**Math != Scary**

Let’s start with a show of hands. Who here understands this?

[Slide: Swift source code]

It’s a piece of source code, right? There’s a for-loop, an if-statement, and so on. This is a pretty basic algorithm that counts how often an element appears in an array. It should be a piece of cake for most of you.

Now, who here understands this?

[Slide: complicated math]

Don’t be shy to put up your hands. :-)

As you probably guessed, this is a piece of math. In case you didn’t recognize it, this is the “explicit formula for the prime counting function”.

Don’t worry if you don’t understand this, there won’t be a quiz. I’m not sure I completely understand it either, to be honest – I just googled for “difficult math equation” and this is what came up.

(If you do want to know what it means, ask that guy who raised his hand.)

I get the sense that this slide is a lot more intimidating to most of you than the previous one. I think I even heard some groans, “Uhf, math!”

[Slide: rage face?]

Math has a pretty bad reputation, not just among normal people, but also amongst us software developers.

Well, let’s turn that frown upside down.

[Slide: same rage face but with silly smile]

The point I’m going to make in this talk is that math is actually pretty cool, and fun, and that it’s not really very different from software development.

And – most importantly – that every one of you is already a lot better at math than you think.

[Slide: someone looking disgusted]

Let’s start with why math is so reviled. How come people will run away as fast as they can, once you start talking about Pythagoras or sine waves or algebra?

[Slide: cheesy pick-up line “Hey baby, you’re as sweet as 3.141592653589793238426433832796…”]

Don’t try this as a pick-up line. It doesn’t work very well.

(To be honest, I’m surprised all you guys showed up, with this talk being about “math” and all. But I’m glad you did. Think of this as a free therapy session at the end of a long day, and then we can all go to the party and blow off some steam after. Sound good?)

If you don’t like math at all, if the thought of it makes you break out in hives, if you have nightmares of doing multiplication tables or trigonometry, then you, poor listener, may suffer from mathophobia, also known as math anxiety.

[Slide: math anxiety (anxious rage face?)]

And where you did pick up this nasty-sounding affliction? Well, it’s been said that “math anxiety is a disease caused by school”.

So there you have it. The reason why math gives you the heebie-jeebies is because of the way it is taught in the traditional classroom.

If you’re terrified of doing math, then you have this [point at slide]. It’s a real thing and it affects just about any one of us.

[Slide: happy nerds (Big Bang Theory)]

Except of course for that handful of lucky people who actually enjoy doing math.

But even for them, it’s been claimed that they only succeeded in learning mathematics *despite* what they were taught in school.

[Slide: how to play piano despite years of lessons]

I have this book, “How to learn piano *despite* years of lessons”.

I only started to play the piano in my late twenties, because for years I had this limiting belief that becoming good at the piano was impossible unless you started when you were like 5 years old.

But it turns out that most kids who take piano lessons end up hating the piano just about as much as they hate math. And for pretty much the same reasons too.

[Slide: boring routine, girl crying at piano?]

For those of you who didn’t take piano lessons, the way that playing the piano is taught is very similar to the way math is taught: all you do is memorize facts and do practice drills, over and over and over [pull bored face].

There’s no room for creativity or having fun. I mean, it’s called “playing” the piano for a reason, you’re supposed to play and mess about, right?

But alas, you don’t really get to learn how to make up your own tunes. And you won’t really learn how music really works.

Maybe if you practice *a lot*, you might become good at reproducing music that someone else wrote down a few centuries ago. And that’s cool. But you still won’t be able to play that Kylie Minogue song that you heard on the radio unless you can find the sheet music for it.

There is no deeper understanding of music; it’s just this mechanical process for playing the right notes at the right time. Just like high school math doesn’t give you a deep understanding of mathematics, it’s just this mechanical process for performing calculations.

The following story is typical; I’ve heard it many times. It goes like this: “As a kid I used to like picking out tunes on the piano, so my parents decided I was talented and made me take music lessons.”

[Slide: horrible piano teacher, but funny]

“But my piano teacher was this horrible witch and I dreaded going, and I couldn’t stomach the thought of playing the piano for years.”

How sad is that? Taking piano lessons actually ruins music for a lot of young people. And how familiar does that sound to doing math?

[Slide: how to play piano despite years of lessons, again]

If you were traumatized by your experiences with piano lessons, then this book will help to undo a lot of the damage, and it shows you how to make music that really comes from within you. It puts the fun back into making music.

[Slide: strike out piano in the book title, replace by math]

I really wish *this* book existed, “how to play *math* despite years of lessons”.

And “play” is the right verb here too. Doing math should really be like playing a game or solving a puzzle.

In my language, we have the word “denksport” or “thinking sports”, exercises for your brain. Sports and games are fun, right? That’s what math could be, and should be, but at an intellectual level.

Unfortunately, just like piano teachers, math teachers tend to suck all the fun and excitement out of math. They are like fun vampires.

[Slide: fun vampire]

If you don’t like math, or if you feel you’re no good at math, then you’ll be glad to hear: it’s not you. You’re not defective. You simply weren’t taught properly. Math anxiety is the result of bad teaching, simple as that.

So we’re all irreparably damaged by our failed educations… Well, no I don’t think so. We just suffered a minor setback.

This is all a bit of a downer, so to cheer you up a bit, I have a picture of balloons:

[Slide: something that screams fun, like balloons]

I keep saying that math can be a lot of fun, something you can really enjoy doing.

I suspect some of you may be a bit skeptical about that, so I’m going to back up my claim with the following piece of evidence:

[Slide: a half-filled in Sudoku]

I’m sure you all recognize this; it’s a Sudoku. This is played by millions of people all over the world. These things are super popular.

Now I know what you’re going to say, “That’s not math! That’s a puzzle!” And that’s true, it’s a puzzle… with numbers.

Well, guess what math is: puzzles with numbers.

Solving puzzles is what humans like to do. We can’t resist it. It’s how our brains are wired. That’s why kids like games, because many games are about problem solving.

Whether you like it or not, this [point at slide] is math; you just don’t think about it that way.

And a lot of the math you learned in school – or were *supposed* to learn – isn’t any more difficult than solving a Sudoku. Your brain is really doing the same thing.

(I hope that didn’t spoil Sudokus for you.)

My girlfriend Deanna, her brain freezes up just at the thought of having to do math. Yet, for some reason, she really likes this game:

[Slide: rummikub]

This is Rummikub. It’s a game where you arrange and rearrange numbers into certain patterns.

This game definitely exercises your math muscles. You have to use pattern-matching skills; you often have to think ahead several steps.

But she doesn’t think about it as math, so it doesn’t trigger the bad memories of school and how she used to get upset at doing her math homework.

(pause)

She beats me far too often at this game.

[Slide: blackjack]

Here’s another game she likes, blackjack. To get good at blackjack, you need to learn all about odds and probabilities. Again, it’s mathematics!

You don’t hate the math because you don’t see it as math. It’s disguised as an activity you like – playing blackjack. And it’s worth learning because you could win some big bucks.

The same thing goes for other card games like bridge or poker. Most games we play are very mathematical in nature.

(pause)

I’m sorry to break it to you, but if you’re the kind of person who likes these kinds of games and puzzles, then you just might be a closet mathematician.

[Slide: closet mathematician]

Obviously, just because you know how to solve Sudokus or win at blackjack that doesn’t mean you’re also able to solve Fermat’s Last Theorem.

But it does mean that you’re definitely able to comprehend the kind of mathematics that is used in science and engineering.

And that brings me back to programming.

[Slide: source code example again, with WTF!? Rage face]

Let’s say 5 years ago, or 2 years ago, or however long ago it was that you first started programming, if I showed you this piece of source code, it probably wouldn’t have made any sense to you.

You first had to learn the language – not just Swift but the language of computers and programming. How to use a compiler, what a variable is, how recursion works, and a thousand other things.

It was probably quite tough to learn too, but eventually you did learn it and now you speak Objective-C or Swift or C++ or Ruby fluently.

This sort of thing [point to slide] makes sense to you now, because you know the language. But it still looks like a bunch of gobbledygook to someone who isn’t a programmer.

[Slide: math example]

Just like this looks like gobbledygook to someone who doesn’t speak the language of math.

My point is that you’re all intelligent, smart people. You’re software developers; you do difficult things all day long. Math isn’t any more difficult than what you do in your development jobs already.

It just looks hard, for the same reason Chinese writing looks hard to anyone who doesn’t know Mandarin.

Just because this doesn’t make any sense to you right now, doesn’t mean you’re not capable of learning it. Of course you are. If you were able to learn how to program computers, you’re able to learn anything.

What you do on a daily basis is basically the same as what a professional mathematician does on a daily basis. In many ways, you already think like a mathematician, you just don’t speak the language yet.

That’s why I said you’re probably better at math already than you think.

[Slide: developer being happy about math]

OK, fine. Developers are mathematicians. So what?

I’m not saying we should all drop what we’re doing and go prove the Riemann hypothesis or some other difficult math problem. That is all purely theoretical research that doesn’t have much practical value.

However, getting better at some of the high school and college-level math such as calculus and statistics may not be such a bad idea.

What do you need that kind of math for? I’d say for any piece of software that is interesting.

[Slide: games]

If you want to make games, even simple 2D ones, it helps to know trigonometry. For 3D games you need to know about vectors and matrices and quaternions and geometry.

[Slide: list of areas, not as bullet list but across the screen with animation]

All of the hot areas of software development right now, machine learning, big data, computer vision, special effects for movies, speech recognition, high frequency trading, robotics, even computer science itself… they all require solid math skills.

For example, I have an interest in audio and digital signal processing, and that requires knowledge of complex numbers and Fourier analysis, and so on. It’s been years since I used that so that was a bit rusty, so studying the math really helped me understand what I was doing.

If you want to get ahead in your field and you want to stay relevant, knowing a bit more about math will be very helpful.

And having a basic level of fluency in mathematics will also make you a better programmer. (And better programmers make more money.)

[Slide: how?]

Let’s say I’ve convinced you to give math a second chance. How do you go about it?

Well, the first thing to do is drop the idea that what you learned in school was math. It’s not. What you learned in school was not math, but calculation.

There is no reason why you should ever have to do long division in your life again, because of this glorious invention:

[Slide: old school calculator]

If you need to do a calculation, use a computer. That’s what they are for.

[Slide: soulver with example]

I really love this app, Soulver. I use it all the time, even to calculate the simplest stuff. So what if I can’t do this in my head? I’ve got better things to think about. I don’t want to waste brain cycles on something my computer is much better at.

I’d rather use my brain for something that my computer *cannot* do, such as being creative.

[Slide: Mathematica]

And when I need to do more heavy-duty calculations like finding the roots of a polynomial or the derivative of a function, I use the most awesome tool for math ever, Mathematica.

But that’s the boring part of math, that’s why we let the computer do it.

Where math gets interesting is figuring out *when* you need a polynomial or derivative to solve a particular problem in the first place.

[Slide: confusion of formulas, trig stuff]

I think the reason why many of us have this aversion to math is because we lack a conceptual understanding of what is going on.

All we see are vague formulas but we have no idea where these come from or how they relate to all the other formulas. You may have memorized that sin^2 + cos^2 equals 1, but what is a sine wave in the first place?

If you lack the deeper understanding, it makes all these formulas worthless.

[Slide: insight, lightbulb?]

Learning math is like debugging a piece of code.

I’m sure you’ve had that a-ha moment where suddenly it became clear why your code wasn’t doing what it was supposed to. You may have been struggling with the problem for hours, but when you finally find the answer it’s really satisfying.

You can almost feel the new neural pathways being formed in your brain. After solving a difficult problem like this, you’re literally becoming smarter. It’s a good feeling. That’s exactly what gaining math insight is like.

Learning math is this very personal journey of discovering for yourself how all the pieces fit together, and how to speak the language.

Here are some tips to get started:

[Slide: Math Overboard]

That “how to do math despite years of lessons” book does exist, sort of.

Math Overboard is the book that I used to brush up on my high school math. It’s not perfect but it’s a lot more accessible than most textbooks, and it’s geared toward adults. This is a good place to start.

You can also find e-books and video courses of people teaching high school and college math to adults, but I haven’t tried any of these myself. Many universities now also offer free online versions of their courses.

[Slide: Khan Academy]

Of course, there is Khan Academy. It’s free and they’ve got tons of lessons on pretty much all areas of math that are interesting to software developers. So definitely check that out.

But if you just want to get your feet wet and explore some mathematical ideas without too much commitment, then I can recommend popular science books like this one:

[Slide: 50 things you need to know]

There are many interesting stories about math and the people who practiced it over the ages. Just reading these kinds of books will give you a new appreciation for the art of mathematics, without making your brain explode. It’s all very accessible and written for the casual reader.

[Slide: BBC podcast]

There are also podcasts. A Brief History of Mathematics is a series from a BBC radio program. It’s highly entertaining, full of intrigue and drama, but it also gives you some idea of what mathematics is really about and how fascinating it can be.

[Slide: math puzzle books]

If you do like puzzles and Sudokus and so on, then pick up a math puzzle book. They sell them at any bookstore, including airports, so pick one up on the way home.

You can’t really learn math by just reading about it, you also have to put it into practice. That means you’ll need to do some hard thinking from time to time, and these math puzzle books are a great way to get started with that.

[Slider: Project Euler]

This is a favorite of mine. The only way to learn mathematics is to do it, just like the only way to learn programming is to do it. That book I mentioned earlier, Math Overboard, has plenty of exercises, but you can also use this website, Project Euler.

It has a ton of challenges of a mathematical nature. Often you’ll have to write a short program to solve the challenges, so this trains both your math skills and your programming skills.

[Slide: roadmap]

So there’s a lot of stuff you can do to get into math, even if you’re starting from scratch. I suggest that you brush up on your high school math first, and then move into college level topics such as calculus and possibly the mathematics of computer science.

From there on, it really depends on what you want to use math for. It’s a big field, so it’s impossible to learn it all, but books such as that *50 Mathematical Ideas You Need to Know* can give you some idea of what is out there.

[Slide: something about not being scared?]

I’m not going to lie to you: learning math can be hard and frustrating. I speak from experience – I get stuck all the time. But so what, learning anything new is always hard. Finding and fixing bugs is hard but it’s also half the fun of programming.

It’s OK to be confused. It’s OK to struggle. It’s OK to be wrong. Even professional mathematicians are in a constant state of confusion. No big deal. Eventually you’ll get those a-ha moments and it will all make sense. And it will be worth it.

I’ve been slowly working my way through Math Overboard and Khan Academy and other books for the past year or so. It’s definitely been more fun than high school. It doesn’t have to take much time, just a couple of hours of study per week, and a lot of thinking about problems in between. Taking long showers is great for figuring out a math problem that you’re stuck on.

[Slide: something about loving math?]

Math isn’t really that scary, all right? It’s only as scary as programming is for a newbie, and you’ve all been there before and stuck with it, and look at you now.

So I hope I’ve inspired you to give math another go, and I wish you a safe and happy journey into the land of mathematical thought.

Thank you!

[Slide: fin/Q.E.D/end-of-proof?]