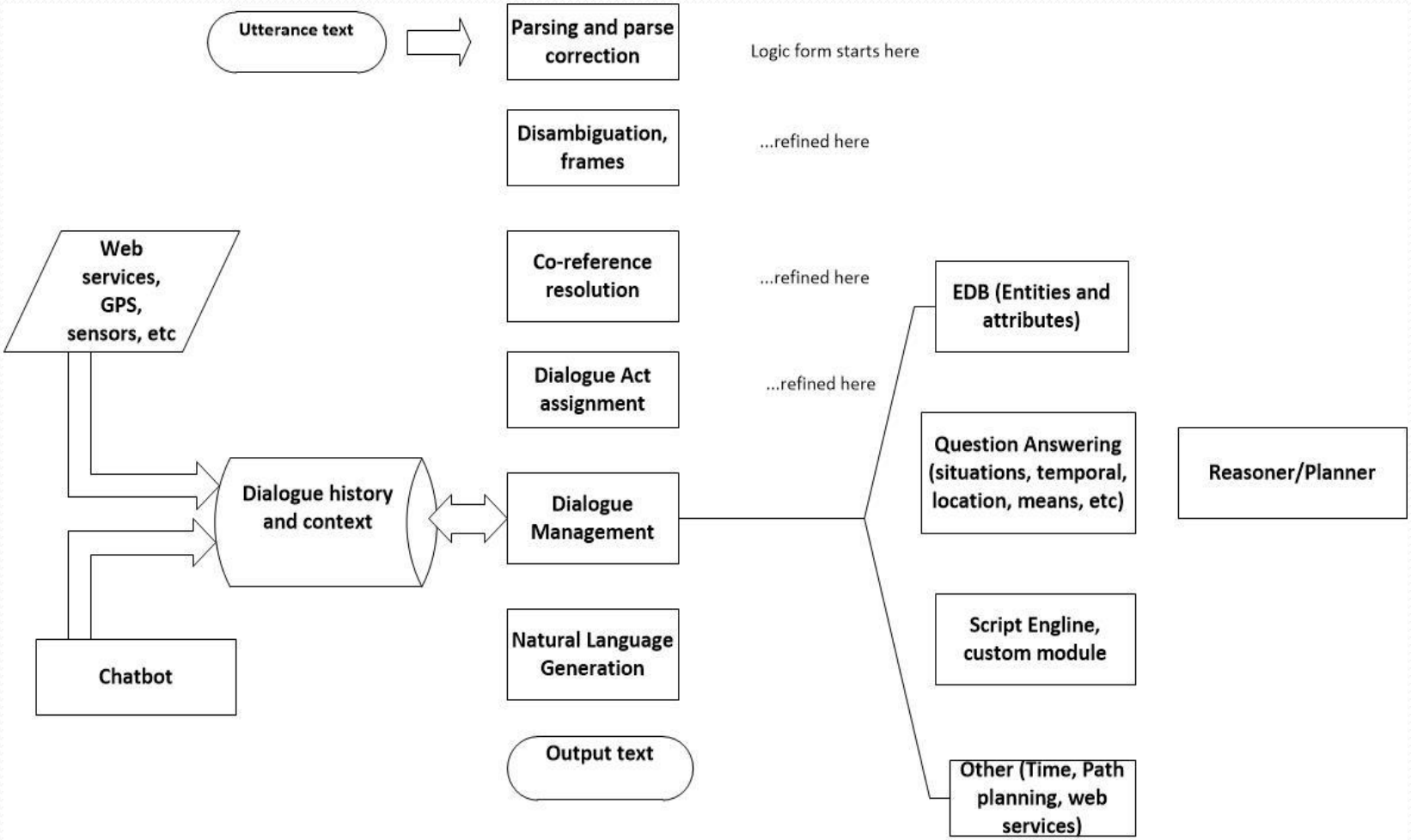
GUI based interfaces to existing customer application

The application gets the SAME API calls and data from the NLU Pipeline



NLU server converses with the user, gathers and clarifies information, calls the SAME API's as the mobile app or browser interface

North Side NLU pipeline built around robust logic form



Pipeline databases and modules

- **Disambiguation** uses a robust Ontology containing all language concepts
- **Co-reference resolution** of nouns, pronouns, determiners, adverbials uses entity database (EDB) [resolve to entities, times, places].
- **A reasoner** applies semantic rules (axioms in English) to the input to simplify it by inferring new facts that are added to the context and used in QA.
- **Question Answering/Semantic Search** module returns answers from unstructured text. Does not rely on keyword matching.
- **Dialogue Management** component uses the context and supports multi-turn dialogue.

INTEGRATION

- Can call same API's as existing mobile or web-based userapplications
- Dialogue context and history can be shared with a chatbot, if one exists
- The component with highest answer confidence serves the answer.

Our Knowledge Acquisition Approach

- Broader understanding requires **massive** language (lexical semantic) and world (domain) knowledge.
- We've mined a lot of reliable knowledge from Machine Readable Dictionaries (MRD's) – rules mentioned before
- We plan to acquire missing world knowledge with Jimmy's World, a free online videogame (summer 2018).
- In Jimmy's World, a player teaches his bot everyday life concepts. The player then competes his bot against other players' bots.

The ‘take home’

- A natural Conversational User Experience doesn’t come easy
- The North Side pipeline (quasi) instantly *conversation-enables* existing GUI-based applications by calling same API’s.
- This massively rule-based pipeline can complement existing chatbots through language analysis and use of context.

SUMMARY

Chatbots able to better understand the ***everyday life context of an utterance*** will offer more relevant answers and will be a lot more engaging.

Thank you!

Questions ?