

MATH299M/CMSC389W

Spring 2019 – Ajeet Gary, Devan Tamot, Vlad Dobrin

Model Ex1: Pi Day Celebration – Generating Digits of Pi

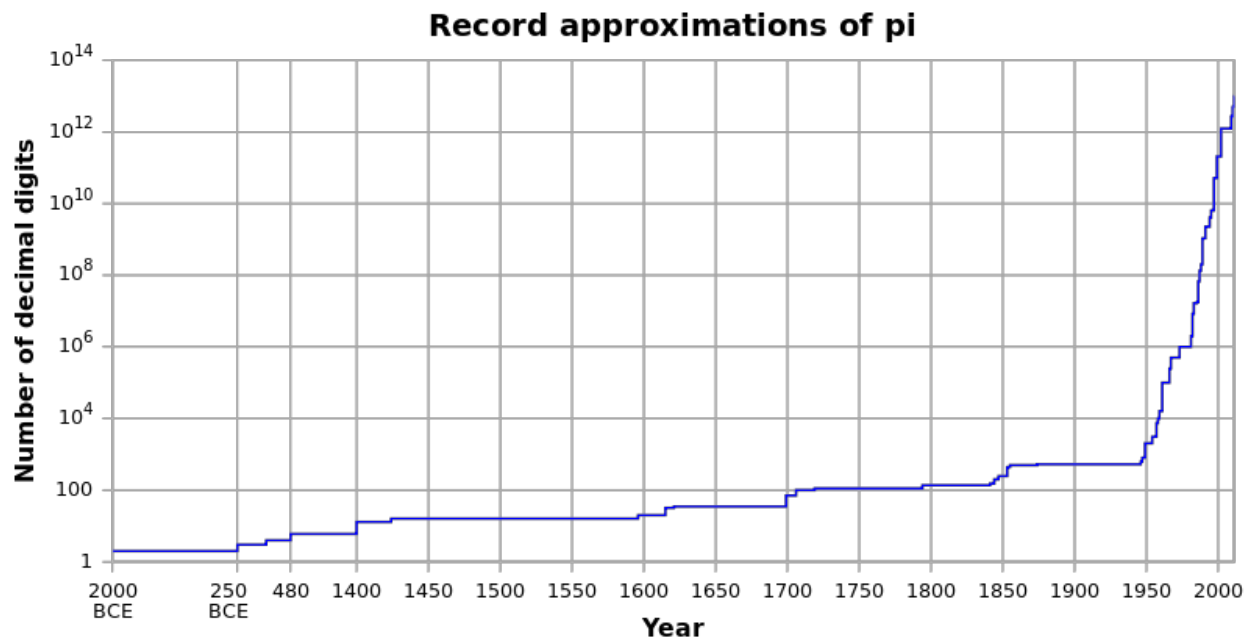
Assigned: Friday March 8th, 11:59PM

Due: Thursday March 14th, 11:59PM

Happy π Day!

As I'm sure you are all aware, Thursday March 14th is what's known as "Pi Day", as the date is 3/14, which is the first three digits of the mathematical constant π , 3.14...

Approximating π dates back nearly as old as math itself – 2400 years before Euclid, the father of proof-based mathematics, was even born. The Ancient Babylonians used $3 + 1/8 = 3.125$, which was precise enough for the architecture of their day. It makes sense that geometry was the first branch of mathematics beyond counting, as we as humans have been building awesome structures since several millennia before modern technology.



https://en.wikipedia.org/wiki/Chronology_of_computation_of_%CF%80

Notice that the x-axis dates back to 2000 BCE, and that it steadily increases over all of human history since then! Also notice the logarithmic scale on the y-axis, that is, in 2016 we computed over 22 trillion digits of π ! You should follow the Wikipedia link to see a full table of world record π approximations dating back 4000 years.

Why is π so important? Well, it's a fundamental mathematical constant that happens to be extremely useful. It's astounding that a constant that one could in principle discover in abstract is so useful to everyday life, that is, the ratio of the circumference to diameter of a circle is something you could think of and study if you were in an isolated box flying through space, however, despite the purity of the concept of π , its applications are extremely practical.

Furthermore, π appears all over the place in math and physics – this is because it is the ratio of the circumference to diameter of a circle, a “circle” simply being a locus of a points equidistant from a chosen center point, which is a context often created in math and physics – so, any time you see π occur in a math or physics problem, you should be thinking “Where’s the circle? It’s gotta be here somewhere”. π is amazing because it is pervasive in our physical world and at the same time a pure mathematical concept – so fundamental that we have purposefully sent out electromagnetic waves into space whose frequencies are in the ratio of π , because if alien life were to ever receive those signals, they would instantly realize that they are in the ratio of π and that that wasn’t a coincidence, so we could communicate to them that we are intelligent life without translating a single word.

Okay, let’s get to it: Your task for this extra credit assignment is to use Mathematica to create a fun way to approximate π ! The easiest way to make π in Mathematica is of course to write `N[π ,10000]` to get the first 10000 digits, but we want to see what else you can implement! You should search the Internet for cool ways to generate digits of π – if ancient mathematicians can figure out ways to do it, so can you! The approximations can converge slowly and be convoluted, the important thing is that they’re cool. You can also go the purely computational route, testing the speed and accuracy of different computation methods; the `AbsoluteTiming[]` function will be useful to you for that. Here are a few ideas:

Buffon’s Needle

https://en.wikipedia.org/wiki/Buffon%27s_needle_problem
<https://www.youtube.com/watch?v=sJVivjuMfWA>

Generating Pi with Dice

https://www.youtube.com/watch?v=RZBhSi_PwHU

Taylor Series Expansion

<https://www.youtube.com/watch?v=HrRMnzANHHs>

Freaking, black magic witchcraft sorcery

<https://www.youtube.com/watch?v=HEfHFsfGXjs>

Also, anything else π related is welcome! A cool visualization of π , a trigonometry animation, or whatever else you can think of!