

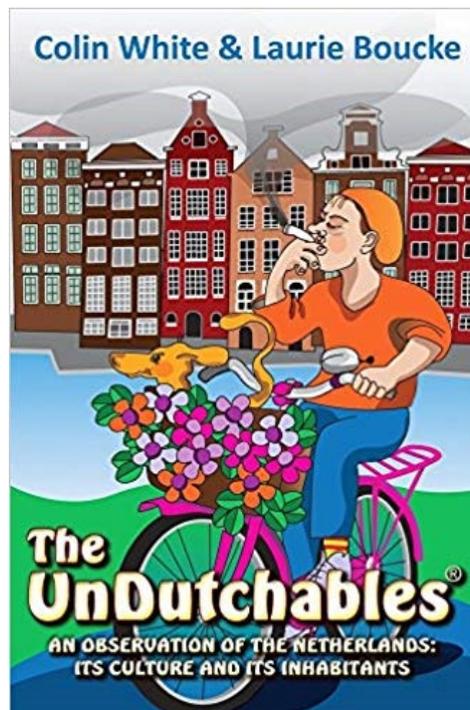
## Congrats to the undutchable Wim: on the quantum Zeno effect

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### *The undutchable Wim*

The undutchable Dutchmen as caricatures depicted in Fig.1, have a special relationship with the number 5 and its multipliers. In no other country in the world, neither in another galaxy, takes the number 5 such a prominent position as means of payment by the thrifty Dutch: a penny, a nickel, a quarter, a thaler, a rix-dollar (Rijksdaalder) and goodbye five guilder coin on January 1<sup>st</sup> 2002. No less exuberant, 2020 is also the year of the step-down of our dear KNAW president Wim and his  $13 \cdot 5 = 65^{\text{th}}$  birthday: warm congratulations with these ‘milestones’, and congrats with the superb successes in the past 4 years as our KNAW vice-president and president with a big hand to our sparkling KNAW!

For me, after knowing Wim already for ages, he became the untouchable ‘undutchable’: extremely talented in bringing people and ideas together, developing every respect for each other proposals and for other novel ideas; always critical and *protest when necessary* to the outside world but clever enough to realize that protest stems from *pro-testari* (Latin) and stands for *testify in favor*, not against. All these characteristics, I have experienced myself when interacting and working with Wim, are not so typical for the Dutch but yes indeed for our untouchable ‘undutchable’ Wim.



*Fig.1: highly recommendable to KNAW: mandatory literature!*

## *What's next ?*

You may ask yourself what is, after a farewell as our KNAW president and celebrating the 65<sup>th</sup> birthday of Wim in 2020, the prospect, say another 65 years from now.

The good news is that, according to my predictions, we will *not* be forced anymore, neither by an executive board of a research institute nor by our faculty (we hope) to go for retirement, but may decide ourselves when we like to leave and say farewell. The latter is already the current situation in USA nationwide and also in UK Cambridge –Oxford-Imperial to name a few top-of-the-top schools. Nevertheless, this is in sharp contrast to the situation today at any university in the Netherlands, simply because ‘by law’ your university employment contract will expire automatically on your pension date (so it is not even necessary to kick you out officially by writing a message over the (e-) mail). In fact I did not see any exception among the current KNAW institutes, NWO, Universities in the Netherlands: rather dull, lacking in sparkle, not ‘leading’ into new ‘laws’, regressively and not progressively.

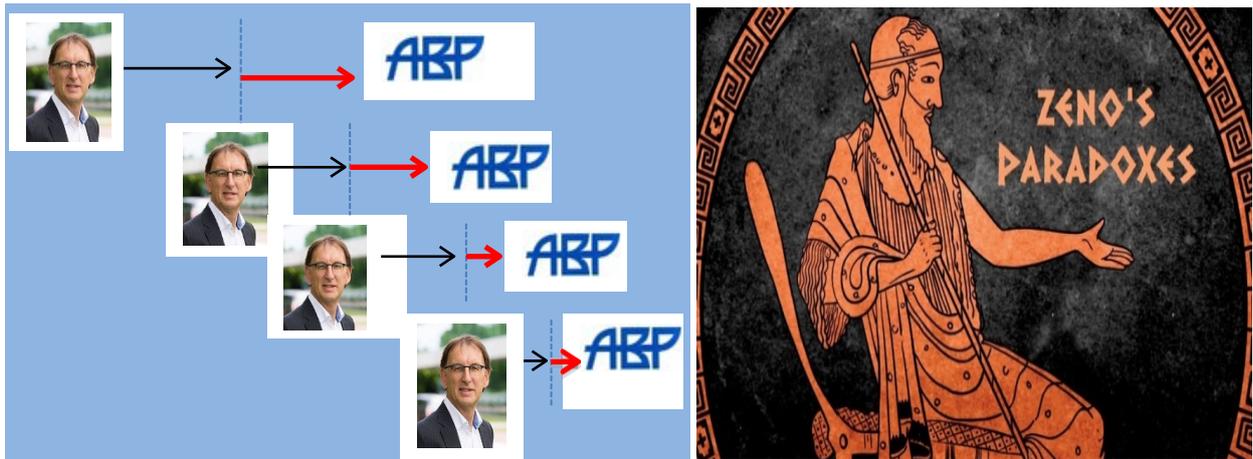
In itself 65 years of age of Wim is a good age to retire in Holland because you get all elderly discounts, (some but not all) people get on their feet in public transportation and you feel not nearly as old, as you are not yet 90. That’s all. However, the bad news for the present generation of students is that suppose you are 20 and want to go for retirement 45 years from now – which is hardly likely for a scientist – there is no money-money-money left in your pension fund when you hit 65 and you will be asked to continue anyway. I decided for this occasion to analyze for Wim the situation in a few simple equations: in physics and mathematics we all love equations and Wim does so in particular (reference is made to [1]).

Most likely I am fully right about changes in future retirement age as these modifications are already very well visible on the political level: parliament and government are trying to shift every year the start of retirement age further upwards. It looks to me as a revival of Zeno’s paradoxes, i.e. a set of philosophical problems devised by the Greek philosopher Zeno of Elea (around 490-430 BC). In particular the two very strong paradoxes and most famous ones are those of ‘*an arrow in flight*’ and the second one is ‘*Achilles and the tortoise*’.

This may sound to Wim and to all of you very old and boring stuff but actually that is not true. For a number of years *Zeno’s paradoxes also appear in quantum theory*. Theoretical expressions are formulated for the probability that an unstable particle initially in a well-defined state is found to decay during a given interval [2,3].

The simplest approach leads to the conclusion that an unstable particle, which is continuously observed to see whether it decays, *will never be found to decay* (like the motion of ‘an arrow in flight’ broken up by Zeno in stationary events). The quantum Zeno effect is also known as the Alan Turing paradox [4]: a system cannot alter while you are watching it. Therefore the ‘arrow in flight’ does not move and Zeno’s message can be summarized in a simplified form: *motion is nothing but an illusion*.

For the ‘*Achilles and the tortoise*’ paradox in Fig.2 Achilles is represented by Wim, and the tortoise is replaced by the ABP pension fund. Suppose we take Zeno’s paradox seriously and agree that before you can enjoy pension you must first put every year some money in the ABP savings account.



*Fig.1: Zeno paradox of Achilles and the tortoise; Achilles is represented by Wim van Saarloos and the tortoise is replaced by the ABP pension fund.*

But (regrettably) the government decides every year to upgrade the retirement age a little, say a few months, i.e. a fraction  $r$  of a year, and so on. Obviously before you reach retirement you have to work a bit longer et cetera. It is like Achilles is trying to catch the tortoise: before he can cross the whole distance he must walk half the distance. And, before he can walk the remaining half he must cover another half, i.e. a quarter et cetera:

$$\sum_{k=1}^{\infty} \left(\frac{1}{2}\right)^k = \frac{1}{2} + \frac{1}{4} + \frac{1}{8} + \frac{1}{16} + \dots = \frac{\frac{1}{2}}{1 - \frac{1}{2}} = 1 \quad (1)$$

The proof of this equality is very simple when realizing that  $\frac{1}{2}$  times the left side is exactly the left side minus  $\frac{1}{2}$ , i.e. the left side is equal to unity.

Eq.1 brings you the solution and clarification of the ‘paradox’, namely: adding up an infinite number of positive numbers (smaller than 1) results in a finite number for the sum, not to an infinite number (in which case Achilles would never catch the tortoise and poor Wim never receives any pension).

In mathematical terms we may say infinite (hyper) geometric series may become finite and in more general terms we may write for the increase in retirement age of Wim in the future:

$$\sum_{k=1}^n r^k = \frac{r(1-r^n)}{1-r} \quad (r < 1) \quad (2)$$

which reduces to Eq.1 for  $r=1/2$ .

Now, suppose the Dutch parliament house and government, together they decide to go for  $r = 1/4$  (3 months), every year. Then, based on Eq.2 we predict that the current student with an age of around 20 has to add, not 45 years till 65, but rather 60 years to his pension fund savings. He/she *may* accept retirement (not obligatory though), i.e. not kicked out around 65 like Wim and myself, but when he/she becomes 80 years old!

On this particular point it is also funny to know that the (rather arbitrary) age of retirement of around 65 in the Western world is due to Otto von Bismarck (German chancellor, near the close of the 19<sup>th</sup> century). He reasoned that a state pension of 1 year at the age of 65 is very adequate and importantly it was just manageable, since the average age in those days was not higher than 66! One year on a state pension should be sufficient according to dear Otto, leaving us behind desperate enough during centuries with his unscientific argument.

With the same argument of von Bismarck and assuming that another 45 years from now the average age of the current students will be close to 90, the government may downsize  $r$  to  $1/5$  in Eq.2.

But we have to emphasize: Wim and all of us, please watch out and protest firmly against the Zeno-BoBo politicians for a  $r \geq 1/5$  proposal in case you like to enjoy more than one year of your pension!

### ***Summary and perspectives***

My personal recommendations to Wim and summary read:

- Warm congratulations with the superb successes of your KNAW presidency. We are all proud of your achievements;
- Retire possibly at an age of 80 but preferably before you reach 90;
- *Pro-testari* firmly against any future Zeno- BoBo plan for an increment of retirement age with  $r > 1/5$  annually;
- And most importantly:..... Enjoy life!

All the best.

jeffthmdehosson, May 15<sup>th</sup> 2020.

### ***References***

[1]Wim van Saarloos, *Front propagation into unstable states*, Physics Reports 386 (2003) 29–222.

[2] P.Facchi, S. Pascazio, (2002) *Quantum Zeno subspaces*, Physical Review Letters. **89** (8): 080401.

[3]E.C.G. Sudarshan, B. Misra, (1977) *The Zeno's paradox in quantum theory*, Journal of Mathematical Physics. **18** (4): 756–763.

[4]C.Teuscher, D. Hofstadter, (2004) *Alan Turing: Life and Legacy of a Great Thinker*, Springer. p. 54. ISBN 978-3-540-20020-8.