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| Assignment answers for AI course |
| Submitted By: Habtamu Worku |
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| ID: ENG/R/164/2000 |
| Submitted to: Ato Alemu |
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**Assignment #1**

1. ***Read and list out the contribution of various disciplines to the foundation of Artificial Intelligence (AI) to exist as a science?***

**The Disciplines of Artificial Intelligence**

The subject of artificial intelligence spans a wide horizon. It deals with the various kinds of knowledge representation schemes, different techniques of intelligent search, various methods for resolving uncertainty of data and knowledge, different schemes for automated machine learning and many others.

**Philosophy:** logic, methods of reasoning mind as physical system foundation of learning

**Psychology:** adaption phenomena of perception and experimental techniques (psychophysics).

**Mathematics:** formal representation and proof algorithms computation, decidability, tractability, probability

**Linguistics:** knowledge representation grammars

**Control theory:** homeostatic systems, stability simple optimal agent designs

**Computer engineering:** provided the artifact that makes AI applications possible. AI programs tend to be large, and they could not work without the great advances in speed and memory that the computer industry has provided.

**Mechanical Engineering:** this field of engineering produce the mechanical part of any robotic and AI system.

1. ***What are the potted histories of AI? Read more about the technological evolution related to AI (state of the art)***

***Ancient history of AI***

Greek myths of [Hephaestus](http://homepage.mac.com/cparada/GML/Hephaestus.html), the blacksmith who manufactured mechanical servants and the bronze man [Talos](http://homepage.mac.com/cparada/GML/Hephaestus.html) incorporate the idea of intelligent robots. Many other myths in antiquity involve human-like artifacts. Many mechanical toys and models were actually constructed, e.g., by Archytas of Tarentum,Hero, Daedalus and other real persons.

***Modern history of AI***

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| 1956 | John McCarthy coined the term "artificial intelligence" as the topic of the [Dartmouth Conference](http://www-formal.Stanford.EDU/jmc/history/dartmouth.html), the first conference devoted to the subject. Demonstration of the first running AI program, the Logic Theorist (LT) written by Allen Newell, J.C. Shaw and Herbert Simon (Carnegie Institute of Technology, now Carnegie Mellon University). See Over the holidays 50 years ago, two scientists hatched artificial intelligence. |
| 1957 | The General Problem Solver (GPS) demonstrated by Newell, Shaw & Simon. |
| 1952-62 | Arthur Samuel (IBM) wrote the first game-playing program, for checkers, to achieve sufficient skill to challenge a world champion. Samuel's machine learning programs were responsible for the high performance of the checkers player. |
| 1958 | John McCarthy (MIT) invented the Lisp language. Herb Gelernter & Nathan Rochester (IBM) described a theorem prover in geometry that exploits a semantic model of the domain in the form of diagrams of "typical" cases. Teddington Conference on the Mechanization of Thought Processes was held in the UK and among the papers presented were John McCarthy's Programs with Common Sense, “Oliver Selfridge's "Pandemonium," and Marvin Minsky's "Some Methods of Heuristic Programming and Artificial Intelligence." |
| Late 50's & Early 60's | Margaret Masterman & colleagues at Cambridge design semantic nets for machine translation. See Themes in the work of Margaret Masterman by Yorick Wilks (1988). |
| 1962 | First industrial robot company, Unimation, founded. |
| 1969 | SRI robot, Shakey, demonstrated combining locomotion, perception and problem solving. Roger Schank (Stanford) defined conceptual dependency model for natural language understanding. Later developed (in PhD dissertations at Yale) for use in story understanding by Robert Wilensky and Wendy Lehnert, and for use in understanding memory by Janet Kolodner. First International Joint Conference on Artificial Intelligence (IJCAI) held in Washington, D.C. |
| 1972 | Prolog developed by Alain Colmerauer. |
| 1980's | Lisp Machines developed and marketed. First expert system shells and commercial applications. |
| Mid 80's | Neural Networks become widely used with the Backpropagation algorithm (first described by Werbos in 1974). |
| 1987 | Marvin Minsky publishes *The Society of Mind*, a theoretical description of the mind as a collection of cooperating agents. |
| 2000's | Interactive robot pets (a.k.a. "smart toys") become commercially available, realizing the vision of the 18th cen. novelty toy makers. Cynthia Breazeal at MIT publishes her dissertation on Sociable Machines, describing KISMET, a robot with a face that expresses emotions. Stanford's autonomous vehicle, Stanley, wins DARPA Grand Challenge race. (October 2005). (See In a Grueling Desert Race, a Winner, but Not a Driver. The Nomad robot explores remote regions of Antarctica looking for meteorite samples. |
| *Today* | See *AI in the News* for history *in the making*! |

1. ***Read about the following topics and write a note about.***
   1. ***Computer Vision***
   2. ***Robotics***
   3. ***Expert Systems (knowledge based systems)***
   4. ***Natural Language Processing***
   5. ***Knowledge representation (knowledge management)***
   6. ***Machine Learning***
   7. ***Neural Networks***

**Computer vision**

Computer vision is concerned with modeling and replicating human vision using computer software and hardware. It combines knowledge in computer science, electrical engineering, mathematics, physiology, biology, and cognitive science. It needs knowledge from all these fields in order to understand and simulate the operation of the human vision system.

Computer vision (image understanding) is a discipline that studies how to reconstruct, interpret and understand a 3D scene from its 2D images in terms of the properties of the structures present in the scene.

**Robotics**

Robotics is the study of robots. Robots are machines that can be used to do jobs. Some robots can do work by themselves. Other robots must always have a person telling them what to do.

Robot- "A reprogrammable, multifunctional manipulator designed to move material, parts, tools, or specialized devices through various programmed motions for the performance of a variety of tasks"

Robot Institute of America, 1979

Obviously, this was a committee-written definition. It's rather dry and uninspiring. Better ones for 'robotics' might include:

Force through intelligence.

Where AI meet the real world.

Generally, Robotics is the science and technology of robots, their design, manufacture, and application.[1] Robotics requires a working knowledge of electronics, mechanics and software, and is usually accompanied by a large working knowledge of many subjects.[2] A person working in the field is a roboticist.

**Expert Systems (knowledge based systems)**

[Artificial intelligence](http://www.businessdictionary.com/definition/artificial-intelligence.html) based system that converts the [knowledge](http://www.businessdictionary.com/definition/knowledge.html) of an expert in a specific subject into a [software](http://www.businessdictionary.com/definition/software.html) [code](http://www.businessdictionary.com/definition/code.html). This code can be merged with other such [codes](http://www.businessdictionary.com/definition/codes.html) (based on the knowledge of other [experts](http://www.businessdictionary.com/definition/expert.html)) and used for answering questions ([queries](http://www.businessdictionary.com/definition/query.html)) submitted through a [computer](http://www.businessdictionary.com/definition/computer.html). Expert [systems](http://www.businessdictionary.com/definition/system.html) typically consist of three [parts](http://www.businessdictionary.com/definition/part.html):

(1) a [knowledge base](http://www.businessdictionary.com/definition/knowledge-base.html) which contains the [information](http://www.businessdictionary.com/definition/information.html) acquired by interviewing experts, and [logic](http://www.businessdictionary.com/definition/logic.html) [rules](http://www.businessdictionary.com/definition/rule.html) that [govern](http://www.businessdictionary.com/definition/govern.html) how that information is applied;

(2) An [Inference](http://www.businessdictionary.com/definition/inference.html) [engine](http://www.businessdictionary.com/definition/engine.html) that interprets the submitted [problem](http://www.businessdictionary.com/definition/problem.html) against the rules and logic of information stored in the knowledge base; and

(3) Interface that allows the [user](http://www.businessdictionary.com/definition/user.html) to express the problem in a human language such as English. Despite its earlier [high](http://www.businessdictionary.com/definition/high.html) hopes, expert systems [technology](http://www.businessdictionary.com/definition/technology.html) has found application only in areas where information can be reduced to a set of computational rules, such as [insurance](http://www.businessdictionary.com/definition/insurance.html) underwriting or some aspects of securities trading. Also called rule based system.

**Natural Language Processing**

Language understanding is a complex problem because it requires programming to extract meaning from sequences of words and sentences. At the lexical level, the program uses words, prefixes, suffixes, and other morphological forms and inflections. At the syntactic level, it uses a grammar to parse a sentence.

Semantic interpretation (i.e., deriving meaning from a group of words) depends on domain knowledge to assess what an utterance means. For example, “Let’s meet by the bank to get a few bucks” means one thing to bank robbers and another to weekend hunters. Finally, to interpret the pragmatic significance of a conversation, the computer needs a detailed understanding of the goals of the participants in the conversation and the context of the conversation.

**Knowledge Representation**

What AI researchers call “knowledge” appears as data at the level of programming. Data becomes knowledge when a computer program represents and uses the meaning of some data. Many knowledge-based programs are written in the LISP programming language, which is designed to manipulate data as symbols.

Knowledge may be declarative or procedural. Declarative knowledge is represented as a static collection of facts with a set of procedures for manipulating the facts. Procedural knowledge is described by executable code that performs some action. Procedural knowledge refers to “how-to” do something. Usually, there is a need for both kinds of knowledge representation to capture and represent knowledge in a particular domain.

**Machine learning**

The advent of highly parallel computers in the late 1980s enabled machine learning through neural networks and connectionist systems, which simulate the structure operation of the brain. Parallel computers can operate together on the task with each computer doing only part of the task. Such systems use a network of interconnected processing elements called “units.” Each unit corresponds to a neuron in the human brain and can be in an “on” or “off” state. In such a network, the input to one unit is the output of another unit. Such networks of units can be programmed to represent short-term and long-term working memory and also to represent and perform logical operations (e.g., comparisons between numbers and between words).

A simple model of a learning system consists of four components:

* The physical environment where the learning system operates
* The learning element
* The knowledge base and
* The performance element.

The environment supplies some information to the learning element, the learning element uses this information to make improvements in an explicit knowledge base, and the performance element uses the knowledge base to perform its task (e.g., play chess, prove a theorem). The learning element is a mechanism that attempts to discover correct generalizations from raw data or to determine specific facts using general rules. It processes information using induction and deduction. In inductive information processing, the system determines general rules and patterns from repeated exposure to raw data or experiences. In deductive information processing, the system determines specific facts from general rules (e.g., theorem proving using axioms and other proven theorems). The knowledge base is a set of facts about the world, and these facts are expressed and stored in a computer system using a special knowledge representation language

E.g. decision tree learning, version space learning

**Neural Network**

A Neural network is an interconnected assembly of simple processing elements, units or node, whose functionality is loosely based on the human neuron. The processing ability of the network is stored in the inter-unit connection strengths, or weigths,obtained by a process of adaptation to or learning from, a set of training patterns.

E.g. brain modeling, time series prediction, classification

1. ***What an AI system can and cannot do?***

**AI Application or thing which it can do efficiently**

Artificial intelligence has so many application areas and some of them are:

* Computer vision
* Robotics
* Natural language processing
* Expert systems
* Spoken language systems- 1000 word continuous speech
* Planning and scheduling- Hubble Telescope experiments
* Learning
* User modeling
* Games-Grand Master level in chess (world champion), checkers, etc

**AI difficulties**

* Understand natural language robustly
* Surf the web
* Interpret an arbitrary visual scene
* Learn a natural language
* Play Go well
* Construct plans in dynamic real-time domains
* Refocus attention in complex environments
* Perform life-long learning