miles2km: The worst ways to convert from miles to km

Lucien Rae*

***Abstract*—Addressing a naïve gap in the literature, we present a multitude of modern approaches to the *miles2km* problem for state-of-the-art conversion from miles to kilometres.**

1 Introduction

The *kilometre* (or *kilometer*[1]) is a measurement of distance equal to 1000 metres [1].

The *mile* is also a measurement of distance, but is instead equal to 5280 feet, 63360 inches, 1760 yards, or 1609.344 metres [2]. This is obviously a whole lot sillier, yet, at least for now, many people are stuck dealing with it [3, 4, 5].

As a link between the rogue imperialism of the mile and the modern charm of the kilometre, conversion from miles to km is a highly common and useful computational task. However, a baffling gap in the literature[2] suggests our only method of doing so is by a naïve method: simply multiplying the number of miles by 1.609344.

In this paper we explore some alternative methods to converting miles to km, leveraging modern techniques such as recurrence relations, geolocation, and advanced data collection to finally take this common conversion into the 21st century.

We summarise the takeaways of each method with the following semi-qualitative metrics:

- **Does it work?** Does this method actually convert a number of miles to the correct number of kilometres?
- **Is it efficient?** Computationally or otherwise, what kind of time/resources are we enjoying here?
- **Hot or not?** Is it interesting? Is it fun? Is it sexy? Emotionally, this is the most important.

2 Standard (naïve) method

Multiply by 1.6093444. Formally:

$$f(m) = 1.609344 \times m$$

Where $f(m)$ returns the number of km for some m number of miles.

2.1 Critique

Does it work? Sure.

Is it efficient? If you're doing it by hand, no. If you're doing it by computer, yes, but don't feel bad about that because numbers are what computers are for [6].

Hot or not? Absolutely *not*. Not interesting, not fun, and certainly not sexy. We can do better.

3 Fibonacci method

The Fibonacci sequence is a sequence of numbers that looks like this:

$$0, 1, 1, 2, 3, 5, 8, 13, 21, 34, 55, 89, \ldots$$

Each term, called a Fibonacci number, is the previous two terms added together[3] [7]. While in most cases this is kinda just fun [8], we pan for gold. Observe the terms:

$$\ldots, 3, 5, 8, 13, 21, \ldots$$

The successor of 3 is 5. Miraculously, 3 miles are *almost*[4] 5 km. 5 miles are also *almost* 8 km, 8 miles are *almost* 13 km, and in fact 13 miles are *almost* 21 km! That's 3, 5, 8, 13, 21, just like the Fibonacci sequence! Breaking the upper-limit of three coincidences, we must be onto something.

F_n miles	Desired km	F_{n+1}
3	4.83	5
5	8.05	8
8	12.87	13
13	20.92	21
21	33.79	34

Figure 1: Some Fibonacci numbers F_n as miles, their desired conversion to km (to two decimal places), and the Fibonacci successor F_{n+1}.

*lucienrae.com/contact.

[1] In this paper the abbreviation *km* is sporadically used to graciously avoid alienating American English-speaking readers.

[2] How do you cite a lack of citations?

[3] Besides the first two, which are 0 and 1 just because they're good at getting the party started.

[4] 3 miles = 4.828032 km ≈ 5 km.

Using this we form an elegant method: "for a number of miles F_n return the next Fibonacci number F_{n+1} as the number of km."

As exampled in Figure 1, this works very well for miles that are Fibonacci numbers. However, what about the edge-case of a number of miles that don't happen to be Fibonacci numbers? We can account for this easily with the following modified method: "for any given number of miles m look for the nearest Fibonacci number $F_n \geq m$ and return the next Fibonacci number F_{n+1} minus the difference between m and F_n as the number of km." Formally we can re-arrange this as:

$$f(m) = m + F_{n+1} - F_n \tag{1}$$

Where F_n is the smallest nth Fibonacci number $\geq m$.

However, as m increases, and so do the gaps between Fibonacci numbers [7], we sustain an error scaling with the ratio between F_n and its successor. Adjusting by this ratio eliminates our error with an elegant simplification:

$$f(m) = \frac{mF_{n+1}}{F_n} \tag{2}$$

As seen in Figure 2, this provides us with a consistently (incredibly!) close approximation to the desired conversion. How? Read on...

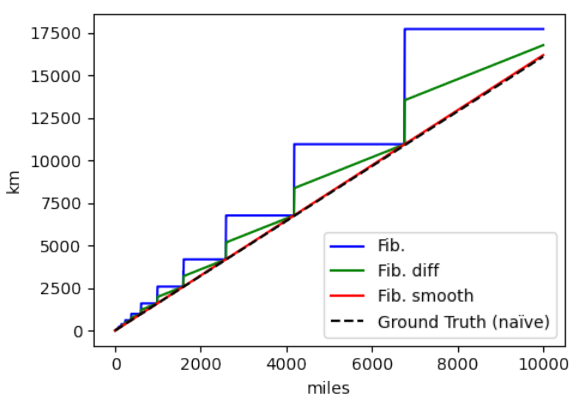

Figure 2: Results of our Fibonacci-based methods converting miles to km, produced by the implementations in Section 3.1 and 3.2, compared to the desired value.

3.1 Iterative implementation

To use our function, we need to work out the Fibonacci number $F_n \geq m$ and its successor F_{n+1}. An iterative (using iterations) implementation is simple: "calculate each term of the Fibonacci sequence until no longer below m." We can trivially decide[5] that this search has some log_ϕ-ish computational complexity against the input due to the exponential gaps between Fibonacci numbers [7]. A Python implementation is presented in Figure 3.

[5]Simply deciding (rather than proving) computational complexity is $O(n)$, where n is how much you care about being correct.

```
def miles2km(m):
    # Converts 'm' miles approximately to km
    a, b = 0, 1
    while a < m:
        a, b = b, a+b
    return (m*b)/a
```

Figure 3: A Python implementation of the iterative smooth Fibonacci method (Equation 2) for converting m miles to km.

3.2 Closed-form solution

While converting 5.47×10^{23} miles (the approximate width of the observable universe [9]) to kilometres using the iterative method takes my 2-year-old laptop a fairly sufficient 7.04×10^{-5} seconds, it would be unrigorous to ignore a hellish future in which we are both (a) calculating distances significantly larger than the width of the known universe and (b) using the mile to do so. To play things safe, we can utilise powerful closed-form Fibonacci expressions to truly optimise our operation.

Where $\phi = \frac{1+\sqrt{5}}{2}$ (the golden ratio) and its conjugate $\psi = 1 - \phi = -\frac{1}{\phi}$, we can compute the nth Fibonacci number with the following expression [10]:

$$F_n = \frac{\phi^n - \psi^n}{\phi - \psi}$$

We can also invert the floored truncation expression $F_n = \left\lfloor \frac{\phi^n}{\sqrt{5}} + \frac{1}{2} \right\rfloor$ [10] to get the index n of the nearest F_n not less than some number m:

$$n(m) = \left\lceil log_\phi \left(m \cdot \sqrt{5} - \frac{1}{2} \right) \right\rceil$$

Alright let's do some maths:

$$\begin{aligned}
f(m) &= \frac{mF_{n+1}}{F_n} \\
&= \frac{mF_{\lceil log_\phi (m\cdot\sqrt{5}-\frac{1}{2}) \rceil + 1}}{F_{\lceil log_\phi (m\cdot\sqrt{5}-\frac{1}{2}) \rceil}} \\
&= \frac{m\frac{\phi^{\lceil log_\phi (m\cdot\sqrt{5}-\frac{1}{2}) \rceil + 1} - \psi^{\lceil log_\phi (m\cdot\sqrt{5}-\frac{1}{2}) \rceil + 1}}{\phi-\psi}}{\frac{\phi^{\lceil log_\phi (m\cdot\sqrt{5}-\frac{1}{2}) \rceil} - \psi^{\lceil log_\phi (m\cdot\sqrt{5}-\frac{1}{2}) \rceil}}{\phi-\psi}} \\
&= \frac{m\phi^{\lceil log_\phi (m\cdot\sqrt{5}-\frac{1}{2}) \rceil + 1} - \psi^{\lceil log_\phi (m\cdot\sqrt{5}-\frac{1}{2}) \rceil + 1}}{\phi^{\lceil log_\phi (m\cdot\sqrt{5}-\frac{1}{2}) \rceil} - \psi^{\lceil log_\phi (m\cdot\sqrt{5}-\frac{1}{2}) \rceil}} \\
&= \frac{m\phi^{\lceil log_\phi (m\cdot\sqrt{5}-\frac{1}{2}) \rceil + 1} - (-\phi)^{-(\lceil log_\phi (m\cdot\sqrt{5}-\frac{1}{2}) \rceil + 1)}}{\phi^{\lceil log_\phi (m\cdot\sqrt{5}-\frac{1}{2}) \rceil} - (-\phi)^{-\lceil log_\phi (m\cdot\sqrt{5}-\frac{1}{2}) \rceil}} \\
&= \frac{m\phi\left(\phi^{\lceil log_\phi (m\cdot\sqrt{5}-\frac{1}{2}) \rceil} - (-\phi)^{-\lceil log_\phi (m\cdot\sqrt{5}-\frac{1}{2}) \rceil}\right)}{\phi^{\lceil log_\phi (m\cdot\sqrt{5}-\frac{1}{2}) \rceil} - (-\phi)^{-\lceil log_\phi (m\cdot\sqrt{5}-\frac{1}{2}) \rceil}} \\
&= m\phi \quad = \frac{m(1+\sqrt{5})}{2} \quad \text{(Hark!)}
\end{aligned}$$

Although the golden ratio is a falsely attributed solution to many things [8], we finally find a useful real-world application! As you may have suspected, because you're so intelligent, the reason that this Fibonacci method works at all is because the golden ratio $\phi = \frac{1+\sqrt{5}}{2} \approx 1.618034$ just happens to be incredibly close to the factor between km and miles (1.609344).

3.3 Critique

Does it work? Incredibly, *almost*. With the *smooth* method (Equation 2) we're only off by $\sim 0.5\%$, but even with the personally cuter *diff* method (Equation 1), our accuracy still holds up to SOTA performance[6]. Imagine asking your friend off the top of their head to convert some miles to km and them having performance like that seen in Figure 2.

There's also an argument that this actually works *better* than the standard method (multiplying by 1.609344) because you naturally get fractional results! Observe:

$$3712 \text{ miles} = 5973.884928 \text{ km} \qquad \text{(yuck!)}$$

vs.

$$3712 \text{ miles} \approx \frac{25111680}{4181} \text{ km} \qquad \text{(beautiful!)}$$

Is it efficient A lot better than you might first think! We can vibe the iterative method out to have some sort of O($log_\phi n$)-ish complexity, thanks to the exponential distribution of Fibonacci numbers, which is already very good. So we were really spoilt to reach an even better constant O(1) closed-form solution (see Section 3.2).

Hot or not? Elegant, fun, mysterious, *bon appétit*.

While the standard/naïve method will always be (aesthetically) weighed down by the unappetising appearance of the 1.609344 constant, our Fibonacci method either (a) uses a less arbitrary-looking constant by using the closed-form solution to the golden ratio, or (b) truly appeases the computer, as seen in Figure 3, by using only 0s and 1s as literals. For both human and computer, this is hot stuff.

The real seduction of this method comes in its elusiveness. If you were to present someone with the code of Figure 3 without the function name and comment, they would have no intuition on its purpose to convert miles to km. Although it all relies on a huge coincidence, perhaps everything/nothing does [11], and this mystery does a lot for computational sex-appeal [12].

[6]Where SOTA is the guesswork of Some-Other-Tertiary-Alumni, or alternatively Some-Obviously-Terrible-Algorithm.

4 Wait, do you mean land miles or nautical miles?

Uh oh. So a *nautical mile* is a unit of length used for (you guessed it) nautical activities [13] that is for some reason *different* than a normal mile.

While the mile we've previously discussed is equal to 1,609.344 metres, the *nautical* mile is slightly (about $\times 1.151$) longer, formally equal to 1,852 metres as historically derived from the meridian arc length of a latitude minute (of course) [14].

Despite the fact that using a slightly different mile for the water is *insane*, the nautical mile is officially used internationally for marine navigation and the definition of territorial waters [15], and its derived speed unit the *knot* (one nautical mile per hour) is very common in sailing for measuring boat speed as well as meteorology for measuring wind speed [16].

So to convert from miles to km *accurately*, we need to know if we're converting from standard miles or nautical miles. The solution is actually very simple: "Before converting from miles to km, use geolocation to find the user's current coordinates, compare this to a basemap projection of the world, calculate whether this point is or is not at sea, and then use this information to return the correct conversion." A simplified implementation is presented in Figure 4.

```python
def miles2km(m):
  lng, lat = get_geolocation_coordinates()
  is_at_sea = not basemap.is_land(lng, lat)
  if is_at_sea:
      return m * 1.852 # Nautical miles
  else:
      return m * 1.609344 # Land miles
```

Figure 4: A Python program that uses geolocation to convert to kilometres from either miles or nautical miles, depending on whether or not you're at sea.[7]

4.1 Critique

Does it work? Given our previous methods don't even take nautical miles into account, this is a big improvement.

Is it efficient? Unfortunately requesting geolocation and constructing/calculating from a global basemap with accuracy is, in a relative sense, very slow. But sometimes that's the cost of rigour.

Hot or not? If you're into boats and using silly measurements for what you do on those boats, then maybe!

[7]Note that this "implementation" majorly abbreviates (a) the requesting of geolocation coordinates, (b) the procurement of a land/sea basemap, and (c) the way in which we could be calculating these results with the Fibonacci method (see Section 3) and multiplying "nautical km" by 1.151.

5 There are actually a lot of different types of miles.

Ugh. If you sensed that the previous section was holding back some information, it was, but you're not going to like it. It turns out almost everyone throughout history has wanted to call their common distance measurement some sort of "mile", and they're all different in their own special, terrible, descent-into-madness way.

Firstly there are many *technical miles.* As already covered a *nautical mile* is a bit longer than a *statute mile*, but there's also a *geographical mile* just slightly longer than that, and a *data mile* just slightly less, and a *U.S. survey mile* in-between (but certainly not equal to) a statute and nautical mile. What are their exact values? It depends! But before going down that rabbit hole it's important to note the even larger rabbit hole of regional and historical miles. For example, one cannot confuse a *statute mile* with a *Scandinavian mile* that measures up a full 621.371% larger! The Scandinavian mile currently sits at a clean 10 km, though historically it was also 10.688 km in pre-1889 Sweden and 11.295 km in pre-1875 Norway, which one must take into account for historical conversions. But, it gets worse; the *Chinese mile* is either 0.405, 0.358, 0.416, 0.4158, 0.323, 0.537, 0.645, 0.545, or 0.5 km depending on which dynasty or party was in power at the time, and the *Roman* mile depends on either how well-fed your legionaries are (varying the distance between planted mile-stones) or (after the "standardisation" of 29 BCE) the exact measurement of former Roman consul Marcus Vipsanius Agrippa's feet. And don't confuse the Roman mile for the *Italian* mile, which is actually not equal at all to a statute mile but instead a geographical mile! Wait, has the statute mile always been the same? Of course not.

To fully tick the "accuracy" box we cannot make any assumptions, adopting the following method: "Before submitting a number of miles m the user must fill out a questionnaire Q to ascertain exactly what type of mile they're converting from."

5.1 Data

Summarising a Kafkaesque horror of research into a very, very brief summary, we use the following information on some of the various important measurements that poeple have called "miles" throughout disciplines, regions, time periods, and beliefs.

5.1.1 Biblical mile (mīl)

Used primarily by Herodian Jews to ascertain distances between cities and to mark the Sabbath limit, equal to 2000 cubits.

Length: Depending on divergent definitions of the length of a cubit: **0.96 km** according to major posek Avraham Chaim Naeh, **1.152 km** according to rabbi Chazon-Ish, **1.058 km** based on the Egyptian cubit Derā.

5.1.2 Roman mile (mille passus, mille)

Used in Ancient Rome for travel, and later, urban planning, equal to 1000 paces.

Length: 1.48-1.52 km pre-29 BCE, depending on weather and rations, **1.479 km** post-29 BCE based on Agrippa's foot.

5.1.3 Chinese mile (lǐ)

Used through mainland China's history as a traditional unit of measurement, referred to internationally as the Chinese mile, equal (variably) to 1,500 chi.

Length: Depending on changing lengths of the *chi* and *chi*-per-*lǐ*: **0.405 km** during the Xia dynasty (2100-1600 BCE), **0.358 km** during the Western Zhou dynasty (1045-771 BCE), **0.416 km** during the Eastern Zhou dynasty (770–250 BCE), **0.4158 km** during the Qin (221–206 BCE) and Han (205 BCE–220 CE) dynasties , **0.323 km** during the Tang dynasty (618–907), **0.537-0.645 km** during the Qing dynasty (1644–1911), **0.5-0.545 km** during the Republic of China (1911–1984), **0.5 km** in the People's Republic of China (1984–present).

5.1.4 Scandinavian mile (mil)

Used in most of Scandinavian history, and still in Norway and Sweden in everyday speech, tax-deductible work-related travelling distances, and fuel consumption, especially on second-hand cars. Historically based off 36,000 Norwegian/Swedish feet.

Length: 11.295 km in pre-1875 Norway, **10.688 km** in pre-1889 Sweden, now **10 km**.

5.1.5 Arabic mile (al-mīl)

Used by Middle-ages Islamic cartographers, based approximately on one arcminute of latitude.

Length: 1.995 km by al-Farghani's method, **1.925 km** by al-Ma'mun's method, **2.285 km** during the Umayyad period (661-750 CE).

5.1.6 Danish mile (mil)

Used in Denmark before converting to the metric system, originally equal to 17,600, then 24,000 Rhineland feet.

Length: 11.13 km pre-1698, **c. 7.5 km** from 1698 to 1835, **7.5325 km** from 1835 to 1907.

5.1.7 Forest mile (skogsmil)

Used historically in Scandanavian colloquialisms, based on a "rast" (distance between rests).

Length: c. 5 km.

5.1.8 Finnish mile (peninkulma)

Used in Finland, based roughly on the modern Scandinavian mile of 36,000 Norweigen/Swedish feet.

Length: 10.688 km pre-1887, **10 km** after 1887.

5.1.9 Welsh mile

Used in Wales up until its abolishment under Edward I's conquest c. 1200. Defined by 9000 Welsh paces (each 3 troedfedd).

Length: 6.17 km.

5.1.10 Scots mile

Used in Scotland up until the late 18th century following three legal abolishments in 1685 in the Parliament of Scotland, 1707 by the Treaty of Union with England, and the Weights and Measures Act 1824. Defined by 8 Scots furlongs (each 320 falls).

Length: 1.81 km

5.1.11 Irish mile (míle, míle Gaelach)

Used in Ireland from the 17th century to 19th century (the Weights and Measures Act 1824), with residual usage in the 20th century. Defined by 8 Irish furlongs or 320 Irish perches.

Length: 2.048 km.

5.1.12 Dutch mile (mijl)

Used in pre-19th century Netherlands equal to 5,600 ells (armpit-to-finger length).

Length: 3.28-4.28 km.

5.1.13 Geographical Dutch mile

Used in pre-19th century Netherlands as a geographical measure equal to one fifteenth of an equator longitude.

Length: 7.157 km.

5.1.14 Saxon post mile (kursächsische postmeile)

Used in pre-17th century Saxony as the standard distance between mile-posts or mile-stones, equal to 2000 Resden rods.

Length: 9.062 km.

5.1.15 German mile (meile)

Used throughout Germanic regions up until 1872, equal to 24,000 German feet.

Length: 7.5325 km in Northern (Prussian) Germany, **7.586 km** in Southern (Austrian) Germany, **7.4127 km** at sea.

5.1.16 Breslau mile

Used in Breslau, and from 1630 all of Silesia (now Poland, Czechia) up until 1872, equal to 11,250 ells (the distance from Piaskow Gate to Psie Pole).

Length: 12.85875 km.

5.1.17 Hungarian mile (mérföld)

Used in Hungary up until 1874, equal to 24000 láb.

Length: 7.585944 km.

5.1.18 Portuguese mile (milha)

Used colloquially in Portuguese-speaking countries up until 1861 with debated origin.

Length: 2.0873 km.

5.1.19 Russian mile (mílja)

Used in Russia up until 1925, equal to 7 versts.

Length: 7.4676 km.

5.1.20 Croatian mile (hrvatska milja)

Used in Croatia between 1673 and 1871, defined by an arc of the equator subtended by 1/10°.

Length: 11.13 km.

5.1.21 Ottomon/Turkish mile

Used in the Ottoman Empire (1299–1923) and early modern Turkey up until 1933, equal to 5000 Ottoman feet (ayak or kadem).

Length: 1.89435 km pre-1923 (dissolution of the Ottoman Empire), **1.853181 km** in 1923-1933 early Turkey.

5.1.22 Old English mile

Used in medieval and early modern England, also sometimes referenced (speculatively) as the idiomatic "country mile"

Length: c. 2.1 km in Medieval England, **1.524 km** by the Customs of London in Early modern England (c. 1400-1500), based on a variable 5000 feet.

5.1.23 Metric mile

Used primarily in US track and field athletics colloquialisms to describe a middle-distance running or speed skating length.

Length: 1.5 km in reference to the premier Olympics middle-distance run, **1.6 km** in US high-school competition.

5.1.24 Nautical mile

Used primarily by the US and UK for marine and air navigation, the definition of territorial waters, and for the derived speed unit the knot (one nautical mile per hour) used most frequently in sailing and meteorology. First used in 1594 based on one minute (one sixtieth degree) of latitude.

Length: 1.853 km by Hues/Gunter calculation at the equator, **1.861 km** by Hues/Gunter calculation at the poles, **1.853249 km** in post-1866 US, **1.853184 km** as the Admiralty mile in post-1866 UK, **1.85185 km** in the post-1906 French navy, **1.853 km** in the UK for pre-1970 historical reference to the Admiralty nautical mile, **1.852 km** as the international nautical mile (US in 1954, Britain in 1970).

5.1.25 Data mile

Used in radar-related subjects and joint tactical information distribution systems equal to 6000 feet or the distance for a 12 μs radar send/return through a vacuum.

Length: 1.8288 km.

5.1.26 US survey mile

Used by the US national geodetic survey from 1893 to 2022, equal to 5280 US survey feet.

Length: 1.609347 km.

5.1.27 Geographical mile

Used in Europe and later internationally for geographical measurements. Defined as one arcminute along the equator with accuracy that depends on models of ellipsoid Earth.

Length: 1.852 km from the Middle Ages, then also known as the Italian mile, **1.8554 km** by the 1924 International ellipsoid, **1.855342 km** by the 1984 WGS-84 ellipsoid, **1.8553247 km** by the IERS 2010 ellipsoid.

5.1.28 Statue/International mile

The term for the now-international "standard" mile. Used officially in the imperial system of the US, Liberia, and Myanmar, as well as in certain contexts in some other countries, such as the UK for distances and motor vehicle speeds, and Canada for historical rail transport and horse racing. Historically equal to 8 furlongs or 1760 yards or 5280 feet, though officially standardised in reference to the metric system as 1,609.344 m.

Length: c. 1.6 km in 1593 Elizabethian-era England, **1.609344 km** by the 1959 international yard and pound agreement.

5.2 Reflection

Wow... That's a lot of miles.

5.3 Questionnaire

It's during implementation that we find no coincidence in the similarity between the words "exhaustive" and "exhausting."

We leave a somewhat open problem for the "optimal" questionnaire[8] for ascertaining which type of miles one is wanting to convert from, but here we propose a workable example:

Question 1: What is the number of miles you want to convert to km?

Question 2: With which of the following are you *currently* most affiliated?

(a) Herodian-dynasty Jews
(b) China (Ancient or Modern)
(c) The Roman Republic or Empire
(d) Scandanavia
(e) The Islamic Empire
(f) The British Isles
(g) The Dutch Empire
(h) Saxon/Prussian/Austrian States
(i) Silesia
(j) The Kingdom of Hungary
(k) The Portuguese Empire
(l) The Soviet Union
(m) The Balkan States
(n) The Ottomon Empire
(o) The United States of America
(p) The Ocean
(q) None of the above

Question 3: Using your response to the previous question, which is currently your strongest political/social/professional affiliation?

(a) Herodian-dynasty Jews
    (i) Follower of major posek Avraham Chaim Naeh
    (ii) Follower of rabbi Chazon-Ish
    (iii) Follower of speculative archeology (utilising the Egyptian cubit Derā)

[8] Optimising ease *or* fun.

(b) China (Ancient and Modern)

  (i) Xia Dynasty
  (ii) Western Zhou Dynasty
  (iii) Eastern Zhou Dynasty
  (iv) Qin Dynasty
  (v) Han Dynasty
  (vi) Tan Dynasty
  (vii) Qing Dynasty
  (viii) Republic of China
  (ix) People's Republic of China
  (x) Global relations

(c) The Roman Republic/Empire

  (i) Pre-Agrippa Rome
  (ii) Post-Agrippa Rome
  (iii) Greek-based Architecture
  (iv) Middle Ages to 1800s Italy

(d) Scandanavia

  (i) Pre-1875 Norway
  (ii) Pre-1889 Sweden
  (iii) Norwegian and Swedish colloquial speech, tax deduction, and fuel consumption
  (iv) Colloquial Danish
  (v) Colloquial Finnish
  (vi) Traditional forest hiking
  (vii) Reference to modern US/UK

(e) The Islamic Empire

  (i) Follower of Al Farghani
  (ii) Follower of Al Ma'mun
  (iii) Umayyad Period

(f) The British Isles

  (i) Medieval England
  (ii) Early Modern England
  (iii) Pre-Edwardian Wales
  (iv) Pre-1824 Scotland
  (v) Pre-20th Century Ireland
  (vi) 1593-1959 England
  (vii) Late 19th Century UK Navy
  (viii) Post-1959 Britain
  (ix) 21st Century legal reference to 19th Century UK Navy

(g) The Dutch Empire

  (i) Pre-1816 Netherlands
  (ii) Pre-1816 Dutch Survey Geography
  (iii) Post-1816 Netherlands

(h) Saxon/Prussian/Austrian States

  (i) Pre-1700s Travel
  (ii) Prussian Empire
  (iii) Austrian Empire
  (iv) At sea
  (v) Post-1870 Germany

(i) Silesia

  (i) Pre-1872 Poland/Czechia
  (ii) Post-1872 Modern Silesian States

(j) The Kingdom of Hungary

  (i) Pre-1874 Hungary
  (ii) Post-1874 Hungary

(k) The Portuguese Empire

  (i) Pre-1861 Portuguese Empire
  (ii) Post-1861 Portuguese Empire

(l) The Soviet Union

  (i) Pre-1925 Russia
  (ii) USSR and post-Soviet Russia

(m) The Balkan States

  (i) Pre-1871 Croatia
  (ii) Post-1871 Croatia

(n) The Ottomon Empire

  (i) Pre-1923 Ottomon Empire
  (ii) 1923-1933 Early Turkey
  (iii) Post-1933 Modern Turkey

(o) The United States of America

  (i) Late 19th Century US Navy
  (ii) US high-school athletics
  (iii) Pre-2022 geodetic survey
  (iv) Post-revolutionary America

(p) The ocean

  (i) Pre-19th Century nearest to equator
  (ii) Pre-19th Century nearest to north or south pole
  (iii) Late 19th Century communication with US Navy

(iv) Late 19th Century communication with UK Navy

(v) Early 20th Century communication with French Navy

(vi) 21st Century legal reference to 19th Century UK Navy

(vii) International nautical activity

(q) None of the above

(i) Olympics middle-distance running

(ii) Radar-related data communication methods

(iii) 1924-1984 Earth ellipsoid approximation

(iv) 1984-2010 Earth ellipsoid approximation

(v) Post-2010 Earth ellipsoid approximation

(vi) General use

Result: Where m is your response to Question 1 and α is the value in the row corresponding to your response to Questions 2 and 3, let your result be $m \times \alpha$ km.

Some values α are presented as a range, where you can randomly select a value in that range for a non-zero chance to get the exact result.

Q2	Q3	α
a	i	0.96
a	ii	1.152
a	iii	1.058
b	i	0.405
b	ii	0.358
b	iii	0.416
b	iv	0.4158
b	v	0.4158
b	vi	0.323
b	vii	0.536-0.645
b	viii	0.5-0.545
b	ix	0.5
b	x	1.609344
c	i	1.48-1.52
c	ii	1.479
c	iii	1.4208-1.512
c	iv	1.852
d	i	11.295
d	ii	10.688
d	iii	10
d	iv	7.5325
d	v	10
d	vi	5
d	vii	1.609344
e	i	1.995
e	ii	1.925
e	iii	2.285
f	i	2.1
f	ii	1.524
f	iii	6.17
f	iv	1.81
f	v	2.048
f	vi	1.6
f	vii	1.853184
f	viii	1.609344
f	ix	1.853
g	i	3.28-4.28
g	ii	7.157
g	iii	1.609344
h	i	9.062
h	ii	7.5325
h	iii	7.586
h	iv	7.4127
h	v	1.609344
i	i	12.85875
i	ii	1.609344
j	i	7.585944
j	ii	1.609344
k	i	2.0873
k	ii	1.609344
l	i	7.4676
l	ii	1.609344
m	i	11.13
m	ii	1.609344
n	i	1.89435
n	ii	1.853181
n	iii	1.609344
o	i	1.853249
o	ii	1.6
o	iii	1.609347
o	iv	1.609344
p	i	1.853
p	ii	1.861
p	iii	1.853249
p	iv	1.853184
p	v	1.85185
p	vi	1.853
p	vii	1.852
q	i	1.5
q	ii	1.8288
q	iii	1.8554
q	iv	1.8553248
q	v	1.8553247
q	vi	1.609344

5.4 Analysis

Out of interest—that is, an interest generated from a prolonged lack of charts—we can plot in Figure 5 the distribution of values for α.

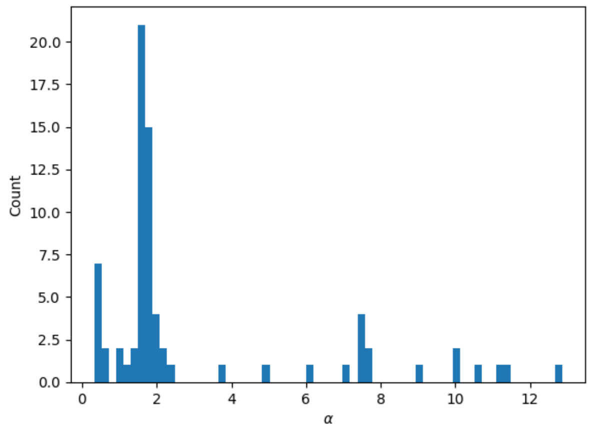

Figure 5: The distribution of values for α.

The dominant mile pile is the 1.609344 tower and the various measurements frustratingly "close" to it, but the true shock is the extent of the skyline's urban sprawl.

The smallest mile to occur, sitting all the way down at 0.323 km, is the Chinese *lǐ* mile during the Tang dynasty from around 618 to 907 B.C.E. Just imagine getting that one right in pub trivia.

The largest is the insane Breslau mile, sitting at a length of 12.85875 km, making it over $\times 7.99$ larger than the "standard" 1.609344, and a full $\times 39.81$ the smallest Tang-dynasty *lǐ*.

For those desperate for a mean and median even though they'll be pretty close to meaningless, the "average" mile here is exactly 3.078846831081081 km long, and the median is a closer-to-useful-but-in-a-way-that-only-makes-it-more-clearly-not-useful 1.840325 km.

5.5 Critique

Does it work? In some cases, this is accurate in ways never before seen. For the Tang-dynasty time-traveller, the naïve use of any of the previous methods could leave them $\times 5$ off their destination. And a similarly-confused Breslavian would get lost by $\times 7.99$. While the literature focuses on future-proofing, we have past-proofed.

Is it efficient? Even the rare combination of expertly-crafted user experience and that user's patient comprehension fails to reliably bring to a questionnaire the description of *efficient*. However seeing these faults constant, we consider the search-algorithm-ish vibe of our method as optimally $O(n \log n)$ where n is however many types of miles we decide are enough.

Hot or not? This is definitely not a universal hotness, if such a thing exists, but there is a market. If you could find yourself liking someone to the point that they say "fun fact!" or "um actually..." without your complete repulsion, this method certainly fulfils a kind of appeal for knowledgeable (even if broadly self-enjoyed) precision.

6 Conclusion

There is not much more to be said. We have taken miles and turned them to kilometres. Now, more confusingly than ever. And although we see none of this as an absolute *good*, we do find solace playing in the murky tides of disunion while full acceptance of the metric system seems miles—that is, $f(m)$ kilometres—away.

7 Future Work

Having heroically present-proofed *and* past-proofed *miles2km*, we graciously[9] leave to future work the logical conclusion of future-proofing. In a true state-of-the-art mindset, this should probably include machine learning, utilising the beautifully noisy history of past miles to predict the world's *future* miles. We leave this as an exercise to the reader. Or, if this crucial work is somehow not done, a sequel paper that you may eagerly await.

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