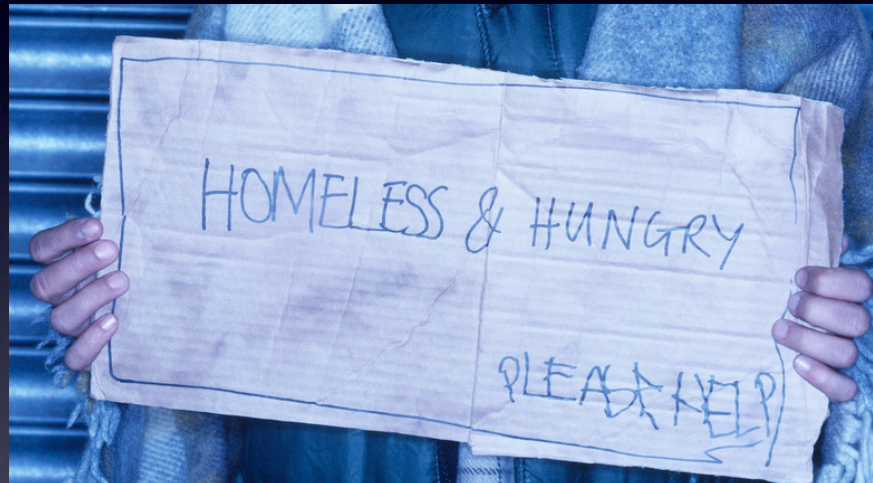


Measuring Income Inequality in Elementary and High School



Charles Collingwood, Cassidy Larkin, Victor Piercey,
and Jordan Schettler, G-TEAMS, University of Arizona

Who are We?

Charles Collingwood: Stats, Precalculus, and AP Calculus Teacher at Rincon High School.

- **Jordan Schettler:** Math Ph.D. Student at University of Arizona.



Who are We?

Cassidy Larkin: Fifth Grade Teacher at McCartney Ranch Elementary School

- **Victor Piercey:** Math Ph.D. Student at University of Arizona.





- GK-12 program housed in the UA Math Department.
- G-TEAMS stands for Graduate Students and Teachers Engaging in Mathematical Sciences.

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- High population of English Language Learners.
- Increasing population of “exceeds” math students.
- Title I school with about 650 students, about 70% of students are receiving free/reduce lunch rates.

Income Inequality Data Analysis

- Each table has a piece of paper with some data and a sheet of graph paper.
- Make a graph (bar, line, circle, etc.) to represent this data.
- Identify any features or trends your graph illustrates.



Using Excel





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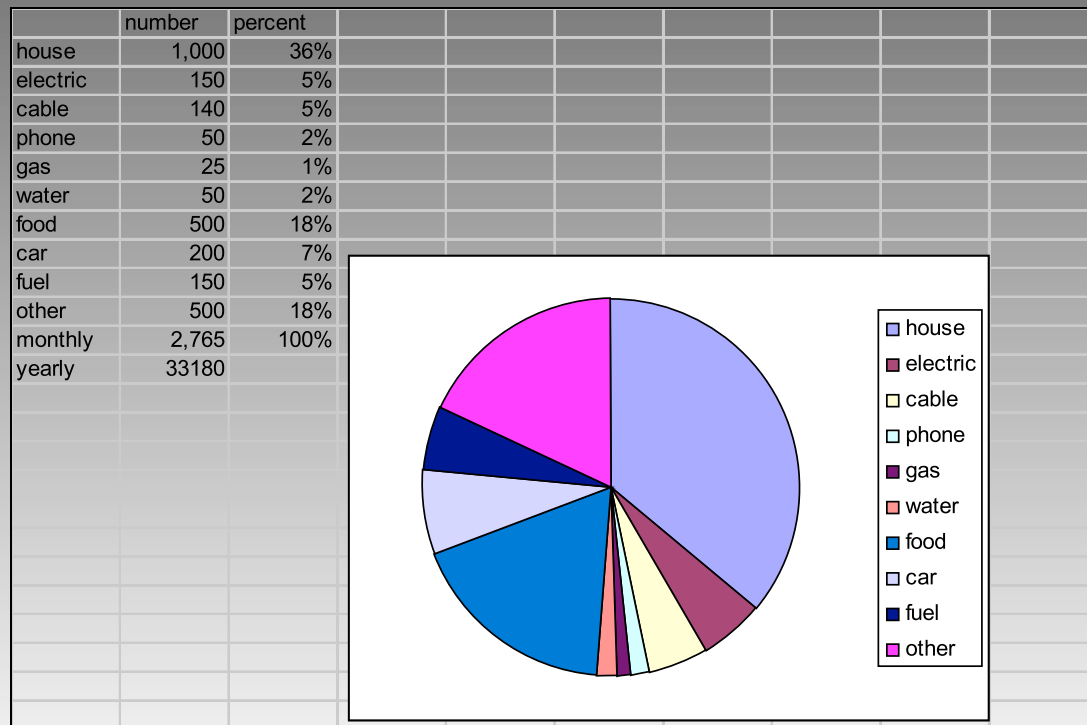
Using Excel

- In the computer lab, students learned rudiments of Excel.
- For example, they:
 - (i) entered data;
 - (ii) used auto-sum;
 - (iii) entered formulas; and
 - (iv) made various types of graphs.

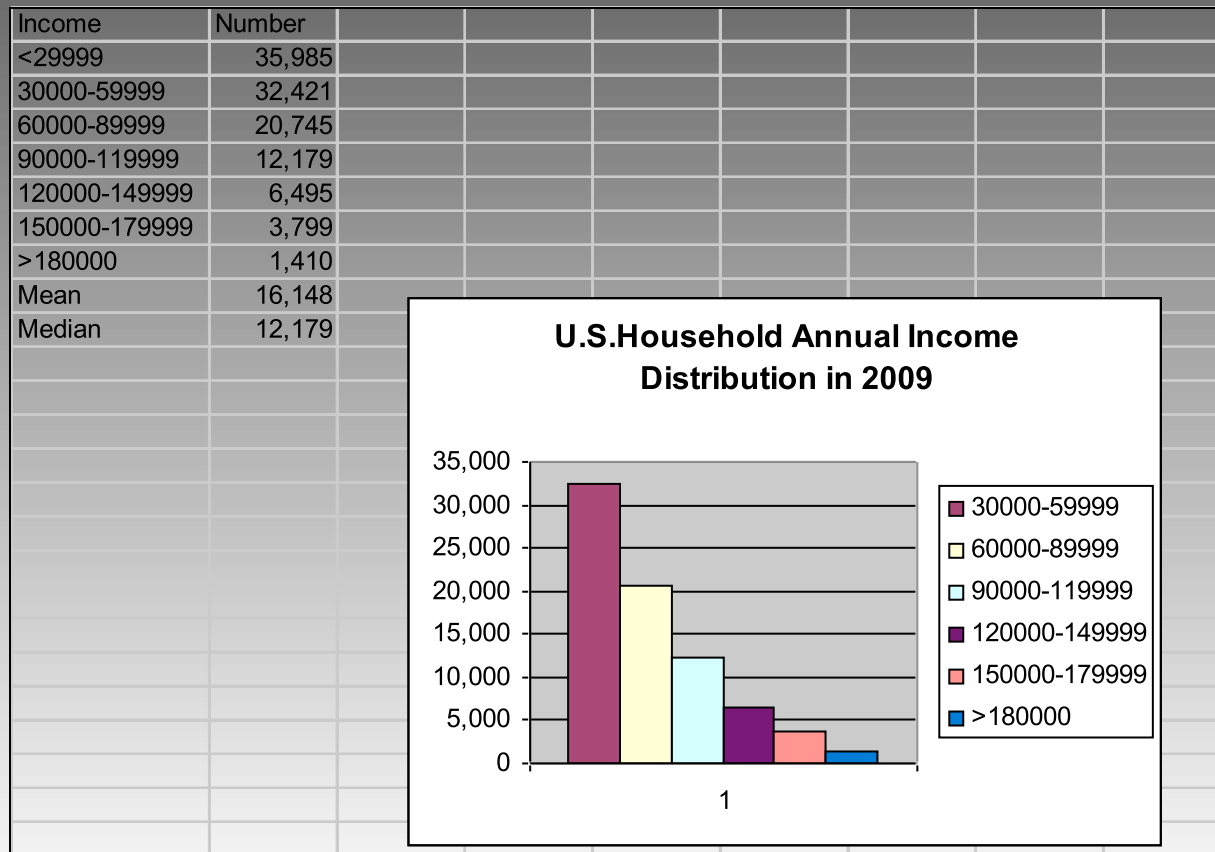


Is \$20,000 per year a lot?

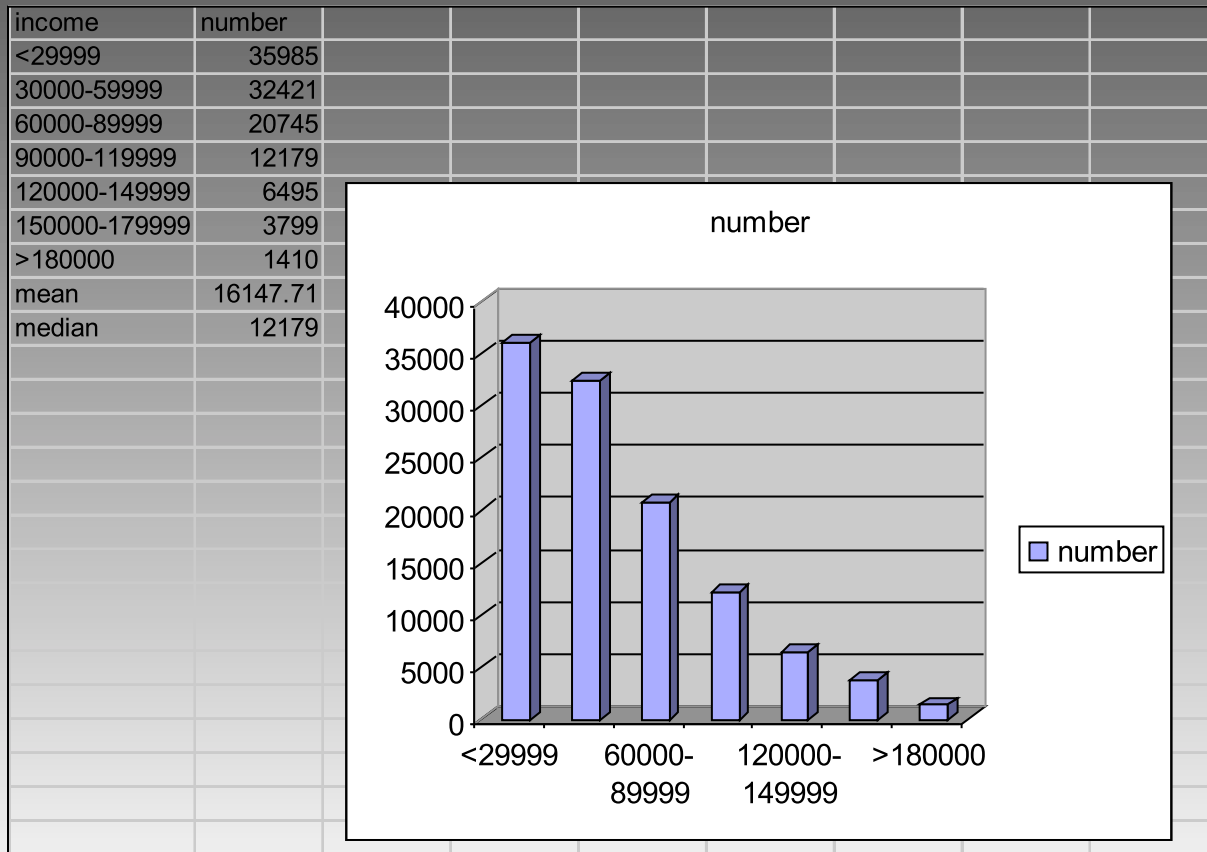
Fifth grade students analyzed a monthly budget for local expenses.



Income Distribution in 2009: Sample One

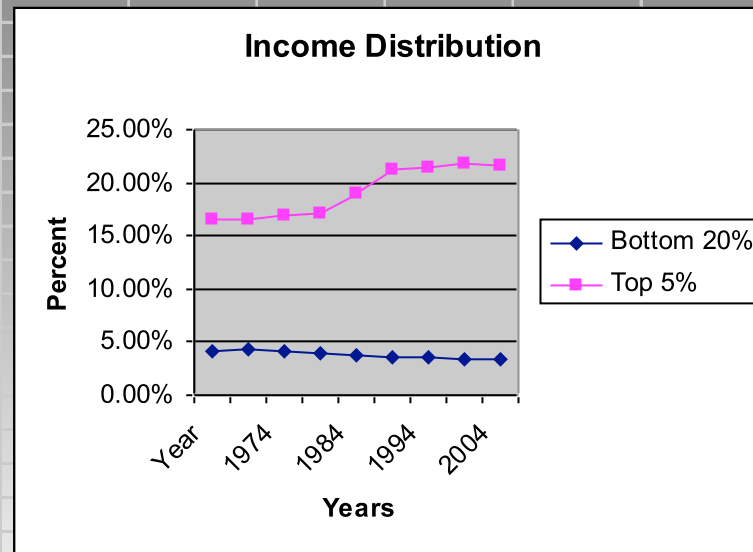


Income Distribution in 2009: Sample Two

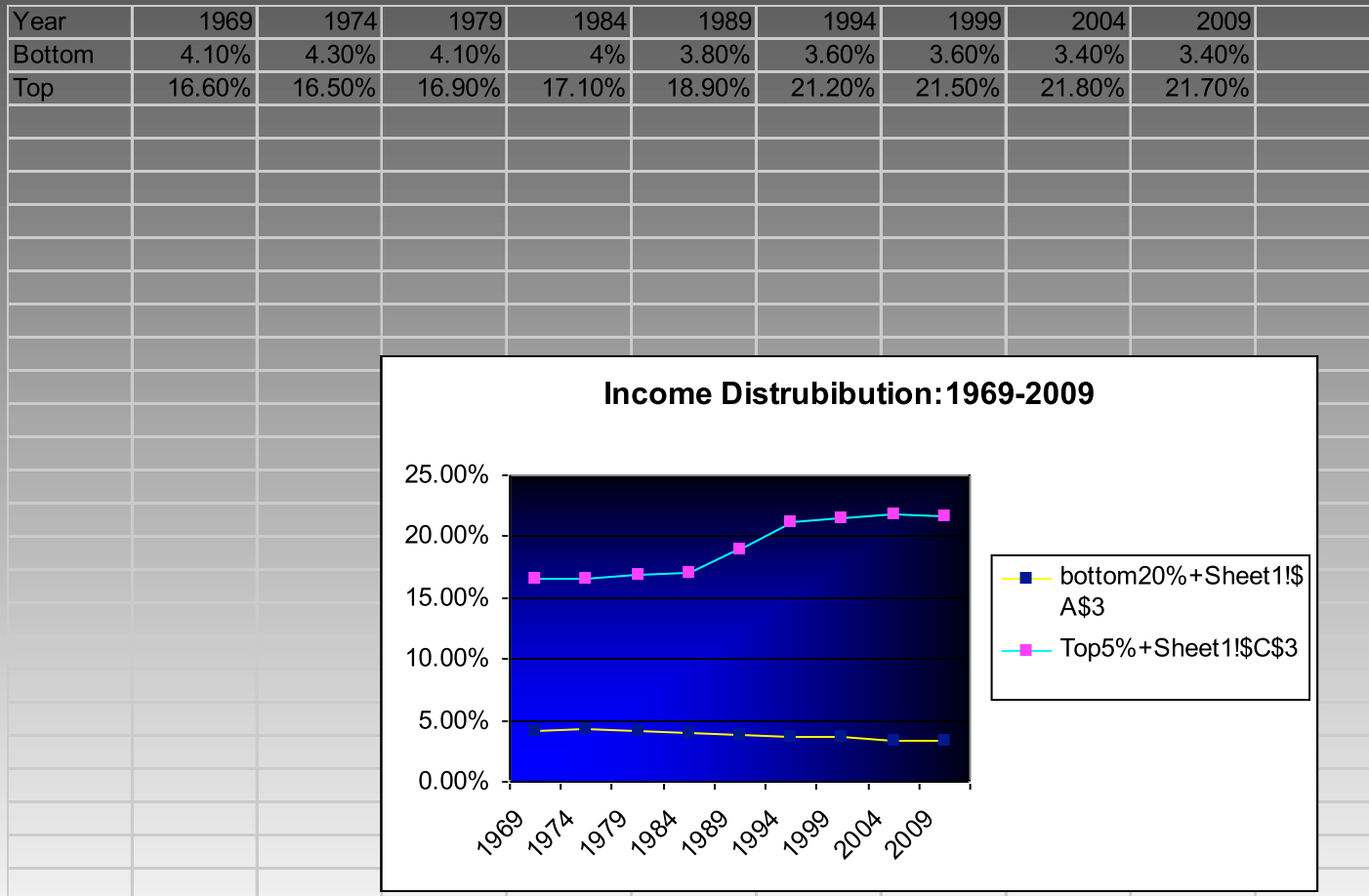


Income Distribution 1969-2009: Sample One

Year	1969	1974	1979	1984	1989	1994	1999	2004	2009
Bottom	4.10%	4.30%	4.10%	4%	3.80%	3.60%	3.60%	3.40%	3.40%
Top	16.60%	16.50%	16.90%	17.10%	18.90%	21.20%	21.50%	21.80%	21.70%

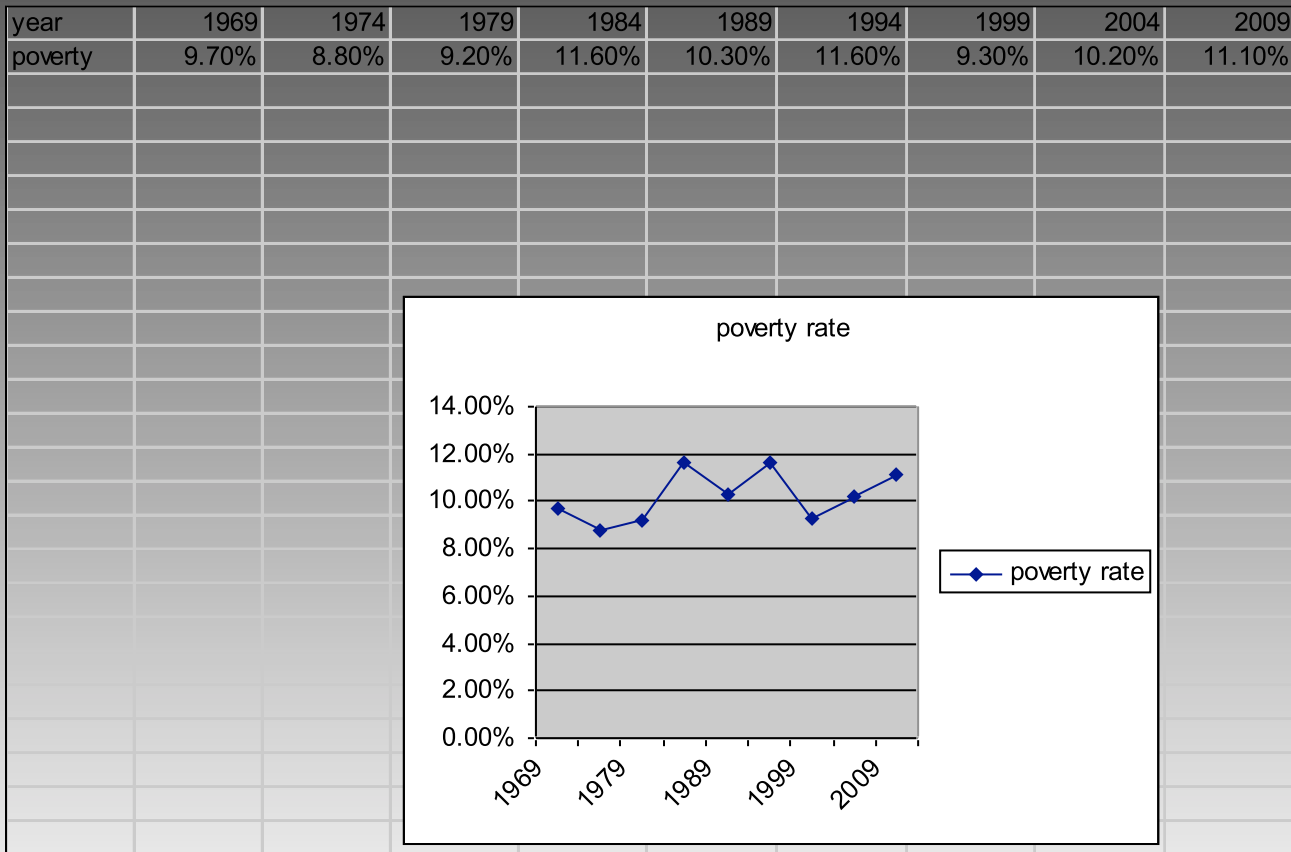


Income Distribution 1969-2009: Sample Two



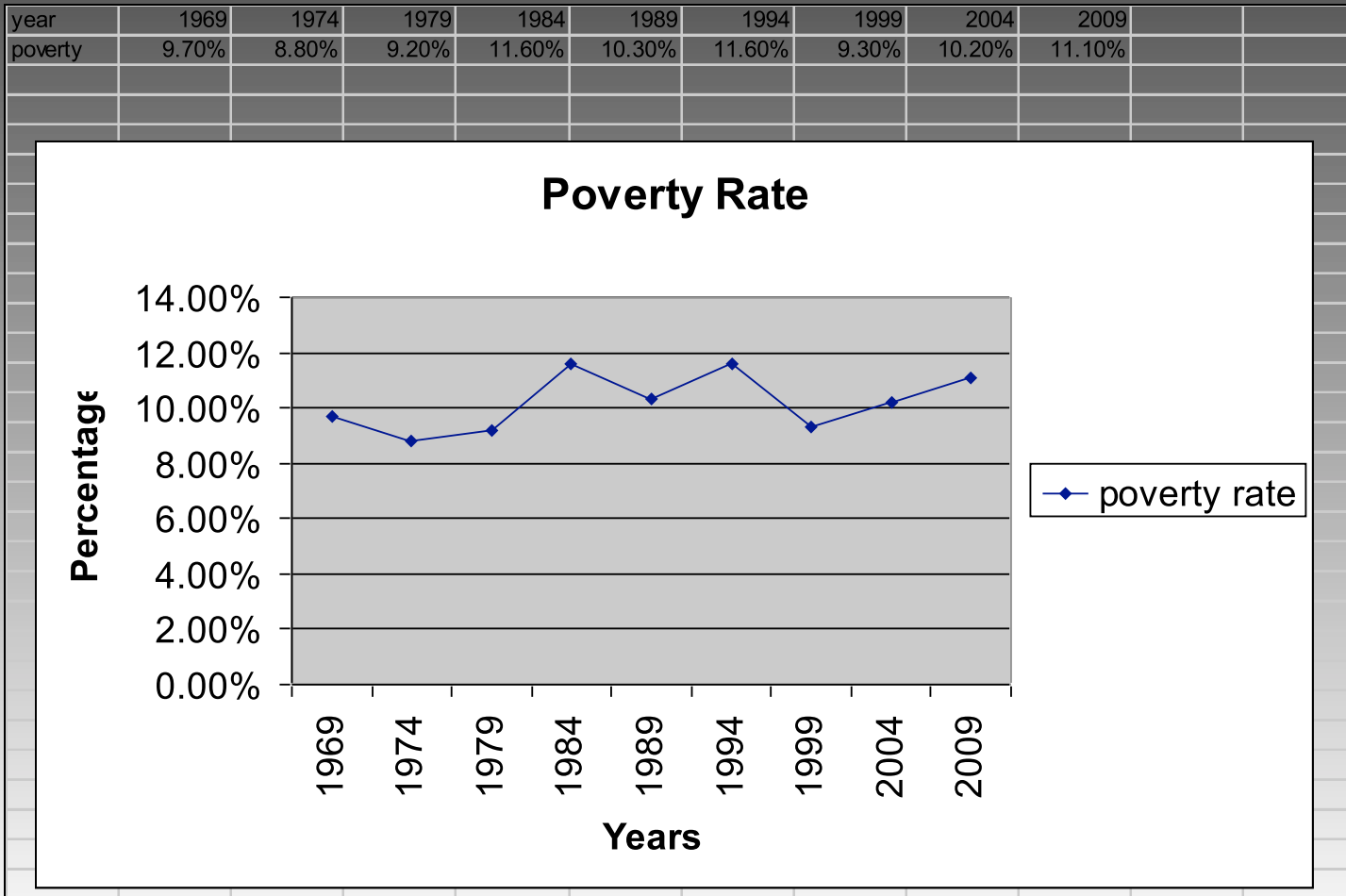
Poverty Rates: 1969 – 2009

Sample One



Poverty Rates: 1969 – 2009

Sample Two



Sample Responses to Questions

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- **Question:** Look at your graph and describe why some people say that “the rich are getting richer and the poor are getting poorer.”
- **Response:** Because the bottom goes down and the top goes up.
- **Response:** Because throughout the years the top 5 starts and is getting a larger increase than the bottom 20.

Sample Responses to Questions

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- **Question: What do you think can be done in order to make this line graph (for poverty rates) decrease between 2009 and 2014?**

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Sample Responses to Questions

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- **Response:** I think we could help the homeless and hungry get money.
- **Response:** More people should leave the United States.

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- Describe patterns of change.
- Summarize mathematical information.

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Reflections



- The real-world application along with the use of real world data was a great motivator for students!
- Some students who had been previously unengaged became enthusiastic. The context led to student “buy-in”.
- When brought back to first principles and properly motivated, young students can understand fairly complicated concepts.
- This type of activity is very difficult to fit within every-day teaching constraints.

Reflections (continued)



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Reflections (continued)



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- Some students didn't understand that they had to read their instructions in order to know what to do next.
- Some students had trouble understanding when to use their instructions and when to use their data sheet.

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- Significant % of free/reduced lunch

Mathematical Practices in the New Common Core Standards

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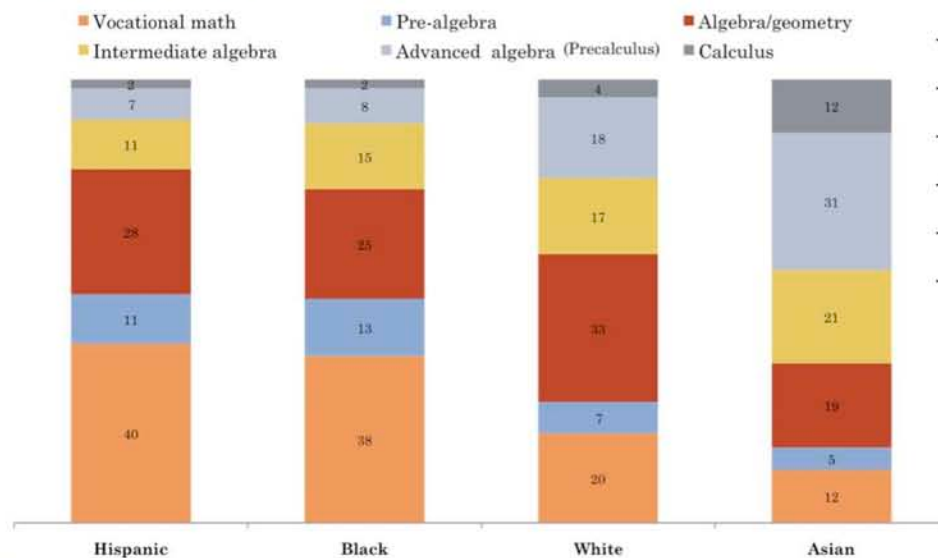
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7. Look for and make use of structure.
8. Look for and express regularity in repeated reasoning.

Math Achievement and Ethnicity: χ^2 -Independence Test

HIGHEST MATH COURSE TAKEN BY ETHNICITY



What's the story at Rincon?

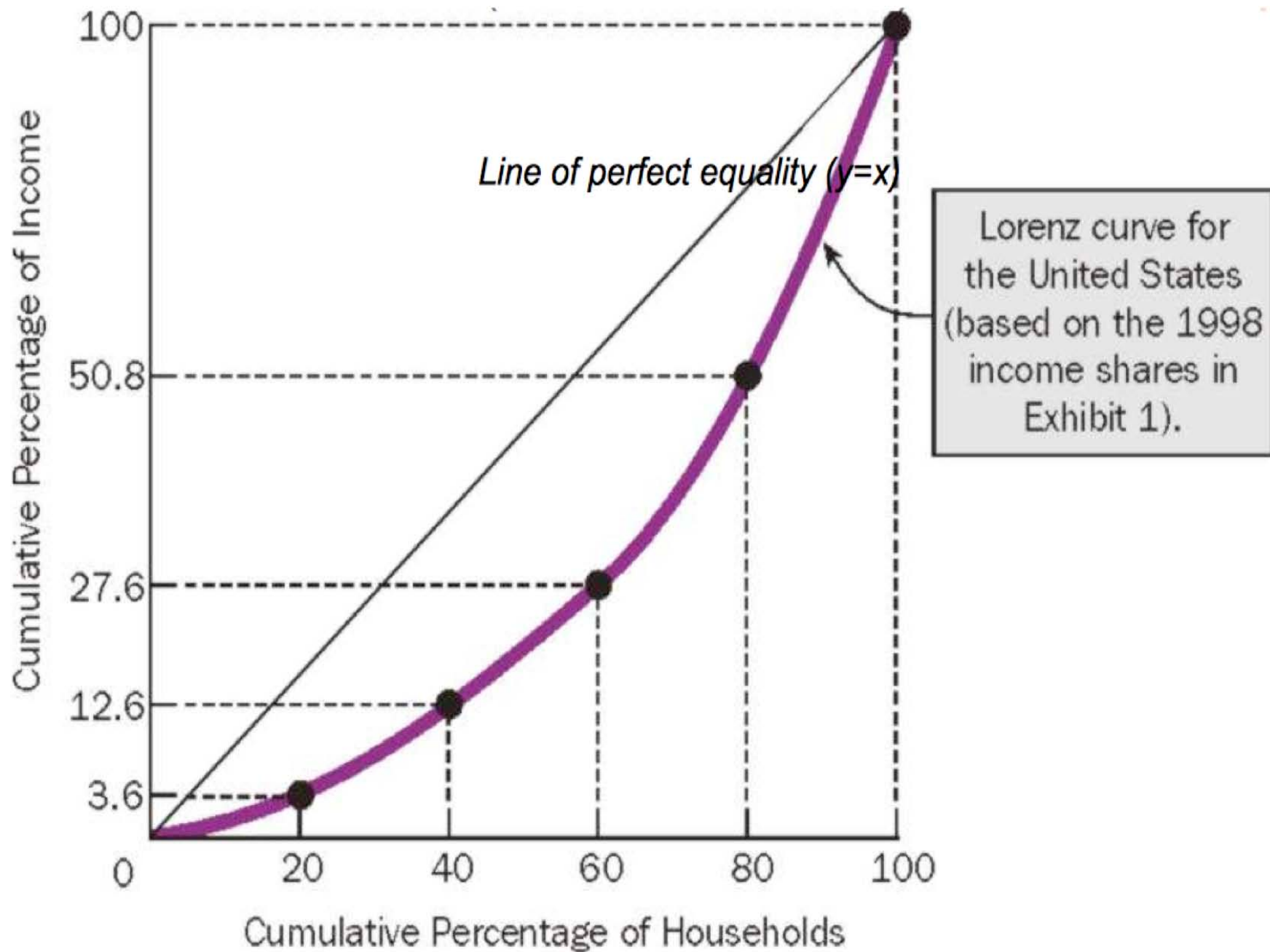
	Hispanic	Black	White	Asian
A	48 (58)	11 (15)	43 (40)	20 (8)
B	73 (79)	14 (21)	65 (55)	14 (11)
C	76 (96)	29 (25)	80 (66)	15 (13)
D	128 (116)	28 (31)	80 (81)	8 (16)
F	199 (175)	56 (46)	96 (122)	16 (25)

Observed vs. (Expected) Grades in Math, 2010

The test statistic is = 52.83061161....

The p -value is $\Sigma = 0.00000044152365$.

Assuming a student's grade in math is independent of their ethnicity, the p -value is the probability of getting a test statistic $\geq \Sigma$. Here the p -value is very small, so we should reject the assumption of independence. We also used this data to create frequency tables from each column. Then students computed mean, standard deviation, and histograms for GPA.



Interpolating Lorentz Curves

- Enter the data: STAT, 1
- Find a regression equation: STAT, ▶, 7
- Graph a regression equation: Y=, VARs, 5, ▶, ▶, 1

x	1968	1992
0.0	0.000	0.000
0.2	0.042	0.038
0.4	0.155	0.132
0.6	0.329	0.290
0.8	0.574	0.532
1.0	1.000	1.000

US Cumulative Household
Income Shares by Quintile

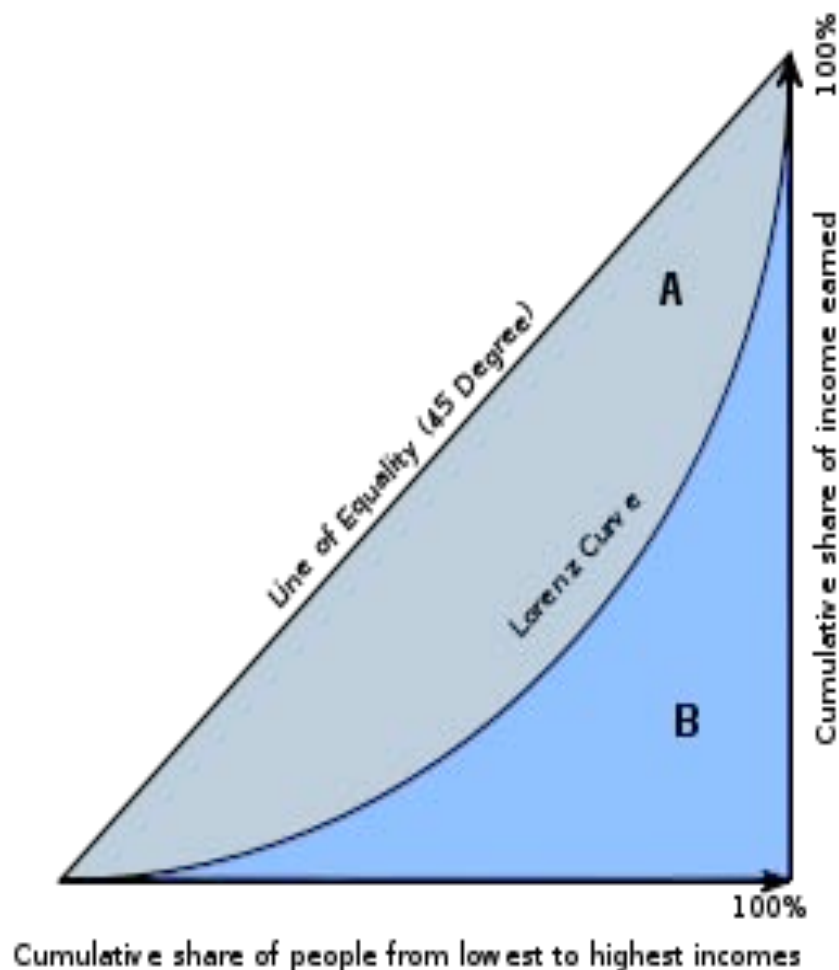
The Gini Coefficient G

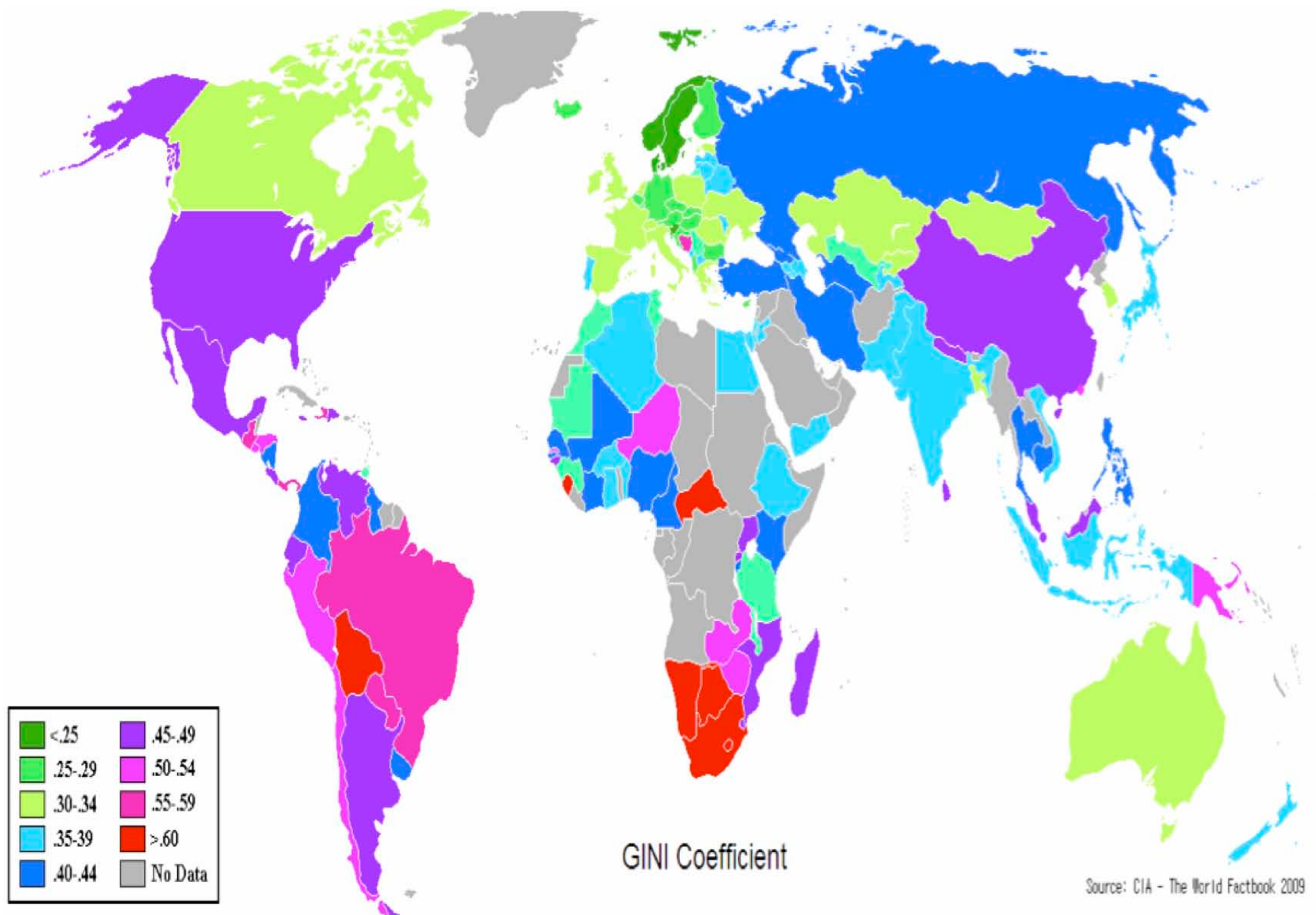
- $G := \frac{A}{A + B}$
- If $L(x)$ = Lorenz curve,

$$B = \int_0^1 L(x) dx$$

- Also, $A + B = 1/2$, so

$$G = 1 - 2B$$

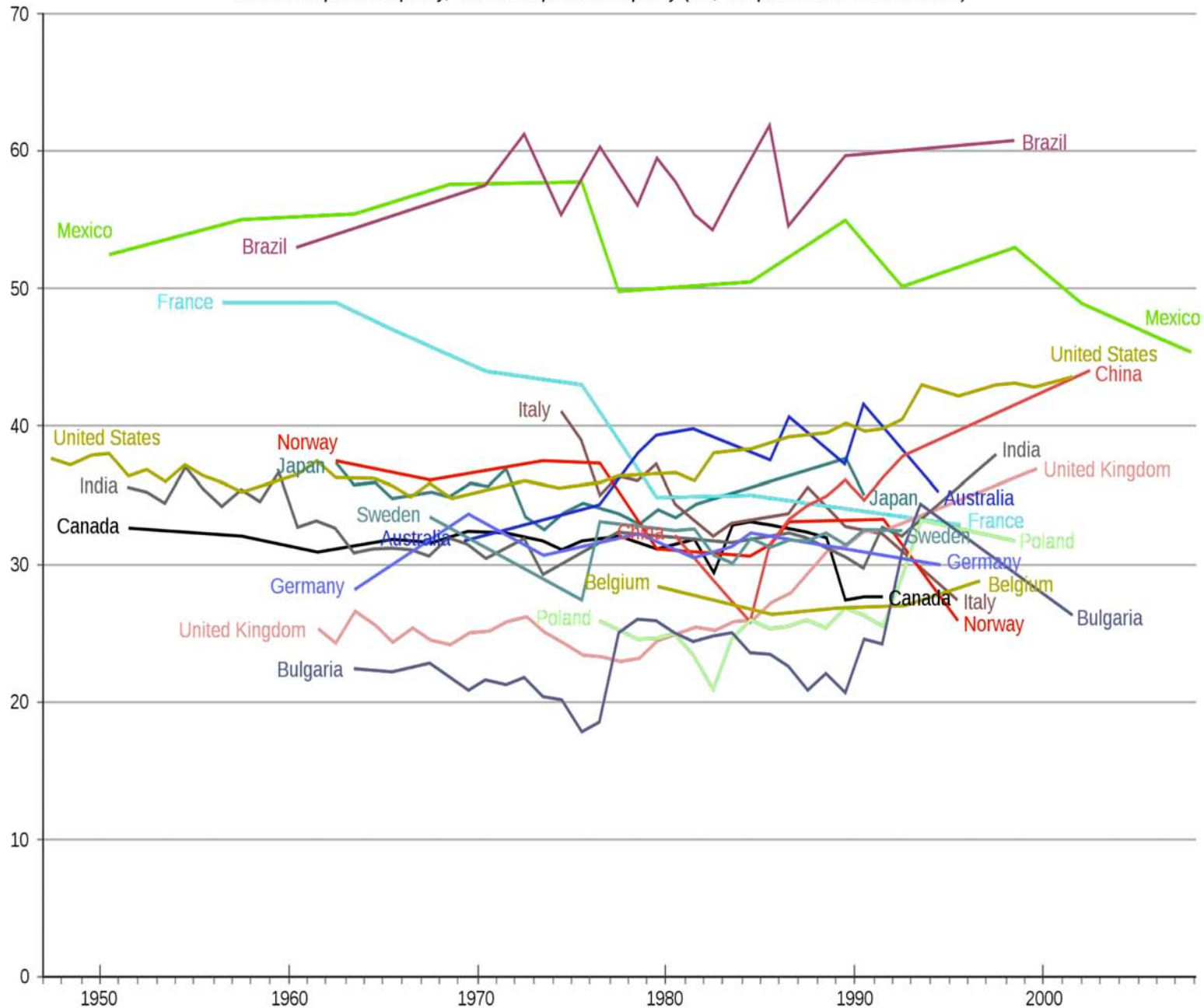




Source: CIA - The World Factbook 2009

Gini Index - Income Disparity since World War II

where 0 is perfect equality, and 100 is perfect inequality (i.e., one person has all the income)



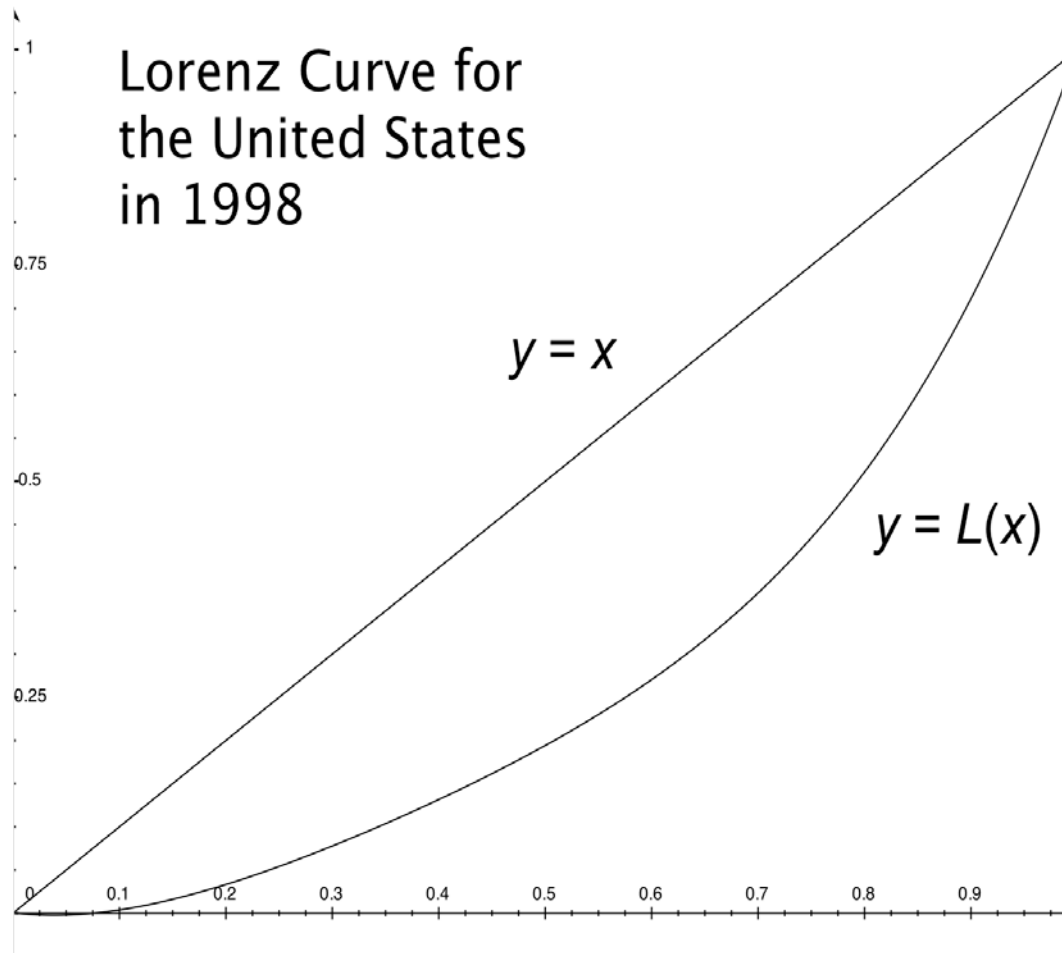
Computing Gini Coefficients

- Enter the data: STAT, 1
- Find a regression equation: STAT, ▶, 7
- Graph a regression equation: Y=, VARS, 5, ▶, ▶, 1
- Find B : 2nd, CALC, 7
- Then $G = 1 - 2B$.

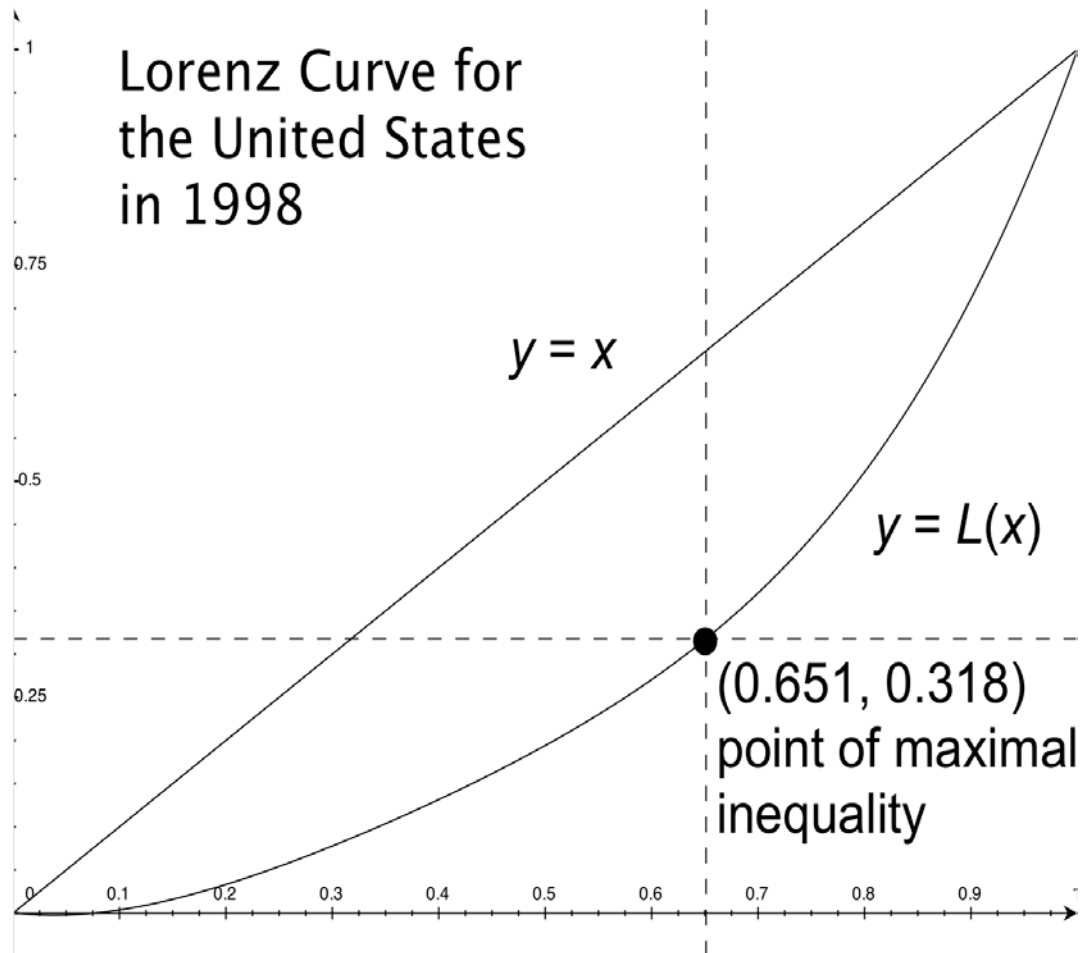
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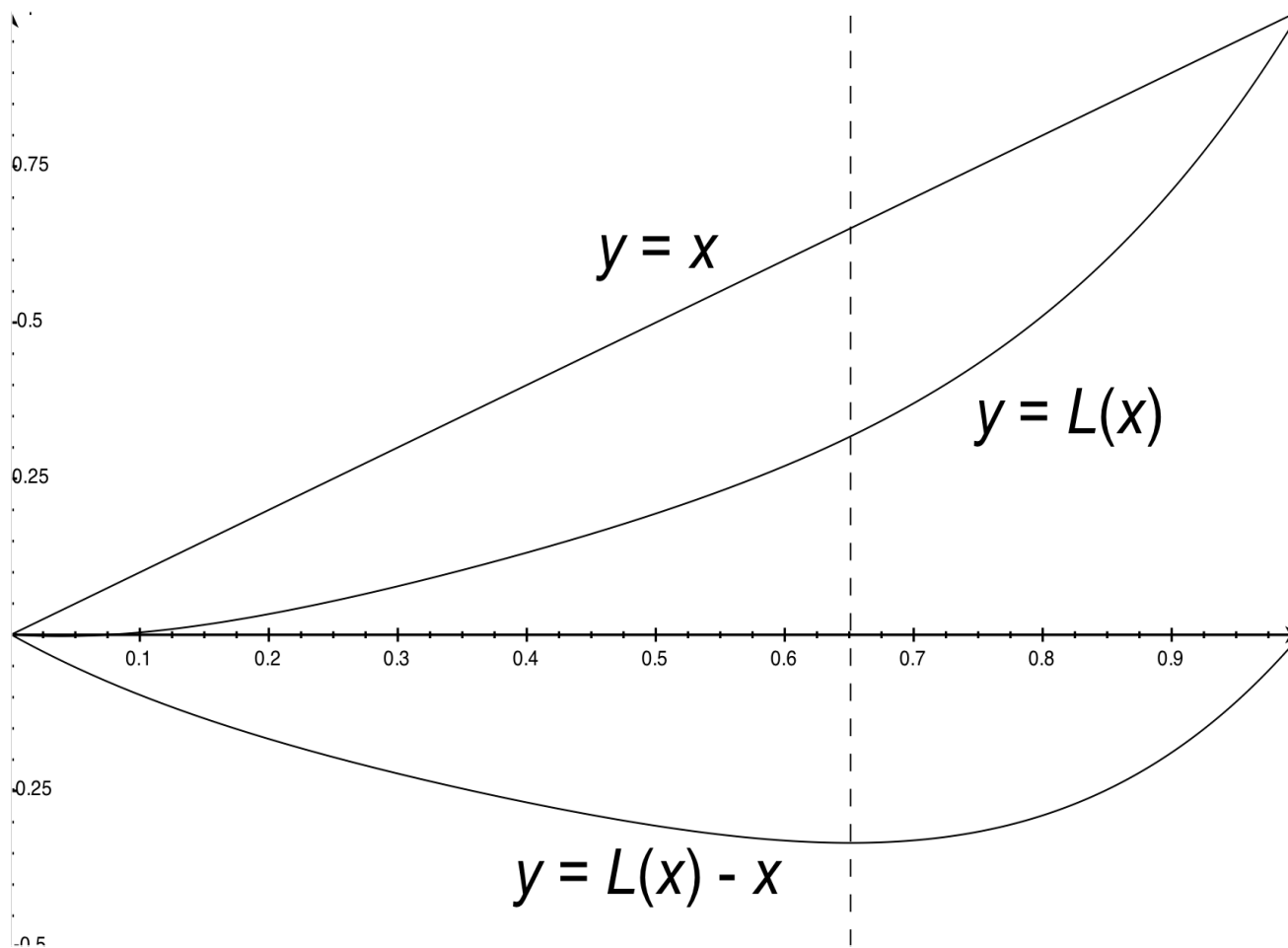
Point of Maximal Inequality (POMI)



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The POMI is a min of $L(x) - x$



Tracking the POMI

- Subtract x from a regression equation
- Find a minimum: 2nd, CALC, 3
- Interpret the movement of this point.

x	1968	1992
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Discussion

- In most schools today, teachers have constraints. Curriculum calendars and scripted curricula do not leave students with the opportunity to have in depth exploration time. Are we producing tomorrow's problem solvers?
- What kinds of ideas do you have that could turn into a possible project that relates to real world problems, yet that have fidelity to school districts?

**ELEMENTARY: LEFT SIDE OF ROOM.
MIDDLE AND HIGH: RIGHT SIDE.**