

Computer-aided medical ethics

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Authors' abstract

This paper describes COMET, the first 'expert' computer system to incorporate a comprehensive set of the rules of law and medical ethics relating to consent to medical treatment.

In recent years, substantial progress has been made in the development of so-called 'expert' or 'knowledge-based' computer systems. These are designed to incorporate in a computer program deductive and inductive 'rules' used by experts in a particular domain of knowledge, so that a non-expert user running the program can, by inputting only the data about a particular case known to him, reach the same conclusions about that case which would normally be reached by an expert in the domain. (Whether the concept of 'artificial intelligence' can be properly ascribed to such systems remains a matter of controversy.)

Until quite recently, such systems were very large and expensive, and could only be run on mainframe computers. However, within the last year or two, some have been reduced to a size which can be run on the small personal microcomputers which are now available on the market for a few hundred pounds, and are therefore increasingly accessible to a growing number of people. Broadly speaking, these new systems take two forms: a 'shell' program containing little more than an 'inference engine' into which a user can put the necessary expert knowledge of the domain (the 'knowledge base') in the form of rules, so creating an expert system in that domain; and systems in particular domains which contain both an inference engine and a knowledge base, and are therefore ready to run without any additional expertise having to be

added by the user.

The authors have for some time taken the view that this technology would eventually become suitable for application to problems in medical ethics, both as a teaching aid and as an aid to decision-making. COMET (an acronym for CONsent to MEDical Treatment) was written in order to test this hypothesis. So far as the authors are aware, it is the first attempt anywhere to devise an 'expert' computer system in any area of medical ethics.

The domain of COMET

The domain of COMET is bounded by two criteria. First, it is confined to the rules of law and of generally accepted medical ethics relating to the need for consent to medical treatment, the competence of the persons giving it, and the states of information and degrees of freedom required for them if any consent they give is to be valid. It does not deal with 'live or let die' issues, or abortion or euthanasia, or the controversial questions about human procreation discussed in the Warnock Report. Nor does it deal with issues of medical confidentiality: the authors are currently developing a similar program in this area.

Secondly, COMET approaches this domain exclusively from the point of view of a medical practitioner. The program cannot offer any help to a parent wondering what is best for his or her child, the Director of Social Services of a local authority considering whether or not to consent to a medical intervention on someone in the authority's care; or a court of law faced with a complex decision in this area on the application of someone *in loco parentis*. In many of the most difficult and controversial cases, some or all of these people will be parties to the ultimate decision, but COMET deals only with the legal and moral rights and obligations of the medical practitioner involved in the case.

Within the boundaries of this domain, COMET contains somewhere over a hundred rules. There are rules about medical emergencies – that is, situations where there is a clear and serious danger to someone's

Key words

Consent to medical treatment; competence to consent; informed consent; proxy consent; medical law; medical ethics; expert computer systems; knowledge-based computer systems; rule-based computer systems; computer program.

life or health, so imminent that there is no time to obtain anyone's consent to treatment; rules about cases where there is no such emergency; and rules about competence to consent, the requirements of sufficiently informed and sufficiently free consent, and the conditions which a person must fulfil before he or she can be a suitable proxy to give consent on behalf of a patient.

Since computers are ignorant of the real world, there also have to be rules about human life. For example, one needs to ensure that if 'John Smith, male, age 33' has been nominated as a possible proxy for a child, the computer does not ask whether he is the patient's wife; likewise, once the patient's mother has been eliminated as a possible proxy, one must ensure that the computer will not ask whether a different female of appropriate age, nominated later, is the patient's mother. Rules have therefore been incorporated such as 'only females can be mothers' and 'no one can have more than one mother'; there are similar limits on spouses, but not on sons and daughters; and there are various rules about age limits.

How COMET runs

COMET is designed, in the well-known jargon phrase, to be as 'user-friendly' as possible. No knowledge or experience of computers is needed, nor any typing skills. Most of the time, there are only two keys that a user need press.

COMET is configured as an interactive question-and-answer program. It puts up questions on the screen, and gives the user a selection of answers from which to choose, rather like a multiple-choice examination paper. A typical screen, for example, might look like this:

Have you been consulted in order –

==> (1) only to cure, alleviate or prevent a particular disorder?

(2) only to act as an impartial medical examiner, and report?

(3) only to engage in clinical or other scientific research?

(4) both (1) and (2)?

(5) both (1) and (3)?

Not sure

I need some help to answer this question

Please remind me of the facts established so far

I should like to go back to the previous question

Use the <SPACE> bar to select the correct (or best) answer, then press <ENTER>

By tapping the Space bar on the keyboard, the user can move the arrow down until it points to the 'correct (or best)' answer; at that point, by pressing the 'Return' or 'Enter' key, he or she communicates this information to the computer which will, on the strength of it, proceed to the next question.

Whenever COMET has acquired enough information in this way to be able to reach some conclusion – as, for example, that the patient is too young to be competent to give a valid consent, or that his mother would not be a suitable proxy – the conclusion is announced on the screen, accompanied by an audible 'beep' to tell the user that something important is happening. Questions, answers, and interim conclusions proceed in this way until COMET has enough information to reach a final conclusion on whether or not it would be ethical for the user to give this patient this treatment in the circumstances described. (Obviously, COMET can reach no conclusions about purely clinical questions.)

Throughout a session, COMET records all the answers given in the form of 'facts', and also its conclusions. At the end of each session, the user can call for a screen display of all those facts, followed by the conclusions, and (in most cases) a brief explanation of how the final conclusion was reached. The user then has a further option of having all this information printed out as a permanent record of the session, to which he or she may add their own comment.

Additional features

One of the useful features of the more sophisticated 'expert' systems is the so-called 'What if?' facility: that is, the user can 'step back' during a session and retroactively change some of the data already supplied, so driving the program down a different path. COMET too has this facility: almost anywhere during a session, the user has the choice of selecting 'I should like to go back to the previous question', and this option may be used several times in succession so as to go back to some much earlier point. When the question at that point is answered again, the new 'fact' now established will be marked with a label '[REVISED]', so that on any review the user will be reminded where the change of direction took place. This facility is particularly useful if COMET reaches a final conclusion such as that 'it would not be ethical for you to give this patient this treatment'; such a conclusion is always followed by the option 'Would you perhaps like to reconsider that last question?', so that the user can continue the session with a different answer.

Another useful facility is that called 'Help'. Most questions include the option 'I need some help to answer this question'. If this is chosen, a 'help screen' appears. For example, in relation to the question 'Has this proxy any interest that conflicts with the patient's best interests?', the associated help screen would read as follows:

CONFLICTS OF INTEREST

If a proxy is to give consent to medical treatment on a patient's behalf, it is essential that the proxy should be motivated only by that patient's best interests, and not by his or her own, or by any others that conflict with the patient's.

When considering whether anyone would be a suitable proxy for a given patient, you must therefore make sure that there are no economic pressures, family conflicts or disagreements, covert relationships (such as incest), or external pressures from the media or from advertising, which have distracted the proposed proxy away from the sole consideration of the patient's own best interests. It is, for instance, by no means always certain that the interests of a parent, or of someone else standing in the parent's place, do not conflict with the interests of a child, or the interests of an adult with those of a senile parent.

As a doctor, your only concern is the health and well-being of your patient. If you ever believe that someone else's wishes – even those of a parent – conflict with your patient's best interests, then you are not bound to follow those wishes. In the last resort, the courts are there to resolve such problems, and there have been several cases in recent years where the courts have supported doctors against parties with interests of their own.

Having absorbed this, the user can return to the question by pressing any key, and then proceed to select the appropriate answer.

Another useful facility is the option, presented with most questions, 'Please remind me of the facts established so far'. By choosing this, the user obtains a display of all the information previously gathered by COMET, so that the user can be reminded of the point that has now been reached and, if so desired, go back to an earlier one in order to change one or more 'facts'.

COMET automatically deletes all facts and conclusions established during a session when that session comes to an end.

Some dangers of expert systems

Lest anyone should be afflicted by the fear that judgements on medical ethics will one day come to be *made* by computers rather than human beings, we would emphasise here that COMET is neither designed, nor able, to do anything of the kind. Like all expert computer systems, COMET can only be an *aid*, either for teaching or for decision-making. In any real case, a decision affecting the life or health of others can only be made by the individuals whom the law authorises to make it, and the responsibility for making such decisions, and for their consequences, is theirs and theirs alone.

Nonetheless, several fears have been articulated (by the authors amongst others) about the possible dangers of expert systems, and full account has been taken of these in the design of COMET. So, for example, COMET announces the names of its authors, and of the British Medical Association (BMA) as its publishers, on its opening screen; Introduction screens explain the program's limitations and the user's ultimate responsibility for the taking of decisions; and at the end of each session a Postscript explains that the user may well disagree with COMET's reasoning and should therefore discuss the case with teachers or colleagues.

Beyond that, every COMET program distributed is accompanied by three independent publications on

medical ethics: the BMA's *Handbook of Medical Ethics*, the General Medical Council's *Professional Conduct and Discipline: Fitness to Practise*, and *Doctors' Dilemmas* by Melanie Phillips and John Dawson. The accompanying User's Guide explains that, if users find any discrepancies between these materials, they must make their own judgements about what is or is not acceptable in particular circumstances. The Guide and the program's own Introduction screens make it clear that neither law nor ethics are ever wholly certain, that both are constantly evolving, that no two cases are ever alike in all respects, that in difficult cases there are often no hard-and-fast answers, and that no computer program can therefore ever hope to provide the 'right' answer with any certainty.

In short, COMET is not designed to *solve* problems in its particular area of medical ethics; what it is designed to do is to give users some guidance about how they might approach such problems, by directing their attention to the kinds of question they should ask themselves in particular cases. For this reason, COMET proceeds by a 'case-study' method: that is, for every session the user must have in mind a particular actual or hypothetical case, and COMET will then present him or her with the questions that ought to be asked about that case, in the order in which they would normally present themselves in real life.

In so far as COMET has a bias, it is *against* medical intervention where there is any doubt about the legal or ethical position. So, for example, if the user answers 'Not sure' to any question, COMET's normal response will be 'If you are not sure, then you ought to find out. Meanwhile, the only safe conclusion is that it would not be ethical for you to give this patient this treatment'. COMET will only conclude that 'there is no ethical reason why you should not give this patient this treatment' if *every* relevant question has been clearly answered in the affirmative.

The uses of COMET

The authors hope that COMET will prove useful in two main areas. The first is as a teaching aid for medical, paramedical, and nursing students, who have long complained that they do not receive enough formal instruction in medical ethics, largely because their schools say that they cannot spare clinicians for the necessary courses of lectures, and claim that medical ethics can be just as well taught in the wards while clinicians attend to their patients. Most medical schools, and an increasing number of students' families, now have microcomputers, and with access to one of these COMET will enable students to try out hypothetical cases in its domain, and so familiarise themselves with the questions which ought to be asked in such cases, and encourage them to discuss any difficulties that arise with their teachers.

The authors also hope that practitioners may find COMET helpful, either as an occasional 'refresher course' to remind themselves of the questions to ask, or as an aid to clarifying their approach in particularly

difficult or complex cases.

During its development, COMET was 'test-driven' by several experienced medical practitioners and a first-year clinical medical student, who made a number of helpful suggestions for which the authors are most grateful.

Technical aspects

The authors originally attempted to use a commercially available expert system 'shell', costing around £500, for the development of COMET, but this soon presented a number of difficulties. The resulting program would have occupied about 500K of memory, which is more than is available on many personal computers; it ran excruciatingly slowly, sometimes taking minutes to move to the next question; and it was frequently apt to jump to the wrong question, or the wrong conclusion.

At an early stage, the authors therefore decided to write the program in the familiar and well-tested BASIC language. In the result, the program runs very fast and predictably, and only occupies about 24K in its interpreted form.

The final version of COMET (version 1.1) is now available in two formats: a floppy 5¼ inch disk ready to run on IBM PC XT and compatible computers (including the Amstrad PC 1512 machine), and a 3-inch disk designed to run on the older Amstrad PCW 8256 or 8512 computers. The IBM-compatible version is in compiled machine-code form, so that no BASIC interpreter (which normally occupies between about 80K and 96K) is needed to run it. In this form, it

occupies approximately 95K. The Amstrad PCW version is in interpreted form, and runs under the Locomotive BASIC interpreter supplied with the computer. Because of the limitations of that machine's operating system and memory, this version has been sub-divided into modules which are chain-merged as and when they are needed, and deleted again when they are not; this entails an occasional delay of a few seconds while a message 'PLEASE WAIT A MOMENT. . . ' appears on the screen.

Distribution

COMET is published by the British Medical Association, whose Central Ethical Committee has endorsed it. The complete package, including the appropriate disk, User's Guide, and the three accompanying books, is available by mail order from the BMA at BMA House, Tavistock Square, London WC1H 9JP; credit card orders may be placed by telephone with the BMA Library on 01-387 4499. The price, including postage and packing, is £45 for the IBM-compatible version and £30 for the Amstrad PCW version, with a discount of one third (ie a net price of £30 and £20 respectively) for Associate Members of the BMA.

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(See also: Ethical considerations concerning computers in medicine in the 1980s, page 179.)