Scribe notes for the talk of Amy Davis
Intelligent Computer-Aided Instruction: A Survey Organized Around System Components (J.W. Rickel, 1989)

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1 Outline of presentation

Amy begins her presentation with the outline, which consists of: Why we want to use ICAI instead of CAI; An overview of main systems and technologies discussed in this paper; and contributions of seminal systems to various components of ICAI system.

2 Why ICAI?

ICAI is better than CAI. People first come with the idea of CAI. It fully specifies presentations. People should input all questions and their answers, it is a strict flow of control. So, CAI seems like "electronic page-turning." The CAI need for intelligence is thus recognized. ICAI has a richer domain knowledge. It has the ability to use the knowledge in unspecified ways and provide individualized instructions to students.

3 ICAI systems

By the time the paper was written, there were no commercial ICAI systems. But now, some exist. Currently, ICAI is still an active research area in AI. Examples of existing systems by the time the paper was written are: WEST, SCHOLAR, WHY, SOPHIE, STEAMER, RBT, WUMPUS, MYCIN and GUIDON.

Our goal is to build systems that are:

1. More effective computer-based tutors.
2. More economical computer-based tutors.
3. Reflect current state of AI research.

4 Components of ICAI systems

The paper recognizes 8 components for an ICAI system:

1. learning scenarios
2. domain knowledge representation
3. student modeling
4. Student diagnosis
5. pedagogical knowledge
6. discourse management
7. Problem generation
8. User interface

We discuss each one in detail.

4.1 Learning scenarios

The goal for ICAI learning scenarios is to involve more senses such as retain information longer or make student an active participant. The methods used here are coaching, Mixed initiative dialog, Socratic, articulate expert, interactive, inspectable simulation and discovery-based learning. After all, the learning scenarios is about determining "look and feel" of tutoring system and based on student-tutor balance of control. It requires support from the knowledge base of the system.

4.2 ICAI domain knowledge representation

The old CAI has poor knowledge of their domain such as canned presentation, canned questions, canned answers. The ICAI has more knowledge which means there is fewer limitations. It supports understanding and allows flexibility in teaching. Knowledge is the key to intelligent behavior, the way knowledge is stored dictates its use. The challenge is that there is no general form suitable for all knowledge. It is really hard to determine types of knowledge required, to find suitable representations and to support teaching particular subjects. In this paper, some forms are examined such as rule-based KB, scripts, semantic networks, simulation, and condition-action rules. We should mention here: one representation doesn't work for everything, we often need multiple representations for one problem. These representations are determined by how the knowledge is to be used.

4.3 ICAI student modeling

The goal for student modeling is to know what the student knows. CAI tries to keep a tally of correct and incorrect answers, so it only has little adaptation to student. There are a few modeling methods which include *overlay* modeling and *buggy* modeling. Student modeling is still very open-ended. This paper didn't fully discuss those modeling, but it said that user modeling allows the computer to find the reasons behind student errors–student diagnosis.

4.4 Student diagnosis

ICAI student diagnosis allows student to make mistakes, capitalizes on them for better learning. Examples of methods that can be used for student diagnosis in ICA are: differential modeling, direct interpretation, plan recognition and error taxonomy. The paper also states that the goal of an ICAI system is teaching, not student diagnosis. Most diagnosis can be made easier by asking a few more questions. Allowing student to discover his/her own errors is more effective. The author recalled the saying "a litter meaningful feedback goes a long way."

4.5 ICAI pedagogical knowledge

Teachers need to know more than just their subject, they also need to know how to teach. The main issues of pedagogy are lesson planning and dealing with student errors. So, just knowing the problem domain isn't enough. The effective teachers should be teaching "common sense" and responding to student.

4.6 ICAI discourse management

Since a CAI system has only a hard-copy syllabus, sometimes with alternate paths. The goal for discourse management is to give some flexibility in the tutorial discourse. The methods to achieve this are reaction, incremental building, context dependent and hierarchical planning. Different authors have different ideas about how much flexibility is best. Discourse management requires knowledge that is not just in subject area.

4.7 Problem generation

Early CAI efforts include canned problems with canned answers. There are several difficulties with this approach such as it places a large burden on the course author to develop a broad set of problems, it is very hard to match canned problems to students needs and canned answers don't allow meaningful feedback. problem generation can be viewed as a tree-structured decision process. Ramani and Newell provide a new techniques of problem generation which is slot filling. Of course, if new problems can be generated, they must also be solved, since answers cannot be canned if problems aren't.

4.8 User interface

A user interface is always very important for any application. Tutoring systems should include many senses. The communication methods are graphics, canned text, and text generation. One can think of the entire tutoring system as a big user interface. As the input of information is more difficult than generating answers, most system use graphics or menus instead of natural language. Natural language is "Achilles heel" of tutoring systems.

5 Summary

In summary, an ICAI system requires:

1. Learning scenario that is appropriate to domain knowledge
2. nature of domain knowledge and types of misconceptions determined the knowledge representation.
3. student models, pedagogical and discourse knowledge are necessary
4. wrap it all in a sensory-stimulating interface

6 Comments of students, Q & S

Cory: If this has all been worked on 10-15 years ago, why am I not being taught by computer right now?

Answer: It is very hard problem. There are only one or two existing commercial ICAI systems.

Cory: Is this still an active research area?

Answer: Yes, it is very hot topic.

Praveen: What do you mean by "bugs interaction"?

Answer: the errors can interact each other.

Dan: It seems that problem generation would require a large amount of knowledge and effort, it seems like it would be easier to just have a large bank?

Answer: Yes, it needs large amount of data, bank may be a good idea.

Tibor: Since the application should be used in real world, is it too hard to build a really good system?

Answer: Yes, it is very hard. Even become a good teacher for a human is really hard.

Rob: more knowledge - fewer limitations seems to leave out far too many practical considerations.

Lin: How can the system update itself when something new happened?

Answer: It should have a big database, we need to update the database, adding something new in the KB.