STATISTICAL LITERACY
and
STATISTICAL COMPETENCE
in the
NEW CENTURY

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- THE ENVIRONMENT
- THE NEW LITERACY
- THE NEW COMPETENCE
- THE NEW PROFESSIONALISM

THE ENVIRONMENT

- **The intellectualizing of work**

  $\Rightarrow$ Need analytical, quantitative, computing skills

  $\Rightarrow$ Need interpretive, communication skills

  $\Rightarrow$ Multiple jobs, multiple careers

  $\Rightarrow$ **Need statistical skills?**

THE ENVIRONMENT

- **The democritization of education**

  Tertiary education is now replacing secondary education as the focal point of access to rewarding careers.

  OECD Education at a Glance 2000

- **University for the masses**

	Tertiary A entry rate, 1999	% Change 1990–1997
Australia	45%	+31%
Japan	37%	na
Korea	43%	+66%
New Zealand	71%	+43%
United Kingdom	48%	+101%
United States	45%	+8%

OECD Education at a Glance 2000, 2001

THE ENVIRONMENT

- **Nonstop education and training**

  Adults ages 25–64 in formal job-related continuing education:

	All adults	University educated
Australia	43%	64%
Canada	22%	33%
New Zealand	38%	62%
United Kingdom	40%	70%
United States	35%	47%

OECD Education at a Glance 2001

THE ENVIRONMENT

> Tertiary institutions will be challenged not only to meet growing demand through an expansion of places offered, but also to adapt programmes, teaching and learning to match the diverse needs of the new generation of students.
>
> OECD Education at a Glance 2001

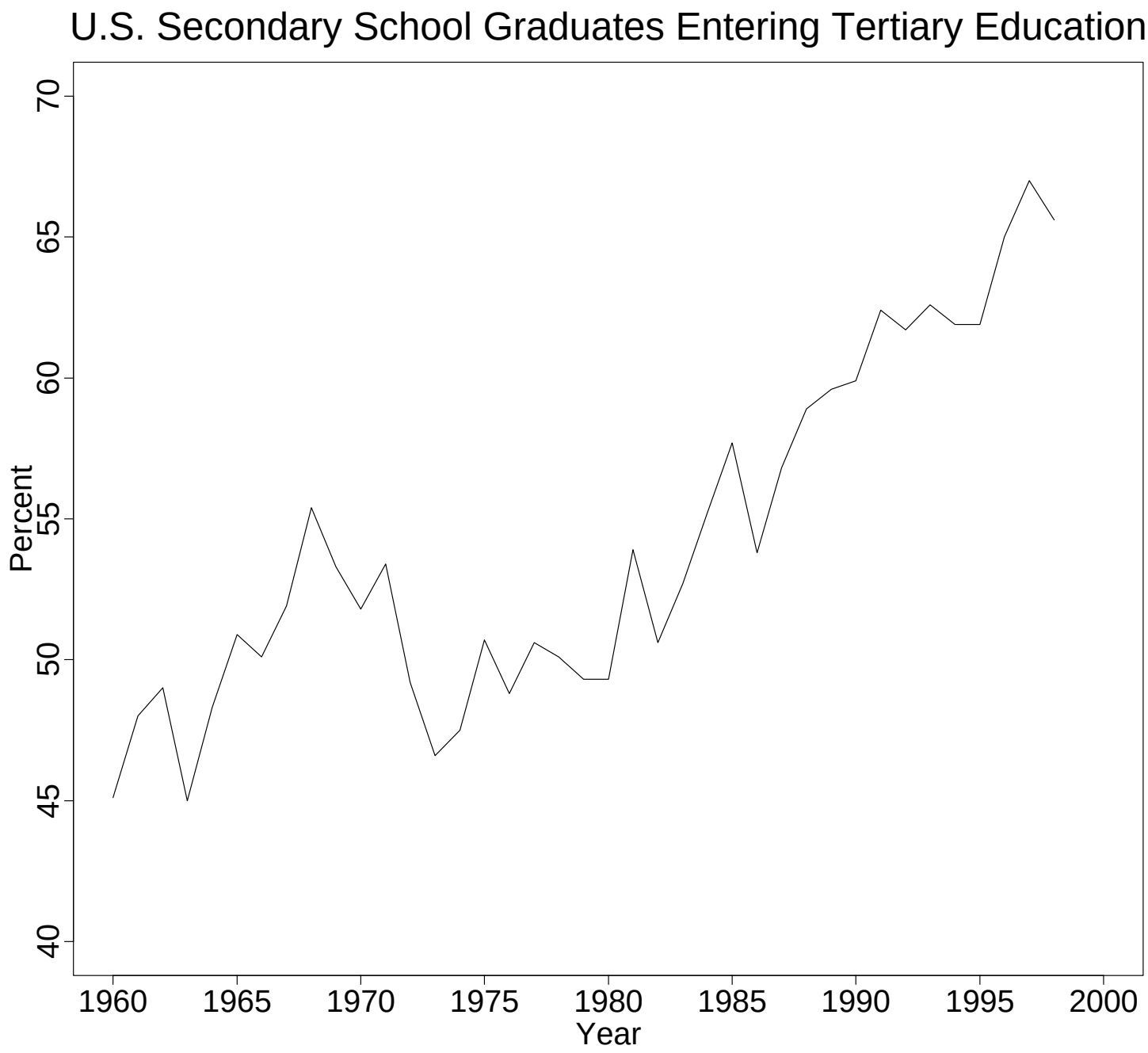
- **University education now**

  $\Rightarrow$ No longer a filter – broader clientele

  $\Rightarrow$ No longer esoteric – link to career

  $\Rightarrow$ Our students are not "us, only younger"

  $\Rightarrow$ **Larger place for statistics.**


U.S. Secondary School Graduates Entering Tertiary Education
Percent
40
45
50
55
60
65
70
1960
1965
1970
1975
1980
1985
1990
1995
2000
Year

WE WANT STATISTICS

- **Elementary Statistics Enrollments**

  $\Rightarrow$ Fall 1995: 236,000 students

  $\Rightarrow$ **Up 38% from 1990**

  $\Rightarrow$ Fall 2000: 274,000 students

  $\Rightarrow$ **Up another 16%**

- **Advanced Placement Statistics**

1997: 7,500 exams	2000: 35,000 exams
1998: 15,500 exams	2001: 43,000 exams
1999: 25,000 exams	

THE ENVIRONMENT

- **Wisdom from research in math education**

  $\Rightarrow$ Students learn by their own activities

  $\Rightarrow$ Understanding and procedures are separate domains: Drill only teaches drilling.

  $\Rightarrow$ Most people learn from specific to general: The math model doesn't work.

  $\Rightarrow$ **We can't teach a wide audience what we used to think we covered.**

THE ENVIRONMENT

- **A changing discipline**

  $\Rightarrow$ Technology

  $\Rightarrow$ Back to data, back to science

  $\Rightarrow$ Interdisciplinary emphasis

- **Technology**

  $\Rightarrow$ Drives changes in the discipline

  $\Rightarrow$ Drives demand for quantitative skills

  $\Rightarrow$ New content emphases

  $\Rightarrow$ New learning tools: The next big change?

  $\Rightarrow$ The information flood

This Is a Revolution

Something momentous is happening, something far more consequential than a mere technological innovation. The last time we experienced such an innovation was the invention of the printing press almost half a millennium ago.

Gertrude Himmelfarb

THE NEW STATISTICAL LITERACY

- **Data beat anecdotes**

  $\Rightarrow$ Power lines and childhood leukemia

  $\Rightarrow$ Will our children be better off?

- **. . . and intuition**

  $\Rightarrow$ General Electric appliance delivery

- **. . . and even "experts"**

  $\Rightarrow$ For every Ph.D., there is an equal and opposite Ph.D.

THE NEW STATISTICAL LITERACY

- **Think broadly: Is this the right question?**

  $\Rightarrow$ Who is unemployed?

- **Think broadly: Does the answer make sense?**

  $\Rightarrow$ "Only 15% of new entrants into the work force will be native white males."

- **Communication: Can you read a graph?**

  $\Rightarrow$ France in a population pyramid

THE NEW STATISTICAL LITERACY

- **Only big ideas need apply (details automated). One cluster:**

  $\Rightarrow$ The omnipresence of variation

  $\Rightarrow$ **Conclusions are uncertain**

  $\Rightarrow$ Avoid inference from short-run irregularity

  $\Rightarrow$ Avoid inference from coincidence

The rule for staying alive as a forecaster
is to give a number or give a date, but
never give both at once.

Jane Bryant Quinn

THE NEW STATISTICAL LITERACY

- **Big ideas: Another cluster:**

  $\Rightarrow$ Beware the lurking variable

  $\Rightarrow$ Association is not causation

  $\Rightarrow$ Where did the data come from?

  $\Rightarrow$ Observation versus experiment

- **Filters for nonsense: Triage on the information flood**

  $\Rightarrow$ The Bible Code predicts the future?

It's easy to lie with statistics. But it is easier to lie without them.

Frederick Mosteller

THE NEW STATISTICAL COMPETENCE

- **Use automated tools gracefully**
- **What can't be automated?**
- **Keep thinking broadly**
- **Statistical thinking (ASA/MAA)**

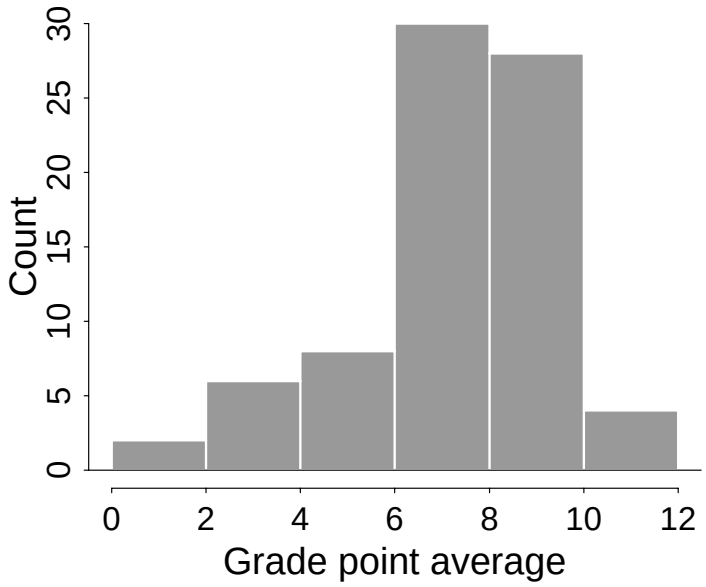
  $\Rightarrow$ The need for data

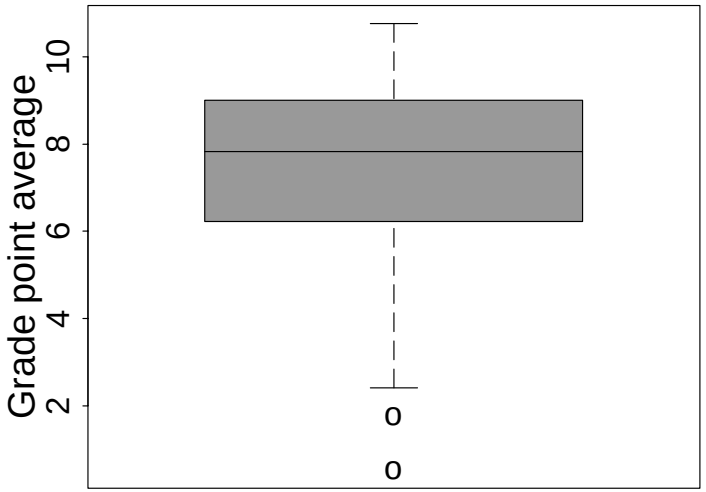
  $\Rightarrow$ The importance of data production

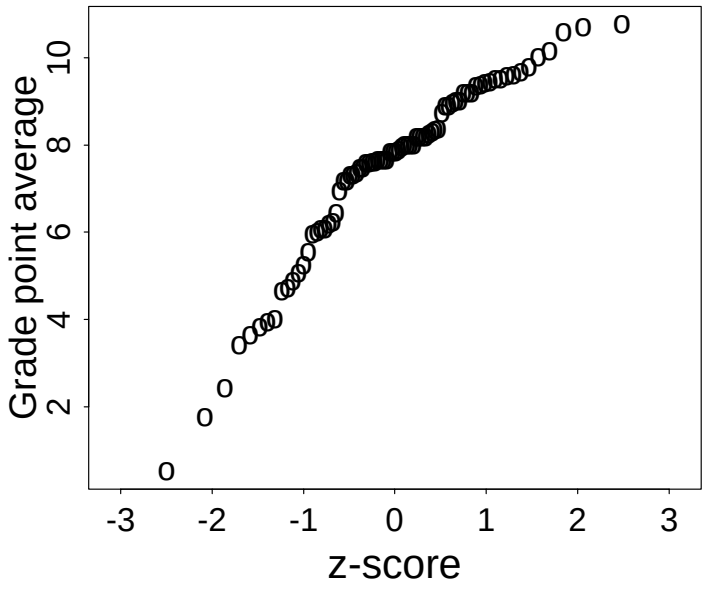
  $\Rightarrow$ The omnipresence of variability

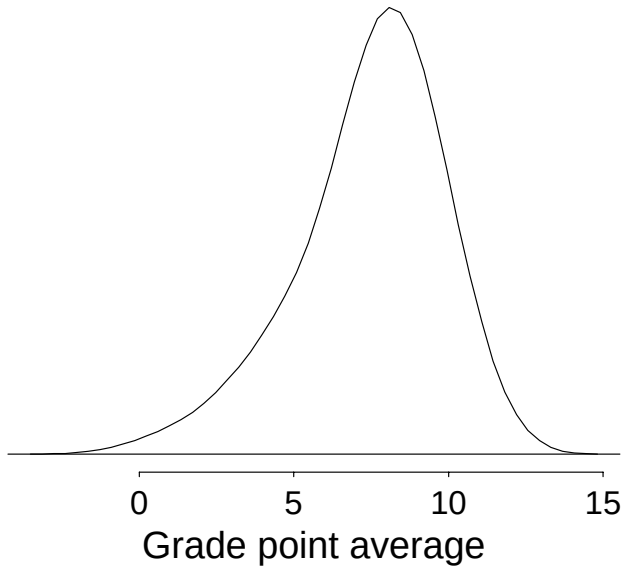
  and . . .

Use Automated Tools Gracefully: An Example









THE NEW STATISTICAL COMPETENCE

⇒ **The quantification and explanation of variability**

→ Randomness and distributions

→ Patterns and deviations (fit and residual)

→ Mathematical models for patterns

→ Model-data dialog (diagnostics)

- **This is serious stuff**

⇒ Understanding chance variation

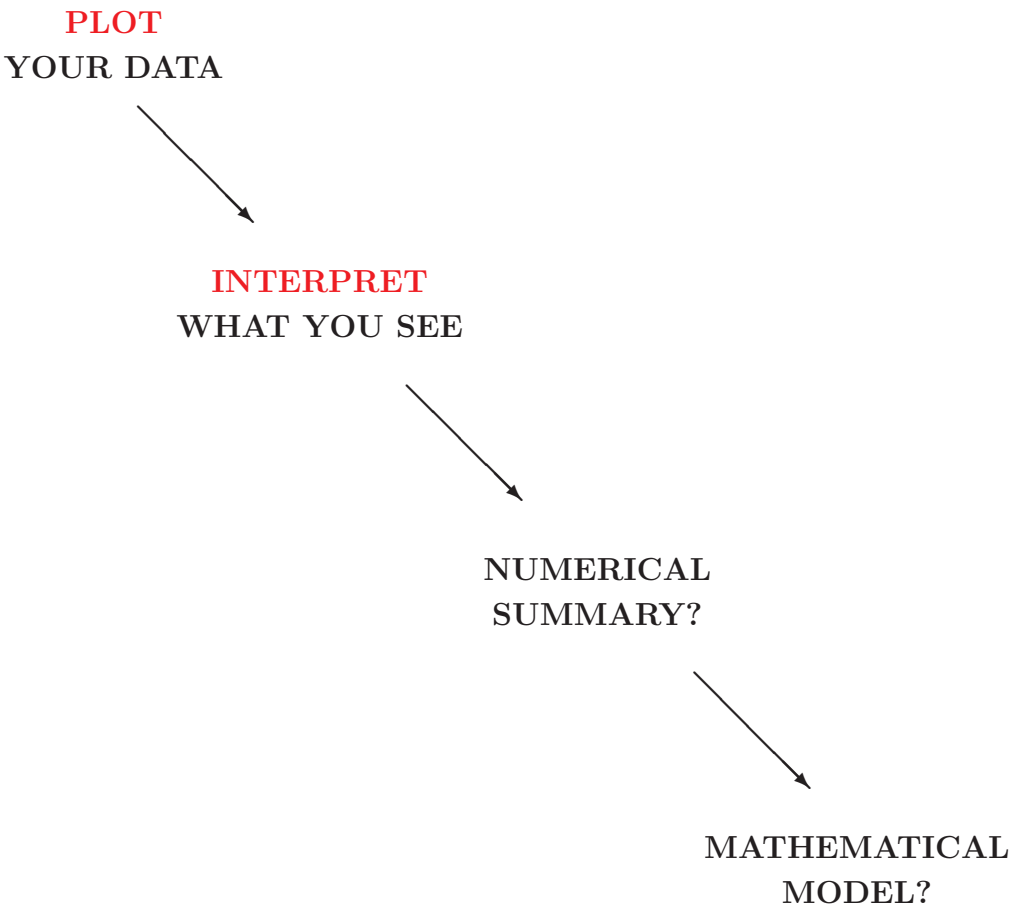
⇒ One pass through software isn't enough

⇒ Models as interpretive tools

⇒ Strategies, not just methods

THE NEW STATISTICAL COMPETENCE

- Data strategies: an example



- But you can choose the details to fit your context

CHALLENGES

- **Our teaching is too narrow.**

  > In the past, "quantitative literacy" and "what you learn in mathematics classes" were seen as largely disjoint. Now, however, they should be thought of as largely overlapping.
  >
  > Alan Schoenfeld

- **Is quantitative literacy our turf?**

- **If the rocket goes up, I don't care where it comes down.**

- **Does statistics retain a core?**