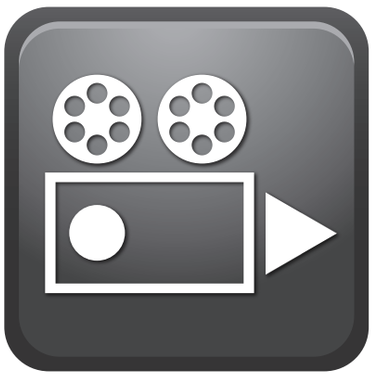
CHAPTER 11 IMPROVING DECISION MAKING AND MANAGING KNOWLEDGE

CASE 1 How IBM's Watson is Mastering Knowledge



SUMMARY This video describes how IBM's Watson computer system is able to compete against humans in answering questions on the popular television game show *Jeopardy!* And how this technology can be used by business firms and other organizations to improve their decision making. Watson's capabilities are now a major part of IBM's product strategy.

(a) IBM Watson: How it Works

URL https://www.youtube.com/watch?v=_Xcmh1LQB9I; L=7:53

(b) IBM Watson: The Science Behind an Answer

URL https://www.youtube.com/watch?v=DywO4zksfXw; L=6:42

CASE *Jeopardy!* is an American television quiz show created in 1964. The show asks contestants questions on a very wide range of topics, including history, language, literature, the arts, the sciences, popular culture, geography, and wordplay. The show had a unique question format: contestants are presented with answers containing clues, and must phrase their responses in the form of a question that would generate that answer. For instance, the clue "5280" is a response to the question, "How many feet in a mile?"

Here are some sample questions and appropriate answers in *Jeopordy!* style:

Q: Hard times, indeed! A giant quake struck New Madrid, Missouri, on February 7, 1812, the day this author struck England.

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A: *Who is Charles Dickens?*

Q: According to C.S. Lewis, it was bordered on the east by the Eastern Ocean and on the north by the River Shribble.
A: *What is Narnia?*

Q: Pseudonym of labor activist & magazine namesake Mary Harris Jones.
A: *Who is Mother Jones?*

Q: To marry Elizabeth, Prince Philip had to renounce claims to this southern European country's crown.
A: *What is Greece?*

The game of *Jeopardy!* makes great demands on its players—from the range of topical knowledge covered to the nuances in language employed in the clues. For instance, to answer the last question you would need to know something about Elizabeth the Queen, and her husband Prince Phillip, and what southern European country the Prince had claims on. Can the analytical power of a computer system—normally accustomed to executing precise requests—overcome these obstacles? Can the troves of knowledge written in human terms become easily searchable by a machine in order to deliver a single, precise answer? IBM's Watson took on that challenge.

In the age of Big Data, the ability to make sense from unstructured data has become critically important in many areas, including medical science, advertising, and law. IBM's Watson cognitive computing system is designed to find the answers and insights hidden within this unstructured data. IBM describes Watson as "an application of advanced Natural Language Processing, Information Retrieval, Knowledge Representation and Reasoning, and Machine Learning technologies to the field of open domain question answering" using IBM's DeepQA technology for hypothesis generation, massive evidence gathering, analysis, and scoring. Watson was named after IBM's first president, Thomas J. Watson. In business terms, Watson was a demonstration of IBM's strategy of providing Big Data analytics services to its corporate customers who are facing the challenge of how to analyze and understand the mountains of data generated by millions of online consumers, posts, Tweets, and smart machines sending performance data to corporate servers. Over 30 million people watched Watson compete with human players.

In February 2011, Watson entered the public consciousness when it competed on *Jeopardy!* against two top human *Jeopardy!* players. Watson beat Brad Rutter, the biggest all-time money winner on *Jeopardy!*, and Ken Jennings, the record holder for the longest championship streak (74 wins). *Jeopardy!* makes great demands on its players, both in the range of information required to answer its questions, as well as the intricate wordplay involved with many clues.In order to win at *Jeopardy!* Watson had to be able to understand the language of a clue, register the intent of a question, scour millions of lines of human language, and return a single, precise answer—in less

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than three seconds. Traditional programming systems requiring precisely organized data as input wouldn't have a chance. Watson is different.

With access to 200 million pages of structured and unstructured information consuming four terabytes of disk storage, including the full text of Wikipedia, Watson's sources of information included encyclopedias, dictionaries, thesauri, newswire articles, and literary works. Watson also used databases, taxonomies, and ontologies. All of this content was stored in Watson's RAM memory for the game because data stored on hard drives are too slow to access, and Watson was also not connected to the Internet, where gathering information is far too slow to meet the response-time requirements in the game. Watson is able to process 500 gigabytes of data, the equivalent of a million books, per second. Watson used 10 IBM 750 refrigerator size computers (about 2,600 PC microprocessors), occupied a living room-size space, required extensive air conditioning to cool its processors, and consumed 200,000 watts of electricity. Its human competitors' minds consume about 7 watts of electricity, and come with a built-in cooling system. Later releases of Watson have been shrunk to 1/16 the size of the original and operate in smaller domains of human knowledge requiring far less storage.

Watson received the *Jeopardy!* clues as electronic texts at the same moment they were made visible to the human players. It would then parse the clues into different keywords and sentence fragments in order to find statistically related phrases. The machine zeroes in on key words in a clue, then combs its knowledge bank for clusters of associations with those words. It rigorously checks the top hits against all the contextual information it can muster: the category name; the kind of answer being sought; the time, place, and gender hinted at in the clue; and so on.

Watson's main innovation was not in the creation of a new algorithm for this task but rather its ability to quickly execute thousands of proven language analysis algorithms simultaneously to find the correct answer. The more algorithms that find the same answer independently, the more likely Watson is to be correct. Once Watson has a small number of potential solutions it is able to check against its database to ascertain whether the solution makes sense. When Watson feels "sure" enough, it signals it is ready. On *Jeopardy!*, Watson spoke with an electronic voice and to deliver the responses in *Jeopardy!*'s question format.

However, IBM is hoping that with the aid of human experts to help curate the content it receives, Watson can become an expert in practically any field. For example, Watson is already helping doctors in recommending treatments for patients, but not doing the diagnosis which is still performed by doctors. Watson analyzes a patient's specific symptoms, medical history, hereditary history (as provided to it), and synthesize that data along with the mass of all unstructured and structured medical information in the world including (but not limited to) medical records of similar situations available to it. Watson uses this information in addition to the wealth of fundamental medical knowledge avail-

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able in the form of all published medical books and articles fed into Watson. In 2013, for example, Watson was able to look at 3,500 textbooks worth of information along with 400,000 other pieces of data in 17 seconds to recommend a treatment for a new patient with a 95 percent confidence interval. IBM has made it clear that Watson is not intended to replace doctors, but can assist them to avoid medical errors and sharpen medical diagnosis with the help of its advanced analytics technology.

Watson has the flexibility for use in many fields. But it does require a massive database of existing knowledge, and records, in order to effectively operate. In other words, Big Data. In addition, it requires a very large computing capacity, and a skilled screw of software engineers to process and analyze the data. IBM hopes to use Watson in fields such as metallurgy, cooking, law, and pharmaceutical research. Although Watson is still relatively new, due to its innate machine learning capabilities, it is getting faster and smarter with each query it performs.

VIDEO CASE QUESTIONS

1. According to the first video, what are the four steps that humans follow when seeking to understand a situation and make a decision? Are these the steps you followed when deciding to take this course? Or when you chose your last vacation destination?
2. Why is Watson different from traditional computer programs?
3. What is the "corpus of knowledge" of a field or domain that Watson needs to work?
4. How do humans train Watson to make the right decision?
5. Was playing Jeopardy a good way to test machine intelligence? Why or why not?
6. Is Watson a good example of a computer system demonstrating intelligence similar to that of a human?
7. Suggest some other applications for Watson.