The Summers and Winters of Artificial Intelligence

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INTRODUCTION

Humanity has toyed with the idea of building intelligent machines from antiquity. The ancient Egyptians, Greeks, and the Chinese are reported to have built mechanical devices that imitated human intelligence, although primitively. In the 16th century, it was Hobbes who stated that thinking was symbolic reasoning like working out an answer with pen and paper. This idea of thinking as symbolic reasoning was further developed by Descartes, Pascal, Spinoza, and Leibniz (Poole & Mackworth, 2010). The English mathematician Charles Babbage, who designed the Analytical Engine in 1837, is considered to be the inventor of the modern computers. Although the Analytical Engine was not built until 1991, it served as a prototype of the modern general-purpose computer. The first link to machines and intelligence is found in the 1950 paper published by Alan Turing, "Computing Machinery and Intelligence" (Turing, 1950). The "Turing test" proposed in this paper, is a simple pragmatic approach assuming that a computer that is indistinguishable from an intelligent human actually shows that machines can think. Its relevance to this day seems to indicate that it will be a goal for the AI field for many years to come (McGuire, 2006).

The term "Artificial Intelligence" was coined by John McCarthy in a conference organized in 1956 in Dartmouth (McCarthy, 1955). He defines *intelligence* as the computational part of the ability to achieve goals in the world and *Artificial Intelligence* (AI) as the science and engineering of making intelligent machines, especially intelligent computer programs (McCarthy, 2001).

AI has had a tumultuous history (McCorduck, 1979; Crevier, 1993). The early theorem proving and checkers playing programs astonished the public with their seemingly intelligent performance. The expert systems, too, drew great admiration from the general public as well as the specialists, since their competence and performance in consultation was in par with human experts. This chapter introduces DENDRAL and MYCIN, two of the most successful expert systems developed in the childhood of AI.

However, the hype and expectations raised by these early systems led to the downfall of AI in the ensuing years. Perceptrons, for example, were just picking up as promising machine learning mechanisms when they were nipped in the bud by other AI researchers owing to a premature evaluation. Their apparent inability in evaluating the XOR and the NXOR functions was later rectified by the introduction of an additional middle layer of neurons. However, this came much later, and enough harm had already been done to the Artificial Neural Network research.

The ALPAC report in 1966 and the Lighthill report in 1973 were responsible for the onset of an all-time low-fund and low-activity period, called the AI winter. The two fatal reports not only led to the cutting of funds, but a general distrust in AI research. The recent victories of AI programs over human champions in chess and in Jeopardy have restored faith in AI discipline. AI has run its course through summers and long winters. True, we are far from an overall theory or framework, explaining what thinking is and how to build intelligent machines (Lungarella, 2007). Nevertheless, AI has made great strides and, after overcoming

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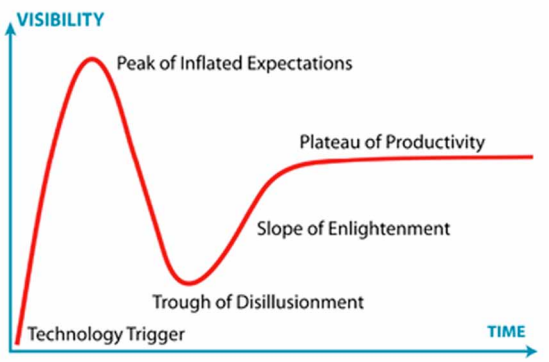
Figure 1. The AI hype curve



the *trough of disillusionment* is marching on the *plateau of productivity*.

BACKGROUND

As it happens to any new technology, the history of AI, too, ran through a hype curve (Menzies, 2003). The early AI programs like the ones elegantly proving theorems and skillfully playing board games aroused great interest and expectations. This was followed by the successful application of Expert Systems in business and academia. This early period in the development of AI is referred to as the "peak of inflated expectations" shown in the AI hype curve (Figure 1).

However, for the next ten years AI did not live up to its expectations. Not getting any substantial returns, the AI investors and stakeholders appointed special committees to inquire in the progress of AI. This period called the "trough of disillusionment" proved fatal to the development of AI. The summers and the winters experienced in the history of AI are tersely expressed in the words of Tim Menzies (Menzies, 2003):

In the 21st century, AI has many reasons to be proud, but it wasn't always this way. New technologies such as AI typically follow the hype curve. By the mid-1980s, early successes with expert systems caused skyrocketing attendance at AI conferences and a huge boom in North American AI startups. Just like the dot-coms in the late 1990s, this AI boom was characterized by unrealistic expectations. When the boom went bust, the field fell into a trough of disillusionment that Americans call the AI Winter. A similar disillusionment had already struck earlier, elsewhere.

The funds were heavily cut and AI research almost came to a grinding halt. Despite the setbacks, some AI researchers persisted with their research in a few selected areas, refraining from calling their work "AI". Their approach finally led to the "slope of enlightenment" bringing AI out of the harsh winters. In the 1990s AI research began to flower again culminating in the victory of IBM's Deep Blue over the reigning chess world champion. Yet another milestone heralding the "plateau of productivity" was IBM's Watson's victory over the Jeopardy world champions in the year 2011.

THE HEY DAYS OF EXPERT SYSTEMS

An Expert System is a program designed to solve problems at a level comparable to that of a human expert in a given domain (Cooper, 1989). Also known as Knowledge-based system, an Expert System relies on the expert human knowledge captured in a computer program to solve problems that ordinarily require human expertise. It