Agenda

- Warm Up   10 min
- Check-up time   10 min
  - *Check, copies*
- Using *z* to get proportions   10 min
- Window/Door   15 min
- Big Example Problem   10 min
- Stations   20 min
- Exit Pass   10 min

- *Copies of z-charts (check existing first)*
- *BACKUP: Grudgeball, Stations*

Warm Up

According to the World Health Organization (WHO), the average weight of a newborn baby is 7.68 pounds, with a standard deviation of 1.781 pounds.

1. My son Ian weighed 7.5375 pounds at birth. What was Ian's z-score? What was his percentile?

The WHO also claims that the height of a newborn baby is 19.34 inches, with a standard deviation of 1.625 inches.

2. My son Ian had a "height" of 20.25 inches at birth. What was Ian's z-score for height? What was his percentile?

Warm Up

According to the World Health Organization (WHO), the weights of newborn babies are **Normally distributed** *with mean 7.68 pounds, and standard deviation 1.781 pounds.*

1. My son Ian weighed 7.5375 pounds at birth. What was Ian's z-score? What was his percentile?

The WHO also claims that the height of newborn babies are **Normally distributed**, *with mean 19.34 inches and standard deviation 1.625 inches.*

2. My son Ian had a "height" of 20.25 inches at birth. What was Ian's z-score for height? What was his percentile?
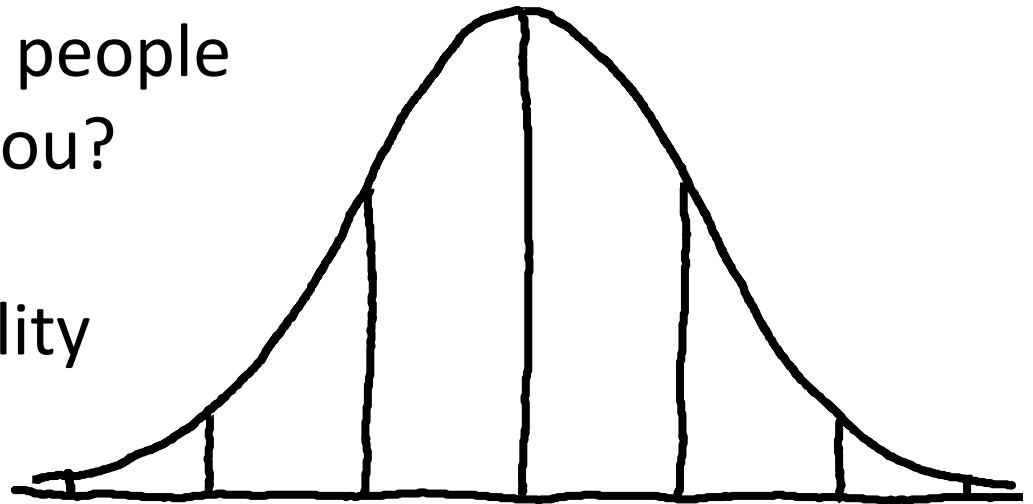
Check-up time

NORMAL DISTRIBUTION

PARANORMAL DISTRIBUTION
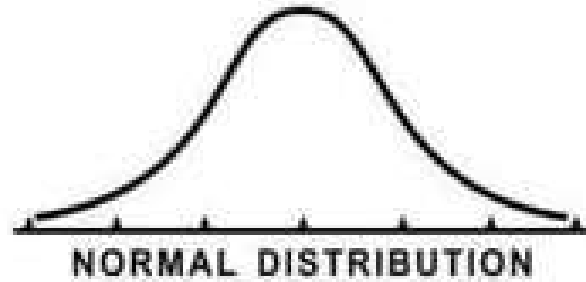
Using *z*-scores (example)

Each SAT test is curved so the mean 500 with σ=100. Let's say you score 625 on the SAT Math.

1. What is my z-score? $\dfrac{625-500}{100}=1.25$

2. What percentage of people scored worse than you?

3. What is the probability of doing better than 625?

More examples

In a Normal distribution, what is the probability of each of the following?
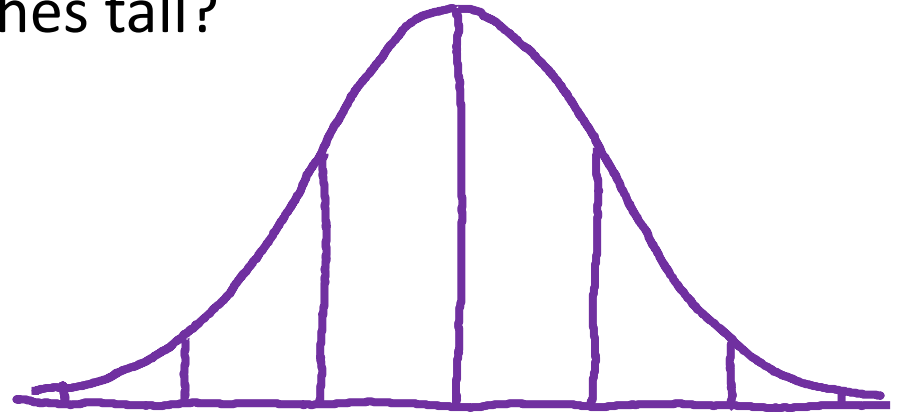
1.   z ≤ 1.5

2.   z ≥ 1.5

3.   -1.5 ≤ z ≤ 1.5

4.   -0.7 ≤ z ≤ 1.5

Example of test problem

The heights of American men are approximately normally distributed, with a mean of μ=70 inches and a standard deviation of σ=3 inches. What percentage of American men are at least as tall as Mr. Colligan, who is 75 inches tall?

$$z = \frac{75-70}{3} = 1.67$$

Area under 1.67 → .9525
Area above 1.67 → 1 - .9525 = .0475

About 4.75% of American men are at least as tall as Mr. Colligan.

You try

The level of cholesterol in the blood is important because high cholesterol levels may increase the risk of heart disease. The distribution of blood cholesterol levels in a large population of people of the same age and sex is roughly Normal. For 14-year-old boys, the mean is μ=170 milligrams of cholesterol per deciliter of blood (mg/dl) and the standard deviation is σ=30 mg/dl. Levels above 240 mg/dl may require medical attention.

1. What percent of 14-year-old boys have more than 240 mg/dl of cholesterol?

2. If a particular 14-year-old boy is at the 30th percentile for cholesterol, what is that boy's cholesterol level?

Door/Window <u>Competition</u>

- Each of you writes a z-score on your whiteboard

- Show each other

- Calculate the area between those z-scores.

- Winner → First with the correct answer written on their whiteboard.

- Best of 3 rounds

Stations

- Piece of paper titled "Stations", with name.
- Hard surface to write on (e.g. notebook, whiteboard)

- 7 Stations around room
  - A. Outlier rule, 1.5xIQR   (**TWO**, #1-4)
  - B. SOCS practice   (**TWO**, #5)
  - C. Make a histogram   (**TWO**, #6)
  - D. Normal quantile plots   (**TWO**, #7)
  - E. Calculate z-scores   (**ONE**, #8-10)
  - F. Use your z-chart   (**ONE**, #11-14)
  - G. Full z-score problems   (**FOUR**, #15-16)

- Complete **SEVEN** points, ~20 minutes.

Station A:
1.5xIQR

For each of the following data sets, identify any outliers. Show your work. No calculator graphs.

1. 0, 0, 5, 6, 7, 18
2. 1, 2, 2.3, 5, 7, 22
3. 10, 20, 30, 110, 111, 112
4. -52, -5, 0, 11, 25, 26, 30, 31, 76

Station B:
Practice with SOCS

These are the self-reported number of hours my Period 1 students spent on the computer during the last day of their summer vacation.

5. Comment on the data.

Time on comp.
0
0
0
0
0
1
2
2
2
2
3
3
3
4
4
5
6
11

Station C:
Histograms

These are my Period 3 students' guesses of my age.

6. Make a histogram that represents these guesses.

Period 3
25
26
26
26
27
27
27
27
27
28
29
30
30
30
30
32
32
33
33
34
35
36
36
36
37
40
43

Station D: n=32
Normal quantile plots

These are my Period 4 students' guesses of my age.

7. Use a calculator to make a Normal quantile plot of these data. Do you think these data appear approximately Normal?

25	32
25	33
25	33
25	34
26	35
26	36
26	36
26	36
26	37
28	40
29	43
30	45
30	45
30	48
30	49
32	52

Station E:
Using the z-score formula

Assume Normality for the following questions.

8. I score 93% on a test. The average was 85%, with a standard deviation of 6.5%. What is my z-score?

9. An In-n-Out hamburger weighs an average of 0.7 pounds, with σ=0.025. If my burger has a z-score of -3.6, how much does my hamburger weigh?

10. An average American adult male weighs 170 pounds. If my weight of 147 gives me a z-score of -1.4375, what is the standard deviation of the weights of adult American males?

Station F:
Using the z-chart

Use Table C to calculate the probability of each of the following:

11.z ≤ 0.83

12.z ≥ 1.24

13.0.2 ≤ z ≤ 1.21

14.-0.89 ≤ z ≤ 2.06

Station G:
Using *z* in the real world

15. The heights of adult American men is Normal with mean 69 inches and standard deviation 2.5 inches. How tall must a man be to be in the tallest 10% of all adult men?

16. One of the most popular IQ tests is called the "Stanford-Binet Intelligence Scale". Scores on this test are generally Normally distributed with a mean of 95 and $\sigma=15$.

    a. If someone scores at the 16th percentile, about what score did that individual have?

    b. Suppose that among 1000 individuals, a person named Einstein scores 130. How many of those 1000 individuals scored higher than Einstein?

Grudgeball

- Groups of 3. Everyone has a whiteboard.
- Assign group members to be A, B, or C. I will also give you a group number. Put that letter *and* your group number at the top of your whiteboard.
- I will put up a problem. Solve it on your whiteboard. Ask your group for help. Use your notes.
- I will call out a letter. Those group members show their whiteboards. *One point* for a correct answer.
- If correct, that person shoots for bonus points. *One*, or *three,* or *four* bonus points.
- Every group starts with 10 points. You can add points to your total, remove them from other groups, or both.
  - Group totals must stay within $0 \leq$ score ≤ 10.
  - You must "spend" your points immediately.
  - Shooting order is from left to right, highest score to lowest score.
- Winners → +5 extra credit

Exit Pass (AP)

Assume the SAT Mathematics section is Normally distributed with a mean of 500 and standard deviation σ=100. Standardize these scores:

1. 500   2. 350   3. 724

4. What is the probability of scoring higher than 724 on the SAT Mathematics test?

5. Mr. Colligan's students have a mean grade of 74 with σ=7. Mr. Hook's students have a mean grade of 78 with σ=18. Both give A's to students scoring 90 or more. Who gives out more A's? Justify your answer with appropriate percentile calculations.

Station A: ANSWERS
1.5xIQR

For each of the following data sets, identify any outliers. Show your work. No calculator graphs.

1. 0, 0, 5, 6, 7, 18   IQR=7•1.5=10.5. 0-10.5=-10.5. 7+10.5=17.5. 18 is an outlier.

2. 1, 2, 2.3, 5, 7, 22 IQR=5•1.5=7.5. 2-7.5=-5.5. 7+7.5=14.5. 22 is an outlier.

3. 10, 20, 30, 110, 111, 112. IQR=91•1.5=136.5. 20 - 136.5 = -116.5. 111+136.5=247.5. No outliers.

4. -52, -5, 0, 11, 25, 26, 30, 31, 76. 30.5-(-2.5)=33•1.5=49.5. -2.5-49.5= -52. 30.5+49.5=80. -52 is maybe(?) an outlier.
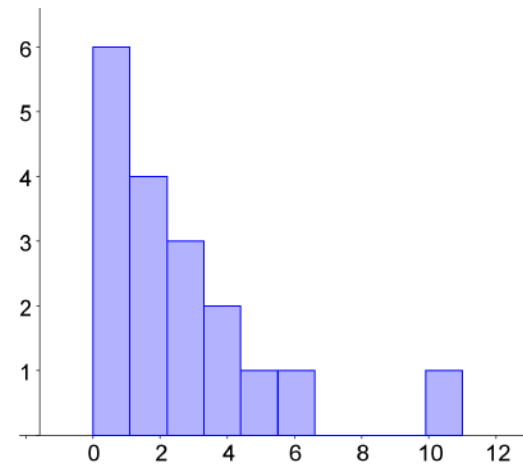
Station B: ANSWERS
Practice with SOCS

Skewed right. 11 is an outlier according to the 1.5xIQR rule. Median is 2. Interquartile range is 4.

Most of my Period 1 students spent between 0-4 hours on their computer on the last day of summer vacation, although a few students spend quite a bit more time.

Min	0
Q1	0
Med	2
Q3	4
Max	11

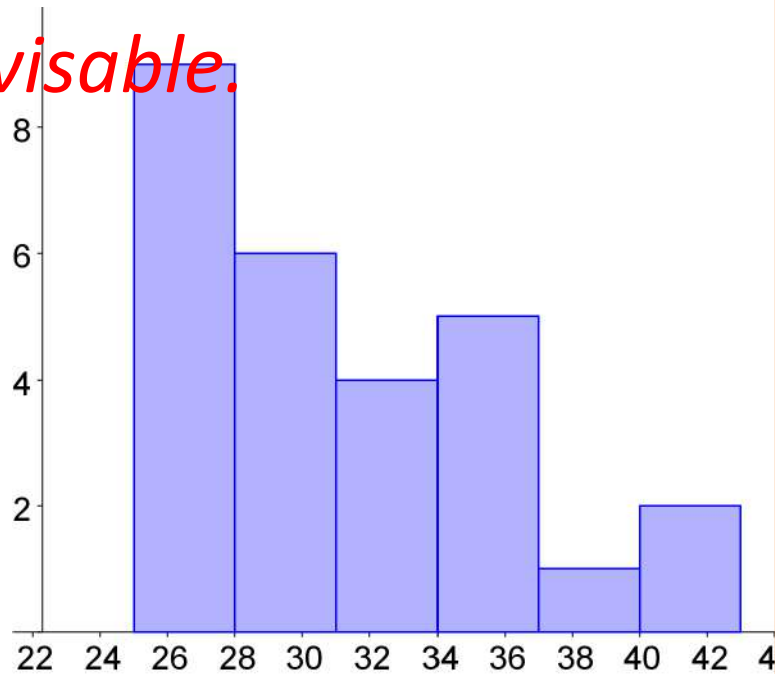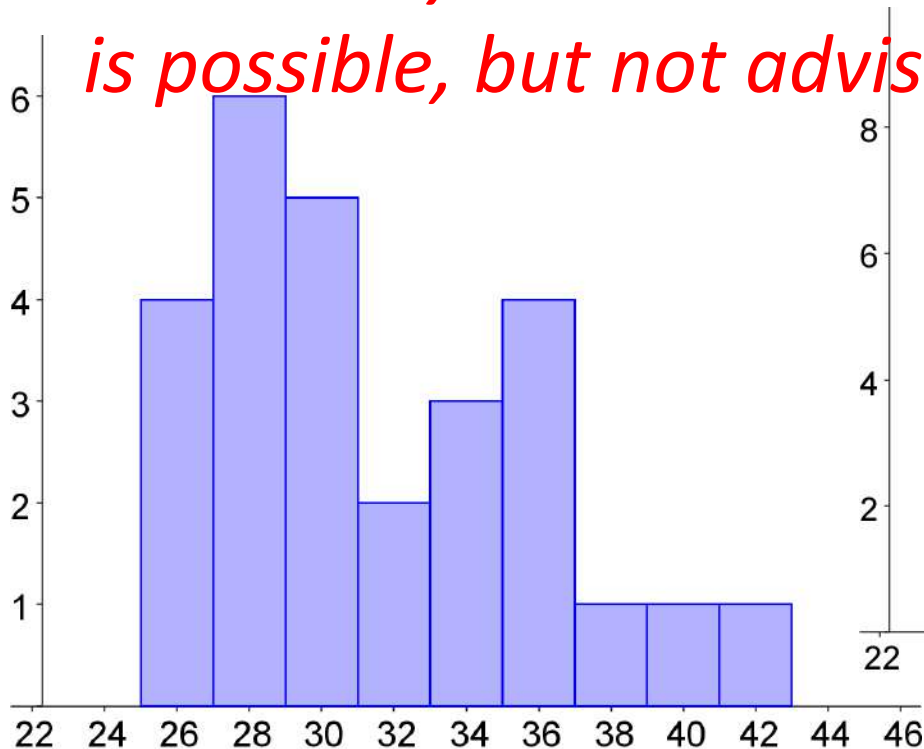| Time on comp. |
|---------------|
| 0 |
| 0 |
| 0 |
| 0 |
| 0 |
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| 2 |
| 2 |
| 2 |
| 2 |
| 3 |
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| 3 |
| 4 |
| 4 |
| 5 |
| 6 |
| 11 |

Station C: ANSWERS
Histograms

*With a range of 43-25=**18**, you can reasonably use 6 or 9 classes. 3 classes is possible, but not advisable.*
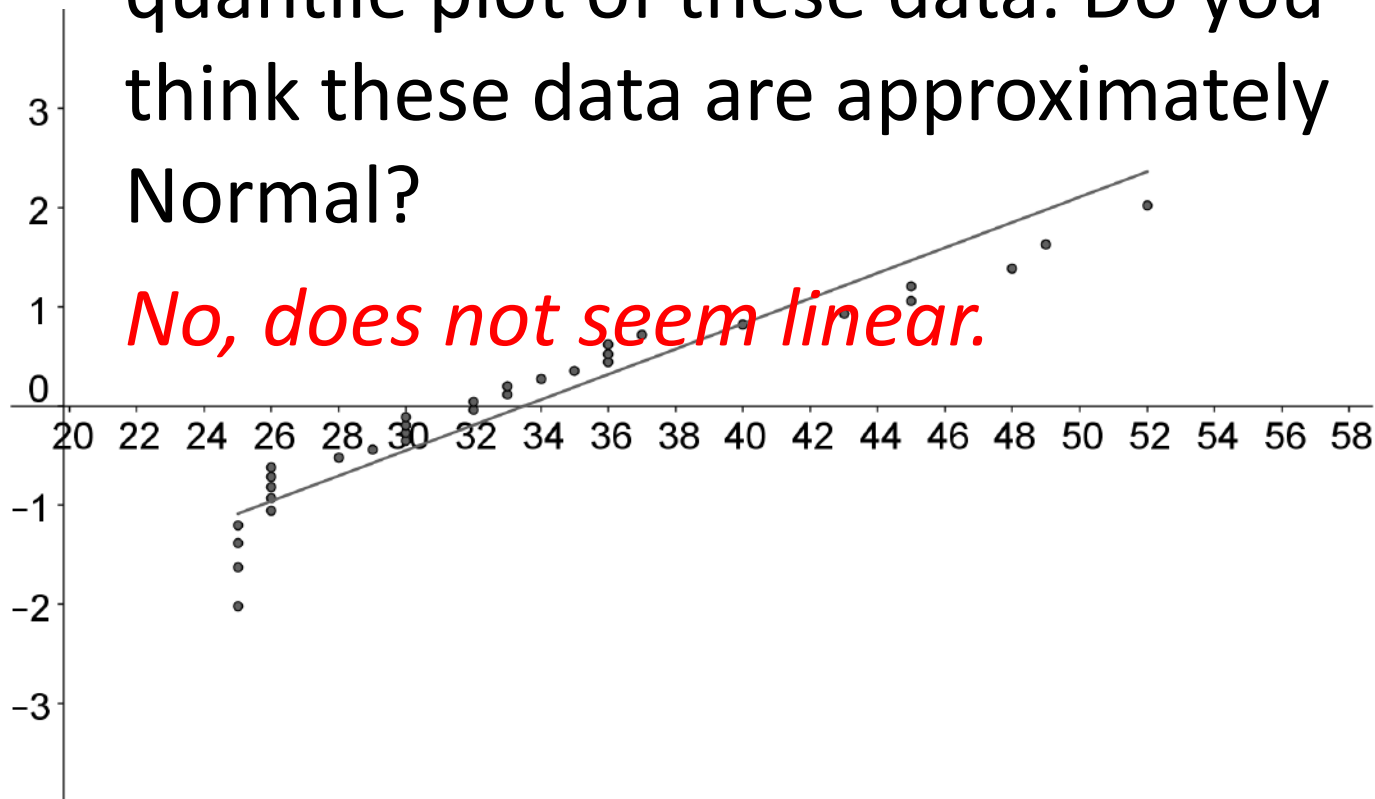

Period 3
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37
40
43

Station D: ANSWERS n=32
Normal quantile plots

Use a calculator to make a Normal quantile plot of these data. Do you think these data are approximately Normal?

No, does not seem linear.

25	32
25	33
25	33
25	34
26	35
26	36
26	36
26	36
26	37
28	40
29	43
30	45
30	45
30	48
30	49
32	52

Station E: ANSWERS
Using the z-score formula

8. I score 93% on a test. The average was 85%, with a standard deviation of 6.5%. What is my z-score?

$$z = \frac{93 - 85}{6.5} = 1.23$$

9. An In-n-Out hamburger weighs an average of 0.7 pounds, with σ=0.025. If my burger has a z-score of -3.6, how much does my hamburger weigh?

$$-3.6 = \frac{x - 0.7}{0.025}$$

$$x = 0.61$$

10. An average American adult male weighs 170 pounds. If my weight of 147 gives me a z-score of -1.4375, what is the standard deviation of the weights of adult American males?

$$-1.4375 = \frac{147 - 170}{\sigma}$$

$$\sigma = 16$$

Station F: ANSWERS
Using the z-chart

Use Table C to calculate the probability of each of the following:

11. $z \leq 0.83$ **0.7967**

12. $z \geq 1.24$ 1 - 0.8925 = **0.1075**

13. $0.2 \leq z \leq 1.21$ 0.8869 – 0.5793 = **0.3076**

14. $-0.89 \leq z \leq 2.06$ 0.9803 – 0.1867 =
          0.7936

Station G: ANSWERS

15. The heights of adult American men is Normal with mean 69 inches and standard deviation 2.5 inches. How tall must a man be to be in the tallest 10% of all adult men?

90th percentile in chart

$$1.28 = \frac{x-69}{2.5}$$

$$x = 72.2$$

16. One of the most popular IQ tests is called the "Stanford-Binet Intelligence Scale". Scores on this test are generally Normally distributed with a mean of 95 and σ=15.

    a. If someone scores at the 16th percentile, about what score did that individual have?

16th percentile in chart

$$-0.99 = \frac{x-95}{15}$$

$$x = 80.15$$

    b. Suppose that among 1000 individuals, a person named Einstein scores 130. How many of those 1000 individuals scored higher than Einstein?

$$z = \frac{130-95}{15} = 2.33$$

Looked up z=2.33 in chart

$$1 - 0.9901 = 0.0099$$

$$0.0099 \bullet 1000 = 9.9$$