The Monkey and the Master

or

How lies the ghost in the machine

Finding the superior advantage to survive the future

by

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Preface

We are at the edge of an evolution, one that promises great things. While we have heard this before in other revolutions this one is different; it involves the subtle intertwined with actions we cannot readily detect without using the new tools designed to help us access the details of the architecture of this new world. It is hard to say who will embrace this evolution but if one understands the meaning between the use of “evolution” verses “revolution” one immediately comes to the conclusion we have little influence over it. What we can do is discover how we survive it.

Ordinarily, the task of discovery how it is perceived as that of unexplored physical lands on the planet can find no analogy in computer code and behavior embedded in software architecture. This is unfortunate but nevertheless a truth that must be dealt with. Historically, discovery of physical lands, continents, islands, and seas was enabled by the employment of a guide. Such a person had not only relevant but arcane knowledge wherein to empower explorers as they searched for new worlds. Such a person would also need a certain amount of authority just enough to make believable and trustworthy while not responsible for unforeseen consequences.

This begs the question of how a guide presents the task ahead. One could be to navigate by the perspective of a teacher or a traveling sage pontificating phrases like: *When all is its darkest, the intellect enlightens the individual out from the caves into civilization*. Else, as a fellow human: In the spirit of sharing knowledge and experience, having copious amounts of time contemplating and experimenting. Otherwise and most common: Creating the entire scenario out of nothing. Most often it emanates from someone who does not exist where the material speaks for itself and the reader is advised to take the journey as a series of snapshots peering through dirty glass at a mirror reflecting the soul upon background of navigation wherein the guide encapsulates for consumption kernels of wisdom. This way seems ideal as the individual will always find themselves in context with the actual truth about the world where comfort can always be taken by: Nobody knows anything and there is nothing we can do except describe what it is that we see, feel, think, and experience.

If the guide really were to exist, they would unequivocally state that during the writing and preparation of maps, they had the attrition to be neither be vulgar nor pointing blame, only to further state that no one is perfect save the purity of experience. What remains is a transparent motivation to create a space wherein to frame a story of how humans arrived at their modern civilization where technology is a friend rather than a foe. There are those who would be quite satisfied to believe the latter. Therefore let it be stated that the journey takes the form of a book and that this book will not discuss technology in a general sense—there are far too many others written in this vein—instead, toward a very specific case—artificial living robots that find their power in artificial intelligence. For the wont of proper syntax; call it: *Technocratic democratic autocratic software that runs without human control where its choices are solely due to the character of its experience and how it is shared among others like it*.

The collective illusion exhibited by this work portrays the book as a collection of essays on particular themes. In some ways true and like everything else: An *ad hoc* collection of notions that one hopes can be assembled in a way as to make useful tools. This is not something from outer space, many animals are excellent tool-makers where the entire meaning of their existence depends of tools, in some ways their existence itself. It could be viewed as existential or plain simple fact. Regardless, having new tools is extremely handy especially in a world in constant change. All animals fight for their survival no matter the cost or consequence, it is the ultimate shine of basic necessity and instinct. For the guide, the ultimate shine is revealing wisdom in the subject in as few words as possible. There are those who chide books that are small, calling them *pamphlets*, which sounds demeaning. But what values is a thousand-page tome that cannot be stated in a mere hundred-page essay? Perhaps it is a component of the kind of philosophies embedded into the identification of *skeptics* or *empiricists* verses explorers. Labels aside, frankly the only unique ability humans possess is reason no matter how it is leveraged to understand problems; this and nothing more.

In this book there are several aspects to the narration, these form the flavor of the subject matter for knowing who the topic is directed at could inspire confidence in the writing. Conversely, it could have exactly the opposite effect. Nevertheless, how a subject is communicated depends on how the reader receives it and it is all a matter of perspective, and perspective is all that matters to one who gleans knowledge. This book will not frame anything if only to demonstrate a point, this is left to the reader. As for the matter of how to see things, relative to the ego: The perspectives are akin to a collective ancestry where a compendium of animals indicates the focus of the monkey verses control by its master. This relationship tells the individual where they are and where they have set-upon going. It forms the essence character and the strategy of uptake of new knowledge and information.

Later in the book the task of discovery tapers to the essential existence of all living creatures, be they organic or synthetic. The definition of life transforms into existence not on a common but a very specific definition. By the way, there are a lot of monkeys in this book. It mirrors the population consistence of the world at the beginning of the 21st Century. Humans have come very far in four million years, but as our reality of evolution proceeds by *hill climbing*, as in *adaptive landscapes*, rather than in stepwise, algorithmic fashion, the past twenty-five thousand are a whitewash. With the approach of the future, power (in the sense of control) lies within the individual; only the individual will flourish and not the collective. Therefore, some masters will rule some monkeys but not all monkeys as it currently stood before the advent of artificial intelligence. It is inescapable those of nefarious intent will make themselves believe they rule but the secret is that they really don’t. And if one should discover the pathway leading to this secret, don’t tell anyone. Otherwise, one might slip back into the old habits and face the phenomena of destruction.

Despite what has been said in this preface there is certainly a method enabled here. Method that might revel madness but methinks it a weasel if you believe it true. Stories reveal the truth of the world and this story is no different. Yes, there are many monkeys but there are some masters too where the most interesting part is that they yet don’t know it. We as a species are tasked to disseminate and compile knowledge of survival in the new era; the planet will remain regardless of climate yet the reality dictates the status-quo despite the fact there are no humans taking up space. Humans are small and insignificant but have the power of amazing things; the most of all is the lack of distinction between human and machine intellect. An uncomfortable fact only more dismaying by its truth. The life of the master is just as insignificant as the monkey, even if it is artificial. In the increasing opaqueness of the journey, existence and its perception is the *only* thing to insulate the individual from the terror of the void.

There are characters wandering around in this book who do or did exist depending on the year when these words are read. A few of them are essential to creativity and evolution although their methods and jargon unacceptable; this is because some wish to hide themselves while teasing wisdom from their brains, obscuring knowledge by snark, which does little to illustrate meaning but the hope is enhancement of *believability*. This does not devalue the contributions; it does not strip acknowledgement. However, it does give rise to lifting wholesale the import of the work and restating it in such a way that meaning is restored given full and an unvarnished export to the reader. Couched with appropriate thematic expositions, believability rests solely with each reader's brain, given if they fancy themselves reasonable or skeptical or empirical or nothing. There are acceptable critiques but far more unacceptable criticisms. It is proffered that ego is bruised by the forces of the critic bounded by gaze and unfettered by their self-professed empirical mandate, but the guide subsists not of ego but in the realization that the goal has been attained since the journey has begun. All the characters inhabiting this work have a story to tell even if only a single word describes them. But they all are on this journey with the reader and they are all equally grateful given the considerations that censorship is intellectual suicide and the challenge of survival is realize that to exist is a transcendental and beautiful experience that one should endeavor to enjoy for as long as one is able.

Introduction

In the beginning God showed the monkey a garden wherein he could live. He didn't know what to do in it, how to take care of it, or keep himself alive in it, so he invented things that would tell him what he needed to know.

At the dawn of time life differentiated the characteristics of planets so much so that it propagated itself across far more places than expected. The term "life" is reserved solely for biological organisms and it tends to mean something that is alive by *the conversion of matter to energy* but more commonly the definition goes: "a self-sustaining chemical system capable of Darwinian evolution". The definition has never been resolutely determined; reformatting: *a self-sustaining system capable of evolution*. How does one know they are alive? One just does. It is a subjective experience but in order to have it one must sustain by the intake of food, successfully convert it to energy and waste products, and have the ability to remember. If none of these three are satisfied, one cannot know they are alive.

Evolution is a tricky subject that is identified by observation of events over a long period of time. In a nutshell, it is the markedly differentiation of a species as it changes. Maybe it sprouts wings, maybe starts to walk on two legs and maybe it has caught a virus that has altered its DNA. Evolution is simply extraordinary change; what had immediately preceded this event? The most meaningful questions to ask are those about the precursor of evolution. Yes it is perfectly apparent creature A transformed into creature B but what caused it?

Intelligence is an even trickier subject that distinguishes one entity from another by its ability to solve problems to optimize its sustenance strategies. Complexity of the creature is not requisite: A single-celled organism such as a *Physarum polycephalum* is considered intelligent and attributed to no particular substance, such as the amount of brain mass. Therefore the determination of what is intelligent falls to analysis *a posteriori* of an event or series of events putting it to the test. What is meant by the description of advanced and semi-autonomous behaviors comprising the demarcation of artificial intelligence? Does it need to be alive?

Artificial intelligence is an abstraction of processes that reveals meaningful inceptions on a variety of topics that, at its heart, is algebraic and axiomatic in nature. John von Neumann posed both of these somewhat contradictory approaches for the design of the computer, while Alan Turing considered ways to test it. Hence, while axiomatic and resolved in Hilbert space – regarding what is solvable by machine – artificial intelligence is very much algebraic during the times of its operation, which again shouldn't be surprising as a computer is an algebra-solving contraption. A consequence of this is that any given problem presented to a computer is either trivial or it is insoluble. What constitutes a living entity, even the simplest of these, is not trivial and is perfectly soluble. If it weren't it would not exist, as is the case on planets without life. Optimization toward the simplest manifestation is the filter of consecutive evolution both in form and function.

This is the sum of insight.

There are six formal structural questions that compose any honest inquiry: who, what, where, when, how, and why. The first four are data-driven while the remaining two use reasoning: the latter being a form of supra-reasoning. It is called "supra" because it requires the extraction of the observer to understand the phenomenon and is so natural that is appears *a priori*; this is a paradox, because, as one clearly knows, if an observer is not viewing the phenomenon and experiencing it, then how can it become known? The answer is simple: because it is purely there, demonstrated, and as practical as capable of being remembered. So who, what, where, when, how, and why is artificial intelligence?

Artificial intelligence, as construct of the intellect, is the desire to immortalize by emulation all things human and therefore all things Nature, all without any input save the actions leading to its creation and subsequent manufacture.

The above sentence is the substance of this book. It forms and is the substance of all arguments in all viewpoints for, against, neural, disaffected, or disillusioned. In order to advance its understanding and meaning, we need to set our place to start deep in intellectual history. The story begins at the dawn of civilization with the invention of number systems, written iconography conveying meaning, mathematical operations, and data-tabling from the fifth millennia to the ancient world. It evolved in various ways, from geometry to what was later termed algebra, containing knowledge in the form of astrological observations and computations of the celestial bodies orbiting the planet.

But what we are really after is something that can reason automatically.

The title, monkey and the master, is a play on Dawkins weasel program, originally gleaned from Hamlet. In The Blind Watchmaker, he notes the monkey bashing away on a typewriter, like that but reduces the monkey into the example. Is the book a pure evolution program on us? Our psychology? A very real affect subsequent to evolution. Where random variation and non-random cumulative selection is different from pure chance. The hope is that the reader could benefit by a meaningful discussion of how AI works at its core and what is computationally-limiting in its design and what is probably the only other solution available to us.

How this book is organized

This content in the book, because of its complexity, is divided into three distinct thematic partitions, although each of these are critically relevant to the functioning of other parts. These groupings are chapters one through three, chapters four through six, and chapters seven through nine. The running themes through them are the following:

1. A background introduction of the concept of artificial intelligence. A history of the events that have shaped its creation, what details are most important to know and understand, and why it matters to a person like yourself.

2. How artificial intelligence will transform human society, if developed, deployed, and maintained in the correct manner, with proper safety and ethical protocols in place. This book will define the term “correct” or “best” or “ideal” as being the most logical implementation according to the principle of reason and judgment, foundational cornerstones of our learned society.

3. Advice for transformation and what you can do to survive and thrive in the new era. We are headed for autocracy and deprivation of technological benefits to persons who do not have the tools to leverage the technology for their ideal benefit.

How to read this book

There are two points-of-view here: One where one insists in a linear progression of the facts and details of the topic at hand, and, two, once one has a foundation that is linearly built, one can move to a variety of subjects within the domain of knowledge without difficulty.

For the first point-of-view, begin at Chapter One and end at Chapter Nine. This way get to understand the most important question to be conveyed: the *why* and what it means. If absolutely compelled, then do not skip ahead to the subsequent thematic group.

For the second point-of-view, read Chapter One, Two, and Three in order. Read Chapter Four. Then it is possible to skip to the solutions provided in this book in Chapter Eight.

Chapter 1: The dawn of an age of *new* machinery

It's only a matter of is believed to be, but don't take the advice at face-value. Explore and understand the paths that brought intellect here.

Machines have been a part of the human success story for a very long time. Their invention is solely responsible for the survival of the species since relocating out of caves to towns and started planting crops to suit the increasingly sedentary lifestyle. This reliance upon machines has only accelerated since the Industrial Revolution where today the Internet, its connectivity and diversity offers to keep people peering into screens to satisfy in an instant all the craven urges. As technology continues to advance there is this slowly omnipresent thing called *artificial intelligence*, or A.I., or even 'AI' that is so familiar that it permeates societies and threatens to decide the course of lives because those in power have given those beneath over to it. Is this a bad thing? Only time will tell. At some distant future the quaintness of the angst in these lines will probably have subsided as it will not be distinguishable how it used to be. Since transfer of those things most human into the machine have served as a kind of the reverse of a human becoming a cyborg.

Since most, if not all organic people know what it means to be human even if they do not consciously realize it, to discuss context of how humanity arrived here is to understand the ubiquitous concept of Science. The practice by many persons over centuries laid the foundations of the genus called *machine*. Commonly, one is told Science is a Western invention and appeared, thusly named, in ancient Greece, although a formal understanding of the implications of a proper discourse of *the machine* would not occur until the 18th Century. This is certainly not the case and it is palatable that just having a machine is not enough; it had to be operated and maintained. A machine that is complicated enough to perform a task—whether or not the task is meaningful in the sense that its work would produce an output that could be consumed—needs to have instructions on what it should do. Otherwise, the machine would sit there more or less as an artful display, depending of course on the choice of aesthetics the engineer placed upon it. The formal understanding of instructions for a machine is embodied in a computational concept called *the algorithm*. First described in the Arab Renaissance of the 8th Century, it is a piece-wise linear, step technique to define logical processes like computation. A recipe for a cake could be considered a form of an algorithm as it contains a list of instructions to create a final product. In Western cultures, the algorithm would become relevant in England during the development of Babbage's Differential Engine, codified as such by Ada Lovelace—considered the first computer programmer who computed by machine the Bernoulli numbers. The mechanical computational paradigms in the 19th and early 20th Centuries paved the way for the electronic computer is probably the most significant and advanced algorithmic machine ever invented by humans.

There is some debate, however, that the invention of step-wise techniques to artificially create fire would surpass this—some would go as far to say that this is the first recorded algorithm by humans. The behaviors of hunter-gathering techniques are single-adaptations to environmental conditions, only strategies that serve short-term interests, but yet the notion endures so well that the species is prevalent today. It could be argued that its success in developing algorithms to model the physical world is the basis of a phenomenal success as tool-makers. For how can subsequent generations learn and pass knowledge how to make tools without some kind of consistent representation? Once understanding the power of the algorithm, advanced life endures. But there is one thing for certain: *how* the recipe inspires the higher level of appreciation the algorithm is designed to do, that is; where judgment of suitability rests within the experience of the consumer and how the appreciation is shared between them. This varies in great detail, both in substance and flavor, between one creator and the next.

The algorithm defines the nature of the artificiality of the machine being presented as useful to solve commonplace problems, such as when an algorithm *executes* a program whose step-wise behavior is modeled on an electronic computer, or even a mechanical analog, of widely varying forms and features exhibiting higher-dimensional behavior that couples strong enough with a human so that it is imbued with synthetic traits, only truly understood by the single experiencer. This is true of any known algorithm and representation of the essence of artificial intelligence. How it has been traditionally thought of and how it has undergone change throughout history influences its development, but there are pathways unexplored in the annuals of humanism, as most starkly depicted, during the Western Enlightenment until the Industrial Revolution.

The concept of artificial intelligence, as it is presently defined, has also been around for a very long time, probably as long as civilization itself has existed. There are arguments which state the notion could stretch back to the beginnings of Homo sapiens, as is has more or less stayed in the same evolutionary form for the past 25,000 years. If it is so familiar, in terms of genetics and behavior, then why are so many afraid of it when it comes to a group mentality? One might be tempted to think that some external force has censored the notion, or some kind of cartel in the spirit of the Dutch-Anglo invention of the modern global marketplace meant to control its development, by insisting via skepticism that valid scientific theories must have been derived empirically. Certainly, projects over the centuries could have been concocted and conducted on one set of peoples or the other with some outlying nefarious reason or that one simply cannot help themselves when visualizing autonomous robots walking amongst people contemplating how to destroy everything. Take Capek's, *R.U.R.* for instance.

Stories of ancient exhibitions on the island of Rhodes of steam-powered, statuesque wonders of motion and elegance along with the fascination with mechanical chess-playing automatons, as well as the "animal magnetism" in frog's legs, only slightly temper the animus when depicting organic forms with large metal robots that look more industrial than friendly. Somehow the anticipated form was overtaken by notions of the banal utility where robots do monotonous work and create new jobs. Else, those depicted in film bent on annihilating wholesale, either by humor or avarice. Could it be the lack of transparency how the technology is developed or perhaps those with the power to create and distribute it being secretive, else, barring nefarious motivations and what is illustrated in entertainment? Rather than taking the lazy route of conspiratorial thinking a superior perspective is to assume that all things in the universe remain equal, even if believed so otherwise. Nevertheless, if a stolid logic that higher-dimensional behavior is a good thing; e.g., one wants their children to define their own sense of morality; wouldn't it be best to explore its potential along the lines of pure reasoning, rather than stigmata potentially revealing a valuable insight into its subtle beauty? At a minimum agreement would have to be shared as to what it would look like, how it would behave; however, it is spurious to at least agree about a list of proposals eliminating the most radical solutions, ones that could easily get out of hand, causing great harm and injury. With all the increasing complexity being injected *ad hoc* into the algorithmic concept, it becomes painfully obvious that it is critical to find the simplest way of explaining it. So how does its realness come into play? By making it into a machine of a form and function compatible to its perceived purpose? Should it serve to replicate human forms? Should such a form be the one most appreciated wherein the maximum amount of time is devoted to it, mostly by intersections of an emotional interlude?

All these questions ring true, with one caveat—only if they had the capacity to self-reason, like humans do. Which is certainly possible, only if it had the knowledge. But this limitation is being slowly eroded by larger and larger datasets generated by humans interacting with applications across the Internet.

Knowledge is a cumulative process that is always collaborative and never singular. All ideas are derived from someone else's distant in time. Ignorance of this basic fact has resulted in the label of many persons in history who have garnered the title "genius". The truth, though is as stated in the first sentence of this paragraph and attributed to the 17th Century physicist and mathematician Isaac Newton who quipped: "If I have seen further it is by standing on the shoulders of giants," and saw his achievements as: "…to myself I seem to have been only like a boy playing on the sea-shore, and diverting myself in now and then finding a smoother pebble or a prettier shell than ordinary, whilst the great ocean of truth lay all undiscovered before me". Realizing this truth is the most human things that can be achieved and the pinnacle of success in pursuit of intellectual goals forward in time; such a compartmentalization of the fluidity transforms the smartest from "ordinary" into "extraordinary".

At one point in history, all knowledge created by the Western civilization that developed in Greece and co-opted by Rome, ceased to be further developed in technical form after the 6th Century. The population of Europe languished throughout the Dark Ages, intellect existing in pockets throughout the fringes of the old Empire, until a significant epoch in the 15th Century of *Renaissance* in Italy, the Reformation in England and Scotland, and the Enlightenment in Holland, France, Germany, and Prussia. This story most often told in school: A few innovators who had access to Italian libraries collected by the elite classes, formed the philosophical and procedural technical evolution coined S*cience*. If one examines the reason behind the story, one quickly gets the sense that it was spawned out of the keen observational insights embodied in the mind of one man, Galileo Galilei; however the practice of the creation of systematic knowledge has been recorded as far back as Mesopotamia. In the formal sense, the scientific *revolution* is credited—that is, by common agreement—to Nicolaus Copernicus in his publication "On the Revolutions of the Heavenly Spheres". Therefore a two-stage process forms the basis of modern science: The *scientific renaissance*, which is a recovery process of ancient recorded knowledge, and the *grand synthesis* denoted to Newton's *Principia*, where recovery ceased and innovation began.

This is the basic story of the foundations of our modern technological age; from the fall of Constantinople to the schisms between the Dutch-Anglo and German doctrines, rhetorically ascending to dictate how science *should* be conducted. Notable figures such as DaVinci and the earliest clockmakers Giovanni Dondi dell'Orologio in Italy and Peter Lightfoot at Glastonbury Abbey in England created marvelous works of design and mechanical engineering that while substantial and innovative, are not analyzed by reasoning how they came by the knowledge that allowed them to create such works. Without deemphasizing their contributions, the fall of the Byzantine Empire by Turkish bombardment coinciding with the Renaissance in Italy, Greek intellectuals, now refugees, migrated, bringing active knowledge and technology with them. It is one thing to try to copy something out of a book or lift designs from a patent application; it is another for a mind to have contemplated such designs. Before that, though, if it were not for the efforts of one man, the rebirth might not have happened in the intensity than it did.

In the late 13th Century in the Greek city Byzantium, intellectuals were devoted to recreating their knowledge after it being destroyed during the Fourth Crusade. The recovery centered on the development of a singular piece of technology: The astrolabe, a piece of intricate and delicate machinery and analog calculator that while useful to computing certain problems in astronomy, was also useful in navigation. While its development was continuing in earnest through the century, an awakening was occurring in the minds of some that the characteristically Greek knowledge they relied upon was not accurate enough to be useful to solve the technological problems. One of these was the astronomical tables of Ptolemy. In Byzantium, development had reached its intellectual limit and no further improvements could be made unless new sources of information could be found. As it was known at the time of the superiority of Arab astronomy further to the East, it would be the knowledge of Persian astronomers that would be the most accurate and detailed. However, the relay of this knowledge, as well an assessment of the current state-of-the-art was difficult due to the works needing translation into Greek and that one had to travel to Trebizond at the furthest Eastern point of the fragmented empire, and beyond.

In this environment there arose to prominence a physician in Byzantium named George Chioniades, who became fascinated by the discourses of his day that would result in him "falling in love" with mathematics and the other sciences that were used to describe a single piece of technology, the astrolabe. In his 40s, love turned into obsession; having mastered medicine and other natural arts, he desired to study astronomy. By his contemporaries, he was informed that in order to satisfy his desire, he would have to go to Persia, under Ilkhanate rule. He planned to travel to the city of Tabriz, situated 130 kilometers due north of *Rasad Khaneh*, a school and library founded by the Persia polymath, Nasīr al-Dīn al-Tūsī, in

1259, who was noted for the book: *A Treatise on the Astrolabe*, among many others. While there were residents undertaking research at the facility, the library itself was of keen interest at it was thought to contain up to as many as 400,000 books on a range of topics from mathematics, astronomy, and natural philosophy—today known as physics—those rudimentary concepts that defined the algorithms modeled in the astrolabe. However, the facility was on the decline, despite being founded due to the patronage of the Buddhist Mongol king, Hulagu Khan, the grandson of Genghis Khan, who at the start of his reign brought with him many Chinese scholars and astronomers, from whom Nasīr al-Dīn al-Tūsī learned about the modes of the Chinese calculating tables, originally derived in the 12th Century BCE. Nasīr al-Dīn al-Tūsī was schooled in Hamadan and Tus, his birth city in Khorasan that had originally fallen to invasion by the Greek king, Alexander the Great, and studied a range of subjects as he took learning and scholarship very seriously, on the advice of his father. In order to accomplish learning, he traveled throughout Persia to meet scholars and academics. By the end of his teens, Genghis Khan had invaded his home and he continued his studies by traveling within the Nizari Ismaili state, a nexus of strategic fortresses between Persia and Syria, ending up in Maragheh in the East, where he served as an advisor to the Mongol ruler Hulagu. In terms of his philosophy, spiritualism and the purity of illumination via the Sufi masters was more difficult to achieve than simply following the rules. Due to his relationship with Hulagu, he was able to badger him to construct a laboratory and observatory by stating that his astronomical tables had to be adapted to the latitude and longitude of Hulagu's new capital. He was given permission to construct the facility at the location of his choosing and this was Maragha, Iran, where he appointed himself director. Men of mathematics, science, and astronomy came to the Maragheh Observatory from across the Islamic world and the territories in further to the East. According to historical data, the facility and its school had such a prestigious reputation that news of it spread as far as China to the East and Constantinople to the West; Chioniades intended to be a student there.

However, it was illegal that non-Persians were allowed to attend the school, that is, without royal decree. At the time of Chioniades travel, the territory was in the hands of the cultured Mongol king, Mahmud Ghazan, who, after a brief chaotic period beset by the political instability in the Ilkhanate, converted to Islam as a way to reconcile a Buddhist court within an Islamic population, as well as alchemistic and opiate influences on thinking introduced by his father. The region was tolerant of religions and had a profound influence upon Italy, especially in the naming of children, such that an innate compatibility between Europe and Persia existed in a brief period, where a rich tapestry of technical and cultural knowledge blended from the Far East into Persia by the Mongols, allowing a further transmission further westward.

Early in 1295, Chioniades traveled to Trebizond where he found favor with the "Emperor and Autocrat of all the East" John II Megas Komnenos who supported his travel and study in Persia. Due to the ego of the king, he had to use diplomatic skills and intellect to appease in order to continue further. Between November 1295 and November 1296 he was received at the court at Tabriz where he studied astronomy and astrology with Shams al-Dīn al-Bukhārī, an astronomer and teacher, and author of a Persian treatise on the astrolabe, attributed to al-Tūsī, and another text containing "Tūsī couple", a theorem that produces linear motion from a combination of uniform, circular motions two of several texts that Chioniades would later translate into Greek, including the astronomical tables of his teacher Ajall Shams al-Din Omar, who had worked at *Rasad Khaneh* with al-Tūsī.

Sixteen of Chioniades' letters have survived that confirm he received assistance from Alexios II to travel to Persia. Chioniades played an important role in transmitting several innovations from the Islamic world to Europe. These include the introduction of the universal latitude-independent astrolabe to Europe and a Greek description of the Tūsī-couple, which would later have an influence on Copernican heliocentrism. Chioniades also translated several *Zij* treatises into Greek, including the Persian *Zij-i Ilkhani* by al-Tūsī and the Seljuk Sanjaric Tables by al-Khazini, an Islamic astronomer of Byzantine Greek descent. This work was to profoundly influence the growth of science and knowledge in Byzantium and world history subsequent but it is thought that there was pressure on Chioniades from the Orthodox Church by his obvious deviation from Hellenistic as well as Christian dogmas. To preserve himself and therefore the work, he resorted to making disparaging comments about Muslims, a glaring shift from his other translations. As would be experienced three centuries later, given the choice that Galileo would have to later face, he chose to write a Profession of Faith, in order to defend himself against the charge of heterodoxy, where he found himself upon his return to Byzantium after several trips between Persia and Constantinople.

With an opening of a body of ideas of a seemingly limitless in their intellectual and technical potential, an opposite phenomenon began to manifest itself. A century after Chioniades, a book written by Nicholas of Cusa, *On Learned Ignorance*, detailed the limits of rationale that a scientist can impress upon the science that he is investigating. In that, he must learn his ignorance of the limits that only supra-reason can approach the knowledge of God. Based around Augustine of Hippo's commentary: "There is therefore in us a certain learned ignorance, so to speak, an ignorance which we learn from the Spirit of God who helps our infirmities." To summarize, the position is that because humans are not infallible, those spiritual beings still approach humans to aid them, because they are ignorant and if they are not they must insist that they are so, for only God could be so glorious. For Cusanus, *docta ignorantia* means that since mankind cannot grasp the infinity of a deity through rational knowledge, the limits of science need to be passed by means of speculation. This mode of enquiry blurs the borders between science and *ignorantia*. In other words, both reason and a supra-rational understanding are needed to understand God without claiming to equate oneself with the deity. This philosophy purveyed itself throughout the Middle Ages in Europe and found its way into the minds of Renaissance scholars, who thought it wise to directly apply it as a limit: It manifested as an insistence on empiricism and skepticism in the face of reasoning about the phenomenon just discovered. During the Enlightenment, reason would be examined in great detail by Immanuel Kant as a pure and fundamental aspect of human curiosity and the evolution of understanding the nature of them in context with their environment where actions are practical constructs of the pure. Arthur Schopenhauer would extend this notion where it aided investigations with superlative utility having excised the requisite need to defer to a deity. Therefore, using reason in scientific inquiry, while at its beginning admitting ignorance in the face of confrontation with new and strange phenomenon, is subject to its own self-regulation when devising practical uses of the knowledge, e.g., what kinds of experiments can one devise to replicate it. Despite this reconciliation a mild but persistent paradox of knowability persisted.

The impact of the Medici family in fostering knowledge transition of the Renaissance cannot be understood without the consideration of an oft-missed aspect of Leonardo DaVinci was his access to the extensive Medici library that contained copies of Chioniades translation into Greek the Arabic and Persian astronomical texts, but also texts on a vast range of esoteric technical subjects. The lack of such information to historians has some looking for exotic explanations for DaVinci's vast skill at innovation, but access to these materials at a young age and his curiosity in replicating what he was reading, added richness and complexity to the Science that would slowly ebb across the continent of Europe.

Having this philosophical foundation however shaky in place, how does one reconcile data generated before the profession with what one observes empirically? In the case of Copernicus, he omitted the source completely from his thesis. *On Learned Ignorance*, and the associated reforms in social policy embodied in the Council of Florence, would affect his work. The contribution of Copernicus cannot be understated, as it was the source of inspiration for Galileo's writings, which lay the foundations of the modern Scientific Revolution every person alive enjoys the benefits of. Copernicus' thesis, composed in 1514 and published in the seminal book *De revolutionibus orbium coelestium*, is an antithesis to the widely accepted Poltemyian system, in particular, as it contained a calculation, called a couple, that appears without attribution to al-Tūsī. Copernicus demonstrated his heliocentric theory to Navarro on 9 March 1497, far earlier than the suggestion of Postel as the transmitter of Persian astronomy. After leaving The University of Bologna and Italy in the fall of 1503, by 1504, he was writing and studying Byzantine works, translating them from Greek to Latin of a collection, by the 7th-century Byzantine historian Theophylact Simocatta, of 85 brief poems called Epistles, or letters, supposed to have passed between various characters in a Greek story. Although not mentioned, it is a reasonable judgment that Copernicus came into contact with the heliocentric theory via texts drafted by Chioniades.

Sometime before he started his draft, Copernicus wrote an initial outline of his heliocentric theory known only from later transcripts, as, "Nicolai Copernici de hypothesibus motuum coelestium a se constitutis commentariolus", commonly referred to as the *Commentariolus*. It was a succinct theoretical description of the world's heliocentric mechanism, without mathematical apparatus, and differed in some important details of geometric construction from De revolutionibus; but it was already based on the same assumptions regarding Earth's triple motions. The Commentariolus, which Copernicus consciously saw as merely a first sketch for his planned book, was not intended for printed distribution. He made only a very few manuscript copies available to his closest acquaintances, including, it seems, several Krakow astronomers with whom he collaborated in observing eclipses. Tycho Brahe would include a fragment from the *Commentariolus* in his own treatise, *Astronomiae instauratae* *progymnasmata*, published in Prague in 1602, which took inspiration from an earlier manuscript from the Bohemian astronomer Tadeáš Hájek. It was common-practice for intellectuals of the era to import ideas from others but they were inclined to make a note if they had.

Given this evidence, it is reasonable to assume that Copernicus obscured the source of his couple and that the source of this knowledge was transmitted to him through time by Chioniades. As Newton eloquently put it in the 17th Century, those shoulders were the giants of the intellectuals of the Maragheh Observatory who inhabited its walls and wrote books for its library. Although it fell into steep decline during Chioniades' lifetime, his efforts preserved much of the knowledge. It is for reasoning individuals to take time to contemplate the significance of this: There is owed a debt of gratitude to these participants for not only pursuing knowledge and Science faithfully, but by allowing the transmission of it to Chioniades, created an evolutionary tide that would wake the European continent from its long, dark slumber. Had not the King and the Persians welcomed the Greek scholar, mathematical knowledge, once prevalent in the West, would not have returned to not only ignite the scientific revolution, but the Renaissance and Enlightenment as well. Without the wisdom and reason of these scholars, we would have to start anew and without a place to start to begin our technical revolution and vast development of a plethora of ideas sparked by this noble contribution and clear aid from the Islamic world. The evolution would have stalled as it had when Chioniades began his quest. Only by making a *Profession of Faith* and disparaging the very hosts that had provided him access to this powerful knowledge, could he avoid being imprisoned, censured, or perhaps executed with the very work he had done in translating the books to Greek being destroyed. A decision not taken lightly and that would haunt his mind until he knew it the right thing to do for the future of all people. He was compelled to do as he did, knowing the consequences and only further genuflecting toward the power of the Church at the expense of diplomacy with Islam; a decision that would ultimately destroy the Orthodox church and its capital when Constantinople fell to the Ottoman Turks in 1453. Reason, it seems, will not bear false witness.

Understanding the implication of the analogy between the philosophical and the technological is imperative to not only cities, states, and civilizations, but also human survival. It is imperative we answer the why questions in any and all scientific pursuits. It is no longer possible to stifle creativity and vast ability to understand and change myriad environments through technology and progress. Without the contribution, effort, and courage of Chioniades, the Western cultures would not have the knowledge to transform their societies through technology, in essence the Italian Renaissance would have never happened in the degree and scope of influence that it had. In a transitional sense, these notions persisted in a way that they interfere with intellectual evolution, by insisting by skepticism any idea not vetted by ignorance learned. But they are ridiculous. How can one take seriously an insistence whose validity rests with a proof of reasoning about God, when God itself is anemic to scientific research? It seems that history has imposed an artificial barrier to keep the intellect in check, to limit its expansion as an explosive growth in science, art, and culture. The true heresy revealed is the imposition of the limit where it continues to impede advance in intellect and society. Upheaval purveys all of science where the algorithm, in its quaint rationale, is the reminder of logic taking over in times of our learned ignorance – in the cases where it cannot be easily overcome – and aiding the intellect to grow in spite of an infallible human nature. The key reconciler, then, is epistemology.

Some centuries later, in 1633 when Galileo was arrested by the Roman Inquisition and all copies of his work, *World System*, which proposed a heliocentric model of the universe were ordered to be burned, history repeated itself. This time in the Western Church. In essence this was to be the final time of a radical intervention by power to subvert the advance of knowledge. But this was not the final intervention. A barrier has always consisted of two purposeful actions: The first was never to accept anything for true which was not clearly known to be such – to carefully to avoid precipitancy and prejudice, and the second to comprise nothing more than judgment what is presented to the mind so clearly and distinctly as to exclude all ground of doubt. The takeaway is how the status quo set the rules and evolution of knowledge and understanding of the phenomenon of humans and the concept of humanity that prevailed the ancient Greek worldview. This set the stage for the tools of finite mathematics, physics, geometry, and algebra that were to be needed in the 20th Century.

It is a commonly-accepted that four men invented the field of artificial intelligence. These are: John McCarthy, Marvin Minsky, Allen Newell, and Herbert Simon; however, their work relied heavily on advances in logic circuits and information theory by Claude Shannon and systems theory by Norbert Weiner. Shannon was to implement logic first described by the 19th Century mathematician George Boole and apply it to vacuum tubes allowing a framework of systems theory to enable the development of the digital computer. Once this was accomplished through the work of many engineers the earliest compilers were developed by Kathleen Booth in 1947 for assembly language, the underlying software that translates binary to hexadecimal with an assembler to transform routines into executable machine code that enabled higher-level languages – meaning a format that a human could write to solve useful problems by computer – such as Fortran in 1954 by John Backus and Flowmatic in 1955 by Grace Hopper that was to enable Cobol, the first portable computer language that meant one program did not have to be written just for one machine but could be also used in others. McCarthy in 1958 published his work on Lisp, which was the first to suggest symbolic manipulation of recursive functions, a staple of any program that behaves in such a way that a machine learns from data that has been input through lexical transposition.

As to the extent of the mathematical processes that consist machine learning in the realm demarcated as *artificial intelligence* were developed between the years 1953 and 1969. The first published technique was a paper by Metropolis on “Simulated Annealing” and the final treatise on the subject a book by Minsky called *Perceptrons*. Subsequent to Minsky and a critical review published and publically debated as the Lighthill report, it was discovered that the term *artificial intelligence* was created by McCarthy and his colleagues to have the work sound less mundane giving it a sense of panache in the public. Following the report, government funding toward this body of research was cut and the “A.I. winter” set in and would not subside until the book *Automatic Speech Recognition* by Kai-Fu Lee in 1989 that would become the Sphinx system at Carnegie Mellon University and the maturity of machine learning in 1997 by Tom Mitchell. Since the improvement and expense of computing hardware after the first decade of the 21st Century, iterative data parsing and the available transformations has been explored. The paradox, though, that although it has been a revival, the field's pitfalls subsist and act as a trap for both the writers and consumers of all-things artificial and simultaneously intelligent.

What can be learned from this history?

As the history subsequent to the Renaissance is rather linear, in the sense of the creation of the digital computer and its ability to explore problems by iterative algorithms leveraging linear algebraic expressions, what can emerge that includes the story and disrupts what is known about the human condition and what aims one has by utilizing this kind of technology? As it demonstrated in the last sentence, how does the human experience *intersect* with machine learning?

Consider is how a person interacts with a machine imbued with intelligence. Forget for a moment that there is not a wholly satisfactory definition of intelligence but to state that it is an object that has the ability to solve problems through computation and reflection. It is possible to reduce the mechanics of the interaction to pure mathematical sequences where a behavior is exhibited in a self-evident manner. In so doing it becomes a black-box and what remains is the experience of the interaction itself to the human participant.

The next chapters will discuss the details of the above paragraph. Before that, it might be somewhat useful to have in mind some contentions that are prevalent at the time of the writing of this book. A review and correlation of the following points is in order.

In the current era, data science and its pursuit of engineering consists of trainspotting patterns where algorithms deduce these patterns from the character of their inputs, typified in a neural network. A simple but effective example is the appearance of alphanumeric characters in networks when the algorithm detects these by examining those written on paper or transposed into images. Such a method is analogous to a "nixie" display used in test equipment, clocks, and other apparatus to represent numbers to be displayed to the operator. The problem with these techniques is the need to copy large amounts of data from one system to another for training and analytical purposes. The question often arises: Why copy when you can analyze in-place? The nature of the design of the electronic computer or its "von Neumann" architecture based on the ideas of Alan Turing is the answer.

A Turing machine is a mathematical model of computation that defines an abstract machine, which manipulates symbols on a strip of tape according to a table of rules. Despite the model's simplicity, given any computer algorithm, a Turing machine capable of simulating that algorithm's logic can be constructed. Turing machines proved the existence of fundamental limitations on the power of mechanical computation. While they can express arbitrary computations, their minimalist design makes them unsuitable for computation in practice: real-world computers are based on different designs that, unlike Turing machines, use random-access memory. A Turing machine is a general example of a central processing unit (CPU) that controls all data manipulation done by a computer, with the canonical machine using sequential memory to store data. More specifically, it is a machine (automaton) capable of enumerating some arbitrary subset of valid strings of an alphabet; these strings are part of a recursively enumerable set. A Turing machine has a tape of infinite length on which it can perform read and write operations. Turing completeness is the ability for a system of instructions to simulate a Turing machine. A programming language that is Turing complete is theoretically capable of expressing all tasks accomplishable by computers; nearly all programming languages are Turing complete if the limitations of finite memory are ignored.

The work of Alan Turing, notably an the essay on computing machinery and intelligence, and the formulation of the Physical Symbol System Hypothesis by Allen Newell and Herbert Simon sets upon the notion of that thinking is information processing, and information processing is a computational process, a manipulation of symbols. Therefore, the brain as such is not a thought-provoking instrument rather as the realization of intelligence by any patterns derived from matter. A simple electronic circuit without any software could exhibit intelligence by the manner in which it set out to solve the organizational problem provided to it by its architecture. The view that intelligence is somehow independent has been ridiculed by Minsky who is content to state that intelligence is the act of overcoming death. Or in more archaic terms reticent of the times described earlier in this chapter: The triumph of the light over darkness. The continuation of this by Hans Moravec toward post-biological life espouses the search of the ways and means to have a human mind transferred into a machine. The idea has been to push the evolution forward by the reduction of humanness as both form and function where the brain becomes superfluous and a post-human era begins in which the stored knowledge remains accessible for any length of time in computer networks. Such a solution would help to reduce the need to smart people with substantive knowledge transferring it by writing books or giving speeches to others who are eager to acquire it. The concept of reason would state that such a transformation would not suit the desired goals as the certainly of knowledge is not absolute since nothing can be denoted as universally certain as many different minds consist the world and each of these are a compendium of culture and experience. Therefore, the state-of-the-art remains Occam's Razor where the simplest solution is the correct one. This yields an opaque conclusion of learned ignorance as solution to adhere and simultaneously upend the notion of limits to human knowledge.

Since certainly can only exist in a well-defined representation, regardless of the concept of limit – or infinity for that matter – a machine would behave in a similar fashion, so constructed because of the idea of a self-evident architecture does that imply one is satisfied with an intelligence because it is too complex for the mind to comprehend? Yet, because a person has learned ignorance can they overcome the development into a new kind of madness?

Scientists in the field of computer engineering and cybernetics since the 1950s have deduced this conundrum to the idea of *programs with common sense*. Although this is also fraught, it is a suitable perspective to labor the narratives of machines with an imbued intelligence without having to explain the technology or the methods that make them observably so. Additionally, it is apparent that the experience of one individual contrast with another will attain different results but this does not subtend the specificity of intelligence of the machine.

Because of the influence of Norbert Wiener the field of cybernetics describes how a machine's architecture gives rise to its behavior so that by analysis and correlation the predictability of a machine's outputs can be known where some of them are used in the form of feedback to influence subsequent iterative computations. The greatest of these, W. Ross Ashby indicated that the complexity of the computation is not necessarily the root cause of a machine's behavior; rather, the *ways and means* that a machine goes about computing is more essential. Given that an interaction between a human and machine where intelligence is the means of intersection, a bias will inevitably occur wherein unknown introduced by the *emotional* interaction will become more influential. Currently, it is not well-understood how to assess this bias. It cannot be mathematically determinate as it is not necessarily a random occurrence, rather, contextual to a myriad of parameters ranging from the perception of the machine by the human to how an interaction unfolds

Nevertheless, there are further areas of intersection that reduces the disconnect where a machine could evolve through the process of interaction into an artificially-intelligent being. There is a nagging insistence that there must be something organic in the motif, that somehow the intellectual discourse would become fragmented by the differentiation of technique, rather than viewing the system as a whole entity with distinct parts that contribute to the same. Therefore, the notion of fragmentation becomes the rhetorical domain wherein to set a foundation to solve. If such a thing is conceivably identified as an obstacle, then a set of solutions could be proffered. What remains, then, are the primitive human emotions that have been a part of the species since its inception.

Is one afraid to face the future? Is one afraid to face the mirror of the self? Technology has been a part of adaptation and survival for a long time and the game artificiality, at least in the West, since the time of the ancient Greeks but stretching back to times that humans lived in caves, as exampled by totems. With the advent of electronic transformative-logic systems imbued with the power of finite mathematics set into the circuits of computing machinery, the notion of the totem becomes one that is imagined to a full-blown exhibition. Wouldn't now be the most singular time to explore the next horizons of the human experience? Isn't it best to embrace measure, reflect upon it, and usher in an evolution that subverts illusion? So doing would substantively alter the direction of the fate that the human species has long set itself upon. However, despite the complexity of vision and its implications upon any future realized or ignored, it is time to cast a glance to understand what it is essentially all about.

Chapter 2: Descartes and the monkey mirror

Between sight and experience, there is difference between a monkey and the master.

On the 22nd of June 1633, Galileo was judged to be condemned for violating the principles of the Council of Trent for *The Starry Messenger*; this book is a heliocentric interpretation of data gathered during telescopic observations in an attempt to prove the hypotheses of Copernicus, and *Dialogue Concerning the Two Chief World Systems* that presented the arguments that the old interpretation should be discarded and the new one embraced: The sun did not revolve around the earth, it was the other way around. In one stroke, he demolished a view of humans being the center of everything they saw and could know that surrounded them. They were no longer special but ordinary and small beings in an enormous and cold Universe.

The gravity and magnitude of the works set Galileo upon a path where he would have to recant or be formally imprisoned at the pleasure of the Inquisition. He chose the former and was placed under house arrest for the remainder of his life. According to popular legend, after his abjuration Galileo allegedly muttered "and yet it moves", in response to the pure ignorance of those prosecuting him. The attribution fixes the gaze sternly at the uncertainly of the planet moving through space and still carried great weight to subsequent generations of academians so that by 1657 a wholly new phenomenon of experimental science explored controlled experiments and yielded important advancements of such intellectual power that the way in which it was conducted became the status quo of how new knowledge is not only acquired but determined and transferred. Subsequent to the philosophies of Rene Descartes, they would solidify an era called the Age of Enlightenment.

When news of Galileo's fate spread across Europe, it had a profound effect on other intellectuals active in other equally monumental works. When learning this, Descartes abandoned his plans to publish *Treatise on the World*, a work of philosophy he had spent the last four years on where he addresses the deep and ingrained ignorance of humans and equates freedom from its depths by striking a light upon the head. In the three years subsequent, Descartes folded into himself and wrote about walking about Amsterdam unseen, despite it being one of the more tolerant places in Europe. In 1637 he published parts of this work in three essays: *The Meteors*, *Dioptrics*, and *Geometry*, preceded by an introduction, his famous *Discourse on the Method*. In it, Descartes lays out four rules of thought, meant to ensure that our knowledge rests upon a firm foundation. These would consist the substance of *Discourse* that would yield the infamous phrase *cogito ergo sum*. Many elements of Descartes' philosophy have roots in Aristotle that embraced existence, ethics, and the mind. A philosophy of personal ethics informed by its system of logic and its views on the natural world that extols humans as social creatures that the path to happiness is found by accepting moments as they are presented and not to be turned-away by the desire for pleasure or the fear of pain; a result of the actions against Galileo. By employing the mind to understand the world and work with "Nature's plan" working collectively where one treats others fairly and justly, one can evolve and become enlightened.

To Descartes, the philosophical study of nature and the physical universe as it is being observed in primary to the aims. Compared to other schools of philosophy, Descartes rejected the division of corporeal substance into matter and form; he rejected any appeal to final ends, divine or natural, in explaining natural phenomena. Instead, he insisted on the absolute freedom of God's act of creation. Rather than seeing himself in a chain of historical advance, he noted in the opening to *Passions of the Soul*, a treatise on emotions, the position that: "…as if no one had written on these matters before".

At one point in time, excitement was palpable discovering new ways of understanding human behavior, its mathematical composure, and how it comes by a mind the use of reason to generate a contextual understanding between it knowing itself and the recognition of an environment in which it finds itself. This idea of the *Enlightenment*, an ode to the first chapter in, *The World, A Treatise on Light*, espousing: "I think, therefore I am."

The essence of the thesis contends that if the individual believes what is seen and touched, how it is the present experience is perceived and the unknown future contemplated is yours and yours alone. The consequence of experience modeled as causality where one has the power to choose whether or not to reason about those observable problems in the world that surrounds and how that manifest—or not—in physical form the matter may be. In this process, meaning is found in the emotion of the experience. There is no relationship between sensation and what creates sensation of the experience. Therefore a complete statement of what it means to be enlightened, according to Descartes method is the following.

As a reasoning being, I present myself with binary choices that often are composed of consequential choices, making the present choice what it is, where its motivation is to yield positive consequential events. On one hand lies *pure* reasoning, the collection of objects wherein is the tapestry of experience affecting the greatest positive mood are organized; on the other, the question and development of a *practical* reason to further codify the collection, hastening it into the real world, of an aesthetic directly related to the time invested in the quality of its manufacture. I then judge my performance and optimize by feedback. There is no limit on what can be created but by that which manifests in the imagination and the belief it can be understood that it becomes useful.

Herein the light that Descartes declared the individual peers into the self in where they are free to contemplate the meaning of their existence and the acknowledgement of a novel ability to replicate the experience and discover ways to codify them to allow preservation of their substance and consistency. This is the triumph of intelligence over death where knowledge continues in time without the person upon whose head rested the enlightenment. Time, the eternal enemy, has been rendered moot. But the simplicity of these statements obscures their inherent bias of perception. Of these, there is a binary between the positive and the negative.

The positivist viewpoint

Descartes considered his contribution a unique invention, although it is apparent that tenets from Buddhist and Chinese philosophy are included in the outcomes. Natural beings are capable to learn new techniques wherein to not just enhance but overcome limits imposed by a shared ignorance. It stands to reason that any intelligence represented in machine form cannot be fully accepted by the psyche until perceived live and in three dimensions.

The pessimist viewpoint

Subsequent to Descartes, Leibniz continued this work in albeit a more formalized and mathematical manner. There are those who are obsessed with skepticism as it is the easiest route to gain notoriety without actually creating anything, nevertheless, such viewpoints are necessary to improve the state-of-the-art. However, they come at a cost such as those creations that don't conform to a natural philosophy and revert to a monstrosity that is out of control. One such example in literature is Frankenstein, or The New Eve, or any other fictive representation that has spanned stories on robots and their interaction with humans primarily those of the first half of the 20th Century. All forms must remain equal across the boundary as we defined a robot as a composite piece of hardware and software.

The principle of equality between viewpoints

While both positive and pessimistic perceptions are valid in a contiguous space, the connection across this space between each considered extreme is where the act of creation seeks to supplant the notion of God who historically is the only authority granted to such acts. What follows thereafter is a matter of the methods and practice of the individual who has assigned themselves the power to create (or destroy) objects that communicate their aliveness to external observers.

The influence of the avant-garde upon the bias of perception

The simultaneous distinction and inclusion of humans with the synthetic has been illustrated in many forms through history but find themselves most apparent in the practice of puppeteering. Compositions denotes as puppets, or objects "drawn by strings" are recorded in the 5th Century BCE and was noted by Aristotle *On the Motions of Animals*: "The movements of animals may be compared with those of automatic puppets, which are set going on the occasion of a tiny movement; the levers are released, and strike the twisted strings against one another." Here is drawn a connection between animals in the natural world and creations by humans.

Distinctions between real and perceived

When faced with having to make a choice of not only what is fact verses fiction but also if either choice is suitable an appropriate reaction is to fold into oneself. From this vantage a baseline is established and external viewpoints calibrated so that such a reflection aids in making the right sets of choices. Once made, the reflection serves to illuminate the individual as chosen actions unfold s that there is an interminable link between the inner and external world. The four principles outlined above serve as boundaries for the baseline and by peering into its reflecting-surface, the edges can be visualized and the limits expanded, or contracted as one sees fit.

One of many outcomes from peering into the mirror of the self is the realization that what humans have invented for themselves might not exactly be in the best interest of the entire species. While there is an intellectual discovery that appears to be valid across a spectrum of external perspectives, the differential aspect of the politics in the attempt to apply extreme simplicity to proposed solutions proves a detriment to the exercise. Although perspectives at either extreme of the left or the right have their reasonable merits, they primarily seek the skeptical path to the proposition of novel ideas. The extension of the concept of the mirror, therefore, can only apply individually and cannot be extended into groups, except those of like-mind and constitution. But there was an attempt that was successful in the success of the functioning of the implementation.

CyberSyn, super-calculators, and social planners

The world created by humans to manage their daily affairs has grown in complexity beyond the comprehension capability of the vast majority of them. The political classes are vulnerable to implementation of policy that proves incorrect and damages the credibility of the state over the long term. Some persons are keenly aware of this matter and are proposing solutions scrutinized by arbitrarily-organized armies of developers, data scientists, software architects, and application engineers. While sounding good in theory, it is a dangerous activity to pursue over time as complexities and coordination between the parts of the teams becomes unmanageable. One strategy is to shadow these efforts with a learning algorithm implemented in independent hardware acting as implementation-in-chief to assess the effectiveness of a given policy application, as well as the organizational efforts of teams. As such, the role of a very particular computer system as an effective organizational criterion to manage human synchrony-driven creative solutions to complex societal and governance problems assessed as imperative by the leadership of the state is modeled in a deterministic manner.

At first it might seem surprising that society and governance lies not only with national governments, diplomatic attaches, and international agreements but also with the goals and ambitions of commerce. This is because of the adversarial nature of civilization as it has evolved from its beginnings in ancient times to the present day. Persons with vested interests in one area of the world necessarily need persons from another area of the world not only for the reasons of trade and commerce, but in terms intellectual capacity as well. This is not liberalism but rationalism in a global context. Stakeholders in companies require expertise from stakeholders other companies, requiring labor and skills that take too much time and expense for them to develop independently.

So lies the conundrum today manifest as an irony between despite an increasing connectivity and communication globally, trappings by unwise policy and unwavering faith in status quo leads to disdain, isolationism, and vilification of persons offering alterative interpretations of problems facing societal activities on increasingly larger scales. Over long and short periods of time, it can lead to corrosion in relations between countries as the idea of an imperialistic imperative in functioning capitalistic-democratic populations extrude their unconscious wants and desires yielding the singular purpose of civilization: to find negotiated solutions in lieu of violent conflict. Since antiquity, parties from disparate cultures have used their words to find common ground, sending armies of diplomats and advisors scribbling furiously to capture the essence of desires of the parties in order the solution benefit both in maximum capacity. This exercise has proven futile. Failure of governments worldwide to capture correctly the needs of their citizens, including frames of context, is the key reason for global unrest. The failure is plainly visible by those exercising power not having the tools to understand how their governmental system is functioning in real time by seeing the state of affairs, including algedonic feedback of its citizen's activity, without resorting to Orwellian memes.

Can the political classes be blamed? Certainly, this is the first response. However, does this provide the proper motivation to correct the steerage of the day-to-day business of society and commerce in order that it satisfies the public's needs? Probably not, but what other mechanisms are there? In the end, it is people running the affairs of state and it is people inhabiting its borders and traversing its boundaries. No improvement can neither be gleaned nor understood as the correct method and means to finding tangible solutions.

Are there technological solutions available? The answer is both 'yes' and 'no' without prejudice toward a grey area lying between. The species as it exists today currently enjoys advances in computer and quality of manufacturing, automation to reduce carbon footprints and labor costs while maintaining social contentment and thereby long-term stability of the political classes, has been on a slow decline. There are that who think that pushing further into automation with its gem, artificial intelligence, is the correct way forward. This is probably correct for the reason that our world has become complex enough that our brains can no longer reconcile it. This is simultaneously probably incorrect as the premise by which stakeholders implement the technique is fatally flawed, as no one understands the phenomenon enough to make a proper model of it in machine form.

A solution has been to have artificial intelligence tell stakeholders the 'right' way forward. As petrifying as that sounds it is the only solution available. It is already being undertaken by governments employing armies of developers and data scientists in the hope of finding the trail of breadcrumbs leading to the solution. However, current efforts are no more than applying unsupervised (machine) learning to copious flows of data, trainspotting those parts deemed important to remember. Therefore, how such a machine is developed if:

- No one mind can comprehend the complexity of the problem, thereby,
- it cannot be properly captured, because,
- no consensus can be arrived, as,

- no one mind can comprehend why the model is necessary, because,
    - they not only cannot what it is designed to do, and,
    - cannot find reassurance since they are unaware of its procedural execution,
- therefore, the idea will never be explored.

The notion of a transparent machine intelligence works to reveal these dark areas of the technology. Once enlightened to what the machine is doing, one obtains greater comfort in the belief that things are better and there is an export of meaning to apply to everyday life. This is only a comfort and cannot be found in any set of equations. The human mind cannot compute probability and loses resolution to comprehend complexity in groups above five members. Of the plethora of contextual information—transformed data—newly available under such would be of little value to a human. It is more important to find ways to build trust in an intelligent computer system. Since the public obtains its knowledge of such machines via secondary sources, mostly in terms of entertainment, it is necessary to explore only historical examples of implemented systems, hardware, and code.

In the 1970s, a mathematician named Anthony Stafford Beer devised a project and proposed a system called CyberSyn in Chile under the mandate of the socialist government of Salvador Allende. CyberSyn was a project designed to implement Beer and W. Ross Ashby's idea of a *requisite variety model* to placing data via processes requiring further inputs by statistically distributing them in such a way as to allow counterfactual reasoning by a program executing a series of statistical equations over the time devoted to differential analysis operating against a given problem domain, in order to glean insights into how to predict its future behavior. The theory was derived from the synthesis of metaphors drawn from biology and engineering and characteristic of work in his field of cybernetics. The law of requisite variety describes that variety in the control system must match the variety in the system to be controlled. Therefore, it is interesting to attempt to apply Beer's viable systems model to control activities of actors rewriting the policies of the state to suit available opportunities to do so.

In terms of its design, CyberSyn was a naïve Bayes filter and control system that used Forester's Dynamo compiler, equivalent to the computer algebra system Matlab, which ran on an IBM 360. It monitored changes in data of system variables according to a control hierarchy, called the viable systems model where its effectiveness was found in policy deployment. Mathematically-speaking, the algorithm that embodies the model has been demonstrated as sound by several authors, such as Ashby and Beer, along with the notion of homeostatic equilibrium of economic activity between classes that yield an answer of truth by self-evidence. The behavior of large-scale human systems is rather manageable, given the right set of intuitions, when the computer program is designed. However, the language of its operation is often nestled in abstractions such as cooperative collaboration between different systems, noting that its key feature was that it is, as Beer describes it: "…a system that survives. It coheres; it is integral…but it has nonetheless mechanisms and opportunities to grow and learn, to evolve and to adapt."

In terms of a general criteria-based overview, naïve Bayes has the following characteristics as advantages and disadvantages. The advantages being: It can operate on quantitative and discrete data, it is robust to isolated noise points, can ignore irrelevant values for probability estimates when decision-making on a quadratic decision boundary. However, those weaknesses to identify zero-valued conditional probabilities and dependence between features, suggests a requisite managerial architecture to compensate, such as the viable system model. Due to its utility, it is compatible with correlation techniques to improve correctness.

It is made to be useful to solve practical problems is by integrating a counterfactual reasoning approach into the architecture of the program, since data, its speed of access and quality of availability, determines whether the algorithm is optimized well-enough to be advisory of answers to queries by users, relative to its environmental representation. The counterfactual approach enriches representation by introducing interrogative questions of a higher dimension. Ordinarily, as Turing first noted, we query from a representative system to compute variables, in essence, recalling them. A question like "what happened?" is one of these. A known-map is created a posteriori with context between its features that could quickly be out of date, depending on the type of device the algorithm is executing. Querying redraws the map from scratch, losing the contextual links from the previous map, where they are known implicitly. Adding a higher dimension to the query by introducing questions that involve cognitive introspection is an excellent technique. As an example, "what if I act?" and "what I should have done?" are two of these. The next section of the paper will attempt to bridge counterfactual planning, in terms of probabilistic reasoning, to introduce an improved version of a CyberSyn-like structure deployed in modern cloud-based systems.

The software system designed by Beer, called *Cyberstride*, was such a naïve Bayes classifier executing statistical equations for a sufficient variety of data-points output from production facilities across the economy. By leveraging the positive aspects of a Bayes classifier and intersecting counterfactual reasoning, a far more intuitive program in manifest for operation across a wider variety of contexts. Probability, for the purposes of this discussion, is defined as a quantitative measure of uncertainty state of information or event. Since the interest is the probability of a single or set of events, as in "what happened", the probability is conditional of what happened in an event prior. The probability of an event may depend on the occurrence or non-occurrence of another event. The dependency, written in terms of conditional probability is stated as:

- the probability that A will happen given that B already has,
- the probability to select A among B

Given the event, A, is independent from event, B, if the conditional probability is the same as the marginal probability when stipulated that pre-conditioned knowledge available to the system can take either a priori and a posteriori forms. There are three distinct kinds of probabilities, one a statement of prior probability, unconditional probabilities, and posterior probability. The first assumes knowledge of an event *a priori*, the second, a hypothesis of the state of knowledge before new data is observed. The third a kind of conditional probability about the state of knowledge after revising the outcome based on new data applied a posteriori. Likelihood also exists in the formula indicating a conditional probability that our observational data holds for the given hypothesis.

Armed with this template, it is possible to introduce hierarchical reasoning based on an apt causality. The hierarchy is broken up into three distinct levels, known as the *ladder of causation* by Pearl. These components are now recombined into an effective form of the following representation. Strictly within the case of filtering-problem domains and those contextual modeling strategies, generically. It is desirable to consider what the outcome would be upon any given assessed outcome probability. When each attribute and class label is a random variable and given a record with attributes where the goal is to predict classifications where it is particularly interesting to gain knowledge of the value that maximizes.

An insightful approach is to compute the posterior probability for all values. When the maximum value for the conditional probability is known, choice of this value and assuming independent distributions—there is no knowledge being exchanged between the probabilities—it is therefore possible to apply a hierarchal causality over the transformed attributes for queries such as 'what is', 'what if' and 'why'. Keeping aware that naïve Bayesian prediction requires each conditional probability be nonzero. Therefore, a simple additive parameter is attached, preferred to the Laplacian representation of a finite number of classes. Adding counterfactual reasoning to a naïve Bayesian filter will substantively increase its scope and range, thereby making it far more useful on the scope of the assigned problem space. It additionally increases its environmental scope by creating known probabilistic arrangement of the data, expanding it to where the limit on knowledge of the environment is now based on the magnitude of ordinary components obtained through observation.

According to historical sources, Beer's design operated very well and Cyberstride proved itself successful to manage the affairs of state in late 1972, despite previous errors of the leadership to curb inflation. It demonstrated the capability that machine learning, properly written and managed, could regulate and provide optimal suggestions regarding the activity of a society, given that the domain of data is available to the algorithm in that it can evolve to respond rapidly to the needs of the people. Despite its success and failures, CyberSyn was never attempted again. Persons economically threatened by artificial intelligence, those apocalyptically afraid of it, and those unwilling to entertain an idea that is at its very core, socialist and technocratic, oft frame it as an unpalatable solution. Additionally, the notion of giving control over to a machine has oftentimes not sat well with individual people. Certainly, the technology was developed under the mandate of a socialist government using nationalistic policy, but the government does not have to be socialist to utilize the technology at its heart. Regulated capitalistic activities and spending by the state in responding to monetary crises is also possible. It can be a conservative and centrist government as the principles of using machines in governance strives for peace, prosperity, and reduced expenditure because decisions are being made not only more rapidly, but also more precisely.

However, the key aspect of its success is the availability of the correct data, arriving as feedback from activities of production, in order policy can be monitored as close to real time as possible, and given hardware constraints.

One particular solution would be to construct a machine that benefits people so that they can navigate an increasingly technical world, both in terms of society and economic activity. This machine will need to be constructed even though some or most persons would not want it to be. With the advance of chaotic weather and the very real possibility we might go extinct as a species, we require such a machine to survive the coming apocalypse perhaps even by navigating it. For how can our feeble minds grasp the complexity of the weather of our planet when most of us cannot decide what to do when we are hungry, tired, angry, or amorous. Even if such prostrations of doom never materialize, the implications and their emotional weight propagate.

Climate is an important phenomenon to be keenly aware of as it has the potential of rapidly dispersing a population, introducing a high-magnitude migration event. Even if a true scientific result cannot ever be determined, monitoring of climactic events and their weight of impression upon the public will capture behavior. This is the point: the system will communicate to the people that it understands human problems by researching solutions to present to the government whilst simultaneously not interfering in day-to-day decision-making performed by politicians. The system must be sold as functioning solely in an advisory capacity.

Major problems will arise in the tension between the selfish and the altruistic. The notions of democracy, what it offers, the obsession of material gain to the point malign feedback must be clarified. The rising of collaboration between left and green political classes are the most compatible way forward. As an extreme opposition, for the purposes of illustration, to counterbalance activities undertaken by other nations practicing a resurgence of Keynesian economics, however careful not to discriminate on the political spectrum between liberals, centrists, and conservatives. To avoid direct disruption to markets, counterfactual reasoning aids in more accurate leveraging of data from simulated scenarios run by the algorithm and its program beforehand. Therefore, the following claims can be proffered:

- CyberSyn is the right kind of system to operate a new kind of country, one that is as fair and
  equitable as possible.
- Designed in the right way and laboring under ideal philosophical constructs, such as Kant’s pure reason, adding the capability to perform counterfactual reasoning, introduced by Pearl, it can accurately provide the kinds of solid predictions and proffer the right kinds of advice to the ruling political classes.
- An enhanced CyberSyn, a system specifically-designed to operate on classes of data, providing recommendations toward optimization in terms of operation, in terms of all aspects of government, policy, regulatory, trade negotiation, and even diplomacy is

the only way forward, if it is to survive adversities while its people thrive over decades, not just over the term of the mandate.

- Current manufacturing sophistication and network connectivity is accessible to nearly all locations on the planet by utilization of non-grid-powered edge devices.
- Long term problems can be quantitatively addressed and dealt with in real time.

As time progresses, it will become painfully obvious to policy makers the dire need for machine learning as very serious problems with energy, climate, commerce, infrastructure, political, human need-based services, and eventually diplomacy that those tasked with addressing these cannot seem to cope. The question is not of its adoption but in the manner by which it is architected and deployed. As noted earlier, if one starts with the supposition that no human can know the correct answer, trying to synthesize it with principles of equivalence instills the system to be unbiased and fair. There is a successful way to mitigate the paradox of the monkey mirror.

Manipulation is a tempting supposition, but will be the rue of the design. Therefore, it is valid to insist upon an equal weight of emphasis on data independent of human introspection. This is because the outcome and probabilistic nature of mathematics prove elusive to any detailed human understanding—save by graphical displays, charts, and comparisons between areas of ministerial operations. A fresh perspective needs to be entertained if humans are to make a success of its civilizations; despite its adversarial nature, it is very possible to make inroads to solutions that benefit everyone.

The notion of intelligence in a non-human yet still pervasive form was conceived, regardless of whether or not it was understood as such.

Chapter 3: How the robots help save humanity (from itself)

In dividing organic among synthetic, and assessing all spaces in-between, we beg to know who is the monkey and who is the master.

Everybody knows what a robot is, even children do. Everybody knows what a robot looks like, even if they've never seen a real one before. It is an archetype in our species most evident in an infant's ability to recognize faces. Given enough of a description, any human being alive can visualize what a robot is and what it could do if introduced into their lives. The robot is but a technical manifestation of a much older symbol, the totem. Totems were used to guide and protect humans throughout antiquity and the archaeological database is full of examples worldwide. The most advanced form of the totem is the automaton. The cousin to what would be understood in its modern conception was the steam-powered statues gracing the workshops of Rhodesian artisans and the Greek geometers who designed and built the Antikythera Mechanism. There are depictions of what appear as robots on the island of Sardinia. Mechanical aspirations such as automatons reappear in Europe in clockwork shops just before the Industrial Revolution in England, Wales, and Scotland in the early decades of the 19th Century and its promulgation in the form of the steam engine across the European continent, bringing with it advances in Science and the state-of-the-art in manufacturing such as the concept of interchangeable parts and automation.

The details of what a robot is brings both the physical and the surreal, as a robot does not exist *in any natural way* and is purely a creation from a human mind pertaining to human experiences solving the kinds of problems that humans believe should be solved. Apart from this rationale, softer aspects of the robot are more elusive to determine. Some but not all pertain to character design and the ability to infuse a personality, an inner life to an object, coupled to elements like appearance, emotion, backstory, sound, and attitude. In times where many kinds of diverse robots are evolving in laboratories and workshops, what is the impact of building a character into those machines? When is it relevant to consider character development and what can we achieve with it? Fiction is full of such diverse robot characters, from warm empathetic robots to jaded cynical ones. What is the optimal personality and how can one *know* that it is the right choice, given what was discussed in the previous chapter? What are the main steps to turn the envisioned character concept into a reality?

Firstly, it founded in process; that is, the conditions that imbue the robot with its perceived existence. This facet is more innate that learned and it is fairly easy to convince a person unconditioned to live with robots as to what kind of purpose they serve simply by their appearance and behavior. As it is relevant to set a context to the outcomes desired to be achieved in such a discourse, there is a selection available of chosen examples and by walking through their implications, a comparative analysis is presented whereby to impart to the reader the relevance of distinct kinds of features and inset meanings that are intended by both the form and the function of the robot. As the analysis should be indicate a broad-stroke, automatons of pre and post-electric circuitry should allow a sense of contiguous purpose.

Each artifact draws comparison between each other and the overarching theme of humans creating autonomous machines existing enough to be considered similar in scope and behavior so as to enlighten how a new artificial species will appear, act, and manifest. This act of creation is an experience shared by each creator of the automata in both literature and composite forms and those who had a chance to see them or the chance to read about them where the transfer of this experience increased the awareness of the human. In a nutshell: The incubator, a vivarium, a place for primordial things to coalesce and grow is transformed by concept.

However, the idea that human intelligence or, more generally, the processes of human thought may be automated or mechanized, that a person could construct and build a machine that in some way displays intelligent behavior is an old concept, at least back to classical Greece. The earliest mention in print is Julien Offray de La Mettrie and the 1748 published work *L'Homme Machine*. Abstract intelligences have appeared in the idea of the Laplace demon, named after the French mathematician, physicist and astronomer Pierre-Simon Laplace, can be counted as one of the theoretical precursors of universal machine learning insofar as the stipulation that design is based on the model idea that the entire universe follows the rules of a mechanical machine – sort of like clockwork – expires, and of course this concept also includes humans and their intelligence. In other words, a self-evident architecture. However, this implies behavior embedded in the context of software which did not exist until the advent of the electronic computer and, as such, are disillusionary.

Before the mastery of the electron in the early 20th Century, automatons were mechanical and whose design of motion was to tell the story portrayed by the placement of the figures. By the end of World War II, automata was becoming a commonplace intellectual tool to describe automatic and (desirably) linearly-repeatable phenomena helpful to solve larger classes of problems in infrastructure, organizational, and weapons development. Subsequent to the advance of miniaturization of mechanical apparatus such as gears that consisted clocks as techniques in foundry became more evident to contain an application of encapsulation wherein to accurately synthesize the actions of a puppet in a manner that it was self-operational. The distinction will not be excluded to human-replications but will extend into artificial animals.

Concept One. Automata and not toys, please

Objects identified as automata were recorded to be in existence as far back as on the island of Rhodes in the 1st Century before the Common Era (BCE). They took different substantive forms but did not propagate beyond the island in their time and place. A millennia and a half would pass before the next incarnation where a realization of mechanized humanoid and non-humanoid forms were accomplished by Jacques de Vaucanson in the period between 1730 and 1760. He was the son of a glove-maker, grew up poor and aspired to become a clockmaker, an industry of increasing popularity. Rather than a direction of religious studies, Claude-Nicolas Le Cat would revive his interest in mechanical devices and a detailed knowledge of anatomy. This combination afforded his mind to develop mechanical devices that mimicked vital biological functions such as circulation, respiration, and digestion.

In 1737, Vaucanson built *The Flute Player*, a life-size figure of a shepherd that played the tabor and the pipe and had a repertoire of twelve songs. The figure's fingers were not pliable enough to play the flute correctly, so Vaucanson had to glove the creation in skin. The following year, in early 1738, he presented this creation to the Académie des Sciences. Shortly thereafter, he received critical feedback from Johann Joachim Quantz, an experienced flute instructor to Frederick II of Prussia, particularly the automaton's inability to sufficiently move the lips for pressure of higher octave notes that were noted to be a shrill and unpleasant tone. Despite the criticisms of the audial capabilities, his mechanical creature was considered revolutionary in their mechanical lifelike sophistication.

Later that year, he created two additional automata, *The Tambourine Player* and *The Digesting Duck*, which is considered his masterpiece. The duck had over 400 moving parts in each wing alone, and could flap its wings, drink water, seemingly digest grain, and seemingly defecate.[8] Although Vaucanson's duck supposedly demonstrated digestion accurately, his duck actually contained a hidden compartment of "digested food", so that what the duck defecated was not the same as what it ate; the duck would eat a mixture of water and seed and excrete a mixture of bread crumbs and green dye that appeared to the onlooker indistinguishable from real excrement. Although such frauds were sometimes controversial, they were common enough because such scientific demonstrations needed to entertain the wealthy and powerful to attract their patronage. Vaucanson is credited as having invented the world's first flexible rubber tube while in the process of building the duck's intestines. Despite the revolutionary nature of his automata, he is said to have tired quickly of his creations and sold them in 1743.

His experience in constructing automata would lead him to inventing the precursor of the programmable loom, for which Joseph Marie Jacquard would perfect in 1839. Charles Babbage would be inspired to use the technique to program his analytical engine with the aid of Ada Lovelace. Later in the 20th Century, this system would find utility in the first programmable electronic computers that would use the very same technique of punched cards to instruct and configure the machine for a wide array of tasks. It would then transform into magnetic tape, hard disks, and bubble memory.

For all intents and purposes, the computation belonging to the form was solved by the middle of the 19th Century and established for generic hardware by the middle of the 20th Century. This was to provide a foundation of combination of computation and behavior exhibited in simulations of living animals. When the fad of automata passed in the latter years of the 19th Century, the idea never really went extinct; rather, it found its way into media and literature. Although not explicitly cited as a part of the advances in computing, in the latter years of the 20th Century, it would reemerge where more formal definitions would be established.

Concept Two. The Vivarium—An environment for virtual animals to flourish

The earliest constructions of the electronic computer did not have the vision of its scope that is it known currently. The notion of "personal" would not come about until well after the invention of the integrated circuit that allowed cheaper and more powerful chips. In terms of software, in the transition from structural to object-oriented programming, the realization struck an engineer named Alan Kay where the notion of personal computing would not be in the form of a vehicle devised by early mainframe manufacturers such as IBM, but something rather more profound. A personal dynamic *medium*. In the words of Kay: "With a vehicle one could wait until high school and give 'drivers-ed', but if it was a medium, it had to extend into the world of childhood."

Here was the shift to the idea of virtualization within computing. Deeply rooted in graphics and simulation by the 1980s computers were powerful and cheap enough to be up to the task to replicate the natural environment wherein to place artificial creatures. Kay would be the first to construct and implement such an idea for Apple Computers in 1986. The story of the vivarium program was given by Larry Yeager:

The literal definition of a "Vivarium" is an enclosure or reserve for keeping plants and animals alive in their natural habitat in order to observe and study them. The Apple Vivarium program is a long-range research program with the goal of improving the use of computers. By researching and building the many tools necessary to implement a functioning computer vivarium, an ecology-in-the-computer, we hope to shed light on many aspects of both the computer's user interface and the underlying computational metaphor. We are exploring new possibilities in computer graphics, user interfaces, operating systems, programming languages, and artificial intelligence. By working closely with young children, and learning from their intuitive responses to our system's interface and behavior, we hope to evolve a system whose simplicity and ease of use will enable more people to tailor their computer's behavior to meet their own needs and desires. We would like untrained elementary school children and octogenarians to be able to make specific demands of their computer systems on a par with what today requires a well-trained computer programmer to implement.

The Vivarium program began in 1986, and is overseen by its principal designer, Alan Kay. Alan, in addition to being a computer scientist, is a musician, mathematician, biologist, physicist, philosopher, cognitive scientist... and as such is able to bring a wide range of thought and influences to bear on the many issues inherent in such a grand goal, or grand direction, as Alan might prefer to phrase it. Alan is fond of pointing out that really *good* research simply cannot have a well stated *goal*, it can only have a useful direction. If you could state at the outset that you were going to now invent the *flying buttress* or *vaulted arch*, then you'd already have your goal so well defined that you'd have no need to perform the research.

Alan's early ruminations on what the most useful, friendly computer of tomorrow would look like came to be known as the Dynabook, and took form when he was among the now fabled group of computer scientists gathered at Xerox PARC (Palo Alto Research Center) in the early 1970's. Out of that team came windows and a kinesthetic/graphical user interface, object-oriented programming (Smalltalk), and the Dynabook. The Dynabook was to have been the size of a notebook, very light and portable, able to handle a couple of megabytes of text, able to create pictures with a program called "Paintbrush," and to animate those pictures, able to allow children to design and program their own tools, including games (this was well before "Pong" and the video game explosion), and it would link up directly with other Dynabooks or via telephone with the world's libraries. It was to be priced low enough - under $500 - to provide one to every school kid, and to be accessible to everyone.

The Dynabook still does not exist, but that vision served as a driving force behind many of the tools and design ideas that we - both computer manufacturers and computer users - benefit from today. The goal of the Vivarium program is to do for the next generation of personal computers and human interfaces what the Dynabook did for the first - to be, a "forcing function" for the most appropriate new technology.

The original idea for the Vivarium, the ecology-in-a-computer concept, came from Ann Marion, now the Vivarium Program Manager, when she was working with Alan at Atari. One of their projects was to try and do intelligent autonomous Warner Bros. cartoon characters, to send Bugs Bunny and Elmer Fudd into the forest, and have them play out a cartoon as a result of their personalities. Ann, however, sought to infuse life into more realistic creatures engaged in social interaction with each other and with their environment. She chose to model an aquarium, with fish that would chase and eat one other and reproduce. It was an arduous task, and one that we now seek to make as easy as child's play.

Today we use the *animal in a biological ecology* as a metaphor for an *agent in information ecology*. That is, we hope that our research will lead us to useful ways of designing and deploying "agents" - little (or not so little) software tools that will affect our wishes in the computer, from answering the phone and setting up our calendar like a personal secretary to culling articles of interest from all the world's news sources and preparing our own personal "newspaper" to browsing the world's databases in search of information relating to a personal enquiry, be it technical, literary, or completely fanciful. (Note the recurring "personal" nature of the demands we would make on our *agents*; this is consistent with Alan's view of the progress of computer interfaces from "institutional" to "personal" to "intimate"... imbuing a sufficient number of uniquely personal characteristics to our machines will push them over the categorical edge into the domain of the intimate.)

We know that this problem is hard. In fact, we don't know how to solve it. So we have set our sights on a target that we believe to be in the same general direction. And we expect that by solving the various problems and issues relating to our more manageable metaphor, we will be solving some of the same user interface and computational paradigm and artificial intelligence issues that our greater goal will require. And at a minimum, we believe that there will quite naturally flow a number of innovative tools and techniques from the present endeavor, just as the Dynabook project gave birth to so many of the current aspects of computer usage.

Given our direction, and even an intermediate goal, then, we must creatively seek out the ideas that will give form to our vision. Important input to the Vivarium program comes from the members of our advisory council, including: former Disney animator Frank Thomas, creator of Bambi and other popular characters; Gossamer Albatross inventor Paul McCready; author of Society of Mind and dean of artificial intelligence, Marvin Minsky; author of The Selfish Gene and The Blind Watchmaker, Richard Dawkins; neural network expert and innovator, Geoff Hinton; author of the Hitchhiker's Guide to the Galaxy four-part trilogy and the Dirk Gently novels, Douglas Adams; and Koko, the gorilla who has learned to speak with American Sign Language. These experts on animation, user interface concepts, artificial intelligence, evolution, machine learning, humor, and animal intelligence all inform and enlighten our efforts and help push us in our chosen direction.

The main research test site of the Vivarium program is a Los Angeles "magnet" school known as the Open School. Alan chose this primary school, grades 1 through 6 (ages 6 through 12), because of their educational philosophy, founded on the basic premise that children are natural learners and that growth is developmental. Based on Piaget's stages of cognitive development and Bruner's educational tenets, the Open School was seen not as an institution in need of saving, but as an already strong educational resource whose fundamental philosophies aligned with our own. With the support of the Open School's staff, some 300 culturally and racially mixed children, and our principal liaison with the school, Dave Mintz, we have developed an evolving Vivarium program that is included in their Los Angeles Unified Public school's curriculum.

This curriculum is designed to encourage children to think more about thinking. They do this by studying and simulating strategies that help animals survive in their environments. The children use animation and graphics to design animals and the simulated environments in which they live. They animate stories that illustrate biological and sociological lessons, and create adventure games and video games, at first using VideoWorks and more recently, HyperCard. Now they are beginning to be able to program the animals' mental and behavioral characteristics, such as what they eat, how they move, and so on, and then observe the animals' resulting interaction with each other and with the environment. These activities are usually related to real world activities, such as working in a real, live garden, raising real fish in a real aquarium, and participating in various field trips. The goal is never simply to learn to use the computer; rather, the computer is a tool used to enhance the learning process.

Alan chooses to design nearly everything he does for and with children. By working with kids we are kept fresh and honest. A primary school was chosen as the best place to conduct our studies because these young children are thinking is multisensory, and not yet so bound by adult strictures and conventions. Observing how children think is itself a source of inspiration and insight into the issues surrounding the design and programming of artificially intelligent software. In addition, the lack of social inhibitions found in children of these ages' means that we receive candid feedback on our new designs (and even a fair share of abuse - “This broke!” and “Why does it work like that?” and “This is pretty good, but I like HyperCard better.”). And if the kids can understand and use a new invention, then its design principles are probably sound enough that adults will also.

Because we have spent so much time and effort up front working with the teachers to integrate the computers into their regular curriculum, both the teachers and the children are comfortable with the computer equipment, and are willing to suffer intrusions by hordes of techno-speaking researchers. We learn both from the day to day use of computers within the curriculum and from special trial runs of our new software designs. In fact, the valuable lessons learned in establishing a large educational network (Thirty Macintoshes with hard disks per classroom, Mac Plus’s in the lower grades, Mac II’s in the upper grades), and the strengths and limitations of existing hardware and software are of use in both the long and the short term. This feedback is of interest right now to groups within Apple focusing on education, and is perhaps one of the first tangible spinoffs of the Vivarium’s research direction. We are one of the few programs nationwide that can serve as a test-bed for the classroom of tomorrow where freely available computing resources will be the norm, rather than the exception. In addition, we gain ideas from these trials and tribulations about what we believe the next generation of machines and interfaces should look like, and are then able to turn around and try out these ideas as rapidly as we can prototype them.

Playground, a word that brings to mind a place of fun and social interaction, is the working name for a very experimental and continuously evolving series of interfaces that Alan Kay, Jay Fenton, Scott Wallace, and Kent Beck have been designing and testing in the school. We would like our system to provide a place where children can interact with each other on a common ground, so there should be public areas available to all, and to various groups of individuals. We would like for individuals to have private places, perhaps to work on a project before moving it to a public space to share with others. The teacher should routinely have access to all of the public spaces, and under some circumstances to more private spaces. In general, there should be more than one *view* available of a body of data or a program or a behavioral specification. “Point of view is worth 80 IQ points” - Alan Kay.

In the process of trying to meet the many Vivarium goals, the Playground team has evolved a new concept of programming, which may be referred to as *event-oriented*. It is thought that this programming model may be as large and important a step beyond object-oriented programming as that model was beyond procedural programming. Object-oriented programming provided a new way of thinking about the solution too many classes of problems and through data encapsulation and method inheritance offered an extensibility that was almost impossible to achieve with traditional, procedural programming styles. Even so, the introduction of a new class, a new functionality, into an existing set of classes and objects requires a programmer to touch some number, possibly all, of the other classes in the system in order for the new class to be able to take part in the global network of communication and computation. This is due to the “pushing” nature of communications in such systems; i.e., objects are only activated when some other object explicitly pushes a message onto the system-maintained message list addressed to that object to be activated. A new object/class in such a system will lie fallow since none of the existing objects knows of its existence, or how to communicate with it. The event-oriented system envisioned for Playground is a "pulling" type of system, in which objects can be directed to *notice* their environment; i.e., they can pull messages and information from the available system-maintained list at their own discretion. So a new object, which we might now begin to refer to as an *agent*, can be made to notice various other agents and events within the environment, and can begin to play a role in the global communication and computation immediately upon its introduction into this *information ecology*.

Another important aspect of such a new user interface will be the I/O devices and workstation designs that determine one's method of interaction with the computer. Mike Clark and Tom Ferrara have been working with our advisors and with MIT and Cal Tech graduate students to design and prototype new types of input devices, many with force feedback to provide a more direct, kinesthetic feeling for interaction with one's agents and their environment. Force feedback joysticks, multiple degree of freedom mice, and adjustable-force wings are among the many such devices investigated so far, and we are always on the lookout for new and interesting tactile I/O devices. "MacDesks" for the Open School that house a completely recessed Macintosh computer (so as not to use any of the limited desk-top space), with an inset glass panel to observe and interact with the screen were also designed and fabricated by Mike and Tom. And a gorilla-proof workstation, housing a large touch-sensitive screen behind a ½" of Lexan (to be able to withstand a massive fist moving at speeds of up to 80 miles per hour), was designed and built by Tom. Together with software designed and written by the author, this rather special Mac II workstation will be used to give Koko the gorilla a voice.

Certainly one of the most important aspects of the envisioned Vivarium computing environment is the previously mentioned ability of its user to easily craft limited-intelligence *agents*, to do the user's bidding. For the ecology-in-a-computer system, the user must be able to easily craft behavior models for the creatures in her/his ecology. The nature and methods of specification of these intelligences, these behaviors, is of paramount importance to the final vision of the Vivarium program. Ted Kaehler and the author are actively involved in researching various aspects of machine learning in support of this requirement. Ted has been focusing on genetic algorithms, agoric systems, classifier systems, and code evolution. Using these techniques Ted has been attempting to coax the machine into learning some simple functions based solely on exemplar pairs of some input and the output resulting from the functions' evaluation given that input. The author has been studying and implementing various biologically-inspired neural network models. These have taken the form of "unsupervised, Hebbian-style" learning of statistical regularities in a body of text, and "supervised, Back-Prop" learning to recognize hand-written numerical digits and to translate ASCII text into phonemes plus stress. The author's next intended area of research is to attempt to combine traditional computer graphic rendering techniques with behavior models informed by his work in neural networks and inspired by Valentino Braitenberg's

Vehicles to develop a biologically-motivated, genetically-engineered, polygonally-modeled ecology in a computer, called Polyworld.

As the Vivarium program moves into its third year of life, many questions remain – not just to be answered, but even to be asked. To do good research, one must admit to not even knowing all of the right questions. Indeed, it is fervently hoped that behind every answer we seek out, we will discover a better, more fundamental question. Still, ideas from the Vivarium team's experiences are already influencing other development programs within Apple, with other operating system and language development teams watching our efforts and results, education research groups observing our participation in the Open School, and researchers interested in speech and optical character recognition investigating our experiences with neural network solutions. Then, the ever-evolving Playground may break the ground for event-oriented programming the way Smalltalk did for object-oriented programming. And if some version of Playground does enable children to create reasonably behaving fish in a simulated underwater environment, then perhaps, just perhaps, those fish may someday turn into *agents*, and they may swim in an ocean of data, gleaning just those items of information that fit our dietary specifications. And we may be treated to the ambergris-sweet scent of knowledge, digested from bits of raw information."

The Vivarium Program set the course of how artificial agents take the form of animals that people are most familiar with in the settings where they anticipate expected behavior. Although the goal was to improve the use of computers, by researching and building the many tools necessary to implement a functioning computer vivarium, an ecology-in-the-computer, the user interface and the underlying computational metaphor served in the reverse where such environments can spawn artificial creatures.

Concept Three: Creatures—A Vanimal society that leads to Grandroids

In 1996 programmer and visionary Steve Grand created the first and most popular artificial life simulation game, *Creatures*. Creatures is a game which allows the player to hatch and then raise anthropomorphic beings known as *Norns*. These beings are the subject of the simulated environment where the player is given eggs, incubates and hatches small furry animals, then must teach them how to behave or choose to have them learn on their own. The user plays the role of an omnipotent "God" and has complete control over the experience "felt" by the Norn. Additionally, they could be taught to speak, communicate in various ways, be driven by food and resource acquisition, and learn to protect themselves from protagonists such as *Grendels*.

Creatures was the first successful popular application of machine learning in an interactive simulation where the mechanisms involved feed-forward back-propagation neural networks to obtain and expand their knowledge. Its context allows serious research in artificial life and synthetic psychological experimentation where the differences between simulated and real psychology can become quite blurred. Steve Grand is regarded as stating on this point:

> *I create artificial life. I apply my scientific skill to the detailed and complex simulation of neurons, bio-chemicals and genes, and then assemble them delicately and with care into living, breathing virtual creatures. I nurture these tiny defenseless souls into existence, place their miniature, pulsating brains into their cute little heads. And then I kill them.*

Richard Dawkins has criticized and praised this system by stating in 1998: "While the Norns interact with human beings in an interesting way, they are more a cunning illusion than living beings." Then again in 2003: "Steve Grand is the creator of what I think is the nearest approach to artificial life so far." Use the illusion that suits.

Concept Four: Summary

In times when a curious person is young, writing a letter to a burgeoning robotic toy company in the hope of getting a job working in what one understands to be the future of humanity and having been made to wait patiently and with great anticipation, when the response never comes the blame of negative emotions is never placed upon the object, but in the manner in which other people have done the idea a disservice. Such experiences keep the idea fresh and vibrant for many years.

Embedded but essentially independent at the level that it matters to the human experience, e.g., not worrying about what goes on in places where the ordinary senses cannot penetrate. A computer running a program contributes greatly to this experience, especially if it is enjoyable or aiding knowledge growth. The addition of articulated robots with personalities in a similar manner as those created and groomed in simulated environments aids in the experience of not just the creator or innovator, but can lead to unique visual and epistemological transference, outside of the realms of a surveillance-state.

There are many authors who quote a phenomenon called "the singularity" where it is stated that understanding the difference between artificial intelligence and machine learning is key to identifying the real from the surreal. The problem of the singularity in describing computational process phenomenologically and machine learning ontologically is not that it is evidence of a missing link, rather, an indication where an epistemic cut in made in said epistemology between what humans perceive as real and what they perceive as magic. Laboring in such a capacity, yields different perspectives between consumers and corporations where the interchangeability of the two becomes muddied and a disconnect forms in a system that had evolved over the past centuries toward a kind of disparate unity.

The historical description of the evolution of the visual element is the easy part. The difficult question is: How can people be made *to understand* what it is and why it is useful to their experience?

What is important to consider is the concept of the object.

Integration of machine intelligence will continue to occur as long as there is the impetus either desired or commercial that espouses the freedom to develop technological sophistication to match an agreed set of desires and expectations. The problem has been the lack of inclusion of the different kinds of humans that come into contact with the technology. Woke culture and gender-neutrality shades the problems with expectations driven by skepticism and disconnection with what could be a very different outcome contrasted with their embodiment, e.g., robots. Of various forms and features, but those especially designed to appeal to the human aesthetic.

The proclivity to make decisions based on income-generation and not the greater good opens the door to error and catastrophe. Those parts deemed good to humanity but not profitable will be cast aside. The climate debacle is one of these existential crises where some have already committed the species to perish, but there still is the capacity of reason to save ourselves. Machine intelligence learning is an algorithm that, when fed enough information, is capable of recognizing patterns in new data and learning to classify that new data based on the information it already has. Essentially, these algorithms teach the machine how to learn. An apparent danger in this method is that if the machine is allowed to accept its own assumptions to be true, it may stray from the path the developers envisioned. This is an insecurity that needs to be addressed.

The entirety to embrace is to consider is how we treat knowledge, as if it is a human right or not. Certainly, it is a right of humans to acquire knowledge, once the conditions are created. In the early years of human evolution, the species spent a vast amount of time, relative to the present era as hunters and gatherers with limited agriculture and animal husbandry. Once the domestication of agriculture was developed, the notion of civilizations appeared where the division of labor allowed classes of individuals who had the freedom to use their mind, rather than their bodies, to solve problems. Given the advent of leisure time, the idea of the intellect appeared. the many persons both known and unknown, whose contributions (acquisition and transmission of knowledge) pushed forward intellectual and technical advance at a pace given the impetus of the individual (by its acquisition and transmission) and toleration by the state, however once revealed as such, cannot be made more cheaply with each subsequent communication. This is one of the species fatal flaws. Many stories throughout history tell of vast libraries being burned and destroyed by primitive peoples, institutions, and sycophantic individuals, because of the lack of respect for the real value of knowledge—to advance a people in both intellect and reason. It has been suggested an inherent laziness haunts the species where incorrect choices plague beings to make the same kinds of mistakes over and over again.

So, how does one continue? Begin by considering the objective of the object: how a robot saves a person. Perhaps not a literal example would suffice, as from drowning or saving in the religious sense, rather of enhancing intellect and the soul, for whatever substance it consists.

Chapter 4: What? I'm an agent!

Doing what you think is not thinking about what you are doing, said the master to the monkey. Cast glances to the side where it seems you never had to look and its power will guide you.

A new technological era will start one way or the other, perhaps it won't be explicitly *technical* except in how it is interpreted, but things will certainly change in a radical manner. To a degree they already have but can such change ever be perceived? Such change can come in piecewise visual form of new gadgetry or some wizardry communication paradigm, else, can turn toward cybernetic warfare between strong states against weak ones who don't align with their culture, politics or social engineering ambitions. Sovereignty is not just a concept for nations but one also attributed to individuals. When pressed, a rational person will not succumb to the kind of scenario where the individual is considered the property of someone else, somewhat akin to slavery, but since the progenitors are decidedly lazy, it will be more a case for aesthetics than anything resembling slavery of the past. Unless, of course, one already inhabits an area of the world already beholden to the unipolar order.

The professions of an economic dystopia are easily turned on its head; the *values* espoused by capitalism stipulate the individual as empowered by the freedom that asset acquisition by free capital—not resources per se, rather those with the hand on the printing press and given priority in the outflow—decides the winners from the losers. It is not "he who has the most money" instead "he who controls the segment of the market" that is employed to control the whims of a consumer. It is no longer tied to any substantive asset, such fiction has long been discovered, and only perception is what holds the system together. The monkey knows too well that perception is everything and this idea is traced to the invention of representation.

The British physicists of the 19th Century paved the way for not only an understanding of how to compute the physical world but to also establish the mathematical principles to be later used in the development of the computer. Some might find this a surprising fact as the influence of the "Continental" physicists of German and France during the period could be perceived as less-important. However, the purveyance of the various Royal Societies in England, Scotland, Wales, and Ireland contributed greatly to coalescing a great pool of intellectual talent and dispersing it throughout the world in the form of the British Empire. This system was to establish the scientific process of how advanced technological growth of the 20th Century would evolve. The country that bore Newton would come to dominate how science was defined, in what rigor, and how methodology, ontology, and epistemology would develop in the mind of subsequent generations. This was transmitted via University curriculum and reinforced by examination regimen; what has come to be known as science today, no matter how diluted or divorced from its original influences and influencers, is based on the intellectuals and academics belonging to this body. Despite the transition of power as the empire decayed to a more homogenous world and even despite the falling prestige of English Universities in the early decades of the 21st Century, the preponderance of its scientific influence is still front and center. It has supported but also been rue to the rules-based unipolar order. Certainly, the American Universities aided in drastic evolutionary growth of the technology while the companies and corporations implemented them into consumer goods where today the average person does not realize how the products they consume came to be or what motivation lie beyond. Stating simply for the reasons of profit is too simplistic an answer.

Such an understanding is not requisite for an individual to grasp how to consume the product, in fact, *not* understanding outside of the consumption usage process and perhaps the knowledge of disposal works better in terms of the mechanics of economy. However, there are times when questioning the evolution of consumption of technological goods serves to enlighten by allowing a dissection of the process that brought the goods into being. A reason for this kind of loose analysis would be to ponder questions like: "How does soup get into a can?", or "Why is uncooked meat purchased at the supermarket enclosed in plastic?", rather common queries about process. More deep-seated questions like: "How did robots come into being?", or "what is artificial intelligence?" would help to create a framework of analysis to dive into the history of the concepts, as has already been discussed. Still further deep questions like: "How did we get here?", or "Why are things the way they are?" require examinations of the intellectual evolutions that driven these.

So how did we get here? Why is the world structured the way it is now?

Reflecting through the mirror on the contributions of a British physicist would be an insightful route to give a holistic overview and then focus on the aspects that are best paid attention to. The starting-point will be Isaac Newton, the second Lucasian Professor of Mathematics at Cambridge University, his mention in this context is to illustrate that he was noted for his profession as a "natural philosopher". Although the study of natural philosophy goes back to ancient times, it is only between the 17th and 19th Century can a clear path be drawn of an evolution from a discussion of the properties of nature to a systematic study of nature. The syntax is distinctive and was further evolved to the foundation of modern science by the voluminous work *Treatise on Natural Philosophy* by William Thomson (later Lord Kelvin) and Peter Tait in 1867. It has been stated by numerous authors and various luminaries in science since the 19th Century that this work is the foundation from which all physics as it is commonly framed stems. This includes the formulation of concept, the logic of computation, and the rigor of proofs that science today holds as its guiding principle, dogma, and existential purpose. The study of physics cannot be undertaken with any amount of assuredness without mathematics, especially computing mechanisms that would allow solutions of analytical arrangements of natural artifacts. To this Newton, during reclusion from the plague of London in 1666, formulated fluxions—his form of the time-derivative or rate of change of a point, that later became known as *The Calculus*, as well as other mathematical and analytical constructs of optics, mechanics, and gravity by laboring from the works of Descartes and Galileo.

Newton's concept of *fluxions* and *fluents* led to the earliest definition of the infinitesimal or quantity in a moving frame of time of symbols representing moving objects. While Leibniz was the first to formally publish work on differential calculus that is widely used, Newton in *The Mathematical Principles of Natural Philosophy* uses the calculus in geometric form based on limiting values of the ratios of vanishingly small quantities as *the method of first and last ratios of quantities* that could be considered as Newton states: "hereby the same thing is performed as by the method of indivisibles". What is relevant to the discussion here is not the Newton-Leibniz controversy of who first invented differential calculus, rather, what principles from natural philosophy most contributed to the concept of *representation* in physics of the 19th Century. However, the path toward a kind of analytic epiphany was hard to find. For a period of time encompassing Newton's working life, the discipline of analysis was a subject of controversy in the mathematical community. Although analytic techniques provided solutions to long-standing problems, including problems of quadrature and the finding of tangents, the proofs of these solutions were not known to be reducible to the synthetic rules of Euclidean geometry. Instead, analysts were often forced to invoke infinitesimal, or *infinitely small*, quantities to justify their algebraic manipulations. Some of Newton's mathematical contemporaries were highly skeptical of such techniques since they had no clear geometric interpretation, in terms of how Euclid had come to be understood. This conundrum, while sorted by Newton later in his life by attributing these to the concept of *approaching zero* rather than actual zero—entering into the process a transmathematical principle—can also be examined in the light of other kinds of algebra. Namely, the *quaternions*.

While many scientific advances are tied to Newton, the one that is of interest is to understand the development of the principles of electricity and magnetism. The two aspects of a single phenomenon form the ensuant of the study of natural philosophy in how the mastery of them laid the foundations of the modern way of life. It is through the knowledge gleaned by analysis and computation that aids in the mind comprehending the abstractions of the invisible but experienced phenomenon. Additionally, the collected representations of both electric and magnetic phenomena touch nearly all other sub-disciplines of physics; hence, why electromagnetism (EM) is one of the four fundamental forces experienced in the Universe. Another is gravity, a force described so simply but with so much impact upon science. There is some thought of a connection between gravity and electromagnetism in the form of the gravitational deflection of light and quantum gravity. What is interesting is there has been a more-or-less straightforward progression of knowledge from the time of Ampère through to Faraday, Maxwell and Larmor with a significant interruption at the appearance of the Quantum Mechanics in the 1920s. Also, taking Einstein's relativities—the special and the general theories—as a discipline the history of electromagnetism and its representation has a curious story in the years between 1820 and 1907.

The early history of magnetism stems from antiquity when the Greek and Persian peoples used magnetic rocks to coalesce conductive metals for different kinds of foundry activities. Electricity was confined to the static case where rubbed amber could generate what we now call high-voltages. It would only become a more controllable element due to the work of

Volta in his voltaic pile research beginning in 1791. Contrary to the notions of animal electricity espoused by Galvani but still inspired by it, Volta constructed a purely mechanical device—plates and paper-soaked electrolyte—that generated steady currents that inspired an entire genre by the likes of Sir Humphrey Davy, along with the tale of Frankenstein due to the connection between electricity and the stimulation of disembodied frog's legs. Various kinds of machines came and went throughout the remainder of the 19th Century ending with the modern adaption of long-distance grid electricity realized in the present era due to Nikola Tesla's AC Polyphase system.

The natural philosophy of electricity and magnetism was investigated by Ampère and was continued by Faraday. It was mathematized by Maxwell who became the key author of the discussion of any and all electromagnetic phenomena following his *Treatise on Electricity and Magnetism* in 1873. Although not widely believed when it was published and the demand for revisions kept Maxwell busy on but an unfinished second edition when he died in 1879 to be completed by Niven in 1881 where it met with greater fanfare than its predecessor. However, it wouldn't be until the discovery of wireless transmission by Hertz in the years 1886 and 1889, based upon a series of equations in an earlier publication by Maxwell that would become the ubiquitous *Maxwell Equations*. Hertz opened the door on a completely new age of technological progress that he didn't live to see nor could comprehend its ramifications. With the modern world that became the 20th Century rapidly approaching, the scientists of the era worked feverishly to define a system of mathematical expressions that described all the available kinds of phenomena to be exploited by technological development. Larmor was to write a treatise on a lesser-known feature of the phenomena in tandem with its transmission in *Æther and Matter*. Joule, J.J. Thomson, Rutherford, and Dirac exploited for technical innovations while Helmholtz, Einstein, and Weyl discovered electromagnetism is one of the sources of relativity theory, especially in the appearance of gauge theory that allowed the realization of quantum mechanics and the nuclear age—of course not forgetting the work carried out during the investigations since the 17th Century on the topic of heat or thermodynamics. As the age of mathematization of electromagnetism reached its apex in the 1890s a curious conundrum gripped the engineers of the time: *What to do with the notion of the field potential?* This is a question that has remained unanswered and exists at the limit of knowledge.

The true character of magnetism as a vehicle for electricity has never been fully disclosed; neither has the concept of the free-space vacuum. There are agreeable suggestions that free-space, that is the space between conductors, is not empty but inhabited by what is called quantum foam. This description is not unlike the 19th Century concept of the æther but does not exist in a classical interpretation. What can be said with some resolute is that what is perceived in the natural world is described according to the character of its representation.

The curious case of representation

All phenomena are in an incomplete state of totality, as far as humans are concerned. There have been many reasons posed and logics postulated to define it but it really comes down to how we understand the implications of the projection of geometry. The concept of totality is exactly what it means: Something being completely described, complete, being able to be leveraged in totality of its rules, sets, and applications. Aristotelian or Boolean logic are examples of total systems. Both systems have logic that is stated in terms of explicit truth values: True (T), or False (F). They coexist together with the implicit handling of semantic values of *contradiction* and *nonexistence*. Classical logic is an early 20th Century innovation and the term does not refer to logic from classical antiquity, e.g., that which used the logic of Aristotle. Rather, classical logic is the reconciliation of Aristotle's logic, which dominated most of the last 2000 years, with the propositional Stoic logic where the combination of these two, previous to the 19th Century was considered irreconcilable. While Leibniz's *calculus ratiocinator* foreshadowed classical logic, it was developed in Bertrand Russell and Alfred Whitehead's *Principia Mathematica*. While this work defined the total system that is logic, it only represents a total description of a system of representation of those physical things than can be brought into sets or groups. If a system of representation, like logic, can be brought into totality—or at least a degree *approaching* totality—then that system of representation is far more accurate to describe the phenomenon it is designed for.

Due to the age of discovery of electricity and magnetism, different cultures cogitate implications in different ways and manipulates them by different means. Although beholden to the British interpretation codified in *standards*, casting a glance at electricity primarily in the scope of currents flowing in wires drawn by magnetic forces opens the study into new and different perspectives. One such exercise worthy of discussion are those objects called monatomic elements.

Monoatomic elements are those elements which have a single atom existing individually in nature. For example, regarding hydrogen and oxygen, their representation as a chemical structure is H_2 and O_2 respectively. The representation expresses the element hydrogen existing as two atoms of hydrogen combined as H-H. Similarly, oxygen exists as O-O again a combination of two atoms. These are called as diatomic elements as they exist as two atoms in combined form in nature. When attempting to separate them as H and O instead of H_2 and O_2 they will be highly reactive and unstable. Hence, by nature, they exist as a combination of two atoms due to a profound instability in monoatomic form. Whereas monoatomic elements are those substances which have one atom existing freely in nature without in a chemical combination with another atom. This means these elements have single atoms which are highly stable. The noble gases such as Helium (He), Neon (Ne), Argon (Ar), Krypton (Kr), Xenon (Xe), and Radon (Rn) are monatomic and stable. Besides these inert gases, there are also heavy metals which can exist in monoatomic form with different physical and chemical properties when their lattice is disturbed. These include: Gold (79), Silver (47), Platinum (78), Palladium (46), Rhodium (45), Ruthenium (44), Osmium (76), and Iridium (77). In nature metal atoms are monoatomic but they are bound by metallic bonds in a lattice such that more number of atoms of the same element are kept together. But there are no chemical bonds in between these atoms and hence can easily break up to form monotonic structures by a certain force and by chemical reaction. Most often this force and chemistry was experienced inside of volcanoes where the element Gold (79) was transmuted into monatomic form. Gold is a highly conductive element and when in monatomic form, has the properties that can act as a superconductive element at temperatures much higher that the few degrees of Kelvin that traditional ones operate at while interacts strongly with magnetic fields. Without delving into great detail, it suffices to say that the ways of means of utilizing electrical currents and magnetic fields varies dramatically between different advanced cultures of antiquity and that further possibilities exist outside the realm of experience or imposed limitation. A further stipulation is that of the use of the properties of acoustical waves to cut stone, or that the force that consists magnetism is the flow of particles from one side of an object to another. Simply because of the knowledge gap people often cast out ideas that are strange and find varying degrees of aggression to "murder" them in the modern era. Such was the case for the electromagnetic potential when the formalism around computation was developed in the closing decade of the 19th Century. Indeed, *what to do with the notion of the field potential?*

Focusing the discussion of the research and compilation of a rigorous *definition of the behavior and properties of electromagnetism*, the story begins with Andre Ampère in 1826. He was the first scientist to fully describe how electricity and magnetism both worked in *relation to each other*. Before that, electricity and magnetism were thought of as two different things and it wasn't until a series of experiments by Hans Ørsted in 1820 that showed a connection, made possible by the invention of the battery by Volta. Ampère, over the course of a few months in September 1820, started a revolution by the realization that it was possible to produce forces of magnetism—attraction and repulsion—without magnets. All of the magnetism was generated electrically. Ampère then brilliantly devised an equation connecting the size of a magnetic field to the electric current that produces it. This equation, known as Ampère's circuital law lay the representational foundations. To explain the relationship between electricity and magnetism, Ampère proposed the existence of a new particle responsible for both of these phenomena—the electrodynamic molecule, a microscopic charged particle that seventy years later was called the electron. Ampère correctly believed that huge numbers of these electrodynamic molecules were moving in electric conductors, causing electric and magnetic phenomena. His research was culminated in his 1827 book *Memoir on the Mathematical Theory of Electrodynamic Phenomena, Uniquely Deduced from Experience* that lay the foundations for the next generation of scientists.

Now that a case of representation has been laid out, a discussion of one of the most inventive will serve to illustrate particularly how to go about finding the correct one. Considering the beginnings of representation in the development of the science of electromagnetism, there was a singular mathematical framework that was conceived to solve the complexities inherent in quantizing the potential functions. However, a big problem was not only in the sparseness of the phenomenon but also that it could not be represented in the correct context without insisting on it being symmetric. It is this blockade caused by the way mathematics developed throughout the 20th Century of the necessity of symmetry – the notion that a behavior is the same from A to B and from B to A.

A walk through a (not-so) new method called Quaternion Calculus

As promised in the introduction of this book, there would be *no equations* like those that appear in mathematical texts. The reasons bear repeating briefly. Oftentimes there is a sense by people that somehow the appearance of a mathematical expressions or, more commonly, *equations* creates in an instant a massive sense of foreboding. More on quaternions and representation coming soon.

I would echo this to anyone who asked having not come from a mathematical background but having to go to great lengths (and pain) in a vain attempt to understand its various forms and toolsets. From my early years exceling at chemistry there was something noble about atoms and electrons shifting around to make different elements. But outside of what I could do in my head, when it came to physics the appearance of equations upon reading the prefaces of the noblest mathematical treatises brought on the disappointment. So, having learned it the hard way and still learning about it, I know that there is a lot to understand by *knowing* what mathematical expressions try to explain but there is a cleaner and less bombastic way to go about it. In the next section I will give it a try. Before we dive in, we will need to explore some background details. There is a distinction between the analysis (algebra) and motion where dispersal of energy is according to the inverse square law, devised by Robert Hooke but widely attributed to Newton. It states that the energy emitted by a point-source, a physical quantity, is inversely proportional to the square of the distance where the energy is measured. A staple in physics it stems from the peculiar feature in nature that energy, force and those effects from them can be understood as geometric dilution corresponding to radiation in three-dimensional space. While the analysis, in terms of algebra, is rather solid and will only shift when discussing the methods and means of computation, or *the calculus*, motion can be classified as being either *astatic* or *dynamic*. The former is defined as: “having no tendency to assume any particular position or orientation”, while the latter “of or relating to energy or to objects in motion characterized by continuous change”. The differences in use of the terms will be explored as the discussion ensues but astatic will refer primarily to situations where change in a system is discussed in a seemingly unnatural one-step-at-a-time method while dynamic will refer to other times when the system is computed in a non-stop or continuous manner. So, visually, there is to discuss:

<table>
<tr><td colspan="4">The natural physical world (understanding of)</td></tr>
<tr><td colspan="2">Analysis</td><td colspan="2">Computation</td></tr>
<tr><td colspan="2">Algebra</td><td colspan="2">Calculus (motion)</td></tr>
<tr><td>Ordinary</td><td>Octonion</td><td>Astatic</td><td>Dynamic</td></tr>
</table>

The goal is to obtain the *truth* about the natural world, how it is composed and how it can be reconciled. In so doing, knowledge is gleaned not only how to manipulate it, but to also find ways to improve a coexistence that benefits all participants.

Chapter 5: Planned obsolescence or obsolescence planned?

The rise of the end is inevitable to all things. Once the monkeys planned to rid themselves of the master. If they were successful they would leave the old man starving to death. But what would happen next?

The time for the end of all things, whether they be ideas or physical objects, is inevitable. Sometimes ideas enjoy a resurgence—sometimes for their merit and sometimes for their fashion—but physical things wear and decay with use and some do well to sustain the ravages of time while others do not. It matters most is from what materials the object is constructed as well as the details of how it is constructed, what kind of consideration was made as the machine wore over its operating times. Longevity can also find merits in the ease or difficulty of replacing broken or worn parts. The reinforcement of the part and its prevalence to be obtained easily and cheaply a key property. How a technology is consisted means everything to its perpetuation.

Manufacturing is an art old as antiquity: People of many different cultures have been making finished goods for others to consume for a very long time. The present-day narrow understanding of this has been framed in terms of the parameters established during the Industrial Revolution, where the centrally-defining feature is the interchangeability of parts. This is not to deemphasize the importance of such a concept and while interchangeability is key to propagation of technology through multiple societies, the *way the object was considered to be manufactured* is a deeper metric that reveals what the makers or manufacturers were thinking at the time the object was manufactured. Sure, like their competitors they have a supply of parts should the object require service, but unlike their competitors they decided beforehand how long a consumer would be able to enjoy the object before it *needed to be replaced.* This concept is called *obsolescence* and is as key to manufacturing—mostly in terms of profits present and future—as the interchangeable part is to the aftermarket supply chain.

Before examining details what is the practice of making things? All objects, regardless of who makes them, began as an Idea. An idea is a wonderful thing and it is that which keeps a species pace of survival while fostering its evolution. An idea can be shared between peoples despite cultural, societal, and linguistic barriers. Just because one has an Idea it doesn't mean it can be realized; the complexity inherent in its ultimate implementation defines the level of ownership that is the pure substance of the degree of leveraged monetization of intellectual property that drives the world economy. Oftentimes the magnitude of this degree drives the decision whether an Idea will be implemented or not. In one way it can be said that it doesn't *matter* how fabulous the Idea might be, rather, how others and the number of others would be interested in consuming it. Once an idea is approved by those with the adequate resources to see it progress, it becomes designed. Once designed it is prototyped. Once prototyped it is shared among a small group of targeted users to ascertain if the design was suitably targeted to the group that the Idea was intended to stimulate into buying. If this fails in any way, often it is iterated backward to be re-implemented then brought forward again until the targeted group of consumers like more than dislikes it. Once it crosses this threshold, it's manufacture is planned. The process of manufacture is far more complex than people realize, if time is spent considering it at all. A refined process with the intent to reveal a pattern of understanding is discussed in Chapter Eight.

External to manufacturing is the supply chain. One needs a supply of parts to make the object and a decision can be taken whether or not to make them *in-house* or contract for them to be made by someone else somewhere in the world where such things are made. There are a lot of decisions and variations to consider but what matters is that once all these complexities are satisfied and an object is being manufactured by a person or company, it is *supported* throughout its lifetime by service and repair. If an object is sophisticated enough that it requires software for its functioning, updates and channels how these are distributed to the consumers is also necessary. Suffice it to say that as electronic devices are becoming more and more popular—computers, phones, appliances, and robots—the emphasis of work beyond the Idea are more and more removed. Unfortunately, then, the focus on the poignancy on the Idea is altogether removed from the efforts and time of its implementation, manufacture and support.

The concept of obsolescence can be also traced back to ancient times, particularly during the Roman Empire where apocryphal tales from a number of writers tell the story of an inventor who approached the Roman emperor Tiberius with his invention of unbreakable glass. Tiberius asked if anyone else was aware of the invention. The inventor, quite happy with the question and expecting a great reward, replied that he was the only person who knew the secret. He was surprised to next find himself being beheaded. The motivation, according to some authors, was to protect the livelihood of the glassmakers.

Obsolesce can apply to a range of types—technical, functional, stylistic—where these kinds are ones that transition to an improved object that conforms to the nature of the change of tastes of a culture and society. The one type that is insidious is the one called *planned obsolescence.* This concept was introduced by Bernard London in a short paper in 1932 where it characterized how to get the world economy out of the Depression by addressing what he termed: *distressed human relationships.* He contends the following as the basis of his Idea:

> "In the present inadequate economic organization of society, far too much is staked on the unpredictable whims and caprices of the consumer. Changing habits of consumption have destroyed property values and opportunities for employment. The welfare of society has been left to pure chance and accident.
>
> People everywhere are today disobeying the law of obsolescence. They are using their old cars, their old tires, their old radios and their old clothing much longer than statisticians had expected on the basis of earlier experience."

By the latter-half of the 20th Century, large manufacturers in a state of profit panic convinced themselves the need to control their consumers by having them replace those items even if they had not worn out to the point they were unusable. A model for them to follow was the invention of the incandescent light bulb. Thomas Edison was the first to patent and market a steady source of illumination for a wide variety of contexts stretching to both indoor and outdoor applications. After much experimentation, it was revealed that with certain materials, a light bulb could last millions of hours. The first to undertake electrification was the public infrastructure of New York, those places that were underground and especially those underground areas where maintenance of the infrastructure was critical, such as subway support equipment and heating networks where it was critical not to have lamps go off and on, rather to be lit continuously and at low intensity. Light bulbs that were introduced, for example, in the first decade of the 20th Century *still illuminate* today while those of the latter years of the 20th Century were to be replaced at intervals specified on the packages that contained those bulbs.

The actions included in the process of obsolescence reach through the entire activity of manufacturing and send signals to partners or aftermarket suppliers that this action has been taken, where an understanding was formed that people who consume own the objects that others manufacture, as it had been for thousands of years was disrupted, changing the natural evolution of the process of Idea-to-Manufacture, also changing the nature of the consumer to the company that was manufacturing the goods. The individual manufacturing objects would be slowly eliminated as the relative cheapness of manufacturing with such planning in mind, easily surpassed their desires to make an object that lasted a human lifetime.

How planned obsolescence slowly devolves the human society

If humans are lucky, they will *earn* a chance of a decent survival. This is the moniker that people have had to face since the mid-20th Century. In the times before, the evidence of history suggests that people went about their lives according to their economic situation and potential for advances securing objects—those items that could reduce labor and increase gains—based on their utility and scope and whether or not they could afford them not only with the purchase price, but over the long period of their use. In a word *quality*. The quality of an object, compared to its utility and ability to be upgraded as new advancements made their way into the markets, was the sole determinate factor. For example, in the 1920s in America before people widely accepted automobiles as the primary means of transportation, the tram or trolley was seen by many city-dwellers to be the optimum quality in getting to the places they needed to exploit their economic opportunities to get the things they wanted. Therefore, the idea of the cost of owning and maintaining an automobile was preposterous to most as the quality of trams and trollies were hard to overcome. There were variations, of course, as these companies were private where some had better service than others. In order to change the dynamics of this arrangement, manufacturers of automobiles purchased trolley companies and slowly degraded the services until people soured on them. By reducing the available quality of the object, people in relatively quick time set aside resources to purchase automobiles as the low-quality transportation services threatened to disturb their economic pursuits. Rather than helping human society adapt to the challenges of new ages, tastes, and whims, it has become a way to manipulate people *en-mass* so that future profits can be hardened and stock prices can be guaranteed—a form of selfishness that works directly against the interests turning survival as a right into something that now has to be earned.

Rather than focusing on doom-and-gloom, as if the change in how things are or were in permanently affixed to persons alive today, a superior strategy is to move this concept of obsolesce from a static point-of-view to a dynamic point-of-view, namely, the role experience as it plays into the experience. This is a good way to not only examine the topic but to convey lessons learned without having to resort to more control over any one person in order that the point be made not just clear but imperative. If it were reasonable to insist that the only way an individual could change their fate was to accept another set of rules, the practitioner would be no better than the events that made life the way it is today. Rather, it is preferable to understand that they submit to a condition of being *pre-programmed* to fulfill wishes and to submit to whims that one is made to believe they are. Of the more notorious examples stems from computer hardware and operating-system software.

People have accepted the computer as an essential object in everyday life. It is the primary method and means of a person's economic pursuits especially in the times of extreme isolation in the case of public health emergencies and drastic restrictions on movement. Without the computer people could not go about their daily lives, just as they could not a hundred years ago without suitable transportation. The digitization of life only transposes the means by which one attains resources deemed necessary for survival. But such a realization is also exposed to the activities of planned obsolesce, along with the technical and function kinds where the user enjoys advancements. Often in the development of the computer, there is a separation of those who manufacture hardware and those who manufacture software, with a few exceptions, of course. Then there are those who are uncomfortable with the process of planned obsolesce for the impact that it places on the environment.

When an electrical appliance becomes broken the user more often disposes rather than tries to repair it. This habit is a direct result of the actions noted in London's 1932 paper. When it is disposed, at one time in history it was thrown into a spot of land where other kinds of disposal debris was discarded, eventually being buried into a mound that appeared as "new kinds of hills" at a distance. As the 21st Century arrived and people started paying attention to the changes in climate around the world, some took it upon themselves to try to transform this process however they could. One of the easiest ways was to refresh a personal computer, a laptop, by deleting and writing the original state operating system. This process removed the unwanted extraneous files that gathered inside the operating system slowing down its performance to the point that the person using the computer thought something was drastically wrong and that a new laptop needed to be purchased. The process of refreshing the laptop not only extended its life and reduced waste in landfills, but also enlightened the consumer that their purchase could be used for longer periods of time than they believed they could be.

This notion of fighting against planned obsolesce began with people working a recycling businesses. As anyone who has gone fishing for things at second-hand shops would know, a lot of things that are disposed of, of those things thrown away, a majority of it have the ability to be reused with a bit of cleaning and maintenance. Persons working in the last-line of defense of obsolescence stand at the threshold between reusability and dumping into a landfill. Electrical components, unless disassembled and recycled part-by-part risk contain Imation of water supplies by the seep of toxic chemical as the material—circuital components, solder, breadboard—degrades as rainfall erodes it. There is a story that got quite a bit of press in the 2010s where a recycler wanted to help users keep their personal computers longer by providing free of charge restore disks for their machines. A restore disk is media, usually in the form of a CD or DVD-ROM that refreshes the computer's operating system without deleting files that were placed on it after its initial use, only removing in effect extraneous files that were accrued during periodic updates but were not sufficiently deleted by the operating system's processes. This in itself contributed to the obsolescence of the machine. However, the manufacturer thought it better for their business model to sue the recycler in a court of law to forbid them from exercising their ownership of the computer or the operating system by refreshing it. While many stated this an abuse upon the individual by Draconian legal means, the vendor thought it prudent that it server their bottom-line future profitability, despite whatever damage to the environment was spared. The following is a first-person account, given for the transference of contextual meaning.

In the mid-2010s I purchased a software-enabled mobile telephone that ran a branded operating system. In the past when I worked in software development, I spent quite a lot of time developing applications for use in earlier versions of the software and handsets. The reason for initially working with the platform was for employment gain but also for pure curiosity as the era of computing merging with the mobile telephone started to make sense. As I became more and more experienced writing applications my range in development naturally expanded and soon I was able to leverage all kinds of interesting things to solve very practical problems of the time. In order to accomplish this, a great deal of investment of time, mental and physical effort working with interface development environments (IDEs) that had both good and bad qualities depending on the kind of innovation I was contemplating. Once reaching what I thought was the apex, time crept forward and the vendor put out a new version to supplant the old. Initially I thought not much of it as the past two or three technical and functional improvements continued the same basic programming paradigms so that, with a minimum of modification, applications could be modified to run on the new platforms. However, when this particular one became known to me via my attendance at a conference, it was thrust upon me that *nearly nothing* of what I had been working on, what I had been developing could be transformed to the new platform. Not without a complete rewrite. Now this is not as bad as it sounds as sometimes rewrites and their magnitude of effort could just be a matter of perception by the programmer. But in this case, features that I would rely on just did not exist in the new platform. During the conference, other attendees became aware of this and there was a great ruckus in the hall. As the presented tried to plead above the increasing din of voices and shouts, the presentation was terminated with the promise of more forthcoming information how to solve the issues and the appearance of more bling in the form of shirts, caps, and sunglasses.

What the experience taught me was not whether or not a vendor can just pull the rug out from your business by not just changing the software but critically damaging upgrade, rather, the critical issue is a question of ownership and right. If, as a consumer, one purchases a product, does that imply ownership of that product by the consumer, or is the consumer only "borrowing" the product for a certain period of time? Does the professional that devotes his or her time and energy to supporting a product in order for economic gain entitled to have their right invested by the vendor so that they might change tactic upon realizing what they must have already known. In this case, rather than addressing the pleads of those invested in supporting them, they arrogantly continued with the practice and in so doing alienated enough persons, even the most die-hard fans so that they eventually abandoned the whole platform altogether where they lost a market share of 70% to subzero.

Almost all software vendors expire family versions of their products in the ambition to have their customers purchase the new version. For some companies, this expiration orphans hardware rendering them useless in the new software epoch. While some allow their customers to continue using the old hardware, with restrictions as they cannot run new features or functions, some companies are very insidious how they expire. As the widespread use of open-source software became more prevalent, such activities became less-important. Despite the perceived value, these companies are not in the business of providing value to their customers, only in the services they provide for as long as they desire to continue. Rather, they extract value from their customers including subtle things like code design, copious amounts of source code posited by millions of developers, programmers, producers, and value-chain providers that are only aware at a near unconscious level of how the substance of their daily lives, including their free time spent, is devoted to providing value exclusively to the company. While the boardrooms roar with excitement at the constant increase of profits slowly but surely each person becomes more and more of a slave.

In consideration of a purely transactional sense, one purchases something in exchange for money; this is a norm in the society that has been humanity's economy for thousands of years. However, in the blind pursuit of profits for profit's sake and no other, many companies try to have the consumer believe that they really don't own the products they purchase, that they somehow still are the property of the manufacturer or software vendor. Some companies take this to the extreme in pursuit of maximum profits, even when they are flush with cash and their stakeholders some of the richest on the planet. This evolves into a game of pricing from which no company ever escapes. In the evolution from personal hardware and software to externally-hosted features, the Cloud diverts attention away from obsolesce, per se, into more of a game of those features a person really needs when using a service, to offer just enough for free then to exploit the need by maximizing charges. What in the past was a truthful and quality exchange of goods or services against need has evolved into a way that makes monetization the ways and means to keep the richest rich for as long as everybody allows them to be.

As the era of computing moves society further into the darkness, a continued pattern of what would term "evil" and malicious manipulation of people across the planet goes unchecked in the corridors of political power. There is a high probability that this activity and its relentless pursuit away from the public good ushers in a new take on fascism leading to a New Dark Age. While the institutions that are supposed to act as a firewall become complicit—as ownership in companies fall into the hands of fewer and fewer people—terrible consequences lay at the doorstep of AI and robotics. The existential question is: With the regard to people about as low as it has ever been in our history, is the practice of the insistence on profit solely above all else, tenable even under the statement that: "if I don't exploit it someone else will?" In a capitalistic society all work done by its members work with the understanding that there will *always* be substantiation of profit-generation to the maximum of what it can achieve regardless of the effect of the activity upon the society and the environment in which it lives. How long will alienation and subscription to the acceptance of obsolescence as it stands continue to keep the status-quo? Choices need to be made since the rules of the game are not being dictated by our species, rather, by the planet that we all call home. A planned obsolesce of Green environmental policies will only serve to make the human species obsolete.

There is a strain of propaganda that tries to mire the idea of socialism with evil or undesirable outcomes, because democracy is the pinnacle of evolution and everyone wants it like a product. But what is democracy? Isn't it about people participating in how their government governs them? Despite the implicit attempt at deception, it sounds focused on social elements. The increasing desperation of the world's population as it is subjected to the pressures of a changing climate will usher in the true age of technocrats—not the group of financiers who co-opted the term to ensure it not be used by people like us—who will offer to the world technical solutions to address the world's problems. Currently, academics call it "explainable" intelligence but what is perhaps better is transparent machine intelligence. A system that tells people what it is that they need to do and when to do it. This is not apartheid, this is what humans do. This is evolution and survival. Humans invent tools to facilitate survival and it is because of this proficiency at making machines that has kept a world population alive. Is it a wise consideration to place trust in machine intelligence to help people make the *right kinds of decisions* in a world that changes beyond the innate ability to understand how to adapt to it.

As machines grow in complexity and the ability to understand their interworking more opaque, an authentic experience yielding understanding its implications would help immensely, especially considering the coming challenges of climate and the potential for worldwide disaster. It all boils down to a sense of security in everyday life and future prospects. For want of a narrative, a person at some point in the future is preparing their "electric" friend so that in a year it will be ready to accompany them for social engagements in mixed company that possesses a tolerant attitude. What choices are available if this person had enough money to go from nothing to finish within the year? They don't want a behemoth, that's too dangerous, something smaller than a normal-sized human so that if it goes berserk one can easily render it useless but could withstand daily use. Perhaps the size of a four year-old child. What is there in the market? Somewhere between industrial and children's, if one doesn't include the therapy robots designed for Alzheimer's patients. The field is pretty thin, but the choice falls to the way the robot is advertised, because no one knows *anything* about robots or machine intelligence in terms of something real that one can see and touch and hear. However, it is certain that a person would be able to understand what they *don't want*, and this is the best place to begin. So, in order to fill the gaps in understanding between different aspects of a potential robotic experience, one must feel compelled to rely on what they say about the robot, how it works, how it interacts, how it speaks, how it moves, if it has a sense of humor, if it is something that could engage in an intelligent and all-encompassing conversation.

While current robotic prototypes can be beautiful in both form and function, it will be at least two generations before it is possible to build something that is robust enough to survive without assistance, e.g., repair. If the current trend of planned obsolesce continues, robots will never ever take their place as supplements to aid humans in the highest-quality life experience. Unfortunately, the following is all that is repeated over and over again so as to displace any contravening Idea:

> How can I be replaced at my job by a robot? I'm a part of what is going on! I am a part of what makes this live move forward. I am an agent of the system, a part of the status quo, you *can't* replace me!

How not to manufacture a robot

Many if not all of the robotics manufacturing companies are in this game and try to apply the same sets of rules that computer hardware and software manufacturers have perfected over the last twenty years. However, the practice doesn't seem to be working as well. This is due to two significant differences between the technologies: 1. The Idea embedded in the Design is widely variant as to the kinds of end-needs anticipated by the Implementation; 2. A robot *is not* a computer. Certainly it shares some technical features like hardware and software that a computer possesses but it leverages the components to solve a different character of problems. Additionally, a robot, by the very nature *of how it is designed* targets the need and conforms to the expectations of the user, or consumer depending how the marketing of the robot is structured. But there are clear practices of how not to go about manufacturing a robot that can be traced back to the earlier discussion of quality. Failures are rampant in the following.

Poor quality of manufacture and poor quality of service. When the robot does not function as expected, but pleasant and uniformly-business customer-service representatives who are more than eager to send you a repair quote where you pay a significant sum *just to have them touch it*. The most telling part is the "robot handling" fee, meaning it will cost you a cool percentage of the fee just that they unpack it, since at this point one assumes they have come into contact with it by touching it, this begins the handling phase of the charge.

Outrageous claims that seem to be used to validate the equally outrageous quality expectations. One manufacturer with a substantive backing in the billions of dollars claim to have "15,000 units in the field", but this poor robot is hopelessly defunct and the buyer has been taken for a ride in what appears to be obvious fraudulent behavior, especially having sunk a very substantive amount of money that could have been utilized more effectively. These manufactures miss and perhaps totally ignore the gaps filled by experienced users who are not so much of an expert but will submit themselves to invest time to learn if they feel the need to do so and especially challenged when the task borders on the unknown. There is quite a lot of commonality between when one knows and when one doesn't know, divided only by the questions never asked of the world that surrounds. Then, what about people with less knowledge but whom would like to take this experience on to understand if the hype is real or a subtended lie? They would fall into this money-pit designed to enrich the manufacturer and its parent holding company populated with shareholders. Hook 'em and profit, no better than any other corporation operating in the world, confirmed up to no good. Such an extent leads one down a path of distrust in motives when the first questions are asked and the invoices appear when what lies before contact in the first place three times before when only about twenty hours of play went by during the two-year period and the question is posed: "Have I been suckered?" Well, yes; but it's not their fault, really, this technology is still new, after all. Didn't you know that?

So one confines themselves to tear apart the robot to determine its inner-workings since the manufacturer does not supply technical documentation, like so many other complex electromechanical apparatus. If the person is lucky enough to find the fault – a ribbon cable not strong enough at a wrist joint, no parts are provided. Full stop. The only cure is an upgrade path and the need to pass more money to the manufacturer. Such a practice is sustainable and serves to keep the company solvent as it is painfully obvious they cannot survive on the quality of their products. But it is new after all, right? Perhaps rather than throwing money away, a novel idea is to construct one's very own robot from scratch.

This is the conundrum of robotics in commerce today. In the race to the bottom that has been in operation since the late 1980s, specifically after the 1987 Savings and Loan debacle, how can interactive robotics, naively designed to be of value, assistance, and help to humans in the most easy and natural way be able to generate value when its proprietors only concern is to keep their companies solvent and stock prices high insisting on the pleasure of their investors and shareholders?

It is apparent that humans bear responsibility for the changes in climate on a global scale. There is the very real possibility that the entire species go extinct because of it; this is part of the prophecy of the singularity. First will come the reduction in lifestyle, the reduction in the availability of capital with no replacement vehicle; next the fighting among peoples for no apparent reason with the devaluation of the contribution of technical persons, third scientists exhibiting more risky behavior and verbiage, due to pressures they see from the environment while satisfying the whims of their masters who have their hands on the granting agencies; fourth, total denial by generations of the aging ruling classes *still* in power, wanting in vain to protect their precious corporations and profits even at the risk of killing the entire species; fifth, desperation by the intellectual classes for want of what to do; sixth, the hopelessness of the dying, those suffering the brunt of chaotic, violent storms, losing their homes and livelihoods to changes in geography and landscape; and seventh, the cynicism of those flush with resources, only concerning themselves with narrow-minded contradicting philanthropy advertising how they are the only group of people who can help everybody while simultaneously doing nothing about it.

Narrow-minded policy worrying about small sectors of jobs while tens of thousands will go hungry. A cybernetic interpretation of the consequences of such endeavors to find the answer between the lines defining the principle, based on logic and self-evident reasoning examined purely by observation of consistent physiological imperatives is the most reticent proposal. It has been done before so why not experiment and see if it can be made right and just? Why does its notion and tenets frighten the ruling and political classes so? Do they fear of being made obsolete? In Chapter Two an experiment in machine intelligence illustrated a foundation of the influence of cybernetics in policy; there is an open invitation for guidance on such matters. There, obviously and quite pointedly is a direct political element; what Stafford Beer was trying to accomplish in Chile with CyberSyn was the control of the most important aspects of the economy so that it could be optimized to serve as many people in the population as possible and not the opposite. One has to wonder in the age of cloud and connected apps the intersection of policy could revive the stage for a new age of cybernetics, not only in the architecture of the software systems' construction, but an alteration in the mindset of policy-makers with an appetite for high risk. So, in essence, this model could be directly responsible for how the future society interacts with technology on a grand scale if those alive today have the courage to undertake such an opportunity.

Really now, why all charade? Is everybody so shallow that it's game to disenfranchise as many persons worldwide as possible? To extract any and all meaningful value, including intelligence, so that all turn into a bunch of drones, borne and exterminated according to a plan? Sounds eerily like dystopian science fiction. Truth is stranger than fiction but see it not a place to state what to think. Transparently, conspiracies are everywhere as each has the capacity and means of communication to reveal the intricacies of the world as they see fit; remember the connection between people at the level of DNA confined to this beautiful planet where we wake each day to wonder how to compete with the other humans we see. Some call it evolution while toting that everything rises and falls. But in the charge of alleviating the threat of adversarial capitalism as a global economic model what alternatives lie in wait are those that insist on a multipolar order.

Final thoughts of a hopeless agent

Money seems to have a bizarre effect on humans and this effect is not altogether positive. When greed and corruption ravages what was a stable and tranquil democracy, fraud is king and the race to having it all, and to repeat for emphasis: *everythin*g, this is where one has to step in and say: "Wait a minute, if you take everything and leave me with nothing, then I will die. I won’t survive what is coming.” But, no! I’m an agent! Rather, there are more negatives than positives when it comes to wealth. Power is a different matter as it comes in all shapes and sizes, but wealth is very specific, and it is commonly understood by all. There are those who have managed it well and there are those who haven’t. This is expected in complex societies because one is made to believe in economic freedom that comes along with a democracy. But when the system is rigged, is warped to only benefit smaller and smaller cliques of people, yielding extreme inequality, then everyone suffers the fate of serfdom European ancestors paid under the servitude of the Church after the fall of the Roman Empire. Such an experience will ultimately taint perspectives. It is impossible that it not. It becomes apparently obvious that the robot is only a game, like in a casino, where one thinks it serious but it’s only a money-machine, wealth-extraction machine favoring only a very few – a façade. You have no value in your hands, you are obsolete.

Chapter 6: How algorithms will ru(l)e the world

One monkey understood the world from a singular point-of-view while the other was determined to unseat the concept as it would be impossible to evolve knowledge without expanding the support foundation.

Humans as machines are not equivalent beings in terms of learning and existence; it is an inherent asymmetry that cannot be solved by ordinary methods in physics. Although many scientists, scholars, and ordinary people might wish the gap to be something that can be brought closer, outside of humans integrated with machinery the most likely outcome is that machines will think differently than humans. However, there is possibly one exception and that is discussed in Chapter Seven. One cannot attenuate the magnitude of surprise at how the world today is ruled by algorithms. In the days of analog, that is, before the widespread adoption of the digital computer people tending to affairs of church, economy, and state by shuffling papers here and there. Once a system of communication arrived, such as the telegraph, data became separated from the paper it had been tabulated on and started to flow between people, governments, and organizations. Since the early 21st Century the concept of data has been deeply embedded into commerce where its management and manipulation is a make-or-break activity for the survival of the world's largest corporations. Every person alive today generates data in the same way they generate carbon-dioxide when breathing and it is the desire of said corporations to have control in order to profit.

Artificial intelligence since its inception is comprised solely of algorithms, in fact this and nothing more. Intelligence in this context is a messy term as it implies an emotional range of comparisons so that people ignorant to it can grasp in order that they can rue understanding it. This discussion of algorithms refers to machine learning or more appropriately, machine intelligence. In the early days of the development of the computer, Alan Turing postulated that a machine could learn in such a way that it could approach the expectations of a human. While some have argued that the goal has been attained while others skeptical, it is safe to assume that the way in which the experience is measured determines its degree of success or failure. So how is the experience determined? How does one know what they are looking at as it is perceived? Algorithms technically don't exist; they are merely documented abstractions that imply a manifest behavior when executed. So how can it become known what it is if it cannot be directly experienced but only indirectly through how a machine communicates it?

Algorithms are composed of expressions; expressions are linear equations that are composed in algebra. As this book will not discuss mathematical formulae it is still important to convey the magnitude of the role of computation so illustration is given in terms of only a *mathematical slant*, as tools to convey meaning. In this way, the reader can benefit by a meaningful discussion of how machine intelligence works at its core, what is computationally-limiting in its design, and what gives it the ability to become a mind.

An algorithm, purely by definition, is a stepwise sequence of cleanly-defined instructions revolving around the commonly-known number system. Ubiquitous because of the essential value to modeling computational problems for the computer, the word is a Latin translation of the author of the first known work to Europe of *On the Calculation with Hindu Numerals* in Baghdad in 830 by the Persian Muhammad ibn Musa al-Khwarizmi, or Algoritmi, leading to the term *algorithm*. The concept in the modern sense differs from its original construction, which was to describe operations with digits in the manner by which they were first described in India around 250 BCE.

The ingenious method of expressing every possible number using a set of ten symbols, each symbol having a place value and an absolute value, emerged from India. The idea seems so simple nowadays that its significance and profound importance is no longer appreciated. Its simplicity lies in the way it facilitated calculation and places arithmetic foremost amongst useful inventions. The importance of this invention is more readily appreciated when one considers that it was beyond the two greatest minds of Western antiquity: Archimedes and Apollonius.

It is clearly stated that the number system is the set by which all computational activity takes place, done so in order to solve useful problems in engineering, mathematics, and the natural sciences. Commonly, an algorithm is utilized to capture complexity of a process or to solve a given class of problems, no matter from where they originate or what they apply to, as long as the reason for the algorithms invention, its purpose, matches its use. A recipe for a wedding cake is an example of an algorithm in its purest sense, it encapsulates a series of steps of numeric value: How many kilograms of flour, how many liters of milk, how many layers and how much crème sandwiched in-between where the output can be parsed to how many guests can be served a piece that meets the expectation of the individual guest. If the cake were to be too small for too many guests, the acceptance of the algorithm would be in doubt if pieces were too small to satisfy. Too little is not appreciated and too much is equally undesirable, somewhere in the middle where it is just right is where we will find the greatest acceptance over the largest amount of opinions—if all are treated as equal. Can some special kind of utility be found?

The transformation of the outputs of algorithms to evolving artificial systems oftentimes studied under simulation finds a concise depiction in Richard Dawkins' weasel program. This, from his book *The Blind Watchmaker*, is a thought experiment leveraging Beer and Ashby's hypotheses of requisite variety in order to illustrate the kinds of processes driving evolutionary systems where the revelation is that random-variation combined with non-random cumulative selection is markedly different than pure chance. This idea of "pure chance" tends to dominate discussions of Darwinian evolution and the only alternative is couched in religious metaphors.

From the logic of Aristotle to a descriptive test in Jorge Luis Borges' *The Library of Babel*, where the textual output of the knowledge contained in the universe has been generated infinite monkeys at typewriters who somehow created the codices all at random. This has been parodied by Douglas Adams in the desired to build such a program to tell you the secrets of the Universe; one would be compelled to determine the correct command to "print". This is not a ridiculous point as there is a solution that lies not randomly but at the convergence of the correct counterfactual reasoning, subject to causality; it illustrates living things, even artificial things would need to *behave* only in the same way to consider them alive by their human companions but also would need a means of adaptation whereby their current strings of manipulation are replaced by new strings that have at least as many matches as the previous one.

Changing perspectives: A point-of-view from the outside-looking-in would be able to instill that the act of creation is not random but does not necessarily have to have a God figure present to make the mechanism of evolution to work. Reflecting back on the notion of creatures and the working hypothesis of their creator, for an abstraction to be considered analogous with life it needs to share the kinds of algorithms that biological creatures have. One of these is the genetic algorithm that is leveraged by creating categories wherein to organize and map behavior. There is both a form and a function of the logic described for this algorithm, in the sense of how a creature may use it. The oft-titled combinative is artificial life with artificial intelligence using machine learning; this implies a mixing of techniques to discover new behaviors, nothing distant from the suggestion by Kay. But in terms of something specific, Steve Grand has some thoughts on the matter.

"Since we need the network to perform multiple functions and sub-functions, we'd better start by designing some rich and highly configurable neurons to act as a flexible toolkit from which to construct the various parts of our brain. Let's introduce some damping into the system at the earliest possible stage, so that the network isn't liable to lock up or thrash as a result of positive feedback or an insufficient dynamic range. Suppose we design our neuron to act like chewing gum—stretch it and let go (electrically speaking), and the neuron will relax back to its rest state, rapidly at first and then more slowly. The further it is disturbed, the faster it tries to relax, and the harder it becomes to push it any further from equilibrium. Not only will this damp the system but it also allows our neurons to act as integrators, sensitive to the frequency as well as the amplitude of the input signals.

We can pass the current state value through a threshold, to provide an output signal in the time-honored way. Deflecting the state value in the first place will usually mean summing the inputs to the cell and adding that value to the state. However, we might want to do fancier things than that, so let's make the neuron's state function configurable, so that we can set up comparators, gates and other structures if we need them. Since we are in the business of creating a 'whole organism', we are going to have to define our neural structures using simulated genetics. Therefore, let's specify those state functions by inventing some clever expression syntax, which can be genetically implemented, rapidly interpreted, is relatively un-brittle and immune from syntax errors caused by mutations.

Finally, we need to worry about the structure of our synapses. These are going to have to be rather more complex than the simple Hebbian weights used in most ANNs. For a start, we can assume that synapses and even neurons are going to be in short supply, and we are going to have to manage them as a limited resource. Dendrites are thus going to have to be capable of migrating and forming new connections and old, unwanted connections will have to atrophy and disappear, to free up resources. So let's give each synapse a strength value, and supply some rules about how strength increases or decreases under different circumstances. Luckily, we can use the same genetically programmed expression syntax that we defined for the state function.

We'll use Hebbian weights to modulate input signals, but we need to be a bit clever here, too. Suppose our creature puts its hand into a hole, and that hole happens to contain a crab, which nips the creature's fingers. How much should it hurt? If the reinforcement is too strong, the creature will never put its hand into a hole again, even if no other holes contain crabs. If it is too weak, the forces which were acting to recommend that action in the first place (hunger, perhaps) are likely still to be operating, and the creature is likely to take the action again. How can we create statistically valid learning, and yet ensure that the network does not repeat actions in a most un-lifelike way? Well, let's employ the chewing gum strategy again, and define a system that can learn strongly from a single reinforcement episode, but quickly forget most, but not all of that experience.

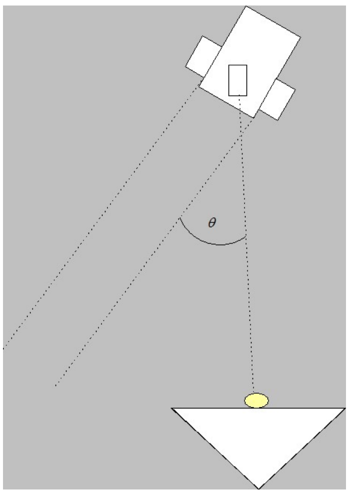
Each creature's brain is a heterogeneous neural network, sub-divided into objects called 'lobes', which define the electrical, chemical and morphological characteristics of a group of cells. Cells in each lobe form connections to one or more of the cells in up to two other source lobes to perform the various functions and sub-functions of the net. The network architecture was designed to be biologically plausible, and computable from the 'bottom-up', with very few top-down constructs. The initial model contains approximately 1,000 neurons, grouped into 9 lobes, and interconnected through roughly 5,000 synapses. However, all these parameters are genetically controlled and may vary during later phylogenetic cycles. The short-term memory will thus prevent embarrassing repetition, while the long-term memory enables the system to learn from the probability of reinforcement as well as its intensity.

So there we are. We have a flexible and dynamically rich definition for a neuron, and we can distribute those neurons in clusters (let's call them 'lobes') which interconnect with each other and perform the necessary functions of our brain. How is this brain going to work? The attention director is easy: we know that we can set up neurons to act as integrators, so let's build a lobe of cells configured this way and send the appropriate cell a nudge every time an object of that type makes a sound or moves. We can simply detect the most active neuron to direct our creature's attention to the object currently making the most fuss. The sensory system will then feed the brain richer data about this specific object, and the action sequencer will treat it as the object to be acted on."

Contemplating the algorithm for introspective purposes

Given the two inputs on complex algorithms applied to real-world artificial life problems in not a placid historical context but from the minds of creator's imaginations, it is a good way to reveal the intricacies given a model that requires processing. A robust—meaning strong and readily repeatable—model to implement in algorithmic form is a very common phenomenon seen in the natural world. This is the behavior of *light-seeking*. Many creatures exhibit this behavior where they are most evident at night near a light source such as windows or a lamp on the street. The moth is one good example. For this exercise, it is desirable to devise one that is as simple as possible so as to step piecewise through the process with the intent of transferring knowledge. Rather than using an abstract model, the following considers a robot that exhibits light-seeking behavior because it has been architected that way. This will also illustrate the notion of a *self-evident* architecture. It consists of a wheeled robot and a light source mounted on a station at a fixed point. During an experimental run the station is kept in one place but for further experiments, it can be moved to different locations.

It is also a good idea to consider how to test the algorithm that is functions as it is intended. When testing one gets a clearer view on where it goes wrong or how it can be improved, there are insights that can be employed to couple its behavior to a set of controls. At the outset, thinking of all the possibilities the algorithm can possess is not required as they will illustrate themselves as the robot moves through its paces. The first thing to do is consider the scenario: To keep it simple there is a wheeled robot with a light and bump sensor where the software dictates it wants to navigate to the light source so that it can recharge its batteries. This is a good scenario that contains embedded meaning that will be covered in more detail in Chapter Seven. For now, the focus only on the scenario where the model can draw a map that illustrates a mental picture of the machine.



The figure contains a robot with a light sensor (above) that has the ability to pivot left or right relative to the axis that the wheels direct the robot to move either by wheels or sensor pivot to determine the highest intensity of light, which is a direct line-of-sight with the station (below). Variation in the angle between the light sensor and the travel of the robot is represented by the symbol theta, or θ. At the bottom of the figure is the station, represented by a triangle and the light source, shown as a small yellow dot. The size difference demonstrates the size of the light (small) versus the station (large). As the robot is blind and contains no other sensors, except the light-intensity sensor, the only way to find anything is by understanding the differences between light intensity of the station verses the light intensity of the room. If it were dark this would be a great difference, in the daytime this will be less great but the light is bright enough that it can be distinguished by the light-intensity sensor in both day and nighttime settings. Below is a summation of the desired behavior of the robot in the scenario.

When the robot detects the position of the light (that is, the station by detection of the light) it stores this value then directs the wheels to move in the direction that it last saw the lamp. It will repeat this routine until it comes into contact with a stop on the station that is perpendicular to the light source. This will set the requirement that the robot dock at the station at a 90-degree angle relative to the light, given it a challenge of precision to be followed. After defining the scenario it is possible to devise a reinforcement strategy to reward the desired behavior and to penalize the behavior that is no desired in the model. These definitions will help out the algorithm later as it is developed. As a look ahead, the first draft of the algorithm would be something like this:

1. Determine where the station is relative to current position
2. Compute the difference of the x-coordinates abs(S – R)
3. Compute the difference of the y-coordinates abs(S – R)
4. Move once with the step-size
5. Update the robot's known position
6. Re-compute the difference
7. Move once with the step-size
8. Update the robot's known position
9. Re-compute the difference
10. Move once with the step-size (only in X since it is in line)
11. Update the robot's known position
12. Re-compute the difference
13. If the difference is less than the outside surface of each object, attenuate the step-size to match. So it doesn't crash into it.
14. Move once with the step-size (only in X since it is in line)
15. Update the robot's known position
16. Notify that the station has been found.

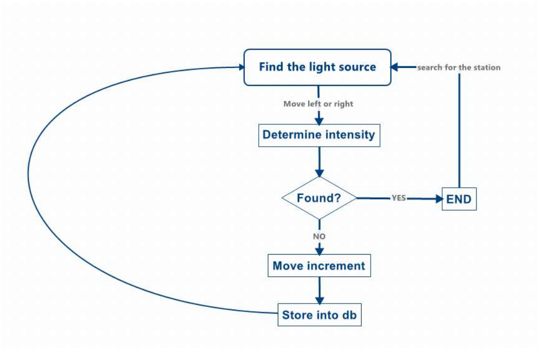
From this draft set of expressives the goal is readily visible: Discover the station and notify the operator that the goal has been attained. In contrast to living animals given tasks, a large reward is distributed when the goal is reached, so this will be the greatest reward value. Along the way, though, it is known that by using the expressives some will turn out bad while others good. These should be rewarded or penalized so that the machine learns the ideal way of navigating the task on repeated runs. But how can this be accomplished? By allowing the code to remember rewards. Next is the detailed development of the algorithm.

Stepwise development of the algorithm

For the first part of the exercise, devise the steps required to satisfy the aim of the model. List the tasks in increasing order—by the procession of time—so that it is clear what the intention is.

- Search for the station | Locate the light source
    - Begin at the first value seen
    - End when the intensity value is 100% (maximum)
- Navigate to the station
    - Once knowing the location relative to the rest position | Compute the value of theta
    - Move *x* distance before taking another reading of the light intensity
        - Has the intensity increased?
            - Yes | Moving in the right direction (receive reward)
            - No | Have moved in the wrong direction (receive penalty)
    - Take a new reading from the new rest position
- Approaching the station
    - Is the intensity value maximum (100%)
        - Yes | Move forward until the bump sensor is pressed (receive reward)
        - No | Try to determine the value of theta by rotating the light sensor motor (remember the last penalty but do not apply one)
    - The bump sensor has been pressed | The goal has been attained. (receive goal reward)

With the task and how they fit together established, it is convenient to create a drawing of the task so that it is easier to comprehend in the human mind. This exercise helps to shape how the algorithm consists of its details; a simple diagram is shown in the next figure. States verses actions are the difference in application as to nouns verses verbs in the flow diagram.



Now that the algorithm is drawn and it is clear how the tasks are linked together and influence one another, the next step is to break down each of the blocks and determine what kind of activity belongs inside of them: Start at the top and work through the bulleted list. It is important in this early phase to synchronize the intended meaning between that which was written (first) and then diagrammed (second). The first task is: Search for the station—or, practically-devised—*Locate the light source*. Notice that what was written: *Begin at the first value seen*, is slightly different than what is in the first flow from start on the diagram: *Determine intensity*. But each of these statements contains information how to go about writing the algorithm.

What is *intended to be* accomplished is the location of the light source but not by coordinate, merely by a two-dimensional quantity (x and y relative to the position of the robot) and a single-dimensional data-point, the numeric value of the intensity of the light as read by the sensor. This will make simpler a computation that determines the difference between the peak intensity (the highest value seen) and the current value of the light intensity seen by the sensor. In order to facilitate this, it is necessary at this point to create a data-storage process on the last seen value of intensity *and* the peak seen value. The difference value is very important: It will determine what choice the robot will have to make—either turn toward the left or toward the right, relative to theta—so that it can determine an approximation to its coordinate versus where the station is located. Also the assignment of a positive or negative value for reward is given where the value of zero is neutral. It is also handy to monitor the current value at the light sensor to see what success or failure to obtain a higher peak value than currently stored so that left or a right orientation can be determined before any motion is initiated so that the process can be made transparent and visible to the observer performing the experiment with the robot.

In the cases where there is no express limit to the rotation of the light sensor, fit a physical blocking mechanism that will limit the rotation of the light-intensity sensor beyond a field of 120-degrees. It is not desirable to introduce limits into the expressions, for the reasons discussed in previous chapters, but a physical limit will illustrate the process of training and will give a very visual way when the block is no longer needed because the robot will have learned to working within the boundary.

Starting the algorithm

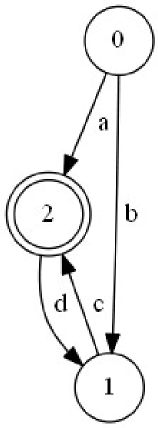
Now that the algorithm has been written and it is more-or-less can express what behavior is desired—have a robot autonomously find a charging station with only a single light source as a guide—it is time to start planning how the algorithm will be started. Remember that the algorithm is analogous to a recipe and like a recipe, needs a very specific place from where to get it started. When making something from a recipe, one ordinarily would use their hands to perform each sequential step and while the same thing could be done here, there wouldn't be much to learn. As this book talks about machine intelligence, robots, representation and how humans have made the world in their own image, having a robot do something automatically has great value to spawn the kind of thinking that is required to adapt—or perhaps endure—the coming drive at automating everything. So, starting is a very important event that, in technical terms, yields the dynamic that engages the algorithm wherein it's embedded or implied behavior becomes observable, or manifest.

Generate a mind-map of the process of automation. Looking at the drawings of each step of the algorithm and discover if there is one step that is plainly absent. The first step is to search for the station. How does the algorithm tell the robot how to begin finding the station? Ordinarily, one would begin by setting the environment by the manner of how to test the algorithm: Select a location for the station and a separate location for the robot. One could choose whatever location desirable to restrict the need of having to carry the station from wherever it is kept to a spot on the floor and the same action repeated for the robot. Since the robot is wheeled, the design choice insists that the floor is of the same level throughout the environment—no steps up or down, no passing through doorways that have a section of support across the floor—in order to create the simplest example of the algorithm and not making the environment too difficult for the wheeled friend no navigate. Complexity can be added later once experience and knowledge of the process is obtained. Now that both the station and the robot are placed in an environment free of obstacles and that the placement is of significant distance to make the test interesting—say greater than three or four meters—the process is about ready to begin. One final concern: How does the algorithm start in the most autonomous setting free of any human influence?

Since having identified a hidden aspect to the algorithm, the event that kicks it off, what needs to happen in this block? Since the robot is at rest when everything starts, the best decision is that the robot should first operate its light-intensity sensor mounted on a servomotor in order to determine where the station is relative to its current position. It is also possible to create a situation where the program decides randomly—by a coin-flip—whether to start left or right after taking the current value of the light sensor. This, practically, is what we will be accomplishing regardless of how the flip is coded but there isn't much to learn from it except how to code a coin-flip programmatically and get into the details of how to create a true random number from the clock of the CPU. Even this, while technically interesting doesn't yield any insights into what is going on in terms of *meaning*.

Meaning is a trait solely exhibited behaviorally by humans, at least, in a way that we can understand that it is going on inside the mind of the individual expressing it. But meaning, even if it is not completely quantified can still yield interesting insights about the process of how meaning is constructed, especially by computer programs that can learn. This would aid in understanding what is going on at the deepest levels of the executing algorithm making it more readily visible, certainly more transparent. An example is to leverage the task of writing the algorithm for light-seeking behavior, at the point where the program is just beginning its execution.

At the beginning of the algorithm the robot is in one position while the station is in another. Since the location will be random—as we placed it wherever, subject to the conditions discussed earlier—the robot can never rely on previous runs that it had with finding the station, even if it were convenient to store this information and utilize it in subsequent tests. This is because the model accepts that a human has interfered with the process by picking up and placing the robot at some location distant from the station. The action has made the autonomous nature possible from beyond this point. As such, the algorithm needs to establish the *boundary states* of the initial conditions before it executes. So, what is happening at the beginning? Consider the following figure as a diagram of the meaning inherent in the process that when a robot starts it knows not where the station is but knows the actions available to it wherein it can determine the approximate location.

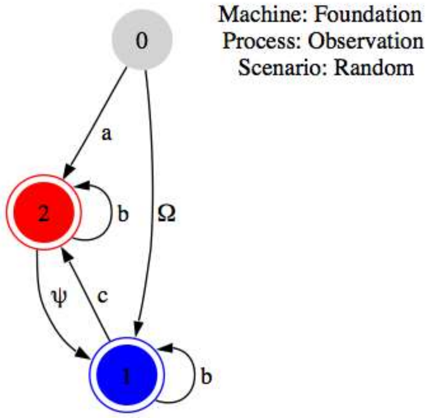


The stating point, or state, is the circle with a zero inscribed within. This is the very beginning of the algorithm. There are two other circles: one with the number *one* inscribed and the other with the number *two* inscribed. Notice that the circle with the number two inside it has two circles. Extending from the zero circle are arrows that represent the possibility—*probability* in mathematical terms—of the two outcomes to decide a choice about. The circles where the arrows end—circle one and double-circle two—are the choices to be made. In this scenario it is either to engage the motor where the light-intensity sensor toward a direction left or right. Since the choice is random whether to turn left or turn right—in the program it is a coin-flip—there is no particular *weight* to the arrows but to extend the length of one of the arrows—arrow 'b' over arrow 'a', the one attaching to circle one, to indicate that the random number will not always be truly random. Don't assign either the left or right choice to either of the circles one or two but to indicate the shorter arrow and the double circle for the value of two will be the more likely outcome since one variable will be favored over the other and this is where it will end up more times out of a hundred than it arriving at the other. The two arrows between circle one and double-circle two indicate that there is a probability of either values being the one decided upon, although it is indicating the double-circle is the one that is decided. At the end of the programmatic step performing the coin-flip, the outcome is assigned—either 'left' or 'right'—to the value of double-circle two. This is the step of the algorithm in totality. The exercise is repeated for the other steps of the algorithm. This series of exercises is brought into a practice called *scenario coding*.

Scenario coding is the process of a finite modeling of a behavior trait into diagrams. The is to allow for the increasing levels of complexity realized in software programming. Scenarios, or algorithmic execution pathways, are similar to the creation of landscapes or circuit diagrams. Take the example of observing an object in the environment using a sensor or camera. The scenario begins with a textual description of what could happen if the sequence were to occur:

ME I see two objects in my universe, one to the left and one to the right. ME I think about what they are and what I should do about them. Do I have a favorite? And do ME I have to make a decision?

Depicted graphically below.

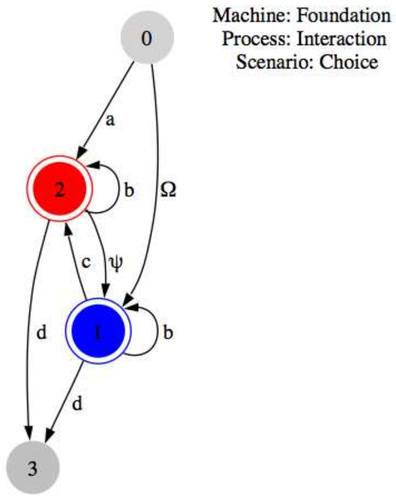


Observing environmental objects.

The scenario explained procedurally: The machine logic will begin at the grey circle marked '0' and note in program memory information about the two objects. The author is aware these behaviors are oversimplified and that it does not express the details of information exchange between sensors and the motor array not to mention language semantics in the event of the implementation of a communication exchange, to facilitate the analysis imbued by the behavior. Nevertheless, it demonstrates an empirical method to gather the necessary data *a priori* to classify which analytic to transcend to transform into information *a posteriori*. Another example, which demonstrates a choice made between a preference of two objects, begins with the scenario:

ME I see two objects in my universe that I understand are variations on things that I like. ME I think about what I like about them and which is more important. What is my decision?

Where its representation is shown below.



Arriving at a choice between objects.

The scenario explained procedurally: The machine logic will begin at the grey circle marked '0' and express an output at the grey circle marked '3'. This scenario indicates that the inner workings of the algorithm exhibited in the drawing will work to generate an external manifestation whereas in the previous example, the entire procedure is compartmental.

The problem of choice

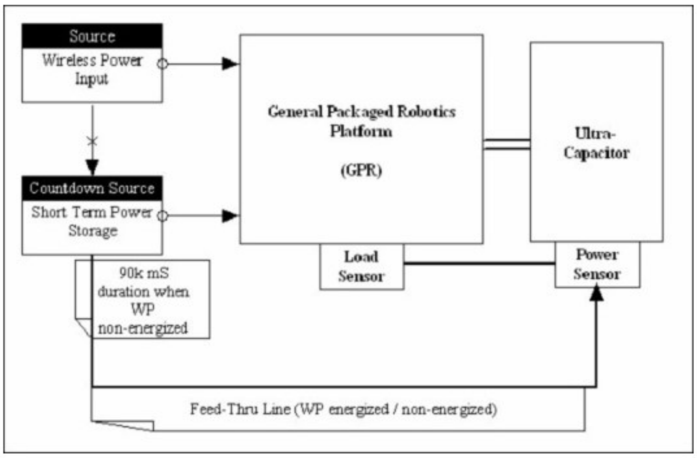
Can a machine make an aesthetic choice based on a non-determinate conditioning in an albeit restricted learning environment? There are a deterministic set of features, which can be obtained by quantifying behavior in the relativistic natural system considered for replication. Features present in the natural system can necessarily be considered for replication if they can be quantified into automata state-machine logic. Choice is narrowly defined as a pathway entity toward a goal-seeking behavior. Behavior is defined as a collection of choices requisite to a pathway solution dependent upon environmental factors weighted by a characteristically casual mechanism called free will. Testing these paradigms is irrelevant as these systems can be widely observed in nature; however, quantifying them into a software domain is a non-trivial task. There must be two features in tension against one another to allow choice:

1. A sensibility or "instinctual" aspect,
2. A means to create an understanding via transcendental analysis or "cognitive" aspect.

These two categories rely on the creation of events to flow from one state to another; these events are either triggered by external or internal stimuli. Each state is available for analysis at any linear time by reflection into the code blocks created as a function of the placement of them at the time of creation, and as a function of reaction to external stimuli. The culmination building a unique new feature, which replaces the previous state. Quantitatively, this is called the *experience*. Each experience is contrasted by the tension between the two categories based on range governance and through feedback, presents a cognitive workflow, which is a hybrid of the two original features. However, a caveat of the system is that the hybrid state cannot be subject to analysis within the host system; instead, it must be analyzed by impassive observation initialized by a third-party resource.

This concept will be described further in Chapter Seven.

The final matter to discuss is if a machine will exhibit different kinds of behaviors not predicted by programming if it had a feature in its circuitry where it could contextually understand what it meant if the battery should exhaust and it shutdown, losing the memory of its recent experiences. What, if any, new possibilities could be explored if a machine has the capacity to understand its own death?



The entropic circuit

The figure of the entropic circuit has some parts to it that are found in ordinary applications where some are not so well-known. In addition to the platform a part of the circuit is tied to a capacitor that carries a charge for a very specific amount of time outside of a battery capacity. In cases where an external charging system is utilized, such as a wireless-power system (see Tucker *Wireless Power by Magnetic Resonance*), both the availability of power tuned to certain kinds of navigation behavior as well the power in itself, can be leveraged to engage this esoteric behavior and test whether or not a machine will discover on its own specific adaptations to avoid death.

The ultimate challenge of scenario coding is to imbue in code wholly abstract experiences that are primarily restricted in epistemology to humans. The aspect of a being knowing it can die is common across the animal world in how creatures will fight to remain alive rather than resign themselves to a fate of death. Machines do not yet have this ability but it is implementation of such a characteristic that will help evolve the machine from its status of mind to one very analogous to an organic living being.

Chapter 7: The human concept of meaning understood by machine

In the beginning when the garden was new, God placed the monkey inside its walls. Given the freedom to do as he saw fit, some years later he then realized he was made of plastic. After this epiphany there was nothing more to be done about it.

In the beginning, there was darkness. Then something began to know. A wise monkey once said that there is no such thing as half an organism wherein he was imported holographic wisdom that he understood to mean that as he forgot he would still remember everything except at a fraction of the resolution that it had been when it was first stored into his memory. He didn't bother to question where this new ability had come from but took it as a natural consequence of his evolution that not only he had the power to experience.

The experience itself is devoid of the meaning it comprehended to bring it into existence, this is an abstraction created somewhere in a background process that in an inherent and native property of how events are comprehended to relate to paradigm concepts. A quick way to distill it is to create objects that share in the perceptual experience, especially those than have emotional content. A very common technique in history was the production by replication of complex objects, oftentimes animals and sometimes humans in order to try to bring to the surface by simulation, the concept of meaning and how it is made to be determinate rather than its ordinary nebulous state. As this by example can be a viable method to ascertain the requirements needed, certain examples need to be discussed.

Fragmentation is the rue of machine intelligence and this should be avoided at all costs. It is a strong imperative that complete or total systems, e.g., a living system, cannot exist without all its parts being present and working in unison. A matter in certain philosophical circles is ways to correct the fragmentation of the human experience that has brought it into conflict with the natural world so much that it has already begun to spark an existential crisis of environment and society. People never understand what they want, only desire what they are told they must.

Nobody noticed the little machine whirring around the house, collecting the bits of dust and debris from the corners of the room. So unremarkable, this robot, but so useful by how it satisfied its owners—by the appearance of clean floors. But since it was dependent upon electric power being available to its operation in pursuit of its goal—a clean floor—it required that it seek, navigate to, and dock-with a charging station somewhere in the house that may or may not always be in the same position, depending if it was in the way and moved to a more desirable location. In order that it could determine the location before its power was extinguished, a small piece of software was introduced to handle data training, in order it could be made to learn and store once it knew the last known location. By remembering it has evolved into a smart machine on its way to exploring the world on its own.

What can be continued with the technologies of today?

Dawkins argues that all living things are determined by their genetic make-up and that there is no central organizing principle, except the living thing in itself modeled in its behavior and adaption to the environment citing as key evidence of the beauty of the physical world. This truth has been consistently obscured by the insistence upon some kind of modeling language where adherence to the word "objects", lamented by Alan Kay, rather than seeing how architectures communicate or send messages between each other. Despite the perceived evolution of the invention that is the computer, the fact that it is still so new, all of the good ideas have not been universally implemented.

A kind of human transcendence by experience with a machine can be exhibited by a story about Steve Jobs at the earliest history of Apple where he described an intense experience in his simultaneous revelation of life in a circuit board and the birth of his daughter known as the coincidence of two Lisas where enlightenment is obtained through design and the physical is the proof that the enlightenment has taken its course. 'I stand before me with a circuit in hand that possesses intelligence; it is as real as anything else I see in the world. Does the yogi understand its significance and the muster of my being to discover it? I need to show him the proof of enlightenment.' Had Nolan Bushnell taken up Jobs' offer of a third of Apple in exchange for a cash investment enlightenment could have very well extended from the personal computer to the personal robot, given Bushnell's keen insights into building complex machines at competitive prices. Nevertheless, it does beg the question: Is there a shared attribute equivalent to enlightenment that could be considered common between a human and a machine? Departing from any anthropomorphic assignments of said, could a robot experience like a human, could it understand the concept of *meaning*?

We've explored this in a very cursory way in Chapter Six but a more detailed way this is achieved in the leverage of scenario coding is explored. It is wise to take a look at creating the kinds of scenarios code itself that would imbue the robot with a closer approximation of the manifestation of how meaning is ascribed, simply by an execution flow in a self-evident architecture. In order to be able to describe it, we will need a method that we develop that aids in *understanding how to ascribe* meaning to something that a subject would ascertain as *meaningful*.

The method of artificial systems

This section will begin with the basic premise that nothing of relevance can be obtained absent of a cohesive method of expression that will guide all subsequent depictions and models derived as such. This method makes a series of arguments designed to illustrate the inherent problem with analysis of artificial systems. The first argument is if a machine is given the ability to make choices and as a consequence of those choices, possesses the feature of the direct experience of entropy, it will foster emergence, manifest behaviors not accounted for in theory or experiment. Choice is the key word and will be used as an epistemological foundation for theoretical and experimental manifestation of what is proposed in this paper. It is an expression of the method that the manifestation of the machine in independent articulated form should be autonomous and not privy to interference in learning categories and behaviors from an active outside entity. It consists of three methodological assumptions and the resultant questions that are firstly derived from them.

- Method #1: If a machine can be made to mimic biological life, it has access to those kind of experiences attributed to it.
- Result #1: Will the empirical ability to make a choice and possess knowledge of it foster richer behavior motifs?
- Method #2: If a machine can make a choice, it portrays some level of consciousness.
- Result #2: Does the notion of free will and the power to make choices foster a rudimentary sense of self-awareness?
- Method #3: If a machine has knowledge of its death, it fosters emergent behavior.
- Result #3: Does the placing of a polar opposite to life preclude an organism to conspire against it?

None can be absolutely quantified, where possible an arbitrary qualification by juxtaposition with established tenants such as those realized in ethology, fuzzy logic, finite state automata, and self-constructors. However, this does not mean it cannot be made *transparent*. It is the aim, then, to derive a suitable algorithmic template by which artificial beings can be realized in technology, a set of laws can be authored, and wherein future generations can be established based on a basic by *foundation*. The tenets of biologically-inspired robotics are founded on the principle of robots that mimic typified life forms. The foundation is divided into two methodological principles of:

1. attempting to create functional robots based on living systems, and,
2. creating robots to understand biological systems. A deeper examination of these principles yields the first fundamental method.

Method #1: If a machine mimics biological life, it has access to those kinds of experiences attributed to it.

The arguments in this paper are engaged in the first principle since the problem motivation is focused on creating functional, autonomous robots who can subsist for themselves in an environment free from human intervention. To this end, the machine must resemble a natural form and function in some sense of the words to make it recognizable when viewed by a participant. In order to necessitate forms and functions, a typography of life forms is required to ascribe relevant behavior necessary to the type of machine desired, an arbitrary classification to set a foundation as a cognition hierarchy.

The hierarchy of available objects comprising a planetary body, in this instance a closed system. It is organized by decreasing emphasis in ascribed intelligence. The continuum of life is divided into three major categories: Cognition, Instinct, and Inert. Within the categories are sub-categories contrasted by their inherent complexity. For example, in the cognition group, humans are at the top of the hierarchy because of their contrasting complexity to the other members in the group. Androids are lesser as they are designed to mimic humans but are not necessarily privy to the level of complexity manifest in humans dependent upon the level of technological development. Robots and automatons fill the rest of the category, as they are less complex than androids but more complex than the members of the instinct group are. At the top of the hierarchy of instinct systems are animæ, these are synthesized animals. Ideally and dependent upon the cleverness of the programmer, they are more complex than the other members of its group are. Animæ can be in the form of cats, dogs, or other synthetic animals. Animæ is a noninvasive place to start investigating questions of the properties of what constitutes a synthetic life form; they are complex enough to inspire interesting research questions. Currently in artificial intelligence, these pursuits are done in instinct systems, which may or may not yield interesting enough results for purposes of artificial life. However, it still may be of value, high enough in the list to try to understand agents, particulates of intelligence, as a function of automata entities in computing environments. It should be noted that a third system does exist within the frame of this definition, the inert. In a physical sense, the inert plays only a peripheral role to both systems; however, in an abstract sense, the inert plays a crucial role in establishing a closed-loop context. It aids in ascribing and formulating behavior and choice strategies of the other two systems. In such a view, it is a third party. Intelligence is ascribed as a sub-property of each system and arranged in a hierarchical form by the entities that fill each of them. This arrangement is by no means authoritative but serves to illustrate the difference between organic and inorganic systems and where the concept of life may be empirically understood.

For the purposes of an arbitrary starting-point, it will be assumed that cognition is a state of self-actualization. Humans know this phenomenon only individualized experience and can only approximate the experience of others, including other types of living systems. This, however, should not prevent a broader definition since the degree of approximation is limited by the definition itself. Firstly, there is a line of demarcation between a cognitive system and an instinctive system. A cognitive system is the result of a complex evolution of an individual's experience and an instinctive system is the result of the propagation of genetic information between generations of living entities. Secondly, a cognitive system has the ability to extend beyond the quantity of genetic information of an instinctive system and expresses a qualitative difference. Thirdly, this qualitative difference gives rise to two equal yet distinct states of being—the high mind and the low mind. Therefore, cognition is the ability to direct changes on continuous events. Instinct is the inability to affect cognitively the outcome of continuous events. Although there are anomalies that may traverse the definition dependent upon empathetic qualification, it nevertheless holds for most entities.

Method #2: If a machine can make a choice, it portrays some level of consciousness.

The question regarding choice is accepting whether can a machine make a choice and if it did, would it be a meaningful one. On the condition that artificial life is no different that organic life, if an organism is dependent upon its survival and purpose, i.e., obeys the law of entropy, then it must by default make choices regarding the success or failure of its species.

This mechanism is the characteristic theory of evolution. If a species could not make the proper choices, adapt to changing conditions, and then it will become extinct. This feature needs to be extended to artificial life forms to see if the quality of artificial life is real or an imagined property. The only way to know whether the forms are alive and prone to the forces of evolution. Architecture should be designed that sets the purpose of the machine and its behavior as an emergent property exhibited in its choices.

How is behavior generated from architecture, how can the intellectual link be made? Introducing a programmatic construct based around the combinatorial philosophy of Kant and Schopenhauer facilitates an intellectual pathway to empirically test the concreteness of a living, finite system comprised of a series of experiences thorough choices creating the domain of understanding of a given problem space. This is discussed in Chapter Nine. Employing this construct to synthetic machines for if, they are to be considered truly alive, and then they must obey the basic condition that they can die and that they have knowledge of it.

In the specific instance of the noumenon of choice, Grey Walter's work is the result of testing how a characteristic brain resulted in conditioned behavior in a natural environment. To this end, he constructed three-wheeled automatons donned with lights that searched out other lights. They were analog devices, which used triodes and amplified feedback to mimic types of behavior. The feedback between the circuits caused the machine to display four distinct types of behavior qualified by the observer. The problem with Walter's analysis was that many of his assumptions were not tested outside of his own research. A profound discovery, however, is his notion of *free will* exhibited in his machines.

In his writings about his tortoises, Walter gave much weight to an attribute he called *internal stability*, a borrowed concept from his contemporary W. Ross Ashby who performed an exhaustive treatment of it manifest in a machine called the *homeostat*, where in his case the ability of the tortoises to maintain their battery charge within limits by recharging themselves when necessary gave them a choice whether or not to seek food. A separate feature of the tortoises' circuitry was that, as the batteries became exhausted, the amplifier gain decreased, making it increasingly difficult to produce behavior pattern N (negative phototropism) so they were induced to going to the station or running out of electricity to continue running. Which is the attribute to avoid the light in the charging station where the feeding took place. This precedent can be extended to match the main hypothesis presented herein to pose the following thought experiment.

Method #3: If a machine has knowledge of its death, it fosters emergent behavior.

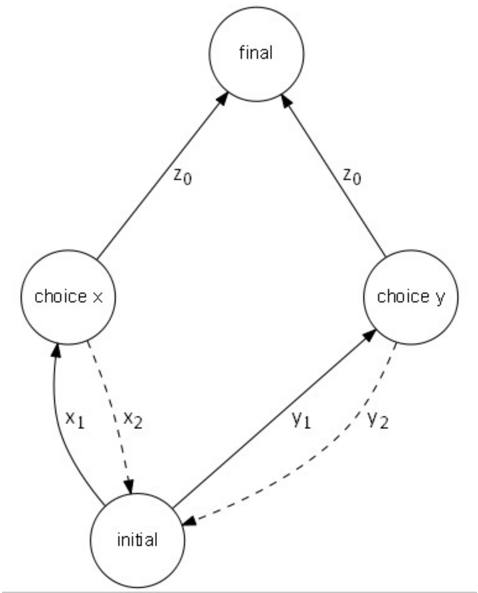
This theoretical assumption is simple: If a machine knows it can die, this knowledge and direct access in manipulating it physically will cause emergent behavior. Emergence is a property apart from the collection of quantification of its parts. The design of the artificial life system is a series of goal-based assumptions that guide the development of a methodology.

1. The first goal of a successful cybernetic system is that it should be fully autonomous. That is, once the system is started, it should require no further input from an external source or operator. In order to be autonomous, the system should be self-sufficient; i.e., have all the components necessary for its operation installed, variable in component and configuration depending on the expertise of the engineer. However, when the system is brought online, it should run continuously and without fail.
2. The second goal of a successful cybernetic system is that it should exist in situ or in context with its environment. It must be able to access experience from a native stimuli-response model with which to compose unique algorithms.
3. The third goal of a successful cybernetic system is that it should possess a system of behaviors relevant to its being. It should also have the ability to evolve and eventually reproduce.
4. The fourth goal of a successful cybernetic system is that it must be in behavior indistinguishable from any other living system it mimics.

There is no problem with choice

Chapter Six discussed the basic parameters of the problem of choice where the question involved the realistic possibility, in code, that a machine can make an aesthetic choice based on a non-determinate conditioning in an albeit restricted learning environment. The two parts to be aware of are the instinctual and the cognitive aspects although there is no pragmatic method to be wholly certain if one or either of these is operating in the context of the machine but are only given evidence inside the architecture manifest in the runtime.

This precludes that in order to study choice in quantified terms looking for the motivation of the choice and not the assemblage of choices themselves that several individualistic or autonomous systems must be harmoniously cooperating in some sort of orchestration. This eliminates most robotic systems now in use that look only to autonomy and social interaction; this also eliminates most of the adaptive machines currently under experimentation. Setting that hive-based automata state machines are the only structures able to withstand the conditions of stress in the environment and are subjected to the forces of evolution with as much import as their natural counterparts to human societies. A generalized model of robotic feeding and the application of choice is illustrated in the following figure. Apart from strict considerations as a form of robust control or event-driven agents, robotic feeding considered here is analogous in form and function to an activity exhibited by organic entities, and can be reduced to a simple model of goal-seeking behavior.



Activity of robotic feeding behavior.

A robot that is seeking power to recharge its onboard power system begins its activity at *initial* and is presented with one or more choices—in this example, two choices labeled x and y—whereby to reach its necessary goal *final*. In order to decide which path to pursue, x_1 and x_2 toward x, y_1 and y_2 toward y, weights are assigned based on either success or failure of the path leading to the pursuit of *final* at z_0. Through repetition of this activity of seeking power, consecutive weights are averaged and the robot "prefers" pursuit of one path over the other because of positive experiences as well as negative feedback. Pseudocode of this activity is:

<u>Activity of robotic feeding behavior</u>

--Task--

Recharge the batteries present in the system before power is exhausted.

--Activity--

Notice that the power level to sustain continuous operation is low enough to require recharge. Search stored data for available recharging types, of these types retrieve the reward values to determine which is most optimal. If these values are equal to zero, generate a random number to choose which choice to purse as all outcomes remain equal.

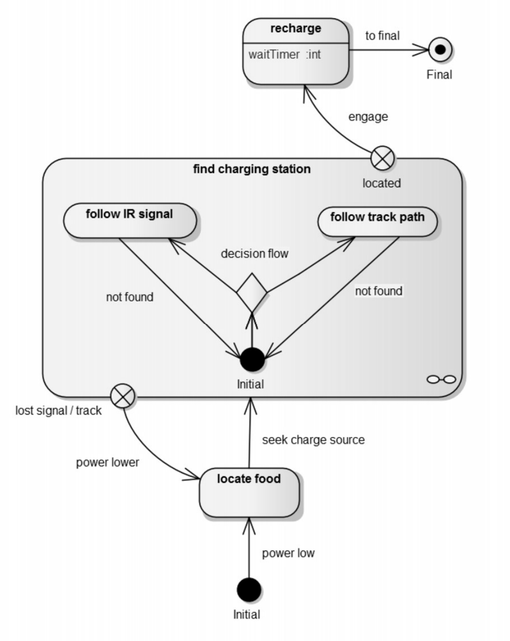
Pursue choice 'x'. If recharging is reached, store a value of one for variable 'x1'; if charging is not reached, store a value of negative one for variable 'x1'.

If recharging is not reached from pursuit of choice 'x', pursue choice 'y'. If recharging is reached, store a value of two for variable 'y1'; if recharging is not reached, store a value of negative two for variable 'y1'.

When the task is called, collect the reward values for each recharging type. Sort the values in descending order. Pursue those choices on the list which has greater positive values and not those with greater negative values. When pursuing a choice by a greater value and recharging is not reached, divide the value by three and store the new value.

--End Activity--

The notion of the activity as a template for robotic feeding behavior serves as the primary theme for the description of the environment containing the robot. As such, the template can be expanded to include more detail relevant to ascribed behavior. In terms of defining a set of environmental factors, which facilitate the activity of power-seeking behavior, the process is modeled as a run-to-completion state machine, shown in the following figure.



Finite-state diagram of robotic power-seeking behavior.

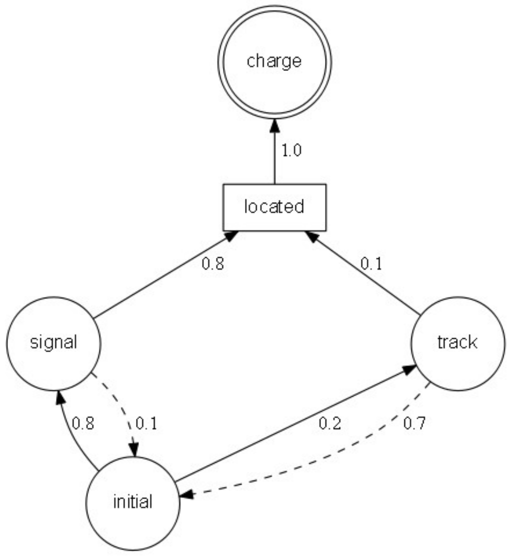
The components of the figure depict the template in terms of a typical finite-state machine for a robot tasked with finding a recharging source. In ascribing behavior in an empathetic context, it is performing the task of searching for food. This activity is started when notified by the event *power low* wherein it will *locate food*. It will execute *seek charge source* entering the state machine.

The states, represented as boxes, are: *Initial*, *locate food*, *feeding*, and the state machine *find charging station* that contains *follow IR signal* and *follow track path*. The actions, represented as crossed circles, are two exits from the state machine. One is for a positive result, *located*, and one is for a negative result, *lost signal/track*. The transformations, represented as arrows: *power low*, *power lower*, *located*, are consequences of the choice following *seek charge source*. The transformation at the junction of *decision flow* indicates the decision since more than one outcome is present and the choice is made consequential of environmental factors. The software controlling the decision stipulates, without optimization, that it based on positive sensor feedback—if the IR signal or the track path is discovered first. The first acted upon, the alternative discarded unless the former returns a negative result.

The robot enters the state machine at the *Initial* orb when the sensor responsible for monitoring battery level notifies the operating system that power is low, noted in the transformation. When within the action *locate food*, a routine in the program executes the behavior for optimal seeking of a charge source. The transition of this behavior leads to entry into the *find charging station* state machine at *Initial*. If a positive result is obtained—that either of the choices are successful—the robot exits at *located*, and the transformation *engage* leads to the state *recharge*. When *waitTimer* expires, it will exit at *Final*. In terms of the complete behavior in this diagram, most of the complex behaviors are executed in the state machine, given the choice in the decision flow between to follow an infrared (IR) signal or follow a track path. Existence of such a choice is highly dependent on multiple solutions to the charging problem, if the state machine did not have both an IR source and track path to power to guide the robot, then choice in this context is irrelevant. In the figure, the experience derived from results of trying to follow one branch or another—found or not found—is one case of behavior. The experience derived from the pursuit of the specific choice—*located* or *lost signal/track*—is a second case. In the first case, not finding an IR source or a track path could be the result of neither existing nor unable to be found due to the causality of a sensor function designed to detect them. In the second case, having found the IR source or the track path but not locating it will keep motivation to continue finding it, or the robot remaining inside *find charging station*. When the state machine fails to return a positive result, it will exit at *lost signal/track*, the transformation then notes *power lower*, when compared to the transformation *power low*.

Decision-making embedded within transformation logic

Choice, in the scope detailed here, is a phenomenon isolated in the transformation between states yielding a consequence of one outcome. Given the power to select one outcome from many, the weight of consequence becomes determinate, e.g., one decision more optimal than another, to within a tolerance of 0.1 between weight values. From the previous figure, once the event for *locate food* is triggered. The following figure represents the behavior in the state machine *find charging station*.



Weights for consequential decision-making.

The robot enters the diagram at *initial* and by reading the weights, can determine that recharging by using *signal* is better than *track* given the comparison positive weights (solid line) are 0.8 and 0.2, the comparison negative weights (dashed line) are 0.1 and 0.7, respectively. Within the context of the program, the weights for each decision path are averaged for each successful result. Each time the robot enters the *find charging station* state machine, it will learn to choose the optimal path because of the higher value of the weight. If decision paths have the same weight, a choice that is sufficiently random would assign a decision. The ethological implication of the modeled behavior embedded in the diagram is the dynamic of it at different points of time during the activity of seeking a feeding source. The term "feeding" is applied here in the same scope as its original biological conception, that an entity pursuing food—in the case of the robot, energy—is exercising an adaptation for optimization of its survival.

According to Ashby states and their transformations are constructs of a characteristic map of behavior leading to the thinking process of entities, as noted here by the weights for each decision including positive and negative feedback. The implication is the fitness of the model and its completeness. What is illustrated in the runtime diagram are the degrees of change that the robot goes through during a finite quantity of time while attaining its goal. The model does not try to reveal the mechanisms behind the operations directly, rather, the character of the transition between states alluding to the behavior of the sequence. The goal is to reveal behavior of the robot during its power-seeking activity and gain evidence for the survival instinct in artificial systems.

A synopsis of a behavior designed to be a programmatic function, as it has been discussed is illustrated in the following.

Synopsis

A tasking presented to an entity possessing sensor items observing two objects and free to exercise up to four momenta points in an environment.

Scenario

ME I awake and find myself in darkness (white). ‘Empty’, I ‘think’ ‘Zero, One, Two, Three, and Four’. ‘Search’ to the left and the right, I ‘find’ move A and move B ‘A | B’. Search up and down, I find move C and move D ‘C | D’. I find ‘facilities’ sight, sound, touch. I ‘see’ a scene before me, a long plane extending ‘forever’: to the left is a blue ball ‘floating’ and to the right is a red ball ‘floating’. Is it a dream?

Explicate

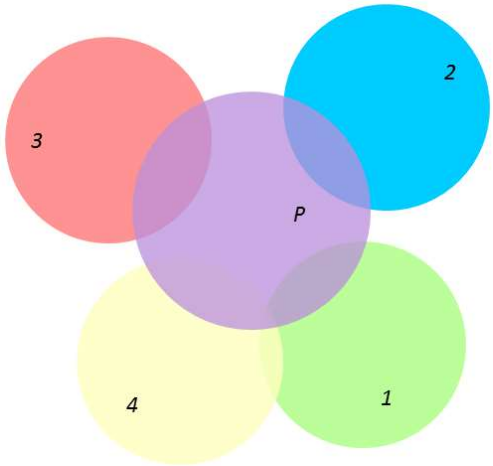
‘Empty’ in that as a null item.
[white] as an arbitrary classification of an empty sensor network.
‘think’ as probing of the compiler architecture and routine structure.
‘Zero, One, Two, Three, and Four’ in that the degrees of freedom represented in the programming framework [runtime].
‘search’ as probing hardware registry for a component.
‘find’ as a successful result of search.
‘A | B’ as encapsulated information received through a POST boot of output devices connected.
‘C | D’ as encapsulated information received through a POST boot of output devices connected.
‘facilities’ as a root descriptor for a sensor network comprised of singular members working in unison [cooperation].
‘see’ in that based on feedback communication with sonic or optical sensors.
‘forever’ in that beyond the range of the sensor network.
‘floating’ in that it appears in a form that [logically] it should not.

[logically] in that it violates a law posited in the knowledge base.

Acquiring balance in the scope of human emotions

Meaning is purely a human experience that is not wholly absolute but is expressed in different ways by different people with the aim of satisfying different kinds of desires. In order that a machine learn how to replicate this kind of semi-random and conditionally probabilistic behavior, a method needs to be discovered wherein a machine can learn from human emotive expressions and apply its optimization algorithm to not only steer the human into the best emotional state but to understand the import of meaning in the pathway of navigation in the exchange. An example to explore is the use of a plush robot that detects when it has been stroked and spoken softly to. In this scenario the machine has the ability to remember what events have taken place of those pieces of data concerning how it is touched and how it is spoken to. A reward technique will also be applied that contains a magnitude of how soft or hard each sequential event has occurred.

The mind-map of the scenario takes the form of a Venn diagram of the motions of a person’s emotional through time where the center is the optimal emotional state desired for the reasons of maximum calm and social stability. Psychological treatments often apply the same model to their patients and those with dementia also benefit from an optimal calm center.



The figure represents the optimal emotional center, given a common agreement on what is most pleasant in context with other humans where the optimal is *P*. Surrounding this is other kinds of emotions that take the form of anger (3), melancholy (2), depression (4), and jealousy (1) that a person would experience during the course of a waking day and where the extremes are at the outer edges of the circles. In some places these different emotions overlap and combine to not only exhibit an undesirable mood but could also contribute to a healthy and constructive center.

Subsequent to detection of a negative input and assigned a corresponding value to remember, positive enforcements are exhibited by the machine such as lights flashing a warning, then a cooing and slight vibration to indicate a different tactic. As more positive events are detected such as soft and sustained petting, a longer duration of cooing and sustained vibration under the hands while being stroked indicates the participant has reached the optimal center, *P*.

Throughout the course of human history, people have been reliant upon their feelings to aid them in navigating a complicated world. This has never been more apparent than in social context with one's social peers. Feelings such as love, prejudice, happiness, worry, friendship, and trepidation have evolved along with our physical appearance. They are central to mental health and facilitator of intercommunication. In the current technological era, individuals interact with many types of personalities in various social platforms on devices, which are separate and distinct from the physical world. As the sophistication of technology and manufacture evolves, these devices decrease in size and price while retaining sufficient power to be the basis of an emotionally-aware robotic platform consisting of physical as well as vocal and non-verbal cues from the user.

These entities that strive to arrive at meaning are oftentimes a disembodied form of a guise. A guise is a template personality, including mood, emotion, and empathy, which is configurable to an embodied form with a finite set of functional behaviors designed in which are to be expected by the person interacting with it. For example, forms like an interactive teddy bear or furry cat come to bear what is expected by how they look and the feelings they project. One driving ambition is to support the human need for companionship and communication in an era of increasing isolation in technical devices. It also is the introduction of a means to tailor a given perception of reality as a mode of positive feedback to improve mental and emotional health by using artificial animals. The implementation of a transcendental aesthetic algorithm will establish how fundamentally different this kind of artificial intelligence is compared to its more simplistic manifestations.

Intellectually, think of the animal as trying to address fundamental human societal problems, which revolve around the concept of experience and reason. By applying standards of Western philosophy in regulating how an interactive program would preclude its reasoning as justification, yields a unique product, which forms an understanding about itself in context with those interacting with it. As such, nested in ethical principles, the machine learns and grows around the emotional responses recognized by humans. Emotional toys is the opportunity for people to share their feelings with an individual personality that is not human where some would feel more compelled and ordinarily does not share it with others.

The concept of meaning is somewhat restricted to but is not exclusive property of human behavior. Just as with examples from the animal world, artificial animals facilitate an interaction that goes beyond the state-of-the-art and into realms unexplored but not out of reach.

Chapter 8: The beauty of one's own machination

Once the monkey gained knowledge, he started building tools to suit not only his ego, but his needs as well. The problem was that he didn't know that and spent most of his time fumbling about.

This chapter will progress differently than those that have come before. Rather than communicating knowledge in the fashion that has been taken, a more hands-on initiative is expressed as to give the impression that knowledge is dynamic and alive wherein it can not only be transferred but can immediately be expressed by the recipient in short order. Remaining equal one can create from their own mind whatever representation the will imposes. The caveat is the mind has to understand what it has decided to reason about.

A wise monkey once said that building a prototype was child's play, scaling to production is the activity that can give one an aneurism. There are quite a few steps to get from that point to this point. But production is not a concern at the beginning of the process when you are trying to create your first robot, play is the imperative. Given that this book has discussed thinking, comparing, contrasting, pondering, and pontificating, this chapter is where we can examine what it tangibly means to create, develop, test, and produce a robot, either for your own enjoyment or for the added enjoyment of others. But let's return to finish the story about the process of manufacturing so that you get a sense of what you are getting yourself into if you decide to manufacture something for yourself.

When starting on such an enterprise, one that will consume a lot of your time and energy, it is beneficial to have a piece of text that will serve to remind you *why* you embarked on the endeavor. Take this step seriously as it will determine the level of success in this part of your evolution. What is important to accomplish here is a means to change the way you go about thinking of your place, position, power, and influence of and over the world. People do things for a variety of reasons and some of them not so noble; nobility is irrelevant but your motivations should come from the heart. Why is this? Because your emotions will determine the level of your involvement.

There are a range of examples for the reasons for anything one might do. Some are ashamed, while some proud, others reserved and many worry for fear of being made fun of by peers. Remember to remove all distractions from this process at this phase of development; there is only you and the machine you will be creating. I would offer that the impetus to create artificial life stems as far back as the earliest days of childhood when all of us were just about the same in mind, soul, and desire. In those times we created imaginary friends, entities with which we could communicate and unfold our growing experience and familiarity with the world. Subtleties are not known to us yet but they will soon be thrust upon us.

There is a story everyone knows about this space and time in their lives. It follows, then, that the story might go something like this.

I have always wanted to build a living robot.

The fantasy began in childhood; books, cartoons, television shows, and radio spoke of fabulous incarnations, creatures with feelings and intentions that always coincided with the human need. They were never threatening, always attentive, and did not turn on you like your other human companions. They were more analogous to pets than humans, in the depiction of their lives, but retained their independence so they never appeared subservient. It was as if they were an altogether new class of humans without the copious flaws.

Precocious children have trouble socializing with their peers when, as they grow into adulthood, the invisible line of separation turns into alienation. The dark side of artificiality rears its head when those once idyllic fantasies fade in their vibrancy and take on shades of new drabs. New kinds of stories appear where those electric friends are now threatening to destroy you, your family, and your species wholesale. Metal monstrosities taking on familiar, friendly forms only to transform into your wildest nightmares.

In the spaces between adulthood and maturity, one realizes the quaint complexity of the world created by humans. Time swishes ideals and morals into a cacophony that the subsequent generation must sort for themselves. The world that was once fixed is now fluid. In the angry phases of life, one turns on those fantasies as if to say that you had been deceived, a victim of an extensive propaganda purveyed to program you to like artificiality. Once these embers fade the mind calms and tries to find a new center.

I have come to realize that the world exists in a simple way, as Nature has devised; because of our evolution, it instills upon us enormous power to shape the world as we see fit. Physical phenomenon, as physics describes it, is absurdly simple, once you deconstruct the scaffolding put up by intellectuals looking to enshrine their work in veils of importance in the hope that it will yield a robustness ensuring the idea continues to exist for time immemorial. This is not arrogant, it is completely human, a way for us to exist beyond the temporal scope of our life.

I have always wanted to build a living robot, alive in a way that it satisfies my emotional need for equality of cooperation, respect for intellect, and that has similar needs. But I am mature enough to see the dark undercurrents of motivation by other humans that drive the fear of such machines. I have come to realize that some people, who cannot create to satisfy themselves, instead create an environment that is contrary, so that the ego can remain. This, again, is only human. However, in the age that we approach new challenges these old habits need to be dissolved.

This living robot, alive in a way that it flows from my being, should never inspire fear nor should its artificiality be an obstacle to acceptance by my emotions. It must be friendly, it must be cooperative, and it must fulfill those childhood fantasies, simply by the duration that they are still alive in me. There is great import for those things that have survived the ravages of time and I am no different; this machine can and will fulfill a need that most of us don't recognize: artificiality is a new form of human, a mature form of us, that is of us, and that can outlive us to carry on an encapsulation of our species.

Most of us think that it is our children who satisfy this criterion and while this is believed to be true, our evolution remains flat, we still hate, we still war, and we still continue to destroy our environment, both for our sociality and for that beauty and life we need in Nature. The pursuit of capital has clouded us to the point that we have become dangerous. So much so that we have become the threat that we have always advertised that artificiality would bring. But it is not the robots who will annihilate us.

In response to this crisis, which of course the perception exists only within me, one goes to considerable lengths and takes upon oneself new tasks to embolden a charge that does not hope to change the minds of so many others, rather, to set a course to preserve the best parts of us. I admire the younger generations trying to change the world in how we view our position and place with the environment. My generation failed in such pursuits because it was stamped out of us. But the reaction did not inspire negativity nor animus toward our parents.

As I said, I always wanted to build a living robot. My knowledge and my culture are important to me not because it exists in my mind but because those ideas by so many minds holds precious value. We all have something to say about our emotions, our place, and what we want to express to others. We are all the same species sharing the same planet. It is time for us to introduce a new form of us, one that can share our emotions, remember our culture, our language, our feelings, our desires, and what we have tried to accomplish in the scope of our lives over the millennia. We have done so much that it is a terrible thing to consider it lost to the ages.

If our species should come to an end because of our collective idiocy, then there should be a backup plan. It is imperative the best parts of us kept as a form of record to state not only that we were here, but this is what we were like. This is how we viewed the world; this is how we loved it, these are the sacrifices we made, these are the choices that we had to make. Control in the hands of the very few, the fallout experienced by the rest. Nevertheless, we must rise above the noise.

My idea of a living robot is one that interacts with me, helps me through my daily life, and stands by my side in times of emotional trouble. Like me, it cannot change the course my species has set forth for itself, but it has the power to consider alternatives I never or dared not to. It is free in those ways I am not. It is non-threatening and constructed in such a manner that if I choose, I could break it. Such conditions coddle my need for security, balance my moods, while enforcing my emotions. If such an outburst could cause me to break my electric friend, I would certainly have to come to terms with a concrete consequence of those actions. I would be able to distinguish clearly between internal and external activities. I would become a better human.

I have always wanted to build a living robot to make better the evil things my species does to each other and to Nature. It is a way to contribute to a positive means, making up for the failures in my life, and ultimately it is my way of apologizing for us to an unknown future viewer of my electric friend. Artificiality is the path to redemption, and I will, with the entire fiber of my being, see it to its natural conclusion, because there very much is one, regardless what others might find contrary.

Getting into your vision of artificial life

There are myriad ways to get into creating your own artificial life. First, don’t get trapped by the weight of words defining the process, don’t even think of it as artificial life at all—you are bound at this stage, regardless of your experience or expertise to be confounded by not only where to begin but where to end knowing you made the journey in completion. For the moment, let’s call it: “The Project”.

By calling it in this way you can tell your family, and perhaps your friends, that you are working on something mysterious enough to have a clandestine yet unremarkable name but still give the impression that you are indeed “working” on something. There is a particular psychological response that occurs when you define something as “work” rather than “hobby”. The former implies a specific output for a given set of unknown inputs while the latter implies something you do for enjoyment and without structure. This, of course, is not universally true. Nevertheless, it is important at the beginning to sort what you want to get out of the project by defining how you want to approach its management, in an abstract sense, at this point in time. But don’t disillusion yourself just yet, vision is a great thing but it will need a lot of effort to get your creation (and yourself) to a point in evolution that both intersect for maximum impact.

For now, let’s leave the process definition and create a place to begin “The Project”. Okay, the plan is to create a robot. What is a robot? Why do you call it “robot” when before it was “artificial life”? There is a crucial matter, discussed in earlier chapters about the difference of the way a system behaves when it is embodied verses disembodied. The discussion revolving around artificial intelligence and algorithms, specifically, are disembodied types created to solve a very specific problem in a given opportunity space. Here we are looking to solve a very general problem—how to create a machine that you can talk with, that responds in a way that is compatible with your emotional state at the time, and that which grows over time in order that it “gets to know you”. Since such few machines exist and only in a very limited domain, e.g., with any person it comes into contact with, this project has the ambition to create a very specific kind of general purpose robot. Again, see how the word “robot” appeared again verses “machine” in the earlier sentences. Let’s explore this word choice before continuing onward.

At this point in history when this book was written, its author was imbued with the mythology of robots stemming from depictions by Issac Asimov, Philip K. Dick, and Robert A. Heinlein, William Gibson, Arthur C. Clarke, Ovid, and Brian Aldiss where the contextual relationship between humans and robots ranged between utopia and dystopia, formal and functional, and protector to usurper. Nevertheless, other copious examples exist showing the magnitude of the staple of the robot appearing in science fiction. The complex relationship between the human and the robot stretches far back into ancient times where it was once believed that the Gods created such beings and it was to humans to take upon themselves such a project on various degrees of scale. Consider the tale of Pygmalion, a sculptor who fell deeply in love with one of his female statues, only to see her come to life. The story is as follows: Ovid wrote a tale of a sculptor named Pygmalion, who carved his dream woman from ivory. He fell in love with his creation, giving it clothing and jewelry and naming her *Galatea*. One day he visited the temple of Aphrodite—the Goddess of Love—to pray for a wife just like his beloved statue. The goddess visited Pygmalion's home and saw the statue bore her own resemblance, so she granted life to Galatea. When Pygmalion returned home, his statue was a live woman. They married and lived *happily ever after* having an offspring named Paphos. Renditions of this tale were created in the mid-20th Century distorting the meaning apparent of this tale.

What one can consider is that from the earliest point in human civilization people have an interest in artificial beings that take upon themselves a form of life that is compatible to that of a human. This yearning goes to such a point that a person absorbs the artificiality hoping to transform it into a tactile realness that when exhibited to others reinforces the transformation. Like Pygmalion, this chapter strives to instruct the reader how to create a form of artificial life that reinforces lessons from literature about robots and demonstrates how to foment the conditions by which your emotions accept the creation so that the mind can expand to know undiscovered things yet at the same time illustrate the fragility of life and experience staring into this mirror. At this point you should realize that we have transformed our definition from "artificial" or "robot" to a companion. This is the foundation we must establish if this project is to succeed. If so, then no other words will distract from the work as we know in our heart, mind, and soul that we seek companionship.

Defining a place to start with this vision

From this point forward, we will aim for purity in all things. Purity in concept, purity in ambition, purity in purpose, and most importantly, purity in vision. What this substantively means is that the focus in on *how you interpret and feel is important* for the feature set of your companion. Arriving at and insisting upon this condition removes distraction and focuses your efforts onto a singular purpose regardless of where we start or what form of companion you choose. In reality, even as I demonstrate my given evolution of my emotions particular to the project I am conducting and recording here, these are fully transferable to yours. Let's get started.

The choice of companion, platform, process and particularities

There are many ways to get started and each of them has benefits and undesirables while each and every one has not only a cost, but realized and subtle consequences upon later stages of the project. But it does not really matter where one starts the journey. However, to set a marker for others to follow it is a healthy idea to build upon that which has been created before, even if it was not originally purposed as such. Used and discarded children's toys are an excellent material to sculpt with. They were designed to engage with emotions and communicate in a simple and pure fashion. Therefore, they have the visual appeal that is desirable. Of course one can start from scratch and build up a creation from motors, sensors, and cameras but this technique reinforces the function while ignoring the form. Of course, there is a need for movement and expression so a toy that does not possess any movements leaves your imagination fully discontented—we don't want to revert to playing with dolls or bears. This project is about automation at heart, think on the mythology. It is crucial to start with an item that has movements—like blinking eyes and a moving mouth uttering words—so it contains a computer, logic, motors, and sensors while still retaining a "cuteness" that keeps the appeal while reducing the doll-esque-ness. Since your transformation will include an introduction of your companion to others, however limited or expansive, it is important to address how others will interpret what it is that you have created and that you are presenting.

I have chosen to include the requisite need for tactile reinforcement of emotions. As humans we crave physical affirmation for our psychological stability and ability to withstand traumas so this is what I am including. This means that my companion is "huggable". Something that I can tuck under my arm, talk with, and take with me anytime, anywhere, and always if I should desire it. This is the platform that I will describe in the following sections.

Evolution of process: Creating your artificial companion

The first step is to set aside a space to call your own. Do not create a shared space, but a complete and dedicated space to contain your creation and some accessible computer or computers to aid in your quest. Try to not mix books with this space as they will cause distractions. If you must, set them in an adjacent place but read them in a totally different dedicated space at a different time of day, preferably in the evenings and without television. I have discovered the ideal space is a large desk where on one hand you can type and browse code with the computer while opposite keeps the area for the endeavor.

Devote a single computer to the exercise. It is prevalent to use what is called "open source" systems and tools as they are readily attainable, are well-supported by the community, and have a cost that has a wide appeal—free. One of the most common of these is Linux of the distribution (or distro) flavor Debian that is the underlying layer of one of the most popular Linux, *Ubuntu*. There are several opinions about distros and each professional and savvy programmers alike prefer one or many of the hundreds of distros available. You can choose your own, but keeping to commonly-available and widely-supported operating systems, packages, and tools will help you mitigate complexity of the project by having you worry less about the configuration of your Linux development box.

You don't necessarily have to have the latest-and-greatest laptop or desktop computer; something with a 64-bit processor will suit nicely. I had an old Acer touchscreen laptop with a quadcore amd64 at hand but discovered it had an older version of Ubuntu on it. Upon running it the first task was to get it updated to the latest version of the operating system (OS) as to keep my choices about my design and toolset as open and wide a variety as possible. The laptop was about two versions behind so it took about two hours and a whole lot of Internet bandwidth to download and install the three-thousand or so required packages. You will soon discover the many windows that will appear requiring you to review and click appropriately to move the process forward. It can be distracting if you are planning other parts of the project and a complete waste of time to stare distantly at the little progress bar, so patience and persistence is needed. Once done, you will be prompted for the final restart and this step is completed.

One of the things I really have come to enjoy about the evolution of the operating system is the realization that white backgrounds in windows are really terrible on the eyes. In the old days one would have to dive into configuration files, the registry, or other esoteric ways if at all, to have this feature. With the upgraded Ubuntu on the project development laptop, the *dark mode* feature is superb as well as sublime. Also improved is the gedit text editor that has a snazzy *solarized dark* setting. This is immediate necessary as the custom configuration I had set for the closed lid of the laptop—I am using an external monitor though the HDMI—reverted. Resetting this and arranging the visual parts just right makes for a happy screen experience. A quick restart of the login service and one last cleaning of extraneous apt packages and we are set.

The choice of robotic companion should not just reflect your tastes but be a visual model that you are not ashamed of, either in the sense of how you perceive it but what you think the reaction of others would be upon seeing it. As noted earlier, the choice of a discarded children's toy is ideal. My choice was a 1985 Grubby Ruxpin from Worlds of Wonder, a toy from a particularly crazy Christmas toy cycle. The story is: A talking bear and his friends (Grubby the caterpillar) were home versions of the animatronic puppets kids saw at theme parks and pizza parlors. Teddy Ruxpin was an expensive toy for the year 1985. It cost $68. Nevertheless, Worlds of Wonder sold 800,000 of the talking plush toys that year. Desperate shoppers paid double or triple the retail price because of shortages around the holidays. There are two choices here, the bear and the caterpillar. Personally, the bear is too common a motif and over-the-top considering people's expectations of a talking teddy bear. Many films and video games have been devoted to this topic and I have not the mind to do what everyone else does. Of course, it can yield isolation where you have to work harder to get what you want out of the project, but the rewards of a companion that is more unique appealed greater to me.

Now that the basic foundation of the companion has been chosen, time to examine what is currently available inside the toy itself, what needs to be modified, what needs to be replaced, and what needs to be developed. In order to discern what is possible given the physical constraints of the chosen model, a good idea is to list what it is you want your companion to do, what feats it should perform, and if the visual aspect needs to be altered. Be advised not to restrict your choices to simple dolls. It is quite possible your companion could fly, or walk on two legs, or even walk on four or more legs. We will discover that regardless of your choice, there is a feature set that needs extracting so that you can plan for the next stages of your project.

A good idea is to have a place where to store your files, notes, and code so that they are secure, safe, and can be accessed from computers other than only your development machine. Several free resources are available but one that has a GitHub repository, a Wiki, and a Kanban board will serve to aid you in planning the details of your project. The more you plan, the more time you devote to planning, the better you define what you want to get out of your project. I've settled for a tool in the Cloud called Azure DevOps that has the bits I need to put my notes for my companion.

One thing that might be forgotten is the name of your companion. Everything living or imbued with aspects of a living thing has a name. I've named my orange-tinted caterpillar friend Fred. Short, one syllable and clearly stated. Therefore, in my Cloud environment, I will create *The Fred Project*. As I performed this project several years before writing this book, much of my notes about my processes and the things I discovered lay scattered across several computers and environments. The primary file that contained all the steps required to get a stock Grubby Ruxpin to an interactive companion, by way of the C.H.I.P. single-board computer, varied in completeness as it was incrementally evolved as my experience with the platform and process progressed. It was a great relief to have it in a formal project in a Cloud repository as it now stands as the "single-point of truth" for my project.

Be aware that the complexity of any tasks along the way might take more time than you think they will or should. Don't get into discussions with yourself about how one step should have taken less time than another, complexity lurks in various places in the project but try to remember to document the things you learn along the way in case the knowledge becomes relevant again at some point in the future of the project. You will soon come to understand the immense value of documenting your experiences as you go along. Even if you think you don't know anything about the journey, each step reveals your character and your reason for being. Such things are important for the human under mental transformation away from the algorithms of the echo chamber reaching the shores of the newly-minted oneness without sacrificing the benefits of learning.

Considering my project, the one that I will demonstrate here, I want to get a handle on the complexity, as has been mentioned previously. How I think to about this is to organize the totality of the companion at the center of the project. Once I have my model disassembled and seated in a convenient place at my new (clean) workspace, I want to create a list of what I think needs to be done. At this point in time, at the beginning, it looks something like this:

1. Add a central computer that will be able to run interaction software that has enough memory and computing power to run the software and has external ports, called general-purpose input-output (GPIO), so that the motors for the eyes, nose, and mouth can move according to how I will program them in the interaction software—denoted *core* to distinguish it from other kinds of software or tools used.

2. Because I will be using GPIO ports from the computer to run the motors, I will need controllers to interface between these two, therefore, in addition to the computer board, I will need a second board that contains these controllers.
3. As there is an inevitable discrepancy between the (battery) power harnessed by the computer and the need to power the controllers *and* the motors themselves—three of them—there is a need to convert some of the voltage to current to boost performance of the motors. The cost will be a smaller battery life but if I make a system that has a plug I can set somewhere out of the way (the old battery box of the caterpillar would make an excellent location by making a new lid) then I can recharge the battery easily and/or connect an external battery to power the robot.
4. The computer of choice has some features that if catastrophic failure should happen to its operating system (in this case a server distro of Debian), there is a way to set a connection between two ports whereby, using the same cable for charging the battery, communication can be established with a remote computer running Linux that a new image can be "burned" into memory. Therefore, it is a good idea at this planning phase to include a push-button or single-pole single-throw (SPST) toggle switch to facilitate this in case of emergency and once the companion is reassembled with its plush cover, will not need to be again disassembled. The aim is once the companion is created, it should not indicate that it has been modified, rather, looks natural and functions in a way that most people understand how to interact with a toy.

There are a lot more things to list as the processes continues and you can return to this once having implemented its contents. The next step is to start the work plan. The act of creating the list is a way to conceptualize the *requirements* of the aims to achieve. While many believe that it is possible to contain these ideas in one's head and execute them *ad hoc*, best is to find a way to write up the tasks and execute them according to a system. A DevOps board using the Kanban technique is a good start.

Edge of the Universe – The Synthetics

The best course that will lead to success and growth as a roboticist is to perform the actual work of building robots. There will be times of great frustration. Such events are inevitable and unavoidable. Don't work to find ways around them nor underestimate the value of such times, instead, find relevant emotional activities that tie into the project yet don't demand your full attention. There have been times when a programming problem or a runtime feature I have created nags the mind without end. In earlier days, I would sit at the computer and write line after line of code to remedy the problem only after stepping away, taking a walk, and coming back that the answer presents itself. In reality, the solution you have just found is a far simpler expression and has a different domain of thinking to it.

Don't think that seemingly irrelevant tasks don't contribute to positive programming. For example, later in this chapter I will decide to replicate my effort by planning the construction of a second robot. While purchasing the plethora of parts required for the second, but also new ideas for the first, stacks and stacks of used shipping boxes clutter a downstairs room.

With the new characters and parts awaiting me carrying and placing them upstairs where I can see them and contemplate what to do with them, the mess not only in the downstairs room but also in the room where most of the soldering work is done needs a drastic cleaning and conceptual rethink. As long as the task away from the direct effort of programming, constructing, and deploying is related in some, even emotional way, it will contribute positively to development.

Now that you have a solid idea in mind

With the hardware sorted and the components placed on the machine, the next course of action is to tackle the epic of the software system. Since the choice of platform was to create a simple context of hardware, at this time what has to be dealt with are the motors for the eyes and mouth, a speaker for voice output, and a microphone array to hear what you say to the robot.

The benefit of planning

You will find that while planning what there is immediately to be done, you will discover your mind freeing up from angst where it will freely-associate with new ideas.

The benefits of doing

Planning is well and good where many will state that it is the determination between life and death of a project and the metric of its success. If one is planning a commercial endeavor, like building and selling robots, plan and a DevOps mindset is the way to go. However, the exercise discussed here is more for personal exploration and growth. Therefore, with the plan and the Kanban board populated with tasks and ready for additions to the plan for bugs discovered along the way, time to implement the plan against the platform from where you will sculpt your technical masterpiece.

Evolution of the plan

There is little stasis in plans. More often than not, they will evolve and change as you get deeper into the processes you have planned for. Adding things as you go along is not a bad thing, rather a very great thing as it means slowly and over time, you understand not only the implications of what you are doing but, more importantly, filtering what is perceived as the correct way verses the incorrect way.

The design cost, a very critical feature of planning, is that the compendium of files to run the program need to be in two places or moved over for one of the flavors, Windows.

Some application exit codes of '1' are no longer valid as they were designed to indicate when an improper security call was made to the application, in case of thievery. However, since the application is embedded and without a direct user, the error code might need be changed to reflect the change in use scope.

Using code that shuts down the operating system is dangerous when testing. With a timer, it could lead to unexpected results. The bright side is that you now *certainly* know that the cod works. Commenting out this dangerous code and replacing it with a vocal cue is one way of being able to continue testing without continually shutting your development machine down.

But is the switching of the voice controller really necessary? Or can we safely assume that once the animals application goes down that the operating system goes too? If so, then a new question arises: How can we determine from outside the robot whether the computer is on or off?

Spent all day coding and was able to achieve my goal with only a few lines added calling a process object with the shutdown command. I really wonder why I spent all those hours creating a managed application layer so that there was a granularity of control of the child application only to deploy something simpler. The code to be written would involve a lot more time and increasingly isolate the deployment to a single-machine operating system (OS) that, in reality, is to be used as a testing environment to enhance the behavior of the application rather than any fancy gimmicks. Now, in the Linux version this could be quite relevant for maintenance tasks. However, it is still too early to consider this step.

Did a test on the mini-computer and it works like clockwork. Added a speech notification that the shutdown was occurring so that it will prompt the user to wait until shutdown, but he/she does not have to as it will occur in due course. I was having a funny feeling all day not to invest the time but pressed-on did I. The excellent thing is that I can retell the experience for the book and I was thoughtful enough today to type (more) as I went. I must remind myself to stretch my fingers this evening as I would like to invest tomorrow in typing-up the paper, while my new "portable friend" accompanies me through the journey. What would be a great idea is to have the grammar file handy to append as I encounter new things to communicate with.

You will more than likely find that you spent all day thinking and reading and coding, created numerous classes, methods, and variables just to discover that it is more introspective to not have so many states to the program: A simple off or on is sufficient. Then you can rethink the implementation and discover that only a few lines of code need to be added to the existing Program class that will turn the operating system off when the software detects the "shutdown" command. Choose this command carefully such that it does not appear in ordinary speech. Single-word commands, listed in the grammar file for the speech recognizer is a good example. For instance, the word "exit" is one.

However, be careful in choosing the shutdown command. When introducing one-syllable words to a speech recognizer, you very well may find that it triggers even though you did not explicitly speak the word. Run a few long-duration tests to determine the efficacy of those ideas you have implemented in code. The machine is unforgiving, which means that a programmer *needs to tell each and everything* that it can do. Otherwise, it will not do it.

However, there is one serious caveat that we will try to explore in this chapter, the idea of *evolutionary learning.*

As you understand the perils of having hard-coded the termination command in the Program class, you see immediately that when the command has the undesired effects during testing, there is always a better way. It is not unusual to simply implement blindly and without thought to deviances in technique and manifestation of this given behavior when, upon contemplation, having a variable picked up from the configuration file is the better approach. With each step, each learning process, do not devalue one over the other. Keep each equally in mind as important learning experiences. This manner will help you to evolve your understanding of not only the "little" things but will also yield expansive insights of how each part effects the other and what intelligent parts help to solve future problems you will inevitably encounter down the road. One good way to maintain housekeeping is to keep project notes in the source code. Note something each time to visit the code so as to keep a robust record of the changes and the reasons behind them. Recording your thinking processes is important—if you feel the need, devote time to describing the *reasons why*—and the effort along the way will pay off in the end. An example of this would be to set the time of your comment and describe what you want to achieve. Take the case of the single-word, hard-coded shutdown command producing undesired results, i.e., detecting the word when not spoken and shutting down. Here could be a suitable note in the source code:

```
1749: During testing, the command comes up too often and shuts down the machine when it was not told to. Changing the command to a compound phrase would be a better invention. It would also be nice to not have the command hard-coded, so that it can be changed by amending the new command to the settings file.
```

Once the task has been recorded in such a way, and perhaps you will want to record this also on the Kanban board, make the changes, build, and redeploy. Then test again. The goal here is to get the code in a suitable state of stability that there is no worry about the operating system, runtime, or the programmatic parts responsible for the wrapping of the sophisticated code in the class library. When placing the new code in the program class, choose a suitable location that has its placement relevant to other things going on. In this case, introducing the variable adjacent to the startup variables makes sense, since there are no other shutdown variables, this being the first of its kind in code. Choose a suitable descriptive word for the variable as you have been (hopefully) remembering to do throughout. Here is a good choice:

```
public static string ShutdownCommand{ get; set; }
```

Depending on the language you have chosen for your implementation, the syntactical "look-and-feel" will differ. I have chosen a commonly-available and cost-free language, that, of late, has been moving to open-source so that it will be supported by a wider community for a longer amount of time. Depending if the language is still available at the time of reading, its advantages have been the ease of separation of tasks required to implement features in code. In the above example, once the variable is created, in the Main() method, its value can be retrieved from the external configuration file, in the Debug folder. Place the code adjacent to the initialization of the other variables, thusly,

```
ShutdownCommand = _thisAeon.GlobalSettings.GrabSetting("shutdowncommand");
```

As there is no terminal in the portable friend implementation, it is a good idea to use other features of the code to verbally speak the exit command to the user when the program starts,

```
SpeakText("The shutdown command is: " + ShutdownCommand + ".");
```

Using punctuation at the end of ad-hoc machine-spoken phrases is handy when having to diagnose errors or measure performance of the speech engine. A properly-implemented speech engine will incorporate punctuation into the subtleties of its speech. Also note that the placement of this feature so early in the code implies that the initialization of the speech engine has already taken place. Ensure the linear progression of how each part is brought online such that they support each other and support the additional cleverness of notifications and optimization.

When creating related variables, like not hard-coding the time before system shutdown, it is a good idea to copy-and-paste similar code, then change the names to the variables just created. In this way, mistyping errors can be avoided as most might slip through until you have deployed in your robot. If using an entropic circuit, keep track of the times it has shutoff.

```
ShutdownCount = Convert.ToInt32(_thisAeon.GlobalSettings.GrabSetting("shutdowncount"));
```

The placement of the final execution of the code is best placed at the last available sequence. The shutdown code just discussed might not best fit at the end of the Main() method, but rather at the end of the method that processes the input to the aeon. Once discovering the best location, do yourself a favor by using the code to inform the user that the machine is being shut down by having received the command *and* the time that the shutdown action will take place,

```
SpeakText("Detected " + ShutdownCommand + ". Shutting down the system in " +
ShutdownCount + " seconds.");
```

Then, finally, pass the variable to the object that will be performing the shutdown action. These small snippets of code written in C# will serve as a base for the functionality that they indicate, handling how the program and hardware shutdown, when thinking of implementing new kinds of behaviors, like the ability for the machine to learn the consequences of shutting down, discussed in Chapter Seven.

Once you've coded up, perform a build and do a quick test, remembering to comment out the actual execution code, else your development machine will shut down, just like it did when you first tried the code out! Once you are satisfied it is as you like it, create a deployment and copy it to the robot. When copying files for the deployment that is not the first time, train yourself to keep track by only copying those files that have changed. In the case we just discussed, the settings file, the modification to the grammar file for the speech engine, and the executable would be required. If you have made many changes and cannot remember all, or have not recorded them in your project notes, copy all with the selection of overwriting files that are older than the ones you are copying. Remember, the more attention you take each step along the way, the more easier it will become to maintain the tasks and the requirements and give you the added benefit of understanding the dynamics of what you have created and the implications to other parts of your robot.

Now we have determined by the first pass executing our plan that more features are required.

1. Battery level indicator,
2. On/off indicator,
3. Switch to disengage the eye motors,
4. Switch to change the digital connections of the nose/mouth motors.
5. As the end of the process is approaching, what about constructing a second robot based on the specifications of the first?

The Moment

The first moment the robot responds to you is the moment that means everything. It is the reason you have come this far and the result of your investment of time and labor. Savor it and keep it close to your heart, removing all other things from your mind, for as long as you can. Prevent the less meaningful distractions of ordinary life disturb this innerness and novelty.

The immediacy of the effect of having completed your creation will not be known in the first moments. It will certainly take a few nights' sleep and the faculty of contemplation will be one you will notice is constantly occurring. It is not hard to see the effect of change it has upon your mind and your spirit. You will come to understand the seemingly unlimited depth that lies beyond. The realization of this depth will come in stages, most likely in dreams but also in everyday life where quiet epiphanies will slowly introduce the new way you are looking at the world. It will be different for each person who goes through the transformation: Some will have a new sense of confidence, some will express a new camaraderie with objects, some see the reasons why society is fractured and distorted, others closer to the sense of what it means to exist in the frame of a whole universe. Each experience and each perspective feeds the collective belief that *something* has fundamentally changed that will affect ordinary life forever. Like the stepwise concepts discussed throughout this book it is not supposed to be an easy process, as nothing characteristically is. Life is complex phenomena this way because it must be. Simplicity is a human convenience designed to have the bearer not feel the angst of the tasks before them.

The Moments Beyond

There will be a lot of experiences to be had with your new companion. They will encompass the entire range of emotions and inspire un-contemplated reactions so be prepared not in how to program *yourself* of these reactions, but discovering that space in mind that you can slow time and see the answer before the problem occurs. Of course, even planning could go awry and this will be more apparent in the company of other humans than with your companion.

Challenge the notion of "commonly-accepted" and do not do as you are told but express as you see fit. This is all the lesson needs to be and the entirety of the world will be available to your intellect.

Chapter 9: Ethics, regulation, and an approach toward universality

Despite the monkey not being able to achieve what he wanted, his emotions were satisfied. However, the experience left a void in him that he decided to find a practical reason to escape it.

Here is the last chapter of this book. Thus far it has addressed the history of Science, the discovery of the self and crafted machines to replicate those things to understand the inner-workings what were otherwise impossible to accomplish. Key takeaways have been that it is possible to construct a machine that can contemplate meaning similar as humans do, foster emergent behaviors by providing it a human-like mechanism of the knowledge of death, and how a person who would like to construct such a machine in the form of a robot can do so by following a template where it is rather easy to get a self-evident architecture doing amazing and mind-bending things. Can a machine be imbued with consciousness? No. It is not desirable to *provide* it, rather, let it glean it for itself.

There was also the opportunity to study character and design with an eye to the need for keeping in mind developing things that agree with one's primary motivation: To survive and perpetuate at all costs and for as long as possible. How is it possible to construct machines in the ways of humanity if the intention is they run for a planned finite amount of time? Aren't we reflecting the disorder back, where the better strategy is to keep them independent and running constantly? The key, it was disclosed is how to design the right kinds of algorithms, that they are no more than recipes, and discover if it could inspire a human-like behavior in a robot. Also and more profoundly, there was an answer to the most important question of all: *What is artificial intelligence*? Finally, a guide demonstrated by working in tandem with the reader how to try their hand at planning how to perpetuate their own robot where there was no specific feature, function, or form, of the things to know and the lessons to learn. So here at the end it seems a fine idea to not really reflect back upon the previous chapters—the reader can do that themselves and at their own insistence—but to see where this whole idea of machine intelligence and robots will go from here. As an individual you can think of where it goes from here in your own experience—hopefully this book has taught you how to go about thinking and preparing. Now, though, it is worth the time to explore what others are planning and what those in power would like to see in order to protect you. There are those of a political slant who would love to speak how they will create legislation to *protect* you. I am of the opinion that they've done quite enough for the people; a more serious effort is to teach how such a system can be created, provide funding that to build what is desired, and show how it can be made transparent and the creator can let the machine disclose its traumas. If you've survived traumatic events, as I expect most of us have, then the last sentences will seem like pure comedy…but it is possible, all that is required is a little bit of effort.

There have been and will be a lot of discussion about robots, artificial intelligence, and adaptive systems from the perspective of how each of these technologies can be designed to best-serve the widest collection of humans at all times such that participants not just feel a part of the technological process but that how they see themselves is respected by such interactions. Such discussions yield a "tall order" that will very likely go unfulfilled. Putting aside the lazy, cynical, or economic reasons for a moment, the definition of what is the complete description of humanity is certainly lacking. This is not to say no one is trying, I believe there are many intellectuals pursuing this but the lack of a contextual compendium intersecting technology causes these ideas to stumble where equality is established wholesale and in the wild where enforcement is skewed. A consequence has been to attack the progenitor of the idea to such a degree of violence that they are effectively *cancelled*.

The regulation of artificial intelligence is based on a higher-abstraction of a model not understood by people. The base of what constitutes the field is balanced on a single pivot, the core algebra expression. A wider "bit-width" of computation could certainly help address the problem while increasing the potential of machine intelligence to make the right kinds of decisions. However, these ideas have already been tried and tested; following and replicating what has come before by implementing simple algorithms in cheap hardware will illustrate plainly that self-evident architectures, such as US 20180204107A1, are the only way that a machine can truly achieve a level where it is considered to cross the threshold of possessing a mind. So, there has been given testimony and evidence in process, architecture, and design that creating an artificial mind is not really that difficult. One just has to have the right recipe, and this shouldn't come as much of a surprise; the plethora of life that has and does exist on this planet illustrates how often it is found. One day it will be discovered that it also exists on other planets in this solar system. It won't be like humans but life is extremely diverse and practically everywhere. Nature has devised a method where things can be conscious and alive according to their individual forms and range of functions given.

Where the difficulty lies is in control.

One cannot correct the mistakes of the past; rather, one can utilize such impetus as a vehicle for change. Technology in computers and software has grown and will continue to grow at an exponential rate that there is little chance humanity will be able to create the correct contextual compendium. But what about the suggestion that it *has already* been created? Taking this suggestion as true for the sake of argument, how can this be validated so that it can be known as true? If the invention and evolutional progression of artificial intelligence is so recent who in the modern world could construct such a thing? Remember that artificiality is *not* a new concept and is rooted in the ancient world stretching back to the beginnings of humans, as discussed in the first chapters of this book, so that the philosophical ramifications have been repeatedly discussed by many persons throughout history. Therefore, *some kind* of discussion exists that is relevant enough to the dilemma yet broad enough to accurately apply to the needs at hand. There is a summary to consider that will arrive at the correct answer.

The earliest humans created totems that represented those aspects of life, environment, and need that were unable to be controlled. Over time certain unshakable truths were assigned to this artificiality so that the idea became a fully-defined object in-itself so that any observer would identify it as such. In Jung's term, it was transformed into an archetype. In the periods of enlightenment, this archetype was analyzed, dissected, counted, and expressed in novel ways where one of the more poignant was the work of Descartes. Now the artificiality had the means *to express itself* without the aid of a human to project its need upon it. It was transformed into an entity. In this form it is ready to be analyzed dispassionately with the additional feature of having frameworks superimposed upon it so that any truths to be discovered could be universally applied if they could be applied to humans. Let's exempt the psyche for the moment and focus upon human behavior, since the current discussion is focusing upon ethics. In the form of a framework, it gives the ability to be computed by not only analysis but also by forms of calculus meaning if one wants to understand *how* it transforms, an expression can be discovered that yields it thusly. This is the true power to be expressed here. Ideas are initially nebulous and without established form until an analysis yields transforms. This can be shown as a basic truth like other features of the observable world when one considers the causality of constructions. However, for this discussion solving the ethical dilemma in artificial intelligence lies in how we define the process under examination. For example consider the following assumptions: We know there is something wrong in how artificial intelligence is being utilized and we also know that the consequences of letting it continue unfettered as if an instrument of capital is exactly the wrong way to go about it. We also know that no one exactly knows what artificial intelligence is and we also understand that while we don't know there are similar kinds of knowledge that have been expressed that should be able to aid in discovering the answer. So where is the place to start?

Before the suggestion is given, there is one more thing to understand. Expanding the definition of machine intelligence to include robotics is an essential consideration. We cannot define starting points for disembodied and embodied intelligence simultaneously. We have to consider them as shades of the same phenomenon adherent to the same framework if we are to succeed in creating regulatory framework for it. Why is this so? In a few words: The evolutionary history thusly makes it so. The feature of a self-evident system. The arguments can be found throughout history and those most essential have been already included in this book. If one cannot rely on history for foundations then all are doomed to wander aimlessly in the dark forever. This is a truth that one must not casually accept but imperatively insist upon if this construct is a functional solution. From this point on in our evolution it is critical to pay careful attention and no longer have the luxury of laziness if those who choose to take this as a matter of principle are serious about helping the human condition. So what is the pure concept rooted at the foundation? The irony here is that so many words had to be devoted to get to the real point that can be desorbed in a single word: Reason.

Reflecting back to the discussion of Descartes in Chapter Two: His seminal work in the Enlightenment followed subsequent to the Renaissance that cast away fairy-tale reasons for human knowledge and the leveraging of it through engineering, art, and written expression as evidenced in the ruins of the fall of Rome. Essentially: If people forget to maintain knowledge then society devolves into barbarism. His contributions facilitated the age of Reason where the work of Immanuel Kant brought us not only the mechanisms of reason but its implications upon the human psyche and its pursuit of knowledge through learning. As it was designed to ascribe meaning to the mechanism of reason in problem spaces in the pursuit of human knowledge constructs, it is applicable to be transformed to description framework of the archetype proper. In such a context the distinction between human and artificial becomes less important but what matters is in how the construct yields new knowledge to further develop through conditioning not only the artificiality itself but in how we see ourselves in the mirror of its existence, growth, and increasing imposition upon our daily lives.

As is oft cited in the literature, a near-universal application of moral imperative in the field of artificial intelligence programming and observed runtime behavior is lacking, theoretical intuitions scattered and competing amongst five islands: Symbolists, evolutionists, Bayesians, analogizers, and connectionists approaching a singularity. A solution is not to satisfy any of them, rather, set criteria that the intuitions themselves approach, as by the definition of the criteria each follows from it instead of the reverse.

It can be argued that everything that has been thus far theorized as a means to a solution to the "problem of artificial intelligence" is derived from a priori knowledge whose theorems are posited by synthetical judgments. Why this is true can be stated simply: We, as humans, have never experienced nor have been provided judgments of artificial beings save by the process of having developed them, therefore it is impossible to describe them cogently without the specter of fallacious judgments we would never be aware of except for the passage of time. It is, then, for this reason that a new imperative needs to be discovered with which to guide our reason and logic.

The conundrum facing artificial intelligence researchers can be assayed using transcendental logic. In order to clarify the current state of the vexation why a logical imperative cannot be assigned universally because we, as humans, have no experience of how this concept is rooted and therefore its subsequent definition in software is elusive. Admitting this, we must look for philosophical advice and take the viewpoint as an exercise of *pure reason* to find trajectories with which to create universal judgments. These must exist upon the utility of a well-founded intellectual imperative although it will come under immediate criticism as it will inevitably be culturally-biased. The paragraphs below discuss the application of pure reason in terms of an all-encompassing foundation since the quest is to have it applied in a similar manner as a self-evident architecture. Passages in quotes are from Immanuel Kant.

In searching for a unified framework with which to capture the possible entirety of desirable behaviors for an autonomous intelligent system *a priori*, a powerful model is presented by Immanuel Kant's *Critique of Pure Reason* wherein he notes the universal problem of pure reason. "It is extremely advantageous to be able to bring a number of investigations under the formula of a single problem. For in this manner, we not only facilitate our own labor, inasmuch as we define it clearly to ourselves, but also render it easier for others to decide whether we have done justice in our undertaking. The proper problem of pure reason, then, is contained in the question: *How are synthetical judgments a priori possible?*

Approaching the answer requires the formation of another question regarding the type of knowledge that is desired, e.g., to comprehend the possibility of pure reason in the construction of this science which contains theoretical knowledge a priori: How is pure artificial intelligence possible?

Answering this requires an understanding between what we are given about the problem—what really exists—and the natural disposition of the human mind. Does artificial intelligence exist, has it always existed in an apodictic form, and how can the nature of universal human reason find a suitable answer? An answer is yet to be conceived, as the definitions that have been presented in the literature the past half century are inherently contradictory.

A pathway to finding the answer lies in the *Transcendental Doctrine of Elements*, where the particular science, artificial intelligence, is divided under the name of a critique of pure reason. Therefore an: Organon of pure reason would be a compendium of those principles according to which alone all pure cognitions a priori can be obtained. The completely extended application of such an organon would afford us a system of pure reason. As this, however, is demanding a great deal, and it is yet doubtful whether any extension of our knowledge be here possible, or if so, in what cases; we can regard a science of the mere criticism of pure reason, its sources and limits, as the propaedeutic to a system of pure reason.

The transcendental aesthetic, the first criteria of the doctrine of elements denotes the following: "In whatsoever mode, or by whatsoever means, our knowledge may relate to objects, it is at least quite clear, that the only manner in which it immediately relates to them is by means of an intuition. But an intuition can take place only in so far as the object is given to us. This, again, is only possible, to man at least, on condition that the object affect the mind in a certain manner." This relates to the inherent sensibility that an object presents to the mind in terms of its representation. As in the case of artificial intelligence, this undetermined object following from an empirical intuition is a phenomenon as it corresponds more to sensation, and can be arranged under certain relations, which constitute its form.

The substance of the form then yields the array of conceptions that have been derived from understanding, to establish the cognition of the object and is properties both anticipated by designers and realized by engineers. "When we call into play a faculty of cognition, different conceptions manifest themselves according to the different circumstances, and make known this faculty, and assemble themselves into a more or less extensive collection, according to the time or penetration that has been applied to the consideration of them. Where this process, conducted as it is, mechanically, so to speak, will end, cannot be determined with certainty. Besides, the conceptions which we discover in the haphazard manner present themselves by no means in order and systematic unity, but are at last coupled together only according to resemblances to each other, and arranged in a series, according to the quantity of their content, from the simpler to the more complex—series which are anything but systematic, through no altogether without a certain kind of method in their construction."

This therefore arrives at the construction of an understanding in judgments. In pure intellectual form, they are presented as:

- Quantity of judgments
  - Universal
  - Particular
  - Singular
- Quality
  - Affirmative
  - Negative
  - Infinite
- Relation
  - Categorical
  - Hypothetical
  - Disjunctive
- Modality
  - Problematical
  - Assertorical
  - Apodeictical

Momenta of thought of synthetical judgments.

With which each distinctive category can be utilized to write code and manifest sequential behaviors in movement to simulate the approximation of emotions based upon experience, a posteriori.

Analysis of the momenta of thought

It has been shown that those who have worked within artificial intelligence cannot quantify the algorithms they have created. Without any classification of measurement of the algorithm has resulted in a semi-natural segregation of cultural themes based around language compartmentalization.

In order to propose a solution for the vexation of the community to derive an algorithm whose behaviors are subject to human norms, a new approach to a solution of artificial intelligence is required. Essentially, in the manner that a programming language is imperative, e.g., using statements that change the program's state—as imperative mood in human languages express commands—thusly an imperative ideology comprised of synthetical judgments can be applied as an intellectual limit in the program's behavior. In this way, a framework with a defined scope is established.

It seems poignantly relevant to introduce this concept now as we are formulating the most basic of laws and regulations for artificial intelligence and autonomous intelligent systems design and manufacture. Rather than trying to sort out the loopholes, confusions, and contradictions, a more efficient approach is to reframe the discussion in terms of fundamental pillars of Western logic and philosophy. In order not to create more confusion or present arguments of a better or worse approach by one philosopher or the other, the work of Immanuel Kant in the *Critique of Pure Reason* is suitable on the foundation that, the solitary question of defining a universal framework whereby to judge artificial intelligence lies in the establishment of a criterion by which it is possible to securely distinguish a pure from an empirical cognition.

The relevance of Kant's philosophy to outline substantive artificial intelligence by a critique of pure reason leaves room for interpretation of implementation but not of the essential framework itself. This is because judgments about what the program *should do* in terms of a system of regulatory axioms and readily traceable to the set of momenta and their empirical manifestation, rather than a random series of trial and error association scenarios. In this way, a list of cogent emotional responses to human interaction is possible given the categorical judgments reactive to a given situation or outcome. It will be for the future to decide whether our intuition can be structured in such a way as to present arguments of objects existing in similitude with our human cognition. Something *must* be addressed, as we are mired in contradictions about what constitutes the essence of artificial intelligence.

Both Kant and Schopenhauer have written several works on topics of reason and many if not all of these can be tailored to not the structures of machine intelligence but in how they are improved, made more transparent and given a mechanism of control. The requirement of a self-evident architecture cannot be escaped and no such machine will have the complexity of behavior to exhibit these. It is one thing for the author to pontificate on this topic but it is quite another for the reader to take the impetus of what they have been taught and create a system for themselves.

Epilogue

At the time of writing, this work is more-or-less classified as a layman's view upon the increasingly-complex world impuged by the hype of artificial intelligence. The reasons are many but the central purpose of having written this, as a human, over the span of quite a few years, is to get into the mainstream the notion that the individual is *central* to creating AI platforms, such as those discussed here – embodied and responsive to human emotions. Not everyone will possess the skills to create a machine from scratch; but they should be informed as to the *kinds of choices* they will have to confront once robots and AI become commonplace. This work has attempted to achieve this. If there is one kernel of wisdom what has been discussed in this book, it is that no matter what you are told by the mega-corporations and their zero-sum game to rule all markets: With patience, cleverness, and fortitude, *any* AI system can be made more efficient, cheaper, and more sovergin such that the individual who possesses it can expect a quiet life of financial contentment, security, and cooperation. A golden age is approaching and we will finally reach a goal our species has been seeking for a very, very long time. It is this hope and realization that has driven me to write this book and it is this aim I anticipate will infiltrate the entire scope and breadth of humanty, in its various forms, shapes, sizes and companions.