

Conrad Grebel University College  
University of Waterloo  
PACS 302 Special Topics: Math for Good and Evil  
Fall 2019

**Class Time:** Tuesday, 6 – 8:50 pm

**Location:** Room 2201, Paetkau Seminar Room, Conrad Grebel University College

**Co-Instructor:** Judith Koeller

**Office Hours:** Monday, 4 – 5:00 pm

**Office Location:** MC 6244

**Phone:** 519-888-4567 x 35128

**Email:** [judith.koeller@uwaterloo.ca](mailto:judith.koeller@uwaterloo.ca)

**Co-Instructor:** Lowell Ewert

**Office Hours:** Tuesday, 3 – 4:00 pm

**Office Location:**

Room 4207, Kindred Centre for Peace Advancement  
Conrad Grebel University College

**Phone:** 519-885-0220 x24380

**Email:** [Lowell.ewert@uwaterloo.ca](mailto:Lowell.ewert@uwaterloo.ca)

## Acknowledgment:

We are on the traditional territory of the Attiwandaron (Neutral), Aniashinaabe, Haudenosaunee peoples. The University of Waterloo is situated on the Haldimand Tract, the land promised to the Six Nations that includes ten kilometers on each side of the Grand River.

## Course Description:

Math and computer science are tools of enormous and increasing power that impact our daily lives in thousands of ways that we seldom recognize. Many of the ways that these disciplines have affected us are very beneficial and have transformed the lives of millions of people for the better. Increasingly, however, technology has surpassed our ability to ensure that these same benefits are not used to also cause harm.

The purpose of this class is to explore how peace and math intersect. Without peace studies understanding how math can be appropriately harnessed for good, peace theory will be inadequate to

prepare students for the twenty-first century. Therefore, peace studies needs to better understand why math matters. Conversely, without peace principles being considered when math is used to accomplish technological objectives, math can instead contribute towards causing harm. Therefore, those studying and utilizing math principles need to also understand and apply peace theory.

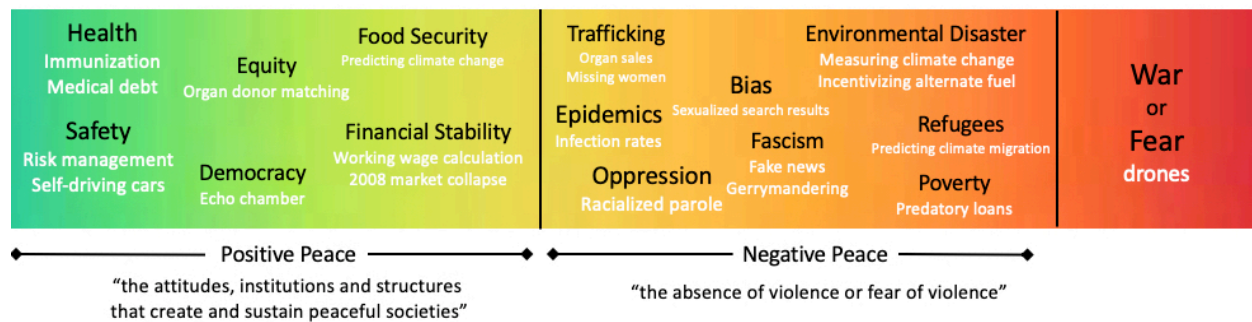
This course will examine topics that lie at the intersection of math and peace - such as democracy and elections, money and wealth, social change, war and technology, bias and equity, policing, health, and environment – and sharpen an analysis of how both math and peace studies contribute to creating a stable and peaceful society. This course is designed for students from all faculties and levels of comfort (or discomfort) with mathematics. Course activities and assignments will focus on discussion and writing; students are not required to do any mathematics.

## Learning Objectives:

Students who complete this course will be able to:

- (Math objectives):
  - Articulate the multiplicity of ways that math can be used to benefit society or cause harm.
  - Develop an understanding of some dilemmas that math graduates may face someday while working in a math-related field.
  - Understand their personal obligation as citizens, governed by general principles of human rights, to question decisions or job duties that may run counter to peace and the common good.
- (Peace objectives):
  - Understand the complexity of peace and how it differs from an approach that is reflected by simply the absence of violence.
  - Visualize the change that may be required to better harness occupations in math for the good of society.
  - Internalize how math and computer science can be leveraged to better serve the interests of society.

## Concept Map:



Text Description: there is a continuum from war or the fear of war, to Negative Peace (the absence of violence or fear of violence), to Positive Peace (the attitudes, institutions and structures that create and sustain peaceful societies). Positive Peace is associated with Health, Safety, Democracy, Food Security and Financial Stability, while Negative Peace includes Trafficking, Epidemics, Oppression, Bias, Fascism, Environmental Disaster, Refugees and Poverty. This course explores how math connects to each.

## Course teaching methodology:

A seminar course, PACS 302 will emphasize critical analysis and discussion. It will not assume that there is one “right” answer to questions posed or issues discussed, but rather that there are ways of thinking that will enable students to develop their own personal viewpoints. Students have much to contribute to this topic and will be expected to be engaged in class discussions and come to class well prepared. This course assumes that we all learn best and internalize lessons learned most effectively in a process of dialogue with each other. Students must therefore personally wrestle with concepts discussed in order to benefit from the course. Teaching methodologies that will be used will include:

- Presentation of key topics by course instructors
- Small group discussions
- Student questions posed in class
- Videos and guest lecturers
- Discussion of current events relevant to course topics
- Student involvement in research, presentations and reports
- Simulations, case studies, or discussion of hypothetical scenarios

## Required Reading Materials:

This course will make use of materials posted on LEARN and on-line resources. There is no required textbook.

## Web Page:

This course will make use of a WATERLOO LEARN website. This site will provide general information for the course, reading assignments, grades for assignments, and other matters that may be posted from time-to-time. Important announcements such as the cancellation of class for some reason will also be posted there, so please try to check the site before each class, just in case.

## Course Evaluation and Assignments:

**Baseline reflection essay** (5% of course mark) – due second week of the term, September 17, 2019, before the start of class. No research is required to complete this essay as this is a reflection paper. Two page essay (500 words) that responds to the following:

- Section 1 – Complete the following sentences and briefly elaborate on each sentence:
  - When I think of math, I think ....
  - The impact math has on my life is.....
  - The connection my likely vocation has to math is.....
- Section 2 - Complete the following sentences and briefly elaborate on each sentence:
  - When I think of peace studies, I think....
  - The impact peace has on my life is.....
  - The connection my likely vocation has to peace is .....
- Section 3 - List three key questions regarding the topic of this course that you hope to answer this term, and why the answers to these questions is important to you.
- Section 4 – reflect on any additional issues related to the course theme and topic that intrigues you that you hope to explore this term.

**On-line quizzes** (15% of course mark) – due each week, week two through 11, throughout the term.

- Students will be required to complete a series of ten quizzes composed of randomly assigned questions, two of which do not count towards the final term grade, on the reading materials assigned each week. Quizzes will be available for any 60 minute period from the Monday the day before class at 5 pm until Tuesday at 5 pm the day of class. Students are permitted to work in groups of two when taking each quiz.

**In-class assignments** (10% of course mark).

- In 10 classes, you will be asked to reflect on some aspect of the class, a reading assignment, or application of the course topic to a contemporary theme. Only the marks of the 8 highest will be recorded. Assignments will be graded mostly as pass/fail if they indicate a reasonable amount of interaction with the question/reflected given. More detail about expectations for this assignment will be given in class prior to the activity. No make-up assignments will be given.

**Book report** (15% of course mark) – due October 8, 2019, at the beginning of class. Students are expected to draft a book report approximately 1,200 words long on one of the books listed below. Other books may be considered for this assignment if a student makes a good case for the applicability of another book that is consistent with course themes. No more than two students may sign up to complete a report on the same book. The signup sheet to select a book is accessible through LEARN. Students may be called on to share key aspects of their book report in class as their book is relevant to themes that will be discussed in class. Guidelines for writing a good book review will be discussed in class.

- We suggest you read one of the following books that we believe is very relevant to the course, and which we believe will also help you as you plan your final major project. Most of these books should be available at the Conrad Grebel University College Milton Good Library on a one-week reserve. Potential books to be reviewed include:
  - John Carreyrou. *Bad Blood: Secrets and Lies in a Silicon Valley Startup*, New York: Alfred A. Knopf, 2018.
  - Brian Christian. *The Most Human Human: What Artificial Intelligence Teaches Us About Being Alive*, Knopf Doubleday Publishing Group, 2012.
  - Brian Christian and Andrew Guthrie Ferguson. *The Rise of Big Data Policing: Surveillance, Race, and the Future of Law Enforcement*, New York: New York University Press, 2017.
  - Pedro Domingos. *The Master Algorithm: How the Quest for the Ultimate Learning Machine Will Remake Our World*, Basic Books, 2018.
  - Virginia Eubanks. *Automating Inequality: How High-Tech Tools Profile, Police, and Punish the Poor*, New York: St. Martin's Press, 2017.
  - Virginia Eubanks. *Digital Dead End: Fighting for Social Justice in the Information Age*, Cambridge: MIT Press, 2012.
  - Hannah Fry. *Hello World: Being Human in the Age of Algorithms*, New York: W.W. Norton & Company, 2018.
  - Tom Griffiths. *Algorithms to Live By: The Computer Science of Human Decisions*, Penguin, 2016.
  - Daniel J. Levitin. *Weaponized Lies: How to Think Critically in the Post-Truth Era*, New York: Dutton, 2017.
  - Safiya Umoja Noble. *Algorithms of Oppression: How Search Engines Reinforce Racism*, New York: New York University Press, 2018.

*(list continued on next page)*

- Cathy O’Neil. *Weapons of Math Destruction: How Big Data Increases Inequality and Threatens Democracy*, New York: Broadway Books, 2017.
  - Alex Rosenblat. *Uberland: How Algorithms are Rewriting the Rules of Work*, Oakland: University of California Press, 2018.
  - Paul Scharre. *Army of None: Autonomous Weapons and the Future of War*, New York: W.W. Norton & Company, 2018.
  - Tom Slee. *No One Makes You Shop at Wal-Mart: the surprising deceptions of individual choice*, Between the Lines Publishing, 2006.
  - David Sumpter. *Outnumbered: From Facebook and Google to fake news and filter-bubbles – the algorithms that control our lives*, New York: Bloomsbury Sigma, 2018.
- Books dealing with thoughtful responsibility or justice-related themes:
- Jonathan Haidt. *The Righteous Mind: Why Good People are Divided by Politics and Religion*, Knopf Doubleday Publishing Group, 2013.
  - Elizabeth Minnich. *The Evil of Banality: On the Life and Death Importance of Thinking*, New York: Rowman and Littlefield, 2017.
  - Scott. E. Page. *The Difference: How the Power of Diversity Creates Better Groups, Firms, Schools, and Societies*, 2008.
  - Hans Rosling. *Factfulness: Ten Reasons We’re Wrong About the World – and Why Things Are Better Than You Think*, New York: Flatiron Books, 2018.

**Major project** (40% of course mark) – due December 3, 2019, at the start of class. Students will be expected to complete a major project that addresses an issue studied that is of particular interest to them. Students may work alone, or in groups of up to three. Projects may consist of a traditional research paper of 12 – 15 pages (roughly 3,000 – 3,500 words in length, excluding the title page and bibliography) **per student contribution**. In other words, if two students are working on a collaborative project, the total length should be double that of an individual project. Students may also propose an alternative assignment (digital, etc.) that will roughly equal an equivalent workload. If the research paper option is selected, students will be expected to use Chicago style footnotes. A bibliography should also be provided in addition to footnotes. Papers should include the following sections:

- Title page
- Table of Contents
- Executive summary
- Main body of paper
- Conclusion
- Bibliography

**Final Reflection Essay** (15% of course mark) – due before the start of class November 26, 2019.

- Students will be required to complete a five-page essay (approximately 1,250 words) that reflects on any changes in attitude they may have experienced towards course topics during the term. This essay should:
  - Review and evaluate your baseline essay and explain why you agree or disagree with what was written at the start of the term.
  - Reflect on what surprised you most when re-reading your baseline reflection.
  - Note significant changes in opinion that you may have had or key areas in which your thinking is still unsettled or unclear.
  - Discuss whether you think a course like this should be included in the PACS or Math programs, and give reasons for your comments.

- Reflect on the role of a university – does a university have an obligation to teach students how their discipline impacts society both positively and negatively? If so, how should a university best do this?
- *If your future vocation is likely to be in Math/CS:* Imagine that your future job duties run counter to peace and the common good. Reflect on how your professional code of ethics and/or personal obligations may influence your response.  
**OR**  
*If your future vocation is not likely to be in Math/CS:* Reflect on how math/computer science might interact with your long-term vocation as a tool with peace implications, or describe other matters related to course themes that you feel pertinent.
- It is expected that this Final Reflection will be footnoted, relying on materials found in at least six sources, some of which, but not more than half, can be sources assigned in class.

## Group work

Note that if students decide to work to collaboratively develop and submit a final project, a [Group Assignment Disclosure](#) required by the Faculty of Arts must be completed and handed in at least one month in advance.

## Submission guidelines

All assignments must be submitted in written, hard copy format. Assignments may not be submitted electronically, and will not be submitted on LEARN.

## Late assignments

Assignments must be submitted when due. Assignments submitted late will be subject to the following deductions:

- An immediate 5% penalty.
- Additional 2% per week day (Monday – Friday) for additional days late

Please be in touch with a course instructor at least 24 hours PRIOR to the assignment due date if there is legitimate need for accommodation. If you are ill, please communicate as quickly as you are able. A medical note may be required for an accommodation.

## UWaterloo Policies

**Academic Integrity:** In order to maintain a culture of academic integrity, members of the University of Waterloo are expected to promote honesty, trust, fairness, respect and responsibility.

Arts: [Academic Integrity website](#) University of Waterloo: [Academic Integrity Office](#)

**Discipline:** A student is expected to know what constitutes academic integrity to avoid committing an academic offence, and to take responsibility for his/her actions. [Check [the Office of Academic Integrity](#) for more information.] A student who is unsure whether an action constitutes an offence, or who needs help in learning how to avoid offences (e.g., plagiarism, cheating) or about “rules” for group work/collaboration should seek guidance from the course instructor, academic advisor, or the undergraduate associate dean. For information on categories of offences and types of penalties, students should refer to [Policy 71, Student Discipline](#). For typical penalties, check [Guidelines for the Assessment of Penalties](#).

**Grievance:** A student who believes that a decision affecting some aspect of his/her university life has been unfair or unreasonable may have grounds for initiating a grievance. Read [Policy 70, Student Petitions and Grievances, Section 4](#) When in doubt, please be certain to contact the department's administrative assistant who will provide further assistance.

**Appeals:** A decision made or penalty imposed under [Policy 70, Student Petitions and Grievances](#) (other than a petition) or [Policy 71, Student Discipline](#) may be appealed if there is a ground. A student who believes he/she has a ground for an appeal should refer to [Policy 72, Student Appeals](#).

**Accommodation for students with Disabilities:** *Note for students with disabilities:* [AccessAbility Services](#), located in Needles Hall, Room 1401, collaborates with all academic departments to arrange appropriate accommodations for students with disabilities without compromising the academic integrity of the curriculum. If you require academic accommodations to lessen the impact of your disability, please register with [AccessAbility Services](#) at the beginning of each academic term.

## Other sources of information for students:

**Mental Health Support:** All of us need a support system. The faculty and staff in Arts encourage students to seek out mental health support if they are needed.

### On Campus

- Counselling Services: [counselling.services@uwaterloo.ca](mailto:counselling.services@uwaterloo.ca) / 519-888-4567 ext. 32655
- **MATES:** one-to-one peer support program offered by Federation of Students (FEDS) and Counselling Services
- Health Services Emergency service: located across the creek from Student Life Centre

### Off campus, 24/7

- **Good2Talk:** Free confidential help line for post-secondary students. Phone: 1-866-925-5454
- Grand River Hospital: Emergency care for mental health crisis. Phone: 519-749-4300 ext. 6880
- **Here 24/7:** Mental Health and Crisis Service Team. Phone: 1-844-437-3247
- **OK2BME:** set of support services for lesbian, gay, bisexual, transgender or questioning teens in Waterloo. Phone: 519-884-0000 extension 213

Full details can be found online on the Faculty of Arts [website](#)

Download [UWaterloo and regional mental health resources \(PDF\)](#)

Download the [WatSafe app](#) to your phone to quickly access mental health support information

**Accommodation for Illness:** A medical certificate presented in support of an official petition for relief from normal academic requirements must provide all of the information requested on the "University of Waterloo Verification of Illness" form or it will not be accepted. More information can be obtained from Health Services and the form is available in pdf: <https://uwaterloo.ca/health-services/student-medical-clinic/services/verification-illness>

**The Writing Centre:** Writing Centre staff offer one-on-one support in planning assignments and presentations, using and documenting research, organizing and structuring papers, and revising for clarity and coherence. Make an appointment or drop in at the Library for quick questions or feedback. To book a 50-minute appointment and to see drop-in hours, visit [www.uwaterloo.ca/writing-centre](http://www.uwaterloo.ca/writing-centre)



## Weekly schedule

The following course schedule may change from time-to-time to reflect the actual pace of class discussion and movement through course topics. Any changes to this course schedule will be announced in class at least a week in advance, and an announcement circulated on LEARN about changes. It is also possible some readings may change, and if so, changes will also be announced in class and noted on LEARN.

### September 10: Introduction

- Reading assignment: none

### September 17: Introduction to the field of peace studies – Lowell Ewert, lead instructor

- Reading assignment:
  - [Peace and Conflict Studies](#) website, University of Waterloo, specifically sections “About Peace and Conflict Studies,” and “What our grads do.”
  - Elizabeth Minnich. “Introduction: What Were They Thinking?” taken from *The Evil of Banality: On the Life and Death Importance of Thinking*, Rowman & Littlefield, 2017, pgs. 1 – 13, available on LEARN.
  - Lowell Ewert, drafts of “Chapter 2: What is Peace?” and “Chapter 3: Grounding the Global Vision – the Micro Dynamic Web of Peace,” available on LEARN.
- Assignments:
  - Two page baseline essay is due.
  - Quiz 1 is due on-line before class begins.

### September 24: Introduction to the field of math – Judith Koeller, lead instructor

- Reading assignment (all available in Learn in the file FieldOfMathReadings.pdf)
  - University of Waterloo, “Fifty Years of the Faculty of Mathematics at the University of Waterloo”, 2017, selected pages.
  - Josh O’Kane, “Canadian technology firms sign Tech for Good Declaration”, The Globe and Mail, May 31, 2018.
  - Canadian Tech Community, “Tech for Good Declaration”, 2018.
  - Institute for Economics and Peace, “Global Peace Index 2018”, 2018, selected pages.
  - Deloitte, “Ethics in the Age of Technological Disruption”, 2018, selected pages.
- Assignment:
  - Quiz 2 is due on-line before class begins.

### October 1: Democracy, peace and math – guest Byron Weber Becker (contact Ewert)

- Reading assignment:
  - [“A Look at the Evidence.”](#)
  - [“First Past the Post.”](#)
  - [“Facts/Mythbusters.”](#)
  - Articles 1 – 27, [International Covenant on Civil and Political Rights](#).
- Assignment:
  - Quiz 3 is due on-line before class begins.



## October 8: Money, wealth, peace and math – guest Steve Furino (contact Koeller)

- Reading assignment (all available in Learn in the file MoneyWealthReadings.pdf)
  - Jones, Schmitt and Wilson, “50 years after the Kerner Commission”, Economic Policy Institute, February 26, 2018, p 1-6
  - Sommeiler and Price, “The new gilded age”, Economic Policy Institute, July 19, 2018, p 1-18
  - Bivens and Shierholz, “What labor market changes have generated inequality and wage suppression?”, December 12, 2018, p 1-11
  - Baker, Bivens and Schneider, “Reining in CEO compensation and curbing the rise of inequality”, Economic Policy Institute, June 4, 2019, p 1-11 with specific attention to Table 1 on p 5
  - It is also recommended to visit <http://www.stateofworkingamerica.org/> and check out the menus Fact Sheets and Charts & Tables.
- Assignments:
  - Quiz 4 is due on-line before class begins.
  - Book report is due.

## October 15: Reading Days, no class

## October 22: Social change, peace and math – guest Paul Born (contact Ewert)

- Reading assignment available on LEARN:
  - “Shared Measurement/The Why is Clear, The How Continues to Develop.”
  - Mark Kramer, Marcie Parkhurst and Lailitha Vaidyanathan. “Breakthroughs in Shared Measurement and Social Impact.”
- Optional assignment our guest has suggested:
  - Webinar – “[Collective Impact: Shared Measurement](#)” (will not be quizzed, but is a good source).
- Assignment:
  - Quiz 5 is due on-line before class begins.

## October 29: War, peace and math – guest Branka Marijan (contact Ewert)

- Reading assignment:
  - Branka Marijan. “[On killer robots and human control.](#)”
  - Article 36. “[Target Profiles.](#)”
  - Read Chapter 1 – Rules 1 – 6: [Distinction Between Civilians and Combatants](#)
  - Read Chapter 2 – Rules 7 – 14: [Specifically Protected Persons and Objects](#),
  - “[The Roots of Restraint in War](#),” ICRC, June 27 2018, pgs. 1 – 52.
- Assignment:
  - Quiz 6 is due on-line before class begins.

### November 5: Equity, bias, oppression, peace and math – lead instructor Judith Koeller

- Reading assignment (all but *Algorithms of Oppression* are available in the file EquityBiasOppressionReadings.pdf)
  - Safiya Umoja Noble, *Algorithms of Oppression*, New York University Press, New York, 2018, pages 17-50.
  - Chelsea Vowel, “Giving my children Cree names is a powerful act of reclamation”, CBC News, November 4, 2018.
  - Adele Peters, “Want to hire a refugee? This program can match you with someone with the right skills”, Fast Company, February 15, 2019.
  - Catherine Thompson, “Kitchener tightens rules on payday loan businesses”, Waterloo Region Record, June 18, 2019.
  - Problem Gambling.ca, “About Slot Machines”, July 4, 2019.
  - Simon Denyer and Annie Gowen, “The Masculine Mistake”, Toronto Star, May 5, 2018.
- Assignment:
  - Quiz 7 is due on-line before class begins.

### November 12: Policing, peace and math – lead instructor Lowell Ewert

- Reading assignment available on LEARN:
  - Cathy O’Neil. “Civilian Casualties: Justice in the Age of Big Data,” in *Weapons of Math Destruction: How Big Data Increases Inequality and Threatens Democracy*, Broadway Books, 2017, pgs. 84 – 104.
  - Andrew Guthrie Ferguson. “Where we Police: Place-Based Predictive Policing,” taken from *The Rise of Big Data Policing: Surveillance, Race, and The Future of Law Enforcement* New York: New York University Press, 2017, pgs. 62-83.
  - Robin D. G. Kelley. “Thug Nation: On State Violence and Disposability,” in Jordan T. Camp and Christina Heatherton, editors, *Policing the Planet: Why the Policing Crisis Led to Black Lives Matter*, New York: Verso Books, 2016, pgs. 15 – 34.
- Assignment:
  - Quiz 8 is due on-line before class begins.

### November 19: Health, peace and math – lead instructor Judith Koeller

- Reading assignment (all but *Weapons of Math Destruction* are available in the file HealthReadings.pdf)
  - Jason Burke, “DRC Ebola cases pass 2,000, prompting call for 'total reset'”, The Guardian, June 4, 2019.
  - Helen Branswell, “Ten years later, SARS still haunts survivors and health-care workers”, The Globe and Mail, March 11, 2018.
  - Katie M. Palmer, “Why Did Vaccinated People Get Measles at Disneyland? Blame the Unvaccinated”, Wired, January 26, 2015.
  - Nicole Ireland, “Why some experts say it's time for Twitter and Facebook to ban anti-vaccination posts”, CBC News, May 22, 2019.
  - Flu Trends: David Lazer and Ryan Kennedy, “What We Can Learn from the Epic Failure of Google Flu Trends”, Wired, October 1, 2015.
  - Judith Koeller, “Organ Donations, Math and Peace”.
  - Brian Resnick, “Living Cadavers: How the Poor are Tricked Into Selling Their Organs”, The Atlantic, March 23, 2012.

- Nancy Scheper-Hughes, “The Market for Human Organs is Destroying Lives”, The Washington Post, January 5, 2016
- Kristin Houser, “Black Market Bodies: How Legalizing the Sale of Human Organs Could Save Lives”, Futursim, November 6, 2017.
- Mary Carole McCauley, “From Sun magazine: ‘Genius’ pair rewrites rules of organ transplants, among other interest”, Baltimore Sun, November 14, 2012.
- Margot Sanger-Katz, “Even Insured Can Face Crushing Medical Debt, Study Finds”, New York Times, January 5, 2016.
- Suzanne Barlyn, “Strap on the Fitbit: John Hancock to sell only interactive life insurance”, Reuters, September 19, 2018.
- Jacqueline Hansen, Meegan Read, Brandie Weikle and Matt Galloway, “Privacy experts say choosing life insurance tied to fitness tracking could have unintended consequences”, CBC News, September 21, 2018.
- Cathy O’Neil, *Weapons of Math Destruction*, Broadway Books, 2016, p 173-178.
- Assignment:
  - Quiz 9 is due on-line before class begins.

### November 26: Environment, peace and math – lead instructor Judith Koeller

- Reading assignment (all available in the file FieldOfMathReadings.pdf)
  - United Nations Human Rights Office of the High Commissioner, “UN expert condemns failure to address impact of climate change on poverty”, June 25, 2019.
  - Peter Armstrong, “‘It’s a problem for society’: Climate change is making some homes uninsurable”, CBC News, June 17, 2019.
  - Daniel Tyrie and Kaitlin Thompson, “It’s time for UW to divest from fossil fuels”, Waterloo Region Record, April 3, 2018.
  - Catherine Stinson, “How Climate Change Will Impact Your Region of Canada”, Chatelaine, June 3, 2019.
  - Michael Ungar, “Put down the self-help books. Resilience is not a DIY endeavour”, The Globe and Mail, May 25, 2019.
  - Judith Koeller, “More with Less: Doing Things Efficiently”.
  - Region of Waterloo, “The Story of Rapid Transit in Waterloo Region”, January 28, 2014.
  - Carlton Reid, “Data From Millions Of Smartphone Journeys Proves Cyclists Faster In Cities Than Cars And Motorbikes”, Forbes, November 7, 2018.
  - James Dunne, “Love them or hate them, research offers financial case for big city bike lanes”, CBC News, June 8, 2019.
- Assignments:
  - Quiz 10 is due on-line before class begins.
  - Final reflection is due.

### December 3: Summary, student presentations, tie up loose ends

- Reading assignment:
  - None.
- Assignment:
  - Final Major project due.
  - Student presentations in class.