Featured Articles

Advanced Research into AI

Debating Artificial Intelligence

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OVERVIEW: This article describes a debating AI that can debate decision-making matters with humans. Given a discussion issue, the system outputs short argument scripts based on multiple viewpoints. The argument scripts are summarized information with a length of about 10 sentences, which is composed of evidence, analytics, and opinions obtained from large amounts of document data. They can be thought of as a consolidated essence for decision-making. The debating AI can automatically investigate business opportunities and risks on a regular basis from multiple points of view. With the aim of creating an enterprise IT system that drives innovation in organizations, Hitachi is accelerating the development of the debating AI through open collaborative creation.

INTRODUCTION

HITACHI has been working on developing a debating artificial intelligence (AI) that can debate decision-making matters with humans. Given a discussion issue and a stance, the system provides useful information for making decisions, such as grounds and counterexamples. For the issue "Should we use electric vehicles as office cars?" for example, it answers "Electric vehicles are environmentally conscious" when asked for a positive stance, or "Electric vehicles are expensive" when asked for a negative stance. Next, it provides evidential information extracted from news articles, white papers, research reports, and other material.

Fig. 1 shows an overview of the debating AI. On the present computing platform, it composes three opinions within 80 seconds. Each generated opinion includes a different viewpoint and is based on the analysis of about 10 million English news articles. The purpose of using the AI system is to explore discussion issues by "debating" with humans, and to induce evidence-based decisions.

The rest of this section explains the background of the development. Hitachi assumes that data analytics technologies will evolve through the three phases illustrated in Fig. 2. While the second phase, optimization using big data, has been well-studied, the focus here is on the third phase. In today's fast-moving world, companies need to continuously produce innovative services and value. R. G. McGrath, a professor at Columbia Business School, argues that competitive advantage is becoming harder to maintain. In an era of transient competitive advantage, companies need to build and manage multiple innovations to keep exploiting transient advantages[(1)]. She also makes the case that the process of developing innovations should not be experimental, but central to corporate strategy. In such an environment, strategic planning should take on a greater importance within enterprises. Therefore, there is value in being able automatically to find business opportunities and risks on a regular basis from multiple points of view through integrating various information resources, such as news articles, company databases, user reviews, white papers, and research reports.

Hitachi has been developing the debating AI with the aim of creating an enterprise IT system that automatically investigates business opportunities and risks. Believing it important to provide counterexamples that represent the risks associated with decisions, the focus is on techniques for composing counterarguments.

The following section describes the value provided by the debating AI. Subsequent sections describe an evidence recognition technique and social implementation through open collaborative creation.

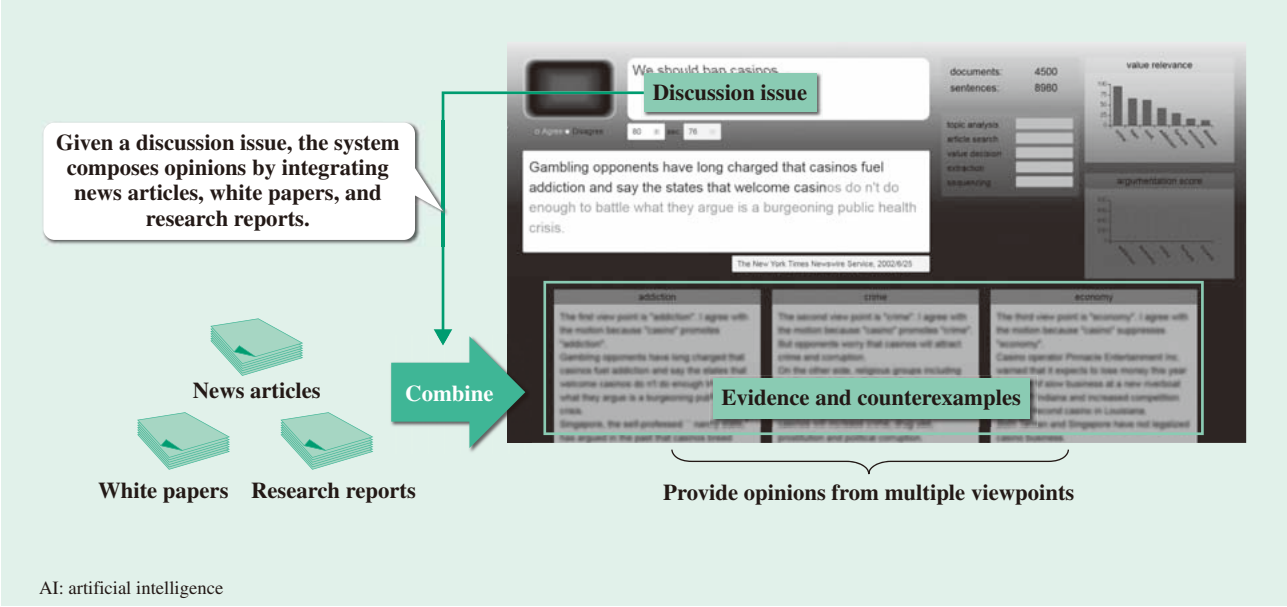

Fig. 1—Overview of Debating AI.
The screenshot is from the interface of the debating AI. When a discussion issue "We should ban casinos" is given, it composes opinions by integrating various information resources. The above example illustrates that the system provides opinions based on three viewpoints: addiction, crime, and economy.

VALUE PROVIDED BY DEBATING AI

As shown in Fig. 1, the debating AI generates short scripts that describe opinions for a given discussion issue. The generated short scripts are called "arguments." The definition is as follows.

Argument: A summarized text, consisting of about 10 sentences, which is composed of evidence, analytics, and opinions from large amounts of document data.

The authors estimate that reading a generated argument is roughly equivalent to reading 400 sentences obtained by querying the discussion topic using a traditional text search technique. The intention is that the arguments will provide a consolidated summary of the material for decision-making.

The arguments are likely to be of most use when people need to read large amounts of document data to investigate a decision. Typical cases are as follows.

(1) Analysis of facilities and policies

Consider the case of investigating past examples prior to building a new casino. It would be desirable to gather information from various accessible resources

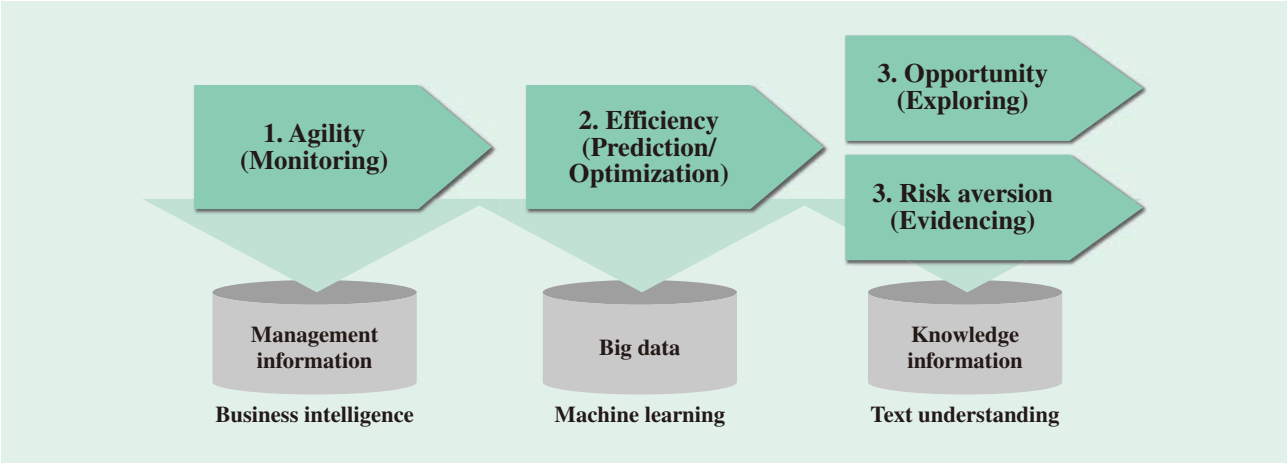

Fig. 2—Values of Data Analytics.
While past studies have dealt with the second phase of optimization using big data, it will also be important to automatically investigate business opportunities and risks on a regular basis.

that describe similar cases from the past about matters such as how much employment was actually created, how the crime rate changed, whether the economy improved or worsened, and the response of residents in the years following the opening of a new casino. Such information would be available in white papers and news articles. In general, investigations of this nature are required whenever companies introduce new facilities or policies.

(2) Analysis of companies or organizations

It can be useful for investigating information about customers or business partners, such as what kind of products a company has launched in the past, the public response to the product, what kinds of problems the company is facing, and whether the company is engaged in any leading-edge programs with foreign governments. In general, numerical data such as profit margins, growth rates, and stock prices are the most important. However, when people have to make important decisions, they also tend to refer to textual information of the sort described above. In some cases, a decision may be changed based on negative evidence despite numerical data supporting the decision. Requirements of this nature tend to occur when making investment decisions or selecting a business partner.

(3) Analysis of locations or markets

When a company plans to expand its business in a new location, it needs to find out about any local security risks in the area, economic trends, the state of social infrastructure, and information about social problems. It also needs up-to-date information about residential interests and important local government plans. While numerical data is available on things like population changes and industrial structure, this can be complemented by textual information.

CORE TECHNICAL COMPONENTS OF DEBATING AI

The debating AI consists of the following technical components[2), 3)].

(1) Understanding user issues

(2) Investigating issues using large amounts of text documents

(a) Identifying relevant factors (such as environment or cost), here referred to as "aspects"

(b) Retrieving grounds or counterexamples

(3) Providing argument scripts in a persuasive manner

The key to the debating AI is the quality of grounds and counterexamples retrieved from large amounts of text data. This section describes the evidence recognition technique used to retrieve this information (2-b).

In this step, the AI recognizes whether a retrieved sentence represents evidence for a predefined claim or not. The claim consists of an argument topic and an argument aspect. For example, that "electric cars" are good for "the environment" is a claim. Evidence comes in two types. Positive evidence is referred to as "grounds" and negative evidence as "counterexamples." While grounds support the claim, counterexamples argue against it.

In trying to find counterexamples, it is important to accurately recognize whether a sentence is a ground or a counterexample. When composing arguments about electric cars, for example, a traditional text search would find a lot of positive evidence such as their producing zero emissions, which makes them good for the environment. On the other hand, a small amount of negative evidence, such as a manufacturing process imposing a large burden on the environment, is likely to be overlooked. However, these counterexamples are important because they can have a significant influence on decision-making. In order to find this important but infrequent evidence, it is necessary to recognize whether a sentence contains positive or negative evidence.

The recognition technique used for this purpose is as follows. In practical situations, many sentences have a more complicated syntax structure than, say, "electric cars are good for the environment." Therefore, the authors constructed a technique to interpret sentences by folding partial linguistic structures into two hierarchical feature structures. The recognition steps are as follows.

(1) Extract partial relations between contextual words as the first feature of the sentence

(2) Combine them into relations of relations as the second feature of the sentence

(3) Calculate a score for the sentence using machine learning

In the example shown in Fig. 3, step (1) extracts five partial linguistic structures, such as whether a subject of a causal verb refers to the topic or the aspect, or whether a specific word is present that reverses the meaning (positive or negative) of the text. In step (3), machine learning can achieve more accurate classification in a broader range of cases than manually created rules.

The debating AI achieved 77-point accuracy in evidence recognition. Future work will include

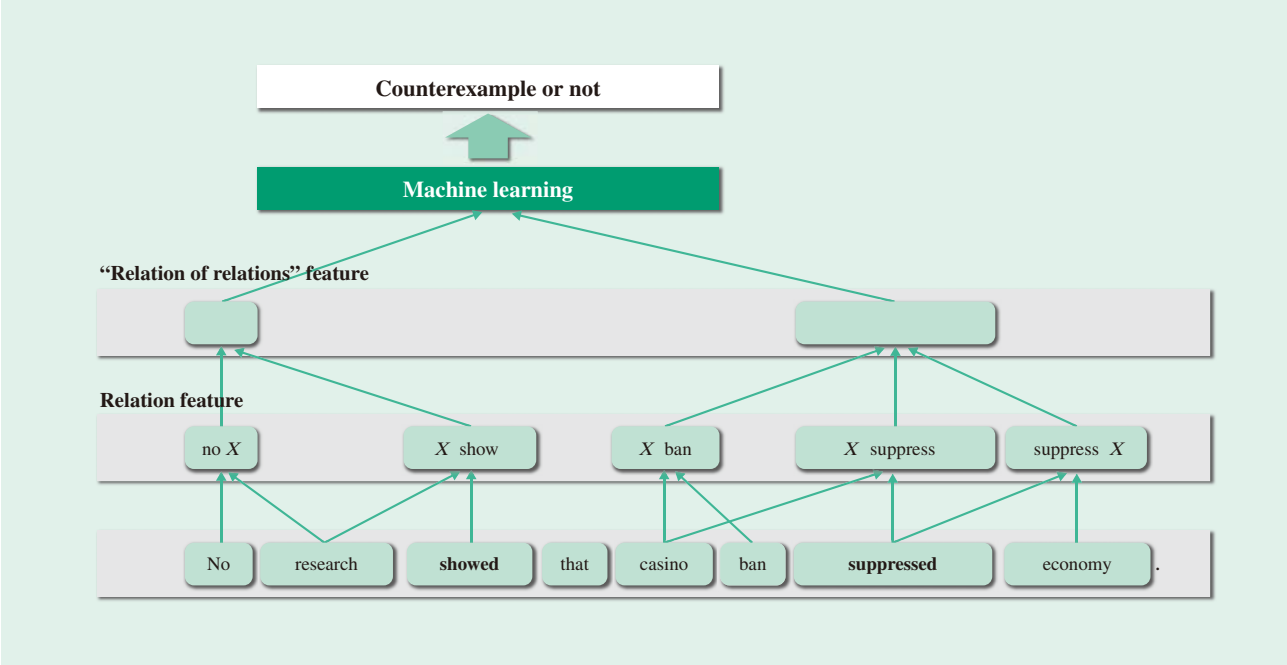

Fig. 3—Evidence Recognition Technique.
The technique extracts linguistic features from a given text. The technique recognizes whether a sentence is evidence or not by extracting information about causal effects, positive and negative factors, and sources, and then calculates a score using a machine learning technique.

improving the accuracy by using more complicated models of machine learning.

SOCIAL IMPLEMENTATION THROUGH OPEN COLLABORATIVE CREATION

The goal of the debating AI is to automatically investigate business opportunities and risks on a regular basis by integrating various information resources. To implement the vision, it is necessary to combine theories of corporate strategy, managers' experiences, and a novel style of providing textual content. For example, it is possible that the form of news articles might change in the future. While news articles currently assume humans readers, in the future AIs may read news articles to support enterprise decision-making. Hitachi plans to start open collaborative creation in which various experts collaborate with one another.

CONCLUSIONS

This article has described an overview of the debating AI. Society has high expectations for AI technology. However, the actual level of the technology has yet to reach these expectations. To implement the vision, Hitachi will continue to improve the accuracy of the arguments that the debating AI provides. Hitachi will also work to build open collaborative creation relationships.

ACKNOWLEDGMENTS

The authors would like to thank Prof. Kentaro Inui from Tohoku University for his valuable discussions.

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