Use ciTools to answer important questions about your data quickly and easily

- Compare results against thresholds
- Quantify uncertainty
- Estimate mission-critical statistics
The New Heavy Truck (NHT) has a requirement to be able to stop quickly from a speed of 20 mph.
What do the data look like?

```r
# A tibble: 50 x 2
  speed dist
  <dbl> <dbl>
1   4.0 2.0
2   4.0 10.0
3   7.0  4.0
4   7.0 22.0
5   8.0 16.0
6   9.0 10.0
7  10.0 18.0
8  10.0 26.0
9  10.0 34.0
10 11.0 17.0
# ... with 40 more rows
```
Plotting the data

Stopping Distance vs. Truck Speed

- Stopping Distance (ft)
- Truck Speed (mph)
Requirement:

“NHT must have a stopping distance of less than 75 feet”
Plotting the requirement shows that we’re doing pretty well, but...
We should use a confidence interval for that comparison!

Stopping Distance vs. Truck Speed: 95% Confidence Interval
“At 20 MPH, the NHT’s average stopping distance is less than 75 feet, meeting the requirement with statistical confidence.”
“At 20 MPH, the NHT’s average stopping distance is less than 75 feet, meeting the requirement with statistical confidence.”

But what if we want to say more?
It may be more interesting to know about the population rather than the average.
“At 20 MPH, the NHT’s average stopping distance is less than 75 feet, and an NHT traveling 20 MPH will be able to stop within 75 feet most of the time.”
“At 20 MPH, the NHT’s average stopping distance is less than 75 feet, and an NHT traveling 20 MPH will be able to stop within 75 feet most of the time.”

What if we want to be more specific?
We can compute the probability of stopping within the required distance!
“At 20 MPH, the NHT will stop in less than the required 75 feet 81 percent of the time”
“At 20 MPH, the NHT will stop in less than the required 75 feet 81 percent of the time”

What if the requirement is written differently?
Alternative Requirement:

“NHT must be able to stop within 75 feet 90 percent of the time.”
We can estimate the 90\textsuperscript{th} percentile and compare it to the requirement.
“NHT will have a stopping distance less than 75 feet 90 percent of the time if it’s speed is less than 18.5 mph.”
We can make all of these plots quickly and easily in R using the ciTools package.
Confidence Intervals
ciTools::add_pi(tb, fit)

Stopping Distance vs. Truck Speed: 95% PI

Prediction Intervals
ciTools::add_probs(tb, fit, p)

Probability Stopping Distance is Less Than 75 ft

Probability Estimates

Pr(Dist < 75ft) vs. Truck Speed (mph)
ciTools::add_quantile(tb, fit, q)
Uniformity in \texttt{ciTools}

\texttt{ciTools} works for many types of models, but the syntax doesn’t change

<table>
<thead>
<tr>
<th>Confidence Intervals</th>
<th>Prediction Intervals</th>
</tr>
</thead>
<tbody>
<tr>
<td>\texttt{add_ci(data, model, ...)}</td>
<td>\texttt{add_pi(data, model, ...)}</td>
</tr>
<tr>
<td><strong>Probabilities</strong></td>
<td><strong>Quantiles</strong></td>
</tr>
<tr>
<td>\texttt{add_probs(data, model, quantile, ...)}</td>
<td>\texttt{add_quantile(data, model, probability, ...)}</td>
</tr>
</tbody>
</table>
Automatically chooses the right method based on your model
## Scope of ciTools

<table>
<thead>
<tr>
<th>R object</th>
<th>Confidence Intervals</th>
<th>Prediction Intervals</th>
<th>Probabilities</th>
<th>Quantiles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linear Models</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Skewed Data (Lognormal)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Count/Binary Data (GLMs)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Random Group Data (Mixed Models)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Skewed Random Group Data</td>
<td>In Progress...</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Survival/Censored Data Models</td>
<td>Future Work</td>
<td>Future Work</td>
<td>Future Work</td>
<td>Future Work</td>
</tr>
</tbody>
</table>

...
\texttt{add_pi(tb, fit, type = "boot")}

\textbf{PI for Binomial GLM}
add_ci(tb, fit, includeRanef = T)

Random slope mixed model
ciTools fits in with your existing workflow!

```r
library(tidyverse)
library(ciTools)
library(viridis)

fit <- lm(mpg ~ cyl + hp + I(hp^2) , data = mtcars)
mtcars %>%
  expand(cyl, hp) %>%
  add_ci(fit, alpha = .2, names = c("lower", "upper"), yhatName = "Miles per Gallon") %>%
  mutate(cyl = as.factor(cyl)) %>%
  ggplot(aes(x = hp, y = `Miles per Gallon`, colour = cyl, fill = cyl)) +
  geom_line(size = 2) +
  geom_ribbon(aes(ymin = lower, ymax= upper), alpha = .4) +
  scale_colour_viridis(discrete = T) +
  scale_fill_viridis(discrete = T)
```

Learn how to use ciTools

Tutorials available for free via R or on GitHub!
Get ciTools where R packages are found!

install.packages("ciTools")

install_github("jthaman/ciTools")