
The Philosophy of Science: what an actuary needs to know

Jethro Green



The problem of induction



- All ravens examined so far are black.
 - Therefore:
- The next raven we examine will be black.
 - and
- All ravens are black.

David Hume



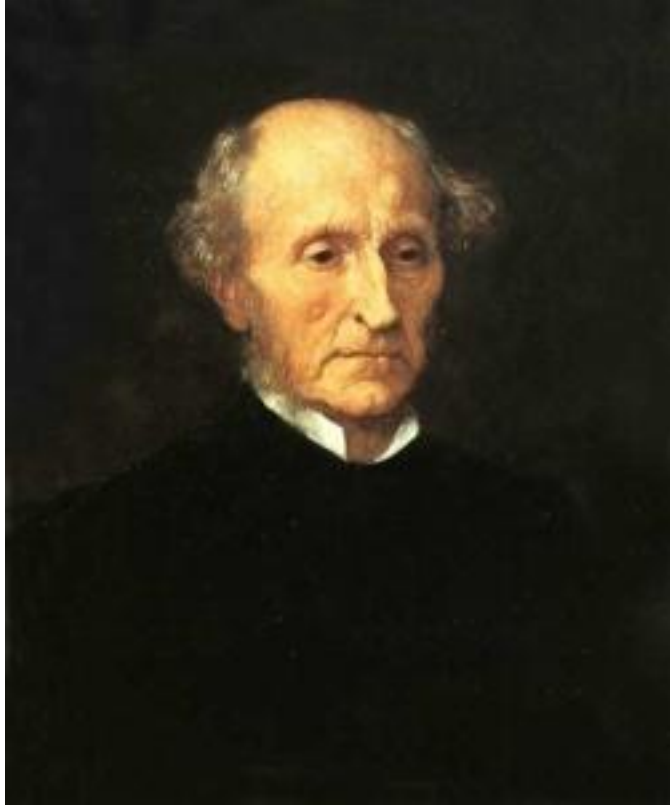
“The bread, which I formerly eat, nourished me ... but does it follow, that other bread must also nourish me at another time ... ? The consequence seems nowise necessary ... there is a certain step taken; a process of thought, and an inference, which wants to be explained.”

The Turkey's induction



- The farmer has fed me every day so far.
 - Therefore:
- The farmer will feed me tomorrow.
 - And also:
- The farmer will feed me on Christmas Day.

John Stuart Mill



“That all swans are white, cannot have been a good induction, since the conclusion has turned out erroneous. The experience, however, on which the conclusion rested was genuine. From the earliest records, the testimony of all the inhabitants of the known world was unanimous on the point. The uniform experience, therefore, of the inhabitants of the known world, agreeing in a common result, without one known instance of deviation from that result, is not always sufficient to establish a general conclusion.”

Some possible solutions

- **Mill: a silent premise about the uniformity of nature.**
- **Black: induction can be “self supporting” – specific inferences can be treated as reliable because similar inferences have proved to be reliable in the past.**
- **Hume: a ‘sceptical solution’.**

The conclusion so far

- **Induction is not infallible.**
- **However, we should not expect the same standards of induction as we do of deduction.**
- **Induction is “reliable”.**

Ludwig Wittgenstein



“We have done exercises and given him tests up to 1000 ... Now we get the pupil to continue a series (say + 2) beyond 1000 – and he writes 1000, 1004, 1008, 1012.

We say to him: ‘Look what you’ve done!’ – He doesn’t understand. We say: ‘You were meant to add *two*: look how you began the series!’ – He answers: ‘Yes, isn’t it right? I thought that was how I was *meant* to do it.’ ... In such a case we might say, perhaps: It comes natural to this person to understand our order with our explanations as *we* should understand the order: ‘Add 2 up to 1000, 4 up to 2000, 6 up to 3000 and so on.’”

The new riddle of induction

An object is “grue” if and only if it is first observed before 1 January 2012 and is green, or it is first observed on or after 1 January 2012 and is blue.

(adapted from Goodman, 1955)

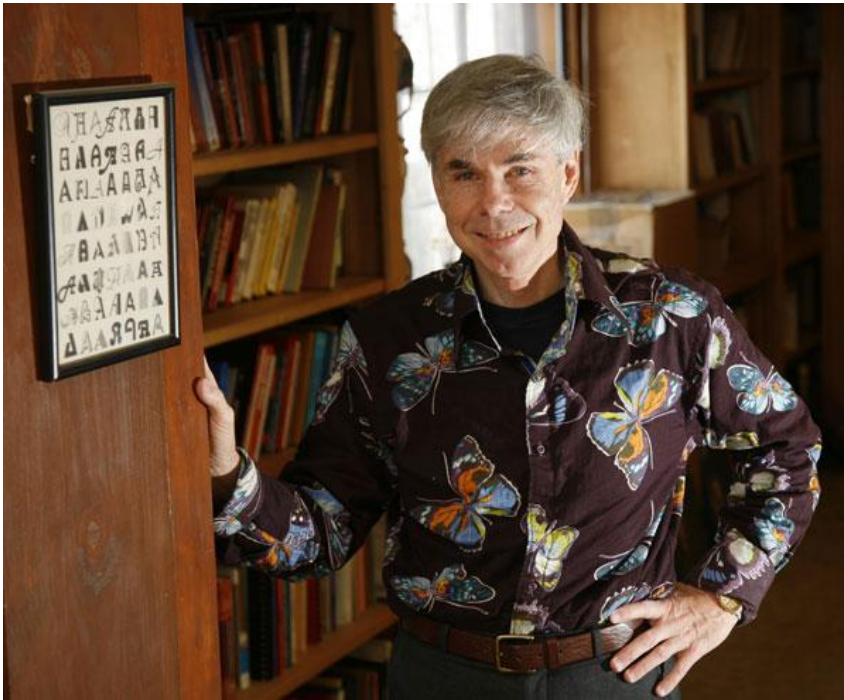
- Every emerald observed before 1 January 2012 has been grue.
 - Therefore:
- Emeralds discovered during 2012 will be grue.
 - and
- All emeralds are grue.

Projecting a predicate

An Hypothesis is evaluated on:

- **Strength**
- **Safety**
- **Simplicity**

Douglas Hofstadter



if

$abc \rightarrow abd$

then

$ijk \rightarrow ???$

$xyz \rightarrow ???$

abc \rightarrow **abd**

$x\underline{y}z \rightarrow xya$

$x\underline{y}z \rightarrow xyd$

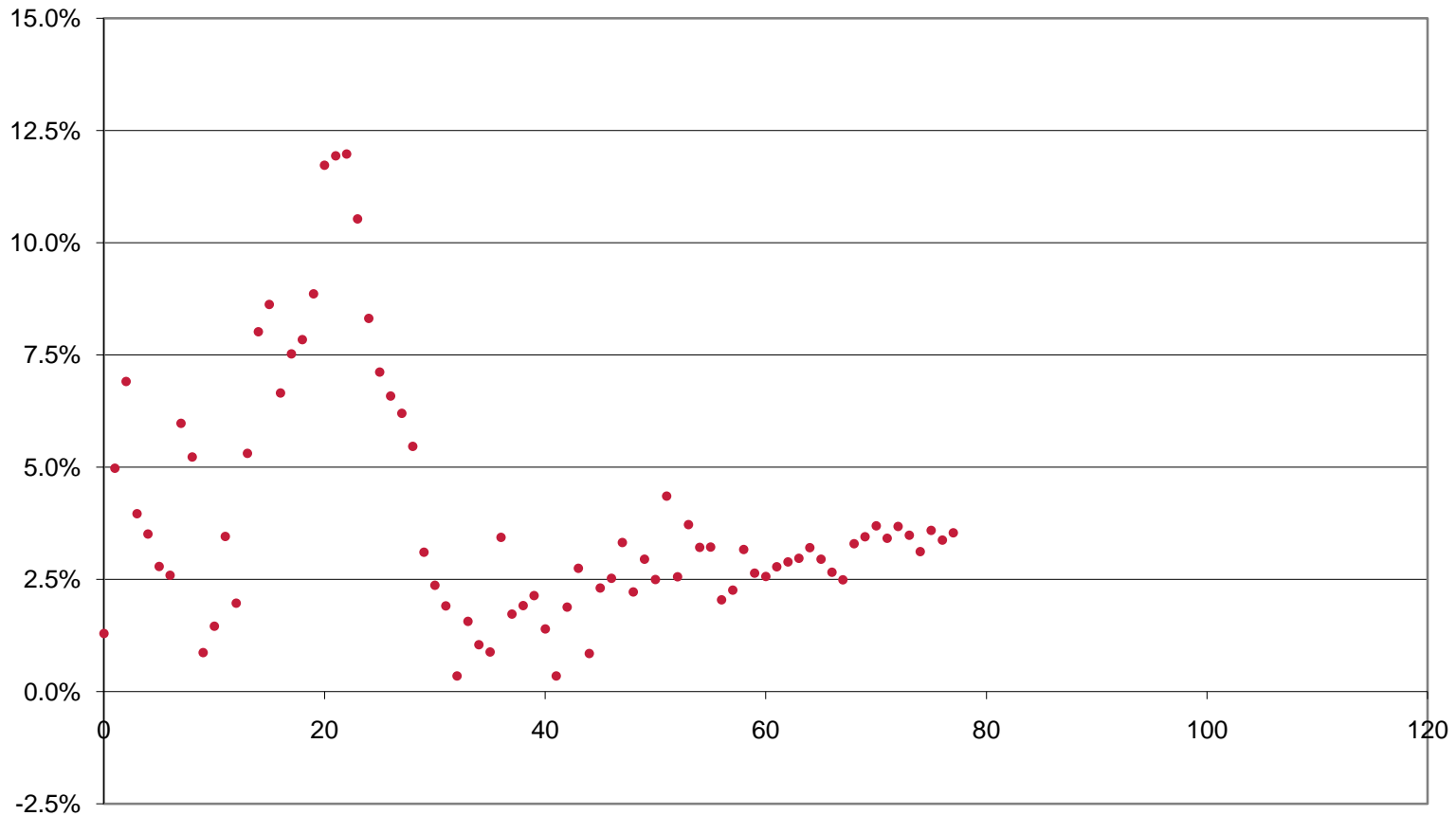
$x\underline{y}z \rightarrow xyz$

$x\underline{y}z \rightarrow wyz$

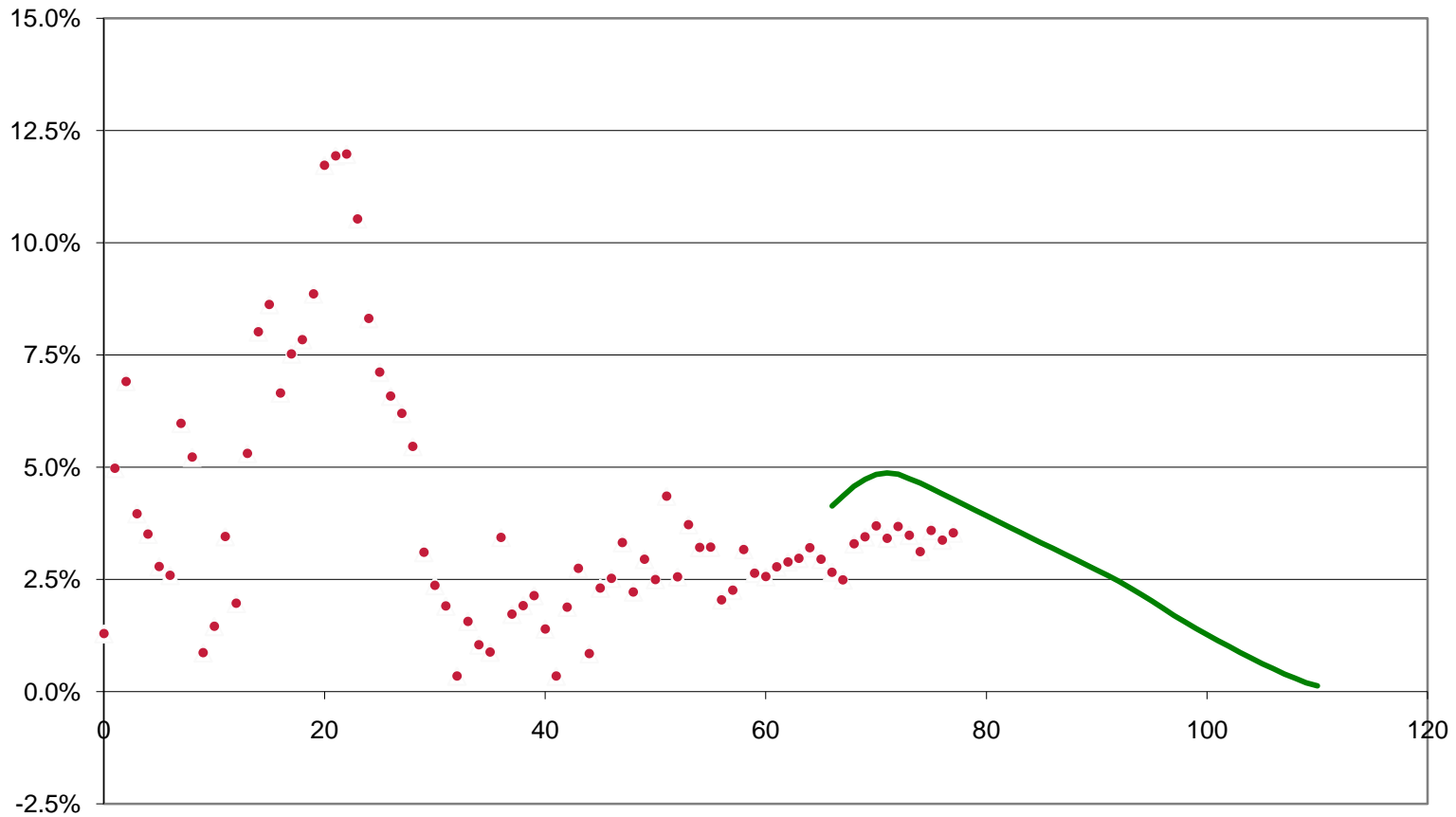
Which is most simple?

- $y = \sin x$
- $y = \exp x$
- $y = ax^3 + bx^2 + cx + d$
- $y = x^4$

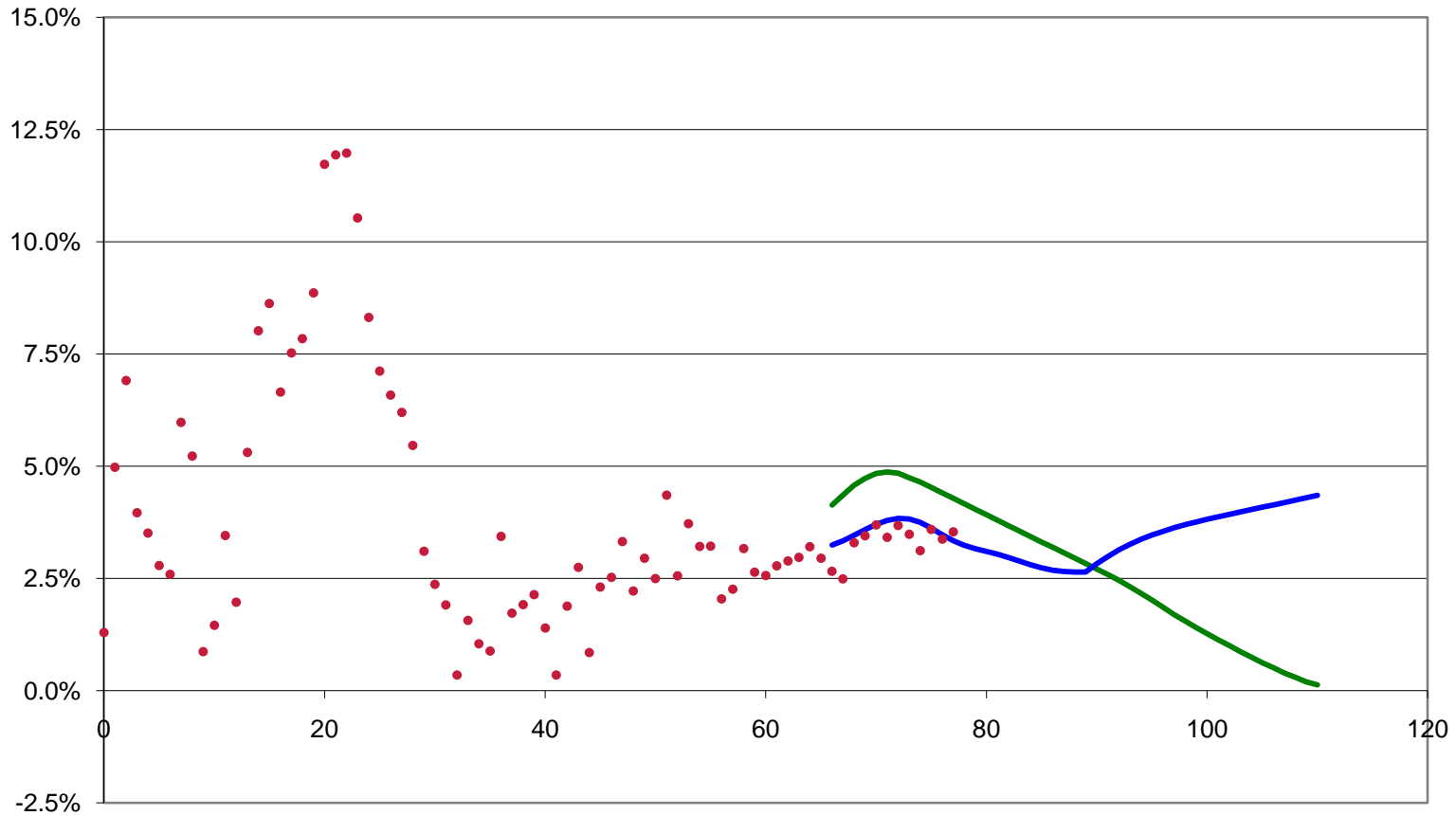
An example of induction: extrapolation



An example of actuarial science




Another example of actuarial science



Why should actuaries care?


How do we choose a curve from amongst an infinity of mathematical functions consistent with the data?

- Mortality projections
 - Catastrophe projections
 - Run-off / claims development
 - Fitting a loss distribution
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Questions / Comments



What does good science look like?

- **Ptolemy: a model with good predictive properties.**
 - **Kepler: a (more 'simple'?) model, with even better predictive properties.**
 - **Newton: a model with not just predictive, but explanatory properties.**
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References

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- L. Wittgenstein, *Philosophical Investigations*, 1953
- N Goodman, *Fact, Fiction and Forecast*, 1955
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- M. Mitchell, *Complexity: a guided tour* , 2009 (for a discussion of the Hofstadter problem, albeit with a different emphasis)
- T.W. Child, 'The Later Philosophy: Intentionality and Rule Following' in *Routledge Philosophers: Wittgenstein*, forthcoming

References

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- *CMI Library of Mortality projections, (long cohort and P-Spline Age Cohort 2003 Males England and Wales 50th percentile)*, available at <http://www.actuaries.org.uk/research-and-resources/pages/cmi-library-mortality-projections>