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Technology in Statistics Education: Where Have We Been? Where Are We? Where Are We Going?

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GEORGIA SOUTHERN UNIVERSITY

Georgia's large-scale, small-feel research university

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Patricia Humphrey STEMEd 2016

Two quotes to get us started

If we teach today as we taught yesterday, we rob our children of tomorrow.

John Dewey

Technology is anything that wasn't around when you were born.

Alan Kay

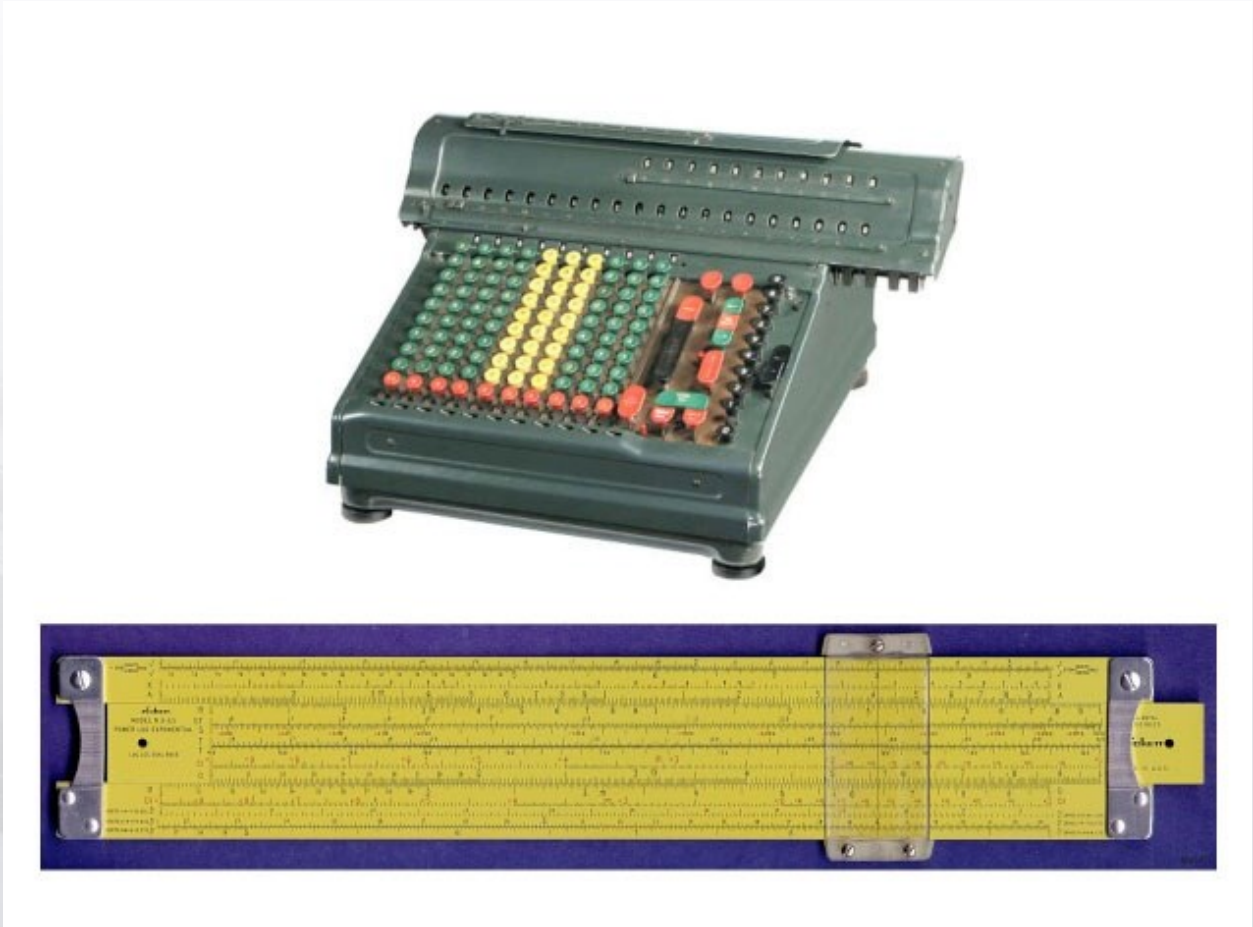
GAISE (2005)

1. Emphasize statistical literacy and develop statistical thinking
2. Use real data
3. Stress conceptual understanding, rather than mere knowledge of procedures
4. Foster active learning in the classroom
5. Use technology for developing conceptual understanding and analyzing data
6. Use assessments to improve and evaluate student learning

GAISE (2016)

1. Teach statistical thinking.
   a) *Teach statistics as an investigative process of problem-solving and decision making*.
   b) Give students experience with multivariable thinking.
2. Focus on conceptual understanding.
3. *Integrate real data with a context and purpose*.
4. Foster active learning.
5. *Use technology to explore concepts and analyze data*.
6. Use assessments to improve and evaluate student learning

Pre “Tech”



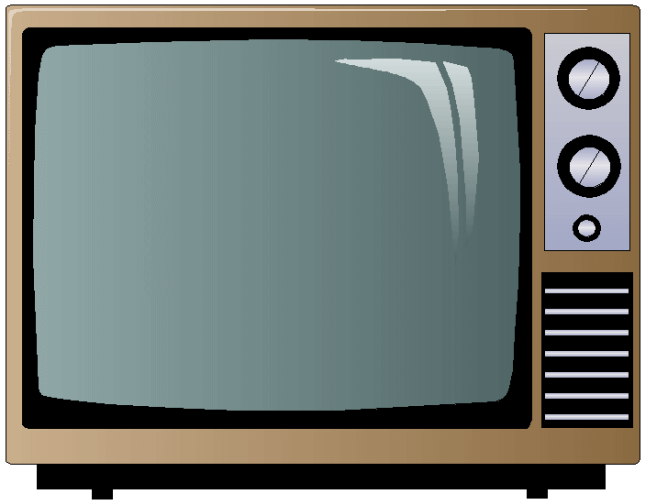
PREHISTORIC PHONES

- Buildings had phones, not people
  - Phones were black, period
  - They looked like this, period

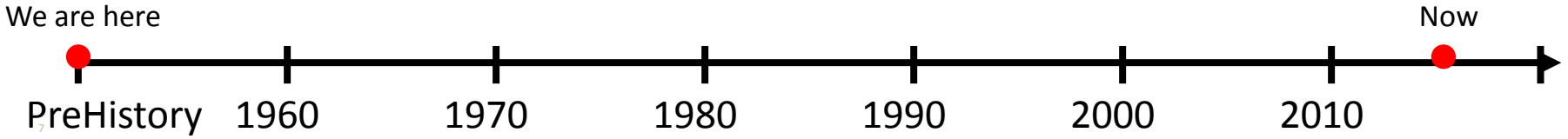
- Pay phones were everywhere
  - And they worked

PREHISTORIC TV

- Each home had exactly 1 B&W TV in the living room
  - All TVs had exactly 3 channels:
    - ABC, CBS, and NBC

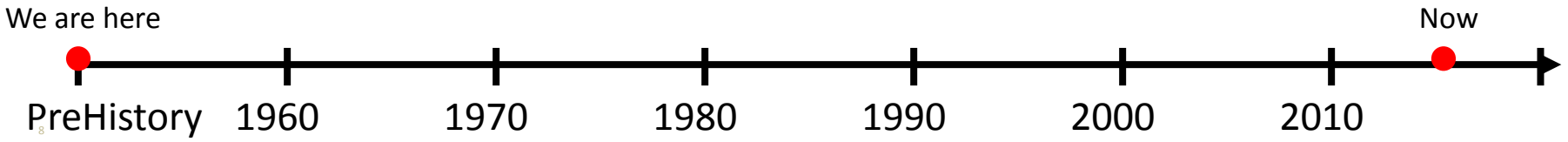


- Restaurants did NOT have TVs
  - Ever



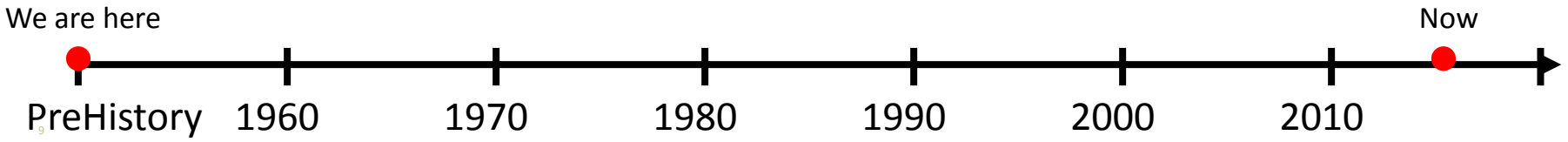
PREHISTORIC COMPUTERS

- Big, like dinosaurs!
- Governments and corporations had them, not people
- Took up an entire floor if not an entire building



THE PREHISTORIC MATH (STAT) CLASSROOM

- **Blackboards**: Yes, one, at the front
- **Desks:** Wood and metal, arranged in rows



4. The grades obtained by 20 students in a short quiz were 9, 4, 7, 6, 10, 10, 5, 9, 7, 10, 3, 10, 9, 8, 9, 10, 6, 8, 4, 6. Find the mean of these grades.

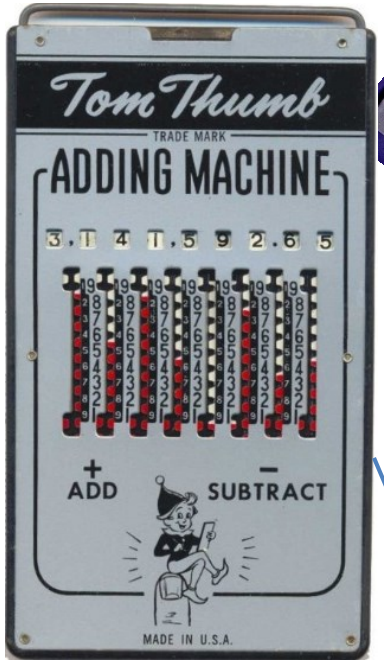
5. The weights of the 39 football players of U.C.L.A.'s 1955–56 squad were:

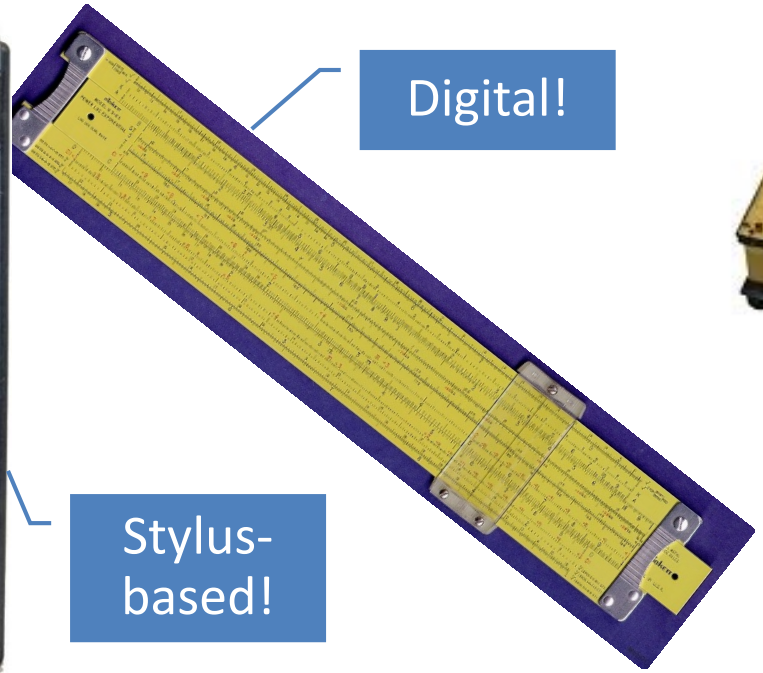
180	174	208	200	185	217	202	218	185	171
187	219	197	172	204	187	231	226	218	212
217	214	219	216	195	192	191	183	173	195
208	172	171	162	173	210	202	191	173	

Find the mean of these weights.

The 1960's:

In the 1960's, calculators were mechanical





Digital!

Stylus-based!

We are here

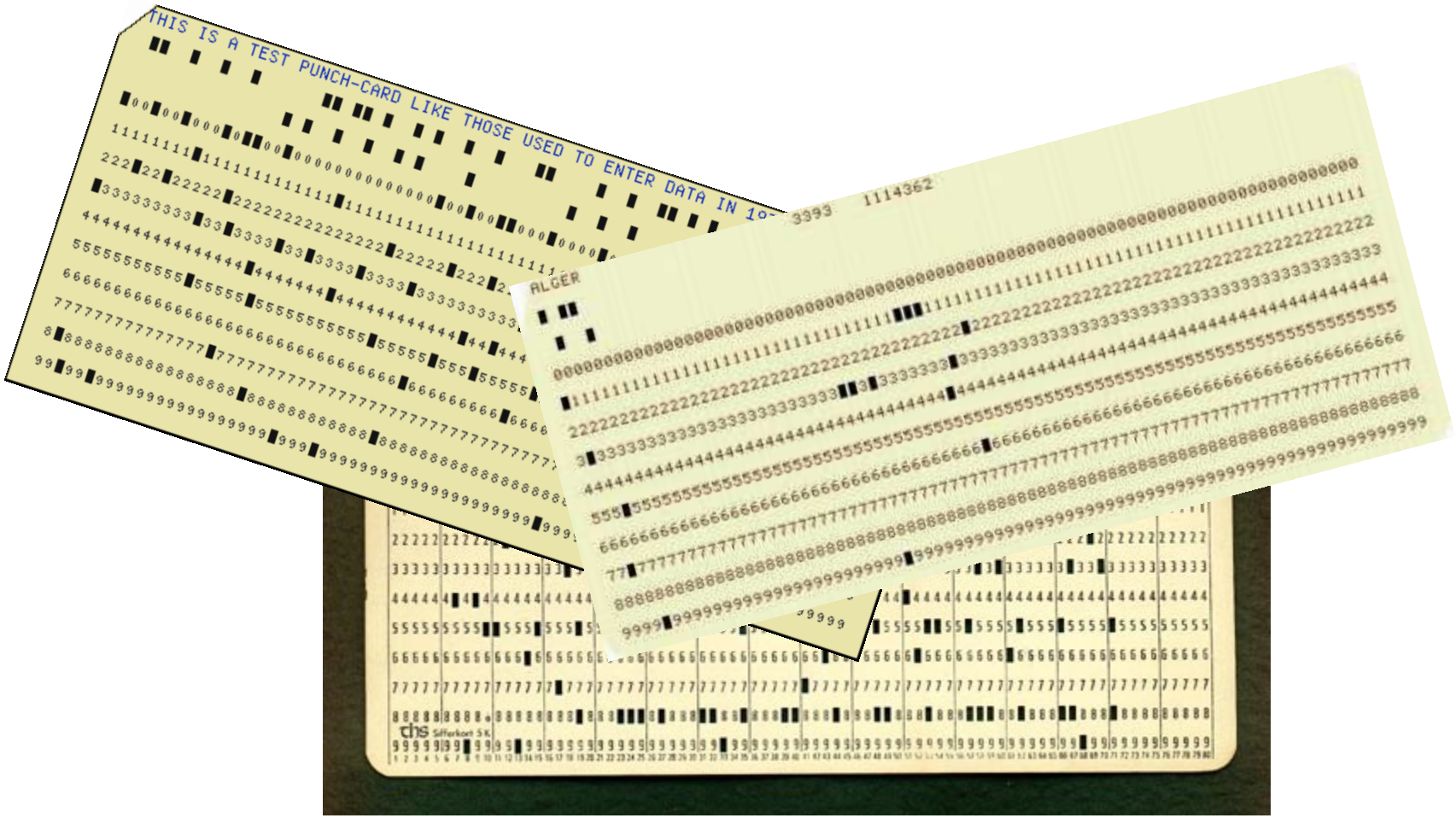
Now

PreHistory 1960 1970 1980 1990 2000 2010

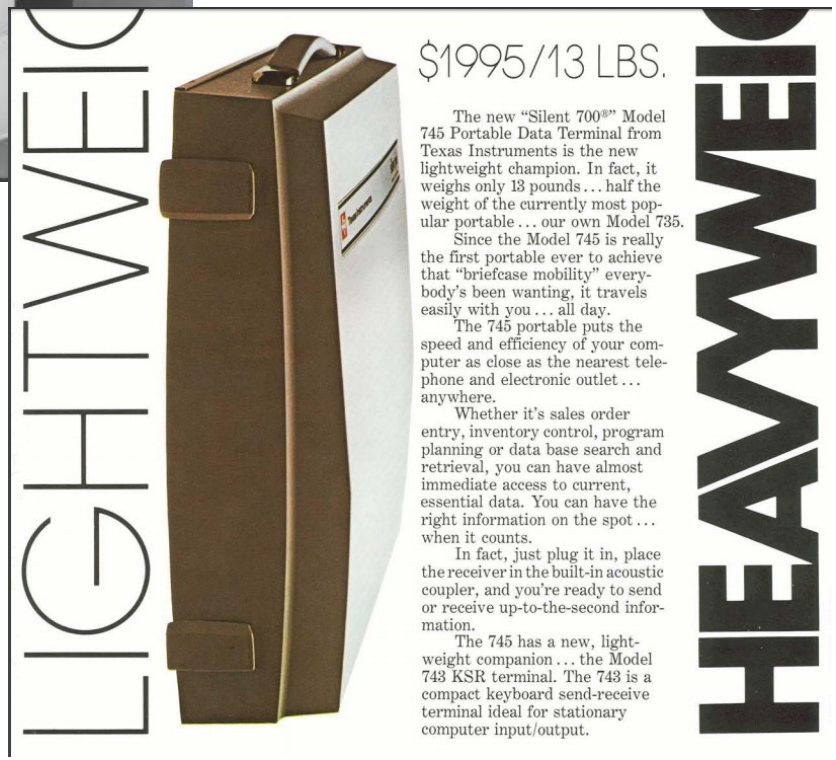
The 1970's:

Calculators and computers

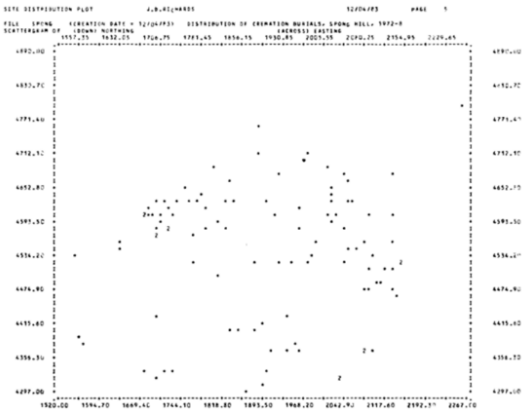
“Serious” Computing

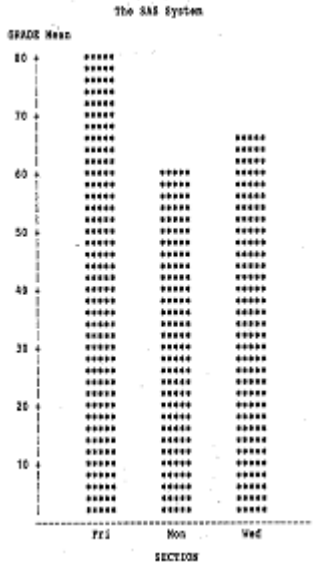


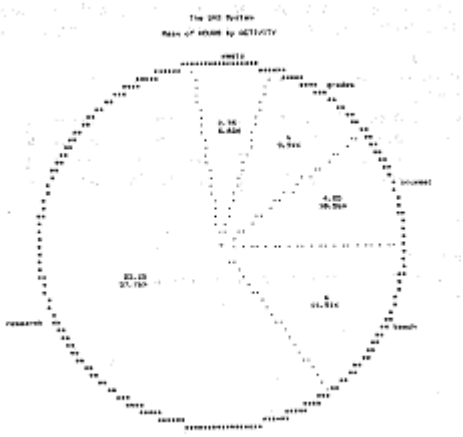
Timesharing!



Graphics?




The SAS System
GRADE Mean
80
70
60
50
40
30
20
10
Fri
Mon
Wed
SECTION



A 1970s text

Display 1.17
Data set for the sixth annual tour of the Rio Grande Valley[a]

OBS	DIST[b]	TOWN[c]	SEX	AGE[d]	TIME[e]	SPEED[f]
1	100	1	M	23	4.9	20.2
2	100	0	F	22	8.3	12.0
3	100	1	M	26	8.0	12.4
4	100	0	M	36	5.7	17.6
5	100	1	M	43	6.1	16.5
6	100	1	M	40	.	.
7	100	1	M	22	.	.
8	100	1	M	17	7.9	12.6
9	100	1	M	29	9.0	11.1
10	100	1	F	46	8.1	12.3
11	100	1	M	33	4.8	21.1
12	100	1	M	25	8.0	12.5
13	100	0	M	54	8.8	11.4
14	.[g]	1	F	27	.	.
15	100	1	F	37	12.4	8.1
16	100	1	M	22	9.3	10.8
17	100	0	M	40	6.8	14.7
18	50	1	F	39	5.6	9.0
19	100	1	M	35	9.1	11.0
20	100	1	M	15	9.8	10.2
21	100	1	F	36	10.7	9.3
22	100	1	M	24	.	.
23	100	1	M	17	.	.
24	75	1	M	9	10.4	7.2

Technology

- With handheld calculators "affordable," many started requiring their use in Stat classes.

The standard function keys that constitute the bare essentials for statistical calculations are $+$, $-$, $\times$, $\div$, x^2, $\sqrt{\ }$ (square root), 1/x (or x^{-1}, the reciprocal), and $+/-$ (change sign). Other features used in the text are parentheses ( ), the exponent function EXP, a memory with keys $x \rightarrow$ M (transfer display to memory), RM (recall memory), M+ (add display to memory). A statistical mode makes possible the convenient computation of the statistical functions $\bar{x}$ (sample mean) and s (sample standard deviation). The El 506 also has the useful feature of displaying n (sample size), Σx (sum of entries), and Σx^2 (sum of squares of entries) in the statistical mode.

“Interesting” Statistics

Midrange $$MR = \frac{Max + Min}{2}$$

Pseudo-standard deviation $$PSD = \frac{IQR}{1.35}$$

“Quick” standard deviation $$\hat{s} = \frac{Max - Min}{4}$$

1980's:

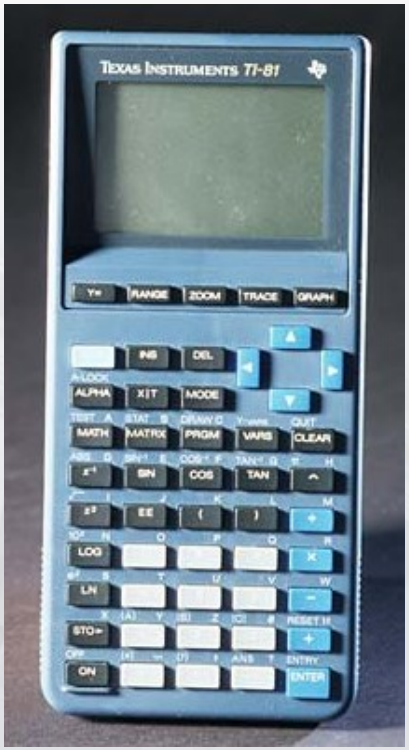
Not much changed (tech-wise).

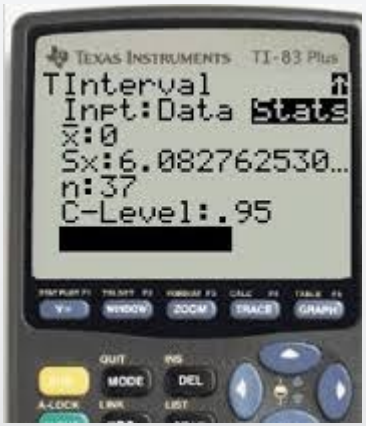
Tech was (possibly) in the hands of the instructor, but PCs were too expensive for students.

Colleges started "computer labs" With dumb mono terminals.

1990's: Going Mobile

1990's: Graphing calculators!





1990's:

Internet really starts. Pretty much text-only.

Texts started emphasizing "concepts" – Moore & McCabe, *Introduction to the Practice of Statistics* (1990)

"Against All Odds – Inside Statistics" (1989-90)

More students started studying statistics – AP Statistics first exam in 1998

1990's: New software!

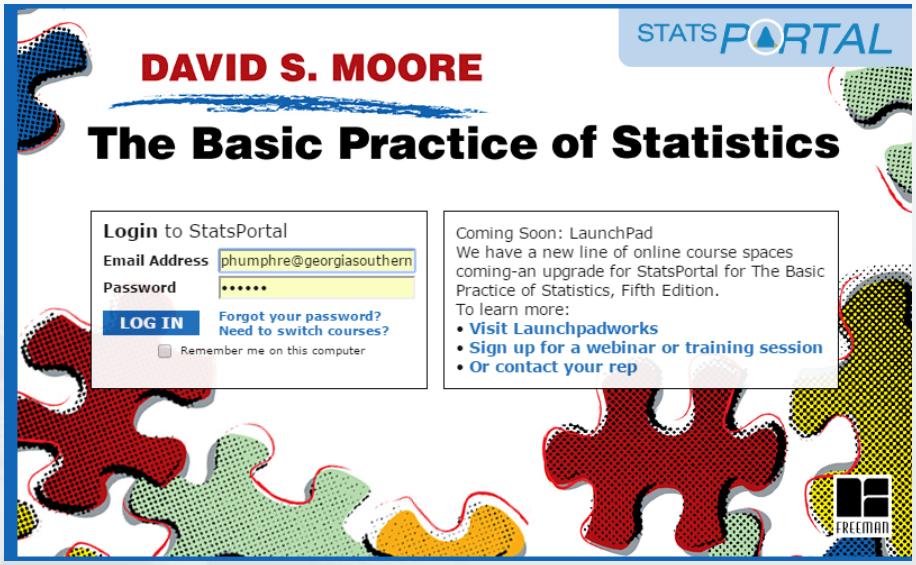
- S, S+
- Minitab release 8 (1991) had first graphical interface
- R (1993)
- Incremental Changes in texts

2000's: Technology explodes!

Internet!

Social media!

2000's: Technology explodes!



PEARSON

MyStatLab™

WileyPLUS

2010's: The Internet of Things

2010's:

- "Big" Data
- Randomization and Bootstrapping
- MQC (2013)

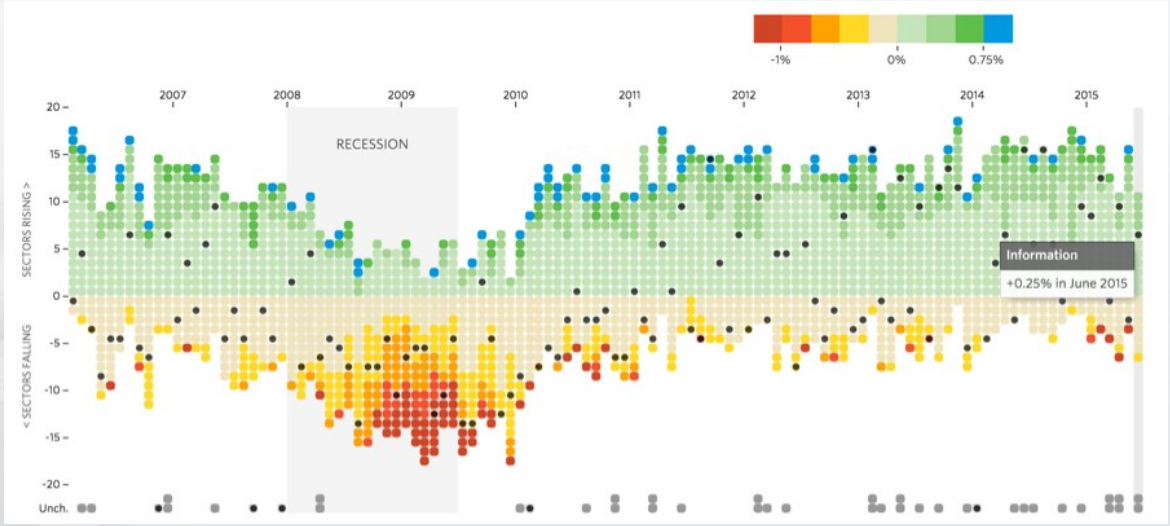
- Stat texts haven't kept up

2010's: Web scraping

231	*Anguilla* (UK)	13,452	May 11, 2011	0.00019%	Preliminary 2011 census result
232	*Wallis and Futuna* (France)	13,135	July 1, 2013	0.00018%	Annual official estimate
233	Tuvalu	11,323	July 1, 2013	0.00016%	Annual official estimate
234	Nauru	10,084	October 30, 2011	0.00014%	2011 census result
235	*Saint Barthélemy* (France)	8,938	January 1, 2010	0.00012%	Official estimate
236	*Saint Pierre and Miquelon* (France)	6,081	January 1, 2010	0.000084%	Official estimate
237	*Montserrat* (UK)	4,922	May 12, 2011	0.000068%	2011 census result
238	*Saint Helena, Ascension and Tristan da Cunha* (UK)	4,000	July 1, 2014	0.000056%	UN projection
239	*Falkland Islands* (UK)	3,000	July 1, 2014	0.000042%	UN projection
240	*Svalbard and Jan Mayen* (Norway)	2,655	September 1, 2012	0.000037%	Official estimate
241	*Norfolk Island* (Australia)	2,302	August 9, 2011	0.000032%	2011 census result
242	*Christmas Island* (Australia)	2,072	August 9, 2011	0.000029%	2011 census result
243	*Niue* (NZ)	1,613	September 10, 2011	0.000022%	Final 2011 census result
244	*Tokelau* (NZ)	1,411	October 18, 2011	0.000020%	Final 2011 census result
245	Vatican City	839	July 1, 2012	0.000012%	Official estimate
246	*Cocos (Keeling) Islands* (Australia)	550	August 9, 2011	0.0000076%	2011 census result
247	*Pitcairn Islands* (UK)	56	2013	0.00000078%	Official estimate

- R or Python – turn any web page with "data" into a data set for further analysis.
- Sample from large data sets.

2010's: Data visualizations



2010's: Data visualizations

Future:

- New texts will eliminate *t* and z tests
- New inference methods will dominate
- Distinction between statistics literacy and "doing" statistics