

Les probabilités, la statistique et le meurtre

(Version française)

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www.probability.ca

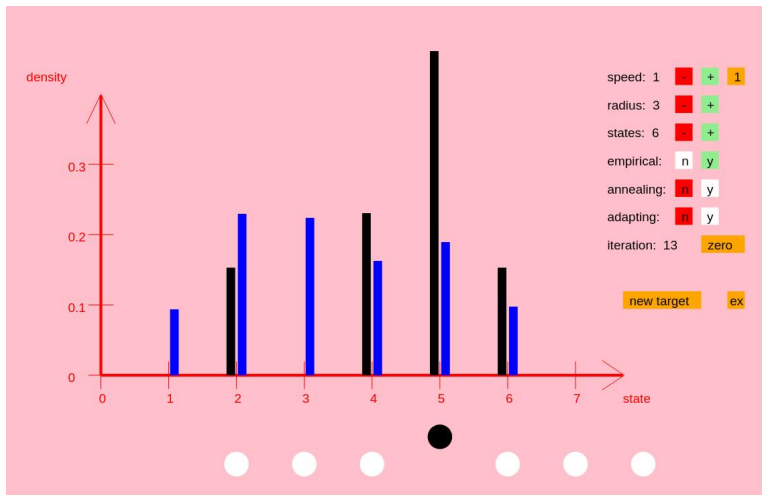
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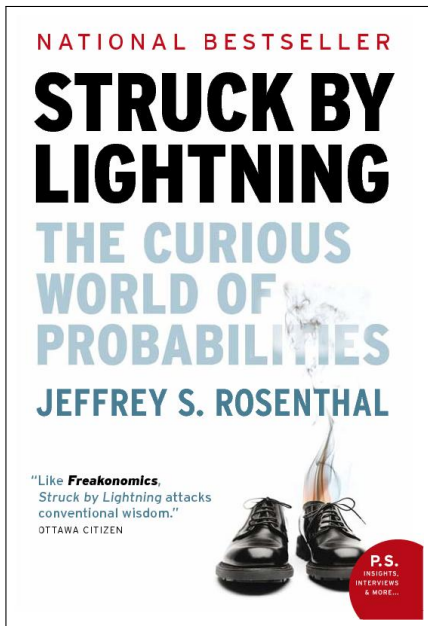
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(Congrès annuel de la SSC, 7 juin 2021)

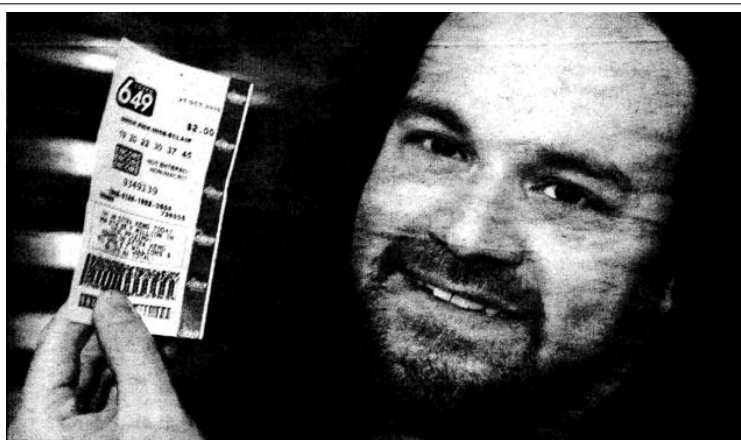
De quoi parler ?

Mon domaine principal de recherche est l'analyse théorique des algorithmes MCMC. Mais vous m'avez tous déjà entendu parler de ça.





... qui m'a amené au scandale des vendeurs des billets de loterie



University of Toronto statistician Prof. Jeffrey Rosenthal holds up a 6/49 ticket. He says so many retailers have won prizes it raises suspicions.

MARK O'NEILL

Storekeepers lucky?

Lottery officials dismiss statistician's claim that retailers' wins defy odds

See IRAQ on page A16

welcoming country. A16

■ Editorial. A26

214 lottery 'insiders' won big bucks

Odds of Ontario results astronomical, investigation by CBC program reports

BY SHANNON KARI

More than two-hundred lottery "insiders" have won prizes of \$50,000 or more in Ontario since 1999, and more than two-thirds of these wins may have involved the deception of a customer who bought the ticket.

The allegation is made by the

CBC program *the fifth estate*, after an investigation into the number of "insider wins" in the province in the past seven years.

A statistical analysis of the number of insider wins concluded that fewer than 60 insiders, such as ticket retailers or clerks, should have won major prizes during the period

that was investigated.

The odds that the 214 insiders who claimed major prizes — \$50,000 or more — since 1999 won as a result of pure luck, is one in a trillion, trillion, trillion, trillion, said University of Toronto professor Jeffrey Rosenthal, who conducted the analysis.

The program airing tonight suggests this may be a problem across Canada and the United States.

See LOTTERY on page A10

Province to probe the win

Opposition wants outside investigator Statisticians lay bets there was fraud

**ROB FERGUSON
AND CURTIS RUSH**
STAFF REPORTERS

Queen's Park has ordered a probe of the Ontario Lottery and Gaming Corporation's security measures in the wake of allegations that an astonishing number of inside retailers have won prizes of \$50,000 or more since 1999.

"If there is anything we can do to strengthen that we certainly will act," David Caplan, the minister responsible for the corporation, said yesterday.

Caplan said he has ordered

frey Rosenthal's statistical analysis carried out for *the fifth estate*.

Rosenthal's numbers suggest that the real odds of 214 insiders claiming major prizes in those years are one in a trillion, trillion, trillion, trillion — that's a 1 followed by 48 zeroes.

In its Tuesday night report, CBC claimed that two-thirds of

wins by so-called insiders may have involved deception by unscrupulous vendors who stole customers' winning tickets.

Rosenthal, a statistician with the University of Toronto, claims the chances of so many vendors winning by chance are so small that "almost anything you can think of is more likely."

The odds that you'll be hit by lightning in the next year are one in 5 million; that you'll be killed in your next vehicle trip one in 7 million, according to

Another lottery gamble

Imagine that you are trusting enough to give your provincial lottery ticket to a store clerk to learn whether you have won. Imagine that, against astronomical odds, the ticket is worth a lot. The vast majority of retailers and clerks will tell you the truth. But, on the evidence of an episode of CBC's *the fifth estate* scheduled to air last night, a number will lie. They will say you won only a tiny prize and will collect the major one themselves. Yes, there are all sorts of mechanisms to prevent that from happening, including self-serve ticket checkers and machines that play different tunes depending on how much money a ticket has won, but it happens.

One case in Ontario has become public, though the Ontario Lottery and Gaming Corporation (OLGC) has worked hard to keep some details secret. Bob Edmonds, now 82, bought a ticket in 2001 worth \$250,000, but a variety-store owner told him he had won only a free ticket. Mr. Edmonds grew suspicious when he later read that the store owner had "won" the big prize. An OLGC investigator had concerns as well, but the corporation paid the retail-

tion incurred \$425,000 in legal costs, far exceeding the amount Mr. Edmonds should have won in 2001. And it required that the settlement be covered by a confidentiality clause — a demand that Mr. Edmonds's lawyer plans to contest in court next Monday, on the excellent grounds that an agency of government should not keep such secrets from the public.

The OLGC says the Edmonds case was "isolated" and insists it keeps a tight rein on those who sell its tickets (lottery mechanisms vary across Canada). The math would suggest otherwise. Initially, using an OLGC figure of 60,000 retailers and clerks in Ontario, *the fifth estate* asked Jeffrey Rosenthal, author of *Struck by Lightning: The Curious World of Probabilities*, what the odds were of those clerks winning nearly 200 times in the past seven years with an average prize of \$500,000. Dr. Rosenthal's answer: "one chance in a trillion, trillion, trillion, trillion." According to the CBC, the OLGC last week said it really had closer to 140,000 retailers and clerks; even at that, Dr. Rosenthal said, the chance of so many winning so much was

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Ce qui a eu des conséquences graves

Ontario Lottery chief fired

Mar. 24, 2007, 6:12 a.m.


 5 comments



Ontario Lottery and Gaming Corporation: Ontario Lottery chief fired

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Rating: ★★★★★

anonymity.

The head of the Ontario Lottery and Gaming Corporation was dismissed from the scandal-plagued organization on Friday, according to CBC News.

CEO Duncan Brown was escorted out of the lottery corporation's offices in Toronto, two sources told the CBC, speaking on condition of

Y compris des débats à la législature de l'Ontario

Mr. Robert W. Runciman (Leeds-Grenville): My question is for the Minister of Public Infrastructure Renewal. Minister, today there are disturbing reports that over the last several years more than 200 lottery insiders have won prizes in excess of \$50,000. Jeffrey Rosenthal, a U of T professor, says that it's "extremely unlikely" these insiders would hit the jackpot that many times. The story, which is going to air on The Fifth Estate tonight, suggests that two thirds of these insider wins may have involved deception. Minister, can you tell us when you became aware of this issue and whether or not you plan to investigate the matter to ensure that Ontarians are not being defrauded of their rightful winnings?

Hon. David Caplan (Minister of Public Infrastructure Renewal, Deputy Government House Leader): There has been an allegation made, and I want all members to know that I take that very, very seriously. Ontario Lottery and Gaming is certainly committed to operating a business in a responsible and ethical manner and has some of the most stringent inside-win provisions of any organization

\$12.5M lottery prize theft leads to 3 arrests

Last Updated: Wednesday, September 29, 2010 | 10:25 PM ET

Comments 462 Recommend 322

CBC News



The case of Kathleen Chung, who allegedly cashed the winning ticket at her brother's convenience store in Burlington in early 2004, was profiled by the CBC's Fifth Estate, triggering a report by the Ontario ombudsman. (CBC)

Three family members in the Toronto area have been charged in the theft of a \$12.5-million lottery prize, while police seek the rightful owner of the Lotto Super 7 ticket bought in 2003.

Two of the accused are a father and son who worked at a Burlington lottery outlet and were actively stealing tickets from customers, Ontario Provincial Police Commissioner Chris Lewis

Est-ce qu'on peut trouver les vrais gagnants ?

\$12.5M lottery ticket stolen; police seeking rightful winner

Article

Photos (5)

Published On Thu Sep 30 2010

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Curtis Rush and Jayme Poisson

51

Staff Reporters



Trouvés !

Lottery fraud victims claim \$12.5M prize – plus interest

Seven men with wraparound smiles claimed their seven-year-old \$12.5 million lottery win Thursday, which stands now at \$14.85 million.

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TANNIS TOOHEY / TORONTO STAR

Et tout ça, c'était grâce aux statistiques

Solving equations and solving crime

Toronto math prof proves his point when it comes to insiders winning lottery prizes

By **THANE BURNETT**, NATIONAL BUREAU

Last Updated: 21st February 2009, 2:36am

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For a guy who's never bought a lottery ticket at a corner store, Jeff Rosenthal has sure hit it big.

And lottery corporations across Canada would likely wish he would just stop playing their numbers so well.

Since 2006, the Toronto math professor has been the brain behind uncovering a suspected massive theft of lottery winnings by sticky fingered store clerks.

- *D'autres investigations plus tards dans d'autres provinces et états.*
- *Un article détaillé : www.probability.ca/lotteryscandal*

Cette affaire m'a fourni des connexions avec le monde légal

- *J'ai fait une présentation au congrès de fraude de la police de Toronto en 2007. Et aussi :*

Royal Canadian Mounted Police *Gazette* magazine

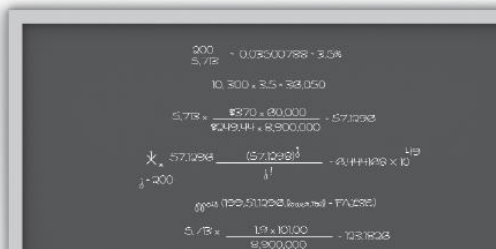
LOTTERY FRAUD

Solving crime using math

By Professor Jeffrey S. Rosenthal
Department of Statistics
University of Toronto

On the CBS television series NUMB3RS, crime-fighting mathematician Charlie Eppes boldly declares, "Everything is numbers!"

Well, that might be an exaggeration. But my involvement in a recent investigation into lottery fraud has convinced me that statistical analysis can indeed be used to uncover fraudulent behaviour that might otherwise pass undetected.



Et a mené à quelques recherches scientifiques légales

- *Albert Yoon (professeur de droit) : Quels juges de la Cour suprême des États Unis demandent le plus souvent à leurs greffiers de les aider à écrire leurs décisions légales ?*
- *Idée : Les greffiers auraient un style d'écriture plus variable.*
- *Alors : Mesurer la variabilité de fréquences des « mots de fonction » (p.e. all, have, not, than, with).*
- *(cf. Mosteller et Wallace, JASA 1963, pour les « Federalist Papers »)*
- *J'ai fait de la programmation et de l'analyse, pour classer les juges.*
- *Ça a confirmé quelques fait déjà connus, et trouvé quelques autres.*
- *Soumis à « JASA – Applications and Case Studies » ...*
- *Publié finalement dans « Annals of Applied Statistics ». (Quadfecta !)*
- *Article lié publié dans « Cornell Law Review ». (J'ai dit à mon ami ...)*
- *La Cour suprême du Canada ? « University of Toronto Law Journal »*
- *Et, c'est sûr que c'est important, parce que ...*

Justices Are Long on Words but Short on Guidance

A forthcoming [study](#) from two professors at the University of Toronto tried to identify the amount of ghostwriting on the court by developing software to analyze how justices' writing styles varied from opinion to opinion and term to term.

"A justice who wrote her own opinions would presumptively possess a less variable writing style than a justice who relied heavily on her law clerks," wrote Jeffrey S. Rosenthal and Albert H. Yoon, the authors of the study.

The opinions of Chief Justice Roberts and Justices Scalia and Breyer were less variable in this sense, and those of Justices Thomas, Ginsburg and Kennedy more so. The highest level of variability among justices who served since 1941 was in the opinions of Justice Sandra Day O'Connor, who retired in 2006.

Two Seventh Circuit judges known to write their own opinions, Judge Posner and Chief Judge Frank H. Easterbrook, have variability rates much lower than those of any current member of the Supreme Court.

Des normes de preuve dans les affaires juridiques

J'ai présenté aux avocats et aux juges : l'Institut canadien d'administration de la justice, La Cour suprême de l'Irlande, ...

Norme de preuve : « hors de tout doute raisonnable »

e.g. Les Poursuites publiques de l'Irlande : « Le juge ou jury doit être convaincu hors de tout doute raisonnable qu'une personne soit coupable. Ça ne suffit pas qu'il pense que l'accusé est probablement coupable. »

Entre « probablement » et « certainement ». Huh ? Entre “< 100%” et “100%” ? Le jugement humain ! Le témoignage des experts ?

The New York Times

April 20, 2019

“An expert can say whatever they want,” said Simon Cole, the director of the registry and a professor of Criminology, Law and Society at [UC -Irvine](#).

That includes offering up invented odds like “one in a million” or “1 in 129,600,” the registry says.

Exemple : l'affaire Sally Clark

- *Avocate à Cheshire, Angleterre.*
- *Deux garçons ; chacun mort comme enfant.*
- *“cot death” (SMSN) ? Ou des homicides!?!*
- *Témoignage du pédiatre Sir Roy Meadow :
« La probabilité de deux morts SMSN dans
la même famille est un sur 73 million. »*
- *Condamnée! Emprisonné! Vilipendé! Troisième
garçon temporairement enlevé!*



Est-ce que « un sur 73 million » était bien calculé?

Et, est-ce que c'était la bonne quantité à calculer? Non!

Comment Meadow a-t-il calculé cet « un sur 73 million » ?

*Il a dit que la probabilité qu'un enfant mort de SMSN
est un sur 8,543. Puis, pour deux enfants, il a multiplié :
 $(1/8,543) \times (1/8,543) = 1/72,982,849 \approx 1/73,000,000.$*

Le cas Clark : calculs de probabilité valides ?

- *Est-ce que la valeur $1/8,543$ était valide ? Pas vraiment !*

La probabilité globale de SMSN au Royaume Uni était $1/1,303$.

Meadow a ajusté pour des circonstances de famille qui la réduisent (pas de fumeurs, parents employés, mère a plus que 26 ans), mais a ignoré d'autres facteurs qui l'augmentent (p.e. deux fois de plus pour des garçons que pour des filles).

- *La multiplication : independant ? Non ! Le SMSN a des tendances dans les familles, alors un deuxième cas est vers 7 fois plus probable.*
- *La vraie probabilité $\approx 1 / 240,000$. Suffisante pour condamnation ?*
- *Non ! Le problème de tests multiples ! Millions de familles au Royaume Uni / au monde ! Correction de Bonferroni ? ("Un sur combien ?")*
- *Des objections de la Société royale de statistique, du Conseil médical.*
- *Sally Clark a finalement été acquittée, sur deuxième appel, après plus de trois ans en prison. Elle n'a jamais récupéré de façon psychologique, et elle est morte de l'intoxication alcoolique quatre ans plus tard.*
- *Quelques autres condamnations d'autres aussi annulées en appel.*

Une affaire liée : Waneta & Tim Hoyt (New York)

- *Cinq bébés entre 1965 – 1971. Tous morts.*
Âges (mois) : 3, 28, 1.5, 2.5, 2.5.

Le pédiatre Alfred Steinschneider a investigué, et a écrit un article en 1972 pour le journal Pediatrics. Sa conclusion : « SMSN lié à la génétique ».

- *En 1977, ils ont reçu la permission d'adopter un autre garçon, qui a survécu jusqu'à l'âge adulte.*
- *En 1985, quelques procureurs et pathologistes se sont méfiés, et ont investigué. Finalement, Waneta Hoyt a avoué qu'elle a étouffé tous les cinq enfants, pour les empêcher de pleurer.*
- *Plus tard elle a « retiré » sa confession, mais elle a été condamnée quand même.*
- *A cause des facteurs ci-dessus, la probabilité devrait être à peu près*
$$1 / [(1303)^5 / 7^4] \doteq 1 / 1.5 \text{ trillion.}$$

Est-ce que ça devait la condamner plus tôt ? Des concernes, au moins !

- *L'évidence statistique peut indiquer la culpabilité, si vous faites attention.*



Une affaire dans laquelle j'ai été impliqué : Leighton Hay

- *Accusé comme complice à un meurtre en 2002.*
- *Témoins : cheveux dreadlocks de deux pouces.*
- *Mais Hay était rasé presque chauve à l'arrestation.*
- *Poursuite : il s'est rasé après le crime !*
- *Évidence : De petites coupures de cheveux dans une poubelle et un rasoir électrique chez lui.*
- *Condamné en 2004. Appel à la Cour suprême en 2011.*
- *Question : Ces coupures venaient d'un cuir chevelu ?*

Échantillon : Les largeurs des cheveux d'un cuir chevelu sont $\leq 125 \mu$, mais de la barbe plus grandes. (Il voulait exclure 125μ aussi.)

Mon rapport d'expert : Des 368 coupures examinées, le nombre d'un cuir chevelu était entre 0 et 106 (29%), et les autres d'une barbe.

- *J'ai donné ma deposition. Contre-interrogé : agressif! 2013 SCC 61 jugement : nouveau processus! Hay libéré de prison, en permanence.*



Une autre affaire dans laquelle j'ai été impliqué : Yuk Yuen Lee

- *Accusé en 2013 d'avoir un « grow-op » de marijuana à Toronto.*
- *Les policiers ont pris 1378 + 2240 plantes. Toutes marijuana ?*
- *Ils ont testé juste 2 + 1 des plantes (!).*
- *Condamné. Mais qu'est-ce qui serait la punition ?*
- *Si plus de 500 plantes, trois ans en prison obligatoires.*

Mon rapport d'expert : Ces tests indiquaient seulement qu'au moins 138 + 16 des plantes étaient la marijuana (intervalle de confiance exact de 99%).

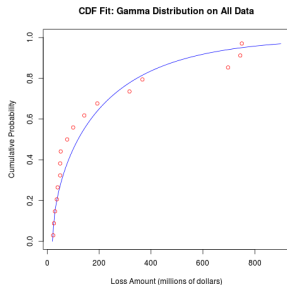
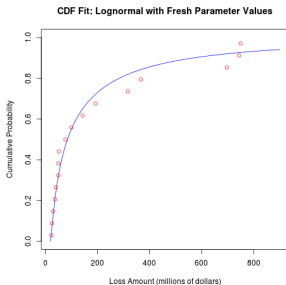
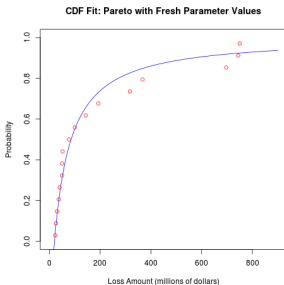
- *Mon témoignage. Contre-interrogé : des attaques! (références ...)*

2017 ONSC 2403 judgment : "Crown counsel suggests that Professor Rosenthal misrepresented the evidence [which] substantially undermined his credibility. . . . I did not find Professor Rosenthal lacking in credibility. . . . His evidence did not misrepresent in any way. . . . I do not accept that the Crown has established the number of marijuana plants"

Punition : *Juste les mois déjà en prison. (Une autre affaire, aussi.)*

Une affaire commerciale : responsabilité du transport pétrolier

- *Les frais des trains pour le transport de marchandises dangereuses sont basés sur la quantité de « risque ». Comment l'estimer ?*
- *La mesure utilisée : « Total Exposure (N%) », le N^{ème} pourcentile des valeurs de dommage. Ici N = 99.7 ou 99.9 ou 99.97 ; les extrêmes.*
- *Mais, seulement 17 observations. Il faut extrapoler. Les distributions et pourcentiles donnent des estimés très différents (facteur > 30) :*



- *J'ai envoyé mon mémo. Reçu. Paiement ? Réponse ? (Des mois plus tard.)*

La statistique et le droit : réflexions

- *Beaucoup de possibilités pour l'analyse academique des données.*
- *En des tribunaux, la statistique peut être mal utilisée, pour donner des fausses indications de coupabilité.*
- *Mais elle peut aussi aider à bien analyser l'évidence – bon.*
- *En fait : Je suis actuellement impliqué dans une autre affaire (prolongée par le covid). « Expert » de l'autre côté : des attaques ! Les statisticiens sont plus amicaux ! (Mon don ...)*
- *Considérer avant d'accepter. (La pression ?) (Collègue pas payé !)*
- *Le témoignage expert statistique peut être : Intéressant ! Différent ! Percutant ! Satisfaisant ! Et ... très bien rémunéré ! (par heure, ou fixe ?)*
- *Mais aussi : Long ! Agaçant ! Frustrant ! Et le système « adversarial » peut devenir désagréable – même méchant !*
- *Malgré tout ça ... si non les statisticiens, alors qui le ferait ?*

Article www.probability.ca/justice, livre « Knock On Wood » (ch. 19).

www.probability.ca / @ProbabilityProf / jeff@math.toronto.edu