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Development Metrics for Intelligent Systems

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ABSTRACT

The existence of metrics for Intelligent systems is very important in order to evaluate, manage, and classify them. Intelligent information systems (IIS) have become a significant part of our daily lives, institutions, and ongoing business, and it has become necessary to have metrics for Intelligent systems in order to measure the success of organizations in using Intelligent systems. In this study, We will choose a group of metrics for intelligent systems, work to develop them, and then determine their source and method of mitigation. It defines the phrase "intelligent systems metrics" and goes over the key metrics and guidelines that can be used to define IISM as well as which metrics have the biggest influence. The significance of each metric in gauging various intelligent systems will be determined, and when these metrics have been reviewed, the effects of each criterion on IIS will be clear.

CONTENTS

1. Introduction:

This study explores the idea of evaluating and measuring an intelligent system and how it can be regulated and evolved. It also highlights the need to define the metrics of intelligent systems (IS) as they become an intrinsic part of daily interactions and activities. This paper will discuss many definitions of intelligent systems and metrics, describe what those metrics are, and look at their potential influences. This is in addition to its significance and the rundown of earlier research and development efforts.

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Software products face significant difficulties owing to the complexity, imperfection, variety of computers, and organizational, technological, and economic factors in the development of software products [1]. Computational metrics of intelligence are traditionally expected to measure how well a machine performs like a human, chess master, or expert diagnostician [2]. Intelligent systems have become increasingly important to human society, from everyday life to exploration adventures [3], and the definition of an intelligent system may be broader than that of intelligent control. As a "system," there may be more constituent parts, such as perception, world modeling, or value judgement [4], we should expect that no single, unique measure of performance is feasible. Therefore, no single overarching or generic intelligence test will suffice. We need to strive for the correct granularity of metrics [5], and the functional features describing the aspect of intelligent behaviors may obscure the existing internal engine by which intelligent behaviors are generated. answer prior to defining the metric of system intelligence:(a) Should intelligence measure be goal-dependent or goal-independent? (b) Should intelligence measures be time-varying or time-invariant? (c) Should intelligence measure be resource-dependent or resource-independent?[6]

Detailed quantitative metrics of general intelligence are difficult to formulate and are potentially unnecessary. Intelligence generally integrates many parameters, and it is not possible to have an objective general measure [2].

1. Primarily literature Review

The definition of metrics for intelligent systems and the monitoring of their evolution remain issues for the information services community. Intelligent systems with precise specifications are difficult to achieve.

The definition of intelligent systems is a difficult problem and is subject to a great deal of debate. From the perspective of computation, the intelligence of a system can be characterized by its flexibility, adaptability, memory, learning, temporal dynamics, reasoning, and the ability to manage uncertain and imprecise information [8], Intelligent Information Systems (IIS) and their applications in various settings such as data mining, cloud computing, big data, and Internet of Things (IoT) are the focus of many research efforts. The use of these systems to solve real-world problems is on rise [9]. The proportion of time a software system is operational serves as a gauge of its uptime and downtime during a certain period. This is known as the availability. [10]. which are self-explaining, robust, fault tolerant, adaptive, self-optimizing, deductive, learning, cooperative, autonomous, and agile [13] There has been increasing effort for industrial applications of artificial intelligence (AI) systems. This is driven by technical advances in machine learning (ML) techniques, including deep learning [14]. The definition and choice of metrics according to which the value of the property is evaluated, namely, the scales and methods of measurement [15].

An AI system is a property of a system that results in different treatments for different people, objects, or groups. In this context, an accuracy issue exists in relation to the functional correctness and completeness of the system [1]. Ensuring the high quality of certain AI modules is a difficult task, particularly in ML, because of their unpredictable reaction to unforeseen inputs and lack of transparency [20]. Software quality is measured in terms of the software defects found by the customer [21].

operation period

A. Intelligent Systems

Intelligence is still debated. In the dictionary, intelligence is defined as the ability to understand and profit from experience, having the capacity for thought and reason [11]. Intelligent systems are a difficult problem and are subject to a great deal of debate. From the perspective of computation, the intelligence of a system can be characterized by its flexibility, adaptability, memory, learning, temporal dynamics, reasoning, and ability to manage uncertain and imprecise information [30].

B. General and Specific Metrics

The development of software products is a special part, and it uses its own system of measures (characteristics, factors, indicators) [1]. Establishing performance measures for intelligent systems is crucial. We offer a basic explanation and some pointers for creating performance measures in the following sections. It can be challenging to develop precise quantitative measurements of general intelligence, which may not be required. Because intelligence typically incorporates multiple factors, there is no single, overall objective metric for it.

C. Criteria Intelligent Systems Development

Software quality for information systems has been measured using several models, including the McCall, Boehm, FURPS, Dromey, ISO 9126, and ISO 25010 models. Each model was created using a distinct principal or idea, in this research, we will attempt to create a set of standards for intelligent systems that may be used as a reference point and added to the list of standards being developed for smart systems.

2. Related Work.

will discuss a few of the current worldwide metrics and provide a brief explanation of the contents of each metric, such as:

a. ***SQuaRE :*** Analyze the latest Metrics of SQuaRE series to identify how we should adapt them for ML-based AI systems, and how they cover ethics guidelines for trustworthy AI. Specifically, we analyzed what should be modified [**14**].

b. ***McCall‟s***: Having evaluation criteria the bridge the gap between user and system ***developer***, consider users' view and developer priorities, focus on accurate measurement of high-level characteristics, based on three perspectives – Product Revision, Product Operation and Product Transition. **[28]**

c. **Boehm‟s** : is define software quality through a set of ***qualitative*** characteristics and metrics, based on hierarchy arranged according to characteristic level – high, moderate)

d. ***FURPS: is represent abbreviation for Functionality, Usability, Reliability, Performance and Supportability, categorized into two types of requirements – functional and non-functional [28]***

e. ***Dromey‟s: is based on product quality perspective, focus on relationship between software product characteristics and software quality attribute [28]***

f. ***ITIL: was created following a call for projects from the UK Ministry of Commerce and established*** as a standard for the delivery of services. ITIL, Information Technology Infrastructure Library, is an efficient methodology in conveying excellent IT [35].

g. ***CMMI:*** is created by the Software Engineering ***Institute (SEI) at Carnegie*** Mellon University, adopted by the DOD and several American institutions, and has established itself as a standard in the IT field. CMMI identifies three areas of interest: CMMI for Development (CMMI-DEV), CMMI for Services (CMMI-SVC), which is dedicated to service management, and CMMI for acquisition (CMMI-ACQ).[35]

h. ***ISO/IEC Standards:*** the ISO 9001 standard concerns the quality assurance processes for the development, supply, installation, and maintenance of computer software. The ISO/IEC 9126 [5], ISO 8402-1986 ***standard defines*** quality as the totality of features and characteristics of a product or service that bears its ability to satisfy stated or implied needs [10]. for software product quality, which must be used in conjunction with ISO/IEC 14598 for the evaluation of software products. [17,27].

i. ***DIN Spec***: This study provides an outline of the AI ***lifecycle*** process and quality requirements. It outlines three quality pillars: functionality, performance, robustness and comprehensibility [16].

3. Methodology

In this research, a descriptive approach was used by conducting a survey to achieve its objectives and questions. IS-related metrics will be identified from other systems, which are characteristics that distinguish it from the rest of the systems. We then study and detail these metrics in detail to reach a mechanism for measuring these metrics separately, to measure smart systems, and obtain a set of indicators that describe smart systems.

A. Intelligent Systems Metrics

An intelligent system must have the following features: fault tolerance, self-correcting, self-organizing, adaptive, mobile and distributed, networked, robust, context-aware, Seamless Integration, Validation and Certification. [11], intelligent system metrics are important for the following reasons.

a. Metrics define the valuable knowledge of an organization. and best practices in organizations. This was achieved after a large number of operations.
b. Metrics provide a framework for determining "quality" in a given environment. To achieve the required level of quality. This depends on defining the user and product metrics for intelligent systems.
c. Metrics ensure that all users have the same performance.

B. Characteristics Intelligent Systems

Currently, AI standards are being developed in the areas of reliability, robustness, safety, and security. However, the field of technical testing still has considerable room for improvement [18]. Existing quality models in the context of AI include knowledge acquisition, knowledge application, and decision making. Robustness and context completeness are introduced as characteristics that relate to the input domain; bias, functional correctness, and ex-post explain ability (run transparency) as relating to the output decision domain; and adaptability, transparency, societal and ethical risk mitigation as non-functional characteristics **[22],** The following metrics must be current in the context of intelligent systems:

a. The properties of the entry field are as follows: (acquisition, knowledge application, decision production, robustness, and context).
b. Realm of choices and results (bias, functional health, and ability for subsequent interpretation).
c. In relation to flaws that prevent functionality (adaptability, transparency, mitigation of societal and ethical risks).

Table (1): Characteristics that must be present in an IS

characteristics	Description
Learning	Improving performance, benefiting from previous experiences, and increasing knowledge
Fault-tolerant	That is, the intelligent system leads to the work and does not fail in the presence of errors
Self-correcting	The intelligent system automatically corrects the wrong inputs
Self-organizing	The intelligent system organizes its data automatically and updates it
Adaptive	Adapting to business and requirements, regardless of change and circumstances
Distributed	The ability to navigate the system and according to a distributed mechanism for use
Robust	shall not fail and safe to use in all environments
Understand the context	be able to know users, environment and threats, plan for risks, and activate responses in real time
Integration	It must be at multiple levels of a hierarchy: household systems, urban systems, regional systems, and national systems
Authentication	It must be ensured that the intelligent system will work properly with all requirements with a high degree of confidence

C. **Under development Metrics for Intelligent systems [19]**

a. **Metrics ISO/IEC TR 24027 (**information technology, Artificial Intelligence (AI), Bias in AI systems, and AI-aided decision making): To provide techniques and measurement methods to assess bias in particular AI-assisted decision-making, with the aim of addressing bias-related vulnerabilities. All stages of the life cycle of an AI system are within the scope.

b. **Metrics ISO/IEC WD 5338 (**information technology–artificial intelligence–AI system life cycle processes): To provide a process assessment that supports the description, control, and optimization of AI system lifecycle processes used in organizations or projects.

c. **Metrics ISO/IEC AWI TR 5469** (artificial intelligence - functional safety and AI systems): describe properties, relevant risk factors, usable methods, and processes for the application of AI in safety-relevant functions, for the application of safety-relevant functions for the control of AI systems, and for the application of AI in the development of safety-relevant functions.

d. **Metrics ISO/IEC AWI TR 24372 (**Information technology- Artificial intelligence (AI)-Overview of computational approaches for AI systems): provide an overview of the state-of-the-art computational approaches for AI systems by describing the) main computational characteristics of AI systems; b) main algorithms and approaches used in AI systems, referencing use cases contained in ISO/IEC TR 24030.

e. **Metrics ISO/IEC AWI 2505 (**Software engineering -Systems and software Quality Requirements and Evaluation (SQuaRE) -Quality model for AI-based systems): Introduce a quality model for AI systems. This is an application-specific extension of the SQuaRE series. The model characteristics provide consistent terminology for specifying, measuring, and evaluating AI system quality.

f. **Metrics IEEE – ECPAIS** (Ethics Certification Program for Autonomous and Intelligent Systems): The ECPAIS program is meant to create specifications for certification and marking processes that advance transparency, accountability, and reduction in algorithmic bias in autonomous and intelligent systems. ECPAIS intends to offer a process and define a series of marks by which organizations can seek certifications for their processes around the A/IS products, systems, and services they provide.

g. **Metrics IEEE 7010™ -2020 (**IEEE Recommended Practice for Assessing the Impact of Autonomous and Intelligent Systems on Human Well-Being**):** The impact of artificial intelligence or autonomous and intelligent systems (A/IS) on humans is measured by this standard. The overall intent of this standard is the positive effect of A/IS on human well-being. Scientifically valid well-being indices, currently in use and based on a stakeholder engagement process, ground this standard. Product development guidance, identification of areas for improvement, risk management, performance assessment, and the identification of intended and unintended users, uses, and impacts on the human well-being of A/IS are the intents of this standard.

h. **Metrics IEEE P7014™ (**standard for emulated empathy in autonomous and intelligent systems**):** Defines a model for ethical considerations and practices in the design, creation, and use of empathic technology, incorporating systems that have the capacity to identify, quantify, respond to, or simulate affective states

D. **Proposed Metrics for intelligent systems**

The following figure demonstrates how to determine intelligent systems metrics:

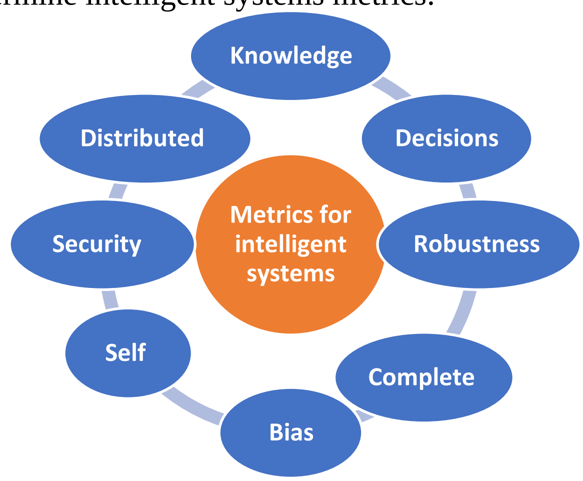

Figure (1) Intelligent systems metrics

1. **Knowledge**: This refers to the ability of an intelligent system to acquire new knowledge and provide the user with meaningful information.
2. **Decisions**: Intelligent systems use a two-stage decision-making process, with the first step being decision making and decision implementation. A decision can be made; however, depending on the results, it loses its effectiveness after it is made.
3. **Adaptability and Robustness**: Intelligent systems have the ability to adapt, which ensures that failure rates are zero regardless of the environment or circumstances. The system's tolerance for user mistakes also ensures that intelligent systems can be used without danger under any circumstances.
4. Complete:'s The ability to be a holistic intern of compliance with all customer requirements.
5. **Self**: As it automatically updates and fixes its data and does not stop working in the midst of problems, it is self-performing and automatic.
6. **Security**: Intelligent systems are exposed to malware, physical infrastructure assaults, human mistakes, social engineering, automated eavesdropping, automated password, spoofing, denial-of-service, and intrusion attacks.

4. Conclusion

In this study, we examined several intelligent system metrics and how they relate to intelligent system control before identifying a set of metrics for intelligent systems. Owing to the scale, diversity, and qualities of intelligent systems, this study cannot be considered exhaustive. The attention that intelligent systems pay to the product and the user varies, and although the majority of the metrics are not brand-new, they are frequently used by intelligent system developers. They can also be used as metrics for the extensive evaluation of intelligent systems, which may be challenging to access and cannot be controlled. Accurate for measuring the quality of intelligent systems.

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