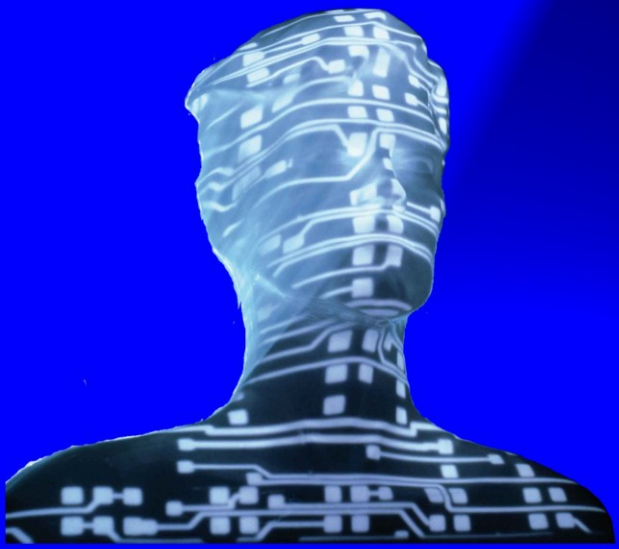
Practical Artificial Intelligence



Humberto Contreras Ph. D.

Practical Artificial Intelligence

Find out how and when computers and robots will become intelligent and how relationships between smart computers and humans will change society. A timeline will show you when to expect these paradigm changes.
This is a tale of the forced evolution of computers and robots by means of scientific research, technological design and engineering so that they are able to learn, to interact with people and the environment, and to become conscious in their own way without necessarily becoming human-like.
Creating **Artificial Intelligence** is most likely the toughest challenge that technology has ever confronted. However, there is no doubt of achieving this goal of developing AI in the near future. The question is up to what point human technology can advance machine intelligence. Will it be up to a level comparable, or maybe surpassing, human intelligence? No matter what the answer will be, smart computers and robots will be increasingly more important in our lives.
To be useful, they will have to plan ahead and they will have to quantify the uncertainty inherent in any prediction about the future. The future that will take place in one millisecond or in one century.
In this book, the technology is discussed; as well as the social, political and economic effects that these inventions will bring along. Our lives will change, be prepared.

'Change is the law of life. And those who look only to the past or present are certain to miss the future.'
John F. Kennedy.

Books by Humberto Contreras

living dangerously in utopia

The War of the Classes
The Preponderant Factor
It is all in the Mind
The Restlessness

technology & social impact

The History of the 21st Century
Practical Artificial Intelligence

These books are also available in Spanish.

Humberto Contreras is a Civil Engineer with a Masters in Structural Engineering and a Doctorate in Earthquake Engineering. As an expert in probabilistic and stochastic systems, he implemented solutions involving risk analysis and safety of Nuclear Power Plants and Nuclear Waste. He has also been a computer software consultant for major corporations. He currently writes books and lives in New England and the Riviera Maya.

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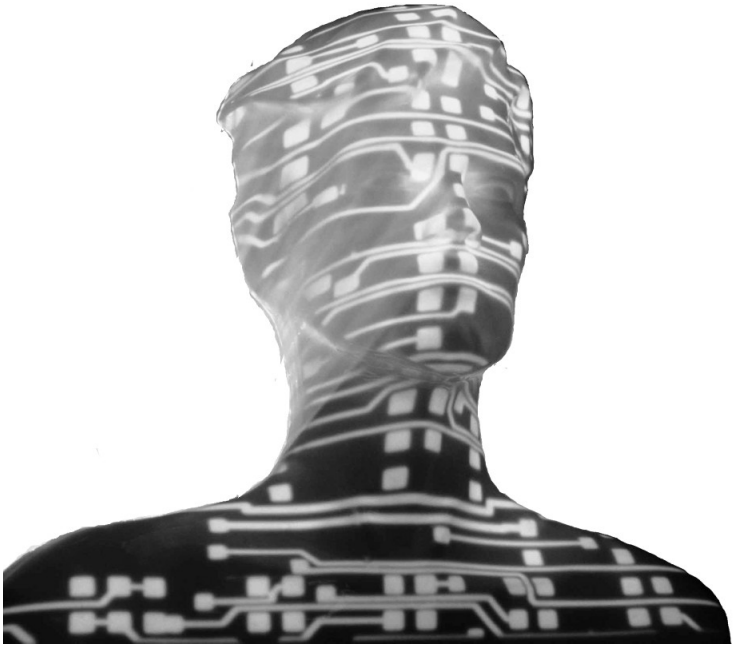

Humberto Contreras Ph. D.

Practical Artificial Intelligence

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To my wife Gloria, my only passionate love.

To my perfect daughter, Cleopatra-Alexandra.

To my children and grandchildren.

I am grateful to the people that have made Artificial Intelligence conceivable. They are many more than we can ever imagine.

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Civilization's Adventure

> *'Progress is impossible without change, and those who cannot change their minds cannot change anything.'* ***George Bernard Shaw.***

Life on earth has been living in an open-ended experiment that has lasted four billion years. Finally, in the years to come tools will exist and it will be up to us to set off another evolutionary step in this experiment.

This experiment has produced human beings, whose evolution has followed a continuous growth pattern, generating the rise of civilization. Every century the world as a whole has been better than the one before, and its people, which are in effect the essence of civilization, have improved in their standards of living, education, and ethical behavior.

This century, technology will unleash progress in a way never seen before and computers leading the bio and nano technologies could very well create a world of abundance for all the inhabitants of the earth.

Alongside this progress, computing power and memory capacities will continue to double every year and by the year 2040, a thousand dollar computer will equal the capacity of one human brain. By the end of this century, any ordinary computer will surpass the computing capacity of all human beings. This will make AI (Artificial Intelligence) and robots commonplace and ubiquitous. They will take over most of human labor and even creativity, development and design.

Milestones

During these years of rising civilization, some milestones have profoundly transformed society, among them we can identify:

- Stone Tools: Ethiopia 2.6 million years BC.
- Fire: Africa 800,000 BC.
- Clothing: Africa 500,000 BC.
- Language: Africa 50,000 BC.
- Bow and Arrow: Africa 16,000 BC.
- Needle and Thread: Europe 15,000 BC.
- Farming: 10,000 BC.
- Brick: Mesopotamia and Egypt 8,000 BC.
- Pottery: Anatolia 6,500 BC.
- Wheel: Mesopotamia 5,000 BC.
- Beer: Mesopotamia 4,000 BC.
- Plough and Draft Animals: Egypt and Mesopotamia 3,500 BC.
- Paper: Egypt 3,500 BC.
- Measuring time: Egypt 3,500 BC.
- Writing: Sumerian cuneiform, Egyptian hieroglyphs 3,200 BC.
- Women Rights: Ancient Egypt 3,200 BC, Rome 200 BC, Visigoth (Spain) 418, Islam 610, UN 1948.
- Ship: Egypt 3,000 BC.
- Money: Mesopotamia 3,000 BC.
- Soap: Babylon 2,800 BC.
- Sundial: Egypt 2,000 BC.
- Glass: Phoenicia 1,500 BC.
- Democracy: Athens 500 BC.
- Zero: Olmecs (México) 400 BC, India 458.
- Cement: Greece 200 BC.
- Scientific method: Iraq 1000.
- Printing press: China 1000, Germany 1440.
- End of Slavery: Western Europe 1100, México 1821, US 1863, UN 1948.
- Gun: Seville 1247.
- Human rights: India 1500, Germany 1525, UN 1948.
- Steam engine, electricity, internal combustion: England 1700.
- Computer: England 1837, Germany 1941, US 1942.
- Internet: US (ARPANET) 1969, (TCP/IP) 1982, CERN (WWW, email and hypertext) 1990.
- Modern medicine: Europe 1880.
- Radio: England 1896.

Social changes tend to follow those produced by technology. It took years from the beginning of the Industrial Revolution to the establishment of a middle class in the industrialized nations. This lag is due to the inertia of social and political systems. Interestingly, once change is established the same politicians that held it up will claim credit for it.

The AI 'revolution' will most likely have the reach of paradigms like the Greek democracy, the onset of the Middle Ages, the Renaissance and the Industrial Revolution.

Greek Democracy

In 510 BC, Cleisthenes an Athenian aristocrat asked the Spartan king Cleomenes I for help to overthrow the tyranny of Peisistratos on the Athenians. Cleomenes I took advantage and named Isagoras as a pro-Spartan leader of Athens. Using the bait of a new form of government Cleisthenes convinced Athenians to revolt: in this democracy, all citizens shared in political power, regardless of status. The advent of democracy led to a golden age for the Athenians.

Greek democracy was not perfect, given that only free native adult males, who were considered citizens of the city, took a part in managing the state. These activities were handled by a direct democracy, based on a popular assembly, which at times was attended by more than 6000 citizens; it could declare war, approve expenses, send diplomatic missions and make treaties. The council of 500 and the courts complemented the assembly.

There were no parties, no opposition and essentially no government, a simple majority of those physically in attendance made the decisions. There was intense interest in the political process, to the point that the name 'idiot' was bestowed to those that did not participate. The system was not always simple or just, and it evolved into an empire of subject states. Moreover, women, foreigners and slaves had almost no rights under this democracy.

Other Greek cities, like Corinth, Megara and Syracuse, eventually also had democratic regimes. In a sense, the Roman Republic was also a democratic government headed by two consuls, elected annually by the citizens and advised by a senate; its constitution upheld the principles of separation of powers and checks and balances.

Rome became an empire, which around the year 300 split in half thus creating the Western and the Eastern Roman Empires. The Western Roman Empire collapsed in 476 when Odoacer, a Germanic warlord,

defeated the Emperor Romulus Augustus. The Eastern Roman Empire, by then called the Byzantine Empire, fell in 1453 when Mehmed II, king of the Ottoman Turks, captured Constantinople.

Middle Ages

After the fall of Rome, Europe went through a period of depopulation, deurbanization, and barbarian invasions, with substantial social and political changes. It was divided into many new kingdoms incorporating many Roman institutions. In Western Europe the Catholic Church took over Christianity and expanded. Monks and monasteries were a focal point of religion and politics in Early Middle Ages.

As Western Europe witnessed the formation of new kingdoms, the eastern section of the Empire remained intact and even enjoyed an economic revival that lasted into the early 7th Century.

In the 10th Century, Europe's population started to grow due to improved agricultural techniques, the decline of slaveholding, a warmer climate, the lack of invasions and the onset of feudalism that allowed peasants to settle in villages under the protection of a noble.

Then in the 12th and 13th Centuries, towns grew. Self-governed towns and cities stimulated the economy and enabled the creation of trade associations. Cities trading with each other eventually led to mergers like the Hanseatic League and the Italian city-states Venice, Genoa and Pisa.

At the closing stages of the Middle Ages, the kingdoms of France, England and Spain consolidated their power and new kingdoms like those in Hungary and Poland were converted to Catholicism. Furthermore, the Pope claimed authority over the entire Christian world.

In the Middle Ages progress took a step back in Europe but not in other parts of the world, like the Bizantine Empire, China or the Islamic Empires. During the Middle Ages Catholicism suppressed any ideas that were not in the Old and New Testament. However, during this same period, science and technology flourished in Islam's Golden Era. For example, an Islamic scientist named Alhazen (Ibn al-Haytham), born in the year 965 in Basra, Iraq, studied the fields of optics, anatomy, astronomy, engineering and many others and made numerous contributions to science, among them the discovery of the scientific method.

Renaissance

This renowned era began in Italy at the end of the Middle Ages, slowly expanding to the rest of Europe from the 14th to the 17th Centuries.

Intellectuals of the time strived to revive ideas from Latin, Greek and Islamic texts of philosophy and mathematics, while artists introduced realistic techniques into the art and literature. Renaissance writers began using local languages; this coincided with the discovery of the printing press by Johannes Gutenberg in 1436, which facilitated access to books.

Independent Italian cities invented monastic states employing some principles of capitalism to pioneer a commercial revolution that funded the Renaissance. The movement was aided by the discovery of America by Christopher Columbus in 1492, which questioned established truths and produced untold riches. The movement also benefited from the Fall of Constantinople, which brought Greek scholars, along with their valuable manuscripts to Italy.

The Renaissance changed the nature of the universe and the explanations about the characteristics of the world. Copernicus, Galileo, and Francis Bacon promoted the scientific method, based in an entirely mechanical philosophy, stressing empirical evidence and the use of mathematical methods. This led to great discoveries in the fields of astronomy, physics, biology, and anatomy.

Industrial Revolution

In the later part of the 18th Century, a transition began in some parts of Great Britain. The use of manual labor and draft-animals evolved to machine-based manufacturing.

This was the Industrial Revolution, which took place in the 18th to the 20th Centuries. Driven by technology, major changes in agriculture, manufacturing, mining, and transportation; it had a profound effect on socioeconomic and cultural conditions. It started in the United Kingdom and spread throughout Europe, North America, and eventually the world.

Around 1850 it merged with the Second Industrial Revolution as technological and economic progress gained momentum with the development of steam-powered ships and railways. Then, later in the 19th century, came the discoveries of the internal combustion engine and electrical power generation.

The Industrial Revolution, which lasted up to the end of the 20th Century, raised productivity and led to new inventions that allowed the institution of a new social order. In this new order, governments and

owners are the new masters, followed by workers that now include a new middle class of managers and professionals, and then the poor.

Being poor is bad. You have to work hard, if you can find a job. Even the middle classes find it difficult sometimes and face what has been called 'wage slavery.' Leading to the saying that 'if you don't work you don't eat.'

20th Century

During this century technology entered the workplace in a massive way. The list of technological improvements in the workplace in the last century is almost endless: computers, communication devices, measuring devices, computer controlled equipment, the x-ray, wind tunnel, arc welder, circuit breaker, transistor, Geiger counter, laser, neon lamp, teletype, fiber optics, stainless steel, carbon-fiber and the Internet. The list goes on-and-on.

At the turn of the century only 5% of factories in the US used electricity to power their machines. By the end of the century, electrical powered machines were omnipresent, as are heating, air conditioning and air filtration. Technological improvements often resulted in improved safety in the workplace, as machines replaced the worker in many of the more dangerous and repetitive tasks.

New machines introduced in the home in the 20th century included: radio, television, refrigerator, dishwasher, clothes washer, dryer, iron, vacuum cleaner, microwave oven, automatic toaster, electric razor, and electric hairdryer. In addition, there was prepackaged food, frozen food, and a host of other convenience items. And do not forget cars and airplanes.

The same story was repeated all over the world. Even third world countries benefited from many of these improvements to their quality of life and of course many women joined the workforce and became paid workers.

Considering the notion of exponential growth in inventions and technology it is entirely possible that by the end of the 21st Century there will be a variety of improvements that will seem overwhelming to us. The 20th Century brought an enormous change in the way we live. Advances during this century will change us even more.

21st Century

There is no question that to a person living in 1900, and suddenly transported to a mall in the year 2000, it would seem the epitome of opulence and amazement! We can strongly infer that, given no tremendous global catastrophe, a mall or its equivalent in the year 2100 would amaze us too. To us, the people in the year 2100 would seem to be living in opulence!

Nowadays malls are generally enjoyable, but only a small percentage of the world's population can afford to 'go to the mall.' There is still 20% of the population of the world living in 'extreme poverty.' In addition, that does not mean that all of the other 80% have ever gone to a mall. In 2010, extreme poverty is defined by the World Bank as living with less than $1.25 dollars a day. Of course, you need a lot more than that to buy anything at the mall. In addition, malls are very far for some people and most probably just getting to a mall would be unaffordable.

The real achievement of the year 2100 would be not in the existence of, or added luxury in the malls themselves, but that everybody in the world could have access to them and afford to buy stuff there.

Now they will also, most probably: work less time, have better health, look younger, healthier and happier. Will all of them share the wealth? Or will it be an extremely radical society with a few as rich as gods and the rest poorer than the poor in the year 2000? If so, what happened, and how did it happen?

To understand the subject of the economic system that will be prevalent in the 21st Century we have to determine who will have the wealth in that system. As whoever has the wealth controls the economy.

For now, and most probably for at least the first half of the century, capitalists have the wealth. We know that the basic premise of capitalism is to accumulate as much wealth as possible for stockholders who have provided capital to create a business. Still, there are several issues about capitalism that could be at odds with the direction of the social order in the near future:

- Capitalism was invented to cope with the need to raise capital to put together factories and then business during the Industrial Revolution.
- It considers that the role of capital in the economy, and even in society, is absolute.
- Its structure implicitly considers that the costs to produce the products must be as low as possible, including labor, materials,

taxes and logistics. Labor is just a resource and does not play a part in the administration.

- Upper level managers consider themselves a part of the capitalists' elite. They do not consider themselves labor, thus contributing to the schism.
- Given that capitalism's function is to obtain more wealth, Boards of Directors fight to obtain as many perks and freebies as they can from the system. They pay the politicians to get laws and regulations enacted that will benefit them. In response, governments provide businesses with tax exemptions, free land, and free reign with their customers, and even huge subsidies.
- The development of the system happened at a time of very scarce resources, where production was limited and could only provide goods and services for the rich. Thus, labor and the poor were left out of the picture.
- During the 20th Century, some workers and the middle class became rich enough to buy goods. Even the employed poor started buying factory products.
- Robotic machines increase the efficiency in manufacturing and in the delivery of services, increasing productivity, lowering costs and reducing the need for human labor.
- Capitalism is not prepared to deal with an economy of abundance where there are fewer and fewer workers. And as it strives to pay as little as possible to reduce costs, the workers become poorer and the owners become richer.

What can be done with all that extra output? Hoard the goods in a vault as some companies allegedly do with diamonds? Who will buy all these goods and services if there are fewer workers? The unemployed are not good customers as they have no money to spend.

In the US in the year 2000, the wealthy consisted of 25% of US households and they owned 87% of the wealth. The middle 50% of households in the country held 13% of the wealth. The bottom 25% held no net wealth at all. This is not a particularly good distribution of wealth. How it is beneficial, for society, for humanity, to have so much in the hands of so few?

Do the rich really need all that money, and why do they still want more? Why do governments have to protect them and reduce their taxes? Why is it that 25% of the population has nothing? In addition, why do the 50% in the middle have to live in constant fear of being fired and joining

the zero wealth crowds? Are we not all human? Does our human condition not entitle us to live with a certain level of dignity and security? With or without a job!

Moreover, the statistics shown in the previous paragraph are from the US, which is the largest economy in the world. Wealth distribution, when measured all around the globe is much worse. The world is becoming smaller; communications, globalization and air travel have increased the awareness of people all over the world. Everybody can find out that an earthquake hit the Pacific an hour ago, that there is a crisis due to bad mortgages in America and what President Obama said a few minutes ago. Most people have the means to know almost everything important or scandalous in real-time. In the years to come this global awareness will expand even more. No country can live in isolation and concealment anymore. The economy is global!

All the promise of abundance, new marvels coming from scientific and engineering improvements, better health and a longer life span are useless unless there is a much better distribution of wealth and buying power. As most technological advances produce wealth, there will be more wealth. In 1900, the Gross National Product of the world was many times smaller than the one in the year 2000 and the increase came mostly from so many goods and services which were unknown or unavailable in 1900, and were bought by people that could afford them.

If consumers do not have money, they cannot buy what businesses are selling. If businesses do not sell, they do not make money, so they cannot produce the goods that consumers need or wish for. Right now, there is production overcapacity; there could be much more overcapacity in the future. This trend will keep on making the poor poorer, the middle class poor and the rich even richer, but places all of us in a precarious situation, waiting for another social upheaval!

In a society where scarcity really does not exist, or is not the essential part of the issue, the only way out is to give money to the poor and middle classes. Consumers drive seventy percent of the economy. Enable them to be consumers. If this happens, the poor join the middle class and the rich will be richer!

New Directions

What will result from the Artificial Intelligence and robotics revolution? Will democracies give way to intelligent administration using AI? Will the rich still be rich or comfortable according to their choice and talent? Will

the middle class evolve to rich or comfortable also according to their choice and talent? Will the poor also become comfortable or rich if they have the drive and talent?

Will it be possible that the difference between being rich, or just enjoying a comfortable life style, will be negligible and not stigmatized? History tells us that new technologies permit and encourage new forms of positive interaction; that social structures evolve to realize their potential in a way that is most of the time evolutionary but sometimes involves radical changes.

Current times portend a paradigm shift. It is an unsettling feeling of disarray. Economic, political, and technological change seem to be coming too fast. Society seems to be on a meandering course. Will this be the time for another revolutionary step forward?

Expectations

Four billion years ago a molecule made a copy of itself. Four million years ago, brain size grew in our hominid ancestors. Fifty thousand years ago, the first Homo Sapiens were born. Ten thousand years ago, we invented civilization. Seventy years ago, the first computer was put together. Can we expect 'the Singularity' to happen fifty years from now?

In 1982, Vernor Vinge, Professor of Mathematics, computer scientist and science fiction author, proposed that: 'the creation of smarter-than-human intelligence represented a breakdown in humans' ability to model their future.' Vinge named this event 'the Singularity.' In the near future, a true Artificial Intelligence or an enhanced human intelligence could surpass the level of human intelligence, which until now is the maximum level on this planet.

Even if 'the Singularity' does not happen as predicted, there is a very strong probability that by the year 2050 the effects of development of bio, nano and robo technologies are going to impact everyday life and will change social and economic conditions.

> *'The advent of strong AI (exceeding human intelligence) is the most important transformation this century will see, and it will happen within 25 years.'* ***Ray Kurzweil, 2006.***

Why Consciousness?

'I think, therefore I am.' ***René Descartes.***

If there is an issue that merits discussion and creates disagreement, it is consciousness. Religious people believe that it is a gift from god. Philosophers have approached the theme from numerous standpoints, linking it to: behavior, the physical world and the soul, the perception of the world, causal relationships, intentional acts, spiritual truths, personal identity, and external actions.

For a long time scientists were banned from studying consciousness, because as religions explain consciousness as a god given spirit, soul or some other extracorporeal entity, therefore it is a holy matter. Now scientists have a plethora of explanations and fields of study of consciousness, such as case studies of conscious states and the study of brain injuries that disrupt normal behavior.

Imaging machines have been able to distinguish different types of controlled input that activate some areas of the brain. Still, to this day there is no definite definition of consciousness.

Nevertheless, we intrinsically understand the notion and we think of ourselves, and even of some animals, as being conscious.

Who is Conscious?

Many agree that some animals, among them dolphins and primates, have consciousness. If so, then consciousness has certainly evolved along with life, which according to the rules of evolution would require that it have survival value.

To us humans it is obvious that consciousness plays a crucial role in decision-making, problem-solving, learning and creativity; and as such, it is a

great asset. Consciousness allows for planning rather than instinctual responses.

Obviously, viruses and bacteria are not conscious, yet they survive. Neural activity of the autonomous functions of the body, such as heart beat, breathing and others, have very little to do with consciousness and rule-based processes can explain instinctual behavior.

Given these facts, it seems obvious that consciousness is not indispensable for survival, but if you have it then it is arguably an asset.

Human Consciousness

Over millions of years, the brain has evolved hundreds of biological computers each one with specialized architecture that are wired together in a network of sub-systems that use different dialects to communicate.

We identify ourselves as conscious. However, within the brain's massive computer systems, our consciousness uses only a small portion of our mind to simulate the real world, using greatly simplified representations.

These simulated worlds are empowered with meaning and purpose. Our brains evolved to meet basic requirements such as comfort, nutrition, defense and reproduction. Later, analysis of cause-and-effect evolved, which lead to knowledge. We perceive reality in the sense of how can it be used because the upper level of our mind is a goal-directed problem-solver. The main purpose of our knowledge is to achieve results.

In a way, our consciousness acts as our 'driver.' In the same way that we can drive a car without knowing how it works internally, we 'drive' ourselves without knowing how we function inside.

Our consciousness is the knowledge and skills that allow us to use our other systems; it does not have to understand how our internal systems actually work.

Intelligence

If an animal is conscious, is it automatically intelligent? It seems to be the case, at least according to the following definitions of intelligence:

- Entity's ability to achieve goals.
- Evolutionary advantage that enables modeling, predicting and manipulating reality.
- The 'stream of consciousness.'
- An entity that a human being recognizes as intelligent.

We acknowledge human intelligence as optimal mainly because it is the greatest intelligence that is in the neighborhood. However, there is no reason to believe that it stands for the developmental limit of intelligence.

Evolutionary history provides no reason to believe that human intelligence represents the top-level of development of thinking entities.

Human intelligence is contained in a brain that weighs a little more than a kilogram, uses twenty watts of power, has a hundred billion neurons with a hundred trillion synapses that work at two hundred cycles per second in a highly parallel modality.

Homo sapiens are the result of totally unintelligent evolutionary pressures acting on genes. At one point, primate evolution stumbled on a path that created Homo sapiens, which happen to be very intelligent.

AI Intelligence

The idea that 'Intelligence measures an agent's ability to achieve goals in a wide range of environments' originated from Legg and Hutter as a description of the 'optimization power' concept of intelligence. It measures an agent's power to optimize the world according to its preferences.

Yudkowsky enhances this definition by dividing the optimization power by the resources used.

At first AI intelligence will be measured comparing it to human intelligence. Eventually, just as we have measures for our intelligence, AI will figure out a way of measuring theirs.

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Humberto Contreras is a Civil Engineer with a Masters in Structural Engineering and a Doctorate in Earthquake Engineering. As an expert in probabilistic and stochastic systems, he implemented solutions involving risk analysis and safety of Nuclear Power Plants and Nuclear Waste. He has also been a computer software consultant for major corporations. He currently writes books and lives in New England and the Riviera Maya.

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