

# Scoring Quality of Life in *Civilization IV*

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## ABSTRACT

In population ethics, Rawls, Parfit, Arrhenius, Broome and others have critiqued social welfare functions. By modifying the score of the historical strategy game, *Civilization IV*, this chapter walks through a few functions. By valuing total population and territory, *Civilization IV* rewards the emperor for conquering neighbors. For example, in an Iraq War scenario, population and territory incentivize Saddam Hussein to conquer Kuwait. Whereas, by valuing average health and happiness, *Civilization IV: Quality of Life* rewards the emperor for making peace and serving citizens. For example, Iraqi health and happiness incentivize Hussein to sign a treaty, stop building tanks and start building hospitals. Technically, in the Python programming language, normalized moral values weigh citizens' lives in units of extended quality-adjusted life-years (QALYs). To prevent a repugnant conclusion from averaging lives, fatalities are mourned. By editing the function, a gamer can play with their own moral values.

## KEYWORDS

quality-adjusted life year, quality of life, social welfare function, repugnant conclusion, utilitarianism, moral values, population ethics, Civilization IV, Python, system design, serious game

## INTRODUCTION

The strategy game about history, called *Civilization IV*, shares the same framework as its predecessor: while wearing the crown of an emperor, the player settles an empire and then advances through epochs of technology, civics, and culture. For the glory of the empire, the player expands a nation, builds monuments, subsidizes industries, proselytizes their culture, and conquers neighbors. *Civilization IV* has consequences. In a series of interesting choices, the player drives the empire closer to greatness or obscurity, closer to victory or defeat. There are optional victory conditions. One condition is the time victory. At game year 2050, the player with the highest score wins. When competing for score, the scoring system defines the consequences of the player's choices. As emperor, essentially the player is scored by glory, comprised of four factors: the mass of his population, the extent of his dominion, the magnificence of his monuments, and the superiority of his technology. A player can play nice and sometimes win *Civilization IV*, such as by: proliferating music and movies while managing large and livable cities.

Unfortunately, the emperor's glory can easily conflict with the citizens' well-being. In order to achieve glory the player may kill thousands, sacrifice thousands, and devote society to war. This militarism may be defended as a mirror of world history. In a study on *Civilization III* that discusses the Iraq War, one student said: "I owe it to these savages to conquer them. Think how happier they'll be in my civilization" (Squire 2007). The student satirizes that *Civilization III* rewards conquest. *Civilization IV* also rewards conquest. For instance, in a fan's Iraq War scenario, Iraq is surrounded by powerful militaries, except for a weak, yet rich, Kuwait. If Saddam Hussein conquers Kuwait, then his score jumps by 10%. For an

evocative example throughout the chapter, all references to the Iraq War are fictional accounts of a custom map of nations in *Civilization IV*, created by (Userr 2009).

While historians of empires recount the conquests, ethicists attempt to score history on a different scale. Some ethicists measure atrocities in terms of lives sacrificed (Broome 2004). These ethicists recommend weighing lives and evaluating quality of life, such that the welfare of persons is the primary criteria for evaluating a consequence (Bentham 1789, Sumner 1996, Broome 2004). Many philosophers are uncomfortable with scoring happiness, because a greedy planner may miscalculate the consequences or lack a yardstick to measure well-being (Rachels 1995). Some ethicists reject consequences, such as Immanuel Kant and John Rawls, who refuse to hurt a few to help many (Rachels 1995, Rawls 1971).

Yet policy makers already weigh our lives. Moreover, as with many strategy games, *Civilization IV* has consequences and has a score, so it is beyond the scope of this chapter to defend consequentialism or utilitarianism. The player of Saddam Hussein is scored and thus the scoring system punishes or rewards his choices. Also outside the scope of this chapter is an instrument to census health and happiness. *Civilization IV* already calculates city health and happiness. *Civilization IV*'s model of medicine and entertainment is too warped to advise any policy planner, yet the model is rich enough to advise the player of Saddam Hussein to choose between building toy tanks or toy hospitals. So, this mod accepts the *Civilization IV* census, as is.

Instead of defending or defining a census of health and happiness, this mod aggregates censuses of health and happiness into a single score. We will weigh the lives of toys and play. The philosopher Derek Parfit and Gustaf Arrhenius concluded that even if an instrument could be devised to census happiness, weighing the lives of masses would incentivize a miserable or murderous society (1989, 2000). Through exploring examples of a fictive Iraq, we discover a social welfare function that incentivizes peace and serving toy citizens. To win in *Civilization IV: Quality of Life*, Hussein will stop building tanks and start building hospitals.

I modified *Civilization IV* because the videogame is a robust playground on which to demonstrate social welfare functions. Firaxis, the videogame developer, distributed their scoring system and demographics on citizen health and happiness. The developers painstakingly exposed detailed hooks and handles to modify most of the game, including the score. Only as necessary to elucidate my mod (which I call "*Civilization IV: Quality of Life*"), we will walkthrough a few functions of Python (Kennerly 2010). Hopefully the code empowers you to play with your own moral values. To start, let us examine how the original scoring system rewards Saddam Hussein for conquering Kuwait.

## How Does Population and Territory Incentivize Iraq to Conquer Kuwait?

In the original *Civilization IV*, the scoring system rates how glorious the empire is. Briefly put, *Civilization IV* rewards a large and content population, expansive territory, extravagant buildings, and advanced technology. In *Civilization IV*, happy citizens add to the score. But after Equation 6, we will see that *quantity* of life outweighs *quality* of life.

Scoring the glory of the empire is evident in the program's game utilities. Firaxis has publicized the utilities in plain text files. Anyone that purchases *Civilization IV*, or downloads the free demo, may browse the *Civilization IV* program folder, read and modify the scoring system. The exact location depends on installation. For example the file might reside at:

```
C:\Program Files (x86)\2K Games\Firaxis Games
  \Sid Meier's Civilization 4 Complete\Assets\Python
```

There is a subfolder "\Assets\Python." Python refers a programming language that Guido van Rossum had designed to be easy to read. Many of the game system calculations are written in these plain text Python script files, which are denoted by the file extension ".py." In "Assets\Python," there is a text file named "CvGameUtils.py." Thus, the file name "CvGameUtils.py" is shorthand for: *Civilization IV* game utilities written in plaintext Python.

As referenced at the end of this chapter (Kennerly 2010), the interested reader is invited to download the functions and follow the examples. In most text editors, one may open "CvGameUtils.py" (or any other ".py" text file). In this text file, the function to calculate the score is defined, which may be found by searching for the function name "calculateScore." The code is dense; yet to make the point that *Civilization IV* scores glory and not citizen well-being, the bottom line is quoted in Listing 1, which says: the score = population + territory + wonders + technology. A "wonder" is *Civilization's* term for a magnificent monument or cultural landmark, such as Angkor Wat or Hollywood. The four factors are too lengthy to define here, and have been discussed on fan forums (Paul57 2006).

```
def calculateScore(self, argsList):
    ...
    return int(iPopulationScore + iLandScore
              + iWondersScore + iTechScore)
```

*Listing 1: Civilization IV scores population, territory, wonders and technology.*

To qualify the population, optimally build wonders, research powerful weapons, and improve infrastructure the player must maintain a majority ratio of citizen health and happiness. Above a majority ratio, citizen welfare contributes little to the glory of the empire. Looking at the demographics (by pressing F9), an approval rating above 50% corresponds to surplus happiness and a life expectancy above 50 years corresponds to surplus health. To see the impact of discounting surplus happiness and health, let us look at the choices that a player of Saddam Hussein makes.

Userr's fictional Iraq War scenario is limited to 16 nations in the Middle East, including a few outposts of England, India, and the United States. Clearly the rules of *Civilization IV* were optimized for fun, and not for historical accuracy. For instance, consider population census. In the fan's scenario starting in 1976, Karbala's population is 6000, whereas, on Earth in 2003, Karbala's population was 570,000. Still, this Iraq war scenario is a concise example of how scoring motivates the leader of a toy nation.

At the start the scenario, Iraq is already at war with Kuwait, England, and the United States. So the Iraqi citizens are unhappy. But as long as citizens are happy enough to work, Saddam Hussein's score remains competitive. To win, Iraq needs to become the biggest and most powerful nation in the Middle East. By this *Civilization IV* algorithm, any small nation, such as Kuwait will lose. Moreover, Saddam Hussein can sacrifice the Iraqi welfare to expand borders.

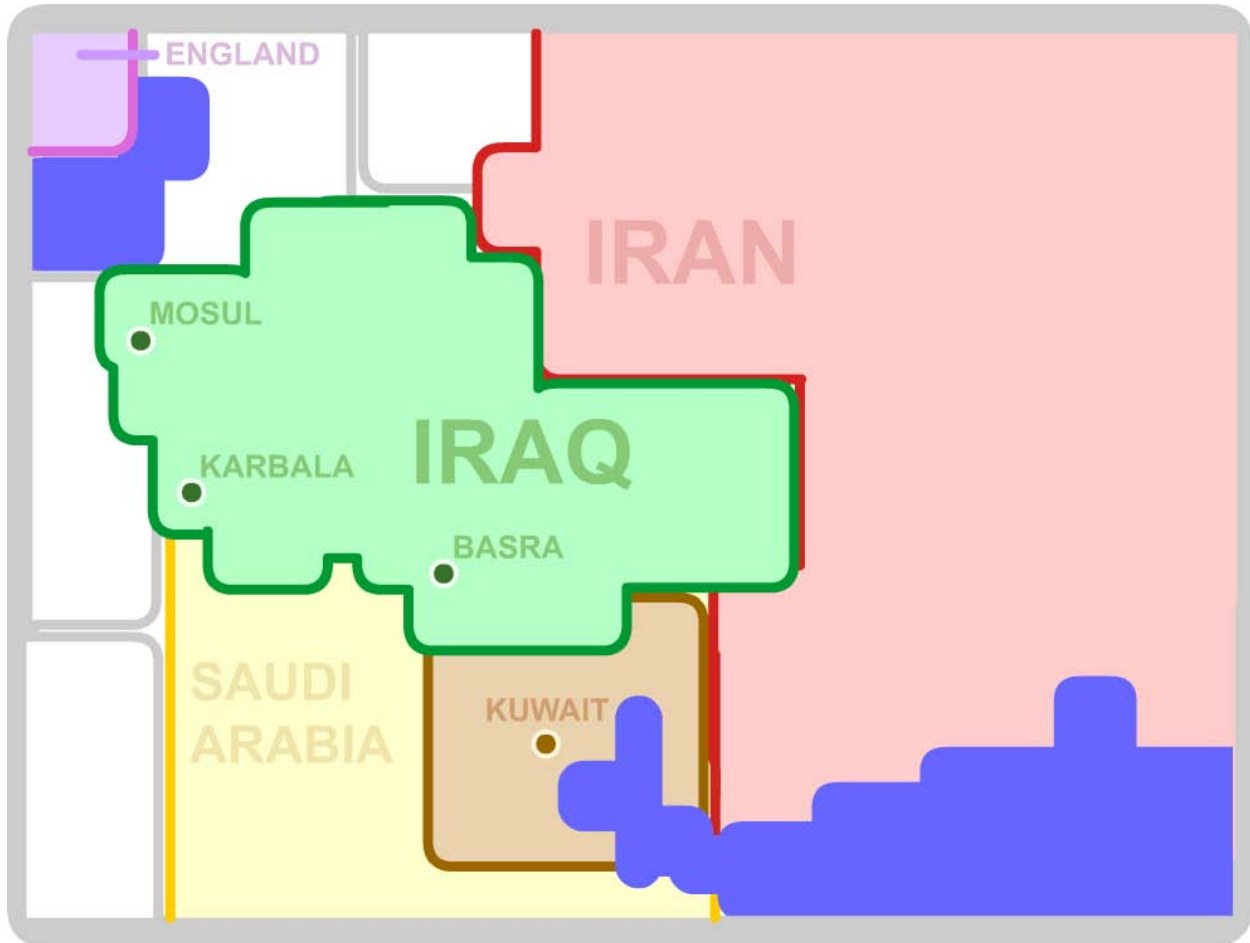


Figure 1: In the beginning of an Iraq War scenario by Userr, Iraq borders Kuwait.

On the fan-created map, Iraq is land locked by Iran, Saudi Arabia, and Kuwait. Of these, Kuwait is the weakest, with only one wealthy city (Figure 1). So the player of Saddam Hussein devotes Iraqi labor to arming and training soldiers, and then invades Kuwait. Thousands of Iraqi and Kuwaiti soldiers and civilians die. Thousands more are devastated. Yet once Kuwait is conquered, the territory immediately becomes part of Iraq. Kuwait's population and territory is added to Iraq's score. With no significant change in wonders or technology, Saddam Hussein's score and rank leaps from 4th place to 3rd place. So scoring population and territory reward Saddam Hussein for conquering Kuwait. Hussein is glorified, but at the expense of thousands of Iraqi lives. Let us expand the circle of concern from the glory of the crown to the well-being of the masses.

## HAVE VIDEOGAMES SCORED LIFE?

In popular construction management games, the criteria of quality of life has been overshadowed by expansionism. Since the text-based simulation, *Hamurabi*, lives counted, but in this crude inventory simulation there is no distinction of the quality of these lives (Ahl 1978). In *SimCity*, crime, pollution and disasters are modeled (Maxis 1989). These are treated as enabling objectives to the primary activity of the player as an autocratic mayor, who constructs and plans the city. Since the original *Civilization*, the satisfaction of the citizens enables productivity, which serves the player as the emperor that often pursues world domination (Microprose 1991). *Civilization IV* is designed to glorify the player as emperor (Meier 2010).

With each sequel, *Civilization* has gradually acknowledged its toy people. Since *Civilization II*, if a city is mostly unhappy then the score lowers. Aristotle's notion of the well-lived life (eudaimonia) and Jeremy Bentham's ethical calculus briefly appeared in a sci-fi *Civilization* spinoff: *Sid Meier's Alpha Centauri*. *Alpha Centauri* shares the same gameplay framework as *Civilization III*. Structurally similar to a tree of college course prerequisites, the player may research futuristic technologies to control their citizens. Two of these public control technologies are called "ethical calculus" and "eudaimonia" (Firaxis 1999). So the designers of *Sid Meier's Alpha Centauri* were aware of utilitarian ethics. In fact, the technology "ethical calculus," incited me to consider this modification.

*Civilization IV* approaches a model of quality of life. Its information screen displays a crude summary of happiness and life expectancy for the empire, and the domestic advisor screen rates the happiness and health of each city (Firaxis 2005). Although it seems most players care less about scoring quality of life, by the three *Civilization IV* expansion pack titles: *Warlords*, *Colonization*, and *Beyond the Sword* (which is not an alluding "from swords to ploughshares," but to advanced weapons, such as nuclear bombs).

Few management videogames have rated the player's performance by quality of life. The Intellivision game, *Utopia*, was exceptional for scoring the player by citizen welfare (Daglow 1982, Cassidy 2004). In *The Sims*, a player manages a family's house to manipulate attributes that might correlate to quality of life are modeled, such as hygiene, sleep, exercise, and creativity (Maxis 2000). Citizen happiness is part of the score in *Tropico* (PopTop 2001). *Ayiti: The Cost of Life* scores the player by the happiness and health of a small family in Haiti, which are directly impacted by the lifestyle and employment of each family member (gameLab 2006). Thus, *Ayiti* exemplifies scoring quality of life. To inform a scoring system, let us look at how some ethicists have modeled and calculated quality of life.

## WHO DARES TO WEIGH LIVES?

Some ethicists extend economic techniques to address ethical choices (Broome 1999). They extend the economic notion of utility to cover the satisfaction and well-being of a person. In theory, utilitarianism proposes a numerical analysis of moral problems. Utilitarians claim that making people healthy and happy is the guide to a moral choice, especially to public policy (Bentham 1789). Moreover they propose to score consequences, which they call utilitarian calculus.

Ethicists perennially debate the possibility of a universal instrument of well-being. And they have interpreted the synonymous concepts of utility, satisfaction, welfare, well-being, and quality of life in various ways. Jeremy Bentham suggested scoring pleasure (Bentham 1789 qtd Rauhut and Bass 2009), and those that agree with him are called hedonists. To distinguish cerebral pleasure, J. S. Mill suggested scoring happiness. Unfortunately, delusion and betrayal may counterfeit happiness (Rachels 1995). So G. E. Moore suggested scoring ideal pleasure, friendship, and enjoyment (Rachels 1995, Baldwin 2008). However, some do not even agree with that. So Kenneth Arrow suggested that, as in economics, let each person decide for herself what she prefers (Arrow 1970). Even though some people prefer health, wealth, or wisdom, normalizing satisfaction is a fair way to compare welfare (Samuelson 1947). Yet satisfaction could counterfeit well-being (Bass 2008). To prevent counterfeit well-being, John Broome suggested measuring artifacts and services that provide health, security, and comfort (1999). He also suggested extending a metric of medical ethics to weigh durations of lives (2004).

Ethical calculus is hubris. Even if an instrument could be devised to census happiness, life is too complicated and the interaction of preferences is intractable. For example, as a parody, in the bureaucratic worksheet "Guide to the Utilitarian Calculus," block (F4) states: "Enter any incalculable emotional or mental repercussion for agent" (Cornell 2001). With inappropriate models, assumptions, or

enforcement a public policy costs lives. A bureaucratic ethical impact analysis can be applied beyond context and fuel opportunistic inspection (Lerner 1997). In Germany, the National Socialists regime demanded public health and kind animal treatment, while enforcing starvation and mutilation (Proctor 1999). In the 20th Century, improving lives was the excuse that preceded these atrocities, and more (Liulevicius 2003). So weighing lives is corruptible.

Regardless of objections, policy makers already weigh our lives. In the 21st Century, demographics on some of the qualities of life are leveraged as premises for public policy. Some countries are extending their demographics to include happiness (White 2007). In the extreme, Bhutan claims a mission of well-being. Instead of measuring gross domestic product, Bhutan attempts to survey gross national happiness. However, Bhutan's happiness economy appears to be unsustainable (Revkin 2005). In the United States, scores from the World Health Organization backed premises in proposals to nationalize insurance (2000). Although a census of well-being is intractable and corruptible, many public and private insurers already census medical well-being (Gold, Stevenson, and Fryback 2002). Health treatment assessors face the dilemma: Save one life or extend another. Besides allocating doctors and beds, administrators allocate money for treatments. An expensive treatment costs lives, since others could have survived on the surplus (Sowell 2003). Therefore, a cost-effective treatment can save lives.

By scoring health and happiness in *Civilization IV*, we will sharpen our ethical reasoning about public calculations that weigh our lives. Let us consider an example.

### Should a Cancer Patient Suffer Chemotherapy?

For 30 years, some medical decision makers analyzed cost-effectiveness with a metric called a quality-adjusted life year (QALY) (Gold, Stevenson, and Fryback 2002). A QALY is comprised of two factors: quality-adjustment and life years. Measuring life years is straightforward. As anyone who has ever been sick knows, health influences the satisfaction derived from living. Through subjective surveys, medical assessors measure satisfaction of healthy living, or a quality-adjustment. The top-level formula is simple (Equation 1).

$$\text{Quality of health} \times \text{years of life} = \text{Individual medical well-being}$$

*Equation 1: Individual quality-adjusted life years (QALYs)*

The conventional benchmarks for quality-adjustment are [0..1], where 0 represents death and 1 represents good health. Here are some example values, using a percent (%) to simplify the presentation. Technically, there are different ways to survey the quality-adjustment, such as a risk-neutral gamble or a ratio of timespans (King, Tsevat, and Roberts 2005). For simplicity, only a ratio of timespans will be implemented here, as the example in Figure 2 shows.




	Quality (%)	Health	Preference
	100	Healthy	Indifferent between living 10 years with gall bladder cancer and living 4 healthy years (and dying six years early).
	40	Gall bladder cancer	Indifferent between living only 4 healthy years and living 10 years with abdominal pain, bloating, fever, nausea, itchiness, and yellow skin.
	0	Dead	Would not give up any healthy years to be oblivious for any number of years.

Figure 2: A quality-adjusted life year claims to model how most people value health.

For example in the Iraq War scenario, suppose an Iraqi archeologist in the city of Karbala is healthy for five years. She experiences 500% quality-adjusted life-years (Equation 2).

$$100 Q \times 1 L \times 5 Y = 500 QLY$$

Equation 2: In algebra, healthy for five life-years.

(Although it is conventional to compute with lower case letters and to write QALY instead of QLY, in this chapter I use upper case letters and one letter per factor, to accentuate legibility of the factors. Also for legibility, I compute with integer percentiles, instead of the conventional decimal fractions. Integer percentiles simplifies the implementation in *Civilization IV*. To be consistent with the videogame code and keep the formulas simple, I omit the "%" percentile sign.)

This is trivial to say in Python, the language that underlies *Civilization IV*'s score (Listing 2). The text ">>>" means Python is listening to you. Like most programming languages, in standard Python it is cumbersome to represent the unit of measurement, so (1) appears instead of 1 life-year.

```
>>> healthy = 100
>>> life = 1
>>> year = 5
>>> healthy * life * year
500
```

Listing 2: In Python, healthy for five life-years.

In Karbala, there is no aqueduct, so it is less sanitary. Suppose the archeologist's brother is an anthropologist who catches typhoid fever that unfortunately develops into gall bladder cancer. According to (Stouthard et al 1997 qtd Victorian Government 2010) the disability of gall bladder cancer weighs 60%, which adjusts quality to 40% (Figure 2 and Equation 3).

$$40 Q \times 1 L \times 5 Y = 200 QLY$$

Equation 3: In algebra, gall bladder cancer for five life-years.

```
>>> cancer = 40
>>> chemotherapy = cancer * 5
>>> chemotherapy
200
```

Listing 3: In Python, gall bladder cancer for five life-years.

Suppose the anthropologist has two options: (A) forego treatment and live one year symptom-free, but then die. Or (B) tolerate chemotherapy and suffer for five years with abdominal pain and all other symptoms. The comparison is clear when we equalize the number of life years (as shown in Figure 3, Equation 4, and Listing 5):

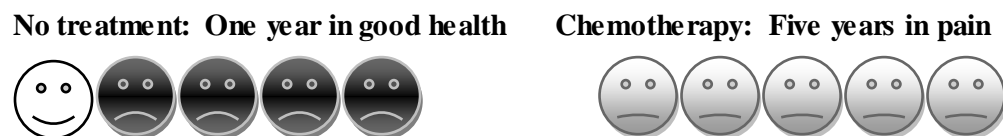


Figure 3: Each face represents one expected year for the same man with gall bladder cancer.

$$(100 Q \times 1 LY) + (0 Q \times 4 LY) = 100 QLY$$

*Equation 4: In algebra, healthy for one life-year and then dead for four expected life-years.*

```
>>> dead = 0
>>> ignore = (healthy * 1) + (dead * 4)
>>> ignore
100
```

*Listing 4: In Python, healthy for one life-year and then dead for four expected life-years.*

The difference is 100% QLY, which is also clear in Python (Listing 5).

```
>>> chemotherapy - ignore
100
```

*Listing 5: In Python, the opportunity value of chemotherapy to treat gall bladder cancer.*

Even within the domain of medical ethics, this calculus is too simple to account for chronic illness, multiple diseases, and extrinsic factors. Strong assumptions of risk neutrality and independence of time and quality must hold for this metric to inform a decision (Broome 2004). Many forms of QALY do not differentiate stages of life, or the personal value attributed to one's own health.

## How Can We Score Life in Karbala?

However, the economist and ethicist John Broome believes a quality-adjusted life year is a starting point for population ethics (Broome 2004). Here is a summary of a rationale for weighing lives. A medical QALY enables two futures for a patient to be compared, and has been used to compare lives of multiple patients. A medical QALY assumes the patient is well-informed (WI) of their health consequences. One may extend the QALY to non-medical conditions by accounting for subjective preferences (S). By sympathetically extending preferences to a hypothetical consideration of the preferences one would have if one were living as a different person, an extended preference (E) between persons could be compared. To distinguish this extension from the medical quality-adjusted life year, I will call this a well-informed, subjective, extended quality-adjusted life year (WISE-QALY). For example of WISE-QALY: A healthy archeologist can imagine the counterfactual case of having gall bladder cancer and speculate on how many years in abdominal pain that an anthropologist would sacrifice to live in good health.

The WISE-QALY is an intuitive and general approximation of what is meant by a good life (Broome 1999). The conventional 0 Q for death has some arithmetic advantages and opens up consideration to lives not worth living. The upper limit of 100% Q, established for good health may be lifted and replaced by another benchmark. To represent that life, for some, has improved through the history of an empire, the scale of the WISE-QALY may go above 100%. For example, 100% may be conventionally assigned to the average quality of life for all humans surveyed during the year 2000.

A case study in *Civilization IV* illustrates such evaluation of good living. Although *Civilization IV* scores imperial glory, the designers have been considering the citizens. *Civilization IV* abstractly represents happiness, unhappiness, health, sickness, and other parameters indicated by a quality of life survey (Stevenson and Wolfers 2008, ANC 2009). After creating a couple of cities in *Civilization IV*, the city attributes are obvious in the Domestic Advisor screen (visible by pressing F1). For convenience, I map each city attribute to a table of moral values. From left to right, I abbreviate each quality of life as: happy, sad, angry, fed, healthy, sick, hungry, productive, wealthy, educated, cultured, and creative (Table 1).

Quality Value %	happy	sad	angry	fed	healthy	sick	hungry	productive	wealthy	educated	cultured	creative
	5	-5	-9	8	20	-20	-8	1	9	3	1	11
Baghdad	6	5	0	14	8	6	10	6	21	21	3	0
Irbil	5	5	0	11	9	5	10	4	12	12	1	0
Karbala	5	2	0	4	6	2	4	3	5	5	0	0
Basra	5	5	0	11	8	6	10	4	12	12	0	0
An-Nasimyah	5	5	0	14	8	6	10	4	12	12	0	0
Mosul	5	5	0	5	9	5	10	9	7	7	1	0

Table 1: In Domestic Advisor, suppose each city attribute corresponds to a moral value.

*Civilization IV*'s city attributes correlate to the logarithm of the population. For example in Iraq, when Karbala has 6000 citizens, it has a sickness of 2; if Karbala grows to 21000 citizens, it will have a sickness of 3, as shown in CvGameUtils.py (Listing 6 sc). Alternatively, if Karbala builds an aqueduct, its health improves by 2 (Listing 6 hl). Thus, the units of attributes are not proportional to the population. Each attribute is an arbitrary resource to manage.

```
# hp, sd, an, fd, h1, sc, hn, pr, wl, ed, cl, gr
'Karbala': [ 5, 2, 0, 4, 3, 2, 4, 4, 5, 5, 0, 0],
'Karbala grow': [ 5,1+2, 0,2+4, 3,1+2,1+4, 4, 5, 5, 0, 0],
'Karbala aqueduct': [ 5, 2, 0, 4,2+3, 2, 4, 4, 5, 5, 0, 0],
```

Listing 6: In CvGameUtils.py, Karbala health consequences for expansion or an aqueduct.

As previously discussed, this modification does not address the validity of *Civilization IV*'s attributes. Yet, I do expose the table so that a player may substitute their own moral values. Since these attributes are exposed, it would be simple to weigh those that contribute to being well. Because, not only can we read the scoring system, we can rewrite it. Let us revisit the code:

```
C:\Program Files (x86)\2K Games\Firaxis Games
\Sid Meier's Civilization 4 Complete\Assets\Python
```

Although one could edit the text file named "CvGameUtils.py," and reboot the videogame, this *alters all sessions!* A single typographical error (such as referring to "IPopulationScore" instead of "iPopulationScore") can break the videogame. Instead, Firaxis recommends modifying a copy of any asset, such as "CvGameUtils.py," and saving this copy to a folder of modifications that has the same structure as "Assets."

For example, on my computer, I created the folder "Quality of Life," which has the file path of:

```
C:\Users\Ethan\Documents\My Games
\Sid Meier's Civilization 4 Complete\MODS\Quality of Life
```

The file path varies depending on the operating system, the version of *Civilization IV*, and the player's configuration. In the subfolder, I saved "\Assets\Python\CvGameUtils.py."

```
C:\Users\Ethan\Documents\My Games
\Sid Meier's Civilization 4 Complete
\MODS\Quality of Life\Assets\Python\CvGameUtils.py
```

The full code of my modification is too long to embed into this chapter. For details, you may download *Civilization IV: Quality of Life* (Kennerly 2010) and load it in *Civilization IV*. Opening the modified "CvGameUtils.py," one may see the revised scoring system.

Near the top of the file "CvGameUtils.py," there is a list of moral values (called "moral\_values"), which corresponds to Table 2. The utilitarian Bentham suggested valuing pleasure, and Mill suggested valuing happiness. Since *Civilization IV* has a city attribute for happiness, unhappiness, and anger, suppose we value happiness and disvalue unhappiness and anger. My value of happiness is depicted positively (5%), of unhappiness negatively (-5%), and of anger negatively (-9%). These numbers only have relative meaning.

Quality	happy	sad	angry	fed	healthy	sick	hungry	productive	wealthy	educated	cultured	creative
Moral value	0.05	-0.05	-0.09	0.08	0.2	-0.2	-0.08	0.01	0.09	0.03	0.01	0.11

Table 2: *Civilization IV: Quality of Life rates life by moral values.*

For a simple implementation in *Civilization IV*, suppose a moral value is represented as a weight to each of the factors that the average citizen may prefer. Blending moral values of citizens into an average disenfranchises outliers. So in computational ethics, each citizen is scored before aggregating (Endriss 2010). Yet for this chapter, homogenized values still provide a player with interesting moral choices. Loosely outlined, the score is calculated as the sum of a quality-value vector (Equation 5).

$$\begin{aligned}
 \text{Score} = & \\
 & (\text{Quality of } \mathbf{Health} \times \text{Moral value of Health}) \\
 & + (\text{Quality of } \mathbf{Happiness} \times \text{Moral value of Happiness}) \\
 & + (\dots)
 \end{aligned}$$

Equation 5: *Multiply each quality by its moral value and add the factors together.*

In *Civilization IV: Quality of Life*, positive moral values add and negative moral values subtract from the quality of life (see Listing 7). So indifference is denoted by 0. However, exaggerating any value inflates the score. Also, normalizing enables us to compare ratings of players with different scales. Therefore, as in Table 2, the program normalizes the moral values, such that their absolute values add up to 100%.

```

def value_qualities(city_qualities, moral_values):
    ...
    quality = 0.0
    for commodity, weight in zip(city_qualities, moral_values):
        value = diminished_marginal_value[commodity]
        quality += sell(value, weight)

```

Listing 7: *In Python, positive and negative moral values add to and subtract from quality of life.*

In *Civilization IV*, it is more challenging to balance many city attributes, rather than to maximize a single attribute. Also according to prospect theory, psychological experiments suggest that many people discount extremely large quantities of a commodity or currency. Therefore, rather than "utility," the *value* function (called "diminished\_marginal\_value" in Listing 7), progressively diminishes the marginal value of large, raw qualities. Examples appear in "CvGameUtils.py." As visible in the demographics screen, *Civilization IV* already calculates life expectancy. The quality of life is multiplied by the normal life expectancy (50 years in *Civilization IV*); therefore a city where people live longer has a higher score. For example, the quality of life for Karbala starts out poor (Listing 8).

```

>>> karbala = iraq_city_qualities['Karbala']
>>> get_quality_of_life(karbala, get_moral_values())
19

```

Listing 8: *In Python, quality of life in Karbala.*

In the future, it may be interesting to refine how *Civilization IV* rates health and happiness. For now, though, it is more important to acknowledge the difficulties of scoring multiple lives. Even if ethicists were to agree on an instrument of happiness for a single person, ethicists disagree on how one person's overall welfare is compared to another person's.

## Should Iraq Build an Aqueduct in Karbala?

A social welfare function is attractive for computer simulation, since functions are straightforward to engineer and compare. Then future scenarios may have their quality-adjusted life years computed. The future with the highest expected total is the most desirable. To account for multiple persons, some utilitarians sum welfare (Broome 2004), such as Equation 6. *Civilization IV* score also correlates to population (see Listing 1) with happy citizens adding more than unhappy citizens.

$$\sum(Q \times L \times Y) = QLY$$

Equation 6: Total individual quality-adjusted life-years

The result is a magnitude that may quantify, for example, the impact of global warming in terms future lives. This could then be compared of the sacrifice of present goods and services in order to save the future (Broome 2004).

But scoring the total leads to a dilemma, which Iraq faces (Figure 4). In 1976, suppose the small city of Karbala (population 6000), considers two possible plans until year 2006. (A) Karbala farms and grows at an alarming pace to 21,000, and a quality of life to 12 per person. (B) Karbala avoids growth and builds an aqueduct which improves quality of life to 31 per person.

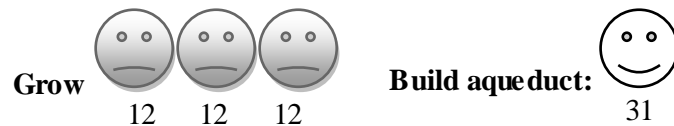


Figure 4: To live well in thirty years, should Karbala grow rapidly or build an aqueduct?

For the year of 2006, by summing lives, which future of Karbala would attain a higher score (Equation 7)?

Grow: 12 Quality  $\times$  21,000 Lives  $\times$  1 Year  
 Aqueduct: 31 Quality  $\times$  6000 Lives  $\times$  1 Year

Equation 7: In QLYs, which future Karbala attains a higher score?

The larger and miserable Karbala has the higher score (Figure 5, left). In Python, we may compute this. Supposing the same number of years for each life, this would be simple to score in *Civilization IV* (Listing 9):

```
def sum_city_quality(city_quality_life_list, year = 1):
    quality_life_year_list = [quality * life * year
                              for quality, life
                              in city_quality_life_list]
    return sum(quality_life_year_list)
```

Listing 9: Sum the quality of lives.

Speaking in Python, we can calculate Karbala's consequences. One way is to open a Python shell and import this function. Another way is to change the *Civilization IV* configuration file as to enable the Python shell in *Civilization IV* (Listing 10).

```
>>> karbala_grow = iraq_city_qualities['Karbala grow']
>>> miserable = get_quality_of_life(karbala_grow,
    get_moral_values())
>>> miserable
12
>>> medium = 21000
>>> karbala_crowded = [(miserable, medium)]
>>> medium_miserable = sum_city_quality(karbala_crowded)
>>> karbala_aqueduct = iraq_city_qualities['Karbala
    aqueduct']
>>> happier = get_quality_of_life(karbala_aqueduct,
    get_moral_values())
>>> happier
31
>>> small = 6000
>>> karbala_with_aqueduct = [(happier, small)]
>>> small_happier = sum_city_quality(karbala_with_aqueduct)
>>> medium_miserable < small_happier
False
>>> medium_miserable
252000
>>> small_happier
186000
```

*Listing 10: In Python, Derek Parfit's first repugnant conclusion: proliferate misery.*

Listing 10 illustrates that summation incentivizes misery. The philosopher Derek Parfit foresaw this first repugnant conclusion: Scoring the total incentivizes saturating the world with miserable lives (Parfit 1989). To avoid incentivizing misery, average the welfare of those living (Equation 8).

$$\frac{\sum_{\text{ifliving}} (Q \times L \times Y)}{\sum_{\text{ifliving}} (L \times Y)} = Q$$

*Equation 8: In algebra, average the quality of the living.*

The units of the average quality of life is no longer quality-life-years (QLY). Instead the unit of the average is quality (Q). Numbers in these different units cannot be directly compared. However, within the scoring system, scenarios can be computed and compared. Returning to Karbala, under the living average of quality, which future yields a higher score (Equation 9)?

Grow: **12** Quality  $\times$  21000 Life-Years / **21000** Life-Years

Build aqueduct: **100** Quality  $\times$  6000 Life-Years / **6000** Life-Years

*Equation 9: If scoring the average quality of the living, which should Karbala develop?*

Comparing quality of life is easy to say in Python (Listing 11):

```
>>> average_living_city_quality(karbala_crowded)
12
>>> average_living_city_quality(karbala_with_aqueduct)
31
```

*Listing 11: In Python, avoid Derek Parfit's first repugnant conclusion: average quality.*

By averaging quality of many similar examples, it becomes clear that a large population of sad lives yields lower quality per living person (Figure 5). Equation 9 is trivial because the population is homogenous, so the average is the same as the quality per person. But with different persons, the average differs.

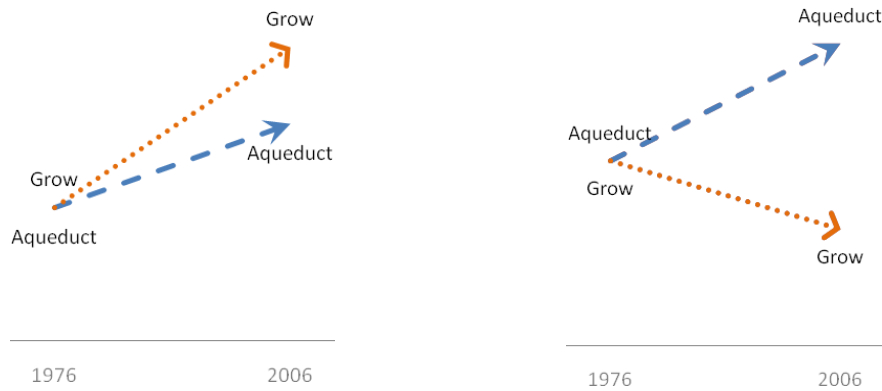


Figure 5: (Left) Summing quality rewards Karbala for growing rapidly.  
(Right) Averaging quality rewards Karbala for building an aqueduct.

### If Mosul Will Starve Anyway Should Iraq Defend It?

So far, the average of living quality function appears agreeable. But what if some people die? In *Civilization IV*, at the start of the Iraq War, England invades beside Mosul (Figure 1). If Iraq does not act fast, England will conquer Mosul and could raze the city. For simplicity, I suppose conquering is as terrible for its citizens as dying. If Iraq sends its tanks and mechanized infantry, it can defend Mosul. However Mosul is already starving. Suppose we only consider the quality of life for Karbala (with an aqueduct) and Mosul. Even if defended, by 1982 Mosul would starve from 90,000 persons to 21,000. Equivalently, *Civilization IV* population points of Mosul starve from 5 to 3. Although the ratio of population points is not as extreme as the estimated population, on either scale, starving leads to the same conclusion of the ethical dilemma: Should Iraq let Mosul die, or save some of the people? Figure 6 illustrates the alternatives.

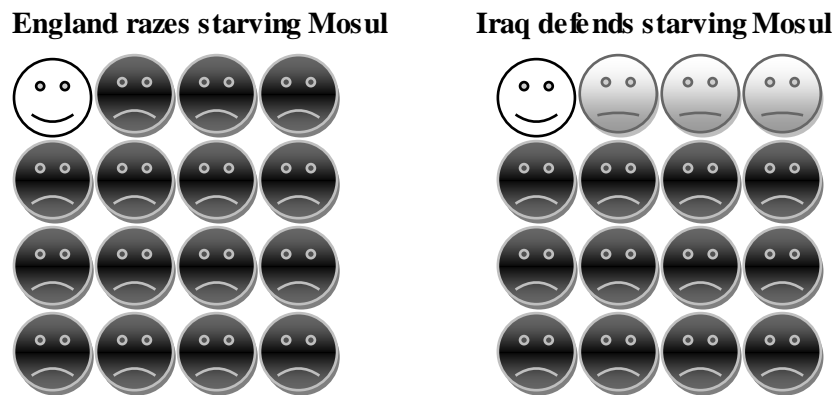


Figure 6: In *Civilization IV*, should Iraq give up starving Mosul, or defend?

In Python, we can compare outcomes (Listing 12). We see that overall quality of life is improved (for the survivors) if we let all of Mosul die (31 Q) instead of saving a few (29 Q).

```
>>> mosul_starves = iraq_city_qualities['Mosul starves']
>>> fed = get_quality_of_life(mosul_starves,
                             get_moral_values())
>>> fed
29
>>> huge = 90000
>>> medium = 21000
>>> many = huge - medium
>>> dead = 0
>>> mosul_starving = [(happier, small), (starving, medium),
                     (starving, many)]
>>> average_living_city_quality(mosul_starving)
9
>>> let_mosul_die = [(happier, small), (dead, medium), (dead,
                 many)]
>>> average_living_city_quality(let_mosul_die)
31
>>> defend_mosul = [(happier, small), (fed, medium), (dead,
                 many)]
>>> average_living_city_quality(defend_mosul)
29
```

*Listing 12: In Python, Derek Parfit's objection: kill the unhappy.*

Averaging the living incentivizes Hussein to sacrifice the unhappy. Again Derek Parfit foresaw this (as illustrated in Figure 6 and computed in Listing 12): By preferring the highest average of *only* the survivors, kill all who are less happy than the average (Parfit 1989).

Incentivizing sacrifice can be avoided: Mourn the dead for the remainder of their expected lifespans. This function is similar to the average, except that those being counted is more inclusive between alternate outcomes (Equation 10).

$$\frac{\sum(Q \times L \times Y)}{\sum(E(L) \times Y)} = Q$$

*Equation 10: In algebra, to account fatality, score quality-life-year per expected life-year.*

Average fatalities, too, for their expected lifespan (at the time of the calculation). When an invasion or a famine kills citizens, expected lives remains constant. When a fatality's life-expectancy lapses, redundant fatalities are removed from the list of expected lives. So, in safe times the expected lives "E(L)" converges to actual lives "L," but in deadly times expected lives "E(L)" remains high while actual lives "L" falls (Equation 10).

Under the average of living and fatal quality, should Iraq let Mosul die or defend and face the famine?

In Python file "CvGameUtils.py," we may verify that the fatalities will be mourned (Listing 13).

```
>>> quality_per_expected(mosul_starving)
9
>>> quality_per_expected(let_mosul_die)
1
```

```
>>> quality_per_expected(defend_mosul)
8
```

Listing 13: In Python, prevent rewarding sacrifice: mourn fatalities.

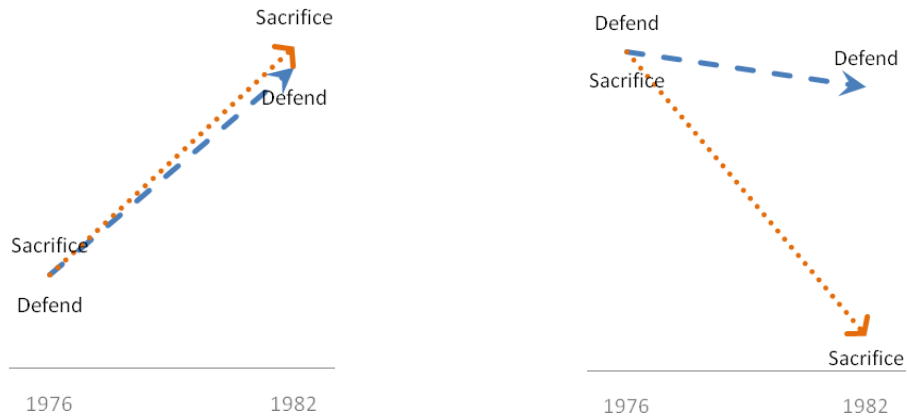


Figure 7: (Left) Averaging quality of the living rewards letting Mosul die. (Right) Mourning fatalities rewards defending Mosul.

For Mosul in Figure 7, we see how the score may change. Let us return the first example, Karbala. Under the average of living and dead utility, which future city would yield a higher score (Listing 14)? Since no one has died prematurely, the scores are equivalent to (Figure 5, right).

```
>>> quality_per_expected(karbala_crowded)
12
>>> quality_per_expected(karbala_with_aqueduct)
31
```

Listing 14: In Python, solving both repugnant conclusions: live happily ever after.

*Civilization IV: Quality of Life* calculates the opportunity cost of battle fatalities. Calculating opportunity cost during expected lifespan enables a mathematical shortcut. The scores of a running average can be compared between each other (see "distributed\_quality" in CvGameUtils.py). This is convenient for a score that is being displayed to the player before the game is over, which is the case in *Civilization IV* and many other videogames. Also, distributed quality prevents some exploits that John Broome foresaw, in which a snapshot of quality improves for the survivors although lives are lost (Broome 2004). Explaining "distributed\_quality" would take too many pages here. For example calculations, see "life\_history\_class" in CvGameUtils.py.

## Should Iraq Sign a Peace Treaty with Kuwait and Reduce Pollution?

Let us compare a session to maximize population and territory with a session to maximize health and happiness. Consider two different outcomes to the scenario of the Iraq War: a) Iraq conquers Kuwait, or b) Iraq signs a peace treaty with Kuwait and England. At the beginning of the Iraq war scenario by User1 (Figure 1), Iraq starts at war with Kuwait, England, and the United States. A human plays as Saddam Hussein, ignores other victory conditions, and plays only to maximize Iraq's score. First he plays by the standard *Civilization IV* scoring (population, territory, wonders and technology), and second plays by *Quality of Life* scoring (health, happiness, creativity and culture). In both cases, a human knows the scoring system and plays to win by score. But the other 15 nations are controlled by the standard artificial

intelligence, which is only programmed to maximize standard score (population, territory, wonders and technology).

<b>Scoring population, territory, wonders and technology</b>	<i>Both timelines</i>	<b>Scoring health, happiness, creativity and culture</b>
Iraq builds SAM infantry and tanks.	<i>1976</i>	Iraq builds theaters and aqueducts.
Iraq accelerates birth rate.	<i>1984 Famine in Mosul.</i>	Iraq reduces birth rate.
	<i>1992 England invades Iraq.</i>	
	<i>2000 Kuwait invades Iraq.</i>	
Iraq establishes police state.	<i>2008 England bombs Iraq.</i>	Iraq liberates its citizens.
Iraq builds SAM infantry and tanks.	<i>2016</i>	Iraq reduces pollution.
	<i>2022 England ceases fire.</i>	Iraq creates fine art.
Iraq conquers Kuwait.	<i>2030</i>	England signs treaty with Iraq.
Iraq builds banks and relaxes culture.	<i>2038</i>	Kuwait signs treaty with Iraq.
	<i>2046 U.S. invades Iraq.</i>	
	<i>2050</i>	Saudi Arabia declares war on Iraq.

*Table 2: (Left) In Civilization IV, to achieve glory, Iraq conquers Kuwait. (Right) In Quality of Life, to be well, Iraq makes peace and aqueducts.*

In terms of population, territory, wonders and technology, Saddam Hussein starts in 4th place, meaning that 75% of the 16 nations in the Middle East have a starting score lower than Saddam Hussein (Figure 4 and Table 3). To prevent other nations from joining England, the United States, and Kuwait, Saddam Hussein opens borders with and donates money to neighboring Turkey, Jordan, and Saudi Arabia. England immediately stealth bombs and invades northern Iraq. Saddam Hussein sends mechanized infantry, fighters, and a gunship to defend. Iraq prevents England from conquering the city of Mosul, and air strikes the mechanized infantry in England's nearest city. Iraq leaves only one marine and an SAM infantry unit in Basra. So when Kuwait invades, their marines easily conquer Basra. Iraqi citizens are unhappy about the war, and their production of SAM infantry is far from complete. Iraq society revolts and establishes a police state. Even more effective than a jail, a police state contains most war dissenters. During the revolution, Iraq also institutes a bureaucracy to pay for the war and organizes Islam to equip and train infantry. As soon as its army is trained, Iraq retakes Basra, and rallies there. Iraq had been planning to conquer Kuwait anyway, because Iraq is land-locked by Iran, Saudi Arabia, and the tiny nation of Kuwait. Iraq's easiest opportunity to expand and gain access to the sea, where it can expand further, is through the port of Kuwait. So, once there is a lull in England's attacks, the Iraqi army invades Kuwait. In just a few turns, artillery devastates Kuwait's only city, and mechanized infantry and marines quickly conquer Kuwait. Iraq now claims what had been Kuwait's territory and the 80% of Kuwait's population that survived the invasion. Thus, Saddam Hussein's score ratchets up 10% and temporarily raises its rank to 3rd place. After the fight, Iraqi citizens become restless and the coffers empty. So Baghdad builds a theater, construction begins on a bank, and Iraq stops forcing communism upon its culture. After a while, a United States destroyer bombards Iraq-owned port of Kuwait. Iraq has no navy and so cannot retaliate or stop the bombardments. Its infantry is sent to stand and die in Kuwait just to prevent the United States from conquering Kuwait. Work begins on a destroyer, but Kuwait is weak and production is slow. As a desperate measure to build a navy, Iraqi vassals overthrow the bureaucracy. The situation is fairly bleak, but at least Iraq still controls its homeland. Overall, in terms population, territory, wonders and technology, Saddam Hussein maintains 4th place (0% profit in Figure 4 and Table 3). Granted that Iraq's future is uncertain, this is currently better than making peace with Kuwait (+6% opportunity profit in Table 3).

So far we have recounted the fiction as an imperial historian, explaining the rise and fall of Saddam Hussein's regime. Let us reexamine this war through the eyes of an ethicist, explaining the rise and fall of the people who live there. In terms of health, happiness, creativity and culture, Iraqi citizens start the war in last place, meaning that 0% of the 16 nations in the Middle East have a starting score lower than Iraq (Figure 4 and Table 3). Iraqi citizens hate the war, and what little free time there is seeded with state communism. With few hospitals and little sanitation, its people are sick and its streets are polluted. In the Middle East, Iraq is the worst place to live. During the armament to conquer Kuwait, police suppress dissidents which means that only the war supporters speak out. So, paradoxically, because Saddam Hussein outlawed unhappiness, people tolerate the war. Once Kuwait is controlled, Hussein relaxes his stranglehold on the culture, and so citizens express themselves and create masterpieces of art. In terms of health, happiness, creativity and culture, Iraq advances from last place to 15th place: not a place most people would choose to live in (-75% opportunity profit in Figure 4 and Table 3).

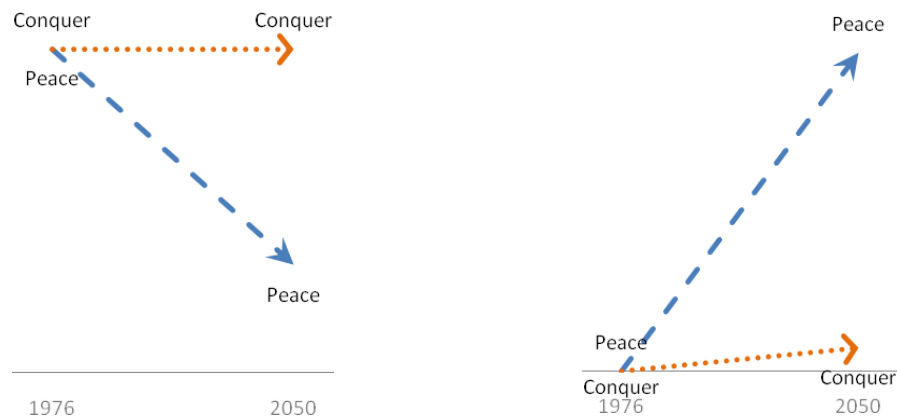


Figure 8: (Left) In Civilization IV, Hussein maintains 4th rank by conquering Kuwait. (Right) In Quality of Life, Iraq advances to 3rd rank by a peace treaty with Kuwait.

	Population, territory, wonders and technology	Health, happiness, creativity and culture	Opportunity for Quality of Life
At beginning of war	75%	0%	(-75%)
Conquer Kuwait	75%	6%	(-69%)
Treaty with Kuwait	69%	81%	+12%
Opportunity for peace	-6%	75%	+81%
Maximum rank gain	0%	81%	+81%

Table 3: In Civilization IV, Hussein maintains 4th rank by conquering Kuwait. In Quality of Life, Iraq climbs to 3rd rank after a treaty with Kuwait. (Percentile: % of 16 nations < Iraq)

Starting from the same situation, the Iraq War by User (Figure 1), let us play again, rewriting the fiction with the aim to maximize health, happiness, culture and creativity. As noted, Iraq starts as the worst place to live, because citizens are weary from being cogs in the war machine. They are unhappy, they have no joy, no creative outlets. Since most of the society fight or train and equip soldiers, they do not have doctors for the sick. This humanitarian Hussein immediately revolts, democratizes its society, welcomes all religions, and subsidizes environmental projects. Regardless of skepticism that we may have about accuracy and feasibility, by the rules of Civilization IV, subsidizing environmentalism (+6 health) increases health more than as building an aqueduct (+2 health) and a hospital (+3 health) in every city. Therefore, to challenge a player, I modified the Iraq War scenario to start Iraq off without Medicine, so that Iraq may not leap twelve ranks in the first few turns.

To start, Hussein immediately downsizes each city's military, and builds mosques and theaters, which (again, by the rules of *Civilization IV*) people enjoy. Most cities follow up with aqueducts and hospitals which improve health. Hussein stops seeding society with state communism and instead its technologists focus on a happy and healthy future. Also, all cities farm less and avoid population growth. Despite its overnight liberation from within, England continues to bomb Iraq. Hussein defends its cities in the north, judiciously bribes Turkey, Jordan, and Saudi Arabia not to join England, the United States and Kuwait. Hussein opens trades with all. Since Kuwait, England, and the United States refuse to even talk, Hussein is left with no direct way to diffuse its war. Instead, Hussein silently suffers attacks and trains a corporation of workers to clean up after each bombing. Meanwhile Iraqi priests and artists create masterpieces of art. Since Hussein cannot initiate a peace treaty, it is fortunate that England eventually initiates a treaty. Kuwait follows suit. The United States is unseen and its nearest outpost is on another continent. Hussein frequently bribes neighbors to patch up poor relations. All is rosy. Iraqi people have risen from last in health, happiness, creativity and culture, to 3rd place (a profit of +80 percentiles). However, just when most people in the Middle East would prefer to live in Iraq, the United States invades. On the eve of the invasion, Saudi Arabia suddenly declares war and sends a token infantry of support alongside the United States mechanized infantry and gunships. The US conquer Basra. At this point, perhaps the US will back down and be happy with a small cut of Iraq, but with Saudi Arabia, they might conquer all of Iraq. Overnight, Iraq is forced to stop creating art and stop stimulating its economy, in order to defend its shrinking borders. Yet, compared to conquering Kuwait, peaceful Iraq profits +75% percentiles (Figure 8 and Table 3), rising from 16th to 3rd most livable nation.

Looking at this rosy scenario through the imperial lens, Iraq has shrunken slightly. Its neighbors are having a baby boom, and Iraq is not, so its population is stable. The United States has carved out a city, which has diminished its territory. Compared to conquering Kuwait, Saddam Hussein profits -6% (percentiles), dropping from 4th to 5th most glorious nation (Figure 8 and Table 3).

Now that we have been informed of two alternate futures for Iraq, let us compare them by the consistent framework for scoring in *Civilization IV*: one player will win by having the highest score. So while scoring scales may vary, and trends in score may not agree, we compare percentile gains in relative ranking. In Table 3, in order to understand maximum profit, suppose the player of Saddam Hussein finishes his game, and then gets to choose which scoring system he wants to rated by. If Iraq has already conquered Kuwait, Saddam Hussein's best outcome is to select *Civilization IV* scoring and remain in 4th place (+0% percentiles in Figure 8 and Table 3). Whereas, if Hussein signed a peace treaty, then Hussein's best outcome is to select *Quality of Life* scoring to reach 3rd place (+81% percentiles in Figure 8 and Table 3). If Hussein knows these options, and if the future is equally unclear, then a rational Hussein would prefer peace and a humanitarian yardstick of success. Regardless of this meta-game analysis, the toy Iraqi citizens clearly benefit most from peace.

Instead of playing to dominate, Hussein may attempt to maximize the citizen welfare. Compared to unmodified *Civilization IV*, scoring quality of life can reward humanitarian strategies. This modification of *Civilization IV* has not altered the strategies of the artificially intelligent players. All players are scored by their own citizen's quality of life. The computer-controlled emperors remain aggressive and expansionist, even though that may lower their score. Therefore, ranking might not improve by behaving humanely. It may be the case that one needs to run to stand still, as seen when all players are trying to maximize glory, and Iraq maintains 4th place. However, it is clear that if Hussein values citizen health, happiness, creativity and culture, then the toy Iraqi people will be happier and healthier.

Originally, *Civilization IV* incentivizes rapid growth through scoring population and territory, and rapid progress through scoring wonders and technology. Populating the moral values can reveal which historical events such moral values incentivize. Here is a summary of my observations. *Civilization IV*:

*Quality of Life*, most strikingly, incentivizes minimal growth. Each new city expands population and productivity. But a new city starts without the infrastructure for health and entertainment: without aqueducts, temples, theaters, libraries, and so on. Therefore, a new city has a lower quality of life, which lowers the empire's average. Because territory is no longer a component of the score, the player's score is not penalized for having a small footprint. Within a city, the option to "avoid growth" becomes attractive, as large population necessarily increases unhappiness and sickness. Growing and producing become enabling objectives of citizen well-being. The empire is less interested in conquering other territories, as the conquered territories may have lower standards of living. Any technology or civic that improves health is also rewarded. The greatest is environmentalism, which adds 6 points to every city's health. Incidentally, John Broome's primary example for improving quality of life is also the environment (2004).

## FUTURE RESEARCH

Could *Civilization IV* be used as a playground to illustrate themes in computational ethics? The videogame *Civilization III* has been used as a playground to illustrate themes in ancient and classical history (Squire 2002, 2004). The student replays the role of an emperor and reflects upon the expansion and diminution of his dominion. The student witnesses that sanitary aqueducts boost productivity, and that research and development hasten conquest. By analyzing the production system of *Civilization III*, some students conjecture about the dynamics that underlie the major events in empires, and thereby grasp that environmental forces and human decisions determine history (Welchel 2007, Hashim, Koh 2009).

By analyzing the scoring system of *Civilization IV*, a player can conjecture about a few consequences of moral values. There are many moral values to explore. Karl Marx objected to Bentham applying the values of an English shopkeeper to diverse cultures. More recently, Kapell objected to Sid Meier applying the values of an American entrepreneur to international gamers (qtd Welch 2007). Players are encouraged to edit the parameters to explore their own moral values, and then observe the strategies that their values incentivize. Therefore, instead of Table 2, in "CvGameUtils.py," a player may calibrate their own "moral\_values."

Advanced players are encouraged to modify and explore alternative social welfare functions. For example, scoring the average could incentivize a few miserable people (Rawls 1970). Average utilitarianism has been criticized for imagined risk (Arrhenius 2000) and for an imagined sum (Parfit 1989). The extreme response is egalitarian: score the worst off. Consequently, a rational player disregards suffering for those above the minimum. For example, recall Iraq's dilemma: let Mosul die or defend Mosul. Since some people will die, the both minimums are equal (Listing 15).

```
>>> minimum_quality(let_mosul_die)
0
>>> minimum_quality(defend_mosul)
0
```

*Listing 15: In Python, even though more die in Mosul, an egalitarian is indifferent.*

John Rawls had anticipated this, and suggested breaking ties between outcomes by scoring the second worst off (1970). Because it sorts outcomes similar to a dictionary sorting words, the words "lexical minimum" are combined into "leximin" (Listing 16).

```
>>> leximin_quality(let_mosul_die, defend_mosul)
0
>>> leximin_quality(defend_mosul, let_mosul_die)
29
```

*Listing 16: In Python, John Rawls' leximin rewards saving lives in Mosul.*

Yet, a leximin could incentivize misery of most people. So computational ethics, more functions have been explored, such as multiplying welfare (Endriss 2010). Each social welfare function implies a set of values for risk and reward. To explore population ethics, could a player score with their own values and play with the consequences?

Balancing the social welfare function is coupled to the rest of the game's economy, tactics, and other dynamics (Johnson 2008). At Games for Change and Mediateca Expandida Arcadia, this mod has been exhibited to a series of single players. So far, the moral values in this mod have been balanced for a single player competing against the computer. The social welfare function could be refined by session reports from multiple players who compete for the most livable nation.

## CONCLUSION

A utilitarian metric of medical ethics, the quality-adjusted life year, has been extended to score the strategy game, *Civilization IV*. When naïvely scoring total or average welfare, Derek Parfit and John Broome foresaw exploits to reward misery and sacrifice. So fatalities are scored, too. Examples demonstrate social welfare functions, and their consequences in a utilitarian game. The player of Saddam Hussein can win *Civilization IV: Quality of Life* with a peaceful nation, prolific artists, hospitals, and a clean environment. Yet as in *Ayiti: The Cost of Life*, the player of Hussein may find enriching lives less exciting than sacking cities.

Moreover, ethical calculus is hubris. Life is too complicated and the interaction of preferences is intractable. Ethicists and laymen alike have conflicting interests. In the 20th Century, some claims of a better life for citizens have premised atrocity. With humility and skepticism, I hope playing with a toy function sharpens a player's reasoning about the public calculations that weigh our lives.

## ACKNOWLEDGMENTS

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## ADDITIONAL READING SECTION

Please see the References section. Any referenced book or article title that matches your area of interest is recommended as additional reading.

In order to script *Civilization IV* yourself, there is no thorough documentation, yet the following were helpful:

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