Intelligence

What is intelligence?

There have been numerous definition of intelligence. But the widely accepted one is, intelligence is the ability to learn from experience and adapt to the new environment which depends highly on the context and social cultures. More intelligent people tend to be superior in problem solving, judgements and decision making, divided and selective attention, reasoning etc.

Most of us have our own implicit concept of intelligence by which we discriminate between intelligent and less intelligent people. On the other hand intelligence varies across cultures. Some cultures value emotional intelligence, some value intra and interpersonal skills or some culture might value social intelligence.

Measures of Intelligence

There are two approaches to measuring intelligence. The traditional approach is to consider three things - 1. Sensory acuity 2. Physical Strength 3. Motor coordination. (Lower Order intelligence)

The other one involves judgemental abilities - 1. thinking 2. reasoning 3. problem solving.

1. **Francis Galton** believed the intelligence is a function of **Psychophysical abilities**. He had in his lab instruments to test weight discrimination, tone frequency discriminator to test people. One of his follower tried to find an unifying links between all the psychophysical parameters by running assorted tests but failed to find such a link. This approach does not explain college grades.

2. An alternative was given by **Alfred Binet**. He tried to measure intelligence in an academic setting. He believed judgement is the main thing behind intelligence. His task was to identify mentally retarded children. Intelligence for him included three different parameters.

   a. **Direction**: It is knowing what has to be done and how to do it.

   b. **Adaption**: Implementing a solution which was directed and monitoring it while implementing.

   c. **Criticism**: It is the ability to have a critical view of oneself.

    Binet then formed tests to assign scores based on intelligence. What he formed is known as the mental age of a person which is the intelligence of an average person of that age.

3. **William Stern** instead suggested another measure of intelligence which is known as the Intelligent Quotient or the IQ. It is the ration of mental age and the chronological age of a person multiplied by 100. This however caused a problem, as the mental age increment does not keep the pace up with chronological age after 16 years hence, it fails to give a fair estimate of intelligence for individuals over 16 years.
An alternative to IQ is the **deviation IQ**. Assuming the IQ of the population to be a gaussian curve the intelligence is referred to as the deviation from the mean IQ.

4. **Wechsler Scale**: Wechsler had three scores as measure of intelligence - 1. Verbal 2. performance 3. overall.
Verbal score is dependent on verbal and vocabulary test. Performance test is dependent on various tasks like picture completion, picture rearrangement etc. The overall score is a combination of the performance and the verbal score. Wechsler also believed that intelligence is beyond what these scores say, it is central to our day to day life.

Now, there arose an issue in measuring intelligence in the form of a question - Do psychologists focus on measuring intelligence or they should try to find the structure of intelligence. From here people tried to find the potential structure of intelligence.

Structure of Intelligence (What constitute intelligence)

Psychologist in an attempt to find the structure of intelligence have heavily relied on the **factor analysis** process. The factor analysis process basically separates a construct into a number of factors which might influence the individual differences for test performances. The factor analysis process believes that the more highly correlated two tests are the more like are they to measure the same thing. A factor analysis process might involve -

1. Giving a large population different tests.

2. Finding correlation between the tests.

3. Depending on the performance of individuals on the tests, decomposing the construct into several factors.

There are many factorial analysis theory on intelligence. The most widely accepted ones are given below:

1. **Spearman's g factor**: Charles Spearman has proposed two different types of factors for intelligence. As per Spearman the general factor which is termed as '**g**' factor is the key factor to understand intelligence. Other than this there are several specific factors which are less important as they have less applicability.

2. **Thurstone's primary mental abilities model**: As per him there are seven factors which are essential to human intelligence. These seven factors provide a direct way to measure intelligence. These measures are still used by some of the experimenters.

3. **Cattell, Vernon and Carroll Hierarchical Models**: An economical way to maintain certain factors is to form a hierarchy out of them. As per **Cattell** there are two major subfactors to intelligence. One is **Fluid Abilities** - The ability to find solution to novel problems and other is **Crystallized Ability** - The ability to have accumulated knowledge and vocabulary. There are many subfactors inside these.
Vernon gave a similar model named practical-mechanical and verbal-educational model.
Carroll came up with a three strata model. The first and bottom most strata contains the specific abilities. The middle strata contains more broad abilities and the uppermost strata contains the general ability of intelligence which is very similar to Spearman's g factor. In addition to fluid and crystallized ability Carroll adds learning and memory, auditory and visual perception, facile production of ideas and speed. Carroll's model is widely accepted till date in the field.
Johnson and Bouchard came up with the idea of verbal, perceptual and image rotation which they argued to be dissimilar with fluid or crystallized intelligence.

Information Processing Approach (How factors operate)

The information processing approach tries to explain how we manipulate the internal knowledge in order to do something. It basically finds the operations of intelligence.

1. **Process Time Theories:**

   a. **Inspection Time:** Inspection time is the amount of time needed to inspect items and make a decision about them. In one experiment a stimulus was shown for a few milliseconds and then a stimulus was shown to erase the trace of the memory and people were given a recognition task to identify what picture was shown. The exposure time is varied and the recognition is tested. It was found that low inspection time shows higher intelligence.

   b. **Choice Reaction Time**: Some investigators have correlated intelligence with their neural conduction of information. The more is the speed the more is the intelligence. In one test the participants needed to hit the light button which gets to on state. The time between light glows and finger moves is known as the reaction time which is a proxy for the neural conduction. However, this approach is under scrutiny.

   c. **Speed of Lexical Access**:
   The speed with which we can access different words is known as lexical speed. The score of lexical speed is defined as the difference between time taken for accessing name code and time taken for accessing physical code. The more intelligent people are the more is the lexical access speed.

   In summary, process time theories say that the more the speed of information the more is the intelligence. But does more speed mean more learning? Does good initial recall mean good long term retention? These are what could be called as the drawback of information processing approach.

2. **Working memory**: Some psychologists believe that working memory is critical to intelligence. The more is the ability to hold and manipulate information in the working memory the more is the intelligence. Although it is an important aspect but it is not all to intelligence (experiment on problems followed by words).

3. **Componential theory and complex problem solving**: Researchers have tried to break down the complex problem solving (Analogies, Number series etc.) into a number of steps. This analysis breaks down the reaction time on each step and the error rate that make up the task. Consider the way an analogy works. Encoding, finding relation, relation mapping and generating a response. There has been found a high correlation between intelligence and the time taken to do all these steps. Another observation is that more intelligent people tend to take more time in

encoding that less intelligent ones i.e. they spend more time on global planning and lesser in local planning to ensure the solution they arrive at is correct.

An integrative Approach

An integrative approach with all the models combine makes the basis of intelligent somewhat like the following:

1. basis of declarative knowledge

2. basis of procedural knowledge

3. capacity of working memory

4. speed of processing

Alternative approaches to intelligence

1. **Cultural Context**: Intelligence is culture dependent. What might be considered as intelligent in one culture others culture might not label it as intelligent. Culture is basically a set of beliefs, norms or behaviours shared among the habitats.

2. **Gardner Multiple Intelligence**: Howard Gardner gave his theory on intelligence stating that it is not a single entity rather it is eight independent entities. Each of the entity performs a different job and related to different part of the brain. In some respect the theory is similar to factorial one but it is not the same as it says the components are independent. Another difference is that he used converging operations for gathering evidences, he did not use the psychometric data to support his claims.
His notion of intelligence is very modular so poses a new research problem to find out the brain areas which are linked to each of the intelligences he mentioned. Some psychologists has criticised this much modularity.

3. **Sternberg's Triarchic Theory**: As opposed to the modularity of Gardner Sternberg has given three interrelated components to intelligence which are:

   a. **Relating intelligence to inner world**: This is concerned with the information processing. The higher order functions make plans for execution of the task and the second order functions implement the orders given by the higher order executive processes. The lowest order function is related to acquiring knowledge which is used by higher order functions.

b. **Relating intelligence to outer world**: There are three aspects of relating intelligence with outer world. One is to adapt to the current environment, second is one to shape the current environment to create a new environment and the third one is to choose between given new environments.

c. **Relating intelligence to the acquired knowledge**: This considers how previously learned knowledge can interfere with the problem at hand. Some problems might be familiar to us and some problems might be completely unfamiliar to us. In these kind of situations the intelligence that is applied is different. The first kind of situation makes automatic responses whereas novel situation forces us to think and respond.

This completes the models for intelligence.

Determinants of intelligence

1. **Genetics**:
   The closer the relationship between two people the more is the correlation of the IQ. There are two studies related to it. Twin studies and Adoption studies. Twin study says as the condition of twins changes and dissimilarity increases the correlation of IQ changes. Adoption studies says that siblings reared together have more correlation in IQ and twins reared apart have less correlation.

2. **The Flynn Effect**: This is an environmental effect. The mean IQ of world regions are found to be increasing. The reason behind this is predicted to be availability of food.

3. **Environmental condition**: Favourable environmental condition increases the chances of learning and intelligence whereas unfavourable decreases the chances.

4. **Gender Difference**: On an average there are gender difference between male and female intelligence. Females are better at verbal intelligence and males are better at spatial intelligence geometry and geography.

Artificial Intelligence

Computers can not really think. They can be programmed to make them look like they are thinking. The one difference between the computer and the humans is humans can gossip whereas computers can not. The machine passing the Turing test can be

labelled as a thinker. Computers just can take in symbols as inputs and run an algorithm previously described on it and then output the result of the algorithm. But they don't understand what the algorithm is really doing.

Consider the Chinese room experiment where one person symbolically maps each English letter to a corresponding Chinese letter. Is it plausible to conclude that the person knows how to speak in Chinese. Using this argument we can say that computers can not think, they can only perform set of instructions to make them look like as if they are thinking.