

# Impacts of AI: COMP3800-03

## Natural Language Processing

### Wentworth Institute of Technology



# Understanding Language

Video 4:22 minutes



# Natural Language Processing (NLP): Definition



**Natural language processing** is the ability to take a body of text and **extract meaning** from it using a computer.

# Natural Language Challenge: Human vs Computer

## HUMAN

*"I drove my friend Mary to the park in my Tesla while listening to music on my iPhone."*



Humans understand that Mary is a friend and that a Tesla is likely a car. Additionally, after many years of popularity and cultural references, we all know that an iPhone is a smartphone.

## MACHINE

### Structured data

{<friend>Mary</friend>  
<car>Tesla</car>  
<phone>iPhone</phone>



None of this is understood by a computer without assistance.



# NLP Components

Let's analyze the phrase ...

*"I drove my friend Mary to the park in my Tesla while listening to music on my iPhone"*

## Entities

The people, places, organizations, and things in your text.

*Example: friend, car, and phone*

## Relations

How entities are related.

*A "createdBy" relation might connect the entities "iPhone" and "Apple."*

## Concepts

Extracting reference to topics that do not explicitly appear in the text.

*An article about Tesla may refer to concepts "electric cars" or "Elon Musk," even if those terms are not explicitly mentioned.*

## Keywords

Identify the important and relevant keywords in your content.

## Semantic Roles

Subjects, actions, and objects in the text.

*"IBM bought a company." The subject is "IBM," the action is "bought," and the object is "company."*

## Categories

Describing what a piece of content is about at a high level.

*Categories could be sports, finance, travel, computing, and so on.*

## Emotion

Understanding the emotion or tone conveyed.

*Is the content conveying anger, disgust, fear, joy, or sadness?*

## Sentiment

Is the feeling/attitude positive, neutral, or negative?

*The level of positive or negative sentiment can be scored.*

# Natural Language Processing

The semantic behind the syntactic

**Syntactic messages**

Subject-verb-object

**Semantic messages**

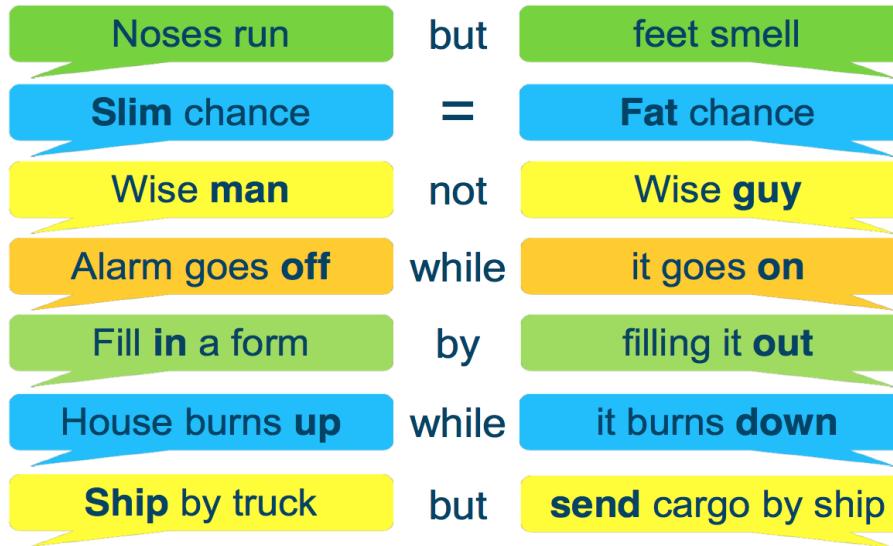
Agent and Patient

What is the message sentiment?



# Natural language processing: a classification problem

- Difficulty of language: Subtleties, idiosyncrasies, idioms, ambiguities, nuances and gaps



- It is highly contextual, imprecise and has gaps (context known outside the conversation)

# Enterprise Applications of NLP

- Social Media Analysis
- Customer Support
- Business Intelligence
- Content Marketing and Recommendation
- Additional Topics

# Social Media Analysis

**How can we extract valuable insights from social media posts?**

What are the relevant trending topics and hashtags for a business?

NLP can deliver this information and more.



**Over 500 million tweets are sent per day.**

# Customer Support

Each support ticket can be analyzed to obtain its sentiment, keywords, and a categorization.

This process can be used to route the customer to the correct representative and in some cases to **automatically respond to the request**.

A photograph of a woman wearing a headset, sitting at a desk and working on a computer keyboard. A blue semi-transparent box is overlaid on the bottom right of the image, containing white text.

Companies lose billions of dollars annually due to poor customer service.

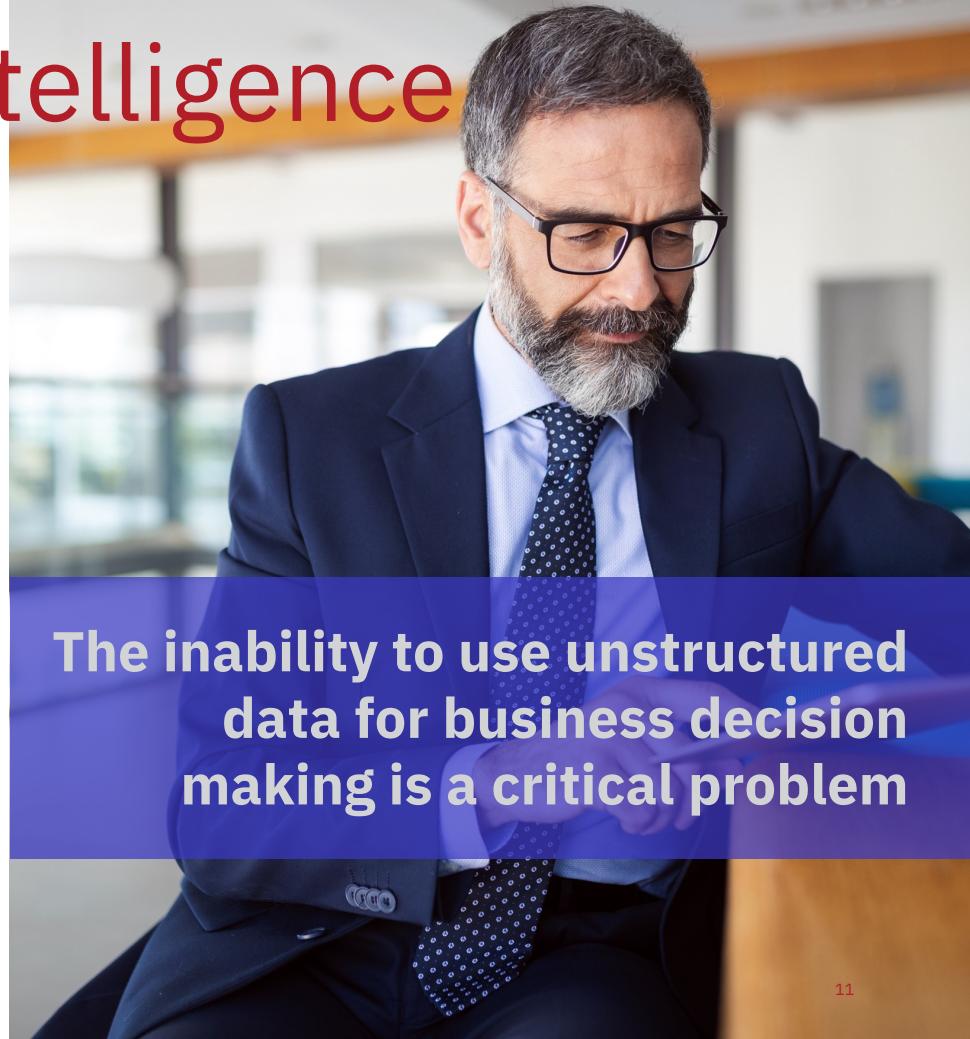
# Business Intelligence

How does a company efficiently access unstructured data?

How can this data be queried on an ad hoc basis without the need for developers to write complex queries?

**NLP allows all users to ask questions of the data without developer assistance.**

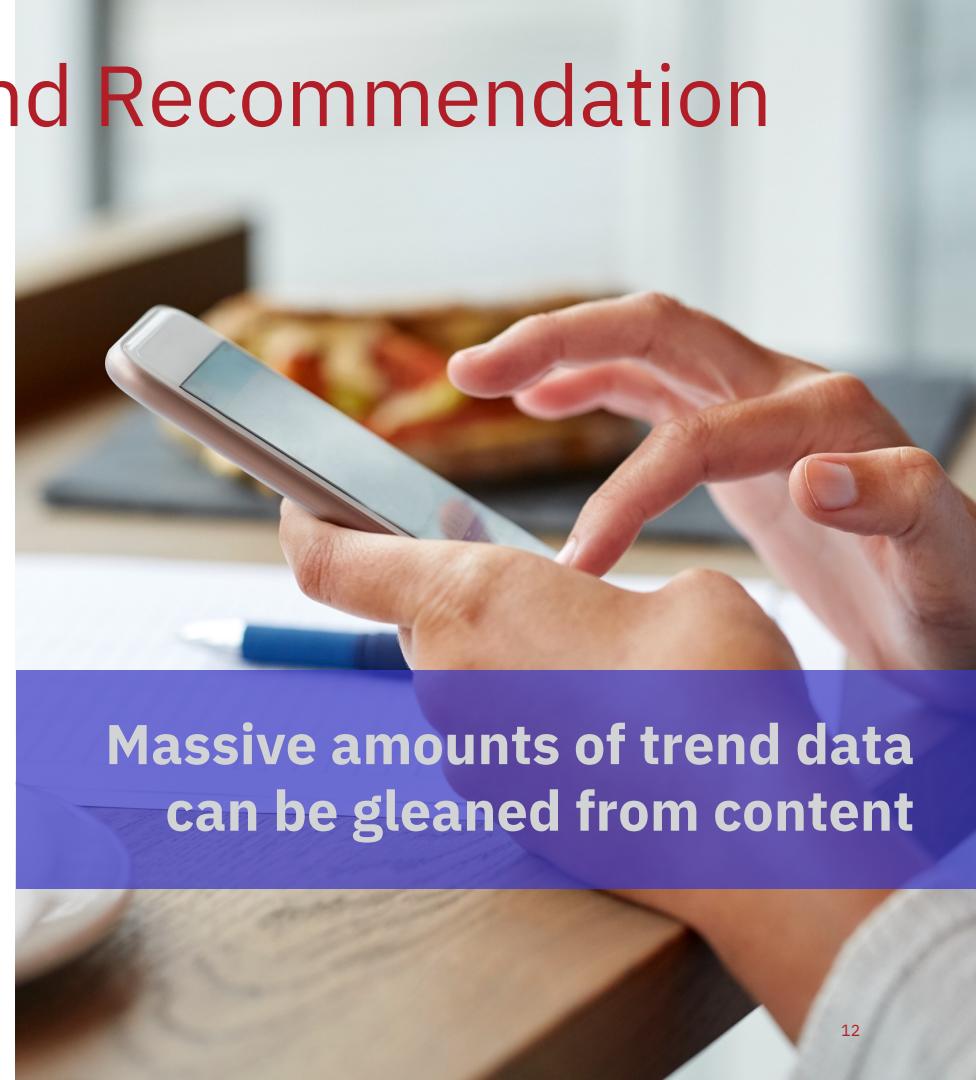
The inability to use unstructured data for business decision making is a critical problem



# Content Marketing and Recommendation

Companies also want better ways to recommend more relevant content to their readers.

**NLP enables companies publishing content to understand what to write about as well as produce more interesting and relevant topics to readers**



# **HOW THE JEOPARDY! CHALLENGE WAS WON**

# Science Behind Watson Jeopardy

Understanding natural language is one of the most challenging endeavors for a machine to realize

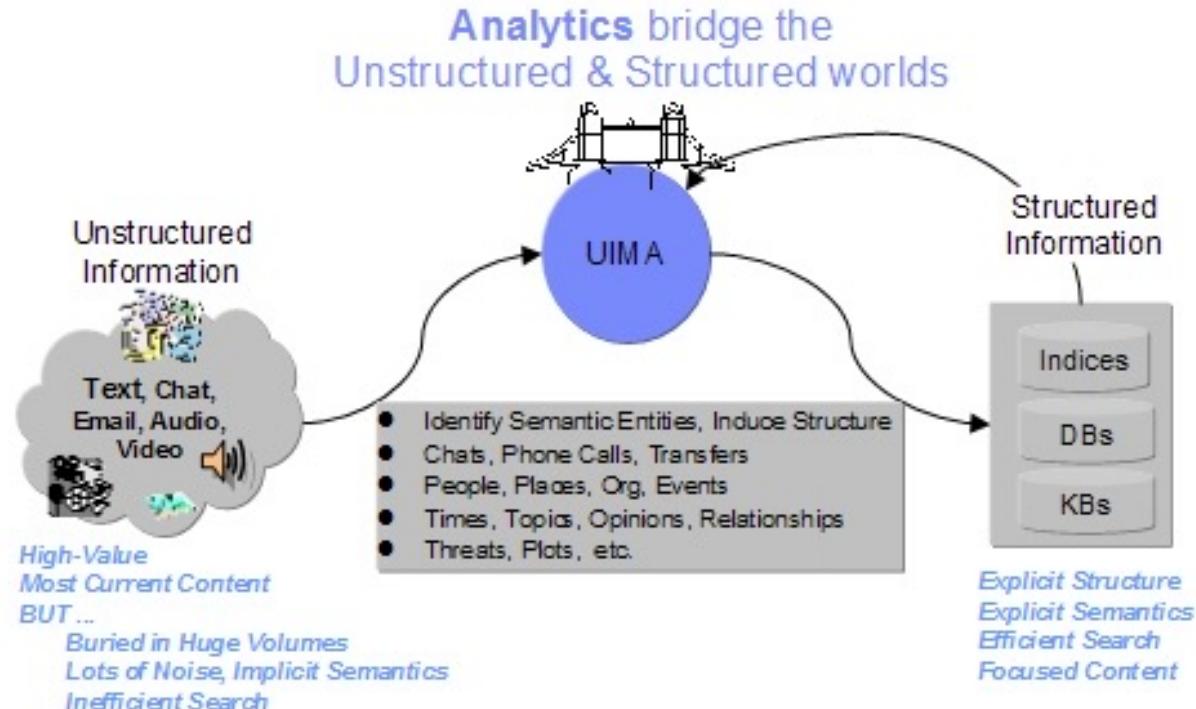


# What is UIMA?

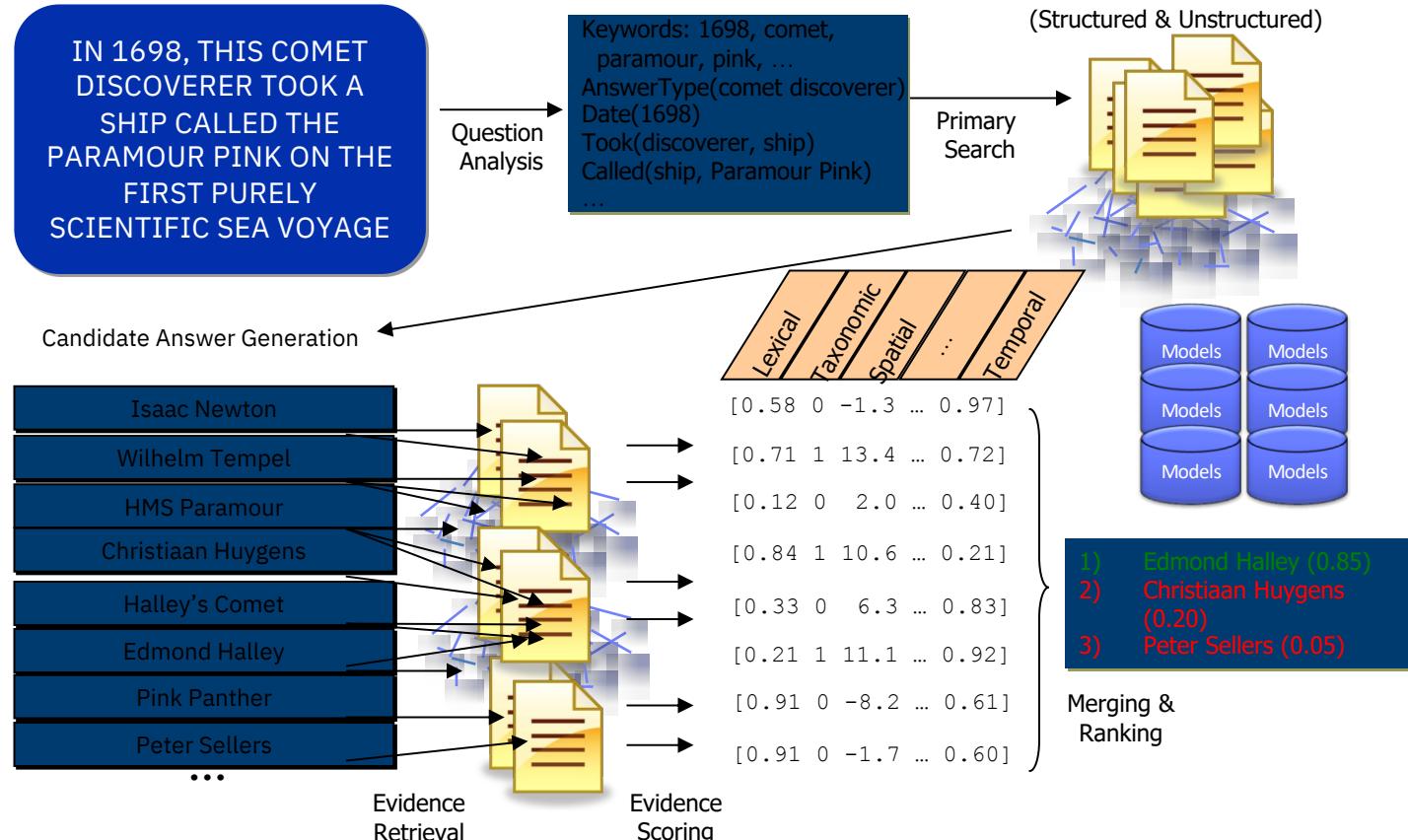
**UIMA stands for  
Unstructured Information  
Management Architecture**

Its main goal is to transform unstructured information to structured information

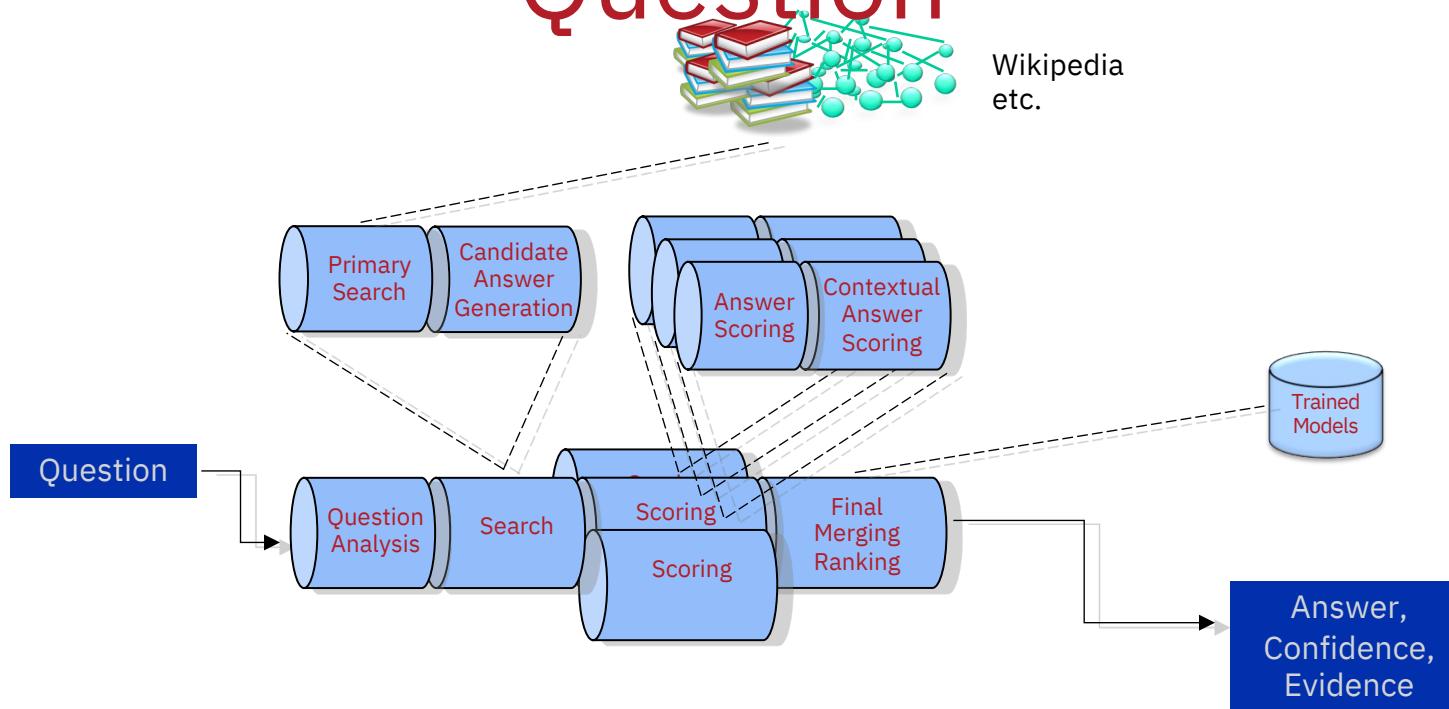
The UIMA pipeline was the engine behind the **Jeopardy!** game played by Watson in 2011.



# An example Jeopardy! question

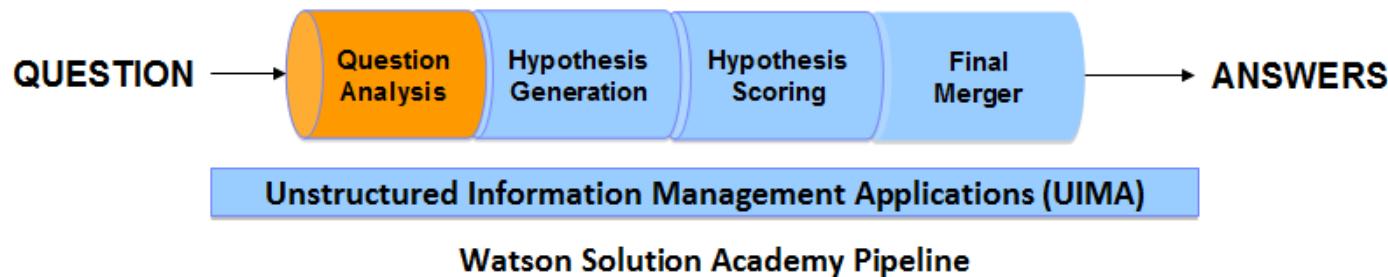


# How Watson responds to a Question



# Question Analysis (QA) Overview

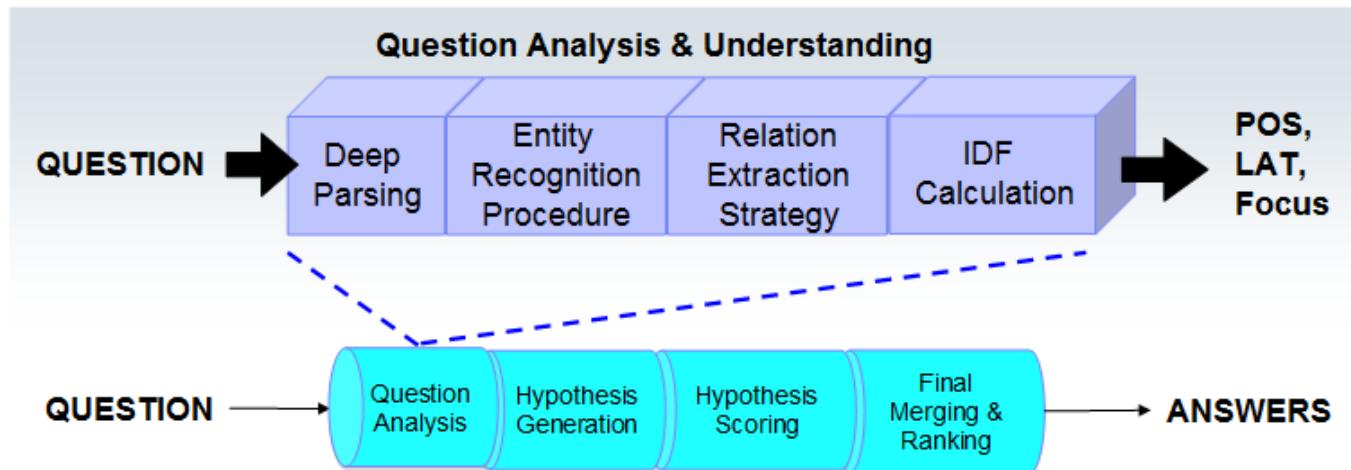
- What is Question Analysis?
  - Question Analysis is the first stage in the Watson pipeline
  - **Ultimate goal:** Understand what is being asked
- Various algorithms and technologies to identify as much as possible about the input question
  - Named Entity Detection
  - Natural Language Processing (NLP)
  - Shallow and Deep Semantic Relation Detection
- All downstream components rely on the annotations produced by QA



# Stage 1: Question Analysis

## Question analysis technologies includes

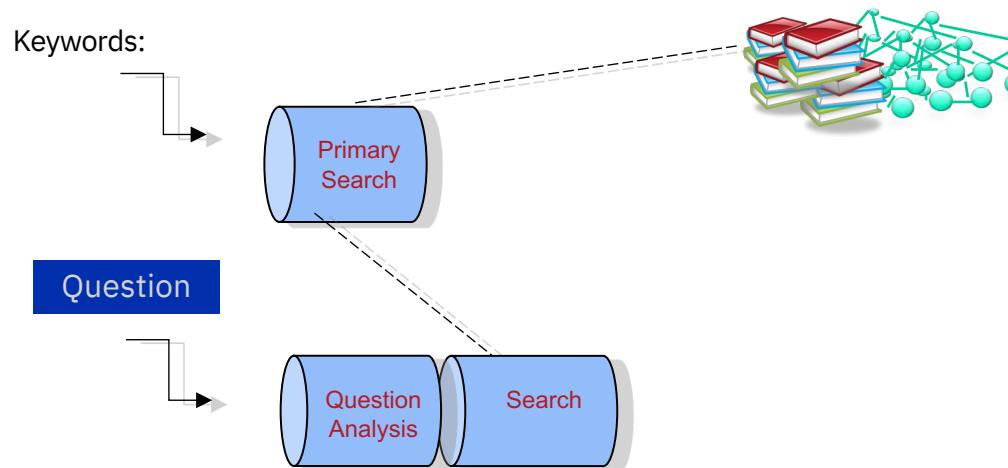
- Part of speech parsing technology
- Named Entity Detection
- Relation Extraction
- Inverse Document Frequency (IDF)



# Stage 1: Question Analysis components

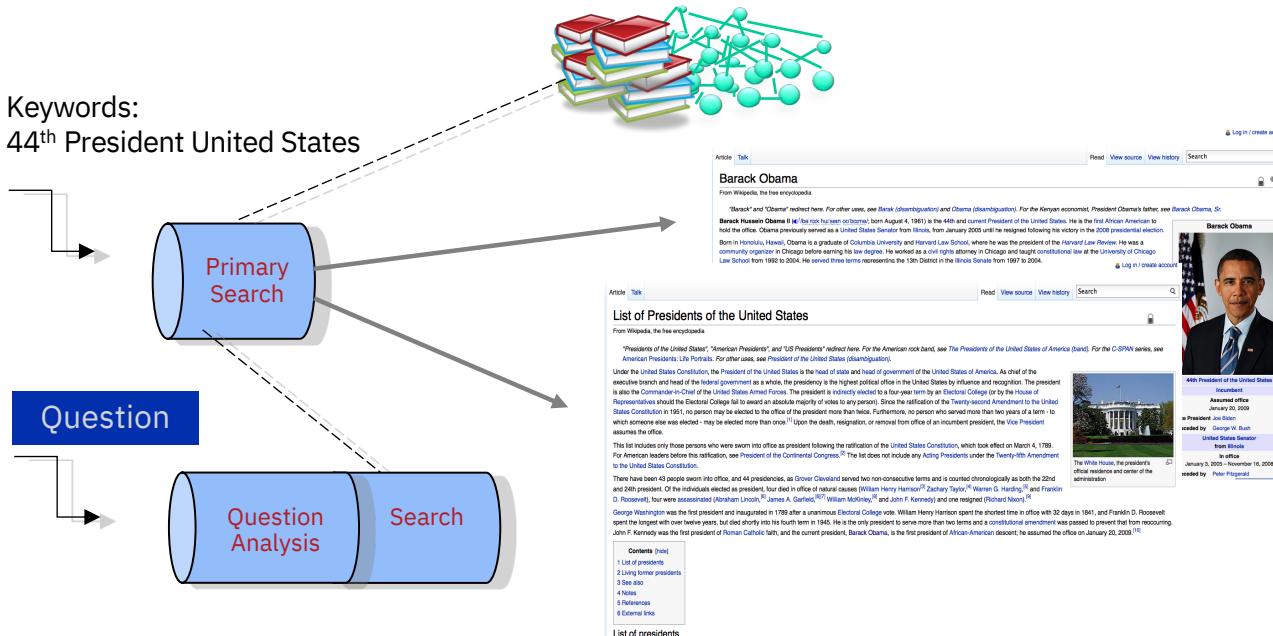
- **Named Entity Detection** is used to annotate names of different objects such as names of companies, names of actors, names of books, etc.
- **Relation Extraction** procedure is used to locate known relations between two entities, such as creator relation, ownership relations, author relations, etc.
- **Inverse Document Frequency** (IDF) of the question keywords is used to compute the informative question words based on the statistics of the text corpus.

# Stage 2: Hypothesis Generation



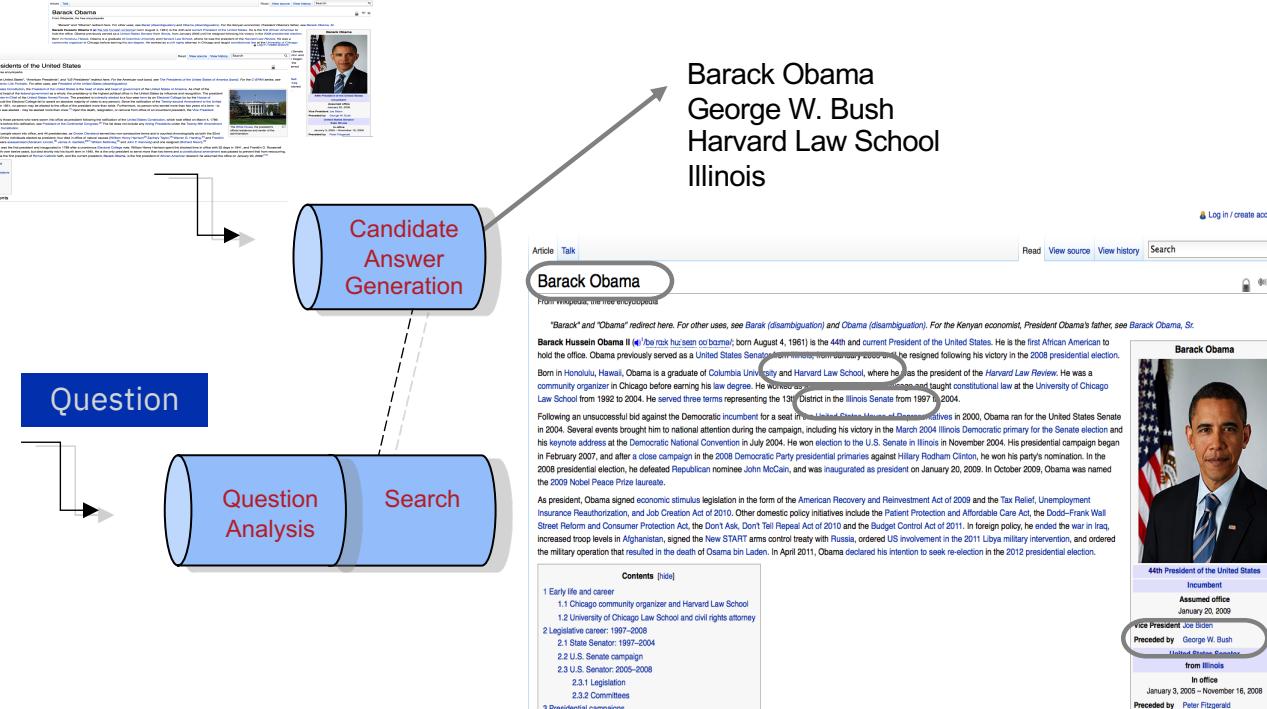
# Stage 2: Hypothesis Generation – Primary search

Who is the 44<sup>th</sup> President of the United States?

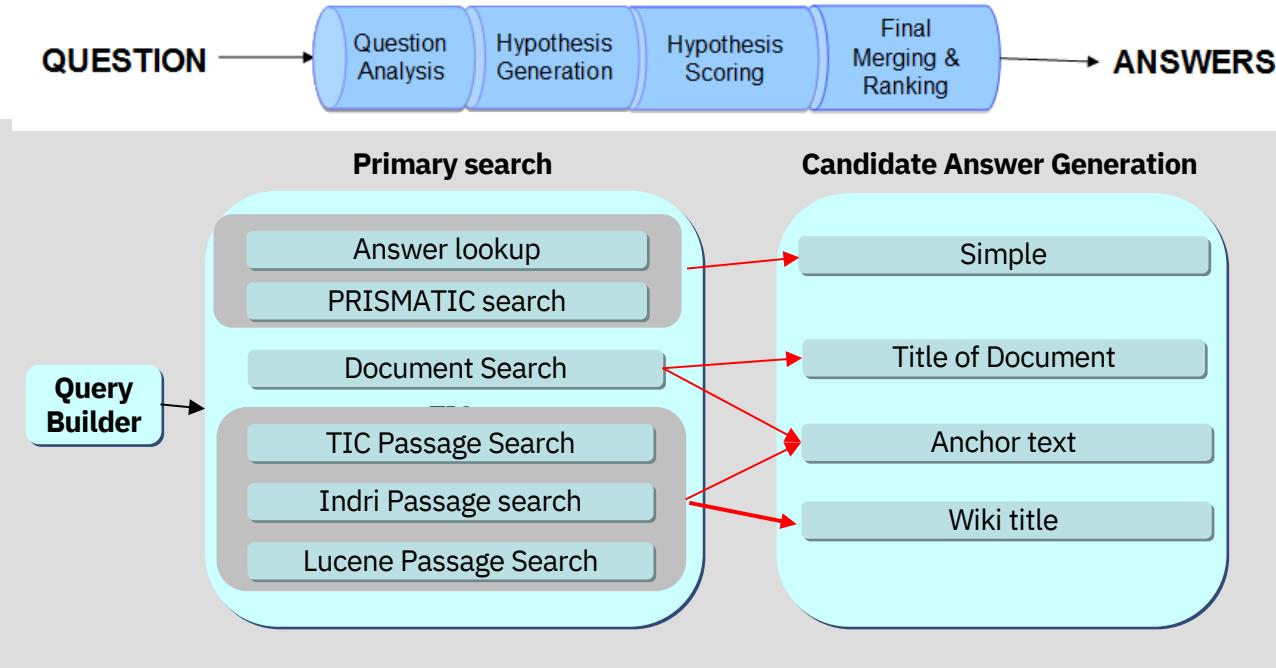


# Stage 2: Hypothesis Generation – Candidate Answer Generation

Who is the 44<sup>th</sup> President of the United States?



# Stage 2: Hypothesis Generation Components



Three major components are

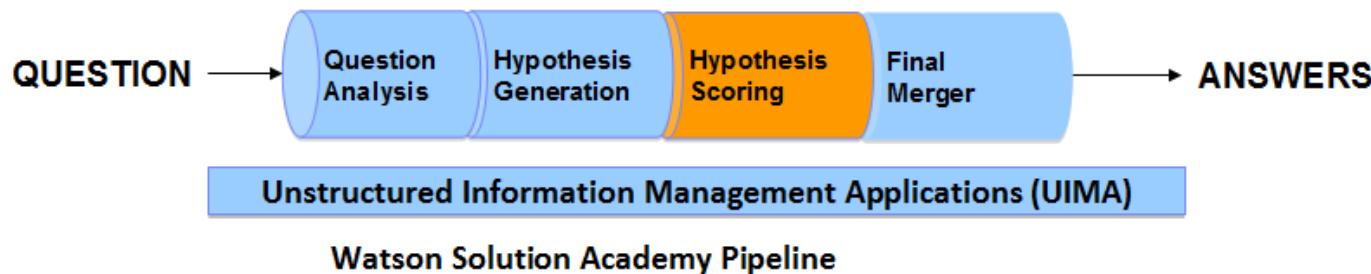
- **Query Builder**
- **Primary Search**
- **Candidate Answer Generation**

# Stage 3: Hypothesis Scoring

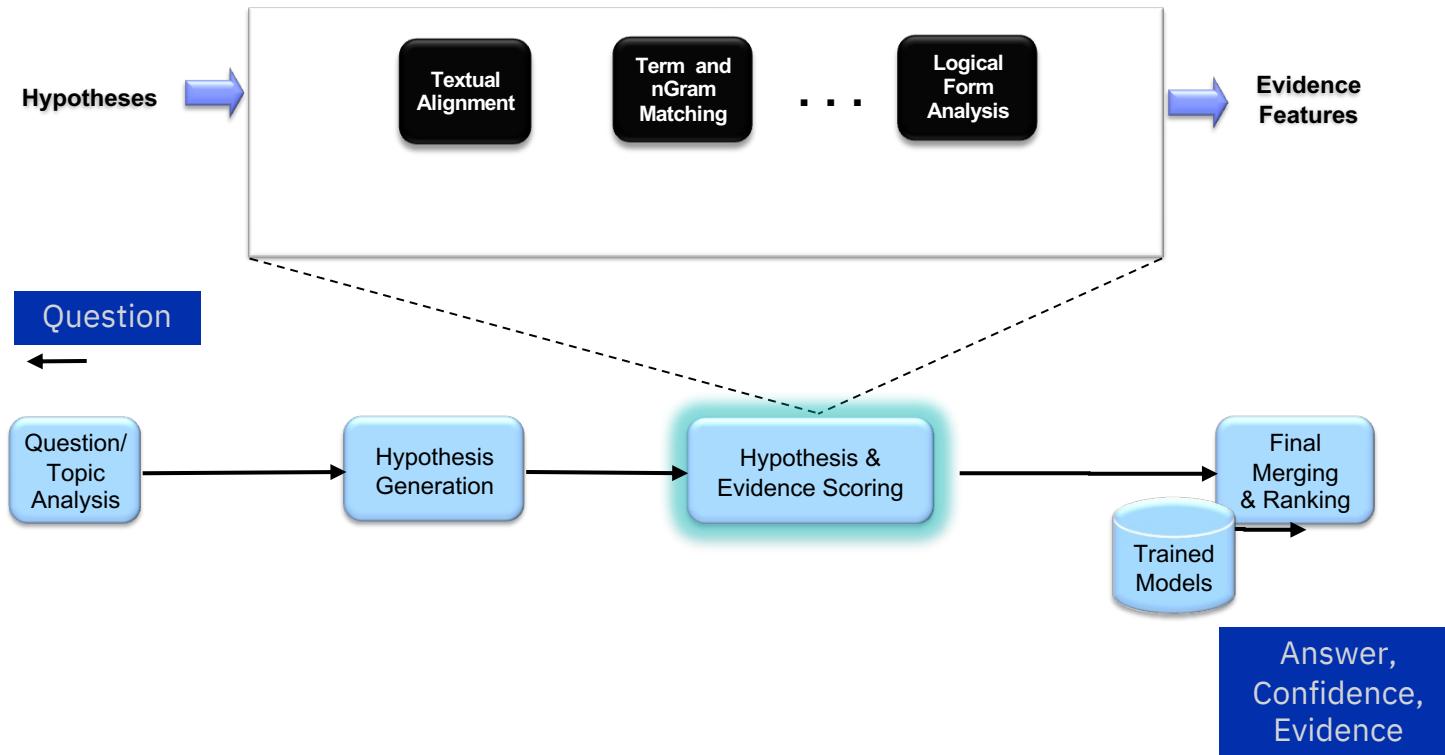
## What is Hypothesis Scoring?

- Enumeration of annotators responsible for scoring previous generated candidate answers
- The results produced by these scorers are ranked by the Merging and Ranking components to produce a ranked list of answers.

**Outcome: a confidence level of a generated hypothesis**



# Hypothesis Scoring - components



# Textual Alignment Answer Scorer

- Surface similarity measurement
- Question
- Supporting passage
- Dynamic programming for subsequence alignment

**Consider the following example:**

*Who led the Allied forces on the European front during World War 2?*

**Dwight D. Eisenhower was supreme commander of Allied forces during the D-Day invasion and European front during World War 2.**

*–Overlap is significant*

**Now, consider the example:**

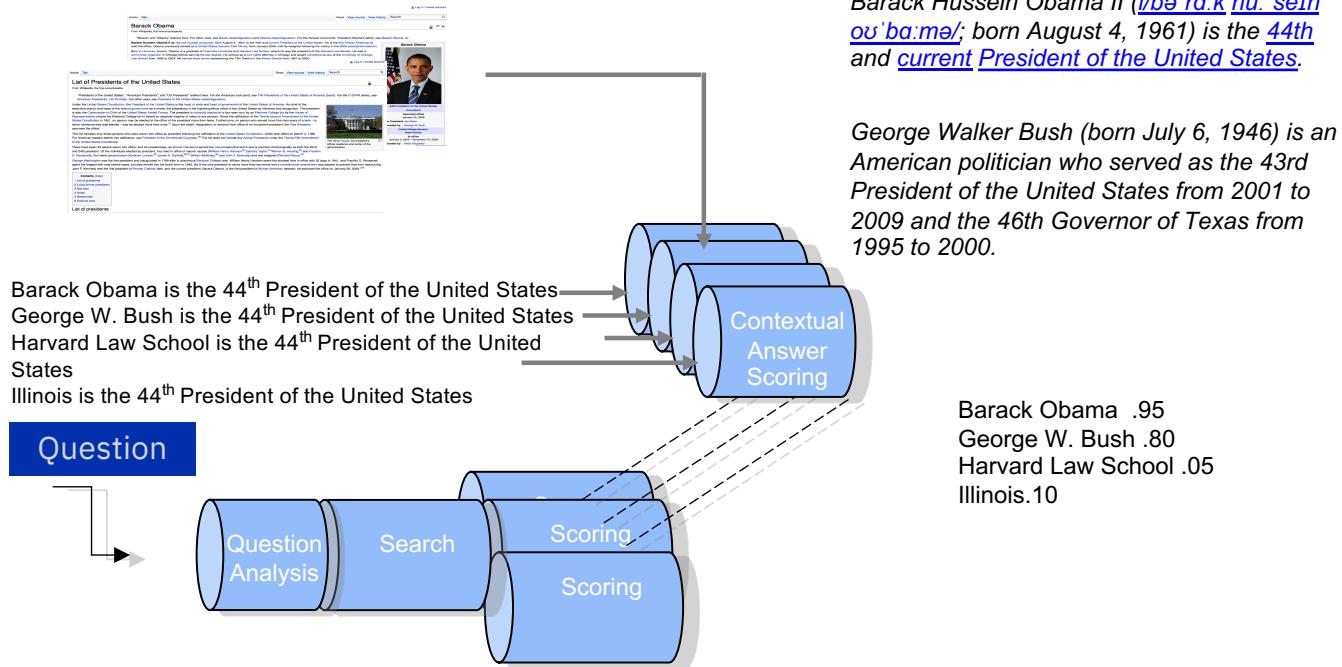
*In 1698, what comet discoverer took a ship called the Paramour Pink on the first purely scientific sea voyage?*

**Edmund Halley made probably the first primarily scientific voyage to study the variation of the magnetic compass**

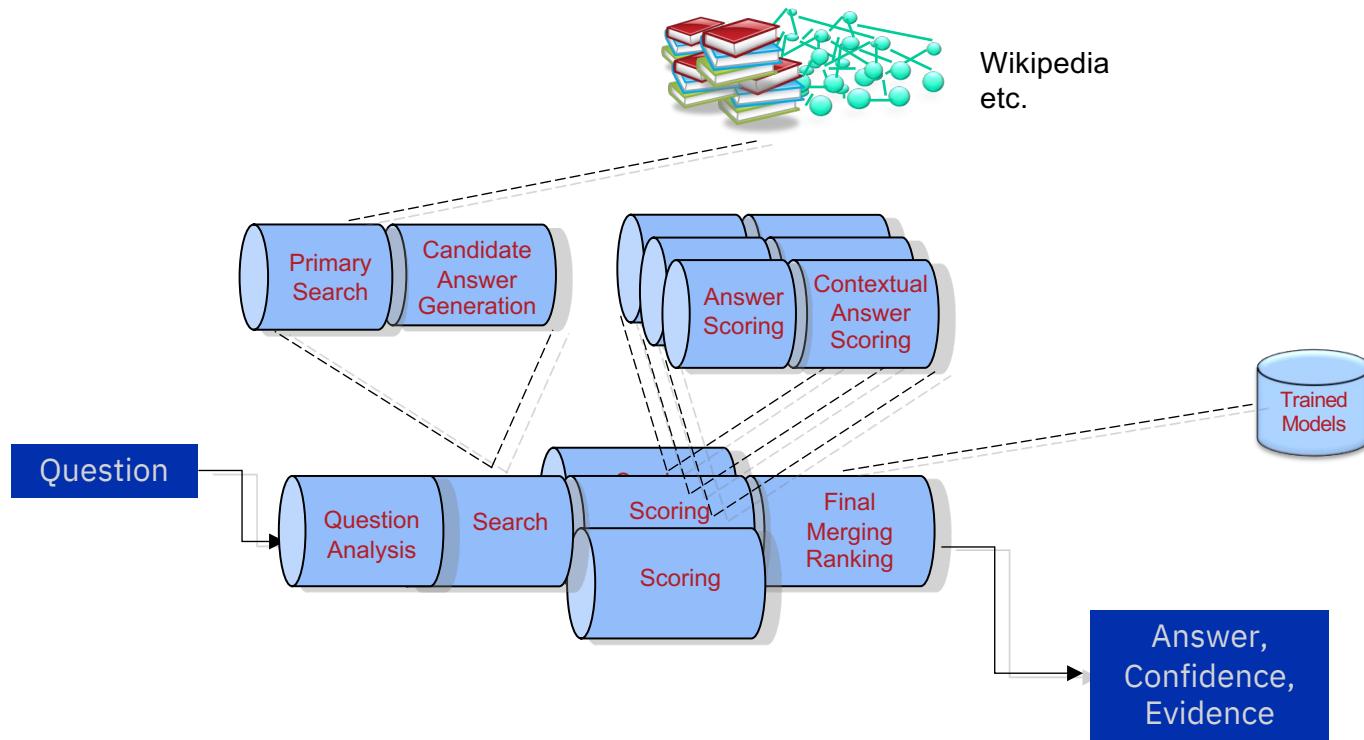
*–Fewer textual overlaps, likely with lower IDF scores*

# Example

## Who is the 44<sup>th</sup> President of the United States?



# Stage 4: Final Merger and Ranking



# Challenge: Heterogenous feature types and values

- Each feature is computed from distinct algorithms that were independently developed.
  - No distinction are made between features computed from context-dependent and context-independent answer scoring components.
- Numerical ranges vary from one feature to another and, thus, their distributions may vary considerably.

Feature Types	Numerical Ranges
Fuzzy Scores	(0, infinity)
Correlation Scores	(-1,+1)
Probabilistic Scores	(0,1)

# Stage 4: Final Merger and Ranking – confidence scoring

**Who is the 44<sup>th</sup> President of the United States?**

Candidate Answer	Answer Scoring	Contextual Answer Scoring	Confidence
Barack Obama	0.90	0.90	.95
George W. Bush	0.90	0.80	.65
Harvard Law School	0.10	0.05	.05
Illinois	0.15	0.10	.10

# How to use NLP Today?

## Open source software projects

The more popular include:

- [Apache NLP](#)
- [Stanford CoreNLP](#)
- [NLTK for Python](#)
- [SyntaxNet](#)

## Software offered as a service

The more popular include:

- **Watson's Natural Language Understanding**
- **Azure Text Analytics**
- **Amazon's Lex**

## NLP as core business\*

The more popular include:

- 35% of Amazon Purchases
- 75% of Netflix Viewings

\*Recommendation engine algorithms

# What Is a Virtual Agent or Chatbot?

A chatbot is a way to expose a business's service or data via a natural language interface.

- A virtual customer support agent can reduce headcount and exponentially scale real-time customer support capabilities.
- A conversational commerce chatbot gives business a whole new channel to engage with customers via messaging platforms.



# Factors in the Rise of Chatbots

## Natural Language Processing in the Cloud

The availability of NLP capabilities in the cloud has been the most potent force behind the rise of chatbots.

Text classifiers and entity extractors power core functionalities inside a chatbot.

## Proliferation of Messaging Platforms

Companies want to reach users through messaging apps using the large amount of contextual data buried in messages.

Companies are now looking to help users by embedding chatbots inside these message channels to answer questions or assist with various tasks.

## Natural Language Interface

The proliferation of devices such as the Amazon Echo has drawn developers toward the idea of a voice-controlled home.

Home appliances are notorious for their clunky user interfaces, and to replace them with smart agents that we could talk to seems like a much better user experience.

# Challenges of Building a Successful Chatbot

## Define the project scope correctly

- Broad enough for the chatbot to be helpful
- Narrow enough so you're not wasting time building artificial general intelligence.

This means capturing as many user requests as possible, yet still being able to reconcile the nuanced differences between each one.

### *Example*

A travel agency tried to deploy a vacation planning chatbot with a vocabulary base large enough to recognize all the destinations.

There were over 10 ways people could refer to the Cayman Islands (not counting spelling mistakes).

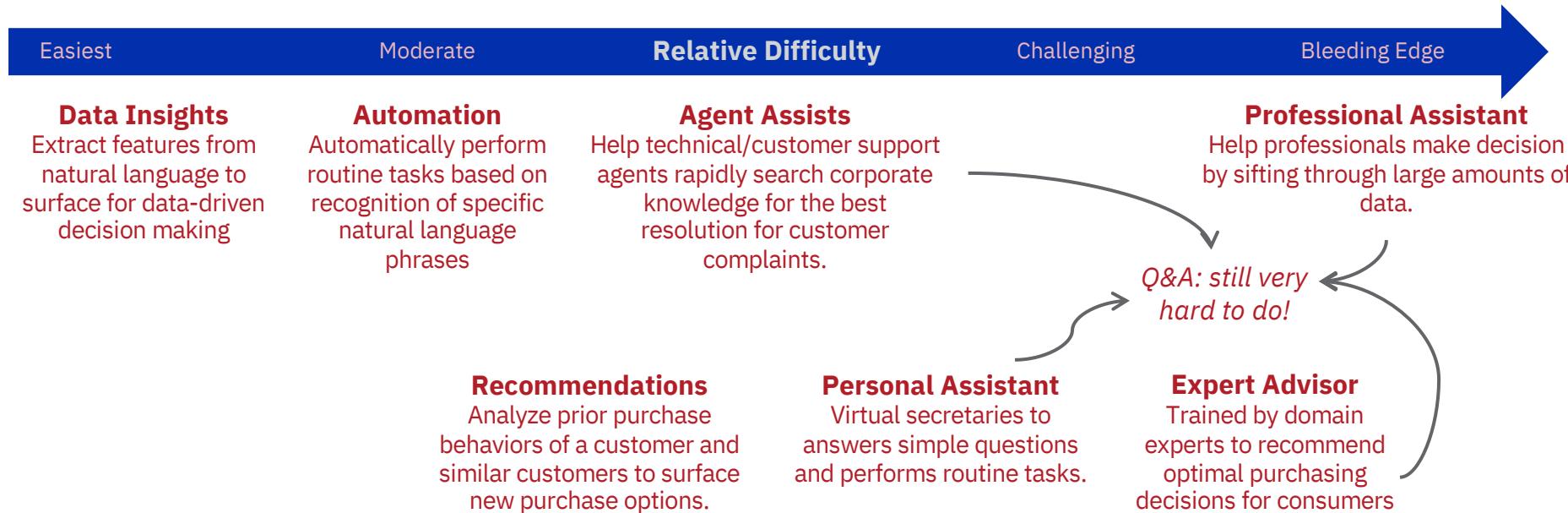
It took the company months to build a list that could confidently capture all the variations for this one destination.

# Best Practices

- Tip #1: Introduce Your Chatbot to First-Time Users
- Tip #2: Add Variations to Your Responses
- Tip #3: Make a Main Menu That's Accessible Anywhere
- Tip #4: Have Context Awareness
- Tip #5: Be Able to Fix Incorrect Inputs
- Tip #6: Handle the “I Do Not Understand” Case
- Tip #7: Be Careful About Creating a Personality

The screenshot shows a chatbot interface with a light blue header bar. On the left is a back arrow, followed by the text "Home". In the center is the name "Poncho" with a right arrow, and on the right is a "Manage" button. Below the header, there are three messages from a user and two responses from the bot "Poncho".  
User message 1: "Hmm...can you be more specific? Or you can try typing the name of a nearby city." This message includes a small yellow circular icon with a cartoon character.  
Bot response 1: "Brooklyn, NY" (in a blue rounded rectangle)  
User message 2: "Oh yeah? My ex is from there. Hm...anyway...it's 43°F and clear there rn."  
Bot response 2: "Tell me what time you'd like to receive your morning forecast. Or, if you'd like to skip this for now, just type "no".  
The bot's responses are preceded by its own small yellow circular icon with a cartoon character.

# Common implementation patterns for conversational cognitive systems



# First there were websites, then apps, now bots

## One-to-one VS one-to-many

Marketers can no longer rely on the “**yell & sell**” approach and hope for the best. They need to “**chat and listen**.”

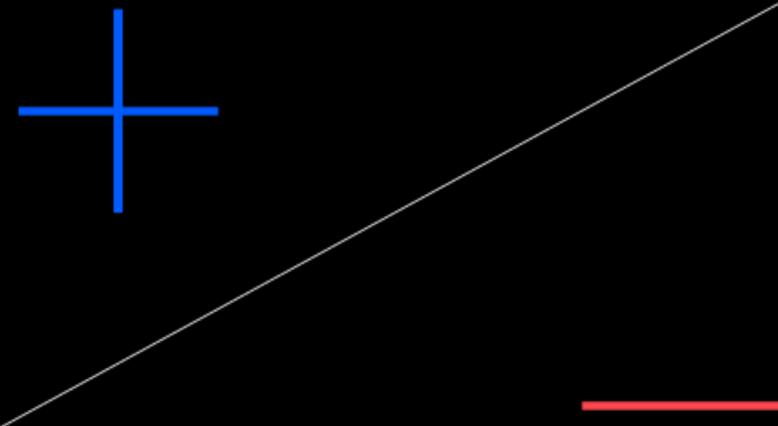
## Small data VS big data

One-to-one communication: **snackable data that is actionable**.

## Always on VS always perfect

The rise of the “**real and raw**” thanks to live apps like Periscope or Snapchat stands as the new social currency.

# THE DEBATER PROJECT



## Project Debater

Project Debater is the first AI system that can debate humans on complex topics. The goal is to help people build persuasive arguments and make well-informed decisions.

[Watch a live debate](#)

# What is Project Debater

Project Debater is the first AI system that can debate humans on complex topics.

**It digests massive texts, constructs a well-structured speech on a given topic, delivers it with clarity and purpose, and rebuts its opponent.**



# Why teach a machine how to debate

Debate enriches decision making, helping people weigh the pros and cons of new ideas and philosophies.

**We debate not only to convince others of our own opinions, but also to understand and learn from each other's views.**





herbal remedies have  
not been proven to be  
efficacious

### Step 1

Understanding a topic



### Step 2

Argument construction



### Step 3

Content organization



### Step 4

Constructing an argument and rebuttal



# Step 1

## Understanding a Topic

Project Debater's knowledge base consists of around 10 billion sentences, taken from newspapers and journals.

**Using AI natural language processing technologies, Project Debater is able to recognize the same concept, even when stated many different ways.**

## Step 2

# Augment Construction

The first step is to build an opening speech to defend or oppose this motion.

**Project Debater searches for short pieces of text in the massive corpora that can serve this purpose.**

# Step 3

## Content Organization

In order to debate effectively, the Project Debater needs to construct the strongest and most diverse arguments to support its case.

**Project Debater does this by removing redundant argumentative texts, selecting the strongest remaining claims and evidence, and arranging these by theme, creating the base of the narrative to support the motion.**

# Step 4

## Constructing an Argument and Rebuttal

Project Debater pieces all the selected arguments together to create a persuasive speech that lasts approximately four minutes.

**The next step is to listen to the opponent's response, digest it and build the rebuttal.**

# Project Debater

Video 9:42 minutes

