

Artificial Intelligence Today

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1 Introduction

Artificial Intelligence(AI) is a vast field with immeasurable value due to practical and intellectual reasons. Several different scientific disciplines like Philosophy, Mathematics, Economics, Neuroscience, Psychology, Computer Science, Linguistics and Cybernetics contribute to it [7]. AI is roughly divided into the fields of reasoning, knowledge, planning, learning, natural language processing (communication), perception and the ability to move and manipulate objects [7].

Lately, Natural Language Processing received a fair amount of attention from mainstream media due to its applications in today's mobile devices. Almost all of the latest smartphones and tablets are equipped with systems to recognize, translate and output spoken data.

This article focuses on the current status of *Natural Language Processing*, concentrating in particular on the sub-fields *Speech Recognition* and *Machine Translation*.

1.1 Overview

In section one we will introduce some terms and describe them briefly. Section two is about the current status of speech recognition. The focus of section three lies on the actual translation process and its difficulties. Afterwards in section four we will give a short summary and provide some thoughts about the future of AI.

2 Disambiguation

Natural Language Processing: Enable a computer to communicate in human language.

AI-Completeness: Is a classification of problems in the AI field. An AI-Complete problem is as hard as the central problem of AI which is the modeling of human(like) intelligence.

Or, in other words, an AI-Complete problem is as hard as the Turing Test [5].

3 Speech Recognition

3.1 Description and Status

Speech Recognition(SR) is a field of Natural Language Processing and has been studied since the 1950s. The main goal is to teach computers how to translate recorded sound into a textual document. This sounds easy at first but turns out to be hard in an uncontrolled real world environment.

Today we are able to recognize speech in a controlled environment with limited vocabulary and fixed grammar such as credit-card numbers with an accuracy of almost 100%.

If we give up the constraints on vocabulary and grammar we end up with a AI-Complete problem [6].

3.2 Challenges and Limitations

One of the problems is owed to the fact that *word boundaries* are not easily detectable in continuous speech. This broadens search space due to the additional ambiguity.

The search space or *vocabulary* is in fact one of biggest problems and its size is directly related to the quality of a SR system.

The fact that words often sound similar and the distinction is not possible only based on the acoustic input, some kind of *semantic analysis* is needed to determine the appropriate word in the given context. A proper SR system should also be able to judge if a sentence is grammatically correct and to rule out nonsensical combination of words. The amount of context knowledge required to achieve this task is immense and makes real time computation almost impossible.

Several other factors need to be taken into account to build a SR system like *environmental noise, speaker dependence or independence, poor articulation and pronunciation*.

4 Machine Translation

4.1 Description and Status

Machine Translation(MT) is the computerized translation of a source document in a given language into a target document in some other defined language while preserving the semantics of the given text. MT is solely computer-driven and shall not be confused with computer aided translation where humans are involved.

Today's most successful systems are based on statistical methods and machine learning. That means that there is no hardwiring of rules for different languages but a learning algorithm which is trained with a large amount of bilingual text material [1].

4.2 Challenges and Limitations

MT is as SR an AI-Complete problem [6]. The overall challenge is once more the ambiguity of language.

Arnold(2003) [2] used four categories to classify those challenges.

Form under-determines content

A sentence can only be fully understood with a context given.

Content under-determines form

There is more than one way to express something.

Languages differ

Simple translation of a sentence does not always preserve meaning.

Description Problem

Is not a problem of speech itself but of computers, which need to be capable to gather and store the knowledge needed to translate.

The main challenges for the current statistical approaches are *training and data-representation* and *decision making* [1]. These two points can be easily translated into Arnold's four point scheme. It is evident that training and data-representation is directly related to Arnold's description problem. Decision making is not that obvious but if you look closer you will see that the first three points of Arnold's categories boil down to making the right decision based on more or less structured data.

5 Conclusion

In science fiction a device capable of translating speech in real time is reality since the book "First Contact"¹. In real life we reach acceptable results in controlled and constrained environments. Moore's law helped to build more sophisticated systems and cope with the immense computing power needed to do so.

Nevertheless are both of the problems considered AI-Complete. This means, that to build a perfect translation system we have to be able to build human-like intelligence. This fact alone should give us a clue about the long road ahead of us.

References

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¹Novelette by Murray Leinster published in November 1945

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