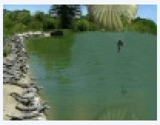
Thread: Scientists Uncover The Mathematics Of Serial Killers

01-17-2012, 11:48 AM #1



Starless
Miss Killjoy

Join Date: Sep 2006
Posts: 20,026

Scientists Uncover The Mathematics Of Serial Killers

http://www.forbes.com/sites/alexknap...erial-killers/

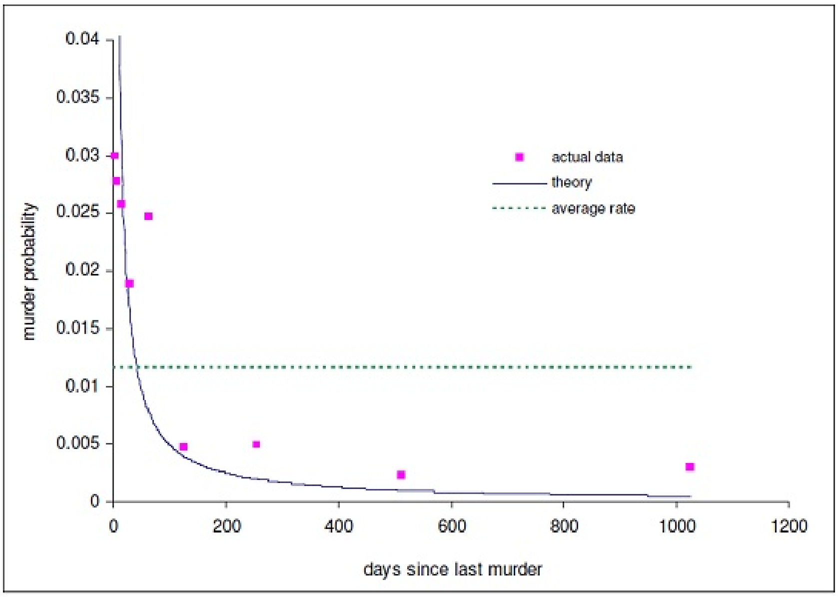
Andrei Chikatilo, “The Butcher of Rostov,” was one of the most prolific serial killers in modern history. Between 1978 and 1990 in the Ukraine, he committed at least 52 murders before he was caught, tried and executed. The pattern of his murders, though, was irregular. There were long periods of no activity, interrupted by several murders within a short period of time.

Hoping to gain insight into serial killings to prevent similar murders, his pattern of behavior was examined by Mikhail Simkin and Vwani Roychowdhury at UCLA. They’ve published a paper on ArXiv with their preliminary results.

What the authors used as the basis of their analysis was the hypothesis that “similar to epileptic seizures, the psychotic affects, causing a serial killer to commit murder, arise from simultaneous firing of large number of neurons in the brain.” Accordingly, they based their model on neuronal firing – the fact that, once a neuron fires, there’s a refractory period that has to pass before it can fire again. When it does fire, it can trigger other neurons to fire if they’re ready to. As you can imagine, though, those firings aren’t always in sync. So what the authors suggest is that there must be a threshold – that is, when a certain number of neurons fire, the serial killer becomes driven by an overwhelming urge to kill.

In modeling the mathematics of this, the authors note that, “We cannot expect that the killer commits murder right at the moment when neural excitation reaches a certain threshold. He needs time to plan and prepare his crime.” So they built that delay into their model as well. Moreover, the authors also note that the murders do appear in clumps, with the killer more likely to kill after another murder. However, the killings eventually have a sedative effect, pushing the neuronal activity below the “killing threshold” – which is why there are large intervals of time between groups of murders.

When the authors completed their mathematical model, it was remarkably close to the real data:



The authors add that they could probably fit the data even better “by introducing a murder success rate. That is with certain probability everything goes well for the killer and he is able to commit the murder as he planned. If not, he repeats his attempt the next day. And so on.” They declined to do so in this paper, though, as it didn’t serve the goal of developing a simpler model.

I’m fascinated by this particular bit of research, though, and I’m interested to see if other researchers build on this work to build a better understanding of serial killings and other similar impulsive criminal behaviors.

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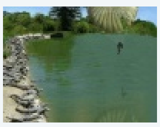
01-17-2012, 11:52 AM #2



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Re: Scientists Uncover The Mathematics Of Serial Killers

http://www.smartplanet.com/blog/thin...thematics/9895

Andrei Chikatilo is a Ukrainian-born serial killer, aka The Butcher of Rostov, who confessed to murdering 56 children and women, between 1978 and 1990. Now scientists have performed a study that suggests his killing pattern matches a typical firing pattern of brain cells. (What will scientists study next?)
Neurons in the brain fire and it’s this firing that ultimately leads to our thoughts, actions, emotions, in fact everything we do. When a neuron fires it launches a domino effect among surrounding neurons that sets into motion a sort of avalanche

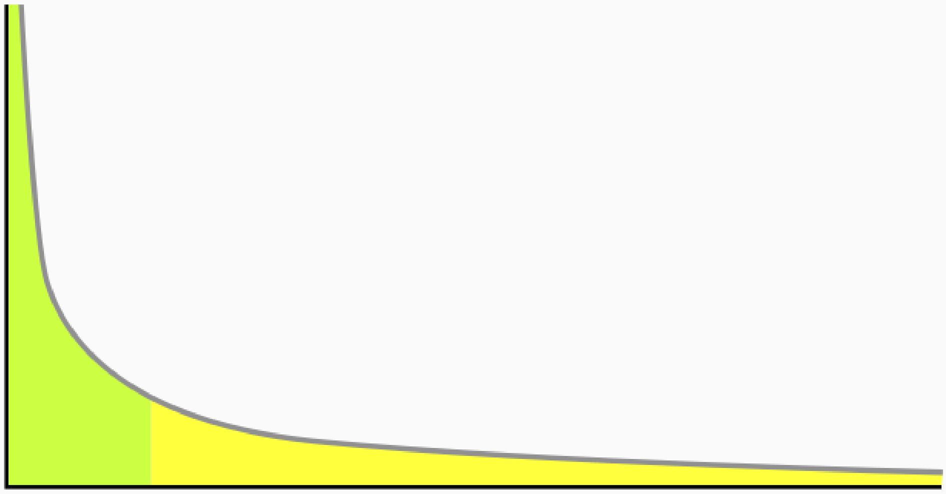
do. When a neuron fires it launches a domino effect among surrounding neurons that sets into motion a sort of avalanche of firing action. This is how the brain works. Waves of sparks, as it were. But here is a key point: After a single neuron fires it cannot fire again until it re-charges. This is known as the refractory period.
The two scientists, Mikhail Simkin and Vwani Roychowdhury at the University of California, Los Angeles, have found through mathematical analysis a connection between Chikatilo's pattern of killings and the firing pattern of neurons.
From the TechReview post:

> …they suggest that a serial killer only commits murder after the threshold [of neuronal firing] has been exceeded for a certain period of time. They also assume that the murder has a sedative effect on the killer, causing the neuronal activity to drop below the threshold.

Simkin and Roychowdhury simulated about 100 billion time steps of neuronal firing, roughly equivalent to 12 years (the length of time that Chikatilo was active.)

> The results are remarkably similar to the distribution of Chikatilo's real murders and Simkin and Roychowdhury speculate that it would be relatively straightforward to introduce a realistic correction factor that would make the fit closer.
> They say: "One could enhance the model by introducing a murder success rate. That is with certain probability everything goes well for the killer and he is able to commit the murder as he planned. If not, he repeats his attempt the next day. And so on.
> This model leads to an interesting insight into the nature of serial killing. It suggests that the likelihood of another killing is much higher soon after a murder than it is after a long period has passed.

Meaning, there is a sort of momentum component that is often found in other physical and biological events. The key thing is here is a mathematical pattern called a power law distribution. A power law describes a mathematical relationship between two things. When the frequency of an event varies as a function of some variable of that event, like its size for example, the frequency of the event follows a power law. For instance, the "long tail graph" made famous by Wired editor Chris Anderson is a power law graph:



This particular power law graph is also known as the Pareto principle, or the 80-20 rule, where for many events 80 percent of the output comes from only 20 percent of the cause, or input. Power law distributions can be found in many events, biological and physical. From the behavior of large earthquakes, to solar flares, to the frequency of words in a language.
Worth noting is that the Occupy Wall Street protesters are, at least according to their slogan of "We Are The 99%", protesting Pareto's principle which is found in business, science, economics and as noted above, in natural systems. Unfortunately it is not something within our control. Complex systems, for better or worse, tend to develop a concentration of extremes. The breadth of areas where we find such a consistent pattern is what is truly amazing.
And now, according to these researchers, Pareto's principle can help explain the behavior of a serial killer. There have also been studies that suggest epileptic fits also follow a power law, meaning that the patterns of neuronal firing can spread through the brain and cause a fit. It may be the case that we'll find a lot of more of our behaviors follow a power law distribution.
[via Technology Review]
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01-17-2012, 11:55 AM #3

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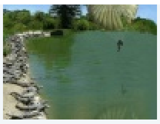

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Miss Killjoy

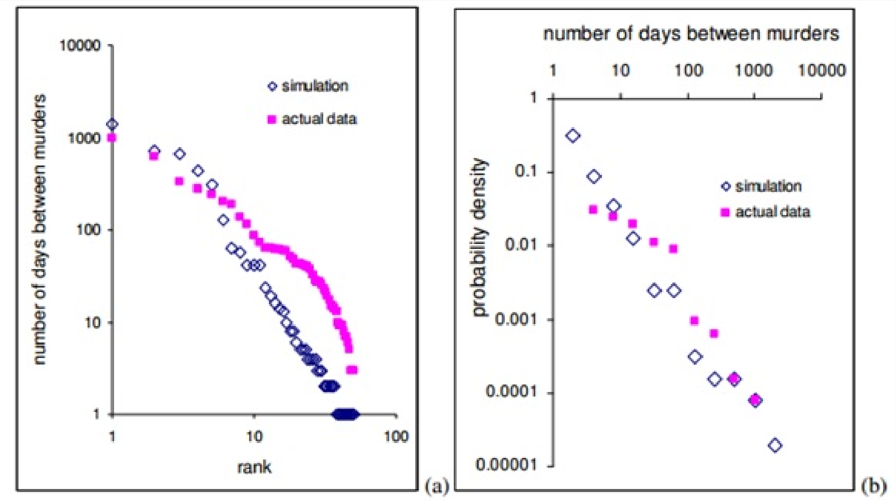
Re: Scientists Uncover The Mathematics Of Serial Killers

http://www.technologyreview.com/blog...7497/?p1=blogs

Mathematicians Reveal Serial Killer's Pattern of Murder

A simple mathematical model of the brain explains the pattern of murders by a serial killer, say researchers
kfc 01/16/2012

- 3 Comments



On 20 November 1990, Andrei Chikatilo was arrested in Rostov, a Russian state bordering the Ukraine. After nine days in custody, Chikatilo confessed to the murder of 36 girls, boys and women over a 12 year period. He later confessed to a further 20 murders, making him one of the most prolific serial killers in modern history.
Today, Mikhail Simkin and Vwani Roychowdhury at the University of California, Los Angeles, release a mathematical analysis of Chikatilo's pattern of behaviour. They say the behaviour is well characterised by a power law and that this is exactly what would be expected if Chikatilo's behaviour is caused by a certain pattern of neuronal firing in the brain.
Their thinking is based on the fundamental behaviour of neurons. When a neuron fires, it cannot fire again until it has recharged, a time known as the refractory period.
Each neuron is connected to thousands of others. Some of these will also be ready to fire and so can be triggered by the first neuron. These in turn will be connected to more neurons and so on. So it's easy to see how a chain reaction of firings can sweep through the brain if conditions are ripe.
But this by itself cannot explain a serial killer's behaviour. "We cannot expect that the killer commits murder right at the moment when neural excitation reaches a certain threshold. He needs time to plan and prepare his crime," say Simkin and Roychowdhury.
Instead, they suggest that a serial killer only commits murder after the threshold has been exceeded for a certain period of time.
They also assume that the murder has a sedative effect on the killer, causing the neuronal activity to drop below the threshold.
Simkin and Roychowdhury used their model to simulate the pattern of firing in a brain to see how often it surpasses a given threshold long enough for a murder to take place.
In the model, they used a 2 millisecond period as the fundamental time step, that's about the time between firings in a real neuron. And they simulated some 100 billion time steps, equivalent to 12 years or so, that's about the period that Chikatilo was active.
The results are remarkably similar to the distribution of Chikatilo's real murders and Simkin and Roychowdhury speculate that it would be relatively straightforward to introduce a realistic correction factor that would make the fit closer.
They say: "One could enhance the model by introducing a murder success rate. That is with certain probability everything goes well for the killer and he is able to commit the murder as he planned. If not, he repeats his attempt the next day. And so on."
This model leads to an interesting insight into the nature of serial killing. It suggests that the likelihood of another killing is much higher soon after a murder than it is after a long period has passed.
That's a well known property of power law distributions that holds true for all kinds of phenomenon. A large earthquake, for example, is more likely soon after another large earthquake.
Interestingly, Simkin and Roychowdhury's work bares much similarity to other recent work suggesting that the distribution of epileptic fits also follows a power law. The reasoning here is the same too--that patterns of neuronal firing can spread through the brain, like an avalanche, causing a fit in the process.
This suggests an obvious avenue for future research in working out whether other forms of extreme behaviour, and indeed ordinary behaviour, follow the same pattern. Perhaps these guys and others are already working on the data.
Chikatilo was eventually convicted of 52 murders and executed by a gunshot to head in 1994.
Ref: arxiv.org/abs/1201.2458: Stochastic Modeling Of A Serial Killer

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