Statistics for Empowerment: opportunities and challenges

Jim Ridgway

www.procivicstat.org

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Durham


North Sea
Edinburgh
Newcastle
Durham
Stockton
Irish Sea
Manchester
Birmingham
Cardiff
London
English Channel

Durham University

- 17,500 students (20% non-UK from 156 countries)
- About 30% post grad
- 3000 staff (30% non-UK)
- Students: collegial, charitable fundraising; sports
- About 70th in world rankings

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Early Statisticians

- Florence Nightingale (1820-1910) – health, infographics
- Enid Charles (1894-1972) – demography
- Elizabeth Scott (1917-1988) - weather, astronomy, equal opportunities
- Dorothy Adkins (1912-1975) - psychometrics

Royal Statistical Society Founders

- Henry Lansdowne - politician (Chancellor of the Exchequer)
- Charles Babbage - mathematician, engineer, astronomer and inventor of the computer
- John Elliot Drinkwater - administrator and champion of girls' education in India
- Henry Hallam - historian and political activist
- Richard Jones – economist

Pullinger (2014)

Statistics: Roots and Raison D'etre

- Tackle real problems using evidence
- Invent some mathematics
- Change the world
- Collaborate with sympathetic people – whatever their background

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STATISTICS – still does

STATISTICS EDUCATION – has lost the plot??

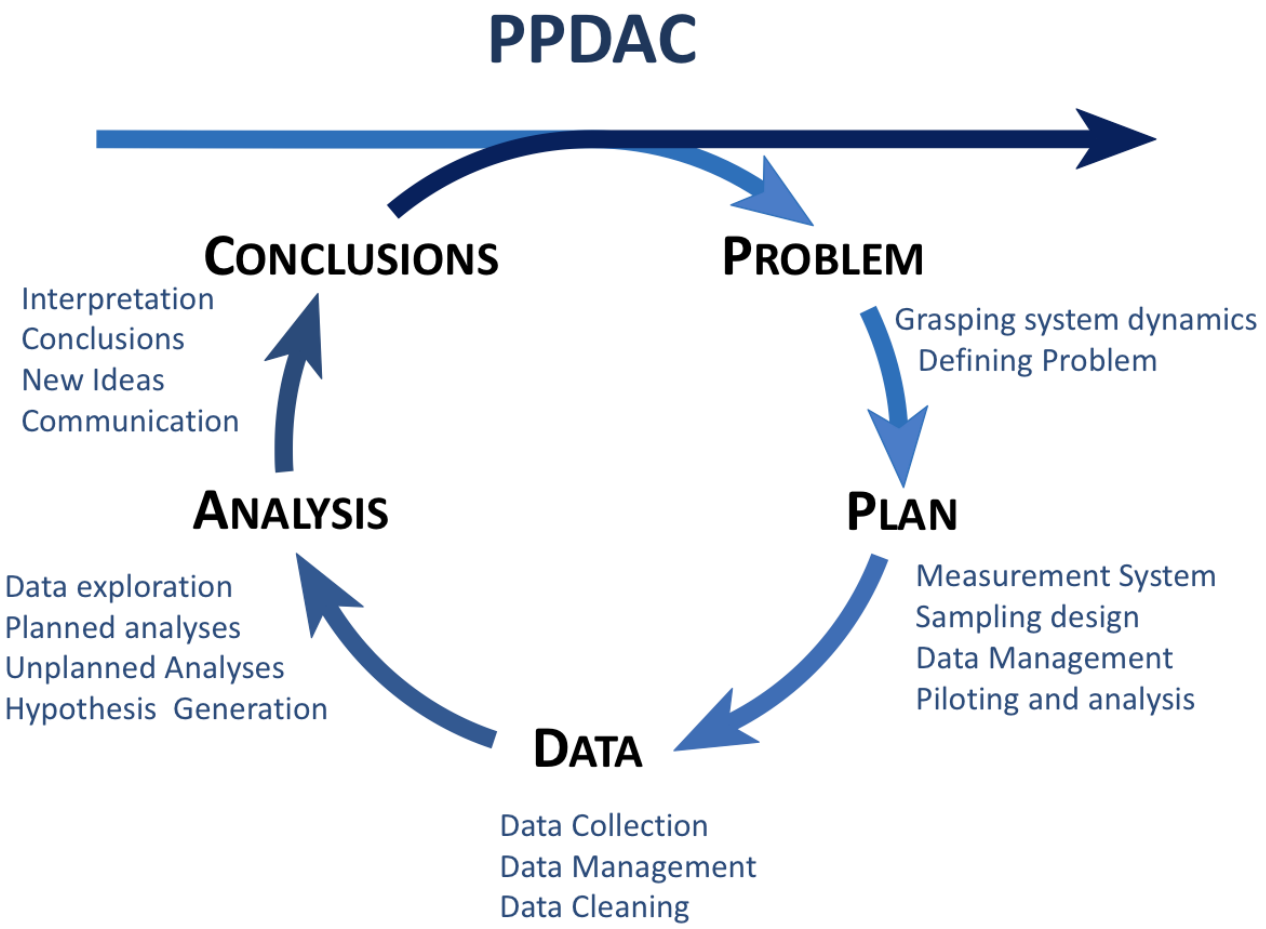
George Cobb…

Mere renovation is too late: we need to rethink our undergraduate curriculum from the ground up

American Statistician

doi:10.1080/00031305.2015.1093029

Wild & Pfannkuch (1999)



Critique of Statistics Education

- Doesn't address enough of the PPDA Cycle
- Stuck in the 1900s
  - Over-value tractable mathematical models
  - Believe in 'simple to complex' pedagogy
- Conservative
  - Focussed on what *we* know, not on student interests or needs
- Resists algorithmic thinking

Opportunities and Challenges

- Newfangled models are available
  - Most of the stats in the introductory curriculum was invented before 1900 (t-test 1908)
- New contexts
  - Social upheaval – we need more evidence informed decision making
- New resources
  - Open data, big data, social media, data visualisation
- New players
  - Data science, data driven journalism, fact checkers, FAKE NEWS
- New audiences
  - Citizens, politicians, social scientists

Opportunities and Challenges

- Newfangled models
  - Most of the stats in the introductory curriculum was invented before 1900 (t-test 1908)
  - Embrace models that everyone uses every day – decision trees, pattern recognition... BUT NOT TODAY!
- New contexts
  - Social upheaval
  - Use data about social phenomena; multivariate, non-linear, with interactions

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Opportunities and Challenges

- New resources
  - *Open data*, big data, social media, *data visualisation*
  - Use them

Sample Open Data Sources

- OECD *https://data.oecd.org/ World Bank*
- European Union Open Data Portal http://open-data.europa.eu/en/data/
- The CIA World Factbook https://www.cia.gov/library/publications/the-world-factbook/

Big Data Sources

Topsy http://topsy.com/
A searchable database of public tweets going back to 2006 as well as several tools to analyze the conversations

Likebutton http://likebutton.com/
Mines Facebook's public data – globally and from your own network

Big Data Sources

New York Times http://developer.nytimes.com/docs
Searchable, indexed archive of news articles going back to 1851

Freebase http://www.freebase.com/
A community-compiled database of structured data about people, places and things, with over 45 million entries

Million Song Data Set http://aws.amazon.com/datasets/6468931156960467
Metadata on over a million songs and pieces of music. Part of Amazon Web Services

Opportunities and Challenges

- New players
  - Data science, data driven journalism, *fact checkers*
  - Use them
  - FAKE NEWS
  - Teach statistical *habits of mind*
- New audiences
  - Citizens, *politicians*, social scientists
  - Teach students what they need to become informed citizens

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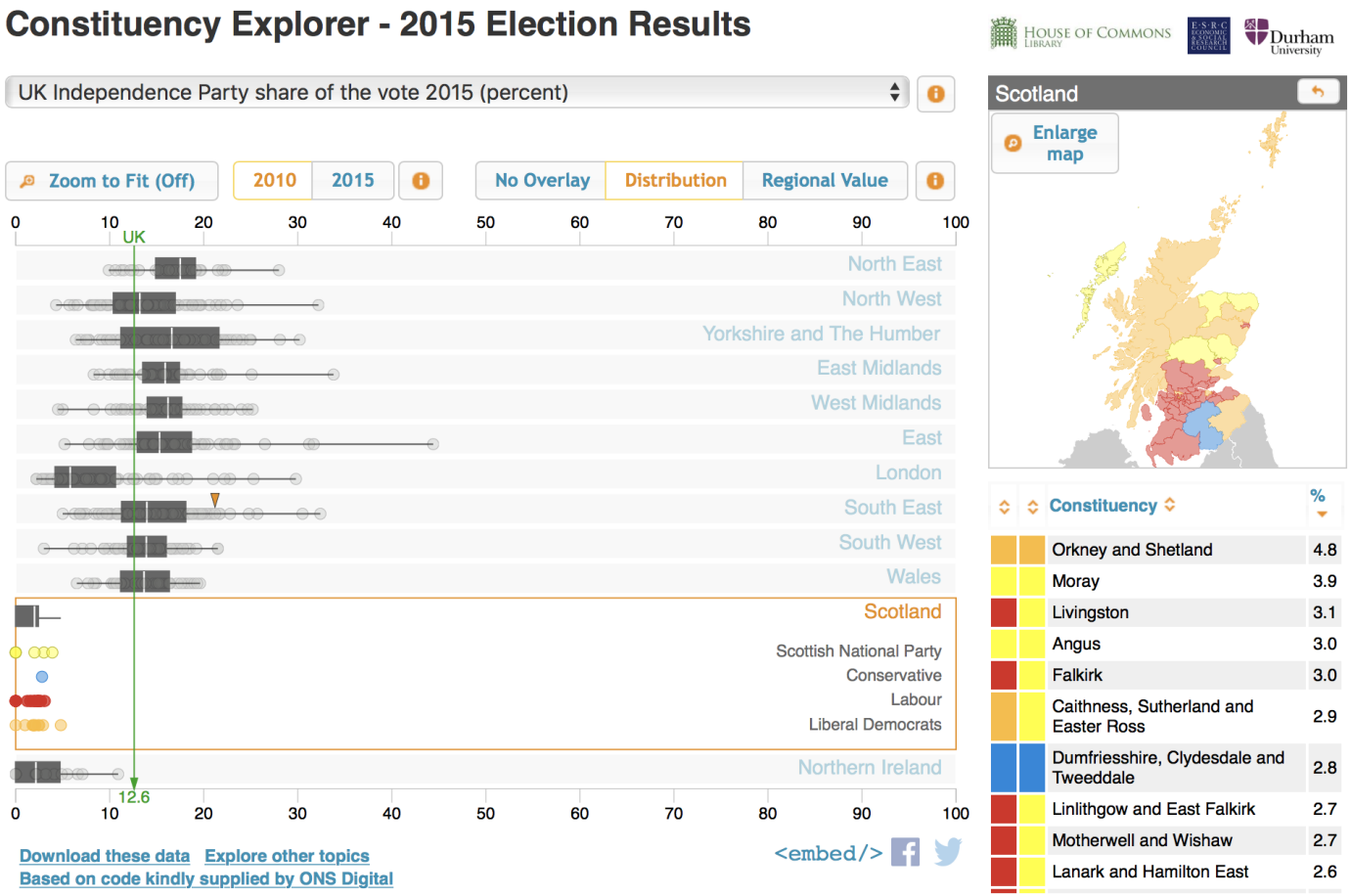
Interactive Open Data



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Statistical Ideas

- *Work with people who influence decision makers*
- *Heuristic: assemble lots of data into an accessible display*

Some Curriculum Approaches

- Set Statistics in the context of *problem solving*
- More data visualisation, fewer equations
  - Formalise *after* understanding
- More large scale authentic data sets
  - To teach *basics* as well as *big ideas*
- Introduce multivariate thinking *early*
  - *Effect size, non-linearity, interaction*
- Show powerful, counter-intuitive results
  - *Birthday problem; when will you die?...*

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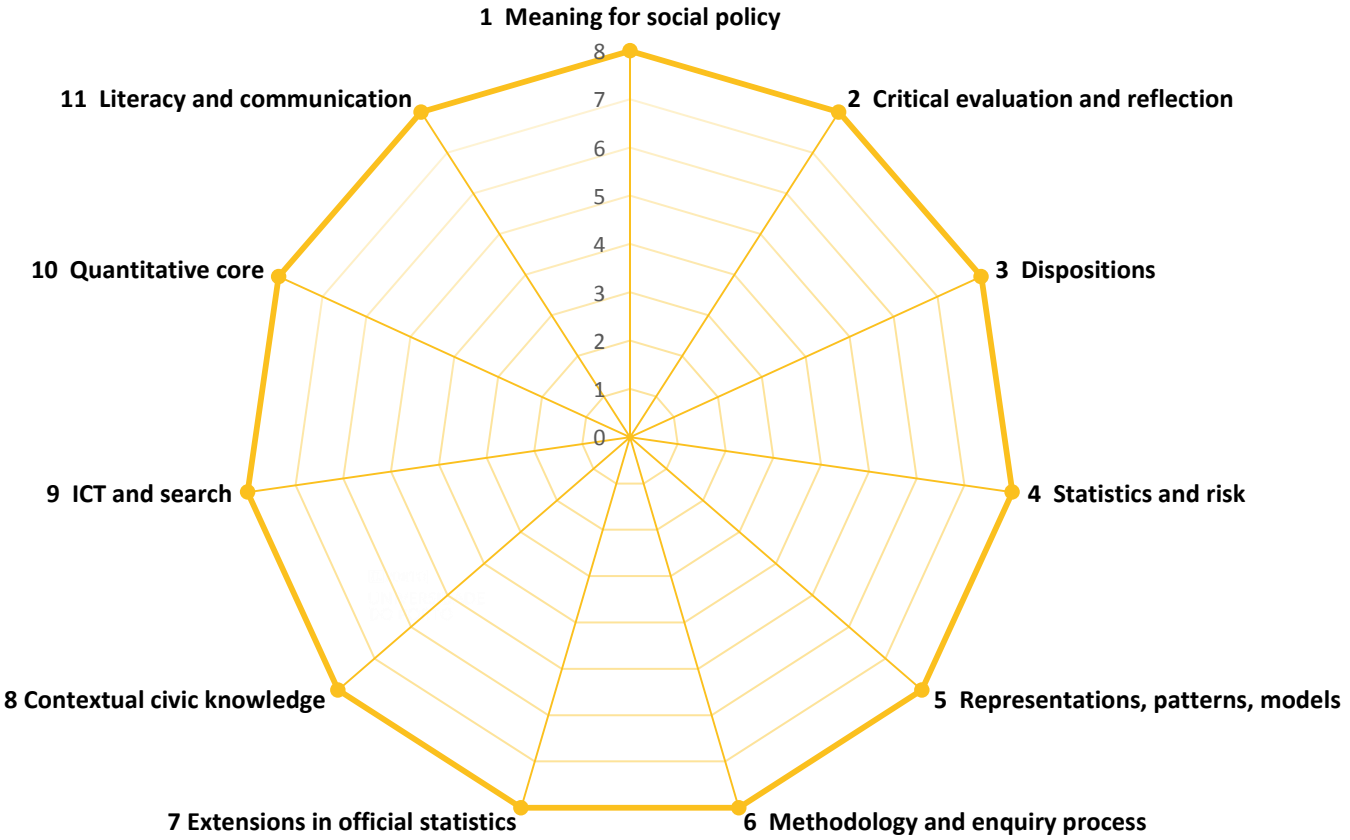
Thinking WITH and ABOUT Data

- Critical thinking
  - Exploring and Challenging
- Problem exploration
  - What evidence is out there? Can we get it, clean it, explore it?
- Decision making
  - OK, so what do we DO?
- BIG Ideas
  - What MUST we teach?

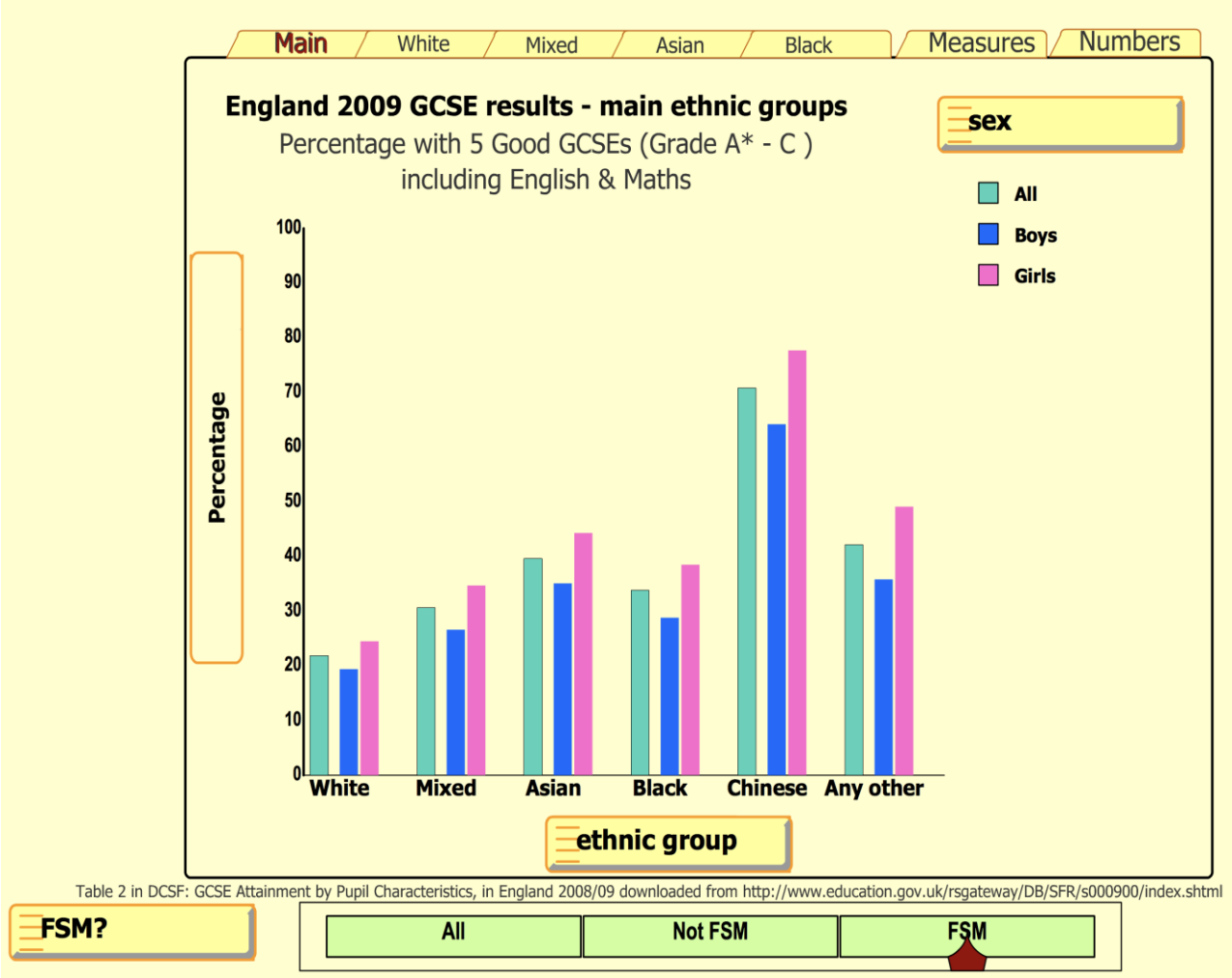
Some Dimensions of Literacy



Problem Exploration

- Explaining educational attainment
  - Intelligence?
  - Social class?
  - Poverty?

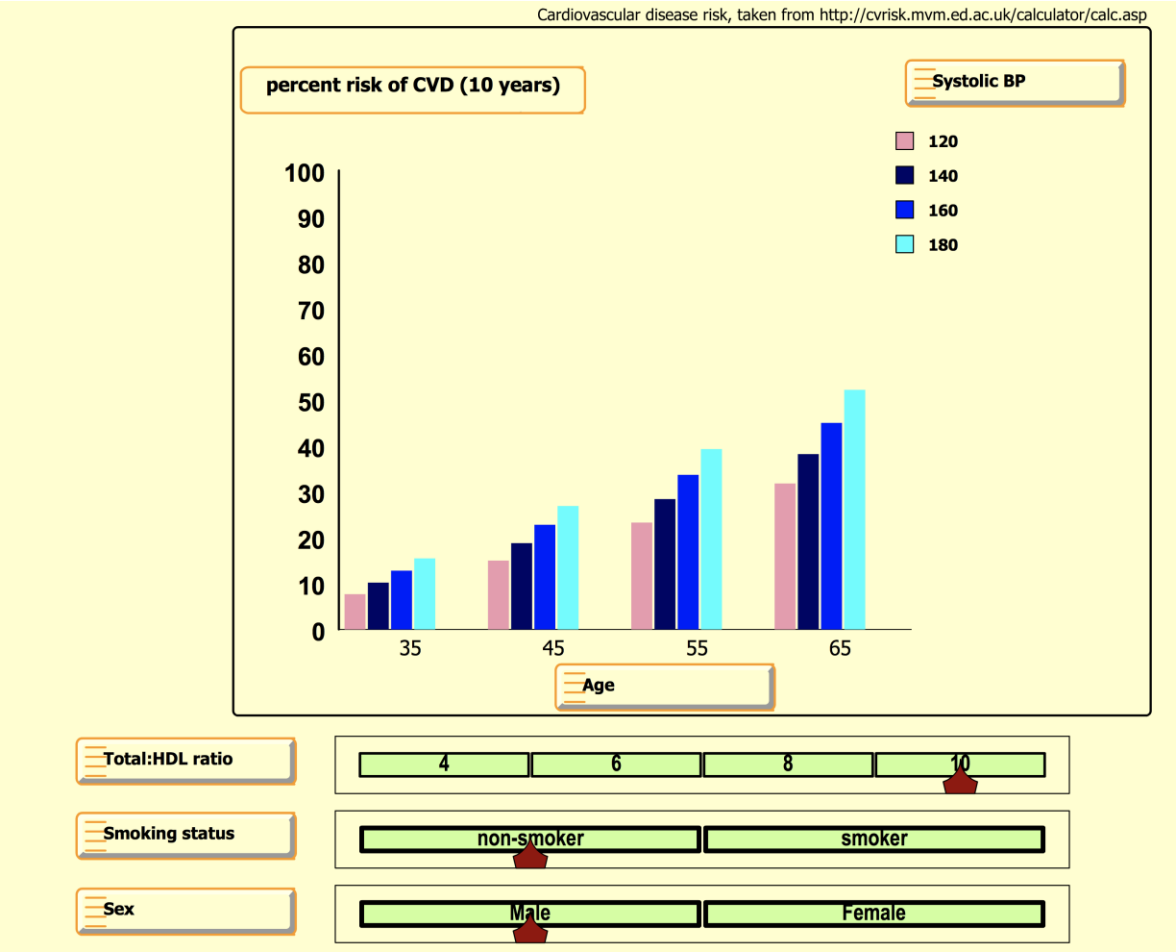
Problem Exploration



Statistical Ideas

- *Heuristic – look at the size of different effects*
- *Heuristic – pay attention to interactions*
- *Heuristic – look carefully at measures*

Decision Making



Evidence should INFLUNCE Decisions

- *Heuristic: externalise your beliefs and theories*
- *Heuristic: think about RISKS and COSTS when making decisions*

From Spiegelhalter (2005)

- Risk-adjusted 30-day mortality rates for coronary artery bypass grafts performed in New York State (1997–99) for 175 surgeons
- Funnel plots for comparing surgical performance, showing 95% and 99.8% control limits

- Who would YOU choose?

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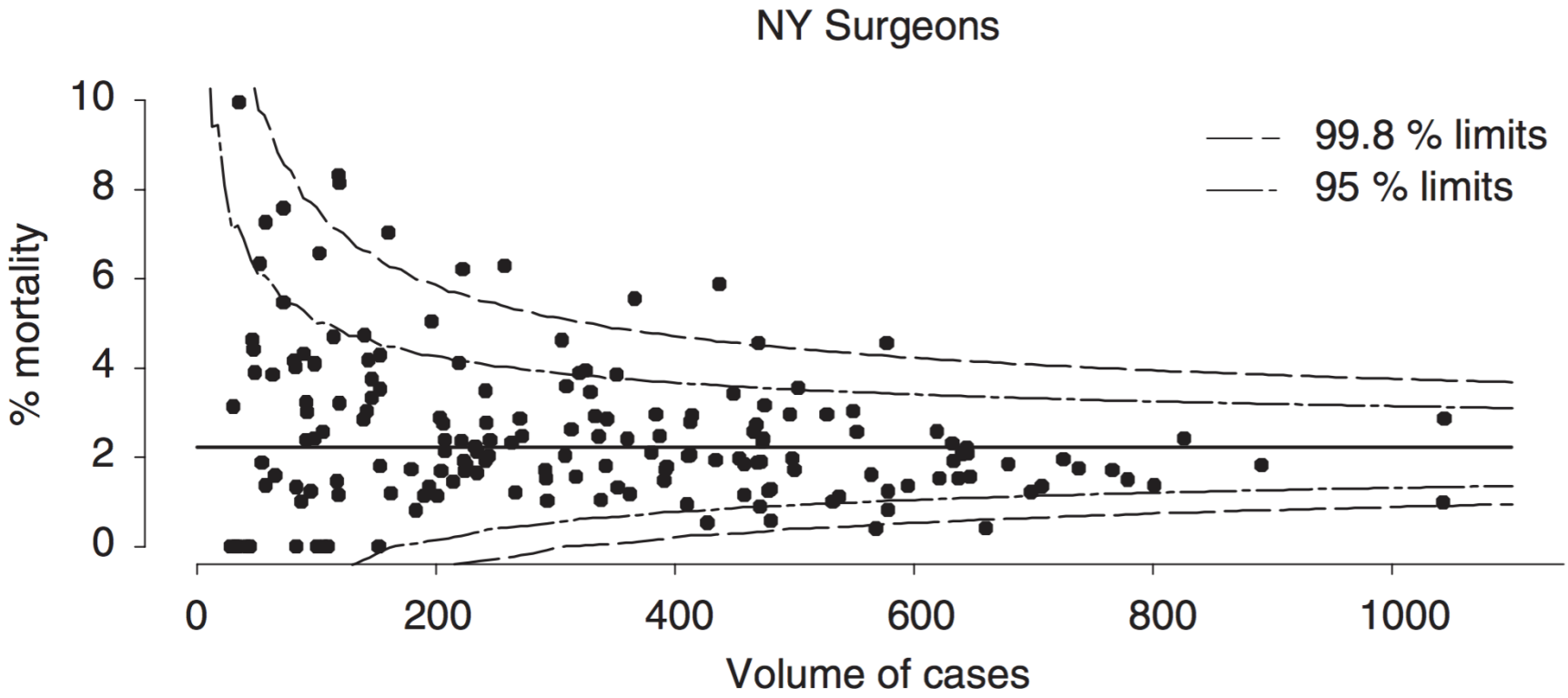
Decision Making



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Statistical Ideas

- *Heuristic: look for robust evidence – sample size IS important*

Opportunities to Introduce Core Ideas

Measurement
Central tendency
Probability
Indices
Time series

Measurement: measures have different properties

- The international standard of *extreme poverty* - an income of less than 1$ a day (UNESCO, 2016)
- UK *relative poverty* - if household income is below 60% of the median household income (Department for Work and Pensions, 2014)

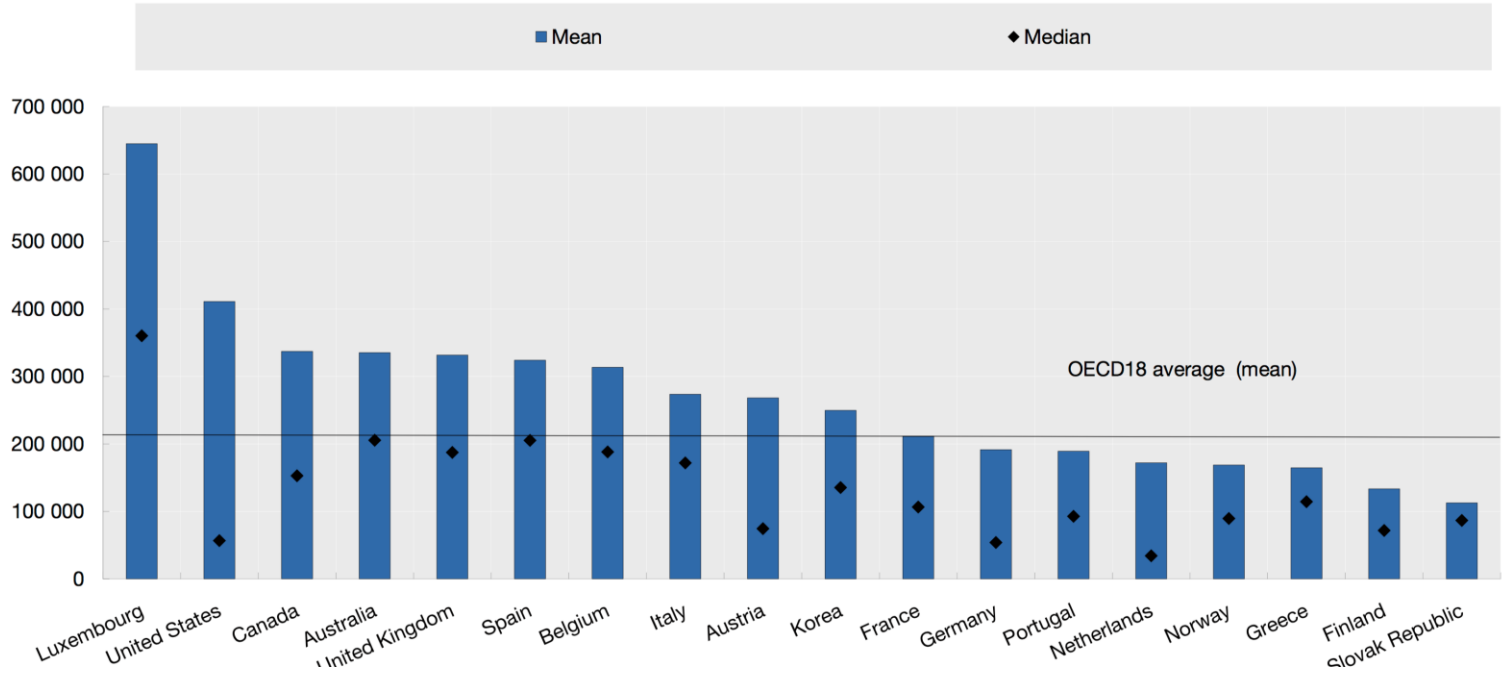
- ???? So if a county's economy is destroyed…

Central Tendency

- Why Donald Trump Won?

Means and Medians – from OECD

Figure 1. **Mean and median net wealth per household in selected OECD countries**
2010 or latest available year, values in 2005 USD PPPs



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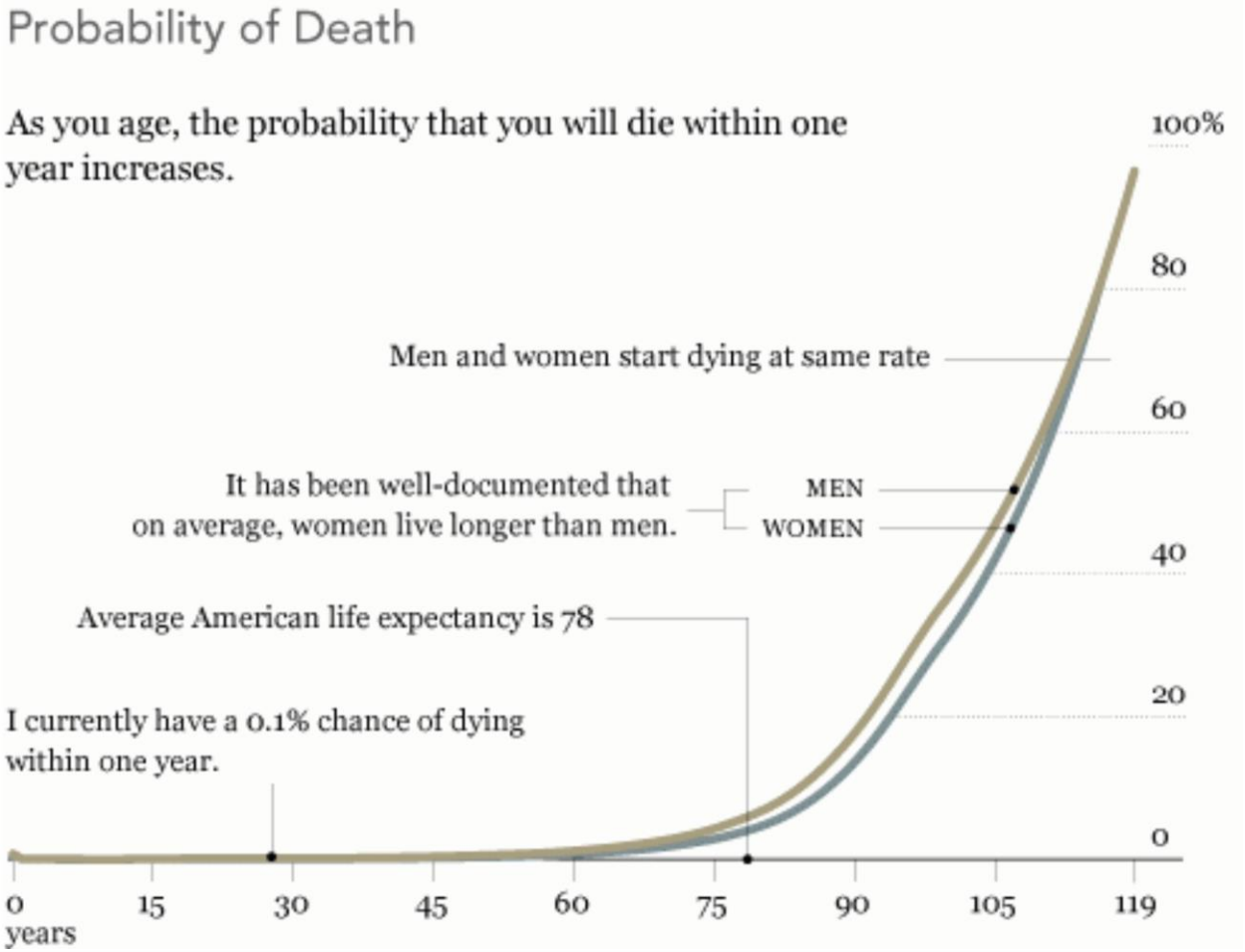
Probability

Jim is an American in average health for his age

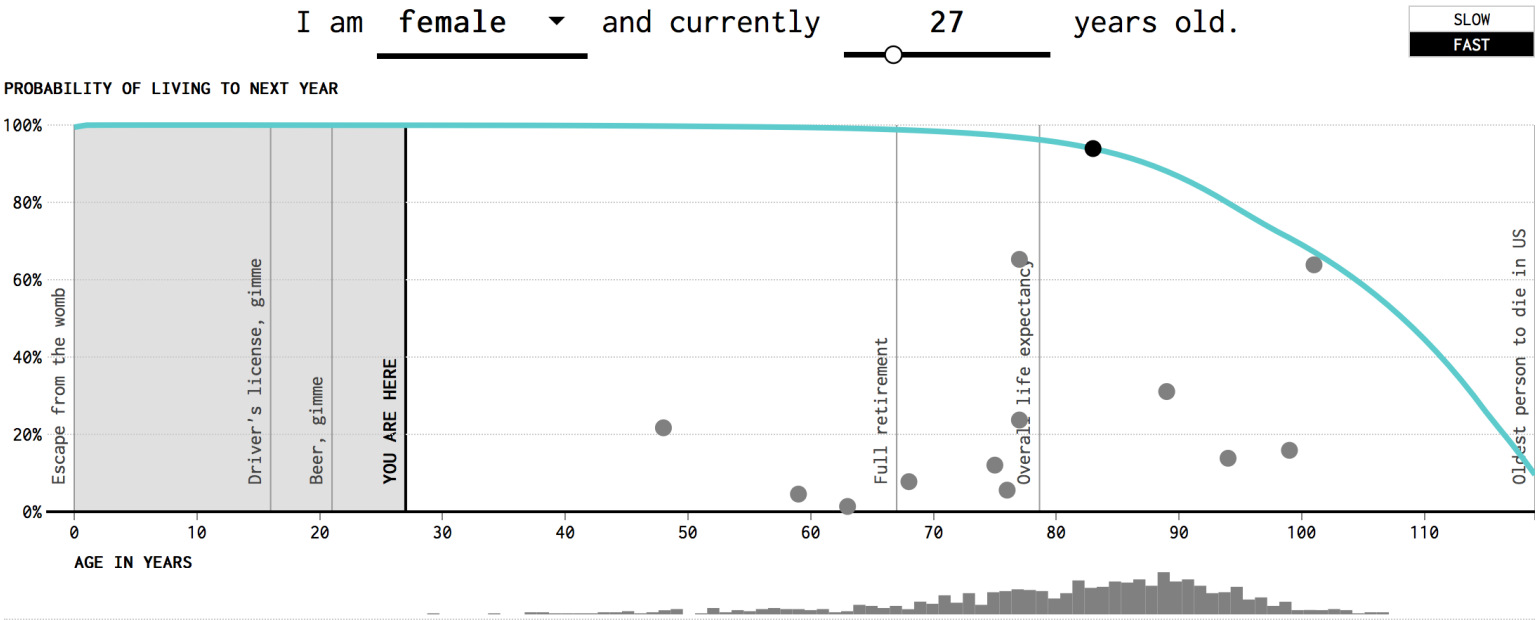
Next year, Jim has a 50% chance of death

How old is Jim?

50% chance of death next year?



Probability Density

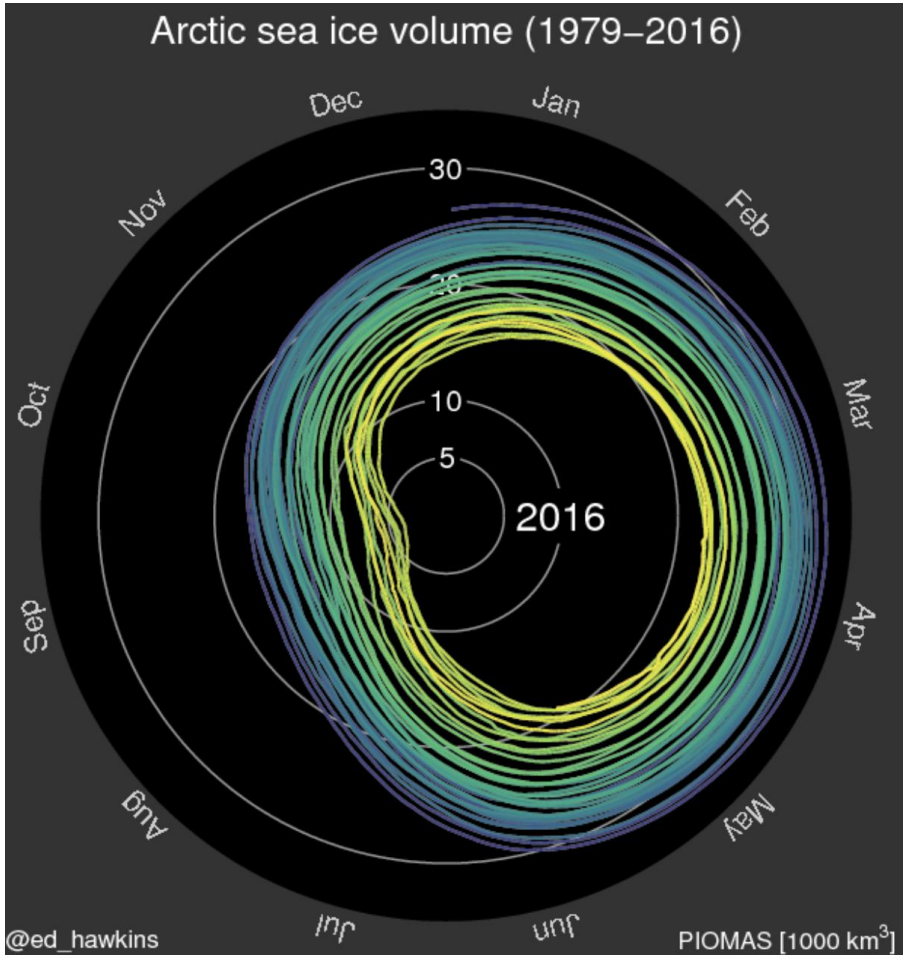


Probabilities For Years Left to Live

0 to 9	10 to 19	20 to 29	30 to 39	40 to 49	50 or more
0%	2%	3%	6%	15%	74%
(2)	(15)	(28)	(52)	(120)	(605)

Indices: OECD Better Life

Global Warming



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George Cobb (2015) *Am Stat*

- Our territory – thinking with and about data – is too valuable to allow old curricular structures to continue to sit contentedly on their aging assets while more vigorous neighbours take advantage of our latest ideas (p267)
- ...we will need an extended period of ferment, experimentation, and setting out to reach a new concensus... (p273)

Thank you for your attention

תודה על תשומת הלב שלך

Danke für ihre Aufmerksamkeit

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Obrigado pela sua atenção

Köszönöm a figyelmet

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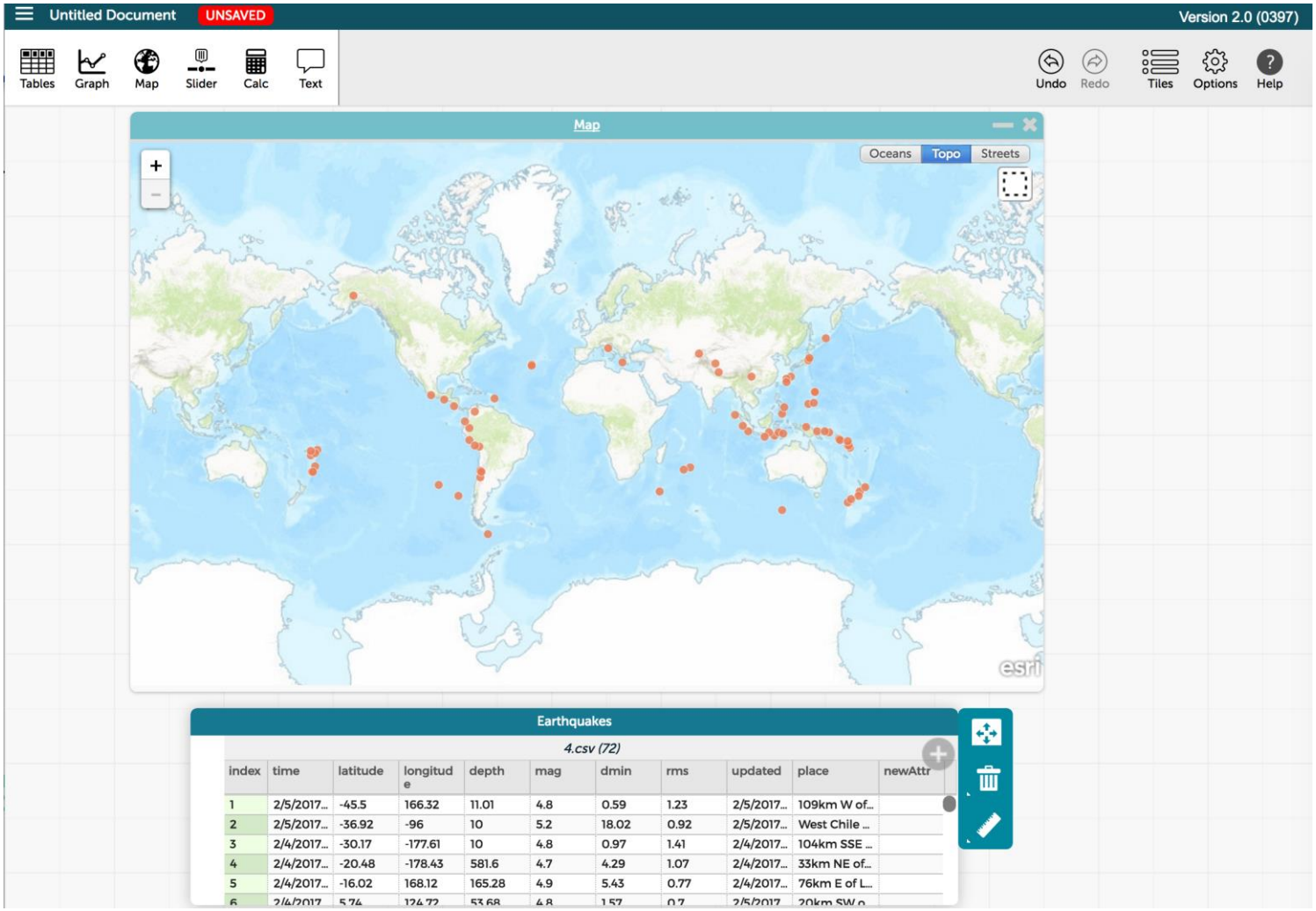
Data Science with CODAP



index	time	latitude	longitude	depth	mag	dmin	rms	updated	place	newAttr
1	2/5/2017...	-45.5	166.32	11.01	4.8	0.59	1.23	2/5/2017...	109km W of...	
2	2/5/2017...	-36.92	-96	10	5.2	18.02	0.92	2/5/2017...	West Chile ...	
3	2/4/2017...	-30.17	-177.61	10	4.8	0.97	1.41	2/4/2017...	104km SSE ...	
4	2/4/2017...	-20.48	-178.43	581.6	4.7	4.29	1.07	2/4/2017...	33km NE of...	
5	2/4/2017...	-16.02	168.12	165.28	4.9	5.43	0.77	2/4/2017...	76km E of L...	
6	2/4/2017	5.74	124.72	53.68	4.8	1.57	0.7	2/5/2017	20km SW o	

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