Divine Action, Sensory Illusions, and Randomness

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Mark Shelhamer
The Johns Hopkins University
School of Medicine
Baltimore, MD USA

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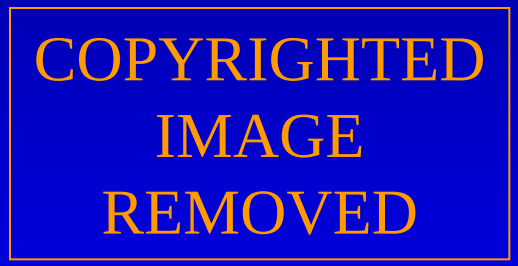
One aspect of science is elimination of supernatural explanations



As a scientist – how can one reconcile God's interaction with the existence of natural laws?

Christian faith is based on verifiable historical evidence.

therefore we have reason to believe that objective exploration can lead to truth about the universe, that God will not deceive us in this endeavor.

Two approaches to the issue of divine action and natural physical law:

- Randomness as a physical law – misunderstanding and misinterpretation.

- Sensory illusions – limitations on our understanding.

We appreciate the beauty and elegance of physical laws, and also mathematical laws, which offer powerful explanations of the physical world and demonstrate its underlying order.

There are rules governing randomness as well, and these too are beautiful and orderly.

Eugene Wigner (1960) The Unreasonable Effectiveness of Mathematics in the Natural Sciences. *Communications on Pure and Applied Mathematics* 13(1): 1–14.

The first point is that the enormous usefulness of mathematics in the natural sciences is something bordering on the mysterious and that there is no rational explanation for it.

The great mathematician fully, almost ruthlessly, exploits the domain of permissible reasoning and skirts the impermissible. That his recklessness does not lead him into a morass of contradictions is a miracle in itself: certainly it is hard to believe that our reasoning power was brought, by Darwin's process of natural selection, to the perfection which it seems to possess.

It is, as Schrödinger has remarked, a miracle that in spite of the baffling complexity of the world, certain regularities in the events could be discovered.

It is difficult to avoid the impression that a miracle confronts us here… (mathematical concepts having such explanatory power in physics).

The miracle of the appropriateness of the language of mathematics for the formulation of the laws of physics is a wonderful gift which we neither understand nor deserve

Wigner again

However, the point which is most significant in the present context is that all these laws of nature contain, in even their remotest consequences, only a small part of our knowledge of the inanimate world. All the laws of nature are conditional statements which permit a prediction of some future events on the basis of the knowledge of the present, except that some aspects of the present state of the world, in practice the overwhelming majority of the determinants of the present state of the world, are irrelevant from the point of view of the prediction. ... As regards the present state of the world, such as the existence of the earth on which we live and on which Galileo's experiments were performed, the existence of the sun and of all our surroundings, the laws of nature are entirely silent. It is in consonance with this, first, that the laws of nature can be used to predict future events only under exceptional circumstances – when all the relevant determinants of the present state of the world are known.

epicycles

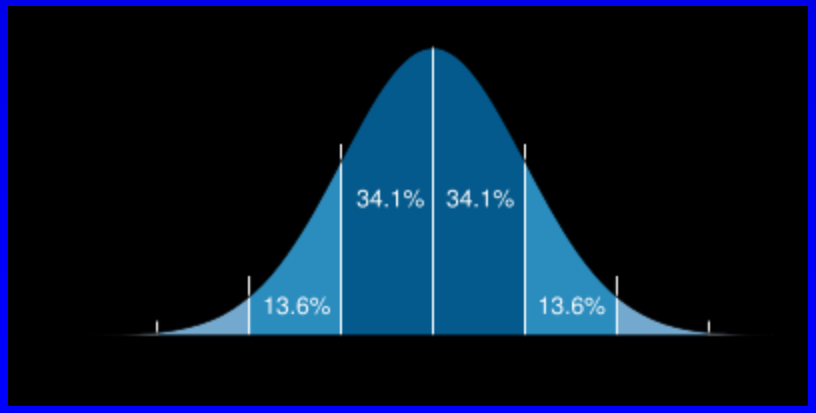
- Mental contortions that we often go through in order to understand: “How could God allow this to happen?”
- A possible solution – these apparently haphazard events with no apparent rationale may, indeed, be *truly random*.
- God can use randomness as He uses deterministic physical rules.

Misunderstanding of probability may be the greatest of all impediments to scientific literacy.

– Stephen Jay Gould

I know of scarcely anything so apt to impress the imagination as the wonderful form of cosmic order expressed by the law of frequency of error. It reigns with serenity and complete self-effacement amidst the wildest confusion. The larger the mob, the greater the apparent anarchy, the more perfect is its sway. It is the supreme law of unreason.

–Francis Galton



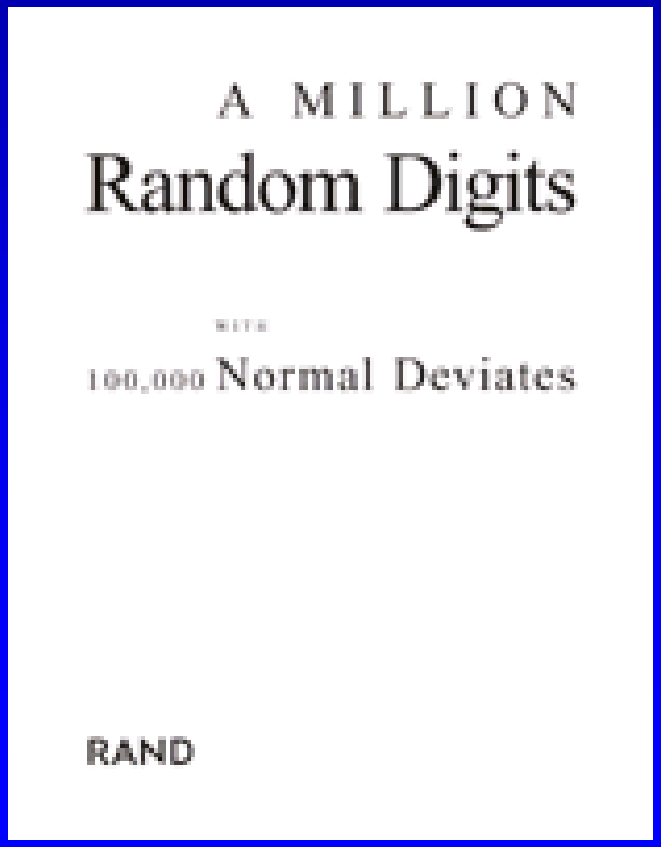
http://en.wikipedia.org/wiki/Image:Standard_deviation_diagram.svg

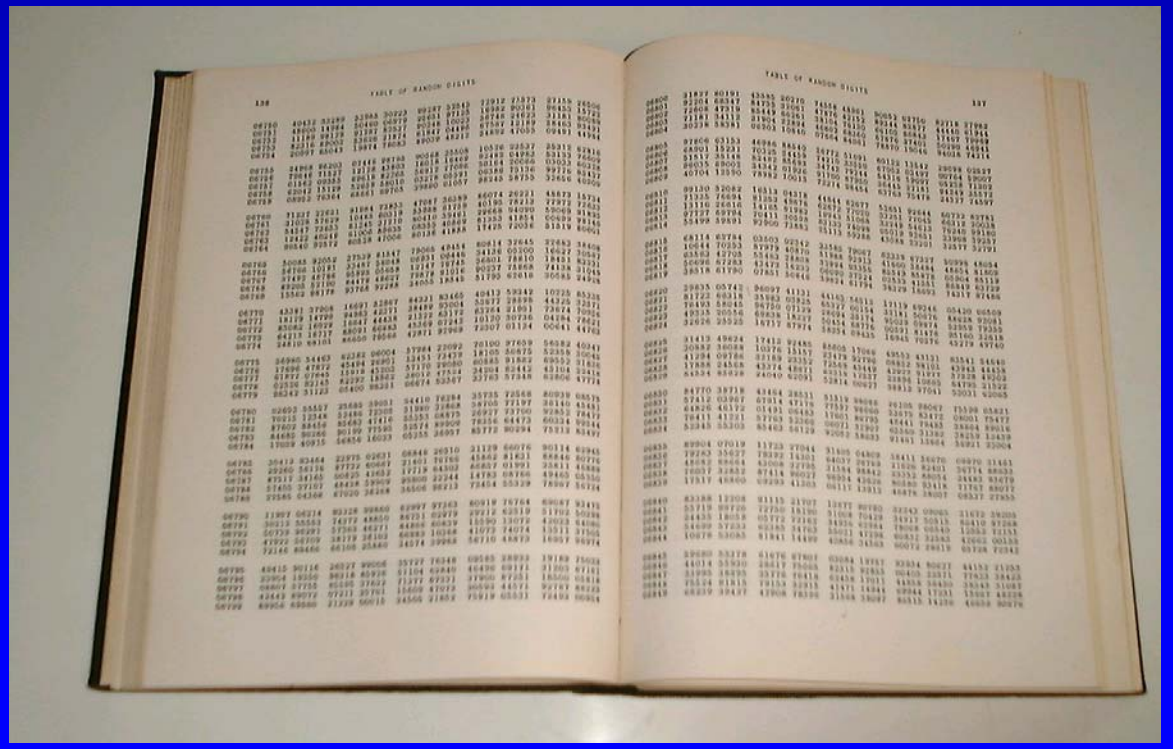
Randomness is not Intuitive

Humans are bad at generating randomness

- tendency to alternate
- tendency to neglect extreme values

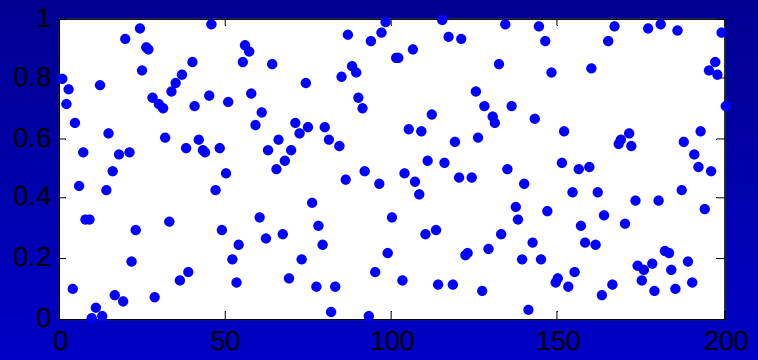
Fortunately, there are reliable sources of randomness

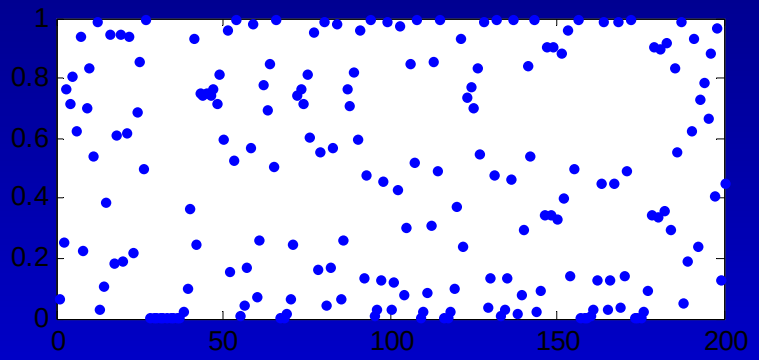


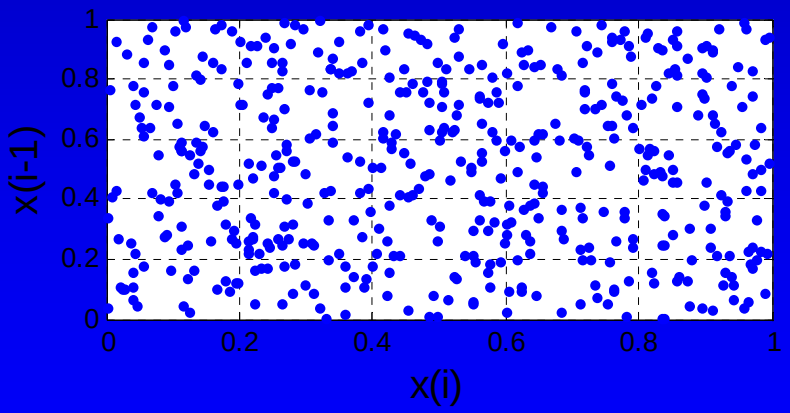


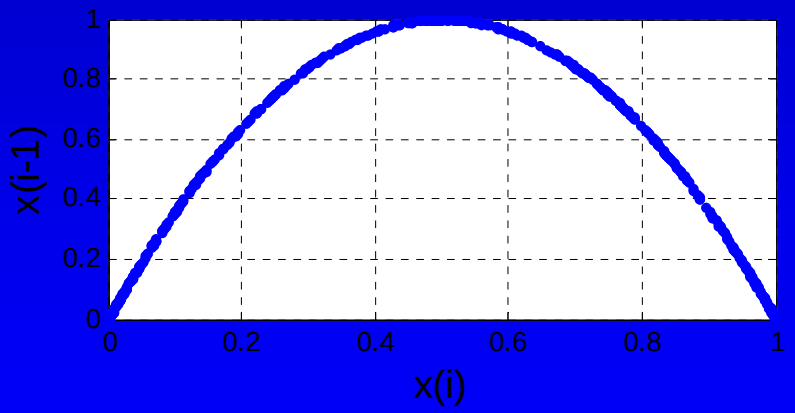
Randomness is not Intuitive

We are bad at judging randomness









Which time series (top) is random? Graphs at bottom show the rule used to generate each value given the previous value. Random is at left.

Randomness is not Intuitive

Monty Hall problem: Select one of three doors, hiding one prize and two duds. I then open one unselected door and show you a dud. To maximize your chances of winning, do you change your choice?

Answer: yes

Widespread misunderstanding of this game shows lack of intuition and understanding of probability, even among professionals.

Randomness is not Intuitive

Gambling and gambler's fallacy

- bet on the next flip of a fair coin: HHHHHHHH

Entire industry built on this misunderstanding

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Randomness is not Intuitive

"There are no such things as coincidences" –

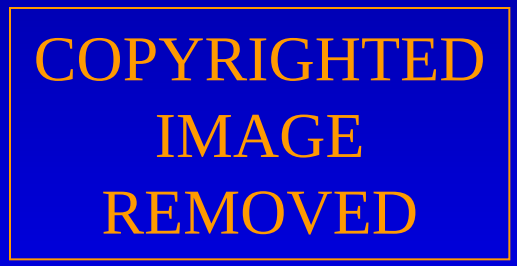
BUT

If God has ordained the laws of randomness just as much as the deterministic laws of physics, we must expect coincidences.

Example: How large must a group be to have the probability of finding two people with the same birthday at least 50%?

Fractals

A deterministic fractal – the Koch Snowflake



Fractals

A deterministic fractal – the Mandelbrot Set

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http://commons.wikimedia.org/wiki/Image:Mandel_zoom_00_mandelbrot_set.jpg

Random Fractals: order in randomness

A random fractal – coastline

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B Mandelbrot (1967) How Long Is the Coast of Britain? Statistical Self-Similarity and Fractional Dimension. *Science* 156:636-638.

http://commons.wikimedia.org/wiki/Image:Britain-fractal-coastline-combined.jpg

Random Fractals: order in randomness

A random fractal – mountains

COPYRIGHTED IMAGES of COMPUTER-GENERATED MOUNTAINS REMOVED

http://www.javaworld.com/javaworld/jw-06-2007/images/jfgfigure8.gif

http://www.effectware.com/download/images/efx_mountain2.jpg

http://www.vb-helper.com/vbgp/fractal_surface.gif

http://www.wizardnet.com/musgrave/cool2.jpg

Random Fractals: order in randomness

A random fractal – lungs

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http://classes.yale.edu/fractals/WorldOfFractals/Us/Lungs/Lungs.html

Rare Events are not necessarily Abnormal

Richter scale and earthquake distribution
– what is a “rare” event?

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http://www.seismo.unr.edu/feature/NVrank.html

Summary I

Randomness is a law as fundamental to how God runs the universe as any other physical-mathematical law we know.

Just as we would not pray for an object to fly upward when released, in violation of the law of gravity, so we should not pray for God's intervention in randomness events.

We should know better than to ask for God to overturn his own order, even if such order appears haphazard to us.

Sensory Illusions

Limitations of Sensory Systems

Visual system and the electromagnetic spectrum

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http://www.skidmore.edu/~hfoley/images/EM.Spectrum.jpg

Auditory illusions exist as well.

Endlessly rising pitch – Auditory illusion analogous to Escher's endlessly rising staircase.

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R Shepard (1964) Circularity in Judgments of Relative Pitch. *Journal of the Acoustical Society of America* 36:2346-2353.

http://blog.sciencenews.org/mathtrek/2007/06/musical_illusions.html

http://web.mit.edu/hst.723/www/ThemePapers/PitchPapers.htm

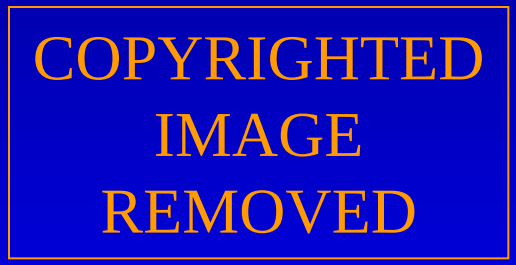
Binding of visual and auditory information

VIDEO OF MCGURK EFFECT REMOVED

H McGurk, J MacDonald (1976) Hearing lips and seeing voices. *Nature* 264**:**746-748.

http://ilabs.washington.edu/kuhl/research.html

Illusions of self-motion



Illusions of orientation

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Which cloud bank
is upside-down?

Rotation illusions

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http://www.hitl.washington.edu/publications/r-96-3/dis1.gif

http://upload.wikimedia.org/wikipedia/en/thumb/1/17/Gravespin.jpg/300px-Gravespin.jpg

Rotation illusions - vection

VIDEO
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Illusions of temporal processing

- Variable and unknown delays in different sensory systems
- Brain must learn these delays in order to correctly combine information from different senses
- Experiment:
  - introduce artificial delay between an action and its effect
  - what is the perception when the delay is reduced?

When artificially introduced delay is reduced, subjects often perceive effect as occurring before action.

C Stetson, X Cui, R Montague, D Eagleman (2006) Motor-Sensory Recalibration Leads to an Illusory Reversal of Action and Sensation. *Neuron* 51:651–659.

Summary II

- Our subjective knowledge of the world is incomplete and imperfect
- Our internal model of the world is flawed
- Attempts to understand God's interaction with the world are subject to this constraint

Conclusions

- That the universe is understandable at all, given our sensory limitations, is a miracle.
- Mathematics and physical laws demonstrate a (Divinely Ordained) universal order.
- Despite our subjective sense, random has a beauty and order of its own.
    - Therefore randomness should be embraced as one of God's organizing principles.

ON THE OTHER HAND

- Divine Intervention might be completely deterministic and orderly, and our limitations prevent us from seeing this.
    - But would a benevolent God do this?