Statistics Road Tour 2012

Changing Needs in a Changing World

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DEPARTMENT OF STATISTICS

The data world …
is getting a whole lot bigger

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- There is an explosion in the …
  - quantities of data being collected
  - conceptions of what constitutes data
  - settings in which it can arise
  - ways of looking at it

Further, Faster, Better

- Data world exploding
- Green shoots in Software
- Vision
- Future is visual
- Accelerators

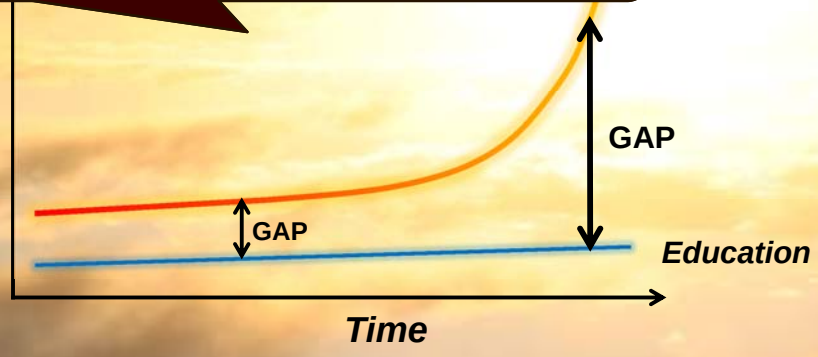
The data world …
is getting a whole lot bigger

Can't just keep illuminating same small patch

- Need to get much …
  - *further*
  - *faster*
  - & with ***better*** *comprehension*

A Growing Gap

Need to **increase the speed** with which we can **open up the world of data**
- But moving slowly enough that teachers can deal with the changes

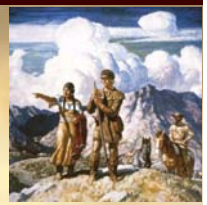


Where did New Curriculum come from?

- Most thrashed out 6 years ago
  in large consultative group organised by NZ Stats Assoc's Ed Committee involving:
  - professional statisticians
  - university lecturers in statistics
  - experienced practicing teachers
  - teacher educators and teacher developers
- volunteers working in their spare time under extremely tight, officially-imposed, time constraints

Where did New Curriculum come from?

It was forward looking



- to the best of our abilities at the time
  - potential to remain in force for a long time
    (Last curriculum sealed in at Year 13 level for ~ 20 years)

Endeavours to emphasise the fundamentals of the subject

- **Big ideas**
  - which will not change with time

  ahead of the details of the ways things are done
  - which are continually changing

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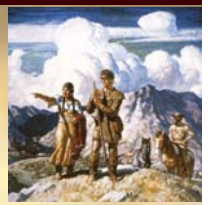

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From **"putting numbers into formulae"** to **"conceptual understandings"**
- help enable them to start "thinking about data like a statistician"

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If the new curriculum could not …

- **adapt to the rapidly increasing expansion** of the **world of data**
- **reflect the ways in which computers dominate statistics & are continuing to revolutionise it**
  - (Causes some problems temporarily that we collectively have to find ways to work around)

then it would quickly **sink into irrelevance**

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It helps that "Getting the numbers" moving from the main part of what students have to do to a fairly trivial part

Some of the changes

- All serious statistical analysis uses computers
  - Only real defence for by-hand procedures is to help better understand something done on a computer
    - So educational emphasis shifts from "*how to get the numbers*" to "*discovery through data*"
      - See Handout ***"Confidence Intervals: What matters most?"***
- Statistics is moving much more towards
  - Visualisations via computer graphics
  - Modern computer-intensive inference methods
    - esp. bootstrap and randomisation

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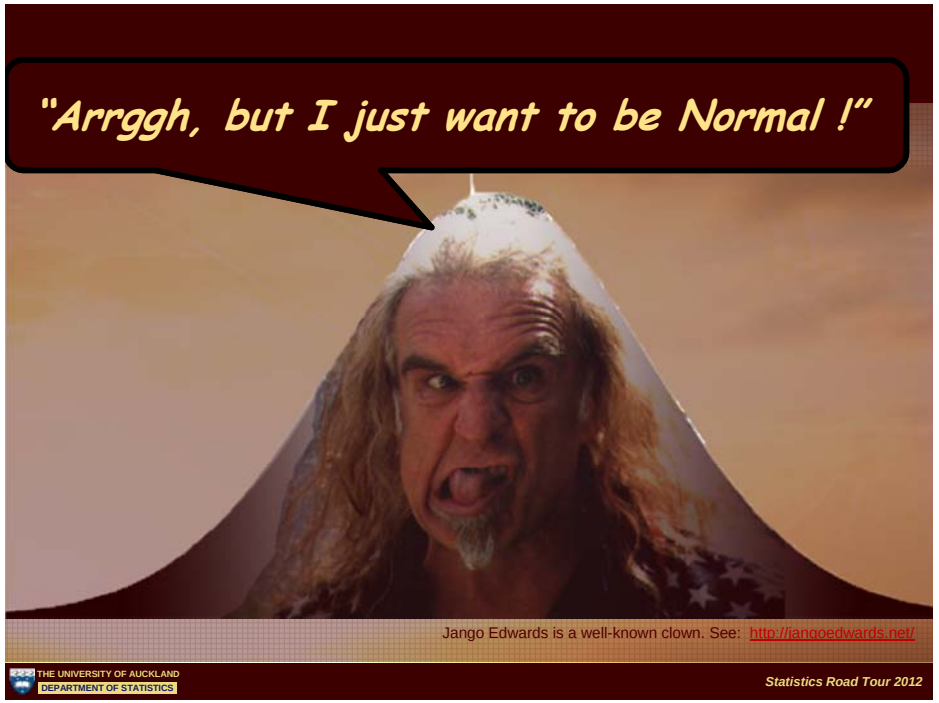
...dout ***"Confidence Intervals: What matters most?"***

Google's Tim Hesterberg (2006) … bootstrapping and randomisation "increasingly pervade statistical practice. They offer ease of use: the same basic procedures can be used in a wide variety of applications, without requiring difficult analytical derivations. This frees statisticians to use a wider range of methods, not just those for which easy formulas for confidence intervals or hypothesis tests are available."



Jango Edwards is a well-known clown. See: http://jangoedwards.net/

Bootstrap

- Brainchild of **Stanford University's Brad Efron**
  - On virtually anyone's list of the 20th century's greatest statisticians and his biggest contribution
- Justified by both high-powered mathematical theory (hundreds of theoretical papers) & extensive computer simulation
- Enables us get further into data world more quickly
  - The most generally applicable method there is of generating confidence intervals
    - Single idea can use for vast majority of quantities of interest
      - e.g. medians, proportions, quartiles, measures of spread (e.g. interquartile ranges), differences in means, medians and proportions, ratios of spreads, regression slopes, correlations and many, many more besides

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Because the bootstrap is much more general the mathematics is much harder

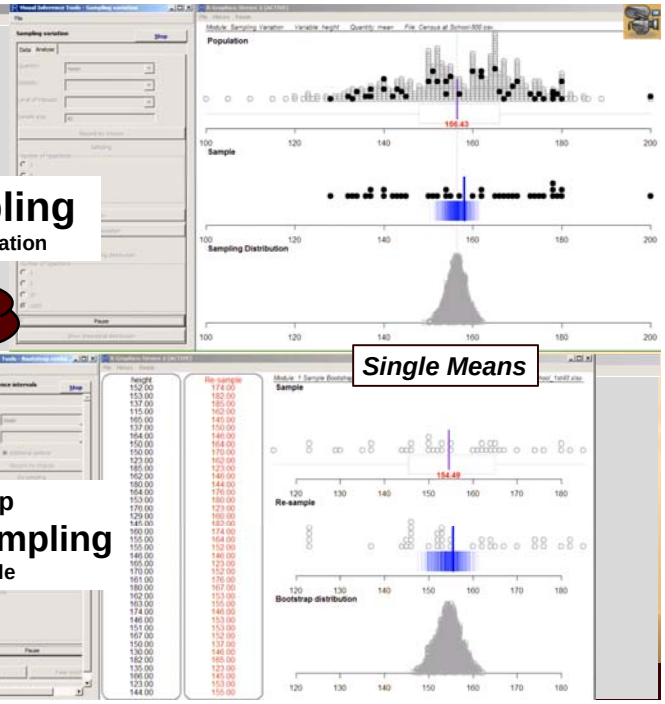
Contrast to methods based on distributional assumptions (e.g. normal) where need to learn a different recipe for each new thing you want to do

Bootstrap
- Sampling with replacement
  - What is it?
  - What does it do?
  - How could we use it?
  - Why might it work?
- Constructing Bootstrap intervals
- Does it work?

Sampling
from population

Looks very similar

Bootstrap Re-Sampling
from sample



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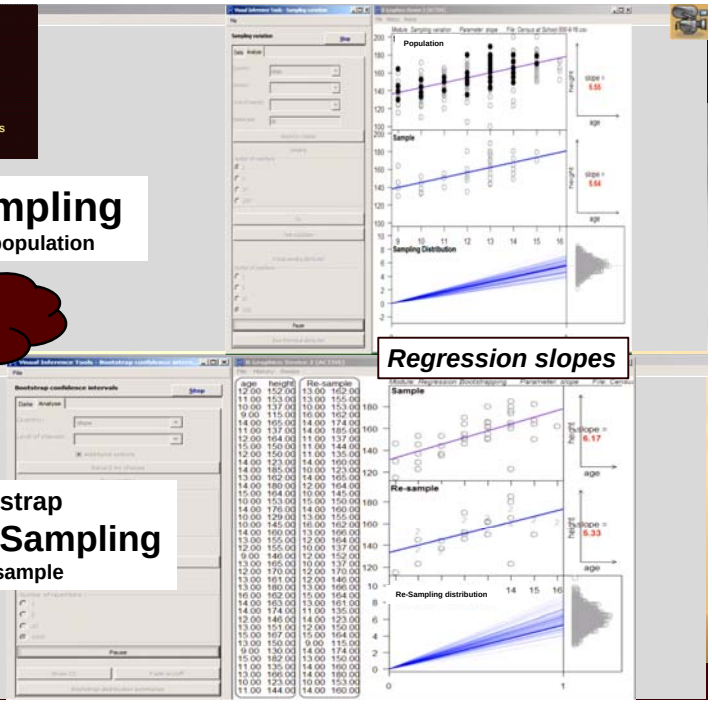

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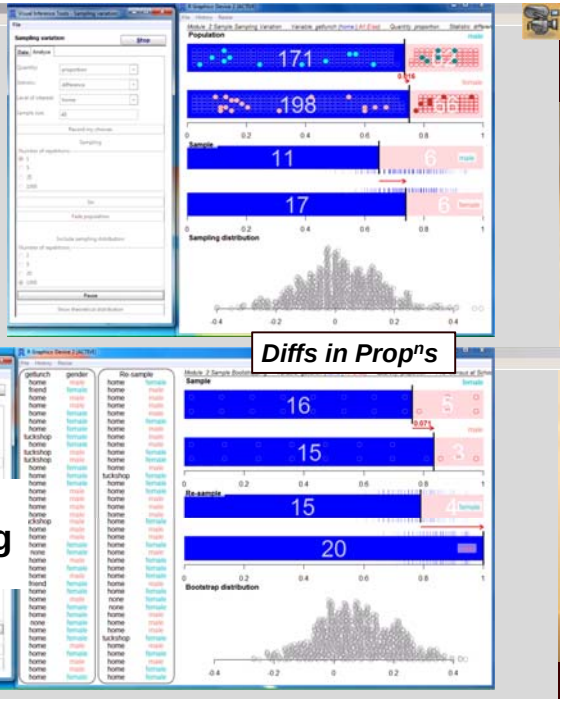

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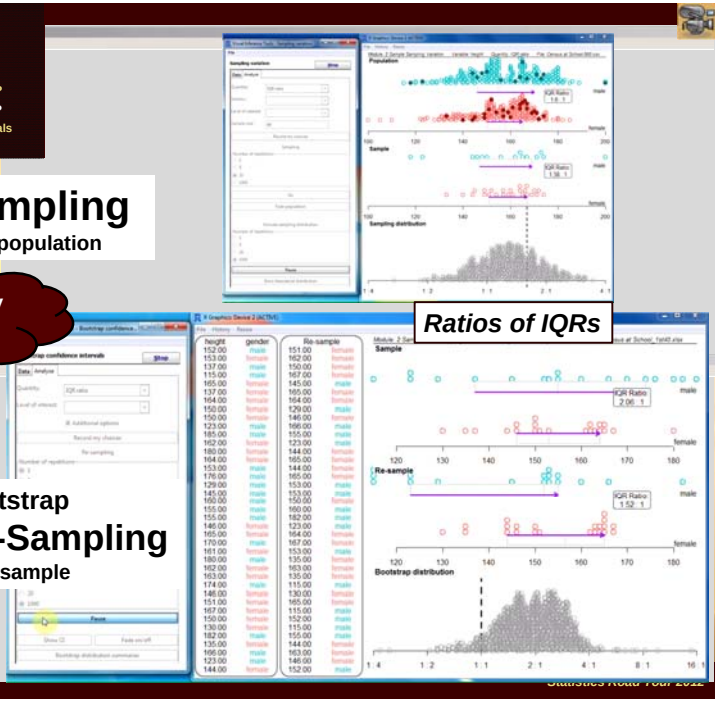

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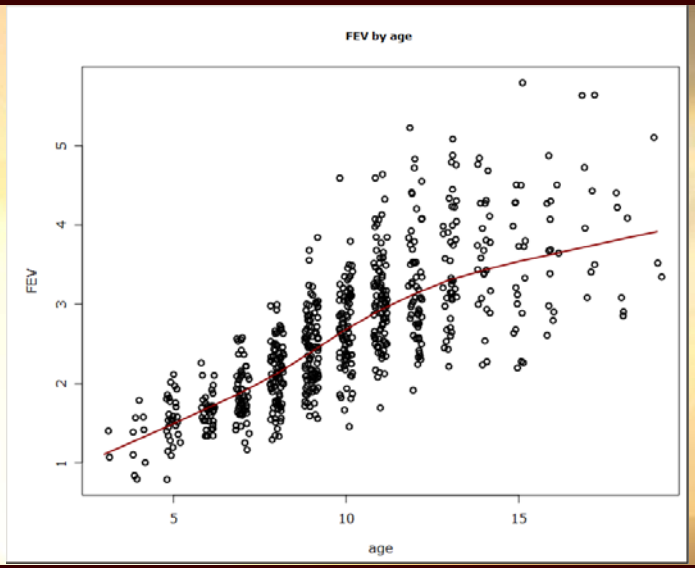
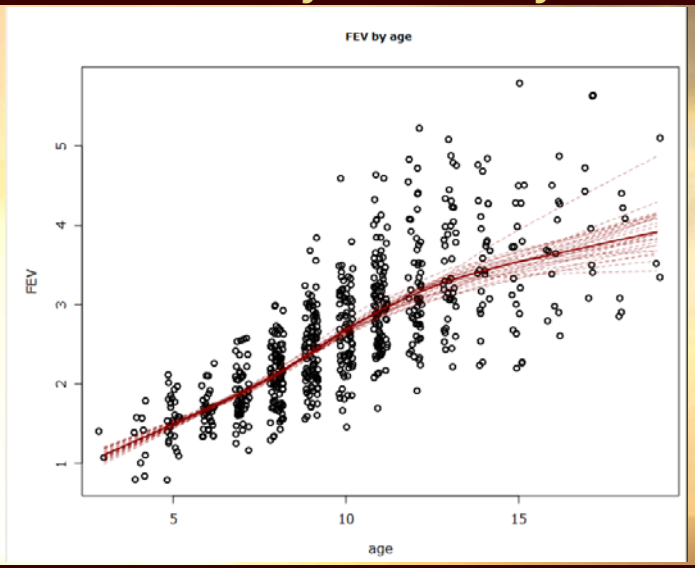
More complex: Scatterplot with smoother



Bootstrap smooths added to convey uncertainty



Bootstrap

- Justified by both high-powered mathematical theory (hundreds of theoretical papers) & extensive computer simulation
- Can get much further into data world more quickly
- Easier to understand
  - More transparent relationship between problem we are trying to solve and method of generating intervals
  - Gives better grounding in “the logic of inference”

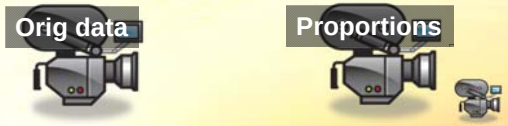
Bootstrap

- Justified by both high-powered mathematical theory (hundreds of theoretical papers) & extensive computer simulation
- Can get much further into data world more quickly
- Easier to understand
- Not reliant on distributional assumptions
- Gives same CIs in the most familiar problems

  (modulo notes on handout)
- Standard tool for very hard problems

Randomisation test visualisations

Can random labelling alone ("*chance alone*") produce differences as large those as I'm seeing?



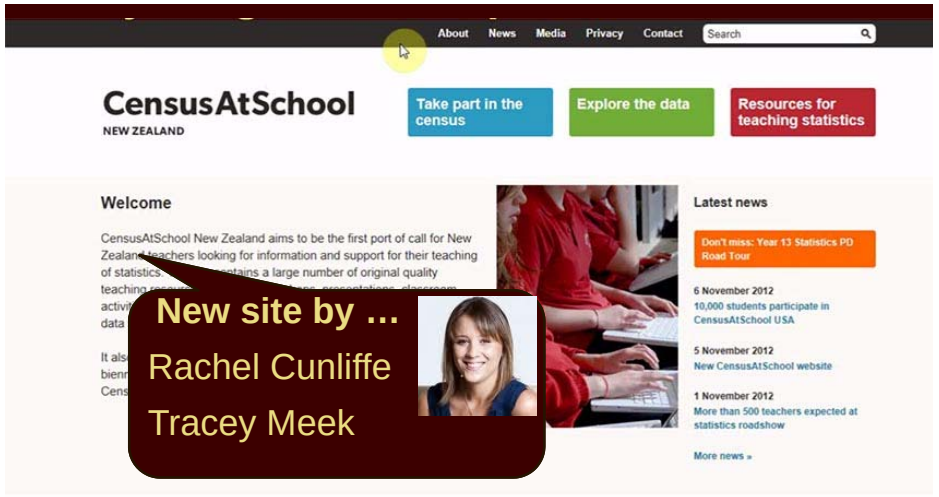
We are in transition

But people in ... are using ...

- Leadership in change comes from centre of the field
  - takes time to percolate out to the peripheries
- Anyone who will do substantial statistical analyses will take some statistics at university
  - Many more do
    - 2 out of every 3 students coming to UoA do at least 1 stats paper
  - UoA is teaching both computer-intensive and traditional and the links between them in 1st year
    - Finding the traditional makes more sense built on the better grounding in the logic of inference from boo & randomisation

This is new for us too

~Everything will end up on Census At School



Thank you