SCC 461 Coursework 0

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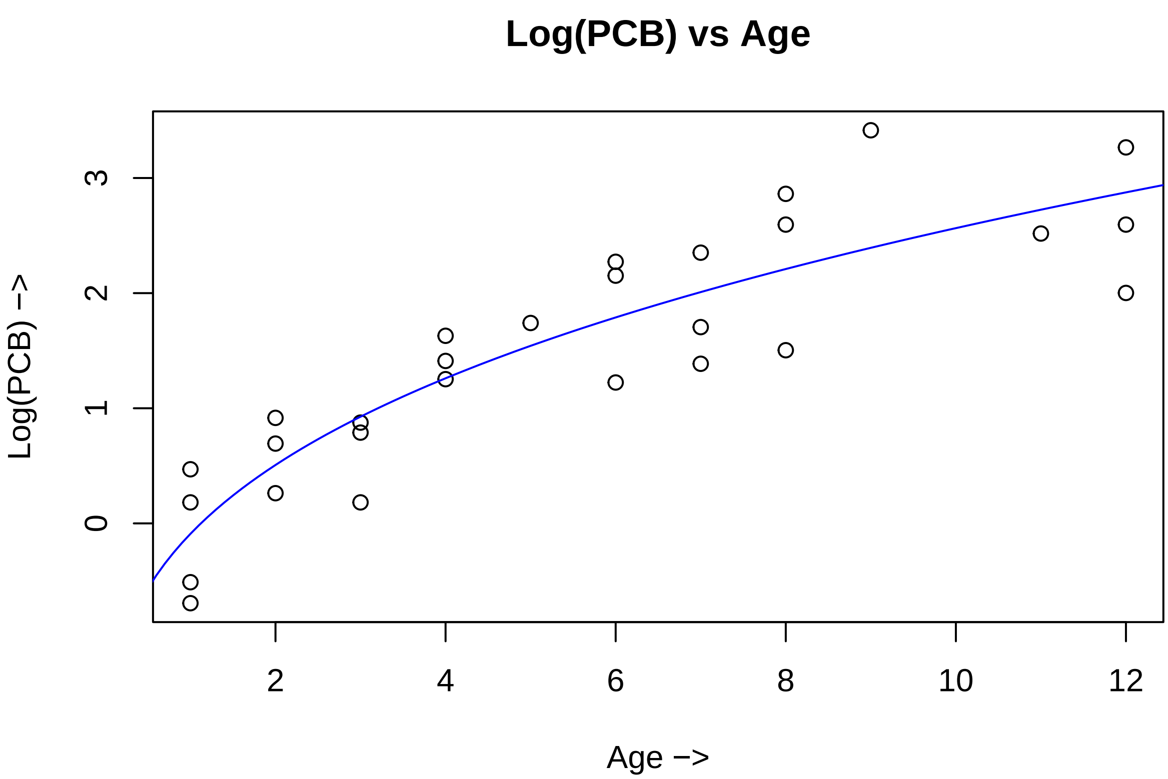
Q1. Write code for log(PCB) against age, reproducing the final plot containing both the equation line and the data points.

```
#Task 1 - Reproducing the plot for age vs. log(PCB)

ages <- seq(from=0, to=13, by=0.1)
a <- -2.3907
b <- 2.300
l <- a + b*ages^(1/3)
trout.age <- c(1, 1, 1, 1, 2, 2, 2, 3, 3, 3, 4,4, 4, 5, 6, 6, 6, 7, 7, 7, 8, 8,
               8, 9, 11, 12, 12, 12)
trout.pcb <- c(0.6 , 1.6, 0.5, 1.2, 2.0, 1.3, 2.5,2.2, 2.4, 1.2, 3.5, 4.1, 5.1, 5.7,
               3.4, 9.7, 8.6, 4.0, 5.5, 10.5, 17.5,13.4, 4.5, 30.4, 12.4, 13.4, 26.2, 7.4)
plot(x=trout.age, y=log(trout.pcb), main="Log(PCB) vs Age", xlab = "Age ->", ylab = "Log(PCB) ->")
lines(x=ages, y=l, type="l", col="blue")
```



Q2. Rewrite the log(PCB) equation as a function which has arguments; a, b, and age, and returns the predicted log(PCB).

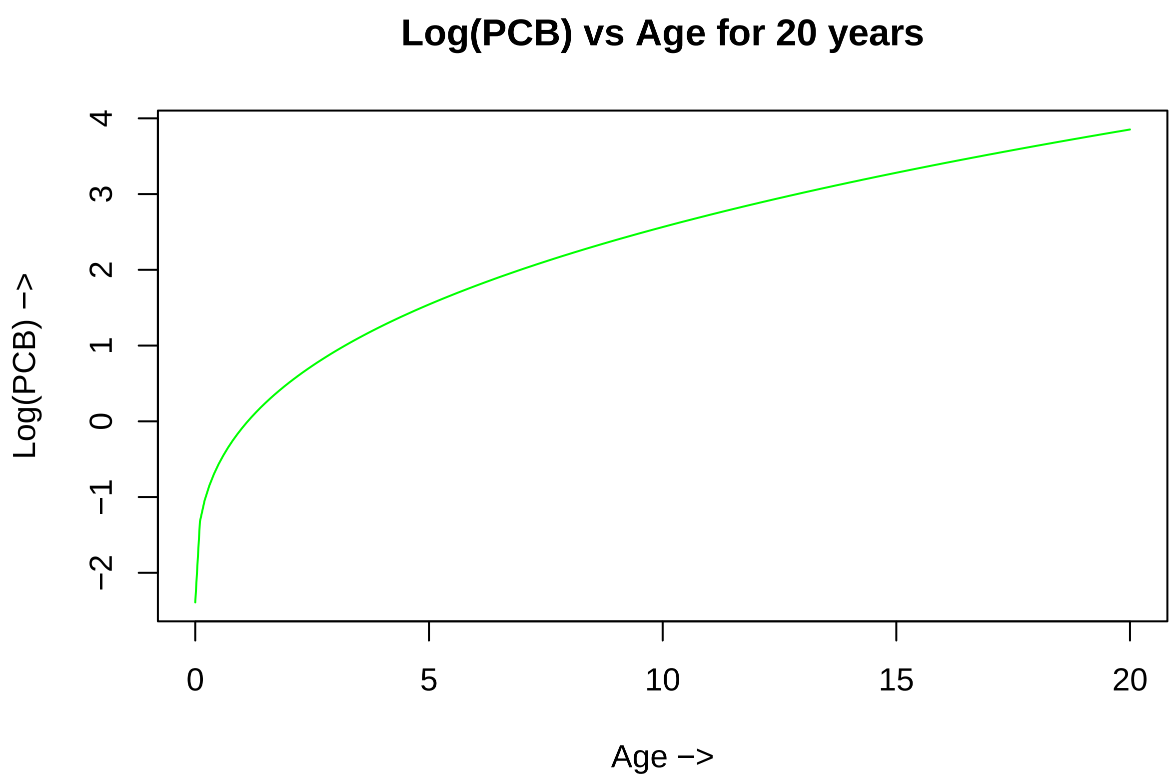
```r
#Task 2 - Rewrite log(PCB) as a function

calc_PCB = function(a, b, age) {
  predicted_l <- a + b*age^(1/3)
  return (predicted_l)
}
```

Q3. By extending the range of age considered, produce a plot which shows the curve for the expected log(PCB) concentration for lake trout up to 20 years old.

```r
#Task 3 - Extend ages to 20 years

ages_20 <- seq(from=0, to=20, by=0.1)
plot(x=ages_20, y=calc_PCB(a,b,ages_20), "l", col="green", main="Log(PCB) vs Age for 20 years",
     xlab="Age ->", ylab="Log(PCB) ->")
```



Q4. Now extract the maximum expected/predicted log(PCB) from the values used to draw the equation line

```r
#Task 4 - Get Maximum
print(paste0("Maximum value is :", max(calc_PCB(a,b,ages_20))))
```

```
## [1] "Maximum value is :3.85246051816828"
```

Q5. It can be shown that a non-linear model of the form $l = a + b \times age^c$ where a, b, and c are constants provides a slightly better fit to the data. The optimal choices are a = -4.865, b = 4.7016, and c = 0.1969.

```r
#Task 5 - Non-linear model

a2 = -4.865
b2 = 4.7016
c2 = 0.1969
```

(a) Rewrite the log(PCB) equation as a function which has arguments; a, b, c and age, and returns the predicted log(PCB).

```
# Task 5.1 - Rewrite log equation function

calc_PCB2 = function(a,b,c,age) {
  predicted_l = a + b * (age^c)
  return (predicted_l)
}
```

(b) Compare the Bates-Watts estimator and the new estimator for the expected log(PCB) concentration of a 10 year old lake trout.

```
# Task 5.2 - Compare

fixed_age = 10
value_BWEstimator = calc_PCB(a,b,fixed_age)
value_newEstimator = calc_PCB2(a2,b2,c2,fixed_age)

value_newEstimator == value_BWEstimator
```

```
## [1] FALSE
```

(c) Create a new plot which has both the old line and new line, allowing a comparison of the differences.

```
# Task 5.3 - Plot both equations

plot(x=ages, y=l, type="l", col="red", ylab = "Log(PCB) ->", xlab = "Ages ->",
     main="Comparing Bates-Watts estimator and the new estimator")
lines(ages, calc_PCB2(a2,b2,c2,ages), type="l", col="orange")
```