

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

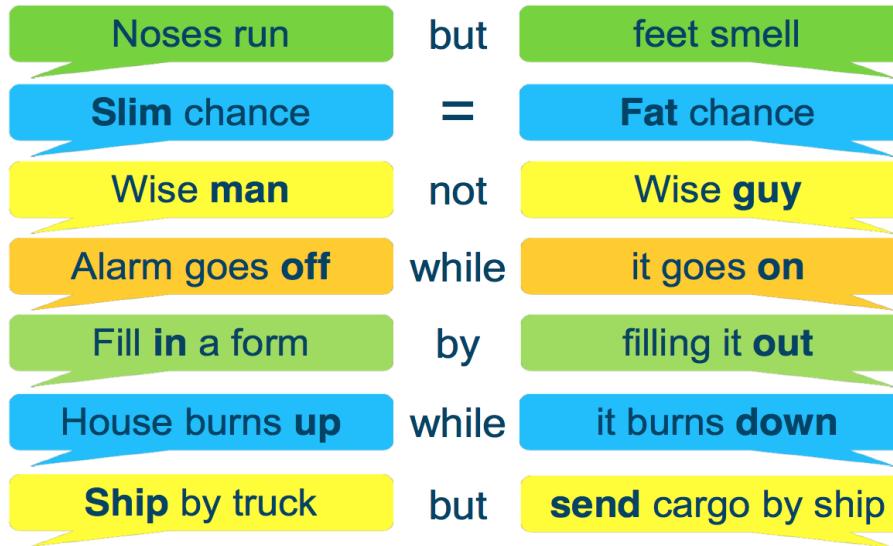
What is the message sentiment?



* Search for 'moving' at <http://www.shoecomics.com/>

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**.



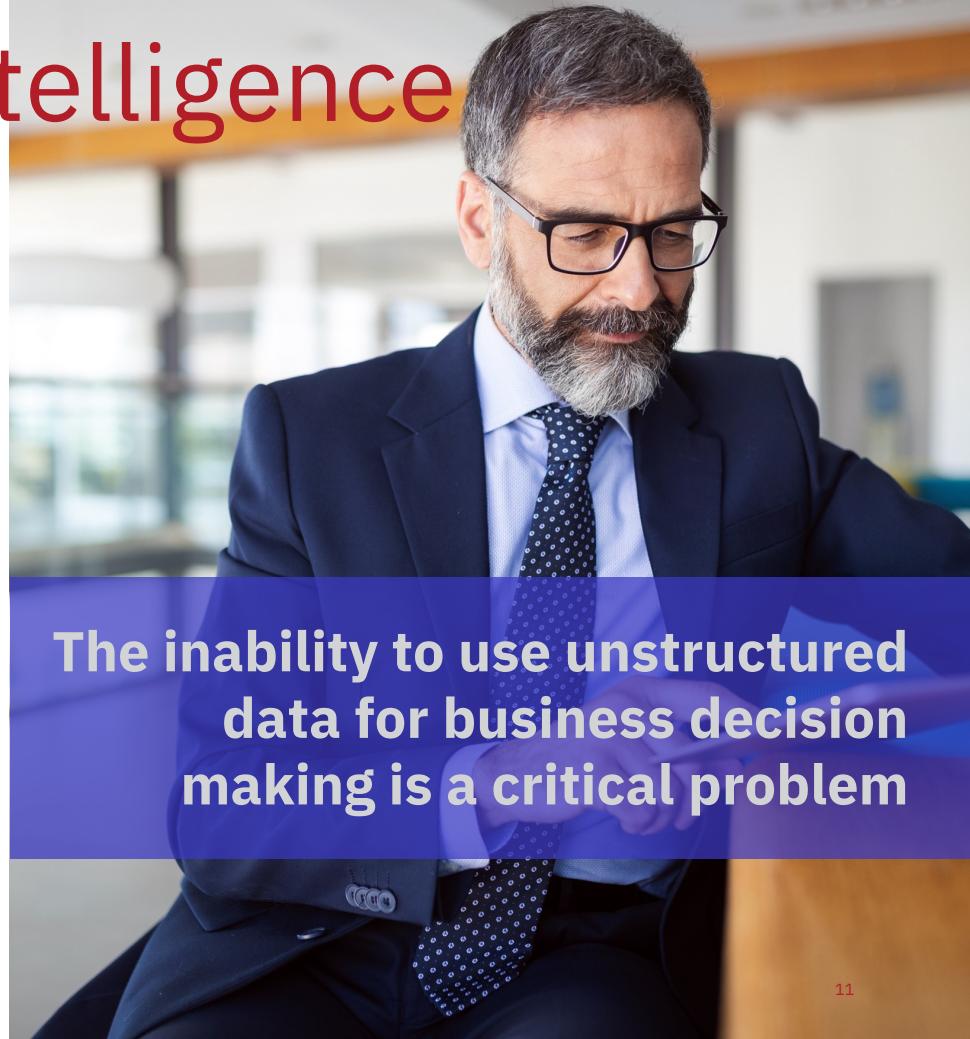
Business Intelligence

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.

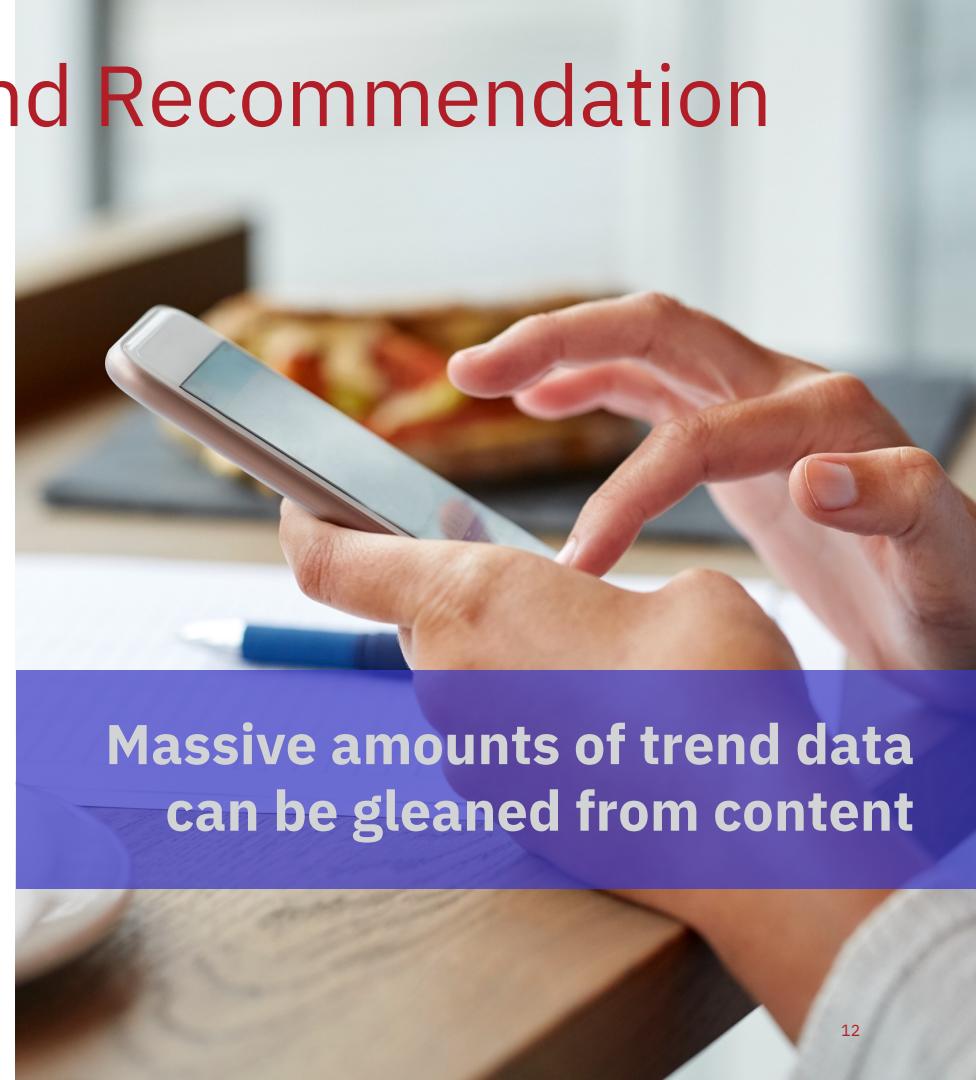
The inability to use unstructured data for business decision making is a critical problem



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

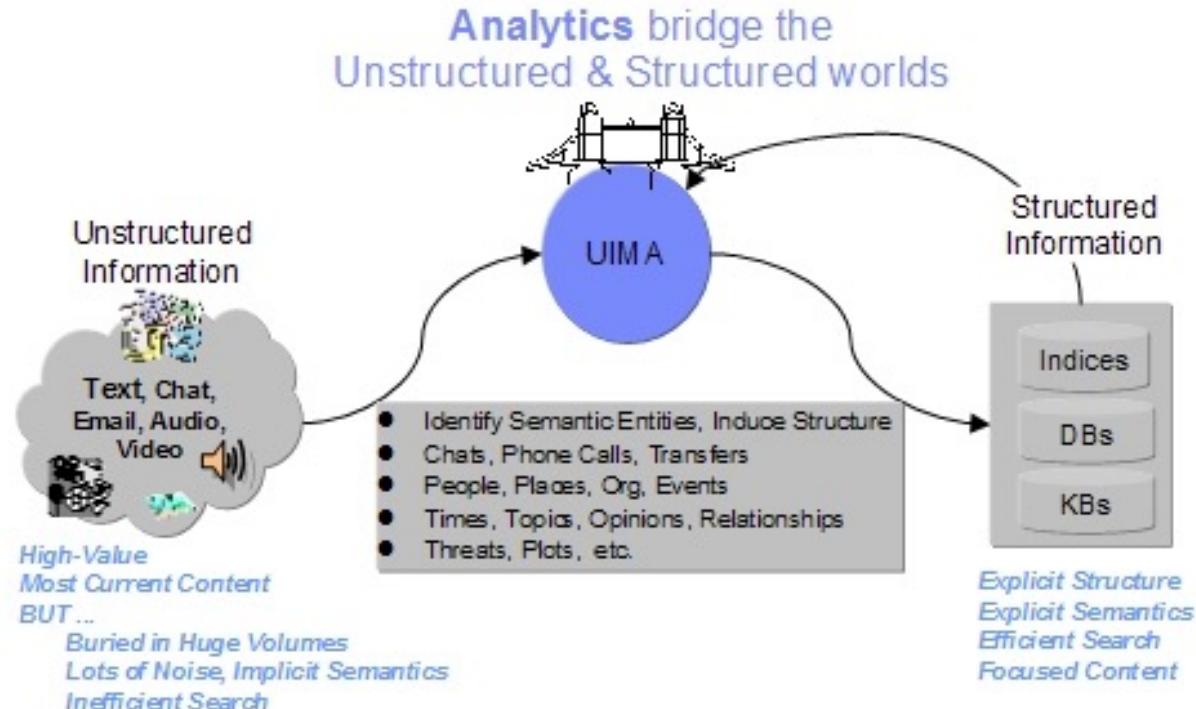


What is UIMA?

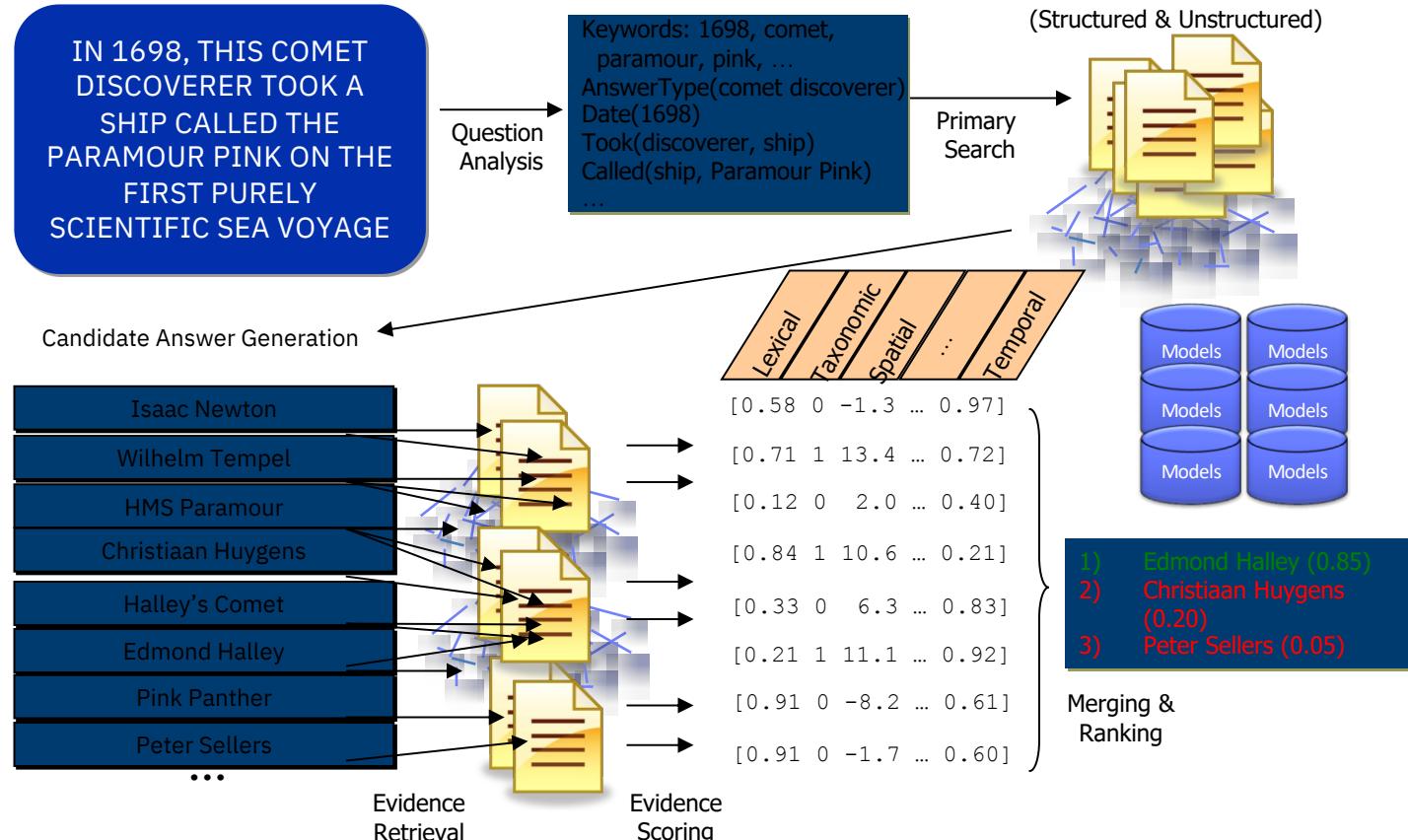
**UIMA stands for
Unstructured Information
Management Architecture**

Its main goal is to transform unstructured information to structured information

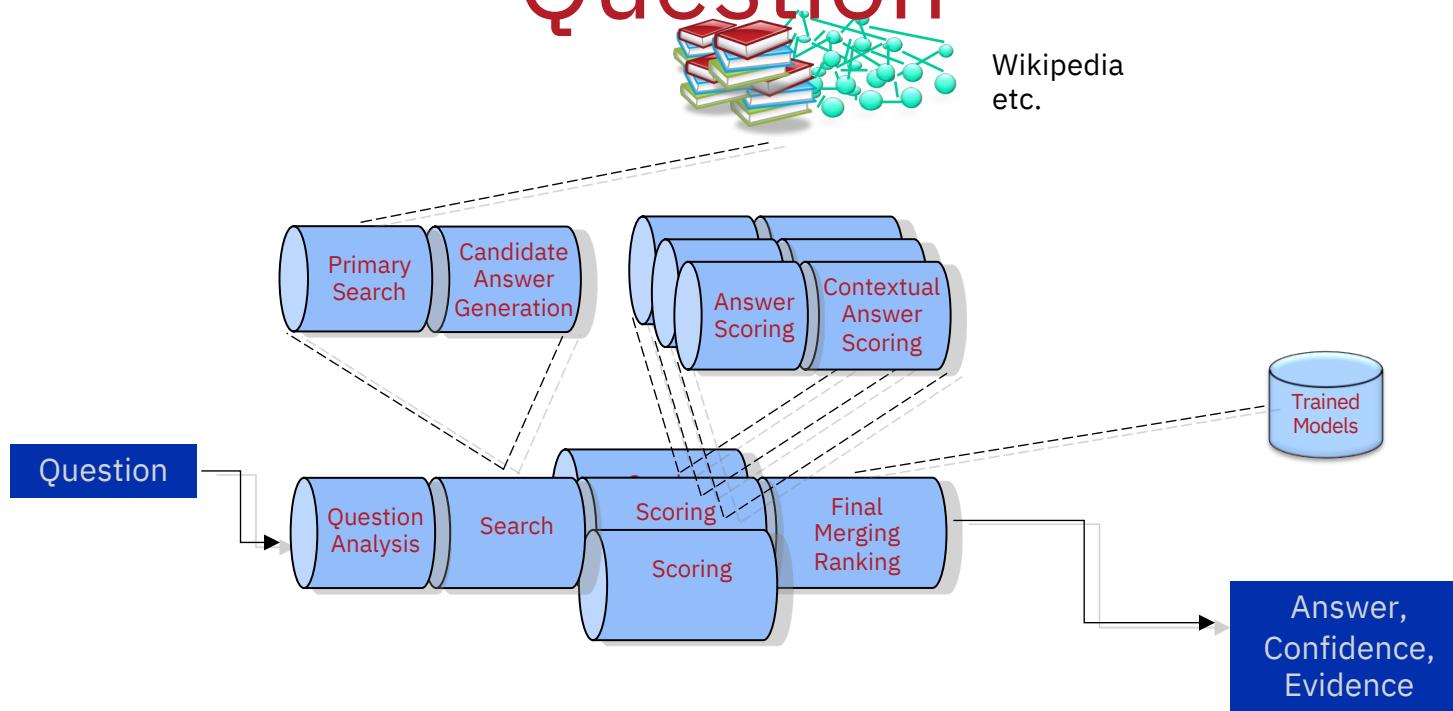
The UIMA pipeline was the engine behind the **Jeopardy!** game played by Watson in 2011.



An example Jeopardy! question

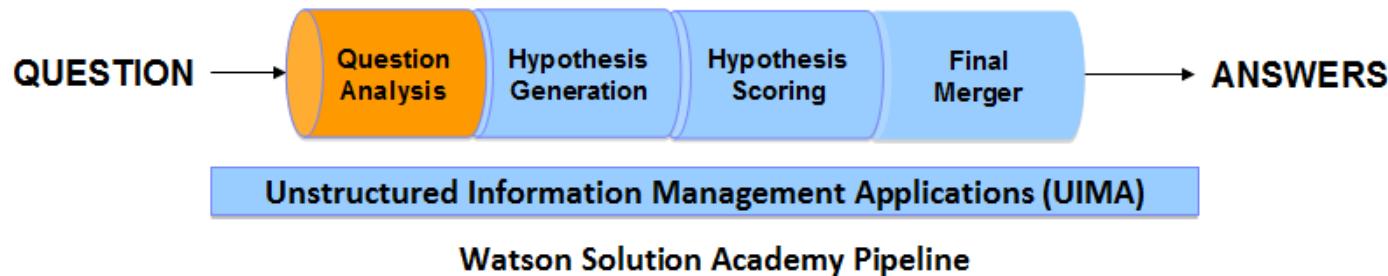


How Watson responds to a Question



Question Analysis (QA) Overview

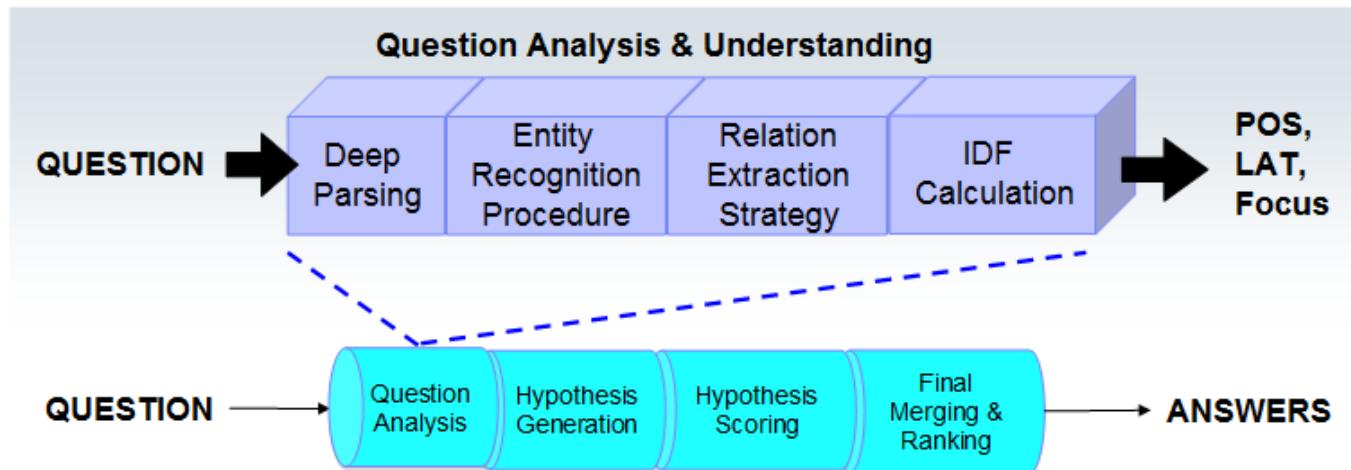
- What is Question Analysis?
 - Question Analysis is the first stage in the Watson pipeline
 - **Ultimate goal:** Understand what is being asked
- Various algorithms and technologies to identify as much as possible about the input question
 - Named Entity Detection
 - Natural Language Processing (NLP)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



Stage 1: Question Analysis

Question analysis technologies includes

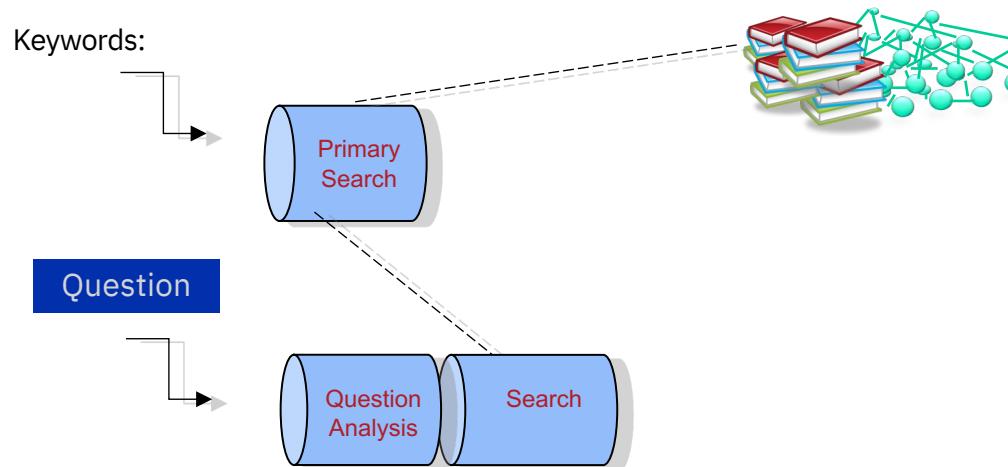
- Part of speech parsing technology
- Named Entity Detection
- Relation Extraction
- Inverse Document Frequency (IDF)



Stage 1: Question Analysis components

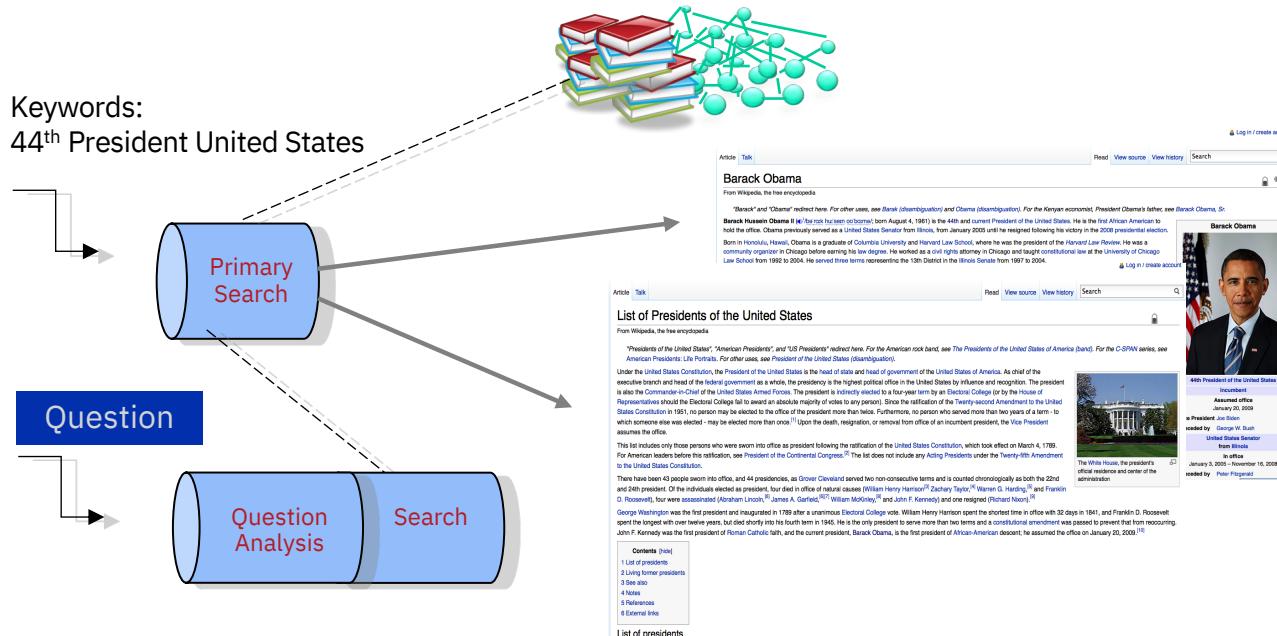
- **Named Entity Detection** is used to annotate names of different objects such as names of companies, names of actors, names of books, etc.
- **Relation Extraction** procedure is used to locate known relations between two entities, such as creator relation, ownership relations, author relations, etc.
- **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



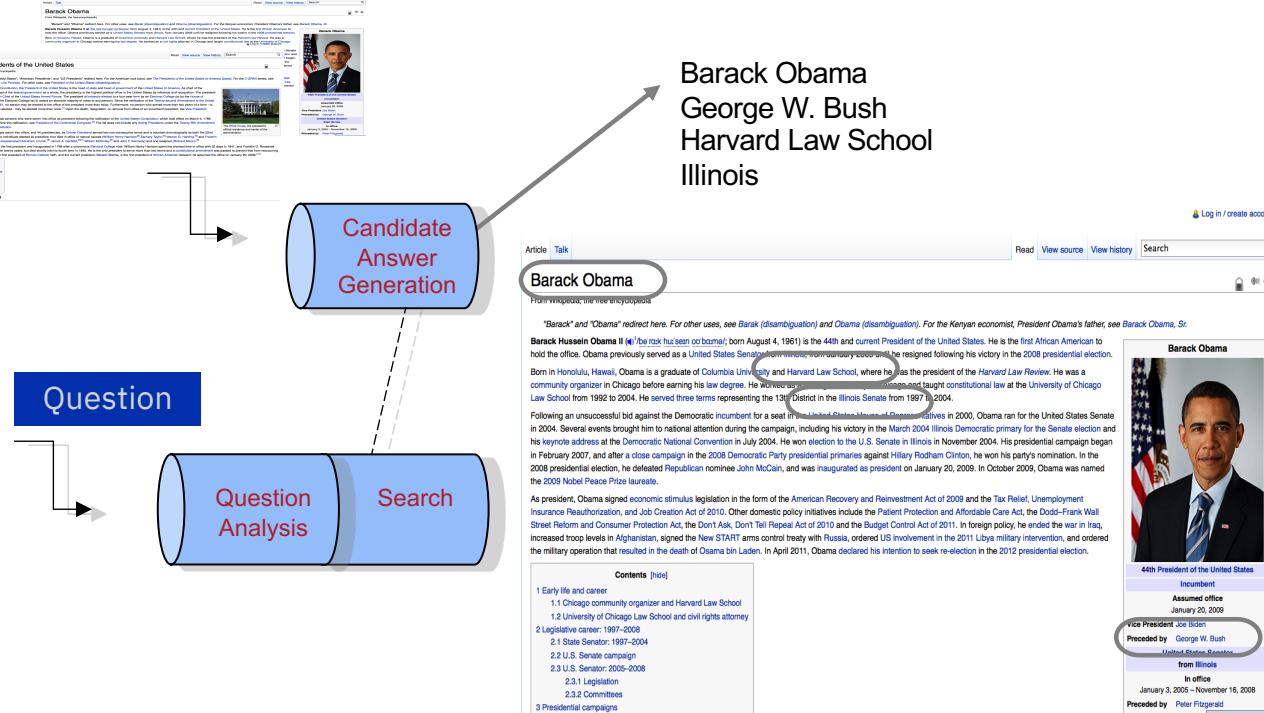
Stage 2: Hypothesis Generation – Primary search

Who is the 44th President of the United States?

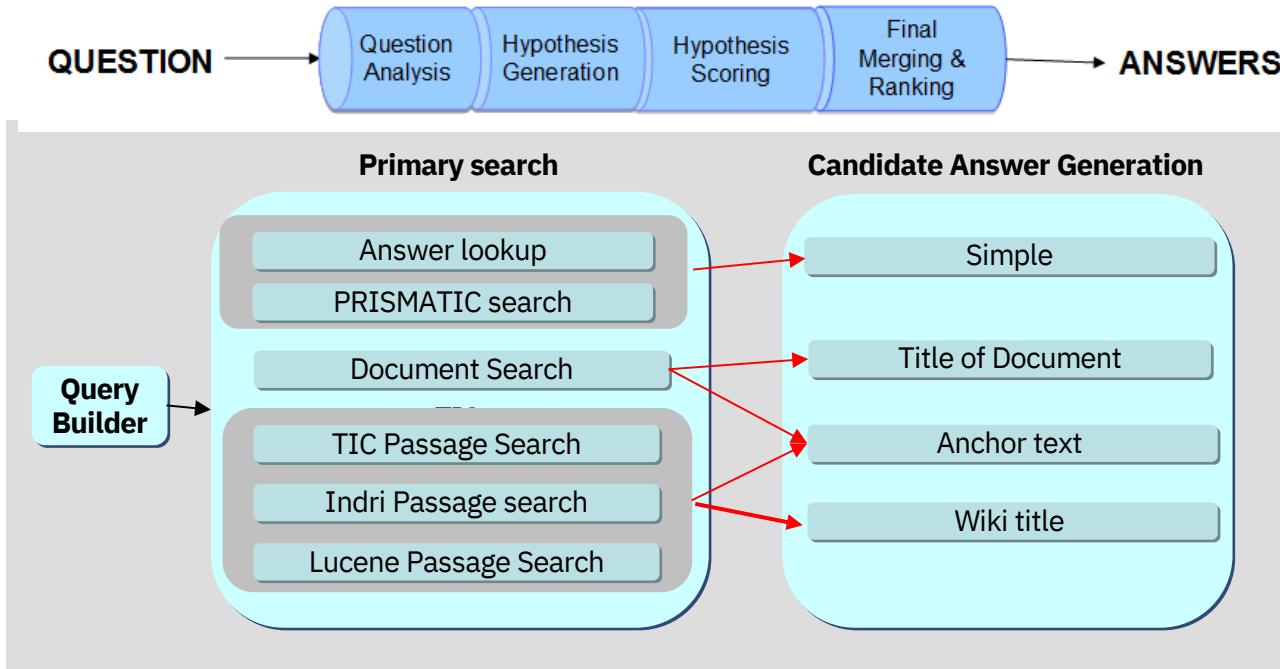


Stage 2: Hypothesis Generation – Candidate Answer Generation

Who is the 44th President of the United States?



Stage 2: Hypothesis Generation Components



Three major components are

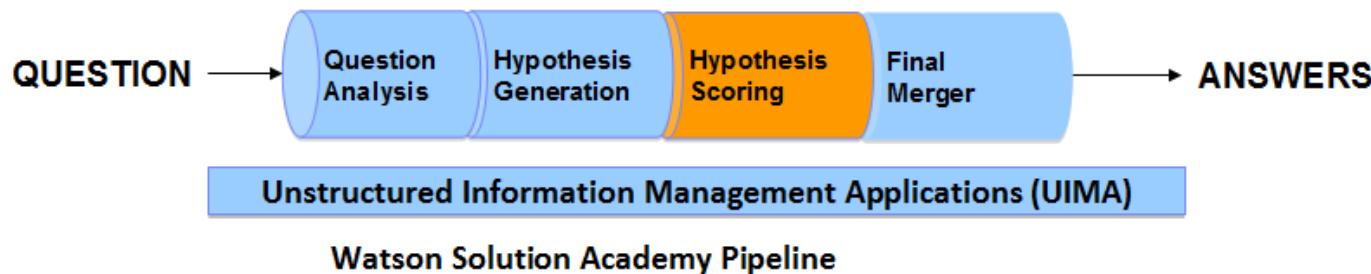
- **Query Builder**
- **Primary Search**
- **Candidate Answer Generation**

Stage 3: Hypothesis Scoring

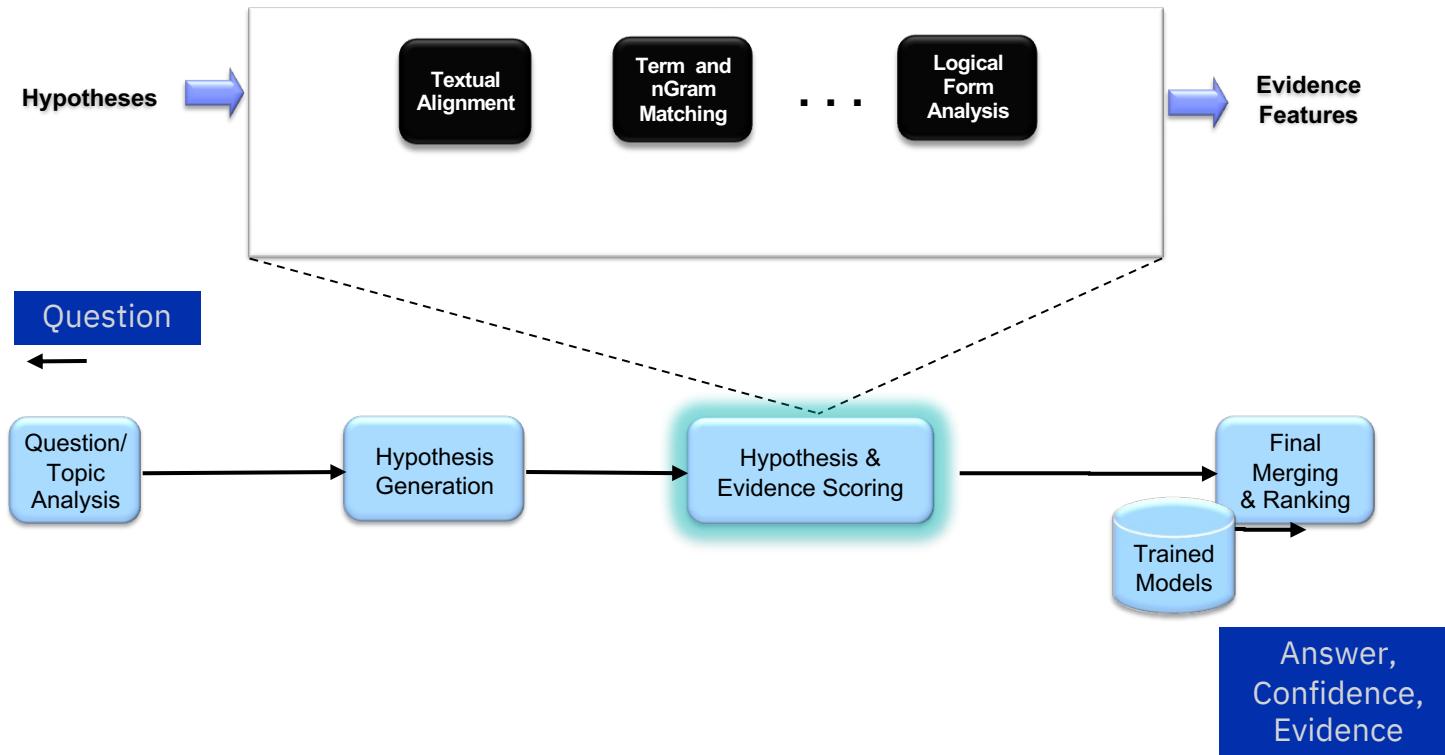
What is Hypothesis Scoring?

- 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:

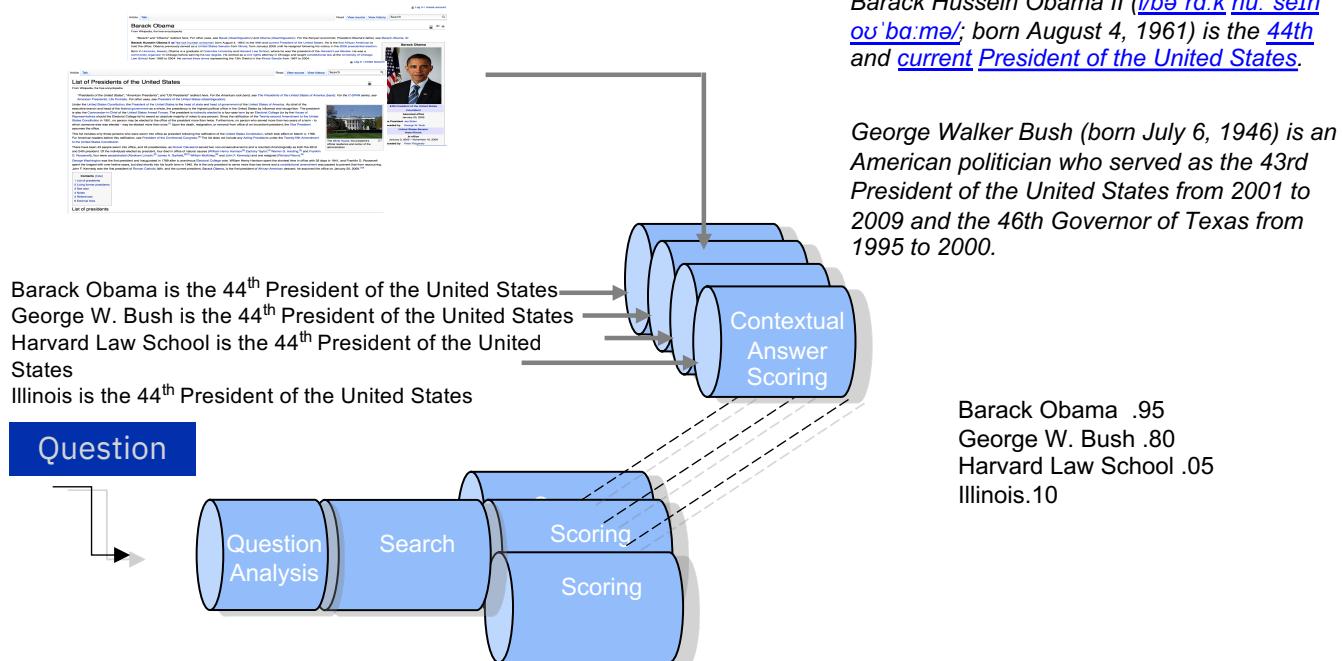
In 1698, what comet discoverer took a ship called the Paramour Pink on the first purely scientific sea voyage?

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

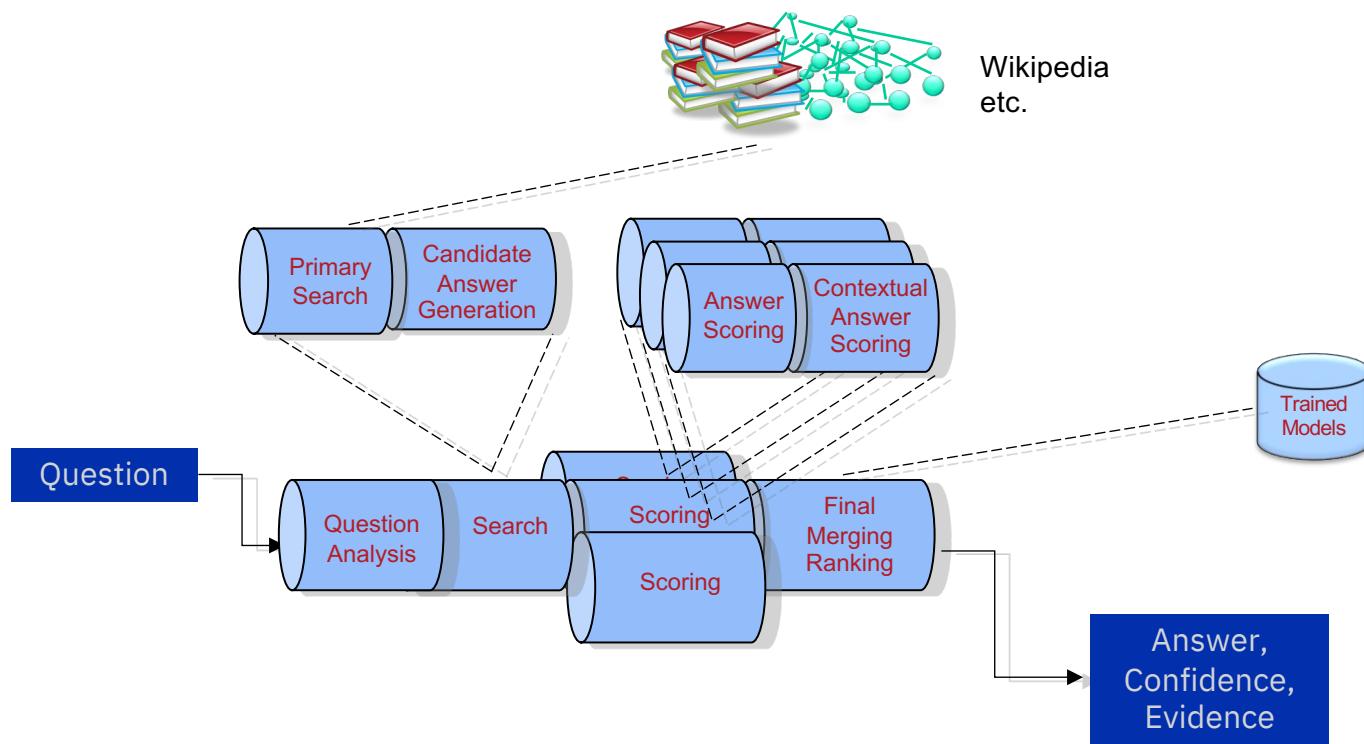
–Fewer textual overlaps, likely with lower IDF scores

Example

Who is the 44th 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 44th 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.

How to Build a Chatbot

A chatbot has a frontend and a backend

The frontend is the messaging channel where the chatbot interacts with the user.

The backend is the application logic, the persistence stores, and the supporting services.

Anatomy of a chatbot backend

If you do decide to choose a framework, the backend of your chatbot will most likely consist of three main parts:

1. Intents 2. Entities 3. Dialog

Example

A customer might say any of the following:

- “How come I can’t log into my account?”
- “I forgot my password.”
- “It says my password is incorrect.”

These requests have the same solution, which is to reset the customer password.

The core functionality of a chatbot is to map all possible user inputs into a much smaller set of responses.

This type of pattern recognition is what text classifiers do best.

Chatbot: Intent

An intent is the purpose of a user's input

This can be a question about your business hours or a complaint about the registration process.

- To train your chatbot, first determine the action you'd like to map to this intent—for example, provide information on business hours.
- Then supply the framework with examples of user inputs that would require this action.

The screenshot shows a user interface for managing chatbot intents. On the left is a dark sidebar with icons for navigation and settings. The main area has tabs for 'Intents', 'Entities', and 'Dialog'. The 'Intents' tab is selected, showing a list under '#greetings'. A button '+ Add a new user example...' is at the top of the list. Below it are numerous user inputs, each preceded by an unchecked checkbox:

- yo my man
- yo
- yello
- What's up?
- What's up ?
- What's up
- what r u doing
- what doing
- sup
- say hello to me
- namaste
- I would like you to say hello
- howdy
- How are you doing
- hola como estas
- Hola
- hiva

Chatbot: Entities

If intents are the verbs for a chatbot to act on, then entities are the nouns.

If a user asks, “What are the hours for the Austin branch?”...

Provide business hours would be the *intent* and Austin would be the *entity*.

Watson Conversation / Recipe Bot / Build

Intents Entities Dialog

My entities System entities

Create new Import Export Delete

@cuisine

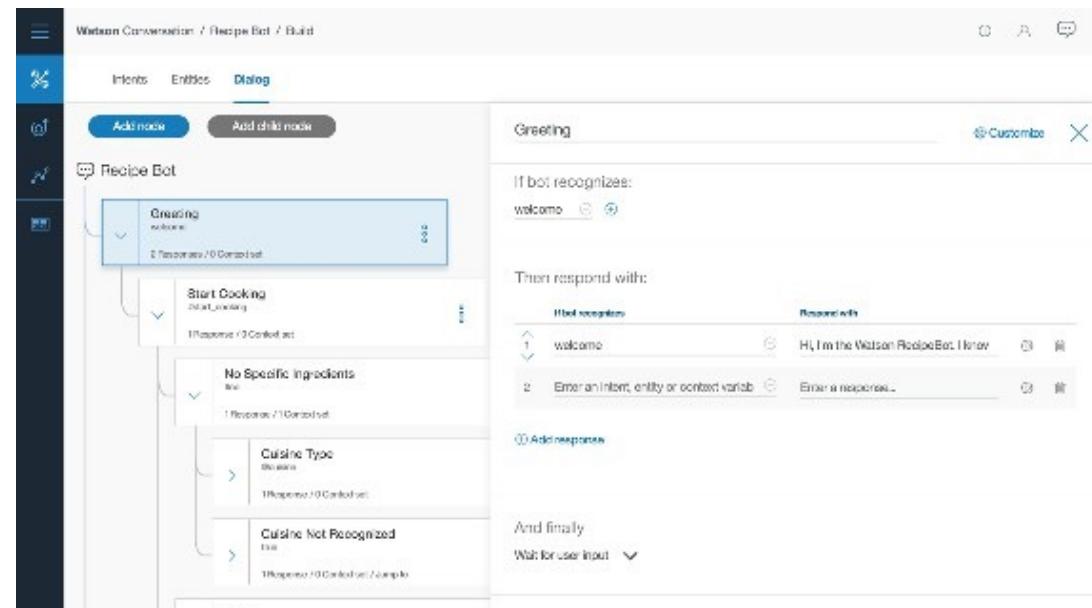
Add a new synonym value	Add a new pattern value
<input type="checkbox"/> vietnamese	<input type="checkbox"/> Add synonyms...
<input type="checkbox"/> irish	<input type="checkbox"/> Add synonyms...
<input type="checkbox"/> mexican	<input type="checkbox"/> Add synonyms...
<input type="checkbox"/> african	<input type="checkbox"/> Add synonyms...
<input type="checkbox"/> cajun	<input type="checkbox"/> Add synonyms...
<input type="checkbox"/> southern	<input type="checkbox"/> Add synonyms...
<input type="checkbox"/> greek	<input type="checkbox"/> Add synonyms...
<input type="checkbox"/> chinese	<input type="checkbox"/> Add synonyms...
<input type="checkbox"/> korean	<input type="checkbox"/> Add synonyms...
<input type="checkbox"/> spanish	<input type="checkbox"/> Add synonyms...
<input type="checkbox"/> latin american	<input type="checkbox"/> Add synonyms...
<input type="checkbox"/> ionanese	<input type="checkbox"/> Add synonyms...

Chatbot: Dialog

Dialog is the conversation flow

Together, it is the combined structure of all your possible conversations.

Most chatbot platforms provide a UI to help you visualize the process.



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 the word "Manage". Below the header, there are three message bubbles. The first bubble is from the bot, featuring a yellow circular icon with a cartoon animal face. The text in this bubble reads: "Hmm...can you be more specific? Or you can try typing the name of a nearby city." To the right of this bubble is a blue button with the text "Brooklyn, NY" in white. The second bubble is from the user, showing the text "Brooklyn, NY". The third bubble is from the bot, featuring the same yellow animal icon. The text in this bubble reads: "Oh yeah? My ex is from there. Hm...anyway...it's 43°F and clear there rn." Below this is another message from the bot: "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".

Industry Case Studies

Autodesk: Customer Support

Autodesk is known for 3D design and engineering software.

Autodesk built a virtual agent called Autodesk Virtual Agent (AVA), to answer common customer queries quickly. It was trained from chat logs, use cases, and forum posts. It analyzed more than 14 million sentences for keywords, entities, phrases, clusters, and other speech patterns.

- AVA has had 146,652 conversations, a 35% increase quarter over quarter (QoQ).
- AVA has helped 45,514 customers total, a 54% increase QoQ.
- Resolution takes an average of 5.6 minutes, compared to the original 38 hours with human support agents.
- Autodesk estimates a headcount savings of 12–15.

Staples: Conversational Commerce

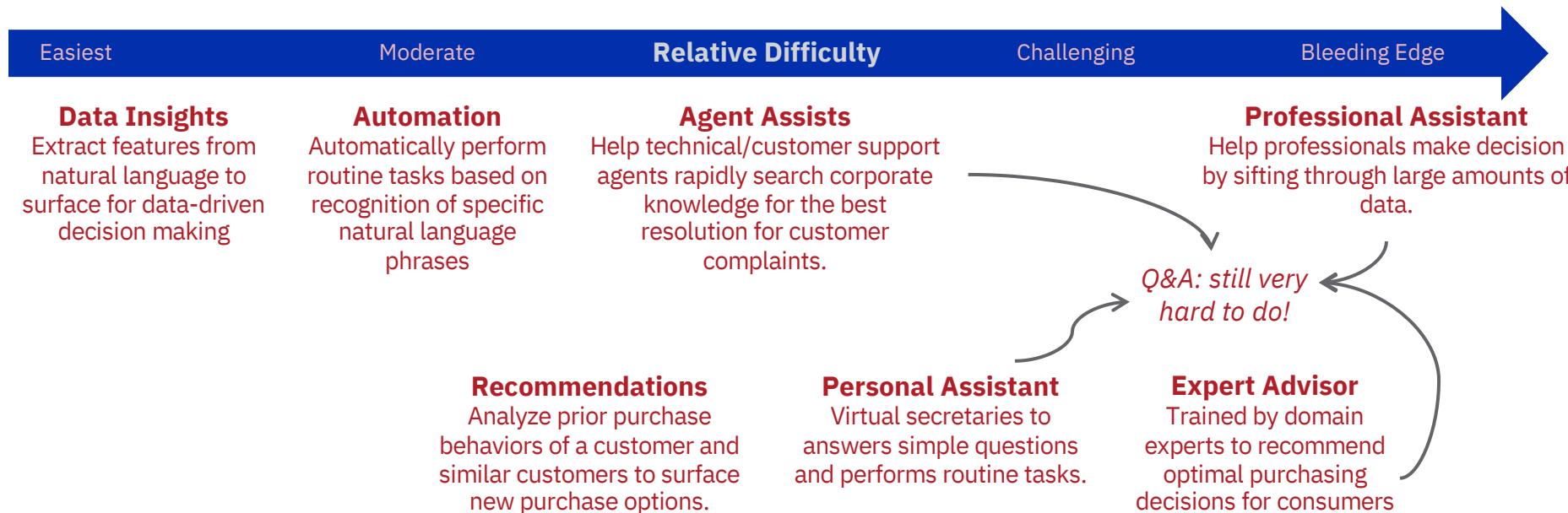
Staples built an intelligent Easy Button using Watson Conversation.

The system currently understands five intents: product ordering, product reordering, shipment tracking, checking on reward summaries, and processing back-to-school lists.

Entities are products contained in the company's catalog (pens, toner, paper, etc.).

After Watson Conversation recognizes the intent and entity of a request such as "I want to reorder black pens," it calls the Staples personalization engine. This engine checks the customer's purchasing history to identify the pen (an excellent use of contextual information) and enables the purchase with the customer.

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.

Conversational AI: the what and the why



Emily Winchurch,
Watson Product Marketing,
writes in the IBM Watson
Blogs the following thoughts:

What is conversational AI?

- Conversational AI is a type of artificial intelligence that enables software to understand and interact with people naturally, using spoken or written language.

Why conversational AI?

- Chatbots make software accessible to everyone who understands human language. Computers can be operated with simple human language that people can understand.
- Chatbots free up agents to respond to the more complex problems that are better solved by a customer service agent.

<https://www.ibm.com/blogs/watson/2019/02/whats-happening-in-conversational-ai/>

Conversational AI: and what's next, per Amy...

Broader Conversations

Conversational bots that can answer questions like “What kind of car should I buy?”

Multiple Touchpoints

With conversation bots, every phone conversation, every text bot interaction, and every website behavior is recorded and remembered by the bot framework forever.

Deeper Understanding

Conversational bots are getting to a point where they can recognize personality, emotion, and the tone of a conversation.

AI in restaurants

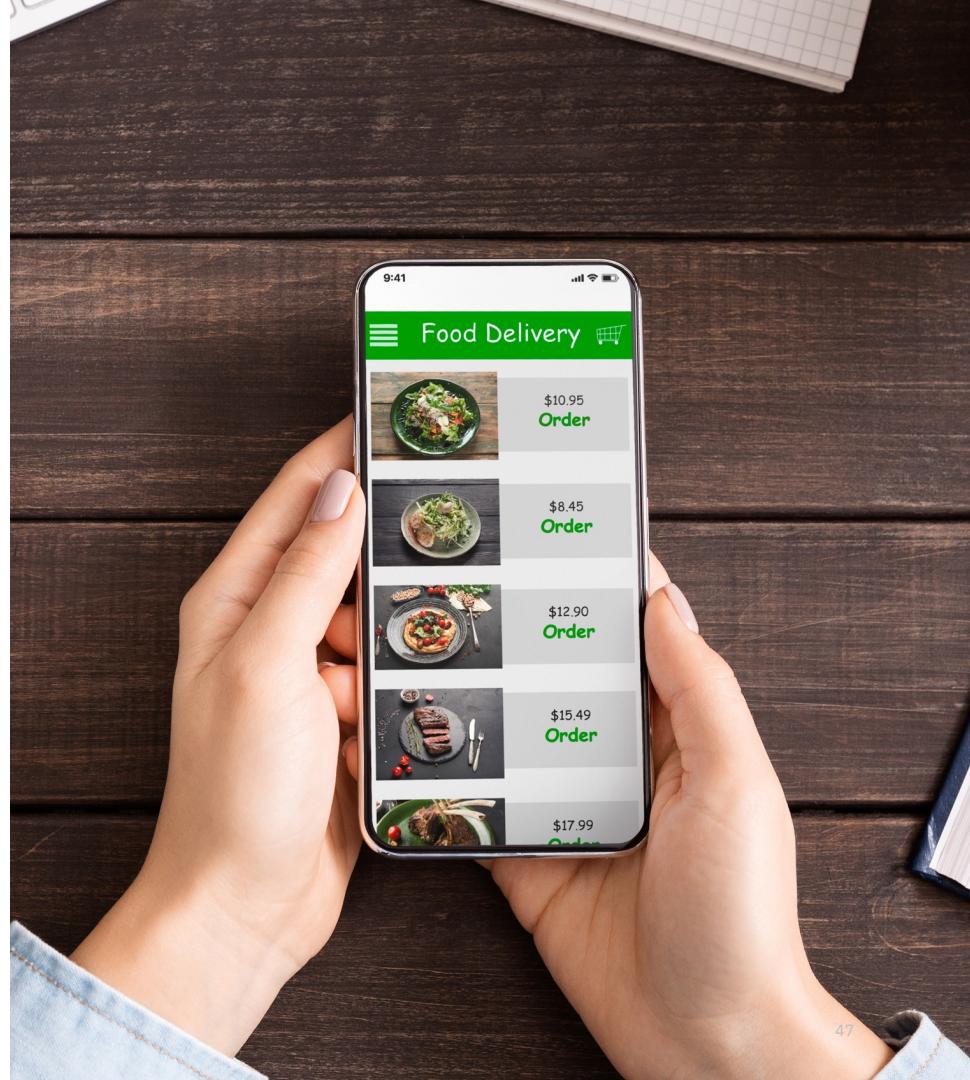
Food service experience is changing, not only for customers, but also in the back-office operations



AI in Restaurants

AI-enabled bots can help manage reservations, respond to customer inquiries and customize customer orders

AI-driven food apps identify the patterns of a customer's dining choices



From Chatbots to Prediction

AI can help with back-office tasks

One thing that every restaurant manager needs to handle is staff schedules. This important but mundane task is one area where AI in restaurants can be particularly proficient.

Machine learning-enabled systems can help.

Are chatbots effective for customer service?

Fifty-three percent of the 3,000 respondents to a Chatbots.org survey conducted in late 2017 found chatbots to be "not effective" or only "somewhat effective."

