### Introduction

Intelligent tutoring systems (ITSs) are computer programs that are designed to incorporate techniques from the AI community in order to provide tutors which know what they teach, who they teach and how to teach it. AI attempts to produce in a computer behaviour which, if performed by a human, would be described as ‘intelligent’: ITSs may similarly be thought of as attempts to produce in a computer behaviour which, if performed by a human, would be described as ‘goad teaching’ (Elsom-Cook, 1987). The design and development of such tutors lie at the intersection of computer science, cognitive psychology and educational research; this intersecting area is normally referred to as cognitive science. For historical reasons, much of the research in the domain of educational software involving AI has been conducted in the name of ‘ICAI’, an acronym for ‘Intelligent Computer- Aided Instruction’. This phrase, in turn, evolved out of the name ‘Computer-Aided Instruction’ (CAI) often referring to the use of computers in education. Nevertheless, to all intents and purposes, ITSs and ICAI are synonymous. However, though some researchers still prefer ‘ICAI’ (e.g. Self, 1988a, uses it in the title of his recent book), it is now often replaced by the acronym ‘ITS’ (Sleeman& Brown, 1982b). The latter, which is also the author’s personal preference, is certainly gaining support, as confirmed by the international conference on Intelligent Tutoring Systems held in Montreal, Canada, as recently as June 2013. This preference is motivated by the claim that, in many ways, the significance of the shift in research methodology goes beyond the adding of an T to CAI (Wenger, 1987). However, some researchers are understandably hesitant to use the term ‘intelligent’, instead opting for labels such as ‘Knowledge-Based Tutoring System’ (KBTS) or ‘Adaptive Tutoring System’ (ATS). Wenger (2008) prefers the label Knowledge Communication Systems. Nevertheless, most researchers appear to be reasonably content with the acronym ITS. This is fine as long as everyone involved with the area understands that the usage of the word ‘intelligent’ is, strictly speaking, a misnomer. This does not appear to be the case, resulting in some very ambitious goals/claims, particularly in the more theoretical parts of the literature: this also appears to be a valid criticism of the entire AI literature. The fact that ITS research spans three different disciplines has important implications. It means that there are major differences in research goals, terminology, theoretical frameworks, and emphases amongst ITS researchers. This will become apparent later in this paper. ITS research also requires a mutual understanding of the three disciplines involved, a very stressful demand given the problems of keeping abreast with even a single discipline today. However, some researchers have stood up to the challenge. As a result, a great deal has been learnt about how to design and implement ITSs. A number of impressive ITSs described in this assignment bear testimony to this fact.

## 1.1 Theoretical Background

Since the early 1970s, the field of Intelligent Tutoring Systems (also known as Artificial Intelligence in Education) has investigated combining research in Artificial Intelligence, Cognitive Science and Education to devise intelligent agents that can act as tutors in computer-aided-instruction (CAI). Traditional CAI systems support learning by encoding sets of exercises and the associated solutions, and by providing predefined remediation actions when the students’ answers to do not match the encoded solutions. This form of CAI can be very useful in supporting well-defined drill-and practice activities. However, it is difficult to scale to more complex pedagogical activities, because the system designer needs to define all relevant problem components, all solutions (correct or incorrect) that the system needs to recognize, and all possible relevant pedagogical actions that the tutor may need to take.

## 1.2 What is an Intelligent Tutoring System?

One reason that ITS is such a large and varied field is that “intelligent tutoring system” is a broad

term, encompassing any computer program that contains some intelligence and can be used in

learning. ITS is an outgrowth of the earlier computer-aided instruction or CAI model, which

usually refers to a frame-based system with hard-coded links, i.e. hypertext with an instructional

purpose.

The traditional ITS model contains four components: the domain model, the student model, the

teaching model, and a learning environment or user interface. ITS projects can vary tremendously

according to the relative level of intelligence of the components. For example, a project focusing

on intelligence in the domain model may generate solutions to complex and novel problems so

that students can always have new problems to practice on, but it might only have simple

methods for teaching those problems, while a system that concentrates on multiple or novel ways

to teach a particular topic might find a less sophisticated representation of that content sufficient.

When multiple components contain intelligence, homogeneous or heterogeneous representations

can be used.

ITS can also be classified by their underlying algorithm. One well-known category is the model-

tracing tutor, which tracks students’ progress and keeps them within a specified tolerance of an

acceptable solution path.

A theme underlying much of ITS research is domain independence, i.e. the degree to which

knowledge encoded in the teaching model can be reused in different domains. Although to the

external observer, domain independence seems like an essential characteristic of intelligence,

many experts believe that some of the essential pedagogical knowledge in every domain is

fundamentally domain-dependent. For example, there are analogies used in teaching physics, and

even in teaching specific topics in physics, that have no equivalents in other domains.

Task independence, or the degree to which the knowledge in the system can be used to support a

variety of tasks on the part of the student, has not yet been addressed by most systems

### INTELLIGENT TUTORING SYSTEM

### http://members.aect.org/edtech/ed1/19/Fig19-2.gif

## 1.3 ITS Components and Relationships

A student learns from an ITS primarily by solving problems--ones that are appropriately selected or tailor-made-- that serve as good learning experiences for that student. The system starts by assessing what the student already knows, the student model. The system concurrently must consider what the student needs to know, the curriculum (also known as the domain expert). Finally, the system must decide what curriculum element (unit of instruction) ought to be instructed next, and how it shall be presented, the tutor (or inherent teaching strategy). From all of these considerations, the system selects, or generates, a problem, then either works out a solution to the problem (via the domain expert), or retrieves a prepared solution. The ITS then compares its solution, in real-time, to the one the student has prepared and performs a diagnosis based on differences between the two.

## 1.4 Applications of ITS

During the rapid expansion of the web boom, new computer-aided instruction paradigms, such as [e-learning](https://en.wikipedia.org/wiki/E-learning) and distributed learning, provided an excellent platform for ITS ideas. Areas that have used ITS include [natural language processing](https://en.wikipedia.org/wiki/Natural_language_processing), [machine learning](https://en.wikipedia.org/wiki/Machine_learning), planning, [multi-agent systems](https://en.wikipedia.org/wiki/Multi-agent_systems), [ontologies](https://en.wikipedia.org/wiki/Ontologies), [semantic Web](https://en.wikipedia.org/wiki/Semantic_Web), and social and emotional computing. In addition, other technologies such as multimedia, [object-oriented systems](https://en.wikipedia.org/wiki/Object-oriented_operating_system), modeling, simulation, and statistics have also been connected to or combined with ITS. Historically non-technological areas such as the educational sciences and psychology have also been influenced by the success of ITS

## 1.5 Structure

Intelligent tutoring systems (ITSs) consist of four basic components based on a general consensus amongst researchers (Nwana,1990; Freedman, 2000; Nkambou et al., 2010):

* The Domain model
* The Student model
* The Tutoring model, and
* The User interface model

## 1.6 Design and implements developments methods

Apart from the discrepancy amongst ITS architectures each emphasizing different elements, the development of an ITS is much the same as any [instructional design](https://en.wikipedia.org/wiki/Instructional_design) process. Corbett et al. (1997) summarized ITS design and development as consisting of four iterative stages:

* needs assessment
* cognitive task analysis,
* initial tutor implementation and
* evaluation

The first stage known as needs assessment is common to any instructional design process, especially software development. This involves a *learner analysis*, consultation with subject matter experts and/or the instructor(s).

The second stage, cognitive task analysis, is a detailed approach to expert systems programming with the goal of developing a valid computational model of the required problem solving knowledge. Chief methods for developing a domain model include:

* interviewing domain experts,
* conducting "think aloud" protocol studies with domain experts,
* conducting "think aloud" studies with novices and
* observation of teaching and learning behavior.

The third stage, initial tutor implementation, involves setting up a problem solving environment to enable and support an authentic learning process. This stage is followed by a series of evaluation activities as the final stage which is again similar to any software development project.

The fourth stage, evaluation includes:

* pilot studies to confirm basic usability and educational impact;
* formative evaluations of the system under development, including
* parametric studies that examine the effectiveness of system features and finally,
* summative evaluations of the final tutor's effect: learning rate and asymptotic achievement levels

## 1.7 conclusions

Intelligent tutoring systems (ITSs) are computer programs that are designed to incorporate techniques from the AI community in order to provide tutors which know what they teach, who they teach and how to teach it. AI attempts to produce in a computer behaviour which, if performed by a human, would be described as ‘intelligent’: ITSs may similarly be thought of as attempts to produce in a computer behaviour which, if performed by a human, would be described as ‘goad teaching’ (Elsom-Cook, 1987). We have most of the components necessary to advance educational reform. Not only is there great need for change, but also there are powerful, affordable technologies available to support it. Missing are definitive answers to the psychological controversies cited earlier. Basic research is actively being pursued to resolve these issues.