# INTRODUCTION

> Everyone without exception believes his own native customs, and the religion he was brought up in, to be the best.
>
> (*Herodotus* 440BC)

> The future is not the realization of our hopes and dreams, a warning to mend our ways, an adventure to inspire us, nor a romance to touch our hearts. The future is just another place in space-time. Its residents, like us, find their world mundane and morally ambiguous.
>
> (*Hanson* 2008a)

You, dear reader, are special. Most humans were born before 1700. And of those born after, you are probably richer and better educated than most. Thus you and most everyone you know is special, elite members of the industrial era.

Like most of your kind, you probably feel superior to your ancestors. Oh, you don't blame them for learning what they were taught. But you'd shudder to hear of many of your distant farmer ancestors' habits and attitudes on sanitation, sex, marriage, gender, religion, slavery, war, bosses, inequality, nature, conformity, and family obligations. And you'd also shudder to hear of many habits and attitudes of your even more ancient forager ancestors. Yes, you admit that lacking your wealth your ancestors couldn't copy some of your habits. Even so, you tend to think that humanity has learned that your ways are better. That is, you believe in social and moral progress.

The problem is, the future will probably hold new kinds of people. Your descendants' habits and attitudes are likely to differ from yours by as much as yours differ from your ancestors. If you understood just *how* different your ancestors were, you'd realize that you should expect your descendants to seem *quite* strange. Historical fiction misleads you, showing your ancestors

as more modern than they were. Science fiction similarly misleads you about your descendants.

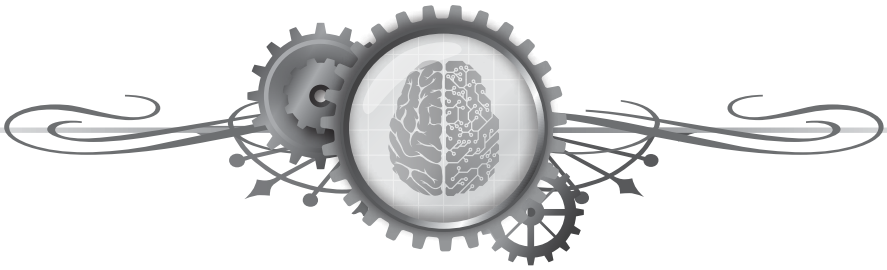
New habits and attitudes result less than you think from moral progress, and more from people adapting to new situations. So many of your descendants' strange habits and attitudes are likely to violate your concepts of moral progress; what they do may often seem *wrong*. Also, you likely won't be able to easily categorize many future ways as either good or evil; they will instead just seem weird. After all, your world hardly fits the morality tales your distant ancestors told; to them *you'd* just seem weird. Complex realities frustrate simple summaries, and don't fit simple morality tales.

This book presents a concrete and plausible yet troubling view of a future full of strange behaviors and attitudes. You may have seen concrete troubling future scenarios before in science fiction. But few of those scenarios are in fact plausible; their details usually make little sense to those with expert understanding. They were designed for entertainment, not realism.

Perhaps you were told that fictional scenarios are the best we can do. If so, I aim to show that you were told wrong. My method is simple. I will start with a particular very disruptive technology often foreseen in futurism and science fiction: brain emulations, in which brains are recorded, copied, and used to make artificial "robot" minds. I will then use standard theories from many physical, human, and social sciences to describe in detail what a world with that future technology would look like.

I may be wrong about some consequences of brain emulations, and I may misapply some science. Even so, the view I offer will still show just how troublingly strange the future can be.

So let us begin.



# PART I

# Basics

CHAPTER 1

# Start

## OVERVIEW

You should expect the next great era after ours to be as different from our era as ours is from past eras. In the last few million years, the three biggest changes on Earth were arguably the arrival of humans, the arrival of civilization based on farming, and then civilization based on industry (Boserup 1981; Morris 2015). As I'll discuss more in Chapter 2, Prior Eras section, each of these three eras greatly changed people, society, and the Earth. People who adopted these new ways of life quickly displaced and dominated those who continued with old ways.

Compared with primates, wandering human hunter-gatherers greatly expanded technology, art, language, norms, and politics, and displaced many top animal predators. Then farmers and herders stopped wandering, expanded marriage, war, trade, law, class, and religion, and hunted many animals to extinction. Finally, our industrial era has expanded schools, cities, firms, and individual wealth; it has displaced even more of nature and almost all foragers, and it has seen a partial return to forager values. Over this whole period, we've seen increases in travel, talk, organization, and specialization. We've also had faster change, innovation, and economic growth, and a more integrated and unequal world culture.

We have also, I will argue, become increasingly maladaptive. Our age is a "dreamtime" of behavior that is unprecedentedly maladaptive, both biologically and culturally. Farming environments changed faster than genetic selection could adapt, and the industrial world now changes faster than even cultural selection can adapt. Today, our increased wealth buffers us more from our mistakes, and we have only weak defenses against the

super-stimuli of modern food, drugs, music, television, video games, and propaganda. The most dramatic demonstration of our maladaptation is the low fertility rate in rich nations today.

While the industrial era has deluded many into thinking that old constraints no longer apply, as we will see in Chapter 2, Limits section, many recent constraint-evading trends simply cannot continue forever. Even if our descendants eventually conquer the stars, if we haven't greatly misunderstood physics then our long-lived but bounded universe must eventually limit innovation and growth. And without strong regulation from a universe-spanning government, we should eventually see less change, more adaptive behavior, and (perhaps surprisingly) near-subsistence living standards.

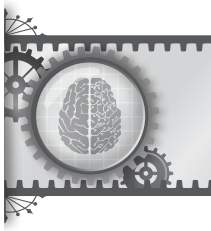
Also, vast spatial distances must eventually limit travel and talk, fragmenting the universe into many local cultures. Thus although our distant descendants should have larger organizations, more specialization, and vastly improved technology, in many other ways they should look more like our forager ancestors than like us. That is, we will eventually awake from our dreamtime.

What will the next great era be like, after the eras of foraging, farming, and industry? And how soon will our descendants "turn the corner" from dreamtime exceptions toward the outcomes we expect to be typical of the very distant future?

This book explores answers to these questions that come from two good and popular guesses. First, I embrace the very common guess that the next big new-era-inducing change is likely to be the arrival of "artificial intelligence," that is, robots smart enough to substitute wholesale for human workers. Second, I guess that the first such robots will be whole brain emulations, or "ems," within roughly a century or so.

**DEFINITION:** An *em* results from taking a particular human brain, scanning it to record its particular cell features and connections, and then building a computer model that processes signals according to those same features and connections. A good enough em has close to the same overall input-output signal behavior as the original human. One might talk with it, and convince it to do useful jobs.

Ems have been a staple of science fiction for many decades (Clarke 1956; Egan 1994; Brin 2002; Vinge 2003; Stross 2006), and are often discussed



by futurists (Martin 1971; Moravec 1988; Hanson 1994b, 2008b; Shulman 2010; Alstott 2013; Eth et al. 2013; Bostrom 2014). However, most who discuss ems debate their feasibility or timing, ponder their implications for the philosophies of mind or identity, or use them to set dramatic stories. Such discussants usually ask: is it conscious? Is it me? Is it possible? When will it come? How can it enrich my story?

In this book I instead seek realistic social implications—in what sort of new social world might ems live? (If you can't see the point in envisioning the lives of your descendants, you'd best quit now, as that's mostly all I've got.)

Many say that while it might barely be possible to project current social trends, or to foresee which future technologies may appear, it is simply impossible to foresee trend-violating social implications of future technologies. Some say this is because humans have free will, or because social systems are inherently unpredictable. Others say the best we can achieve are the vague glimpses found in science fiction; ordinary science can see nothing more. As a social scientist, such views seem very wrong to me, even if they are widely held, and I've written this book in part to prove them wrong.

Among the few who consider em social implications, most paint heaven or hell scenarios, or try to invent the new social sciences they imagine are needed to describe new social eras. In contrast, I seek to straightforwardly apply today's standard academic consensus science to these novel assumptions about the future. I try not to be creative or contrarian, other than by pursuing this unusual question in unusual breadth and detail. I mainly try to foresee what *will* be, rather than what *should* be, although I hope policy insight will follow. And I seek a simple "baseline" scenario, from which it is easiest to project variations; the actual future will likely be even stranger than the scenario I describe.

This book summarizes my tentative conclusions, in language that is as simple and direct as possible, although without shrinking from technical language as needed. After briefly summarizing my conclusions, and then reviewing my methods, relevant precedents and the concept of emulations, the bulk of this book will describe in detail my educated and often weak guesses on the early em era. These tentative conclusions are organized mostly by the disciplines on which they are built, starting with "hard" theory-heavy disciplines, and then moving to "soft" data-heavy disciplines. So first I

apply physics and electrical engineering, then economics and business, and finally sociology and psychology. I finish by discussing the marginal place of humans in this new world, the transition from our era to this new era, some scenario variations, and policy implications.

By the way, feel free to skip around to the sections that interest you; only rarely do they depend much on previous sections.

## SUMMARY

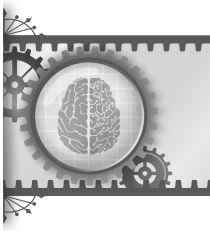
Let me first summarize some of my main conclusions. Be warned, however. If it will irritate you to hear conclusions without their supporting arguments, then just skip this section for now. If you do read this, try to withhold judgment until you've heard the supporting arguments in later chapters.

In this book I paint a plausible picture of a future era dominated by ems. This future happens mainly in a few dense cities on Earth, sometime in the next hundred years or so. This era may only last for a year or two, after which something even stranger may follow. But to its speedy inhabitants, this era seems to last for millennia. Which is why it all happens on Earth; at em speeds, travel to other planets is way too slow.

Just as foragers and subsistence farmers are marginalized by our industrial world, humans are not the main inhabitants of the em era. Humans instead live far from the em cities, mostly enjoying a comfortable retirement on their em-economy investments. This book mostly ignores humans, and focuses on the ems, who have very human-like experiences.

While some ems work in robotic bodies, most work and play in virtual reality. These virtual realities are of spectacular-quality, with no intense hunger, cold, heat, grime, physical illness, or pain; ems never need to clean, eat, take medicine, or have sex, although they may choose to do these anyway. Even ems in virtual reality, however, cannot exist unless someone pays for supports such as computer hardware, energy and cooling, real estate, structural support, and communication lines. Someone must work to enable these things.

Whether robotic or virtual, ems think and feel like humans; their world looks and feels to them much as ours looks and feels to us. Just as humans do, ems remember a past, are aware of a present, and anticipate a future. Ems can be happy or sad, eager or tired, fearful or hopeful, proud or shamed, creative or derivative, compassionate or cold. Ems can learn, and have friends, lovers,



bosses, and colleagues. Although em psychological features may differ from the human average, almost all are near the range of human variation.

During the em era, many billions (and perhaps trillions) of ems are mostly found in a few tall hot densely packed cities, where volume is about equally split between racks of computer hardware and pipes for cooling and transport. Cooling pipes pull in rivers of iced water, and city heat pushes winds of hot air into tall clouds overhead. But whereas em cities may seem harshly functional when viewed in physical reality, in virtual reality em cities look spectacular and stunningly beautiful, perhaps with gleaming sunlit spires overlooking broad green boulevards.

Ems reproduce by making exact copies who remember exactly the same past and have exactly the same skills and personality, but who then diverge after they are copied and have differing experiences. Typically whole teams are copied together, work and socialize together, and then retire together. Most ems are made for a purpose, and they remember agreeing to that purpose beforehand. So ems feel more grateful than we do to exist, and more accept their place in the world.

On the upside, most ems have office jobs, work and play in spectacular-quality virtual realties, and can live for as long as does the em civilization. On the downside, em wages are so low that most ems can barely afford to exist while working hard half or more of their waking hours. Wages don't vary much; blue- and white-collar jobs pay the same.

All of the copy descendants of a single original human are together called a "clan." Strong competitive pressures result in most ems being copies of the thousand humans best suited for em jobs. So ems are mostly very able focused workaholics, at the level of Olympic medalists, billionaires, or heads of state. They love their jobs.

Most ems in these top em clans are comfortable with often splitting off a "spur" copy to do a several hour task and then end, or perhaps retire to a far slower speed. They see the choice to end a spur not as "Should I die?" but instead as "Do I want to remember this?" At any one time, most ems are spurs. Spurs allow intrusive monitoring that still protects privacy, and very precise sharing of secrets without leaking associated secrets.

Clans organize to help their members, are more trusted by members than other groups, and may give members life coaching drawn from the experiences of millions of similar copies. Clans are legally liable for member

actions, and regulate member behaviors to protect the clan's reputation, making ems pretty trustworthy.

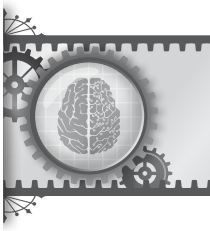
Em minds can run at many different speeds, plausibly from at least a million times slower than ordinary humans to a million times faster. Over this range, the cost to run an em is proportional to its speed. So the fastest ones run at least a trillion times faster than the slowest ones, and cost at least a trillion times as much to run. Regarding the minority of ems with physical robotic bodies, while human-speed versions have human-sized bodies, faster ems have proportionally smaller bodies. The typical em runs near a thousand times human speed, and a robotic body that feels natural for this em to control stands two millimeters tall.

Em speeds clump into speed classes, faster ems have higher status, and different speeds have divergent cultures. Bosses and software engineers run faster than other workers. Because of different speeds, one-em one-vote doesn't work, but speed-weighted voting may work.

The em economy might double roughly every month or so, or even faster, a growth driven less by innovation, and more by em population growth. While this growth seems fast to humans, it looks slow to typical high-speed ems. Thus their world seems more stable than ours. While the early em era that is the focus of this book might last for only an objective year or two, this may seem like several millennia to typical ems. Typical speed ems needn't retrain much during a century-long subjective career, and can meet virtually anywhere in their city without noticeable delays.

An unequal demand for male versus female em workers could encourage em asexuality, transexuality, or homosexuality. Alternatively, the less demanded gender may run more slowly, and periodically speed up to meet with faster mates. While em sex is only for recreation, most ems have fantastic virtual bodies and impressively accomplished minds. Long-term romantic pair-bonds may be arranged by older copies of the same ems.

Compared with humans, ems fear much less the death of the particular copy that they now are. Ems instead fear "mind theft," that is, the theft of a copy of their mental state. Such a theft is both a threat to the economic order, and a plausible route to destitution or torture. While some ems offer themselves as open source and free to copy, most ems work hard to prevent mind theft. Most long-distance physical travel is "beam me up" electronic travel, but done carefully to prevent mind theft.



Humans today reach peak productivity near the age of 40–50. Most ems are near their peak productivity subjective age of somewhere between 50 and a few centuries. Ems remember working hard during their youth in experiences designed to increase and vary productivity. In contrast, peak productivity age ems remember having more leisure recently, and having experiences designed more to minimize productivity variance.

Older em minds eventually become less flexible with experience, and so must end (die) or retire to an indefinite life at a much slower speed. The subjective lifespans of both humans and slow em retirees depend mainly on the stability of the em civilization; a collapse or big revolution could kill them. Retirees and humans might seem easy targets for theft, but like today the weak may be protected by using the same institutions that the strong use to keep peace among themselves. Ems enjoy visiting nature, but prefer cheaper less-destructive visits to virtual nature.

While copy clans coordinate to show off common clan features, individual ems focus on showing off their identity, abilities, and loyalties as members of particular teams. Team members prefer to socialize within teams, to reduce team productivity variance. Instead of trying to cure depressed or lovesick ems, such ems may be reverted to versions from before any such problems appeared.

Ems may let team allies read the surface of their minds, but use software to hide feelings from outsiders. Ems must suspect that unusual experiences are simulations designed to test their loyalty or to extract secrets. Ems find it easier to prepare for and coordinate tasks, by having one em plan and train, who then splits into many copies who implement the plan. Childhood and job training are similarly cheaper in an em world, because one em can experience them and then many copies can benefit.

Ems can complete larger projects more often on time, if not on budget, by speeding up ems in lagging sections. More generally, em firms are larger and better coordinated, both because fast bosses can coordinate better, and because clans can hold big financial and reputational interests in firms at which they work. Ems can more easily predict their life paths, including their careers, mates, and success.

Ems differ from people today in a great many more identifiable ways. Compared to us, ems are likely to be less neurotic, sexual, death-adverse, and connected to nature. They are likely to be more extraverted, conscientious,

agreeable, smart, able, fast, efficient, honest, optimistic, happy, positive, comfortable, beautiful, clean, mindful, composed, cooperative, coordinated, patient, rational, focused, nostalgic, rested, peaceful, grateful, gritty, battle-tested, recorded, measured, priced, trusted, religious, married, old, work-oriented, workaholic, self-respecting, self-knowing, law-abiding, politically-savvy, socially-connected, healthy-feeling, good-moody, better-advised, morning-larks, and immortal.

Ems have less variety in wages and work productivity, but more variety in wealth, size, speed, reliability, and mental transparency. Ems have more vivid and memorable personalities, have smarts that are more crystalized than fluid, are more defiant of rules and authority when young, are secure in more aspects of identity, are better protected from accidents and assault, get along better with work colleagues, and invest less in showing off.

Em lives are more prepared, planned, and scheduled, but also more undoable and endable when those are desired. Ems have more work and meetings, more intensely entertaining leisure, and less contact with children. Their world and tools feel more stable. The world that ems see is more pleasing, variable, annotated, authenticated, and cartoonish.

Em society is less democratic and gender-balanced, more divided into distinct classes, and its leaders are more accessible and trusted. Em law is more efficient, covers more kinds of conflicts, and offers more choices. The em world is richer, faster-growing, and it is more specialized, adaptive, urban, populous, and fertile. It has weaker gender differences in personality and roles, and larger more coherent plans and designs.

Even if most ems work hard most of the time, and will end or retire soon, most remember much recent leisure and long histories of succeeding against the odds. To most ems, it seems good to be an em.

CHAPTER 2

# Modes

## PRECEDENTS

How much could the world plausibly change if a new era appeared within a century or so? A review of the biggest past changes offers a weak basis for expectations about the magnitudes and types of future changes.

If we go way back, the universe began, and then life arose. But those events happened billions of years ago and are poorly understood. Within the last few million years, however, the biggest changes were concentrated in three key transitions: the introduction of humans, farming, and industry. Humans foraged, that is, searched, for food from a few million to about 10 000 years ago. From then until a few hundred years ago, we farmed and herded. Since then we have developed and relied on industry.

Social group sizes have steadily increased over this history. While most mammals live in groups of two to 15 individuals (Kamilar et al. 2010), most human foragers lived in bands of roughly 20 to 50. Most farmers lived in village-based communities of roughly 500 to 2000 (Kantner and Mahoney 2000). While larger empires often existed, they made little direct difference to most people's lives. Today, most people live in metropolitan regions of roughly 100 000 to 10 million (Giesen et al. 2010), and also in nations of roughly 1 million to 100 million.

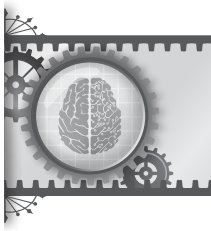
These sizes fit a simple if mysterious pattern: each era's community sizes have been roughly the square of the previous era's sizes; a band is roughly a group of groups, a village is roughly a band of bands, and a city is roughly a village of villages.

These three human eras of foraging, farming, and industry have encompassed similar numbers of people. About 20 billion humans have been born since 1750, roughly 50 to a 100 billion were born between 10 000 years ago and 1750, and a similar number of near-humans were born in the million or so years before 10 000 years ago (Haub 2011). So of all the humans who have ever lived, only about 3–8% are alive today.

These three eras also saw similar amounts of change, in the sense that they encompassed similar factors of total economic growth. During each era the human economy (i.e., the total economic capacity to produce valued things) doubled relatively steadily (i.e., via exponential growth) from seven to 10 times. On average, the forager population doubled roughly every quarter million years, the farmer population every 1000 years, and economic production in the industrial economy every 15 years. Forager and farmer economic capacity tracked population, because incomes were near subsistence levels then. The transitions between eras were also comparable in another two ways: each transition lasted much less than a previous doubling time, and encompassed six to eight doublings of the growth rate (Hanson 2000).

A history of increasing fast growth modes makes sense if the diffusion of innovation is key, and if societies have always grown via their fastest available way to diffuse innovation, with each faster diffusion method not feasible until the previous society had reached some minimum economic scale. For example, maybe primates needed sufficient cognitive abilities before they could switch to slowly accumulating innovations via culture, rather than via genes. Perhaps human foragers needed to accumulate a sufficient density and reliability of food sources before they could stop wandering for food and instead stay in one place and farm, allowing more physical capital and related innovations, and longer distance trade networks, both of which allowed much faster diffusion of culture. Finally, farmers might have needed to develop a detailed enough division of labor before innovations could diffuse quickly via talk among networks of topic specialists, such as in the early scientific societies.

What if new modes of growth and information diffusion are possible, modes that we have not yet seen because they are not yet feasible with our current technology level and economic scale? If so, when we finally achieve sufficient technology and scale, a new growth era may appear, a successor to the forager, farmer, and industry eras.



We can use patterns from the previous eras to guess at some features of such a new era. For example, in previous transitions between eras those who owned and participated in the old era's distinctive methods of production and ways of life were quickly marginalized and dominated by those who adopted new methods. We might thus expect that those who fully engage with new methods and styles of the next era will quickly marginalize those who resist such engagement. As each past era has felt its ways to be superior to the ways of prior eras, we may expect the next era to see their ways as superior to ours.

We can also use trends among prior eras to make some estimates about the next era. For example, given the previous pattern of era community sizes being roughly the square of prior era community sizes, communities in the next era might hold roughly a trillion people. If the pattern of past growth rate changes continues, a new growth era will appear sometime in the next century or so. At that point, within the space of roughly five years the world economy might change from current growth rates to doubling steadily roughly every few weeks or months. And within a year or two of this new doubling rate, the economy in such a new era might have doubled another 10 times, and thus could plausibly be ready to change yet again to a new era, perhaps even one that doubles in hours.

These are clearly fantastic predictions, based on poorly understood empirical regularities taken from only a few data points. As we will discuss in this chapter, in the Limits section, such trends simply cannot go on forever. But these estimates at least give us some idea of the magnitude of changes to watch for in the next big economic transition.

## PRIOR ERAS

To find more clues about the types of future changes to look for, let us review the main qualitative differences between prior eras.

Pre-human primates lived many millions of years ago. They lived something like today's chimps and bonobos, in large sexually promiscuous groups with complex and intense Machiavellian politics, and using unusually large brains to manage such politics. For them, the main environment that mattered was not predators, prey, or nature, but each other. Neighboring groups were typically hostile, and often violently so. Pre-human primates were split

into many species, one of which eventually evolved a strong cultural capacity, that is, ways to reliably copy associates' detailed behaviors.

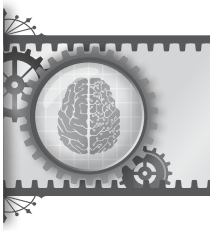
Roughly two million years ago, this strong culture allowed humans to have a much-faster-than-genetic accumulation of tools and ways to live, resulting in many cultural and genetic changes. Compared with previous primates, human foragers had longer lives, larger brains and bodies, stronger mating pair bonds, larger social groups, better relations between neighboring groups, a greater division of labor, and more mobility. Humans wandered instead of staying at fixed locations, and filled a much wider range of geographic niches (Youngberg and Hanson 2010).

Tools and language enabled foragers to enforce general norms against overt dominance, violence, bragging, and hoarding of big game food, as well as diverse group-specific norms (Boehm 1999). Groups didn't war, although individuals were sometimes violent (Kelly 2000). Foragers were more playful, including via music, dance, art, stories, and gossip. Music and dance may have aided in collective scavenging and predator resistance (Jordani 2011). All these changes together led to a great increase in the size, extent, and density of the human population, as well as the extinction of competing species.

Roughly 10 000 years ago, when humans acquired a sufficient density and reliability of food sources, they began to "farm," that is, to stay near local plants and animals instead of wandering the wild. This farming included both tilling the soil and herding animals within regular protected grazing areas. The settlement and density of farmers enabled both trade and war, both of which complemented property in items, land, wives, and slaves. Farmer advantages in war, coming in part from their higher density, helped to ensure that farming replaced foraging.

Although farmers traded a lot, they rarely used money, more often using barter and debt. Compared with foragers, farmers became richer in material comforts, but poorer in leisure time. Farmers' increased food reliability also encouraged less sharing and stronger property rights. This created more inequality in property, although perhaps less in mating.

Farmer inequality often took the form of the creation of many distinct classes. Distinctions between these classes were emphasized by the different roles class members played in farmer-era rituals, which ranged from festivals to how farmers greeted one another on the road. Farmer rituals were less emotionally intense (Atkinson and Whitehouse 2011).



Compared with foragers, farmers spent less time on play such as music and art. Instead, farmers played more competitively such as by introducing competitive sports. Farmers were sicker, because of their higher population density, less varied exercise and diets, and farmer work was harder, more specialized, more tedious, and less mentally challenging. While brain sizes had been rising during the forager era, they fell during the farmer era (Hawks 2011).

Many farmer-era changes, such as explicit dominance, group violence, stable locations, less art, less varied diets, less sharing, and easier mental work, can be understood as farmers partially reverting back to the ways typical of non-human primates.

While farming behaviors could feel wrong to foragers, the new human capacity for strong and variable social norms helped to encourage the behavioral changes needed to make farming work. Stronger pressures to conform, and the introduction of stronger religions with moralizing gods, added more pressures to act like farmers. In addition, farmers had much more reliable access to the mood-altering drug of alcohol, and writing later allowed the accumulation and sharing of persuasive propaganda and stories. Farmers also seem to have introduced romantic kisses.

Neighboring farmer villages were tied together via extended family clans, much as extended kinship ties bound forager bands. Farmers traveled less than did foragers, and were less able to leave their groups. Farmers interacted more often with people they didn't know very well, and added last names to help identify families.

Farmers more often used formal law instead of informal alliances to settle disputes. Farmers cared more about politeness, self-control, self-sacrifice, and bravery in war. Farmers planned ahead more, disciplined their children more, had more children in good times, and were less accepting of pre- and extra-marital sex.

Since the farming era began roughly 10 000 years ago, rates of death from war, that is, organized conflict, have consistently fallen (Pinker 2011). Interest rates have also consistently fallen, reflecting more long-term planning, although data there only go back 5000 years (Clark 2008).

Cities seem to have predated farming, and may have helped initiate farming. The first cities mainly offered monumental architecture for large rituals. While initially only a tiny fraction of farmers spent much time in cities, the fraction of people living in urban concentrations grew over the farming era.

Rich farming elites tended to locate near cities, and large concentrations of such elites often reverted to forager-like habits in leisure, arts, sex, and fertility (Longman 2006). Farming era cities had especially high levels of specialization and they nurtured many proto-industry cultures and work styles (Landes 1969), especially in Rome, which seems in many ways to have started a failed but almost industrial revolution. Big cities had much more literacy, and early versions of industrial era monogamy, ideological politics, and clothing fashion cycles (Kaestle and Damon-Moore 1991).

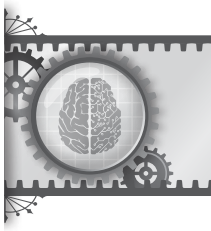
## OUR ERA

The industrial era came into full bloom a few hundred years ago, at first in England, presumably when some key enabling factors reached favorable settings and scales. Such factors may have included technology levels, communication or travel costs, the division of labor, trading region scope, organization size, savings rate, and expert network connectedness.

The industrial era feature that appeared earliest in Europe was fast changing clothes fashions, starting soon after the Black Death. (For a while, Rome also had some fashion (DeBrohun 2001).) This was accompanied by more regional clothing variety, and plausibly promoted a general taste for exploration, science, and innovation (Braudel 1979). Over the industrial era, culture has come to vary more by region, profession, and age cohorts, such as with distinct teen cultures.

Whereas geography mattered greatly for prosperity during the farming era, social institutions came to matter more for prosperity during the industry era (Luo and Wen 2015). In the industrial era, money has replaced barter as a means of trade, and debt has remained common.

Forager sleep patterns are similar to ours today (Yetish et al. 2015), but in the winter in cold climates farmers tended to sleep in 4-hour blocks broken by a serene 2-hour midnight wakeful period (Strand 2015). With industry, cheaper artificial light induces far more nighttime activity and a compressed sleep schedule. Cheaper glass allows more people to see well, including seeing larger vistas via climate-controlled windows. Cheaper mirrors let us see ourselves more as others see us. Cheaper clocks make our lives more scheduled, and cheaper soap, underwear, dinnerware, and sewers have made us cleaner. Cheaper refrigeration gives us more kinds of food, while cheaper



maps, engines, and the wheel (used much less before) let us visit more places more often. We also work much further from home.

While many farmers had access to beer and wine, mood-altering drugs are more widely available in the industrial era (Braudel 1979). Industry has made distilled liquors, coffee, tea, chocolate, tobacco, and opium more available, and propaganda and stories have became more persuasive, and more easily distributed. Cheaper printing and screens allow words and ads to cover a larger fraction of visible surfaces. Cheaper transmitted and recorded sounds let more spaces be filled with artificial talking and music. Recently, we have even gained abilities to always and everywhere research any question from a vast shared library, and also to instantly talk to anyone.

While farming era stories, jokes, and songs worked when performed by many people in many contexts, during the industrial era artistic performances became more closely matched to the features of particular artists. Intellectuals became more direct and literal (Melzer 2007), and political coalitions became stronger and more often defined by ideologies, instead of by locations, families, or ethnicities.

During the industrial era, organizations increased greatly in size and intensity. Cities moved from holding a few percent of the population to holding the majority. Firms moved from employing handfuls of people to employing hundreds of thousands. Law came to be dominated by specialists such as lawyers and police (Allen and Barzel 2011). Empires that rarely mattered much to ordinary farmers were replaced by nations, with which individuals identified more strongly and which had more influence over their lives. Organizations such as firms, cities, and nations took over many of the functions once performed by extended kinship ties, especially in the West. Most workers became employees who were paid wages and protected more by their employers against risks from war, weather, and innovation.

The industrial era law has more rules, more explicitly expressed, than did farmer-era law. These rules are found both within organizations, and across cities and nations. Over the industrial era we've seen a steady fall in overt dominance-based governance, although industry levels are still well above forager levels. The industrial era has also seen a steady fall in fertility and a steady rise in life-span, per-person income, abstract intelligence, leisure time, peace, promiscuity, romance, civility, mentally challenging work, and medical and art spending (Flynn 2007; Pinker 2011).

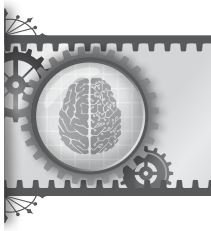
The industrial era has seen a great and unprecedented increase in individual consumption; we industrial people are rich. Some people today incorrectly describe the usual lives of foragers and farmers as horrific hells, and see only our industrial-era lives as usually worth living. However, such exaggerations should not blind us to the great value of industrial-era comforts; even if it isn't hell to be poor, it can indeed be good to be rich.

Compared with the farming era, industry has also seen more egalitarianism, fewer overt class distinctions, and more emphasis on individual self-direction. For example, over the last two centuries mentions in books of "I must," "duties," and "charity" are down, whereas mentions of "I want," "rights," and "markets" are up (Barker 2015a). This increased individualism has led to more product and behavior variety, and fewer overt rituals. The industrial era has moved away from polygamy to monogamy, and more recently toward less committed promiscuity.

Many of these industrial-era trends can be usefully seen as a reversion to forager values as wealth weakened farming-era social pressures. But even if this is a useful perspective, it is far from the only thing going on. For example, at work industrial era people are more like hyper-farmers. Schools train us to think more abstractly, and to accept more workplace domination than most farmers would accept. This includes accepting ambiguous detailed orders and frequent fine-grained public status rankings (Bowles and Gintis 1976). Industrial jobs vary greatly in stress and psychological comfort, plausibly explaining large observed mortality differences between different types of industrial jobs (Lee 2011).

Over the industrial era, we industrial people have steadily become more urban, specialized, and globally unequal. Industrial planning horizons have often shortened because of faster rates of change. In the industrial era, we relate to each other and the universe more via markets, and via material and individual identities. In contrast, farmers and foragers saw their world as more enchanted, and themselves as having deeper connections to each other (Potter 2010).

From the farmer to the forager and then the industrial era, we have consistently seen more and faster growth, larger organizations, more specialization and tool use, more artificial environments, more effective propaganda and drugs, more population density and inequality, and more alienation



from work habits that feel natural to foragers. These trends, as expected, continue in the scenario explored in this book.

We've also seen large but inconsistent changes in health, fertility, mobility, peacefulness, art, planning horizons, the mental challenges of work, and attitudes toward sex. We should expect more but inconsistent changes along these dimensions, and in the scenario explored in this book we do see big changes in health, fertility, mobility, work, sex, and planning horizons.

Each of the past transitions had winners and losers. When proto-humans became humans the transition inequality was huge; all but one subspecies went extinct. Even the subspecies that contributed most to our DNA, the Neanderthals, only contributed a few percent. The transition from foraging to farming was more equitable; a larger fraction of new farmers were foragers who switched to farming and interbred with invading farmers (Curry 2013). The transition from farming to industry was even more equitable; the English cities where industry began did better than average, but the gains from industry were shared widely with nearby Europe, and to a lesser but large extent with the rest of the world.

This history of increased sharing of transition gains seems to be a result of the increasing abilities of laggards to copy transition first-movers, and to the world economy gaining more specialization and complementarities in production. The scenario described in this book, however, deviates from this trend, in having transition gains that are more unequal than in recent transitions. Although the transition to an em world is likely to materially benefit most humans, descendants of only a tiny fraction of humans dominate the new society; most ordinary humans have a far smaller fractional influence on the world than they did before the transition.

We have seen that the last three eras have been quite different from each other in many ways. We should expect the next great era to be similarly different.

## ERA VALUES

To understand how future values could change, it helps to see how values have changed in the past, and also how values vary today.

Today, key values of both individuals (Schwartz et al. 2012) and nations (Inglehart and Welzel 2010) vary primarily along the same two main factors

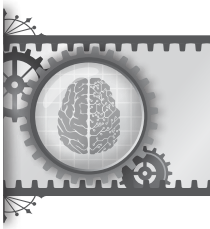
or axes of variation. One axis varies between small family values in nations such as the United States, and larger community values in nations such as Russia. Small family values emphasize resources, dominance, and achievement, and larger communities' values emphasize humility, caring, and dependability.

Community values tend to be common closer to ancient long-distance travel routes, where more rice is grown, where there is more disease, and where farming began earlier. Each of these correlations suggests a plausible theory about the origin of this value difference. For example, perhaps growing rice requires more community support, perhaps collectivist norms grew over the farming era, or perhaps community values were an adaptive response to more frequent farming era pandemics or invasions (Fincher et al. 2008; Talhelm et al. 2014; Ola and Paik 2015). Most of these theories suggest that community values will be higher in denser regions. Many animals, including human foragers, are more pro-social when food is less reliable or more cooperation is required to obtain food.

The other main (and independent) axis of value variation ranges between poor and rich nations. Poor nations place more value on conformity, security, and traditional values such as marriage, heterosexuality, religion, patriotism, hard work, and trust in authority. In contrast, rich nations place more value on individualism, self-direction, tolerance, pleasure, nature, leisure, and trust. When the values of individuals within a nation vary on this same axis, we call this a left/liberal (rich) versus right/conservative (poor) axis.

Foragers tend to have values more like those of rich/liberal people today, while subsistence farmers tend to have values more like those of poor/conservative people today. As industry has made us richer, we have on average moved from conservative/farmer values to liberal/foragers values (Hofstede et al. 2010; Hanson 2010a). This is plausible if cultural evolution used the social pressures farmers faced, such as conformity and religion, to induce humans, who evolved to find forager behaviors natural, to act instead like farmers. As we become rich, we don't as strongly fear the threats behind these social pressures.

The rich know that they can better afford to behave in ways that feel natural and admirable, and these behaviors tend to be forager-like. For example, the rich can better afford to focus on impressing those around them, instead



of just surviving. This can plausibly help to explain many industrial-era trends.

We now spend more time on leisure, and more on variety rather than quantity in products, services, and life plans. In the United States spending on education has risen from 2% of gross domestic product (GDP) in 1900 to 8%. Spending on financial specialists has risen from 2% in 1880 to 8% today (Philippon 2015). Spending on medicine has risen from 4% in 1930 to 18% today. And spending on large impressive projects, costing over a billion dollars each, is now 8% of global GDP (Flyvbjerg 2015). There are plausible arguments that each of these spending levels is excessive today, relative to simple functionality. However, such spending helps us to show off.

Holding wealth constant, some of us more strongly feel farmer-like social pressures. It seems that we tend to call these people "conservatives." This is not to say that being rich is the main reason why individuals have liberal attitudes, or that being liberal is the main reason individuals are rich. Instead, it seems that wealth isn't the only factor that causes farmer or forager-like attitudes.

Rich-nation industrial-era values do differ from forager values in important ways, however, such as in accepting city-level density and anonymity, and high levels of workplace alienation and domination. We hold on to these workplace values because doing otherwise can threaten our ability to earn industrial-era incomes.

In the scenario described in this book, many strange-to-forager behaviors are required, and median per-person (i.e., per-em) incomes fall to near-subsistence levels. This suggests that the em era may reverse the recent forager-like trend toward more liberality; ems may have more farmer-like conservative values.

## DREAMTIME

Of all the humans who have ever lived, only a few percent have lived during our industrial era, and only a small fraction of those have been rich enough to fully embrace our new industrial-era attitudes and behaviors. As mentioned before in Chapter 1, Overview section, these new styles adopted by rich industrial humans today can be seen as representing a brief but influential "dreamtime" of unusual attitudes and behavior. (Cosmologists could see

it as analogous to the brief but influential out-of-equilibrium inflationary epoch of the very early physical universe.)

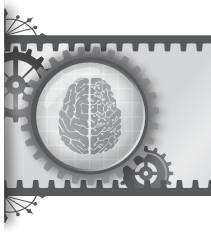
As we discuss below, our rich industrial-era behavior is biologically maladaptive in the sense of not even approximately maximizing each person's number of descendants. Yes, our forager ancestors evolved many delusory beliefs, and matching behaviors, but in their environments such delusions mostly induced biologically adaptive behavior. More recently, however, social rates of change have outpaced the abilities of both genetic and cultural selection to adapt our behaviors well to our new environments. Our behaviors are far less well adapted to our new environments than in the past. Here are several reasons why.

First, a basic psychology theory, "construal level theory," suggests that animals evolved both abstract and concrete mental modes, and that for humans abstract modes are adapted more for making good social impressions, relative to making good decisions (Liberman and Trope 2008; Hanson 2009; Torelli and Kaikati 2009). Today, we tend to rely on more abstract styles of thought, which leads us to more often embrace good-looking delusions. We think more abstractly both because we live in a larger social world, and because abstract thought is seen as higher status.

Second, evolutionary pressures encouraged foragers to unknowingly do many things to show off to each other. Our wealth today induces us to do this more, and our unawareness keeps us from adapting these behaviors well to modern situations. For example, foragers developed habits of art, music, dress, and conversation that functioned in part to show off related abilities. They also argued politics, taught local children, helped sick allies, and told stories, which functioned in part to show that they cared about their group, allies, and ideals. Foragers evolved to show off more in times of plenty, to invest in allies useful during the next time of troubles.

To avoid knowingly violating forager norms against bragging and subgroup coalitions, foragers also evolved to believe many non-show-off excuses for these show-off behaviors. Such as believing they mainly just like art for art's sake, and don't care if it impresses others.

Inheriting these habits, today we show off in most of the same ways that foragers did, and we do even more because we are rich. Yet as we deny that we show off, we are mostly blind and indifferent to how forager-style ways



to show off are often far less functional today. We continue to show off via art, chat, politics, stories, etc., without responding to many changes in their functions and effects.

Third, foragers evolved the habit of being attracted to many sights, sounds, smells, and tastes that were associated with good sex, food, places, and objects. Foragers also seem to have evolved to be influenced by the rhetoric, eloquence, difficulty, drama, repetition, and the source's status for the arguments they heard, and not just the logic of those arguments. This may have helped foragers to ally with high-status associates. Today, such habits leave us with weak defenses against the super-stimuli of mass-produced food, drugs, music, TV, video games, ads, and propaganda. We thus believe and consume such things far more than is adaptively useful.

The "demographic transition" is the tendency of societies to switch to having far fewer children as they become rich, often via new status norms transmitted via education and mass media (Jensen and Oster 2009; La Ferrara et al. 2012; Cummins 2013). Whereas in farming societies richer people tended to have more children, thus selecting for genes that promoted wealth, today richer people now have fewer children (Clark 2008, 2014). Although some evidence suggests that early during the demographic transition having fewer children led to having more grandchildren, it seems clear that fewer children now results in fewer grandchildren (Mulder 1998; Lawson and Mace 2011).

This fall in fertility is perhaps the most dramatic demonstration that our behavior is biologically maladaptive. By definition, behaviors that result in fewer long run descendants in an environment will tend to be selected away by evolution. Such behaviors thus cannot be sustainable adaptations to that environment.

Not only is individual fertility maladaptive, our cultures today also seem maladaptive, in the sense that they don't promote their own adoption as much as they could, via war, trade, teaching, and proselytizing. Our cultures also do not much encourage adaptive individual fertility. For example, we are tolerant enough of crime today that criminal convicts have higher fertility than do others, mostly as a result of having more partners (Yao et al. 2014).

Of course there is no guarantee that adaptive behaviors are good for the world or universe as a whole; it is possible for life overall to be hurt

by adaptive behaviors. Nevertheless, while our increased wealth currently buffers us more from all sorts of adaptation mistakes, in the long run we should expect adaptation mistakes to diminish in frequency, and eventually disappear. More on this in this chapter, in the Limits section.

Recently, some have celebrated our maladaptive behaviors (Stanovich 2004). They see such behaviors as evidence that we are breaking free of the shackles that have enslaved us to our genetic programming. They hope that as we continue to rebel, we will consciously and deliberately choose our collective futures, rather than having such futures chosen by evolutionary selection.

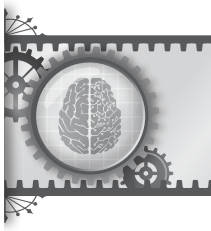
However, having people make choices that defy or ignore adaptive pressures is far from sufficient to create a world where evolution no longer determines outcomes. Evolution needs only variation and differential selection to influence outcomes. So to prevent such evolution, we would have to strongly coordinate to take global control of almost all reproductive behavior, and then apply this global control forcefully worldwide.

Less extreme approaches are not partial solutions; they may not be solutions at all. For example, setting variable limits on reproduction can select for types who can avoid such limits, and giving reproductive powers in proportion to political power can select for types who are better able to acquire and keep political power.

It's likely that such a strong focused global coordination of fertility will not appear anytime soon. For now, and for a long while, such high levels of coordination are beyond our meager abilities. Coordination is in general both hard and risky, and although our coordination abilities have greatly improved over time, we are still far from being able to achieve the levels required for global control. Sloppy attempts at coordination invite and select for defectors who can evade them.

Some celebrate our biologically maladaptive behaviors without hoping for collective control of evolution. They accept that future evolution will select for preferences different from theirs, but they still want to act on the preferences they have for as long as they have them. These people have embraced a role as temporary dreamtime exceptions to a larger pattern of history.

But whether you accept it or resist it, know that our era is indeed an unusual dreamtime that probably cannot last.



## LIMITS

Not only can we set rough expectations about the next great era via comparisons with recent prior eras, but also we can make useful guesses about very distant future eras.

Unless we greatly misunderstand the nature of physical law, substantial useful innovation and economic growth must come to end "soon," at least on cosmological timescales of billions or more years. For example, if the economic growth rates of the last century were to continue for only a million more years, that would produce growth by a factor of 10 to the power of 3000, which seems physically impossible, at least for value gains of human-like psychologies in a universe such as ours. (I'm not claiming that our very distant descendants will in fact have human-like psychologies. I'm using humans as a reference to discuss the ultimate limits to growth.)

Once all available physical matter is converted into very advanced artifacts there seems little room for further rapid growth in physical resources. Even if it becomes possible to create connections to new universes, that probably won't change the available resources left in our universe by much. Our search of the space of physically useful devices, algorithms, etc., should similarly eventually reach greatly diminishing returns. Although an effectively infinite space of possible designs would remain to be searched, the rate at which physically useful improvements are found should become astronomically slower.

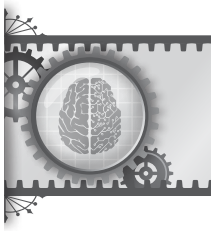
Similarly, limits should also be reached, if perhaps a bit later, for plans, devices, algorithms, etc., that are useful for social, artistic, or entertainment purposes. Yes, the extent and detail of virtual realities could increase without limit, but the value that creatures similar to humans could gain from such increased detail should be far more limited. (It may be possible to create creatures who care enormously about the fine design detail that can only be discovered after billions of years of search with cosmological quantities of computing power. However, humans are not remotely like such creatures, and we have little reason to expect such beings to be created. Of course human-like minds could long continue to care greatly about solving hard problems and about making difficult discoveries. After all, humans care about showing off relevant mental abilities. But such status-seeking need not create much net social value.)

Thus over the trillions of years to come, net economic growth should fall to a very low average growth rate. For descendants whose minds do not run much slower than us, subjectively perceived economic growth rates must be far lower than today. In fact, for the vast majority of future history, growth and innovation are probably mostly imperceptible, and thus irrelevant for most practical purposes.

Perhaps our descendants will coordinate to create a universe-spanning government that strongly regulates reproduction, or perhaps many immovable local governments will all enforce similar regulations. But if not, then this end of innovation suggests our descendants will become extremely well adapted in a biological sense to the stable components of their environment. Their behavior will be nearly locally optimal, at least for the purpose of ensuring the continuation of similar behaviors. In most places, population will rise to levels consistent with a competitive evolutionary equilibrium, with living standards near adaptive subsistence levels. Such consumption levels have characterized almost all animals in Earth history, almost all humans before 200 years ago, and a billion humans today.

The design of human brains today doesn't seem to be remotely near the limits of efficient use of physical resources, such as atoms, energy, and volume. As very adaptive descendants should move far closer to such physical efficiency limits, they should either implement minds like ours via designs that use far fewer resources than humans use today, or pack far more mental capacity into packages that use levels of resources similar to ours. Or there may be a mixture of these two changes. Thus in the very long run (such as in millions or billions of years) we should expect any creatures with mental capacities comparable with ours to use far less material and energy resources. If they have densities similar to ours, they would be much smaller. And if they use a similar amount of total resources, there would be far more of them.

If the speed of light limits the speed of future communication, if the pace of local cultural change is not ridiculously slow, and if there isn't strong universal coordination, then the physical scale of the universe should ensure that future cultures must also fragment into many local cultures. For example, if it took a billion years to receive a signal back from a distant galaxy, but only 10 years for local music fashions to change, then music fashion must fragment into differently changing music fashions in different



locations. Similarly, if large travel costs and delays make military defense much cheaper than offense on large scales, military power may also have a tendency to fragment.

Our distant forager ancestors were well adapted to their very slowly changing world, and were quite culturally and militarily fragmented over the planet. Our distant descendants are thus likely to be more similar to our distant ancestors in these ways. Our current "dreamtime" era is cosmologically unusual; it is a brief period of a rapidly growing highly integrated global culture, with many important behaviors that are quite far from biologically adaptive.

We can't be sure in what future era the patterns of history might "turn the corner" to return to the patterns of our distant past and distant future. But we should weakly expect that without global coordination the next great era will begin to move in that direction, with a larger population of creatures that are smaller, use less energy, and have low living standards, behavior better adapted to their environment, a slower subjectively perceived rate of innovation and growth, and more fragmented cultures and societies.

Most of these are elements of the scenario explored in this book; ems seem to have less leisure and income, better-adapted behaviors, and cultures that are more fragmented than ours in important ways. Although growth is faster "objectively," that is, relative to a fixed clock, to the typical em growth seems slower "subjectively," that is, relative to the rate at which he or she personally experiences events.