# Week 7: Systems Applications & Inequalities

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## Session 7.3
## Linear Modeling & Fit-by-Eye

# Quick Reference: Linear Modeling

## What is a Line of Best Fit?

A **line of best fit** (or trend line) is a straight line that best represents the data on a scatter plot.

**Key Ideas:**

- Not all points will be exactly on the line
- The line shows the general trend or pattern
- We use the line to make predictions
- The line minimizes the distance from all the data points

## Steps to Create a Line of Best Fit

### 1. Plot the Data

- Create a scatter plot of all data points
- Label axes with variable names and units
- Choose an appropriate scale

### 2. Draw the Line

- Use a ruler or straightedge
- Try to balance points above and below the line
- The line should follow the general trend
- Extend the line across the entire graph

### 3. Find the Equation

- Pick two points ON your line (they don't have to be data points)
- Calculate the slope: $m = \frac{y_2 - y_1}{x_2 - x_1}$
- Find the y-intercept using point-slope form
- Write in slope-intercept form: $y = mx + b$

## Residuals

A **residual** measures how far each data point is from the line of best fit.

**Formula:**

$$\text{Residual} = \text{Actual value} - \text{Predicted value}$$

**Interpretation:**

- **Positive residual**: data point is above the line
- **Negative residual**: data point is below the line
- **Zero residual**: data point is exactly on the line
- Smaller residuals mean better fit

## Interpreting Slope and y-Intercept

**Slope ($m$):**

- Rate of change
- How much $y$ changes for each 1-unit increase in $x$
- Include units: "For every [unit of $x$], [variable $y$] changes by [slope] [unit of $y$]"

**y-Intercept ($b$):**

- Starting value when $x = 0$
- May or may not make sense in context
- Include units: "When [variable $x$] is 0, [variable $y$] is [y-intercept] [unit of $y$]"

# Worksheet 7.3: Linear Modeling

## Instructions

:

For each problem,

1. Plot the data points on graph paper
2. Draw a line of best fit by eye
3. Find the equation using two points on your line
4. Calculate residuals for specified data points
5. Interpret the slope and y-intercept in context

## Worksheet Problem 1: Temperature and Hot Chocolate Sales

A café tracks hot chocolate sales at different temperatures.

| Temperature (°F) | Hot Chocolates Sold |
|---|---|
| 30 | 45 |
| 35 | 42 |
| 40 | 38 |
| 45 | 35 |
| 50 | 30 |
| 55 | 28 |

### Part A

Choose your scale:

- x-axis: Temperature from _____ to _____ (include units)
- y-axis: Sales from _____ to _____ (include units)

Add your scale and label axes.

Plot the points.



### Part B

Draw a line of best fit (using a different color).

**Part C**

Choose two points ON your line and find the equation.

Point 1: (_____, _____)

Point 2: (_____, _____)

Calculate the slope:

Find the y-intercept using point-slope form:

Equation: _____

**Part D**

Calculate residuals for $x = 30$, $x = 40$, and $x = 50$:

For $x = 30$:

- Actual value: _____
- Predicted value (from equation): _____
- Residual = Actual − Predicted = _____

For $x = 40$:

- Actual value: _____
- Predicted value: _____
- Residual = _____

For $x = 50$:

- Actual value: _____
- Predicted value: _____
- Residual = _____

**Part E**

Interpret the slope in context:

For every _____ (include units) increase in temperature,

the number of hot chocolates sold

_____ (increases/decreases) by about _____ (include units).

**Part F**

Interpret the y-intercept in context:

When the temperature is 0°F, the model predicts _____ hot chocolates sold.

**Part G**

Does the y-intercept make sense in this context? Why or why not?

**Part H**

Use your model to predict sales at 60°F:

Is this prediction reasonable? Explain.

## Worksheet Problem 2: Study Time and Quiz Score

A teacher tracks student study time and quiz scores.

| Study Time (hours) | Quiz Score (%) |
|---|---|
| 0.25 | 67 |
| 0.5 | 70 |
| 0.75 | 73 |
| 1.0 | 79 |
| 1.25 | 88 |
| 1.5 | 93 |

### Part A

Add a scale and label axes.

Plot the points.



### Part B

Draw a line of best fit (using a different color).

**Part C**

Find the equation of the line of best fit using two points on your line.

**Part D**

Calculate residuals for $x = 0.5$, $x = 1.0$, and $x = 1.5$:

**Part E**

Use your model to predict the quiz score for someone who studies 4 hours:

**Part F**

Is this prediction reasonable? Why or why not?

(Hint: Can quiz scores go above 100%?)

## Worksheet Problem 3: Car Value Over Time

A used car dealer tracks how a car's value changes with age.

| Car Age (years) | Value ($1000s) |
|---|---|
| 1 | 23 |
| 2 | 20 |
| 3 | 17 |
| 4 | 15 |
| 5 | 12 |
| 6 | 9 |

### Part A

Add a scale and label axes.

Plot the points.



### Part B

Draw a line of best fit (using a different color).

**Part C**

Find the equation of the line of best fit.

**Part D**

What does the y-intercept represent?

Does this make sense? (What was the car worth when new?)

**Part E**

According to your model, when will the car be worth \$0?

**Part F**

Is this prediction realistic? Why or why not?

## Worksheet Problem 4: Plant Growth

A biology student measures plant height over time.

| Days | Height (cm) |
|---|---|
| 0 | 3 |
| 5 | 5 |
| 10 | 9 |
| 15 | 12 |
| 20 | 15 |
| 25 | 17 |

**Part A**

Add a scale and label axes.

Plot the points.

Draw a line of best fit (using a different color).



**Part B**

Find the equation of the line of best fit.

**Part C**

Interpret the y-intercept:

**Part D**

Calculate the residual for day 10:

**Part E**

Predict the height after 30 days:

**Part F**

If the plant can only grow to a maximum of 25 cm,
when will it reach this height according to your model?