Some Aspects of the Legacy of Ronald Aylmer Fisher (1890-1962)

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Abstract

Few would dispute that RA Fisher is the father of modern statistics. Many would agree that he is one of the fathers of modern epidemiology. His legacy is massive, complex and filled with challenges. As a young researcher, he had a very bitter and extended set of arguments with Karl Pearson (1857-1938). Late in his life, he had a series of animated disagreements with medical researchers.

Sir Ronald Aylmer Fisher, FRS

Born : February 17, 1890 : North London, England
: a twin, other twin was still born
Died : July 29, 1962 : Adelaide, Australia
: embolism, cancer of the bowel

My 'background' in History

- Father, Uncle and Grandfather all majored in History at the University of Toronto [UofT] and were high school History teachers. Grandfather also taught Latin!
- Youngest brother studied History [also UofT] but then went on to be a Guidance Counsellor
- I am an amateur Historian of:

  : Probability and Statistics

  : Jazz

Some of the Canadian connections to Fisher

- 1924 : Toronto : RA Fisher [RAF] presents at the International Congress of Mathematics
- University of Toronto : DB DeLury, DAS Fraser
- University of Waterloo : GA Barnard, DA Sprott
- Queen's : AM Herzberg
- University of Calgary : GHF =>

GH Fick (1993) "Detecting the Interaction of Quantity and Quality:
A Study of Fisher's Analysis".
Canadian Journal of Statistics, 21:97-106.

Father of ?

- Modern Statistics
- Modern Epidemiology
- Genetics
- Biology
- Agronomy
- Eugenics
- 'Applied' Mathematics

RAF was an Outsider

- Held many prestigious positions but he was never a 'Professor of Statistics'
- “Fisher was a genius who almost single-handedly created the foundations for modern statistical science, without detailed study of his predecessors.” Hald (1998)
- First paper in statistics was in 1912 (while still an undergraduate) on “curve fitting”, questioning the “method of moments” and proposing a new method that was to become “likelihood” in his 1921 paper

Disputes with the “Establishment”

- Karl Pearson [KP] : Over two decades he published more than a dozen papers, with several assistants, on approximating the first two moments of the sample correlation coefficient
- Fisher derived the relevant distribution, not just the first two moments
- KP : The Methods of Moments
- RAF : Maximum Likelihood

Begrudging thanks...

- RAF : after the vote of thanks for his 1935 paper
- “The acerbity, to use no stronger term, with which the customary vote of thanks has been moved and seconded [ ] does not, I confess, surprise me. From the fact that thirteen years have elapsed between the publication, by the Royal Society, of my first rough outline of the developments, which are the subject of to-day’s discussion, and the occurrence of that discussion itself, it is a fair inference that some at least of the Society’s authorities on matters theoretical viewed these developments with disfavour, and admitted with reluctance.”

Bitterness...

- RAF : “I find that [the person giving the vote of thanks] is offended with me for “introducing misleading ideas”. He does not, however, find it necessary to demonstrate that any such idea is, in fact, misleading. It must be inferred that my real crime, in the eyes of his academic eminence, must be that of “introducing ideas”.

The Chi-Squared Test

- Definition : A test any fool can carry out and frequently does – SJ Penn
- KP: developed and first published in 1900
- RAF : 1924 [or earlier?] provides major correction to the original work
- RAF : the 'Exact Test'

THE LADY TASTING TEA

HOW STATISTICS REVOLUTIONIZED SCIENCE IN THE TWENTIETH CENTURY

DAVID SALSBURG

"Entertaining . . . The pleasures of the book emerge easily . . . and the end result is both educational and fun."—*Nature Medicine*

Intervals

RAF : Fiducial [from the Latin 'Faith']

J Neyman [JN] & E Pearson [EP] : Confidence => repeated sampling interpretation

Confidence Intervals and Fiducial Intervals are the same with many [most?] commonly used methods

Their interpretations are not the same

Tests of Significance

- RAF : Observed Level of Significance
- JN, EP, A Wald and others : Rejection Rules
- Until the 1970s - Rejection Rules dominated
- Now the observed level of significance is everywhere [p=0.0311]
- Where did 'p-value' come from?
- Power: A probability of a possible outcome of a potential decision conditional upon an imaginable circumstance given a conceivable value of an algebraic embodiment of an abstract mathematical idea and the strict adherence to an extremely precise rule. - SJ Penn

RAF versus some 'Mathematicians'

- RAF : (1935) provided the first 'non-parametric' method
- RAF : (~ 1954) “The reader will realize that [ ] was in no sense put forward to supercede the common and expeditious tests based on the Gaussian theory or errors.”
- RAF : [DOE] “In inductive logic, [ ] an erroneous assumption of ignorance is not innocuous; it often leads to manifest absurdities.”

RAF : The person

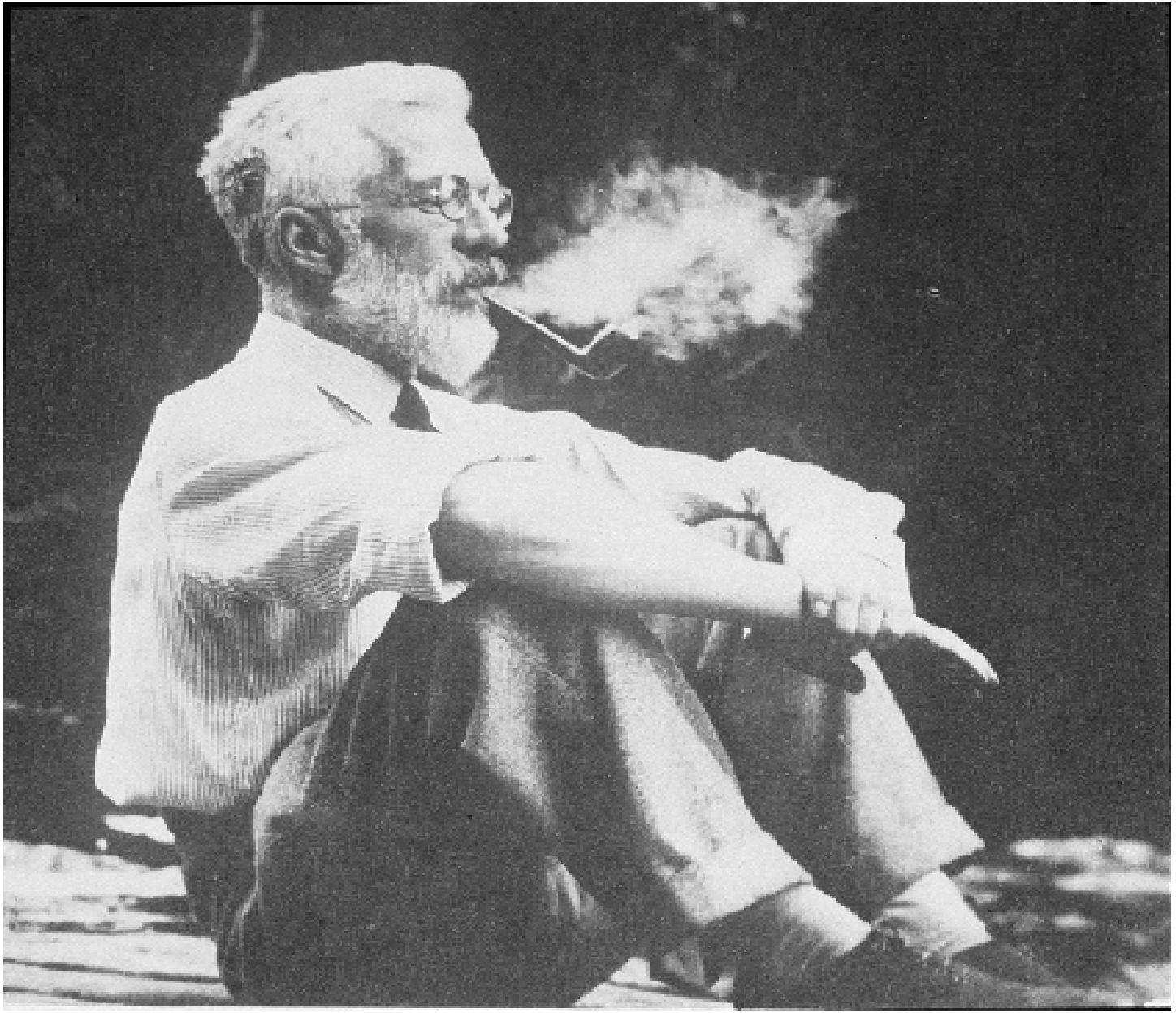
- “Fisher was a difficult man to live with. The many children, the hard physical work, the perpetual shortage of money, and Fisher's inattention to his wife's health and other needs led to a complete domestic break in 1942.” - JFB(1978) as cited by Kruskal (1980)
- “Fisher suffered a tragedy harsh in another way: the elder of his two sons, George, was killed in the crash of his Air Force plane at the age of 24.” - JFB (1978) as cited by Kruskal (1980)

Smoking and Lung Cancer

- 1952 : A study of smoking and lung cancer begins
- : 2/3 of the doctors in Great Britain returned a questionnaire
- 1956 : BMJ : an 'association' is 'shown'
- JFB : “An annotation 'went beyond the evidence' to offer that 'it has been proven that smoking causes lung cancer.' “

RAF was 'unpopular' with some of the medical profession

- RAF : “The almost shrill conclusion that that it was necessary that every device of modern publicity should be employed to bring home to the world at large this terrible danger.”
- JFB : “There was a prima facie case for further investigation of smoking and of possible causes of lung cancer.”
- RAF : “to plant fear in the minds of perhaps a one hundred million smokers [ ] without knowing for certain they had anything to be afraid of [ ]”



Inhaling and Lung Cancer

- Doll and Hill (1950) 'show' a negative association between inhaling and lung cancer
- RAF : “There is nothing to stop those who greatly desire it from believing that lung cancer is caused by smoking cigarettes. They should also believe that inhaling cigarette smoke is a protection. To believe either is, to run the risk of failing to recognize, and failing to prevent, other and more genuine causes.”

Randomization

- RAF : (1926) “One way of making sure that a valid estimate of error will be obtained is to arrange the plots deliberately at random, so that no distinction can creep in between pairs of plots treated alike and pairs treated differently; in such a case an estimate of error, derived in the usual way from the variation of sets of plots treated alike, may be applied to test the significance of the observed difference between the averages of plots treated differently.”

Randomization in Medicine

- “[Some years later], Austin Bradford Hill (1897-1991) promulgated the random assignment of treatments in clinical trials as the only means of avoiding systematic bias between the characteristics of patients assigned to different treatments.” - Armitage (2003)

DB DeLury was one of the finest interpreters of Fisher's writings

- “...as a matter statistical decency, we never average things that differ through more than error. To do so is to distort and deceive.” - DB DeLury
- “The decision to reject observations should never be reached lightly. The decision to reject is a decision that the error system is out of control and we lose the essential basis for reaching assured conclusions. In a way, the concern is less about the observations we remove than the ones we retain. How trustworthy are they if the error system is not to be trusted?” - DB DeLury
- “The occurrence of observations we do not like is the commonest feature of all experimental and other statistical inquiries.” - DB DeLury

More Quotations

- “No aphorism is more frequently repeated in connection with field trials, than that we must ask Nature few questions or, ideally, one question, at a time. The writer is convinced that this view is wholly mistaken. Nature, he suggests, will best respond to a logical and carefully thought out questionnaire; indeed, if we ask her a single question, she will often refuse to answer until some other topic has been discussed.” (R.A. Fisher)

Others

“Fisher was of course a fine mathematician but difficult to follow. He would leap over intermediate stages in a calculation, leaving his colleagues floundering. I have several times heard a distinguished mathematician say, 'He has evidently solved the problem correctly, but I don’t see how he has done it.' ” (EB Ford)

“To become a statistician, practice statistics and mull Fisher over with patience, respect, and skepticism.” (Harold Hotelling)

Poignant ?

“...it would still be true that the Natural Sciences can only be successfully conducted by responsible and independent thinkers applying their minds and their imaginations to the detailed interpretation of verifiable observations.

The idea that this responsibility can be delegated to a vast computer programmed with Decision Functions belongs to the fantasy of circles rather remote from scientific research.”

- RA Fisher