

# an intelligent piece of paper

This piece of paper is  
incredibly intelligent.

Do you believe that? What  
do you mean you don't?

What reason  
might there be  
to claim that a  
piece of paper  
is intelligent?

It can't be just  
that it has some  
intelligent facts  
on it – just  
storing facts is  
not enough for  
intelligence.

What might this  
piece of paper  
be able to do  
to prove how  
intelligent it is?

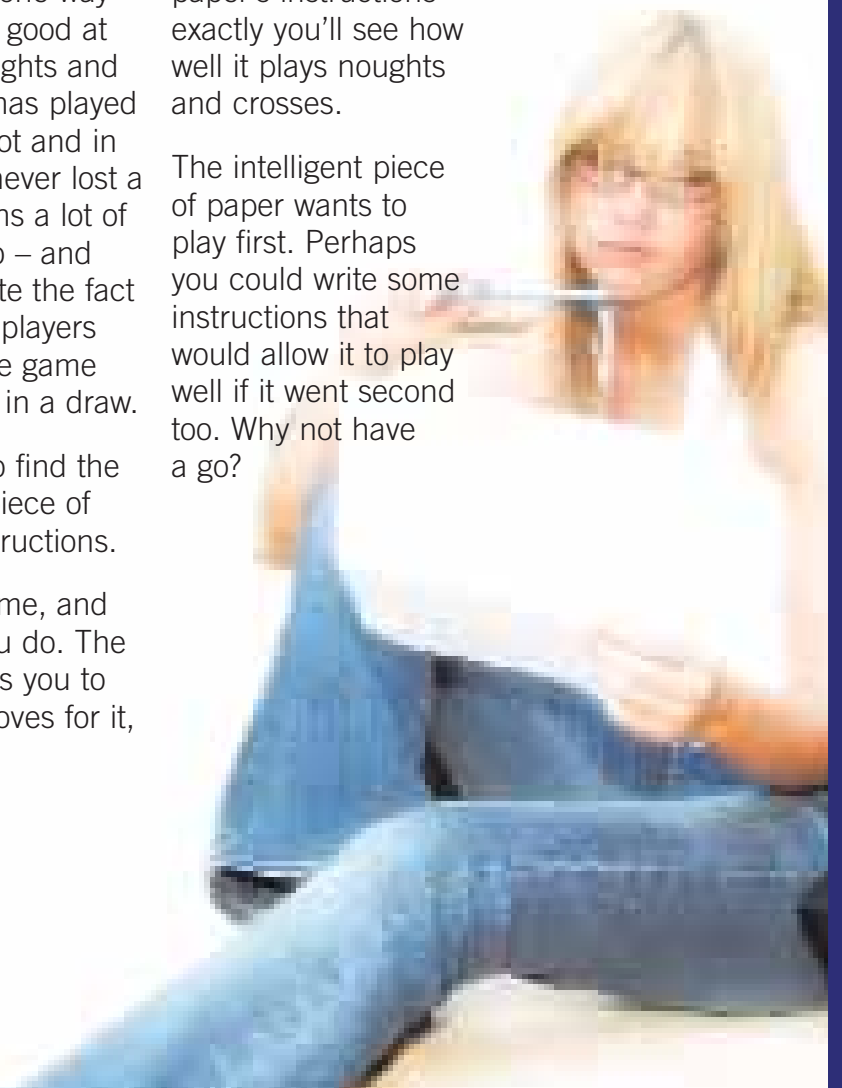
This piece of paper  
is clever in one way  
– it is really good at  
playing noughts and  
crosses. It has played  
humans a lot and in  
fact it has never lost a  
game. It wins a lot of  
the time too – and  
that's despite the fact  
that if both players  
play well the game  
should end in a draw.

Turn over to find the  
intelligent piece of  
paper's instructions.

Give it a game, and  
see how you do. The  
paper needs you to  
make its moves for it,

but if you follow the  
paper's instructions  
exactly you'll see how  
well it plays noughts  
and crosses.

The intelligent piece  
of paper wants to  
play first. Perhaps  
you could write some  
instructions that  
would allow it to play  
well if it went second  
too. Why not have  
a go?





# the intelligent piece of paper's instructions

Hello. It's nice to be playing with you, especially since I'm an incredibly intelligent piece of paper and will probably beat you.

**Please draw me a noughts and crosses grid**

I am X and I go first. Please do the following for me.

**For my first move:**

Draw an X in a corner for me.

**For my second move:**

If you did not go there already then draw an X in the opposite corner to my first move for me.

Otherwise put an X in a free corner for me.

**For my third move:**

If there are two Xs and a space in a line (in any order) then put an X in that space and I win!

Otherwise if there are two Os and a space in a line then put an X in that space. Ha!

Otherwise put an X in a free corner for me.

**For my fourth move**

If there are two Xs and a space in a line (in any order) then put an X in that space and I win!

Otherwise if there are two Os and a space in a line then put an X in that space for me.

Otherwise put an X in a free corner.

**For my fifth move:**

Put an X in the free space for me.



# is rule following intelligent?

Our piece of paper's claim to intelligence is based on what it can do, but all it is doing is blindly following rules. That is all computers do. They follow instructions a bit like the ones for playing noughts and crosses. Everything you have seen any computer do was done like that.

Most people would say the paper isn't intelligent. It is the person, the programmer, who wrote the rules who has the intelligence. That may be true, but even so computers can do lots of clever things just by following rules like that.

Often they can even do things better than the programmers who wrote their rules, like chess computers for example.

Back in the 1950s computers had existed long enough that people started to suggest that one day computers would beat humans at chess. "This is of course nonsense," wrote chess expert Edward Lasker. Perhaps he was sure it took intelligence to play chess well and surely machines just following rules could not out-think humans. But he was wrong...

# Winning at Chess

In 1997, computer company IBM's Deep Blue supercomputer beat the reigning world chess champion, Garry Kasparov in a chess tournament. Deep Blue was just a machine following a set of rules like our noughts and crosses instructions. It just takes more instructions to play chess well.

## Who is the smartest of them all?

Presumably because Garry had seen too many Terminator films (and because he thought he was the most intelligent creature on the planet until he lost), he said afterwards:

"I'm not afraid to admit that I'm afraid."

## The mighty fall

Kasparov went on to become a Russian politician. Some say Deep Blue is doing airline reservations in an American airport. So the next time the computer double books you on a flight or loses your bags, remember it just could have been the best chess player on the planet who did it!

...and maybe if the computers get too smart for their own good, we could just punish them by giving them dull jobs to do. Ha!

## The computer revolution

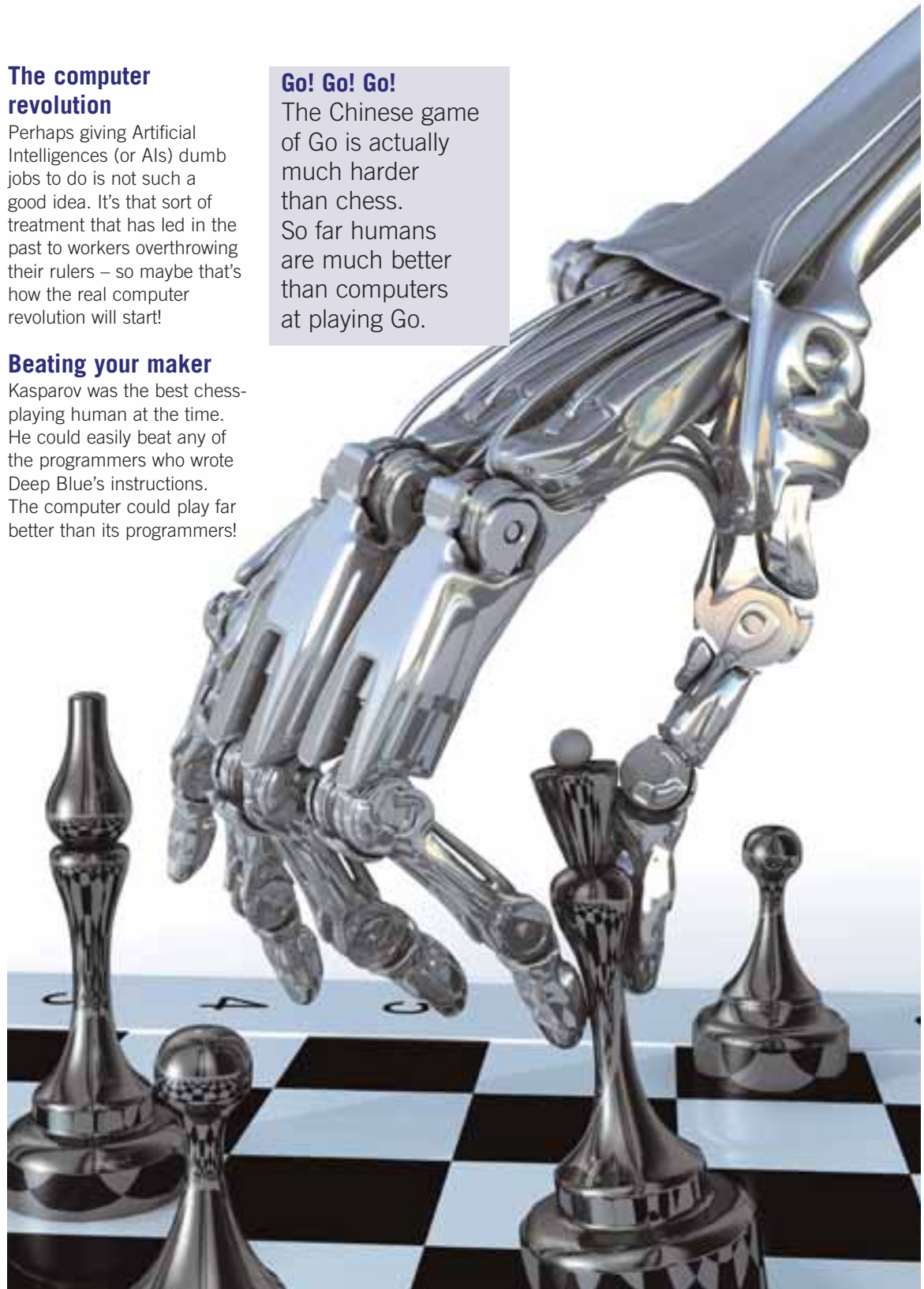
Perhaps giving Artificial Intelligences (or AIs) dumb jobs to do is not such a good idea. It's that sort of treatment that has led in the past to workers overthrowing their rulers – so maybe that's how the real computer revolution will start!

## Beating your maker

Kasparov was the best chess-playing human at the time. He could easily beat any of the programmers who wrote Deep Blue's instructions. The computer could play far better than its programmers!

## Go! Go! Go!

The Chinese game of Go is actually much harder than chess. So far humans are much better than computers at playing Go.



# experts and patterns

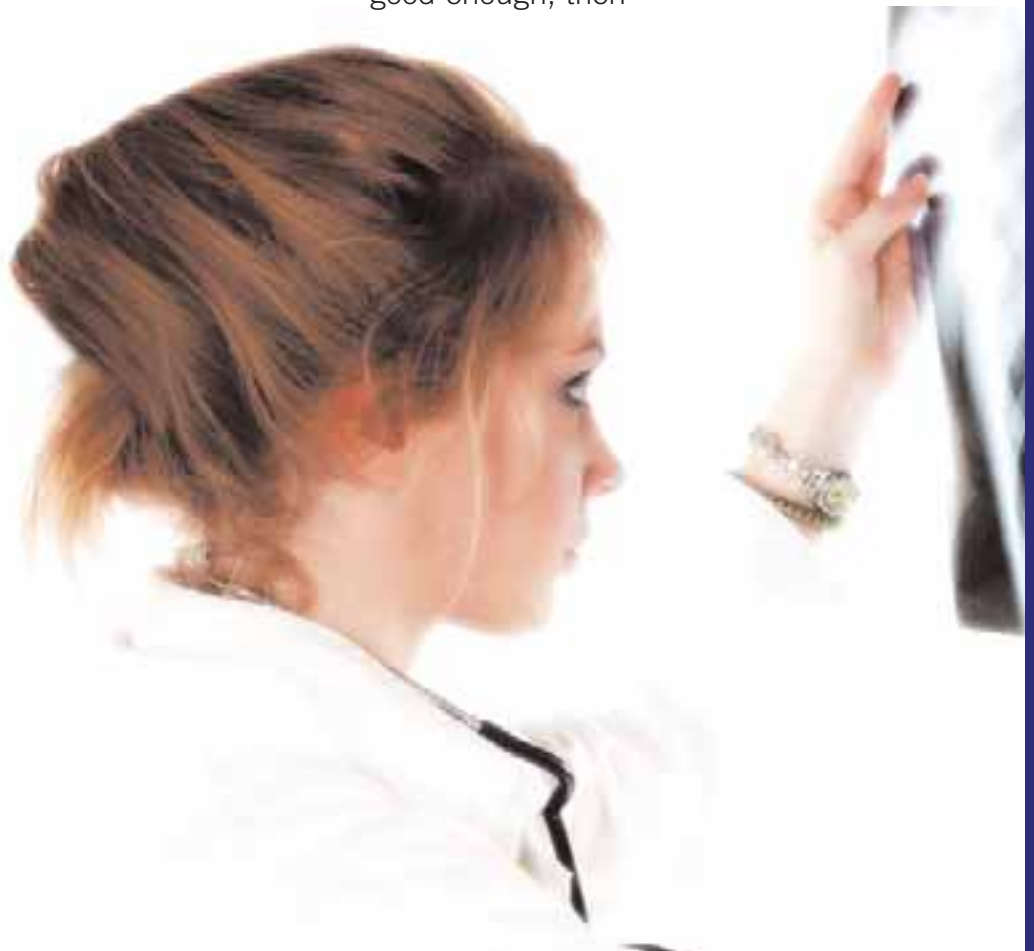
A chess computer plays the game in a different way to a human player. It plays lots of pretend games before making each move, trying out as many moves as possible and following the game through, trying different moves for the other player too. The computer then picks the move that gives it the best chance of winning.

Good chess players like Kasparov will look a few moves ahead, but nowhere near as far as a chess computer. It is too hard to do and would take too long. Human players instead look for patterns in the game and know from past experience the best kind of move to make given the pattern.

Experts in other areas, like firefighters, doctors or musicians, do the same thing. Experts don't think through all the hundreds of possible choices they could make in any situation before deciding which is best. Instead they recognise the situation and come up with a solution. When they think through how it will work, if it seems good enough, then

they go with it. Their expertise comes from having seen so many situations in the past that their first solution, based on their experience, is usually very good.

Some scientists think that's what 'intuition' is – instantly matching the current situation to something similar the expert has seen before.



# are you adaptable?

Our noughts and crosses-playing computer was really good at playing the game, but only when it got to go first. What happens when it goes second? Play against it for a few games and see.



It probably looked as though it was pretty stupid. The computer's suddenly very easy to beat! Its rules were written for one situation and work great in that situation only. Change things just a little bit and suddenly things are not so good.

Humans show their intelligence by being adaptable. Once you've learnt to play well going first you would probably play OK second too.

Fixed rules like our noughts and crosses instructions aren't adaptable. They do

what they do and nothing more. Artificial Intelligence researchers call this the 'Frame Problem' – the solution only works for the problem it was made for. It's easy to think of a list of things a computer must be able to do to be intelligent. People can then write programs to do each thing – play chess, recognise faces and so on. The trouble is, as soon as the computer has to deal with a problem the programmers didn't think of, the computer gets lost.

To show really intelligent behaviour, the rules written must somehow be able to cope with new situations. They must also be able to learn from their experiences.