Trying to be a 'public' (Bayesian) statistician

David Spiegelhalter
@d_spiegel

winton professor for the public understanding of risk,
university of cambridge

ISBA 2016
Welcome to Understanding Uncertainty

Welcome to the site that tries to make sense of chance, risk, luck, uncertainty and probability. Mathematics won’t tell us what to do, but we think that understanding the numbers can help us deal with our own uncertainty and allow us to look critically at stories in the media.

‘Tails you win: the science of chance’ aired on BBC4 at 9pm on October 18th. The video trailer is up on Youtube

Maximise your chances of living to 100 - Tails ...
Sex by numbers

David Spiegelhalter
Times in qualifier

median: 3' 10"
time needed to qualify for 2nd round

qualifying time - minutes

programme

Series 1 | Series 2 | Series 3 | Series 4

0  5  10  15  20  25  30
0  1  2  3  4  5  6 Series 1 Series 2 Series 3 Series 4
The usual suspects ....
The usual suspects ....

- Lotteries
The usual suspects ....

- Lotteries
- Birthday coincidences
The usual suspects ....

- Lotteries
- Birthday coincidences
- Sport
Communicating chances of a jackpot win
Communicating chances of a jackpot win

- 6/49 Lotto
Communicating chances of a jackpot win

- 6/49 Lotto
- About 1 in 14,000,000
Communicating chances of a jackpot win

- 6/49 Lotto
- About 1 in 14,000,000
- 60 grains of rice weigh 1gm
Communicating chances of a jackpot win

- 6/49 Lotto
- About 1 in 14,000,000
- 60 grains of rice weigh 1gm

- 14,000,000 grains of rice weigh 225 kg
Communicating chances of a jackpot win

- 6/49 Lotto
- About 1 in 14,000,000
- 60 grains of rice weigh 1gm

- 14,000,000 grains of rice weigh 225 kg
- Around 250 litres
Communicating chances of a jackpot win

- 6/49 Lotto
- About 1 in 14,000,000
- 60 grains of rice weigh 1gm
- 14,000,000 grains of rice weigh 225 kg
- Around 250 litres
- A standard bath, 20 cm deep
What does 100,000,000 grains of rice look like?
What does 100,000,000 grains of rice look like?
Football and birthday coincidences
Football and birthday coincidences
Dog vs Man - #EURO2016 predictions with @d_spiegel and @EvanHD's Mr Whippy bbc.in/1syomU6
DONALD TRUMP'S FOCUS

DONALD TRUMP PLANS TO FOCUS ON 15 STATES IN THE GENERAL ELECTION

AMERICA'S ELECTION HQ 2016
2012 Presidential Run

GOP Candidates

- 70% Back Palin
- 60% Back Romney
- 63% Back Huckabee

Source: Opinions Dynamic
Some serious stuff..
This programme is not currently available on BBC iPlayer

At the heart of the climate change debate is a paradox - we've never had more information about our changing climate, yet surveys show that the public are, if anything, getting less sure they understand what's...
DURATION: 1 HOUR
Smart and witty, jam-packed with augmented-reality graphics and fascinating history, this film, presented by Professor David Spiegelhalter, tries to pin down what chance is and how it works in the real world. For...

SHOW MORE

Next on

Next Thursday
21:00
BBC Four

See all upcoming broadcasts of Tails You Win: The Science of Chance (3)
DURATION: 1 HOUR
Smart and witty, jam-packed with augmented-reality graphics and fascinating history, this film, presented by Professor David Spiegelhalter, tries to pin down what chance is and how it works in the real world. For...

> SHOW MORE
## Type of Jump

<table>
<thead>
<tr>
<th></th>
<th>Jumps</th>
<th>Fatalities</th>
<th>Fatality Rate (per 100,000 jumps)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Tandem:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tandem Instructors</td>
<td>341,608</td>
<td>1</td>
<td><strong>0.3</strong></td>
</tr>
<tr>
<td>Student Tandem Jumpers</td>
<td>341,608</td>
<td>1</td>
<td><strong>0.3</strong></td>
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<tr>
<td><strong>All First Jumps</strong></td>
<td>649,078</td>
<td>7</td>
<td><strong>1.1</strong></td>
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<tr>
<td><strong>All Student Jumps</strong></td>
<td>1,204,029</td>
<td>13</td>
<td><strong>1.1</strong></td>
</tr>
<tr>
<td><strong>All Jumpers Combined</strong></td>
<td>4,599,435</td>
<td>48</td>
<td><strong>1.0</strong></td>
</tr>
</tbody>
</table>
US Parachuting Association data

Fatalities per 1,000 Jumps By Year

Year
Fatalities per 1,000 Jumps
0.014 0.013 0.013 0.01 0.008 0.01 0.008 0.012 0.007 0.007 0.008 0.005 0.006 0.0075 0.0075
A unit of acute risk?
A unit of acute risk?

A *micromort*

A 1-in-a-million chance of sudden death
<table>
<thead>
<tr>
<th>micromorts</th>
<th>All averages – individuals circumstances will vary</th>
</tr>
</thead>
<tbody>
<tr>
<td>45,000</td>
<td>First day on the Somme WW1</td>
</tr>
<tr>
<td>25,000</td>
<td>One mission in RAF Bomber command in WW2</td>
</tr>
<tr>
<td>16,000</td>
<td>CABG (Coronary Artery Bypass Graft)</td>
</tr>
<tr>
<td>8,900</td>
<td>One day in Great Ormond St Cardiac ICU</td>
</tr>
<tr>
<td>1,100</td>
<td>Giving birth in Chad (mother)</td>
</tr>
<tr>
<td>530</td>
<td>UK service personnel in Iraq at peak risk period</td>
</tr>
<tr>
<td>47</td>
<td>One day serving in Afghanistan at peak risk period</td>
</tr>
<tr>
<td>10</td>
<td>Skydive</td>
</tr>
<tr>
<td>1</td>
<td>Getting out of bed and going to work</td>
</tr>
<tr>
<td>1</td>
<td>Lifetime risk from asteroid</td>
</tr>
</tbody>
</table>
Chronic risks?
Bacon, ham and sausages have the same cancer risk as cigarettes warn experts

Processed meats are now on World Health Organisation list of substances as carcinogenic as tobacco
100 people NOT eating a bacon sandwich each day
50g processed meat a day associated with 18% increased risk of getting bowel cancer
50g processed meat a day associated with 18% increased risk of getting bowel cancer

Around 6% of people will get bowel cancer anyway.
50g processed meat a day associated with 18% increased risk of getting bowel cancer

Around 6% of people will get bowel cancer anyway.

So what is an 18% increase over 6%!!
100 people eating a bacon sandwich each day
Death by Bacon: Did the News get to the Meat of the Matter?

by Rebecca Goldin | Nov 11, 2015 | Causality, Risk | 3 comments
What is understood by these relative risks?
What is understood by these relative risks?

LESS MEAT, MORE VEG IS THE SECRET FOR LONGER LIFE

By Jo Willey, Health Correspondent

A DIET packed with fish, chicken, fruit and vegetables, rather than red meat, can help you live longer and ward off a host of chronic diseases, researchers claim.

Scientists say the secret to a long and healthy life is slashing the amount of red meat we eat.

If people cut down the amount of red meat they eat—such as steak or beefburgers—to less than half a serving a day, 10 per cent of all deaths could be avoided, they say.
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Scientists say the secret to a long and healthy life is slashing the amount of red meat we eat and replacing it with fish, chicken, nuts, beans, low-fat dairy and whole grains.

If people cut down the amount of red meat they eat—such as steak or beefburgers—to less than half a serving a day, 10 per cent of all deaths could be avoided, they say.
The RealAge® Test is a unique calculation of your body’s health age, created by top doctors including Dr. Mike Roizen and Dr. Mehmet Oz. Powered by the latest medical research, your RealAge Test results create personalized tips and action plans to get healthier and grow younger! See Doctor Oz’s test results below.

See Dr. Oz’s test results below:

Oz’s Age
Born on 06/11/1960

Oz’s RealAge
Test taken on 11/12/2012

Life Gained
Great Work!

55
47
8
Check your heart age

How healthy is your heart? Use this tool to find out if your heart age is higher or lower than your actual age.

Anyone over 30 can use the tool, even if you don't know your blood pressure and cholesterol. However, without these numbers, your result will be an estimate and we recommend you get tested to get an accurate result.

Start

Full terms and conditions can be read here
How many cars or vans are owned, or available for use, by you or members of your household?

(Please include company vehicles if available for private use)
How would you describe your usual walking pace?

- Slow pace
- Steady average pace
- Brisk pace
- None of the above
From the answers you have provided, we have calculated that:

1. Your **Ubble age** is **52 years (51 to 54 years)**

This means that your risk of dying in the next five years is equivalent to the average risk for men aged 52 in the UK.
2. Your five-year risk of dying is 2.5%

This means that, out of 100 men aged 62 years with similar answers, 98 will survive and 2 will die over the next 5 years.
Why is almost everyone’s Ubble age so low?
Why is almost everyone’s Ubble age so low?

• Compares you with ‘average 5-year risk’ (mean)
Why is almost everyone’s Ubble age so low?

- Compares you with ‘average 5-year risk’ (mean)
- Almost all risk contributed by few very sick people
Why is almost everyone’s Ubble age so low?

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- So nearly everyone less than average
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- Like ‘numbers of legs’
Why is almost everyone’s Ubble age so low?

- Compares you with ‘average 5-year risk’ (mean)
- Almost all risk contributed by few very sick people
- So nearly everyone less than average
- Like ‘numbers of legs’
- Maybe better to compare with median
New UK Cancer Screening leaflets, 2013
New UK Cancer Screening leaflets, 2013

• “Consider the offer”
New UK Cancer Screening leaflets, 2013

- “Consider the offer”
- Presents pros and cons
New UK Cancer Screening leaflets, 2013

- “Consider the offer”
- Presents pros and cons
- Does not make recommendation
New UK Cancer Screening leaflets, 2013

- "Consider the offer"
- Presents pros and cons
- Does not make recommendation
- ‘Uniform reporting of harms and benefits’
Citizens’ Jury on information for women about breast screening

Report to Informed Choice about Cancer Screening

Public engagement through Citizens’ Jury
What happens to 100 women each time they have breast screening

100 women have breast screening

96 women have a normal result

4 women need more tests

3 women have no cancer found

1 woman is diagnosed with cancer

These women will receive further invitations for breast screening every 3 years
Expected frequency trees

What happens to 100 women each time they have breast screening

100 women have breast screening

96 women have a normal result

4 women need more tests

3 women have no cancer found

1 woman is diagnosed with cancer

These women will receive further invitations for breast screening every 3 years
200 women between 50 and 70 who attend screening

- 200 attend screening
- 185 never have breast cancer
- 15 develop breast cancer
- None are unaffected
- 12 are treated and survive
- 3 die from breast cancer
200 women between 50 and 70 who attend screening

185 never have breast cancer

15 develop breast cancer

12 are treated and survive

3 die from breast cancer

None are unaffected

3 more treatments, 1 fewer death

200 women between 50 and 70 who are not screened

185 never have breast cancer

15 develop breast cancer

8 are treated and survive

4 die from breast cancer

3 fewer treatments, 1 extra death
A numeracy paradox?
A numeracy paradox?

- Leaflets optimised for people with low numeracy
A numeracy paradox?

- Leaflets optimised for people with low numeracy
- Those people tend to be less interested in shared-care / informed-choice
‘Expected frequency trees’ now in GCSE Maths syllabus:

"{calculate and interpret conditional probabilities through representation using expected frequencies with two-way tables, tree diagrams and Venn diagrams}."
Risk communication

• Respect range of audiences
• Layered format, e.g.
  1. ‘Gist’, ‘number-lite’
  2. Numbers in tables and tested graphics
  3. Certainty and strength of evidence
• Co-produce

• [Winton Centre]
Twitter
Financial crisis caused 500,000 extra cancer deaths, according to Lancet study
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They found that every one-per cent increase in unemployment was associated with 0.37 additional cancer deaths per 100,000 people.

Every one-per cent drop in healthcare spending was associated with 0.0053 additional deaths per 100,000 people.
Financial crisis caused 500,000 extra cancer deaths, according to Lancet study

They found that every one-per cent increase in unemployment was associated with 0.37 additional cancer deaths per 100,000 people.

Every one-per cent drop in healthcare spending was associated with 0.0053 additional deaths per 100,000 people.

"1% drop in healthcare spending associated with 0.0053 additional deaths per 100,000 people"
[link]

In UK that's .. 3 more
How much is ‘Bayesian’?
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- Never mention the ‘B’ word
How much is ‘Bayesian’?

- Never mention the ‘B’ word
- But implicit ideas about probabilities/chances include –
How much is ‘Bayesian’?

• Never mention the ‘B’ word
• But implicit ideas about probabilities/chances include –
  – They do not ‘exist’
How much is ‘Bayesian’?

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  – Change as information comes in
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  - Can be applied to uncertain facts (epistemic uncertainty)
  - Change as information comes in
  - Can be elicited
Quantifying your ignorance
Quantifying your ignorance

• Think whether you prefer (A) or (B) for each question
Quantifying your ignorance

• Think whether you prefer (A) or (B) for each question
• Then think of how confident you are with your answer
Quantifying your ignorance

- Think whether you prefer (A) or (B) for each question
- Then think of how confident you are with your answer
- Give your confidence a number 5 to 10
Quantifying your ignorance

- Think whether you prefer (A) or (B) for each question
- Then think of how confident you are with your answer
- Give your confidence a number 5 to 10
- Score yourself when you hear the correct answer
<table>
<thead>
<tr>
<th>Your ‘confidence’ in your answer</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Score if you are right</td>
<td>0</td>
<td>9</td>
<td>16</td>
<td>21</td>
<td>24</td>
<td>25</td>
</tr>
<tr>
<td>Score if you are wrong</td>
<td>0</td>
<td>-11</td>
<td>-24</td>
<td>-39</td>
<td>-56</td>
<td>-75</td>
</tr>
</tbody>
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   **A (77m vs 57m)**

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   **A (77m vs 57m)**  
2. Who is older, A) Prince William or B) Kate?
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   A (77m vs 57m)
2. Who is older, A) Prince William or B) Kate?  
   B (Born 21/6/82 vs 9/1/82)
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3. In the IMDB rankings (17/3/2016), which film comes higher,
1. Who has the most followers on Twitter, A) Justin Bieber, B) Rihanna?
   **A (77m vs 57m)**
2. Who is older, A) Prince William or B) Kate?
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5. Which is bigger, A) Venus B) Earth?
   B (6051 vs 6371 km radius)
1. Who has the most followers on Twitter, A) Justin Bieber, B) Rihanna?
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   \[B \ (1827 \ vs \ 1791)\]
Still a Bayesian knight
When things go badly....
When things go badly....

- Getting asked the ‘wrong’ questions
When things go badly….

- Getting asked the ‘wrong’ questions
- Wrong time
Sex by Numbers
The Statistics of Sexual Behaviour
David Spiegelhalter
Numbers can get mangled...

- I gave a lecture with Dame Anne Johnson (runs NATSAL)
- She said ‘one third of people had sex before 16’
- By the time this got to the Daily Mail...
More sex please, we’re British! Amorous Brits make love 2,500 times a minute (and that includes time for sleep)

- British people have sex 2,500 times a minute or 900 million times a year
- The figure applies to the entire population and has been adjusted for sleep
- Finding is part of a project by Cambridge mathematician, David Spiegelhalter
- Also found that 30 per cent of total sexual encounters take place before 16
- People between 64 and 74 are also having far more sex than previously

By DAILY MAIL REPORTER
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How many sexual partners do people report?
How many sexual partners do people report?

Reported number of lifetime opposite-sex partners
Median (middle) number of occasions of sex in the past 4 weeks (people aged 16–44)

<table>
<thead>
<tr>
<th></th>
<th>Natsal-1</th>
<th>Natsal-2</th>
<th>Natsal-3</th>
</tr>
</thead>
<tbody>
<tr>
<td>count</td>
<td>2</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>lower</td>
<td>5</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>upper</td>
<td>9</td>
<td>9</td>
<td>7</td>
</tr>
</tbody>
</table>

The bars represent the interquartile range: 50% of the population were in this range, 25% were below the lower value, and 25% were above the higher value.
Britons having sex less often

National Survey of Sexual Attitudes and Lifestyles finds frequency of sex has fallen by 20% since last survey in 2000
Last week I said all this at the Hay literary festival.
Last week I said all this at the Hay literary festival

And a journalist in the audience didn’t quite get the joke......
Britons are having less sex, and Game of Thrones could be to blame, warns Cambridge professor
Game of Thrones and other addictive box sets are preventing British couples having as much sex as they did in the past, a Cambridge University statistician has warned.

David Spiegelhalter, the Winton Professor of the Public Understanding of Risk, said the trend in declining sex rates over the last 30 years was ‘very worrying.’

In 1990 couples had sex around five times a month, but now it is just three times, a 40 per cent decrease in just 20 years. If current trends continue couples would not be having sex at all by 2030.
CULTURE

IS 'GAME OF THRONES' RUINING OUR SEX LIVES?

BY TUFAEL AHMED ON 6/6/16 AT 1:42 PM
Is 'Game Of Thrones' Killing Your Sex Life?

JV Chamary, CONTRIBUTOR
I cover the science of life. FULL BIO →
Number of times the average person had sex in the past 4 weeks

![Line graph showing the number of times the average person had sex in the past 4 weeks. The graph indicates a decrease over time from 1990 to 2010.](image-url)
Number of times the average person had sex in the past 4 weeks

Sex per month
Couples ‘will stop having sex by 2030’ due to the large rise in TV ratings
Sex Will Be Obsolete by 2030 Because of Netflix, According to One Lone Scientist

Apparently, the future holds no chill.

BY KORIN MILLER, June 7, 2016
Warum wir wegen "Game of Thrones" alle weniger Sex haben

Wo man auch hinschaut, findet man heute Sex, nur in den Schlafzimmern wird er immer weniger. Ein Statistikprofessor gibt daran nun ausgerechnet der heißen Serie "Game of Thrones" die Schuld.
Benessere

Il sesso sparirà, nel 2030 tutti in bianco
Lo dice la scienza e la colpa è tutta della tecnologia, lo studio arriva da Cambridge

Dai mitici anni settanta tutti sesso, droga e rock and roll a un futuro senza sesso, una generazione triste quella futura. E le dinamiche di coppia e i giochi di potere e il toy boy e il vechio con la Lolita? Sarà un mondo allo sfascio quello futuro, senza punti di riferimento, senza trasgressioni, senza tradimenti e fughe d’amore, perché il sesso aiuta a vivere.

L’allarme arriva dall’Università Cambridge dove un esperto di statistica il professor David Spiegelhalter, ha realizzato che gli inglesi fanno sesso il 40% in meno rispetto a quanto ne facevano 20 anni fa. Secondo
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• Contacts important - takes time