ep 101 average

**Mark:** [00:00:00] Welcome to the Endless Knot Podcast

**Aven:** where the more we know

**Mark:** the more we want to find out.

**Aven:** Tracing serendipitous connections through our lives

**Mark:** and across disciplines.

**Aven:** Hi, I'm Aven

**Mark:** and I'm Mark.

**Aven:** And today for our first podcast of 2022, we're talking about average things,

**Mark:** but this is not your average podcast episode.

**Aven:** Indeed it's going to be actually a little bit odd because it's going to be three videos in one, three stories in one that are all part of the same one. Anyway, we'll get to that in a moment, but first of all, happy new year. Woo. I don't know how happy it is, but 2021 can bite me in the...

**Mark:** in the average.

**Aven:** Yeah. And good riddance to it. It was a beast of a year. It finished on we don't need to get into it, but on some [00:01:00] highly aggravating notes and I am very glad to be into a new year, even if it does not appear to be starting in a particularly good way. So to start off this year, we're going back to an older podcast about mathematics, really.

Yep. And some other related elements, but we have a few things to deal with first. So first of all, thank you again to everybody who participated in our hundredth episode extravaganza and to everybody who commented on it or said nice things about it. And various especially thank you to the new Patreon supporters that we have who presumably, perhaps, were responding to our call asking for support and I really appreciate them. So thank you to Victoria M, Ian Patrick J, Tom W, and Amanda B. All of you have become new patrons since our last episode, and we are really [00:02:00] grateful.

**Mark:** Woo. Thank you.

**Aven:** Second. I have a new podcast to recommend to you, our listeners, if you're interested in this one, I think you might be interested in Khameleon Classics, which is a fairly new podcast, just started in the fall, Khameleon with K H. They are a podcast about classics and the classical world, but specifically they're interested in WHY classics. Basically, I will read you their little writeup: "For 2000 years, study of the Greek and Roman world has been at the center of Western education. Khameleon Classics is the podcast that asks why? What is our fixation with classics? And why does the classical world only encompass Greece and Rome? How can ancient history shed light on the fight for a fairer society today? And what responsibility does it bear for the complicated legacy of colonialism that we struggle to face up to even now?"

And basically every episode is an interview with a scholar [00:03:00] or other experts in various areas of classics and in particular with how it struggles with and engages its own history and the current world.

So if you've been interested in some of our episodes on topics of such note, or if you're just interested in g to people who are passionate about the field talk. I strongly recommend this show. There are some people who we are friends with who've been on it so far. There are 19 episodes. The most recent was about Medea in politics from 1750 to 1800. So, you know, it's a very wide ranging is not just about modern stuff. And it's really interesting and I've been really enjoying it since I was made aware it existed. And I strongly recommend that you check it out.

I will put a link in the show notes to further information.

All right. The next thing is a cocktail.

**Mark:** Indeed.

**Aven:** I looked so hard to find a cocktail called an average cocktail in some form or another,

**Mark:** but why [00:04:00] would anyone want to drink an average cocktail?

**Aven:** It doesn't really have a good brand. So unsurprisingly it wasn't, we weren't able to. So instead I found a cocktail that has coffee liqueur in it. And the why of that will hopefully become clear as you listen to this podcast. This is called the revolver.

And you had some reason why that was an appropriate name though. I don't think so.

**Mark:** Did I? Oh oh, revolving, because there will be some discussion of celestial movements.

**Aven:** Oh, yes. That's right. So what revolves around other things? Yeah, exactly. All right. Fair. I do not think that is the revolver that is being referenced by the name of this cocktail.

**Mark:** That's okay. Of course it refers to the excellent Beatles album

**Aven:** Sure.

This cocktail then is two ounces of bourbon, half an ounce of coffee liqueur, and two dashes of orange bitters. So just a take on a Manhattan basically. And we used my homemade coffee liqueur, [00:05:00] so cheers.

**Mark:** Cheers.

Ooh, I like it. Yeah.

**Aven:** Pretty nice.

Not too sweet because it's not that much coffee liqueur. And the one I made isn't that sweet. Anyway, it's probably not as sweet as Kahlua.

**Mark:** It's got a nice bite to it.

**Aven:** All right. Well, that taken care of, shall we turn to these? Do you want to talk about what they are and how they work?

**Mark:** Yeah, I'll set this up a little bit.

So the jumping off point, as you will find in a moment is the etymology of the word average, which is as you will see kind of surprising and it will expand into all kinds of different aspects of that word and what it refers to. From mathematical concepts to insurance and statistics and,

**Aven:** and interesting things too.

Sorry, actually this is, I find it is really interesting. It just, when you describe when one describes it, [00:06:00] this series of, of subject matter,

**Mark:** most people aren't necessarily interested in the history of insurance.

**Aven:** Yeah. They don't know they're interested in, it turns out it's interesting. It just doesn't sound interesting.

**Mark:** And when we did it at the time, we were not accustomed to my writing hour long scripts.

**Aven:** No, this was back in the days when we thought a script that went past 10 minutes was really, like, I remember having an intense discussion with you about whether we could really break that 10 minute barrier or whether no one would ever watch a 10 minute video. So, yeah.

**Mark:** So what we decided at the time was to break it up into three parts.

And so what you will hear is the three individual parts with breaks in between and we'll come back and comment on each part individually. Added alt together, those three parts are considerably shorter than our most recently videos.

**Aven:** Well, I mean, everything in the world is considerably, Get Back is almost shorter than our most recent video though not quite.

But yes, it's 45 minutes or something in [00:07:00] total. And we said in the, not the part you'll hear, but in, in the sort of tail end of the third video on this one, you know, let us know if you'd like this kind of format, if you want us to do more series. And I think we got quite a few comments saying, yes, we like it quite a lot, I'd like to see more series like this, and we never did another one like that. We just started doing, because the problem was that we didn't really get, we put them out on three, consecutive days or something like that. We put them out pretty quickly together and the, the second and third just didn't get very many views. No. So we've just, we decided it didn't work for us. But I, I like the structure of it and the recaps part way through, you'll see it sort of recaps each at the beginning of each second and third part.

So sorry if you commented at the time saying, yeah, I'd love to see more of these and then we completely ignored you. Sorry. It just didn't end up working for us. All right. Well, let's listen to part one of average and then come back and talk about some of that.

**Mark:** People often seem to want to predict the future. I mean, after all, horoscopes are still [00:08:00] regularly published in newspapers and magazines. Businesses are always trying to predict what consumers will want and what the economy’s going to be like next year. And in Norse mythology, the god Odin was always after wisdom and knowledge, particularly about the impending Ragnarok, the Norse version of Doomsday, so much so that he even gives up one of his eyes for wisdom. And speaking of astrology, it’s thanks to that that humans started studying the universe around us. It’s why we invented constellations and star charts. But soon enough people started to use those constellations and star charts for navigation. One of the most influential star charts was produced by the Greek Ptolemy. The work was originally titled Mathematike Syntaxis meaning “Mathematical Treatise”, and in fact was a work on Greek mathematics with a special focus on the maths of the apparent motion of the celestial bodies as the Greeks saw it. No mean feat as the Greek conception of the cosmos had the earth in the centre with everything else revolving around it like giant glass spheres, a notion first introduced by the philosopher Aristotle. This [00:09:00] geocentric conception came to be known as the Ptolemaic model. The catalogue of 1022 stars within their constellations was only a part of this great work, but it would come to be important to celestial navigation in later eras, especially when European sailors gained the necessary naval technology to sail away from sight of land into the deep ocean. But it was due to the Islamic world that the medieval west had access to this treatise, as it had been translated into Arabic, and from there into Latin in the 12th century, making it available to Europeans. Its name had shifted to Greek He Megale Syntaxis “The Great Treatise” to simply Megiste “greatest” which was rendered in Arabic as Al-majisti, leading to the European name Almagest. This is an example of the enormously important contribution of the Islamic world, who transmitted and built upon the knowledge of ancient Greece, to European learning. Christian Europeans generally had no access to or ability to read ancient Greek texts in their original forms. As we’ll see, the Islamic world is [00:10:00] above average in importance to our story in a number of ways.

And this brings us to the word average. The earliest senses of the word have to do with maritime shipping. In English contexts it originally referred to a customs-duty or expense over and above the freight incurred in the shipment of goods and payable by their owner. But the word seems to come from the Old French availe which meant “damage to shipping” and by extension any expense, with the -age ending coming by way of a parallel to the semantically related damage. And since the usual practise was to share out these expenses between all the owners of freight on the ship as well as the ship owners, kind of like an early form of insurance, the term gained the mathematical sense of the ‘arithmetic mean’ from the idea of distributing a sum between a number of people, and the sense of “typical” or “usual” developed from there. Now the deeper etymology of this word is a matter of some speculation and disagreement. As the Oxford English Dictionary puts it “few words have received more etymological investigation”. But [00:11:00] the explanation that seems to carry the most weight, and the one we’re going to go with here, is that it comes from Arabic ‘awariya “damaged goods”, from ‘awar “fault, blemish, defect, flaw”, from ‘awira “to lose an eye”, from a Proto-Semitic root that means “to be or become blind”. Kind of recalls Odin giving up his eye, and in a way this is fitting since average in its maritime shipping sense, which is the beginnings of insurance, is all about making plans for future contingencies.

The practise, now referred to as general average, was to share out the losses in freight if for instance some had to be jettisoned overboard in the event of a storm at sea in order to save the ship. The sailors therefore weren’t faced with the decision of what to jettison on the basis of who owned it since all the freight owners would share the expense of the loss. This practise goes back a long way, and can be found in the Lex Rhodia, a maritime code from Rhodes around 800 BCE. The law disappeared after the fall of Rome, but the principle was revived in the Rolls of Oléron promulgated [00:12:00] by Eleanore of Aquitaine after returning from the Second Crusade around 1160 CE. There were of course other ancient forerunners of insurance by distributing or transferring risk, such as the 3rd century BCE Chinese practise of distributing goods among several vessels in case one capsized in river rapids. And in the Code of Hammurabi from around 1750 BCE a merchant taking a loan to fund a shipment could pay an additional fee guaranteeing the loan would be cancelled in the event of theft or loss. By the way, the code of Hammurabi also records the first evidence of interest-bearing loans. But in any case the first example of actual contract insurance for maritime shipping dates to 1347 CE in Genoa. Actual insurance laws became codified first in 15th century Barcelona, with the first statute in England in 1601.

Insurance brokers kind of grew up organically from there, and funnily enough we have coffee to thank for it. Which is appropriate since coffee is another of those things that Europe got from the Islamic [00:13:00] world. The word coffee came into English through Dutch and Italian from Turkish kahveh, which in turn came from Arabic qahwah. The ultimate origin of the word is debated. Some trace it back to the Kaffa region of Ethiopia, where coffee was originally grown. But a more likely etymology is that it comes from a Proto-Semitic root which means “to be or become weak, dim, dull, dark”, thus meaning “dark stuff”, appropriately enough. Interestingly, the word seems to have originally referred to a kind of wine, also dark in colour, until the Islamic prohibition against drinking alcohol made the word obsolete, whereupon it shifted over to refer to coffee, a non-alcoholic drink which nonetheless has a pleasant effect on the drinker. The drink itself made it to Europe in the 16th century by way of Turkey. It arrived in England before the end of that century through trading by the Dutch and British East India Companies, and soon coffeehouses sprang up in Europe, and they soon became centres of social life and business. For instance the Café Procope in Paris was where Denis Diderot and Jean le Rond d’Alembert brewed [00:14:00] up the idea of creating the first modern Encyclopedia.

But more important to our story is the coffeehouse opened in London in 1686 by a man named Edward Lloyd. You see, shortly after it opened, it was relocated in 1691 to an area called Exchange Alley which was conveniently located near the Royal Exchange where the exchange of goods was carried out. As a result people involved in trade and commerce began to congregate at the nearby coffeehouses such as Lloyd’s Coffeehouse. Lloyd installed a pulpit from which shipping news could be announced, and for the benefit of his patrons engaged in their wheelings and dealings began to compile a list of ships engaged in trade which included information about the condition and seaworthiness of the ships both in terms of the state of their hulls and the quality of their equipment. That way you’d know what trade venture to underwrite. He used an alphanumerical rating system — A1 was top notch both in terms of hull and equipment. That’s where we get the expression A1 for something that is first-rate. At the time, a ship’s hull was [00:15:00] vulnerable to shipworms, actually a species of salt-water clam which bored into the hull. The solution for shipworm was to coat the hull with a mixture of tar and pitch. No problem for England as their American colonies produced the necessary stuff. But after American Independence, England was in a bit of a pickle. Eventually a solution was found in sheathing the hull in copper. And that’s where we get the expression copper-bottomed, as in a copper-bottomed investment—a really safe bet. The practise began with the navy but soon was adopted by commercial ships, and in 1777 the first such ship was listed in Lloyd’s register, and by 1786 there were 275 copper-bottomed vessels. And in case you hadn’t guessed by now Lloyd’s Coffeehouse eventually became the great insurance market Lloyd’s of London. So thanks to Islamic prohibition and maritime shipping with its distributed averages, we have insurance brokers.

So, first of all, I want to reemphasize the importance, the great [00:16:00] importance of Islamic learning during the middle ages especially in the areas of science and mathematics and therefore by extension from that the amount of vocabulary that came into English related to related to those fields.

And so I've been wanting to do more scientific terminology etymologies. So when, when I do get around to eventually doing those, there will be a lot of, a lot more terms that I will talk about that come from Arabic sources. So it is really important point to, take away from this.

But next, a little bit more information about that contract insurance business that began in the 14th century in Italy. So these new insurance contracts allowed insurance to be separated from investment. Okay. Which is kind of an important point. And it's a separation of roles that first proved useful in Marine insurance.

So there was a [00:17:00] distinction between, you know, insuring a venture, a shippiing venture, a vessel, and investing in, you know, procurement of some goods or whatever. Okay. Now one of the problems, however, was the issue of usury. So usually if you're not familiar with this term, is the religious prohibitions.

**Aven:** Well, usury is the practice of charging interest, charging interest on the loan. That's what usury is.

**Mark:** And so there is a prohibition against usury in, in a number of religions in this case, importantly, Christianity.

So another way of getting around this is that originally these contract insurances were disguised as a sale or an exchange to prevent any question as to whether it was legal on the grounds that, it wasn't a loan. So you get around that. And so you would pay money in one [00:18:00] currency and then you could take the money back in a different currency. And so it was an exchange or something like that.

And then the rate of exchange would take into account the sort of interest that you weren't paying.

Or that you were getting, but without calling it interest.

So at this point special courts were set up to solve the disputes of Marine insurance, like in Genoa. so eventually insurance regulations were passed to impose a fine on who did not obey the church's prohibitions of usury. So, you know, it was this sort of tension of, what the rules are, the rules are, and then you have to go, reword it in a way that escaped those rules or whatever.

Sea loans had already existed for some time before that. Again, always a problem that the church sort of looked at. And so since sea loans involved paying for risk, essentially Pope Gregory` the ninth had earlier condemned the practice as usury in 1236. So [00:19:00] that's the context for this 14th century invention. Yeah. The first printed book on insurance was a legal treatise called On Insurance and Merchants Bets by Pedro de Santarém or also known as Santerna, a Latinized form of his name because it was written in Latin. In fact it was written in 1488 but only published in 1552, but he cites and refutes the various authors who held insurance contracts void on the grounds that it was usury.

And he argues that even a loan of money to X person who pays a premium to the lender to insure it is not usury. So

**Aven:** it's all about the technicalities of what counts as, are you profiting off of loaning money? Is it's the sort of central question and is this just a way around it?

**Mark:** So the first printed work on [00:20:00] insurance is refuting this attack on the practice, right? The other point that I wanted to pick up on from this first bit, and this is one of these things that I know you're going to say, this is like the most boring topic ever, why are you, why are you talking to me about it.

**Aven:** Who, me? I never say such things!

**Mark:** But it's more, technical information about the sheathing on ships.

**Aven:** So you can't even get it out without

**Mark:** So in addition to the ship worm, another danger to the hulls of ships was seaweed.

**Aven:** Oh, it's getting fascinating now.

**Mark:** Seaweed!

The problem with the seaweed is it doesn't necessarily bore into the wood and split the planks or whatever. The problem with the seaweed was that it would create drag, right? You get these long bits of seaweed,

**Aven:** same with mollusks, right? Like limpets and things like that.

That there's another word, barnacles. That's the word I was trying to come up with. Yeah. Where they don't harm the ship necessarily. They just create

**Mark:** They create drag and more time is less money. Now [00:21:00] in the ancient world, the Greeks similarly used a sheathing method that involved lead sheathing to protect the hull, the boat hulls.

So the lead was also sometimes used in early modern Europe, no better solution had been devised by that point. But one of the problems that they had in early modern Europe is that the lead plus the iron bolts that were used to fasten the ship hull together caused galvanic corrosion.

Basically it works like a battery.

**Aven:** I was about to say, are you about to tell me that they started electrifying their boats without meaning to?! And you're about to say they are!

**Mark:** Exactly! So you've got two metals and sea water, an electrolyte, so it allows them. Yeah. So eventually what happens is suddenly, it starts wearing away the bolts. Atom by atom, the iron would migrate to the lead and the bolts would disappear, disappear.

So this [00:22:00] is a problem.

**Aven:** I imagine they weren't able to explain what was happening, but they definitely knew it happened.

**Mark:** Yeah. So one of the other solutions they came up with was using wooden sheathing which could be, so you, you put on an extra layer of wood that could

**Aven:** then be replaced more easily

**Mark:** feed the, the ship worm, they can eat the whatever, and then you could replace that surface layer wooden sheathing in dry dock, relatively cheaply. Right. But copper was better because you didn't have to replace it and didn't have to go into dry dock and all of that. And an additional advantage to the copper sheeting was that, again, chemical reaction here. So copper plus the water created a poisonous film of copper oxychloride.

So it's the seawater, I guess the salty seawater reacting, and that copper oxychloride was toxic to the, the various organisms. Right. [00:23:00] And so that further deterred the bio-fouling. Right. But again, there was the problem of the galvanic corrosion. So interaction between the copper and the iron bolts still is the same problem

**Aven:** Copper's a great conductor.

**Mark:** Now eventually the Royal Navy decided to copper the entire fleet starting in 1778. That's a significant date because that's during the American revolution when they lost access to the tar, to the pitch, to the pitch. So that, that really, you know, drove them to find another solution to, well, to do this.

And it was expensive. Britain could do it because they had good copper mines. A lot of other European countries did not have the access to sufficient copper to do this. Right. So that was an advantage for Britain. But they also came up with at that time something of an advancement, technological advancement that made it a little better.

They added thick paper [00:24:00] between the copper sheathing and the hull to deter the corrosion.

**Aven:** Right. As an

**Mark:** insulator. Yeah. But ironically, they lost the colonies anyways, in spite of investing all of this money to save the colonies for, you know, in their war effort. But it came to nothing

Now at this time there was another concept to get around this problem. Archibald Cochrane, who became the ninth Earl of Dundonald. By which point, when he came to this position there was virtually nothing left in the family holdings due to previous Earls backing of the wrong king at various points in history and added to that excessive gambling and general frittering away of the family fortune.

Except for that, the only thing remaining, the family home and a small coal mine. Okay. So Cochrane, having this meager inheritance, but this coal mine began experimenting and his experiments were [00:25:00] funded by the way, through three marriages. It was an expensive business, I guess, began experimenting with coal in an attempt to recoup the family fortune somehow out of this one remaining asset.

And he worked out a process to extract various useful products from it, including importantly, coal tar,

**Aven:** which becomes so important at the end of the 19th century.

**Mark:** Yes, but not for the reason that he was originally intending because it would have been useful in tarring the bottom of the Royal Navy's ships, but the Admiralty had just decided to switch to the copper sheathing.

And so his plan failed and Cochrane became financially ruined and eventually died pennyless in a Paris slum in 1831. So, it didn't pay off for him, but, he'd accidentally discovered something kind of useful. So In a sense what's worse is that as I say, he discovered something useful that he thought was kind of a problem.

He actually exploded his [00:26:00] equipment.

**Aven:** You can see why he thought that was a problem,

**Mark:** Discovering a kind of flammable gas by-product from his coal tar process which he didn't know what to do with. And he mentioned it in passing to James Watt that James Watt, yes, of the steam engine fame, but he didn't develop it.

James Watt kind of passed this information along and in the end it was a man named William Mudoch. No, not that William Murdoch.

It definitely was that William Murdoch. And if you don't know what we're talking about, go look up CBC TV dramas. It's absolutely him. Come on. The man was an inventor.

William Murdoch, this William Murdoch who was an employee at the firm of Matthew Bolton and Watt

**Aven:** do you think that's where they got the name? I wonder.

**Mark:** Who invented gas lighting. [00:27:00]

**Aven:** You're not going to persuade me

**Mark:** by designing a lamp that burned this coal gas and this William Murdoch was a particular showman and created all these kinds of lamp burning show it off, you know, flashy things.

And so he was a bit of a showman as well as being this inventor. But the important thing about the coal gas lamp is that it helped to make the industrial revolution possible because you could more safely light factories allowing them to run for longer,

**Aven:** without blowing up without blowing up burning down, more to the point, I guess.

**Mark:** And if you want to learn more about the invention of artificial lighting and its importance to the industrial revolution, you can check out episode 31 all about the word create.

**Aven:** Absolutely.

**Mark:** Then a last point about all this copper bottomed-ness is the term copper bottomed as being [00:28:00] used figuratively to mean a good investment, a sure bet. A similar term was copper fastened, which similarly came to be used figuratively to mean to reinforce, strengthen, to make permanent embed.

So it's a slight difference in the connotations of those two terms, but they're very similar. The emphasis on copper fastened is more on security and lack of ambiguity. In other words, nailed down, right? Copper fastened. Rather than on the certainty and trustworthiness of copper bottomed. But it's used in reference to the use of copper fasteners instead of iron bolts to eliminate that corrosion problem.

**Aven:** Ah, right. Cause if you use only copper, then you don't have the problem.

**Mark:** So another little etymological tidbit.

**Aven:** Yeah. Well that was surprisingly interesting.

So I have a few things to add that are a little tangential, but I just think they're [00:29:00] interesting. And so I'm shoehorning them in here. First of all, just to talk a little tiny bit about Ptolemy, whom you mentioned as the first star chart and as being very important to later science the thing is you talk about him as a star chart maker and that is important and obviously Ptolemaic conception of the world, et cetera.

But the other thing he was, was a geographer. So, you know, he's related to this whole topic of shipping in a different way. He was a mathematician really is at bottom when he was, and then he used it in various ways and he was interested in astrology as well. Hence the Almagest, but also the Tetrabiblios, which is also about astrology and Aristotle.

But the Geography was interesting because it is a work that essentially is a map in non-map form. He devised a system of latitudes and longitudes though he used different terminology for it, and then marked places all around the Mediterranean by their latitude and longitude. Now they're not the [00:30:00] same as the latitude and longitude we use now, but, you know, by numbers, so he gave the coordinates for every sort of section of the Mediterranean, he gives the coordinates of the coastline of places along the coastline. Is it just ports

**Mark:** or does he mention other

**Aven:** no, he mentioned other things as well, it's mostly coastline, but not entirely. So he doe inland stuff too, so it's not just for navigation. But you could then draw a map from it. It's not clear that he ever conceived of it as a guide for drawing a map. I don't think that's particularly what he was trying to do because of course you could use these coordinates for navigation.

Right. But you could, and people have but it was very much an attempt to sort of pin down in a really objective, not just by landmarks kind of navigational guide. And I have a specific connection to it in that when I was an undergrad student, I did a research project for a prof at university of Toronto who was transcribing and translating and writing about, but he was doing an edition of Ptolemy's [00:31:00] geography. So I spent a summer transcribing these lists and that was boring.

But especially exciting because it's in Greek and Greek numerals are Greek letters. Yeah. So I had to, I don't even remember them anymore, but I had to learn all about Greek numerical notation and how it works for this project and figuring that out. So somewhere there is a, an edition of the Ptolemy's geography that has an acknowledgement of my work, my name in it.

**Mark:** I almost managed to work in a reference to another bit of work you did as a student with John Evelyn, for John Evelyn. Cause you worked on

**Aven:** transcribing a lot more of him, but I did that transcribing too. Yeah.

**Mark:** Because I really wanted to connect him. I mean, he is connected. We'll find this out later.

He is, he definitely comments on the great fire of London.

**Aven:** And he also was very involved in the Navy and Navy plans. He did a lot. I remember a lot of the letters that I was transcribing where, because of the Dutch wars that were going on, but like trying to figure out better. And he was, he was [00:32:00] involved with dealing with provisioning of the Navy and provisioning of dealing with sick and wounded men and stuff like that to my

**Mark:** memory. And I was, I was also hoping to connect him to the, the whole tulip bubble market that we'll get into later, but he was only a teenager when that happened.

**Aven:** He was really into gardening.

**Mark:** He was really into gardening. So that would have, I mean, he totally would have, but he didn't, he didn't start his diary writing until he was 20.

So it was just a few years before.

**Aven:** Yeah. Yeah. John Evelyn I've again worked on transcribing his, his letters specifically. They were his letter copy book, it wasn't his diary. It was his letters. He kept a copy of every letter he sent. Though he's particularly famous for his diary, he is very famous for his diary.

But what I was subscribing was this correspondence, which is to be honest, it's a really interesting combination of deeply boring and really fascinating.

anyway. Okay. So the [00:33:00] other thing I wanted to talk about was this topic of astrology and predicting the future.

Which you kind of start the video with, and then move away from pretty fast and we're going to come back to it a little bit. But astrology in particular I was thinking about it and thinking about how astrology played out in Rome in particular. So astrology was obviously very important to all of the ancient world and not just the Mediterranean, like China and, Mesoamerica, like everybody's been interested in astrology at one point or another, but during the Roman period, which is the period I know best there were astrologers at Rome and I read an, a particularly interesting article about the ongoing sort of repeated expulsions of the astrologers at Rome. So I want to talk a little bit about what astrology was, how it was used at Rome and why Romans had anxieties about it. And then some of the issues around that. So astrology was associated for the Romans with, you know, they had lots of methods of trying to foretell the [00:34:00] future.

Many of which were associated with the Etruscans that was reading the flight of birds or other omens or cutting open animals and looking at their insides, right? Those are associated with Etruscans in their mind. Astrology was associated in their mind with Babylonia, whatever that meant.

And the Romans didn't always have a very good sense of what that actually meant. And Chaldaea was the other term that they'd use, so Chaldean or Chaldean. Eastern, isthe important thing, right. And for the Romans Eastern is bad. But Eastern is also mythical and magical and learned. Esoteric knowledge comes from the east for the Romans.

And so astrology in particular, the way was used to foretell the future was through the casting of horoscopes. So you would do a horoscope for someone, you know, you had to know exactly when they were born on what hour of what day, and then their horoscope would be worked out. And then it would tell sort of the hour of their death and particularly important points about their life.[00:35:00]

And so that was sort of, there were other ways you could use astrology, but that was a particularly common and important one. And at various points throughout Roman history, we're told by our sources that the astrologers were expelled from Rome, or there are sort of panics about astrologers.

Now why? Like what's so scary about astrologers? Well, this article, so which is by Pauline Ripat from 2011, mentions that the conventional argument is that astrology became very popular at Rome in the late Republic and that the upper classes and/or the masses believed in it. And so the Senate, and then later the emperors became very wary of people using the knowledge from horoscopes, either to foretell or encourage rival claimants to power, and then to the throne, or to foretell or encourage the death of the emperor.

So the argument sort of goes that if you cast the horoscope of some powerful Senator and the horoscope says, this man is destined to become king of Rome, then [00:36:00] he is going to take steps to try to do that. Or other people will encourage him to do it. Or if you cast a horoscope that says the emperor will die on October 25th, then that encourages people to make that prediction come true or to act in other ways.

And so the conventional argument was that they were worried about this as a process. And so there were repeated expulsions of astrologers from the city and they made the casting of the horoscope of an emperor into a crime. There was an Augustan law, by Augustus in 11 CE that made it a crime to consult a seer about one's own or another's death.

Hmm. So that we know about, but Pauline argues that this idea of these mass expulsions coming from people being so credulous and like everybody believed in them that that idea is not a correct interpretation of the evidence. So I won't go into all of the details of her argument, but I thought it was really Interesting. She says that in fact, we don't [00:37:00] see sort of astrology being linked with conspiracies very often. There's one or two, there are eight known expulsions of astrologers. And only two of them seem to be associated with conspiracies actually and then there were various other places where we're told about astrologers, but there seems to be no expulsion connected to them, you know?

So, so she says, it's not really a lot of evidence for this, this premise.

**Mark:** So it's like genuine fear of,

**Aven:** well, so we'll get to that. So she says that, Yes, we do see emperors being paranoid about astrology. And we do see astrologies and horoscopes being implicated in various plots and conspiracies, but the expulsions don't line up with those very often.

So, so what she was really, the article is really about like, what's going on with these mass expulsions. The earliest expulsions we have on record are 139 BC E and 33 BCE. So that's before there were emperors. And in both cases of those, the people who passed those laws said they were aimed at driving out foreign influences on Rome. So they're part of a larger [00:38:00] xenophobic idea about like restoring Roman ways. And at least one of those was connected with also the expulsion of Jews from, from Rome. Right. Which is, again, this xenophobic, like these are weird people who don't do what we d. Later ones are not connected specifically to conspiracies. The last one we have recorded is in the time of Marcus Aurelius. So it kind of spans from the middle of the second century BC to Marcus Aurelius. So what she argues is that in fact, this idea of circulating predictions about the Imperial prospects of leading men.

Cause that's sort of the thing that happens is and we see this during periods, like the year of the four emperors several of the claimants to the throne after Nero, the story circulated afterwards that there had been that they were sort of driven to make their bid for power because there was an astrologer predicting that their horoscope said they were, would be Imperial.

Pauline Ripat argues that this is in large part as a way to get fame for themselves, for the [00:39:00] astrologers. In other words, there's no real evidence that the people went to the astrologers to ask for their horoscopes

**Mark:** "We're so good, we're being banned!"

**Aven:** well, exactly! She basically makes that point because when you think about it, she says, okay, astrologers were expelled.

How do you know who's an astrologer? Like, okay, Jews being expelled, that is a community. And there are markers of who's part of that community. Who's an astrologer? Because as she points out, we hear frequently of like, even Tiberius was said to be really learned in astrology and cast his own horoscopes and lots of people at the high levels seem to have dabbled in astrology, but they're never the astrologers who are expelled. In fact, the well-known sort of court astrologers don't ever seem to be expelled. What is a street astrologer? What is a, what is an astrologer? And so it seems to be that a lot of these cases of treasonous or possibly treasonous astrology. It wasn't that the person involved actually consulted an astrologer it's that the astrologer publicized a [00:40:00] horoscope of some fairly prominent person.

And it does seem in some cases that this publication of this did actually lead to people, making a bid for power, but Sometimes, and we definitely have stories about people who are like, oy my god, no, I didn't, I didn't want to be emperor at all, like, what are you talking about? I don't have an imperial horoscope! And getting like seeming to have done nothing, to try to be emperor and being exiled or even killed by the emperor because a story was circulated that they had an Imperial horoscope, right?

So sometimes it seems to have been completely against the will of the person, even implicated in it. I mean, these stories are hard to, to unpick completely. But it seems that the expulsions actually increased the status of astrologers. If you're so scary that you have to be expelled because it puts them as dangerous anti-authority figures who are important, and that people seem to have gone out of their way.

some people went out of their way to be identified as astrologers so that they would be [00:41:00] expelled because none of these expulsions actually worked. Right? Like, how do you identify astrologers? Like in all of these cases, Rome has this long history of expelling cults or expelling certain groups of people, and then they do it again 10 years later.

So obviously it doesn't work because they don't actually have the kind of surveillance state that would actually make these things work and astrologers of all people. How do you know who's an astrologer? Especially when other kinds of seers and people who foretell the future are allowed.

Astrology is just this one particular area. So, you know, but it seems that people seem to have like claimed the status of astrologer because once expelled, even if they didn't come back, even if they just set up camp outside of the city, and now they're like an exile who's been exiled because of the power of astrology,

**Mark:** It's like those ads.

I don't see them as often anymore, but they're like this technique that your, your profs will be so angry if you learn about this technique,

**Aven:** doctors, doctors hates this. I see that doctors hate this one [00:42:00] simple method of weight loss or whatever it is, you know? Oh, I mean, it's frankly we see it all the time with the mainstream media stuff.

Right. Cancel culture. Oh, they're canceling me. So now suddenly I'm like really famous and anti-authoritarian, and I get my books sell. Right? Like what more do you want than to be canceled so that you can prove how really dangerous you are?

Yeah. I mean, this is what she's arguing now. I mean, it's an argument that goes to some extent, counter to conventional wisdom, but I've found it very persuasive and I'm not giving all the details here.

**Mark:** It immediately made me think though, of Doc Brown in, in back to the future saying, oh, it's dangerous to know too much about your own personal future.

**Aven:** Well, and I mean, so this idea of being like of horoscopes being dangerous, I don't think she's trying to suggest that people, like, I think that is a true thing and I think it is a real worry. Her argument is that the mass expulsions, so, but the thing is mass expulsion still did happen. So why did they happen if they weren't connected to conspiracies?

She says that they seem to come in times of unrest and instability in general when people are just trying to sort of, [00:43:00] make things right with the gods or just get rid of anything that they think of as being destabilizing and also as just moral panics. Right, right. You know, just sort of ongoing, which Rome definitely definitely was prone to moral panics.

**Mark:** " won't somebody think of the children!"

**Aven:** Yeah,

exactly. And just one last little note on that, which is kind of interesting, is that at one point somewhere four or five years before his death Augustus actually published his own horoscope made it public because he was trying to show that he did not fear people making predictions about his death and also perhaps it's a little unclear maybe because people were circulating the rumor that he'd been predicted to die soon, and that was causing a sort of panic and/.or conspiracies.

And so he published his horoscope for everyone to see so that they could see that it didn't predict that he was going to die anytime soon. So either to quell public unrest or maybe to head off thoughts of assassination, So [00:44:00] that's an interesting example of like the power of a horoscope, where he felt compelled to actually publish his horoscope.

Now, the reason this is a big argument is because a, we don't know when he did it and B we're not sure when he was actually born, partly because of the Julian calendar problem, but for other reasons, too. So there's a big question about whether, what his sign is and what his, so I started to read an article about the details of his horoscope and my brain shut down entirely because stuff about the dates and the times and how astrology works makes no sense to me whatsoever.

**Mark:** But surely you can tell from his personality, what kind of personality he

**Aven:** had.

Anyway. I just thought that was all kind of an interesting way to think about it. And I really, I really took from it that point about astrologers as a group, what marks out, how do you even know who's an astrologer? And really, I do think she's right.

That it would surely have to be a, basically a self identified group that in order to expel astrologers, there has to be a bunch of people who are willing to stand up and say, they're astrologers [00:45:00] because surely you could just be like, no, all I do is interpret bird omens. And like a few people sure, maybe it'll be proven against them, but most people could just .

**Mark:** "I sell melons!"

**Aven:** Could just not be an astrologer on the day that the astrologers are expelled. So if, if they're actually expelling people and people are actually going out of the city,

Oh yeah, no, no. Yeah. I'm an astrologer me. I'm an astrologer. Like I think that's, I think that's a really interesting point, so, right.

So anyway that's what I wanted to say about astrology.

**Mark:** All right. Well that was part one from coffee to insurance and everything in between. So next up is the second segment part two property and probability.

**Aven:** Let's listen to that.

**Mark:** As we saw in the last video, the word average, which comes from an Arabic word that means ‘blemish’ and ultimately from a Proto-Semitic root that means “to be one eyed”, originally referred damage to shipping and how averaging out those losses was [00:46:00] an early form of insurance. We also saw how Ptolemy had a geocentric model of the universe, and how his star charts were passed on to medieval Europe by Islamic scholars, and how the Islamic world also passed along coffee to European society, where coffeehouses became hives for business transactions, including the Italian invention of contract insurance, which led to insurance brokers in Lloyd’s Coffeehouse in London to become the insurance market Lloyd’s of London.

Well the other thing the insurance business needed to really get going was a way of predicting the likelihood or chances of unfavourable events. So we’re back to predicting the future again. The word likely, by the way, which around 1300 had the sense of “having the appearance of truth or fact” and from that gained its sense of “probable” in the late 14th century, comes from Old Norse likligr, replacing the native Anglo-Saxon cognate geliclic. The word chance, on the other hand, comes through French from Latin cado “to fall, die”, and when it entered English around 1300 it had the sense “something that takes place, what [00:47:00] happens, an occurrence”, in other words how matters fall, but reminding us I suppose of how the dice fall, and thus became a synonym for probability. And the word probability itself comes from Latin as well, from probabilitas. This in turn is cognate with the word prove and comes from the Latin verb probare “to make good, esteem, represent as good, make credible, show” from probus “worthy, good, upright, virtuous” from Proto-Indo-European \*pro-bhwo- “being in front”.

As for calculating probabilities, we again have the Islamic world to thank. For the first name in the history of probability theory is Al-Kindi the 9th century Arab mathematician, philosopher and, if you’ll pardon the pun, all around polymath. As a philosopher he adopted and adapted Greek ideas, and as a mathematician he was the first to use statistics and probability to decode a cipher by working out what the letter frequencies were. But in addition to his kicking off the study and use of probability and statistics, he is probably best known for introducing Indian numerals to the Islamic world, and thence to Christian Europe, where they became known [00:48:00] as Arabic numerals. The 12th to 13th century Italian mathematician Fibonacci was the first to popularize the so-called Arabic numerals in Europe through his 1202 book Liber Abaci or Book of Calculation. You probably know him from the Fibonacci numbers, which he also introduced in that book. It was an important and influential work, and was the inspiration and one of the main sources for the book Summa arithmetica or Summary of arithmetic, by the 15th to 16th century Italian mathematician Luca Pacioli, itself containing a number of firsts. It was the first description of double-entry bookkeeping, useful I suppose for all those later coffeehouse financial transactions, which led to Pacioli often being referred to as the “father of accounting and bookkeeping”. But for our purposes Pacioli’s book is important for another first, the first mention of the problem of points, to which he, incorrectly, offered a solution. The problem of points can be explained thusly: imagine two gamblers are playing a coin toss game upon which is riding a monetary [00:49:00] prize. The game is to see who is the first to win ten coin tosses. But for some reason the game is interrupted and the players want to figure out how to fairly distribute the stakes between them. Simple enough to divide it in half if they were tied, but harder to work out if one had a lead. It’s clear in that case that one of the players has a greater chance of winning than the other, but what chance? This problem kicked off the development of probability theory and the maths to solve problems of probability.

Our next stop in the history of probability was one Gerolamo Cardano, who was inspired by Pacioli’s work. You see Cardano was another one of these polymath types, working as a physician, but also a part-time mathematician and inventor, inventing for instance the combination lock. He was also an avid and disreputable gambler — you can see why he was so interested in Pacioli’s probability work — and he was often short on funds, keeping himself afloat by gambling and playing chess. He was thus the first to write systematically about probability and games of chance, publishing his Liber de ludo aleae or [00:50:00] Book about Games of Chance in 1539, which included not only the mathematical treatment of probability, but also ways to cheat like rubbing a card you want to draw from a deck with soap. He wrote about the use of expressing odds as the ratio of favourable to unfavourable outcomes, like there’s a 1 in 6 chance of rolling a six with one die, and even worked on figuring out the probability of rolling a seven with two dice. As a result of all this, Cardano is sometimes referred to as “the gambling scholar”. So we also have gambling to thank for probability theory.

Speaking of gambling, the word gamble is related to the word game, as in games of chance, coming from Old English gamenian “to play, joke, pun” ultimately from the Proto-Germanic collective prefix \*ga- plus \*mann meaning “person” giving a sense of “people together”. Gamble probably gained its “b” by influence from the otherwise unrelated word gambol, as in a lamb gambolling. I suppose you need good luck when gambling, and luck is an odd word with an uncertain etymology. It probably comes from Middle Dutch luk, a shortening [00:51:00] of gheluk meaning “happiness, good fortune” and cognate with modern German Glück meaning “fortune, good luck”. But where this word ultimately comes from is entirely unknown. Another unexpectedly luck-related word is speed, which comes from Old English sped “luck, prosperity, success”. It comes ultimately from Proto-Indo-European \*spe- “to thrive, prosper”. The sense of “quickness”, now the dominant sense, didn’t emerge until late Old English, but there is a remnant of the older meaning in the expression Godspeed which actually means “may God prosper you” or even just “good luck” and has nothing to do with quickness, though I’m sure God is very fast.

But getting back to the gambling scholar Cardano, he was also into astrology — there’s predicting the future again — and struck up a friendship with fellow astrologer and Lutheran theologian Andreas Osiander. Osiander edited a number of Cardano’s books and even received a dedication in one of them. Another writer that Osiander edited, who didn’t get along so well with him, was Nicolaus Copernicus. You see in [00:52:00] his De revolutionibus orbium coelestium or On the Revolutions of the Celestial Spheres, Copernicus challenged that old Ptolemaic geocentric model of the universe, presenting instead a solar system with the sun in the centre and the planets in orbit around it and the various moons in orbit around the planets. Made more sense of the apparent movement of the celestial objects. But while editing, unbeknownst to Copernicus, Osiander slipped in his own preface to the book stating that it wasn’t meant to be taken literally, it was just a mathematical model. Copernicus was furious but by then it was too late and there was nothing that could be done about it, and soon after Copernicus died.

But coming back to Pacioli’s problem of points, it was finally solved in 1654. The problem came to the attention of a French writer named Antoine Gombaud who is more commonly known as the Chevalier de Méré. He wasn’t actually an aristocrat, it was just a name he invented for his dialogues, but soon his friends started to refer to him that way and the name just stuck. In addition to [00:53:00] being a writer, the Chevalier de Méré was also a proficient gambler as well as an amateur mathematician, but his math skills weren’t up to solving the problem, so he brought it to his friend Blaise Pascal. Pascal was a child prodigy in mathematics, making many discoveries while still a teenager. In 1650 he had something of a religious epiphany while suffering from ill health, and abandoned mathematics, turning instead to religious meditation and philosophy. He eventually did return to mathematics but died at the unfortunately young age of 39. As a result of all this he is known as greatest might-have-been of mathematics. Well, he started corresponding with fellow French mathematician Pierre de Fermat about that problem of points which the Chevalier de Méré brought to him. Actually Fermat was a lawyer with no formal mathematical training. Indeed he didn’t even get onto mathematics until he was in his thirties. But unlike his friend Pascal his life was long and mathematically productive. Perhaps best known for Fermat’s Last Theorem, his contributions to mathematics were so great [00:54:00] that he is often referred to as “the prince of amateurs”. Well between them in their correspondence, Pascal and Fermat worked out two entirely different ways of solving the problem which produced the same results, and the methods they developed became the backbone of probability mathematics. And in keeping with Pascal’s vacillation between mathematics and religion and philosophy, Pascal united these two interests in the realm of probability, writing “We know neither the existence nor the nature of God … Let us weigh the gain and the loss in wagering that God is. Let us estimate these two chances. If you gain, you gain all; if you lose, you lose nothing. Wager, then, without hesitation that He is”.

In 1657, just three years after Pascal and Fermat created probability maths, the Dutch astronomer and physicist Christiaan Huygens wrote it all up in the first formal treatise called De ratiociniis in ludo aleae or On Reasoning in Games of Chance. And it’s perhaps fitting that Huygens is best known today as an astronomer, since probability came to [00:55:00] be very useful in that field. For instance, years later another child prodigy mathematician Carl Friedrich Gauss used the method of least squares to accurately predict the location of the dwarf planet Ceres from only a few observations as data points. Imagine you have a graph with just a few data points on it. The method of least squares allows you to find the line of best fit for that scant data. So once again we return to the effort to determine the motion of celestial objects, just like Ptolemy and Copernicus.

Another important early contributer to probability and statistics was Thomas Bayes, a Presbyterian minister by calling. He is most famous for Bayes Theorem, which basically allows one to accurately work out the probability of an event based on prior knowledge. Bayes actually published very little on mathematics during his lifetime, and it was up to French aristocrat and scholar Pierre-Simon Laplace to further develop Bayes’ Theorem. And in a nice bit of interconnection, Laplace had also tried but was unable to calculate the orbit of the dwarf planet Ceres, a problem which you [00:56:00] remember Gauss solved. One of Leplace’s students, Joseph Fourier made important contributions to both mathematics and physics, but it’s, oddly enough, his work on heat transfer that interests us. Fourier was very interested in heat, and is credited with discovering the greenhouse effect. You see, Fourier got into an academic argument with Siméon Denis Poisson over the theory of heat — Poisson was forced to retract. However Poisson had more luck in his work on probability theory, which included the Poisson distribution, which allows one to know the probability of a given number of events occurring in a fixed interval of time, exactly the sort of thing an insurance company needs to know.

After marine insurance, the next type to develop was property insurance, specifically fire insurance. Unfortunately it’s a bit of a shut-the-barn-door-after-the-horse-has-bolted sort of thing, because what really pointed out the need for fire insurance was the Great Fire of London in 1666, in which more than 13,000 homes burned down. The job of rebuilding fell to architect [00:57:00] Christopher Wren, also a sometime physicist and mathematician whose scientific work was highly regarded by our friend Pascal. Clearly Wren observed the need for an insurance office as he included in his rebuilding plans a site for one. Wren’s assistant was polymath Robert Hooke, the trajectory of whose life ran from being a penniless scientist, to a wealthy and admired member of society, to eventually an old man in ill health, jealous and bitter towards his scientific contemporaries. However, Hooke’s efforts as surveyor after the Great Fire of London won him much acclaim. In addition, Hooke worked on the problem of timekeeping and celestial navigation. You see in order to calculate longitude, how far east or west you were, you needed to know the time back home where all your star charts were calibrated to. If you take a reading of a star’s position and find out how far out it is compared to the star chart, you can work out how far east or west you are to see the star in that position. But you can’t use a pendulum clock at sea, and spring driven clocks weren’t accurate enough. So Hooke invented a balance [00:58:00] spring pocket watch which was up to the challenge, and tried to patent and develop the technology, but was unable to finance it, no doubt adding to the bitterness of his later years. What’s more our astronomer friend Christiaan Huygens independently came up with the same idea some five years later.

But getting back to the insurance office, the first one to be established was founded by a man with an unusual middle name: Nicholas If-Christ-had-not-died-for-thee-thou-hadst-been-damned Barbon. Yes that’s actually his legal middle name, the practise of giving such hortatory middle names being popular with the Puritans at the time. Well, Barbon and eleven associates founded the Insurance Office for Houses located at the back of the Royal Exchange, the first fire insurance company, and soon other companies were started. And once those new insurance companies got their hands on all of that new probability math such as the Poisson distribution, insurance companies could estimate how often claims would come in and thus set their premiums appropriately to average out their risks and losses.

Okay, [00:59:00] let me start off with a note about pronunciation. So I mentioned a particular scientist named Huygens

**Aven:** I'm suddenly remembering this. Yes.

**Mark:** In fact his name really should be pronounced as 'huch-ens". Probably. I think that's pretty close, closer to that. But of course

**Aven:** As we were very kindly told in the comments by a great fan of the show.

**Mark:** But of course in the Anglophone world, the name is Anglicised "hoy-genz'. So I guess I thought, oh, well, he's the pronunciation that people will recognize.

**Aven:** Yeah. That English speakers will recognize this. This is in English. Yeah.

**Mark:** It's not the actual pronunciation of his name. It should be something more like "heogh-enz".

**Aven:** Yeah. It's a Van Gogh issue. Yes.

**Mark:** Now I talked about the likely etymology which I said came from Old Norse likligr, likely, and [01:00:00] Old English geliclic, which is just a silly sounding word. And it, it sounds like it's repeating itself because it is, the point being that it comes from Old English, gelic, which means like, or similar, which is closely related to the Old English, non prefixed version of that lic, lic meaning body or corpse. And I guess the word Lich has survived into modern English in very specialized usage.

the only thing I'm thinking of is like fantasy stuff, referring to an undead thing, L I C H. Right. But it's not a word that I think most people know. In any case this word lic or gelic, with the prefix, comes from proto Germanic, lik which means body, form or like, same.

Okay. So the idea is it's, either literally a body or in the form [01:01:00] of a thing, right. As an adjective. And so that proto Germanic root not only produced the independent words, gelic and lic, but it also produced an Old English ending, a suffix - lic, which meant having the form of, being like a thing, which

**Aven:** is the ending that is like in modern English

**Mark:** Which is like, so if you say something is I don't know, shiplike or something.

**Aven:** Right.

**Mark:** But that - lic also reduced down to the pronunciation -ly, L Y. So it's also the suffix L Y both in its adjective form from -lic, having the form of, and its adverbial form, which in Old English was -lice, with an E. So that E is also a suffix that's added to turn adjectives into adverbs.

Okay. So - lice, in a manner denoted by which we, so we have LY as an ending that both forms [01:02:00] adjectives, like lovely, lovely, quickly quickly that's the adverb form, right.

**Aven:** Yeah. Lovely is an

**Mark:** adjective, an adjective formed from a noun. Then you can add it to an adjective to form an adverb, but

**Aven:** you can't do it twice.

So lovely-ly. No, it's not, doesn't work. We can't do that even though sometimes you want to yeah.

**Mark:** Yeah. And so both of those modern English suffixes L Y come from this same root. So likely is there for literally like, like or body body or similar, similar in, yeah. like the form of like having the, I dunno anyways, however you want to interpret it.

That's that's what's going on there. So it is a kind of reduplication or something, a doubling of, of that, that form. Now I mentioned the only other thing I want to say here is that I, I mentioned this problem of points which was incorrectly solved by Pacioli and as it turns out others as well.

[01:03:00] So I just thought it was, it'd be interesting to see what the various incorrect solutions were. And then will give a sort of explanation of the correct solution.

**Aven:** Is this going to be math?

**Mark:** A little bit, I'm not going to fully explain the correct solution because it's too much math and I would probably do it poorly, but I will explain the incorrect solutions because they're easier to understand, but that's why they're incorrect, I guess.

So Pacioli's incorrect solution was to simply divide the stakes in proportion to the number of rounds won, already won by each player ignoring the number of rounds needed to win. So you can see that's a problem, right? Yeah. It's just what their performance already was, but who knows what could happen in the future?

The other guy could just win all the next, it doesn't count the uncertainty. So that was incorrect. Cardano, who was influenced by Pacioli, discussed this problem as well. And his contemporary 15th century Venetian mathematician engineer, surveyor and bookkeeper, Niccolò Fontana Tartaglia, I'm [01:04:00] probably pronouncing that poorly.

**Aven:** There's no way that Tartaglia is pronounced that way.

**Mark:** Who is perhaps most important for his work on ballistics, calculating trajectory of a cannonball's flight with his book on the subject becoming a common reference manual for gunners.

It was actually used by, actual gunners in the 18th century. That's what mainly he's known for, but he also talked about this problem and he came up with a different incorrect solution. His method was to relate the size of the division of the pot to the ratio of the size of the lead and the length of the game.

Okay. Now the problem with this is that it would mean for instance, that in a game of say a hundred rounds the division of the stakes would be the same if it was 65 to 55, as it would be if the lead was 99 to 89, they're both 10 apart. And [01:05:00] so it was purely based on that different, that difference.

But as you can see, if it's 65 to 55, there's a lot more space for it to go on, it's anyone's game. Really. It's not that much an important lead, but if you're already at 99, you're going to win.

**Aven:** The probability. Well, not necessarily, but the probability is much

**Mark:** higher than you'll you'll

**Aven:** win. Hence why this is a probability problem.

**Mark:** Yeah. So that was his solution. Not correct, but he fired cannons correctly. So we still like him, I guess,

Now, as I said, I want to attempt to explain the actual solution, but I will say that the key insight that Pascal and Fermat both had was that it doesn't depend on the number of past wins.

Each player has. That's kind of irrelevant, right? It depends on the number of rounds. Each player still needs to win in order to achieve the overall victory and how many

**Aven:** rounds there are going to be.

**Mark:** So that way,

**Aven:** if there's 30 rounds left to [01:06:00] play, how many rounds does each player need to win? Yeah. And how likely is it that they will win that many in 30 rounds?

Yeah. And whatever that math is. Okay. I understand that much, theoretically. I just want to say for the record that I'm actually perfectly good at math. I don't want to be a "math is hard Barbie" person here. But I theoretical math of this sort is not my jam. I've

**Mark:** worked so hard to understand Bayes theorem for this.

And I didn't, I didn't really know how to explain it. Well, I think I, I did come to an understanding of Bayes theorem, but I still didn't feel comfortable enough including a full explanation in the video. Cause I didn't think I could write one good enough. But I think it's really, really important.

So the last thing I will say is you know, these two Pascal and Fermat is that we have their correspondence on this topic.

And it's kind of interesting. And so I'll just read two little quotes of what Pascal wrote because they sort of, [01:07:00] tussled with the solution to this. And he disagreed and agreed and sort of went back and forth. And finally they figured it all out. But a couple of little quotes that are just kind of fun.

Pascal writes: "Your method is very sound. And it is the first one that came to my mind in these researches. But because the trouble of these combinations was excessive. I found an abridgment and indeed another method that is much shorter and more neat."

**Aven:** Well, that's important. Yeah.

**Mark:** And then the other quote is: "Monsieur, your last letter satisfied me perfectly. I admire your method for the problem of the points, all the more because I understand it well. It is entirely yours. It has nothing in common with mine and it reaches the same end easily. Now our harmony has begun again."

**Aven:** That's sweet.

**Mark:** So I thought those were nice little quotes and

**Aven:** it's such French letter writing.

**Mark:** And [01:08:00] so now we just have part three stats and stocks.

**Aven:** All right. Let's listen to that one.

**Mark:** In the previous videos we started from the word ‘average’ and its origins in maritime shipping, and looked at the development of probability maths and their role in property insurance: how Islamic scholar Al-Kindi did early work on probability and statistics, and passed on Arabic numerals to Europe, which were picked up by Fibonacci, who inspired Pacioli, who was the first to mention the problem of points, which was incorrectly solved by the gambling scholar Cardano, but was correctly solved by Pascale and Fermat, whose math became the backbone of probability theory, which was written up by astronomer Huygens, and became useful in solving astronomical problems, like Gauss locating the dwarf planet Ceres, and was added to by other mathematicians like Bayes, Laplace, and Poisson, which eventually became useful to property insurance companies, which earlier had got their start after the Great Fire of London.

Well, the other thing that the insurance game really needed to get going, [01:09:00] particularly life insurance, was statistics, and the lack of good mathematical ways of dealing with statistics was holding things back. Sure, there had been some fairly basic forms of life insurance since the ancient world, such as burial societies in Rome. You pay a regular fee, and when you die, the society makes sure you get a proper funeral and assists your survivors. And you can find statistics being collected and used in some fairly basic ways since the ancient world. Again, the Romans collected census data, and in medieval England, shortly after William the Conqueror and the Normans defeated King Harold and the Anglo-Saxons at the Battle of Hastings, the Normans went about compiling census data for taxation purposes, into a document known as the Domesday Book, which really just means Judgement Day book, by way of analogy to the finality of the judgements on Judgement Day, and not actually as apocalyptic as the Norse Ragnarok we started off with back in the first video. In a surprisingly sophisticated use of statistics, the Greek historian Thucydides records how the Athenians used what we would now call the mode, loosely speaking a kind of [01:10:00] average, of a number of attempts to count bricks in the wall of a city they were invading to estimate the size of ladders they’d need to scale the wall. And the 9th century Arab mathematician Al-Kindi’s work with using letter frequencies to decypher encrypted texts can also be seen as a mathematical foundation to statistics. But it wasn’t until the 19th century when the new probability math was brought to bear on the analysis of statistics that statistics as a mathematical endeavour really took off. The word statistics, by the way, doesn’t necessarily refer to numerical data. It actually comes from the New Latin statisticus “affairs of state”, so it really originally referred to collecting and studying any information about the state. It came into German as statistich to mean “of the collection and evaluation of data…relating to the study of the state”, and after the 18th century German political scientist Gottfried Achenwall coined the noun form Statistik, the word began to narrow in meaning. It was introduced into English by Sir John Sinclair in his 21 volume Statistical Account of Scotland, in which he [01:11:00] acknowledges borrowing the word from German but applying to it a slightly different meaning, in his words “an inquiry into the state of a country, for the purpose of ascertaining the quantum of happiness enjoyed by its inhabitants, and the means of its future improvement”. So the data was still not specifically numerical. But by 1829 the word had further narrowed in sense to “numerical data collected and classified”, and no longer referred specifically to data about the state.

But for the advancement of numerical statistics [even if not by that name], and specifically leading to the use of statistics in life insurance, we turn to Sinclair’s earlier fellow Scotsman John Arbuthnot, a physician by trade, who also engaged in literary and mathematical pursuits in his off-time. As a writer, he was a member of the early 18th century Scriblerus Club, an informal association of authors including such satirical bigwigs as Johnathan Swift, Alexander Pope, and John Gay. Arbuthnot may have even provided inspiration for elements in Swift’s Gulliver’s Travels and Pope’s The [01:12:00] Dunciad. In addition, he also likely invented the English national personification John Bull, originally a figure of political satire. In more probability-related endeavours he translated Huygens’s book on probability, making it the first work on probability in English. But for our purposes Arbuthnot’s most important mathematical contribution is in the study of birthrates. In doing that study, he made one of the first inferences from statistical data when he noted that there was a slightly higher proportion of girls to boys in the birthrates, which he took to be evidence of divine providence, as it allowed for the fact that males die young more often than females, due to fighting in wars and such. Well, right data, but wrong conclusions.

Actually, before Arbuthnot, John Graunt made similar observations about birth and death rates, compiling the first life table in the 17th century. Graunt was in fact a haberdasher by trade but is now remembered as one of the first demographers, and in recognition of his statistical work was elected to the Royal Society, and is now sometimes referred to as the [01:13:00] “father of statistics”. Not bad for a haberdasher. Sadly though, his house burned down in the Great Fire of London and he eventually went bankrupt, dying some eight years after the fire of jaundice and liver disease. Too bad he didn’t have insurance. But the other 17th century person to work on the mortality tables which were necessary for life insurance was economist Sir William Petty. A charter member of the Royal Society, Petty also apparently came up with the idea of laissez-faire government. As a statistician his only statistical technique was the basic use of simple averages, but he was nevertheless able to estimate population sizes.

But the first to work out a life table relating the death rate to age, which you can imagine would be crucial for life insurance, was Edmond Halley. Yes that Edmond Halley, who “discovered” the comet that came to be known as Halley’s Comet by studying earlier sightings and thereby predicting its return in 1758, some 16 years after his death, bringing us to motifs of calculating the movements of celestial objects and to predicting the [01:14:00] future. Actually comets had themselves been seen as predictors of great calamity since time immemorial. Indeed Halley’s Comet itself was taken as an omen, at least retrospectively, of the Norman Conquest when William the Conquerer defeated King Harold taking over the throne of England, as we saw earlier. It’s even pictured in the Bayeux Tapestry. Also seemingly depicted in the tapestry is the death of King Harold, who legend has it was killed by an arrow to the eye. Bet he didn’t see that coming!

But as I mentioned before it wasn’t until probability maths were applied to statistics that statistics as a field could begin in earnest, and one of the first to do this was Belgian astronomer and mathematician Adolphe Quetelet, who was by the way deeply influenced by the astronomy work by Pierre-Simon Laplace, who did most of the legwork on Bayes’ theorem, which was very important to probability. As an astronomer, Quetelet founded and directed the Brussels Observatory, and studied periodicity in celestial objects. At the time the probability maths were mainly being used in astronomy — like Carl Friedrich Gauss using the method of [01:15:00] least squares to predict the orbit of Ceres. Well Quetelet took what he learnt from probability in astronomy and began to apply it to other things, including the statistics of human populations, and came up with the concept of the “average man” — there’s that word average again — who is characterized by the mean values of measured variables that follow a normal distribution. Which means that he’s responsible for the Body Mass Index or BMI. So you can blame him as you diet in the attempt to reach some unrealistic expectation of the ideal body!

And that brings us to the first life insurance company, which was actually founded sometime earlier in 1706 by William Talbot, bishop of Oxford, and Sir Thomas Allen and was called the Amicable Society for a Perpetual Assurance Office. The scheme was basically that members, who had to be between the ages of 12 and 45, could purchase 1 to 3 shares at a fixed rate and proceeds would be divided between the families of deceased members proportional to the number of shares purchased. So not taking [01:16:00] into account probability at all. Plus, anyone over 45 was out of luck. Like the British mathematician James Dodson. Dodson worked as an accountant and math teacher, and when he tried to join the Amicable Society, he was turned down as he was then over 45. So he decided to do something about it, hatching a scheme for a more equitable insurance company. He would build on the tables of Edmond Halley so that the premiums charged would be calculated on age-based life expectancy. Unfortunately Dodson wasn’t able to get his scheme off the ground before he died at the age of 52, leaving three motherless children unprovided for. Fortunately antiquarian and scholar Edward Rowe Mores, who worked on history and typography, picked up the baton, and eventually got The Equitable Life Assurance Society founded in 1762. Oh, and in case you were worried, Dodson’s children were eventually provided for by Equitable Life in recognition of Dodson’s work on the life tables. As for Mores, he decided that the chief official of the company would be termed [01:17:00] an actuary, a word which had previously been used to refer to a “registrar or clerk”, but since then gained its more specific sense in the world of insurance. Though Mores was the first to use that title, he wasn’t really a statistician, so the first actual actuary was Welsh physician, physicist, and statistician William Morgan, when he was hired as Assistant Actuary in 1774. In addition to working for Equitable Life, Morgan published papers on actuarial science and is considered the father of that field. He got the job on the recommendation of his uncle Richard Price. Price was a mathematician and nonconformist preacher who was, among other things, the literary executor of mathematician Thomas Bayes, gathering for publication all of Bayes’ unpublished work, including the work on probability and Bayes’ Theorem. Price continued the work on life tables for the Equitable Society.

Now one thing you may have noticed from the preceding discussion is that these early life insurance companies were actually assurance companies. Indeed the terms were used [01:18:00] rather interchangeably and assurance is actually the older term, coming through French from the Latin ad- “to” and securus “safe”. And indeed to this day many British life insurance companies are called assurance companies, whereas insurance is used to refer to marine and fire insurance. This distinction between assurance and insurance was suggested by Charles Babbage, inventor of the analytical engine, the world’s first computer. And Babbage fits into our story in more ways than one, for he along with our friend Quetelet, inventor of the “average man”, formed the Royal Statistical Society, a group which fostered the continuing work on statistics and promoted the use of statistics for the common good.

As a bit of a coda, aside from the insurance market, there’s another kind of market to come out of those coffee shops I mentioned way back in the first episode: the stock market. The first company that issued stocks was the Dutch East India Company. Not to be outdone by their trading rivals, Britain followed suit. But the problem was, where could the [01:19:00] exchange of stock be carried out? At first they did so in the Royal Exchange, but were banned from there, reportedly on account of their rude behaviour. So instead they began frequenting one of the nearby coffeehouses, in particular Jonathan’s Coffeehouse, where there were regular postings of stock and commodity prices, so the first stock market in England. And this was the beginning of the London Stock Exchange or LSE.

Many similar institutions subsequently popped up around the world, including the New York Stock Exchange in the US. And this is where American journalist Charles Dow founded the Wall Street Journal to report on business and finance. Dow also, along with statistician Edward Jones, invented the Dow Jones Industrial Average. Basically by averaging the stock prices of certain companies thought to be indicators of how the market was doing as a whole, you could make a pretty good prediction of market behaviour overall. When the average is rising we call that a bull market. The opposite is the bear market. Basically a bear is a trader who is pessimistic about how the market is [01:20:00] going and wants to sell stock, whereas a bull is a trader who intends to buy believing the price of the stocks will go up. It’s all about predicting the future. And where did the bear and bull terms come from? Well some suggest the analogy that bulls fight with their horns pointing up, whereas bears fight with their claws pointing down. However, bear seems to get this sense from the expression bearskin jobber, from the proverb sell the bearskin before one has caught the bear. And bull seems to go back to a slang expression used in Jonathan’s Coffeehouse.

The word bull itself comes from Old Norse boli, which can possibly be traced back to the Proto-Indo-European root \*bhel- meaning “to blow, swell”. As for bear, well that’s an interesting one. The usual Proto-Indo-European root meaning “bear” leads to Latin ursus as in ursa minor, the little bear constellation which now contains the north star. In ancient Greece, when astronomers like Ptolemy were charting the skies, the north star didn’t exactly line up with the North Pole as it does now, so the whole constellation of ursa [01:21:00] minor indicated north. The Greek derivative of this root is arktos meaning “bear”. And we get the word arctic from this Greek word because that ursa minor constellation marks out the arctic [not because of polar bears]. But the English word bear doesn’t come from this root at all. Instead it comes from the Proto-Germanic \*bero- meaning “dark” so the dark animal. This is what’s called a taboo replacement. When a culture believes a certain object or concept can’t be named directly, perhaps for religious reasons or other social taboos, they come up with an indirect way of referring to it. So the bear becomes instead the dark animal. And this may also lie behind the name of the hero Beowulf, from the Anglo-Saxon eponymous epic poem. One explanation of his name is that it means “bee-wolf”, which is what’s called a kenning, a kind of metaphorical play on words. What acts like a predatory wolf to bees? A bear, who steals their honey. So another way of saying bear, without actually saying bear. And the final upshot of all this [01:22:00] is that Beowulf, who was no average man and was said to have the strength of 30 men in his hand grip, has for that reason lent his name to the Beowulf cluster, a way of using a network of ordinary, or should we say average, personal computers, our old friend Babbage’s progeny, to cheaply produce a system capable of large computational power. Beowulf clusters are popular with universities, who don’t have a lot of cash, but need to do the sorts of complex calculations that are required for things like finding binary pulsars—the kind of astronomy we can do now, as a result of all the mathematical advances of the past.

So stats and stocks, Roman burial societies.

**Aven:** Sure. I don't have a lot to say on that, but it is an interesting thing. Sometimes people talk about groups in Rome and they kind of refer to them as guilds and trade associations. And while there were certainly associations of groups of people who did the same trade, they weren't guilds [01:23:00] in the medieval sense of guild.

What a lot of them were, were burial societies. So burial societies were often groups of like, you know, bakers or some other group, dyers or whatever. They would have other, they would do other community oriented things as well. But since burial was really, really important, it was a super important problem that you be buried properly and could cost money.

And commemoration was good if you could manage it. And a lot of trades people and people just in general, in the lower echelons of society, didn't have a lot of money. And quite often were freed slaves who might also not have much family, so they didn't necessarily have family they could rely on to do the burial.

What you get is these burial societies where people contribute a fixed amount and then if any member of the group dies, everybody else would bury them and also perform some of the sort of commemorative rituals.

Like they might have a yearly feast [01:24:00] where they celebrate, you know, they commemorated each of, and there were certain rituals that were involved with attending on the tombs of dead people that were normally done by the family. But if you didn't have family, then these burial societies might tend to your grave in these kinds of ways, which would rescue you from being thrown into the paupers pits, where they literally just threw the bodies of people who had no one to take care of them.

And, and that was like a big deal. So that's, you know, it's not really what we would think of as life insurance, but one of the things that people buy life insurance for these days is for covering burial costs because funeral costs can be so high, especially if you do want to be properly, you know, to be buried and commemorated in certain ways.

And so people buy life insurance simply to cover funeral costs. So that still is happening.

**Mark:** Well, these ancient Roman burial societies did not survive into the middle ages. However the actual medieval guilds eventually came to supply a similar [01:25:00] service. So they provided other insurance like support covering well, first of all, they would do the burials, but they would also support covering losses suffered from shipwreck, fire, water, and theft, or burglary of cattle. So they are an important buffer, proto insurance kind

**Aven:** a buffer against total disaster. Yeah. Yeah. Which, which at any point was like one bad thing away for so many people, still is today.

**Mark:** Now I mentioned a bunch of terms in there and one that I, for some reason, didn't give the etymology for is census, which, you know, It's a significant word in this semantic field. So I thought I'd do that now. it comes from Latin census, the enrollment of the names and property assessments of all Roman citizens for the purpose of taxation, really taxation

**Aven:** and the army, [01:26:00] and the army.

It was important also for determining whether you qualified for enrollment in the army, what your position would be, what your duties would be, and for voting, it was hugely important for voting not only whether or not you voted, but what economic class you voted in because of the complicated assemblies of Rome.

**Mark:** So census comes from the past participle of the verb censere, to assess, appraise, value or judge, which comes from the proto Indo European root \*kems- or \*kens- which would mean to proclaim or speak solemnly. So it gives you a sense of, how censuses were done or where it came from anyways, as a kind of proclamation of your yourself.

**Aven:** Yeah. And also a calling on the calling on people

**Mark:** to come forward, I guess. Yeah. So another thing that comes from this root \*kems- or \*kens-, [01:27:00] there's a suffixed form, or there is presumed to be a suffix form, \*kems-ti- which is perhaps the first member of the compound, \*ke(m)sty-an(d)ra or \*kensty-anra literally meaning praise of men. \*anr or \*andr means man or men from the root \*ner- man.

And you can see that clearly in the Greek aner, andros. So from this compound \*ke(m)sty-an(d)ra perhaps comes the Greek personal name, Cassandra. Hmm. Okay. Which is also thought to partly come from another root \*skand- or \*kand-, or \*skend- or \*kend- meaning to shine. So, again, this brings up the idea of predicting the future.

Cassandra being a

**Aven:** notable predictor of the future

**Mark:** Whose predictions were not believed. [01:28:00] And therefore Troy was destroyed because she predicted the fall of Troy. And none of the Trojans believed her prediction. If only Troy had insurance,

I'm just glad there's nothing in reach of you that you could throw at me now. So

**Aven:** oh my God. I can't believe that whole thing was just leading up to that.

I would like to censor that! I should probably bring up census, censor, same word because the census was also an opportunity for the censor who was the one who took the census to strike you from the rolls to take you out of the class for shameful or other kinds of illegitimate behavior that made you no longer a credit to the group that you were part of.

**Mark:** And you're just wishing you could strike me now,

**Aven:** [01:29:00] did you have anything to add?

**Mark:** Well, I would like to read a cultural note about this reconstructed name, proto Indo European name. So this is, this is from Calvert Watkin's dictionary of Indo-European roots, American heritage dictionary of Indo-European roots. And that's also where I got this, etymology from.

But he includes an extra interesting cultural note here. So he writes in ancient India, the fire God Agni was sometimes called Narasama, praise of men because in his role as messenger of the gods, he conveyed the praise formula offered by poets, the men to the gods. The word Narasama Shama nara-sama or nara-shama, I'm not sure, is a compound of Nara, meaning man from \*ner-, that same route and Sama or Shama praise.

And kemso from \*kems-. The word [01:30:00] sama has a close relative sasti from the form of the reconstructed noun, kempsi, also meaning praise, which occurs in similar contexts. If we take the Indo European reconstructions for Nara and sasti and make a compound out of them, kemsti aner, meaning praise of men, we have what looks exactly like the ancestor of the Greek name, Cassandra from pre Greek \*kemstri anra, or kestri anra, the a is the feminine ending.

So it's the feminine form of this name. This variant of Cassandra, the name of the legendary prophetess who was cursed by always being disbelieved. This etymology of Cassandra's name is not universally accepted, but her gift of prophecy has close links to the word of both divine messenger and the Indo-European poet, one of whose functions was as a seer. So poet as seer, compare the Sanskrit word, kavi, meaning [01:31:00] both poet and seer"

**Aven:** and the Latin word vates, which means both poet and seer.

**Mark:** Ah! So, yeah, so that seems to be an association. Okay. So a last few points to pick up on from some of the things that I mentioned in that bit. I talked about this guy Playfair, no, I didn't talk about Playfair. I almost included Playfair but he is another important person in the history of statistics that I almost included, but I sort of left them out at the last minute. So William Playfair he is the founder of graphical methods of statistics and he invented several types of diagrams.

So in 1786 he invented the line area and bar chart of economic data. And in 1801, he came up with the pie chart and circle graph use to show the part, whole relations. So the inventor of the pie chart, if you like pie, which I'm sure you all do. He was brought up by his brother, [01:32:00] John Playfair, who is notable for having made accessible the geological work of James Hutton, specifically the concept of uniformitarianism, which is the idea that physical processes, geological processes are the same now as they were, you know, a million years ago that the laws of geological physics don't change.

Exactly. And we talk about him in episode 39 From Fossil Hunters to Mammoth Cheese. And as a child, older brother John had younger brother William record temperature changes or temperature readings every, every day and compiled a sort of chart out of this. And this was the inspiration for his interest in statistics and, and doing this sort of thing.

And he gives credit to his brother. He says, you know, my brother was the inspiration for me being interested in this stuff and, you know, pursuing this. But William Playfair was not as much of a pillar of society, I [01:33:00] guess, as, as his brother was, he was a bit of a scoundrel figure he early on apprenticed for James Watt, steam engine James Watt.

He worked as a draftsman and clerk. And then after that, he jumped around from city to city and job to job. He had a silver smithing business. He claimed to have invented the Semaphore Telegraph, but he actually didn't and was sent on his way by the actual inventors of it. He tried to blackmail a Scottish Lord claiming he had purchased his heirs.

I'm not quite sure how that works, but anyways it was, again, an unsuccessful scheme. He was sued for libel. He was nearly jailed for fraud. He was forced to flee from France after sending some of the countries aristocrats, this is during, the revolution and all of this business sending some of the country's aristocrats to settle on American tracts of land that he didn't actually own.

He was nevertheless a [01:34:00] staunch royalist, and he worked as a secret agent during the revolution, the French revolution reporting on what was happening with the revolution and organized a clandestine counterfeiting operation in 1793 to collapse the French currency.

In terms of his work on the statistics stuff, he published a book called The Commercial and Political Atlas which was a compendium of bar and line charts representing different European countries, imports, exports, wages, and other trends which he had access to data. So he didn't produce the data itself, but he produced the visualizations of it.

Right. And then later also published a book. Well he published a bunch of books, but another book that he published was The Statistical Breviary which is the one that included the pie chart for the first time. But at the time people didn't pick up on this and in fact, people generally dismissed statistical graphics [01:35:00] because they thought it was just show and that to make an argument, you had to make it with words and pictures were, pictures could mislead. They weren't real hard evidence. Interesting. So no one really paid any, in fact, he was criticized widely by other sort of men of learning at the time for this work saying, this is rubbish.

What is he doing? And so he died in poverty and obscurity.

**Aven:** That's sort of depressing. Yes.

**Mark:** But later people sort of picked up on it obviously. And obviously he's massively important to now the way that the statistics are always conveyed. Right. It's always given through graph

**Aven:** visualization as a huge field.

Yeah.

**Mark:** I mentioned Price, right. Who did all the insurance, math and stuff. Another interesting fact about him was that he supported US independence and this sort of recalls that, that moment of the U S colonies breaking away and taking away the the means [01:36:00] to producing tar for the boats. He was also a protege of Elizabeth Montague who was an important salon hostess at the time.

So various great artists and thinkers and things at the time. So he was part of that kind of crowd. Unlike Playfair, Price was an ardent republican, supporting both the French and American revolutions. He wrote pamphlets encouraging and supporting the American revolution and was known to and helped foster communication between many famous revolutionary figures.

He was invited by the Continental Congress to go to America and assist in the financial administration of the states, but he turned it down because he was already the private secretary to Lord Shelburne, the British PM at the time.

**Aven:** Okay.

**Mark:** He was something of a mentor to Mary Wollstonecraft whose book, A Vindication of the Rights of Men was a response to Edmund Burke's attack on Price, over [01:37:00] his support of the French revolution and her book, A Vindication of the Rights of Women, which extended Price's arguments about equality to women.

So he was also you know, you also wrote about equality of the sexes. Another previously mentioned in our podcast figure historical figure who is important to statistics is Florence Nightingale. Hm. So in addition to being a pioneer in nursing, she was also a pioneer in statistics. She actually had training in mathematics from an early age.

So she was one of the people that did pick up on Playfair's graphical statistics and developed a sort of new form of the pie chart that is now known as the polar area diagram. That's the kind of pie chart where it's not just a circle, but bits like the triangles extend

**Aven:** yeah, I sort of know what you're talking. I think

**Mark:** anyways, she used these graphical statistics to convey her arguments about health data and all this sort of [01:38:00] thing. And as a result of her pioneering work in the field of statistics, she was elected as the first female member of the Royal Statistical Society that I mentioned in 1859.

Another previously mentioned figure who I hesitate somewhat to mention. But who was also important to the development of the field of statistics is Francis Galton not friend of the show enemy of the show. I don't know what his

**Aven:** That effin' guy,

**Mark:** he was the cousin of Charles Darwin. And he was interested in the heritability of traits like talent and genius.

He figured he was one given all his famous relatives in the great Darwin Wedgewood family. And he coined both the concept and the word eugenics.

**Aven:** I mean, that's something to go down in history for, isn't it.

**Mark:** As well as the phrase nature versus nurture. And he loved to quantify everything mathematically, including [01:39:00] women's beauty, compiling a beauty map of Britain, spoiler London rated highest Aberdeen, lowest, and the efficacy of prayer, spoiler, not at all. And he developed the science of statistics and the concepts in particular of correlation, regression towards the mean, and standard deviation. Right. And so if you actually want to hear more about this lovely fellow you can go back to episode 32 Ariadne's Clue and also a video which has not yet become a podcast episode.

The video called How Do We Perceive a Poem?

And the final point that I want to make about this last part is about stock markets. So I covered the origins of the insurance industry and along the way, I did mention that the first English stock market started around the same time as the insurance markets in the late 17th century.

But that [01:40:00] wasn't the world's first stock market. That was, Britain's first stock market. The world's first stock market was established in Amsterdam in 1602 by the Dutch East India company. So now we're going to look briefly at a couple of the consequences of this market.

So with all the money coming in from the Dutch East India company there was a lot of money to go around in the Netherlands. And when people start getting rich, inevitably, they want to have status symbols.

**Aven:** They spend money on stupid stuff is what you're saying.

**Mark:** And the status symbol in this case was the tulip, the flower which had arrived in Europe by way of Turkey.

So another contribution from the Islamic world to Europe. The name itself is also from Turkish. So the word tulip is etymologically related to the word turban from the notion that the flower shape resembles a turban. So it comes from Turkish, tülbent, meaning turban, which comes in turn from [01:41:00] the Persian word, dulband, meaning turban, and this is a compound of the words, dōl, meaning bucket, probably a reference to the tall cap around which a turban was wound and of Arabic origin.

Akin to the Syriac, dawlā and Akkadian dalû meaning bucket plus the word band meaning band of cloth or like a ribbon, strip of something. So like a hat band, essentially. And in fact it's the same word band. the Persian word band comes from the proto Indo European root which is the same that gives us band and bind.

It's the proto Indo European root \*bhendh which means to bind. Okay. So the tulip became very popular in the Netherlands around the 1630s, and because the tulip bulbs took a long time to produce, demand outstripped supply. We can see where that's going. And so yeah, the price of the tulip shot up [01:42:00] dramatically.

Soon enough people began to buy tulips, not to plant them, but as an investment, right. You know, well, I don't care about the pretty tulip, this is a good money-making scheme. So they were hoping to sell them for profit. And eventually this began to happen only as paper contracts, not the actual tulip bulb, so now you've got stocks, what we would now call futures contracts, right.

And rarely tulip bulbs and actual money, rarely passing between them. It was just done on this, theoretical paper level. And well, as with all bubble markets, high prices eventually collapsed. And this seems to be the first example of a bubble market in collapse. So, you know, this is a thing that is obviously relevant to us now, having experienced similar bubble market collapses in recent years.

**Aven:** Not that recent,

**Mark:** not that reason now. Yeah. Now it's all about COVID but you know, before COVID, well,

**Aven:** I just mean like a decade ago, a [01:43:00] decade ago, more than a decade ago, the housing market bubble, but

**Mark:** there'll be more so, oh yeah, of course, of course. And then secondly back in England in the early 18th century, we see the first instance of market manipulation.

So this is the event of, the South Sea Company which was created in a scheme to consolidate and reduce the cost of national debt. So this was from the start designed as a scheme that had nothing to do with trade. So the company was granted a trade monopoly with South America, but the founders of the company themselves had no actual belief or intention that anything would come of this monopoly.

It was indeed an out and out fraud. Nevertheless, people were seduced by the company's promises and the idea of getting rich trading with the exotic new world. And so the stock price soared before inevitably crashing as would happen you know, with such bubble markets. Many were [01:44:00] ruined by the collapse and many were implicated in the scheme, but ultimately the event led to the Bubble Act passed by British parliament which forbade the formation of any other joint stock companies, unless approved by Royal charter.

And so that is, the best I can say about the stock market

**Aven:** and nothing bad ever happened again with stocks. So that's good.

Well, I think that. It hardly exhausts the topic of mathematics or stocks or probability or any of those things or Arabic contributions or all of the things you've talked to. But I think it's perhaps a good place to leave it for tonight. I'm sure we will come back to some of these things. As you've already pointed out, how many other podcasts and videos this interconnects with, and there will be more to talk about on these topics.

I am sure. So I hope you've had a, more than average, good time [01:45:00] with this more than averagely long episode,

**Mark:** it's alright it will average out of it over other episodes.

**Aven:** So as you can see, we still don't actually understand math,

but I think that's where we'll, we'll leave it for tonight. So thanks for listening. And for being part of this ongoing project, we're now at 101 episodes. So we're started on our next Centennial?

So we'll be back. The next episode will be an interview episode.

**Mark:** Excellent.

**Aven:** Goodnight

**Mark:** Goodnight

**Aven:** For more information on this podcast, check out our website, www.alliterative.net, where you can find links to the videos, blog, posts, sources, and credits, and all our contact info.

**Mark:** And please check out our Patreon where you can pledge to support this show and our video project. You can go directly to the videos at youtube.com/alliterative.

**Aven:** Our email is on the website, but the easiest way to get in touch with us is Twitter. I'm @AvenSarah A V E N S A [01:46:00] R A H.

**Mark:** And I'm at @alliterative. To keep up with the podcast, subscribe on your favorite podcast app or to the feed on the website.

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**Mark:** Bye