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M.C.S.-224

Artificial Intelligence and Machine Learning

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Sample Preview of the Solved Sample Question Papers

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QUESTION PAPER

June – 2023

(Solved)

ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

M.C.S.-224

Time: 3 Hours] ***[Maximum Marks : 100***
Weightage: 70%

Note: *Question* ***No. 1*** *is compulsory. Attempt any* ***three*** *questions from the rest.*

Q. 1. ***(a)*** **Compare descriptive, predictive and prescriptive analytics in machine learning.**

Ans. Ref.: See Chapter-1, Page No. 10, Q. No. 8.

(b) **What is Min-Max Search Strategy? Write minimax algorithm.**

Ans. Ref.: See Chapter-2, Page No. 20-21, 'Min-Max Search Strategy' and 'Minimax Algorithm'.

(c) **Differentiate between informed search and uninformed search. Name *one* algorithm for each.**

Ans. Ref.: See Chapter-3, Page No. 34-35, 'Uninformed Search' and Page No. 39, 'Informed (Heuristic) Search'.

(d) **Describe the *Modus Ponens* and *Modus Tollens* as propositional rule of inference.**

Ans. Ref.: See Chapter-4, Page No. 54, 'Propositional Rules of Inference'.

(e) **What is Prenex Normal Form (PNF)? Transform the following formula into PNF :**

$$(\forall_x)(Q(x) \rightarrow (\exists_x)R(x, y))$$

Ans. Ref.: See Chapter-5, Page No. 64, 'Prenex Normal Form'.

Also Add: To transform the given formula $(\forall x)(Q(x) \rightarrow (\forall x)R(x,y))$ into Prenex Normal Form, we can follow these steps:

Move the existential quantifier out of the implication, and eliminate the universal quantifier from the implication: $(\forall x)(\neg Q(x) \vee (\exists x)R(x,y))$

Move the existential quantifier to the front: $(\exists x)(\forall x)(\neg Q(x) \vee R(x,y))$

Now, the formula is in Prenex Normal Form. The quantifiers appear at the beginning, followed by the quantifier-free matrix $(\neg Q(x) \vee R(x,y))$.

(f) **What is Ensemble Learning? Briefly discuss any *one* of the ensemble learning method.**

Ans. Ref.: See Chapter-9, Page No. 106, Q. No. 10.

(g) **Draw confusion matrix and write formula for accuracy, precision, sensitivity and specificity.**

Ans. Ref.: See Chapter-10, Page No. 117, 'Confusion Matrix'.

(h) **What is a Neural Network? How biological neuron relates to Artificial Neuron? Illustrate with suitable diagram and a table to map the components of Biological Neuron with Artificial Neuron.**

Ans. Ref.: See Chapter-12, Page No. 134, 'Introduction' and Page No. 135, 'Overview of Artificial Neural Networks'.

Q. 2. ***(a)*** **Explain Turing test, with the help of a block diagram. Also, discuss Chinese room test as criticism to Turing test.**

Ans. Ref.: See Chapter-1, Page No. 8-9, Q. No. 6.

(b) **Briefly discuss the following, with suitable example for each:**

(i) **Rule-based machine learning**

(ii) **Bayesian Algorithms**

(iii) **Decision trees**

(iv) **Dimensionality reduction**

Ans. Ref.: See Chapter-9, Page No. 99-100, 'Supervised Learning Techniques', 'Rule-Based Machine Learning', 'Bayesian Decision Tree' and 'Dimensionality Reduction'.

Q. 3. ***(a)*** **What do you understand by State Space Search? Explain the state space representation of Water-Jug Problem (WJP), given below:**

"Given two jugs of 5-gallon and 3-gallon, both of which do not have measuring indicators on them. The jugs can be filled with water with the help of any pump, any number of times."

The question is "how can you get 4 gallons of water in a 5-gallon jug?"

Ans. Ref.: See Chapter-2, Page No. 15, 'Introduction to State Space Search'.

Also Add: The Water-Jug Problem (WJP) is a classic problem in artificial intelligence and problem-solving. The goal is to find a sequence of actions that leads to a desired state, which in this case is having 4 gallons of water in a 5-gallon jug. Let's represent the state space of the problem.

State Representation: In the Water-Jug Problem, a state is defined by the amount of water in each jug. Since there are two jugs, a state can be represented as an ordered pair *(x,y)*, where *x* is the amount of water in the 5-gallon jug, and *y* is the amount of water in the 3-gallon jug. The state space consists of all possible combinations of water levels in the two jugs.

For example, if $x = 3$ and $y = 2$, it means the 5-gallon jug has 3 gallons of water, and the 3-gallon jug has 2 gallons of water.

Initial State: The initial state is usually represented as (0,0)(0,0), meaning both jugs are empty.

Goal State: The goal state, in this case, is (4, ∗) (4, ∗), where the 5-gallon jug has 4 gallons of water. The second component can be any value since the water level in the 3-gallon jug is not relevant to the goal.

Actions:

Fill: Fill a jug to its maximum capacity.

F5: Fill the 5-gallon jug.

F3: Fill the 3-gallon jug.

Empty: Empty the contents of a jug.

E5: Empty the 5-gallon jug.

E3: Empty the 3-gallon jug.

Transfer: Pour water from one jug to another.

T53: Transfer water from the 5-gallon jug to the 3-gallon jug.

T35: Transfer water from the 3-gallon jug to the 5-gallon jug.

State Space: The state space consists of all possible states that can be reached from the initial state by applying the defined actions. The edges between states represent possible actions, and the nodes represent the states.

***(b)* What is Binary Classification? Can binary classification algorithms be altered to work for problems with more than two classes? Justify. Also, discuss one-versus the rest and one-versus-one approach.**

Ans. Ref.: See Chapter-10, Page No. 115, Q. No. 4.

Q. 4. *(a)* Differentiate between the following:

***(i)* A* and AO* algorithm**

Ans. Ref.: See Chapter-3, Page No. 41, 'A* algorithm' and Page No. 43, 'AO* algorithm'.

***(ii)* Depth First Search and Breadth First Search**

Ans. Ref.: See Chapter-3, Page No. 35-36, 'Depth First Search' and Page No. 40, 'Breadth First Search'.

***(b)* What is linear regression? How linear regression is performed using least square method? Find the regression line for the data points *(x, y)* tabulated below:**

x	*y*
1	3
2	4
3	2
4	4
5	5

Also, discuss the terms 'mean squared error' and 'mean absolute errors'.

Ans. Ref.: See Chapter-11, Page No. 123, 'Linear Regression' and Page No. 124, 'Linear Regression Least Square Method' and Page No. 125, 'Mean Squared Error and Mean Absolute Error'.

Also Add:

x	y	$(x-\bar{x})$	$(y-\bar{y})$	$(x-\bar{x})^2$	$(x-\bar{x})(y-\bar{y})$
1	3	-2	-0.6	4	1.2
2	4	-1	0.4	1	-0.4
3	2	0	-1.6	0	0
4	4	1	0.4	1	0.4
5	5	2	1.4	4	2.8
3	3.6	0	0	10	4

where $m = \dfrac{\sum(x-\bar{x})(y-\bar{y})}{\sum(x-\bar{x})^2}$

$m = 4/10 = 0.4$

$\bar{x}$ = mean of $x = 3$

$\bar{y}$ = mean of $y = 3.6$

$y = mx + c$

$m = 0.4$

$c = 2.4$

$y = .4x + 2.4.$

Q. 5. Write short notes on any *five* of the following:

***(a)* Backward Chaining**

Ans. Ref.: See Chapter-6, Page No. 74, 'Backward Chaining'.

***(b)* Scripts**

Ans. Ref.: See Chapter-6, Page No. 71-72, 'Scripts'.

Sample Preview of The Chapter

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ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

Introduction to Artificial Intelligence

1

INTRODUCTION

Artificial intelligence is being applied in many different fields, such as engineering, technology, the military, opinion mining, sentiment analysis, and many others. Additionally, it is utilized in more complex fields including language processing and aeronautical applications.

In the modern world, AI is pervasive, and people are slowly growing accustomed to it. Systems that recognize speech and faces both make use of it. Additionally, it can offer you shopping advice that is customized to your individual purchase tastes. It makes it much simpler to find spam and stop credit card fraud when you have this talent. Virtual assistants like Apple's Siri, Amazon's Alexa, Microsoft's Cortana, and Google's own Google Assistant are currently the most cutting-edge technology available on the market. It's conceivable that you are already familiar with the artificial intelligence (AI) technology. Do you?

AI is popular worldwide. It simulates human intelligence in robots. AI will touch daily life more. Today, everyone wants to use AI. We must discuss some fundamentals before we can grasp AI. What distinguishes knowledge from intelligence? This question unlocks this unit.

Life experiences give people knowledge. Intelligence means using knowledge. Simply put, knowledge is what we have learnt over time and grows. It depicts our life's realizations. Intelligence, not information, makes one clever.

CHAPTER AT A GLANCE

BASICS OF ARTIFICIAL INTELLIGENCE (AI)?

The following is a list of four definitions of artificial intelligence that have been provided by well-known authors of artificial intelligence textbooks.

1. According to Haugeland in 1985, "The Exciting New Effort to Make ComputersThink... Machines with Minds, in the Full and Literal Sense,"

2. According to Bellman, "The automation of behaviours that we connect with humanthinking, activities such as decision-making, problem-solving, and learning..." 1978.

3. "The study of mental capabilities through the application of computer models," (also known as "The Study of Mental Capabilities"), Charniak and McDermott's 1985.

4. According to Winston (1992), "the study of the calculations that make it possible toperceive, reason, and act."

(a) Artificial Narrow Intelligence-(ANI)

(b) Artificial General Intelligence-(AGI)

(c) Artificial Super Intelligence

Types of Artificial Intelligence

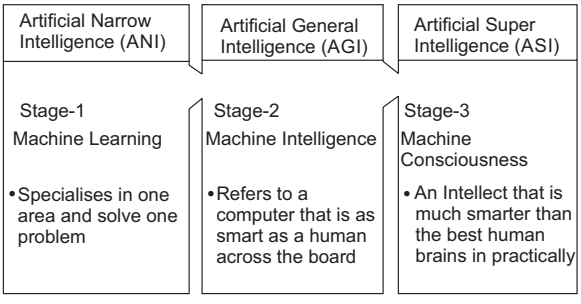

Fig.: Three Stages of Type-I Artificial Intelligence

BRIEF HISTORY– ARTIFICIAL INTELLIGENCE

The concepts of AI are derived from early studies on how individuals learn and reason. The notion that a machine may behave like a person is also quite old. Greek mythology is where the concept of autonomous machines originates.

- Aristotle created a non-formal syllogistic logic system during his lifetime (384-322 BC). This

is where the first formal deductive reasoning framework was developed.

- Descartes asserted that animal bodies are merely sophisticated machines at the start of the 17th century.
- In the year 1642, Pascal created the first mechanical digital calculator.
- A number system dubbed "binary algebra" developed in the 1800s by George Boole revealed (some) "laws of thought."
- Charles Babbage and Ada Byron worked on mechanical calculators that could be programmed.

In 1950, Turing published "Computing Machines and Intelligence." This essay presented AI well.

Marvin Minsky and Dean Edmonds constructed the SNARC in 1951. It was the first SNARC (Stochastic Neural Analog Reinforcement Computer) neural network learning machine using randomly wired neural networks. A network of 40 neurons and 3000 vacuum tubes made up the computer.

In the 1990s,

- 1997 saw the inaugural Robo-Cup soccer contest. 40 robot teams conversed on a tabletop.
- Web crawlers and other AI-based programs that pull information from the web are growing increasingly vital as more people utilize it.
- Deep Blue Deep Blue defeated world champion Gary Kasparov in 1997.

In 2000,

- The Nomad robot searches remote Antarctica for meteorites.
- Robotic space probes study space independently. They observe, decide, and act to achieve their goals. NASA's Mars rovers' three-month missions were successful in April 2004. Spirit was staring at a Mars hill group that took two months to reach. It's discovering curiously eroded rocks that may add to the area's history. Opportunity, Spirit's twin, examined crater rock strata.

COMPONENTS OF INTELLIGENCE

Following are few of the components, according to the mainstream psychology school: learning, reasoning, problem-solving, perception, and language understanding dominate artificial intelligence research.

APPROACHES TO ARTIFICIAL INTELLIGENCE

Maybe one day AI will be able to act like a human, but what assurances do we have that this will be the case? Is it possible to create a system that mimics human behavior in order to verify artificial intelligence? The foundation for assessing an AI entity's resemblance to a human being is laid forth in the following methods:

- Turing Test
- Approach of The Cognitive Modelling
- Approach of The Law of Thought
- Approach of The Rational Agent

The most famous pioneer, Alan Turing, considered how to test A.I. products for intelligence. Turing invented the Turing Test in 1950.

"What is the Turing Test in AI?" The most well-known of the pioneers, Alan Turing, considered how to determine whether an A.I. system was intelligent. Turing created a test to determine whether or not something is intelligent, which is now known as the Turing Test.

Criticism to Turing Test: Numerous arguments against the Turing test as a test of artificial intelligence have been made. One of the most well-known critiques was created by John Searle and is called the Chinese Room Test. The core idea behind the Chinese Room Test, which we'll go over below, is that persuading a system, let's say A, that it has characteristics of a system, let's say B, does not imply that system A actually has those characteristics. For instance, a male human's capacity to pass for a woman does not indicate that he is able to procreate like a woman.

Thinking Humanly: From this perspective, the Artificial Intelligence model is founded on Human Cognition, which is the heart of the human mind. Thinking like a human: This is the cognitive modeling technique. Three methods are used to do this, and they are as follows:

- Introspection, which refers to examining one's own thoughts and using them to construct a model.
- Psychological experiments, which entail administering tests to participants and observing their behavior.
- Brain imaging, which entails using an MRI to observe how the brain functions in various scenarios and then duplicating that behavior using computer code.

Thinking Rationally: This way Using logic to think: The lengthy Laws of Thought instruct our minds. This strategy, "Thinking Rationally," is founded on these laws. These laws can be codified using artificial intelligence systems. However, observing the law doesn't solve real-world problems. This technique has several major drawbacks.

Acting Rationally: Rational agents always seek the optimal outcome. It chooses the optimal option given the circumstances. The agent approach is more adaptable. The Laws of Thought method requires a thing to operate rationally. In some cases, there is no theoretically right answer and multiple ways to address the problem, each with distinct results and trade-offs. The rational agent method works then.

COMPARISON – ARTIFICIAL INTELLIGENCE, MACHINE LEARNING AND DEEPLEARNING

AI is the broader concept, ML is a subset of AI focused on learning from data, and DL is a further subset of ML that specifically deals with deep neural networks. Each of these fields has its own applications, learning approaches, and dependencies on data.

SUB-DOMAINS OF ARTIFICIAL INTELLIGENCE

Artificial Intelligence (AI) encompasses a variety of sub-domains, each addressing different aspects of simulating human intelligence. Here are some key sub-domains of AI:

- Deep Learning
- Natural Language Processing
- Machine Learning
- Neural Networking
- Computer Vision

APPLICATION AREAS OF ARTIFICIAL INTELLIGENCE SYSTEMS

AI is the most essential factor in transforming economies from the ground up and is an efficient alternative. It has a lot of potential to optimize any industry, whether it's smart cities, health, agriculture, or any other relevant sector. Below are a few systems where AI is the main source of competitive advantage:

(a) **Healthcare:** AI can reduce obstacles to healthcare access, especially in remote areas with weak connection and a shortage of healthcare personnel. This is especially true in locations with limited healthcare professionals. AI-driven diagnostics, personalized treatment, early pandemic detection, and imaging diagnostics can help achieve this goal.

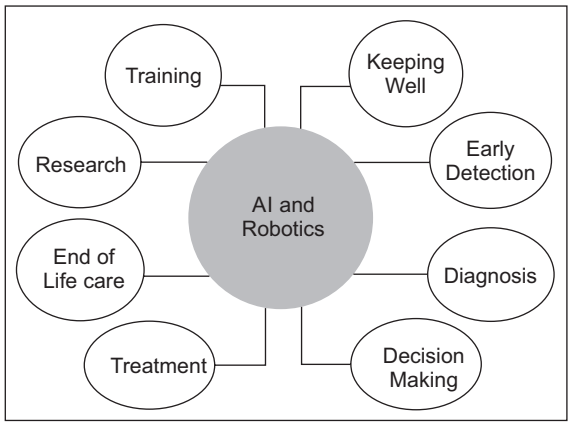

Fig.: Potential Use of AI in Health Care

(b) **Agriculture:** AI could revolutionize food production and feed 2 billion more people by 2050. It can help fix demand prediction, irrigation, pesticide, and fertilizer abuse. It could fix these and more. Real-time counseling can boost agricultural yield. Advanced pest detection and crop price forecasts for sowing is other uses.

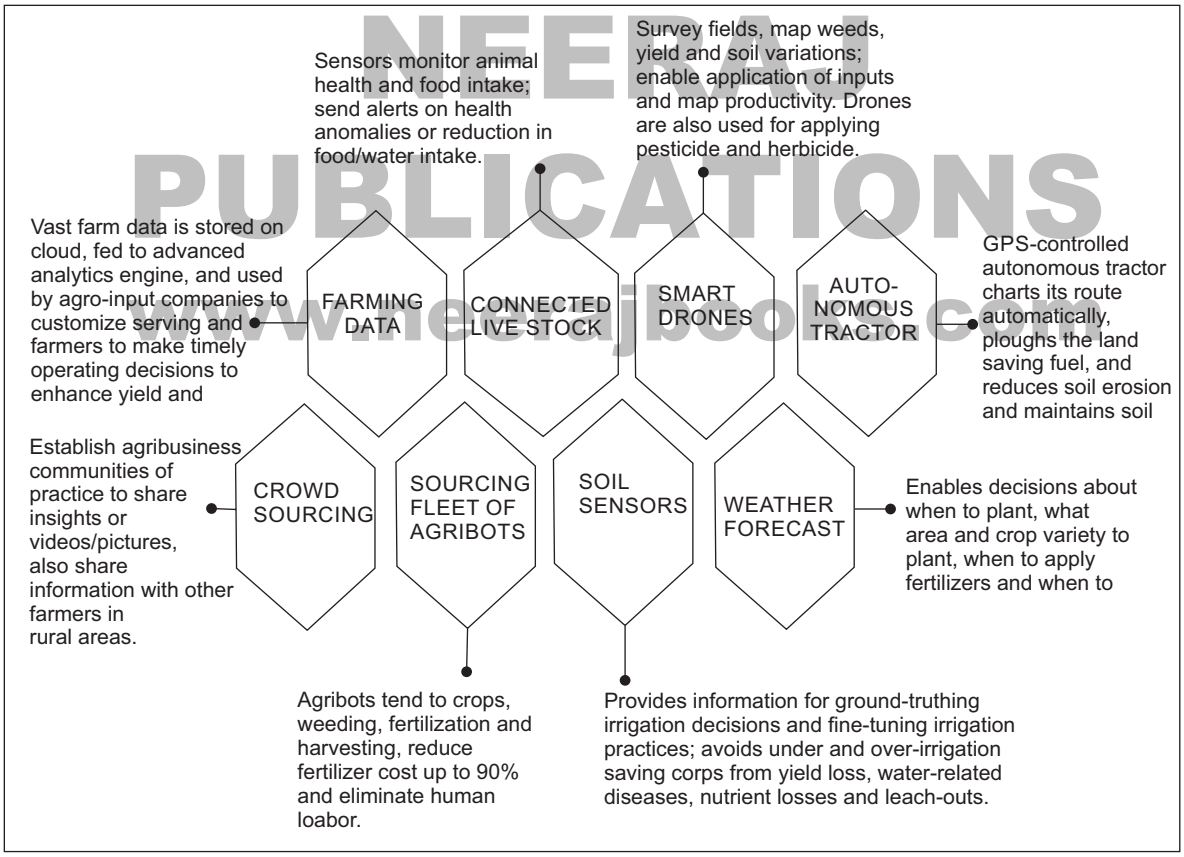

Fig.: AI for Precision Farming

(c) **Smart Mobility**, **including Transportation and Logistics:** Ride-sharing fleets, semiautonomous features like driver assistance, and predictive engine monitoring and maintenance are smart mobility use cases. AI can improve traffic control, self-driving vehicles, and deliveries.

(d) **Retail:** AI was initially used in retail. Personalized suggestions, user-preference-based browsing, and image-based product search have all improved user experience. Predicting client needs, improving inventory management, and streamlining deliveries are further uses.

(e) **Manufacturing:** AI-based solutions will benefit manufacturing the most. This will enable the "Factory of the Future" by providing flexible and adaptable technical solutions to automate processes and machinery that can make smart decisions in unexpected scenarios. Engineering, supply chain management, production, maintenance, quality assurance, and in-plant logistics and warehousing are affected by AI.

(f) **Energy:** Energy system modeling and forecasting can reduce uncertainty and improve power balancing and consumption. Smart meters and intelligent grids assist AI store energy in renewable energy systems. It can improve photovoltaic energy reliability and cost. Like manufacturing, AI might foresee grid infrastructure upkeep.

(g) **Smart Cities:** Integrating AI into newly created smart cities and infrastructure could address the needs of a rapidly urbanizing population and improve their quality of life. Traffic control and crowd management can increase security and alleviate traffic bottlenecks.

(h) **Education and Skilling:** AI may improve education quality and access.Personalized learning, administrative automation, and anticipating when a student needs aid to prevent dropout or advise vocational training are possible uses.

(i) **Financial Industry:** AI is also used in finance. It aids bank fraud departments in detecting irregular debit card activity and significant account deposits. AI streamlines trading. Making it easier to determine how many securities are purchased and sold and their prices does this.

INTELLIGENT AGENTS

An entity that acts, typically on someone else's behalf, is referred to as an agent. An agent, in more specific terms, is a thing that uses sensors to observe its surroundings and actuators to change it. Some specialists in the field demand that an agent also be autonomous and goal-oriented.

A percept can be viewed as an input that the agent receives through its censors during a period of time that is long enough for the agent to derive some meaning from the input.

A percept sequence is a collection of perceptions that is typically long enough for the agent to take action.

The first approach defines agent. "Agent is that agent does" is a common phrase among agents. An agent is expected to perform a task for someone else in everyday life. The agent must know its domain and the user's properties to succeed. In normal life, we recruit agents for different jobs based on their skills. A non-human intelligent agent also has domain expertise based on job requirements. Football players and email managers are distinct, but both model their users.

The second definition of agent holds that an agent must have some or all of the following characteristics:

Reactivity: Reactivity is the capacity to sense one's surroundings and respond appropriately.

Autonomy: Autonomy is the capacity to progress toward a goal while adapting its actions or approach as needed, usually with little assistance from a person.

Communicating ability: The capacity to interact verbally and in writing with people and other agents.

Ability to co-exist by cooperating: The capacity to cooperate in a setting with multiple agents in order to accomplish a common objective.

Ability to adapt to a new situation: Ability to learn, change, and adapt to situations in the environment: The capacity to deal with new situations.

Ability to draw inferences: The capacity to infer or derive conclusions from facts that may be relevant but are not directly available.

Temporal continuity: The capacity to work continuously for an extended amount of time.

Personality: Ability to replicate or impersonate the person on whose behalf the agent is acting.

Mobility: Mobility is the capacity to move between different environments.

Under the name PEAS, we then go over a common collection of measurements or characteristics for defining a task environment.

PEAS (Performance, Environment, Actuators, Sensors)

PEAS is an acronym that stands for Performance measure, Environment, Actuators, and Sensors. It is a framework used in artificial intelligence to define the key components and parameters of an intelligent agent. Each letter in the acronym represents a different aspect of the agent's design:

- **P (Performance measure):** How the agent's success is measured.
- **E (Environment):** The external context in which the agent operates.
- **A (Actuators):** Mechanisms through which the agent takes actions.
- **S (Sensors):** Components that provide information about the environment.

CHECK YOUR PROGRESS

Q. 1. How knowledge differs from intelligence? What do you understand by the term Artificial Intelligence (AI)? List the various techno-logies and their corresponding illustrative solutions.

Ans. The accumulation of information and abilities that a person has gained through their life experiences is known as knowledge. The capacity to put one's knowledge to use is the hallmark of intellectual capacity. Someone's lack of familiarity with a particular field does not exclude them from being able to use their intelligence to the process of finding solutions to challenges.

Although knowledge is invaluable, it tends to become obsolete when new methods and technology