English

As a Technical Language

for Students and Professionals

of Computing and Information Technology

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Introduction

These notes are intended as *supplementary material* for my *Scientific and Technical English* course, offered normally every year in *fall semester* at University of Tabriz. The material presented here include some essays, supplemented by related exercises. I have chosen the essays from my own publications and the exercises are designed and prepared by students of CS'85, attending the course in Fall 1986.

I do not expect the exercises to be all correct and perfect. I do expect, however, that the students to practice and learn from the exercises, improving their comprehension skills, while correcting and improving on the exercises.

In any case, these notes are not intended to replace the course material, which is outlined at http://users.tabrizu.ac.ir/isazadeh/courses/te.htm

Chapter 1, Essay

Software Engineering: The Trend

By:
Ayaz Isazadeh [1]

Abstract

This paper presents the author's view of the current trend in the world of software engineering. Software engineering has already taken the responsibility of providing the necessary tools for organizing, structuring, and making efficient use of the huge volume of information currently floating around. The responsibility of software engineering will increase dramatically by the exponential increases expected in the volume of information. The volume of information, in every branch of science and technology, is getting so high that without a software engineering tool cannot be of any use. This is an extreme power, and responsibility, for software engineering.

The paper provides an analysis of the increasing power and responsibilities associated with software engineering as an engineering discipline, points out the catastrophic results of failures, as well as significance of accuracy and correctness in this discipline, and concludes that software engineering cannot afford to go wrong. The paper then investigates the significance of mathematical foundations and formal approaches to software engineering, specially in the area of software requirements specification. Finally, the paper recommends using a visual formalism, designed based on a representationistic approach, as a sound and simple foundation, for a sound and successful software engineering practice. An example of such a formalism concludes the paper.

Keyword: *Software Engineering, Requirements Engineering, Formal Methods*

1.1 Introduction

Living in an age of information, we have collected and stored a huge volume of information in different media, all around the world. And yet, we are just starting to realize the vast dimensions of the universe, the huge volume of information out there, and the astronomical world of unknowns. Considering what we do not yet know of the universe, the huge volume of information currently floating around will be increasing dramatically! The volume of information we will be dealing with, will be beyond our wildest imagination.

All scientists are in search of information. The search for information is structured as different sciences. In every branch of science the key objective is information. Who can deal with all the information in all sciences? The answer is *software engineering*. Software engineering has already taken the responsibility of providing the necessary tools for organizing, structuring, and making efficient use of the huge volume of information currently floating around. The responsibility of software engineering will increase dramatically by the exponential increases expected in the volume of information. The volume of information, in every branch of science and technology, is getting so high that without a software engineering tool cannot be of any use. Software Engineering is, indeed, heavily involved in all sciences. It appears that no science can live without software engineering tools. This is an extreme power, and responsibility, for software engineering. More research, than currently underway, is required to assure that this powerful too is put to proper work. In this paper, as an small step in this research direction, I investigate the significance of formal approaches and mathematical foundations for software engineering.

1.2 An Engineering Discipline

A hot debate has started years ago and still going on: Is *software engineering* a *science* or an *engineering discipline*? The debate in some prestigious universities is still going on whether software engineering belongs to the *school of engineering* or *faculty of science*. Software engineering is, in fact, an *interdisciplinary* field; it requires mathematics for analysis and proof of correctness, engineering for costs, risks, and tradeoffs, and management for personnel, facilities, and progress.

Software engineering provides the most powerful tools of all sciences. Software engineering is now, and will be more so in the future, providing the very infrastructure of every science. That is, indeed, an extreme power for software engineering. Extreme power, however, requires extreme care. That is why software engineering, today, must be considered as an engineering discipline with all the associated responsibilities.

1.2.1 Problems

The major problem with software engineering practice, currently, is inaccuracy and ambiguity in system requirement specifications. The Ariane 5 Flight 501 Failure was caused by a poor software engineering practice. The causes of the failure were faults in the capture of the overall Ariane 5 application/environment requirements, and faults in the design and the dimensioning of the Ariane 5 on-board computing system [2, 3].

Verrazano Narrows Bridge in New York City, the largest suspension bridge ever built, completed within budget, just on target date. IBM OS project, involving over 5000 man-years of work, completed, finally, well beyond the target date [4]. Why *software engineering* cannot be planned and completed like any other engineering project? Because, software engineering is more complex, and software engineers are not as experienced. Specifically, software engineering is a young discipline and, therefore, the corresponding professional do not yet have adequate education and training, compared to the other engineering professionals. A closer look at the *formal approaches* to software engineering may lead to the solution.

1.3 Formal Approaches

Research on improving the quality of software systems includes using formal methods (e.g., ESTEREL [5], VDM [6], Z [7, 8], Statecharts [9, 10, 11]) for specifying software behaviors and possibly refining the specifications to design and implementation. Despite the controversial issues concerning the practicality of formal methods, there are some undeniable facts:

1. Most of the defects in software systems can be traced back to the requirements phase. Specifically, studies in Bell Labs and IBM have shown that 80% of all defects in software systems are rooted in the requirements phase [12].

2. Accurate requirements specification of software systems, therefore, will improve quality and increase reliability of the software. Accuracy in software systems definition and requirements specification, in turn, demands using formal methods. Formality and mathematics are, generally, becoming more and more useful in all phases of software engineering. Manfred Broy, for example, describes how mathematics can provide a scientific foundation for the modeling aspects, description techniques, and development methods of software engineering, leading to a deeper understanding of the development process [13].

3. For over 20 years, IBM received failure reports on CICS [7]; it was developed without using a formal method. Finally CICS was formally specified using Z

[8]. An overall objective was to reduce the total number of errors, detected both in the development cycle and by customers, and thereby produce a better quality product. Some 2000 pages of specifications were produced. This experience proved that formal methods can be helpful; it became a considerable source of education and discussion in the software engineering community [14].

4. Formal methods have not been practical for large-scale complex systems. The IBM CICS experience proved that formal methods can be helpful, but not necessarily practical. Based on experience with the A-7 project [15], John Guttag and others [16] conclude that one problem with formal methods is size. The difficulties of managing a large volume of formal specifications have made formal methods impractical for large-scale systems.

5. Using formal methods is, indeed, difficult. Part of this difficulty is due to the way in which formal specifications are presented. Large volumes of specifications presented textually, many pages of mathematical/logical statements, are indeed difficult to produce, read, understand, and verify, specially for the user side. We may accept that the specifiers are technical people and are supposed to be experts in producing formal specifications. However, the users who are supposed to at least read, understand, and verify the specifications are not normally too enthusiastic to get involved with such formal texts. The *presentation* of formal specifications, therefore, is an important factor for practicality of formal methods. This is one factor that the software industry has been resisting against using formal approaches in software engineering practices. Visual formalism are introduced as a attempt to simplify presentations of formal specification.

Visual formalisms have the advantage of specifying software systems, formally, using graphical notations. The specification then is accurate, because it is formal, and simple to understand, because it is visual. Visual formal methods, therefore, are already getting popular in software requirements engineering and will be more so in the future.

The State Transition Diagrams (STD) of Finite State Machines (FSM) [17] has a sound mathematical foundation and, therefore, are the best formal technique for systems definitions and requirements specifications. However, in these machines the number of states grows exponentially as the scale of the system grows linearly. This growth leads to a problem known as *blow-up in the number states* for large-scale systems. There has been some relatively successful attempts made, by defining Extended Finite State Machines (EFSM), to solve this problem. The most popular of these attempts is made by Harel, introducing Statecharts.

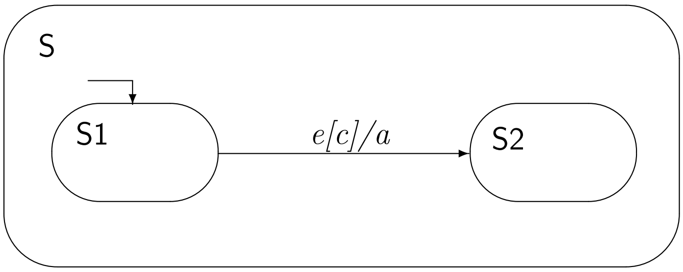

Figure 1.1: An OR-state.

1.3.1 Statecharts

Introduced by David Harel [9, 10, 18, 11], Statecharts is an extension of Finite State Machines (FSM) designed as a formal method for behavior specification of complex systems. Harel and others [19] have also developed a set of tools called STATEMATE for the specification, design, analysis, and documentation of large and complex reactive systems. STATEMATE uses Statecharts for behavior specification of a system under development. In addition, STATEMATE provides *module-charts* and *activity-charts* for specifying the structural and functional view of the system, respectively.

Harel describes Statecharts as:

state diagrams + depth + orthogonality + broadcast communication.

Depth refers to a clustering of some states into a superstate and thus forming a hierarchy of states.

Orthogonality refers to a composition of two or more states into a superstate called an AND-state. If a system enters into an AND-state, it must enter in all the AND components (i.e., immediate substates) of the AND-state. Similarly, if a system exits from an AND-state, it must exit from all the AND components of the AND-state.

In contrast to AND-states, there are also OR-states in Statecharts. If a system enters into an OR-state, it must enter in only one of the immediate substates of the OR-state.

A transition label, in Statecharts, can have three components: *event, condition,* and *action.* In Figure 1.1, for example, if the system is in the state S1 and the event e occurs, while the condition expression c evaluates to true, then the transition from S1 to S2 takes place and the action a is generated. An action generated by a transition can be used as an event in another transition. The action, therefore, must be communicated between the components. The communication mechanism used in Statecharts is broadcasting. For example, when an event occurs or an action is generated, in a statechart, it is sensed throughout the statechart.

The problem with Statecharts is the *complexity of scale.* In conventional finite state machines, as mentioned above, the number of states grows exponentially as the scale of the system grows linearly. This growth leads to a blow-up in the number states for large-scale systems. Drusinsky and Harel [20, 21] prove that Statecharts is exponentially more succinct than finite state machines. The proof is based on the cooperative concurrency mechanism (i.e., orthogonality) of Statecharts and applies for any model that uses this mechanism, such as Petri Nets [22] or CSP [23, 24]. If we assume that an increase in the scale of a system results in additional orthogonal components in the corresponding statechart, then the number of states in the statechart has a linear relationship with the scale of the system; in Harel's words "Statecharts represents the scale of the system" [25]. Orthogonality is, indeed, a powerful feature in Statecharts. However, it is not clear that any increase in the scale of a system does result in additional orthogonal components. For example, if an increase in the scale of a system, corresponds to additional complexities in the existing orthogonal components, then the increase in the number of states would still be exponential.

Another problem with Statecharts is the *global name space*. There is no "visibility" control mechanism in Statecharts. (The term *visibility* is defined in terms of *declaration*, *scope*, and *binding*; a visibility control mechanism, essentially, refers to a mechanism that controls scope [26].) When an event occurs, it is sensed throughout the system and, therefore, it must have a unique name. Managing the name space in the global environment of Statecharts, for large-scale software systems, can be difficult. Name management, in general, is one of the fundamental issues in software engineering [27].

1.3.2 Other Extensions of State Machines

The following is a list of some other extensions of state machines or variations of Statecharts. Leveson's RSML and Selic's ROOMcharts, as described below, provide some mechanisms for reducing the complexity of managing name space. Besides that, none of these machines provide any solutions for the complexity of scale.

- David Carr introduces an executable graphical notation, called Interaction Object Graphs (IOGs) [28], for specification of user interface. This notation combines the data flow and constraint specification of Interface Representation Graphs (IRG) [29] and Statecharts. IOGs, therefore, extends Statecharts to show data relationships as well as control flow.

- Jahanian and Mok introduce another specification language, called Modechart [30], for real-time systems. They also define the semantics of Modechart in terms of Real Time Logic (RTL) [31]. Modechart is originated based on the mode concept of Parnas [15, 32] and Statecharts of Harel; its emphasis, however, is on the specification of absolute timing properties.

- Alan Shaw [33] describes an executable notation, based on communicating real-time state machines (CRSM's), for specifying concurrent real-time systems. CRSM's are state machines that communicate with each other using a CSP-like synchronous scheme [24, 34]. Shaw also provides an algorithm for simulating CRSM's and some techniques for reasoning about the system behavior.

- Charles Hendricksen [35] describes another extension of finite state machines, called the *Augmented State Transition Diagram* (ASTD), and an associated CASE tool called *State-Graph*. ASTD has been used in the definition, design, and implementation of some applications including a PBX phone system and some complex user interface programs.

- Nancy Leveson and others [36] describe their approach to behavior specification of a real aircraft *Traffic Alert and Collision Avoidance System* (TCAS). The specification language used for this system is a variation of Statecharts called *Requirements State Machine Language* (RSML). In RSML, physically distinct components are modeled as separate communicating statecharts. The overall system requirement specification can be viewed as a directed graph (not a statechart), where each node represents a component and each edge represents an intercomponent communication channel. The broadcast communication mechanism of Statecharts is used within each component. Intercomponent communication is provided as directed messages transmitted between components over unidirectional channels. An event, therefore, is local to the component in which it occurs. The event does not affect any other component, unless directly transmitted to another one. Therefore, RSML provides a visibility control mechanism that reduces the complexity of name management. The mechanism, however, has a negative consequence: the direct communication method used for intercomponent communications complicates the specifications.

- ROOM [37] is a specialized high-level modeling language, designed for distributed real-time systems and supported by a modeling environment, the ObjectTime toolset. Software behavior in ObjectTime is expressed by ROOMcharts, which is an extension of Statecharts. ROOMcharts replaces the AND-states of Statecharts by encapsulated entities called *actors* (similar to RSML). It also replaces the broadcast communication of statecharts by a port-to-port message-passing mechanism for communications between the actors. As a result, it reduces the complexity of managing name space.

  ROOM starts with the high level design of software components and leads to their implementations. ROOM is not designed for software requirement specification; it is basically a design notation. However it can be used for requirements analysis at a very high level design phase by prototyping and trying out alternative designs.

1.3.3 OOAD Methods

Some object-oriented analysis and design (OOAD) methods describe the behavior of objects and classes using variations of extended finite state machines. This includes a considerable amount of work in the area of inheritance and refinement of software behavior. Some of this work is outlined below:

- James Rumbaugh and others [38] use an extension of state diagram, based on Harel's Statecharts, to describe the *dynamic model* of Object Modeling Technique (OMT).

- Neal Walters [39] expands on Rumbaugh's work by providing mechanisms for object collaborations: the invocation of object services and interchange of data between objects. Emphasizing the importance of predicting system behavior for validating completeness and analyzing performance, he describes a method for building dynamic models of object-oriented systems using STATEMATE.

- Derek Coleman and others [40] introduce an extension of Statecharts called *Objectcharts* for object-oriented design. They use Objectcharts to specify the behavior of objects and expect that the future work will provide firm semantics for Objectcharts, enabling the behavior of object-oriented systems to be deduced from the specifications of the corresponding objects.

- Finally, the most widely publicized object-oriented method, the Unified Modeling Language (UML) [41, 42, 43], in spite of all its success stories, has not been able to gain the trust of software engineering community for not having a sound mathematical foundation.

  In general, a software engineering methodology, specially in the area of software system definition and requirements specification, cannot succeed unless it has a sound mathematical foundation. The idea of *information hiding*, first proposed by Parnas [44] gave birth to the object oriented methodologies. By mid 90's, these methodologies were going out of momentum for what believed to be their diversity of standards. Introduction of UML, as *the* standard object-oriented notation, was the last attempt made by Object Modeling Group (OMG), to unify the diverse OO methodologies and thereby save the object-oriented approach to software engineering. However, in spite of all the advantages that the unified standard notation could offer, the notation went under attack for not having a sound mathematical foundation.

  There is currently a body of work underway on the importance of, and the need to provide, a sound mathematical foundation for UML. Some of this work is as follows:

  - Martin Glinz investigate the suitability of UML as a semiformal requirements specification language and, using a case study, identify and demonstrate various problems and deficiencies of UML, particularly concerning use case models and system decomposition [45].

- Robert France [46] describes the role that formal specification techniques can play in the development of well-defined standard modeling languages.
- Breu and others [47, 48] are investigating the possibility of integrating different UML description techniques on a sound mathematical foundation by using a common semantic basis for all notions used by UML.
- Fernandez and others [49] use algebraic specification formal theory to formalized the UML Statechart diagrams and thereby verify the specifications.
- Grosu and others [50] are investigating the formal foundation of UML for Real-Time systems (UML-RT).
- Morgan Bjrkander describes a two-language merger, combining UML's expressive power and SDL's semantics strengths, to provide a modeling paradigm for visual software engineering that is supposed to be more effective than either language alone [51].

Each of the methods described above has strong features. They provide the accuracy of formality and simplicity of visualism. They simplify the presentation of formal specifications using their graphic notations, solving the problem of presentation. None of these methods, however, provide any solution for the problem of *blow-up in the number states.* This problem, therefore, makes visual formal methods impractical for large-scale systems. That is, of course, if we try to specify the system as a whole. But, how practical is it to accurately and fully describe a system while we can only work with the "representations" of the system? Next section is devoted to this question.

1.4 Representations

Generally speaking, one can only describe one's "view" of the world. A user's attempt to specify a system, at best, can only result in the specification of his or her "view" of the system. Intuitively, A *view* is a description of the behavior of the system observable from a specific point of view. For a formal definition of *view* see [52]. We also refer to a *view* of a system as a *representation* of the system. "Representation", however, is a much more general term and applies for all entities. Therefore, it deserves a formal definition here.

Formally, r is the *(ρ, t)-representation* of e, if there exists a function ρ and a point in time t, such that $\rho(e, t) = r$. Notice that different functions may produce different representations of a given entity; and a function may produce different representations of a given entity at different times. Using a convention that r refers to the current value of the function, we can eliminate t, simplifying the definition. Thus, we can say r is the *ρ-representation* of e, if there exists a function ρ, such that $\rho(e) = r$. In this case, we can also simply refer to r as a *representation* of e.

With this introduction, therefore, the notion of representation is defined by

$$\begin{array}{rrl} \rho(e,t) = r, & & \text{where} \\ & \rho & \text{is the } \textit{representation function}, \\ & t & \text{is the } \textit{representation time}, \\ & e & \text{is the } \textit{representandum}, \text{ and} \\ & r & \text{is the } \textit{representation}. \end{array} \tag{1.1}$$

Having defined the notion of representation, we can now define "information" by stating, r is *information* about e or r provides some *information* about e, if r is a representation of e. Any representation of an entity, therefore, provides some information about the entity.

Similarly, any representation of a system provides a partial specification of the system.

Furthermore, any representation of a system specifies a view of the system.

If the inverse of ρ is also a function, then $\rho^{-1}(\rho(e)) = e$ and given r we can reproduce e ($\rho^{-1}(r) = e$), in which case r is a *perfect representation* of e. A perfect representation of e provides all the information about e. For example, on the set of positive integers, if $\rho(e) = e^2$, then $\rho(5) = 25$ and $\rho^{-1}(25) = 5$ and, therefore, 25 is a perfect representation of 5. As another example, in the *Theory of Algorithms and Data Structures*, a graph G is routinely represented by its adjacency matrix M [53]. If we define ρ as $\rho(G) = M$, then $\rho^{-1}(M) = G$ and, therefore, M is a perfect representation of G.

Most representations, however, are not perfect. For example, let us consider the function ρ defined on positive integers as

$$\rho(e) = \begin{cases} \text{odd}, & \text{if } e \text{ is an odd number} \\ \text{even}, & \text{otherwise} \end{cases}$$

The inverse of this function is not a function and, therefore, the corresponding representations are not perfect. By this definition, all odd numbers are represented as "odd". The representation "odd" is not enough to reproduce the representandum. However, there are cases, where it can be useful just to know whether the number is odd or even. In general, there are cases, where we want only as much information about an entity as we need and not more. This is because, it serves no purpose to collect and carry around more information about the entity than we need; besides, not all the information on the entity is necessarily available. In other words, for many entities, imperfect representations of the entity are all that we have to work with. In addition, a representation of a representandum can be further represented, creating a hierarchy of representations. In fact, each layer of the communication protocols is described by one level of the corresponding hierarchical representations.

Our notion of representation and the consequent definition of information and specification are consistent with, and describe, most of the familiar concepts. For example:

- *Out-of-date and Up-to-date Information:* If the value of t, in the Equation (1.1), is equal to an old time, then the corresponding information is said to be *out-of-date*. For the *up-to-date* information t must specify the current time.

- *Volume of Information:* In data communication, a message m is represented as $\rho(m)$, transmitted to the destination, where the original message m is reproduced by $m = \rho^{-1}(\rho(m))$. The volume of information contained in the message is $\log_2(n)$ bits, where n is the size of domain of ρ. That is, the number of bits required to code a message out of n possible messages is $\log_2(n)$ [54]. The logarithmic base 2 is for our choice of "bit" as the unit of measuring information, considering that a bit consists of 2 states. If we choose a another mechanism, consisting of b states, then the logarithmic base will be b.

- *Misinformation (Error) or Inconsistent Specification:* A representation may not reflect the true state of the world, in which case it is misrepresentation, misinformation, or error.

  Formally, $r = \rho(e)$ is misinformation if $\rho^{-1}(r)$ is inconsistent with e. In particular, where perfect representations are required, $r = \rho(e)$ is misinformation if $\rho^{-1}(r) \neq e$.

In addition, our notion of representation provides a new view of the world. I call this view of the world *representationism*, which is the way in which we deal with entities, in representing, manipulating, transferring, and reproducing them. The representationistic approach to study an entity, in general, is to extract representations of the entity, study them, and compose the results to construct knowledge of the entity. Notice that this is different from the well known *reductionistic*, (in contrast to *holistic*) approach in the philosophy of science. In reductionism, a whole is dissected into pieces, each piece is studied and analyzed separately, and then the results are synthesized and integrated. There are similarities, but also major differences: The pieces in reductionism are smaller parts of the whole, while the representations in representationism are simple and mostly imperfect representations of the entire whole. There we have a picture of a section, while here we have a picture of the whole, but from a specific point of view.

Critics of science have portrayed reductionism as an *obsessional disorder, declining toward a terminal stage, as one writer recently dubbed "reductive megalomania"* [55]. This criticism does not apply for representationism. Because, the representationistic approach to study an entity, reduces the problem by describing it in terms of simple representations, but unlike reductionism, keeps the entity intact.

An example of a representationistic approach to system specification is a formalism called Viewcharts.

1.4.1 Example

The Viewcharts formalism [52], designed based on a representationistic approach, is the most recent attempt to resolve the complexity of scale. In Viewcharts, the behavior of a system is specified, formally and visually, as a composition of "views". Intuitively, as discussed above, A *view* (or *behavioral view*) is a complete description of the behavior of the system observable from a specific point of view. Using this notion of view, the formalism is designed to specify the behavioral requirements of large-scale complex systems on a *need-to-specify* basis. In Viewcharts, one does not have to specify the full behavior of a system and, therefore, is not concerned with the complexity or scale of the system. A complex system may consist of many different sub-systems and components, distributed worldwide, and it may exhibit a combination of many different and identical behavioral views. Current research and industrial advances in networking and distributed systems indicate that software systems will continue to get larger and more complex. One cannot envision producing an integrated behavioral requirements specification for an arbitrarily large and complex system. However, if we define the behavior of a system in terms of behavioral views, then all we need to do is to specify the views of our interest. The Viewcharts formalism allows these views to be specified independent of each other.

Furthermore, views in Viewcharts limit the scope of broadcast communication, solving the problem of *global name space*.

It is, therefore, expected that the Viewcharts formalism will be practical in large-scale systems behavioral specifications.

1.5 Conclusion

Software engineering is involved, deeply, in every science and technology. Software engineering provides the very infrastructure of every science and technology. With all these responsibilities, software engineering cannot afford to go wrong. Software engineering, therefore, has no choice but to go formal. Software engineering requires professionals, educated and trained in working on a sound foundation. A software engineer, before writing down the first line of code, must be able to do different kinds of mathematical analysis on his/her design and prove that the system-to-be-developed is specified correctly, consistently, without ambiguity, and once it is developed, is going to work as specified. The universities, professional schools, and education centers, in this field, are responsible for training the software engineers, prepared to face the challenging tasks ahead. And, that is the trend.

In addition to an analysis of the responsibilities associated with software engineering and the corresponding trend, the contribution of this paper can be summarized as an approach to the way in which *information*, in general, and *software systems*, in particular, can be defined and specified. The paper has proposed a representationistic approach to software definition and specification. In this approach we do not deal with a system as a whole, we deal with different representations of the system and, thereby, simplify the system definition, specification, and analysis.

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Chapter 2, Exercise

On Comprehension of the Essay,

Software Engineering: The Trend

This is an exercise chapter; it is intended to test and improve comprehension of the essay presented in previous chapter.

Design and preparation of all the exercises are started by students of CS'85, attending an introductory course on *Technical English*.

I do not expect the exercises to be all correct and perfect. I do believe, however, that they would serve students to improve their comprehension skills.

I expect the students to practice and learn from the exercises, while correcting and improving on them; should be a good experience.

I will keep editing, organizing, and revising the exercises, for as long as I find them useful.

2.1 On the "Abstract"

Read the *Abstract*, on page 8 and do the following exercises:

Compliments of Reza[1]

2.1.A. Fill in the blanks with the appropriate words or phrases.

1. . . . . has taken the responsibility of providing the necessary tools for organizing, structuring and making efficient use of the information.

2. The increases in the volume of . . . . will increase the responsibility of software engineering.

3. The paper provides an analysis of the increasing . . . . and . . . . associated with software engineering as an engineering discipline.

4. Mathematical foundations and formal approaches are significant, specially in the area of software requirements . . . .

5. An example of a . . . . concludes the paper.

2.1.B. Determine whether the statements are *True* or *False*.

1. The current trend in the world of software engineering is not a very efficient approach

   True ☐ *False* ☐

2. The increment in the volume of information is not ignorable in different branches of science and technology

   True ☐ *False* ☐

3. The decrement in the volume of information is the main reason for the increment in the responsibility of software engineering

   True ☐ *False* ☐

4. Catastrophic results of failures indicate that software engineering can not always be an efficient discipline

   True ☐ *False* ☐

[1] This exercise is designed by Reza Yeganeh, CS'85.

5. A visual formalism is a good foundation for a successful software engineering practice

   True ☐ *False* ☐

2.1.C. Pick the most appropriate choice, for each question.

1. What is the main topic of the paper?

   (a) a specific trend in algorithm designing ☐

   (b) software engineering practice ☐

   (c) different branches of science and technology ☐

   (d) mathematical foundations ☐

2. The volume of information in different branches of science and technology . . . .

   (a) is getting so high. ☐

   (b) doesn't have anything to do with the information management. ☐

   (c) requires a software engineering tool. ☐

   (d) a and c ☐

3. Which one plays a critical role in the area of software requirements specification?

   (a) software engineering practice ☐

   (b) science and technology ☐

   (c) visual formalism ☐

   (d) mathematical foundations ☐

4. Which statement is NOT true?

   (a) In the area of software requirements specification, mathematical foundations and formal approaches to software engineering are very important. ☐

   (b) The increases in the volume of information will cause the responsibility of software engineering to increase. ☐

   (c) The catastrophic results of failures are not indicated in the paper in comparison to the successes of software engineering practice. ☐

   (d) Making efficient use of the plenty of information is a goal for software engineering practice. ☐

5. Which one is mentioned in the text?

   (a) reverse engineering trend ☐
   (b) a specific discipline in software designing ☐
   (c) visual basic functions ☐
   (d) none of the above ☐

2.1.D. Answer the questions.

1. What is the significant responsibility of the software engineering?
2. What causes the responsibility of software engineering to increase?
3. What is mainly analyzed in the paper?
4. What is the paper's recommendation for a successful software engineering?
5. What are the two significant matters in the area of software requirements specification?

2.1.E. Write your understanding of the text, specified bellow, in your own language.

The first paragraph ("This paper presents...") of the Abstract on page 8

2.2 On the "Introduction"

Read Section 1.1, the *Introduction*, on page 10 and do the following exercises:

Compliments of Farid & Mahdi[2]

2.2.A. Fill in the blanks with the appropriate words or phrases.

1. In Every branch of science the key objective is . . . .
2. . . . . has already taken the responsibility of providing the necessary tools for organizing, structuring, and making efficient use of the huge volume of information.
3. Living in the age of information, we have collected and stored a huge volume of information in . . . . all around the world.
4. All scientists are in the search of . . . .
5. . . . . is, indeed, heavily involved in all sciences.

2.2.B. Determine whether the statements are *True* or *False*.

1. The responsibility of software engineering will increase dramatically by exponential decrease expected in the volume of information.
   True ☐ *False* ☐
2. The volume of information in very branch of science and technology, is getting so high that without a information technology cannot be of any use.
   True ☐ *False* ☐
3. All scientists are in search of data bases.
   True ☐ *False* ☐
4. Who can deal with all information in all sciences? the answer is software engineer.
   True ☐ *False* ☐
5. The search for information is not structured as different sciences.
   True ☐ *False* ☐

[2]This exercise is designed by Farid Bekran and Mahdi Mousavi, CS'85.

2.2.C. Pick the most appropriate choice, for each question.

1. Why the huge volume of information currently floating around will be increasing dramatically?
   - (a) Because we have collected and stored a huge volume of information. ☐
   - (b) Because we are living in an age of information. ☐
   - (c) Because every branch of science need information. ☐
   - (d) None of them. ☐
2. Why software engineering is important?
   - (a) The volume of information is increasing. ☐
   - (b) All scientists is in search of information. ☐
   - (c) We are just starting to realize the vast dimension of universe. ☐
   - (d) The search for information is structured as different sciences. ☐
3. It appears that no science can live without what?
   - (a) software engineering. ☐
   - (b) software. ☐
   - (c) information. ☐
   - (d) computer. ☐
4. In this sentence what is "this powerful tool? (More research, than currently underway, is required to assure that this powerful too is put to proper work.)
   - (a) software engineering. ☐
   - (b) software. ☐
   - (c) information. ☐
   - (d) computer. ☐
5. The search for what is structured as different sciences?
   - (a) information. ☐
   - (b) powerful tool. ☐
   - (c) scientists. ☐
   - (d) Non of them. ☐

2.2.D. Answer the questions.

1. Why no science can live without software engineering tools?
2. Why we have collected and stored a huge volume of information?
3. What is investigated in this paper?
4. Why all scientists are in search of information?
5. Why we need software engineering?

2.2.E. Write your understanding of the text, specified bellow, in your own language.

The second paragraph (“All scientists...”) of Section 1.1 on page 10

2.3 On the "An Engineering Discipline"

Read Section 1.2, the *An Engineering Discipline*, on page 10 and do the following exercises:

Compliments of Sina[3]

2.3.A. Fill in the blanks with the appropriate words or phrases.

1. Software engineering is, in fact, an . . . . field.
2. Software engineering requires mathematics for . . . .
3. Software engineering requires . . . . for costs, risks, and tradeoffs.
4. Software engineering is now, and will be more so in the future, providing the very . . . . of every science.
5. Software engineering, today, must be considered as an engineering discipline with all the associated . . . .

2.3.B. Determine whether the statements are *True* or *False*.

1. The debate in some prestigious universities is still going on whether software engineering belongs to the school of arts or faculty of science.
   True ☐ *False* ☐
2. Software engineering is, in fact, an interdisciplinary field.
   True ☐ *False* ☐
3. Software engineering requires Engineering for analysis and proof of correctness.
   True ☐ *False* ☐
4. Software engineering requires management for personnel, facilities, and progress.
   True ☐ *False* ☐
5. Software engineering provides the most powerful tools of all sciences.
   True ☐ *False* ☐

[3] This exercise is designed by Sina Khanmohammadi, CS'85.

2.3.C. Pick the most appropriate choice, for each question.

1. The debate in some prestigious universities is still going on whether software engineering belongs to the school of . . . . or faculty of science.

   (a) Engineering ☐
   (b) Arts ☐
   (c) Law ☐
   (d) Physics ☐

2. Software engineering provides the most powerful . . . . of all science.

   (a) Subjects ☐
   (b) Definition ☐
   (c) Tools ☐
   (d) Answers ☐

3. Extreme power, however, requires extreme . . . .

   (a) Responsibilities ☐
   (b) Care ☐
   (c) Tools ☐
   (d) Engineers ☐

4. Software engineering requires . . . . for analysis and proof of correctness.

   (a) Mathematics ☐
   (b) Psychologies ☐
   (c) Physics ☐
   (d) Mechanics ☐

5. Software engineering requires . . . . for costs, risks, and tradeoffs.

   (a) Science ☐
   (b) Arts ☐
   (c) Engineering ☐
   (d) Law ☐

2.3.D. Answer the questions.

1. Is software engineering a science or an engineering discipline?
2. Why Does Software Engineering require Mathematics?
3. Why Does Software Engineering require Management?
4. What is the extreme power of software engineering?
5. Why software engineering, today, must be considered as an engineering discipline with all the associated responsibilities?

2.3.E. Write your understanding of the text, specified bellow, in your own language.

The first paragraph ("A hot debate...") of Section 1.2 on Page 10

2.4 More on the "An Engineering Discipline"

Read Section 1.2, the *An Engineering Discipline*, on page 10 and do the following exercises:

Compliments of Salma[4]

2.4.A. Fill in the blanks with the appropriate words or phrases.

1. Is software engineering an . . . . or a science
2. Software engineering is, in fact, an . . . . field
3. . . . . requires mathematic for analysis and proof of correctness
4. Software engineering provides the most . . . . tools of all sciences
5. Extreme power, requires extreme . . . .

2.4.B. Determine whether the statements are *True* or *False*.

1. A hot debate-an engineering discipline-has finished years ago
   True ☐ *False* ☐
2. Software engineering is an engineering tool
   True ☐ *False* ☐
3. Software engineering is providing the infrastructure of every science
   True ☐ *False* ☐
4. In all universities whole the world, software engineering belongs to the school of engineering
   True ☐ *False* ☐
5. Software engineering requires management for personnel and progress
   True ☐ *False* ☐

2.4.C. Pick the most appropriate choice, for each question.

1. Is software engineering a science or an engineering discipline?

   (a) A science ☐

[4] This exercise is designed by Salma Kheiravar, CS'85.

(b) An engineering discipline ☐
(c) a and b ☐
(d) none ☐

2. Extreme power, however, requires extreme...

(a) tool ☐
(b) care ☐
(c) science ☐
(d) Knowledge ☐

3. What software engineering provides?

(a) The most powerful tool of computer science ☐
(b) The most powerful tools of all sciences ☐
(c) The most important tool of computer engineering ☐
(d) The most important tool of mathematic science ☐

4. Software engineering requires...

(a) mathematics and proof of correctness ☐
(b) mathematics and engineering ☐
(c) management and progress ☐
(d) management and mathematics ☐

5. Software engineering requires management for...

(a) facilities ☐
(b) progress ☐
(c) personnel ☐
(d) a, b and c ☐

2.4.D. Answer the questions.

1. Why software engineering is an interdisciplinary field?
2. What will be provide by software engineering in the future?
3. What is the requirement of mathematics?
4. Why software engineering requires management?
5. Explain that, why software engineering must be considered as an engineering discipline, today?

2.4.E. Write your understanding of the text, specified bellow, in your own language.

The second paragraph ("Software engineering provides...") of Section 1.2 on page 10

2.5 On the "Problems"

Read Section 1.2.1, the *Problems*, on page 11 and do the following exercises:

Compliments of Batool & Manizheh[5]

2.5.A. Fill in the blanks with the appropriate words or phrases.

1. The major problem with software engineering practice, is . . . . and ambiguity in system requirement specifications.

2. The causes of the failure of the Ariane 5 Flight were faults in the . . . .

3. Software engineers are not as . . . .

4. Software engineering cannot be . . . . and completed like any other engineering project.

5. The Ariane 5 Flight 501 Failure was caused by a . . . . software engineering practice.

2.5.B. Determine whether the statements are *True* or *False*.

1. The Ariane 5 Flight 501 Failure was because of the poor performance of the designers.

   True ☐ *False* ☐

2. Software engineering poor performance is just because of it's complexity.

   True ☐ *False* ☐

3. we should train more professionals to solve our problems.

   True ☐ *False* ☐

4. Accuracy in system requirement specifications is very important.

   True ☐ *False* ☐

5. IBM OS project completed just on target date.

   True ☐ *False* ☐

[5] This exercise is designed by Manizheh Ghaemi and Batool Fathi, CS'85.

2.5.C. Pick the most appropriate choice, for each question.

1. we can understand that....
   - (a) software engineering is an old discipline. ☐
   - (b) education in software engineering is not sufficient. ☐
   - (c) software engineering can be planned like other projects. ☐
   - (d) software engineering problems can not be solved. ☐
2. Software engineering....
   - (a) is completely accurate. ☐
   - (b) has no problem achieving its goals. ☐
   - (c) is more complex. ☐
   - (d) is inaccurate in system specification. ☐
3. Software engineers ....
   - (a) are skillfully trained . ☐
   - (b) are not as experienced . ☐
   - (c) completed a project on target date . ☐
   - (d) couldn't find any solution . ☐
4. All the sentences listed below is correct except...
   - (a) Inaccuracy and ambiguity are major problems with software engineering. ☐
   - (b) Software engineers are not as experienced. ☐
   - (c) Software engineers do not have adequate education. ☐
   - (d) Software engineering projects can be completed on target date. ☐
5. Which statement is true
   - (a) There was failure in Verrazano Narrows Bridge project. ☐
   - (b) IBM OS project failure was caused by a poor software engineering. ☐
   - (c) Software engineering's advantage is accuracy. ☐
   - (d) Formal approaches are solutions to Software engineering problems. ☐

2.5.D. Answer the questions.

1. What may inaccuracy and ambiguity in system requirement specifications cause?
2. What is the difference between software engineering professionals and other professionals?
3. How could the formal approaches to software engineering help us?
4. What is wrong with software engineering projects?
5. When was the IBM OS project completed?

2.5.E. Write your understanding of the text, specified bellow, in your own language.

The second item ("Verrazano Narrows...") in Section 1.2.1 on Page 11

2.6 On the "Formal Approaches"

Read Section 1.3, the *Formal Approaches*, on page 11 and do the following exercises:

Compliments of Arsalan[6]

2.6.A. Fill in the blanks with the appropriate words or phrases.

1. Research on improving the . . . . of software systems includes using formal methods.
2. Accurate requirements specification of software systems, therefore, will . . . . quality and . . . . reliability of the software.
3. Using formal methods is . . . .
4. The difficulties of managing a large volume of formal specifications have made formal methods . . . . for large-scale systems.
5. The users who are supposed to at least . . . . , ... , and . . . . the specifications are not normally too enthusiastic to get involved with formal texts.

2.6.B. Determine whether the statements are *True* or *False*.

1. For over 20 years IBM did not receive any failure reports on CICS
   True ☐ *False* ☐
2. Formality and mathematics are becoming more useful in all phases of software engineering
   True ☐ *False* ☐
3. Part of the difficulty of formal methods is due to the way in which they are written
   True ☐ *False* ☐
4. Visual formalism are introduced as a way to simplify presentations of formal specification
   True ☐ *False* ☐
5. The formal specifications are accurate
   True ☐ *False* ☐

[6] This exercise is designed by Arsalan Zoghi, CS'85.

2.6.C. Pick the most appropriate choice, for each question.

1. Which studies have shown that 80% of all defects is software systems are rooted in the requirements phase?

   (a) IBM ☐
   (b) BELL ☐
   (c) OXFORD ☐
   (d) Choice 1 and 2 ☐

2. Which one is not expected from an nonexpert user?

   (a) To read formal specifications ☐
   (b) To understand formal specifications ☐
   (c) To write formal specifications ☐
   (d) To verify formal specifications ☐

3. What was done to solve the problem of *blow-up in the number of states*?

   (a) EFSM ☐
   (b) STD ☐
   (c) FSM ☐
   (d) CICS ☐

4. Which one has an advantage?

   (a) Visual formalism ☐
   (b) Natural formalism ☐
   (c) Visual programming ☐
   (d) Natural programming ☐

5. Visual formal methods are...

   (a) getting old ☐
   (b) getting popular ☐
   (c) new ☐
   (d) the best ☐

2.6.D. Answer the questions.

1. What is "blow-up in the number of states" ?
2. What made formal methods impractical for large-scale systems?
3. What STD stands for?
4. What did STD and FSM do?
5. What do accuracy in software systems definition and requirements specification demands in return?

2.6.E. Write your understanding of the text, specified bellow, in your own language.

The second item ("Accurate requirements...") in Section 1.3 on page 11

2.7 On the "Statecharts"

Read Section 1.3.1, the *Statecharts*, on page 13 and do the following exercises:

Compliments of Sara[7]

2.7.A. Fill in the blanks with the appropriate words or phrases.

1. . . . . in Statecharts can have three components.

2. The number of states in the Statecharts has a . . . . with the scale of system.

3. Name management, in general, is one of the . . . . issues in software engineering.

4. The problems with Statecharts is the . . . . and . . . .

5. In contrast to AND-states, there are also . . . . in Statecharts.

2.7.B. Determine whether the statements are *True* or *False*.

1. Statecharts use module-charts for behavior specification of a system under development

   True ☐ *False* ☐

2. A transition label, in Statecharts can have five components

   True ☐ *False* ☐

3. The action must be communicated between the components

   True ☐ *False* ☐

4. If a system exits from AND-states, it must exits from all the AND components of AND-states

   True ☐ *False* ☐

5. Number of states in the Statecharts has a non-linear relationship with the scale of the system

   True ☐ *False* ☐

[7] This exercise is designed by Sara Mohammadi, CS'85.

2.7.C. Pick the most appropriate choice, for each question.

1. Which one is not a component of a transition label?

   (a) event ☐
   (b) condition ☐
   (c) action ☐
   (d) depth ☐

2. Which choice is in Statecharts, as described by Harel?

   (a) depth ☐
   (b) orthogonality ☐
   (c) state diagram ☐
   (d) all of them ☐

3. What is the fundamental issue in software engineering?

   (a) visibility ☐
   (b) managing the name space ☐
   (c) name management ☐
   (d) none of them ☐

4. Which of these choices are the problem with Statecharts?

   (a) global name space ☐
   (b) complexity of scale ☐
   (c) transition label ☐
   (d) a and b ☐

5. What is an extension of FSM designed as a formal method for behavior specification of complex system?

   (a) Statecharts ☐
   (b) statemate ☐
   (c) action ☐
   (d) global name space ☐

2.7.D. Answer the questions.

1. What does Statemate provide for specifying the system?
2. How many components can a transition label have?
3. How is the term ”visibility” defined?
4. What is the orthogonality?
5. For what purposes are Statecharts designed?

2.7.E. Write your understanding of the text, specified bellow, in your own language.

The sixth paragraph (“A transition label...”) of Section 1.3.1 on page 13

2.8 On the "Other Extensions of State Machines"

Read Section 1.3.2, the *Other Extensions of State Machines*, on page 14 and do the following exercises:

Compliments of Hossein and Hassan[8]

2.8.A. Fill in the blanks with the appropriate words or phrases.

1. The IOG notation combines the data flow and . . . . specification of Interface Representation Graphs.

2. Alan Show and David Carr introduces an . . . . notation.

3. In RSML distinct . . . . are physically modeled as sperate communicating . . . .

4. Software behavior in Object Time is expressed by . . . . , which is an extension of . . . .

5. ROOM starts with the high level design of software . . . . and leads to their . . . .

2.8.B. Determine whether the statements are *True* or *False*.

1. David Carr introduces an executable graphical notation.
   True ☐ *False* ☐

2. Modechart is originated based on the mode concept of Harel and statecharts of Parnas.
   True ☐ *False* ☐

3. Shaw's notation is based on communicating real-time state machines.
   True ☐ *False* ☐

4. In RSML, an event occurring in a component applies for other components, as well.
   True ☐ *False* ☐

5. ROOM is a specialized high-level modeling language.
   True ☐ *False* ☐

[8] This exercise is designed by Hossein Azarbonyad and Hassan Dana, CS'85.

2.8.C. Pick the most appropriate choice, for each question.

1. David Carr introduces an executable graphical notation called . . . .

   (a) RTL ☐
   (b) CRSM ☐
   (c) IOG ☐
   (d) TCAS ☐

2. Alan Show describes an . . . . notation, based on communicating real-time state machines.

   (a) Graphical ☐
   (b) Executable ☐
   (c) Finite ☐
   (d) Visible ☐

3. Charles Hendricksen describes an extension of finite state machine, called . . . .

   (a) ASTD ☐
   (b) RSML ☐
   (c) ROOM ☐
   (d) IRG ☐

4. The broadcast communication mechanism of . . . . is used within each component.

   (a) ROOMchart ☐
   (b) State Machine ☐
   (c) Statechart ☐
   (d) RSML ☐

2.8.D. Answer the questions.

1. What do Leveson's RSML and Selic's Roomcharts provide?
2. What does IOG combine?
3. What does Modechart emphasize?
4. What is the CRSM?
5. Where is ASTD used?

2.8.E. Write your understanding of the text, specified bellow, in your own language.

The first item ("David Carr...") in Section 1.3.2 on page 14

2.9 On the "OOAD Methods"

Read Section 1.3.3, the *OOAD Methods*, on page 16 and do the following exercises:

Compliments of Batool & Manizheh[9]

2.9.A. Fill in the blanks with the appropriate words or phrases.

1. The methodologies were going out of momentum for what believed to be their . . . .
2. UML, in spite of all its success stories, has not been able to gain the trust of . . . .
3. There is currently a body of work underway on the importance of a sound . . . . for UML.
4. The object-oriented methodologies were developed from the idea of . . . .
5. The . . . . formalism is a consequence of an attempt to solve the problem of blow-up in the number states.

2.9.B. Determine whether the statements are *True* or *False*.

1. The Unified Modeling Language has no advantage.

   True ☐ *False* ☐
2. Introduction of UML, as the standard object-oriented notation, was the last attempt made by OMG.

   True ☐ *False* ☐
3. The major problem of software engineering methodologies is in the area of software system definition.

   True ☐ *False* ☐
4. All of the methodologies were successful.

   True ☐ *False* ☐
5. For solving the problem of blow-up in the number states we must specify the system as a whole.

   True ☐ *False* ☐

[9]This exercise is designed by Manizheh Ghaemi and Batool Fathi, CS'85.

2.9.C. Pick the most appropriate choice, for each question.

1. The Unified Modeling Language....
   - (a) was not reliable anymore ☐
   - (b) was completely successful ☐
   - (c) do not have a sound mathematical foundation ☐
   - (d) was the first attempt made by OMG ☐
2. The idea of information hiding....
   - (a) was given birth by mid 90's ☐
   - (b) was going out of momentum for what believed to be their diversity of standards ☐
   - (c) first proposed by OMG ☐
   - (d) gave birth to the object oriented methodologies ☐
3. All the sentences listed below is correct except...
   - (a) UML and SDL together is better than either language alone. ☐
   - (b) UML has semantic power and SDL has expressive strength. ☐
   - (c) Algebraic specification formal theory was used in formalizing the UML Statechart diagrams. ☐
   - (d) Grosu and others are investigating the formal foundation of UML for Real-Time systems. ☐
4. Each of the methods mentioned....
   - (a) provide solution for the problem of blow-up in the number states. ☐
   - (b) provide the ambiguity of formality of visualism. ☐
   - (c) provide the accuracy of simplicity of visualism. ☐
   - (d) could find a solution for the problem of presentation. ☐
5. Robert France investigate....
   - (a) the formal foundation of UML ☐
   - (b) the role that formal specification techniques can play in the modeling language ☐
   - (c) suitability of UML as a semiformal requirements specification language ☐
   - (d) possibility of integrating different UML description techniques ☐

2.9.D. Answer the questions.

1. How did the methods solve the problem of presentation?
2. What was the last attempt made by OMG?
3. Why did the notation go under attack?
4. Who gave birth to the object-oriented methodologies?
5. Why are UML and SDL together effective than either language alone?

2.9.E. Write your understanding of the text, specified bellow, in your own language.

The second item (“Neal Walters...”) in Section 1.3.3 on Page 16

2.10 More on the "OOAD Methods"

Read Section 1.3.3, the *OOAD Methods*, on page 16 and do the following exercises:

Compliments of Nasim[10]

2.10.A. Fill in the blanks with the appropriate words or phrases.

1. James Rumbaugh and others use an extension of . . . .
2. NEAL Waters describes a method for building dynamic models of object-oriented systems using . . . .
3. Derek Coleman and others introduce an extension of statecharts called . . . .
4. Derek Coleman and others use objectcharts to specify the behavior of . . . .
5. some OOAD methods describe the behavior of . . . . using variations of extended finite state machines.

2.10.B. Determine whether the statements are *True* or *False*.

1. James Rumbaugh and others work by providing mechanism for object collaborations

   True ☐ *False* ☐
2. Derek Coleman introduce an extension of statecharts

   True ☐ *False* ☐
3. NEAL Waters and others use an extension of state diagram

   True ☐ *False* ☐
4. Derek Coleman and others describe a method for building dynamic models of object-oriented systems using statemate

   True ☐ *False* ☐
5. Harel use an extension of state diagram, based on James Rumbaugh's statecharts

   True ☐ *False* ☐

[10]This exercise is designed by Nasim Nobary, CS'85.

2.10.C. Pick the most appropriate choice, for each question.

1. How did OOAD methods describe...?

   (a) the behavior of objects ☐

   (b) the behavior of classes ☐

   (c) the behavior of using variations of extended finite state machines ☐

   (d) the behavior of object and classes ☐

2. What did James Rumbaugh and others describe...?

   (a) dynamic model ☐

   (b) the behavior of objects ☐

   (c) the behavior of classes ☐

   (d) b and c ☐

3. Who expanded on James Rumbaugh's work...?

   (a) NEAL waters ☐

   (b) Harel ☐

   (c) Derek Coleman ☐

   (d) Derek Coleman and NEAL waters ☐

4. What did Derek Coleman and others introduction call ...?

   (a) dynamic models ☐

   (b) objectcharts ☐

   (c) OOAD methods ☐

   (d) none of theme ☐

5. what did Derek Coleman and others use to specify the behavior of objects...?

   (a) OOAD methods ☐

   (b) OTM ☐

   (c) dynamic models ☐

   (d) objectcharts ☐

2.10.D. Answer the questions.

1. What did Derek Coleman and others call their introduction?
2. How do James Rumbaugh and others describe the dynamic model of OTM?
3. Who described a method for building dynamic models?
4. What did James Rumbaugh and others describe by using an extension of diagram?
5. What did NEAL Waters do?

2.10.E. Write your understanding of the text, specified bellow, in your own language.

The first item (“Some object-oriented...”) in Section 1.3.3 on Page 16

2.11 On the "Representations"

Read Section 1.4, the *Representations*, on page 17 and do the following exercises:

Compliments of Kamellia & Milad[11]

2.11.A. Fill in the blanks with the appropriate words or phrases.

1. If r is a representation of e, then we say .... is information about ....
2. A graph G is routinely represented by ....
3. There are ...., where we want only as much information about an .... as we need not more.
4. It .... no purpose to .... and carry .... more information about the entity than we need.
5. For many entities .... representation of the entity are all that we have to work.
6. Each layer of communication .... is described by one level corresponding .... representation.
7. Over notion of representation and the .... Definition of information and specification are .... With, and describe most of the familiar ....
8. A message is represented by $\rho(m)$, transferred to a destination, and reproduced by ....
9. Our notion of representation provides a new view of world that called ....
10. In .... a whole dissected into pieces.

2.11.B. Determine whether the statements are *True* or *False*.

1. Different functions produce same representation

   True ☐ *False* ☐

[11] This exercise is designed by Kamellia Reshadi and Milad Rahmani, CS'85.

2. Assuming $\rho(e) = r$, then r is referred to as a representation of e

   True ☐ *False* ☐

3. We define the information first and then representation

   True ☐ *False* ☐

4. All representations are perfect

   True ☐ *False* ☐

5. All the information on the entity is available

   True ☐ *False* ☐

6. Many entities the perfect representation of the entity are all that we have to work

   True ☐ *False* ☐

7. In reductionism dissected pieces studied and analyzed separately

   True ☐ *False* ☐

2.11.C. Pick the most appropriate choice, for each question.

1. If the value of t in the Equation (1.1) is equal to an old time, then the corresponding information is said to be ...?

   (a) out-of-data ☐

   (b) volume of information ☐

   (c) misinformation ☐

   (d) a and c ☐

2. A representation may not reflect the true state of the world, in which case it is ...

   (a) out-of-data ☐

   (b) volume of information ☐

   (c) misinformation ☐

   (d) a and c ☐

3. Definition of function ρ can be useful when ...?

   (a) it serves no purpose to collect and carry around more information about an entity than we need ☐

   (b) not all the information on the entity is necessarily available ☐

   (c) the inverse of the function is a function ☐

(d) all of them ☐

4. Each layer of the communication protocols is described by one level of the ... hierarchical representation?

(a) different ☐
(b) corresponding ☐
(c) special ☐
(d) a and c ☐

5. The notion of representation is defined by $\rho(e) = r$, where....

(a) t is the representation time ☐
(b) e is the representandum ☐
(c) r is the representation ☐
(d) all of them ☐

2.11.D. Answer the questions.

1. What do the users do to specify a system?
2. What's the formal definition of "view"?
3. What's the equivalent of "view"?
4. Why the definition of "representation" is a more formal definition?
5. What does the representation of an entity depend on?
6. When can we say that r is the *ρ-representation* of e?
7. What does this statement mean? $\rho(e) = r$
8. In which cases representations are perfect?
9. Define a perfect representation of a graph?
10. Why most representations are not perfect?
11. In which cases definition of the function ρ can be useful?
12. How a representation of a representandum can be further represented?
13. When do we use the expression "the information is out-of-date"?
14. What is the meaning of the out-of-date and up-to-date information?

15. What can we do for updating information?
16. Explain that when this definition $\rho(e) = r$ is not correct?
17. How do we deal with in representationism?
18. How does representationism approaches to the study of an entity?
19. What are the differences between reductionism and representationism?
20. How do the representations reduce a problem?

2.11.E. Write your understanding of the text, specified bellow, in your own language.

The last paragraph ("In addition...") of Section 1.4 on page 19

2.12 More on the "Representations"

Read Section 1.4, the *Representations*, on page 17 and do the following exercises:

Compliments of Salma[12]

2.12.A. Fill in the blanks with the appropriate words or phrases.

1. A . . . . is a description of the behavior of the system observable from a specific point of view
2. We refer to a view of a system as a . . . . of the system
3. Different functions may produce deferent representations of a entity at different . . . .
4. Variable r in a function provides some . . . . about e, if r is a representation of e
5. Any representation of a system provides partial . . . . of the system

2.12.B. Determine whether the statements are *True* or *False*.

1. A perfect representation provides just some of information

   True ☐ *False* ☐
2. For many entities, imperfect representation of the entity are all we have to work with

   True ☐ *False* ☐
3. Software engineering provides the most powerful tools of all sciences

   True ☐ *False* ☐
4. Different functions may produce different representation of an entity

   True ☐ *False* ☐
5. A representation of a representandum can be further represented creating a hierarchy of representations

   True ☐ *False* ☐

[12] This exercise is designed by Salma Kheiravar, CS'85.

2.12.C. Pick the most appropriate choice, for each question.

1. r provides some information about e, if...

    (a) e is a representation of r ☐

    (b) r is a representation of e ☐

    (c) e is representation time ☐

    (d) r is representandum ☐

2. ?(e,t)=r then...

    (a) ? is the representation time ☐

    (b) t is the representandum ☐

    (c) r is the representation ☐

    (d) e is the representation function ☐

3. We refer to a view of a system as a...

    (a) definition of a system ☐

    (b) representation of the system ☐

    (c) view of a system ☐

    (d) description of a system ☐

4. Having defined the notion of representation, we can define...

    (a) knowledge ☐

    (b) representandum ☐

    (c) information ☐

    (d) society ☐

5. Any representation of a system specifies...

    (a) a view of a system ☐

    (b) background of a system ☐

    (c) definition of a system ☐

    (d) information ☐

2.12.D. Answer the questions.

1. What is the author's definition of view intuitively?
2. Why in some cases imperfect representation is as useful as perfect one?
3. Explain what representandum is?
4. Give an example for perfect representation?
5. Write your own view about representation?

2.12.E. Write your understanding of the text, specified bellow, in your own language.

The first paragraph ("Generally speaking, one can...") of Section 1.4 on Page 17

2.13 On the “Example”

Read Section 1.4.1, the *Example*, on page 20 and do the following exercises:

Compliments of Esmaeil[13]

2.13.A. Fill in the blanks with the appropriate words or phrases.

1. The Viewcharts . . . . is the most recent attempt to resolve the complexity of scale.

2. In Viewchart the behavior of the system is . . . . , formally and visually.

3. A complex system may . . . . of many sub-system.

4. Views in Viewcharts limit the scope of broadcast . . . . , solving the problem of global name space.

5. In Viewcharts, one does not have to specify the full . . . . of system.

2.13.B. Determine whether the statements are *True* or *False*.

1. The Viewcharts formalism will be practical in small-scale systems behavioral specifications.

   True ☐ *False* ☐

2. View in Viewcharts expand the scope of broadcast communications.

   True ☐ *False* ☐

3. A complex system may consist of many different sub-systems.

   True ☐ *False* ☐

4. The Viewcharts formalism is the most recent attempt to resolve the complexity of system.

   True ☐ *False* ☐

5. Current research and industrial advances indicate that software system to get larger and more complex.

   True ☐ *False* ☐

[13]This exercise is designed by Esmaeil Saberinia, CS’85.

2.13.C. Pick the most appropriate choice, for each question.

1. The viewchart formalism is designed to resolve the .... of system.

   (a) Mathematical aspects ☐
   (b) Volume ☐
   (c) Complexity ☐
   (d) Time of execution ☐

2. In Viewchart, the behavior of a system is ....

   (a) Specified ☐
   (b) Unclear ☐
   (c) Complicated ☐
   (d) Unpredictable ☐

3. The Viewcharts formalism will be .... in large scale system.

   (a) Practical ☐
   (b) Theatrical ☐
   (c) Experimental ☐
   (d) a and c ☐

4. A .... system may consist of many-different sub-systems.

   (a) Normal ☐
   (b) Mathematical ☐
   (c) Software ☐
   (d) Complex ☐

5. The Viewcharts formalism allows the views to be specified .... of each other

   (a) separate ☐
   (b) independent ☐
   (c) connected ☐
   (d) dependant ☐

2.13.D. Answer the questions.

1. What is the most recent attempt to resolve the complexity of systems?
2. What is the behavioral view?
3. What is the behavioral view designed for?
4. How do views in Viewcharts limit the scope of broadcast communication?
5. In what kind of systems, viewcharts will be practical?

2.13.E. Write your understanding of the text, specified bellow, in your own language.

The first paragraph ("The Viewcharts...") of Section 1.4.1 on Page 20

2.14 On the "Conclusion"

Read Section 1.5, the *Conclusion*, on page 20 and do the following exercises:

Compliments of Sina[14]

2.14.A. Fill in the blanks with the appropriate words or phrases.

1. Software engineering is involved, deeply, in . . . .
2. Software engineering, therefore, has no choice but to go . . . .
3. A software engineer must be able to do different kinds of mathematical . . . . on his/her design and prove that the system-to-be-developed is specified correctly.
4. The universities, professional schools, education centers, in this field, are responsible for training the software engineers, prepared to face the challenging . . . . ahead.
5. In this . . . . we do not deal with a system as a whole, we deal with different representations of the system.

2.14.B. Determine whether the statements are *True* or *False*.

1. Software engineering provides the very infrastructure of every science and technology.

   True ☐ *False* ☐

2. Software engineering doesn't require professionals, educated and trained in working on a sound foundation.

   True ☐ *False* ☐

3. The contribution of this paper can be summarized as an approach to the way in which information, in general, and software systems, in particular, can be defined and specified.

   True ☐ *False* ☐

4. In this approach we deal with a system as a whole.

   True ☐ *False* ☐

[14] This exercise is designed by Sina Khanmohammadi, CS'85.

5. A software engineer must be able to prove that the system-to-be-developed is specified correctly, consistently and without ambiguity.
True ☐ *False* ☐

2.14.C. Pick the most appropriate choice, for each question.

1. Software engineering is . . . . , deeply, in every science and technology.
   (a) Required ☐
   (b) Preferred ☐
   (c) Presented ☐
   (d) Involved ☐
2. With all the . . . . , software engineering cannot afford to go wrong.
   (a) Personalities ☐
   (b) Responsibilities ☐
   (c) Realities ☐
   (d) Peculiarities ☐
3. A software engineer must be able to do different kinds of . . . . analysis on his/her design and prove that the system-to-be-developed is specified correctly, consistently, without ambiguity.
   (a) Mathematical ☐
   (b) Psychological ☐
   (c) Physical ☐
   (d) Mechanical ☐
4. In this approach we do not deal with a system as a whole, we deal with different representations of the system and, thereby, ... the system definition, specification, and analysis.
   (a) Generalize ☐
   (b) Summarize ☐
   (c) Simplify ☐
   (d) Classify ☐
5. The contribution of this paper can be . . . . as an approach to the way in which information, in general, and software systems, in particular, can be defined and specified.

(a) Generalized ☐
(b) Capitalized ☐
(c) Summarized ☐
(d) Customized ☐

2.14.D. Answer the questions.

1. Where does Software engineering involved?
2. What kinds of people does Software engineering require?
3. What does Software engineering provide?
4. What kinds of organizations are responsible for training the software engineers?
5. In addition to an analysis of the responsibilities associated with software engineering and the corresponding trend, how the contribution of this paper can be summarized?

2.14.E. Write your understanding of the text, specified bellow, in your own language.

The second paragraph (“In addition to...”)of Section 1.5 on page 21

Chapter 3, Essay

Information Society: The Sociotechnical Concepts

By:
Ayaz Isazadeh [1]

Abstract

This paper presents the author's view of the Information Society*, emphasizing the significance of the sociotechnical concepts. Traditional and familiar concepts can no longer describe the evolving notion of* information society. *Information society demands a clear understanding of the* Sociotechnical concepts*, blending technical efficiency with sensitivity to organizational and human needs. The clear understanding of these concepts, leading to the so-called* Sociotechnical Approach*, which is the central topic of my focus in this paper, is the way in which we can deal with the behavior of information society.*

After some introductory definitions, the paper outlines some of the basic characteristics of information society, presents a discussion of the sociotechnical approach and the sociotechnical design process, and concludes with some final remarks.

Keyword: *Information Society, Sociotechnical Approach, Virtual Organization, Virtual Enterprise*

3.1 Introduction

Virtual organizations are taking shape and expanding in all different aspects of our societies. Operating virtually, organizations are no longer limited by geographic borders. e-Commerce and e-Business enable companies operate globally on limited physical resources. They no longer have to expand physical resources to expand business. e-Learning enables universities operate virtually, turning the entire globe to a common classroom. e-Governments can now serve citizens on a 24-hour basis. This is how virtual societies are taking shape, making it possible to get the answer for any question, anywhere, anytime, provided that such an answer does exist. In other words, if the information we need does exist, it is available, anywhere, anytime. We are indeed living in *information age*, where all different human societies are shaping up based on *information* and *knowledge*. Currently developing islands of information societies here and there are going to evolve, as the information age unfolds, into one *Global Information Society*.

The most shinning star within information society is "information". What is *information*? It is the most valuable commodity in our age, the *information age*. Information provides awareness, knowledge, and power! We live in a competitive world and in any area of competition, friendly or otherwise, the most informed party has the upper hand. An "informed" person generally makes the most appropriate decision. *Information* is the *keyword* in our age.

Information is defined in different ways by different scholars [2]. Scholars like, [3],[4],[5],[6],[7],[8],[9],and [10], have their own definition of information. Robert Losee presents a comprehensive and critical discussion of the various definitions given for *information* [11]. He considers all other definitions as *field-specific*, and provides a *discipline-independent* definition of his own. For Losee, *information* is produced by all processes and it is the values of characteristics in the process' output that are *information* [11].

I take an entity/representation approach to define information, a formal description of which is presented in [2]. Informally however, I say, any "representation" of an entity is *information* about the entity, where *representation* is formally defined in [2].

3.2 Information Society

Information Society is defined as a society based on information and knowledge. Information society is an evolving concept and it is now at its youth. At the present, here and there, islands of information societies are taking shape. This is the early stage of information society. It will evolve, as the information age unfolds, and all these islands will join together, forming the *Global Information Society*. Currently, each country has its own action plan for developing the information society of its own; e.g., Finland [12], New South Wales of Australia [13]. Countries are also working together in several groups, where each group is trying to coordinate the efforts of the member countries in developing and integrating the information society of the group; e.g., South Eastern European countries [14]. Finally, worldwide organizations are working with the entire world on the development of the *Global Information Society*; e.g., World Information Technology and Services Alliance [15], World Summit on the Information Society [16].

Some of the very basic characteristics of information society are as follows:

- *Information society* is *global* in principle, for geographic borders are not recognized by the flow of information. It is, therefore, not our choice that the isolated information societies currently being developed in different parts of the world are going to join together, forming the *Global Information Society.* It is the natural trend in the evolution of information society.

- *Information society* demands and promotes clarity, precision, honesty, and openness. Dishonest politicians and officials cannot survive in this society. They can no longer fool citizens by false stories, for a wealth of information would be available for every citizen, who can simply look up and discover the facts.

- *Information society* is governed by knowledge, competence, and only informed decisions and actions. There will be no room for incompetence in this society. The wealth of information and knowledge available for the citizens of information society provide an environment, where only informed, knowledged, and competent individuals can survive as managers and leaders of the society.

- *Information society* is a new environment, a new game, and a whole new set of rules. We must learn the rules and play the game by the rules. Those who cannot adapt to the new environment or violate the rules will not survive.

- *Information society* promotes equal opportunity. It has been a well known fact since long time ago that "information is power." The free flow of information, in the information society, therefore, translates to equal distribution of power in this society. The availability of information to everyone without any restriction, control, or filtering, provides equal opportunity for all the citizens of information society.

- *Information society* is *Sociotechnical* in principle, for traditional and familiar concepts are no longer the only components of this society. Information society demands a clear understanding of the *Sociotechnical concepts*, blending technical efficiency with sensitivity to organizational and human needs.

A more comprehensive discussion of these characteristics are presented by [17].

3.3 Sociotechnical Nature of Information Society

As mentioned above *Information society* is a new environment, a new game, and a whole new set of rules. Social behaviors, like any other aspect of this society, must be re-defined and re-structured in accordance with the rules and characteristics of this new environment. Traditional notions, defining and describing the structure and infrastructure of the traditional societies, are no longer enough to describe *information society*. The information-based, knowledge-based, communication-intensive, and global nature of information society makes it the most complex and sophisticated society we have ever seen. And..., and that is just the beginning. As mentioned above, geographic borders are not recognized by the flow of information. As information flows and knowledge expands throughout the currently developing islands of information societies in different parts of the world, all human societies will be joining together, forming (or approaching to) the *Global Information Society*. Such a complex and sophisticated society, obviously, must have a sound foundation based on *sociotechnical principles*.

3.3.1 Sociotechnical Systems

Speaking in a slightly formal sense, "Information Society" can be viewed as a system, a large-scale, complex, and safety-critical system, consisting of some highly different types of components. The basic components of this system are obviously the hierarchically formed units of traditional human societies. The other components include technological entities, such as software and hardware subsystems. A major component in this category is *information technology*. To cope with information society, therefore, we must have a good understanding of the increasing effect of information technology on different aspects of the society.

We all are familiar with the concept of *system* and *user*. Users normally interact with systems. We usually think of a user as an individual human being, or a group of individuals. But the user does not really have to be a human; it can well be another system. Then we have a system interacting with another system. That is in fact what is happening all around us; systems interacting with systems, forming higher level systems and leading to the hierarchy of systems. And of course, a major infrastructure of this interaction is provided by the Internet. Returning to our familiar *user-system interaction* model, it appears that the user side of the interaction can be indistinguishable from the system side. A *user*, therefore, whether a human individual or a system, can be viewed just as a sub-system (or component) within a higher level system. Consequently, in a system design and analysis, we cannot overlook the human individuals who are going to form certain components of the system. The *Sociotechnical approach* to a system design accepts the reality of human components within the system and treats them, just like any other component, vulnerable to faulty behavior.

There has been a variety of discussions on *Sociotechnical Capital* [18], *Sociotechnical Perspective of Personnel Management* [19], *Sociotechnical Perspective of Systems* [20], *Sociotechnical Constituencies as Processes of Alignment* [21], and *Sociotechnical Systems Approach for Process Analysis* [22, 23]. In this paper, however, I am more interested in the *Safety-Critical Nature of Sociotechnical Systems*.

3.3.2 Safety-Critical Nature of Sociotechnical Systems

In previous section, we discussed the way in which the *user* in a *user-system interaction* model, evolves to another system, leading to *system-system interaction* model, where two systems are interacting on a symmetric basis.

Let us now consider the *user-system interaction* model, once again, and this time within the software systems integration framework. Experience in software systems integration shows that side effects of simple modifications or small enhancements have caused failures of software systems which had been functioning properly for years [24]. A system, functioning as specified in the field for years, may not behave according to the specifications when integrated with another system. This is due to the change in the "environment". In the *user-system interaction* model, therefore, there are more into *user* than meet the eyes. There are implicit assumptions on the *user* side that may change in the process of integration, causing the system failure. The *user*, in fact, includes these assumptions and, consequently, evolves to *environment*, leading to *system-environment interaction* model. Here too, the *environment* is in a symmetric position with respect to the system and behaves just like another system. Furthermore, some interacting systems within, and in interaction with, a common *environment* form a higher level system, leading to a hierarchy of systems. Consequently, a complex system can be viewed as a hierarchically shaped different levels of interacting components, where a component is either a technological entity or a human being.

Now, let us focus and consider an isolated case of man-machine interaction, a *user-system interaction* model, where a human user is using the system to achieve certain objective. Let us further assume that the user is a manger, managing a division of an enterprise, and the objective does not correspond to the overall objectives of the enterprise. Assume, for example, that the manager's objective is centered around his (or her) personal interests. Such a manager may interact with, and use, all different types of MIS (Management Information Systems), DSS (Decision Support Systems), ESS (Executive Support Systems), and even KWS (Knowledge Work Systems) to protect his (or her) personal interests. But, in an analysis of the system behavior at a higher level, we will see that a particular component, namely the manager, is not behaving according to the specification. Yes, sociotechnical systems are complex safety-critical systems, which include human components. Safety-critical systems must be designed to tolerate or avoid faults. Certain components, including human components, are critical in fault tolerant systems and must be guaranteed to work properly. For the critical components of safety-critical software systems fault tolerance methods, like diverse programming techniques, *Recovery Block* [25], *N-Version Software* [26], or a combination of both [27] are suggested, where the validity of the component behavior is checked and corrective actions are taken, if necessary. Why should not we take a similar measure for the critical components (including human components) of sociotechnical systems.

I realize that it may well be slightly extreme to accept and treat a human being just like a technological component. Then again, the faulty behavior of a human within the most sophisticated system, namely the *information society,* can lead to an extreme situation of failure and destruction. And, of course, extreme situations demand extreme measures.

3.4 Conclusion

This paper has presented the author's view of the *Information Society*, emphasizing the significance of the sociotechnical concepts. *Information* and *knowledge* have been emphasized as the most significant and valuable commodities in our age. The paper demonstrated that the evolving concept of "global information society", which is taking shape on the basis of *Information* and *knowledge*, provides a new environment with a new set of rules and regulations. *Information society* is governed by knowledge, competence, and only informed decisions and actions. It demands and promotes clarity, precision, honesty, and openness.

Information Society is described as a large-scale, complex, sophisticated, and safety-critical *sociotechnical system,* consisting of human components, units of traditional human societies, as well as technological entities, such as software and hardware subsystems. The sociotechnical nature of this system, the *Information Society*, demands extreme care regarding the proper behavior the the system components, including the human components.

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Chapter 4, Exercise

On Comprehension of the Essay, Information Society: The Sociotechnical Concepts

This is an exercise chapter; it is intended to test and improve comprehension of the essay presented in previous chapter.

Design and preparation of all the exercises are started by students of CS'85, attending an introductory course on *Technical English*.

I do not expect the exercises to be all correct and perfect. I do believe, however, that they would serve students to improve their comprehension skills.

I expect the students to practice and learn from the exercises, while correcting and improving on them; should be a good experience.

I will keep editing, organizing, and revising the exercises, for as long as I find them useful.

4.1 On the "Abstract"

Read the *Abstract*, on page 71 and do the following exercises:

Compliments of Kamellia[1]

4.1.A. Fill in the blanks with the appropriate words or phrases.

1. The paper presents the authors view of the Information Society, emphasizing the .... of the sociotechnical concepts.
2. .... and .... concepts can no longer describe the evolving notion of information society.
3. Information society .... a clear understanding of the Sociotechnical concepts.
4. The clear understanding of these concepts .... to the so-called Sociotechnical Approach.
5. After some .... definitions, the paper .... some of the basic characteristics of information society.

4.1.B. Determine whether the statements are *True* or *False*.

1. Traditional and familiar concepts can no longer describe the evolving notion of information society

   True ☐ *False* ☐
2. Traditional and familiar concepts can completely describe the evolving notion of information society

   True ☐ *False* ☐
3. Information society demands a little understanding of the Sociotechnical concepts

   True ☐ *False* ☐
4. The clear understanding of these concepts leading to the so-Called Sociotechnical Approach

   True ☐ *False* ☐

[1] This exercise is designed by Kamellia Reshadi, CS'85.

5. After some introductory definitions, the paper outlines some of the basic characteristics of information society

   True ☐ *False* ☐

4.1.C. Pick the most appropriate choice, for each question.

1. The paper presents the authors view of the ...

   (a) Information technology ☐
   (b) Information society ☐
   (c) Sociotechnical design ☐
   (d) b and c ☐

2. Information society ... a clear understanding of sociotechnical concepts.

   (a) needs ☐
   (b) shows ☐
   (c) leads ☐
   (d) none of them ☐

3. The central topic of authors focus in this paper is ...

   (a) Sociotechnical Information ☐
   (b) Sociotechnical Approach ☐
   (c) Sociotechnical design ☐
   (d) a and b ☐

4. The clear understanding of these concepts ... to the so-Called Sociotechnical Approach.

   (a) showing ☐
   (b) emphasizing ☐
   (c) describing ☐
   (d) leading ☐

5. Traditional and familiar concepts can ... describe the evolving notion of information society.

   (a) some times ☐
   (b) completely ☐
   (c) no longer ☐
   (d) b and c ☐

4.1.D. Answer the questions.

1. What does the paper present?
2. How does the paper present the authors view of the information society?
3. Which concepts are not good enough to describe the evolving notion of information society?
4. How does the the information society demand a clear understanding of the Sociotechnical concepts?
5. What is the central topic of the authors focus in this paper?
6. What does the information society demand?
7. What does the paper outline after some introducing definitions?
8. What does the paper conclude with?

4.1.E. Write your understanding of the text, specified bellow, in your own language.

The first paragraph ("This paper presents...") of the Abstract on page 71

4.2 On the "Introduction"

Read Section 3.1, the *Introduction*, on page 72 and do the following exercises:

Compliments of Salma[2]

4.2.A. Fill in the blanks with the appropriate words or phrases.

1. E-learning enables universities operate . . . . turning the entire globe to a common classroom

2. In information age, all different human societies based on . . . . and knowledge

3. Currently developing islands of information societies are going to evolve as the information age unfolds into one . . . . information society

4. Information provides . . . . , knowledge and power

5. An . . . . person generally makes the most appropriate decision

4.2.B. Determine whether the statements are *True* or *False*.

1. Virtual organization is not really useful in our society
   True ☐ *False* ☐

2. Operation virtually organizations are limited by geographic borders
   True ☐ *False* ☐

3. Virtual societies are making it possible to get the answer for any question, anywhere, anytime provided that such an answer does exist
   True ☐ *False* ☐

4. There is just one way definition of information
   True ☐ *False* ☐

5. The most shining star within information age is information
   True ☐ *False* ☐

[2]This exercise is designed by Salma Kheiravar, CS'85.

4.2.C. Pick the most appropriate choice, for each question.

1. Which choice is the keyword in our age?

   (a) Knowledge ☐
   (b) Society ☐
   (c) Information ☐
   (d) Awareness ☐

2. Which age we are living in?

   (a) Communication ☐
   (b) Information ☐
   (c) Web ☐
   (d) Knowledge ☐

3. What is the advantage of e-business?

   (a) It is working by a virtual organization ☐
   (b) It is new ☐
   (c) There is no need to expand physical resources to expand business ☐
   (d) No advantage ☐

4. Which person makes the most appropriate decision in information age?

   (a) A person with wealth ☐
   (b) An informed person ☐
   (c) A person who uses the web ☐
   (d) A person with knowledge ☐

5. What is the base of information age?

   (a) Society ☐
   (b) Knowledge ☐
   (c) An informed person ☐
   (d) communication ☐

4.2.D. Answer the questions.

1. What is the most valuable commodity in our age?
2. What is the Robert Losee definition of information?
3. Explain the common importance of e-business and e-learning in our age?
4. What is the most advantage of virtual society in your own idea?
5. Name two bases of information age?

4.2.E. Write your understanding of the text, specified bellow, in your own language.

The second paragraph ("The most shinning...") of Section 3.1 on page 72

4.3 More on the "Introduction"

Read Section 3.1, the *Introduction*, on page 72 and do the following exercises:

Compliments of Benjamin[3]

4.3.A. Fill in the blanks with the appropriate words or phrases.

1. . . . . and . . . . enable companies operate globally on limited physical resources.
2. . . . . enables universities operate virtually, turning the entire the global to a common classroom.
3. . . . . can now serve citizens on a 24-hour basis.
4. We are indeed living in . . . ., where all different human societies are shaping up based on . . . . and . . . .

4.3.B. Determine whether the statements are *True* or *False*.

1. *information technology* is the keyword in our age.

   True ☐ *False* ☐
2. We are indeed living in *information age*.

   True ☐ *False* ☐
3. Information is defined in the same ways by different scholars.

   True ☐ *False* ☐
4. For Losee, information is produced by all processes and it is the values of characteristic in the process output that are information.

   True ☐ *False* ☐

4.3.C. Pick the most appropriate choice, for each question.

1. What is the most shinning star within information society?

   (a) Information ☐

   (b) Computer ☐

[3]This exercise is designed by Benjamin Jafari, CS'85.

(c) Web ☐
(d) Networks ☐

2. What does information provides?

(a) Awareness ☐
(b) Knowledge ☐
(c) Power ☐
(d) 1,2 and 3 ☐

3. . . . . can now serve citizens on a 24-hour basis.What is the most appropriate answer?

(a) E-commerce ☐
(b) E-learning ☐
(c) E-governments ☐
(d) E-business ☐

4. What do enable companies operate globally on limited physical resources?

(a) E-commerce and E-learning ☐
(b) E-government and e-commerce ☐
(c) E-learning and e-commerce ☐
(d) E-learning and E-learning ☐

4.3.D. Answer the questions.

1. When we talking about the virtual organizations what is the our main suppose?
2. Write some aspect of virtual organizations?
3. What does expand the commerce out of geographic borders?
4. What is the main aim of developing islands of information societies?

4.3.E. Write your understanding of the text, specified bellow, in your own language.

The first paragraph ("Virtual organizations...") of Section 3.1 on page 72

4.4 More on the "Introduction"

Read Section 3.1, the *Introduction*, on page 72 and do the following exercises:

Compliments of Sooheil[4]

4.4.A. Fill in the blanks with the appropriate words or phrases.

1. . . . . organizations are taking shape in information age.
2. E-commerce is not limited by . . . . borders.
3. . . . . has turned the entire globe to a common classroom.
4. In information age companies do not need to expand . . . . resources, to expand business.
5. Any . . . . of an entity is information about that entity.

4.4.B. Determine whether the statements are *True* or *False*.

1. We are now living in nuclear age.
   True ☐ *False* ☐
2. The most powerful parties are informed ones.
   True ☐ *False* ☐
3. In information age companies need to expand physical resources to expand business.
   True ☐ *False* ☐
4. In information age all different human societies are based on data.
   True ☐ *False* ☐
5. Information is a clear concept and can be defined in one way.
   True ☐ *False* ☐

4.4.C. Pick the most appropriate choice, for each question.

1. We are now living in . . . . age?

   (a) Information ☐

[4]This exercise is designed by Sooheil Sourchi, CS'85.

(b) Nuclear ☐
(c) Electronics ☐
(d) Transportation ☐

2. Information is the same as . . . . ?

(a) Data ☐
(b) Knowledge ☐
(c) Representation ☐
(d) Entity ☐

3. Which organizations are taking shape and expanding in all aspects of our societies?

(a) Virtual ☐
(b) Electronic ☐
(c) Local ☐
(d) International ☐

4. Which government can serve on a 24-hour basis?

(a) E-government ☐
(b) Local government ☐
(c) Federal government ☐
(d) Religious government ☐

5. What is the most valuable commodity in our age?

(a) Data ☐
(b) Knowledge ☐
(c) Information ☐
(d) Space technology ☐

4.4.D. Answer the questions.

1. What kind of organizations are taking shape in our age?
2. What do enable companies operate globally on limited physical resources?
3. What is the relationship between information and representation?
4. In information age, which party does have the upper hand?
5. In information age, who makes the most appropriate decision?

4.4.E. Write your understanding of the text, specified bellow, in your own language.

The first paragraph ("Virtual organizations are taking shape...") of Section 3.1 on page 72

4.5 On the "Information Society"

Read Section 3.2, the *Information Society*, on page 72 and do the following exercises:

Compliments of Nasim[5]

4.5.A. Fill in the blanks with the appropriate words or phrases.

1. . . . . is defined as a society based on information and knowledge.
2. At the present, here and there, ... are taking shape.
3. Information Society is defined as a society based on . . . .
4. . . . . politicians cannot survive in this society.
5. Information society is a new . . . .

4.5.B. Determine whether the statements are *True* or *False*.

1. Information society promotes equal opportunity

   True ☐ *False* ☐

2. Those who cannot adapt to the new environment or violate the rules will survive

   True ☐ *False* ☐

3. Information society demands a clear understanding of the Sociotechnical concepts

   True ☐ *False* ☐

4. Information society is governed by environment

   True ☐ *False* ☐

5. Information society is global in principle,for geographic borders are recognized by the flow of information.

   True ☐ *False* ☐

[5] This exercise is designed by Nasim Nobary, CS'85.

4.5.C. Pick the most appropriate choice, for each question.

1. Information society is governed by...

   (a) knowledge ☐
   (b) competence ☐
   (c) only informed decisions and actions ☐
   (d) all of them ☐

2. Who cannot survive in information society...?

   (a) clarity politicians ☐
   (b) honest politicians ☐
   (c) Dishonest politicians ☐
   (d) a and b ☐

3. Which countries working together for developing the information society...?

   (a) Finland ☐
   (b) New South Wales of Australia ☐
   (c) a and b ☐
   (d) South Eastern European countries ☐

4. Information society is ...

   (a) global in principle ☐
   (b) governed by knowledge ☐
   (c) a new environment ☐
   (d) all of theme ☐

5. Information would be available for every citizen,who....?

   (a) cannot adapt to the new environment ☐
   (b) can simply look up and discover the facts ☐
   (c) can work together ☐
   (d) none of theme ☐

4.5.D. Answer the questions.

1. Why information society is Sociotechnical in principle?
2. What does information society demand?
3. Who will not survive?
4. What does information society promote?
5. What did countries do for developing the information society?

4.5.E. Write your understanding of the text, specified bellow, in your own language.

The first paragraph("Information Society...") in Section 3.2 on Page72

4.6 More on the "Information Society"

Read Section 3.2, the *Information Society*, on page 72 and do the following exercises:

Compliments of Benjamin & Samira[6]

4.6.A. Fill in the blanks with the appropriate words or phrases.

1. It has been a well known fact since long time ago that . . . . is power.
2. Information society demands a clear understanding of the . . . . concepts.
3. Information society demands and promotes . . . . , ... , ... , and openness.
4. Those who cannot adapt to the new environment or violate the rules will not . . . .
5. The free flow of . . . . , in the information society translates to equal distribution of power.

4.6.B. Determine whether the statements are *True* or *False*.

1. *Information Society* is defined as a society based on information and networks.
   True ☐ *False* ☐
2. Worldwide organizations are working with themselves on the development of the Global Information Society.
   True ☐ *False* ☐
3. *Information society* is *global* in principle.
   True ☐ *False* ☐
4. A wealth of information would be available for the citizens of information society.
   True ☐ *False* ☐
5. The free flow of information, in the information society, therefore, translate to equal destination of power in this society.
   True ☐ *False* ☐

[6] This exercise is designed by Benjamin jafari, CS'85, and improved by Samira Doshmankosh, CS'86.

4.6.C. Pick the most appropriate choice, for each question.

1. *Information Society* is defined as a society based on .... and knowledge.

   (a) Concepts ☐
   (b) Competence ☐
   (c) Information ☐
   (d) All of them ☐

2. Why are the different parts of information society going to join together?

   (a) Because of its natural trend ☐
   (b) Because honest politicians ☐
   (c) None of them ☐
   (d) a and b ☐

3. Which worldwide organizations are working with the entire world on the development of the *Global Information Society*?

   (a) World Information Technology ☐
   (b) Services Alliance ☐
   (c) World Summit on the Information Society ☐
   (d) All of them ☐

4. Information society is .... in principle.

   (a) Global ☐
   (b) Governed by knowledge ☐
   (c) Sociotechnical ☐
   (d) a and c ☐

5. Which one does translate to equal distribution of power in information society?

   (a) Sociotechnical ☐
   (b) The free flow of information ☐
   (c) Concepts ☐
   (d) None of theme ☐

4.6.D. Answer the questions.

1. How does information society promote equal opportunity?
2. Why is information society sociotechnical in principle?
3. What is the early stage of information society?
4. Why must we learn the rules of information societies?
5. what do the wealth of information and knowledge provide?

4.6.E. Write your understanding of the text, specified bellow, in your own language.

The third item ("Information society is governed...") in Section 3.2 on Page 73

4.7 On the "Sociotechnical Nature of..."

Read Section 3.3, the *Sociotechnical Nature of...*, on page 74 and do the following exercises:

Compliments of Salma[7]

4.7.A. Fill in the blanks with the appropriate words or phrases.

1. .... is a new environment and a new game

2. Social behaviors must be re-defined and re-structured in accordance with the .... and rules of this new environment

3. Geographic borders are not recognized by the flow of ....

4. All human societies will be joining together and approaching to the .... information society

5. A complex society, must have a foundation based on .... principles

4.7.B. Determine whether the statements are *True* or *False*.

1. There is no need to re-define new social behaviors in new environments such as information society

   True ☐ *False* ☐

2. Traditional notions, defining the structure of traditional societies, are no longer enough to describe information society

   True ☐ *False* ☐

3. Information society is limited by geographic borders

   True ☐ *False* ☐

4. The information society is the most complex society whole the world

   True ☐ *False* ☐

5. Social behaviors must be re-structured

   True ☐ *False* ☐

[7] This exercise is designed by Salma Kheiravar, CS'85.

4.7.C. Pick the most appropriate choice, for each question.

1. Information society is...

   (a) a new game ☐
   (b) a new environment ☐
   (c) a whole new set of rules ☐
   (d) a, b and c ☐

2. Which choices make information society sophisticate?

   (a) Information-based, Knowledge-base ☐
   (b) Communication-intensive, Information-based ☐
   (c) Global-nature, Knowledge-base ☐
   (d) a, b and c ☐

3. Which choice can not be stopped by the geographic borders?

   (a) Human ☐
   (b) Society ☐
   (c) Information ☐
   (d) Principles ☐

4. What is expanding throughout the developing islands of information societies?

   (a) Knowledge ☐
   (b) Global society ☐
   (c) Traditional notions ☐
   (d) Principle ☐

5. Which society is the most complex one?

   (a) Human society ☐
   (b) Traditional society ☐
   (c) Information society ☐
   (d) Global information society ☐

4.7.D. Answer the questions.

1. Why information society is global?
2. How all human societies can join together?
3. Why information society must have a foundation based on sociotechnical principles?
4. What makes information society the most complex society?
5. How global information society being organized?

4.7.E. Write your understanding of the text, specified bellow, in your own language.

The first six lines ("As mentioned above...*information society.*") of Section 3.3 on page 74

4.8 More on the "Sociotechnical Nature of..."

Read Section 3.3, the *Sociotechnical Nature of...*, on page 74 and do the following exercises:

Compliments of Benjamin[8]

4.8.A. Fill in the blanks with the appropriate words or phrases.

1. . . . . , like any other aspect of this society, must be re-defined and re-structured.
2. The . . . . , knowledge-based , ... and global nature of information society makes it the most complex.
3. . . . . are not recognized by the flow of information
4. . . . . flows and . . . . expands throughout the currently developing islands of information societies in different parts of the world.
5. All human societies will be joining together, forming (or approaching to) the . . . .

4.8.B. Determine whether the statements are *True* or *False*.

1. As mentioned above *Information* is a new environment, a new game, and a whole new set of rules. Social behaviors, like any other aspect of this society
   True ☐ *False* ☐
2. The only reason that make the information society most complex and sophisticated society we have ever seen is global nature.
   True ☐ *False* ☐
3. *sociotechnical principles*is foundation of global information society.
   True ☐ *False* ☐
4. Social behaviors must re-defined in in information society.
   True ☐ *False* ☐
5. Traditional notions, defining and describing the structure and infrastructure of the traditional societies, are no longer enough to describe *information society.*
   True ☐ *False* ☐

[8] This exercise is designed by Benjamin jafari, CS'85.

4.8.C. Pick the most appropriate choice, for each question.

1. . . . . , like any other aspect of this society, must be re-defined and re-structured

   (a) . ☐
   (b) Social behaviors ☐
   (c) Social traditional ☐
   (d) a whole new set of rules ☐

   a, b and c

2. what does traditional notions do?

   (a) Defining and describing the structure of societies ☐
   (b) Defining and describing the structure of information society ☐
   (c) Defining and describing the structure of traditional societies ☐
   (d) Defining and describing the structure of global information society ☐

3. By knowledge expands throughout the currently human societies join together and make . . . . ?

   (a) Global village ☐
   (b) Global information society ☐
   (c) Global society ☐
   (d) Global networks ☐

4. Geographical borders are not recognized by . . . .

   (a) Traditional notions ☐
   (b) Flow of information ☐
   (c) Social information ☐
   (d) Knowledge expands ☐

5. what is really indeed a global information society need?

   (a) Sociotechnical principles ☐
   (b) Traditional notions ☐
   (c) Flow of information ☐
   (d) Environment ☐

4.8.D. Answer the questions.

1. How can we describe information society in brief?
2. Social behaviors re-defined and re-structured in accordance with what?
3. What does traditional notions really do?
4. How is global information society forming?
5. What does global nature of information society make?

4.8.E. Write your understanding of the text, specified bellow, in your own language.

The first six lines ("As mentioned above...*information society.*") of Section 3.3 on page 74

4.9 On the "Sociotechnical Systems"

Read Section 3.3.1, the *Sociotechnical Systems*, on page 74 and do the following exercises:

Compliments of Farid & Mahdi[9]

4.9.A. Fill in the blanks with the appropriate words or phrases.

1. Speaking in a slightly formal sense, ... can be viewed as a system, a large scale, complex, and safety-critical system, consisting of some highly different types of components.

2. The basic components of this system are obviously the hierarchically formed . . . . The other components include technological entities, such as . . . . and . . . . subsystems.

3. We all are familiar with the concept of . . . . and . . . .

4. We usually think of a user as an individual human being, or a group of individuals. But the user does not really have to be a human; it can well be . . . .

5. We have a system interacting with another system. That is in fact what is happening all around us; systems interacting with systems, forming higher level systems and leading to the hierarchy of systems. And of course, a major infrastructure of this interaction is provided by the . . . .

4.9.B. Determine whether the statements are *True* or *False*.

1. To cope with information society, therefore, we must have a good understanding of the increasing effect of information technology on different aspects of the society.

   True □ *False* □

2. To cope with information society, therefore, we must have a good understanding of the decreasing effect of data bases on different aspects of the society.

   True □ *False* □

3. We usually think of a user as an systems.

   True □ *False* □

[9]This exercise is designed by Farid Bekran and Mahdi Mousavi, CS'85.

4. Users normally interact with systems.

   True ☐ *False* ☐

5. A user, therefore, if is a system, can be viewed just as a sub-system within a higher level system.

   True ☐ *False* ☐

4.9.C. Pick the most appropriate choice, for each question.

1. What is it that users normally interact with?

   (a) Data Bases ☐
   (b) Information technology ☐
   (c) Computers ☐
   (d) System ☐

2. Who are users?

   (a) System ☐
   (b) Human ☐
   (c) Both of them ☐
   (d) None of them ☐

3. How we can viewed the Information Society in a formal sense?

   (a) System ☐
   (b) Knowledge ☐
   (c) Science ☐
   (d) None of them ☐

4. How is the basic components of Sociotechnical Systems?

   (a) Units of traditional human societies ☐
   (b) Units of systems ☐
   (c) Unit of Computer science ☐
   (d) None of them ☐

5. How a user, therefore, whether a human individual or a system, can be viewed within a higher level system?

   (a) Sub-system ☐
   (b) Component ☐
   (c) Another system ☐
   (d) Sub-system and Component ☐

4.9.D. Answer the questions.

1. What are Sociotechnical Systems?
2. How is the basic components of Sociotechnical Systems?
3. What we must have to cope with information society?
4. Are users only human?
5. How we can viewed the Information Society in a formal sense?

4.9.E. Write your understanding of the text, specified bellow, in your own language.

The first paragraph ("Speaking in a...") of Section 3.3.1 on page 74

4.10 More on the "Sociotechnical Systems"

Read Section 3.3.1, the *Sociotechnical Systems*, on page 74 and do the following exercises:

Compliments of Benjamin[10]

4.10.A. Fill in the blanks with the appropriate words or phrases.

1. A major component in this category is . . . .
2. To cope with information society, therefore, we must have a good understanding of the increasing effect of . . . . on different aspects of the . . . .
3. Users normally interact with systems. We usually think of a user as an individual . . . . being, or a group of . . . .
4. A *user*, therefore, whether a human individual or a system, can be viewed just as a . . . . or . . . . within a higher level system.
5. The . . . . to a system design accepts the reality of human components within the system and treats them, just like any other component, vulnerable to faulty behavior.

4.10.B. Determine whether the statements are *True* or *False*.

1. We usually think of a user as an individual human being, or a group of individuals.

   True ☐ *False* ☐
2. But the user does not really have to be a human; it can well be another computer.

   True ☐ *False* ☐
3. Returning to our familiar *user-system interaction* model, it appears that the user side of the interaction can be indistinguishable from the system side.

   True ☐ *False* ☐
4. A major infrastructure of this interaction is provided by the networks.

   True ☐ *False* ☐

[10] This exercise is designed by Benjamin jafari, CS'85.

5. The basic components of this system are obviously the hierarchically formed units of traditional human societies.

   True ☐ *False* ☐

4.10.C. Pick the most appropriate choice, for each question.

1. Information Society can be viewed as a system, a large-scale, complex, and . . . . system.

   (a) Data Base ☐
   (b) Safety-critical ☐
   (c) Computers ☐
   (d) Huge ☐

2. A *user*, therefore, whether a human individual or a system, can be viewed just as a . . . . (or component).

   (a) System ☐
   (b) Sub systems ☐
   (c) Large systems ☐
   (d) Interactition systems ☐

3. The . . . . approach to a system design accepts the reality of human components

   (a) Safety-critical ☐
   (b) Knowledge ☐
   (c) sociotechnical ☐
   (d) None of them ☐

4. A major component in this category is . . . .

   (a) Information technology ☐
   (b) Human society ☐
   (c) Information systems ☐
   (d) Intenet ☐

5. How we can cope with the information society?

   (a) By increasing the information networks. ☐

(b) By understanding of the increasing effect of information technology on different aspects of the society. ☐

(c) By e-defining and re-structuring in accordance with the rules and characteristics of this new environment. ☐

(d) By learning the rules of this information. ☐

4.10.D. Answer the questions.

1. What are Sociotechnical Systems?
2. How is the basic components of Sociotechnical Systems?
3. What we must have to cope with information society?
4. Are users only human?
5. How we can viewed the Information Society in a formal sense?

4.10.E. Write your understanding of the text, specified bellow, in your own language.

The first paragraph ("Speaking in a...") of Section 3.3.1 on page 74

4.11 On the "Safety-Critical Nature of..."

Read Section 3.3.2, the *Safety-Critical Nature of...*, on page 75 and do the following exercises:

Compliments of Salma[11]

4.11.A. Fill in the blanks with the appropriate words or phrases.

1. Experience in . . . . systems integration shows side effects of simple modifications
2. A system, functioning as specified in the field for years, may not behave according to the specifications when . . . . with another system
3. A complex system can be viewed as a hierarchy shaped different levels of . . . . components
4. Sociotechnical systems are complex . . . . systems, whose failure may cause injury or death to human beings
5. Safety-critical systems must be designed to . . . . or avoid faults

4.11.B. Determine whether the statements are *True* or *False*.

1. Human components are critical in fault tolerant systems and must be guaranteed to work properly

   True ☐ *False* ☐
2. The most sophisticated system, namely the information society, can lead to an extreme situation of destruction

   True ☐ *False* ☐
3. Changing the environment of a system may not change the behavior of system

   True ☐ *False* ☐
4. An isolate case of man-machine interaction is a user system interaction model

   True ☐ *False* ☐
5. Any fault of safety-critical software system is not really important

   True ☐ *False* ☐

[11] This exercise is designed by Salma Kheiravar, CS'85.

4.11.C. Pick the most appropriate choice, for each question.

1. Which one is the most sophisticated system?

   (a) Information society ☐
   (b) Safety-critical system ☐
   (c) Knowledge work systems ☐
   (d) Decision support systems ☐

2. Which systems can be useful for a manager to achieve his/her objects?

   (a) Management information systems ☐
   (b) Executive support systems ☐
   (c) Decision support systems ☐
   (d) a, b and c ☐

3. What safety-critical software systems fault tolerance methods, really do?

   (a) They check the validity of the component behavior. ☐
   (b) They take the corrective actions. ☐
   (c) They check the validity of the component behavior and take the corrective actions if needed. ☐
   (d) Non ☐

4. Why sophisticated systems must be under control?

   (a) Because they are really important. ☐
   (b) Because they can make destructions. ☐
   (c) Because faulty behavior of humans can lead them to an extreme situation of failure. ☐
   (d) Because they may cause extreme measures. ☐

5. Sociotechnical systems are complex safety-critical systems, which include...

   (a) human components ☐
   (b) society information ☐
   (c) knowledge ☐
   (d) tolerance ☐

4.11.D. Answer the questions.

1. How implicit assumptions in the user system interaction model can cause the system failure?
2. As an example, assume that the manager‘s objective is centered around his/her personal interests. how he/she can protect his/her interests?
3. Name some safety-critical software systems fault tolerance methods?
4. What is the task of the methods, mentioned in the previous question?
5. What is important in design of safety-critical systems?

4.11.E. Write your understanding of the text, specified bellow, in your own language.

The last paragraph ("I realize that it may...") of Section 3.3.2 on page 75

4.12 More on the "Safety-Critical Nature of..."

Read Section 3.3.2, the *Safety-Critical Nature of...*, on page 75 and do the following exercises:

Compliments of Benjamin[12]

4.12.A. Fill in the blanks with the appropriate words or phrases.

1. In . . . . model, where two systems are interacting on a symmetric basis.
2. In the . . . . model, therefore, there are more into *user* than meet the eyes.
3. The *environment* is in a . . . . with respect to the system and behaves just like another system.
4. An isolated case of man-machine interaction, a *user-system interaction* model, where a . . . . is using the . . . . to achieve certain objective.
5. I realize that it may well be slightly extreme to accept and treat a human being just like a . . . .

4.12.B. Determine whether the statements are *True* or *False*.

1. In a *system-system interaction* model, two systems are interacting on a symmetric basis.

   True ☐ *False* ☐
2. Let us now consider the *user-system interaction* model, once again, and this time within the soft systems integration framework.

   True ☐ *False* ☐
3. Experiment in software systems integration shows that side effects of simple modifications or small enhancements have caused failures of software systems.

   True ☐ *False* ☐
4. For the critical components of safety-critical software systems fault tolerance methods, like diverse programming techniques, *Recovery Block* [77], *N-Version*

[12] This exercise is designed by Benjamin jafari, CS'85.

Software [3], or a combination of both [76] are suggested.

True ☐ *False* ☐

5. In the user-system models implicit assumptions on the *user* side that may change in the process of integration, causing the system failure.

True ☐ *False* ☐

4.12.C. Pick the most appropriate choice, for each question.

1. What kind of system can we evolve from a user-system interaction model?

(a) System-system model ☐

(b) user-system model ☐

(c) Knowledge-systems model ☐

(d) Systems-user model ☐

2. . . . . in software systems integration shows that side effects of simple modifications or small enhancements have caused failures of software systems which had been functioning properly for years.

(a) Experiment ☐

(b) Executive support systems ☐

(c) Experience ☐

(d) Executing ☐

3. What kind of changing may cause failures of software systems?

(a) Simple modifications ☐

(b) User changing ☐

(c) small enhancements ☐

(d) a and c ☐

4. A system, functioning as specified in the field for years, may not behave according to the specifications when integrated with another system.why?

(a) Because of changing in managers ☐

(b) Because of changing in environment ☐

(c) Because of changing in initializing ☐

(d) None of them ☐

5. At a higher level, we will see that a particular component, namely the . . . . , is not behaving according to the specification.

(a) Manager ☐

(b) User ☐

(c) Systems ☐

(d) Information ☐

4.12.D. Answer the questions.

1. How implicit assumptions in the user system interaction model can cause the system failure?
2. As an example, assume that the manager‘s objective is centered around his/her personal interests. how he/she can protect his/her interests?
3. Name some safety-critical software systems fault tolerance methods?
4. What is the task of the methods, mentioned in the previous question?
5. What is important in design of safety-critical systems?

4.12.E. Write your understanding of the text, specified bellow, in your own language.

The last paragraph (“I realize that it may...”) of Section 3.3.2 on page 75

4.13 On the "Conclusion"

Read Section 3.4, the *Conclusion*, on page 76 and do the following exercises:

Compliments of Hossein & Mohammad[13]

4.13.A. Fill in the blanks with the appropriate words or phrases.

1. . . . . is governed by knowledge,competence,and only informed decisions and actions.

2. Knowledge and . . . . have the most significant and valuable commodities in our age.

3. Information society is described as a large-scale,complex,sophisticated,and . . . . sociotechnical system.

4. . . . . is taking shape on the basis of information and knowledge.

5. Information society consisting of human components,units of traditional human societies, such as . . . . and . . . . subsystems.

4.13.B. Determine whether the statements are *True* or *False*.

1. The sociotechnical nature of the information society demands extreme care regarding the proper behavior the system components.
   True ☐ *False* ☐

2. "Global information society"provides a new environment with a new set of rules and regulations.
   True ☐ *False* ☐

3. Information society don't demand and promotes clarity,precision,honesty and openness.
   True ☐ *False* ☐

4. The system components including the human components.
   True ☐ *False* ☐

5. "Global information society" is a society based on information and knowledge.
   True ☐ *False* ☐

[13]This exercise is designed by Hossein Azarbonyad and Mohammad Naderi, CS'85.

4.13.C. Pick the most appropriate choice, for each question.

1. Information society is governed by

   (a) Knowledge ☐
   (b) Competence ☐
   (c) a and b ☐
   (d) None ☐

2. The global information society is taking shape on the basis of

   (a) Information ☐
   (b) Knowledge ☐
   (c) Technology ☐
   (d) a and b ☐

3. Author emphasizes the significance of the

   (a) Sociotechnical consents ☐
   (b) Knowledge and information ☐
   (c) Global information society ☐
   (d) None of them ☐

4. How is the basic components of Sociotechnical Systems?

   (a) Units of traditional human societies ☐
   (b) Consisting of human components ☐
   (c) a and b ☐
   (d) None of them ☐

5. Information society demands and promotes

   (a) Clarity ☐
   (b) precision ☐
   (c) Honesty and openness ☐
   (d) All of them ☐

4.13.D. Answer the questions.

1. What information society consists?
2. What does the information society demand?
3. What does the evolving concept of "global information society" provides?
4. How does the paper present the author's view of information society?
5. Are the system components include the human components?

4.13.E. Write your understanding of the text, specified bellow, in your own language.

The first paragraph ("This paper presented...") of Section 3.4 on page 76

Chapter 5, Essay

Beyond the Information Age: A Philosophical Perspective

By:
Ayaz Isazadeh[1]

Abstract

This paper presents the author's view of the current trend in the world of information science. Based on the current trend in the development of modern science and technology, a theory *regarding what lies ahead beyond the* information age *is taking shape. The purpose of this paper is to present this theory for further discussion.*

We have made tremendous advances in science and technology. I believe, however, considering the vast dimensions of the known (and unknown) universe, in spite of all the valuable advances in science and technology, our information and knowledge of the universe are almost nothing compared to the mind boggling sizes and mysteries of the universe. It appears, therefore, that any significant advance in discovering the mysteries of the universe, considering what is ahead, demands a radically different approach. Information science is leading and evolving to this approach, in which unification *has a key role. The paper concludes with a discussion of a general trend, approaching a* unified theory, unified knowledge, *and/or* unified intelligence.

Keyword: *Information Science, Computer Science, Philosophy of Science*

5.1 Introduction

Mathematics, the father of all sciences, the very foundation of information science, and the language of entire universe, has always had and will always have a special position among different sciences. Mathematical concepts are not limited to the human civilization, they are shared by any probable intelligence of the entire universe.

This paper is intended to characterize the current state of our civilization and, based on the outlook of science and technology, present a *theory* describing the current trend in the world of information science. Considering the fact that all the sciences, mathematics up front, are in search of information, we are in fact living in the *information age.* In this information age, consider the volume of information we have gathered so far. Imagine the number of computers, from PC's to work stations, mini's, mainframes and to supercomputers, collecting, processing and storing information. Imagine the millions of computers in the world wide network, Internet, and the tremendous amount of information floating around. We have gathered a large amount of information on a large number of topics. On the other hand, there are certainly subjects on which we have little or no information. In this regard, the paper attempts to give a feel for the volume of information we do not yet have, compared to the information we do have: What we do not know compared to what we do know. The paper then considers the vast dimensions of the universe and, in spite of all the valuable advances in science and technology, concludes that the information we have from the universe is almost nothing compared to the mind boggling size and mysteries of the universe. It appears, therefore, that any significant advance in discovering the mysteries of the universe, considering what is ahead, demands a "radically" different approach. In conclusion, the paper argues that information science is in the process of leading and evolving to this approach, where a *unification* appears to be the objective.

5.2 The universal science

Mathematics is a universal science. Mathematical concepts are not limited to the human civilization. A sequence of some prime numbers, for example, implies the same concept anywhere in the universe. Any probable intelligence anywhere in the universe would understand such a sequence, as we do. Mathematical concepts, therefore, can be considered as the vocabularies of a universal language. That is why I have started the WWW homepage of our faculty, the Faculty of Mathematical Science in Tabriz University, with the following statement:

Think Mathematics!
To share the intelligence of entire universe

This means that there exists a *unifying* factor, mathematics, that can link together all probable intelligence all around the universe.

5.3 Characterization of our age

In this age, we have witnessed the breakup of atom and have seen its destructive power in war as well as its constructive power in peace. Can we characterize our age as *nuclear age*?

In this age, we have witnessed human curiosity bringing moon down from the dreams of poets to a dead planet. With respect to the advances in space explorations, can we characterize our age as *space age*?

In this age, we have witnessed tremendous advances in electronics and yet we cannot characterize our age as *electronics age*. The fact is advances in all sciences and technologies, from microelectronics, supercomputers, artificial intelligence, neural networks, and robotics to astrophysics, from biology, neurobiology to nuclear science, all have something in common: *information*. We want to increase our knowledge and information. All human curiosities and the consequent research activities, structured as different sciences and technologies, are after *information*.

Just consider the volume of information we have gathered so far. Imagine the number of computers, from PC's to work stations, mini's, mainframes and supercomputers, collecting, processing and storing information. Imagine the millions of computers in the worldwide network, Internet, and the tremendous amount of information floating around. We are, in deed, living in the *information age*.

5.4 What is information?

Living in the information age, it is necessary that we give a proper definition for *information*.

5.4.1 Definition of information

Informally, *information* is defined in different ways by different scholars:

- For Shannon, *information* is something which reduces uncertainty [2].
- For Pratt, *information* is something which occurs within the mind upon the absorption of a message [3].
- For Peters, *information* is knowledge with the human body taken out of it [4].

- For Resnikoff, *information* is what remains after one abstracts the material aspects of physical reality [5].
- For Dretske, *information* is, like beauty, in the mind of the beholder [6].
- For others, *information* is something else [7, 8, 9]. Robert Losee presents a comprehensive and critical discussion of the various definitions given for *information* [10]. He considers all other definitions as *field-specific*, and provides a *discipline-independent* definition of his own.
- For Losee, *information* is produced by all processes and it is the values of characteristics in the process' output that are *information* [10].
- And for me, any "representation" of an entity is *information* about the entity.

Formally, r is the (ρ, t)*-representation* of e, if there exists a function ρ and a point in time t, such that $\rho(e,t) = r$. Notice that different functions may produce different representations of a given entity; and a function may produce different representations of a given entity at different times. Using a convention that r refers to the current value of the function, we can eliminate t, simplifying the definition. Thus, we can say r is the ρ*-representation* of e, if there exists a function ρ, such that $\rho(e) = r$. In this case, we can also simply refer to r as a *representation* of e.

With this introduction, therefore, the notion of representation is defined by

$$\rho(e,t) = r, \quad \text{where} \tag{5.1}$$

ρ is the *representation function*,
t is the *representation time*,
e is the *representandum*, and
r is the *representation*.

Having defined the notion of representation, we can now say r is *information* about e or r provides some *information* about e, if r is a representation of e. Any representation of an entity, therefore, provides some information about the entity. If the inverse of ρ is also a function, then $\rho^{-1}(\rho(e)) = e$ and given r we can reproduce e ($\rho^{-1}(r) = e$), in which case r is a *perfect representation* of e. A perfect representation of e provides all the information about e. For example, on the set of positive integers, if $\rho(e) = e^2$, then $\rho(5) = 25$ and $\rho^{-1}(25) = 5$ and, therefore, 25 is a perfect representation of 5. As another example, in the *Theory of Algorithms and Data Structures*, a graph G is routinely represented by its adjacency matrix M [11]. If we define ρ as $\rho(G) = M$, then $\rho^{-1}(M) = G$ and, therefore, M is a perfect representation of G.

Most representations, however, are not perfect. For example, let us consider the function ρ defined on positive integers as

$$\rho(e) = \begin{cases} \text{odd}\ , & \text{if } e \text{ is an odd number} \\ \text{even}\ , & \text{otherwise} \end{cases}$$

The inverse of this function is not a function and, therefore, the corresponding representations are not perfect. By this definition, all odd numbers are represented as "odd". The representation "odd" is not enough to reproduce the representandum. However, there are cases, where it can be useful just to know whether the number is odd or even. In general, there are cases, where we want only as much information about an entity as we need and not more. This is because, it serves no purpose to collect and carry around more information about the entity than we need; besides, not all the information on the entity is necessarily available. In other words, for many entities, imperfect representations of the entity are all that we have to work with. In addition, a representation of a representandum can be further represented, creating a hierarchy of representations. In fact, each layer of the communication protocols is described by one level of the corresponding hierarchical representations.

Our notion of representation and the consequent definition of information are consistent with, and describe, most of the familiar concepts in *information theory*. For example:

- *Out-of-date and Up-to-date Information:* If the value of t, in the Equation (5.1), is equal to an old time, then the corresponding information is said to be *out-of-date*. For the *up-to-date* information t must specify the current time.

- *Volume of Information:* In data communication, a message m is represented as $\rho(m)$, transmitted to the destination, where the original message m is reproduced by $m = \rho^{-1}(\rho(m))$. The volume of information contained in the message is $\log_2(n)$ bits, where n is the size of domain of ρ. That is, the number of bits required to code a message out of n possible messages is $\log_2(n)$ [12]. The logarithmic base 2 is for our choice of "bit", as the unit of measuring information, considering that a bit consists of 2 states. If we choose a another mechanism, consisting of b states, then the logarithmic base will be b.

- *Misinformation or Error:* A representation may not reflect the true state of the world, in which case it is misrepresentation, misinformation, or error.

  Formally, $r = \rho(e)$ is misinformation if $\rho^{-1}(r)$ is inconsistent with e. In particular, where perfect representations are required, $r = \rho(e)$ is misinformation if $\rho^{-1}(r) \neq e$.

- *Belief:* Given an entity e, belief is an idea one may choose to have on $\rho(e)$ being a representation (and not misrepresentation).

- *Knowledge:* Knowledge refers to justified true belief. Notice that there is no proof obligation for one's belief, while knowledge must be justified and proved, otherwise it is not knowledge.

In addition, our notion of representation, provides a new (and I believe better) view of the world. I call this view of the world *representationism*, which is the way in which information science has been dealing with entities, in representing, manipulating, transferring, and reproducing them. The representationistic approach to study an entity, in general, is to extract representations of the entity, study them, and compose the results to construct knowledge of the entity. Notice that this is different from the well known *reductionistic*, (in contrast to *holistic*) approach in the philosophy of science. In reductionism, a whole is dissected into pieces, each piece is studied and analyzed separately, and then the results are synthesized and integrated. There are similarities, but also major differences: The pieces in reductionism are smaller parts of the whole, while the representations in representationism are simple and possibly imperfect representations of the entire whole. There we have a picture of a section, while here we have a picture of the whole, but from a specific point of view.

Critics of science have portrayed reductionism as an *obsessional disorder, declining toward a terminal stage, as one writer recently dubbed "reductive megalomania"* [13]. This criticism does not apply for representationism. Because, the representationistic approach to study an entity, reduces the problem by describing it in terms of simple representations, but unlike reductionism, keeps the entity intact.

5.4.2 Volume of information

There are tremendous amount of information out there. The volume of information collected and stored in different media is astronomical and increasing every day.

I remember in 1984, in the software engineering process of a system in Bell Labs, I proposed using a distributed DBMS, just because the volume of information to be stored was too large for a single machine. This volume was in the order of some hundred megabytes. Today, for some statistical analysis, information in the order of gigabytes is not enough, we are talking terabytes and still increasing.

5.4.3 Significance of information

Information provides awareness, knowledge, and power! It has been a well known fact since long time ago that "information is power." In economics, in politics, in military, in medicine, in science and technology, and in planning any project, collecting the necessary information is normally the first step. We live in a competitive world and in any area of competition, friendly or otherwise, the most informed party has the upper hand. An "informed" person generally makes the most appropriate decision.

5.4.4 Structure of information

Without a proper structure information is useless. Having all the information of the world in a box, or in a cabinet, or in a computer does not help; it is important that we find the information we need, when we need. Computers are getting faster and faster and yet, due to the high volume of information, finding the information we need can be time consuming or even impossible. Information must be organized in a proper structure so that when we need information on a particular subject, we get it immediately.

There is a body of work on the methods and techniques for structuring, storing, and retrieving information. Disciplines like *Data Structures* [14, 15], *Theory of Algorithms* [11], and *Database Management Systems* [16, 17, 18, 19, 20] have been developed for giving the proper structure to the information.

5.4.5 Communication of information

Without on-time communication, information is useless. It is quite possible that some information on a particular subject is collected and stored somewhere in the world, while the same information is needed somewhere else in the world. In such a situation, we have a *source*, where the information stored and a *destination*, where the information is needed. The information must be retrieved at the source and communicated to the destination. Information retrieval requires a proper organization, as discussed above. Fast communication of information is also necessary; otherwise, the information would lose its value. Disciplines like *Data Networks* [21, 22] and *Computer Networks* [23] are designed basically for information communication. We need fast retrieval as well as fast communication of information. We need immediate access to the information we need at any source in the world. *Internet* is designed to serve this need. Surfing the net, you see the power of information when there is fast retrieval and fast communication.

Internet is an example of the trend towards *collective information processing*. However, there are more into collective information processing than what Internet provides. The nodes of Internet are too independent of each other and the communication of Internet is too slow. A better but small example of collective information processing is *neural networks* [24, 25]. A neural network basically *learns* to solve the problem or do the job. One of the early examples of neural networks, NetTalk [26], learns from a human teacher to read English texts. Here we do not program the system, we *train* the system and it *learns*. Yes, some intelligence is needed for an entity to be train-able; and yes, collective information processing leads to intelligence. A superior example of a neural network is the human brain, a network of over 100 billion neurons, each of which in simultaneous communication with over 10,000 neighboring neurons [27]. This is, of course, based on our limited knowledge of the brain. We do not yet know how exactly the brain works. Neurobiologists are still trying to understand and describe the workings of the brain, which may well be the most complex task in the universe.

5.5 Evaluation: What do we know?

We have gathered a lot of information. We have developed advanced sciences and technologies. We have knowledge spanning from microbiology to astrophysics. But, how many mysteries of the universe have we discovered? Consider the *unknowns*, look at the astronomical dimensions of the universe, and see how much we really *know.*

How much do we really know, for example, on extraterrestrial intelligence? Astronomer Paul Horowitz [28], in 1978, scanned all 185 sun-like star systems within 80 light years of our solar system and found no traces of radio emissions from intelligent life. Later in 1979 Donald Goldsmith and Tobius Owen on their search for extraterrestrial intelligence (SETI) extended the search for 600 star systems, also with negative result. On the other hand, the probability of intelligent life emerging within our galaxy is surprisingly large. Frank Drake of the University of California at Santa Cruz [28] estimates that a staggering 200,000 stars, in our galaxy, can have planets harboring some form of intelligent life. This estimate is based on a conservative assumption that only one-millionth of the 200 billion stars in our galaxy will probably have some intelligent life form and, yet, there are 200,000 star systems to search, just in our own galaxy! There are 100 billion galaxies in the universe!!

We know almost nothing compared to what is out there! It appears, therefore, that any significant advance in discovering the mysteries of the universe, considering what is ahead, demands a radically different approach.

Late Carl Sagan [29] in a discussion on some major unresolved cosmic questions, predicts that *the most amazing discoveries will be ones we are not wise enough to foresee.* What we are not wise enough to foresee, I believe, is *the* approach. Sagan's prediction, therefore, is just another way of stating that *the most amazing discoveries demand a radically different approach, which we cannot yet foresee.*

5.6 Unification

On the one hand, there are separate entities and/or phenomena (such as individual human beings, different societies and cultures, different components of a system, different laws of the universe, and so on), each with its own points of strengths and weaknesses. These entities are not complete or perfect in their separate forms. As an undeniable fact of life these separate entities do exist.

On the other hand, these entities, which are normally studied using their representations, may well be representations of some higher level representandums. Going up in the hierarchy of representations, the unification of some separately simple, weak, and imperfect entities can lead to perfection and mere beauty.

There are cases, where we want to concentrate on a particular aspect of an entity. Even if the entity is well defined as a whole, we may still be interested in a smaller and imperfect representation of it. An example of such case is in Database Management System (DBMS). A DBMS usually contains a large volume of information. Each group of users, are normally interested in some specific information in the DBMS. There may be particular fields in the DBMS that contains valuable information; but not all the information are valuable for all the users. That is why the DBMS technology uses a mechanism, called *view*, to organize and classify the information in the database. A database view, therefore, is a convenient way of providing the information of interest to a user or a group of users, while hiding away the rest of the information [30]. Different views of a DBMS are, in fact, different representations of the DBMS in our terminology. And, this is how a DBMS manages to supply each user the representation of the database tailored for the user.

It is important, also, to note that we are naturally dealing with separate entities and if we try to studying an object as a whole, we can see, understand, and/or describe only parts of it. There are many reasons as to why we can only see parts and pieces: Studying a physical object, for example, the object can be so large and complex that cannot be considered simultaneously in all its dimensions, specially now that we are not even sure of the number of dimensions. For years we were thinking that we are living in a universe of three (four, including time) dimensions. Recent discoveries in *string theory* [31] show that the building elements of our universe, the *strings*, are vibrating in at least nine dimensions, six of which are so small (Planck length) that cannot be physically detected by any available equipment. And so, the separated entities and parts are all we have. Nevertheless, the unification of these insignificant entities, parts, and pieces leads to the perfect whole.

As another example, the very basic philosophy of a recent methodology for software systems specification and definition is totally based on the representationistic approach, using a notion called *view* [32]. According to this methodology, one can only describe his/her view of the world and, therefore, the specifier should not even attempt to specify the system as a whole. What the specifier can do and should do is to specify specific views of the system. The methodology, then, *composes* the views, producing higher level views, and thereby approaching to the whole picture, the *unified view*, of the system. The key points in this methodology are:

- Specific views of a system are all we can see, understand, describe, and work with.

- The system can only be defined as a *unified view*, produced by the hierarchical composition of views.

And, all these validate the approach I called representationism.

The fascination with the *unified theory, unified knowledge,* and/or *unified intelligence*, in one way or another, is certainly nothing new. For example,

- Albert Einstein spent the last thirty years of his life in search of a single unified field theory, describing all forces of the universe. He believed in existence of an elegant theory, unifying all the forces of nature and describing the workings of the universe. Einstein never realized his dream [31].

- Paul Davies on the search for a grand unified theory of nature and how this theory may affect us, states that *we could change the structure of space and time, tie our own knots in nothingness and build matter to order. Controlling the superforce would enable us to construct and transmute particles at will, thus generating exotic forms of matter. We might even be able to manipulate the dimensionality of space itself, creating bizarre artificial worlds with unimaginable properties. Truly we should be the lords of the universe* [33].

- Stephen Hawking in the prospect of discovering the unified theory states: *Then we shall all, philosophers, scientists, and just ordinary people, be able to take part in the discussion of the question of why it is that we and the universe exist. If we find the answer to that, it would be the ultimate triumph of human reason – for then we would know the mind of God* [34].

- Steven Weinberg fascinated by the elegance of a unified theory, calls it *a beautiful theory* [35].

- Brian Greene poetically speaking about the string theory, as a station on the road to the unified theory, states: *With the discovery of superstring theory, musical metaphors take on a startling reality, for the theory suggests that the microscopic landscape suffused with tiny strings whose vibrational patterns orchestrate the evolution of the cosmos* [31].

- Edward Wilson has written a whole book [13] on his belief in the intrinsic unity of knowledge. He believes that all branches of knowledge, from biology to physics and from sociology to economics and arts, are unified under what he calls *consilience.*

5.7 Conclusion

In this paper, we talked about representations. Representations are all we can see, examine, and study. Our science and all our findings on a given entity is based on (not necessarily perfect) representations of the entity. All around us are nothing but imperfect representations. Information age is, in deed, the representation age. Information technology requires to go further down in the hierarchy of representations. Our understanding of an entity is now, more than ever, based on low level representations of the entity. Information age has been the age of traveling down in the hierarchy of representations. Beyond the information age, I believe, lies an age of traveling up in the hierarchy of representations. We will be approaching the reality by traveling up in the hierarchy. Following a representationistic approach, composing different representations of a given entity, in hopes of reaching the entity, the inverse of the function ρ, will be clearing the road to unification.

We talked about the existence of a *unifying* factor, mathematics, that can link together all probable intelligence all around the universe. We talked about computers, networks, and Internet linking together millions of people all around the world. We talked about the beauty and perfection resulting from the unification of imperfect and insignificant parts and pieces.

Finally, we talked about *communication*, playing a key role in this information age. Higher level intelligence demands massive and fast communications. Ultimately, we would like to receive massive amount of information, instantly, at will. That is joining the source of information, which can only mean *unification*.

The notion of unification has fascinated mathematicians, philosophers, and poets for centuries. I would like to conclude the paper with a poem in this regard from Khayam, the great mathematician, philosopher, and poet of 12th century Iran. In this poem, he describes the distinction between *you* and *me* as nothing but a short-lived little talk, which is going to seize to exist once we all are unified. Here is the poem:

اسرار ازل را نه تو دانی و نه من   وین حرف معما نه تو خوانی و نه من

هست از پس پرده گفتگوی من و تو   چون پرده برافتد نه تو مانی و نه من

خیام

There was a Door to which I found no Key:

There was a Veil past which I could not see:

Some little Talk awhile of ME and THEE

There seemed–and then no more of THEE and ME.

Khayam

Translated by Fitzgerald

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Chapter 6, Exercise

On Comprehension of the Essay,

Beyond the Information Age: A Philosophical Perspective

This is an exercise chapter; it is intended to test and improve comprehension of the essay presented in previous chapter.

Design and preparation of all the exercises are started by students of CS'85, attending an introductory course on *Technical English*.

I do not expect the exercises to be all correct and perfect. I do believe, however, that they would serve students to improve their comprehension skills.

I expect the students to practice and learn from the exercises, while correcting and improving on them; should be a good experience.

I will keep editing, organizing, and revising the exercises, for as long as I find them useful.

6.1 On the "Definition of information (I)"

Read Section 5.4.1, the *Definition of information (I)*, on page 121 and do the following exercises:

Compliments of Sima & Hadi[1]

6.1.A. Fill in the blanks with the appropriate words or phrases.

1. *Information* is defined in .... ways by different scholars.
2. For Shannon, *information* is something which .... uncertainty.
3. .... is something which occurs within the mind upon the absorption of a message.
4. For Petters, *information* is .... with the human body taken out of it.
5. Robert Losee presents a .... and .... discussion of *information*.

6.1.B. Determine whether the statements are *True* or *False*.

1. *Information* is defined in the same way by different scholars.
   True ☐ *False* ☐
2. For shannon, *information* reduces uncertainty.
   True ☐ *False* ☐
3. *information* is the values of characteristics in the process' output.
   True ☐ *False* ☐
4. Robert Losee presents a various definitions given for *information* from others.
   True ☐ *False* ☐
5. Any production of an entity is *information* about the entity.
   True ☐ *False* ☐

[1]This exercise is designed by Sima Pirani and Hadi Seiiedzaier, CS'86.

6.1.C. Pick the most appropriate choice, for each question.

1. We live in .... age.

   (a) Technology ☐

   (b) Nuclear ☐

   (c) Electronic ☐

   (d) *information* ☐

2. For Dretske, ... is, like beauty, in the mind of beholder.

   (a) Picture ☐

   (b) *information* ☐

   (c) Nature ☐

   (d) a and b ☐

3. Robert Losee considers all other definition as .... and provides a .... definition of his own.

   (a) Discipline-independent, field-specific ☐

   (b) Discipline-independent, field-various ☐

   (c) Both of them ☐

   (d) None of them ☐

4. For Losee, *information* is produced by all ....

   (a) Data ☐

   (b) Processes ☐

   (c) Output ☐

   (d) Representation ☐

5. *information* is what remains after ....

   (a) one abstracts the material aspects of physical reality. ☐

   (b) looking deeply to entities. ☐

   (c) any representation of an entity. ☐

   (d) a and b and c ☐

6.1.D. Answer the questions.

1. What is the Shannon's idea about *information*?
2. What is the Resinkoff's idea about *information*?
3. How Robert Losee present a definition for *information*?
4. What is difference between Robert Losee's definition of information and other scholars'?
5. What is the definition of *information* about an entity?

6.1.E. Write your understanding of the text, specified bellow, in your own language.

The first paragraph ("Informally,...") of Section 5.4.1 on page 121

6.2 On the "Definition of information (II)"

Read Section 5.4.1, the *Definition of information (II)*, on page 122 and do the following exercises:

Compliments of Hadi & Sima[2]

6.2.A. Fill in the blanks with the appropriate words or phrases.

1. In $\rho(e) = r$ we can say r is *information* about e, if r is a .... of e.
2. If we define ρ as $\rho(G) = M$, and $\rho^{-1}(M) = G$ then we say, M is a .... of G.
3. All odd numbers are .... as odd.
4. For many entities, ... of the entity are all that we have to work with.
5. Each layer of the communication protocols is described by one level of the corresponding ....

6.2.B. Determine whether the statements are *True* or *False*.

1. A function only produces one representation of a given entity.
   True ☐ *False* ☐
2. r provides some *information* about e, if e is a representation of r.
   True ☐ *False* ☐
3. If $\rho^{-1}(r) = e$, then r is called the perfect representation of e.
   True ☐ *False* ☐
4. A graph G is routinely represented by its adjacency matrix M.
   True ☐ *False* ☐
5. Most representations, are not perfect.
   True ☐ *False* ☐

[2]This exercise is designed by Hadi Seiiedzaier and Sima Pirani, CS'86.

6.2.C. Pick the most appropriate choice, for each question.

1. In $\rho(e) = r$, r is a representation of . . . .

   (a) ρ ☐
   (b) t ☐
   (c) e ☐
   (d) None of them ☐

2. Using a convention that r refers to . . . ., we can eliminate t.

   (a) Main function ☐
   (b) The current time of function ☐
   (c) Definition of function ☐
   (d) The current value of function ☐

3. $\rho(e, t) = r$, where . . . .

   (a) ρ - is the representation time. ☐
   (b) r - is the representandum. ☐
   (c) e - is the representandum. ☐
   (d) t - is the representation function. ☐

4. A . . . . of e provides all the information about e.

   (a) Perfect representation ☐
   (b) Representation ☐
   (c) Definition ☐
   (d) Theory ☐

5. Assuming M is the adjacency matrix a graph G, if we define ρ as $\rho(G) = M$, then $\rho^{-1}(M) = G$ and, therefore, ... is a perfect representation of . . . .

   (a) G - M ☐
   (b) G - ρ ☐
   (c) ρ - M ☐
   (d) M - G ☐

6.2.D. Answer the questions.

1. How could we simplify the definition?
2. What is the meaning of the sentence "r is *information* about e"?
3. When is a representation perfect?
4. How could we further represent a representation of a representandum?
5. When is M a perfect representation of G?

6.2.E. Write your understanding of the text, specified bellow, in your own language.

The paragraph starting with "Formally,..." of Section 5.4.1 on page 122

6.3 On the "Definition of information (III)"

Read Section 5.4.1, the *Definition of information (III)*, on page 123 and do the following exercises:

Compliments of Parinaz & Saber[3]

6.3.A. Fill in the blanks with the appropriate words or phrases.

1. For the .... information t must specify the current time.

2. The logarithmic base 2 is for our choice of .... , as the unit of measuring information, considering that a bit consists of 2 states.

3. In data communication, a message m is .... as $\rho(m)$, transmitted to the destination, where the original message m is .... by $m = \rho^{-1}(\rho(m))$.

4. $r = \rho(e)$ is .... if $\rho^{-1}(r)$ is inconsistent with e.

5. .... refers to justified true belief.

6.3.B. Determine whether the statements are *True* or *False*.

1. Our notion of representation and consequent definition of information are not consistent with the familiar concepts in *information theory*.

   True ☐ *False* ☐

2. The inverse of a function is not necessarily a function.

   True ☐ *False* ☐

3. For the out-of-date information t must specify the current time.

   True ☐ *False* ☐

4. The number of bits required to code a message out of n possible messages is $\log_2(n)$.

   True ☐ *False* ☐

5. A representation may not reflect the true state of the world.

   True ☐ *False* ☐

[3] This exercise is designed by Parinaz Rahmani and Saber Shakeri, CS'86.

6.3.C. Pick the most appropriate choice, for each question.

1. If the value of t, in the equation, is equal to an old time, then the corresponding information is said to be . . . .

   (a) Out-of-date ☐
   (b) Up-to-date ☐
   (c) Both of them ☐
   (d) None of them ☐

2. If . . . . then $\rho^{-1}(\rho(e)) = e$.

   (a) the inverse of ρ is also a function. ☐
   (b) ρ is a function. ☐
   (c) e is the representation function. ☐
   (d) ρ is the representandum. ☐

3. The original message m is reproduced by $m=$ . . . .

   (a) $\rho^{-1}(\rho(m))$ ☐
   (b) $\rho(m)$ ☐
   (c) $\rho^{-1}(m)$ ☐
   (d) None of them ☐

4. . . . . refers to justified true belief.

   (a) Function ☐
   (b) Representation ☐
   (c) Knowledge ☐
   (d) Information ☐

5. Which three words have the same meaning in information world?

   (a) Misinformation - Up to date - Error ☐
   (b) Misinformation - Error - Misrepresentation ☐
   (c) Up to date - Out of date - Misrepresentation ☐
   (d) Misrepresentation - Equation - Error ☐

6.3.D. Answer the questions.

1. What would be the value of t for the up-to-date information?
2. When the information is said to be out-of-date?
3. When does the error case occur?
4. When $r = \rho(e)$ is misinformation?
5. What is the difference between belief and knowledge?

6.3.E. Write your understanding of the text, specified bellow, in your own language.

The paragraph starting with "Our notion of..." of Section 5.4.1 on page 123

6.4 On the "Definition of information (IV)"

Read Section 5.4.1, the *Definition of information (IV)*, on page 124 and do the following exercises:

Compliments of Saber & Parinaz[4]

6.4.A. Fill in the blanks with the appropriate words or phrases.

1. . . . . is the way in which information science has been dealing with entities, in representing, manipulating, transferring, and reproducing them.
2. There we have a picture of a section while here we have a picture of the whole, but from specific . . . . of view.
3. Notice that this is different from the well known . . . . , (in contrast to *holistic*) approach in the philosophy of science.
4. The representationistic approach to study an entity, in general, is to extract representations of the entity, study them, and compose the results to construct . . . . of the entity.
5. Representations in representationism are simple . . . . of the entire whole.

6.4.B. Determine whether the statements are *True* or *False*.

1. The pieces in reductionism are smaller parts of the whole.
   True ☐ *False* ☐
2. The criticism does not apply for representationism.
   True ☐ *False* ☐
3. The pieces in reductionism are just like the representations representationism.
   True ☐ *False* ☐
4. The representationistic approach has nothing in common with *reductionistic*, nor with the *holistic*) approach.
   True ☐ *False* ☐
5. Critics of science have portrayed reductionism as an *obsessional disorder*.
   True ☐ *False* ☐

[4] This exercise is designed by Saber Shakeri and Parinaz Rahmani, CS'86.

6.4.C. Pick the most appropriate choice, for each question.

1. An example of a representationistic approach to system specification is a formalism called . . . .

   (a) Viewership ☐
   (b) Viewpoints ☐
   (c) Viewcharts ☐
   (d) None of them ☐

2. Representations unlike reductionism, keeps the . . . . intact.

   (a) Globe ☐
   (b) Mathematician ☐
   (c) Entity ☐
   (d) Champ ☐

3. The . . . . does not apply for representationis.

   (a) Criticism ☐
   (b) Treatise ☐
   (c) Definition ☐
   (d) Presentation ☐

4. The . . . . approach to study an entity extracts representations of the entity.

   (a) representationistic ☐
   (b) Representation ☐
   (c) Knowledge ☐
   (d) Information ☐

5. What is the representationism?

   (a) Our notion of representation, provides a new view of the science ☐
   (b) Our notion of representation, provides a new view of the information ☐
   (c) Our notion of representation, provides a new view of the world ☐
   (d) Our notion of representation, provides a new view of the mechanism ☐

6.4.D. Answer the questions.

1. What is the *piece* in reductionism and how it defers from the *representation*?
2. Why the criticism does not apply to representationism?
3. What is the representation?
4. What is the major difference between reductionism and representationism?
5. Why the criticism of reductionism doesn't apply for representationism?

6.4.E. Write your understanding of the text, specified bellow, in your own language.

The paragraph starting with "In addition,..." of Section 5.4.1 on page 124

6.5 On the "Volume of information + 2"

Read Section 5.4.2, the *Volume of information + 2*, on page 124 and do the following exercises:

Compliments of Somayeh[5]

6.5.A. Fill in the blanks with the appropriate words or phrases.

1. The volume of information collected and stored in . . . .
2. It has been a well known fact since long time ago that . . . . is power .
3. Information must be organized in . . . .
4. DBMS have been developed for giving the proper . . . . to the information.
5. There is a body of work on the methods and techniques for . . . . , ... , and . . . . information.

6.5.B. Determine whether the statements are *True* or *False*.

1. The volume of information collected and stored in different media is increasing every day.

   True ☐ *False* ☐
2. In economics, military, in science and technology collecting the necessary information is normally the second step .

   True ☐ *False* ☐
3. Without a proper structure information is useless.

   True ☐ *False* ☐
4. It is not important that we find the information we need, when we need.

   True ☐ *False* ☐
5. Due to the high volume of information, finding the information we need cannot be time consuming.

   True ☐ *False* ☐

[5]This exercise is designed by Somayeh Ahmadi, CS'86.

6.5.C. Pick the most appropriate choice, for each question.

1. Which one is wrong about information?

   (a) Information is power. ☐
   (b) Information provides awareness. ☐
   (c) Volume of information decreases every day. ☐
   (d) Information must be organized in a proper structure. ☐

2. An . . . . person generally makes the most appropriate decision

   (a) informed ☐
   (b) intelligent ☐
   (c) sharp ☐
   (d) experienced ☐

3. In competitive world who has the upper hand?

   (a) Scientist ☐
   (b) Politician ☐
   (c) The richest party ☐
   (d) Most informed party ☐

4. What is the first step in science and technology?

   (a) Collecting the necessary information ☐
   (b) Analyzing information ☐
   (c) Searching for information ☐
   (d) Processing the information ☐

5. When can we have immediate access for information on a particular subject?

   (a) When information is organized. ☐
   (b) When we are in the process of collecting information. ☐
   (c) When information is being processed. ☐
   (d) When information is being stored. ☐

6.5.D. Answer the questions.

1. Why we use the distributed DBMS?
2. Why collecting the necessary information is the first step in planning a project?
3. Why the information must be organized?
4. Why without a proper structure information is useless?
5. Why finding the information we need can be time consuming?

6.5.E. Write your understanding of the text, specified bellow, in your own language.

The second paragraph ("I remember...") of Section 5.4.2 on page 124

6.6 On the "Communication of information"

Read Section 5.4.5, the *Communication of information*, on page 125 and do the following exercises:

Compliments of Somayeh[6]

6.6.A. Fill in the blanks with the appropriate words or phrases.

1. Information . . . . requires a proper organization.
2. The information must be retrieved at the . . . . and communicated to the . . . .
3. Disciplines like *Data Networks* and *Computer Networks* are designed basically for . . . .
4. . . . . is an example of the trend towards *collective information processing.*
5. A better but small example of collective information processing is . . . .

6.6.B. Determine whether the statements are *True* or *False*.

1. Without on-time communication, information is useless.
   True ☐ *False* ☐
2. The nodes of internet are too independent of each other and the communication of internet is too fast.
   True ☐ *False* ☐
3. Fast communication of information is useful.
   True ☐ *False* ☐
4. We know how exactly the brain works.
   True ☐ *False* ☐
5. Some Intelligence is needed for an entity to be train-able.
   True ☐ *False* ☐

[6] This exercise is designed by Somayeh Ahmadi, CS'86.

6.6.C. Pick the most appropriate choice, for each question.

1. .... of information is also necessary otherwise the information would lose its value

   (a) Fast communication ☐

   (b) Slow communication ☐

   (c) Retrieval ☐

   (d) Proper organization ☐

2. Disciplines like Data Networks and Computer Networks are designed basically for ....

   (a) information communication ☐

   (b) proper organization ☐

   (c) Internet ☐

   (d) neural networks ☐

3. We need immediate access to the information we need; .... is designed to serve this need.

   (a) source ☐

   (b) destination ☐

   (c) neural network ☐

   (d) internet ☐

4. The nodes of internet are .... each other to serve a *collective information processing unit.*

   (a) very dependent on ☐

   (b) too independent of ☐

   (c) attached to ☐

   (d) connected to ☐

5. Some .... is needed for an entity to be train-able.

   (a) power ☐

   (b) source ☐

   (c) intelligence ☐

   (d) nodes of internet ☐

6.6.D. Answer the questions.

1. Why without on-time communication information is unless?
2. What is designed to serve as the source of information in the world?
3. Give an early example for neural network?
4. Who are still trying to understand and describe the working of the brain?
5. What leads to intelligence?

6.6.E. Write your understanding of the text, specified bellow, in your own language.

The second item ("Internet is...") in Section 5.4.5 on page 125

6.7 On the "Unification"

Read Section 5.6, the *Unification*, on page 126 and do the following exercises:

Compliments of Javad & Avin[7]

6.7.A. Fill in the blanks with the appropriate words or phrases.

1. Data base Management Systems use a mechanism, called . . . . , to organize information.

2. The very basic philosophy of a recent methodology for software systems specification is based on the . . . .

3. Recent discoveries in . . . . show that the building elements of our universe are . . . . in at least nine dimensions.

4. Different views of a DBMS are, in fact, different . . . . of the DBMS in our terminology.

5. Steven weinberg called unified theory, ...

6.7.B. Determine whether the statements are *True* or *False*.

1. Entities in separate forms are prefect.
   True ☐ *False* ☐

2. The system can only be defined as a specific view.
   True ☐ *False* ☐

3. Unified view produce by hierarchical composition of views.
   True ☐ *False* ☐

4. According to Paul davies, we can't change the structure of space and time.
   True ☐ *False* ☐

5. DBMS contains a lot of information, all of which are valuable for all users.
   True ☐ *False* ☐

[7] This exercise is designed by Javad rafie and Avin Esmaeili, CS'86.

6.7.C. Pick the most appropriate choice, for each question.

1. Who was in search of a single unified field theory, which was never realized?

   (a) Albert Einstein. ☐

   (b) Paul Davies. ☐

   (c) Brian Greene. ☐

   (d) Steven Weinberg. ☐

2. Fascinated with the grand unified theory, who believes that we should be the lords of the universe?

   (a) Albert Einstein. ☐

   (b) Paul Davies. ☐

   (c) Brian Greene. ☐

   (d) Steven Weinberg. ☐

3. Which one is true?

   (a) Separate entities can't lead to perfection. ☐

   (b) Studying an object as a whole is efficient. ☐

   (c) We are dealing with whole entities. ☐

   (d) Unified view is produced by the hierarchical composition of views. ☐

4. According to the recent methodology for software systems specification and definition........

   (a) Specifier can attempt to specify the system as a whole. ☐

   (b) One can only describe his/her view of the world. ☐

   (c) Specifier should attempt to specify the system as a whole. ☐

   (d) Specifier shouldn't specify specific views of the system.. ☐

5. He believes that all branches of knowledge are unified to what he calls consilience?

   (a) Albert Einstein. ☐

   (b) Paul Davies. ☐

   (c) Brian Greene. ☐

   (d) Steven Weinberg. ☐

6.7.D. Answer the questions.

1. Why does DBMS technology use the mechanism of view ?
2. What does DBMS stands for?
3. Why don't we try to studying an object as a whole?
4. What can lead to perfection in the hierarchy of representation?
5. How is unified view created?

6.7.E. Write your understanding of the text, specified bellow, in your own language.

The second paragraph ("On the other hand,...") of Section 5.6 on page 126

6.8 On the “Conclusion”

Read Section 5.7, the *Conclusion*, on page 129 and do the following exercises:

Compliments of Javad[8]

6.8.A. Fill in the blanks with the appropriate words or phrases.

1. . . . . are all we can see, examine, and study.

2. Our science and all our findings on a given entity are based on (not necessarily perfect) . . . . of the entity.

3. . . . . is playing an important role in the information age.

4. Our understanding of an entity is now, more than past and it is based on . . . . representation of entity .

5. The existence of a . . . . factor and mathematics, that can link with each other all probable . . . . all around the universe.

6.8.B. Determine whether the statements are *True* or *False*.

1. All around us are nothing but imperfect representations.
   True ☐ *False* ☐

2. Information technology requires to go further more in the hierarchy of representations.
   True ☐ *False* ☐

3. We will be approaching the reality by traveling down in the hierarchy.
   True ☐ *False* ☐

4. We would like to receive massive amount of information, instantly, at will.
   True ☐ *False* ☐

5. Beyond the information lies an age of traveling down in the hierarchy of representations.
   True ☐ *False* ☐

[8] This exercise is designed by Javad Behmaram, CS’86.

6.8.C. Pick the most appropriate choice, for each question.

1. Representations are all we can .... , ... and ....

   (a) Study - Understand - See ☐
   (b) See - Say - Examine ☐
   (c) Study - See - Examine ☐
   (d) Examine - Make - Involve ☐

2. Our understanding of an entity is now .... ever.

   (a) Less than ☐
   (b) More less than ☐
   (c) Extremely ☐
   (d) More than ☐

3. .... is indeed the representation age.

   (a) Software engineering ☐
   (b) Information age ☐
   (c) Communication age ☐
   (d) Unification age ☐

4. Joining the source of information can only mean ....

   (a) Unification ☐
   (b) Communication ☐
   (c) Information ☐
   (d) Representation ☐

5. The beauty and perfection resulting from the unification of imperfect and .... parts and pieces.

   (a) Significant ☐
   (b) Information ☐
   (c) Insignificant ☐
   (d) Massive ☐

6.8.D. Answer the questions.

1. What are the representations?
2. What is based on the representations of the entity?
3. What does the information technology require?
4. What does the higher level intelligence demand?
5. What is unification?

6.8.E. Write your understanding of the text, specified bellow, in your own language.

The second paragraph (”We talked about the existence...”) in Section 1.5 on page 129

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