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Impact of Increased Computing Power through Artificial Intelligence

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Abstract: ***Computers and computer science have been made remarkable contributions to medical, commerce and engineering practice, but have also left the trials of unfulfilled promises. One of the most difficult tasks in engineering is to access which of the half-backed ideas of the computer scientist might be promising for industrial use. In recent years, various manifestations of artificial intelligence have been touted as providing revolutionary capabilities in several of domains viz. Communications, time management, health & safety, education, games, manufacturing, marketing, opportunistic planning, medical science and many more. Because these contributing fields have experienced tremendous growth in the last few years, AI research has strengthened and expanded. Because AI research is maturing, the resulting technologies promise to revolutionary's daily human life by making people's surroundings flexible and adaptive.***

Keywords: Artificial Intelligence, Computer Science, Revolution

1. Introduction

Computer science is a relatively new branch of science and as such it has gone through rapid and yet important transformations during the first decades of its existence. Those transformations have produced a very interesting mix of available experiences, and expectations which are making possible the creation and deployment of technology to ultimately improve the way our environments help us. This technical possibility is being explored in an area called Artificial Intelligence.

1.1 Emergence of AI

Artificial intelligence (AI) is a term that in its broadest sense would indicate the ability of a machine or artifact to perform the same kind of functions that characterized human thought. The term AI has also been applied to computer systems and programs capable of performing tasks more complex than straightforward programming, although still far from the realm of actual thought. According to Barr and Feigenbaum [1] AI is the part of computer science concerned with the design of intelligent computer systems, i.e. systems that exhibit the characteristics associated with intelligence in human behavior—understanding, language, learning, reasoning, solving problems and so on [2,3]. Several intelligent computing technologies are becoming useful as alternate approaches to conventional techniques or as components of integrated systems [4].

AI consists of several branches, namely, expert systems (ESs), artificial neural networks (ANNs), genetic algorithms (GAs), fuzzy logic (FL), problem solving and planning (PSP), non monotonic reasoning (NMR), logic programming (LP), natural language processing (NLP), computer vision (CV), robotics, learning, planning [5] and various Hybrid systems (HS). In the early 1950s Herbert Simon, Allen Newell and Cliff Shaw conducted experiments in writing programs to imitate human thought processes [5]. The experiments resulted in a program called Logic Theorist, which consisted of rules of already proved axioms. When a new logical expression was given to it, it would search through all possible operations to discover a proof of the new expression, using heuristics. This was a major step in the development of AI. The Logic Theorist was capable of solving quickly 38 out of 52 problems.

1.2 Expert Systems

ES's perform reasoning using previously established rules for well-defined and narrow domains. The terms ES and knowledge-based expert system (KBES) can therefore be used interchangeably. The KBES is the first realization of research in the field of AI, in the form of software. For developers of application software, particularly in medical and engineering disciplines, it was a benefit, as it addressed the decision-making process with the use of symbols rather than numbers. Tasks belonging to the classification and diagnosis category were the first to benefit from the emergence of KBES technology. Though AI researchers were carrying out symbolic processing much earlier, the results of such research could be taken from lab to field only when KBES was introduced as a software tool for addressing a class of problems that require simulation of the knowledge-based decision-making process.

ESs has been built to solve a range of problems in domains such as medicine, mathematics, engineering, chemistry, geography, computer science, business, law, defense and education.

- Interpretation: forming high-level conclusions or deception from collections of raw data.
- Prediction: projection probable consequences of given situations.
- Diagnosis: determining the cause of malfunctions in

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complex situations based on observable symptoms.
- Design: finding a configuration of system components that meet performance goals while satisfying a set design constraints.
- Planning: devising a sequence of actions that will achieve a set goal giving certain starting conditions and run-time constraints.
- Monitoring: comparing a system's observed behavior to its expected behavior.
- Debugging and repair-prescribing and implementing remedies for malfunctions.
- Instruction detecting and correcting deficiencies in students understanding of a subject domain.
- Control: governing the behavior of a complex environment.

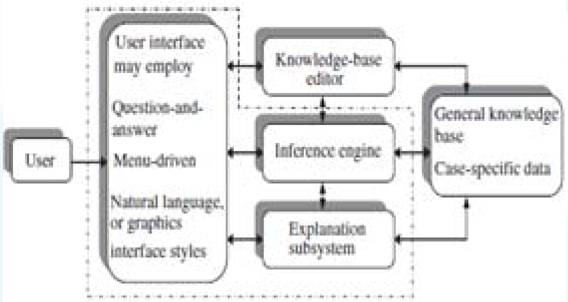

Figure 1: Architecture of KBES with its component and the way the components interact with each other [5]

2. Literature Review

2.1 Industrial Applications of AI

The types of problems which AI attempts to solve are non-linear and combinatorial complex (e.g. planning/scheduling, image understanding, etc.). The impact of their being non-linear is that there exist no algorithms which will provide optimal solutions in polynomial time. Hence, the use of symbolic, heuristic knowledge, or "rules of thumb", plays a major role in al systems. AI research can be divided into two basic categories. Knowledge representation is concerned with how to represent knowledge in a computer understandable form, so that systems can act in an intelligent manner. Consider a description of an activity that occurs on a factory floor [6].

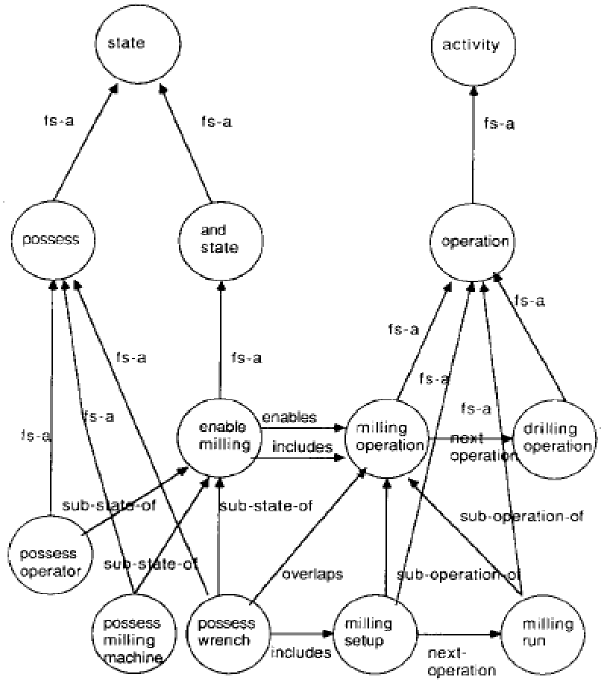

Figure 2: Activity Schematic Network [6]

2.2 Power System Applications of AI [7]

- Distribution Automation System: is defined as a system that enables an electric utility to remotely monitor, coordinate and operate distribution components in a real-time mode from remote locations. More than 125 individual distribution functions have been identified. The three basic capabilities are: monitoring, control and protection. These functions can benefit by the application of the expert's knowledge.
- High Voltage Direct Current Transmission Systems: In the author, demonstrated the feasibility of using expert systems for HVDC systems for protection purpose. Practical results are still awaited.
- Environmental Considerations: Environmental considerations are becoming important for power plants. Environmental engineering considerations involve multi-disciplinary knowledge of chemistry, biology, fluid mechanics, mathematics, statistics, economics and law. Individual engineers are not always well versed in these areas. Expert systems can serve as valuable support tool to supply solution-directed knowledge in unfamiliar objects. Moreover this subject is dependent upon empiricism.

2.3 Application of Hybrid Artificial Intelligence in Waste Water Treatment

An automatic control system for the operation of the wastewater treatment is processed, by applying hybrid artificial intelligence (AI) techniques in real-time control. The main goal of a wastewater treatment plant (WWTP) is to reduce the level of pollution of the wastewater; that is, to remove, within certain limits, strange pollutants in the inflow water prior to discharge to the environment. Most WWTP designs, based on the crisis condition, waste resources and energy, and also reduce the cost effectiveness of reaching

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permissible effluent levels. The application of AI techniques in wastewater treatment provides an alternative way to operate the complex treatment process, to reduce the energy consumption in the operation, and to improve the efficiency of the treatment equipment.

Krovvidy and Wee (1992) developed an intelligent hybrid system, combining inductive learning, artificial neural network approaches and case-based reasoning for a wastewater treatment plant. Boger (1992) has pointed out the use of fuzzy logical statistical process control for formulating expert rules from historical plant operating data. However, artificial neural net- works (ANN), which can learn from example, are believed to be a better solution for this task, and for the many additional problems encountered in the operation of the WWTP.

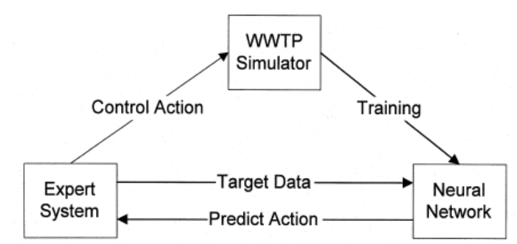

Figure 3: A hybrid AI system applied to the control of a WWT plant [8]

The hybrid AI system combines expert systems and neural networks. The model of the hybrid AI system in control of the simulated WWTP is shown in Fig. 3. The training data needed for the neural network was created from the simulation system, which was controlled by the expert system. Therefore, the neural net- work was learning the control pattern from the expert system. The expert system generates a target value for the biochemical oxygen demand (BOD) in the aeration tank, and then sends that value to the neural network to generate the sludge recycle rate. If the sludge recycle rate cannot release the critical condition such as when the concentration of the BOD is high in the aeration tank, then the expert system will generate another tar- get value for the BOD and perform the control again, until the critical condition in the treatment process is released.

3. Methodology

3.1 Process Flow in Industrial Production

First, starting with a single order, it generates alternative first operations. Then, for each operation, it generates alternative machines on which to perform that operation, and for each machine it generates alternative queue positions, that is, times to perform that operation. There may be other alternatives such as alternative shifts and substitute tooling and fixtures, which expand the tree into a larger network. Once the first operation is fully defined, the search proceeds with the next operation that follows it. Search can be performed in a forward manner or in a backward manner, starting from the due date.

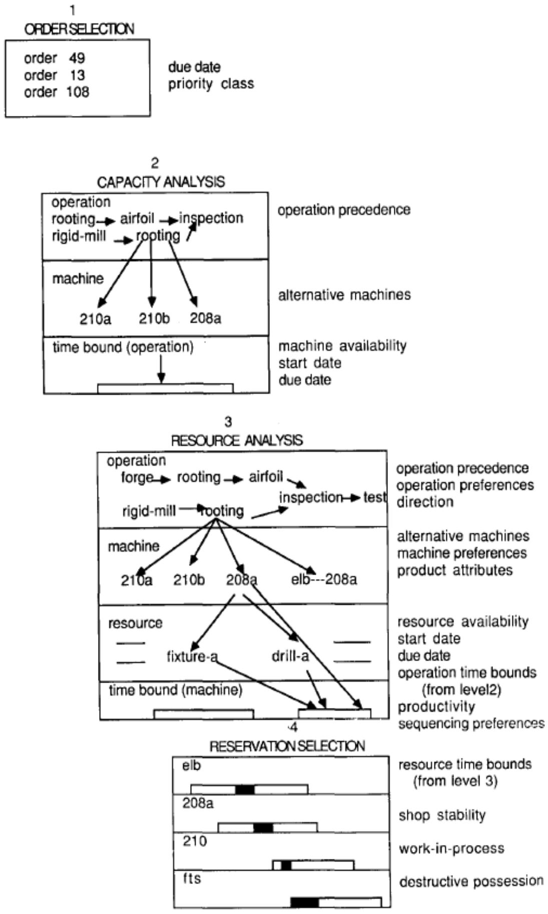

Figure 4: Search Hierarchy [6]

3.2 Importance of Fuzzy Neural Network in AI

Neural networks can be modified to incorporate fuzzy techniques and produce a neural network with improved performance. One approach is to allow the fuzzy neural network to receive and process fuzzy input. Another option is to add layers on the front end of the network to fuzzify crisp input data to the fuzzy neural processing [4]. The fuzzy neuron is a fundamental concept used in many approaches to integrate fuzzy and neural technologies. In networks that map fuzzy input to crisp output, nodes in every layer of the network can have modified neurons. The input vector consists of a set of fuzzy values and the weights connecting the node with nodes in the previous layer also have fuzzy values. Input values and the weights are each represented by membership functions. A modified summation process is used to find the product of the membership functions of the fuzzy inputs and weights and then add the resulting membership functions to obtain another one that represents the integration of weighted fuzzy inputs to the node.

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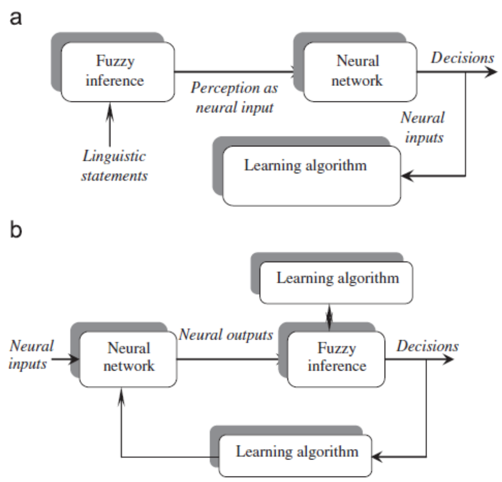

Figure 5: (a) The first model of fuzzy neural system (b) The second model of fuzzy neural system [4]

3.3 Design of Waste Water Treatment Plant

The equipment in the WWTP can be classified by the process into four units: preliminary, primary, secondary, and sludge treatment units. As shown in Figs 6 and 7 the screen, the grit chamber, and the equalization tank are in the preliminary unit. The main purpose of this unit is to remove the coarse solids and grit that can damage other equipment, and to equalize the inflow rates of the waste water. The equalization tank is used to equalize the inflow strength of the wastewater. This simulation system considers only the suspended solids and the dissolved components in the wastewater; therefore, the necessary equipment in the preliminary unit is the equalization tank.

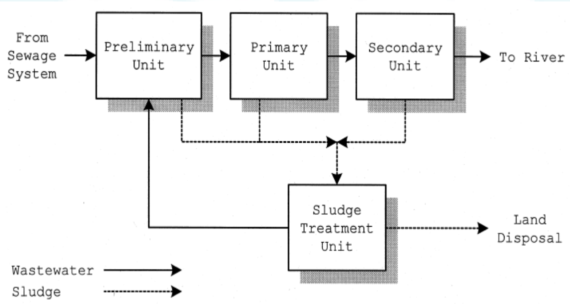

Figure 6: The four units involved in WWTP: preliminary, primary, secondary, and sludge treatment units [8]

The major component in the primary unit is the primary clarifier, which is used to sediment the suspended solids that are heavier than water and are settle able within 30 min. To remove the suspended solids in the primary unit, a sediment tank to settle the suspended solids, and a pump to remove sludge from the basin, are needed. The secondary unit combines the aeration tanks with the final clarifiers and sludge recycle unit. The aeration tank is used to reduce the dissolved BOD. Microorganisms are used to digest the organic matter in the wastewater. When the micro organisms digest the organic matter, they need oxygen; otherwise, they will become anaerobic and emit a foul odor into the air. The aeration tank needs an air pump to introduce air. The mixed microorganisms and suspended solids in the wastewater can settle in the secondary clarifier since they become large particles during aeration in the aeration tank. The sludge recycle unit controls the recycling sludge in order to maintain the concentration of the microorganisms in the aeration tank.

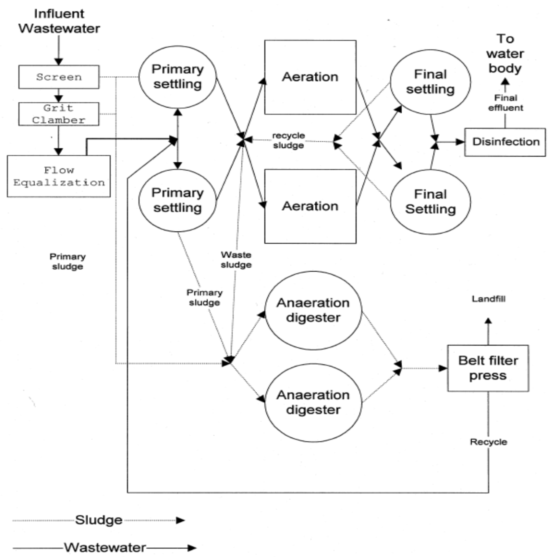

Figure 7: Process flow diagram for designed waste water treatment plant [8]

4. Result & Discussion

The results of a recent survey show the extent to which AI is being applied to manufacturing problems. The survey shows that in the 60s and70s there was very little work being done (Fig. 8).But in the 1980s there are at least 68 systems in research, 38 in development, 9 in field test and 14in production use. With a response of about 125systems this represents about a quarter of the number of real systems being investigated today. There are closer to 500 systems that are under construction around the world today using Artificial Intelligence techniques. The survey demonstrates that a number of people believe that AI will have an impact. The question is: where? In the following, I review the areas of impact by examining each phase of manufacturing.

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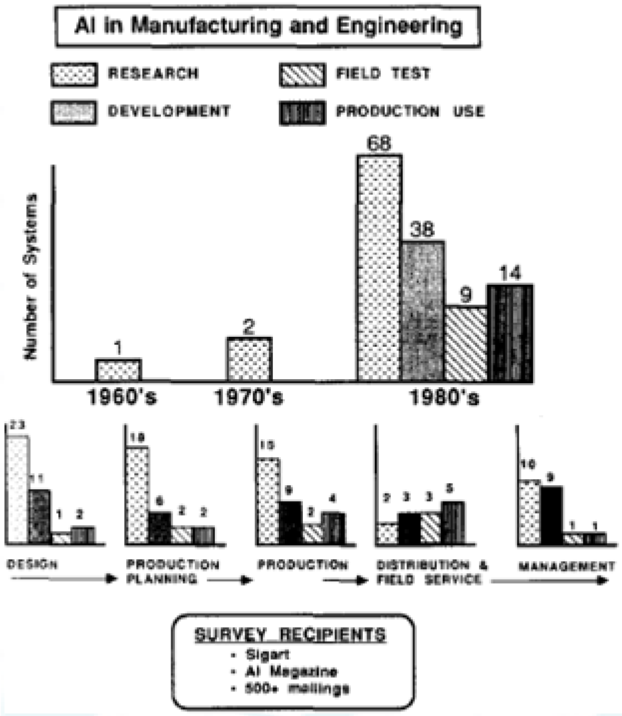

Figure 8: AI in Manufacturing Survey [6]

The aeration tank is designed to digest the substrata (nutrient) contained in wastewater into insert mass. It shows the inputs and outputs of the neural network for simulation of the aeration tank. The inputs of the neural network use the previous condition of the aeration, and the past and current values of the inflow wastewater and recycle, to predict the current condition of the aeration tank. The conditions of the aeration tank, obtained from sensors are BOD, MLSS, and flow rate. The conditions of the inflow are measured as BOD, SS, and flow rate. There cycle categorized by recycle rate, MLSS, BOD, and flow rate. The whole system uses the flow, BOD, and SS sensors for getting input data from the WWTP.

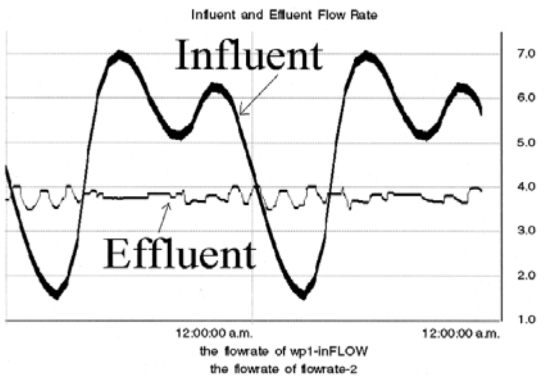

Figure 9: The influent flow rate (bold) and effluence flow rate of the simulation wastewater in the WWTP [8]

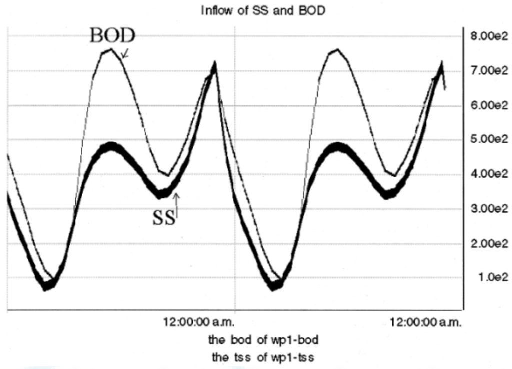

Figure 10: The simulation value of the concentration of the SS (bold) and the BOD inflow to the WWTP [8]

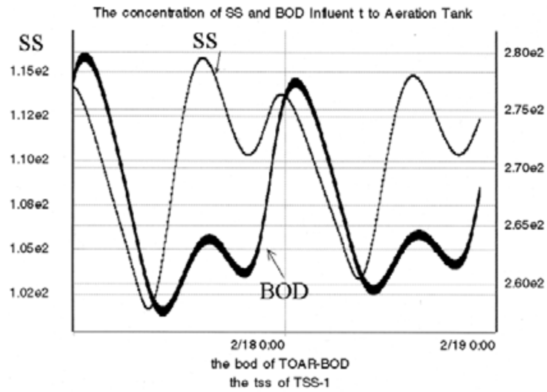

Figure 11: The concentration of the BOD (bold) and the SS flow to the aeration tank without the sludge recycle [8]

5. Conclusion

In conclusion, there exist a number of applications of AI in manufacturing, photovoltaic systems & waste water treatments today. They are beginning to impact manufacturing both on the shop floor and in engineering design. Also one can see that AI techniques have been applied in a wide range of fields for modeling, prediction, simulation, optimization and control in PV systems. Moreover an improved wastewater treatment system should apply AI techniques to the design or redesign of waste-water treatment plants, and add automatic diagnosis of the influent wastewater to adjust their operation. The number of systems will continue to increase at an even larger rate as corporations acquire more AI expertise and feel more comfortable about its application. More systems which capture scarce expertise and make it available throughout the organization will be created. Systems that enhance our problem solving by making better decisions more quickly will be created. Systems that integrate more knowledge about the factory floor and, hence, make better decisions will be created. There will be increased accessibility to these systems by people who are not computer-oriented through the use of natural language and explanation facilities.

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Author Profile

M R Bhatt received the B.Sc. and M.Sc. degrees in Computer Science & Information and Communication Technology respectively from Veer Narmad South Gujarat University. During this period, she underwent many projects of networking, data mining & data warehousing and AI along with many other subjects at PG level. She has been associated with academics since after studies and having more than three years of experience in teaching various subjects of computer science & engineering.

R J Bhatt received B.E. & M. Tech. degrees in Mechanical engineering. He is having wide knowledge of artificial intelligence & expert systems along with the robotics. He has been served for more than two years in academics & later on started his Ph.D. from SVNIT, Surat. He is also qualified ASNT NDT Level II.