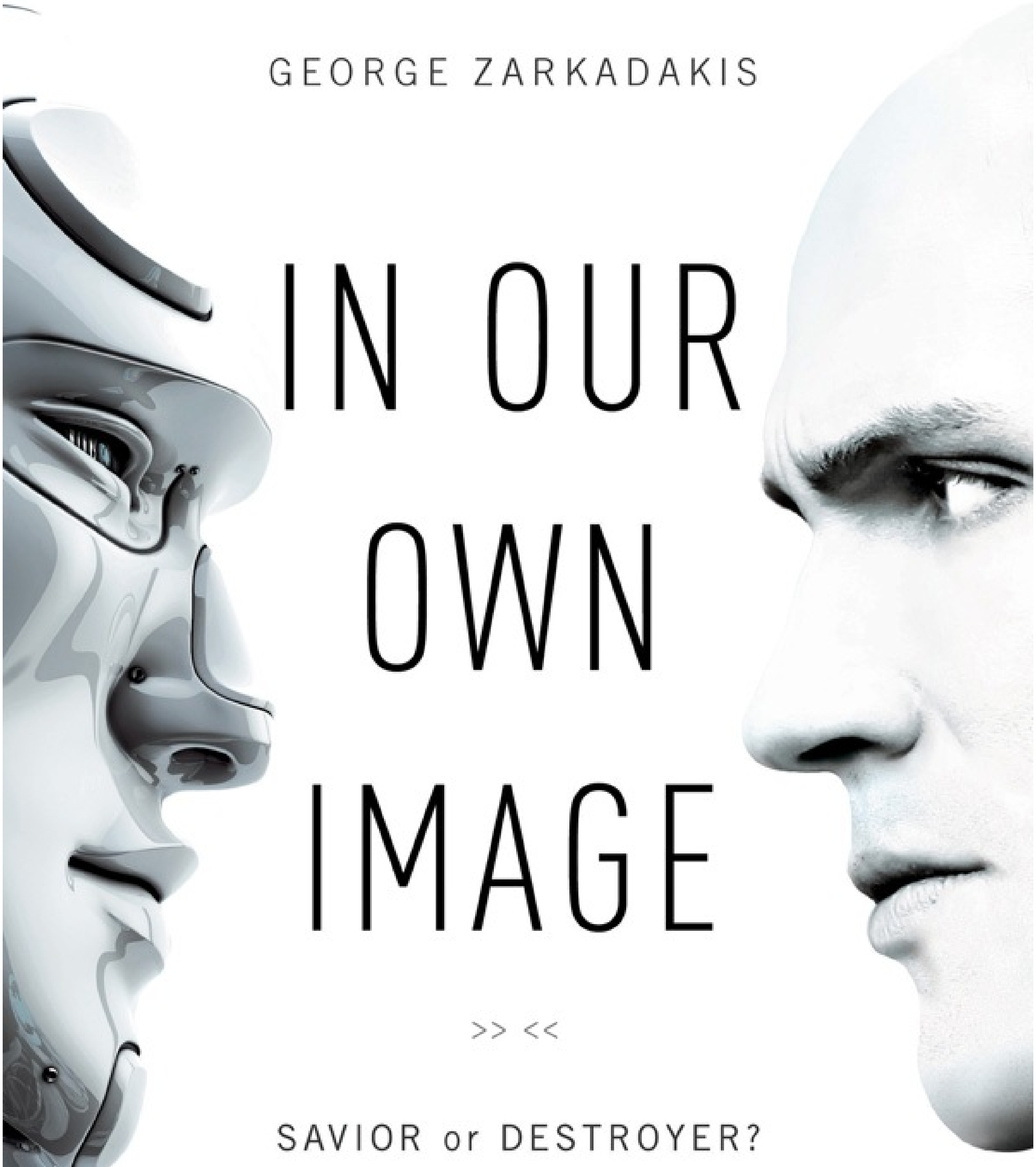
GEORGE ZARKADAKIS



IN OUR OWN IMAGE

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SAVIOR or DESTROYER?

THE HISTORY and FUTURE of

ARTIFICIAL INTELLIGENCE

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SAVIOR or DESTROYER? THE HISTORY and FUTURE of ARTIFICIAL INTELLIGENCE

GEORGE ZARKADAKIS

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INTRODUCTION

I met my first robot when I was five. It was a warm summer evening in Athens when my mother too me to an open-air cinema close to our house. Only a month earlier the first men had landed on th Moon and the world was abuzz with space fever. Every kid wanted to become an astronaut. We woul dress up in all kinds of oddments that looked vaguely space-like and pretend to bounce about in ze gravity. It was a no-brainer for the owners of the cinema to screen a film set in the distant futur where humans would casually visit stars on the other side of the galaxy.

The cinema was jam-packed. I recall the aroma of jasmine mixing with pungent popcorn and swea the chatter of people and of crickets, the uncomfortable chair, the excitement of going to the movies the days when television was a luxury afforded only by a few. My mother and I were ushered to ou seats as the lights dimmed. The spirited babbling of the audience ebbed. Loud music blasted out of th speakers. The dark screen flickered and became a window to another world: there was a spaceship th looked like a round pie, and men in shiny uniforms speaking a language I did not understand. As fo the subtitles, I was too young to read them. Maybe it was somewhat premature of my mother to tal me to that film; nevertheless, watching *Forbidden Planet* in Athens that night changed my life fo ever.

I am told that in the following days I would scribble countless sketches of the one thing that ha impressed me the most: Robby the Robot. I would draw him with his lights flashing, explaining whomever had the patience to listen how they flashed when he spoke in his mechanical voice, wavin his arms and running about. Without question, a mechanical thing that walked, talked – and obeye orders – would make the ideal playmate. Moreover, with a super-strong robot following me aroun who would dare bully me? I could return the favour by teaching him all the things I knew: how to kic a football through a window, how to chase cats, how to draw. We would be the best of friends, pals fo life. Robby the Robot had me in his grip for days, and held me tightly therein well into my final yea at school when I decided to become an engineer and build my own robot one day. And that's how m journey into Artificial Intelligence began.

And quite a journey it was, too, for I literarily had to pack my suitcases and fly to London to stud at university. My choice of subject was Control and Systems Engineering, a discipline based on th theory of cybernetics as developed by the American mathematician Norbert Wiener in the 1940s.

Wiener is one of the demigods of Artificial Intelligence. Born in Missouri in 1894, he was a chil prodigy who earned a degree in mathematics at the age of fourteen and a doctorate at seventeen. polymath with an insatiable appetite for knowledge, Wiener studied philosophy as well as zoolog then travelled to Europe to learn from the most prominent mathematical celebrities of the ear twentieth century: Bertrand Russell at Cambridge and David Hilbert at Göttingen. He was a pacifi who objected to scientists colluding with the military establishment. He moonlighted as a journali for the *Boston Herald*, and believed that automation would improve standards of living and put an en to economic underdevelopment. Many apocryphal tales are told of him, particularly about his absen mindedness. The one I like best is about when he returned home one day to find his house empt There was a girl waiting outside, so he went up to her and asked her what had happened. She explaine that the family had moved house that day. When he thanked her for the information, she replie 'That's why I stayed behind, Daddy!'

Cybernetics, Wiener's most important scientific legacy, is a unique synthesis of biology an mathematics that aims to understand how complex natural systems behave and evolve. Wiener's b ~~idea was that by studying how life solves problems – such as, for instance, locomotion or informatic~~ processing (things such as 'seeing' or 'feeling') – one could apply mathematics to mimic life ar build automated engineering systems. Cybernetics envisaged a world in which we could decode natu and reproduce it by constructing a brave new civilisation, with self-regulating factories, therapies f every disease, robust economies, fair societies, and – yes – machines that thought.

As my studies in systems engineering progressed I became increasingly interested in computers ar computer programming. This may sound obvious nowadays but when I started university in the ear 1980s PCs were not widely available.[1] Undergraduate engineers had to program 'analogue computers large calculating machines that looked like old-fashioned telephone switchboards and which use cathode ray tubes to perform calculations. Programming these ugly behemoths was a ve cumbersome exercise, as they were prone to many errors that were difficult to trace or rectify. The was, of course, a 'digital computer' in our university, a Honeywell-built giant that took up most of th university's basement, but direct access to it was strictly controlled. To use it one had to book a tim slot of a few minutes several days in advance.

The advent of PCs changed all that forever. They empowered experimentation and fast learnin One could now quickly test ideas about automation without having to look like a mad scienti surrounded by flashing lights and scores of wires. By the time I graduated I had acquired a lot experience in computer programming, and decided to go into research. Applying Wiener's cybernet concept to the field of computing, my PhD focused on automating the thought processes of medic doctors in intensive care units. This is an area of Artificial Intelligence that goes by the name 'expe systems'. What these systems do is study the way human experts process knowledge and tal decisions, then use logic to encode human decision-making in a computer. There are many potenti benefits from such systems: imagine expert decisions that must be taken in the absence of huma experts, in remote and dangerous places such as on a battlefield or in interplanetary space. Nowaday expert systems are routinely used in a wide spectrum of applications from medical diagnosis, finan and engineering, to video games and communications.

As I worked on my research, I began to have my first doubts about automating human intelligenc There was something about programming that did not quite capture the way minds seemed to functio Something was amiss. To understand why one must first look at the two fundamental and interlockin ideas upon which automation rests: *logic* and *feedback*. Although logic is not a trivial subject by ar measure, it is the latter idea of *feedback* that is more important in the design and success of automat systems. Feedback is perhaps the most prevalent mechanism in nature; it is how biological ar ecological systems respond to their ever-changing environments. For instance, when bright lig flashes in your eyes, you reflexively shut them in order to protect your retina. When the carbo dioxide in the atmosphere increases, ocean plankton consequently multiplies in greater numbers order to absorb it. Markets use prices as feedback signals to determine levels in the production goods and services. From amoebas to ecosystems, our world is a dense network of interconnecte systems of ever-increasing complexity, all of which use feedback information to exist in dynam equilibrium. Artificial cybernetic systems try to mimic the feedback mechanisms of nature. Take fo example the simple system that helps you flush your toilet. A float 'senses' the water level an connected to a valve, controls the water supply. The float is the measuring instrument that 'feed back' to the valve information about the water level. Dynamic equilibrium is achieved when the wat level is at a set limit. When you flush the toilet this equilibrium is disturbed, so the system tries regain it by opening up the valve and refilling the water tank.

An ‘automated’ mind would be considerably more sophisticated than a flushing toilet bu ~~according to cybernetic theory, it would use the same basic principles of feedback and logic.~~ It wou mimic the human mind by using ‘senses’ to provide it with information about its environment, ar logic to process this information and take informed decisions about its actions. For example, m medical expert system was fed with data about patients’ vital signs, medical history and other te results and measurements; it then used its coded knowledge in a logical way in order to process th data and make decisions about treatment, just like a human doctor would. New data would change ‘th mind’ of the system, as its logic processed the changes and adapted its decisions. After all, isn’t th what we humans do every moment of our waking lives? Don’t we perceive our ever-changing worl and then use our knowledge and logic to act, change our minds and decide?

Well, that’s how it seemed to me when I started my research but, by the time I’d finished it, I ha formed a more nuanced opinion. Although my expert system worked very well – and got me a PhD in no way could I claim that I had developed a truly ‘intelligent’ system. Perhaps it was smart, eve fiendishly smart on certain occasions. But whenever it processed information about a patient, suggested a therapy, it was not really ‘aware’ of its actions. It did not know what a ‘patient’ reall meant, in the fullness of the meaning of a person with a mind, family, friends, aspirations, fear discomforts, and everything else that it means to be human. What was missing from my expe systems was *consciousness*.

In the late 1980s, the ‘c-word’ was not something you uttered lightly in scientific, let alor engineering, circles. It conjured up images of hippies on LSD and books about shamans by Carl Castaneda. At best, consciousness belonged to the mysterious – and, to the hardliner scientis profoundly pointless – realms of psychology and philosophy. At worst, it was the surest way to b relegated to the nether world of psychic research on a one-way ticket.

And yet consciousness lay at the very heart of the problem of Artificial Intelligence. Creatin automated systems that mimicked human experts and performed useful tasks was indeed possible. M research, and that of many others, demonstrated as much. But the ‘holy grail’ of machine intelligenc its quintessence, the ultimate game-changer, was to create a machine that *really* thought like a huma That meant one thing only: that the machine had to be *awar*e of its thinking, that it somehow kne that it was ‘it’ that thought – just like I know that ‘I’ am writing these words. Otherwise the machir would be a zombie: it might appear to behave, or think, or write like a human, but would lack th subjective experience of its actions and thoughts; it would have no sense of ‘self’; no ‘inn existence’; its actions would be instinctive reflexes bereft of meaningful context or intent. Witho consciousness, intelligent machines are senseless automata. Disillusioned with the lack of serio debate about consciousness in the field of Artificial Intelligence and cybernetics among my peers, left academia to work in the private sector, and to continue my studies privately in that ultima waste-of-time-and-effort area for most engineers and scientists: philosophy.

I often wish that philosophy were a core subject in undergraduate science or engineering curricul Not only would it fertilise young minds with the richness of thought bequeathed by some of the mo brilliant thinkers who ever lived, but it would spur new and innovative ways of approaching scientif questions. In my case, philosophy helped me realise the true magnitude of the problem in Artifici Intelligence.

For a machine to become conscious it would be necessary to code consciousness in a logical ar consistent way; in other words to design a computer program endowed with self-awareness. The wo used in computer engineering for logic programming is ‘algorithm’. An algorithm is a sequence finite logical steps that lead to the solving of a problem. So the central question in creating tru intelligent machines is whether consciousness is *algorithmic* or not. If it is algorithmic then it can b ~~coded. But this question is a very difficult one to study. At the core of the problem resides our curren~~ and very partial, understanding of consciousness as a biological phenomenon. Thankfully, after th late 1980s consciousness was purged of its pseudo-scientific reputation and became a respectable fie for scientific research. We must thank Francis Crick for that, the English biologist who together wi James Watson discovered DNA. In his 1994 book *The Astonishing Hypothesis*, Crick proposed th there had to be a neural mechanism[2] in the brain that was the cause of our sense of self. In effec Crick suggested that consciousness is a purely biological phenomenon that could be identified an measured just like any other phenomenon in nature. If Crick's hypothesis is true then consciousness indeed algorithmic, and therefore can be automated, just as Wiener envisaged nearly one hundre years ago. But is this hypothesis true? More importantly, is there a scientific, i.e. experimental, way test[3] it?

Since the publication of Crick's seminal book, advances in medical scanning technologies hav revealed many unknown details about the workings of the human brain. Neuroscience has advanced an unprecedented rate. However, curiosity is not the only driver of this amazing evolution in ou understanding of the brain. Declining demographics in Western societies are causing brain diseases t become increasingly prevalent. In Europe, brain-related diseases afflict more people than cance cardiovascular diseases and diabetes put together. One out of three people will suffer from suc diseases, at least once in their lifetime, a daunting statistic that in Europe translates to 165 millio people at a cost of €800 billion per year.[4] Owing to the advances of neuroscience, the twenty-fir century has been called the 'century of the brain' – and sometimes 'of the mind'. The deep-roote belief that rigorous science, powerful computers and ever more accurate scanning instruments wi ultimately 'crack the code' of the mind, has spurred governments into supporting even more intensiv and systematic scientific research. The 'Human Brain Project' (HBP), one of the European Union flagship ten-year projects, will be funded, initially, with a budget of €1.19 billion. The HBP bring together a host of scientific disciplines and talents from across Europe and the world in order produce an accurate simulation of the human brain in a supercomputer. Decoding the human brain the most significant scientific challenge of our times.

It is also a challenge like none before. The human brain is the most complex object in the know universe. It is made up of approximately one hundred billion cells called 'neurons', which connect one another by means of nearly one hundred billion connections. Apart from being incredib complex, the brain is also deeply mysterious: it 'thinks'. No one knows yet how. But the scientists HBP believe that they can discover how the brain thinks by mapping it carefully. This is what scienc has done best since the Age of Enlightenment: it painstakingly and methodically catalogues ever little aspect of the natural world, studies it, then connects the studied parts like dots in order understand and explain the whole. Could this centuries-old scientific approach prove equal successful in the case of the human brain?

Although the scientists of HBP, as well as the politicians who fund them, seem to be convinced th their approach is infallible, they are up against a deep philosophical problem regarding the min which is known, rather prosaically, as 'the hard problem'. Australian philosopher David Chalmers ha defined the *hard problem of consciousness* by distinguishing it from 'easier' problems that could b explained by examining brain functions: for example, memory, attention or language. These 'easie problems are by no means easy. The HBP project is going to keep itself very busy trying to solve the by applying the scientific method. But Chalmers made the point that there is a certain problem th cannot be explained by a purely materialistic view of the brain. This is the problem of subjecti experience, sometimes called *qualia*.

Take, for instance, the ‘redness’ of red wine. The colour we call ‘red’ is an electromagnetic wav radiation with a wavelength between 620 and 740 nanometres. Although science can measure th wavelength with precision it has nothing to say about its ‘redness’, or why this particular waveleng appears to most of us to have a subjective quality we call ‘red’. Chalmers argues that science c *never* be able to tell why we see light between 620 and 740 nanometres as ‘red’.

Closely related to the hard problem of consciousness is the nature of the subjective experience the self that wreaks havoc with the fundamental philosophical school to which science adhere Science is based on empiricism, the notion that reality is what can be tested by experiment. Ange and fairies are beyond the scope of science because they cannot be experimentally verified (falsified). For scientists angels and fairies are therefore ‘unreal’. The problem with subjecti experience is that it cannot be tested by an objective experiment. If I am the subject of an experime to measure my conscious experiences then the only possible ‘measurement’ is my person description of my inner feelings, a narrative that I make up by responding to a question. Scientists not like narratives because they smack of the qualitative anti-empiricism of social sciences a humanities.

Thus, the problem of consciousness is not only scientific and philosophical but anthropological well. It is an example of the ‘two cultures’ problem identified by the English chemist and novelist P. Snow in his famous 1959 Rede Lecture.[5] Snow suggested that Western civilisation suffers from deep intellectual dichotomy between the exact sciences and the humanities. Mutual incomprehensi between these two disciplines explains why so many of the world’s problems are so hard to solve. David Chalmers and C. P. Snow are right, the Human Brain Project may end up in ten years’ time as synonym for the Tower of Babel: a fruitless, lavish and arrogant effort to build the unbuildable. A all because of the cultural incomprehension between the brilliant brain scientists and those equal brilliant colleagues of theirs down the university corridor, the philosophers.

I met David Chalmers on several occasions in Tucson, during the biannual world conferences Consciousness Studies organised by the University of Arizona. David, looking more like the guitar of a heavy metal band than a university professor, was one of the main organisers together wi anaesthesiologist Stuart Hameroff. Participating in several of these conferences during the early a mid-2000s, I had the opportunity to meet and talk with many scientists and philosophers who shar my fascination with the brain. By then, my journey in Artificial Intelligence had been diverted fro computer programming towards trying to understand how the brain actually functioned. It had tak me from rainy London to sunny Arizona, and many other places in between. My private studies neurophysiology and neuroscience enforced my conviction that developing machine consciousne was feasible, provided we applied the findings of neuroscience to reimagine computing machines. effect, I too belonged to the intellectual camp of the Human Brain Project. Subjectivity had to ari from objectivity, for there could be no other way. If we took a brain apart and put it back together, ought to get consciousness.

Then, one evening, I had a strange epiphany. It was April 2006 and I was at the official dinner the last day of that year’s Towards a Science of Consciousness conference. The dinner was takin place at the Sonora Desert Museum, a few miles south of Tucson. The Arizona sun was settin majestically over the barren hills and the vast plains that stretched all the way to the Mexican bord Iconic saguaro cactuses populated the darkening desert, and seemed like the silent guardians of a we kept secret. The tables were arranged outdoors and I sat with a group of scientists discussing some the talks we had attended. Soon enough, the conversation shifted from the hard problem consciousness to Commander Data of *Star Trek*. It turned out we were all huge fans of the televisio series. In fact, we were all big sci-fi fans and avid readers of the masters of the genre, writers such Philip K. Dick and Isaac Asimov. And then it struck me: fictional stories, such as the tale o Commander Data, had played a pivotal role in influencing everyone's academic life. I was there, o the other side of the world, *because* of that fateful night in Athens when I first encountered mechanical life form, Robby the Robot. And I was not the only one. Movies, novels and sci- television shows had inspired the rest around the table too. Indeed, stories with robots as heroes villains had determined the direction of our scientific lives. Could there be a link between litera narratives and scientific research agendas? Could our obsession with consciousness and AI be th result of fictional stories we read when we were younger? If so, where did these narratives com from? And why were we so fond of them?

A curious thing about literary narratives is that they resemble a network of veins. They seem connect to a central source, a mighty river of archetypal stories flowing in the mists of time. From th source new stories evolve by constantly bifurcating, exploring new characters and new twists in th original plot, new directions and eventualities. But, whatever direction they take, they never seem lose their deep connection with a primal story. Take, for instance, the plot of *Forbidden Planet* an how it resembles Shakespeare's *The Tempest*. The distant planet Altair IV of the movie is similar the remote island of the play. Dr Morbius the scientist is reminiscent of Prospero the magician. Robb the Robot is a reinvention of Ariel, the ethereal spirit that obligingly serves his master, Prospero. Bu whence had Shakespeare taken *his* inspiration?

At that curious moment, with the setting sun and the saguaro cactuses in the background, it occurre to me that a deeper and more profound connection between our humanness and our technologies ha to exist, which could be traced in art and literature. Our technological quest for artificial simulac forged in our own image ought to have been somehow hardwired into our cognitive make-up as o species evolved. Perhaps we seek to construct Artificial Intelligence out of some instinctive impuls rather than the utilitarian need for it. Consider the ramifications of a conscious machine: one th thinks and feels like a human, an 'electronic brain' that dreams and ponders its own existence, falls and out of love, writes sonnets under the moonlight, laughs when happy, cries when sad. What exactl is it *useful* for? What could be the point of spending billions of euros, and countless hours of preciou researcher intellect, in order to arrive at an exact replica of oneself? Why not simply get a huma friend to talk to? Or a human employee to do the job?

Artificial Intelligence is arguably the most puzzling technology ever aspired to, a seeming irrational enterprise, for the simple reason that it aims to duplicate *us* with all our misgivings an imperfections. The English novelist Douglas Adams made that sensitive point with gusto when h penned Marvin, the depressed, hyper-intelligent android of *The Hitchhiker's Guide to the Galax* Marvin was so intelligent that people did not know what to do with him. Conscious machines wou be just like us: bored, feeling undervalued and unloved – with an IQ many times higher than all of u put together. So why make one? Why are we so fascinated by mechanical simulacra furnished wi intelligence?

This book recounts my quest to understand if it is possible to build an artificial mind, how w should go about it, as well as why artificial minds are so important and fascinating. It explores th questions I have been asking myself throughout my life as an engineer, but also as a novelist and science communicator. I have structured the book in three parts, broadly corresponding to thre perspectives from which I will try to explore Artificial Intelligence: literature, philosophy an computer science.

Part I ~~traces the origins of stories about robots to the advent of art among our Palaeolithic ancestor~~ But why do I have to go so far back in order to explore something that is still very much in the futur Because I believe that, if we really want to understand Artificial Intelligence, we must begin by askin two important questions. Firstly, how the modern mind evolved, and what is special about the min of modern humans that make us who we are? Secondly, why do we have stories about mechanic beings possessing minds similar to our own? Where did these stories originate? Could there be deeper connection between our cognitive system and the reasons we want to build Artifici Intelligence? I will report on my archaeological digs into ancient and modern stories about robots ar androids, and examine how relevant they are to research agendas and scientific expectations.

Part II ventures into the philosophy of mind and neuroscience. It summarises the most importa philosophical ideas that are central to the modern debate about the mind, from Plato and Aristotle t prominent contemporary mind philosophers such as David Chalmers, Daniel Dennett and John Searl What insights can they offer to our quest for an artificial mind? And how might the philosophic foundations of Western civilisation influence and determine our ideas about the nature of our ow minds as well as computers and computer intelligence? What are the latest findings of neuroscientis about consciousness? Could engineers use these findings in order to create a conscious machine?

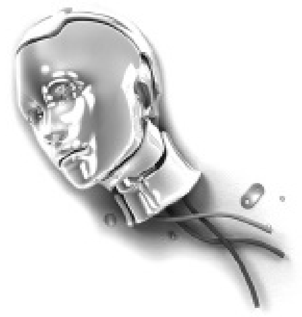
Part III presents the fascinating history of computers, the technology that has changed our world. begins with the formulation of logic by Aristotle, and goes on to show how his ideas were develope further in the nineteenth and early twentieth centuries, until they led to the birth of comput languages and Artificial Intelligence. I will explore how ancient automata evolved into mechanic calculating machines, to Babbage's Analytical Engine, and all the way to modern supercomputers ar the Internet of things; and speculate about futuristic alternative computer architectures that mimic t neural networks of the brain. I will ask how close computers are to achieving self-awareness, and wh might happen once they do.

This book aspires to incite a fresh look at Artificial Intelligence by bridging the 'two cultures' ga and illustrating the interconnection between literary narratives, philosophy and technology in defini and addressing the two most important scientific questions of all time: whence our minds and can w recreate them? You may find these questions interesting, or be sufficiently curious, to want to follo me on this journey. But the importance of Artificial Intelligence goes beyond intellectual curiosit Artificial Intelligence is already with us, whether we ponder the ethical questions of autonomo drones killing people in the mountains of Pakistan or protest against government agencies mining o personal data in cyberspace. Increasingly, we interact with machines while expecting them to 'kno what we want, 'understand' what we mean and 'talk' to us in our human language.

As Artificial Intelligence evolves further, it will become the driver of a new machine age that cou usher our species to new economic, social and technological heights. Supercomputers endowed wi intelligence will be able to accurately model and simulate almost every natural process. We wi acquire the power to engineer virtually everything: from new drugs to predicting markets and solvin the problems of economic scarcity, to terraforming planets. Artificial Intelligence could make u virtually omnipotent. As citizens of a free society, we have a duty to come to terms with this futur and to understand and debate its moral, legal, political and ethical ramifications today. Heate arguments about stem cells or genetics will pale in comparison to what Artificial Intelligence wi allow us to do in a few years' time. Artificial Intelligence will define and shape the twenty-fir century. It will determine the future of humanity in the centuries beyond.

Or it may be the cause of our demise, for there is a darker scenario at play. Many in the field of A are convinced that whenever more powerful computers become conscious they will take over th world, and exterminate us. This ‘AI Singularity’ moment seems to borrow pages from the scripts o the *Matrix* and *Terminator* sagas. Super-intelligent machines interconnecting and becoming infinite intelligent; then self-aware; then turning against us and blowing us all up, or using us as batterie Could this be the sad and violent fate of humanity? Meeting our end at the robotic hands of our ov creations? Should we heed Mary Shelley’s cautionary tale *about the animation of the inanimate*, ar take appropriate action now – before it’s too late? I will be addressing these questions towards the en of this book, as well as highlighting the way Artificial Intelligence might impact our politics ar ethics long before it becomes self-aware. But now, we must set out on our journey towards th creation of an artificial mind. And what better point to begin than the time when our own mind wa born ….

DREAMING OF ELECTRIC SHEEP



Did I request thee, Maker, from my clay
To mould Me man? Did I solicit thee
From darkness to promote me?

John Milton, *Paradise Lost* (X.743–5)

1

THE BIRTH OF THE MODERN MIND

In February 2013, the British Museum held one of the most remarkable exhibitions in its histor Under its esteemed roof the curators gathered the world's most ancient sculptures, drawings ar portraits, loaned from the top prehistorical collections of Europe and Asia. It was the mo comprehensive display of prehistoric art ever assembled. Among the objects on display, cocoone behind tempered glass and attracting awe-struck onlookers in droves, stood one of the mo fascinating objects I have ever laid my eyes upon: the replica[1] of a statuette made of mammoth ivor about 30 centimetres tall, of a creature with the head of a lion and the body of a man.

It was practically impossible to tear my eyes away from it. The alert forward gaze of the lion hea those pricked-up ears, that upward stance and athletic masculine body were laden with meaningf familiarity. The statuette touched something inside me with its unmistakable signature of kinshi Instantaneously, I felt that whoever had carved the original was as human as me. It was also masterpiece – the work of an accomplished and highly skilful artist, for carving a mammoth tus needs highly specialised dexterity and deep knowledge of the natural world. But what made th artefact even more special was that the 'Hohlenstein Stadel lion-man' – as the statuette is known – the oldest object of art in the world. Discovered in the Stadel Cave in the Lone valley of south-weste Germany, it has been dated to around 40,000 years ago.

By the time the lion-man was sculpted, humans had lived in Europe for five millennia. They ha arrived from the Near East as our species made its grand exodus from Africa to colonise the worl Upon arrival in Europe those direct ancestors of ours met the Neanderthals, a different species human with whom we shared a common ancestor. The Neanderthals were somewhat less advanced b they were also better adapted to the European Ice Age. The two human species co-existed for sever thousand years, in what was a very rough place to live. The Gulf Stream had stopped circulatin which meant that there were no currents of warm seawater flowing from the equator to the Arctic. Th North Atlantic was much colder than it is today and glaciers covered most of the British Isles ar Scandinavia, as well as the better part of northern Europe all the way down to the Alps. Europe wa cold and dry. Westerly winds did not bring rain or snow to the continent. The ground was frozen ar temperatures dropped to minus 25^{0}C in the winter with summer highs barely exceeding 10^{0}C. B there was plentiful game to hunt. Tundra-steppe vegetation supported large herds of reindeer, hors and mammoth, as well as lions and bears. The first Europeans, having forfeited the balmy clime their African motherland, had to readapt their lifestyles to the frostiness of their new home. The dressed in heavy clothing and endured rough living in extreme weather conditions, not unlike today Inuit of Alaska or the Sami of Lapland. The going was far from easy. And yet they somehow found th time, the need and the exhilaration to express their minds in art.

The emergence of art in Europe 40,000 years ago is arguably the most fascinating, and significan occurrence in the evolutionary history of our species. Why did we begin to create art? Mo importantly, why hadn't we done so before? Our species existed for nearly 360,000 years before th time of the first Europeans,[2] and yet we had created nothing artistic.[3] For aeons we pursued mundane life not dissimilar to that of other human species that preceded us, living and dying witho fanfare, copiously reproducing the single artefact we had inherited from those who preceded us: th hand axe. And then, all of a sudden, 40,000 years ago, everything changes with a bang: we begin paint cave walls with murals of stunning beauty and narrative complexity, to carve sumptuo figurines of women, to play flutes and dance, to adorn our bodies with beads and colours, to develo highly specialised new weapons and hunting techniques; to bury our dead with sophisticated rituals if the dead continued to live beyond the grave; to imagine chimeras, half lion and half human. Th emergence of art must represent a quantum evolutionary leap in our cognitive system. Take, fo example, the chimpanzees, our closest living relatives today. We share nearly 98.8 per cent of ou genetic material with them. And yet, however fascinating, likeable and intelligent chimpanzees ar they have never developed art.[4] Indeed, no other species on our planet has developed art except *Hom sapiens sapiens* – us. We are truly unique. If we want to understand how our minds became so uniqu – and why we seek to construct artificial minds – we must first seek whatever turned us into artists. T begin our quest we must climb down our genealogical tree by some six million years, to arrive at th common ancestor of human and chimpanzee, and begin our story from there.

The drama of our past

The common ancestor we share with the chimpanzees must have included several curious individua within its ranks. They separated from their kin to explore better feeding grounds, and wandered abo the ever-changing environment of Africa. Around 1.5 million years later, they evolved into severa new species we call australopithecines.[5] The Earth's climate had changed considerably by then; th long grass of the savannah had replaced much of the tropical forest that once covered Africa. If w could pay a visit to those hairy distant grandfathers and grandmothers of ours we would be ha pushed to distinguish them from the other apes that roamed about the place at that same time. But the were indeed different, mutants set on a destiny that would one day separate them from the rest of th animal kingdom. A few would occasionally stand on their back feet to peek over the grass for lions, o food. With time, this advantageous habit of the few was inherited by their offspring, who were bor with the gift of bipedalism. They could now run faster in the savannah, spot enemies more quickly an survive for longer. Their numbers multiplied with each generation. They evolved even more. The became less ape and more a type of being that could use tools and strategy to hunt, collaborate teams, and increase the probability of survival by learning to adapt. Around two million years ago, th first member of our 'homo' lineage appears: *Homo habilis*. He inherits the knowledge of creati basic stone tools for chopping, scraping and pounding, and perfects it. Stone tools were used by earli species too. There are relics from around two and three million years ago which are often difficult distinguish from naturally occurring rocks. They belong to what archaeologists call the 'Om Industrial complex', from the Omo area in Ethiopia where most of these archaic stone tools we found. With the appearance of *H. habilis* between two and 1.5 million years ago, stone tools becom clearly identifiable as artefacts consisting of flakes removed from quartz, basalt or obsidian.[6] Har axes appear around 1.4 million years ago, and they become the pinnacle of utilitarian design in term of supporting human existence. The hand axe remains to this day the most successful technologic innovation on Earth, if one judges its merits according to how long it was used. There were no furth innovations until the Middle Palaeolithic, around 200,000 years ago. Was this because we remaine relatively stupid and unimaginative for several millennia? Let's try to answer that by examining th brains of our ancestors – or, should I say, their skulls.

At 800 cubic centimetres *H. habilis* had almost double the brain size of the last australopithecines His was truly a giant leap in human evolution. A more evolved *H. habilis* called *Homo erectus* was th first human to leave the African homeland 1.8 million years ago. This is when the Pleistocene epoc begins. The Earth's climate changes once again. Ice sheets begin to form in high altitudes. *H. erectu* seems to appear simultaneously in three parts of the world: East Africa, China and Java. His brain siz now leaps to a whopping 1250 cc. Let's scrutinise this fellow more closely. The most spectacular, an complete, *H. erectus* skeleton found is that of an eight-year-old boy dating 1.5 million years, fro Nariokotome in Kenya.[8] The skeleton provides evidence for a linear rate of child development th appears to be characteristic of early humans. This contrasts with the growth spurt of modern huma that occurs in puberty. Although *H. erectus* is considered 'human' he was considerably different fro us. He still retained many of the characteristics of apes. 'Human' was still in the making.

It took another 1.1 million years for the ape inside us to melt away, at least for the most par Around 400,000 years ago[9] archaic *Homo sapiens* appears in Asia and Africa. It is an ill-define species. It seems that, as *H. erectus* spread across Europe and Asia, he diversified in several ways, different times, and in various geographical locations. By now brain size has reached 1400 cc. One the sub-species of archaic *H. sapiens*, a species called *Homo heidelbergensis*, made Europe his hom fossils discovered in Atapuerca, Spain, have been dated to at least 780,000 years ago. From th species evolved the Neanderthals (*H. neanderthalensis*) who appear 220,000 years ago and survive Europe until 40,000 years ago.[10] Brain size has now reached a plateau between 1200 and 1750 c Neanderthals are muscular and stout with strongly built bodies and short legs, all anatom adaptations finely tuned for living in a glacial environment.

Around the time that the Neanderthals appeared some significant changes occur in tool-makin There is now more diversity in the tools, and hand axes become less prominent. New tools are mad with the so-called 'Levallois method', which produces carefully shaped flakes and points of ston Neanderthals use the method to make weapons and hunt big game. Yet almost since the inception o the hand axe toolkits tend to involve the same essential ingredients. True, some are now more finel crafted, but all are still made of stone, or wood, just like before. There is no experimentation wi other materials, such as bone or antler. It seems that for one and a half million years, and despite th impressive development in brain size, the 'mind' of these evolved humans somehow remains 'stuck Their intelligence seems to have been of a specialised type; it worked well in several dimensions suc as social interactions, tool-making, hunting, but not across all these dimensions at once. They seem have lacked 'general intelligence', the type of intelligence that connects the dots, innovates, discover questions – all those things that our modern mind does.

The earliest anatomically modern humans appear in Palestine and South Africa about 100,000 yea ago. Their bodies are less robust; they have no brow ridges, more rounded skulls and smaller tee than the Neanderthals. The size of their brains is now between 1200 and 1700 cc, slightly smaller tha that of the Neanderthals. Almost upon appearance, these new humans start making bone artefacts, a excavations in southern Africa have revealed. They place parts of animals into human burials in th Near East. For several thousands of years, our direct ancestors co-exist with other humans such as th Neanderthals, as well as remnant populations of other archaic *Homo sapiens*. But this time, evolutio has decreed that only one species of human will survive – and that it will be us. We begin to colonis the planet anew, in a repeat of the first exodus from Africa that had taken place several million yea previously with *H. erectus*. By 60,000 years ago, we have arrived in South East Asia, built boat crossed the southern seas and colonised Australia. We enter Europe 40,000 years ago.

Evidence for this immigration scenario comes from the limited genetic diversity among livi ~~humans today. Living Africans have a higher degree of genetic variation than people elsewhere~~ in th world. This can only be explained by a severe, and relatively recent, 'bottleneck' in human evolutio The first people to leave Africa must have been very few in number. One estimate suggests there we no more than six breeding individuals for seventy years, which means a population size of around fif first colonists.[11] From this small group of people, our species gradually replaced all existing ear humans. Thirty thousand years later, *Homo sapiens sapiens* was the only surviving member of th *Homo* lineage. We had conquered the world.

New things happen in tool manufacturing with the appearance of our species. Archaeologic findings in the Near East show that instead of flakes being produced by the Levallois method, lo thick slivers of flint are now removed from stones that look like – and are – blades. An interestin innovation, but perhaps more interesting is that nothing else is invented for the next 60,000 years. W have now arrived in the so-called Upper Palaeolithic Age.[12] Then, suddenly, instead of stone tools ne materials such as ivory and bone are used. Instead of continuing to live in caves, *Homo sapie* constructs dwellings. Caves are mostly abandoned and repurposed: their walls become covered wi naturalistic paintings. In small, nomadic settlements, people sit around campfires and carve anim and human figures from stone and ivory, while others sew clothes with bone needles. They wear bea and pendants. They decorate their bodies. They want to look good. The fact that the denizens of th Upper Palaeolithic spent so much of their productive time making themselves pretty points to beau acquiring a high degree of social value. Aesthetics must have become part of everyday life, lik hunting and celebrating. The ritualistic burial of the dead becomes increasingly sophisticated. The humans behave in ways that we can relate to today.

The Neanderthals who live close by attempt to mimic these ingenious and creative humans b recreating crude versions of tools and body decorations. But they soon fade away from existence, do all other *Homo* species. Was this because we hunted them down? Or was it simply because th competition proved too much? Did they breed with us, or did they simply die off? These questions a still researched and debated. Whatever happened, by 40,000 years ago *H. sapiens sapiens* is alone the world stage.

The rate of change accelerates. Europe is ablaze with the colour of cave art between 30,000 a 12,000 years ago, although most of the continent remains frozen under the last Ice Age. Rapid glob warming returns around 10,000 years ago, and the agricultural revolution takes place. We still live that 'long summer' that began ten millennia ago, in the scientifically termed 'Holocene period'. took humans four million years to evolve the hand axe, another two million years to somewh improve it. And then, within a mere 20,000 years, a geological blink of an eye, they created a agriculture, the wheel, computers and spaceships. This unbounded creativity kicked in between 65,00 and 40,000 years ago in what scientists call 'the Middle/Upper Palaeolithic transition', sometim referred to as 'the big bang' of the modern mind. But what exactly banged?

What banged?

In 1979, an American archaeologist named Thomas Wynn published an article in which he claime that the modern mind was already in place 300,000 years ago.[13] He based his claim on the eviden that *H. erectus* and archaic *H. sapiens* made symmetrical axes. To explain his theory, he adopted th idea that the phases of mental development in children reflect the phases of cognitive evolution in o human ancestors, an idea referred to as ‘ontogeny recapitulates phylogeny’. This is an importa scientific idea that correlates behaviour to cognition: one can observe behaviour, such as symmetric tool-making, and draw conclusions about cognitive architecture and function.

Viewed from this – essentially behavioural – perspective, something important seems to occur our brains after the age of four: we acquire the belief that other people have thoughts, desire intentions and feelings of their own. We thus acquire the agency for empathy, which is essential i forging human relationships. I guess I am not the only parent to have carried out a false-beli experiment with their child in order to test this hypothesis in developmental psychology. If you’d lil to perform it too, here’s what you should do. Show your three-year-old a box of crayons and ask hi what is inside. He will most likely tell you ‘crayons’. But you, being the scientifically inclined so will have replaced the crayons with something else, say, sweets. Show him the candy, and put it bac inside the box. Then ask your three-year-old to tell you what his mummy would think was in the bo if she walked through the door. He will most probably tell you ‘sweets’ – at least that’s what my so told me when I did the experiment with him at the age of three. But when I repeated the experiment year later he told me, correctly, that his mummy would think that the box contained crayons. Why Because she did not know what he and I knew. Because his mummy had a different mind. My son ha acquired what psychologists call ‘theory of mind’. Most humans[14] have it. In fact, most humans at th age of four start believing that not only other humans but animals and objects have minds too: dol and toy soldiers are very much alive in a child’s imagination. However, according to Wynn and other our species took time to develop theory of mind. It is very possible that it was the acquisition theory of mind that gave rise to the Upper Palaeolithic transition.

English psychologist Nicholas Humphrey[15] elaborated further on the evolutionary rationale f theory of mind. He argued that when individuals live within a group and enter into a diverse set cooperative, competitive and mutualistic relationships, individuals with the ability to predict th behaviour of others will achieve the greatest reproductive success. He coined the term ‘soci intelligence’ to describe the mental toolbox that is essential to maintain social cohesion. Therefor there is selective pressure to have the ability to ‘read’ other people’s minds. Early humans wer dependent on retaining harmonious social relationships within their group for their survival. Th involved much manipulation of other people’s emotions, fears and wants. Today, six million year after we parted ways with the chimpanzees, the instinctive need to belong to a group dominates o personal and social life. Social rejection hurts: exile is a terrible punishment; separation from fami and friends a personal tragedy. Our high-level consciousness, or general intelligence, seems to hav evolved as part of social intelligence.

But what did it mean to be a human before the advent of high-level consciousness? How did it ‘fee to *be H. habilis*? What level of consciousness did those early humans experience? What was it like think, or make sense of the world, with only a specialised intelligence? Daniel Dennett, the America mind philosopher, has described the consciousness of early humans as being akin to a state of ‘rollin consciousness with swift memory loss’.[16] According to him, for *H. habilis* consciousness would hav been somewhat like the state we experience when driving a car while engaged in conversation with passenger. We do not ‘think’ of driving at all. We are, however, conscious of being at the wheel an thus always ready to react in an emergency.

Reduced consciousness in early humans explains the puzzle of their lack of variation in tools acro time and space. They did not make tools designed for specific purposes. They ignored bone, antler an ivory as raw materials. For millions of years, it was just hand axes made of stone and little else. Ent our species with the invention of art, the development of new hunting technologies and tools and a ~~evolved theory of mind. Something profoundly radical must have occurred within our cognitiv~~ system. Intriguingly, all the archaeological evidence suggests that this mental transformation o monumental proportions happened within a relatively short period of time. The sudden emergence modern behaviour in Europe around 40,000 years ago has led many scientists to question the gradu evolution of the human cognitive system. Something must have 'kicked in' that caused the 'big bang of the modern mind: a spark, a fifth element. The most dominant candidate for this cognitiv transformation is language.

The first piece of evidence to support the notion that language begot our highly evolve consciousness is genetic. In the late 1990s, a team of British scientists[17] isolated a gene that crucially involved in the development of speech and language. Dubbed 'FOXP2', it also becam known as the 'language gene'. Steven Pinker, the renowned MIT psychologist, has called the findin the smoking gun for the relationship between genes and language.[18] The gene exists in other mamma too, including chimpanzees, but seems to have undergone a significant mutation in humans aroun 200,000 years ago, a period that roughly coincides with the advent of *H. sapiens sapiens*. Th discovery of FOXP2 provides some validation of the language theory proposed by Noam Chomsk about the connection between genes and language. Chomsky observed that children are born with a innate knowledge about language and grammatical structure, which had to be biologically determine According to his language theory, we are hardwired for language, a notion shared and supported b Steven Pinker and other neurolinguists.

We saw how human brains became increasingly larger as our biological lineage made its ep journey though time; from 750 to 1250 cc for earliest *H. erectus* to 1200 to1750 cc for Neanderthal Brain size reached a plateau between 1.8 million and 500,000 years ago, and rapidly increased archaic *H. sapiens* appeared. Archaeological findings show the early humans had all the hardware fo language installed. These are the two areas in the left-brain hemisphere responsible for gramm (Brocca's) and comprehension (Wernicke's). Given the existing brain architecture in early human genetic variations such as the mutation of FOXP2[19] must have accelerated the evolution of gener intelligence.

However, genes mutate all the time. If mutant genes triggered the evolution of language there ha to be a compelling evolutionary reason for their selection, and propagation in the next generation The reason was probably that they facilitated the social cohesion of human groups, which was of vit importance. Persons with mutated language genes made better social conservationists. They were th unstoppable chatters of prehistory, the naturally born public relations experts. They wooed bett mates with their words, or even their poetry perhaps, and passed on their mutant, chatty genes to the offspring. Their numbers proliferated with every new generation until being uber-talkative became th norm. Once early humans started talking they literarily could not stop – and this led to our cognitiv fluidity.

The language of those early humans was different from ours in several aspects. As Robin Dunbar has suggested, the language of early humans was a social language, a way of grooming. They used as a means to send and receive social information. It was a language solely given to social gossip. Th should not come as a surprise to us. We, the humans of the twenty-first century, continue to us language mostly for social gossip. Knowing what our neighbour did yesterday or bought in the sales arguably more interesting than nuclear physics or climate change for the vast majority of humankin A quick search on any social network is enough to convince the most hardened sceptic that chat abo celebrities far outweighs any other form of conversation on any other given subject.[21] We hav inherited this love of gossip from our ancestors.

Social language must have evolved rapidly between 150,000 and 50,000 years ago into a genera purpose language that was now used to convey information about the non-social as well. Genera purpose language has selective advantage because it introduces general questions about anim behaviour, hunting and tool-making. The dynamics of evolution kicked in and ushered our species in an ever-increasing awareness of our surrounding world, expressed in words previously used only f people. Individuals with a facility for general-purpose language could compete more successfully f mates and provide better care for their offspring. It was general-purpose language that begot gener intelligence. This is a stunning realisation. It means that words came before painting, music, danc and sculpture, as well as science and religion. Indeed, it suggests that language created our world.

But the primal, social origins of language were never abandoned. When we talk about physic objects, we still tend to ascribe to them an intrinsic tendency towards motion, implying they posse minds, as if they were living, social beings. As linguist Leonard Talmy[22] has observed, sentences suc as ‘the book toppled off the shelf’ and ‘the ball sailed through the window’ imply that these objec move under their own power, since they are the equivalent of sentences such as ‘a man entered th room’. Our world remains populated by social entities, whether these be artefacts, trees, river mountains, houses or the engine of our car that refuses to start. Who among us has not kicked a do to take revenge on wood? Who has not played with dolls or toy soldiers, and not believed that they ha minds too, that they were truly alive?

So let us recap what we have discovered so far. During the big bang of the modern mind human acquired and developed general-purpose language that altered their consciousness, possibly because a number of enabling genetic mutations. As a result, the close-knit groups of early humans expande rapidly to embrace their wider environment, for we now had the words with which to describ everything. The world of animals and of things became filled with the mind. Humans thus became th creators of a symbolic universe imbued with meaning.

Art and the mind of objects

All three cognitive processes critical to making art – the mental conception of an image, intention communication and the attribution of meaning – were present in the early human mind. Howeve thanks to the rapid evolution of language between 60,000 and 40,000 years ago, they began to functio together, thereby creating a new cognitive process we call visual symbolism, or simply art.[23] Mo prehistoric art is representational. In the Chauvet Cave in the Ardèche region of France, a cav discovered on 18 December 1994 and dating to 30,000 years ago, there are 300 remarkable naturalist paintings of animals (rhinoceroses, lions, horses, reindeer, an owl). The paintings are on a par wi better-known caves at Lascaux in France and Altamira in Spain. Representational art is n coincidental. Nowadays when we speak of art we usually mean non-utilitarian objects; owning the objects reflects wealth and social status. But this was not how our ancestors regarded the wonderf paintings on the walls of their caves. Art for the prehistoric people, and indeed for all subseque generations until Western societies became secularised, was sacred and utilitarian. It served a usef purpose. It provided the symbolic canvas for making existence bearable for a species that had evolve to realise that its life was ephemeral and that death conquers all. The realisation of your inevitab death can only take place if you have a mind capable of self-awareness. In prehistoric art we discov the beginnings of religion and science, and importantly the cognitive roots of our hardwired belief th ~~things can have minds, which also means that robots can ultimately become as intelligent~~ ourselves.

Our mind became modern when it perceived inanimate objects as social beings. Our languag social by origin, continues to frame our thinking in such a way that inanimate things have – by defau – their own volition. Our cognitive make-up, mutated under evolutionary pressure towards gener intelligence, compels us to instinctively regard representations of reality as reality itself. It is n hyperbole to claim that the 'world' did not really exist before we developed general intelligence. Th it came into existence when we found words to describe it. In a curious alignment with the Book Genesis, cognitive archaeology agrees that words[24] created the universe; and that the first thin modern humans did was to name the objects of that newly born universe.

Consequently, every time we think or speak about something we virtually create, again and agai the universe we live in. For it can only be a mental projection of our cognitive system, a linguist interpretation of 'reality' (whatever that is) enmeshed in the haphazard complexities of huma evolution. Our consciousness lives in a simulation of its own making, where we – or, rather, our brain – are the simulators, where the inner and the outer are indiscriminate. That is why prehistoric a resonates so much with us today: because it is full of 'spirit'. Because we, regardless of whether w claim to be religious or agnostic or atheist, know full well what spirit 'is': we feel it inside us an around us; it is a part of us, for we cannot escape the fact that we are *H. sapiens sapiens*.

Let us now see what interesting conclusions we can draw from our brief sojourn into the distant pa that are also relevant to Artificial Intelligence. Firstly, and most importantly perhaps, is that genera purpose language predated, and begot, general intelligence. Language was what caused the genesis the modern mind. The repercussions of this finding are enormous, and I will explore them in mo detail in the final part of the book. Just consider, for now, the importance of language. It is not only means of communication, but also the way that the world is represented in our consciousness.

An artificial mind may have other ways of representing the world. However, since ultimately w will be the creators of this artificial mind, we will aim to furnish it with representations familiar to u for otherwise we will not be able to communicate with it, or comprehend it. A central research goal i Artificial Intelligence has always been to find a solution whereby an artificial system ca communicate in natural language, i.e. in a general-purpose language. This has turned out to be a maj problem for programmers and system designers. Language is very difficult to code for, and o journey into the Palaeolithic has shown why: language evolved in a haphazard way as a means enhancing social cohesion within small hunter-gatherer groups. The main purpose of language wa and still is, gossip.

Second finding: by evolving general-purpose language we became inexorably dualistic: we starte to perceive the world as a combination of the seen and the unseen, a mixture of what one felt throug the senses and what one 'saw' with the imagination. A direct result of our dualistic thinking was tha according to our perceptions of them, inanimate objects acquired minds. Our theoretical debates (wel theoretical for the time being) about androids, and whether they should have equal rights with human stem from this dualistic way of thinking. How could they not? The sculptures and paintings of th Palaeolithic were considered as alive as other people, animals, trees, rocks, or indeed natur phenomena such as the bright, terrifying lightning that cut across a cloudy sky. As the modern min emerged everything possessed a spirit in a landscape filled with social meaning. The invention of a is a manifestation of this uniquely human worldview.

But, ultimately, art did more than simply help our ancestors come to terms with their new, genera purpose, dualistic minds: it provided a means for expressing narrative, for telling stories ar recording knowledge, for expressing religion and, after many thousands of years, for inventi science. Narratives are at the core of what we do, they codify what we believe, and guide how we thir of ourselves. When we seek to create androids and robots with an artificial soul, age-old narrativ about non-human beings continue to motivate us, and condition our expectations and goals. We nee to understand these narratives, how they result from our cognitive systems, and how time h transformed them from stories about prehistoric chimeras into novels and films starring futurist cyborgs. But first, let’s return to the lion-man and listen to his story ….

2

LIFE IN THE BUSH OF GHOSTS

I am borrowing the title for this chapter from a wonderful novel written in 1954 by the Nigeri author Amos Tutuola. In the novel, a seven-year-old boy flees his village in western Africa after it ha been destroyed by slave traders, and enters a forbidden place populated by supernatural beings. The he lives amongst the spirits for twenty-four years, gets married twice and frequently transforms in an animal. The novel inspired Brian Eno and David Byrne to write one of the most iconic mus albums of all time, *My Life in the Bush of Ghosts*. It is also a novel that is very relevant to our quest understand how our minds interpret the world. Ghosts, spirits, the metamorphosis of humans in animals are cultural universals. Tutuola's novel echoes the roaring primal river of stories created b the first modern humans. It was a river in which the visible and the invisible formed an uninterrupt continuum, where everything had a soul, a mind, and intelligence.

The lion-man of Stadel Cave is a relic of that ancient river of stories. It speaks of a lost myth of th Upper Palaeolithic, according to which this half human, half lion creature was a hero, a demon or god. Perhaps the lion-man was a seven-year-old boy from a village who transformed into a lion. Th is perhaps the reason why we relate so strongly to this ivory statuette from 40,000 years ago. It tells familiar story. Like many Western children, I was raised with Aesop's Fables, where the resolut tortoise beats the smug hare in a race; the cunning fox steals the cheese from the hapless crow; and th carefree grasshopper learns a hard lesson about life from the diligent ant. Stories about animals a common not only in the West but in every culture on our planet. In them, animals not only 'talk' bu are attributed with every other aspect of our humanity as well. Anthropomorphising animals appea to be instinctive. Give a twenty-first-century child a puppy and she will start talking to it as if th puppy had a mind like her own. Animals are often attributed human minds by adults too; if you are th owner of a dog or a cat you will know exactly what I mean. A tiny cognitive step separates anima with minds (think of a mouse called Mickey) and inanimate objects or machines with minds (think McQueen, the hero of the movie *Cars*, or your car). The anthropomorphising process appears to hav remained unaltered since the dawn of the modern mind. The lion-man, as well as the plethora of oth Upper Palaeolithic statues that depict animals or chimeras, are 'alive', 'feeling' and 'thinking', ju like us humans. They have minds. But why is this so? What evolutionary advantage do anthropomorphising confer?

Anthropology provides us with plenty of evidence for a possible answer. Again, the soci dimension of our existence comes into play. Modern hunter-gatherers think of their natural world as social network in which everything, living or not, is related. When the Inuit of the Canadian Arctic k a polar bear they treat it as if it were another hunter. Often the bear is considered to be an ancest being. For the Aborigines of Australia their landscape is full of social meaning, and they naviga through it by ascribing stories to its landmarks. Wells are supposed to have been dug by ancest beings who used the trees as digging sticks. As anthropologist Tim Ingold[1] writes: 'For them there a not two worlds of persons (society) and things (nature) but just one world – one environment saturated with personal powers and embracing both human beings, the animals and the plants which they depend, and the landscape in which they live and move.' By extrapolating from today hunter-gatherers to our ancestors of 40,000 years ago, we can see that the painted caves of the Upp

Palaeolithic represent landscapes full of symbolic meanings, where the social and the natural worl fuse into one. The forests, the tundra, the mountains, the rivers, the animals, the spirits are a denizens of a continuum in which humans are included and embedded deep within its narrative fabri Animals move because they ‘think’ of moving. The falling of rain, the roaring of thunder ‘speak Everything is alive and possesses intentions, thoughts and feelings, sometimes benign and other tim not. The conflation and confusion of functions, aims and criteria seems like the normal, origin condition of mankind.[2] It is also the basis of totemic thinking.

To understand the vital significance of totemic thinking for the survival of our forefathers an foremothers, let us revisit Ice Age Europe circa 17,000 years ago. The continent is at its coldest. Nev before have humans lived in an environment harsher than the one that these ancient hunter-gathere endure. This period is called ‘the Magdalenian’[3] and lasts until around 10,000 years ago when the la Ice Age ends, and the agricultural revolution begins. Equipped with a general-purpose language an general intelligence, our species applies their evolved minds to surviving the long and ruthless wint of the Ice Age. They innovate. Archaeologists have unearthed evidence of a major shift in huntin techniques from that period. Elaborate tactics, weapons, logistics and strategies are developed an employed. Fishing spears, hooks and nets become increasingly common. The spear thrower invented: a wood or bone rod with a hook on one end is fitted at the base of a spear, helping the bear to throw the spear further away and with improved accuracy. But the real revolution lies in the tactics, in the coordinated group hunting techniques for the killing of large herd animals, especially the river valleys of Western Europe and the plains of central and Eastern Europe. Until then, huntin had been undertaken either by individuals or small groups. But although the game remains the same reindeer, red deer, bison and horse – these animals are now slaughtered en masse. The efficiency the new hunting tactics is overwhelming. It is perhaps the first recorded instance of the devastatin impact an intelligent species can have on its environment. At least fifty genera of large anima (mostly mammals) become extinct during this period because of overhunting.

The advantages of anthropomorphising when hunting become clearly, if not dauntingly, apparen Modern humans, by imagining animals as possessing thoughts, could predict animal behaviour bette Hunters could foresee where the herd would feed, or in what direction it would move, and strategi accordingly. Their modern way of thinking, equipped with an advanced theory of mind, reaped cle utilitarian benefits from anthropomorphising animals. Group-hunting strategies were possible becau of totemic thinking. The connection between survival and imagining non-human minds was forge forevermore.

But totemic thinking did not end with the anthro-pomorphism of animals. Totemism embe humans within the natural world, and traces their descent from non-human species – ancestral bein created by the human imagination. The origin of these beings is always the unseen. Our min instinctively imagine the invisible as writhing with dangerous life forms. When one walks alone in t dark, one’s mind compulsively produces images of invisible beings lurking in the gloom. It is almo impossible not to. There seems to be an evolutionary explanation for this. Because of the way our ey have evolved, we cannot distinguish shapes or movements very well at dusk. Things get very blurr At nightfall we are virtually blind. But not so our prime enemies, the big cats. It is possible that ov many millennia our ape and australopithecine ancestors were ambushed in the dark by mastodon lions and leopards. Out of the dark came unexpected death. Inherited fear of darkness was articulate by the modern mind through general-purpose language. Abstract, fearsome darkness becam populated with anthropomorphic demons and spirits. Once we were able to imagine the invisible o minds went wild with imagining. Creatures of our imagination populated the stories that old generations passed on to the young. Imaginary creatures became protagonists in depictions on th walls of caves.

Many archaeologists believe that the painted prehistoric caves were sites for the practice of magic ceremonies. The few findings of human debris suggest that no one lived in them on a permanent basi Engravings, tucked away in narrow or low niches, represent individual devotions. Footprints of adult adolescents and children imply that dances were performed inside the painted caves, possibly with th use of hallucinogenic drugs to induce ecstatic states of mind.[4] Perhaps those rituals were somewh like a Palaeolithic movie theatre and church rolled into one: a shaman, flaming torch in hand, lea the procession into the cave's mystical innards, stopping under a mural of lions chasing horses, ar recites a story about hero-hunters transforming into animals, or supernatural beings. Admiration wa mixed with fear; and thus the two essential ingredients of a captivating yarn were invented. Our brai were ready for them.

Our storytelling brain

The neurological basis of storytelling was discovered by the celebrated American neuroscienti Michael Gazzaniga[5] while he and his team were working with split-brain patients. Patients such these usually suffer from extreme cases of epilepsy that can be treated only by surgically severing th corpus callosum, the part of the brain that connects the right and left hemispheres. The result of suc an operation is that the patient stops having seizures, but the connection between his hemispheres lost. His right hemisphere (the non-speaking one) stops communicating with his left hemisphere (th speaking one). It is as if the patient now has two separate brains cohabiting the same cranium.

Gazzaniga experimented by asking the right hemisphere of his patients' brains to perform a tas for example to move the left hand, by providing the instructions within the visual field accessible on to the right brain. However, when he asked the left hemisphere the reason why the hand had move this hemisphere gave a coherent explanation that was, of course, confabulated. What the le hemisphere was doing was filling the gaps in the patient's memory with plausible inventions in ord to explain what had happened. Narrative continuity had to be preserved. The hand moved ar therefore there *had* to be an explanation. Of course, the left hemisphere had no idea that the rig hemisphere had given the order for the hand to move. But the left hemisphere had to *invent* a reaso So the left hemisphere *created a story*.

The part of the brain's anatomy that is responsible for storytelling (fictitious or otherwise) was thu identified and named 'the interpreter'. Not surprisingly, the interpreter resides in the left hemispher where the brain areas for language also reside. It organises our memories into plausible stories. It ac like a writer collecting disparate pieces of information and patching everything together by filling th gaps with his imagination.

However, you do not have to be a split-brain patient for the interpreter in your brain to confabulat It's what we all do all the time. Our memories are not precise recording instruments. Our brain is n like the hard drive of a video camera. Every time we describe a past event, our brain recalls a fe facts and automatically fills the gaps with whatever can be used to preserve the coherence of o narrative. We are not compulsive liars, just natural storytellers. Which explains why several witness of the same event always give different accounts or testimonies.

We can only postulate why narratives were wired into our brains during the Upper Palaeolithi Perhaps the telling of stories helped us to prepare psychologically for life's eventualities. Perha