The wise old scientist: a commentary on ethics, old age and science

Giuseppe Metere
Università degli Studi di Palermo

Personalised services for the Elders.
Discussing design options in an interdisciplinary and intercultural way.

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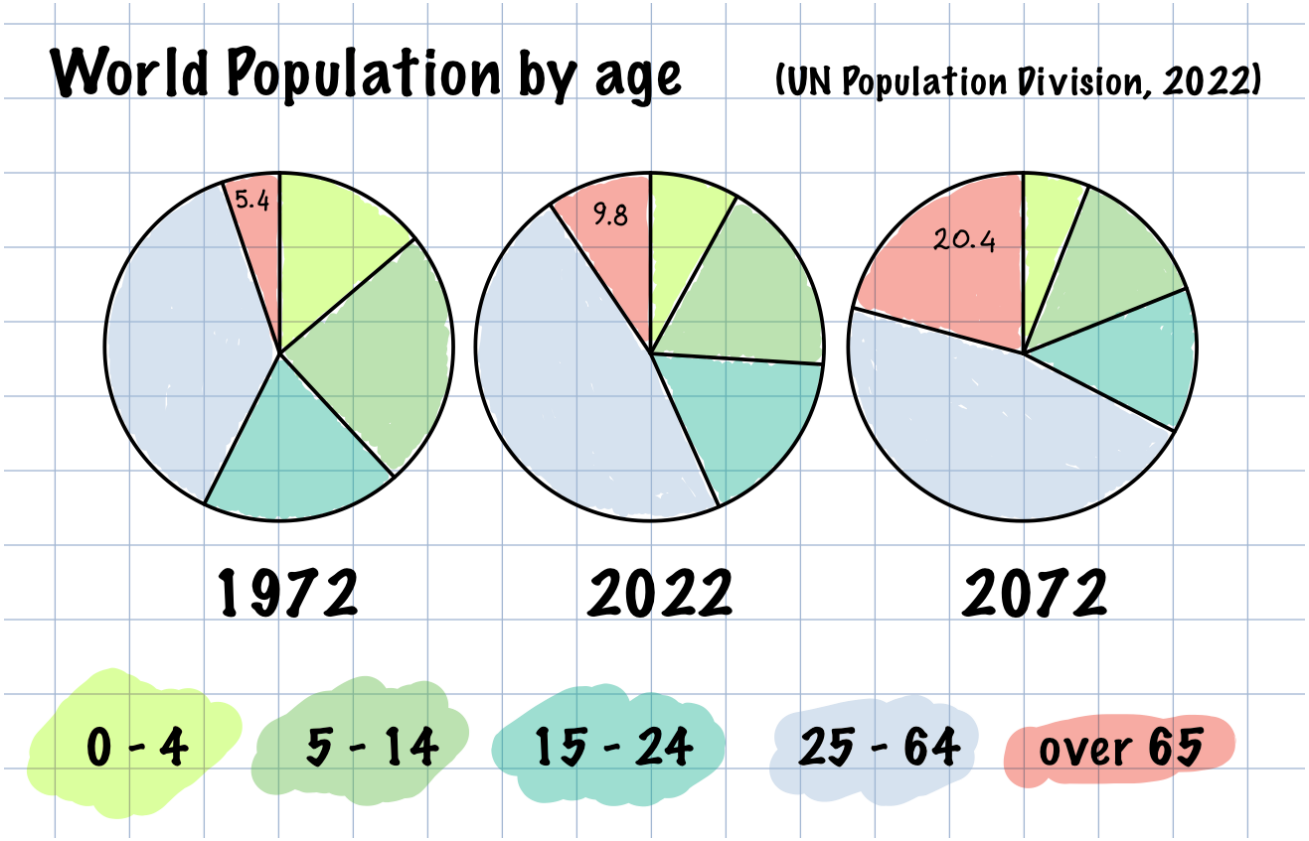
Intro

Demographic change is by far the most significant challenge facing Europe and ultimately the whole world in the next 40–50 years.

- This is not just a matter of the increase in the number of humans living on our planet: such a number has an upper bound, given that the resources on our planet Earth are limited.
- A relevant point is that we are getting older. For the past two centuries life expectancy has, in average, increased of around 0.25 years per year, and this trend is expected to continue in the future.
- What is dramatically changing is age distribution. This relatively new phenomenon concerns not only the developed countries, but, at different rates, all the countries.

Demographic Pies are served!



In 2019, for the first time, there were more people over 65 than children up to 4. We are shaping a future society of elder people: it becomes crucial to make longevity a sustainable achievement.

Ageing issues

Sustainability of ageing can be studied under several viewpoints:

- Economical
- Social
- Medical
- Technological
- ...

Unexpectedly (since I am a mathematician), I would like to address this theme from a cultural perspective, rather than from a technical one.

I will give an overview on the extent to which ageing concerns the academic communities, scholars and researchers, highlighting the tension between two extremes: the young ones, brilliant and hungry, and the elder ones, experienced and wise.

Here and there, I will focus on the community I know better, and I will comment on some episodes involving mathematicians.

These 8 children have deeply influenced the world...

...a few years after each picture was taken!

The Wise Old Scientist Paradigma

Carl Jung describes an **archetype**:

⇒ the **wise old man**, the **sage** (old french *sage*; latin *sapio, sapere*: to taste, to discern, to be wise) or the **senex** (latin, old man).

The iconography of the *scientist*, as a stereotyped character in arts and letterature, is that of an elder and possibly absent-minded, person, and the equation **old = wise** is present in several ancient cultures.

Society was more static in the past, evolving slower than now:

⇒ the more you lived, the more you gathered experiences that would eventually give you the keys to knowledge.

Moreover, the demographic pies were quite different, and only few people could live a long and healthy life.

⇒ this could have contributed to reinforce the association of wisdom with ageing.

Life Span vs Life Expectancy

There is a widespread misconception according to which in the past lifespan of sapiens was much shorter than today.
It is true that life expectancy at birth was heavily influenced by infant mortality.
On the other hand, human biology has not changed that much in the last few thousand years and a well-to-do healthy person could live a long life also, say, in ancient Grece.

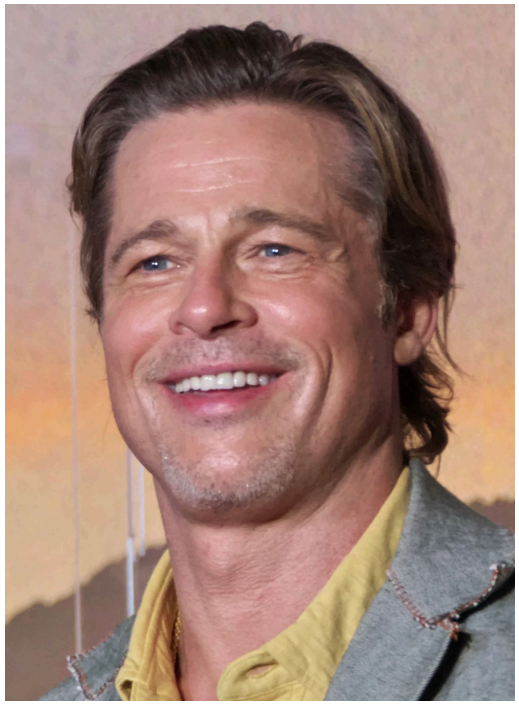
- Xenophanes (570 B - 478 B) died 92.
- Hippocrates (460 BC - 370 BC) died 90.
- Pythagoras of Samos (570/580 BC - 495 BC) died 75-85.
- Plato (428 BC - 348 BC) died 80.
- Thales of Miletus (624 BC - 548 BC) died 76.
- Archimedes (287 BC - 282 BC) died 75.
- Socrates (470 BC - 399 BC) died 71.

This list is just a cherry-picking list of ancient Greek sages, call them scientists or philosophers. Notice: the last two of them could have lived longer.

Does *old* still mean *wise*?

Despite the idea of old sage is still present in the contemporary society, a social stigma can be related to the physiological changes of ageing. Indeed, perceived age is not always aligned with actual age, and mature persons are often inclined to follow youthful models.

Leonardo da Vinci, 60-65.



Brad Pitt, 59.

Age and scientific performance

Several human activities show a correlation between age and performance. This raises the question whether this aspect concerns also scholars and researchers.

In fact, history of science abounds of discoveries made by U-30.

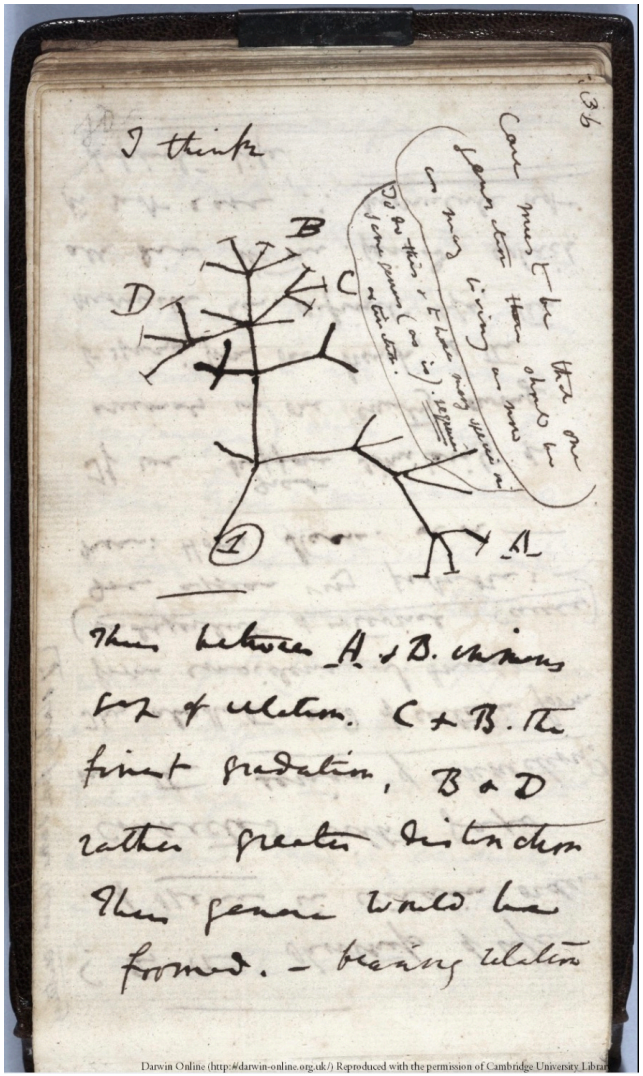
- Isaac Newton, 24, starts working on the theory of universal gravitation.
- James Watson, 25, discovers DNA.
- Albert Einstein, 26, invents special relativity theory.
- William Thomson (aka Lord Kelvin), 27, establishes the principles of thermodynamics.
- Ada Lovelace, 28, working on Babbage's Analytical Engine, initiates modern computer science.
- Niels Bohr, 28, creates his named-model of atom.

Charles Darwin

- Charles Darwin publishes his treatise "*On the Origin of Species*" on 24 November 1859, when he was 50, but... look at his notebook on the right: it is dated 1837, when he was 28!

"I think [sketch] *Case must be that one generation then should be as many living as now. To do this & to have many species in same genus (as is) requires extinction. Thus between A & B immense gap of relation. C & B the finest gradation, B & D rather greater distinction. Thus genera would be formed."*

He was 22 when sailed the *Beagle*.



Évariste Galois

- Évariste Galois (1811-1832) was a French mathematician. He solved the 350 y.o. problem of determining the conditions under which a polynomial equation can be solved by radicals.

To this end, he invented a groundbreaking theory, which is now considered the beginning of modern algebra. He died 21, in a duel, after he spent the night writing down his theory in a letter to one of his friends.

Galois work was not recognized by the mathematicians of his time. He was not admitted to the École Polytechnique in 1828. Augustin-Louis Cauchy refused to publish three of his papers. His memoir on equations was refused several times... In 1830 it was submitted to Joseph Fourier, who died soon after, and the memoir was lost! Siméon Denis Poisson defined his work "incomprehensible".

A golden age of scientific production

These anecdotes seem to suggest we should consider science as a "young man's game". Can we speak of a golden age of scientific research?

This idea has been taken quite seriously by mathematicians. It is well known that there is no Nobel for mathematics, the most prestigious prize for a mathematician being the *Fields Medal*, awarded since 1936 every four years to scholars **under 40 years of age**.

Caveat: there is still hope for mature mathematicians! Since 2003, the *Abel Prize* is awarded annually by the King of Norway to one or more outstanding mathematicians.

However, the question remains open: does there really exist a golden age of scientific production? Are there any evidences of this fact, other then anecdotes as the ones referred above?

Alexander Grothendieck

Alexander Grothendieck, 1950

Alexander Grothendieck, born in Berlin in 1928, is considered one of the most influential mathematician of the last century.

In 1966 he was awarded the Fields Medal for his contributions to algebraic geometry, homological algebra, and K-theory. He declined to attend the ceremony in Moscow, as a protest against war.

He left IHÉS in 1970, after he realized they were getting money from the military. Soon after, he left active mathematical research and 1991 he moved to a remote village at the foot of the Pyrenees Mountains.

In what category would you put Grothendieck?

The young promising talent...

Alexander Grothendieck

Alexander Grothendieck, 2014

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The young promising talent or the old sage?

Is science really a young's man game?

K. Brad Wray [2003], discussing Kuhn's claim that young scientists are expected to make the most revolutionary contribution to science [Kuhn, 1996], singles out three (possibly complementary) interpretations:

(i) older scientists are resistant to change;

(ii) young scientists are more productive;

(iii) young scientists are more likely to make significant discoveries.

Of the three claims the second one seems to be more suitable for a quantitative analysis, so let us keep it for later, and start by discussing number (i) and number (iii).

(i) Are older scientists are resistant to change?

Resistance to new ideas occurred several times along the timeline of Science, but little correlation can be shown with the age of scientists.

Planck's Principle

Do younger scientists accept new scientific ideas with greater alacrity than older scientists?

David L. Hull, Peter D. Tessner, Arthur M. Diamond

A case study is analyzed in [Hull et al., 1978], and concerns the acceptance of Darwin's theory of evolution by British scientists 10 years after the pubblication of O. of S.

They conclude that "*less than 10 percent of the variation in acceptance is explained by age*", and that "*of scientists who accepted the evolution of species before 1869, older scientists were just as quick to change their minds as younger scientist*".

This and other examples lead us to derubricate Plank's principle to a unnecessary myth.

(iii) Are young scientists more likely to make significant discoveries?

Concerning (iii), Brad Wray [2003] analyzes 24 scientists mentioned in Kuhn's work, and finds no correlation. He concludes that:

[...] *young scientists are not especially well positioned to make revolutionary scientific discoveries.* [...] *If we consider the broad range of factors that are required to turn a research finding into a significant discovery, it is not surprising that it is the middle-aged scientists that are especially well poised to make revolutionary discoveries. A scientist often needs to develop a rhetoric, an institutional basis, and an audience if her new findings are to be acknowledged as significant discoveries. And middle-aged scientists are generally better situated with respect to the research community to ensure that these conditions are satisfied.*

(ii) Are young scientists more productive?

Since bibliometrics have become so important in evaluating scholarly performance, a huge amount of data has been gathered concerning journal articles, books, and their impact.

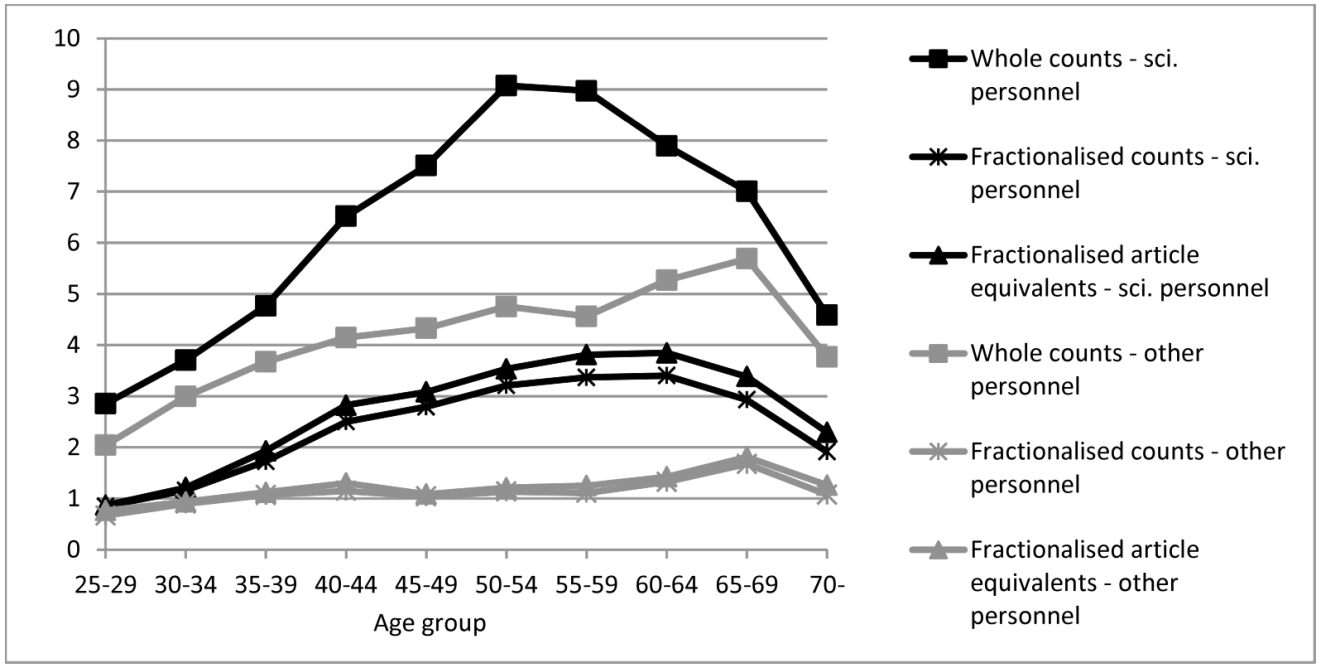
Some analyses of these data seem to confirm an inverted U-shaped diagram to describe scientific production vs age of academics (of course, other factors are taken into consideration, such as gender, academic position, area of research... but let us focus on ageing issues).

Call this paradigm "peak-and-decline", since it would entail that the typical dynamics of academic productivity would show a peak during the early stage of the scholar's career, followed by a gradual -yet inexorable- decline.

Notice: this is not just style exercise. In designing research projects, bias can condition the distribution of resources among personnel, or suggest the age of retirement of professors, and so on.

Even though it is substantiated by common sense, more evidences are needed if we want to glorify the peak-and-decline model.

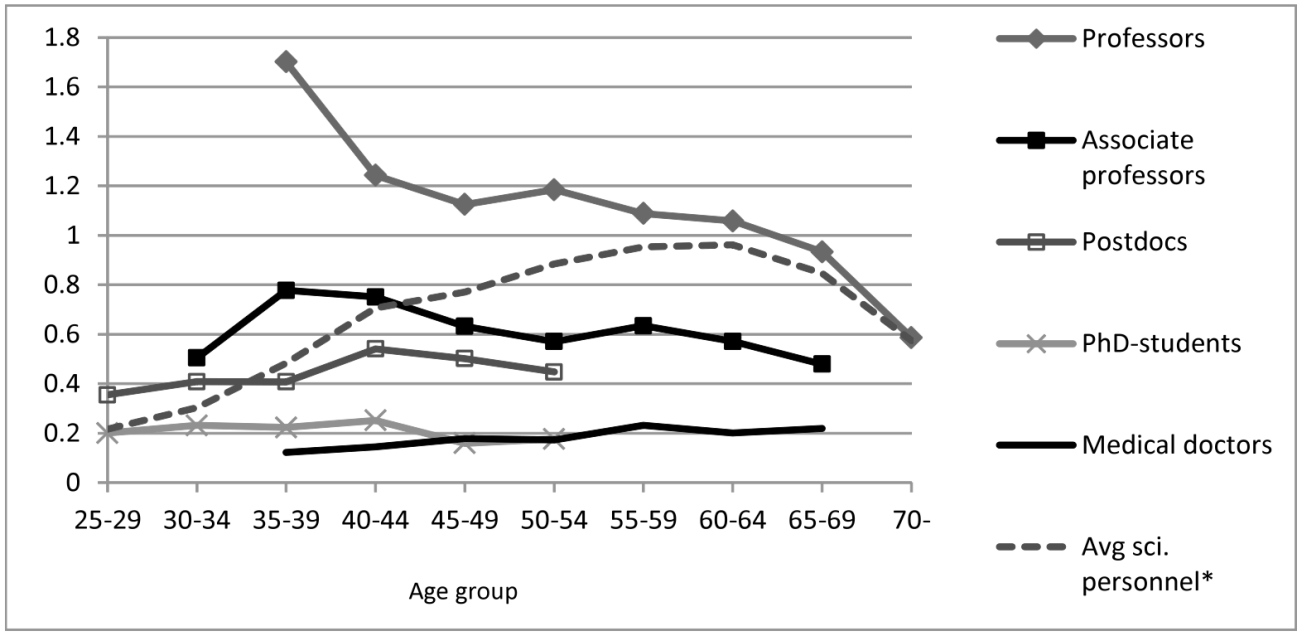
Peak-and-decline



data set: 11 519 Norwegian university researchers who contributed to 59 868 publications (33 902 excluding duplicates). Main source: Thompson Reuters NCR for Norway, data covering 1981-2009; pub's indicators: average number of pubs.
fractionalized: divided by no. of authors.
article equivalents: combined with monographs, weighted 5 papers.
sci personnel: professors, post-doc's and PhD's.
other personnel: medical doc's, tech's and admn's, adj. professors.

[Aksnes et al. 2011]

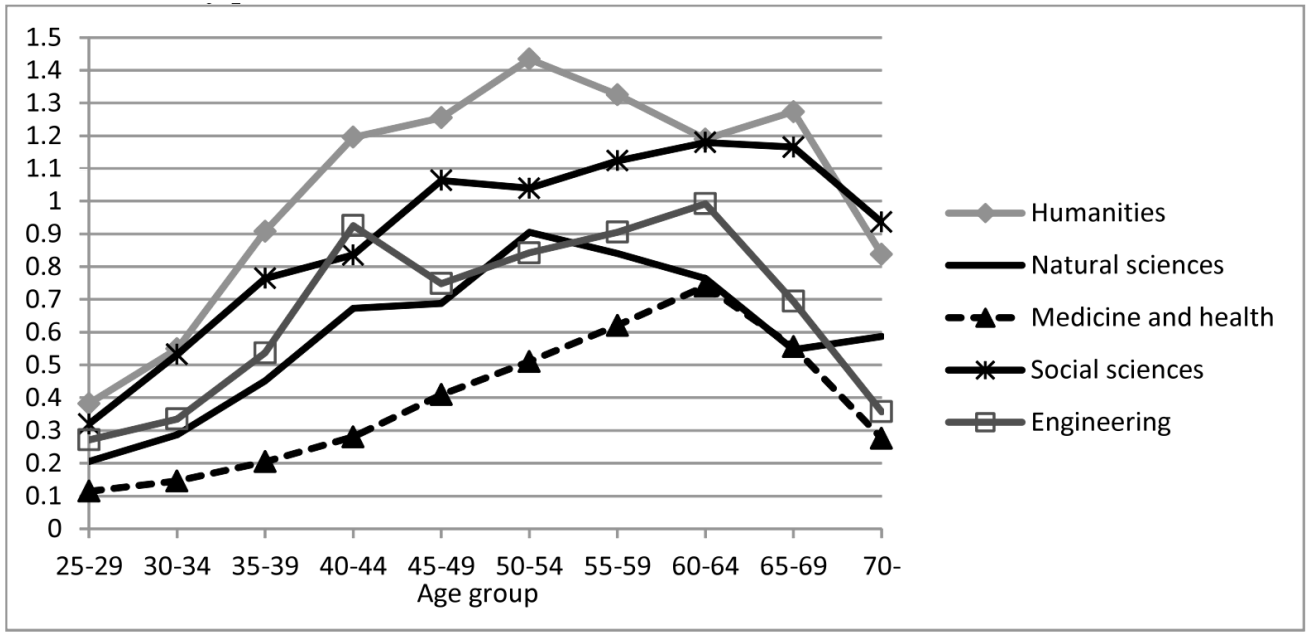
There is a peak, but it is around 60's!



Average number of publications (fractionalized article equivalents) per person per year, by age group and group of personnel.

[Aksnes et al. 2011]

Peak-and-decline, per discipline



Average number of publications (fractionalized article equivalents) per person per year, by age group and domain, scientific personnel only.

[Aksnes et al. 2011]

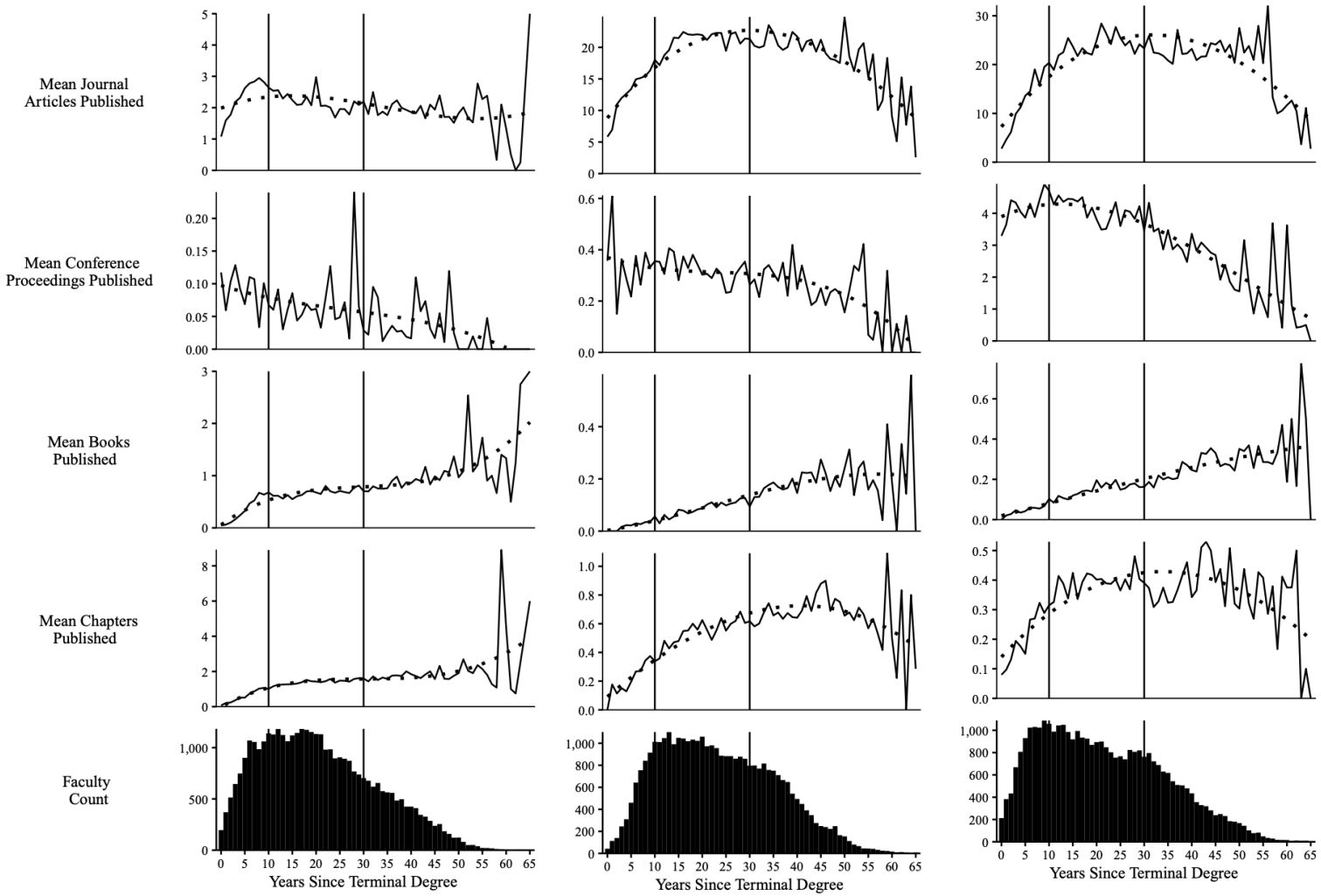
The peak-and-decline model demystified

However, many researches (including the one I just referred about) are focused on journal articles, thus providing only a partial description.

Recently, in [Savage and Olejniczak, 2021], a massive analysis has given quite a different picture. The study, which involves 167 299 faculty members across the US, analyzes four modes of knowledge dissemination (journal articles, conference proceedings, books, and book chapters) vs. three academic age cohorts (1-10, 11-30 and 31-∞), and explores the production and the impact over six areas of knowledge.

The motivation of this research is so explained:

> *The aging of the professoriate throughout the end of the twentieth century and the early years of the 2000's (both before and after the end of mandatory retirement in the United States, ca. 1994) has become a source of concern for some scholars and research administrators, who posit that the "greying" of the academy results in lower research activity and a decline in scientific advancement.*



Humanities | Bio-Medical | Maths and Physics

[Savage and Olejniczak, 2021]

A new perspective

The study concludes that the peak-and-decline model

> [...] *does not universally characterize career trajectories across fields or across publication types. Some fields show no evidence of a "peak and gradual decline" in journal article or conference proceeding publishing activity, while others reveal a gradual decline over time, particularly among conference proceeding publications. Moreover, the increased book and book chapter publishing activity of senior faculty across all fields clearly shows this model is not applicable to all types of scholarly publishing. We posit that a more accurate description of general career trajectories may be stated as a gradual change of focus away from journal articles and conference proceedings, toward book and book chapter publication.*

Across the horizon: the case of a prominent mathematician

To conclude, I would like to face a very sensible point, and I hope to do it with delicacy and respect.

Sir Michael Atiyah (1929–2019) was British-Lebanese mathematician.
His long lasting career can be taken both as an example of that of a early genius, he was awarded the Fields Medal when he was 37, and an example of old scientist, he obtained the Abel prize in 2004 (together with I. M. Singer), when he was 75.

He gave fundamental contributions to many areas of mathematics, at first bringing together topology, geometry and analysis, then with physics.

His approach to mathematics was based primarily on the idea of finding new horizons and opening up new perspectives.

[Connes and Kouneiher, 2019]

Atiyah's last years.

Atiyah left us on 11 January 2019. During the last years of his long life, he was involved in some disputes.

Indeed,

- in 2016 he claimed a proof of the non-existence of complex structures on the 6-sphere, a problem that had been unsolved for 60 years;
- in 2017 he presented a short proof of the Feit-Thompson theorem on the solvability of finite groups of odd order;
- in 2018 he claimed to have solved the Riemann hypothesis, Hilbert's eighth problem.

In the three cases, his arguments were not conclusive. However, many of his colleagues and friends declined to comment on his proofs, perhaps for fear of jeopardizing the relationship.

One exception: Alain Connes, Fields medalist, who wrote an article inspired by the fallacious proof referred in the second item above.

At night, under the full moon...

Connes writes:

> *His idea* [...] *taken too literally* [...] *cannot work.*
>
> *The goal of the present paper, as a tribute to a luminous mathematical imagination that never dimmed, is to take seriously his proposal and to show that, understanding it in a broader sense, one arrives at a very interesting idea.* [Connes 2019]

And then, citing Atiyah:

> *In the broad light of day, mathematicians check their equations and their proofs, leaving no stone unturned in their search for rigour. But, at night, under the full moon, they dream, they float among the stars and wonder at the miracle of the heavens. They are inspired. Without dreams there is no art, no mathematics, no life.* [Atiyah, 2018]

Inconclusive Conclusion

I cannot draw any conclusion, but rather I would like to deliver a suggestion.

In fact, it appears that folk models such as: the old sage, the young productive scientist, the peak-and-decline, show a complex correlation (if any) of scientific development with a non-epistemic factor such as the age of the scientist. However, the demographic pie of the Academia is following the general trend, and the actual quota of elder scientists is expected to expand in the near future.

This poses the issue of determining the best practices in order to take the maximum advantage from the foreseen change. I think that such a point of view should be our guiding principle to face this question in the future.

What are the best practices?

I shall leave this question unanswered, and hope that this can start a fruitful discussion.

THANKS FOR LISTENING!

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