

Are Dialog Systems Finally Going Mainstream?

A look at the challenges from an industry perspective

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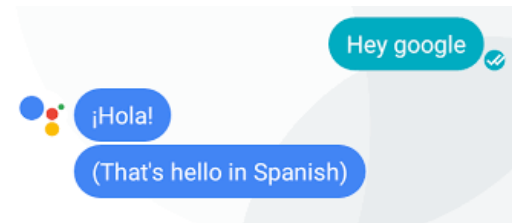
PRYON

Explosion of “things” you can talk to

iPhone 4



Google Home
Voice-activated speaker

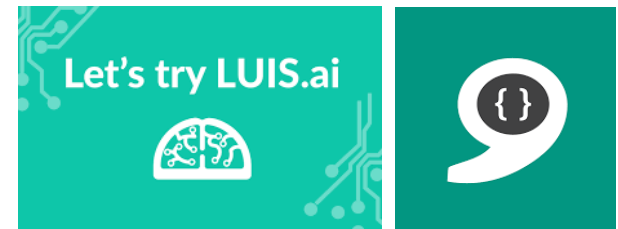


PRYON

Current state

- Usage is high
 - 70K Alexa Skills
 - 100M Alexa devices
 - 1B voice queries across Google Assistant on Android and IOS
- Works very well for a single utterance-action-reply
 - Alexa, What's the weather
 - Siri, Send a text
- Not yet conversational
 - Poor tracking of context and history of the dialog
 - Limited "Mixed Initiative" capabilities
- Not yet able to understand what it doesn't understand
 - Either an answer or "Sorry I can't answer that"

What can you build today?



IBM WATSON



PRYON

Goals of the Major Dialog Toolkits

- Provide a console for developers to create dialog systems
- Remove the “pain points” in dialog development
 - Only a few examples needed for ML classification
 - Frequently used types (e.g. dates, currency) predefined and carefully tuned
 - Console integrates design, training and testing
- Reduce the amount of code required
 - “Fulfillment” and responses associated directly with intents
 - “One-click” integrations with communications platforms such as Slack, Facebook, Twitter, Skype ...
- Sell more cycles on their hosted services, AWS, Google Cloud, ...

Dialog Development Consoles

Language Understanding | My apps | Docs | Pricing | Support | About

CoxSecurityTopics-prod (v 0.2) | DASHBOARD | BUILD | MANAGE

App Assets

- Intents
- Entities

Improve app performance

- Review endpoint utterances
- Phrase lists
- Patterns

Intents ?

+ Create new intent + Add prebuilt intent

Name ^

- BestPractice
- BestPractice_Send
- BestPractice_SeparatePasswords
- BestPractice_Share
- Cancel
- Define

Dialogflow

CoxSecurity

- Intents
- Entities
- Knowledge (beta)
- Fulfillment
- Integrations
- Training
- History
- Analytics

Intents

CREATE INTENT

Search intents

1 OF 2

- BestPractice
- BestPractice_Send
- BestPractice_SeparatePasswords
- BestPractice_Share
- Cancel
- Default Fallback Intent
- Default Welcome Intent
- Define
- Greeting
- Help

IBM Watson Assistant

Skills / CoxSecurityTopics-prod / Build

CoxSecurityTopics-prod

Intents Entities Dialog Content Catalog

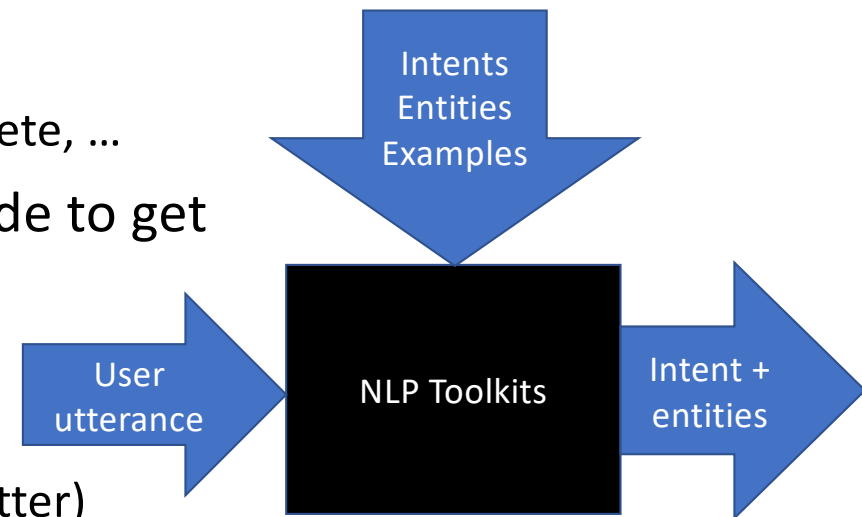
Add intent

Show only conflicts

Intent (22)	Description	Modified	In Conflict	Examples
#BestPractice		2 minutes ago		25
#BestPractice_Send		2 minutes ago		23
#BestPractice_SeparatePasswords		2 minutes ago		22
#BestPractice_Share		2 minutes ago		17
#Cancel		2 minutes ago		6
#Define		2 minutes ago		138
#Greeting		2 minutes ago		6
#Help		2 minutes ago		6
#IdentifyTools_DataStorage		2 minutes ago		41

Natural Language Understanding

- Intent: What question is the user asking?
 - Classification based on training examples
 - Define term, recognize threat, Procedure_Delete, ...
- Entities: What objects does the user include to get the specific answer
 - Mac OS vs. Windows 10
- Examples
 - The ways a question can be asked (more is better)
 - Synonyms for entities
- Modeling and run time is a black box



Design stage

- Question types

- Informational
 - What is a ...
 - What are the types of ...
- Procedure
 - How do I ...
- Policy / Best Practice
 - Should I ...
 - How frequently should I ...
 - Why do I need to ...
 - What do I do if ...
 - What's the best way to ...
- Recognize
 - How do I know if ...

- Actions

- Send email
- Store
- Get account
- Delete

- Object

- VPN
- MFA
- Information
 - Confidential
 - Internal use
- Threat type
 - Phishing email
 - Vishing
- Cookies
- Password
- Device
 - Flash drive

How do I get a VPN account?

What is MFA?

Can I send confidential information over email?

How often should I delete cookies?

Can I put internal use information on a flash drive?

Examples for training


- Capture the variety of ways users can ask questions
- Initial: Use a paraphrase collection tool
- Best: Log users
 - Capture alternative phrasings and synonyms
 - Find errors in the system
 - Find questions that are out of scope or domain for better error and clarification dialog

[Home](#) [Dialog Development Console](#) [mmeteer](#)

[SKIP THIS QUESTION](#) [ADD ANOTHER PARAPHRASE](#) [ADD A RELATED QUESTION](#) [SUBMIT AND CONTINUE](#)

Type or speak a paraphrase for the following question:

Question	Answer
'How do I set up MFA?'	Condition: Office 365 1. You must be an Office 365 global admin to do these steps. 2.Go to the Office 365 Admin center 3.Go to Users > Active users. 4.Choose More > Setup Azure multi-factor auth. If you don't see the More



[END SESSION](#)

- To add a paraphrase, you can either speak or type your question. To speak, click the microphone to start / stop the recording.
- If you'd like to edit a transcription after recording, you can do so in the text box. If you'd like to re-record your question, just hit the microphone button again.
- Your paraphrase will be automatically saved when you click "Add Another Paraphrase" or "Add a Related Question," or "Submit and Continue".

Examples

- How should I handle the storage of public information?
 - what's the best way to store public info
 - what's a good way to store public info
 - how should i store public information
 - i want to store public info
- Do I need to back up the files on my computer?
 - Are computer backups necessary?
 - do i need to use backup for my files?
 - Am I required to back up my computer?
 - Must I back up my computer?
- What are company-approved password manager tools?
 - what kind of password manager tools does the company approve of
 - are there any recommended password management tools
 - can I use lastpass to save my passwords?
 - what browser plugins are approved for password management?
- How do I set up MFA?
 - setup MFA on my device
 - I would like to setup MFA
 - how do I get an MFA
 - tell me how to set up MFA

Domain Terrain

Domains	IT FAQ	Finance
Intents	23	14
Entities	30	15
Training utterances	1164	426
In domain test utts.	267	113
OOD/OOS test utts.	50 / 41	100

- Sample Intents
 - BestPractice_Send
 - BestPractice_SeparatePasswords
 - BestPractice_Share
 - IdentifyTools_DataStorage
 - Procedure_DisableNetwork
 - Procedure_GetAccount
 - Procedure_PasswordProtect
 - Procedure_PermanentlyDelete
 - Procedure_SetupAutoUpdates
 - Procedure_Threat
 - Recognize_Threat
- Sample Entities
 - OS: Windows, Version: 10
 - OS:Mac OS X
 - Browser::Chrome
 - Browser::Safari
 - Password
 - Phishing
 - Sensitive Data
 - Social Engineering
 - Software Updates
 - Virus

Entities

- Dialogflow, LUIS, and Watson provide the multiple ways to define entities

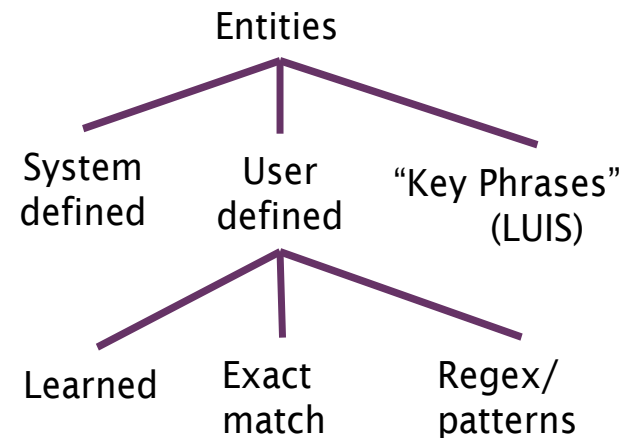
- Built in system entities
 - Time, dates, currency
- Exact match: Definite synonyms
 - But if only “**password**” is included, can’t get “**passphrase**”
- Learned
 - Give examples, system learns new ones from context
 - “**Confidential information**” → “**Confidential data**” and “**Confidential documents**”
- Regular expressions
 - Product code [A-Z][A-Z][0-1]+

- Only LUIS will pick out other possible entities

- How do I know if information is classified as **internal use** only?
- Am I allowed to save my work files on a **flash drive**?

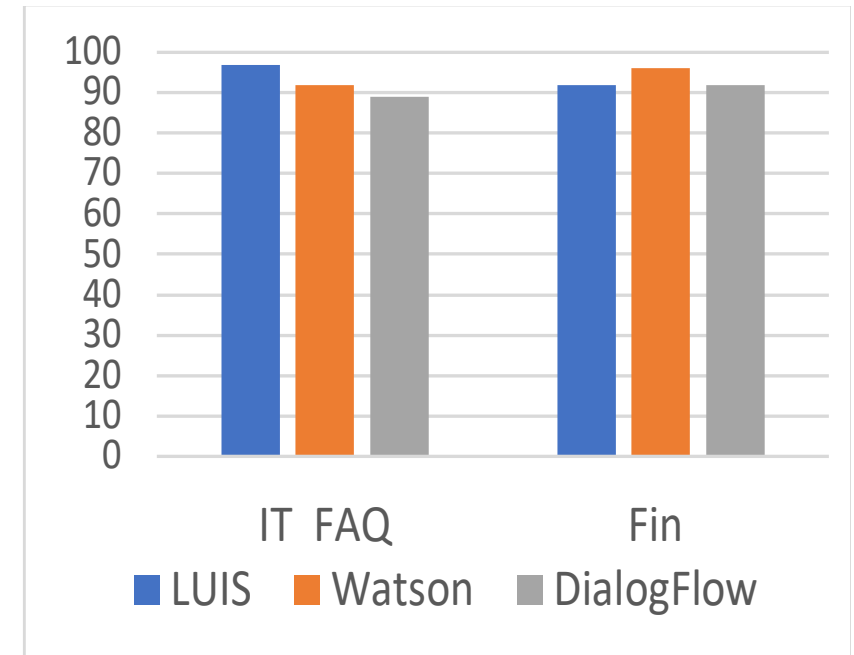
- All three had problems with slot filling:

- Recognizing not just the entity, but what role it fills
 - How to I move files from my laptop to the server?



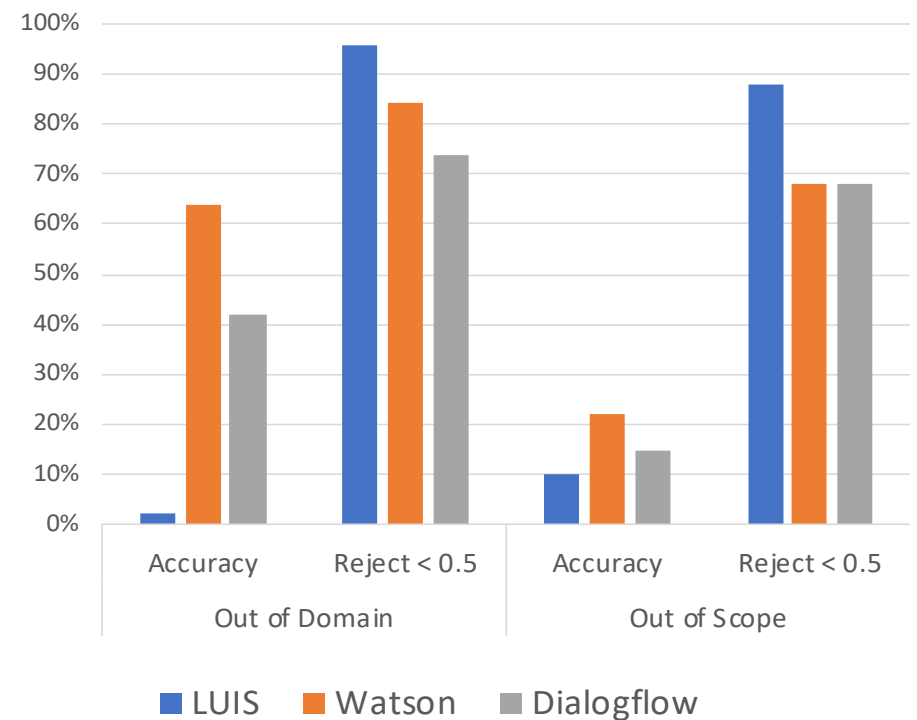
NLP Results on Intent Recognition

- Begin with single set of intents, entities, and examples
- Loaded all 3 systems with that data
- Training
 - Used the “paraphrase collection” tool to get alternative phrasings for all the intents
- Test
 - Utterances separate from training
 - All were “fully specified”, containing all required entities



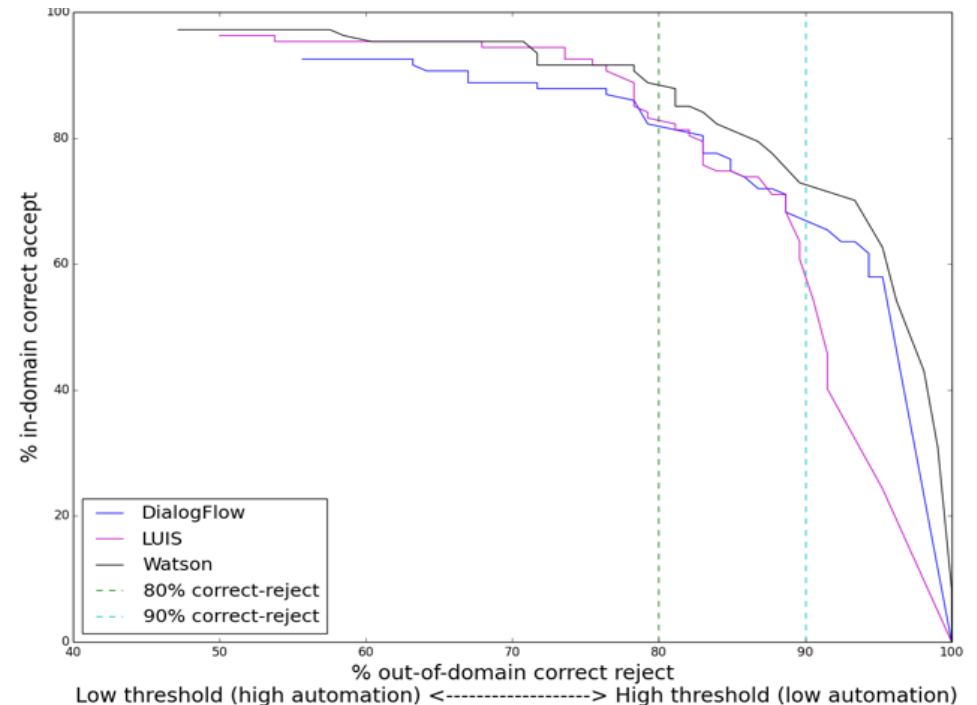
Recognizing when to “Reject”

- Out of Domain
 - Different domain
 - Weather or cafeteria menu
 - Adversarial: Non-cooperative user
 - Can I eat VPN?
 - Do you love me?
- Out of Scope
 - User believes this question can be answered
 - “How do I get a VPN account” vs. “How do I get a Jira account”
- Rejection using Confidence
 - Rejection below 50% significantly improves performance
 - Actual threshold will be tuned and likely to be tool dependent



Using Confidence

- All three systems provides a confidence score
- Goal is to minimize “False Accept”, that is providing an incorrect answer
- Performance falls off steeply over 90% rejection accuracy



Language Contraction

- Using pronouns to refer to things already mentioned
 - What are cookies?
 - How often should I delete **them**?
 - How do I do **that**?
- “Ellipsis”: Leaving out parts all together
 - What is phishing?
 - **How about** vishing?
 - **Smishing**?
- None of the three tools provide general mechanisms for this

From utterances to interactions:

Dialog Management

- Functions of the Dialog Manager
 - Representing the dialog structure
 - “Frames”
 - Fills in required entities from user’s question and through dialog
 - “Mixed Initiative”: No strict order on how information is collected
 - Question answer pairs
 - Tracking the context
 - Saving variable values for later use
 - User’s name, operating system
 - Recording that actions are completed
 - Whether the user has logged in
 - Collecting information over multiple turns
 - Criteria to narrow search
 - Selecting the appropriate action:
 - Answer, ask a clarifying question, give an error message

User: How do I delete cookies?

System: What browser are you using?

User: **Chrome**

System: ... Do you want me to fill out ticket for you?

User: **Yes**

System: OK, **David**. You’ll be getting a confirmation email from the IT office

Frames vs. Procedural

- User: How do I permanently delete a **file** on **Windows 10**?
- System: Go to the Desktop on your Windows 10 OS.

- User: How do I permanently delete a **file**?
- System: What kind of computer do you have?
- User: I have a **PC** running **Windows 10**

- User: How do I permanently delete a **file**?
- System: What kind of computer do you have?
- User: I'm using **Windows**
- System? What is the version of the operating system
- User: **10**

- Intents with required entities
 - If user doesn't include all of the required entities, system will ask
 - Prompts are predefined
- “Mixed initiative”
 - User starts
 - System takes initiative to get necessary info

- Procedure_PermanentlyDelete

SAVE

Enter action name					
REQUIRED ?	PARAMETER NAME ?	ENTITY ?	VALUE	IS LIST ?	PROMPTS ?
<input checked="" type="checkbox"/>	File	@File	\$File	<input type="checkbox"/>	What would you ...
<input checked="" type="checkbox"/>	OSName	@OSName	\$OSName	<input type="checkbox"/>	What operating ...
<input checked="" type="checkbox"/>	Version	@Version	\$Version	<input type="checkbox"/>	What's the ve rs...
<input checked="" type="checkbox"/>	Computer	@Computer	\$Computer	<input type="checkbox"/>	What kind of co...
<input type="checkbox"/>	Enter name	Enter entity	Enter value	<input type="checkbox"/>	—

Frames on steroids

- A single node
- 9 slots

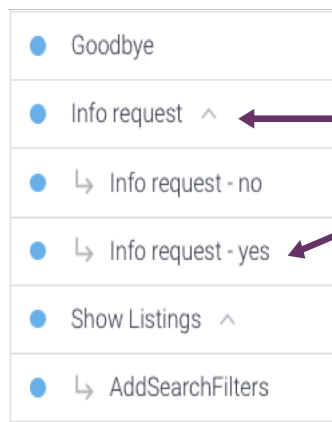
The screenshot shows the Watson Assistant dialog editor interface. The left sidebar contains tabs for 'Intents', 'Entities', 'Dialog' (selected), 'Version History', and 'Content Catalog'. Below these are buttons for 'Add node', 'Add child node', 'Add folder', and 'Settings'. The main area displays a dialog flow for 'Watson Frame Test'. It starts with a 'Welcome' node (1 Response / 0 Context set / Does not return) which leads to a '#PurchaseItem' node (2 Responses / 10 Context set / 10 Slots / Does not return). The '#PurchaseItem' node is highlighted with a blue border and a checkmark. Below it are three more nodes: 'check for cuffs' (1 Response / 0 Context set), 'anything_else' (1 Response / 0 Context set), and 'Anything else' (1 Response / 0 Context set / Does not return). The right panel shows the configuration for the '#PurchaseItem' node. It has a title 'Name this node...' and a 'Customize' button. Below the title, it says 'If assistant recognizes: #PurchaseItem'. The main section is titled 'Then check for:' and has a 'Manage handlers' button. It contains a table with 8 rows of checks.

Check for	Save it as	If not present, ask	Type
1 @clothingItem	\$clothingItem	What type of clothin	Required
2 @mens_women	\$mens_women	Men's or Women's?	Required
3 @size	\$size	What size? Small, m	Required
4 @brand	\$brand	What brand would y	Required
5 @color	\$color	What color? We hav	Required
6 @pattern	\$pattern	What pattern? Solid	Required
7 @style	\$style	What style? Button	Required
8 @sleeveLength	\$sleeveLength	Long sleeved or sho	Required

Comparison

Dialogflow

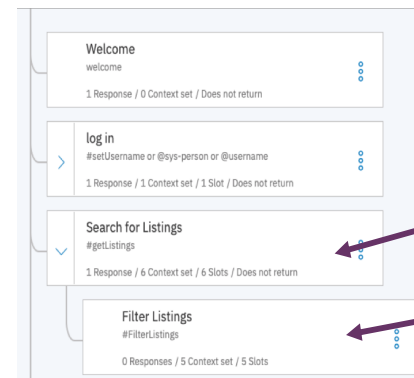
- Associates all dialog structure with specific intents
- Allows the correct interpretation of answers based on what question was asked



U: Send me that listing.
S: Would you like me to text it?
U: Yes

Watson Assistant

- Provides a separate “Dialog” interface to create a dialog tree
- Allows the reuse of intents in multiple dialog contexts



U: Find listings in Arlington.
S: There are 43 listings.
U: How about Lexington

Challenges: Context

Question	Intent	Entities
What's the value of my personalized portfolio plan	IdentifyValue	personalized portfolio plan ↑
Did it go up over the last quarter?	Get_ValueChange	Same, last quarter ↑
How about over the last year?	Same ↑	Same, last year ↑
How much are <u>the fees</u> ?	Identify_Fees	Same ↑
How does that compare to the preservation fund?	Compare_Fees	Same, preservation fund ↑
When does it vest	Identify_VestingDate	? ↑ ↗

Challenges: Entity names

- Proper names: Investment accounts, Health care plans, product names
 - Full set can be very large
 - Unusual combinations of words
 - Terms that are not English words (Pyron, NikiaDX, Infoslips)
 - For one user, set is generally very small
 - "preservation pension fund", "personalized portfolio plan", "member contributions pension funds", "wealth creator"
 - But the overlap in names is unpredictable
 - There are 2 “member contribution pension funds”.
 - There are 2 pension funds, could have been two annuities
- Humans are not very precise

Challenge: Knowing when you don't know

- Out of scope
 - A question on the topic, but not in the defined set of answers
 - *How much have my fees changed in the last year*
- Out of domain
 - Not on the topic: *What's the weather?*
 - Adversarial: *Do you love me?*
- What action to take?
 - Alexa: *I'm sorry I can't help you with that.*
 - Better: What is recognized?
 - *I think you're asking about your fees but I don't recognize the account.*
 - *I think you're asking about your retirement annuity, but could you rephrase the question.*

Challenges in Dialog

- Digressions

- U: I'd like to look for a 3 bedroom house.
- S: What zip code would you like to look in?
- U: What's the zip code for Arlington?

Dialogflow: Can't leave the sequence and come back

Watson: Allows defined "Digressions" but have to be anticipated at design time

- Clarification questions

- U: How do I get a Jira account?
- S: Sorry, I didn't understand you?
- S: I understand you want to get an account but I can't help with a "Jira account"

Watson & Dialogflow: Either "None" or error

Correct: Intent is correct, LUIS can extract the key phrase "Jira"

Response Generation

- All response generation is prepared text or templates
 - Difficult to maintain
 - Need to tailor to the modality (e.g. spoken response vs. text)
- Limited representation of the dialog context
 - Responses are unable to use pronouns or other forms of language contraction
 - Responses can't be tailored by what has already been said
 - “Tell me more about phishing”

Error Recovery and Clarification

- False Positives: When rejection fails
 - User: what are the signs of a flu virus
 - System: Here are the most frequent warning signs your computer is infected with a virus or malware: ...
 - User: ?? No, I want to know if I have the flu
- Challenge:
 - User's replay would not be understood. Can't even pick out "No" to understand it was the wrong answer
- "Reprise Clarification"
 - Repeat the part of the utterance that is understood
 - User: what are the signs of a flu virus
 - System: I think you're asking about recognizing the signs of a threat, but I don't know about a "flu virus"
 - Challenge:
 - Toolkits ignore words they don't know, so can't recognize "flu virus" is not the same as "virus"

Conclusions

- **+ Advantages**

- Framework to bootstrap new domains
 - Require only “reasonable” amounts of training data
 - Built in, well tuned components for frequent entity types
- Typical single turn exchanges and frames are easy to implement
- Interfaces are generally clear and easy to use

- **- Disadvantages**

- Poor performance on out of domain and out of scope utterances
- Only LUIS can recognize new types of entities
- Complex frames can't be implemented
 - e.g. only ask for the operating system if it's windows, not mac
- Dialog management very primitive
 - Only Watson allow digressions