Estimate height

```
source(here::here("load_pkgs.R"))
```

Explore data

```
tree <- read_csv(here::here("data/tree_data.csv"), col_types = cols())

tree %>% group_by(sp) %>%
  count(is.na(h)) %>%
  spread(`is.na(h)`, n) %>%
  rename(n=`FALSE`, n_na = `TRUE`) %>%
  knitr::kable()
```

```
## group_by: one grouping variable (sp)

## count: now 8 rows and 3 columns, one group variable remaining (sp)

## spread: reorganized (is.na(h), n) into (FALSE, TRUE) [was 8x3, now 7x3]

## rename: renamed 2 variables (n, n_na)
```

sp	n	n_na
Aopa	3	NA
Cmon	21	NA
Pdul	9	NA
Pter	9	NA
Qilex	NA	3
Qpyr	2434	664
Saria	9	NA

Trees with no values for height belongs to *Q. ilex* and *Q. pyrenaica*. Height data for computation of *Q. ilex* biomass is not needed according to allometric equation proposed by Ruiz-Peinado, Montero, and Del Rio (2012). For *Q. pyrenaica* and estimation of height values was done using non-linear squares model. We used the best equation according to Adame, del Río, and Cañellas (2008)

$$h = 1.3 + a * \exp(b/dbh)$$

Model height-diameter

```
# see pag. 391 from @PommereningGrabarnik2019IndividualbasedMethods
# See @Adameetal2008MixedNonlinear for equations. The best equation is
# h ~ 1.3 + a*e^(b/D)
# start values from @Adameetal2008MixedNonlinear
```

```r
# Remove data withouth dbh
df_model <- tree %>%
  filter(sp == "Qpyr") %>%
  filter(!is.na(h))
```

```
## filter: removed 54 rows (2%), 3,098 rows remaining
```

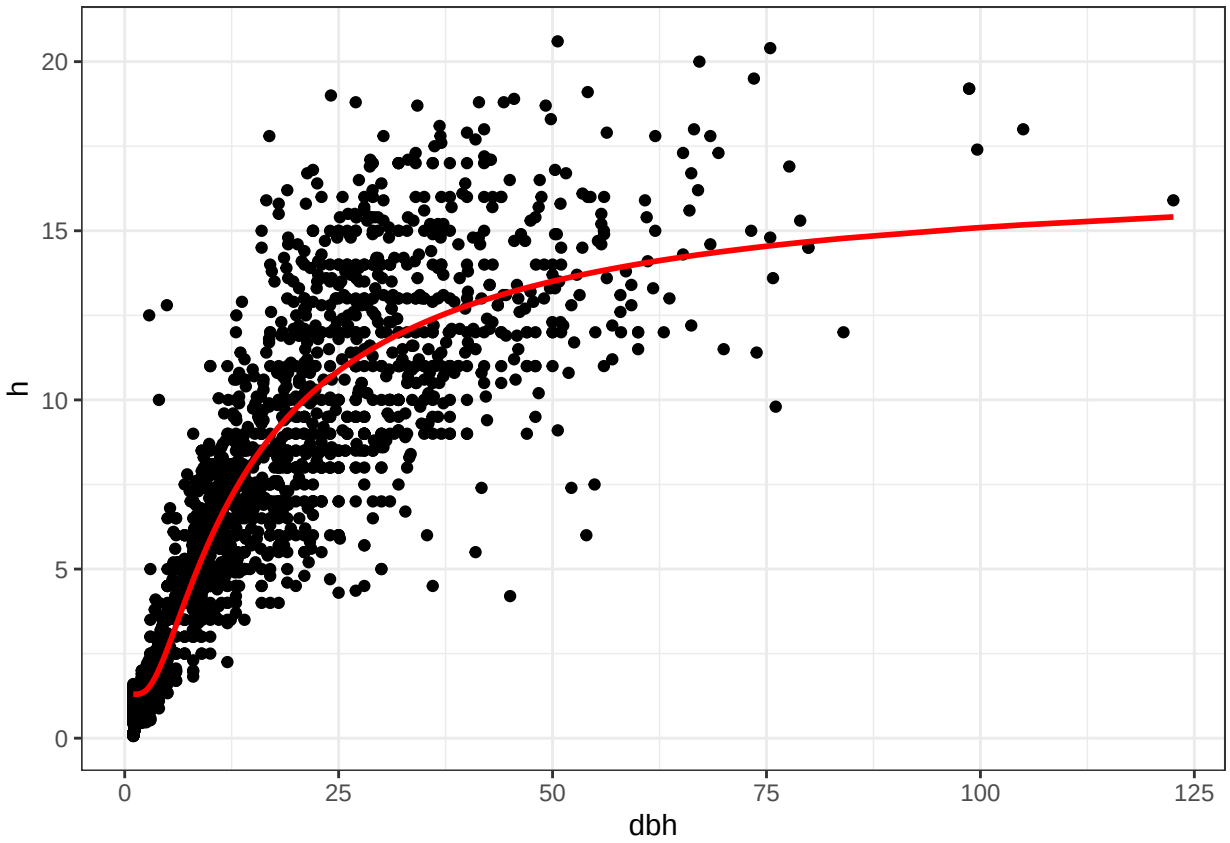
```
## filter: removed 664 rows (21%), 2,434 rows remaining
```

```r
# NonLinear Least Squares
m <- nls(h ~ 1.3 + a * exp(b / dbh),
         data = df_model,
         start = list(a = 15, b = -10), trace = TRUE)
```

```
## 10262.34 :   15 -10
## 9567.954 :   15.36456 -11.82731
## 9557.48 :   15.56767 -12.20178
## 9557.407 :   15.58911 -12.23456
## 9557.407 :   15.59068 -12.23703
## 9557.407 :   15.59079 -12.23721
```

term	estimate	std.error	statistic	p.value
a	15.59079	0.1834735	84.97573	0
b	-12.23721	0.2495367	-49.03973	0

sigma	isConv	finTol	logLik	AIC	BIC	deviance	df.residual
1.982386	TRUE	1.1e-06	-5118.285	10242.57	10259.96	9557.407	2432



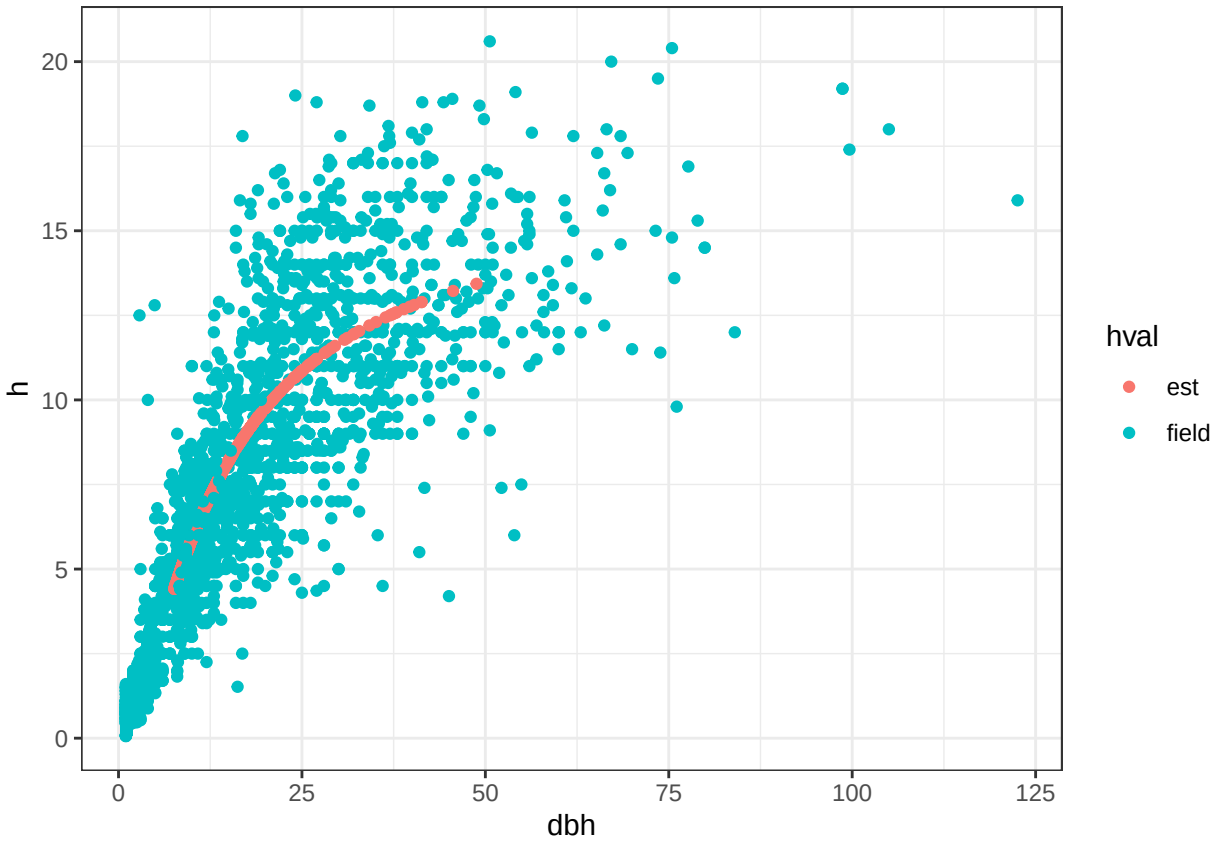
Compute the estimate values

```
tree %<>%
  mutate(h = ifelse(
    sp == "Qpyr" & hval == "est",
    predict(m, list(dbh = dbh)),
    h))
```

```
## mutate: changed 662 values (21%) of 'h' (662 fewer NA)
```

```
# (1.3 + coef(m)[1]*exp(coef(m)[2]/dbh))
```

```
## Warning: Removed 5 rows containing missing values (geom_point).
```



Export data

```
write_csv(tree, here::here("data/tree_data_full.csv"))
```

References

Adame, Patricia, Miren del Río, and Isabel Cañellas. 2008. "A Mixed Nonlinear HeightDiameter Model for Pyrenean Oak (Quercus Pyrenaica Willd.)." *Forest Ecology and Management* 256 (1-2): 88–98. https://doi.org/10.1016/j.foreco.2008.04.006.

Ruiz-Peinado, R., G. Montero, and M. Del Rio. 2012. "Biomass Models to Estimate Carbon Stocks for Hardwood Tree Species." *Forest Systems* 21 (1): 42. https://doi.org/10.5424/fs/2112211-02193.