The University of Georgia

FIA DATA PROJECT

WED 13TH NOV, 2019[1]

SHINGO OBATA [2] [3]

TOPIC: THE SOLUTIONS FOR THE EQUATIONS[4]

Abstract

This document shows the solutions for the 5 base tree height models for age. The purpose of this task is to estimate the dominant tree age at some of the FIA sampling plots on which the dominant tree age is not available from the data. All the equations solved in this document are presented in *"SITE INDEX SYSTEMS FOR MAJOR YOUNG-GROWTH FOREST AND WOODLAND SPECIES IN NORTHERN CALIFORNIA"*(https://www.fire.ca.gov/media/3789/forestryreport4.pdf). Result of the application of the models are discussed in the later section.

Contents

1 solutions for the base age invariant models

1.1 CR1 model

$$A = \log \frac{\left\{1 - (\dfrac{H-4.5}{H_0-4.5})^{(1/b_2)}(1-\exp(b_1 A_0))\right\}}{b_1}$$

The answer is confirmed by https://www.wolframalpha.com/input/?i=solve+H%3D4.5%2B%28H0-4.5%29%28%281-exp%28b1*A%29%29%2F%281-exp%28b1*A0%29%29%29%5Eb2+for+A

[1] Last modified at Twelve minutes to Nine in the afternoon EST

[2] Warnell School of Forestry and Natural Resources, University of Georgia, United States

[3] sobata@uga.edu

[4] This document is available from my GitHub page (https://github.com/ShingObt).

1.2 CR2 model

Solution for the equation in p.30.

$$A = \frac{\log\left(1 - (\frac{(H-4.5)}{(H_0-4.5)})^{(R_0/b_2 b_3)} + e^{(b_1 A_0)}(\frac{(H-4.5)}{(H_0-4.5)})^{(R_0/b_2 b_3)}\right)}{b_1}$$

please read p.30 of the document to refer to R_0

1.3 SH1 model

Solution for the equation in p.32.

$$A = (\frac{\log(H-4.5) - R_0}{b_1})^{(1/b_2)}$$

1.4 SH2 model

Solution for the equation in p.33.

$$A = (\frac{\log(H-4.5) - b_1 - R_0}{b_2 + b_3 R_0})^{(1/b_2)}$$

1.5 KP1 model

Solution for the equation in p.34.

$$A = \left\{\frac{(H-4.5)(b_2 + b_3 R_0)}{HR_0 - 4.5R_0 - 1}\right\}^{(1/b_1)}$$

1.6 LG1 model

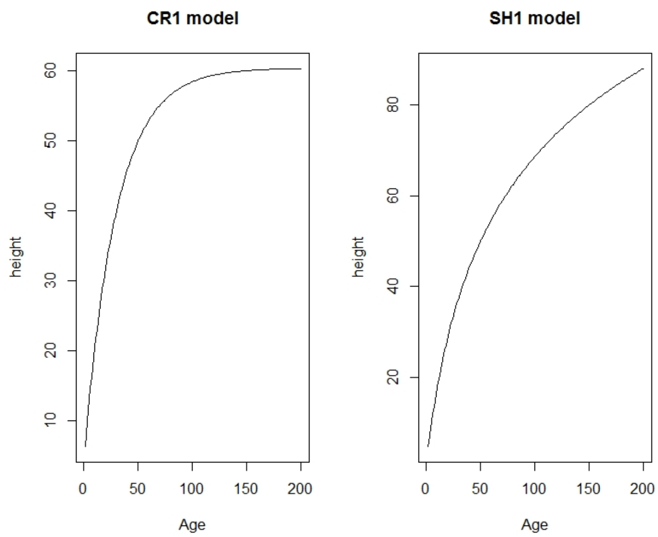
Solution for the equation in p.35.

$$A = \left(\frac{-R(-b_1 + H - R_0 - 4.5)}{(b_2(H-4.5))}\right)^{(1/b_3)}$$

2 Issues found

2.1 The formula does not exist for some of the species groups

The formula does not exist for some of the species groups that there is no way to assign the value to these group.



(a) (b)

Figure 1: Numeric simulation of the two base age invariant models

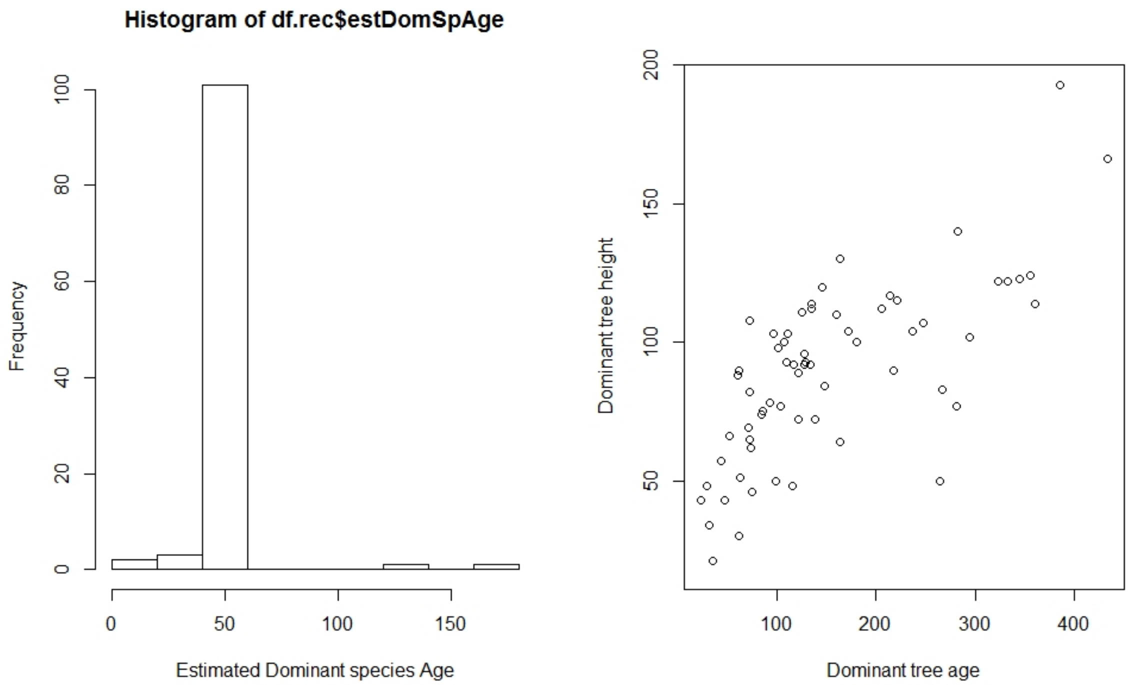
2.2 The formula does not return the correct age

I applied the formula acquired by solving the base age invariant models. However, most of them except SH1 model returned the values that makes sense as the dominant tree age. It is probably because the measured height of the dominant height is far greater than the asymptotic value of the model. As a result, the sample plot of which primary species requires CR1 model returned NA when the model was applied to the plot data. SH1 model worked

I show the result of the numerical simulation with code *Figure* 1. The asymptotic value of the CR1 for True fir was around 60 while the measured dominant tree height was over 100. On the other hand, asymptotic value of the SH1 model was more than 80 and the dominant tree height of the most of the Oak forests were less than 80.

```
######################################
# CR1 simulation
######################################
# Species: True fir
h0=50# site index
a0=50# age for the site index
b1=-0.03357
b2=1.658
height=c()
# simulate the height from age 1 to 200.
for (age in 1:200){
  height[age]=4.5+(h0-4.5)*((1-exp(b1*age))/(1-exp(b1*a0)))
}
plot(height,xlab="Age",main="CR1 model",type="l")# plot it.


######################################
# SH1 simulation
######################################
# Oak
```



(a) (b)

Figure 2: The result of the age estimation based on the age invariant models
(a) The histogram of the estimated dominant species age
(b) Dominant species age vs Domonant tree height

```
h0=50# site index
a0=50# age for the site index
b1=-6.455
b2=-0.3725
r0=log(h0-4.5)-(b1*a0^b2)
height=c()
# simulate the height from age 1 to 200.
for (age in 1:200){
  height[age]=4.5+exp(r0+b1*age^b2)
}
plot(height)
```