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Artificial Intelligence: A Tool in Machine Translation

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Abstract: *The thought process of humans is formulated according to the language one is familiar with. The process of reasoning process is complex. It is highly dependent on the language in which humans think and express their ideas. The human brain immediately starts the process of translating a text from one language to another. Translation is not just literal, word to word conversion of text from one language to the other, but the context and culture where the said languages are prevalent also play a vital role. Today, translation is based on literal conversions using methods like pattern recognition. The available corpora of knowledge is also limited. This paper attempts to explore how artificial intelligence can be used as a tool in machine translation and how far can it be used as a replacement of human translation.*
Keywords*: Translation, Artificial Intelligence, Machine Translation, knowledge*

I. Introduction to Intelligent Agents

An agent is an entity that senses or perceives its environment through **sensors** and responds to it to take action on its environment through **actuators. [6]**

Agents are abstract concepts or concrete software programs that accomplish tasks that we require them to do, on behalf of us humans[13]. What separates agents from objects and robots is the element of autonomy they provide, which is why they are named “intelligent agents”. They make decisions and act out of their own discretion based on past experiences (for instance, case based reasoning[18,19]) and various evolutionary algorithms. Learning agents also learn from feedback of their performance and evaluation criteria imposed on their results. They take actions to accomplish certain, predefined goals and produce results based on criteria that defines their appropriateness.[5]

A **rational agent** acts such that it achieves the goal it is designed to accomplish. How successful is an agent depends on what it is designed for. A **performance measure** is determined for each agent. If it meets the performance measure and achieves its **goal**, it is said to be successful.

An **ideal rational agent** takes the appropriate action necessary to optimize and increase its performance measure and reach it based on its previous perceptual experience and its built-in knowledge and code.

An **autonomous agent** has built-in knowledge and also learns or acquires knowledge through its percepts and experience. It uses the two to take appropriate action. These agents are called **intelligent agents.** Real life examples of agents include humans, their sensors being eyes, ears, skin, taste buds, etc i.e. their sense organs through which they perceive their environment. Their effectors include hands, fingers, legs, mouth, etc that enable them to take action. Another example of an agent is a robot, whose sensors are its camera, infrared, bumper, etc and effectors are grippers, wheels, lights, speakers, etc
This paper attempts to study intelligent agents and how they can be used to solve real-world problems and deployed in the field.[7,8]

II. Agent Architecture

An agent[1,2] consists of an Environment[10], that an agent acts on and interacts with[9], Percepts, the set of inputs that the agent has perceived from its environment through Sensors. It comprises of Action, the appropriate output of the system generated on the bases of percept sequence and the program, through Actuators or Effectors . Besides these, there are predefined goals that the agent is required to accomplish. An agent is mainly composed of its architecture and a program that maps input percept sequences to the output actions. An agent architecture is based on sensors and actuators. Agents are built based on three types of architectural paradigms. It could be an integrated part of an end program, with all the rules set. This requires the user to extensively set if-else conditions for the agent to act. The second approach is knowledge- based approach where agent is fed with domain-specific knowledge. In this approach, a lot of domain-specific knowledge is required. The third approach, namely learning approach removes the disadvantages of the previous two. In this approach, the agent learns from examples and cases and adds to its existing knowledge database.

III. Examples of Intelligent Agents

Table 1 gives various real-life examples of Intelligent Agents.

Agent	Percepts	Actions	Goals	Environment
Medical Diagnosis Agent	Patient Symptoms	Prescribing Drugs & Treatments	Restoration of patient helath	Hospital, Clinics
Analysis of satellite images	Image Pixels	Making sense of the scene, classifying it	Categorizing the image	Images from satellite
Robot navigation	Locations, Obstacles	Tracking locations and avoiding obstacles	Navigate the correct path	A house
Interact ive tutor	Typed words, questions	Display answers, study material	Better exam results	Study Material

Table 1. Real Life Examples of Intelligent Agents

IV. Types of Agents

There are various categorizations of an agent. A simple agent is based on simple if-else conditions preprogrammed into them. There is no deduction or reasoning involved, just a static database. Model based agents are slightly better, in that they have a record of past cases encountered, which are used to find solutions to new problems. Learning agents learn and evolve through feedback and have an element of reasoning and Strong AI, helping them find solutions to unexpected problems.

These are the most complex of them all and are capable of making their own decisions leading to an effective and scalable accomplishment of the defined goal.

4.1 Simple Reflex Agents

Simple Reflex Agents act based on current inputs and percepts. They act according to if-else rules, i.e. if a particular input is given, produce the particular output that maps to it.

It would be impossible, except for the most trivial of situations, to find the appropriate action for a given set of percepts because the if-else rules would be too large in number. We can, however, shorten the number by enlisting common condition-action rules in the lookup table.

4.2 Model Based Reflex Agents

Reflex agents also needed to keep a track of all its previous states. Along with knowing about evolution of the world, and of its previous history would give it more current state information. Thus, it would decide on actions better. This was made possible by model based reflex agents, an improvement on simple reflex agents..

4.3. Goal Based Agents

The right action to be taken by the agent not only depends on its current state, but also on the goal it needs to achieve, besides the state of the world. Goal based agents are designed such that they need to be given goal information.

These agents use the knowledge about the world and how it evolve, besides the effect of their actions on the world, their current state, etc. It compares each output to the goal state and chooses the action that leads us to the goal state.

4.4 Utility Based Agents

A utility based agent has a utility function that maps its current state to a number which represents its usefulness. Thus if two decisions conflict, it assigns utility to both and decides which one to go with.

4.5 Learning Agents

The most powerful out of all these agents are learning agents. This is because they "have the capability to learn by their previous actions and solutions to already solved problems. They learn by exploring, discovering and experimenting with the outside environment. This knowledge helps them to solve existing problems. They are thus able to decide appropriate actions. This distinguishes them from the others. A generic learning agents has following four components. **The Performance Element** takes percepts as inputs and decides appropriate actions like all other agents. **The Critic**, uses a defined standard of performance, to assess the agent output. This measure of performance is conveyed to the learning element so it knows how the agent is performing

The Learning Element receives assessment and details about performance from the critic and uses the feedback to learn and feed new information about the world. **The Problem Generator** suggests better alternative actions for more informative experiences that'd help the agent learn (e.g. like carrying out experiments)."

V. Agent Environment

Environments can be deterministic, i.e. complete information could be available about them, based on which we can determine the effect of the agent's actions on it. On the other hand, there are non-deterministic environments, on whose state the effects of agents' actions cannot be determined. There are episodic environments, which can be divided into episodes, differentiated from each other, and non- episodic environments. In real life, as opposed to simulations, environments are non-episodic and non-deterministic. An environment program is used to simulate various kinds of environments during testing of agents.

Agent environments can be accessible, whose complete state can be determined using the agent's sensory apparatus. The "agent would have to maintain an internal state corresponding to its perception of the environment.[11] On the other hand, inaccessible environments can't be determined using an agent's sensors. Deterministic environments facilitate prediction of the next agent state using percepts and current state while non-deterministic environments are complex and we can't predict the next agent state. Discrete environments have a limited number of states. Episodic environments are those where the scenarios witnessed by the agents can be divided into episodes. On the other hand, we have non-episodic environments. Static Environments can't be changed while agents act on them while dynamic environments keep changing, thus the agent has to keep up. Real environments are usually dynamic and non-deterministic.

VI. Intelligent Agents for Machine Translation

6.1 Machine Translation

Agents provide solutions to problems that were hitherto unsolvable or infeasible or too expensive to solve. They add a layer of "intelligence" or automation to existing systems. They also solve problems which have already been solved, optimizing the existing solutions and technology and making them less costly, faster, better and more effective. They provide innovative solutions where no existing technology is available. They make existing technology "smarter", so to speak. Intelligent Agents have made a foray into fields like manufacturing [16], air traffic control, information management, ecommerce[3,14], business process management, health and entertainment.

One of the key applications of intelligent agents is Machine Translation [20]. Machine Translation uses Artificial Intelligence to translate text from one language to another by using **bilingual text corpora.**

A common difficulty encountered in natural language translation is usually the translation is word to word and literal. However, the context is neglected and this leads to subtle differences in meaning. Intelligent Agents can translate the text literally, word by word, as well as autonomously take the entire sentence and text into account, in order to prevent a change in meaning. They can dynamically monitor the translation to ensure the underlying implication of both texts remain the same.

Learning agents can be used which have a learning element that learns from available text corpora of concerned languages. Relevant body of text is curated by experts of the language to train the agents. With training and examples, the agent can learn the context and meaning of complete sentences as well as the entire text as a whole. We can train intelligent agents to translate for a particular language, say German, at the outset. These agents are trained for the concerned language and English and facilitate two-way translation between English and that particular language.

Intelligent Translation between the languages would entail literal translation and comparing the underlying context and meaning. The difference in the meaning of the original text and translated text can be quantified as a function of sum of differences of individual functions. This difference cannot be beyond a predefined threshold for accurate translation. A metric can be used to determine the accuracy of the translation.

6.2 How Artificial Intelligent Works

We take the example of a sample correspondence text in German given below.

Sehr geehrte Herr RRR,vielen Dank für das interessante und konstruktive Gespräch in Ihrem Hause und Ihr Interesse an unserem Unternehmen und MMM-Financials. Wunschgemäß haben wir Ihnen ein Angebot für eine gemeinsame Projektrealisierung zusammengestellt. Die Details entnehmen Sie bitte den folgenden Seiten bzw. den Anlagen. Für Fragen oder ein weiteres persönliches Beratungsgespräch steht Ihnen Herr CCC gerne zur Verfügung.

Mit freundlichen Grüßen

The above text is translated to the English text below.

Dear Mr. RRR,

Thank you very much for the interesting and constructive discussion in your office. We appreciate your interest in our firm and MMM Financials. We are pleased to submit the requested proposal to assist you in accomplishing your project, as detailed in the following pages and attachments. Please do not hesitate to contact Mr. CCC for any questions you may have.

Sincerely
In the sample text, each line in English corresponds to a line in German. To learn from this text, the agent needs to find word-to-word correspondence between English and German, i.e. for each word in German, it could map a corresponding word in English. The agent can map each word with its frequency to find word to word correspondence. Say, the word “and” appears the highest number of times as compared to other words. In the corresponding German text, “und” appears at the highest frequency. Thus, there is a high probability that “and” in English is “und” in German as both appear at the same frequency. Thus, the word “and” corresponds to “und”. We work with probabilities based on corresponding frequencies here. We are not 100% sure but the correspondence doesn't have to be 100% to indicate the probability of a correlation. In Machine Translation, this type of alignment can be used to create probability tables, hence the term Statistical Machine Translation. Thus, the probability of a phrase in one language corresponds to the probability of another phrase in another language. This way, the agent can be trained to correlate meanings in terms of words, phrases, sentences and the text as a whole, of languages, and thereby derive the context and underlying meaning of the text. It can then compare original and translated texts for more precise translations.

6.3 Limitations

Text corpora for the concerned language is not readily available. If it is available, the results can be impressive. However, this is rarely the case. Relative sizes of corpora for different languages, in this case English and German, differ. This causes difficulties in precise translation. On a large scale, corpora can be extracted from the web. On a small scale, humans could train the agent with examples.

VII. Conclusion

Intelligent Agents are making a revolutionary difference in myriad fields. They act on behalf of humans, make tasks easier, autonomously make decisions and take appropriate actions towards fulfillment of a goal. Automated Translations is one such field into which intelligent agents could foray. They can transform translations from passive and literal to intelligent, dynamic and more accurate. The resultant, translated text is more human-like and context-appropriate and hence, more comprehensible by users.

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