



What If the Computer Doesn't Know the Answer?

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Most educational software assumes the system knows more than the learner. In simple cases, the system knows the correct answers; in more elaborate cases, the system knows how to solve problems. We could wonder why the learner would answer the machine's questions if he or she knows that the machine already knows the answers? We could wonder why bother arguing with a machine if the learner knows that, by definition, the expert computer is always right? Hence, we asked, what if the learner knows more than the system and teaches the system? Or what if the learner and the system are both beginners and learn collaboratively? We addressed the latter question, which, despite the fact it corresponds to a rather common educational practice, was, in the late 1980s, unexplored in educational computing.

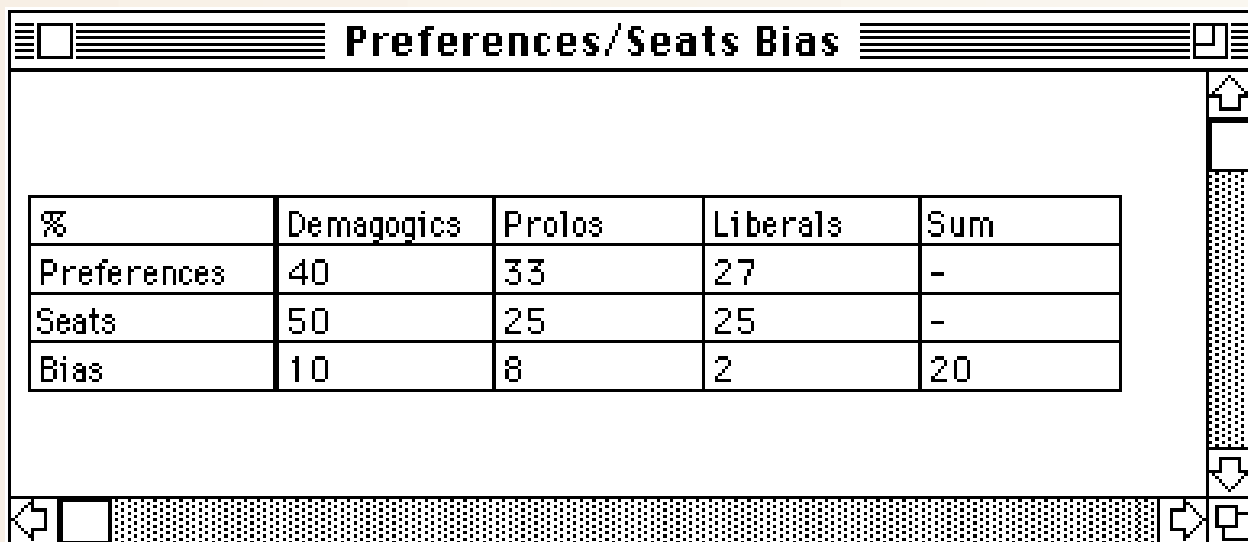


Figure 1. After simulating elections, the system computes electoral bias.

WE developed a research prototype called People Power to investigate human-computer collaborative learning. In People Power, a human learner collaborates with a co-learner, played by a machine. People Power is written in Procyon Lisp and runs on Macintosh systems. Its pedagogical goal is for human users to deepen their understanding of electoral systems. In Europe, each country has a different electoral system and each system has pros and cons. For instance, in the U.K., only one member of Parliament is elected by each constituency. Hence, if a party gets 51% of the votes in 51% of the constituencies and 0% of the votes in other constituencies, it gains the absolute majority of the parliament with only 26% of the votes at the national level. In contrast, the Belgian electoral system is proportional. One can argue whether or not highly proportional systems are more democratic; they often yield coalition governments that do not represent a real political constituency (see Figure 1).

People Power does not discuss democracy per se, helping users instead discover which features make an electoral system more or less proportional. The learner can design an electoral system by defining parties, candidates, constituencies, and so forth. The learner can also modify the electoral laws, run a simulation of the elections, and read the results of elections. Figure 1 shows the results of a simulated election. The system computes the electoral bias, that is, the sum of the (absolute) differences between the percentage of votes and the percentage of seats, for each party. For instance, the Demagogics won 50% percent of the seats while receiving only 40% of the votes. The electoral mechanisms the learner tested

give this party 10% more seats than it deserves. Such bias is often detrimental to small parties.


Gerrymandering

The People Power electoral microworld also includes a game based on gerrymandering. Players have to modify the grouping of wards so that, with the same percentage of votes, their party gains one seat. For instance, if party P has 38% of the votes in constituency A and 48% in constituency B, moving from A to B a ward in which party P has a high percentage of votes might be sufficient to achieve 50% in B. The game is played collaboratively by a human learner and an artificial partner, simulated by the machine. The computer co-learner begins the game with some knowledge, although it is also naive and incomplete. Its knowledge is implemented as a small rule-based system, including such rules as "If a party gains votes, it gains seats." Such rules are not completely wrong, but are overly general. By discussing the issues with the human learner and by designing and analyzing elections, the co-learner progressively finds out when a rule applies (a process called rule specialization).

The learner and the co-learner discuss which ward should be moved from one constituency to another constituency. Either learner can ask the collaborator to justify any change. During the explanation, either learner can refute the argument expressed by the other. Figure 2 shows such a dialogue. The machine learner keeps track of the dialogue and replays it partially for its own reasoning. This learning mechanism is not inspired by traditional machine-learning techniques, but by psychological theories concerning the influence of social interactions on individual development.

Impatient Humans

When we tested People Power with human subjects, we told them they would collaborate with a non-expert computerized co-learner. However, when the computerized co-learner made its first mistakes, a few subjects immediately complained that the program was buggy. Despite our preliminary explanations, computer ignorance is still a surprise. We had to explain that, as a co-learner, the machine might suggest incorrect actions. After the surprise, human tolerance of computer ignorance apparently decreases rapidly. The co-learner did not improve its knowledge quickly enough to sustain the human

learner's commitment to collaborate. However, the human learners expressed a feeling of being involved in a collaborative process, even if their partner was less flexible and less opportunistic than a human partner. Our current research focuses on the design of computational agents that engage in more flexible and opportunistic collaboration. 

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Figure 2. An excerpt from a dialogue between a human learner and the artificial co-learner

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Jerry > I suggest move ward2 from Nord to Sud
Lucil > Why?
Jerry > If Demages Has Less Preferences In "ward2" Than In Nord
      And If One Remove "ward2" From Nord
Jerry > Then Demages Will Gain Preferences In Nord
Lucil > Continue
Jerry > If Demages Gets More Preferences In Nord
      Then Demages Will Get More Votes In Nord
Lucil > Refute
Lucil > If When We Remove "ward1" From Nord
      The Demages Don 'T Get More Preferences Than Mortales In Nord
      Then Demages Won'T Take A Seat To Mortales In Nord
Jerry > That's not the case here!
Jerry > If Demages Gets More Preferences In Nord
      Then Demages Will Get More Votes In Nord
Lucil > Continue
Jerry > If The Demages Party Gets More Votes In Nord
      Then It Will Get More Seats In Nord
Lucil > Continue
Jerry > If Demages Gets More Seats In Nord
      Then Demages Will Have More Seats In Portugal
Lucil > Continue
Jerry > That's All
Jerry > Do you accept my proposal ?
Lucil > Yes
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