



Memorial Sloan Kettering  
Cancer Center

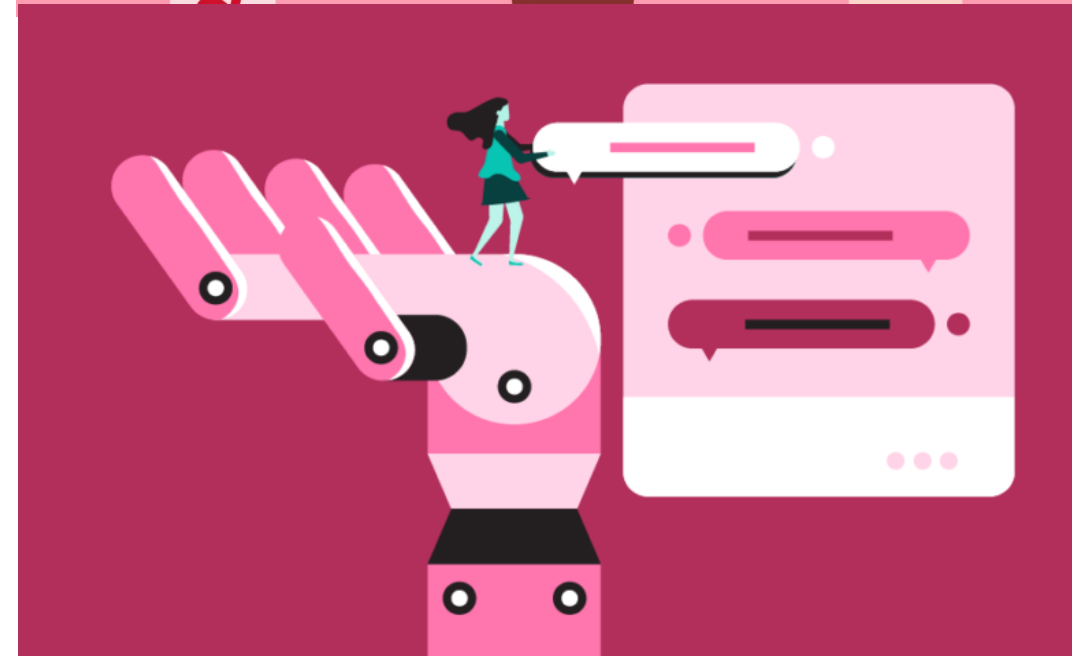
**DigITs**

DIGITAL, INFORMATICS, TECHNOLOGY

# Exploring IBM Watson as a product to conversationalize surveys

Tech Incubation Internship, Summer 2020

Christie Yu



June - August 2020

# Acknowledgments

What a support system!

## Thank you very much for your help!

- **Kristine, Divya, and Dr. Stein**, for continual project management support
- **Ricardo**, for being the project's engineering backbone
- **Monica Allison, Wynne Kim, Zach Rachlin, and Priti Parekh**, for situating me with Engage & Knowledge Bank
- **Naveen, Eric, and Mac**, for onboarding me with IBM Watson
- The **TechInc** team, for teaching so much about discovery, exploration, and SOTA of conversational interfaces
- **Hal and Ethan**, for a great summer!

# Personal learning goals, revisited

The fastest 3 months of my life

## What I wanted

- Designing for humans (UI/UX)
- Ownership of engineering project
- Project management... what is it?
- And then maybe I can figure out what I want to do in the future?



Never got the chance to take a group photo :( but here is Hal, Ethan and I in about 3 pixels each

## What I got

- Agile & iterative project design
  - Timelining, defining success metrics, documenting blockers and areas of further exploration
- Full-stack, IBM project engineering
  - API's, SQL databases, webhooks, IBM functions, AI/NLP/ML, GitHub collaboration
- Forward-thinking technology design
- Insight into small, full-stack team coordination
- A true appreciation for digital healthcare work
- Lots... and lots... and lots of slide decks

**So what did I do?**

MSK is interested in pursuing **IBM Watson** as a vendor for conversational interfaces.

My project explores how we can create an accessible touchpoint for MSK Engage in the form of a **mobile survey conversational agent**.

Users can complete required forms on-the-go with an assistant that will **authenticate** them, direct them to their list of **to-do surveys**, and **collect their responses** to the existing Engage database.

A mobile survey conversational experience will save patients time on self-reporting and help MSK achieve greater engagement with required surveys.

**But before that...**

# Projects: Christie's summer at MSK

Interaction with multiple projects and project roles

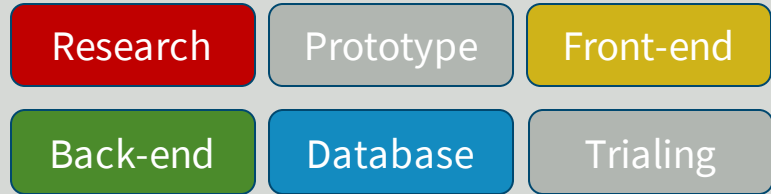
## Digital Therapeutics

- Starts with **research** (both medical **papers** and patient **interviews**) on the design of VR trials — what VR to display, at what situations, for which demographics, etc.
- Involves experimentation with Unity or other animation **software** & VR **hardware** to create **prototypes**
- Requires careful planning of **patient trials** and a step-by-step guide to how a study may run in the future



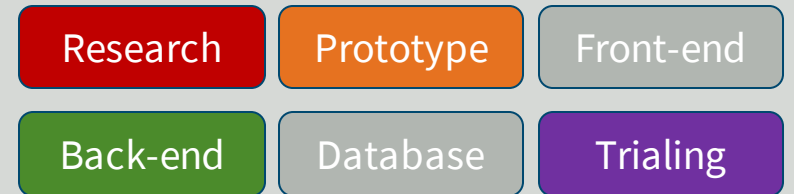
## Failure Knowledge Base

- Begins with **research** via **interviews** with the team on past project failure and lessons we wish to propagate
- Requires extensive reworking of **front-end design**, after which we can create a **back-end infrastructure** to securely store data
- Since we cannot yet populate such a database, we will likely have to run trial runs with other teams or test in **beta stage** before reframing



## Ambient Computing

- Requires further **research** of SOTA as to what a digital transformation in clinical setting looks like
- Would require hardware work as well as **back-end** engineering, **hardware design**, and lots of **QA testing**
- Most importantly, since ambient computing is all about seamlessness with the everyday, such a project would require extensive patient-physician **trialing and surveying**



# Conversational Interface

● BankBot

I can help you schedule an appointment with one of our bankers.

Which date would be best for you? We need 24 hours notice for an appointment, the earliest would be tomorrow.

I can do tomorrow!

Great, Sat, Jun 13, 2020.

What time would you like to meet with our banker?

I can help you find a credit card to suit your needs. We have credit cards to build credit, provide rewards, and help you save money. What are you looking for most in a credit card?

Low interest rates

We have several credit cards with low interest and no fees.

Are you interested in rewards?

I can help you with credit card payments.

One moment while I retrieve a list of accounts.

Please select which credit card account you'd like to pay.

Card # 5624

Card # 5893

Card # 9225



# Conversational Interface: Project

Digital transformation of the patient/physician experience

## Developing a beginning-to-end appointment aid

Mission: create a "personal assistant" for patients from pre-visit to post-treatment

- **Appointment:** scheduling, what to bring, notifications
- **Forms\*:** auto-generate via natural language, jargon explanation
- **Treatment:** prescriptions, follow-up visits, reminders & warnings
- **Payment:** insurance breakdown, total payment transparency
- **Queries\*:** pulls information from database and only contacts physician if necessary
- **Notifications:** medication adherence reminders, fitness tracker
- Room for multilingual support, phone call version

Christie

Hi Sloane. I'd like to fill out my prelim survey for my appt tmr at 3.

Sloane

Hi Christie. I already have this information in the system. Please let me know if this is the correct info:

Birthdate: 09/14/2000  
SSN: 123123123  
Current medications: none

Christie

Yes, that's correct

Sloane

I'll generate your check-in form now. In a minute I'll send a PDF you need to sign and bring with you tomorrow.

Christie

Do I need to fast before my blood test tomorrow?

Sloane

Yes. Please read MSK's policy below:

# Conversational Interface: Deliverables

Digital transformation of the patient/physician experience

## Developing a beginning-to-end appointment aid

### Appointment\*

- **Prototype:** simulation of appointment scheduling
- **Implementation:** integration between IBM Watson and existing MSK scheduling software

### Forms\*

- **Prototype:** simulation of natural language form generation
- **Implementation:** transforming forms to natural language & secure PDF downloading

### Payment

- **Prototype:** simulation of patient payment and record generation
- **Implementation:** integration between IBM Watson and existing MSK payment software

### Treatment

- **Prototype:** design friendly reminder language; physician interface for inputting reminders
- **Implementation:** translating physician orders to Watson tasks

### Queries\*

- **Prototype:** Q&A simulation with chatbot redirection to general, MSK, patient-specific resources
- **Implementation:** training & testing IBM Watson ML capabilities

### Notifications

- **Prototype:** patient & doctor request for notifications; design friendly reminder language
- **Implementation:** connecting chatbot app to individual devices

# Conversational Interface: Deliverables

Digital transformation of the patient/physician experience

## Developing a beginning-to-end appointment aid

### Forms

- Create a **chatbot** that can:
  1. Identify **intent** when patients ask to fill out a specific type of form
  2. Depending on PHI security, be able to **pre-fill** the form with existing knowledge
  3. Ask user for info in a **natural**, comfortable way
  4. **Save info** for next form
  5. Generate secure **PDF's** for the user to sign
  6. [Conduct rudimentary **sentiment analysis** for patient experience forms (MSK Engage)]

### Queries

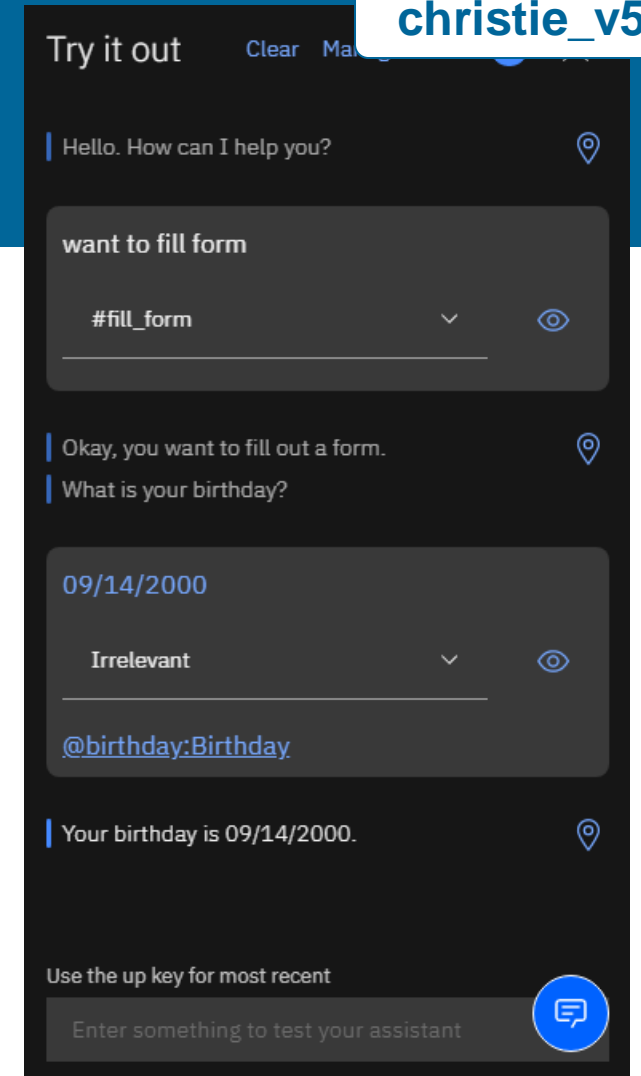
- Focus on **one dataset** primarily
  - e.g: MSK-specific q's from 1 knowledge base
  - or even more specific sector, like MSK's chemotherapy protocols, policies, and payments
- Create **chatbot** with concluding **report**
  - Detailed **precision & recall** measurements
  - **Training & testing** set counts
  - Major blockers and bot's areas of confusion
    - Bot comes pre-filled with sector knowledge

# Conversational Interface: Engage integration

My first technical task is integrating IBM Watson with MSK Engage's database

## Project pt 1: Integrate IBM Watson with MSK Engage

1. Retrieve MSK Engage Q&A text and display it as **IBM Watson Assistant chatbot** dialogue
2. Chatbot can **handle user mistakes**, interruption, nonsensical answers, etc
3. Chatbot **uses API's** to retrieve **PHI** as proof of concept that chatbot can smartly pre-populate known answers (e.g: medication history)
4. Chatbot inserts responses to existing **MSK Engage database**
5. Chatbot **returns different instructions** based on user input (e.g: recommendation to call PHP)



This week I worked on understanding Watson interface & having the assistant identify user intent & store user variables

# Conversational Interface: Prototype

I will also prototype the features of an engaging CI app

## Project pt 2: Prototype patient texting experience

- Consider the **full chatbot experience**
  - Design **alerts and reminders** for new forms to complete
  - Design **transition** between forms if users have multiple forms to fill
- **What can a chatbot provide that MSK Engage cannot?**
  - What will maximize patient engagement while minimizing patient work?
    - **Patient burnout** is real!
    - Leverage our existing attachment to mobile phones & create **easy texting experience**
      - Research the **best platform** for users to receive notifications & chat with bot (MSK app? Messenger? WhatsApp?)
      - **Deliverable**: visual prototype of interactions, functionalities, alerts, etc.

**Exploring IBM Watson as a product  
to conversationalize surveys**

**Integrating MSK Engage  
with an IBM Watson assistant**

# Conversational Interface: Example COVID form

To show a proof of concept, I will conversationalize the current COVID screening form

## Proof of Concept: Novel Coronavirus (COVID-19) Screening Questionnaire

For everyone's health and safety, including other patients and all of our dedicated staff, it is important that you answer the questions below truthfully. Your answers will help us prepare for your appointment.

1. Within the last 14 days, have you been in close contact with a person confirmed to have novel coronavirus (COVID-19)?\*

Yes

No

2. Do you have a fever, cough, difficulty breathing, body aches, chills, or new loss of your sense of taste or smell?\*

Yes

No

3. In the past 14 days, have you traveled to Alabama, Arkansas, Arizona, California, Delaware, Florida, Georgia, Iowa, Idaho, Kansas, Louisiana, Mississippi, North Carolina, Nevada, Oklahoma, South Carolina, Tennessee, Texas, or Utah?\*

Yes

No

### Ideal CI proof of concept candidate

- Widely used
- Short & sweet
- Little room for user error
- Returns customized user alert based on user COVID risk

### Ambitious future use case: CARE questionnaire

- Widely used
- 80 questions
- Heavy clinical language

# Different types of questionnaires

Memorial Sloan Kettering  
Cancer Center

Engage Questionnaire Library

BACK TO QUESTIONNAIRES

## Brief Symptom Assessment (ESAS)

Section: (No Name)

Please do not complete this survey if you are logged in from the patient portal. Only complete this survey if you are at your doctor's office.

Please answer the following questions based on your symptoms during the past 24 hours:

Overall Distress

Distress is an unpleasant emotional state that may affect how you think, feel and act. It can be caused by physical and emotional problems or other symptoms.

On a scale of 0-10 what is the WORST level of distress you have experienced?

No distress at all  Worst possible distress

3

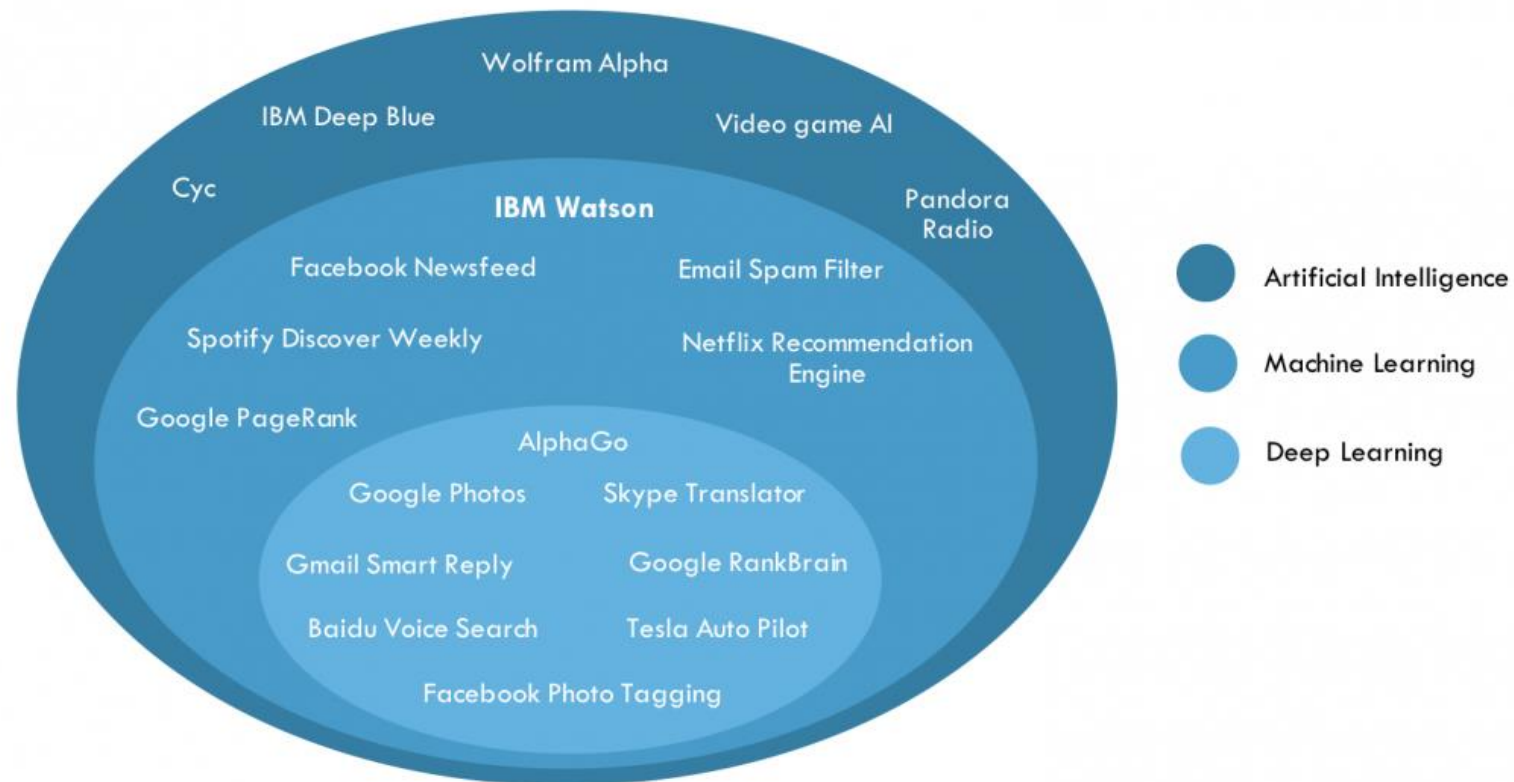
Slider question

Pain



# IBM Watson demo

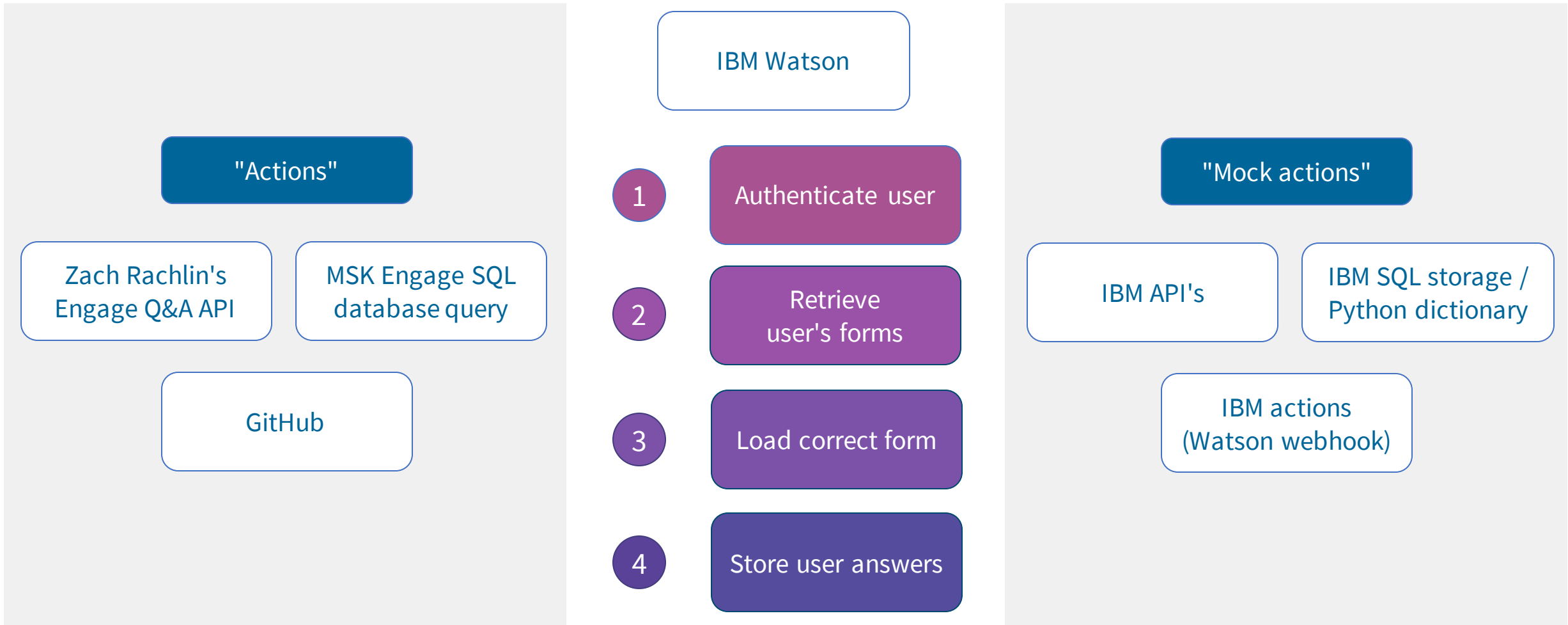
## Artificial Intelligence Categories



Source: ARK Investment Management LLC

# IBM Watson: Infrastructure

Digital transformation of the patient/physician experience



```

{
  "0": {
    "children": [
      7565,
      7638
    ]
  },
  "7565": {
    "English": {
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      "ChildQuestions": [],
      "DateAnswerLabel": null,
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      "DropdownPlaceholderText": null,
      "ElementType": "SectionSurveyElement",
      "FullSurveyName": "Brief Symptom Assessment (ESAS)",
      "Id": 7565,
      "Increment": null,
      "InstrumentName": "ESAS",
      "Language": "English",
      "LanguageId": 1,
      "LevelId": 0,
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      "ListAnswerMin": null,
      "MaxSliderAnswer": null,
      "MaxValue": null,
      "MinSliderAnswer": null,
      "MinValue": null,
      "NumericAnswerLabel": null,
      "NumericAnswerPlaceholder": null,
      "OriginalText": "None",
      "ParentId": null,
      "ParentQuestions": [],
      "ParentQuestionsText": [],
      "PatientContextText": null,
      "QuestionAnswerAlias": null,
      "SurveyDiscontinued": null,
      "SurveyId": 12,
      "SurveyName": "Brief Symptom Assessment",
      "Text": "None",
      "TextBoxLabel": null,
      "TextBoxPlaceholder": null,
      "TextBoxValidMessage": null,
      "_Logic": null
    },
    "children": [
      7640,
      7683,
      7684,
      7643,
      7685,
      7688,
      7689,
      7692,
      7693,
      7696,
      7697,
      7700,
      7701,
      7663,
      7704,
      7667,
      7707,
      7671
    ]
  }
}

```

```

"elementType": "QuestionSurveyElement",
"languages": [
  "English"
],
"parentId": 7565,
"surveyDiscontinued": null
},
"7703": {
  "English": {
    "ApprovedQuestion": null,
    "ChildQuestions": [],
    "DateAnswerLabel": null,
    "DropdownLabelText": null,
    "DropdownPlaceholderText": null,
    "ElementType": "AnswerSurveyElement",
    "FullSurveyName": "Brief Symptom Assessment (ESAS)",
    "Id": 7703,
    "Increment": null,
    "InstrumentName": "ESAS",
    "Language": "English",
    "LanguageId": 1,
    "LevelId": 2,
    "ListAnswerMax": null,
    "ListAnswerMin": null,
    "MaxSliderAnswer": "Worst possible depression",
    "MaxValue": null,
    "MinSliderAnswer": "Not depressed at all",
    "MinValue": null,
    "NumericAnswerLabel": null,
    "NumericAnswerPlaceholder": null,
    "OriginalText": "None",
    "ParentId": 7701,
    "ParentQuestions": [],
    "ParentQuestionsText": [],
    "PatientContextText": null,
    "QuestionAnswerAlias": "brief_depression:slider",
    "SurveyDiscontinued": null,
    "SurveyId": 12,
    "SurveyName": "Brief Symptom Assessment",
    "Text": "None",
    "TextBoxLabel": null,
    "TextBoxPlaceholder": null,
    "TextBoxValidMessage": null,
    "_Logic": null
  },
  "elementType": "AnswerSurveyElement",
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    "English"
  ],
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  "surveyDiscontinued": null
},
"7704": {
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    "DateAnswerLabel": null,
    "DropdownLabelText": null,
    "DropdownPlaceholderText": null,
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    "Id": 7704,
    "Increment": null,
    "InstrumentName": "ESAS",

```

# Pulling questionnaires from Zach Rachlin's API

# Engage behind-the-scenes

Enter a part of table name here

- DMSKPEFORMSAdvancedReports\_RESTI
- DMSKPEFORMS\_RESTORE
- DMSKTEFORMS**
  - dbo**
    - AHSFormDropdownAllergen
    - AHSFormDropdownAllergySeverit
    - AdvancedReport
    - Answer
    - AppConfiguration
    - AppointmentExtract
    - AppointmentExtract\_20181011
    - AppointmentExtract\_OLD
    - Assessment**
    - AssessmentDetails
    - AssessmentHistory
    - AssessmentLock
    - AssessmentPreviewSession
    - AssessmentQualifiedAdvancedRe
    - AssessmentStatus
    - BodyPart
    - Cancer
    - ClinDocImportOption
    - ClinicianFilter
    - ClinicianNotification
    - ClinicianNotificationTemplate

Properties | Data | ER Diagram | DMSKTEFORMS 2 | DMSKTEFORMS | dbo | Assessment

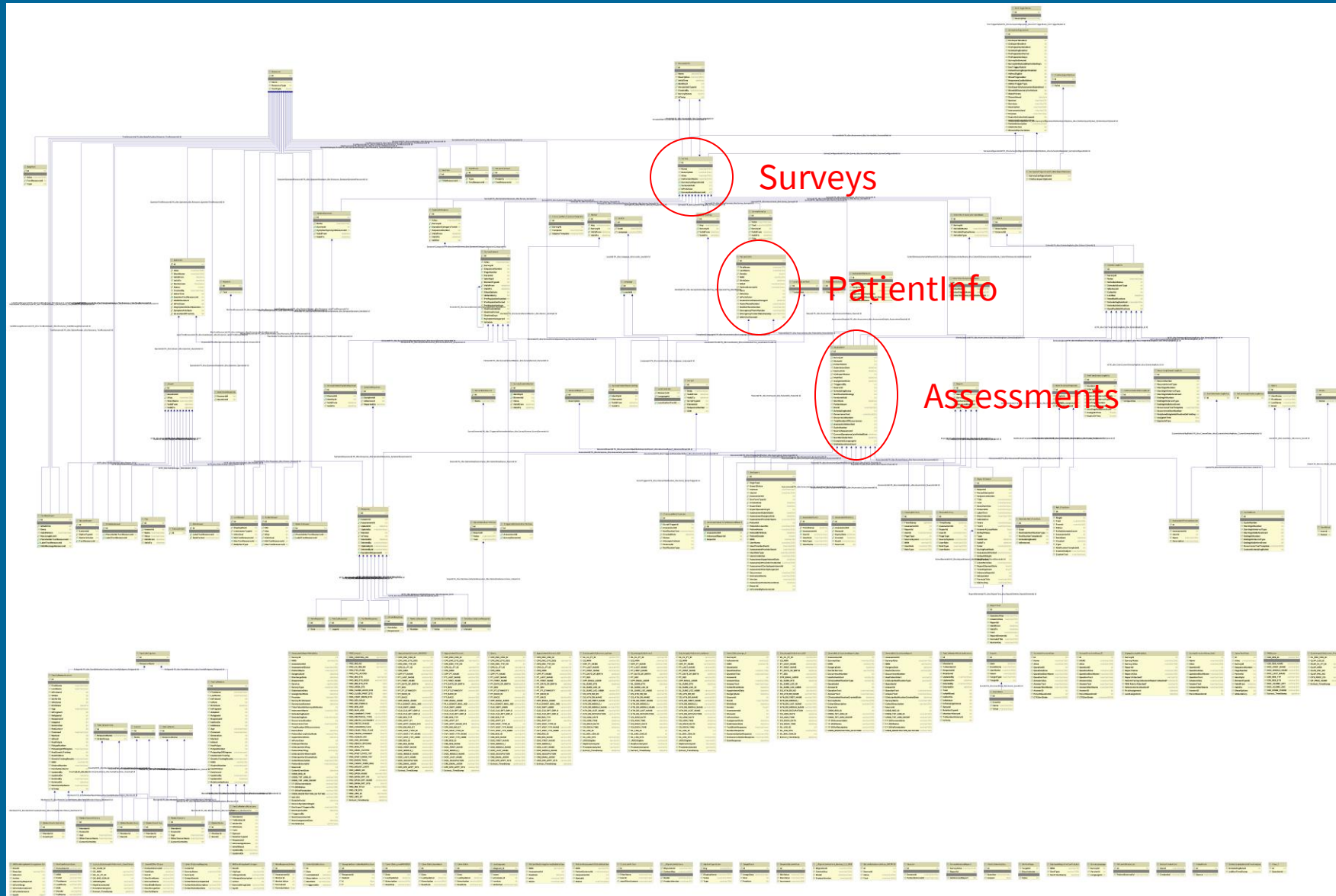
Assessment | Enter a SQL expression to filter results (use Ctrl+Space)

Grid	123 Id	123 SurveyId	123 StatusId	123 PatientInfolD	SubmissionDate	ExpiryDate	123 CisExportStat
1	292,774	4	3	107,439	2018-08-30 15:48:06	2018-09-29 14:16:33	
2	292,775	3,146	3	107,439	2018-08-30 14:40:47	2018-09-29 14:17:12	
3	292,776	4	3	107,439	2018-08-30 15:54:58	2018-09-29 14:23:46	
4	292,777	73	5	129,717	[NULL]	2018-09-21 23:59:59	
5	292,778	73	5	126,112	[NULL]	2018-08-31 23:59:59	
6	292,779	73	5	128,564	[NULL]	2018-09-17 23:59:59	
7	292,780	73	5	128,335	[NULL]	2018-09-18 23:59:59	
8	292,781	73	5	127,877	[NULL]	2018-09-12 23:59:59	
9	292,782	73	5	126,410	[NULL]	2018-08-31 23:59:59	
10	292,783	73	5	126,411	[NULL]	2018-09-03 23:59:59	
11	292,784	73	5	116,379	[NULL]	2018-09-11 23:59:59	
12	292,785	73	5	128,565	[NULL]	2018-09-17 23:59:59	
13	292,786	73	5	128,566	[NULL]	2018-09-17 23:59:59	
14	292,787	73	5	128,392	[NULL]	2018-09-14 23:59:59	
15	292,788	73	5	129,718	[NULL]	2018-09-21 23:59:59	
16	292,789	73	5	126,412	[NULL]	2018-09-03 23:59:59	
17	292,790	73	5	127,278	[NULL]	2018-09-07 23:59:59	
18	292,791	73	5	126,413	[NULL]	2018-09-03 23:59:59	
19	292,792	73	5	129,908	[NULL]	2018-09-24 23:59:59	

Record | Save | Cancel | Script | 200 row(s) fetched - 12ms (+39ms) | Rows: 1

EST en

# ... Engage *behind* behind-the-scenes



- ~1,500,000 assessments
- ~190,000 patients
- 147 tables in database
- Lots of ID systems...

# Dialog nodes

IBM Watson Assistant Plus

Engage Forms Test Version: Development

Intents  
Entities  
Dialog  
Options  
Analytics  
Versions  
Content Catalog

**Add node** Add child node Add folder

- Set up  
welcome  
0 Responses / 1 Context Set / Jump to / Does not return
- Identify user  
2 Responses / 2 Context Set / 1 Slots / Jump to / Does not return
- Retrieve user forms  
0 Responses / 0 Context Set / Jump to / Does not return
- Select form  
0 Responses / 1 Context Set / 1 Slots / Jump to / Does not return
- Validate form  
2 Responses / 1 Context Set / 1 Slots / Skip user input / Does not return
- Return home  
#return\_home  
1 Responses / 0 Context Set / Does not return

- form\_covid\_screen\_5 **Alert nodes**  
1 Responses / 0 Context Set / Jump to / Return allowed
- covid\_screeningstates  
1 Responses / 1 Context Set / 1 Slots / Jump to / Return allowed
- covid\_symptoms  
1 Responses / 1 Context Set / 1 Slots / Jump to / Return allowed
- covid\_contact **Question nodes**  
1 Responses / 1 Context Set / 1 Slots / Jump to / Return allowed
- form\_covid\_screen\_1 **Text nodes**  
1 Responses / 0 Context Set / Jump to / Return allowed
- form\_covid\_screen\_0  
1 Responses / 0 Context Set / Jump to / Return allowed

# Slots

Configure slot 1

Check for: @ `covid_symptoms` Save it as:  `$form_covid_screen_3`

Validate answer option

Dynamically generated answer storage variable

If slot context variable is not present ask: Slot is required ⓘ

Option

Title: 2. Do you have a fever, cough, difficulty breathing Description (optional): Add description

	List label	Value
1	Yes	<code> covid_symptoms_option_1</code>

Dynamically generated answer options

# Webhooks

Then callout to my webhook [Learn more](#)

Parameters

Key	Value
action	<code> "store_response" </code>
answer_id	<code> "1289347" </code>
assessment_id	<code> "189203" </code>

Add parameter +

Return variable

`webhook_result`

Dynamically generated answer\_alias and question\_alias for storage method

# "Entities" for answer verification

<input type="checkbox"/> Entity (41) ↑	Values	Modified ↑↓
<input type="checkbox"/> @bowelproblemsq	bowelproblemsq_bowelproblemsnone, bowelproblemsq_bowelproblemssmall, bowelproblemsq_bowelproblemsmod, bowelpr...	8 days ago
<input type="checkbox"/> @brief_breathing	brief_breathing_option_0, brief_breathing_option_9, brief_breathing_option_8, brief_breathing_option_4, brief_breathing_opti...	8 days ago
<input type="checkbox"/> @brief_constipation	brief_constipation_option_7, brief_constipation_option_10, brief_constipation_option_2, brief_constipation_option_4, brief_con...	8 days ago
<input type="checkbox"/> @brief_depression	brief_depression_option_7, brief_depression_option_10, brief_depression_option_0, brief_depression_option_4, brief_depressi...	8 days ago
<input type="checkbox"/> @brief_distress	brief_distress_option_3, brief_distress_option_4, brief_distress_option_5, brief_distress_option_7, brief_distress_option_8, brie...	8 days ago
<input type="checkbox"/> @brief_fatigue	brief_fatigue_option_7, brief_fatigue_option_4, brief_fatigue_option_8, brief_fatigue_option_2, brief_fatigue_option_6, brief_fat...	8 days ago
<input type="checkbox"/> @brief_nausea	brief_nausea_option_8, brief_nausea_option_2, brief_nausea_option_4, brief_nausea_option_7, brief_nausea_option_1, brief_...	8 days ago
<input type="checkbox"/> @brief_pain	brief_pain_option_1, brief_pain_option_4, brief_pain_option_3, brief_pain_option_8, brief_pain_option_6, brief_pain_option_5,...	8 days ago
<input type="checkbox"/> @brief_peace	brief_peace_option_3, brief_peace_option_4, brief_peace_option_5, brief_peace_option_8, brief_peace_option_7, brief_peace_...	8 days ago
<input type="checkbox"/> @brief_sleep	brief_sleep_option_2, brief_sleep_option_10, brief_sleep_option_7, brief_sleep_option_3, brief_sleep_option_5, brief_sleep_op...	8 days ago
<input type="checkbox"/> @brief_worry	brief_worry_option_5, brief_worry_option_9, brief_worry_option_8, brief_worry_option_2, brief_worry_option_6, brief_worry_op...	8 days ago
<input type="checkbox"/> @Covid_contact	Covid_contact_option_0, Covid_contact_option_1	8 days ago
<input type="checkbox"/> @covid_screeningstates	covid_screeningstates_option_0, covid_screeningstates_option_1	8 days ago
<input type="checkbox"/> @covid_symptoms	covid_symptoms_option_0, covid_symptoms_option_1	8 days ago



# Webhook-side

- Retrieves ser info
- Retrieves users' assessments
- Retrieves surveys
- Room for answer storage (currently Python dictionaries)

The screenshot displays the 'Actions' management interface for the 'watson-assistant' namespace. A sidebar on the left contains navigation options: Functions, Getting Started, Actions (selected), Triggers, APIs, Monitor, Logs, and Namespace Settings. The main content area features a search bar and a 'Create' button. Below, a table lists the actions, with the 'main' action being the only one that is 'Enabled'.

Name	Runtime	Web Action	Memory	Timeout
create_dialog	Python 3.7	Not Enabled	256 MB	60 s
flatten_form	Python 3.7	Not Enabled	256 MB	60 s
get_questionnaire	Python 3.7	Not Enabled	256 MB	60 s
get_user_forms	Python 3.7	Not Enabled	256 MB	60 s
identify_user	Python 3.7	Not Enabled	256 MB	60 s
main	Node.js 10	Enabled	256 MB	60 s
store_response	Python 3.7	Not Enabled	256 MB	60 s

Items per page: 10 | 1-7 of 7 items | 1 of 1 pages

# Also interacts with IBM API's

Functions / APIs / watson-engage

## watson-engage

  API Online



Monitor

Define and Secure

Manage Sharing and Keys


Review and Test

### API Info

**API name**

watson-engage

**Route**

<https://0a7320af.us-south.apigw.appdomain.cloud/api> 

[Manage this API's domain](#)



**Rate Limit**

None



**Security**

CORS enabled

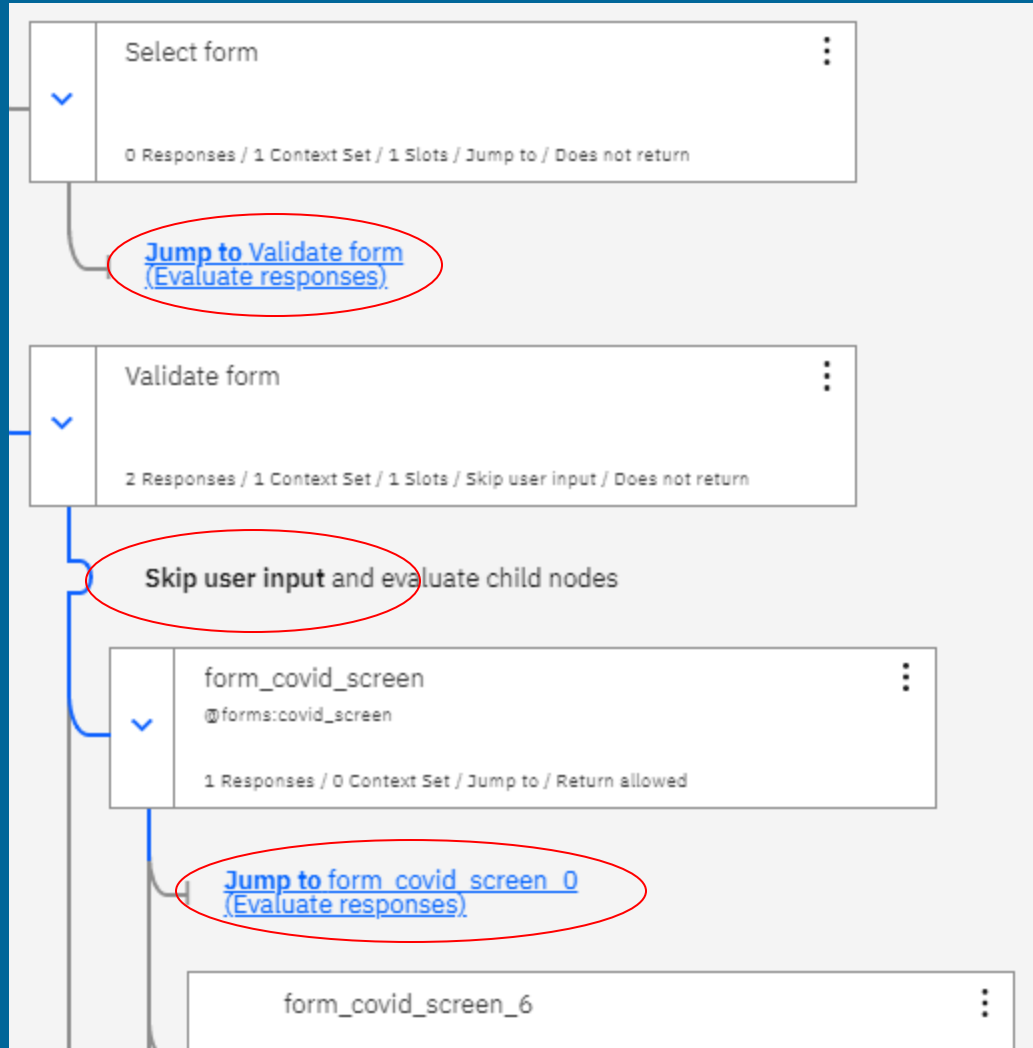


**Sharing**

Shared with IBM Cloud account

# What Ricardo and I learned

# Hard-code "jumps"



# Entity recognition

The screenshot shows a chat interface with a dark background. At the top, it says "Try it out" with "Clear" and "Manage Context 5" buttons. The chat history includes:  
- A message: "Hello! What is your username?"  
- An entity recognition card for "yuc3" (circled in red) with a dropdown menu set to "Irrelevant" and a visibility icon.  
- A mention: "@username:yuc2" (circled in red).  
- A message: "Welcome Christie!" (circled in red).  
- A message: "I need you to choose a form from the list below."  
- A list of forms:  
 12 - Brief Symptom Assessment  
 68 - Novel Coronavirus (COVID-19) Screening Questionnaire

# IBM Watson: What Ricardo and I learned

A survey may not be a conversation

## Lessons from this exploration

- IBM Watson is a powerful integrated platform with SQL storage, API's, function methods, chatbot AI, etc
- But... it is a little too powerful for a transactional task like survey-filling ("on rails")
  - Not taking advantage of IBM's cognitive capability; technology mismatch

## **A survey may not be a conversation, but the survey experience is!**

- Lots of creative ways to:
  - Transition between surveys
  - Remind users to complete forms
  - Assess non-verbal cues
- **How do we make MSK Engage "friendly"? Now *that* is a conversational task!**

# Conversational Interface: Project

Digital transformation of the patient at MSK experience

## Developing a beginning-to-end appointment aid

Mission: create a "personal assistant" for patients from pre-visit to post-treatment

- **Appointment:** scheduling, what to bring, notifications
- **Forms\*:** auto-generate via natural language, jargon explanation
- **Treatment:** prescriptions, follow-up visits, reminders & warnings
- **Payment:** insurance breakdown, total payment transparency
- **Queries\*:** pulls information from database and only contacts physician if necessary
- **Notifications:** medication adherence reminders, fitness tracker
- Room for multilingual support, phone call version

Christie

Hi Sloane. I'd like to fill out my prelim survey for my appt tmr at 3.

Sloane

Hi Christie. I already have this information in the system. Please let me know if this is the correct info:

Birthdate: 09/14/2000  
SSN: 123123123  
Current medications: none

Christie

Yes, that's correct

Sloane

I'll generate your check-in form now. In a minute I'll send a PDF you need to sign and bring with you tomorrow.

Christie

Do I need to fast before my blood test tomorrow?

Sloane

Yes. Please read MSK's policy below:

# Conversational Interface: Digital transformation

Digital transformation of the patient at MSK experience

## Problems

Physician burnout

Patients unsure what resources to turn to

Tedious paperwork often filled incorrectly

PHI passes through too many hands

Loss of autonomy for non-English speakers

## Project solutions

**Offloading physician work:** questions are filtered, only reaching physician if truly necessary; also reduces secretarial work & patient lookup process

**Central knowledge bank:** combine general, MSK, and patient-specific info by merging databases = reliable PA throughout treatment process

**Efficiencies on patient end:** no redundant PHI input for forms; filling out forms via natural language eliminates jargon barrier

**Increased PHI security:** questions are not passed around the pipeline — only internal software "reads" patient PHI within patient account

**Multilingual support** (out of project scope?): multilingual chatbot for step-by-step walkthrough of forms, payments, scheduling

# IBM Watson: For the future

So, what's next?

## Further exploring IBM Watson for Engage

- Transition between forms
- User notifications (chatbot platform exploration)
- Non-verbal cues
- Voice

More with Engage

## Exploring other conversational methods

- Twilio for "on rails" surveys
- Integration between Twilio and IBM Watson transitions

## Further exploring IBM Watson as a platform

- Collaboration issues
- Security issues

More with IBM

## Exploring IBM Watson for other uses

- Appointments
- Payments
- Queries
- Notifications



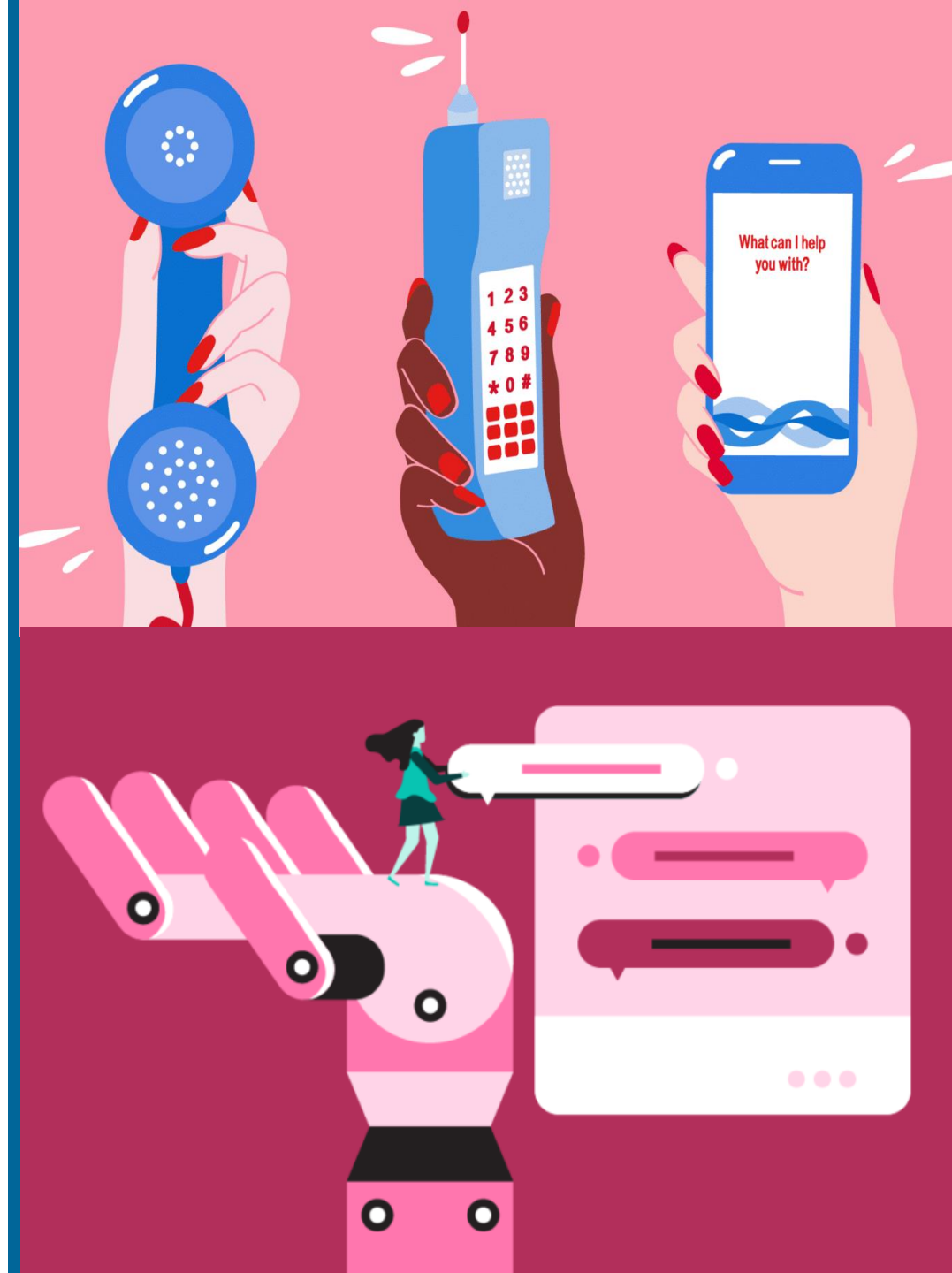
# Turning vision into action



Memorial Sloan Kettering  
Cancer Center

**DigiTs**

DIGITAL, INFORMATICS, TECHNOLOGY



# Appendix

# **Appendix A: Conversational Interfaces**

# Conversational Interface: Background

Digital transformation of the patient/physician experience

## Harnessing AI to reduce physician burnout

AI advancements can help reduce redundant work

- **General questions**
  - What are common side effects of Leukeran? Are they dangerous?
  - My doctor said I have low blood pressure. What does that mean?
  - I'm filling out a form. What does "medical record number" mean?
- **MSK questions**
  - Can I have visitors come in tomorrow at 5 p.m.?
  - Should I fast before tomorrow's surgery? Can I eat after my surgery?
  - Is this blood test covered by my insurance?
- **Patient-specific questions**
  - What were the results of my lab test? How long until they come back?
  - What immunizations do I have? Can I get a PDF of my history?
  - When is my next appointment?
  - Can I check my payment record?

For every **1** hour with a patient, physicians spend **2** at the computer.

More than **half** of physicians reported feeling burnt out.

Paperwork costs the health industry (conservatively) **\$4.6 billion** annually.

[Source](#)

# Conversational Interface: Cancer SOTA

Current advancements of chatbots in the cancer landscape

## A Chatbot Versus Physicians to Provide Information for Patients With Breast Cancer

- "A total of 142 patients were included and randomized into two groups of 71. They were all female with a mean age of 42 years (SD 19). The success rates (as defined by a score >3) was **69% (49/71) in the chatbot group** versus 64% (46/71) in the physicians group. The binomial test showed the **noninferiority** ( $P < .001$ ) of the chatbot's answers."
- Conclusion: "Artificial conversational agents may save patients with minor health concerns from a visit to the doctor. This could **allow clinicians to spend more time to treat patients** who need a consultation the most."
  - **Chatbots can accurately relay information and reduce physician burnout**

## One-Year Prospective Study of Conversations Between Patients With Breast Cancer and a Chatbot

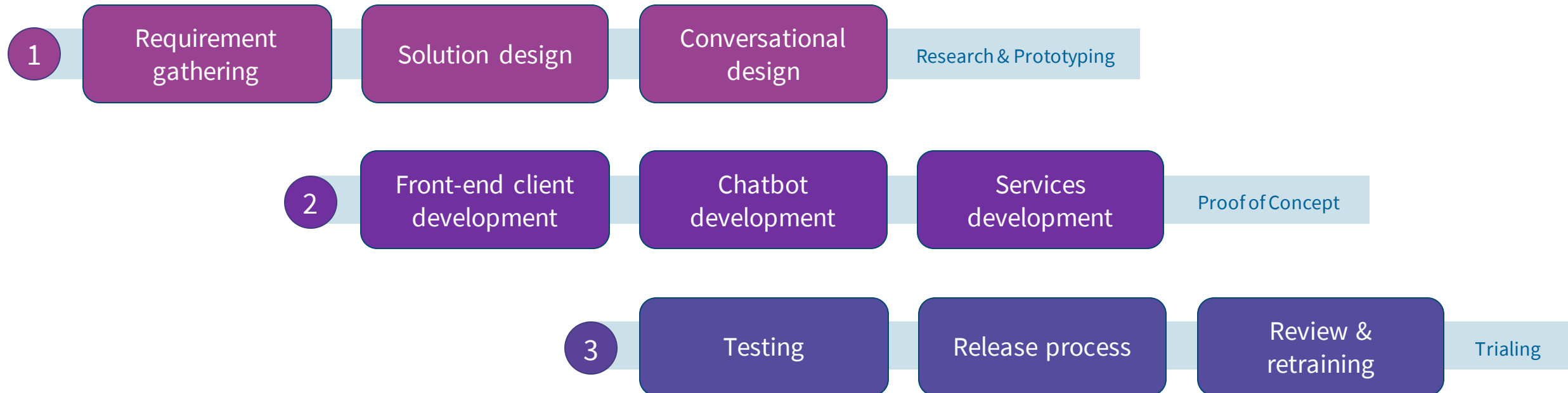
- "A total of 4737 patients were included. Results showed that an average of 132,970 messages exchanged per month was observed between patients and the chatbot, Vik ... Patients regularly left **positive comments** and **recommended** Vik to their friends. The **overall satisfaction was 93.95%** (900/958). When asked what Vik meant to them and what Vik brought them, 88.00% (943/958) said that Vik **provided them with support** and helped them **track their treatment** effectively.
- Conclusion: "It is possible to obtain **support** through a chatbot since Vik improved the **medication adherence rate** of patients with breast cancer."
  - **Chatbots are effective at improving patient medication adherence and supporting patients emotionally**

[Source](#)

# Conversational Interface: Timeline

Digital transformation of the patient/physician experience

## Developing a beginning-to-end appointment aid



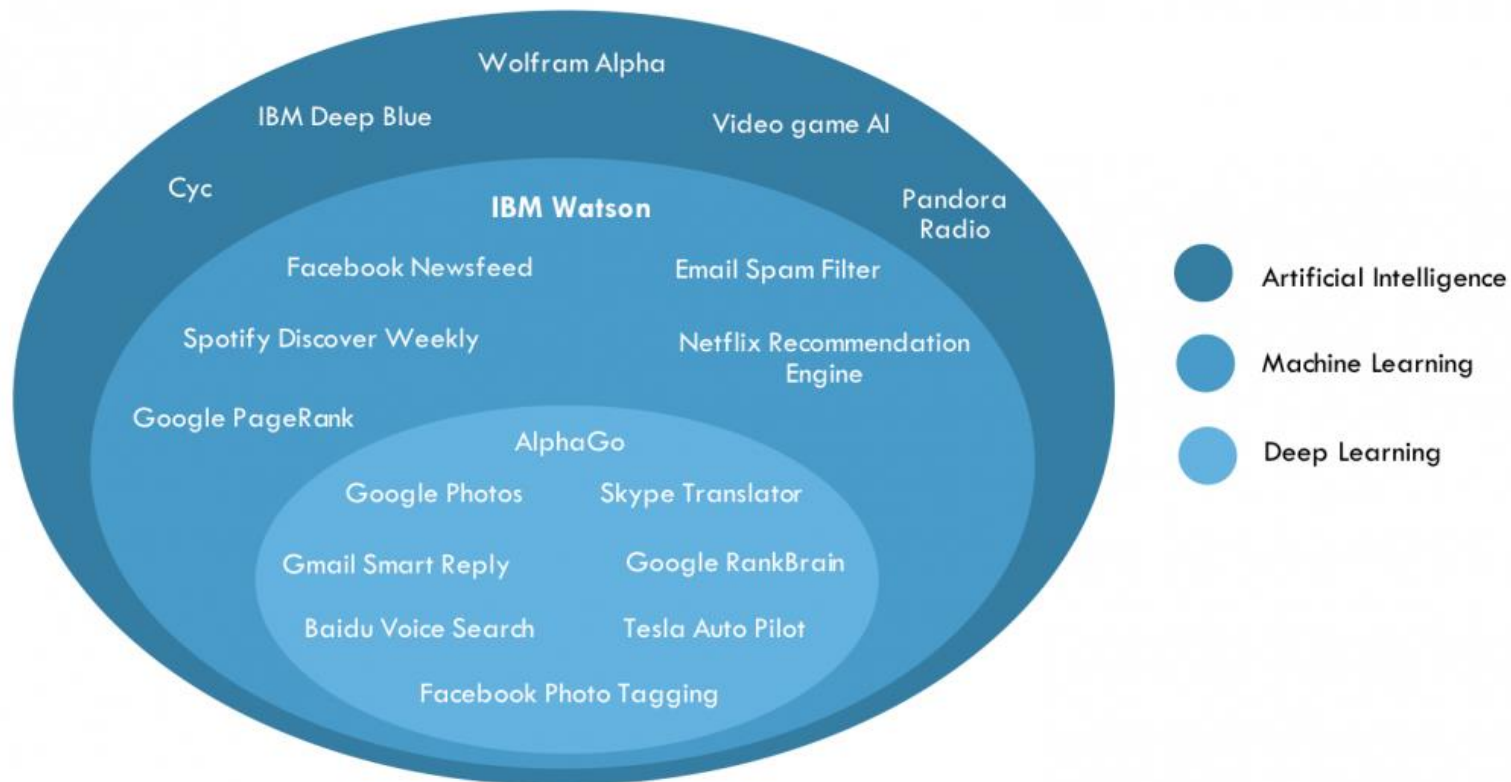
[Source](#)

# Appendix B: IBM Watson

# Conversational Interface: IBM Watson

Digital transformation of the patient/physician experience

## Artificial Intelligence Categories



Source: ARK Investment Management LLC

BankBot

I can help you schedule an appointment with one of our bankers.

Which date would be best for you? We need 24 hours notice for an appointment, the earliest would be tomorrow.

I can do tomorrow!

Great, Sat, Jun 13, 2020.

What time would you like to meet with our banker?

I can help you find a credit card to suit your needs. We have credit cards to build credit, provide rewards, and help you save money. What are you looking for most in a credit card?

Low interest rates

We have several credit cards with low interest and no fees.

Are you interested in rewards?

I can help you with credit card payments.

One moment while I retrieve a list of accounts.

Please select which credit card account you'd like to pay.

Card # 5624    Card # 5893    Card # 9225



# Conversational Interface: IBM Watson

Digital transformation of the patient/physician experience

- **IBM Watson Assistant**
  - Build, test, and deploy a bot or virtual agent across mobile devices, messaging platforms, or even on a physical robot
- **IBM Watson Discovery**
  - A cognitive search and content analytics engine for applications to identify patterns, trends, and actionable insights
- **IBM Watson Natural Language Understanding**
  - Analyze text to extract meta-data from content such as concepts, entities, keywords, categories, sentiment, emotion, relations, and semantic roles, using natural language understanding
- **IBM Watson Tone Analyzer**
  - Uses linguistic analysis to detect communication tones in written text
- **Node.js**
  - An asynchronous event driven JavaScript runtime, designed to build scalable applications

[Source](#)

# Conversational Interface: IBM Watson Assistant

Digital transformation of the patient/physician experience

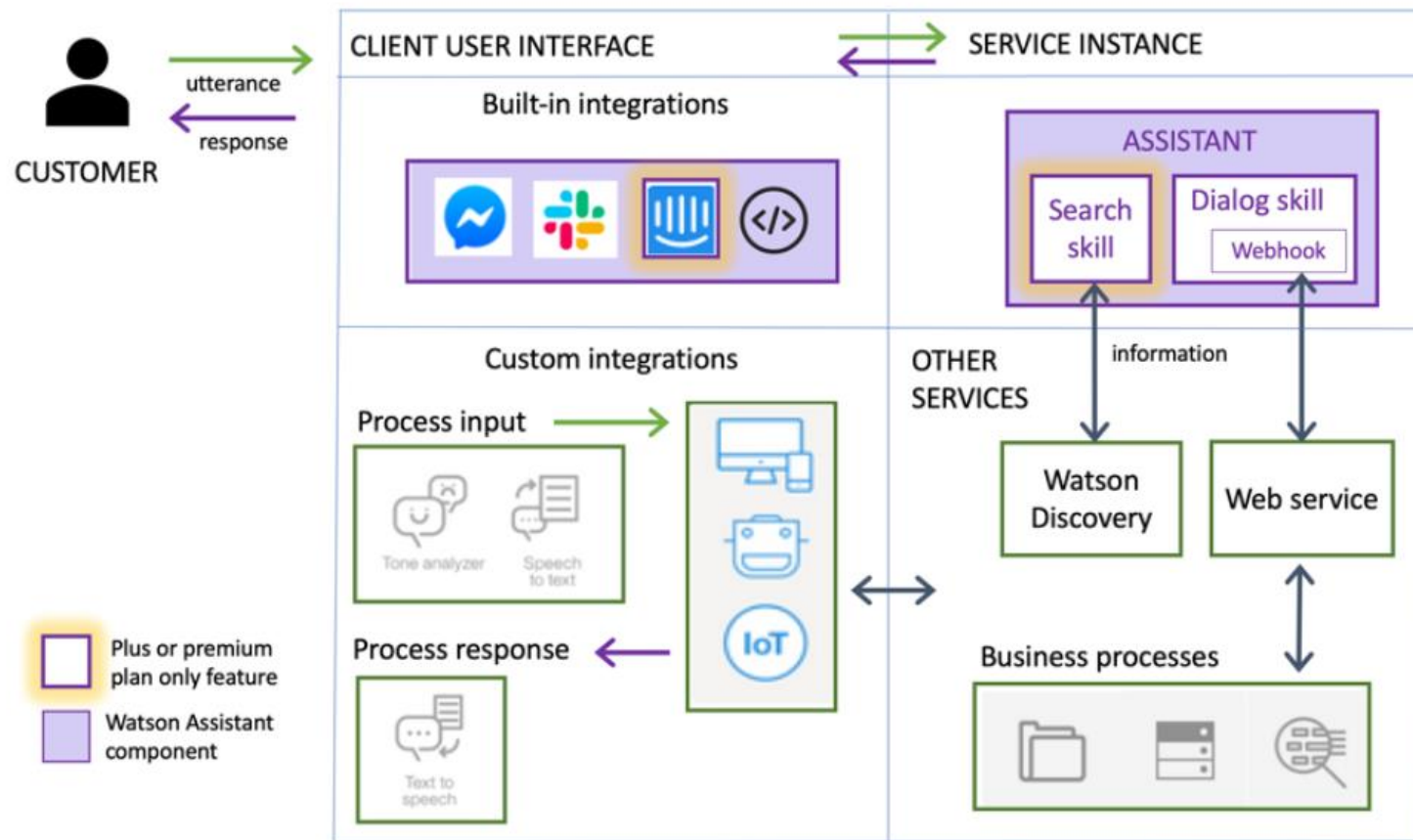


Figure 2: A typical approach used when deploying Watson Assistant

[Source](#)

- Intents
- Entities
  - System entities
- Dialogues
  - Condition
  - Response
  - Slots

# **Appendix B: Project Timeline**

# Conversational Interface: Updates

Forging a reliable, all-in-one assistant for MSK patients

## Since we last spoke...

- I decided to **drop the knowledge base querying feature**. Wynne Kim (owner of the new knowledge bank) met with TechInc and it was clear that this project is still in ideation. I want to continue to sit in on these meetings so I can be better informed of the larger picture of CI, but I think I can't help much with knowledge base querying if 1) content isn't yet in the knowledge base and 2) the TechInc engineers are struggling to figure out where to start.
- I refined my forms idea. I spoke with Monica Allison (owner of MSK Engage) and she suggested I tackle the **3-question COVID screening form** as a proof of concept for **integrating IBM Watson with the MSK Engage SQL database**.
  - This involves integrating a bunch of API's and SQL queries. Priti Parekh, an engineer on Monica's team, suggested I retrieve Q&A text from an API rather than hard-code it, so the project can be **scalable** in the future for 80+ question surveys.
- I also plan on producing a **visual prototype** of what the forms chatbot experience will look like, from morning notifications to filling out multiple forms to alerting users to take further action depending on form response.

# Conversational Interface: Steps taken

Here is who I've talked to so far.

## General

- **Monica Allison** (MSK Engage owner) gave me points of contact on her team & access to Engage dashboard & test platform
  - **Alyse Kassa & Elizabeth Kemeny** (Monica's team) will give me an in-depth tour of MSK Engage interface
- **Wynne Kim** (new knowledge bank owner) outlined future collaboration timeline between TechInc and Fernanda's team... I decided here that I would not pursue engineering knowledge bank querying since TechInc engineering team (**Eric Schmitz & Mac Macgari**) themselves were struggling with progress on that

## Engineering

- **Priti Parekh** (IS on MSK Engage API) gave me access to MSK Engage SQL database & info on next steps
- Reached out to **Bing Zhang & Peter Roehrich** (IS) for access to PHI API (they use this for clinical check-ins; user inputs ID and zip code, tablet asks them to verify their name)
- Reached out to **Zach Rachlin** (Health Informatics) for access to MSK Engage Q&A API so I can retrieve Q&A text dynamically for Watson = future scalability for 80+ question forms!

## UI/UX

- **Divya Gaitonde** meets biweekly with me to advise project timeline & give feedback on project details
- Working with **Qingyan Ma** and **Keri Martin**'s team to collect secondary research on future of conversational interfaces
- And of course, **Kristine** has helped me every step of the way!

# Proposed Timeline

## W6: Import COVID questionnaire from Q&A text API (by Zach Rachlin) & create Watson logic

- Account for user making mistakes in form
- Account for user taking a break
- Account for user interrupting form
- Have answers collectable and ID'd for SQL insertion

## W7: Chatbot connects to PHI API (Bing Zhang & Peter Roehrlich) to authenticate user and pre-populate form

- Chatbot can identify user's name using ID/zip code input (POC that chatbot can connect to PHI and potentially pre-populate form)

## W8: Form responds differently based on user input

- Input logic for COVID-suspected patients
- Alert user & store flag in SQL
- Retrieve PHP phone number for flagged patients (Bing's API)
- Retrieve list of next forms for user to complete (Priti's API)

## W9: Prototype full chatbot forms experience using InVision & Adobe Illustrator

- Design schedule for forms reminders
- Write language for daily alerts
- Create visual prototype for all stages of patient forms experience