

# Assistive Technologies for Second-Year Statistics Students who are Blind

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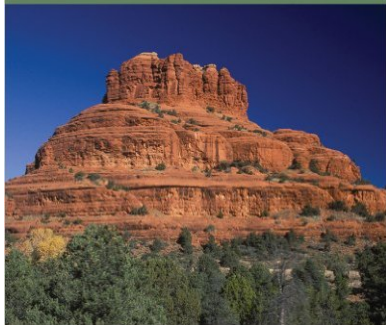
# Intro

- At Wake Forest University, a student who is blind enrolled in a second course in statistics. The course covered simple and multiple regression, model diagnostics, model selection, data visualization, and elementary logistic regression.
- Specifically, this talk will detail the extensive use of screen readers, L<sup>A</sup>T<sub>E</sub>X, a modified use of R and the BrailleR package, a desktop Braille embosser, and a modified classroom approach.
- Americans with Disabilities Act of 1990 and Section 504 of the Rehabilitation Act of 1973.

# Intro

## STAT2 | Building Models for a World of Data

Ann R. Cannon • George W. Cobb • Bradley A. Hartlaub  
Julie M. Legler • Robin H. Lock • Thomas L. Moore  
Allan J. Rossman • Jeffrey A. Witmer



# Intro

- There are six essential skills:

	Interpreting	Producing
Mathematical Writing	✓	✓
Computer Code	✓	✓
Images and Graphical Displays	✓	✓

# High Peaks



- $n = 46$  so-called “High Peaks” mountains of the Adirondacks in upstate New York
- Two variables are Time (hours needed for a round trip to hike to summit) and Length (miles).

$$Time = \beta_0 + \beta_1 \cdot Length + \epsilon, \quad \epsilon \sim N(0, \sigma)$$

# High Peaks

```
> library(Stat2Data)
> data(HighPeaks)
> attach(HighPeaks)
> lm1=lm(Time~Length)
> summary(lm1)
```

Call:

```
lm(formula = Time ~ Length)
```

Residuals:

Min	1Q	Median	3Q	Max
-2.4491	-0.6687	-0.0122	0.5590	4.0034

Coefficients:

	Estimate	Std. Error	t value	Pr(> t )
(Intercept)	2.04817	0.80371	2.548	0.0144 *
Length	0.68427	0.06162	11.105	2.39e-14 ***

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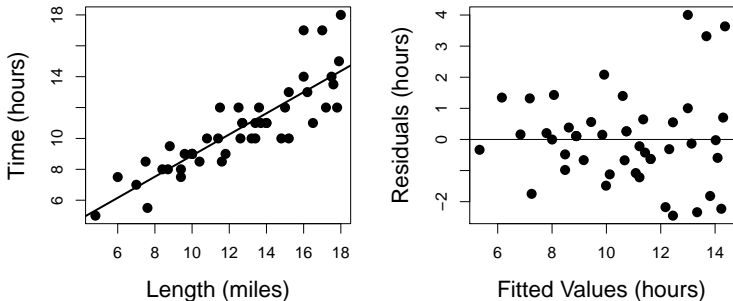
Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 1.449 on 44 degrees of freedom

Multiple R-squared: 0.737, Adjusted R-squared: 0.7311

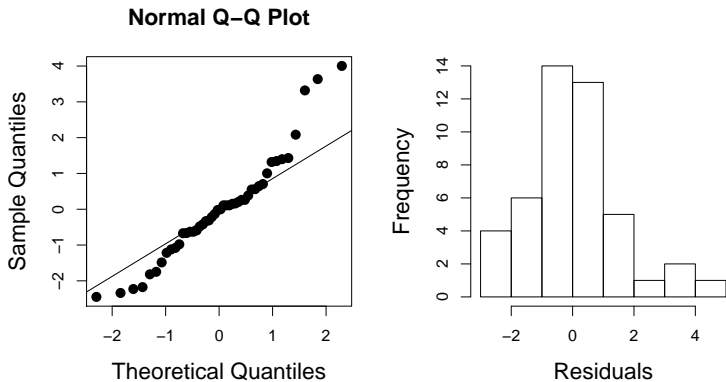
F-statistic: 123.3 on 1 and 44 DF, p-value: 2.39e-14

## High Peaks



**Figure:** Scatterplot and Residual plot for Time (hours) vs. Length (miles). Students will use these figures to assess assumptions of linearity and constant variance.

# High Peaks



**Figure:** Quantile comparison and histogram of residuals.

# Intro

There are six essential skills:

	Interpreting	Producing
Mathematical Writing	✓	✓
Computer Code	✓	✓
Images and Graphical Displays	✓	✓

## Mathematical Writing: JAWS® Screen Reader

Well, it ain't no use to sit and wonder why, babe  
Even you don't know by now  
And it ain't no use to sit and wonder why, babe  
It'll never do somehow  
When your rooster crows at the break of dawn  
Look out your window, and I'll be gone  
You're the reason I'm a-traveling on  
But don't think twice, it's all right.

~ Bob Dylan, Don't Think Twice

(play sound)

## Mathematical Writing: Braille

- Grade 2 standard English Braille has  $2^6 - 1 = 63$  unique characters; not enough for math!
- 8-bit Braille extends to  $2^8 - 1 = 255$  characters, and covers all ASCII symbols



- All mathematical information can be encoded in ASCII through  $\text{\LaTeX}$ ; therefore, a student can **read** math with a refreshable Braille display or using a screen reader, and can **write** using either a refreshable Braille display or a standard keyboard.
- Effectively, the student reads and writes in  $\text{\LaTeX}$  source code, and “compiles” in her head.

# Mathematical Writing

$$Time = \beta_0 + \beta_1 \cdot Length + \epsilon, \quad \epsilon \sim N(0, \sigma)$$

$$C_p = \frac{SSE_m}{SSE_k/(n-k-1)} + 2(m+1) - n$$

`Time = \beta_0 + \beta_1 \cdot Length + \epsilon,`  
`\hspace{4mm} \epsilon \sim N(0, \sigma)`

`C_p = \frac{SSE_m}{SSE_k/(n-k-1)} + 2(m+1) - n`

(fast)

(middle speed)

(slow)

# Mathematical Writing



BrailleNote® by HumanWare

# Statistical Software

Rterm (32-bit)

```
> txtStart(file="HW1.txt")
Output being copied to text file,
use txtStop to end
txt> getwd()
[1] "C:/Users/WFU2012"
txt> data(HighPeaks)
txt> attach(HighPeaks)
The following object(s) are masked from 'HighPeaks (position 3)':

    Ascent, Difficulty, Elevation, Length, Peak, Time
txt> lm1=lm(Time~Length)
txt> UI(hist(lm1$resid))
Error in hist.default(lm1$resid) : 'x' must be numeric
txt> UI(hist(lm1$resid))

This is a histogram, with lm1$resid marked on the x-axis, unless
used the xlab argument.
There are a total of 46 elements for this variable.
It has 8 bins with equal widths, starting at -3 and ending at 5.
The mids and counts for the bins are...
mid = -2.5 count = 4
mid = -1.5 count = 6
mid = -0.5 count = 14
mid = 0.5 count = 13
mid = 1.5 count = 5
mid = 2.5 count = 1
mid = 3.5 count = 2
mid = 4.5 count = 1

txt>
```

C:\Users\WFU2012\HW1.txt

C:\Users\WFU2012\HW1.txt

```
> getwd()
[1] "C:/Users/WFU2012"
> data(HighPeaks)
> attach(HighPeaks)
The following object(s) are masked from 'HighPeak':

    Ascent, Difficulty, Elevation, Length, Peak, '
> lm1 = lm(Time ~ Length)
> VI(hist(lm1$resid))

This is a histogram, with lm1$resid marked on the
There are a total of 46 elements for this variable.
It has 8 bins with equal widths, starting at -3 and ending at 5.
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```

- Modify the PATH variable to allow R to run in the terminal window
- Use the BrailleR package and the command txtStart keeps a log file; keep open in an internet browser and refresh

# Images and Graphical Displays

```
>VI(hist(lm1$resid))
```

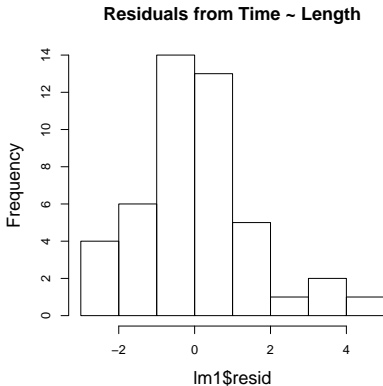
This is a histogram, with `lm1$resid` marked on the x-axis, unless you explicitly used the `xlab` argument.

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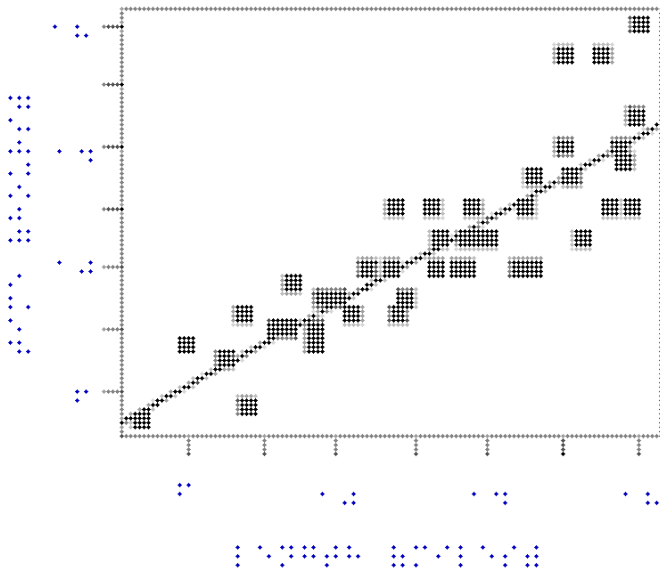
It has 8 bins with equal widths, starting at -3 and ending at 5.

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mid = 3.5	count = 2
mid = 4.5	count = 1



## Images and Graphical Displays



## Conclusion and References

- Cannon, A., Cobb, G., Hartlaub, B., Legler, J., Lock, R., Moore, T., Rossman, A., Witmer, J, (2013), *Stat2: Building Models for a World of Data*, New York, NY W.H. Freeman.
- Erhardt, R., Shuman, M. (2015). Assistive Technologies for Second-Year Statistics Students who are Blind. *Journal of Statistics Education* 23:2, 1-28.
- Godfrey, A. J. R. (2013), "Statistical Software from a Blind Person's Perspective," *R Journal*, 5(1), 73-79.
- Godfrey, A. J. R., Erhardt R.J. (2014), "Addendum to Statistical Software from a Blind Person's Perspective," *R Journal*, 6(1), 182.
- Godfrey, A. J. R. (2012), "BrailleR: Improved access for blind useRs," 2012. R package version 0.4. [p77]

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