IBM Watson

IBM

Watson Intelligent Advisors

Discovery and Conversational Technology for Now and the Future

Dr. Graham Katz, IBM Watson AI Delivery

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Two Faces of Natural Language Understanding

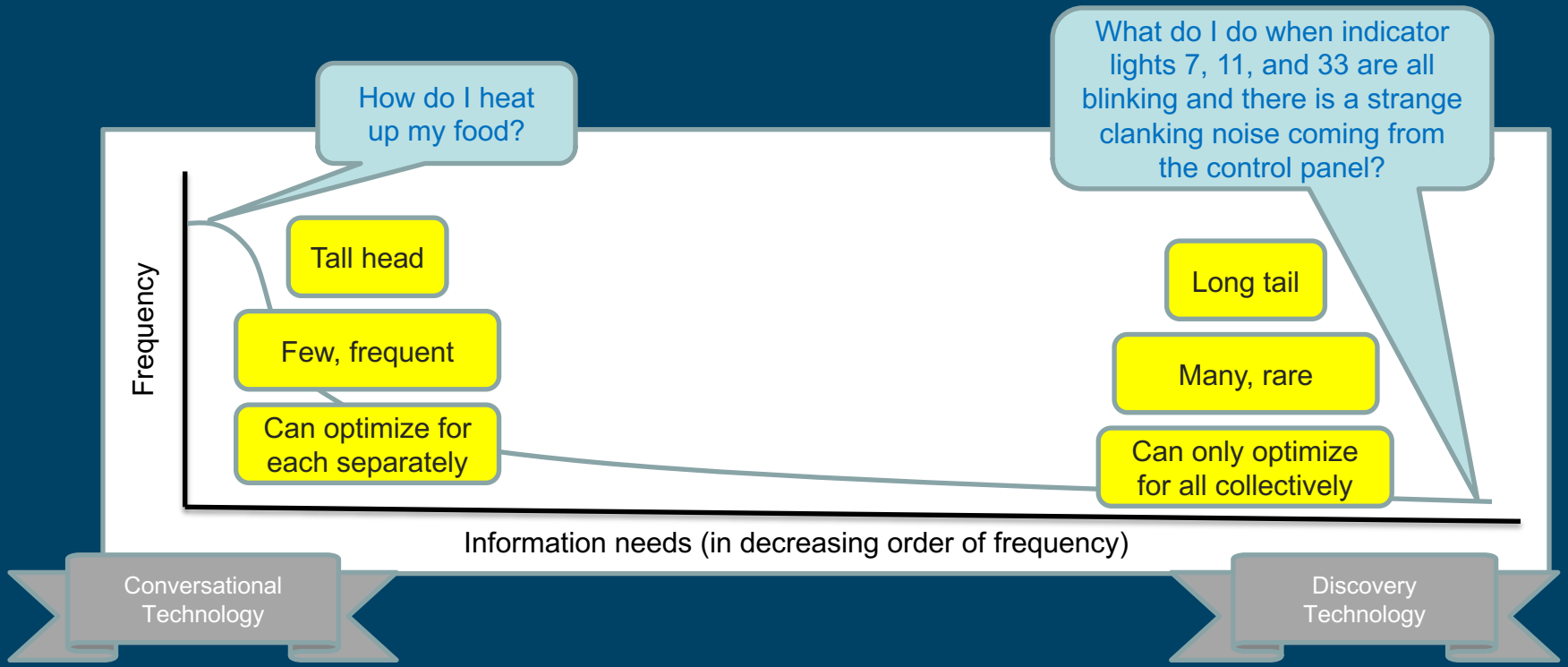
- Natural Language Interfaces (*with Speech):*
  Alexa, Watson Assistant, Siri
  - *Controlling lights, A/V, HVAC equipment, robots with voice*
  - *Querying databases in natural language*

Rachel Avatar (Soul Machines)

- Natural Language Understanding for reading, learning, and answering questions
  - *Extracting facts from unstructured text*
  - *Answering questions based on collection of documents*

Watson Jeopardy!

Tall Head/Long Tail in information needs and technology



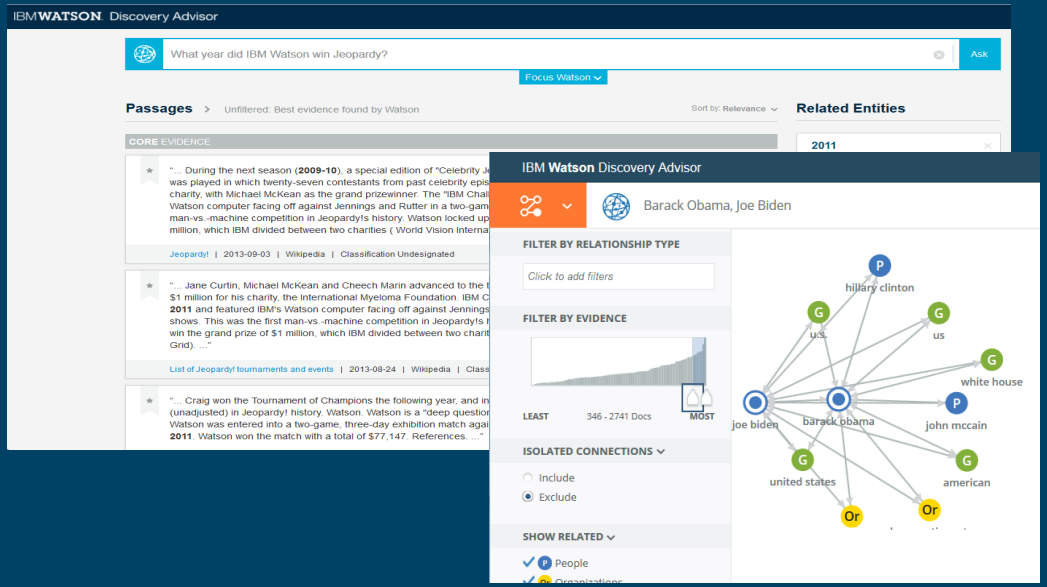
Discovery Technology: Expert Advisor Applications

Provide information to experts to assist them in carrying out their jobs

NASA/IBM prototype developments

- Innovation Advisor: provide assistance to researchers engaged in scientific research to find information in related fields that might impact their field
- Pilot Expert Advisor: provide informational assistance to flight crew members to aid in troubleshooting

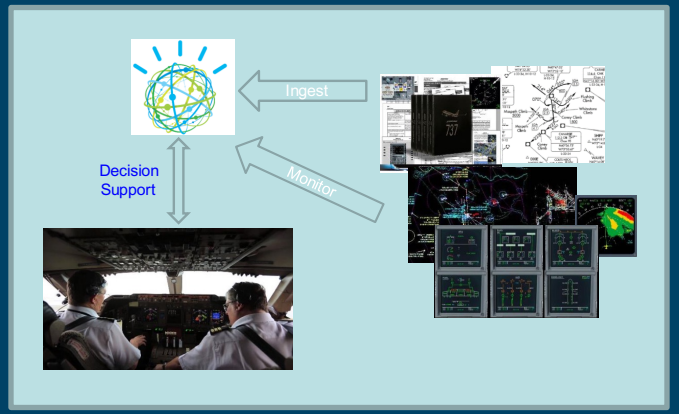
Watson Discovery Advisor (WDA) is an Discovery application for finding facts in large quantities of unstructured text based on the Watson Jeopardy! system. It exposes two main functions: answering factual questions and exploring discovered entities and relationships.



Pilot Expert Advisor Vision

NASA Pilot Expert Advisor links aircraft systems with external sources of information to provide flight crews (experts) with relevant information based on IBM Watson Discovery Advisor (WDA) technology

- Long-tail Discovery application
- Integration of multiple data sources
- Core functionality based on WDA question answering



Pilot Expert Advisor Project

NASA and IBM worked together to customize Watson Discovery Advisor to answer questions about the chosen use case through WDA domain adaptation

Corpus Data Selection

Select and ingest relevant textual material, evaluating the technical requirements for ingesting each data source

Domain Language Customization

Develop custom dictionaries to expand Watson's baseline of recognized terminologies, definitions, spellings, abbreviations,

Machine Learning

Train the native candidate answer scoring algorithms by using collections of questions with known answers to train answer ranking models

Pilot Expert Advisor Use Case: Loss of airplane-state awareness incident

Flight: Midwest Express 490 (B717-200)

Visibility and Weather: Night, thunderstorms in the area

Event occurred while climbing through 19,000 ft

- "**Rudder Limiter Fail**" message shows on crew alerting system
- 10 seconds later, wild pitch oscillations lasting ~ 8 minutes
- Altitude fluctuations between 10,600 – 23,300 ft;
- Speed fluctuations between 290 – 552 knots

NTSB findings

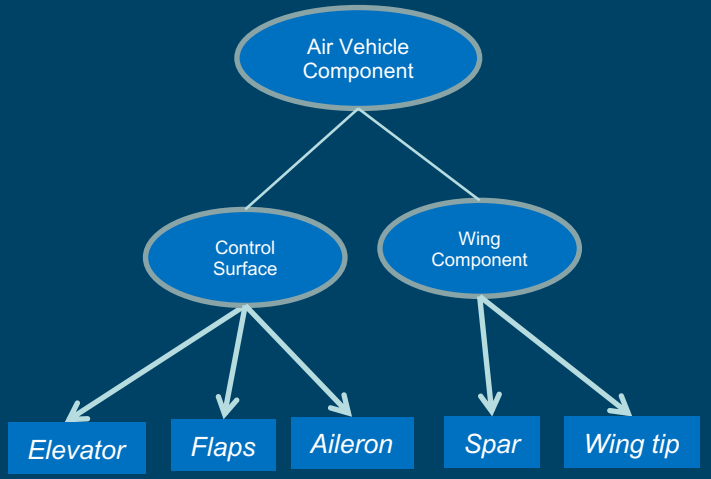
- Lighting strike caused pitot heat system to fail
- Pitot icing produced unreliable airspeed data

Can Watson help?

Pilot Expert Advisor Data Sources

Data Source	Description
ASRS	Flight crew reports. Acronyms, conventionalized and idiosyncratic abbreviation, first person perspective; unanalyzable content
NTSB Accident Database	Investigation reports. Textual factual data, highly Use Case relevant, some non-textual and semi-structured content
Boeing 717	Technical documentation. Much non-textual data; some textual factual data; highly Use Case relevant
Basic Aviation Information	General Aviation information. Much textual factual material, some non-textual content; large heterogeneous documents; may have relevance
Title 14 CFR, Subchapter G	Legal specifications. Regulatory and legal (not factual) text ; apparent low relevance to Use Case
Aviation Weather (WX)	Aviation weather science. Factual textual content; some semi-structured data; long heterogeneous documents
SKYbrary Aviation Safety	General aviation safety. Highly specific, factual, textual data; some semi-structured textual content

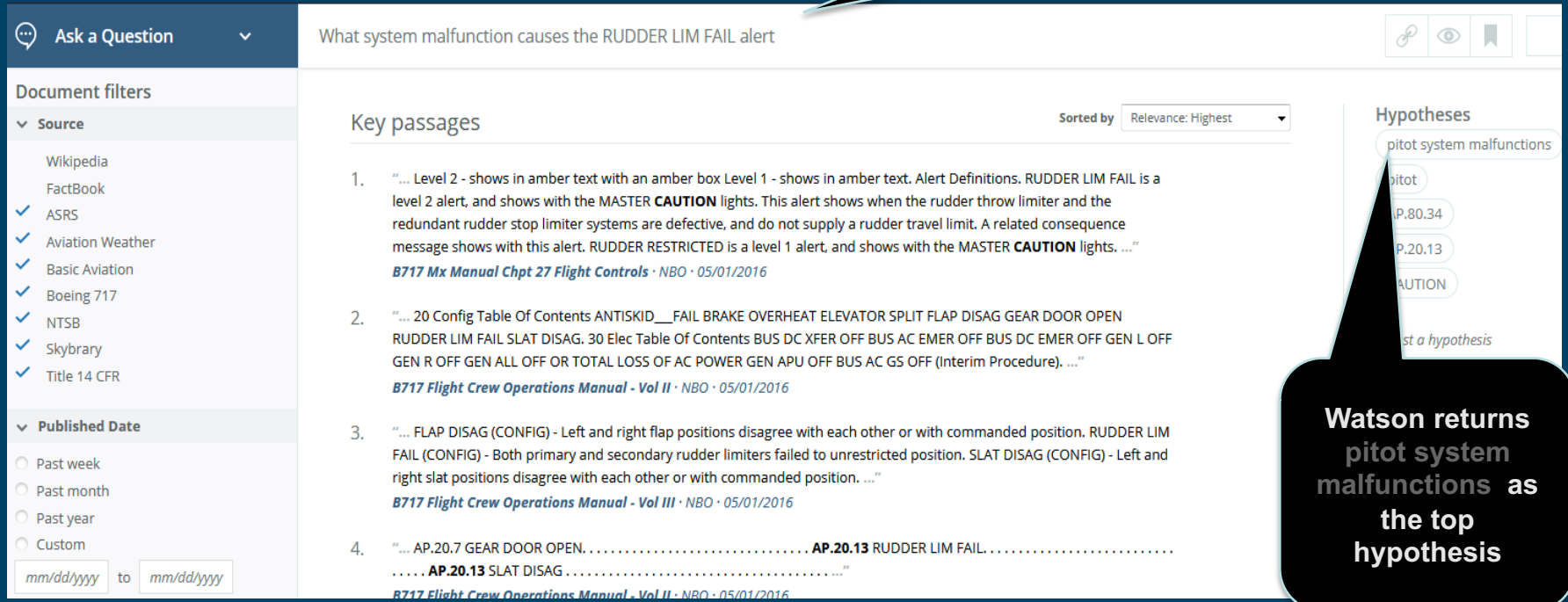
Domain Taxonomy



IBM Watson

Pilot Expert Advisor Prototype

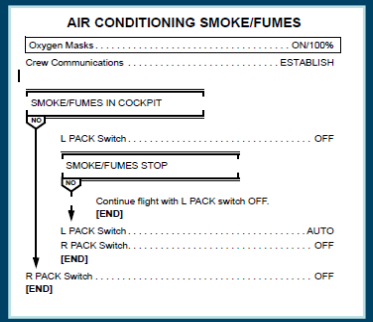
The captain instructs the first officer to ask Watson: "What system malfunction causes the RUDDER LIM FAIL alert?"



Watson returns pitot system malfunctions as the top hypothesis

Key Challenges : Non-Textual Information

Watson reads text– but there are many sources of information in technical domains that are non-textual



Semi-structured text

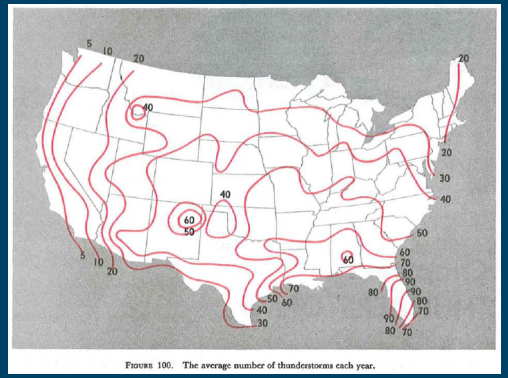


FIGURE 100. The average number of thunderstorms each year.

Maps

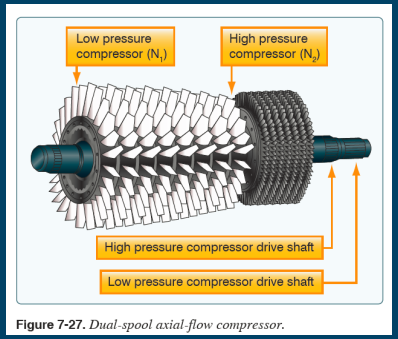


Figure 7-27. *Dual-spool axial-flow compressor.*

Diagrams

Type of error	Unchallenged errors		All primary errors[a]	
	Number of errors	Percent	Number of errors	Percent
Aircraft handling	9	12.9	46	19.8
Communication	5	7.1	13	5.6
Navigational	3	4.3	6	2.6
Procedural	11	15.7	73	31.5
Resource management	0	0	11	4.7
Situational awareness	13	18.6	19	8.2
Systems operation	1	1.4	13	5.6
Tactical decision	28	40.0	51	22.0
Total	70	100.0	232	100.0

[a] Primary errors are not dependent on making a prior error.

Tables

Key Challenges: Non-Textual Information

Example: Question answering from Tables

"What percentage of unchallenged errors are procedural?"

"15.7"

Requires:

- Ability to parse table into rows and columns
- Ability to relate structure of table to "meaning"
- Ability to relate table interpretation to question

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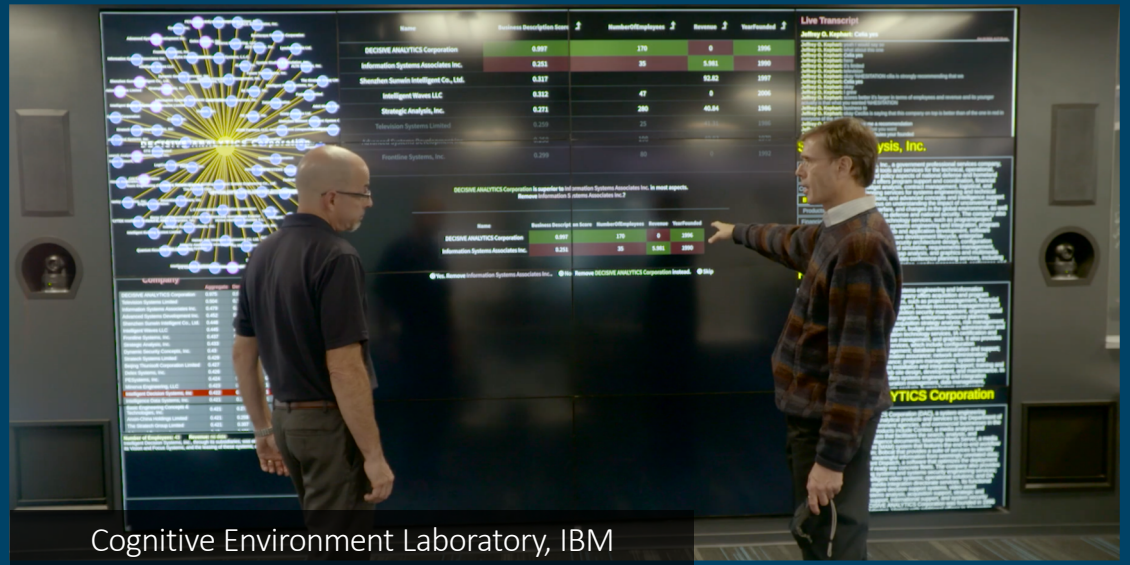
Key Challenges: Contextual Information

- **In context, questions often mean more than they say**:
  - *"Where is the hydraulic pump switch?"* actually means:
    "Where is the hydraulic pump switch on the aircraft I am flying?"
  - *"What could cause that?"* might mean:
    "What could cause that [RUDDER LIM FAULT] alert to display?"

- **Contextual Data Augmentation** component of Pilot Expert Advisor system provides the extra contextual data that user might leave out

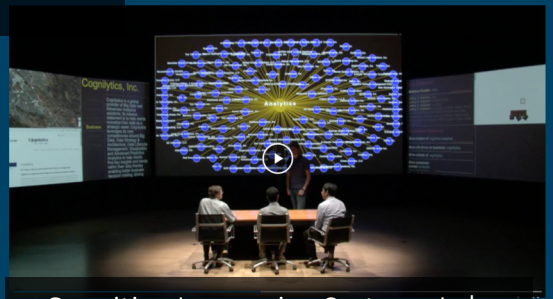
Embodied Conversational Agents

- Make use of physical and conversational context in interaction
- Utilize extra-linguistic information such as gesture and pointing



Cognitive Environment Laboratory, IBM Yorktown

ThinkLab, IBM Yorktown



Cognitive Immersive Systems Lab, RPI

Summary

- Expert Advisor systems require discovery solutions that can address “long tail” information needs

- Technical domains have significant technical requirements related to
  - Domain specific terminology
  - Non-textual or semi-textual sources of information

- Intelligent Advisors of all sorts must leverage contextual information to increase naturalness
  - Embodied context
  - Informational context