

Vassar Lecture

Vassar Lecture, April 2019

Michael Harris

Columbia University

April 9, 2019

Outline

- 1 **Ethics in Mathematics**
 - Is mathematics ethically neutral?
 - Useless number theory
- 2 **Some ethical challenges**
 - Military funding
 - Big data
 - Artificial Intelligence
- 3 **Codes of ethics for mathematicians**
 - Some principles
 - Should we cooperate?
 - Positive ethical engagement

Math professors accused of crimes against humanity



Michel Rocard, former French Prime Minister,
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Math professors teach their students to make a killing on the stock market. Although they don't know it, what they are doing amounts to a crime against humanity.

(Rocard quoted in *Le Monde*,
November 1, 2008)

“where most mathematicians are today”

ETHICS IN MATHEMATICS DISCUSSION PAPER 1/2018

University of Cambridge

Four Levels of Ethical Engagement

We observe that the types of reactions of mathematicians to ethical issues proper to mathematics differ, and we attempt a sensible categorisation of the states of social and ethical responsibility of mathematicians.

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Many [mathematicians] feel that mathematics is value-free ... or that mathematics itself does not have ethical implications or consequences. Rather – this line of thinking goes – any ethical issues solely lie with the user of the tool their mathematics helps create. Many consciously exclude themselves from the issue by reducing their role to that of the discoverer of mathematics, arguing that “the mathematics was always there anyway.”

Useful science, harmless mathematics

A science is said to be useful if its development tends to accentuate the existing inequalities in the distribution of wealth, or more directly promotes the destruction of human life.

(G. H. Hardy, writing in 1915.)

“The study of mathematics is, if an unprofitable, a perfectly harmless and innocent occupation.”

from Hardy's Oxford lecture, 1920



Hardy in Cambridge, circa 1900

Hardy on uselessness of mathematics

“The great modern achievements of applied mathematics have been in relativity and quantum mechanics, and these subjects are, at present at any rate, almost as ‘useless’ as the theory of numbers.”

From *A Mathematician's Apology*, 1940



Useless number theory?

From a 2017 grant proposal

On the surface, pure mathematics may seem abstract, yet it is vitally important for [Country X] to maintain a strong base in number theory in particular, and core mathematics sub-disciplines in general, as they provide the basis on which the physical sciences rely. Pure mathematics and number theory also have direct practical relevance. For example, number theory itself has increasingly important applications to cryptography as well as efficient data transmission and digital security. These are areas where it is vital that [Country X] maintains a strong base of expertise to meet future technological and economic challenges. To illustrate this, one of the key insights of modern computing is the existence of security schemes that are asymmetric in nature.

Useless number theory?



... public-key cryptography is now providing the infrastructure for e-commerce. When you enter your credit details on the Internet, they are encrypted using pure mathematics so that only the dealer can decrypt your message and complete the transaction. The entire boom in e-commerce would not have been possible without pure mathematics [that is, without number theory].

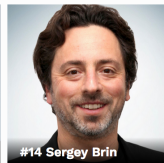
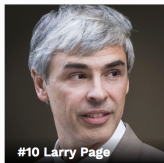
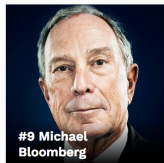
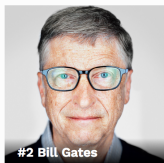
Useless number theory?



"Book store owners and record store owners used to be oracles...; you'd go in this dusty old place and they might point you toward something that would change your life. All that's gone."

Tom Waits, quoted in the *Guardian*,
October 23, 2011

Useless number theory?



Plato on the utility of mathematics



Bust of Plato, Vatican
Museum

By Dudva - Own work, CC

In so far as it pertains to war, [Glaucon] said, it is obviously suitable [to study geometry]. As regards encampments, occupation of positions, concentration and deployments of troops, and all the other formations... being a geometer or not makes all the difference...

(Plato, *Republic*, 526 d)

NSA


“It is no secret that the NSA employs some of the world’s greatest cryptographic minds. In my opinion, an algorithm that has been designed by NSA with a clear mathematical structure giving them exclusive back door access is no accident, particularly in light of the Snowden documents. This is precisely the expertly designed way to insert an exclusive back door.

(Hales explained the mathematical principles behind the backdoor in the NIST standard for pseudo-random number generation, 2014.)



Tom Hales giving a lecture
By Slawekb - Own work, CC BY-SA
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Heilbronn Institute



Perspectives on the Riemann Hypothesis

4 – 7 June 2018
School of Mathematics, University of Bristol

A meeting on the Riemann Hypothesis,
and on the theory of the zeta-function
and other L-functions.

Speakers to include:
E. Bombieri (IAS, Princeton)
A. Booker (Bristol)
A. Connes (IHES)
A. Florea (Stanford)
H. Iwaniec (Princeton)
N. Katz (Princeton)
K. Matsumoto (Tokyo)
P. Michel (EPFL)
S. Patterson (Cologne)
M. Radziwiłł (McGill)
C. Skinner (Princeton)
K. Soundararajan (Stanford)
W. Zhang (Columbia)

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Dr Sarah Penland, A. Miles, Oxford

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Limited support may be available for PhD students and their carers. Please email
We like working sustainably by using local.

Please apply using the correct section in the registration system.

“Tom Leinster, a category theorist from Edinburgh, has called the Heilbronn Institute GCHQ’s ‘mathematical brand.’”

(From “Sums for Spooks,”
*Times Higher Education
Supplement*, March 8,
2018)

This event is organized in partnership with: University of Mathematics, University of Bristol, Clay Mathematics Institute, EPSRC, Heilbronn Institute for Mathematical Research and the National Science Foundation.



*Speakers to register their responsibility as a result of attending the meeting.

Weapons of Math Destruction

Algorithms ... determine how much we pay for insurance ..., or what the terms of our loans will be, or what kind of political messaging we'll receive. There are algorithms that find out the weather forecast and only then decide on the work schedule of thousands of people,

... Their popularity relies on the notion they are objective, but the algorithms that power the data economy are based on choices made by fallible human beings. ... [they] encode human prejudice, misunderstanding, and bias into automatic systems that increasingly manage our lives... Their verdicts, even when wrong or harmful, are beyond dispute or appeal.

(*Guardian*, September 1, 2016)



(Cathy
O'Neil in
2016)

Ethics of big data



Achille Mbembe, Cameroonian philosopher, pictures the “21st century political landscape” as a Big Data apocalypse.

Image CC BY-SA 4.0

The market itself will be re-imagined as the primary mechanism for the validation of truth. As markets themselves are increasingly turning into algorithmic structures and technologies, the only useful knowledge will be algorithmic.

Instead of people with body, history and flesh, statistical inferences will be all that count. ... The new human being will be constituted through and within digital technologies and computational media.

Big data vs. democracy

For Google and other 'big data' aggregators ... the data are merely bits. Subjectivities are converted into objects that repurpose the subjective for commodification. Individual users' meanings are of no interest to Google or other firms in this chain. Populations are the sources from which data extraction proceeds and the ultimate targets of the utilities such data produce. ...

[Surveillance capitalism] is a ubiquitous networked institutional regime that records, modifies, and commodifies everyday experience from toasters to bodies, communication to thought, all with a view to establishing new pathways to monetization and profit.

(Shoshanna Zuboff, Big other: surveillance capitalism and the prospects of an information civilization, *J. Info. Tech* 2015)

Artificial Intelligence

...the feverish promotion of the Internet of Things as a technological inevitability and a promising investment opportunity. The ethical implications of these developments seem to have been entrusted, in particular by the EU, to the AI industry itself:

In connection with [the risks of AI], it was announced that Facebook, IBM, Amazon, Google, and Microsoft had just formed the “Partnership on AI” for the purpose of “conducting research and promoting best practices.”

Since then Apple has joined (the big five + IBM) and there are now representatives of civil society (ACLU, EFF, and Center for Democracy and Technology, among others). Of course the relative weight of the corporate and civil partners in defining ‘best practices’ remains to be seen. My point, however, is that the vision of democratic decision-making still places the expert at the center.

It's not only the applications

Insofar as the possibility of the most visible aberrations (Cambridge Analytica, NSA undermining of encryption standards, credit default swaps, and so on) are built into the normal functioning of the status quo, and are justified by an ideology of expertise that is maintained by our universities and research institutes, our very existence as experts guarantees that our profession provides no refuge of ethical purity.

being entrusted with power by virtue of our role in the transmission of mathematical knowledge imposes the responsibility to insist on the limitations of that knowledge. The ideology of mathematical certainty and objectivity is our most potent weapon; we should not allow it to be used to undermine democracy.

Taking responsibility

“It should not be a hard argument or claim to make that the highest level of ethical practice is taking responsibility not just of one’s own actions, but also of the actions of all of those in the profession. There are mathematicians who will come to the realisation that they must do it because no one else will, nor can. The challenge is to go beyond speaking out in a way that only other mathematicians can understand; it involves denouncing mathematics and raising ethical issues stemming from technical mathematics in a public forum and in a language the non- mathematician can understand.”

(Chiodo and Bursill, Four levels of ethical engagement)

Uppsala codex, 1984

A group of researchers at Uppsala University are behind what is nowadays known as the Uppsala Codex. The codex was formulated in 1984. The researchers, who were from the disciplines of science, technology, medicine, social sciences, law and theology, had been working on ethical issues for a number of years.

Uppsala codex, 1984

1. Research shall be so directed that its applications and other consequences do not cause significant ecological damage.
2. Research shall be so directed that its consequences do not render it more difficult for present and future generations to lead a secure existence. Scientific efforts shall therefore not aim at applications or skills for use in war or oppression. Nor shall research be so directed that its consequences conflict with basic human rights as expressed in international agreements on civic, political, economic, social and cultural rights.
3. The scientist has a special responsibility to assess carefully the consequences of his/her research, and to make them public.
4. Scientists who form the judgement that the research which they are conducting or participating in is in conflict with this code, shall discontinue such research, and publicly state the reasons for their judgement. Such judgements shall take into consideration both the probability and the gravity of the negative consequences involved.

Toronto Resolution, 1991

The Toronto Resolution was formulated at a Workshop on "Ethical Considerations in Scholarship and Science" held in Toronto, November 8 and 9, 1991.

This Workshop followed a Symposium on "Constraints on the Freedom of Scholarship and Science" organized by the Royal Society of Canada, Ottawa, November 4-6, 1991. The Symposium was international and interdisciplinary, being attended by about 20 scientists and scholars from Africa, Asia, Europe, and the Americas, as well, of course, as Canada.

Toronto Resolution, 1991

1. a code should articulate as far as possible the underlying assumptions and guiding principles of a working ethic;
2. a code should indicate specific measures designed to ensure that signatories adhere to its principles;
3. a code should be sufficiently general to encompass scholarly work and basic, applied and technological research as well as the actions of practitioners engaged in the discipline or profession;
4. a code should oppose prejudice with respect to sex, religion, national or ethnic origin, age, sexual preference, colour, or physical or mental disability;
5. a code should take into account that, while in general it is difficult to anticipate all the consequences of research, scientists and scholars have a responsibility, individually and collectively, to try to foresee, and to keep themselves aware of, the developing applications of their work, and to choose or redirect it accordingly;

Toronto Resolution, 1991

6. a code should recognize that actions designed narrowly to benefit humankind may in fact threaten the survival of all species, since the ecosystem is a seamless web;
7. a code should forbid research directed towards developing or using methods of torture, or other devices and techniques that threaten or violate individual or collective human rights;
8. a code should direct scholarly and scientific activity towards the peaceful resolution of conflict and universal disarmament; since all research has military potential, every scientist and scholar should seek to resolve the ethical problem that knowledge, which should enlighten and benefit humanity, may be used instead to harm the planet and its people in war and in preparation for war;

Toronto Resolution, 1991

9. a code should encourage its adherents to comply with established procedures for the scientific and (where appropriate) ethical peer review of research studies conducted under its auspices and, where such procedures do not exist, a code should specify them;
10. a code should urge its adherents to make all basic research results universally available;
11. a code should urge its adherents to identify and report violations of its terms, and should correspondingly ensure their protection from retribution by their fellow-scientists, professional and learned societies, and the judiciary for such exposure;
12. a code should be widely disseminated through the school and university curricula, to educate the rising generations, as well as practising scientists and scholars, about their emerging responsibilities.

A Hippocratic Oath for Data Scientists



“Like doctors, data scientists should pledge a Hippocratic Oath, one that focuses on the possible misuses and misinterpretations of their models.”

(from *Weapons of Math Destruction*, covered in *Wired*, *Time*, *Slate*, *Scientific American*)

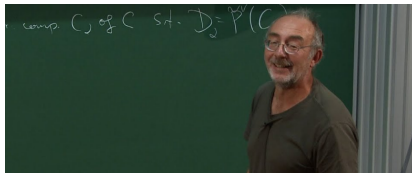
A Hippocratic Oath for Data Scientists



- ~ I will remember that I didn't make the world, and it doesn't satisfy my equations.
- ~ Though I will use models boldly to estimate value, I will not be overly impressed by mathematics.
- ~ I will never sacrifice reality for elegance without explaining why I have done so.
- ~ Nor will I give the people who use my model false comfort about its accuracy. Instead, I will make explicit its assumptions and oversights.
- ~ I understand that my work may have enormous effects on society and the economy, many of them beyond my comprehension.

Derman and Wilmott, Hippocratic Oath for financial engineers, quoted in WMD

Should the AMS cooperate with NSA?



Letter to the *Notices of the AMS* by Alexander Beilinson received September 13, 2013, in the wake of the Snowden revelations, and quoted in *Nature*, *New Scientist*, and elsewhere.

the whole planet. But if any healing is possible, it would probably start with making the NSA and its ilk *socially unacceptable*—just as, in the days of my youth, working for the KGB was socially unacceptable for many in the Soviet Union.

The AMS regularly publishes advertisements for positions at the NSA and manages reviews for the NSA Mathematical Sciences Grants Program. The relationship between the NSA and the AMS seems to be a symbiotic one: The NSA needs mathematicians for its tasks, and the AMS has an interest in increasing research funding. But any relationship with an organization whose activity is so harmful for the fabric of human society is unhealthy. For the sake of integrity, the AMS should shun all contacts with the NSA.

—Alexander Beilinson
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Should mathematicians cooperate with GCHQ?

SHOULD MATHEMATICIANS COOPERATE WITH GCHQ?

One of the UK's largest employers of mathematicians has been embroiled in a major international scandal for the last nine months, stands accused of law-breaking on an industrial scale, and is now the object of widespread outrage. How has the mathematical community responded? Largely by ignoring it.

GCHQ and its partners have been systematically monitoring as much of our lives as they possibly can, including our emails, phone calls, text messages, bank transactions, web browsing, Skype calls, and physical location. The goal: "collect it all". They tap internet trunk cables, bug charities and political leaders, disrupt lawful activist groups, and conduct economic espionage, all under the banner of national security.

Perhaps most pertinently to mathematicians, the NSA (GCHQ's major partner and partial funder) has deliberately undermined internet

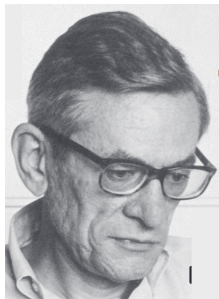


Tom Leinster, first ever opinion column in the LMS Newsletter, 24 February 2014

NATO funding, 1971

Si nous croyons que nous pouvons accepter l'argent de n'importe qui pour le profit des mathématiques ..., si nous nous comportons comme si nous étions d'accord avec les politiciens ... qui pensent que la science et l'éducation sont simplement des branches de la Défense, comment pouvons-nous alors espérer regagner un jour le respect des jeunes? ou de nous-mêmes?

L'ultime preuve de sincérité pour un mathématicien est son consentement à renoncer à un peu de ses mathématiques, sans parler de son argent, afin d'adhérer à son propre code de morale

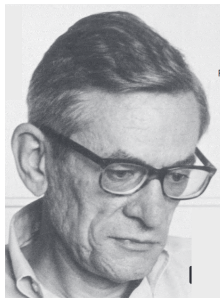


Roger Godement, explaining his refusal to attend a 1971 conference sponsored by NATO.

NATO funding, 1971

If we believe we can accept money from anyone for the sake of mathematics... if we act as if we agreed with politicians who think that science and education are mere branches of the military, how can we then hope to recover the respect of the young? or of ourselves?

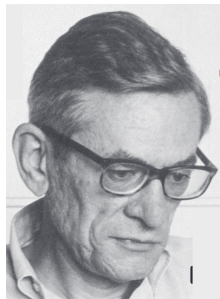
A mathematician's ultimate proof of sincerity is willingness to give up a bit of mathematics, not to mention funding, out of respect for a moral code...



Roger Godement, explaining his refusal to attend a 1971 conference sponsored by NATO.

Ethical commitment carries risks

The OAS firebombed the homes of Godement and of (Fields Medalist) Laurent Schwartz in 1961, along with those of other prominent opponents of French torture in Algeria.



Gerrymandering

PUBLISHED MARCH 16, 2018 BY RESEARCH

DUKE MATHEMATICS HAS ITS DAY IN COURT

Duke test is the principal evidence in NC partisan gerrymandering case before the Supreme Court March 26



Duke mathematics professor Jonathan Mattingly and colleagues wanted to find out if North Carolina's congressional map was gerrymandered. So they did the math. And now, the evidence is going before the Supreme Court. Photo by Jared Lazarus.

Meet the Math Professor Who's Fighting Gerrymandering With Geometry

By Shannon Najmabadi | FEBRUARY 22, 2017



Tufts U.

Moon Duchin, of Tufts U., has helped create a program to train mathematicians to serve as expert witnesses in court cases over redrawn electoral districts.

Gerrymandering and statistics

PUBLISHED MARCH 26, 2018 BY RESEARCH

DUKE MATHEMATICS HAS ITS DAY IN COURT

Duke test is the principal evidence in NC partisan gerrymandering case before the Supreme Court March 26



Duke mathematics professor Jonathan Mattingly and colleagues wanted to find out if North Carolina's congressional map was gerrymandered. So they did the math. And now, the evidence is going before the Supreme Court. Photo by Jared Lazarus.

[Mattingly's] team used computer algorithms to generate more than 24,000 alternative maps that meet the state's redistricting criteria, without regard to party affiliation. Then, using the actual vote tallies from each precinct, they did a simulation to see what would happen if they re-ran the election under each map.

Gerrymandering and statistics

PUBLISHED MARCH 23, 2018 BY RESEARCH

DUKE MATHEMATICS HAS ITS DAY IN COURT

Duke test is the principal evidence in NC partisan gerrymandering case before the Supreme Court March 26



Duke mathematics professor Jonathan Mattingly and colleagues wanted to find out if North Carolina's congressional map was gerrymandered. So they did the math. And now, the evidence is going before the Supreme Court. Photo by Jared Latawa.

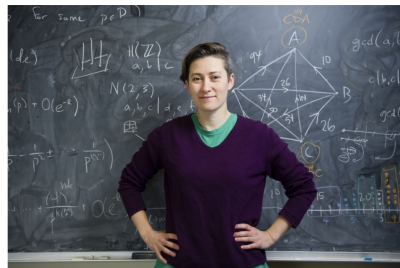
... fewer than one percent of the 24,000-plus maps Mattingly's team generated yielded the 10-3 Republican advantage that North Carolina saw in the 2016 election. ... even though the [2016] votes were closely split 47-53 percent between the two major parties. In other words, Mattingly says, the General Assembly could not have drawn a map that turned the close statewide vote totals into more lopsided results if they tried.

Gerrymandering and geometry

I was surprised to see that even though there were different mathematical attempts at a definition [of compact districts], you don't ever see mathematicians testifying in court about it. So our first aim was to think like mathematicians about compactness and look at all the definitions that already exist, and compare them and try to prove theorems about the relationships between the definitions.

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Moon Duchin, of Tufts U., has helped create a program to train mathematicians to serve as expert witnesses in court cases over redrawn electoral districts.

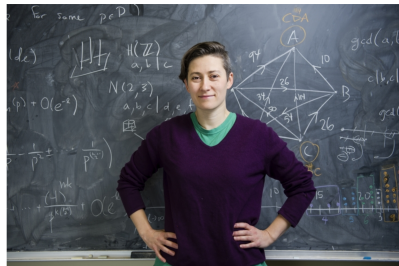
Gerrymandering and geometry

Because of the increase in cases challenging new electoral maps, [Duchin] says, there's a need for expert witnesses who understand the mathematical concepts applicable to gerrymandering.

To meet that need, she's spearheaded the creation of a five-day summer program at Tufts that aims to train mathematicians to do just that.

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Bertrand Russell prize



The Bertrand Russell prize was established by Tom Hales in 2016.

“The Bertrand Russell Prize ... looks beyond the confines of the profession to research or service contributions of mathematicians or related professionals to promoting good in the world. It recognizes the various ways that mathematics furthers fundamental human values.”

Christiane Rousseau



Christiane Rousseau, Montreal
Winner of the first Bertrand Russell Prize

“through her visionary leadership of the thematic year Mathematics of Planet Earth 2013 and her continuing active involvement in the ongoing activities that grew from it, Professor Rousseau has created opportunities for the mathematics community worldwide to confront crucial challenges facing our planet while highlighting the contributions of mathematicians to the well-being of society.”

Christiane Rousseau



Professor Christiane Rousseau, Montreal

“the more I learnt about the threats coming from global changes and the increase of the world population, the more I felt that our community has to play a role. Indeed, mathematics has so much to say on these challenges that it is a must to train a new generation of researchers who can contribute to [solving] these problems; this is why MPE spread by itself over the world.”