JOHNS HOPKINS
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SCHOOL of PUBLIC HEALTH

Section C

Normal Scores and Variability in Non-normal Data

Why Do We Like the Normal Distribution So Much?

- The truth is, there is nothing "special" about standard normal scores
  - These can be computed for observations from any sample/ population of continuous data values
  - The score measures how far an observation is from its mean in standard units of statistical distance

Why Do We Like The Normal Distribution So Much?

- However, unless population/sample has a well known, “well behaved” (like a normal) distribution, we may not be able to use mean and standard deviation to create interpretable intervals, or measure “unusuality” of individual observations

Hospital Length of Stay Example

- Random sample of 500 patients
  - Mean length of stay: 4.8 days
  - Median length of stay: 3 days
  - Standard deviation: 6.3 days

- Data in Stata

```
list hospstay in 1/10

     +----------+
     | hospstay |
     |----------|
  1. |        2 |
  2. |        7 |
  3. |        4 |
  4. |        5 |
  5. |        6 |
     |----------|
  6. |        5 |
  7. |        1 |
  8. |        1 |
  9. |        1 |
 10. |        1 |
     +----------+
```

Hospital Length of Stay Example

- Random sample of 500 patients
  - Mean length of stay: 4.8 days
  - Median length of stay: 3 days
  - Standard deviation: 6.3days

```
. summarize  hospstay

    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
    hospstay |       500       4.808    6.282521         1         60
```

Hospital Length of Stay Example

- Summarize command with detail option

```
summarize  hospstay, detail
```

```
                          hospstay
-------------------------------------------------------------
      Percentiles      Smallest
 1%             1             1
5%              1             1
10%             1             1       Obs                 500
25%             1             1       Sum of Wgt.         500

50%             3                     Mean              4.808
                        Largest       Std. Dev.      6.282521
75%             5            37
90%            11            37       Variance       39.47008
95%            17            39       Skewness       3.622325
99%            35            60       Kurtosis       21.68121
```

Hospital Length of Stay Example

- Summarize command with detail option

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summarize  hospstay, detail

                          hospstay
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50%             3                     Mean              4.808
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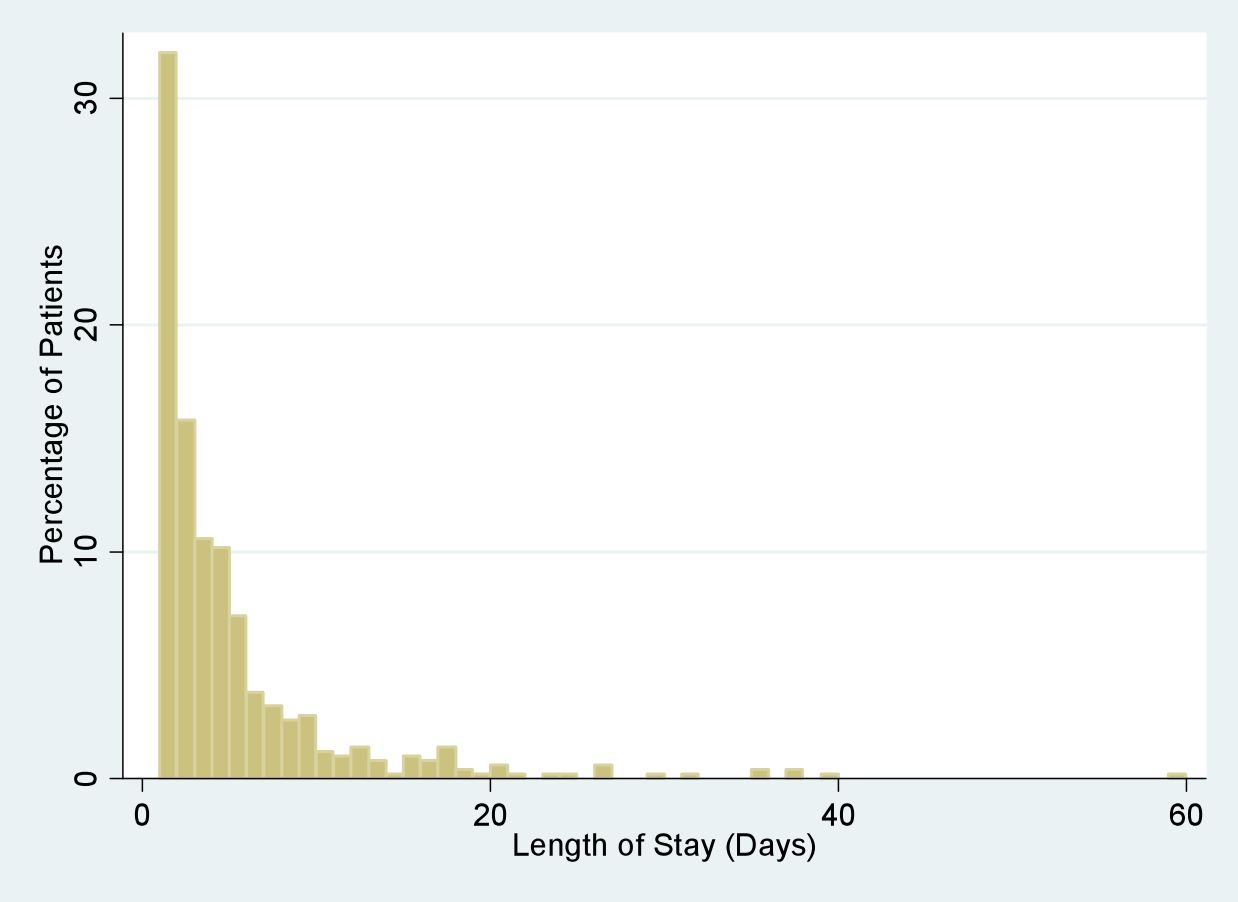
```

Hospital Length of Stay Example

- Histogram of sample data



Constructing Intervals

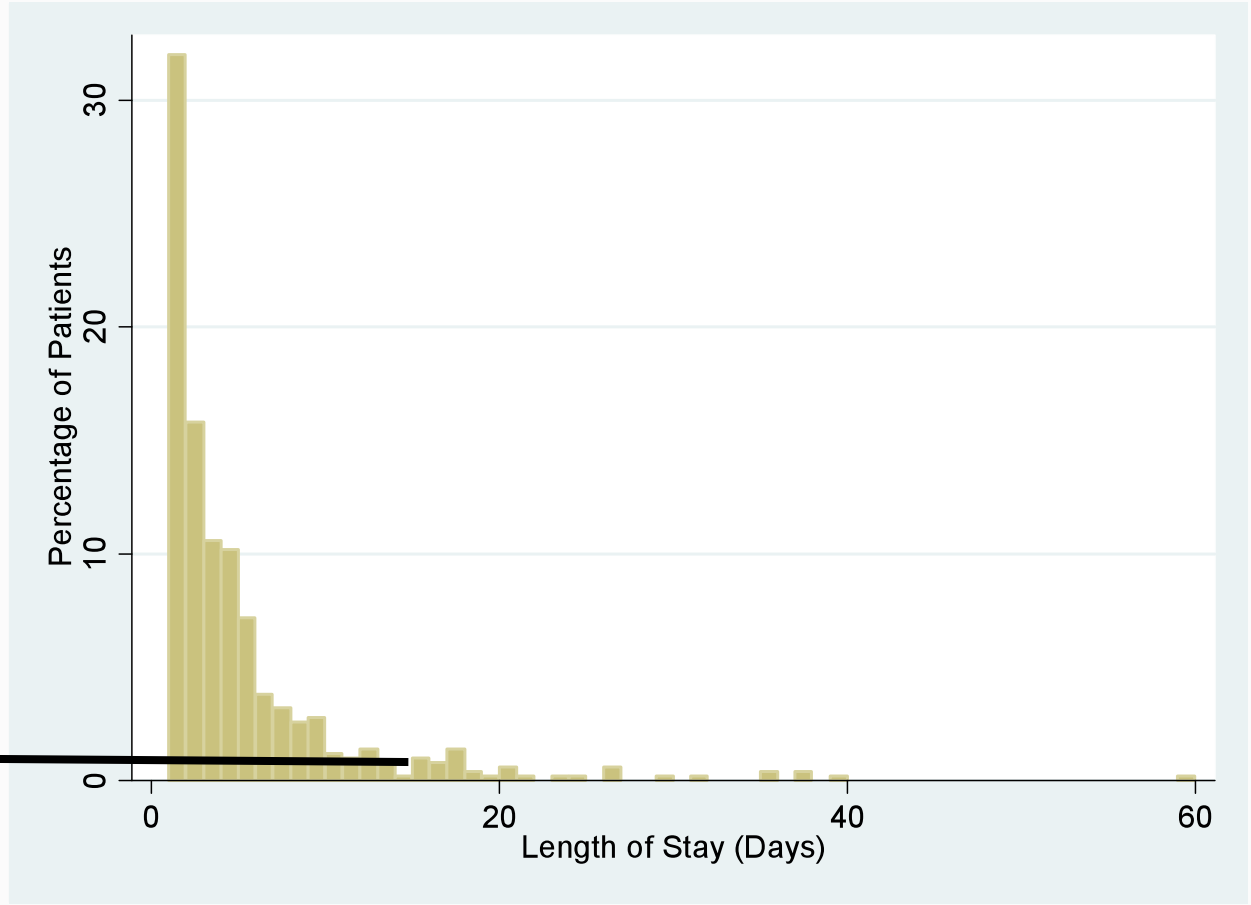
- Suppose I wanted to estimate an interval containing roughly 95% of the values of hospital length of stay in the population

- Distribution right skewed—can not appeal to properties/methods of normal distribution!

- Mean ± 2SDs
  - $4.8 \pm 2 \times 6.3$
  - This gives an interval from -7.8 to 17.4 days!

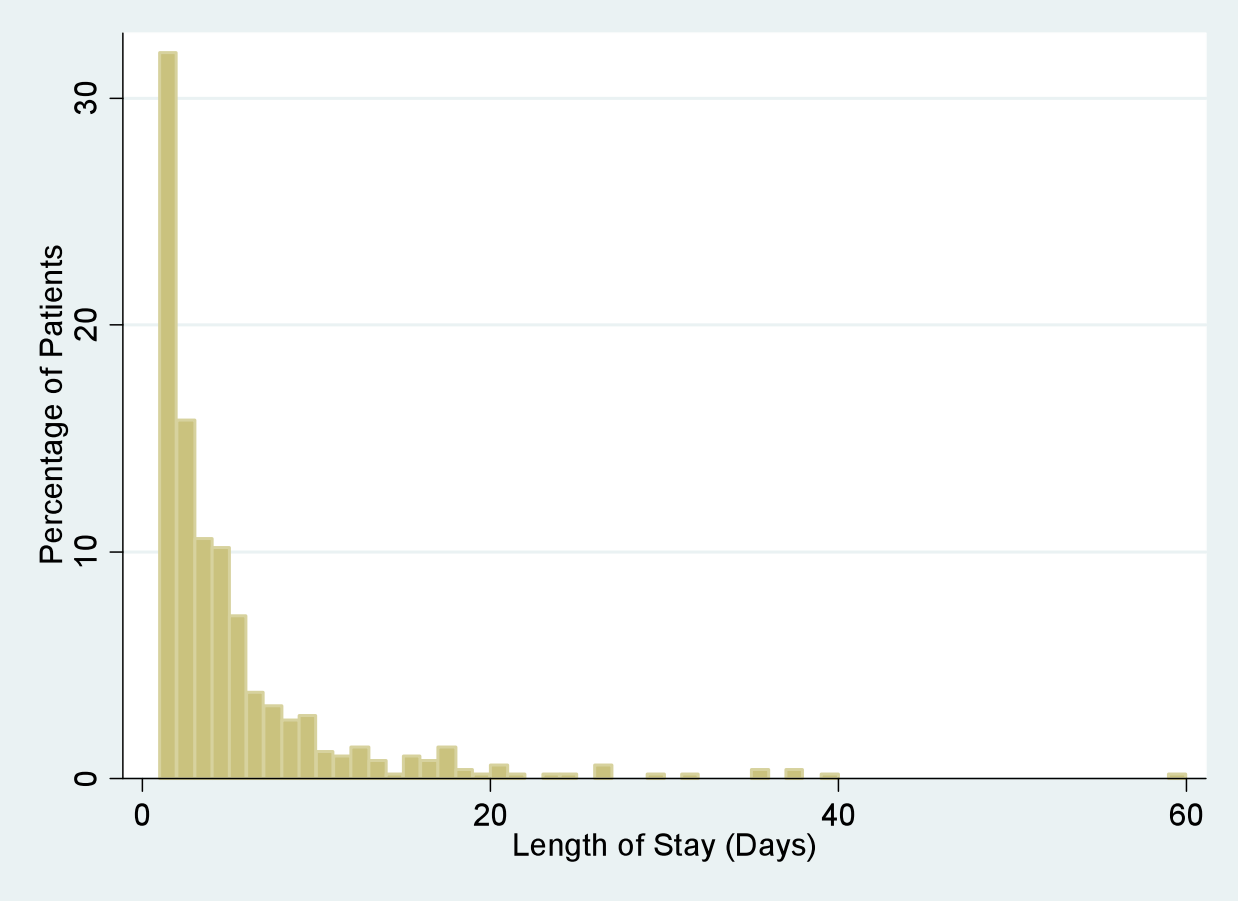
Hospital Length of Stay Example

- Histogram of sample data



Constructing Intervals

- We would need to estimate this interval from the histogram and/or by finding sample percentiles



Constructing Intervals

- Using percentiles
  - Syntax *"centile varname, c(#1, #2, . . .)"*

```
. centile hospstay, c(2.5,97.5)

                                                       -- Binom. Interp. --
    Variable |     Obs  Percentile      Centile        [ 95% Conf. Interval]
-------------+-------------------------------------------------------------
    hospstay |     500         2.5             1                1           1
             |                97.5        23.475         17.69772    32.67554
```

Constructing Intervals

- Using percentiles
  - Syntax *"centile varname, c(#1, #2, . . .)"*

```
. centile hospstay, c(2.5,97.5)
```

Variable	Obs	Percentile	Centile	-- Binom. Interp. -- [95% Conf.	Interval]
hospstay	500	2.5	1	1	1
		97.5	23.475	17.69772	32.67554

  - So based on this sample data we estimate that 95% of discharged patients had length of stay between 1 and 24 days

Constructing Intervals

- What percentage of patients had length of stay greater than five days?
- (Wrong approach) z-score $z = \frac{5 - 4.8}{6.4} = 0.03$
- Assuming normality, this would suggest that nearly 50% of the patients had length of stay greater than five days

Hospital Length of Stay Example

- According to percentiles, five days is the 75th percentile: so only 25% of the sample have length of stay over 5 days

```
summarize  hospstay, detail
```

hospstay

Percentiles		Smallest		
1%	1	1		
5%	1	1		
10%	1	1	Obs	500
25%	1	1	Sum of Wgt.	500
50%	3		Mean	4.808
		Largest	Std. Dev.	6.282521
75%	5	37		
90%	11	37	Variance	39.47008
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