

The Movies Have Your Number

Burkard Polster and Marty Ross — Burkard.Polster@monash.edu; martinirossi@gmail.com

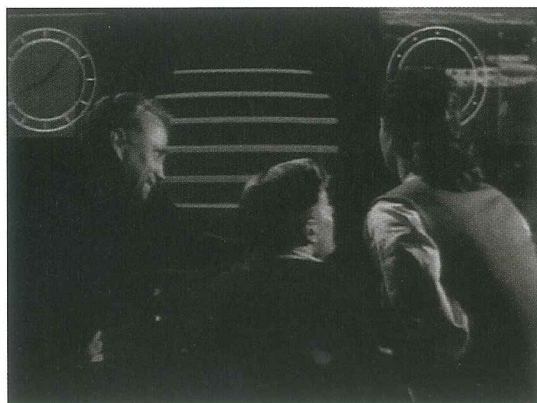
Burkard Polster currently lectures at Monash University. Marty Ross is a mathematical nomad who while watching movies likes to smash calculators with a hammer. Together, Burkard and Marty write the Maths Masters column for *The Age* and are co-authors of *Math Goes to the Movies*.

A Red Planet Appears

One of the great pleasures of living in Melbourne is the preponderance of film groups, and our favourite has long been *Splodge Films*. This amazing one man show is run out of a pub, with Alan Quirk (aka Irving Z. Gribbish) manning two 16mm projectors. Alan presents whatever takes his fancy and his tastes are, well, fanciful.

What does this have to do with maths? On occasion Alan has presented the brilliant Eames documentary *Powers of Ten* (1977), but he doesn't tend to show films with a particularly technical bent. However one night, over a decade ago, Alan happened to show the 1952 movie *Red Planet Mars*.

It's a crazy sci-fi film, a hilarious piece of cold war propaganda. (The *Red* in the title is no coincidence.) That was Alan's interest in showing the movie. However it also turns out that mathematics plays a critical role in the plot. The Martians appear to be sending signals to Earth, and Admiral Carey and ace American astronomer Chris Cronyn are trying to decide how to respond.



Sending the wrong digits in Red Planet Mars (1952).

We don't even know what language they speak, if any. It's like working out a system of communication with gollywogs. How the devil to find a point of contact?

Cronyn's precocious son Stewart provides the answer:



How about pie?

That's hardly the way to offer it, Stew, and by the size of that slice I doubt if there's anything left.

I mean *pi*.

Now what are you talking about?

Well if we're getting answers, they have to have a transmitter as powerful as ours.

Go on, what are you driving at?

Well, they can't build anything like that unless they know how to make a wheel. That means a circle.

And you can't make a circle without knowing the ratio of the diameter to the circumference, pi.

I still don't understand what that has to do with ...

Your son's ahead of you, Cronyn. What is pi?

Three point one four one six as I remember.

Roughly.

That's it, roughly. Actually, it's three point one four one five nine two six and so on, an infinite number of decimals.

Well so what? We broadcast three point one four one six to Mars and what can they answer?

Nothing. But they must be trying as hard to talk to you as you're straining to talk to them. All we're looking for is an opening. So, you don't broadcast three one four one six, you broadcast three one four one *five*.

And if they understand they continue the equation.

Right.

Huh. Where'd you get that idea, son?

Biting into this.

Red Planet Mars turned out to be a very handy clip for adding a touch of lightness and fun to maths presentations, and there were obviously a few other great maths movie clips around. We decided to collect them.

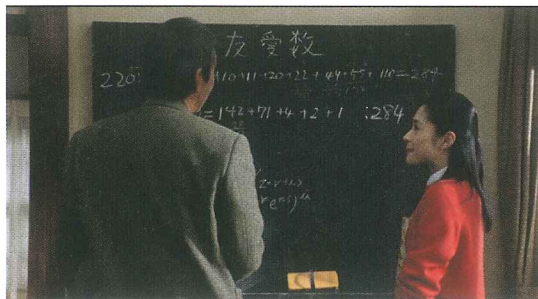


Cronyn then successfully employs the digits of pi to establish communication with the Martians. We won't give away the incredible plot. Suffice to say, the anti-communism and pro-religiousness of the movie is enough to make even George Pell pause.

Math(s) goes to the movies

That movie started it all. *Red Planet Mars* turned out to be a very handy clip for adding a touch of lightness and fun to maths presentations, and there were obviously a few other great maths movie clips around. We decided to collect them. All of them.

Well, we don't have them all, but we *do* have a lot. Our ever-growing Mathematical Movie Database currently lists over 800 movies and TV show episodes containing mathematics. Some, such as *Good Will Hunting* (1997) and *A Beautiful Mind* (2001), are famous and contain tons of mathematics. Others, for example the beautiful Japanese film *The Professor's Beloved Equation* (2006), are not famous but should be. Still others contain just a line or two of arithmetic.



Amicable numbers in The Professor's Beloved Equation (2006).

These one-liner movies can still be great value. A perfect example is *Rules of Attraction* (2002), where the ditzy girl is considering safe sex. She decides that since a condom is 98% safe, two condoms must be 196% safe.

It is impossible here to even touch on all the mathematics contained in these hundreds of movies. That's why we wrote a book.

Math Goes to the Movies (available through the MAV) appeared last year. It was our attempt to cover as much as possible of the maths-movie material, and to do so as entertainingly as

possible. There are things we might have done differently, and nothing compares to actually watching the movies, but overall we are pleased with the results.

Below, we briefly consider two movie-maths topics, to illustrate the manner in which maths is handled — usually mishandled — in the movies. Some of the movies mentioned are quite obscure, but most of the clips are available on our webpage.

Below, we briefly consider two movie-maths topics, to illustrate the manner in which maths is handled — usually mishandled — in the movies. Some of the movies mentioned are quite obscure, but most of the clips are available on our webpage.

How and how not to contact aliens

The most illustrative maths clips are those that get it wrong, and the above scene from *Red Planet Mars* is a fine example. The error is not subtle but it still tends to go unnoticed.

It seems reasonable to grant that the Martians know about π , though it's not difficult to make a wheel without it. How would they then think about π ? Yes, they may know π by its decimal expansion, but of course we Earthlings only use decimals because of the biological happenstance of our having ten fingers.

If the Martians happen to be four-toed monsters, they would more naturally think of π as 3.021003331222..., in base four, or maybe 3.1103755242102..., in base eight. In any case, it is presumptuously human-centric to assume the Martians would typically use decimals.

What, then, would our four-toed Martians make of Cronyn's decimals? They still might make sense of it all, since Cronyn is signalling something to do with 3, and π is one of the few nearby numbers of special importance. Nonetheless, Cronyn is making it needlessly tricky.

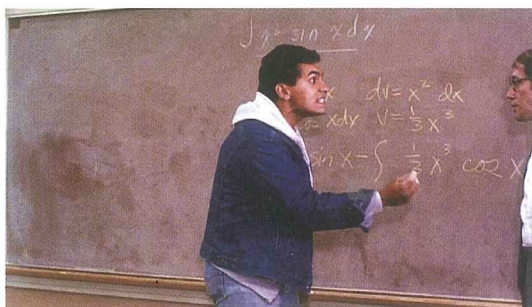
What, then, is the *right* way to contact aliens? This is a fascinating question, the flipside of encoding a message: rather than making our message as difficult as possible to decipher, we wish to make it as simple as possible.

The Dutch mathematician Hans Freudenthal answered this question by creating the language and dictionary of *Lincos*. It was Freudenthal's attempt to build up from $1 + 1 = 2$ to a description of human beings and our world. The result is a fascinating and totally unreadable book.

If the Martians happen to be four-toed monsters, they would think of π as 3.02100333... in base four or 3.11037552... in base eight. It is presumptuously human-centric to assume Martians would use decimals.

One gets the impression that moviemakers are the 'hated maths at school' types. The deficiencies come through loud and strong by considering the movies' treatment of π .

Lincos made an appearance in an episode of the cult TV show *Kolchak* (1974). There, the gentle scholar attempts to talk to the alien in 'Mathematico, the universal language'. Unfortunately, he attempted this with the wrong type of alien, and the next (and last) thing we hear from the scholar is 'Arggggh!'



Intense integration by parts in Stand and Deliver (1988).

Most aliens either speak English or the communication is conducted with weapons. However, there are two other movies we know of where communication is considered as an essentially mathematical problem. One is the ultra-low budget but surprisingly good *The Man From Planet X* (1951). It is suggested that geometry is the universal language, but unfortunately the plot takes a different direction before they can try it out on the alien.

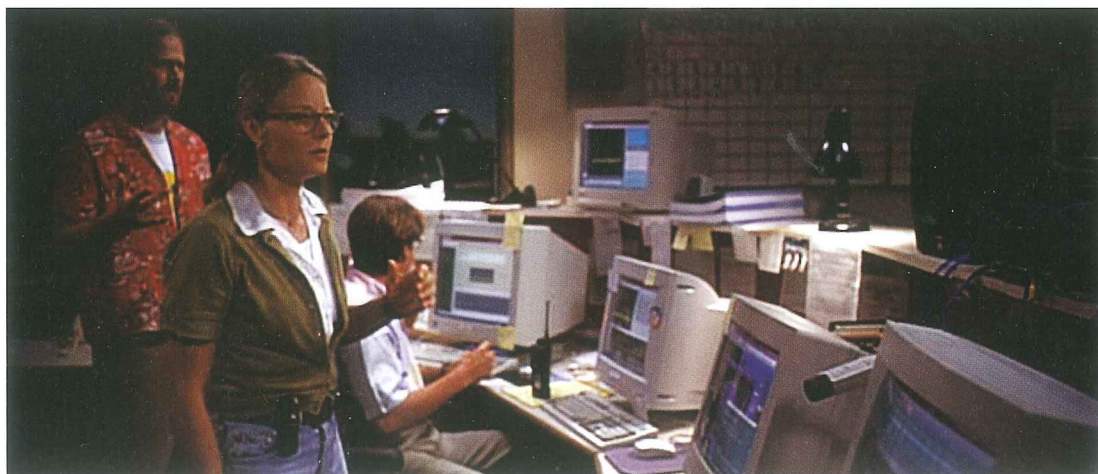
The much more famous movie is *Contact* (1997). Based upon the Carl Sagan novel, it is not surprising that this movie gets it right. Well, almost.

Contact gets going with SETI fan Dr. Arroway (Jodie Foster) intercepting signals from outer space. The signals are identifiable as prime numbers. That's a genuinely clever choice, since prime numbers are truly universal and are very rare in nature (at least in sequence), a clear sign of intelligent intent. Unfortunately, Jodie Foster flubs the moment, referring to them as 'base ten numbers'. This not only negates the very purpose of Sagan's choice of prime numbers, it is also meaningless.

Pieces of pi

It would be naive to expect the movies to contain much in the way of higher mathematics. Occasionally one sees a bit of calculus. Our favourite such scene is of Gary Cooper in *Cloak and Dagger* (1946), calculating (wrongly) the distance travelled by a merry-go-round horse. And one has to mention *Stand and Deliver* (1988), the brilliantly told story of the legendary teacher Jaime Escalante.

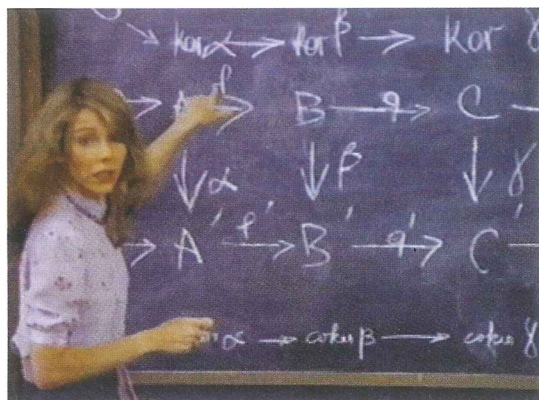
Anything more advanced than calculus is close to non-existent. *A Beautiful Mind* refers to the Riemann hypothesis and other research level mathematics, but there is essentially no detail provided.



Counting the numbers in Contact (1997).

Even the excellent movie π (1998), which contains plenty of stylish and correct mathematics, gets it wrong; the title sequence features thousands of digits of π scrolling up the screen, but only the first nine are correct.

A remarkable exception is *It's My Turn* (1980), which has a female mathematician Kate Gunzinger (Jill Clayburgh) as the romantic lead. The movie opens with an incredible scene of Kate (correctly!) working through the details of the homological snake lemma. Unfortunately, the rest of the movie is astonishingly dull, even for a chick flick.



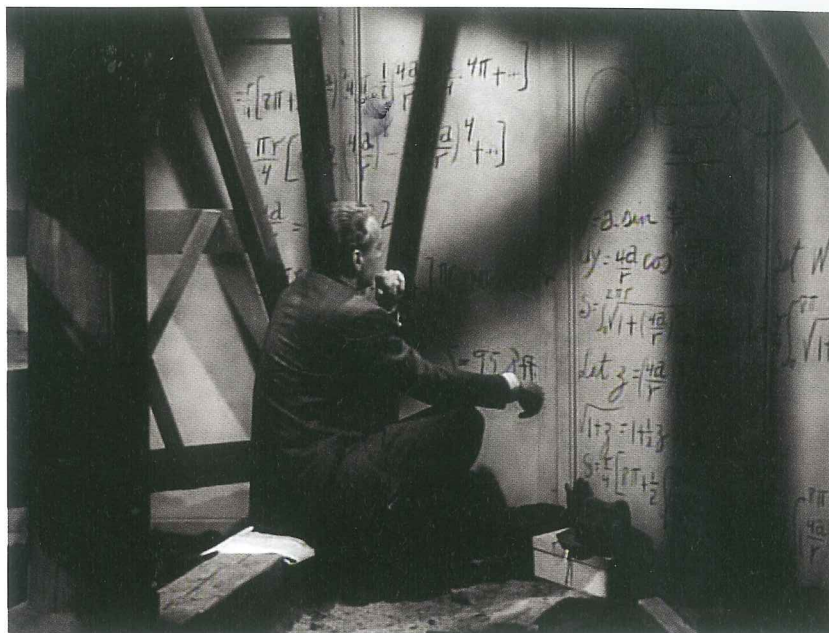
Homological algebra in *It's My Turn* (1980).

Unsurprisingly, moviemakers tend to stick to what they assume their audiences will know and, more importantly, to what they themselves (sort of) know. That means school mathematics, which means lots of arithmetic and the like.

Not that we have anything against school mathematics. However, one gets the impression that moviemakers are the 'hated maths at school' types. The mathematics is generally grudging and clumsy. The deficiencies come through loud and strong by considering the movies' treatment of π .

In this regard, *Red Planet Mars* is one of the better movies. It goes on about the decimals, but before doing so it introduces π as a circle concept. That is very uncommon.

Actually, there is a very notable circle in *Cabiria* (1914), the earliest movie containing maths of which we are aware. In one scene Archimedes can be seen employing an impressively large compass. Unfortunately, Archimedes is doing so in order to design his parabolic mirrors. An inauspicious beginning for maths in the movies.



A complicated arc length integral in *Cloak and Dagger* (1946).



Archimedes in *Cabiria* (1914).

The vast majority of appearances of π in the movies are simply as a string of decimals. Two rare exceptions are *The Infinite World of H. G. Wells* (2001) and *St. Trinians* (2007). Unfortunately, both of these movies inform us that the volume of a sphere is πr^3 . Sigh!



Some excellent π formulas and one horrible one in *The Infinite World of H. G. Wells* (2001).

Not only do most π -appearances consist of little more than a string of decimals, in most cases the decimals are wrong. In *The Virgin Suicides*

Piscine Molitor Patel, 'Pi' of *The Life of Pi* introduces his schoolmates to π as the ratio of circumference to diameter of a circle, and then wows them by writing thousands of digits of π on the blackboard from memory.

There have been rumors for a while that a film about the great Srinivasa Ramanujan may be in the work, and we have high hopes.

(1999), for example, the blackboard is draped by forty-seven digits of π , of which only the first eleven are correct. Similarly, the wonderful *Donald in Mathmagic Land* (1959) features a birdlike creature reciting sixteen digits of π , of which the last two are incorrect. Even the excellent movie π (1998), which contains plenty of stylish and correct mathematics, gets it wrong; the title sequence features thousands of digits of π scrolling up the screen, but only the first nine are correct.



A zillion digits in The Story of Pi (1998)>

It's all very strange. On the one hand, for the purposes of the moviemakers it clearly doesn't matter if the digits are eventually incorrect: it's only professional nitpickers such as ourselves who will notice. On the other hand, why not just do it right? It would seem easier to just put in the correct digits and be done with it.

But then there are the movies that frankly just don't give a damn. *Never Been Kissed* (1999), for example, features twelve digits of π , beginning 3.14578.... Why even bother?

But maybe the movies are getting better. Last year saw the release of *The Life of Pi* (2012). The main character is Piscine Molitor Patel, and to avoid being referred to as 'Pissing' he decides to have his schoolmates refer to him as Pi. To convince

them to do so, he introduces them to π as the ratio of circumference to diameter of a circle, and then wows them by writing thousands of digits of π on the blackboard from memory. It works.

The scene is *almost* correct. We see Pi writing the 3778th digit of π , and the previous digits appear to be correct. Unfortunately, the teacher who declares that Pi's digits are correct is checking from a book that only lists the first 2000 digits of π .

Still, it's a great scene. The minor blooper indicates less the carelessness of the director, and more the impossibility of avoiding criticism from nitpickers with the time and ability to analyse movies frame by frame. If only more movies required such careful detective work.

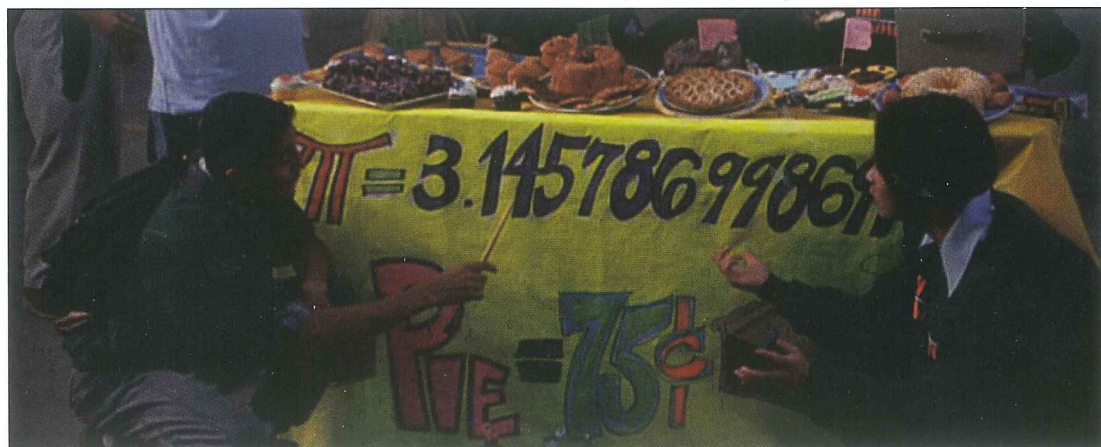
Movies containing mathematics will of course continue to appear, and of course in many of them the mathematics will be laughably bad. Some, such as *The Life of Pi*, will be stylish and correct, and occasionally an entire movie might be devoted to a mathematical character. There have been rumors for a while that a film about the great Srinivasa Ramanujan may be in the work, and we have high hopes.

Well, we have medium hopes. Even given great material, such as Ramanujan's brilliant mathematics and tragic life, moviemakers tend to get more wrong than right. But that's fine with us, too. We'll always be happy to engage in another session of nitpicking.

References

- Polster, B., Ross, M. (2012). *Math Goes to the Movies*. John Hopkins University Press.
Available through the MAV.
www.qedcat.com/moviemath — Burkard and Marty's mathematical movie database

On the one hand, for the purposes of the moviemakers it clearly doesn't matter if the mathematics is incorrect: it's only professional nitpickers such as ourselves who will notice. On the other hand, why not just do it right?



Cheap pie and cheaper pi in Never Been Kissed (1999).