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A Collection of Definitions of Intelligence

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Abstract

This paper is a survey of a large number of informal definitions of "intelligence" that the authors have collected over the years. Naturally, compiling a complete list would be impossible as many definitions of intelligence are buried deep inside articles and books. Nevertheless, the 70-odd definitions presented here are, to the authors' knowledge, the largest and most well referenced collection there is.

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Keywords

Intelligence definitions, collective, psychologist, artificial, universal.

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1 Introduction

> *"Viewed narrowly, there seem to be almost as many definitions of intelligence as there were experts asked to define it."*
>
> — *R. J. Sternberg quoted in [14]*

Despite a long history of research and debate, there is still no standard definition of intelligence. This has lead some to believe that intelligence may be approximately described, but cannot be fully defined. We believe that this degree of pessimism is too strong. Although there is no single standard definition, if one surveys the many definitions that have been proposed, strong similarities between many of the definitions quickly become obvious. In many cases different definitions, suitably interpreted, actually say the same thing but in different words. This observation lead us to believe that a single general and encompassing definition for arbitrary systems was possible. Indeed we have constructed a formal definition of intelligence, called *universal intelligence* [22], which has strong connections to the theory of optimal learning agents [19].

Rather than exploring very general formal definitions of intelligence, here we will instead take the opportunity to present the many informal definitions that we have collected over the years. Naturally, compiling a complete list would be impossible as many definitions of intelligence are buried deep inside articles and books. Nevertheless, the 70 odd definitions presented below are, to the best of our knowledge, the largest and most well referenced collection there is. We continue to add to this collect as we discover further definitions, and keep the most up to date version of the collection available online [21]. If you know of additional definitions that we could add, please send us an email.

2 Collective definitions

In this section we present definitions that have been proposed by groups or organisations. In many cases definitions of intelligence given in encyclopedias have been either contributed by an individual psychologist or quote an earlier definition given by a psychologist. In these cases we have chosen to attribute the quote to the psychologist, and have placed it in the next section. In this section we only list those definitions that either cannot be attributed to a specific individuals, or represent a collective definition agreed upon by many individuals. As many dictionaries source their definitions from other dictionaries, we have endeavoured to always list the original source.

1. "The ability to use memory, knowledge, experience, understanding, reasoning, imagination and judgement in order to solve problems and adapt to new situations." AllWords Dictionary, 2006

2. “The capacity to acquire and apply knowledge.” The American Heritage Dictionary, fourth edition, 2000

3. “Individuals differ from one another in their ability to understand complex ideas, to adapt effectively to the environment, to learn from experience, to engage in various forms of reasoning, to overcome obstacles by taking thought.” American Psychological Association [28]

4. “The ability to learn, understand and make judgments or have opinions that are based on reason” Cambridge Advance Learner’s Dictionary, 2006

5. “Intelligence is a very general mental capability that, among other things, involves the ability to reason, plan, solve problems, think abstractly, comprehend complex ideas, learn quickly and learn from experience.” Common statement with 52 expert signatories [13]

6. “The ability to learn facts and skills and apply them, especially when this ability is highly developed.” Encarta World English Dictionary, 2006

7. “...ability to adapt effectively to the environment, either by making a change in oneself or by changing the environment or finding a new one ... intelligence is not a single mental process, but rather a combination of many mental processes directed toward effective adaptation to the environment.” Encyclopedia Britannica, 2006

8. “the general mental ability involved in calculating, reasoning, perceiving relationships and analogies, learning quickly, storing and retrieving information, using language fluently, classifying, generalizing, and adjusting to new situations.” Columbia Encyclopedia, sixth edition, 2006

9. “Capacity for learning, reasoning, understanding, and similar forms of mental activity; aptitude in grasping truths, relationships, facts, meanings, etc.” Random House Unabridged Dictionary, 2006

10. “The ability to learn, understand, and think about things.” Longman Dictionary or Contemporary English, 2006

11. “: the ability to learn or understand or to deal with new or trying situations : ... the skilled use of reason (2) : the ability to apply knowledge to manipulate one’s environment or to think abstractly as measured by objective criteria (as tests)” Merriam-Webster Online Dictionary, 2006

12. “The ability to acquire and apply knowledge and skills.” Compact Oxford English Dictionary, 2006

13. “...the ability to adapt to the environment.” World Book Encyclopedia, 2006

14. “Intelligence is a property of mind that encompasses many related mental abilities, such as the capacities to reason, plan, solve problems, think abstractly, comprehend ideas and language, and learn.” Wikipedia, 4 October, 2006

15. “Capacity of mind, especially to understand principles, truths, facts or meanings, acquire knowledge, and apply it to practise; the ability to learn and comprehend.” Wiktionary, 4 October, 2006

16. “The ability to learn and understand or to deal with problems.” Word Central Student Dictionary, 2006

17. “The ability to comprehend; to understand and profit from experience.” Wordnet 2.1, 2006

18. “The capacity to learn, reason, and understand.” Wordsmyth Dictionary, 2006

3 Psychologist definitions

This section contains definitions from psychologists. In some cases we have not yet managed to locate the exact reference and would appreciate any help in doing so.

1. “Intelligence is not a single, unitary ability, but rather a composite of several functions. The term denotes that combination of abilities required for survival and advancement within a particular culture.” A. Anastasi [2]

2. “...that facet of mind underlying our capacity to think, to solve novel problems, to reason and to have knowledge of the world.” M. Anderson [3]

3. “It seems to us that in intelligence there is a fundamental faculty, the alteration or the lack of which, is of the utmost importance for practical life. This faculty is judgement, otherwise called good sense, practical sense, initiative, the faculty of adapting ones self to circumstances.” A. Binet [5]

4. “We shall use the term ‘intelligence’ to mean the ability of an organism to solve new problems ... ” W. V. Bingham [6]

5. “Intelligence is what is measured by intelligence tests.” E. Boring [7]

6. “...a quality that is intellectual and not emotional or moral: in measuring it we try to rule out the effects of the child’s zeal, interest, industry, and the like. Secondly, it denotes a general capacity, a capacity that enters into everything the child says or does or thinks; any want of ’intelligence’ will therefore be revealed to some degree in almost all that he attempts;” C. L. Burt [8]

7. “A person possesses intelligence insofar as he has learned, or can learn, to adjust himself to his environment.” S. S. Colvin quoted in [35]

8. "…the ability to plan and structure one's behavior with an end in view." J. P. Das

9. "The capacity to learn or to profit by experience." W. F. Dearborn quoted in [35]

10. "…in its lowest terms intelligence is present where the individual animal, or human being, is aware, however dimly, of the relevance of his behaviour to an objective. Many definitions of what is indefinable have been attempted by psychologists, of which the least unsatisfactory are 1. the capacity to meet novel situations, or to learn to do so, by new adaptive responses and 2. the ability to perform tests or tasks, involving the grasping of relationships, the degree of intelligence being proportional to the complexity, or the abstractness, or both, of the relationship." J. Drever [9]

11. "Intelligence A: the biological substrate of mental ability, the brains' neuroanatomy and physiology; Intelligence B: the manifestation of intelligence A, and everything that influences its expression in real life behavior; Intelligence C: the level of performance on psychometric tests of cognitive ability." H. J. Eysenck.

12. "Sensory capacity, capacity for perceptual recognition, quickness, range or flexibility or association, facility and imagination, span of attention, quickness or alertness in response." F. N. Freeman quoted in [35]

13. "…adjustment or adaptation of the individual to his total environment, or limited aspects thereof …the capacity to reorganize one's behavior patterns so as to act more effectively and more appropriately in novel situations …the ability to learn …the extent to which a person is educable …the ability to carry on abstract thinking …the effective use of concepts and symbols in dealing with a problem to be solved …" W. Freeman

14. "An intelligence is the ability to solve problems, or to create products, that are valued within one or more cultural settings." H. Gardner [11]

15. "…performing an operation on a specific type of content to produce a particular product." J. P. Guilford

16. "Sensation, perception, association, memory, imagination, discrimination, judgement and reasoning." N. E. Haggerty quoted in [35]

17. "The capacity for knowledge, and knowledge possessed." V. A. C. Henmon [16]

18. "…cognitive ability." R. J. Herrnstein and C. Murray [17]

19. "...the resultant of the process of acquiring, storing in memory, retrieving, combining, comparing, and using in new contexts information and conceptual skills." Humphreys

20. "Intelligence is the ability to learn, exercise judgment, and be imaginative." J. Huarte

21. "Intelligence is a general factor that runs through all types of performance." A. Jensen

22. "Intelligence is assimilation to the extent that it incorporates all the given data of experience within its framework ... There can be no doubt either, that mental life is also accommodation to the environment. Assimilation can never be pure because by incorporating new elements into its earlier schemata the intelligence constantly modifies the latter in order to adjust them to new elements." J. Piaget [30]

23. "Ability to adapt oneself adequately to relatively new situations in life." R. Pinter quoted in [35]

24. "A biological mechanism by which the effects of a complexity of stimuli are brought together and given a somewhat unified effect in behavior." J. Peterson quoted in [35]

25. "...certain set of cognitive capacities that enable an individual to adapt and thrive in any given environment they find themselves in, and those cognitive capacities include things like memory and retrieval, and problem solving and so forth. There's a cluster of cognitive abilities that lead to successful adaptation to a wide range of environments." D. K. Simonton [33]

26. "Intelligence is part of the internal environment that shows through at the interface between person and external environment as a function of cognitive task demands." R. E. Snow quoted in [34]

27. "...I prefer to refer to it as 'successful intelligence.' And the reason is that the emphasis is on the use of your intelligence to achieve success in your life. So I define it as your skill in achieving whatever it is you want to attain in your life within your sociocultural context — meaning that people have different goals for themselves, and for some it's to get very good grades in school and to do well on tests, and for others it might be to become a very good basketball player or actress or musician." R. J. Sternberg [36]

28. "...the ability to undertake activities that are characterized by (1) difficulty, (2) complexity, (3) abstractness, (4) economy, (5) adaptedness to goal, (6) social value, and (7) the emergence of originals, and to maintain such activities under conditions that demand a concentration of energy and a resistance to emotional forces." Stoddard

29. "The ability to carry on abstract thinking." L. M. Terman quoted in [35]

30. "Intelligence, considered as a mental trait, is the capacity to make impulses focal at their early, unfinished stage of formation. Intelligence is therefore the capacity for abstraction, which is an inhibitory process." L. L. Thurstone [37]

31. "The capacity to inhibit an instinctive adjustment, the capacity to redefine the inhibited instinctive adjustment in the light of imaginally experienced trial and error, and the capacity to realise the modified instinctive adjustment in overt behavior to the advantage of the individual as a social animal." L. L. Thurstone quoted in [35]

32. "A global concept that involves an individual's ability to act purposefully, think rationally, and deal effectively with the environment." D. Wechsler [40]

33. "The capacity to acquire capacity." H. Woodrow quoted in [35]

34. "…the term intelligence designates a complexly interrelated assemblage of functions, no one of which is completely or accurately known in man …" R. M. Yerkes and A. W. Yerkes [41]

35. "…that faculty of mind by which order is perceived in a situation previously considered disordered." R. W. Young quoted in [20]

4 AI researcher definitions

This section lists definitions from researchers in artificial intelligence.

1. "…the ability of a system to act appropriately in an uncertain environment, where appropriate action is that which increases the probability of success, and success is the achievement of behavioral subgoals that support the system's ultimate goal." J. S. Albus [1]

2. "Any system …that generates adaptive behviour to meet goals in a range of environments can be said to be intelligent." D. Fogel [10]

3. "Achieving complex goals in complex environments" B. Goertzel [12]

4. "Intelligent systems are expected to work, and work well, in many different environments. Their property of intelligence allows them to maximize the probability of success even if full knowledge of the situation is not available. Functioning of intelligent systems cannot be considered separately from the environment and the concrete situation including the goal." R. R. Gudwin [15]

5. "[Performance intelligence is] the successful (i.e., goal-achieving) performance of the system in a complicated environment." J. A. Horst [18]

6. "Intelligence is the ability to use optimally limited resources – including time – to achieve goals." R. Kurzweil [20]

7. "Intelligence is the power to rapidly find an adequate solution in what appears *a priori* (to observers) to be an immense search space." D. Lenat and E. Feigenbaum [23]

8. "Intelligence measures an agent's ability to achieve goals in a wide range of environments." S. Legg and M. Hutter [22]

9. "...doing well at a broad range of tasks is an empirical definition of 'intelligence' " H. Masum [24]

10. "Intelligence is the computational part of the ability to achieve goals in the world. Varying kinds and degrees of intelligence occur in people, many animals and some machines." J. McCarthy [25]

11. "...the ability to solve hard problems." M. Minsky [26]

12. "Intelligence is the ability to process information properly in a complex environment. The criteria of properness are not predefined and hence not available beforehand. They are acquired as a result of the information processing." H. Nakashima [27]

13. "...in any real situation behavior appropriate to the ends of the system and adaptive to the demands of the environment can occur, within some limits of speed and complexity." A. Newell and H. A. Simon [29]

14. "[An intelligent agent does what] is appropriate for its circumstances and its goal, it is flexible to changing environments and changing goals, it learns from experience, and it makes appropriate choices given perceptual limitations and finite computation." D. Poole [31]

15. "Intelligence means getting better over time." Schank [32]

16. "Intelligence is the ability for an information processing system to adapt to its environment with insufficient knowledge and resources." P. Wang [39]

17. "...the mental ability to sustain successful life." K. Warwick quoted in [4]

18. "...the essential, domain-independent skills necessary for acquiring a wide range of domain-specific knowledge – the ability to learn anything. Achieving this with 'artificial general intelligence' (AGI) requires a highly adaptive, general-purpose system that can autonomously acquire an extremely wide range of specific knowledge and skills and can improve its own cognitive ability through self-directed learning." P. Voss [38]

5 Is a single definition possible?

In matters of definition, it is difficult to argue that there is an objective sense in which one definition could be considered to be the correct one. Nevertheless, some definitions are clearly more concise, precise and general than others. Furthermore, it is clear that many of the definitions listed above are strongly related to each other and share many common features. If we scan through the definitions pulling out commonly occurring features we find that intelligence:

- Is a property that an individual agent has as it interacts with its environment or environments.
- Is related to the agent's ability to succeed or profit with respect to some goal or objective.
- Depends on how able the agent is to adapt to different objectives and environments.

Putting these key attributes together produces the informal definition of intelligence that we have adopted,

> "Intelligence measures an agent's ability to achieve goals in a wide range of environments." S. Legg and M. Hutter

Features such as the ability to learn and adapt, or to understand, are implicit in the above definition as these capacities enable an agent to succeed in a wide range of environments. For a more comprehensive explanation, along with a mathematical formalisation of the above definition, see [22] or our forthcoming journal paper.

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