The Great Gibberish - Mathematics in Western Popular Culture

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Introduction

In one of the most famous scenes of one of the most famous movies Hollywood has ever produced, *The Wizard of Oz* (1939), the character Scarecrow gets a diploma from the wizard, convincing him that he now possesses the brain he has always hoped to have. It is a nice lesson: Scarecrow had a brain all along, he just needed someone to convince him of that. Once that is done, Scarecrow shows off his new intelligence by reciting his version of the Pythagorean Theorem. It goes:

> "the sum of the square roots of any two sides of an isosceles triangle is equal to the square root of the remaining side".

There is an outside chance that the makers of the movie were making a sophisticated point with the erroneous mathematics. While Scarecrow now believes he has a brain, the botched mathematics shows that he still has a long way to go. But that is presupposing a level of subtlety conspicuously lacking in rest of the movie. Thus the best explanation is probably the most straight-forward one: the makers of *The Wizard of Oz* simply did not know how the Pythagorean Theorem goes.

That is remarkable when one remembers that the film had - for the time an astonishing - budget of almost three million dollars, roughly 20 million adjusted to 2015 money. But by itself the erroneous "theorem" is not particularly interesting, as Hollywood is hardly known for its commitment to factual accuracy. What is interesting, however, is that *The Wizard of Oz* is symptomatic of a much wider phenomenon. As is often the case, here the entertainment of a people seems to mirror its general attitudes. In the case of *The Wizard of Oz* and mathematics, this happens in three important ways. First, mathematics is clearly something that is highly esteemed as an intellectual pursuit. It is not a coincidence that Scarecrow recites - or at least makes an effort to recite - a

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theorem of mathematics when he is giving his new brain a test run. In this *The Wizard of Oz*, as we will see, is no exception.

The second lesson we can learn from *The Wizard of Oz* comes from the fact that Scarecrow's line is erroneous in so many ways. Of course the Pythagorean Theorem concerns *right* triangles, not all isosceles ones. It applies to the *squares* of the sides, not square roots. And even if we adjust the theorem in these two ways, it is not the case that the sum of *any* two sides equals the third side. To have three such major confusions in one simple line is quite remarkable, and worth analyzing in detail. However, more interesting is the fact that also in this regard *The Wizard of Oz* is just one example of a general attitude. Mathematical knowledge may be held as a paragon of intelligence, but ridiculously little effort seems to be made to present mathematics accurately.

There is also a third way in which the scene from *The Wizard of Oz* portrays general attitudes toward mathematics. Scarecrow recites his version of the theorem from rote memory, making his intellectual performance distinctly unmathematical. Granted, in the few seconds reserved for Scarecrow's new brain it is hard to display any real mathematical ability. However, that only shows why mathematics was a bad fit with the scene to begin with, not any compromise in presenting mathematical proficiency. This is also symptomatic of a wider phenomenon in cinema and television: portraits of mathematicians and what they do are highly misleading.

In this paper I will also present a fourth and a fifth important stereotype in which mathematics and mathematicians are portrayed in western popular culture, but for that we have to go beyond *The Wizard of Oz*. Those stereotypes can be, if the author is excused, illuminated with the help of a short personal anecdote. Once in a conference a professor of philosophy asked me about my scientific interests. When I mentioned that I had studied mathematics as a second major, he asked me whether I thought it was a good idea for a philosopher to get education also in mathematics. Somewhat baffled, I muttered something about the value of logical thinking to all philosophers. He replied by asking whether I knew who Ted Kaczynski was.

Ted Kaczynski is of course better known to the world as the Unabomber, and the reason the professor brought him up is that Kaczynski had a PhD in mathematics. Kaczynski worked briefly as an assistant professor at Berkeley, before at the age of 26 (in 1969) he suddenly resigned and became a recluse. In 1978 he started a mail bombing campaign, which he continued until his capture in 1995. Three people were killed and dozens more injured.

The professor's question was rather incredible, but not surprising. There is a wide stereotype, often perpetuated in popular culture, that too much mathematics is liable to make one insane. But aside from being incredible, there was something quite familiar about the question about Ted Kaczynski. It occurred to me only much later that the exact same question was asked by Robin Williams' character in the hit movie *Good Will Hunting* (1997). When the character of Matt Damon is torn between staying with his girlfriend and embarking on a mathematical career, it is reminded that there was a serial killer

who was a mathematician. How can such a random connection be a focal point of the movie? The only answer can be that it must tap into some widely shared understanding about mathematicians, i.e., that mathematicians are somehow exceptionally susceptible to madness.[1]

But the story of Ted Kaczynski, as it is usually presented, is not only a story about mental illness. It is also the story of an anti-social man struggling with normal everyday life. This, too, seems to be a common stereotype when it comes to presenting mathematicians in the popular media. The assumption seems to be that mathematicians must lack social skills. Derogatory words like geek or nerd are commonly used to refer to mathematicians. In the worst case mathematicians are presented as completely asocial, often with issues in mental health.

In this paper I will study how mathematicians are presented in western popular culture, and above I have described the five stereotypes that I will be testing on the best-known modern movies and television shows containing a significant amount of mathematics or important mathematician characters.

1. Mathematics is highly valued as an intellectual pursuit.

2. Little attention is given to the mathematical content.

3. Mathematical practice is portrayed in an unrealistic way.

4. Mathematicians are asocial and unable to enjoy normal life.

5. Higher mathematics is often connected to mental instability - if not downright mental illness.

But before we move on to that analysis, let me explain the context a little further. The first question to ask is what exactly is meant by *western* popular culture? Such terminology is inevitably somewhat vague and unfortunately I cannot give a full analysis here. But by "western" I mean the kind of popular culture that most people at least in North America and Western Europe are familiar with.[2] While there is clearly a great deal of variation in what popular culture consists of from country to country, there are also some parts which remain remarkably constant. If a movie is widely shown across Europe and North America, with an overwhelming probability it was produced in Hollywood. Hardly any television shows not originally in English are shown in North America. There are exceptions, but there is little doubt that modern western popular culture is dominated by American entertainment. Hence in this paper the focus is on American movies and television shows.

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[1]The stereotype of an insane mathematician has been perpetrated in print, as well. Joan Didion (1998), for example, wrote an article in the *New York Review of Books,* presenting the connection between mathematics and insanity in Kaczynski almost as something to be expected.

[2]This can be expanded to include other parts of the world. Big parts of Oceania, for example, are largely part of the same cultural sphere. But the movies and television shows studied in this paper are for the most part relatively well-known on all continents.

I will also focus only on recent works, from the past twenty years or so. I want to find out what kind of an image a person living in a western country will get of mathematics and mathematicians. Regrettable as it may be, older cinema and television is likely to play a small part in that. Even more regrettably, other forms of art will often play an even more minor part. There are, for example, many fiction and non-fiction books featuring important mathematical content, but the popularity of these is on a totally different scale from movies.[3]

Just like books, television documentaries can get sizable audiences, but nowhere near the figures of Hollywood films. In addition to the smaller audiences, the problem with non-fiction books and documentaries is that their audiences are likely to be much more specialized. Blockbuster movies like *Good Will Hunting* and *A Beautiful Life* get viewers from all kinds of audiences, whereas television documentaries about mathematics are more likely to get viewers that have an interest in mathematics in the first place.[4]

Based on the considerations above, I have limited the approach here to recent movies and television shows that have important mathematical content or mathematician characters, and which are well-known at least in North America and Western Europe. What counts as a *mathematician* is of course also something that should be defined more precisely. One common character, after all, is the math teacher. Films like *Stand and Deliver* (1988), *Lambada* (1990) and *Mean Girls* (2004), as well as television shows such as *Wonder Years* (1988-93), feature inspiring math teachers. Mathematics is often presented as the subject most difficult to make interesting for students, particularly less-privileged ones. Why that is the case is an interesting question which is not unrelated to the topic at hand. In this paper, however, I focus on characters that are professional working mathematicians. While the image of math education in popular culture is an important question, so is the image audiences get of mathematicians. Most people would probably not consider their old high school teacher and, say, John Nash to be professional mathematicians in the same sense. It is the image of the latter that I want to examine here.

Finally, I want to emphasize that the list of five stereotypes is not supposed to be exhaustive. In fact, when it comes to portraying mathematicians in popular culture, there are stereotypes concerning gender and race that are at least equally prevalent and in many ways much more troubling than the ones studied here. With very few exceptions (most importantly the film *Proof*, which

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[3]Sales figures for books are unfortunately not released, but selling a few thousand copies in a week is usually enough to make *The New York Times* bestseller list. Sylvia Nasar's biography of John Nash, *A Beautiful Mind*, was a number one bestseller in biography, so it should be reasonable to assume that it has sold copies in the tens of thousands, at most hundreds of thousands. Ron Howard's film based on the book, however, has grossed more than 300 million dollars worldwide, seen by dozens of millions of people - and that is not including TV audiences. I do not want to suggest that books about mathematics cannot get sizable audiences, but there is often an overwhelming difference in the popularity. The influence of movies and television shows on our popular culture are much more widespread.

[4]Of course mathematics in popular culture includes a wide array of other subjects. One interesting subject is mathematics in advertising, which is studied in Evans, Tsatsaroni & Staub 2007. Paulos (1997) has written about the flawed math in newspapers. These are just two examples of the many areas of popular culture in which mathematics plays a role.

is built on challenging the male-dominant stereotype), all the mathematician characters analyzed in this paper are white men. While this is perhaps understandable given that traditionally mathematics in the western world has been a male-dominated field with limited ethnic diversity, these stereotypes could clearly be challenged more often.[5] The main reason I will not address these stereotypes is that I feel that they are well-acknowledged in the literature on the subject. This is particularly the case with the gender bias, which has been treated in numerous papers and books.[6] Here I want to focus on the question what *other* stereotypes permeate our popular culture, ones which may not have received as much attention.[7]

It should be added that in no way do I want to imply that it is unproblematic that mathematician characters are almost exclusively white males, even if this has traditionally corresponded to the demographics of mathematicians.[8] But there other other important questions, as well. It should be interesting to ask *how* those white males are presented. There are many subjects which suffer from the same gender and racial stereotypes in popular culture. In this paper, I want to examine what stereotypes are peculiar to mathematics and mathematicians.

1   What was studied

For the sample, five well-known films containing important mathematician characters were chosen. Some were huge hits while others have gained cult appreciation, but it should be safe to say that all the films have entered the western popular culture in some manner. In addition, four popular television shows were included. Below is a brief synopsis of each film and television show, focusing on their mathematical content. In the next section, the five stereotypes will be analyzed with regard to each film and show. Although here I have focused on the five movies with major mathematician characters, there have of course been mathematicians in many other well-known movies. In Steven Spielberg's *Jurassic Park* (1993), for example, the character most skeptical about bringing

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[5]Although at least with the gender stereotype, there is starting to be a change. As explained in Kasman (2011), the amount of female mathematician characters in fictional literature has increased greatly in the past decades. But while we may have come a long way from the times of talking Barbie doll's infamous line "Math class is tough!", it is clear that gender is still one of the most important stereotypes we need to deal with.

[6]See, e.g., Damarin (1995), Duchin (2004), Mendick (2006) and Greenwald & Thomley (2007).

[7]This is not to suggest that no literature on the subject exists. Damarin (2000), for example, deals with some of the stereotypes that are associated with mathematicians, including insanity.

[8]There is also one strong stereotype that seems to have a strong presence, even when it means ignoring or changing historical facts. In addition to being white males, the mathematicians in films and television are almost exclusively heterosexual - and even biographical stories are changed to exclude references to homosexuality. These include *A Beautiful Mind*, which does not mention John Nash's homosexual affairs and *Enigma*, which tells the story of Bletchley Park codebreakers during World War II. The film revolves around a love story and replaces Alan Turing, a well-known (and tragically, convicted) homosexual, with a heterosexual character.

dinosaurs back to life is a mathematician. But the mathematical content itself was limited to an unfathomable demonstration of chaos theory. There are many similar cases in which the mathematician characters are not developed enough, or the mathematical content is not presented seriously. To be included in the study here, mathematics or mathematicians must play a more important role.

1.1 Movies

Good Will Hunting

In Gus Van Sant's *Good Will Hunting* (1997), the main character Will Hunting is a mathematically gifted misfit who works as a janitor at MIT. A professor of mathematics there leaves a problem on a blackboard in the corridor and Will solves it. Unable to find out who solved the problem, the professor leaves another problem on the blackboard, this time a more difficult one that has taken two years for the professor and his colleagues to solve. Will also solves the second problem and the professor realizes he has found a mathematical genius.

Although highly talented, Will is a troubled young man and somewhat reluctant to follow a career in mathematics. The professor asks his old friend, a therapist, to have sessions with Will. The main tension of the film is built around the duel between the mathematics professor and therapist in deciding Will's future. The professor of course wants him to become a mathematician, while the therapist is more concerned about Will's happiness.

While Hollywood films may have complex plots, one thing the viewer can usually count on is that the moral of the story is presented unambiguously in the end. In *Good Will Hunting*, the main character is so improbably complex that this proved to be challenging. Not only is Will a math genius working as a janitor - as well as an expert on seemingly every other academic subject - but also an abused orphan with severe psychological issues. His main hobby seems to be spoiling for fights with his friends. So when in the end he goes for the girl - inevitably there is one - he is rejecting so many things that it is hard to keep track. But one thing the writers make clear is that he is rejecting mathematics. The mathematics professor emerges as the villain because he wants Will to embark on a mathematical career. In one central scene, Will burns some of his mathematical work, which the professor then pathetically tries to rescue. The lesson is clear: there are bigger things in life than mathematics.

What is not clear is why anyone would think differently? Why could Will not become a mathematician, have his old friends *and* get the girl? Aside from the standard story-telling preference for conflicts, the role of mathematics in the story becomes interesting. As Will becomes emotionally more open, his interest in mathematics seems to dwindle. The final blow for mathematics comes when Will's psychologist brings up Ted Kaczynski. The Unabomber does not quite enter the story as a warning about what a life in mathematics leads to, but it certainly suggests a dark side. If there were any doubts about the position of the filmmakers, there is the added twist that the therapist - a warm emotional

person - was in fact himself a gifted student who, in no unclear terms, chose love over ambition in academics.

Pi

In Darren Aronofsky's *Pi* (1998), the madman theme is played to full effect, along with other common stereotypes of mathematicians. The protagonist, Max Cohen, is a number theorist who is driven insane by trying to find mathematical patterns in everything. The mathematics in the movie, when not outright wrong, is mostly unfathomable. Max's mentor, for example, had spent much of his career "researching pi". Max wonders how he could stop when he was so close to finding a pattern in that number. A mathematically literate viewer must wonder what all that might mean. But really cringe-worthy is the way Cohen, a number theorist, works. The only thing he seems to do is stare at printouts of random numbers, looking for patterns. In *Pi*, number theory seems to be simply numerology and number theory and Kabbalah are presented - even explicitly, when Cohen describes a man studying the Torah as a number theorist - as two sides of the same thing.

To be fair, in one scene the mentor - the one who researched pi - says that if Cohen loses scientific rigor, he is no longer doing mathematics - he's doing numerology. But since that is what all of the characters have been doing all along, the difference between mathematics and numerology seems to be only one of rigor - not methodology.

Yet even more important than the flawed math is the amount of stereotypes that the character of Max Cohen manages to include. He can multiply two three-digit numbers in a couple of seconds, he is socially extremely awkward, he was a child prodigy and, of course, he also goes insane. A more depressing character or a film is hard to find and mathematics is throughout the film presented as the main reason for Cohen's problems.[9] Just to make sure, when Cohen finally loses his mathematical ability through self-inflicted brain damage (in a fantasy section), we see him smile for the first time.

A Beautiful Mind

Ironically, few movies give a more stereotypical portrait of a mathematician than the most famous one based on an actual person: Ron Howard's *A Beautiful Mind*, the 2001 Oscar winner for the best picture. The film, based on Sylvia Nasar's (1998) bestselling biography by the same name, tells the story of John Nash, the Nobel laureate mathematician who struggled with schizophrenia.[10] Aside from suffering from mental illness, Nash was a highly creative mathematician with an asocial character; in other words, a perfect subject for a Hollywood film about a mathematician. Drawing formulas on windows and

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[9]Although Aronofsky himself provides this with his later films, such as *Requiem for a Dream*.

[10]Nash won his Nobel for economic sciences. There is, of course, no Nobel prize for mathematics.

having lines like "The truth is, I don't like people much," the Nash character of *A Beautiful Mind* is quickly set up as the stereotypical single-minded recluse.

While Nash undoubtedly was socially awkward, the filmmakers have clearly emphasized the characteristics fitting a stereotypical movie mathematician. In Nasar's biography, Nash is presented as a rather complex character. Finding socializing among people difficult, he was nevertheless confident - even arrogant - among his peers. He was a well-known prankster and sometimes his behavior toward his fellow mathematicians could be downright obnoxious. He struggled with homosexual impulses, but also fathered an illegitimate son. He refused to marry the child's mother in a large part due to her lower social status, even wanting to give his son for adoption - before vanishing from the boy's life altogether.

In the end, most of the real story of John Nash was omitted from the movie, and much of the Nash of *A Beautiful Mind* was invented by the screenwriters. In the sappy final scene, Nash gives his Nobel speech - actual Nobel laureates do not give winning speeches - including phrases like "it is only in the mysterious equations of love that any logic or reasons can be found." It is not particularly apropos for the film's portrayal of Nash's marriage and struggle with sanity, but it is even more out of place as something that John Nash would say.[11]

Perhaps Hollywood biopics should not be evaluated too much by their historical accuracy. In a movie with star-gazing, car chases and other Hollywood staples, it is also understandable that aside from one (as will be explained below, rather unsuccessful) scene about the non-cooperative game of picking up girls in a bar, there is very little effort to explain Nash's mathematical ideas. And as becomes clear in the second part of the film, *A Beautiful Mind* is mostly a movie about mental illness. As will be seen, the film creates a simplistic storyline in which mathematics and mental illness are tightly connected. In a quite troubling way, mathematics is portrayed as the demon that tormented Nash. This interpretation is deeply problematic, but even if it were accepted, it has to be remembered that Nash never abandoned mathematics. Considering this, it is quite strange that a biopic about someone who has devoted most of his life to mathematics ends with a line devaluing logic and reason - of course followed by thunderous applause from the audience. Although not as clearly and radically as in *Good Will Hunting* and *Pi,* also in *A Beautiful Mind* mathematics is presented as an obstacle in the pursuit of love and happiness.

Enigma

Enigma (2001), directed by Michael Apted and based on the novel by Robert Harris, is a film about the Bletchley Park code breakers during World War II. The main character - just like the most famous real Bletchley Park worker - is a mathematician, but for some reason, Alan Turing is replaced by a fictional character with quite different characteristics. Like Turing, the character, Tom

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[11]Indeed, the word "love" cannot be found in the short autobiography Nash wrote for the occasion of his Nobel prize: http://www.nobelprize.org/nobel_prizes/economic-sciences/laureates/1994/nash-bio.html

Jericho, is a brilliant mathematician who puts his logical ability to work in breaking the codes in messages sent to German U-boats. There is little doubt that the Jericho character draws heavily from Turing. For example, he works on Hilbert's *Entscheidungsproblem*, which was one of Turing's main contributions to mathematics. Yet Tom Jericho could hardly be more different from Turing in many other aspects. Perhaps most glaringly, Turing was homosexual while Jericho's story in *Enigma* is built around a heterosexual love affair.

Not surprisingly, Jericho has had trouble with his mental health. The starting point of *Enigma* is the return of Jericho to Bletchley Park after suffering a nervous breakdown. While working too hard is suggested as a reason, the failed love affair is presented as the most important factor. Turing famously had troubles with his love affairs, but these were mainly due to the general difficulty of being homosexual in the Britain of the time. Homosexuals were treated as mentally ill, but also as criminals. Turing went through hormonal treatment as a "cure", which left him in a state of profound depression and ultimately led to his suicide (Hodges (1983)).

When it comes to *Enigma*, otherwise an entertaining yet somewhat ordinary wartime home front drama, the most interesting issue for the topic here is the difference between Turing and the character of Tom Jericho. The film is built around a love affair and presumably the filmmakers felt safer with the more conservative choice of making the affair heterosexual. But also in many other respects, Tom Jericho is very different from Alan Turing. The troubling part is that, as will be seen, many of those differences make him a more stereotypical movie mathematician than what Turing was.[12]

Proof

Along with *Good Will Hunting* and *A Beautiful Mind*, the third major film made in the turn of the century Hollywood interest in mathematics was John Madden's *Proof* (2005), based on David Auburn's Pulitzer-winning play. The protagonist is Catherine Llewellyn, a young woman whose father Robert is a world-famous mathematician. The film is set at the time right after Robert's death. The plot focuses on a proof that is found in Robert's notebooks posthumously. Catherine claims that the proof was actually done by her and that becomes the key topic in the film (and the play). The plot works well as the audience will have to rid itself of the old stereotypes and start believing that Gwyneth Paltrow's character may have been as good a mathematician as Anthony Hopkins'. In this, *Proof* plays quite successfully with a common stereo-

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[12]After I gave the talk that this paper is based on, another film about Alan Turing and the Bletchley Park was released. *The Imitation Game* (2014) is more biographical than *Enigma*, including Turing's homosexuality as an important theme. In terms of historical accuracy, however, the film takes many liberties. Most notably, the actual nature of Turing's work is badly distorted. In *The Imitation Game*, Turing works as a solitary figure against a wide array of colleagues trying to hinder his work. This is in clear contrast with the description of the events in Hodges' biography on which the movie is based. Turing is also portrayed as manic, desperately unsocial and almost autistic, greatly exaggerating Hodges' portrait of a shy and somewhat eccentric scientist.

type which, for the reasons explained in the introduction, has not been included in the list of five here: that all mathematicians are men.

The mathematics itself is never really specified in the film - we learn that the proof is about prime numbers but that is the extent of it - but the general portrayal of how mathematics is practiced is much more realistic than in other films. The characters are working rigorously on proofs and they are part of a mathematical community.

What is less laudable, however, is the film's portrayal of mathematicians. Robert had gone completely insane before his death and Catherine struggles seriously with her own sanity. Like *A Beautiful Mind*, *Proof* is not so much a film about mathematics as it is about mental illness with mathematics as its backdrop. The world of mathematics is presented as one where true innovation carries a close connection to madness.

1.2 Television

The sample of television shows here is by no means meant to be exhaustive. Science fiction shows like *Doctor Who* often make references to mathematics. In addition, aside from documentaries, there are also some other non-fiction programs with a great deal of mathematical content. In the UK, the comedy game show *Dara Ó Briain: School of Hard Sums* presents puzzles - mathematical as well as everyday ones - which are then solved by mathematical means. The show is based on a Japanese game show called *Takeshi Kitano Presents Comaneci University Mathematics*. There is little doubt that such game shows involving mathematics can make math more interesting and exciting to viewers. It can also do wonders to the stereotype of boring, asocial mathematicians. However, so far such shows have not made the leap from local television to international recognition. For this reason, I have focused here on four popular fictional shows with important connections to mathematics.

The Big Bang Theory

As of writing this, one of the most popular comedy shows on television in many parts of the world is the American situation comedy *The Big Bang Theory* (2007-). While none of the characters is a mathematician, mathematics is a recurring subject. In addition, the same stereotypes that are used with the physicists of the show are often applied to mathematicians. In *The Big Bang Theory*, these stereotypes are particularly strong. Much of the humor in the show comes from the physicist characters being nerdy to a comical degree. All the scientists are physically weak, socially awkward, and their non-professional interests are limited mostly to video games and comic books. Sometimes the social awkwardness is developed to absurd proportions. One of the characters, for example, cannot talk to women.[13]

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[13]Although in the later seasons of the show, this changes.

The initial setting of the show is that two nerdy physicists share an apartment and a beautiful young blonde moves across the hall. A recurring scene includes one or more of the scientists explaining a scientific idea to the blonde supposedly in too much detail. The girl, being a typical Hollywood character, is of course totally uninterested in science. When she reacts either in a puzzled or sarcastic manner and the inevitable canned laughter comes, it is clear that the joke is on the nerds: it is always the stereotypically ignorant girl who emerges as the cool person.[14]

The Big Bang Theory has been praised for bringing science to prime time television in an entertaining yet informative manner. That is indeed often the case with the show. There clearly are scientific consultants who provide the content and for the most part their work is well done. It is not easy to explain scientific ideas in the quick-paced style of modern sitcoms, but by watching *The Big Bang Theory* one can indeed learn something about science and scientific methodology.

In that sense, the show is clearly pro-science and quite revolutionary in prime time television. It is all the more unfortunate then that *The Big Bang Theory* uses such tired stereotypes for much of its humor. When the scientist characters talk to each other, and there is no need to make jokes about nerdiness, the dialogue is often witty and sophisticated. To balance that, however, there is always a great deal of humor based on the premise that these are geeky people unable to understand and enjoy "normal" life.

The Simpsons and Futurama

The Big Bang Theory is of course nothing new in its portrayal of scientists as nerds. From Jerry Lewis' *The Nutty Professor* (1963) and much before, the socially awkward geeky scientist has been a comedy standard.[15] Most of the time the character is not a mathematician, perhaps because laboratories make for a better comedic setting than offices. In general, mathematics is not often to be found in television comedies.

There are notable exceptions, however, in Matt Groening's animated series *The Simpsons* (1989-) and *Futurama* (1999-2003). To be sure, *The Simpsons* uses many of the usual stereotypes. There is a scientist character based on the *The Nutty Professor* and all the mathematically gifted children are somewhat socially inept. But as is often the case with the show, behind the tribute to classical comedic stereotypes there is an underlying appreciation for science. The future of Lisa and Martin, the two mathematically gifted children, is always

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[14]As the show progresses, there are some variations on this theme. The blonde sometimes takes interest in nerdy things and the scientists are sometimes presented as successful. But perhaps the most important development is the inclusion of two new major characters, both scientists and both female. This is a refreshing change to the gender stereotype, although the female scientists are well within the usual socially awkward stereotype of a scientist.

[15]The geeky scientist is the comedic cousin of another standard character, the mad scientist. From Mary Shelley's *Frankenstein* (1818) and Robert Louis Stevenson's *Strange Case of Dr Jekyll and Mr Hyde* (1886) on, cinema and television have had an abundance of scientists suffering from a wide variety of mental problems.

presented as successful - unlike that of Bart and the other less academically inclined ones. In general, the show has been pro-science, including guest voices like Stephen Jay Gould and Stephen Hawking.[16]

In addition to including scientists, *The Simpsons* has often taken in explicitly mathematical content. In one episode ("$pringfield (or, How I Learned to Stop Worrying and Love Legalized Gambling)"), the show even corrected Scarecrow's mistake in *The Wizard of Oz* - or to be more precise, one of them. When Homer finds Henry Kissinger's glasses in the toilet, he recites Scarecrow's line verbatim. But someone from a booth shouts: "It's a right triangle, you idiot." Of course the other two errors remain, but to be fair, going through all three flaws would have ruined the joke. In one episode ("Homer^3"), Homer enters a three-dimensional land full of mathematical content including P = NP and the false equation $1782^{12} + 1841^{12} = 1922^{12}$. The latter, if true, would of course be a counter-example to Fermat's Last Theorem. But the equation is close enough to be true so that when you put in the numbers to a normal calculator, it looks correct - a mathematical in-joke if there ever was one.

While little more than glimpses in the background, these kinds of small mathematical details can be found regularly in *The Simpsons* and *Futurama*. There is a comprehensive website dedicated on the subject[17] and Simon Singh has even written a book called *The Simpsons and their Mathematical Secrets*. But how did such content come to appear in the animated series? There is one certain way of ensuring that mathematics is included in movies and TV shows, and that is to have mathematicians as writers. Right from the beginning, there have been many writers of *The Simpsons* with mathematical backgrounds.[18] The first ever regular episode of the show ("Bart The Genius") included a lot of mathematical content, provided by longtime writers Al Jean and Mike Reiss. This tradition has continued throughout the show's long history. In later years, one writer in particular has been important in including mathematical content. Ken Keeler has a PhD in applied mathematics and has written many episodes of both *The Simpsons* and *Futurama*.

Futurama as an animated science fiction show is a particularly fitting platform for mathematical content. There are numerous examples of this, but none more explicit than an episode ("The Prisoner of Benda") that revolves around a farce based on a mind-switching machine. In the end, when the minds of all the characters have been switched to other bodies, they find out that the switch cannot be reversed. So there emerges a problem: how can the minds be switched to the original bodies. What follows is quite remarkable: Keeler (or in the show, two basketball players from the Harlem Globetrotters) provides a proof that only two extra people with unchanged minds are required to guarantee that the original mind-body pairings can be reached. In the Internet this is

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[16]Hawking has also appeared in *The Big Bang Theory* and *Futurama*.

[17]simpsonsmath.com, by Sarah J. Greenwald and Andrew Nestler.

[18]Singh's book expands rather generously on the subject of *The Simpsons* to reach full book-length, but it does help one realize the full extent of mathematical references in the show. Furthermore, it includes interesting insights on humor by the mathematician writers of *The Simpsons*, including the connection between humor and distorted logic.

called "The Futurama Theorem". That is perhaps a bit grandiose a phrase since the proof is more like a student exercise, but nevertheless, it is a mathematical proof constructed for the purpose of an animated TV show. Moreover, it is not just a formula shown in the background: the proof is central to the plot. This portrayal of pure mathematics as something not only useful but cool - keeping in mind that the two mathematicians are Harlem Globetrotters - is in many ways a unique piece of mathematics in popular entertainment.

Numb3rs

Finally, let us take a look at the most mathematical TV show of them all, the crime drama *Numb3rs* (2005-2010). For the most part, *Numb3rs* is a rather generic crime show, but there is one exception. One of the two main characters, Charlie Eppes, is a mathematician who helps in solving the crimes. What is remarkable is that his work involves realistic mathematics, much of it actually used in solving crimes. In addition to those mathematical methods, the show also takes many opportunities to present mathematical concepts and puzzles without direct applications in crime fighting.

The character of Charlie Eppes is also refreshing among the usual stereotypical mathematicians in popular entertainment. He has some limitations in his social skills and is disorganized, as well as somewhat obsessive. But for all the eccentricities, the character seems very much like a real person instead of a television stereotype. Indeed, a remarkable feature of many episodes is that while scientists are portrayed as sharp and worldly - even *cool* - other specialized groups, such as rock climbers in one episode, are often presented as nerdy.

The mathematics in *Numb3rs* is clearly provided by expert consultants. Each episode of the show includes a mathematical connection. These range from plausible ones such as cryptology or image enhancing to more far-fetched applications.[19] Often the connection of the mathematics to the plot is stretched - after all, it is not easy to find mathematical applications for every episode in a long-running series - and the insights Charlie Eppes provides are not always particularly mathematical. Even when the insights are properly mathematical, the show has such a quick pace that the average viewer often has little chance to understand the mathematical ideas. With the difficulty of finding mathematical applications and the fast pace, by the last season of the series, the Charlie Eppes character is not so much a mathematician as just an extremely smart and knowledgeable man.[20] While there are platitudes like "everything is numbers" and the mathematical connection become rather stretched by the late seasons, overall the show does a remarkable job in including mathematics in a high-paced crime drama.

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[19]There is a comprehensive resource online that contains all the mathematics in *Numb3rs*. *http://numb3rs.wolfram.com/*

[20]Aside from the mathematics used to solve crimes, a lot of mathematical content is presented outside the plot. While *Numb3rs* is, aside from the focus of science and mathematics, basically a rather run-of-the-mill crime action show, there is something remarkable about a successful TV show that mentions people like Gian-Carlo Rota.

2 The stereotypes

2.1 *Mathematics is highly valued as an intellectual pursuit.*

In the introduction, I suggested that mathematics is generally valued highly in movies and television shows. Mathematics demands an intelligent person, perhaps even a genius. In *Good Will Hunting* this is clearly the case, as seen in the choice that Will Hunting is a mathematical genius. The moral of the story is that intellectual proficiency is no match for love and the filmmakers most likely wanted to choose what they saw as the paragon of intellectual activity.

While *Good Will* Hunting treats mathematics - in good and bad - as the ultimate academic, intellectual pursuit, it is harder to decide how *Pi* values mathematics. There is an underlying idea of connecting mathematics with exceptional intelligence, but the connection to proper mathematics is hard to make due to the film's bizarre notion of what mathematics is. However, stock brokers want to get help from Max Cohen in predicting the market, so mathematics (such as it is in the movie) is valued at least for its applications.

In *A Beautiful Mind*, the value of mathematics is best seen in the choice of subject. It is the fact that Nash was a top mathematician that makes the whole film possible: the character has to be intellectually exceptional. The story is not merely about mental illness: the essence of the film is the connection between genius and insanity.

Mathematics in *Enigma* is mostly limited to the main character Tom Jericho being a mathematician. The connection between code-breaking and mathematics is not explained in much detail. Jericho, however, is clearly the star codebreaker and his intellectual ability is shown through glimpses of mathematical genius. Also in *Proof,* mathematics is held in great esteem intellectually, perhaps more so than in any other movie studied here. Not only are mathematicians presented as highly intelligent people, but mathematics is presented as something that can be both beautiful and fulfilling.

When it comes to the television shows, the high evaluation of mathematics is equally ubiquitous. While none of the characters in *The Big Bang Theory* are mathematicians, it is clear that mathematics is valued highly as part of science. The character of Sheldon Cooper, the most brilliant scientist in the show, seems to appreciate only physics (his own field) and mathematics as worthwhile scientific pursuits.

While mathematics is not a central subject either in *The Simpsons* or *Futurama*, it does appear regularly. When it does, mathematics and mathematical ability are usually presented in an appreciative manner. This is clearly also the case with *Numb3rs*, as it is the one feature that distinguishes the show from other crime dramas. Not only is mathematics valued in crime-fighting, but there is an underlying appreciation for mathematics for its own sake. Many math-

ematical concepts are mentioned without any direct connection to the crimes under investigation, especially in the later episodes.

2.2 *Little attention is given to the mathematical content.*

The stereotype about the lack of attention to the mathematical content can be divided into three parts. First is the case of *The Wizard of Oz*, erroneous mathematics. Second is the *lack* of mathematics. A story about mathematicians may involve little mathematics, perhaps none at all. Third is *unrealistic* mathematics: although there may be mathematical content and it might be correct, it does not reflect the kind of mathematics that the characters could be expected to deal with.

In the case of *Good Will Hunting* it is this third stereotype that is fulfilled. There is explicit mathematical content and it is correct, but the mathematics is way too elementary. The mathematics in the film can mostly be seen in the two problems that the MIT professor leaves on the blackboard. The first problem is straight-forward linear algebra which the students shouldn't have much problem solving. The second one is actually even simpler, particularly in the way Will (partly) solves it. The problem is: how many non-isomorphic homeomorphically irreducible trees are there with ten knots? It is fairly elementary graph theory to show that there are ten. But Will does not even do that: by the time he's caught in action solving the problem, he has drawn eight trees. This is enough for the professor to see Will as a mathematical genius.

Hollywood being Hollywood, perhaps it should not be expected that Will engages in actual cutting-edge mathematics. But nevertheless, it is hard to understand why the mathematics was made so elementary. In the few seconds that the mathematical problems are shown on screen, the audience - if not already acquainted with them - will have no chance of understanding the problems. The mathematics could be properly high-level without losing anything. Also strange is that the problem about trees does not even *look* particularly mathematical to the layman, and to the mathematically informed, Will's partial solution does not seem very mathematical at all. The situation is not unlike a movie about a golf *wunderkind* having as a central scene the character sinking a one-yard putt. Will Hunting is shown to have mathematical ability, but nothing suggesting the genius he is supposed to be.

As far as the mathematical content is concerned, *Pi* is the worst offender of all the works studied for this paper. All the mathematics in the film is mere numerology. For the most part, it is impossible to say that the mathematics is erroneous, but that is only because the film has such a flawed idea of what mathematics consists of.[21] In a similar way, it can be said that there is lack of mathematics. But if we accept that Max Cohen is dealing with number theory in his numerologist pursuits, then certainly the mathematics is completely unrealistic. In any case, whichever way one wants to see the mathematical content of *Pi*, it is clear that very little attention was given to it.

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[21] The film does have a clear case of erroneous physics, however, when Cohen's mentor describes density as "weight over volume".

In *A Beautiful Mind,* the mathematical content, understandably, focuses on Nash's work in game theory. Although Nash made other important contributions to mathematics, game theory won him his Nobel prize and game-theoretic concepts are presumably easier to explain to a movie audience. The actual mathematical content is only seen in one scene, in which Nash describes the Nash Equilibrium in terms a group of guys picking up girls in a bar. The group of girls consists of one blonde that all the guys want, the other girls being brunettes. The Nash character explains that if all the guys go for the blonde, they harm each other because they subsequently cannot get the offended brunettes. So the best strategy is for each guy to go for a brunette. But that is *not* a Nash Equilibrium, which is defined as the situation in noncooperative games in which no player can benefit by changing his strategy while the others keep their strategy. In the scene in *A Beautiful Mind*, one of the guys could clearly change his strategy by going for the blonde. So the only effort to explain a mathematical idea in a movie about a mathematician is flawed, thus fulfilling two of the three stereotypes about mathematical content.[22]

The mathematical content of *Enigma* is restricted to a couple of references to Tom Jericho's mathematical interests (like the *Entscheidungsproblem*). The film does go through some trouble explaining the principles of code-breaking - an area of directly applied mathematics. The explanations are, understandably, rather general and not much mathematical detail is presented. It must be remembered that mathematics is often only incidental to the story of the film and more mathematical content would probably damage the flow of the movie. Similar lack of mathematical content can also be seen in *Proof*. The centerpiece of the story is the proof found in the old mathematician's notebooks. The proof is about prime numbers, but nothing more is revealed. This is quite understandable given that it is supposed to be a new original mathematical proof. This way, while the movie - unlike *Enigma*, for example - has mathematics as its central subject, the actual mathematical content in the movie is limited to namedropping a few mathematicians and mathematical concepts. Both films feature very little mathematical content, but in both cases the decision is understandable. Indeed, in the case of *Proof* it could be said that the lack of mathematical details makes it work better as a drama also for the mathematically proficient, since it is hardly possible to have an original interesting mathematical proof in the movie.

In television, it can be clearly seen that the shows employ experts to get the scientific and mathematical details right. Mathematics as such is a rare topic in *The Big Bang Theory*, but the show does a rather good job in explaining scientific content. While much of the science is inevitably little more than namedropping of scientists, theories and concepts, there are also scenes in which scientific concepts are explained in more detail. Obviously television sitcoms cannot include actual cutting-edge science, but *The Big Bang Theory* comes as close as possible while remaining light entertainment.

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[22]It has been remarked to me that nowhere in the movie is it explicitly claimed that the scene is supposed to explain Nash equilibrium. While that is indeed the case, this prompts the question just what the scene *is* meant to illuminate.

In the case of *The Simpsons* and *Futurama*, the attention to mathematics also defies stereotypes. Considering how mathematics is rarely a key subject of the episodes, there is a remarkable amount of attention given to mathematical content, and the content is generally presented accurately. While much of the mathematics is little more than mathematical in-jokes in the background, the makers of the two shows have gone through a lot of trouble to include mathematical references.

When it comes to *Numb3rs,* this trend of television shows including more accurate mathematics continues. The mathematics is generally correct and regularly quite sophisticated, in addition to being often based on actual crime-investing methods. Keith Devlin and Gary Lorden (the main math adviser for the show) have written a book, *The Numbers behind Numb3rs*, presenting real-life applications of mathematics used in crime investigations. While these form the main mathematical content, the show also finds space for mathematical content that is not directly applicable to crime-fighting.

2.3 *Mathematical practice is portrayed in an unrealistic way.*

As far as the stereotype of mathematical practice is considered, generally very little of it is shown. Mathematical work does not make for particularly gripping entertainment and the mathematical thought process is hard to portray. Of all the stereotypes studied for this paper, the one about mathematical practice was by far the least common in the films and television shows. Often the stereotype is about what mathematical practice is implied to be, rather than flawed depictions of mathematical practice. But even as such, it is not as prevalent as the other stereotypes.

In this respect *Good Will Hunting*, for example, does not fare too badly. It is refreshing that Will is actually solving mathematical problems, even if they are too elementary. The mathematical thought process is next to impossible to portray in cinema, but in *Good Will Hunting* one gets the general idea that this is a highly intelligent person who is putting his logical skills to work. There are also scenes of him briefly co-working with his new colleagues. While there definitely are cinematic cliches - Will likes to draw formulas on mirrors which, as we will see, is a Hollywood standard - the viewer does not get an unrealistic image of how mathematicians work. Perhaps it is unrealistic that a self-educated young man - no matter how brilliant - could have all that mathematical knowledge, but from Ramanujan on, this is at least a plausible scenario.[23] More implausible is the fact that Will - who must have spent countless of hours studying mathematics - is presented as getting no *joy* from it. Brilliant mathematicians are certain to be fascinated by mathematics, yet in the climactic scenes of the film it is never suggested that Will might get any pleasure at all from his work.

In *Pi,* mathematical practice is portrayed in an equally bizarre manner as

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[23]What is less plausible is that Will's expertise seems to continue to just about every academic subject.

mathematics is. Max Cohen does his research almost exclusively by staring at printouts of randomly generated numbers, looking for patterns. Max's mathematical ability is portrayed by his exceptional ability to do mental arithmetic - a questionable cliche of its own, as many top mathematicians are not particularly skillful in mental calculations.

Not much mathematical practice is shown in *A Beautiful Mind*, aside from Nash inevitably drawing formulas on windows. But the impression is given that mathematics is about ideas and proofs and not mental calculation or such. Although Nash mostly works alone in his office, he is also shown discussing mathematical ideas with his peers. This social aspect is very prominent in *Enigma*, which presents the group of codebreakers as a tightly-knit unit who cooperate a great deal - even though progress often relies on the insights and breakthroughs of individuals.[24] While mathematical practice as such is not portrayed, the codebreakers work is presented in a plausible way as something that mathematically inclined people could do. Yet, of all the films reviewed for this paper, *Proof* is perhaps the most realistic about mathematical practice - and it is that by not including mathematical details. Although the content of the proof is never revealed, its elegance, validity and importance are discussed in a realistic manner.

In television, there is even less mathematical practice. In *The Big Bang Theory* mathematical practice is hardly ever shown, but scientific practice - including the use of mathematics - is not portrayed in a particularly unrealistic fashion. The creative process, the social aspect, and the importance of rigor are all subjects in the show. Mathematical practice is hardly ever seen in *The Simpsons* and *Futurama*, either, but in the case of the "Futurama Theorem", for example, the portrayal is quite realistic. In particular, it is made clear that the result is achieved by rigorous proof, and not by experimentation. *Numb3rs* includes more portrayals of mathematical practice and it is presented in an unusually realistic way. Aside from some usual cliches - Charlie Eppes also likes to draw formulas on windows - the portrayal of mathematicians is quite realistic. They discuss ideas and do research, providing a social angle that is missing from more stereotypical characters.

2.4 *Mathematicians are asocial and unable to enjoy normal life.*

While the mathematician characters in *Good Will Hunting* are not presented as asocial geeks, the stereotype of mathematicians as unable to enjoy normal life is at the very heart of the movie. The absurd setting that Will has to choose between love and mathematics is only the pinnacle of the plot, in which mathematics is constantly presented as something that will prevent Will from finding love and true happiness. But at least Will, with all his troubles, is presented as mostly a normal person with a social life - which is not the case with

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[24]Ironically, this spirit of co-operation is lost in the more biographical film about Turing, *The Imitation Game.*

most of the films and television shows studied for this paper. The stereotype of asocial mathematician is played to full effect in *Pi*. Max Cohen is a loner and tormented by numbers all his waking hours. It is only after the self-inflicted brain damage to remove his mathematical ability that he is able to enjoy life. Normal life seems to be totally out of the question and that is in no unclear terms due to Cohen being a mathematician.

While a fictitious character like Max Cohen can be made as stereotypically abnormal as the filmmakers want, in a biopic like *A Beautiful Mind* the stereotype is particularly interesting. As it happens, the real John Nash did have limited social skills. But according to Nasar's biography, he was almost the opposite of the character in the movie. Instead of being the unassuming, shy and kind man of the film, Nasar reports Nash being arrogant and sometimes even cruel before his mental breakdown. The negative sides to his personality are completely forgotten, as are his struggles with homosexuality and professional ambition. Presumably, the real John Nash did not fit the stereotypical mathematician well enough, which is rather ironic as the more complex real John Nash actually seems like a *more* interesting on-screen character.

The main character of *Enigma*, Tom Jericho, is another somewhat socially awkward mathematician, but he is also presented as a confident and industrious worker who can communicate his ideas to laymen. Since the character is based on Alan Turing, it is interesting to see how the Jericho character is different from Turing. Turing is generally seen as a kind, friendly and sensitive man, whereas Jericho is much more taciturn and brooding, again fitting the asocial stereotype better.[25]

In *Proof*, the stereotype of socially awkward mathematician is almost overwhelming in the main character, the daughter. She is asocial, a nervous wreck and emotionally unstable, which is emphasized by her worldly and commonsensical sister. The daughter's love interest, also a mathematician, is portrayed often as exceptional since he has interests outside mathematics. Interestingly, the boyfriend is an ordinary mathematician while the daughter is exceptionally talented, thus suggesting a connection between great mathematical ability and asocial character. A mathematician may be a normal person, but in that case he cannot be very talented.

As the stereotype of a nerdy, socially awkward scientist is a comedy standard, it is no surprise that television sitcoms use it extensively. *The Big Bang Theory* could not exist if it were not for this stereotype. The whole premise and much of the humor is based on the nerdiness of the scientists. There are some variations to the theme and in later seasons the characters develop more depth, but the show has never escaped the premise of putting together scientist and an attractive woman - supposedly an automatic mismatch. It should be noted that in the later seasons, after major female scientist characters have been in-

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[25]In this regard, *The Imitation Game* goes even further with the stereotype of an eccentric, asocial mathematician. In that film, Turing doesn't understand humor, can't co-operate with his colleagues, and is altogether unable to function in social situations. While these characteristics were present in Turing to some degree according to his biographers, the film greatly exaggerates them.

troduced, the humor becomes much more versatile. One must wonder whether losing some other stereotypes would have the same effect; after all, there are only so many laughs one can get from a scientist saying geeky things while "cool" people roll their eyes.

The geeky asocial stereotype is also played around with in both *The Simpsons* and *Futurama*. The scientist characters are often nerds, but at the same time they are also clearly overblown caricatures of nerds. As is often the case with *The Simpsons*, there are different levels to how the characters are presented. Lisa Simpson, a scientifically-minded main character, is always presented in a positive light as the voice of reason in the overall wackiness of Springfield. At the same time, there are characters like Professor Frink, who is an over-the-top caricature of a nerdy scientist. Sometimes *The Simpsons* is happy to go along with old stereotypes, while whole episodes can focus on how damaging such stereotypes can be - as seen in the recurring theme of Lisa being unpopular in school because of her intelligence.

As with many other stereotypes, *Numb3rs* manages to grow beyond the image of an asocial mathematician. While the character of Charlie Eppes can be brooding, somewhat disorganized and has a tendency to be obsessive, he is also in many ways a normal human being. Considering that it is not unheard of that mathematicians in real life *do* have such qualities, the character seems quite realistic. Especially in the later seasons, Charlie becomes increasingly complex and less stereotypical. He has an active social life and he can communicate perfectly well with people who are not mathematicians. His scientist colleagues are also presented in a much less stereotypical manner than usual.

2.5 Higher mathematics is often connected to mental instability - if not downright mental illness.

Finally, let us look at perhaps the most damaging of all the stereotypes concerning mathematicians: the connection to mental illness. As we will see, this is an extremely common stereotype that is used in two ways. In the first case, mathematician characters are made mentally unstable for dramatic purposes. In the second case, the main theme is mental illness and mathematicians are chosen as subjects accordingly. Even when there are no mathematician characters suffering from mental illness, like in the case of *Good Will Hunting*, insanity is clearly a concern. While Will is not mentally ill, he clearly has mental issues. He is violent and frequently lies - and of course the whole film revolves around his visits to a therapist. When discussing Will's future with the mathematics professor, the therapist mentions Ted Kaczynski as an example of what a career in mathematics could lead to. It is only one line in the movie and perhaps not too much should be made out of it. But it is a very strange line indeed. Would a movie about an American football prodigy mention O.J. Simpson as a warning in a key scene? Including Ted Kaczynski in the dialogue only makes sense if the audience has some kind of prior conception that connects mathematics with insanity.

There is no better example of the second way of using the stereotype of

mentally ill mathematician than the film *Pi*. It is a movie about insanity and already the fact that it has a mathematician as the main character is enough to propagate this stereotype. In the end, Cohen finds happiness and an escape from insanity by finding an escape from mathematics. Before that, the audience is treated to several scenes in which mathematics torments Cohen. Whereas in other works the connection between mathematics and insanity may be more subtle, *Pi* makes every effort to underline mathematics as the reason for Cohen's troubles.

As *A Beautiful Mind* is a biopic about a mathematician suffering from mental illness, mental instability and insanity is obviously the central subject. But there are many ways to portray Nash's mental illness, which was diagnosed as schizophrenia. The simplistic storyline suggests that mathematics caused mental illness and human relationships cured it. But that story has little basis in reality - it is just feeding off an old stereotype of mathematicians. In the film's simplistic storyline, Nash's mental illness is tightly connected to his mathematical genius, whereas his wife - the divorce from whom is conveniently omitted - manages to bring him back to sanity. By portraying Nash as a shy, kind man - which by all accounts is grossly mistaken - the effect is even more powerful. The power of *A Beautiful Mind* draws less from the actual characteristics of John Nash than the Hollywood stereotype of a mathematician. In Nasar's book, Nash's homosexual forays are given an important role and there is little doubt that they contributed to his problems. He was, for example, dismissed from his position at the RAND think tank because of a indecent exposure charge brought on by police who were trapping homosexuals. While schizophrenia is now believed to be largely genetic - an explanation particularly probable in Nash's case since his son also suffered from the illness[26] - it is also the case that personal stress contributes to its outbreak. In Nasar's book, much of Nash's stress comes from his difficulties with sexuality and relationships. He was, for example, rumored to be in love with the logician Paul Cohen before his undoing.

Later on, Nash blamed his failed attempt at quantum theory for his illness, but it would be understandable for him to be either reluctant or unable to point to more personal causes. To be sure, in Nasar's book Nash's failed efforts on quantum theory and the Riemann hypothesis are given as important sources of stress. On the other hand, however, mathematics is sometimes presented as a much-needed break from all the stress. His frustrations in personal life, losing the competition for individual awards - such as the Field's medal - and other factors outside mathematical research are given a crucial role in the outbreak of his schizophrenia. In the movie, the roles are almost reversed. Mathematics contributes to Nash's mental illness while his wife works as a balancing force. Nothing is of course mentioned of their divorce, his earlier relationship, the son he abandoned, or his homosexual tendencies and the frustration with them. This is quite surprising, because they would have seemed to provide quite fitting material for a dramatic movie. Instead, the filmmakers dropped all these subjects, perhaps in order to put the focus on the connection between mathematical

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[26]Although it should be noted that his son was also a mathematician.

genius and mental illness.[27]

In *Enigma*, mental illness is not the main theme and problems with sanity are used in the first way, to add dramatic effect to the main character. Tom Jericho has suffered a nervous breakdown, seemingly from a combination of too much work and a failed love affair. It is interesting to ask why the filmmakers made the choice of bringing in a character with problems with mental illness instead of using the real characteristics of Alan Turing. The real Turing was ironically - and tragically - diagnosed with a mental illness, the absurd one of homosexuality. Given how interesting a character Turing was, to replace him with a heterosexual character presumably to have a rather generic wartime love story is a curious choice. Perhaps the nervous breakdown was included to mirror Turing's struggle with the persecution of homosexuality. But whatever the motivation, the filmmakers made the choice of replacing an extremely interesting real-life character with a stereotypical fictional one.

In *Proof,* insanity is one of the key themes and mental illness is at the forefront throughout the film. The father has gone insane and no reason beyond mathematics is ever suggested. The daughter also has severe mental problems. So, two of the three main mathematician characters have serious issues with mental health, and the one who does not is portrayed as an exception in the mathematical world - not to mention by far the least talented of the three. Since the main theme is the gender stereotype, which is treated very sharply, it is hard to see why insanity had to play such an important role in the characters - other than fulfilling the stereotypes that audiences might expect of mathematicians.

In television, the link to insanity is much less pronounced. In *The Big Bang Theory* there are minor characters who suffer from mental illness and with one of the main characters, Sheldon Cooper, sanity is constantly questioned. The premise that too much science can make you crazy is present, although not specifically concerning mathematics. In *The Simpsons* or *Futurama*, when there is a mad scientist character, it is often a reference to the tradition of mad scientists in cinema and television. The one recurring such character, Professor Frink, is more of an oddball than mentally ill. The stereotype of mathematics and mental illness does not feature prominently in *Numb3rs*, either. Charlie Eppes has his problems and mathematical work causes him anxiety, but he is not mentally ill and neither is it suggested that mathematics will lead to insanity.

2.6   Conclusions

We have seen how prevalent the five stereotypes have been in our sample of five films. While one stereotype, that about mathematical practice, is relatively uncommon, the others have shown to be worryingly prevalent. The extremely problematic one about mental illness, for example, is a theme in every film studied for this paper - and the main theme in three of them. But while the

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[27]This connection is suggested also by the fact that Nash is the only asocial and mentally ill mathematician in the film. So it seems that a mathematician can be normal, but not in the case he is genius.

stereotypes here can be found regularly in cinema, the stereotypes about mathematicians are by no means limited to them. Popular entertainment often works on stereotypes and the ones about mathematicians would seem to be particularly enduring. More often than not, a movie mathematician is an asocial man struggling with mental illness. Obviously there are variations on these themes, but that seems to be the general stereotype the characters are often based on. The proposed connection to mental illness is definitely a troubling one, but I am also concerned about the image that mathematics stands in the way of finding happiness - an idea central to *Good Will Hunting* and *Pi*, as well as behind the fabricated Nobel-winning speech of the John Nash of *A Beautiful Mind*.

It is almost as these movies serve as a warning against a career in mathematics. In the preface of the new edition of the book *A Beautiful Mind*, the author Sylvia Nasar tells about a letter she received from a little girl who saw the movie and decided that she wants to be a mathematician. It cannot be denied that the movie can have such an effect, as it does portray mathematics as something profound and intriguing, almost mystical. But it also portrays John Nash as a nice guy who was pushed into mental illness by his preoccupation with mathematical problems. For every person finding inspiration in the story, one must wonder how many people saw the movie and thought that mathematics is dangerous and ultimately something not worth pursuing.

While the five stereotypes are common in modern cinema, the analysis of television shows presents a different image. The nerdy scientists of *The Big Bang Theory* may be as stereotypical as anything on the big screen, but we have seen that television can also provide much more complex and realistic characters. It is an interesting question why this is the case. One factor is clearly the key role that scientists and mathematicians have as advisers of television shows. It is hard to think of reasons why a television show should be more accurate than a movie in its mathematical content, but it is no wonder that shows that have mathematicians in their writing teams tend to get the mathematics right more often.

Another factor is that in a long-running television show it is possible to develop the characters further and there is less need for them to be stereotypical. In a two-hour movie, a character like Charlie Eppes of *Numb3rs* would most likely be less complex and less realistic. In a television series, we can watch a character grow and develop. This can be seen in how the Charlie Eppes character develops. In the first season, the character is more stereotypical and reclusive, but he gradually changes into something much more complex, up to the point that in the later seasons the character is hardly stereotypical at all. In a movie, there is simply no time for that kind of growth for the characters.

When it comes to the stereotype of mental illness, the best explanation is perhaps that insanity makes for a better subject in a short movie than a long television series. Mentally ill characters may be hard for audiences to handle for several episodes, whereas a story like *A Beautiful Mind* gives shorter glimpses to insanity.

Whatever the reasons, it is clear that when it comes to mathematics and mathematicians in entertainment, it is television that has shown promise of

expanding beyond the tired old stereotypes. *Numb3rs,* in particular, should be applauded for this. It does include its own stereotypes: Charlie Eppes is, for example, a former child genius - another often-seen stereotype when it comes to mathematics. But this is somewhat understandable. Movies and television shows tend to be about exceptional people. While most mathematicians no doubt have been gifted already as children, by and large they are just normal hard-working people. But the geniuses (however we want to define the term) also exist - and it is natural to assume that they make for better entertainment.

3 What is behind the stereotypes?

After analyzing the use of the five stereotypes, we should conclude by asking why these stereotypes have come to play such a prominent place in cinema and television. I believe that a good starting hypothesis is that our entertainment mirrors our general attitudes - which are of course in turn influenced by our entertainment. This circle of reinforcement of attitudes leads to the strengthening of the stereotypes and prejudices. In many ways it is correct that Hollywood does not tell us how to think - it just turns on the camera.

Prejudices on scientists have quite understandably not been among the most pressing issues among sociologists and psychologists, but the birth of prejudices has been a much-studied subject. Researchers usually identify many factors in how, e.g., racial prejudice develops. Much of it comes through indirect learning, sources of which include parents, peers, school and media.[28]

When it comes to prejudice against scientists, the last two sources would seem to play key roles. Most people are not likely to have much contact with scientists in their everyday life, but they will learn about science and mathematics in school. School education of mathematics, however, often has very little focus on the people behind the developments in mathematics. Aside from learning a few names, a typical student is not likely to learn anything at all about the mathematicians who made all that knowledge possible. For that, media and in particular popular entertainment may be the only source. And as we have seen, it can be grossly inaccurate and dependent on stereotypes.

This is not a new concern. E.T. Bell in the introduction to *Men of Mathematics* (1937, p. 8) writes:

> The mathematician is a much rarer character in fiction than his cousin the scientist, and when he does appear in the pages of a novel or on the screen he is only too apt to be a slovenly dreamer totally devoid of common sense – comic relief.

In his book, Bell tried to rectify this image. He was notoriously sloppy as a historian, accepting anecdotes as facts and altogether determined to paint as vivid pictures as possible of his subjects. But people loved the book. It became an unexpected bestseller and it did that by portraying mathematicians - allowing

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[28]See, e.g., Whitley & Kite (2009), Katz (2003) and Yang (2000).

for quite a bit of hyperbole - as brilliant but ultimately quite normal people, rather than the stereotypical solitary madmen. Countless mathematicians have found inspiration in Bell's book as youths. These included the young John Nash, who thought school mathematics was trivial. When Nash first got to know about the kind of problems that the great mathematicians have actually worked on, he was instantly fascinated (Nasar 1998).

For all its historical inaccuracies, that already makes Bell's *Men of Mathematics* an important book. The reader starts reading about people and ends up understanding more about mathematics. This has got a lot to do with the fact that mathematicians are not portrayed as "slovenly dreamers", but as people working in competition and cooperation with each other. People not driven by madness but by the simple goal of understanding and advancing mathematics as much as possible.[29]

Simon Singh followed Bell's footsteps closely in his 1997 book *Fermat's Enigma*. It focuses on the people as much as the mathematics, and it makes for a truly exciting narrative in following Andrew Wiles' work on the theorem. It also includes a lot of history of mathematics and mathematicians, and as in Bell, mathematicians are portrayed as interesting people without reverting to the usual stereotypes. The book was a number one bestseller in Britain and an international success.

The lesson from Bell and Singh is clear. There is enough in mathematics and mathematicians to catch people's imaginations without reverting to cheap stereotypical characteristics. This can also be done in fiction, as seen in the television show *Numb3rs*. As we have seen, compared to the stereotypical mathematician, the main characteristic of Charlie Eppes is that he appears so much like a regular person. This is not a coincidence, because the character of Charlie Eppes was inspired by the physicist Richard Feynman.

Feynman's two autobiographical works, particularly *Surely You're Joking, Mr. Feynman!*, have done wonders to the popular image people have of scientists. The book was first published in 1985 and became a bestseller. At the time of the publication, Feynman was perhaps the most esteemed theoretical physicist in the world. The autobiographical stories made him seem distinctively human, whether they were about picking up girls, joining a samba school, or not feeling at home with the ancient traditions at Princeton. What *Surely You're Joking, Mr. Feynman!* taught the general public was that a top scientist can be an interesting person also outside his or her scientific work.

In retrospect, some of the reception Feynman's book received seems pointedly condescending. Why was it such a surprise that a scientist is not a boring person without any extra-scientific interests? But that tells us how deeply en-

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[29]It has to be said that when trying to fight the old stereotypes, Bell fell into the trap of creating new ones. In his book, more or less all the great mathematicians are decent people who lived fulfilling lives, heroes that rise above the ordinary people. He, for example, makes a point of remarking that there were no sexual "deviants" among them. Another problem in Bell's book is propagating the old stereotype already found in the title. While the focus on male mathematicians is inevitable for historical reasons, Bell no doubt marginalizes the contributions of female mathematicians. See Duchin (2004) for an analysis of Bell's stereotypes about mathematicians, with focus on the gender bias.

trenched the stereotypes that scientists face can be. They can be seen in our entertainment, but they can also seen all around us. Mathematics is highly valued as an intellectual pursuit, because that is the general image of mathematics in modern western society. Mathematics may be disliked as a subject, but it is generally accepted that professional mathematics requires exceptional intelligence and effort - and that it can be valuable.

Little attention is given to mathematical content not only because mathematics is a bad fit with the quick pace of modern cinema and television. I believe that a more important reason is that mathematics still is largely seen as the *great gibberish*. Even with expert consultants, there seems to be little effort to make viewers appreciate what mathematicians are doing - as long as they are doing something that *appears* difficult. Mathematics is highly valued, but a normal person is not expected to understand what it is about. It is not surprising that our entertainment mirrors this attitude.

Mathematical practice is portrayed in an unrealistic way because the general public has been told very little about what mathematicians do. It is easier to present them as dreamy geniuses drawing formulas on windows. Again, there are understandable difficulties in portraying mathematical thought process in films or television. But that notwithstanding, the solitary man drawing formulas on windows is a poor effort to shed light on mathematical practice. Particularly lacking is the social element of mathematics. The media loves stories about reclusive mathematicians like Grigori Perelman because it fits the stereotype. But for every Perelman, there are math departments full of social people actively discussing their ideas with colleagues.

The portrayal of mathematics is one thing, but the portrayal of *mathematicians* can be more damaging. At its most innocent, this can be mildly frustrating for mathematicians who need to explain that they can enjoy normal life. But there can be more serious consequences of the stereotype of the loner asocial mathematician. Employers, for example, may not wish to have someone with limited social skills in their team.

The stereotype of asocial mathematician, while often overdone, admittedly may have some plausibility.[30] There are introvert and even socially awkward people among mathematicians. But just how prominent such characteristics are is something that should be studied. In any case, to suggest the kind of social inability that many of the mathematician characters in movies and television have is almost offensive. Such stereotypes may come from the fact that people associate mathematicians (and other scientists) with "nerd" kids in school, a stereotype that is even more common in popular culture.

Finally, mental illness is an extremely serious stereotype to deal with. The suggestion that someone is more prone to such problems based on his or her profession can be highly damaging. The problem is that there are well-known cases of mental illness among mathematicians: John Nash, Georg Cantor, Kurt Gödel - and, yes, Ted Kaczynski. There have also been some studies suggesting

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[30]This is of course not to suggest that the stereotypes in popular culture should be considered acceptable even if they mirror reality.

connections between the brain chemistry of highly creative people and people with schizophrenia. But the fact is, mental illness is extremely rare among mathematicians. Most probably, the stereotype of mad mathematician comes from the simple, but extremely questionable, connection: a great deal of mental strain can cause insanity.

While the stereotypes are still largely prevalent, I must end this paper on a positive note. Stereotypes are broken by presenting cases that defy them, whether real ones like Richard Feynman or fictional like Charlie Eppes. In the mid-90s, Andrew Wiles' proof of Fermat's Last Theorem captured the public imagination. Most likely this was one factor in the emergence of mathematical movies in the turn of the century. While these movies, as we have seen, were still largely guilty of applying the old stereotypes, there have also been positive developments in making mathematics a part of popular culture. Popular writers like Simon Singh and Alex Bellos have played a part in this, as have the television shows analyzed in this paper.

One example of a popular work that has shown a new promising way is the graphic novel *Logicomix* (2009), written by Apostolos Doxiadis and Christos Papadimitriou, which tells the story of Bertrand Russell and the early 20th century pursuit of foundations for mathematics. The book takes many historical liberties, but it does a great job in presenting the mathematical and philosophical content. The popularity of *Logicomix* has been extremely promising. It is just the kind of work that can work to change stereotypes: it presents both mathematical ideas and the people behind them. While the insanity angle is somewhat over-emphasized in the book - although this is explicitly discussed in the meta-story of the book - overall it reaches an unforeseen combination of presenting mathematical ideas and history of mathematics in an entertaining yet informative way. If it is possible for a graphic novel to achieve all that, it raises hopes that the same can be done in cinema and television.

In addition to the developments in traditional media, the emergence of the Internet has of course played a crucial role in bringing mathematics to people's attention in new ways. One main feature of the Internet - its enormous scope - can work wonders in breaking stereotypes. While Hollywood too often speaks with a single voice, that is not the case with the Internet. When it comes to mathematics and mathematicians, this can be a most welcome development. There are vast resources of information about mathematics that are both exciting and accurate. In order to break out of the old stereotype of mathematics as the great gibberish practiced by asocial madmen, these can invaluable. They can influence our education - as well as our entertainment.

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