## Chatbots to learn about, with, and from

### Illustrated by a project between IBM CAS and the Mauritshuis

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### For context, where I'm from: **IBM Benelux Center for Advanced Studies (CAS)**

Research

### Innovation



# CAS

### **Education**

Next Learning



### CAS: Collaboration with Academia



IBM

providing technology and industry knowledge



### **Clients in the Benelux**

get challenges addressed in innovative ways by

. . . . . . . . . . .

Academia

1

contributing with deep knowledge and independent view







### Where CAS Research fits









## Are chatbots new?

### User: My head hurts

Eliza: Why do you say your head hurts?

### **ELIZA; the psychoterapist** Joseph Weizenbaum – MIT - 1966



```
File Edit Options Buffers Tools Help
🜔 📁 × 🝈 💰 🤊 🎸 🚯 🕷 🚱 🧭 🦓 🤅
 I am the psychotherapist. Please, describe your problems.
SEach time
  you are finished talking, type RET twice.
  I have a terrible headache.
  Maybe you should consult a doctor of medicine, I am a psychi
 Satrist.
  Okay, I'll do that then.
  Can you elaborate on that?
  What are vou talking about? No I cannot elaborate. See vou l
         "Thank you, that will be $150. Have a good day!"]],
274
275
       [r'(.*)',
276
       [ "Please tell me more.",
277 🔻
         "Let's change focus a bit... Tell me about your family.",
         "Can you elaborate on that?",
279
         "Why do you say that %1?",
280
281
         "I see.",
282
         "Very interesting.",
283
         "%1.",
         "I see. And what does that tell you?",
284
         "How does that make you feel?",
285
         "How do you feel when you say that?"]]
286
287
         command interface
      def command interface():
       print('Therapist\n----
             'Talk to the program by typing in plain English, using normal upper-
             'and lower-case letters and punctuation. Enter "quit" when done.')
       print(
       print('='*72)
       print('Hello. How are you feeling today?')
298
       s = '''
       therapist = eliza();
301 🔻
       while s != 'quit':
302
         try
        s = input('> ')
except EOFError:
303
304
305
          s = 'quit'
306
         print(s)
         while s[-1] in '!.':
307
308
          s = s[:-1]
         print(therapist.respond(s))
309
310
311
     if __name__ == "__main__":
312
       command_interface()
313
314
```



"I went to the races." Please go on.

"I gamble on horses." Please go on.

"Do you know anything about bookies?" What makes you think I know anything about bookies?

"A bookie didn't pay me off once." What does that suggest to you?

"I beat up the bookie who did not pay off, and I thought he might use his friends in the underworld to get even with me."

PARRY Kenneth Colby, Stanford 1972



## When PARRY Met ELIZA: A **Ridiculous Chatbot Conversation From 1972**

They might not have passed the Turing Test, but they won the battle for wackiness.

Network Working Group Request for Comments: 439 NIC: 13771

#### PARRY Encounters the DOCTOR

The session recorded below actually happened on 18 September 1972 and is herewith reproduced for your entertainment.

Good Evening.

Tell me your problems. Please terminate input with a period or a question mark.

\*People get on my nerves sometimes.

I am not sure I understand you fully.

\*You should pay more attention.

Suppose you should pay more attention.

\*You're entitled to your own opinion.













## Cleverbots (video from 2011)

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







## Chatbot vs. Conversational Assistant

Has to have a clear purpose

Not the solution to every problem you may have





## **Customer Support Use Case Types**

### Virtual Agent



### $\rightarrow$ Virtual Agent scenarios are often good candidates for the NLClassifier



 $\rightarrow$  Human Agent can concentrate more complex and infrequently asked question and Retrieve and Rank Service can assist the Agent can find answers for unknown questions





Should a chatbot be conversational?

### When you do need conversation: Differentiation from competition •Humanising a brand

### When you don't need conversation:

- User error leading to failed transaction
- If your competitive advantage is simplicity
- If you cannot handle unbounded input







## Should a chatbot be conversational?

**Considerations for chatbots:** 

- •How are you setting user expectations?
- •Is your chatbot utilitarian or entertainmentdriven?
- Does your chatbot reflect your brand's voice?
- •Is your chatbot a familiar service or product?
- Does your chatbot need to differentiate itself in a competitive market?
- How strong is your technical team and AI platform?
- •How strong is your writing team?





## The Mauritshuis seeks to innovate



Mauritshuis heeft primeur met HoloLens tijdens Museumnacht 19 oktober 2017



New App Reveals Secrets of Girl with a Pearl Earring. 09 November 2016









Mauritshuis Rediscovers Jan Steen Painting 'As if it's fresh from Jan Steen's studio' 09 February 2018





## How to get to learning?

- Good data and Al models lead to a good system
- A good system leads to good user experience
- Good experience leads to engagement
- Engagement leads to Learning





## An chatbot as starting point for exploration

## The system answers questions, we do our research on it





## The Application



### Chat with Watson









## Visual discovery (no AI in here...yet)









#### **About Doctor Tulp**

The real name of Doctor Nicolaes Tulp was actually Claes Pieterszoon. He was one of the most famous doctors of the XVII century and he was also mayor of Amsterdam.

### What is interesting to know?

#### Did Doctor Tulp pay to be in the painting?

Both Dr Tulp and the students depicted in the painting paid Rembrandt to be portrayed in this painting.

#### Is it true that his real name was not Dr. Nicolaes Tulp?

Yes, that is correct. Dr Tulp was born as Claes Pieterszoon, but later in life changed his name into Nicolaes and adopted the surname Tulp, which translates as tulip in Dutch.

#### Who is the man with the hat?

The man with the hat is doctor Nicolaes Tulp.

#### How many dissections did doctor Tulp perform during his career?

Dr. Tulp taught nine anatomy lessons during his career.





People



## Answering people's questions







### Watson (2011) Question-Answering on unconstrained domains









## **Cognitive Computing: Three elements** EXPANDS massive data, or data that requires human interpretation

LEARNS as you use it – most machine errors are easy for LEARNS a human to detect, and we can instrument usage of systems to better understand the system and the problem it solves

## INTERACTS



EXPANDS human cognition, makes the jobs we do easier, like a cognitive prosthesis, especially when dealing with processing

> INTERACTS naturally. We need to bring machines closer to their users, we have adapted ourselves enough to them, they should understand natural language, spoken or written, be able to process images and videos. These *simple* human problems are extremely complex for machines, but are hallmarks of a new computing era.





## The story of Watson (very high level, not all aspects covered)

Create something specific (Jeopardy, 2011)

- $\rightarrow$  Try to use framework on other domains (WEA, ~2013)
- → Break it apart (Developer Cloud, ~2015-) you do the assembling
- $\rightarrow$  Address specific use cases (Watson for Oncology, etc., ~2015-) *IBM does the assembling*















**Direct Link Network Service Provider** 

Establish unparalleled network performance to and from



IBM Cloud offers domain registration services complete

#### **Dedicated Virtual Server (Hourly)**

Our virtual servers deliver a higher degree of customization, transparency, predictability, and



#### Dedicated Virtual Server (Monthly)

Our virtual servers deliver a higher degree of customization, transparency, predictability, and

IBM

#### Public Virtual Server (Monthly)

Our virtual servers deliver a higher degree of customization, transparency, predictability, and

#### **Cloud Object Storage**

Provides flexible, cost-effective, and scalable cloud storage for unstructured data.



#### Content Delivery Network

The Content Delivery Network service distributes content where it is needed. The first time content is reque

IBM

#### **Direct Link Cloud Exchange**

Establish unparalleled network performance to and from your IBM laaS platform.



#### **Direct Link Colocation**

Establish unparalleled network performance to and from your IBM laaS platform.

#### IBM

#### **Domain Name Service**



#### **IPSec VPN**

VPN access is designed to allow users to remotely



### Language

Analyze text and extract metadata from unstructured content.

-0-

#### Language Translator

Translate text from one language to another.

#### Natural Language Classifier

Interpret and classify natural language with confidence.

#### **Retrieve and Rank**

Retrieve and Rank features are now available in Watson Discovery.

#### Conversation

Integrate diverse conversation technology into your application.



Conversation Quickly build a chatbot with easy tooling and dialog trees.

#### Virtual Agent Create a bot for customer service.

### Speech

Convert text and speech with the ability to customize models.



Speech to Text

Easily convert audio and voice into written text.

#### **Text to Speech**

Convert written text into natural-sounding audio.

#### Knowledge



Get insights through accelerated data optimization capabilities.

#### Discovery

Unlock hidden value in data to find answers, monitor trends and surface patterns.

#### **Discovery News**

Access pre-enriched news content in real-time.

#### Natural Language Understanding

Natural language processing for advanced text analysis.

#### **Knowledge Studio**

Teach Watson to discover meaningful insights in unstructured text.

#### **Document Conversion**

Document Conversion features are now available in Watson Discovery.

Empathy

Understand tone, personality, and emotional state.



**Personality Insights** Predict personality characteristics through text.

#### **Tone Analyzer**

Understand emotions and communication style in text.

#### Vision

Identify and tag content then analyze and extract detailed information found in an image.



**Visual Recognition** Tag and classify visual content using machine learning.





## What kind of Al?





Artificial super-intelligence is an intellect that is much smarter than the best human brains in practically every field, including scientific creativity, general wisdom and social skills. Artificial Super-intelligence ranges from a computer that's just a little smarter than a human to one that is trillions of times smarter across the board.



### Back to the Mauritshuis app – what's in it?









## Who learns?

- Users learn about the painting
- Curators/Museum Researchers learn about user behaviour and interest
- Computer Scientists learn about application of their algorithms in the cultural heritage domain
- The system learns as people use it, provide feedback to it.







## Questions on top of a QA system



Can it go bad if users don't give the right feedback? How do you establish a connection between questions, answers, and parts of the painting?



I con Discover the Painting

How do we change the user experience to incorporate emotional states?



## People can indicate if they like/approve/ accept an answer

## What if they don't do it 'right'?





er [5] maintained be wearing a hat. er than the left, with

Next Learning











**200 USERS/DAY** 



**10 QUESTIONS/** USER



**9** Scenarios













## Learning is good, but we need to learn the right things!



At what percentage of malicious users will system performance start decreasing?



## Up to a point the system still improves

<20% System is Learning

System is Stagnating

>30% Performance Decreases









## To wrap up

Investigation of the robustness of a QA system

Simulation allows for making important choices before deployment



### Applicability in other domains utilising user feedback





## Establishing visual focus for a QA system

## Where should people look when asking questions and getting answers?





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## **Connecting data with a painting**

Information about the artwork (subject, style, background, etc.)



**/stem** with more than 5000 QA



### Visual mapping of the information on the artwork



### How to gather and process visual data?

Next Learning



## How to gather and process data?

### QA SYSTEM







### PAINTING

### CROWDSOURCING





## **Focus investigation in 4 steps**

**Question:** Who is the man with the hat?





## **Answer:** The man with the hat is Doctor Nicolaes Tulp



## **Focus investigation in 4 steps**

**Question:** Who is the man with the hat?



### **Collect boxes** for the questions only

2

### **Clustering** on all the boxes for one question





## **Answer:** The man with the hat is Doctor Nicolaes Tulp





Determine the final mapping between each QA pair and the painting



Collect bounding **boxes** for the questions only **Read the following question about the painting:** 

It is possible to draw more than one bounding box, or none in case there are no visual references between the question and the painting.





### Who is the man with the hat?

### Draw a bounding box on the location that the question is referring to in the painting.





### **K-Means** Clustering

It is possible to draw more than one bounding box, or none in case there are no visual references between the question and the painting.





### **Read the following question about the painting:**

### Who is the man with the hat?

### Draw a bounding box on the location that the question is referring to in the painting.



Each cluster obtains a score (*QCS*) from the question side applying the **CrowdTruth metrics** 



### Who is the man with the hat?





### Evaluate the relevance of the clusters for each **answer**

### BOX 1 (required)

- YES, the text is relevant to this box
- NO, the text is not relevant to this box

### BOX 2 (required)

- YES, the text is relevant to this box
- NO, the text is not relevant to this box



### The man with the hat is Doctor Nicolaes Tulp

### Draw a bounding box on the location that the question is referring to in the painting.

It is possible to draw more than one bounding box, or none in case there are no visual references between the question and the painting.





**Read the following question about the painting:** 

Next Learning



Each cluster obtains a score (*ACS*) from the answer side applying the **CrowdTruth metrics** 



### The man with the hat is Doctor Nicolaes Tulp

![](_page_42_Picture_4.jpeg)

![](_page_42_Picture_5.jpeg)

### How to establish the mapping between the QA pair and the painting?

![](_page_43_Picture_3.jpeg)

![](_page_43_Picture_4.jpeg)

### Who is the man with the hat? The man with the hat is Doctor Nicolaes Tulp

![](_page_44_Picture_0.jpeg)

Who is the man with the hat? The man with the hat is Doctor Nicolaes Tulp

![](_page_44_Picture_2.jpeg)

### Nothing to Box: **NO**

![](_page_44_Picture_4.jpeg)

### Two scores: QCS, ACS

![](_page_44_Figure_6.jpeg)

**Correlation between QCS and ACS** 

Question Cluster Score (QCS)

### **Pearson Correlation Index: 0.933**

![](_page_44_Figure_12.jpeg)

Q: What is he doing??

A: I am afraid I do not understand the question could you please be more specific?

![](_page_45_Picture_3.jpeg)

Nothing to Box: **NO** 

![](_page_45_Picture_5.jpeg)

### Two scores: QCS, ACS

![](_page_45_Figure_8.jpeg)

### **Correlation between QCS and ACS**

## To wrap up

New methodology to establish visual focus for a painting based QA system

New annotations and smart use of the resources in the **Cultural Heritage** Domain

![](_page_46_Picture_3.jpeg)

### Research: Cognitive Computing and Crowdsourcing

![](_page_46_Picture_7.jpeg)

![](_page_46_Picture_8.jpeg)

## Moving Forward

### A new user experience (work ongoing)

![](_page_47_Picture_2.jpeg)

![](_page_47_Picture_4.jpeg)

![](_page_47_Picture_7.jpeg)

![](_page_48_Picture_0.jpeg)

### 1. Shift the focus of the visitor back to the painting

![](_page_48_Picture_2.jpeg)

![](_page_48_Picture_3.jpeg)

![](_page_48_Picture_6.jpeg)

### **3-4 Seconds**

![](_page_49_Picture_1.jpeg)

![](_page_49_Picture_2.jpeg)

![](_page_49_Picture_5.jpeg)

### **3-4 Seconds**

![](_page_50_Picture_1.jpeg)

![](_page_50_Picture_2.jpeg)

### **15 minutes**

![](_page_50_Picture_4.jpeg)

![](_page_50_Picture_7.jpeg)

![](_page_51_Picture_0.jpeg)

1. Shift the focus of the visitor back to the painting

2. Generate more questions to further train the QA system

![](_page_51_Picture_3.jpeg)

![](_page_51_Picture_4.jpeg)

![](_page_51_Picture_7.jpeg)

### Watson in a museum

![](_page_52_Picture_1.jpeg)

![](_page_52_Picture_2.jpeg)

tp://www.adweek.com/creativity/ibm-watsons-new-job-as-art-museum-guide-could-hint-at-lots-of-future-roles-with-brands/ More info at h

![](_page_52_Picture_7.jpeg)

## A QA based audio tour?

 How can we make this really interesting (for the researcher), and engaging (for the user)?

![](_page_53_Picture_2.jpeg)

### Options

![](_page_53_Picture_5.jpeg)

![](_page_53_Picture_6.jpeg)

## Personalising message delivery

- 1. Adjustment of delivery
- Speed
- Emotion

- 2. Adjustment of content
- Two-way conversation

![](_page_54_Picture_6.jpeg)

![](_page_54_Picture_7.jpeg)

![](_page_54_Figure_8.jpeg)

![](_page_54_Picture_11.jpeg)

## How can we engage museum visitors more and change their way of looking at a painting?

In an audio QA system:

Does matching speed increase user engagement and system satisfaction?

Does emotion matching increase user engagement?

Does matching of speed and emotion create a **change** in user speaking rate and/or user voice emotion?

![](_page_55_Picture_5.jpeg)

![](_page_55_Picture_8.jpeg)

![](_page_55_Picture_9.jpeg)

## Why should we all care?

- **productive** conversations (studies in automated **call centres**)
- message (studies with car voices and road **safety**)

![](_page_56_Picture_3.jpeg)

![](_page_56_Picture_4.jpeg)

## Adjustment of speed and personalized content creates more responsive and

Emotion matching ensures less distraction and less effort to understand the

![](_page_56_Picture_9.jpeg)

## **Emotion matching vs emotional contagion**

and tone of voice to the other's

![](_page_57_Picture_2.jpeg)

• In a conversation, you start to (subconsciously) match your mood

![](_page_57_Picture_6.jpeg)

## **Emotion matching vs emotional contagion**

- and tone of voice to the other's
- emotion?

![](_page_58_Picture_3.jpeg)

• In a conversation, you start to (subconsciously) match your mood

Can you induce a change in user emotion by choosing system

![](_page_58_Picture_8.jpeg)

## **Emotion matching vs emotional contagion**

- and tone of voice to the other's
- emotion?
  - Should you?

![](_page_59_Picture_4.jpeg)

• In a conversation, you start to (subconsciously) match your mood

Can you induce a change in user emotion by choosing system

![](_page_59_Picture_9.jpeg)

## To wrap up

New way to **interact** with a painting, using audio only

Studying engagement and user behaviour for better user experience

![](_page_60_Picture_3.jpeg)

### **Applicability in** other domains

such as customer service bots

![](_page_60_Picture_8.jpeg)

![](_page_60_Picture_9.jpeg)

### We should consider all three edges when building a (learning) system

![](_page_61_Picture_2.jpeg)

"We should do it!"

![](_page_61_Picture_4.jpeg)

**Ethics** "Should we do it? (& Security) How should we do it right?"

![](_page_61_Picture_6.jpeg)

![](_page_61_Picture_9.jpeg)

## Thank You!

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![](_page_62_Picture_2.jpeg)

**CAS Benelux** casbnl@nl.ibm.com @cas\_benelux

![](_page_62_Picture_6.jpeg)

## Cognitive Computing for Cultural Heritage

A collaboration between the Mauritshuis, IBM, and the VU on the various aspects that AI might mean for the cultural heritage domain.

![](_page_63_Picture_2.jpeg)

![](_page_63_Picture_3.jpeg)

Crowdsourcing, image processing, language understanding

![](_page_63_Picture_5.jpeg)

### Chat with Watson

User experience, affective computing, adaptive system

![](_page_63_Picture_10.jpeg)

![](_page_63_Picture_11.jpeg)

![](_page_63_Picture_12.jpeg)