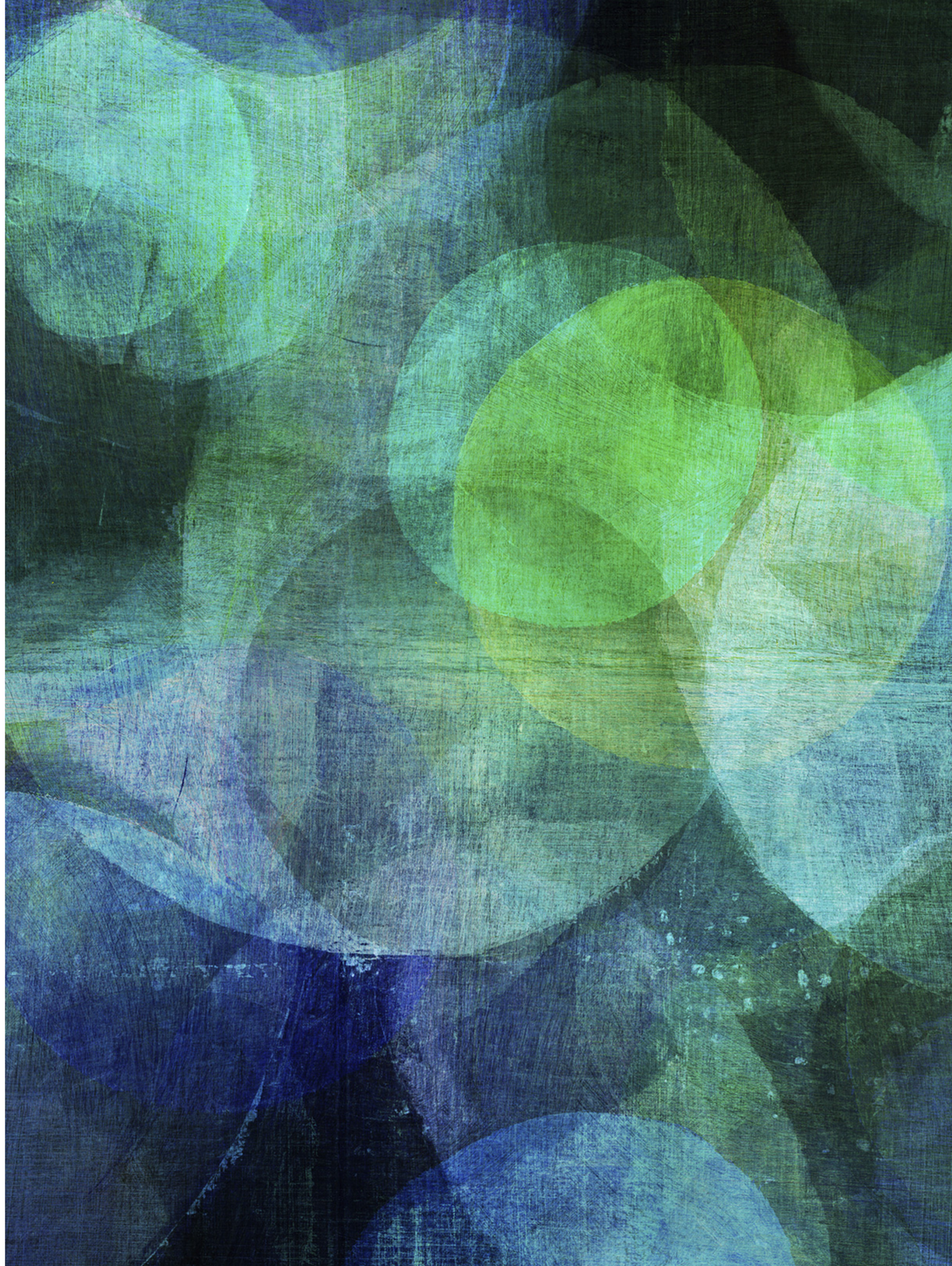
WHY LOGIC IS SO MUCH FUN

Yoshihiro Maruyama

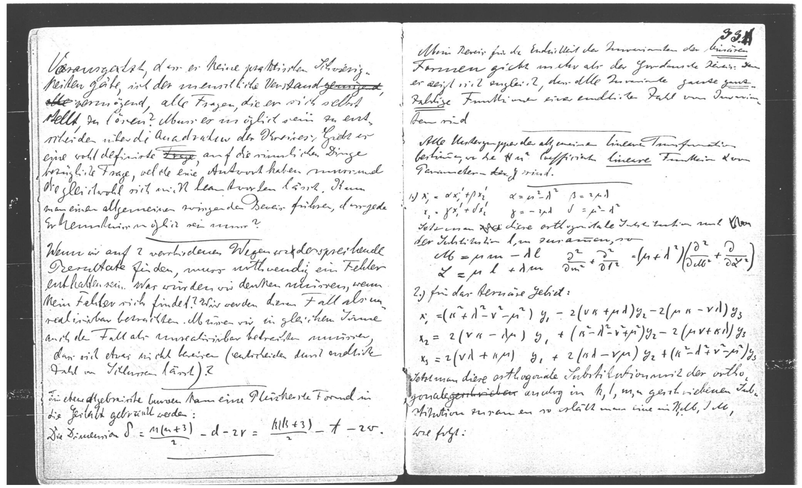


DISCLAIMER

- I will briefly talk about why logic is interesting to me.

- All this is my view and my perspective on the origins, roles, and nature of logic.
- Others may have different views, different perspectives, and different stories to tell.

- NB. I have been trained in mathematical and philosophical logic and history of them, but my view may still be incomplete (and changes over time).

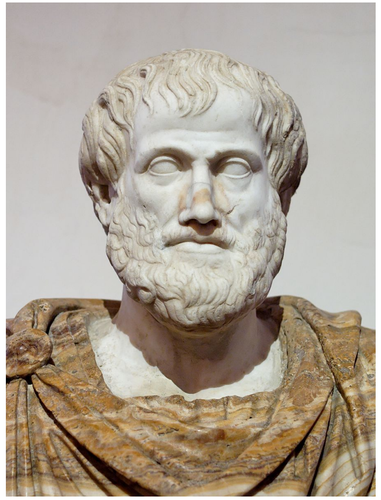


Hilbert's handwritten text I have read to study history of logic

http://www.shayashi.jp/HNBP/index.html

TWO ORIGINS OF LOGIC, ANCIENT AND MODERN

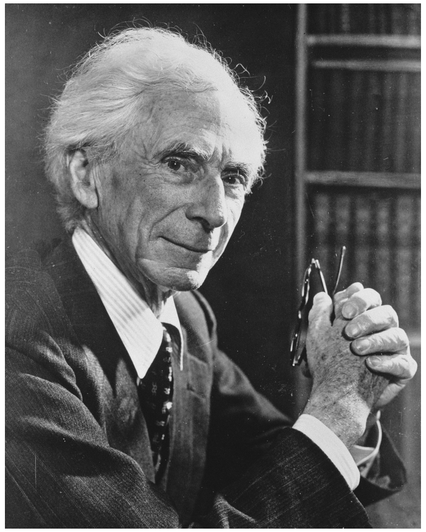
- **Logic as Foundations of Natural Language Reasoning:** you convince others via logos (as well as pathos and ethos; Aristotle's *Rhetoric*); an origin of Ancient Logic.

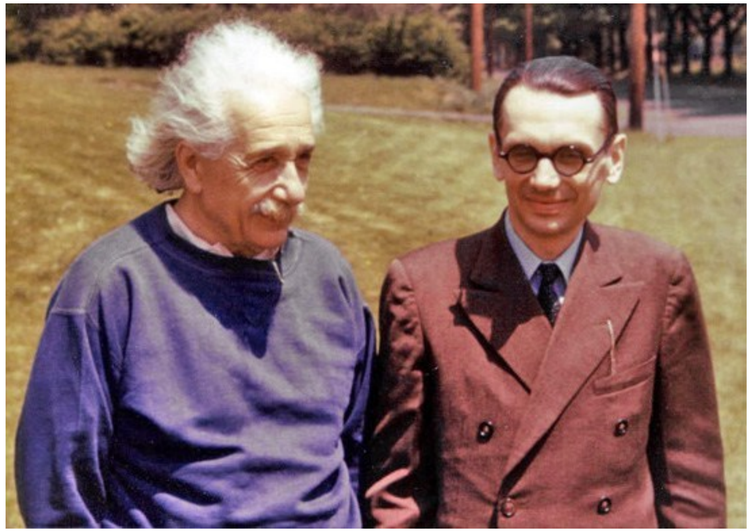


- **Logic as Foundations of Mathematics:** you use logical reasoning in math, but what does it mean to be logical / illogical? Where is the border? What reasoning exactly is allowed in math? Why is mathematical truth universal? Is math really consistent?

TWO ORIGINS OF LOGIC, ANCIENT AND MODERN

- **The Foundational Crisis of Mathematics**:
  - Inconsistencies were discovered in math, and mathematicians and philosophers such as Russell and Hilbert worked hard to build solid foundations of mathematics

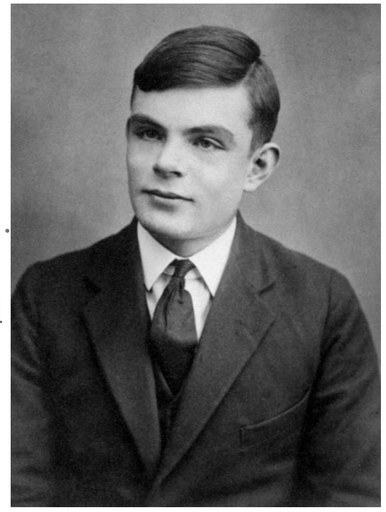




https://www.brainpickings.org/2015/05/07/rebecca-goldstein-incompleteness-godel-einstein-time/

  - And failed; Gödel proved it is impossible to prove the consistency of math (certain conditions, 1931). Yet the endeavour yielded modern logic as a scientific discipline. Before then: only mathematical philosophers and philosophical mathematicians.

APPLICATIONS OF LOGIC



- **Logic as Foundations of Computer Science:** the computer itself was born from logic (e.g., Turing, was a logician; no computer scientist at that time).
- **Logic as Foundations of Artificial Intelligence:** the very idea of AI stemmed from Turing's thinking machines (older origins; Leibniz's alphabet of human thought).
- **Logic as Foundations of Physics:** the empirical nature of logic has been debated in foundations of quantum physics, the logic of which is essentially different from classical logic. Logical foundations of quantum physics and quantum computing.

- **Logic as Philosophical Methodology:** analytic philosophy, arguably the strongest tradition of philosophy today, was born from Frege and Russell's logical studies.
- **Logic as Foundations of Formal Linguistics, Microeconomics, Cognitive Sci.**, etc.

LOGIC AND THE CERTAINTY AND OBJECTIVITY OF MATHEMATICS

- **Logic as Foundations of Computer Verifications of Proofs:** Vladimir Voevodsky, a Fields Medalist in Mathematics (2002), found non-trivial mistakes in his published proofs (his theorems were used by other mathematicians as well).

https://www.nytimes.com/2017/10/06/obituaries/vladimir-voevodsky-revolutionary-mathematician-dies-at-51.html

- Voevodsky thus started to work on computer verifications of proofs (cf. **automated theorem proving**; interactive proof assistant).
- You can also verify the correctness of computer programs via logic. It is called **Hoare logic** (Hoare is a Turing award winner in 1980).
- Shinichi Mochizuki released a proof of the **abc conjecture** in 2012, which is going to be published in 2021 (after 10 years reviewing). But the proof is too complex and the mathematics community still has not agreed upon the correctness of the proof…

CONCLUSIONS

- **Conclusions:** Logic is foundations of everything (cf. a theory of everything; Leibniz's characteristica universalis), from mathematics and philosophy to physics and computer science / artificial intelligence (and thus logic is interesting).
- **Medieval Logic** I omitted (not because of dark ages), e.g. Ockham known for Razor:

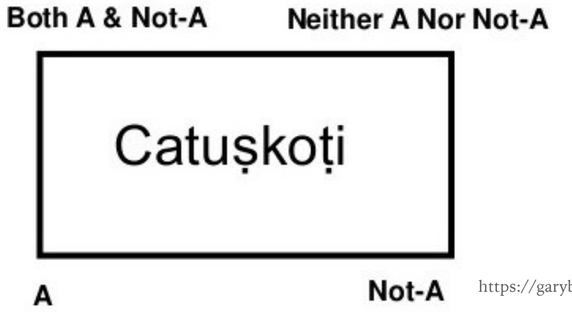
https://richardzach.org/2009/05/09/robert-k-meyer-1932-2009/

THE LOGIC TRADITION IN AUSTRALASIA AND ANU

- Australasia has an interesting tradition in logic, especially substructural logic and paraconsistent logic, which is even related with Buddhist logic (an expert at ANU).

- The ANU School of Computing is especially well known for the tradition of substructural logic (Robert Meyer, John Slaney, Rajeev Goré, etc.); I work on it too.

- Even today, there are five logicians in the ANU School of Computing (R. Clouston, P. Höfner, D. Pattinson, A. Tiu, and me), and two in the ANU School of Philosophy (A. Hájek and K. Tanaka, who works on paraconsistent logic and Buddhist logic).



https://garybasin.com/the-logic-of-buddhist-philosophy/