Data609

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February 4, 2018

9. The data in the accompanying table show the speed n (in increments of 5 mph) of an automobile and the associated distance a_n in feet required to stop it once the brakes are applied. For instance, $n = 6$ (representing $6 \times 5 = 30$ mph) requires a stopping distance of $a_6 = 47$ ft.

a. Calculate and plot the change Δa_n versus n. Does the graph reasonably approximate a linear relationship?

b. Based on your conclusions in part (a), find a difference equation model for the stopping distance data. Test your model by plotting the errors in the predicted values against n. Discuss the appropriateness of the model.

n	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
a_n	3	6	11	21	32	47	65	87	112	140	171	204	241	282	325	376

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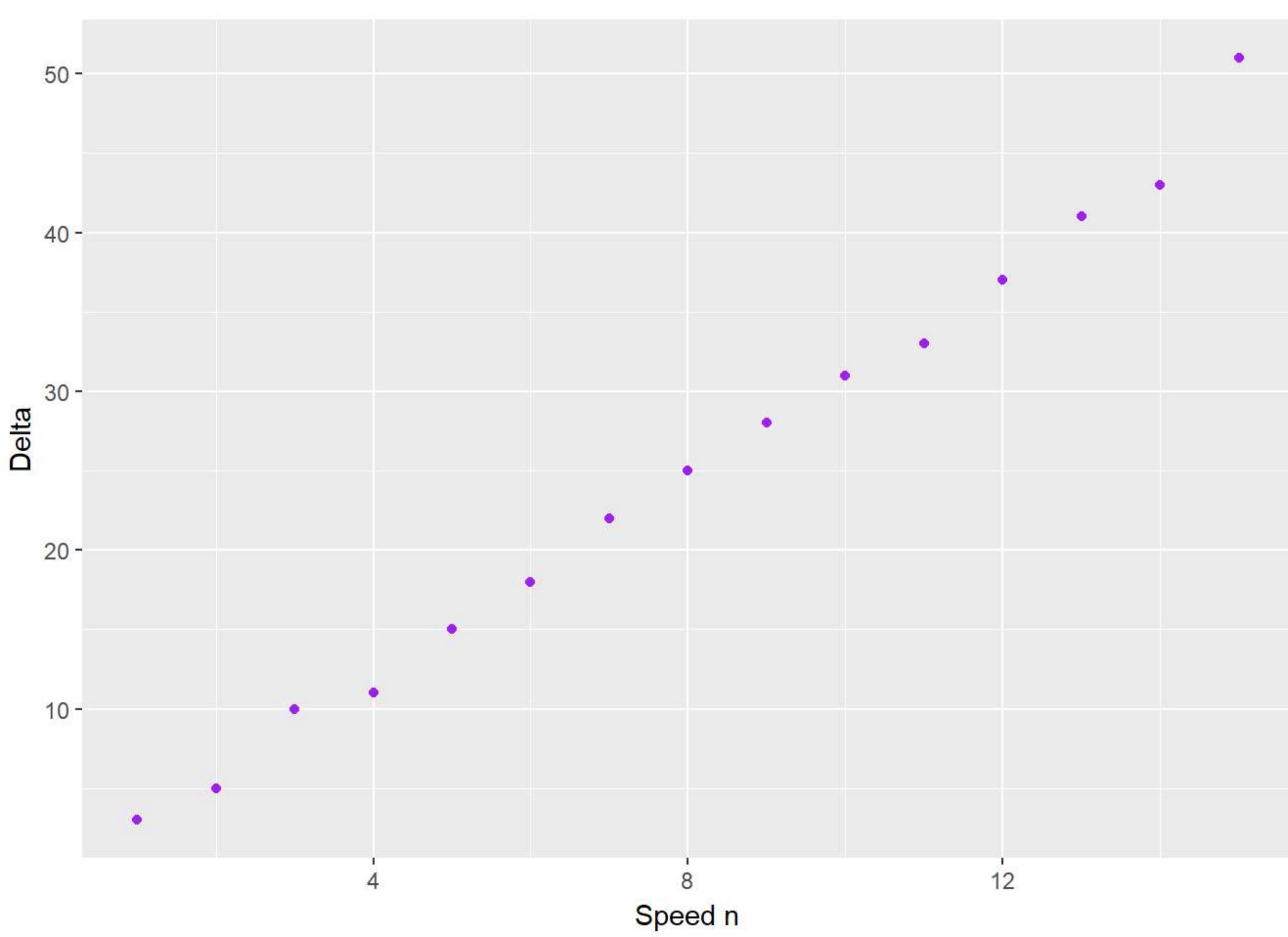
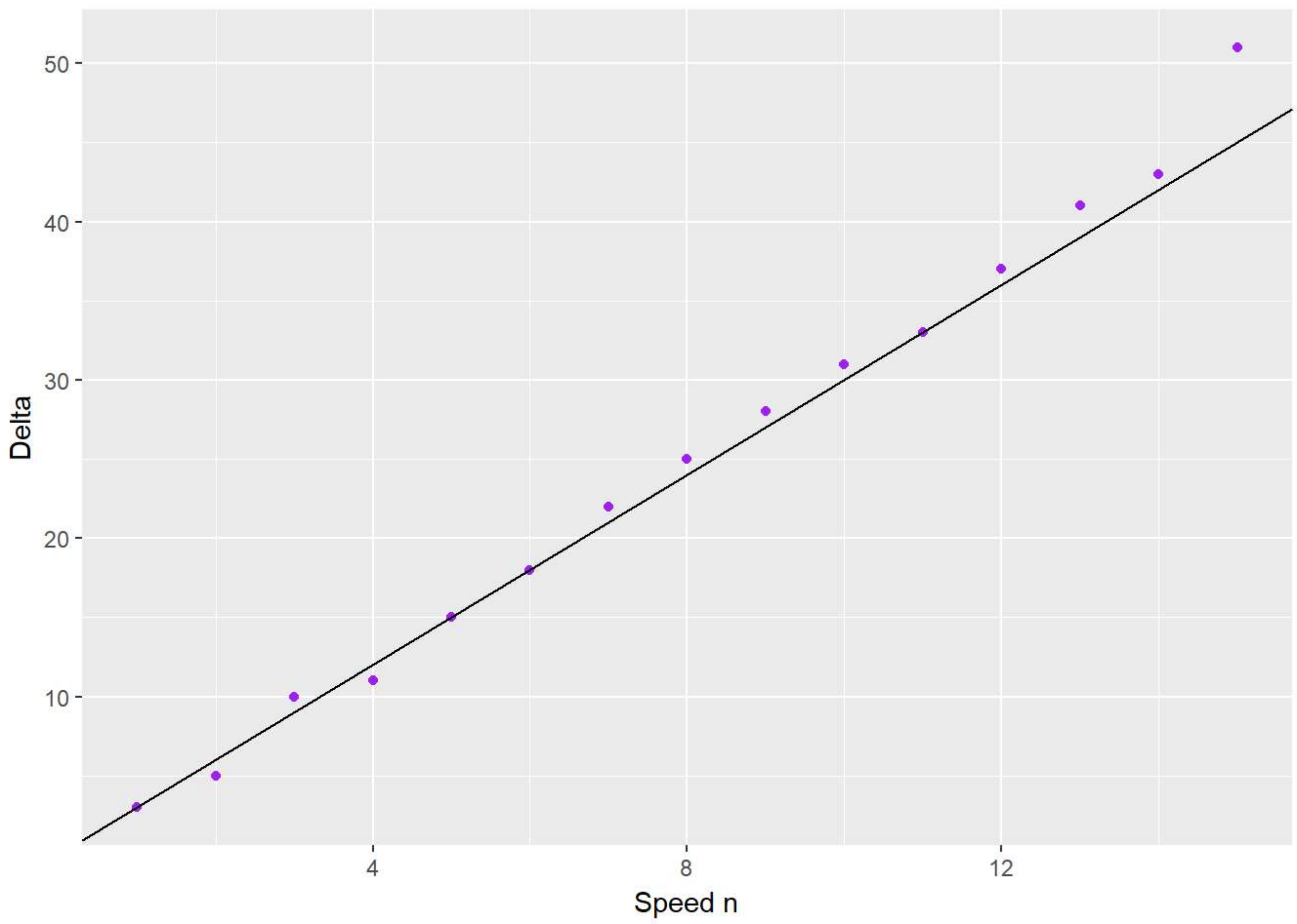
```
library(ggplot2)

# Set variables
n_vector <- seq(1, 15, 1)
delta_a <- c(3, 5, 10, 11, 15, 18, 22, 25, 28, 31, 33, 37, 41, 43, 51)

dt <- cbind.data.frame(n_vector, delta_a)

fig1 <- ggplot(dt, aes(x=n_vector, y=delta_a)) + geom_point(color = "purple")
fig1 <- fig1 +  xlab("Speed n") + ylab("Delta")

fig1
```



```
fig2 <- fig1 + geom_abline(intercept = 0, slope = 3)
fig2
```




```
p <- 1000
n <- 0
r0 <- 4
k <- 0.001

r <- r0
loop_continue <- TRUE
r_n <- double()

while(loop_continue){
  n <- n + 1
  b <- r
  r <- b + k*b*(p-b)
  i <- trunc(r)
  r_n <- c(r_n, i)

  if(i>=p){
    loop_continue <- FALSE
  }
}
```

13. Consider the spreading of a rumor through a company of 1000 employees, all working in the same building. We assume that the spreading of a rumor is similar to the spreading of a contagious disease (see Example 3, Section 1.2) in that the number of people hearing the rumor each day is proportional to the product of the number who have heard the rumor previously and the number who have not heard the rumor. This is given by

$$r_{n+1} = r_n + k r_n (1000 - {}_n)$$

where k is a parameter that depends on how fast the rumor spreads and n is the number of days. Assume $k = 0.001$ and further assume that four people initially have heard the rumor. How soon will all 1000 employees have heard the rumor?

Question 13

```
n_vector <- seq(1, 14, 1)


dt <- cbind.data.frame(n_vector, r_n)

fig3 <- ggplot(dt, aes(x=n_vector, y=r_n)) + geom_point(colour = "blue")
fig3 <- fig3 +  xlab("Days") + ylab("Number of People Rumor Reached")
fig3 <- fig3 + geom_text(aes(label = r_n, y=r_n-50), size = 3)

fig3
```