Group Project: Question 19

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Data Point	A	B	C	D
Year	2007	2008	2009	2010
Net Profit	14,065	17,681	14,596	18,760

Year	2011	2012	2013	2014
Net Profit	23,150	23,171	22,453	22,074

Problem 19:

- The table shows the net profit (in millions of dollars) for Microsoft from 2007 through 2014.
- A) Set up a system of equations to fit the data for the years 2007, 2008, 2009, and 2010 to a cubic model.
- B) Solve the system. Does the solution produce a reasonable model for determining net profits after 2010? Explain

Polynomial Curve Fitting

- One degree less than data points
- We have four data points so we will use a cubic equation
- Use equation:
  - $p(x) = a_0 + a_1x + a_2x^2 + a_3x^3 + \cdots + a_nx^n$
- Horizontal Shift (2007 = 0)

Equations for Data Points

- *Using equation:* $p(x) = a_0 + a_1 x + a_2 x^2 + a_3 x^3$
  - $p(a) = a_0 + a_1(0) + a_2(0)^2 + a_3(0)^3 = 14{,}065$
  - $p(\ b) = a_0 + a_1(1) + a_2(1)^2 + a_3(1)^3 = 17{,}681$
  - $p(c) = a_0 + a_1(2) + a_2(2)^2 + a_3(2)^3 = 14{,}569$
  - $p(d) = a_0 + a_1(3) + a_2(3)^2 + a_3(3)^3 = 18{,}760$
- Now we set up the matrix:

$$\begin{bmatrix} 1 & 0 & 0 & 0 & 14{,}065 \\ 1 & 1 & 1 & 1 & 17{,}681 \\ 1 & 2 & 4 & 8 & 14{,}569 \\ 1 & 3 & 9 & 27 & 18{,}760 \end{bmatrix}$$

Part A: Gauss/Jordan Elimination

$$\begin{bmatrix} 1 & 0 & 0 & 0 & 14{,}065 \\ 1 & 1 & 1 & 1 & 17{,}681 \\ 1 & 2 & 4 & 8 & 14{,}569 \\ 1 & 3 & 9 & 27 & 18{,}760 \end{bmatrix} \begin{matrix} R_2 - R_1 \to R_2 \\ R_3 - R_1 \to R_3 \\ R_4 - R_1 \to R_4 \end{matrix}$$

$$\begin{bmatrix} 1 & 0 & 0 & 0 & 14{,}065 \\ 0 & 1 & 1 & 1 & 3{,}616 \\ 0 & 2 & 4 & 8 & 504 \\ 0 & 3 & 9 & 27 & 4{,}695 \end{bmatrix} \begin{matrix} R_3 - 2R_2 \to R_3 \\ \frac{1}{2}R_3 \to R_3 \end{matrix}$$

$$\begin{bmatrix} 1 & 0 & 0 & 0 & 14{,}065 \\ 0 & 1 & 1 & 1 & 3{,}616 \\ 0 & 0 & 1 & 3 & -3{,}364 \\ 0 & 3 & 9 & 27 & 4{,}695 \end{bmatrix} \frac{1}{3}R_3 \to R_3$$

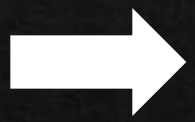
$$\begin{bmatrix} 1 & 0 & 0 & 0 & 14{,}065 \\ 0 & 1 & 1 & 1 & 3{,}616 \\ 0 & 0 & 1 & 3 & -3{,}364 \\ 0 & 1 & 3 & 9 & 1{,}565 \end{bmatrix} R_4 - R_2 \to R_4$$

$$\begin{bmatrix} 1 & 0 & 0 & 0 & 14{,}065 \\ 0 & 1 & 1 & 1 & 3{,}616 \\ 0 & 0 & 1 & 3 & -3{,}364 \\ 0 & 0 & 2 & 8 & -2{,}051 \end{bmatrix} R_4 - 2R_3 \to R_4$$

$$\begin{bmatrix} 1 & 0 & 0 & 0 & 14{,}065 \\ 0 & 1 & 1 & 1 & 3{,}616 \\ 0 & 0 & 1 & 3 & -3{,}364 \\ 0 & 0 & 0 & 2 & 4{,}677 \end{bmatrix} \frac{1}{2}R_4 \to R_4$$

Part B: Back Substitution

$$\begin{bmatrix} 1 & 0 & 0 & 0 & 14{,}065 \\ 0 & 1 & 1 & 1 & 3{,}616 \\ 0 & 0 & 1 & 3 & -3{,}364 \\ 0 & 0 & 0 & 1 & 2{,}338.5 \end{bmatrix}$$



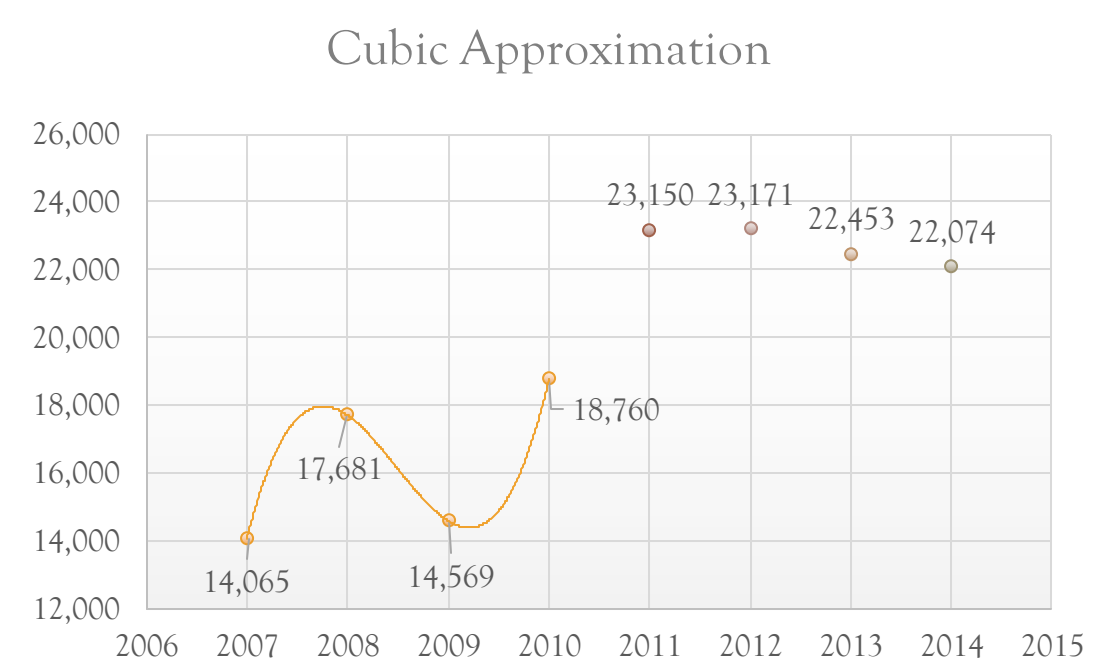
$$a_0 = 14{,}065$$
$$a_1 + a_2 + a_3 = 3{,}616$$
$$a_2 + 3a_3 = -3{,}364$$
$$a_3 = 2{,}338.5$$

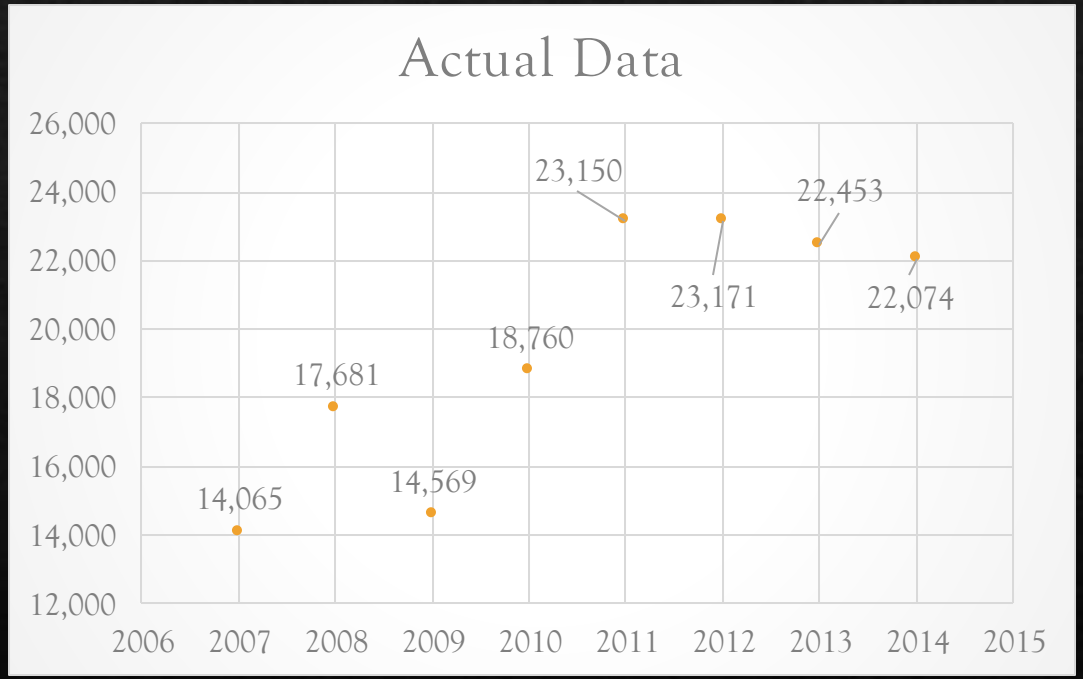
$$a_0 = 14{,}065$$
$$a_1 = 11{,}657$$
$$a_2 = -10{,}379.5$$
$$a_3 = 2{,}338.5$$

Creating an Equation

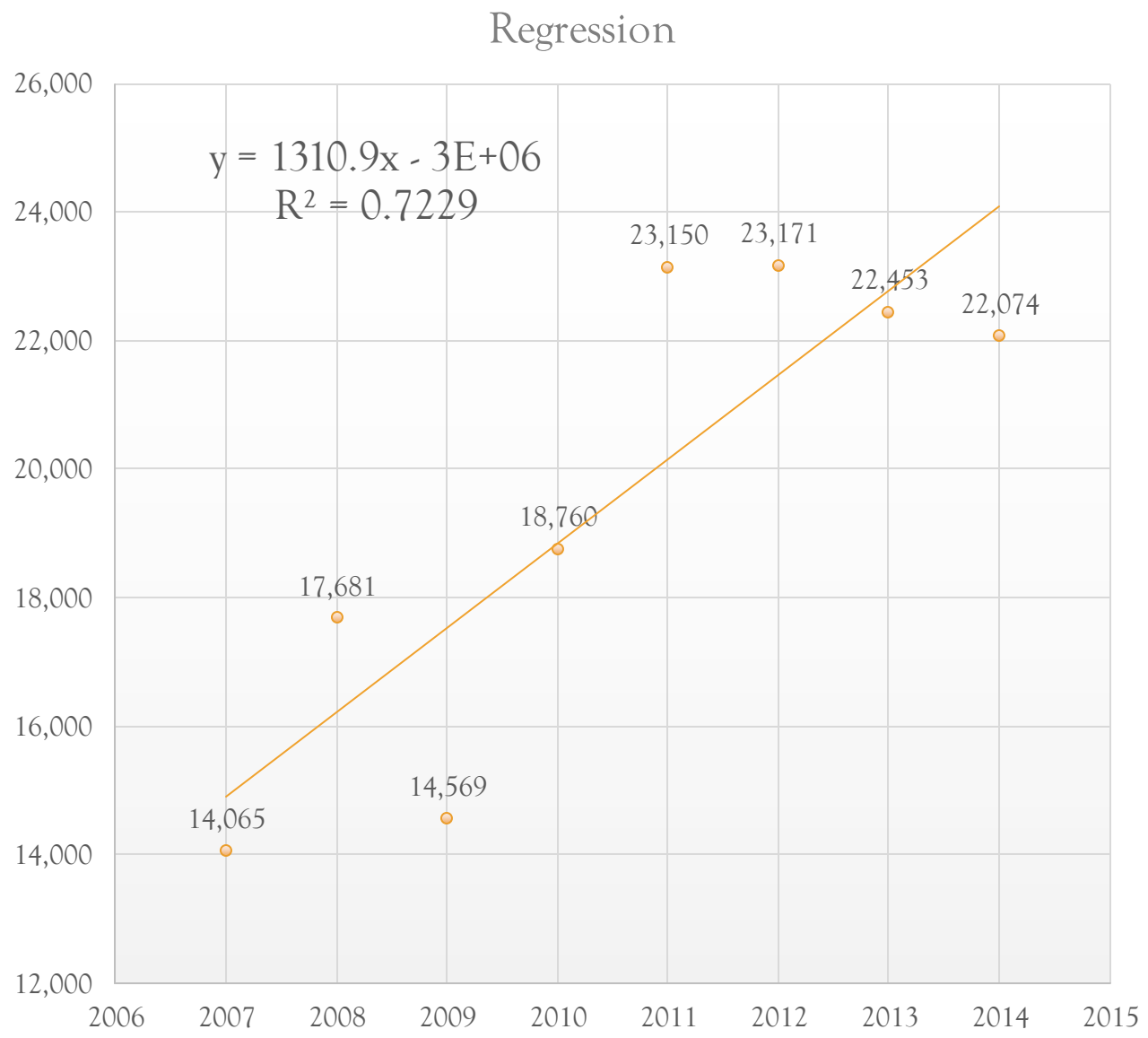
- Plugging in our values for a_0, a_1, a_2, and a_3.
  - $p(a) = 14{,}065 + 11{,}657(x - 2007) - 10{,}379.5(x - 2007)^2 + 2{,}338.5(x - 2007)^3$
- Now we can get our values for 2011-2014
  - $p(2011) = 44285$
  - $p(2012) = 105175$
  - $p(2013) = 215461$
  - $p(2014) = 389174$
- Therefore, graphed prediction of 44,285 is not approximate to the 23,150 in the data

Graphing the Solution





Least Squares Regression Model



Microsoft's Profits

- In 2009, Microsoft experienced their first ever drop in revenue
- Due to the worldwide economic recession in 2009
  - Worst economic recession since the Great Depression
- Effected the entire world, not just Microsoft

Microsoft's Profits cont.

- Adjusted cost structure
- Reduced spending
- 5,000 Layoffs
- Unveiled future products, which gained interest in the company (Windows 7, Kinect, etc.)
- Resulted in increased annual revenue the next year

Technology Used

- Internet for background research
- Excel for calculations and graphing results
- Calculators and Desmos to double check our answers
- PowerPoint to display findings
- Microsoft Equation Editor to present our work in a logical fashion

Teamwork

- Dividing and Conquered
- Starting Early
- Consistent Communication
- Using Technology to our advantage

Works Cited

- Ballmer, Steven A. "MSFT Annual Report 2009." *MSFT Annual Report 2009*, 1 Sept. 2009, https://www.microsoft.com/investor/reports/ar09/10k_sl_eng.html#:~:text=As%20consumers%20and%20businesses%20reset,%2420.4%20billion%2C%20down%209%20percent.
- "Microsoft Gross Profit 2010-2021: MSFT." *Macrotrends*, https://www.macrotrends.net/stocks/charts/MSFT/microsoft/gross-profit.