Magical Memories just shuffling along

"Pick a card, any card!" How often have you heard magicians say that? The normal routine is that you pick a card, the magician shuffles the deck, and abracadabra, reveals your chosen card. But behind this magic often lies some interesting maths, and as we will see later, magicians' shuffles have actually led to the development of new ways for computers to work. Let's start with a trick to amaze your friends.

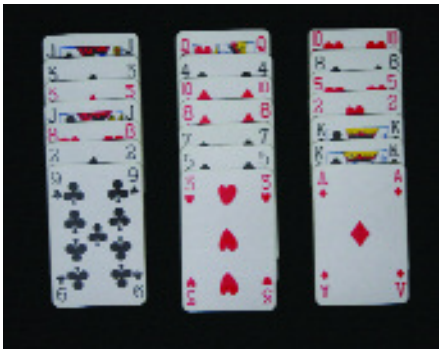
The 21-card trick.

The Magic effect: Have your friend shuffle a pack of cards and then you deal out single cards left to right into 3 piles of 7 cards, all face up. Your friend has to mentally select one of the cards. They mustn't tell you which card it is, but should tell you the pile it is in. You collect up the cards, and deal them out a card at a time left to right into three piles once more. Again they tell you the pile their card is in, you collect the cards once more, saying you're struggling to "read your friend's mind". Deal the cards out across the table in the three piles again in the same way. Your friend indicates the pile their card is in. Collect the cards again and deal them into the three piles one last time. You immediately announce their card and magically it is in the very middle position of the pack.

How do you perform the trick?

Let's look at the 'mechanics' of the trick. It involves several deals, each apparently shuffling the order of the cards, but doing so in a rather cunning way.

In fact it's really rather simple. All you have to do is make sure you always put the pile your friend selects carefully **between** the other two piles and deal the pack as above. Do that and after the fourth deal the middle card of the middle pile is the chosen card, which you can reveal as you see fit. Try and work out why it works, but then go to the cs4fn web site for an explanation.



Magic and Computers- developing your own algorithms

Once you understand the mechanics you can play with some ideas. The order of the chosen pile must not be changed, but the two other piles could for example be shuffled before being put together. As long as the chosen pile goes undisturbed between the two other piles of seven cards the order of the other cards doesn't matter. You might want to try and come up with your own additional twists now you know how it's done. The workings of this trick are what's known as an algorithm to computer scientists. The set of steps that you go through to get the trick to work are similar to the way that a computer steps through its instructions in a software program.

Brent Morris: Magician and Computer Scientist

The magicians' art of shuffling in special ways to make tricks, like the 21 card trick, work can also help us build computers. Magicians want to move cards around efficiently; computers want to move data around in their memory efficiently.

Perfecting the perfect shuffle

In a perfect shuffle, the magician cuts the cards exactly in half and perfectly interlaces them, alternating one card from each half. It takes years of practice to do but does look impressive. There are 2 kinds of perfect shuffles: With an out-shuffle the top card of the deck stays on top. With an in-shuffle the top card moves to the second position of the deck. Magicians know that 8 perfect out-shuffles restore the deck to its original order! It looks like the deck has been really mixed up, but it hasn't.

Computer scientist Brent Morris was fascinated by magic. In particular he became interested in the "perfect shuffle" in high school and has pursued its mathematics for more than 30 years with some amazing results. He earned his Doctorate in Maths from Duke University, and a Master's in computer science from Johns Hopkins University in the United States. He is believed to have the only doctorate in the world in card shuffling. He also holds two US patents on computers designed with shuffles, and has written a book on the subject called *Magic Tricks,*

A perfect shuffle in action

Card Shuffling, and Dynamic Computer Memories. Why the interest in perfect shuffles?

Binary shifts - as if by magic

You can use perfect shuffles to move the top card to any position in the pack, using a little bit of the maths behind computers: binary. Suppose you want the top card (let's call that position 0) to go to position 6. Write 6 in base 2 (binary), giving 110 (1x4+1x2+0x1). Now read the 0's and 1's from left to right: 1:1:0. Then, working through the 1's and 0's, you perform an out-shuffle for a 0 and an in-shuffle for a 1. In our case that means:

1: an in-shuffle, first

1: another in-shuffle,

0: and finally, an out-shuffle

As if by magic (if you are capable of doing perfect shuffles) the top card will have moved to position 6. Of course it works whatever the number, not just 6.

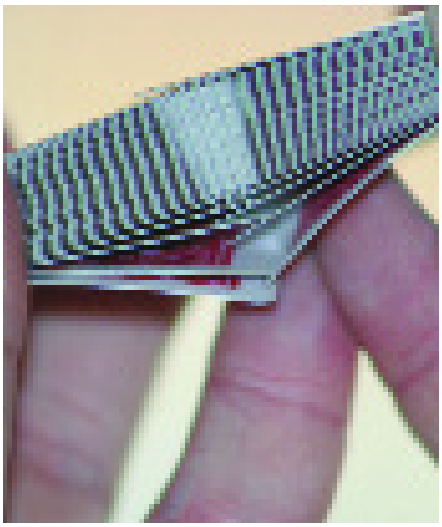
What does this have to do with the design of computers? You can use exactly the same ideas to move data efficiently around computer memory, which is what Brent Morris discovered and patented.

Curtain call

So as you impress your friends with your 21-card trick, coming up with your own performance ideas and are basking in that applause, remember two things.

Number one: a magician never reveals their secrets.

Number two: computers don't work by Hogwart's magic … only by mathematical magic.



Point, click and Sodarace

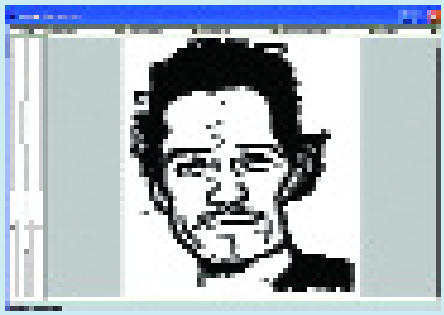
Following on from its successful 'run' at the Royal Society summer exhibition Sodarace, the online Olympics competition between human and machine creativity, has taken the next step forward.

Loads of people throughout the world have used Sodarace for their school and even university projects; from art and design to physics, chemistry, maths and biology, the options seem limitless and it's great fun.

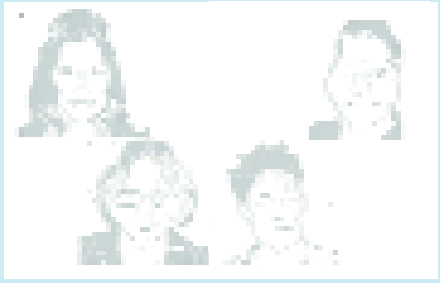
So to help make this even easier you can now download simple to use 'point and click' software free from **www.sodarace.net** that lets you select the racetrack terrain and the racers for your competitions. It's now straightforward to watch as your selected human and machine created racers go head to head; use your scientific skills to predict which will win on a particular racetrack (or just have a guess).

You can also download the first of a range of 'ready to use' lesson plans for classroom activities to try out. Why not ask your teachers to give them a go and let us know how you get on. Keep on racing.

Talk of the Toon



Orlando Bloom as a Soda Cartoon



It could be you!

Do you think computers can be creative like humans? They are good at repetitive tasks that are just too boring for humans to do, searching the web for pages on fashion tips or football scores. They can even play some games like chess better than humans. That's just done by searching through more possible moves than a person can. Does that count as creative? It doesn't seem, so. How about drawing? Cartoonists are creative people. If a computer could draw caricatures of people as well as human artists do, would that count as being creative? Queen Mary, University of London, computer science undergraduates, Lila Harrar and Akbar Hussain decided to find out. As part of their course, they created an Artificial Intelligence program based on the BAFTA award winning SodaConstructor, which draws cartoons of people. It works by choosing the most distinctive features of a face and exaggerating them just as human cartoonists do. At the Royal Society Summer Exhibition it was so successful they even had a Robot trying it out. You can get the AI to do a caricature of you at **www.dcs.qmul.ac.uk/cs4fn/** and find out how it sees you, then decide for yourself whether it is creative or not.