



ciTools: Quantifying Uncertainty in R

Matthew Avery

Institute for Defense Analyses

John Haman

Bowling Green State University

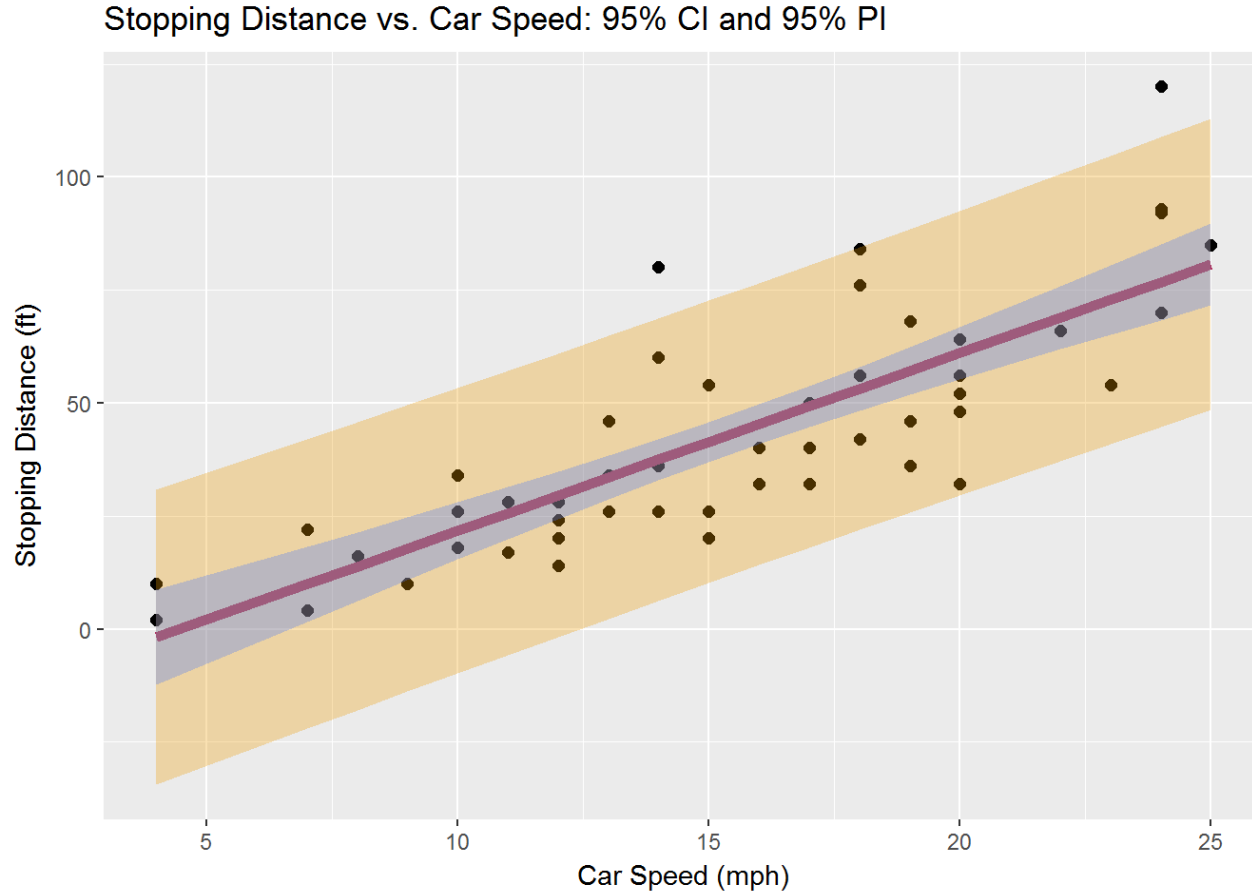
1 February 2018

Use ciTools to add uncertainty estimates to your tibble

```
library(ciTools)
my_data %>%
  add_ci(model, names = c("lcb", "ucb"))
```

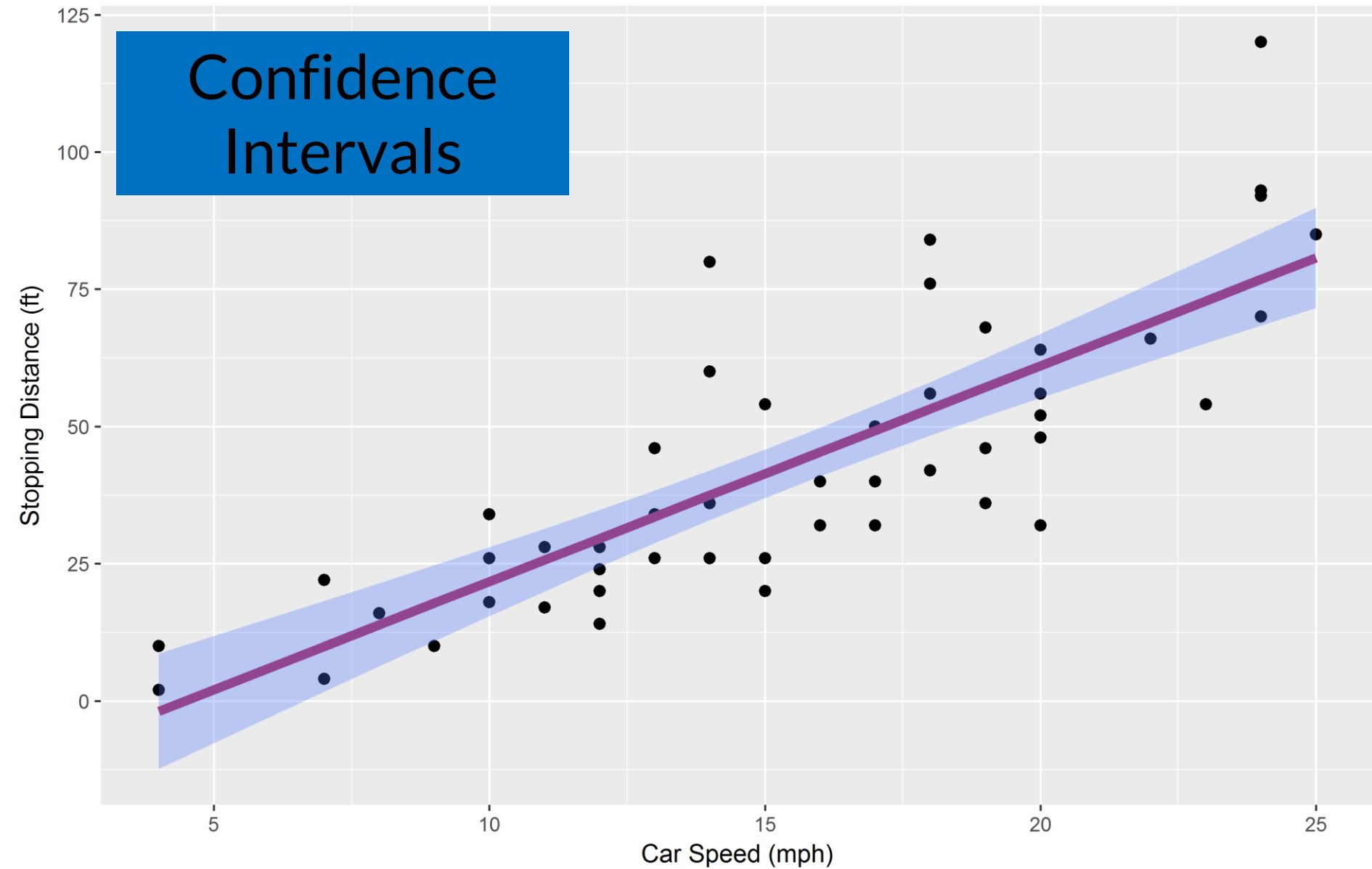
```
## # A tibble: 50 x 5
##   speed  dist    pred    lcb    ucb
##   <dbl> <dbl>   <dbl>   <dbl>   <dbl>
## 1     4     2 -1.849460 -12.329543  8.630624
## 2     4    10 -1.849460 -12.329543  8.630624
## 3     7     4  9.947766  1.678977 18.216556
## 4     7    22  9.947766  1.678977 18.216556
## 5     8    16 13.880175  6.307527 21.452823
## 6     9    10 17.812584 10.905120 24.720047
## 7    10    18 21.744993 15.461917 28.028068
## 8    10    26 21.744993 15.461917 28.028068
## 9    10    34 21.744993 15.461917 28.028068
## 10   11    17 25.677401 19.964525 31.390278
## # ... with 40 more rows
```

Quickly generate uncertainty intervals, quantiles estimates, and probabilities based on your fitted model



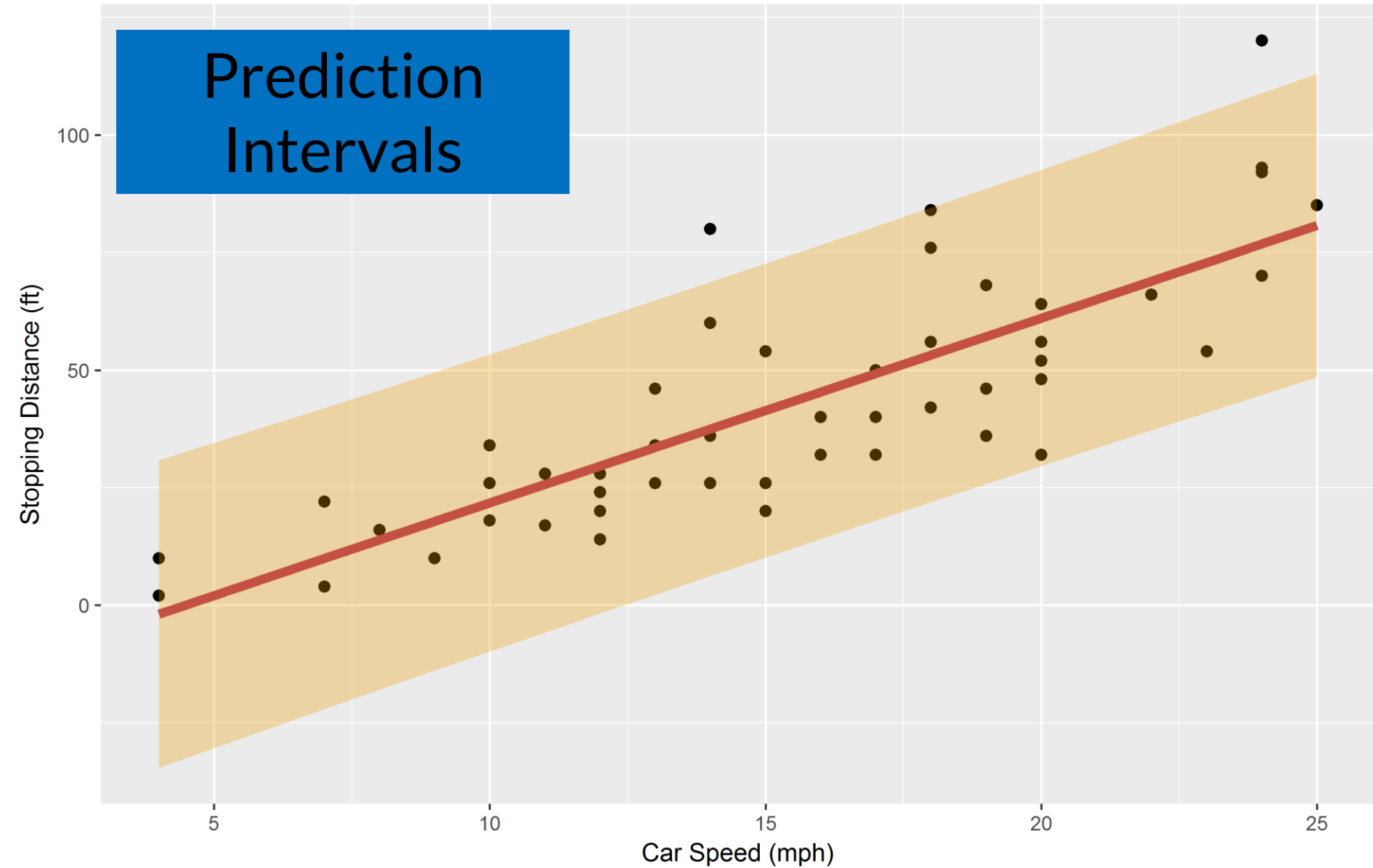
```
ciTools::add_ci(tb, fit)
```

Confidence Intervals

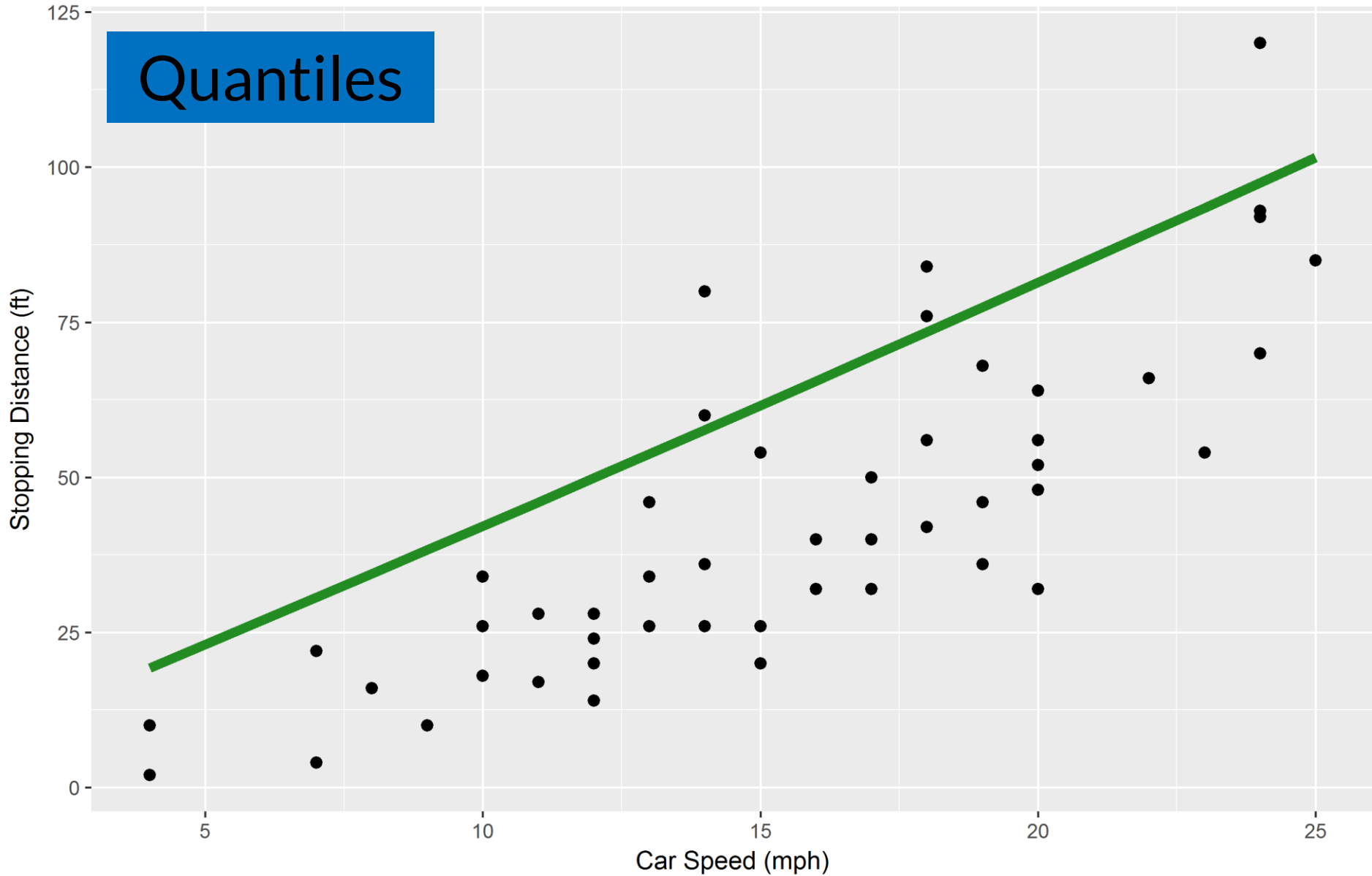


ciTools::add_pi(tb, fit)

Prediction
Intervals

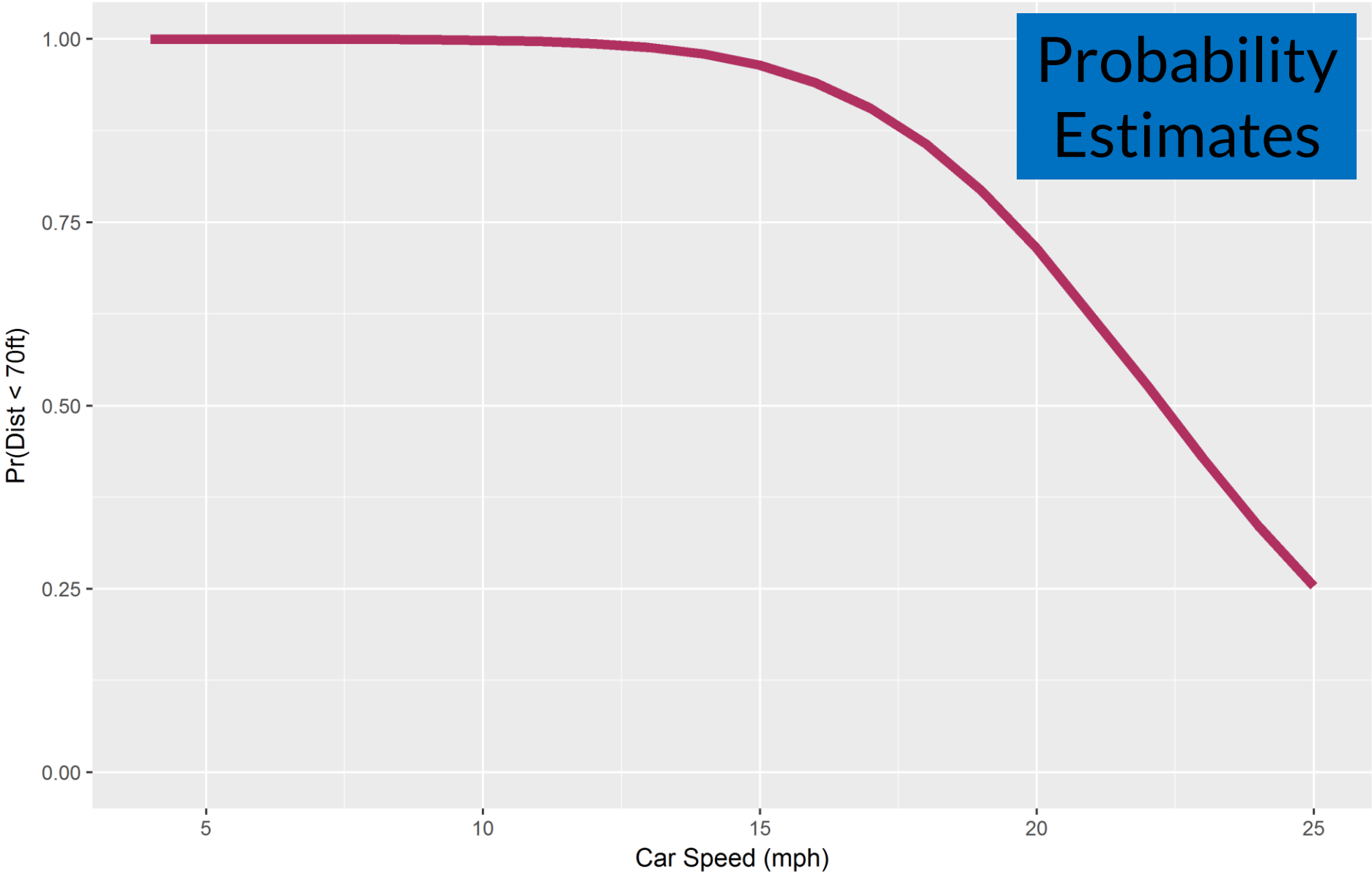


ciTools::add_quantile(tb, fit, q)



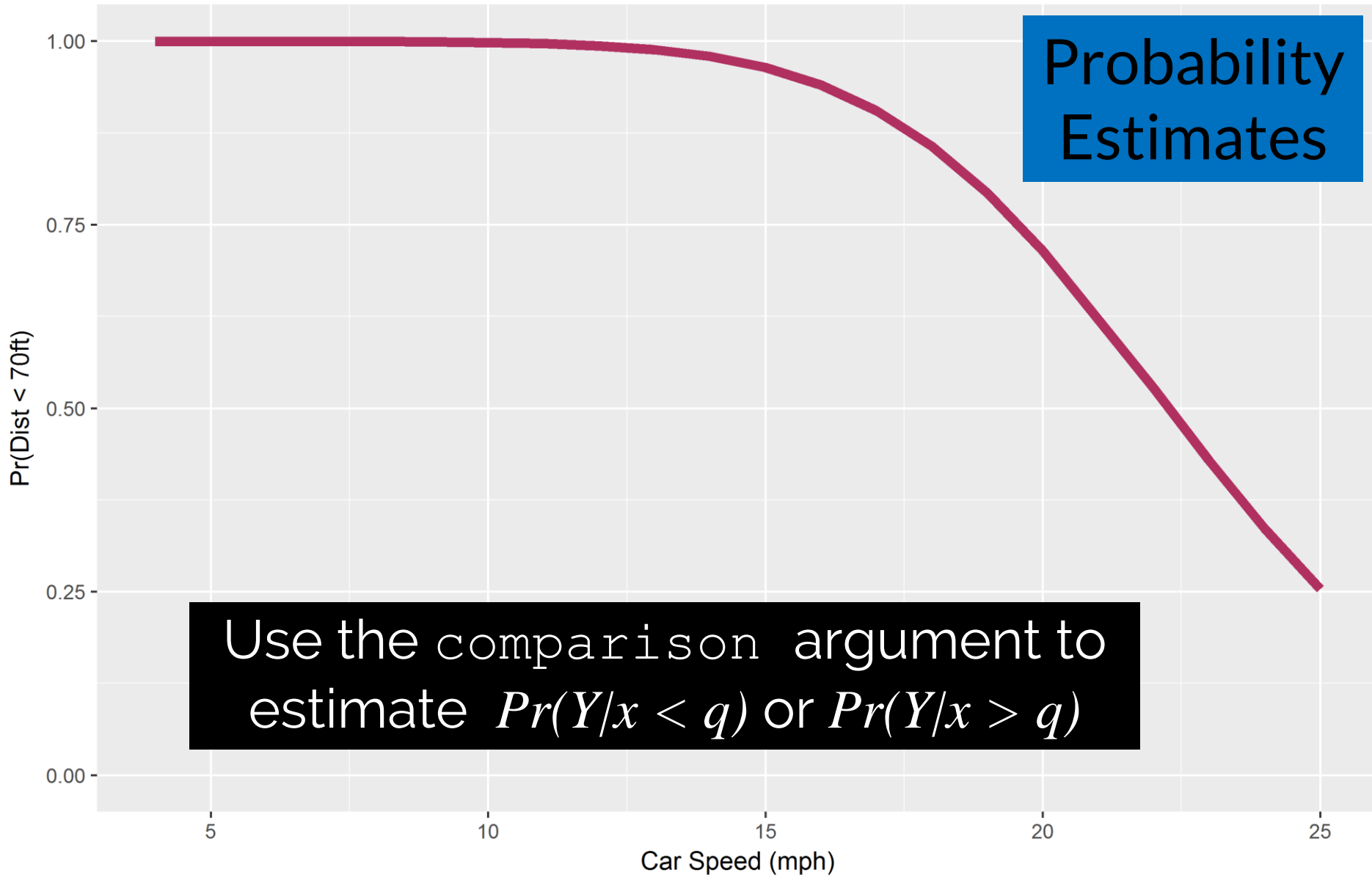
ciTools::add_probs(tb, fit, p)

Probability
Estimates



```
ciTools::add_probs(tb, fit, p)
```

Probability
Estimates



Uniformity in ciTools

ciTools works for many types of models, but the syntax doesn't change

Confidence Intervals <code>add_ci(data, model, ...)</code>	Prediction Intervals <code>add_pi(data, model, ...)</code>
Probabilities <code>add_probs(data, model, quantile, ...)</code>	Quantiles <code>add_quantile(data, model, probability, ...)</code>

Inspired by `modelr::add_predictions()`

```
modelr::add_predictions
function (data, model, var = "pred")
{
  data[[var]] <- stats::predict(model, data)
  data
}
```

Powered by generics...

```
add_ci <- function (tb, fit, alpha = 0.05,  
  names = NULL, yhatName = "pred", ...) {  
  
  UseMethod("add_ci", fit)  
  
}
```

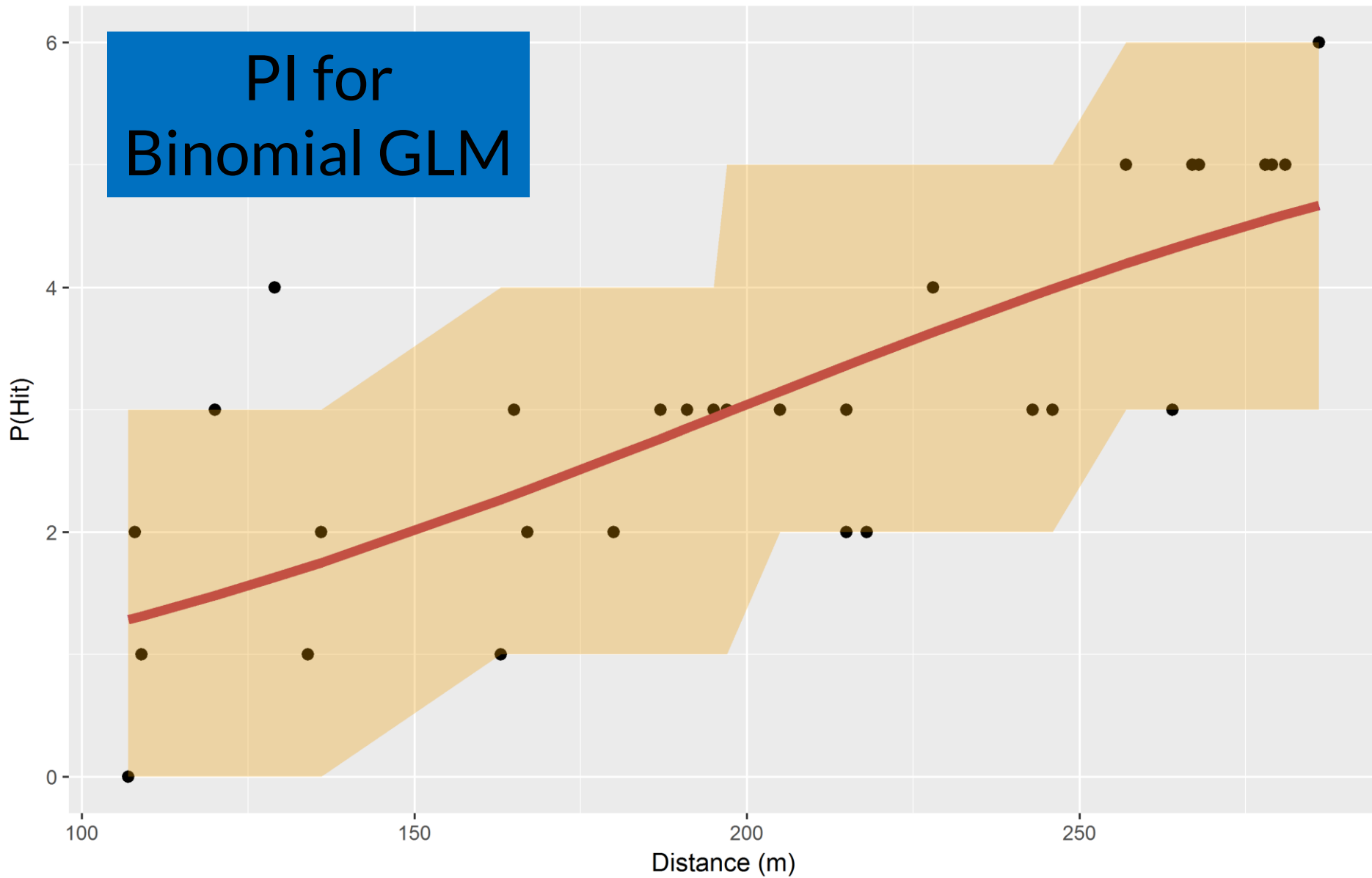
... which choose the right method based on your model

```
add_ci.lm <- function(tb, fit, alpha = 0.05, names = NULL,
  yhatName = "pred", log_response = FALSE, ...){
  ...
  out <- predict(fit, tb, interval = "confidence",
    level = 1 - alpha) tb[[names[1]]] <- out[, 2]
  tb[[names[2]]] <- out[, 3]
  tb
}
```

Scope of ciTools

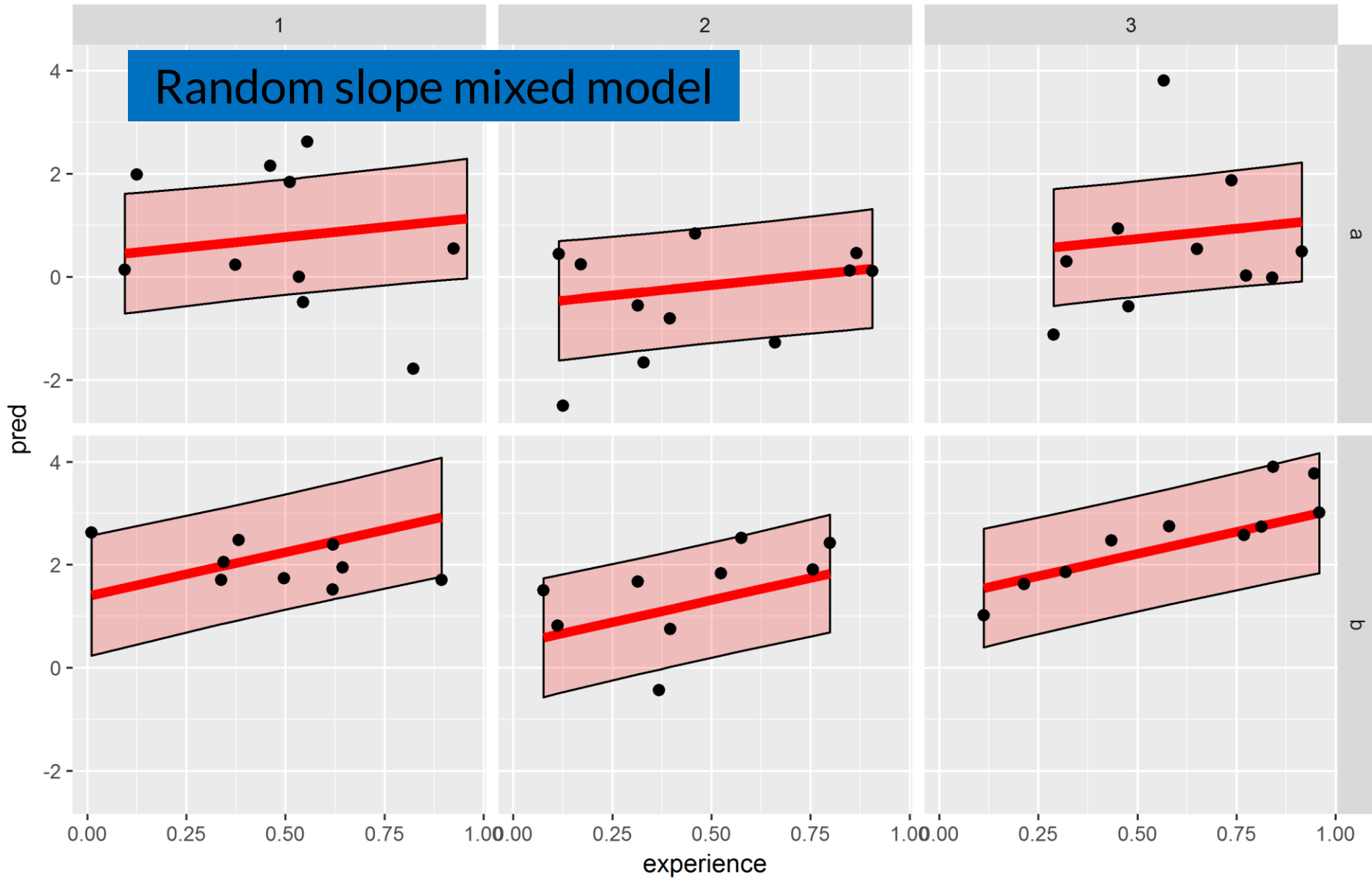
R object	Confidence Intervals	Prediction Intervals	Probabilities	Quantiles
<code>lm</code>	✓	✓	✓	✓
<code>lm(ln(y) ~...)</code>	✓	✓	✓	✓
<code>glm</code>	✓	✓	✓	✓
<code>merMod</code>	✓	✓	✓	✓
<code>lmer(ln(y) ~...)</code>	In Progress...	✓	✓	✓
<code>SurvReg</code>	Future Work	Future Work	Future Work	Future Work
...

```
add_pi.glm(fit, tb, type = "boot")
```



```
add_ci.lmerMod(tb, fit, includeRanef = T)
```

Random slope mixed model

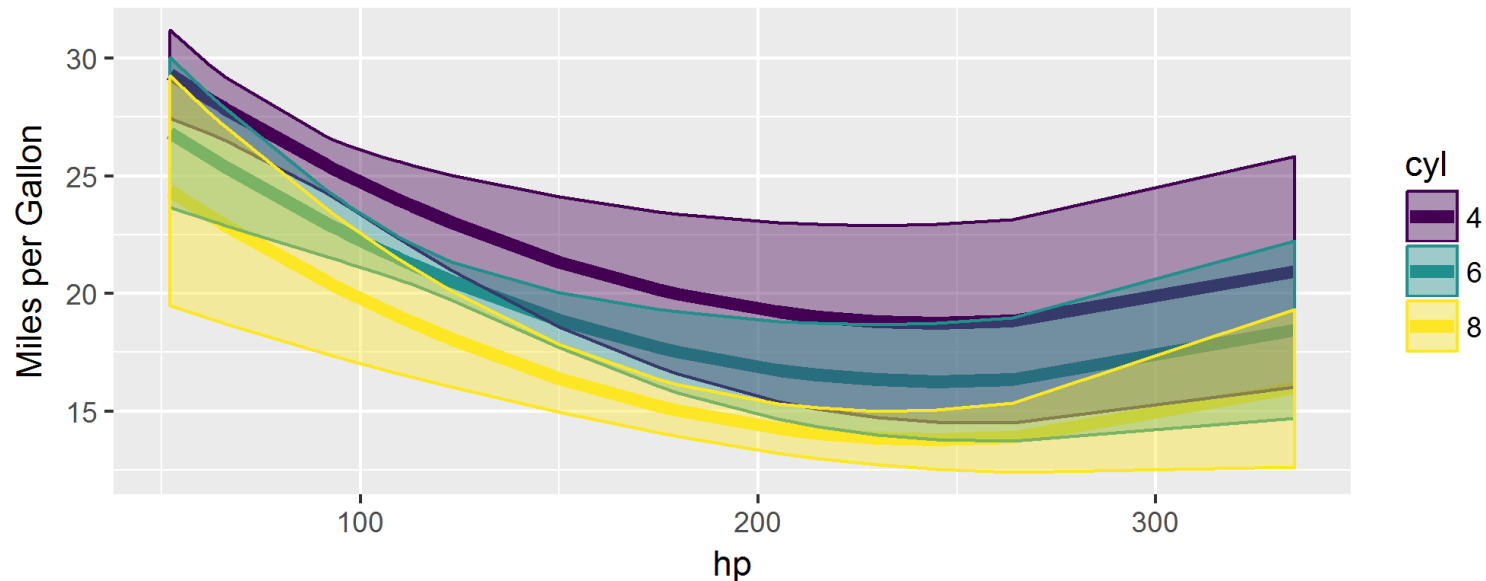


ciTools in the tidy workflow

```
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)
```



Get ciTools where R packages are found!



```
install.packages("ciTools")
```

```
install_github("jthaman/ciTools")
```

Learn how to use ciTools

- Introducing ciTools
CIs, PIs, quantiles, probabilities with lm
- Generalized Linear Models with ciTools
logistic, Poisson, quasi-Poisson methods, simulation studies
- Mixed Models with ciTools
Conditional and unconditional approaches, simulation studies
- Binomial Regression with ciTools
Binomial vs. Bernoulli logistic regression, relevant warning messages